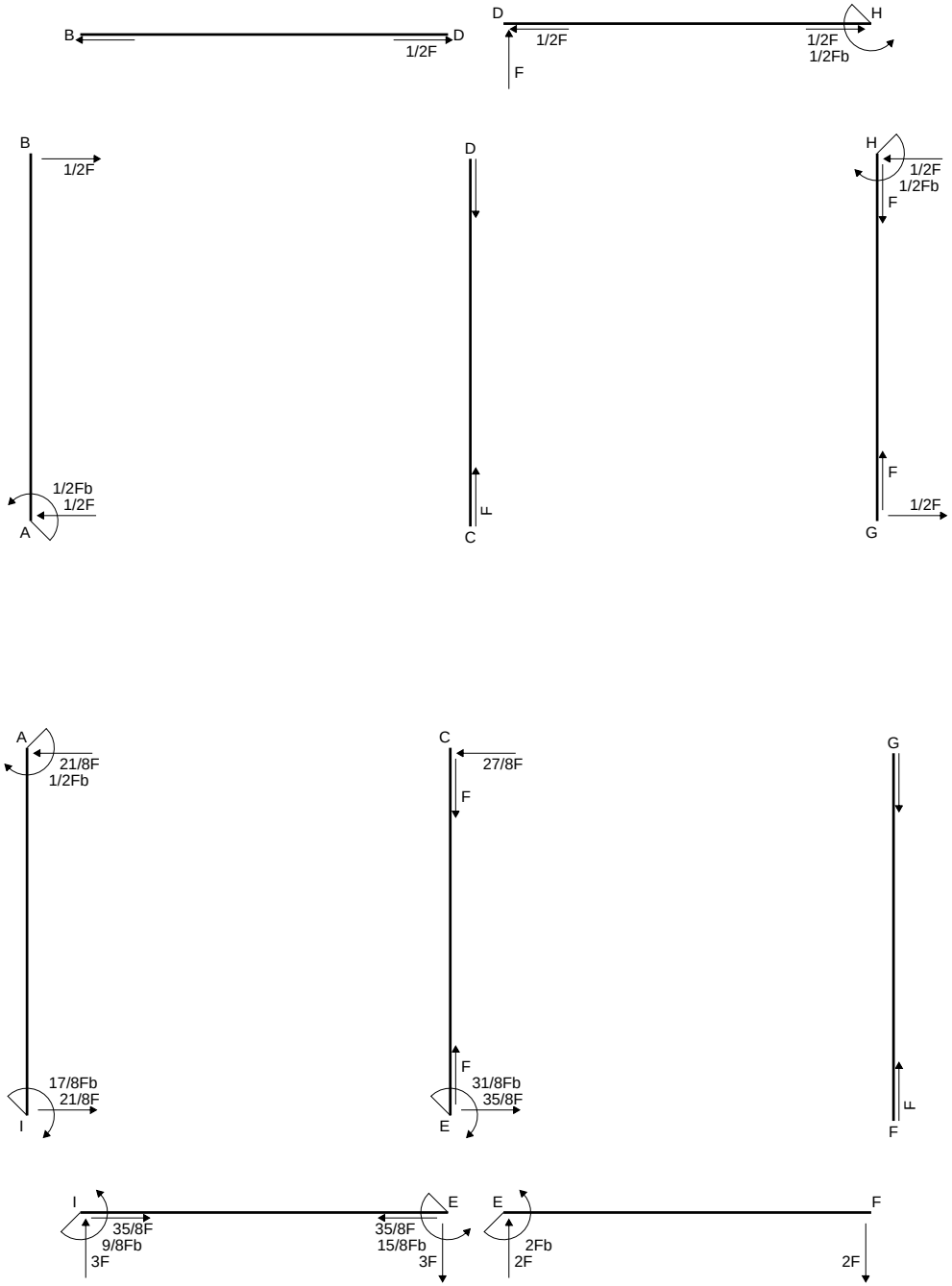
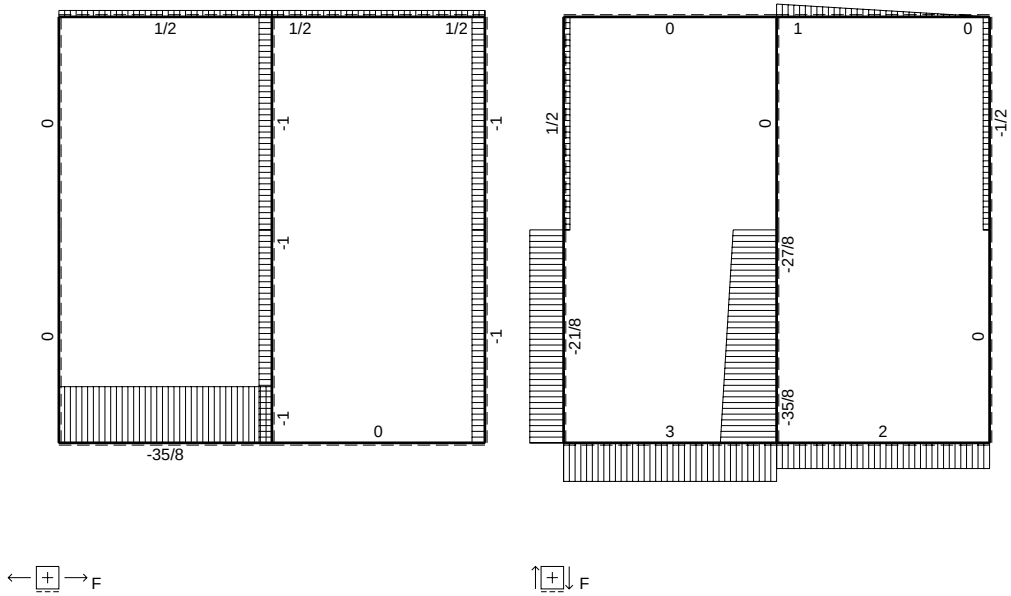
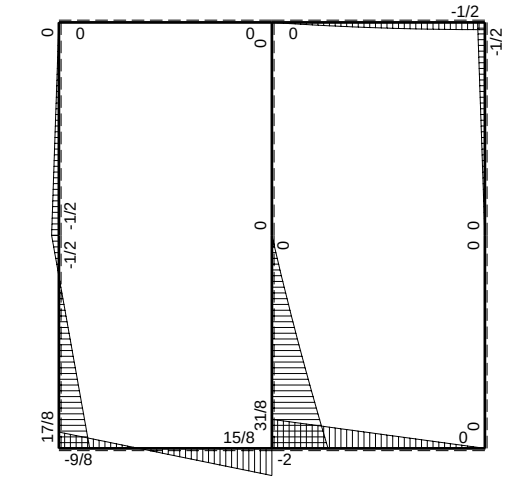
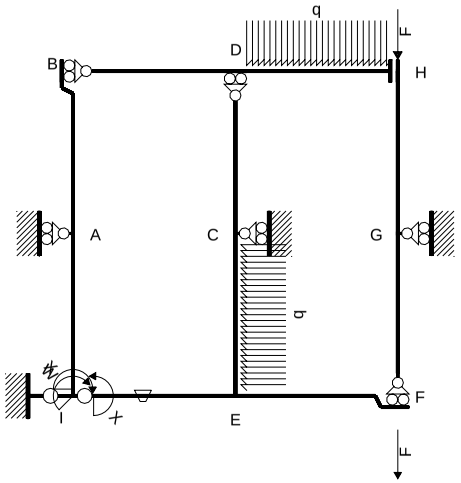
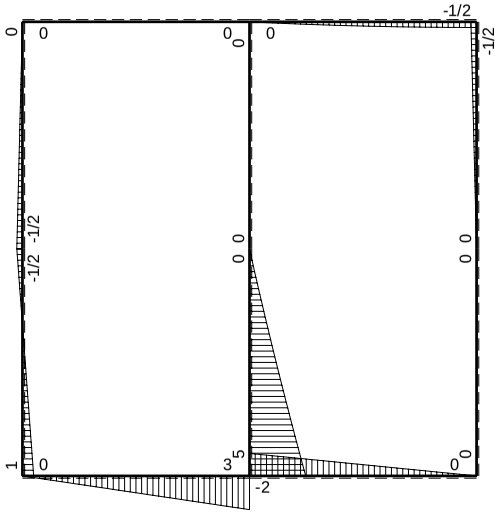

B
D
1/2F
D
H
1/2F
1/2F
1/2Fb
F
B
1/2F
1/2Fb
1/2F
A
D
F
C
H
1/2F
1/2Fb
F
F
1/2F
G
A
21/8F
1/2Fb
17/8Fb
21/8F
I
C
27/8F
F
F
31/8Fb
35/8F
E
G
F
F
I
35/8F
9/8Fb
3F
E
35/8F
15/8Fb
3F
E
2Fb
2F
F
2F


1/2
1/2
1/2
0
-1
-1
-1
0
-1
-1
-1
0
-35/8
F
0
1
0
1/2
-1/2
0
-27/8
-21/8
0
-35/8
3
2
F

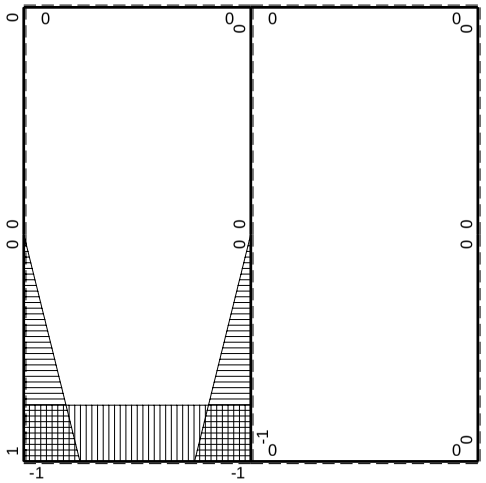

-1/2
0
0
0
0
-1/2
-1/2
-1/2
0
0
0
0
0
0
17/8
-9/8
15/8
31/8
-2
0
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 218726 CI07.xxxx.001

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	-1/2Fx	0	0	0	0	0+0	0
HG b	0	1/2Fb-1/2Fx	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	$5Fb-11/2Fx+1/2qx^2$	0	$-5Fb+21/2Fx-6Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-13/8+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-9/2Fx-1/2qx^2$	0	$-9/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2		
IA b	1-x/b	Fb-3/2Fx	0	$Fb-5/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/4+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-3/2Fx	0	$-1/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-15/8Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						9/8Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 21/2\ x/b - 6\ x^2/b^2 + 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx = [-5\ x + 21/4\ x^2/b - 2\ x^3/b^2 + 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 21/4\ b - 2\ b + 1/8\ b\ )\ Fb\ 1/EJ\ = -13/8\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-9/2\ x^2/b^2 - 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx = [-3/2\ x^3/b^2 - 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

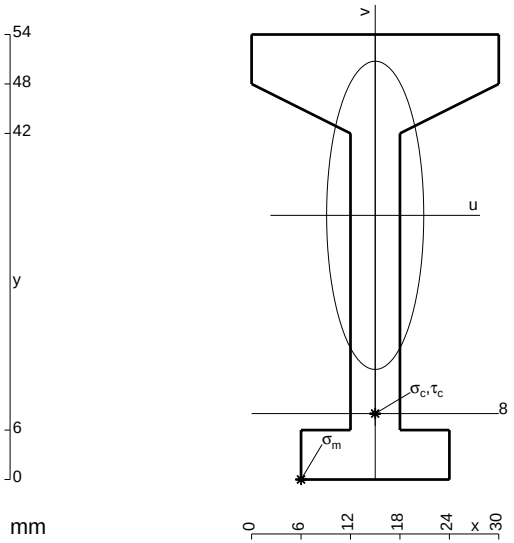
$= (-3/2\ b - 1/8\ b\ )\ Fb\ 1/EJ\ = -13/8\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1 - 5/2\ x/b + 3/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [\ x - 5/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

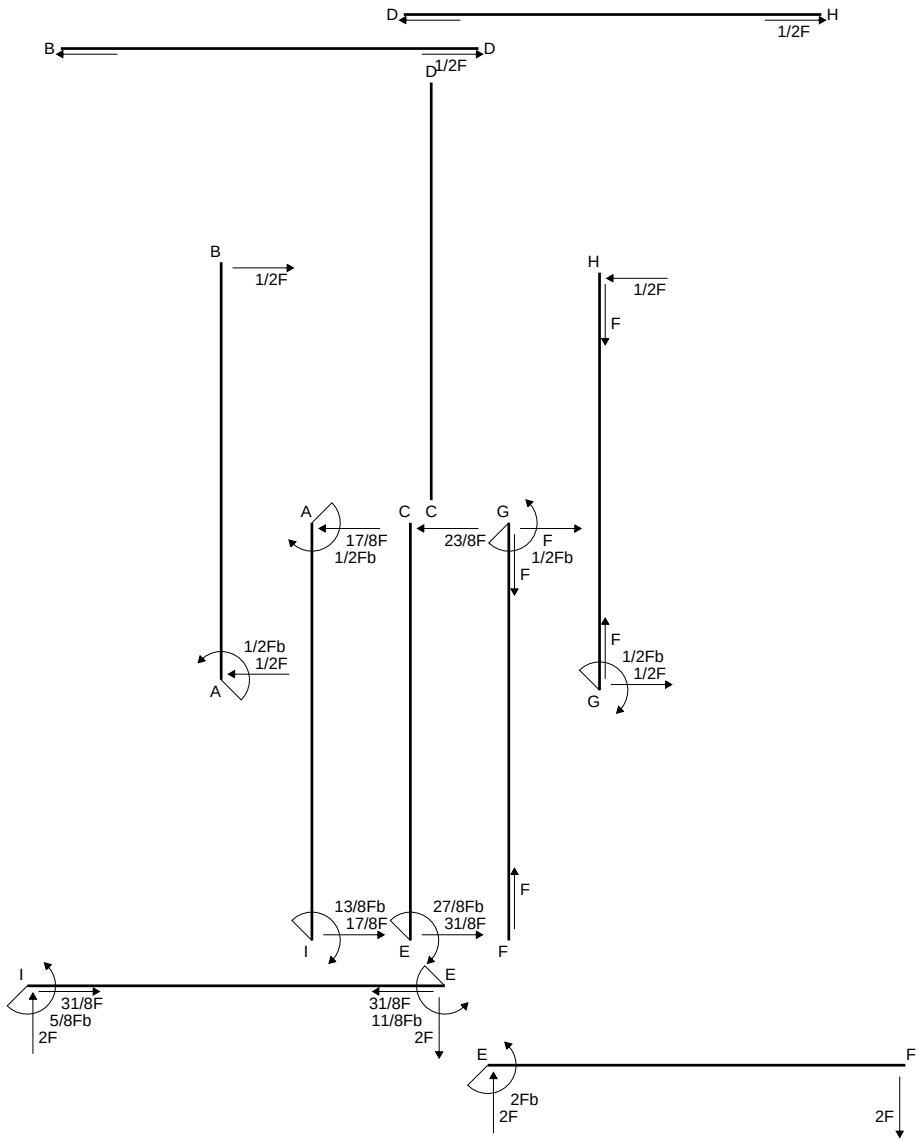
$= (\ b - 5/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = 1/4\ Fb^2/EJ$

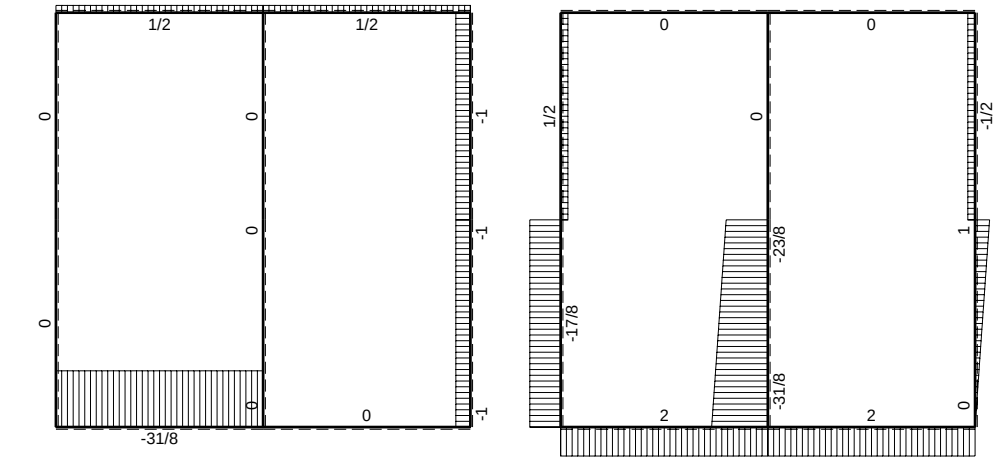
$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 3/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = 1/4\ Fb^2/EJ$



A = 612. mm^2
J_u = 214270. mm^4
J_v = 21276. mm^4
y_g = 32.06 mm
T_y = 2360. N
M_x = -1392400. Nmm
x_m = 6. mm
u_m = -9. mm
v_m = -32.06 mm
$\sigma_m = -Mv/J_u$ = -208.3 N/mm^2
x_c = 15. mm
y_c = 8. mm
v_c = -24.06 mm
$\sigma_c = -Mv/J_u$ = -156.3 N/mm^2
τ_c = 6.313 N/mm^2
$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2}$ = 156.7 N/mm^2
S^* = 3439. mm^3


D
H
1/2F
B
D
D 1/2F
B
1/2F
H
1/2F
F
A
C C
G
17/8F
1/2Fb
23/8F
F
1/2Fb
F
1/2Fb
1/2F
A
F
1/2Fb
1/2F
G
F
13/8Fb
17/8F
27/8Fb
31/8F
I
E
F
I
E
31/8F
5/8Fb
2F
31/8F
11/8Fb
2F
E
F
2Fb
2F
2F


1/2
1/2
0
0
0
0
-1
-1
-1
0
0
-31/8
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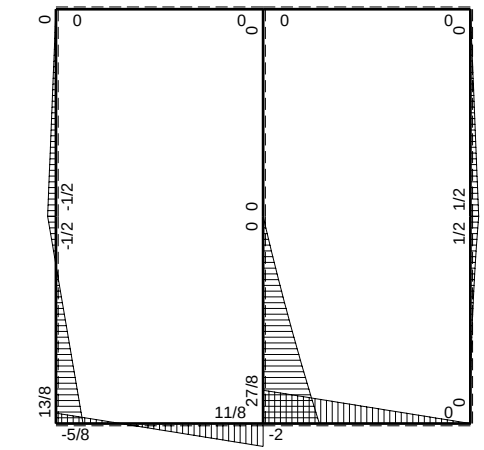
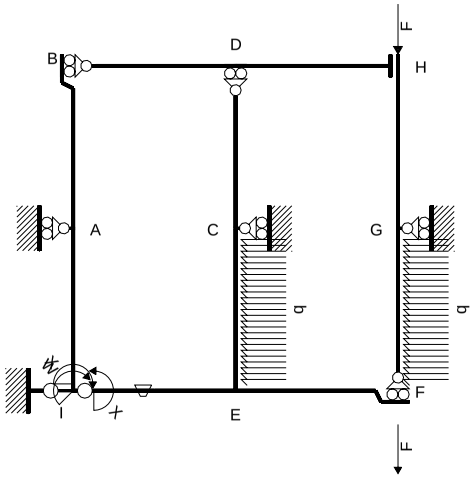
1/2
0
0
-1/2
-23/8
1
-17/8
-31/8
2
2
0

F

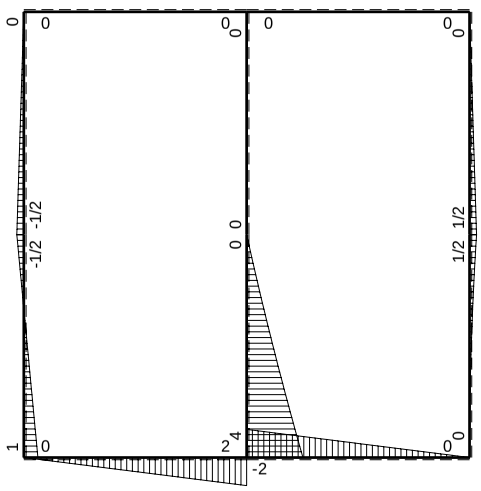
F


0
0
0
0
0
0
0
0
-1/2 -1/2
1/2 1/2
0 0
13/8
27/8
11/8
0
-5/8
-2

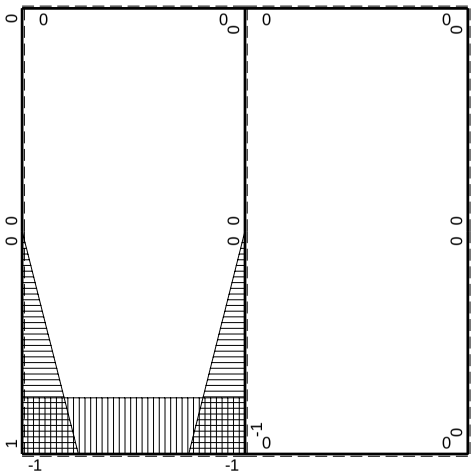
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 209802 CI07.xxxx.002

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PROCEDIMENTO E RISULTATI 209802 CI07.xxxx.002

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	-1+x/b	$4Fb-9/2Fx+1/2qx^2$	0	$-4Fb+17/2Fx-5Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-31/24+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-7/2Fx-1/2qx^2$	0	$-7/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2		
IA b	1-x/b	Fb-3/2Fx	0	$Fb-5/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/4+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-3/2Fx	0	$-1/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-25/24Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						5/8Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L_{EI}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L_{EC}^{Xo} = \int_o^b (-4 + 17/2\ x/b - 5\ x^2/b^2 + 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx$

$= [-4\ x + 17/4\ x^2/b - 5/3\ x^3/b^2 + 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

$= (-4\ b + 17/4\ b - 5/3\ b + 1/8\ b\ )\ Fb\ 1/EJ\ = -31/24\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-7/2\ x^2/b^2 - 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx = [-7/6\ x^3/b^2 - 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

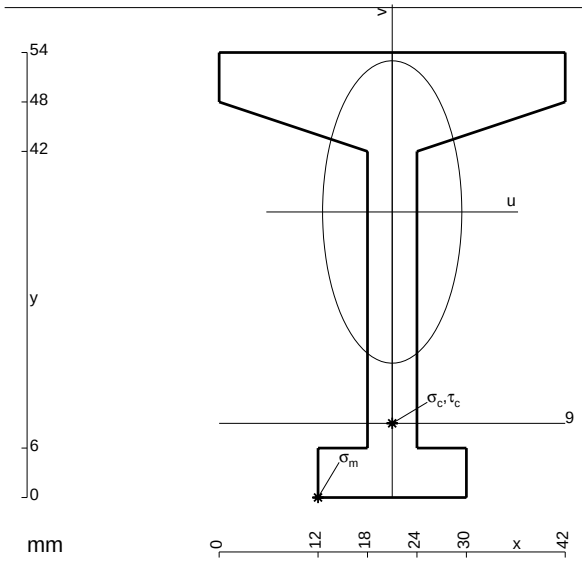
$= (-7/6\ b - 1/8\ b\ )\ Fb\ 1/EJ\ = -31/24\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1 - 5/2\ x/b + 3/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [\ x - 5/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (\ b - 5/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = 1/4\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 3/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = 1/4\ Fb^2/EJ$



$A = 720.\ mm^2$

$J_u = 242552.\ mm^4$

$J_v = 51408.\ mm^4$

$y_g = 34.65\ mm$

$T_y = 2400.\ N$

$M_x = -1536000.\ Nmm$

$x_m = 12.\ mm$

$u_m = -9.\ mm$

$v_m = -34.65\ mm$

$\sigma_m = -Mv/J_u = -219.4\ N/mm^2$

$x_c = 21.\ mm$

$y_c = 9.\ mm$

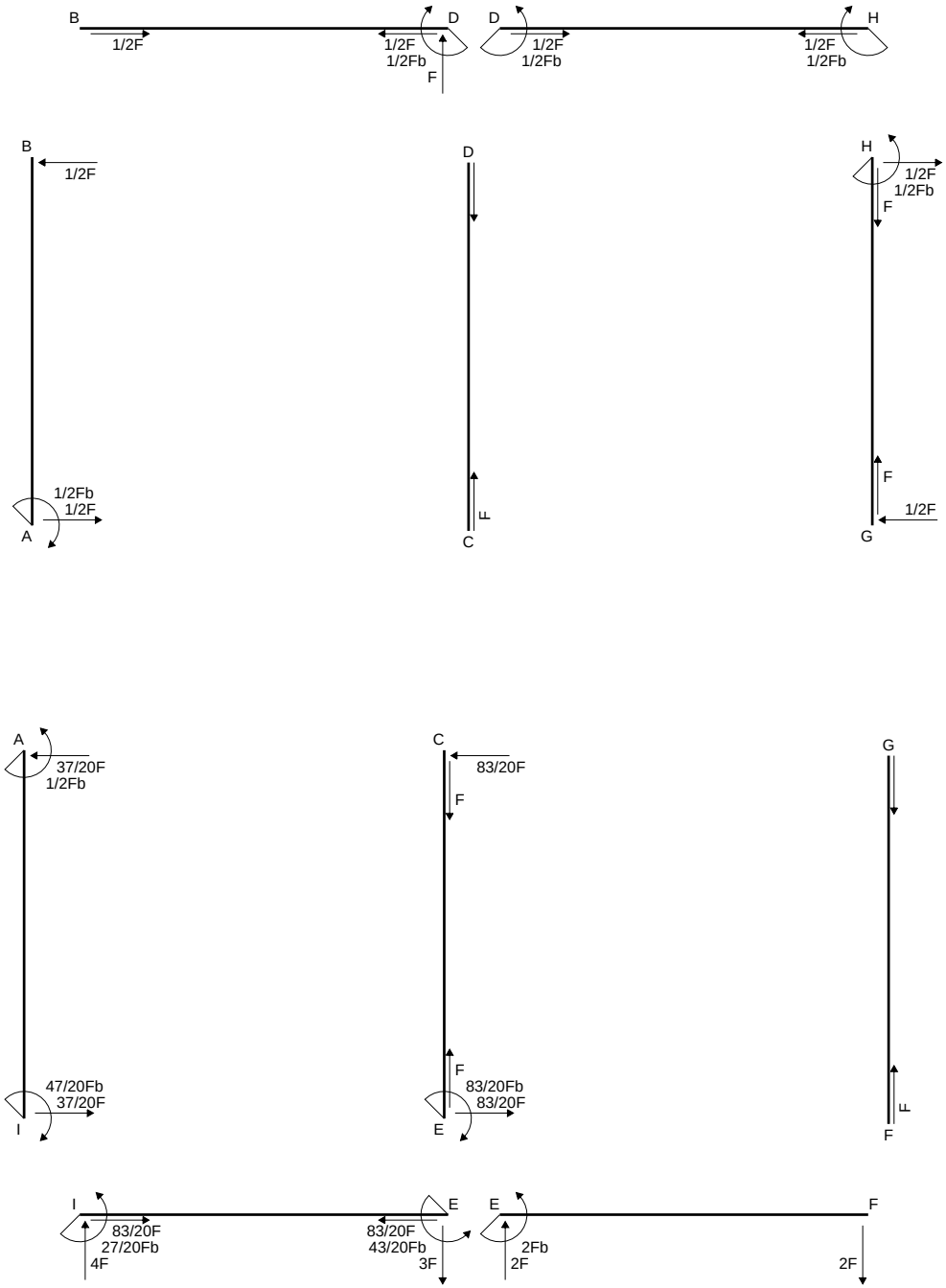
$v_c = -25.65\ mm$

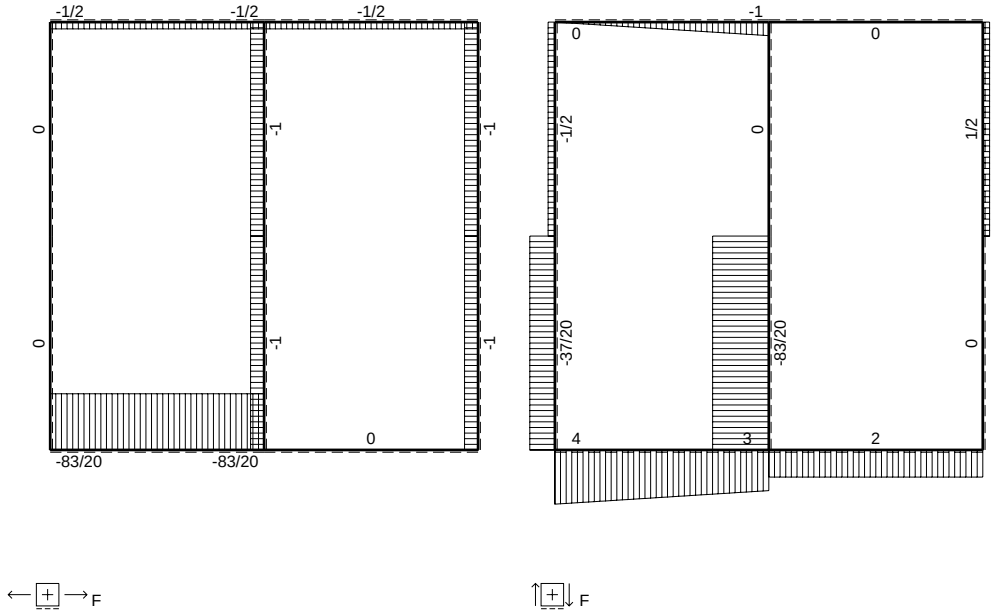
$\sigma_c = -Mv/J_u = -162.4\ N/mm^2$

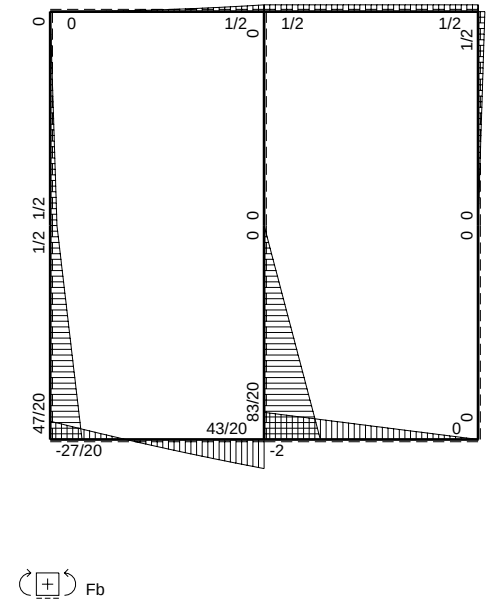
$\tau_c = 6.443\ N/mm^2$

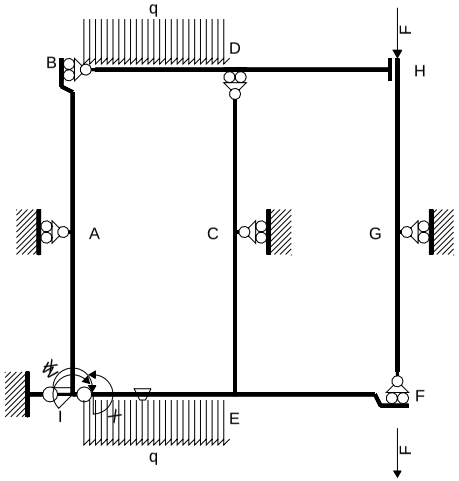
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 162.8\ N/mm^2$

$S^* = 3907.\ mm^3$

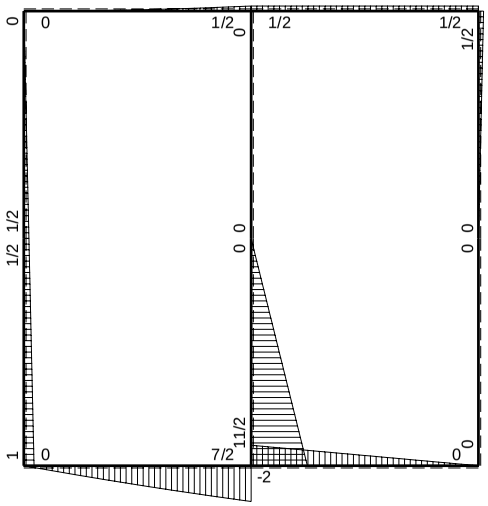

B
D
D
H
1/2F
1/2F
1/2Fb
F
1/2F
1/2Fb
1/2F
1/2Fb
B
1/2F
1/2Fb
1/2F
A
D
F
C
H
1/2F
1/2Fb
F
F
1/2F
G
A
37/20F
1/2Fb
47/20Fb
37/20F
I
C
83/20F
F
F
83/20Fb
83/20F
E
G
F
I
E
E
F
83/20F
27/20Fb
4F
83/20F
43/20Fb
3F
2Fb
2F
2F


-1/2
-1/2
-1/2
0
0
-1
-1
-1
-1
0
-83/20
-83/20
0
F
-1
0
0
-1/2
0
1/2
-37/20
-83/20
0
4
3
2
F

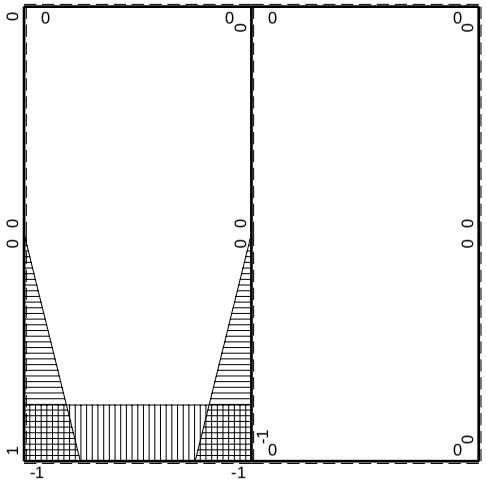

0
0
1/2
1/2
1/2
1/2
0
0
1/2
1/2
0
0
0
0
47/20
83/20
43/20
0
-27/20
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 218191 CI07.xxxx.003

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PROCEDIMENTO E RISULTATI 218191 CI07.xxxx.003

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
BA b	0	-1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fb+1/2Fx	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$4Fx-1/2qx^2$	-Fb/EJ	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	$-1+x/b$	11/2Fb-11/2Fx	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-11/2Fx	0	$-11/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fb-1/2Fx	0	$Fb-3/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(5/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	-1/2Fb-1/2Fx	0	$1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-9/4Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						27/20Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-4\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-7/2 + 3\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx$

$= [-7/2\ x + 3/2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-7/2\ b + 3/2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-11/2 + 11\ x/b - 11/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-11/2\ x + 11/2\ x^2/b - 11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-11/2\ b + 11/2\ b - 11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-11/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

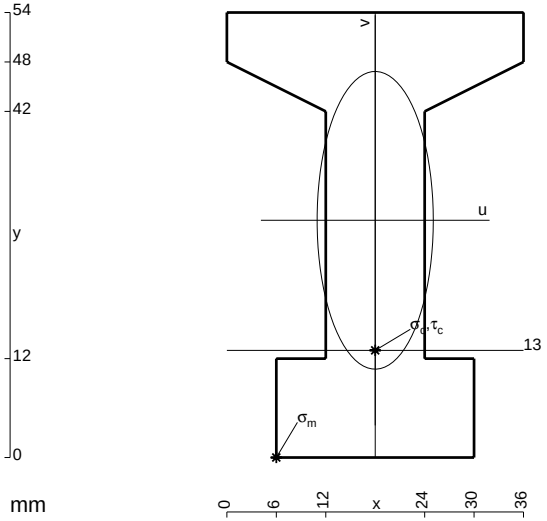
$= (-11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1 - 3/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [\ x - 3/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

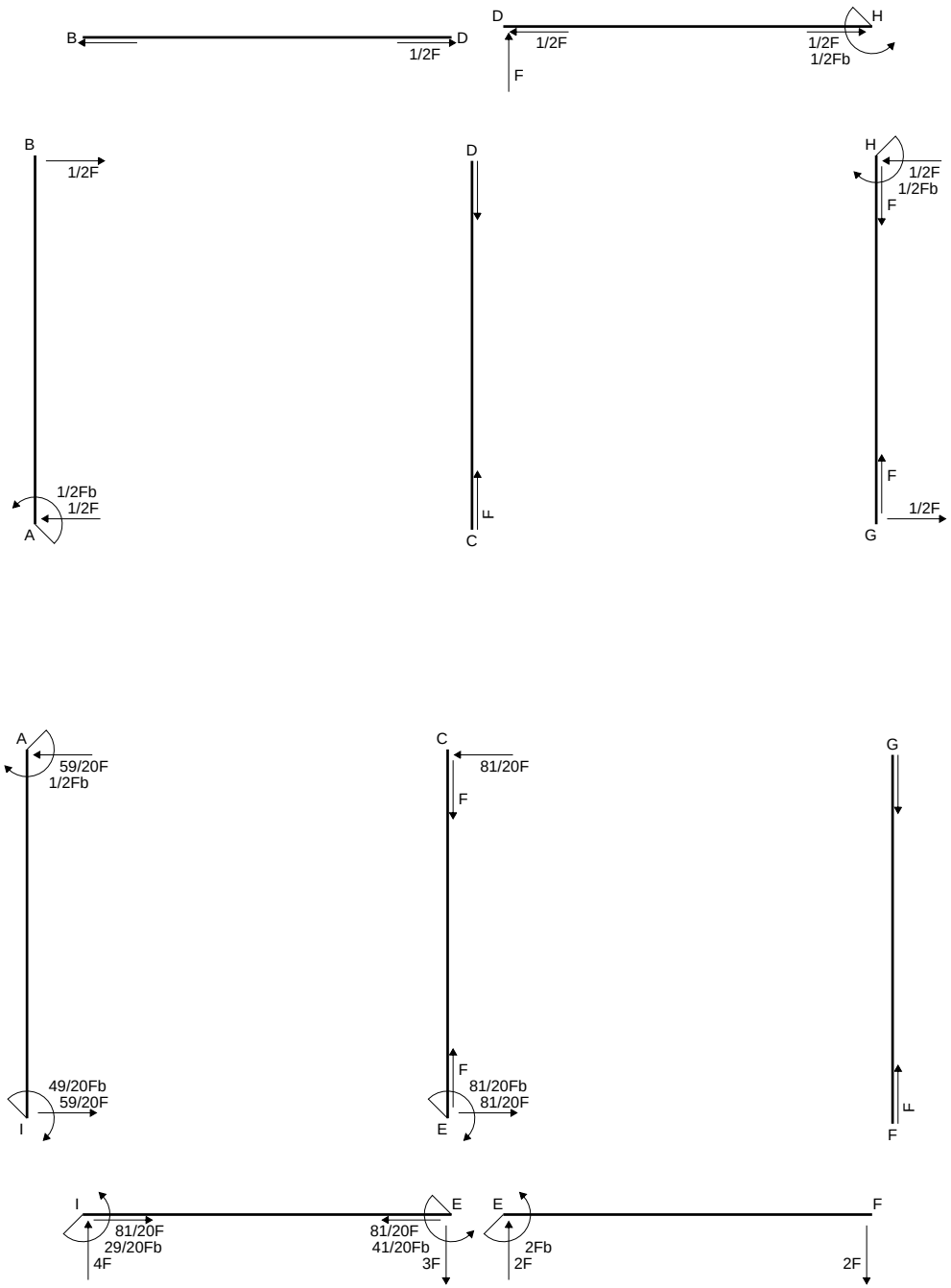
$= (\ b - 3/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = 5/12\ Fb^2/EJ$

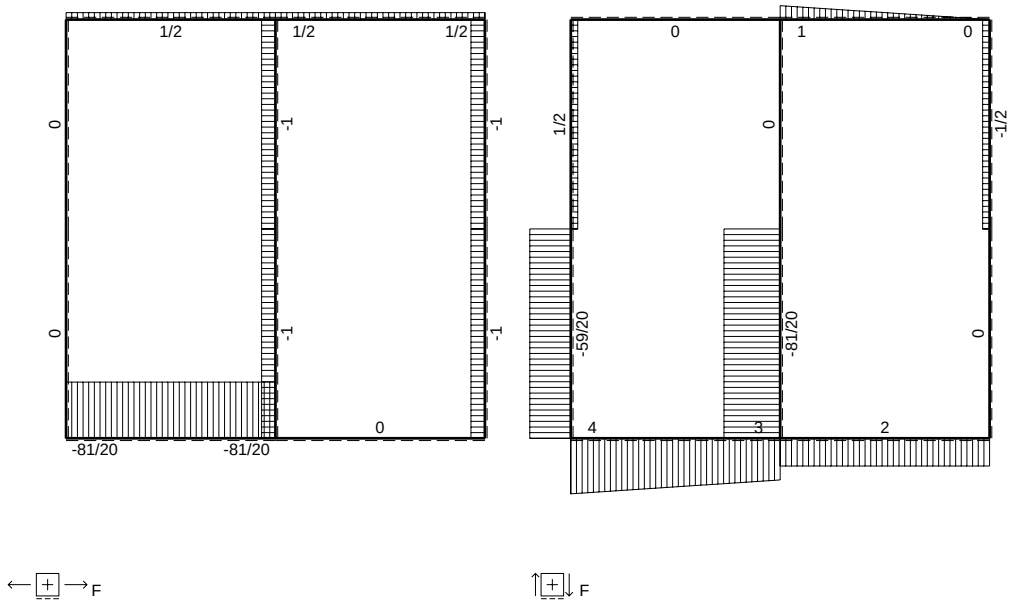
$L_{AI}^{Xo} = \int_o^b (1/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = 5/12\ Fb^2/EJ$



A = 1008. mm^2
J_u = 328994. mm^4
J_v = 50112. mm^4
y_g = 28.79 mm
T_y = 3740. N
M_x = -2618000. Nmm
x_m = 6. mm
u_m = -12. mm
v_m = -28.79 mm
$\sigma_m = -Mv/J_u$ = -229.1 N/mm^2
x_c = 18. mm
y_c = 13. mm
v_c = -15.79 mm
$\sigma_c = -Mv/J_u$ = -125.6 N/mm^2
τ_c = 6.402 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 126.1 N/mm^2
S^* = 6758. mm^3


B
D
1/2F
D
H
1/2F
1/2F
1/2Fb
F
B
1/2F
D
H
1/2F
1/2Fb
F
1/2Fb
1/2F
A
F
C
F
1/2F
G
A
59/20F
1/2Fb
C
81/20F
F
G
F
49/20Fb
59/20F
I
F
81/20Fb
81/20F
E
F
I
E
E
F
81/20F
29/20Fb
4F
81/20F
41/20Fb
3F
2Fb
2F
2F


1/2
1/2
1/2
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-1
-1
0
-1
-1
0
-81/20
-81/20
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F
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1
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1/2
0
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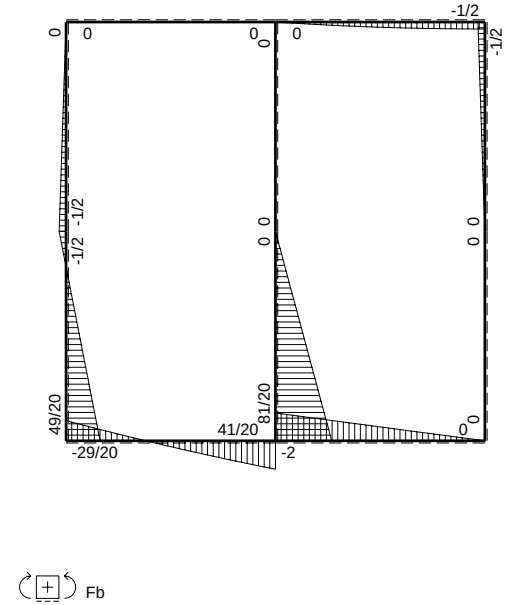
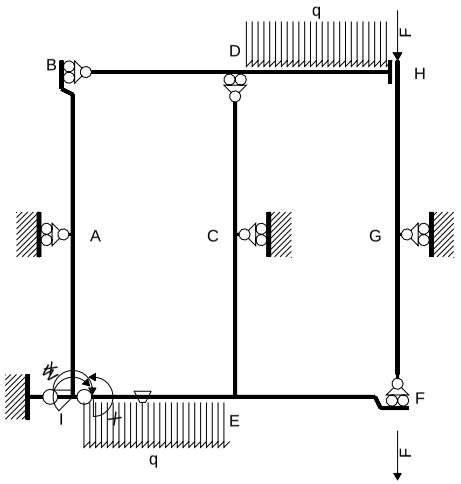
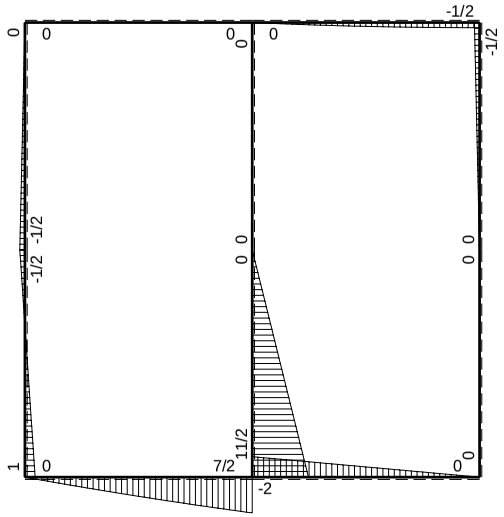
-59/20
-81/20
0
4
3
2
F

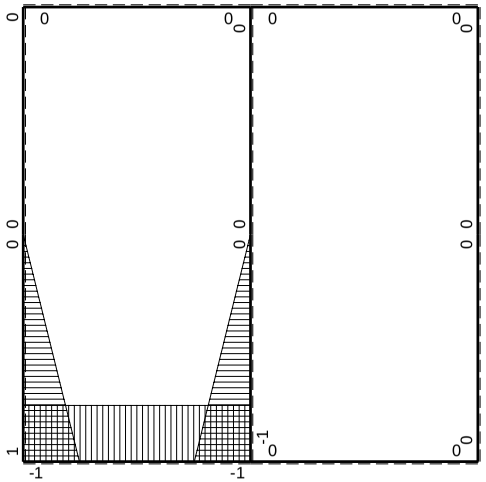

-1/2
0
0
0
0
-1/2
-1/2 -1/2
0 0
0 0
0 0
49/20
81/20
41/20
0
-29/20
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 961555 CI07.xxxx.004

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PROCEDIMENTO E RISULTATI 961555 CI07.xxxx.004

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	-1/2Fx	0	0	0	0	0+0	0
HG b	0	1/2Fb-1/2Fx	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$4Fx-1/2qx^2$	-Fb/EJ	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	-1+x/b	11/2Fb-11/2Fx	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-11/2Fx	0	$-11/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fb-3/2Fx	0	$Fb-5/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/4+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-3/2Fx	0	$-1/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-29/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						29/20Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-4\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b + 1/6\ b)\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-7/2 + 3\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx$

$= [-7/2\ x + 3/2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-7/2\ b + 3/2\ b + 1/6\ b)\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-11/2 + 11\ x/b - 11/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-11/2\ x + 11/2\ x^2/b - 11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-11/2\ b + 11/2\ b - 11/6\ b)\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-11/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

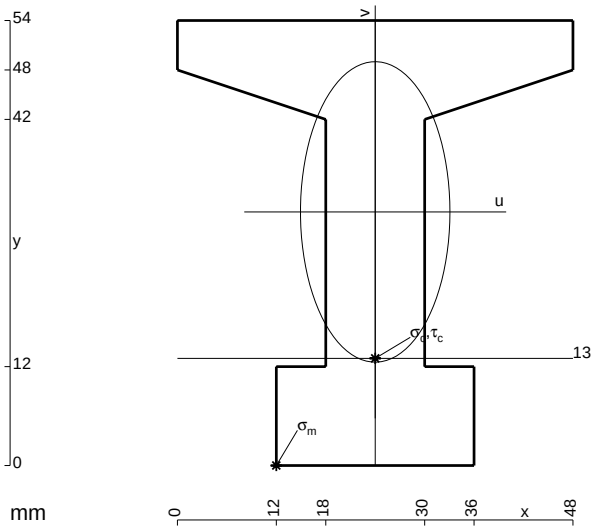
$= (-11/6\ b)\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1 - 5/2\ x/b + 3/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [\ x - 5/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (\ b - 5/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = 1/4\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 3/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/2\ b)\ Fb\ 1/EJ\ = 1/4\ Fb^2/EJ$



$A = 1116.\ mm^2$

$J_u = 371067.\ mm^4$

$J_v = 91800.\ mm^4$

$y_g = 30.77\ mm$

$T_y = 3840.\ N$

$M_x = -2880000.\ Nmm$

$x_m = 12.\ mm$

$u_m = -12.\ mm$

$v_m = -30.77\ mm$

$\sigma_m = -Mv/J_u = -238.9\ N/mm^2$

$x_c = 24.\ mm$

$y_c = 13.\ mm$

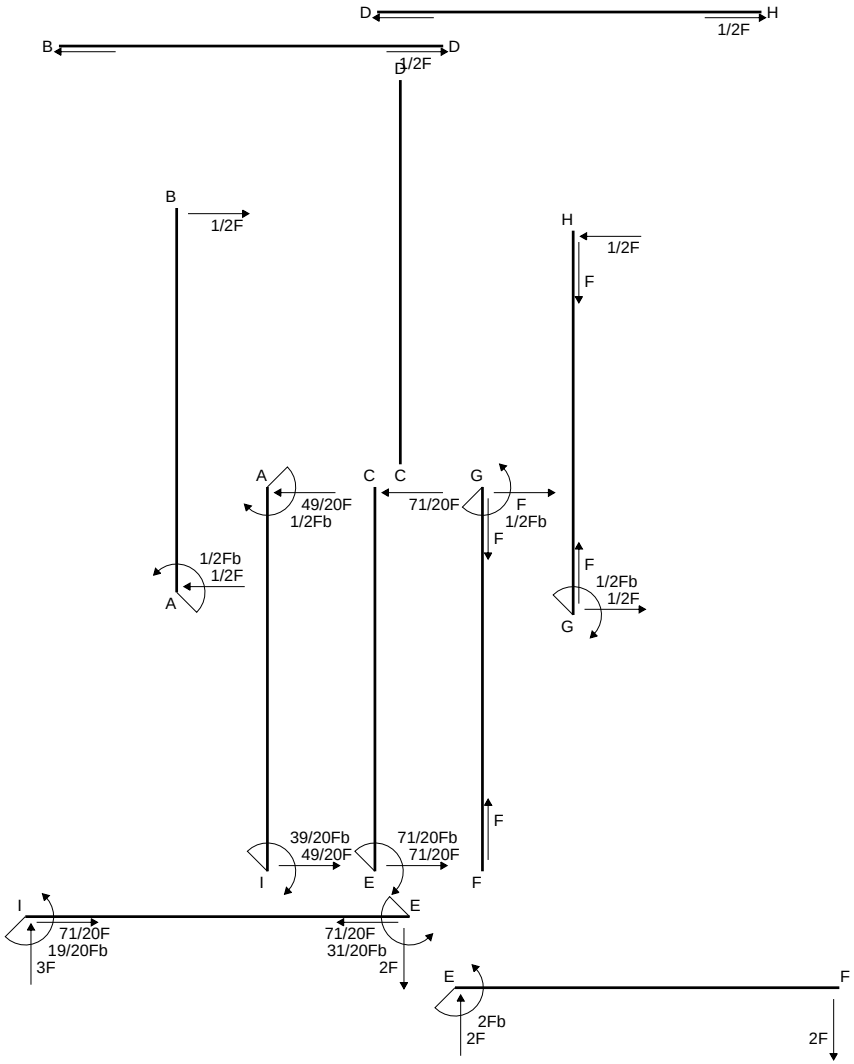
$v_c = -17.77\ mm$

$\sigma_c = -Mv/J_u = -138.\ N/mm^2$

$\tau_c = 6.342\ N/mm^2$

$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 138.4\ N/mm^2$

$S^* = 7354.\ mm^3$


D
H
1/2F
B
D
1/2F
D
B
1/2F
H
1/2F
F
A
C C
G
49/20F
1/2Fb
71/20F
F
1/2Fb
F
1/2Fb
1/2F
A
F
1/2Fb
1/2F
G
F
39/20Fb
49/20F
71/20Fb
71/20F
I
E
F
I
E
71/20F
19/20Fb
3F
71/20F
31/20Fb
2F
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F
2Fb
2F
2F

1/2
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-1
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-49/20
-71/20
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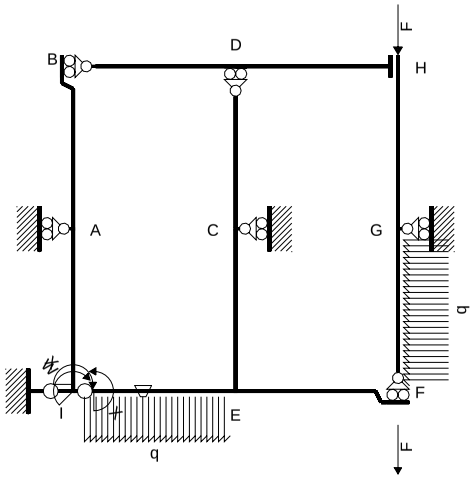
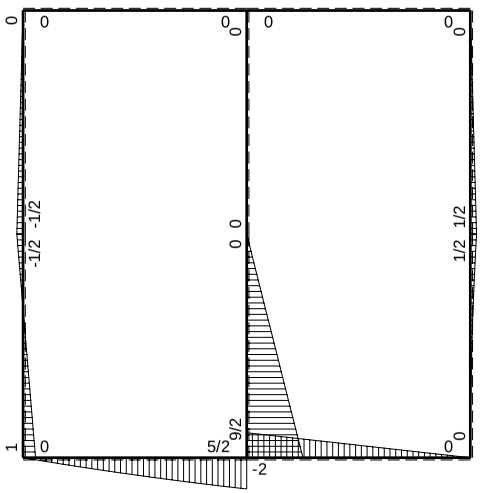
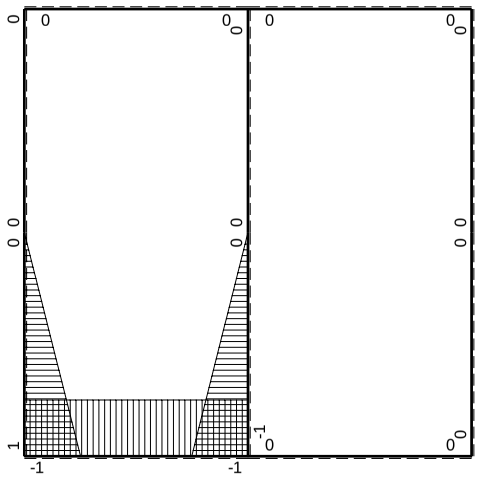
31/20
0
-19/20
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 962997 CI07.xxxx.005

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PROCEDIMENTO E RISULTATI 962997 CI07.xxxx.005

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx-1/2qx^2$	-Fb/EJ	$-3Fx+1/2Fx^2/b$	Fb/EJ	1	$(-4/3+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-5/2Fb+2Fx+1/2qx^2$	Fb/EJ	$-5/2Fb+2Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	-1+x/b	9/2Fb-9/2Fx	0	$-9/2Fb+9Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-9/2Fx	0	$-9/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fb-3/2Fx	0	$Fb-5/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/4+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-3/2Fx	0	$-1/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-19/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						19/20Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/3\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-5/2 + 2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx$

$= [-5/2\ x + x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-5/2\ b + b + 1/6\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/3\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-9/2 + 9\ x/b - 9/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-9/2\ x + 9/2\ x^2/b - 3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-9/2\ b + 9/2\ b - 3/2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-9/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

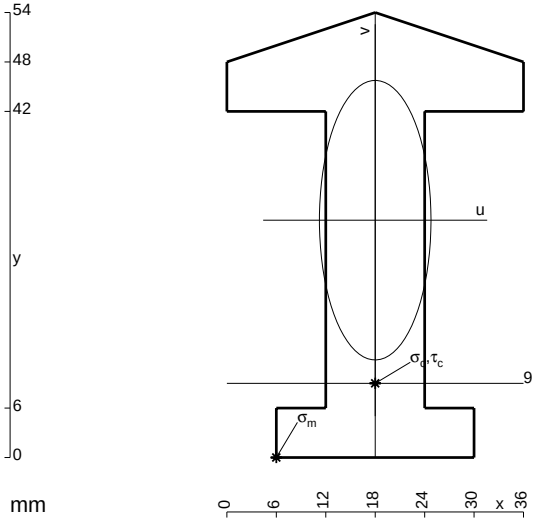
$L_{IA}^{Xo} = \int_o^b (1 - 5/2\ x/b + 3/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [\ x - 5/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (\ b - 5/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = 1/4\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 3/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = 1/4\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 962997 CI07.xxxx.005



A = 900. mm^2
J_u = 258984. mm^4
J_v = 41256. mm^4
y_g = 28.8 mm
T_y = 2220. N
M_x = -1798200. Nmm
x_m = 6. mm
u_m = -12. mm
v_m = -28.8 mm
$\sigma_m = -Mv/J_u$ = -200. N/mm^2
x_c = 18. mm
y_c = 9. mm
v_c = -19.8 mm
$\sigma_c = -Mv/J_u$ = -137.5 N/mm^2
τ_c = 3.202 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 137.6 N/mm^2
S^* = 4482. mm^3

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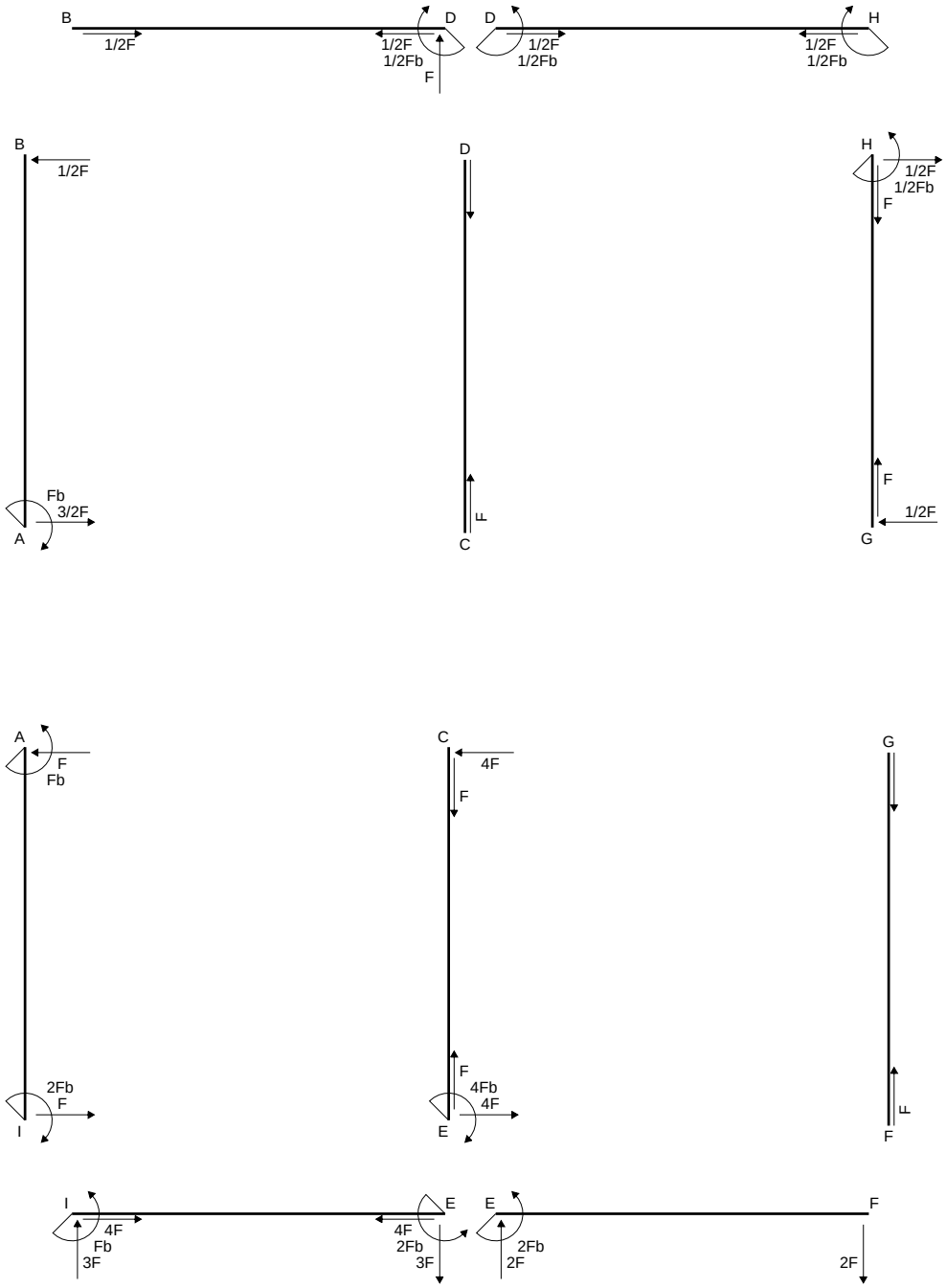
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1/2F
1/2Fb
F
D
1/2F
1/2Fb
H
1/2F
1/2Fb
B
1/2F
A
Fb
3/2F
D
F
C
H
1/2F
1/2Fb
F
F
1/2F
G
A
F
Fb
I
2Fb
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4Fb
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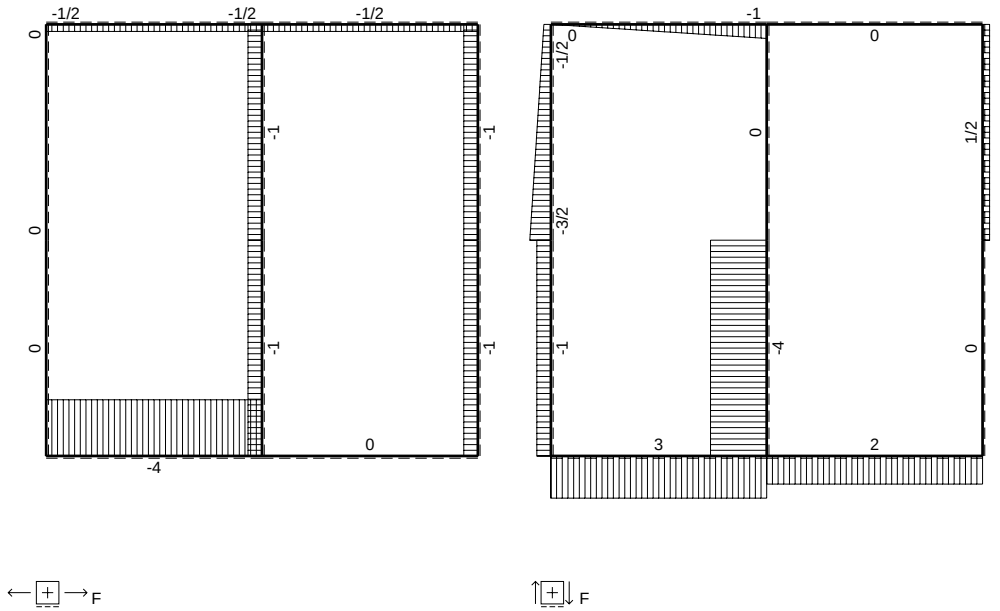
2F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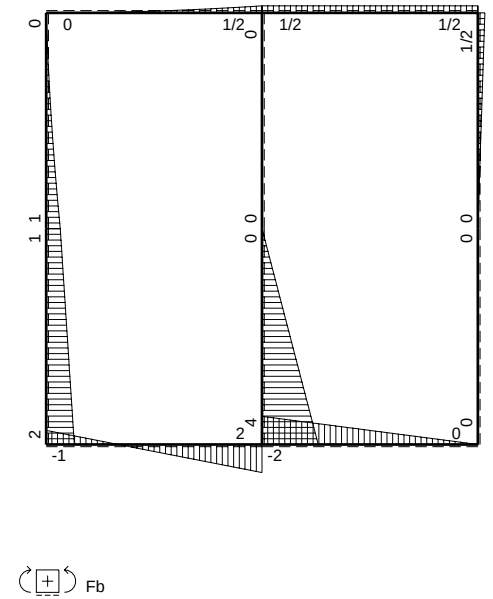
2
F
F


0
0
1/2
1/2
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0
0
1 1
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0 0
2
-1
2
4
-2
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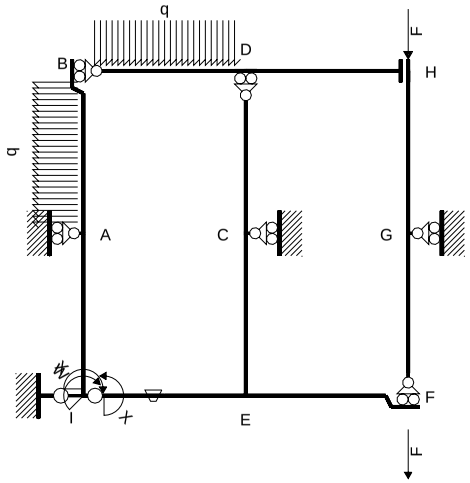
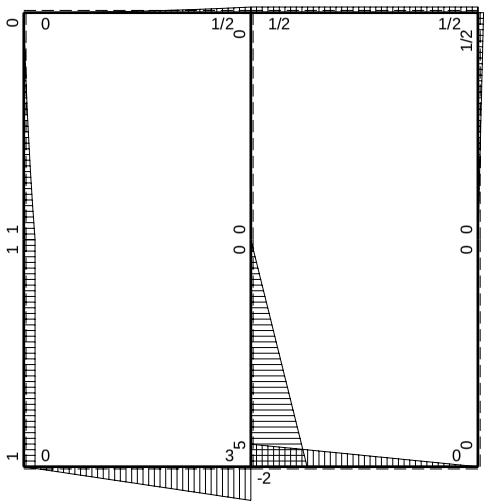
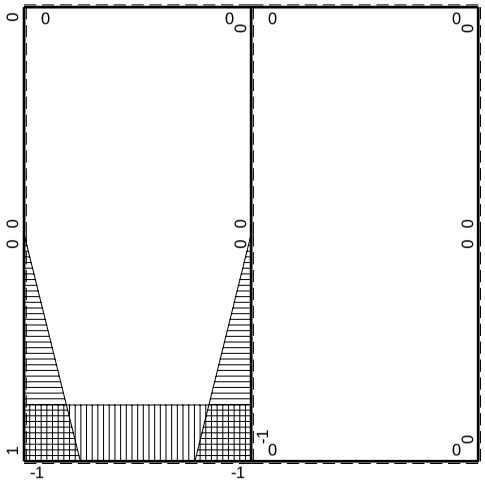
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 226695 CI07.xxxx.006

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$Fb-3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$-1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-5Fx$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	Fb	0	$Fb-Fx$	0	$1-2x/b+x^2/b^2$	$(1/2+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-Fb$	0	Fx	0	x^2/b^2		
	totali						$-5/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						Fb	

PROCEDIMENTO E RISULTATI 226695 CI07.xxxx.006

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

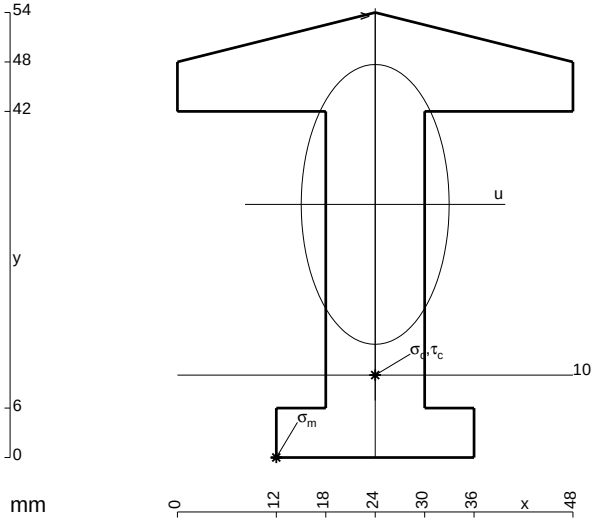
$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1 - x/b\ )\ Fb\ 1/EJ\ dx = [\ x - 1/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ$

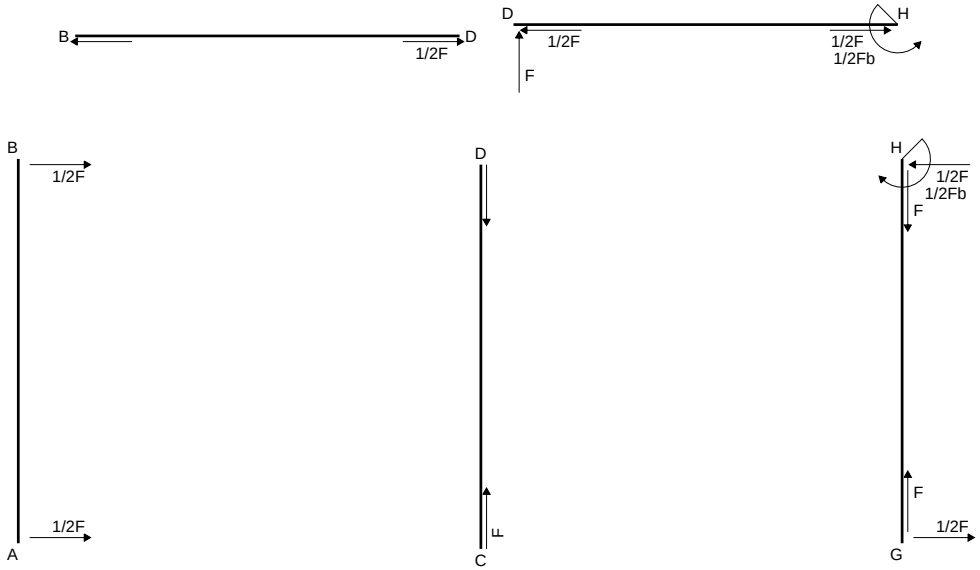
$= (\ b - 1/2\ b\ )\ Fb\ 1/EJ\ = 1/2\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (\ x/b\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ$

$= (1/2\ b\ )\ Fb\ 1/EJ\ = 1/2\ Fb^2/EJ$



A = 1008. mm^2
J_u = 290654. mm^4
J_v = 81216. mm^4
y_g = 30.71 mm
T_y = 2300. N
M_x = -1978000. Nmm
x_m = 12. mm
u_m = -12. mm
v_m = -30.71 mm
$\sigma_m = -Mv/J_u$ = -209. N/mm^2
x_c = 24. mm
y_c = 10. mm
v_c = -20.71 mm
$\sigma_c = -Mv/J_u$ = -141. N/mm^2
τ_c = 3.351 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 141.1 N/mm^2
S^* = 5081. mm^3


B
D
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D
H
1/2F
1/2F
1/2Fb
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B
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1/2Fb
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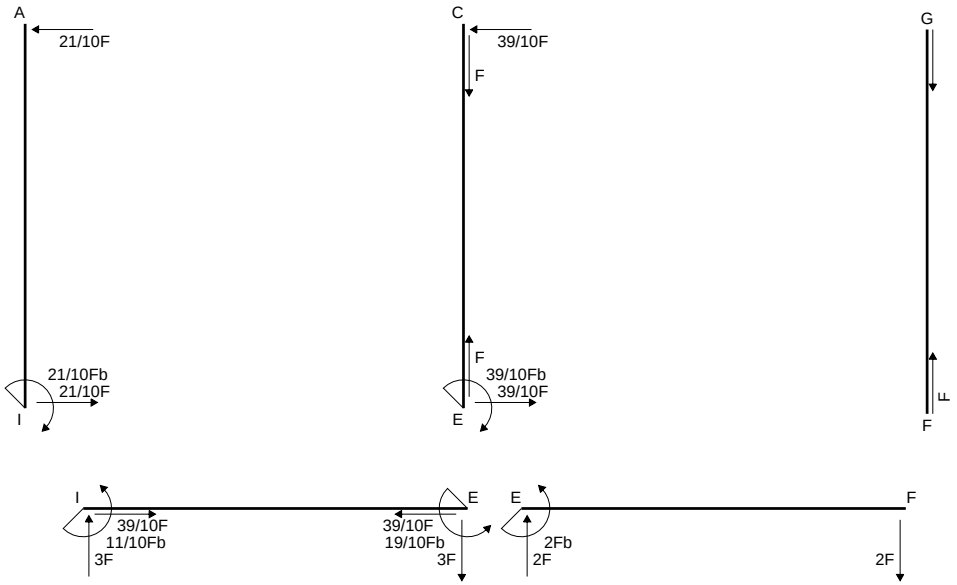
1/2F
G


A
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21/10Fb
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C
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F
F
39/10Fb
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G
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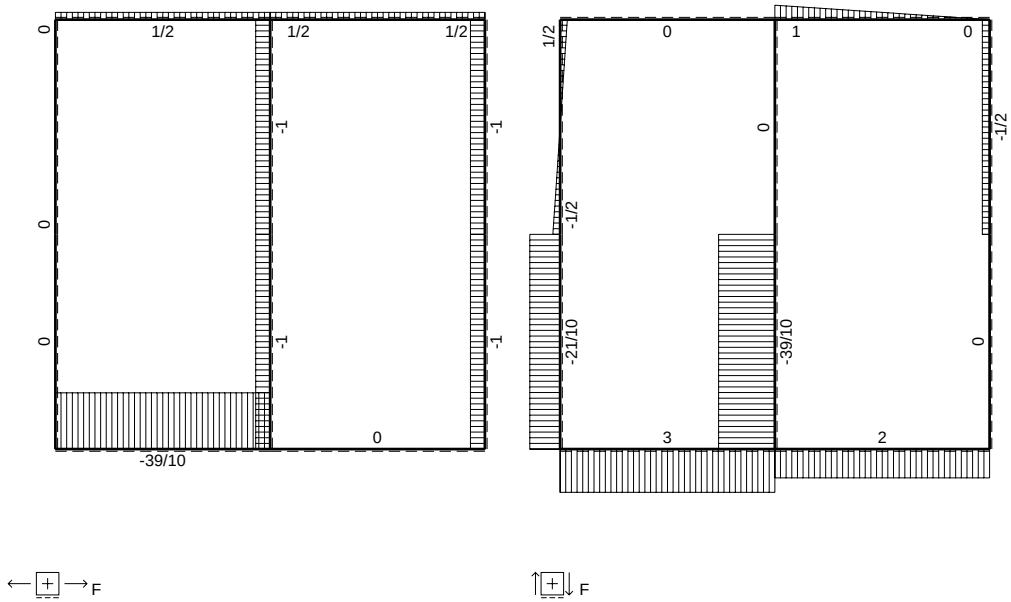
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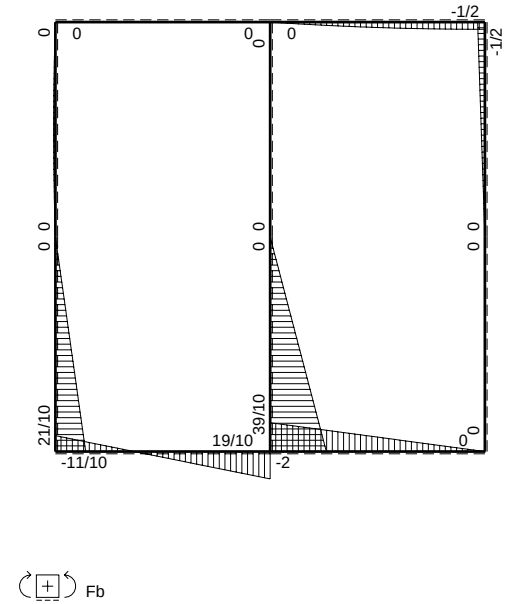
2
F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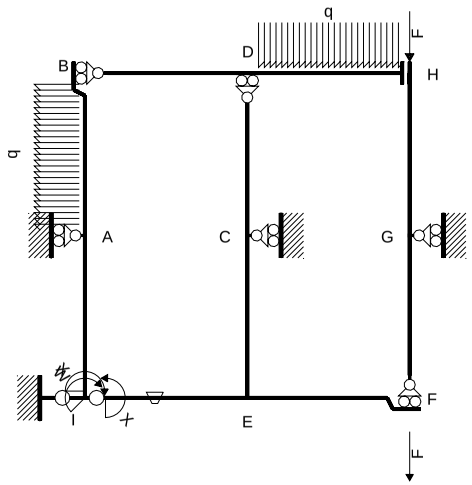
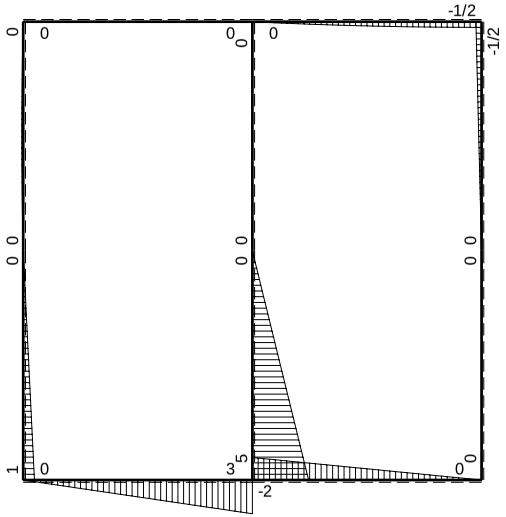
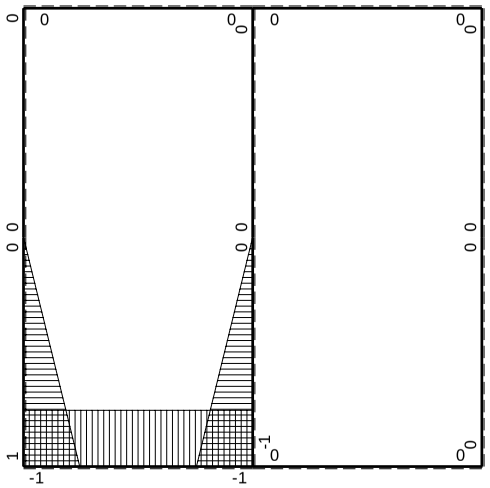
0 0
21/10
39/10
19/10
0
-11/10
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 959720 CI07.xxxx.007

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-1/2Fx$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-5Fx$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$Fb-Fx$	0	$Fb-2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-Fx$	0	Fx^2/b	0	x^2/b^2		
	totali						$-11/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$11/10Fb$	

PROCEDIMENTO E RISULTATI 959720 CI07.xxxx.007

Sviluppi di calcolo iperstatica

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

$L^{XX}_{IE} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EI} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EC} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{CE} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{IA} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{AI} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{Xo}_{IE} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L^{Xo}_{EI} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L^{Xo}_{EC} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L^{Xo}_{CE} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

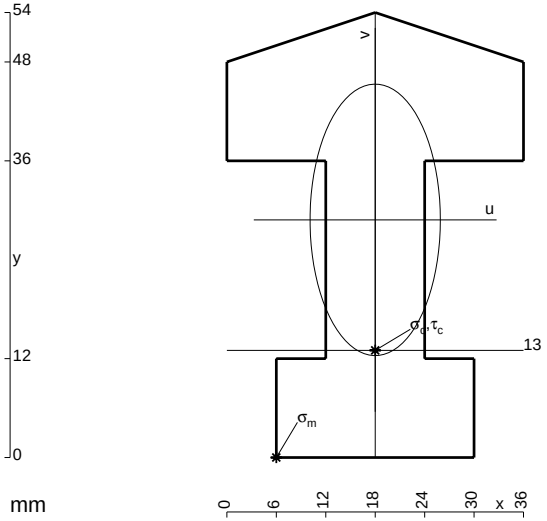
$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L^{Xo}_{IA} = \int_o^b (1 - 2\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

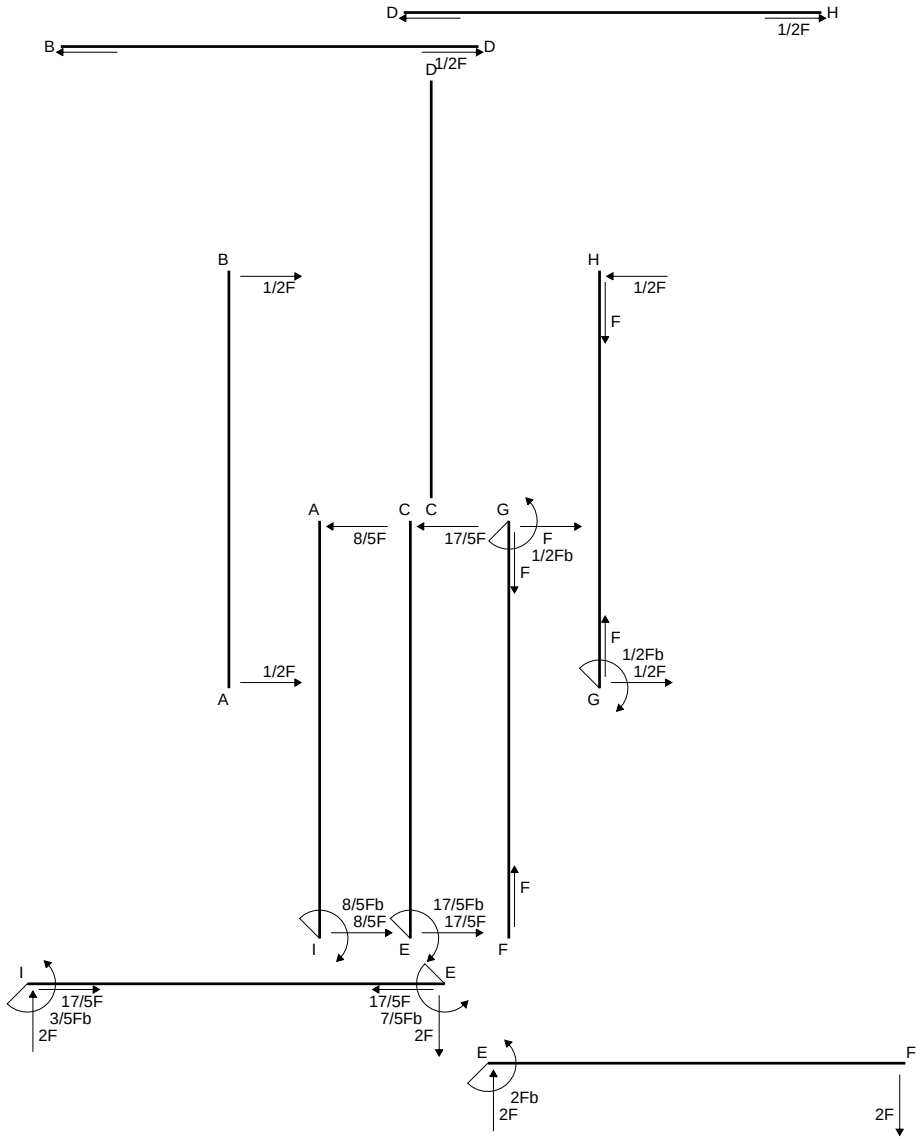
$= (\ b - b + 1/3\ b\ )\ Fb\ 1/EJ\ = 1/3\ Fb^2/EJ$

$L^{Xo}_{AI} = \int_o^b (\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/3\ b\ )\ Fb\ 1/EJ\ = 1/3\ Fb^2/EJ$



A = 1116. mm^2
J_u = 302839. mm^4
J_v = 69768. mm^4
y_g = 28.84 mm
T_y = 2520. N
M_x = -2293200. Nmm
x_m = 6. mm
u_m = -12. mm
v_m = -28.84 mm
$\sigma_m = -Mv/J_u$ = -218.4 N/mm^2
x_c = 18. mm
y_c = 13. mm
v_c = -15.84 mm
$\sigma_c = -Mv/J_u$ = -119.9 N/mm^2
τ_c = 4.697 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 120.2 N/mm^2
S^* = 6774. mm^3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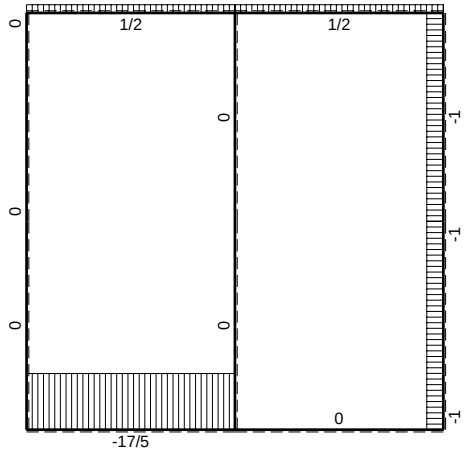
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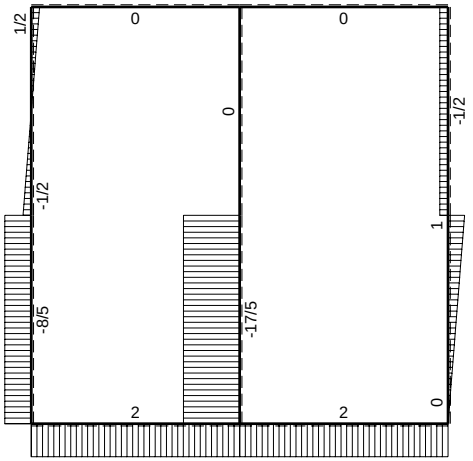
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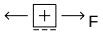
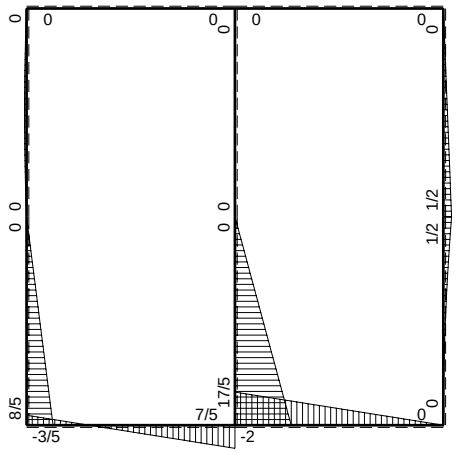
-8/5
-17/5
2
2
0


F

F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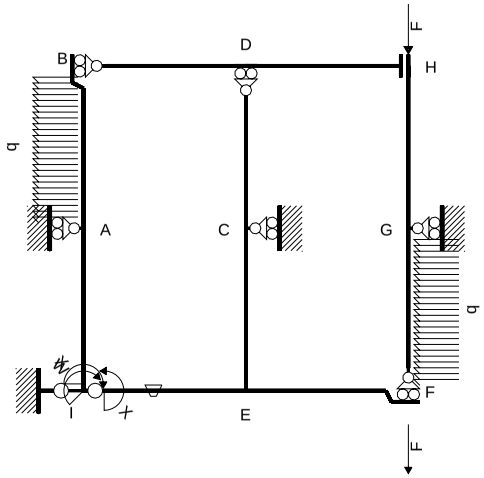
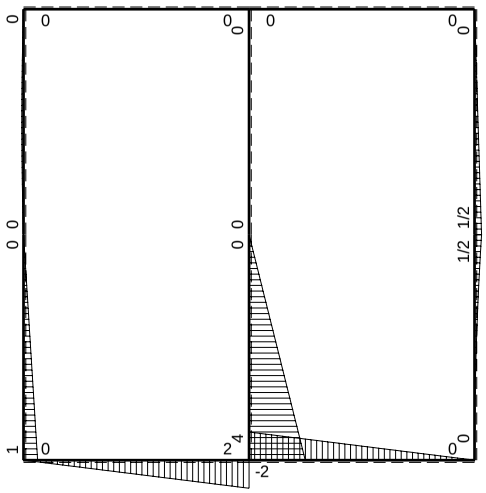
1/2
1/2
8/5
17/5
7/5
-3/5
-2
0

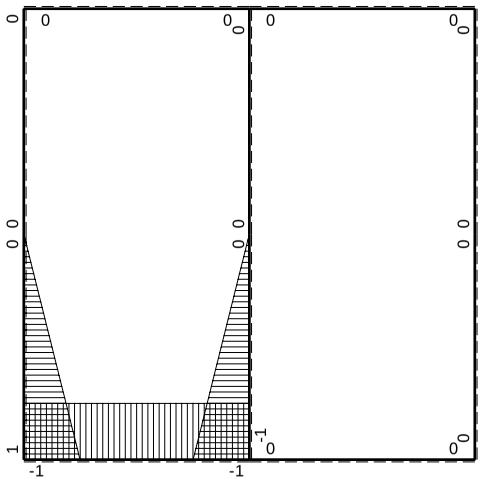
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 213017 CI07.xxxx.008

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	-1+x/b	4Fb-4Fx	0	$-4Fb+8Fx-4Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-4/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-4Fx	0	$-4Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fb-Fx	0	$Fb-2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/3+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	-Fx	0	Fx^2/b	0	x^2/b^2		
	totali						$-Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						3/5Fb	

PROCEDIMENTO E RISULTATI 213017 CI07.xxxx.008

Sviluppi di calcolo iperstatica

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L_{EI}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L_{EC}^{Xo} = \int_o^b (-4 + 8\ x/b - 4\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4\ x + 4\ x^2/b - 4/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-4\ b + 4\ b - 4/3\ b\ )\ Fb\ 1/EJ\ = -4/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-4\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

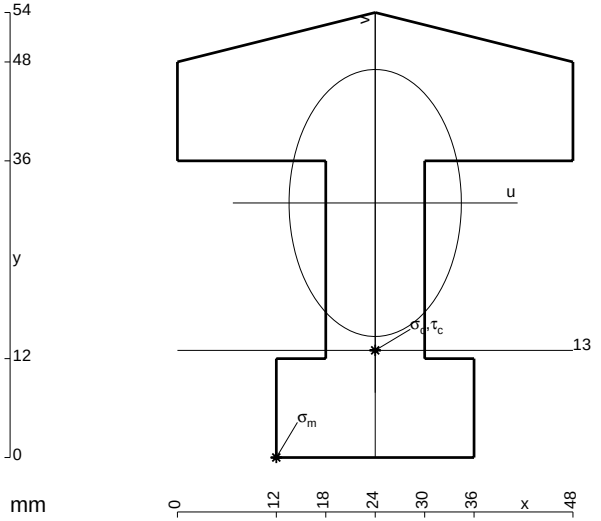
$= (-4/3\ b\ )\ Fb\ 1/EJ\ = -4/3\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1 - 2\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ Fb\ 1/EJ\ = 1/3\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/3\ b\ )\ Fb\ 1/EJ\ = 1/3\ Fb^2/EJ$



$A = 1296.\ mm^2$

$J_u = 340256.\ mm^4$

$J_v = 141696.\ mm^4$

$y_g = 30.89\ mm$

$T_y = 2600.\ N$

$M_x = -2522000.\ Nmm$

$x_m = 12.\ mm$

$u_m = -12.\ mm$

$v_m = -30.89\ mm$

$\sigma_m = -Mv/J_u = -229.\ N/mm^2$

$x_c = 24.\ mm$

$y_c = 13.\ mm$

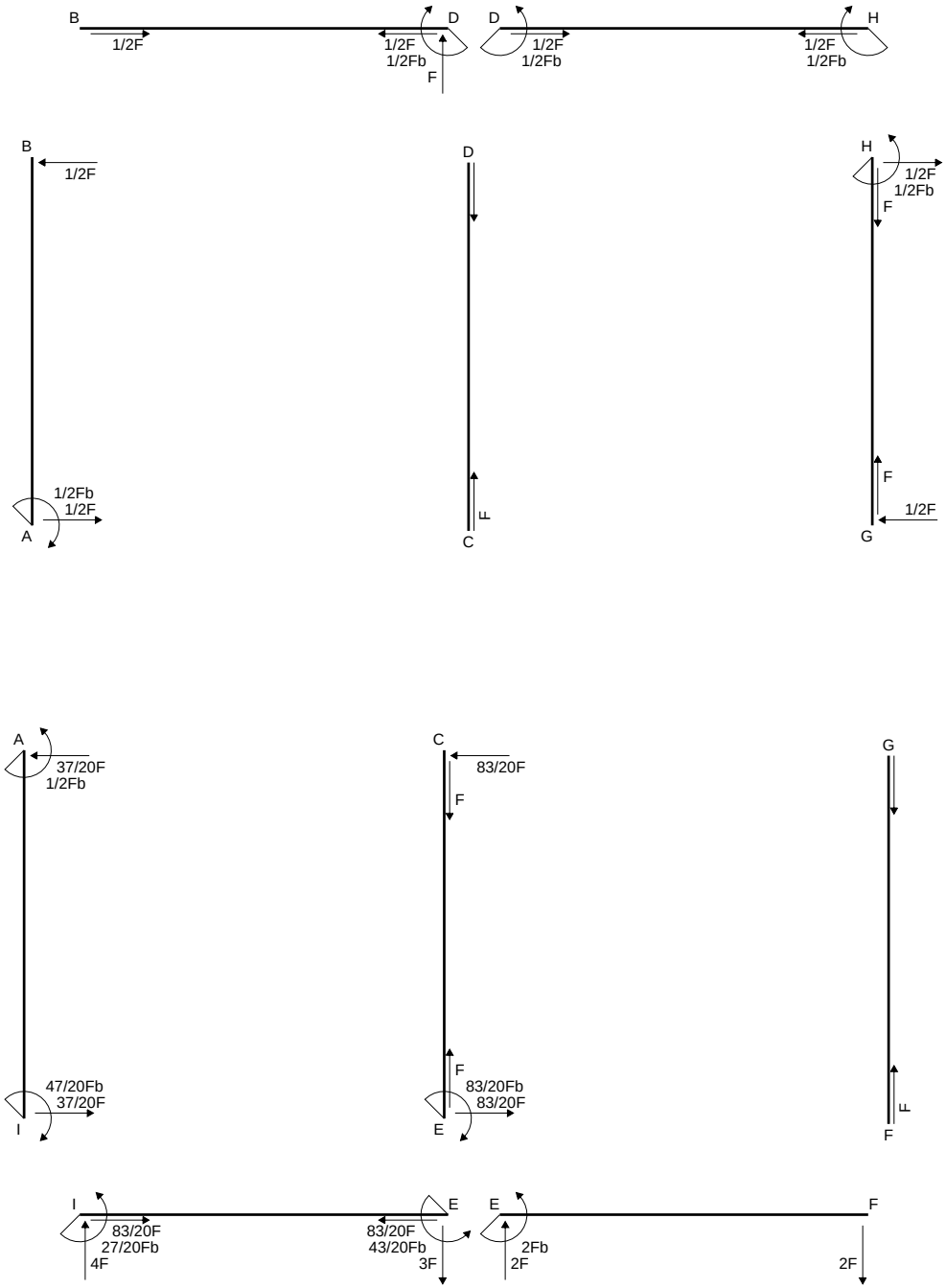
$v_c = -17.89\ mm$

$\sigma_c = -Mv/J_u = -132.6\ N/mm^2$

$\tau_c = 4.705\ N/mm^2$

$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 132.8\ N/mm^2$

$S^* = 7389.\ mm^3$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1/2Fb
F
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1/2Fb
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1/2Fb
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F
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G
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1/2Fb
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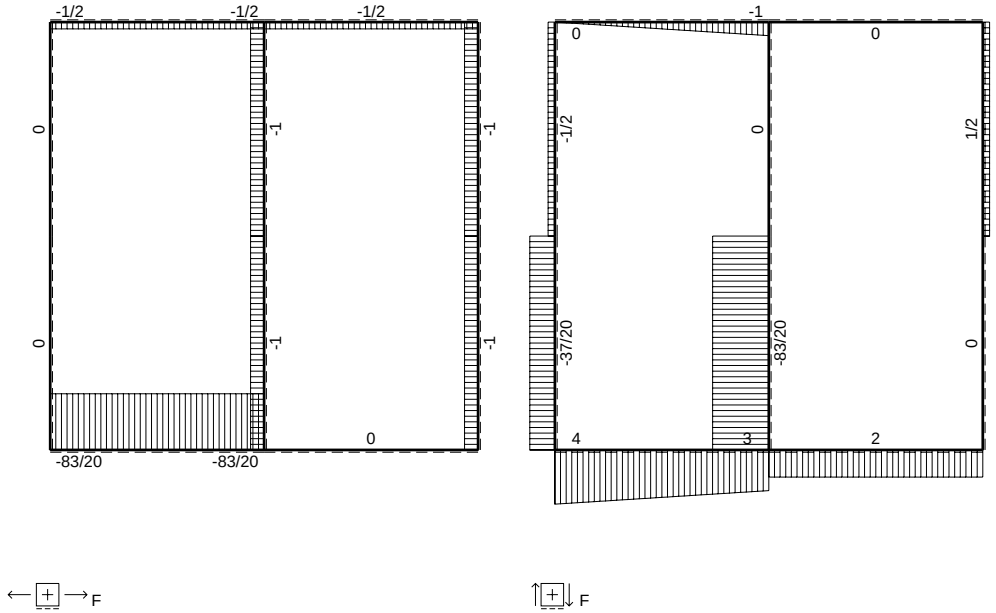
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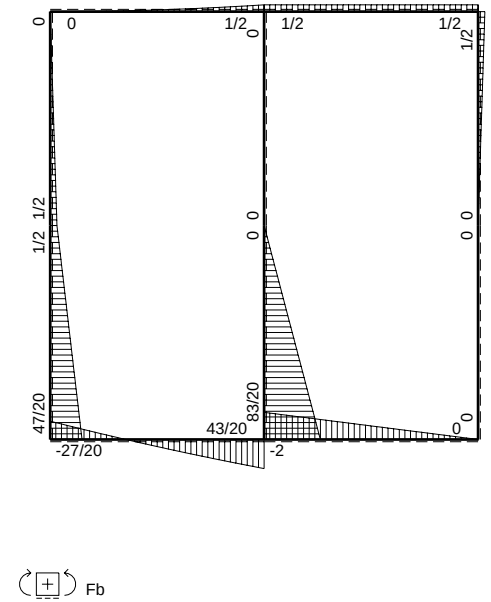
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47/20
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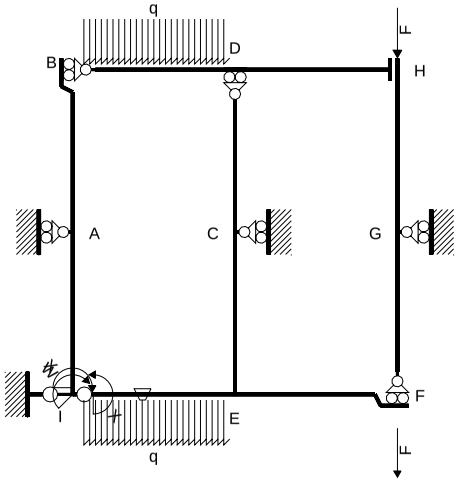
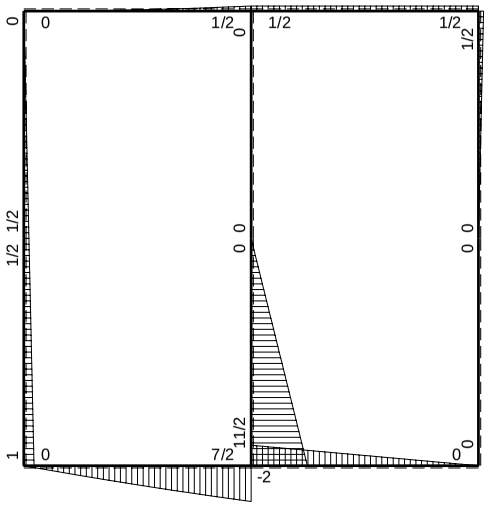
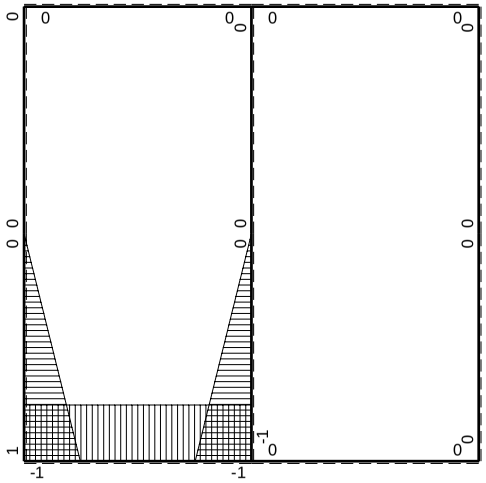
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 211563 CI07.xxxx.009
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PROCEDIMENTO E RISULTATI 211563 CI07.xxxx.009

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
BA b	0	-1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fb+1/2Fx	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$4Fx-1/2qx^2$	-Fb/EJ	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	$-1+x/b$	11/2Fb-11/2Fx	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-11/2Fx	0	$-11/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fb-1/2Fx	0	$Fb-3/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(5/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	-1/2Fb-1/2Fx	0	$1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-9/4Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						27/20Fb	

Sviluppi di calcolo iperstatica

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$L^{XX}_{IE} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EI} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EC} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{CE} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{IA} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{AI} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{Xo}_{IE} = \int_o^b (-4\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L^{Xo}_{EI} = \int_o^b (-7/2 + 3\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx$

$= [-7/2\ x + 3/2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-7/2\ b + 3/2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L^{Xo}_{EC} = \int_o^b (-11/2 + 11\ x/b - 11/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-11/2\ x + 11/2\ x^2/b - 11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-11/2\ b + 11/2\ b - 11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L^{Xo}_{CE} = \int_o^b (-11/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

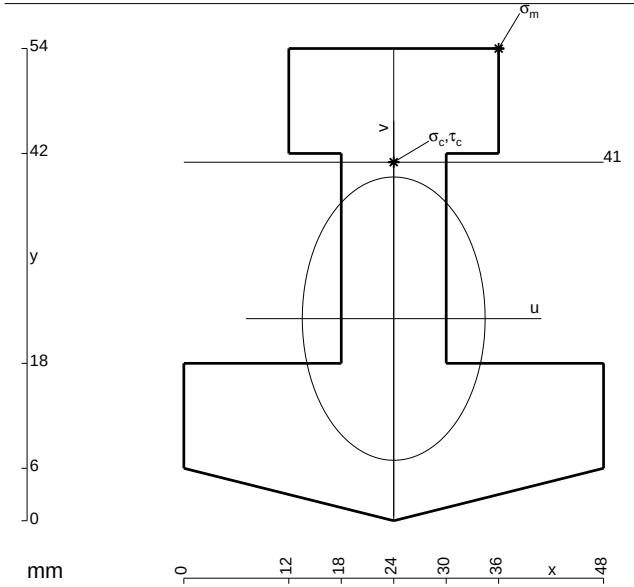
$= (-11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L^{Xo}_{IA} = \int_o^b (1 - 3/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [\ x - 3/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (\ b - 3/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = 5/12\ Fb^2/EJ$

$L^{Xo}_{AI} = \int_o^b (1/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = 5/12\ Fb^2/EJ$



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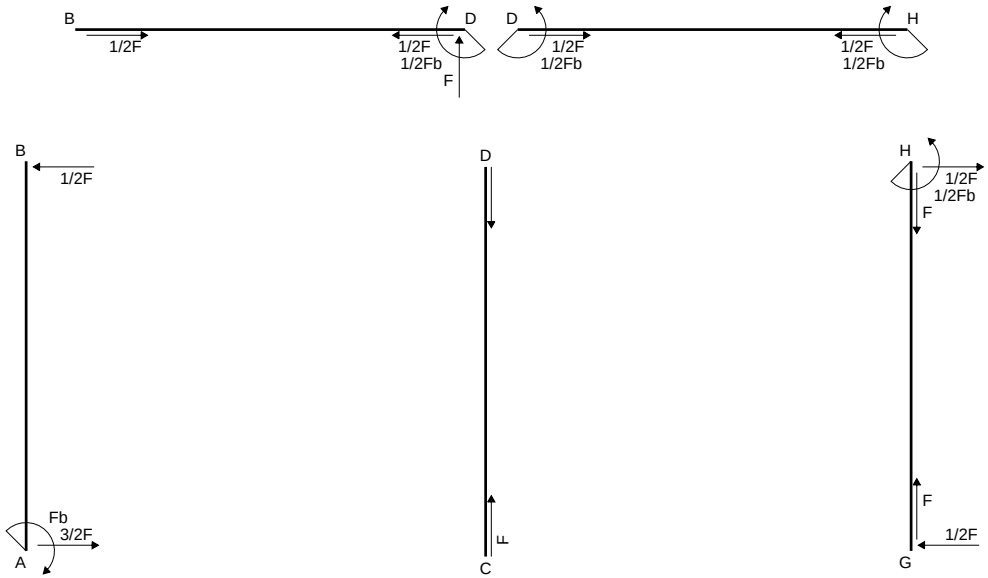
J_u = 340256. mm^4
J_v = 141696. mm^4
y_g = 23.11 mm
T_y = 2580. N
M_x = -2631600. Nmm
x_m = 36. mm
y_m = 54. mm
u_m = 12. mm
v_m = 30.89 mm
$\sigma_m = -Mv/J_u$ = 238.9 N/mm^2
x_c = 24. mm
y_c = 41. mm
v_c = 17.89 mm
$\sigma_c = -Mv/J_u$ = 138.4 N/mm^2
τ_c = 4.669 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 138.6 N/mm^2
S^* = 7389. mm^3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1/2F
1/2Fb
F
D
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1/2Fb
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1/2Fb
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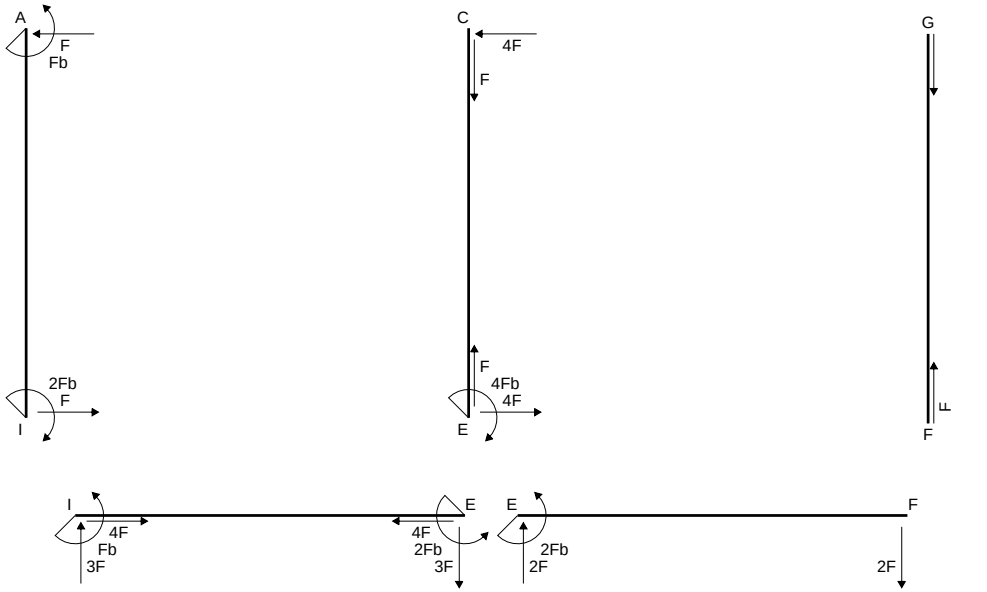
D
F
C
H
1/2F
1/2Fb
F
F
1/2F
G


A
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3F
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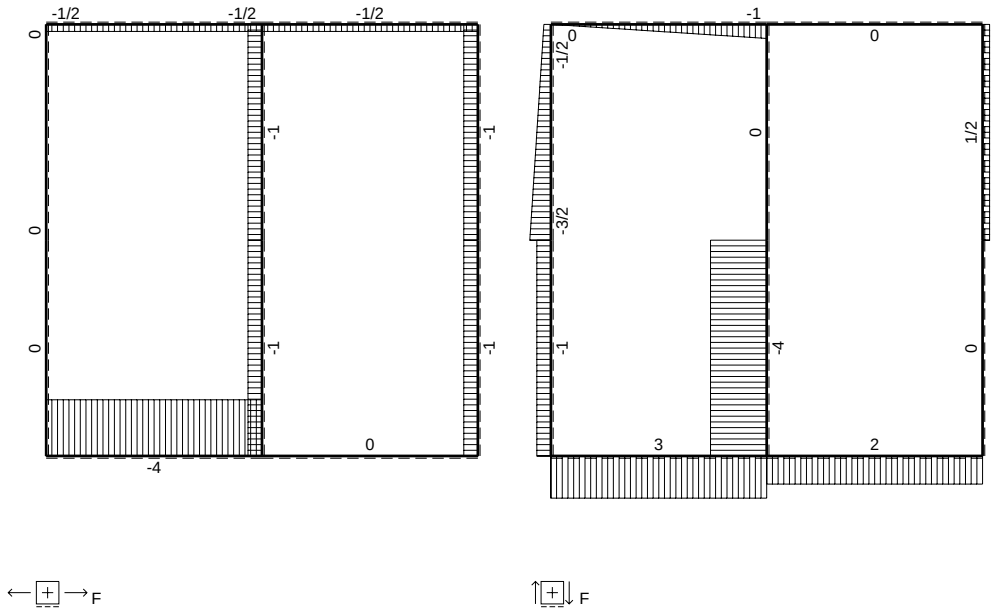
2Fb
2F
F
2F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-1/2
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-3/2
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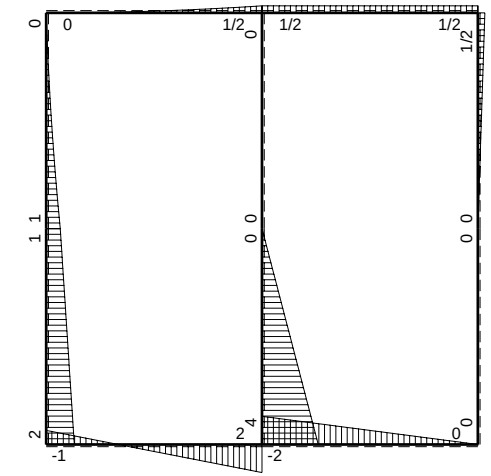
-1
1/2
-4
0
3
2
F
F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4
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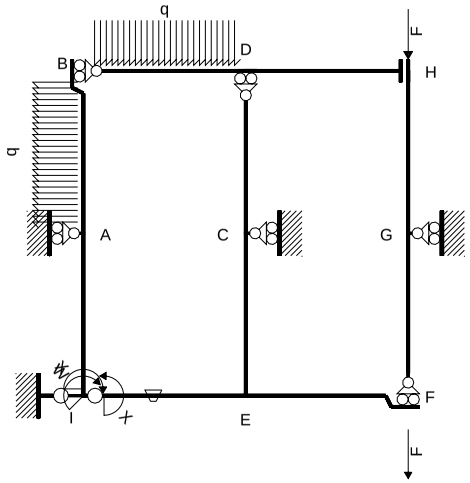
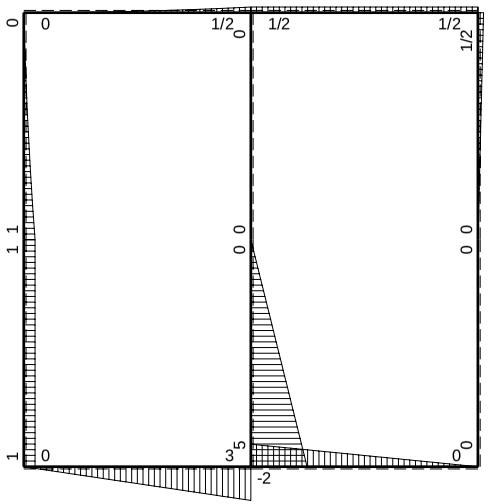
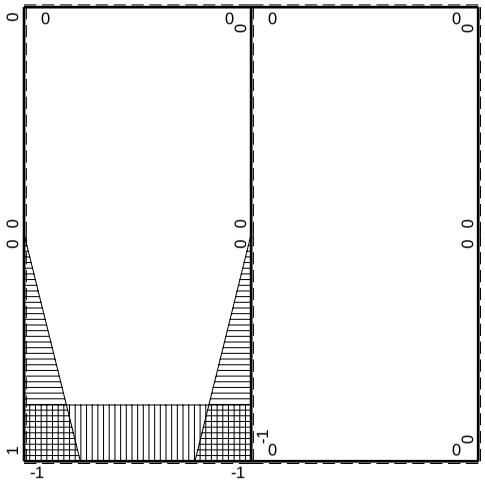
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$Fb-3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$-1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-5Fx$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	Fb	0	$Fb-Fx$	0	$1-2x/b+x^2/b^2$	$(1/2+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-Fb$	0	Fx	0	x^2/b^2		
	totali						$-5/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						Fb	

Sviluppi di calcolo iperstatica

PROCEDIMENTO E RISULTATI 962819 CI07.xxxx.010

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

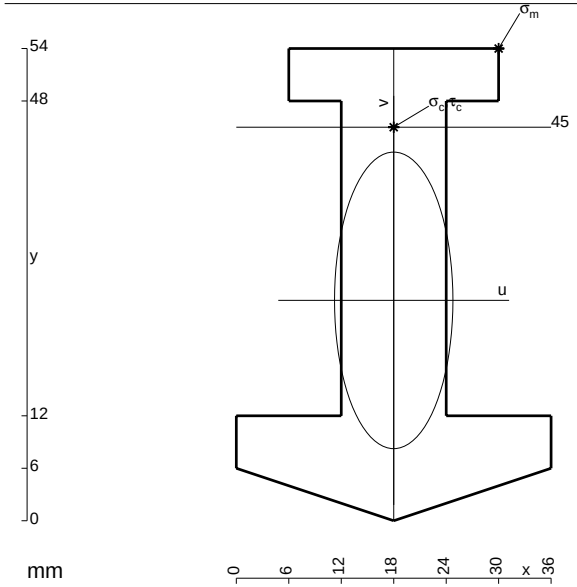
$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1 - x/b\ )\ Fb\ 1/EJ\ dx = [\ x - 1/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ$

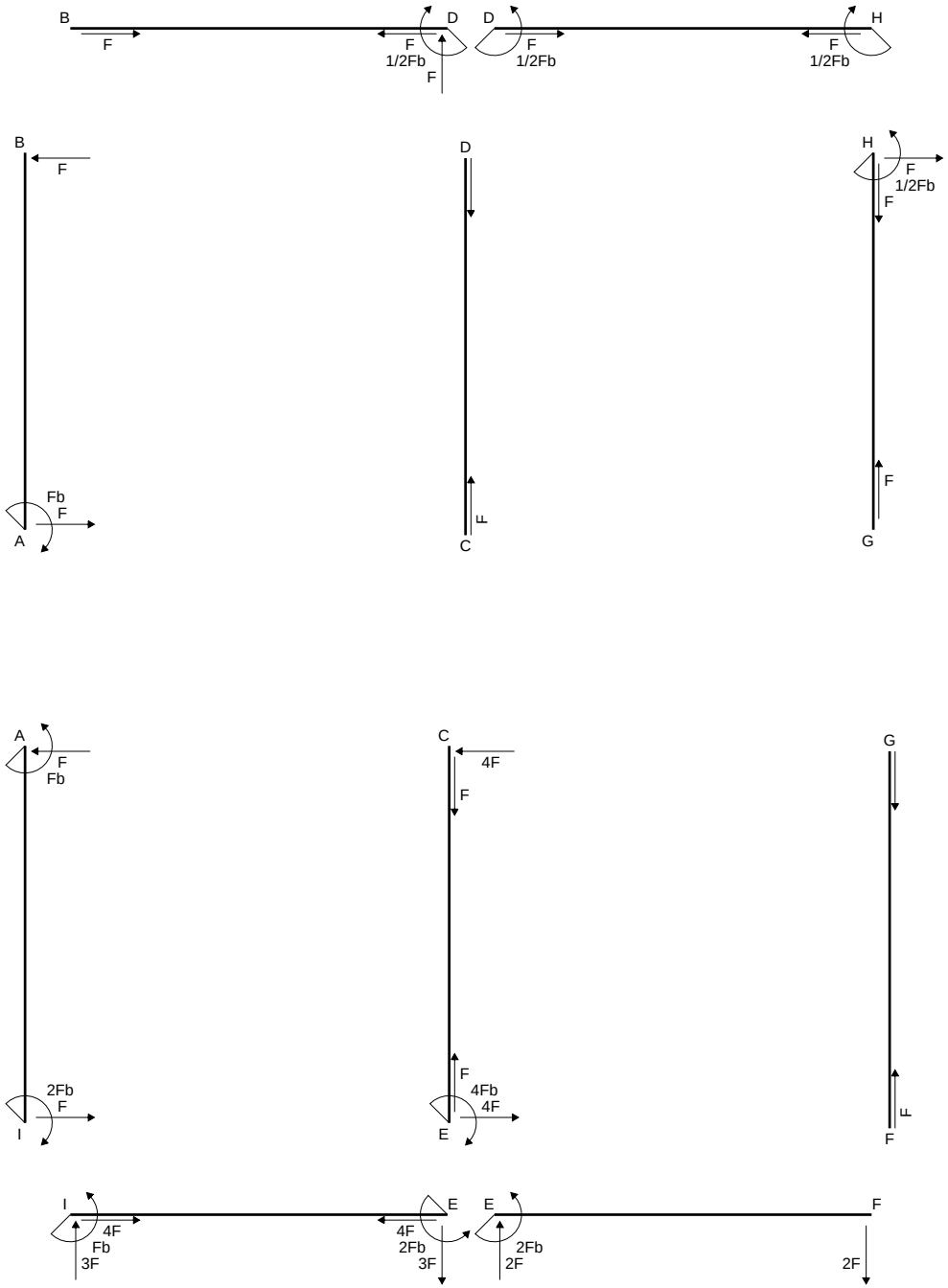
$= (\ b - 1/2\ b\ )\ Fb\ 1/EJ\ = 1/2\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (\ x/b\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ$

$= (1/2\ b\ )\ Fb\ 1/EJ\ = 1/2\ Fb^2/EJ$



A = 900. mm^2
J_u = 258984. mm^4
J_v = 41256. mm^4
y_g = 25.2 mm
T_y = 3320. N
M_x = -1792800. Nmm
x_m = 30. mm
y_m = 54. mm
u_m = 12. mm
v_m = 28.8 mm
$\sigma_m = -Mv/J_u$ = 199.4 N/mm^2
x_c = 18. mm
y_c = 45. mm
v_c = 19.8 mm
$\sigma_c = -Mv/J_u$ = 137.1 N/mm^2
τ_c = 4.788 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 137.3 N/mm^2
S^* = 4482. mm^3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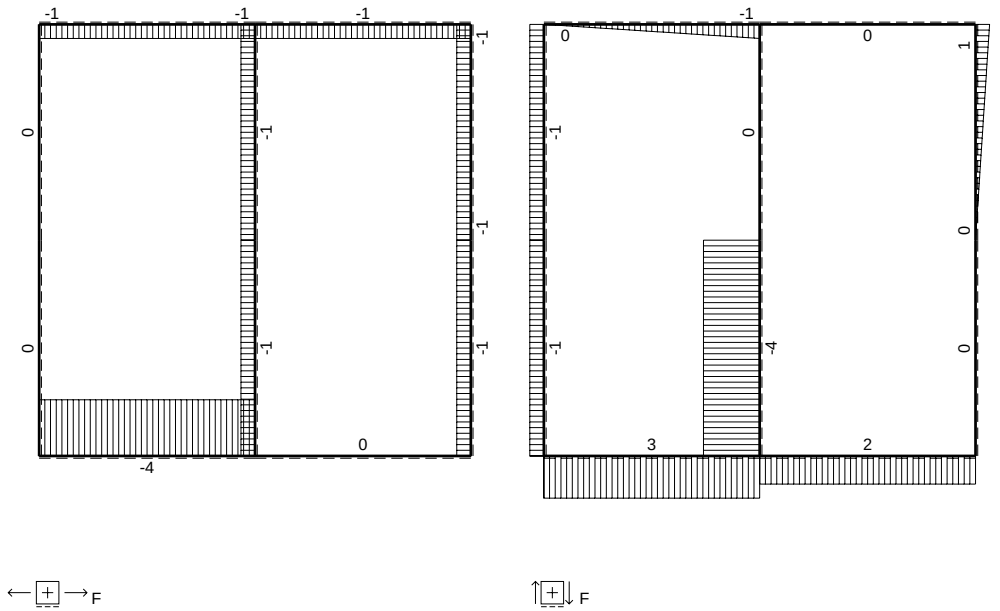
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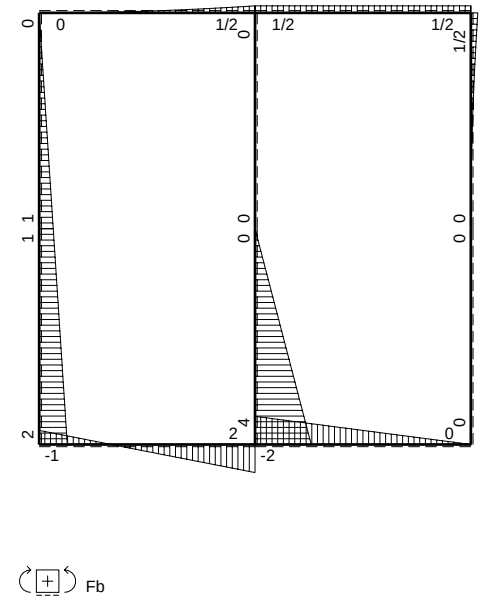
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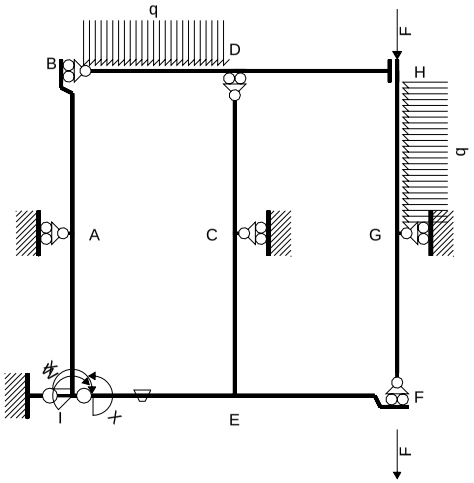
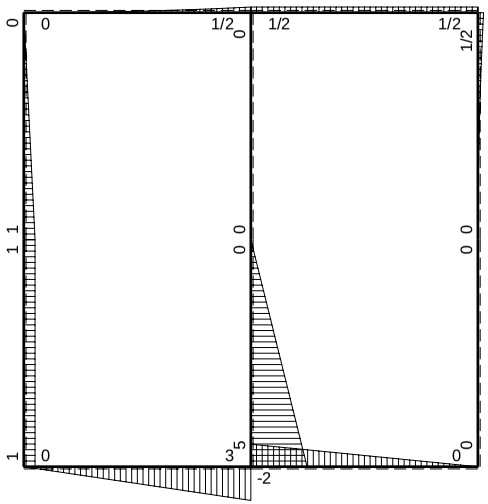
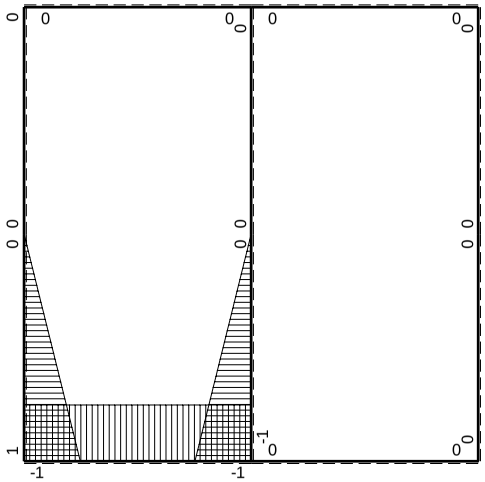
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 213012 CI07.xxxx.011

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	Fb-Fx	0	0	0	0	0+0	0
BA b	0	-Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	5Fb-5Fx	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-5Fx	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fb	0	Fb-Fx	0	$1-2x/b+x^2/b^2$	$(1/2+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	-Fb	0	Fx	0	x^2/b^2		
	totali						$-5/3Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

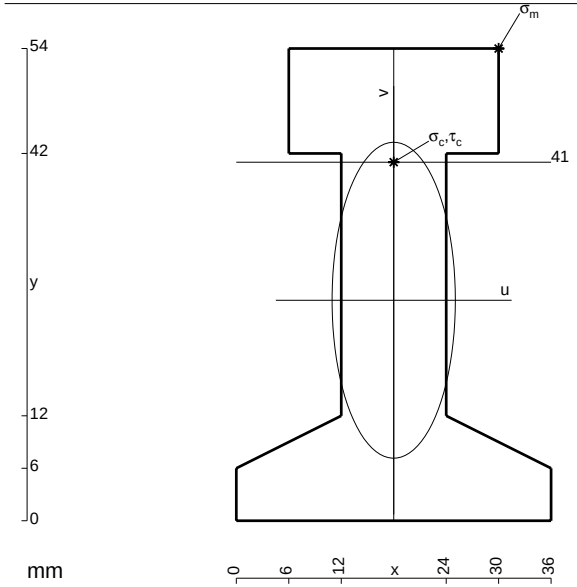
$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1 - x/b\ )\ Fb\ 1/EJ\ dx = [\ x - 1/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ$

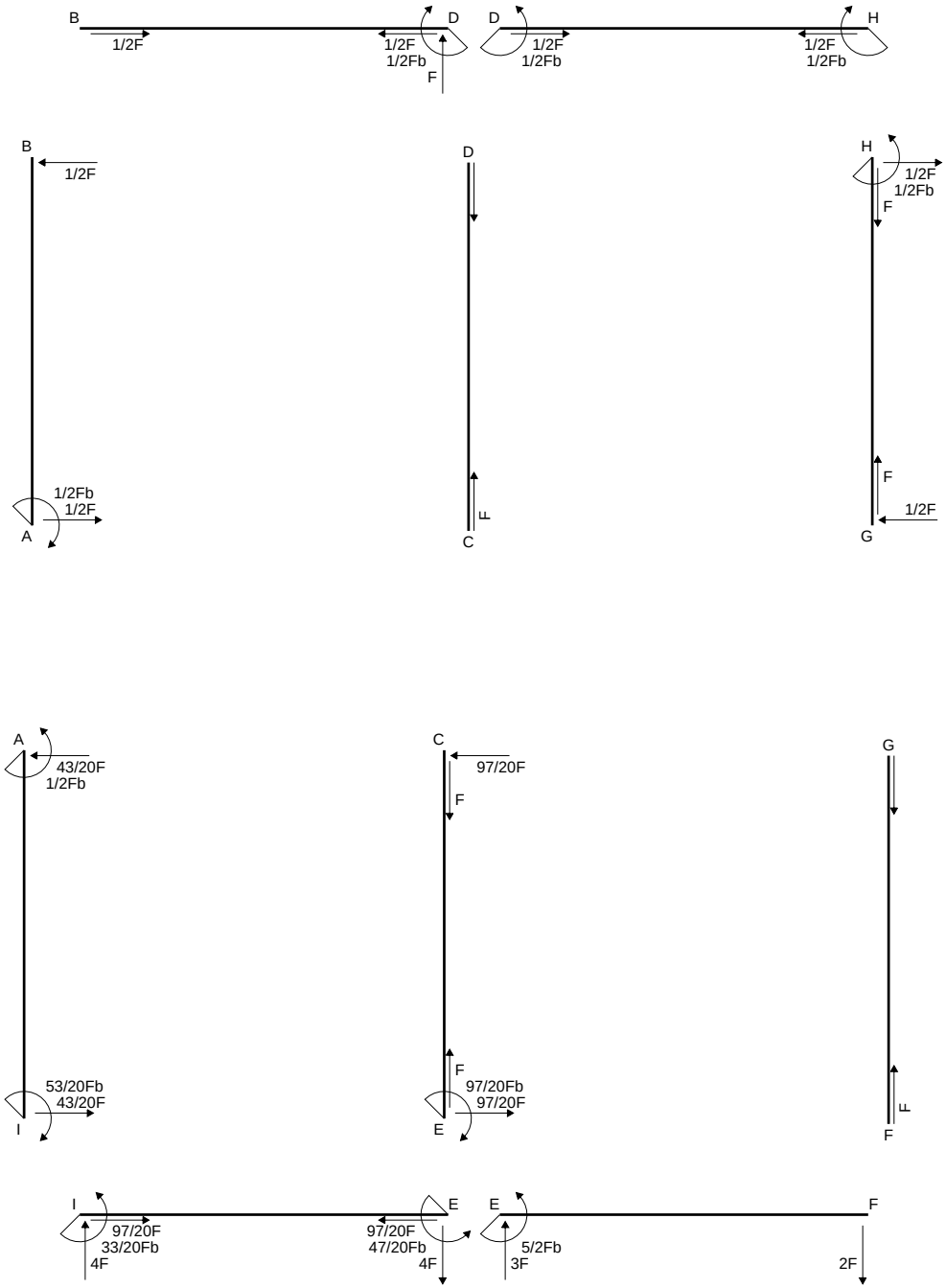
$= (\ b - 1/2\ b\ )\ Fb\ 1/EJ\ = 1/2\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (\ x/b\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ$

$= (1/2\ b\ )\ Fb\ 1/EJ\ = 1/2\ Fb^2/EJ$



A = 1008. mm^2
J_u = 328994. mm^4
J_v = 50112. mm^4
y_g = 25.21 mm
T_y = 4060. N
M_x = -2395400. Nmm
x_m = 30. mm
y_m = 54. mm
u_m = 12. mm
v_m = 28.79 mm
$\sigma_m = -Mv/J_u$ = 209.6 N/mm^2
x_c = 18. mm
y_c = 41. mm
v_c = 15.79 mm
$\sigma_c = -Mv/J_u$ = 114.9 N/mm^2
τ_c = 6.95 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 115.6 N/mm^2
S^* = 6758. mm^3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1/2Fb
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1/2Fb
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1/2Fb
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A
D
F
C
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1/2Fb
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1/2Fb
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43/20F
I
C
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F
F
97/20Fb
97/20F
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G
F
F
I
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97/20F
47/20Fb
4F
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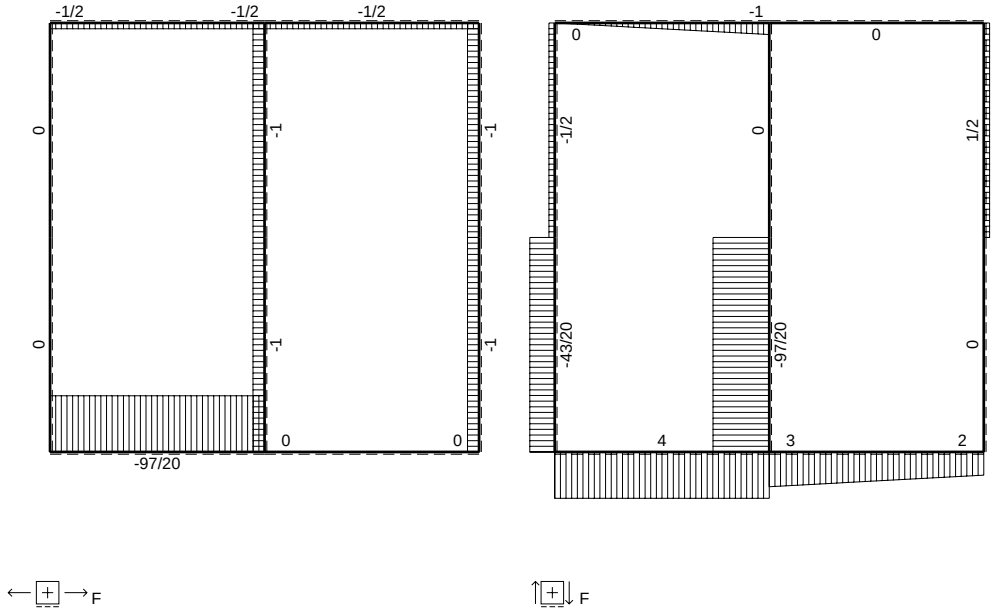
3F
F
2F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-97/20
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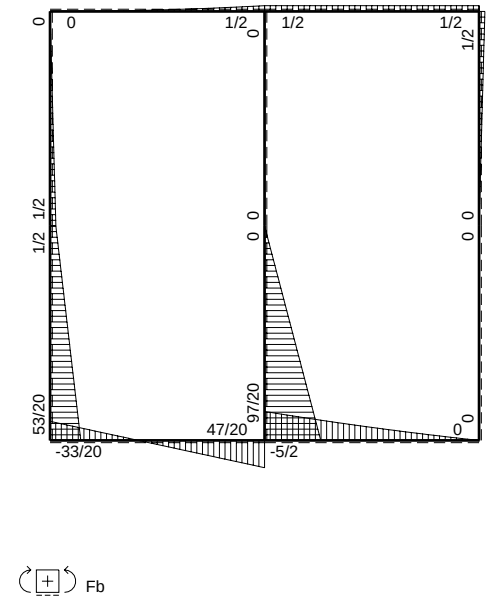
F
F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97/20
47/20
0
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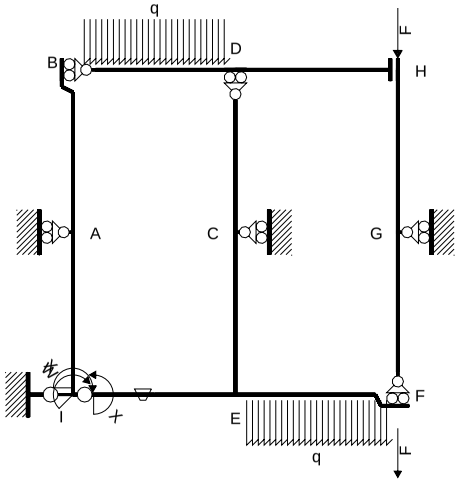
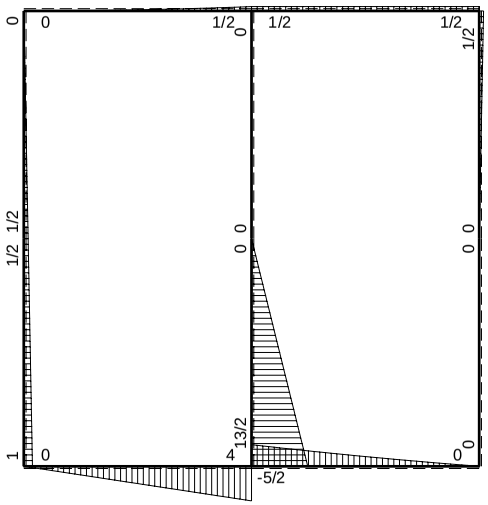
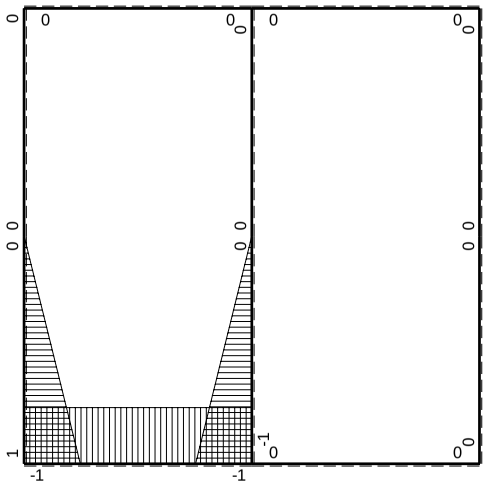
-5/2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
BA b	0	-1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-5/2Fb+3Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$2Fx+1/2qx^2$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fb+1/2Fx	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	4Fx	-Fb/EJ	-4Fx	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-4Fb+4Fx	Fb/EJ	-4Fb+4Fx	Fb/EJ	1		
EC b	-1+x/b	13/2Fb-13/2Fx	0	$-13/2Fb+13Fx-13/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-13/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-13/2Fx	0	$-13/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fb-1/2Fx	0	$Fb-3/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(5/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	-1/2Fb-1/2Fx	0	$1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-11/4Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						33/20Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-4 + 4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-4\ x + 2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-4\ b + 2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-13/2 + 13\ x/b - 13/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-13/2\ x + 13/2\ x^2/b - 13/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-13/2\ b + 13/2\ b - 13/6\ b\ )\ Fb\ 1/EJ\ = -13/6\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-13/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-13/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-13/6\ b\ )\ Fb\ 1/EJ\ = -13/6\ Fb^2/EJ$

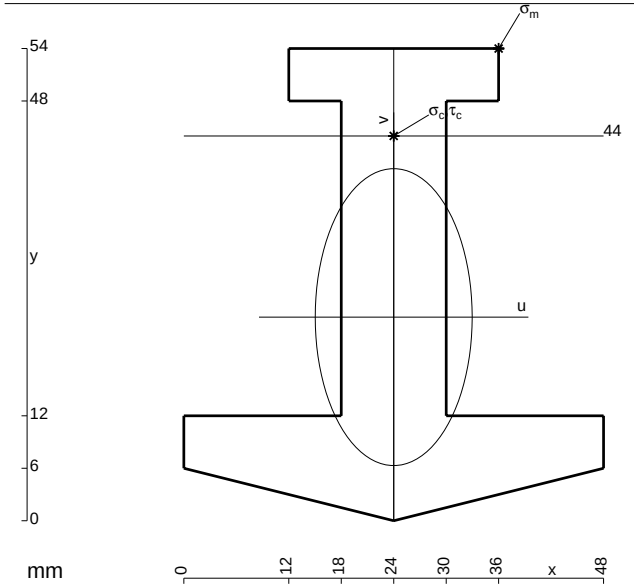
$L_{IA}^{Xo} = \int_o^b (1 - 3/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [\ x - 3/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (\ b - 3/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = 5/12\ Fb^2/EJ$

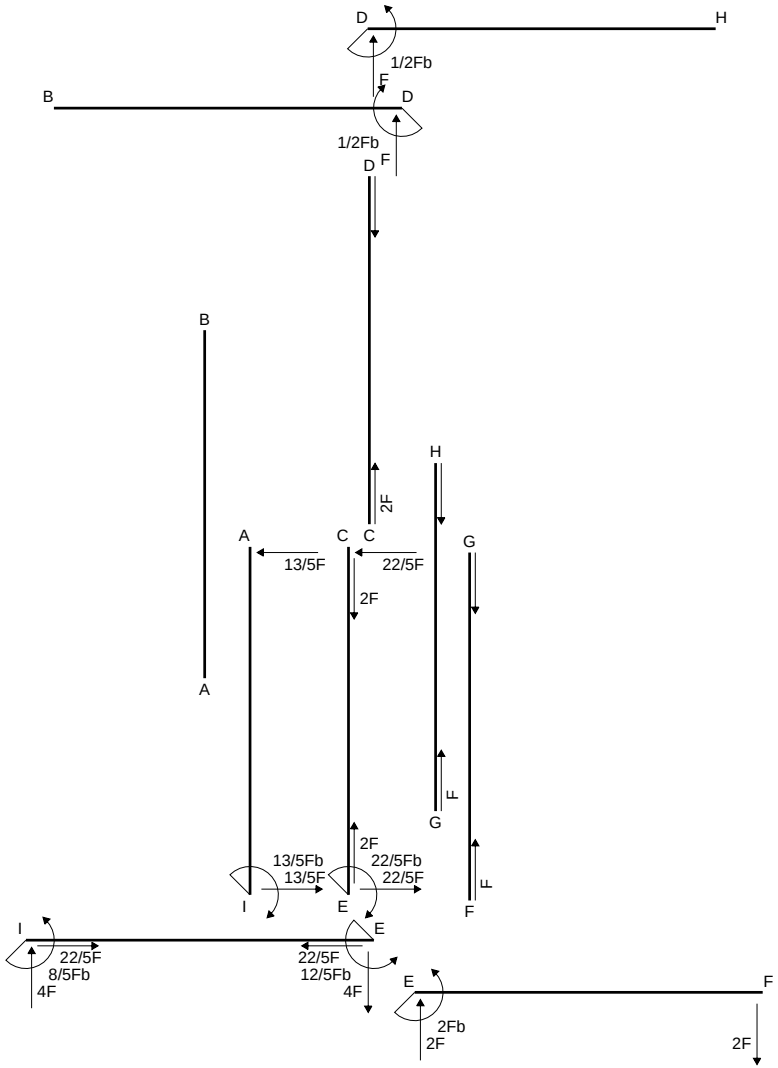
$L_{AI}^{Xo} = \int_o^b (1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = 5/12\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 957249 CI07.xxxx.012



A = 1008. mm^2
J_u = 290654. mm^4
J_v = 81216. mm^4
y_g = 23.29 mm
T_y = 3900. N
M_x = -2080000. Nmm
x_m = 36. mm
y_m = 54. mm
u_m = 12. mm
v_m = 30.71 mm
$\sigma_m = -Mv/J_u$ = 219.8 N/mm^2
x_c = 24. mm
y_c = 44. mm
v_c = 20.71 mm
$\sigma_c = -Mv/J_u$ = 148.2 N/mm^2
τ_c = 5.682 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 148.6 N/mm^2
S^* = 5081. mm^3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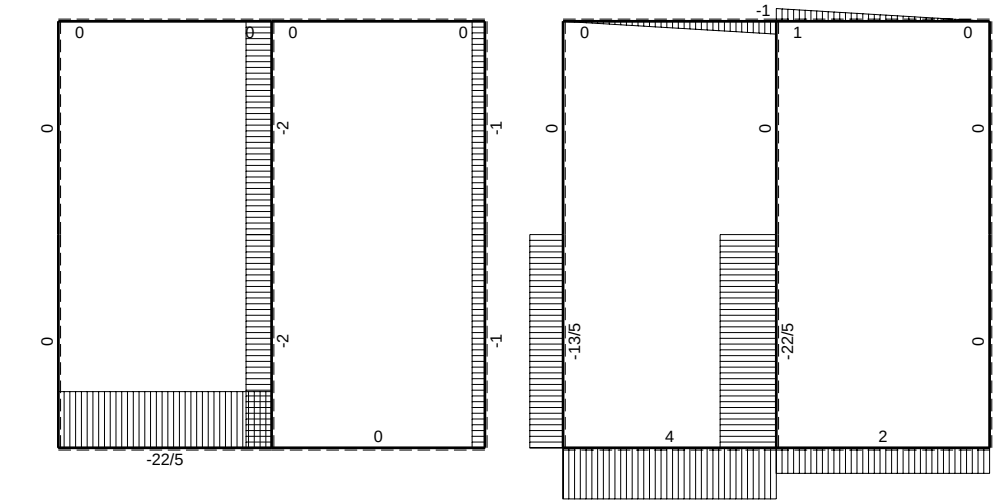
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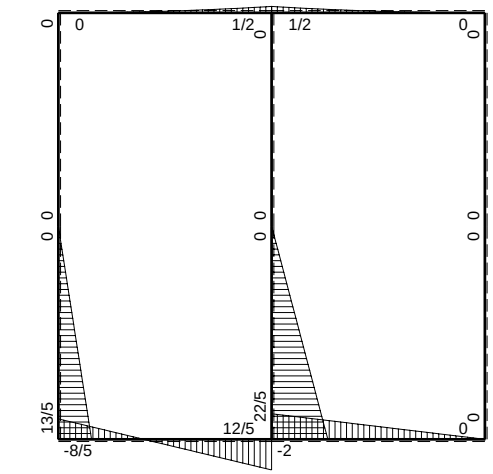
2

F F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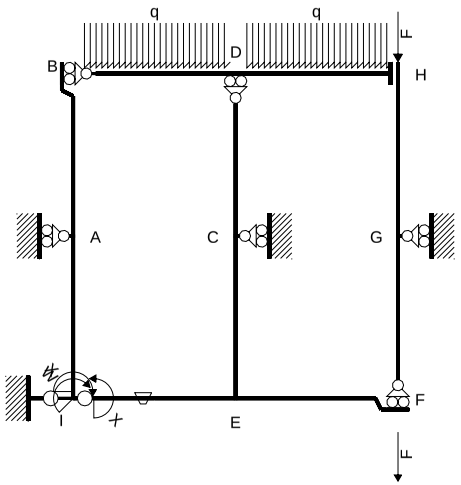
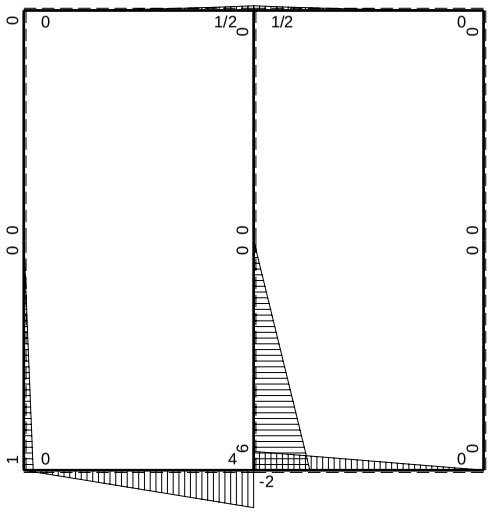
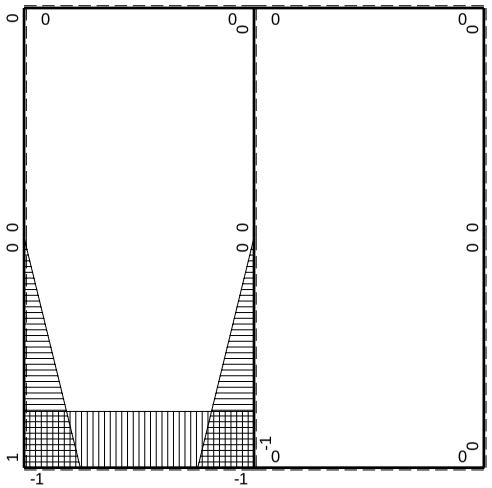
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 211733 CI07.xxxx.013

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

PROCEDIMENTO E RISULTATI 211733 CI07.xxxx.013

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	0	0	0	0	0	0+0	0
HG b	0	0	0	0	0	0		
HD b	0	$1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	4Fx	-Fb/EJ	-4Fx	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-4Fb+4Fx	Fb/EJ	-4Fb+4Fx	Fb/EJ	1		
EC b	$-1+x/b$	6Fb-6Fx	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-6Fx	0	$-6Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fb-Fx	0	$Fb-2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/3+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	-Fx	0	Fx^2/b	0	x^2/b^2		
	totali						$-8/3Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						8/5Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-4 + 4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-4\ x + 2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-4\ b + 2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-6 + 12\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-6\ x + 6\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-6\ b + 6\ b - 2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

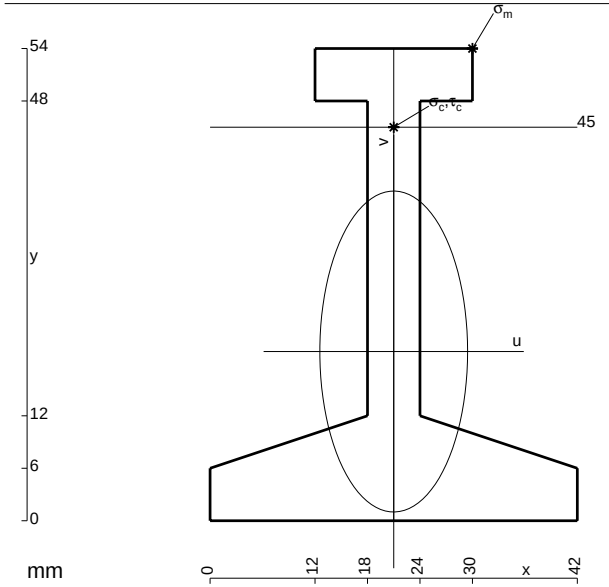
$= (-2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1 - 2\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

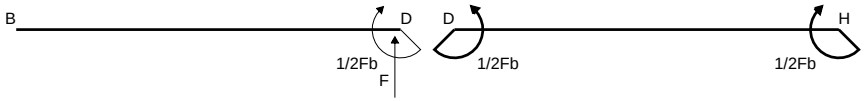
$= (\ b - b + 1/3\ b\ )\ Fb\ 1/EJ\ = 1/3\ Fb^2/EJ$

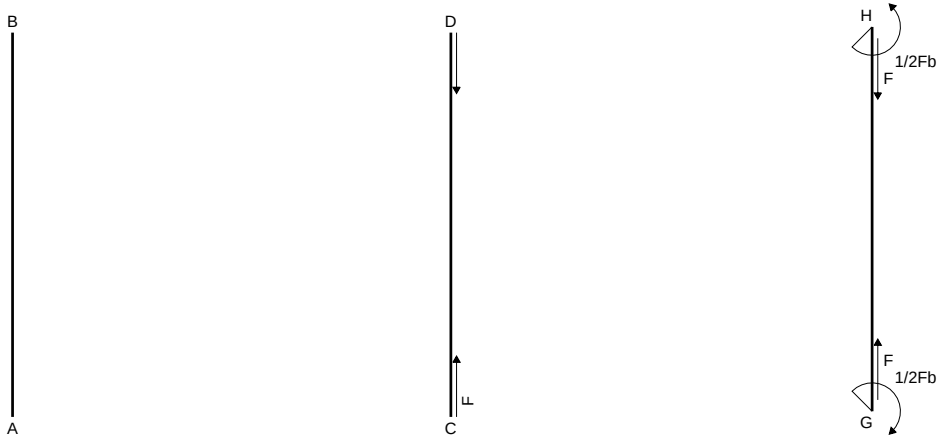
$L_{AI}^{Xo} = \int_o^b (\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/3\ b\ )\ Fb\ 1/EJ\ = 1/3\ Fb^2/EJ$



A = 720. mm^2
J_u = 242552. mm^4
J_v = 51408. mm^4
y_g = 19.35 mm
T_y = 2300. N
M_x = -1610000. Nmm
x_m = 30. mm
y_m = 54. mm
u_m = 9. mm
v_m = 34.65 mm
$\sigma_m = -Mv/J_u$ = 230. N/mm^2
x_c = 21. mm
y_c = 45. mm
v_c = 25.65 mm
$\sigma_c = -Mv/J_u$ = 170.3 N/mm^2
τ_c = 6.175 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 170.6 N/mm^2
S^* = 3907. mm^3


B
D
D
H
1/2Fb
F
1/2Fb
1/2Fb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A
D
C
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H
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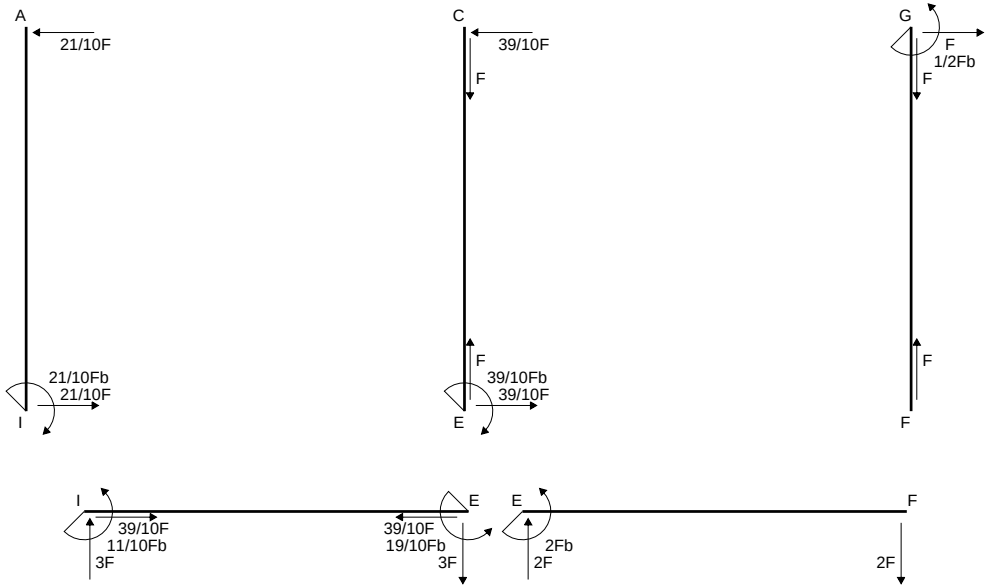
F
1/2Fb
G


A
21/10F
21/10Fb
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C
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F
F
39/10Fb
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F
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2F
F
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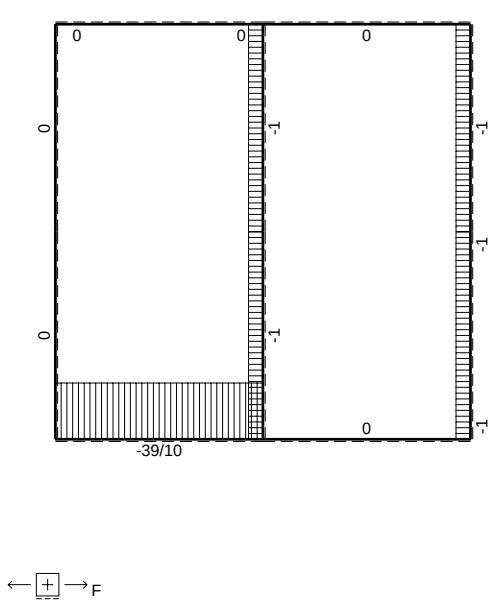
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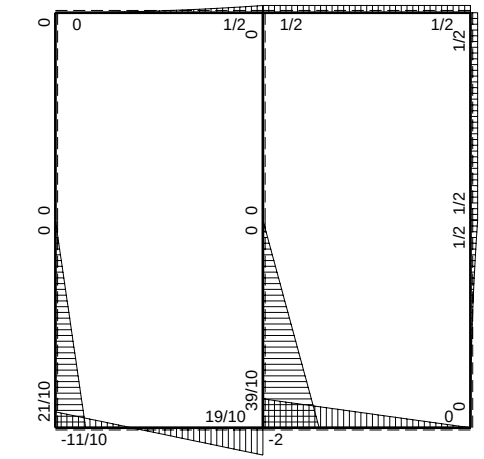
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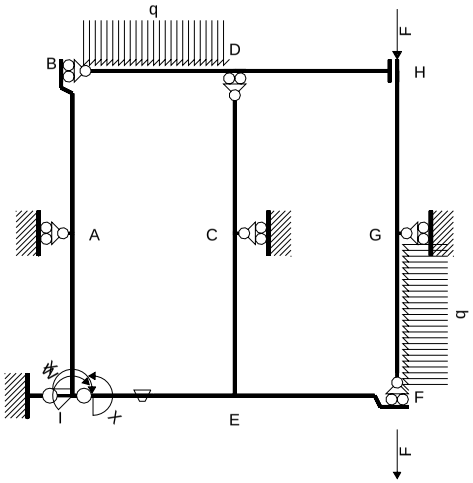
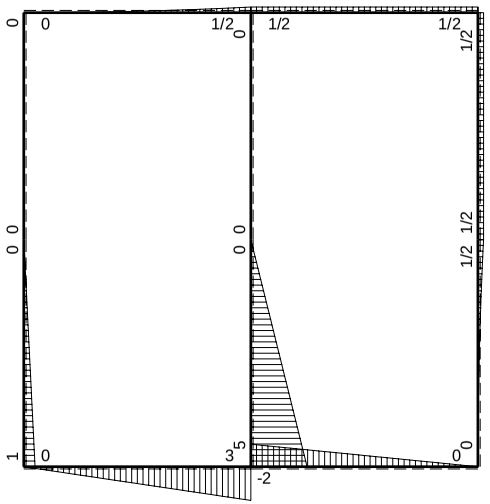
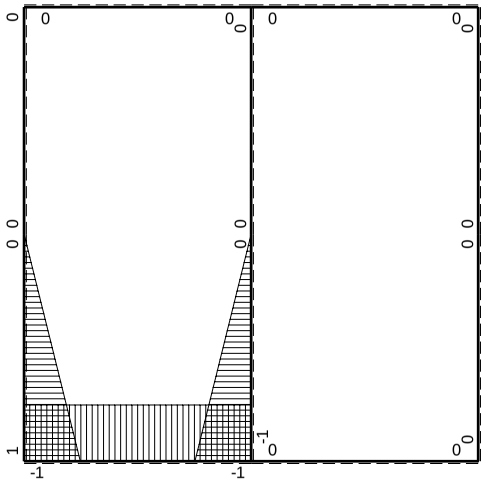


Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 211996 CI07.xxxx.014

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PROCEDIMENTO E RISULTATI 211996 CI07.xxxx.014

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb	0	0	0	0	0+0	0
HG b	0	-1/2Fb	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	5Fb-5Fx	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-5Fx	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fb-Fx	0	$Fb-2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/3+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	-Fx	0	Fx^2/b	0	x^2/b^2		
	totali						$-11/6Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						11/10Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

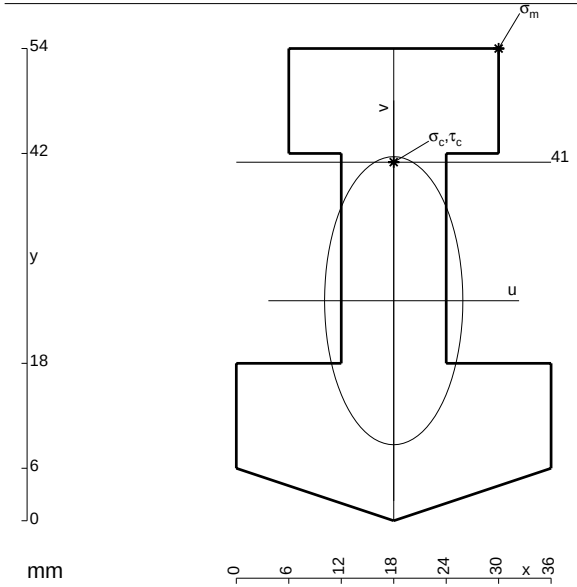
$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1 - 2\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

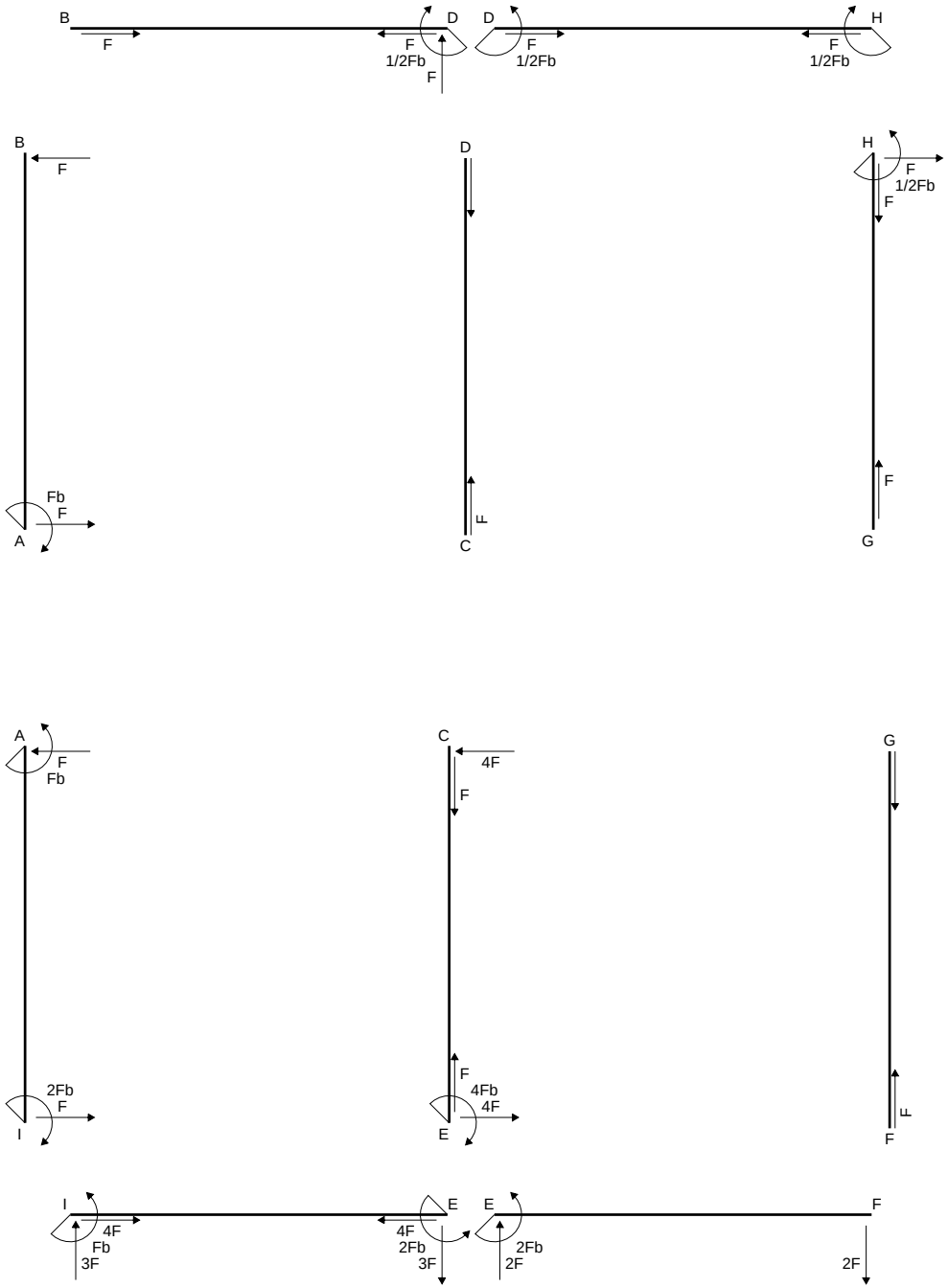
$= (\ b - b + 1/3\ b\ )\ Fb\ 1/EJ\ = 1/3\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/3\ b\ )\ Fb\ 1/EJ\ = 1/3\ Fb^2/EJ$



A = 1116. mm^2
J_u = 302839. mm^4
J_v = 69768. mm^4
y_g = 25.16 mm
T_y = 3360. N
M_x = -2520000. Nmm
x_m = 30. mm
y_m = 54. mm
u_m = 12. mm
v_m = 28.84 mm
$\sigma_m = -Mv/J_u$ = 240. N/mm^2
x_c = 18. mm
y_c = 41. mm
v_c = 15.84 mm
$\sigma_c = -Mv/J_u$ = 131.8 N/mm^2
τ_c = 6.263 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 132.2 N/mm^2
S^* = 6774. mm^3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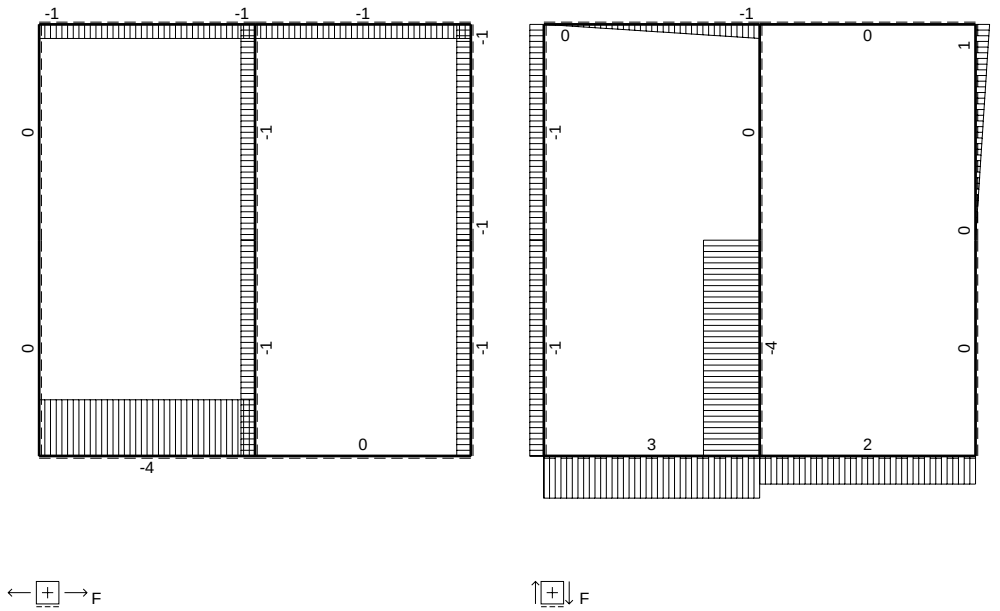
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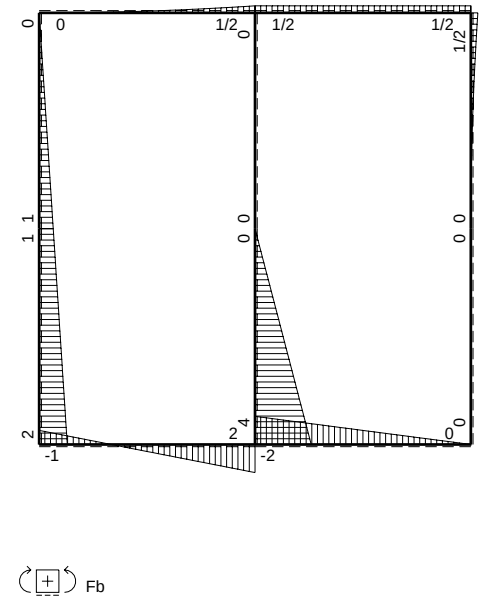
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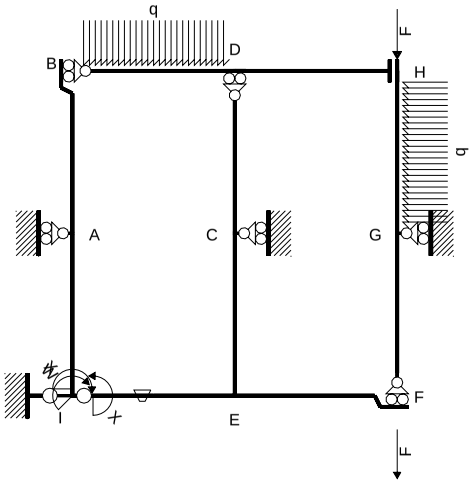
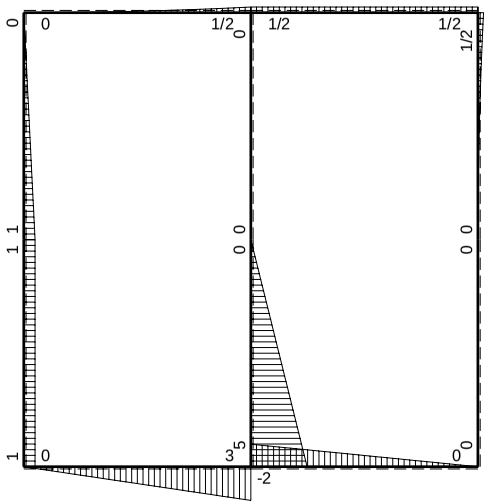
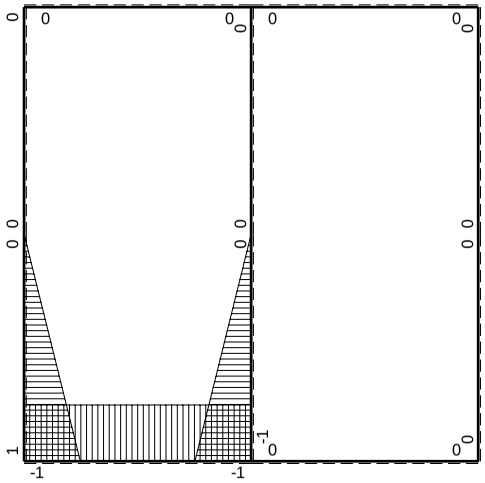


Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 942417 CI07.xxxx.015

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PROCEDIMENTO E RISULTATI 942417 CI07.xxxx.015

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	Fb-Fx	0	0	0	0	0+0	0
BA b	0	-Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	5Fb-5Fx	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-5Fx	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fb	0	Fb-Fx	0	$1-2x/b+x^2/b^2$	$(1/2+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	-Fb	0	Fx	0	x^2/b^2		
	totali						$-5/3Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

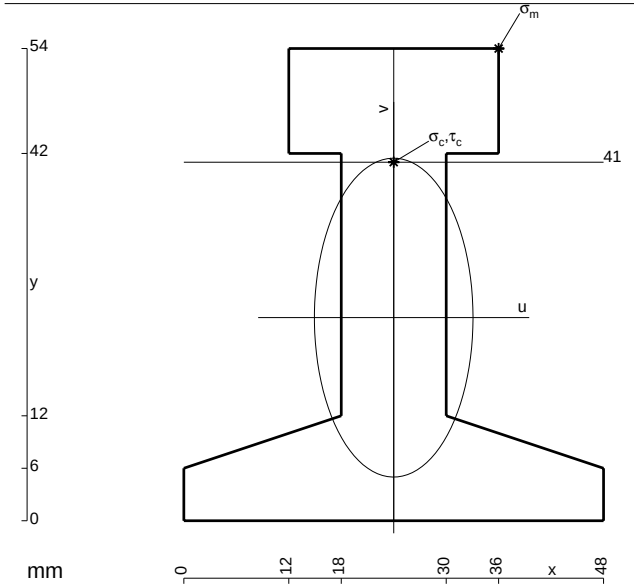
$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1 - x/b\ )\ Fb\ 1/EJ\ dx = [\ x - 1/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ$

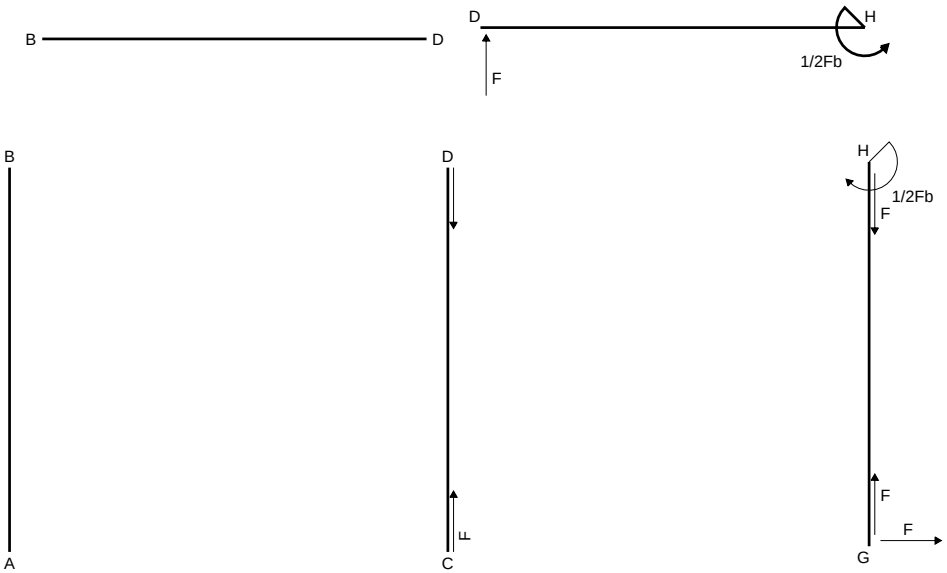
$= (\ b - 1/2\ b\ )\ Fb\ 1/EJ\ = 1/2\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (\ x/b\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ$

$= (1/2\ b\ )\ Fb\ 1/EJ\ = 1/2\ Fb^2/EJ$



A = 1116. mm^2
J_u = 371067. mm^4
J_v = 91800. mm^4
y_g = 23.23 mm
T_y = 2960. N
M_x = -2397600. Nmm
x_m = 36. mm
y_m = 54. mm
u_m = 12. mm
v_m = 30.77 mm
$\sigma_m = -Mv/J_u$ = 198.8 N/mm^2
x_c = 24. mm
y_c = 41. mm
v_c = 17.77 mm
$\sigma_c = -Mv/J_u$ = 114.8 N/mm^2
τ_c = 4.889 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 115.2 N/mm^2
S^* = 7354. mm^3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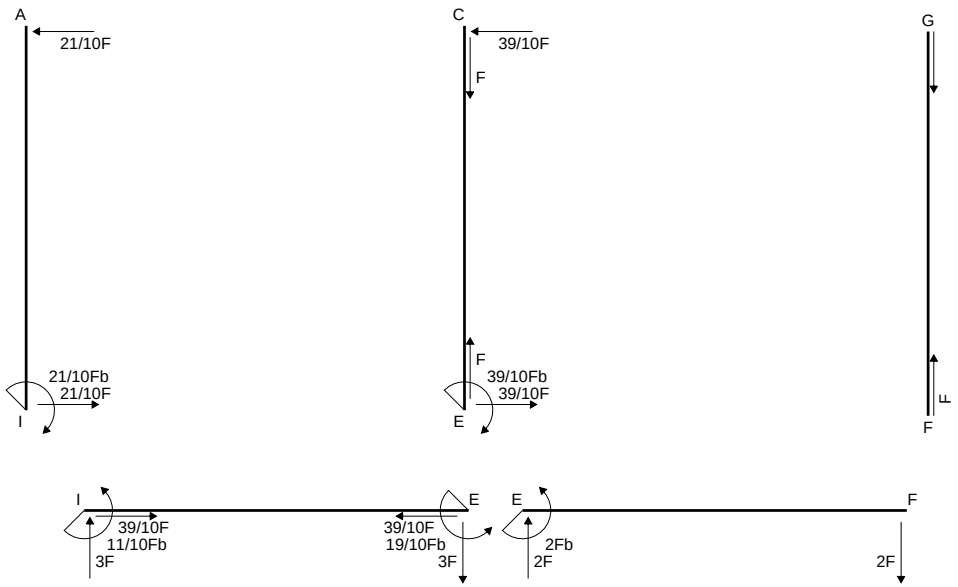
F
G


A
21/10F
21/10Fb
21/10F
I
C
39/10F
F
F
39/10Fb
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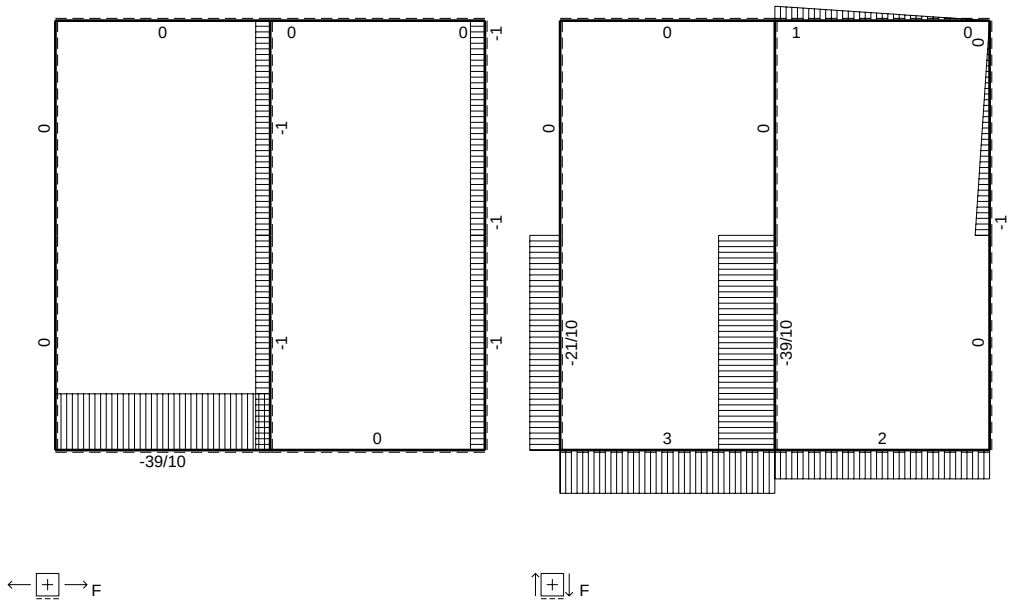
F
2F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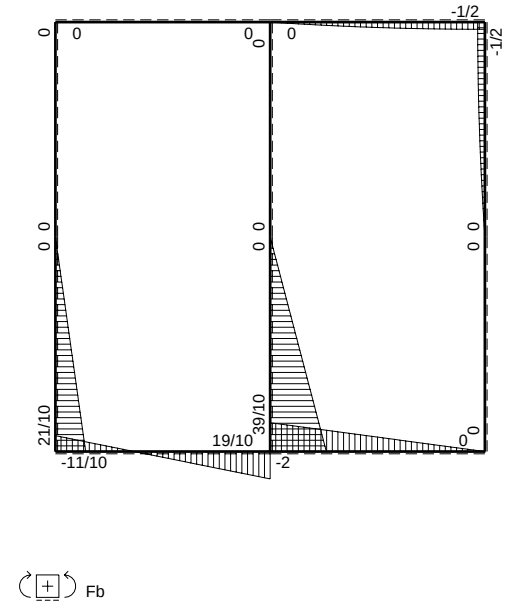
F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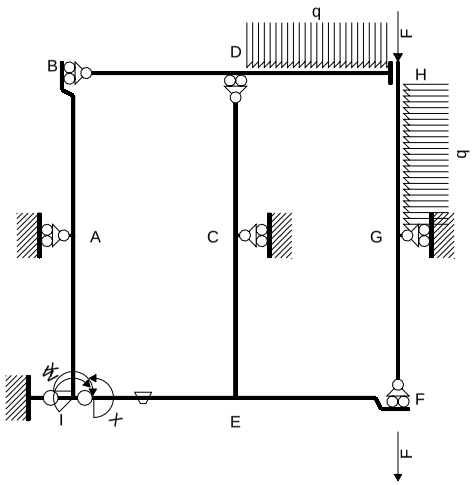
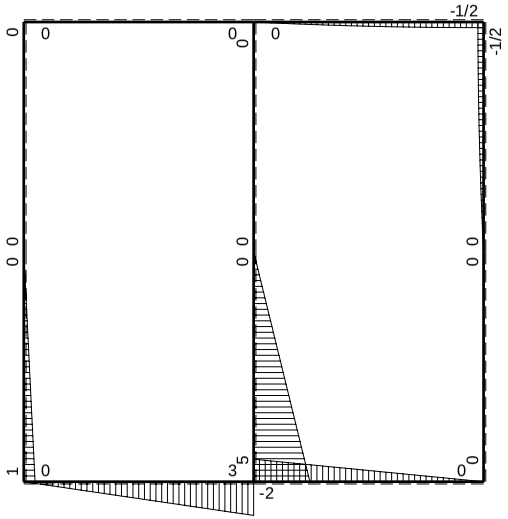
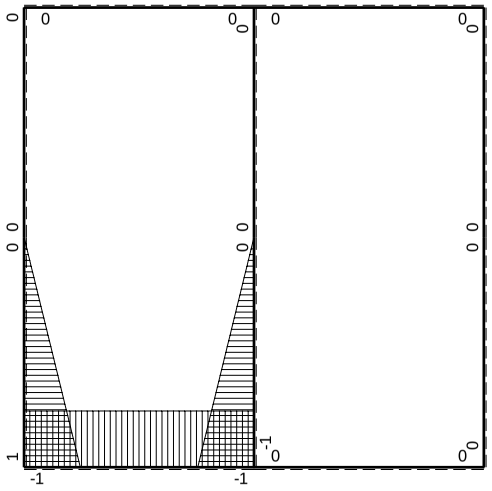
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 209824 CI07.xxxx.016

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-5Fx	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-5Fx	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fb-Fx	0	$Fb-2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/3+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	-Fx	0	Fx^2/b	0	x^2/b^2		
	totali						$-11/6Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						11/10Fb	

PROCEDIMENTO E RISULTATI 209824 CI07.xxxx.016

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

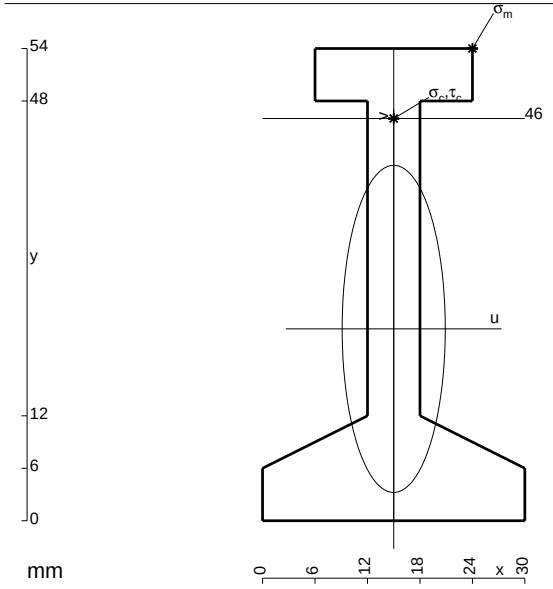
$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1 - 2\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

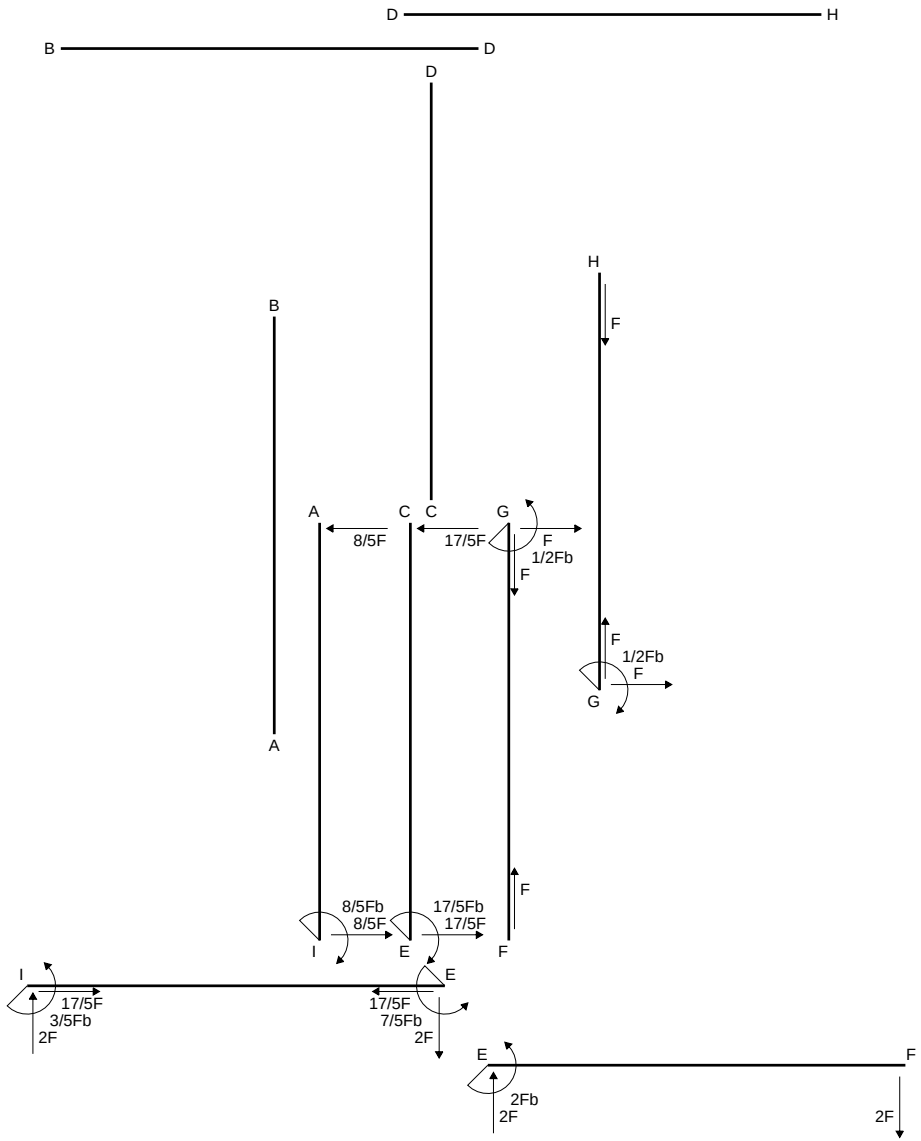
$= (\ b - b + 1/3\ b\ )\ Fb\ 1/EJ\ = 1/3\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/3\ b\ )\ Fb\ 1/EJ\ = 1/3\ Fb^2/EJ$



A = 612. mm^2
J_u = 214270. mm^4
J_v = 21276. mm^4
y_g = 21.94 mm
T_y = 1620. N
M_x = -1393200. Nmm
x_m = 24. mm
y_m = 54. mm
u_m = 9. mm
v_m = 32.06 mm
$\sigma_m = -Mv/J_u$ = 208.4 N/mm^2
x_c = 15. mm
y_c = 46. mm
v_c = 24.06 mm
$\sigma_c = -Mv/J_u$ = 156.4 N/mm^2
τ_c = 4.334 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 156.6 N/mm^2
S^* = 3439. mm^3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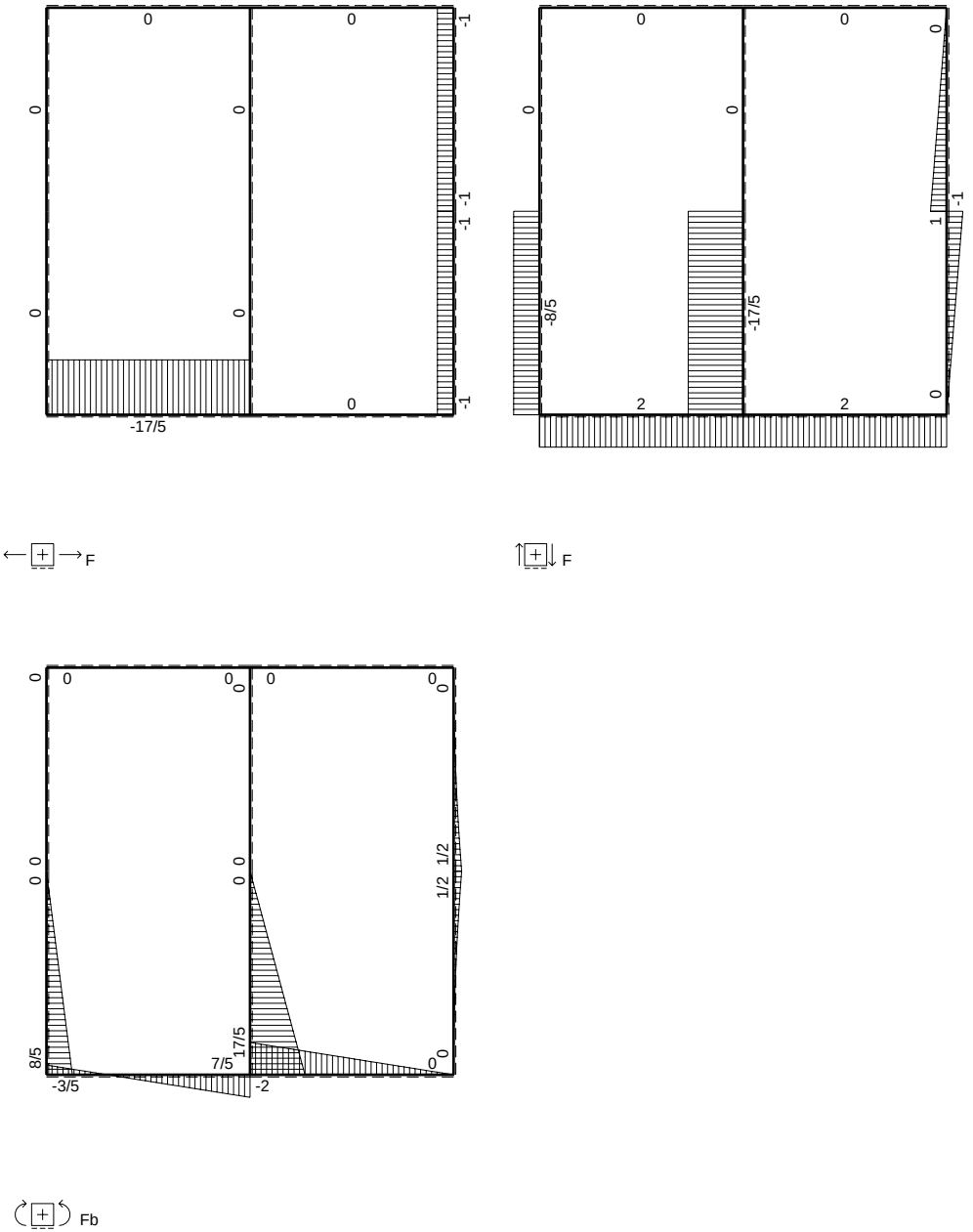
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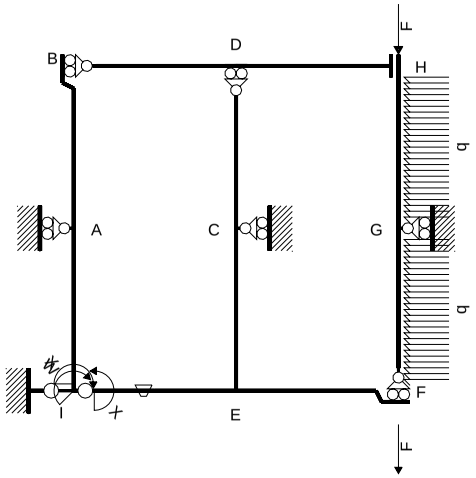
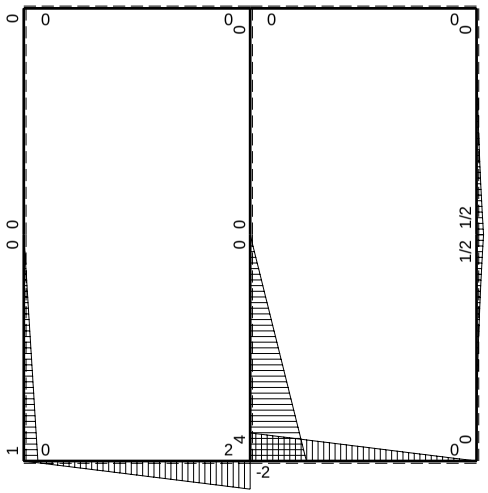
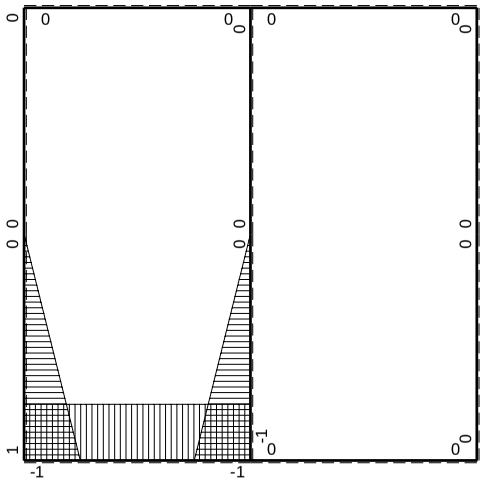


Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 986318 CI07.xxxx.017

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2qx^2$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	-1+x/b	4Fb-4Fx	0	$-4Fb+8Fx-4Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-4/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-4Fx	0	$-4Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fb-Fx	0	$Fb-2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/3+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	-Fx	0	Fx^2/b	0	x^2/b^2		
	totali						$-Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						3/5Fb	

PROCEDIMENTO E RISULTATI 986318 CI07.xxxx.017

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L_{EI}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-2\ b + b)\ Fb\ 1/EJ\ + (-\ b)\ \theta\ = 0$

$L_{EC}^{Xo} = \int_o^b (-4 + 8\ x/b - 4\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-4\ x + 4\ x^2/b - 4/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-4\ b + 4\ b - 4/3\ b)\ Fb\ 1/EJ\ = -4/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-4\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-4/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

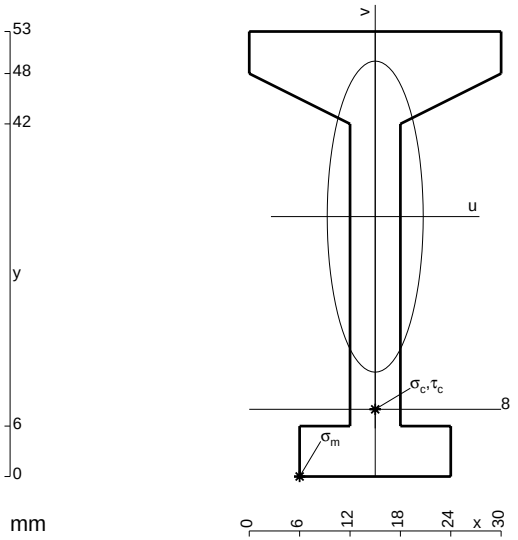
$= (-4/3\ b)\ Fb\ 1/EJ\ = -4/3\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ Fb\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

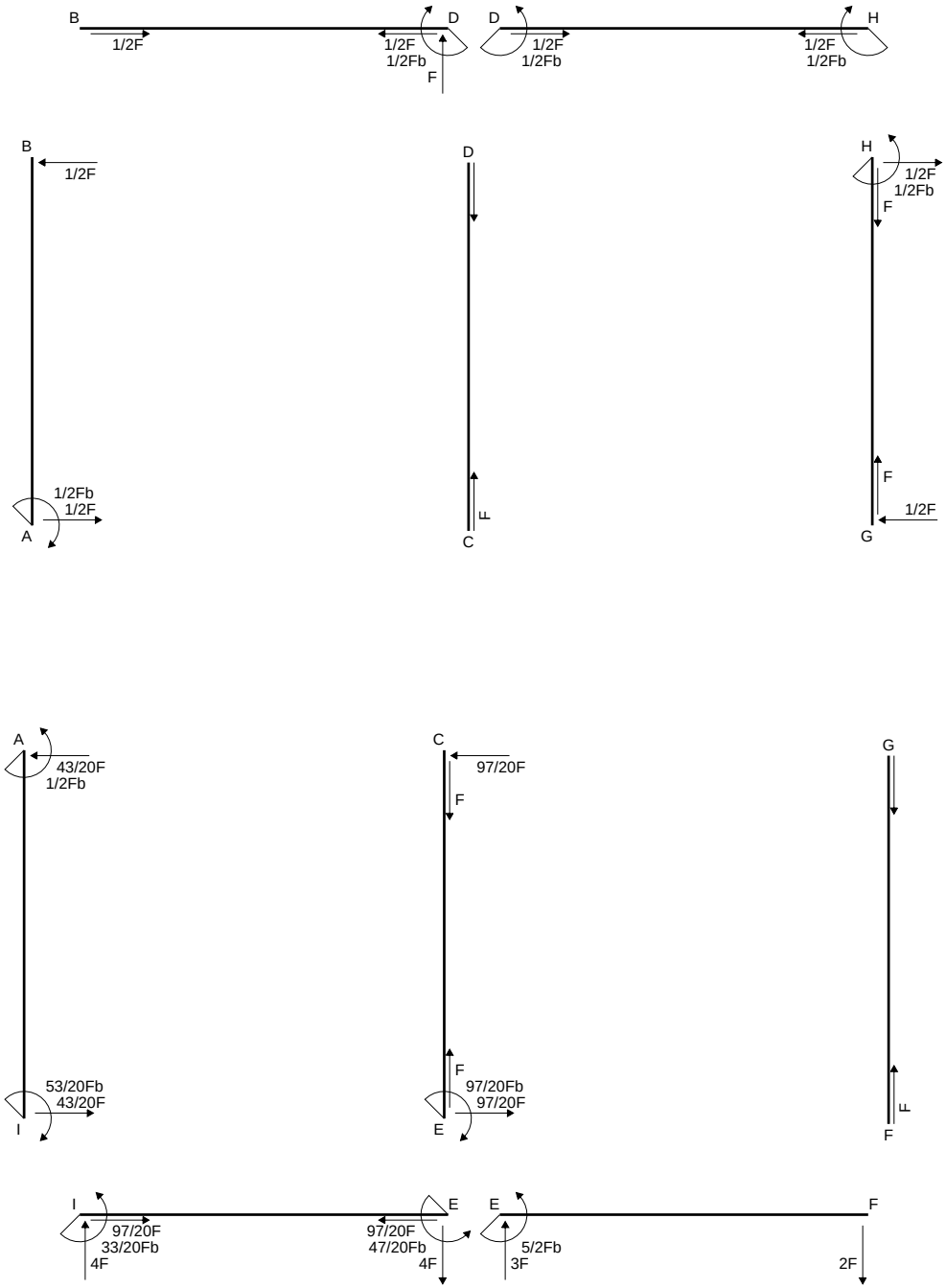
$= (\ b - b + 1/3\ b\ )\ Fb\ 1/EJ\ = 1/3\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/3\ b\ )\ Fb\ 1/EJ\ = 1/3\ Fb^2/EJ$



A = 582. mm^2
J_u = 199765. mm^4
J_v = 19026. mm^4
y_g = 30.95 mm
T_y = 1560. N
M_x = -1404000. Nmm
x_m = 6. mm
u_m = -9. mm
v_m = -30.95 mm
$\sigma_m = -Mv/J_u$ = -217.6 N/mm^2
x_c = 15. mm
y_c = 8. mm
v_c = -22.95 mm
$\sigma_c = -Mv/J_u$ = -161.3 N/mm^2
τ_c = 4.303 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 161.5 N/mm^2
S^* = 3306. mm^3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A
C
F
F
1/2F
G
A
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G
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E
F
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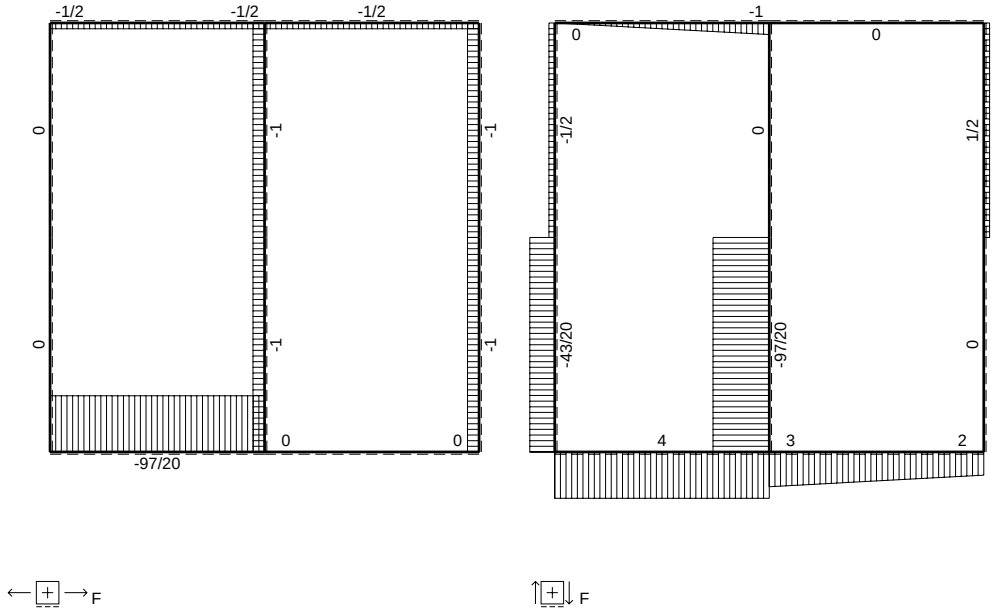
4F
5/2Fb
3F
2F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2
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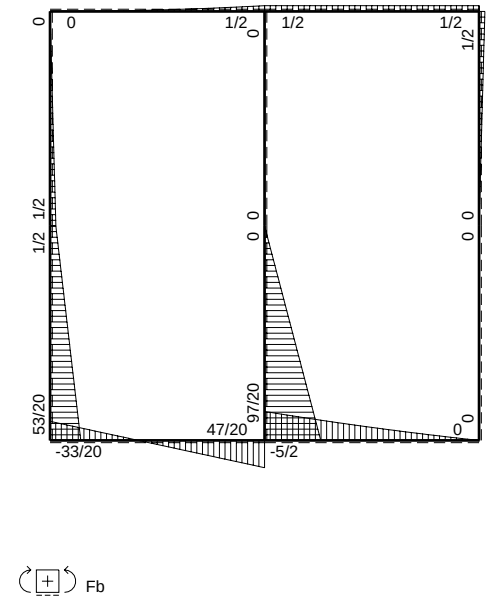
F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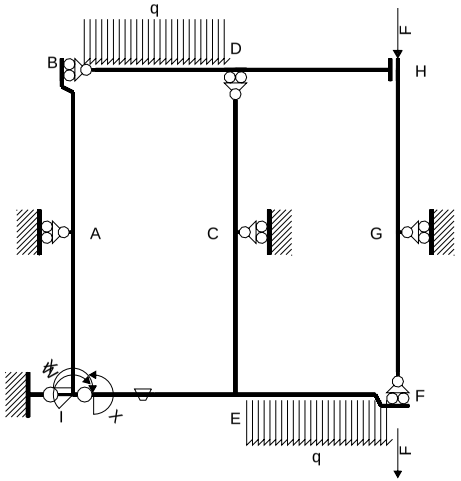
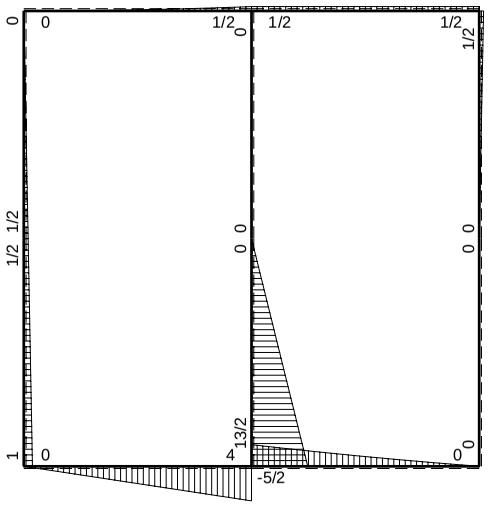
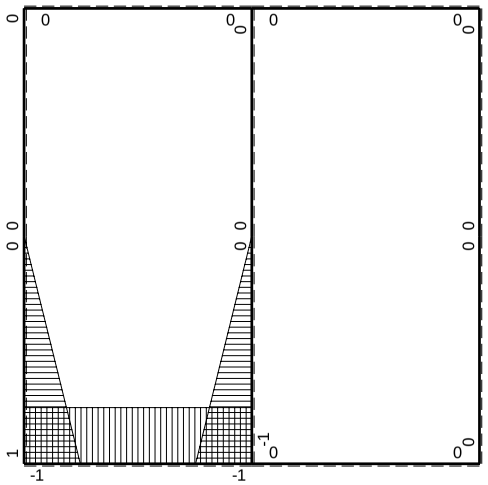
-5/2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 984261 CI07.xxxx.018

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
BA b	0	-1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-5/2Fb+3Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$2Fx+1/2qx^2$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fb+1/2Fx	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	4Fx	-Fb/EJ	-4Fx	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-4Fb+4Fx	Fb/EJ	-4Fb+4Fx	Fb/EJ	1		
EC b	-1+x/b	13/2Fb-13/2Fx	0	$-13/2Fb+13Fx-13/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-13/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-13/2Fx	0	$-13/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fb-1/2Fx	0	$Fb-3/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(5/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	-1/2Fb-1/2Fx	0	$1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-11/4Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						33/20Fb	

Sviluppi di calcolo iperstatica

PROCEDIMENTO E RISULTATI 984261 CI07.xxxx.018
@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-4 + 4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-4\ x + 2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-4\ b + 2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-13/2 + 13\ x/b - 13/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-13/2\ x + 13/2\ x^2/b - 13/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-13/2\ b + 13/2\ b - 13/6\ b\ )\ Fb\ 1/EJ\ = -13/6\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-13/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-13/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

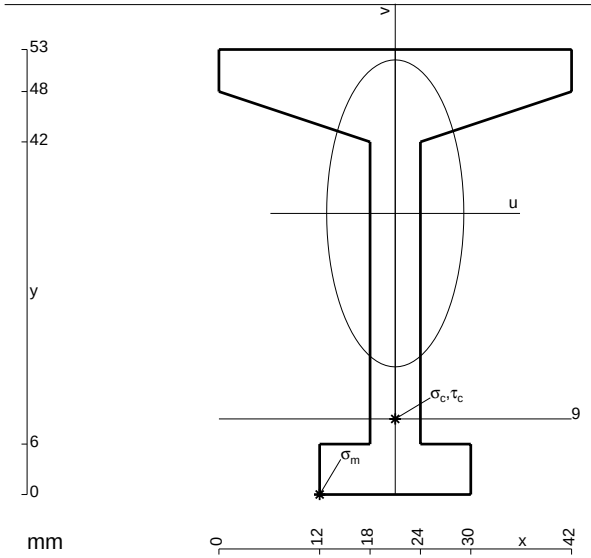
$= (-13/6\ b\ )\ Fb\ 1/EJ\ = -13/6\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1 - 3/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [\ x - 3/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

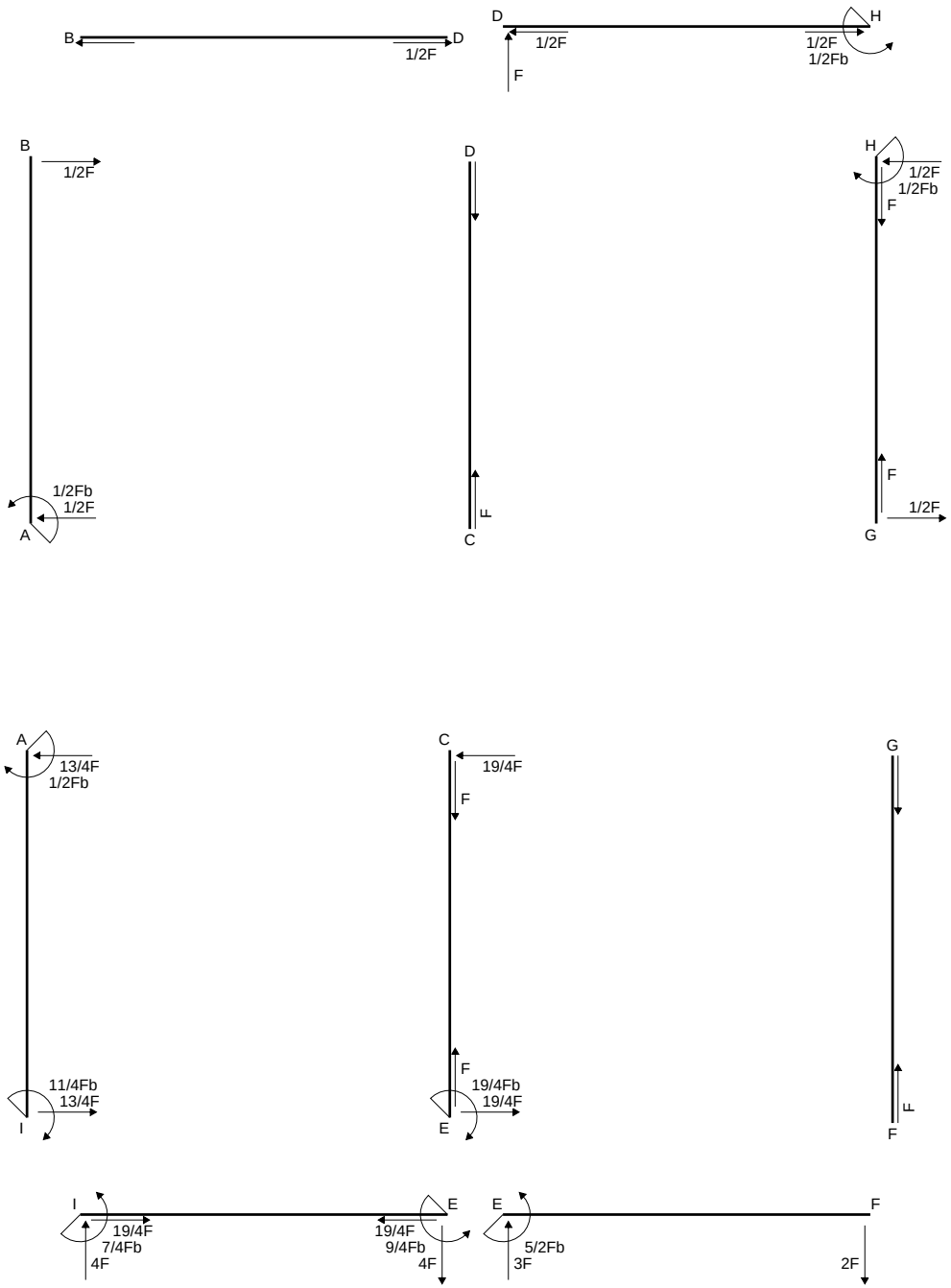
$= (\ b - 3/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = 5/12\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = 5/12\ Fb^2/EJ$



A = 678. mm^2
J_u = 226700. mm^4
J_v = 45234. mm^4
y_g = 33.48 mm
T_y = 1950. N
M_x = -1543750. Nmm
x_m = 12. mm
u_m = -9. mm
v_m = -33.48 mm
$\sigma_m = -Mv/J_u$ = -228. N/mm^2
x_c = 21. mm
y_c = 9. mm
v_c = -24.48 mm
$\sigma_c = -Mv/J_u$ = -166.7 N/mm^2
τ_c = 5.39 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 167. N/mm^2
S^* = 3760. mm^3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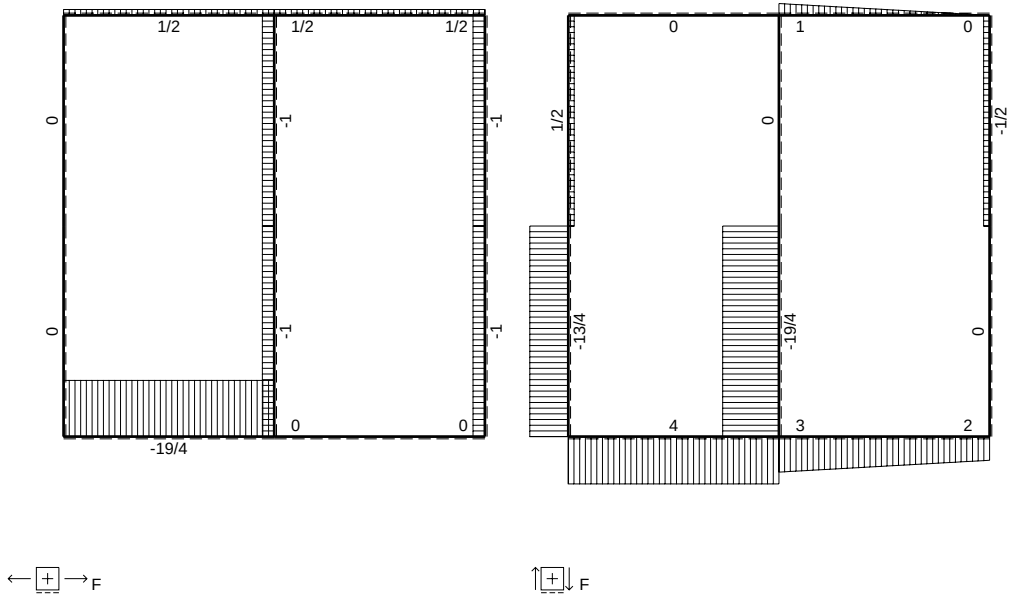
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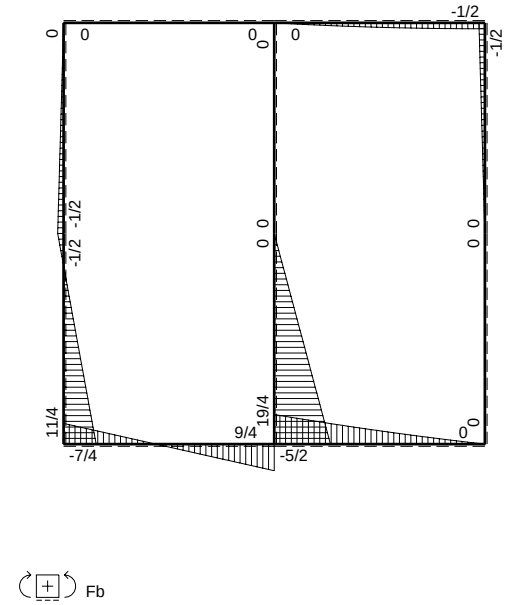
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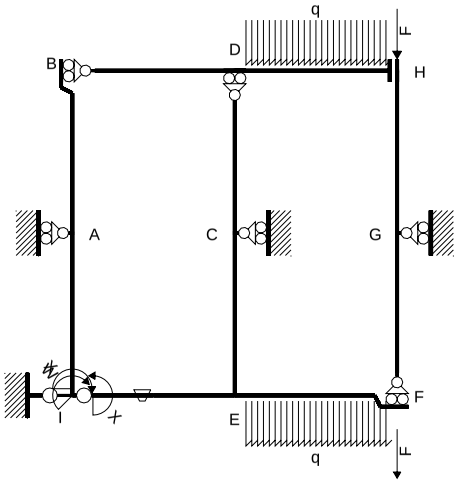
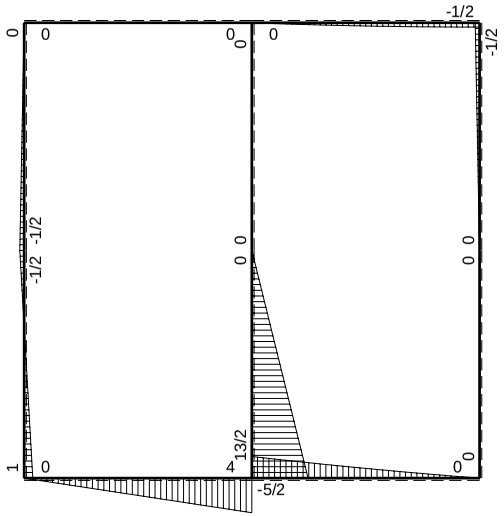
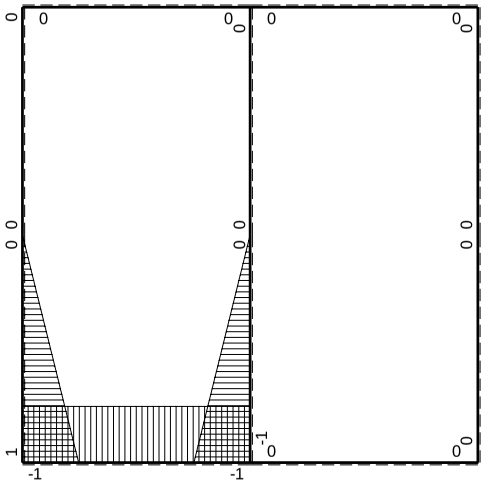
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 212606 CI07.xxxx.019

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

PROCEDIMENTO E RISULTATI 212606 CI07.xxxx.019

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-5/2Fb+3Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$2Fx+1/2qx^2$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	-1/2Fx	0	0	0	0	0+0	0
HG b	0	1/2Fb-1/2Fx	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	4Fx	-Fb/EJ	-4Fx	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-4Fb+4Fx	Fb/EJ	-4Fb+4Fx	Fb/EJ	1		
EC b	-1+x/b	13/2Fb-13/2Fx	0	$-13/2Fb+13Fx-13/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-13/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-13/2Fx	0	$-13/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fb-3/2Fx	0	$Fb-5/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/4+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-3/2Fx	0	$-1/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-35/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						7/4Fb	

Sviluppi di calcolo iperstatica

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-4 + 4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-4\ x + 2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-4\ b + 2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-13/2 + 13\ x/b - 13/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-13/2\ x + 13/2\ x^2/b - 13/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-13/2\ b + 13/2\ b - 13/6\ b\ )\ Fb\ 1/EJ\ = -13/6\ \ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-13/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-13/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

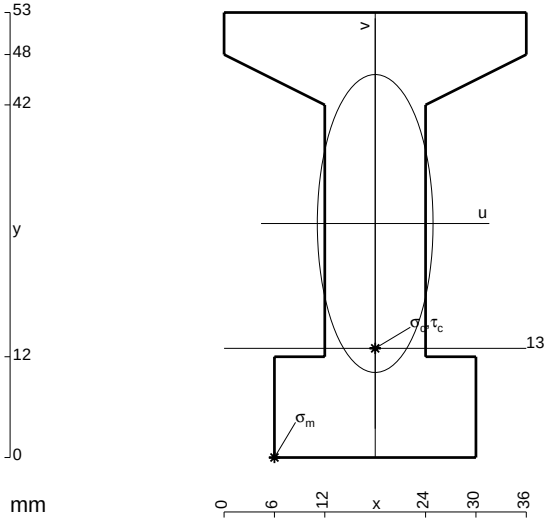
$= (-13/6\ b\ )\ Fb\ 1/EJ\ = -13/6\ \ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1 - 5/2\ x/b + 3/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [\ x - 5/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

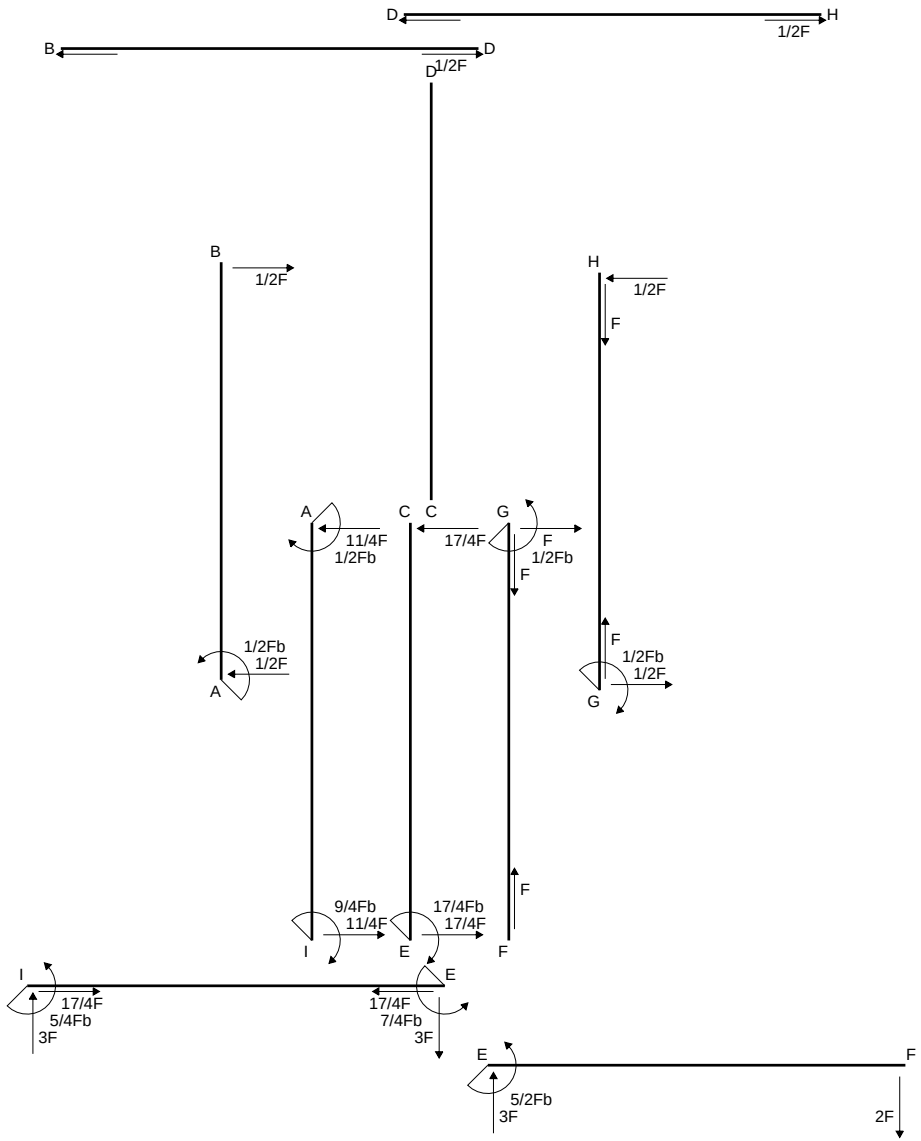
$= (\ b - 5/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = 1/4\ \ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 3/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = 1/4\ \ Fb^2/EJ$



A = 972. mm^2
J_u = 306188. mm^4
J_v = 46224. mm^4
y_g = 27.87 mm
T_y = 3150. N
M_x = -2625000. Nmm
x_m = 6. mm
u_m = -12. mm
v_m = -27.87 mm
$\sigma_m = -Mv/J_u$ = -238.9 N/mm^2
x_c = 18. mm
y_c = 13. mm
v_c = -14.87 mm
$\sigma_c = -Mv/J_u$ = -127.5 N/mm^2
τ_c = 5.558 N/mm^2
$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2}$ = 127.8 N/mm^2
S^* = 6483. mm^3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H
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B
D
D 1/2F
B
1/2F
H
1/2F
F
A
C C
G
11/4F
1/2Fb
17/4F
F
1/2Fb
F
1/2Fb
1/2F
A
F
1/2Fb
1/2F
G
F
9/4Fb
11/4F
17/4Fb
17/4F
I
E
F
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3F
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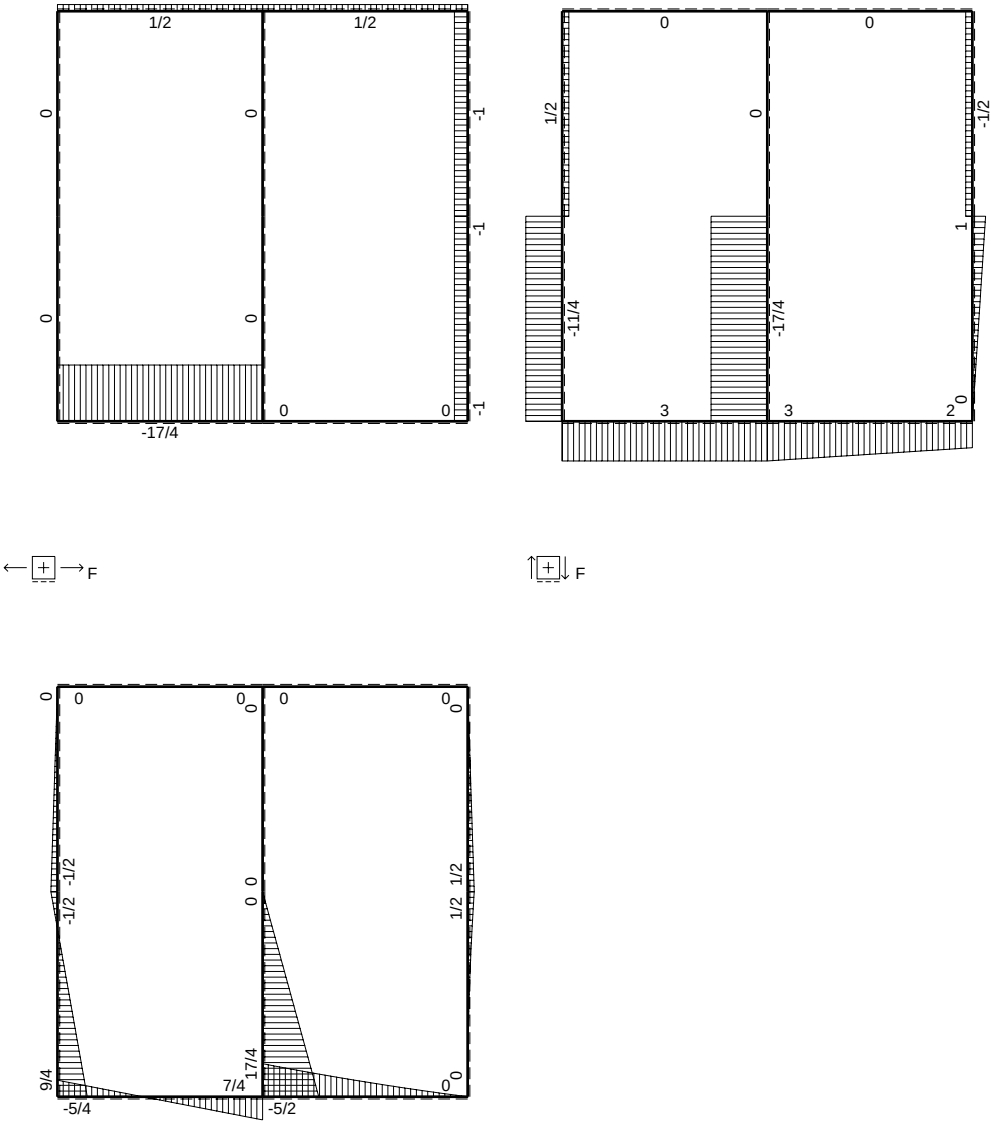
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-1/2
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-17/4
1
3
3
2
F
F
0
0
0
0
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0
0
0
0
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1/2
9/4
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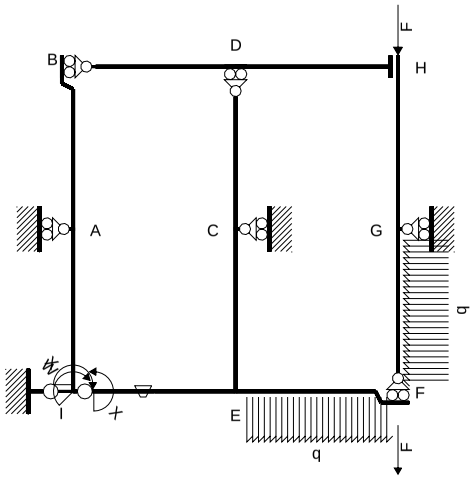
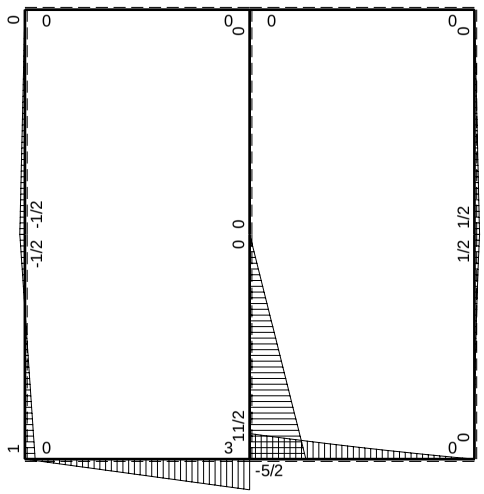
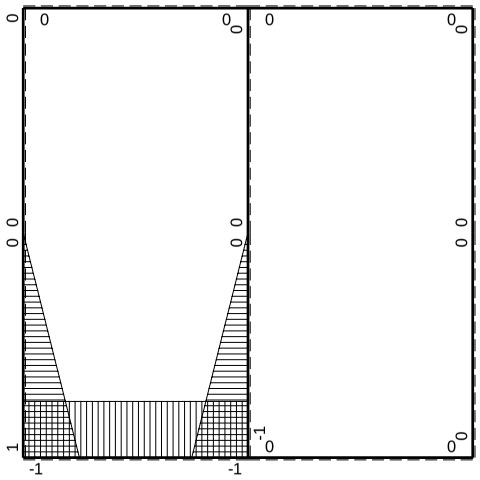
7/4
17/4
0
0
-5/2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 907291 CI07.xxxx.020

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-5/2Fb+3Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$2Fx+1/2qx^2$	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	11/2Fb-11/2Fx	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-11/2Fx$	0	$-11/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fb-3/2Fx	0	$Fb-5/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/4+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-3/2Fx	0	$-1/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-25/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						5/4Fb	

Sviluppi di calcolo iperstatica

PROCEDIMENTO E RISULTATI 907291 CI07.xxxx.020
@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-11/2 + 11\ x/b - 11/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-11/2\ x + 11/2\ x^2/b - 11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-11/2\ b + 11/2\ b - 11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-11/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

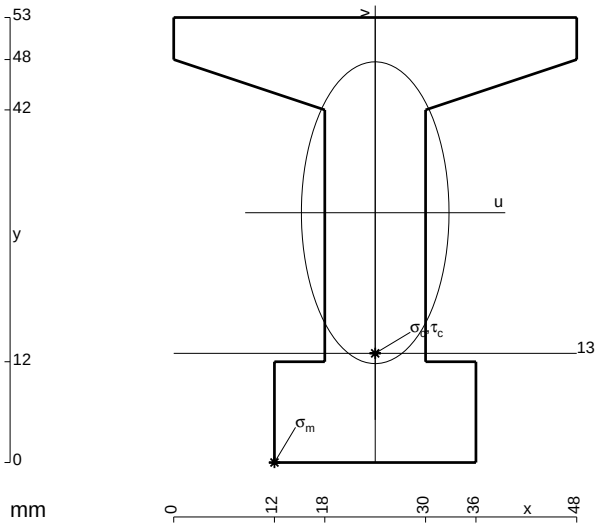
$= (-11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1 - 5/2\ x/b + 3/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [\ x - 5/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (\ b - 5/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = 1/4\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 3/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = 1/4\ Fb^2/EJ$



$A = 1068.\ mm^2$

$J_u = 345159.\ mm^4$

$J_v = 82584.\ mm^4$

$y_g = 29.75\ mm$

$T_y = 5250.\ N$

$M_x = -2318750.\ Nmm$

$x_m = 12.\ mm$

$u_m = -12.\ mm$

$v_m = -29.75\ mm$

$\sigma_m = -Mv/J_u = -199.9\ N/mm^2$

$x_c = 24.\ mm$

$y_c = 13.\ mm$

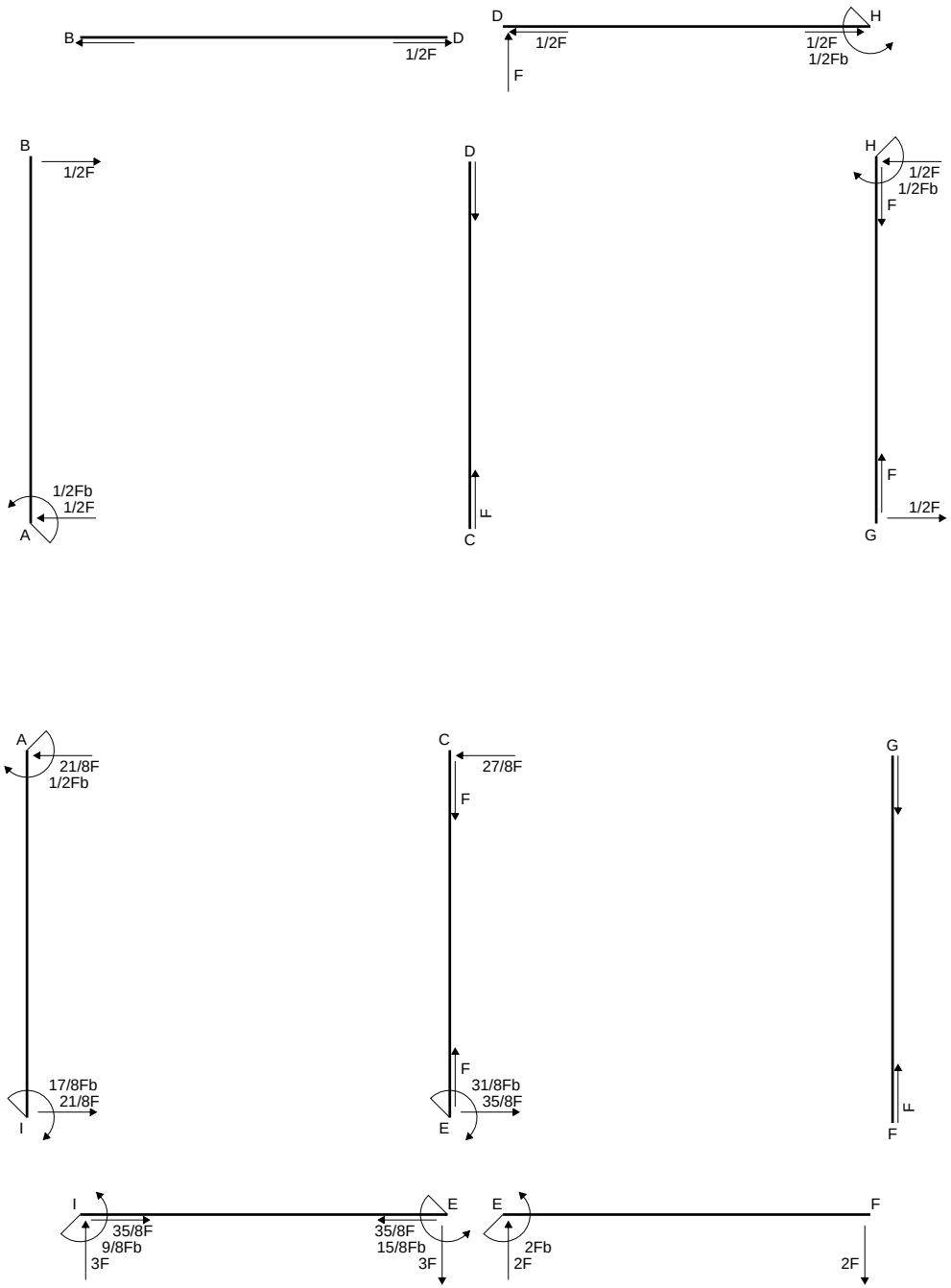
$v_c = -16.75\ mm$

$\sigma_c = -Mv/J_u = -112.5\ N/mm^2$

$\tau_c = 8.933\ N/mm^2$

$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 113.6\ N/mm^2$

$S^* = 7048.\ mm^3$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F
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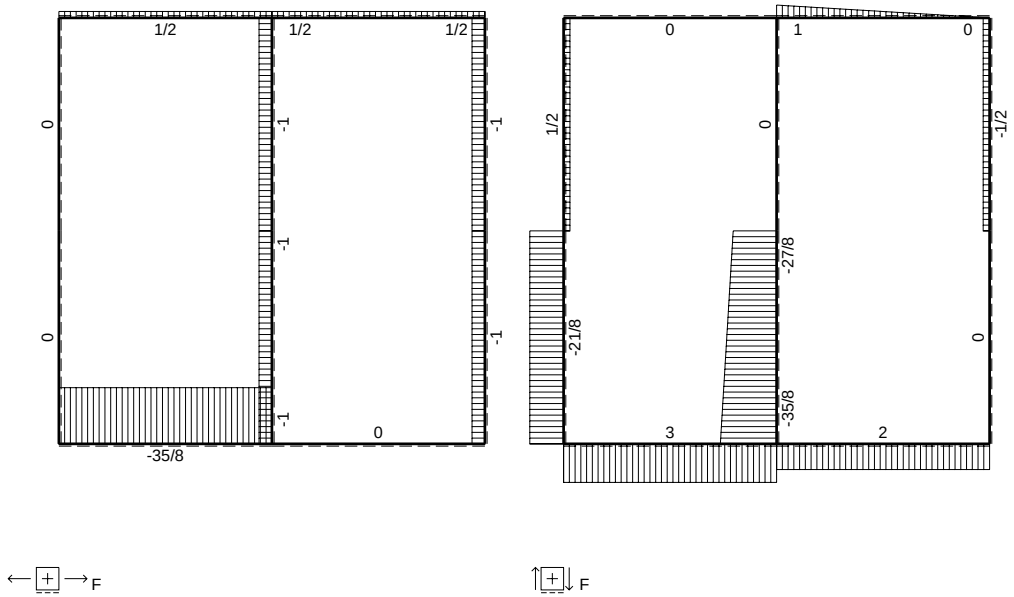
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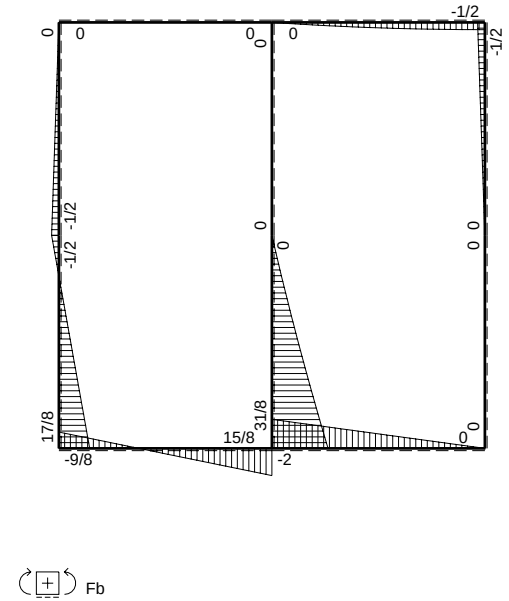
F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15/8
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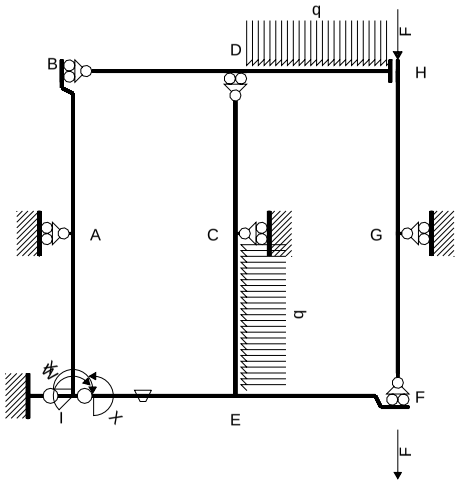
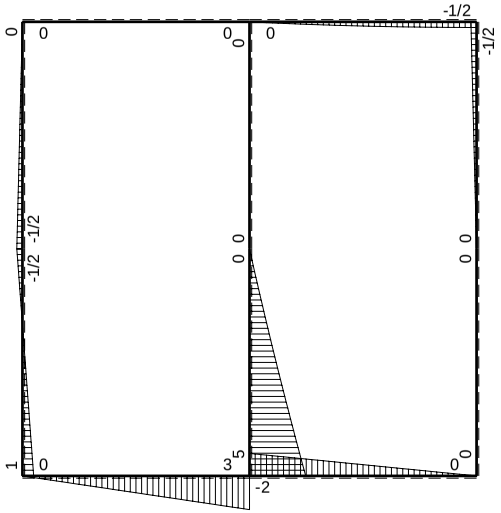
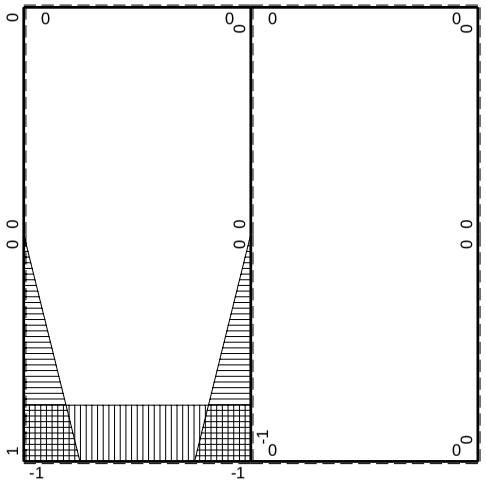
-2
0
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 213363 CI07.xxxx.021

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PROCEDIMENTO E RISULTATI 213363 CI07.xxxx.021

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	-1/2Fx	0	0	0	0	0+0	0
HG b	0	1/2Fb-1/2Fx	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	$5Fb-11/2Fx+1/2qx^2$	0	$-5Fb+21/2Fx-6Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-13/8+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-9/2Fx-1/2qx^2$	0	$-9/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2		
IA b	1-x/b	Fb-3/2Fx	0	$Fb-5/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/4+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-3/2Fx	0	$-1/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-15/8Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						9/8Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 21/2\ x/b - 6\ x^2/b^2 + 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx = [-5\ x + 21/4\ x^2/b - 2\ x^3/b^2 + 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 21/4\ b - 2\ b + 1/8\ b\ )\ Fb\ 1/EJ\ = -13/8\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-9/2\ x^2/b^2 - 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx = [-3/2\ x^3/b^2 - 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

$= (-3/2\ b - 1/8\ b\ )\ Fb\ 1/EJ\ = -13/8\ Fb^2/EJ$

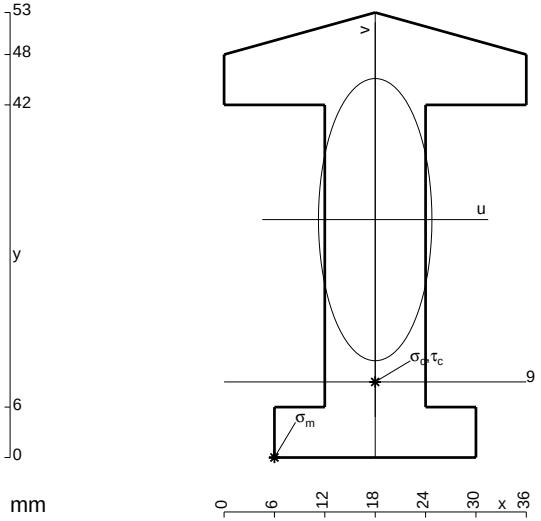
$L_{IA}^{Xo} = \int_o^b (1 - 5/2\ x/b + 3/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [\ x - 5/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (\ b - 5/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = 1/4\ Fb^2/EJ$

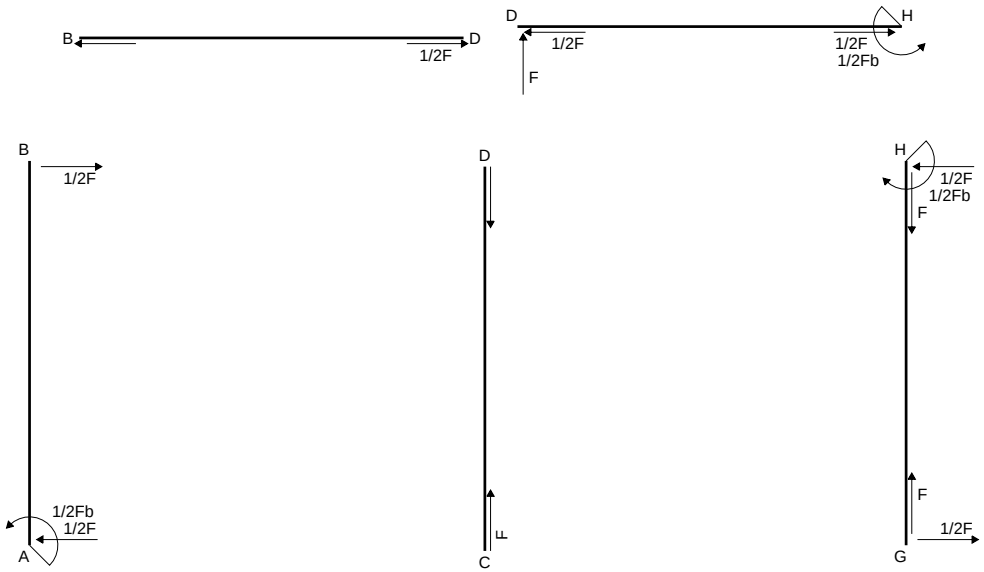
$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 3/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = 1/4\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 213363 CI07.xxxx.021



A = 882. mm^2
J_u = 249349. mm^4
J_v = 40284. mm^4
y_g = 28.33 mm
T_y = 3180. N
M_x = -1844400. Nmm
x_m = 6. mm
u_m = -12. mm
v_m = -28.33 mm
$\sigma_m = -Mv/J_u$ = -209.6 N/mm^2
x_c = 18. mm
y_c = 9. mm
v_c = -19.33 mm
$\sigma_c = -Mv/J_u$ = -143. N/mm^2
τ_c = 4.674 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 143.2 N/mm^2
S^* = 4398. mm^3


B
D
1/2F
D
H
1/2F
1/2F
1/2Fb
F
B
1/2F
1/2Fb
1/2F
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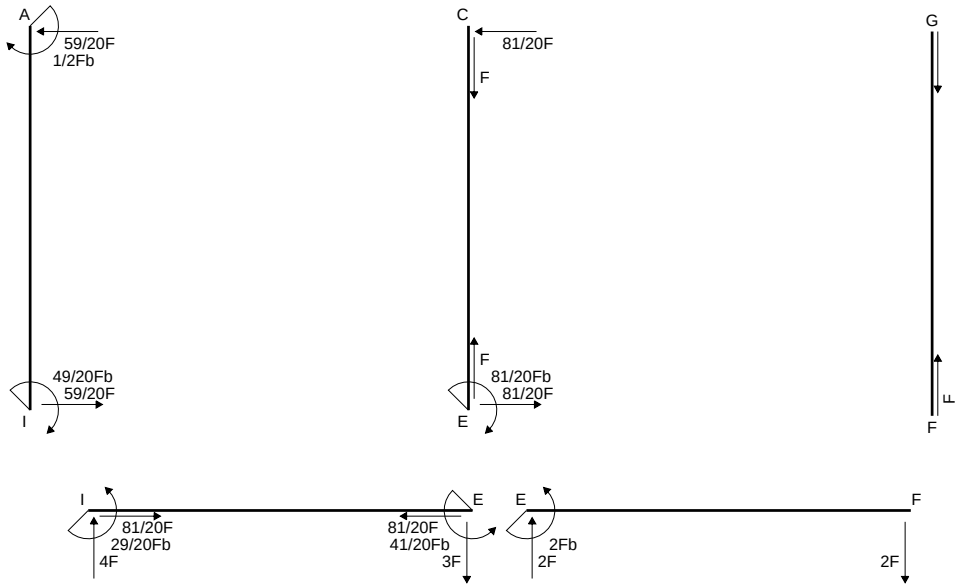
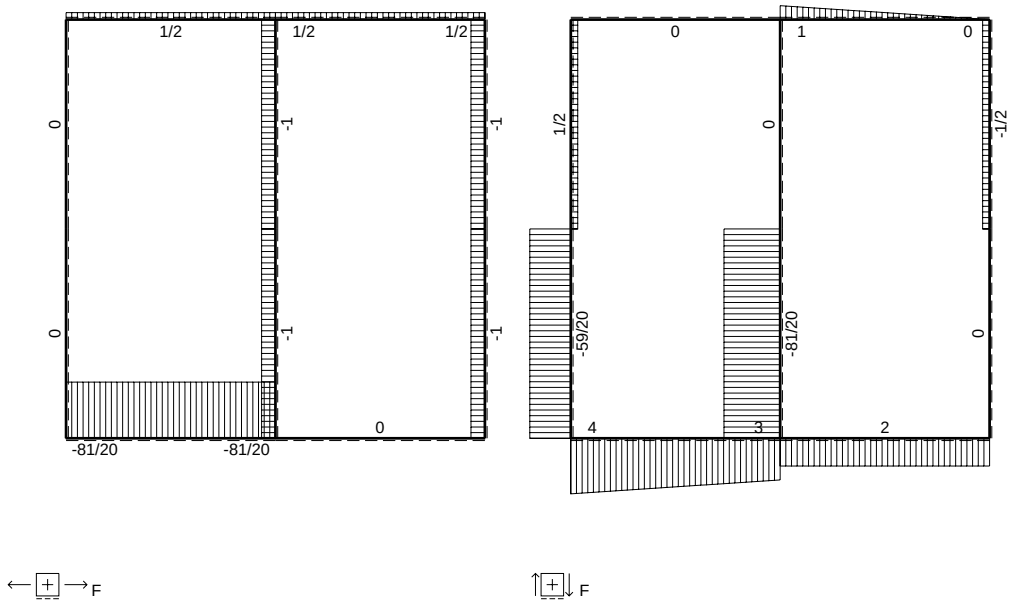
D
F
C
H
1/2F
1/2Fb
F
F
1/2F
G


A
59/20F
1/2Fb
49/20Fb
59/20F
I
C
81/20F
F
F
81/20Fb
81/20F
E
G
F
F
I
81/20F
29/20Fb
4F
E
81/20F
41/20Fb
3F
E
2Fb
2F
F
2F


1/2
1/2
1/2
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-1
-1
0
-1
-1
-81/20
-81/20
0
F
0
1
0
1/2
0
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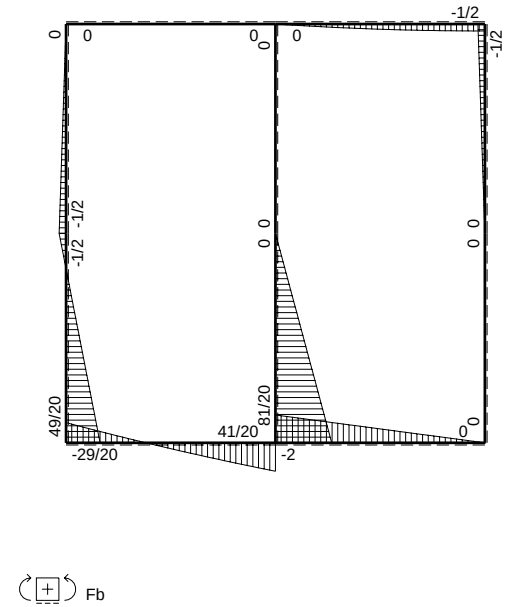
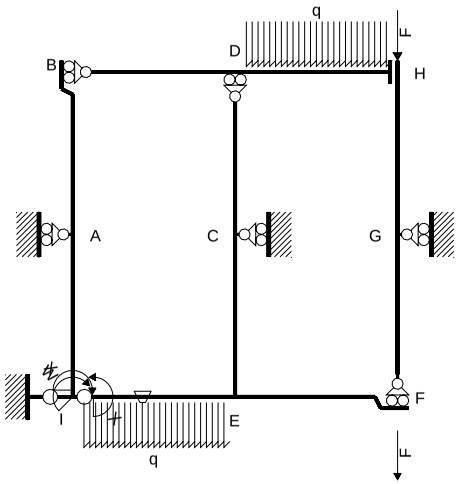
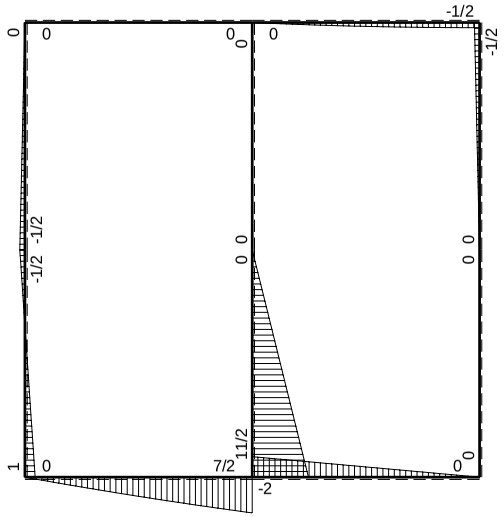
-59/20
-81/20
0
4
3
2
F

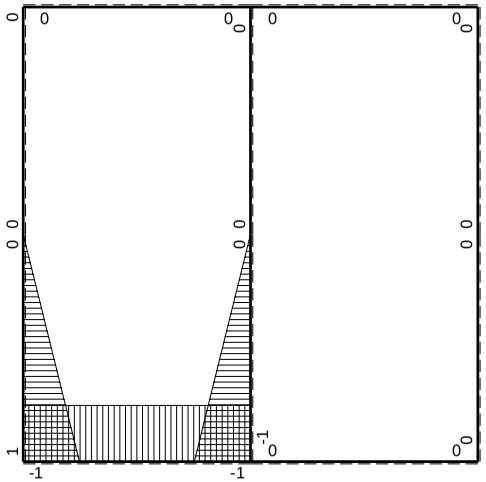

-1/2
0
0
0
0
-1/2
-1/2 -1/2
0 0
0 0
49/20
41/20
81/20
0
0
-29/20
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 226747 CI07.xxxx.022

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PROCEDIMENTO E RISULTATI 226747 CI07.xxxx.022

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	-1/2Fx	0	0	0	0	0+0	0
HG b	0	1/2Fb-1/2Fx	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$4Fx-1/2qx^2$	-Fb/EJ	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	-1+x/b	11/2Fb-11/2Fx	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-11/2Fx	0	$-11/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fb-3/2Fx	0	$Fb-5/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/4+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-3/2Fx	0	$-1/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-29/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						29/20Fb	

Sviluppi di calcolo iperstatica

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$L^{XX}_{IE} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EI} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EC} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{CE} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{IA} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{AI} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{Xo}_{IE} = \int_o^b (-4\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L^{Xo}_{EI} = \int_o^b (-7/2 + 3\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx$

$= [-7/2\ x + 3/2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-7/2\ b + 3/2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L^{Xo}_{EC} = \int_o^b (-11/2 + 11\ x/b - 11/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-11/2\ x + 11/2\ x^2/b - 11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-11/2\ b + 11/2\ b - 11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L^{Xo}_{CE} = \int_o^b (-11/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

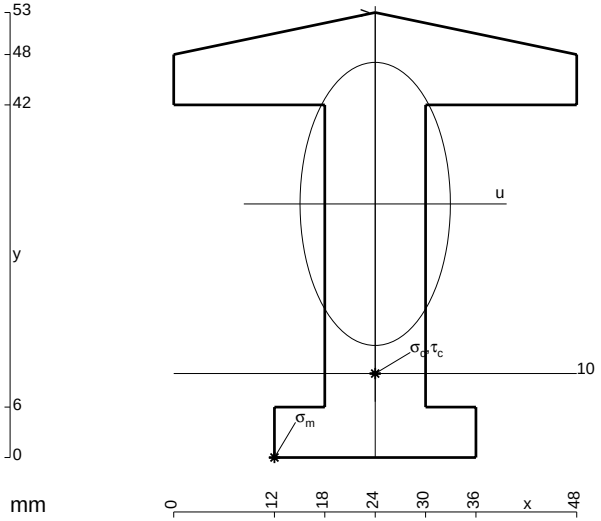
$L^{Xo}_{IA} = \int_o^b (1 - 5/2\ x/b + 3/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [\ x - 5/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (\ b - 5/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = 1/4\ Fb^2/EJ$

$L^{Xo}_{AI} = \int_o^b (-1/2\ x/b + 3/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = 1/4\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 226747 CI07.xxxx.022



A = 984. mm^2
J_u = 279819. mm^4
J_v = 78912. mm^4
y_g = 30.2 mm
T_y = 3220. N
M_x = -2028600. Nmm
x_m = 12. mm
u_m = -12. mm
v_m = -30.2 mm
$\sigma_m = -Mv/J_u$ = -219. N/mm^2
x_c = 24. mm
y_c = 10. mm
v_c = -20.2 mm
$\sigma_c = -Mv/J_u$ = -146.5 N/mm^2
τ_c = 4.778 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 146.7 N/mm^2
S^* = 4983. mm^3

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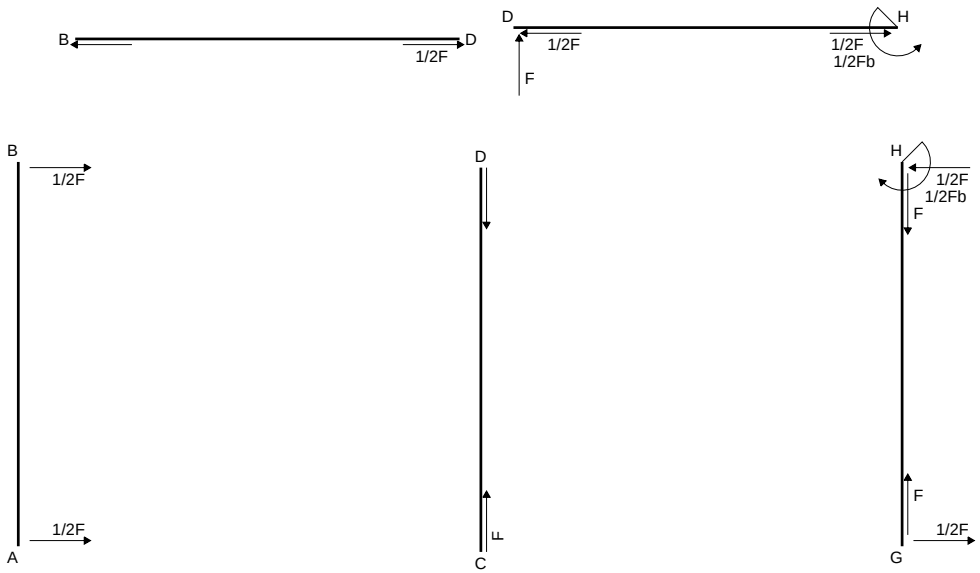
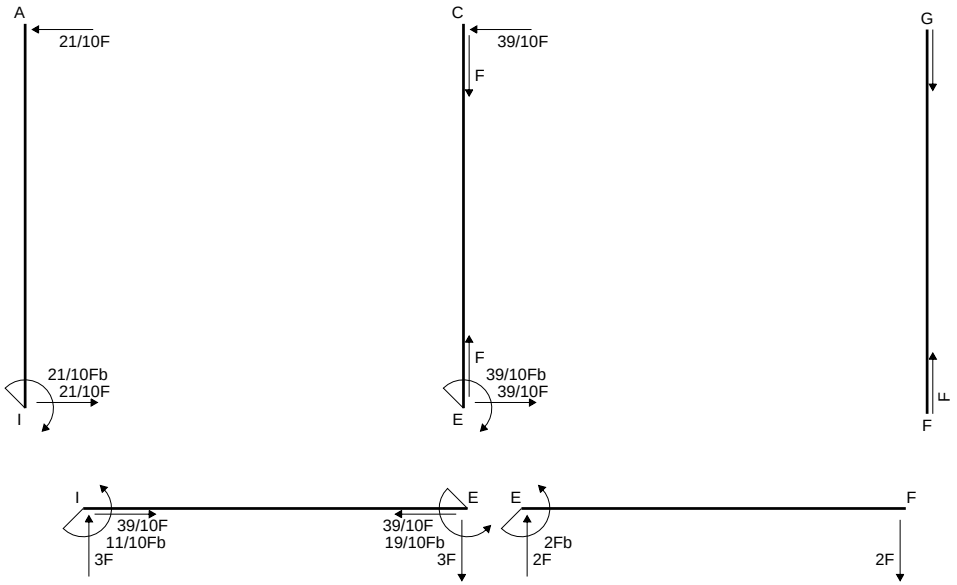

B
D
1/2F
D
H
1/2F
1/2F
1/2Fb
F
B
1/2F
A
1/2F
D
F
C
H
1/2F
1/2Fb
F
F
G
1/2F


A
21/10F
21/10Fb
21/10F
I
C
39/10F
F
F
39/10Fb
39/10F
E
G
F
F
I
39/10F
11/10Fb
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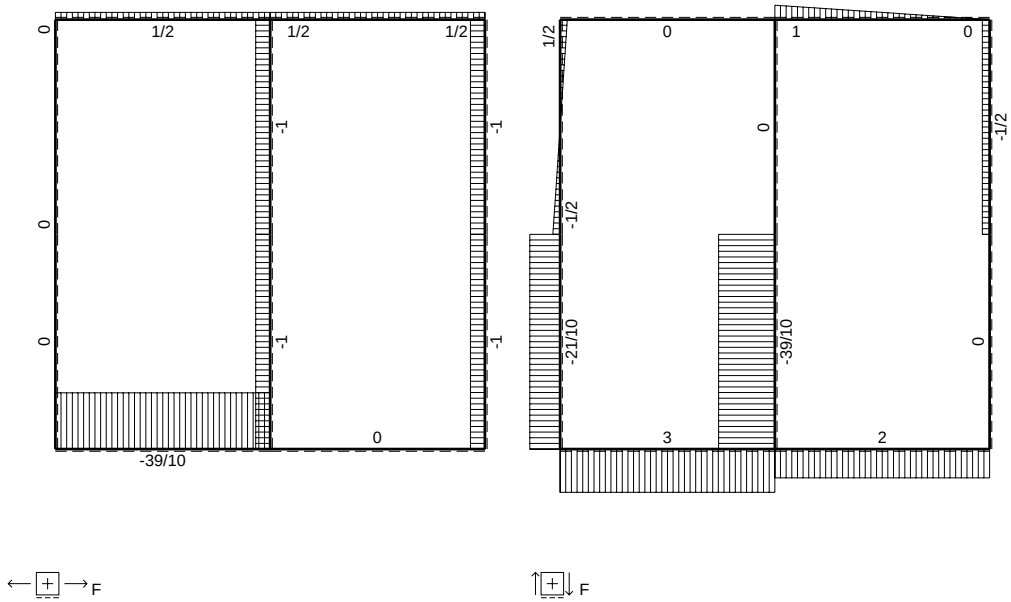
19/10Fb
3F
E
2Fb
2F
F
2F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F
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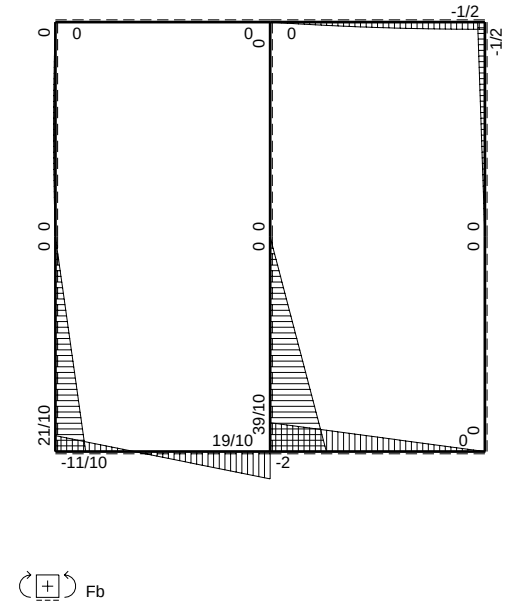
-39/10
0
-1/2
3
2
F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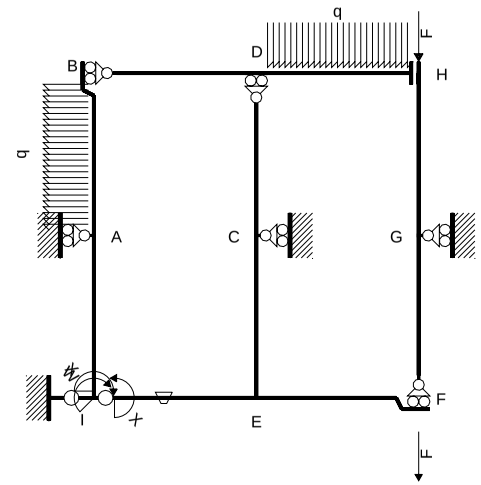
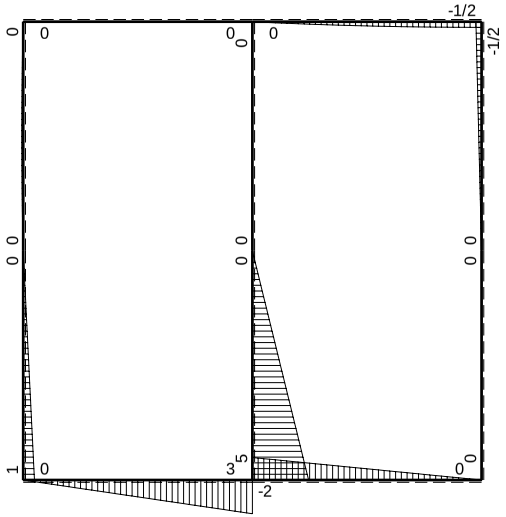
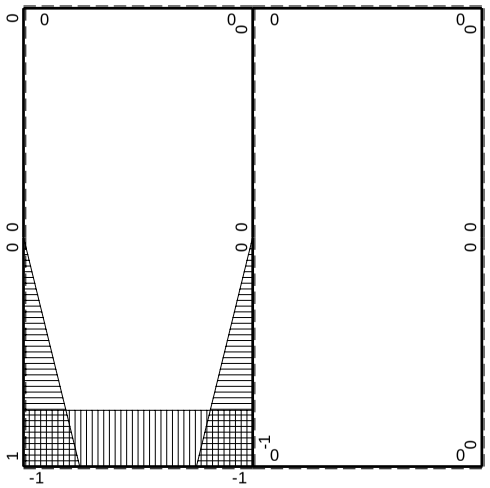
0 0
21/10
39/10
19/10
0
-11/10
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 933579 CI07.xxxx.023

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	-1/2Fx	0	0	0	0	0+0	0
HG b	0	1/2Fb-1/2Fx	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-5Fx	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-5Fx	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fb-Fx	0	$Fb-2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/3+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	-Fx	0	Fx^2/b	0	x^2/b^2		
	totali						$-11/6Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						11/10Fb	

PROCEDIMENTO E RISULTATI 933579 CI07.xxxx.023

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

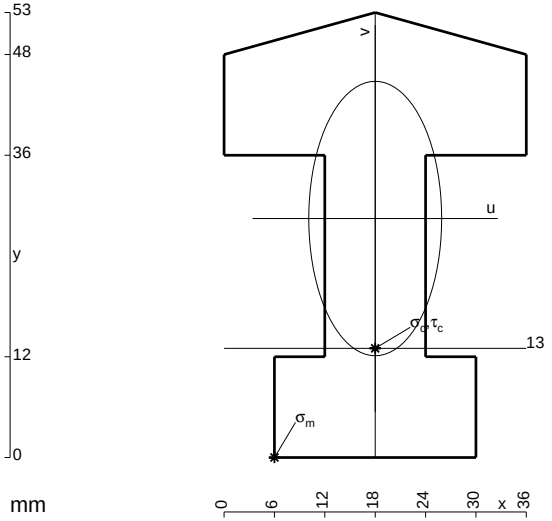
$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1 - 2\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

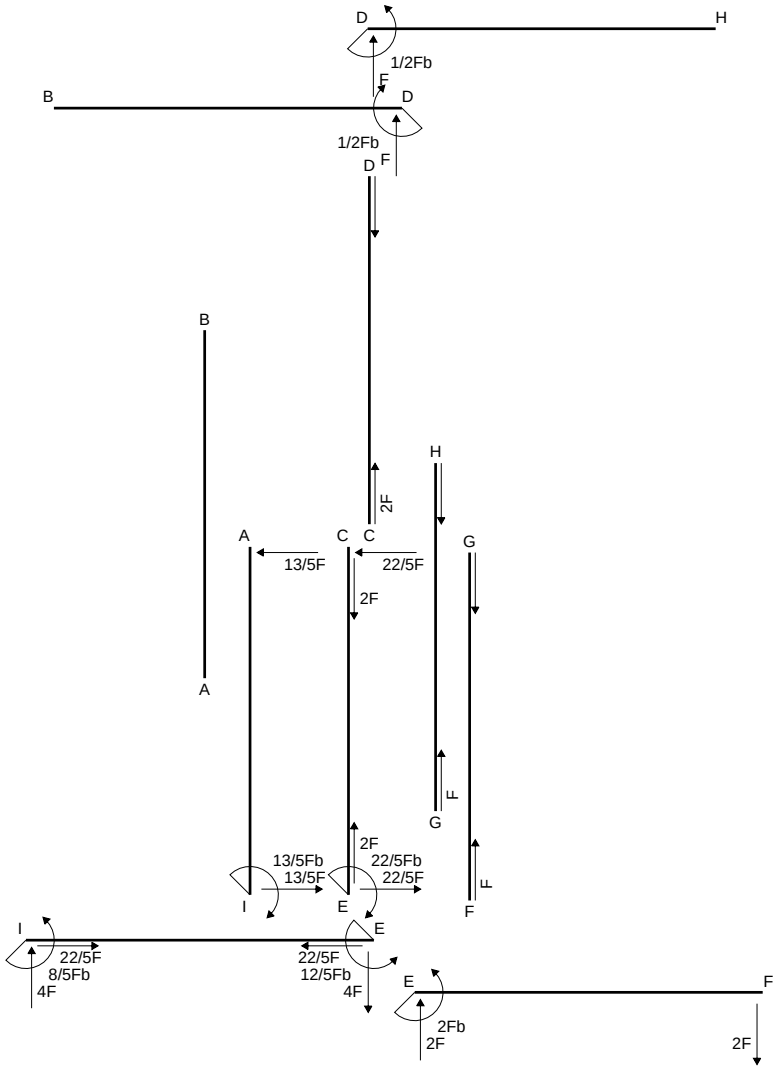
$= (\ b - b + 1/3\ b\ )\ Fb\ 1/EJ\ = 1/3\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/3\ b\ )\ Fb\ 1/EJ\ = 1/3\ Fb^2/EJ$



A = 1098. mm^2
J_u = 293274. mm^4
J_v = 68796. mm^4
y_g = 28.46 mm
T_y = 3480. N
M_x = -2366400. Nmm
x_m = 6. mm
u_m = -12. mm
v_m = -28.46 mm
$\sigma_m = -Mv/J_u$ = -229.7 N/mm^2
x_c = 18. mm
y_c = 13. mm
v_c = -15.46 mm
$\sigma_c = -Mv/J_u$ = -124.8 N/mm^2
τ_c = 6.587 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 125.3 N/mm^2
S^* = 6661. mm^3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A
H
2F
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C
C
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2F
F
G
2F
13/5Fb
22/5Fb
13/5F
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2F
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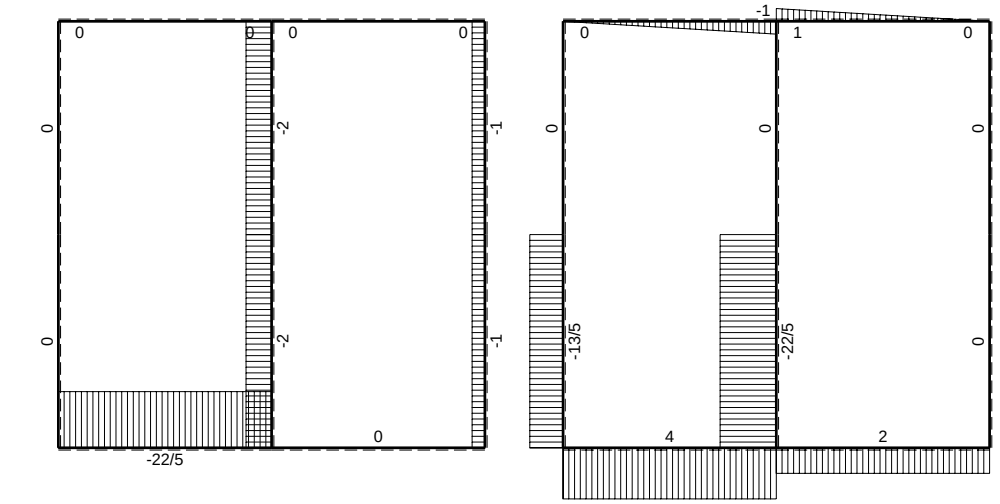
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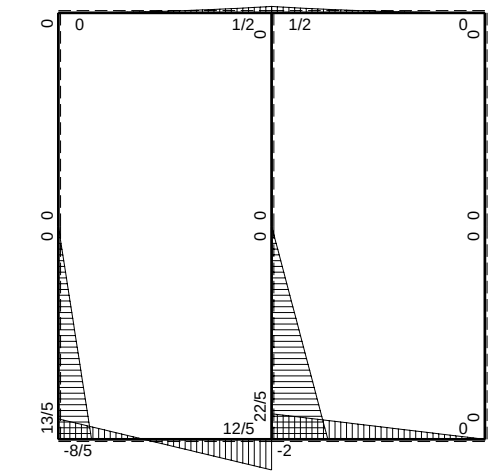
0
-13/5
-22/5
4
2

F F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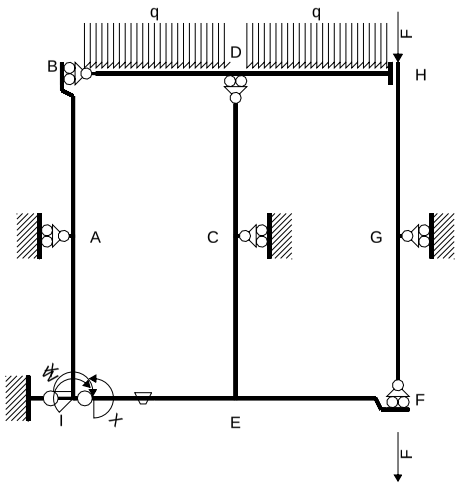
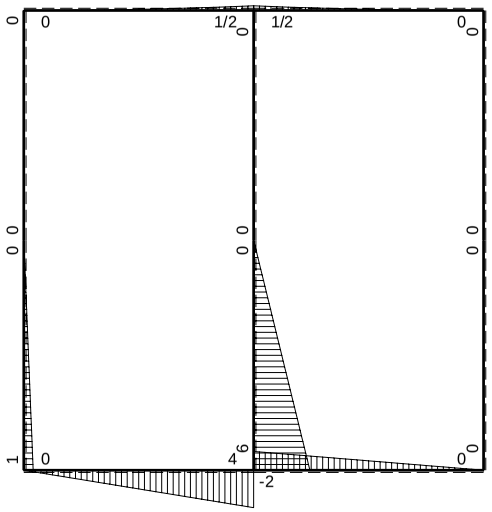
13/5
22/5
12/5
-8/5
-2

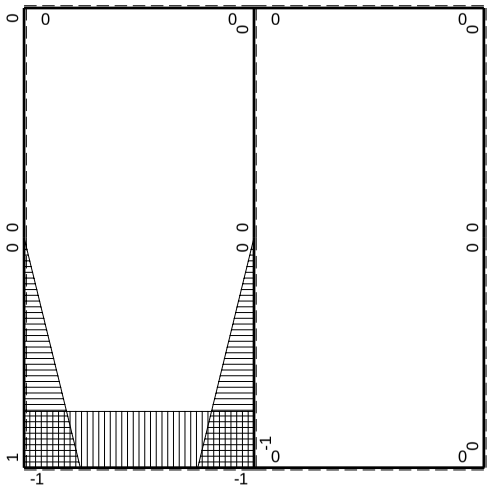
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 215670 CI07.xxxx.024

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PROCEDIMENTO E RISULTATI 215670 CI07.xxxx.024

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	0	0	0	0	0	0+0	0
HG b	0	0	0	0	0	0		
HD b	0	$1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	4Fx	-Fb/EJ	-4Fx	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-4Fb+4Fx	Fb/EJ	-4Fb+4Fx	Fb/EJ	1		
EC b	$-1+x/b$	6Fb-6Fx	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-6Fx	0	$-6Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fb-Fx	0	$Fb-2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/3+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	-Fx	0	Fx^2/b	0	x^2/b^2		
	totali						$-8/3Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						8/5Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-4 + 4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-4\ x + 2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-4\ b + 2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-6 + 12\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-6\ x + 6\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-6\ b + 6\ b - 2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

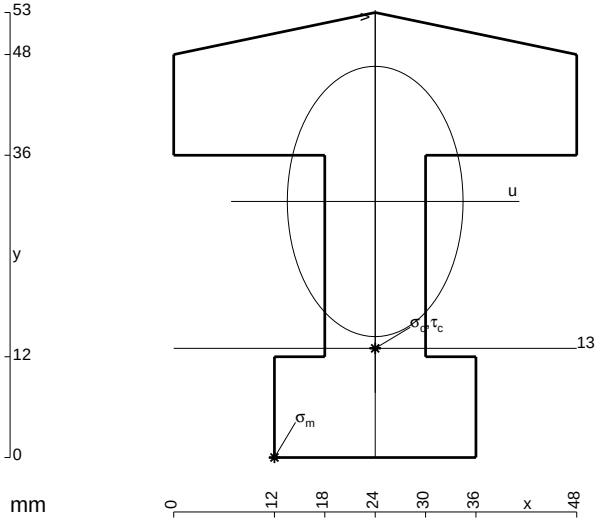
$= (-2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1 - 2\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ Fb\ 1/EJ\ = 1/3\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/3\ b\ )\ Fb\ 1/EJ\ = 1/3\ Fb^2/EJ$



$A = 1272.\ mm^2$

$J_u = 329658.\ mm^4$

$J_v = 139392.\ mm^4$

$y_g = 30.5\ mm$

$T_y = 3500.\ N$

$M_x = -2590000.\ Nmm$

$x_m = 12.\ mm$

$u_m = -12.\ mm$

$v_m = -30.5\ mm$

$\sigma_m = -Mv/J_u = -239.6\ N/mm^2$

$x_c = 24.\ mm$

$y_c = 13.\ mm$

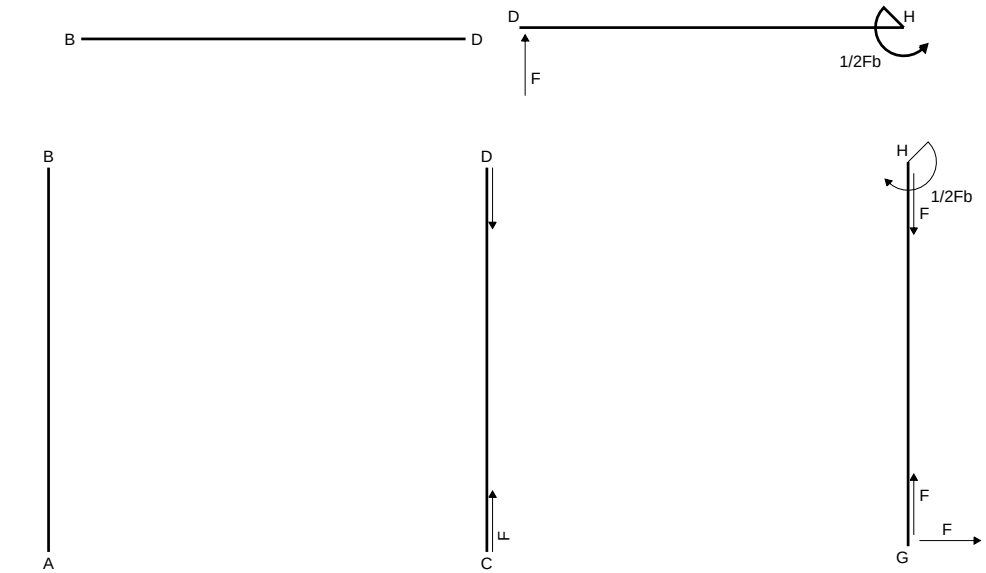
$v_c = -17.5\ mm$

$\sigma_c = -Mv/J_u = -137.5\ N/mm^2$

$\tau_c = 6.433\ N/mm^2$

$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 137.9\ N/mm^2$

$S^* = 7271.\ mm^3$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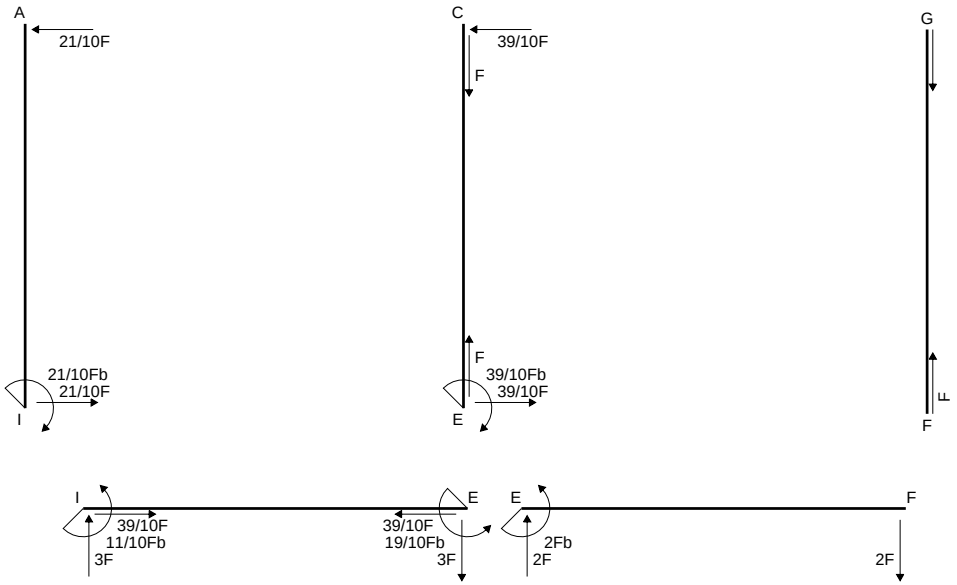
B
D
H
1/2Fb
F
A
C
F
F
F
G


A
21/10F
21/10Fb
21/10F
I
C
39/10F
F
F
39/10Fb
39/10F
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F
F
I
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39/10F
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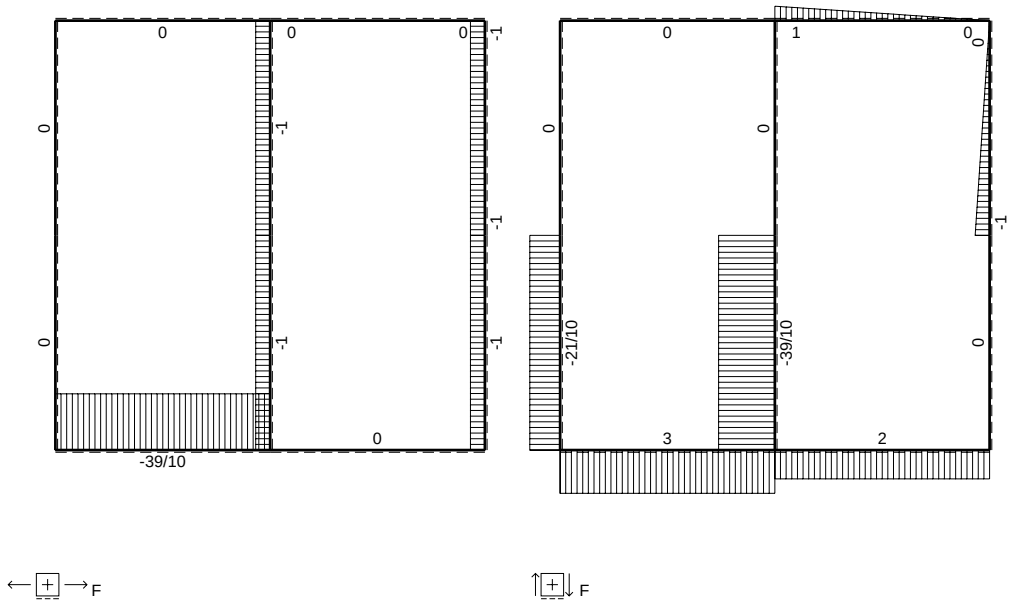
2Fb
2F
F
2F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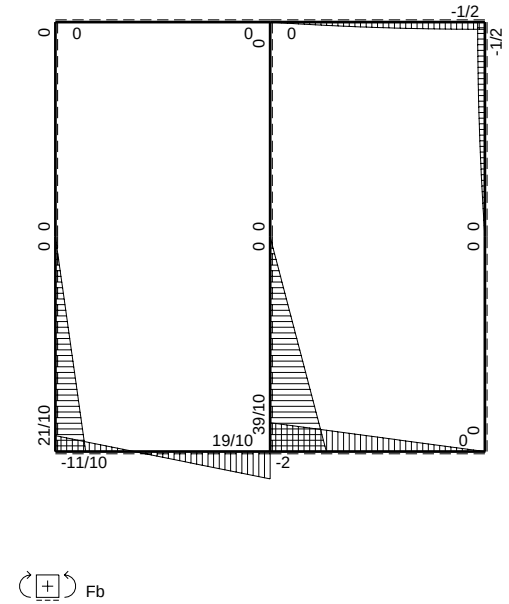
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19/10
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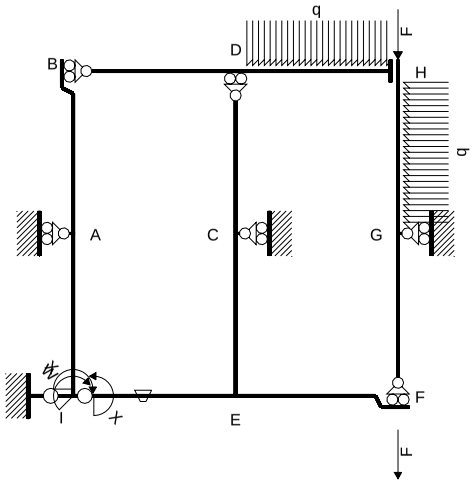
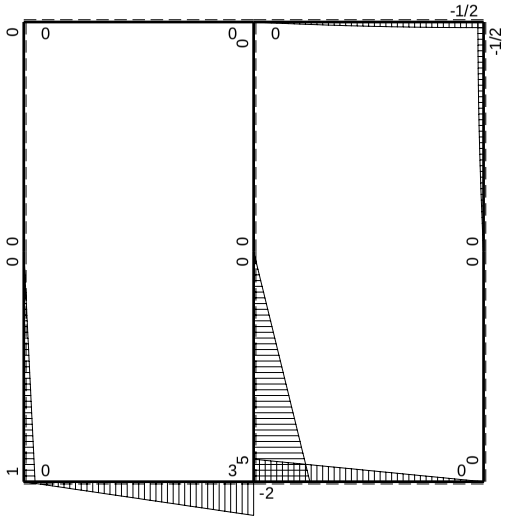
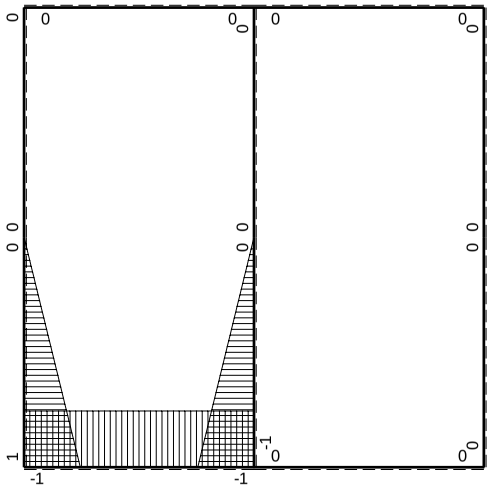
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 214212 CI07.xxxx.025

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-5Fx	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-5Fx	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fb-Fx	0	$Fb-2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/3+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	-Fx	0	Fx^2/b	0	x^2/b^2		
	totali						$-11/6Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						11/10Fb	

PROCEDIMENTO E RISULTATI 214212 CI07.xxxx.025

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

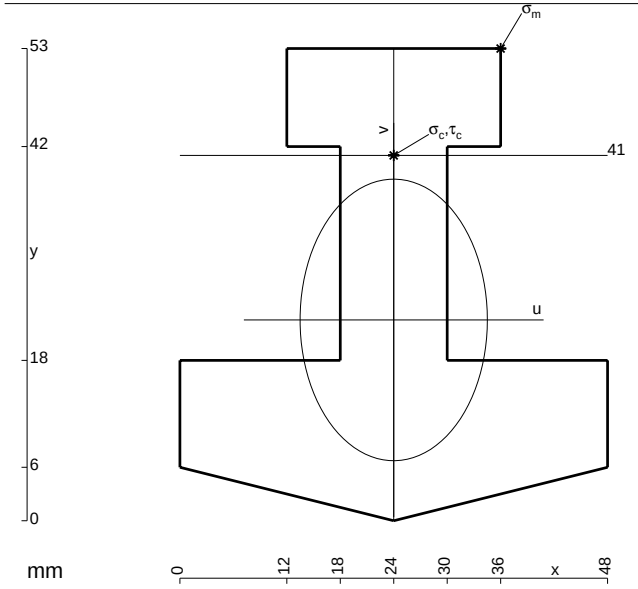
$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1 - 2\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

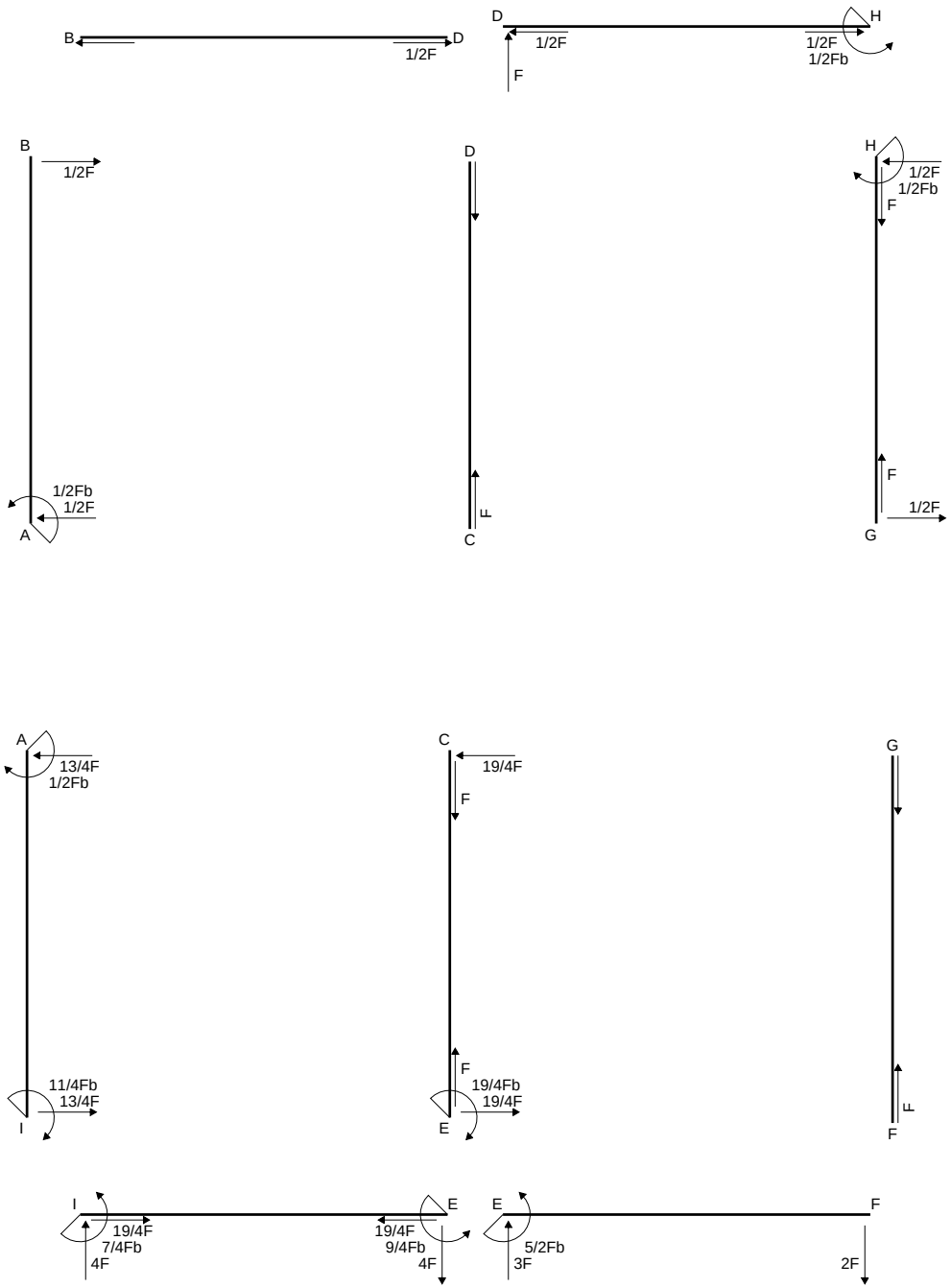
$= (\ b - b + 1/3\ b\ )\ Fb\ 1/EJ\ = 1/3\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/3\ b\ )\ Fb\ 1/EJ\ = 1/3\ Fb^2/EJ$



A = 1272. mm^2
J_u = 317672. mm^4
J_v = 140544. mm^4
y_g = 22.54 mm
T_y = 2640. N
M_x = -2085600. Nmm
x_m = 36. mm
y_m = 53. mm
u_m = 12. mm
v_m = 30.46 mm
$\sigma_m = -Mv/J_u$ = 200. N/mm^2
x_c = 24. mm
y_c = 41. mm
v_c = 18.46 mm
$\sigma_c = -Mv/J_u$ = 121.2 N/mm^2
τ_c = 4.721 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 121.5 N/mm^2
S^* = 6818. mm^3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D
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1/2F
1/2F
1/2Fb
F
B
1/2F
D
H
1/2F
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1/2F
A
F
C
F
1/2F
G
A
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1/2Fb
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G
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13/4F
I
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19/4Fb
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E
F
I
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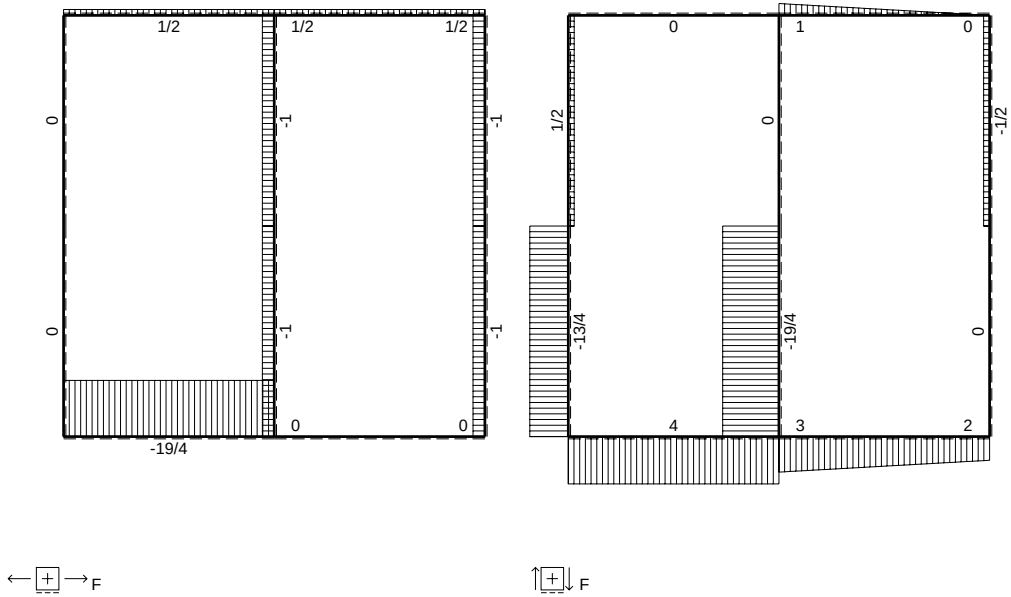
19/4F
9/4Fb
4F
E
5/2Fb
3F
F
2F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-1
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0
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-1/2
0
-13/4
-19/4
0
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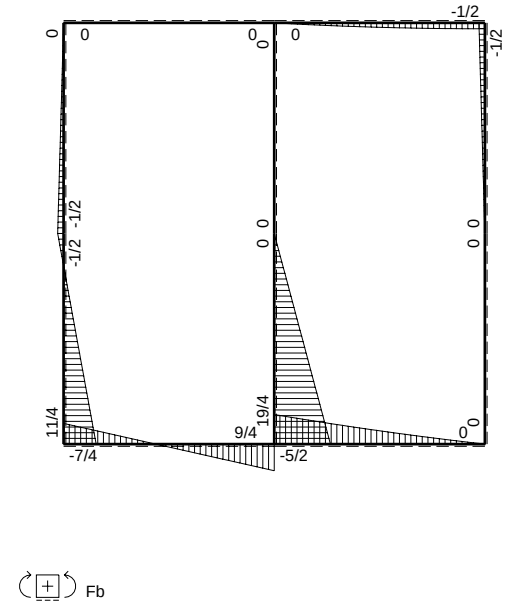
3
2
F
F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0
0
-1/2
-1/2
-1/2
0 0
0 0
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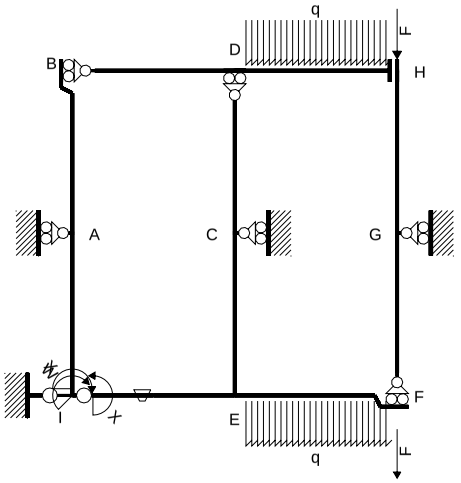
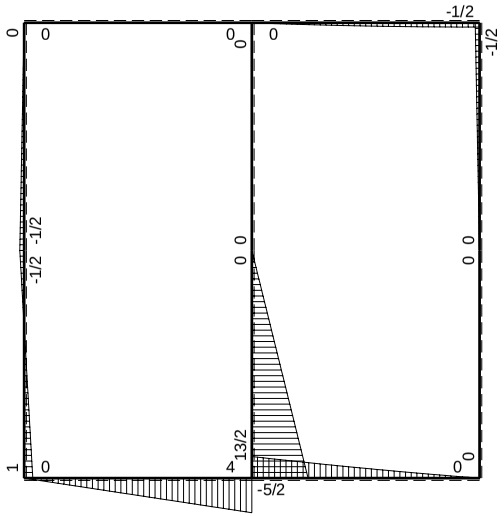
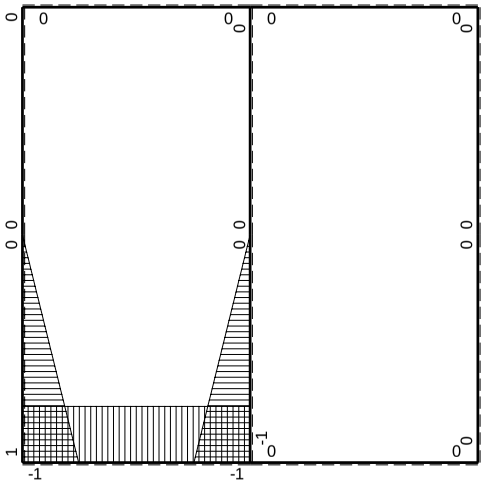
19/4
9/4
0
-7/4
-5/2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 917219 CI07.xxxx.026
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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-5/2Fb+3Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$2Fx+1/2qx^2$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	-1/2Fx	0	0	0	0	0+0	0
HG b	0	1/2Fb-1/2Fx	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	4Fx	-Fb/EJ	-4Fx	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-4Fb+4Fx	Fb/EJ	-4Fb+4Fx	Fb/EJ	1		
EC b	-1+x/b	13/2Fb-13/2Fx	0	$-13/2Fb+13Fx-13/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-13/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-13/2Fx	0	$-13/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fb-3/2Fx	0	$Fb-5/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/4+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-3/2Fx	0	$-1/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-35/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						7/4Fb	

Sviluppi di calcolo iperstatica

PROCEDIMENTO E RISULTATI 917219 CI07.xxxx.026
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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-4 + 4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-4\ x + 2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-4\ b + 2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-13/2 + 13\ x/b - 13/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-13/2\ x + 13/2\ x^2/b - 13/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-13/2\ b + 13/2\ b - 13/6\ b\ )\ Fb\ 1/EJ\ = -13/6\ \ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-13/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-13/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-13/6\ b\ )\ Fb\ 1/EJ\ = -13/6\ \ Fb^2/EJ$

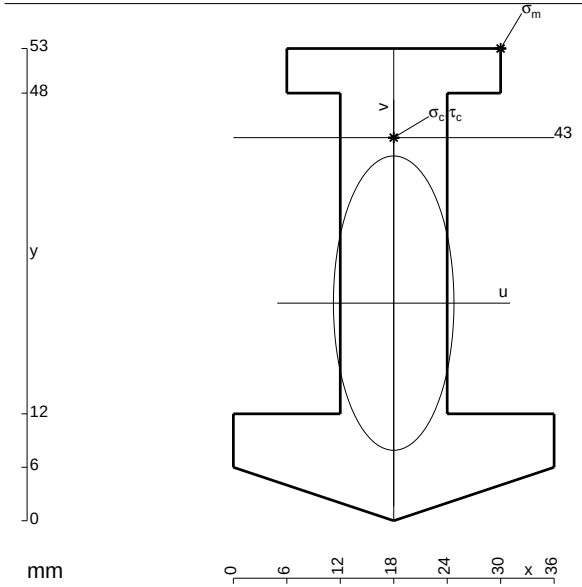
$L_{IA}^{Xo} = \int_o^b (1 - 5/2\ x/b + 3/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [\ x - 5/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (\ b - 5/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = 1/4\ \ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 3/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = 1/4\ \ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 917219 CI07.xxxx.026



A = 876. mm^2
J_u = 239234. mm^4
J_v = 40104. mm^4
y_g = 24.42 mm
T_y = 2490. N
M_x = -1743000. Nmm
x_m = 30. mm
y_m = 53. mm
u_m = 12. mm
v_m = 28.58 mm
$\sigma_m = -Mv/J_u$ = 208.2 N/mm^2
x_c = 18. mm
y_c = 43. mm
v_c = 18.58 mm
$\sigma_c = -Mv/J_u$ = 135.3 N/mm^2
τ_c = 3.811 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 135.5 N/mm^2
S^* = 4394. mm^3

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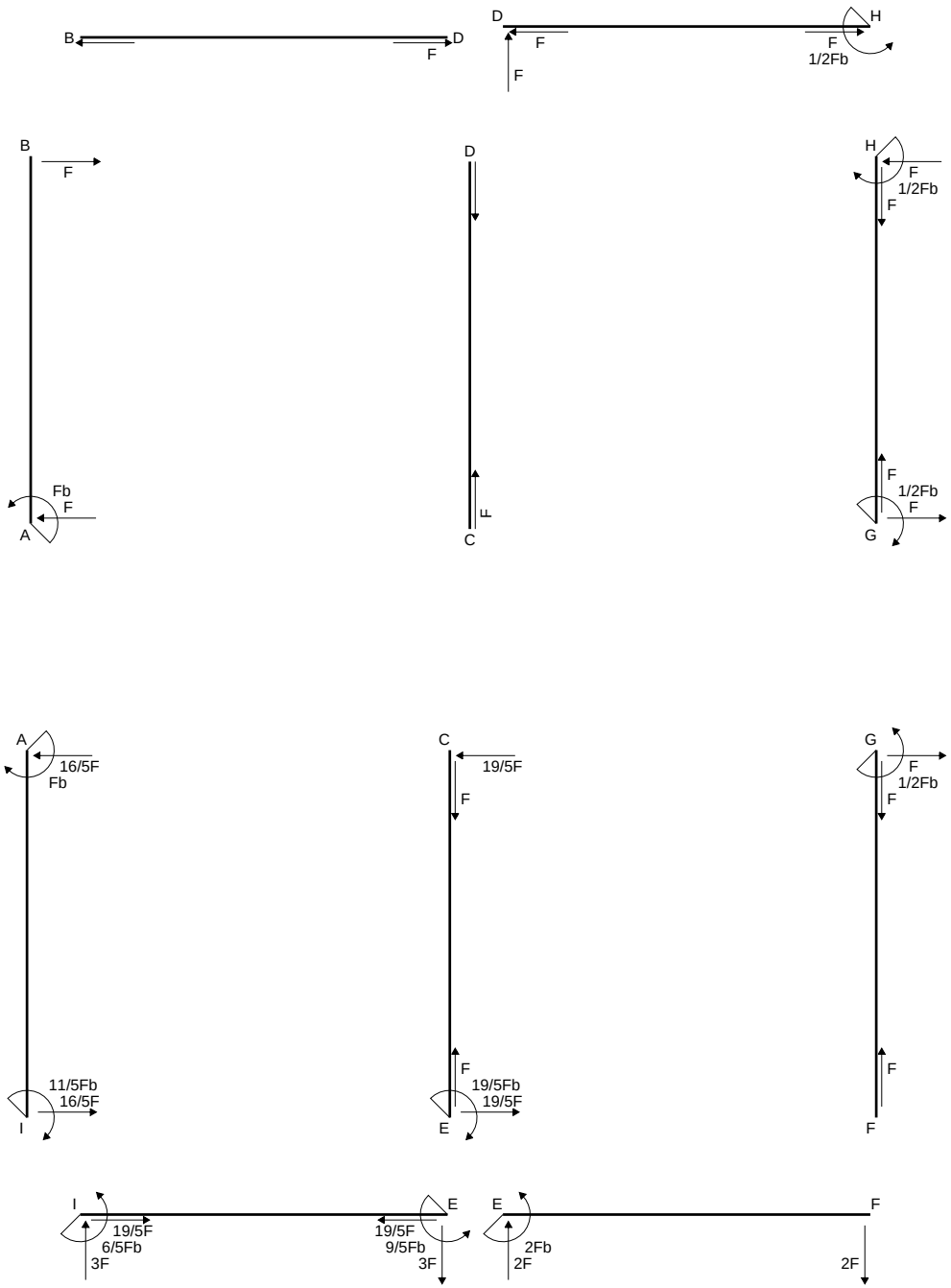
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D
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F
1/2Fb
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C
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Fb
C
19/5F
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G
F
1/2Fb
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11/5Fb
16/5F
I
F
19/5Fb
19/5F
E
F
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19/5F
9/5Fb
3F
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2Fb
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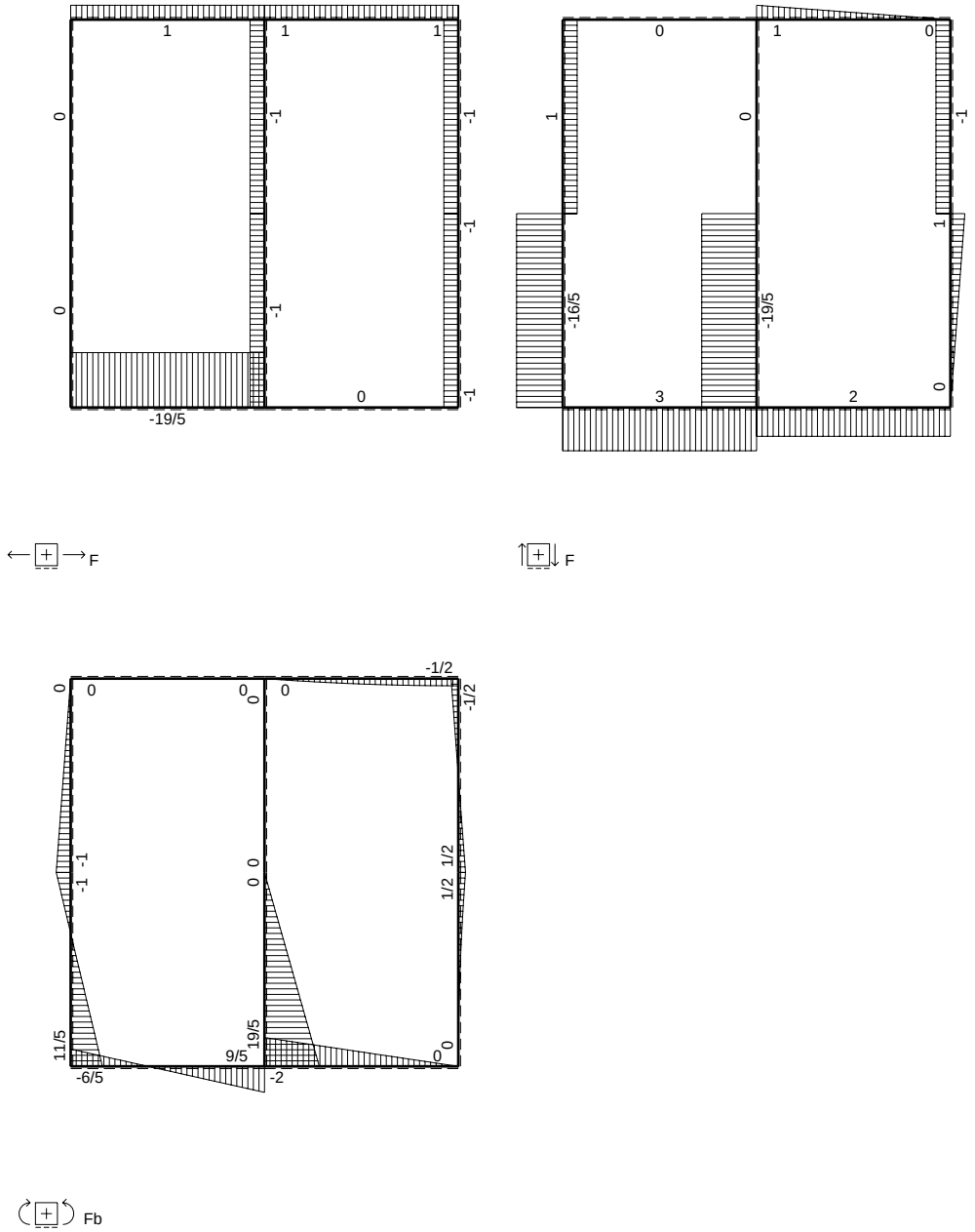
F
2F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0
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0
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1/2
1/2
11/5
19/5
9/5
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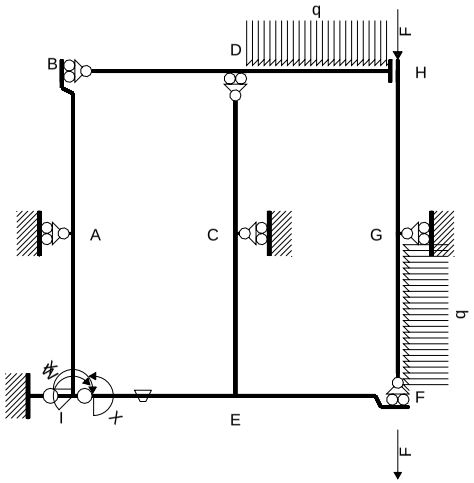
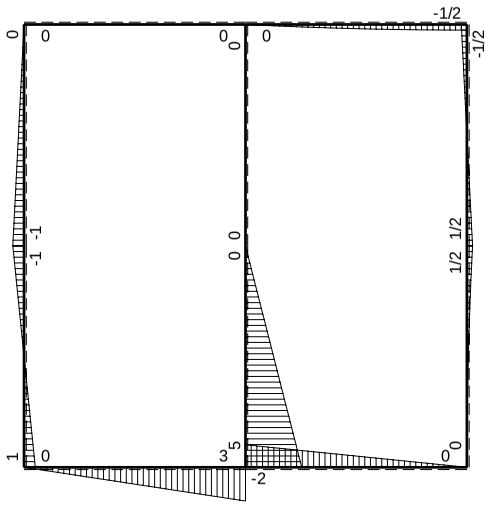
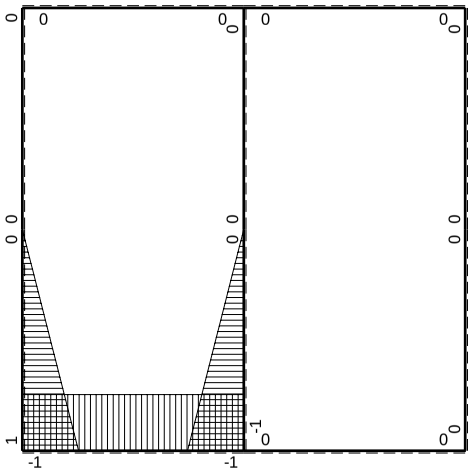
-6/5
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 209903 CI07.xxxx.027

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PROCEDIMENTO E RISULTATI 209903 CI07.xxxx.027

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb-Fx	0	0	0	0	0+0	0
HG b	0	1/2Fb-Fx	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-5Fx	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-5Fx	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fb-2Fx	0	$Fb-3Fx+2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	Fb-2Fx	0	$-Fx+2Fx^2/b$	0	x^2/b^2		
	totali						$-2Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						6/5Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

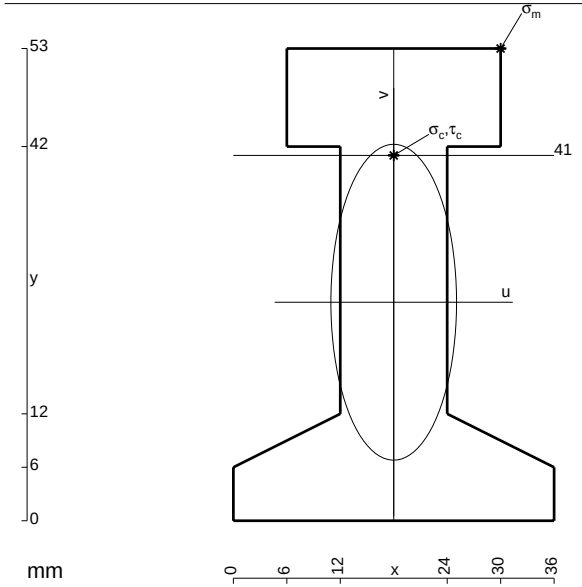
$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1 - 3\ x/b + 2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [\ x - 3/2\ x^2/b + 2/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

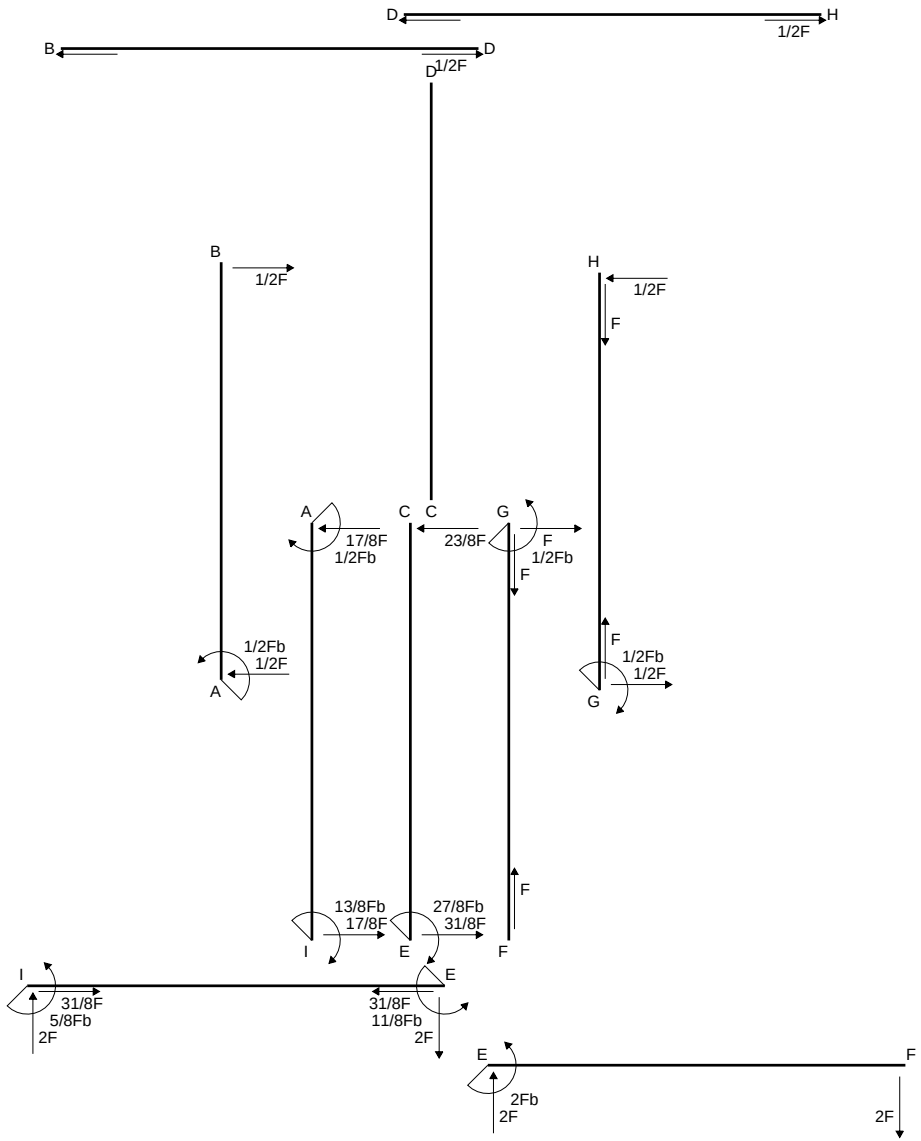
$= (\ b - 3/2\ b + 2/3\ b\ )\ Fb\ 1/EJ\ = 1/6\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-\ x/b + 2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 2/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 2/3\ b\ )\ Fb\ 1/EJ\ = 1/6\ Fb^2/EJ$



A = 984. mm^2
J_u = 309321. mm^4
J_v = 48960. mm^4
y_g = 24.52 mm
T_y = 2640. N
M_x = -2376000. Nmm
x_m = 30. mm
y_m = 53. mm
u_m = 12. mm
v_m = 28.48 mm
$\sigma_m = -Mv/J_u$ = 218.7 N/mm^2
x_c = 18. mm
y_c = 41. mm
v_c = 16.48 mm
$\sigma_c = -Mv/J_u$ = 126.6 N/mm^2
τ_c = 4.459 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 126.8 N/mm^2
S^* = 6269. mm^3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D 1/2F
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1/2F
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1/2F
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A
C C
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1/2Fb
23/8F
F
1/2Fb
F
1/2Fb
1/2F
A
F
1/2Fb
1/2F
G
13/8Fb
17/8F
27/8Fb
31/8F
I
E
F
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I
E
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5/8Fb
2F
31/8F
11/8Fb
2F
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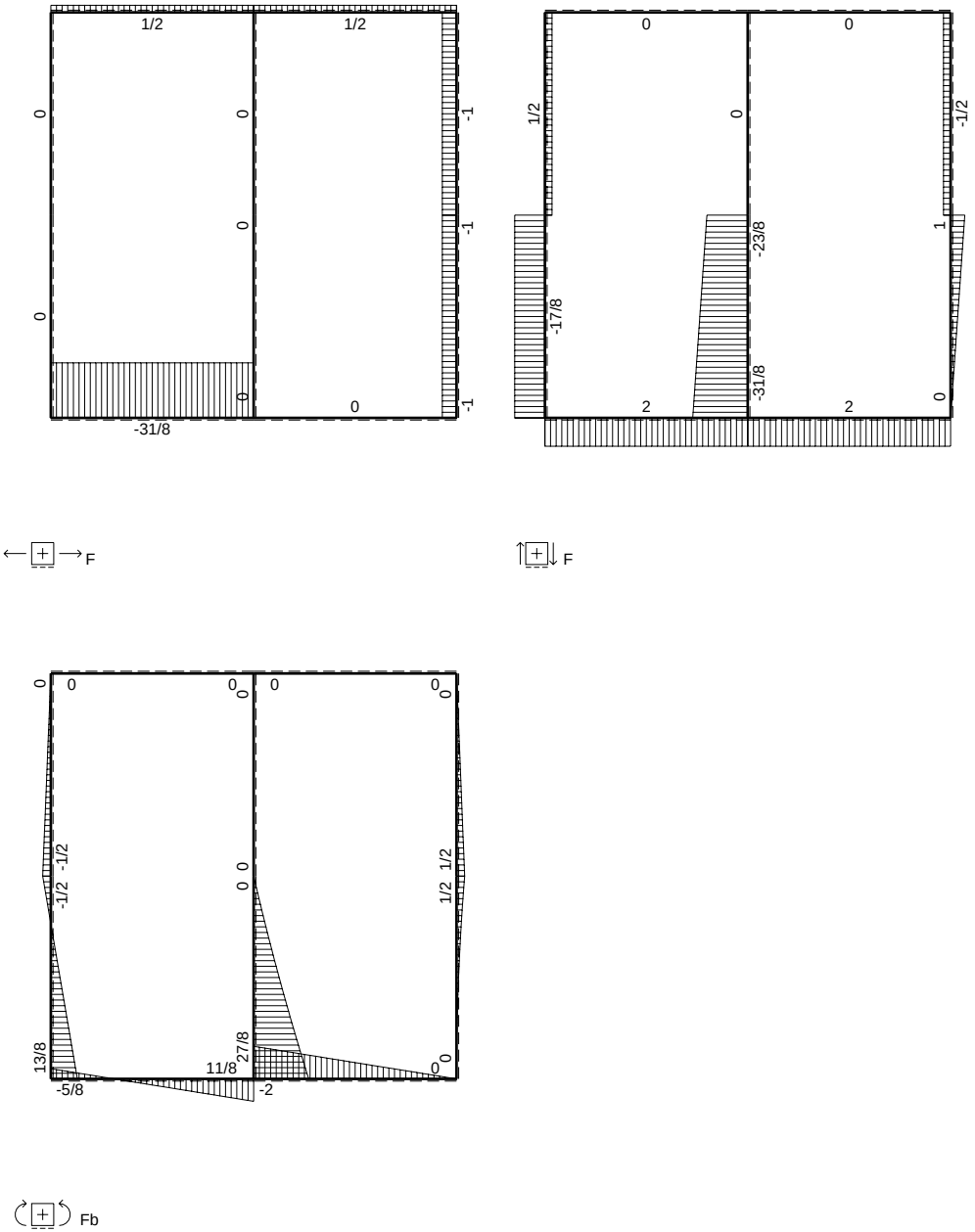
F
2Fb
2F
2F


1/2
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-31/8
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-23/8
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-17/8
-31/8
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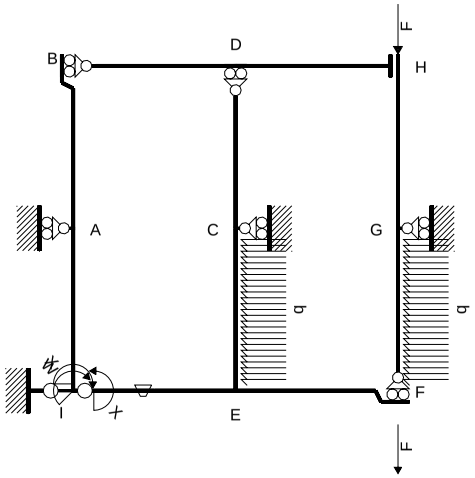
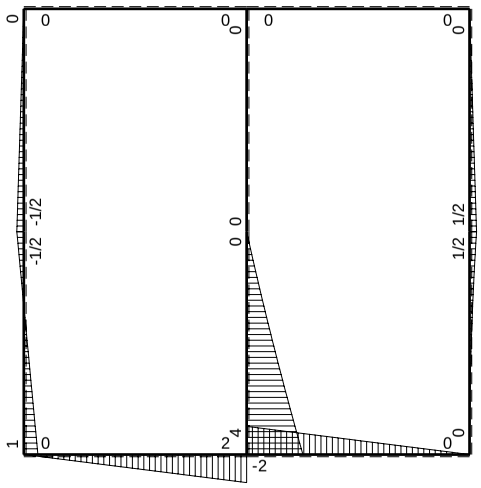
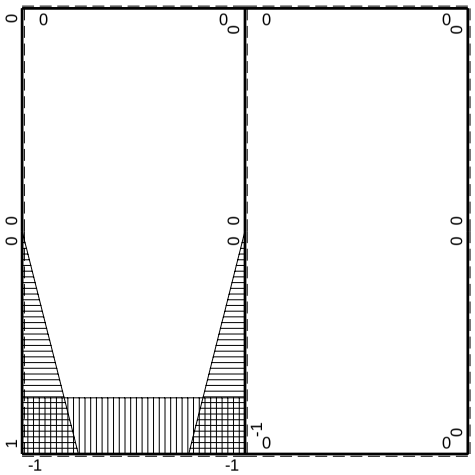
13/8
27/8
11/8
0
-5/8
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 210421 CI07.xxxx.028

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PROCEDIMENTO E RISULTATI 210421 CI07.xxxx.028

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	-1+x/b	$4Fb-9/2Fx+1/2qx^2$	0	$-4Fb+17/2Fx-5Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-31/24+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-7/2Fx-1/2qx^2$	0	$-7/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2		
IA b	1-x/b	Fb-3/2Fx	0	$Fb-5/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/4+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-3/2Fx	0	$-1/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-25/24Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						5/8Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L_{EI}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L_{EC}^{Xo} = \int_o^b (-4 + 17/2\ x/b - 5\ x^2/b^2 + 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx$

$= [-4\ x + 17/4\ x^2/b - 5/3\ x^3/b^2 + 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

$= (-4\ b + 17/4\ b - 5/3\ b + 1/8\ b\ )\ Fb\ 1/EJ\ = -31/24\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-7/2\ x^2/b^2 - 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx = [-7/6\ x^3/b^2 - 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

$= (-7/6\ b - 1/8\ b\ )\ Fb\ 1/EJ\ = -31/24\ Fb^2/EJ$

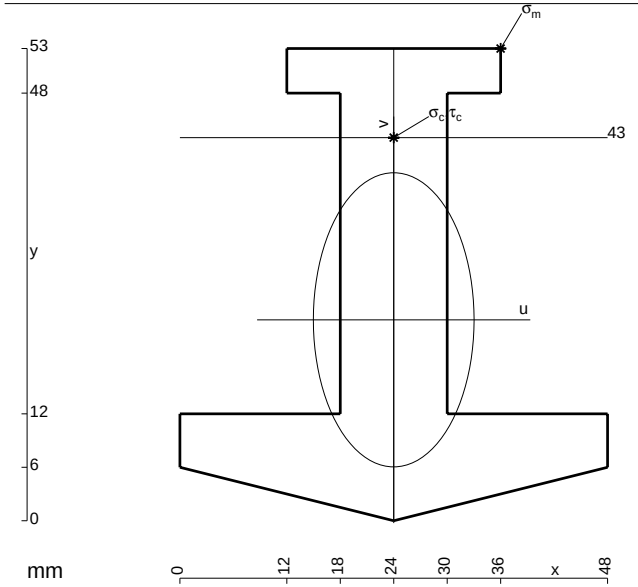
$L_{IA}^{Xo} = \int_o^b (1 - 5/2\ x/b + 3/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [\ x - 5/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (\ b - 5/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = 1/4\ Fb^2/EJ$

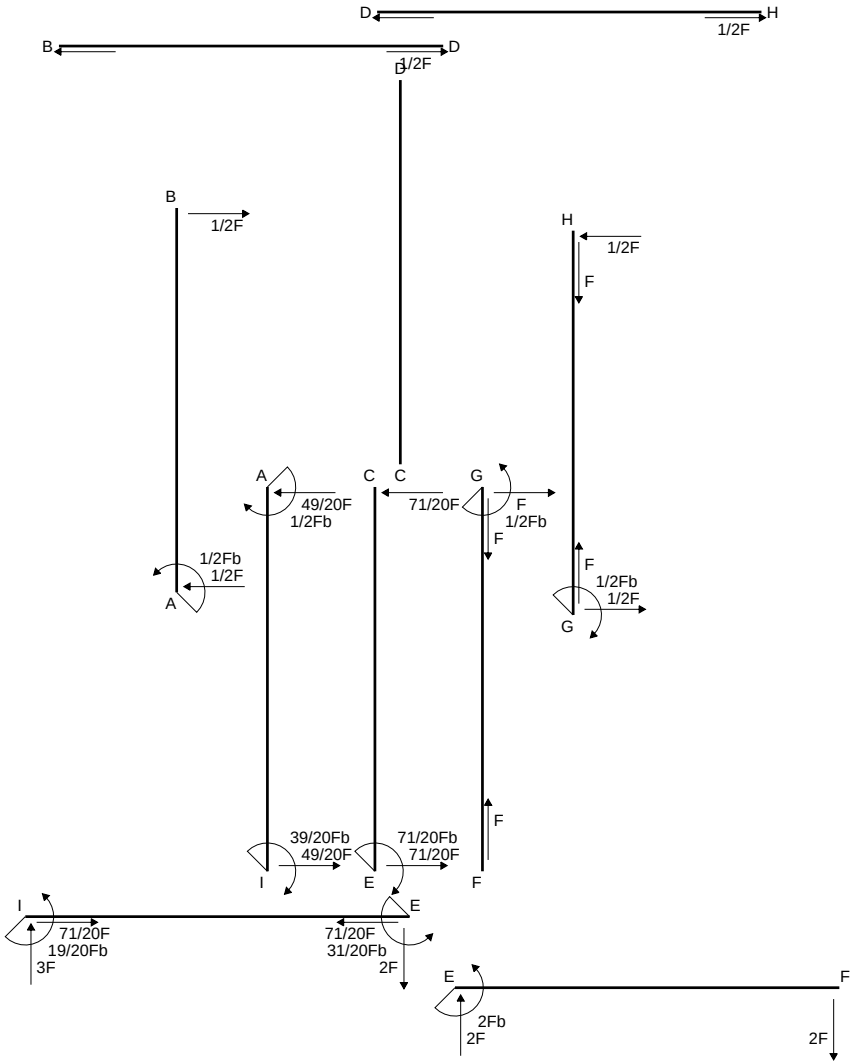
$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 3/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = 1/4\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 210421 CI07.xxxx.028



A = 984. mm^2
J_u = 268208. mm^4
J_v = 80064. mm^4
y_g = 22.55 mm
T_y = 2120. N
M_x = -2014000. Nmm
x_m = 36. mm
y_m = 53. mm
u_m = 12. mm
v_m = 30.45 mm
$\sigma_m = -Mv/J_u$ = 228.7 N/mm^2
x_c = 24. mm
y_c = 43. mm
v_c = 20.45 mm
$\sigma_c = -Mv/J_u$ = 153.6 N/mm^2
τ_c = 3.116 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 153.7 N/mm^2
S^* = 4731. mm^3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49/20F
1/2Fb
71/20F
F
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1/2F
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G
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39/20Fb
49/20F
71/20Fb
71/20F
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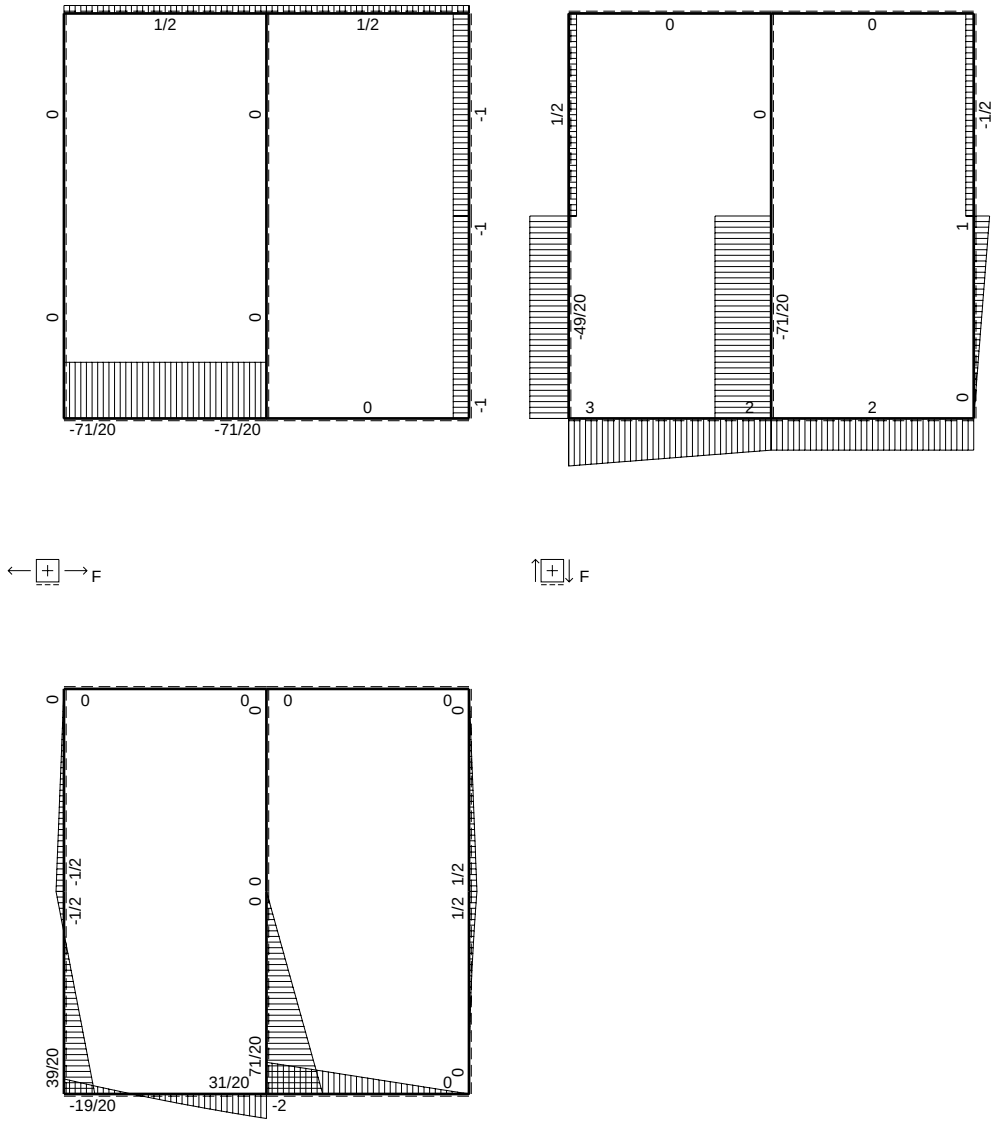
2Fb
2F
2F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71/20
31/20
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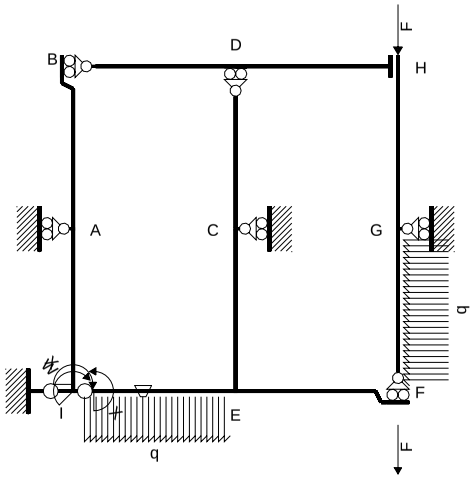
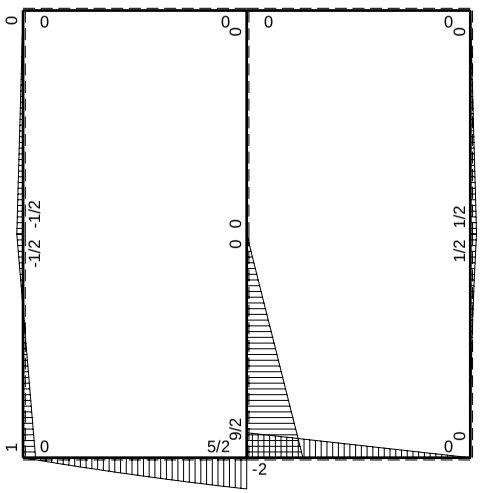
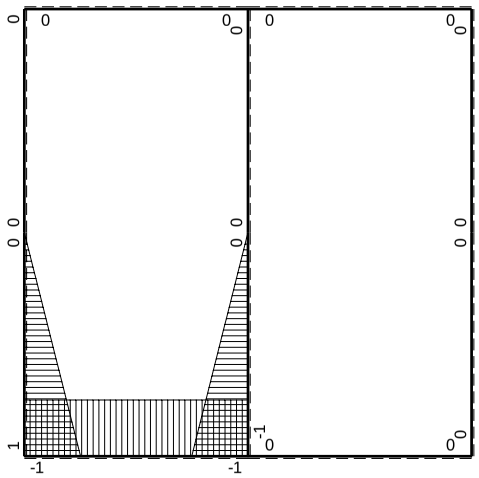
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 211463 CI07.xxxx.029

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PROCEDIMENTO E RISULTATI 211463 CI07.xxxx.029

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx-1/2qx^2$	-Fb/EJ	$-3Fx+1/2Fx^2/b$	Fb/EJ	1	$(-4/3+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-5/2Fb+2Fx+1/2qx^2$	Fb/EJ	$-5/2Fb+2Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	-1+x/b	9/2Fb-9/2Fx	0	$-9/2Fb+9Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-9/2Fx	0	$-9/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fb-3/2Fx	0	$Fb-5/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/4+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-3/2Fx	0	$-1/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-19/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						19/20Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/3\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-5/2 + 2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx$

$= [-5/2\ x + x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-5/2\ b + b + 1/6\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/3\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-9/2 + 9\ x/b - 9/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-9/2\ x + 9/2\ x^2/b - 3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-9/2\ b + 9/2\ b - 3/2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-9/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

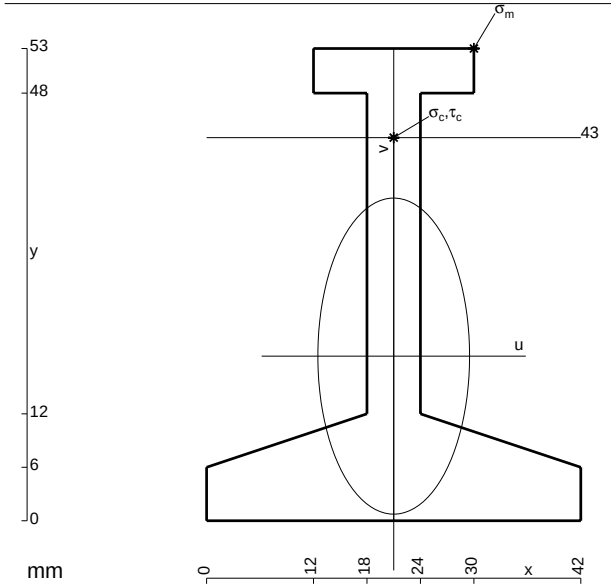
$L_{IA}^{Xo} = \int_o^b (1 - 5/2\ x/b + 3/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [\ x - 5/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (\ b - 5/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = 1/4\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 3/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = 1/4\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 211463 CI07.xxxx.029



A = 702. mm^2
J_u = 221020. mm^4
J_v = 50922. mm^4
y_g = 18.47 mm
T_y = 1520. N
M_x = -1520000. Nmm
x_m = 30. mm
y_m = 53. mm
u_m = 9. mm
v_m = 34.53 mm
$\sigma_m = -Mv/J_u$ = 237.4 N/mm^2
x_c = 21. mm
y_c = 43. mm
v_c = 24.53 mm
$\sigma_c = -Mv/J_u$ = 168.7 N/mm^2
τ_c = 4.233 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 168.8 N/mm^2
S^* = 3693. mm^3

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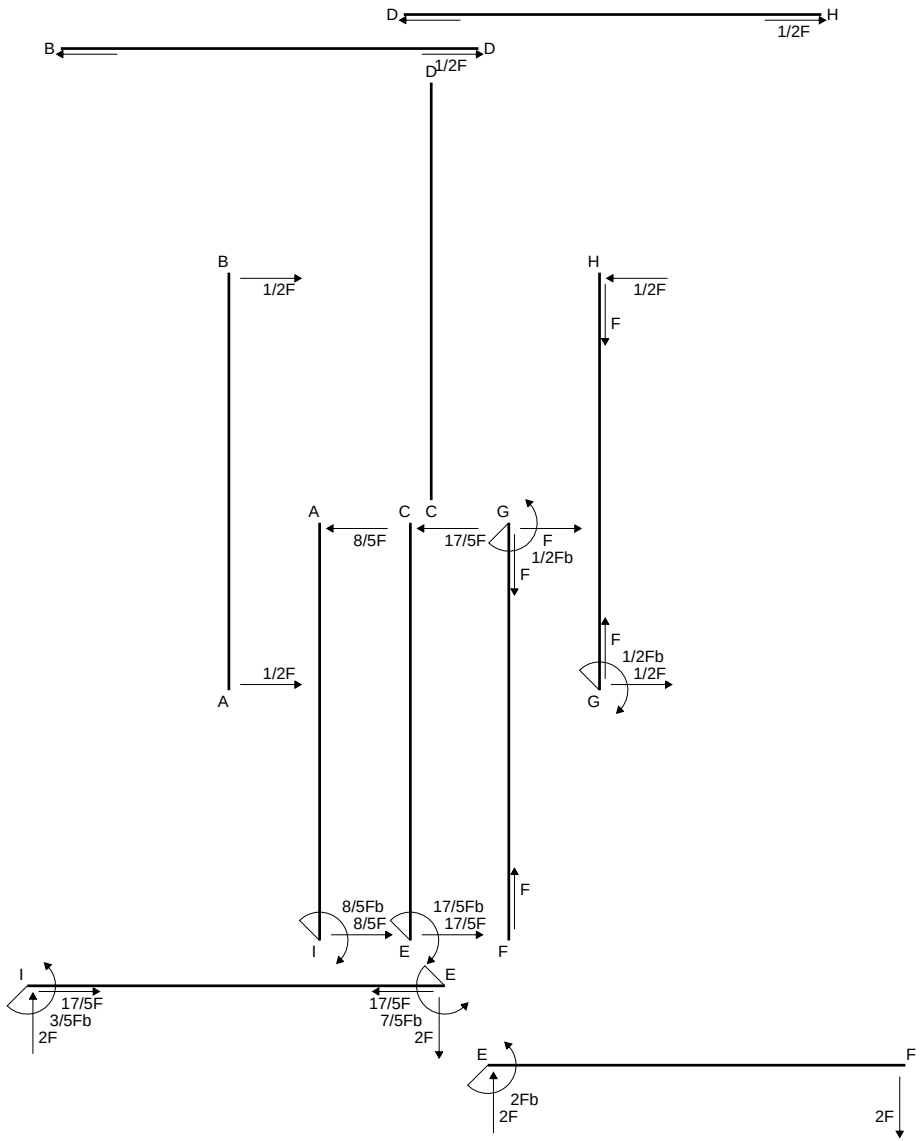
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C
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8/5F
17/5F
F
1/2Fb
F
F
1/2Fb
1/2F
1/2F
A
G
F
8/5Fb
8/5F
17/5Fb
17/5F
I
E
F
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E
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17/5F
7/5Fb
2F
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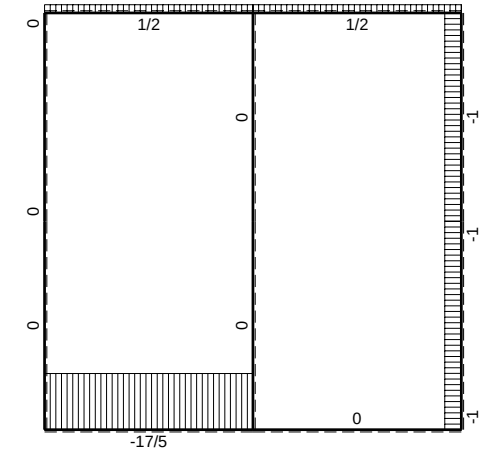
2F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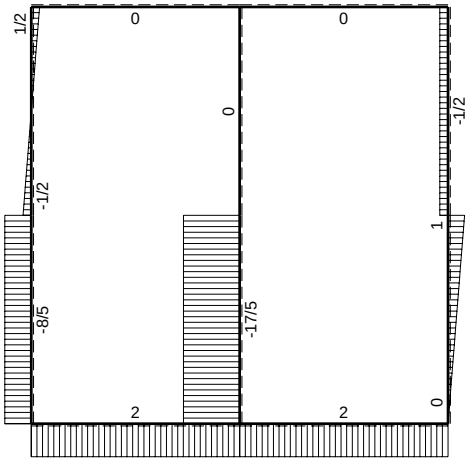
-1
-1
0
-17/5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-1/2
-1/2
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-8/5
-17/5
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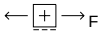
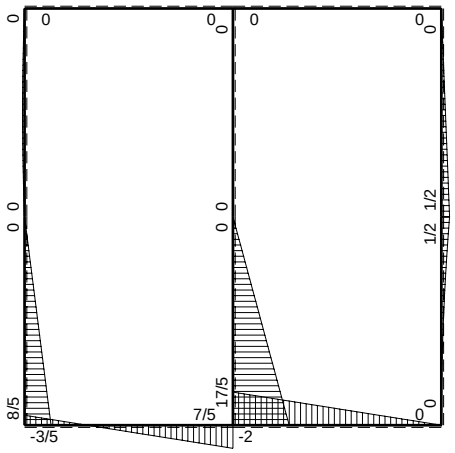
2
0


F

F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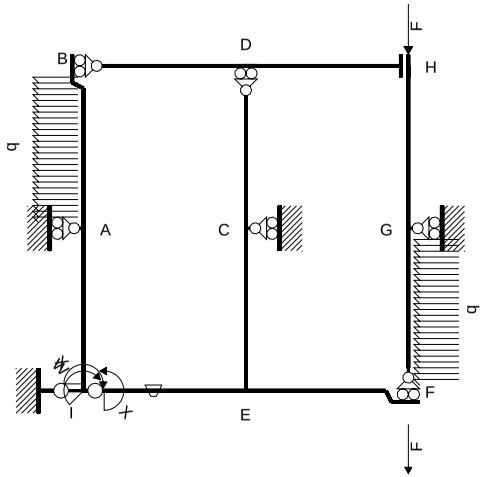
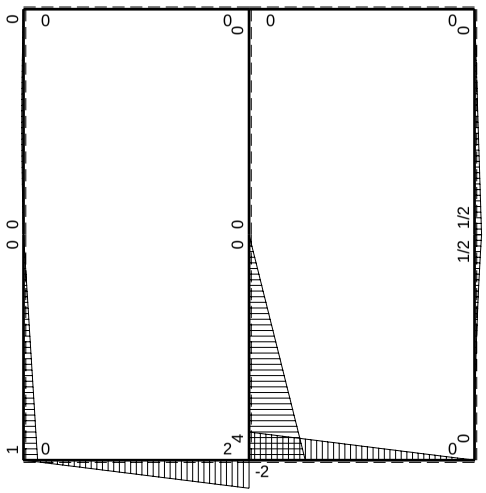
0
0
1/2
1/2
8/5
17/5
7/5
-3/5
-2

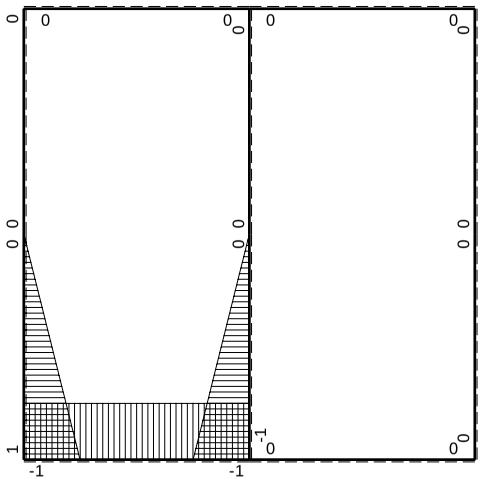
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 210203 CI07.xxxx.030

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	-1+x/b	4Fb-4Fx	0	$-4Fb+8Fx-4Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-4/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-4Fx$	0	$-4Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fb-Fx	0	$Fb-2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/3+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	-Fx	0	Fx^2/b	0	x^2/b^2		
	totali						$-Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						3/5Fb	

PROCEDIMENTO E RISULTATI 210203 CI07.xxxx.030

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L_{EI}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L_{EC}^{Xo} = \int_o^b (-4 + 8\ x/b - 4\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4\ x + 4\ x^2/b - 4/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-4\ b + 4\ b - 4/3\ b\ )\ Fb\ 1/EJ\ = -4/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-4\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-4/3\ b\ )\ Fb\ 1/EJ\ = -4/3\ Fb^2/EJ$

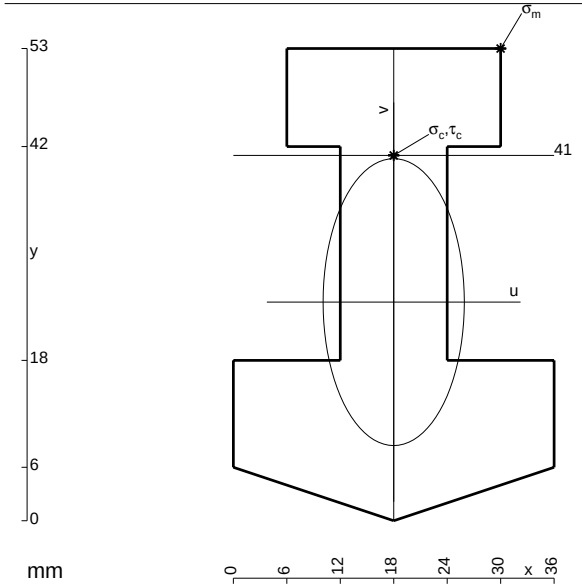
$L_{IA}^{Xo} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ Fb\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ Fb\ 1/EJ\ = 1/3\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/3\ b\ )\ Fb\ 1/EJ\ = 1/3\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 210203 CI07.xxxx.030



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J_u = 283139. mm^4
J_v = 68616. mm^4
y_g = 24.54 mm
T_y = 3740. N
M_x = -1982200. Nmm
x_m = 30. mm
y_m = 53. mm
u_m = 12. mm
v_m = 28.46 mm
$\sigma_m = -Mv/J_u$ = 199.3 N/mm^2
x_c = 18. mm
y_c = 41. mm
v_c = 16.46 mm
$\sigma_c = -Mv/J_u$ = 115.2 N/mm^2
τ_c = 6.897 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 115.9 N/mm^2
S^* = 6265. mm^3

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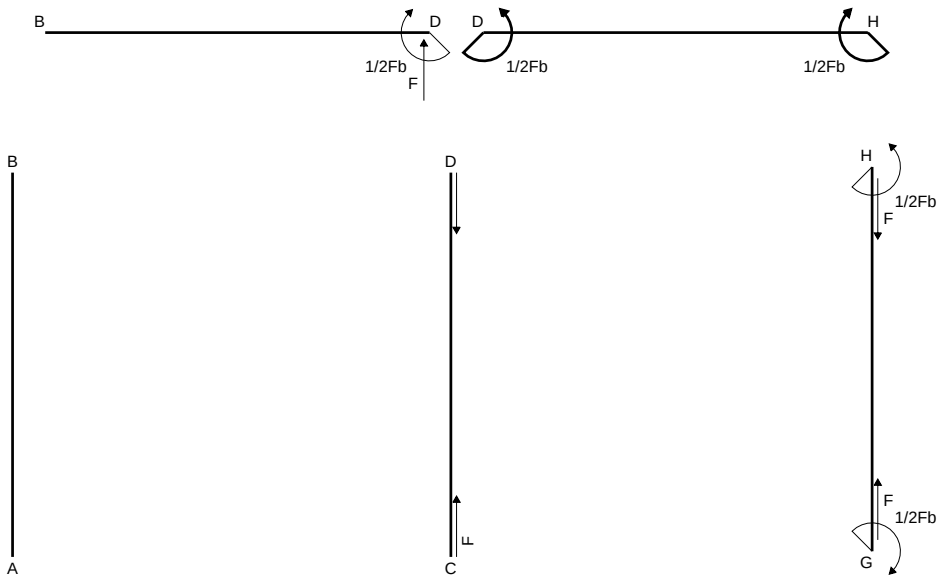
B
D
D
H
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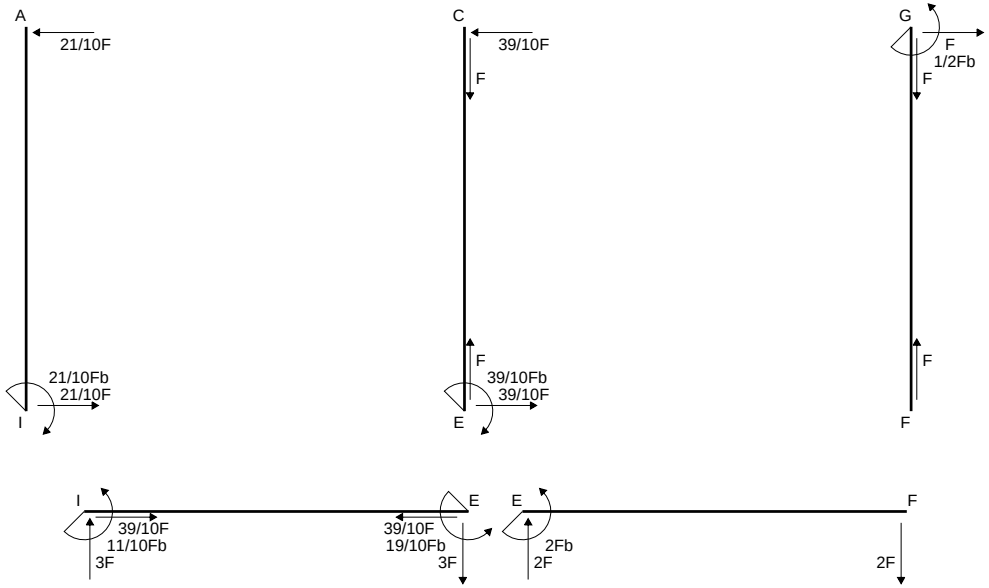
F
1/2Fb
1/2Fb
B
D
H
1/2Fb
F
F
1/2Fb
A
C
G


A
21/10F
21/10Fb
21/10F
I
C
39/10F
F
F
39/10Fb
39/10F
E
G
F
1/2Fb
F
F
I
39/10F
11/10Fb
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E
39/10F
19/10Fb
3F
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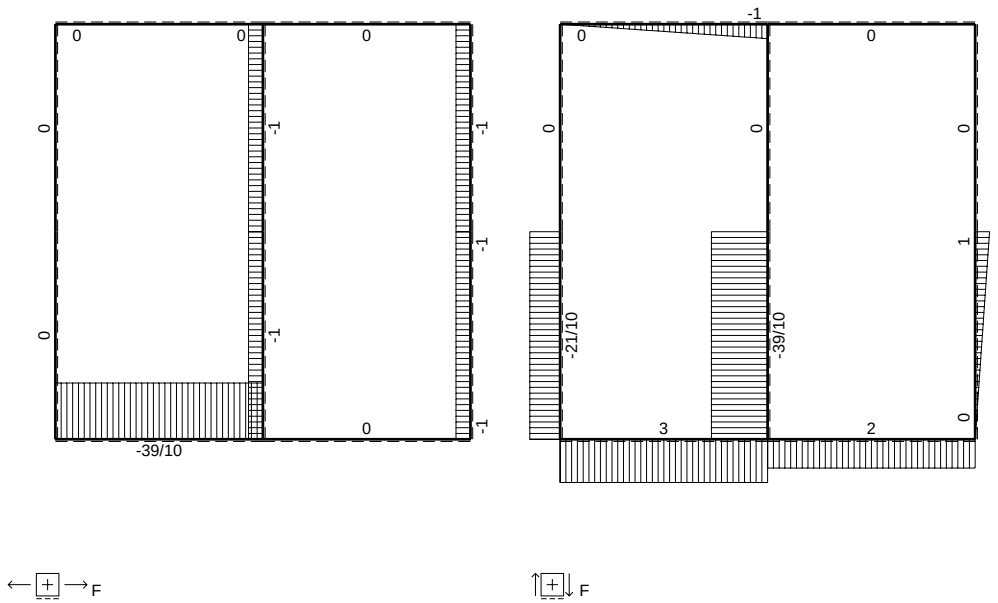
2Fb
2F
F
2F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3
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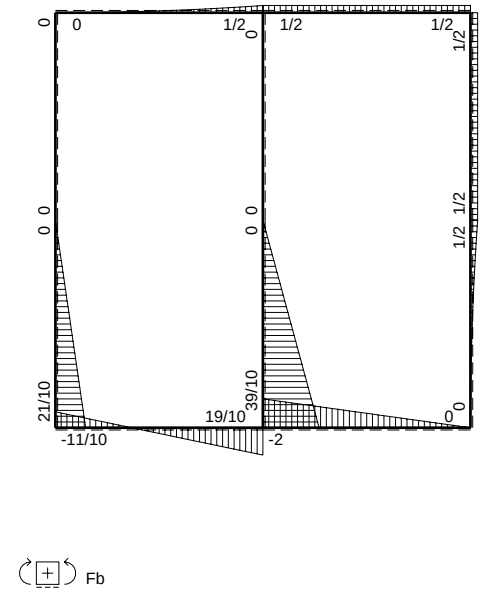
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39/10
19/10
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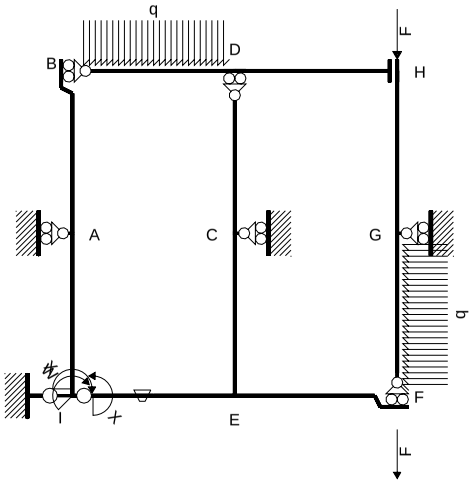
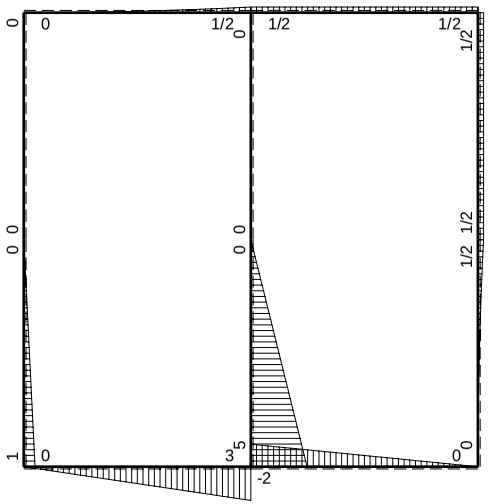
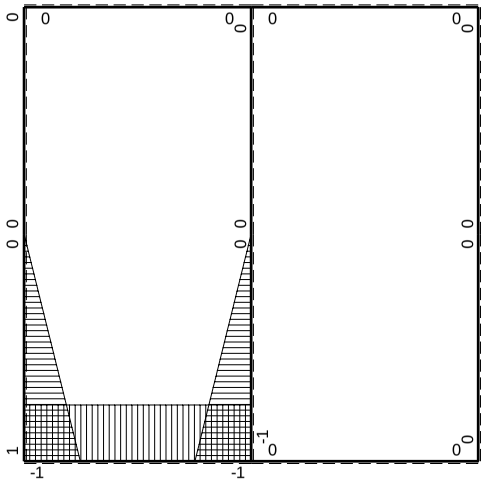
-2



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 225153 CI07.xxxx.031

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PROCEDIMENTO E RISULTATI 225153 CI07.xxxx.031

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb	0	0	0	0	0+0	0
HG b	0	-1/2Fb	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-5Fx	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-5Fx	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fb-Fx	0	$Fb-2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/3+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	-Fx	0	Fx^2/b	0	x^2/b^2		
	totali						$-11/6Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						11/10Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

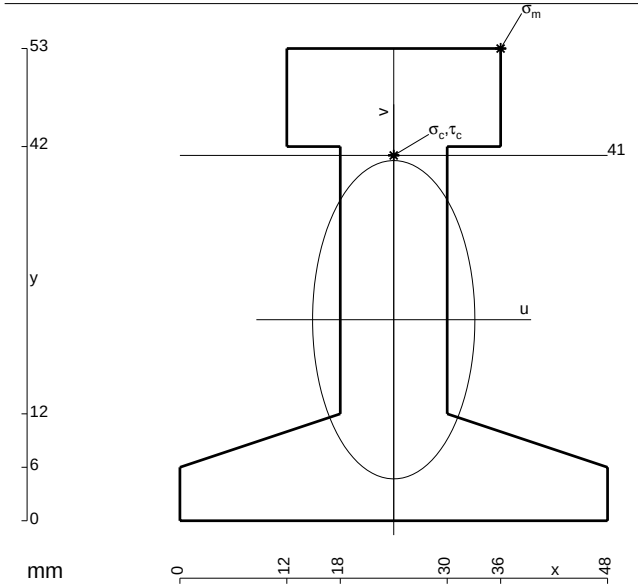
$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1 - 2\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

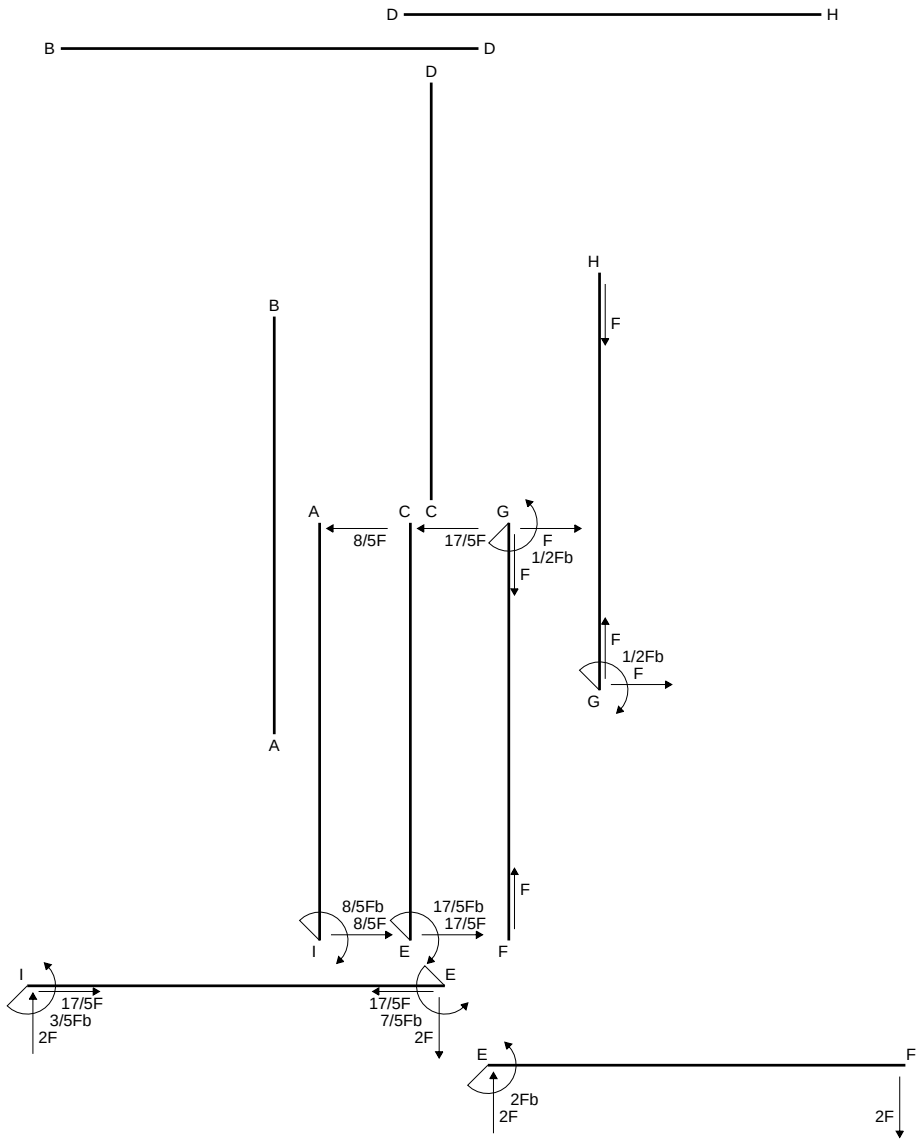
$= (\ b - b + 1/3\ b\ )\ Fb\ 1/EJ\ = 1/3\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/3\ b\ )\ Fb\ 1/EJ\ = 1/3\ Fb^2/EJ$



A = 1092. mm^2
J_u = 348585. mm^4
J_v = 90648. mm^4
y_g = 22.56 mm
T_y = 4140. N
M_x = -2401200. Nmm
x_m = 36. mm
y_m = 53. mm
u_m = 12. mm
v_m = 30.44 mm
$\sigma_m = -Mv/J_u$ = 209.7 N/mm^2
x_c = 24. mm
y_c = 41. mm
v_c = 18.44 mm
$\sigma_c = -Mv/J_u$ = 127. N/mm^2
τ_c = 6.741 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 127.6 N/mm^2
S^* = 6811. mm^3


D
H
B
D
D
H
F
B
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C
G
A
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17/5F
F
1/2Fb
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F
1/2Fb
F
G
A
F
8/5Fb
8/5F
17/5Fb
17/5F
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F
I
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17/5F
3/5Fb
2F
17/5F
7/5Fb
2F
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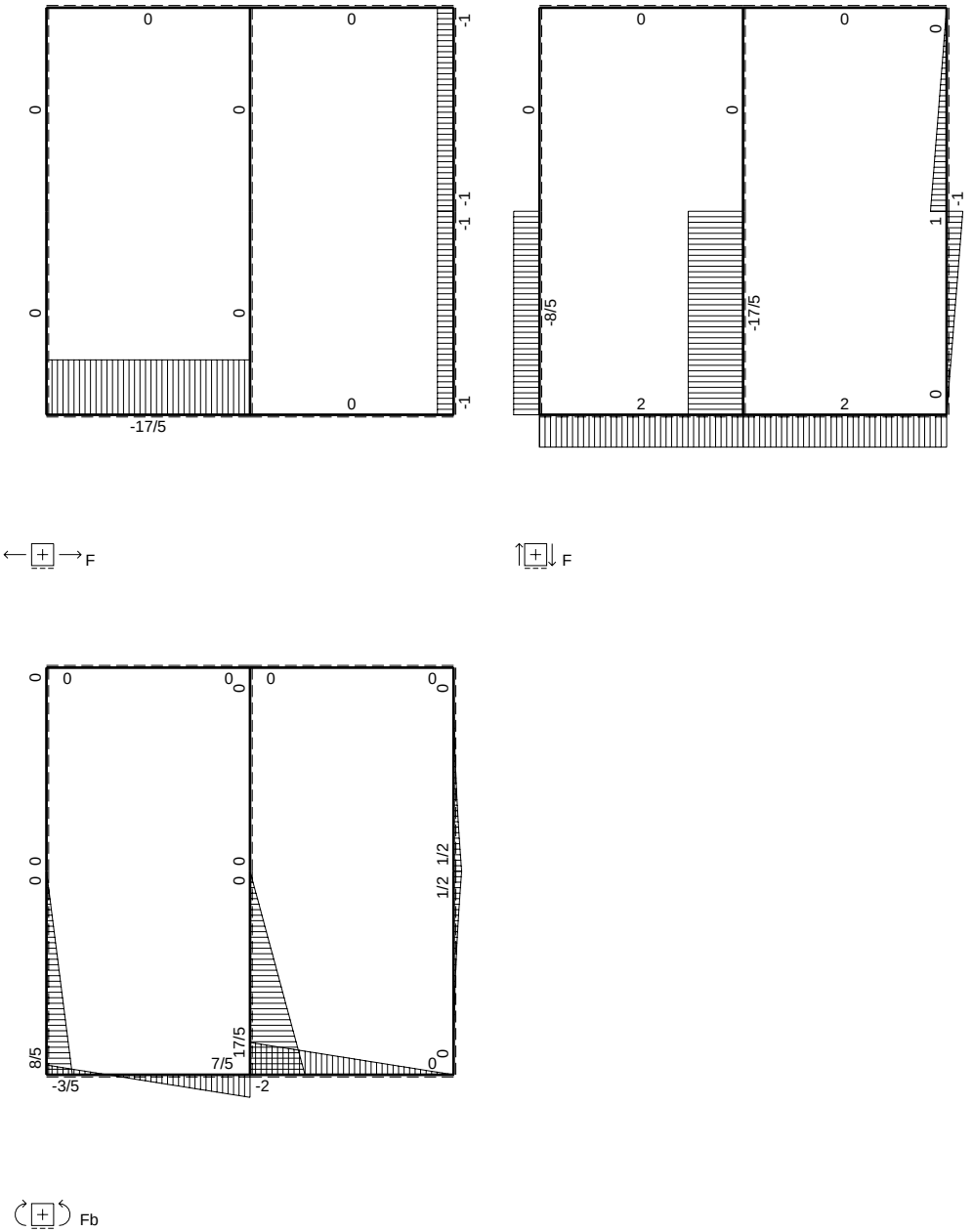
F
2Fb
2F
2F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-1
-17/5
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-1
-8/5
-17/5
2
2
F
F
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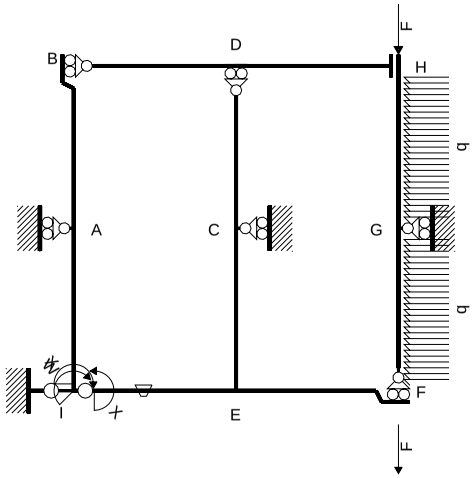
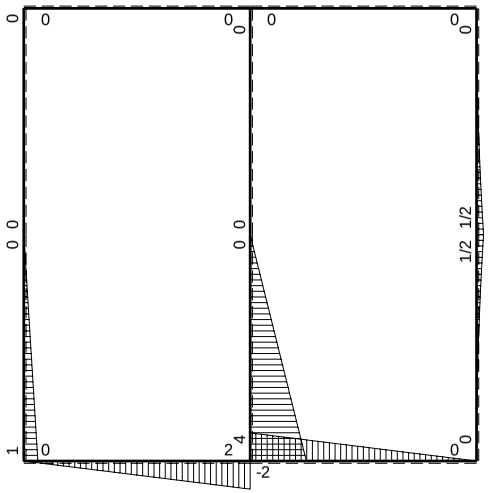
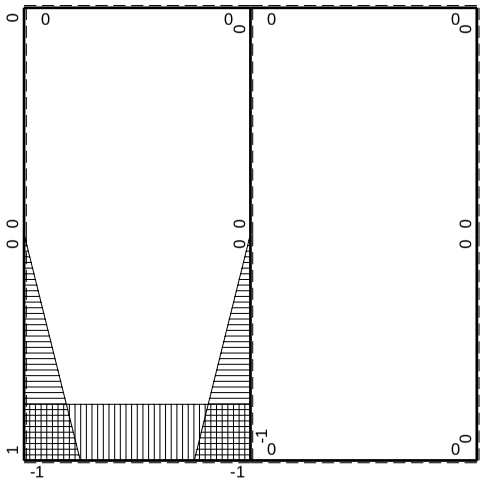
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 937934 CI07.xxxx.032

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2qx^2$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	-1+x/b	4Fb-4Fx	0	$-4Fb+8Fx-4Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-4/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-4Fx	0	$-4Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fb-Fx	0	$Fb-2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/3+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	-Fx	0	Fx^2/b	0	x^2/b^2		
	totali						$-Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						3/5Fb	

PROCEDIMENTO E RISULTATI 937934 CI07.xxxx.032

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L_{EI}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L_{EC}^{Xo} = \int_o^b (-4 + 8\ x/b - 4\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4\ x + 4\ x^2/b - 4/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-4\ b + 4\ b - 4/3\ b\ )\ Fb\ 1/EJ\ = -4/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-4\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-4/3\ b\ )\ Fb\ 1/EJ\ = -4/3\ Fb^2/EJ$

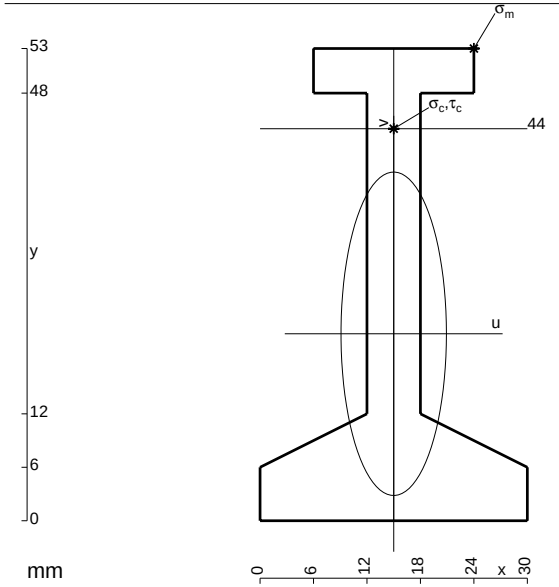
$L_{IA}^{Xo} = \int_o^b (1 - 2\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ Fb\ 1/EJ\ = 1/3\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/3\ b\ )\ Fb\ 1/EJ\ = 1/3\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 937934 CI07.xxxx.032



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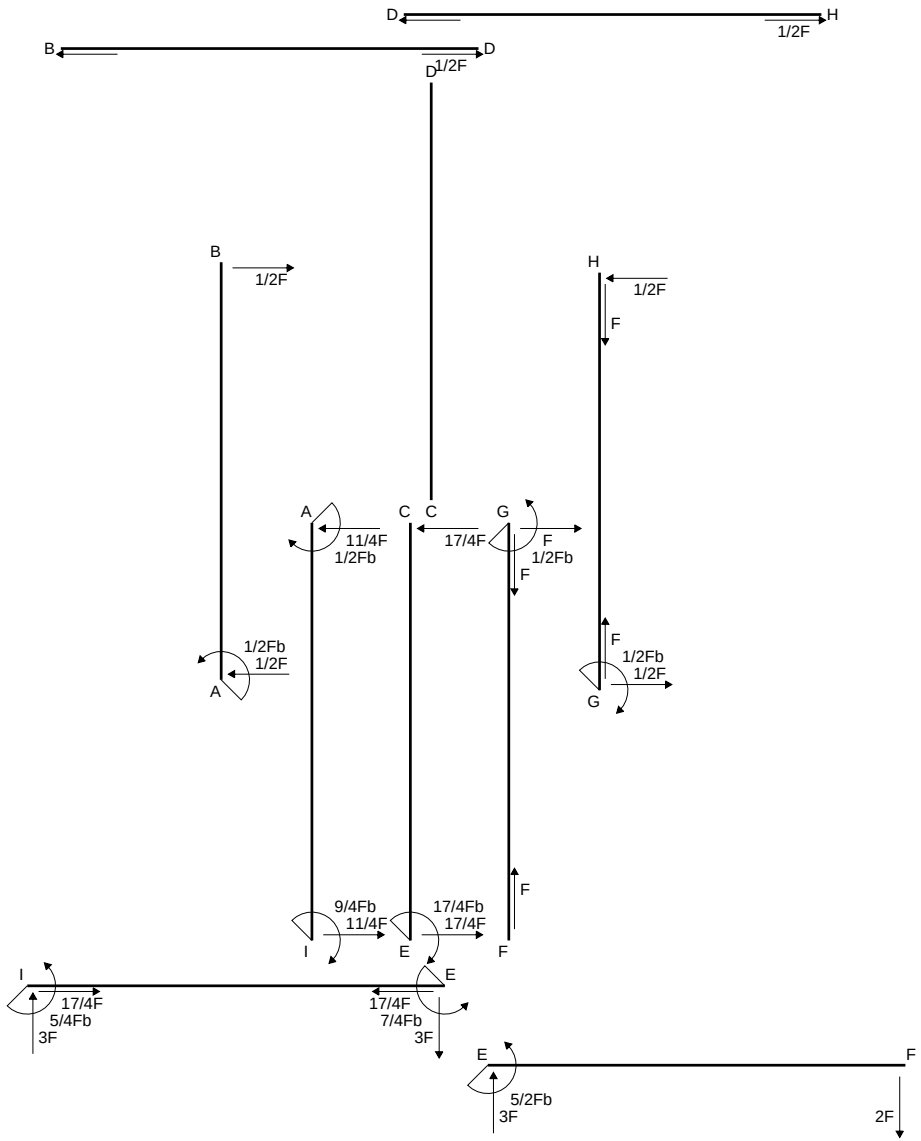
J_u = 195798. mm^4
J_v = 20790. mm^4
y_g = 20.98 mm
T_y = 2120. N
M_x = -1335600. Nmm
x_m = 24. mm
y_m = 53. mm
u_m = 9. mm
v_m = 32.02 mm
$\sigma_m = -Mv/J_u$ = 218.4 N/mm^2
x_c = 15. mm
y_c = 44. mm
v_c = 23.02 mm
$\sigma_c = -Mv/J_u$ = 157. N/mm^2
τ_c = 5.877 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 157.3 N/mm^2
S^* = 3257. mm^3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A
C
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F
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1/2F
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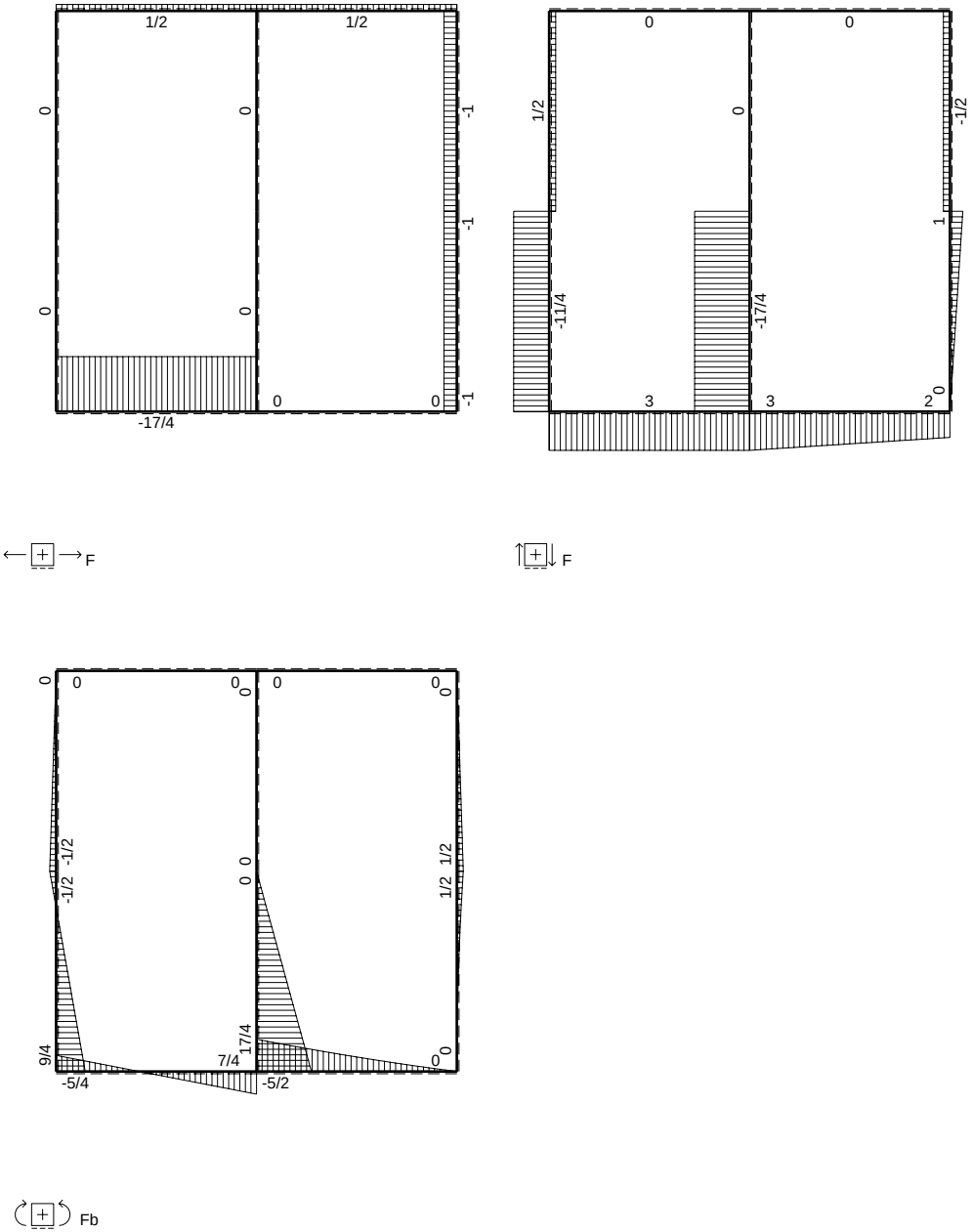
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0
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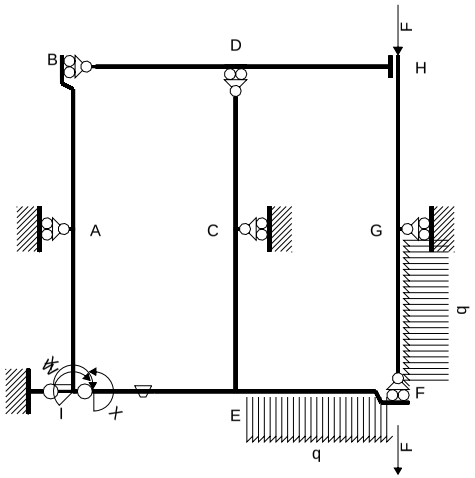
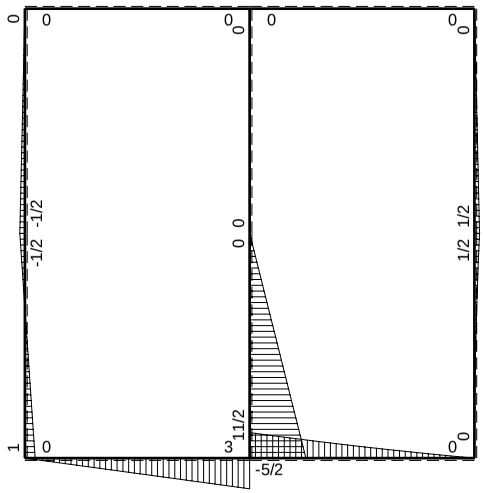
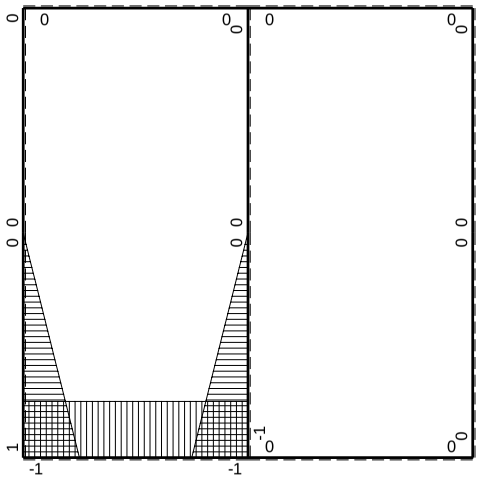
-5/4
-5/2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 251904 CI07.xxxx.033

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-5/2Fb+3Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$2Fx+1/2qx^2$	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	11/2Fb-11/2Fx	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-11/2Fx$	0	$-11/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fb-3/2Fx	0	$Fb-5/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/4+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-3/2Fx	0	$-1/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-25/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						5/4Fb	

PROCEDIMENTO E RISULTATI 251904 CI07.xxxx.033

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-11/2 + 11\ x/b - 11/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-11/2\ x + 11/2\ x^2/b - 11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-11/2\ b + 11/2\ b - 11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-11/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

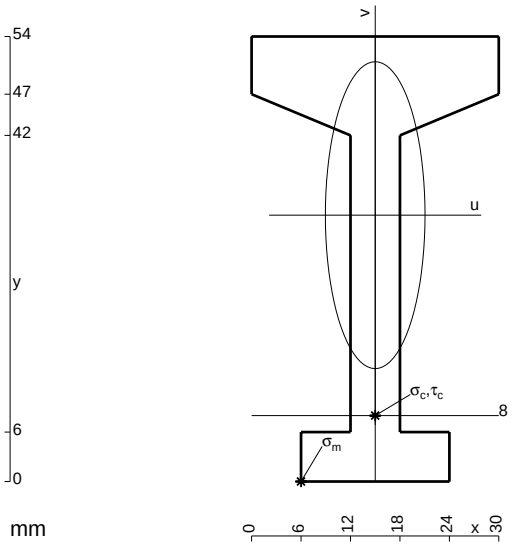
$L_{IA}^{Xo} = \int_o^b (1 - 5/2\ x/b + 3/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [\ x - 5/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (\ b - 5/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = 1/4\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 3/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = 1/4\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 251904 CI07.xxxx.033



A = 624. mm^2
J_u = 216470. mm^4
J_v = 22824. mm^4
y_g = 32.32 mm
T_y = 2640. N
M_x = -1540000. Nmm
x_m = 6. mm
u_m = -9. mm
v_m = -32.32 mm
$\sigma_m = -Mv/J_u$ = -229.9 N/mm^2
x_c = 15. mm
y_c = 8. mm
v_c = -24.32 mm
$\sigma_c = -Mv/J_u$ = -173. N/mm^2
τ_c = 7.054 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 173.5 N/mm^2
S^* = 3470. mm^3

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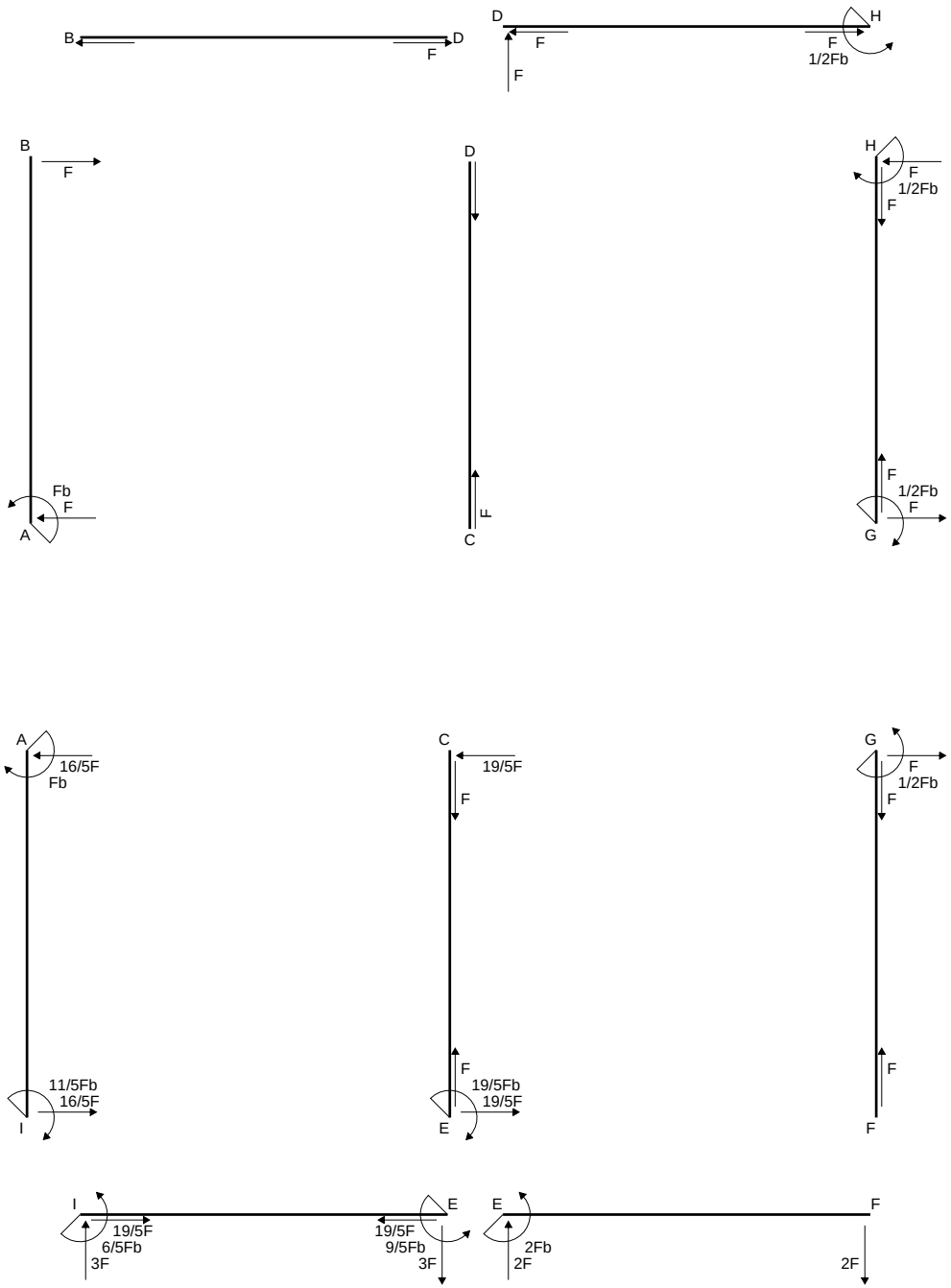
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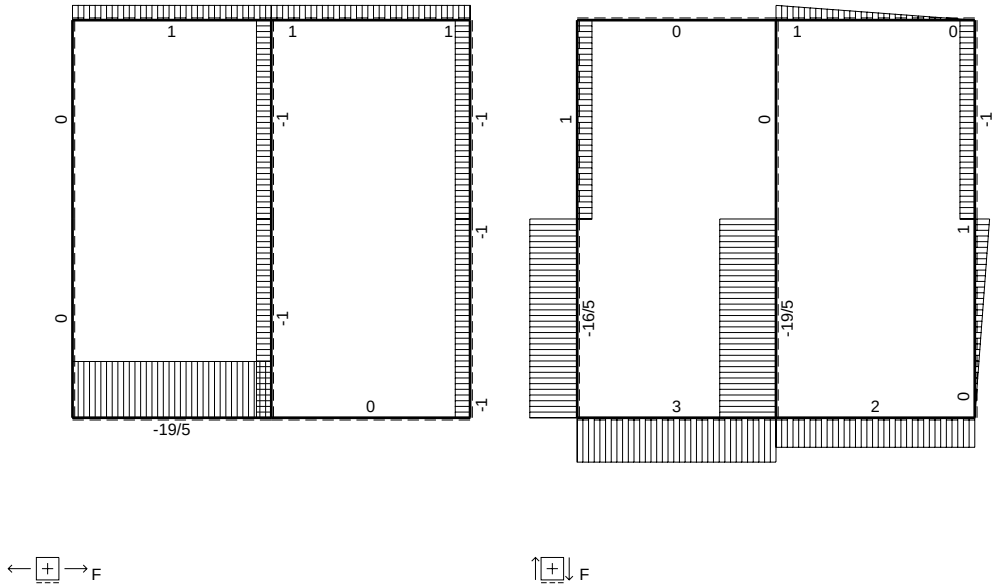
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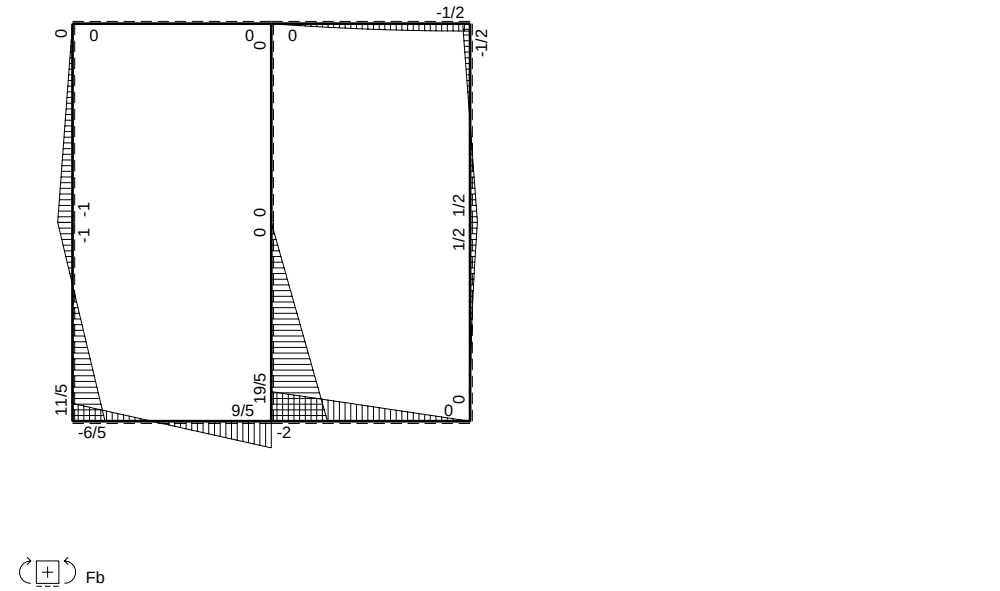
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1/2 1/2
11/5
19/5
9/5
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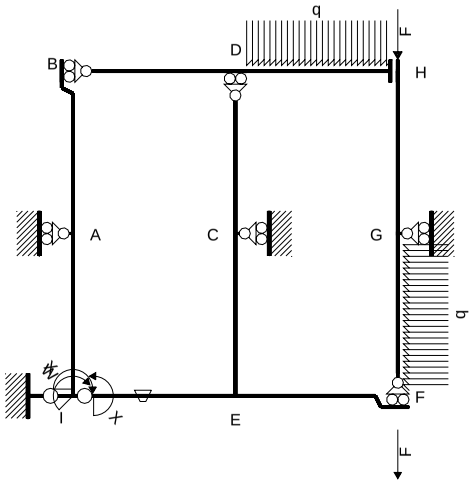
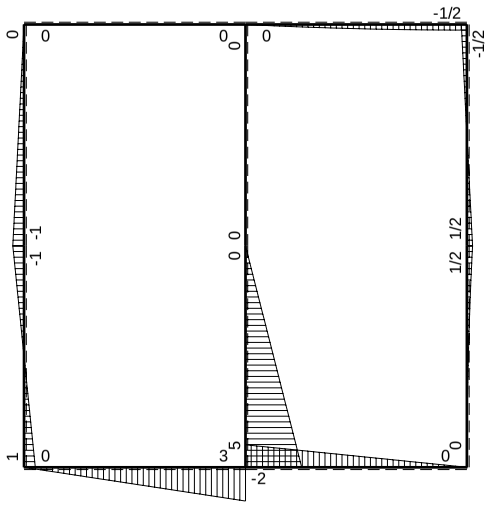
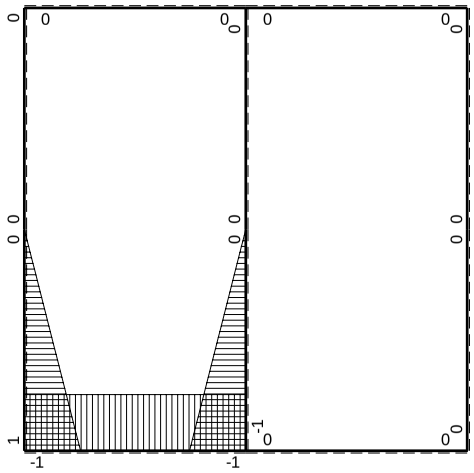
0
-6/5
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 247160 CI07.xxxx.034

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PROCEDIMENTO E RISULTATI 247160 CI07.xxxx.034

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb-Fx	0	0	0	0	0+0	0
HG b	0	1/2Fb-Fx	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-5Fx	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-5Fx	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fb-2Fx	0	$Fb-3Fx+2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	Fb-2Fx	0	$-Fx+2Fx^2/b$	0	x^2/b^2		
	totali						$-2Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						6/5Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

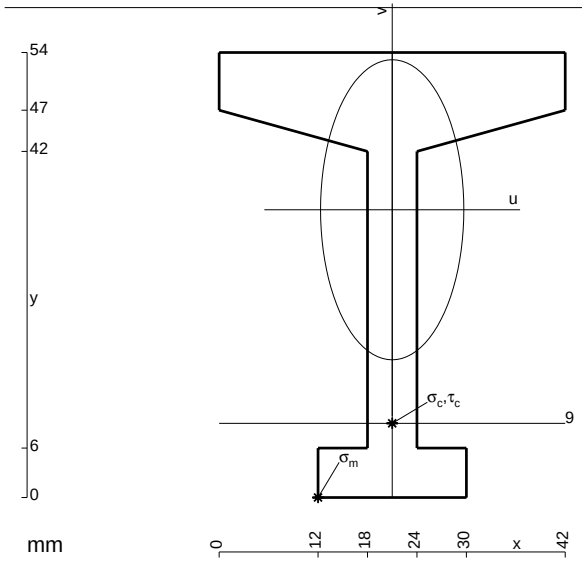
$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1 - 3\ x/b + 2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [\ x - 3/2\ x^2/b + 2/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

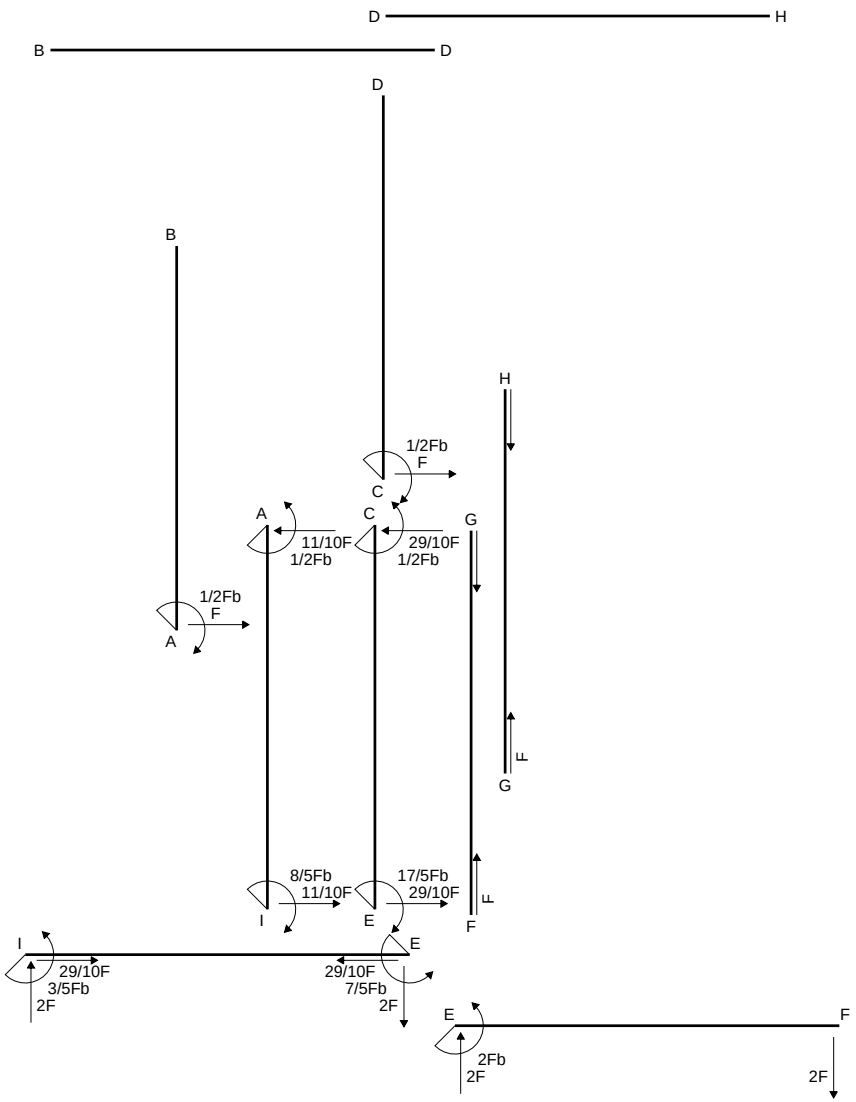
$= (\ b - 3/2\ b + 2/3\ b\ )\ Fb\ 1/EJ\ = 1/6\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-\ x/b + 2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 2/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 2/3\ b\ )\ Fb\ 1/EJ\ = 1/6\ Fb^2/EJ$



A = 738. mm^2
J_u = 244714. mm^4
J_v = 55782. mm^4
y_g = 34.92 mm
T_y = 2240. N
M_x = -1680000. Nmm
x_m = 12. mm
u_m = -9. mm
v_m = -34.92 mm
$\sigma_m = -Mv/J_u$ = -239.7 N/mm^2
x_c = 21. mm
y_c = 9. mm
v_c = -25.92 mm
$\sigma_c = -Mv/J_u$ = -177.9 N/mm^2
τ_c = 6.012 N/mm^2
$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2}$ = 178.2 N/mm^2
S^* = 3941. mm^3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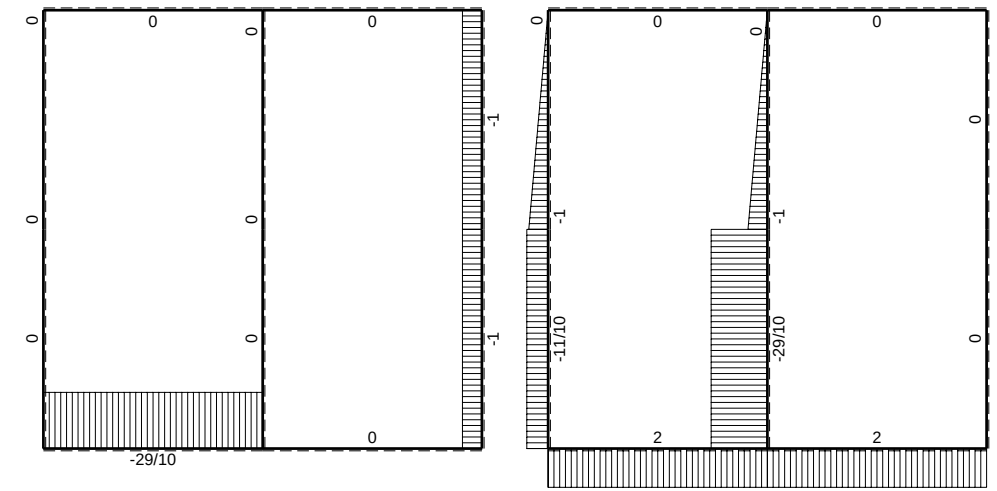
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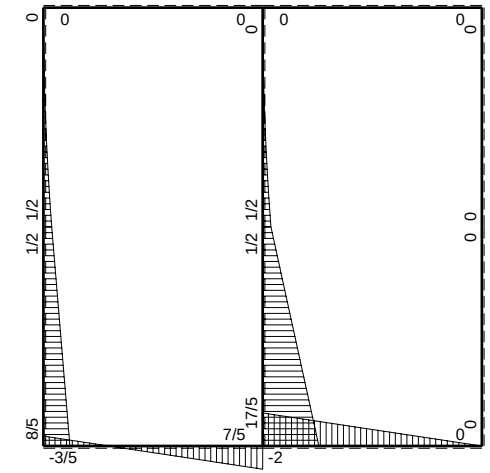
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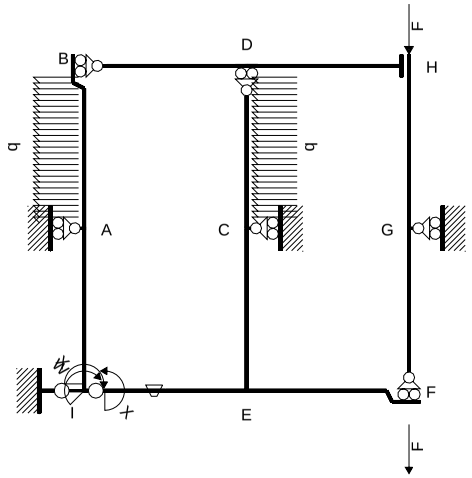
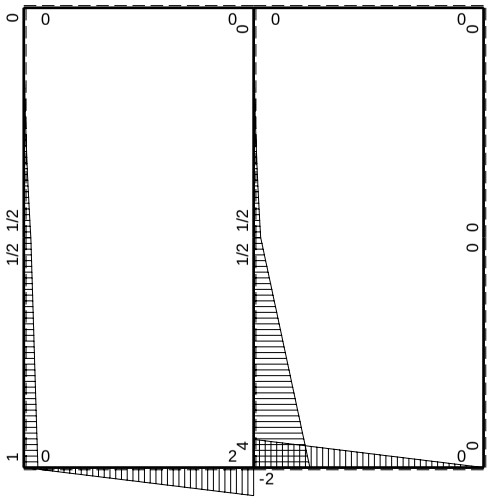
-2

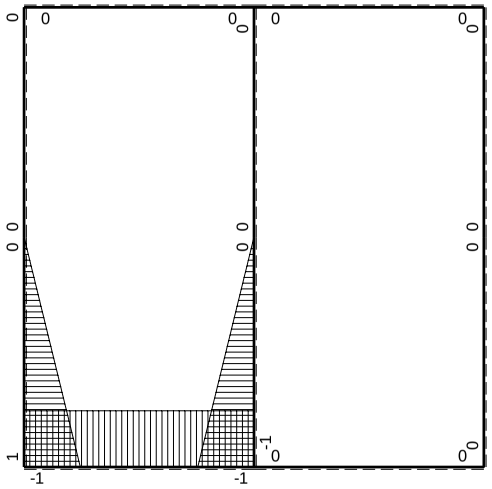
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 218343 CI07.xxxx.035

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PROCEDIMENTO E RISULTATI 218343 CI07.xxxx.035

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$-1/2qx^2$	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	0	0	0	0	0	0+0	0
HG b	0	0	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	-1+x/b	4Fb-7/2Fx	0	$-4Fb+15/2Fx-7/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-17/12+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-1/2Fb-7/2Fx$	0	$-1/2Fx-7/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fb-1/2Fx	0	$Fb-3/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(5/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	$-1/2Fb-1/2Fx$	0	$1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						3/5Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L_{EI}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L_{EC}^{Xo} = \int_o^b (-4 + 15/2\ x/b - 7/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4\ x + 15/4\ x^2/b - 7/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-4\ b + 15/4\ b - 7/6\ b\ )\ Fb\ 1/EJ\ = -17/12\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-1/2\ x/b - 7/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b - 7/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

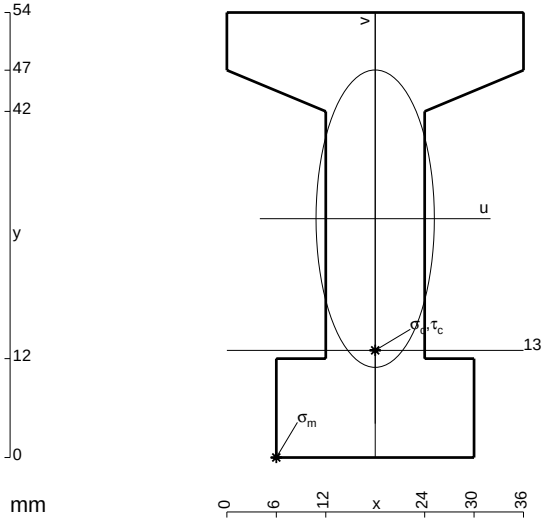
$= (-1/4\ b - 7/6\ b\ )\ Fb\ 1/EJ\ = -17/12\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1 - 3/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [\ x - 3/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (\ b - 3/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = 5/12\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = 5/12\ Fb^2/EJ$



$A = 1020.\ mm^2$

$J_u = 332394.\ mm^4$

$J_v = 52560.\ mm^4$

$y_g = 28.98\ mm$

$T_y = 2820.\ N$

$M_x = -2284200.\ Nmm$

$x_m = 6.\ mm$

$u_m = -12.\ mm$

$v_m = -28.98\ mm$

$\sigma_m = -Mv/J_u = -199.2\ N/mm^2$

$x_c = 18.\ mm$

$y_c = 13.\ mm$

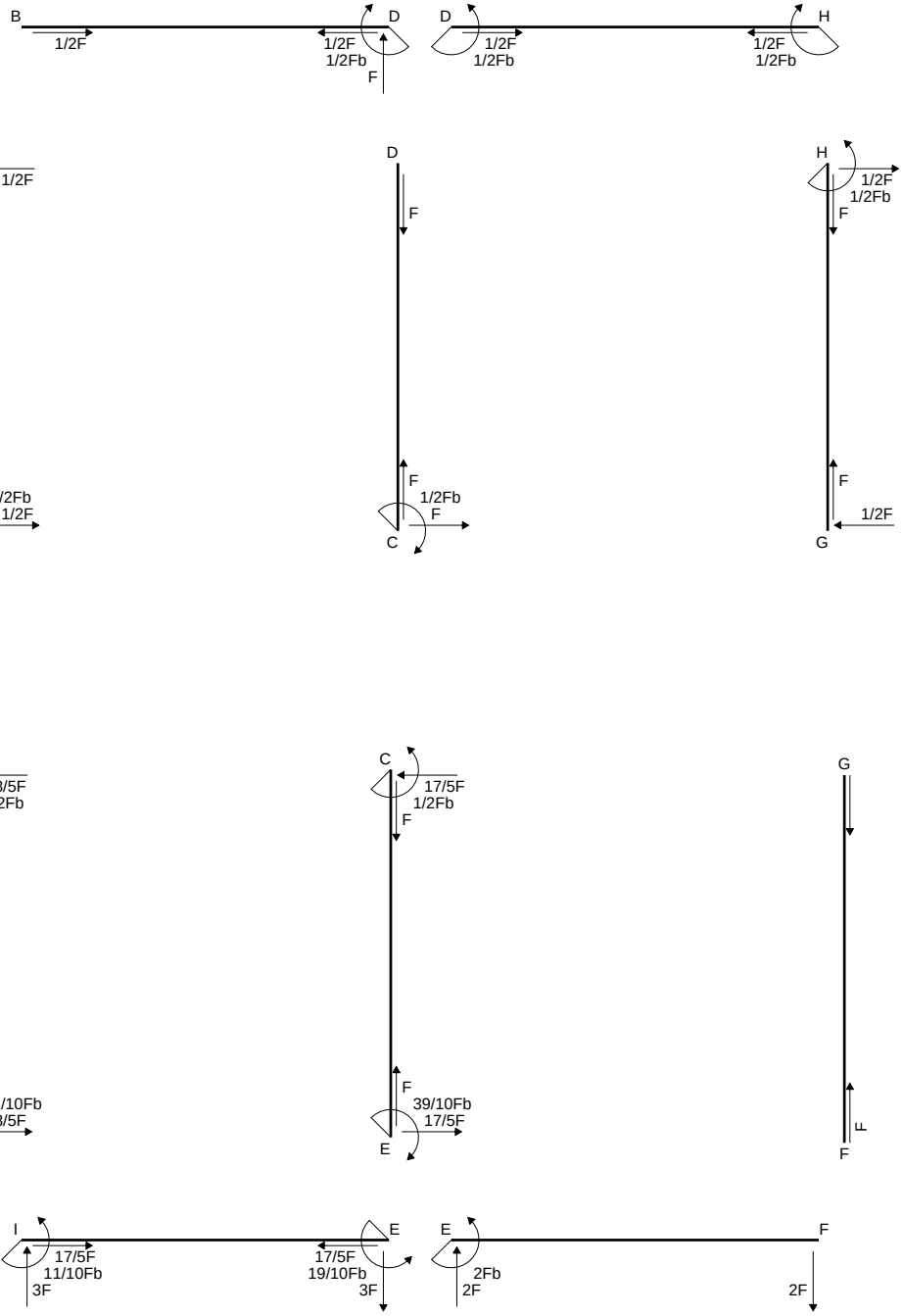
$v_c = -15.98\ mm$

$\sigma_c = -Mv/J_u = -109.8\ N/mm^2$

$\tau_c = 4.82\ N/mm^2$

$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 110.2\ N/mm^2$

$S^* = 6817.\ mm^3$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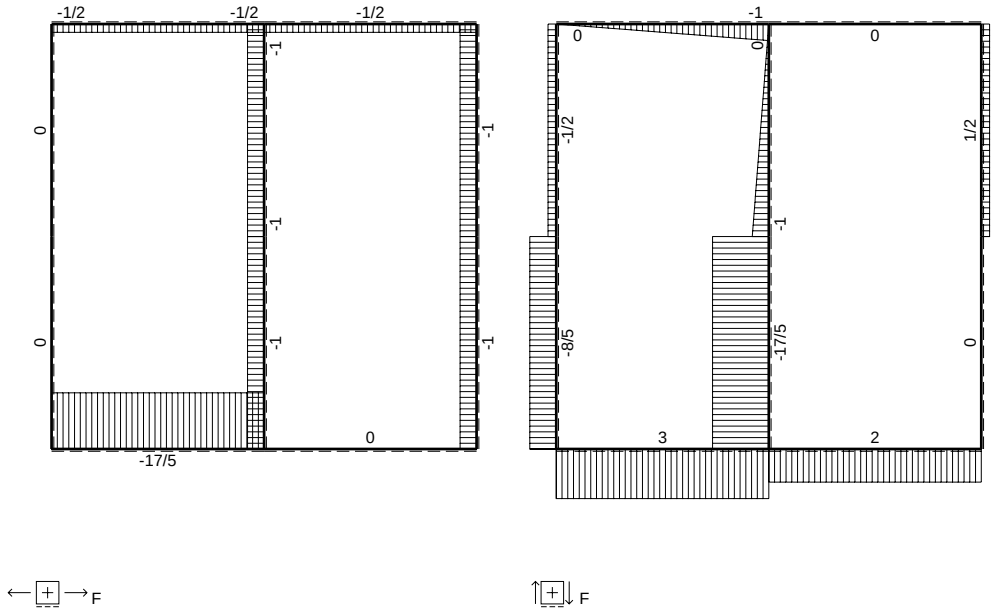
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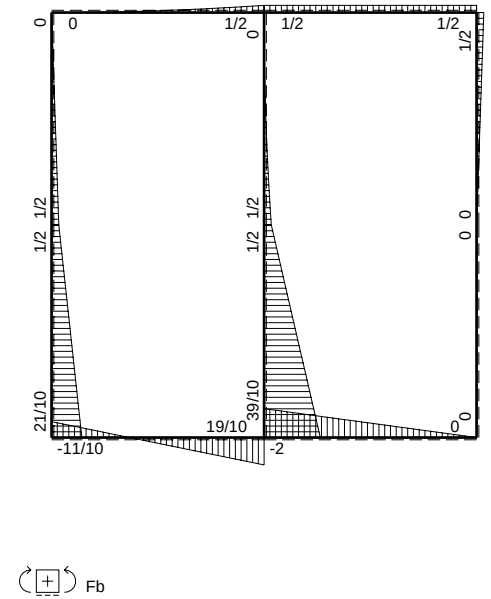
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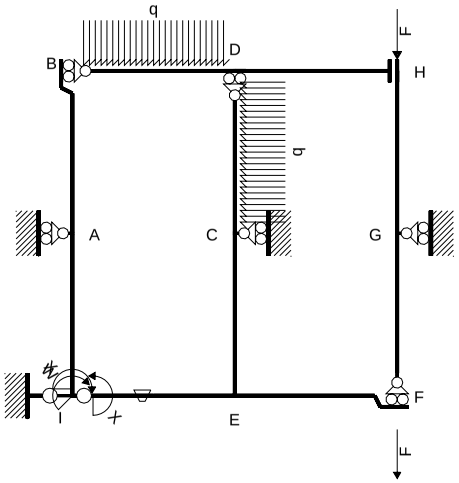
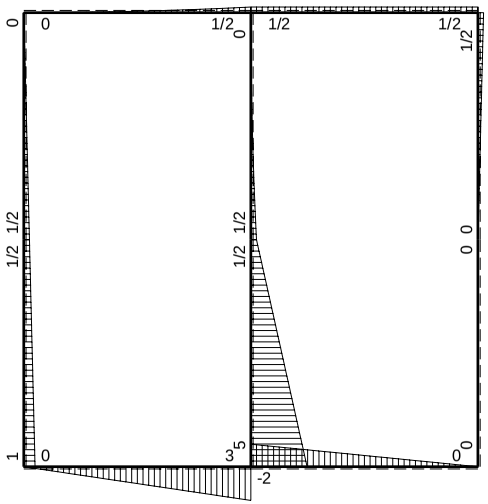
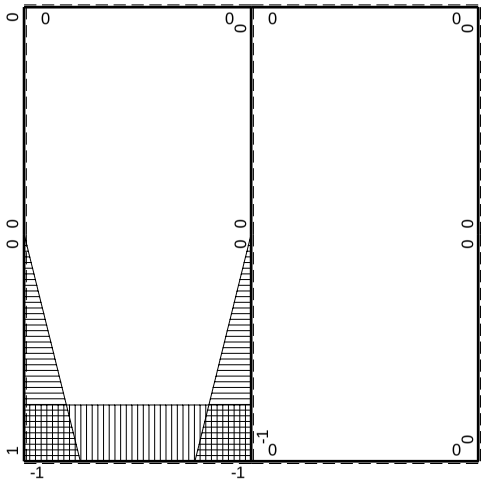


Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 892431 CI07.xxxx.036

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PROCEDIMENTO E RISULTATI 892431 CI07.xxxx.036

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
BA b	0	-1/2Fx	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fb+1/2Fx	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-9/2Fx	0	$-5Fb+19/2Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-7/4+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-1/2Fb-9/2Fx$	0	$-1/2Fx-9/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fb-1/2Fx	0	$Fb-3/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(5/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	$-1/2Fb-1/2Fx$	0	$1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-11/6Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						11/10Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 19/2\ x/b - 9/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 19/4\ x^2/b - 3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 19/4\ b - 3/2\ b\ )\ Fb\ 1/EJ\ = -7/4\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-1/2\ x/b - 9/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b - 3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

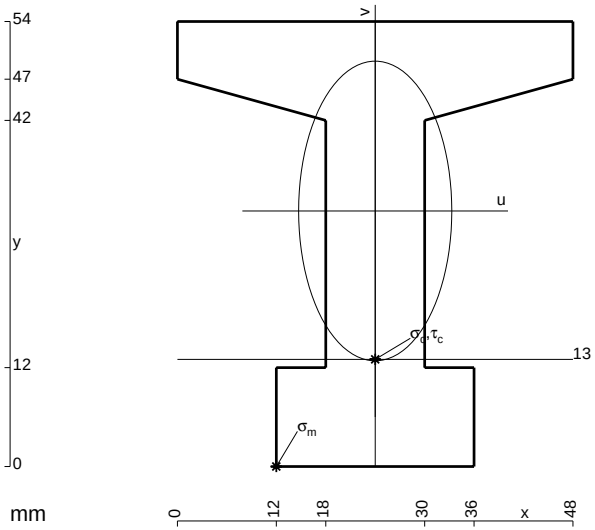
$= (-1/4\ b - 3/2\ b\ )\ Fb\ 1/EJ\ = -7/4\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1 - 3/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [\ x - 3/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (\ b - 3/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = 5/12\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = 5/12\ Fb^2/EJ$



$A = 1134.\ mm^2$

$J_u = 375027.\ mm^4$

$J_v = 97956.\ mm^4$

$y_g = 31.01\ mm$

$T_y = 2940.\ N$

$M_x = -2528400.\ Nmm$

$x_m = 12.\ mm$

$u_m = -12.\ mm$

$v_m = -31.01\ mm$

$\sigma_m = -Mv/J_u = -209.1\ N/mm^2$

$x_c = 24.\ mm$

$y_c = 13.\ mm$

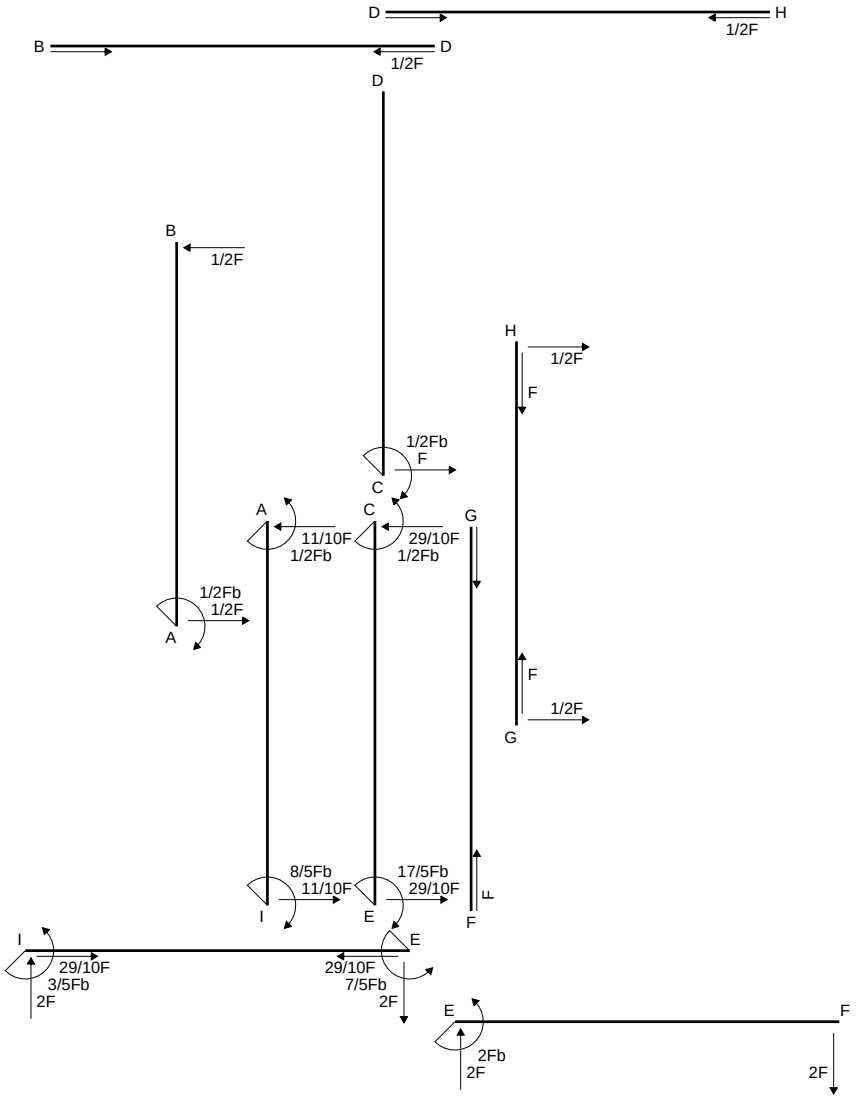
$v_c = -18.01\ mm$

$\sigma_c = -Mv/J_u = -121.4\ N/mm^2$

$\tau_c = 4.851\ N/mm^2$

$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 121.7\ N/mm^2$

$S^* = 7425.\ mm^3$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F
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17/5Fb
29/10F
I
E
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2F
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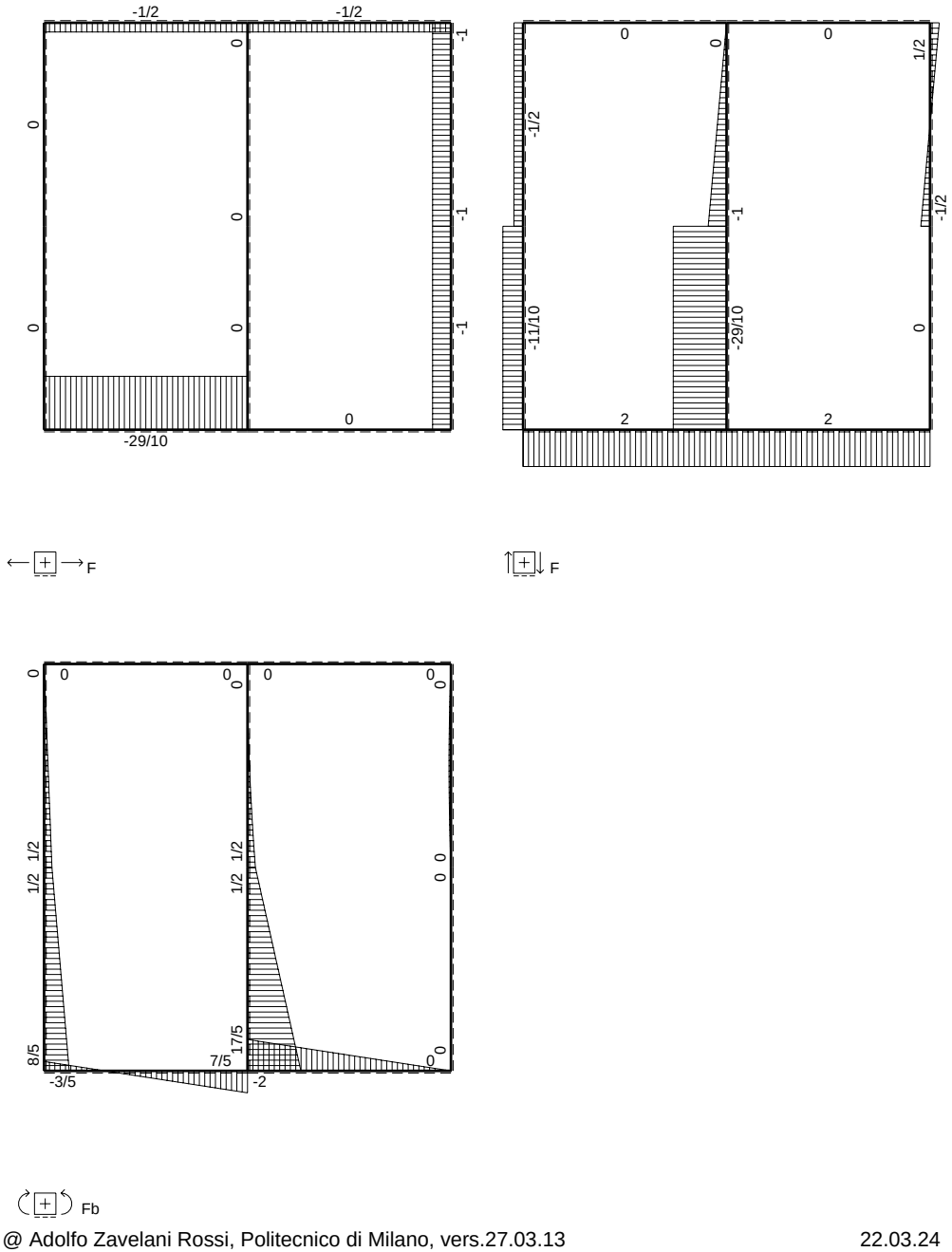
2Fb
2F
2F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F
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17/5
7/5
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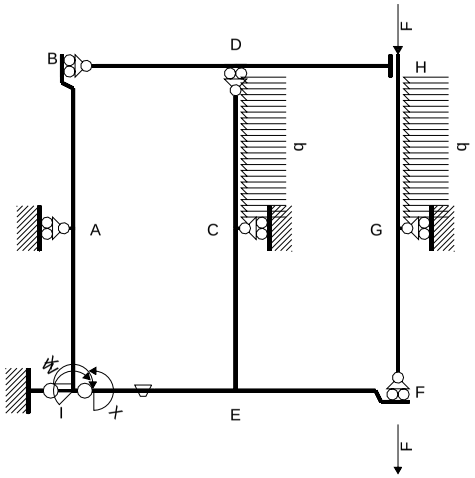
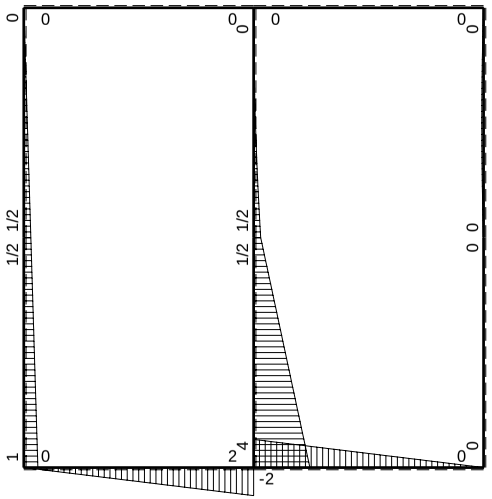
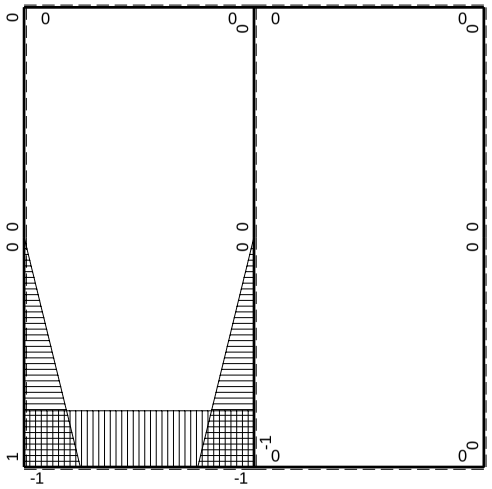
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 211866 CI07.xxxx.037

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
BA b	0	-1/2Fx	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	-1+x/b	4Fb-7/2Fx	0	$-4Fb+15/2Fx-7/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-17/12+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-1/2Fb-7/2Fx$	0	$-1/2Fx-7/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fb-1/2Fx	0	$Fb-3/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(5/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	$-1/2Fb-1/2Fx$	0	$1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						3/5Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L_{EI}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L_{EC}^{Xo} = \int_o^b (-4 + 15/2\ x/b - 7/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4\ x + 15/4\ x^2/b - 7/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-4\ b + 15/4\ b - 7/6\ b\ )\ Fb\ 1/EJ\ = -17/12\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-1/2\ x/b - 7/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b - 7/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

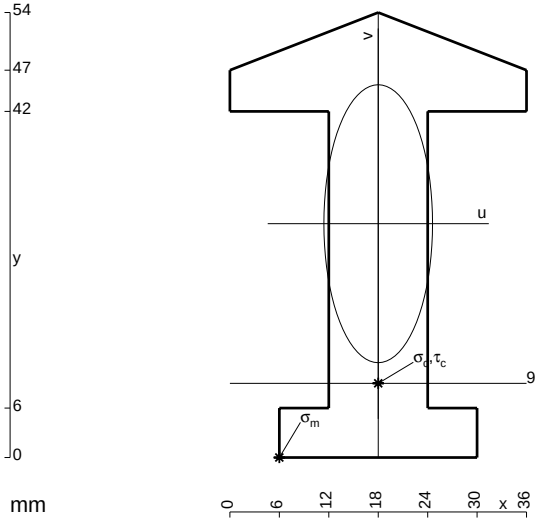
$= (-1/4\ b - 7/6\ b\ )\ Fb\ 1/EJ\ = -17/12\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1 - 3/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [\ x - 3/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

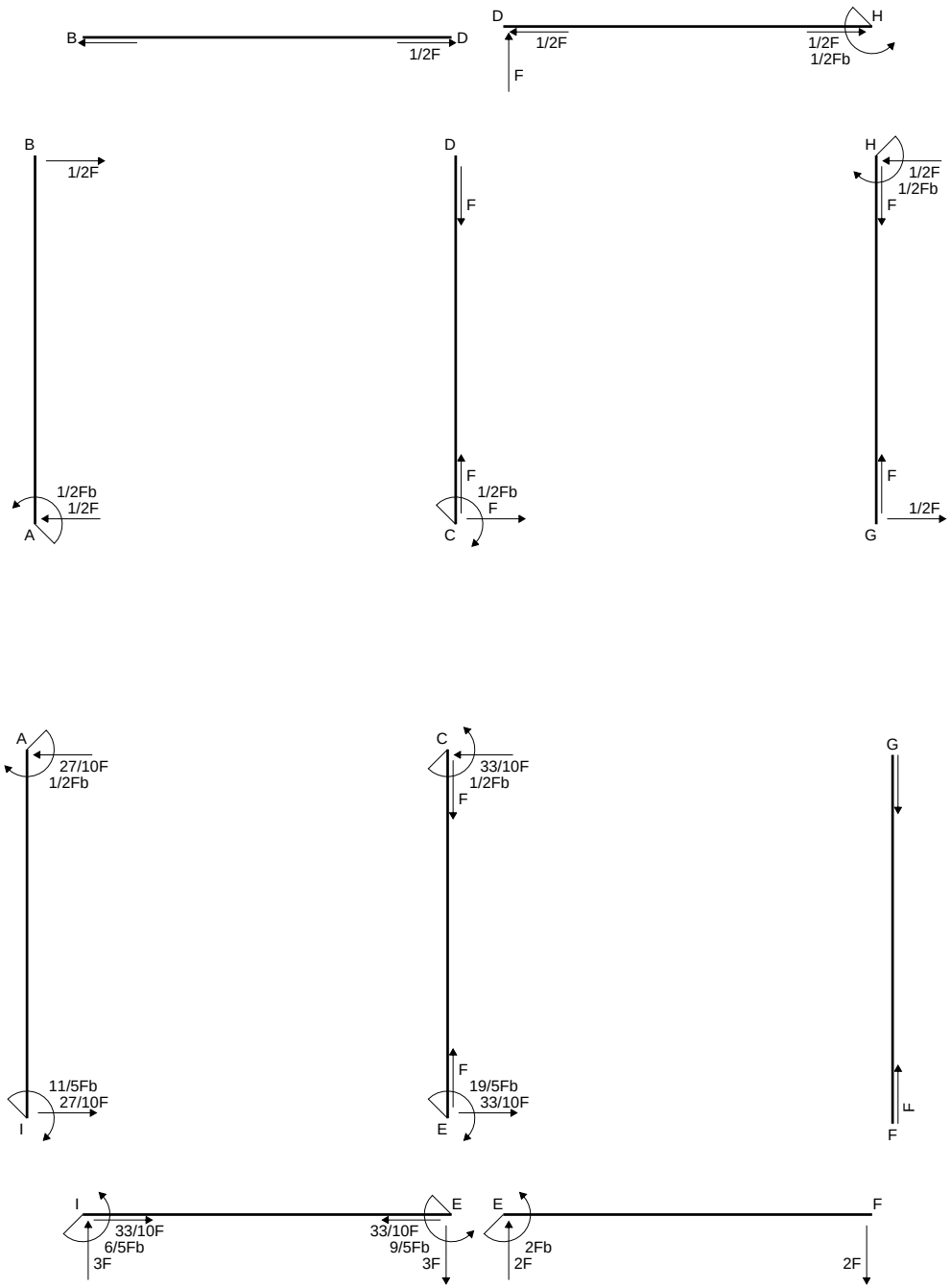
$= (\ b - 3/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = 5/12\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = 5/12\ Fb^2/EJ$



A = 882. mm^2
J_u = 250944. mm^4
J_v = 38340. mm^4
y_g = 28.37 mm
T_y = 2120. N
M_x = -1929200. Nmm
x_m = 6. mm
u_m = -12. mm
v_m = -28.37 mm
$\sigma_m = -Mv/J_u$ = -218.1 N/mm^2
x_c = 18. mm
y_c = 9. mm
v_c = -19.37 mm
$\sigma_c = -Mv/J_u$ = -148.9 N/mm^2
τ_c = 3.101 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 149. N/mm^2
S^* = 4405. mm^3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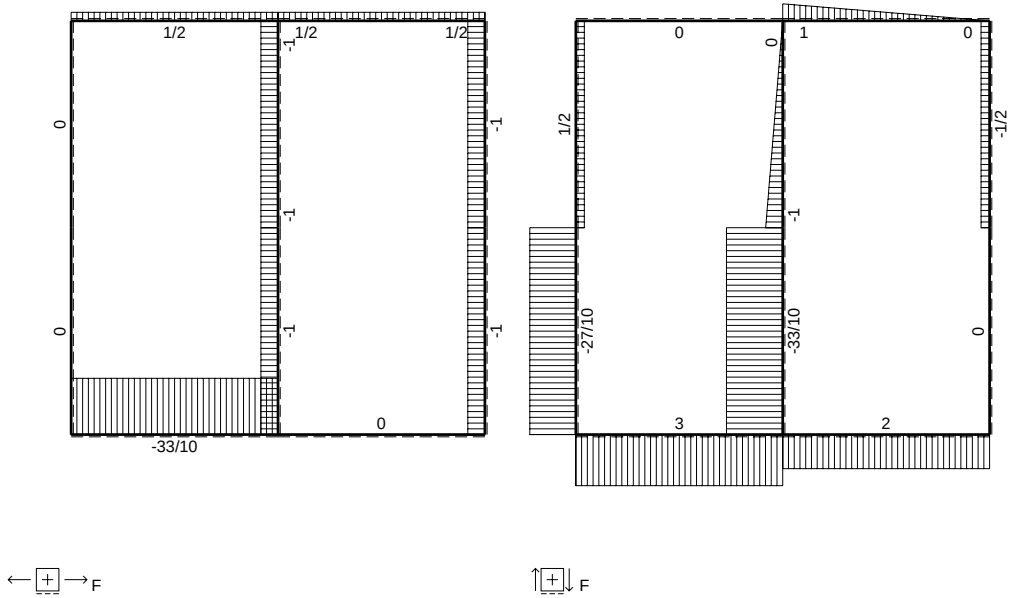
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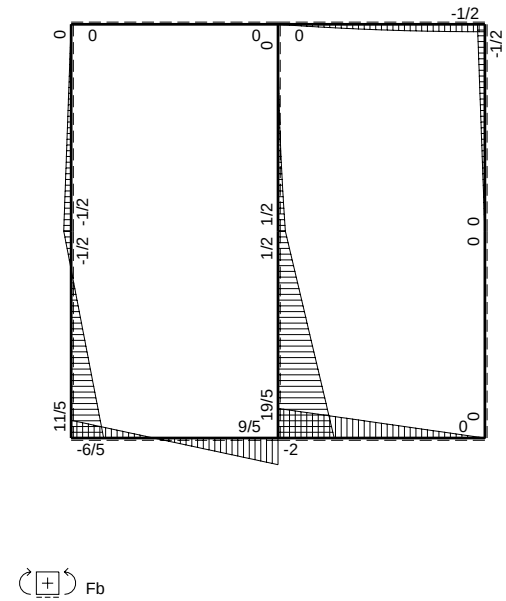
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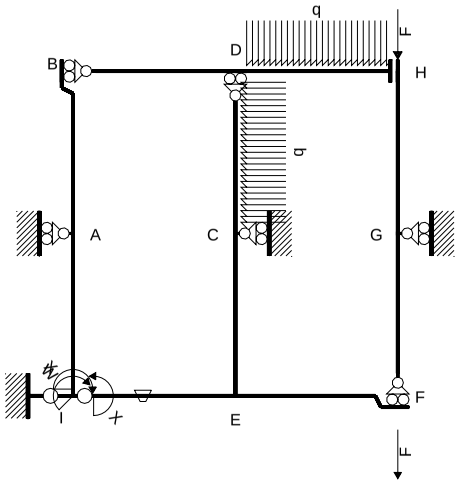
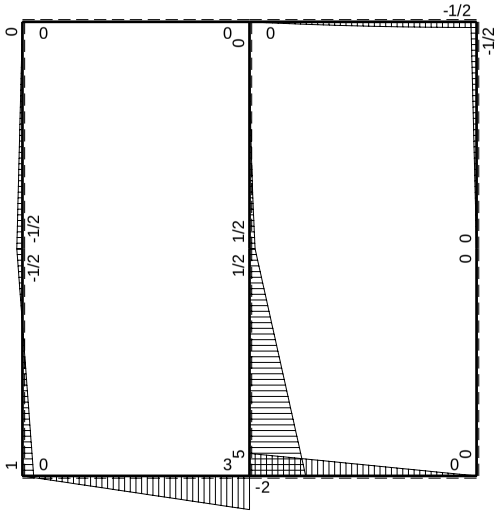
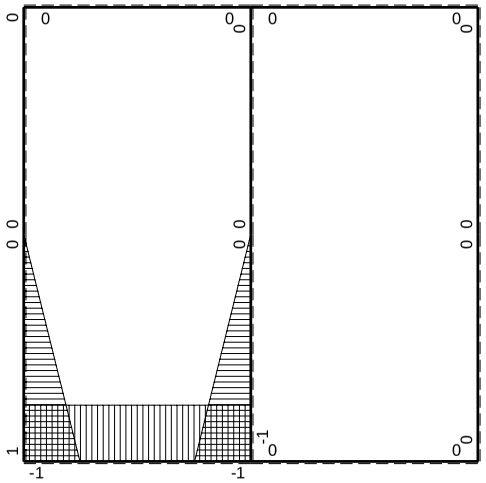
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 224000 CI07.xxxx.038

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PROCEDIMENTO E RISULTATI 224000 CI07.xxxx.038

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	-1/2Fx	0	0	0	0	0+0	0
HG b	0	1/2Fb-1/2Fx	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-9/2Fx	0	$-5Fb+19/2Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-7/4+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-1/2Fb-9/2Fx$	0	$-1/2Fx-9/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fb-3/2Fx	0	$Fb-5/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/4+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-3/2Fx	0	$-1/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-2Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						6/5Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 19/2\ x/b - 9/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 19/4\ x^2/b - 3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 19/4\ b - 3/2\ b\ )\ Fb\ 1/EJ\ = -7/4\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-1/2\ x/b - 9/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b - 3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

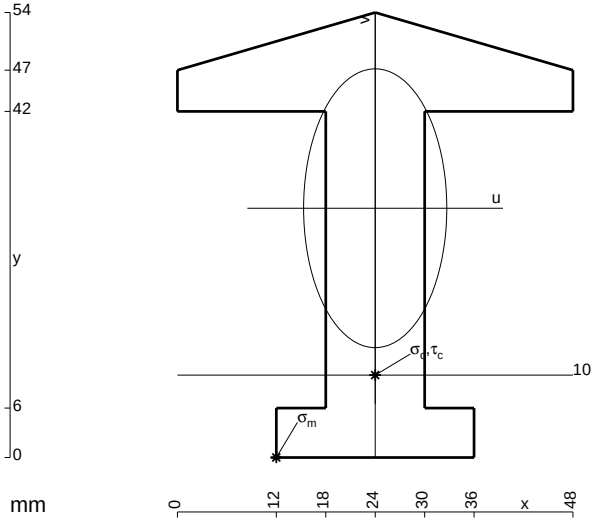
$= (-1/4\ b - 3/2\ b\ )\ Fb\ 1/EJ\ = -7/4\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1 - 5/2\ x/b + 3/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [\ x - 5/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (\ b - 5/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = 1/4\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 3/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = 1/4\ Fb^2/EJ$



$A = 984.\ mm^2$

$J_u = 281765.\ mm^4$

$J_v = 74304.\ mm^4$

$y_g = 30.25\ mm$

$T_y = 2200.\ N$

$M_x = -2134000.\ Nmm$

$x_m = 12.\ mm$

$u_m = -12.\ mm$

$v_m = -30.25\ mm$

$\sigma_m = -Mv/J_u = -229.1\ N/mm^2$

$x_c = 24.\ mm$

$y_c = 10.\ mm$

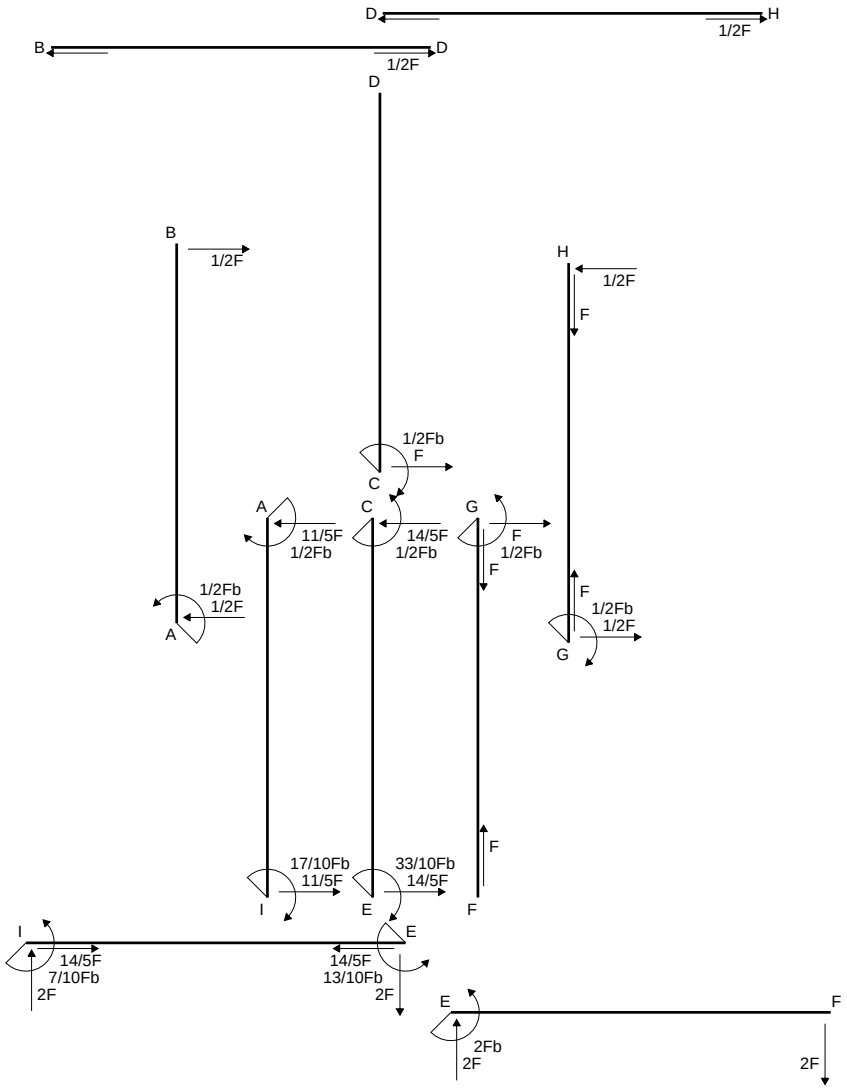
$v_c = -20.25\ mm$

$\sigma_c = -Mv/J_u = -153.4\ N/mm^2$

$\tau_c = 3.248\ N/mm^2$

$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 153.5\ N/mm^2$

$S^* = 4992.\ mm^3$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1/2F
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F
1/2Fb
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14/5F
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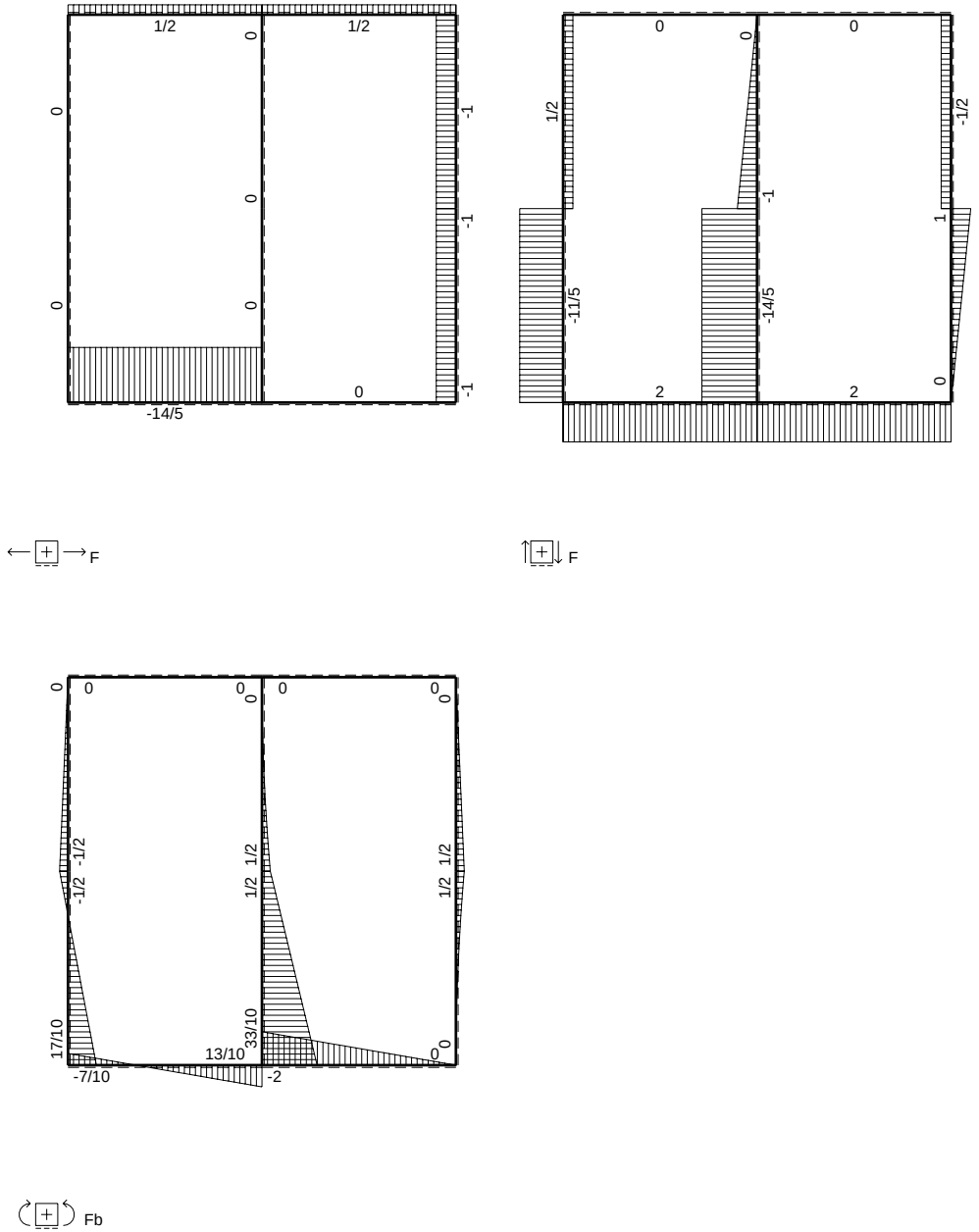
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-1/2
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-14/5
1
0
2
2
F
F
0
0
0
0
0
0
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1/2 1/2
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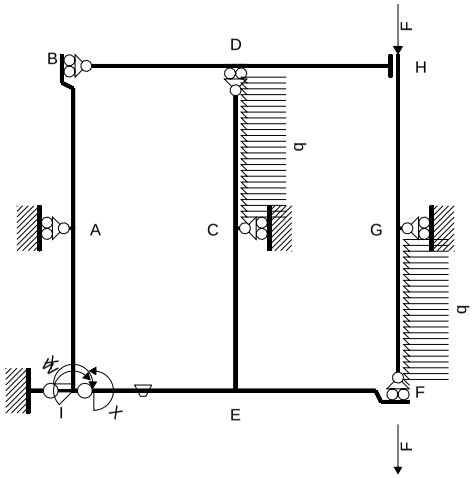
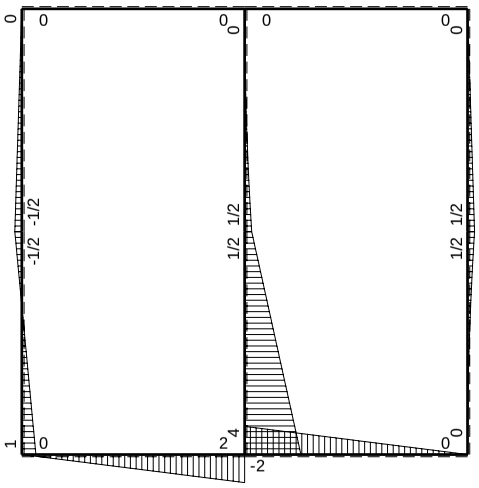
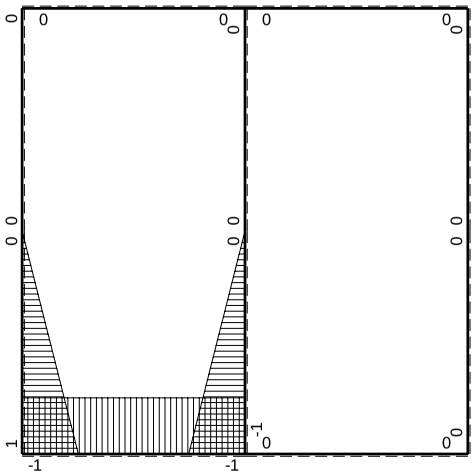
33/10
13/10
-7/10
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 954987 CI07.xxxx.039

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	-1+x/b	4Fb-7/2Fx	0	$-4Fb+15/2Fx-7/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-17/12+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-1/2Fb-7/2Fx$	0	$-1/2Fx-7/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fb-3/2Fx	0	$Fb-5/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/4+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-3/2Fx	0	$-1/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-7/6Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						7/10Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L_{EI}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L_{EC}^{Xo} = \int_o^b (-4 + 15/2\ x/b - 7/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4\ x + 15/4\ x^2/b - 7/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-4\ b + 15/4\ b - 7/6\ b\ )\ Fb\ 1/EJ\ = -17/12\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-1/2\ x/b - 7/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b - 7/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

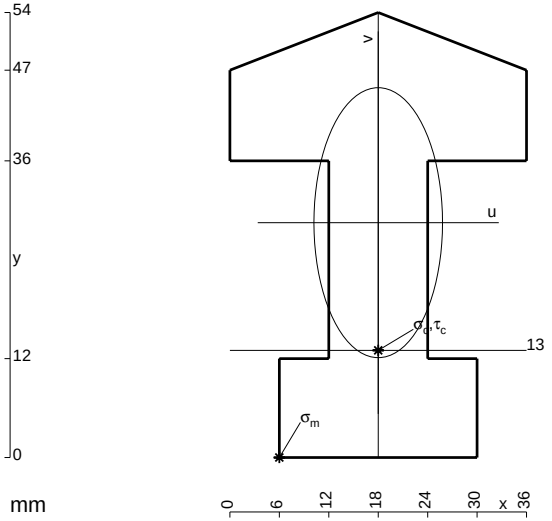
$= (-1/4\ b - 7/6\ b\ )\ Fb\ 1/EJ\ = -17/12\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1 - 5/2\ x/b + 3/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [\ x - 5/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

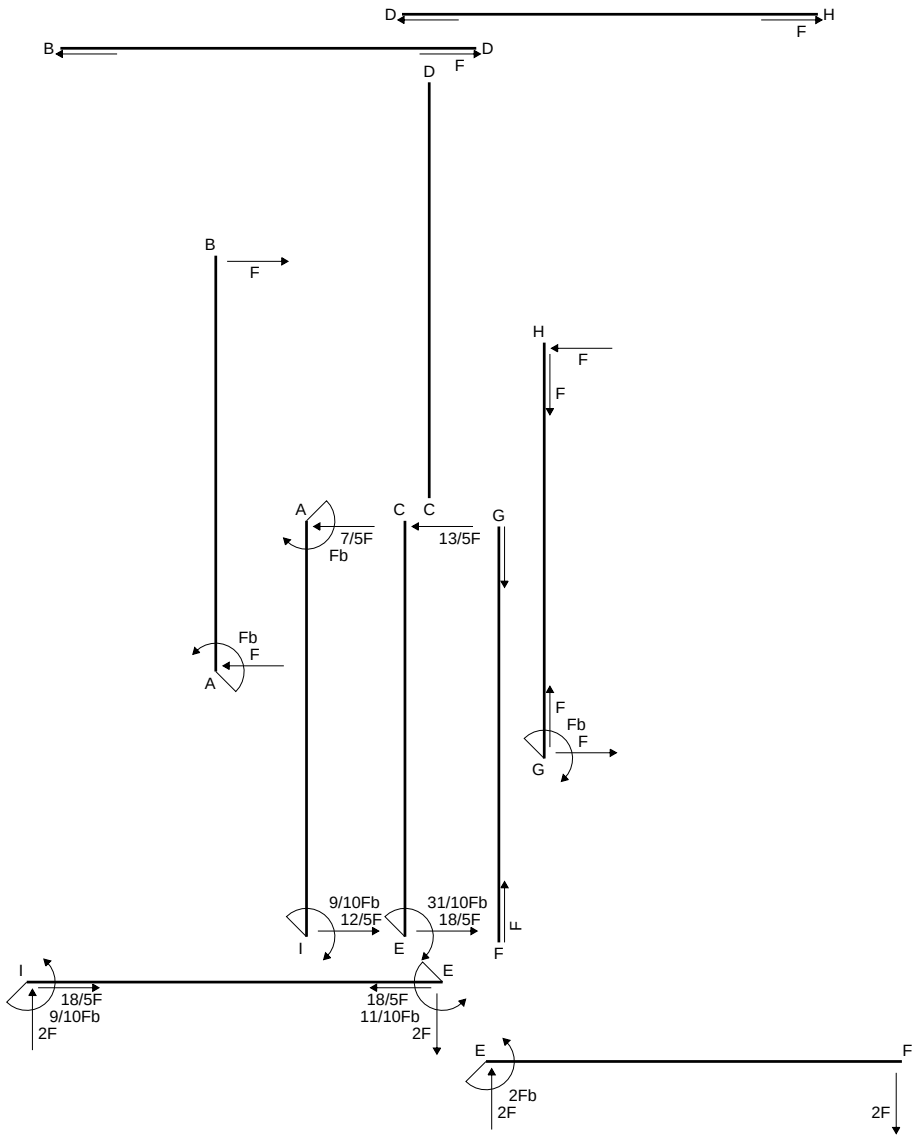
$= (\ b - 5/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = 1/4\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 3/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = 1/4\ Fb^2/EJ$



A = 1098. mm^2
J_u = 294859. mm^4
J_v = 66852. mm^4
y_g = 28.5 mm
T_y = 2420. N
M_x = -2468400. Nmm
x_m = 6. mm
u_m = -12. mm
v_m = -28.5 mm
$\sigma_m = -Mv/J_u$ = -238.6 N/mm^2
x_c = 18. mm
y_c = 13. mm
v_c = -15.5 mm
$\sigma_c = -Mv/J_u$ = -129.7 N/mm^2
τ_c = 4.563 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 130. N/mm^2
S^* = 6671. mm^3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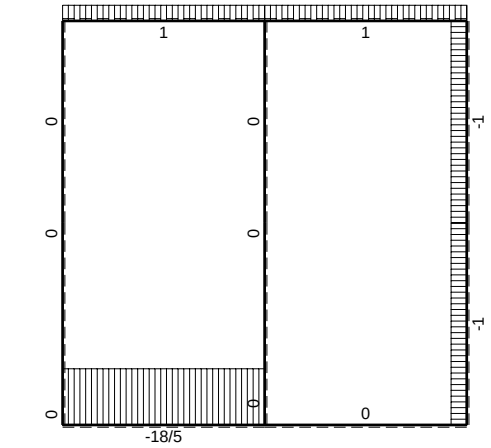
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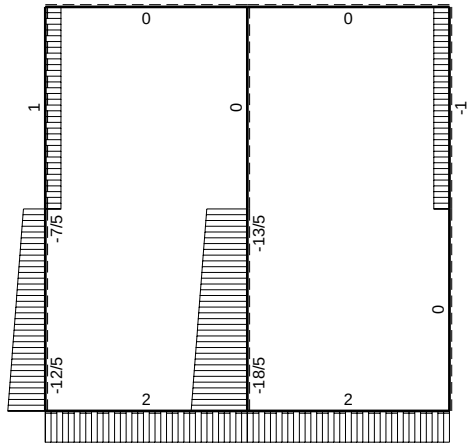
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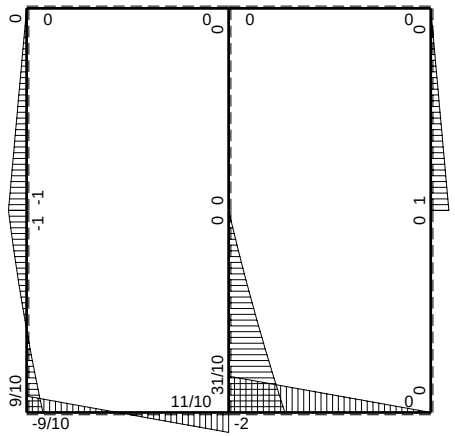
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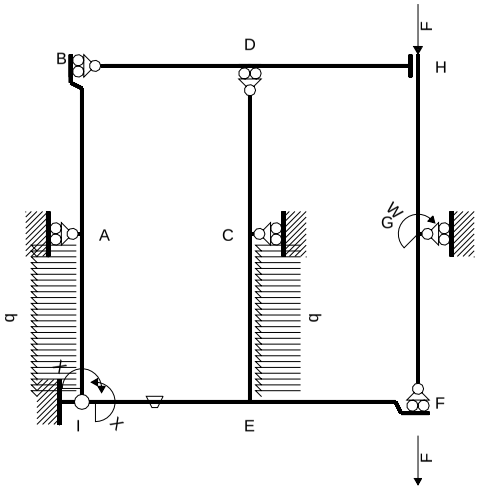
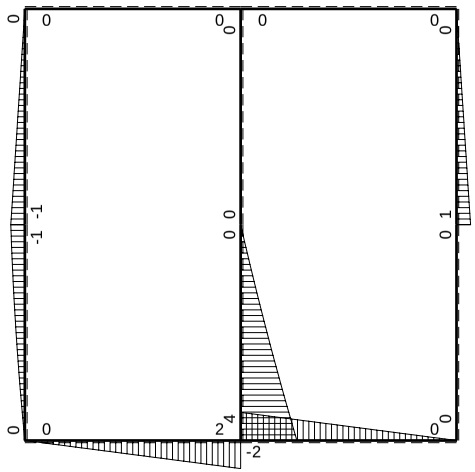
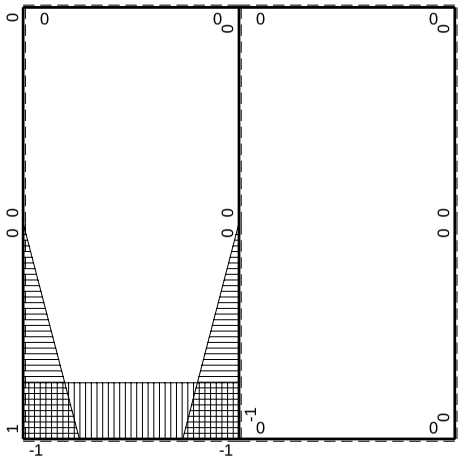
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 985202 CI07.xxxx.040

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PROCEDIMENTO E RISULTATI 985202 CI07.xxxx.040

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	Fb-Fx	0	0	0	0	0+0	0
HG b	0	-Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	-1+x/b	$4Fb-9/2Fx+1/2qx^2$	0	$-4Fb+17/2Fx-5Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-31/24+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-7/2Fx-1/2qx^2$	0	$-7/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2		
IA b	1-x/b	$-3/2Fx+1/2qx^2$	0	$-3/2Fx+2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-5/24+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	$Fb-1/2Fx-1/2qx^2$	0	$-Fx+1/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
	totali						$-3/2Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						9/10Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L_{EI}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L_{EC}^{Xo} = \int_o^b (-4 + 17/2\ x/b - 5\ x^2/b^2 + 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx$

$= [-4\ x + 17/4\ x^2/b - 5/3\ x^3/b^2 + 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

$= (-4\ b + 17/4\ b - 5/3\ b + 1/8\ b\ )\ Fb\ 1/EJ\ = -31/24\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-7/2\ x^2/b^2 - 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx = [-7/6\ x^3/b^2 - 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

$= (-7/6\ b - 1/8\ b\ )\ Fb\ 1/EJ\ = -31/24\ Fb^2/EJ$

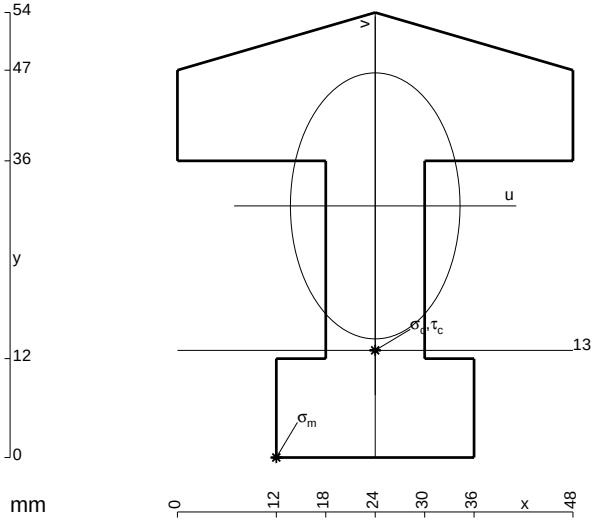
$L_{IA}^{Xo} = \int_o^b (-3/2\ x/b + 2\ x^2/b^2 - 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx = [-3/4\ x^2/b + 2/3\ x^3/b^2 - 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

$= (-3/4\ b + 2/3\ b - 1/8\ b\ )\ Fb\ 1/EJ\ = -5/24\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-\ x/b + 1/2\ x^2/b^2 + 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/6\ x^3/b^2 + 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/6\ b + 1/8\ b\ )\ Fb\ 1/EJ\ = -5/24\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 985202 CI07.xxxx.040



A = 1272. mm^2
J_u = 331576. mm^4
J_v = 134784. mm^4
y_g = 30.53 mm
T_y = 4020. N
M_x = -2170800. Nmm
x_m = 12. mm
u_m = -12. mm
v_m = -30.53 mm
$\sigma_m = -Mv/J_u$ = -199.9 N/mm^2
x_c = 24. mm
y_c = 13. mm
v_c = -17.53 mm
$\sigma_c = -Mv/J_u$ = -114.8 N/mm^2
τ_c = 7.358 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 115.5 N/mm^2
S^* = 7282. mm^3

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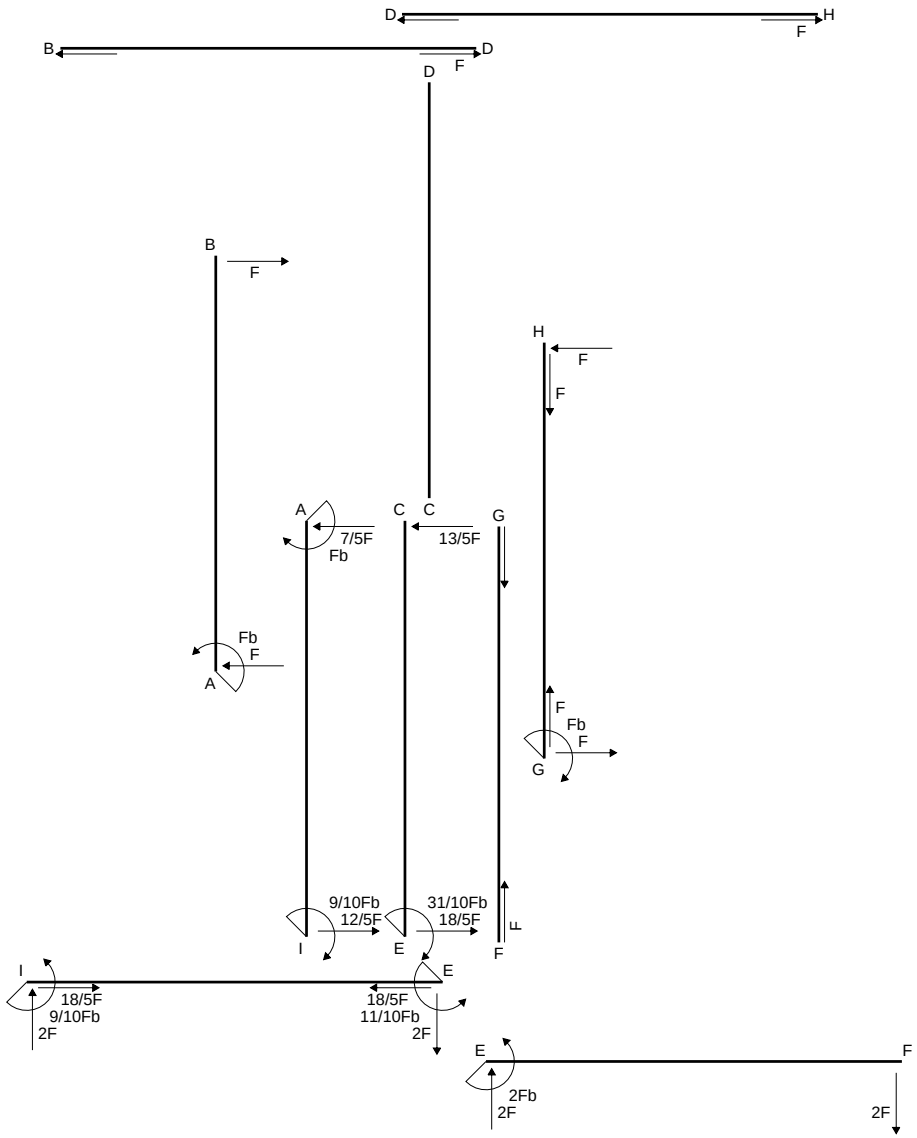
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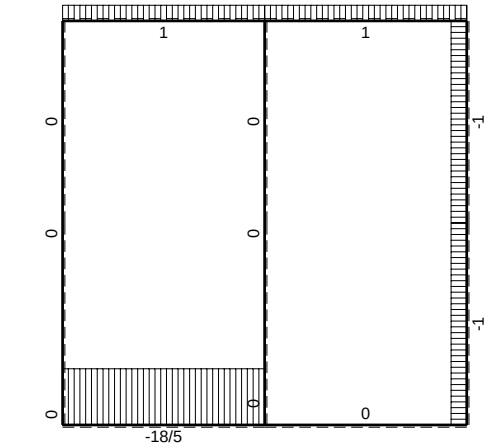
2F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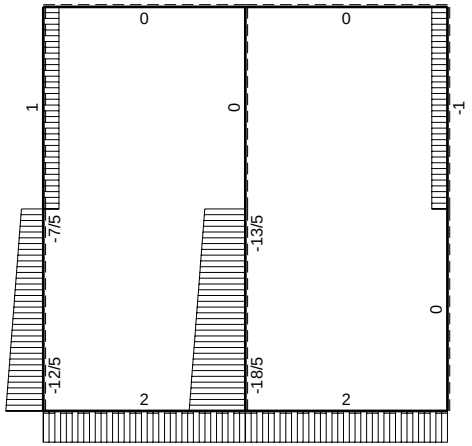
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2
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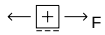
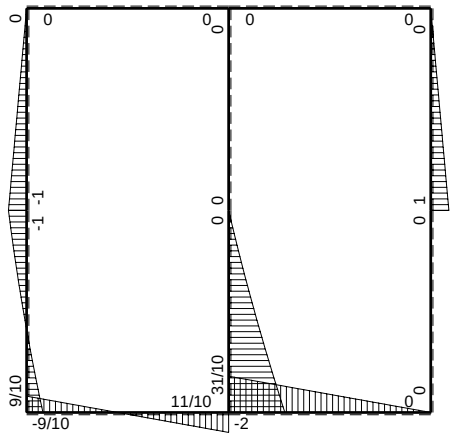

F

F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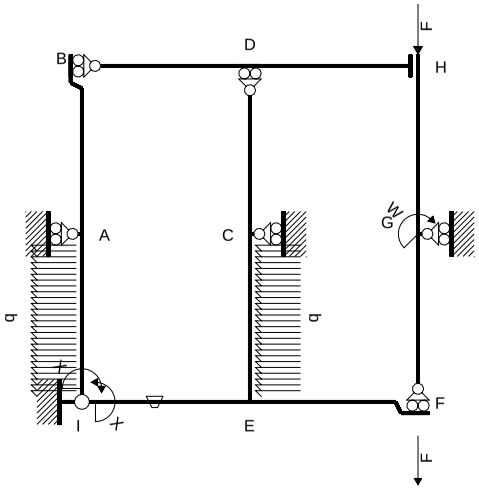
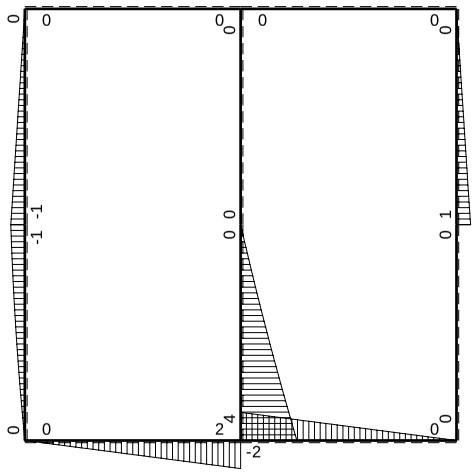
31/10
11/10
0
-9/10
-2

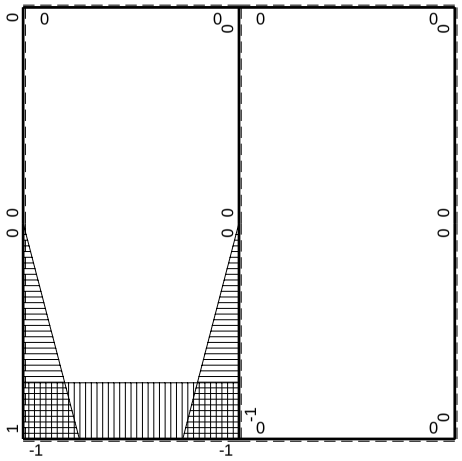
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 944381 CI07.xxxx.041

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PROCEDIMENTO E RISULTATI 944381 CI07.xxxx.041

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	Fb-Fx	0	0	0	0	0+0	0
HG b	0	-Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	-1+x/b	$4Fb-9/2Fx+1/2qx^2$	0	$-4Fb+17/2Fx-5Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-31/24+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-7/2Fx-1/2qx^2$	0	$-7/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2		
IA b	1-x/b	$-3/2Fx+1/2qx^2$	0	$-3/2Fx+2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-5/24+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	$Fb-1/2Fx-1/2qx^2$	0	$-Fx+1/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
	totali						$-3/2Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						9/10Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L_{EI}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L_{EC}^{Xo} = \int_o^b (-4 + 17/2\ x/b - 5\ x^2/b^2 + 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx$

$= [-4\ x + 17/4\ x^2/b - 5/3\ x^3/b^2 + 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

$= (-4\ b + 17/4\ b - 5/3\ b + 1/8\ b\ )\ Fb\ 1/EJ\ = -31/24\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-7/2\ x^2/b^2 - 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx = [-7/6\ x^3/b^2 - 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

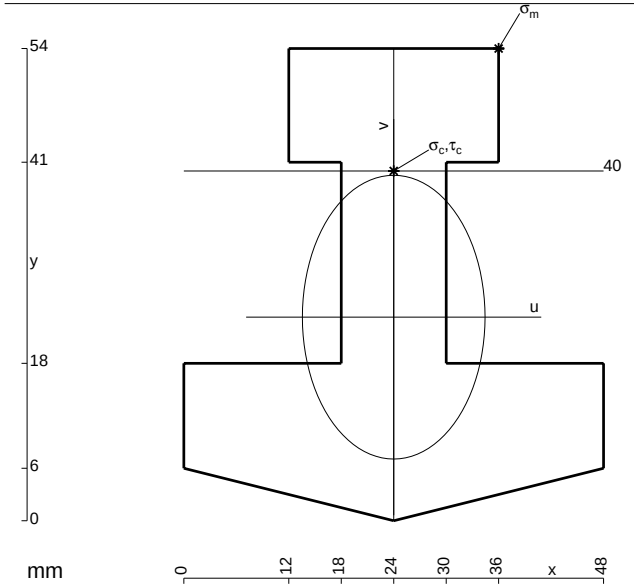
$= (-7/6\ b - 1/8\ b\ )\ Fb\ 1/EJ\ = -31/24\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-3/2\ x/b + 2\ x^2/b^2 - 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx = [-3/4\ x^2/b + 2/3\ x^3/b^2 - 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

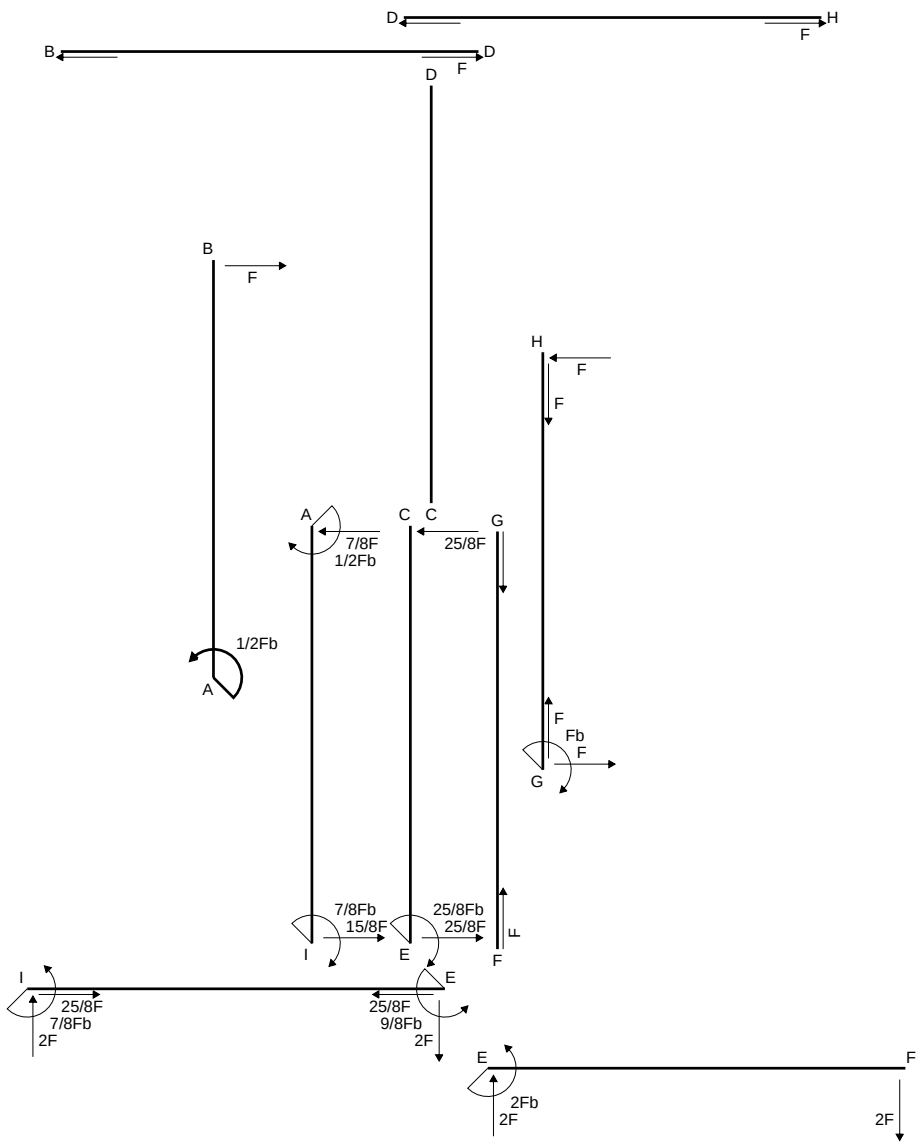
$= (-3/4\ b + 2/3\ b - 1/8\ b\ )\ Fb\ 1/EJ\ = -5/24\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-\ x/b + 1/2\ x^2/b^2 + 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/6\ x^3/b^2 + 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/6\ b + 1/8\ b\ )\ Fb\ 1/EJ\ = -5/24\ Fb^2/EJ$



A = 1308. mm^2
J_u = 344278. mm^4
J_v = 142704. mm^4
y_g = 23.28 mm
T_y = 3980. N
M_x = -2348200. Nmm
x_m = 36. mm
y_m = 54. mm
u_m = 12. mm
v_m = 30.72 mm
$\sigma_m = -Mv/J_u$ = 209.5 N/mm^2
x_c = 24. mm
y_c = 40. mm
v_c = 16.72 mm
$\sigma_c = -Mv/J_u$ = 114. N/mm^2
τ_c = 7.479 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 114.8 N/mm^2
S^* = 7763. mm^3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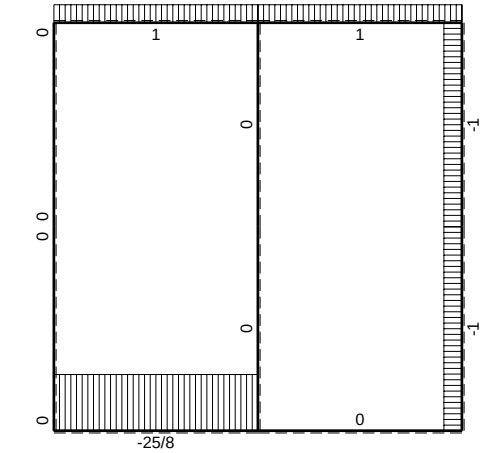
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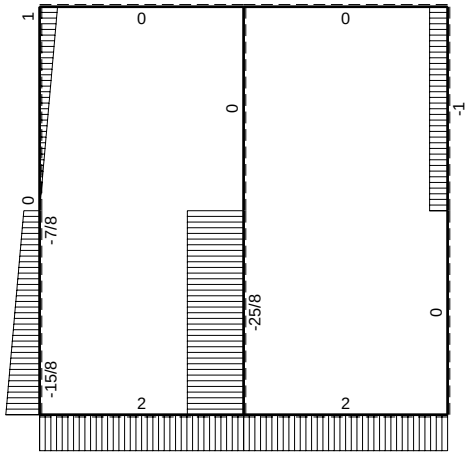
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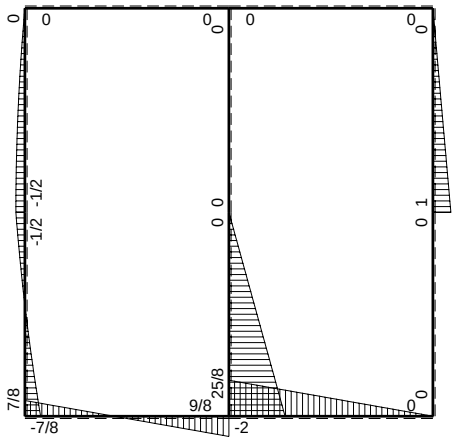
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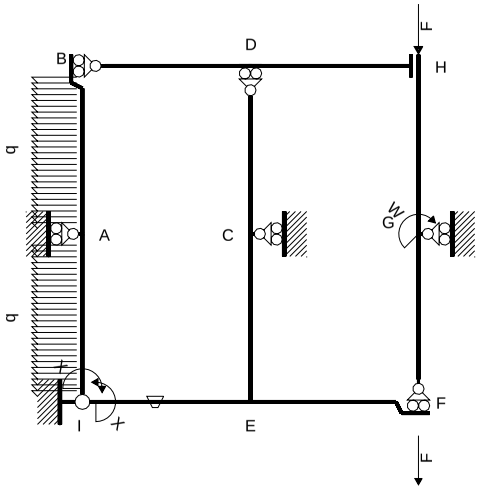
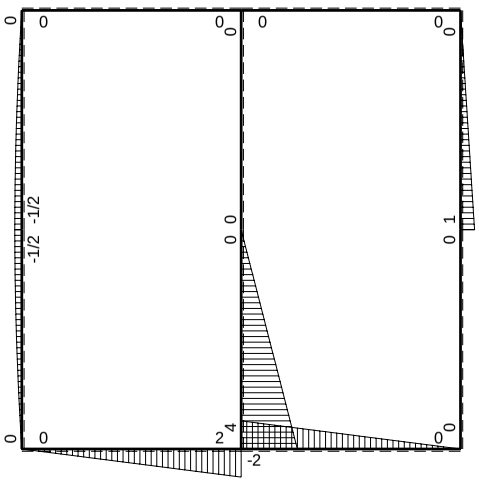
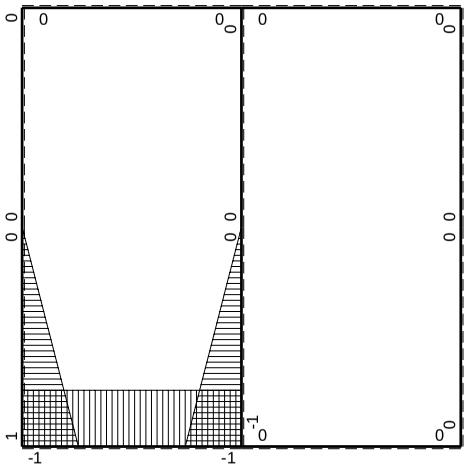
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 990086 CI07.xxxx.042

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PROCEDIMENTO E RISULTATI 990086 CI07.xxxx.042

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-Fx$	0	0	0	0	0+0	0
HG b	0	$-Fx$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$4Fb-4Fx$	0	$-4Fb+8Fx-4Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-4/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-4Fx$	0	$-4Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-Fx+1/2qx^2$	0	$-Fx+3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-1/2qx^2$	0	$-1/2Fx+1/2qx^3/b$	0	x^2/b^2		
	totali						$-35/24Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$7/8Fb$	

Sviluppi di calcolo iperstatica

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L_{EI}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L_{EC}^{Xo} = \int_o^b (-4 + 8\ x/b - 4\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4\ x + 4\ x^2/b - 4/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-4\ b + 4\ b - 4/3\ b\ )\ Fb\ 1/EJ\ = -4/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-4\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-4/3\ b\ )\ Fb\ 1/EJ\ = -4/3\ Fb^2/EJ$

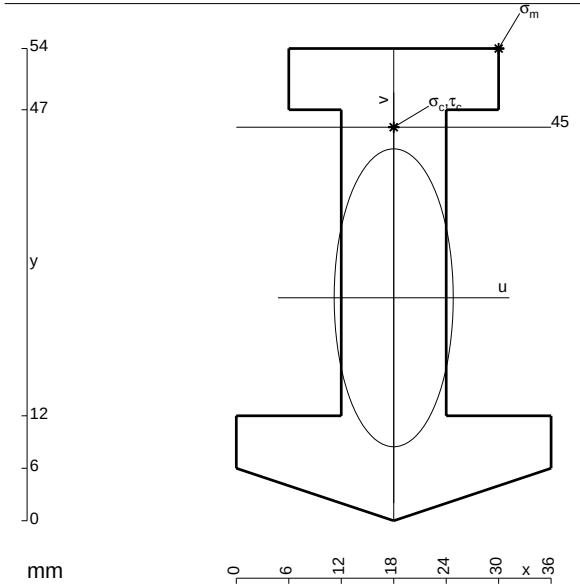
$L_{IA}^{Xo} = \int_o^b (-\ x/b + 3/2\ x^2/b^2 - 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/2\ x^3/b^2 - 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/2\ b - 1/8\ b\ )\ Fb\ 1/EJ\ = -1/8\ Fb^2/EJ$

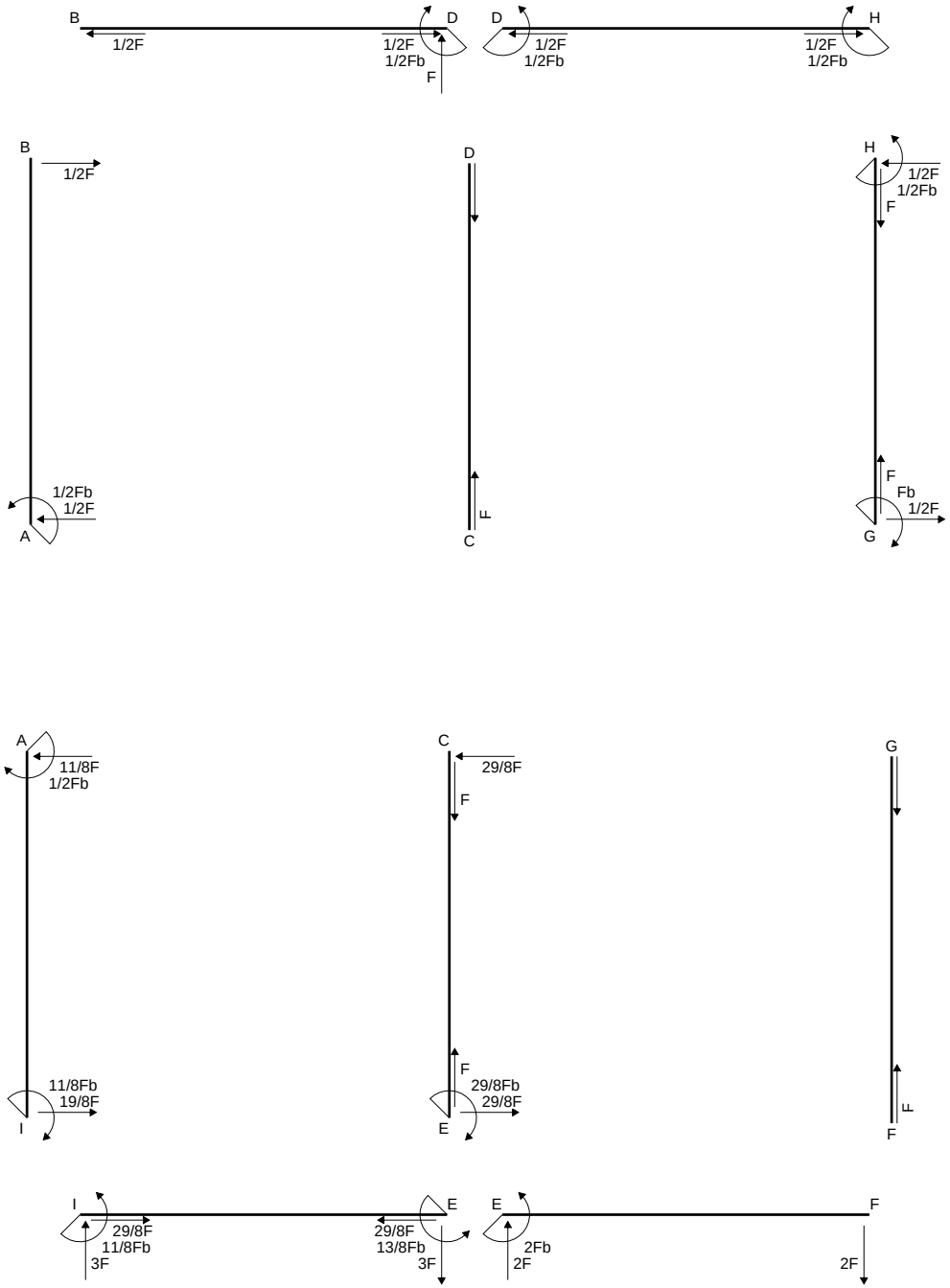
$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/8\ b\ )\ Fb\ 1/EJ\ = -1/8\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 990086 CI07.xxxx.042



A = 912. mm^2
J_u = 264874. mm^4
J_v = 42264. mm^4
y_g = 25.49 mm
T_y = 3180. N
M_x = -2035200. Nmm
x_m = 30. mm
y_m = 54. mm
u_m = 12. mm
v_m = 28.51 mm
$\sigma_m = -Mv/J_u$ = 219. N/mm^2
x_c = 18. mm
y_c = 45. mm
v_c = 19.51 mm
$\sigma_c = -Mv/J_u$ = 149.9 N/mm^2
τ_c = 4.695 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 150.1 N/mm^2
S^* = 4693. mm^3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G
F
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F
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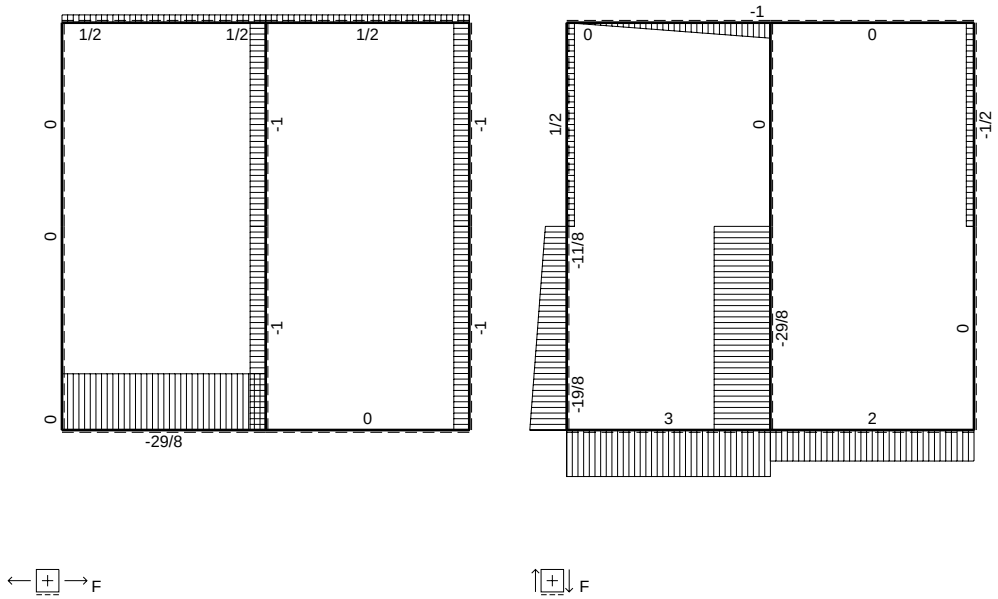
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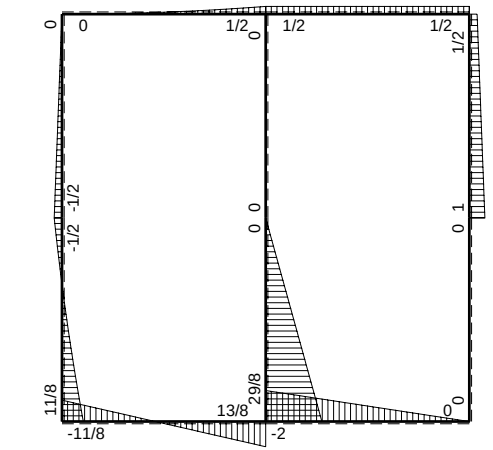
F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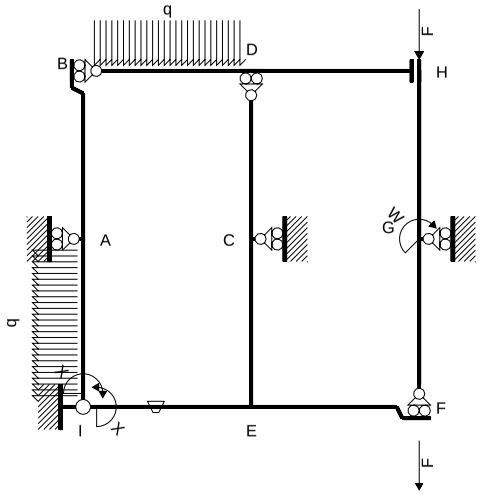
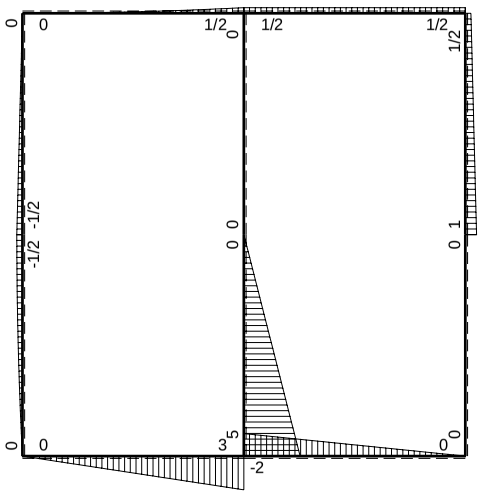
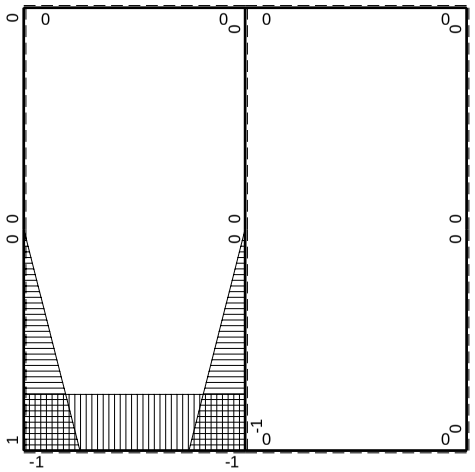
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 224944 CI07.xxxx.043

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PROCEDIMENTO E RISULTATI 224944 CI07.xxxx.043

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	Fb-1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fb-1/2Fx	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-5Fx	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-5Fx^2/b$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	$-Fx+1/2qx^2$	0	$-Fx+3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-1/8+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	$1/2Fb-1/2qx^2$	0	$-1/2Fx+1/2qx^3/b$	0	x^2/b^2		
	totali						$-55/24Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						11/8Fb	

Sviluppi di calcolo iperstatica

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$L_{lE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{El}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{lA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{Al}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{lE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{El}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

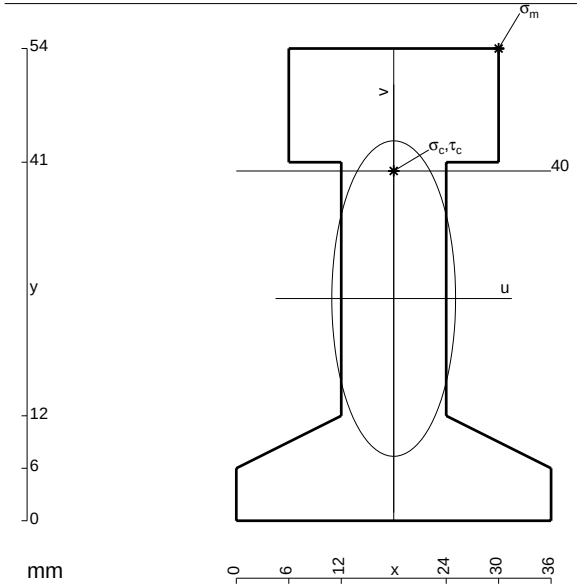
$L_{lA}^{Xo} = \int_o^b (-\ x/b + 3/2\ x^2/b^2 - 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/2\ x^3/b^2 - 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/2\ b - 1/8\ b\ )\ Fb\ 1/EJ\ = -1/8\ Fb^2/EJ$

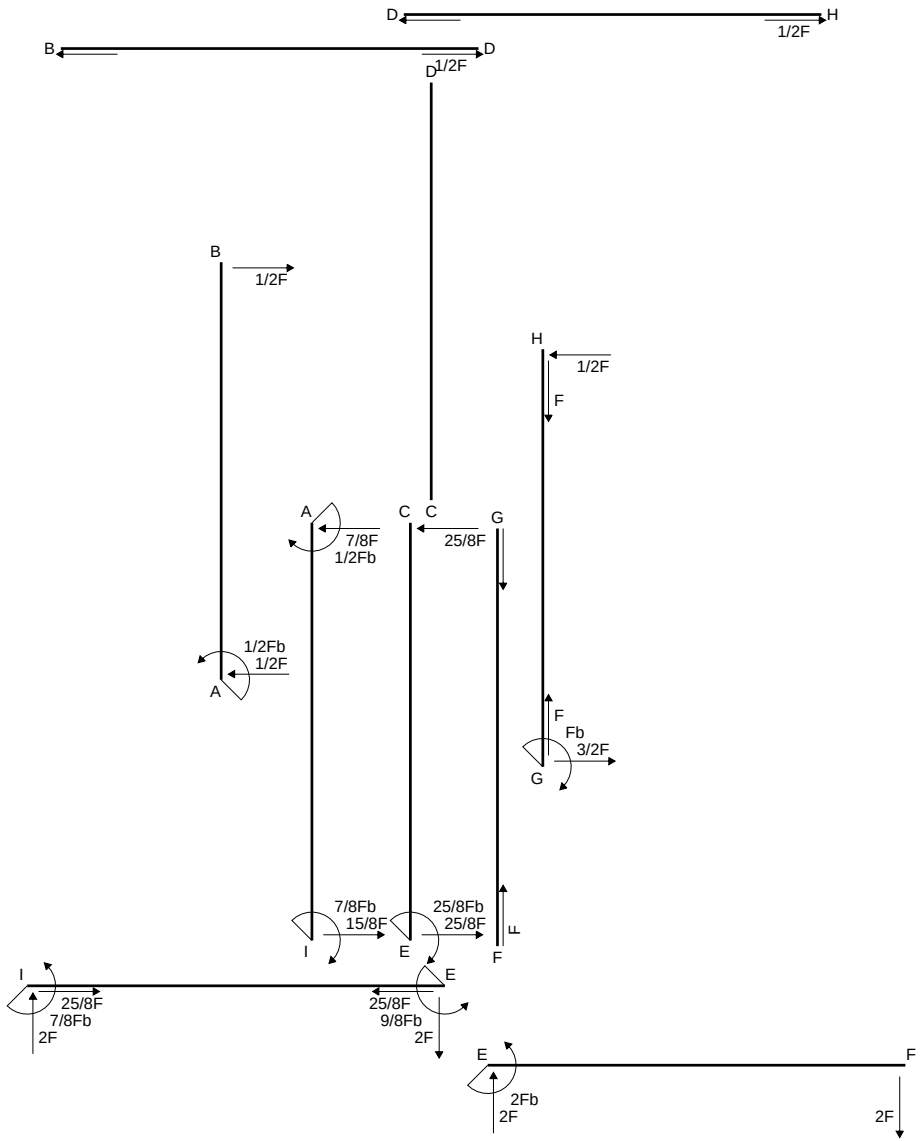
$L_{Al}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/8\ b\ )\ Fb\ 1/EJ\ = -1/8\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 224944 CI07.xxxx.043



A = 1020. mm^2
J_u = 332140. mm^4
J_v = 51120. mm^4
y_g = 25.41 mm
T_y = 3800. N
M_x = -2660000. Nmm
x_m = 30. mm
y_m = 54. mm
u_m = 12. mm
v_m = 28.59 mm
$\sigma_m = -Mv/J_u$ = 229. N/mm^2
x_c = 18. mm
y_c = 40. mm
v_c = 14.59 mm
$\sigma_c = -Mv/J_u$ = 116.9 N/mm^2
τ_c = 6.745 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 117.5 N/mm^2
S^* = 7074. mm^3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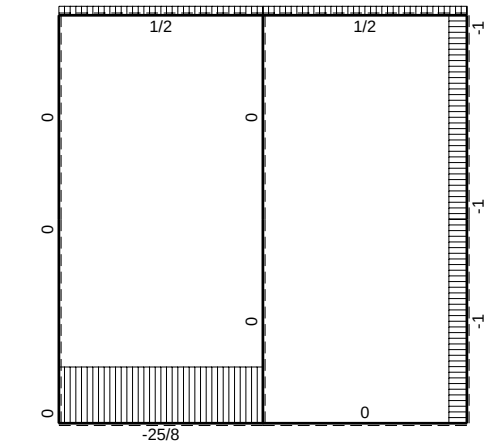
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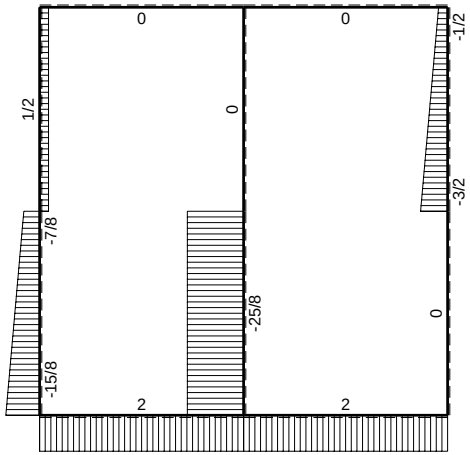
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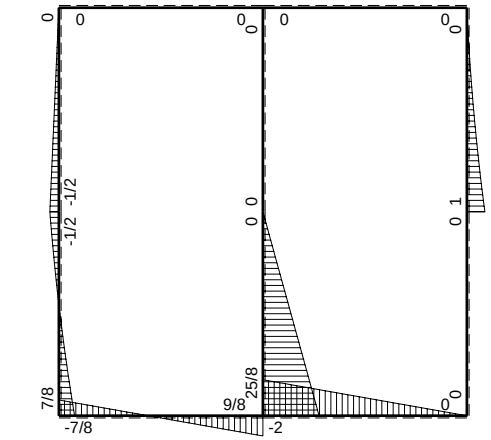
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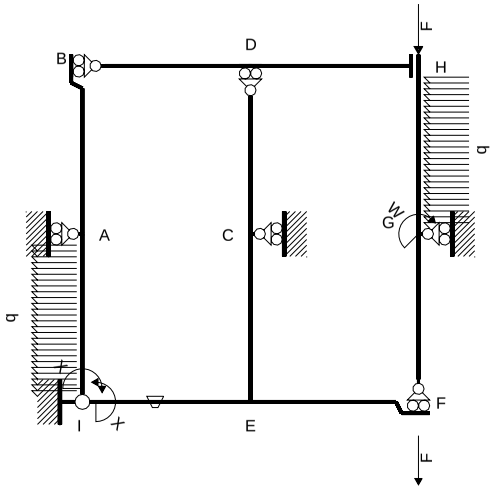
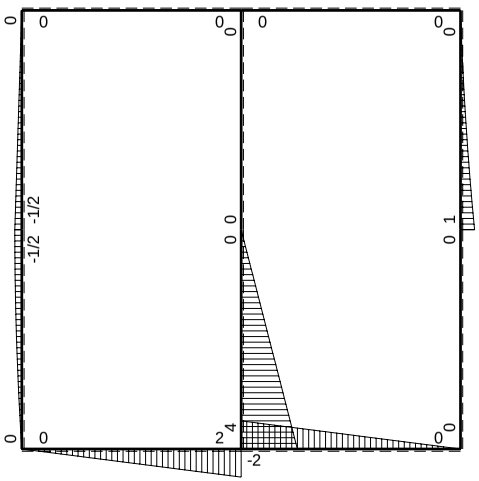
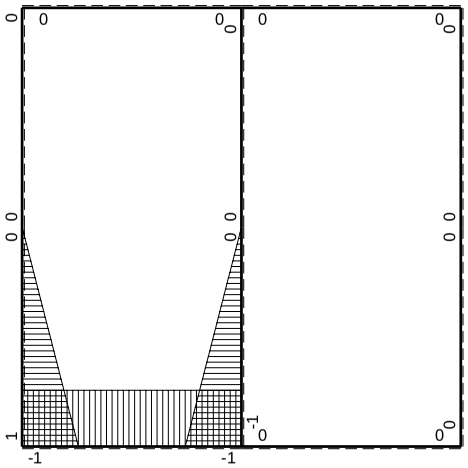
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 912362 CI07.xxxx.044

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PROCEDIMENTO E RISULTATI 912362 CI07.xxxx.044

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2Fx-1/2qx^2$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	-1+x/b	4Fb-4Fx	0	$-4Fb+8Fx-4Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-4/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-4Fx$	0	$-4Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	$-Fx+1/2qx^2$	0	$-Fx+3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-1/8+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	$1/2Fb-1/2qx^2$	0	$-1/2Fx+1/2qx^3/b$	0	x^2/b^2		
	totali						$-35/24Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						7/8Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L_{EI}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L_{EC}^{Xo} = \int_o^b (-4 + 8\ x/b - 4\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4\ x + 4\ x^2/b - 4/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-4\ b + 4\ b - 4/3\ b\ )\ Fb\ 1/EJ\ = -4/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-4\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

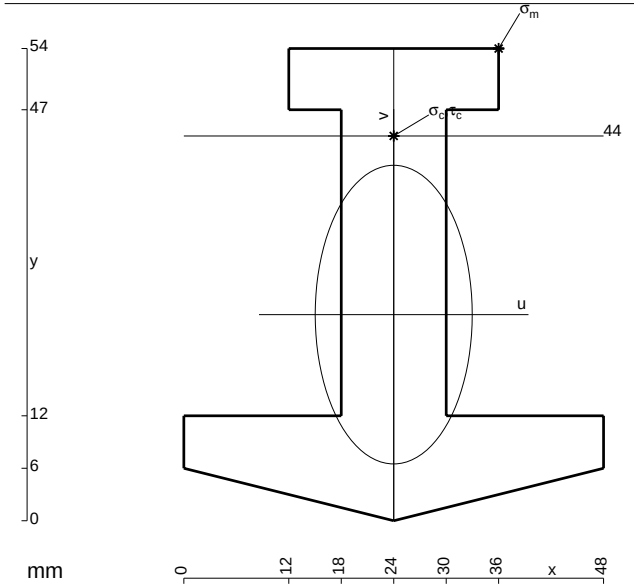
$= (-4/3\ b\ )\ Fb\ 1/EJ\ = -4/3\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-\ x/b + 3/2\ x^2/b^2 - 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/2\ x^3/b^2 - 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

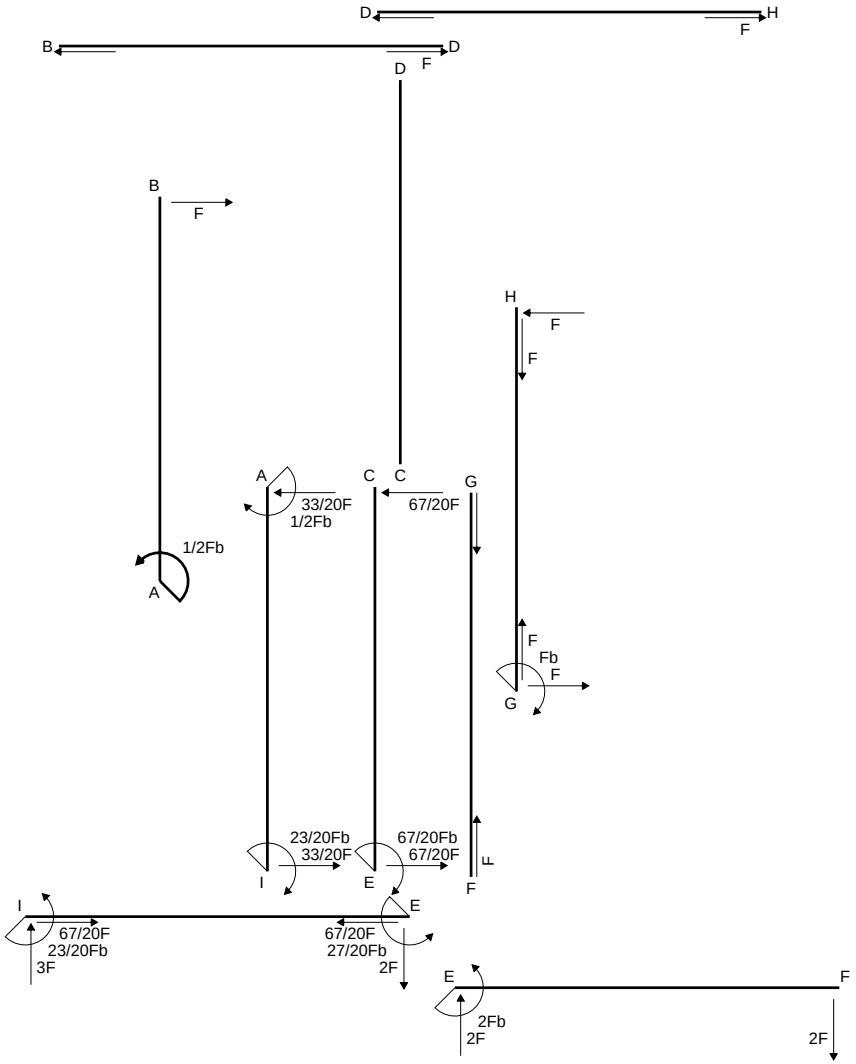
$= (-1/2\ b + 1/2\ b - 1/8\ b\ )\ Fb\ 1/EJ\ = -1/8\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/8\ b\ )\ Fb\ 1/EJ\ = -1/8\ Fb^2/EJ$



A = 1020. mm^2
J_u = 297608. mm^4
J_v = 82224. mm^4
y_g = 23.57 mm
T_y = 3120. N
M_x = -2340000. Nmm
x_m = 36. mm
y_m = 54. mm
u_m = 12. mm
v_m = 30.43 mm
$\sigma_m = -Mv/J_u$ = 239.3 N/mm^2
x_c = 24. mm
y_c = 44. mm
v_c = 20.43 mm
$\sigma_c = -Mv/J_u$ = 160.6 N/mm^2
τ_c = 4.642 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 160.8 N/mm^2
S^* = 5314. mm^3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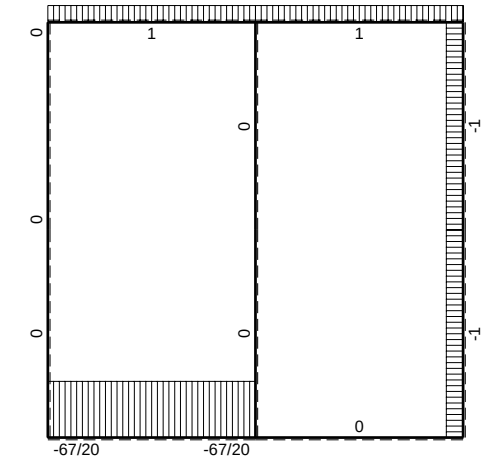
2F
2F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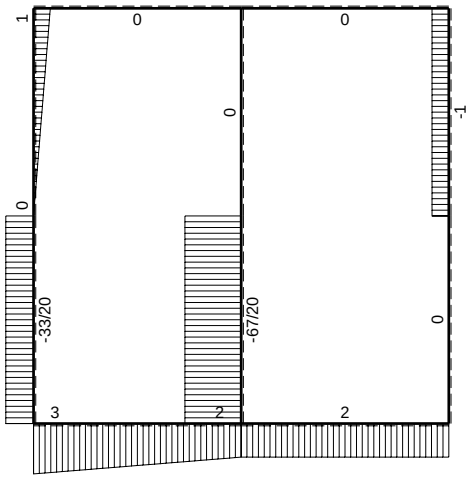
-67/20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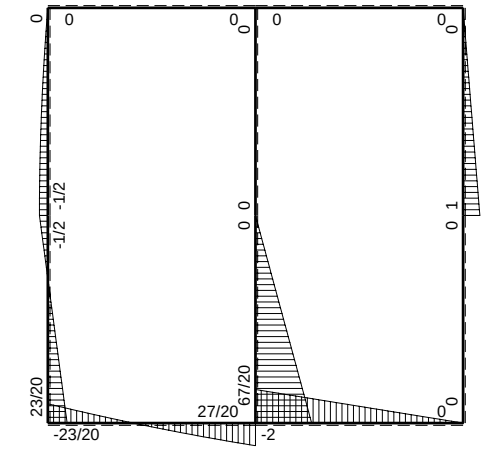
3
2
2

F

F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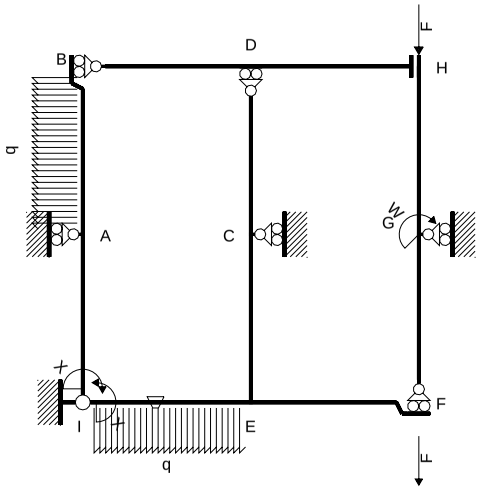
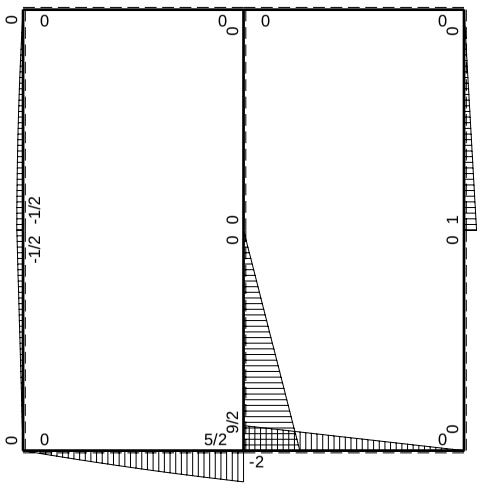
67/20
27/20
0
-23/20
-2

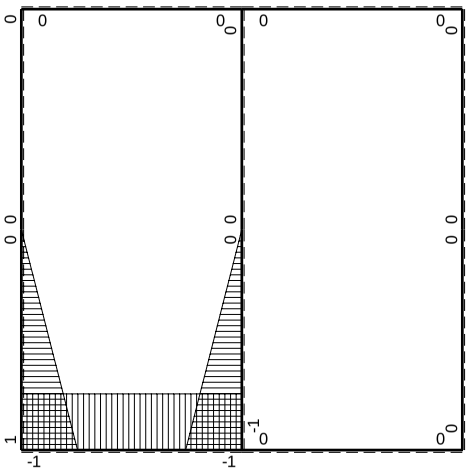
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 215339 CI07.xxxx.045

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	Fb-Fx	0	0	0	0	0+0	0
HG b	0	-Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx-1/2qx^2$	-Fb/EJ	$-3Fx+1/2Fx^2/b$	Fb/EJ	1	$(-4/3+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-5/2Fb+2Fx+1/2qx^2$	Fb/EJ	$-5/2Fb+2Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	-1+x/b	9/2Fb-9/2Fx	0	$-9/2Fb+9Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-9/2Fx	0	$-9/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-23/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						23/20Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/3\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-5/2 + 2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx$

$= [-5/2\ x + x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-5/2\ b + b + 1/6\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/3\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-9/2 + 9\ x/b - 9/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-9/2\ x + 9/2\ x^2/b - 3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-9/2\ b + 9/2\ b - 3/2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-9/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

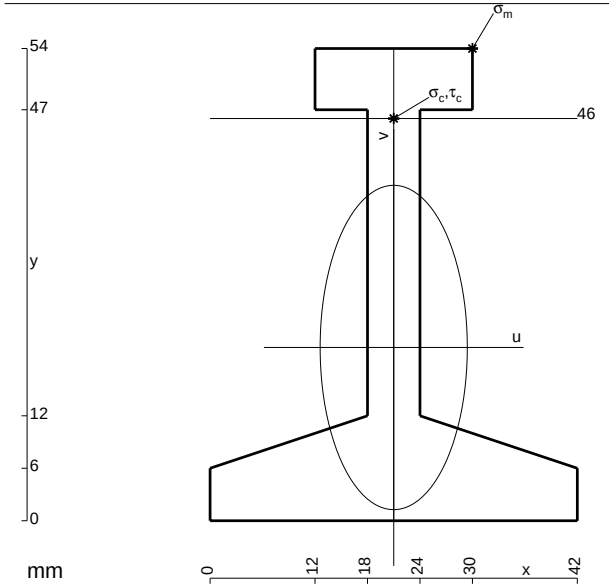
$= (-3/2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

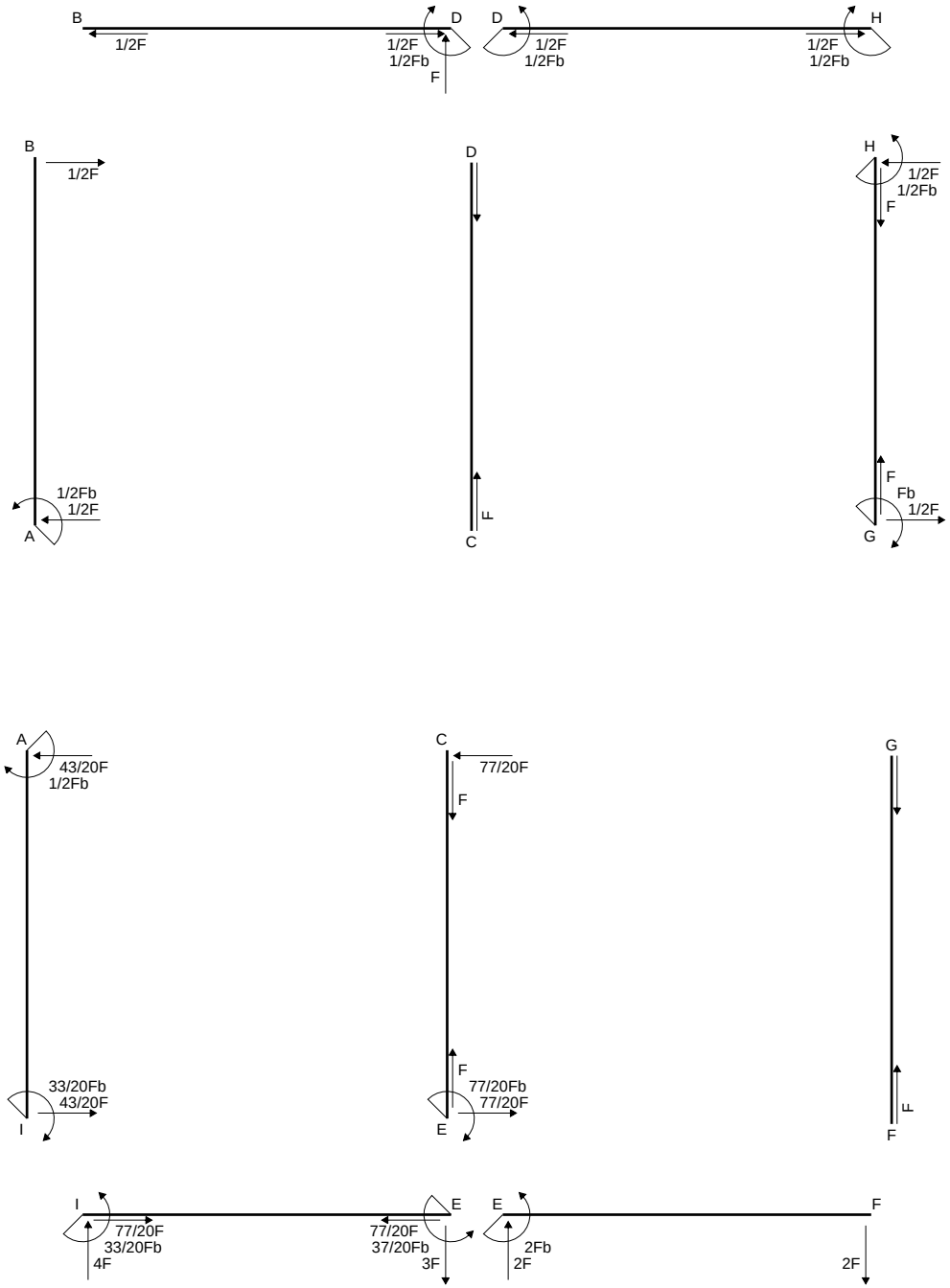
$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$



A = 732. mm^2
J_u = 251906. mm^4
J_v = 51876. mm^4
y_g = 19.81 mm
T_y = 1800. N
M_x = -1458000. Nmm
x_m = 30. mm
y_m = 54. mm
u_m = 9. mm
v_m = 34.19 mm
$\sigma_m = -Mv/J_u$ = 197.9 N/mm^2
x_c = 21. mm
y_c = 46. mm
v_c = 26.19 mm
$\sigma_c = -Mv/J_u$ = 151.6 N/mm^2
τ_c = 4.796 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 151.8 N/mm^2
S^* = 4027. mm^3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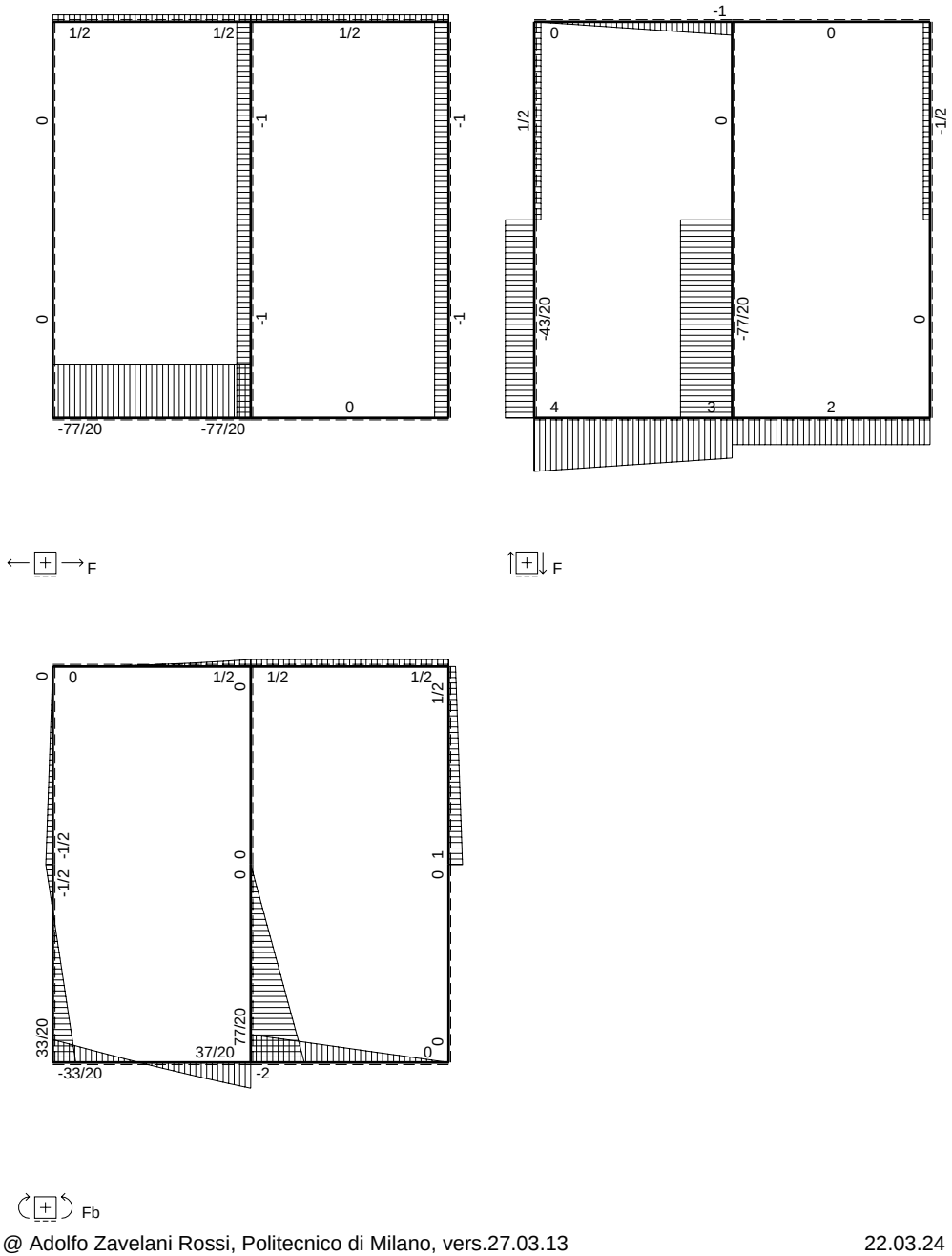
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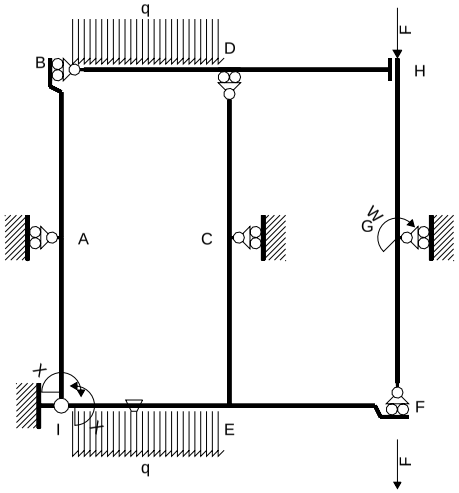
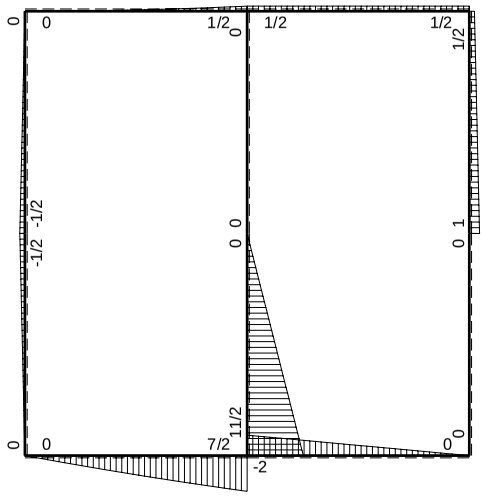
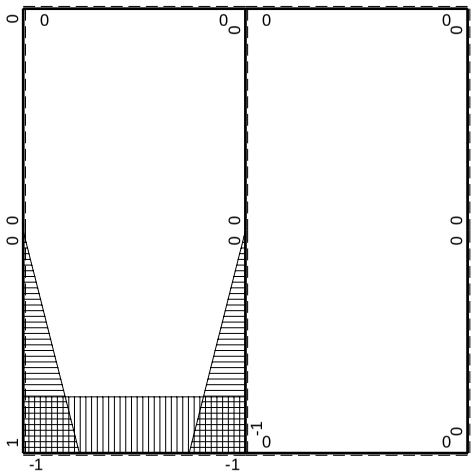


Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 960303 CI07.xxxx.046

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PROCEDIMENTO E RISULTATI 960303 CI07.xxxx.046

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	Fb-1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fb-1/2Fx	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$4Fx-1/2qx^2$	-Fb/EJ	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	-1+x/b	11/2Fb-11/2Fx	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-11/2Fx	0	$-11/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-11/4Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						33/20Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-4\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-7/2 + 3\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx$

$= [-7/2\ x + 3/2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-7/2\ b + 3/2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-11/2 + 11\ x/b - 11/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-11/2\ x + 11/2\ x^2/b - 11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-11/2\ b + 11/2\ b - 11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-11/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

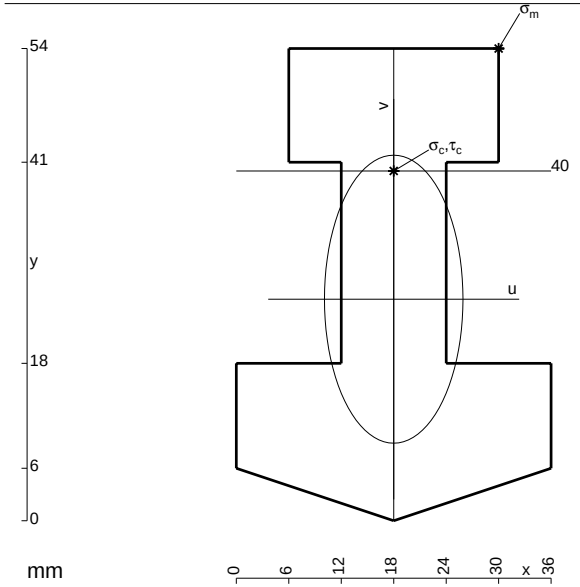
$L_{IA}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 960303 CI07.xxxx.046



A = 1128. mm^2
J_u = 306009. mm^4
J_v = 70776. mm^4
y_g = 25.34 mm
T_y = 2600. N
M_x = -2236000. Nmm
x_m = 30. mm
y_m = 54. mm
u_m = 12. mm
v_m = 28.66 mm
$\sigma_m = -Mv/J_u$ = 209.5 N/mm^2
x_c = 18. mm
y_c = 40. mm
v_c = 14.66 mm
$\sigma_c = -Mv/J_u$ = 107.2 N/mm^2
τ_c = 5.025 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 107.5 N/mm^2
S^* = 7097. mm^3

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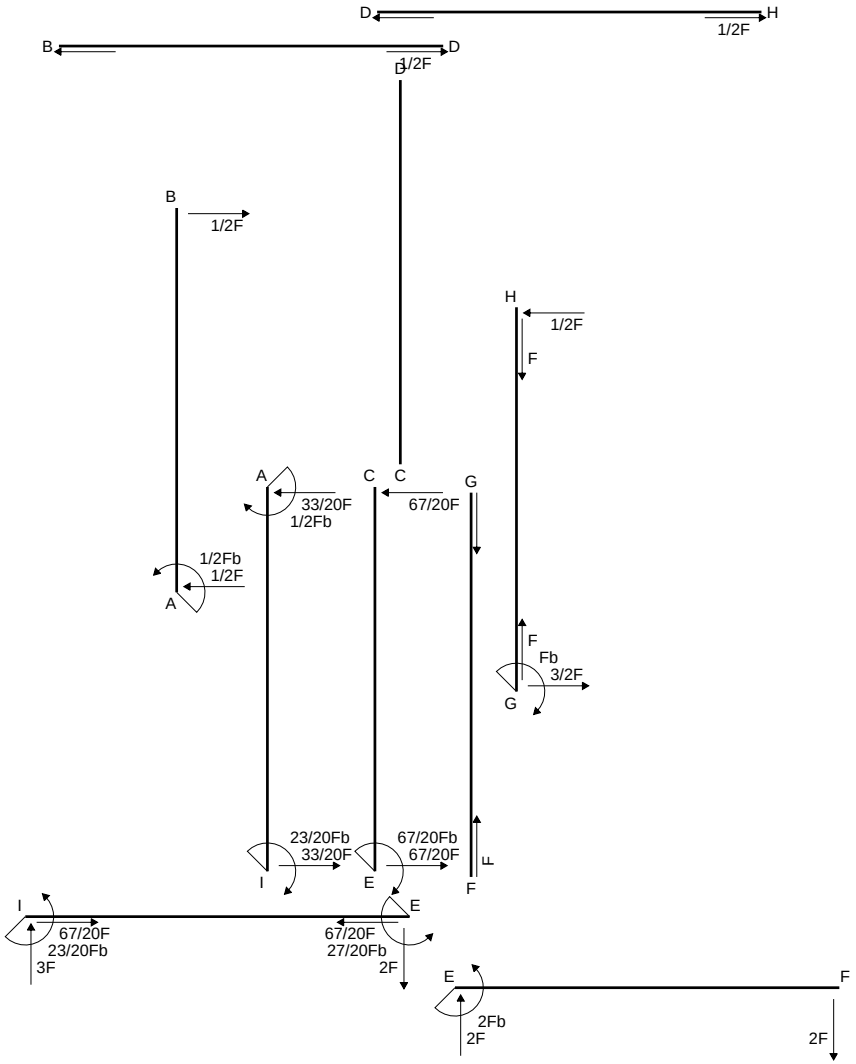
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1/2Fb
67/20F
1/2Fb
1/2F
A
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Fb
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G
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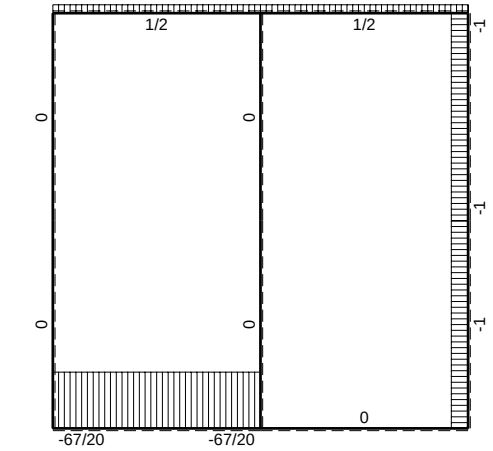
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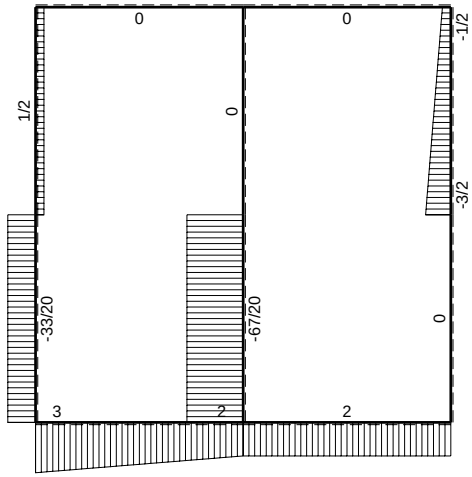
-67/20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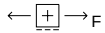
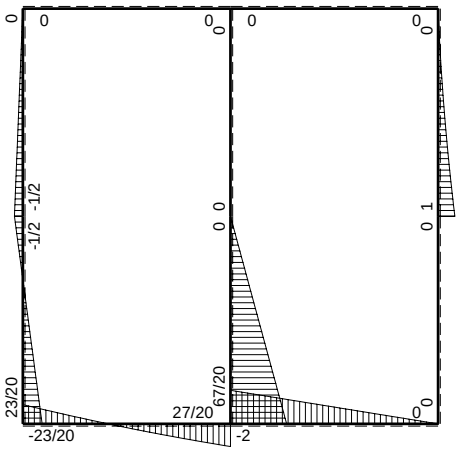

F

F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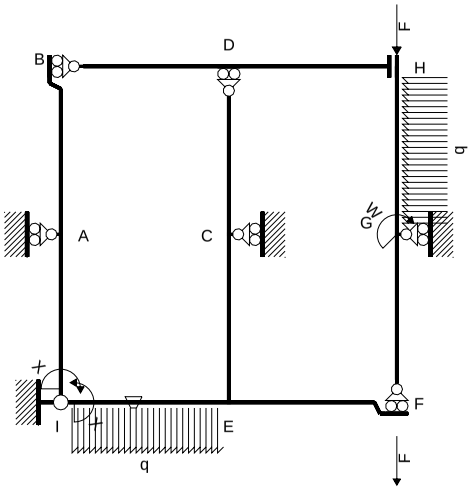
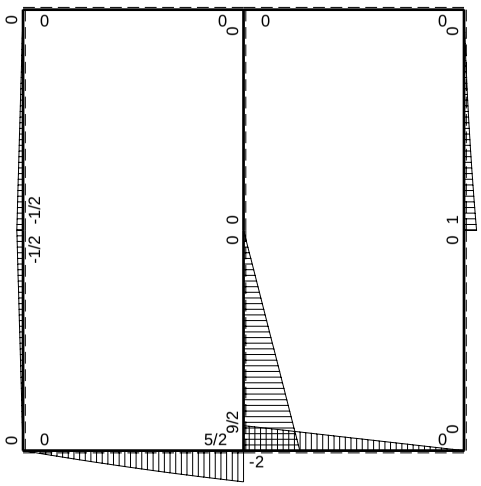
-2

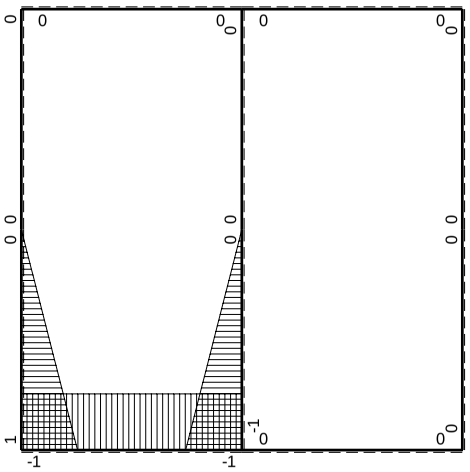
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 216011 CI07.xxxx.047

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2Fx-1/2qx^2$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx-1/2qx^2$	-Fb/EJ	$-3Fx+1/2Fx^2/b$	Fb/EJ	1	$(-4/3+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-5/2Fb+2Fx+1/2qx^2$	Fb/EJ	$-5/2Fb+2Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	-1+x/b	9/2Fb-9/2Fx	0	$-9/2Fb+9Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-9/2Fx	0	$-9/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-23/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						23/20Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/3\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-5/2 + 2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx$

$= [-5/2\ x + x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-5/2\ b + b + 1/6\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/3\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-9/2 + 9\ x/b - 9/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-9/2\ x + 9/2\ x^2/b - 3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-9/2\ b + 9/2\ b - 3/2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-9/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

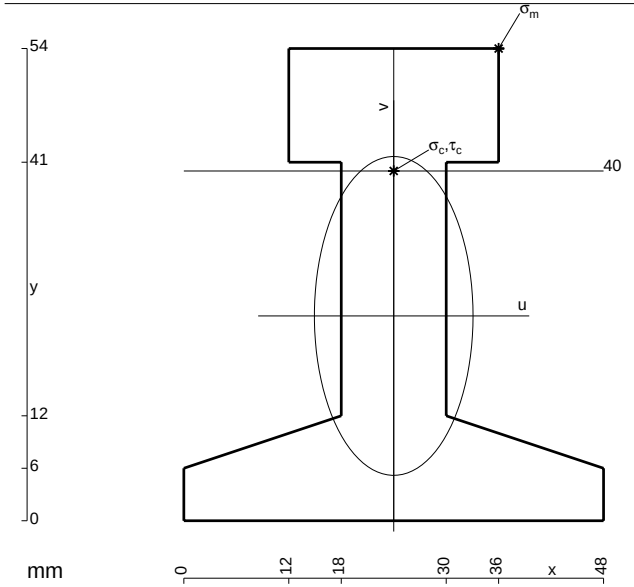
$= (-3/2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

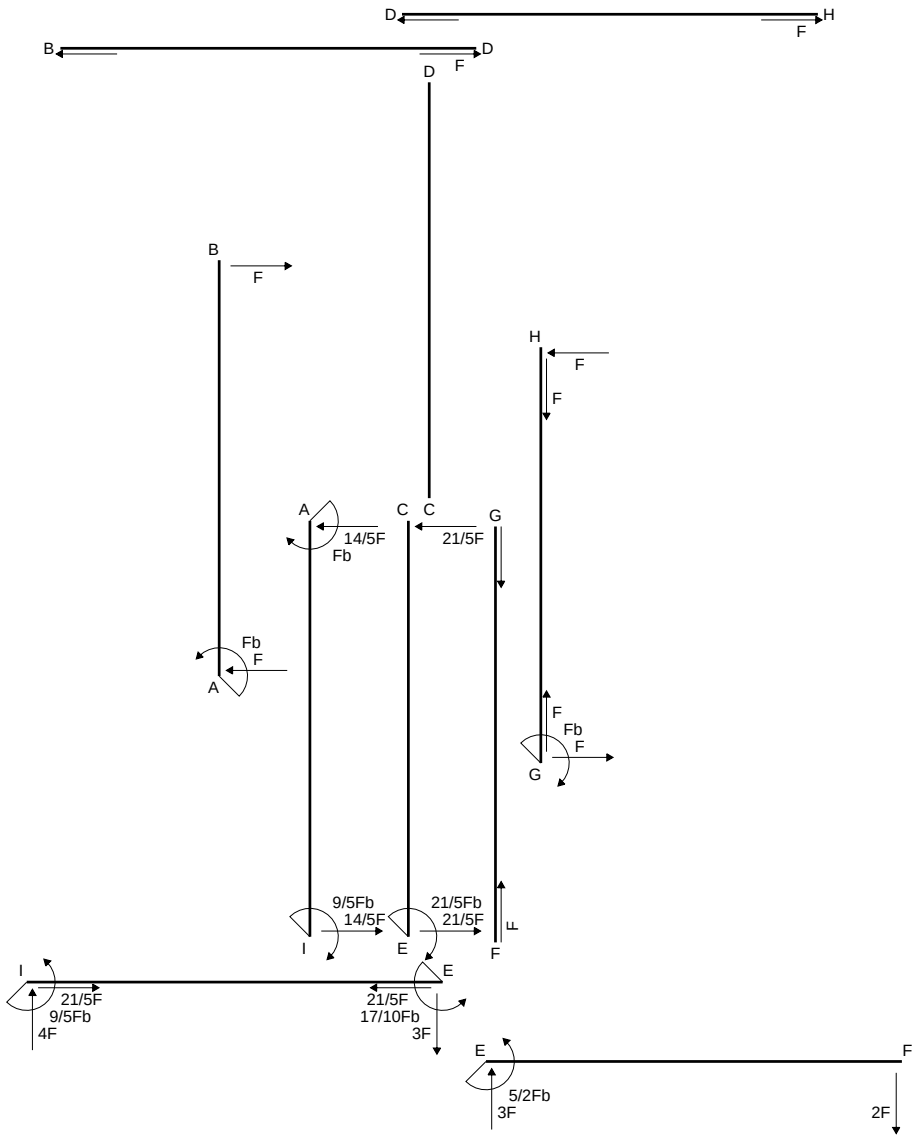
$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$



A = 1128. mm^2
J_u = 375033. mm^4
J_v = 92808. mm^4
y_g = 23.42 mm
T_y = 2960. N
M_x = -2693600. Nmm
x_m = 36. mm
y_m = 54. mm
u_m = 12. mm
v_m = 30.58 mm
$\sigma_m = -Mv/J_u$ = 219.6 N/mm^2
x_c = 24. mm
y_c = 40. mm
v_c = 16.58 mm
$\sigma_c = -Mv/J_u$ = 119.1 N/mm^2
τ_c = 5.076 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 119.4 N/mm^2
S^* = 7718. mm^3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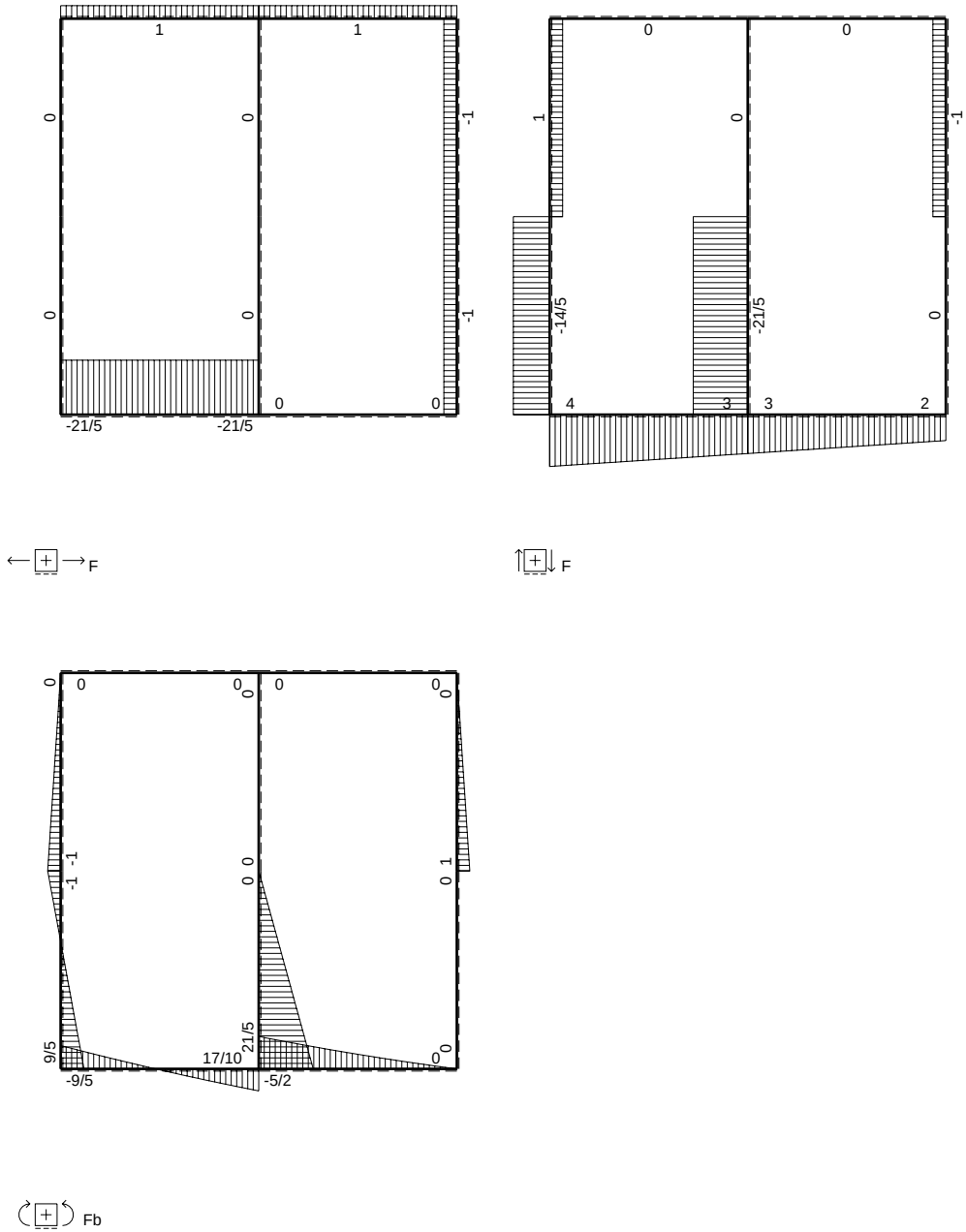
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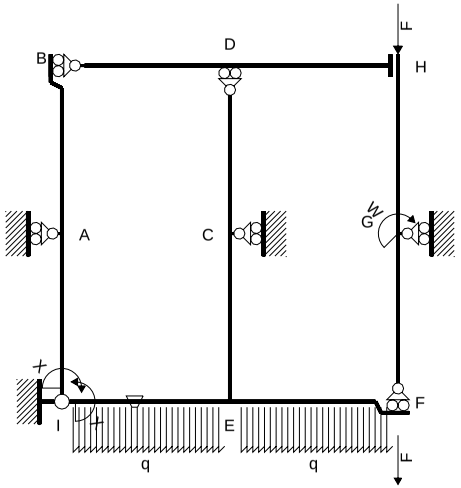
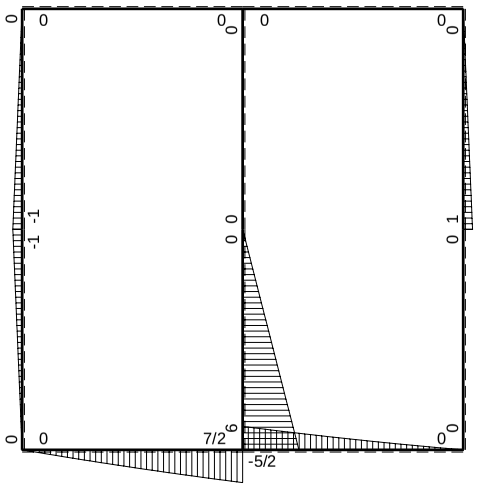
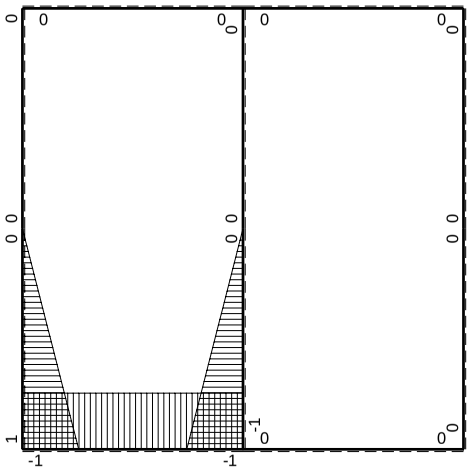


Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 209665 CI07.xxxx.048

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PROCEDIMENTO E RISULTATI 209665 CI07.xxxx.048

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-5/2Fb+3Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$2Fx+1/2qx^2$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	Fb-Fx	0	0	0	0	0+0	0
HG b	0	-Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$4Fx-1/2qx^2$	-Fb/EJ	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	-1+x/b	6Fb-6Fx	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-6Fx	0	$-6Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-Fx	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	Fb-Fx	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-3Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						9/5Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-4\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-7/2 + 3\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx$

$= [-7/2\ x + 3/2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-7/2\ b + 3/2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-6 + 12\ x/b - 6\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-6\ x + 6\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-6\ b + 6\ b - 2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

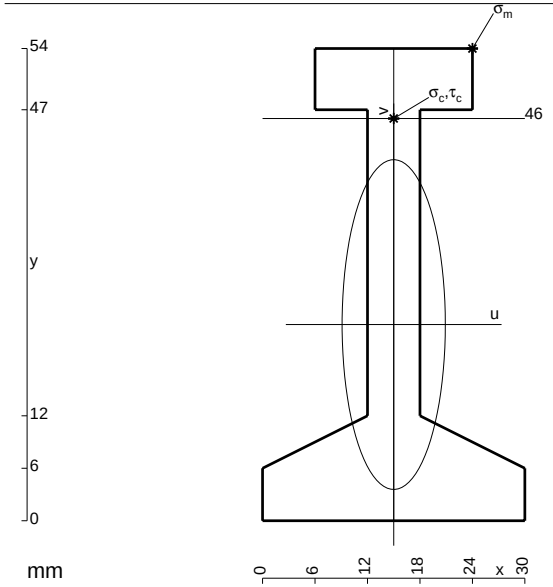
$= (-2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

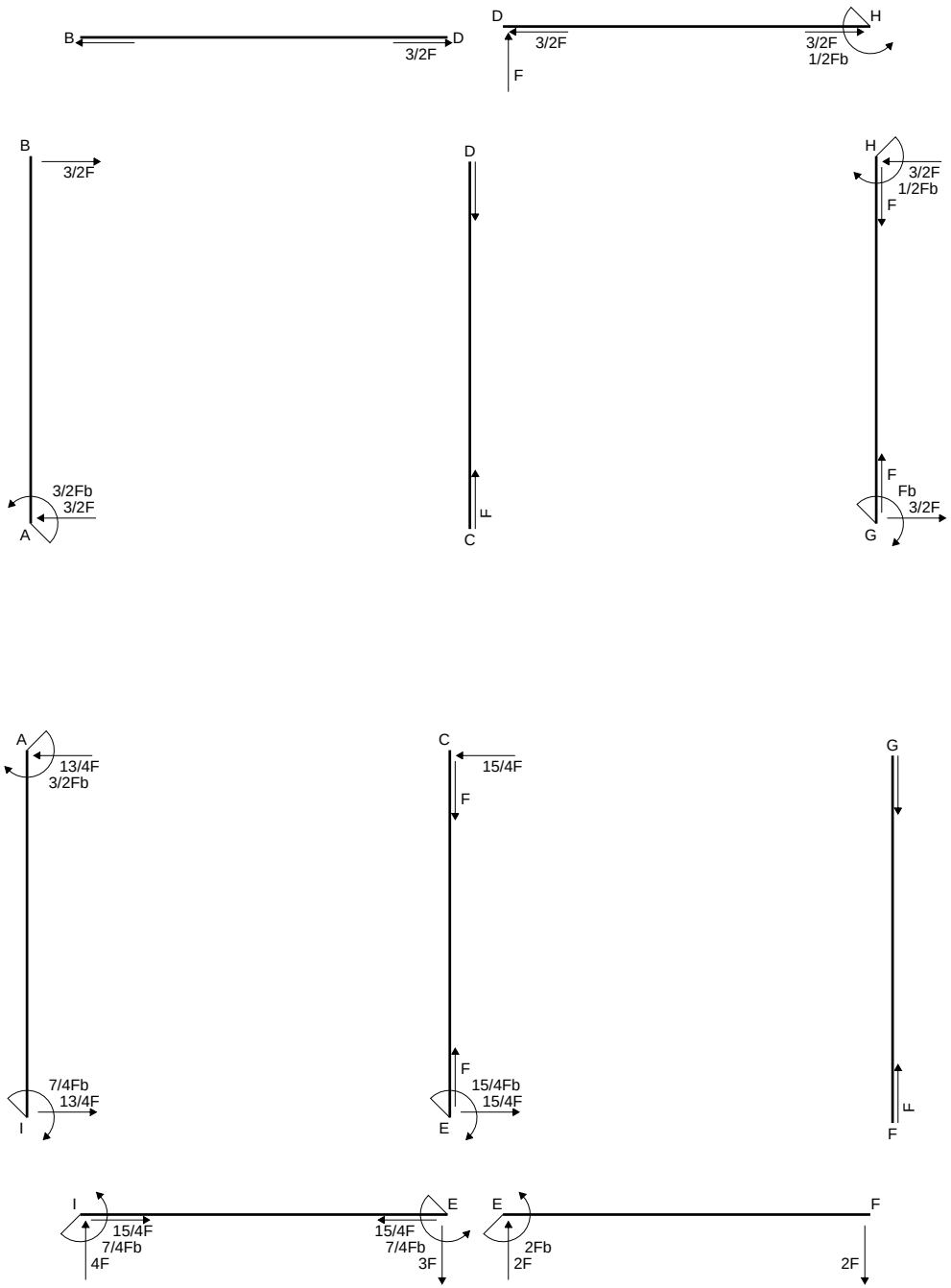
$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$



A = 624. mm^2
J_u = 221959. mm^4
J_v = 21744. mm^4
y_g = 22.43 mm
T_y = 1980. N
M_x = -1600500. Nmm
x_m = 24. mm
y_m = 54. mm
u_m = 9. mm
v_m = 31.57 mm
$\sigma_m = -Mv/J_u$ = 227.6 N/mm^2
x_c = 15. mm
y_c = 46. mm
v_c = 23.57 mm
$\sigma_c = -Mv/J_u$ = 169.9 N/mm^2
τ_c = 5.473 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 170.2 N/mm^2
S^* = 3681. mm^3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C
H
3/2F
1/2Fb
F
F
Fb
3/2F
G
A
13/4F
3/2Fb
7/4Fb
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G
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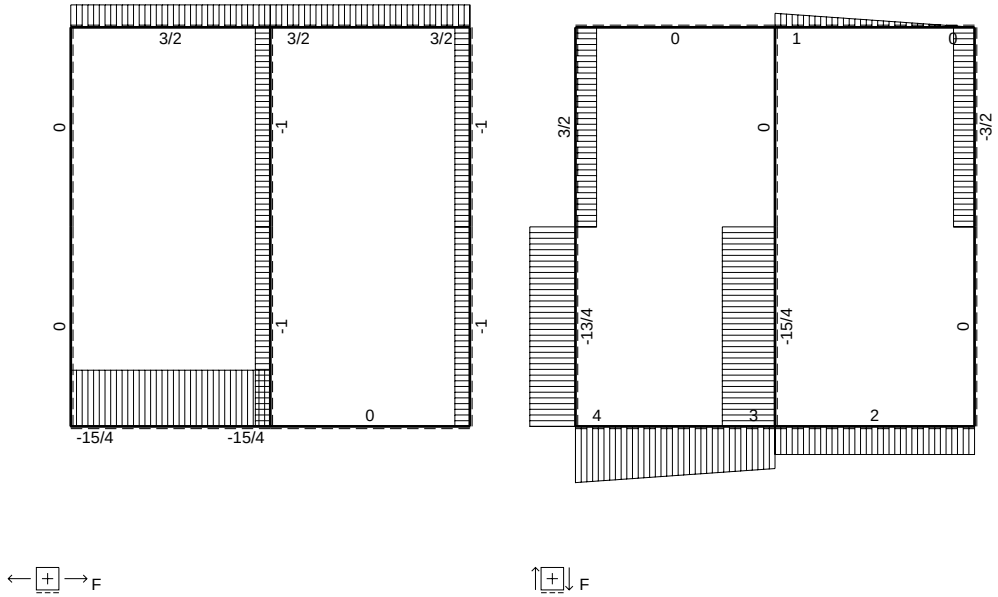
2F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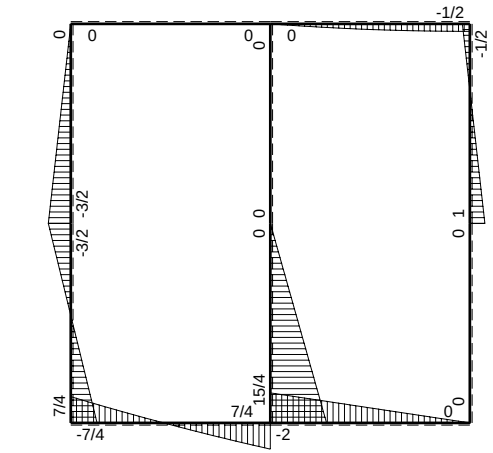
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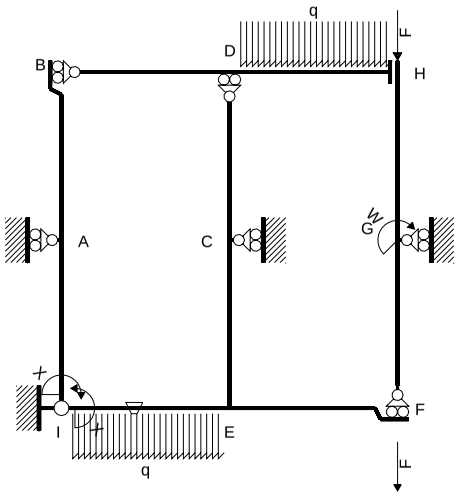
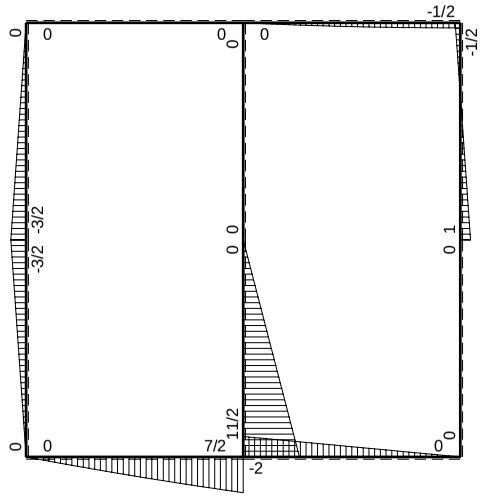
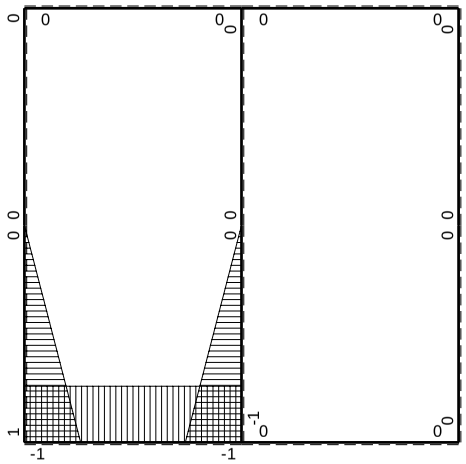
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 212248 CI07.xxxx.049

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-3/2Fb+3/2Fx	0	0	0	0	0+0	0
BA b	0	3/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	Fb-3/2Fx	0	0	0	0	0+0	0
HG b	0	1/2Fb-3/2Fx	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$4Fx-1/2qx^2$	-Fb/EJ	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	-1+x/b	11/2Fb-11/2Fx	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-11/2Fx	0	$-11/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-3/2Fx	0	$-3/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/4+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	3/2Fb-3/2Fx	0	$-3/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-35/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						7/4Fb	

Sviluppi di calcolo iperstatica

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$L^{XX}_{IE} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EI} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EC} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{CE} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{IA} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{AI} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{Xo}_{IE} = \int_o^b (-4\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L^{Xo}_{EI} = \int_o^b (-7/2 + 3\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx$

$= [-7/2\ x + 3/2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-7/2\ b + 3/2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L^{Xo}_{EC} = \int_o^b (-11/2 + 11\ x/b - 11/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-11/2\ x + 11/2\ x^2/b - 11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-11/2\ b + 11/2\ b - 11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L^{Xo}_{CE} = \int_o^b (-11/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

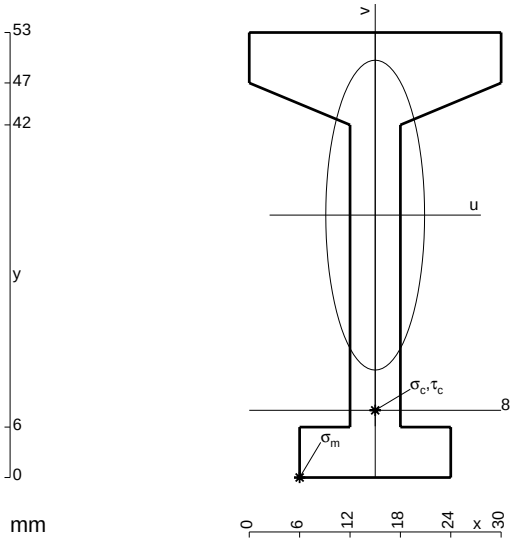
$= (-11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L^{Xo}_{IA} = \int_o^b (-3/2\ x/b + 3/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-3/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-3/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = -1/4\ Fb^2/EJ$

$L^{Xo}_{AI} = \int_o^b (-3/2\ x/b + 3/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-3/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-3/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = -1/4\ Fb^2/EJ$



$A = 594.\ mm^2$

$J_u = 202331.\ mm^4$

$J_v = 20574.\ mm^4$

$y_g = 31.25\ mm$

$T_y = 1540.\ N$

$M_x = -1540000.\ Nmm$

$x_m = 6.\ mm$

$u_m = -9.\ mm$

$v_m = -31.25\ mm$

$\sigma_m = -Mv/J_u = -237.9\ N/mm^2$

$x_c = 15.\ mm$

$y_c = 8.\ mm$

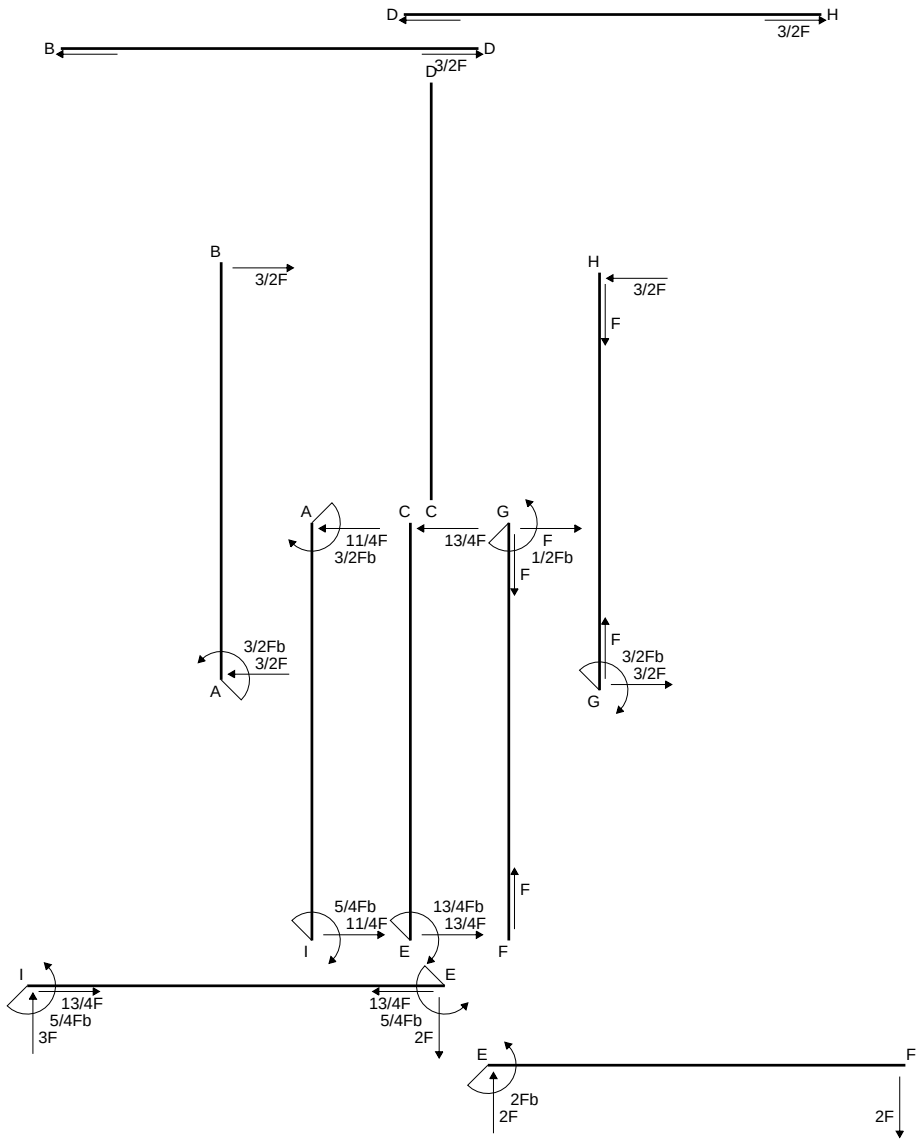
$v_c = -23.25\ mm$

$\sigma_c = -Mv/J_u = -177.\ N/mm^2$

$\tau_c = 4.24\ N/mm^2$

$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 177.1\ N/mm^2$

$S^* = 3342.\ mm^3$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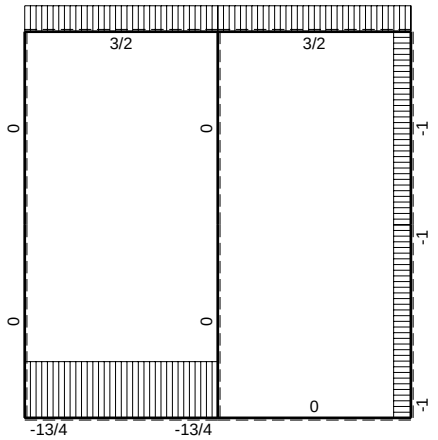
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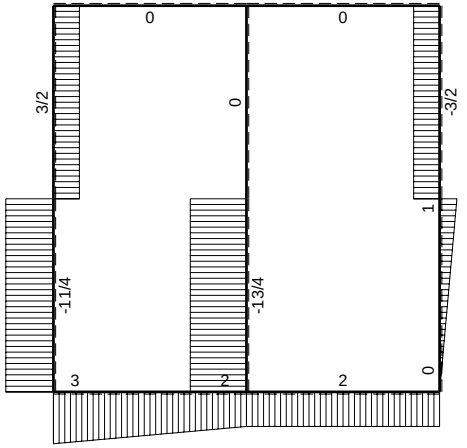
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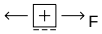
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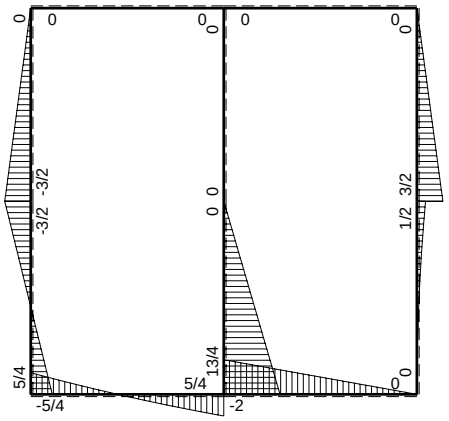
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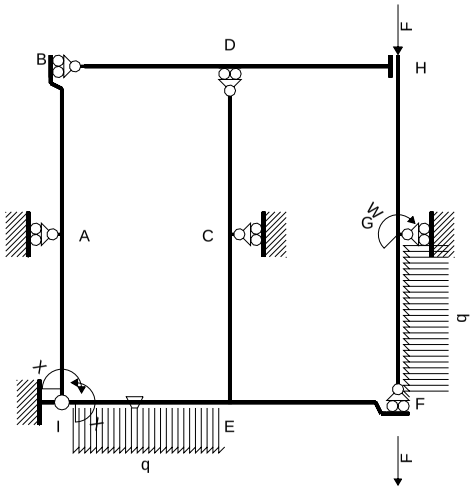
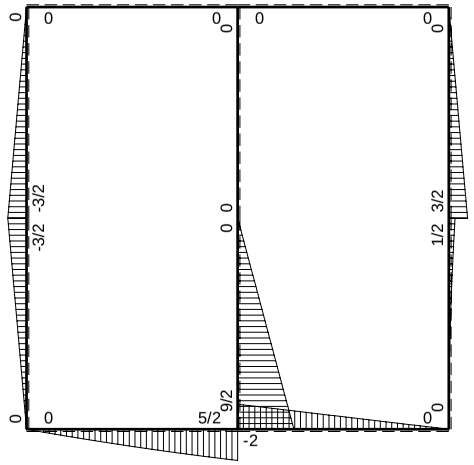
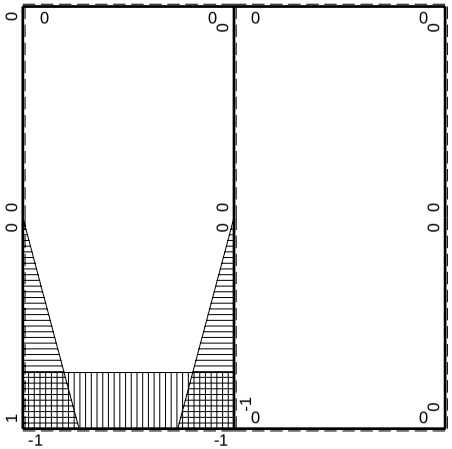
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 247036 CI07.xxxx.050

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PROCEDIMENTO E RISULTATI 247036 CI07.xxxx.050

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-3/2Fb+3/2Fx	0	0	0	0	0+0	0
BA b	0	3/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	3/2Fb-3/2Fx	0	0	0	0	0+0	0
HG b	0	-3/2Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx-1/2qx^2$	-Fb/EJ	$-3Fx+1/2Fx^2/b$	Fb/EJ	1	$(-4/3+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-5/2Fb+2Fx+1/2qx^2$	Fb/EJ	$-5/2Fb+2Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	-1+x/b	9/2Fb-9/2Fx	0	$-9/2Fb+9Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-9/2Fx	0	$-9/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-3/2Fx	0	$-3/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/4+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	3/2Fb-3/2Fx	0	$-3/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-25/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						5/4Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/3\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-5/2 + 2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx$

$= [-5/2\ x + x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-5/2\ b + b + 1/6\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/3\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-9/2 + 9\ x/b - 9/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-9/2\ x + 9/2\ x^2/b - 3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-9/2\ b + 9/2\ b - 3/2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-9/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

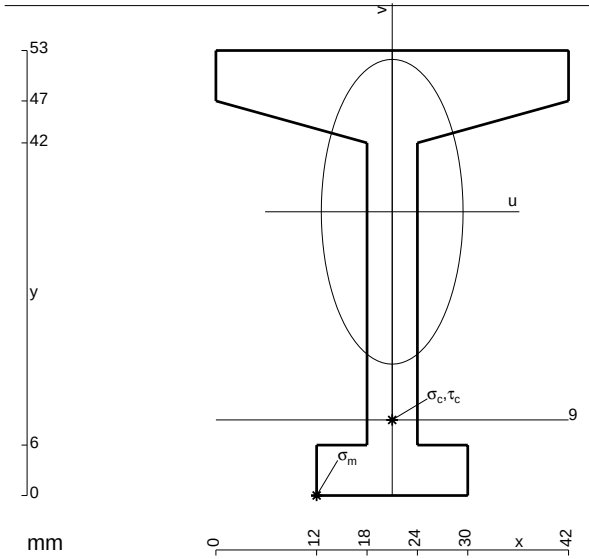
$= (-3/2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-3/2\ x/b + 3/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-3/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

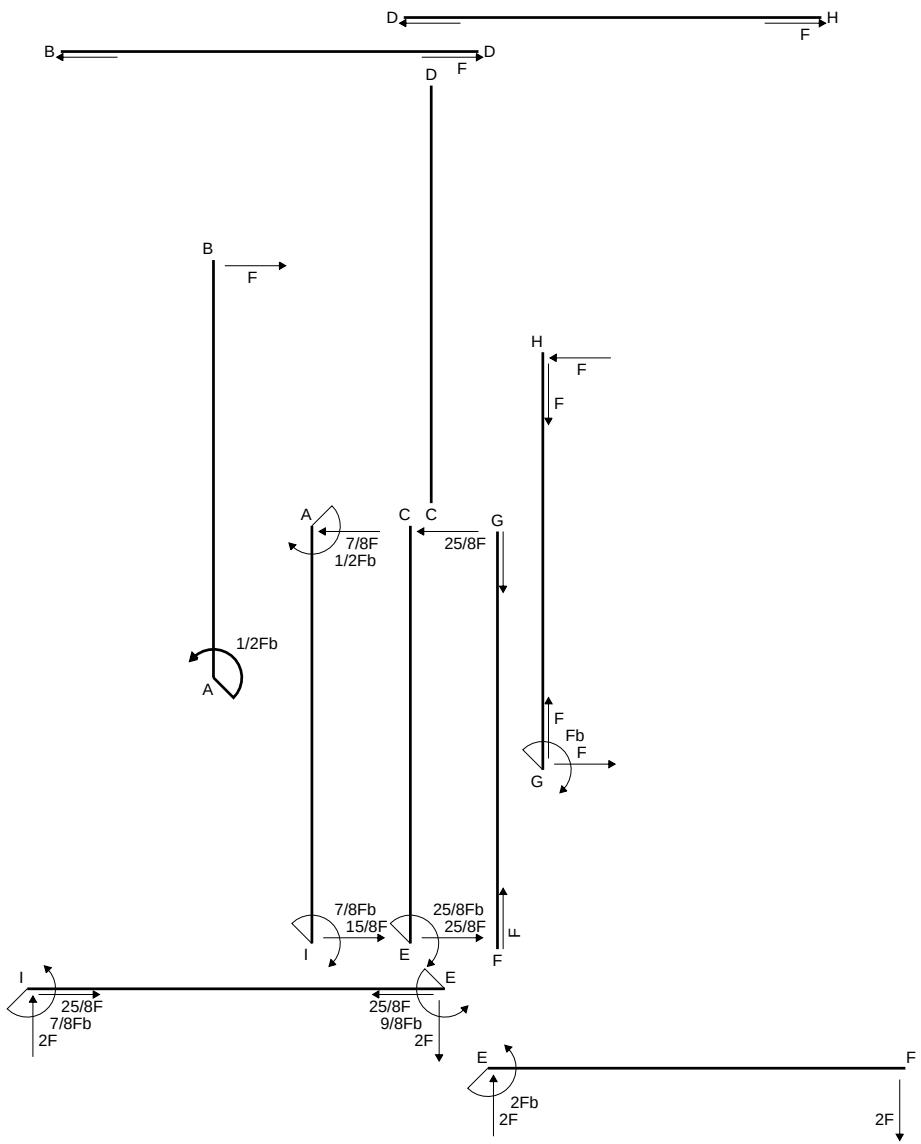
$= (-3/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = -1/4\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-3/2\ x/b + 3/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-3/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-3/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = -1/4\ Fb^2/EJ$



A = 696. mm^2
J_u = 229334. mm^4
J_v = 49608. mm^4
y_g = 33.8 mm
T_y = 2560. N
M_x = -1356800. Nmm
x_m = 12. mm
u_m = -9. mm
v_m = -33.8 mm
$\sigma_m = -Mv/J_u$ = -200. N/mm^2
x_c = 21. mm
y_c = 9. mm
v_c = -24.8 mm
$\sigma_c = -Mv/J_u$ = -146.7 N/mm^2
τ_c = 7.069 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 147.2 N/mm^2
S^* = 3799. mm^3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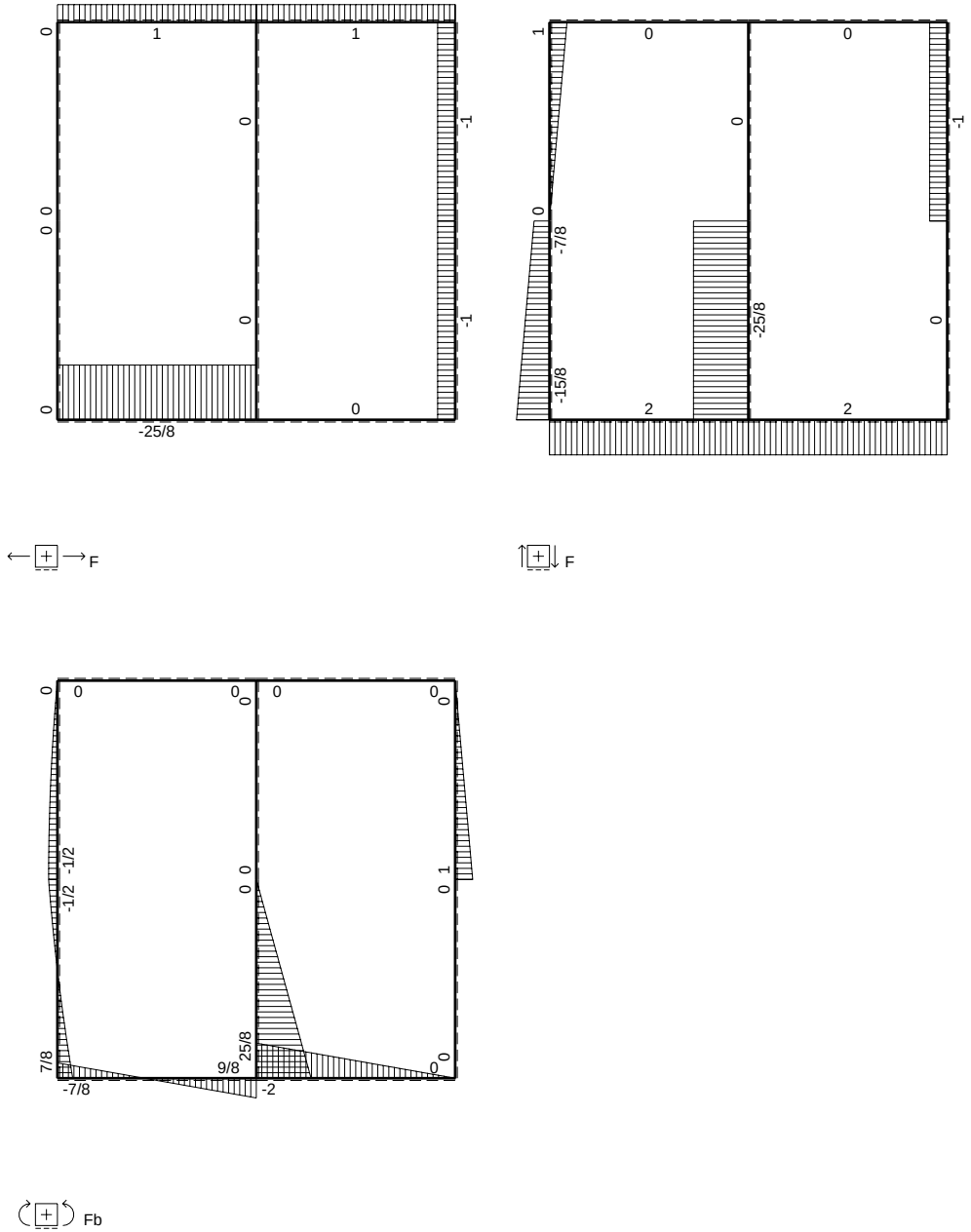
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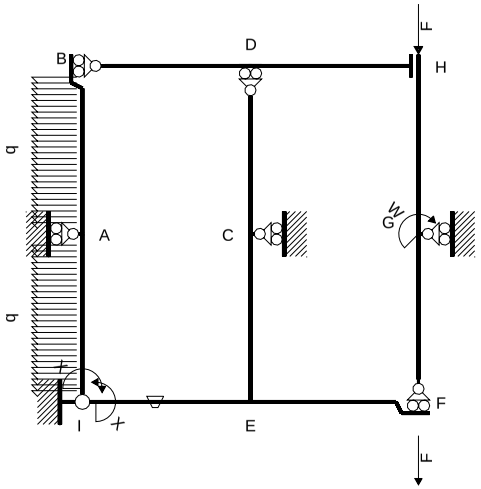
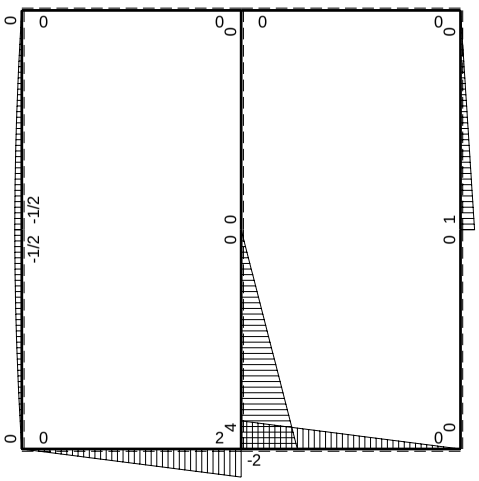
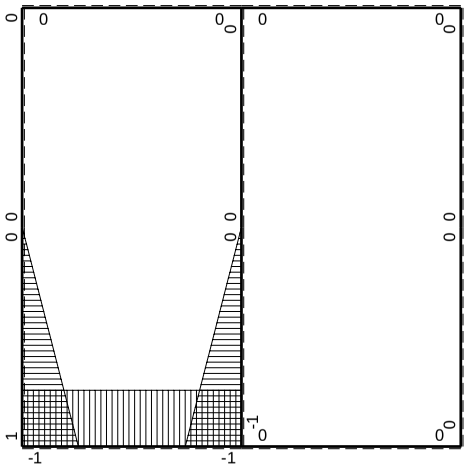
-7/8
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 939051 CI07.xxxx.051

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	Fb-Fx	0	0	0	0	0+0	0
HG b	0	-Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	-1+x/b	4Fb-4Fx	0	$-4Fb+8Fx-4Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-4/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-4Fx$	0	$-4Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	$-Fx+1/2qx^2$	0	$-Fx+3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-1/8+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	$1/2Fb-1/2qx^2$	0	$-1/2Fx+1/2qx^3/b$	0	x^2/b^2		
	totali						$-35/24Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						7/8Fb	

PROCEDIMENTO E RISULTATI 939051 CI07.xxxx.051

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L_{EI}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L_{EC}^{Xo} = \int_o^b (-4 + 8\ x/b - 4\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4\ x + 4\ x^2/b - 4/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-4\ b + 4\ b - 4/3\ b\ )\ Fb\ 1/EJ\ = -4/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-4\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-4/3\ b\ )\ Fb\ 1/EJ\ = -4/3\ Fb^2/EJ$

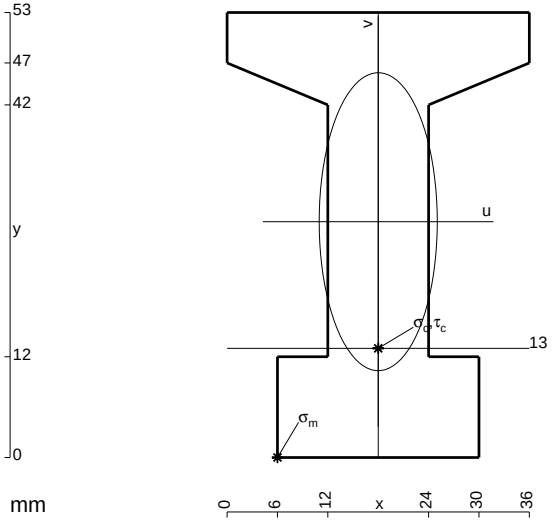
$L_{IA}^{Xo} = \int_o^b (-\ x/b + 3/2\ x^2/b^2 - 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/2\ x^3/b^2 - 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/2\ b - 1/8\ b\ )\ Fb\ 1/EJ\ = -1/8\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/8\ b\ )\ Fb\ 1/EJ\ = -1/8\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 939051 CI07.xxxx.051



A = 984. mm^2
J_u = 309962. mm^4
J_v = 48672. mm^4
y_g = 28.09 mm
T_y = 3980. N
M_x = -2308400. Nmm
x_m = 6. mm
u_m = -12. mm
v_m = -28.09 mm
$\sigma_m = -Mv/J_u$ = -209.2 N/mm^2
x_c = 18. mm
y_c = 13. mm
v_c = -15.09 mm
$\sigma_c = -Mv/J_u$ = -112.4 N/mm^2
τ_c = 7.007 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 113. N/mm^2
S^* = 6548. mm^3

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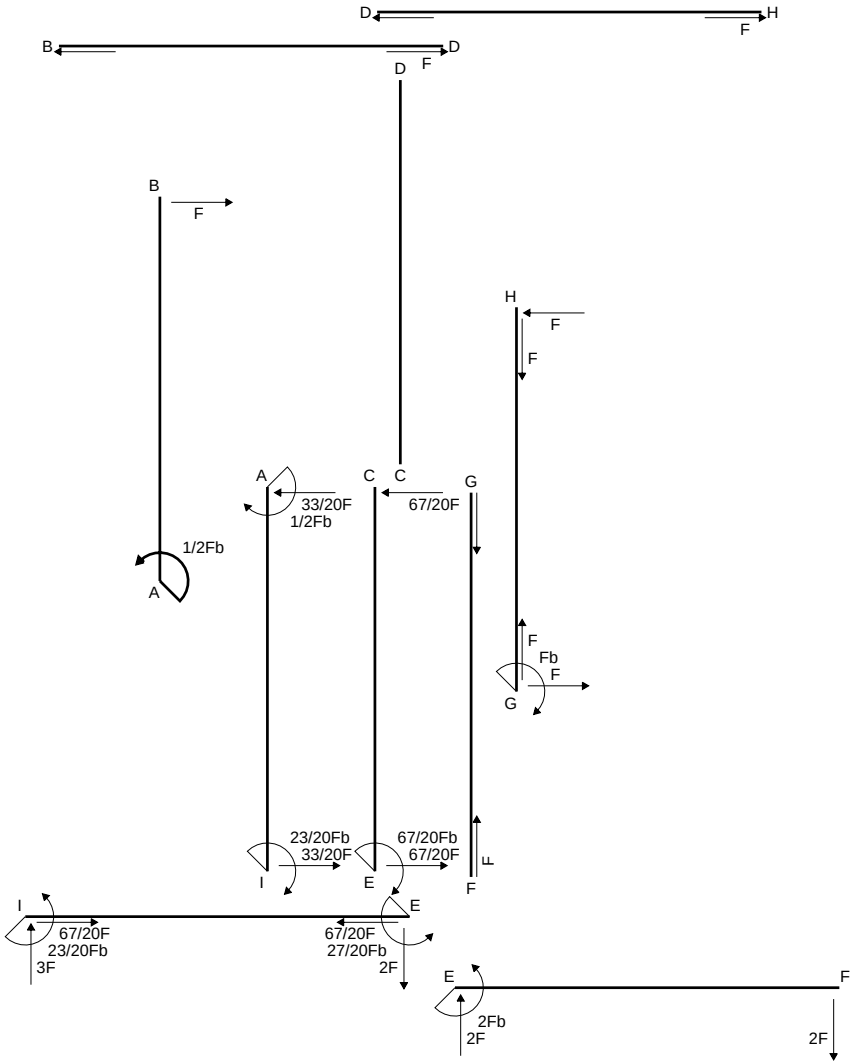
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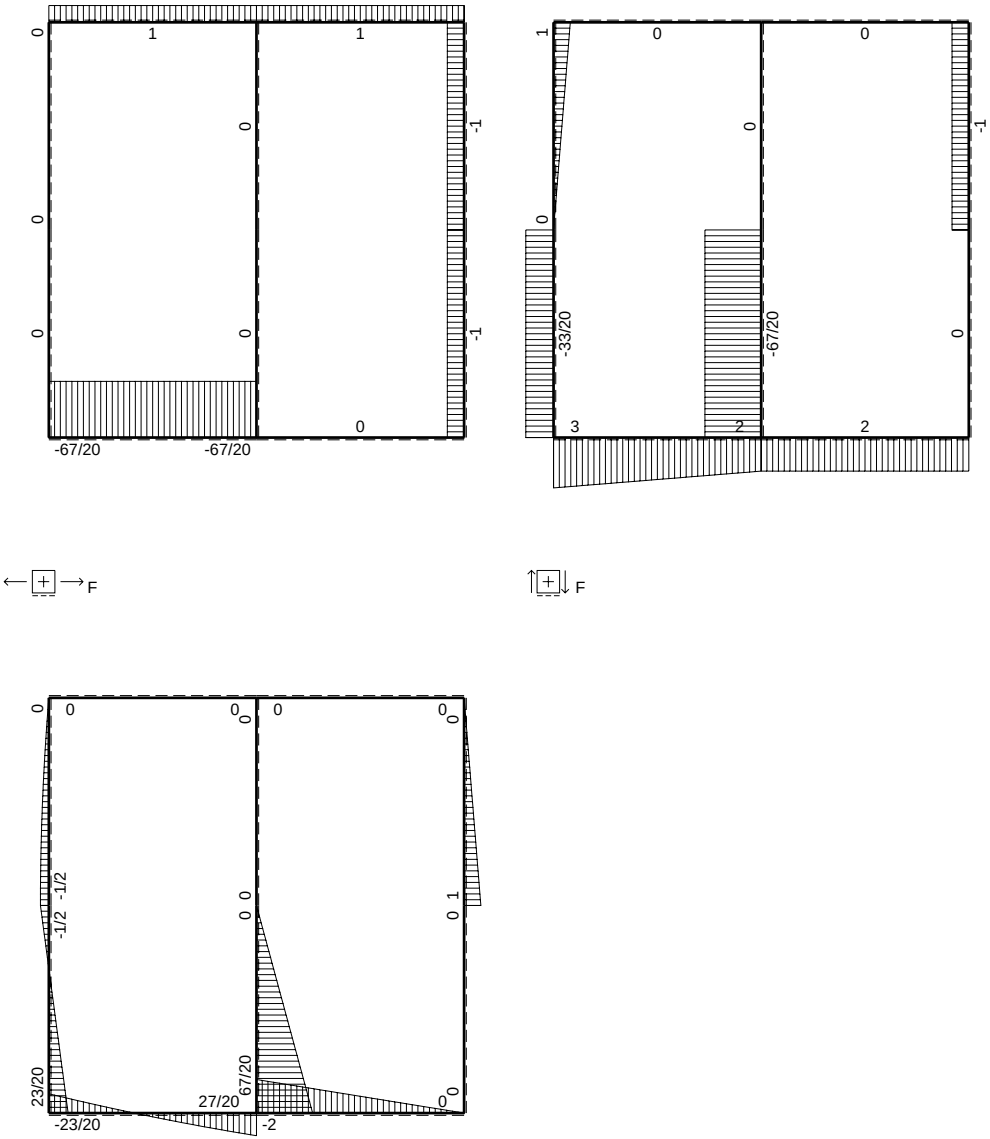
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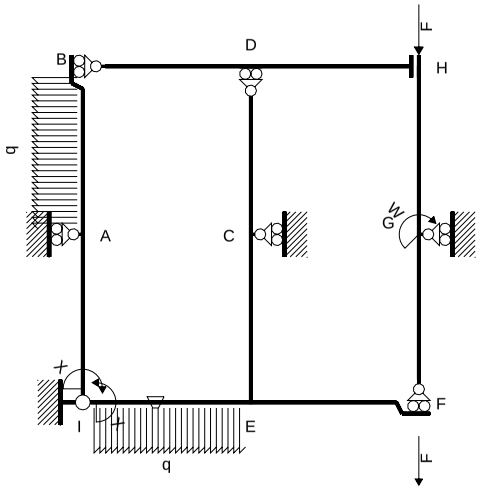
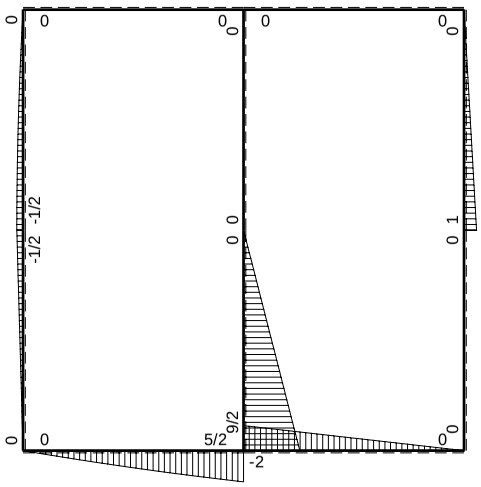
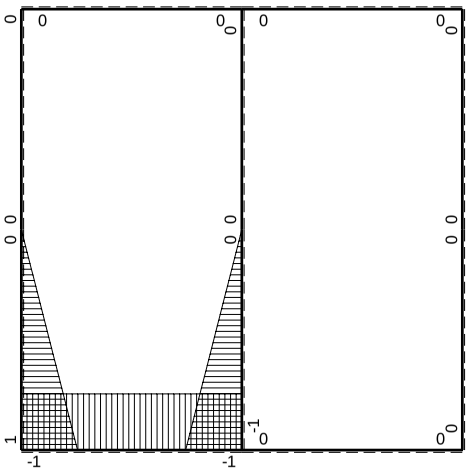


Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 215246 CI07.xxxx.052

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PROCEDIMENTO E RISULTATI 215246 CI07.xxxx.052

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	Fb-Fx	0	0	0	0	0+0	0
HG b	0	-Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx-1/2qx^2$	-Fb/EJ	$-3Fx+1/2Fx^2/b$	Fb/EJ	1	$(-4/3+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-5/2Fb+2Fx+1/2qx^2$	Fb/EJ	$-5/2Fb+2Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	-1+x/b	9/2Fb-9/2Fx	0	$-9/2Fb+9Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-9/2Fx	0	$-9/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-23/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						23/20Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/3\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-5/2 + 2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx$

$= [-5/2\ x + x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-5/2\ b + b + 1/6\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/3\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-9/2 + 9\ x/b - 9/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-9/2\ x + 9/2\ x^2/b - 3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-9/2\ b + 9/2\ b - 3/2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-9/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

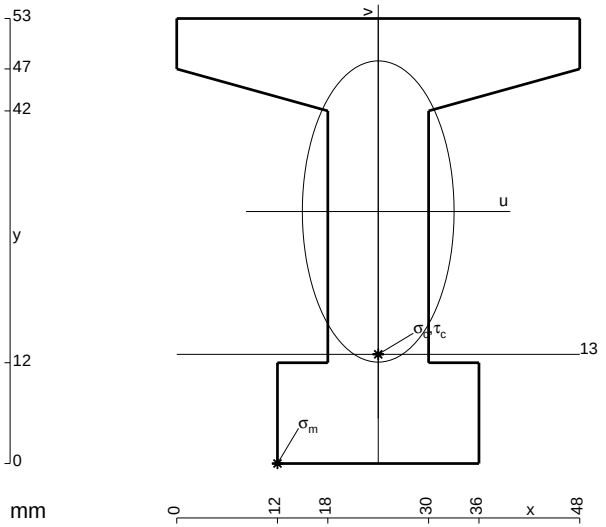
$= (-3/2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

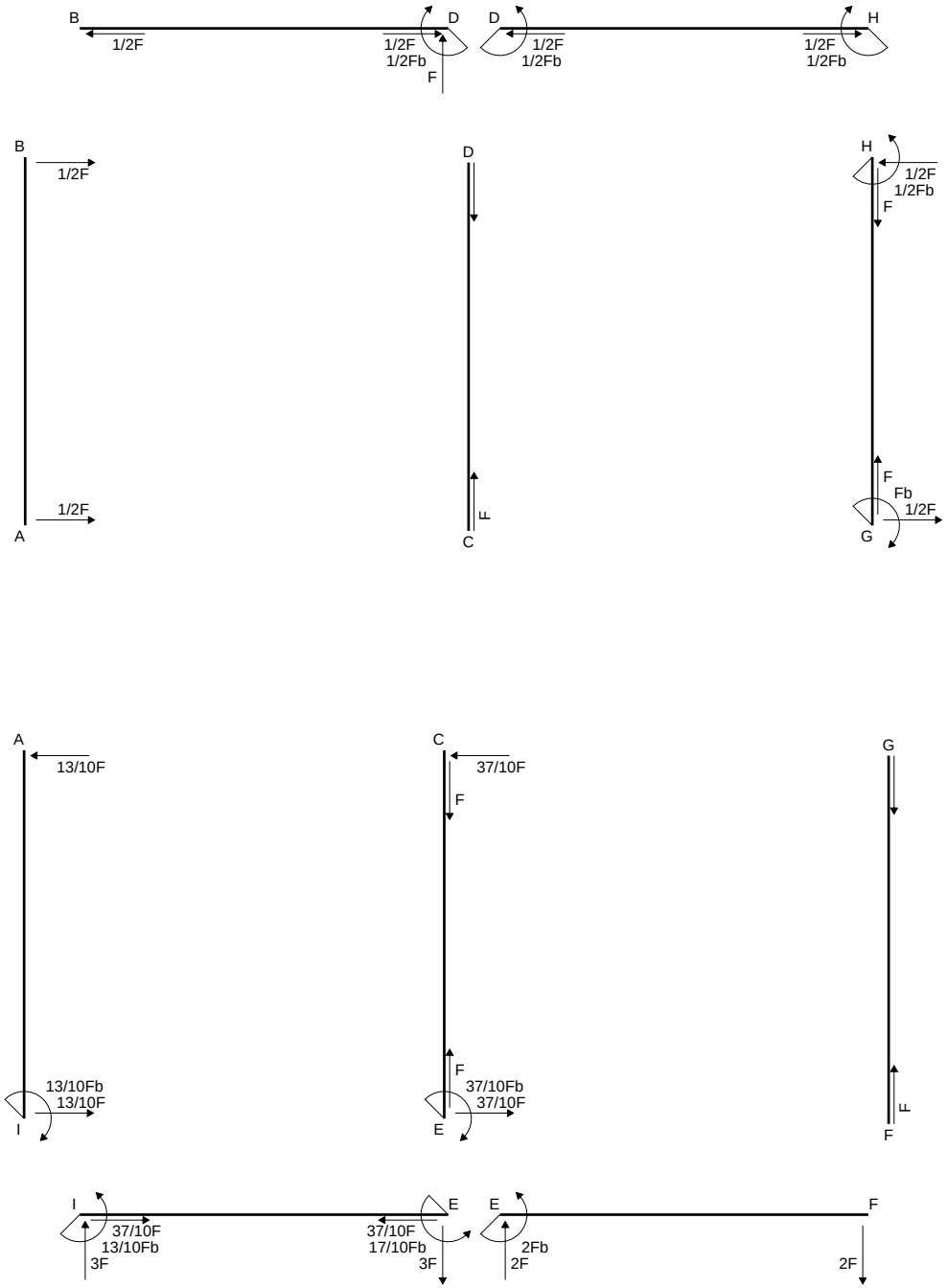
$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$



A = 1086. mm^2
J_u = 349673. mm^4
J_v = 88740. mm^4
y_g = 30.02 mm
T_y = 4060. N
M_x = -2557800. Nmm
x_m = 12. mm
u_m = -12. mm
v_m = -30.02 mm
$\sigma_m = -Mv/J_u$ = -219.6 N/mm^2
x_c = 24. mm
y_c = 13. mm
v_c = -17.02 mm
$\sigma_c = -Mv/J_u$ = -124.5 N/mm^2
τ_c = 6.896 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 125. N/mm^2
S^* = 7127. mm^3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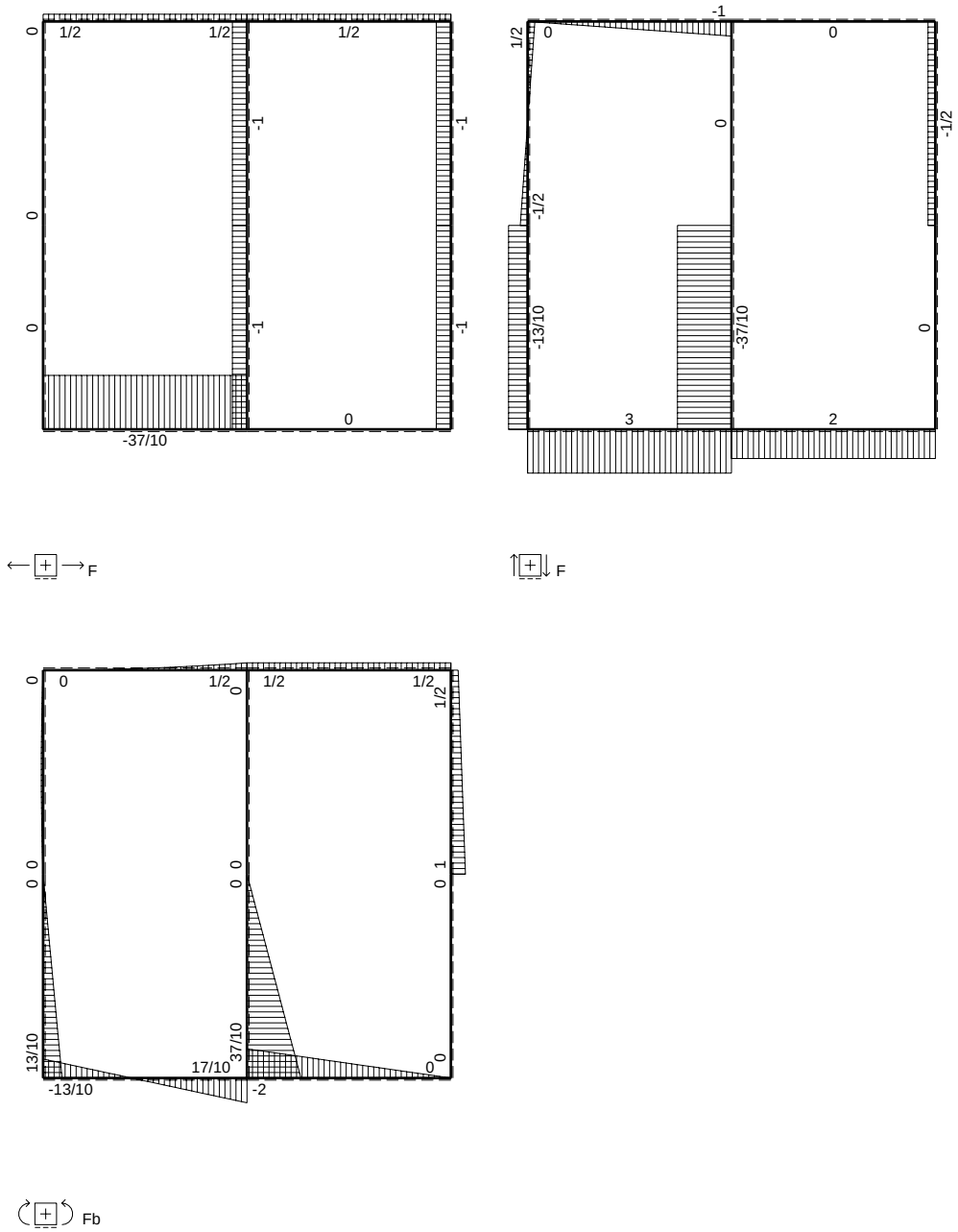
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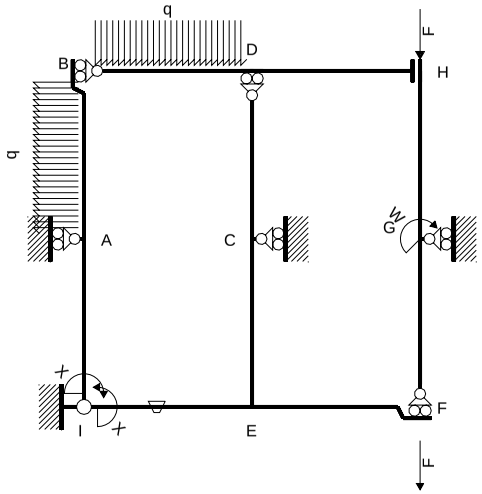
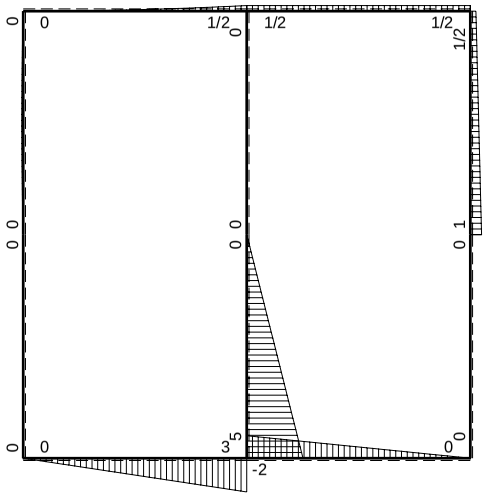
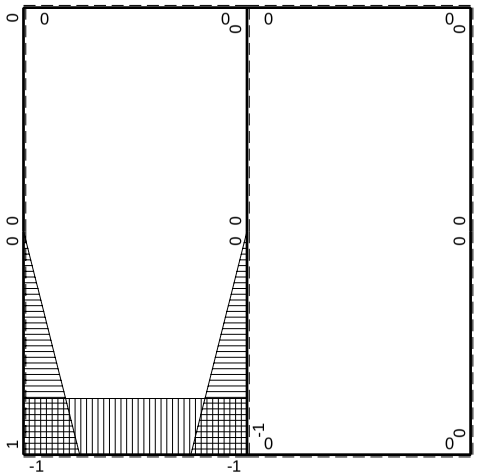


Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 987512 CI07.xxxx.053

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb-1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-5Fx$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
AI b	$-x/b$	0	0	0	0	x^2/b^2		
	totali						$-13/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						13/10Fb	

Sviluppi di calcolo iperstatica

PROCEDIMENTO E RISULTATI 987512 CI07.xxxx.053

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

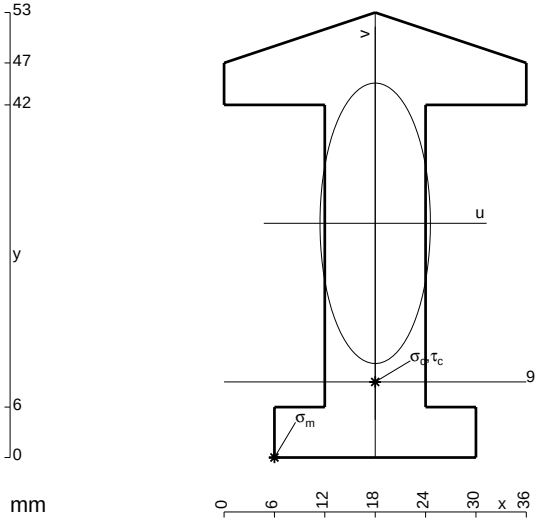
$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

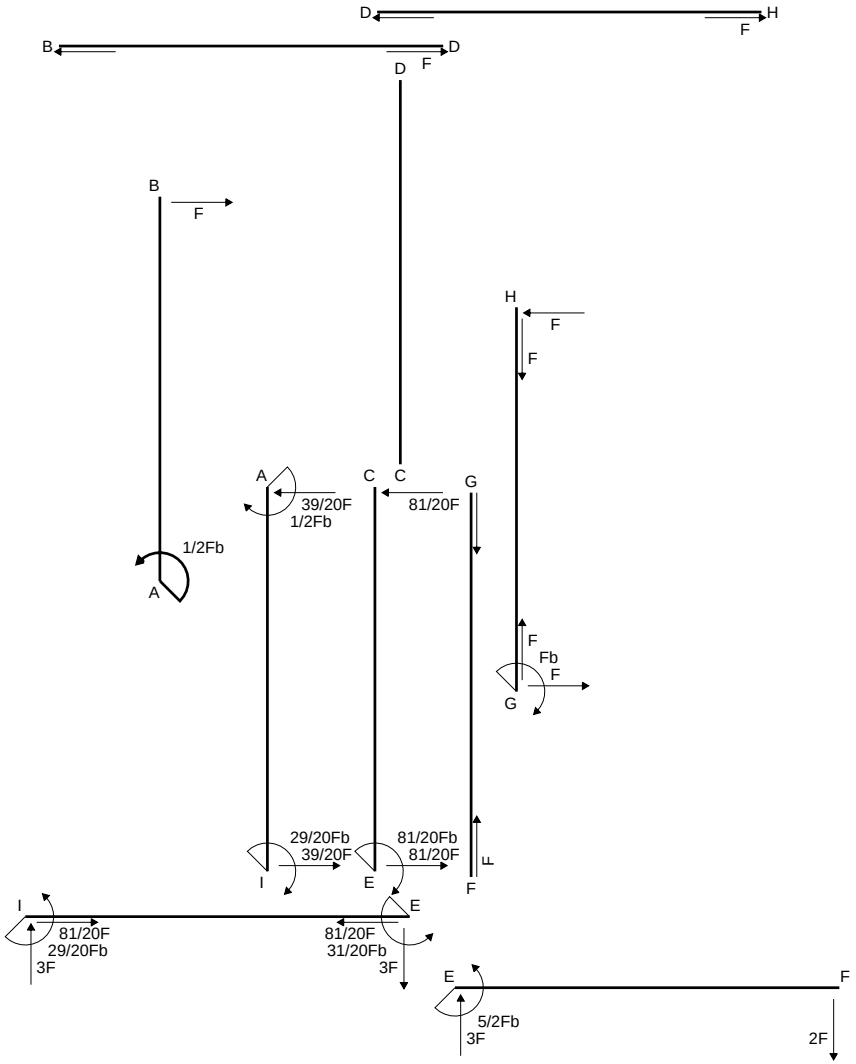
$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$



A = 864. mm^2
J_u = 241215. mm^4
J_v = 37368. mm^4
y_g = 27.9 mm
T_y = 2920. N
M_x = -1985600. Nmm
x_m = 6. mm
u_m = -12. mm
v_m = -27.9 mm
$\sigma_m = -Mv/J_u$ = -229.6 N/mm^2
x_c = 18. mm
y_c = 9. mm
v_c = -18.9 mm
$\sigma_c = -Mv/J_u$ = -155.5 N/mm^2
τ_c = 4.357 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 155.7 N/mm^2
S^* = 4319. mm^3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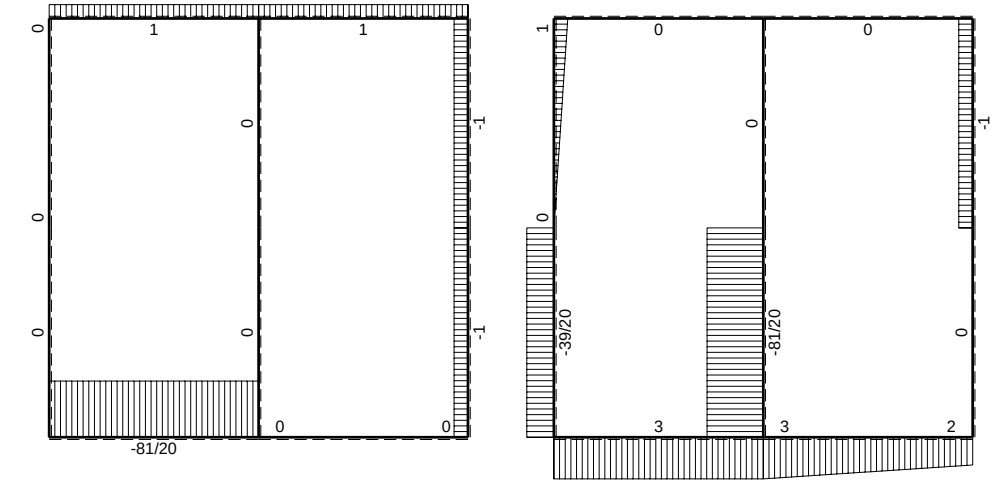
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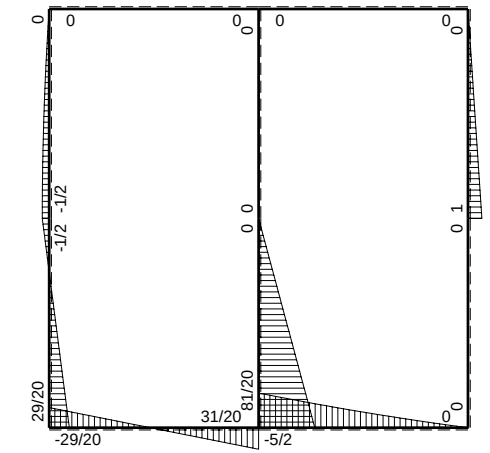
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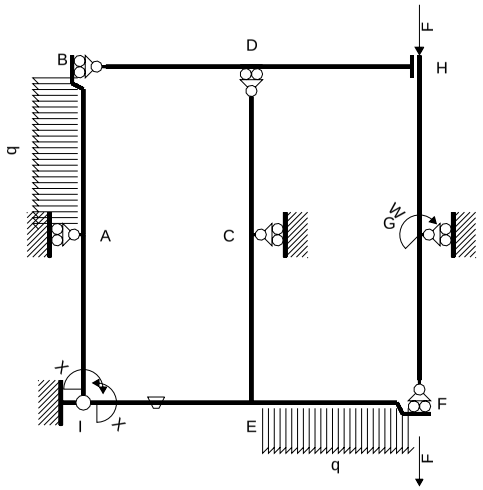
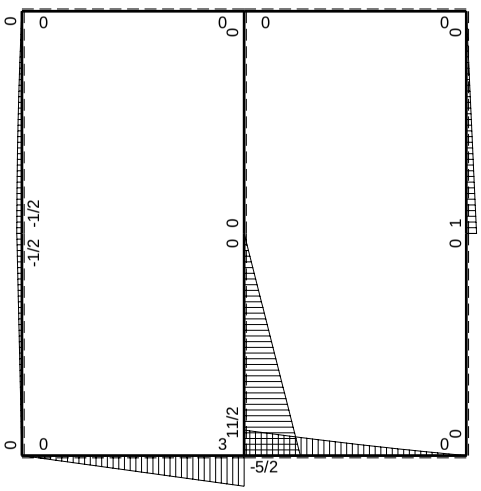
-5/2

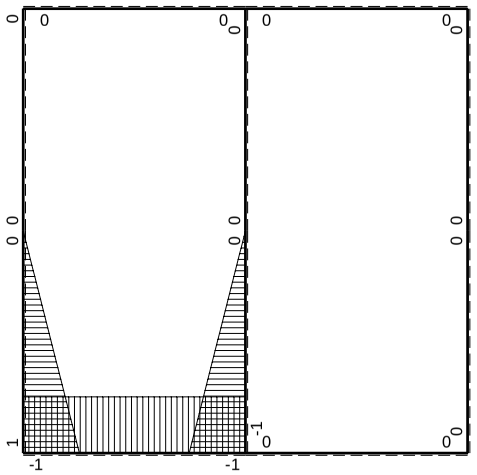
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 218373 CI07.xxxx.054

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

PROCEDIMENTO E RISULTATI 218373 CI07.xxxx.054

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-5/2Fb+3Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$2Fx+1/2qx^2$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	Fb-Fx	0	0	0	0	0+0	0
HG b	0	-Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	11/2Fb-11/2Fx	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-11/2Fx	0	$-11/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-29/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						29/20Fb	

Sviluppi di calcolo iperstatica

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-11/2 + 11\ x/b - 11/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-11/2\ x + 11/2\ x^2/b - 11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-11/2\ b + 11/2\ b - 11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-11/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

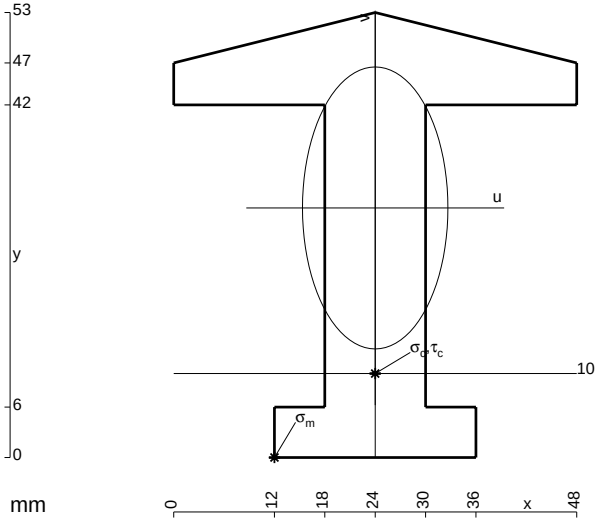
$= (-11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

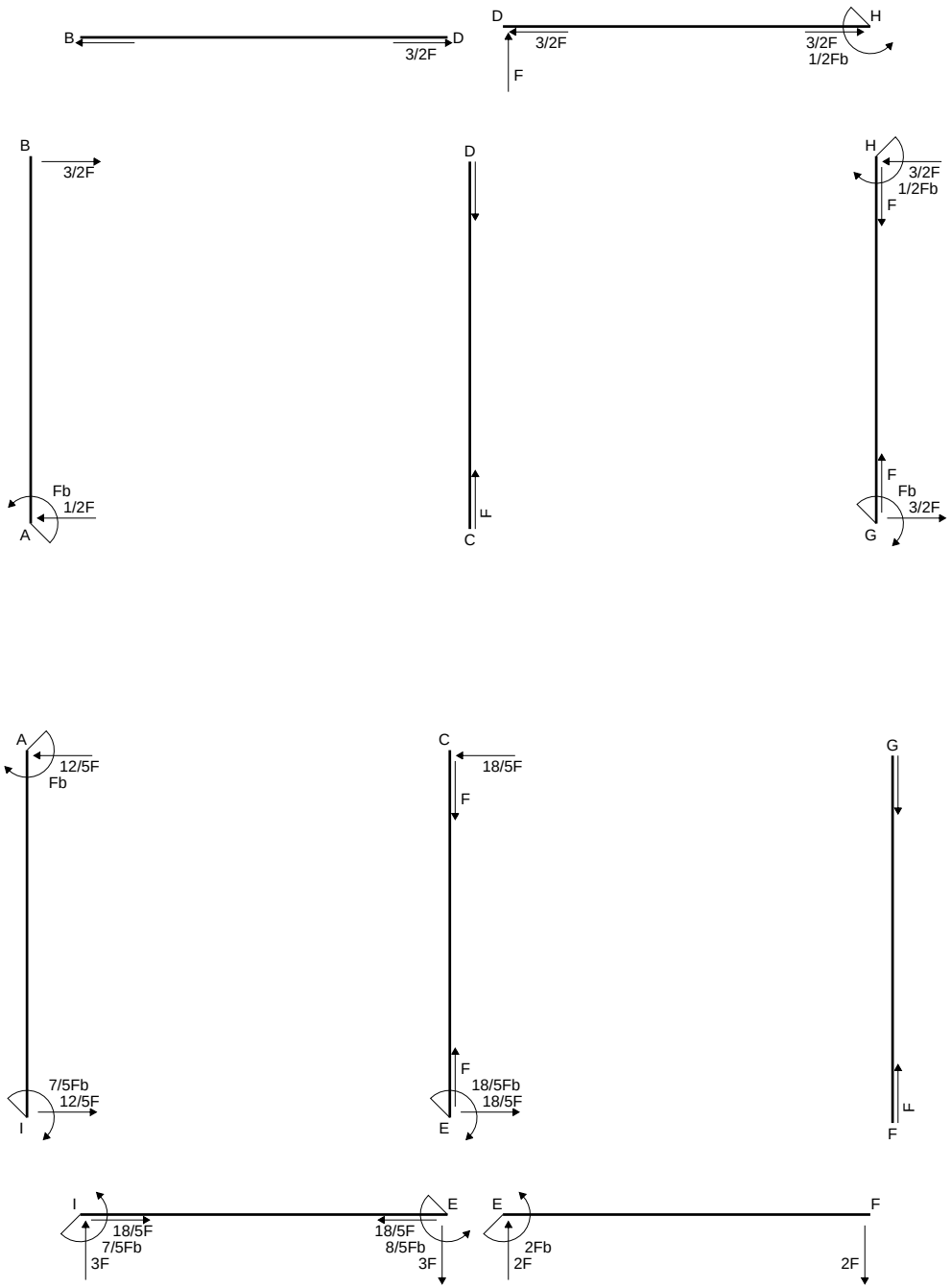
$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$



A = 960. mm^2
J_u = 270775. mm^4
J_v = 72000. mm^4
y_g = 29.73 mm
T_y = 3540. N
M_x = -2183000. Nmm
x_m = 12. mm
u_m = -12. mm
v_m = -29.73 mm
$\sigma_m = -Mv/J_u$ = -239.6 N/mm^2
x_c = 24. mm
y_c = 10. mm
v_c = -19.73 mm
$\sigma_c = -Mv/J_u$ = -159. N/mm^2
τ_c = 5.329 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 159.3 N/mm^2
S^* = 4891. mm^3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2F
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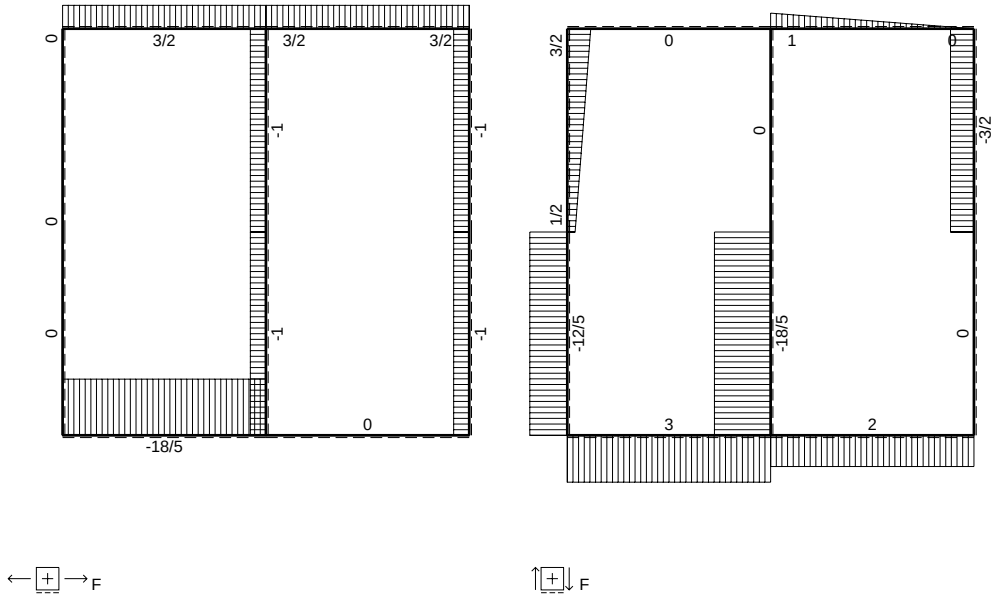
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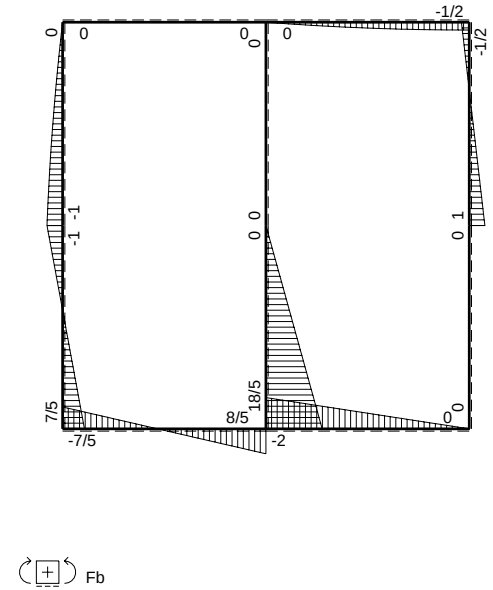
F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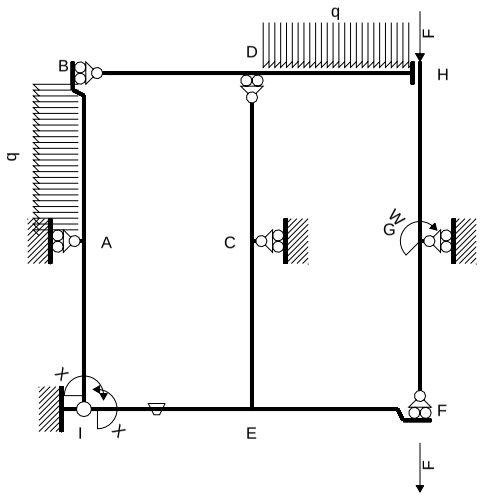
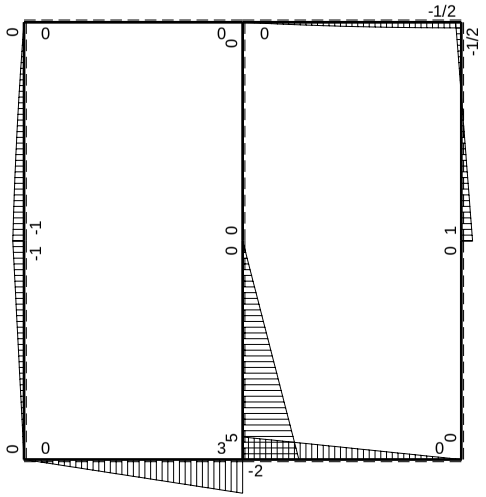
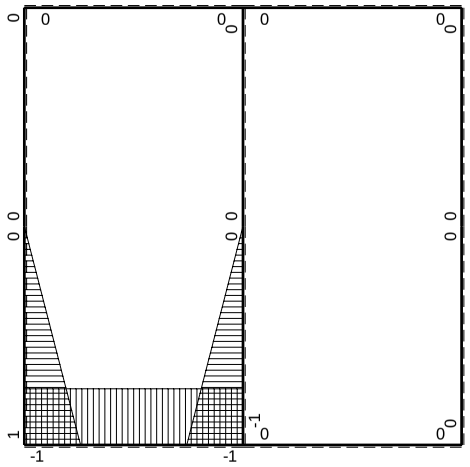
18/5
8/5
0
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 985726 CI07.xxxx.055

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$-Fb+1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$3/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-3/2Fx$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-3/2Fx$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-5Fx$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-Fx$	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$Fb-Fx$	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-7/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$7/5Fb$	

PROCEDIMENTO E RISULTATI 985726 CI07.xxxx.055

Sviluppi di calcolo iperstatica

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

$L^{XX}_{IE} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EI} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EC} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{CE} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{IA} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{AI} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{Xo}_{IE} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L^{Xo}_{EI} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L^{Xo}_{EC} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L^{Xo}_{CE} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

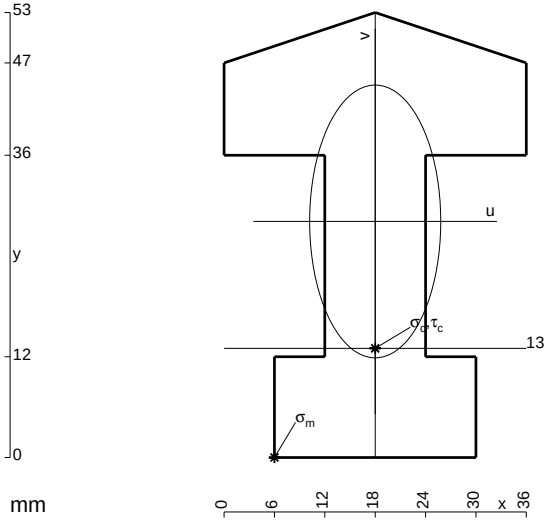
$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L^{Xo}_{IA} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

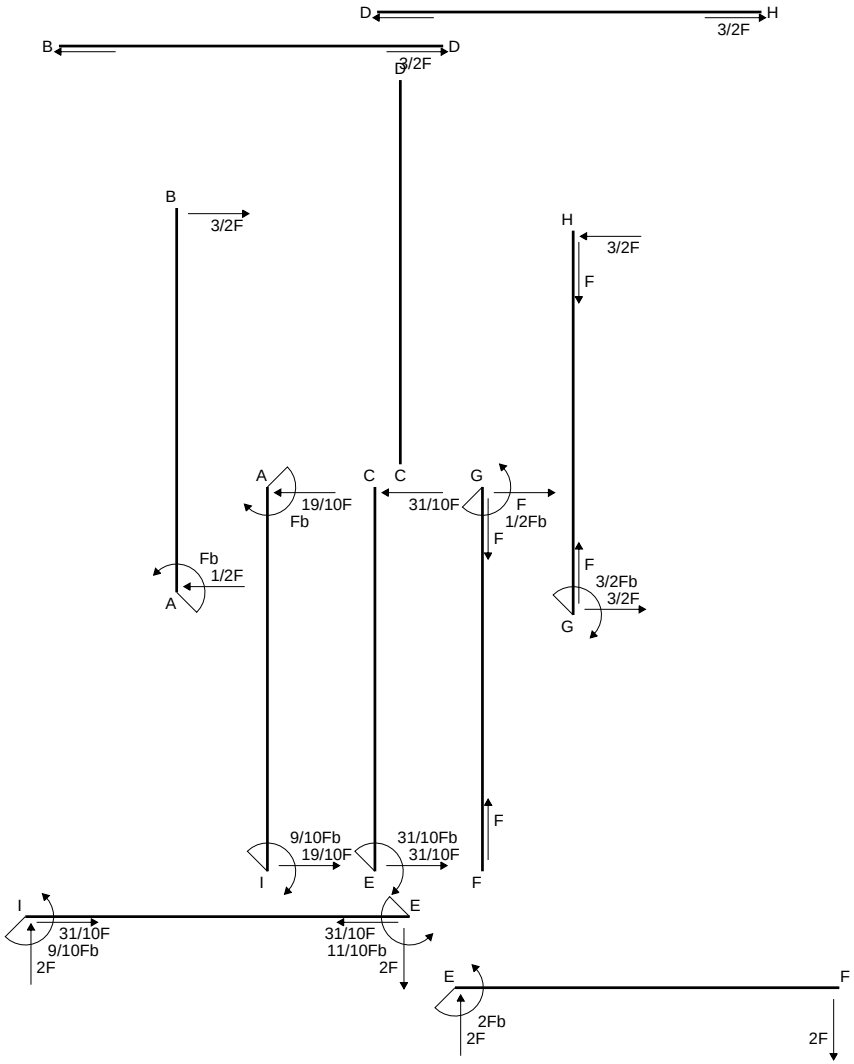
$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$

$L^{Xo}_{AI} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$



A = 1080. mm^2
J_u = 285273. mm^4
J_v = 65880. mm^4
y_g = 28.12 mm
T_y = 2560. N
M_x = -2022400. Nmm
x_m = 6. mm
u_m = -12. mm
v_m = -28.12 mm
$\sigma_m = -Mv/J_u$ = -199.3 N/mm^2
x_c = 18. mm
y_c = 13. mm
v_c = -15.12 mm
$\sigma_c = -Mv/J_u$ = -107.2 N/mm^2
τ_c = 4.903 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 107.5 N/mm^2
S^* = 6557. mm^3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Fb
31/10F
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Fb
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A
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3/2Fb
3/2F
G
F
9/10Fb
19/10F
31/10Fb
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I
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2F
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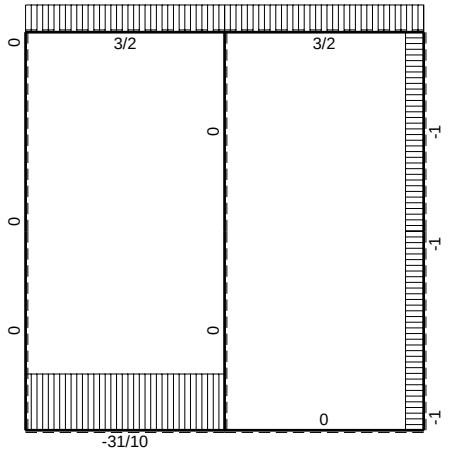
2Fb
2F
2F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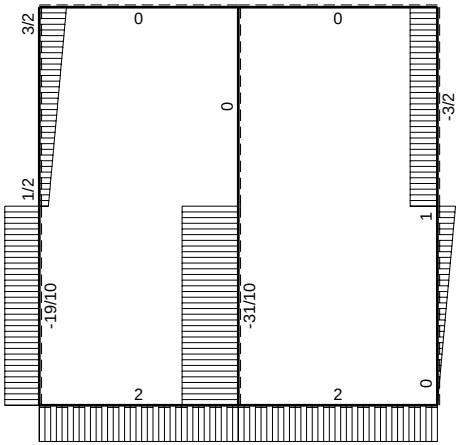
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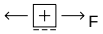
F

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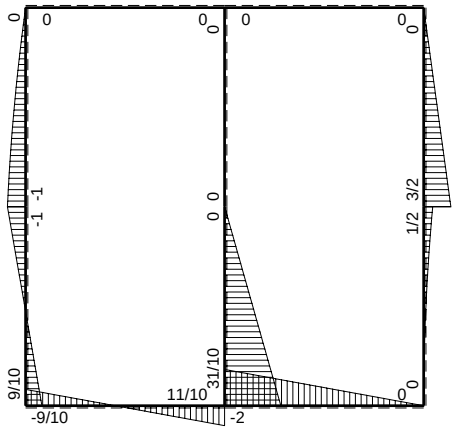
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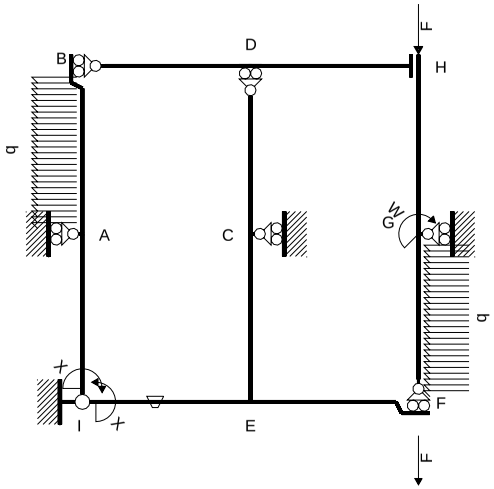
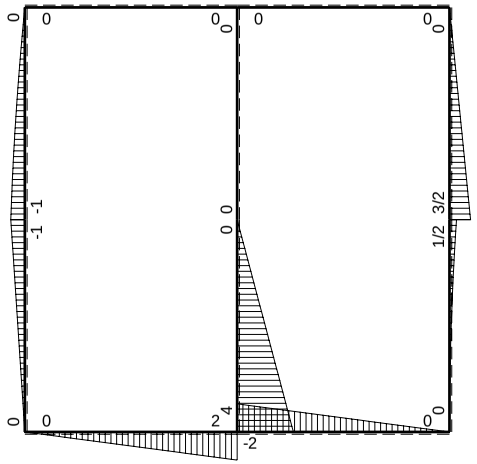
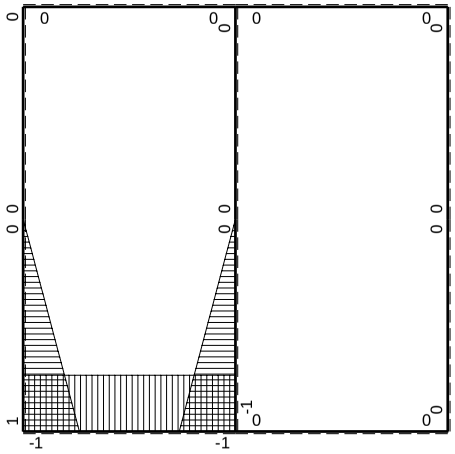
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 253104 CI07.xxxx.056

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$-Fb+1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$3/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$3/2Fb-3/2Fx$	0	0	0	0	0+0	0
HG b	0	$-3/2Fx$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$4Fb-4Fx$	0	$-4Fb+8Fx-4Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-4/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-4Fx$	0	$-4Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-Fx$	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$Fb-Fx$	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-3/2Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$9/10Fb$	

PROCEDIMENTO E RISULTATI 253104 CI07.xxxx.056

Sviluppi di calcolo iperstatica

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

$L_{lE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{El}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{lA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{Al}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{lE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L_{El}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L_{EC}^{Xo} = \int_o^b (-4 + 8\ x/b - 4\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4\ x + 4\ x^2/b - 4/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-4\ b + 4\ b - 4/3\ b\ )\ Fb\ 1/EJ\ = -4/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-4\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-4/3\ b\ )\ Fb\ 1/EJ\ = -4/3\ Fb^2/EJ$

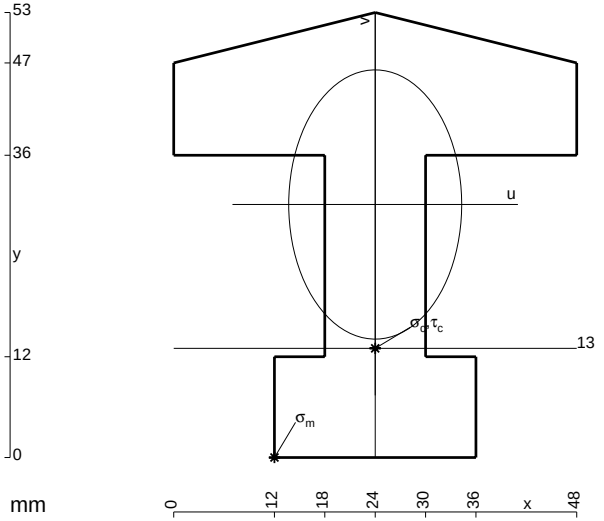
$L_{lA}^{Xo} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$

$L_{Al}^{Xo} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 253104 CI07.xxxx.056



A = 1248. mm^2
J_u = 320937. mm^4
J_v = 132480. mm^4
y_g = 30.13 mm
T_y = 2660. N
M_x = -2234400. Nmm
x_m = 12. mm
u_m = -12. mm
v_m = -30.13 mm
$\sigma_m = -Mv/J_u$ = -209.8 N/mm^2
x_c = 24. mm
y_c = 13. mm
v_c = -17.13 mm
$\sigma_c = -Mv/J_u$ = -119.3 N/mm^2
τ_c = 4.947 N/mm^2
$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2}$ = 119.6 N/mm^2
S^* = 7162. mm^3

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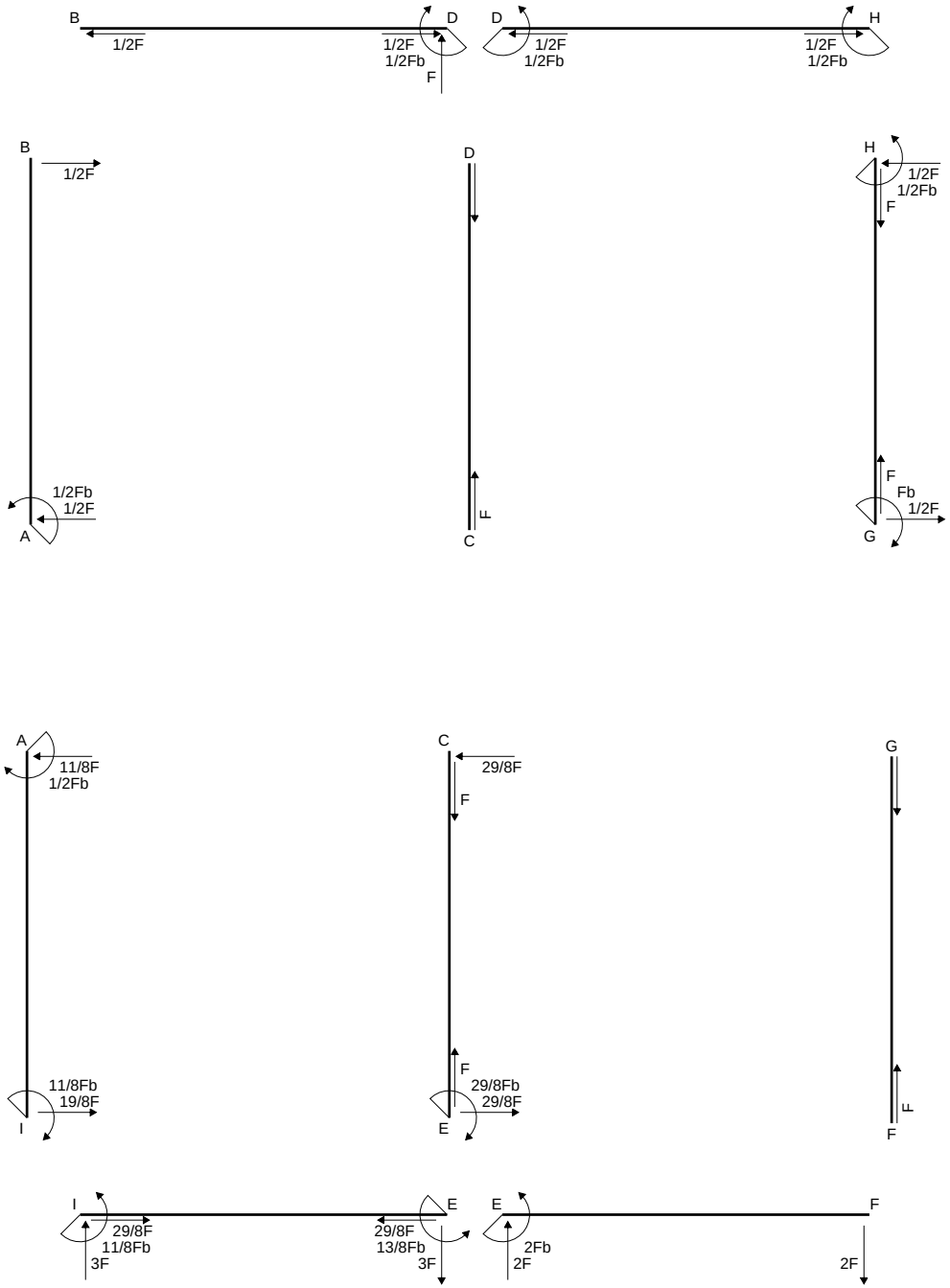
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D
1/2F
1/2Fb
F
D
1/2F
1/2Fb
H
1/2F
1/2Fb
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1/2Fb
1/2F
A
D
F
C
H
1/2F
1/2Fb
F
F
Fb
1/2F
G
A
11/8F
1/2Fb
11/8Fb
19/8F
I
C
29/8F
F
F
29/8Fb
29/8F
E
G
F
I
29/8F
11/8Fb
3F
E
29/8F
13/8Fb
3F
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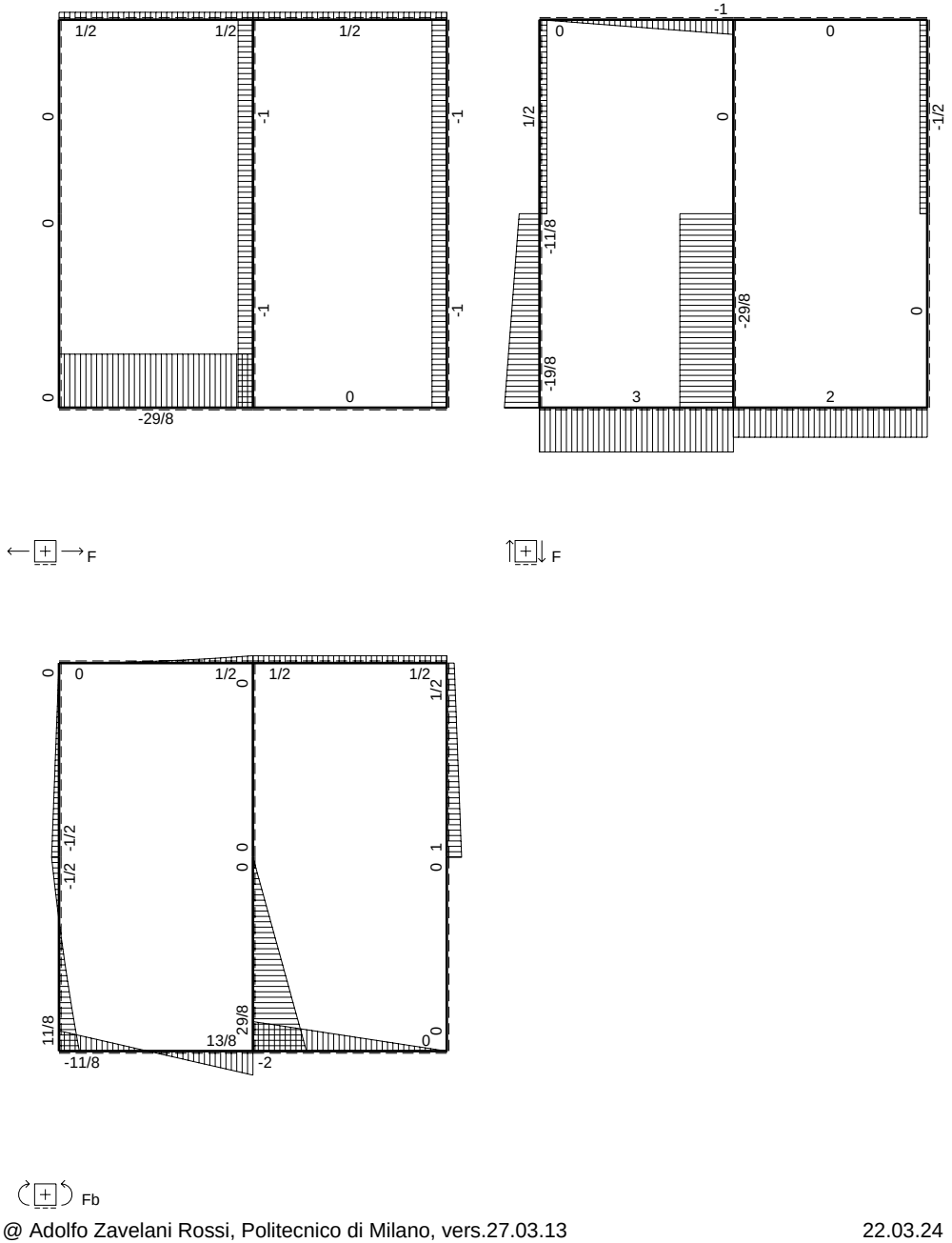
2Fb
2F
F
2F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-1
-1
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-29/8
F
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0
1/2
0
-1/2
-11/8
-29/8
-19/8
0
3
2
F
0
0
1/2
1/2
1/2
0
0
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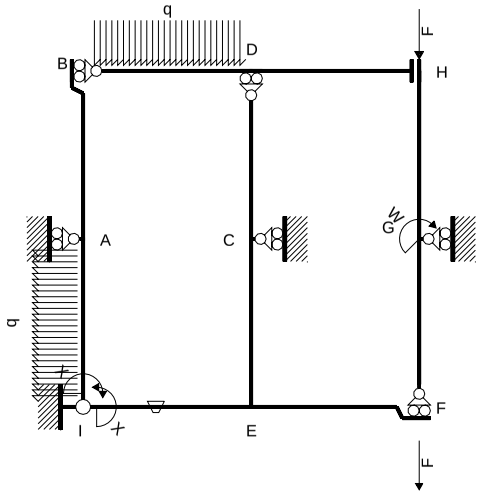
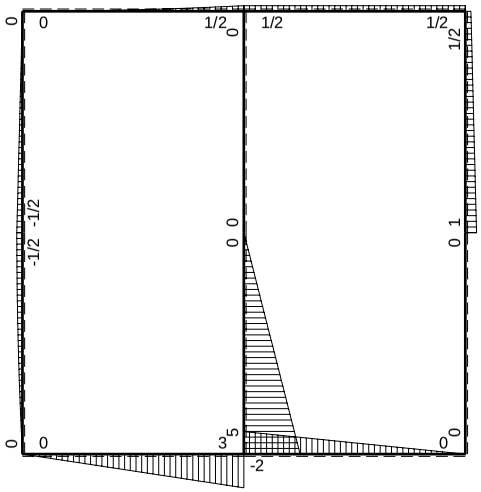
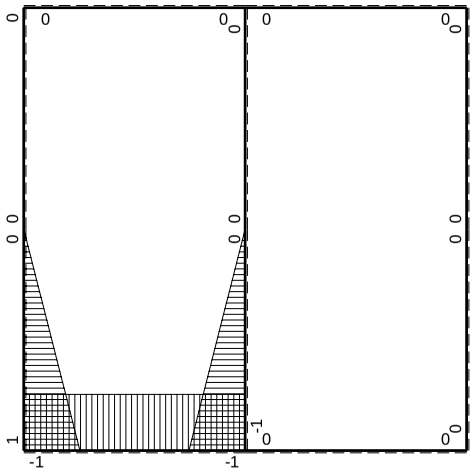
0
1
11/8
-11/8
29/8
13/8
-2
0
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 215440 CI07.xxxx.057

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	Fb-1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fb-1/2Fx	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-5Fx	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-5Fx^2/b$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	$-Fx+1/2qx^2$	0	$-Fx+3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-1/8+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	$1/2Fb-1/2qx^2$	0	$-1/2Fx+1/2qx^3/b$	0	x^2/b^2		
	totali						$-55/24Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						11/8Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

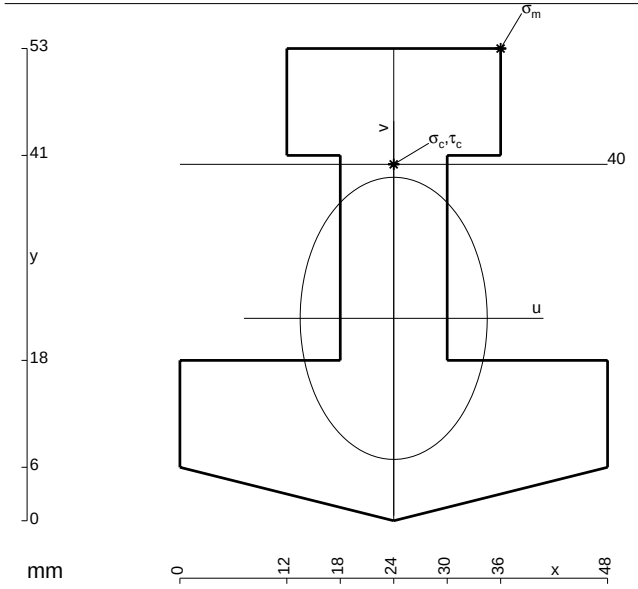
$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-\ x/b + 3/2\ x^2/b^2 - 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/2\ x^3/b^2 - 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

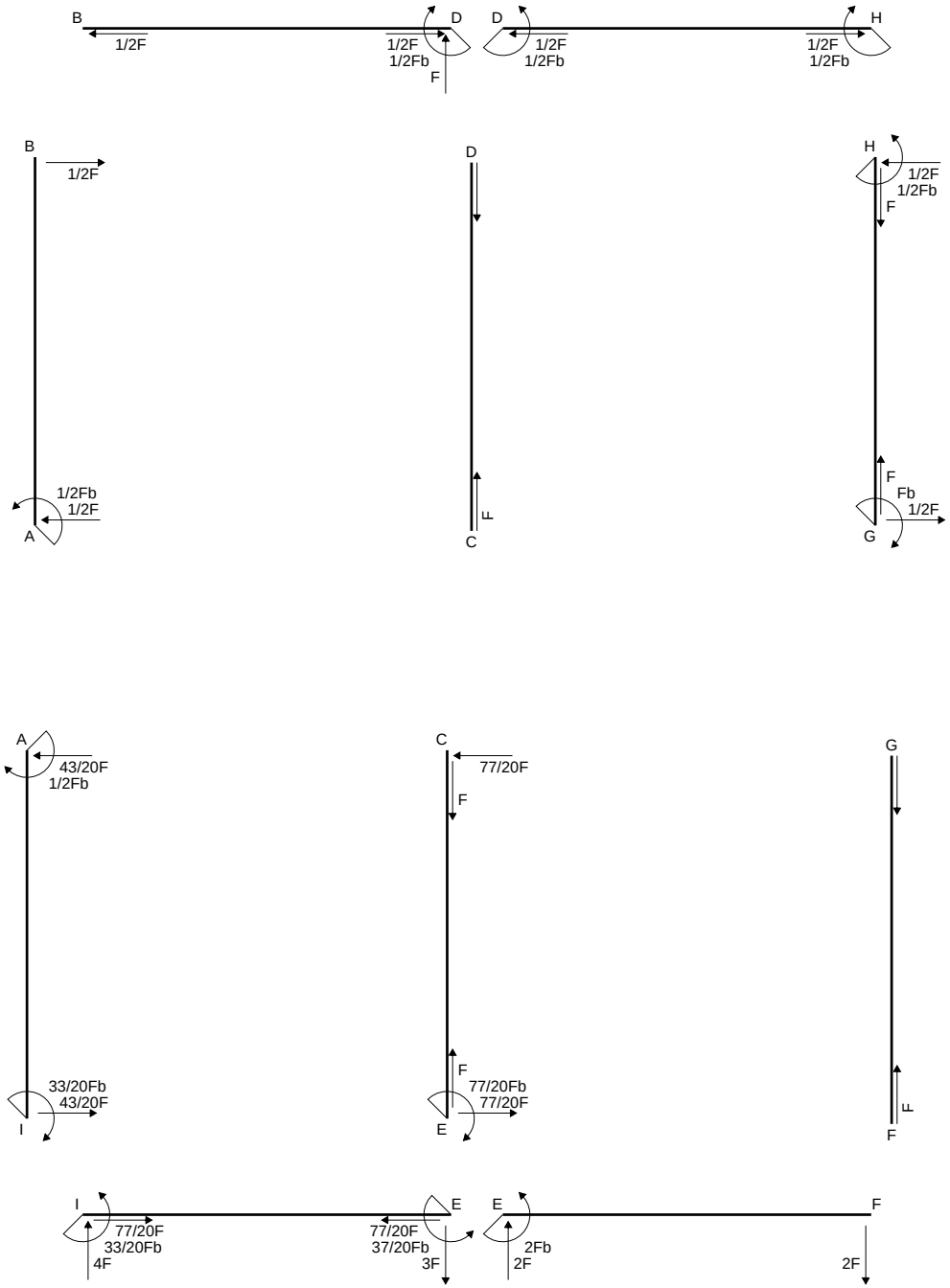
$= (-1/2\ b + 1/2\ b - 1/8\ b\ )\ Fb\ 1/EJ\ = -1/8\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/8\ b\ )\ Fb\ 1/EJ\ = -1/8\ Fb^2/EJ$



A = 1284. mm^2
J_u = 321948. mm^4
J_v = 141552. mm^4
y_g = 22.72 mm
T_y = 2580. N
M_x = -2322000. Nmm
x_m = 36. mm
y_m = 53. mm
u_m = 12. mm
v_m = 30.28 mm
$\sigma_m = -Mv/J_u$ = 218.4 N/mm^2
x_c = 24. mm
y_c = 40. mm
v_c = 17.28 mm
$\sigma_c = -Mv/J_u$ = 124.7 N/mm^2
τ_c = 4.813 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 124.9 N/mm^2
S^* = 7208. mm^3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D
1/2F
1/2Fb
F
D
1/2F
1/2Fb
H
1/2F
1/2Fb
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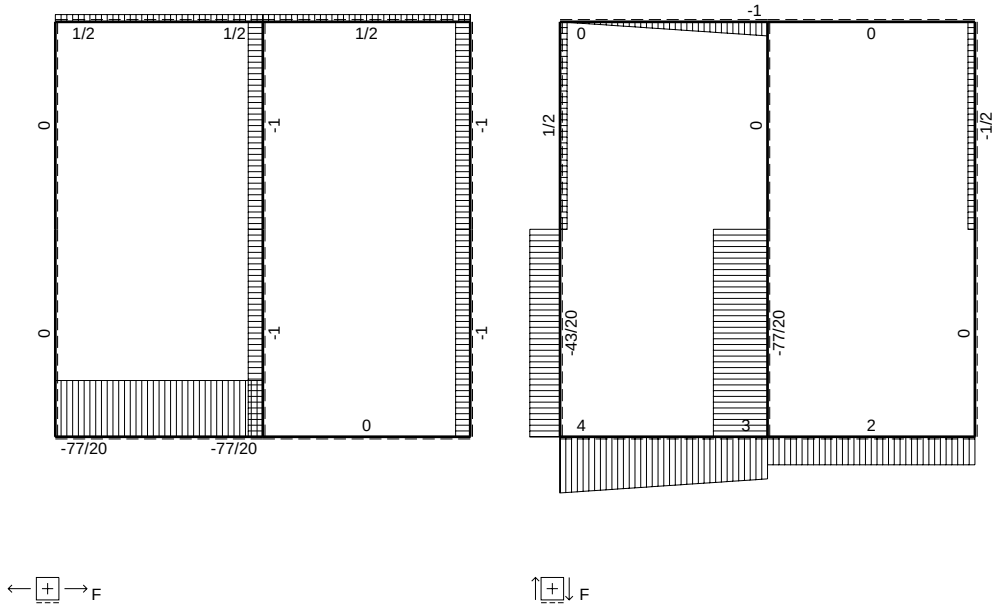
1/2Fb
1/2F
A
D
F
C
H
1/2F
1/2Fb
F
F
Fb
1/2F
G
A
43/20F
1/2Fb
33/20Fb
43/20F
I
C
77/20F
F
F
77/20Fb
77/20F
E
G
F
F
I
77/20F
33/20Fb
4F
E
77/20F
37/20Fb
3F
E
2Fb
2F
F
2F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-77/20
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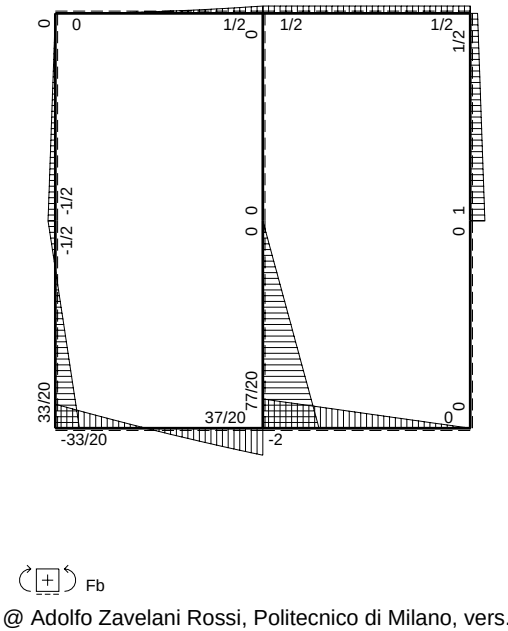
3
2
F


0
0
1/2
1/2
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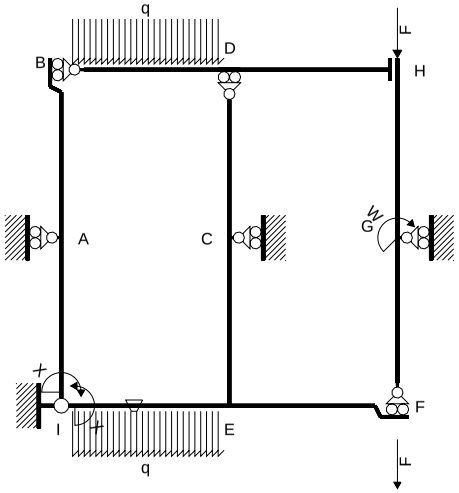
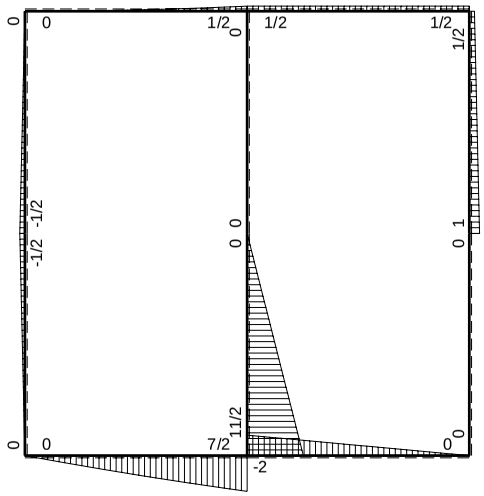
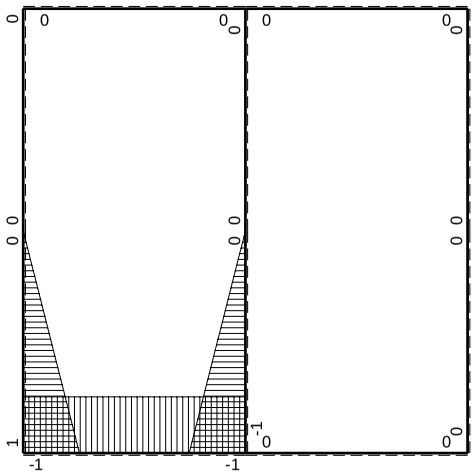
0 1
33/20
37/20
77/20
0
-33/20
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 987283 CI07.xxxx.058

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PROCEDIMENTO E RISULTATI 987283 CI07.xxxx.058

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	Fb-1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fb-1/2Fx	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$4Fx-1/2qx^2$	-Fb/EJ	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	-1+x/b	11/2Fb-11/2Fx	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-11/2Fx	0	$-11/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-11/4Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						33/20Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-4\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-7/2 + 3\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx$

$= [-7/2\ x + 3/2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-7/2\ b + 3/2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-11/2 + 11\ x/b - 11/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-11/2\ x + 11/2\ x^2/b - 11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-11/2\ b + 11/2\ b - 11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-11/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

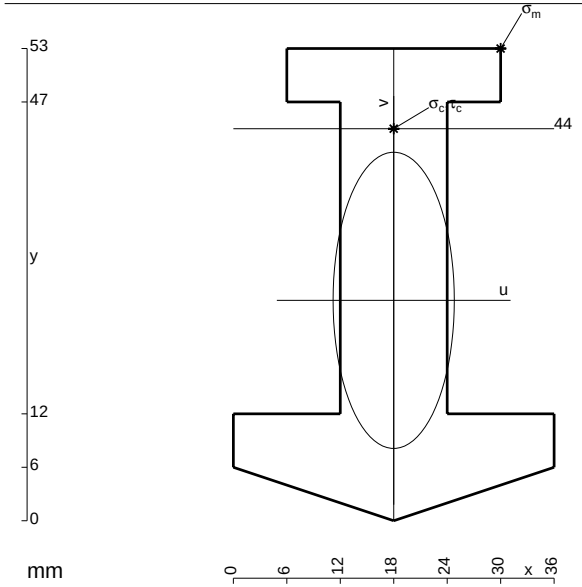
$L_{IA}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

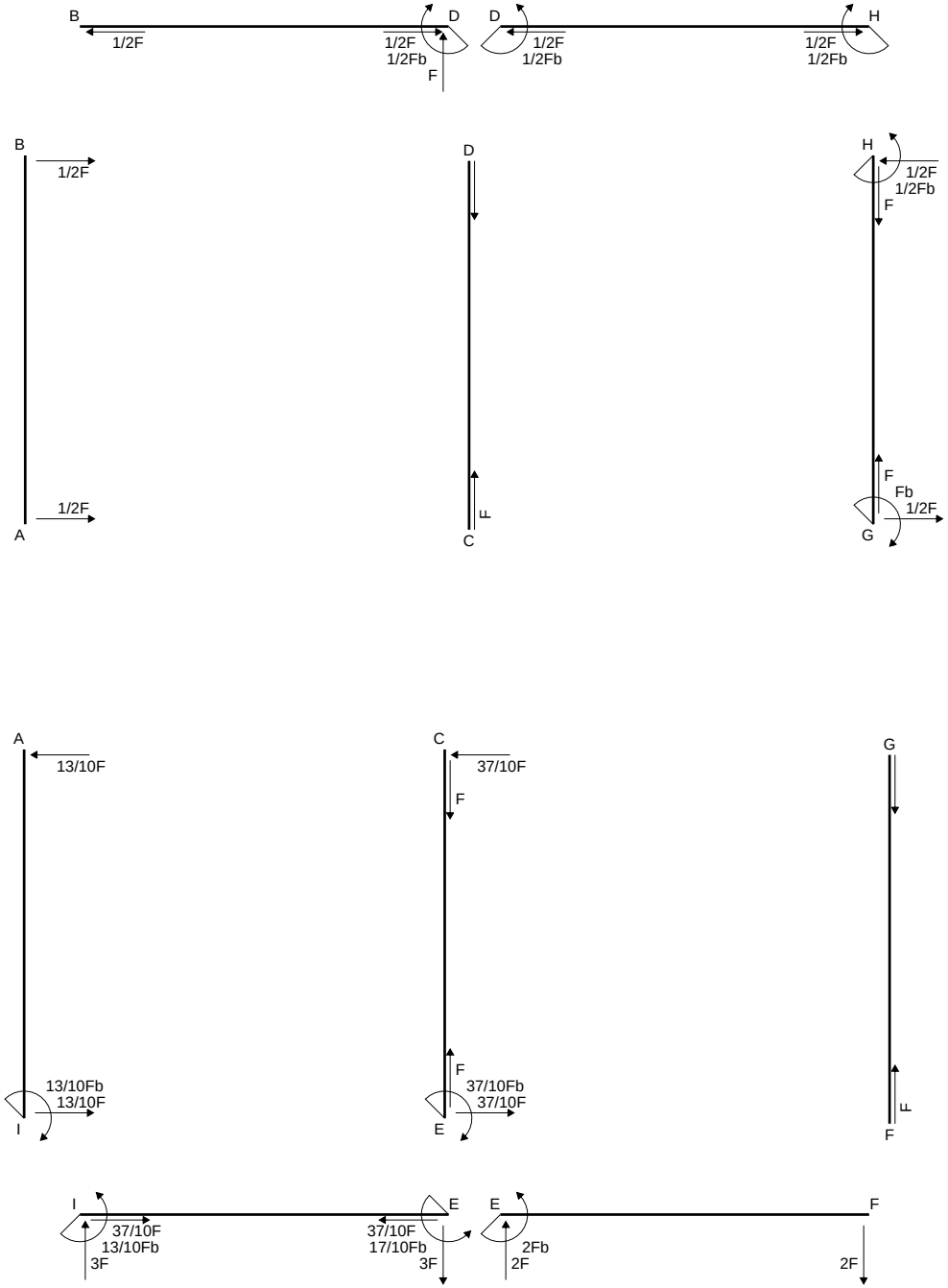
$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 987283 CI07.xxxx.058



A = 888. mm^2
J_u = 245538. mm^4
J_v = 41112. mm^4
y_g = 24.74 mm
T_y = 2100. N
M_x = -1995000. Nmm
x_m = 30. mm
y_m = 53. mm
u_m = 12. mm
v_m = 28.26 mm
$\sigma_m = -Mv/J_u$ = 229.6 N/mm^2
x_c = 18. mm
y_c = 44. mm
v_c = 19.26 mm
$\sigma_c = -Mv/J_u$ = 156.5 N/mm^2
τ_c = 3.126 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 156.6 N/mm^2
S^* = 4385. mm^3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13/10Fb
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37/10Fb
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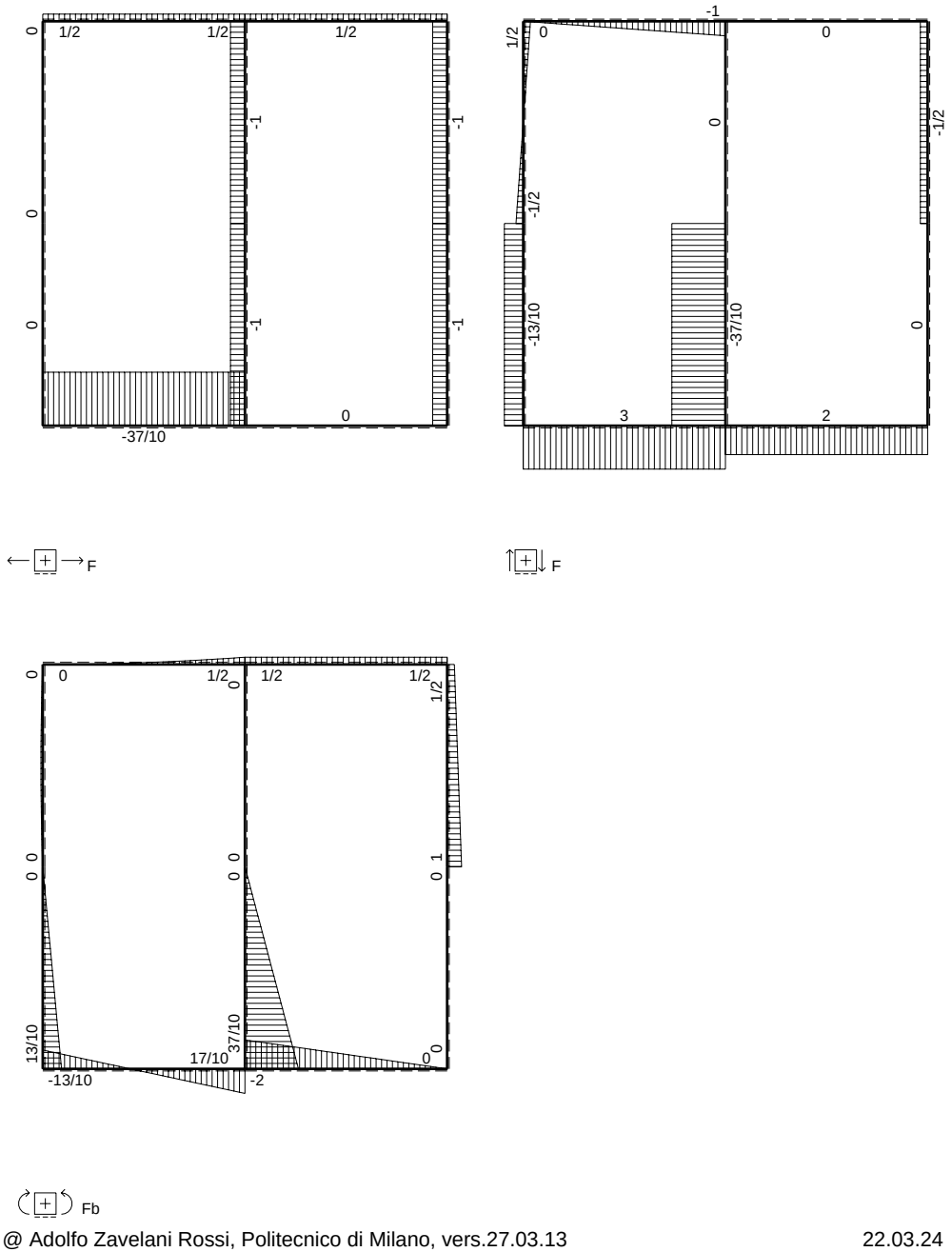
37/10F
17/10Fb
3F
2Fb
2F
2F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-13/10
-37/10
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13/10
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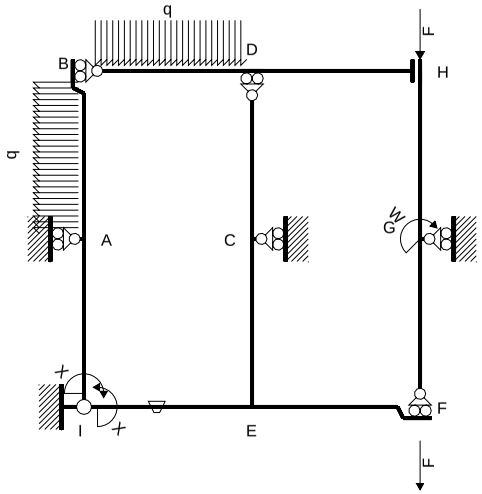
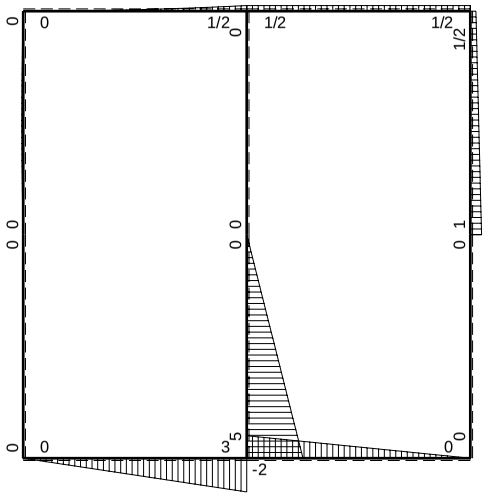
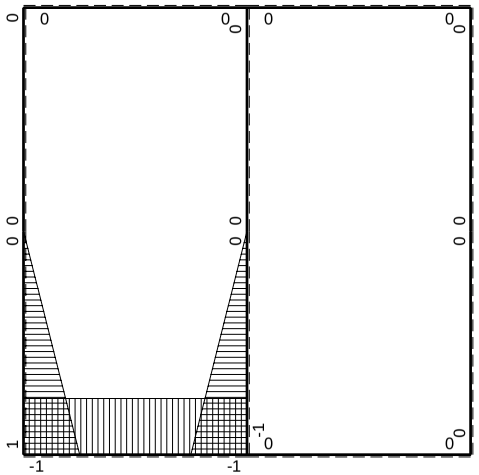
-13/10
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 992702 CI07.xxxx.059

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	Fb-1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fb-1/2Fx	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-5Fx	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-5Fx	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	1/3Xb/EJ
AI b	-x/b	0	0	0	0	x^2/b^2		
	totali						$-13/6Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						13/10Fb	

PROCEDIMENTO E RISULTATI 992702 CI07.xxxx.059

Sviluppi di calcolo iperstatica

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

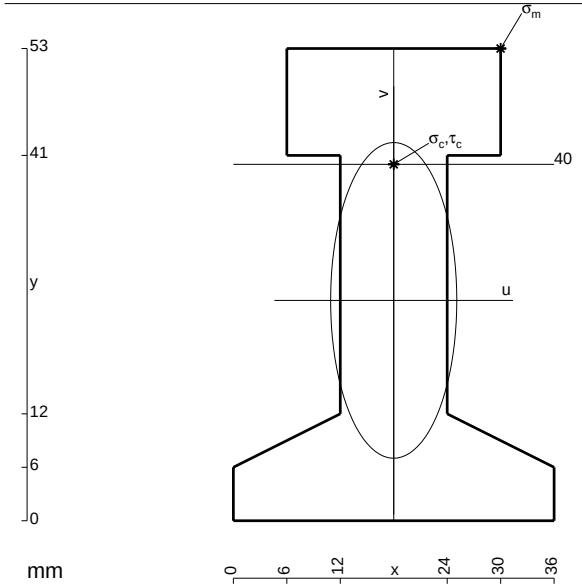
$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

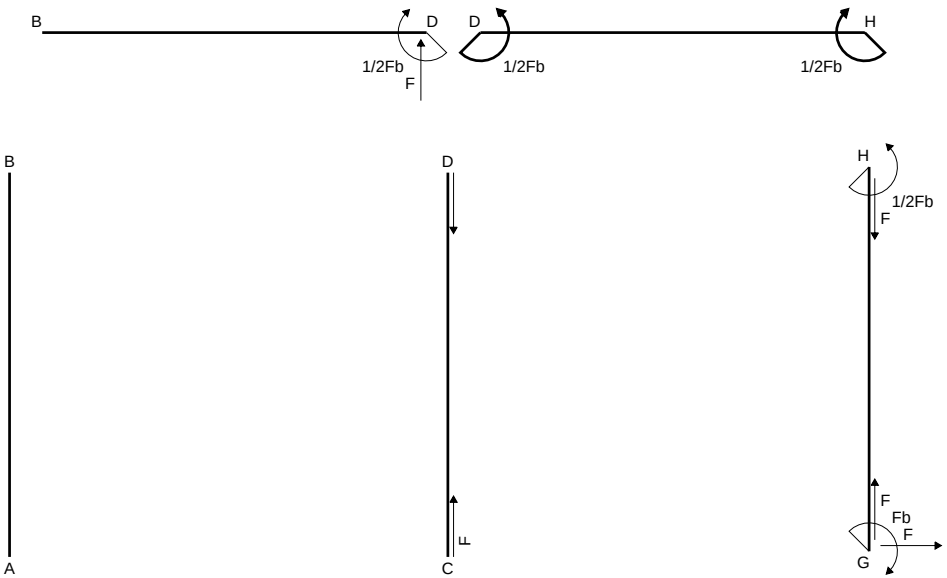
$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$



A = 996. mm^2
J_u = 312739. mm^4
J_v = 49968. mm^4
y_g = 24.73 mm
T_y = 2640. N
M_x = -2640000. Nmm
x_m = 30. mm
y_m = 53. mm
u_m = 12. mm
v_m = 28.27 mm
$\sigma_m = -Mv/J_u$ = 238.7 N/mm^2
x_c = 18. mm
y_c = 40. mm
v_c = 15.27 mm
$\sigma_c = -Mv/J_u$ = 128.9 N/mm^2
τ_c = 4.645 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 129.2 N/mm^2
S^* = 6603. mm^3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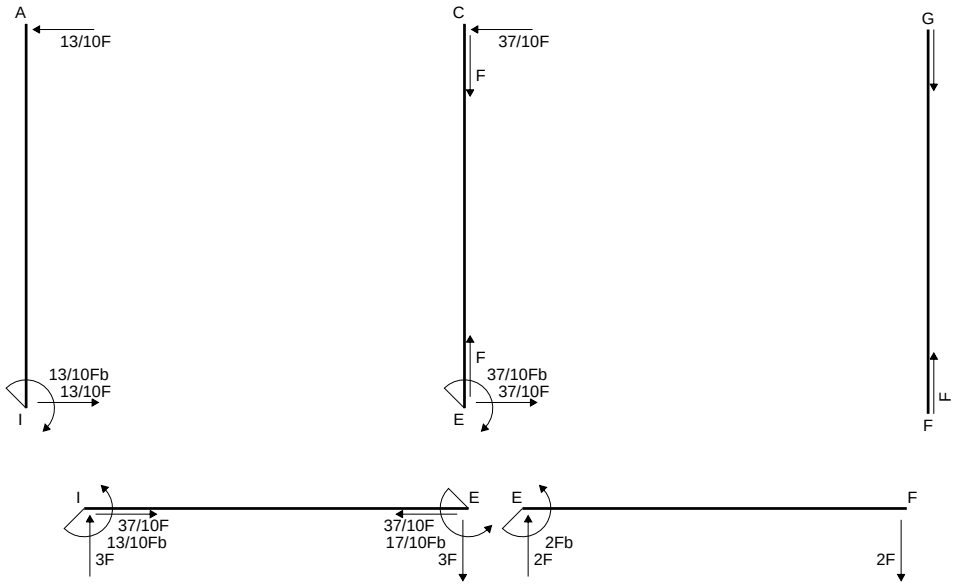
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13/10Fb
13/10F
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37/10Fb
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G
F
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I
E
E
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37/10F
13/10Fb
3F
37/10F
17/10Fb
3F
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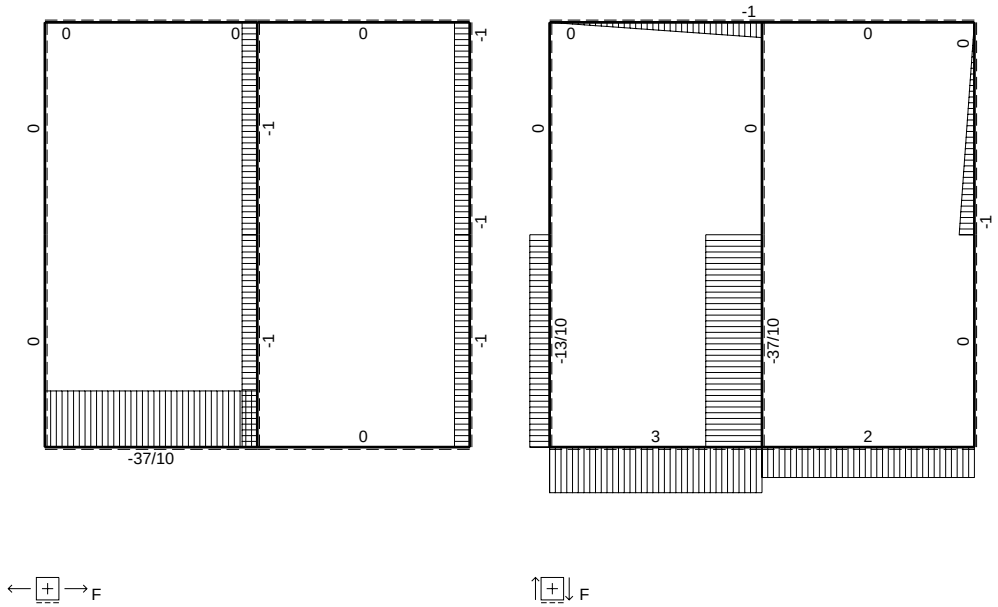
2F
2F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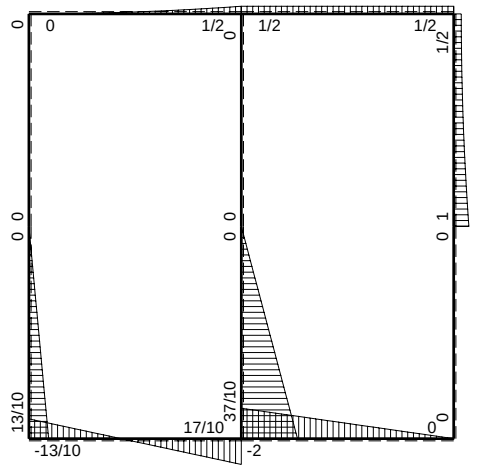
F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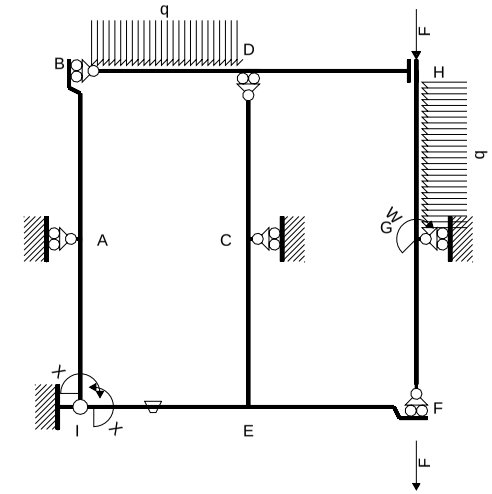
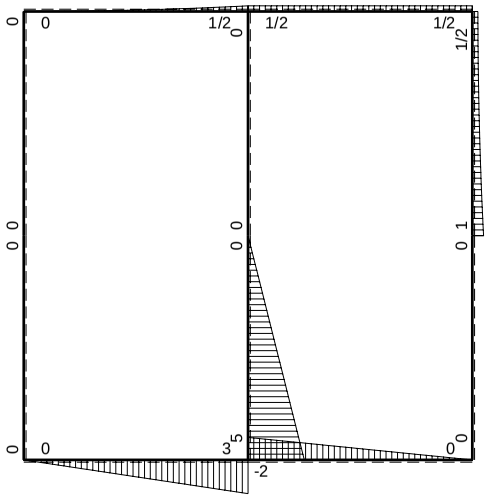
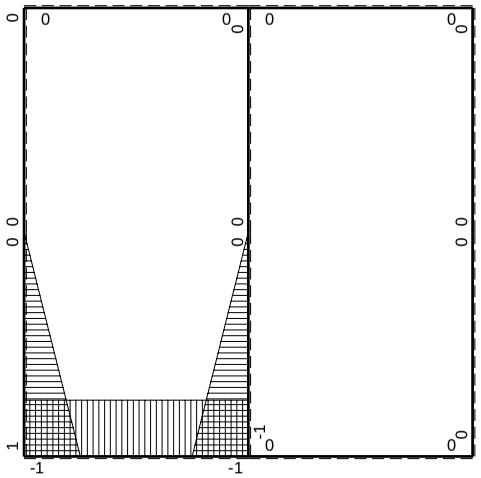


Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 215079 CI07.xxxx.060

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb-1/2qx^2$	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-5Fx	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-5Fx	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	1/3Xb/EJ
AI b	-x/b	0	0	0	0	x^2/b^2		
	totali						$-13/6Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						13/10Fb	

PROCEDIMENTO E RISULTATI 215079 CI07.xxxx.060

Sviluppi di calcolo iperstatica

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

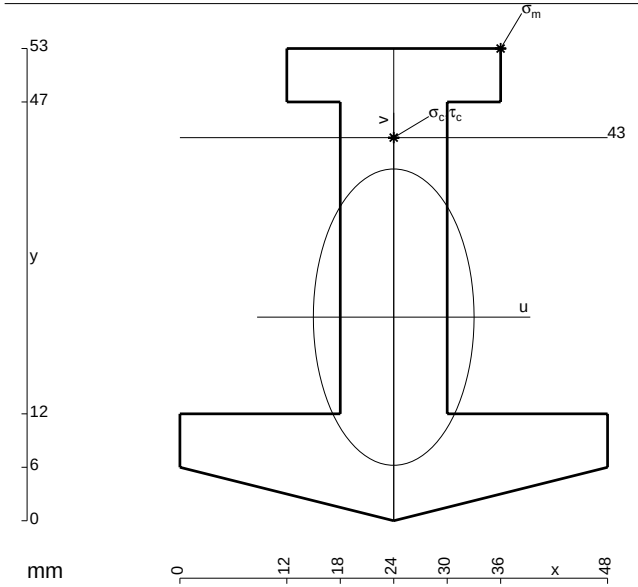
$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

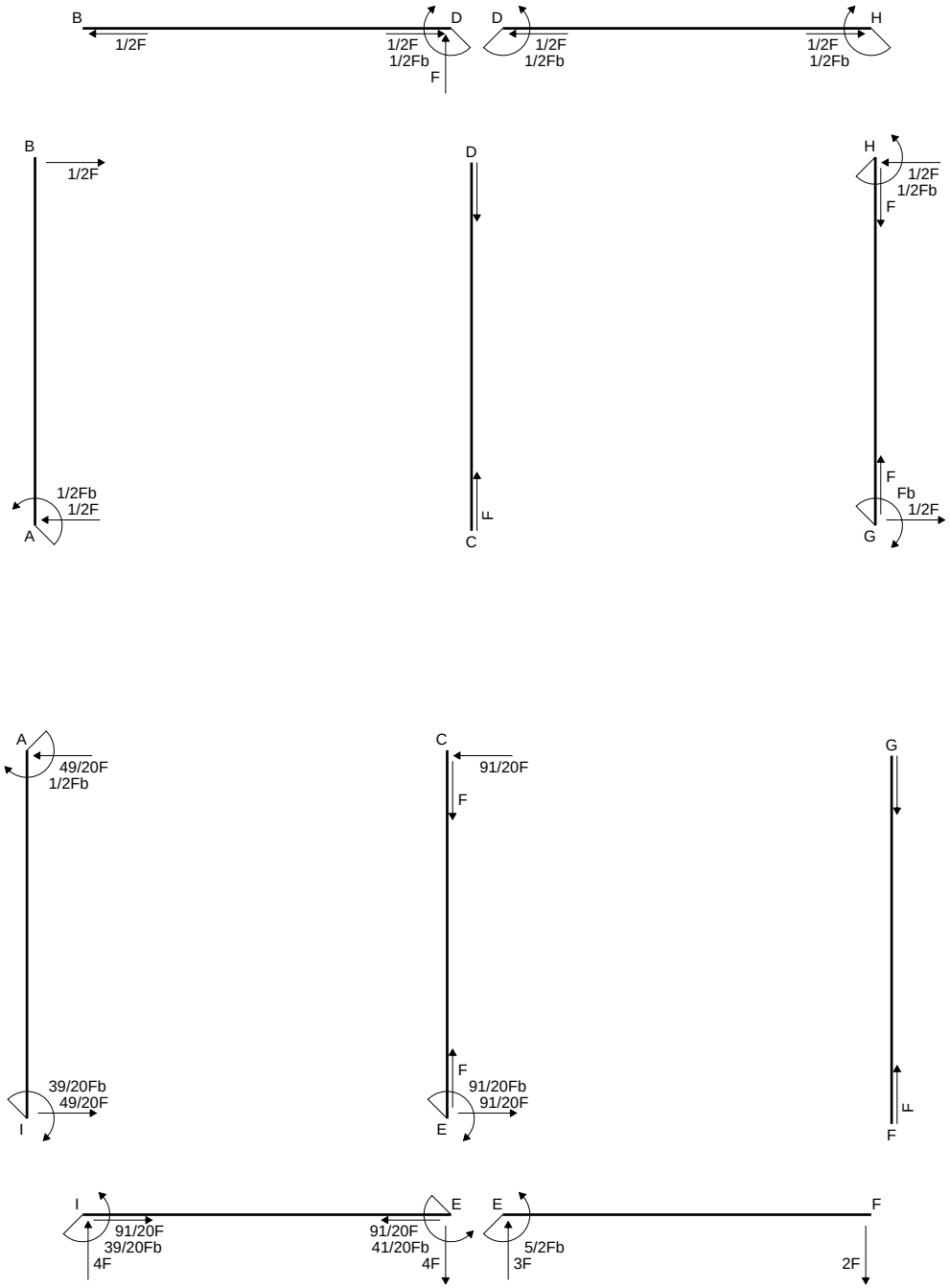
$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$



A = 996. mm^2
J_u = 275589. mm^4
J_v = 81072. mm^4
y_g = 22.85 mm
T_y = 3440. N
M_x = -1823200. Nmm
x_m = 36. mm
y_m = 53. mm
u_m = 12. mm
v_m = 30.15 mm
$\sigma_m = -Mv/J_u$ = 199.5 N/mm^2
x_c = 24. mm
y_c = 43. mm
v_c = 20.15 mm
$\sigma_c = -Mv/J_u$ = 133.3 N/mm^2
τ_c = 5.173 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 133.6 N/mm^2
S^* = 4973. mm^3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91/20F
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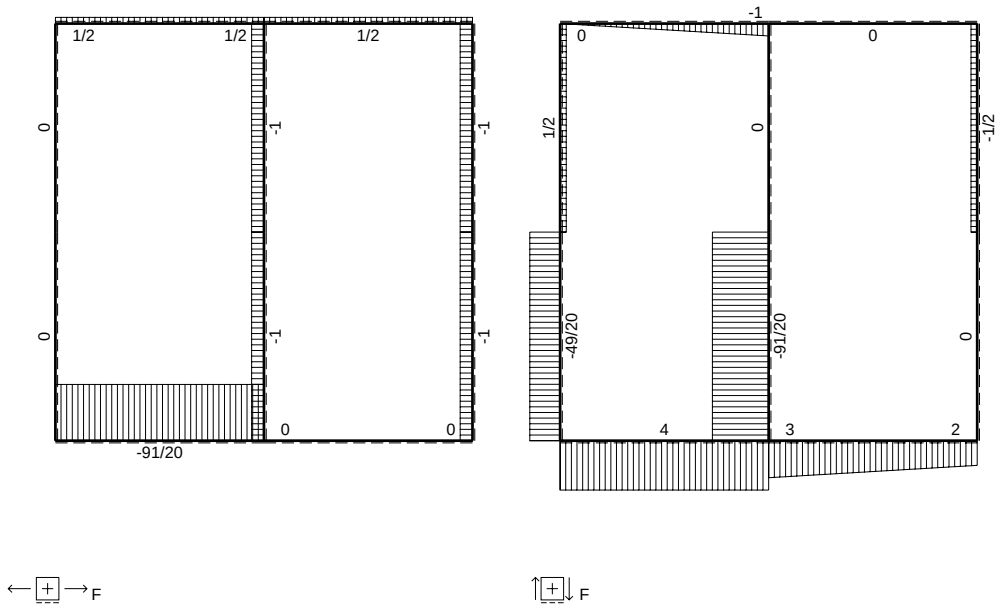
E
F
91/20F
39/20Fb
4F
91/20F
41/20Fb
4F
5/2Fb
3F
2F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1/2
1/2
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-1
-1
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-1
-1
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0
-91/20
-1
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1/2
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-49/20
-91/20
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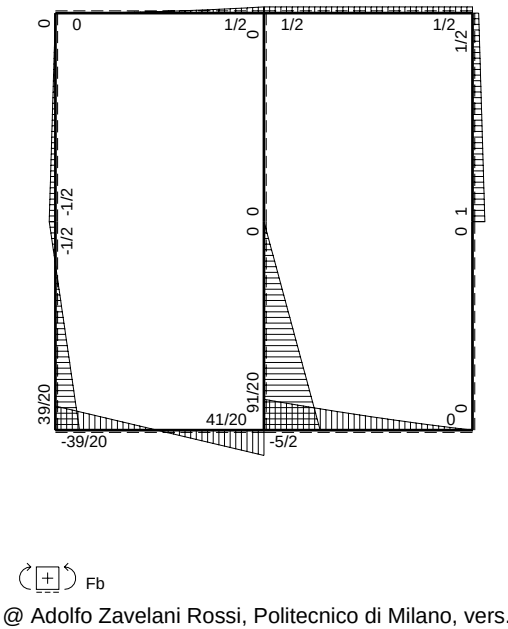
F
F


0
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1/2
1/2
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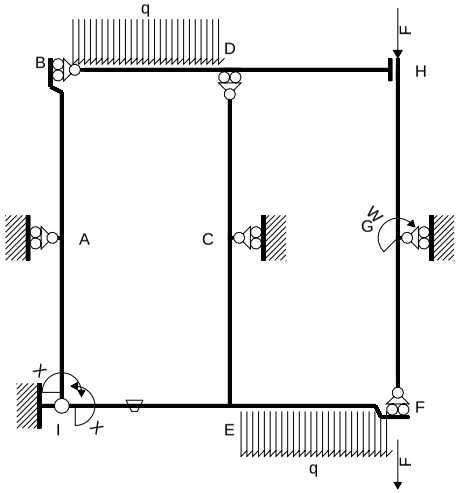
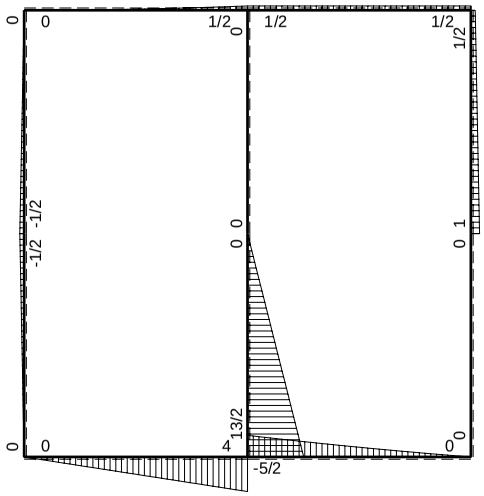
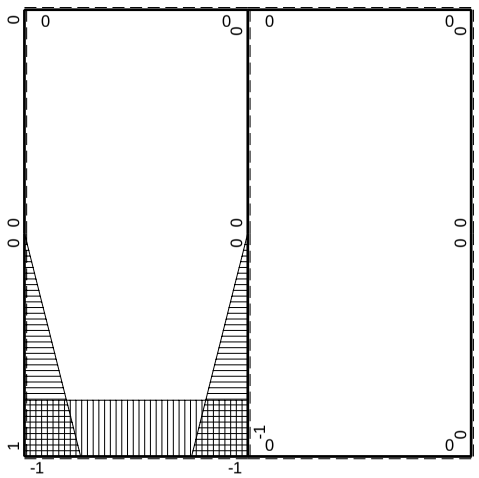
-1/2 -1/2
0 0
0 1
39/20
-39/20
41/20
91/20
0 0
-5/2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 212399 CI07.xxxx.061

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PROCEDIMENTO E RISULTATI 212399 CI07.xxxx.061

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-5/2Fb+3Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$2Fx+1/2qx^2$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	Fb-1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fb-1/2Fx	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	4Fx	-Fb/EJ	-4Fx	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-4Fb+4Fx	Fb/EJ	-4Fb+4Fx	Fb/EJ	1		
EC b	-1+x/b	13/2Fb-13/2Fx	0	$-13/2Fb+13Fx-13/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-13/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-13/2Fx	0	$-13/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-13/4Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						39/20Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-4 + 4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-4\ x + 2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-4\ b + 2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-13/2 + 13\ x/b - 13/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-13/2\ x + 13/2\ x^2/b - 13/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-13/2\ b + 13/2\ b - 13/6\ b\ )\ Fb\ 1/EJ\ = -13/6\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-13/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-13/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

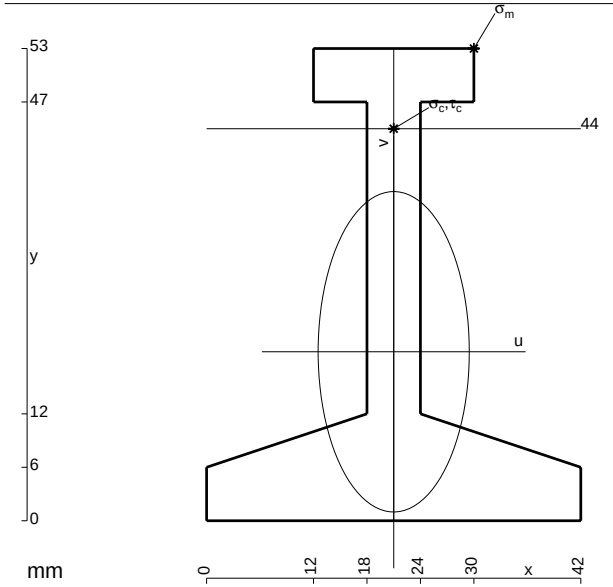
$= (-13/6\ b\ )\ Fb\ 1/EJ\ = -13/6\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

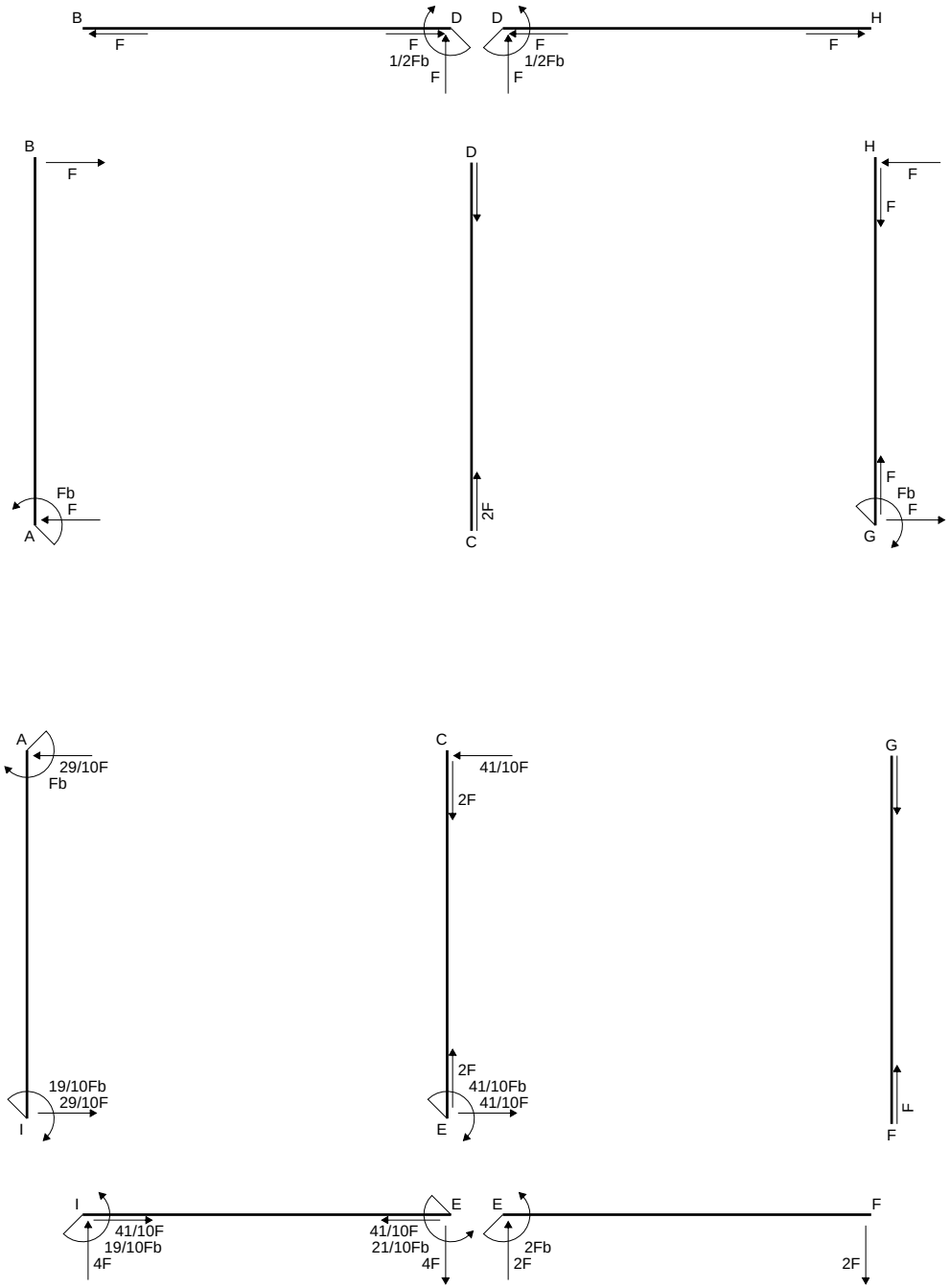
$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$



A = 714. mm^2
J_u = 230961. mm^4
J_v = 51390. mm^4
y_g = 18.96 mm
T_y = 2940. N
M_x = -1421000. Nmm
x_m = 30. mm
y_m = 53. mm
u_m = 9. mm
v_m = 34.04 mm
$\sigma_m = -Mv/J_u$ = 209.4 N/mm^2
x_c = 21. mm
y_c = 44. mm
v_c = 25.04 mm
$\sigma_c = -Mv/J_u$ = 154. N/mm^2
τ_c = 8.125 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 154.7 N/mm^2
S^* = 3830. mm^3


B
D
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1/2Fb
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Fb
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29/10F
I
C
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2F
2F
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E
G
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41/10F
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2F
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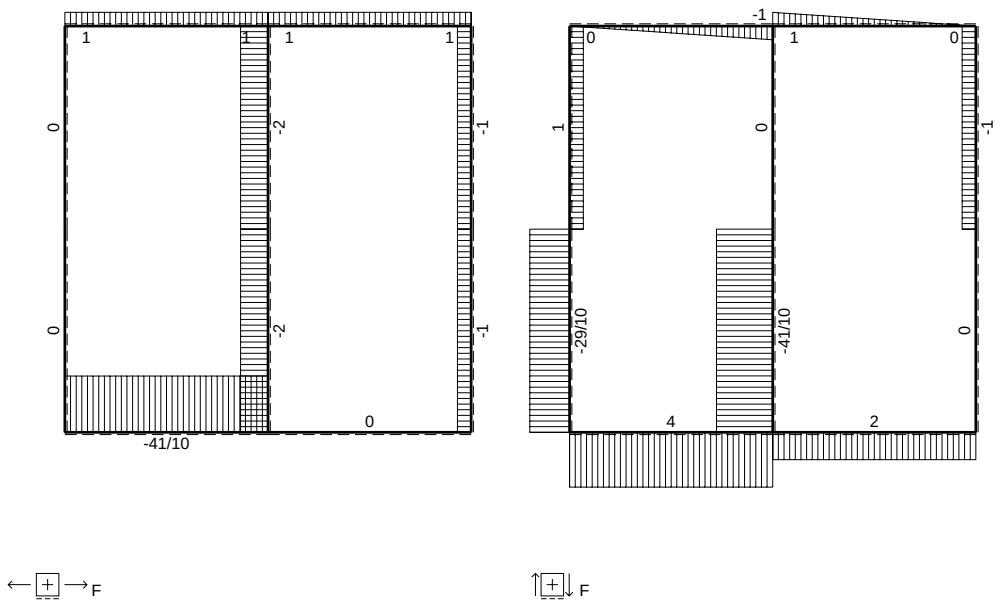
2F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-1
-29/10
-41/10
0
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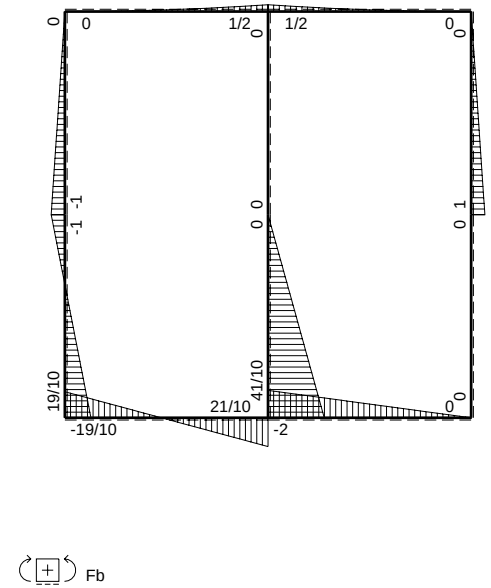
2
F
F


0
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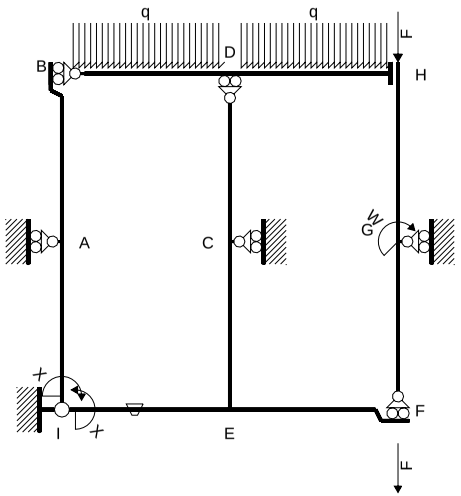
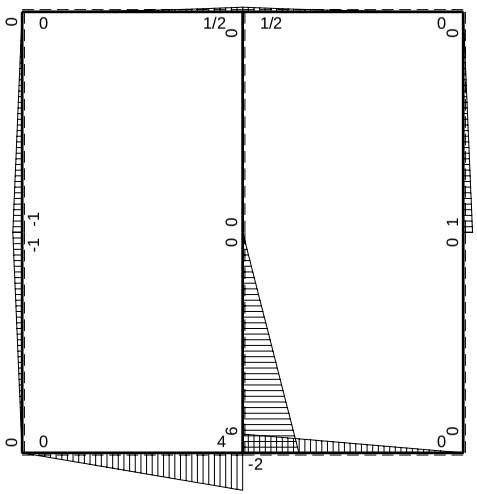
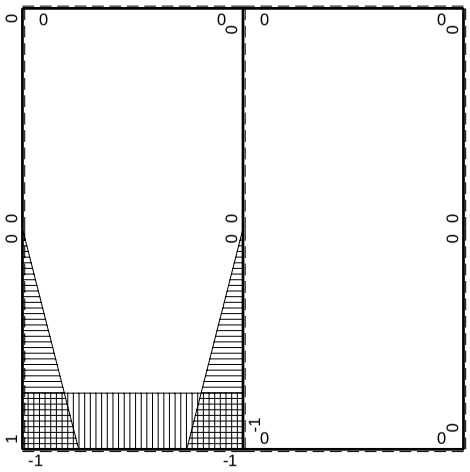
0
0
1
19/10
41/10
21/10
0
-19/10
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 987804 CI07.xxxx.062

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PROCEDIMENTO E RISULTATI 987804 CI07.xxxx.062

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	Fb-Fx	0	0	0	0	0+0	0
HG b	0	-Fx	0	0	0	0		
HD b	0	$1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	4Fx	-Fb/EJ	-4Fx	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-4Fb+4Fx	Fb/EJ	-4Fb+4Fx	Fb/EJ	1		
EC b	-1+x/b	6Fb-6Fx	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-6Fx	0	$-6Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-Fx	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	Fb-Fx	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-19/6Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						19/10Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-4 + 4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-4\ x + 2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-4\ b + 2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-6 + 12\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-6\ x + 6\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-6\ b + 6\ b - 2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

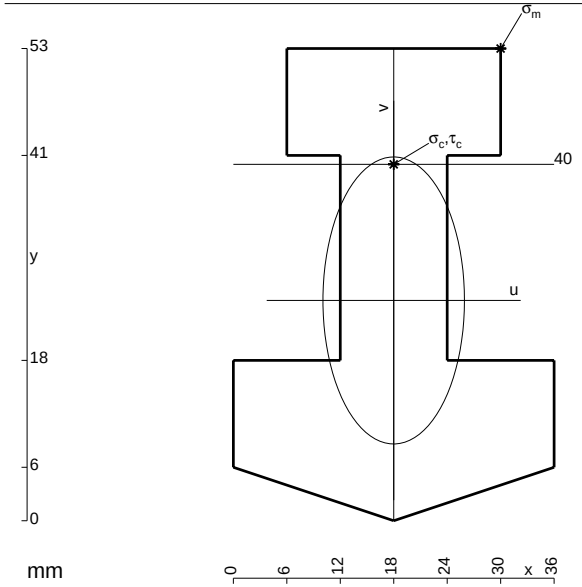
$= (-2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

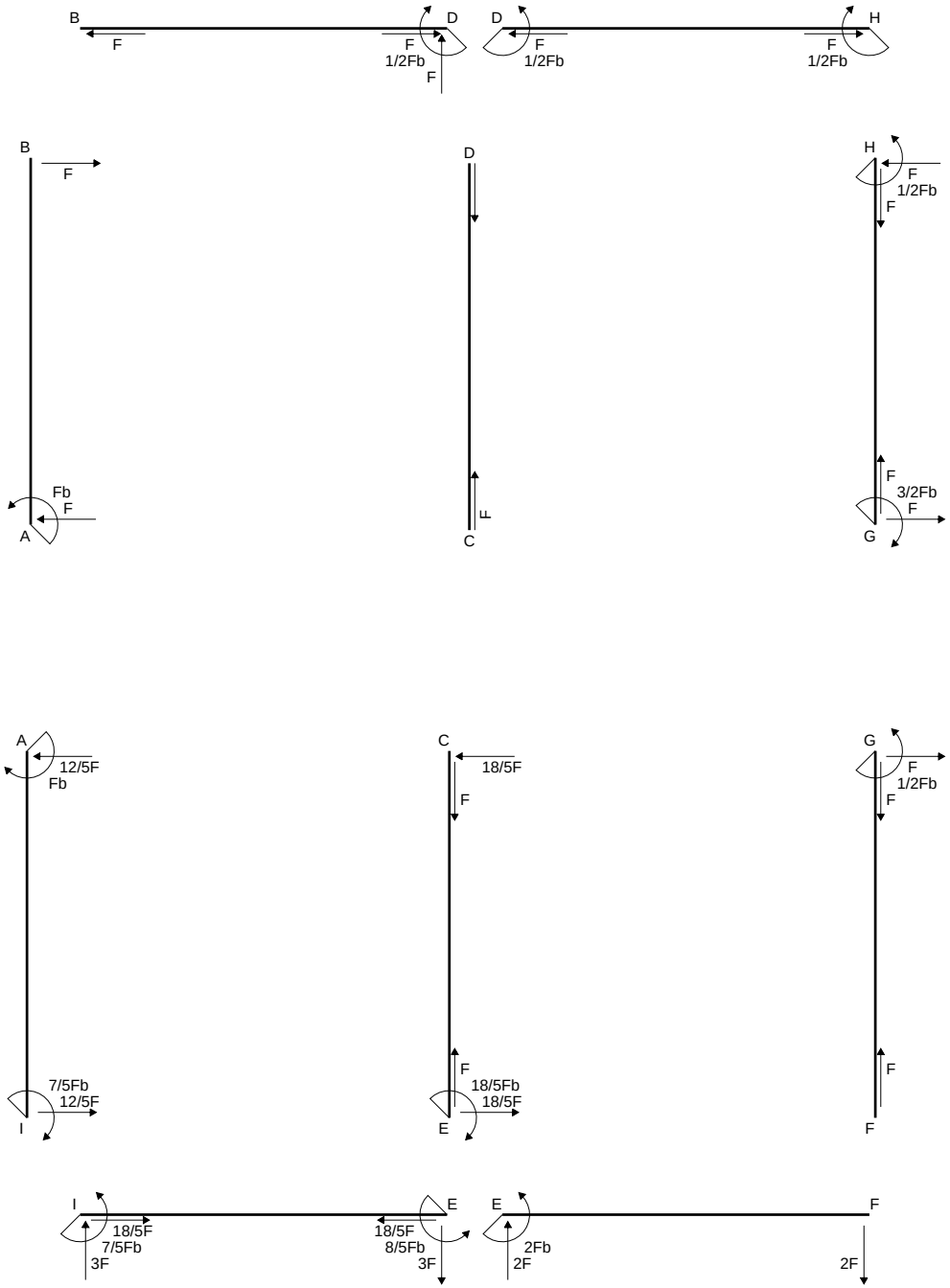
$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$



A = 1104. mm^2
J_u = 286555. mm^4
J_v = 69624. mm^4
y_g = 24.72 mm
T_y = 3520. N
M_x = -2217600. Nmm
x_m = 30. mm
y_m = 53. mm
u_m = 12. mm
v_m = 28.28 mm
$\sigma_m = -Mv/J_u$ = 218.8 N/mm^2
x_c = 18. mm
y_c = 40. mm
v_c = 15.28 mm
$\sigma_c = -Mv/J_u$ = 118.2 N/mm^2
τ_c = 6.761 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 118.8 N/mm^2
S^* = 6605. mm^3


B
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D
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H
F
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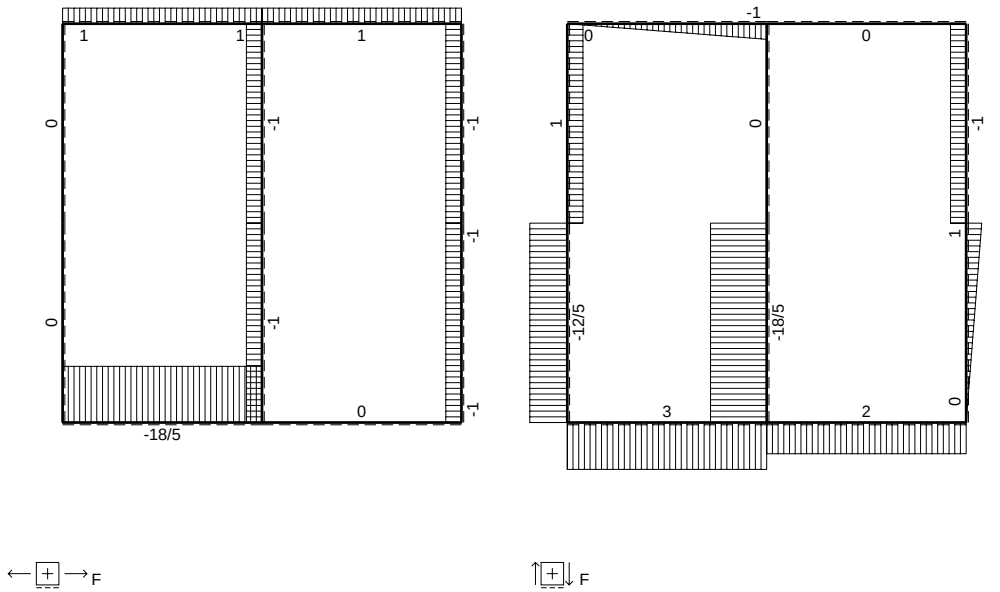
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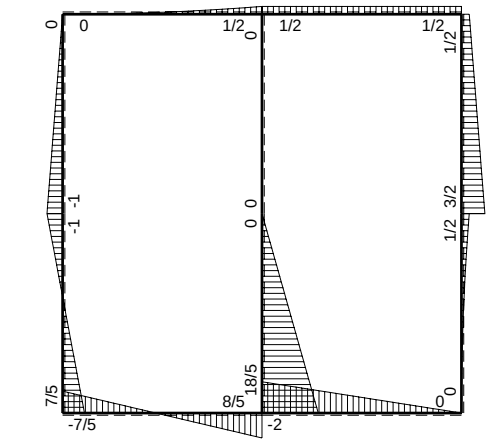
F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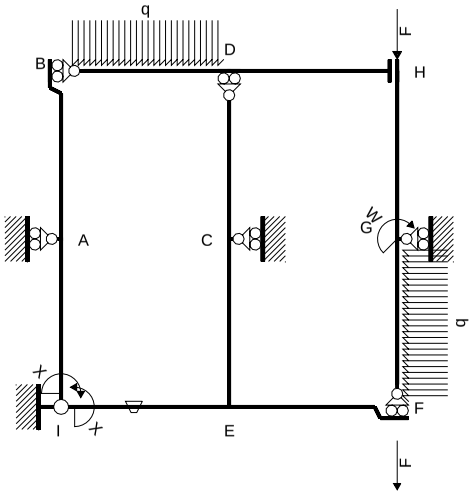
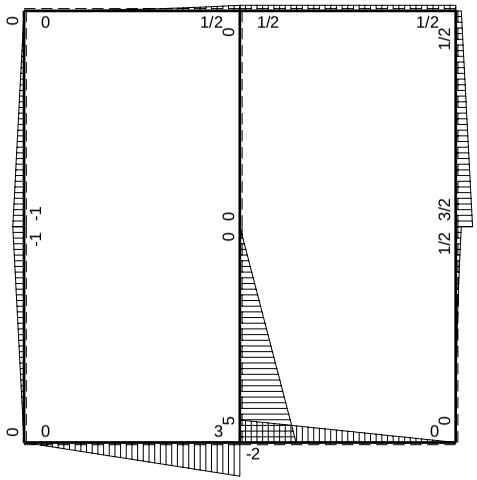
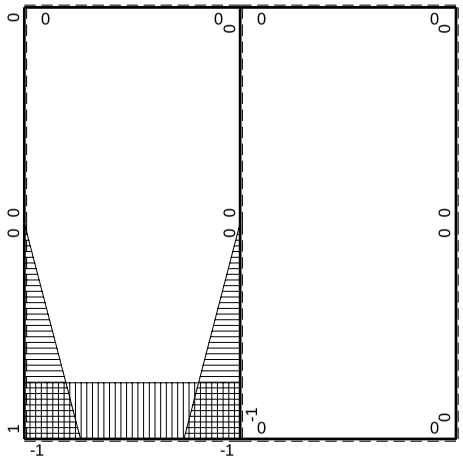
18/5
8/5
0
0
-7/5
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 986373 CI07.xxxx.063

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	3/2Fb-Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fb-Fx	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-5Fx	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-5Fx	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-Fx	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	Fb-Fx	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-7/3Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						7/5Fb	

Sviluppi di calcolo iperstatica

PROCEDIMENTO E RISULTATI 986373 CI07.xxxx.063
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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

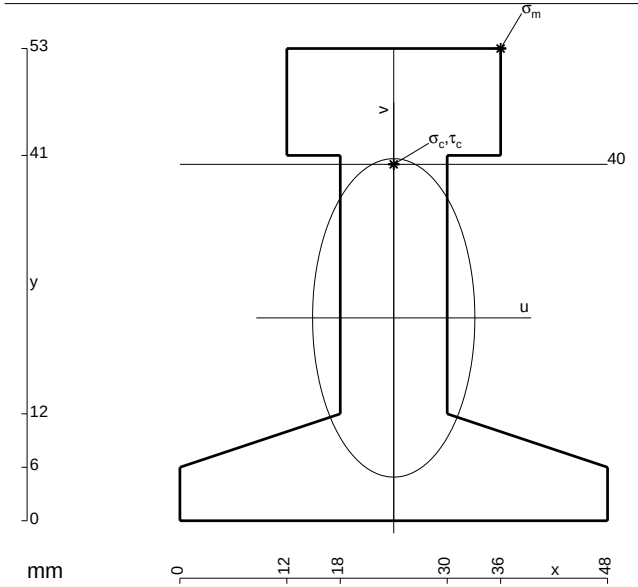
$L_{IA}^{Xo} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 986373 CI07.xxxx.063



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J_u = 352844. mm^4
J_v = 91656. mm^4
y_g = 22.77 mm
T_y = 3940. N
M_x = -2679200. Nmm
x_m = 36. mm
y_m = 53. mm
u_m = 12. mm
v_m = 30.23 mm
$\sigma_m = -Mv/J_u$ = 229.6 N/mm^2
x_c = 24. mm
y_c = 40. mm
v_c = 17.23 mm
$\sigma_c = -Mv/J_u$ = 130.9 N/mm^2
τ_c = 6.693 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 131.4 N/mm^2
S^* = 7192. mm^3

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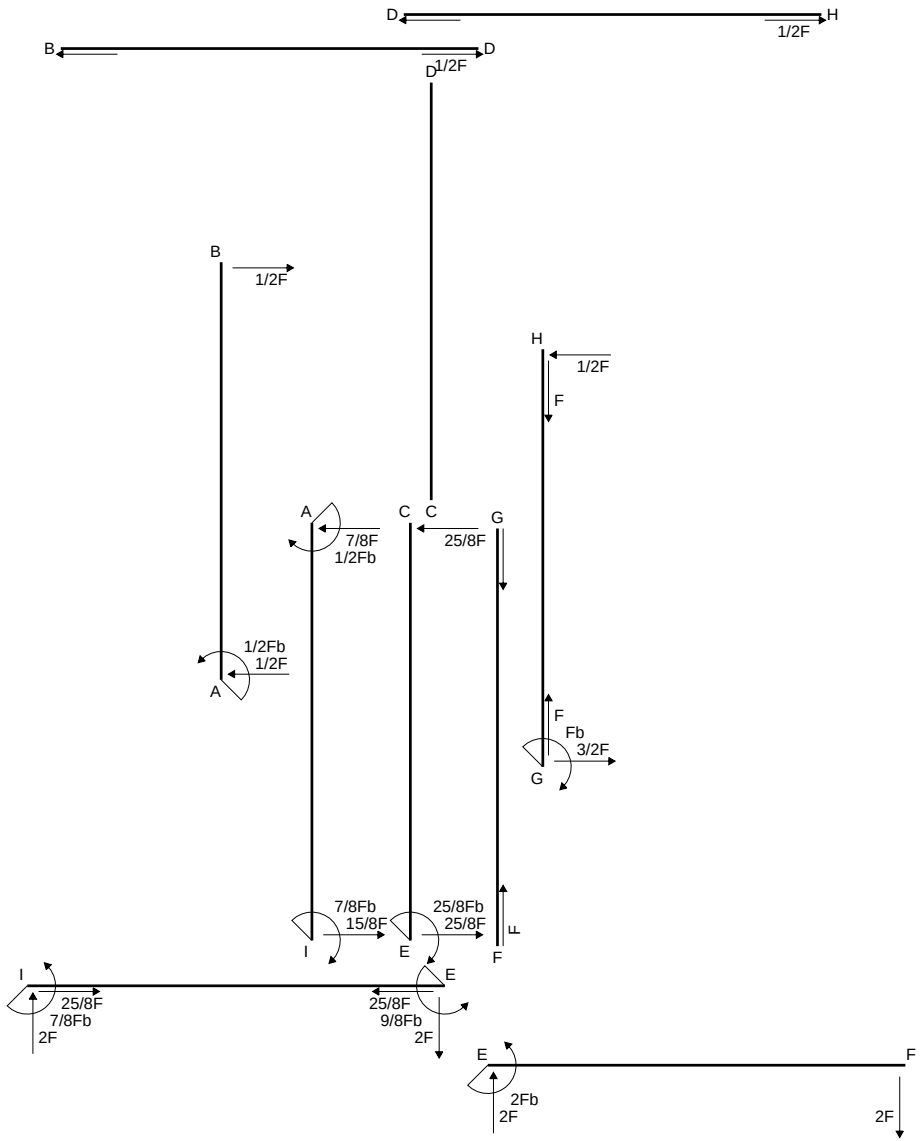
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A
C C
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25/8F
1/2Fb
1/2F
A
F
Fb
3/2F
G
7/8Fb
15/8F
25/8Fb
25/8F
I
E
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2F
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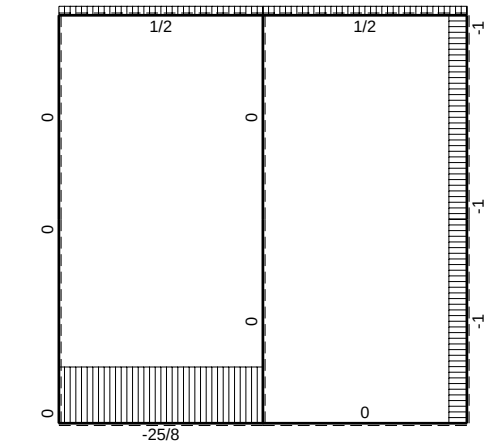
2Fb
2F
2F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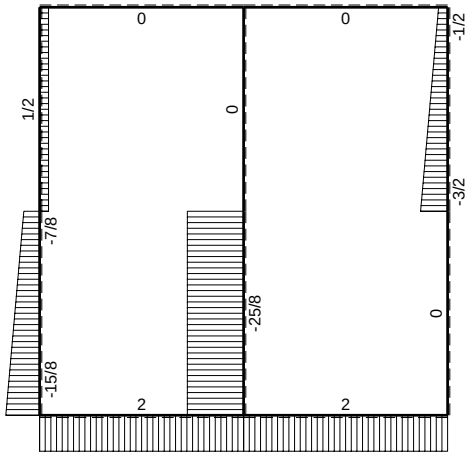
-25/8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1/2
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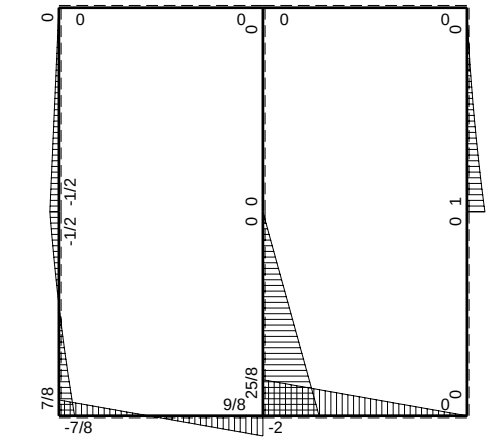
-3/2
-7/8
-25/8
-15/8
0
2
2

F

F


0
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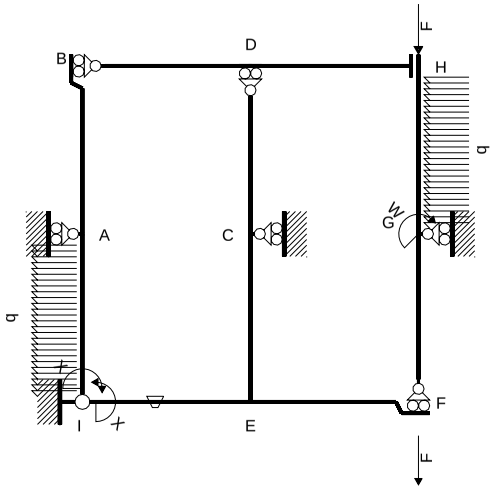
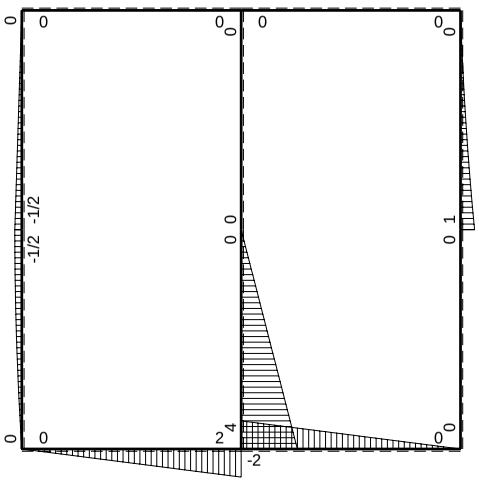
1
7/8
25/8
9/8
0
0
-7/8
-2

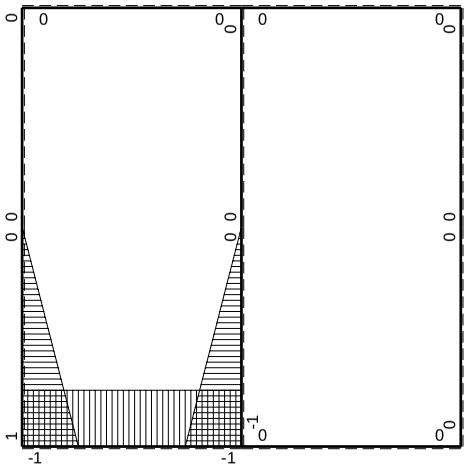
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 258140 CI07.xxxx.064

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PROCEDIMENTO E RISULTATI 258140 CI07.xxxx.064

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2Fx-1/2qx^2$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	-1+x/b	4Fb-4Fx	0	$-4Fb+8Fx-4Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-4/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-4Fx$	0	$-4Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	$-Fx+1/2qx^2$	0	$-Fx+3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-1/8+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	$1/2Fb-1/2qx^2$	0	$-1/2Fx+1/2qx^3/b$	0	x^2/b^2		
	totali						$-35/24Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						7/8Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L_{EI}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L_{EC}^{Xo} = \int_o^b (-4 + 8\ x/b - 4\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4\ x + 4\ x^2/b - 4/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-4\ b + 4\ b - 4/3\ b\ )\ Fb\ 1/EJ\ = -4/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-4\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-4/3\ b\ )\ Fb\ 1/EJ\ = -4/3\ Fb^2/EJ$

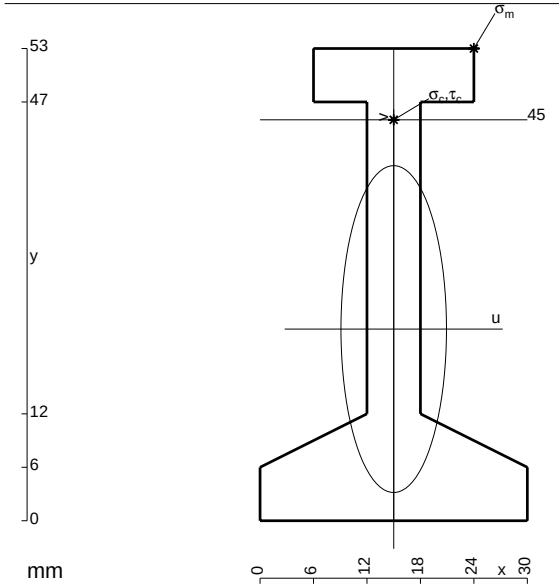
$L_{IA}^{Xo} = \int_o^b (-\ x/b + 3/2\ x^2/b^2 - 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/2\ x^3/b^2 - 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/2\ b - 1/8\ b\ )\ Fb\ 1/EJ\ = -1/8\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/8\ b\ )\ Fb\ 1/EJ\ = -1/8\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 258140 CI07.xxxx.064



A = 606. mm^2
J_u = 204068. mm^4
J_v = 21258. mm^4
y_g = 21.51 mm
T_y = 2100. N
M_x = -1554000. Nmm
x_m = 24. mm
y_m = 53. mm
u_m = 9. mm
v_m = 31.49 mm
$\sigma_m = -Mv/J_u$ = 239.8 N/mm^2
x_c = 15. mm
y_c = 45. mm
v_c = 23.49 mm
$\sigma_c = -Mv/J_u$ = 178.9 N/mm^2
τ_c = 5.781 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 179.2 N/mm^2
S^* = 3371. mm^3

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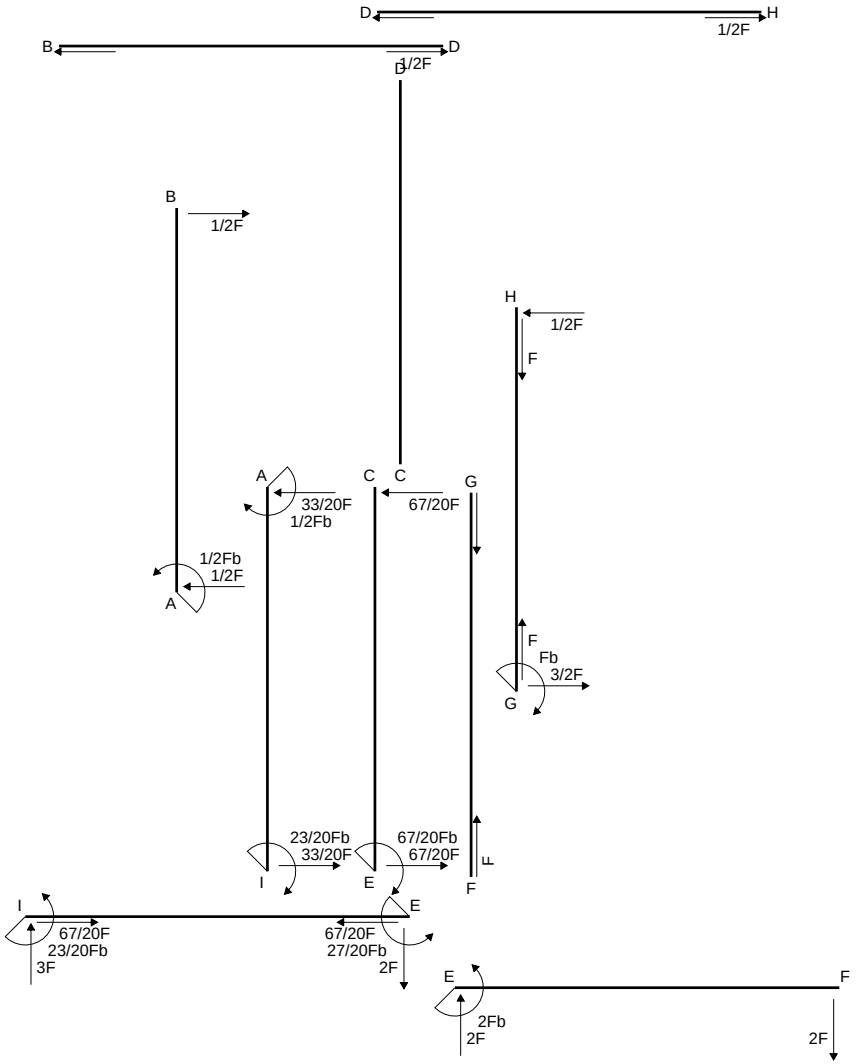
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1/2F
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A
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G
33/20F
1/2Fb
67/20F
1/2Fb
1/2F
A
F
Fb
3/2F
G
23/20Fb
33/20F
67/20Fb
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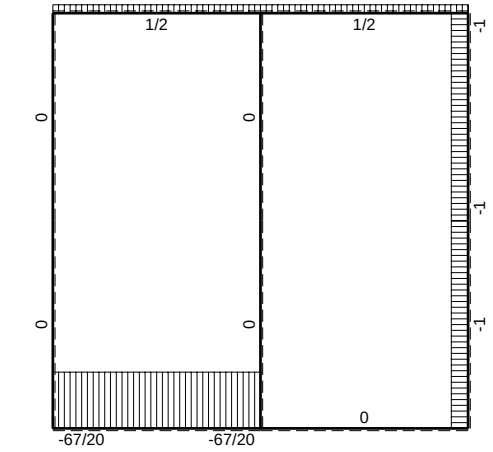
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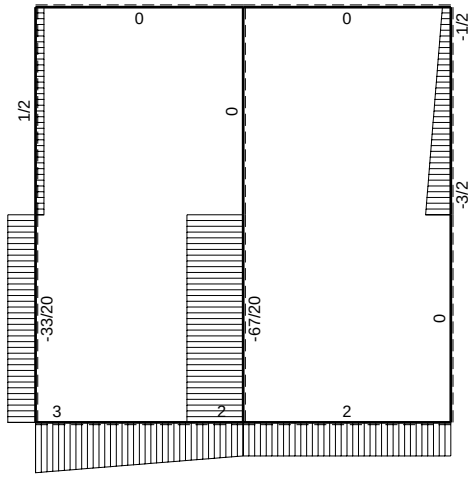
-67/20
-67/20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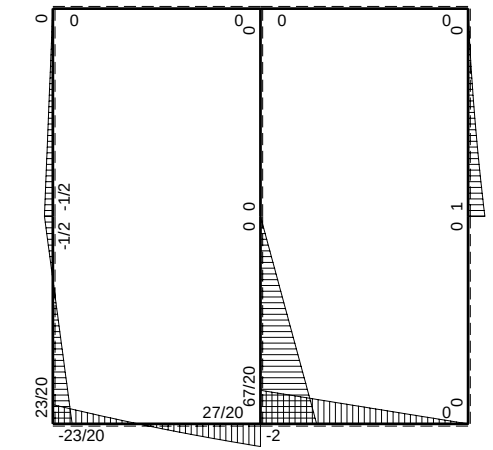
F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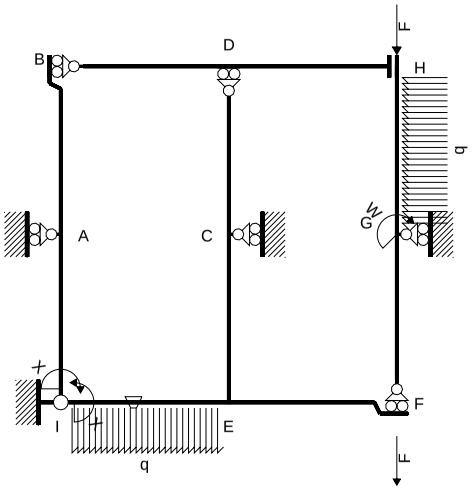
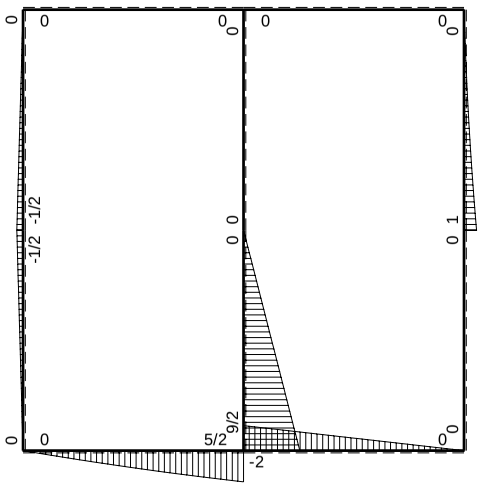
23/20
27/20
67/20
0
-23/20
-2

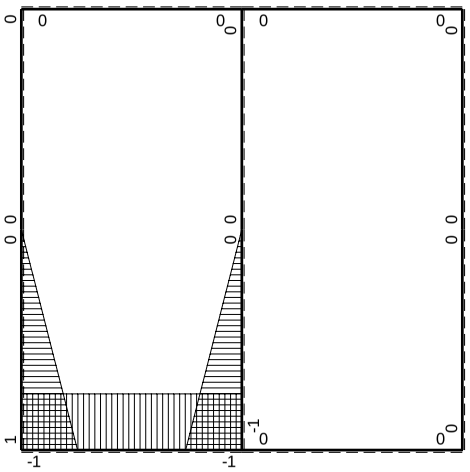
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 937400 CI07.xxxx.065

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PROCEDIMENTO E RISULTATI 937400 CI07.xxxx.065

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2Fx-1/2qx^2$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx-1/2qx^2$	-Fb/EJ	$-3Fx+1/2Fx^2/b$	Fb/EJ	1	$(-4/3+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-5/2Fb+2Fx+1/2qx^2$	Fb/EJ	$-5/2Fb+2Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	-1+x/b	9/2Fb-9/2Fx	0	$-9/2Fb+9Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-9/2Fx	0	$-9/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-23/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						23/20Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/3\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-5/2 + 2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx$

$= [-5/2\ x + x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-5/2\ b + b + 1/6\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/3\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-9/2 + 9\ x/b - 9/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-9/2\ x + 9/2\ x^2/b - 3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-9/2\ b + 9/2\ b - 3/2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-9/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

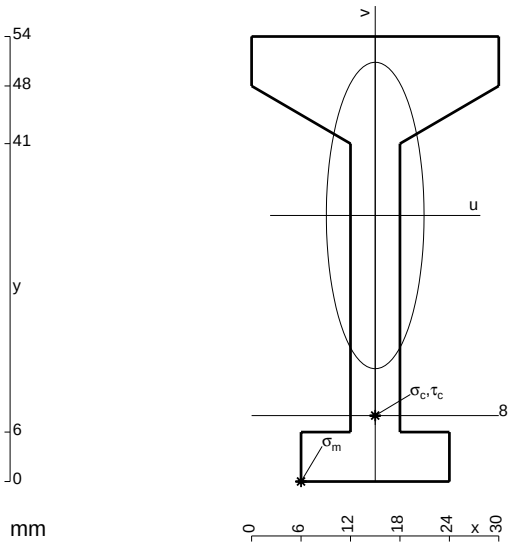
$= (-3/2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

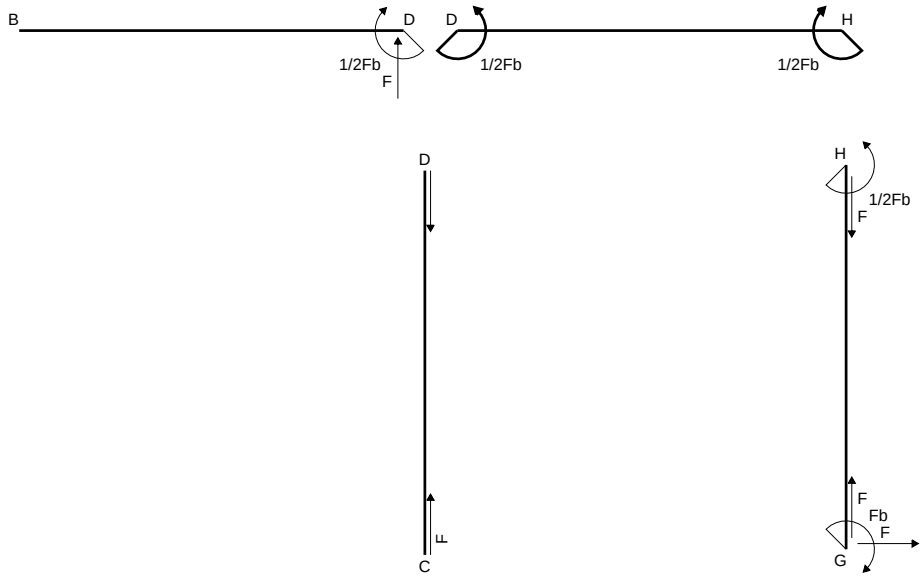
$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

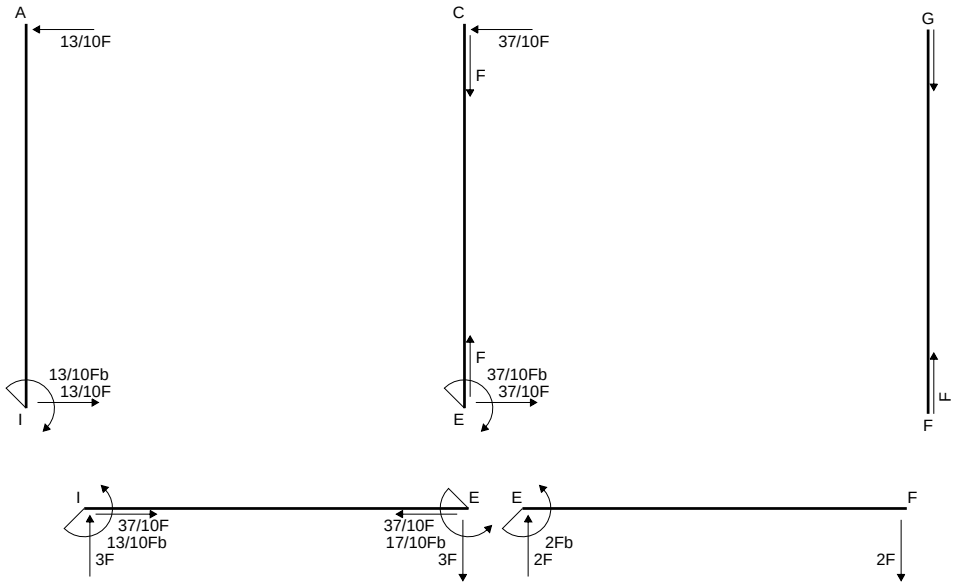
$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

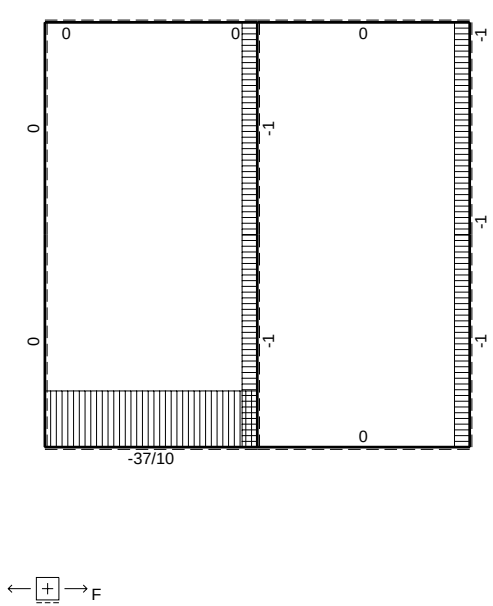
$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$



A = 624. mm^2
J_u = 215884. mm^4
J_v = 21960. mm^4
y_g = 32.28 mm
T_y = 1640. N
M_x = -1328400. Nmm
x_m = 6. mm
u_m = -9. mm
v_m = -32.28 mm
$\sigma_m = -Mv/J_u$ = -198.6 N/mm^2
x_c = 15. mm
y_c = 8. mm
v_c = -24.28 mm
$\sigma_c = -Mv/J_u$ = -149.4 N/mm^2
τ_c = 4.388 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 149.6 N/mm^2
S^* = 3466. mm^3


B
D
D
H
1/2Fb
F
1/2Fb
1/2Fb
B
D
H
1/2Fb
F
F
Fb
F
G
A
C


A
13/10F
13/10Fb
13/10F
I
C
37/10F
F
F
37/10Fb
37/10F
E
G
F
F
I
E
E
F
37/10F
13/10Fb
3F
37/10F
17/10Fb
3F
2Fb
2F
2F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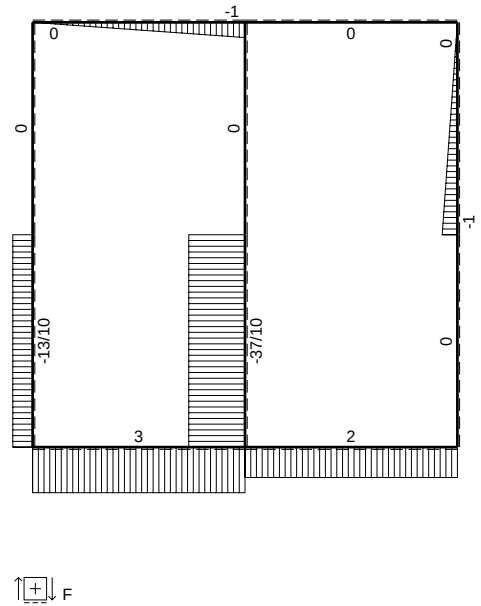
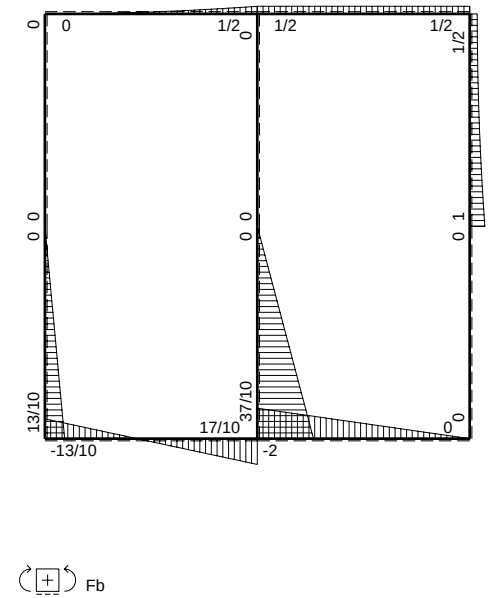
0
-1
-1
0
-1
-1
0
-37/10
F


-1
0
0
0
0
0
-1
-13/10
-37/10
0
3
2
F


0
0
1/2
1/2
1/2
1/2
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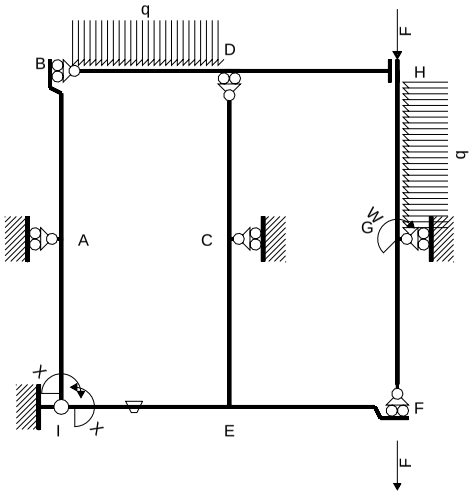
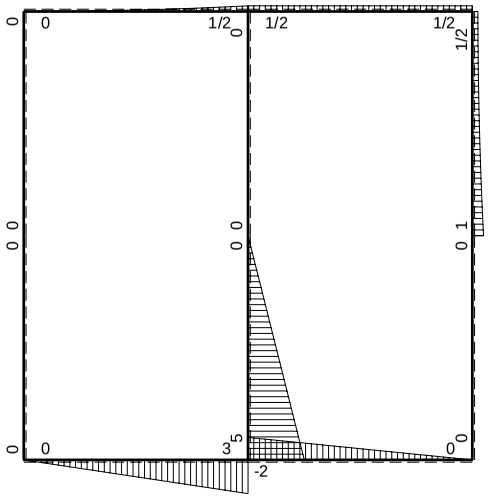
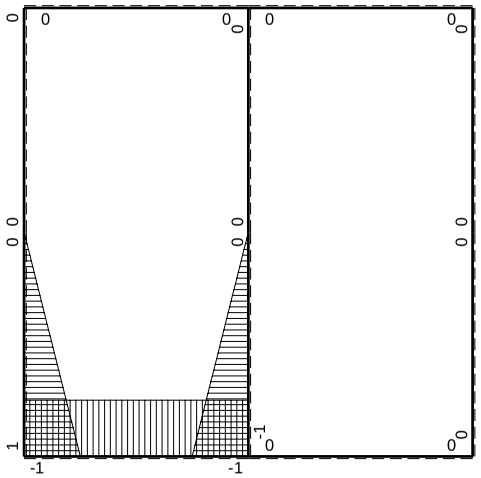
0 0
0 0
0 1
13/10
37/10
17/10
0
-13/10
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 981229 CI07.xxxx.066

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb-1/2qx^2$	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-5Fx	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-5Fx	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	1/3Xb/EJ
AI b	-x/b	0	0	0	0	x^2/b^2		
	totali						$-13/6Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						13/10Fb	

Sviluppi di calcolo iperstatica

PROCEDIMENTO E RISULTATI 981229 CI07.xxxx.066

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

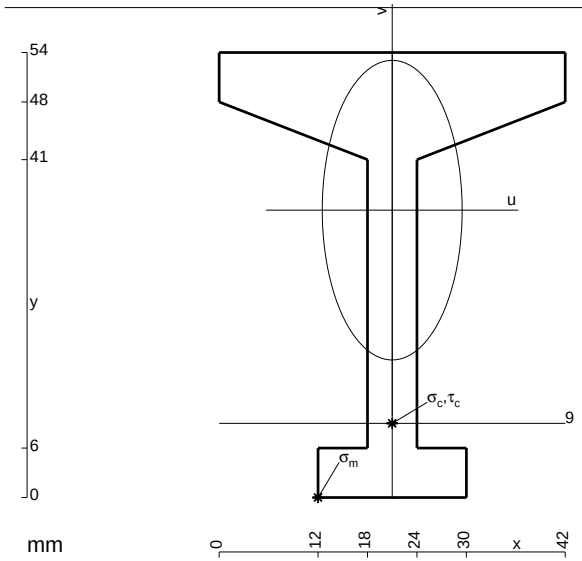
$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

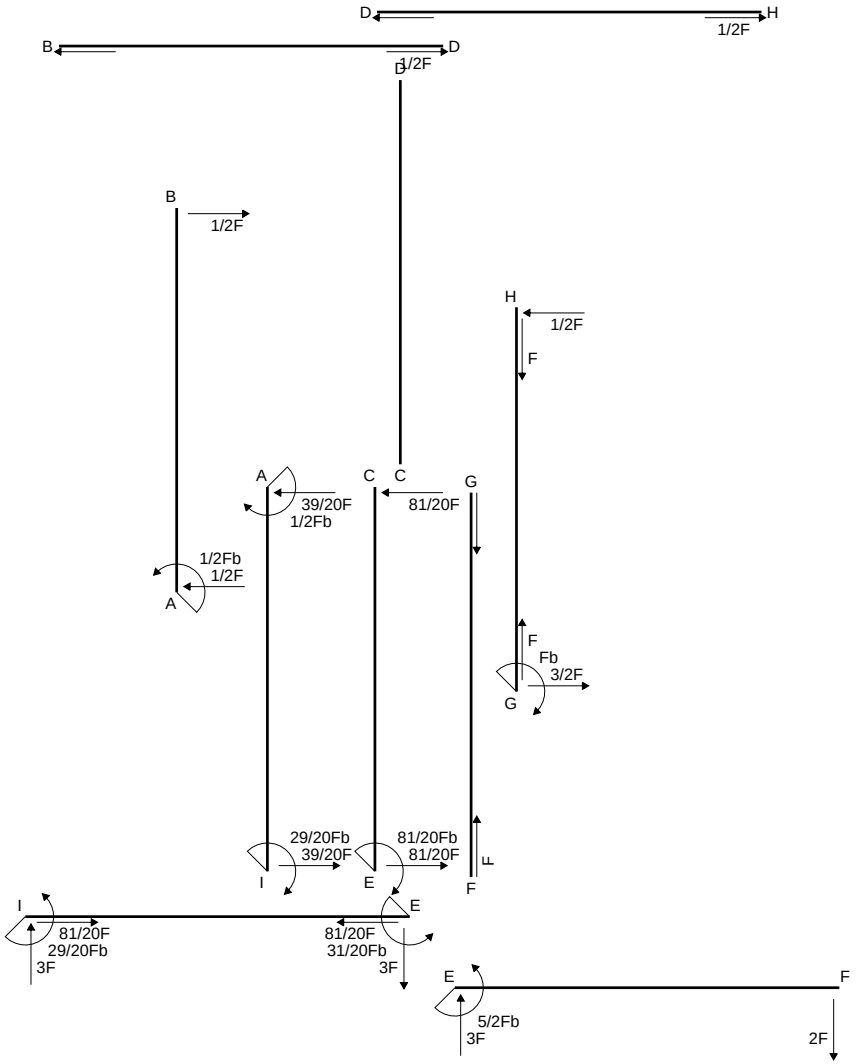
$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$



A = 738. mm^2
J_u = 244023. mm^4
J_v = 53190. mm^4
y_g = 34.87 mm
T_y = 1700. N
M_x = -1462000. Nmm
x_m = 12. mm
u_m = -9. mm
v_m = -34.87 mm
$\sigma_m = -Mv/J_u$ = -208.9 N/mm^2
x_c = 21. mm
y_c = 9. mm
v_c = -25.87 mm
$\sigma_c = -Mv/J_u$ = -155. N/mm^2
τ_c = 4.568 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 155.2 N/mm^2
S^* = 3935. mm^3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H
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B
D
1/2F
D
B
1/2F
H
1/2F
F
A
C
C
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1/2Fb
81/20F
1/2Fb
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Fb
3/2F
G
29/20Fb
39/20F
81/20Fb
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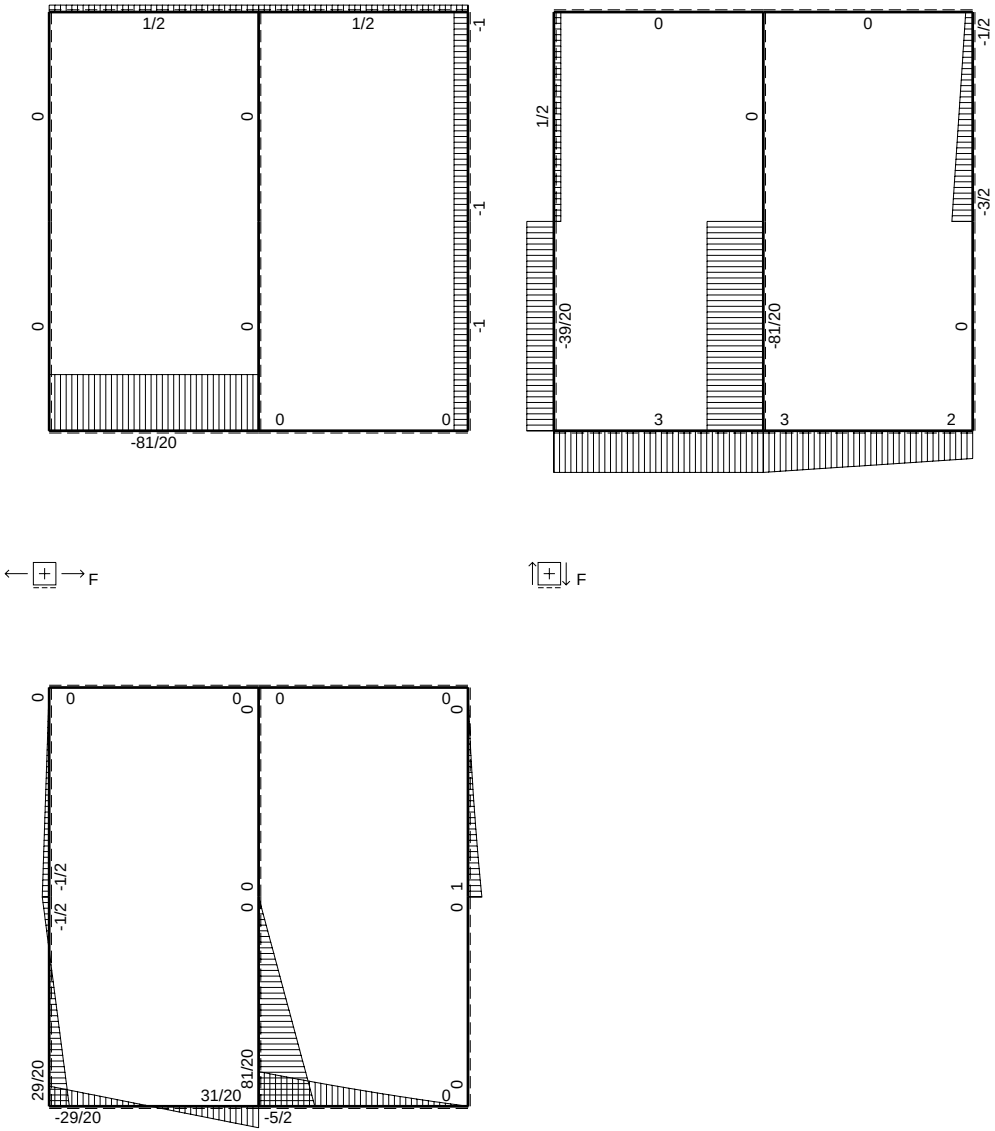
3F
2F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F
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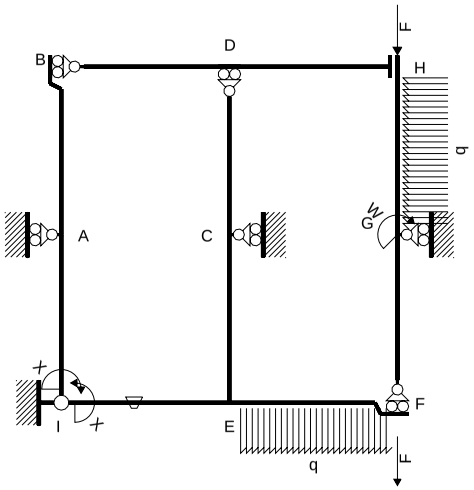
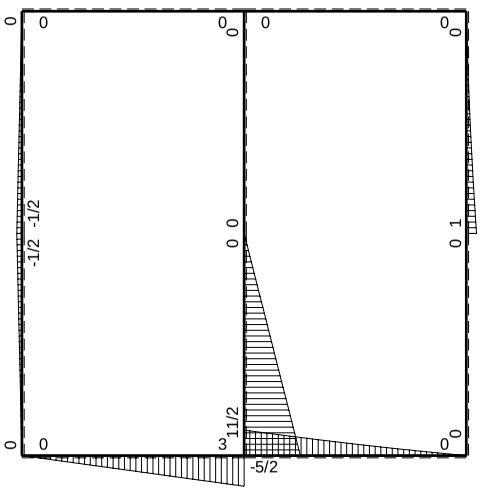
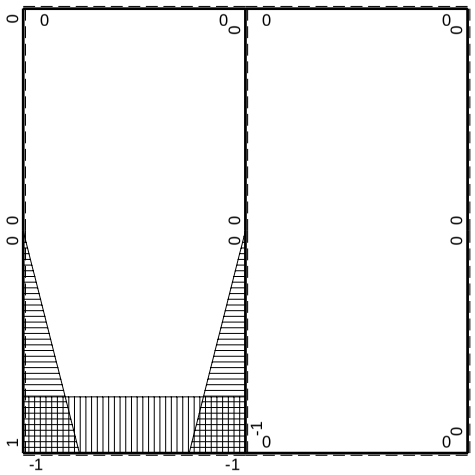
29/20
81/20
31/20
-29/20
-5/2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 917495 CI07.xxxx.067

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-5/2Fb+3Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$2Fx+1/2qx^2$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2Fx-1/2qx^2$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	11/2Fb-11/2Fx	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-11/2Fx$	0	$-11/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-29/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						29/20Fb	

Sviluppi di calcolo iperstatica

PROCEDIMENTO E RISULTATI 917495 CI07.xxxx.067

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-11/2 + 11\ x/b - 11/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-11/2\ x + 11/2\ x^2/b - 11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-11/2\ b + 11/2\ b - 11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-11/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

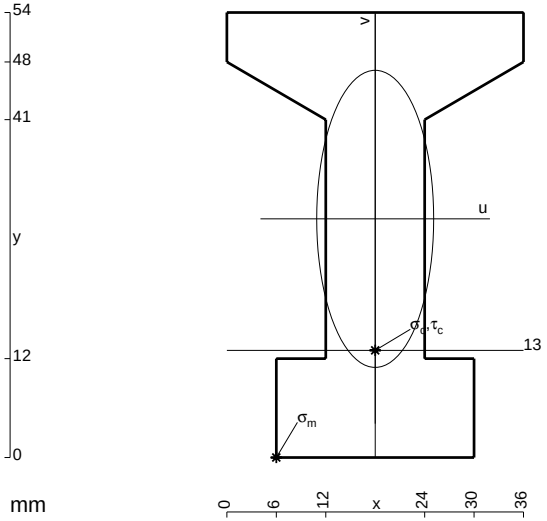
$= (-11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$



$A = 1020.\ mm^2$

$J_u = 331648.\ mm^4$

$J_v = 51408.\ mm^4$

$y_g = 28.96\ mm$

$T_y = 3300.\ N$

$M_x = -2502500.\ Nmm$

$x_m = 6.\ mm$

$u_m = -12.\ mm$

$v_m = -28.96\ mm$

$\sigma_m = -Mv/J_u = -218.5\ N/mm^2$

$x_c = 18.\ mm$

$y_c = 13.\ mm$

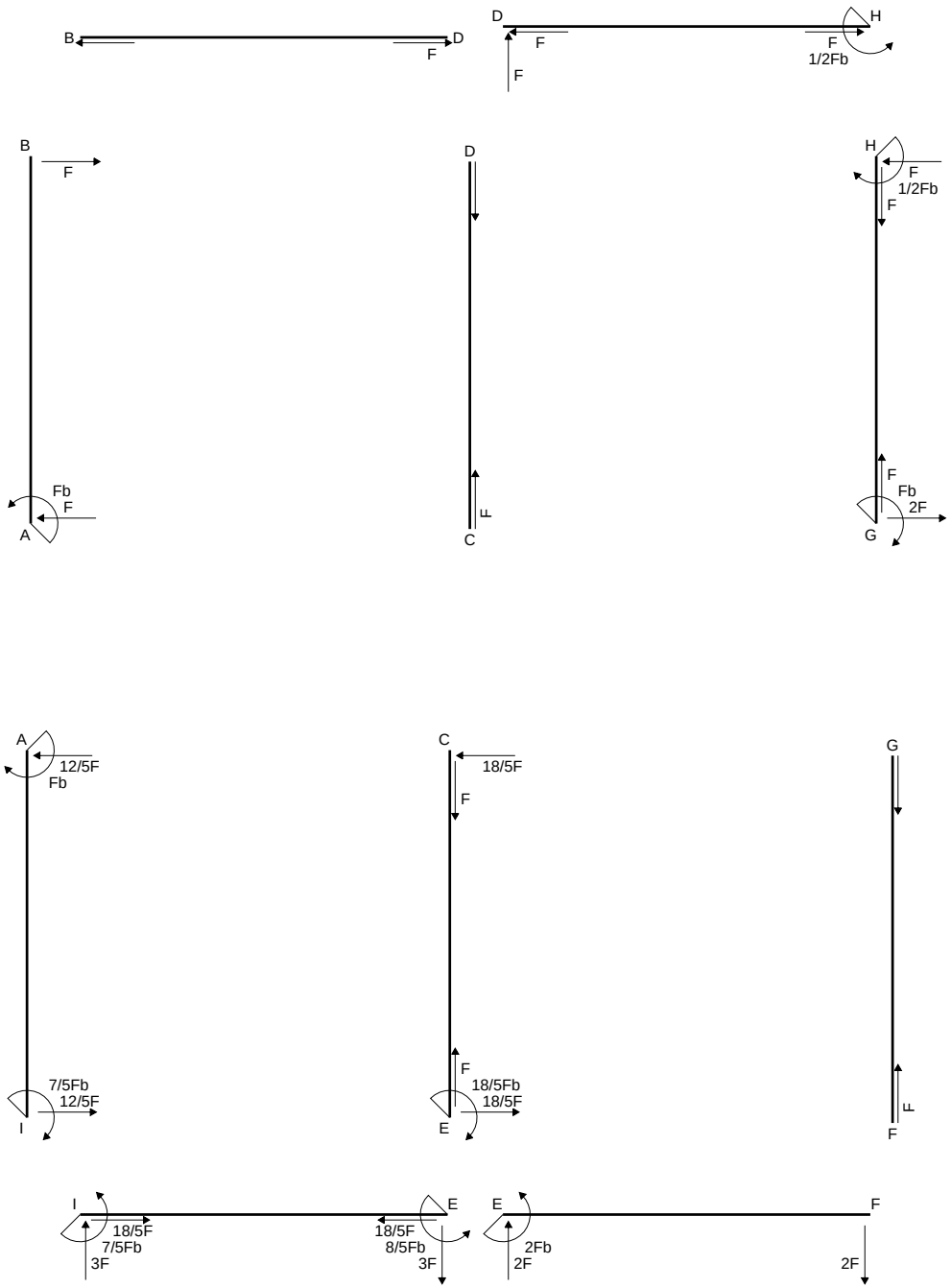
$v_c = -15.96\ mm$

$\sigma_c = -Mv/J_u = -120.4\ N/mm^2$

$\tau_c = 5.647\ N/mm^2$

$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 120.8\ N/mm^2$

$S^* = 6810.\ mm^3$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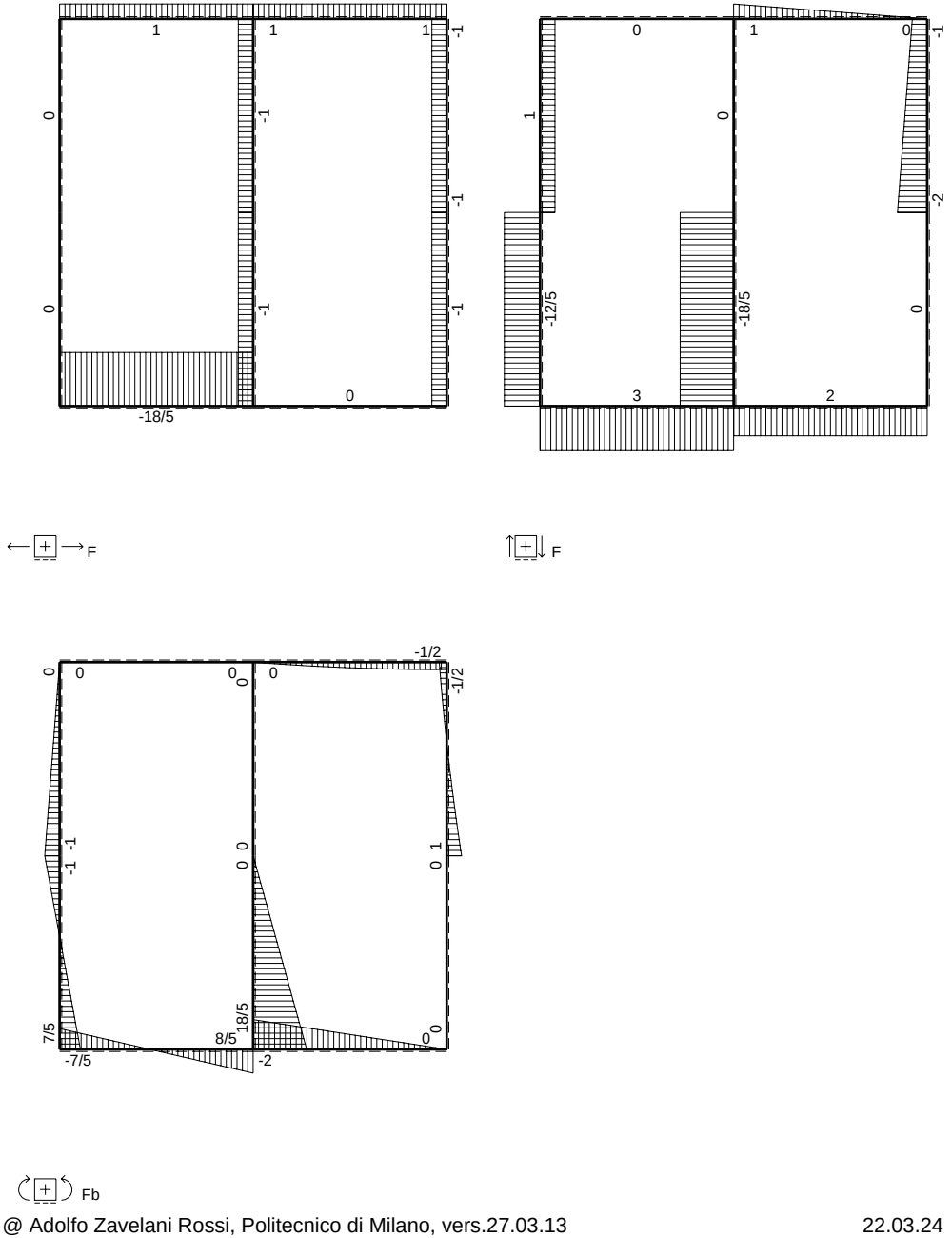
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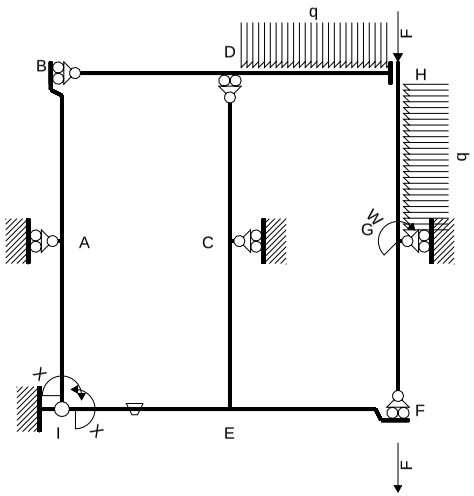
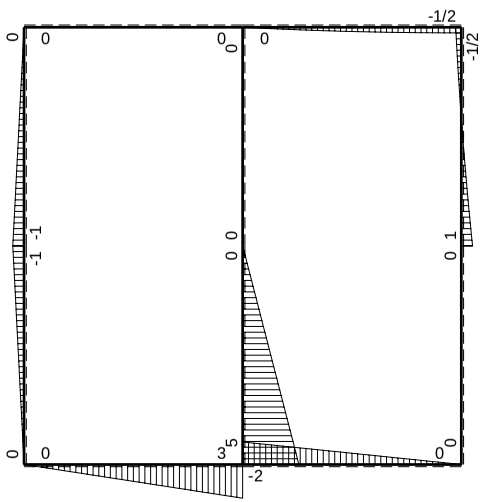
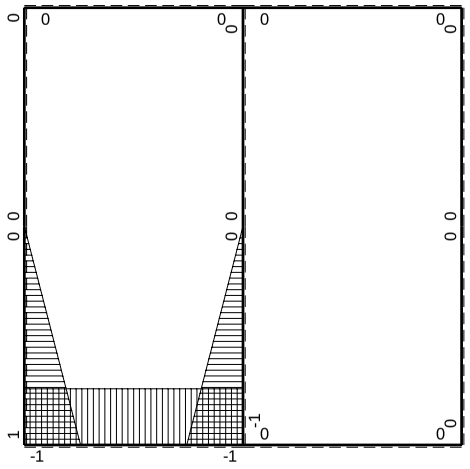


Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 212041 CI07.xxxx.068

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-Fx-1/2qx^2$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-5Fx	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-5Fx	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-Fx	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	Fb-Fx	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-7/3Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						7/5Fb	

PROCEDIMENTO E RISULTATI 212041 CI07.xxxx.068

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

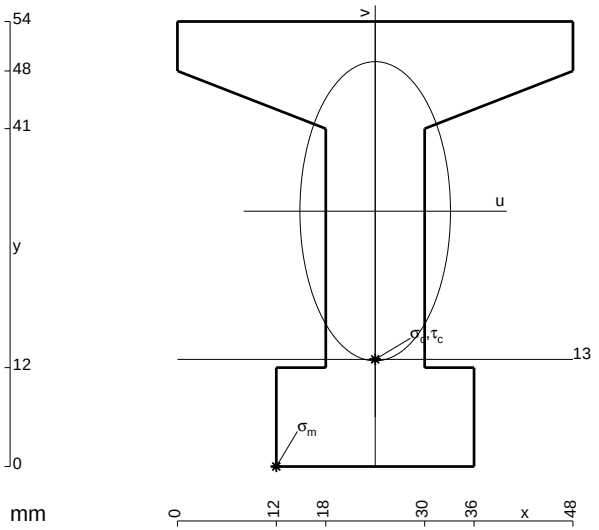
$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$



$A = 1134.\ mm^2$

$J_u = 374055.\ mm^4$

$J_v = 94716.\ mm^4$

$y_g = 30.98\ mm$

$T_y = 2860.\ N$

$M_x = -2774200.\ Nmm$

$x_m = 12.\ mm$

$u_m = -12.\ mm$

$v_m = -30.98\ mm$

$\sigma_m = -Mv/J_u = -229.8\ N/mm^2$

$x_c = 24.\ mm$

$y_c = 13.\ mm$

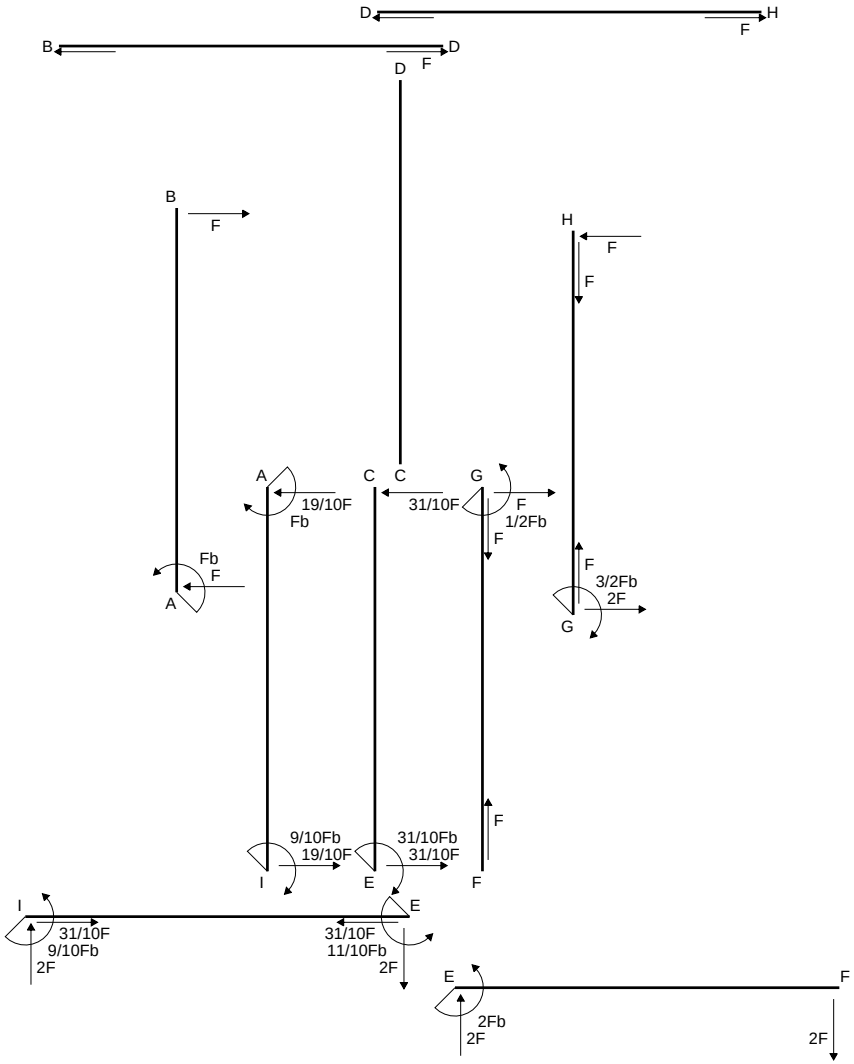
$v_c = -17.98\ mm$

$\sigma_c = -Mv/J_u = -133.3\ N/mm^2$

$\tau_c = 4.725\ N/mm^2$

$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 133.6\ N/mm^2$

$S^* = 7416.\ mm^3$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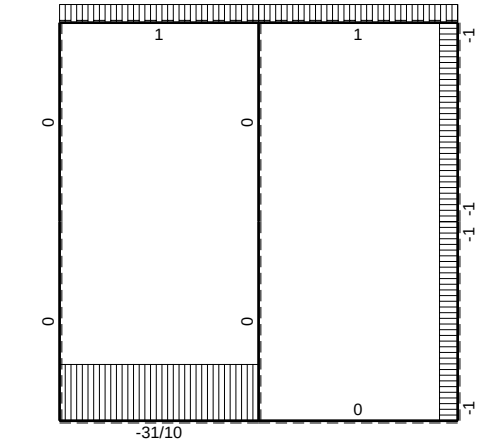
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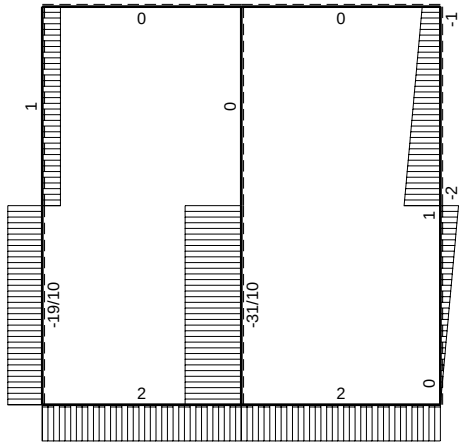
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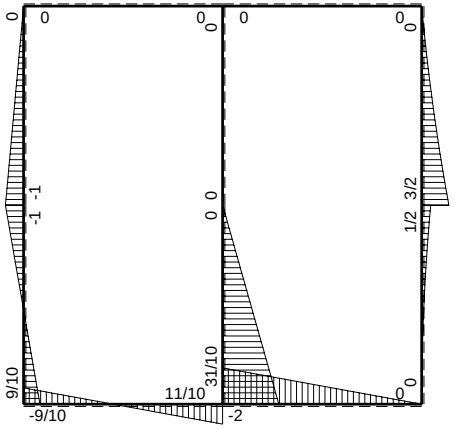
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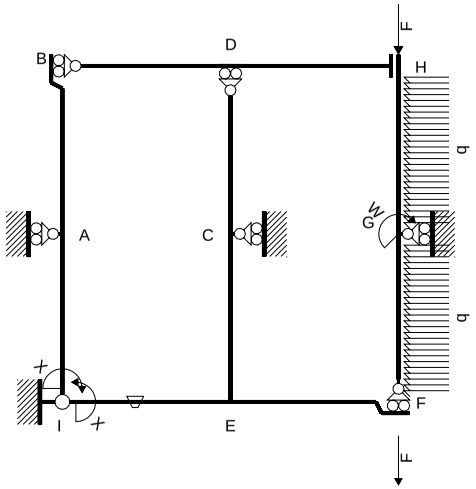
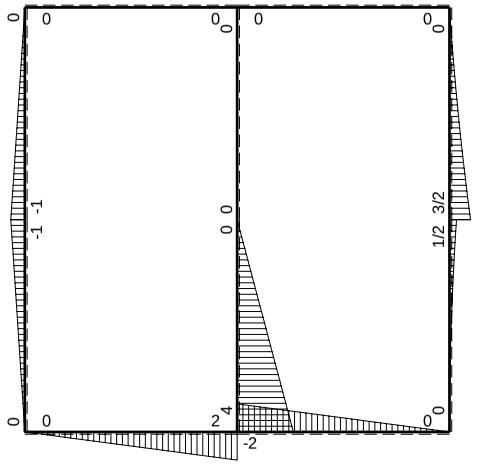
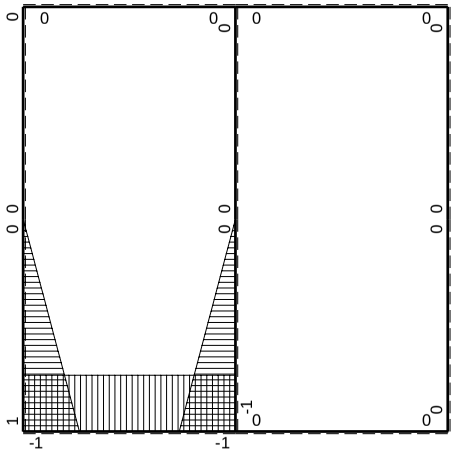


Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 983766 CI07.xxxx.069

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-Fx-1/2qx^2$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	-1+x/b	4Fb-4Fx	0	$-4Fb+8Fx-4Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-4/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-4Fx	0	$-4Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-Fx	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	Fb-Fx	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-3/2Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						9/10Fb	

PROCEDIMENTO E RISULTATI 983766 CI07.xxxx.069

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L_{EI}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L_{EC}^{Xo} = \int_o^b (-4 + 8\ x/b - 4\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4\ x + 4\ x^2/b - 4/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-4\ b + 4\ b - 4/3\ b\ )\ Fb\ 1/EJ\ = -4/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-4\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

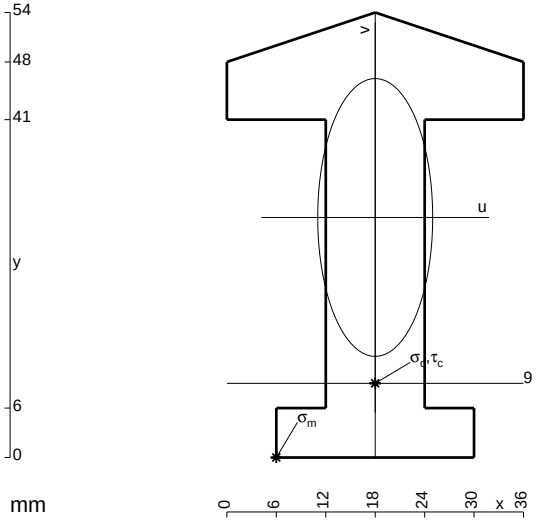
$= (-4/3\ b\ )\ Fb\ 1/EJ\ = -4/3\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$



$A = 924.\ mm^2$

$J_u = 262756.\ mm^4$

$J_v = 45000.\ mm^4$

$y_g = 29.13\ mm$

$T_y = 2120.\ N$

$M_x = -2162400.\ Nmm$

$x_m = 6.\ mm$

$u_m = -12.\ mm$

$v_m = -29.13\ mm$

$\sigma_m = -Mv/J_u = -239.7\ N/mm^2$

$x_c = 18.\ mm$

$y_c = 9.\ mm$

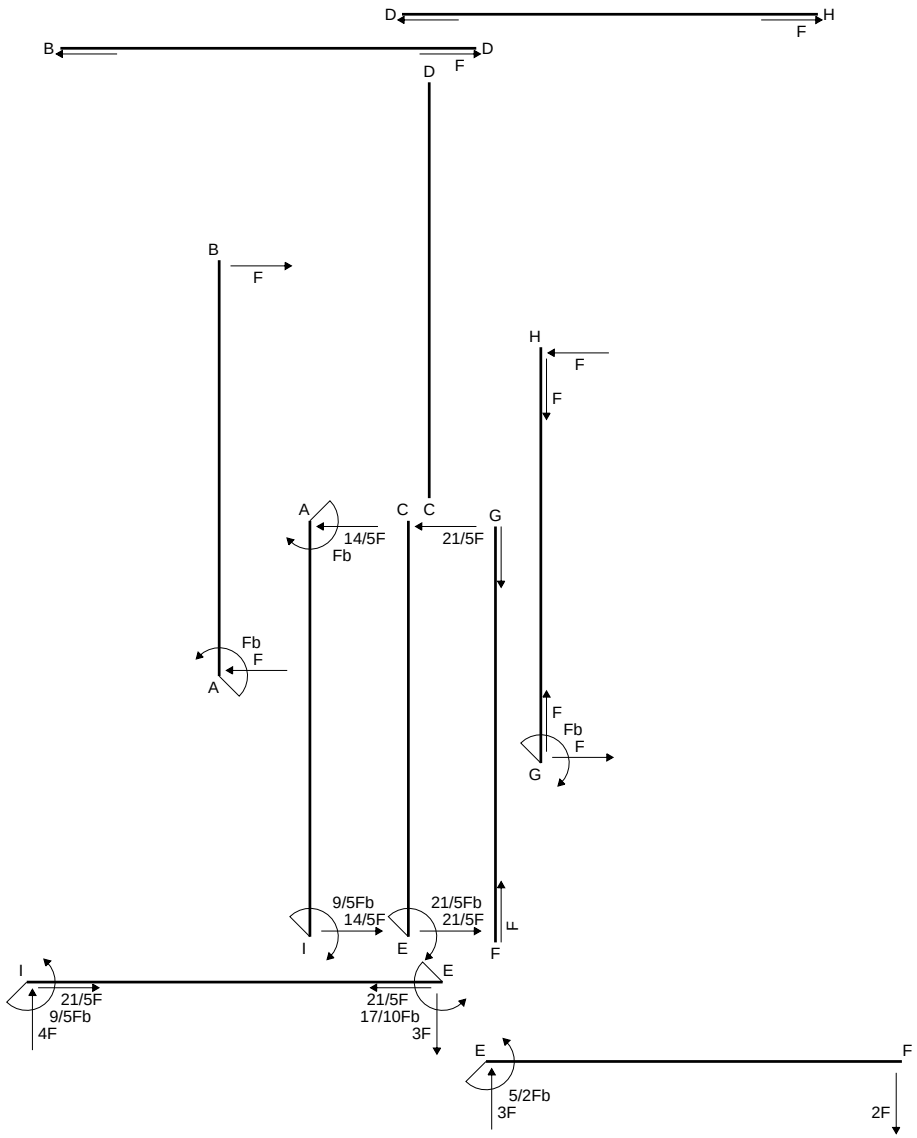
$v_c = -20.13\ mm$

$\sigma_c = -Mv/J_u = -165.7\ N/mm^2$

$\tau_c = 3.053\ N/mm^2$

$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 165.7\ N/mm^2$

$S^* = 4541.\ mm^3$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Fb
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3F
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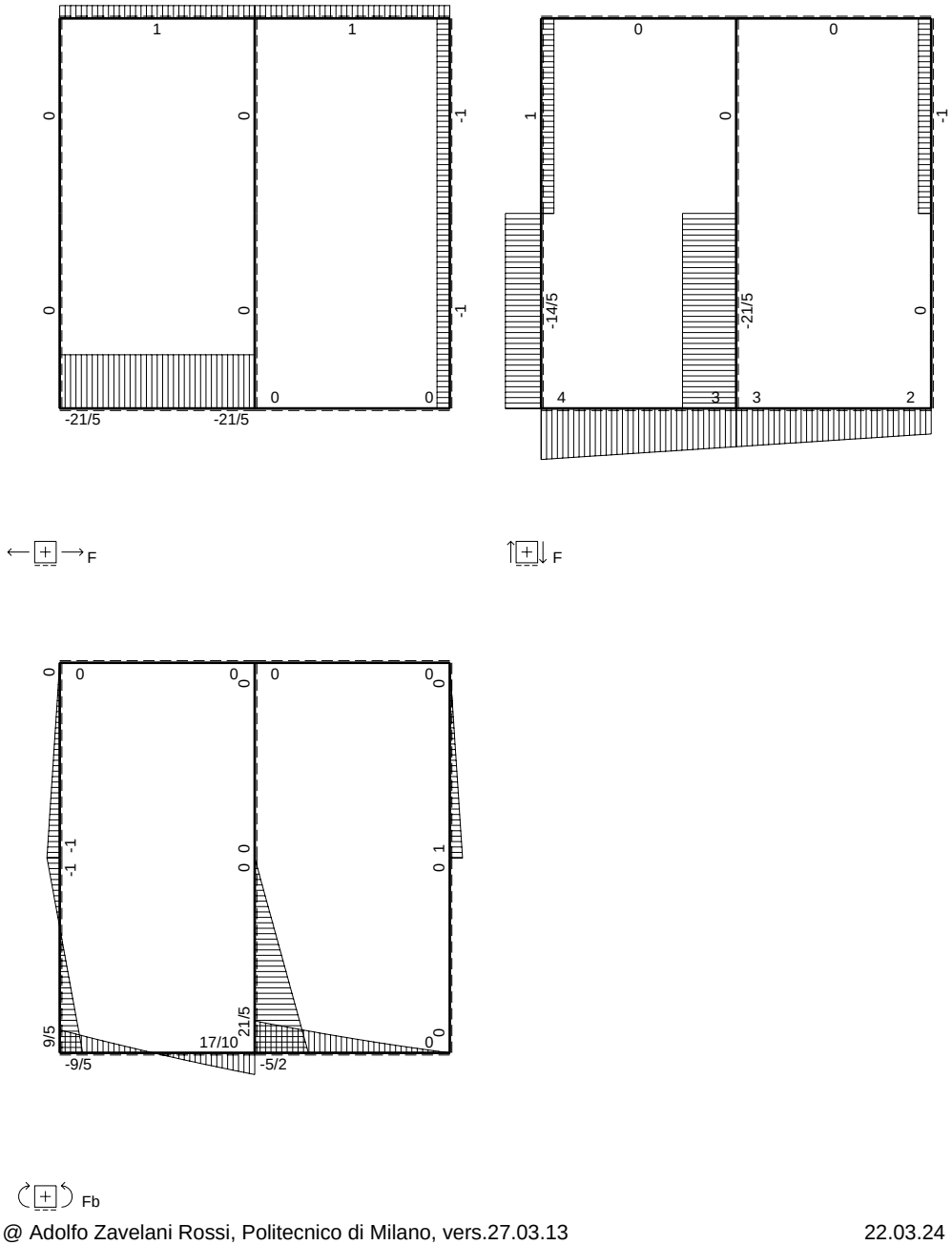
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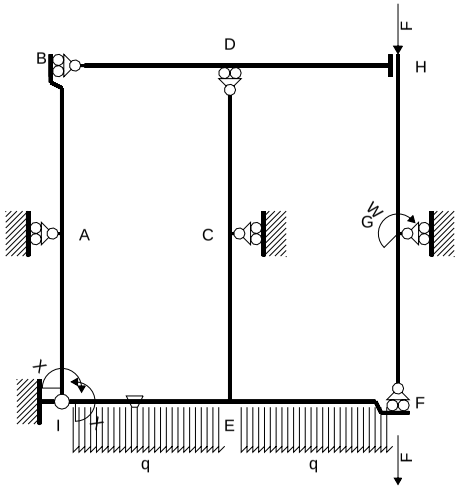
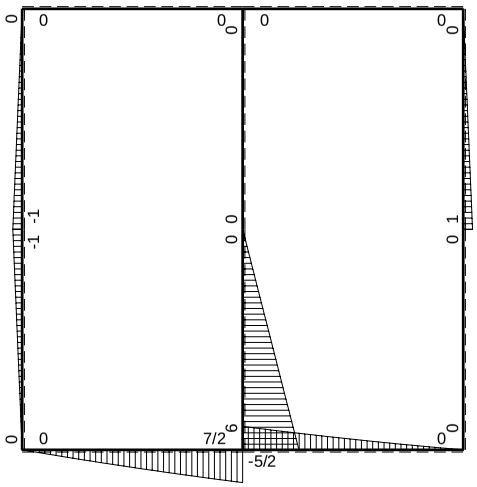
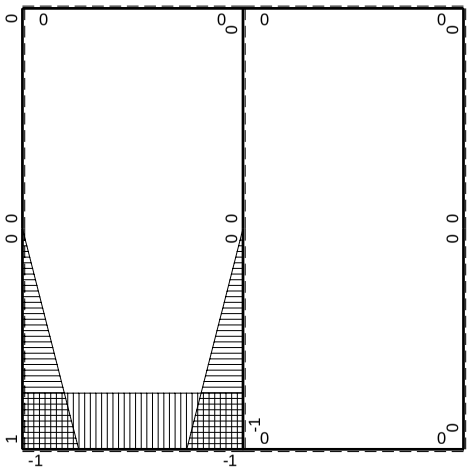
-9/5
-5/2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 212301 CI07.xxxx.070

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PROCEDIMENTO E RISULTATI 212301 CI07.xxxx.070

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-5/2Fb+3Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$2Fx+1/2qx^2$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	Fb-Fx	0	0	0	0	0+0	0
HG b	0	-Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$4Fx-1/2qx^2$	-Fb/EJ	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	-1+x/b	6Fb-6Fx	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-6Fx$	0	$-6Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-Fx	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	Fb-Fx	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-3Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						9/5Fb	

Sviluppi di calcolo iperstatica

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$L^{XX}_{IE} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EI} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EC} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{CE} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{IA} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{AI} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{Xo}_{IE} = \int_o^b (-4\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L^{Xo}_{EI} = \int_o^b (-7/2 + 3\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx$

$= [-7/2\ x + 3/2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-7/2\ b + 3/2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L^{Xo}_{EC} = \int_o^b (-6 + 12\ x/b - 6\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-6\ x + 6\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-6\ b + 6\ b - 2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

$L^{Xo}_{CE} = \int_o^b (-6\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

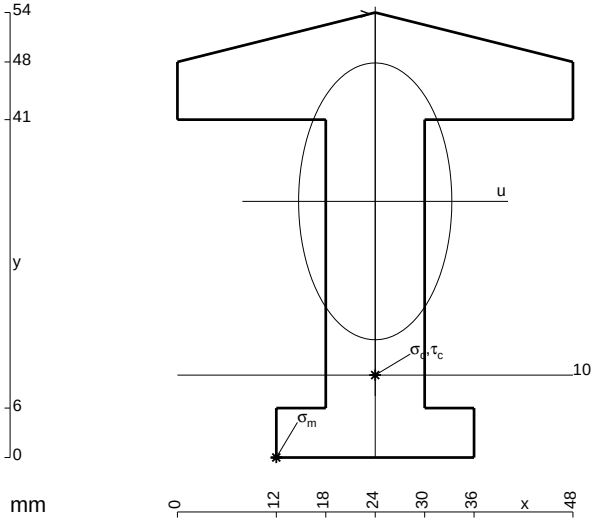
$L^{Xo}_{IA} = \int_o^b (-\ x/b + x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$

$L^{Xo}_{AI} = \int_o^b (-\ x/b + x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 212301 CI07.xxxx.070



A = 1044. mm^2
J_u = 294700. mm^4
J_v = 90288. mm^4
y_g = 31.09 mm
T_y = 4200. N
M_x = -1890000. Nmm
x_m = 12. mm
u_m = -12. mm
v_m = -31.09 mm
$\sigma_m = -Mv/J_u$ = -199.4 N/mm^2
x_c = 24. mm
y_c = 10. mm
v_c = -21.09 mm
$\sigma_c = -Mv/J_u$ = -135.2 N/mm^2
τ_c = 6.119 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 135.6 N/mm^2
S^* = 5153. mm^3

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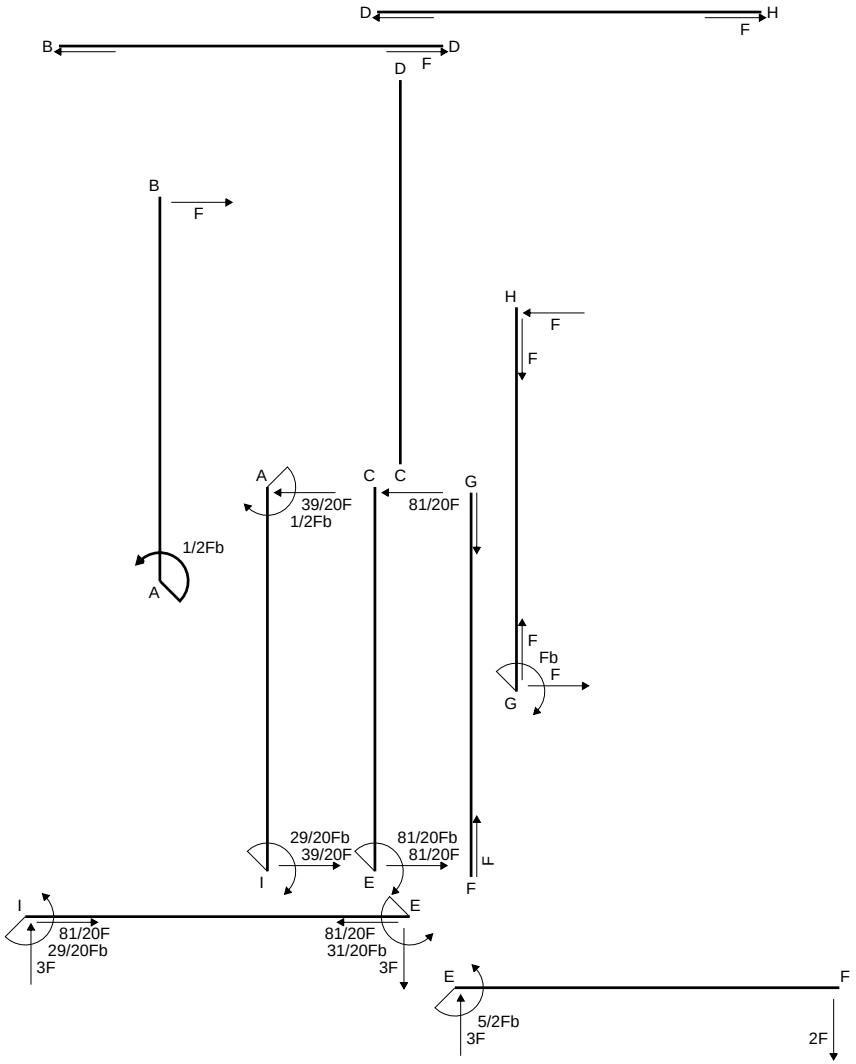
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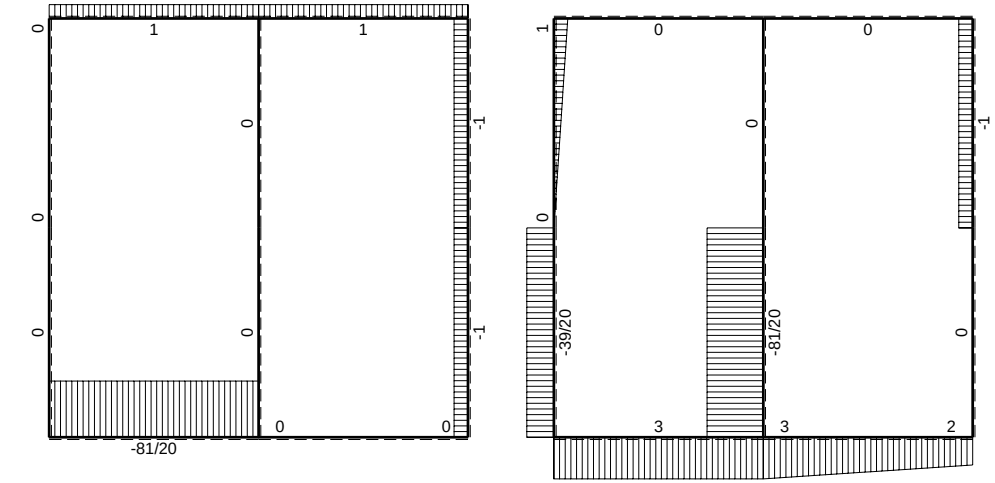
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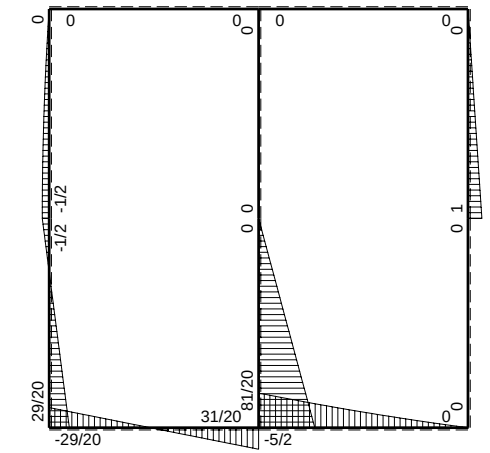
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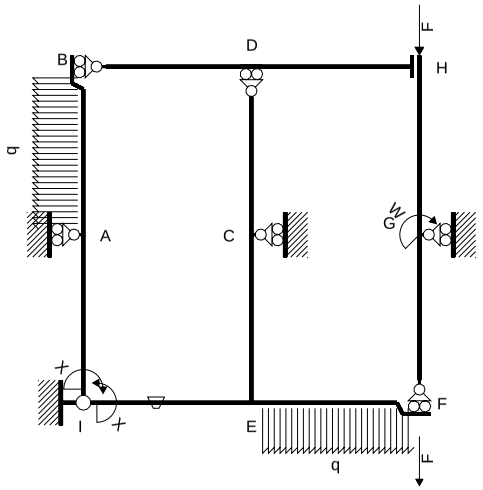
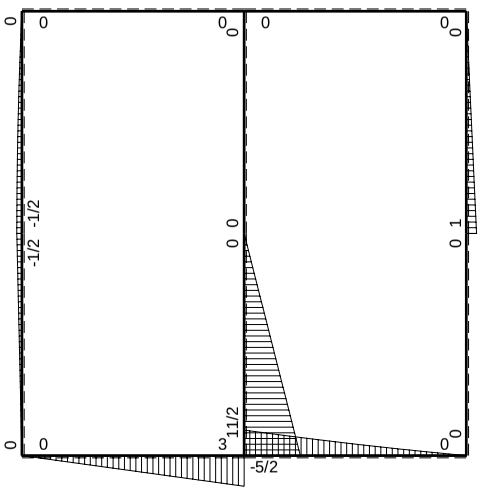
-5/2

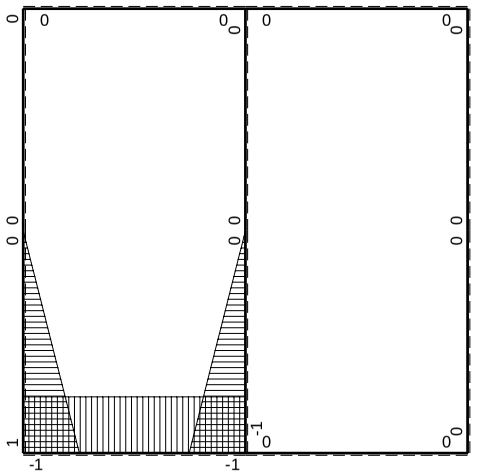
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 216391 CI07.xxxx.071

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-5/2Fb+3Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$2Fx+1/2qx^2$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	Fb-Fx	0	0	0	0	0+0	0
HG b	0	-Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	11/2Fb-11/2Fx	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-11/2Fx	0	$-11/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-29/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						29/20Fb	

Sviluppi di calcolo iperstatica

PROCEDIMENTO E RISULTATI 216391 CI07.xxxx.071

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-11/2 + 11\ x/b - 11/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-11/2\ x + 11/2\ x^2/b - 11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-11/2\ b + 11/2\ b - 11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-11/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

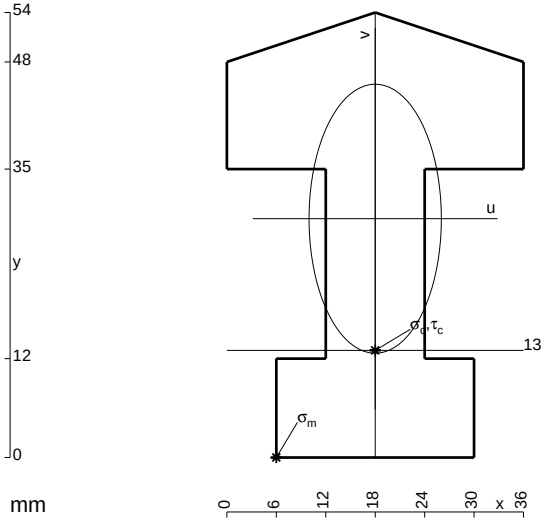
$= (-11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$



$A = 1140.\ mm^2$

$J_u = 303884.\ mm^4$

$J_v = 73512.\ mm^4$

$y_g = 28.98\ mm$

$T_y = 4470.\ N$

$M_x = -2197750.\ Nmm$

$x_m = 6.\ mm$

$u_m = -12.\ mm$

$v_m = -28.98\ mm$

$\sigma_m = -Mv/J_u = -209.6\ N/mm^2$

$x_c = 18.\ mm$

$y_c = 13.\ mm$

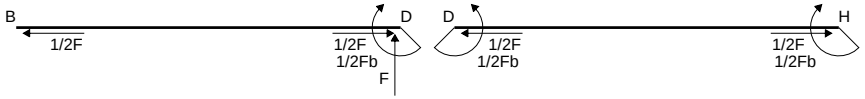
$v_c = -15.98\ mm$

$\sigma_c = -Mv/J_u = -115.6\ N/mm^2$

$\tau_c = 8.355\ N/mm^2$

$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 116.5\ N/mm^2$

$S^* = 6816.\ mm^3$


B
D
D
H
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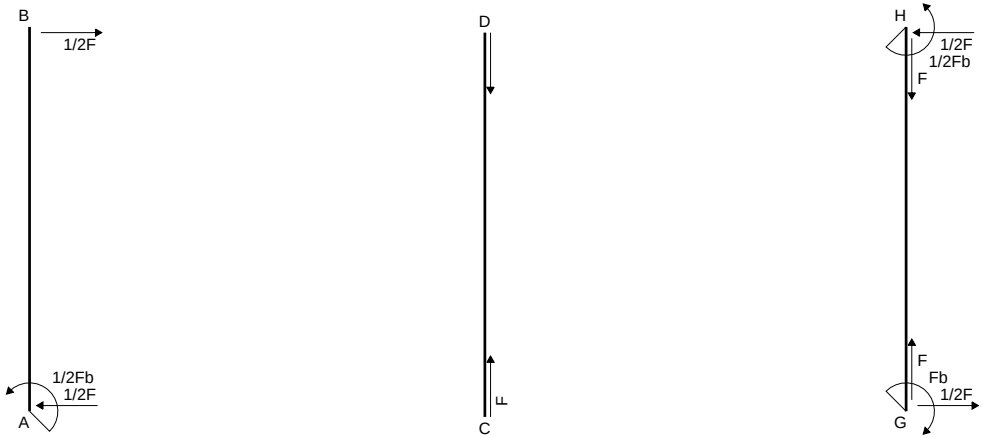
1/2F
1/2Fb
F
1/2F
1/2Fb
1/2F
1/2Fb


B
1/2F
A
1/2Fb
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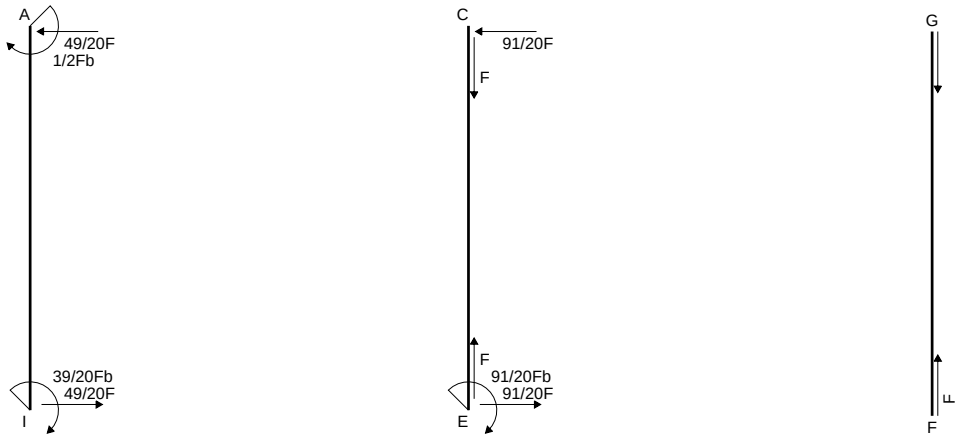
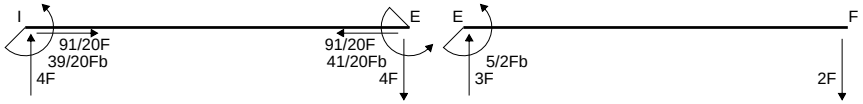
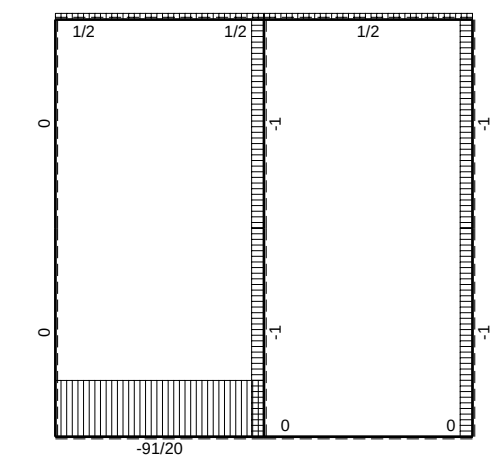
D
F
C
H
1/2F
1/2Fb
F
F
Fb
1/2F
G


A
49/20F
1/2Fb
I
39/20Fb
49/20F
C
91/20F
F
E
F
91/20Fb
91/20F
G
F


I
E
E
F
91/20F
39/20Fb
4F
91/20F
41/20Fb
4F
5/2Fb
3F
2F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1/2
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0
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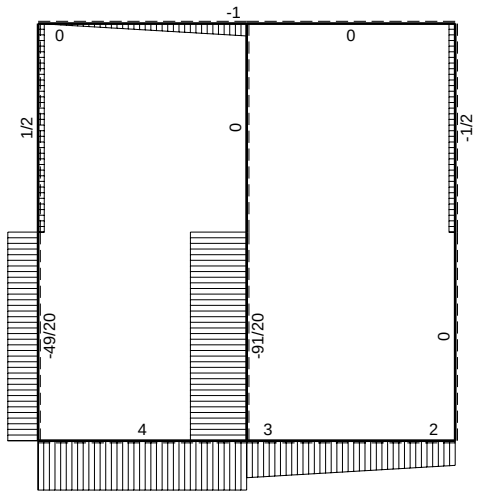
-1
0
0
-91/20


-1
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1/2
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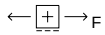
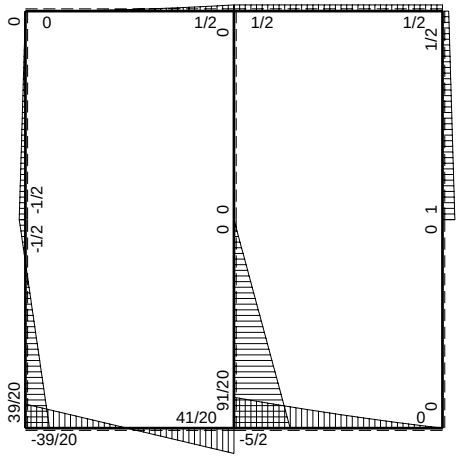
-49/20
-91/20
0
4
3
2


F

F


0
0
1/2
1/2
1/2
1/2
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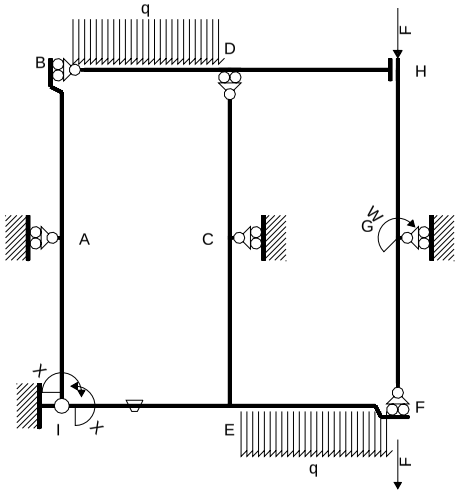
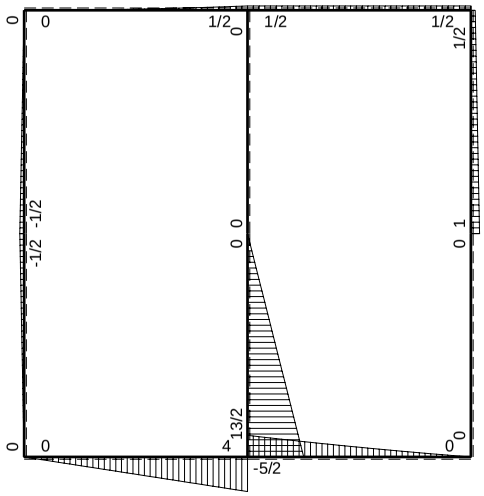
0 0
0 1
39/20
91/20
41/20
0 0
-39/20
-5/2

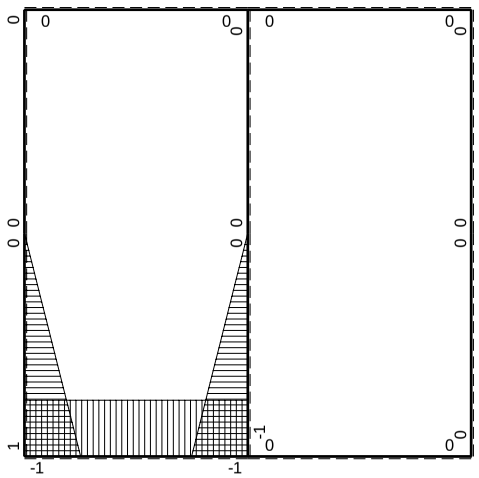
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 215845 CI07.xxxx.072

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-5/2Fb+3Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$2Fx+1/2qx^2$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	Fb-1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fb-1/2Fx	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	4Fx	-Fb/EJ	-4Fx	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-4Fb+4Fx	Fb/EJ	-4Fb+4Fx	Fb/EJ	1		
EC b	-1+x/b	13/2Fb-13/2Fx	0	$-13/2Fb+13Fx-13/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-13/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-13/2Fx	0	$-13/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-13/4Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						39/20Fb	

PROCEDIMENTO E RISULTATI 215845 CI07.xxxx.072

Sviluppi di calcolo iperstatica

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

$L^{XX}_{IE} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EI} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EC} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{CE} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{IA} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{AI} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{Xo}_{IE} = \int_o^b (-4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L^{Xo}_{EI} = \int_o^b (-4 + 4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-4\ x + 2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-4\ b + 2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L^{Xo}_{EC} = \int_o^b (-13/2 + 13\ x/b - 13/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-13/2\ x + 13/2\ x^2/b - 13/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-13/2\ b + 13/2\ b - 13/6\ b\ )\ Fb\ 1/EJ\ = -13/6\ Fb^2/EJ$

$L^{Xo}_{CE} = \int_o^b (-13/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-13/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

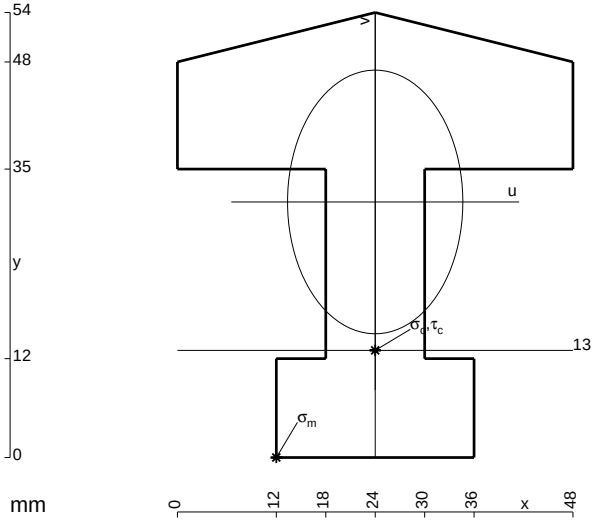
$= (-13/6\ b\ )\ Fb\ 1/EJ\ = -13/6\ Fb^2/EJ$

$L^{Xo}_{IA} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

$L^{Xo}_{AI} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$



$A = 1332.\ mm^2$

$J_u = 341004.\ mm^4$

$J_v = 150768.\ mm^4$

$y_g = 31.01\ mm$

$T_y = 4530.\ N$

$M_x = -2416000.\ Nmm$

$x_m = 12.\ mm$

$u_m = -12.\ mm$

$v_m = -31.01\ mm$

$\sigma_m = -Mv/J_u = -219.7\ N/mm^2$

$x_c = 24.\ mm$

$y_c = 13.\ mm$

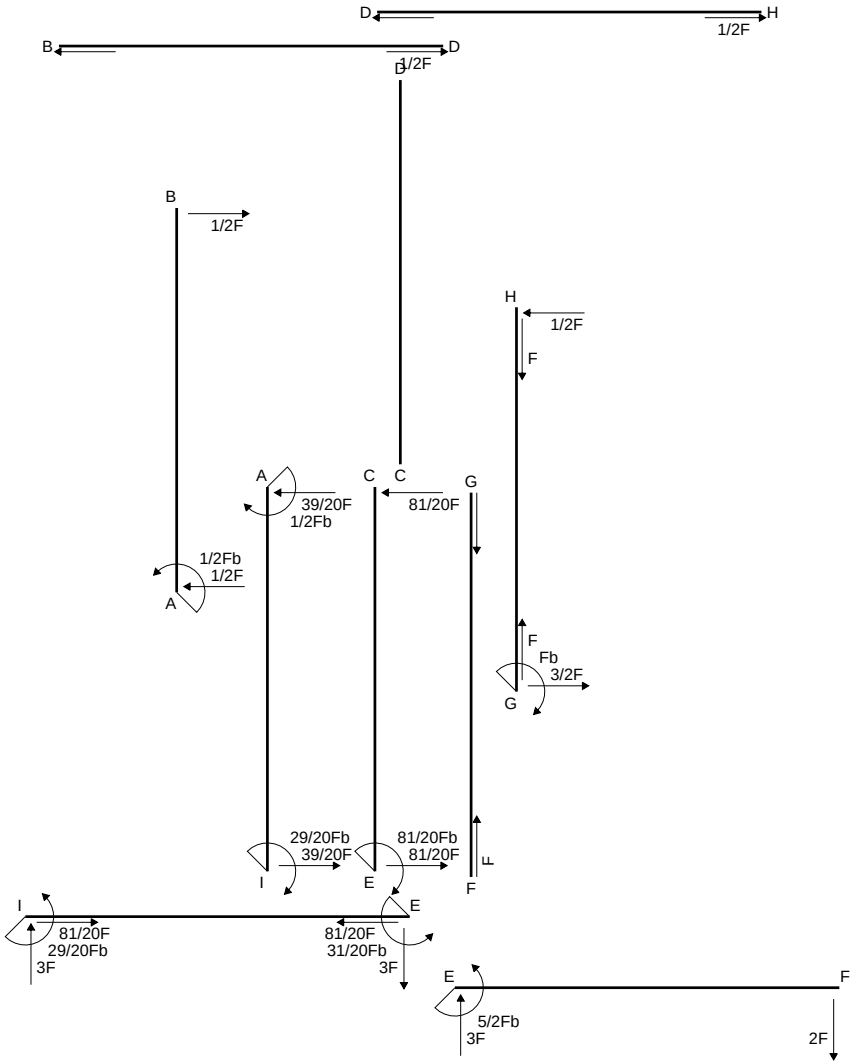
$v_c = -18.01\ mm$

$\sigma_c = -Mv/J_u = -127.6\ N/mm^2$

$\tau_c = 8.221\ N/mm^2$

$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 128.4\ N/mm^2$

$S^* = 7426.\ mm^3$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H
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F
A
C
C
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1/2Fb
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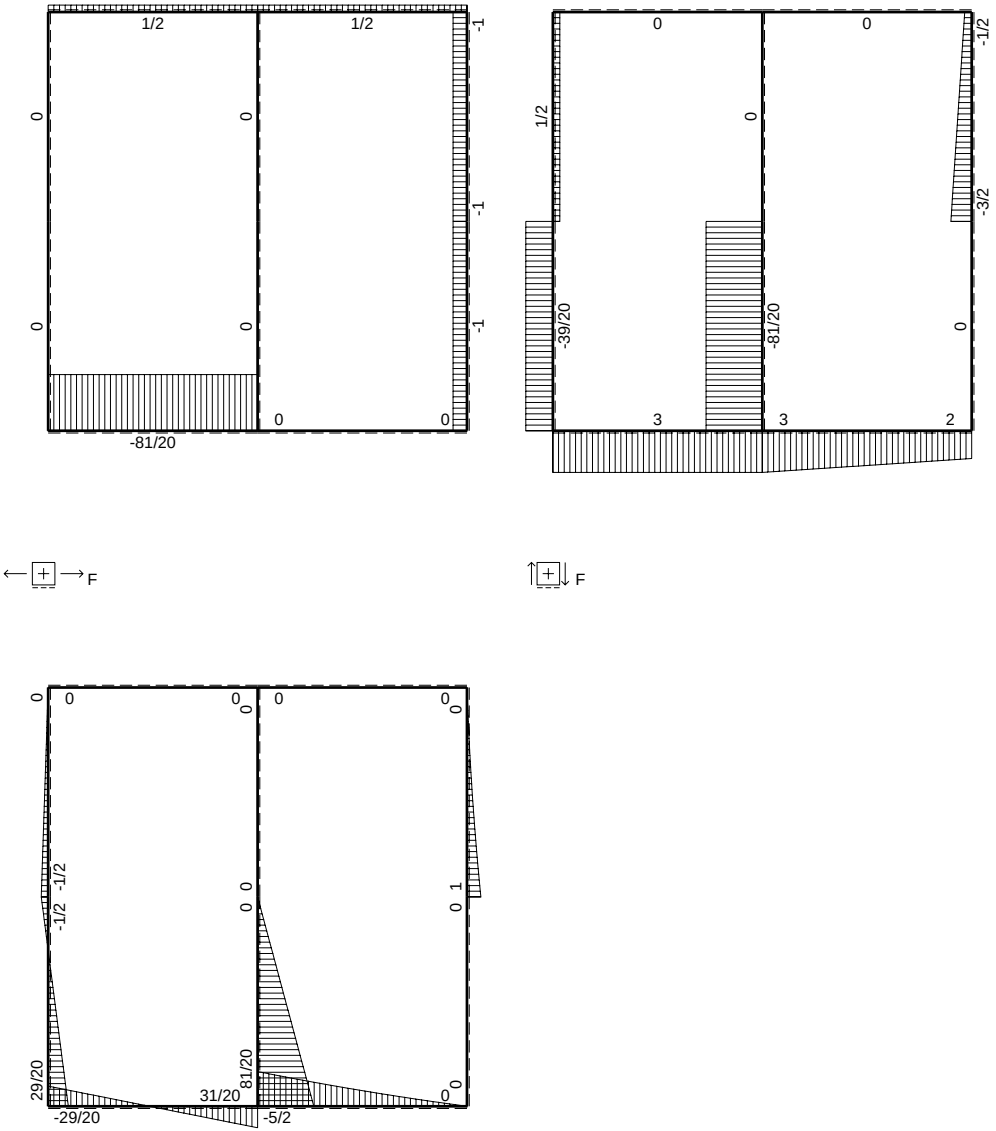
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81/20
31/20
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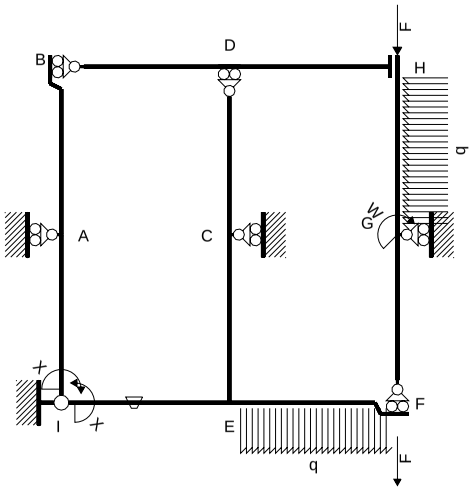
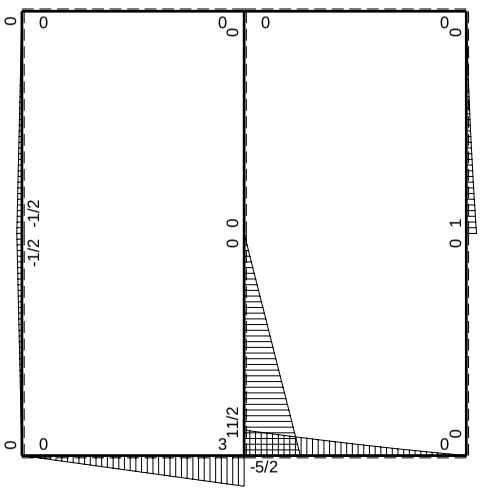
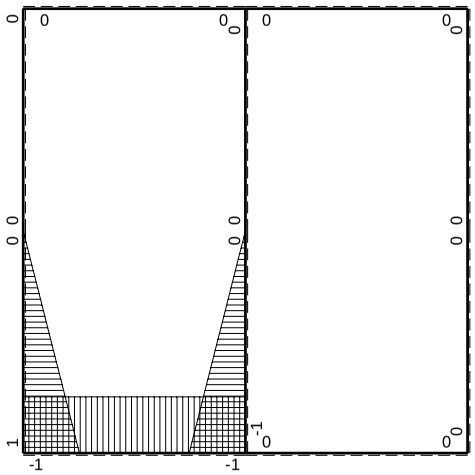
-5/2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 982141 CI07.xxxx.073

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-5/2Fb+3Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$2Fx+1/2qx^2$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2Fx-1/2qx^2$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	11/2Fb-11/2Fx	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-11/2Fx$	0	$-11/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-29/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						29/20Fb	

Sviluppi di calcolo iperstatica

PROCEDIMENTO E RISULTATI 982141 CI07.xxxx.073

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-11/2 + 11\ x/b - 11/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-11/2\ x + 11/2\ x^2/b - 11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-11/2\ b + 11/2\ b - 11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-11/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

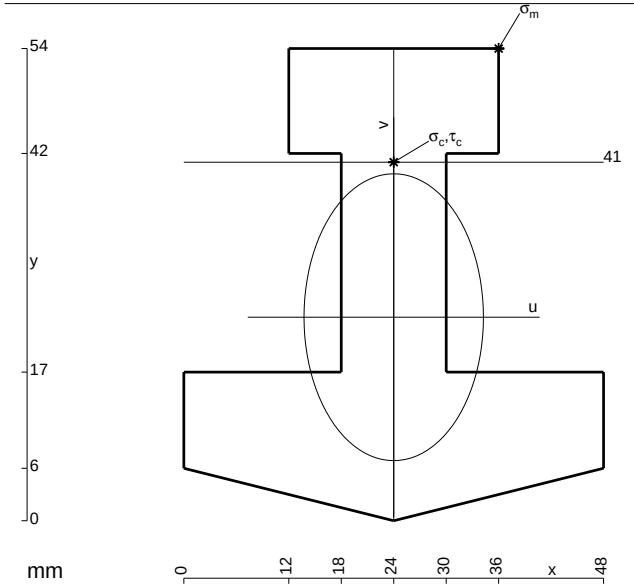
$= (-11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

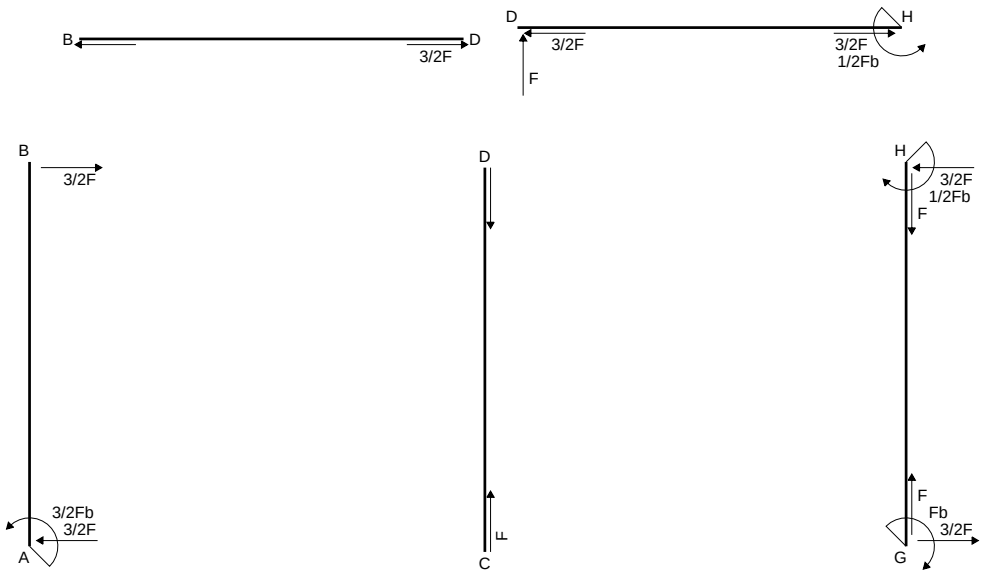
$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$



A = 1260. mm^2
J_u = 339087. mm^4
J_v = 132624. mm^4
y_g = 23.27 mm
T_y = 4350. N
M_x = -2537500. Nmm
x_m = 36. mm
y_m = 54. mm
u_m = 12. mm
v_m = 30.73 mm
$\sigma_m = -Mv/J_u$ = 230. N/mm^2
x_c = 24. mm
y_c = 41. mm
v_c = 17.73 mm
$\sigma_c = -Mv/J_u$ = 132.7 N/mm^2
τ_c = 7.847 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 133.4 N/mm^2
S^* = 7341. mm^3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1/2Fb
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3/2F
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A
C
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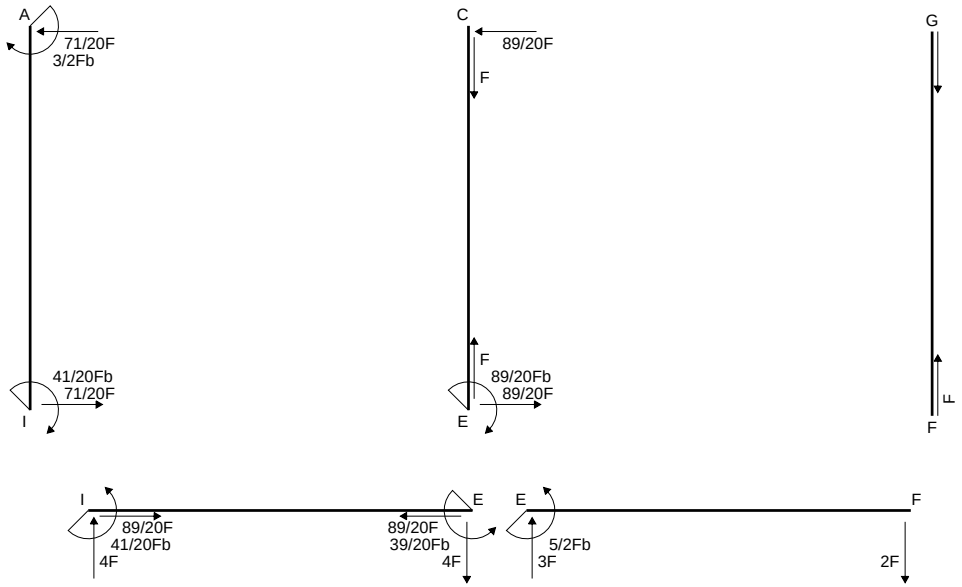
Fb
3/2F
G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C
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F
G
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I
F
89/20Fb
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E
F
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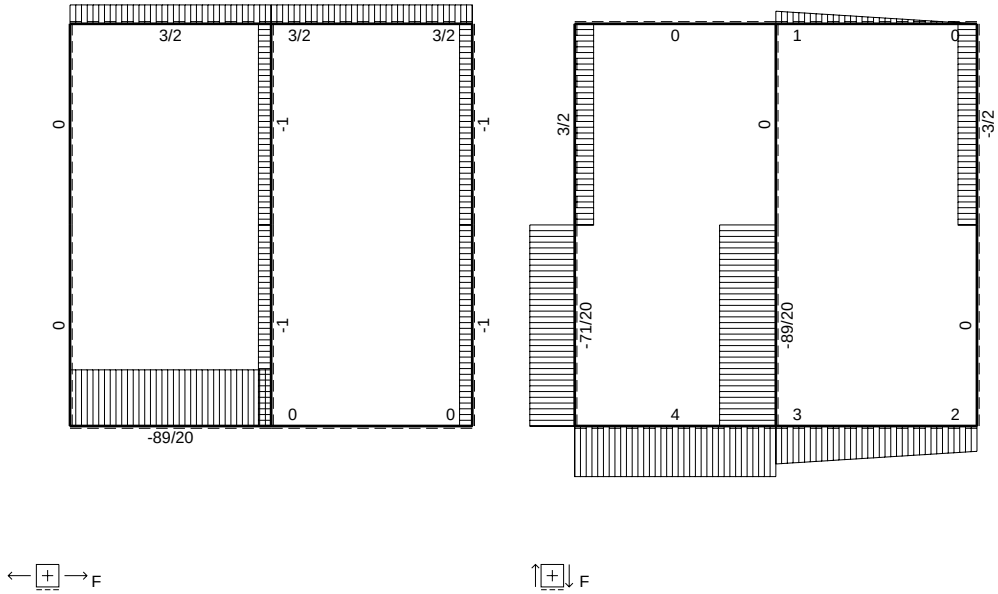
89/20F
39/20Fb
4F
5/2Fb
3F
2F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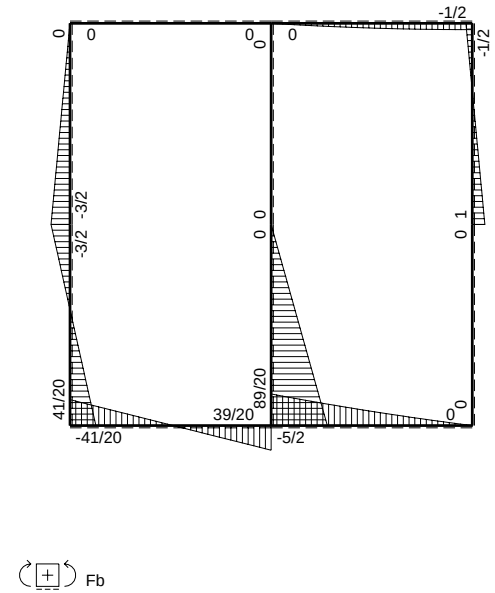
F
F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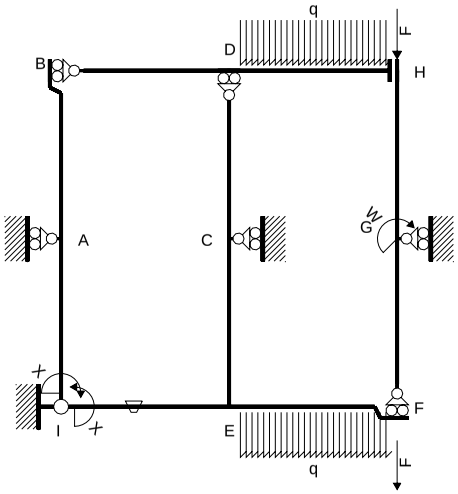
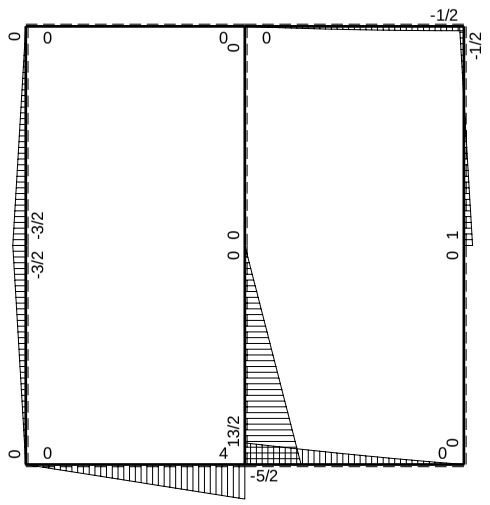
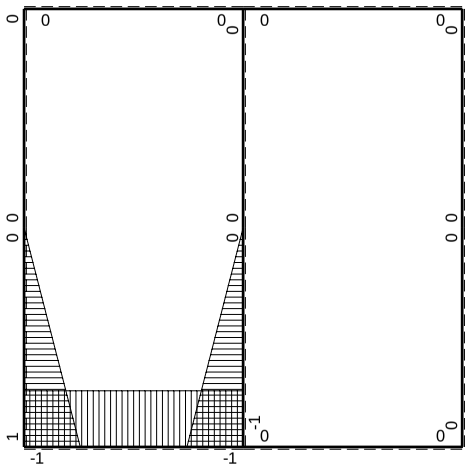
41/20
89/20
39/20
0
-41/20
-5/2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 981176 CI07.xxxx.074

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-3/2Fb+3/2Fx	0	0	0	0	0+0	0
BA b	0	3/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-5/2Fb+3Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$2Fx+1/2qx^2$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	Fb-3/2Fx	0	0	0	0	0+0	0
HG b	0	1/2Fb-3/2Fx	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	4Fx	-Fb/EJ	-4Fx	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-4Fb+4Fx	Fb/EJ	-4Fb+4Fx	Fb/EJ	1		
EC b	-1+x/b	13/2Fb-13/2Fx	0	$-13/2Fb+13Fx-13/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-13/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-13/2Fx	0	$-13/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-3/2Fx	0	$-3/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/4+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	3/2Fb-3/2Fx	0	$-3/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-41/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						41/20Fb	

Sviluppi di calcolo iperstatica

PROCEDIMENTO E RISULTATI 981176 CI07.xxxx.074

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-4 + 4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-4\ x + 2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-4\ b + 2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-13/2 + 13\ x/b - 13/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-13/2\ x + 13/2\ x^2/b - 13/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-13/2\ b + 13/2\ b - 13/6\ b\ )\ Fb\ 1/EJ\ = -13/6\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-13/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-13/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-13/6\ b\ )\ Fb\ 1/EJ\ = -13/6\ Fb^2/EJ$

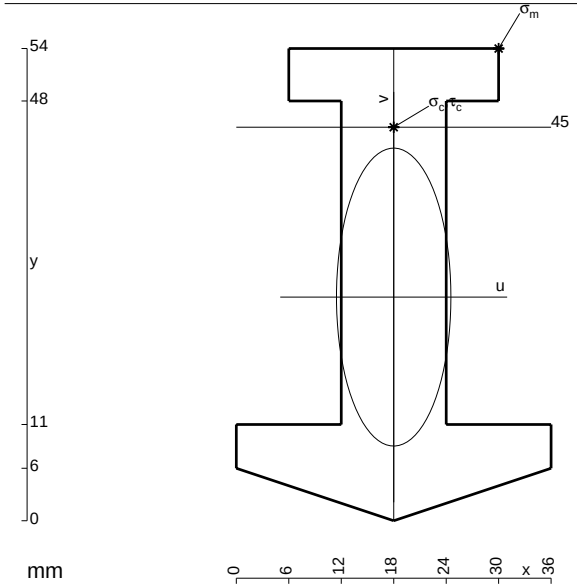
$L_{IA}^{Xo} = \int_o^b (-3/2\ x/b + 3/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-3/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-3/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = -1/4\ Fb^2/EJ$

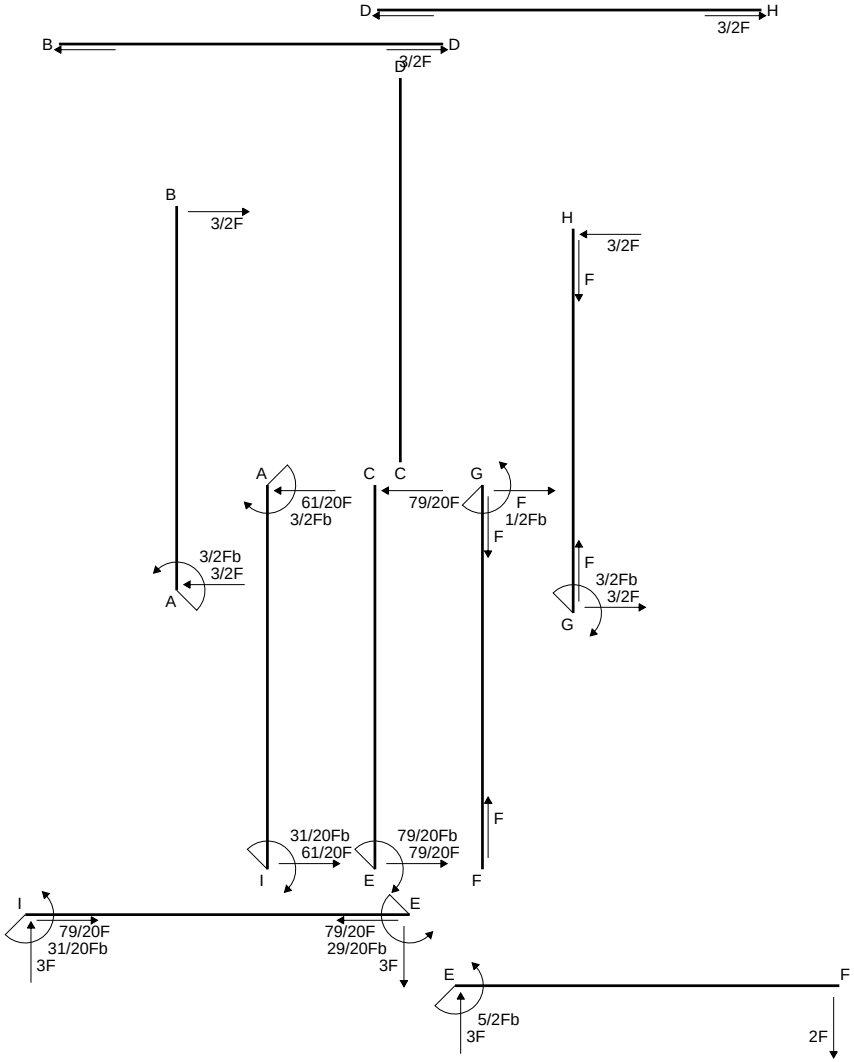
$L_{AI}^{Xo} = \int_o^b (-3/2\ x/b + 3/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-3/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-3/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = -1/4\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 981176 CI07.xxxx.074



A = 876. mm^2
J_u = 254354. mm^4
J_v = 37512. mm^4
y_g = 25.58 mm
T_y = 3420. N
M_x = -2137500. Nmm
x_m = 30. mm
y_m = 54. mm
u_m = 12. mm
v_m = 28.42 mm
$\sigma_m = -Mv/J_u$ = 238.9 N/mm^2
x_c = 18. mm
y_c = 45. mm
v_c = 19.42 mm
$\sigma_c = -Mv/J_u$ = 163.2 N/mm^2
τ_c = 4.946 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 163.5 N/mm^2
S^* = 4414. mm^3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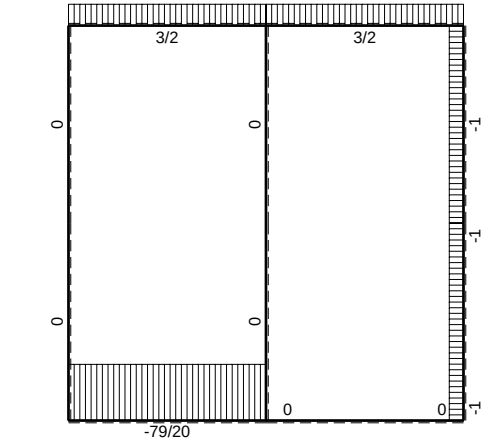
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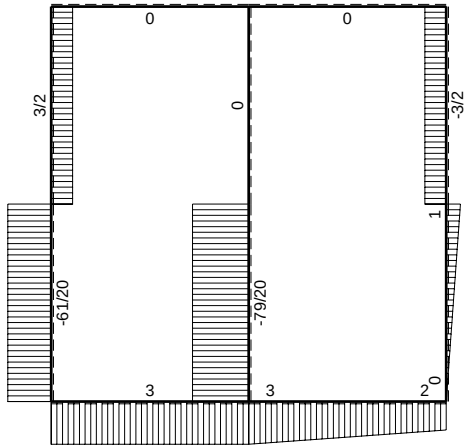
-79/20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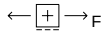
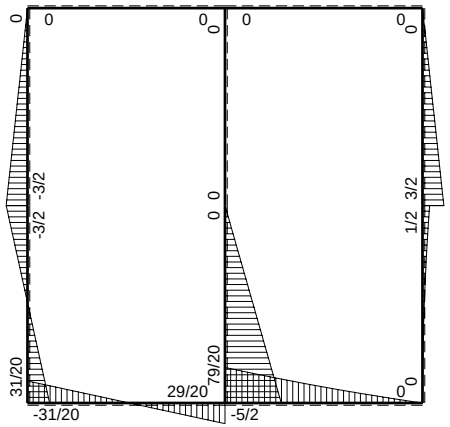

F

F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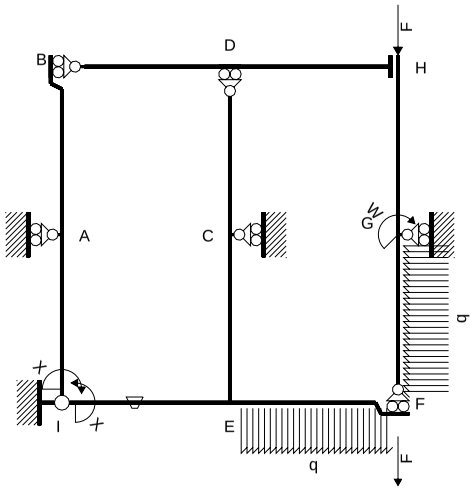
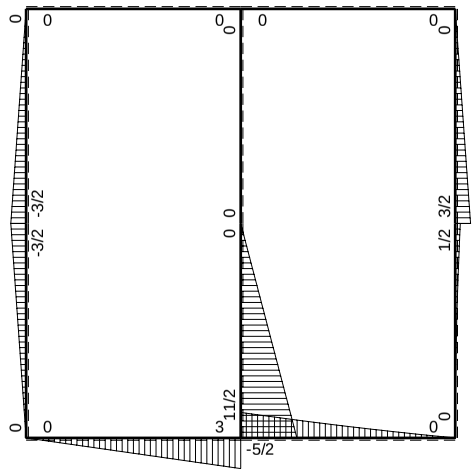
-5/2

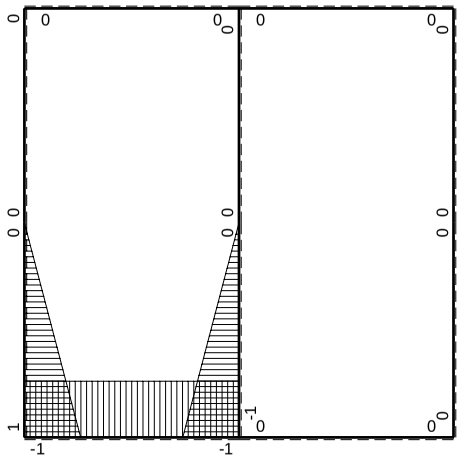
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 216487 CI07.xxxx.075

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$-3/2Fb+3/2Fx$	0	0	0	0	0+0	0
BA b	0	$3/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-5/2Fb+3Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$2Fx+1/2qx^2$	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$3/2Fb-3/2Fx$	0	0	0	0	0+0	0
HG b	0	$-3/2Fx$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$11/2Fb-11/2Fx$	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-11/2Fx$	0	$-11/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-3/2Fx$	0	$-3/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$3/2Fb-3/2Fx$	0	$-3/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-31/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$31/20Fb$	

Sviluppi di calcolo iperstatica

PROCEDIMENTO E RISULTATI 216487 CI07.xxxx.075

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-11/2 + 11\ x/b - 11/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-11/2\ x + 11/2\ x^2/b - 11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-11/2\ b + 11/2\ b - 11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-11/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

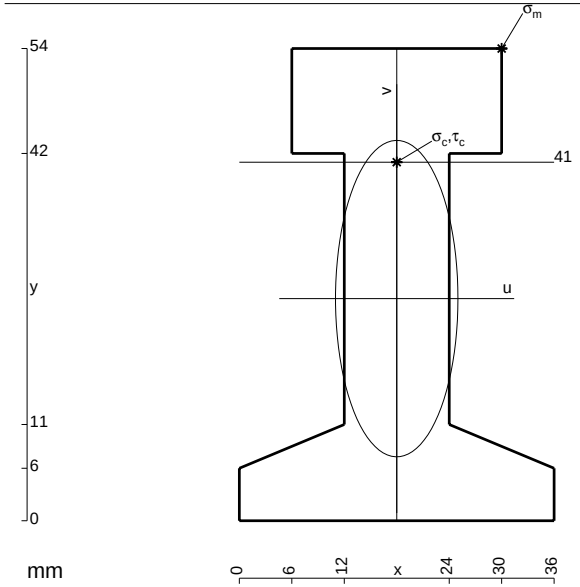
$= (-11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-3/2\ x/b + 3/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-3/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

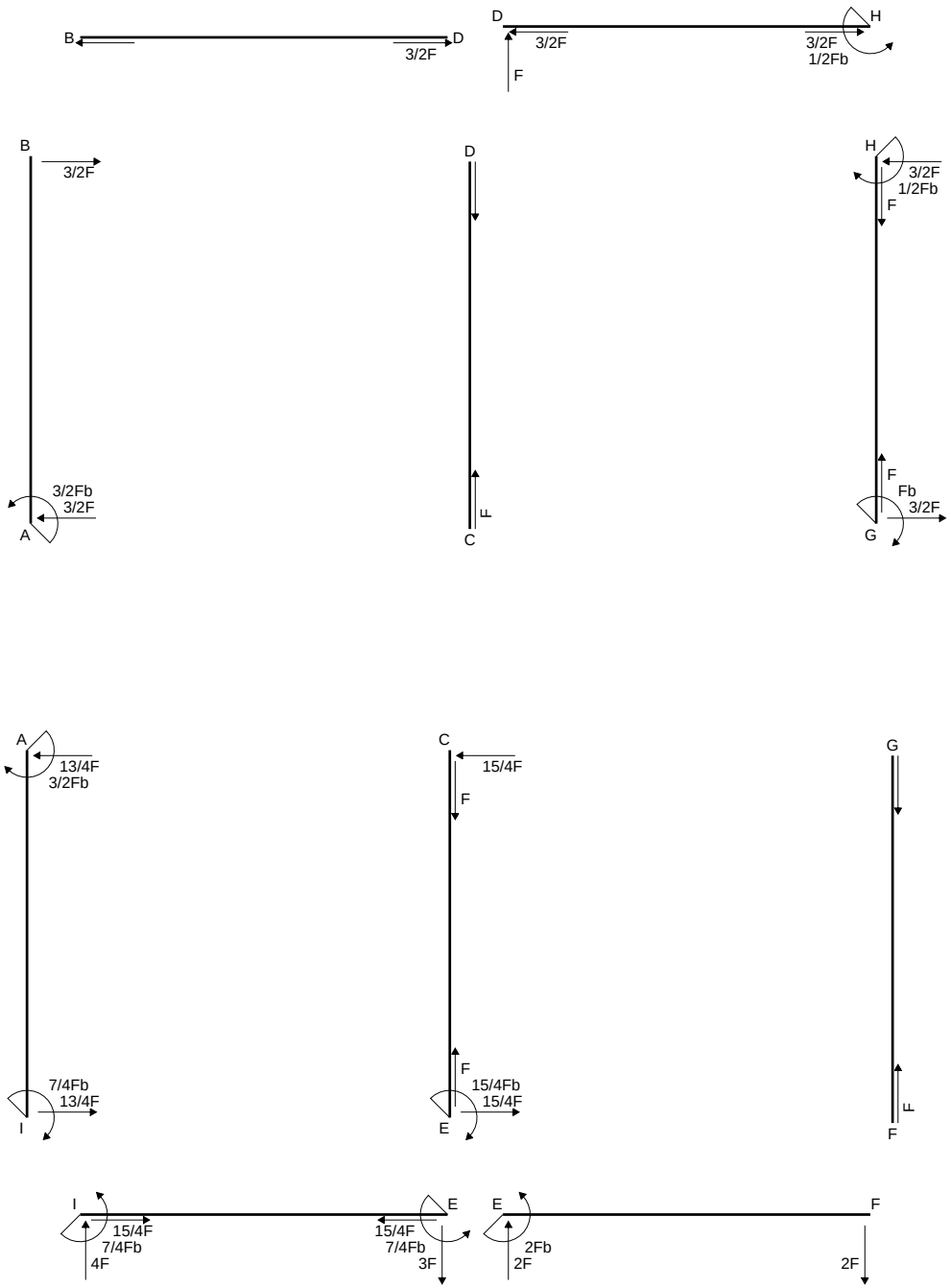
$= (-3/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = -1/4\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-3/2\ x/b + 3/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-3/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-3/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = -1/4\ Fb^2/EJ$



A = 996. mm^2
J_u = 326037. mm^4
J_v = 48816. mm^4
y_g = 25.4 mm
T_y = 3360. N
M_x = -2268000. Nmm
x_m = 30. mm
y_m = 54. mm
u_m = 12. mm
v_m = 28.6 mm
$\sigma_m = -Mv/J_u$ = 198.9 N/mm^2
x_c = 18. mm
y_c = 41. mm
v_c = 15.6 mm
$\sigma_c = -Mv/J_u$ = 108.5 N/mm^2
τ_c = 5.755 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 109. N/mm^2
S^* = 6702. mm^3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E
G
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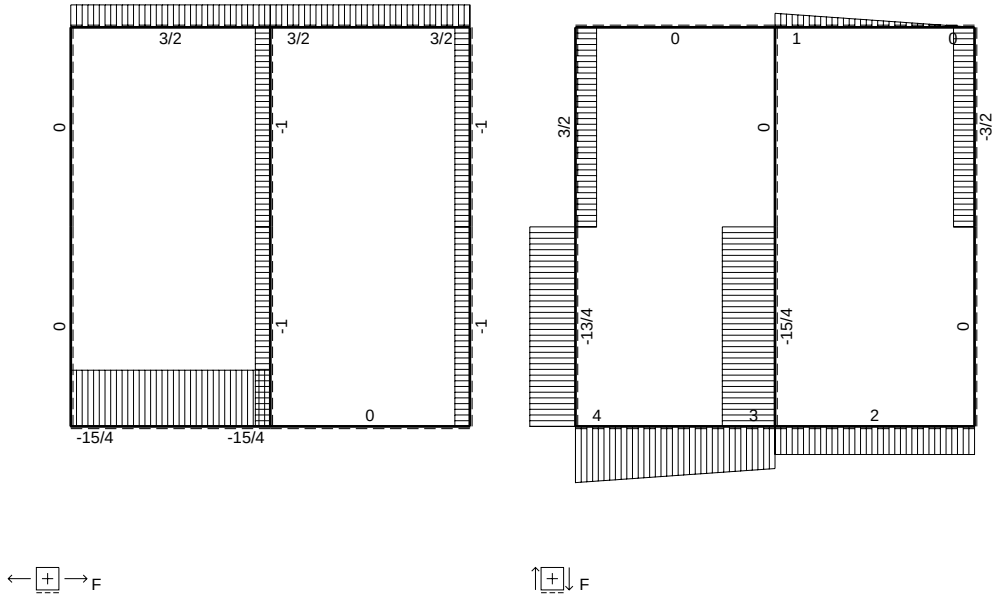
2Fb
2F
F
2F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F
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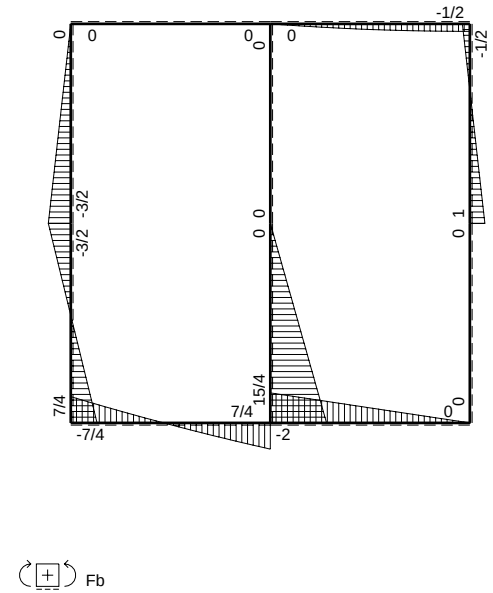
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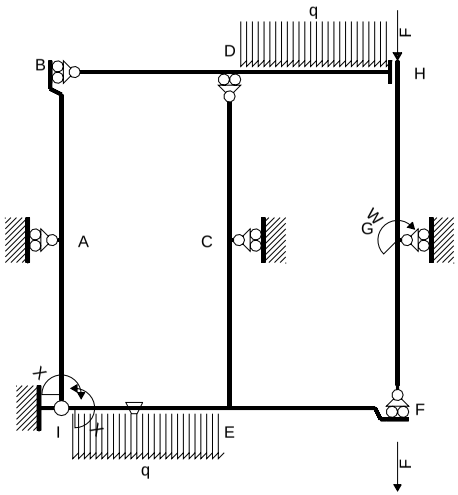
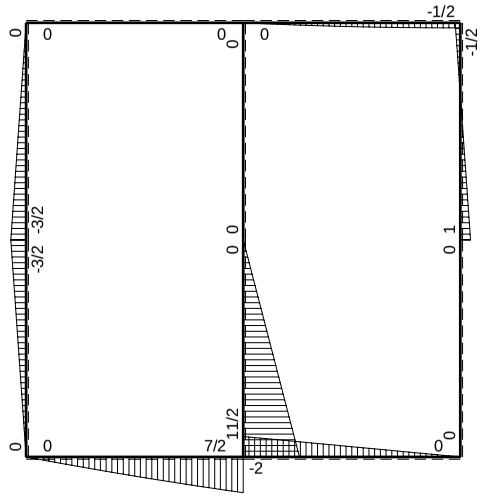
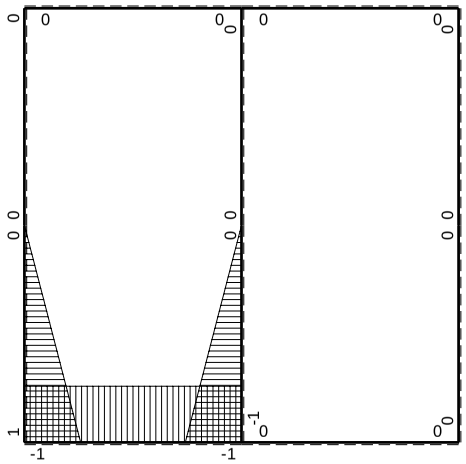
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 992677 CI07.xxxx.076

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PROCEDIMENTO E RISULTATI 992677 CI07.xxxx.076

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-3/2Fb+3/2Fx	0	0	0	0	0+0	0
BA b	0	3/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	Fb-3/2Fx	0	0	0	0	0+0	0
HG b	0	1/2Fb-3/2Fx	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$4Fx-1/2qx^2$	-Fb/EJ	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	-1+x/b	11/2Fb-11/2Fx	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-11/2Fx	0	$-11/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-3/2Fx	0	$-3/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/4+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	3/2Fb-3/2Fx	0	$-3/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-35/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						7/4Fb	

Sviluppi di calcolo iperstatica

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$L^{XX}_{IE} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EI} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EC} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{CE} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{IA} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{AI} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{Xo}_{IE} = \int_o^b (-4\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L^{Xo}_{EI} = \int_o^b (-7/2 + 3\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx$

$= [-7/2\ x + 3/2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-7/2\ b + 3/2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L^{Xo}_{EC} = \int_o^b (-11/2 + 11\ x/b - 11/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-11/2\ x + 11/2\ x^2/b - 11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-11/2\ b + 11/2\ b - 11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L^{Xo}_{CE} = \int_o^b (-11/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

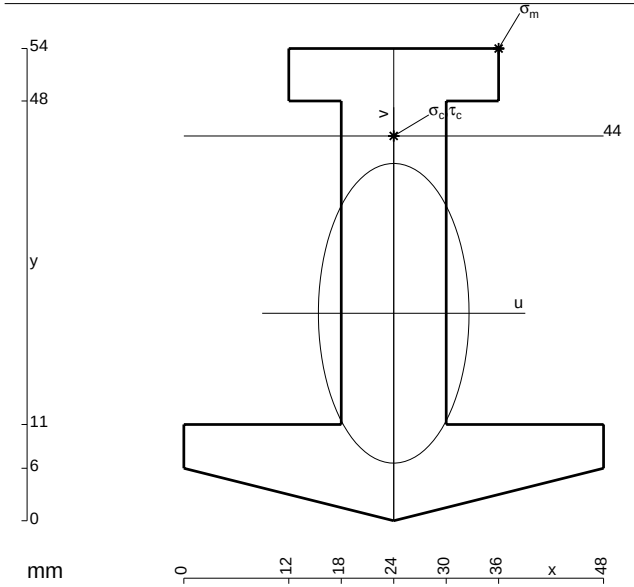
$L^{Xo}_{IA} = \int_o^b (-3/2\ x/b + 3/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-3/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-3/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = -1/4\ Fb^2/EJ$

$L^{Xo}_{AI} = \int_o^b (-3/2\ x/b + 3/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-3/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-3/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = -1/4\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 992677 CI07.xxxx.076



A = 972. mm^2
J_u = 285465. mm^4
J_v = 72144. mm^4
y_g = 23.72 mm
T_y = 2300. N
M_x = -1978000. Nmm
x_m = 36. mm
y_m = 54. mm
u_m = 12. mm
v_m = 30.28 mm
$\sigma_m = -Mv/J_u$ = 209.8 N/mm^2
x_c = 24. mm
y_c = 44. mm
v_c = 20.28 mm
$\sigma_c = -Mv/J_u$ = 140.5 N/mm^2
τ_c = 3.355 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 140.6 N/mm^2
S^* = 4997. mm^3

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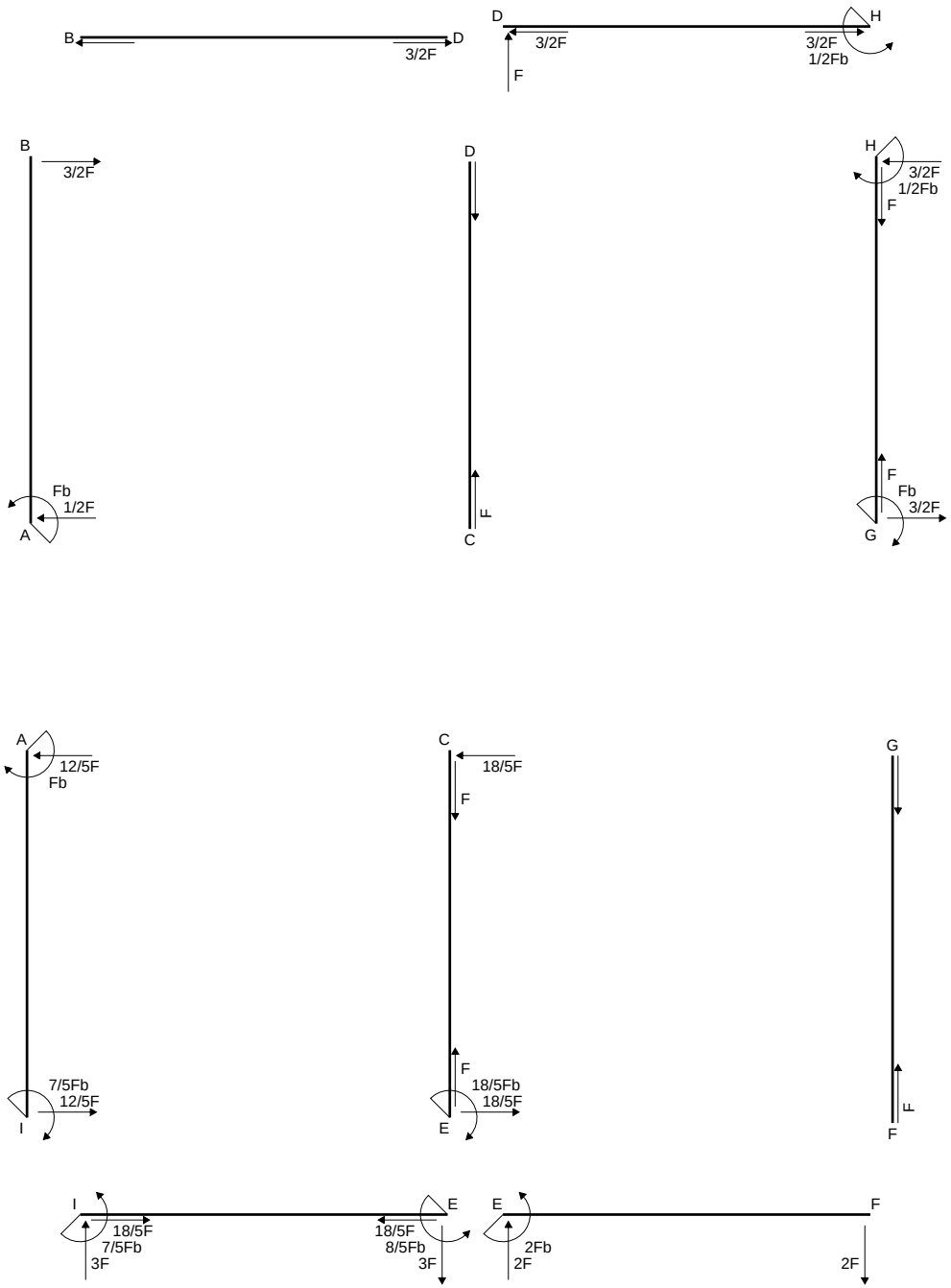
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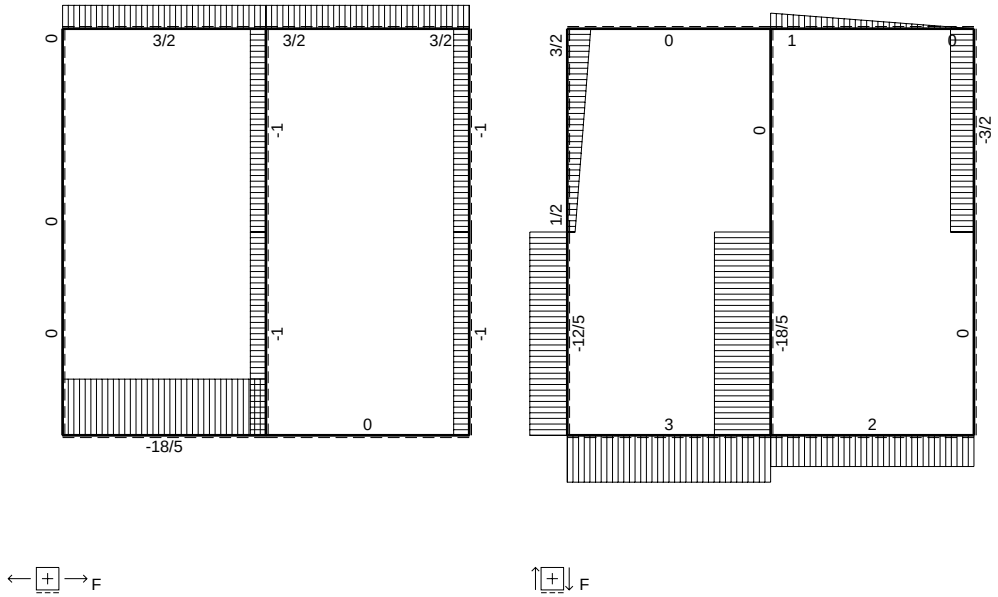
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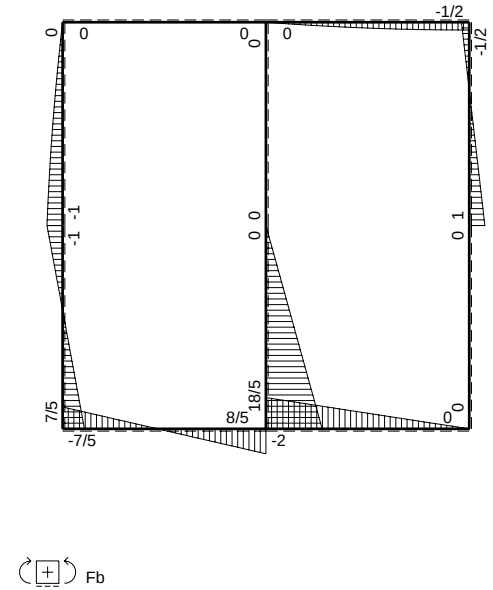
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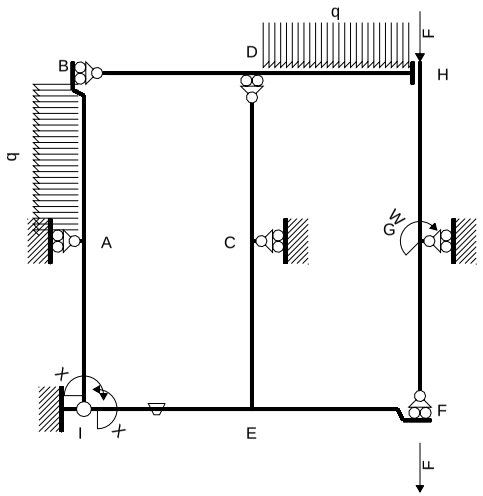
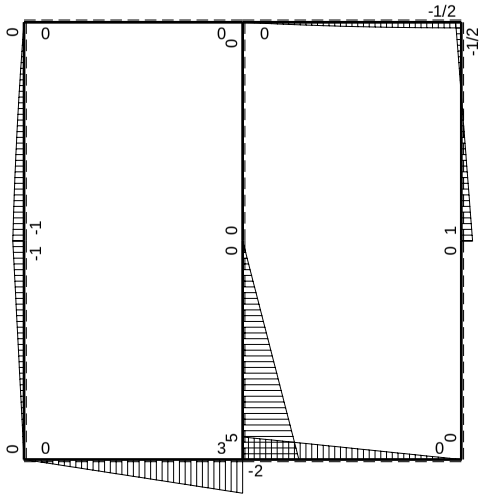
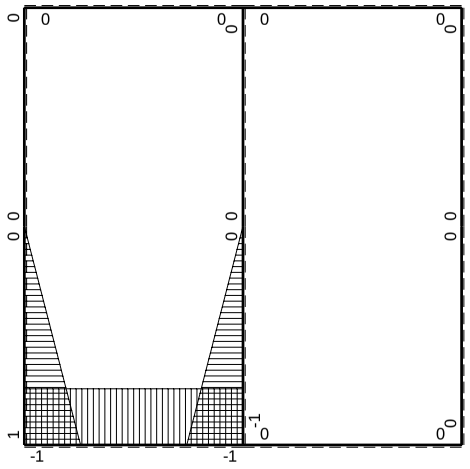


Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 209820 CI07.xxxx.077

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$-Fb+1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$3/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-3/2Fx$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-3/2Fx$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-5Fx$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-Fx$	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$Fb-Fx$	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-7/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$7/5Fb$	

PROCEDIMENTO E RISULTATI 209820 CI07.xxxx.077

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

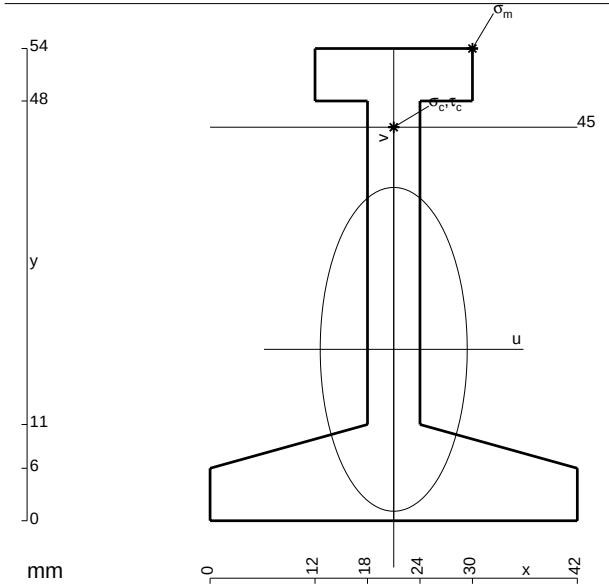
$L_{IA}^{Xo} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 209820 CI07.xxxx.077



A = 702. mm^2
J_u = 240790. mm^4
J_v = 49626. mm^4
y_g = 19.6 mm
T_y = 1680. N
M_x = -1528800. Nmm
x_m = 30. mm
y_m = 54. mm
u_m = 9. mm
v_m = 34.4 mm
$\sigma_m = -Mv/J_u$ = 218.4 N/mm^2
x_c = 21. mm
y_c = 45. mm
v_c = 25.4 mm
$\sigma_c = -Mv/J_u$ = 161.3 N/mm^2
τ_c = 4.507 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 161.5 N/mm^2
S^* = 3876. mm^3

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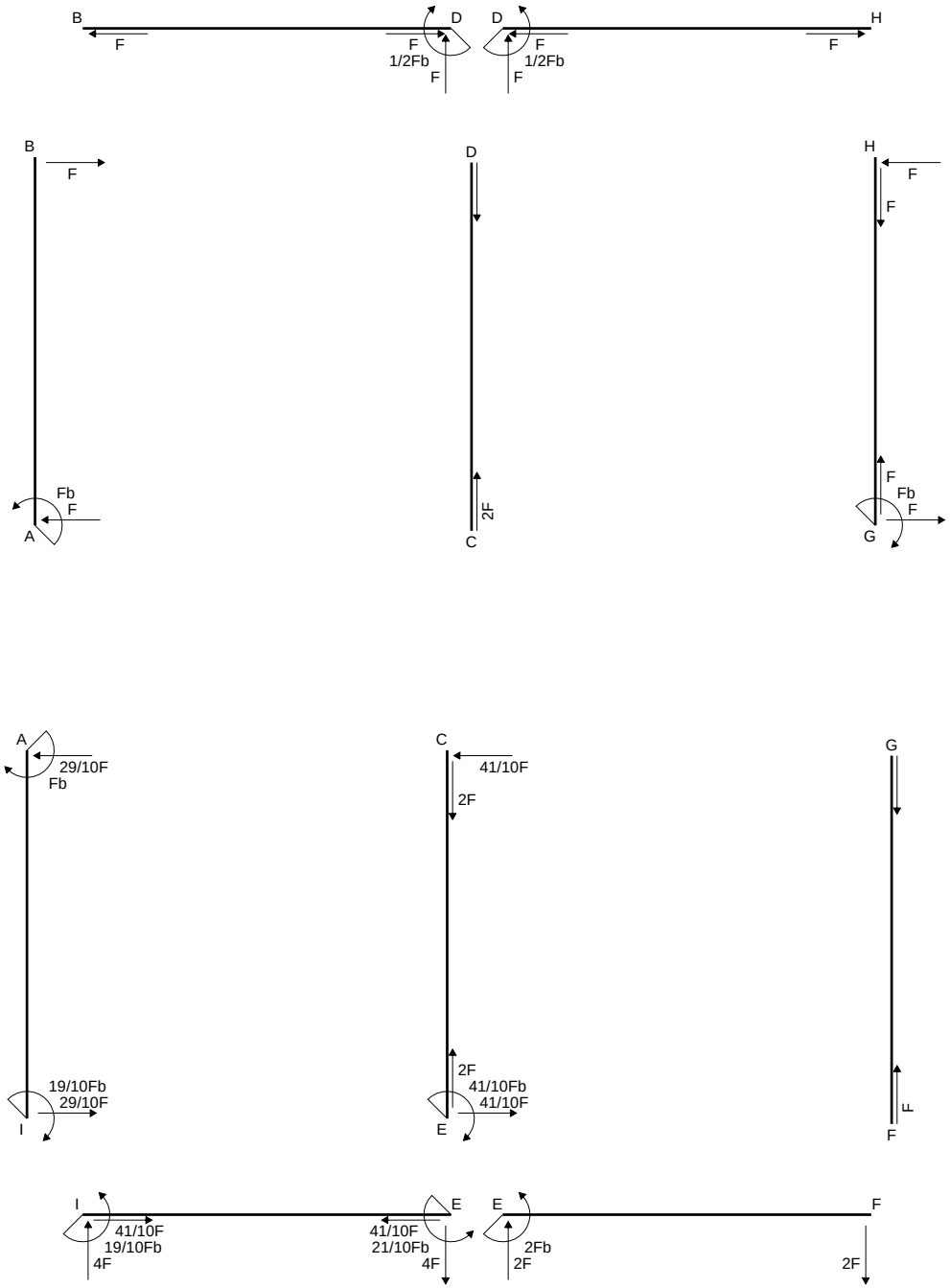
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G
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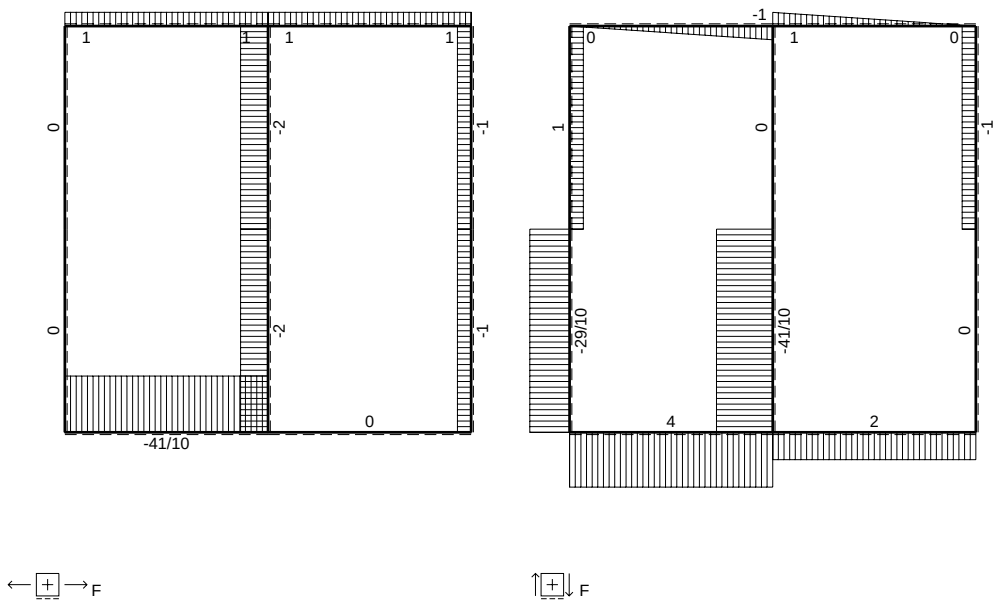
2F
2F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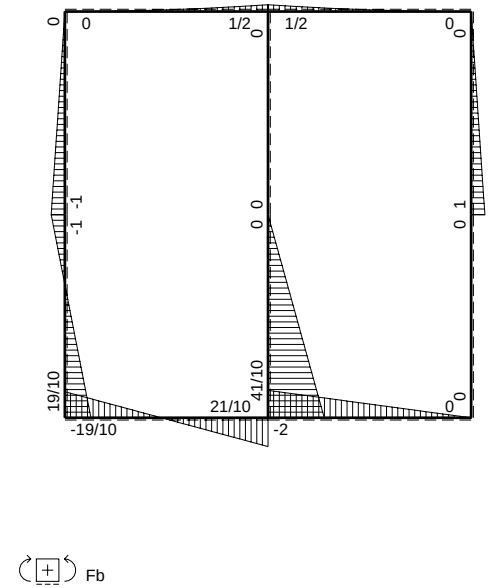
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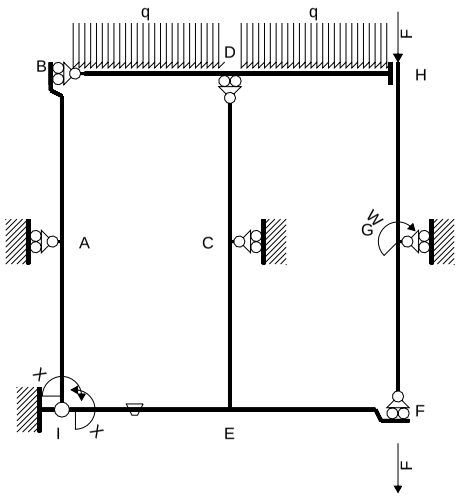
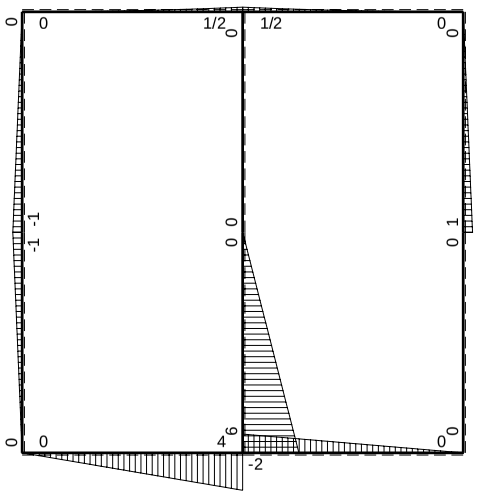
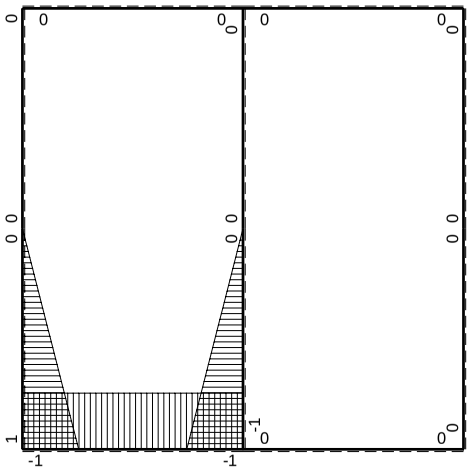
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 963079 CI07.xxxx.078

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	Fb-Fx	0	0	0	0	0+0	0
HG b	0	-Fx	0	0	0	0		
HD b	0	$1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	4Fx	-Fb/EJ	-4Fx	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-4Fb+4Fx	Fb/EJ	-4Fb+4Fx	Fb/EJ	1		
EC b	-1+x/b	6Fb-6Fx	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-6Fx^2/b$	0	$-6Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-Fx	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	Fb-Fx	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-19/6Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						19/10Fb	

Sviluppi di calcolo iperstatica

PROCEDIMENTO E RISULTATI 963079 CI07.xxxx.078
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$L^{XX}_{IE} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EI} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EC} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{CE} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{IA} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{AI} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{Xo}_{IE} = \int_o^b (-4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L^{Xo}_{EI} = \int_o^b (-4 + 4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-4\ x + 2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-4\ b + 2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L^{Xo}_{EC} = \int_o^b (-6 + 12\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-6\ x + 6\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-6\ b + 6\ b - 2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

$L^{Xo}_{CE} = \int_o^b (-6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

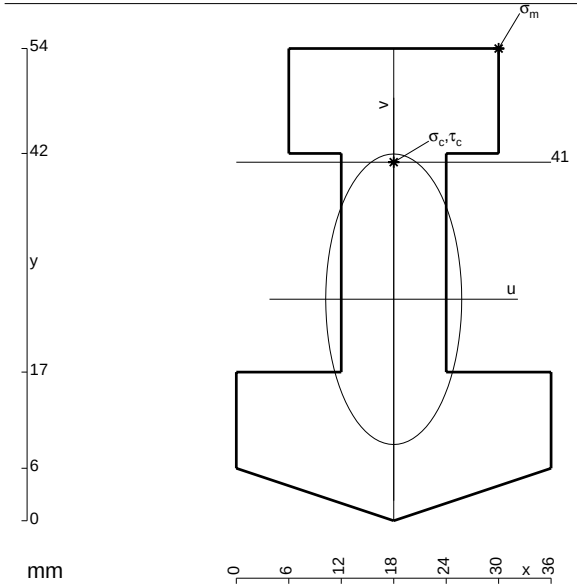
$= (-2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

$L^{Xo}_{IA} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

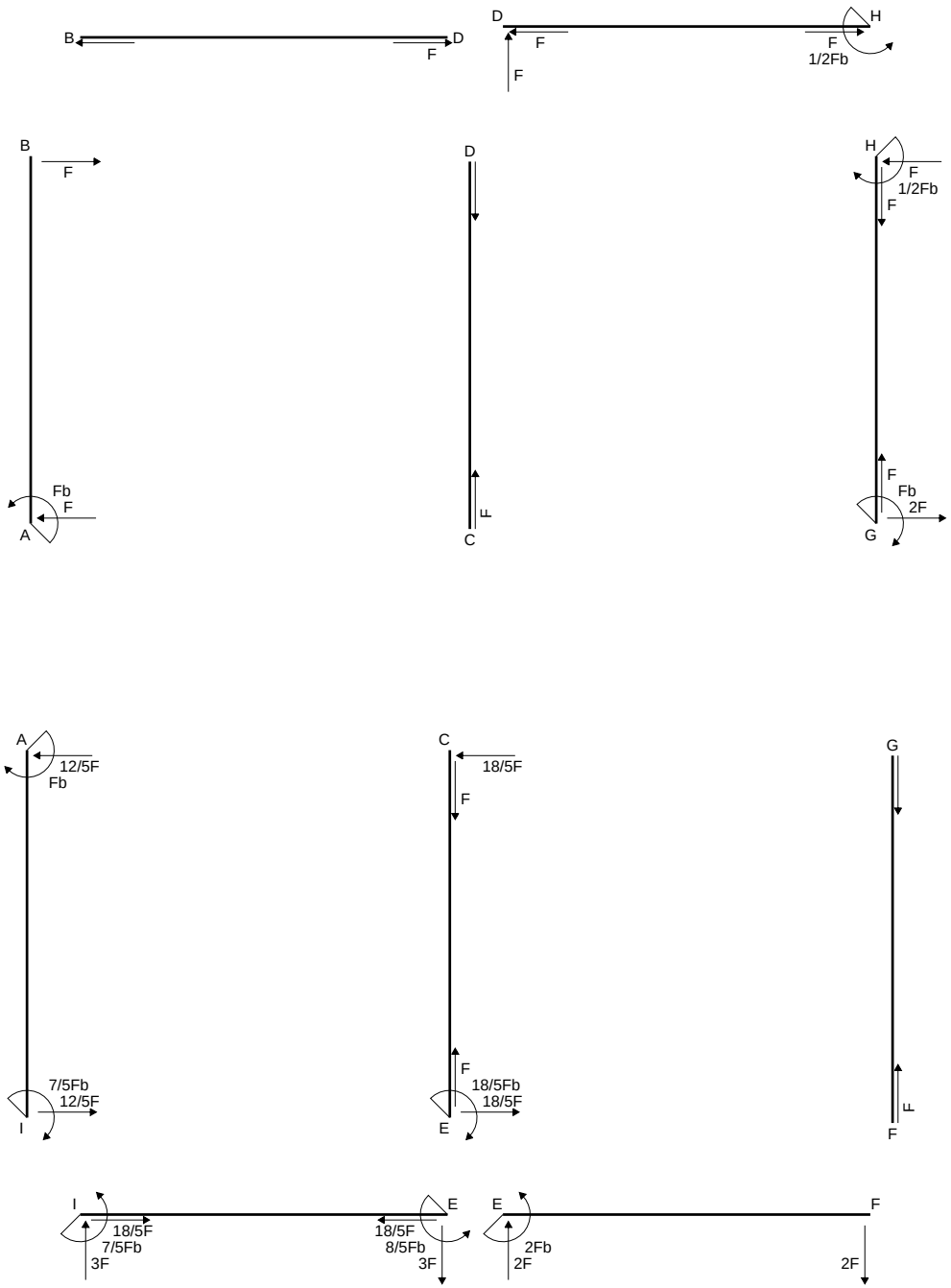
$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$

$L^{Xo}_{AI} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$



A = 1092. mm^2
J_u = 301397. mm^4
J_v = 66024. mm^4
y_g = 25.33 mm
T_y = 2480. N
M_x = -2405600. Nmm
x_m = 30. mm
y_m = 54. mm
u_m = 12. mm
v_m = 28.67 mm
$\sigma_m = -Mv/J_u$ = 228.8 N/mm^2
x_c = 18. mm
y_c = 41. mm
v_c = 15.67 mm
$\sigma_c = -Mv/J_u$ = 125.1 N/mm^2
τ_c = 4.61 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 125.3 N/mm^2
S^* = 6723. mm^3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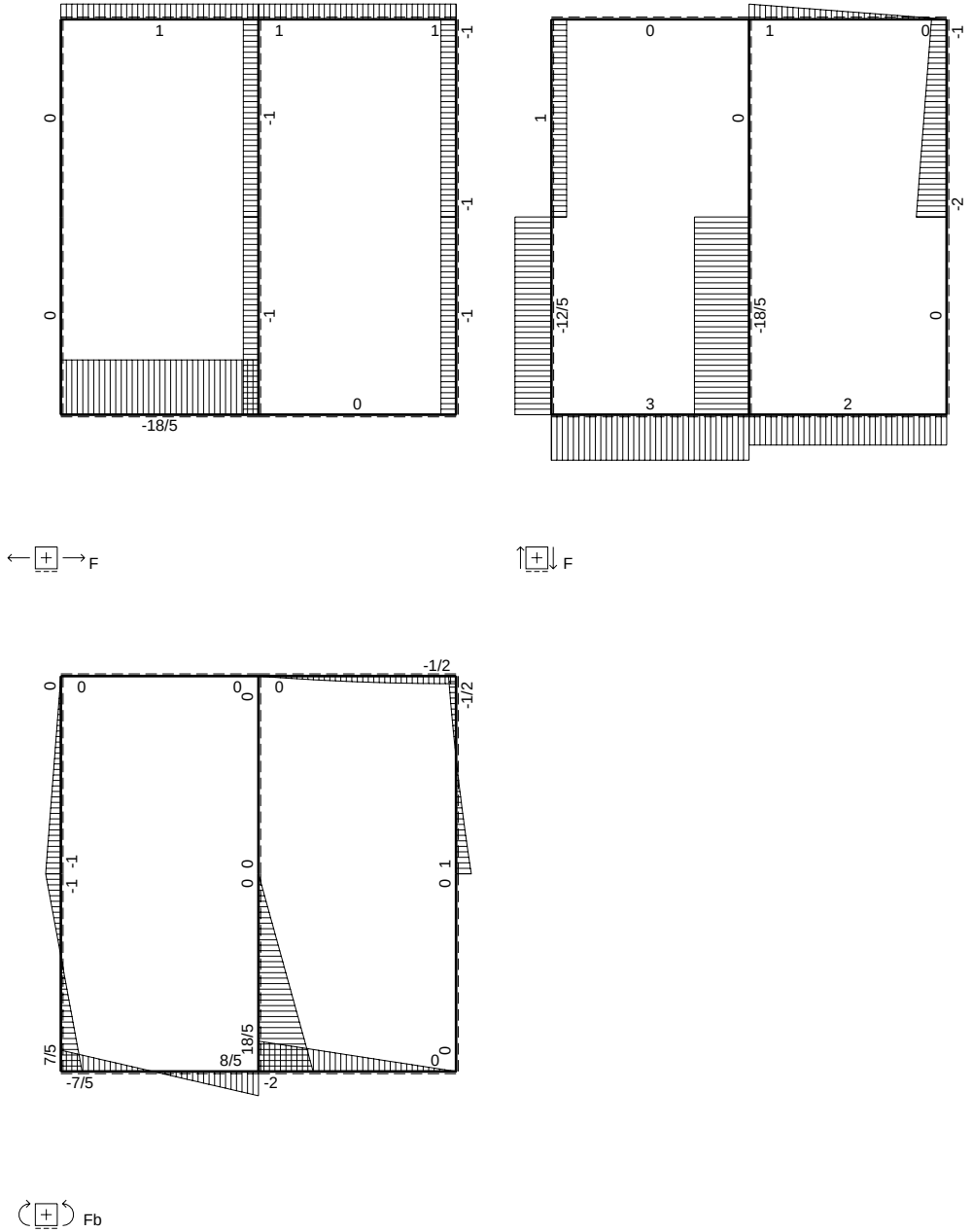
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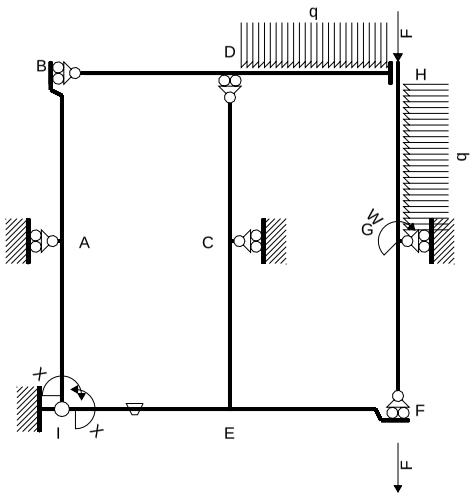
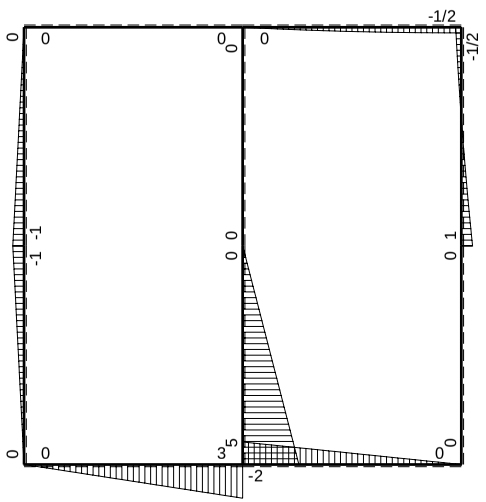


Schema di calcolo iperstatico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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-Fx-1/2qx^2$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-5Fx	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-5Fx	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-Fx	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	Fb-Fx	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-7/3Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						7/5Fb	

PROCEDIMENTO E RISULTATI 962891 CI07.xxxx.079

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

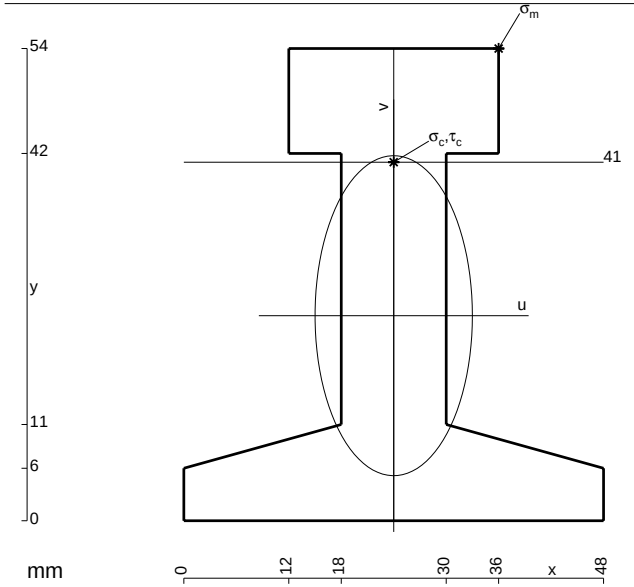
$L_{IA}^{Xo} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$

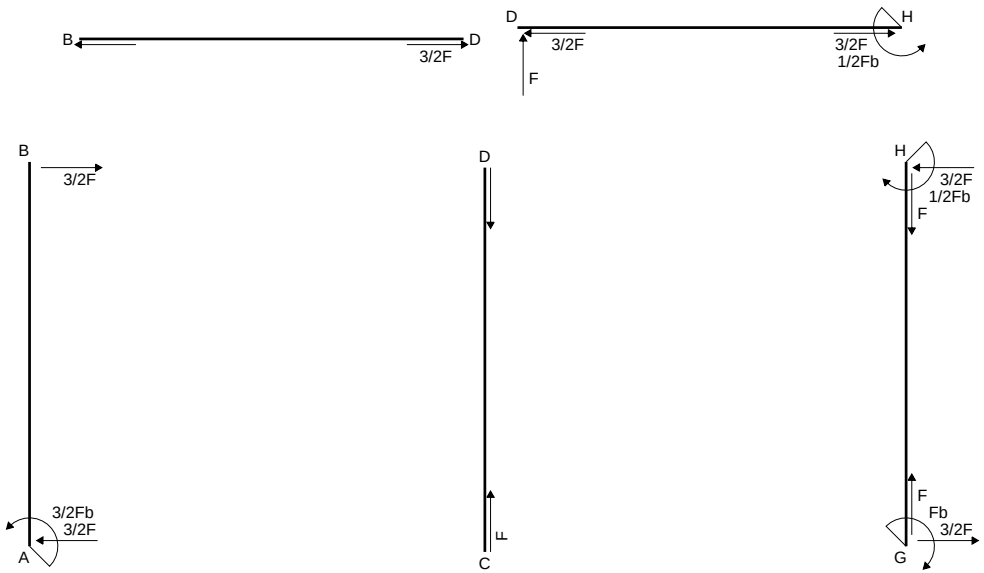
$L_{AI}^{Xo} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 962891 CI07.xxxx.079



A = 1098. mm^2
J_u = 367673. mm^4
J_v = 88884. mm^4
y_g = 23.45 mm
T_y = 2820. N
M_x = -2876400. Nmm
x_m = 36. mm
y_m = 54. mm
u_m = 12. mm
v_m = 30.55 mm
$\sigma_m = -Mv/J_u$ = 239. N/mm^2
x_c = 24. mm
y_c = 41. mm
v_c = 17.55 mm
$\sigma_c = -Mv/J_u$ = 137.3 N/mm^2
τ_c = 4.658 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 137.6 N/mm^2
S^* = 7288. mm^3


B
D
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D
H
3/2F
3/2F
1/2Fb
F
B
3/2F
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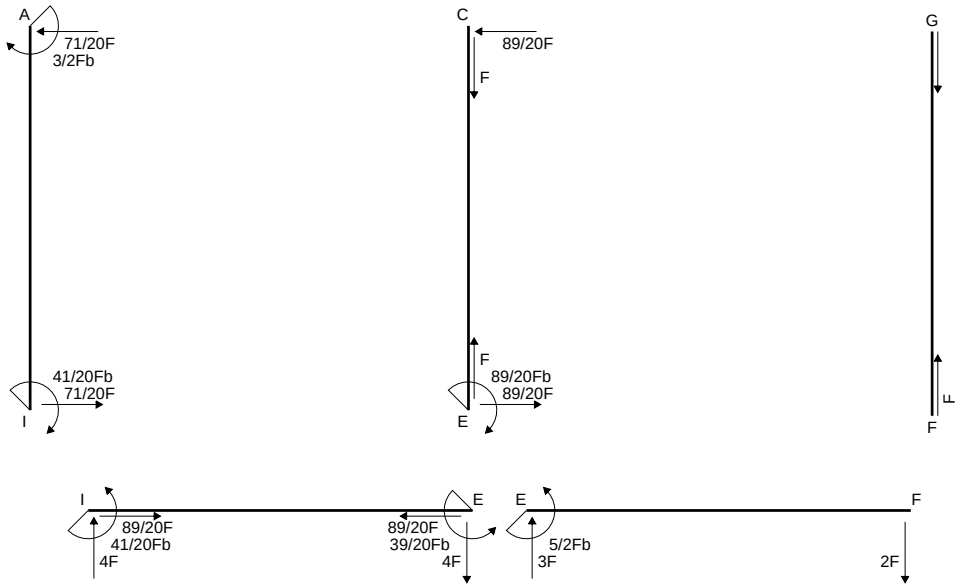
Fb
3/2F
G


A
71/20F
3/2Fb
C
89/20F
F
G
41/20Fb
71/20F
I
F
89/20Fb
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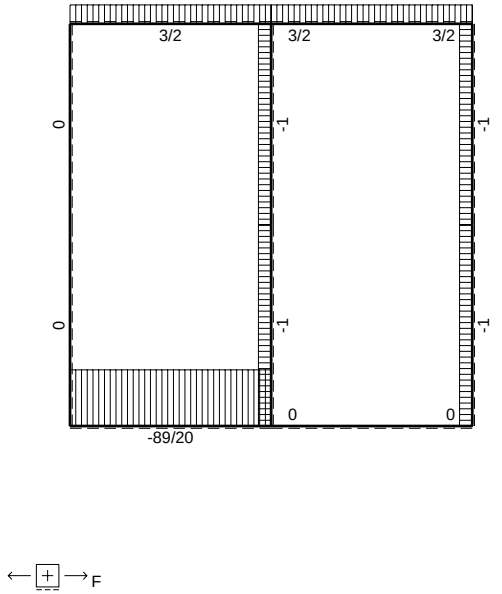
E
F
I
E
E
F
89/20F
41/20Fb
4F
89/20F
39/20Fb
4F
5/2Fb
3F
2F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3/2
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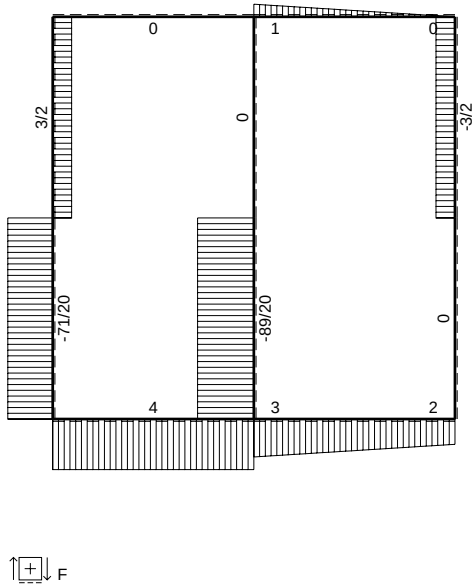
-1
-1
0
0
-89/20
F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0
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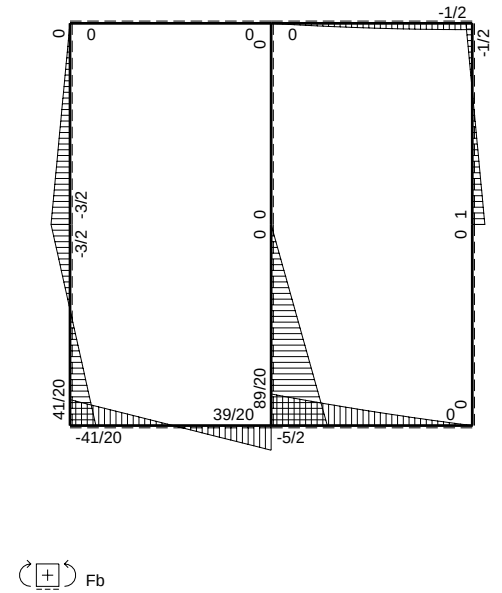
-71/20
-89/20
0
4
3
2
F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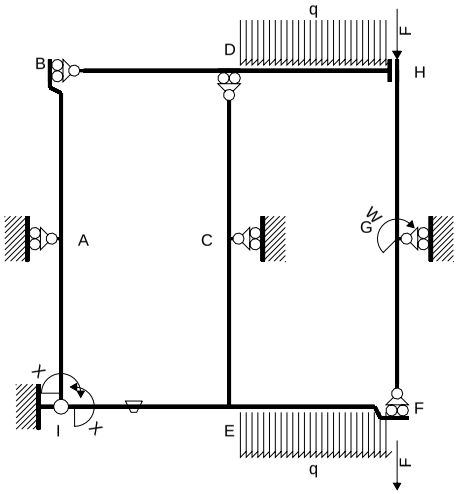
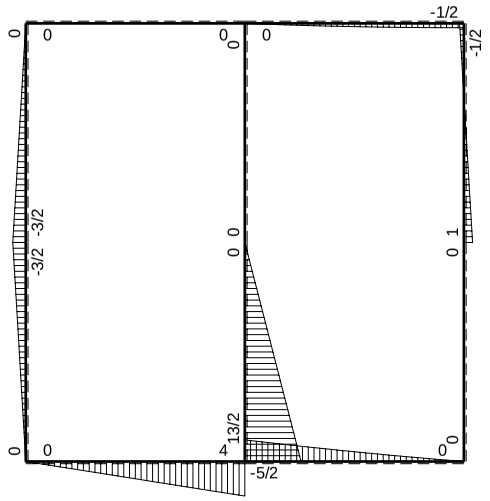
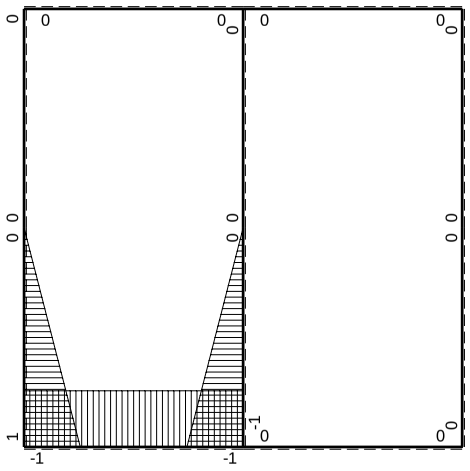
-3/2
0 0
0 1
41/20
89/20
39/20
0
-41/20
-5/2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 211949 CI07.xxxx.080

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PROCEDIMENTO E RISULTATI 211949 CI07.xxxx.080

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-3/2Fb+3/2Fx	0	0	0	0	0+0	0
BA b	0	3/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-5/2Fb+3Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$2Fx+1/2qx^2$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	Fb-3/2Fx	0	0	0	0	0+0	0
HG b	0	1/2Fb-3/2Fx	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	4Fx	-Fb/EJ	-4Fx	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-4Fb+4Fx	Fb/EJ	-4Fb+4Fx	Fb/EJ	1		
EC b	-1+x/b	13/2Fb-13/2Fx	0	$-13/2Fb+13Fx-13/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-13/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-13/2Fx	0	$-13/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-3/2Fx	0	$-3/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/4+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	3/2Fb-3/2Fx	0	$-3/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-41/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						41/20Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-4 + 4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-4\ x + 2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-4\ b + 2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-13/2 + 13\ x/b - 13/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-13/2\ x + 13/2\ x^2/b - 13/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-13/2\ b + 13/2\ b - 13/6\ b\ )\ Fb\ 1/EJ\ = -13/6\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-13/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-13/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

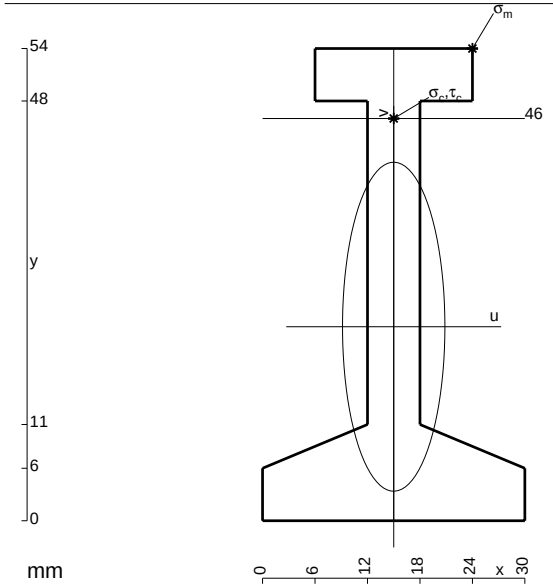
$= (-13/6\ b\ )\ Fb\ 1/EJ\ = -13/6\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-3/2\ x/b + 3/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-3/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

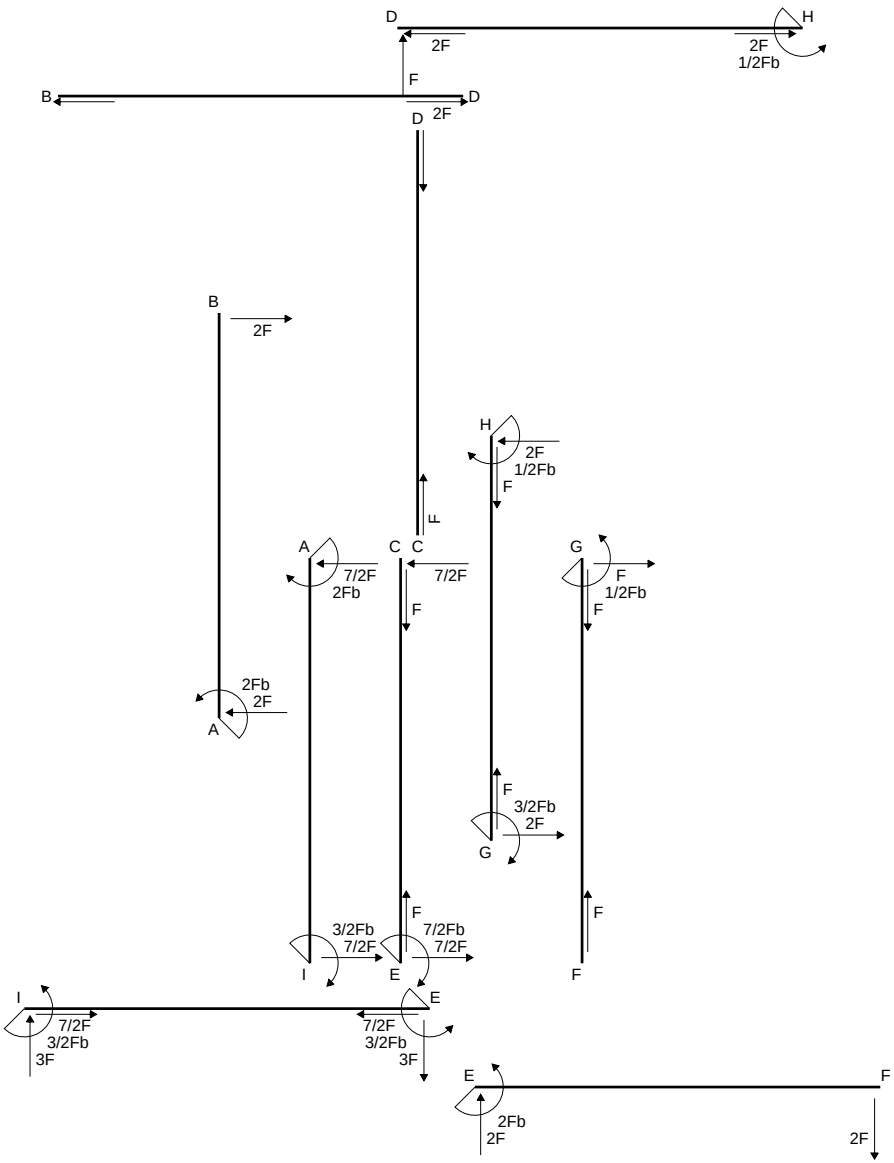
$= (-3/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = -1/4\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-3/2\ x/b + 3/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-3/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-3/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = -1/4\ Fb^2/EJ$



A = 600. mm^2
J_u = 212405. mm^4
J_v = 20592. mm^4
y_g = 22.19 mm
T_y = 2940. N
M_x = -1323000. Nmm
x_m = 24. mm
y_m = 54. mm
u_m = 9. mm
v_m = 31.81 mm
$\sigma_m = -Mv/J_u$ = 198.2 N/mm^2
x_c = 15. mm
y_c = 46. mm
v_c = 23.81 mm
$\sigma_c = -Mv/J_u$ = 148.3 N/mm^2
τ_c = 7.866 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 148.9 N/mm^2
S^* = 3410. mm^3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F
F
A
C C
G
7/2F
2Fb
7/2F
F
F
1/2Fb
F
2Fb
2F
A
F
3/2Fb
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I
E
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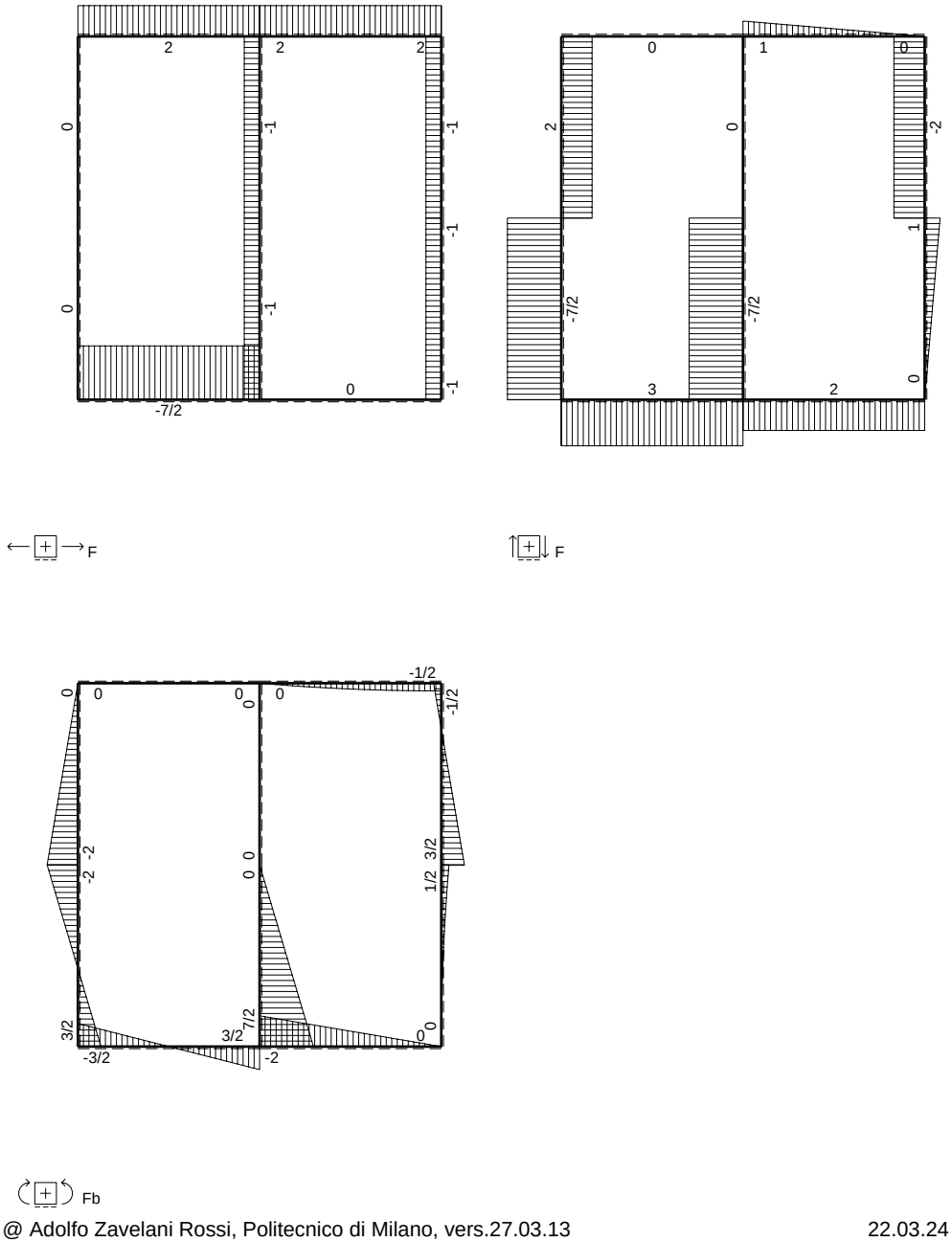
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F
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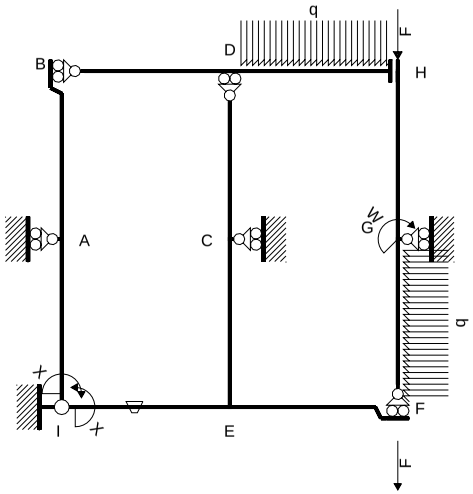
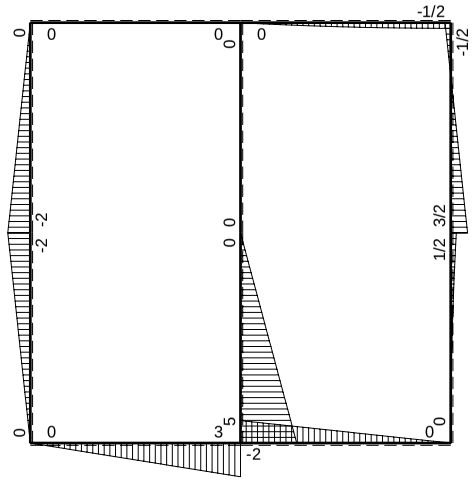
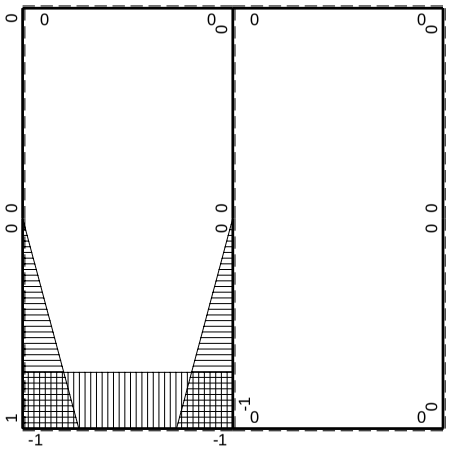


Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 937214 CI07.xxxx.081

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-2Fb+2Fx	0	0	0	0	0+0	0
BA b	0	2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	3/2Fb-2Fx	0	0	0	0	0+0	0
HG b	0	1/2Fb-2Fx	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	5Fb-5Fx	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-5Fx	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-2Fx	0	$-2Fx+2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/3+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	2Fb-2Fx	0	$-2Fx+2Fx^2/b$	0	x^2/b^2		
	totali						$-5/2Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						3/2Fb	

Sviluppi di calcolo iperstatica

PROCEDIMENTO E RISULTATI 937214 CI07.xxxx.081
@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

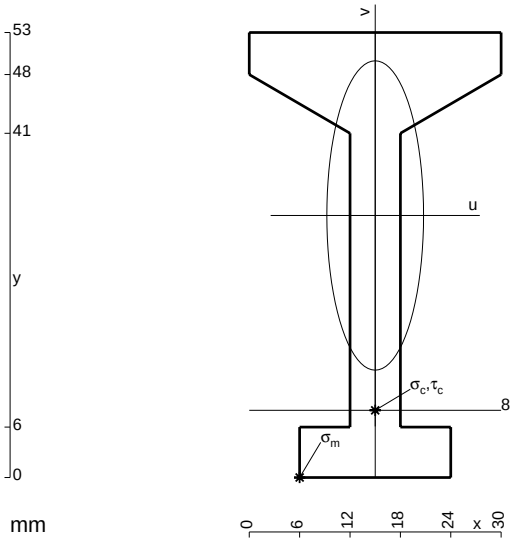
$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-2\ x/b + 2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-\ x^2/b + 2/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

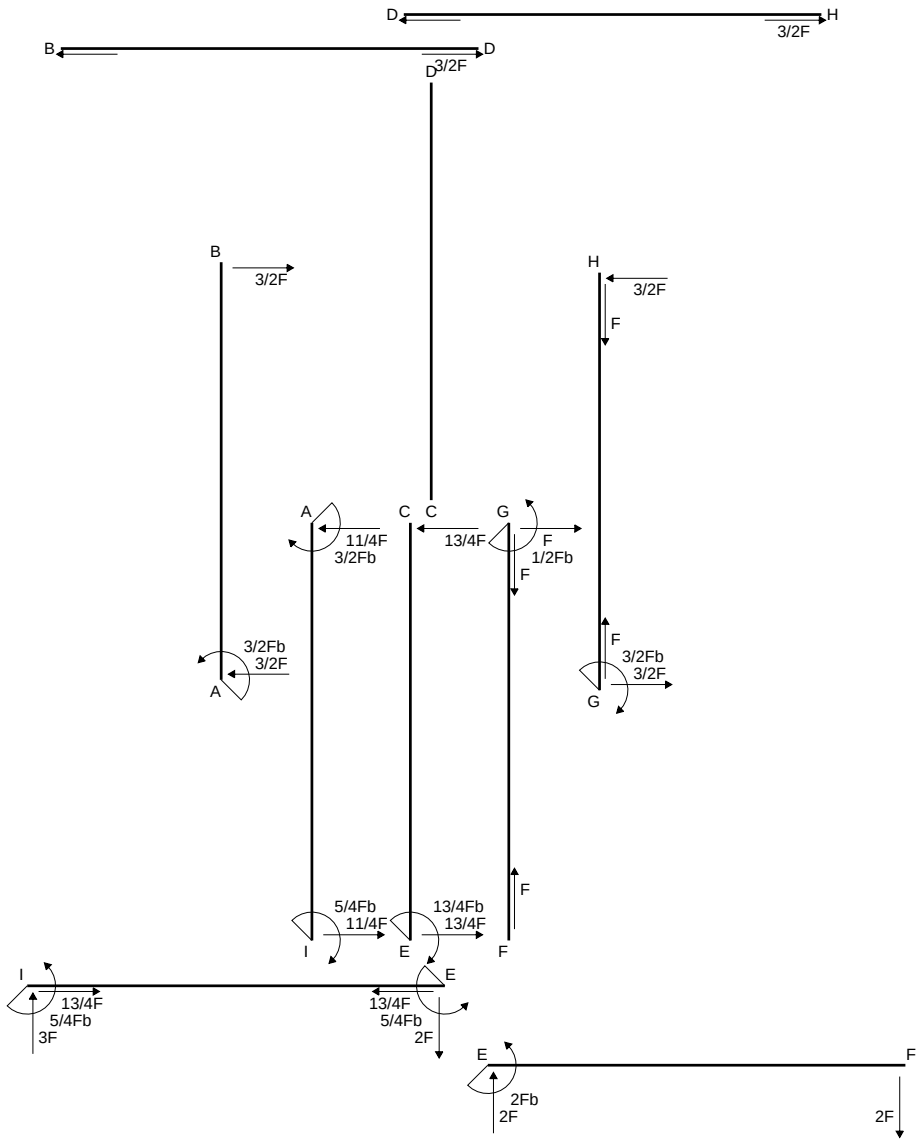
$= (-\ b + 2/3\ b\ )\ Fb\ 1/EJ\ = -1/3\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-2\ x/b + 2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-\ x^2/b + 2/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-\ b + 2/3\ b\ )\ Fb\ 1/EJ\ = -1/3\ Fb^2/EJ$



A = 594. mm^2
J_u = 201694. mm^4
J_v = 19710. mm^4
y_g = 31.21 mm
T_y = 2320. N
M_x = -1345600. Nmm
x_m = 6. mm
u_m = -9. mm
v_m = -31.21 mm
$\sigma_m = -Mv/J_u$ = -208.2 N/mm^2
x_c = 15. mm
y_c = 8. mm
v_c = -23.21 mm
$\sigma_c = -Mv/J_u$ = -154.8 N/mm^2
τ_c = 6.398 N/mm^2
$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2}$ = 155.2 N/mm^2
S^* = 3337. mm^3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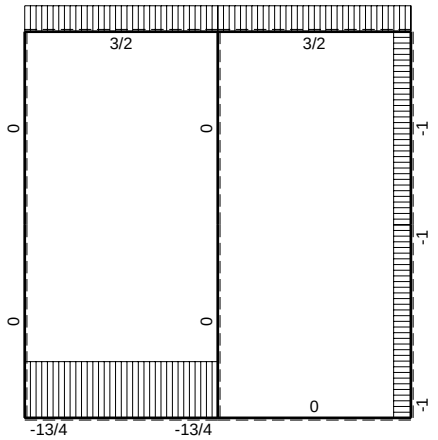
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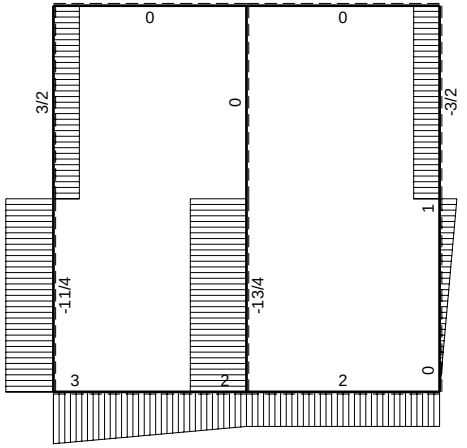
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2
2
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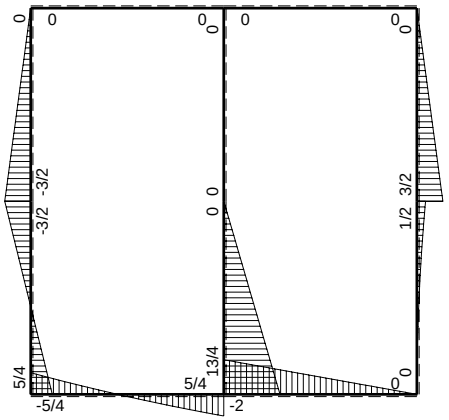
F

F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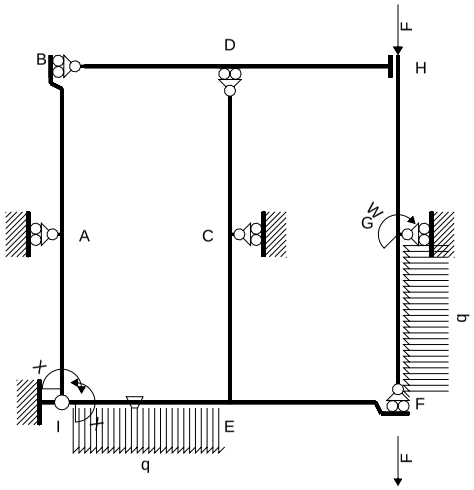
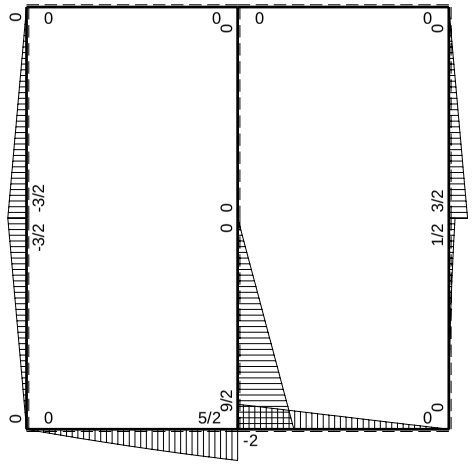
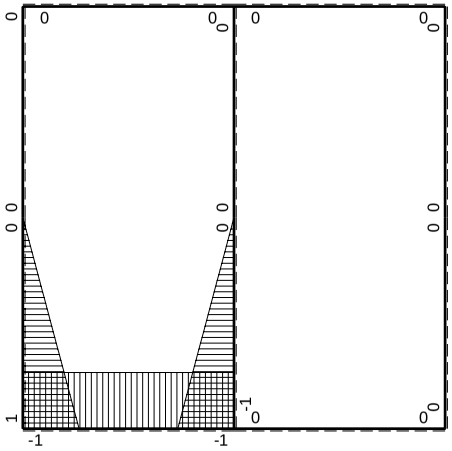
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 986591 CI07.xxxx.082

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PROCEDIMENTO E RISULTATI 986591 CI07.xxxx.082

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$-3/2Fb+3/2Fx$	0	0	0	0	0+0	0
BA b	0	$3/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$3/2Fb-3/2Fx$	0	0	0	0	0+0	0
HG b	0	$-3/2Fx$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx-1/2qx^2$	$-Fb/EJ$	$-3Fx+1/2Fx^2/b$	Fb/EJ	1	$(-4/3+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-5/2Fb+2Fx+1/2qx^2$	Fb/EJ	$-5/2Fb+2Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	$-1+x/b$	$9/2Fb-9/2Fx$	0	$-9/2Fb+9Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-9/2Fx$	0	$-9/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-3/2Fx$	0	$-3/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$3/2Fb-3/2Fx$	0	$-3/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-25/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$5/4Fb$	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/3\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-5/2 + 2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx$

$= [-5/2\ x + x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-5/2\ b + b + 1/6\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/3\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-9/2 + 9\ x/b - 9/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-9/2\ x + 9/2\ x^2/b - 3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-9/2\ b + 9/2\ b - 3/2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-9/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

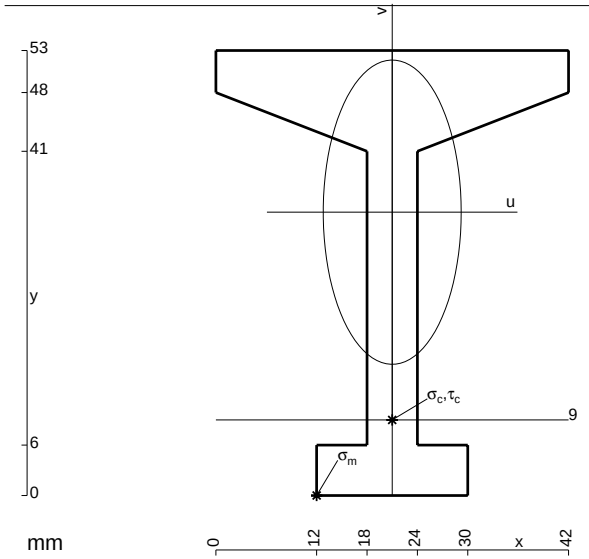
$= (-3/2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-3/2\ x/b + 3/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-3/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

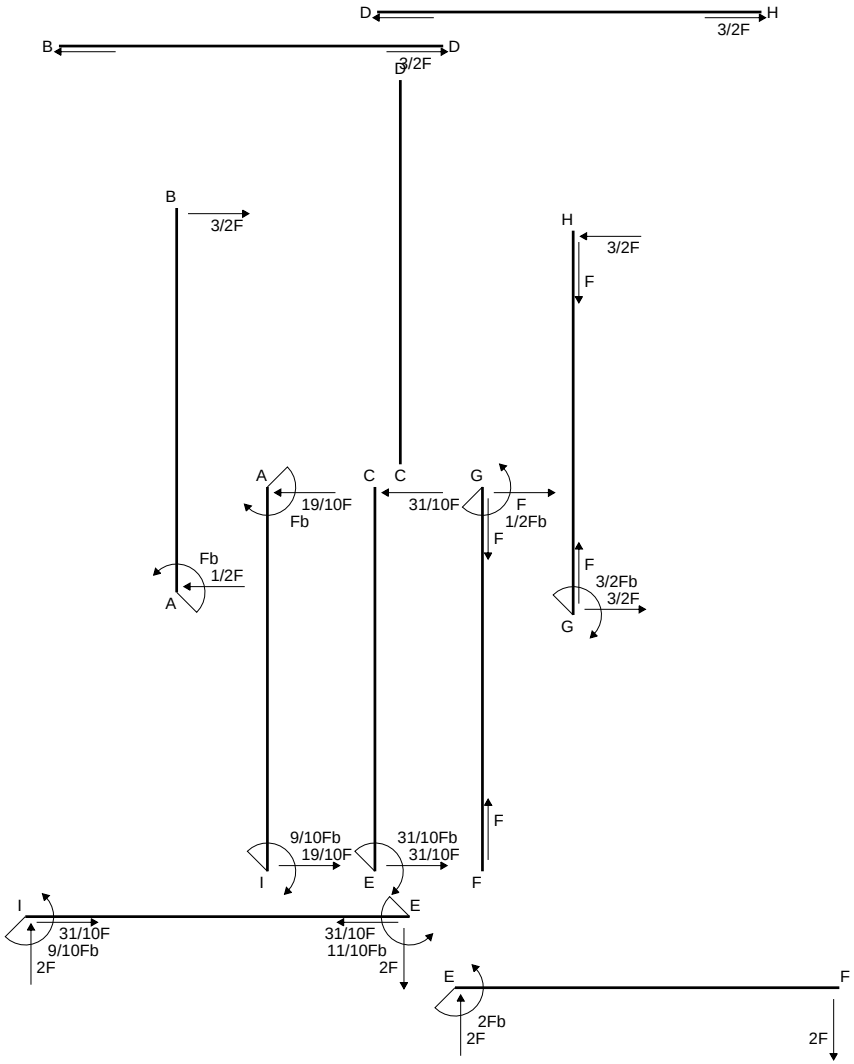
$= (-3/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = -1/4\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-3/2\ x/b + 3/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-3/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-3/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = -1/4\ Fb^2/EJ$



A = 696. mm^2
J_u = 228562. mm^4
J_v = 47016. mm^4
y_g = 33.75 mm
T_y = 2360. N
M_x = -1486800. Nmm
x_m = 12. mm
u_m = -9. mm
v_m = -33.75 mm
$\sigma_m = -Mv/J_u$ = -219.5 N/mm^2
x_c = 21. mm
y_c = 9. mm
v_c = -24.75 mm
$\sigma_c = -Mv/J_u$ = -161. N/mm^2
τ_c = 6.527 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 161.4 N/mm^2
S^* = 3793. mm^3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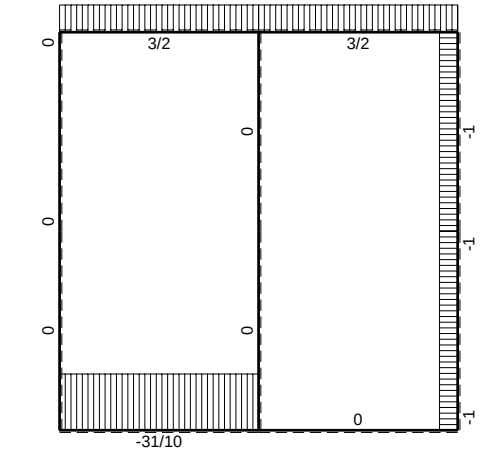
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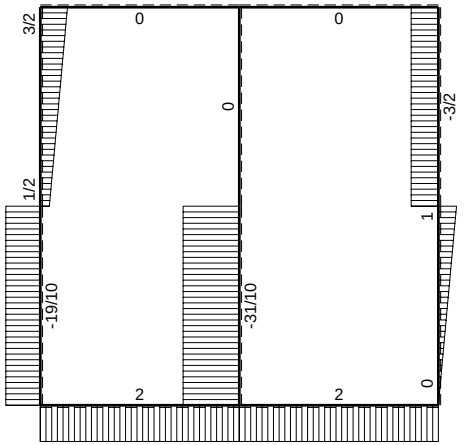
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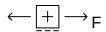
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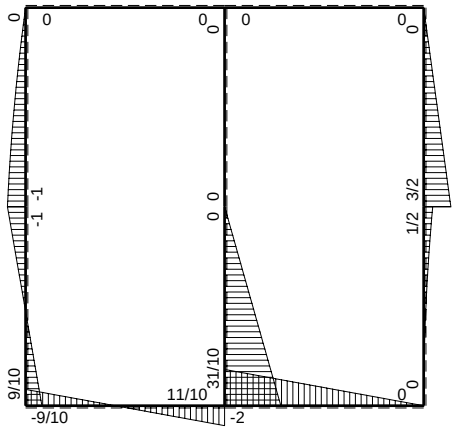
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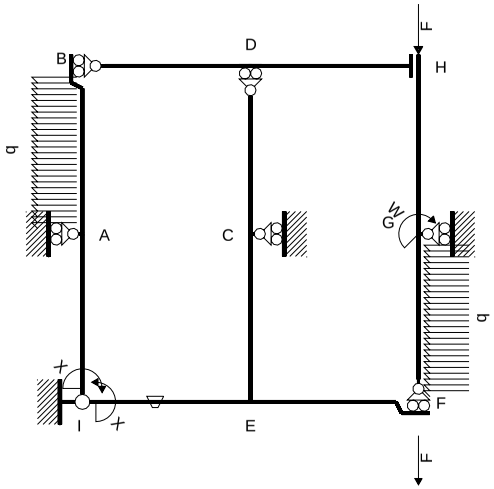
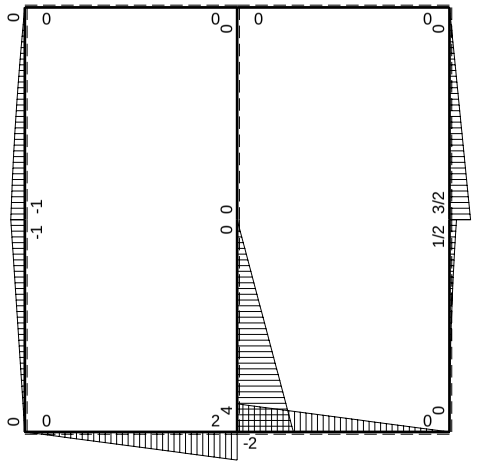
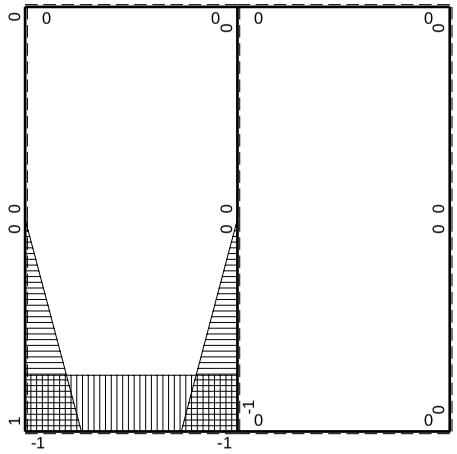


Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 939244 CI07.xxxx.083

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$-Fb+1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$3/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$3/2Fb-3/2Fx$	0	0	0	0	0+0	0
HG b	0	$-3/2Fx$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$4Fb-4Fx$	0	$-4Fb+8Fx-4Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-4/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-4Fx$	0	$-4Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-Fx$	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$Fb-Fx$	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-3/2Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						9/10Fb	

PROCEDIMENTO E RISULTATI 939244 CI07.xxxx.083

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L_{EI}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L_{EC}^{Xo} = \int_o^b (-4 + 8\ x/b - 4\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4\ x + 4\ x^2/b - 4/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-4\ b + 4\ b - 4/3\ b\ )\ Fb\ 1/EJ\ = -4/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-4\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

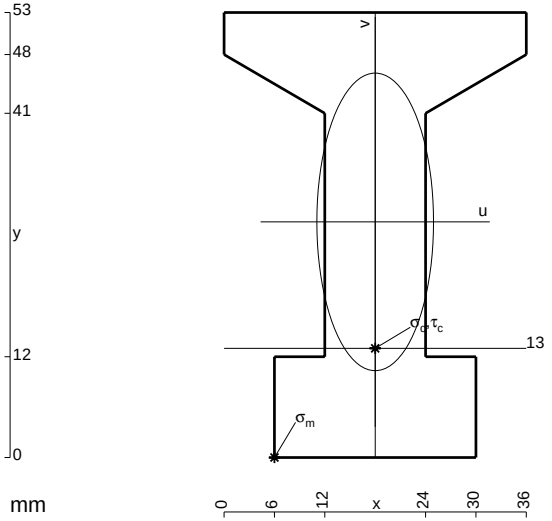
$= (-4/3\ b\ )\ Fb\ 1/EJ\ = -4/3\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

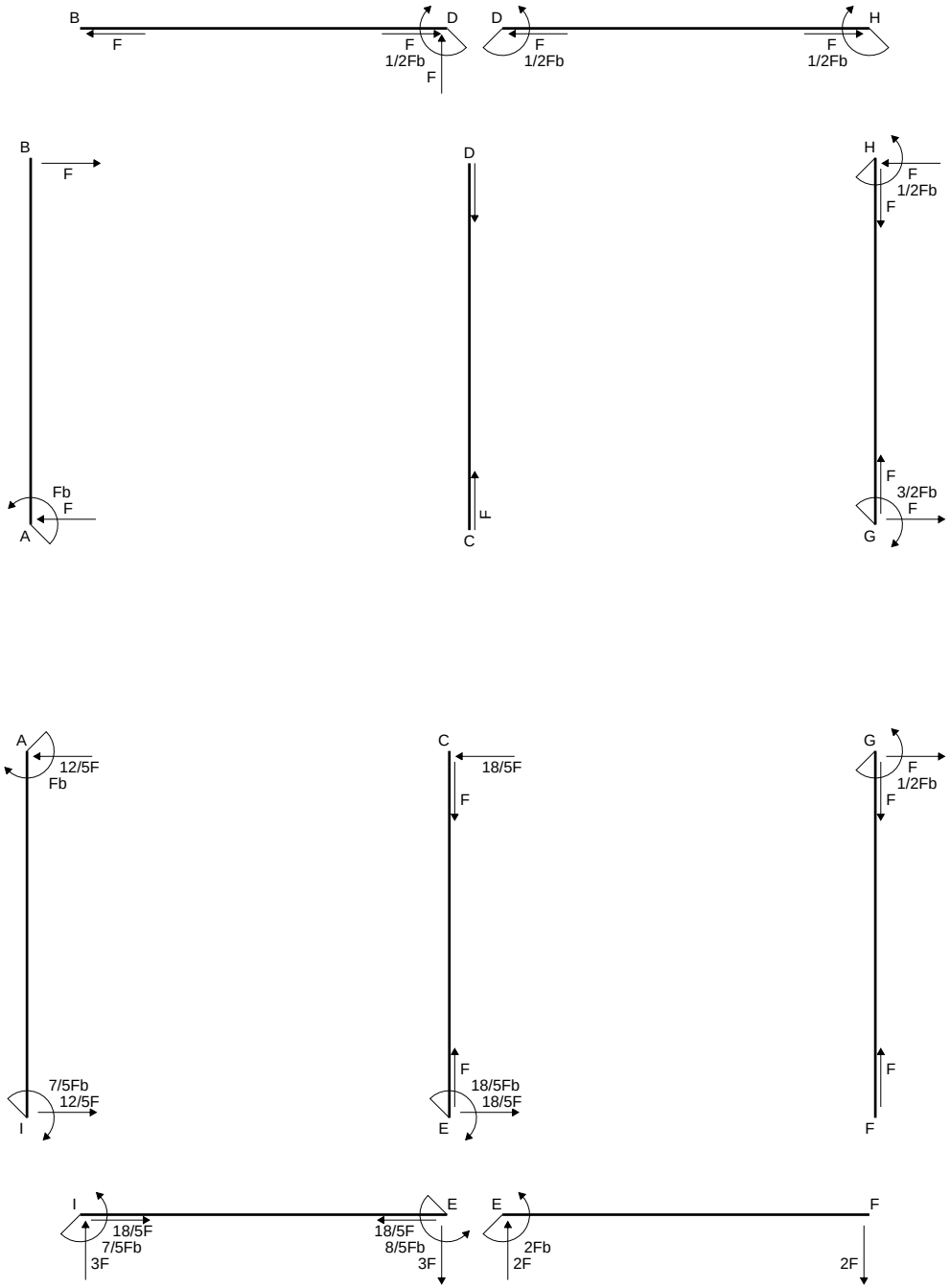
$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$



A = 984. mm^2
J_u = 309174. mm^4
J_v = 47520. mm^4
y_g = 28.06 mm
T_y = 3720. N
M_x = -2529600. Nmm
x_m = 6. mm
u_m = -12. mm
v_m = -28.06 mm
$\sigma_m = -Mv/J_u$ = -229.6 N/mm^2
x_c = 18. mm
y_c = 13. mm
v_c = -15.06 mm
$\sigma_c = -Mv/J_u$ = -123.2 N/mm^2
τ_c = 6.558 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 123.8 N/mm^2
S^* = 6541. mm^3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F
G
A
12/5F
Fb
7/5Fb
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F
F
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8/5Fb
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2F
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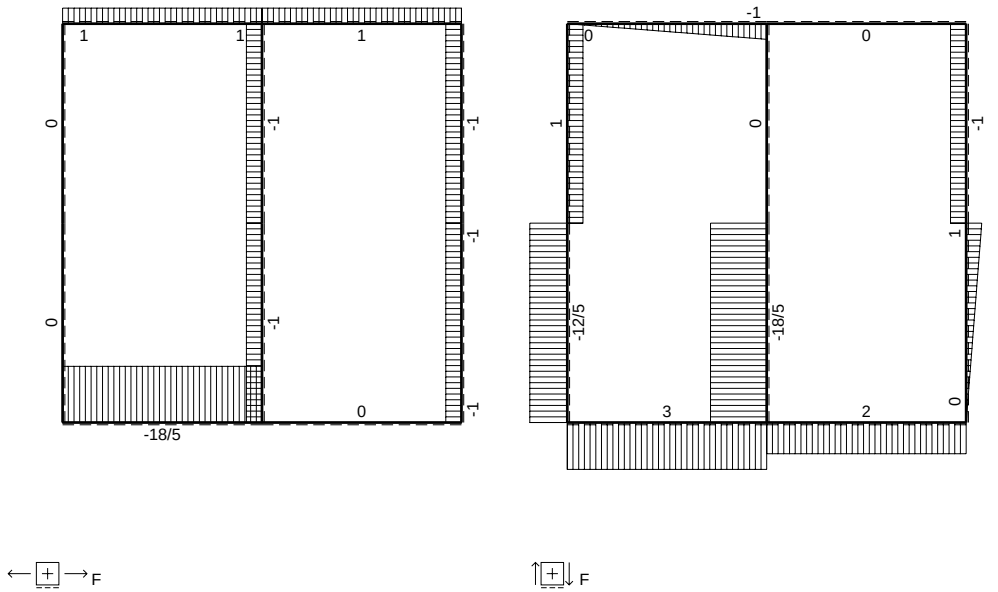
2F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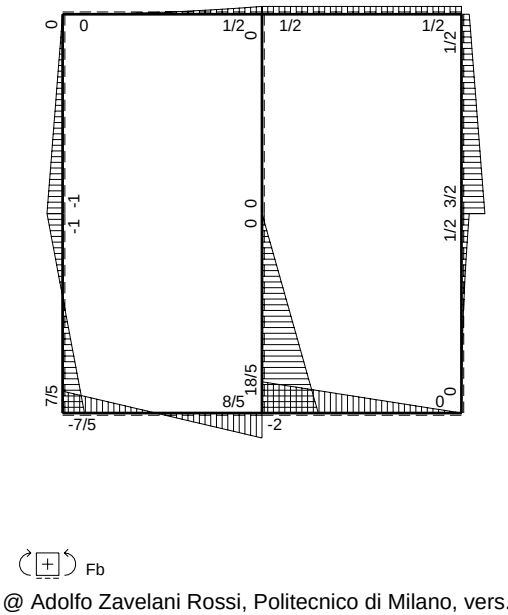
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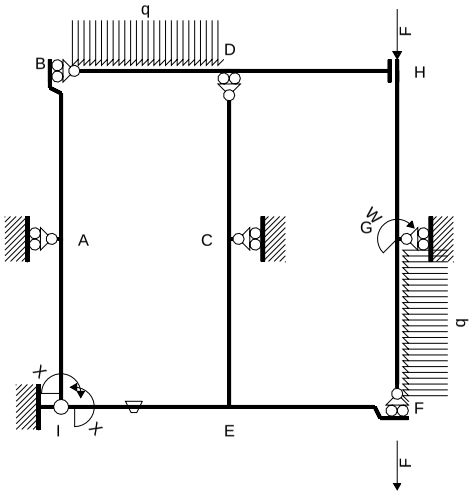
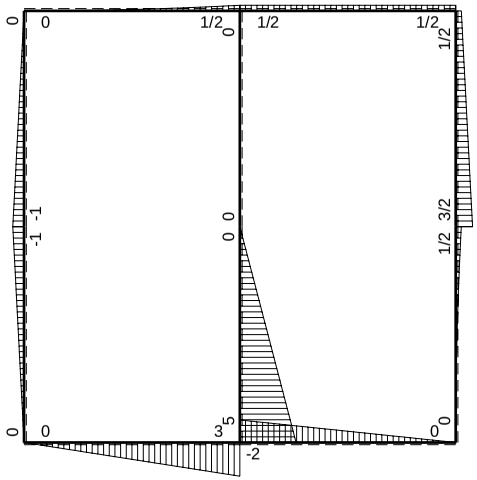
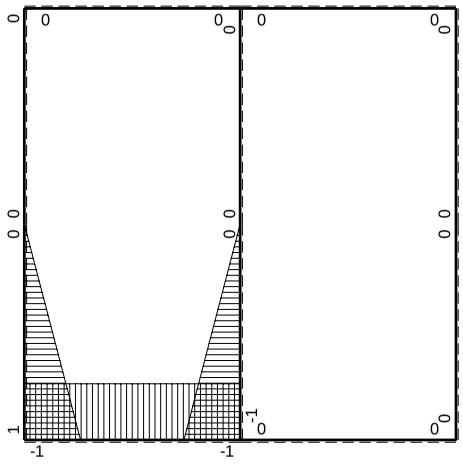


Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 215674 CI07.xxxx.084

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	3/2Fb-Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fb-Fx	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-5Fx	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-5Fx	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-Fx	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	Fb-Fx	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-7/3Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						7/5Fb	

Sviluppi di calcolo iperstatica

PROCEDIMENTO E RISULTATI 215674 CI07.xxxx.084
@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

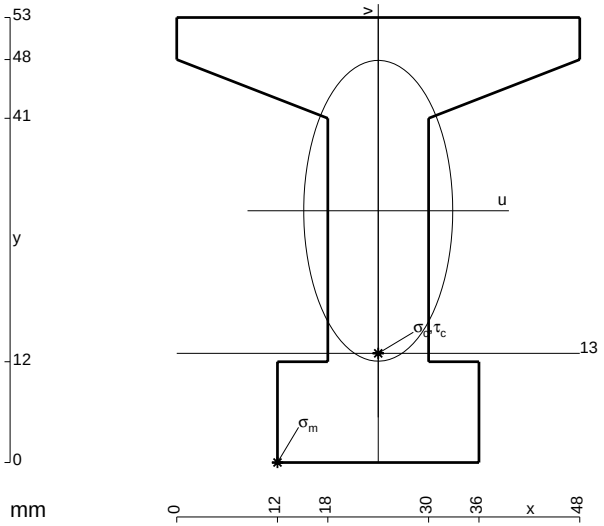
$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

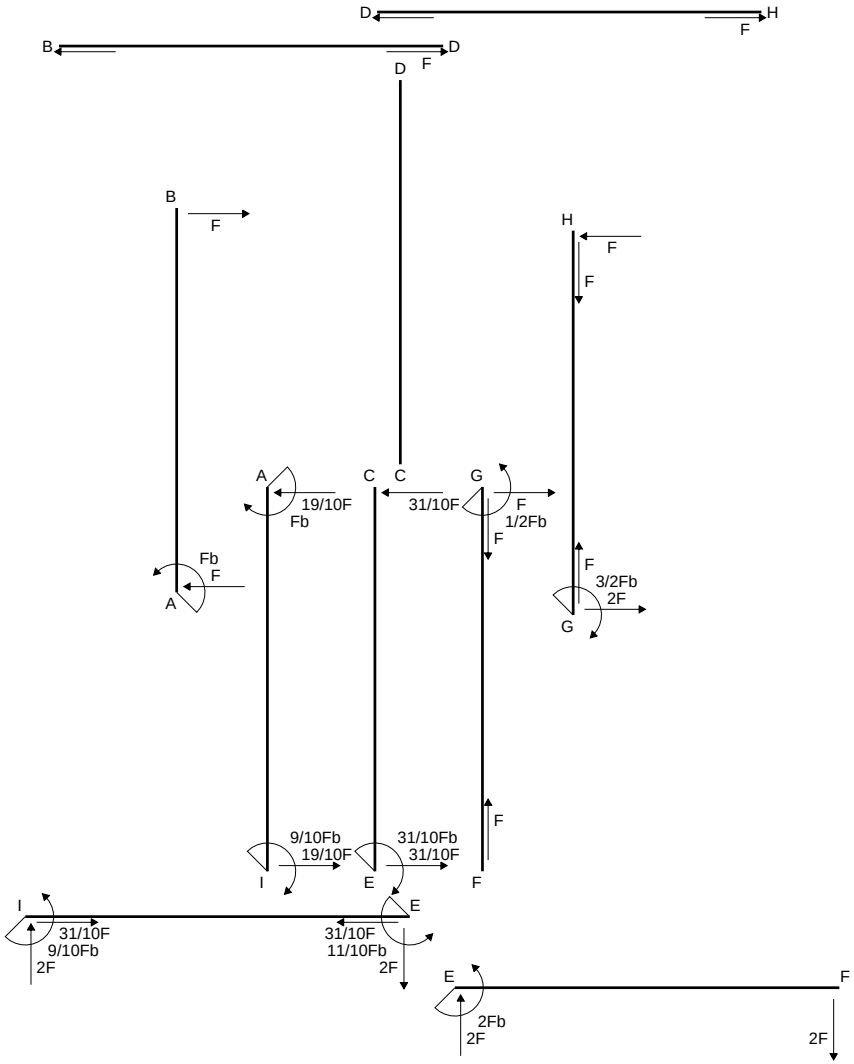
$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$



A = 1086. mm^2
J_u = 348629. mm^4
J_v = 85500. mm^4
y_g = 29.98 mm
T_y = 3760. N
M_x = -2782400. Nmm
x_m = 12. mm
u_m = -12. mm
v_m = -29.98 mm
$\sigma_m = -Mv/J_u$ = -239.3 N/mm^2
x_c = 24. mm
y_c = 13. mm
v_c = -16.98 mm
$\sigma_c = -Mv/J_u$ = -135.5 N/mm^2
τ_c = 6.397 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 136. N/mm^2
S^* = 7117. mm^3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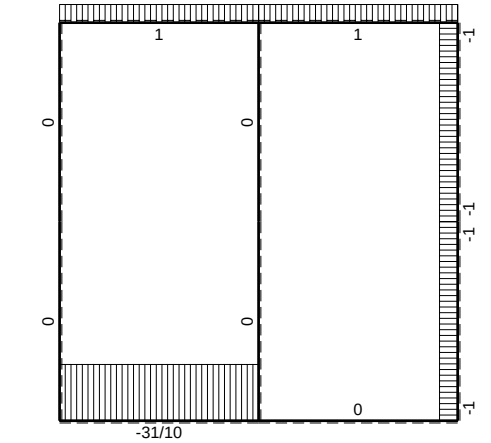
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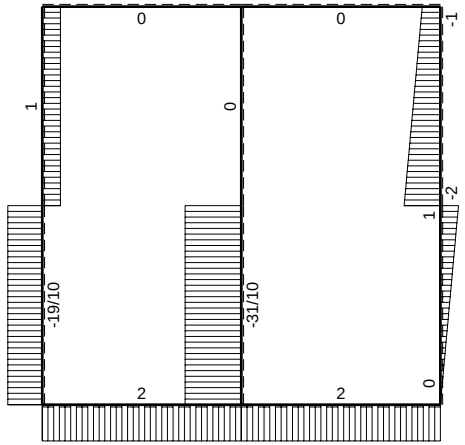
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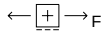
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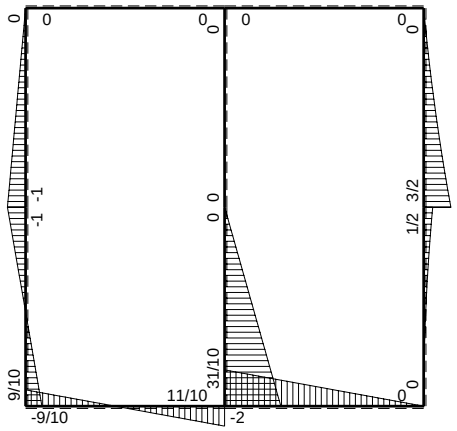
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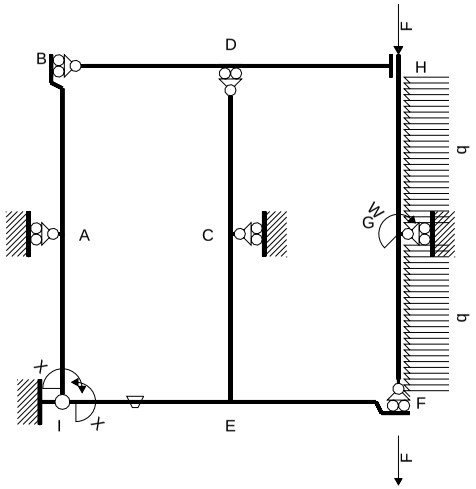
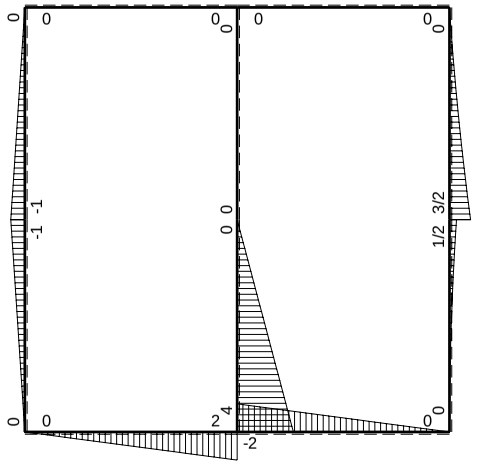
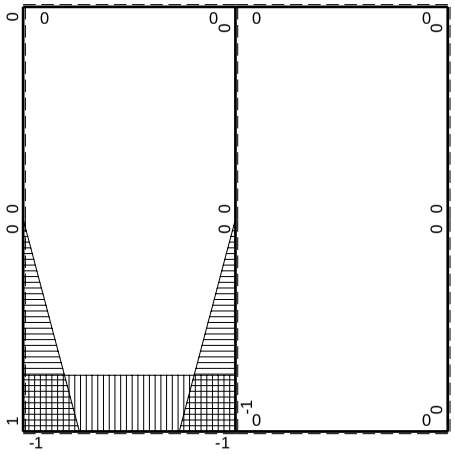
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 963092 CI07.xxxx.085

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-Fx-1/2qx^2$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	-1+x/b	4Fb-4Fx	0	$-4Fb+8Fx-4Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-4/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-4Fx	0	$-4Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-Fx	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	Fb-Fx	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-3/2Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						9/10Fb	

PROCEDIMENTO E RISULTATI 963092 CI07.xxxx.085

Sviluppi di calcolo iperstatica

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

$L^{XX}_{IE} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EI} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EC} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{CE} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{IA} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{AI} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{Xo}_{IE} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L^{Xo}_{EI} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L^{Xo}_{EC} = \int_o^b (-4 + 8\ x/b - 4\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4\ x + 4\ x^2/b - 4/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-4\ b + 4\ b - 4/3\ b\ )\ Fb\ 1/EJ\ = -4/3\ Fb^2/EJ$

$L^{Xo}_{CE} = \int_o^b (-4\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

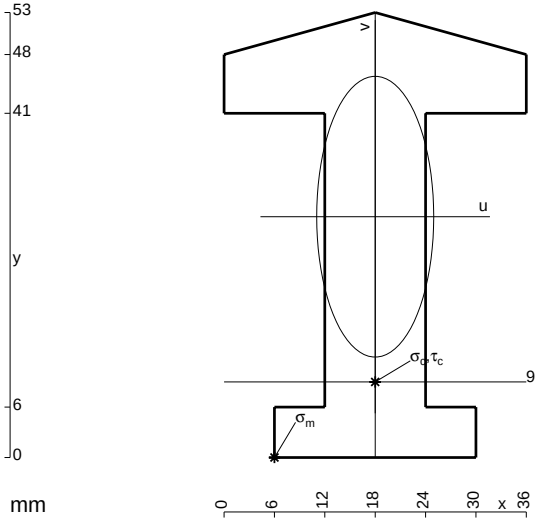
$= (-4/3\ b\ )\ Fb\ 1/EJ\ = -4/3\ Fb^2/EJ$

$L^{Xo}_{IA} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$

$L^{Xo}_{AI} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$



$A = 906.\ mm^2$

$J_u = 253401.\ mm^4$

$J_v = 44028.\ mm^4$

$y_g = 28.68\ mm$

$T_y = 2220.\ N$

$M_x = -1753800.\ Nmm$

$x_m = 6.\ mm$

$u_m = -12.\ mm$

$v_m = -28.68\ mm$

$\sigma_m = -Mv/J_u = -198.5\ N/mm^2$

$x_c = 18.\ mm$

$y_c = 9.\ mm$

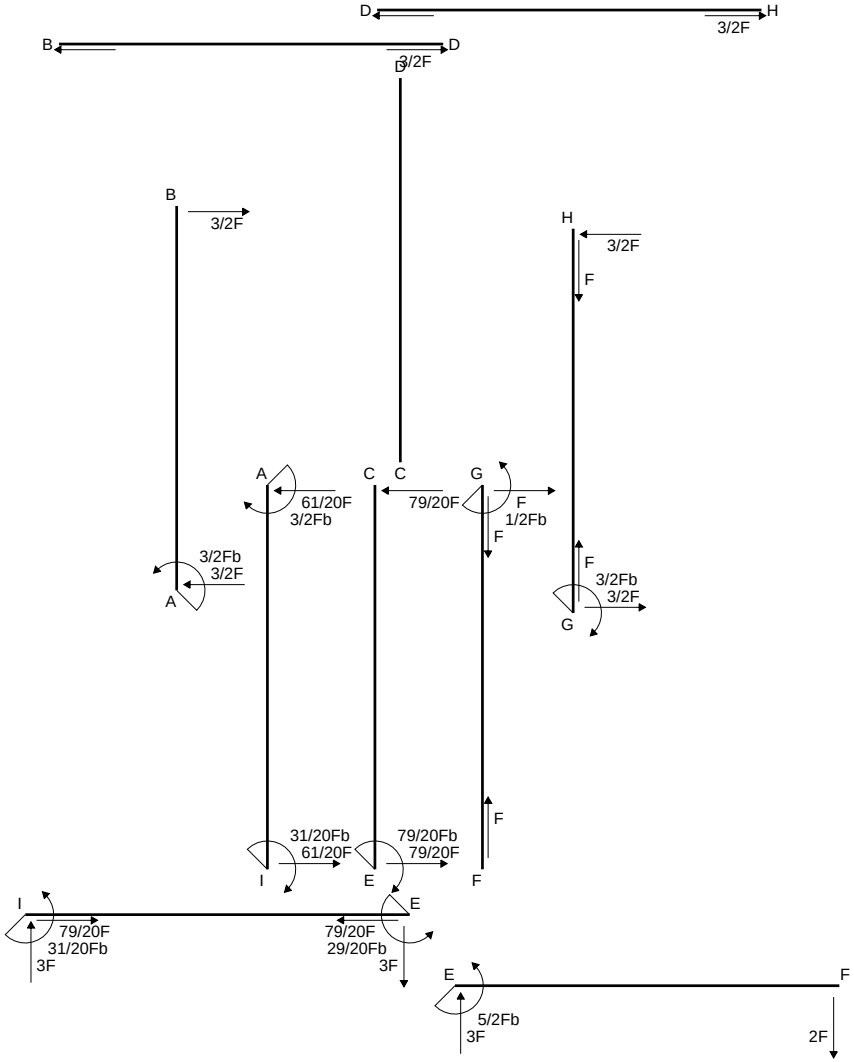
$v_c = -19.68\ mm$

$\sigma_c = -Mv/J_u = -136.2\ N/mm^2$

$\tau_c = 3.257\ N/mm^2$

$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 136.3\ N/mm^2$

$S^* = 4461.\ mm^3$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H
3/2F
F
A
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G
61/20F
3/2Fb
79/20F
F
1/2Fb
F
3/2Fb
3/2F
A
F
3/2Fb
3/2F
G
F
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61/20F
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3F
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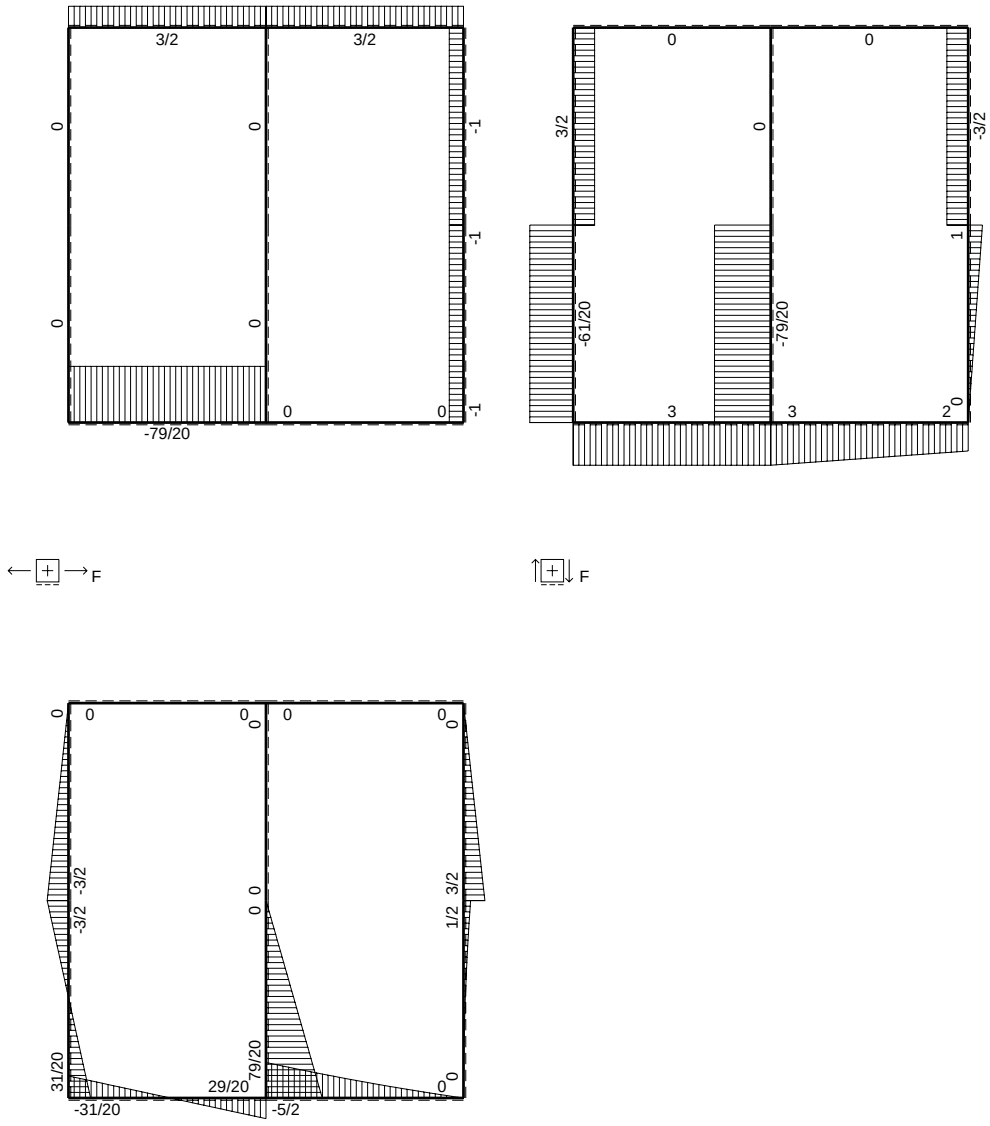
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-61/20
-79/20
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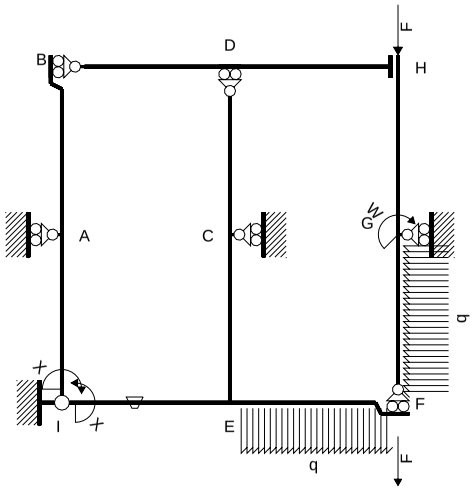
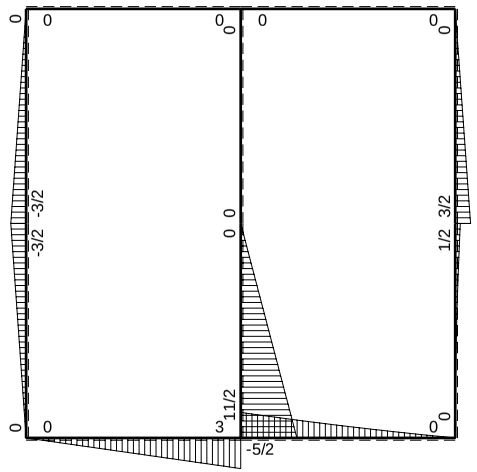
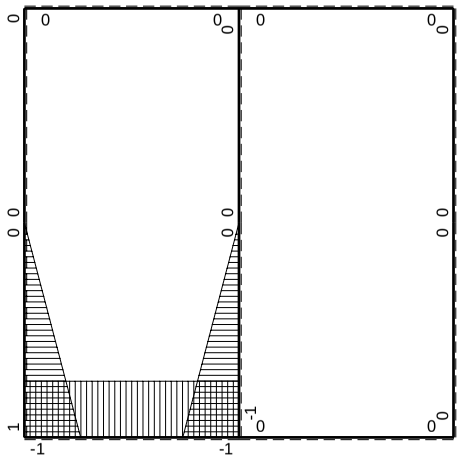
79/20
29/20
-31/20
-5/2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 211005 CI07.xxxx.086

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-3/2Fb+3/2Fx	0	0	0	0	0+0	0
BA b	0	3/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-5/2Fb+3Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$2Fx+1/2qx^2$	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	3/2Fb-3/2Fx	0	0	0	0	0+0	0
HG b	0	-3/2Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	11/2Fb-11/2Fx	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-11/2Fx$	0	$-11/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-3/2Fx	0	$-3/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/4+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	3/2Fb-3/2Fx	0	$-3/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-31/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						31/20Fb	

Sviluppi di calcolo iperstatica

PROCEDIMENTO E RISULTATI 211005 CI07.xxxx.086
@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-11/2 + 11\ x/b - 11/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-11/2\ x + 11/2\ x^2/b - 11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-11/2\ b + 11/2\ b - 11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-11/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

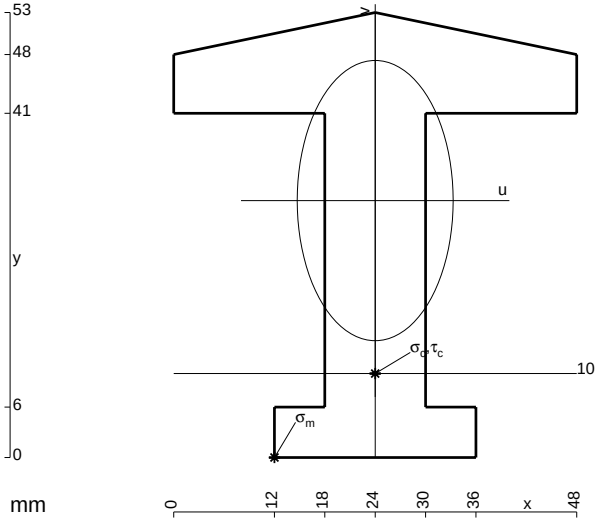
$L_{IA}^{Xo} = \int_o^b (-3/2\ x/b + 3/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-3/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-3/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = -1/4\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-3/2\ x/b + 3/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-3/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-3/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = -1/4\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 211005 CI07.xxxx.086



A = 1020. mm^2
J_u = 284254. mm^4
J_v = 87984. mm^4
y_g = 30.6 mm
T_y = 2760. N
M_x = -1932000. Nmm
x_m = 12. mm
u_m = -12. mm
v_m = -30.6 mm
$\sigma_m = -Mv/J_u$ = -208. N/mm^2
x_c = 24. mm
y_c = 10. mm
v_c = -20.6 mm
$\sigma_c = -Mv/J_u$ = -140. N/mm^2
τ_c = 4.094 N/mm^2
$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2}$ = 140.2 N/mm^2
S^* = 5060. mm^3

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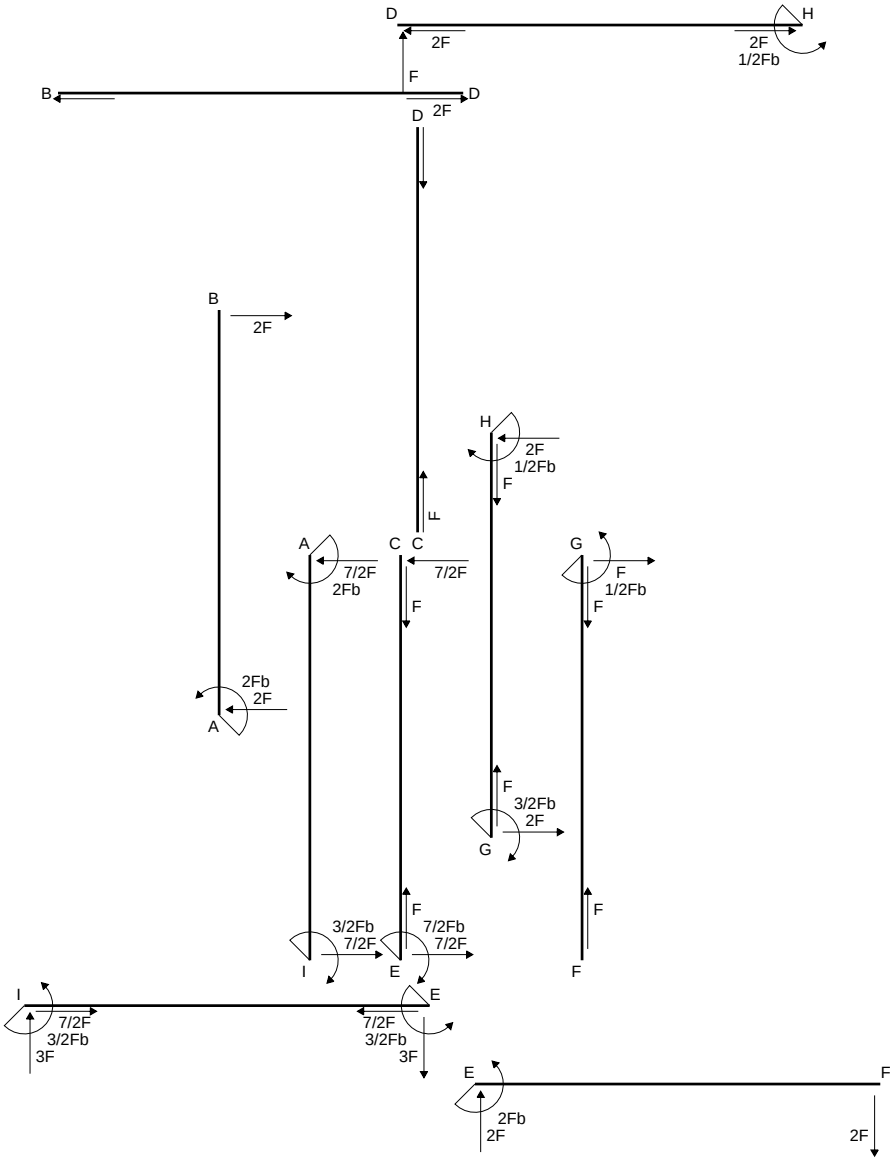
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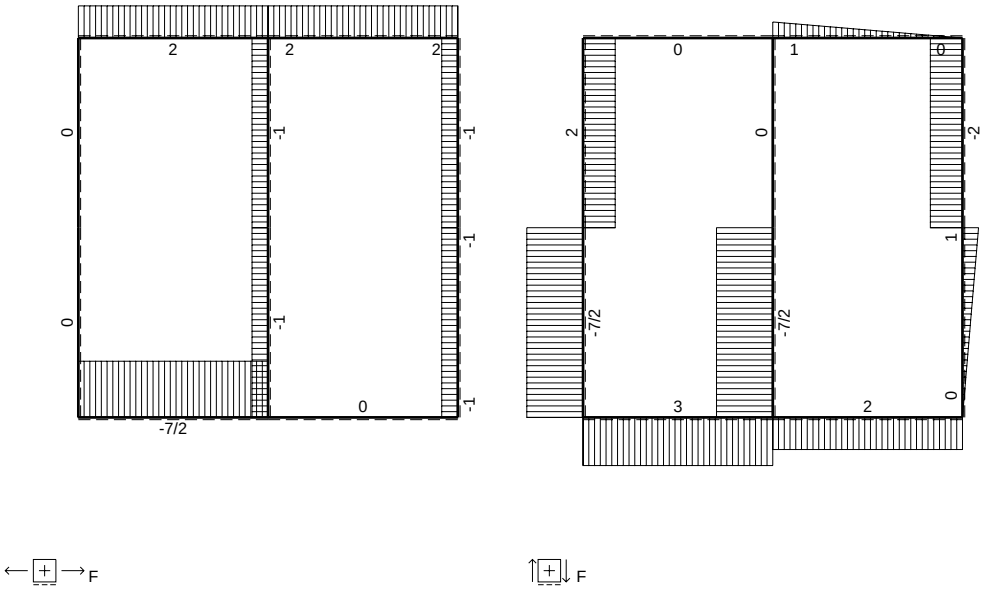
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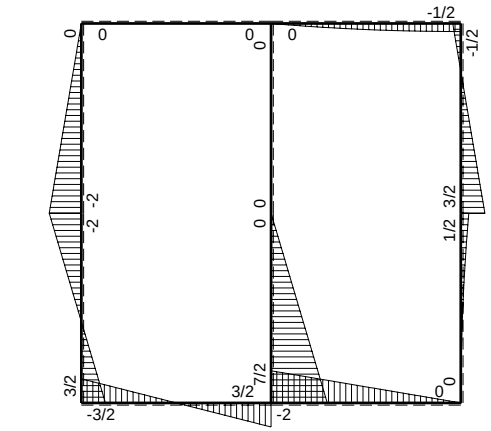
F F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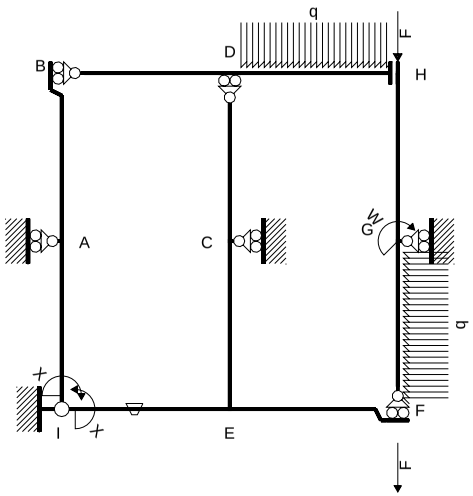
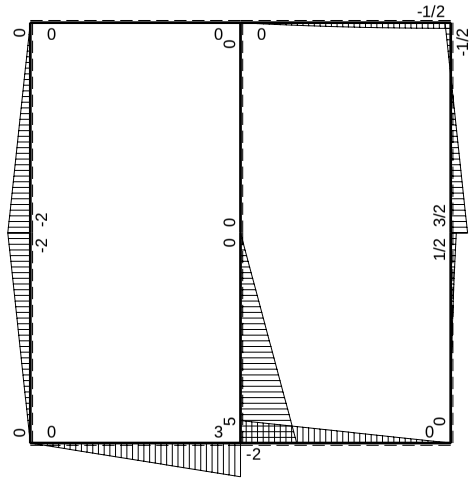
-3/2
-2

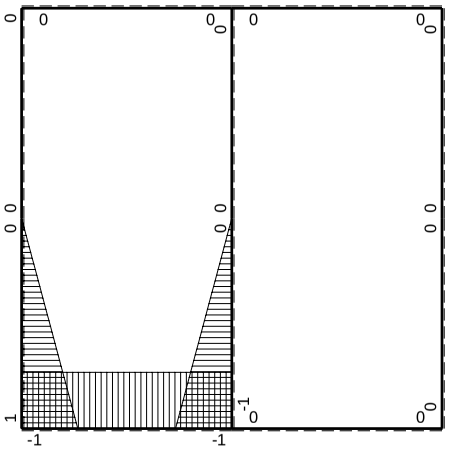
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 987352 CI07.xxxx.087

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-2Fb+2Fx	0	0	0	0	0+0	0
BA b	0	2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	3/2Fb-2Fx	0	0	0	0	0+0	0
HG b	0	1/2Fb-2Fx	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	5Fb-5Fx	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-5Fx	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-2Fx	0	$-2Fx+2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/3+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	2Fb-2Fx	0	$-2Fx+2Fx^2/b$	0	x^2/b^2		
	totali						$-5/2Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						3/2Fb	

Sviluppi di calcolo iperstatica

PROCEDIMENTO E RISULTATI 987352 CI07.xxxx.087
@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

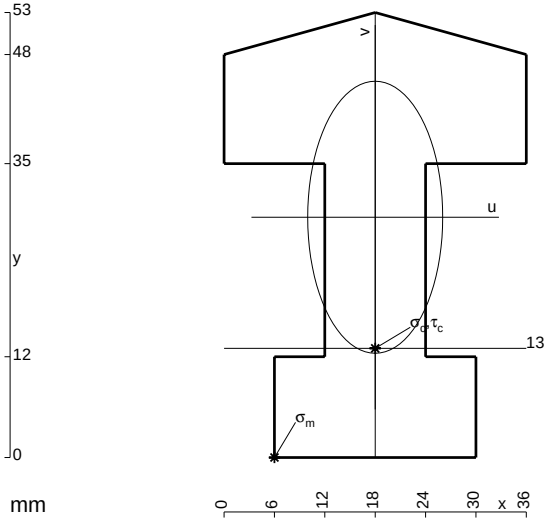
$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-2\ x/b + 2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-\ x^2/b + 2/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

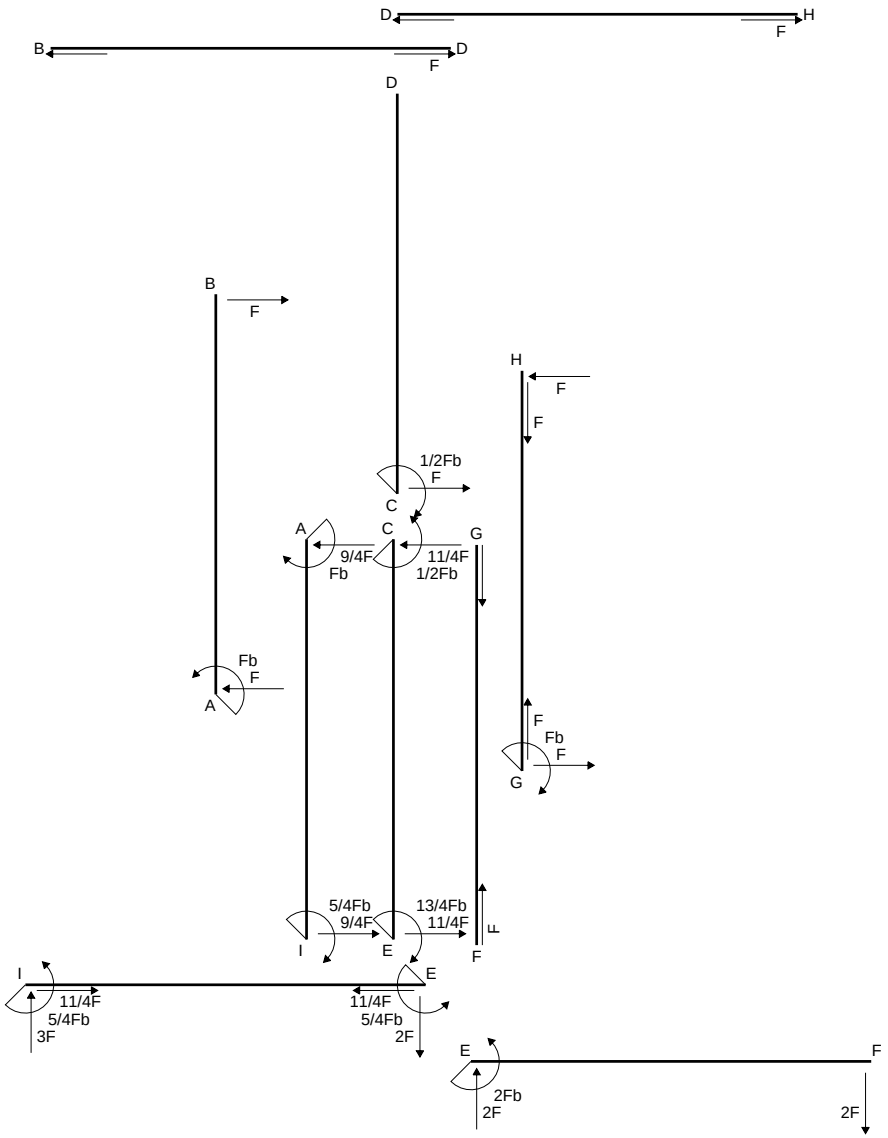
$= (-\ b + 2/3\ b\ )\ Fb\ 1/EJ\ = -1/3\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-2\ x/b + 2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-\ x^2/b + 2/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-\ b + 2/3\ b\ )\ Fb\ 1/EJ\ = -1/3\ Fb^2/EJ$



A = 1122. mm^2
J_u = 294439. mm^4
J_v = 72540. mm^4
y_g = 28.61 mm
T_y = 2500. N
M_x = -2250000. Nmm
x_m = 6. mm
u_m = -12. mm
v_m = -28.61 mm
$\sigma_m = -Mv/J_u$ = -218.7 N/mm^2
x_c = 18. mm
y_c = 13. mm
v_c = -15.61 mm
$\sigma_c = -Mv/J_u$ = -119.3 N/mm^2
τ_c = 4.745 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 119.6 N/mm^2
S^* = 6706. mm^3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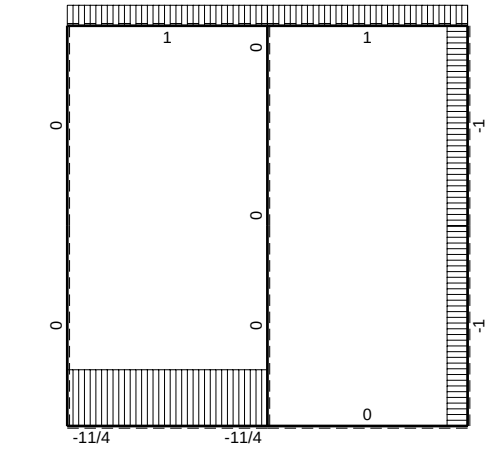
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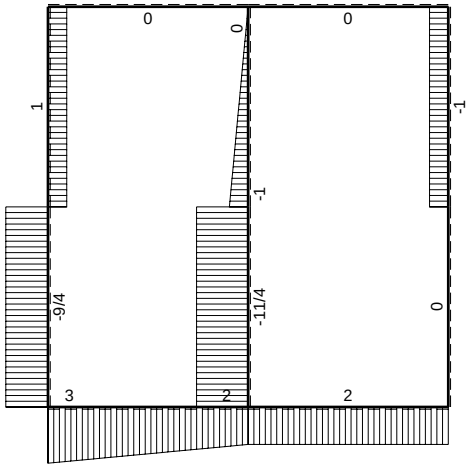
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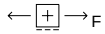
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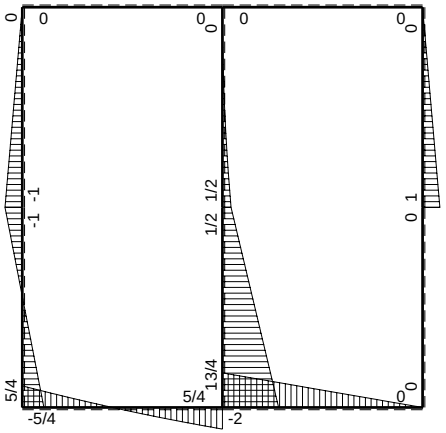
F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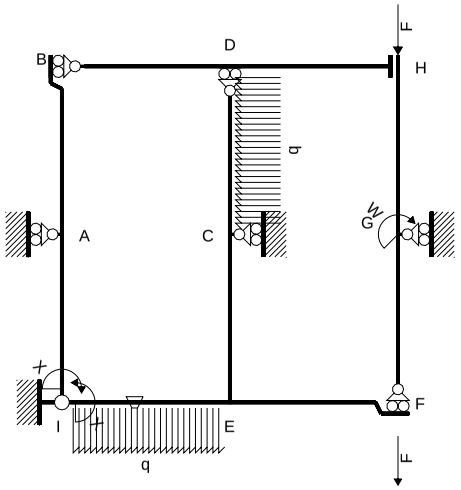
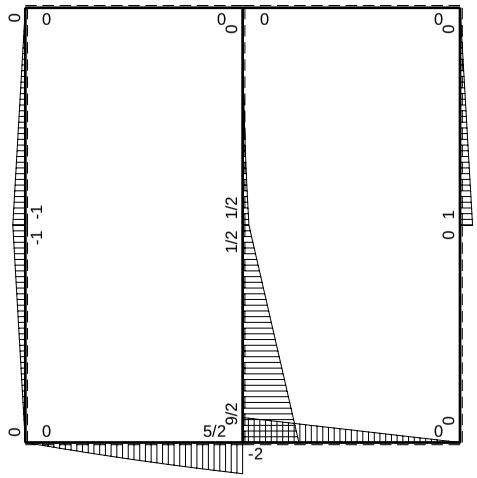
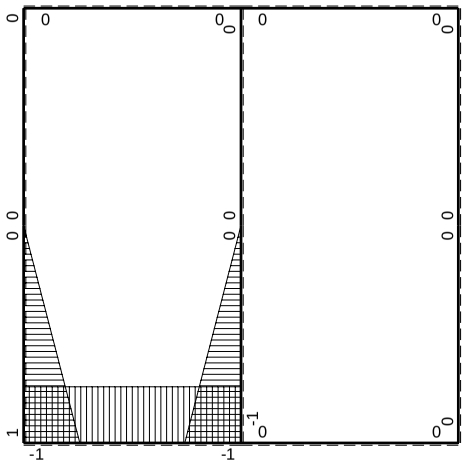
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 939352 CI07.xxxx.088

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	Fb-Fx	0	0	0	0	0+0	0
HG b	0	-Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx-1/2qx^2$	-Fb/EJ	$-3Fx+1/2Fx^2/b$	Fb/EJ	1	$(-4/3+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-5/2Fb+2Fx+1/2qx^2$	Fb/EJ	$-5/2Fb+2Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	-1+x/b	9/2Fb-4Fx	0	$-9/2Fb+17/2Fx-4Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-19/12+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-1/2Fb-4Fx	0	$-1/2Fx-4Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-Fx	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	Fb-Fx	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-25/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						5/4Fb	

Sviluppi di calcolo iperstatica

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$L^{XX}_{IE} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EI} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EC} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{CE} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{IA} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{AI} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{Xo}_{IE} = \int_o^b (-3\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/3\ Fb^2/EJ$

$L^{Xo}_{EI} = \int_o^b (-5/2 + 2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx$

$= [-5/2\ x + x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-5/2\ b + b + 1/6\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/3\ Fb^2/EJ$

$L^{Xo}_{EC} = \int_o^b (-9/2 + 17/2\ x/b - 4\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-9/2\ x + 17/4\ x^2/b - 4/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-9/2\ b + 17/4\ b - 4/3\ b\ )\ Fb\ 1/EJ\ = -19/12\ Fb^2/EJ$

$L^{Xo}_{CE} = \int_o^b (-1/2\ x/b - 4\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b - 4/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

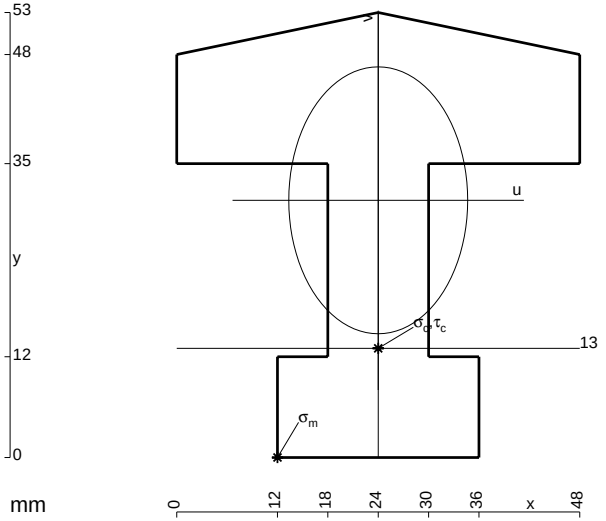
$= (-1/4\ b - 4/3\ b\ )\ Fb\ 1/EJ\ = -19/12\ Fb^2/EJ$

$L^{Xo}_{IA} = \int_o^b (-\ x/b + x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

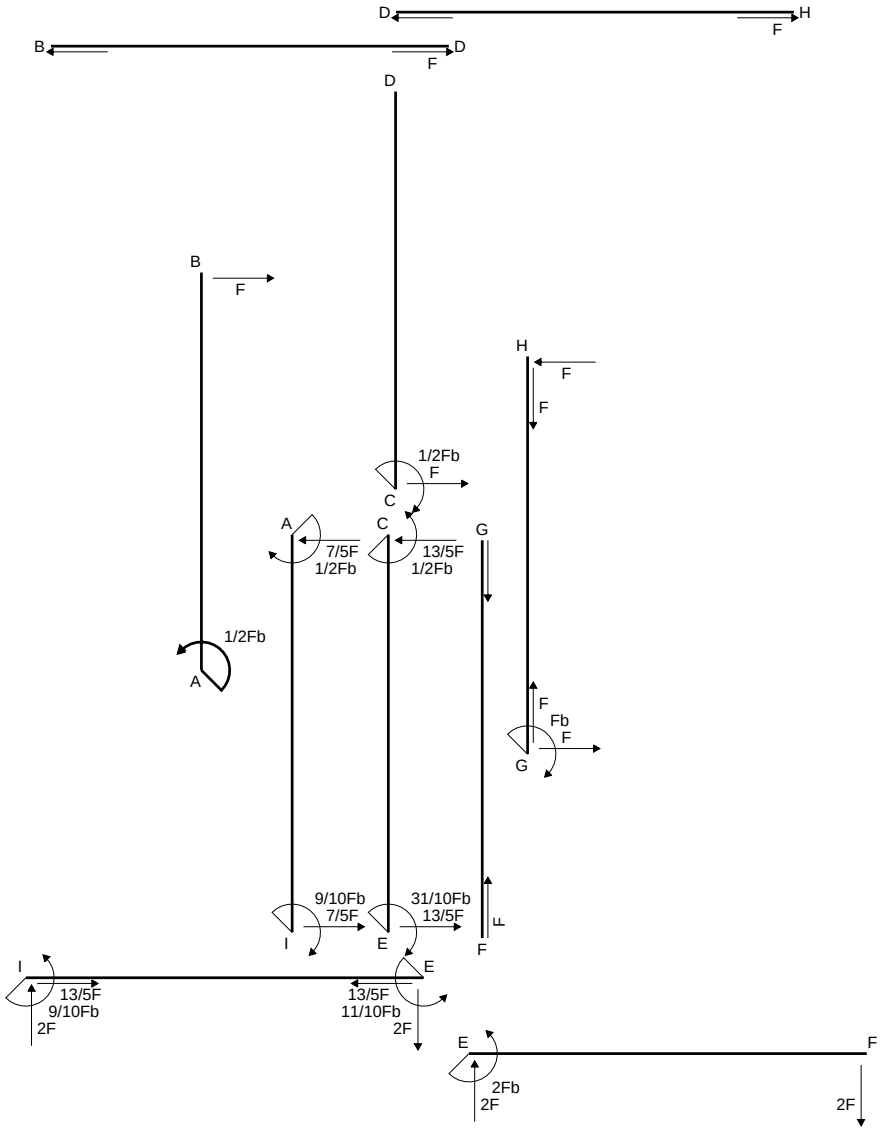
$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$

$L^{Xo}_{AI} = \int_o^b (-\ x/b + x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$



A = 1308. mm^2
J_u = 330537. mm^4
J_v = 148464. mm^4
y_g = 30.63 mm
T_y = 2600. N
M_x = -2470000. Nmm
x_m = 12. mm
u_m = -12. mm
v_m = -30.63 mm
$\sigma_m = -Mv/J_u$ = -228.9 N/mm^2
x_c = 24. mm
y_c = 13. mm
v_c = -17.63 mm
$\sigma_c = -Mv/J_u$ = -131.8 N/mm^2
τ_c = 4.793 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 132. N/mm^2
S^* = 7312. mm^3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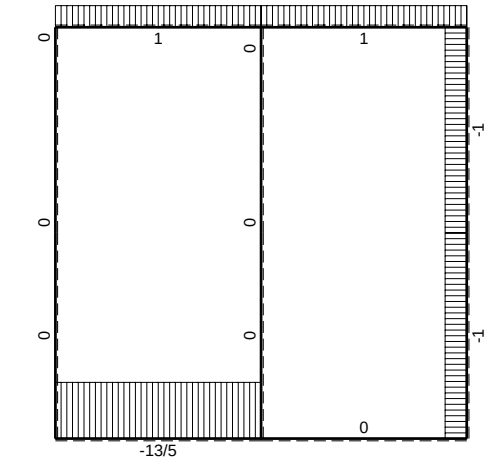
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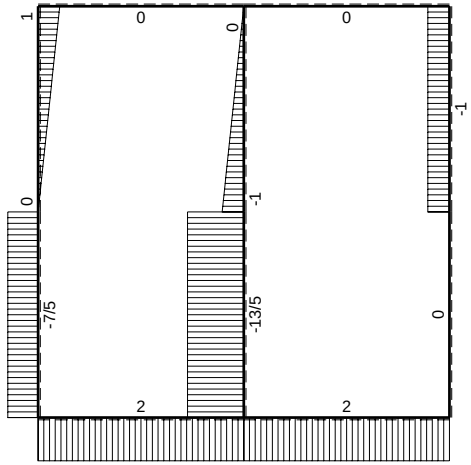
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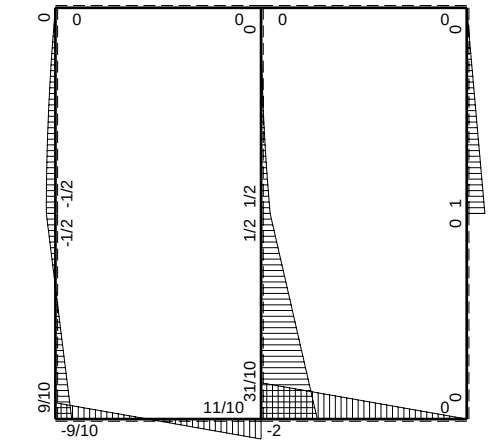
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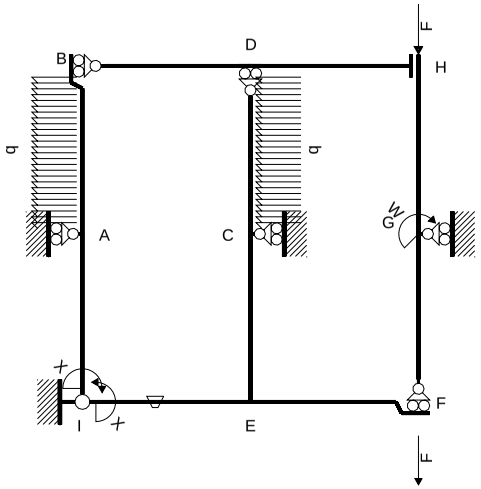
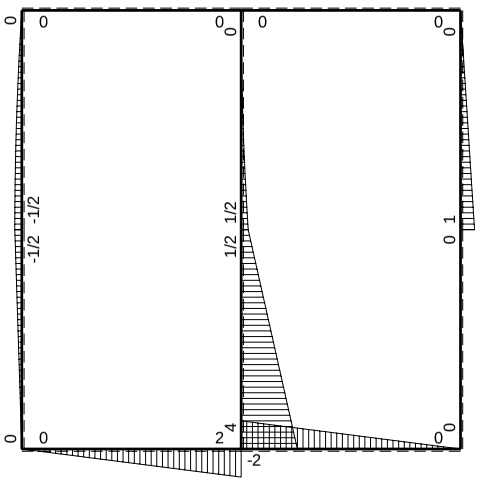
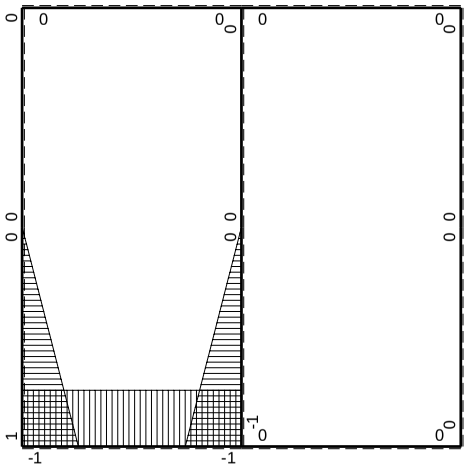


Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

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PROCEDIMENTO E RISULTATI 987504 CI07.xxxx.089

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$Fx-1/2qx^2$	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	Fb-Fx	0	0	0	0	0+0	0
HG b	0	-Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	-1+x/b	4Fb-7/2Fx	0	$-4Fb+15/2Fx-7/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-17/12+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-1/2Fb-7/2Fx$	0	$-1/2Fx-7/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-3/2Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						9/10Fb	

Sviluppi di calcolo iperstatica

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$L^{XX}_{IE} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EI} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EC} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{CE} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{IA} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{AI} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{Xo}_{IE} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L^{Xo}_{EI} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L^{Xo}_{EC} = \int_o^b (-4 + 15/2\ x/b - 7/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4\ x + 15/4\ x^2/b - 7/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-4\ b + 15/4\ b - 7/6\ b\ )\ Fb\ 1/EJ\ = -17/12\ Fb^2/EJ$

$L^{Xo}_{CE} = \int_o^b (-1/2\ x/b - 7/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b - 7/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

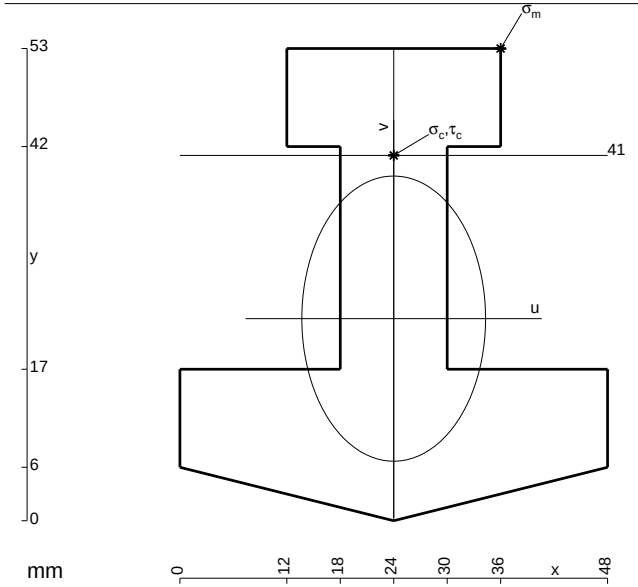
$= (-1/4\ b - 7/6\ b\ )\ Fb\ 1/EJ\ = -17/12\ Fb^2/EJ$

$L^{Xo}_{IA} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

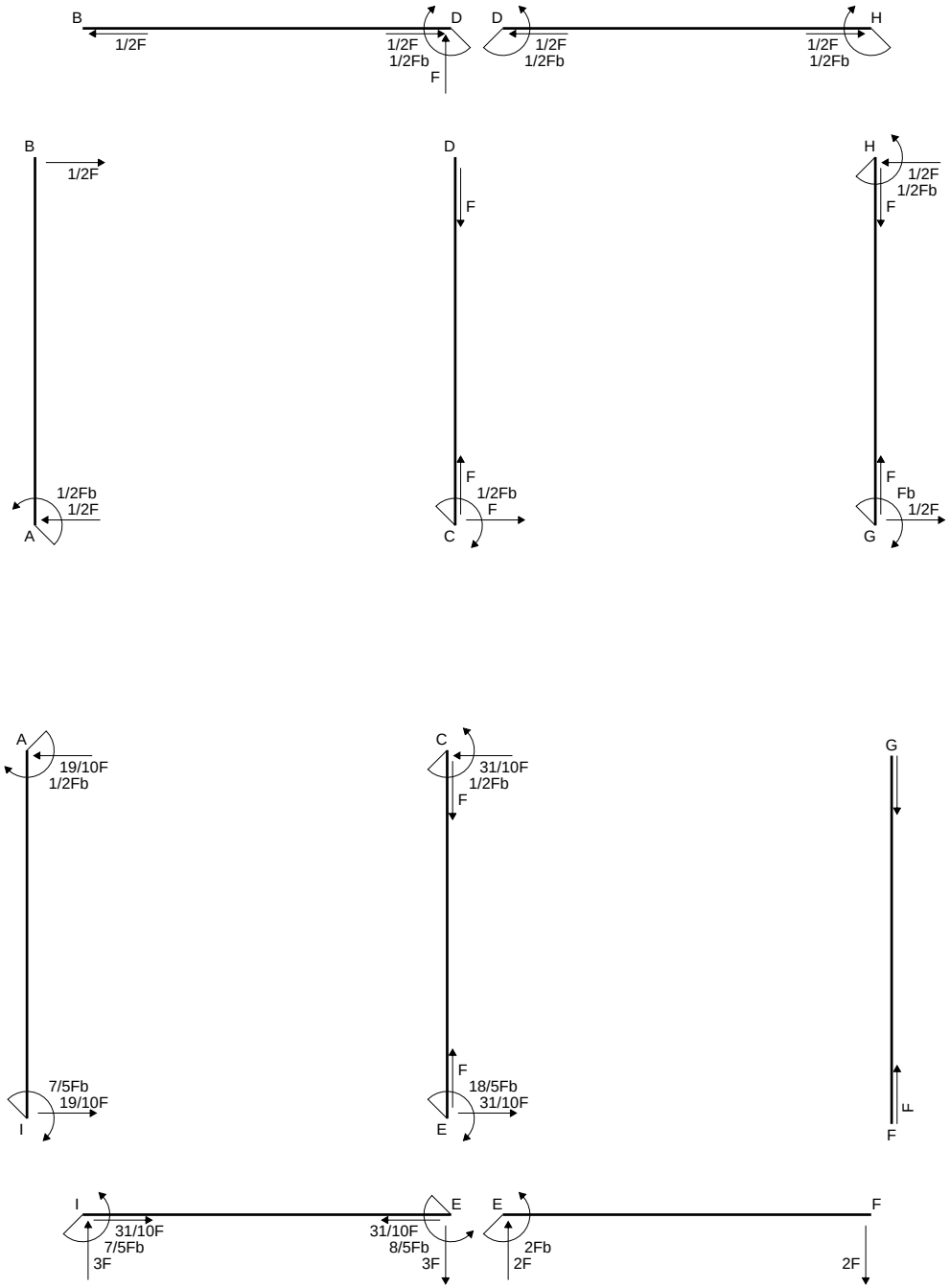
$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

$L^{Xo}_{AI} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$



A = 1236. mm^2
J_u = 316729. mm^4
J_v = 131472. mm^4
y_g = 22.68 mm
T_y = 2500. N
M_x = -2500000. Nmm
x_m = 36. mm
y_m = 53. mm
u_m = 12. mm
v_m = 30.32 mm
$\sigma_m = -Mv/J_u$ = 239.3 N/mm^2
x_c = 24. mm
y_c = 41. mm
v_c = 18.32 mm
$\sigma_c = -Mv/J_u$ = 144.6 N/mm^2
τ_c = 4.458 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 144.8 N/mm^2
S^* = 6777. mm^3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E
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8/5Fb
3F
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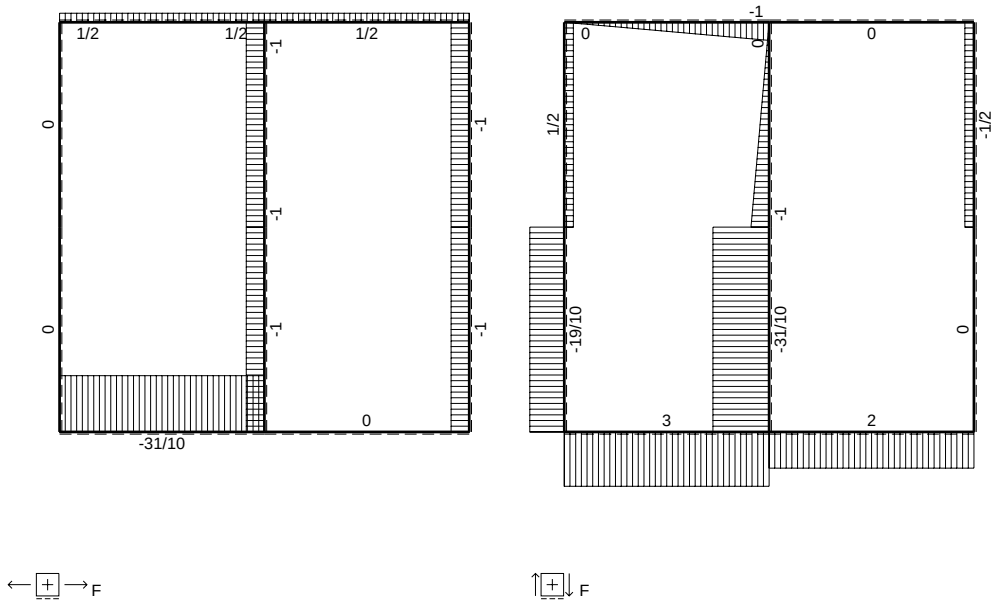
2F
2F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-1/2
-19/10
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-31/10
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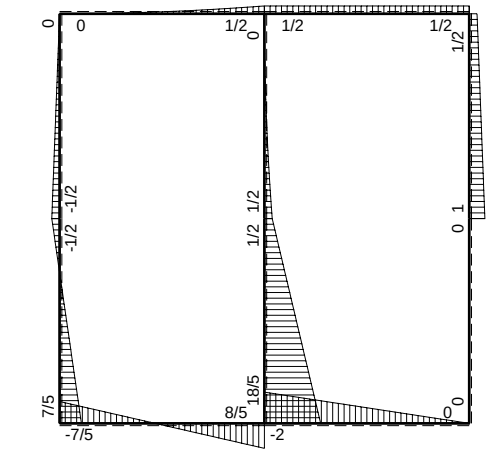
3
2
F
F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1/2
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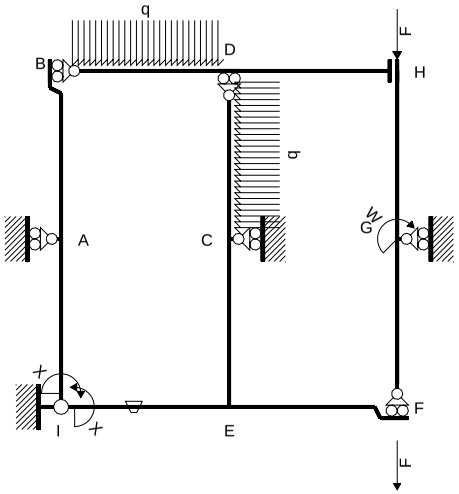
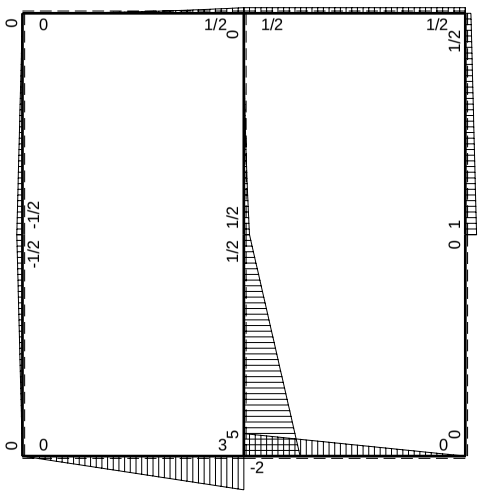
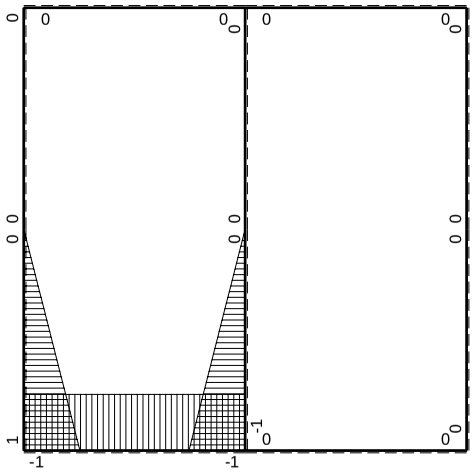
8/5
18/5
0
-7/5
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 956343 CI07.xxxx.090

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PROCEDIMENTO E RISULTATI 956343 CI07.xxxx.090

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	Fb-1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fb-1/2Fx	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-9/2Fx	0	$-5Fb+19/2Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-7/4+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-1/2Fb-9/2Fx$	0	$-1/2Fx-9/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-7/3Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						7/5Fb	

Sviluppi di calcolo iperstatica

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$L^{XX}_{IE} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EI} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EC} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{CE} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{IA} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{AI} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{Xo}_{IE} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L^{Xo}_{EI} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L^{Xo}_{EC} = \int_o^b (-5 + 19/2\ x/b - 9/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 19/4\ x^2/b - 3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 19/4\ b - 3/2\ b\ )\ Fb\ 1/EJ\ = -7/4\ Fb^2/EJ$

$L^{Xo}_{CE} = \int_o^b (-1/2\ x/b - 9/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b - 3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

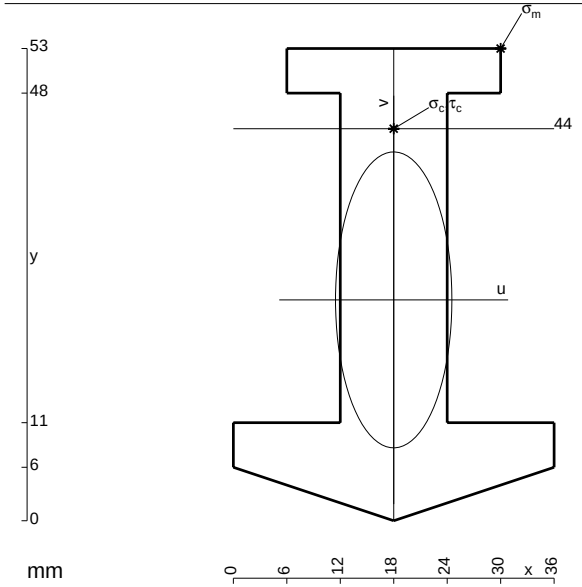
$= (-1/4\ b - 3/2\ b\ )\ Fb\ 1/EJ\ = -7/4\ Fb^2/EJ$

$L^{Xo}_{IA} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

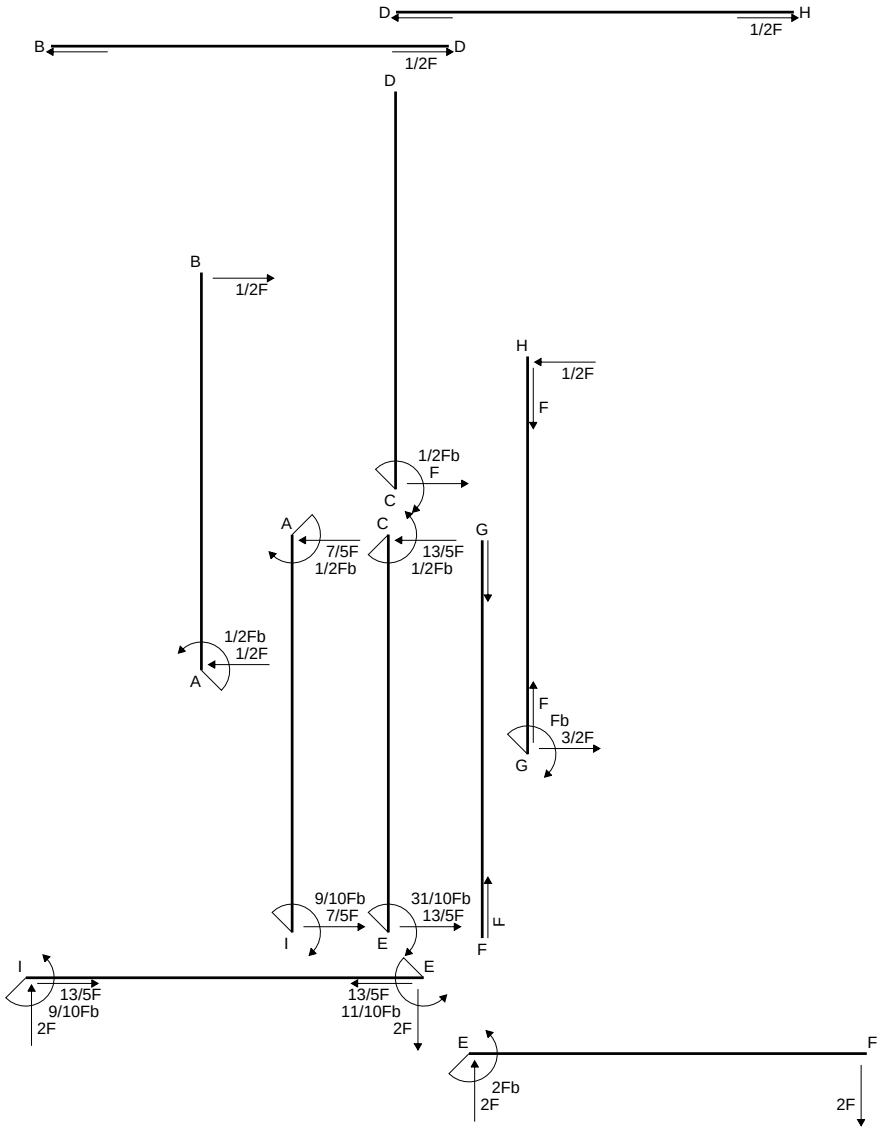
$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

$L^{Xo}_{AI} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$



A = 852. mm^2
J_u = 235110. mm^4
J_v = 36360. mm^4
y_g = 24.79 mm
T_y = 3140. N
M_x = -1664200. Nmm
x_m = 30. mm
y_m = 53. mm
u_m = 12. mm
v_m = 28.21 mm
$\sigma_m = -Mv/J_u$ = 199.7 N/mm^2
x_c = 18. mm
y_c = 44. mm
v_c = 19.21 mm
$\sigma_c = -Mv/J_u$ = 136. N/mm^2
τ_c = 4.567 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 136.2 N/mm^2
S^* = 4103. mm^3


D
H
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H
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F
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F
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C
G
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13/5F
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Fb
3/2F
G
9/10Fb
7/5F
31/10Fb
13/5F
I
E
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9/10Fb
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13/5F
11/10Fb
2F
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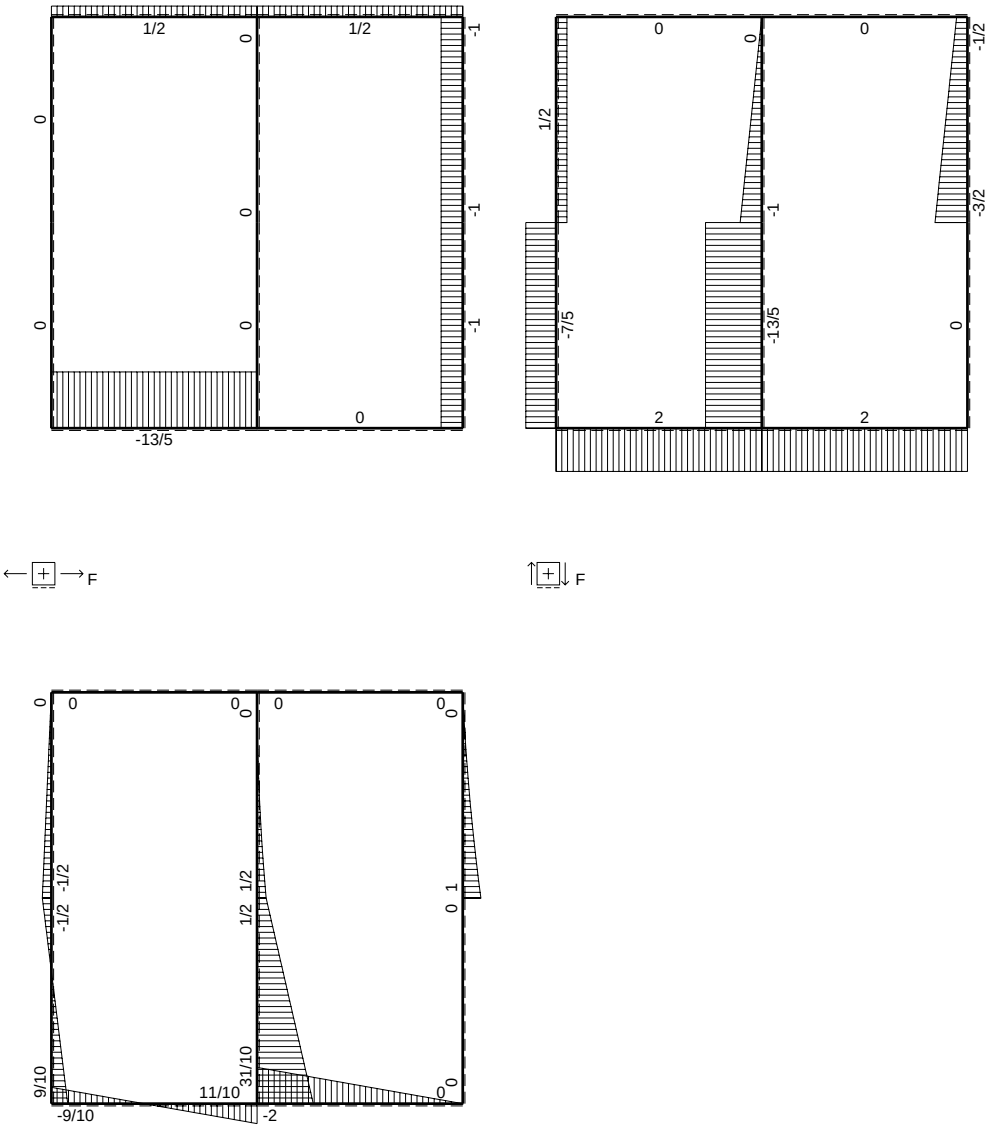
2F
2F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31/10
11/10
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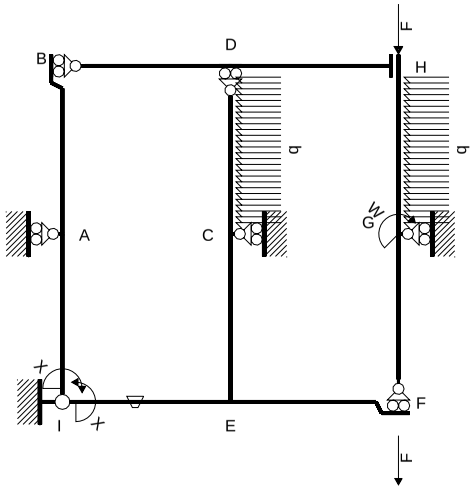
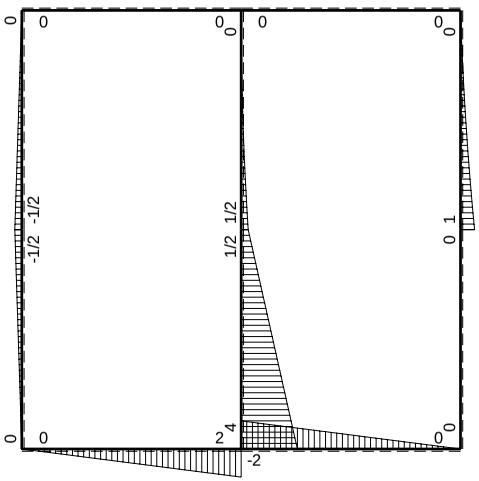
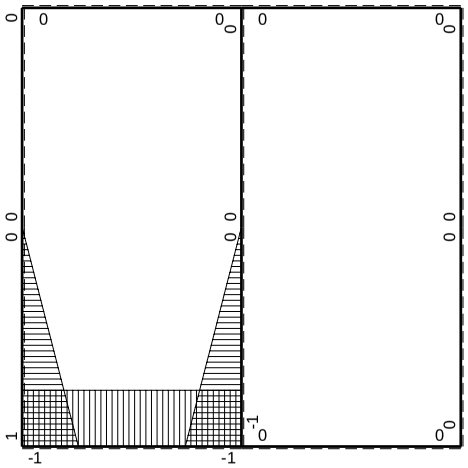
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 212572 CI07.xxxx.091

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PROCEDIMENTO E RISULTATI 212572 CI07.xxxx.091

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	1/2Fb-Fx+1/2qx^2	0	0	0	0	0+0	0
DC b	0	-1/2qx^2	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	Fb-3/2Fx+1/2qx^2	0	0	0	0	0+0	0
HG b	0	-1/2Fx-1/2qx^2	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	(-1+1)Fb^2/EJ	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	-1+x/b	4Fb-7/2Fx	0	-4Fb+15/2Fx-7/2Fx^2/b	0	1-2x/b+x^2/b^2	(-17/12+0)Fb^2/EJ	1/3Xb/EJ
CE b	x/b	-1/2Fb-7/2Fx	0	-1/2Fx-7/2Fx^2/b	0	x^2/b^2		
IA b	1-x/b	-1/2Fx	0	-1/2Fx+1/2Fx^2/b	0	1-2x/b+x^2/b^2	(-1/12+0)Fb^2/EJ	1/3Xb/EJ
AI b	-x/b	1/2Fb-1/2Fx	0	-1/2Fx+1/2Fx^2/b	0	x^2/b^2		
	totali						-3/2Fb^2/EJ	5/3Xb/EJ
	iperstatica $X=W_{IE}$						9/10Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L_{EI}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L_{EC}^{Xo} = \int_o^b (-4 + 15/2\ x/b - 7/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4\ x + 15/4\ x^2/b - 7/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-4\ b + 15/4\ b - 7/6\ b\ )\ Fb\ 1/EJ\ = -17/12\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-1/2\ x/b - 7/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b - 7/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

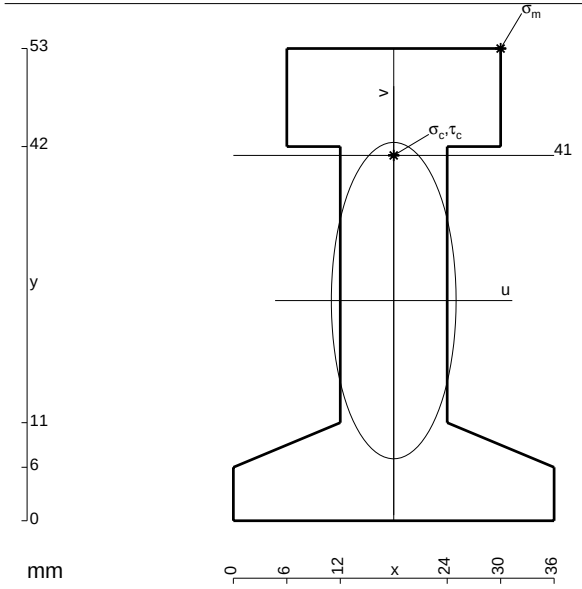
$= (-1/4\ b - 7/6\ b\ )\ Fb\ 1/EJ\ = -17/12\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

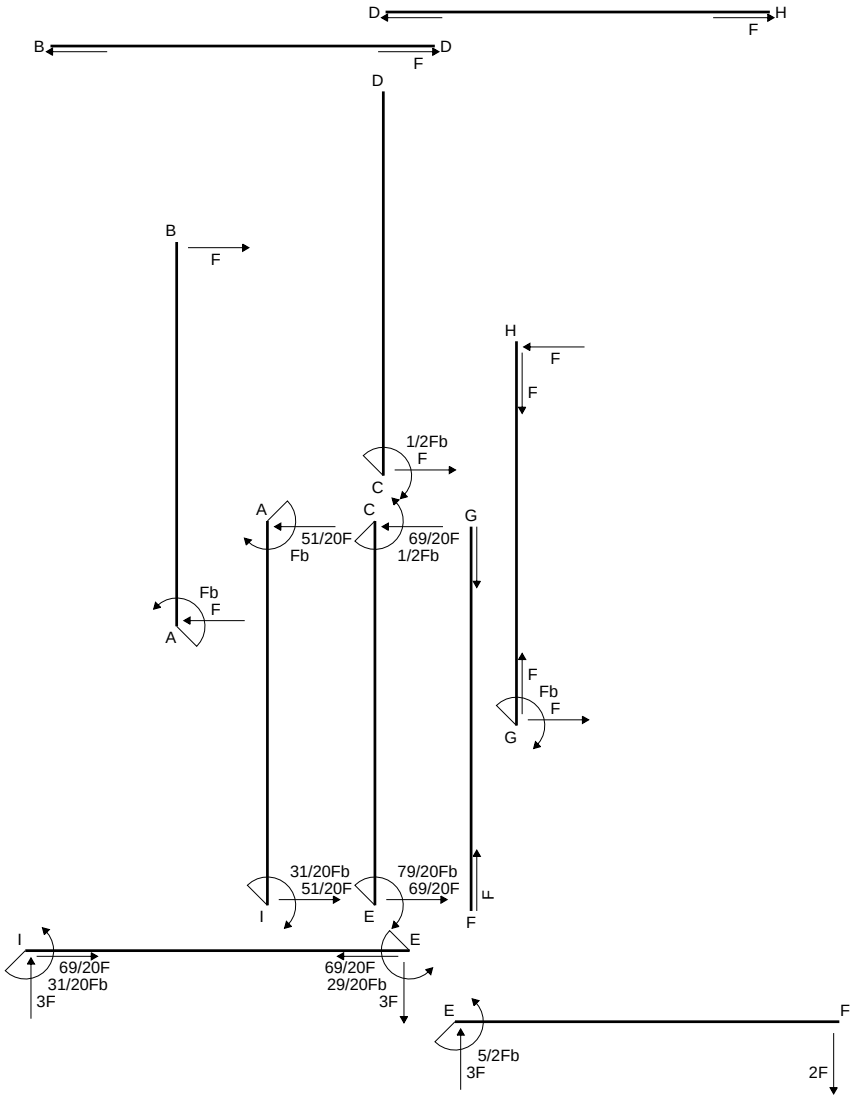
$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$



A = 972. mm^2
J_u = 306619. mm^4
J_v = 47664. mm^4
y_g = 24.71 mm
T_y = 3920. N
M_x = -2273600. Nmm
x_m = 30. mm
y_m = 53. mm
u_m = 12. mm
v_m = 28.29 mm
$\sigma_m = -Mv/J_u$ = 209.8 N/mm^2
x_c = 18. mm
y_c = 41. mm
v_c = 16.29 mm
$\sigma_c = -Mv/J_u$ = 120.8 N/mm^2
τ_c = 6.625 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 121.4 N/mm^2
S^* = 6219. mm^3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D
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F
F
1/2Fb
F
C
A
C
G
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Fb
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1/2Fb
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G
31/20Fb
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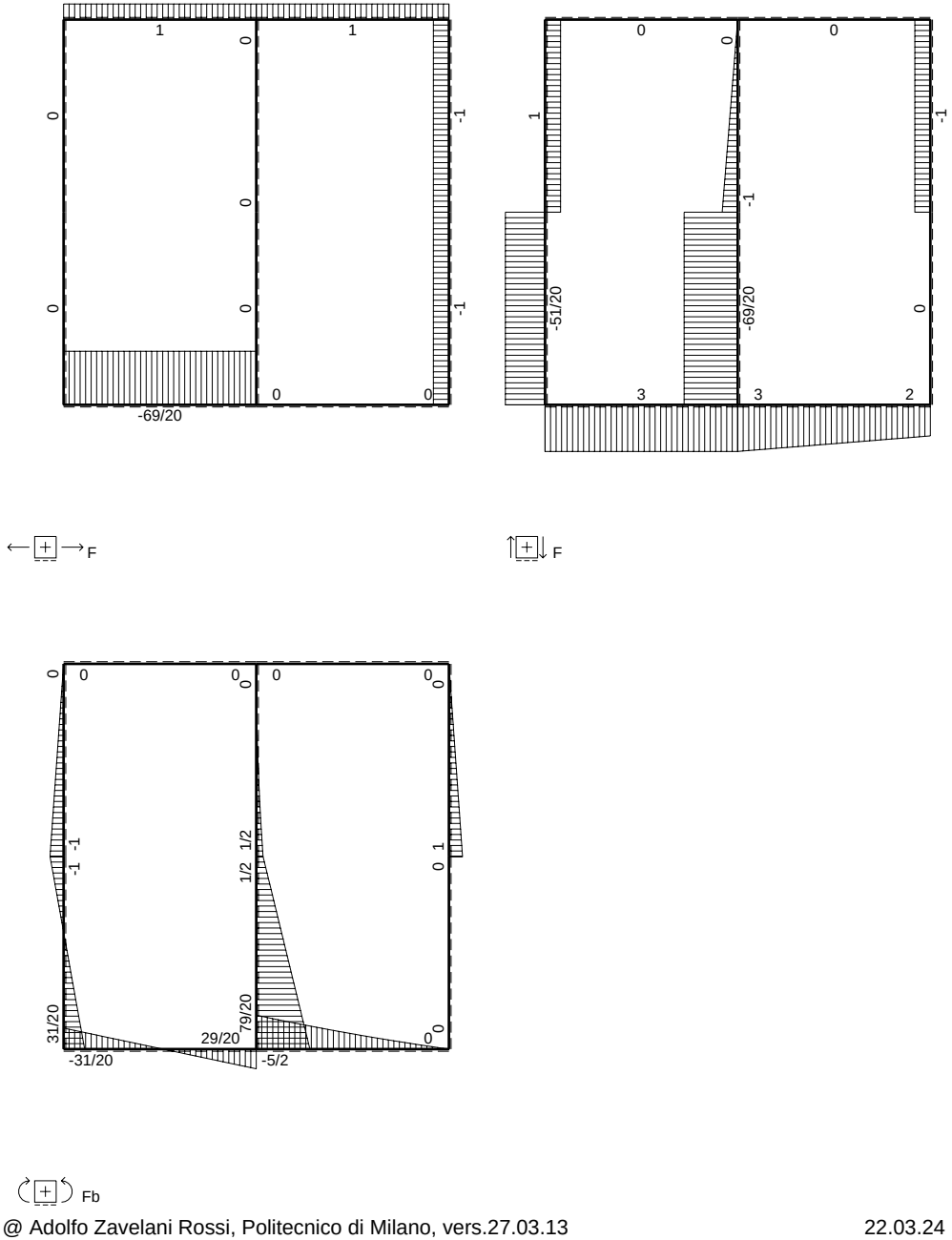
3F
2F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0
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0
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1/2
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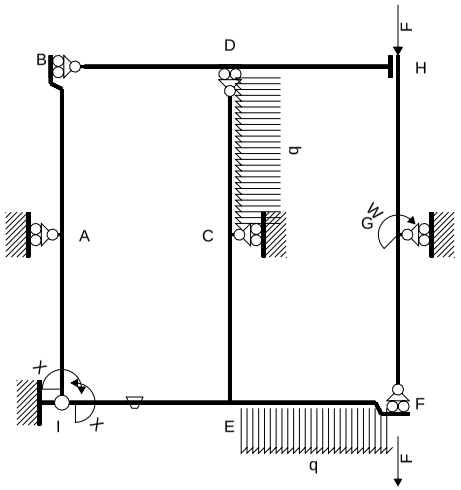
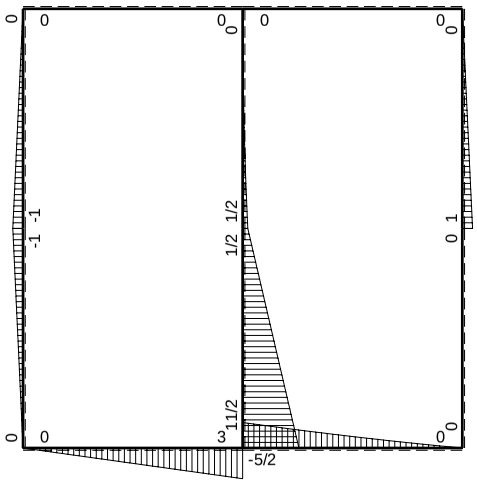
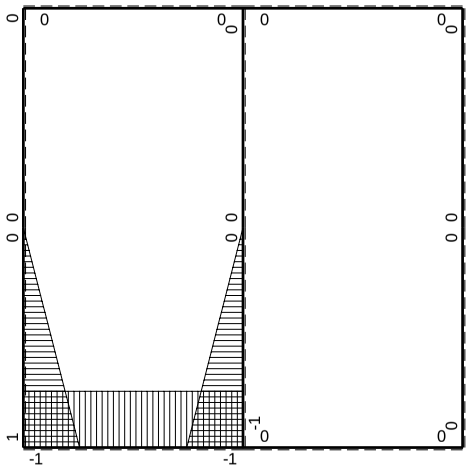
79/20
29/20
-31/20
-5/2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 216153 CI07.xxxx.092

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	$-5/2Fb+3Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$2Fx+1/2qx^2$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	Fb-Fx	0	0	0	0	0+0	0
HG b	0	-Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	11/2Fb-5Fx	0	$-11/2Fb+21/2Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-23/12+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-1/2Fb-5Fx	0	$-1/2Fx-5Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-Fx	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	Fb-Fx	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-31/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						31/20Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-11/2 + 21/2\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-11/2\ x + 21/4\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-11/2\ b + 21/4\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -23/12\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-1/2\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -23/12\ Fb^2/EJ$

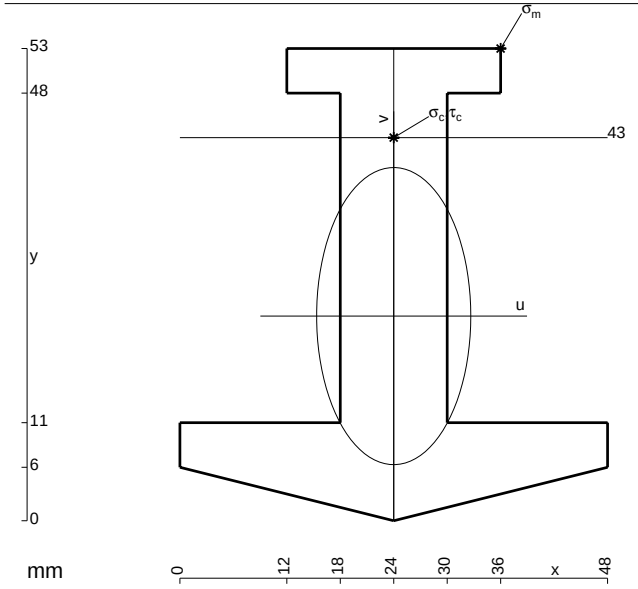
$L_{IA}^{Xo} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$

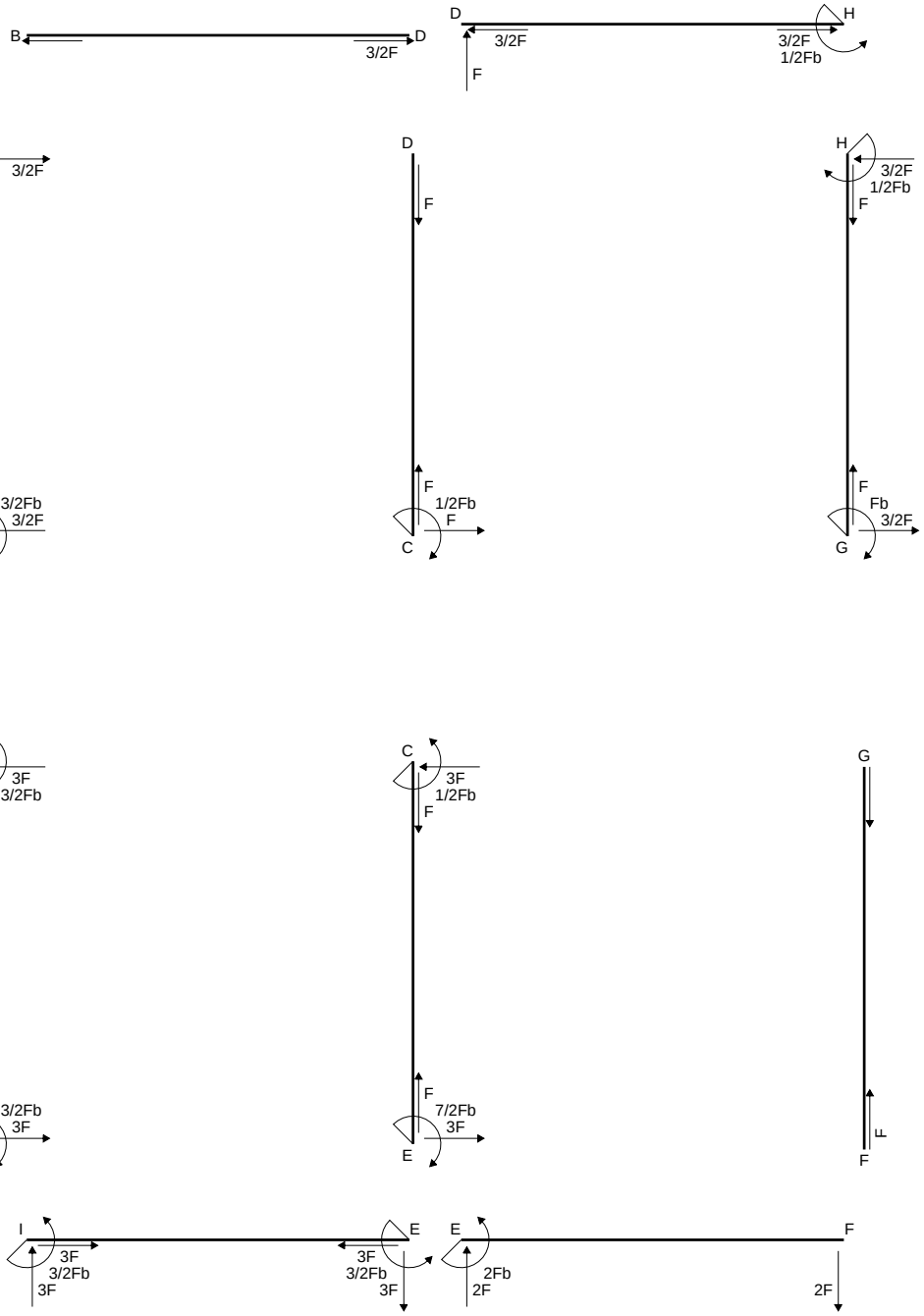
$L_{AI}^{Xo} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 216153 CI07.xxxx.092



A = 948. mm^2
J_u = 263643. mm^4
J_v = 70992. mm^4
y_g = 22.97 mm
T_y = 3660. N
M_x = -1921500. Nmm
x_m = 36. mm
y_m = 53. mm
u_m = 12. mm
v_m = 30.03 mm
$\sigma_m = -Mv/J_u$ = 218.9 N/mm^2
x_c = 24. mm
y_c = 43. mm
v_c = 20.03 mm
$\sigma_c = -Mv/J_u$ = 146. N/mm^2
τ_c = 5.386 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 146.3 N/mm^2
S^* = 4656. mm^3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3/2F
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F
B
3/2F
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3F
I
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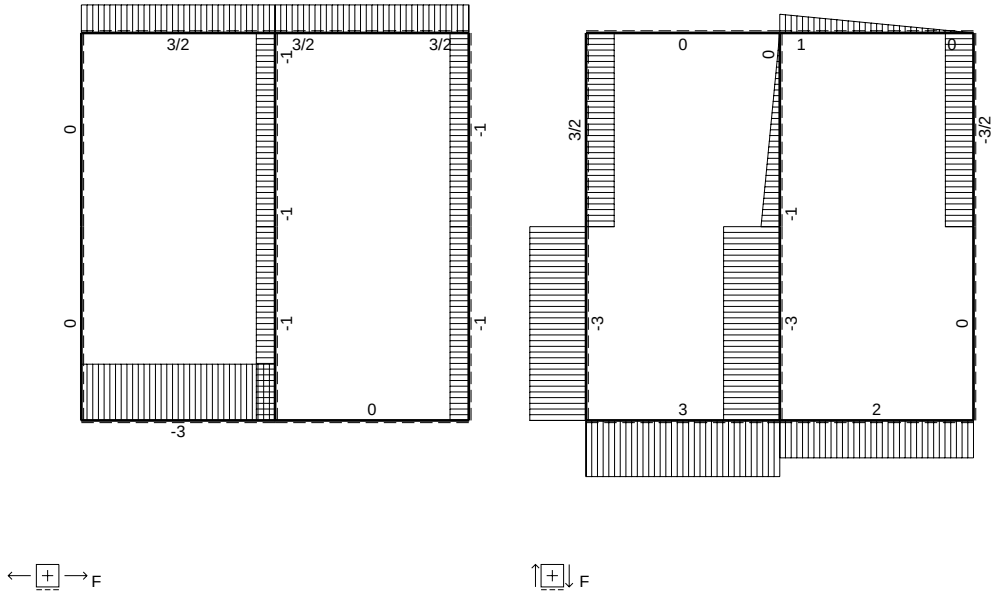
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-1
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-3
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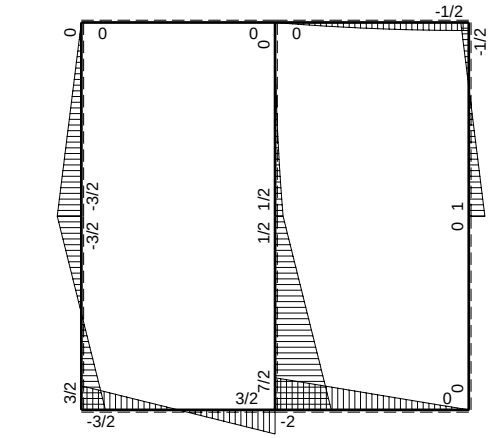
2
F
F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3/2
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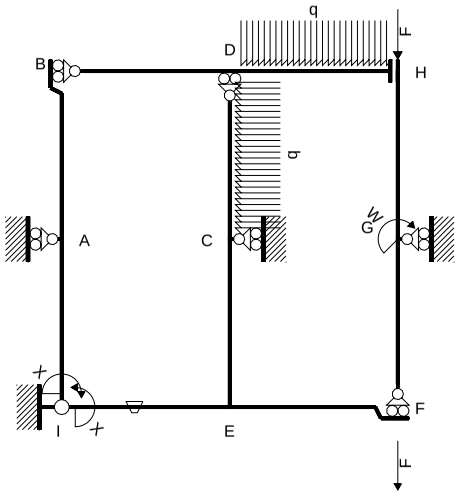
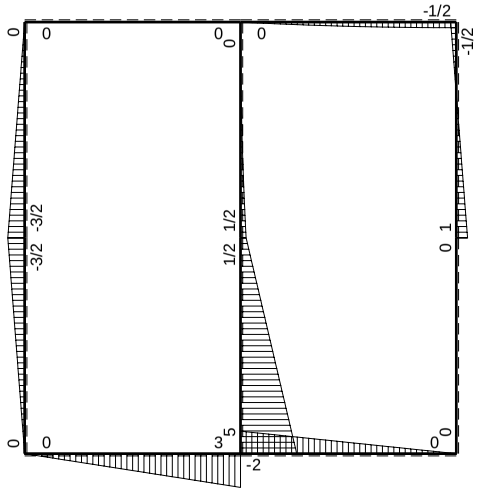
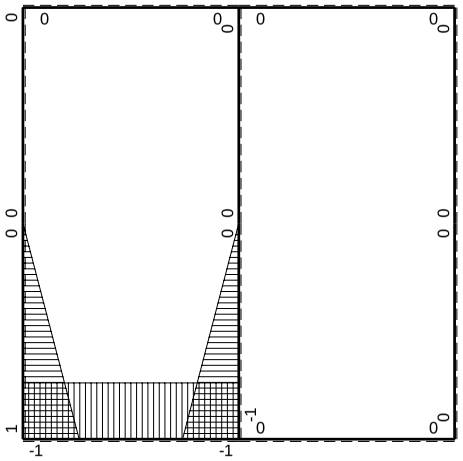
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 226461 CI07.xxxx.093

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PROCEDIMENTO E RISULTATI 226461 CI07.xxxx.093

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-3/2Fb+3/2Fx	0	0	0	0	0+0	0
BA b	0	3/2Fx	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	Fb-3/2Fx	0	0	0	0	0+0	0
HG b	0	1/2Fb-3/2Fx	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-9/2Fx	0	$-5Fb+19/2Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-7/4+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-1/2Fb-9/2Fx$	0	$-1/2Fx-9/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-3/2Fx	0	$-3/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/4+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	3/2Fb-3/2Fx	0	$-3/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-5/2Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						3/2Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 19/2\ x/b - 9/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 19/4\ x^2/b - 3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 19/4\ b - 3/2\ b\ )\ Fb\ 1/EJ\ = -7/4\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-1/2\ x/b - 9/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b - 3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

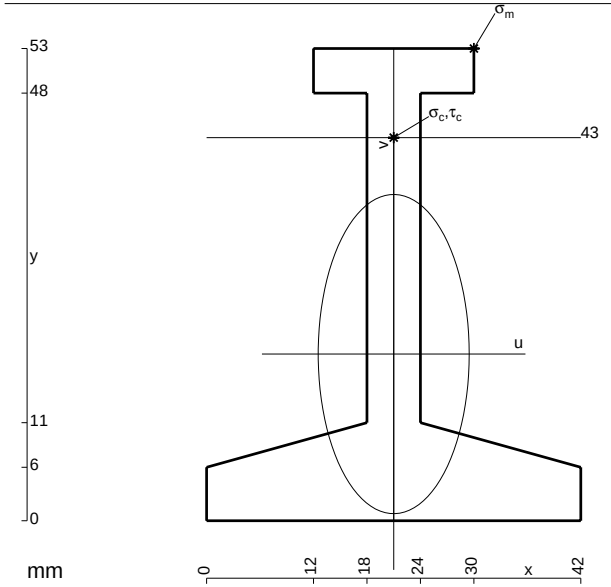
$= (-1/4\ b - 3/2\ b\ )\ Fb\ 1/EJ\ = -7/4\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-3/2\ x/b + 3/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-3/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

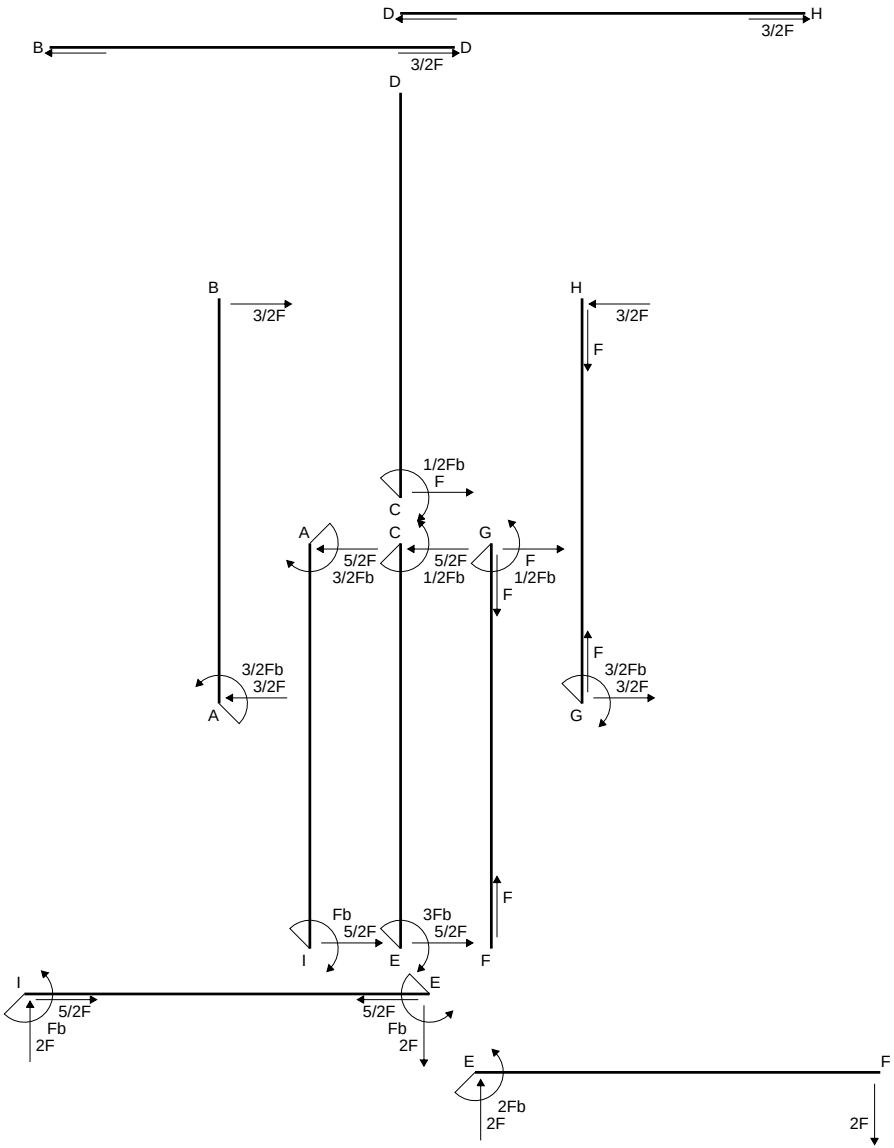
$= (-3/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = -1/4\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-3/2\ x/b + 3/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-3/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-3/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = -1/4\ Fb^2/EJ$



A = 684. mm^2
J_u = 219556. mm^4
J_v = 49140. mm^4
y_g = 18.71 mm
T_y = 2160. N
M_x = -1468800. Nmm
x_m = 30. mm
y_m = 53. mm
u_m = 9. mm
v_m = 34.29 mm
$\sigma_m = -Mv/J_u$ = 229.4 N/mm^2
x_c = 21. mm
y_c = 43. mm
v_c = 24.29 mm
$\sigma_c = -Mv/J_u$ = 162.5 N/mm^2
τ_c = 6.01 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 162.9 N/mm^2
S^* = 3665. mm^3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D
3/2F
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H
3/2F
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F
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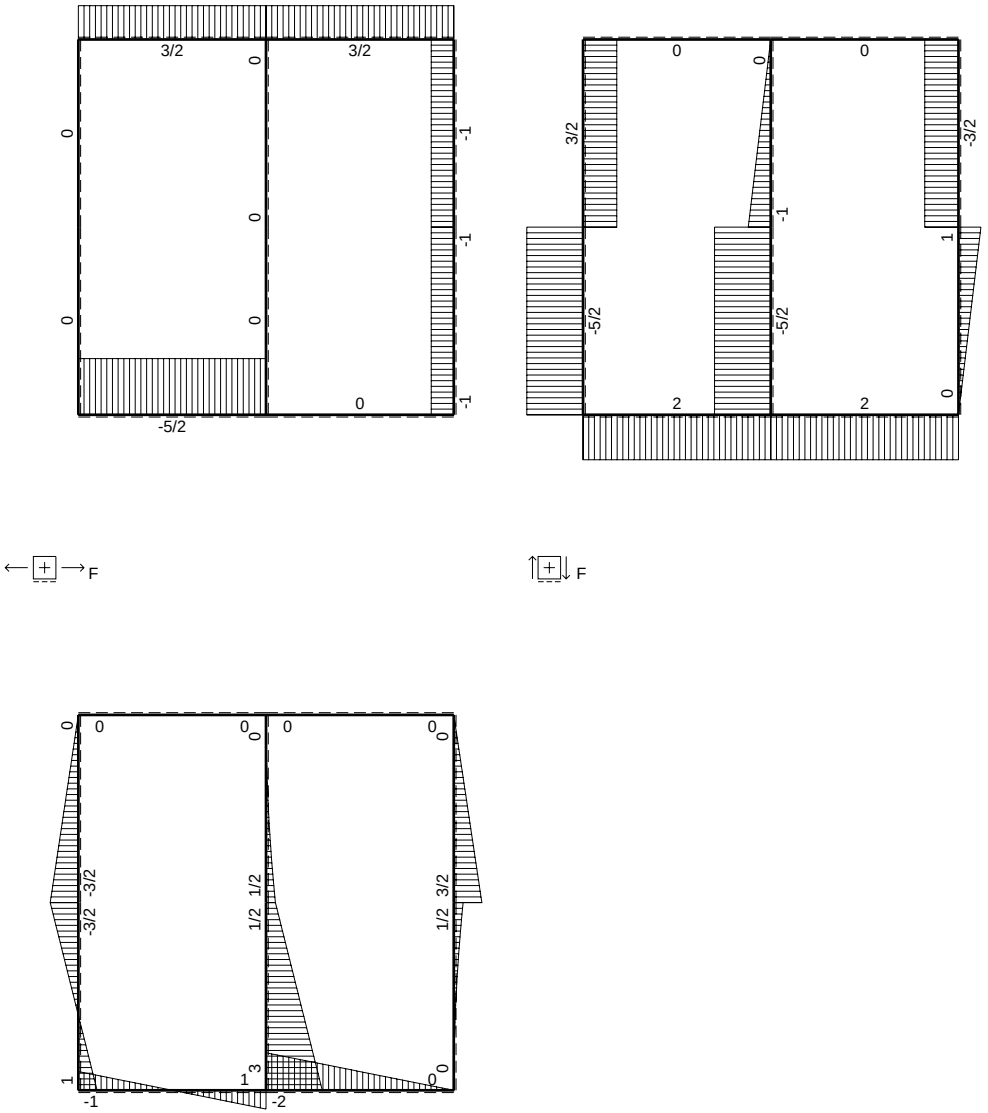
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1
-5/2
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2
2
0
F
F
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3/2
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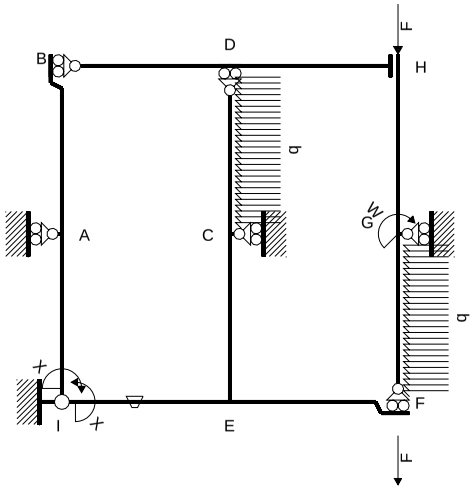
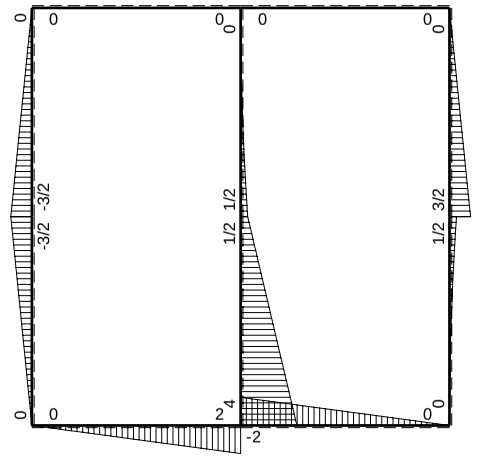
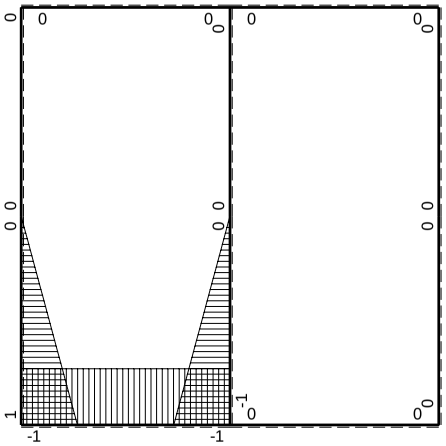
-1
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 214237 CI07.xxxx.094

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-3/2Fb+3/2Fx	0	0	0	0	0+0	0
BA b	0	3/2Fx	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	3/2Fb-3/2Fx	0	0	0	0	0+0	0
HG b	0	-3/2Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	-1+x/b	4Fb-7/2Fx	0	$-4Fb+15/2Fx-7/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-17/12+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-1/2Fb-7/2Fx$	0	$-1/2Fx-7/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-3/2Fx	0	$-3/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/4+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	3/2Fb-3/2Fx	0	$-3/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-5/3Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L_{EI}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L_{EC}^{Xo} = \int_o^b (-4 + 15/2\ x/b - 7/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4\ x + 15/4\ x^2/b - 7/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-4\ b + 15/4\ b - 7/6\ b\ )\ Fb\ 1/EJ\ = -17/12\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-1/2\ x/b - 7/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b - 7/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b - 7/6\ b\ )\ Fb\ 1/EJ\ = -17/12\ Fb^2/EJ$

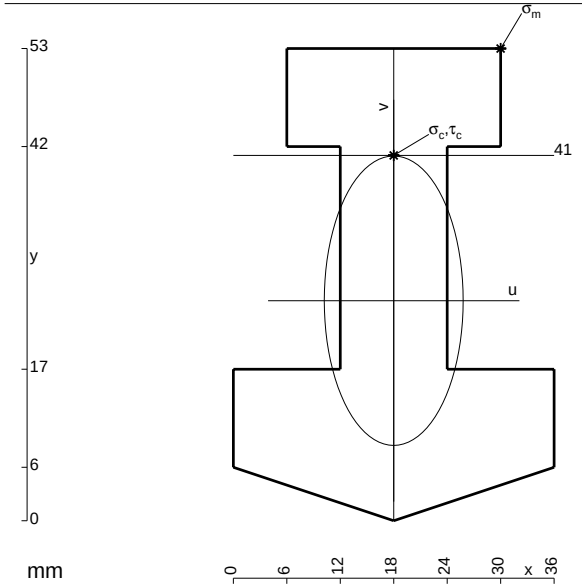
$L_{IA}^{Xo} = \int_o^b (-3/2\ x/b + 3/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-3/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-3/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = -1/4\ Fb^2/EJ$

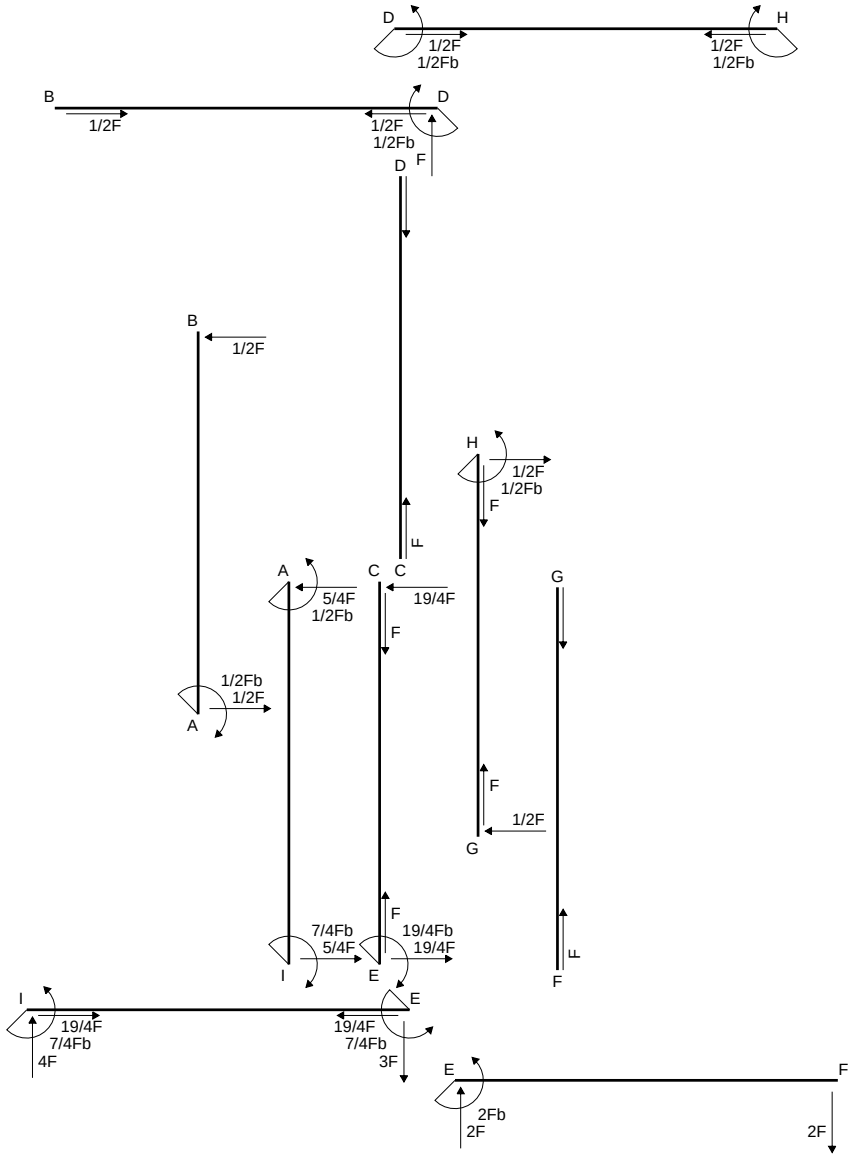
$L_{AI}^{Xo} = \int_o^b (-3/2\ x/b + 3/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-3/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-3/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = -1/4\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 214237 CI07.xxxx.094



A = 1068. mm^2
J_u = 281922. mm^4
J_v = 64872. mm^4
y_g = 24.7 mm
T_y = 3220. N
M_x = -2382800. Nmm
x_m = 30. mm
y_m = 53. mm
u_m = 12. mm
v_m = 28.3 mm
$\sigma_m = -Mv/J_u$ = 239.2 N/mm^2
x_c = 18. mm
y_c = 41. mm
v_c = 16.3 mm
$\sigma_c = -Mv/J_u$ = 137.8 N/mm^2
τ_c = 5.922 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 138.2 N/mm^2
S^* = 6222. mm^3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1/2Fb
F
F
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C
C
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1/2Fb
19/4F
F
G
1/2Fb
1/2F
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G
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F
7/4Fb
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19/4Fb
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7/4Fb
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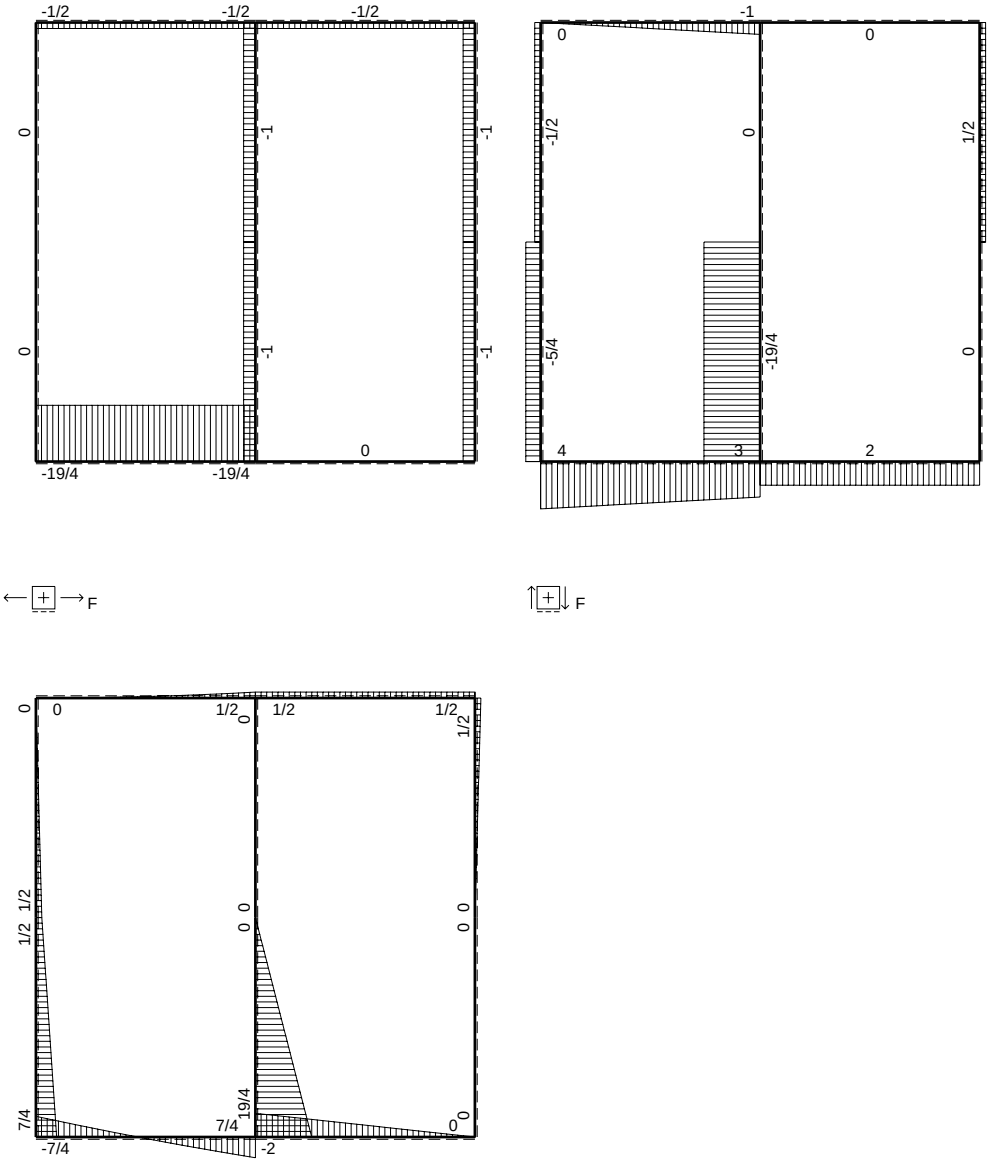
2F
2F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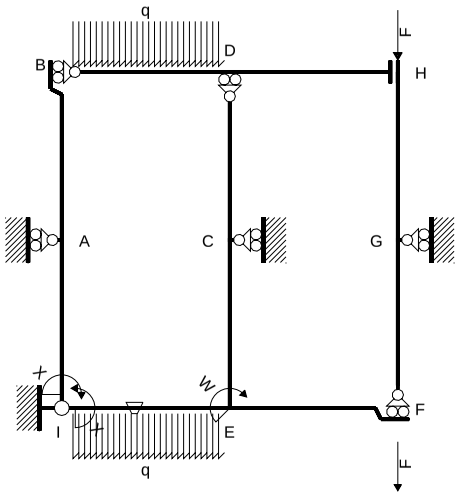
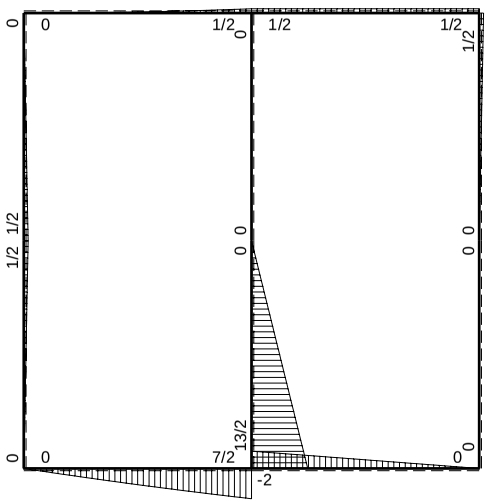
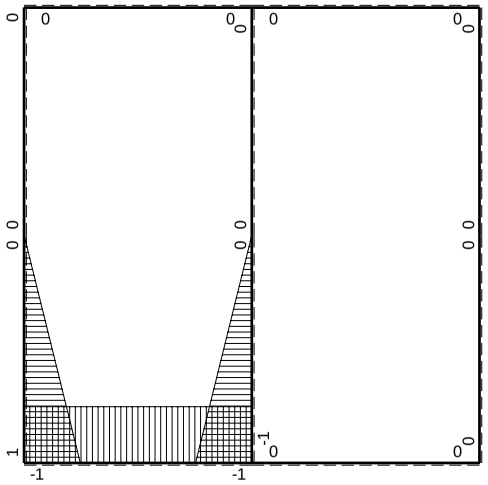
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 213543 CI07.xxxx.095

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PROCEDIMENTO E RISULTATI 213543 CI07.xxxx.095

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
BA b	0	-1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fb+1/2Fx	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$4Fx-1/2qx^2$	-Fb/EJ	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	-1+x/b	13/2Fb-13/2Fx	0	$-13/2Fb+13Fx-13/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-13/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-13/2Fx$	0	$-13/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	1/2Fx	0	$1/2Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	-1/2Fb+1/2Fx	0	$1/2Fx-1/2Fx^2/b$	0	x^2/b^2		
	totali						$-35/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						7/4Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-4\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-7/2 + 3\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx$

$= [-7/2\ x + 3/2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-7/2\ b + 3/2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-13/2 + 13\ x/b - 13/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-13/2\ x + 13/2\ x^2/b - 13/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-13/2\ b + 13/2\ b - 13/6\ b\ )\ Fb\ 1/EJ\ = -13/6\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-13/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-13/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

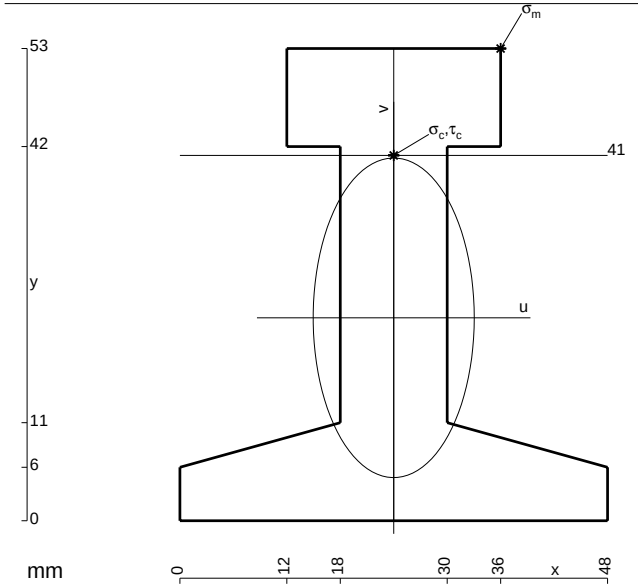
$= (-13/6\ b\ )\ Fb\ 1/EJ\ = -13/6\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1/2\ x/b - 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [1/4\ x^2/b - 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

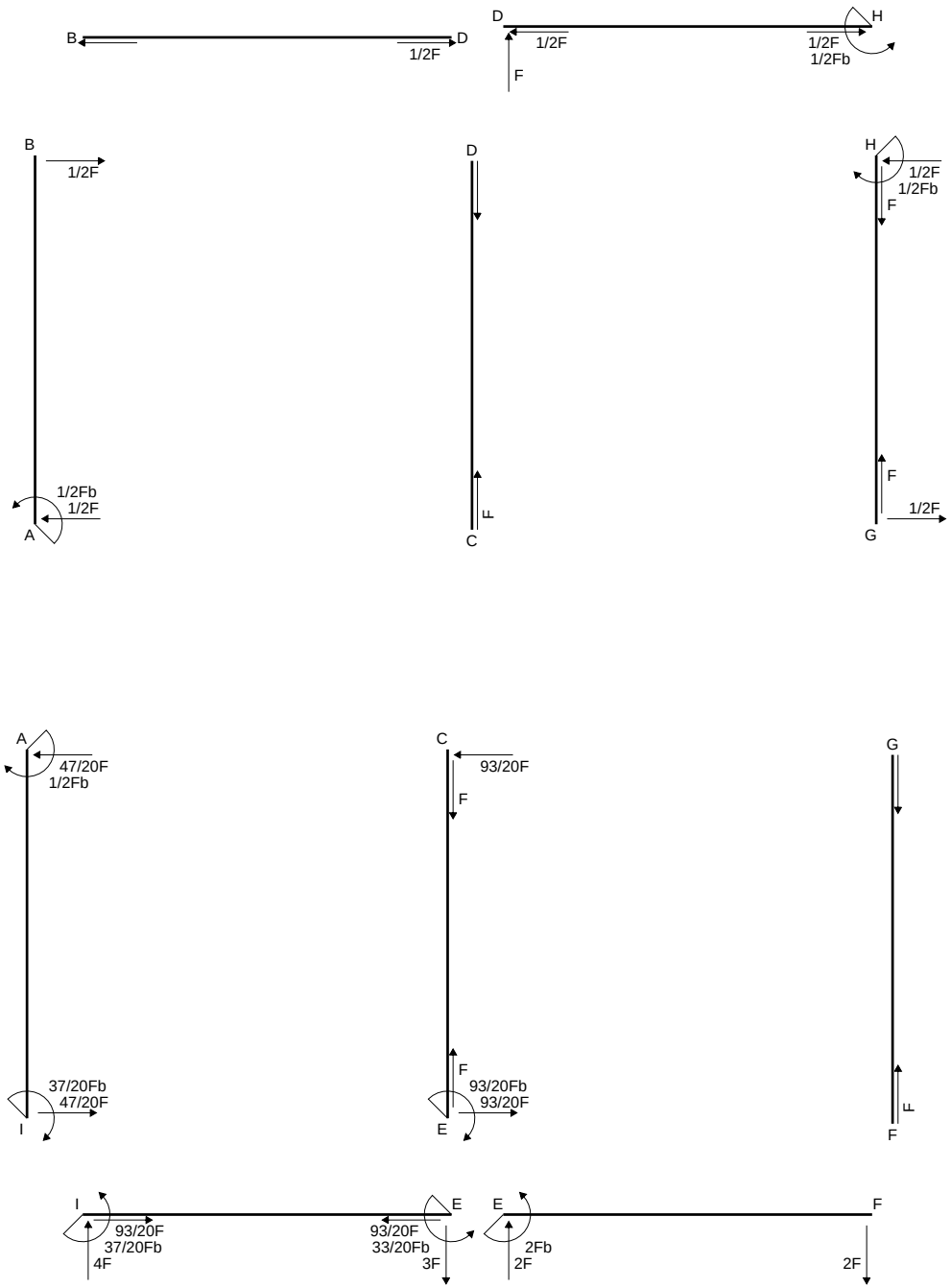
$= (1/4\ b - 1/6\ b\ )\ Fb\ 1/EJ\ = 1/12\ Fb^2/EJ$

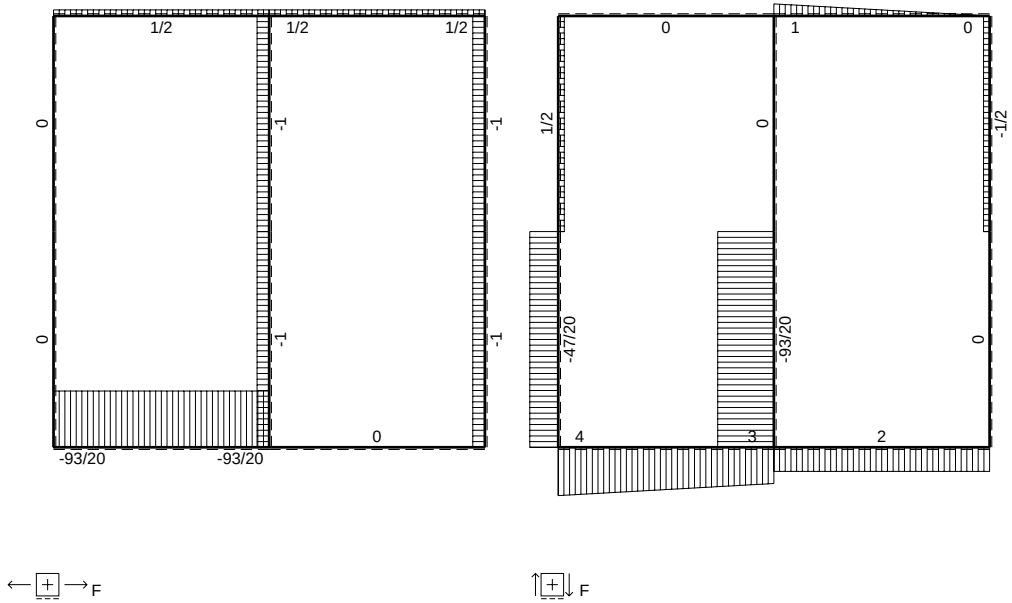
$L_{AI}^{Xo} = \int_o^b (1/2\ x/b - 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [1/4\ x^2/b - 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

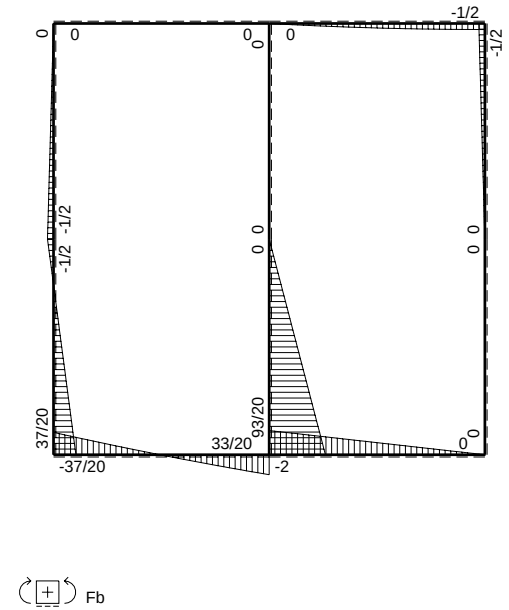
$= (1/4\ b - 1/6\ b\ )\ Fb\ 1/EJ\ = 1/12\ Fb^2/EJ$

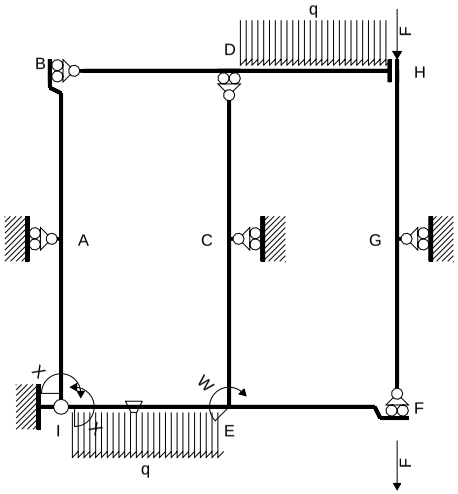


A = 1074. mm^2
J_u = 345511. mm^4
J_v = 87732. mm^4
y_g = 22.78 mm
T_y = 2880. N
M_x = -2275200. Nmm
x_m = 36. mm
y_m = 53. mm
u_m = 12. mm
v_m = 30.22 mm
$\sigma_m = -Mv/J_u$ = 199. N/mm^2
x_c = 24. mm
y_c = 41. mm
v_c = 18.22 mm
$\sigma_c = -Mv/J_u$ = 120. N/mm^2
τ_c = 4.69 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 120.3 N/mm^2
S^* = 6752. mm^3

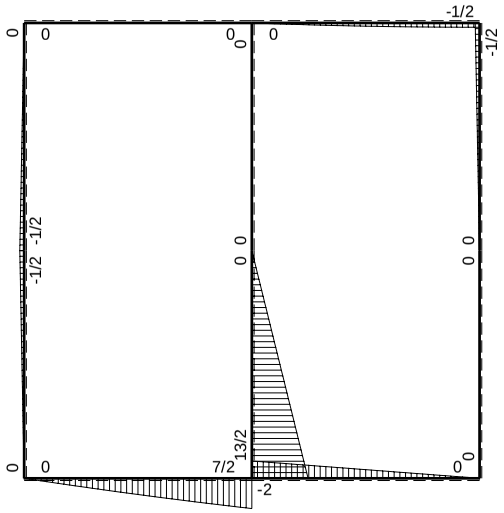

B
D
1/2F
D
H
1/2F
1/2F
1/2Fb
F
B
1/2F
D
H
1/2F
1/2Fb
F
1/2Fb
1/2F
A
F
C
F
F
1/2F
G
A
47/20F
1/2Fb
C
93/20F
F
G
F
37/20Fb
47/20F
I
F
93/20Fb
93/20F
E
F
I
E
E
F
93/20F
37/20Fb
4F
93/20F
33/20Fb
3F
2Fb
2F
2F


1/2
1/2
1/2
0
-1
-1
0
-1
-1
-93/20
-93/20
0
F
0
1
0
1/2
0
-1/2
-47/20
-93/20
0
4
3
2
F

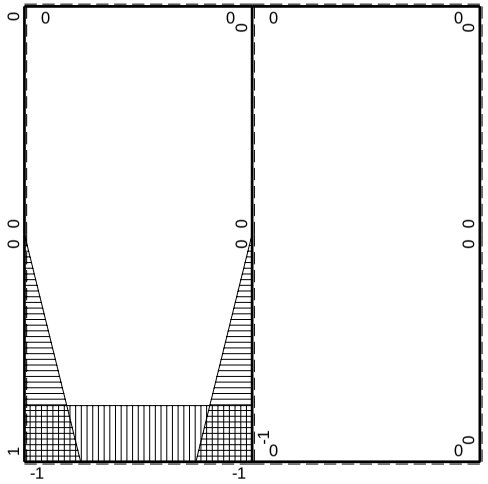

-1/2
0
0
0
0
-1/2
-1/2
-1/2
0 0
0 0
37/20
93/20
33/20
0
-37/20
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	-1/2Fx	0	0	0	0	0+0	0
HG b	0	1/2Fb-1/2Fx	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$4Fx-1/2qx^2$	-Fb/EJ	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	-1+x/b	13/2Fb-13/2Fx	0	$-13/2Fb+13Fx-13/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-13/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-13/2Fx$	0	$-13/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-37/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						37/20Fb	

Sviluppi di calcolo iperstatica

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$L^{XX}_{IE} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EI} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EC} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{CE} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{IA} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{AI} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{Xo}_{IE} = \int_o^b (-4\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L^{Xo}_{EI} = \int_o^b (-7/2 + 3\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx$

$= [-7/2\ x + 3/2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-7/2\ b + 3/2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L^{Xo}_{EC} = \int_o^b (-13/2 + 13\ x/b - 13/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-13/2\ x + 13/2\ x^2/b - 13/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-13/2\ b + 13/2\ b - 13/6\ b\ )\ Fb\ 1/EJ\ = -13/6\ Fb^2/EJ$

$L^{Xo}_{CE} = \int_o^b (-13/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-13/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

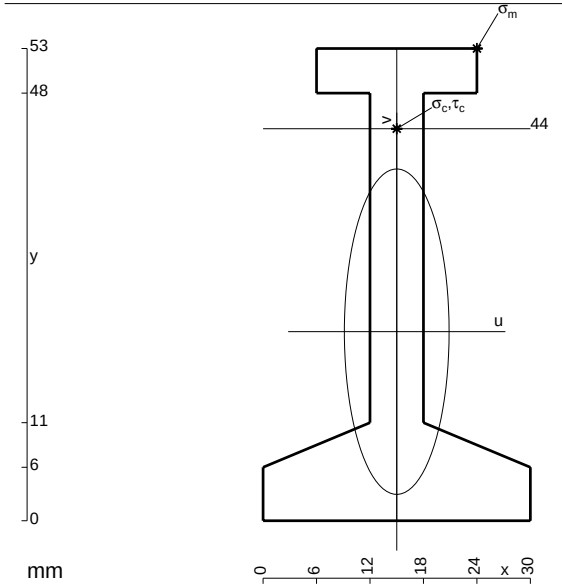
$= (-13/6\ b\ )\ Fb\ 1/EJ\ = -13/6\ Fb^2/EJ$

$L^{Xo}_{IA} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

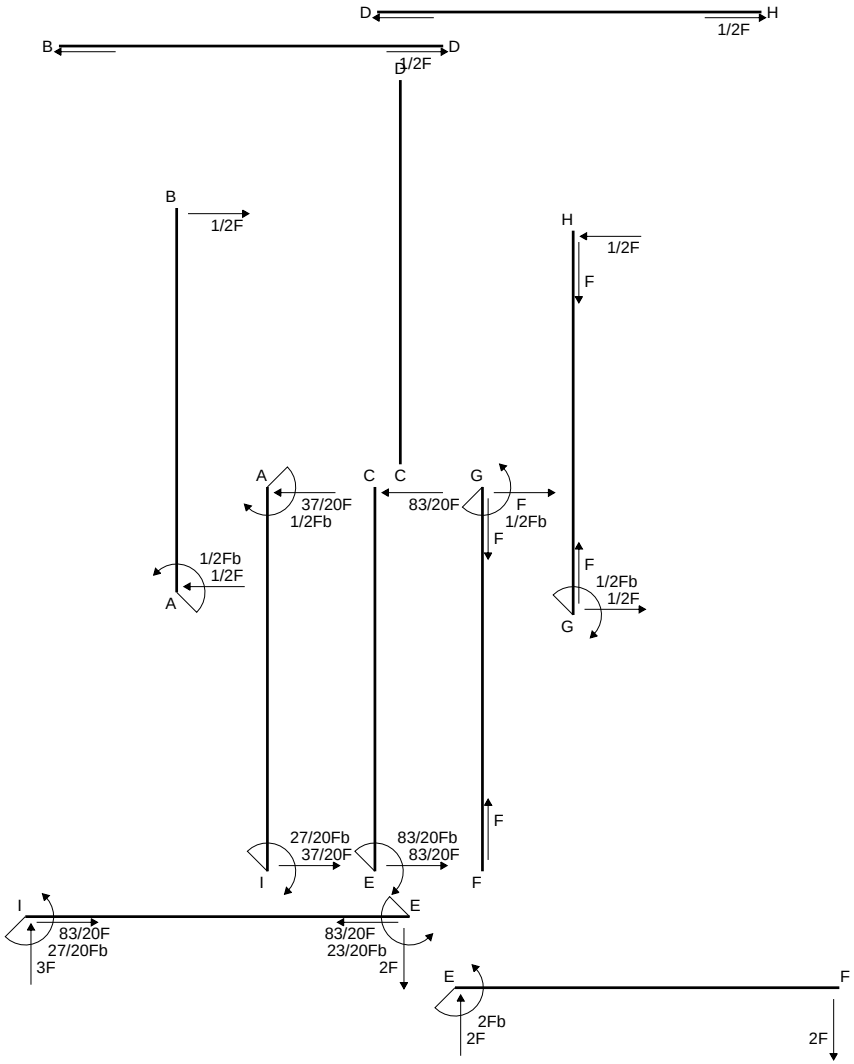
$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

$L^{Xo}_{AI} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$



A = 582. mm^2
J_u = 194208. mm^4
J_v = 20106. mm^4
y_g = 21.22 mm
T_y = 1520. N
M_x = -1276800. Nmm
x_m = 24. mm
y_m = 53. mm
u_m = 9. mm
v_m = 31.78 mm
$\sigma_m = -Mv/J_u$ = 208.9 N/mm^2
x_c = 15. mm
y_c = 44. mm
v_c = 22.78 mm
$\sigma_c = -Mv/J_u$ = 149.8 N/mm^2
τ_c = 4.214 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 150. N/mm^2
S^* = 3230. mm^3


D
H
1/2F
B
D
1/2F
D
B
1/2F
H
1/2F
F
A
C
C
G
37/20F
1/2Fb
83/20F
F
1/2Fb
F
1/2Fb
1/2F
A
F
1/2Fb
1/2F
G
F
27/20Fb
37/20F
83/20Fb
83/20F
I
E
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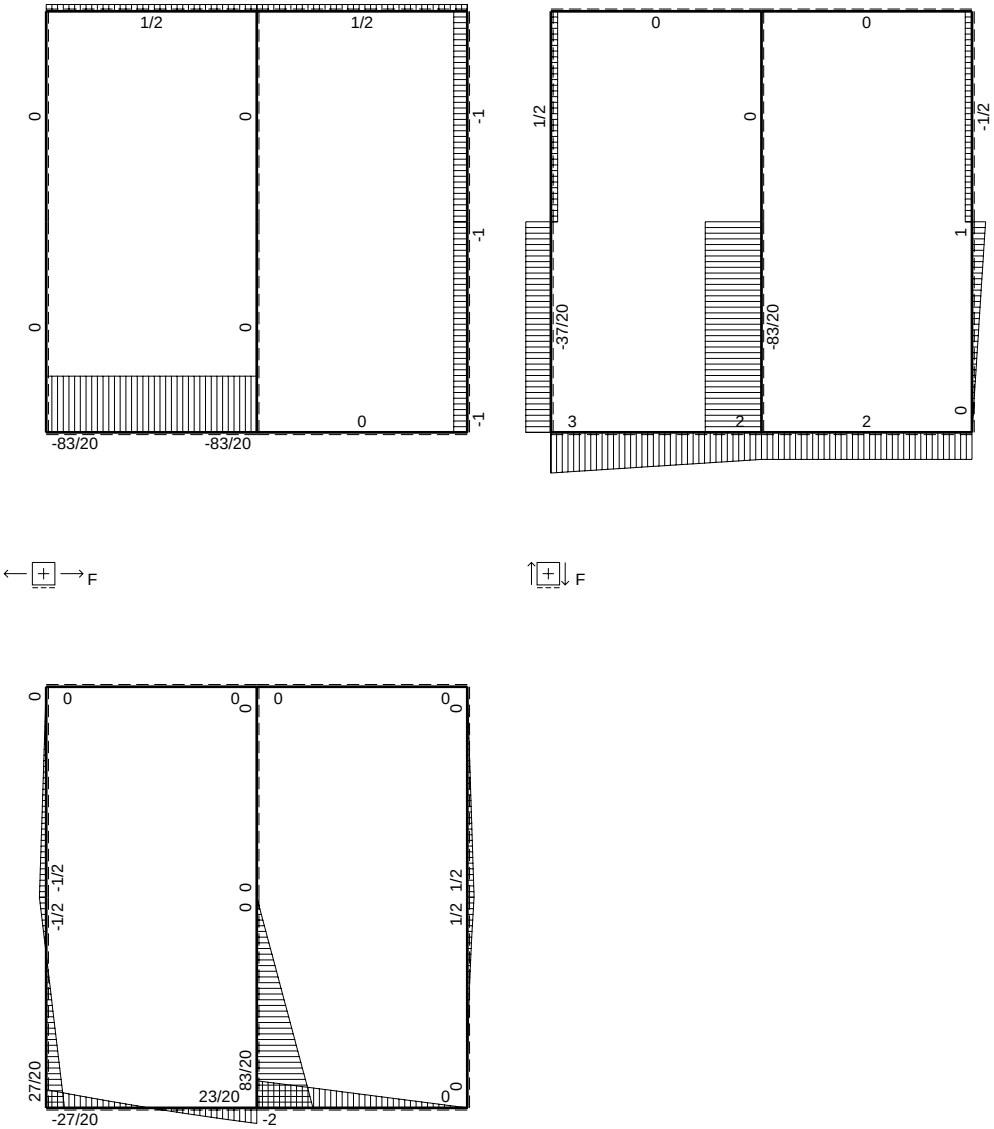
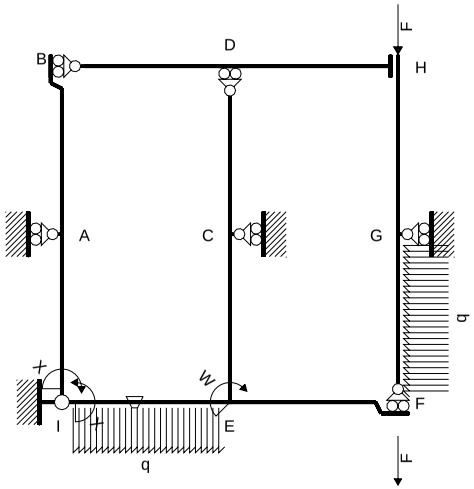
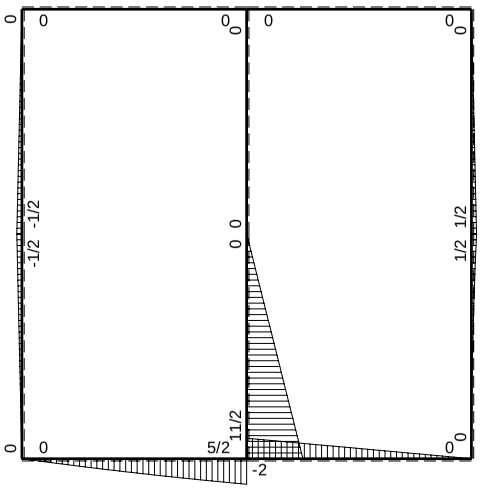
2Fb
2F
2F

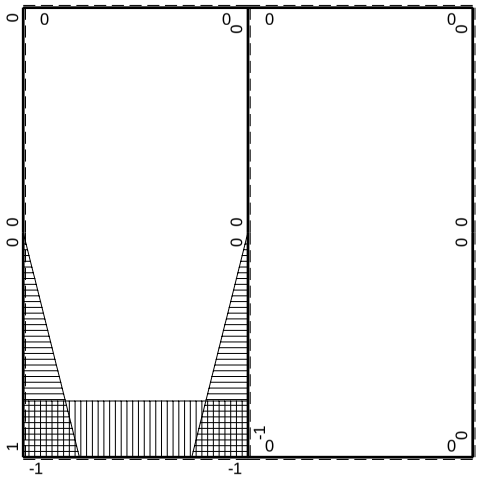

1/2
1/2
0
0
0
0
-1
-1
-1
0
-83/20
-83/20
0
0
1/2
0
-1/2
-37/20
-83/20
1
3
2
2
0
F
F
0
0
0
0
0
0
0
0
0
0
-1/2 -1/2
1/2 1/2
27/20
83/20
23/20
0
-27/20
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 218499 CI07.xxxx.097

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PROCEDIMENTO E RISULTATI 218499 CI07.xxxx.097

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx-1/2qx^2$	-Fb/EJ	$-3Fx+1/2Fx^2/b$	Fb/EJ	1	$(-4/3+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-5/2Fb+2Fx+1/2qx^2$	Fb/EJ	$-5/2Fb+2Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	-1+x/b	11/2Fb-11/2Fx	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-11/2Fx	0	$-11/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-9/4Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						27/20Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/3\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-5/2 + 2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx$

$= [-5/2\ x + x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-5/2\ b + b + 1/6\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/3\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-11/2 + 11\ x/b - 11/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-11/2\ x + 11/2\ x^2/b - 11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-11/2\ b + 11/2\ b - 11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-11/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

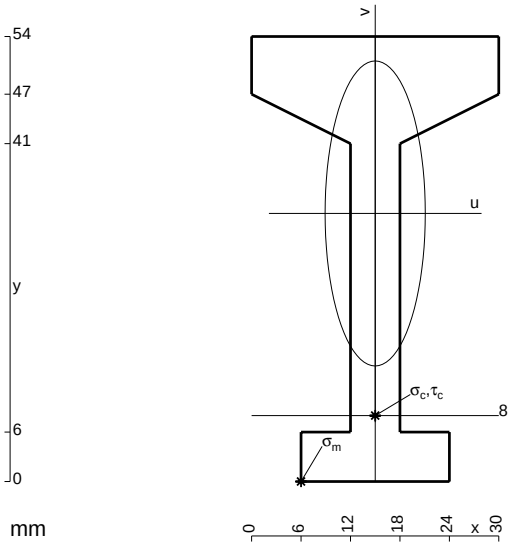
$= (-11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

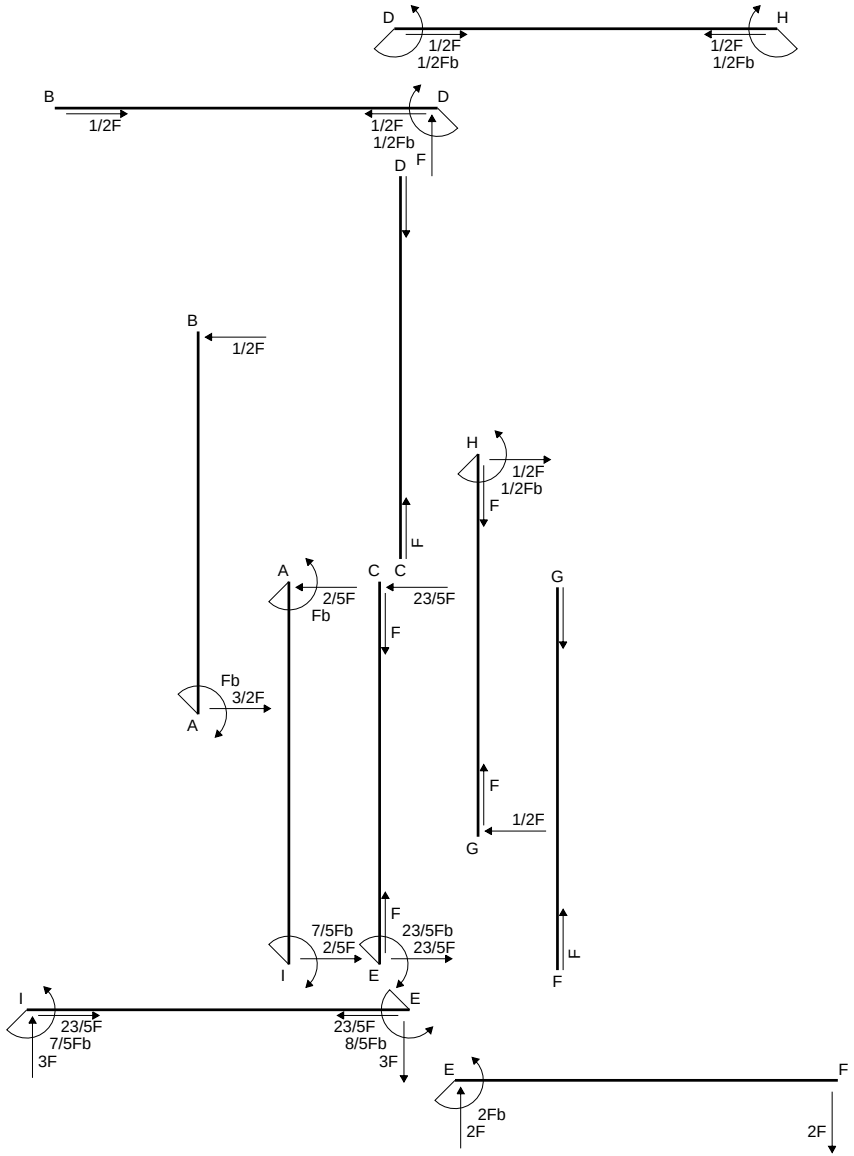
$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$



A = 636. mm^2
J_u = 217919. mm^4
J_v = 23508. mm^4
y_g = 32.53 mm
T_y = 1600. N
M_x = -1456000. Nmm
x_m = 6. mm
u_m = -9. mm
v_m = -32.53 mm
$\sigma_m = -Mv/J_u$ = -217.3 N/mm^2
x_c = 15. mm
y_c = 8. mm
v_c = -24.53 mm
$\sigma_c = -Mv/J_u$ = -163.9 N/mm^2
τ_c = 4.277 N/mm^2
$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2}$ = 164.1 N/mm^2
S^* = 3495. mm^3


D
H
1/2F
1/2Fb
B
D
1/2F
1/2F
1/2Fb
F
D
B
1/2F
H
1/2F
1/2Fb
F
F
A
C
C
2/5F
23/5F
Fb
F
G
Fb
3/2F
A
F
1/2F
G
F
F
7/5Fb
23/5Fb
2/5F
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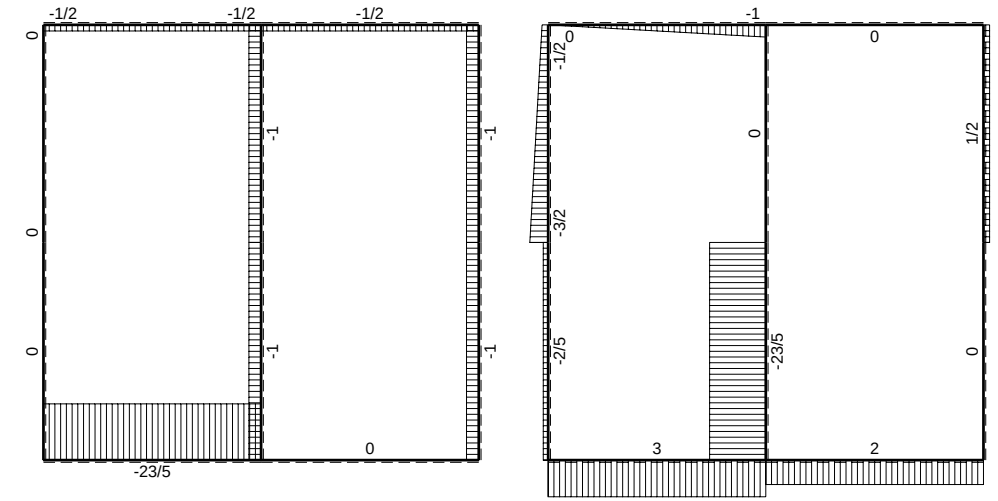
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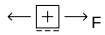
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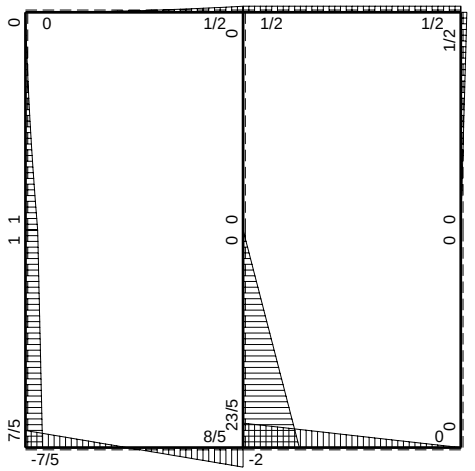
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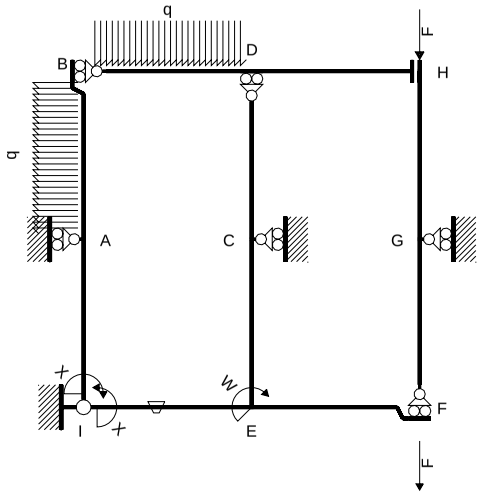
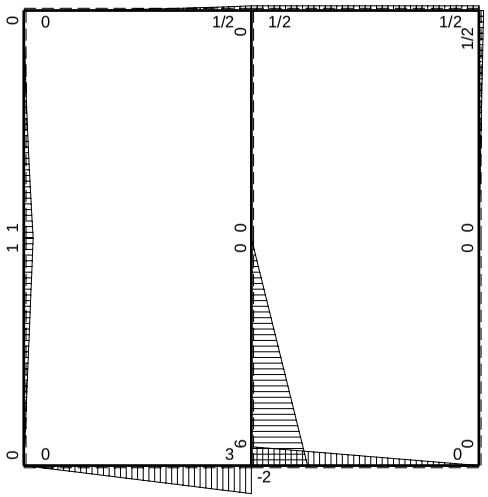
7/5
23/5
8/5
0
0
-7/5
-2

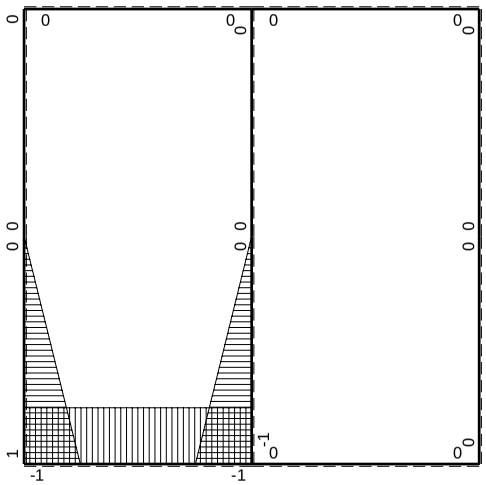
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 215080 CI07.xxxx.098

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$Fb-3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$-1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$6Fb-6Fx$	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-6Fx$	0	$-6Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	Fx	0	$Fx-Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-Fb+Fx$	0	$Fx-Fx^2/b$	0	x^2/b^2		
	totali						$-7/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$7/5Fb$	

PROCEDIMENTO E RISULTATI 215080 CI07.xxxx.098

Sviluppi di calcolo iperstatica

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

$L_{lE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{El}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{lA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{Al}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{lE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{El}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-6 + 12\ x/b - 6\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-6\ x + 6\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-6\ b + 6\ b - 2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

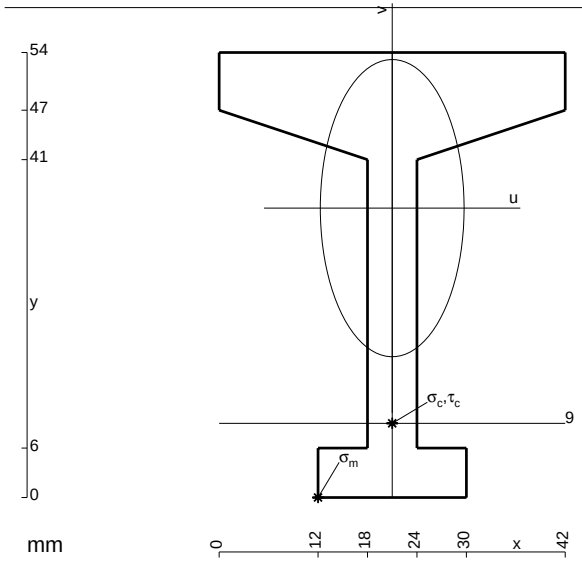
$= (-2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

$L_{lA}^{Xo} = \int_o^b (\ x/b - x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/2\ b - 1/3\ b\ )\ Fb\ 1/EJ\ = 1/6\ Fb^2/EJ$

$L_{Al}^{Xo} = \int_o^b (\ x/b - x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/2\ b - 1/3\ b\ )\ Fb\ 1/EJ\ = 1/6\ Fb^2/EJ$



$A = 756.\ mm^2$

$J_u = 245989.\ mm^4$

$J_v = 57564.\ mm^4$

$y_g = 35.12\ mm$

$T_y = 1660.\ N$

$M_x = -1610200.\ Nmm$

$x_m = 12.\ mm$

$u_m = -9.\ mm$

$v_m = -35.12\ mm$

$\sigma_m = -Mv/J_u = -229.9\ N/mm^2$

$x_c = 21.\ mm$

$y_c = 9.\ mm$

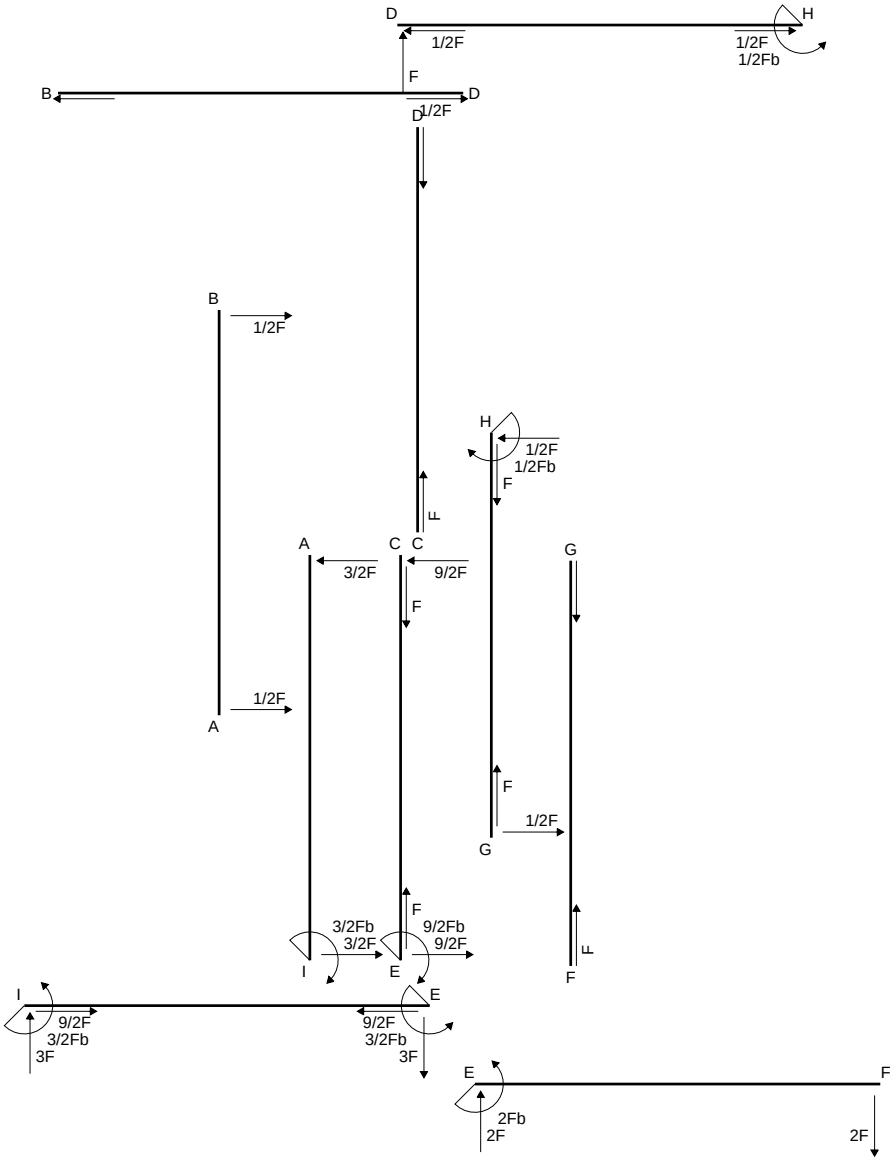
$v_c = -26.12\ mm$

$\sigma_c = -Mv/J_u = -171.\ N/mm^2$

$\tau_c = 4.461\ N/mm^2$

$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 171.1\ N/mm^2$

$S^* = 3966.\ mm^3$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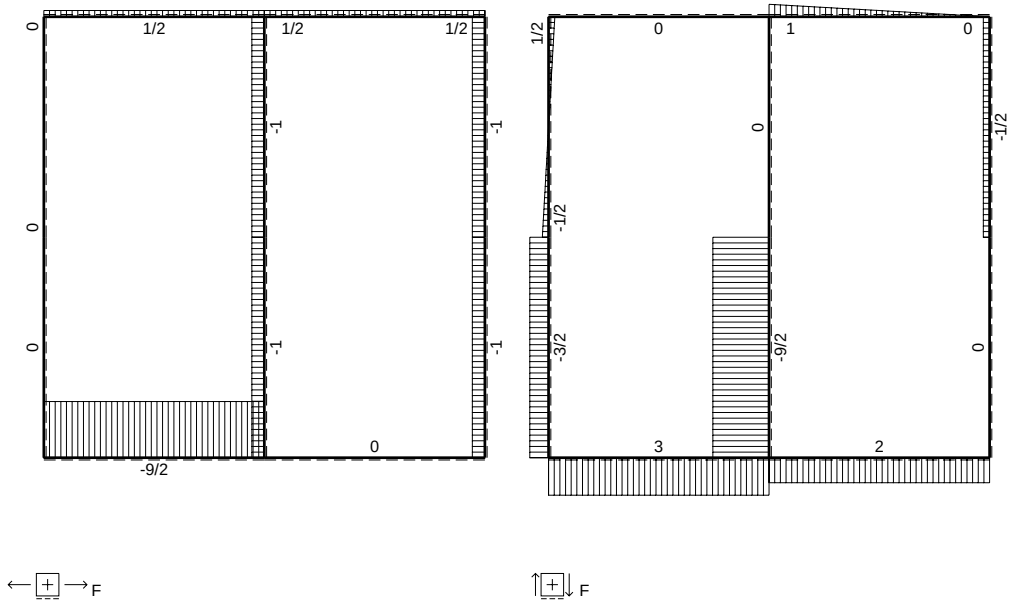
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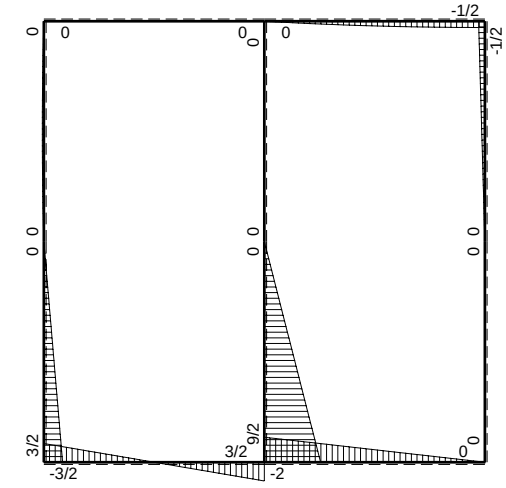
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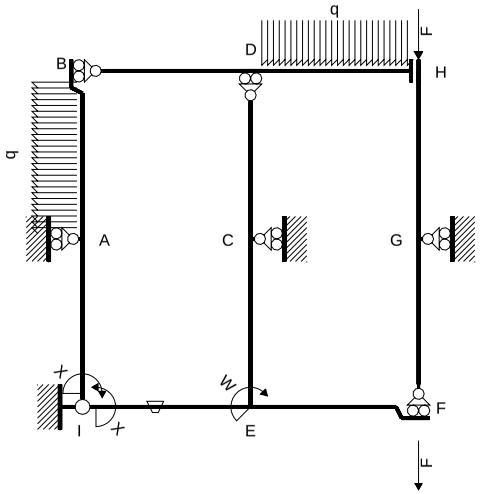
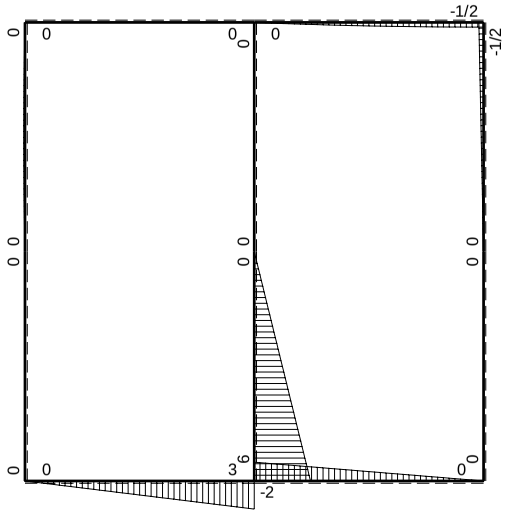
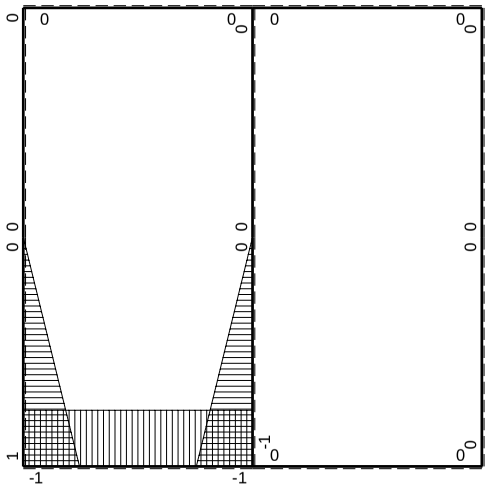


Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 213198 CI07.xxxx.099

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	-1/2Fx	0	0	0	0	0+0	0
HG b	0	1/2Fb-1/2Fx	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	6Fb-6Fx	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-6Fx	0	$-6Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	1/3Xb/EJ
AI b	-x/b	0	0	0	0	x^2/b^2		
	totali						$-5/2Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						3/2Fb	

PROCEDIMENTO E RISULTATI 213198 CI07.xxxx.099

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

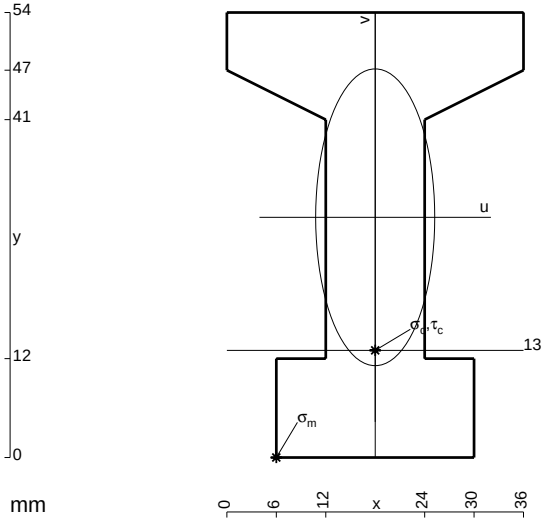
$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-6 + 12\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-6\ x + 6\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

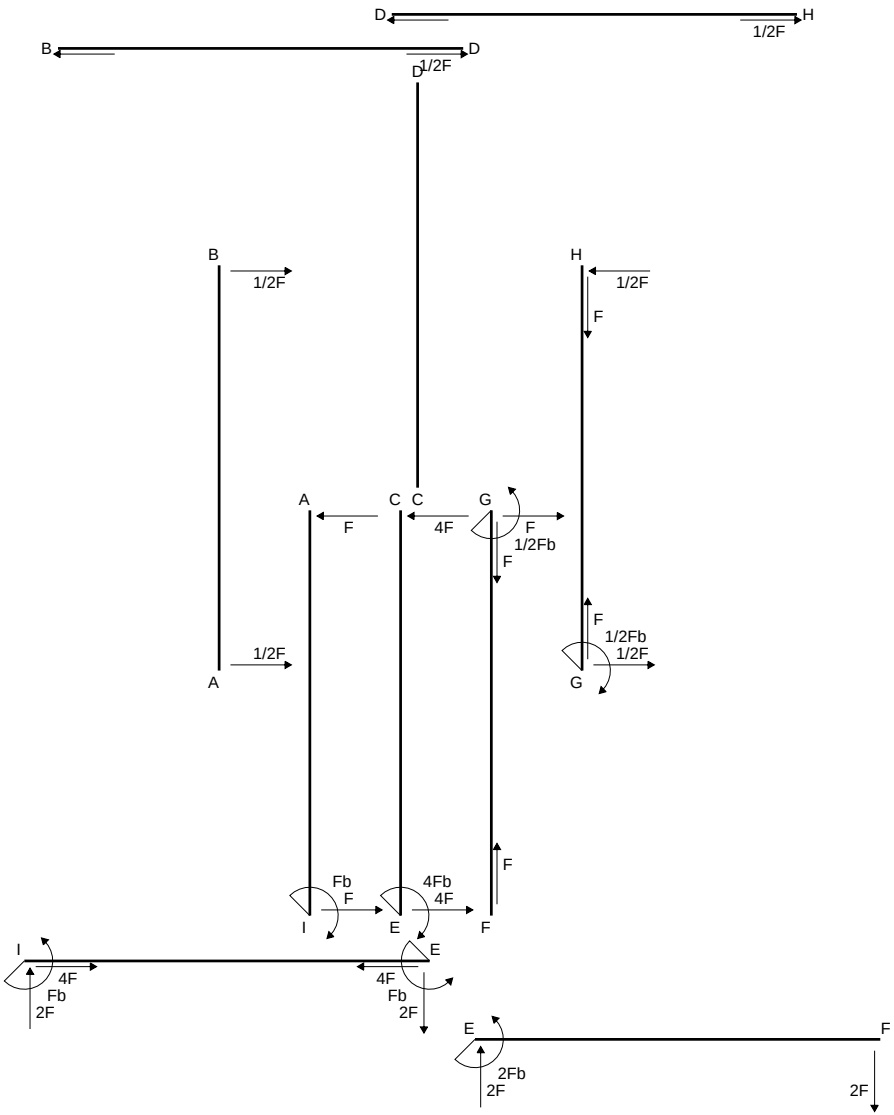
$= (-6\ b + 6\ b - 2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$



A = 1032. mm^2
J_u = 334856. mm^4
J_v = 53856. mm^4
y_g = 29.15 mm
T_y = 2700. N
M_x = -2754000. Nmm
x_m = 6. mm
u_m = -12. mm
v_m = -29.15 mm
$\sigma_m = -Mv/J_u$ = -239.8 N/mm^2
x_c = 18. mm
y_c = 13. mm
v_c = -16.15 mm
$\sigma_c = -Mv/J_u$ = -132.8 N/mm^2
τ_c = 4.614 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 133.1 N/mm^2
S^* = 6867. mm^3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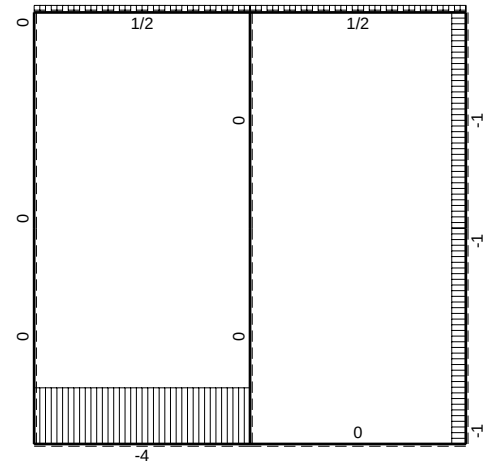
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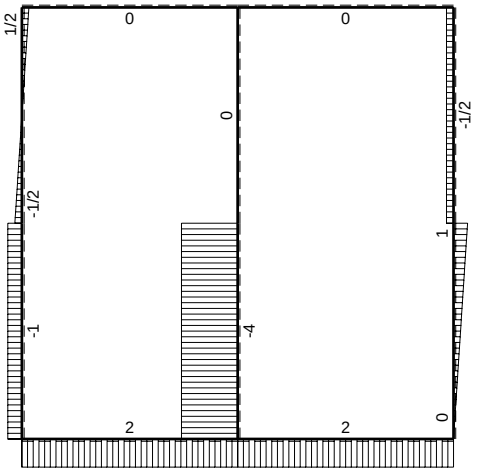
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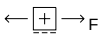
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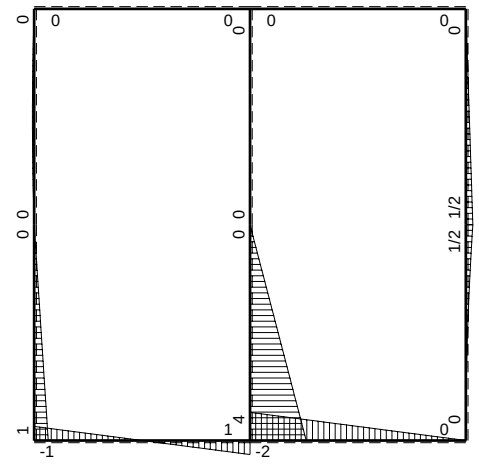
F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0
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1
4
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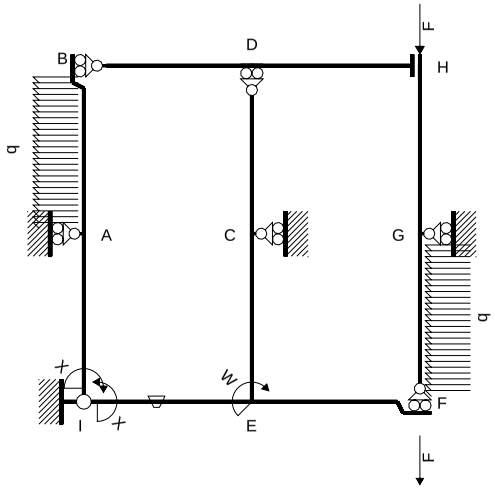
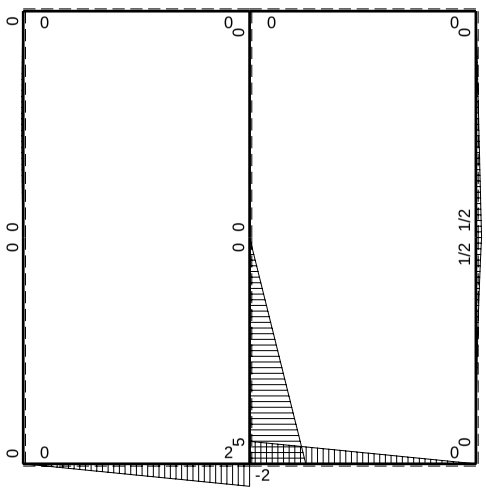
0
-1
-2

Fb



Schema di calcolo iperstatico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0
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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-5Fx	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-5Fx	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	1/3Xb/EJ
AI b	-x/b	0	0	0	0	x^2/b^2		
	totali						$-5/3Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						Fb	

Sviluppi di calcolo iperstatica

PROCEDIMENTO E RISULTATI 218296 CI07.xxxx.100
@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L_{EI}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

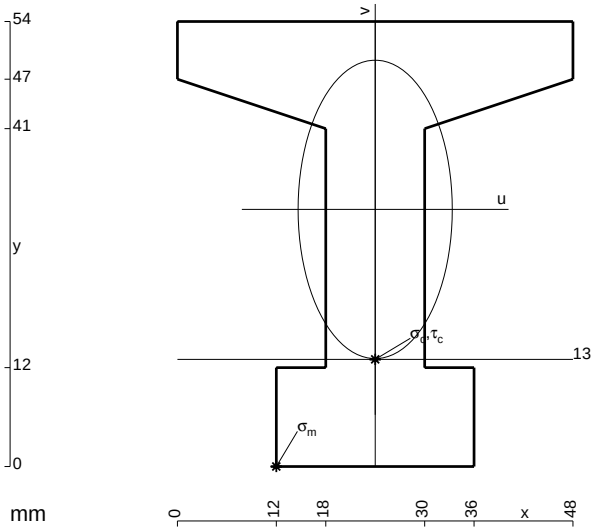
$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L_{EC}^{Xo} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

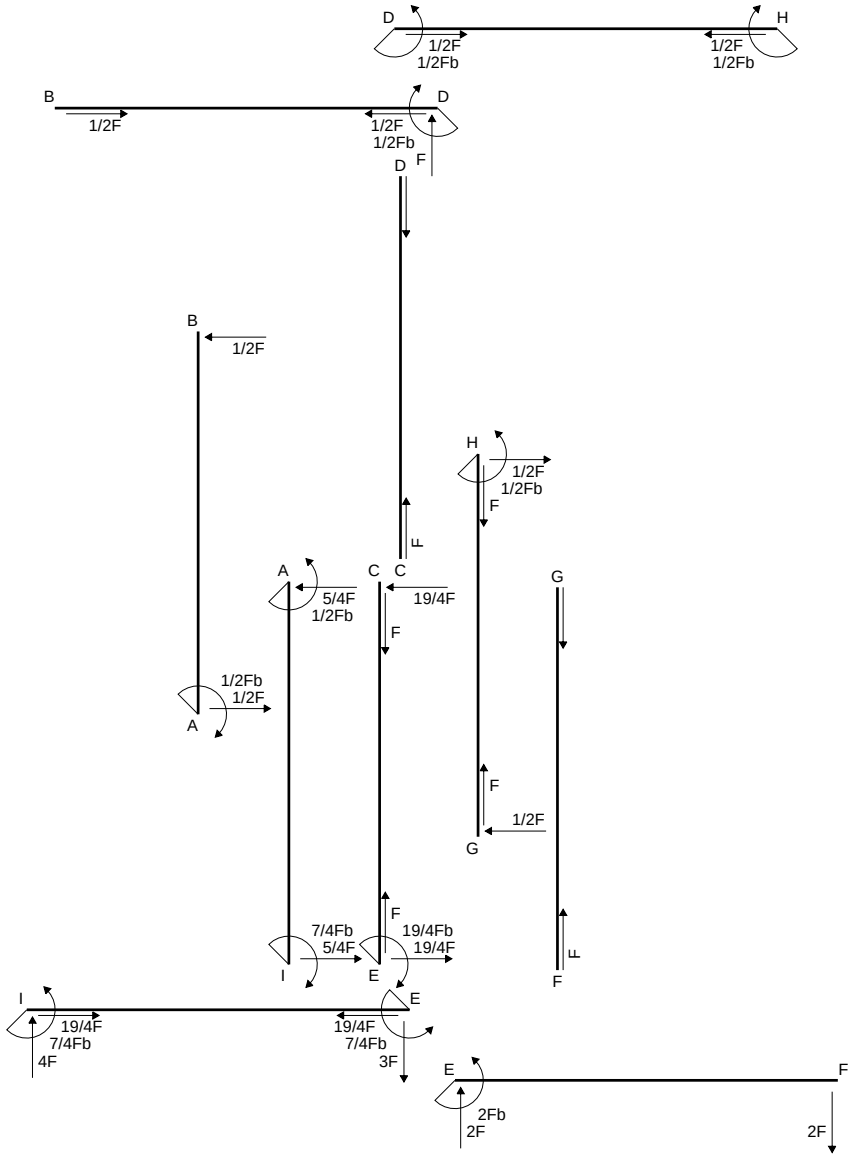
$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$



A = 1152. mm^2
J_u = 377748. mm^4
J_v = 100872. mm^4
y_g = 31.2 mm
T_y = 4480. N
M_x = -2419200. Nmm
x_m = 12. mm
u_m = -12. mm
v_m = -31.2 mm
$\sigma_m = -Mv/J_u$ = -199.8 N/mm^2
x_c = 24. mm
y_c = 13. mm
v_c = -18.2 mm
$\sigma_c = -Mv/J_u$ = -116.6 N/mm^2
τ_c = 7.395 N/mm^2
$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2}$ = 117.3 N/mm^2
S^* = 7483. mm^3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A
C
C
5/4F
1/2Fb
19/4F
F
G
1/2Fb
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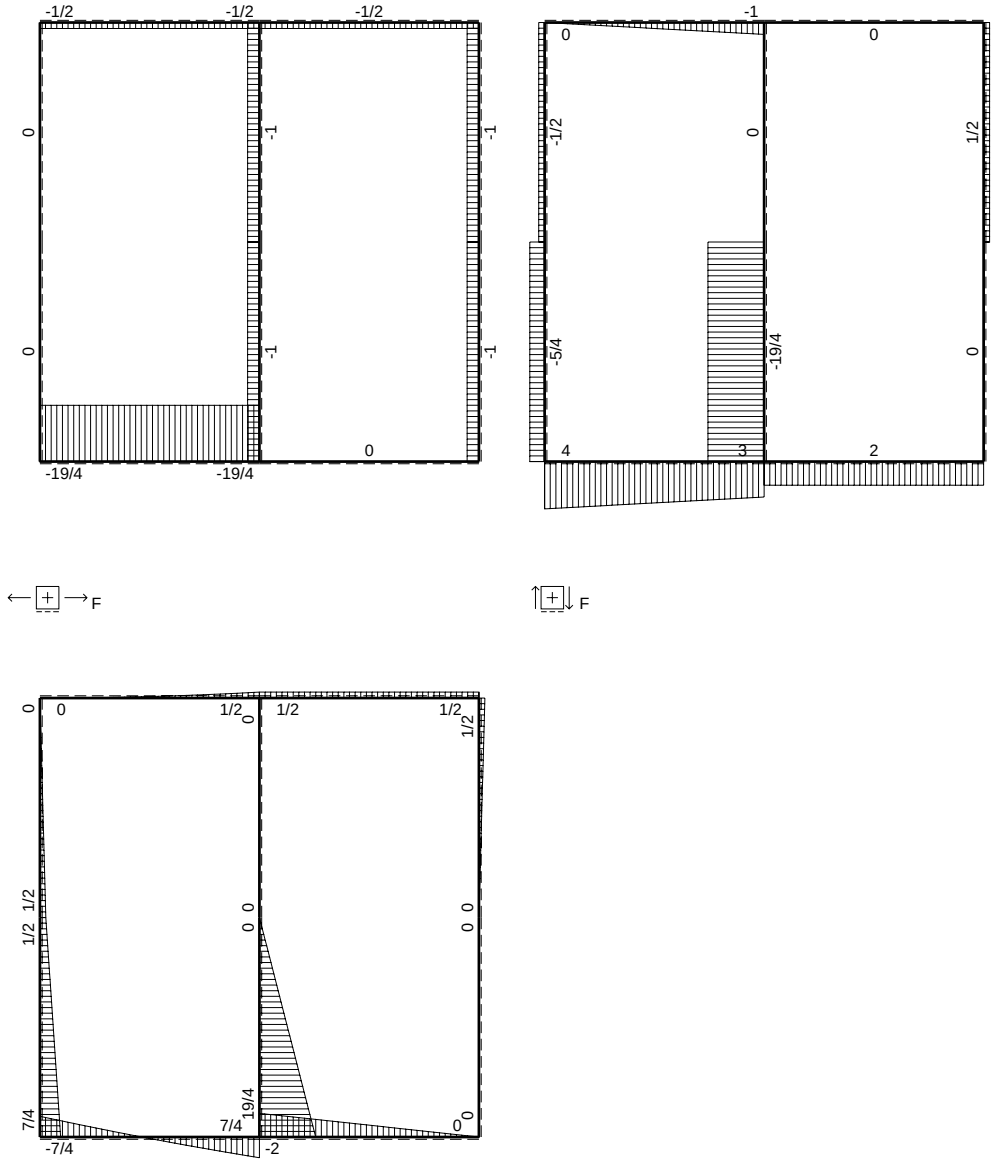
2F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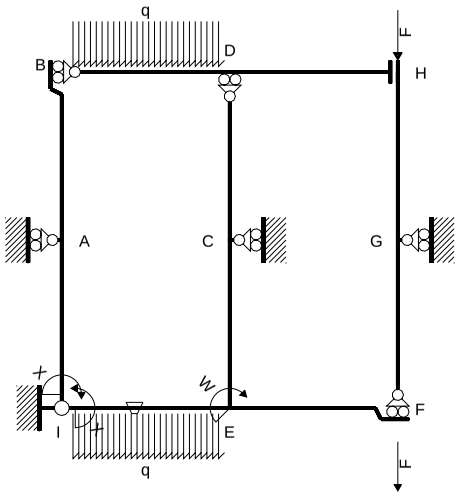
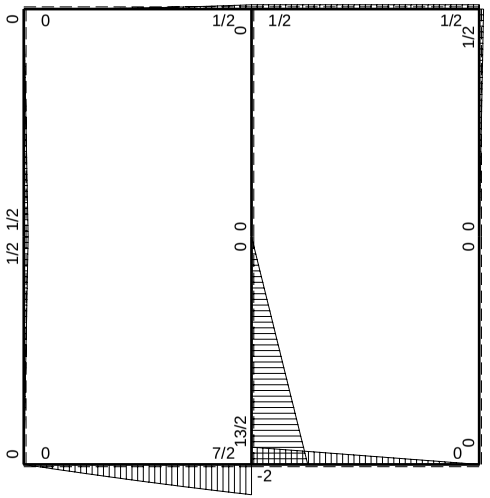
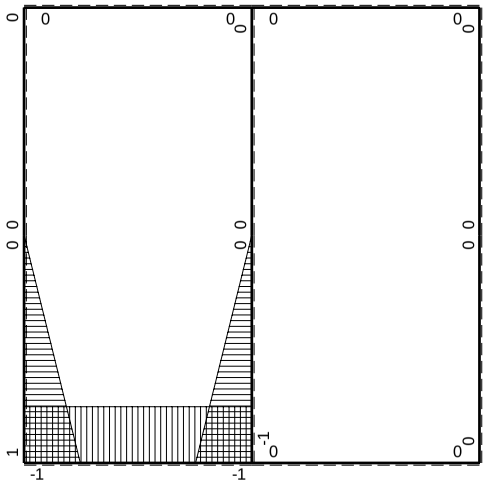


Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 939153 CI07.xxxx.101

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PROCEDIMENTO E RISULTATI 939153 CI07.xxxx.101

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
BA b	0	-1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fb+1/2Fx	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$4Fx-1/2qx^2$	-Fb/EJ	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	-1+x/b	13/2Fb-13/2Fx	0	$-13/2Fb+13Fx-13/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-13/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-13/2Fx$	0	$-13/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	1/2Fx	0	$1/2Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	-1/2Fb+1/2Fx	0	$1/2Fx-1/2Fx^2/b$	0	x^2/b^2		
	totali						$-35/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						7/4Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-4\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b + 1/6\ b)\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-7/2 + 3\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx$

$= [-7/2\ x + 3/2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-7/2\ b + 3/2\ b + 1/6\ b)\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-13/2 + 13\ x/b - 13/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-13/2\ x + 13/2\ x^2/b - 13/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-13/2\ b + 13/2\ b - 13/6\ b)\ Fb\ 1/EJ\ = -13/6\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-13/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-13/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

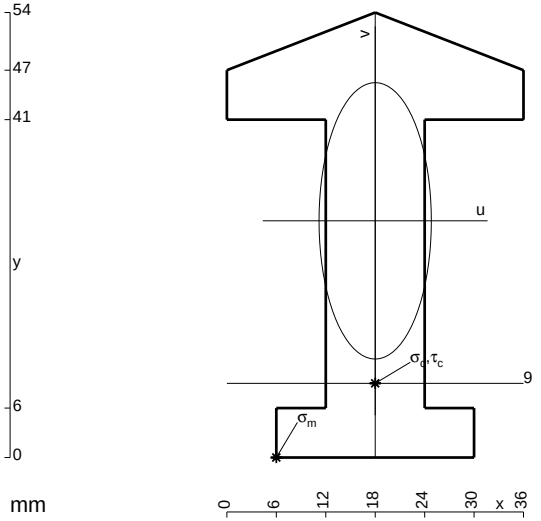
$= (-13/6\ b)\ Fb\ 1/EJ\ = -13/6\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1/2\ x/b - 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [1/4\ x^2/b - 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/4\ b - 1/6\ b)\ Fb\ 1/EJ\ = 1/12\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (1/2\ x/b - 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [1/4\ x^2/b - 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/4\ b - 1/6\ b)\ Fb\ 1/EJ\ = 1/12\ Fb^2/EJ$



$A = 906.\ mm^2$

$J_u = 254971.\ mm^4$

$J_v = 42084.\ mm^4$

$y_g = 28.72\ mm$

$T_y = 3140.\ N$

$M_x = -1852600.\ Nmm$

$x_m = 6.\ mm$

$u_m = -12.\ mm$

$v_m = -28.72\ mm$

$\sigma_m = -Mv/J_u = -208.7\ N/mm^2$

$x_c = 18.\ mm$

$y_c = 9.\ mm$

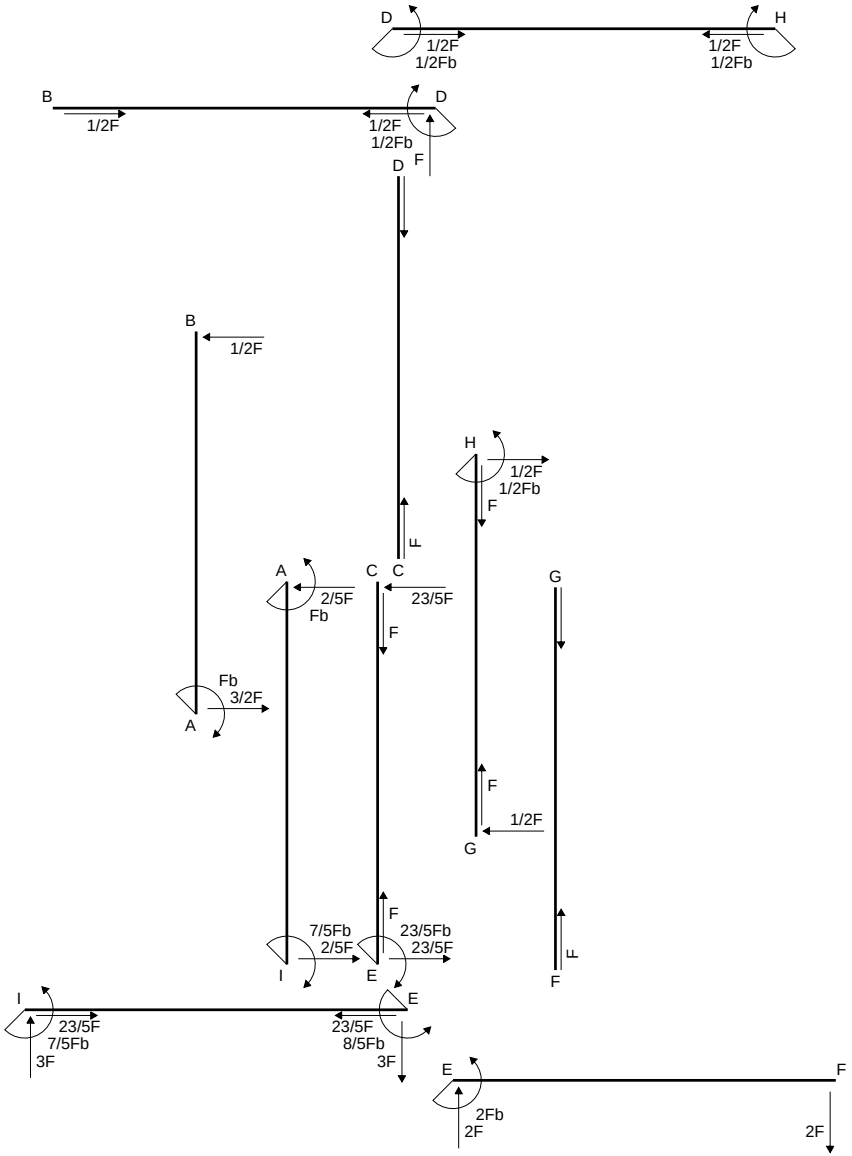
$v_c = -19.72\ mm$

$\sigma_c = -Mv/J_u = -143.3\ N/mm^2$

$\tau_c = 4.585\ N/mm^2$

$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 143.5\ N/mm^2$

$S^* = 4468.\ mm^3$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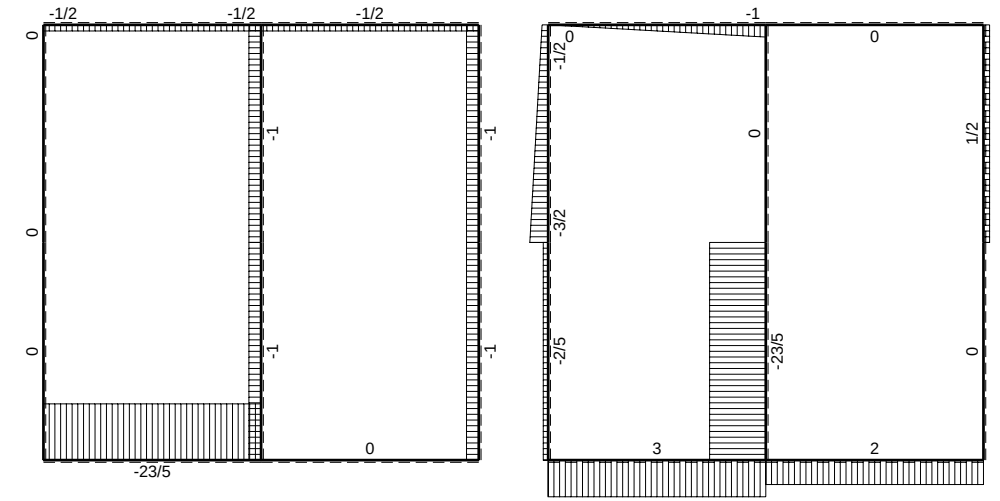
2F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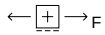
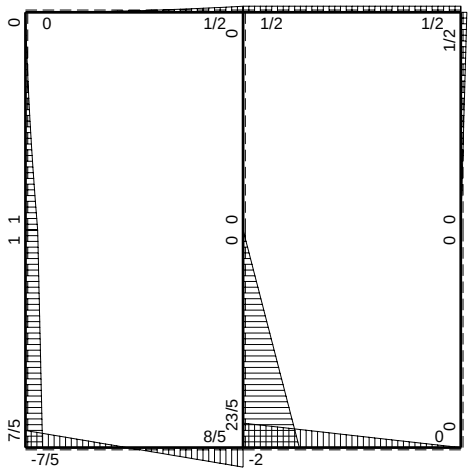
3
2


F

F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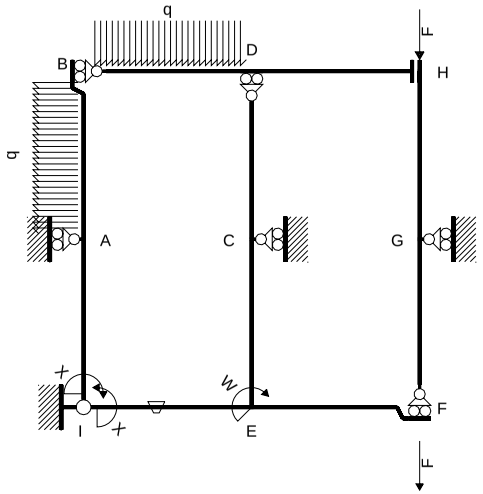
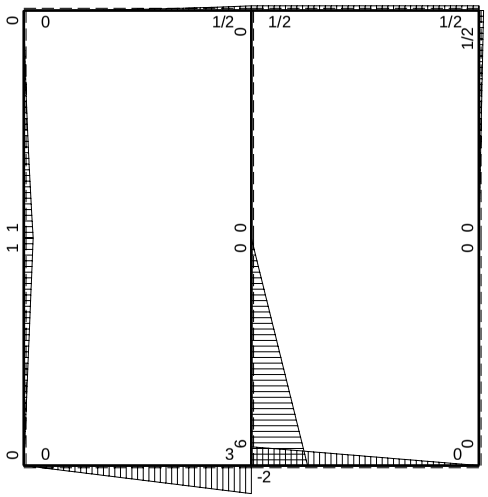
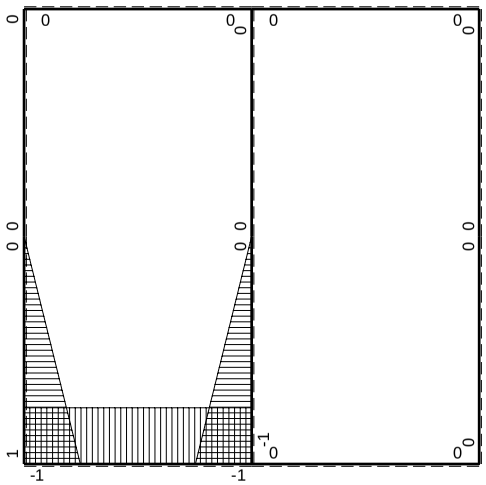
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 210892 CI07.xxxx.102

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$Fb-3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$-1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$6Fb-6Fx$	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-6Fx$	0	$-6Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	Fx	0	$Fx-Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-Fb+Fx$	0	$Fx-Fx^2/b$	0	x^2/b^2		
	totali						$-7/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$7/5Fb$	

PROCEDIMENTO E RISULTATI 210892 CI07.xxxx.102

Sviluppi di calcolo iperstatica

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$L^{XX}_{IE} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EI} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EC} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{CE} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{IA} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{AI} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{Xo}_{IE} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L^{Xo}_{EI} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L^{Xo}_{EC} = \int_o^b (-6 + 12\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-6\ x + 6\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-6\ b + 6\ b - 2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

$L^{Xo}_{CE} = \int_o^b (-6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

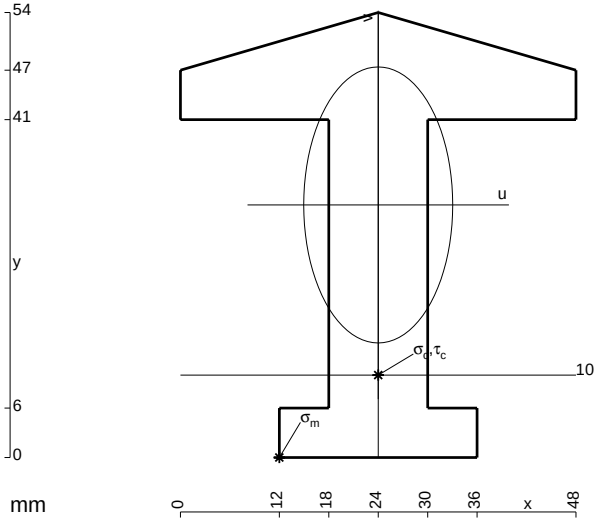
$= (-2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

$L^{Xo}_{IA} = \int_o^b (\ x/b - x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

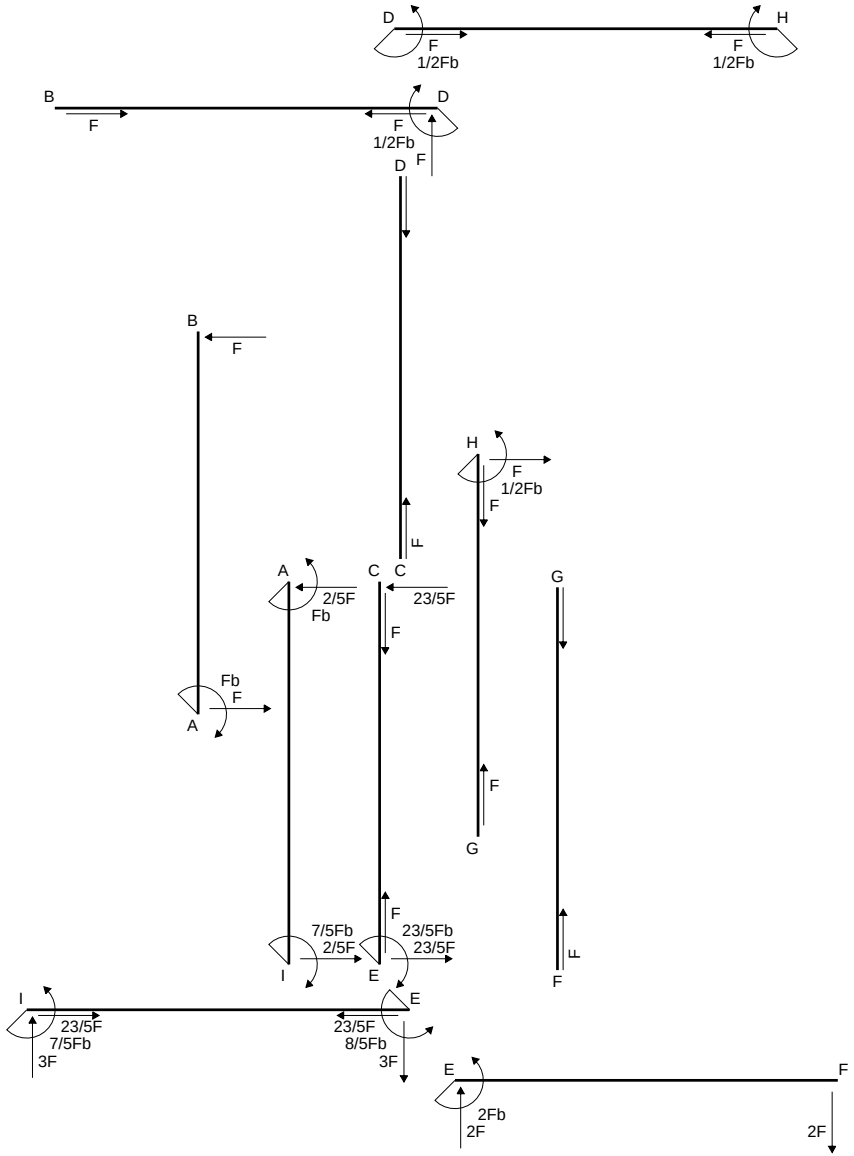
$= (1/2\ b - 1/3\ b\ )\ Fb\ 1/EJ\ = 1/6\ Fb^2/EJ$

$L^{Xo}_{AI} = \int_o^b (\ x/b - x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/2\ b - 1/3\ b\ )\ Fb\ 1/EJ\ = 1/6\ Fb^2/EJ$



A = 1020. mm^2
J_u = 286162. mm^4
J_v = 83376. mm^4
y_g = 30.65 mm
T_y = 3200. N
M_x = -2048000. Nmm
x_m = 12. mm
u_m = -12. mm
v_m = -30.65 mm
$\sigma_m = -Mv/J_u$ = -219.3 N/mm^2
x_c = 24. mm
y_c = 10. mm
v_c = -20.65 mm
$\sigma_c = -Mv/J_u$ = -147.8 N/mm^2
τ_c = 4.723 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 148. N/mm^2
S^* = 5069. mm^3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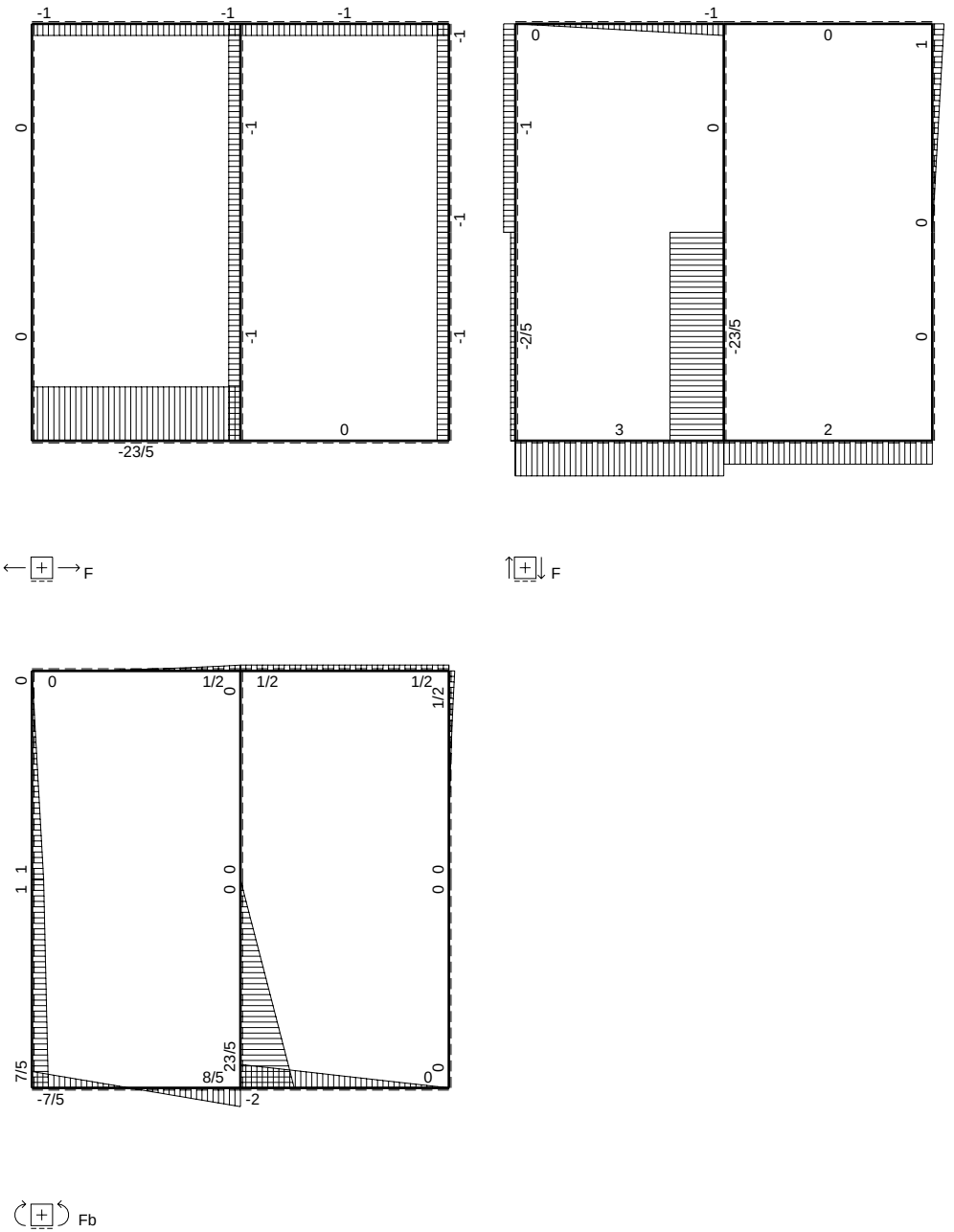
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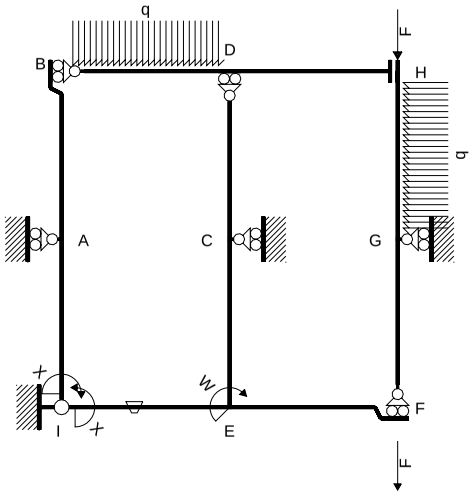
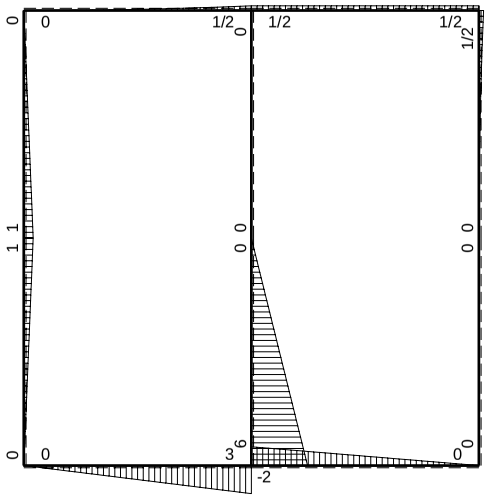
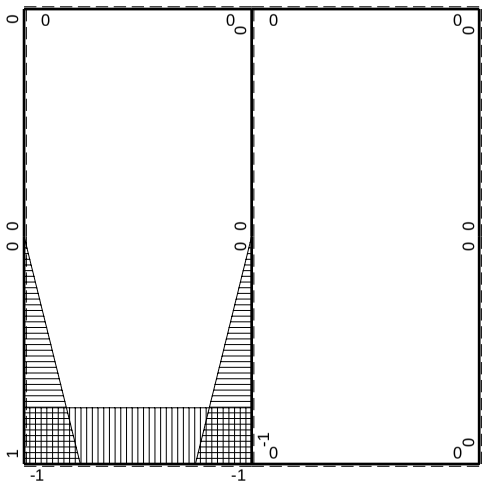
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 990867 CI07.xxxx.103

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PROCEDIMENTO E RISULTATI 990867 CI07.xxxx.103

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	Fb-Fx	0	0	0	0	0+0	0
BA b	0	-Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	6Fb-6Fx	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-6Fx	0	$-6Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fx	0	$Fx-Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	-Fb+Fx	0	$Fx-Fx^2/b$	0	x^2/b^2		
	totali						$-7/3Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						7/5Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-6 + 12\ x/b - 6\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-6\ x + 6\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-6\ b + 6\ b - 2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

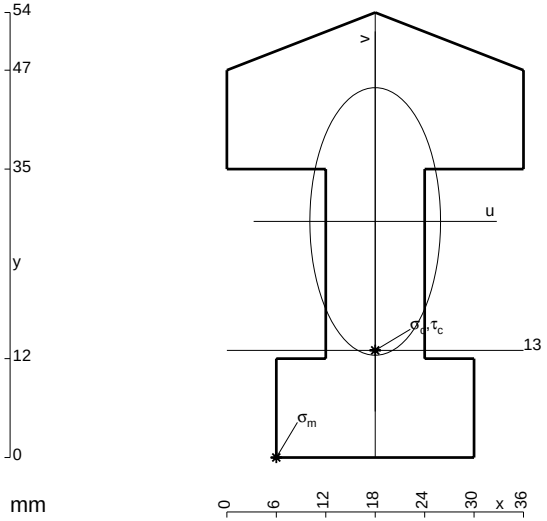
$= (-2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (\ x/b - x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/2\ b - 1/3\ b\ )\ Fb\ 1/EJ\ = 1/6\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (\ x/b - x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/2\ b - 1/3\ b\ )\ Fb\ 1/EJ\ = 1/6\ Fb^2/EJ$



$A = 1122.\ mm^2$

$J_u = 296013.\ mm^4$

$J_v = 70596.\ mm^4$

$y_g = 28.65\ mm$

$T_y = 3380.\ N$

$M_x = -2366000.\ Nmm$

$x_m = 6.\ mm$

$u_m = -12.\ mm$

$v_m = -28.65\ mm$

$\sigma_m = -Mv/J_u = -229.\ N/mm^2$

$x_c = 18.\ mm$

$y_c = 13.\ mm$

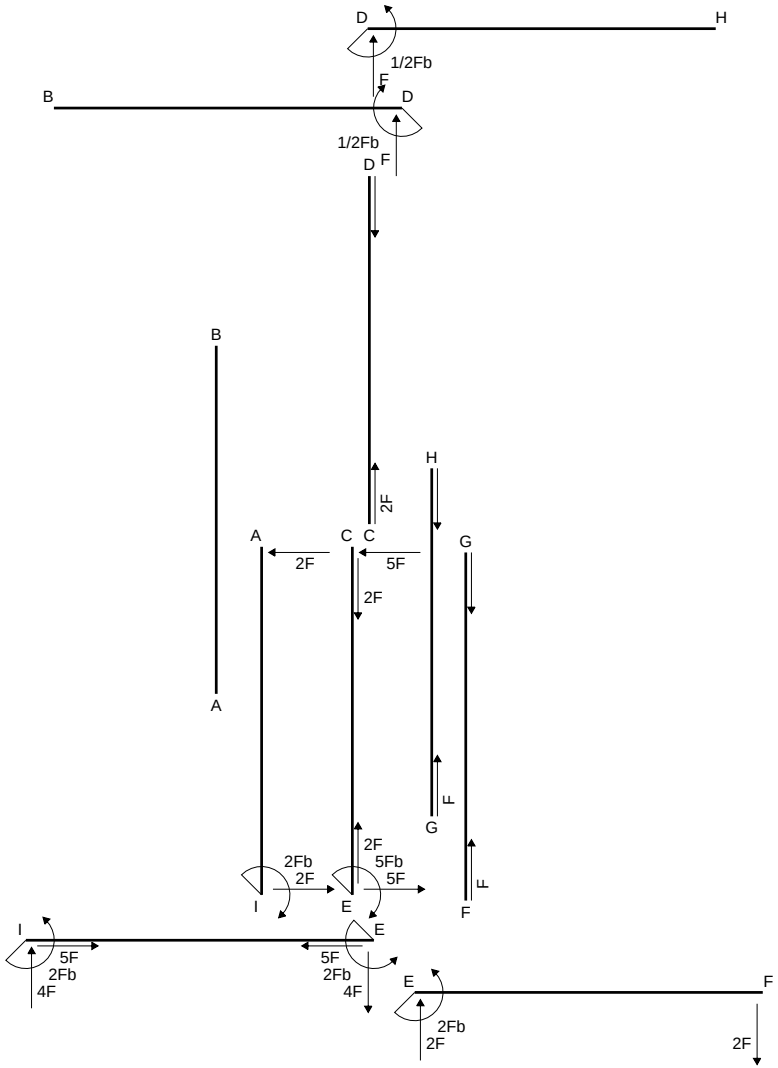
$v_c = -15.65\ mm$

$\sigma_c = -Mv/J_u = -125.1\ N/mm^2$

$\tau_c = 6.391\ N/mm^2$

$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 125.6\ N/mm^2$

$S^* = 6716.\ mm^3$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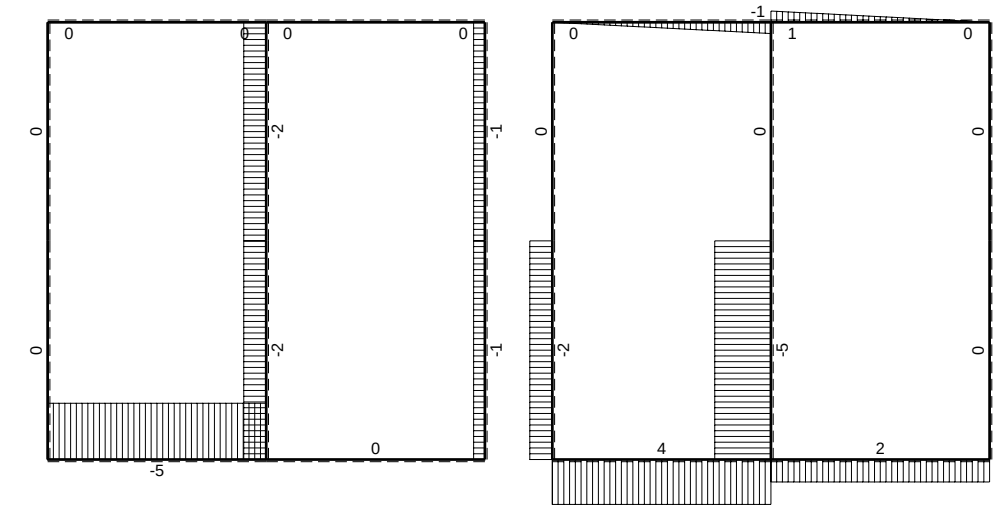
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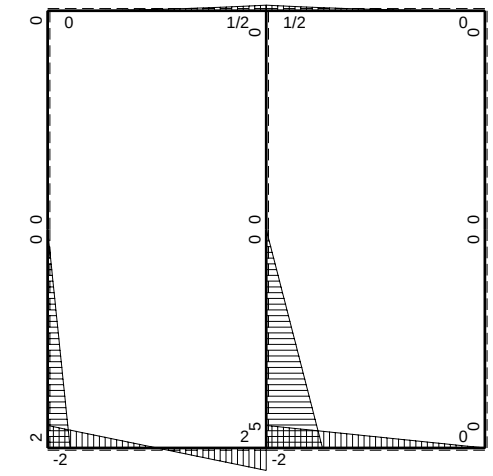
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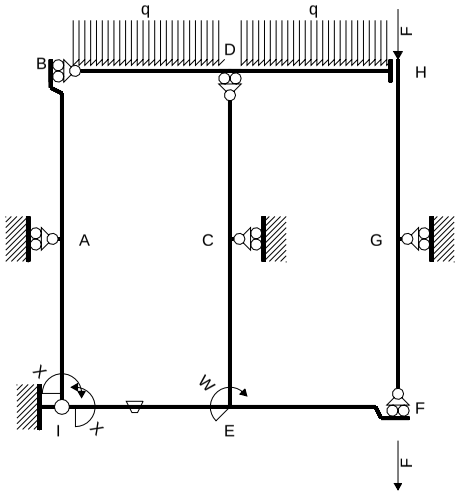
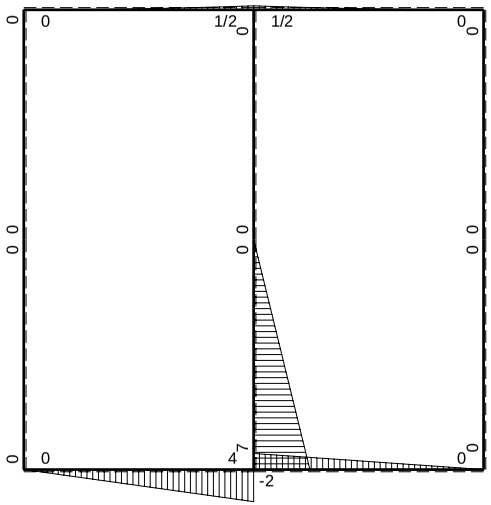
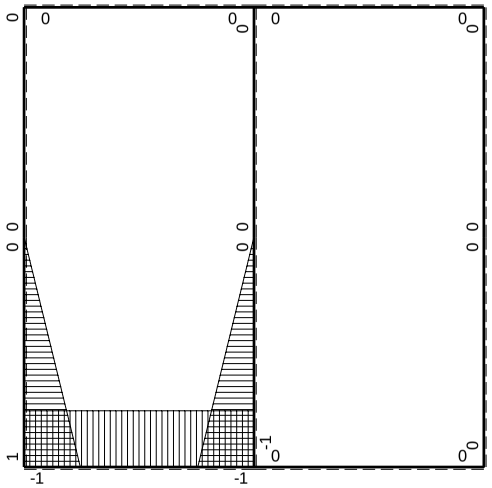


Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 218005 CI07.xxxx.104

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	0	0	0	0	0	0+0	0
HG b	0	0	0	0	0	0		
HD b	0	$1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	4Fx	-Fb/EJ	-4Fx	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-4Fb+4Fx	Fb/EJ	-4Fb+4Fx	Fb/EJ	1		
EC b	$-1+x/b$	7Fb-7Fx	0	$-7Fb+14Fx-7Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-7/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-7Fx	0	$-7Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	1/3Xb/EJ
AI b	-x/b	0	0	0	0	x^2/b^2		
	totali						$-10/3Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						2Fb	

Sviluppi di calcolo iperstatica

PROCEDIMENTO E RISULTATI 218005 CI07.xxxx.104
@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-4 + 4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-4\ x + 2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

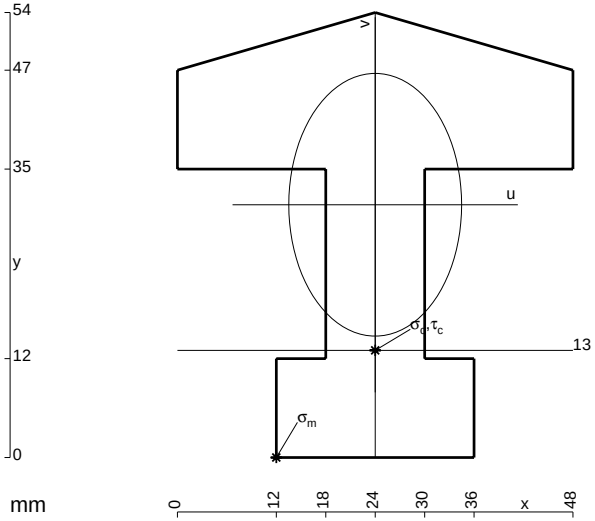
$= (-4\ b + 2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-7 + 14\ x/b - 7\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-7\ x + 7\ x^2/b - 7/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

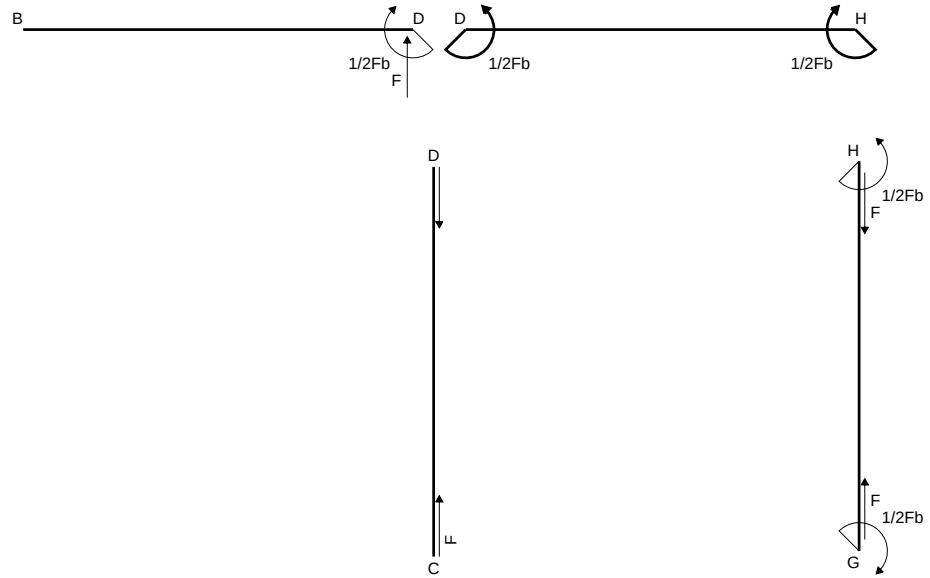
$= (-7\ b + 7\ b - 7/3\ b\ )\ Fb\ 1/EJ\ = -7/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-7\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-7/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-7/3\ b\ )\ Fb\ 1/EJ\ = -7/3\ Fb^2/EJ$



A = 1308. mm^2
J_u = 332443. mm^4
J_v = 143856. mm^4
y_g = 30.67 mm
T_y = 3460. N
M_x = -2595000. Nmm
x_m = 12. mm
u_m = -12. mm
v_m = -30.67 mm
$\sigma_m = -Mv/J_u$ = -239.4 N/mm^2
x_c = 24. mm
y_c = 13. mm
v_c = -17.67 mm
$\sigma_c = -Mv/J_u$ = -137.9 N/mm^2
τ_c = 6.352 N/mm^2
$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2}$ = 138.4 N/mm^2
S^* = 7323. mm^3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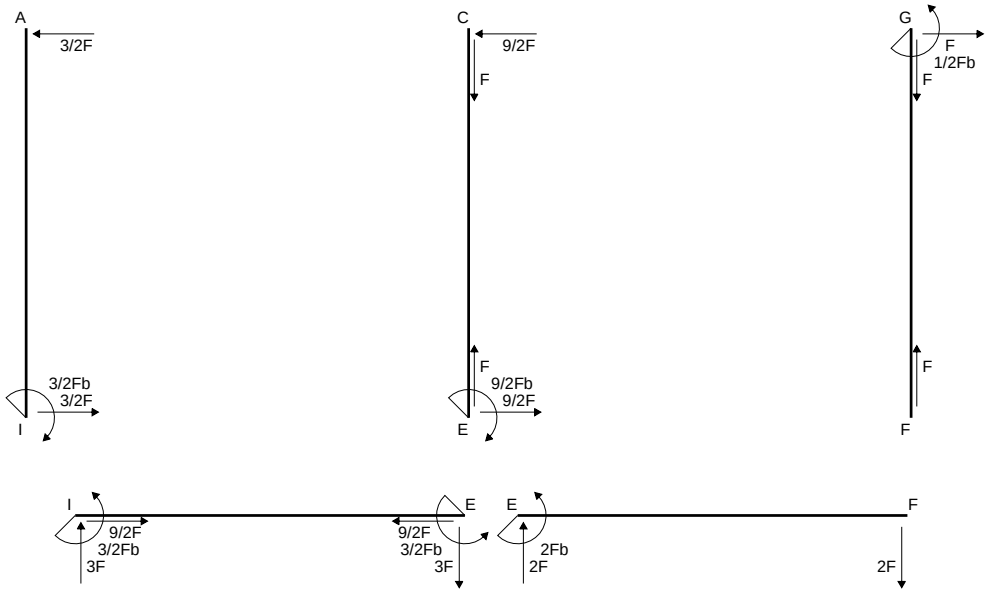
C
G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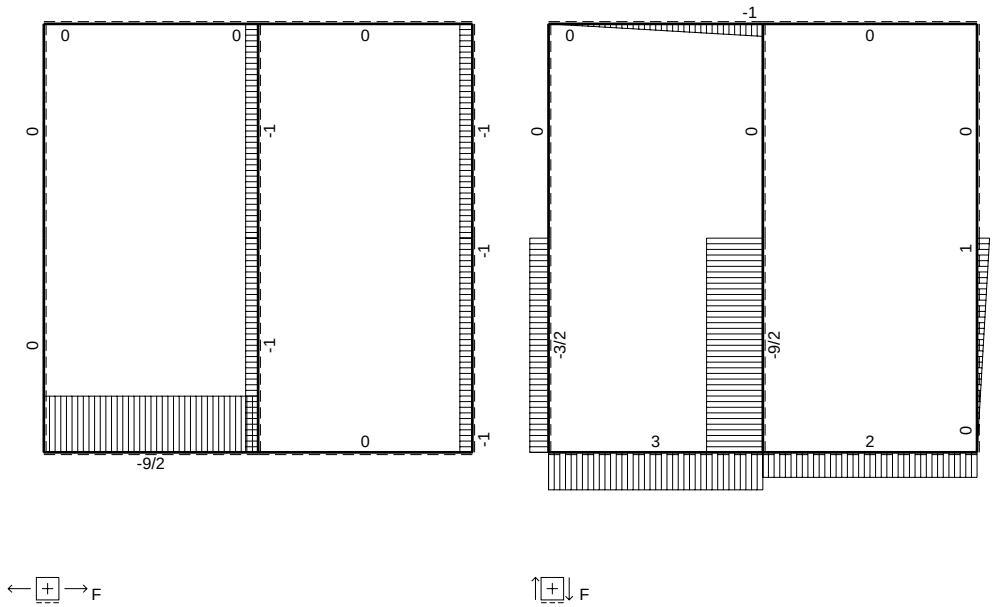
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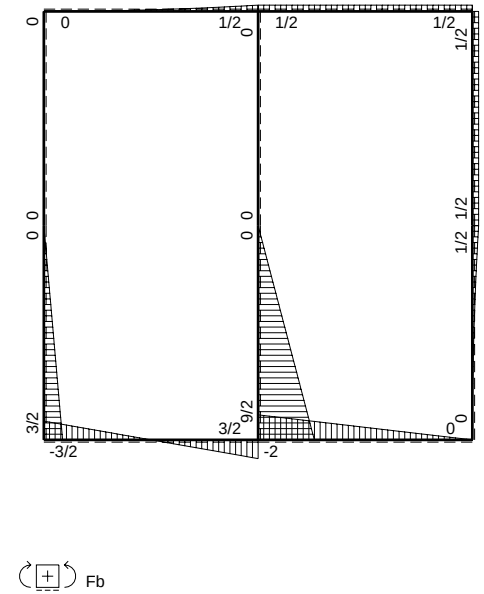
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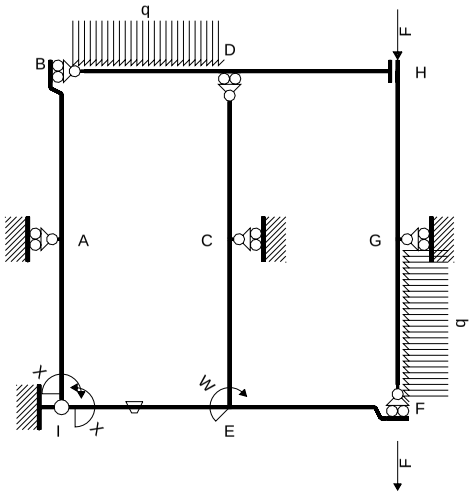
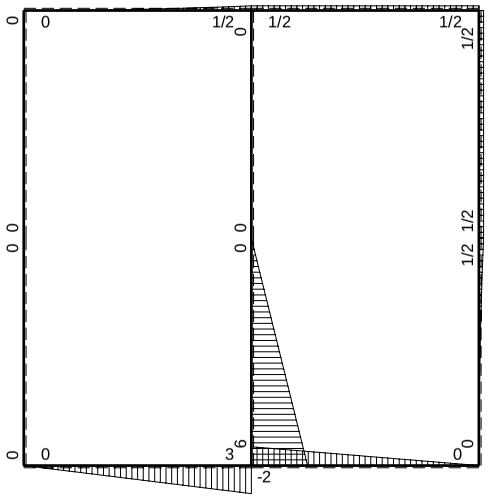
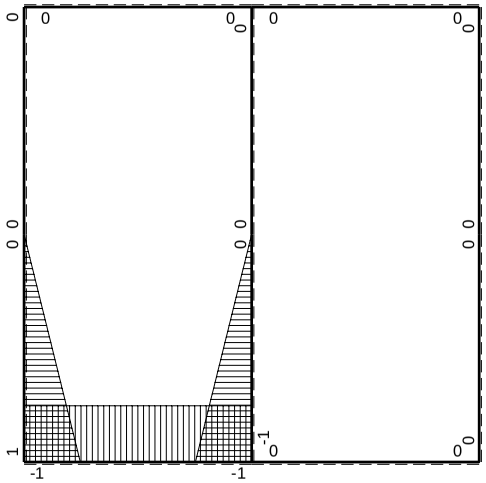
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 988213 CI07.xxxx.105

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PROCEDIMENTO E RISULTATI 988213 CI07.xxxx.105

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb	0	0	0	0	0+0	0
HG b	0	-1/2Fb	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	6Fb-6Fx	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-6Fx	0	$-6Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	1/3Xb/EJ
AI b	-x/b	0	0	0	0	x^2/b^2		
	totali						$-5/2Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						3/2Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

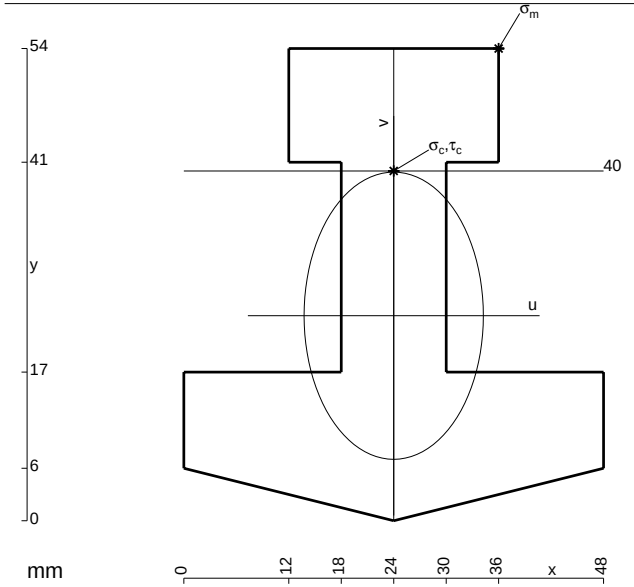
$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-6 + 12\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-6\ x + 6\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

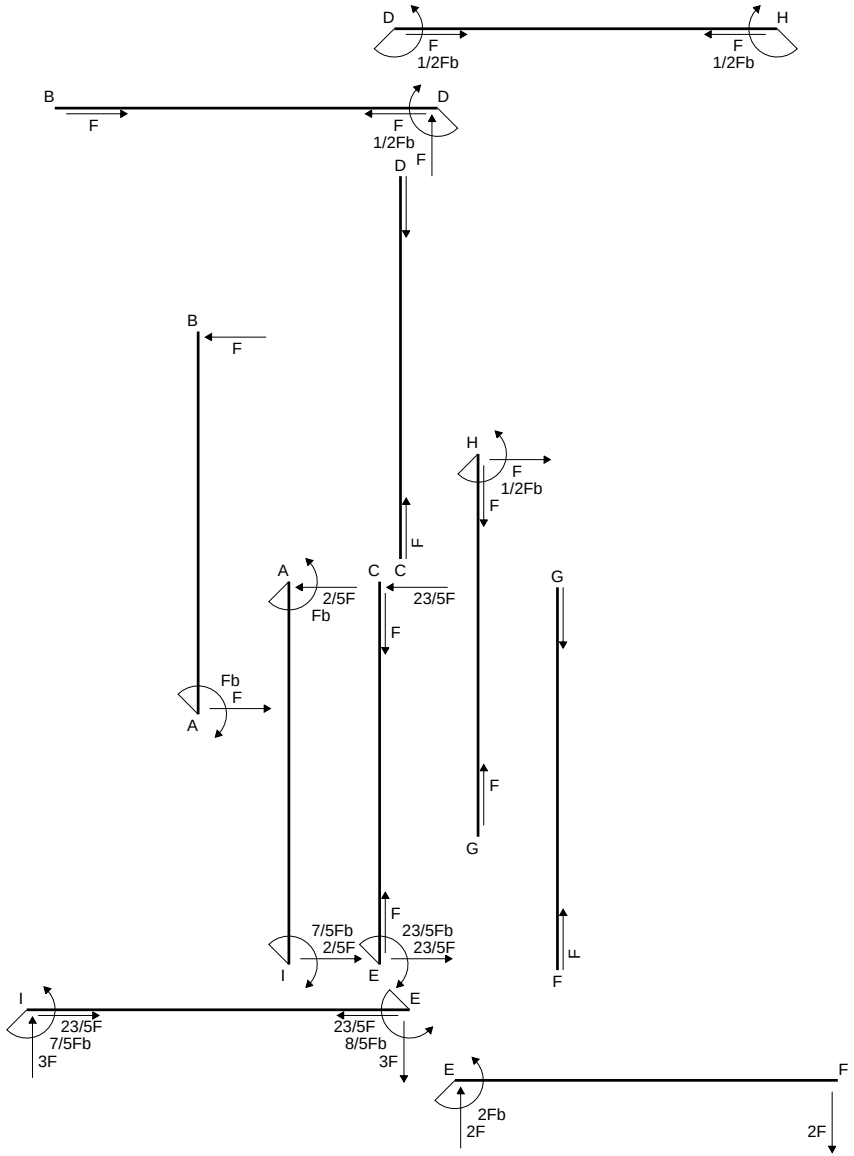
$= (-6\ b + 6\ b - 2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$



A = 1272. mm^2
J_u = 343038. mm^4
J_v = 133632. mm^4
y_g = 23.44 mm
T_y = 2760. N
M_x = -2235600. Nmm
x_m = 36. mm
y_m = 54. mm
u_m = 12. mm
v_m = 30.56 mm
$\sigma_m = -Mv/J_u$ = 199.1 N/mm^2
x_c = 24. mm
y_c = 40. mm
v_c = 16.56 mm
$\sigma_c = -Mv/J_u$ = 107.9 N/mm^2
τ_c = 5.17 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 108.3 N/mm^2
S^* = 7710. mm^3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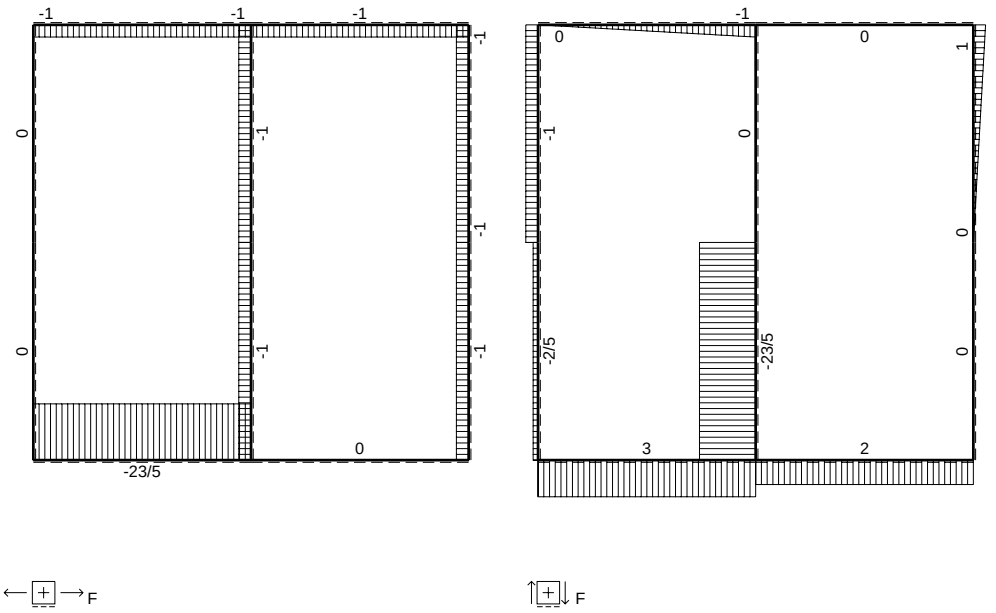
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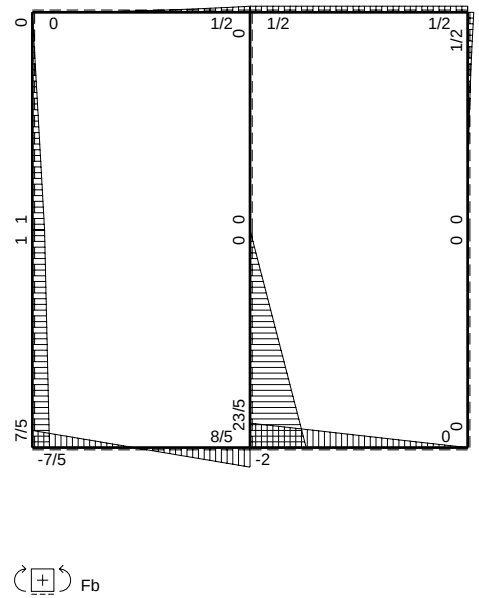
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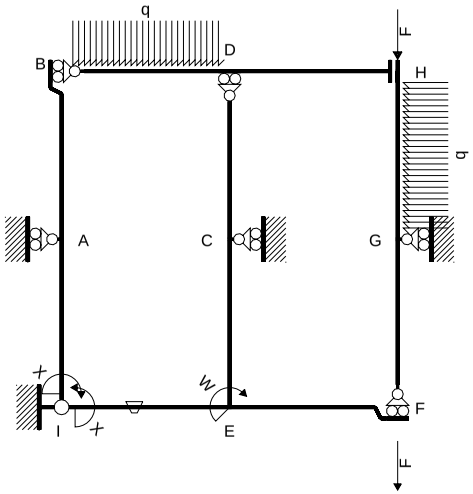
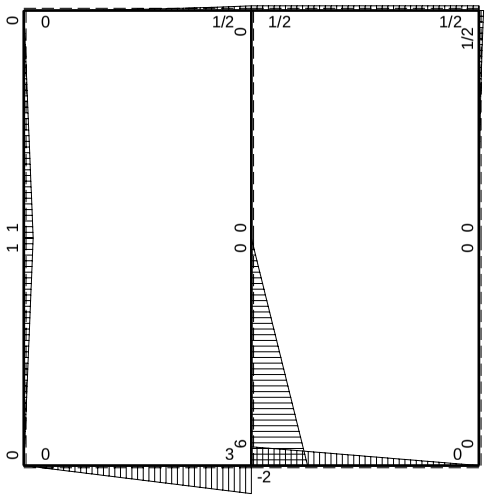
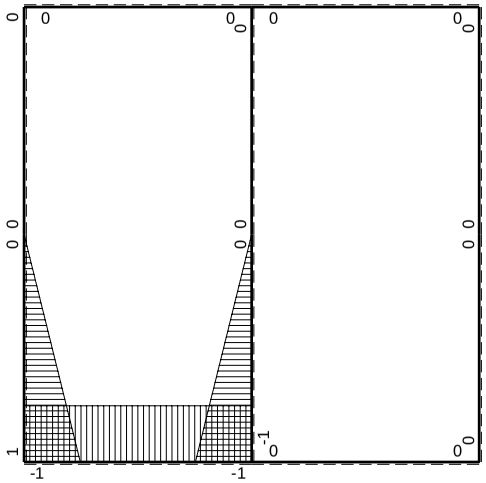


Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 983811 CI07.xxxx.106

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PROCEDIMENTO E RISULTATI 983811 CI07.xxxx.106

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	Fb-Fx	0	0	0	0	0+0	0
BA b	0	-Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	6Fb-6Fx	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-6Fx$	0	$-6Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fx	0	$Fx-Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	-Fb+Fx	0	$Fx-Fx^2/b$	0	x^2/b^2		
	totali						$-7/3Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						7/5Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-6 + 12\ x/b - 6\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-6\ x + 6\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-6\ b + 6\ b - 2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

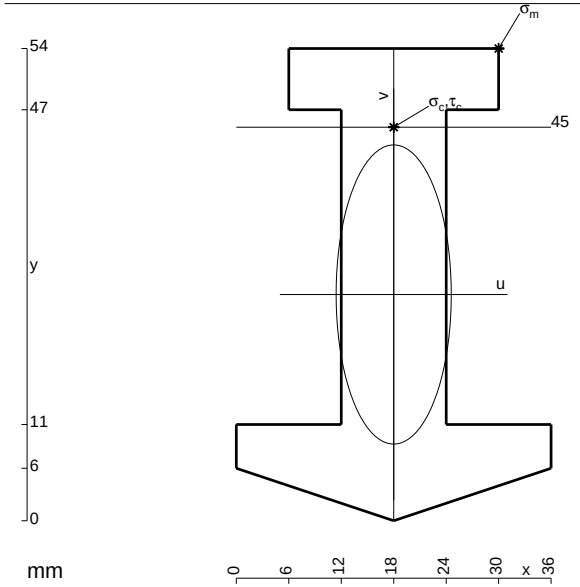
$= (-2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (\ x/b - x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

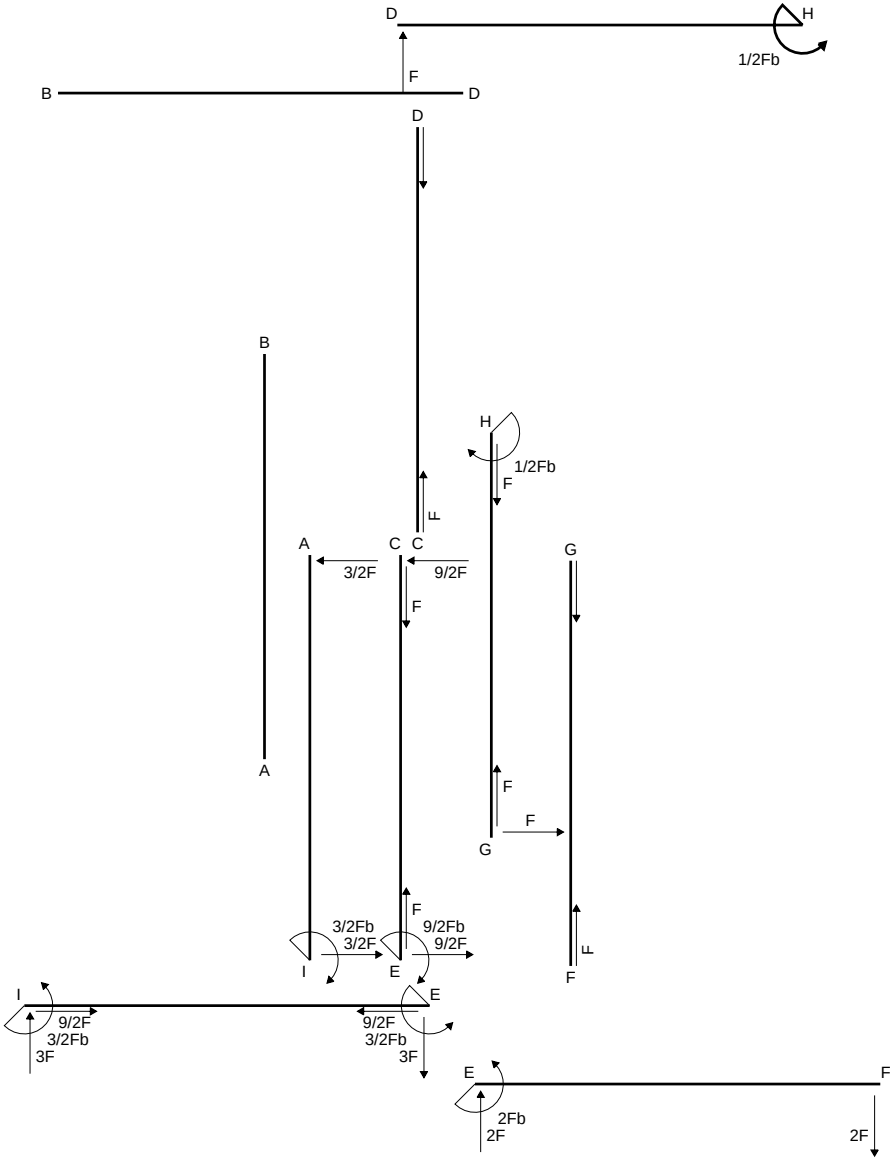
$= (1/2\ b - 1/3\ b\ )\ Fb\ 1/EJ\ = 1/6\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (\ x/b - x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/2\ b - 1/3\ b\ )\ Fb\ 1/EJ\ = 1/6\ Fb^2/EJ$



A = 888. mm^2
J_u = 260045. mm^4
J_v = 38520. mm^4
y_g = 25.87 mm
T_y = 2240. N
M_x = -1926400. Nmm
x_m = 30. mm
y_m = 54. mm
u_m = 12. mm
v_m = 28.13 mm
$\sigma_m = -Mv/J_u$ = 208.4 N/mm^2
x_c = 18. mm
y_c = 45. mm
v_c = 19.13 mm
$\sigma_c = -Mv/J_u$ = 141.7 N/mm^2
τ_c = 3.317 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 141.8 N/mm^2
S^* = 4621. mm^3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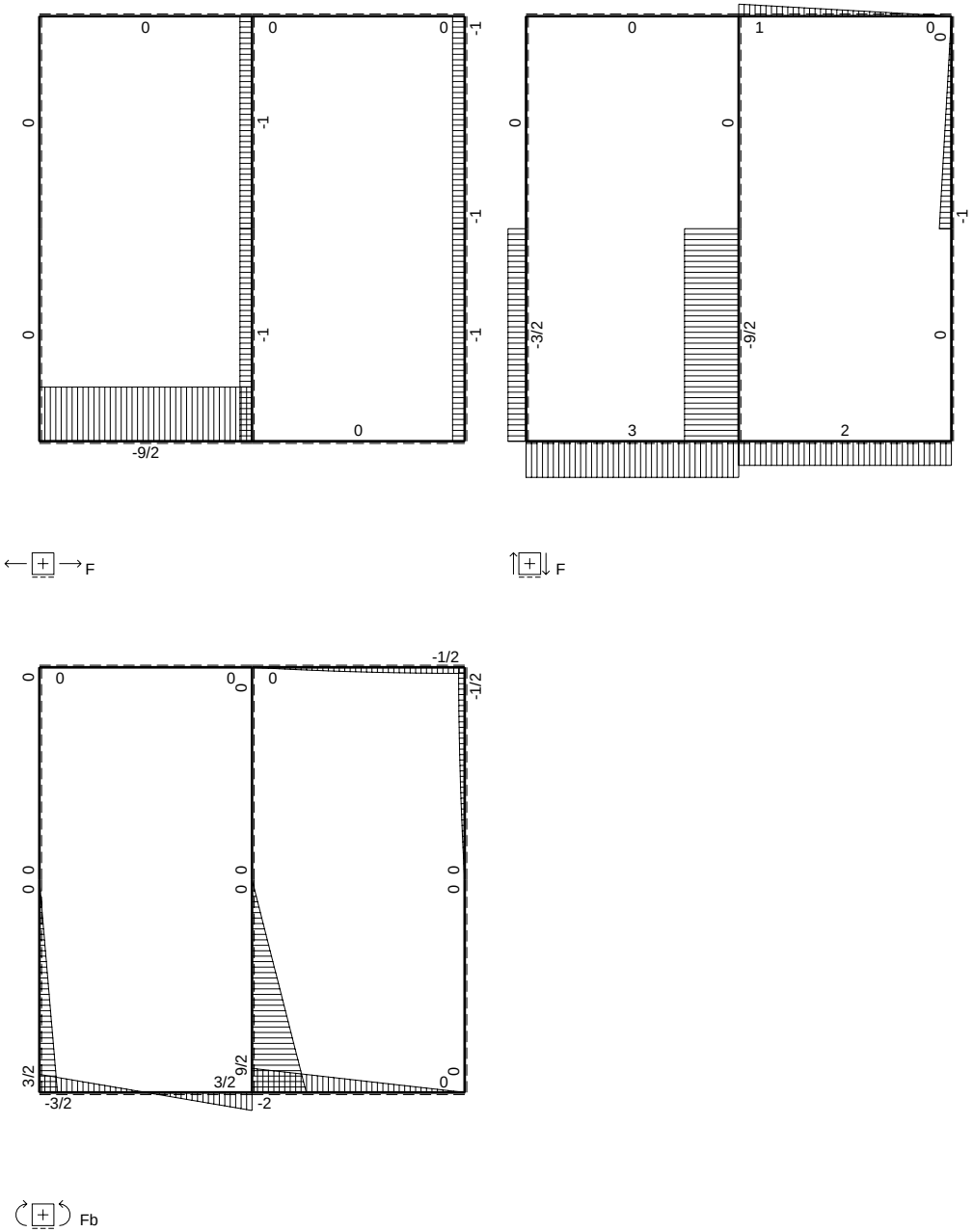
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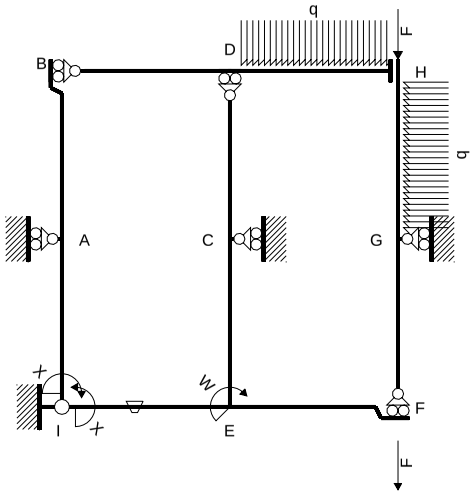
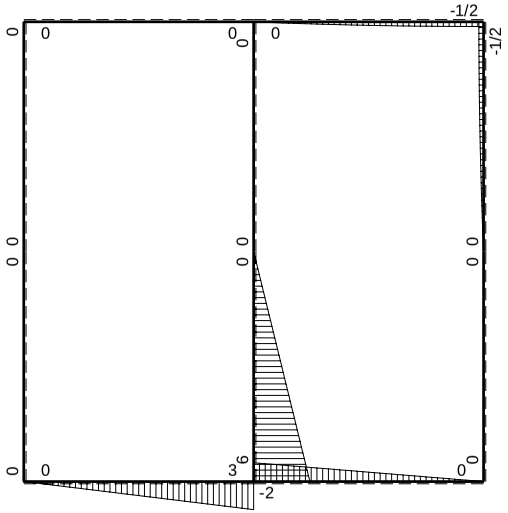
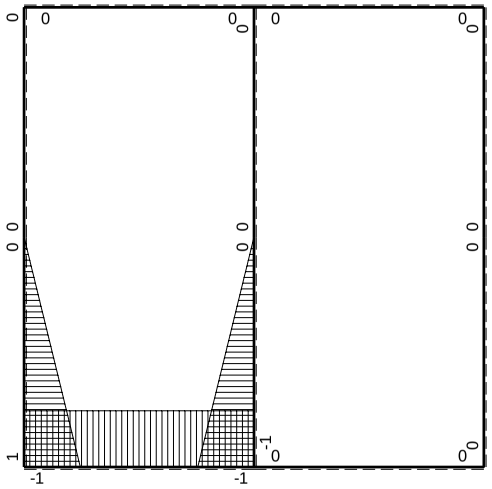


Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 215763 CI07.xxxx.107

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	6Fb-6Fx	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-6Fx	0	$-6Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	1/3Xb/EJ
AI b	-x/b	0	0	0	0	x^2/b^2		
	totali						$-5/2Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						3/2Fb	

PROCEDIMENTO E RISULTATI 215763 CI07.xxxx.107

Sviluppi di calcolo iperstatica

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$L_{lE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{El}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{lA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{Al}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{lE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{El}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

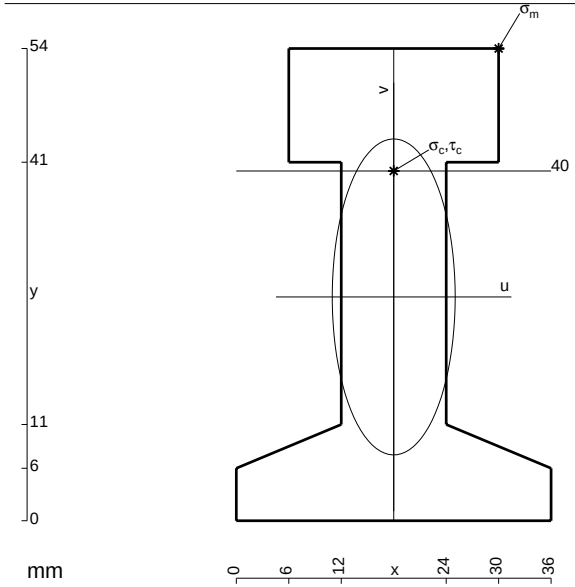
$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-6 + 12\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-6\ x + 6\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

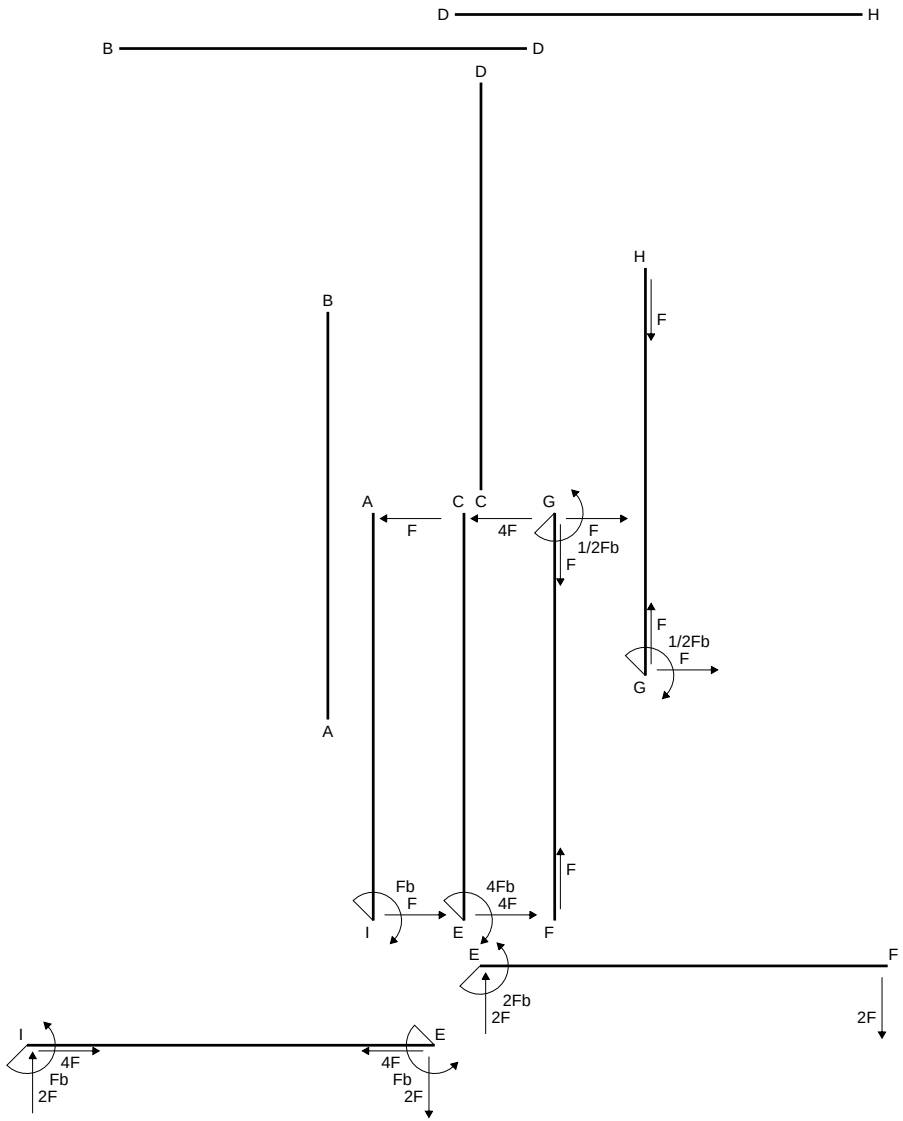
$= (-6\ b + 6\ b - 2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$



A = 1008. mm^2
J_u = 329111. mm^4
J_v = 49824. mm^4
y_g = 25.59 mm
T_y = 2800. N
M_x = -2548000. Nmm
x_m = 30. mm
y_m = 54. mm
u_m = 12. mm
v_m = 28.41 mm
$\sigma_m = -Mv/J_u$ = 219.9 N/mm^2
x_c = 18. mm
y_c = 40. mm
v_c = 14.41 mm
$\sigma_c = -Mv/J_u$ = 111.5 N/mm^2
τ_c = 4.973 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 111.9 N/mm^2
S^* = 7014. mm^3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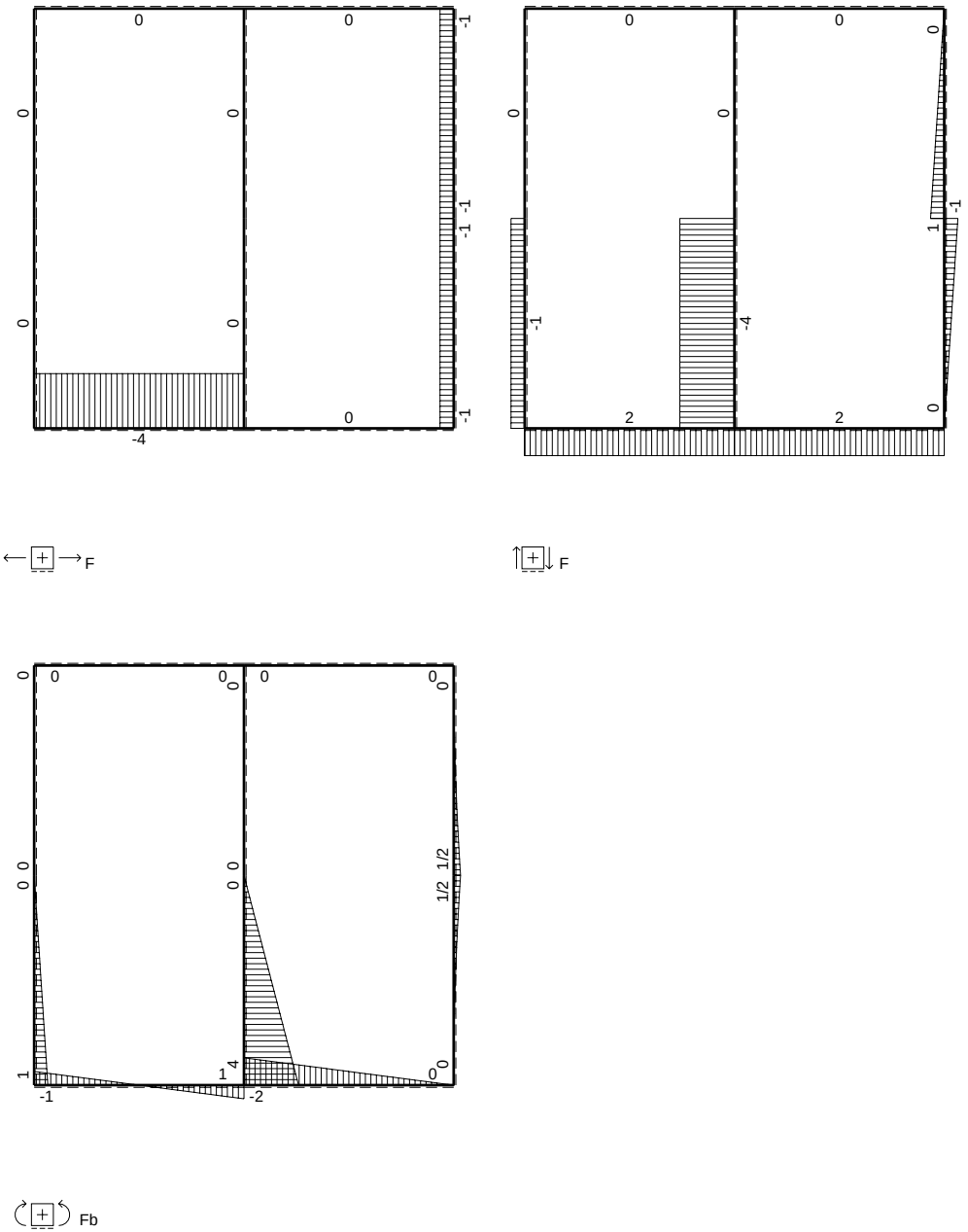
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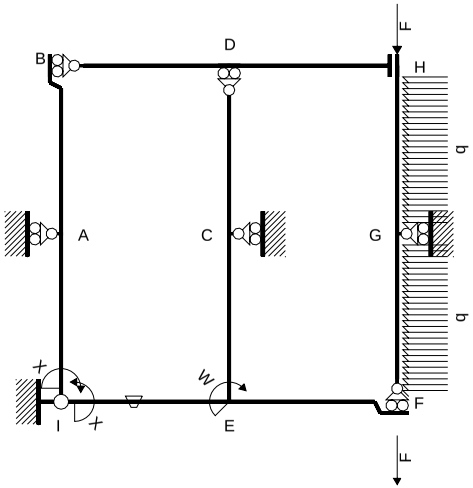
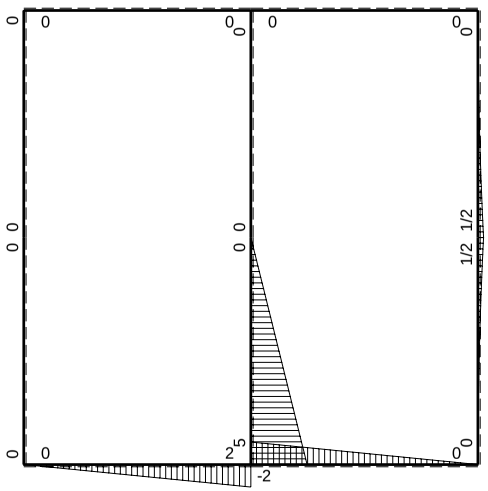


Schema di calcolo iperstatico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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2qx^2$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-5Fx	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-5Fx	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	1/3Xb/EJ
AI b	-x/b	0	0	0	0	x^2/b^2		
	totali						$-5/3Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						Fb	

Sviluppi di calcolo iperstatica

PROCEDIMENTO E RISULTATI 218395 CI07.xxxx.108
@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L_{EI}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

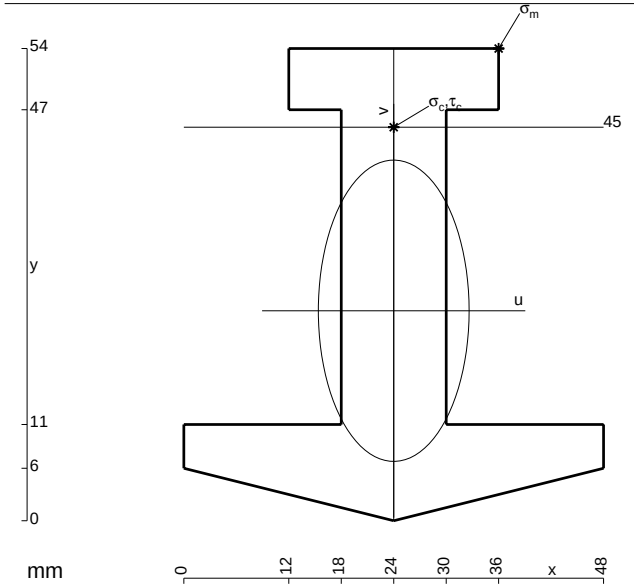
$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L_{EC}^{Xo} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

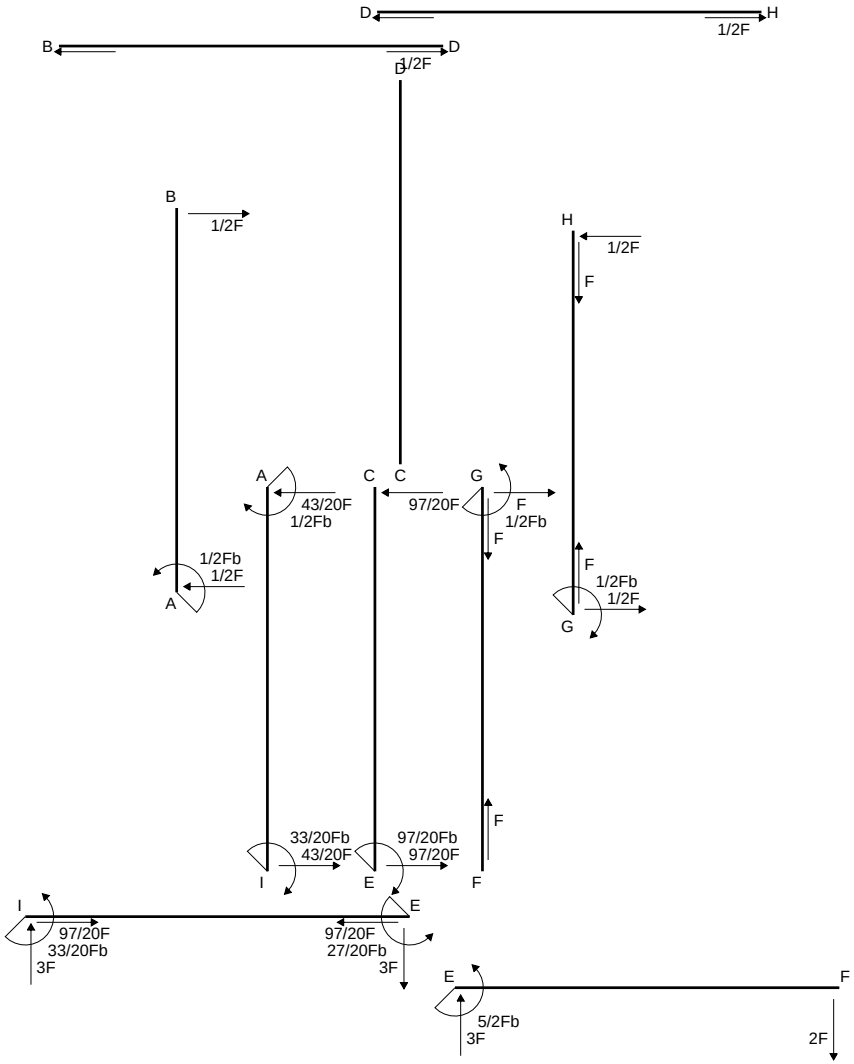
$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$



A = 984. mm^2
J_u = 292168. mm^4
J_v = 73152. mm^4
y_g = 24.01 mm
T_y = 2300. N
M_x = -2231000. Nmm
x_m = 36. mm
y_m = 54. mm
u_m = 12. mm
v_m = 29.99 mm
$\sigma_m = -Mv/J_u$ = 229. N/mm^2
x_c = 24. mm
y_c = 45. mm
v_c = 20.99 mm
$\sigma_c = -Mv/J_u$ = 160.3 N/mm^2
τ_c = 3.265 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 160.4 N/mm^2
S^* = 4978. mm^3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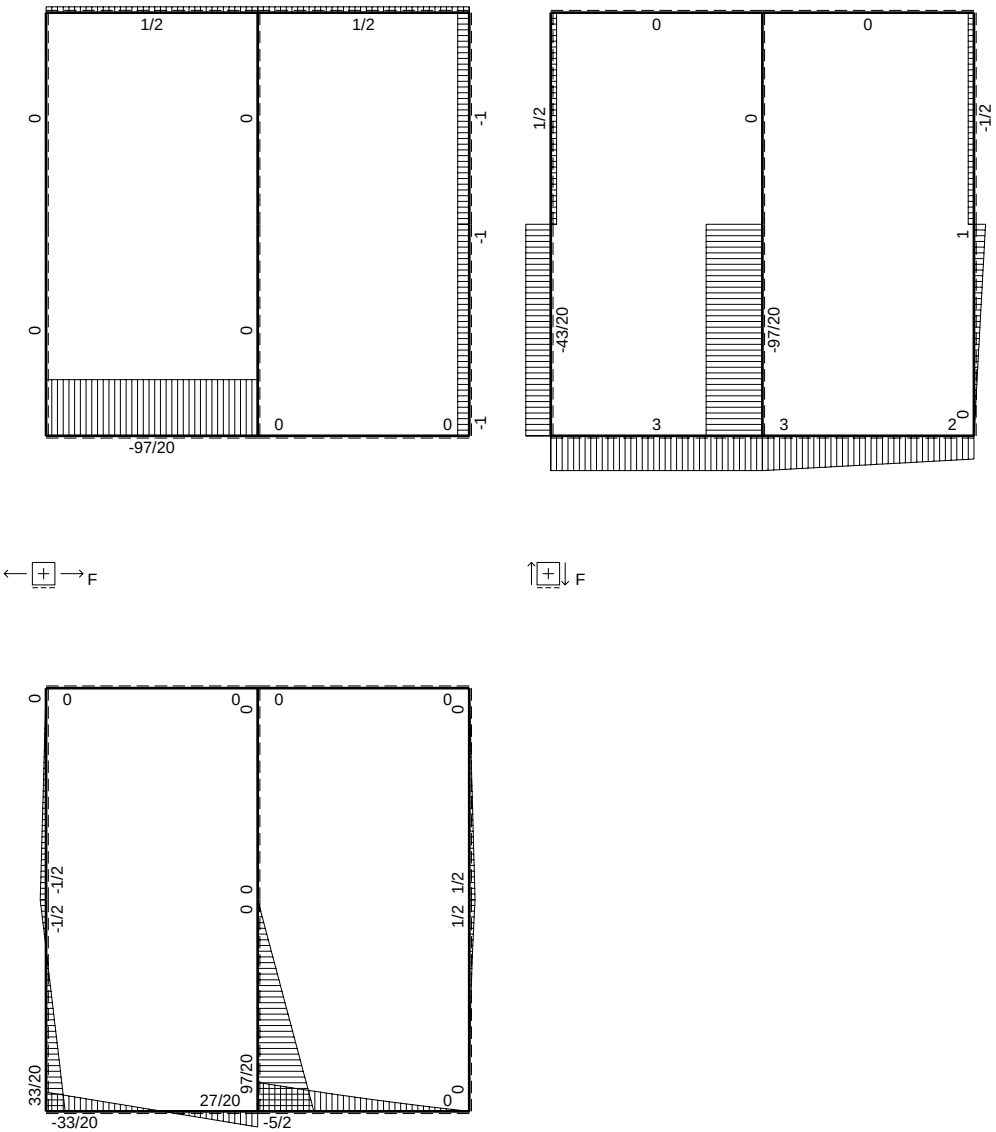
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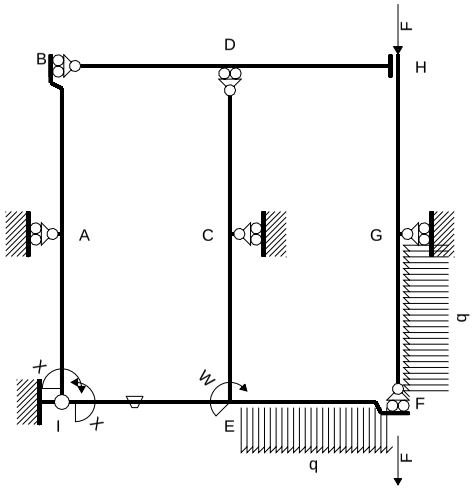
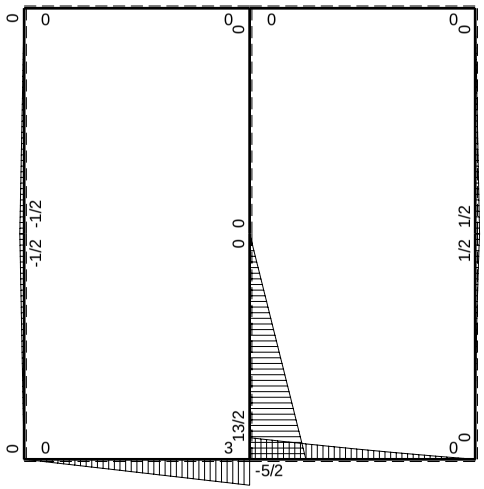
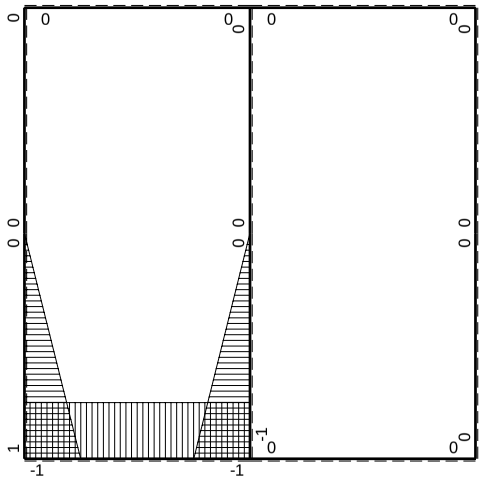


Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 213944 CI07.xxxx.109

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PROCEDIMENTO E RISULTATI 213944 CI07.xxxx.109

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-5/2Fb+3Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$2Fx+1/2qx^2$	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	13/2Fb-13/2Fx	0	$-13/2Fb+13Fx-13/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-13/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-13/2Fx	0	$-13/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-11/4Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						33/20Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-13/2 + 13\ x/b - 13/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-13/2\ x + 13/2\ x^2/b - 13/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-13/2\ b + 13/2\ b - 13/6\ b\ )\ Fb\ 1/EJ\ = -13/6\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-13/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-13/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

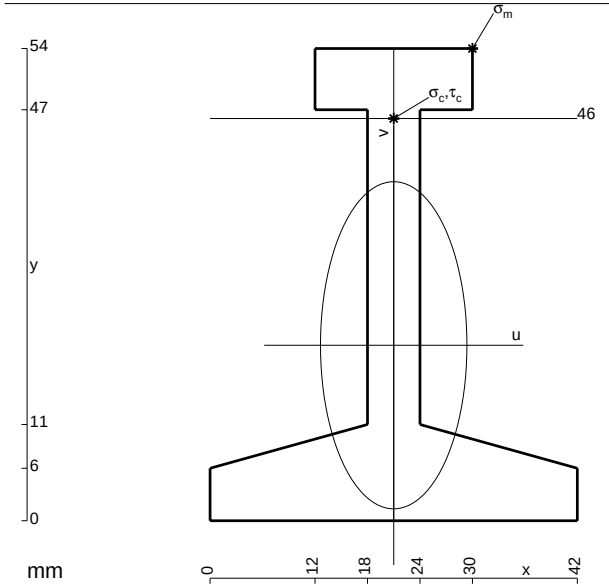
$= (-13/6\ b\ )\ Fb\ 1/EJ\ = -13/6\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

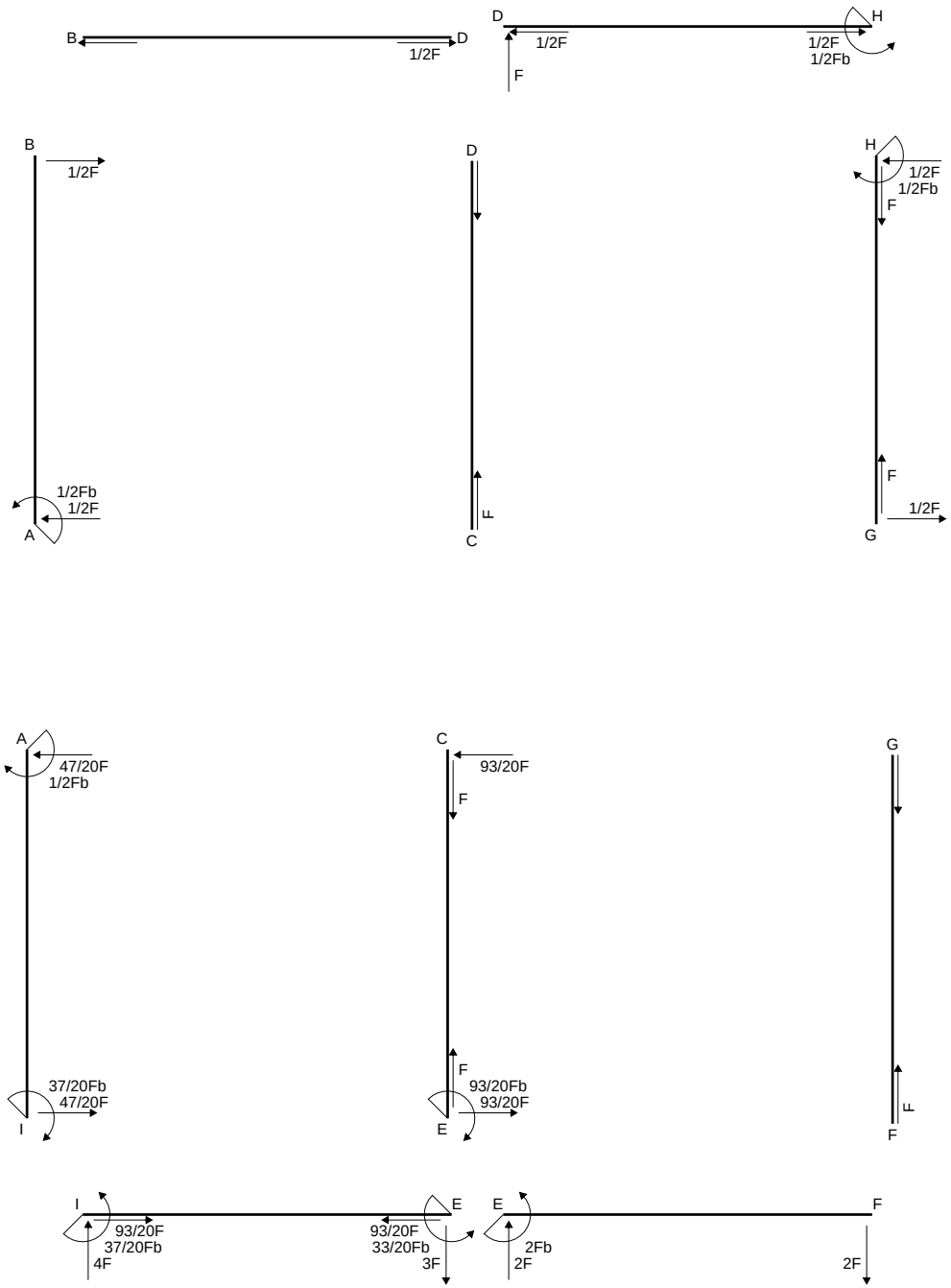
$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$



A = 714. mm^2
J_u = 249976. mm^4
J_v = 50094. mm^4
y_g = 20.07 mm
T_y = 2070. N
M_x = -1759500. Nmm
x_m = 30. mm
y_m = 54. mm
u_m = 9. mm
v_m = 33.93 mm
$\sigma_m = -Mv/J_u$ = 238.8 N/mm^2
x_c = 21. mm
y_c = 46. mm
v_c = 25.93 mm
$\sigma_c = -Mv/J_u$ = 182.5 N/mm^2
τ_c = 5.511 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 182.8 N/mm^2
S^* = 3993. mm^3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1/2Fb
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C
H
1/2F
1/2Fb
F
F
1/2F
G
A
47/20F
1/2Fb
37/20Fb
47/20F
I
C
93/20F
F
F
93/20Fb
93/20F
E
G
F
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F
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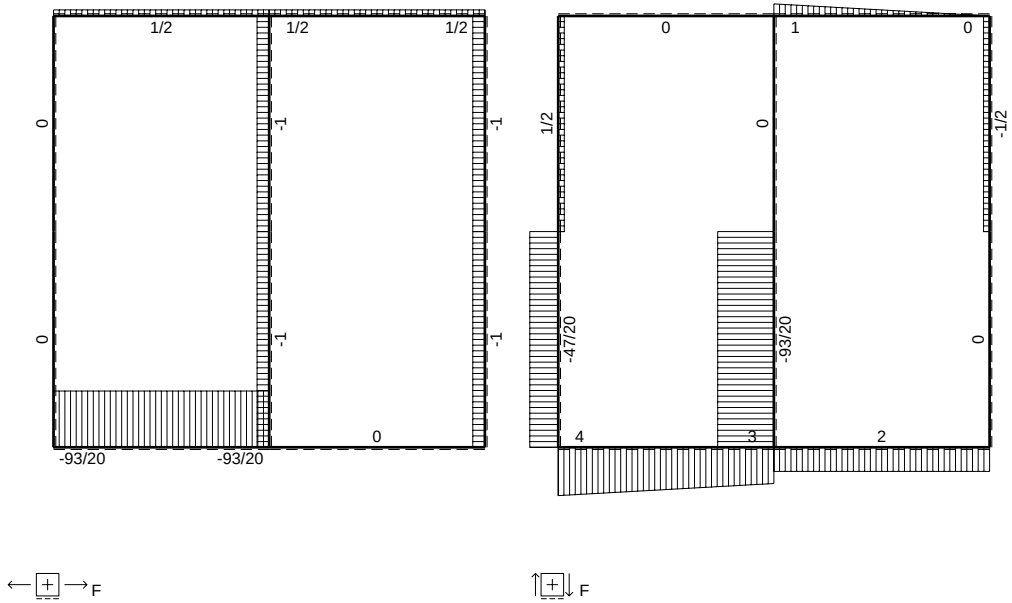
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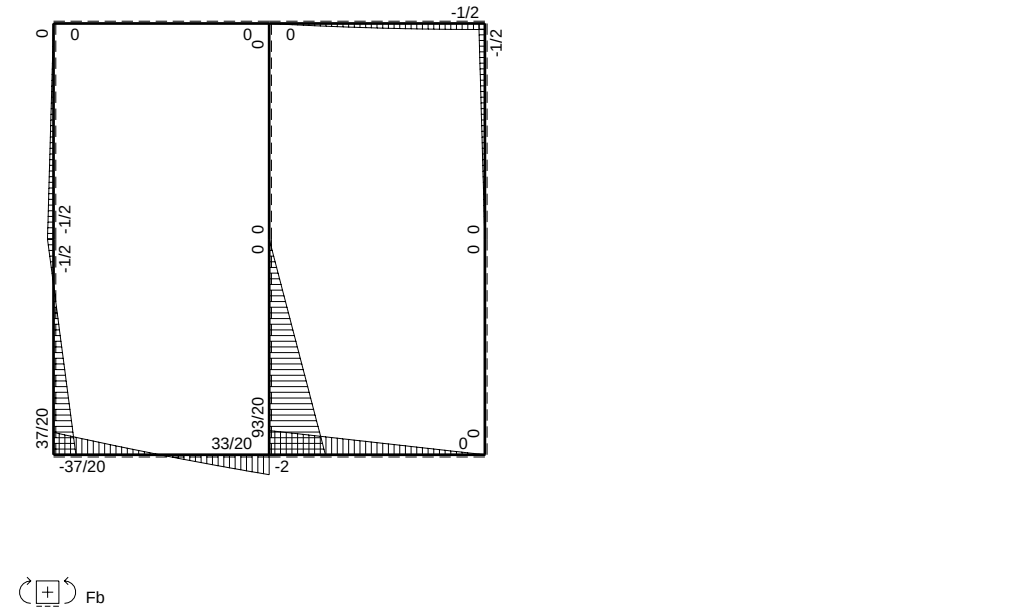
F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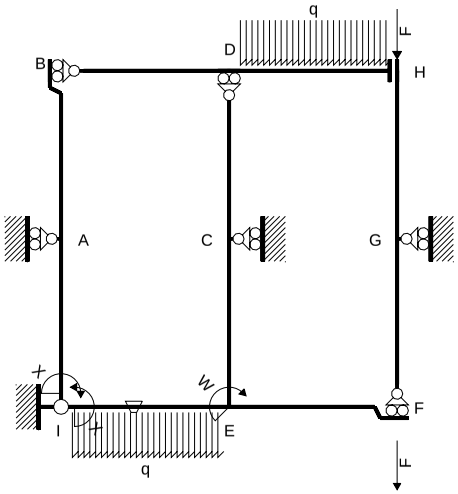
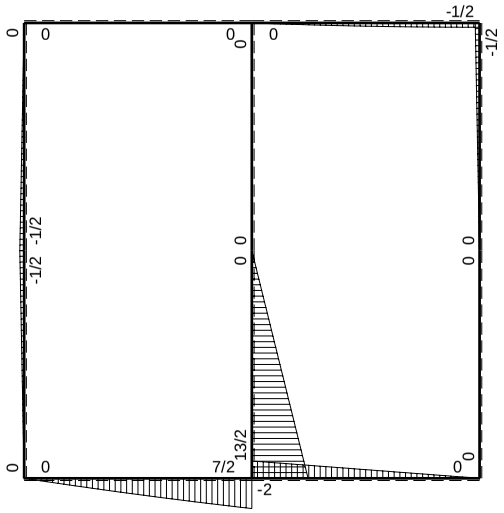
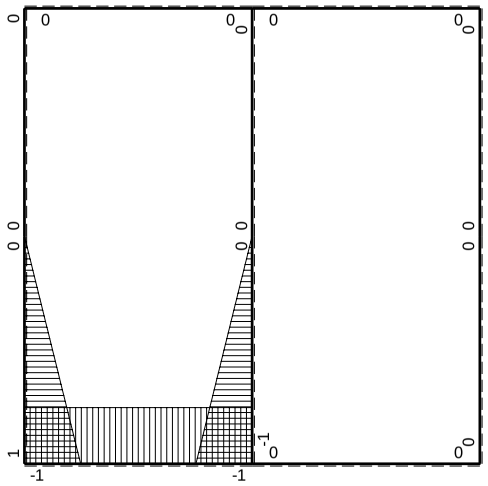
-1/2
0 0
0 0
37/20
93/20
33/20
0
0
-37/20
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 962832 CI07.xxxx.110

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PROCEDIMENTO E RISULTATI 962832 CI07.xxxx.110

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	-1/2Fx	0	0	0	0	0+0	0
HG b	0	1/2Fb-1/2Fx	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$4Fx-1/2qx^2$	-Fb/EJ	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	-1+x/b	13/2Fb-13/2Fx	0	$-13/2Fb+13Fx-13/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-13/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-13/2Fx	0	$-13/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-37/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						37/20Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-4\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-7/2 + 3\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx$

$= [-7/2\ x + 3/2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-7/2\ b + 3/2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-13/2 + 13\ x/b - 13/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-13/2\ x + 13/2\ x^2/b - 13/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-13/2\ b + 13/2\ b - 13/6\ b\ )\ Fb\ 1/EJ\ = -13/6\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-13/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-13/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

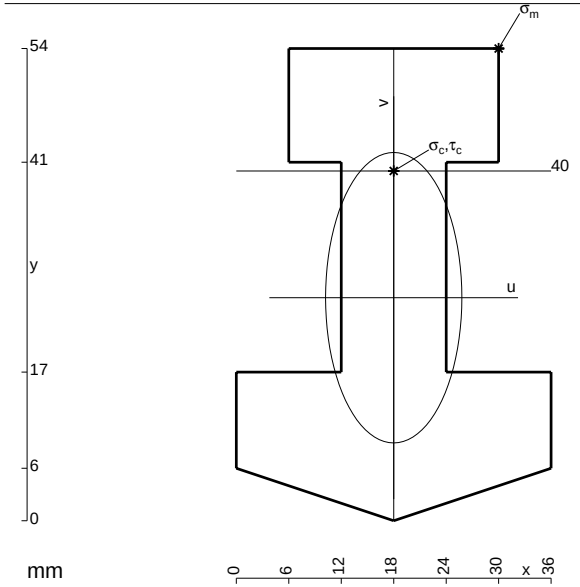
$= (-13/6\ b\ )\ Fb\ 1/EJ\ = -13/6\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

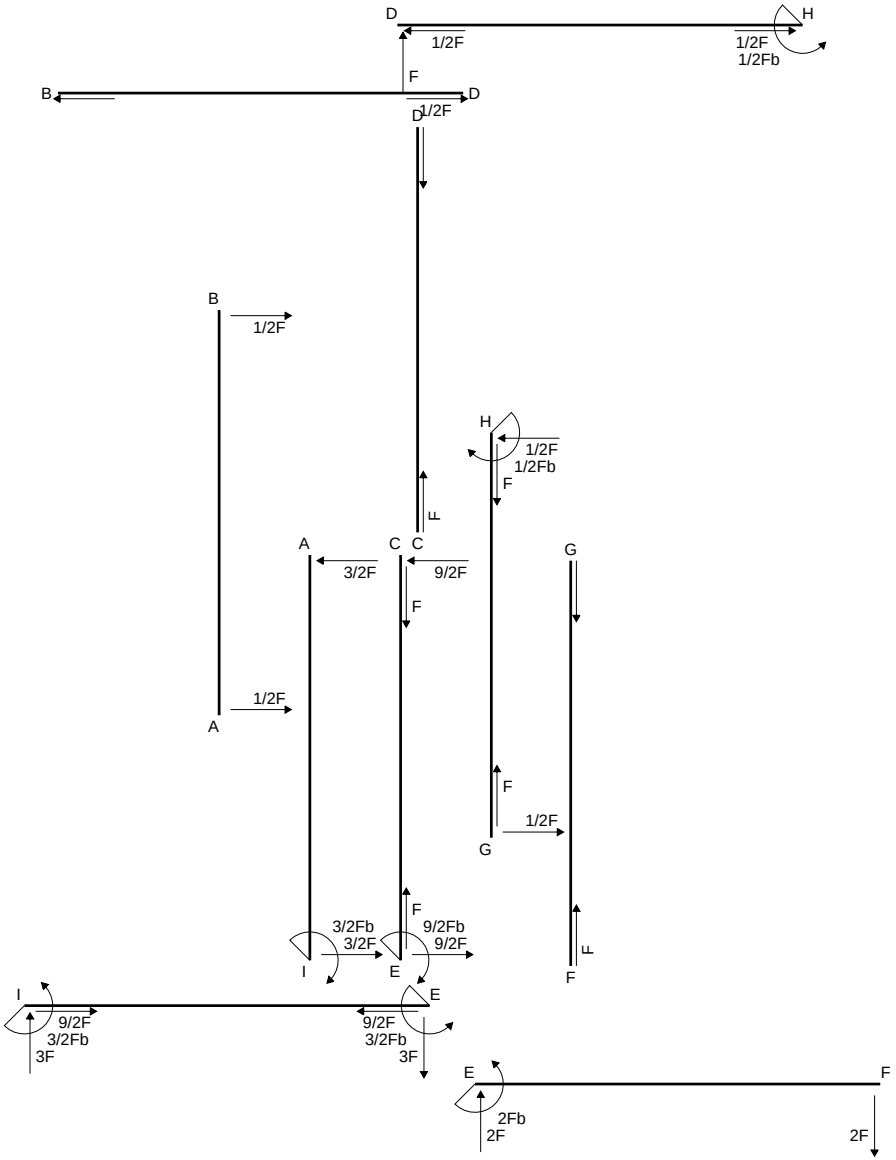
$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$



A = 1104. mm^2
J_u = 304502. mm^4
J_v = 67032. mm^4
y_g = 25.51 mm
T_y = 3940. N
M_x = -2127600. Nmm
x_m = 30. mm
y_m = 54. mm
u_m = 12. mm
v_m = 28.49 mm
$\sigma_m = -Mv/J_u$ = 199.1 N/mm^2
x_c = 18. mm
y_c = 40. mm
v_c = 14.49 mm
$\sigma_c = -Mv/J_u$ = 101.3 N/mm^2
τ_c = 7.593 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 102.1 N/mm^2
S^* = 7042. mm^3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G
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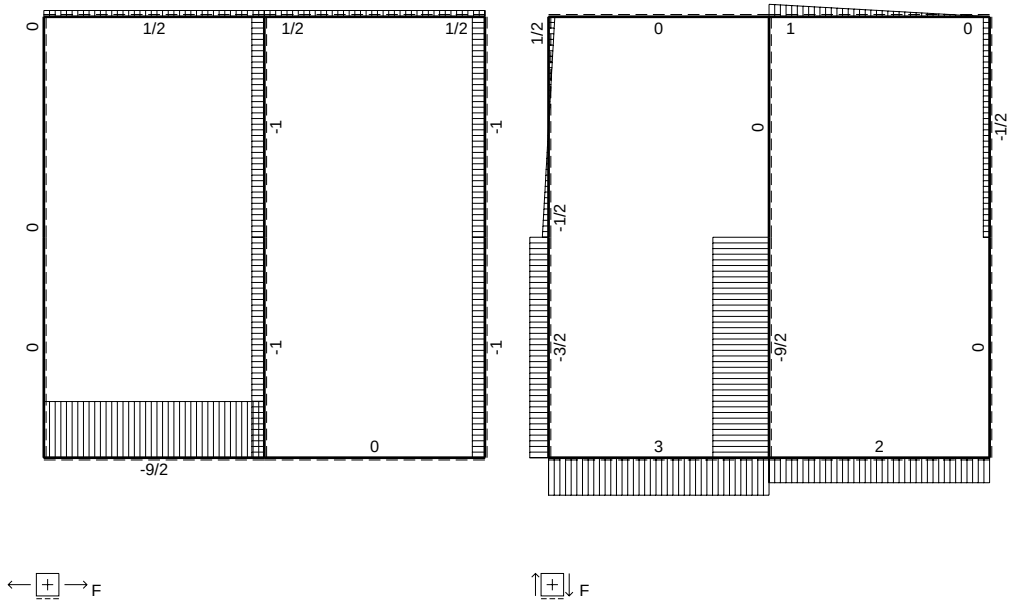
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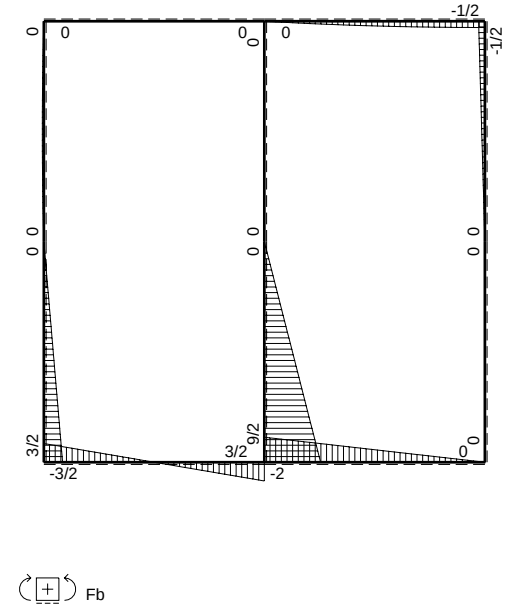
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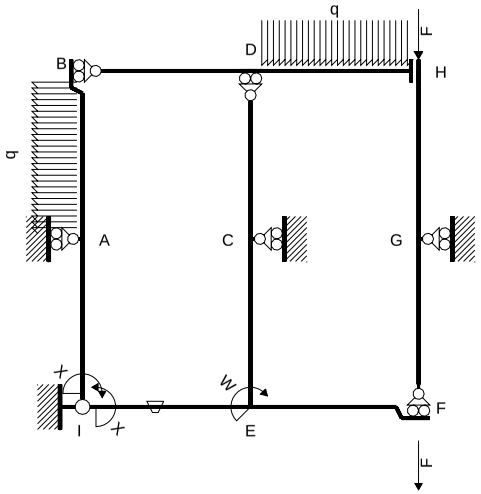
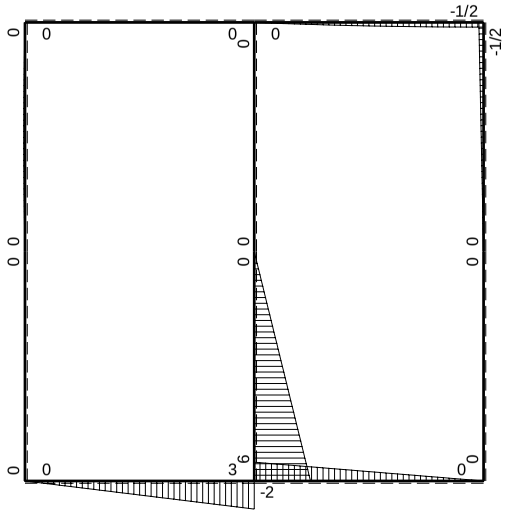
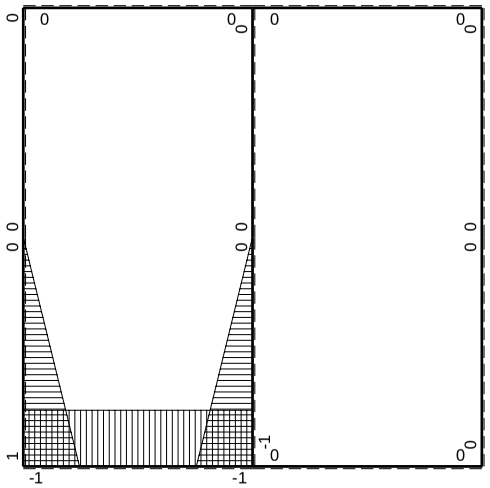
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 213974 CI07.xxxx.111

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	-1/2Fx	0	0	0	0	0+0	0
HG b	0	1/2Fb-1/2Fx	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	6Fb-6Fx	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-6Fx	0	$-6Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	1/3Xb/EJ
AI b	-x/b	0	0	0	0	x^2/b^2		
	totali						$-5/2Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						3/2Fb	

PROCEDIMENTO E RISULTATI 213974 CI07.xxxx.111

Sviluppi di calcolo iperstatica

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

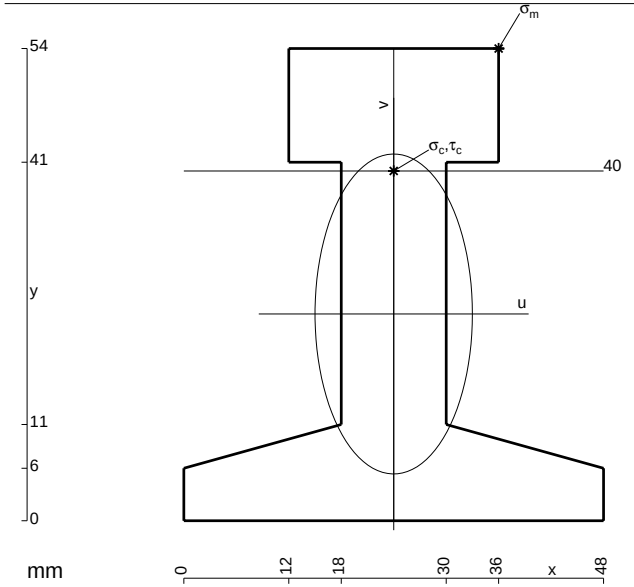
$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-6 + 12\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-6\ x + 6\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

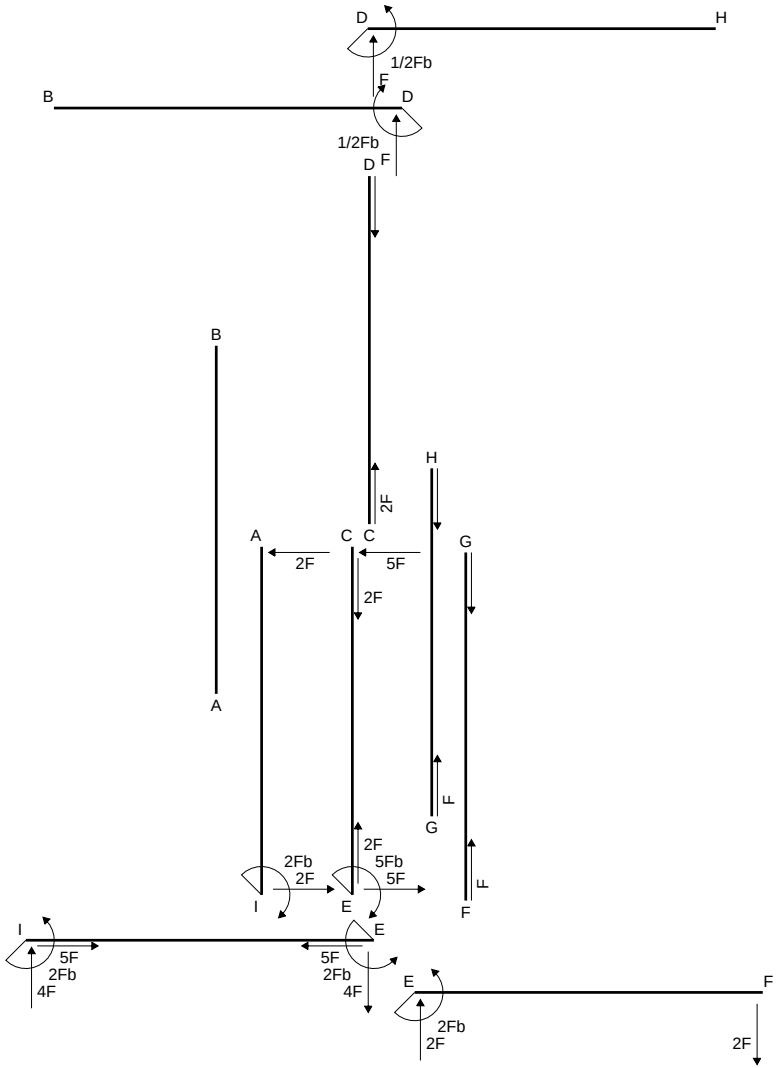
$= (-6\ b + 6\ b - 2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$



A = 1110. mm^2
J_u = 371542. mm^4
J_v = 89892. mm^4
y_g = 23.64 mm
T_y = 4340. N
M_x = -2560600. Nmm
x_m = 36. mm
y_m = 54. mm
u_m = 12. mm
v_m = 30.36 mm
$\sigma_m = -Mv/J_u$ = 209.2 N/mm^2
x_c = 24. mm
y_c = 40. mm
v_c = 16.36 mm
$\sigma_c = -Mv/J_u$ = 112.7 N/mm^2
τ_c = 7.442 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 113.5 N/mm^2
S^* = 7646. mm^3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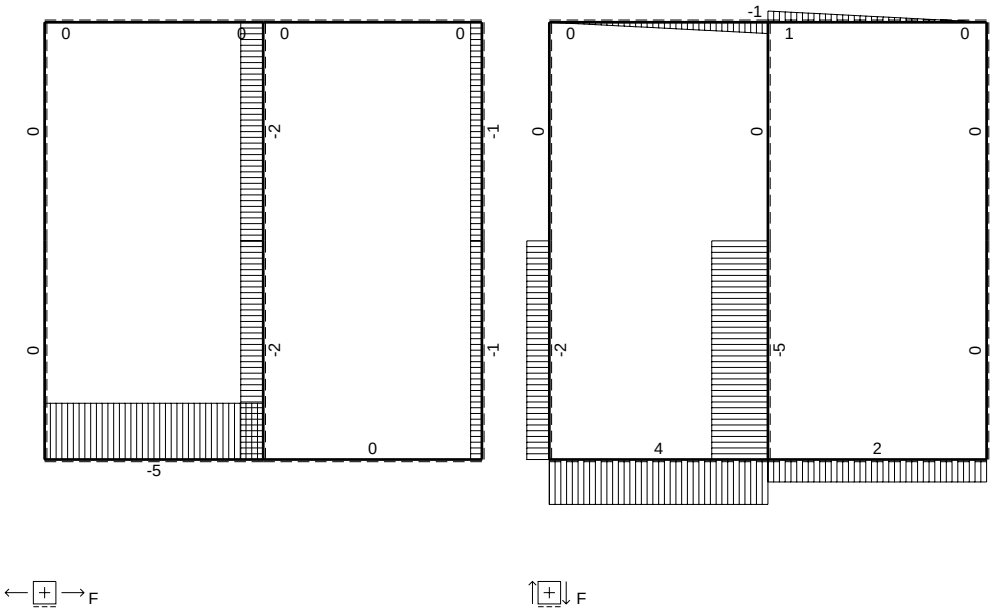
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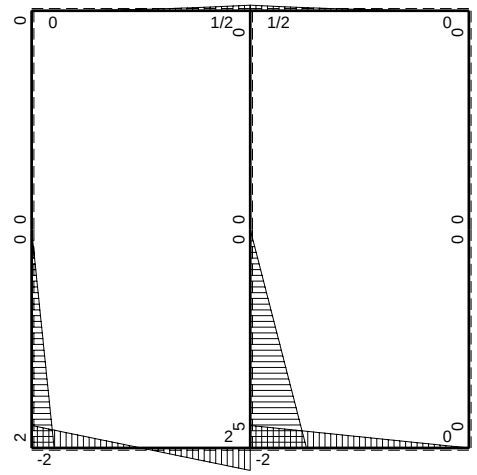
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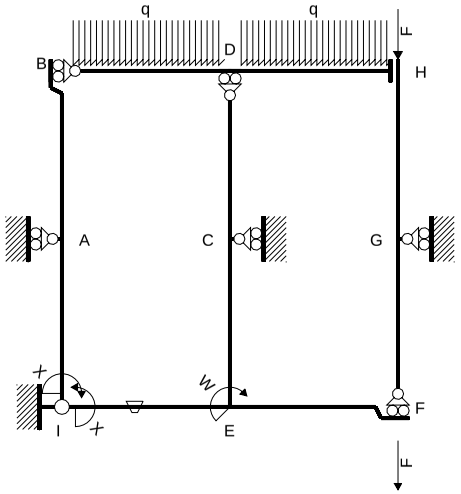
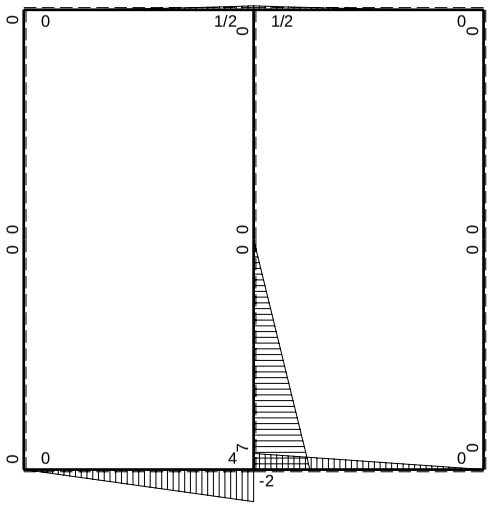
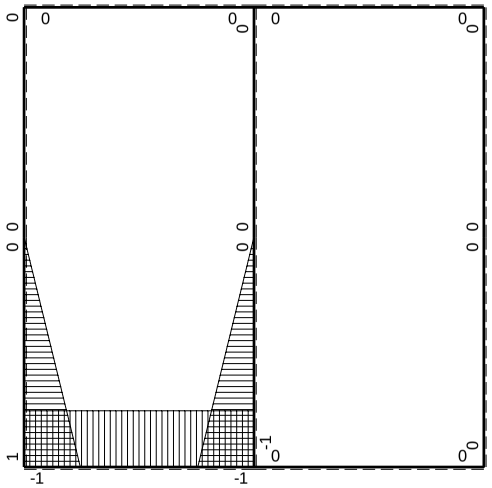


Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 212105 CI07.xxxx.112

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	0	0	0	0	0	0+0	0
HG b	0	0	0	0	0	0		
HD b	0	$1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	4Fx	-Fb/EJ	-4Fx	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-4Fb+4Fx	Fb/EJ	-4Fb+4Fx	Fb/EJ	1		
EC b	$-1+x/b$	7Fb-7Fx	0	$-7Fb+14Fx-7Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-7/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-7Fx	0	$-7Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	1/3Xb/EJ
AI b	-x/b	0	0	0	0	x^2/b^2		
	totali						$-10/3Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						2Fb	

Sviluppi di calcolo iperstatica

PROCEDIMENTO E RISULTATI 212105 CI07.xxxx.112
@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-4 + 4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-4\ x + 2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

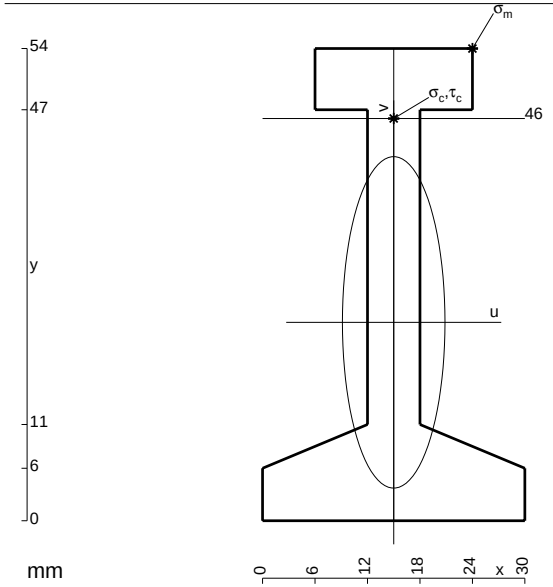
$= (-4\ b + 2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-7 + 14\ x/b - 7\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-7\ x + 7\ x^2/b - 7/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

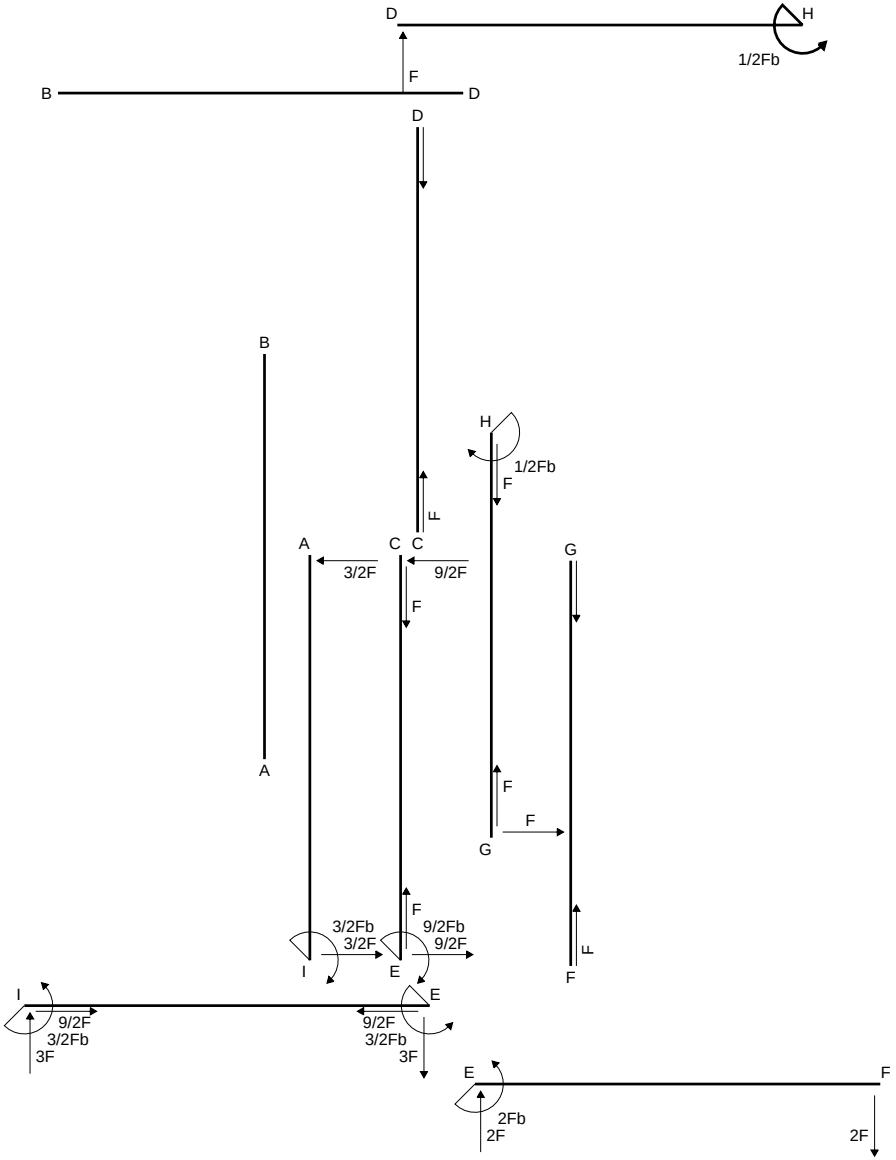
$= (-7\ b + 7\ b - 7/3\ b\ )\ Fb\ 1/EJ\ = -7/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-7\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-7/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-7/3\ b\ )\ Fb\ 1/EJ\ = -7/3\ Fb^2/EJ$



A = 612. mm^2
J_u = 219945. mm^4
J_v = 21060. mm^4
y_g = 22.68 mm
T_y = 2400. N
M_x = -1536000. Nmm
x_m = 24. mm
y_m = 54. mm
u_m = 9. mm
v_m = 31.32 mm
$\sigma_m = -Mv/J_u$ = 218.7 N/mm^2
x_c = 15. mm
y_c = 46. mm
v_c = 23.32 mm
$\sigma_c = -Mv/J_u$ = 162.8 N/mm^2
τ_c = 6.634 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 163.2 N/mm^2
S^* = 3648. mm^3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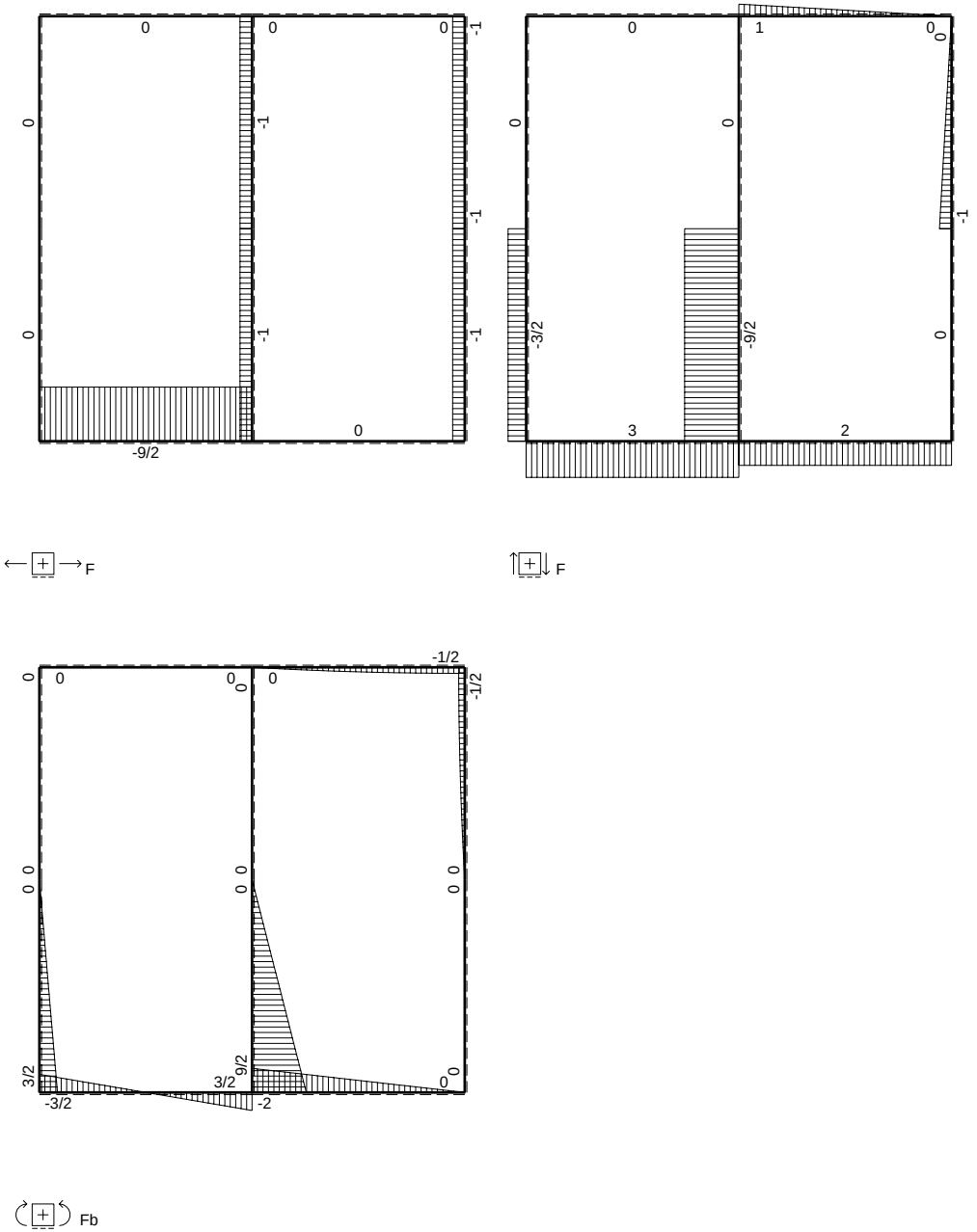
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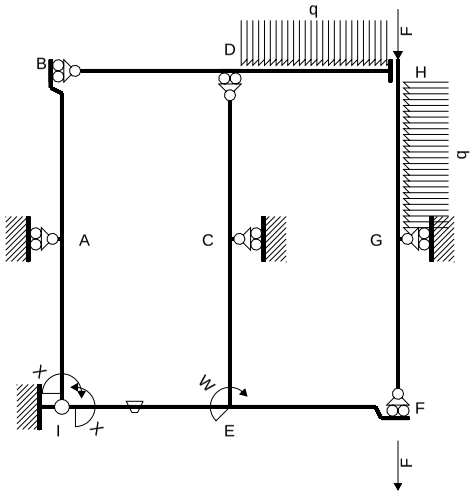
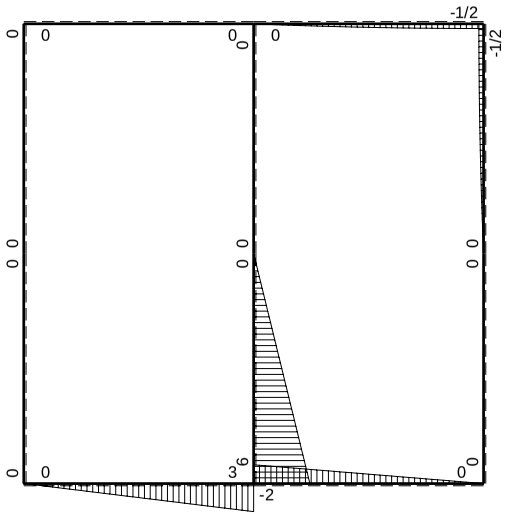
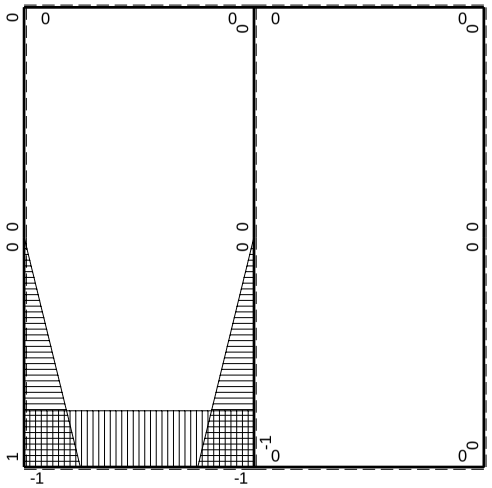


Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 213277 CI07.xxxx.113

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	6Fb-6Fx	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-6Fx	0	$-6Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	1/3Xb/EJ
AI b	-x/b	0	0	0	0	x^2/b^2		
	totali						$-5/2Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						3/2Fb	

PROCEDIMENTO E RISULTATI 213277 CI07.xxxx.113

Sviluppi di calcolo iperstatica

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

$L^{XX}_{IE} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EI} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EC} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{CE} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{IA} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{AI} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{Xo}_{IE} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L^{Xo}_{EI} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

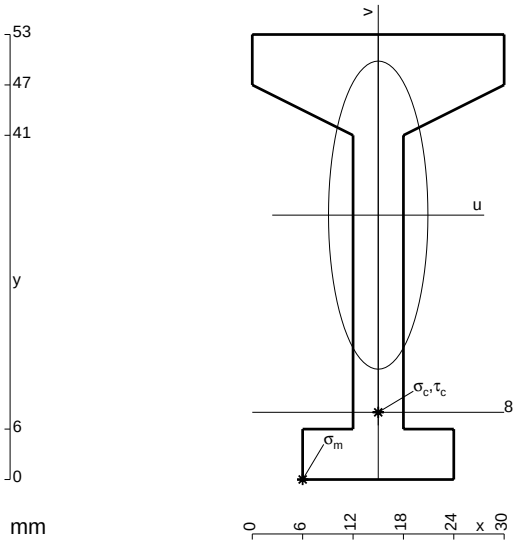
$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L^{Xo}_{EC} = \int_o^b (-6 + 12\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-6\ x + 6\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

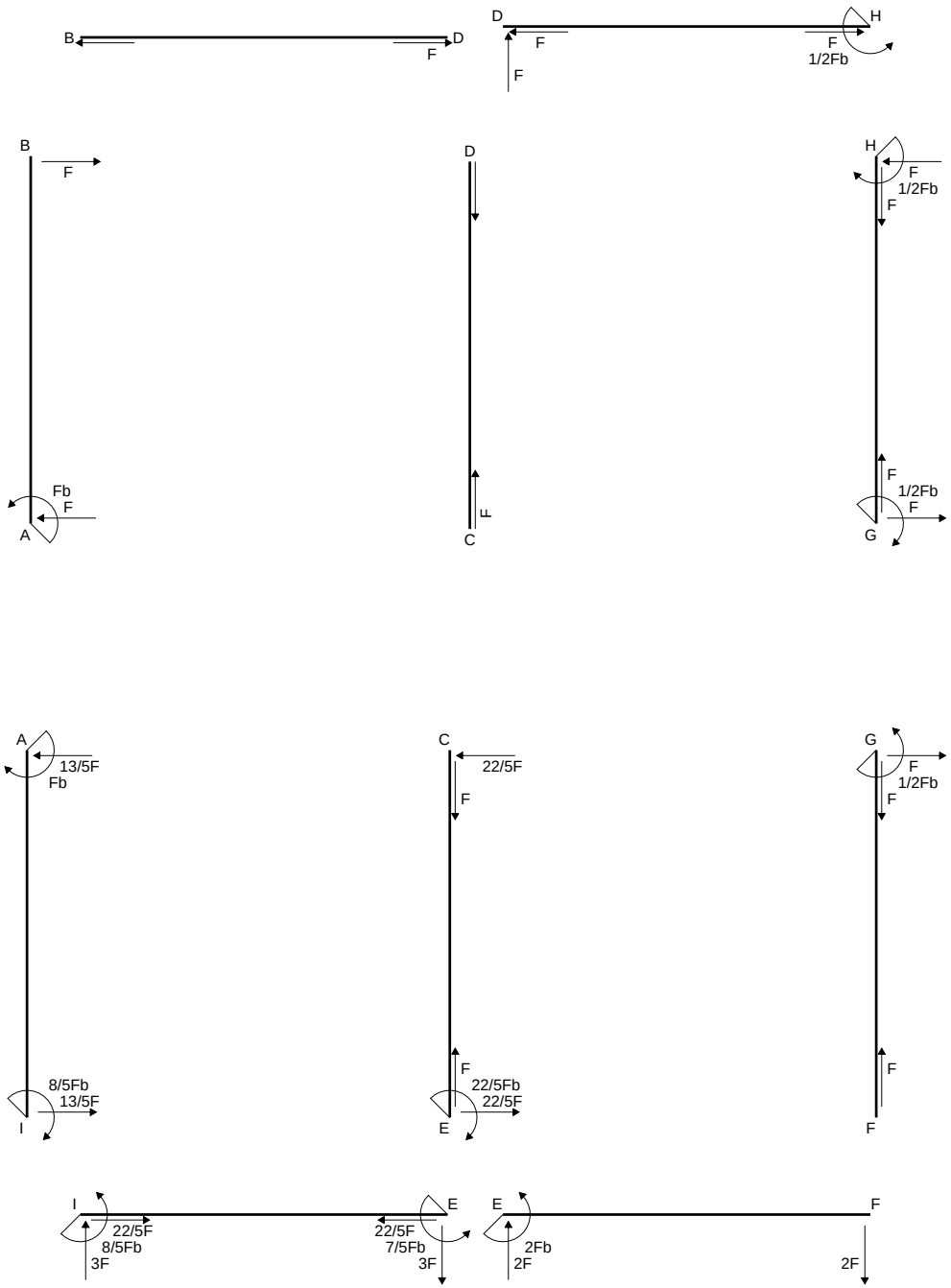
$= (-6\ b + 6\ b - 2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

$L^{Xo}_{CE} = \int_o^b (-6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$



A = 606. mm^2
J_u = 204068. mm^4
J_v = 21258. mm^4
y_g = 31.49 mm
T_y = 2180. N
M_x = -1482400. Nmm
x_m = 6. mm
u_m = -9. mm
v_m = -31.49 mm
$\sigma_m = -Mv/J_u$ = -228.8 N/mm^2
x_c = 15. mm
y_c = 8. mm
v_c = -23.49 mm
$\sigma_c = -Mv/J_u$ = -170.6 N/mm^2
τ_c = 6.002 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 171. N/mm^2
S^* = 3371. mm^3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2Fb
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F
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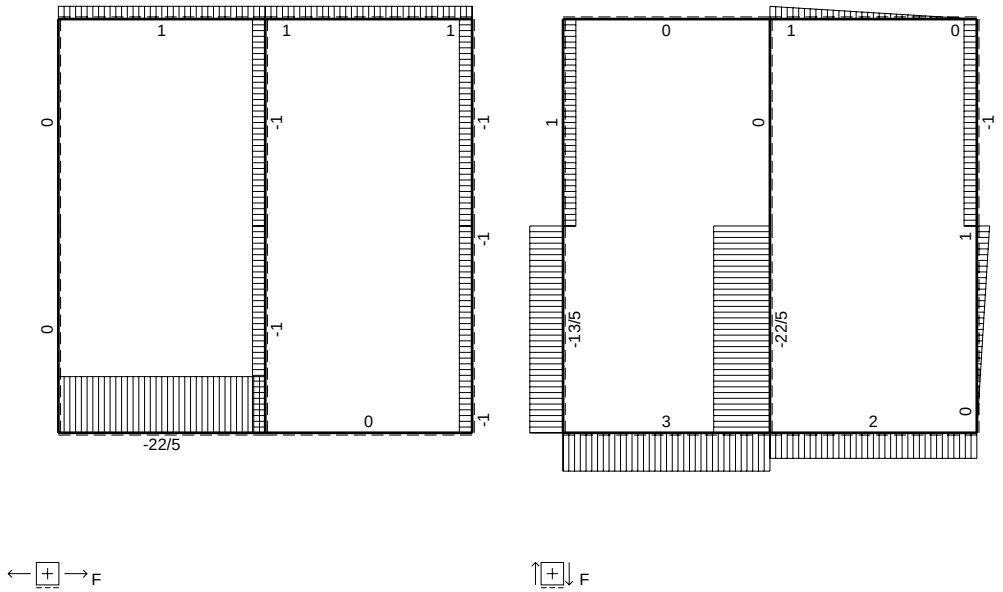
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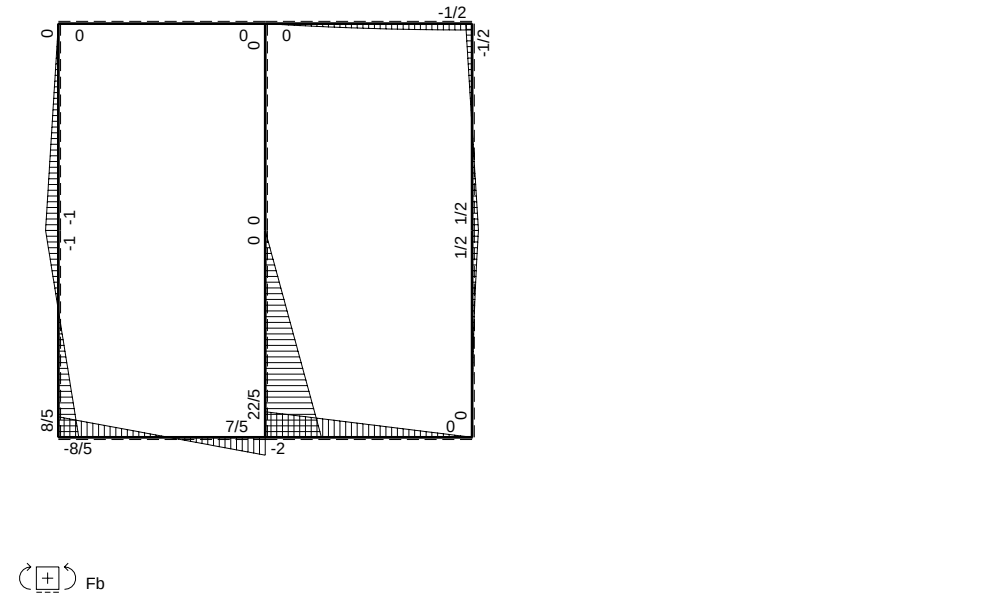
F
F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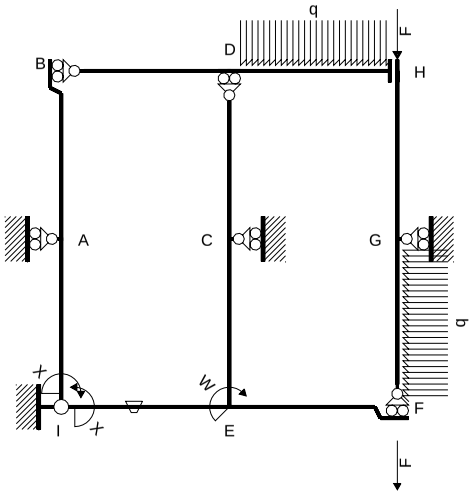
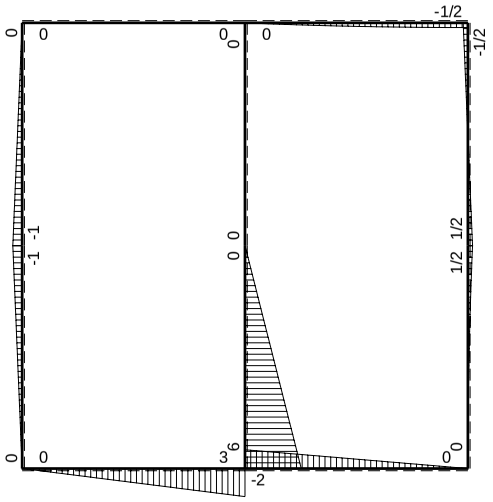
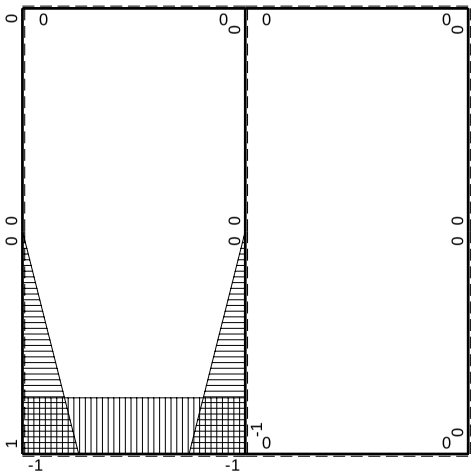
-8/5
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 961156 CI07.xxxx.114

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PROCEDIMENTO E RISULTATI 961156 CI07.xxxx.114

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb-Fx	0	0	0	0	0+0	0
HG b	0	1/2Fb-Fx	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	6Fb-6Fx	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-6Fx	0	$-6Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-Fx	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	Fb-Fx	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-8/3Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						8/5Fb	

Sviluppi di calcolo iperstatica

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$L_{lE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{El}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{lA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{Al}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{lE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{El}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-6 + 12\ x/b - 6\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-6\ x + 6\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-6\ b + 6\ b - 2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

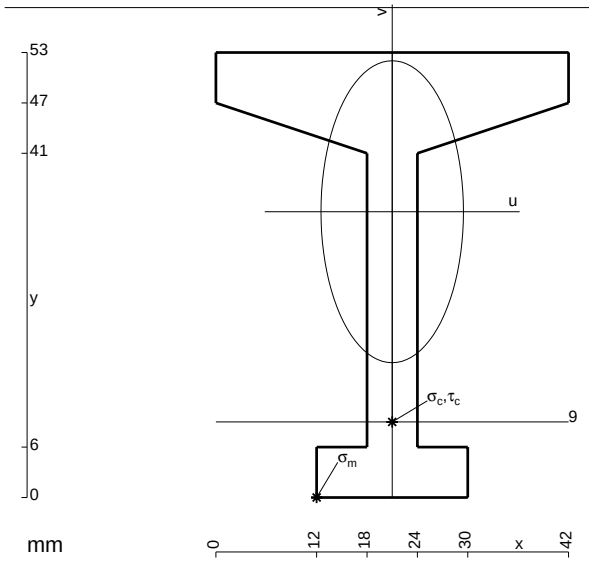
$= (-2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

$L_{lA}^{Xo} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

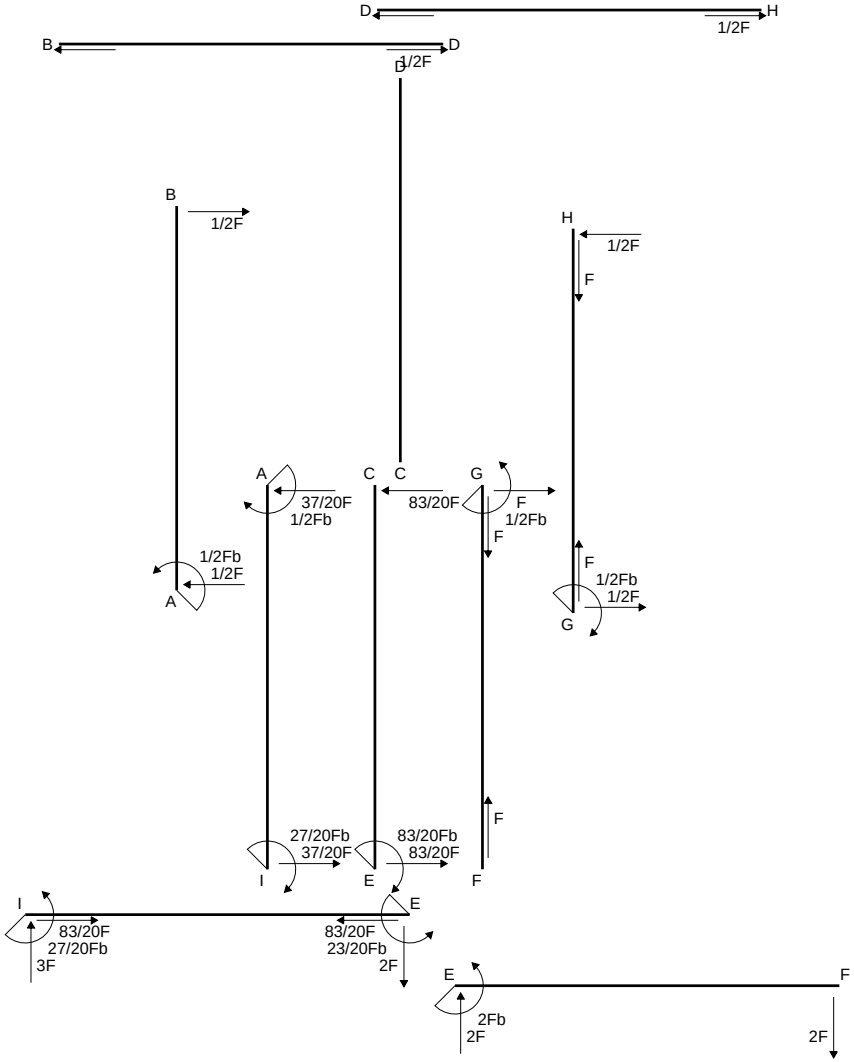
$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$

$L_{Al}^{Xo} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$



A = 714. mm^2
J_u = 230961. mm^4
J_v = 51390. mm^4
y_g = 34.04 mm
T_y = 2200. N
M_x = -1628000. Nmm
x_m = 12. mm
u_m = -9. mm
v_m = -34.04 mm
$\sigma_m = -Mv/J_u$ = -239.9 N/mm^2
x_c = 21. mm
y_c = 9. mm
v_c = -25.04 mm
$\sigma_c = -Mv/J_u$ = -176.5 N/mm^2
τ_c = 6.08 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 176.8 N/mm^2
S^* = 3830. mm^3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G
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83/20F
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1/2Fb
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1/2F
G
F
27/20Fb
37/20F
83/20Fb
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2F
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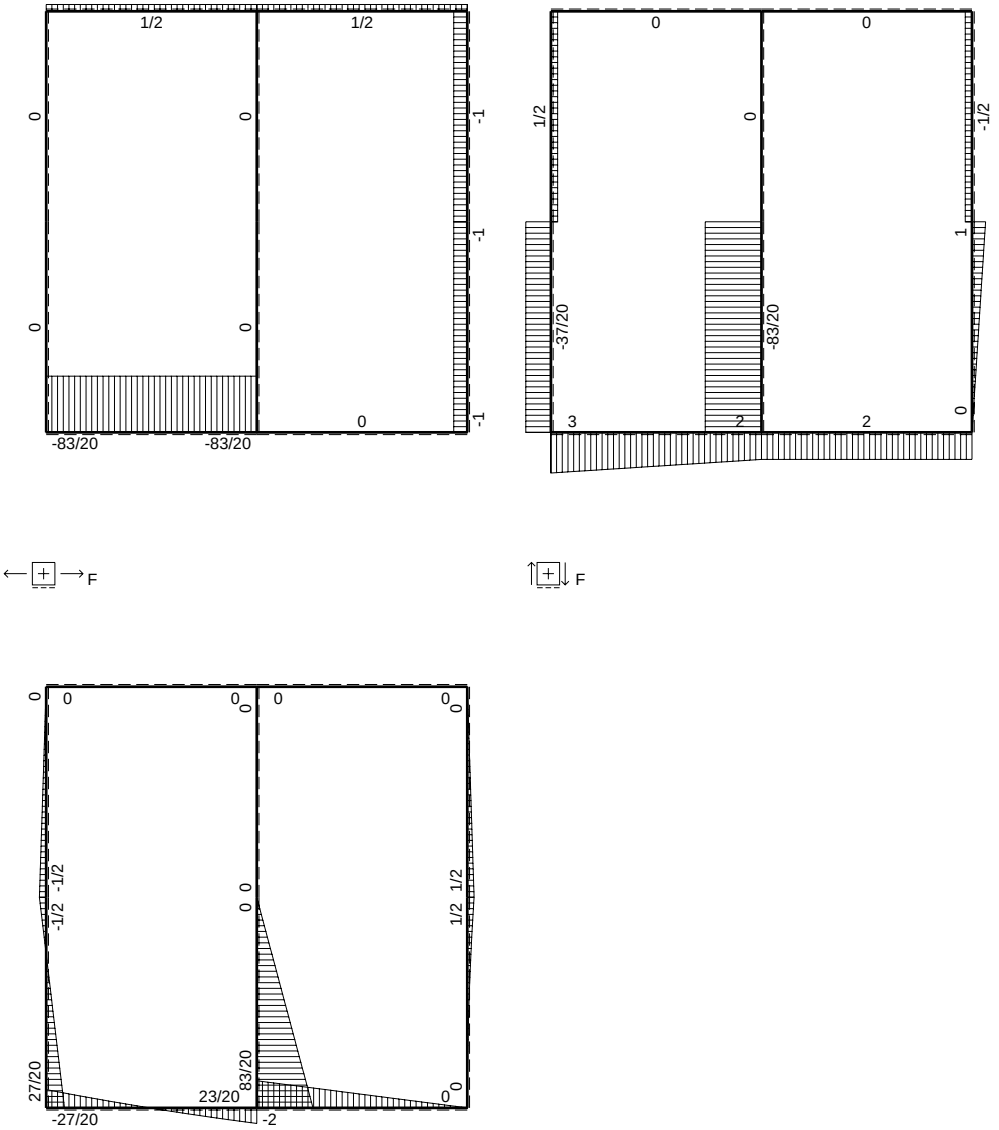
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23/20
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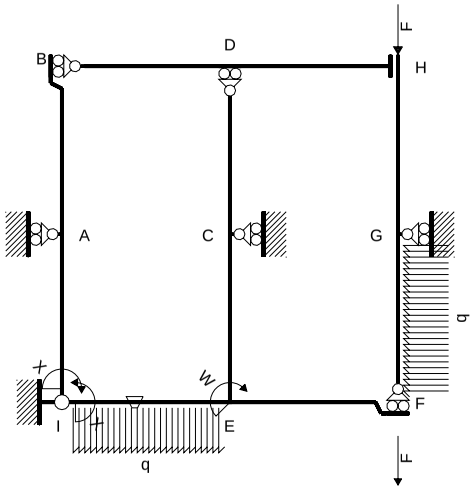
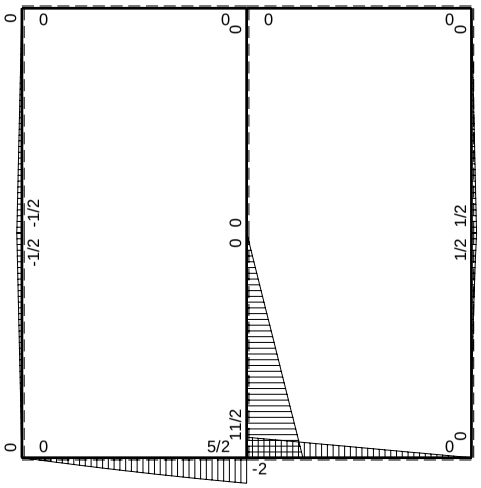
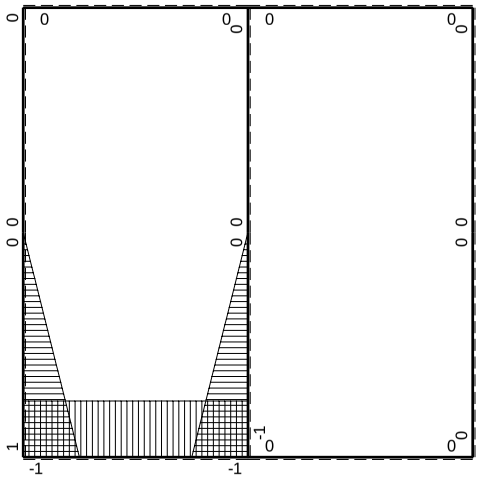
-27/20
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 984797 CI07.xxxx.115

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PROCEDIMENTO E RISULTATI 984797 CI07.xxxx.115

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx-1/2qx^2$	-Fb/EJ	$-3Fx+1/2Fx^2/b$	Fb/EJ	1	$(-4/3+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-5/2Fb+2Fx+1/2qx^2$	Fb/EJ	$-5/2Fb+2Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	-1+x/b	11/2Fb-11/2Fx	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-11/2Fx	0	$-11/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-9/4Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						27/20Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/3\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-5/2 + 2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx$

$= [-5/2\ x + x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-5/2\ b + b + 1/6\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/3\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-11/2 + 11\ x/b - 11/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-11/2\ x + 11/2\ x^2/b - 11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-11/2\ b + 11/2\ b - 11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-11/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

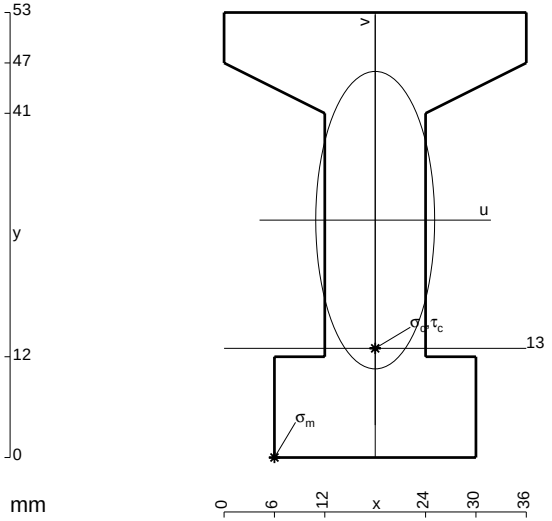
$= (-11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

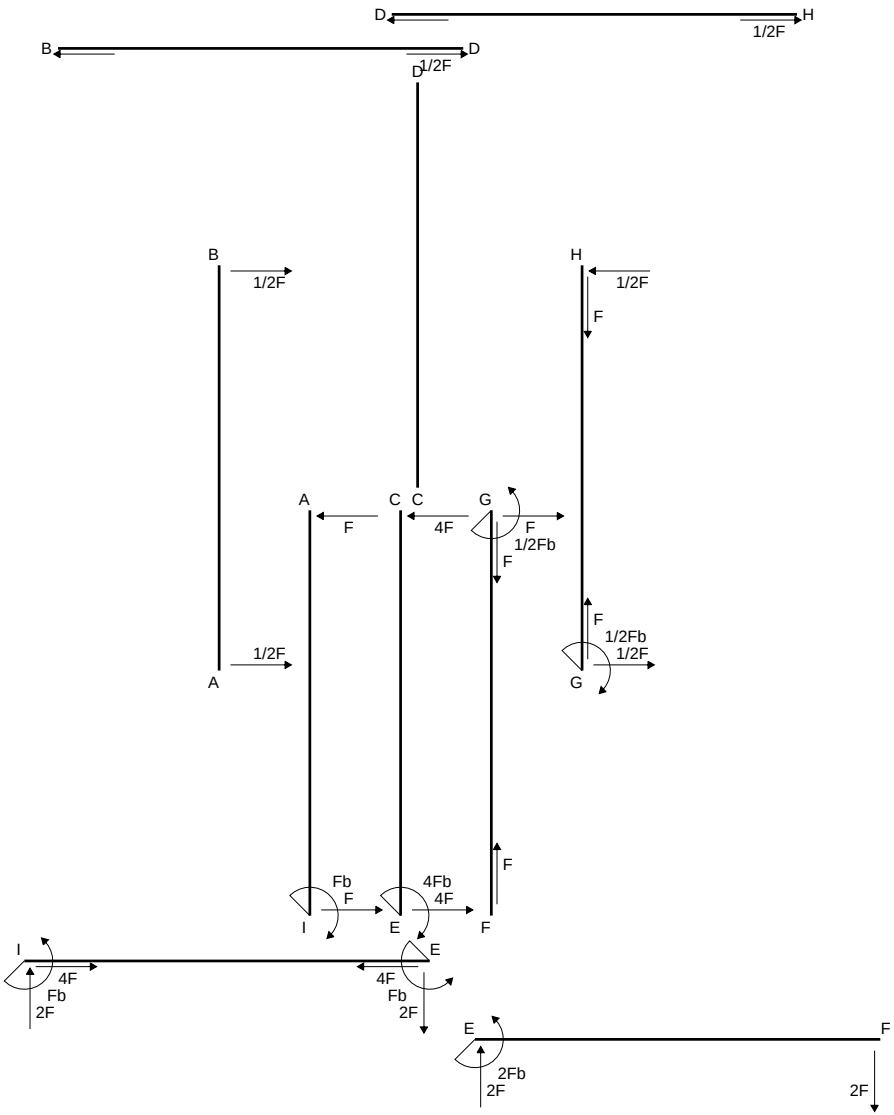
$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$



A = 996. mm^2
J_u = 312739. mm^4
J_v = 49968. mm^4
y_g = 28.27 mm
T_y = 2800. N
M_x = -2212000. Nmm
x_m = 6. mm
u_m = -12. mm
v_m = -28.27 mm
$\sigma_m = -Mv/J_u$ = -200. N/mm^2
x_c = 18. mm
y_c = 13. mm
v_c = -15.27 mm
$\sigma_c = -Mv/J_u$ = -108. N/mm^2
τ_c = 4.927 N/mm^2
$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2}$ = 108.3 N/mm^2
S^* = 6603. mm^3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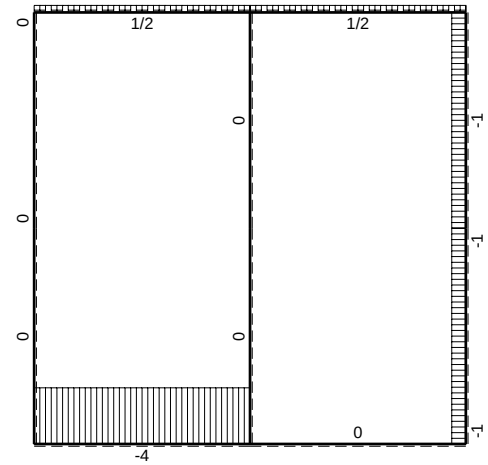
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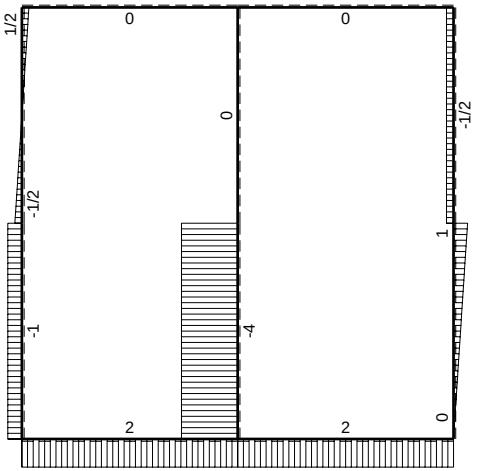
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1
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2
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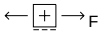
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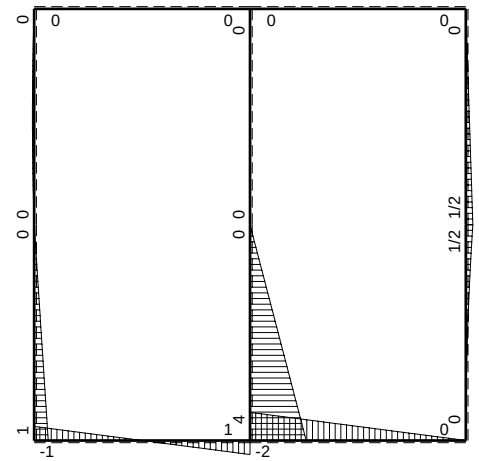
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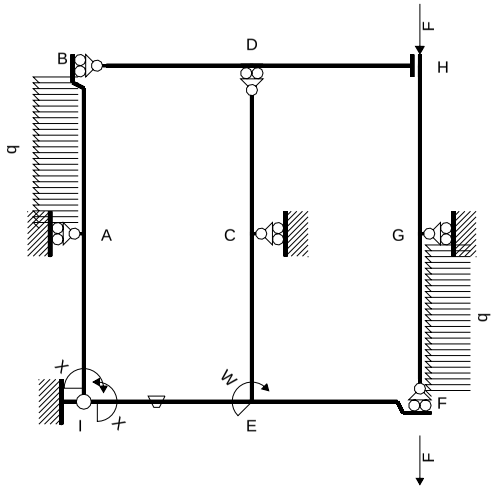
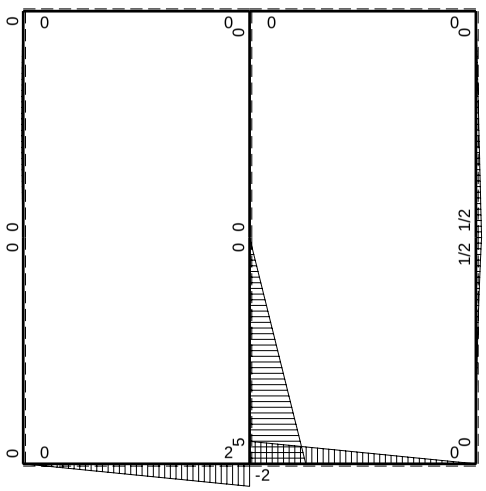
Fb



Schema di calcolo iperstatico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PROCEDIMENTO E RISULTATI 990848 CI07.xxxx.116

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-5Fx	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-5Fx	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	1/3Xb/EJ
AI b	-x/b	0	0	0	0	x^2/b^2		
	totali						$-5/3Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L_{EI}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

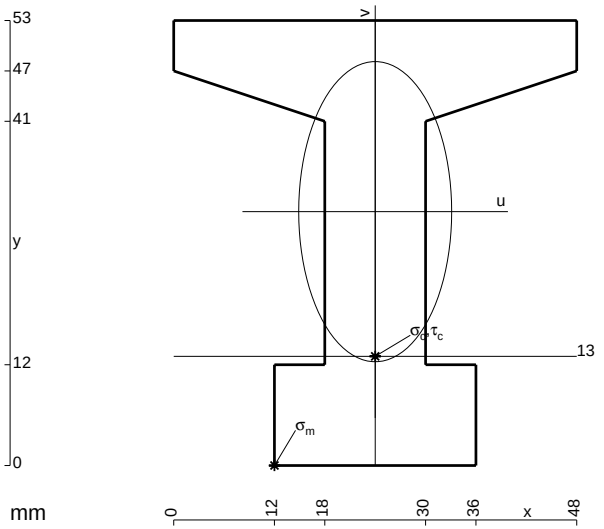
$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L_{EC}^{Xo} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

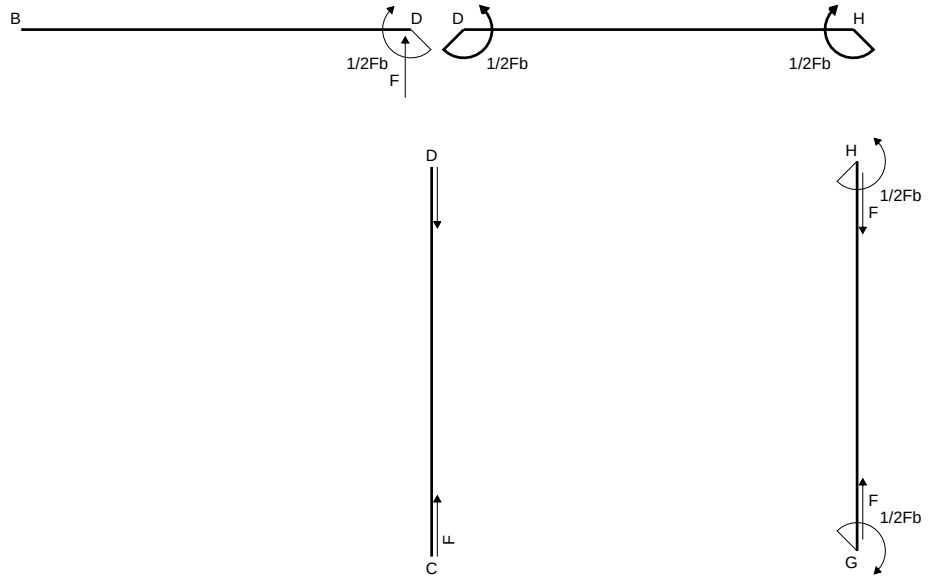
$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$



A = 1104. mm^2
J_u = 352844. mm^4
J_v = 91656. mm^4
y_g = 30.23 mm
T_y = 2900. N
M_x = -2436000. Nmm
x_m = 12. mm
u_m = -12. mm
v_m = -30.23 mm
$\sigma_m = -Mv/J_u$ = -208.7 N/mm^2
x_c = 24. mm
y_c = 13. mm
v_c = -17.23 mm
$\sigma_c = -Mv/J_u$ = -119. N/mm^2
τ_c = 4.926 N/mm^2
$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2}$ = 119.3 N/mm^2
S^* = 7192. mm^3


B
D
D
H
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F
1/2Fb
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B
D
H
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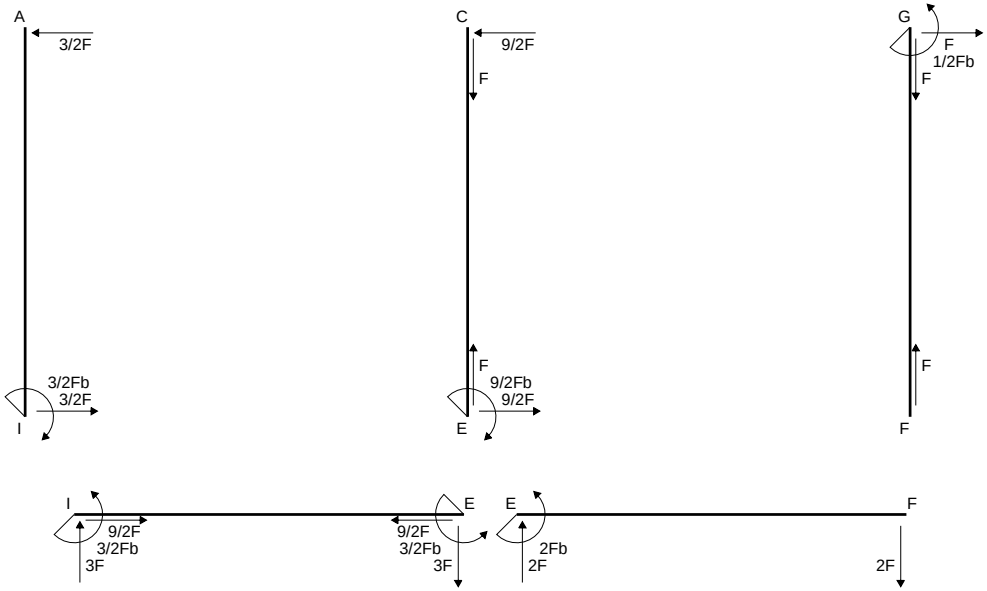
F
F
1/2Fb
A
C
G


A
3/2F
C
9/2F
F
G
F
1/2Fb
F
3/2Fb
3/2F
I
F
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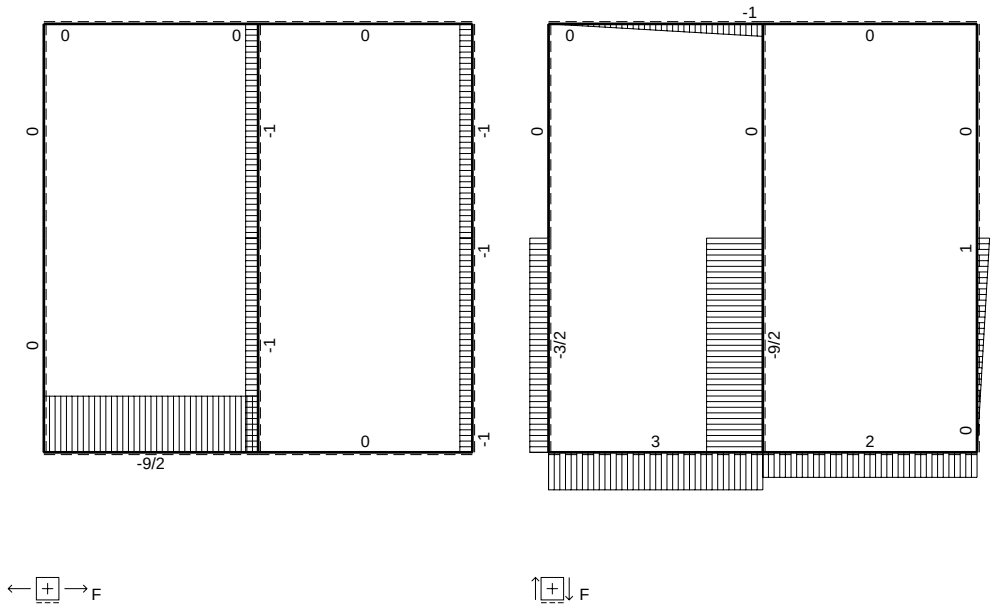
9/2F
E
F
I
E
E
F
9/2F
3/2Fb
3F
9/2F
3/2Fb
3F
2Fb
2F
2F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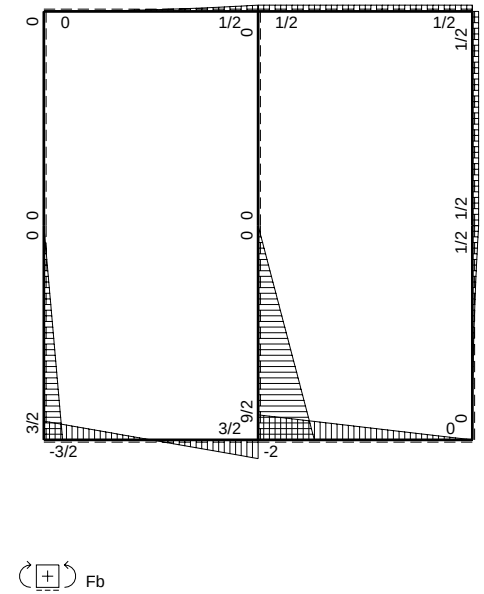
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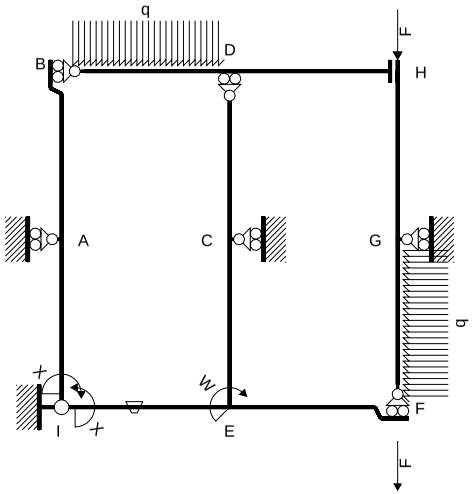
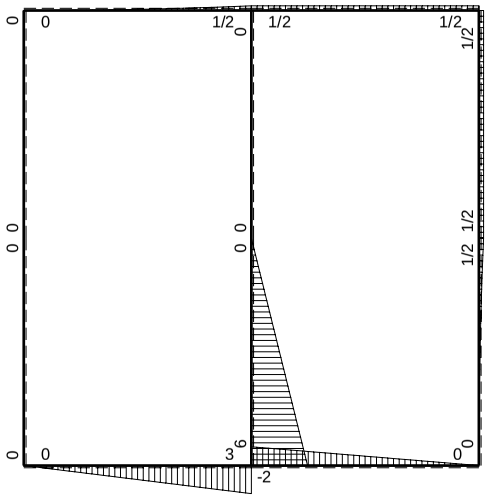
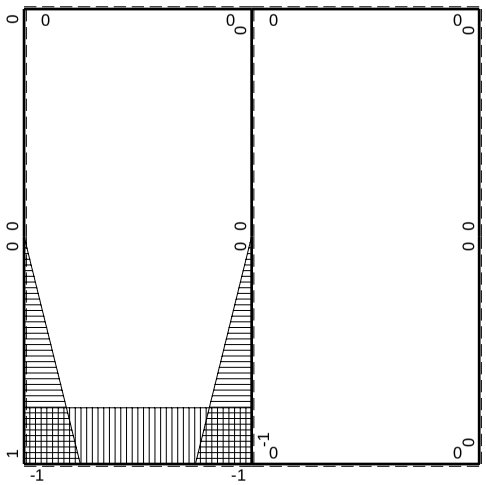


Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 212993 CI07.xxxx.117

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PROCEDIMENTO E RISULTATI 212993 CI07.xxxx.117

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb	0	0	0	0	0+0	0
HG b	0	-1/2Fb	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	6Fb-6Fx	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-6Fx	0	$-6Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	1/3Xb/EJ
AI b	-x/b	0	0	0	0	x^2/b^2		
	totali						$-5/2Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						3/2Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

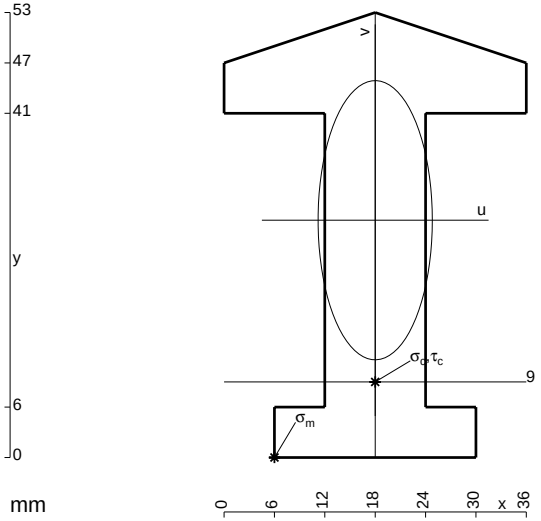
$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-6 + 12\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-6\ x + 6\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

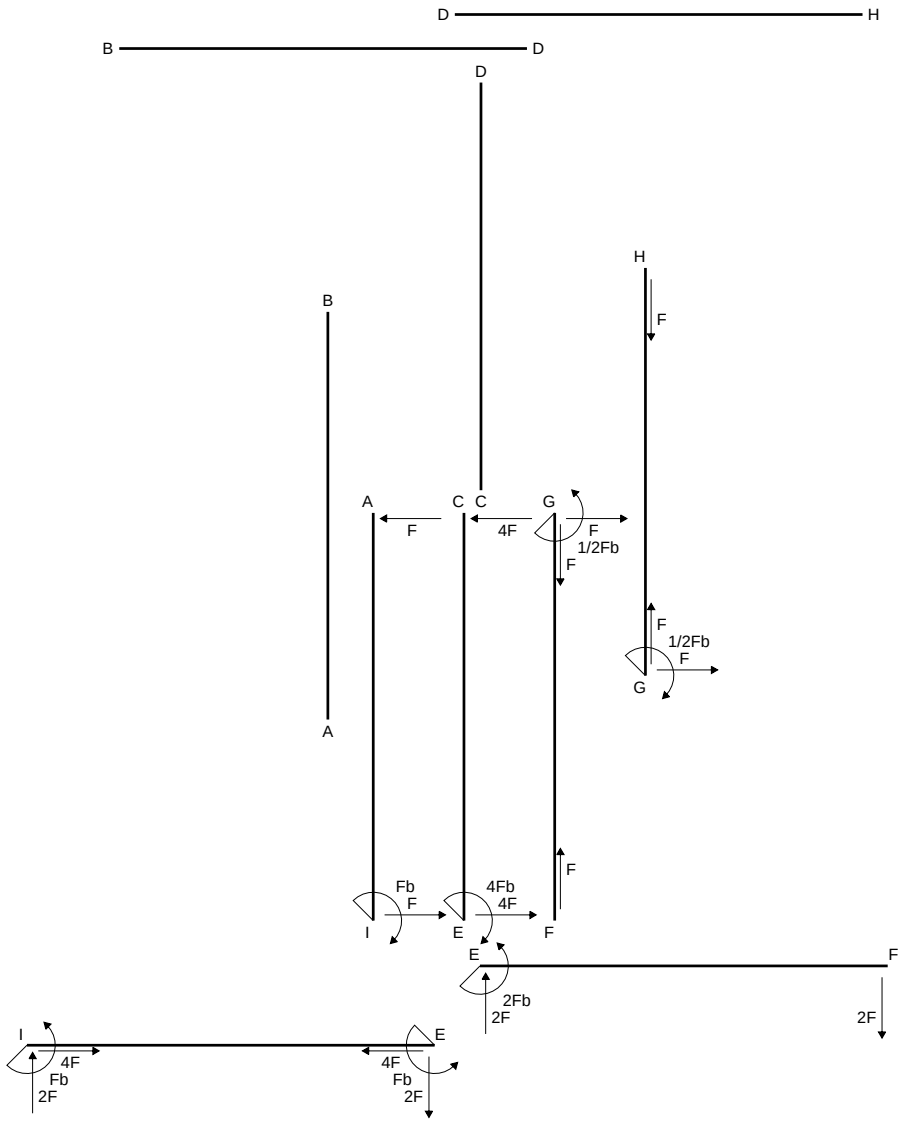
$= (-6\ b + 6\ b - 2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$



A = 888. mm^2
J_u = 245538. mm^4
J_v = 41112. mm^4
y_g = 28.26 mm
T_y = 2120. N
M_x = -1908000. Nmm
x_m = 6. mm
u_m = -12. mm
v_m = -28.26 mm
$\sigma_m = -Mv/J_u$ = -219.6 N/mm^2
x_c = 18. mm
y_c = 9. mm
v_c = -19.26 mm
$\sigma_c = -Mv/J_u$ = -149.7 N/mm^2
τ_c = 3.155 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 149.8 N/mm^2
S^* = 4385. mm^3


D
H
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F
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4F
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1/2Fb
F
F
1/2Fb
F
G
A
F
Fb
F
4Fb
4F
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2F
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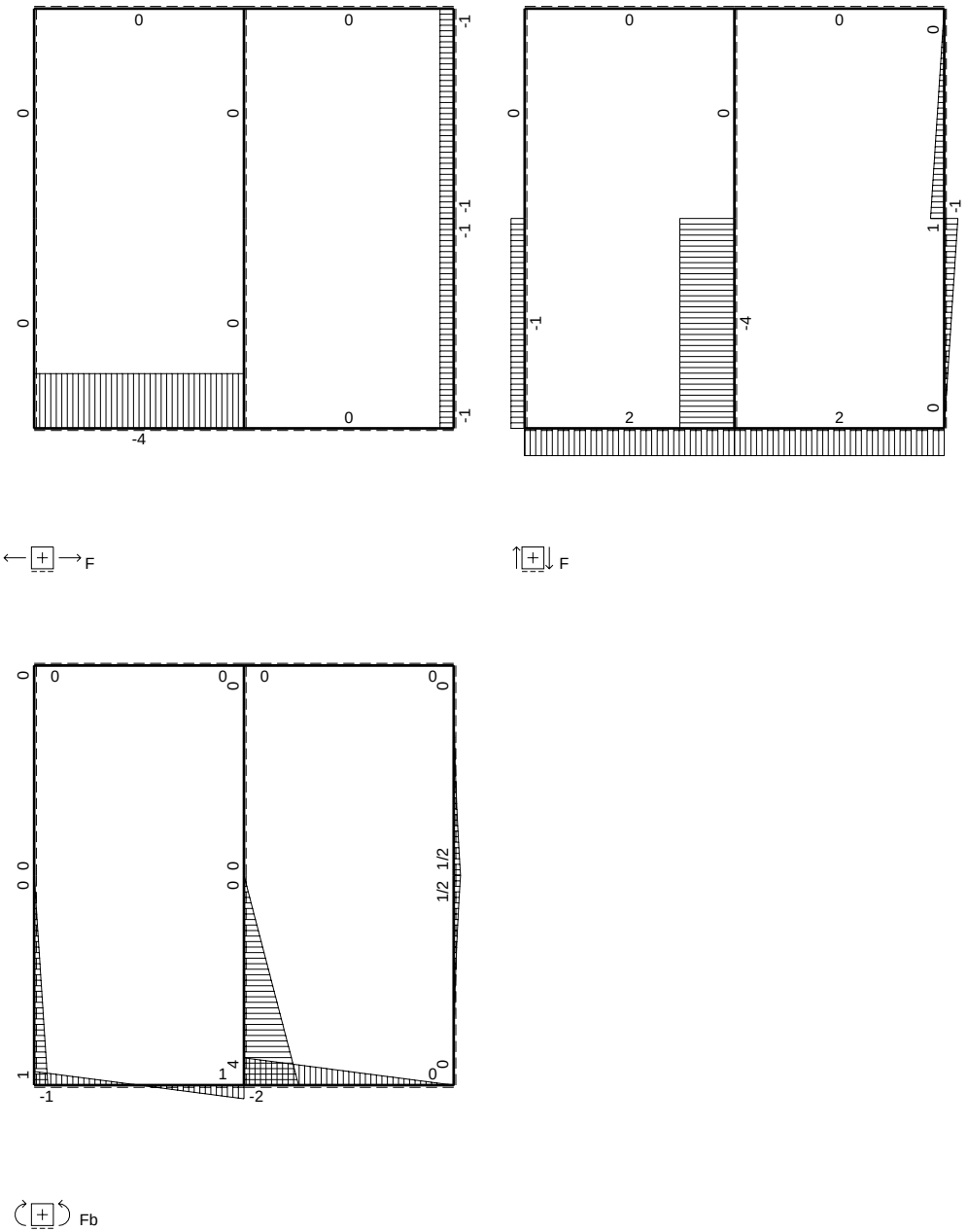
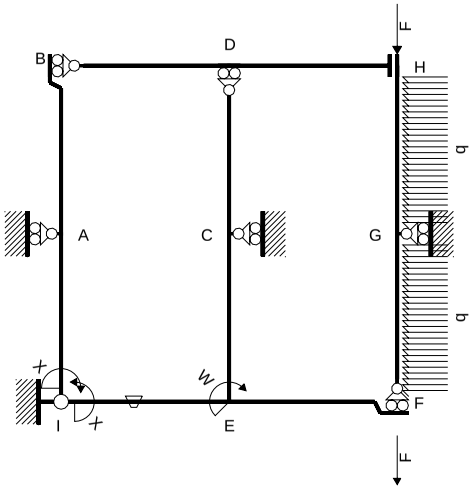
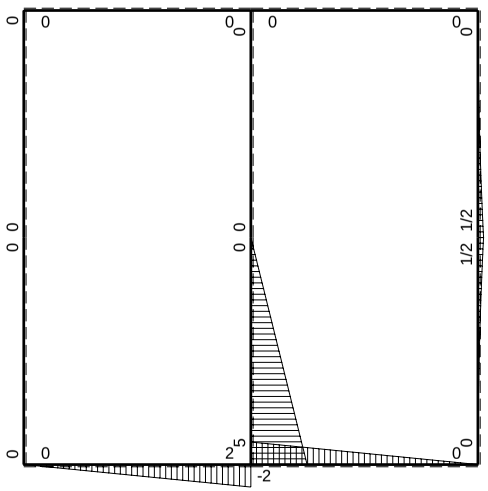
4F
Fb
2F
4F
Fb
2F


F
F
Fb



Schema di calcolo iperstatico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0
0

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2qx^2$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-5Fx	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-5Fx	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	1/3Xb/EJ
AI b	-x/b	0	0	0	0	x^2/b^2		
	totali						$-5/3Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						Fb	

Sviluppi di calcolo iperstatica

PROCEDIMENTO E RISULTATI 211288 CI07.xxxx.118
@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L_{EI}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

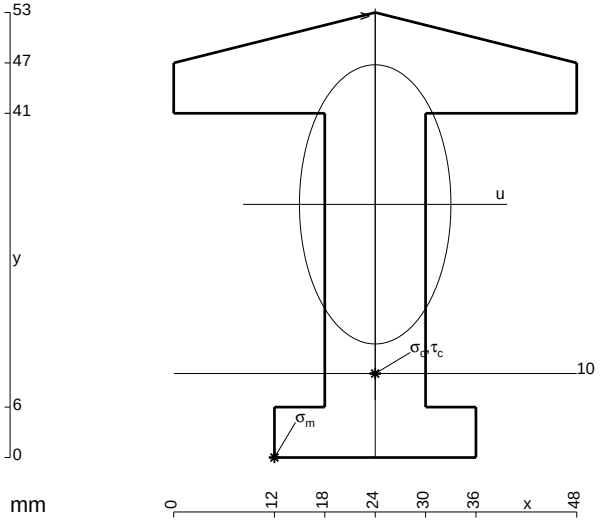
$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L_{EC}^{Xo} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

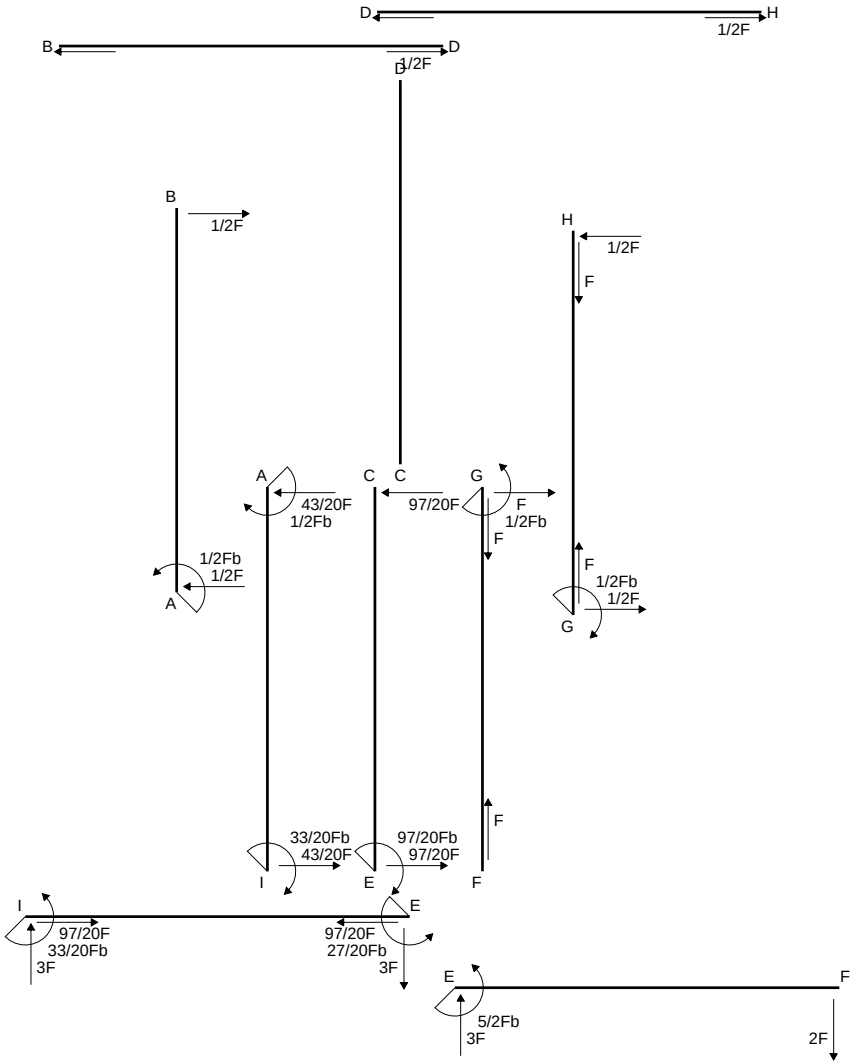
$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$



A = 996. mm^2
J_u = 275589. mm^4
J_v = 81072. mm^4
y_g = 30.15 mm
T_y = 2200. N
M_x = -2090000. Nmm
x_m = 12. mm
u_m = -12. mm
v_m = -30.15 mm
$\sigma_m = -Mv/J_u$ = -228.7 N/mm^2
x_c = 24. mm
y_c = 10. mm
v_c = -20.15 mm
$\sigma_c = -Mv/J_u$ = -152.8 N/mm^2
τ_c = 3.308 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 152.9 N/mm^2
S^* = 4973. mm^3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H
1/2F
B
D
1/2F
D
B
1/2F
H
1/2F
F
A
C
C
G
43/20F
1/2Fb
97/20F
F
1/2Fb
F
1/2Fb
1/2F
A
F
1/2Fb
1/2F
G
F
33/20Fb
43/20F
97/20Fb
97/20F
I
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F
I
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97/20F
33/20Fb
3F
97/20F
27/20Fb
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F
5/2Fb
3F
2F

1/2
1/2
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-1
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0
-97/20
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-43/20
-97/20
3
3
2
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0
0
0
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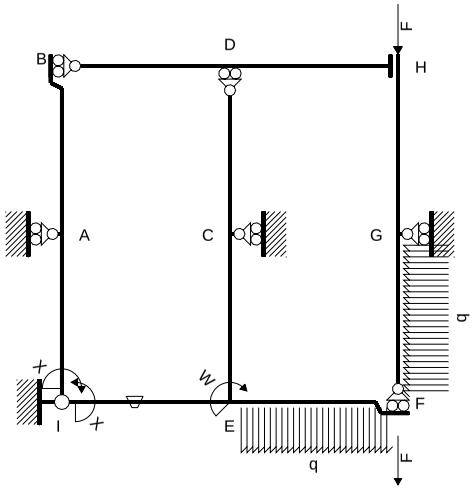
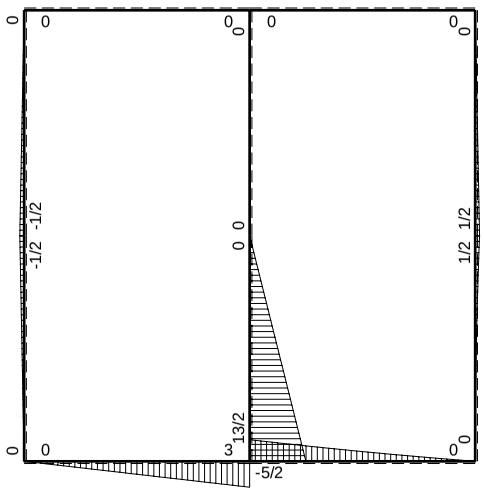
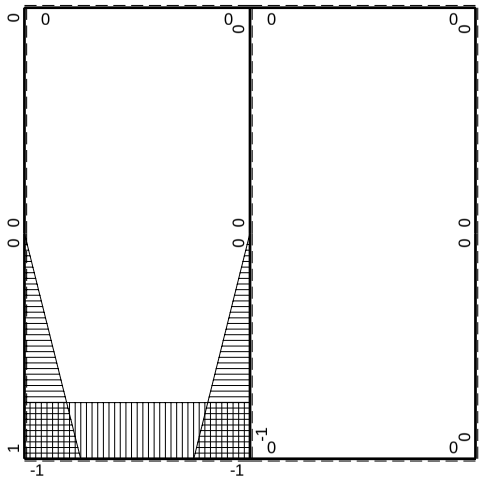
-1/2 -1/2
1/2 1/2
33/20
97/20
27/20
-33/20
-5/2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 215523 CI07.xxxx.119

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-5/2Fb+3Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$2Fx+1/2qx^2$	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	13/2Fb-13/2Fx	0	$-13/2Fb+13Fx-13/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-13/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-13/2Fx	0	$-13/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-11/4Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						33/20Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-13/2 + 13\ x/b - 13/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-13/2\ x + 13/2\ x^2/b - 13/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-13/2\ b + 13/2\ b - 13/6\ b\ )\ Fb\ 1/EJ\ = -13/6\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-13/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-13/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

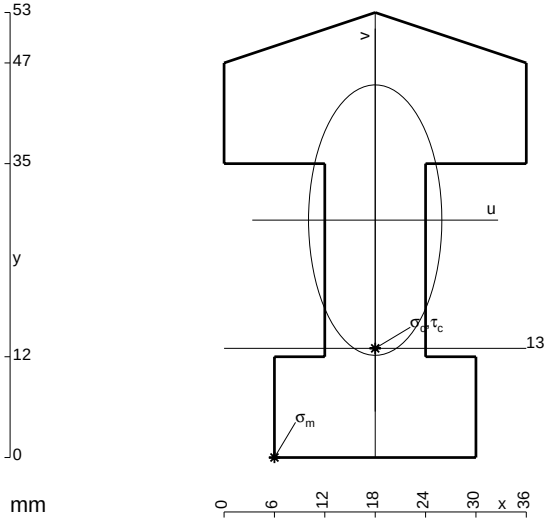
$= (-13/6\ b\ )\ Fb\ 1/EJ\ = -13/6\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$



$A = 1104.\ mm^2$

$J_u = 286555.\ mm^4$

$J_v = 69624.\ mm^4$

$y_g = 28.28\ mm$

$T_y = 2910.\ N$

$M_x = -2425000.\ Nmm$

$x_m = 6.\ mm$

$u_m = -12.\ mm$

$v_m = -28.28\ mm$

$\sigma_m = -Mv/J_u = -239.3\ N/mm^2$

$x_c = 18.\ mm$

$y_c = 13.\ mm$

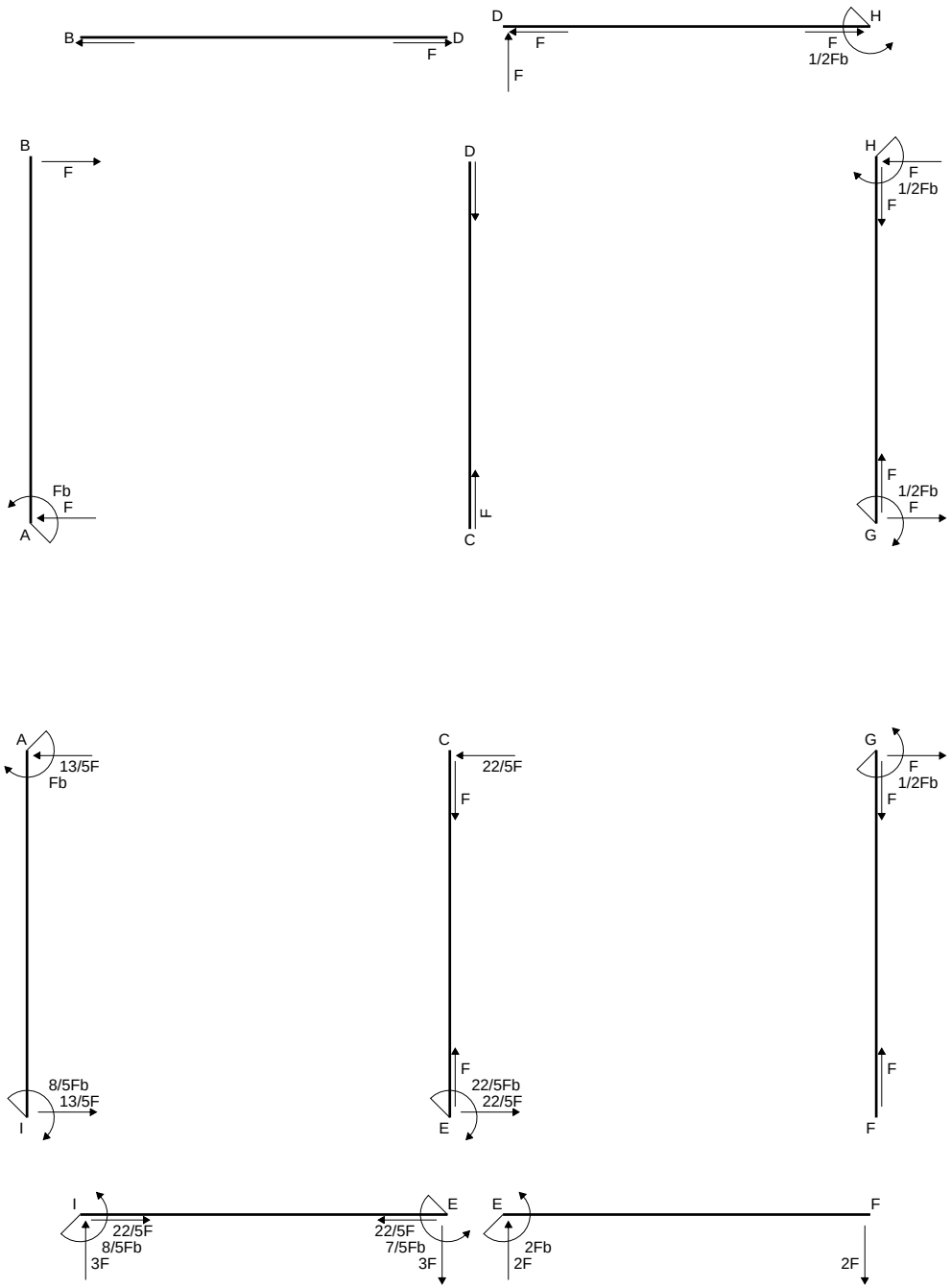
$v_c = -15.28\ mm$

$\sigma_c = -Mv/J_u = -129.3\ N/mm^2$

$\tau_c = 5.59\ N/mm^2$

$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 129.6\ N/mm^2$

$S^* = 6605.\ mm^3$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G
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I
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22/5Fb
22/5F
E
F
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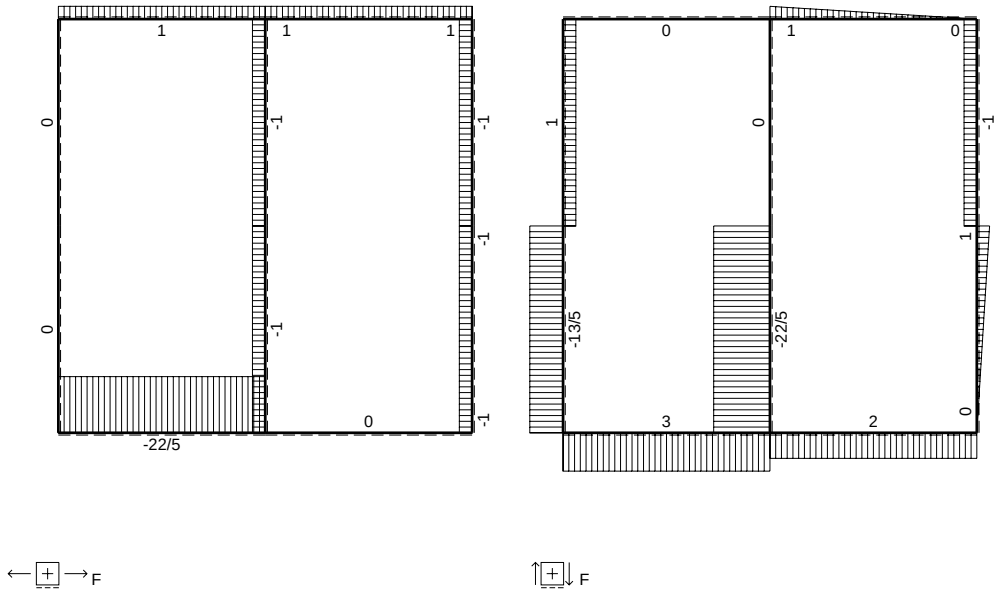
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1
-1
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-13/5
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3
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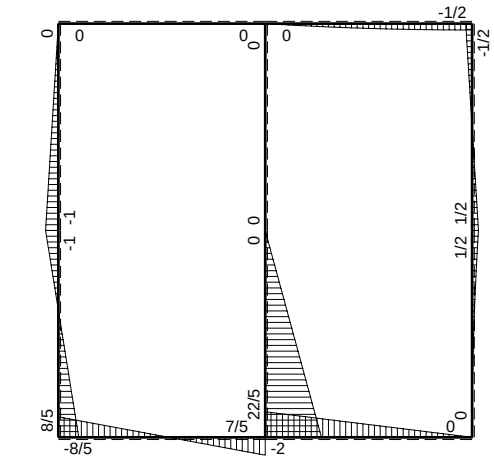
F F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7/5
22/5
0
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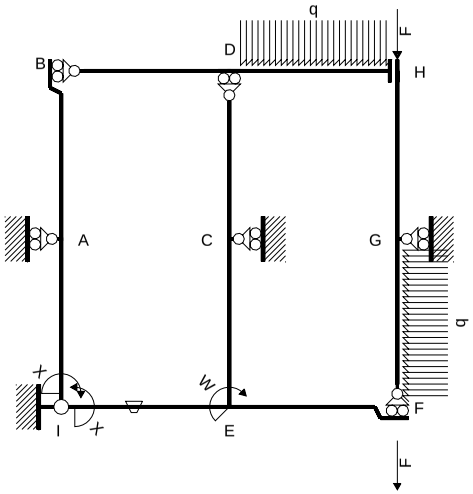
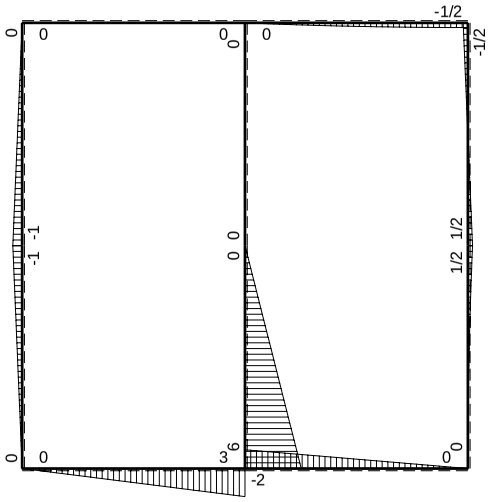
-8/5
-2

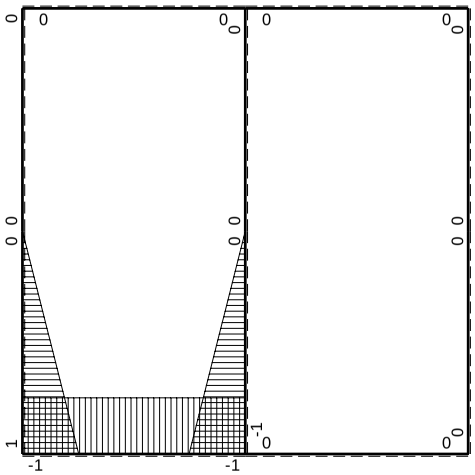
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 960423 CI07.xxxx.120

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb-Fx	0	0	0	0	0+0	0
HG b	0	1/2Fb-Fx	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	6Fb-6Fx	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-6Fx$	0	$-6Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-Fx	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	Fb-Fx	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-8/3Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						8/5Fb	

Sviluppi di calcolo iperstatica

PROCEDIMENTO E RISULTATI 960423 CI07.xxxx.120
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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-6 + 12\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-6\ x + 6\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-6\ b + 6\ b - 2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

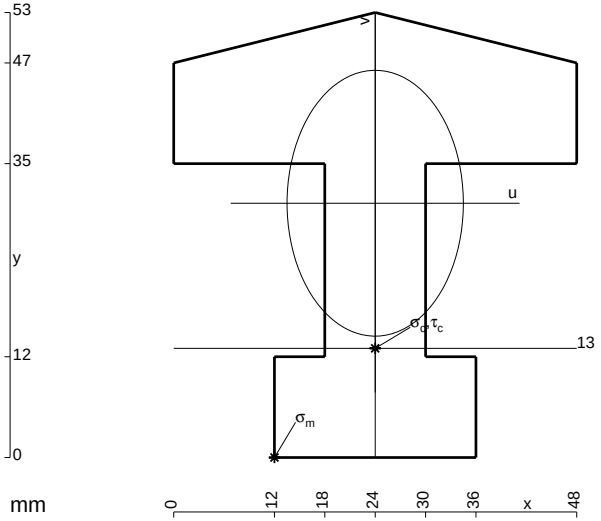
$= (-2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

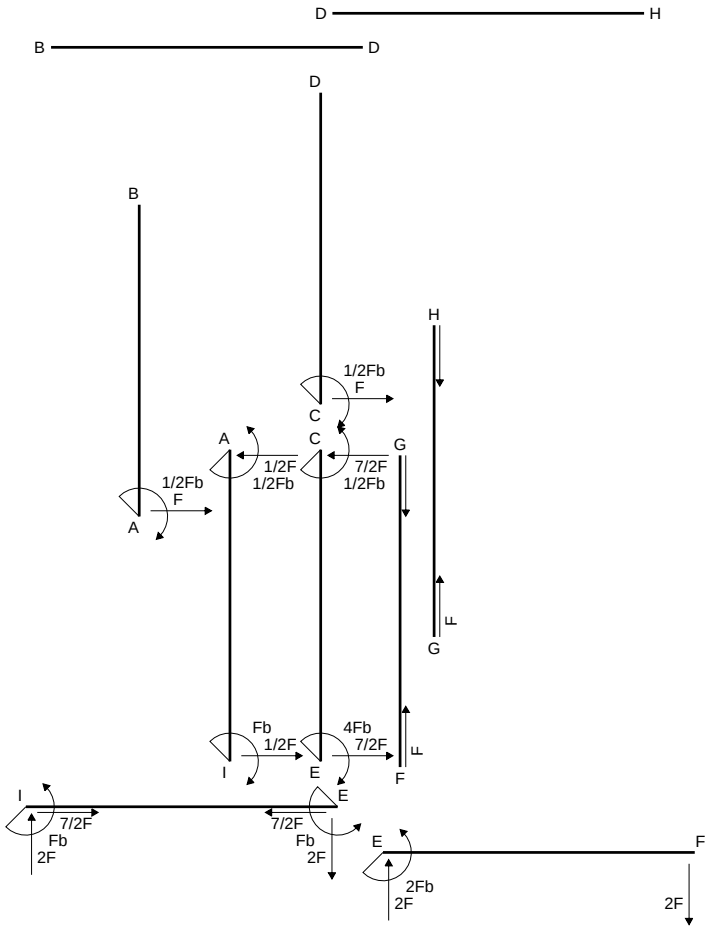
$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$



A = 1284. mm^2
J_u = 321948. mm^4
J_v = 141552. mm^4
y_g = 30.28 mm
T_y = 4000. N
M_x = -2120000. Nmm
x_m = 12. mm
u_m = -12. mm
v_m = -30.28 mm
$\sigma_m = -Mv/J_u$ = -199.4 N/mm^2
x_c = 24. mm
y_c = 13. mm
v_c = -17.28 mm
$\sigma_c = -Mv/J_u$ = -113.8 N/mm^2
τ_c = 7.462 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 114.6 N/mm^2
S^* = 7208. mm^3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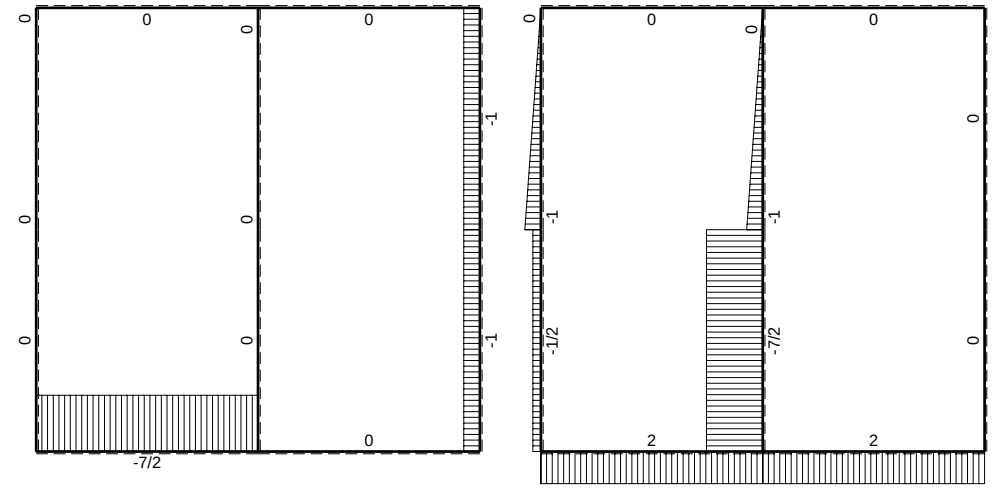
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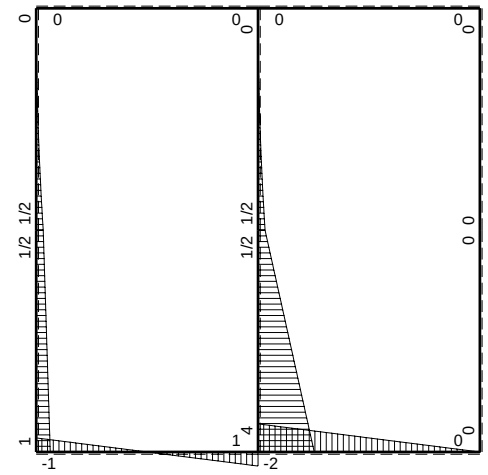
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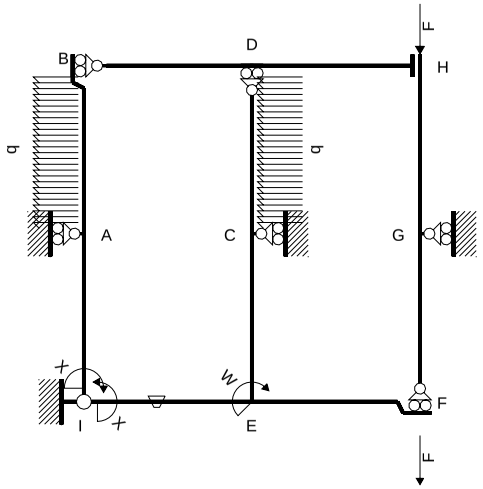
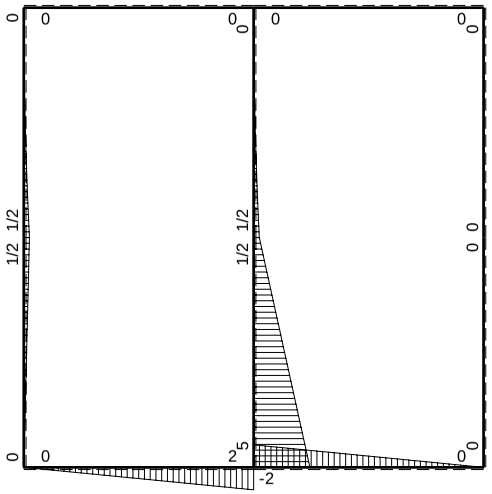
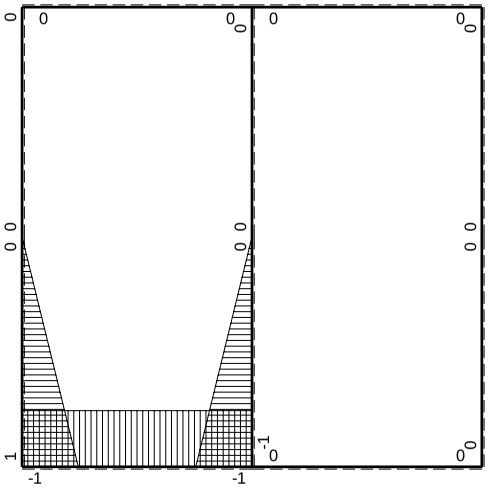
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 991137 CI07.xxxx.121

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PROCEDIMENTO E RISULTATI 991137 CI07.xxxx.121

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$-1/2qx^2$	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	0	0	0	0	0	0+0	0
HG b	0	0	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-9/2Fx$	0	$-5Fb+19/2Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-7/4+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-1/2Fb-9/2Fx$	0	$-1/2Fx-9/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$1/2Fx$	0	$1/2Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-1/2Fb+1/2Fx$	0	$1/2Fx-1/2Fx^2/b$	0	x^2/b^2		
	totali						$-5/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L_{EI}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L_{EC}^{Xo} = \int_o^b (-5 + 19/2\ x/b - 9/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 19/4\ x^2/b - 3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 19/4\ b - 3/2\ b\ )\ Fb\ 1/EJ\ = -7/4\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-1/2\ x/b - 9/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b - 3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

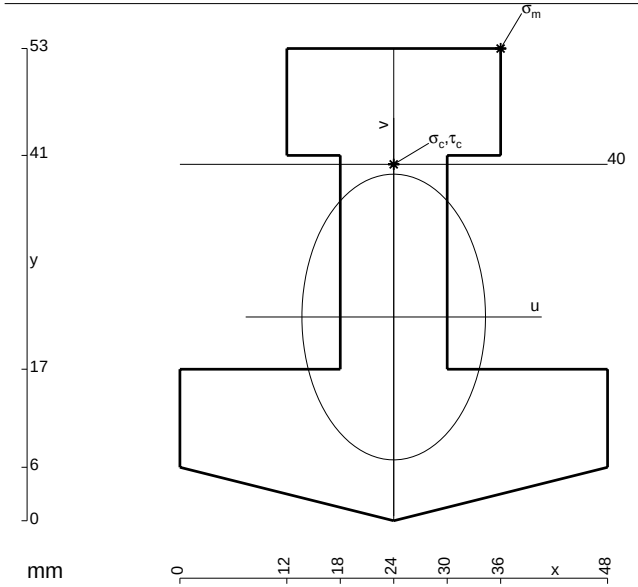
$= (-1/4\ b - 3/2\ b\ )\ Fb\ 1/EJ\ = -7/4\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1/2\ x/b - 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/4\ x^2/b - 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

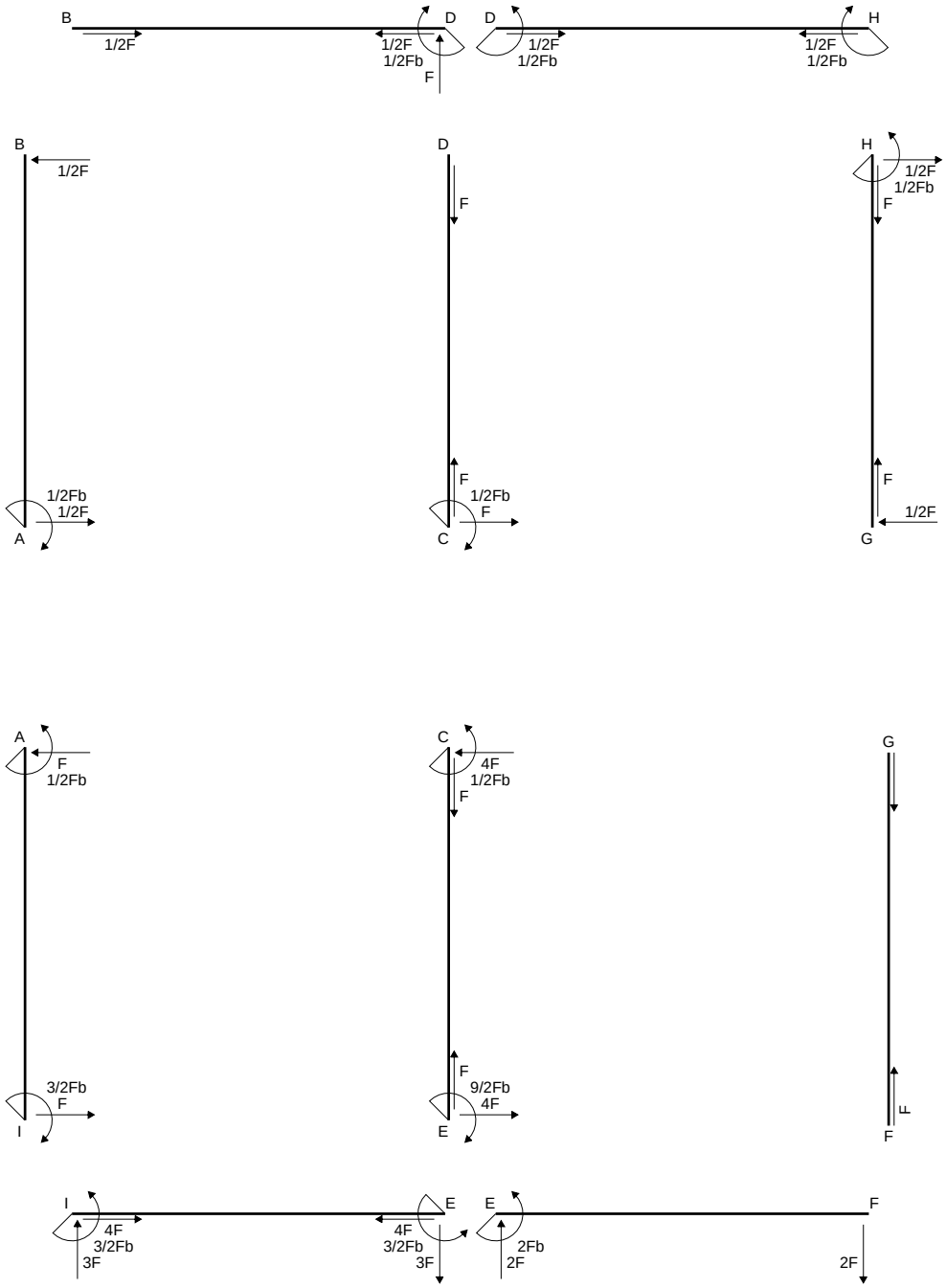
$= (1/4\ b - 1/6\ b\ )\ Fb\ 1/EJ\ = 1/12\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (1/2\ x/b - 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/4\ x^2/b - 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/4\ b - 1/6\ b\ )\ Fb\ 1/EJ\ = 1/12\ Fb^2/EJ$



A = 1248. mm^2
J_u = 320937. mm^4
J_v = 132480. mm^4
y_g = 22.87 mm
T_y = 3840. N
M_x = -2227200. Nmm
x_m = 36. mm
y_m = 53. mm
u_m = 12. mm
v_m = 30.13 mm
$\sigma_m = -Mv/J_u$ = 209.1 N/mm^2
x_c = 24. mm
y_c = 40. mm
v_c = 17.13 mm
$\sigma_c = -Mv/J_u$ = 118.9 N/mm^2
τ_c = 7.141 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 119.6 N/mm^2
S^* = 7162. mm^3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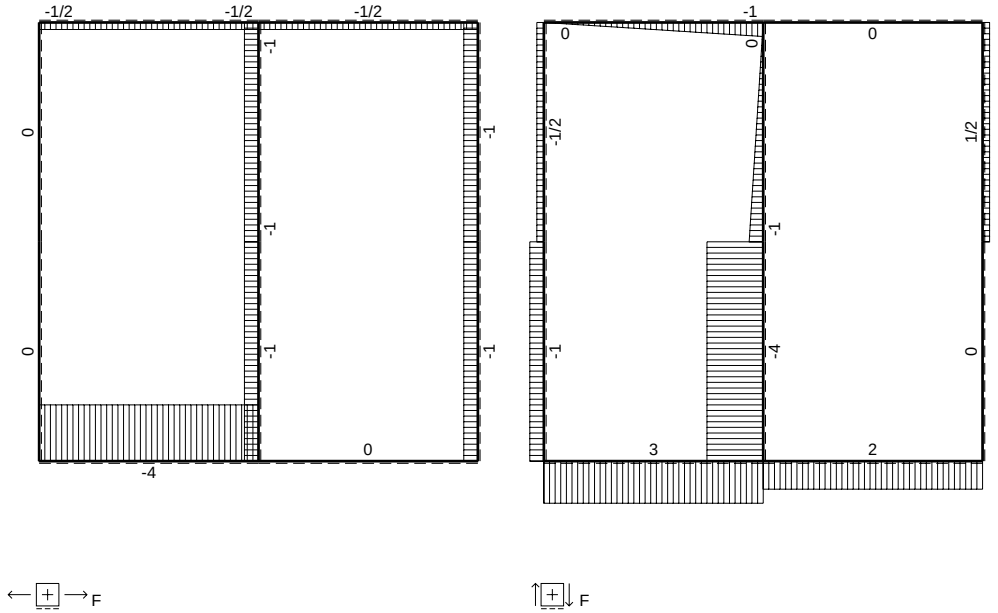
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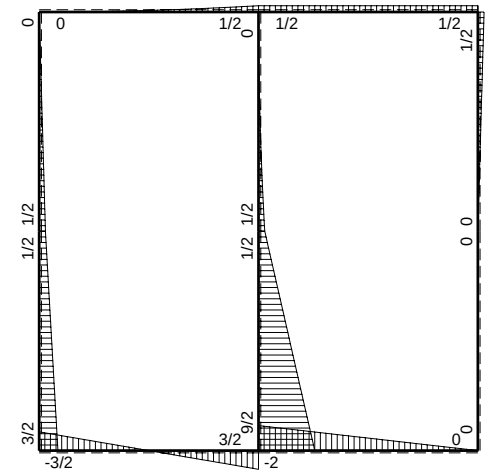
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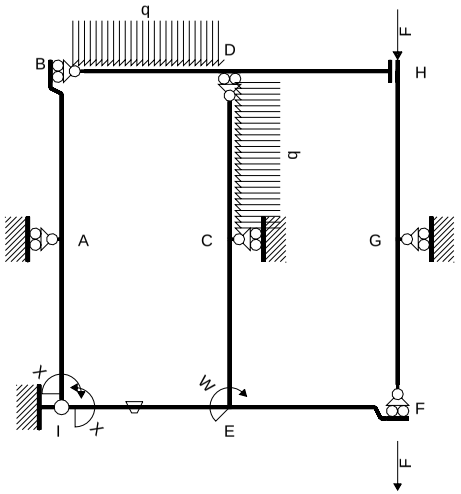
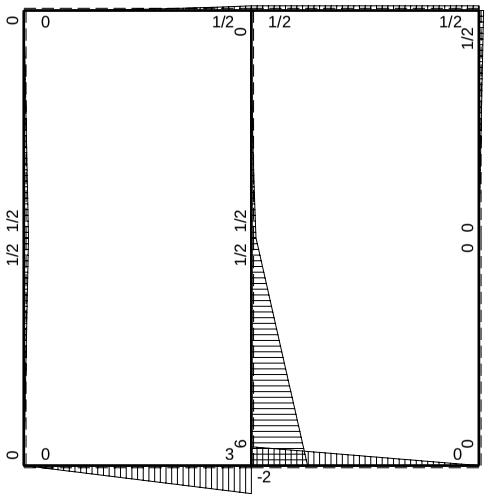
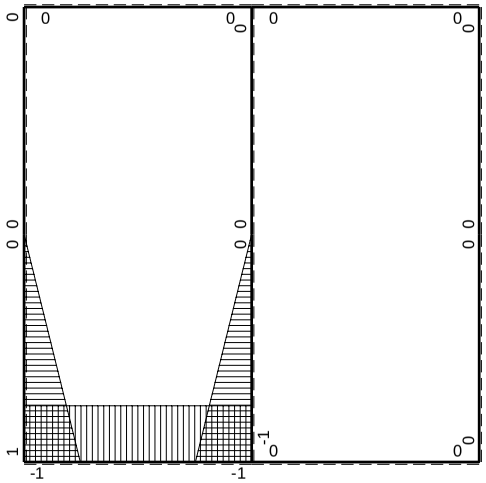


Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 215668 CI07.xxxx.122

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PROCEDIMENTO E RISULTATI 215668 CI07.xxxx.122

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
BA b	0	-1/2Fx	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fb+1/2Fx	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	6Fb-11/2Fx	0	$-6Fb+23/2Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-25/12+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-1/2Fb-11/2Fx$	0	$-1/2Fx-11/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	1/2Fx	0	$1/2Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	-1/2Fb+1/2Fx	0	$1/2Fx-1/2Fx^2/b$	0	x^2/b^2		
	totali						$-5/2Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						3/2Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-6 + 23/2\ x/b - 11/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-6\ x + 23/4\ x^2/b - 11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-6\ b + 23/4\ b - 11/6\ b\ )\ Fb\ 1/EJ\ = -25/12\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-1/2\ x/b - 11/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b - 11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b - 11/6\ b\ )\ Fb\ 1/EJ\ = -25/12\ Fb^2/EJ$

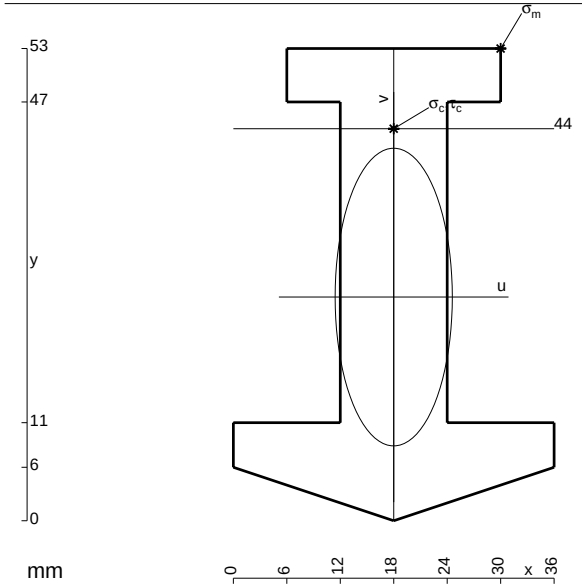
$L_{IA}^{Xo} = \int_o^b (1/2\ x/b - 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/4\ x^2/b - 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/4\ b - 1/6\ b\ )\ Fb\ 1/EJ\ = 1/12\ Fb^2/EJ$

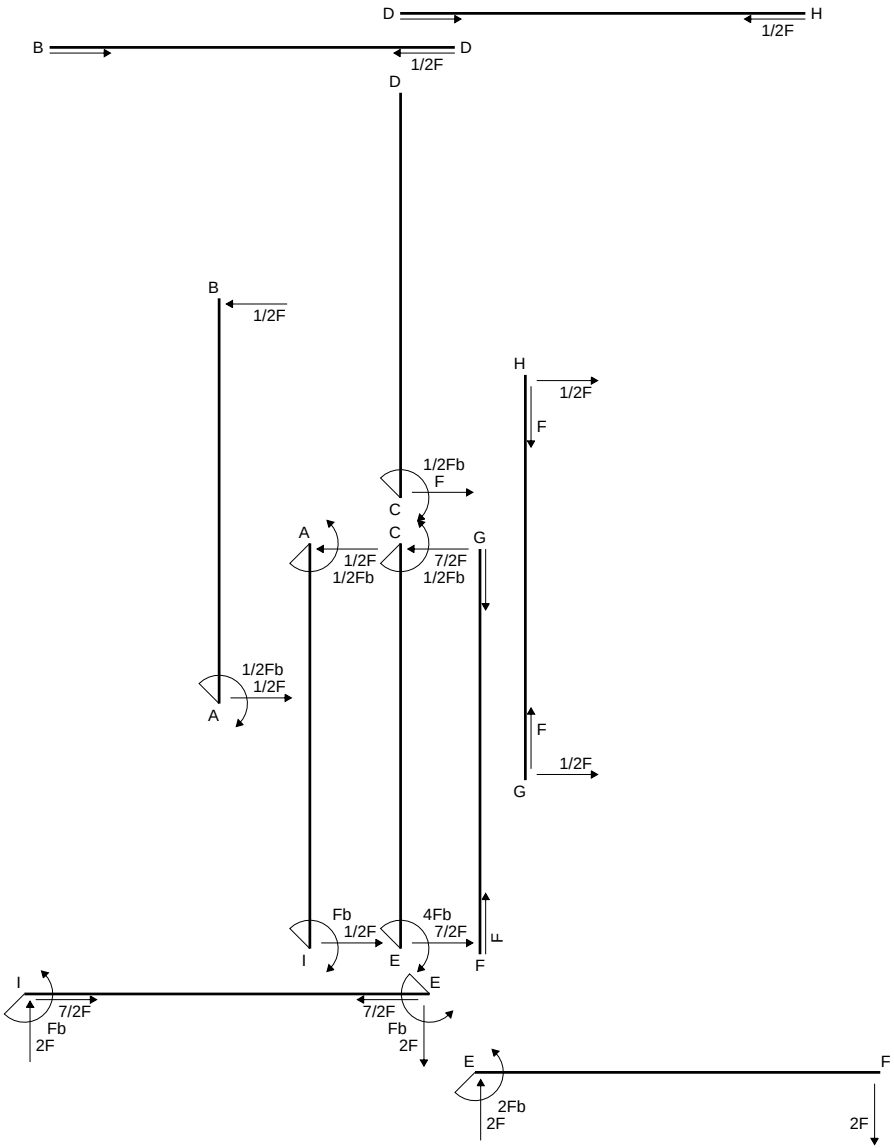
$L_{AI}^{Xo} = \int_o^b (1/2\ x/b - 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/4\ x^2/b - 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/4\ b - 1/6\ b\ )\ Fb\ 1/EJ\ = 1/12\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 215668 CI07.xxxx.122



A = 864. mm^2
J_u = 241215. mm^4
J_v = 37368. mm^4
y_g = 25.1 mm
T_y = 3000. N
M_x = -1890000. Nmm
x_m = 30. mm
y_m = 53. mm
u_m = 12. mm
v_m = 27.9 mm
$\sigma_m = -Mv/J_u$ = 218.6 N/mm^2
x_c = 18. mm
y_c = 44. mm
v_c = 18.9 mm
$\sigma_c = -Mv/J_u$ = 148.1 N/mm^2
τ_c = 4.477 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 148.3 N/mm^2
S^* = 4319. mm^3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H
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F
1/2Fb
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2F
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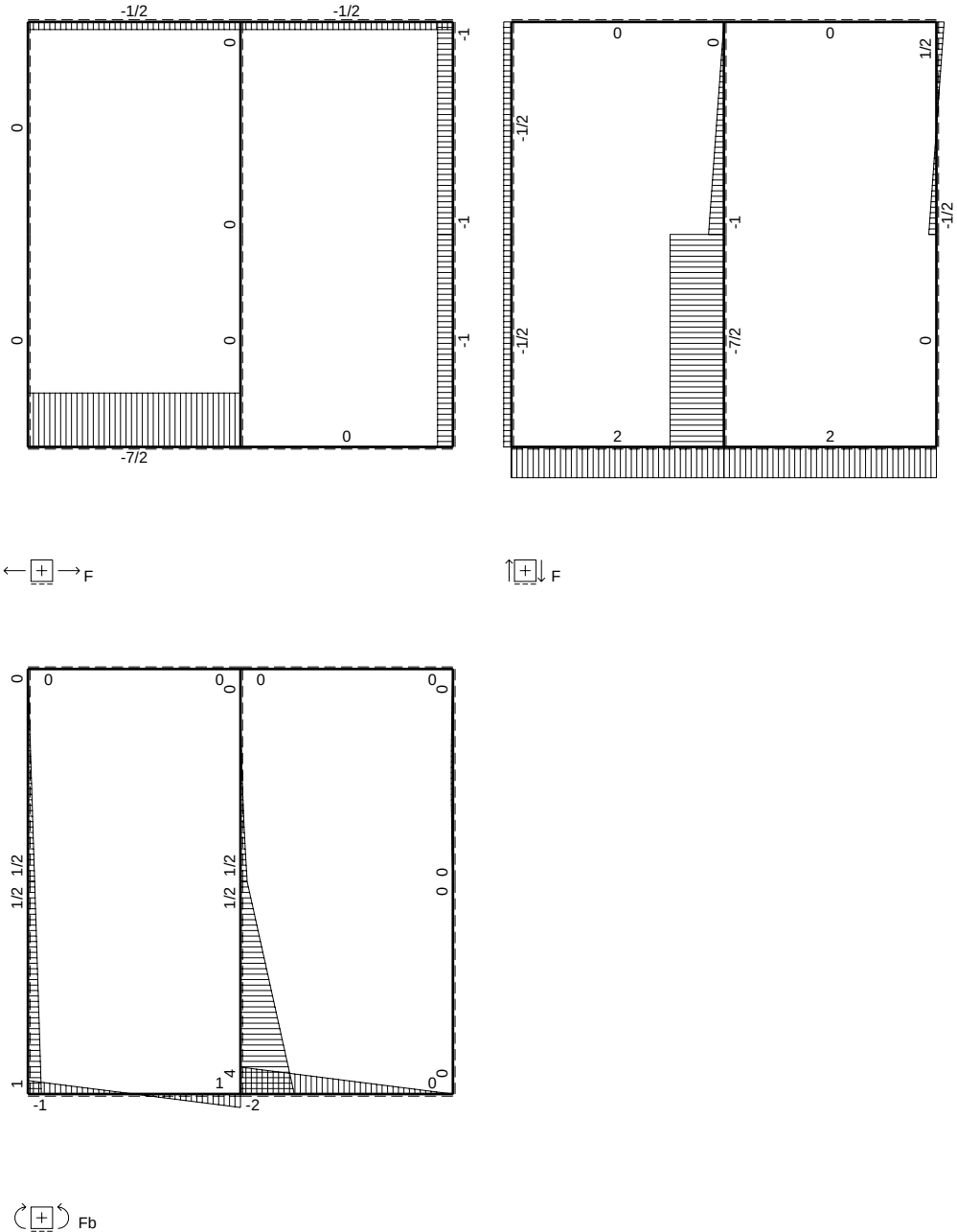
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2
2
F
F
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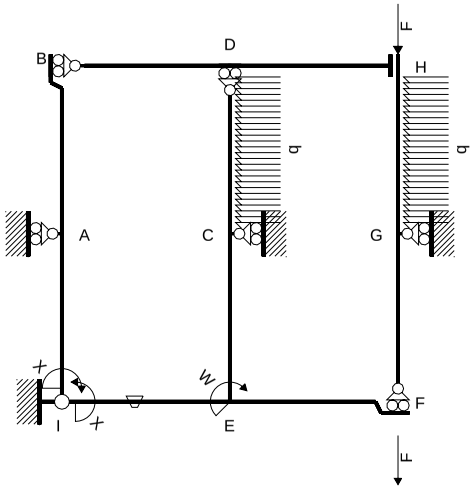
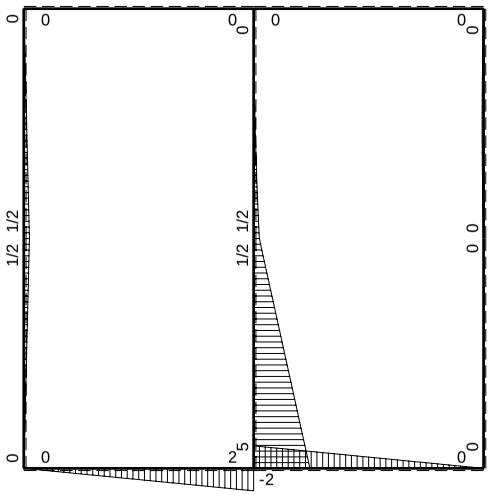
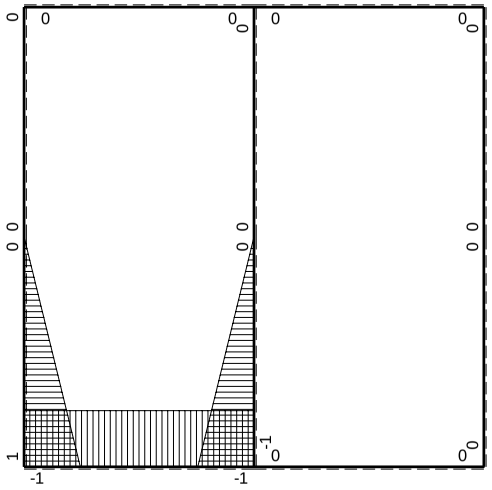
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 213147 CI07.xxxx.123

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PROCEDIMENTO E RISULTATI 213147 CI07.xxxx.123

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
BA b	0	-1/2Fx	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-9/2Fx	0	$-5Fb+19/2Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-7/4+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-1/2Fb-9/2Fx$	0	$-1/2Fx-9/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	1/2Fx	0	$1/2Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	$-1/2Fb+1/2Fx$	0	$1/2Fx-1/2Fx^2/b$	0	x^2/b^2		
	totali						$-5/3Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L_{EI}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L_{EC}^{Xo} = \int_o^b (-5 + 19/2\ x/b - 9/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 19/4\ x^2/b - 3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 19/4\ b - 3/2\ b\ )\ Fb\ 1/EJ\ = -7/4\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-1/2\ x/b - 9/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b - 3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

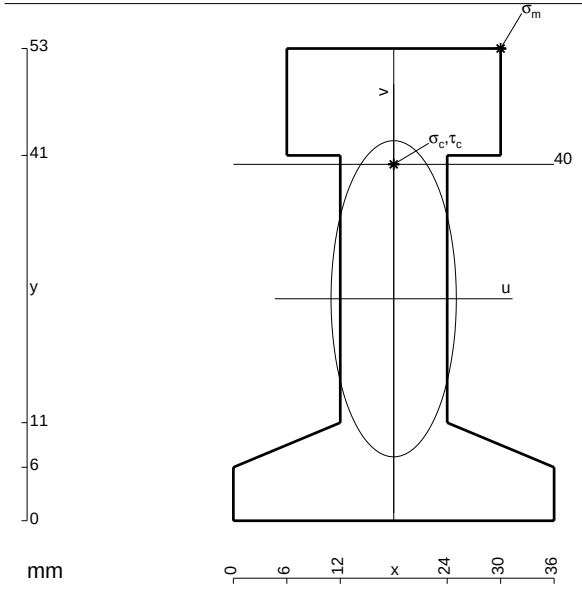
$= (-1/4\ b - 3/2\ b\ )\ Fb\ 1/EJ\ = -7/4\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1/2\ x/b - 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/4\ x^2/b - 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

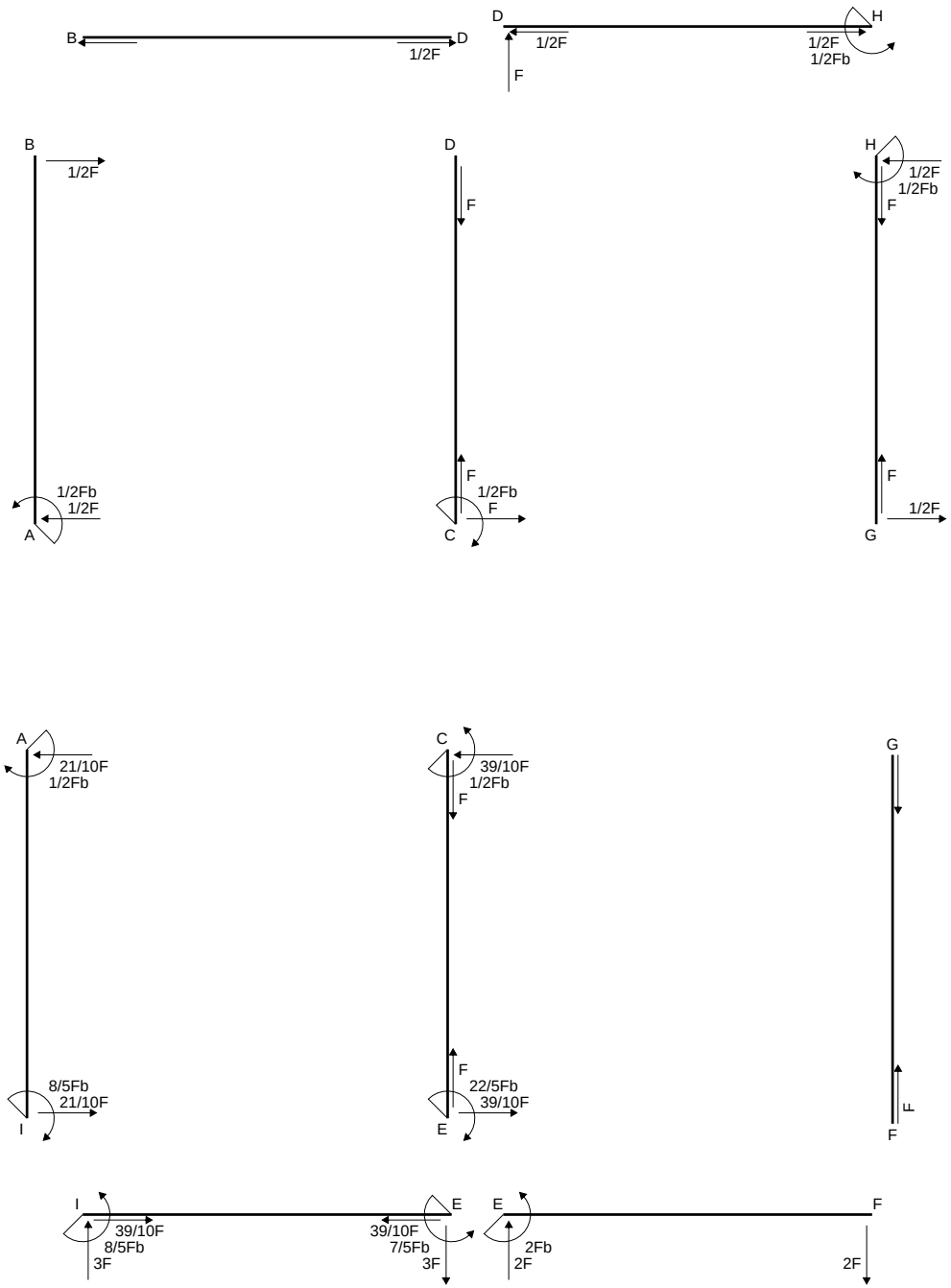
$= (1/4\ b - 1/6\ b\ )\ Fb\ 1/EJ\ = 1/12\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (1/2\ x/b - 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/4\ x^2/b - 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/4\ b - 1/6\ b\ )\ Fb\ 1/EJ\ = 1/12\ Fb^2/EJ$



A = 984. mm^2
J_u = 309963. mm^4
J_v = 48672. mm^4
y_g = 24.91 mm
T_y = 3720. N
M_x = -2529600. Nmm
x_m = 30. mm
y_m = 53. mm
u_m = 12. mm
v_m = 28.09 mm
$\sigma_m = -Mv/J_u$ = 229.2 N/mm^2
x_c = 18. mm
y_c = 40. mm
v_c = 15.09 mm
$\sigma_c = -Mv/J_u$ = 123.1 N/mm^2
τ_c = 6.549 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 123.6 N/mm^2
S^* = 6548. mm^3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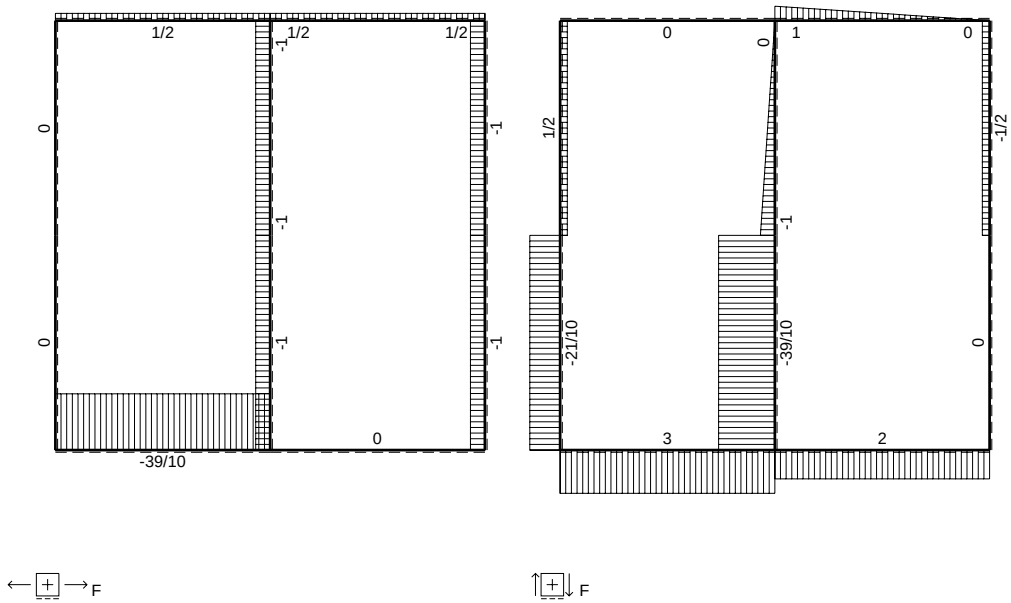
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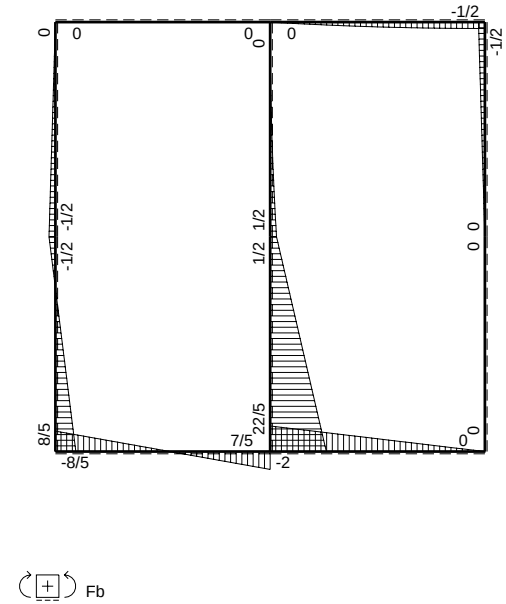
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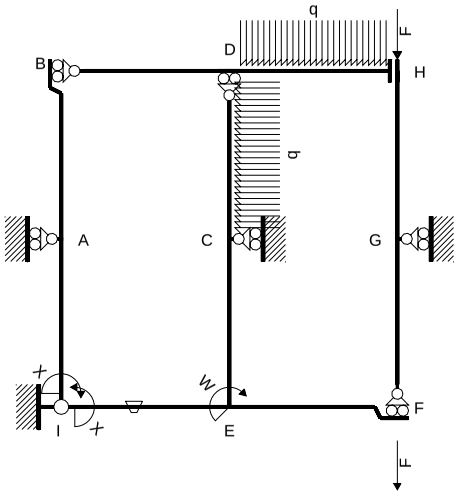
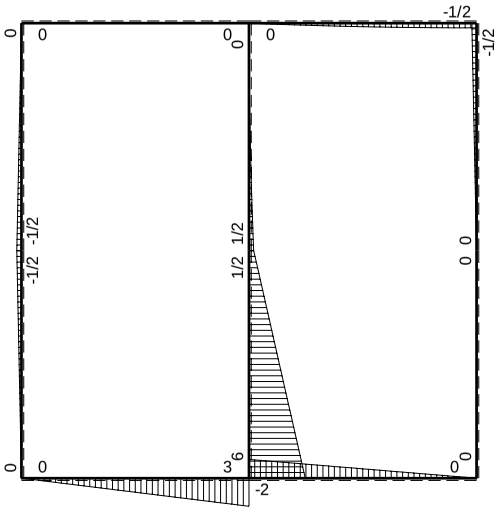
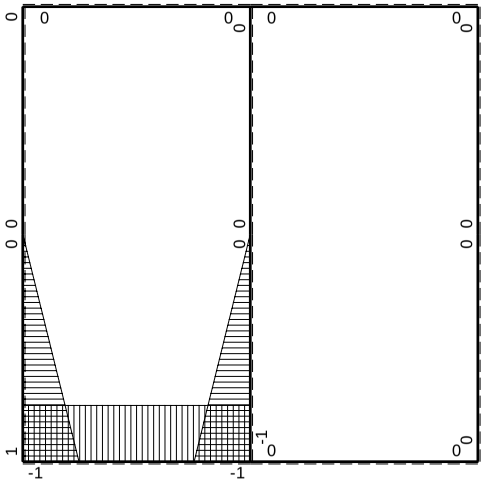
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 957847 CI07.xxxx.124

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PROCEDIMENTO E RISULTATI 957847 CI07.xxxx.124

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	-1/2Fx	0	0	0	0	0+0	0
HG b	0	1/2Fb-1/2Fx	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	6Fb-11/2Fx	0	$-6Fb+23/2Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-25/12+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-1/2Fb-11/2Fx$	0	$-1/2Fx-11/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-8/3Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						8/5Fb	

Sviluppi di calcolo iperstatica

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$L^{XX}_{IE} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EI} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EC} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{CE} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{IA} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{AI} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{Xo}_{IE} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L^{Xo}_{EI} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L^{Xo}_{EC} = \int_o^b (-6 + 23/2\ x/b - 11/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-6\ x + 23/4\ x^2/b - 11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-6\ b + 23/4\ b - 11/6\ b\ )\ Fb\ 1/EJ\ = -25/12\ Fb^2/EJ$

$L^{Xo}_{CE} = \int_o^b (-1/2\ x/b - 11/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b - 11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

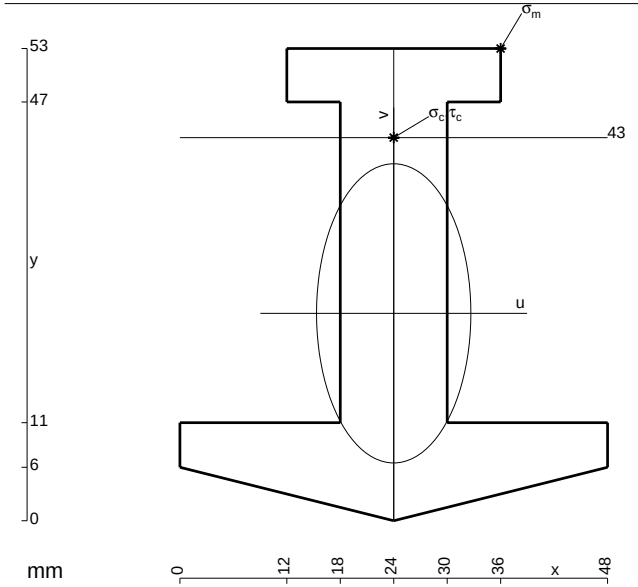
$= (-1/4\ b - 11/6\ b\ )\ Fb\ 1/EJ\ = -25/12\ Fb^2/EJ$

$L^{Xo}_{IA} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

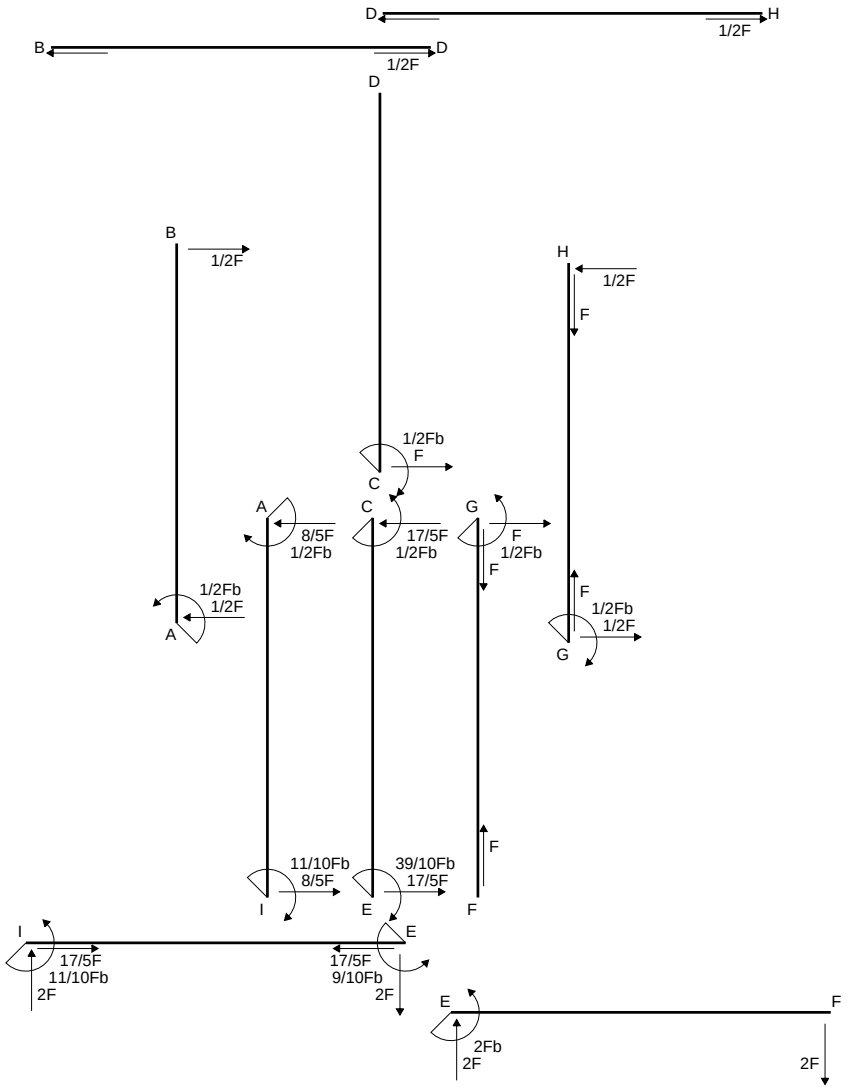
$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

$L^{Xo}_{AI} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$



A = 960. mm^2
J_u = 270775. mm^4
J_v = 72000. mm^4
y_g = 23.27 mm
T_y = 2940. N
M_x = -2175600. Nmm
x_m = 36. mm
y_m = 53. mm
u_m = 12. mm
v_m = 29.73 mm
$\sigma_m = -Mv/J_u$ = 238.8 N/mm^2
x_c = 24. mm
y_c = 43. mm
v_c = 19.73 mm
$\sigma_c = -Mv/J_u$ = 158.5 N/mm^2
τ_c = 4.426 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 158.7 N/mm^2
S^* = 4891. mm^3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G
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1/2Fb
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2F
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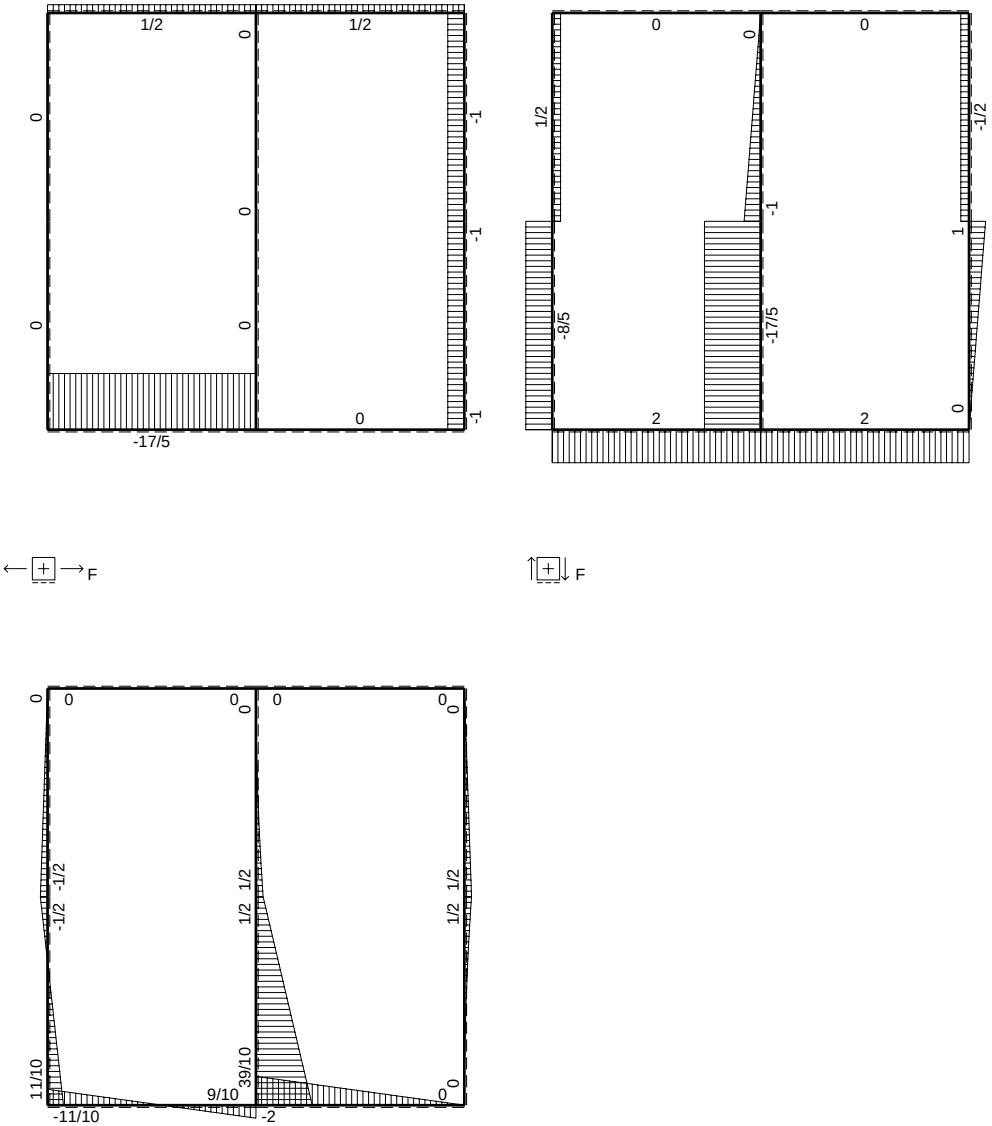
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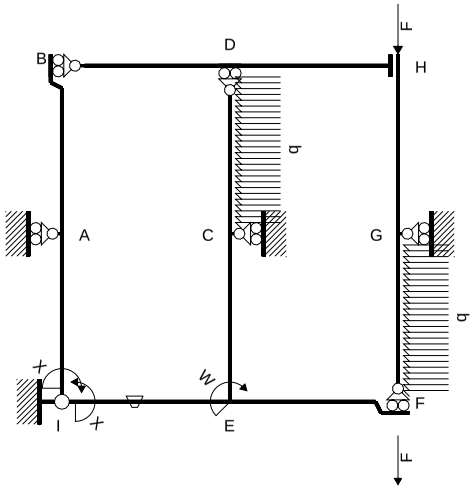
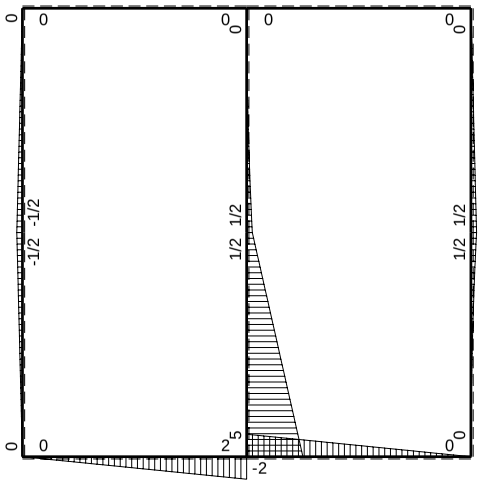
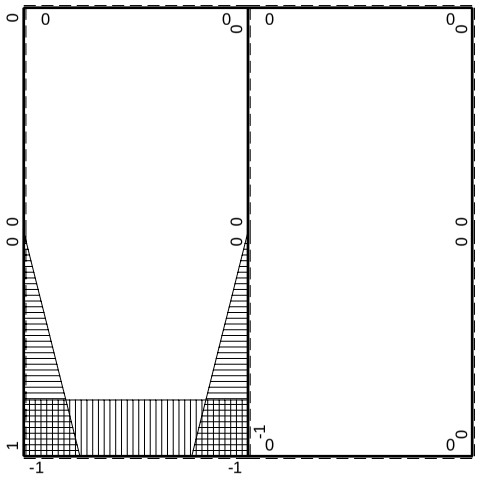
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 991058 CI07.xxxx.125

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-9/2Fx	0	$-5Fb+19/2Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-7/4+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-1/2Fb-9/2Fx$	0	$-1/2Fx-9/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-11/6Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						11/10Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L_{EI}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L_{EC}^{Xo} = \int_o^b (-5 + 19/2\ x/b - 9/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 19/4\ x^2/b - 3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 19/4\ b - 3/2\ b\ )\ Fb\ 1/EJ\ = -7/4\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-1/2\ x/b - 9/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b - 3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

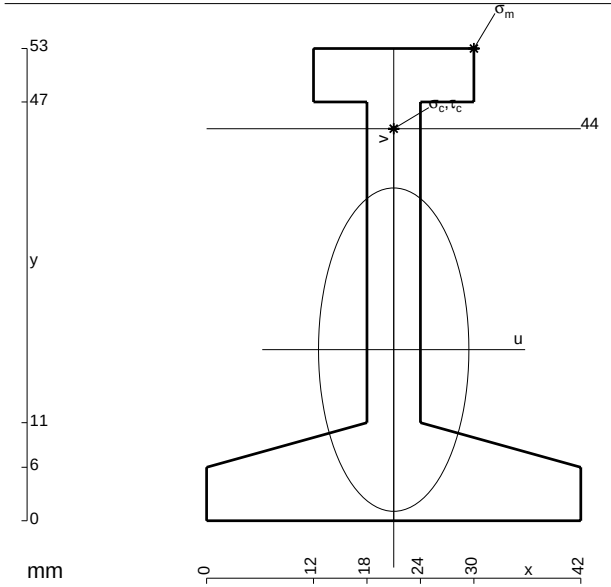
$= (-1/4\ b - 3/2\ b\ )\ Fb\ 1/EJ\ = -7/4\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

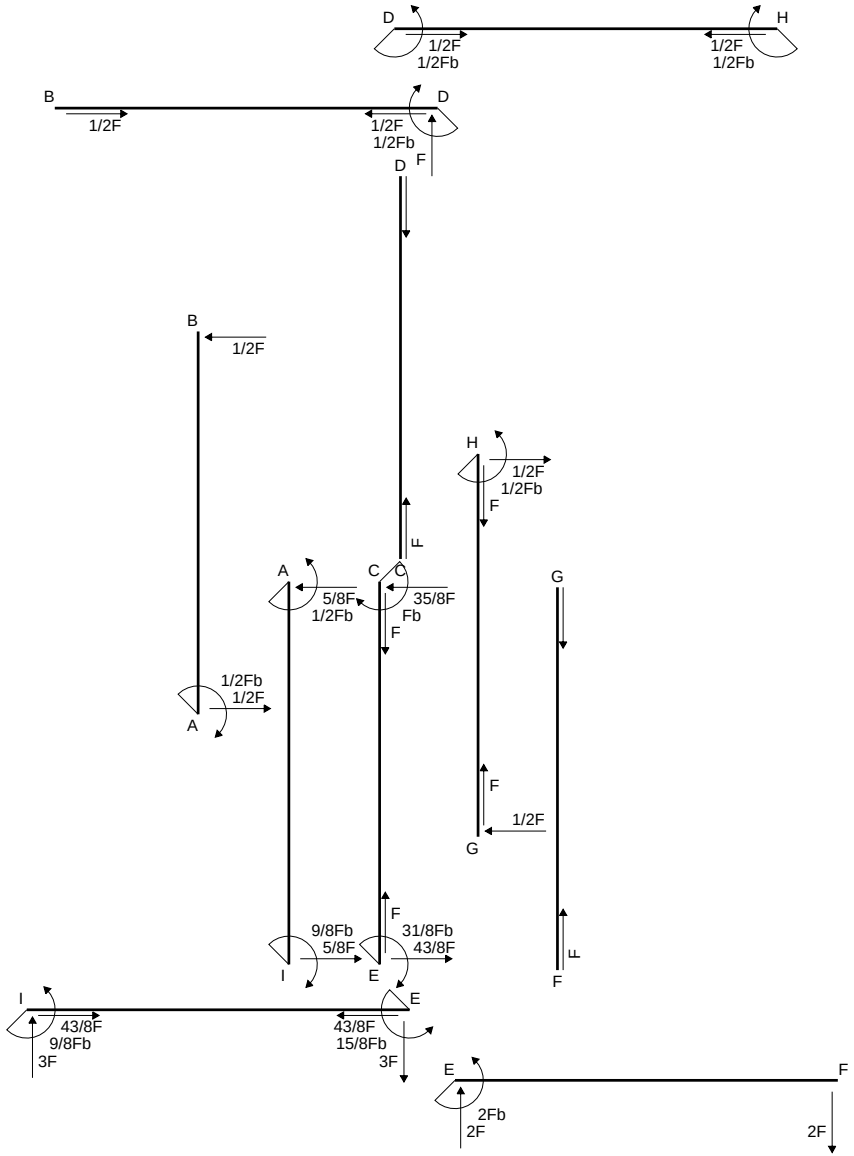
$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$



A = 696. mm^2
J_u = 229334. mm^4
J_v = 49608. mm^4
y_g = 19.2 mm
T_y = 1700. N
M_x = -1343000. Nmm
x_m = 30. mm
y_m = 53. mm
u_m = 9. mm
v_m = 33.8 mm
$\sigma_m = -Mv/J_u$ = 197.9 N/mm^2
x_c = 21. mm
y_c = 44. mm
v_c = 24.8 mm
$\sigma_c = -Mv/J_u$ = 145.2 N/mm^2
τ_c = 4.694 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 145.4 N/mm^2
S^* = 3799. mm^3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C
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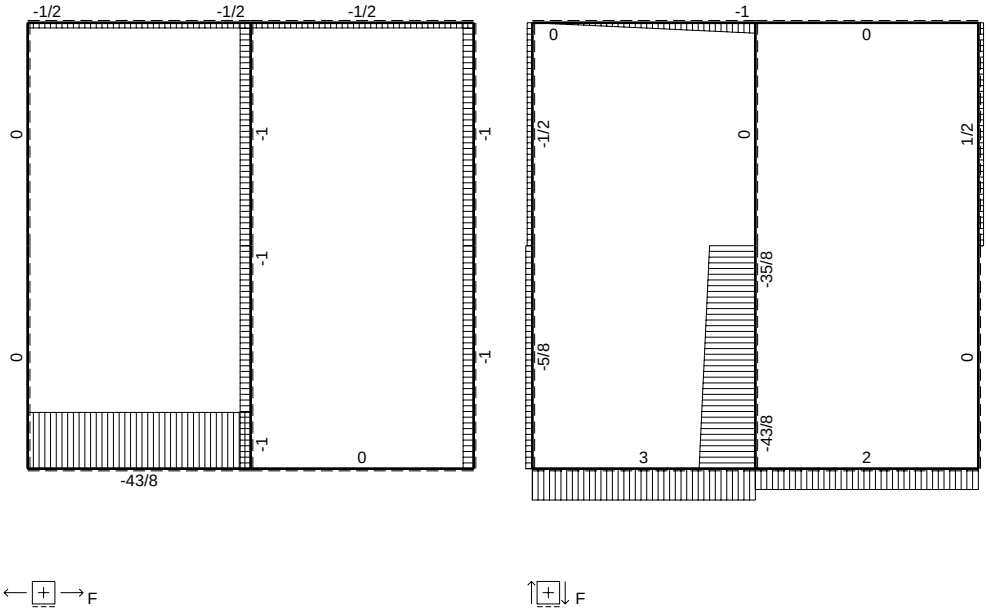
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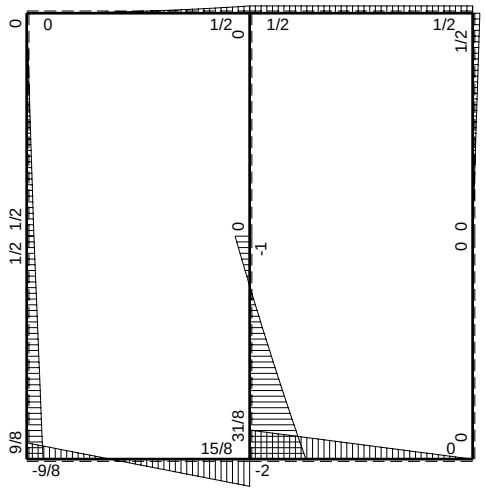
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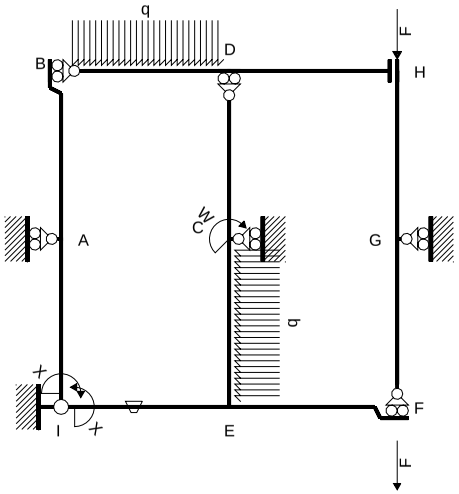
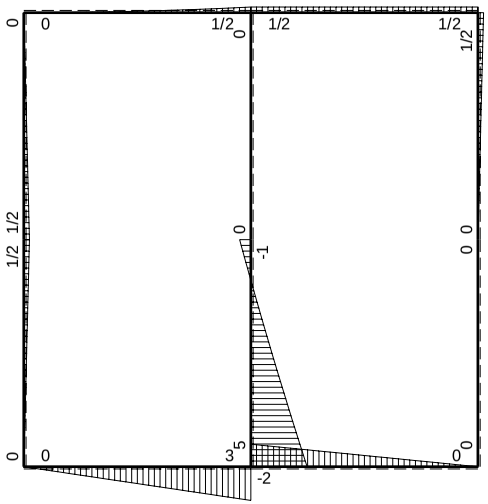
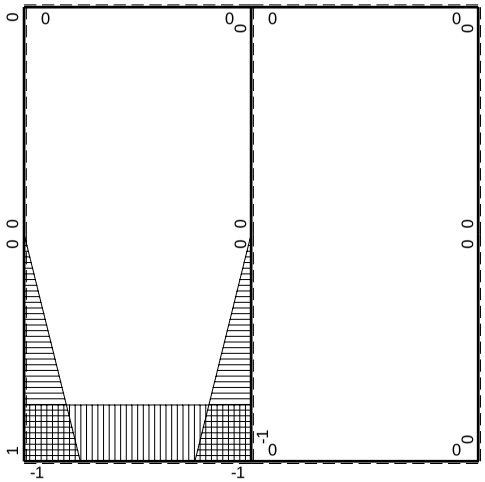
-9/8
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 214190 CI07.xxxx.126

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
BA b	0	-1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fb+1/2Fx	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	$5Fb-13/2Fx+1/2qx^2$	0	$-5Fb+23/2Fx-7Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-35/24+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$Fb-11/2Fx-1/2qx^2$	0	$Fx-11/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2		
IA b	1-x/b	1/2Fx	0	$1/2Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	-1/2Fb+1/2Fx	0	$1/2Fx-1/2Fx^2/b$	0	x^2/b^2		
	totali						$-15/8Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						9/8Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 23/2\ x/b - 7\ x^2/b^2 + 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx$

$= [-5\ x + 23/4\ x^2/b - 7/3\ x^3/b^2 + 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 23/4\ b - 7/3\ b + 1/8\ b\ )\ Fb\ 1/EJ\ = -35/24\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (\ x/b - 11/2\ x^2/b^2 - 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 11/6\ x^3/b^2 - 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

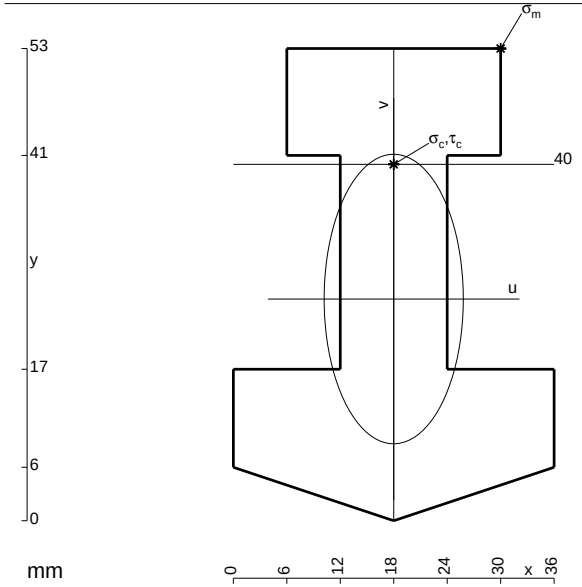
$= (1/2\ b - 11/6\ b - 1/8\ b\ )\ Fb\ 1/EJ\ = -35/24\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1/2\ x/b - 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/4\ x^2/b - 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

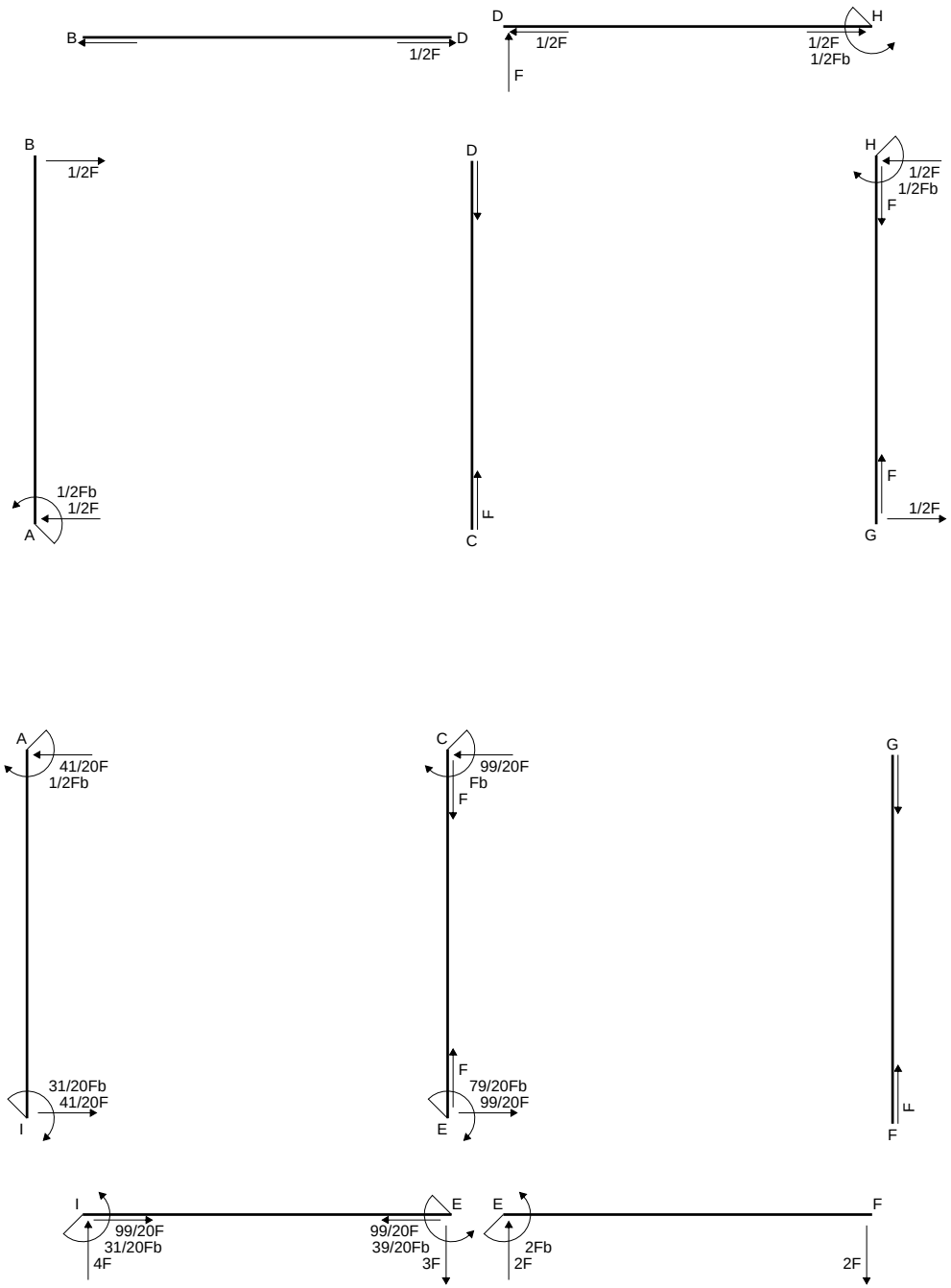
$= (1/4\ b - 1/6\ b\ )\ Fb\ 1/EJ\ = 1/12\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (1/2\ x/b - 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/4\ x^2/b - 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/4\ b - 1/6\ b\ )\ Fb\ 1/EJ\ = 1/12\ Fb^2/EJ$



A = 1080. mm^2
J_u = 285273. mm^4
J_v = 65880. mm^4
y_g = 24.88 mm
T_y = 2520. N
M_x = -2116800. Nmm
x_m = 30. mm
y_m = 53. mm
u_m = 12. mm
v_m = 28.12 mm
$\sigma_m = -Mv/J_u$ = 208.6 N/mm^2
x_c = 18. mm
y_c = 40. mm
v_c = 15.12 mm
$\sigma_c = -Mv/J_u$ = 112.2 N/mm^2
τ_c = 4.827 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 112.5 N/mm^2
S^* = 6557. mm^3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1/2F
1/2Fb
F
B
1/2F
1/2Fb
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D
F
C
H
1/2F
1/2Fb
F
F
1/2F
G
A
41/20F
1/2Fb
31/20Fb
41/20F
I
C
99/20F
Fb
F
F
79/20Fb
99/20F
E
G
F
I
99/20F
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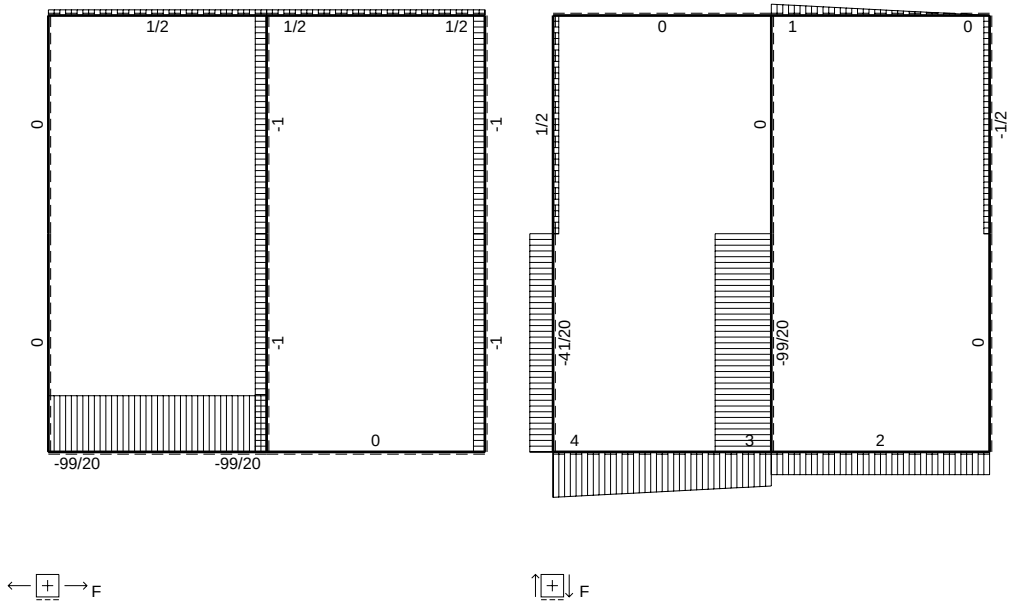
4F
E
99/20F
39/20Fb
3F
E
2Fb
2F
F
2F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-1
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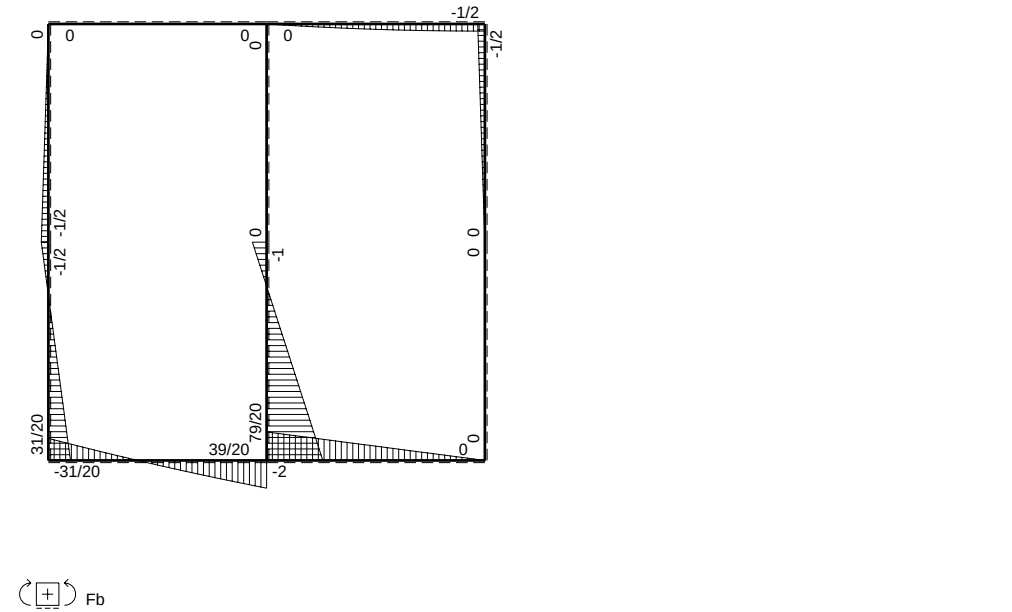
3
2
F


-1/2
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0
-1/2
-1/2
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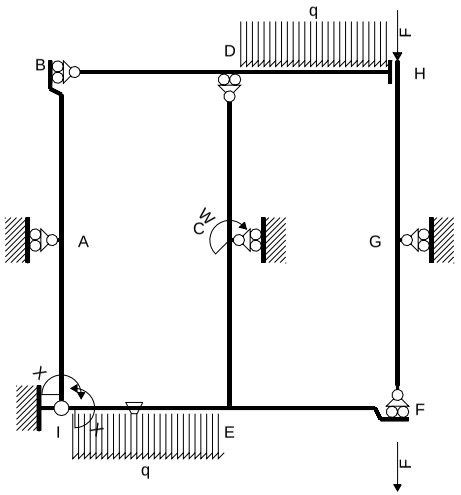
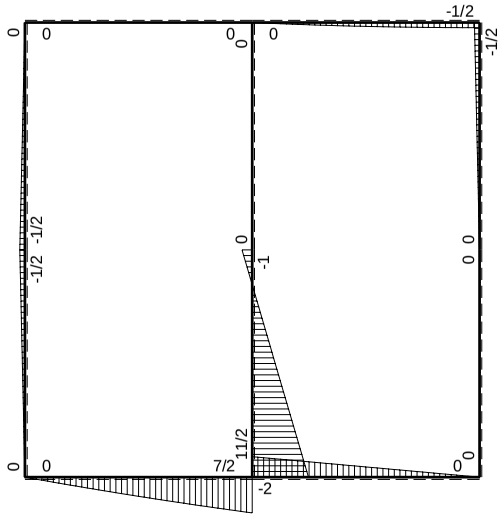
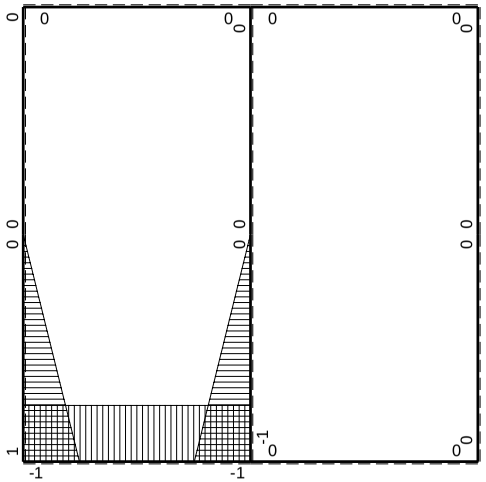
0
-1
0 0
0 0
31/20
39/20
79/20
-31/20
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 211351 CI07.xxxx.127

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PROCEDIMENTO E RISULTATI 211351 CI07.xxxx.127

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	-1/2Fx	0	0	0	0	0+0	0
HG b	0	1/2Fb-1/2Fx	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$4Fx-1/2qx^2$	-Fb/EJ	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	-1+x/b	11/2Fb-13/2Fx	0	$-11/2Fb+12Fx-13/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	Fb-13/2Fx	0	$Fx-13/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-31/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						31/20Fb	

Sviluppi di calcolo iperstatica

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$L^{XX}_{IE} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EI} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EC} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{CE} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{IA} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{AI} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{Xo}_{IE} = \int_o^b (-4\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L^{Xo}_{EI} = \int_o^b (-7/2 + 3\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx$

$= [-7/2\ x + 3/2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-7/2\ b + 3/2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L^{Xo}_{EC} = \int_o^b (-11/2 + 12\ x/b - 13/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-11/2\ x + 6\ x^2/b - 13/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-11/2\ b + 6\ b - 13/6\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L^{Xo}_{CE} = \int_o^b (\ x/b - 13/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 13/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

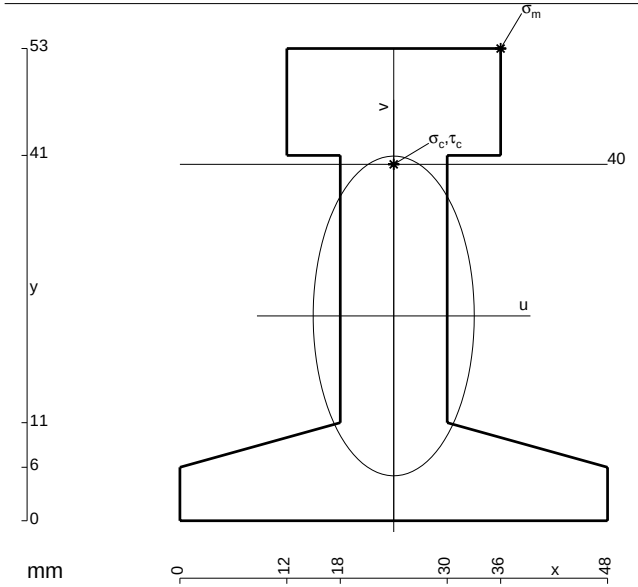
$= (1/2\ b - 13/6\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L^{Xo}_{IA} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

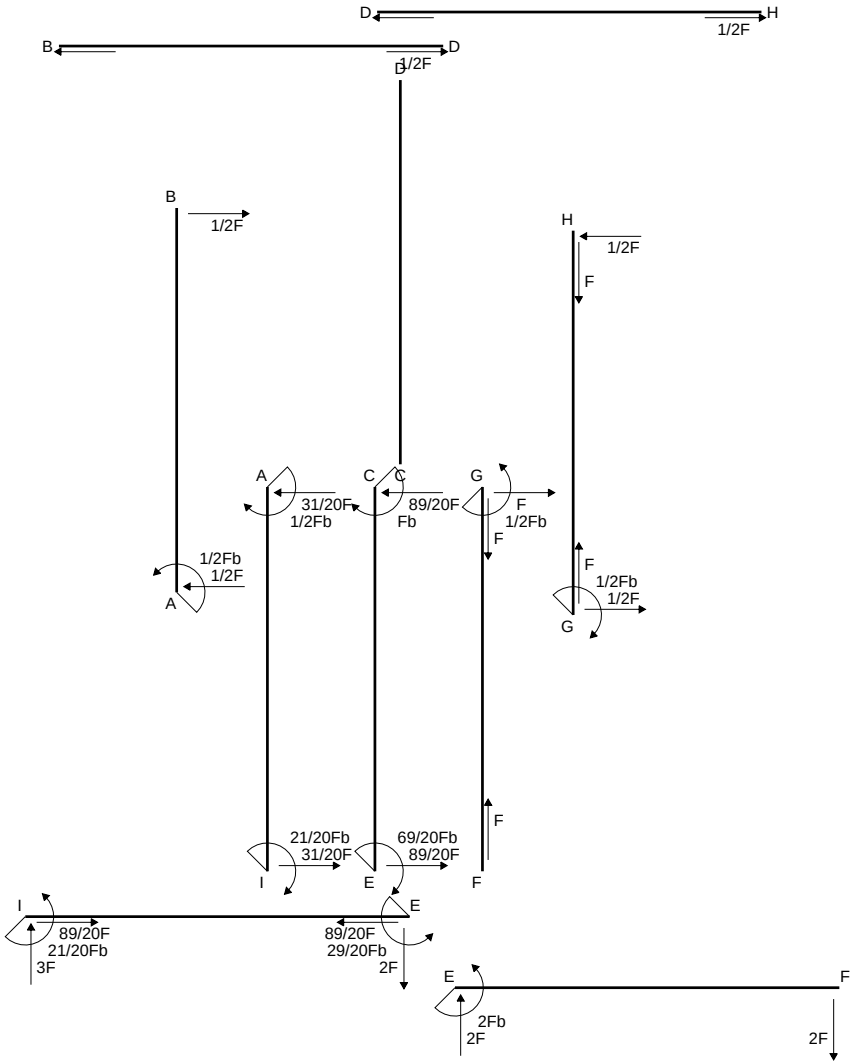
$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

$L^{Xo}_{AI} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$



A = 1086. mm^2
J_u = 349673. mm^4
J_v = 88740. mm^4
y_g = 22.98 mm
T_y = 2840. N
M_x = -2556000. Nmm
x_m = 36. mm
y_m = 53. mm
u_m = 12. mm
v_m = 30.02 mm
$\sigma_m = -Mv/J_u$ = 219.4 N/mm^2
x_c = 24. mm
y_c = 40. mm
v_c = 17.02 mm
$\sigma_c = -Mv/J_u$ = 124.4 N/mm^2
τ_c = 4.824 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 124.7 N/mm^2
S^* = 7127. mm^3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89/20F
Fb
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F
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1/2F
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G
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3F
89/20F
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F
2Fb
2F
2F

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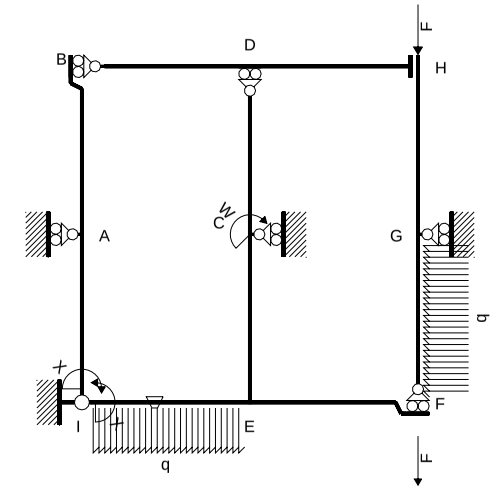
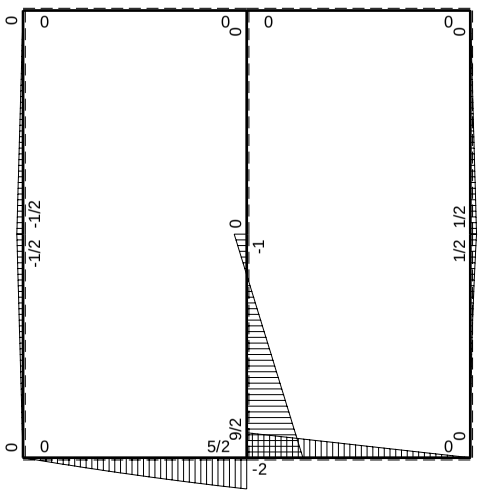
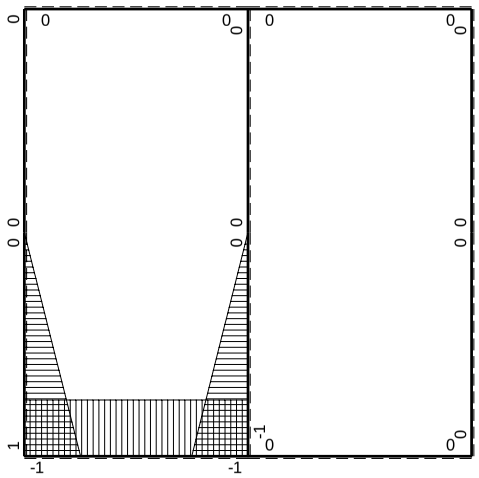


Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 215181 CI07.xxxx.128

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PROCEDIMENTO E RISULTATI 215181 CI07.xxxx.128

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx-1/2qx^2$	-Fb/EJ	$-3Fx+1/2Fx^2/b$	Fb/EJ	1	$(-4/3+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-5/2Fb+2Fx+1/2qx^2$	Fb/EJ	$-5/2Fb+2Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	$-1+x/b$	$9/2Fb-11/2Fx$	0	$-9/2Fb+10Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-4/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$Fb-11/2Fx$	0	$Fx-11/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-7/4Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						21/20Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/3\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-5/2 + 2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx$

$= [-5/2\ x + x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-5/2\ b + b + 1/6\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/3\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-9/2 + 10\ x/b - 11/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-9/2\ x + 5\ x^2/b - 11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-9/2\ b + 5\ b - 11/6\ b\ )\ Fb\ 1/EJ\ = -4/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (\ x/b - 11/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

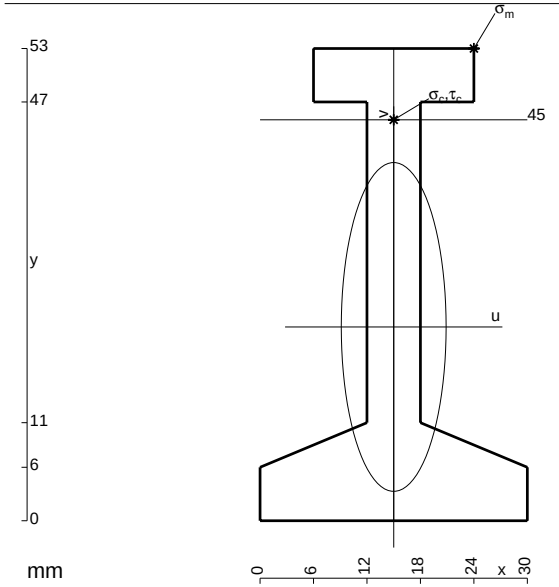
$= (1/2\ b - 11/6\ b\ )\ Fb\ 1/EJ\ = -4/3\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

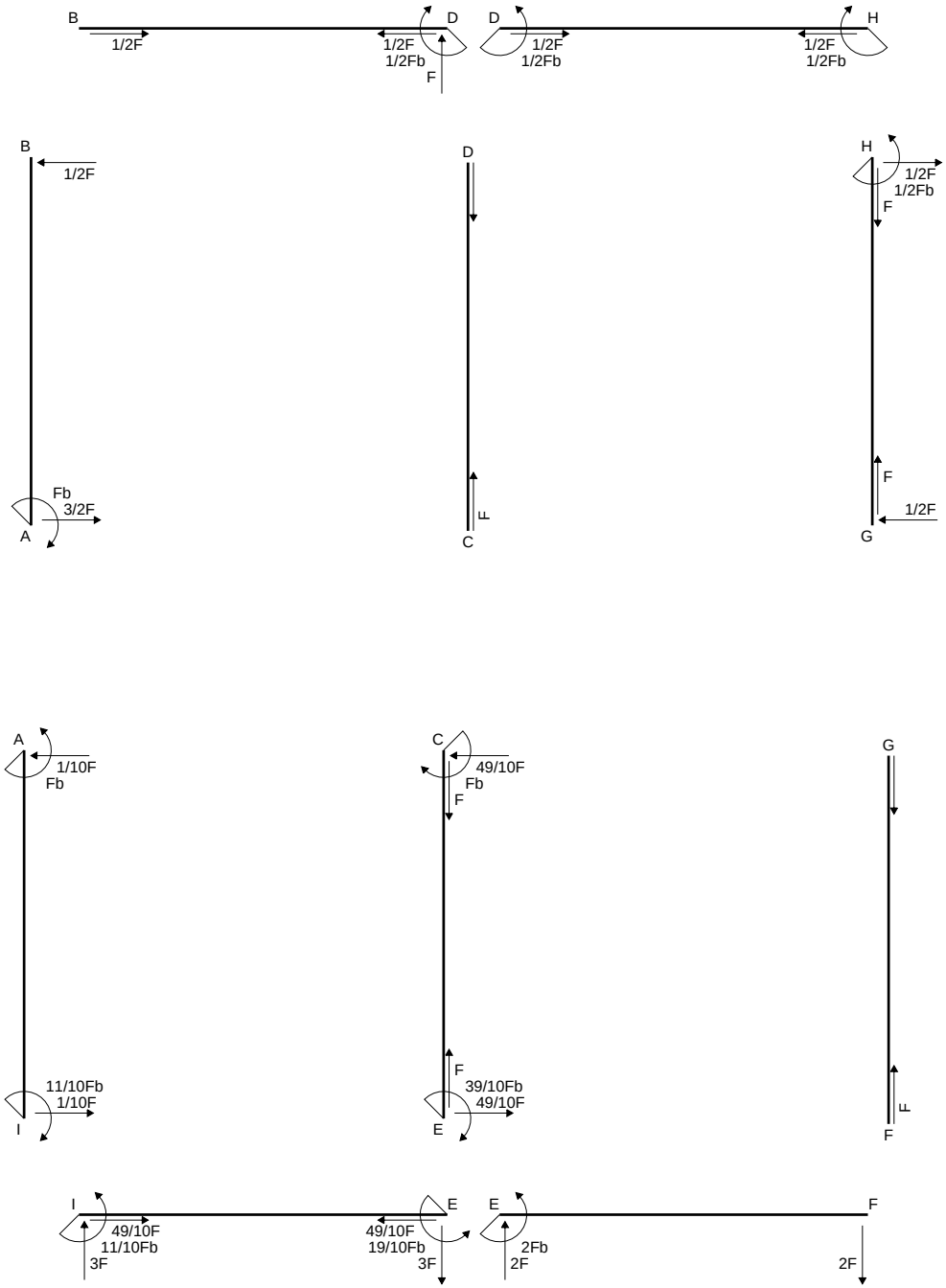
$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$



A = 594. mm^2
J_u = 202331. mm^4
J_v = 20574. mm^4
y_g = 21.75 mm
T_y = 1560. N
M_x = -1482000. Nmm
x_m = 24. mm
y_m = 53. mm
u_m = 9. mm
v_m = 31.25 mm
$\sigma_m = -Mv/J_u$ = 228.9 N/mm^2
x_c = 15. mm
y_c = 45. mm
v_c = 23.25 mm
$\sigma_c = -Mv/J_u$ = 170.3 N/mm^2
τ_c = 4.295 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 170.5 N/mm^2
S^* = 3342. mm^3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1/2F
1/2Fb
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D
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1/2Fb
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1/2Fb
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D
F
C
H
1/2F
1/2Fb
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C
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Fb
F
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39/10Fb
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E
G
F
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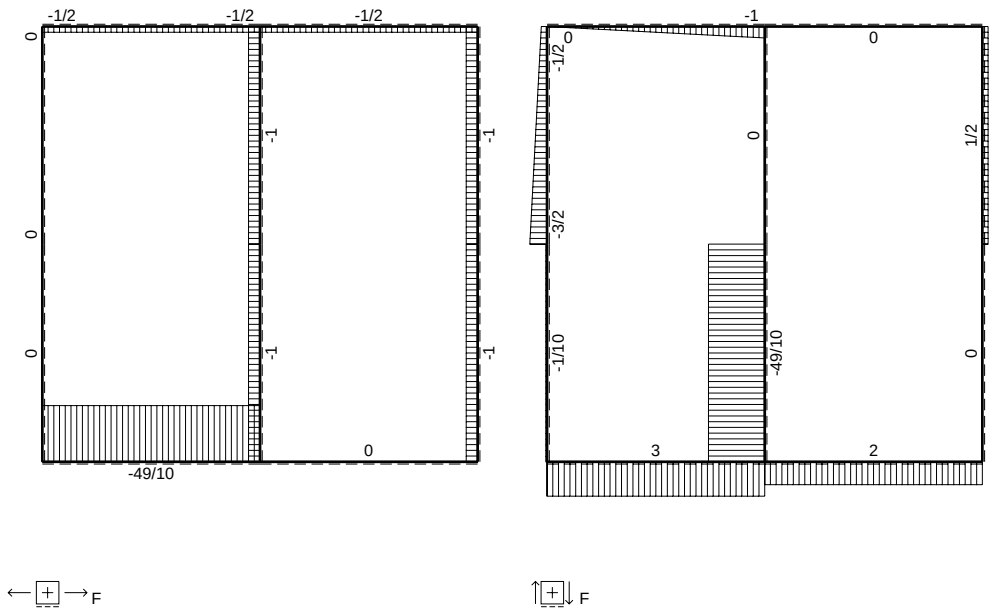
49/10F
19/10Fb
3F
E
2Fb
2F
F
2F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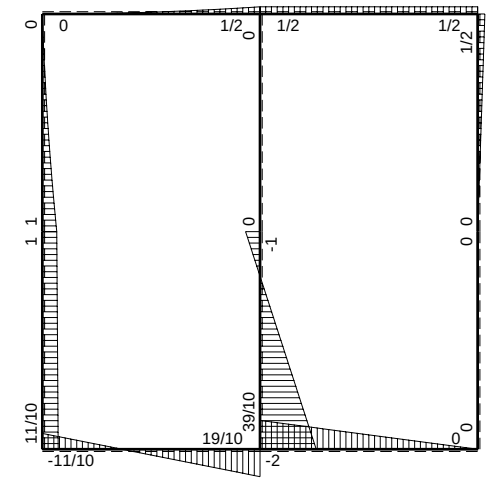
-1/10
-49/10
1/2
0
3
2
F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11/10
39/10
19/10
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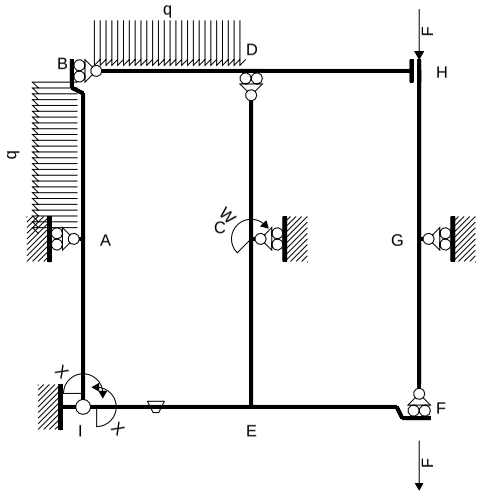
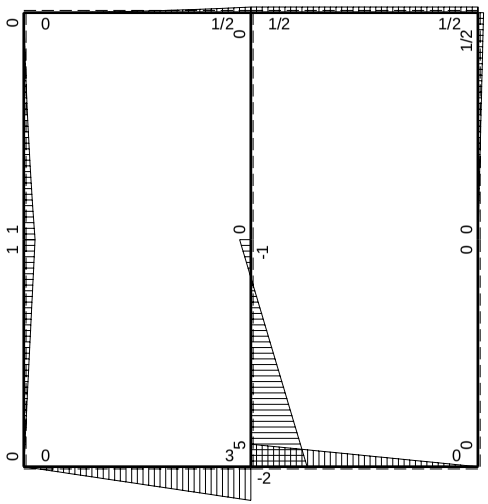
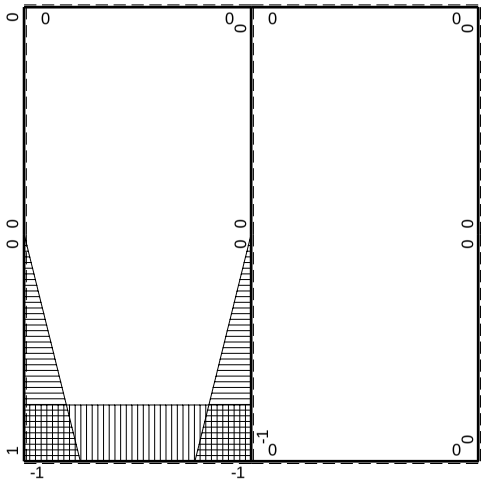
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 917806 CI07.xxxx.129
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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$Fb-3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$-1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-6Fx$	0	$-5Fb+11Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$Fb-6Fx$	0	$Fx-6Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	Fx	0	$Fx-Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-Fb+Fx$	0	$Fx-Fx^2/b$	0	x^2/b^2		
	totali						$-11/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$11/10Fb$	

PROCEDIMENTO E RISULTATI 917806 CI07.xxxx.129

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 11\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 11/2\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 11/2\ b - 2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/2\ b - 2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

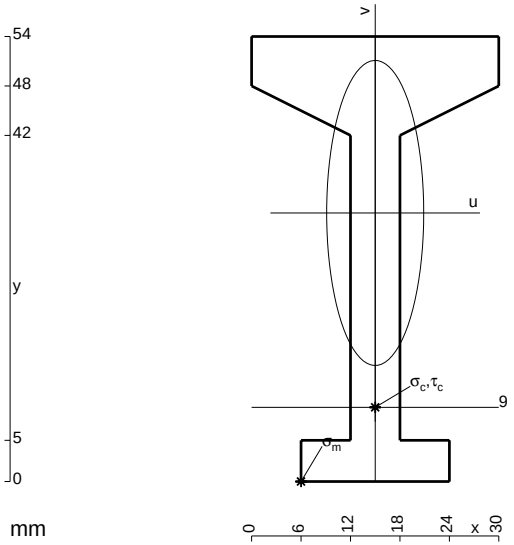
$L_{IA}^{Xo} = \int_o^b (\ x/b - x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/2\ b - 1/3\ b\ )\ Fb\ 1/EJ\ = 1/6\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (\ x/b - x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/2\ b - 1/3\ b\ )\ Fb\ 1/EJ\ = 1/6\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 917806 CI07.xxxx.129



A = 600. mm^2
J_u = 205635. mm^4
J_v = 20808. mm^4
y_g = 32.59 mm
T_y = 1480. N
M_x = -1509600. Nmm
x_m = 6. mm
u_m = -9. mm
v_m = -32.59 mm
$\sigma_m = -Mv/J_u$ = -239.2 N/mm^2
x_c = 15. mm
y_c = 9. mm
v_c = -23.59 mm
$\sigma_c = -Mv/J_u$ = -173.2 N/mm^2
τ_c = 3.985 N/mm^2
$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2}$ = 173.3 N/mm^2
S^* = 3322. mm^3

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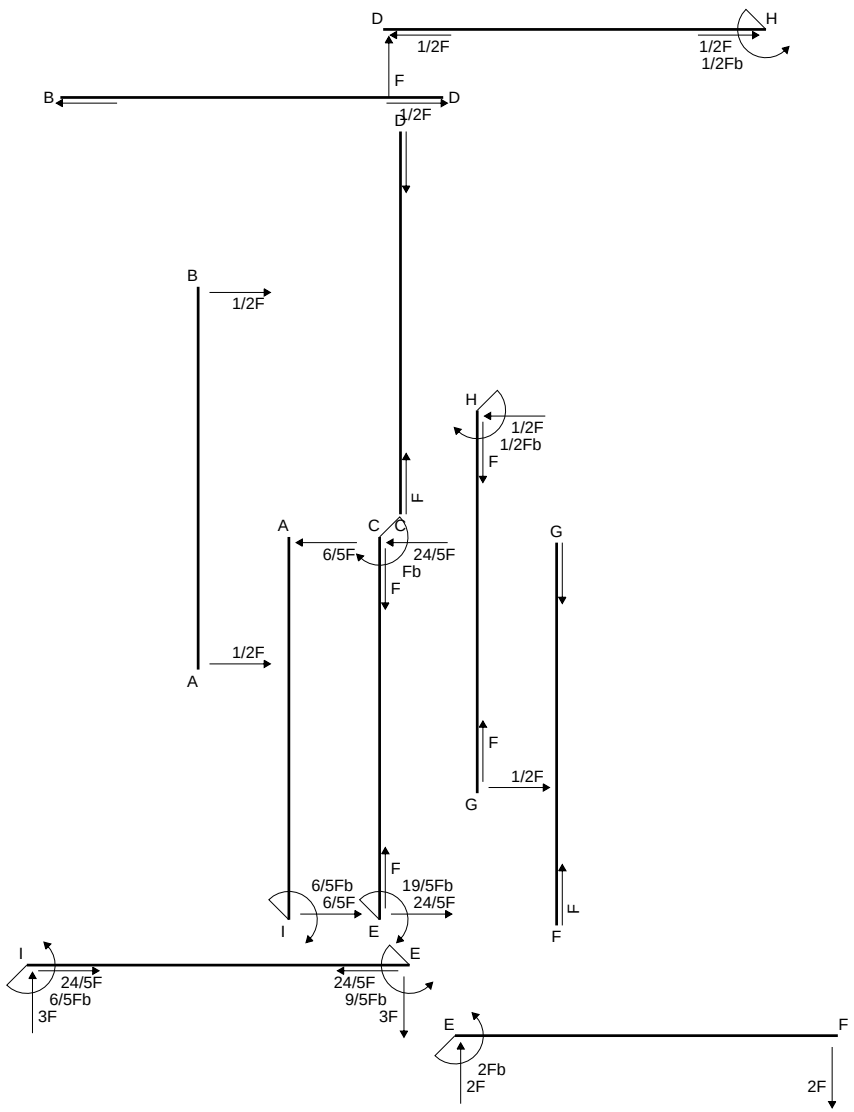
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1/2Fb
F
F
A
C
C
6/5F
24/5F
Fb
F
G
1/2F
A
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1/2F
G
F
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6/5F
19/5Fb
24/5F
I
E
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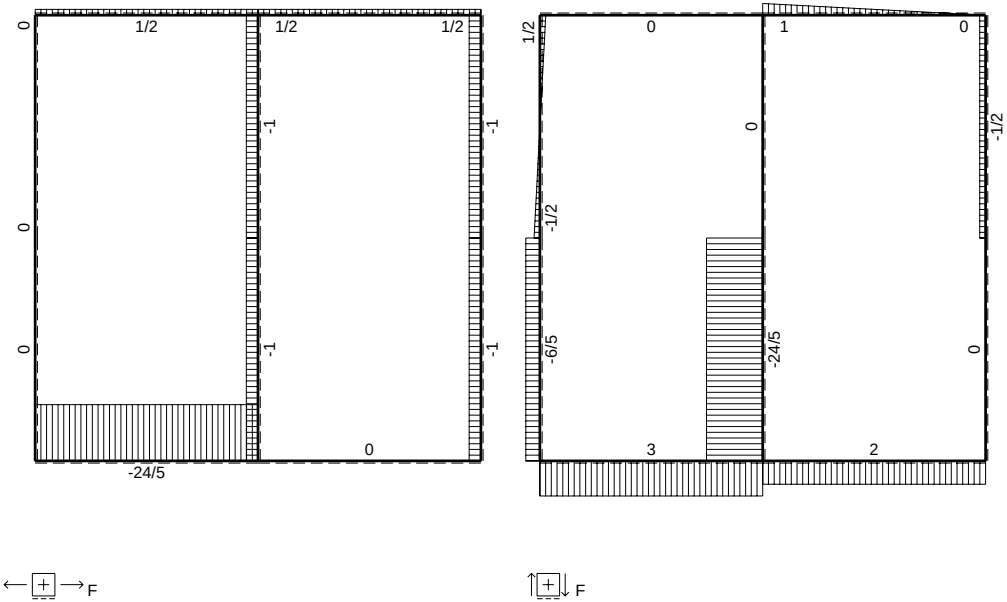
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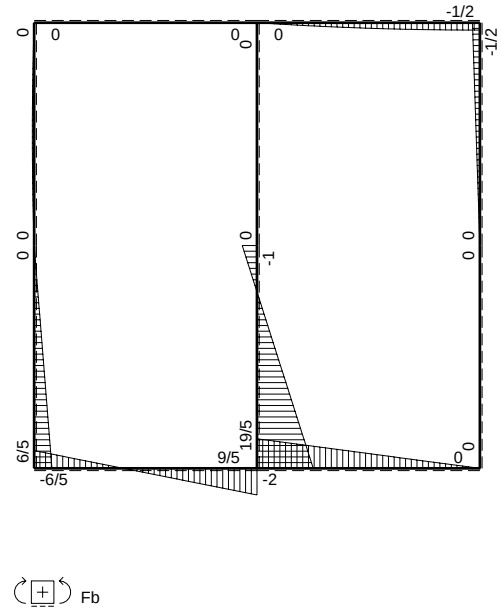
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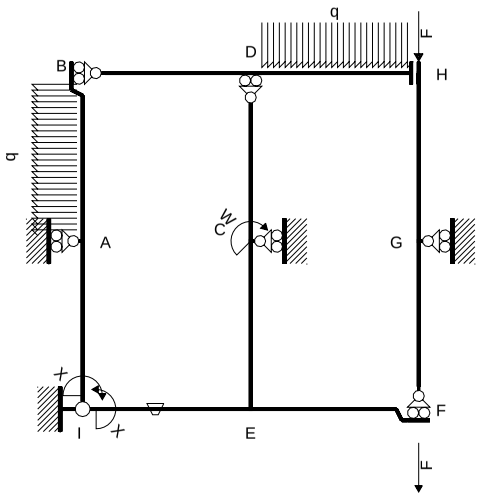
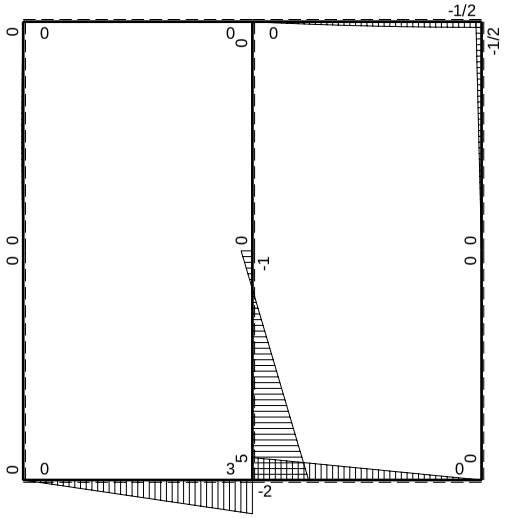
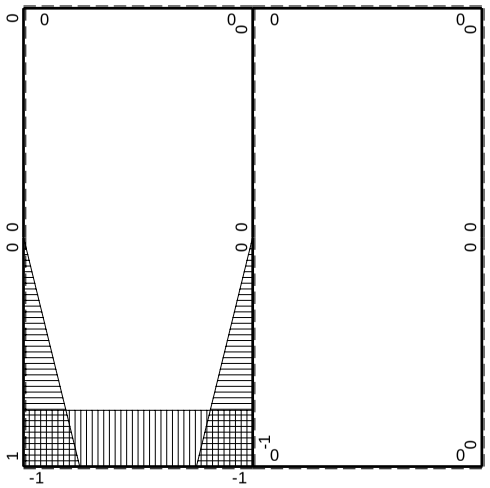
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 985349 CI07.xxxx.130

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-1/2Fx$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-6Fx$	0	$-5Fb+11Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$Fb-6Fx$	0	$Fx-6Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
AI b	$-x/b$	0	0	0	0	x^2/b^2		
	totali						$-2Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$6/5Fb$	

PROCEDIMENTO E RISULTATI 985349 CI07.xxxx.130

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

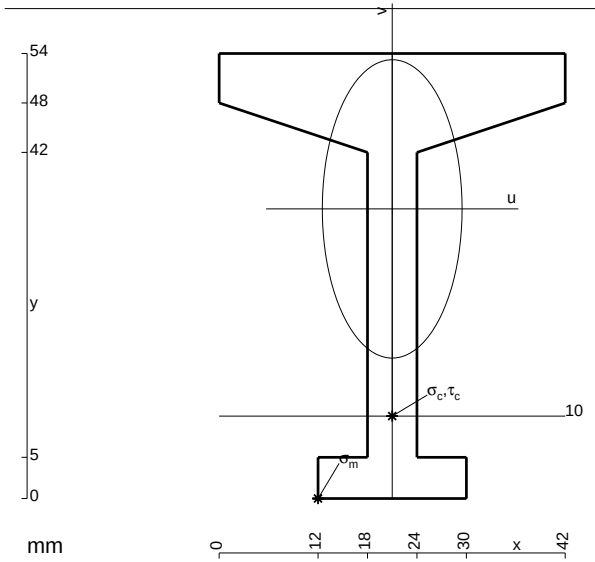
$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 11\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 11/2\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

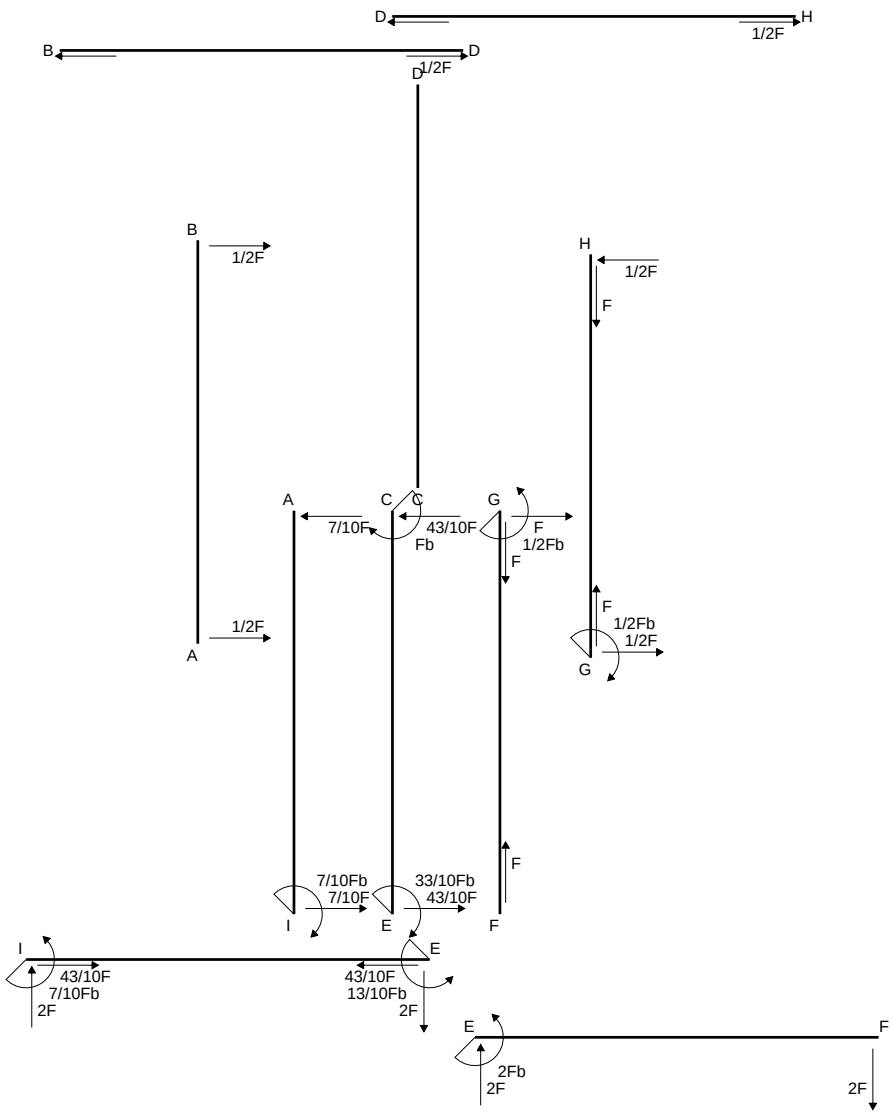
$= (-5\ b + 11/2\ b - 2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/2\ b - 2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$



A = 708. mm^2
J_u = 232181. mm^4
J_v = 50940. mm^4
y_g = 35.14 mm
T_y = 2440. N
M_x = -1317600. Nmm
x_m = 12. mm
u_m = -9. mm
v_m = -35.14 mm
$\sigma_m = -Mv/J_u$ = -199.4 N/mm^2
x_c = 21. mm
y_c = 10. mm
v_c = -25.14 mm
$\sigma_c = -Mv/J_u$ = -142.7 N/mm^2
τ_c = 6.598 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 143.1 N/mm^2
S^* = 3767. mm^3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B
D
1/2F
D
B
1/2F
H
1/2F
F
A
C
C
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43/10F
F
Fb
1/2Fb
F
F
1/2Fb
1/2F
1/2F
A
G
F
7/10Fb
33/10Fb
7/10F
43/10F
I
E
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I
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7/10Fb
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43/10F
13/10Fb
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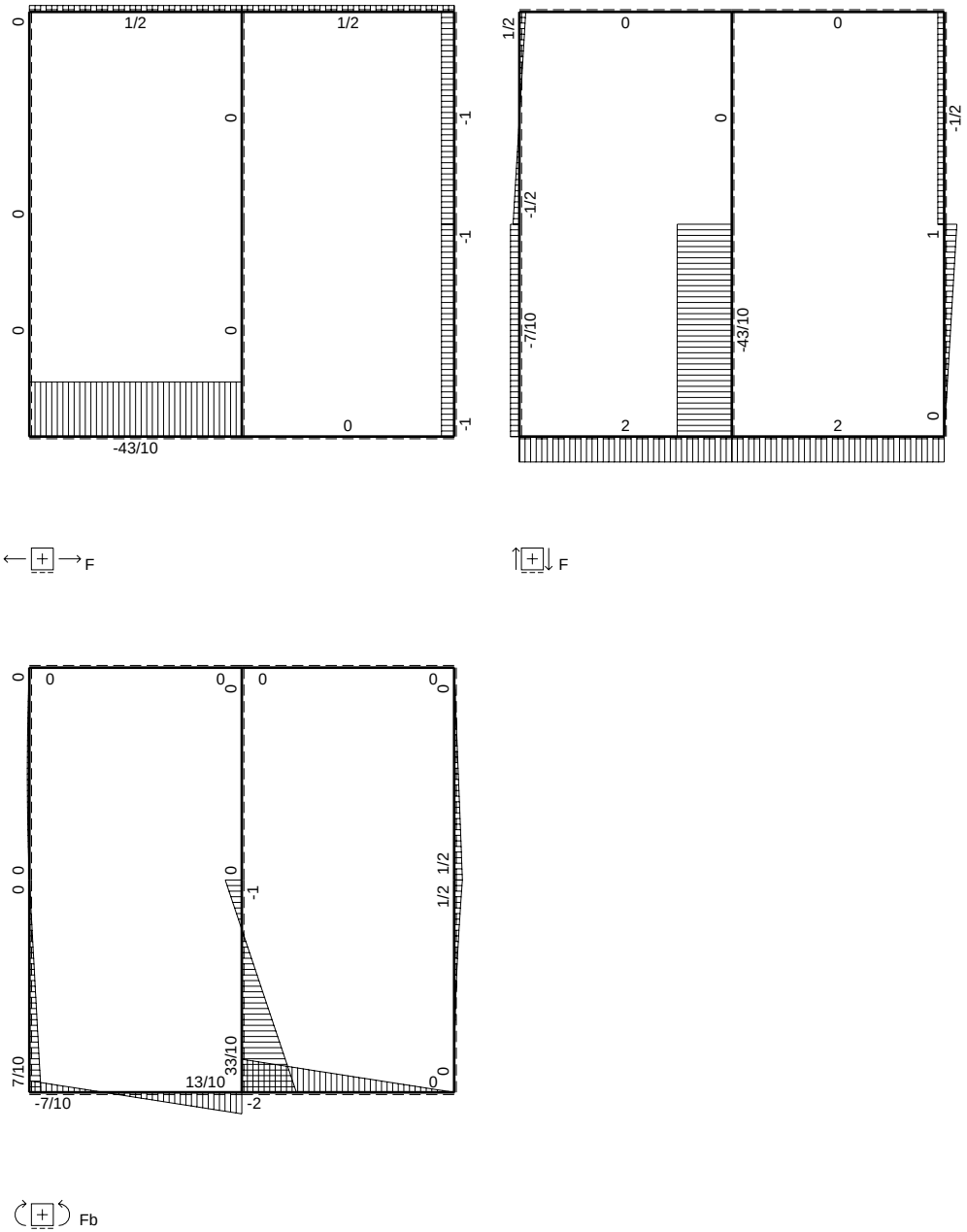
F
2Fb
2F
2F


1/2
1/2
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-1
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-43/10
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1/2
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0
-1/2
-7/10
-43/10
1
2
2
0
F
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0
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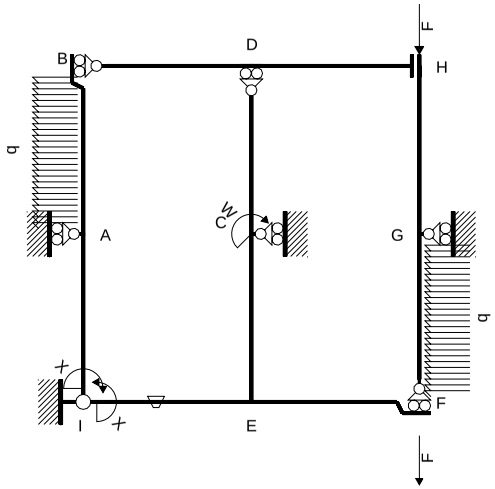
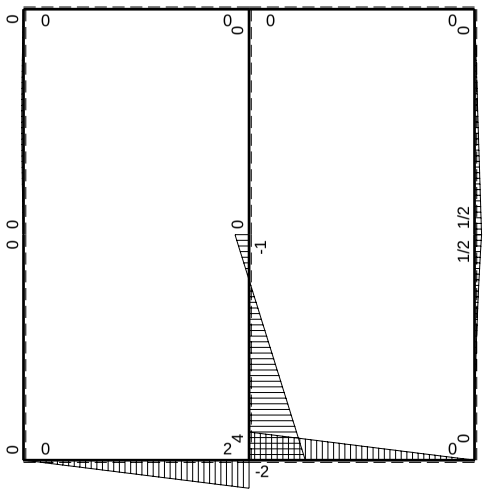
-1
1/2 1/2
7/10
33/10
13/10
0
0
-7/10
-2
Fb



Schema di calcolo iperstatico


0
0
0

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	-1+x/b	4Fb-5Fx	0	$-4Fb+9Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-7/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	Fb-5Fx	0	$Fx-5Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	1/3Xb/EJ
AI b	-x/b	0	0	0	0	x^2/b^2		
	totali						$-7/6Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						7/10Fb	

PROCEDIMENTO E RISULTATI 218352 CI07.xxxx.131

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L_{EI}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

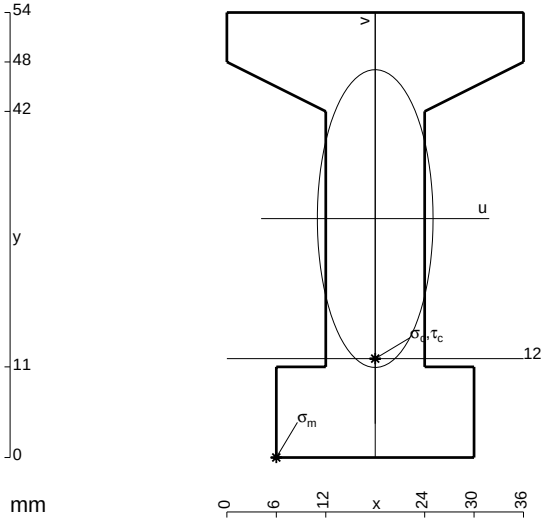
$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L_{EC}^{Xo} = \int_o^b (-4 + 9\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4\ x + 9/2\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

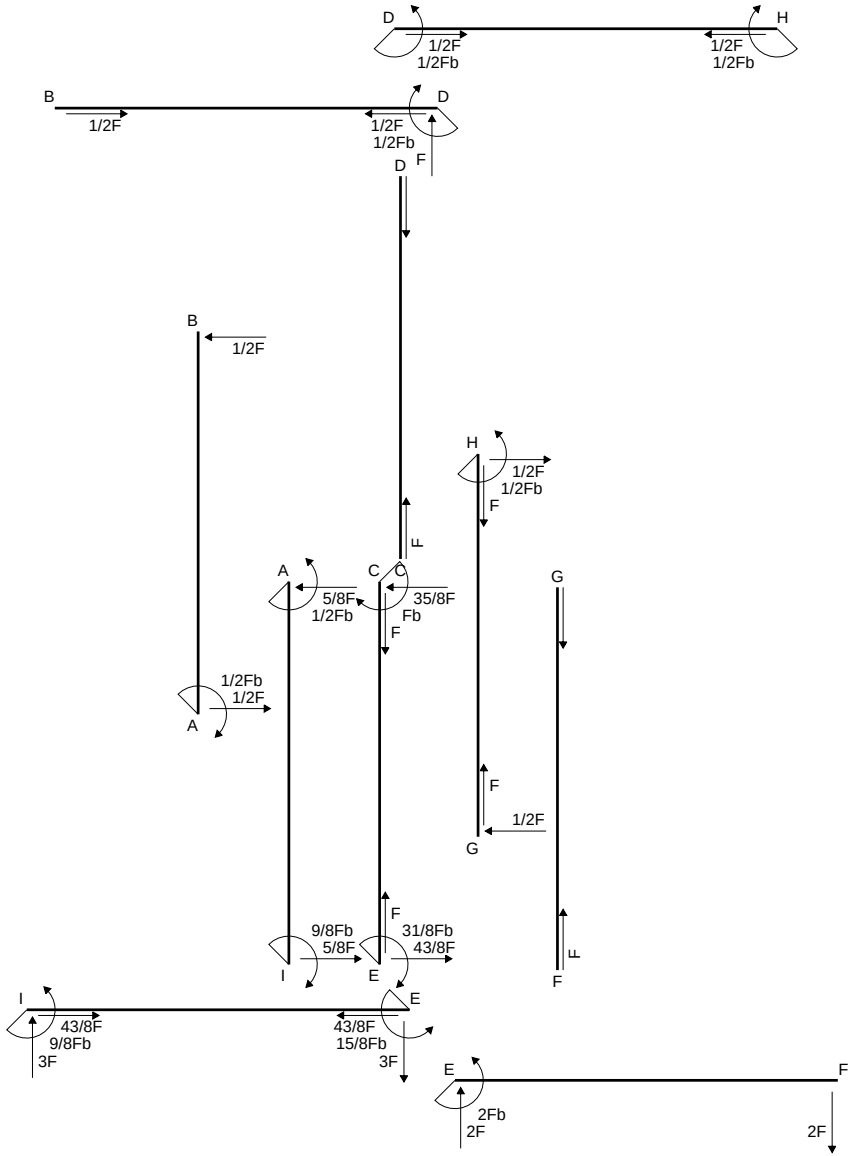
$= (-4\ b + 9/2\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -7/6\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/2\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -7/6\ Fb^2/EJ$



$A = 996.\ mm^2$
$J_u = 325364.\ mm^4$
$J_v = 49104.\ mm^4$
$y_g = 28.99\ mm$
$T_y = 3980.\ N$
$M_x = -2348200.\ Nmm$
$x_m = 6.\ mm$
$u_m = -12.\ mm$
$v_m = -28.99\ mm$
$\sigma_m = -Mv/J_u = -209.3\ N/mm^2$
$x_c = 18.\ mm$
$y_c = 12.\ mm$
$v_c = -16.99\ mm$
$\sigma_c = -Mv/J_u = -122.6\ N/mm^2$
$\tau_c = 6.537\ N/mm^2$
$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 123.2\ N/mm^2$
$S^* = 6412.\ mm^3$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G
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G
F
F
9/8Fb
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31/8Fb
43/8F
I
E
F
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E
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9/8Fb
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43/8F
15/8Fb
3F
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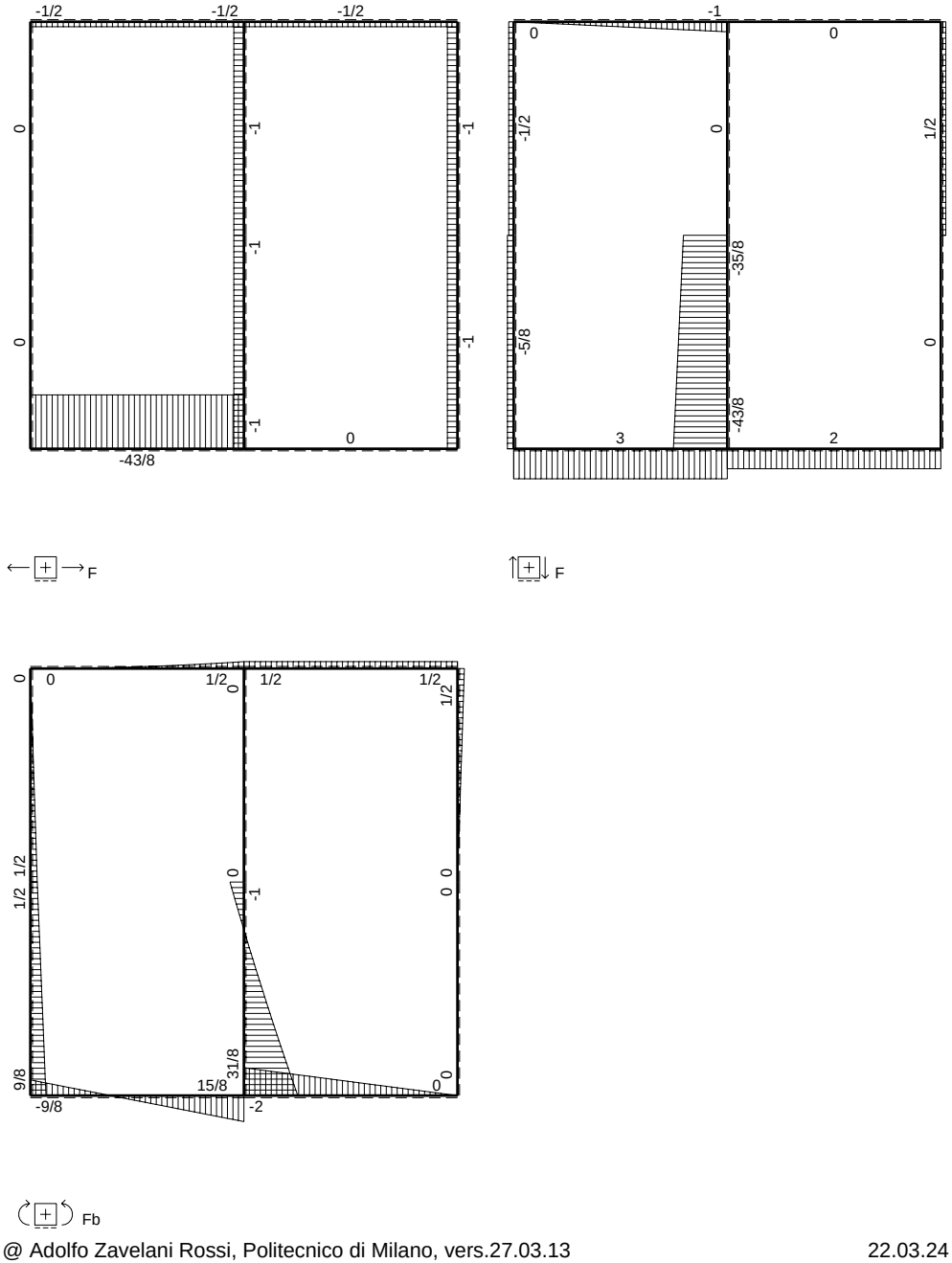
F
2Fb
2F
2F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-5/8
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-43/8
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F
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1/2
1/2
1/2
1/2
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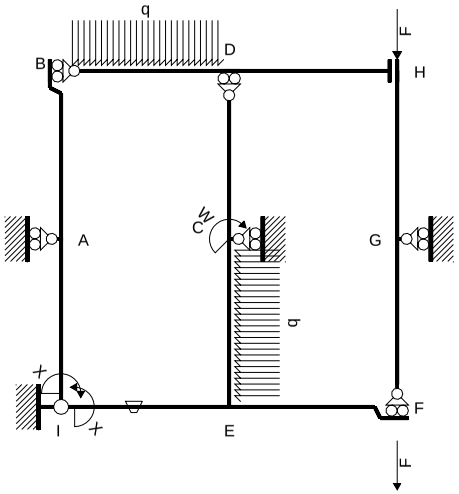
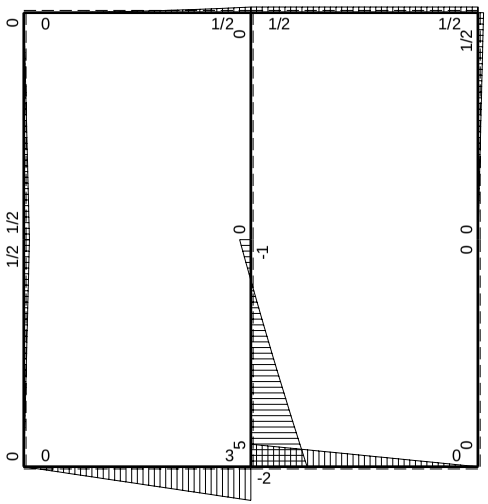
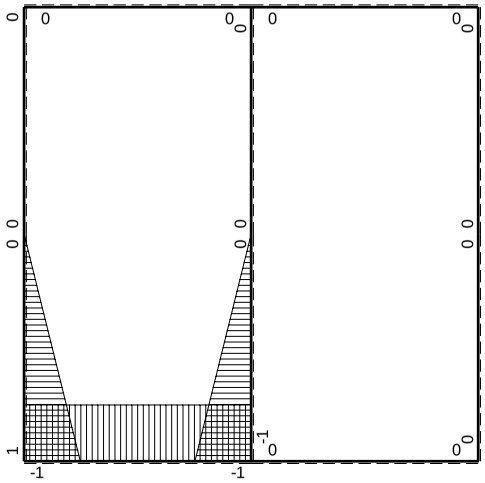
0
0
9/8
31/8
15/8
0
-9/8
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 211277 CI07.xxxx.132

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
BA b	0	-1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fb+1/2Fx	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	$5Fb-13/2Fx+1/2qx^2$	0	$-5Fb+23/2Fx-7Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-35/24+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$Fb-11/2Fx-1/2qx^2$	0	$Fx-11/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2		
IA b	1-x/b	1/2Fx	0	$1/2Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	-1/2Fb+1/2Fx	0	$1/2Fx-1/2Fx^2/b$	0	x^2/b^2		
	totali						$-15/8Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						9/8Fb	

Sviluppi di calcolo iperstatica

PROCEDIMENTO E RISULTATI 211277 CI07.xxxx.132
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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 23/2\ x/b - 7\ x^2/b^2 + 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx$

$= [-5\ x + 23/4\ x^2/b - 7/3\ x^3/b^2 + 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 23/4\ b - 7/3\ b + 1/8\ b\ )\ Fb\ 1/EJ\ = -35/24\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (\ x/b - 11/2\ x^2/b^2 - 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 11/6\ x^3/b^2 - 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

$= (1/2\ b - 11/6\ b - 1/8\ b\ )\ Fb\ 1/EJ\ = -35/24\ Fb^2/EJ$

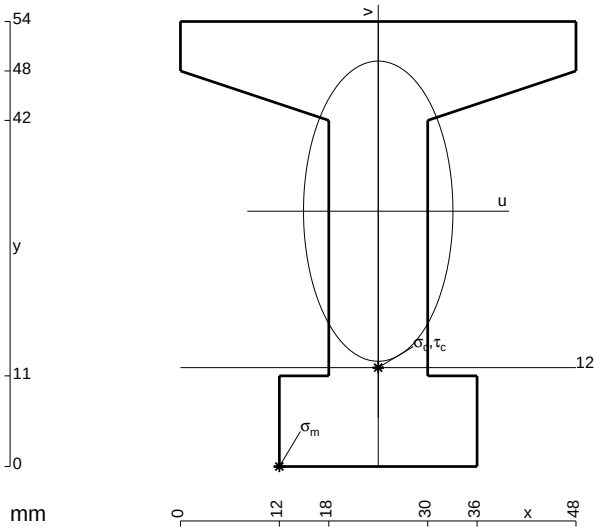
$L_{IA}^{Xo} = \int_o^b (1/2\ x/b - 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/4\ x^2/b - 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/4\ b - 1/6\ b\ )\ Fb\ 1/EJ\ = 1/12\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (1/2\ x/b - 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/4\ x^2/b - 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/4\ b - 1/6\ b\ )\ Fb\ 1/EJ\ = 1/12\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 211277 CI07.xxxx.132



A = 1104. mm^2
J_u = 366560. mm^4
J_v = 90792. mm^4
y_g = 30.98 mm
T_y = 4060. N
M_x = -2598400. Nmm
x_m = 12. mm
u_m = -12. mm
v_m = -30.98 mm
$\sigma_m = -Mv/J_u$ = -219.6 N/mm^2
x_c = 24. mm
y_c = 12. mm
v_c = -18.98 mm
$\sigma_c = -Mv/J_u$ = -134.6 N/mm^2
τ_c = 6.425 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 135. N/mm^2
S^* = 6962. mm^3

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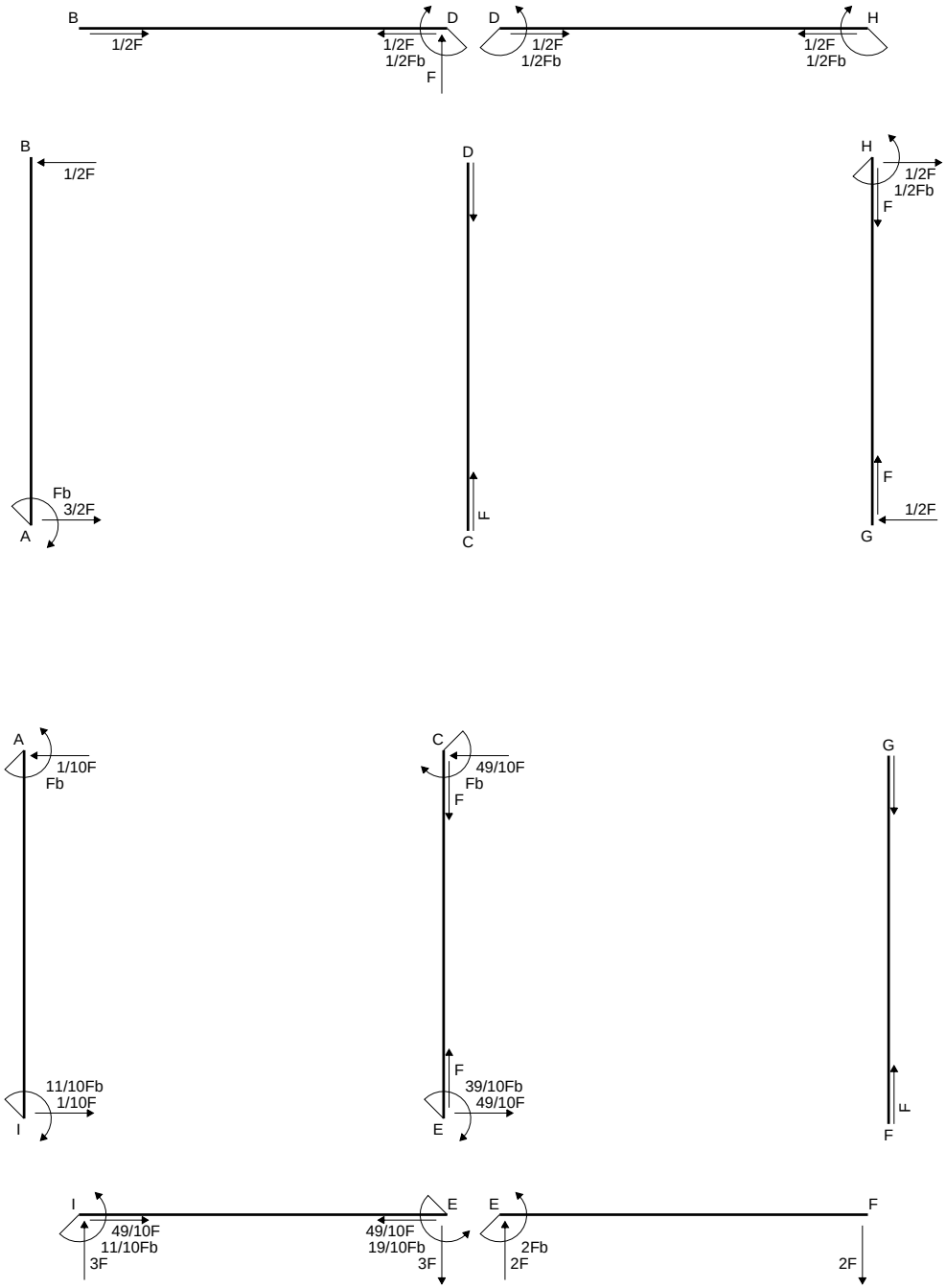
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1/2Fb
F
D
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1/2Fb
H
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1/2Fb
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1/2F
Fb
3/2F
A
D
F
C
H
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1/2Fb
F
F
1/2F
G
A
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Fb
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1/10F
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49/10F
E
G
F
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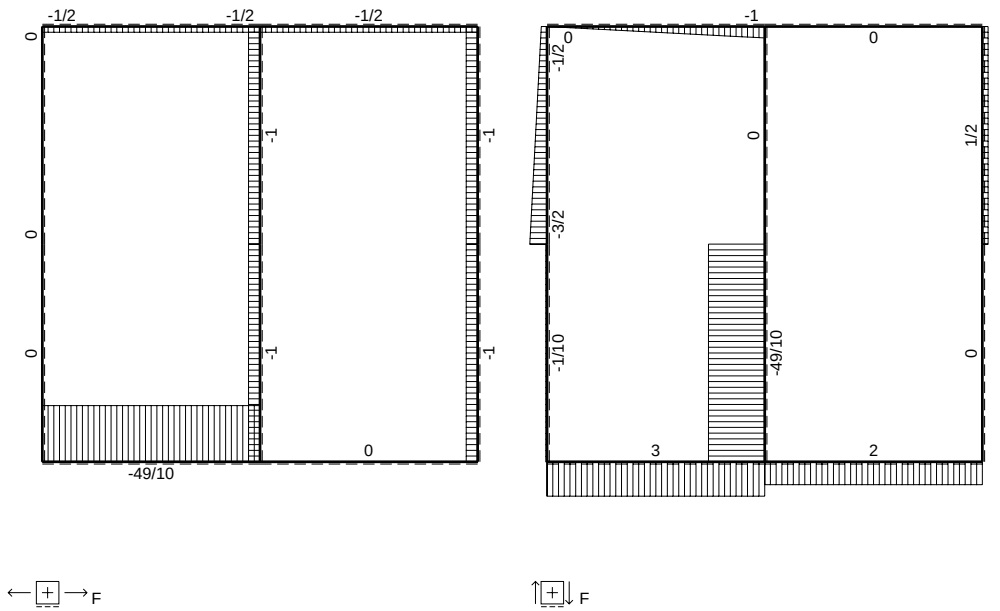
11/10Fb
3F
E
49/10F
19/10Fb
3F
E
2Fb
2F
F
2F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-3/2
-1/10
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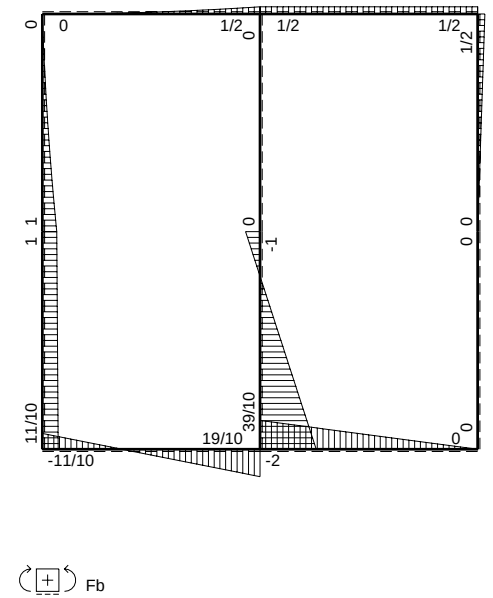
0
-49/10
1/2
0
3
2
F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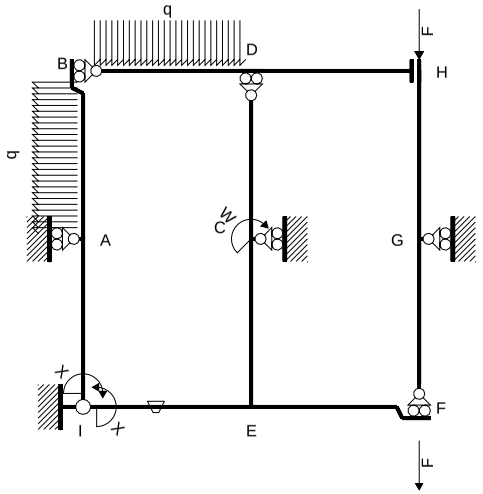
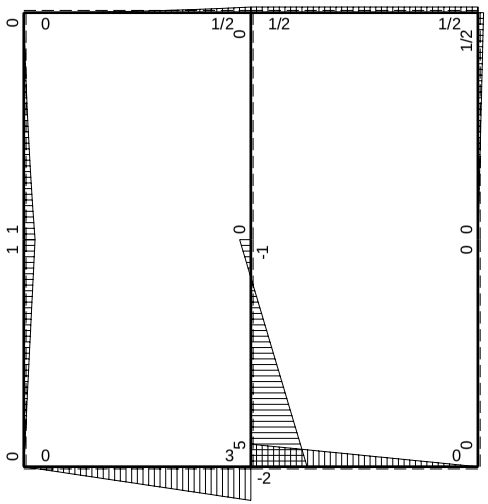
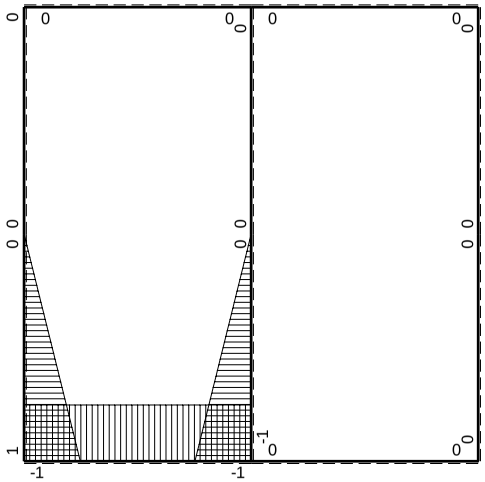
11/10
39/10
19/10
0
-11/10
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 218194 CI07.xxxx.133

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$Fb-3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$-1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-6Fx$	0	$-5Fb+11Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$Fb-6Fx$	0	$Fx-6Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	Fx	0	$Fx-Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-Fb+Fx$	0	$Fx-Fx^2/b$	0	x^2/b^2		
	totali						$-11/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$11/10Fb$	

PROCEDIMENTO E RISULTATI 218194 CI07.xxxx.133

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 11\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 11/2\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 11/2\ b - 2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

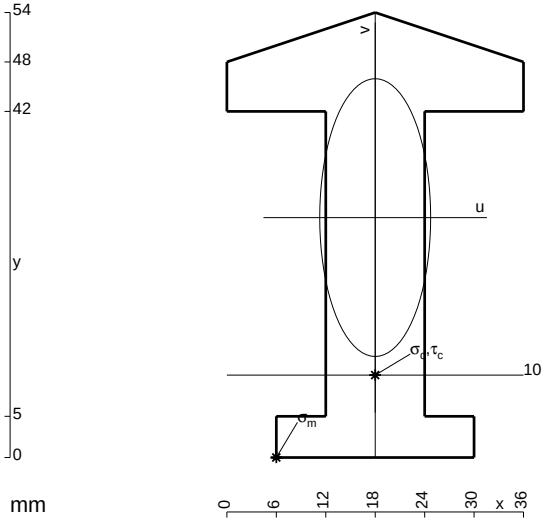
$= (1/2\ b - 2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (\ x/b - x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/2\ b - 1/3\ b\ )\ Fb\ 1/EJ\ = 1/6\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (\ x/b - x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/2\ b - 1/3\ b\ )\ Fb\ 1/EJ\ = 1/6\ Fb^2/EJ$



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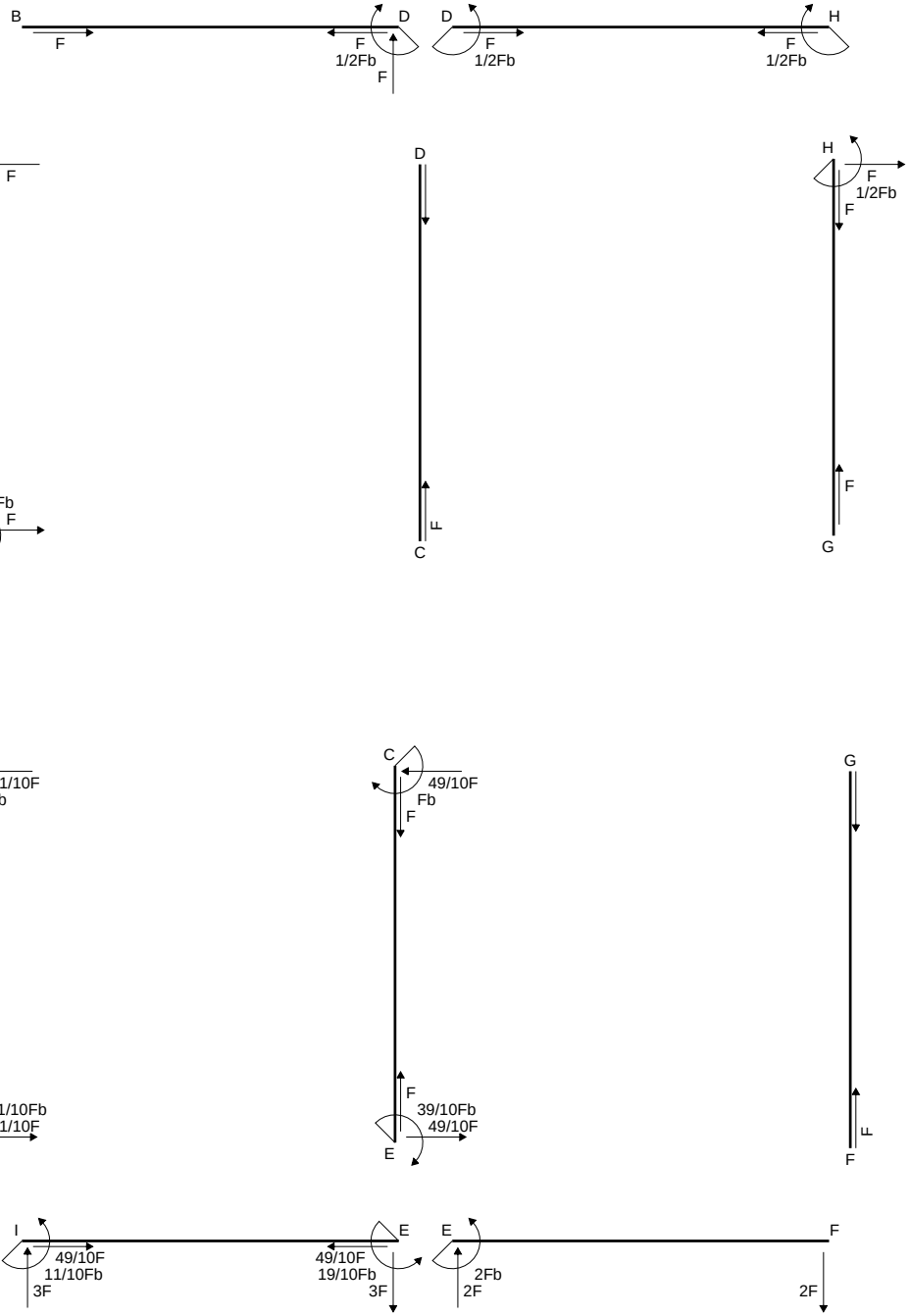
J_u = 252380. mm^4
J_v = 40248. mm^4
y_g = 29.11 mm
T_y = 2840. N
M_x = -1988000. Nmm
x_m = 6. mm
u_m = -12. mm
v_m = -29.11 mm
$\sigma_m = -Mv/J_u$ = -229.3 N/mm^2
x_c = 18. mm
y_c = 10. mm
v_c = -19.11 mm
$\sigma_c = -Mv/J_u$ = -150.6 N/mm^2
τ_c = 4.211 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 150.7 N/mm^2
S^* = 4491. mm^3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1/2Fb
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G
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Fb
11/10Fb
1/10F
I
C
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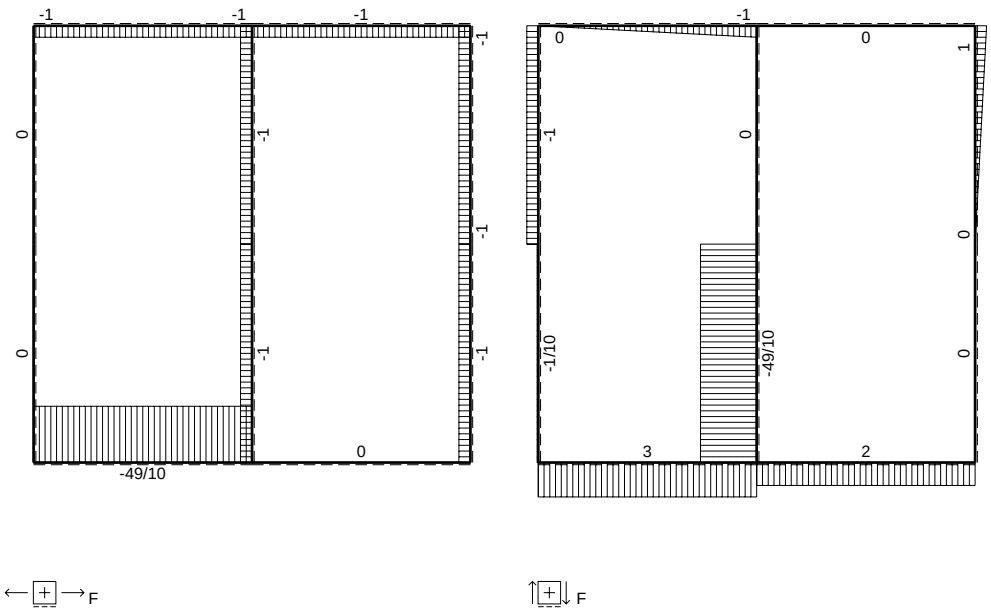
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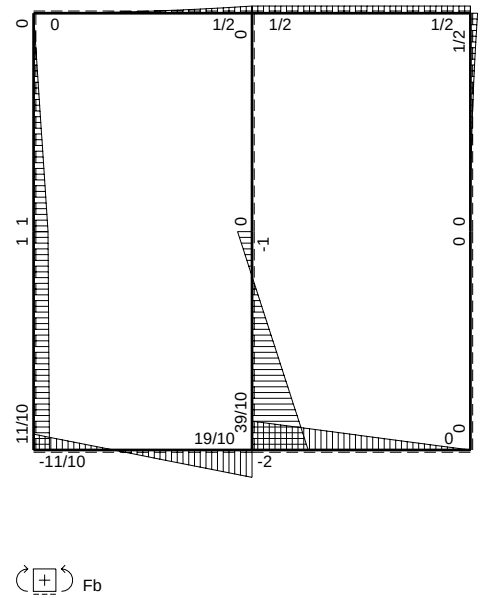
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39/10
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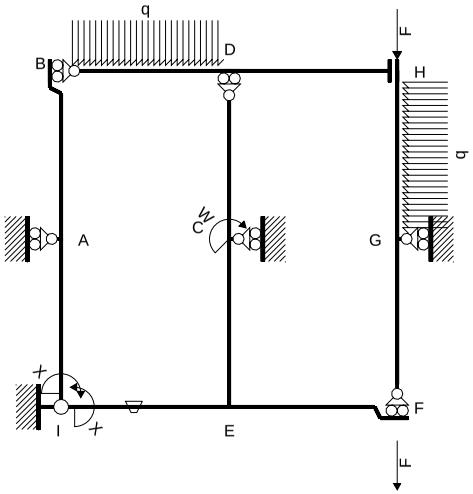
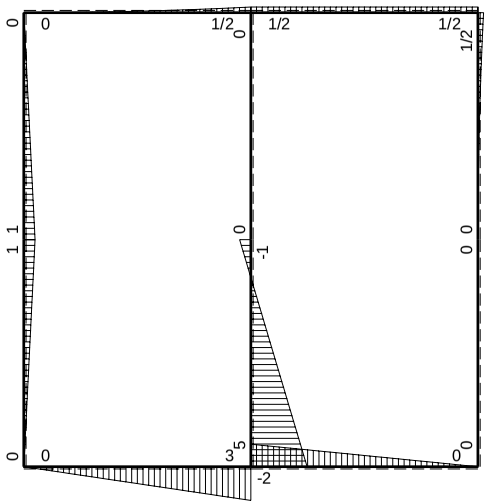
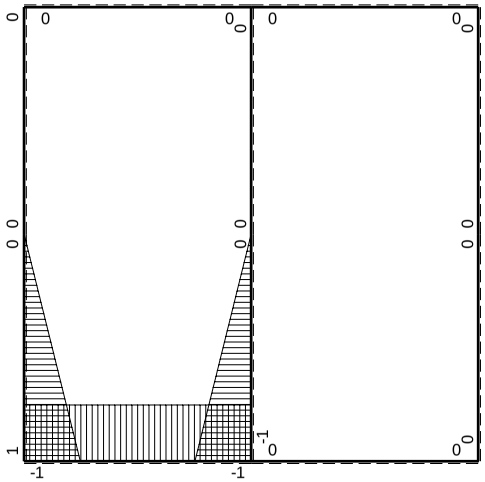
-11/10
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 212206 CI07.xxxx.134

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PROCEDIMENTO E RISULTATI 212206 CI07.xxxx.134

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	Fb-Fx	0	0	0	0	0+0	0
BA b	0	-Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	5Fb-6Fx	0	$-5Fb+11Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	Fb-6Fx	0	$Fx-6Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fx	0	$Fx-Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	-Fb+Fx	0	$Fx-Fx^2/b$	0	x^2/b^2		
	totali						$-11/6Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						11/10Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 11\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 11/2\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 11/2\ b - 2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/2\ b - 2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

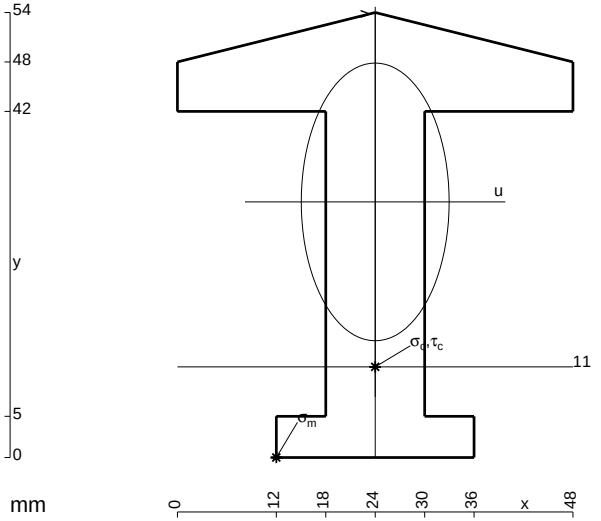
$L_{IA}^{Xo} = \int_o^b (\ x/b - x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/2\ b - 1/3\ b\ )\ Fb\ 1/EJ\ = 1/6\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (\ x/b - x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/2\ b - 1/3\ b\ )\ Fb\ 1/EJ\ = 1/6\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 212206 CI07.xxxx.134



$A = 996.\ mm^2$

$J_u = 282932.\ mm^4$

$J_v = 80208.\ mm^4$

$y_g = 31.02\ mm$

$T_y = 2900.\ N$

$M_x = -2175000.\ Nmm$

$x_m = 12.\ mm$

$u_m = -12.\ mm$

$v_m = -31.02\ mm$

$\sigma_m = -Mv/J_u = -238.4\ N/mm^2$

$x_c = 24.\ mm$

$y_c = 11.\ mm$

$v_c = -20.02\ mm$

$\sigma_c = -Mv/J_u = -153.9\ N/mm^2$

$\tau_c = 4.339\ N/mm^2$

$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 154.1\ N/mm^2$

$S^* = 5079.\ mm^3$

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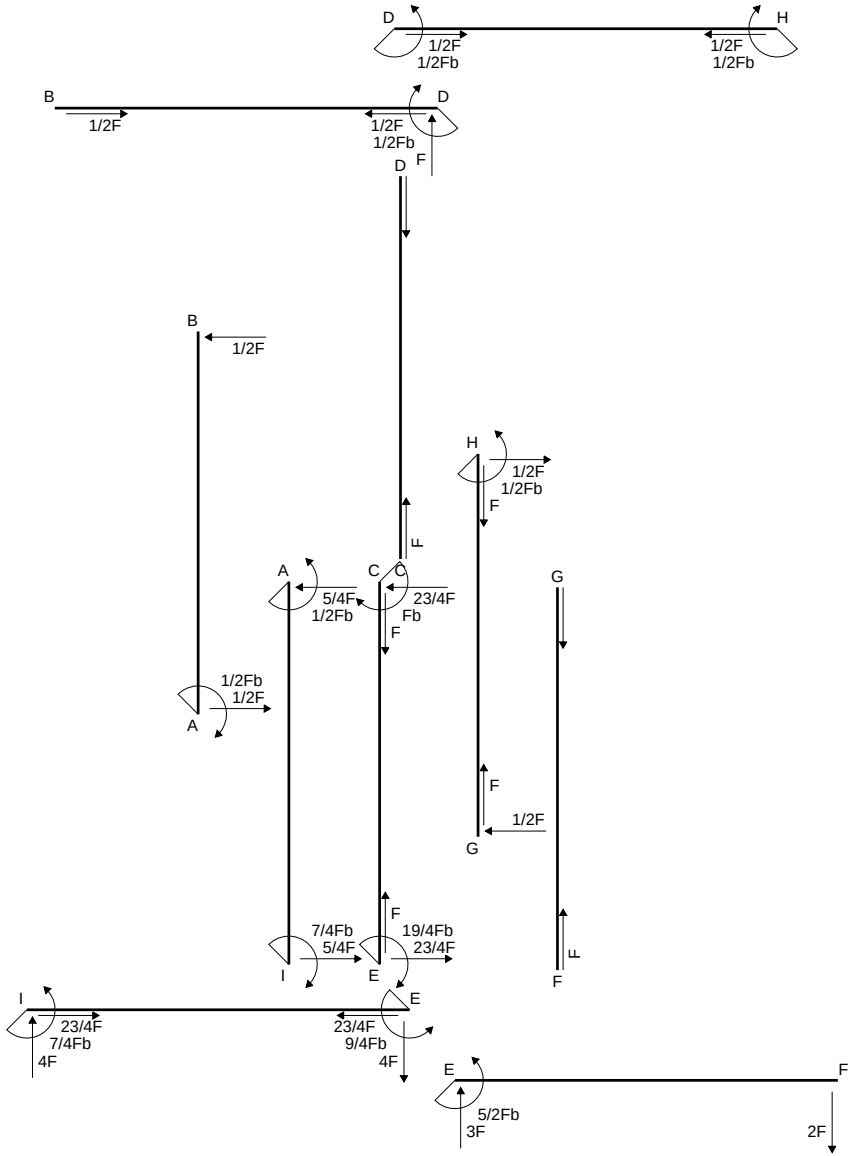
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1/2Fb
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1/2Fb
F
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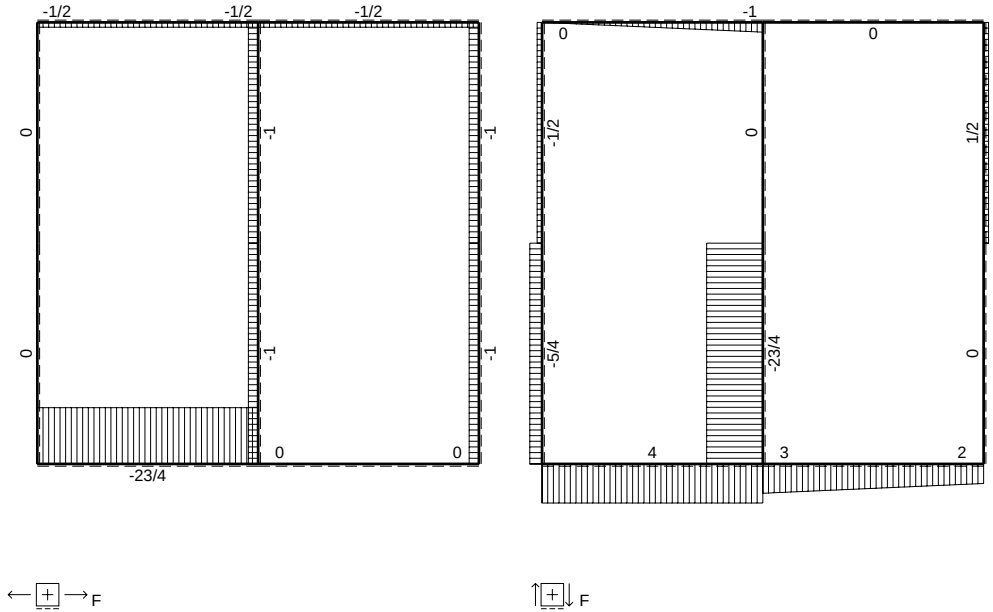
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4
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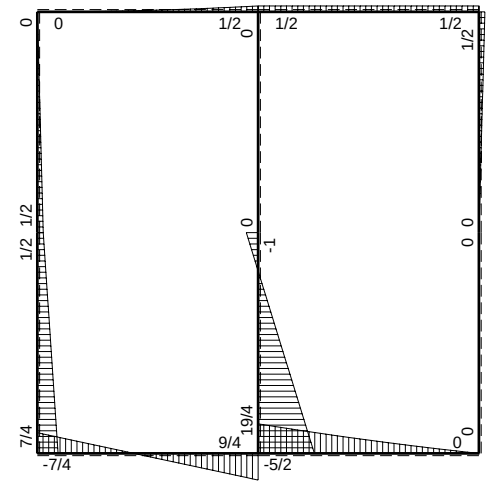
2
F
F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-5/2
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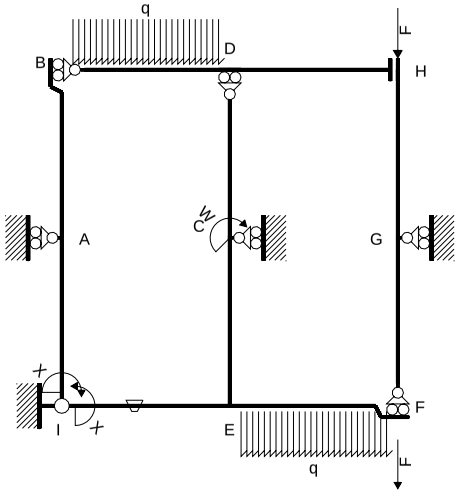
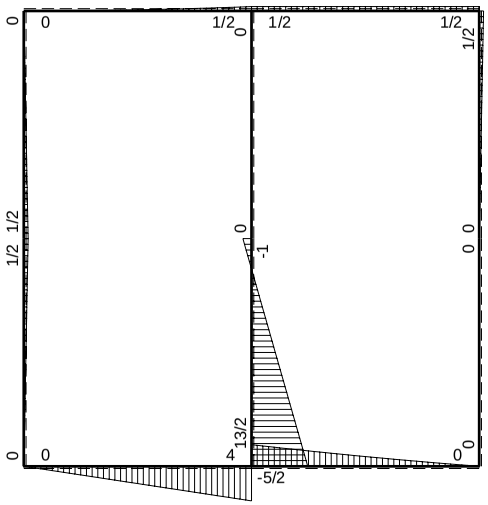
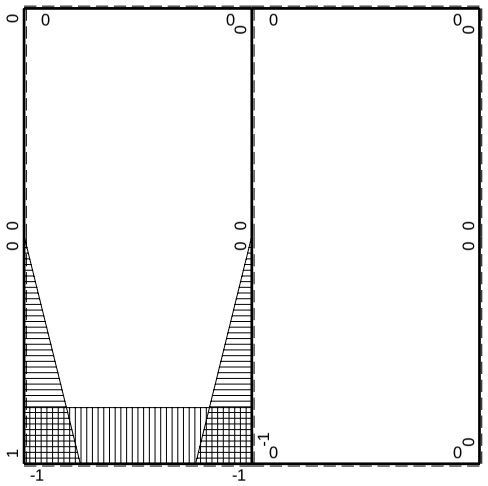
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 225500 CI07.xxxx.135

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
BA b	0	-1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-5/2Fb+3Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$2Fx+1/2qx^2$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fb+1/2Fx	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	4Fx	-Fb/EJ	-4Fx	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-4Fb+4Fx	Fb/EJ	-4Fb+4Fx	Fb/EJ	1		
EC b	-1+x/b	13/2Fb-15/2Fx	0	$-13/2Fb+14Fx-15/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	Fb-15/2Fx	0	$Fx-15/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	1/2Fx	0	$1/2Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	-1/2Fb+1/2Fx	0	$1/2Fx-1/2Fx^2/b$	0	x^2/b^2		
	totali						$-35/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						7/4Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-4 + 4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-4\ x + 2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-4\ b + 2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-13/2 + 14\ x/b - 15/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-13/2\ x + 7\ x^2/b - 5/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-13/2\ b + 7\ b - 5/2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (\ x/b - 15/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 5/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

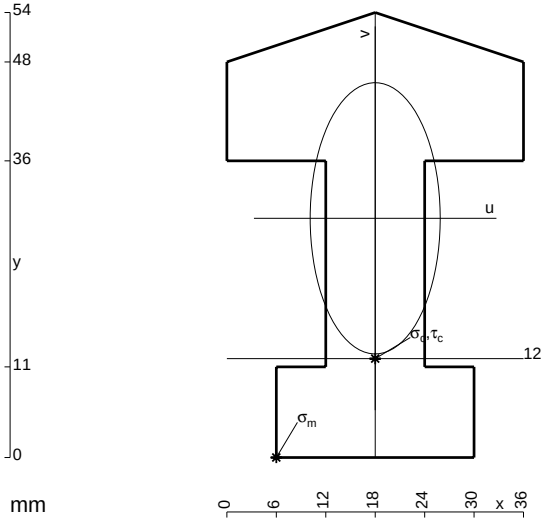
$= (1/2\ b - 5/2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1/2\ x/b - 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/4\ x^2/b - 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

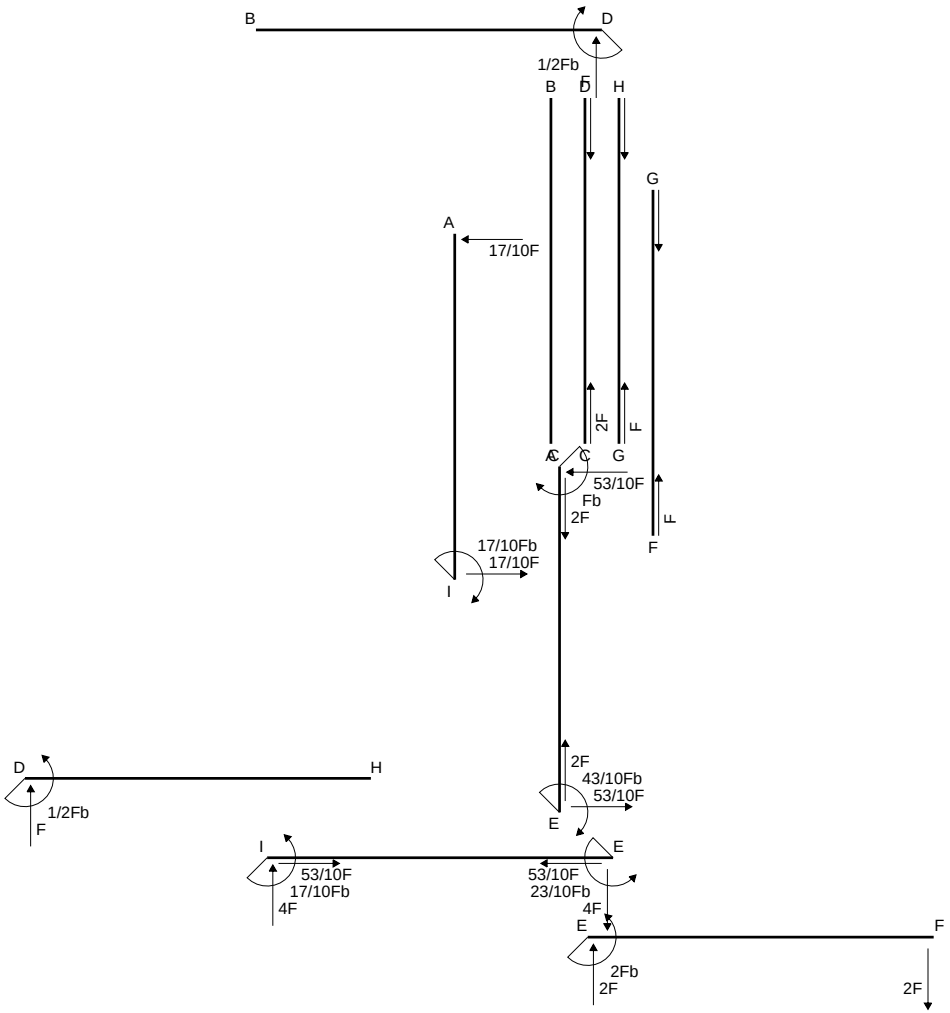
$= (1/4\ b - 1/6\ b\ )\ Fb\ 1/EJ\ = 1/12\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (1/2\ x/b - 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/4\ x^2/b - 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/4\ b - 1/6\ b\ )\ Fb\ 1/EJ\ = 1/12\ Fb^2/EJ$



A = 1104. mm^2
J_u = 299191. mm^4
J_v = 68760. mm^4
y_g = 29.03 mm
T_y = 3030. N
M_x = -2045250. Nmm
x_m = 6. mm
u_m = -12. mm
v_m = -29.03 mm
$\sigma_m = -Mv/J_u$ = -198.4 N/mm^2
x_c = 18. mm
y_c = 12. mm
v_c = -17.03 mm
$\sigma_c = -Mv/J_u$ = -116.4 N/mm^2
τ_c = 5.419 N/mm^2
$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2}$ = 116.8 N/mm^2
S^* = 6422. mm^3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17/10F
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2F
43/10Fb
53/10F
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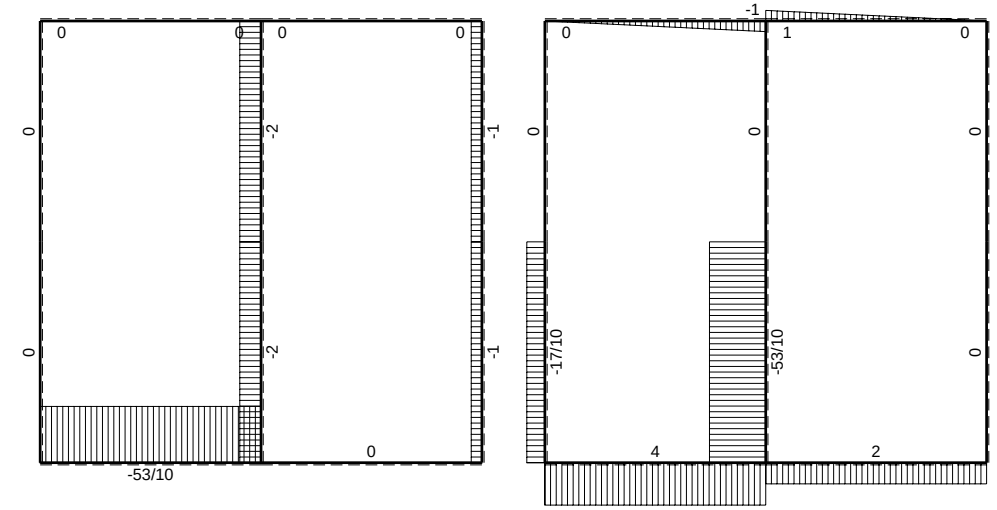
2F
2F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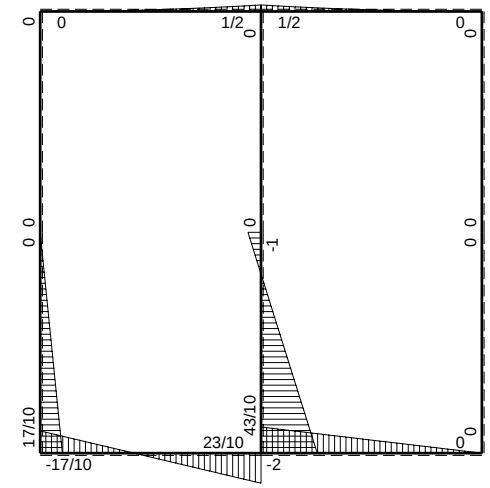
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17/10
43/10
23/10
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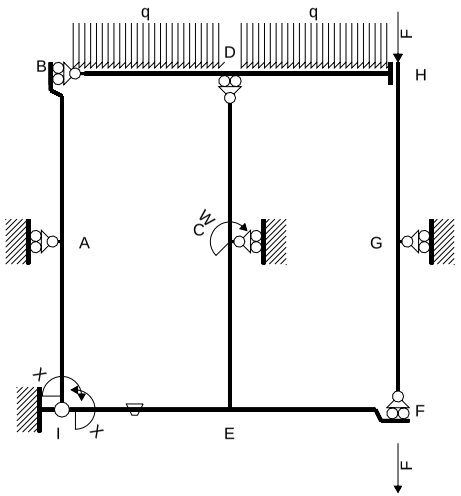
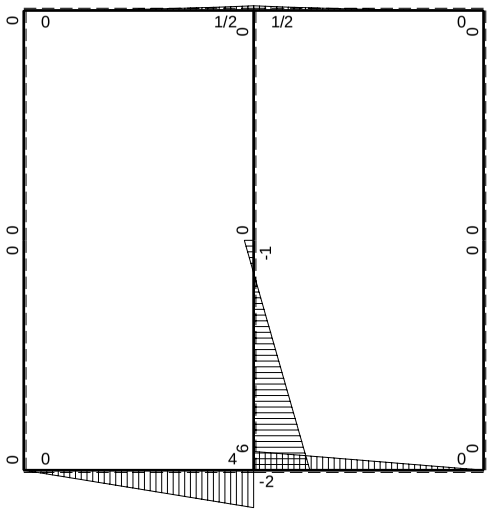
-17/10
-2

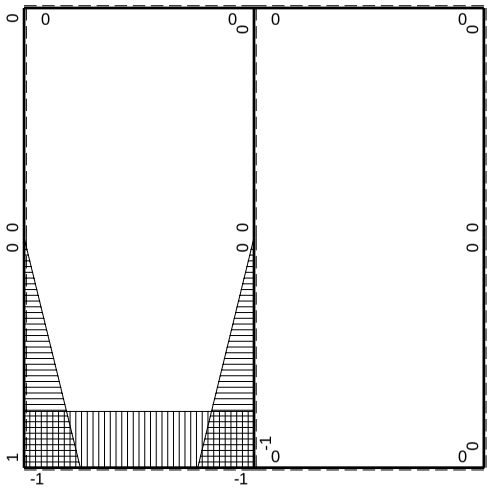
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 218622 CI07.xxxx.136

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PROCEDIMENTO E RISULTATI 218622 CI07.xxxx.136

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	0	0	0	0	0	0+0	0
HG b	0	0	0	0	0	0		
HD b	0	$1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	4Fx	-Fb/EJ	-4Fx	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-4Fb+4Fx	Fb/EJ	-4Fb+4Fx	Fb/EJ	1		
EC b	$-1+x/b$	6Fb-7Fx	0	$-6Fb+13Fx-7Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	Fb-7Fx	0	$Fx-7Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	1/3Xb/EJ
AI b	-x/b	0	0	0	0	x^2/b^2		
	totali						$-17/6Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						17/10Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-4 + 4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-4\ x + 2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

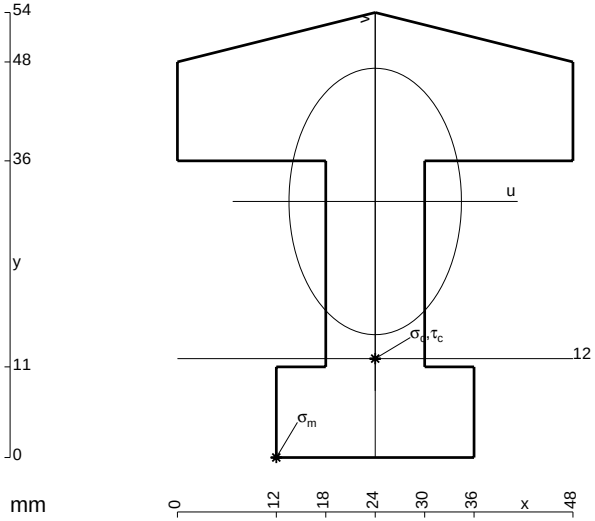
$= (-4\ b + 2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-6 + 13\ x/b - 7\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-6\ x + 13/2\ x^2/b - 7/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

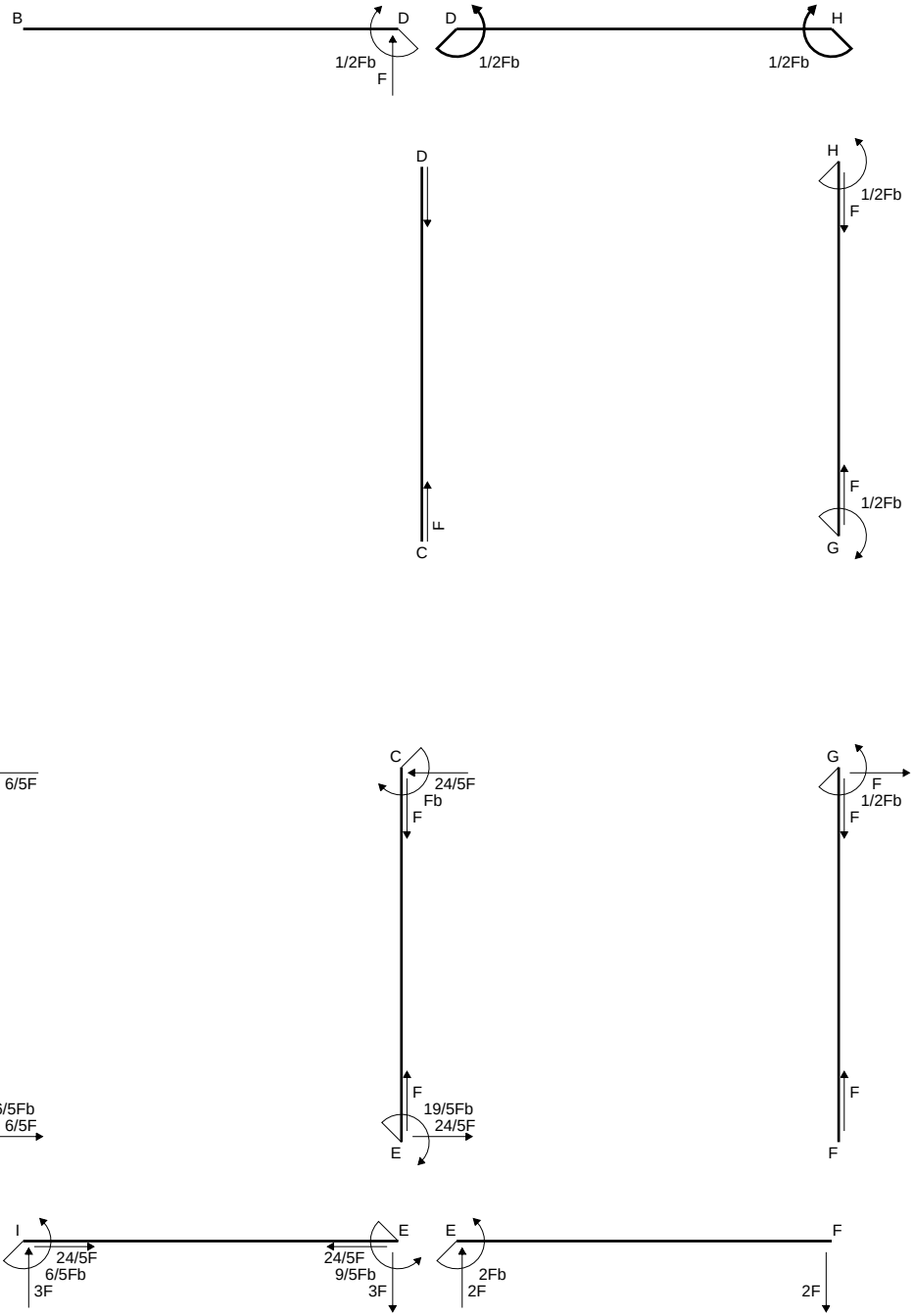
$= (-6\ b + 13/2\ b - 7/3\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (\ x/b - 7\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 7/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/2\ b - 7/3\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$



A = 1284. mm^2
J_u = 335702. mm^4
J_v = 140688. mm^4
y_g = 31.07 mm
T_y = 2620. N
M_x = -2253200. Nmm
x_m = 12. mm
u_m = -12. mm
v_m = -31.07 mm
$\sigma_m = -Mv/J_u$ = -208.5 N/mm^2
x_c = 24. mm
y_c = 12. mm
v_c = -19.07 mm
$\sigma_c = -Mv/J_u$ = -128. N/mm^2
τ_c = 4.543 N/mm^2
$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2}$ = 128.2 N/mm^2
S^* = 6985. mm^3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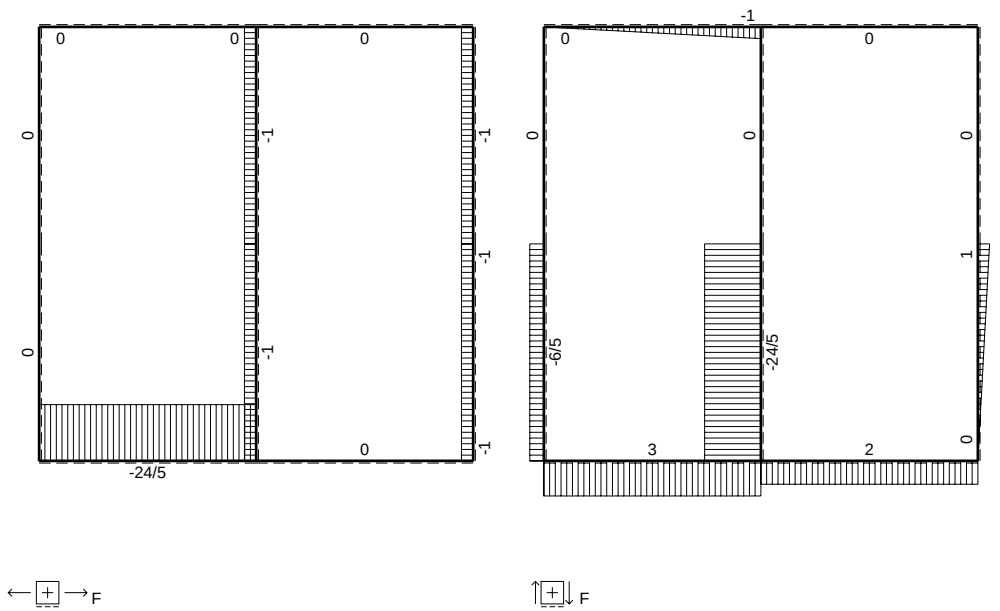
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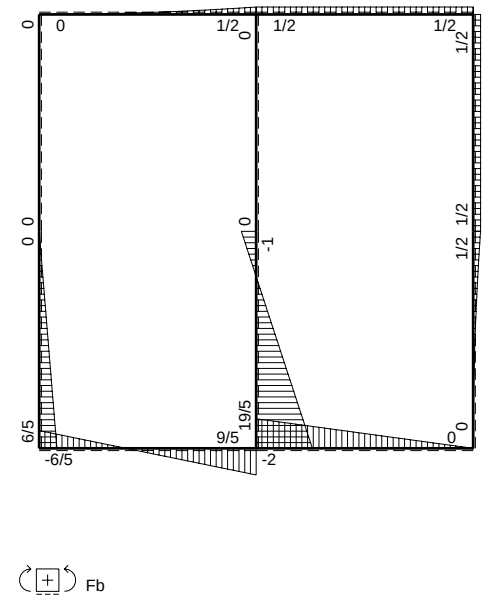
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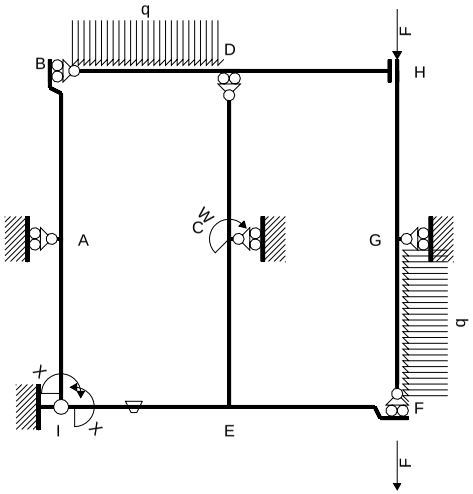
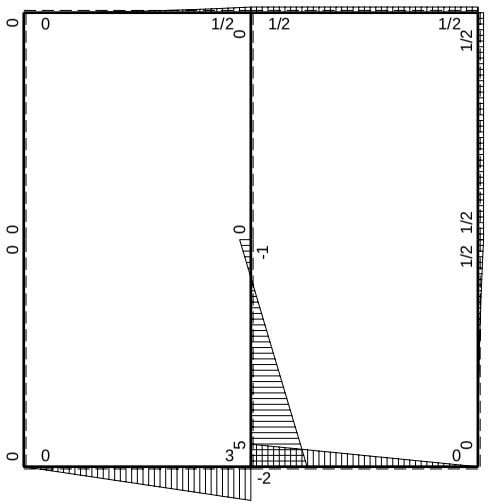
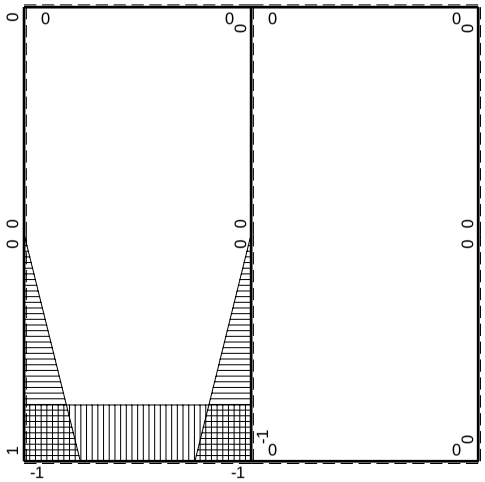
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

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PROCEDIMENTO E RISULTATI 216073 CI07.xxxx.137

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb	0	0	0	0	0+0	0
HG b	0	-1/2Fb	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-6Fx	0	$-5Fb+11Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	Fb-6Fx	0	$Fx-6Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	1/3Xb/EJ
AI b	-x/b	0	0	0	0	x^2/b^2		
	totali						$-2Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						6/5Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

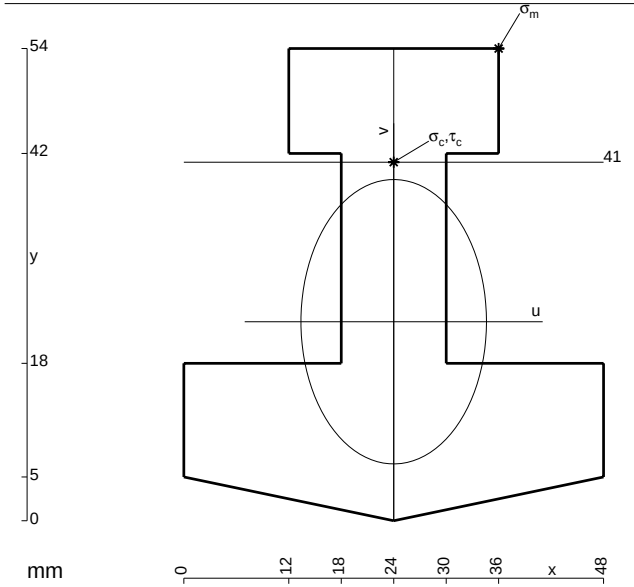
$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 11\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 11/2\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

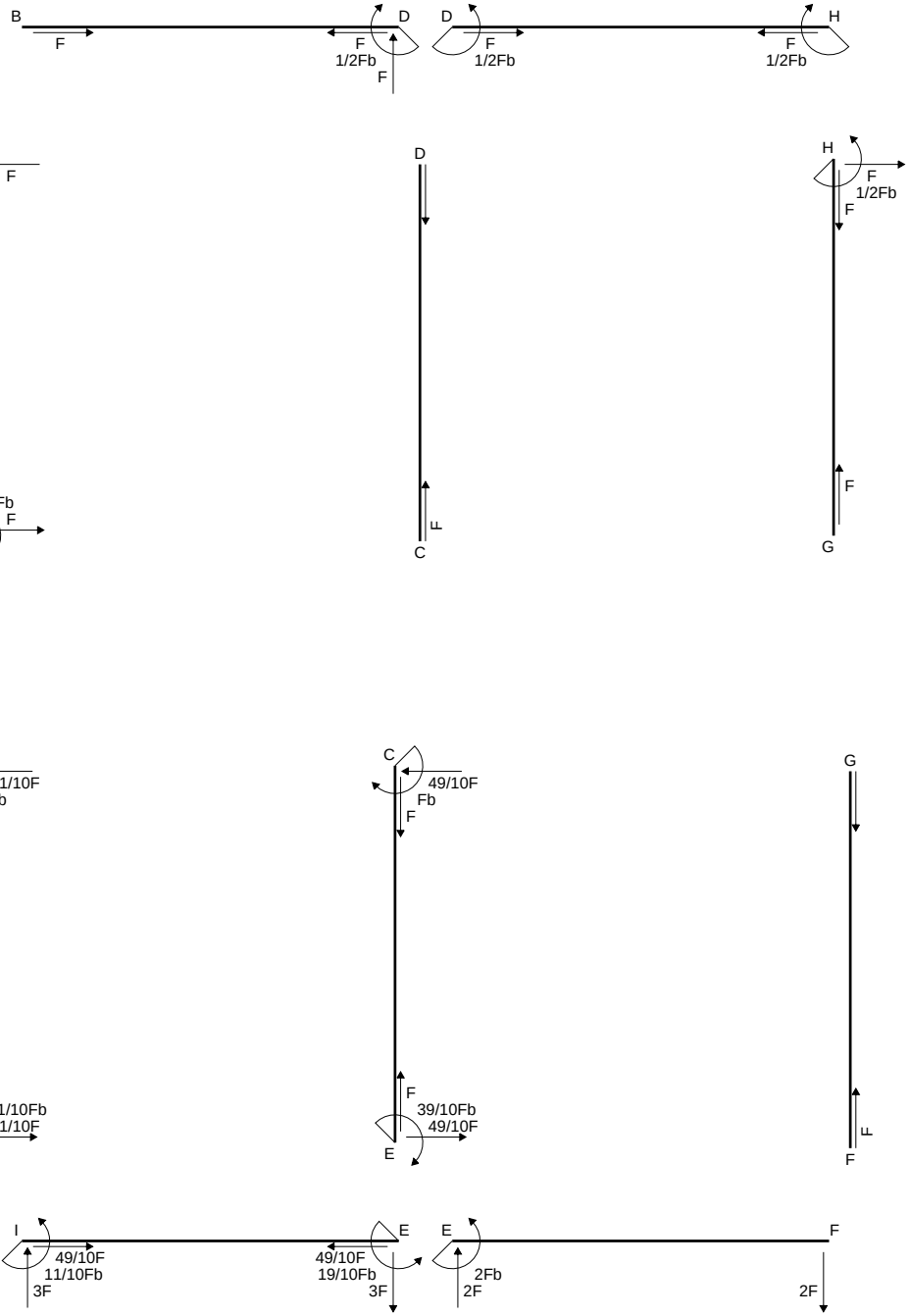
$= (-5\ b + 11/2\ b - 2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/2\ b - 2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$



A = 1320. mm^2
J_u = 349206. mm^4
J_v = 148608. mm^4
y_g = 22.76 mm
T_y = 2700. N
M_x = -2457000. Nmm
x_m = 36. mm
y_m = 54. mm
u_m = 12. mm
v_m = 31.24 mm
$\sigma_m = -Mv/J_u$ = 219.8 N/mm^2
x_c = 24. mm
y_c = 41. mm
v_c = 18.24 mm
$\sigma_c = -Mv/J_u$ = 128.4 N/mm^2
τ_c = 4.829 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 128.6 N/mm^2
S^* = 7495. mm^3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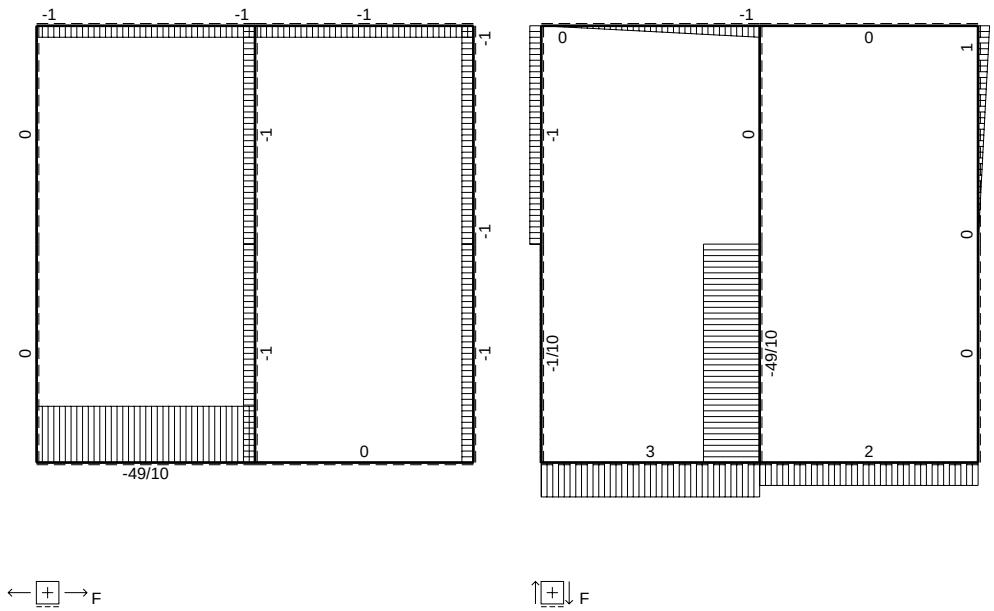
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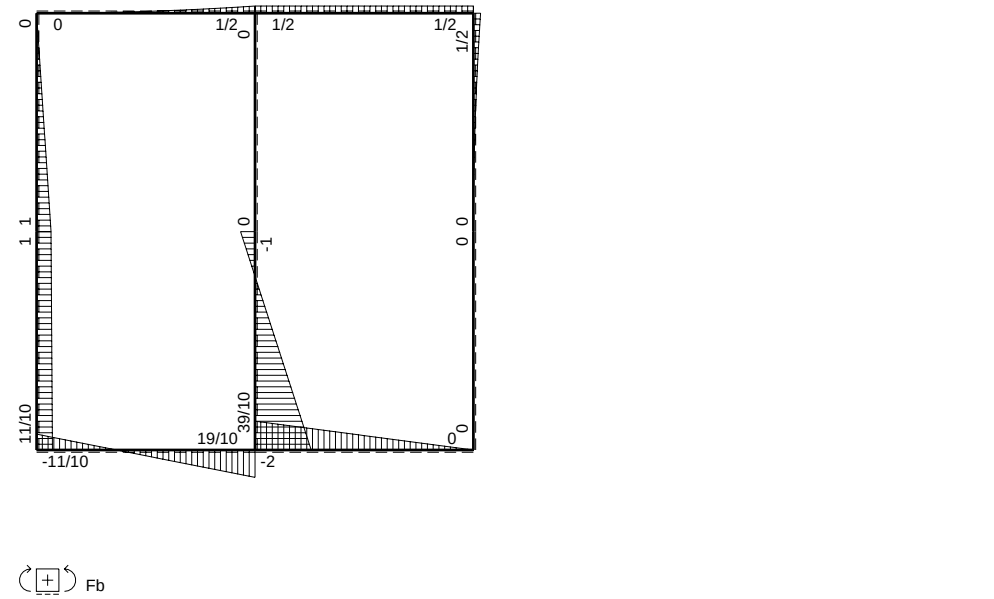
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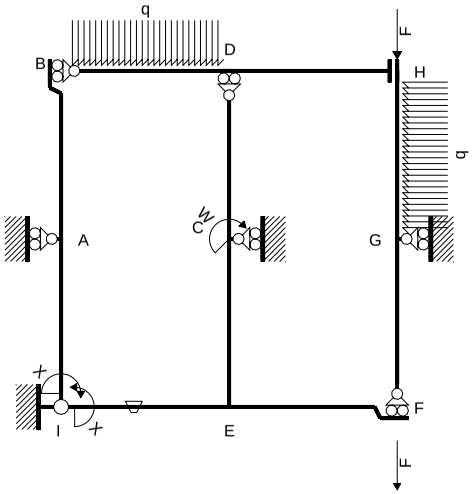
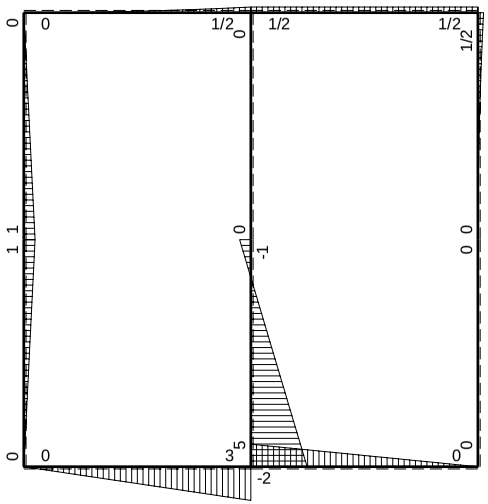
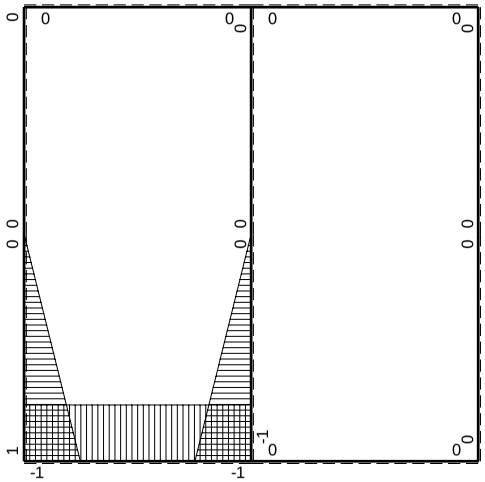
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 960451 CI07.xxxx.138

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PROCEDIMENTO E RISULTATI 960451 CI07.xxxx.138

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	Fb-Fx	0	0	0	0	0+0	0
BA b	0	-Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	5Fb-6Fx	0	$-5Fb+11Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	Fb-6Fx	0	$Fx-6Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	Fx	0	$Fx-Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	-Fb+Fx	0	$Fx-Fx^2/b$	0	x^2/b^2		
	totali						$-11/6Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						11/10Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 11\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 11/2\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 11/2\ b - 2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

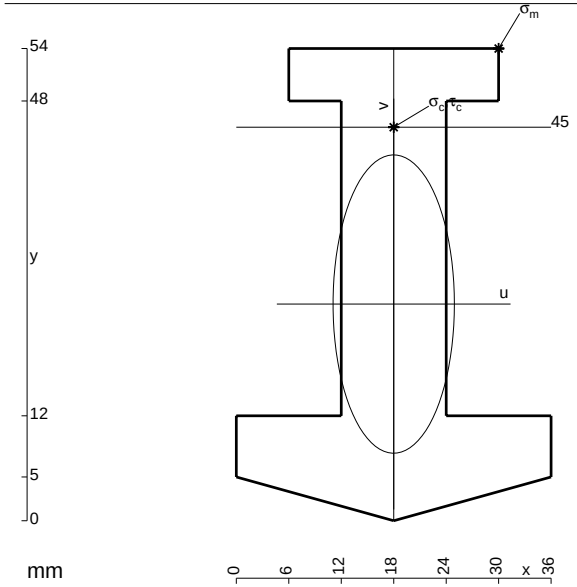
$= (1/2\ b - 2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (\ x/b - x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

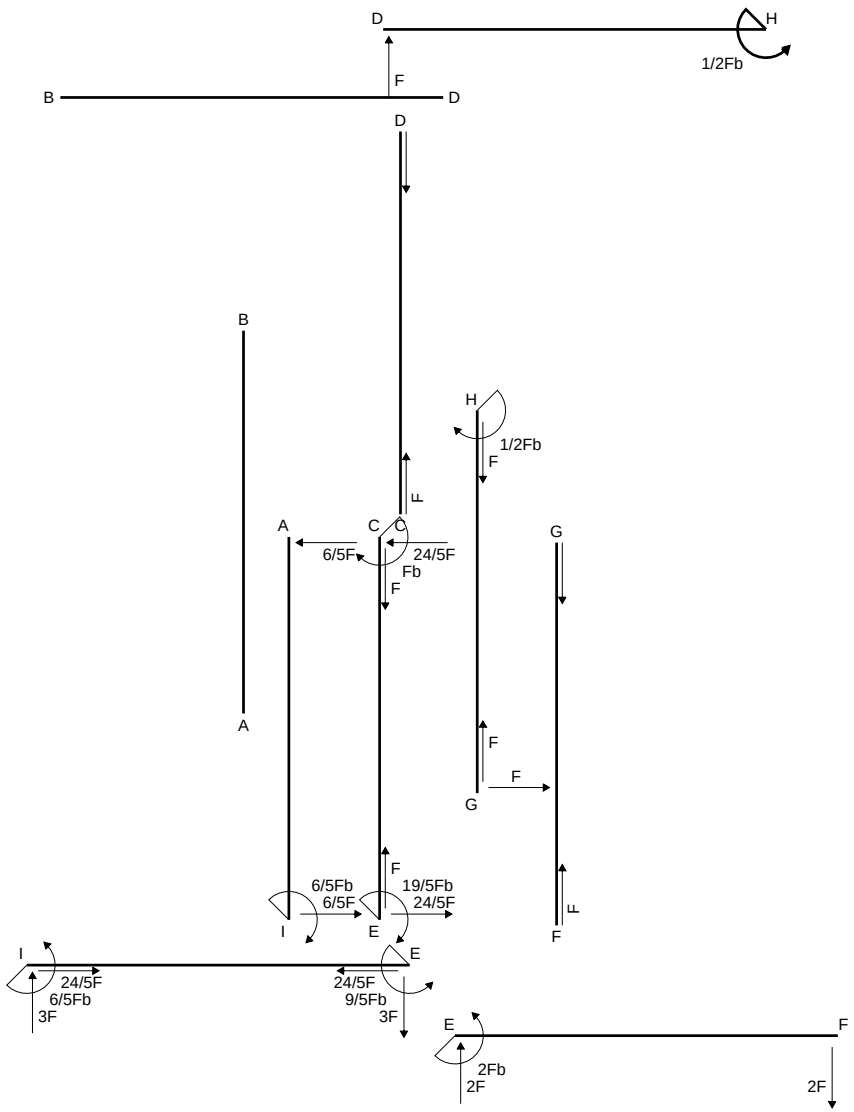
$= (1/2\ b - 1/3\ b\ )\ Fb\ 1/EJ\ = 1/6\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (\ x/b - x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/2\ b - 1/3\ b\ )\ Fb\ 1/EJ\ = 1/6\ Fb^2/EJ$



A = 918. mm^2
J_u = 267198. mm^4
J_v = 44172. mm^4
y_g = 24.78 mm
T_y = 2160. N
M_x = -2095200. Nmm
x_m = 30. mm
y_m = 54. mm
u_m = 12. mm
v_m = 29.22 mm
$\sigma_m = -Mv/J_u$ = 229.1 N/mm^2
x_c = 18. mm
y_c = 45. mm
v_c = 20.22 mm
$\sigma_c = -Mv/J_u$ = 158.6 N/mm^2
τ_c = 3.071 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 158.7 N/mm^2
S^* = 4558. mm^3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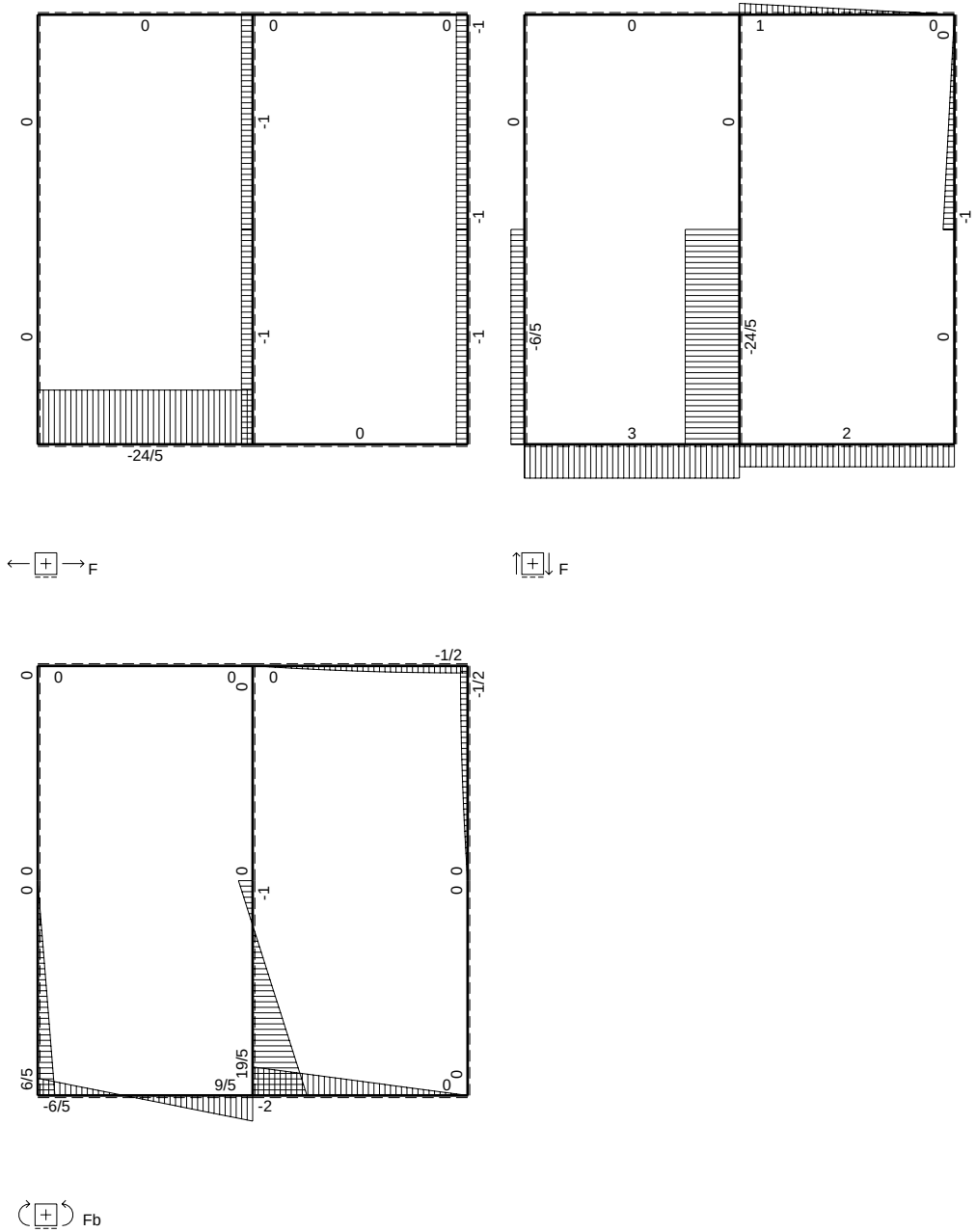
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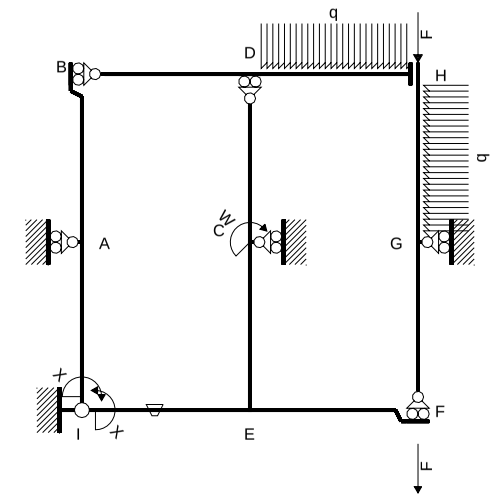
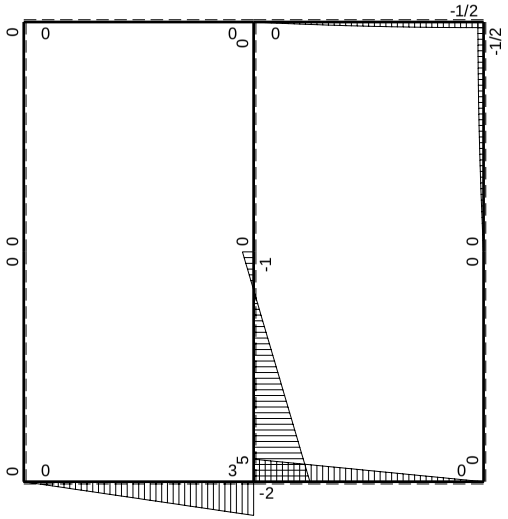
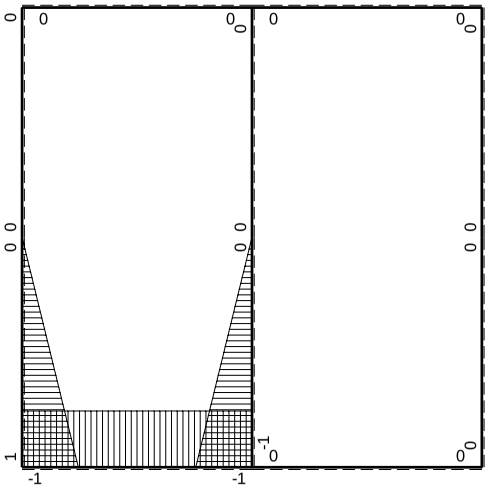


Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 986595 CI07.xxxx.139

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-6Fx	0	$-5Fb+11Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	Fb-6Fx	0	$Fx-6Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	1/3Xb/EJ
AI b	-x/b	0	0	0	0	x^2/b^2		
	totali						$-2Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						6/5Fb	

PROCEDIMENTO E RISULTATI 986595 CI07.xxxx.139

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

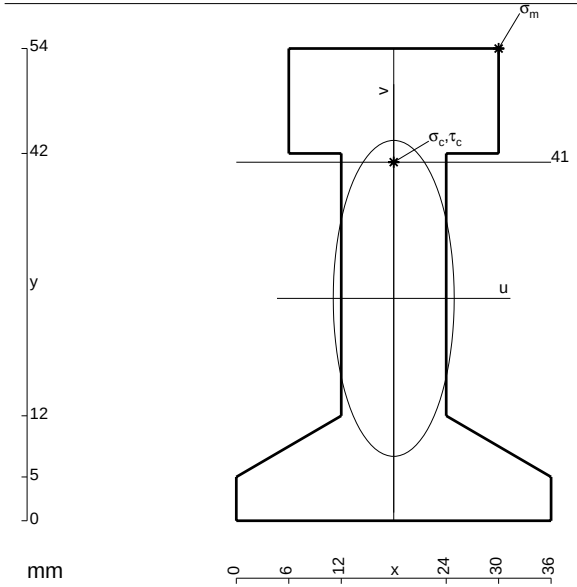
$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 11\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 11/2\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

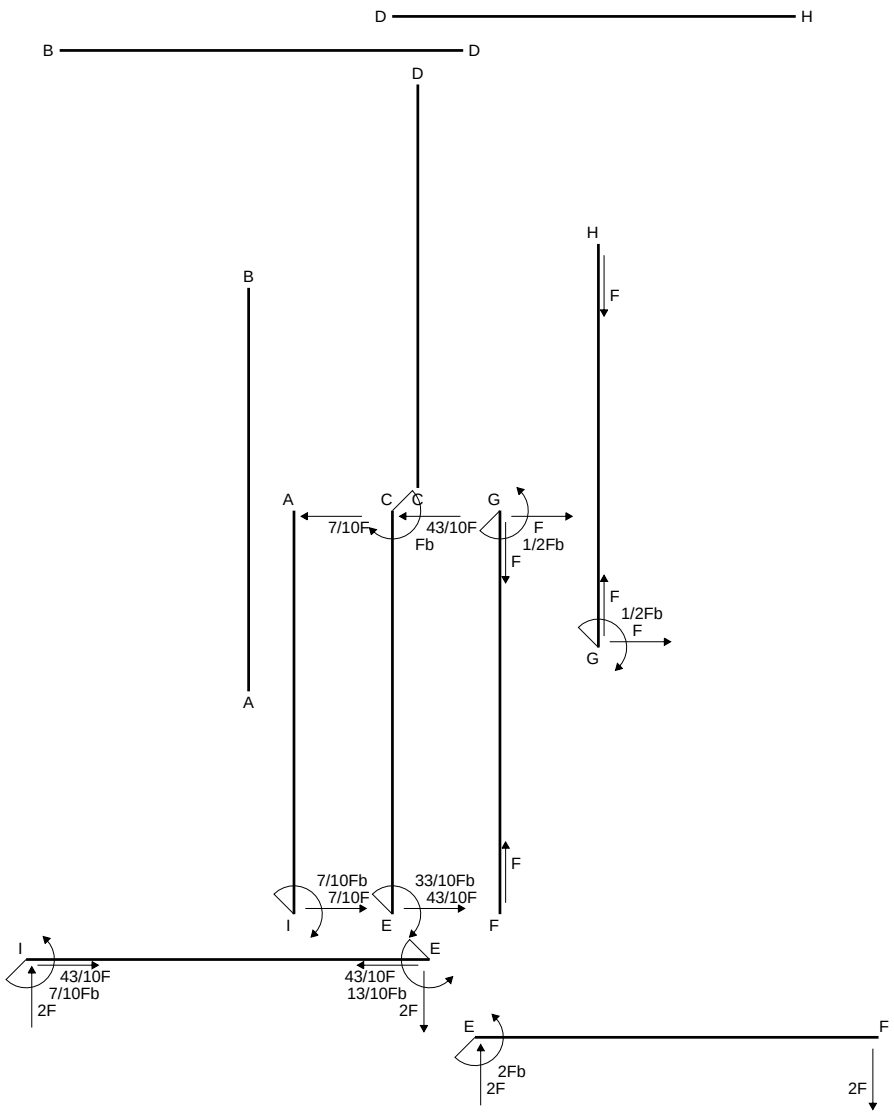
$= (-5\ b + 11/2\ b - 2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/2\ b - 2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$



A = 996. mm^2
J_u = 325226. mm^4
J_v = 47664. mm^4
y_g = 25.43 mm
T_y = 2660. N
M_x = -2713200. Nmm
x_m = 30. mm
y_m = 54. mm
u_m = 12. mm
v_m = 28.57 mm
$\sigma_m = -Mv/J_u$ = 238.4 N/mm^2
x_c = 18. mm
y_c = 41. mm
v_c = 15.57 mm
$\sigma_c = -Mv/J_u$ = 129.9 N/mm^2
τ_c = 4.563 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 130.2 N/mm^2
S^* = 6694. mm^3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F
7/10Fb
7/10F
33/10Fb
43/10F
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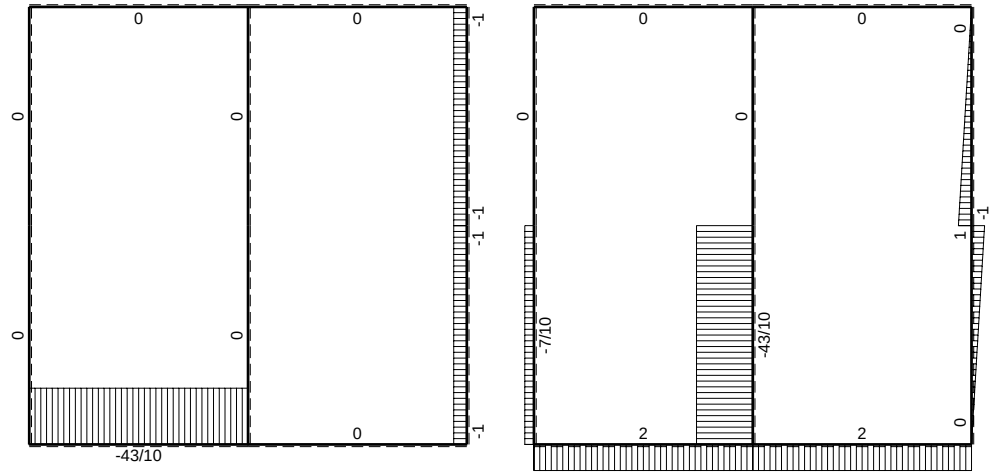
2F
2F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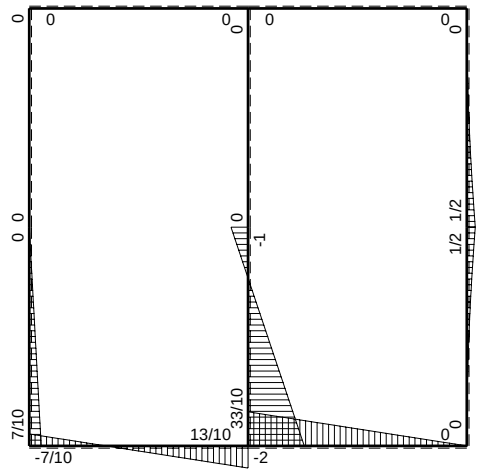
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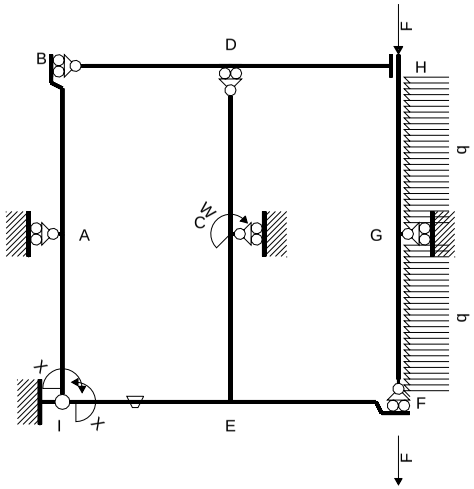
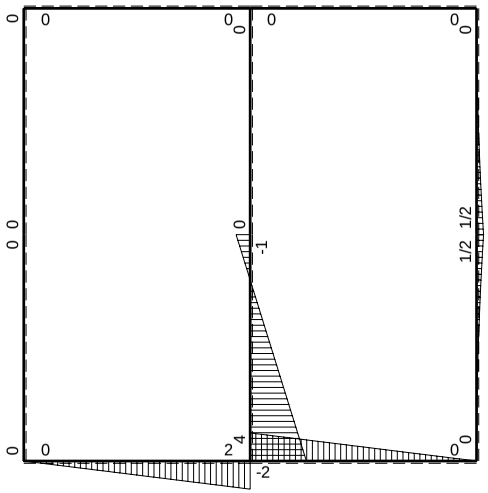
-2

Fb



Schema di calcolo iperstatico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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2qx^2$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	-1+x/b	4Fb-5Fx	0	$-4Fb+9Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-7/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	Fb-5Fx	0	$Fx-5Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	1/3Xb/EJ
AI b	-x/b	0	0	0	0	x^2/b^2		
	totali						$-7/6Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						7/10Fb	

PROCEDIMENTO E RISULTATI 998772 CI07.xxxx.140

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L_{EI}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

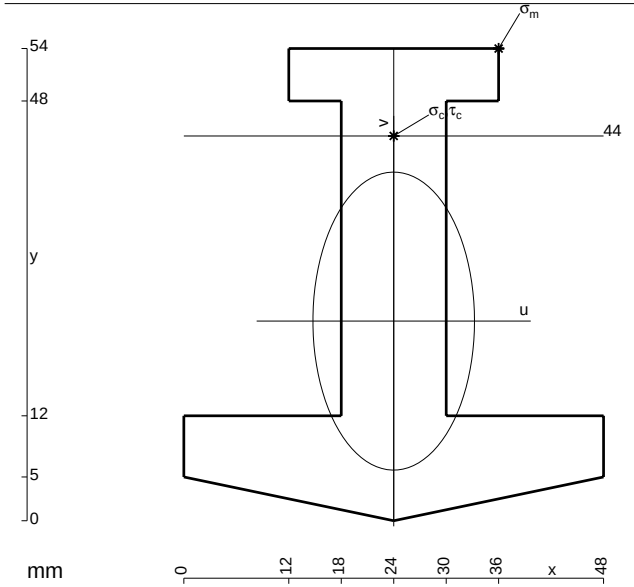
$L_{EC}^{Xo} = \int_o^b (-4 + 9\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4\ x + 9/2\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-4\ b + 9/2\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -7/6\ Fb^2/EJ$

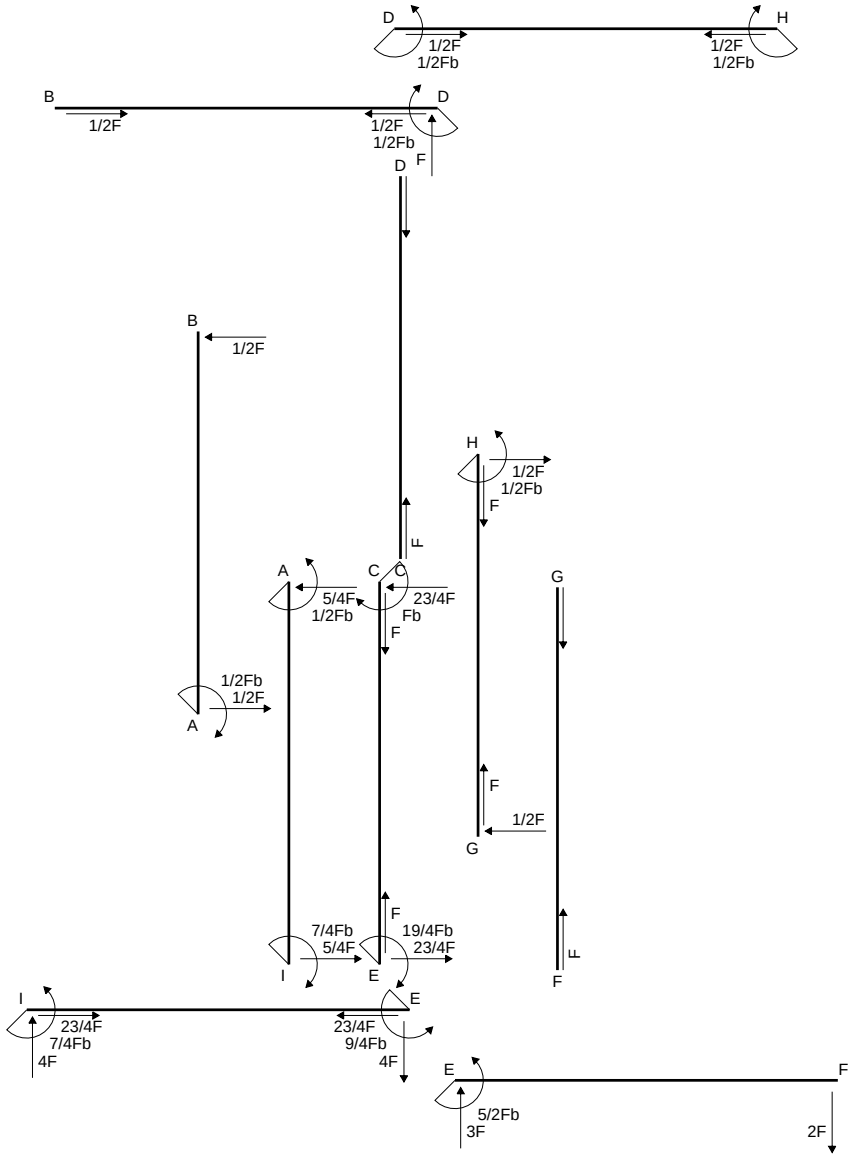
$L_{CE}^{Xo} = \int_o^b (\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/2\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -7/6\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 998772 CI07.xxxx.140



A = 1032. mm^2
J_u = 299718. mm^4
J_v = 88128. mm^4
y_g = 22.83 mm
T_y = 3560. N
M_x = -1922400. Nmm
x_m = 36. mm
y_m = 54. mm
u_m = 12. mm
v_m = 31.17 mm
$\sigma_m = -Mv/J_u$ = 199.9 N/mm^2
x_c = 24. mm
y_c = 44. mm
v_c = 21.17 mm
$\sigma_c = -Mv/J_u$ = 135.8 N/mm^2
τ_c = 5.116 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 136.1 N/mm^2
S^* = 5169. mm^3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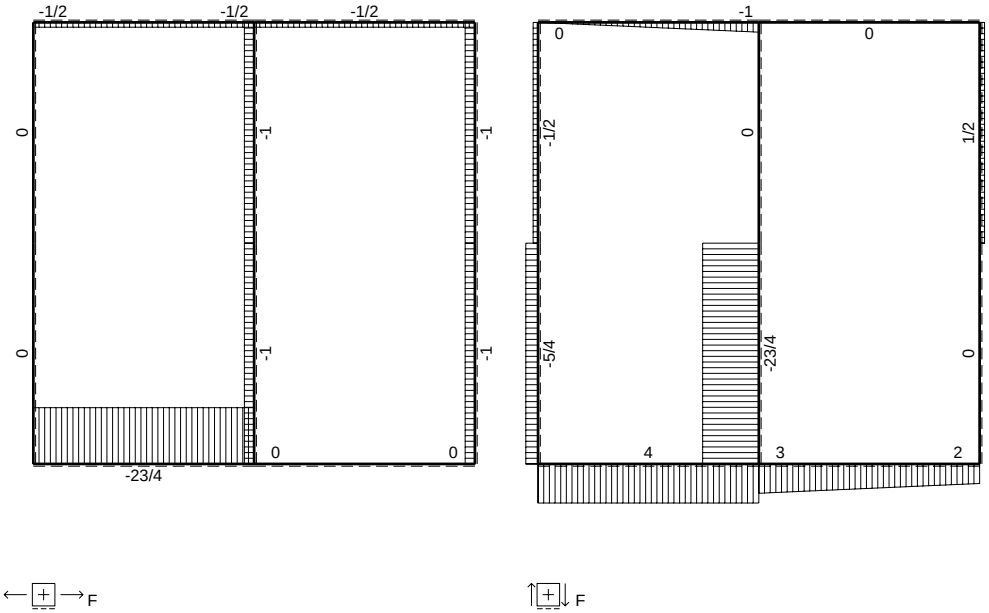
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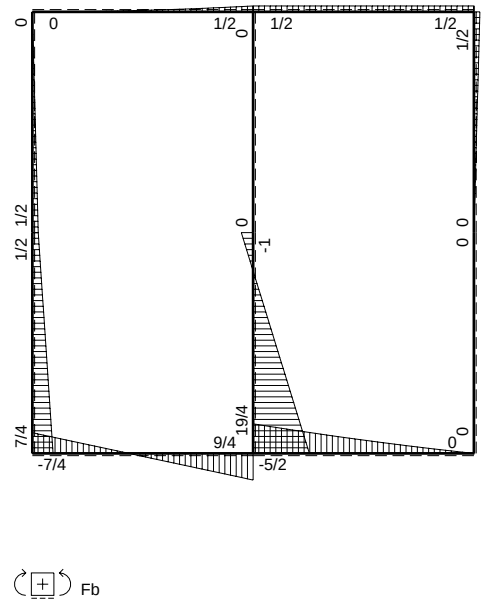
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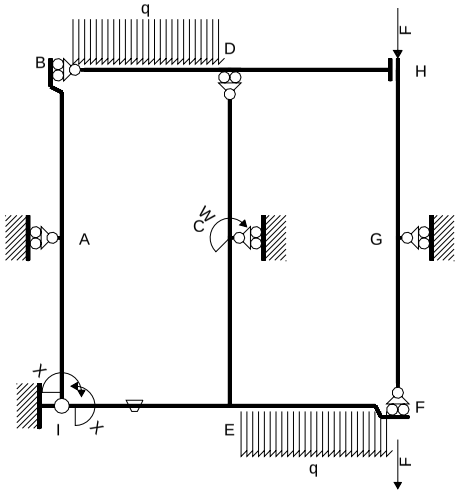
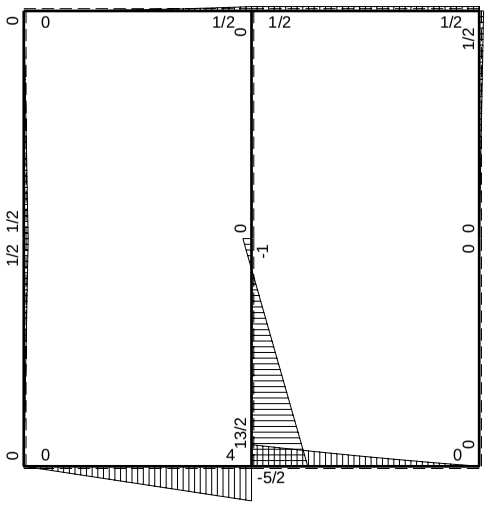
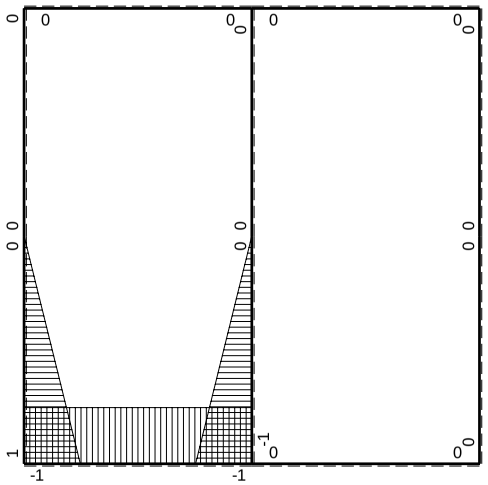
-5/2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 994404 CI07.xxxx.141

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PROCEDIMENTO E RISULTATI 994404 CI07.xxxx.141

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
BA b	0	-1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-5/2Fb+3Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$2Fx+1/2qx^2$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fb+1/2Fx	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	4Fx	-Fb/EJ	-4Fx	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-4Fb+4Fx	Fb/EJ	-4Fb+4Fx	Fb/EJ	1		
EC b	-1+x/b	13/2Fb-15/2Fx	0	$-13/2Fb+14Fx-15/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	Fb-15/2Fx	0	$Fx-15/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	1/2Fx	0	$1/2Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	-1/2Fb+1/2Fx	0	$1/2Fx-1/2Fx^2/b$	0	x^2/b^2		
	totali						$-35/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						7/4Fb	

Sviluppi di calcolo iperstatica

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$L^{XX}_{IE} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EI} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EC} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{CE} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{IA} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{AI} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{Xo}_{IE} = \int_o^b (-4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L^{Xo}_{EI} = \int_o^b (-4 + 4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-4\ x + 2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-4\ b + 2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L^{Xo}_{EC} = \int_o^b (-13/2 + 14\ x/b - 15/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-13/2\ x + 7\ x^2/b - 5/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-13/2\ b + 7\ b - 5/2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

$L^{Xo}_{CE} = \int_o^b (\ x/b - 15/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 5/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

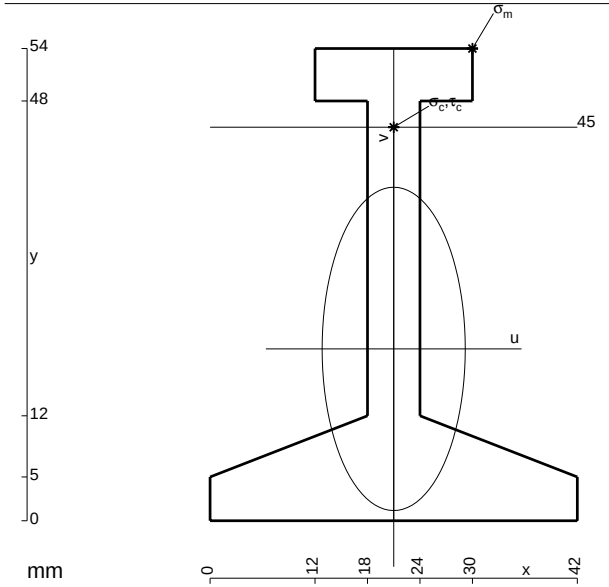
$= (1/2\ b - 5/2\ b\ )\ Fb\ 1/EJ\ = -2\ Fb^2/EJ$

$L^{Xo}_{IA} = \int_o^b (1/2\ x/b - 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/4\ x^2/b - 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

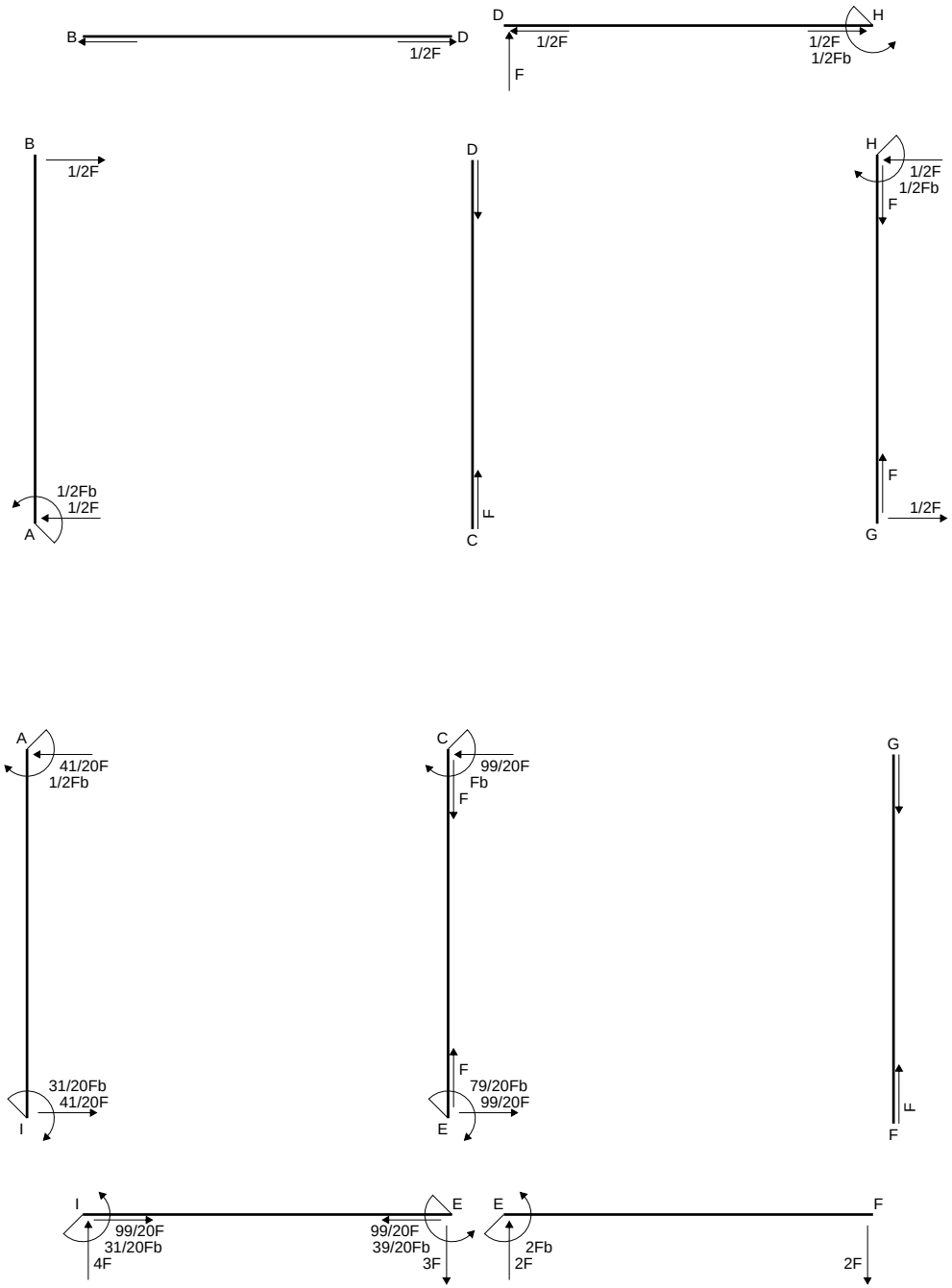
$= (1/4\ b - 1/6\ b\ )\ Fb\ 1/EJ\ = 1/12\ Fb^2/EJ$

$L^{Xo}_{AI} = \int_o^b (1/2\ x/b - 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/4\ x^2/b - 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/4\ b - 1/6\ b\ )\ Fb\ 1/EJ\ = 1/12\ Fb^2/EJ$



A = 702. mm^2
J_u = 239989. mm^4
J_v = 47034. mm^4
y_g = 19.65 mm
T_y = 2970. N
M_x = -1460250. Nmm
x_m = 30. mm
y_m = 54. mm
u_m = 9. mm
v_m = 34.35 mm
$\sigma_m = -Mv/J_u$ = 209. N/mm^2
x_c = 21. mm
y_c = 45. mm
v_c = 25.35 mm
$\sigma_c = -Mv/J_u$ = 154.2 N/mm^2
τ_c = 7.981 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 154.9 N/mm^2
S^* = 3869. mm^3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1/2F
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D
F
C
H
1/2F
1/2Fb
F
F
1/2F
G
A
41/20F
1/2Fb
31/20Fb
41/20F
I
C
99/20F
Fb
F
F
79/20Fb
99/20F
E
G
F
I
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4F
E
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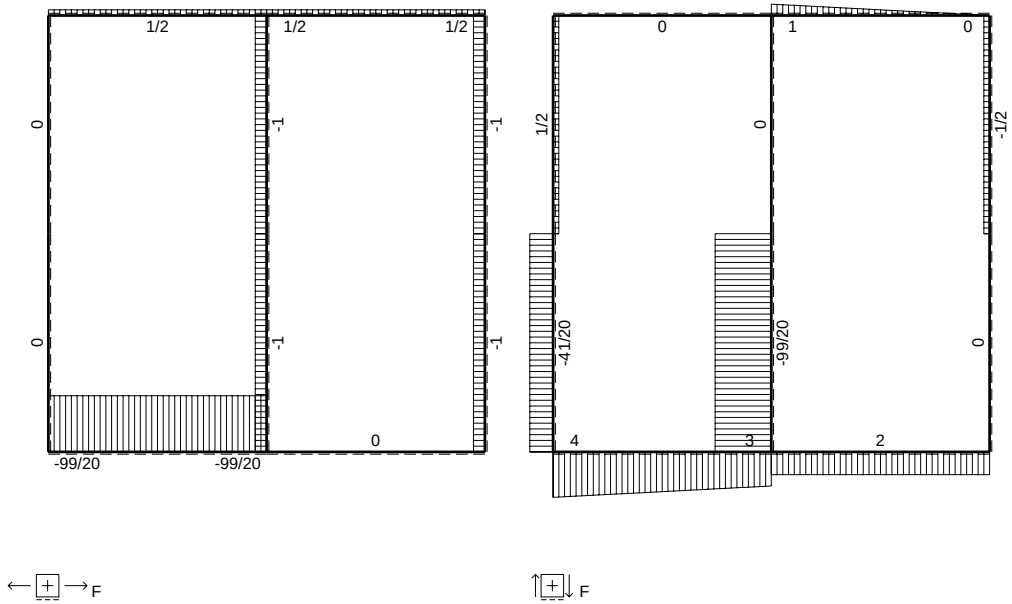
39/20Fb
3F
E
2Fb
2F
F
2F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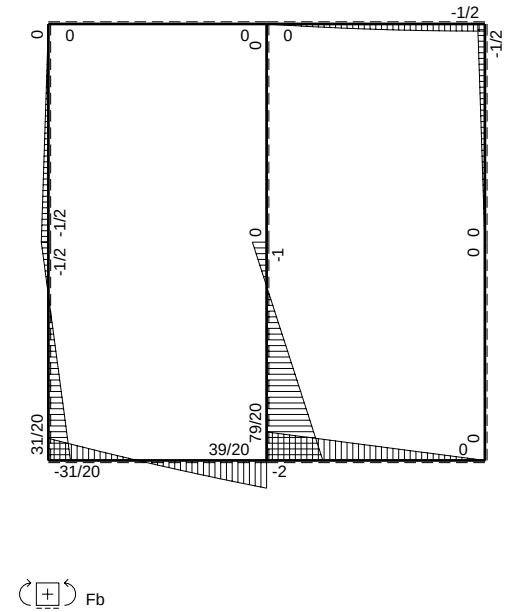
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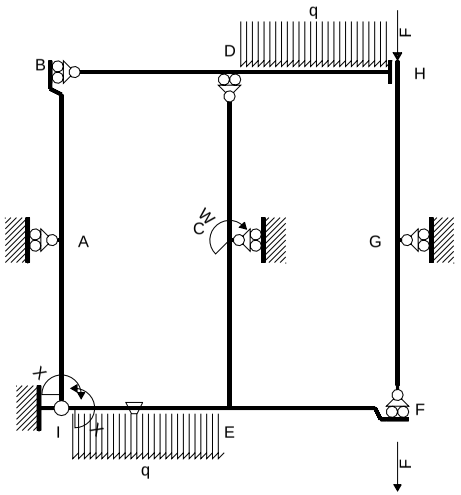
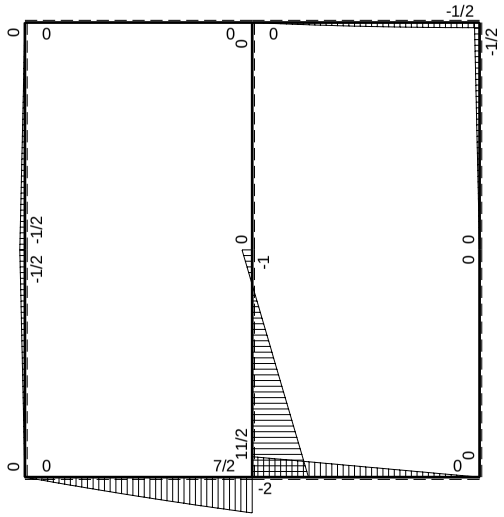
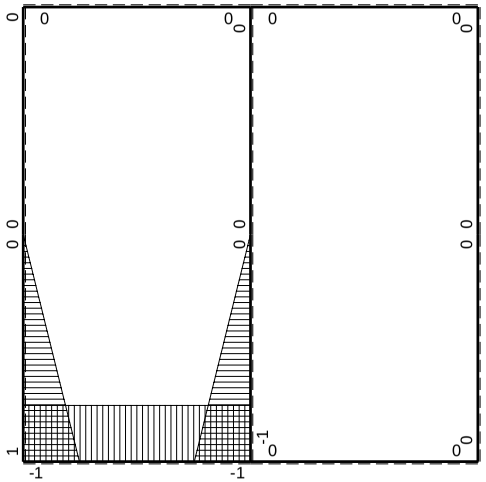
0 0
0 0
31/20
39/20
79/20
-31/20
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 939660 CI07.xxxx.142

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	-1/2Fx	0	0	0	0	0+0	0
HG b	0	1/2Fb-1/2Fx	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$4Fx-1/2qx^2$	-Fb/EJ	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	-1+x/b	11/2Fb-13/2Fx	0	$-11/2Fb+12Fx-13/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	Fb-13/2Fx	0	$Fx-13/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-31/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						31/20Fb	

Sviluppi di calcolo iperstatica

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$L^{XX}_{IE} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EI} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EC} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{CE} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{IA} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{AI} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{Xo}_{IE} = \int_o^b (-4\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L^{Xo}_{EI} = \int_o^b (-7/2 + 3\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx$

$= [-7/2\ x + 3/2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-7/2\ b + 3/2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L^{Xo}_{EC} = \int_o^b (-11/2 + 12\ x/b - 13/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-11/2\ x + 6\ x^2/b - 13/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-11/2\ b + 6\ b - 13/6\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L^{Xo}_{CE} = \int_o^b (\ x/b - 13/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 13/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/2\ b - 13/6\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

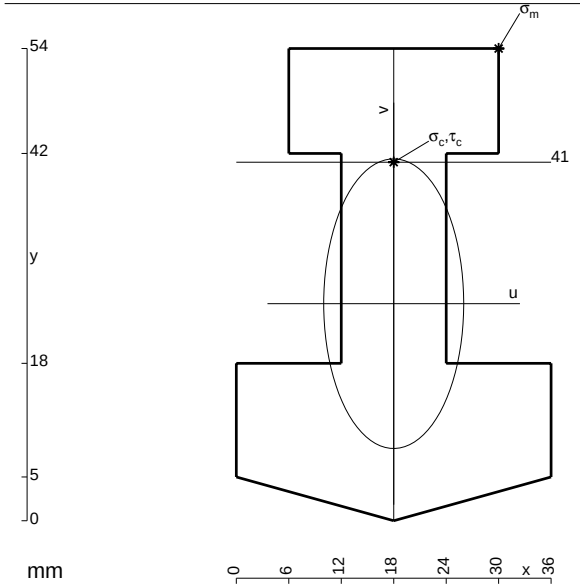
$L^{Xo}_{IA} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

$L^{Xo}_{AI} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 939660 CI07.xxxx.142



A = 1134. mm^2
J_u = 311054. mm^4
J_v = 72684. mm^4
y_g = 24.82 mm
T_y = 3660. N
M_x = -2342400. Nmm
x_m = 30. mm
y_m = 54. mm
u_m = 12. mm
v_m = 29.18 mm
$\sigma_m = -Mv/J_u$ = 219.7 N/mm^2
x_c = 18. mm
y_c = 41. mm
v_c = 16.18 mm
$\sigma_c = -Mv/J_u$ = 121.8 N/mm^2
τ_c = 6.742 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 122.4 N/mm^2
S^* = 6876. mm^3

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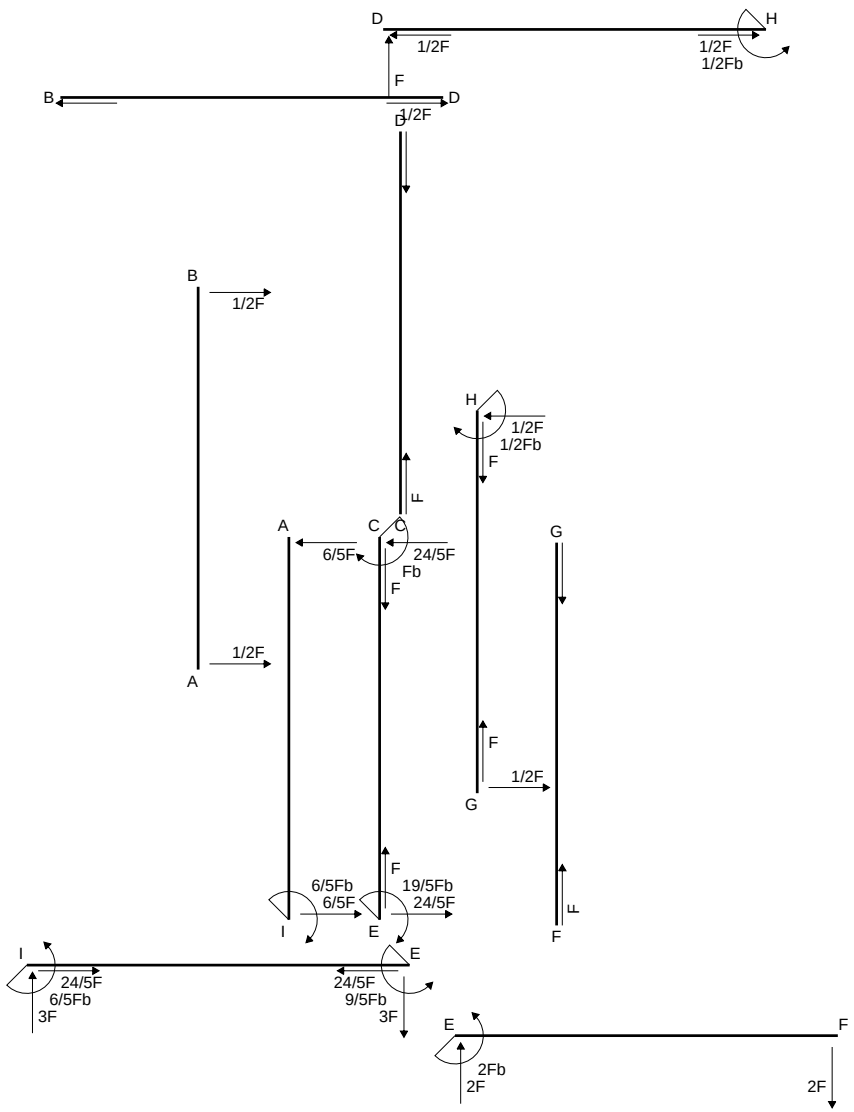
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B
1/2F
H
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1/2Fb
F
F
A
C
C
6/5F
24/5F
Fb
F
G
1/2F
A
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F
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1/2F
G
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F
6/5Fb
6/5F
F
19/5Fb
24/5F
I
E
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6/5Fb
3F
24/5F
9/5Fb
3F
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2F
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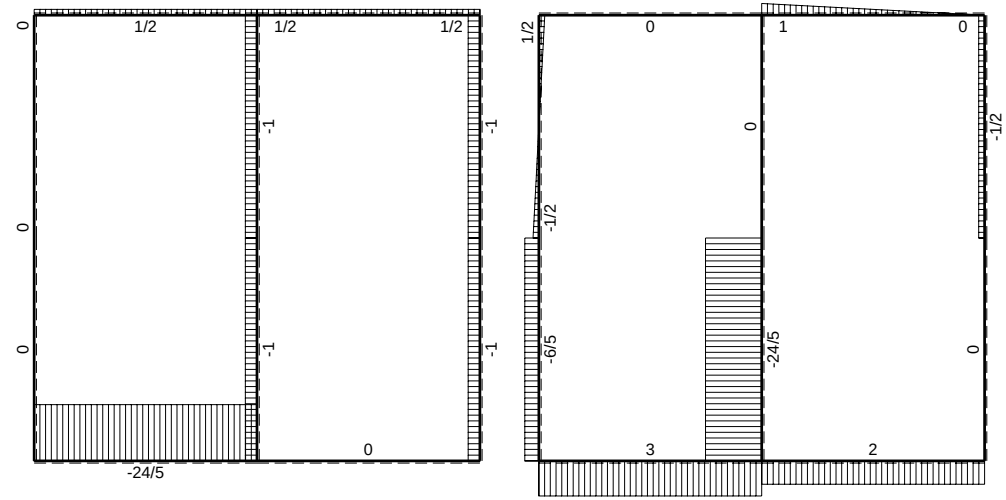
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-24/5
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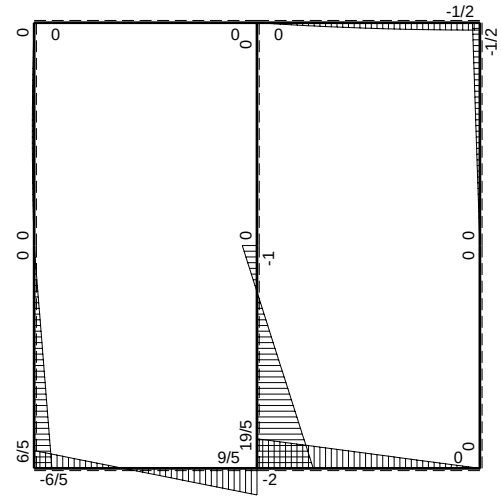
2
F
F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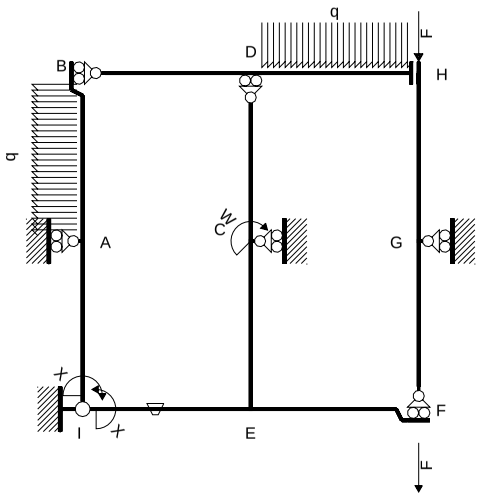
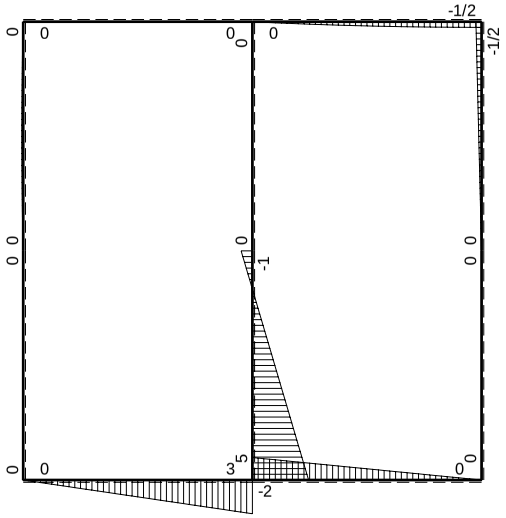
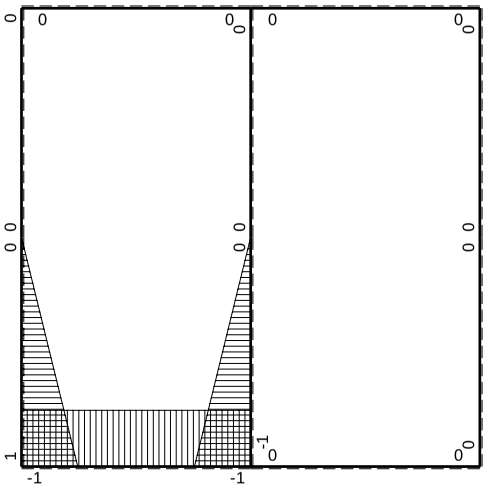


Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 986254 CI07.xxxx.143

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-1/2Fx$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-6Fx$	0	$-5Fb+11Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$Fb-6Fx$	0	$Fx-6Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
AI b	$-x/b$	0	0	0	0	x^2/b^2		
	totali						$-2Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$6/5Fb$	

PROCEDIMENTO E RISULTATI 986254 CI07.xxxx.143

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

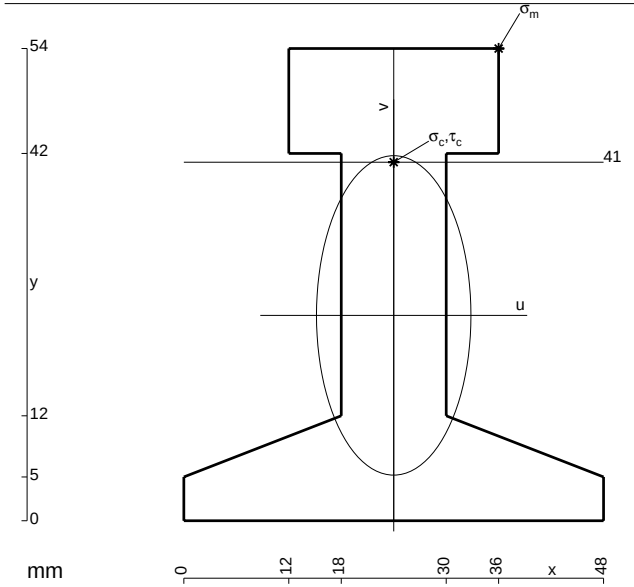
$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 11\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 11/2\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

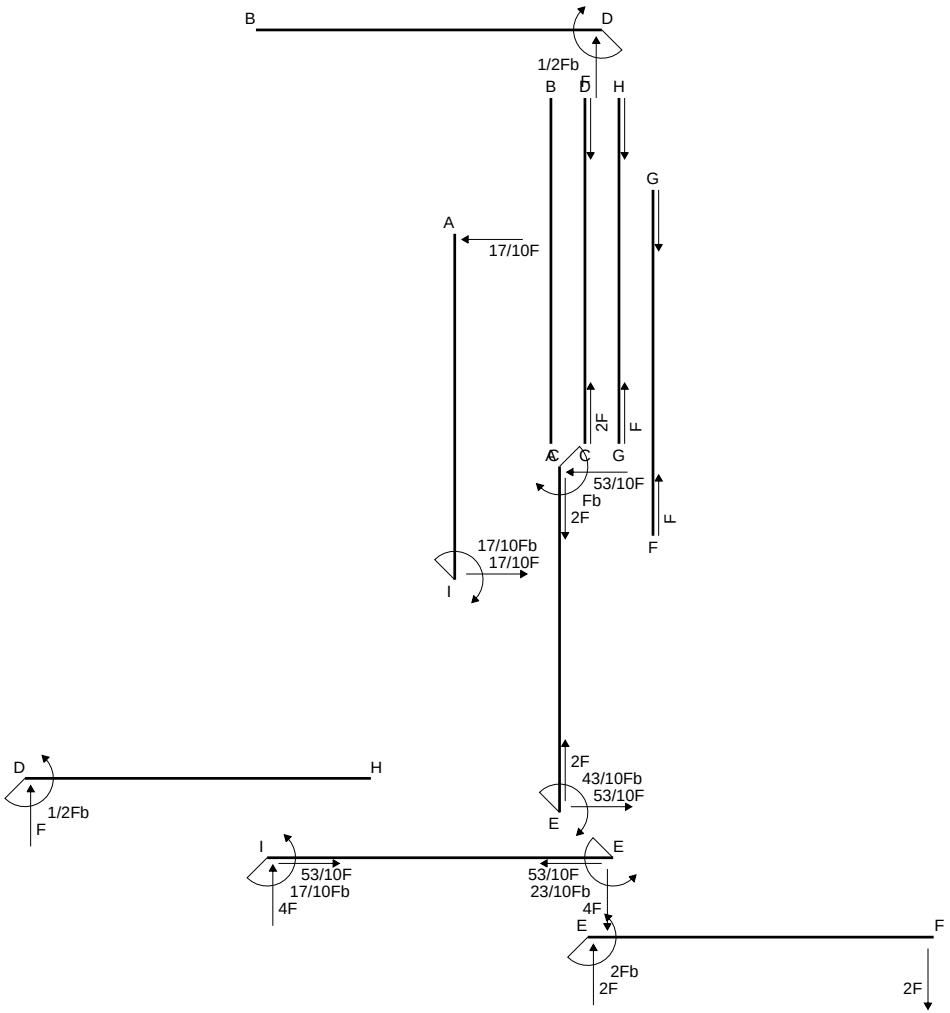
$= (-5\ b + 11/2\ b - 2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

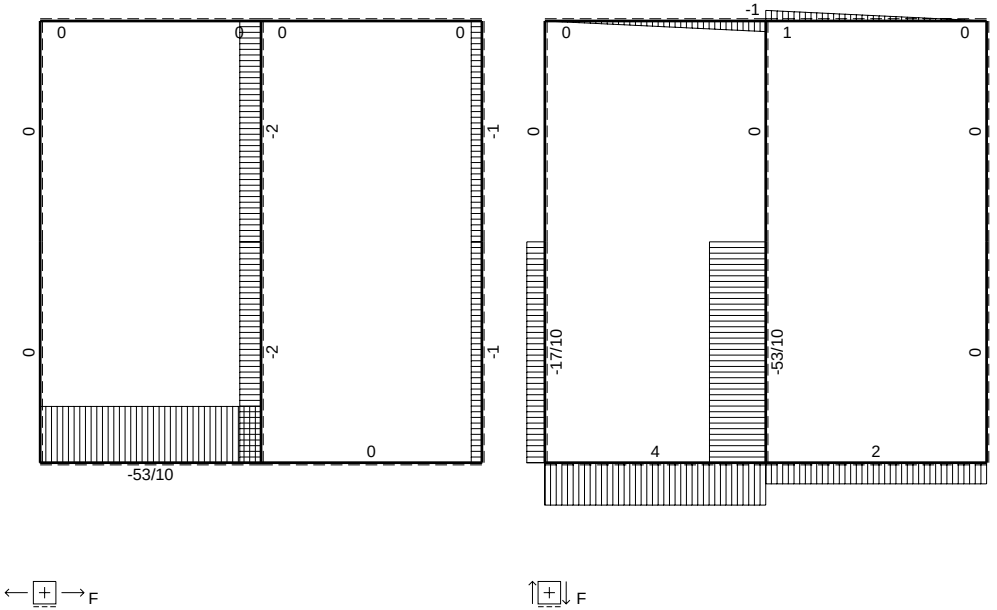
$L_{CE}^{Xo} = \int_o^b (\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/2\ b - 2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$



A = 1098. mm^2
J_u = 366595. mm^4
J_v = 85644. mm^4
y_g = 23.48 mm
T_y = 3940. N
M_x = -2758000. Nmm
x_m = 36. mm
y_m = 54. mm
u_m = 12. mm
v_m = 30.52 mm
$\sigma_m = -Mv/J_u$ = 229.6 N/mm^2
x_c = 24. mm
y_c = 41. mm
v_c = 17.52 mm
$\sigma_c = -Mv/J_u$ = 131.8 N/mm^2
τ_c = 6.518 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 132.3 N/mm^2
S^* = 7278. mm^3


B
D
1/2Fb
B
D
H
G
A
17/10F
2F
F
A
C
G
53/10F
Fb
2F
F
F
17/10Fb
17/10F
I
D
H
1/2Fb
F
2F
43/10Fb
53/10F
E
I
E
53/10F
17/10Fb
4F
53/10F
23/10Fb
4F
E
F
2Fb
2F
2F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-2
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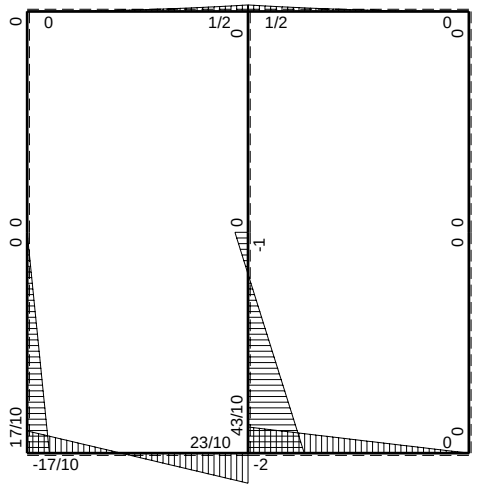
-17/10
-53/10
0
4
2
F
F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1/2
1/2
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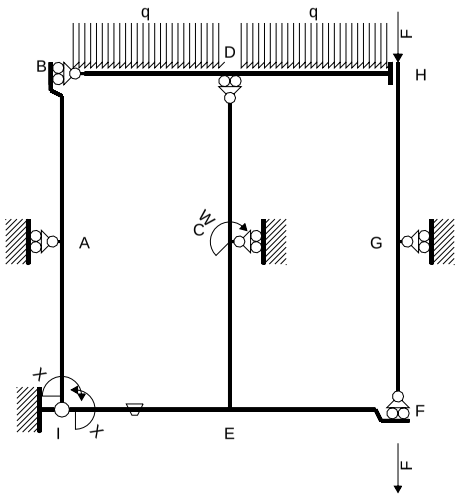
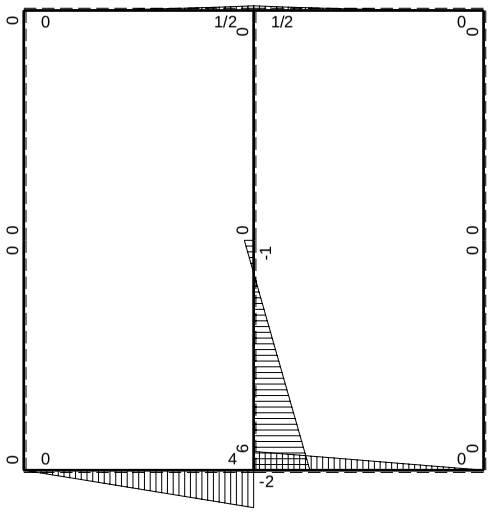
0
17/10
43/10
23/10
0
-17/10
-2
Fb



Schema di calcolo iperstatico


0
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PROCEDIMENTO E RISULTATI 214984 CI07.xxxx.144

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	0	0	0	0	0	0+0	0
HG b	0	0	0	0	0	0		
HD b	0	$1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	4Fx	-Fb/EJ	-4Fx	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-4Fb+4Fx	Fb/EJ	-4Fb+4Fx	Fb/EJ	1		
EC b	$-1+x/b$	6Fb-7Fx	0	$-6Fb+13Fx-7Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	Fb-7Fx	0	$Fx-7Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	1/3Xb/EJ
AI b	-x/b	0	0	0	0	x^2/b^2		
	totali						$-17/6Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						17/10Fb	

Sviluppi di calcolo iperstatica

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$L^{XX}_{IE} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EI} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EC} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{CE} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{IA} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{AI} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{Xo}_{IE} = \int_o^b (-4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L^{Xo}_{EI} = \int_o^b (-4 + 4\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-4\ x + 2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

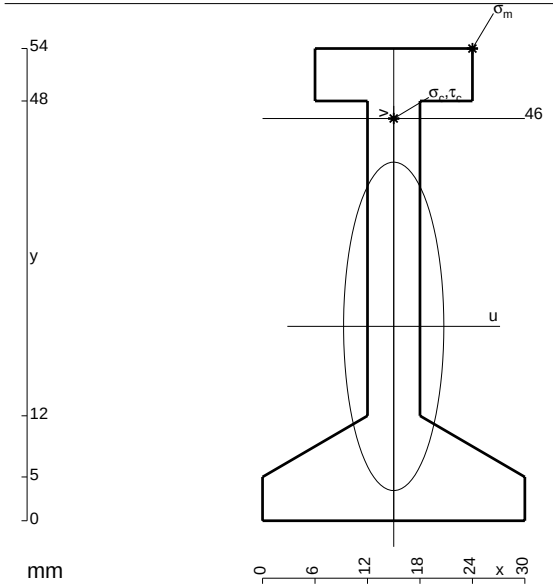
$= (-4\ b + 2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -\ Fb^2/EJ$

$L^{Xo}_{EC} = \int_o^b (-6 + 13\ x/b - 7\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-6\ x + 13/2\ x^2/b - 7/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

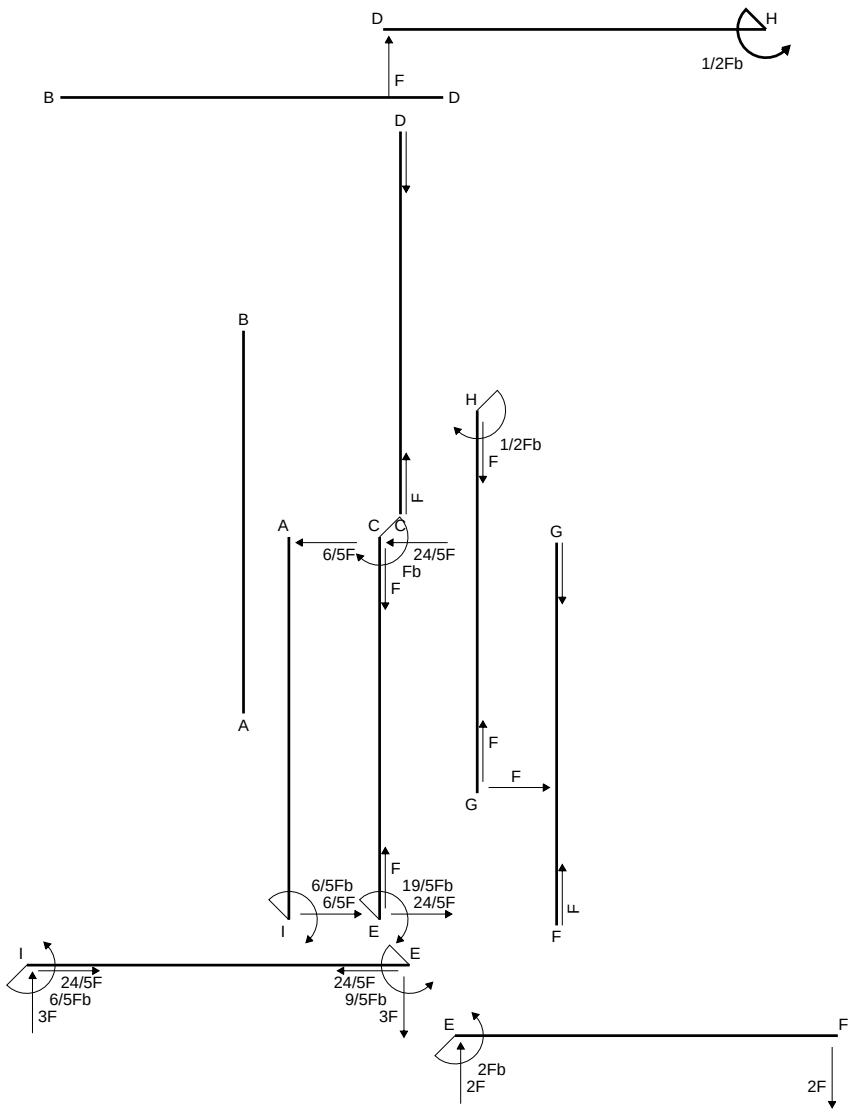
$= (-6\ b + 13/2\ b - 7/3\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L^{Xo}_{CE} = \int_o^b (\ x/b - 7\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 7/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/2\ b - 7/3\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$



A = 600. mm^2
J_u = 211747. mm^4
J_v = 19728. mm^4
y_g = 22.23 mm
T_y = 2120. N
M_x = -1590000. Nmm
x_m = 24. mm
y_m = 54. mm
u_m = 9. mm
v_m = 31.77 mm
$\sigma_m = -Mv/J_u$ = 238.6 N/mm^2
x_c = 15. mm
y_c = 46. mm
v_c = 23.77 mm
$\sigma_c = -Mv/J_u$ = 178.5 N/mm^2
τ_c = 5.681 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 178.8 N/mm^2
S^* = 3405. mm^3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H
1/2Fb
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B
D
D
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1/2Fb
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C
6/5F
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Fb
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G
A
F
F
G
F
F
6/5Fb
6/5F
19/5Fb
24/5F
I
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9/5Fb
3F
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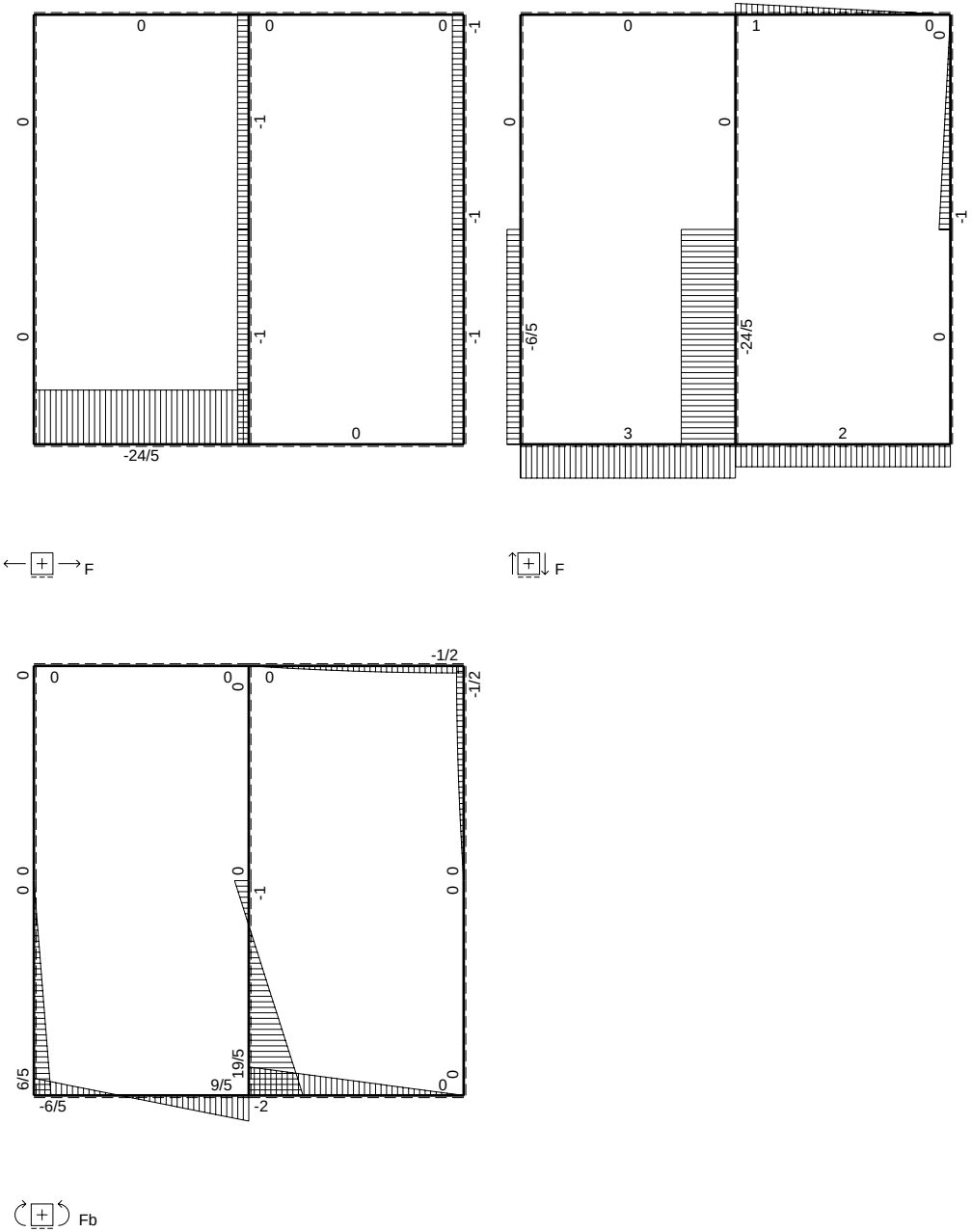
F
2Fb
2F
2F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0
0
-1
-6/5
-24/5
0
3
2
F
-1/2
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0
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19/5
9/5
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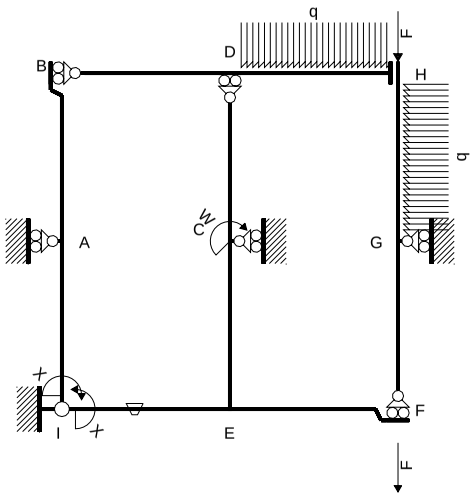
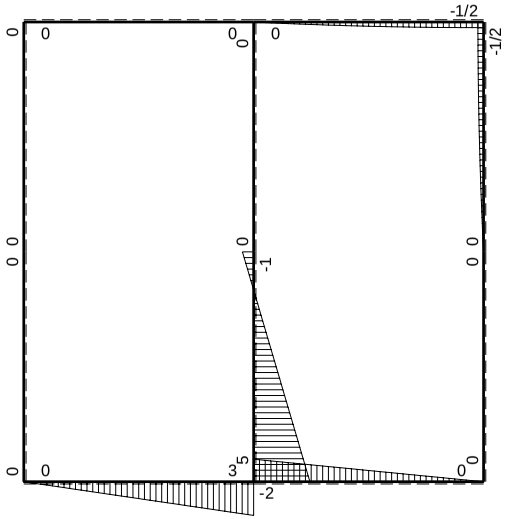
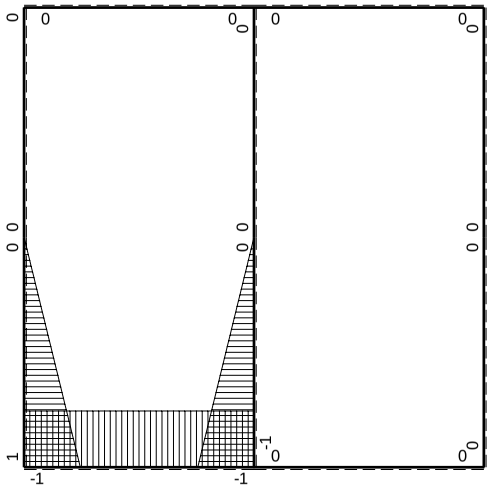
-6/5
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 212930 CI07.xxxx.145

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-6Fx	0	$-5Fb+11Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	Fb-6Fx	0	$Fx-6Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	1/3Xb/EJ
AI b	-x/b	0	0	0	0	x^2/b^2		
	totali						$-2Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						6/5Fb	

PROCEDIMENTO E RISULTATI 212930 CI07.xxxx.145

Sviluppi di calcolo iperstatica

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$L_{lE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{El}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{lA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{Al}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{lE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{El}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

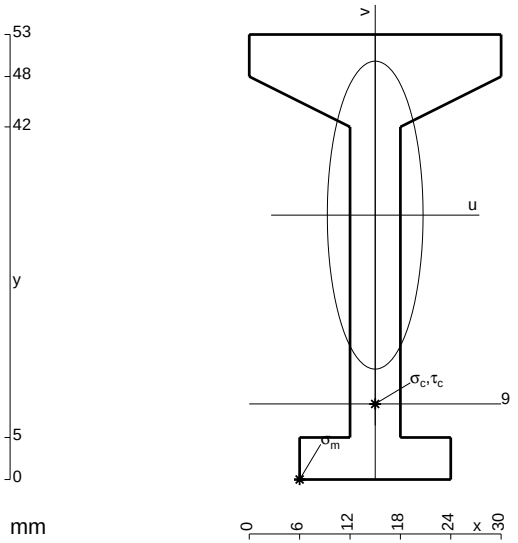
$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 11\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 11/2\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

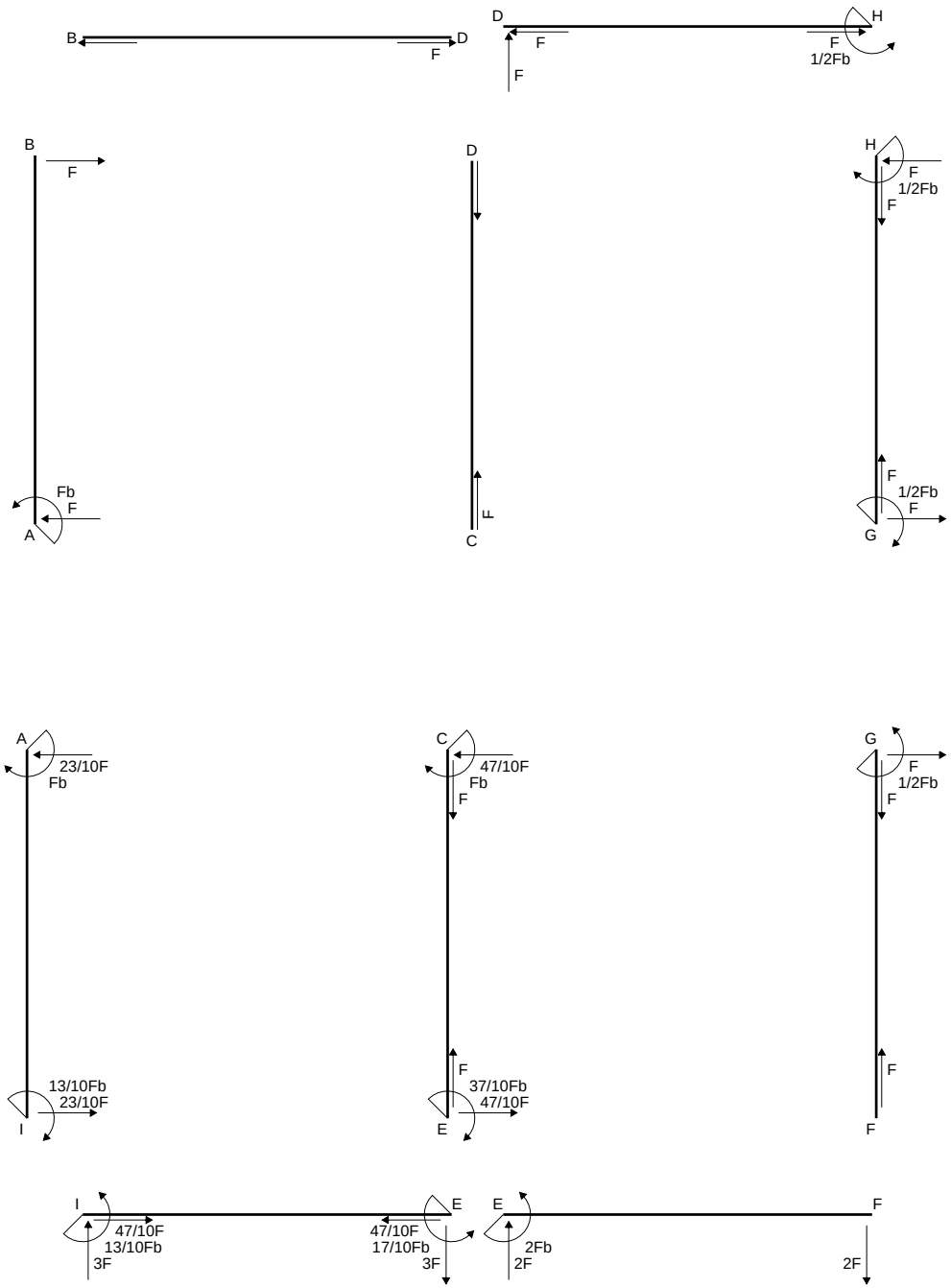
$= (-5\ b + 11/2\ b - 2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/2\ b - 2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$



A = 570. mm^2
J_u = 191825. mm^4
J_v = 18558. mm^4
y_g = 31.49 mm
T_y = 1540. N
M_x = -1216600. Nmm
x_m = 6. mm
u_m = -9. mm
v_m = -31.49 mm
$\sigma_m = -Mv/J_u$ = -199.7 N/mm^2
x_c = 15. mm
y_c = 9. mm
v_c = -22.49 mm
$\sigma_c = -Mv/J_u$ = -142.6 N/mm^2
τ_c = 4.277 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 142.8 N/mm^2
S^* = 3197. mm^3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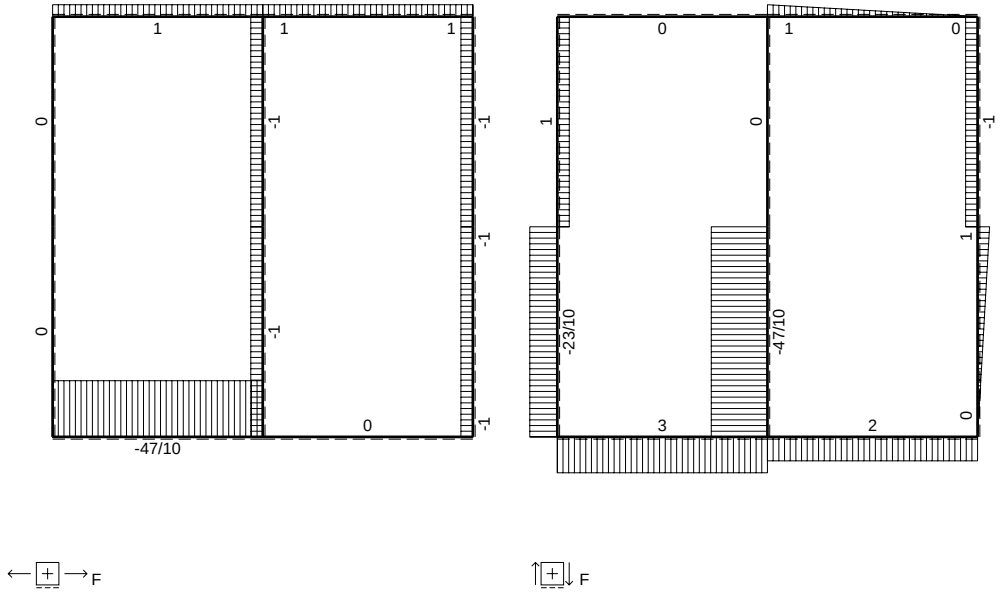
1
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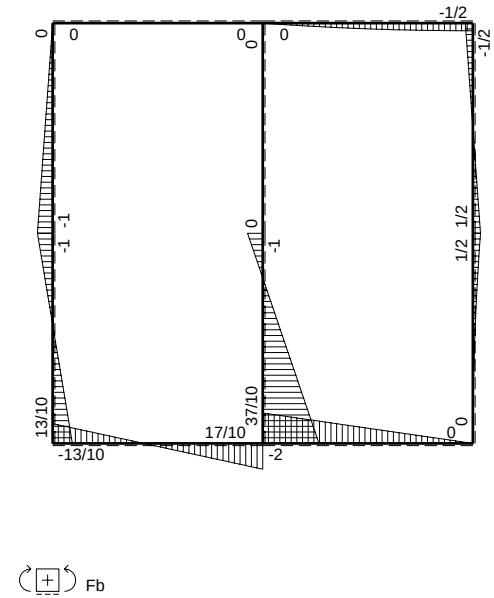
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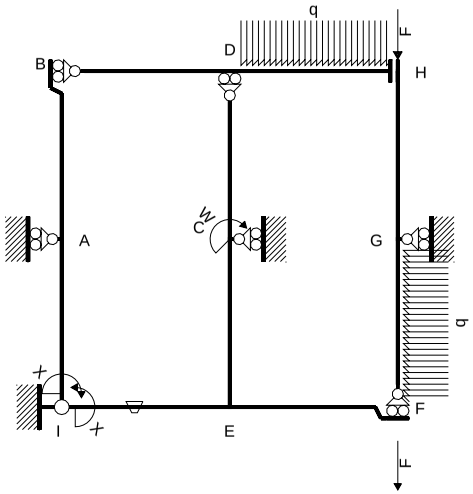
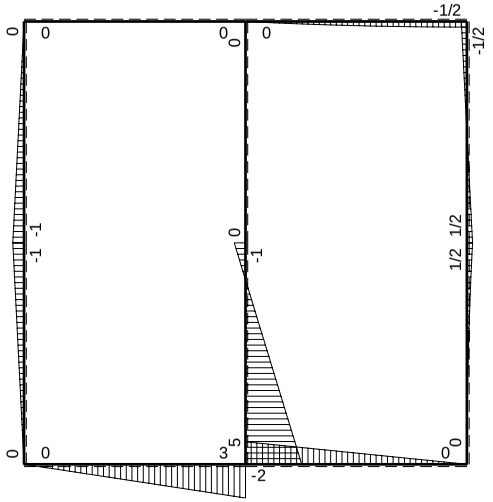
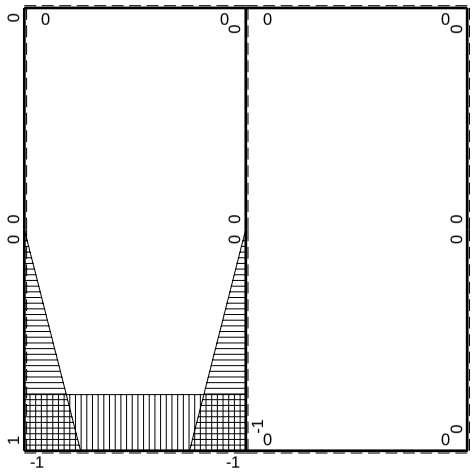
1/2
1/2
13/10
37/10
17/10
0
0
-13/10
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 960326 CI07.xxxx.146

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb-Fx	0	0	0	0	0+0	0
HG b	0	1/2Fb-Fx	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-6Fx	0	$-5Fb+11Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	Fb-6Fx	0	$Fx-6Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-Fx	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	Fb-Fx	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-13/6Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						13/10Fb	

Sviluppi di calcolo iperstatica

PROCEDIMENTO E RISULTATI 960326 CI07.xxxx.146
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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 11\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 11/2\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 11/2\ b - 2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

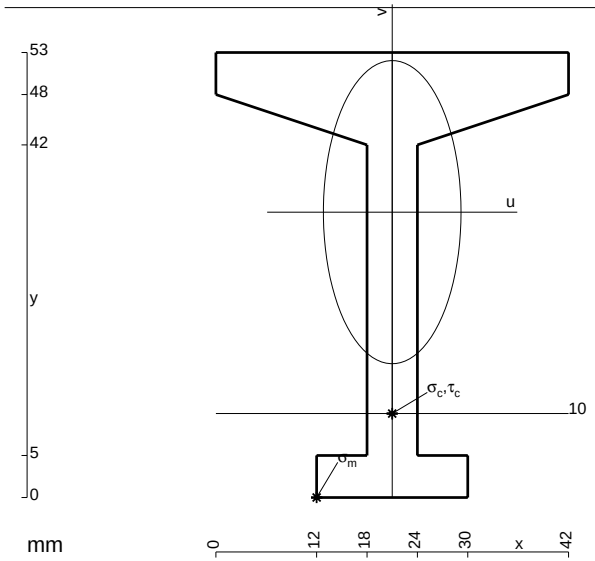
$= (1/2\ b - 2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

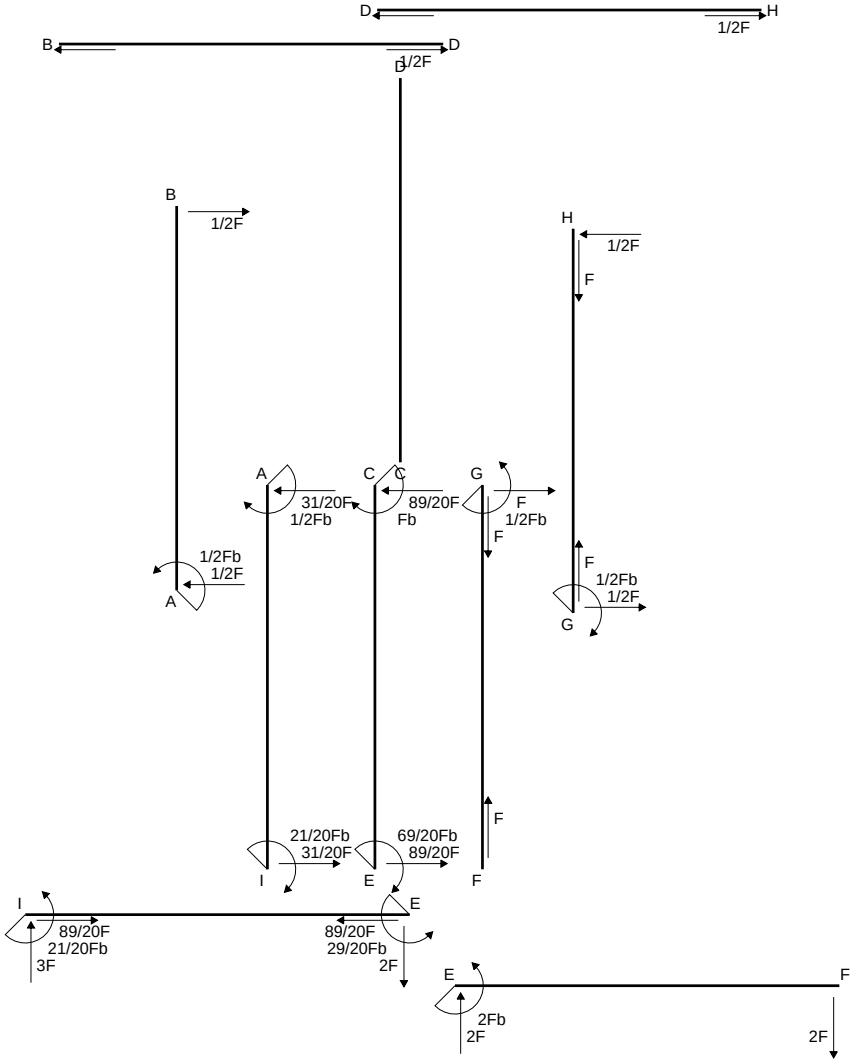
$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$



A = 666. mm^2
J_u = 217134. mm^4
J_v = 44766. mm^4
y_g = 33.99 mm
T_y = 1580. N
M_x = -1327200. Nmm
x_m = 12. mm
u_m = -9. mm
v_m = -33.99 mm
$\sigma_m = -Mv/J_u$ = -207.7 N/mm^2
x_c = 21. mm
y_c = 10. mm
v_c = -23.99 mm
$\sigma_c = -Mv/J_u$ = -146.6 N/mm^2
τ_c = 4.4 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 146.8 N/mm^2
S^* = 3628. mm^3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B
D
1/2F
D
B
1/2F
H
1/2F
F
A
C
C
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1/2Fb
89/20F
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F
1/2Fb
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A
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3F
89/20F
29/20Fb
2F
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2Fb
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29/20
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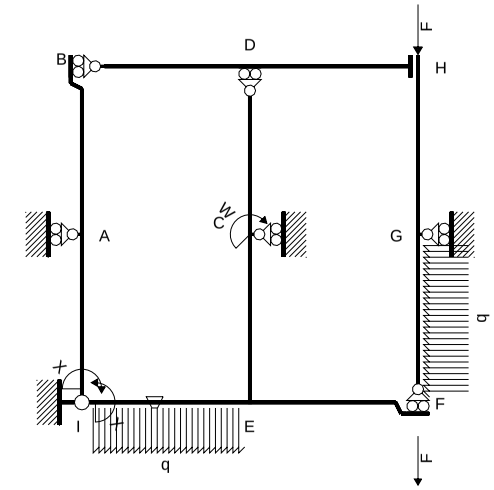
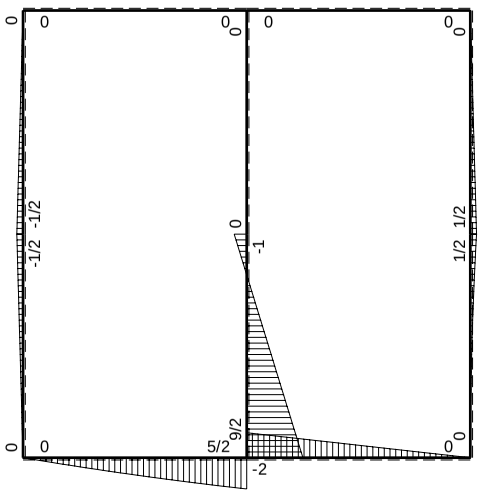
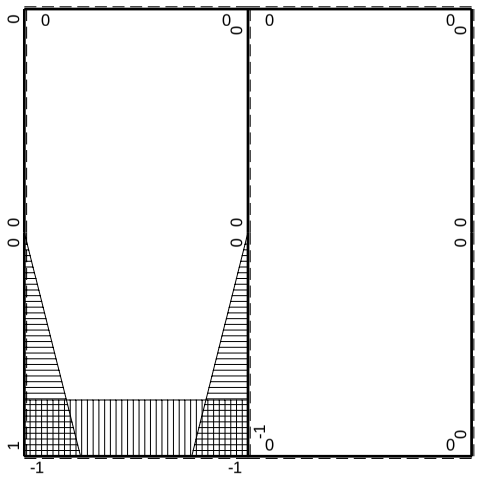
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 986709 CI07.xxxx.147

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PROCEDIMENTO E RISULTATI 986709 CI07.xxxx.147

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx-1/2qx^2$	-Fb/EJ	$-3Fx+1/2Fx^2/b$	Fb/EJ	1	$(-4/3+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-5/2Fb+2Fx+1/2qx^2$	Fb/EJ	$-5/2Fb+2Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	$-1+x/b$	$9/2Fb-11/2Fx$	0	$-9/2Fb+10Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-4/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$Fb-11/2Fx$	0	$Fx-11/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-7/4Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						21/20Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/3\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-5/2 + 2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx$

$= [-5/2\ x + x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-5/2\ b + b + 1/6\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/3\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-9/2 + 10\ x/b - 11/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-9/2\ x + 5\ x^2/b - 11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-9/2\ b + 5\ b - 11/6\ b\ )\ Fb\ 1/EJ\ = -4/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (\ x/b - 11/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/2\ b - 11/6\ b\ )\ Fb\ 1/EJ\ = -4/3\ Fb^2/EJ$

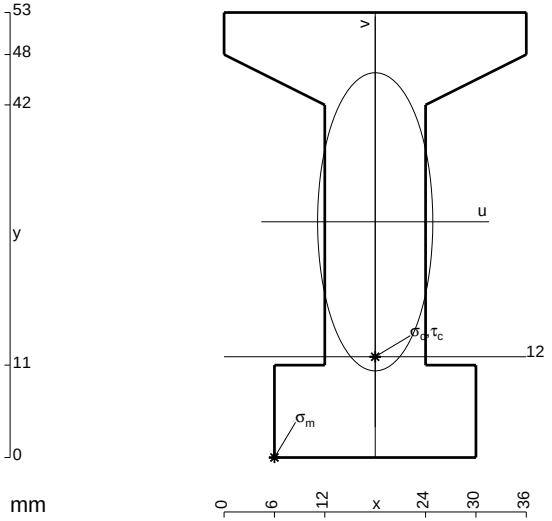
$L_{IA}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 986709 CI07.xxxx.147



A = 960. mm^2
J_u = 302931. mm^4
J_v = 45216. mm^4
y_g = 28.08 mm
T_y = 2620. N
M_x = -2358000. Nmm
x_m = 6. mm
u_m = -12. mm
v_m = -28.08 mm
$\sigma_m = -Mv/J_u$ = -218.5 N/mm^2
x_c = 18. mm
y_c = 12. mm
v_c = -16.08 mm
$\sigma_c = -Mv/J_u$ = -125.1 N/mm^2
τ_c = 4.439 N/mm^2
$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2}$ = 125.4 N/mm^2
S^* = 6159. mm^3

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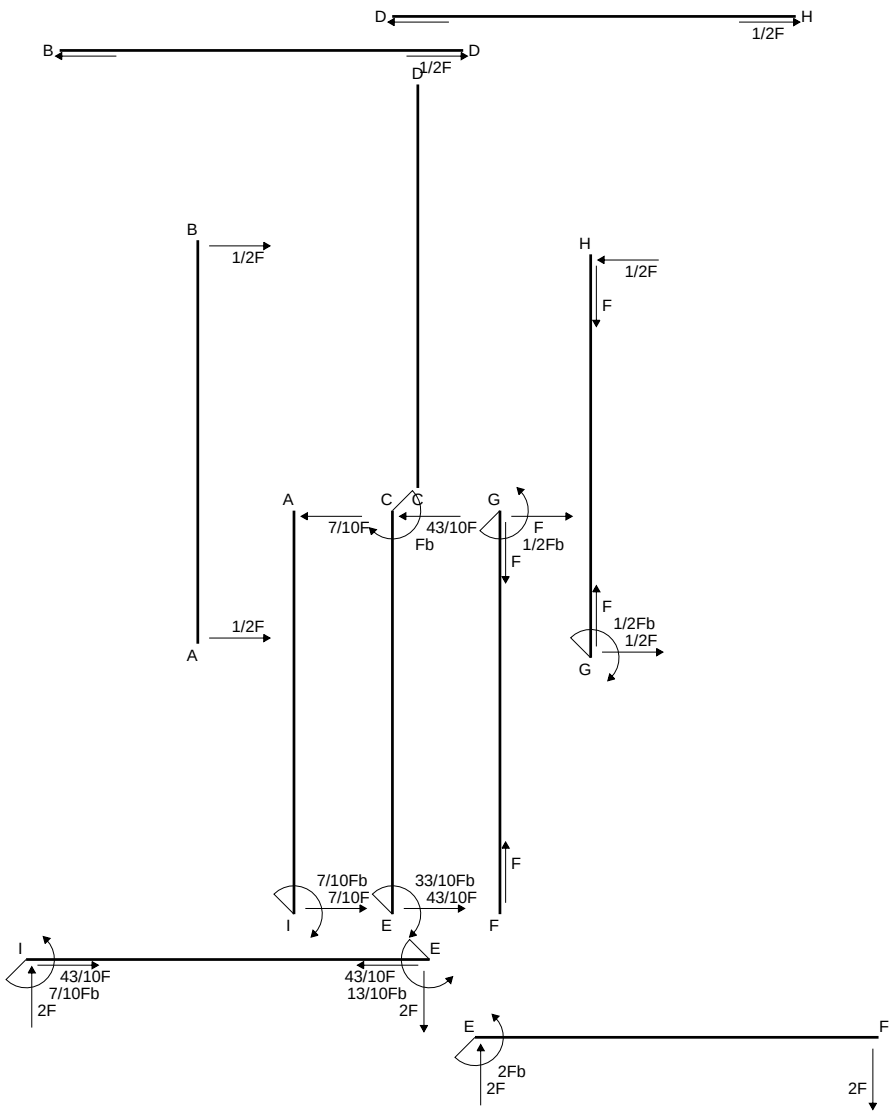

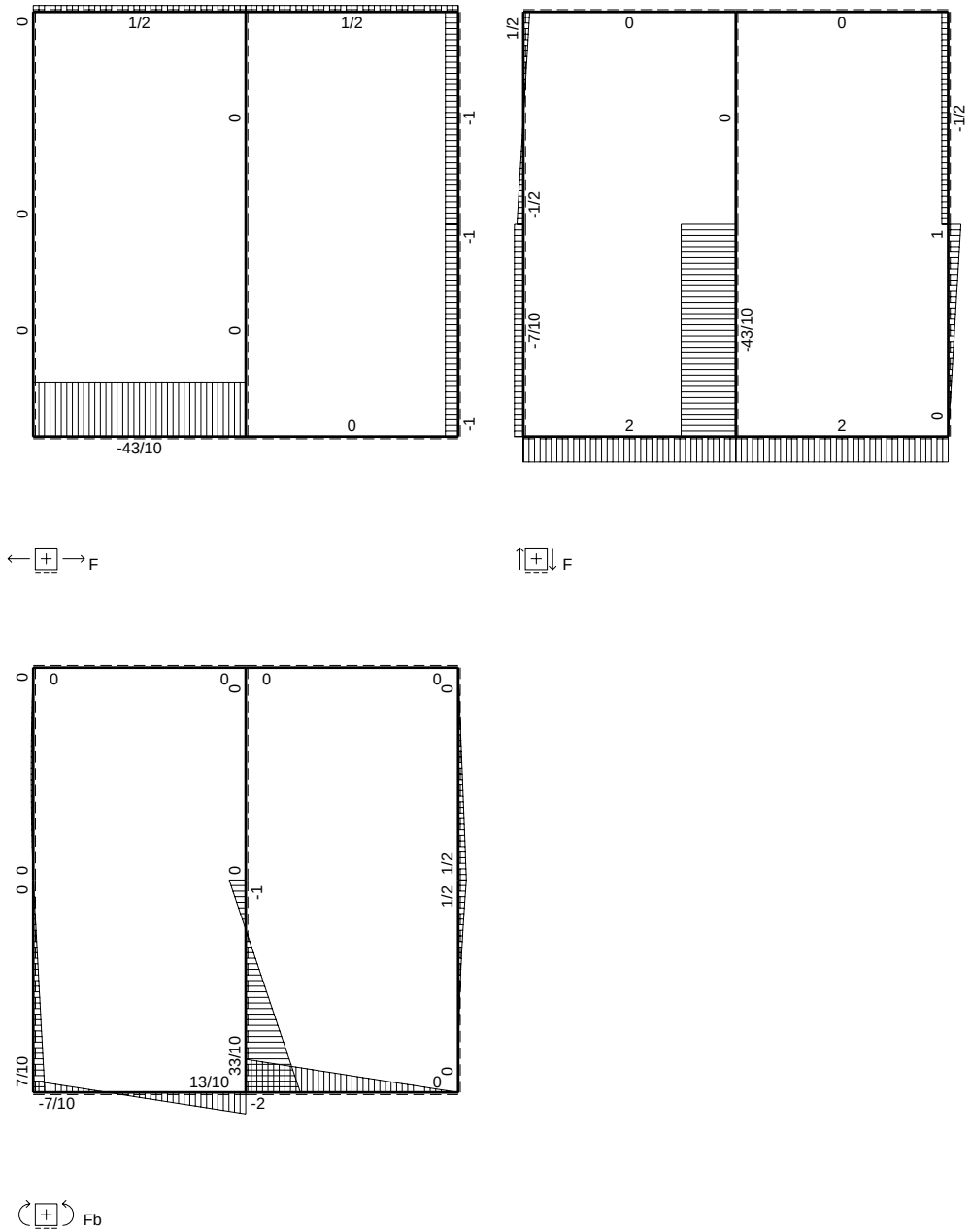
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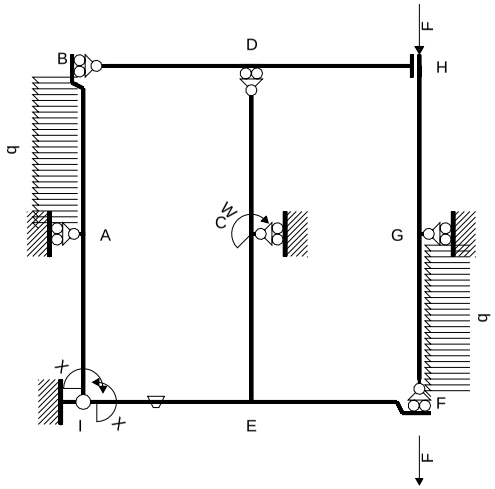
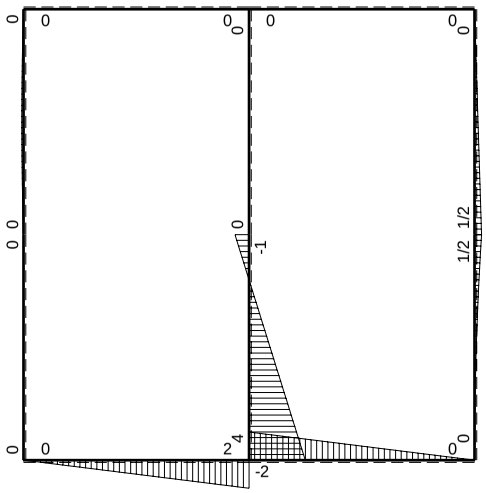


Schema di calcolo iperstatico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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	-1+x/b	4Fb-5Fx	0	$-4Fb+9Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-7/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	Fb-5Fx	0	$Fx-5Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	1/3Xb/EJ
AI b	-x/b	0	0	0	0	x^2/b^2		
	totali						$-7/6Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						7/10Fb	

PROCEDIMENTO E RISULTATI 214301 CI07.xxxx.148

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ +\ [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ +\ (\ b\ )\ \theta\ = 0$

$L_{EI}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ +\ [-\ x\ ]_o^b\ \theta$

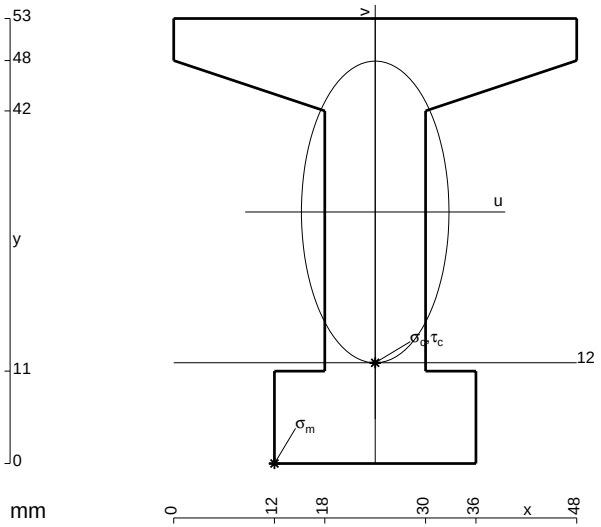
$= (-2\ b + b\ )\ Fb\ 1/EJ\ +\ (-\ b\ )\ \theta\ = 0$

$L_{EC}^{Xo} = \int_o^b (-4 + 9\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4\ x + 9/2\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

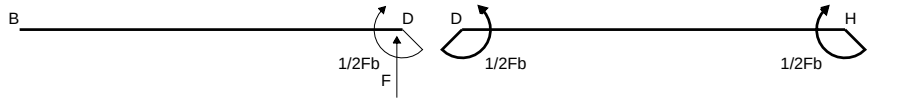
$= (-4\ b + 9/2\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -7/6\ Fb^2/EJ$

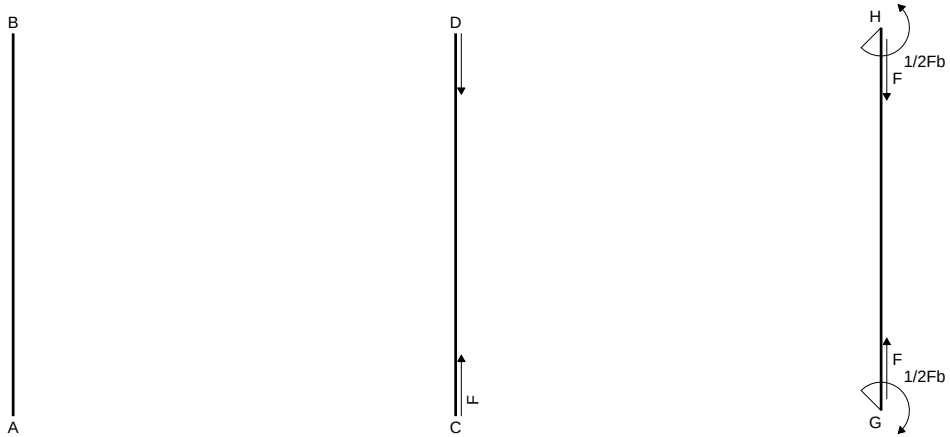
$L_{CE}^{Xo} = \int_o^b (\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

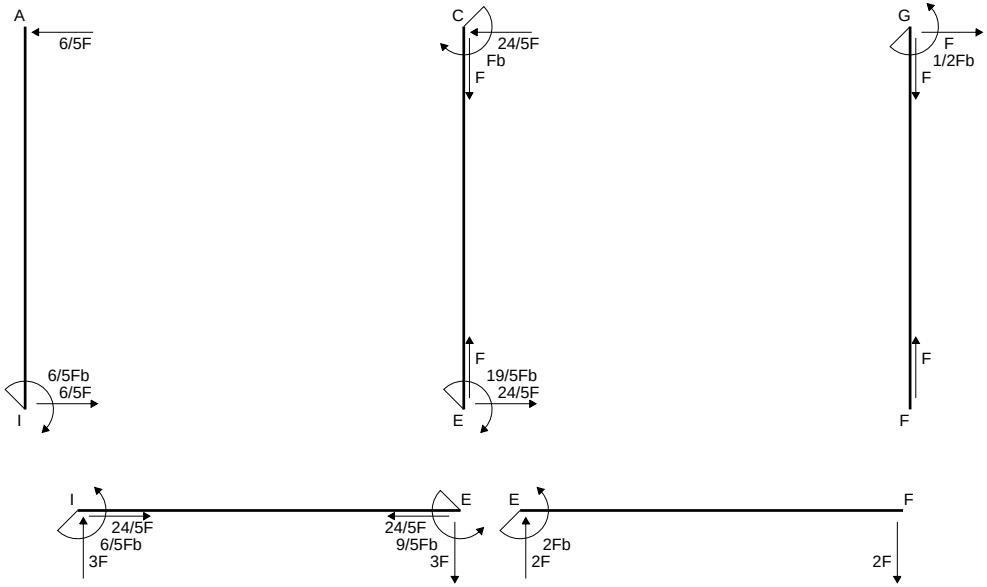
$= (1/2\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -7/6\ Fb^2/EJ$

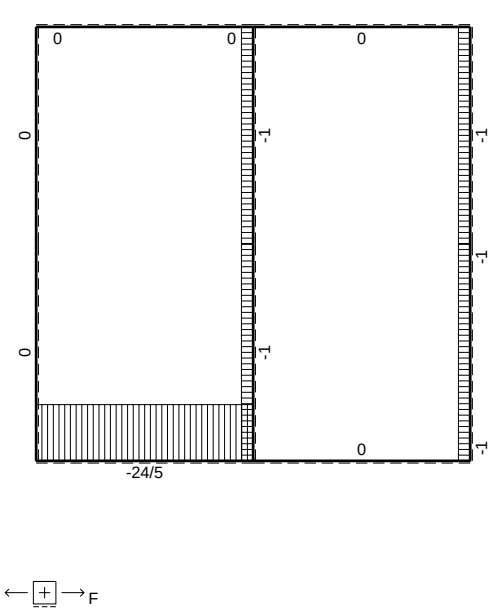


$A = 1056.\ mm^2$
$J_u = 341114.\ mm^4$
$J_v = 81576.\ mm^4$
$y_g = 29.96\ mm$
$T_y = 2740.\ N$
$M_x = -2603000.\ Nmm$
$x_m = 12.\ mm$
$u_m = -12.\ mm$
$v_m = -29.96\ mm$
$\sigma_m = -Mv/J_u = -228.6\ N/mm^2$
$x_c = 24.\ mm$
$y_c = 12.\ mm$
$v_c = -17.96\ mm$
$\sigma_c = -Mv/J_u = -137.1\ N/mm^2$
$\tau_c = 4.471\ N/mm^2$
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 137.3\ N/mm^2$
$S^* = 6679.\ mm^3$


B
D
D
H
1/2Fb
F
1/2Fb
1/2Fb


B
A
D
C
F
H
1/2Fb
F
F
1/2Fb
G


A
6/5F
6/5Fb
6/5F
I
C
24/5F
Fb
F
F
19/5Fb
24/5F
E
G
F
1/2Fb
F
F
F
I
24/5F
6/5Fb
3F
E
24/5F
9/5Fb
3F
E
2Fb
2F
F
2F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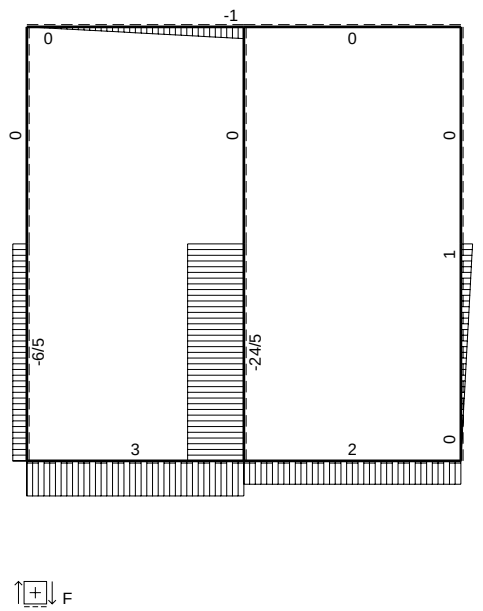
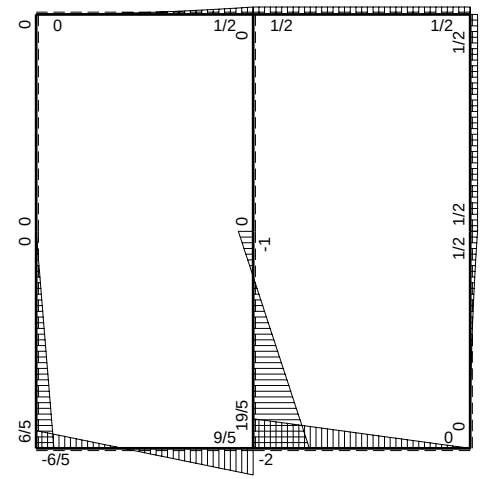
0
0
0
-1
-1
-1
-1
0
0
-24/5
F


-1
0
0
0
0
0
-6/5
-24/5
1
0
3
2
F


0
1/2
1/2
1/2
0
1/2
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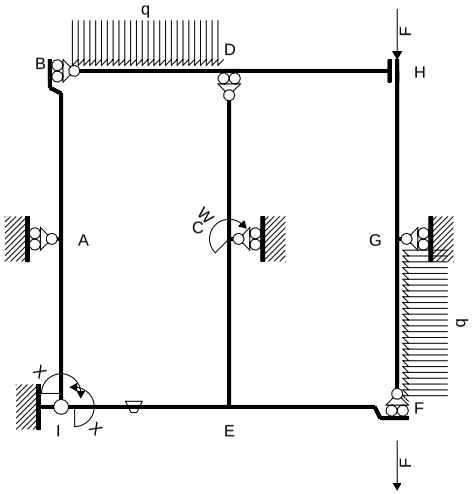
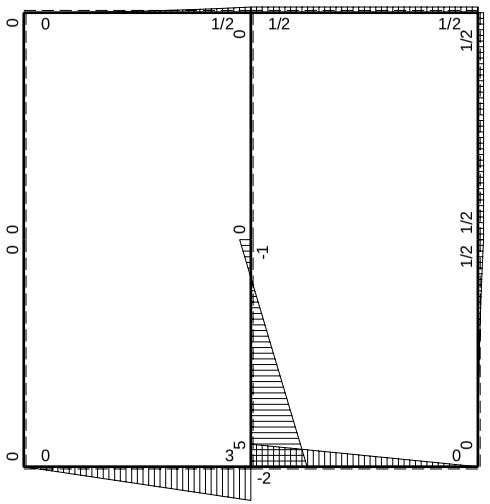
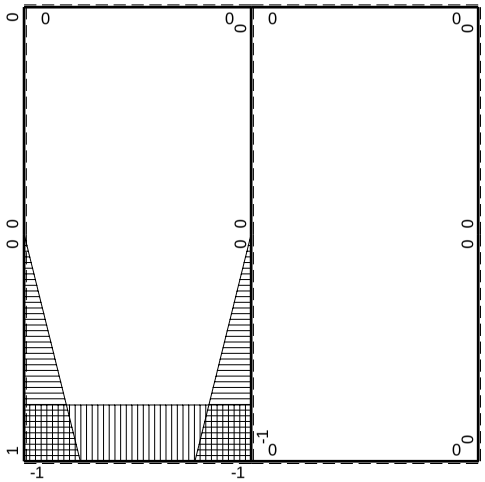
0
-1
1/2
1/2
6/5
9/5
19/5
0
-6/5
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 986260 CI07.xxxx.149

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb	0	0	0	0	0+0	0
HG b	0	-1/2Fb	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-6Fx	0	$-5Fb+11Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	Fb-6Fx	0	$Fx-6Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	1/3Xb/EJ
AI b	-x/b	0	0	0	0	x^2/b^2		
	totali						$-2Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						6/5Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

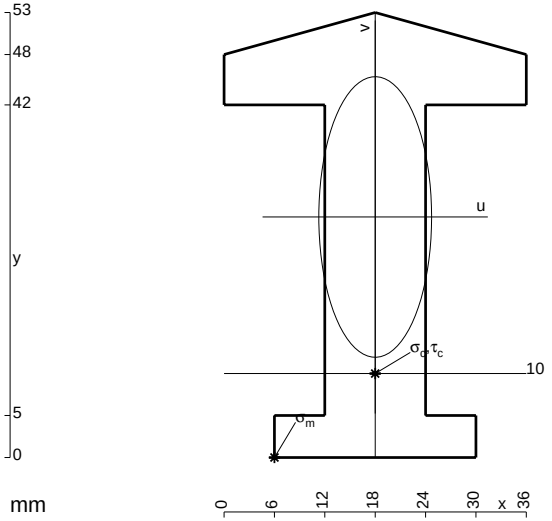
$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 11\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 11/2\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

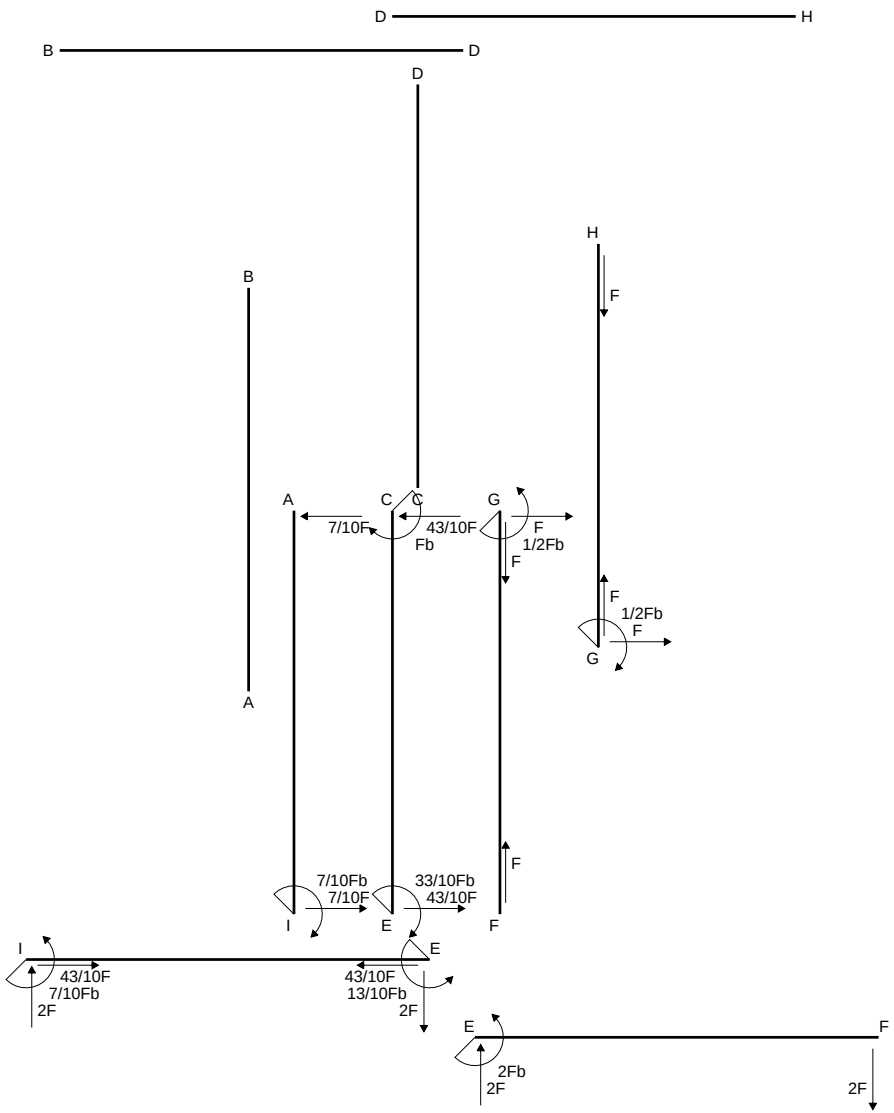
$= (-5\ b + 11/2\ b - 2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/2\ b - 2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$



A = 870. mm^2
J_u = 243005. mm^4
J_v = 39276. mm^4
y_g = 28.65 mm
T_y = 2020. N
M_x = -2020000. Nmm
x_m = 6. mm
u_m = -12. mm
v_m = -28.65 mm
$\sigma_m = -Mv/J_u$ = -238.1 N/mm^2
x_c = 18. mm
y_c = 10. mm
v_c = -18.65 mm
$\sigma_c = -Mv/J_u$ = -155. N/mm^2
τ_c = 3.053 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 155.1 N/mm^2
S^* = 4407. mm^3


D
H
B
D
D
H
B
F
A
C
C
G
7/10F
43/10F
Fb
F
1/2Fb
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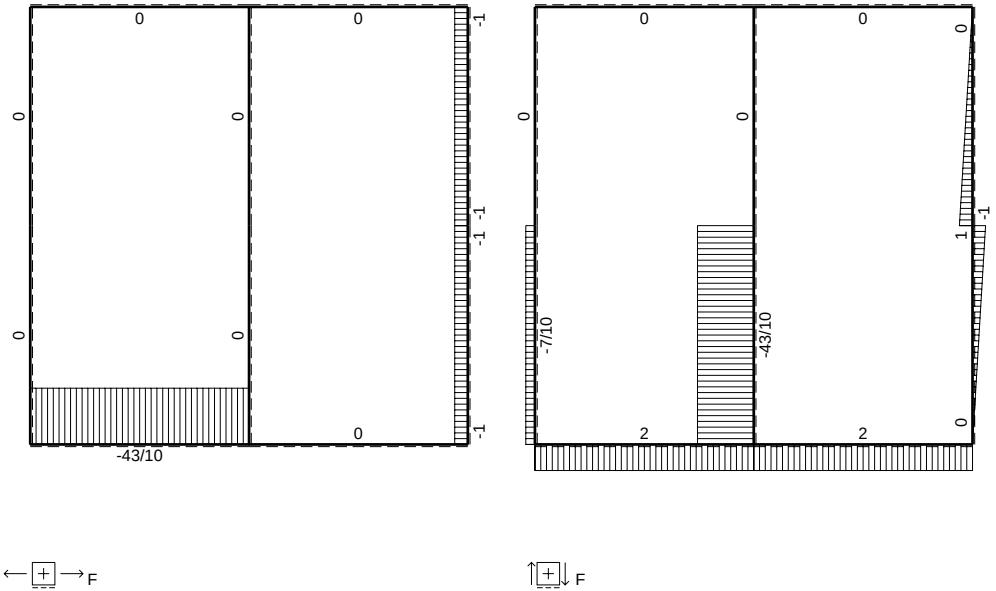
F
1/2Fb
F
G
A
F
7/10Fb
7/10F
33/10Fb
43/10F
I
E
F
I
E
43/10F
7/10Fb
2F
43/10F
13/10Fb
2F
E
F
2Fb
2F
2F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-1
0
0
-1
-43/10
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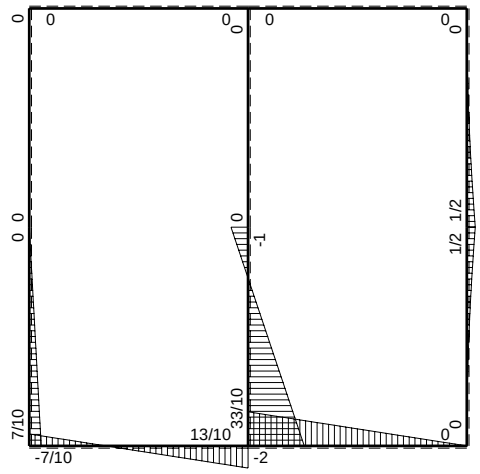
0
0
0
0
0
0
1
-1
-7/10
-43/10
2
2
0
F
F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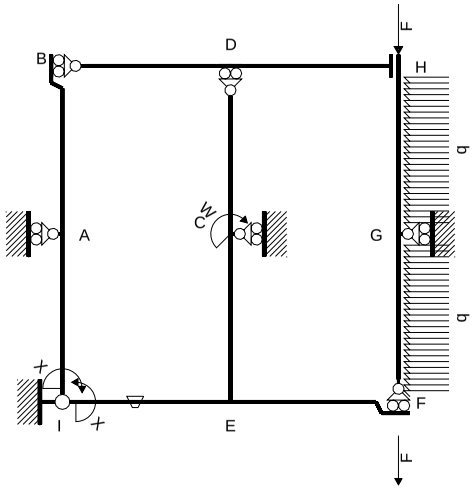
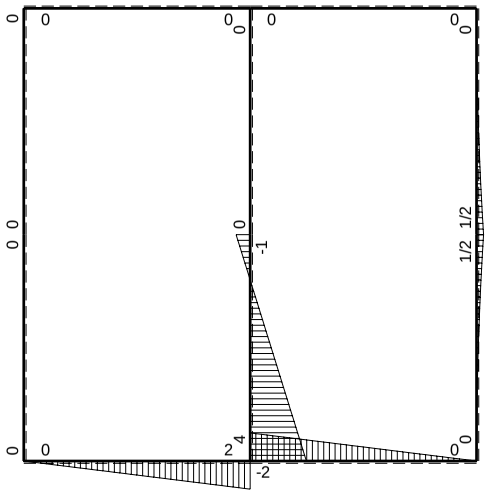
1/2
1/2
7/10
33/10
13/10
0
-7/10
-2
Fb



Schema di calcolo iperstatico


0
0
0

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2qx^2$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	-1+x/b	4Fb-5Fx	0	$-4Fb+9Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-7/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	Fb-5Fx	0	$Fx-5Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	1/3Xb/EJ
AI b	-x/b	0	0	0	0	x^2/b^2		
	totali						$-7/6Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						7/10Fb	

PROCEDIMENTO E RISULTATI 216220 CI07.xxxx.150

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L_{EI}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

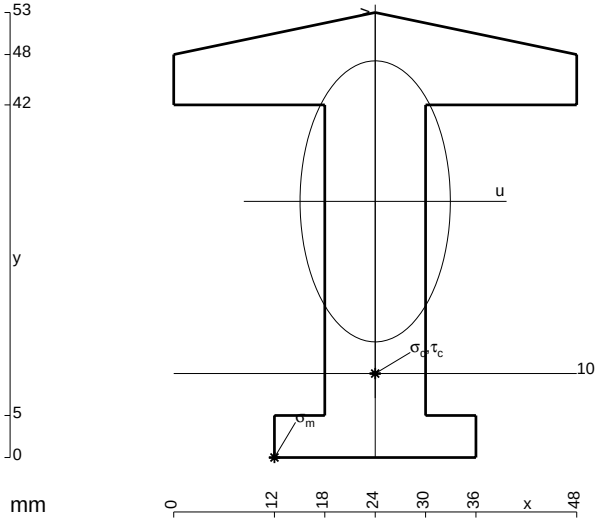
$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L_{EC}^{Xo} = \int_o^b (-4 + 9\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4\ x + 9/2\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

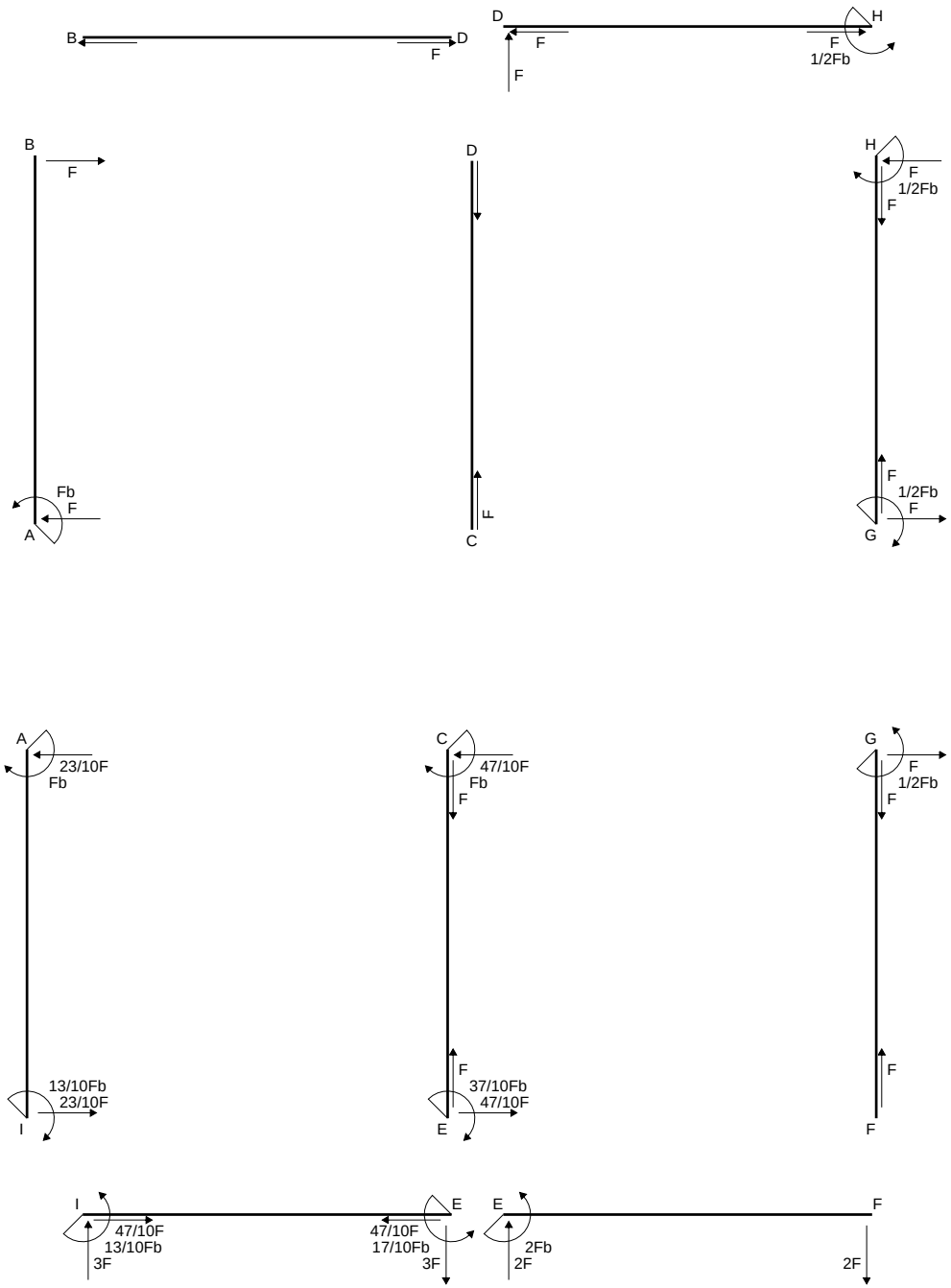
$= (-4\ b + 9/2\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -7/6\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/2\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -7/6\ Fb^2/EJ$



A = 972. mm^2
J_u = 272405. mm^4
J_v = 77904. mm^4
y_g = 30.51 mm
T_y = 3360. N
M_x = -1780800. Nmm
x_m = 12. mm
u_m = -12. mm
v_m = -30.51 mm
$\sigma_m = -Mv/J_u$ = -199.4 N/mm^2
x_c = 24. mm
y_c = 10. mm
v_c = -20.51 mm
$\sigma_c = -Mv/J_u$ = -134.1 N/mm^2
τ_c = 4.874 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 134.3 N/mm^2
S^* = 4741. mm^3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A
C
F
F
1/2Fb
F
G
A
23/10F
Fb
C
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Fb
F
G
F
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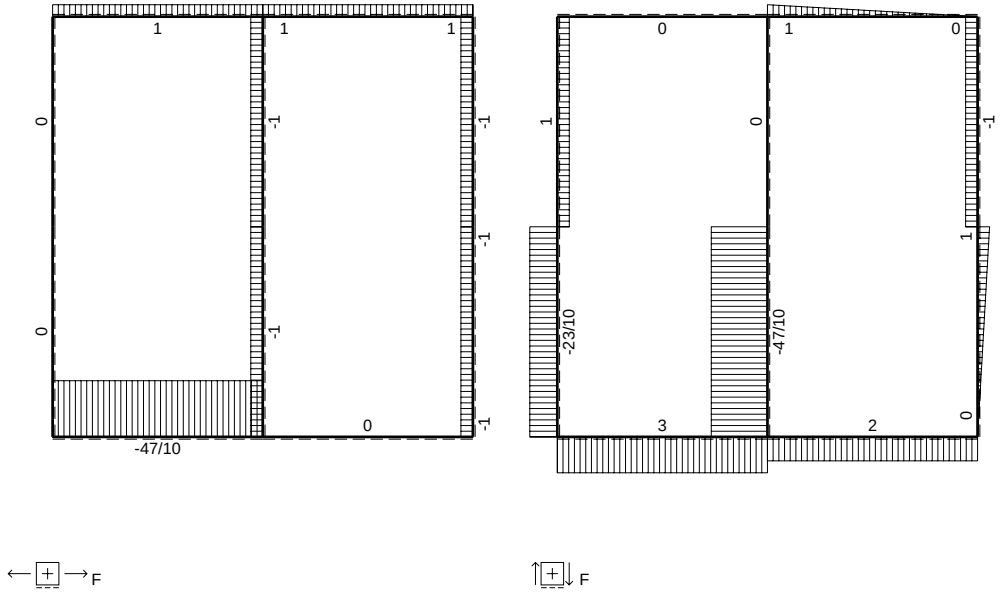
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-23/10
-47/10
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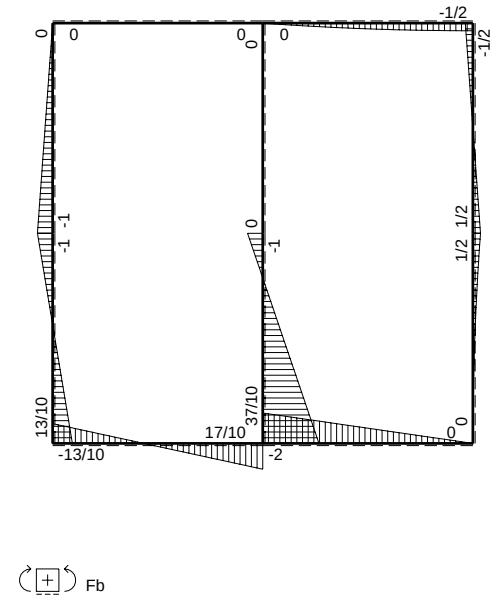
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17/10
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0
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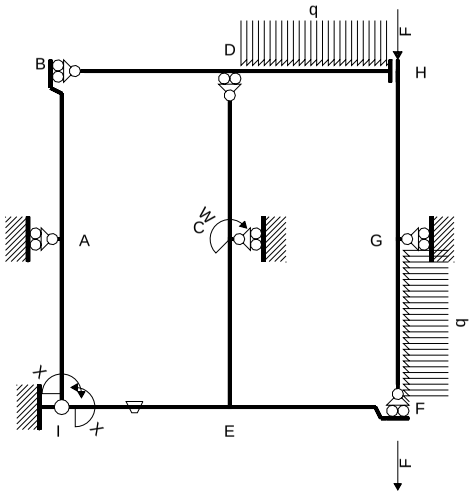
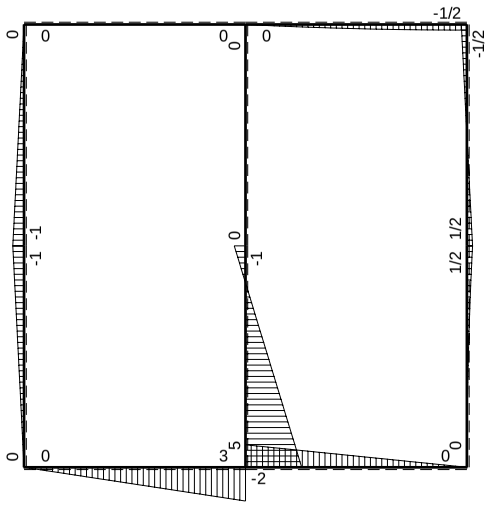
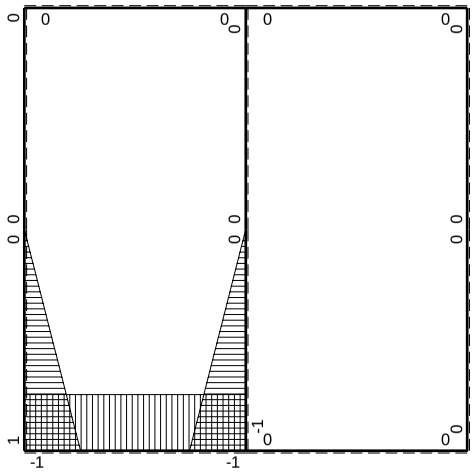
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 994726 CI07.xxxx.151

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb-Fx	0	0	0	0	0+0	0
HG b	0	1/2Fb-Fx	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-6Fx	0	$-5Fb+11Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	Fb-6Fx	0	$Fx-6Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-Fx	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	Fb-Fx	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-13/6Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						13/10Fb	

Sviluppi di calcolo iperstatica

PROCEDIMENTO E RISULTATI 994726 CI07.xxxx.151
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$L_{lE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{El}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{lA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{Al}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{lE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{El}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 11\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 11/2\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 11/2\ b - 2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (\ x/b - 6\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/2\ x^2/b - 2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

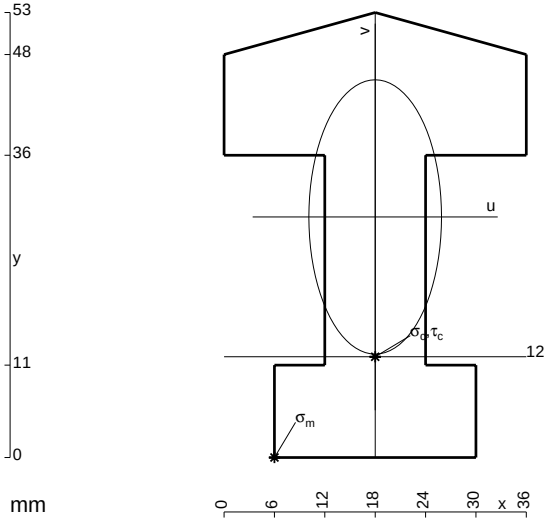
$= (1/2\ b - 2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

$L_{lA}^{Xo} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

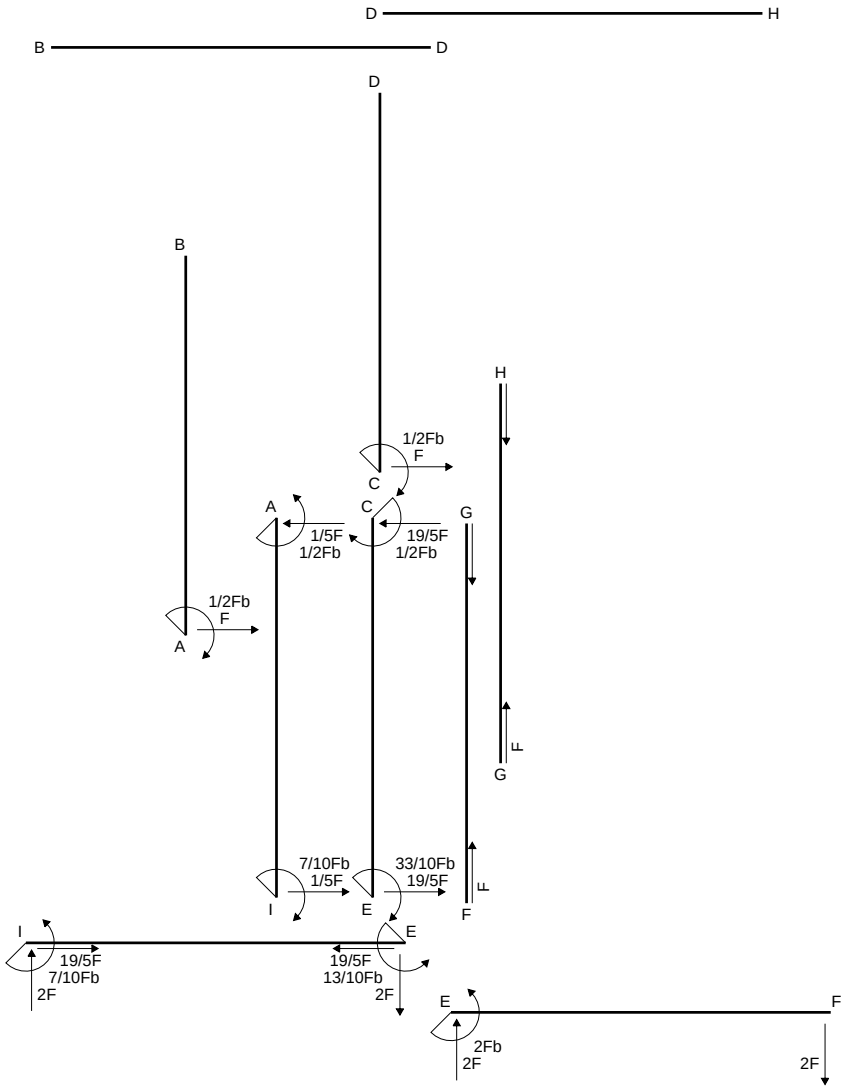
$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$

$L_{Al}^{Xo} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$



A = 1086. mm^2
J_u = 289781. mm^4
J_v = 67788. mm^4
y_g = 28.65 mm
T_y = 3660. N
M_x = -2122800. Nmm
x_m = 6. mm
u_m = -12. mm
v_m = -28.65 mm
$\sigma_m = -Mv/J_u$ = -209.9 N/mm^2
x_c = 18. mm
y_c = 12. mm
v_c = -16.65 mm
$\sigma_c = -Mv/J_u$ = -122. N/mm^2
τ_c = 6.65 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 122.5 N/mm^2
S^* = 6318. mm^3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F
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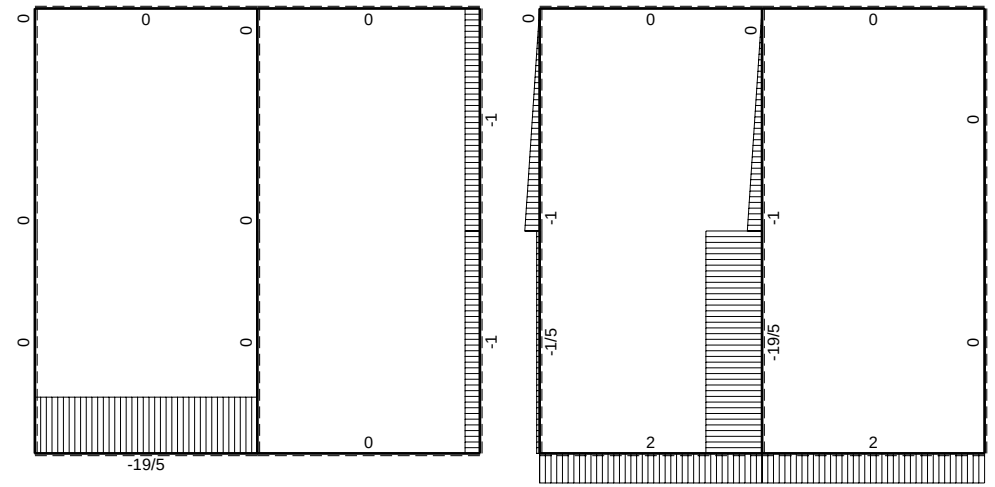
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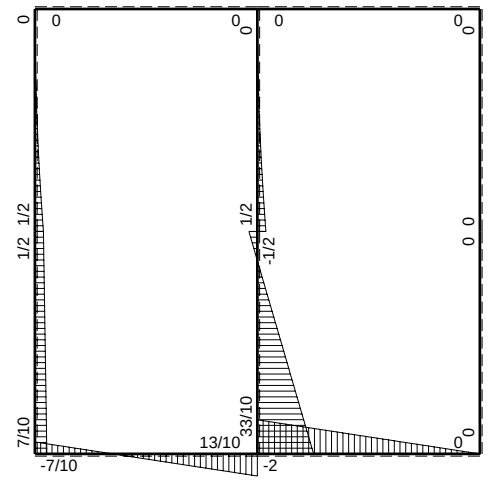
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7/10
33/10
13/10
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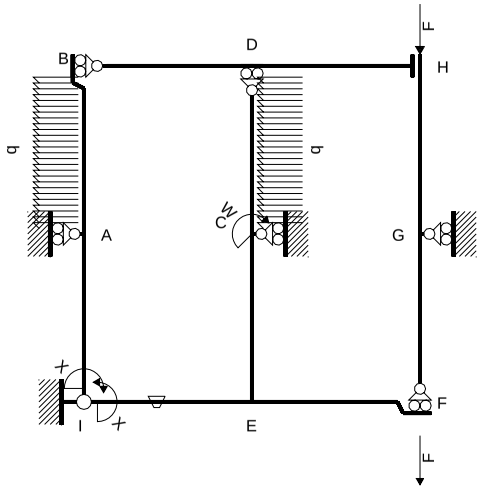
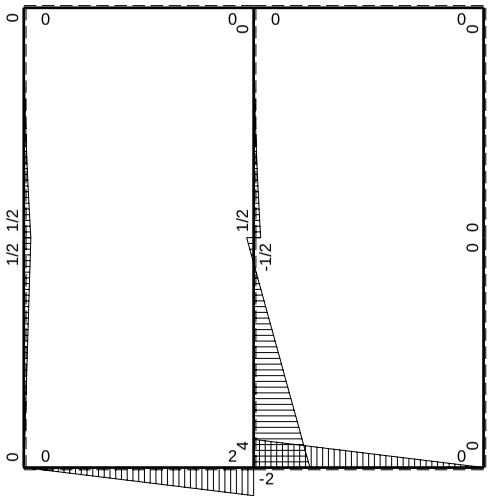
-2

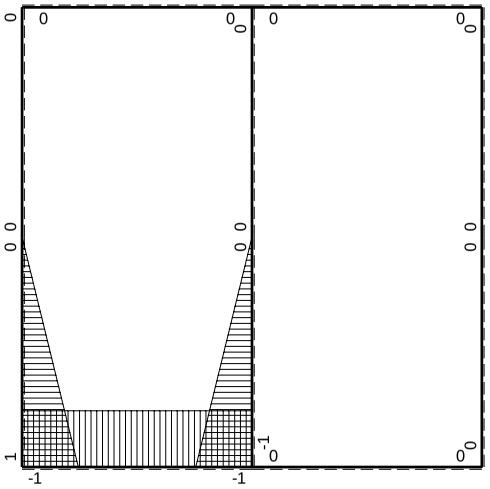
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 215489 CI07.xxxx.152

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.27.03.13 22.03.24

PROCEDIMENTO E RISULTATI 215489 CI07.xxxx.152

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$-1/2qx^2$	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	0	0	0	0	0	0+0	0
HG b	0	0	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	-1+x/b	4Fb-9/2Fx	0	$-4Fb+17/2Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/4+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$1/2Fb-9/2Fx$	0	$1/2Fx-9/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	1/2Fx	0	$1/2Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	$-1/2Fb+1/2Fx$	0	$1/2Fx-1/2Fx^2/b$	0	x^2/b^2		
	totali						$-7/6Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						7/10Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L_{EI}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L_{EC}^{Xo} = \int_o^b (-4 + 17/2\ x/b - 9/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4\ x + 17/4\ x^2/b - 3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-4\ b + 17/4\ b - 3/2\ b\ )\ Fb\ 1/EJ\ = -5/4\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (1/2\ x/b - 9/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/4\ x^2/b - 3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

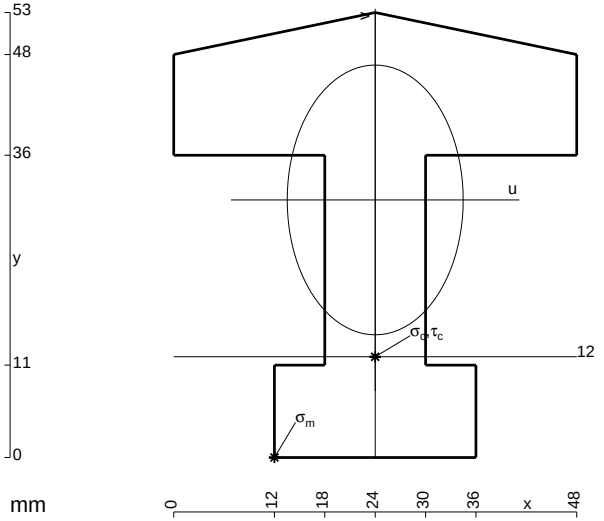
$= (1/4\ b - 3/2\ b\ )\ Fb\ 1/EJ\ = -5/4\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1/2\ x/b - 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/4\ x^2/b - 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/4\ b - 1/6\ b\ )\ Fb\ 1/EJ\ = 1/12\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (1/2\ x/b - 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/4\ x^2/b - 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/4\ b - 1/6\ b\ )\ Fb\ 1/EJ\ = 1/12\ Fb^2/EJ$



$A = 1260.\ mm^2$

$J_u = 325285.\ mm^4$

$J_v = 138384.\ mm^4$

$y_g = 30.68\ mm$

$T_y = 3700.\ N$

$M_x = -2331000.\ Nmm$

$x_m = 12.\ mm$

$u_m = -12.\ mm$

$v_m = -30.68\ mm$

$\sigma_m = -Mv/J_u = -219.8\ N/mm^2$

$x_c = 24.\ mm$

$y_c = 12.\ mm$

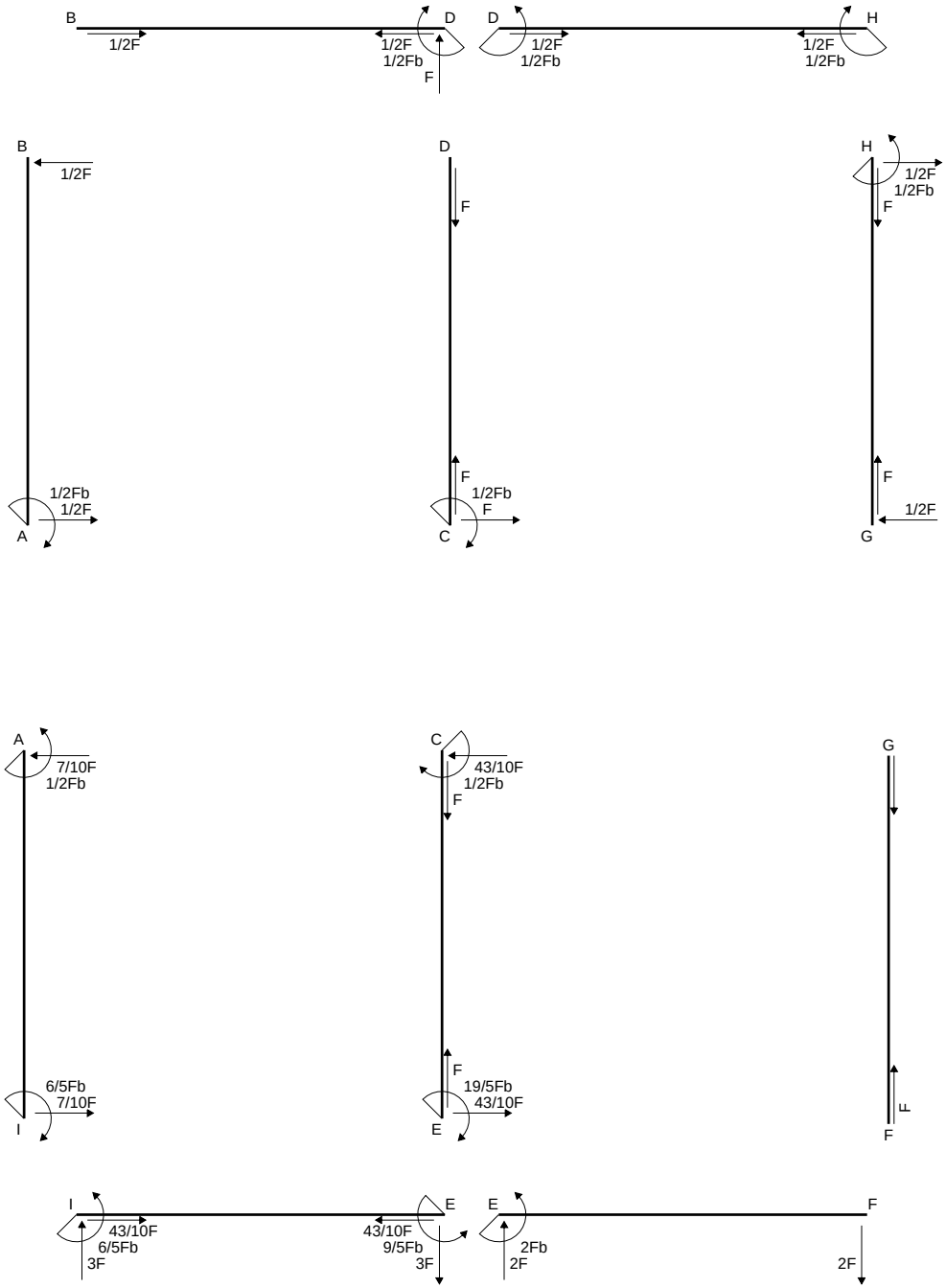
$v_c = -18.68\ mm$

$\sigma_c = -Mv/J_u = -133.8\ N/mm^2$

$\tau_c = 6.519\ N/mm^2$

$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 134.3\ N/mm^2$

$S^* = 6877.\ mm^3$


B
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D
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1/2F
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F
1/2F
1/2Fb
1/2F
1/2Fb
B
1/2F
D
F
H
1/2F
1/2Fb
F
1/2Fb
1/2F
A
F
1/2Fb
F
C
F
1/2F
G
A
7/10F
1/2Fb
C
43/10F
1/2Fb
F
G
F
6/5Fb
7/10F
I
F
19/5Fb
43/10F
E
F
I
E
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F
43/10F
6/5Fb
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43/10F
9/5Fb
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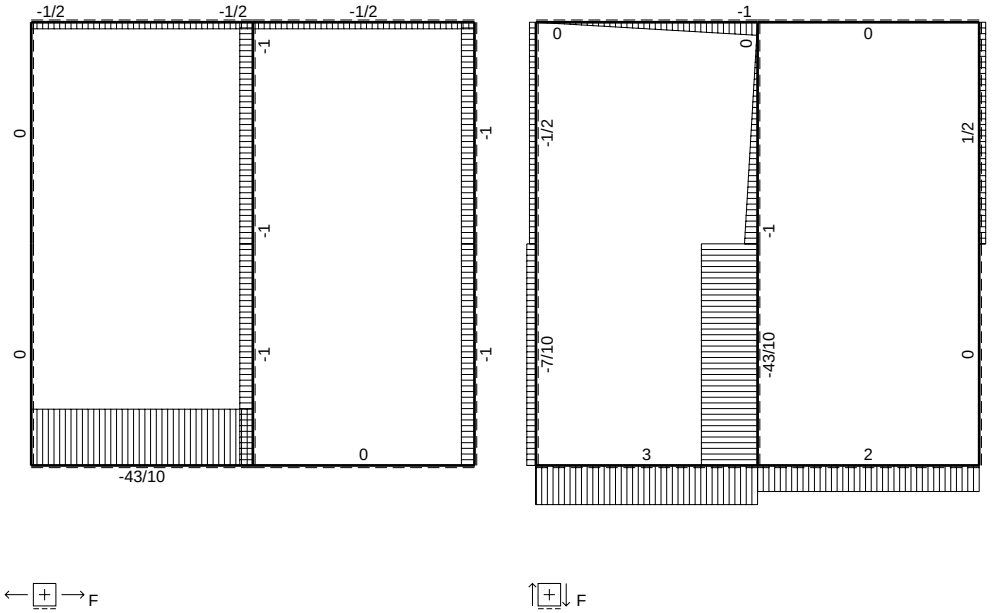
2F
2F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-1
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-1
-1
-1
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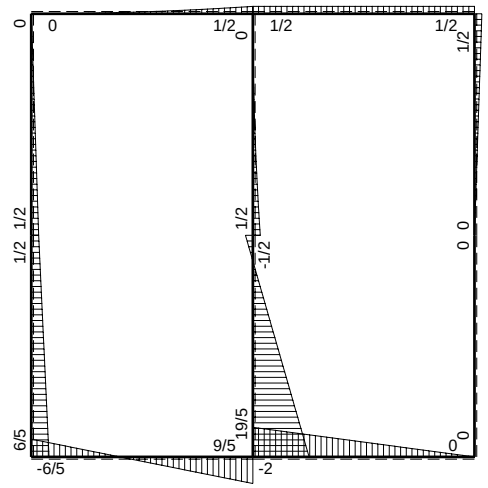
-1
-7/10
-43/10
0
3
2
F


0
0
1/2
1/2
1/2
0
1/2
1/2
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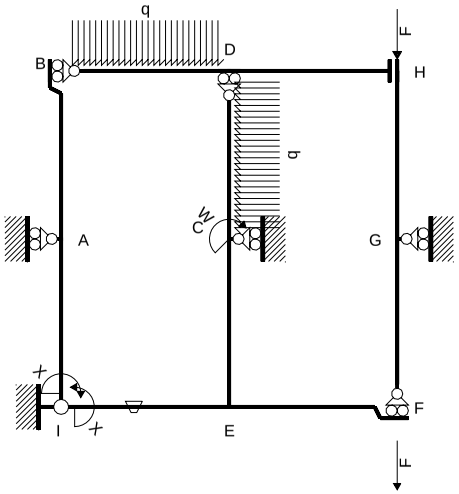
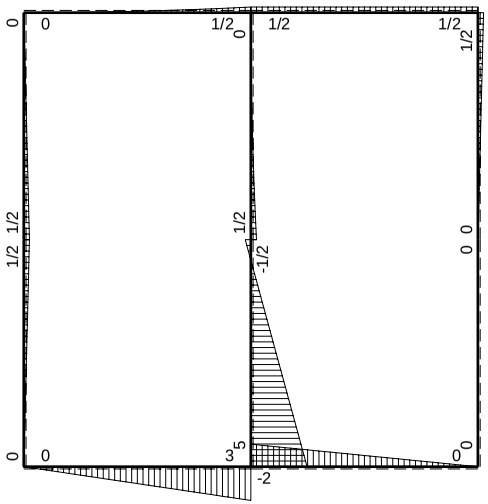
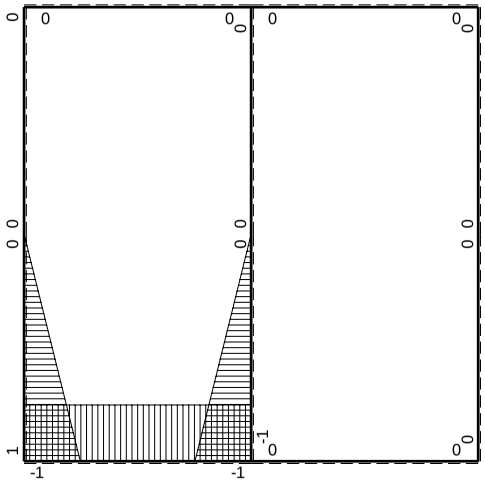
-1/2
0
0
6/5
9/5
19/5
0
-6/5
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 213127 CI07.xxxx.153

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
BA b	0	-1/2Fx	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fb+1/2Fx	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-11/2Fx	0	$-5Fb+21/2Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-19/12+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	1/2Fb-11/2Fx	0	$1/2Fx-11/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	1/2Fx	0	$1/2Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	-1/2Fb+1/2Fx	0	$1/2Fx-1/2Fx^2/b$	0	x^2/b^2		
	totali						$-2Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						6/5Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 21/2\ x/b - 11/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 21/4\ x^2/b - 11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 21/4\ b - 11/6\ b\ )\ Fb\ 1/EJ\ = -19/12\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (1/2\ x/b - 11/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/4\ x^2/b - 11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/4\ b - 11/6\ b\ )\ Fb\ 1/EJ\ = -19/12\ Fb^2/EJ$

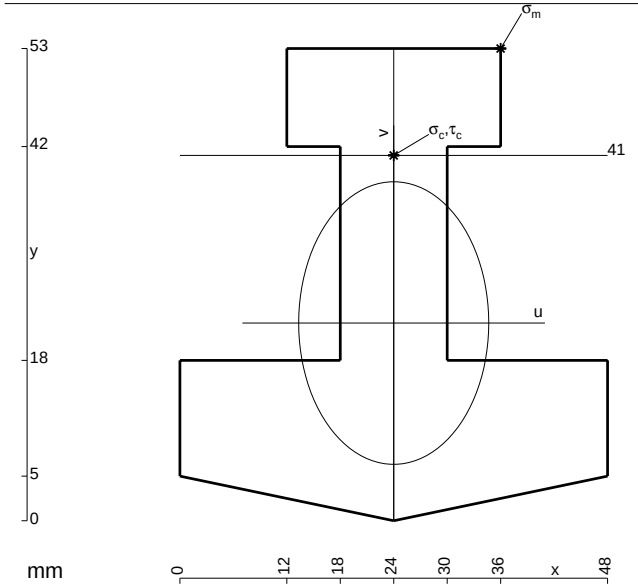
$L_{IA}^{Xo} = \int_o^b (1/2\ x/b - 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/4\ x^2/b - 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/4\ b - 1/6\ b\ )\ Fb\ 1/EJ\ = 1/12\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (1/2\ x/b - 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/4\ x^2/b - 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/4\ b - 1/6\ b\ )\ Fb\ 1/EJ\ = 1/12\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 213127 CI07.xxxx.153



A = 1296. mm^2
J_u = 326102. mm^4
J_v = 147456. mm^4
y_g = 22.19 mm
T_y = 3560. N
M_x = -2420800. Nmm
x_m = 36. mm
y_m = 53. mm
u_m = 12. mm
v_m = 30.81 mm
$\sigma_m = -Mv/J_u$ = 228.7 N/mm^2
x_c = 24. mm
y_c = 41. mm
v_c = 18.81 mm
$\sigma_c = -Mv/J_u$ = 139.6 N/mm^2
τ_c = 6.29 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 140.1 N/mm^2
S^* = 6914. mm^3

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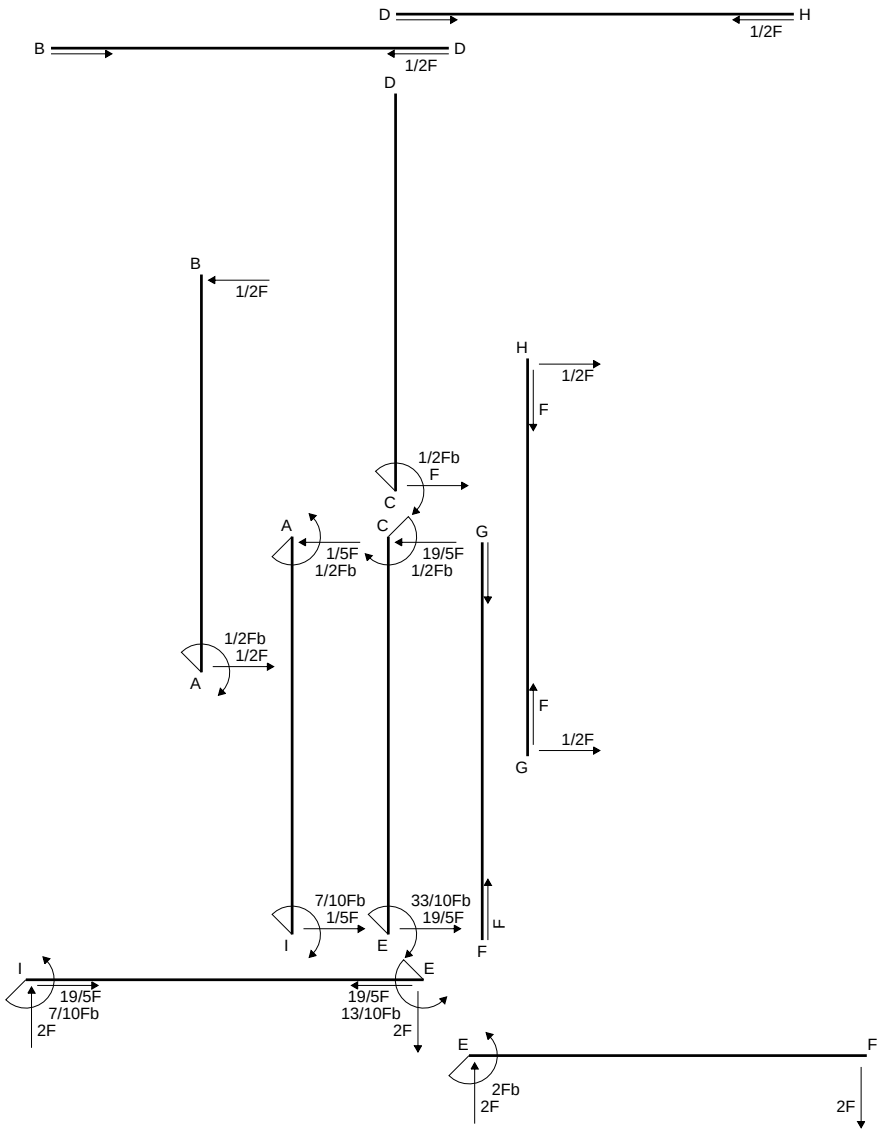
D
H
1/2F
B
D
1/2F
D
B
1/2F
H
1/2F
F
1/2Fb
F
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A
C
G
1/5F
1/2Fb
19/5F
1/2Fb
1/2Fb
1/2F
A
F
1/2F
G
7/10Fb
1/5F
33/10Fb
19/5F
I
E
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7/10Fb
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19/5F
13/10Fb
2F
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F
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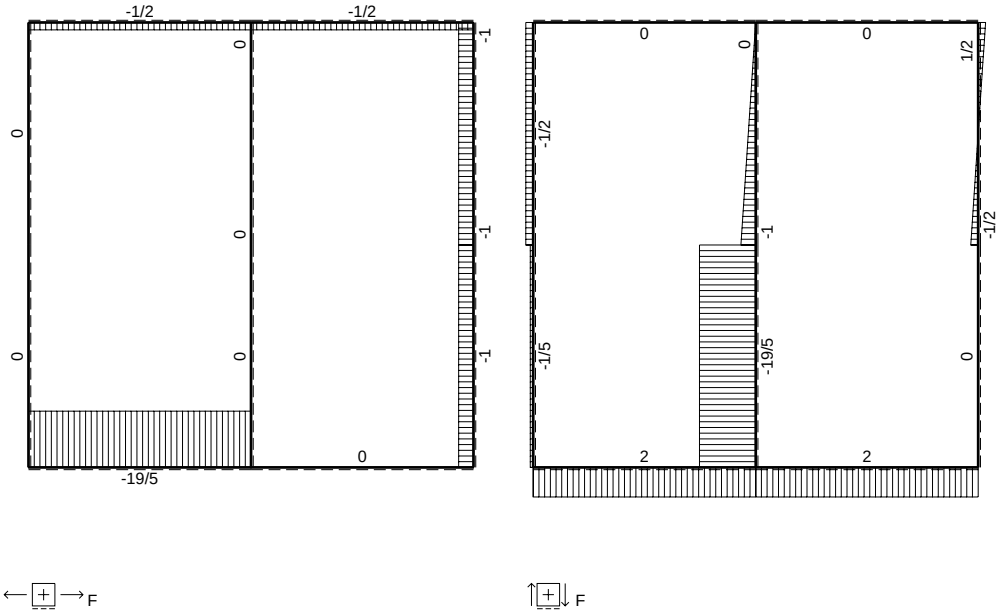
2F
2F


-1/2
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-19/5
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-1/5
-19/5
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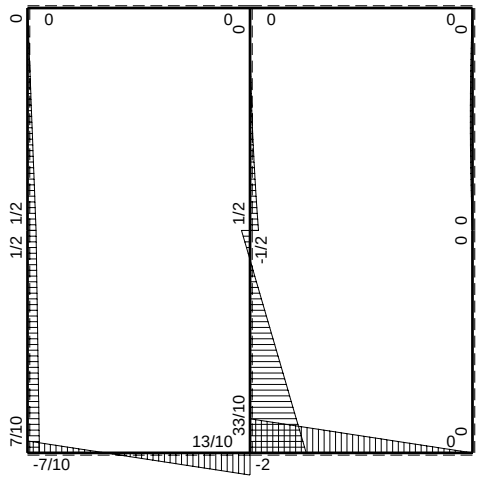
2
F
F


0
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0
0
0
1/2
1/2
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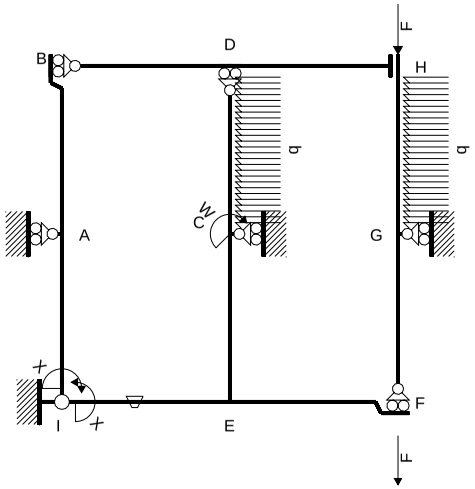
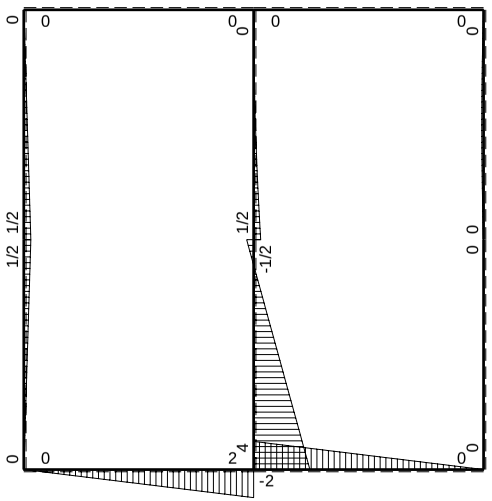
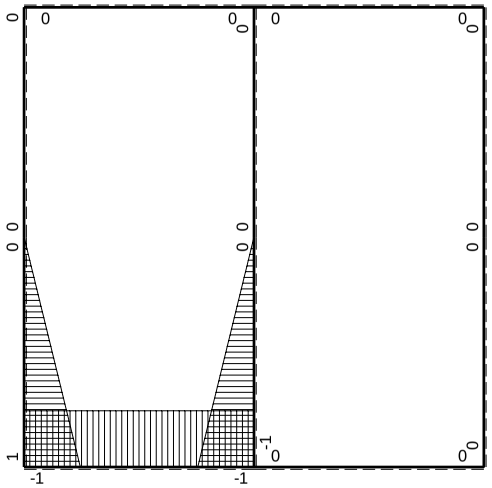
-1/2
0
0
0
0
7/10
33/10
13/10
-7/10
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 218550 CI07.xxxx.154

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PROCEDIMENTO E RISULTATI 218550 CI07.xxxx.154

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
BA b	0	-1/2Fx	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	-1+x/b	4Fb-9/2Fx	0	$-4Fb+17/2Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/4+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$1/2Fb-9/2Fx$	0	$1/2Fx-9/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	1/2Fx	0	$1/2Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	$-1/2Fb+1/2Fx$	0	$1/2Fx-1/2Fx^2/b$	0	x^2/b^2		
	totali						$-7/6Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						7/10Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L_{EI}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L_{EC}^{Xo} = \int_o^b (-4 + 17/2\ x/b - 9/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4\ x + 17/4\ x^2/b - 3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-4\ b + 17/4\ b - 3/2\ b\ )\ Fb\ 1/EJ\ = -5/4\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (1/2\ x/b - 9/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/4\ x^2/b - 3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

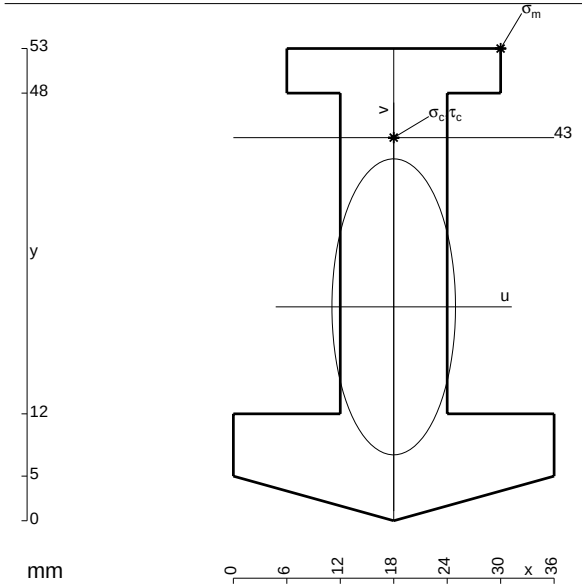
$= (1/4\ b - 3/2\ b\ )\ Fb\ 1/EJ\ = -5/4\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (1/2\ x/b - 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/4\ x^2/b - 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

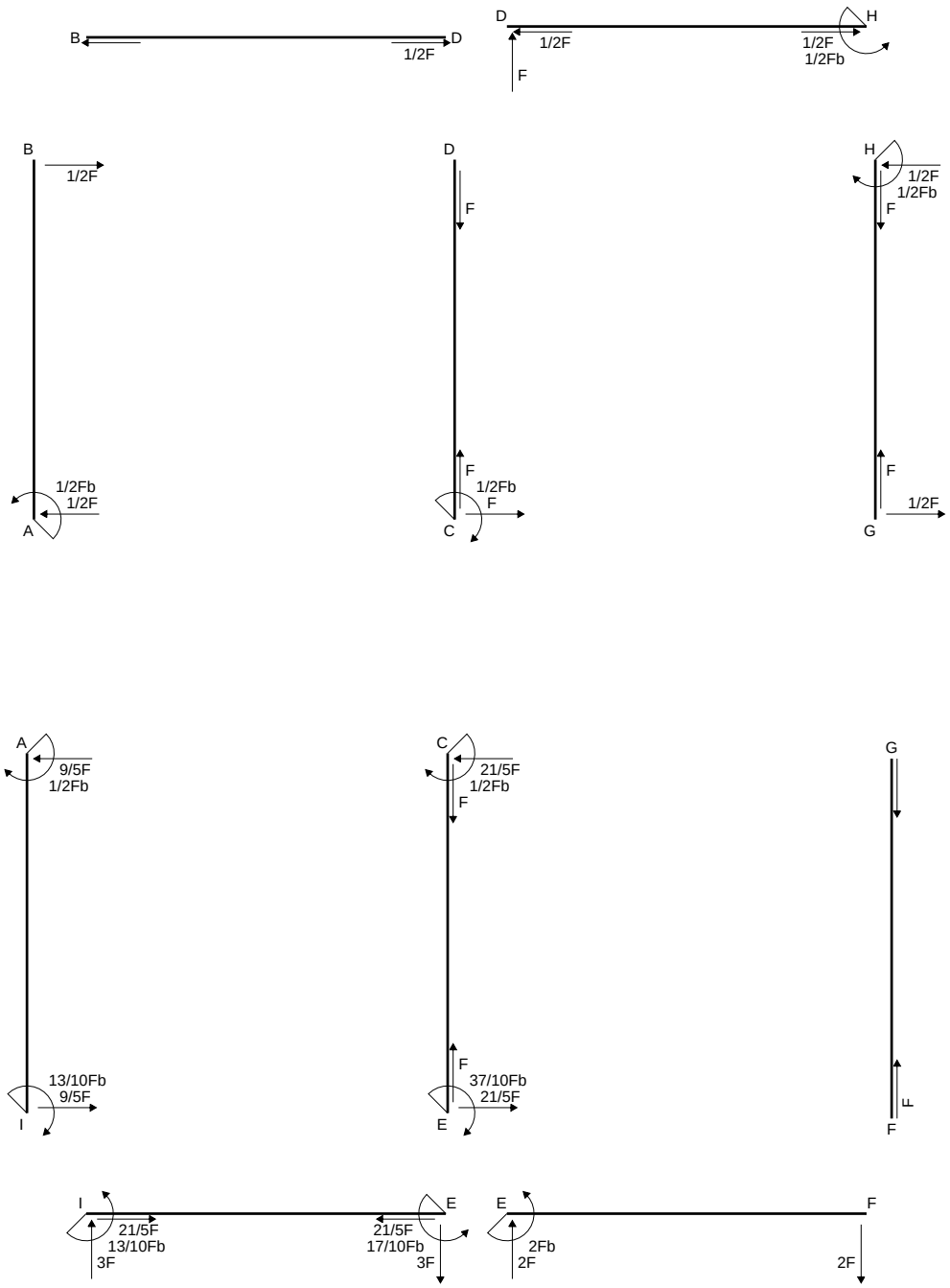
$= (1/4\ b - 1/6\ b\ )\ Fb\ 1/EJ\ = 1/12\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (1/2\ x/b - 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/4\ x^2/b - 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/4\ b - 1/6\ b\ )\ Fb\ 1/EJ\ = 1/12\ Fb^2/EJ$



A = 894. mm^2
J_u = 246865. mm^4
J_v = 43020. mm^4
y_g = 24.01 mm
T_y = 2760. N
M_x = -2042400. Nmm
x_m = 30. mm
y_m = 53. mm
u_m = 12. mm
v_m = 28.99 mm
$\sigma_m = -Mv/J_u$ = 239.9 N/mm^2
x_c = 18. mm
y_c = 43. mm
v_c = 18.99 mm
$\sigma_c = -Mv/J_u$ = 157.1 N/mm^2
τ_c = 4.163 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 157.3 N/mm^2
S^* = 4469. mm^3


B
D
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D
H
1/2F
1/2F
1/2Fb
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B
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1/2Fb
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D
F
F
1/2Fb
F
C
H
1/2F
1/2Fb
F
F
1/2F
G
A
9/5F
1/2Fb
I
13/10Fb
9/5F
C
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1/2Fb
F
F
37/10Fb
21/5F
E
G
F
F
I
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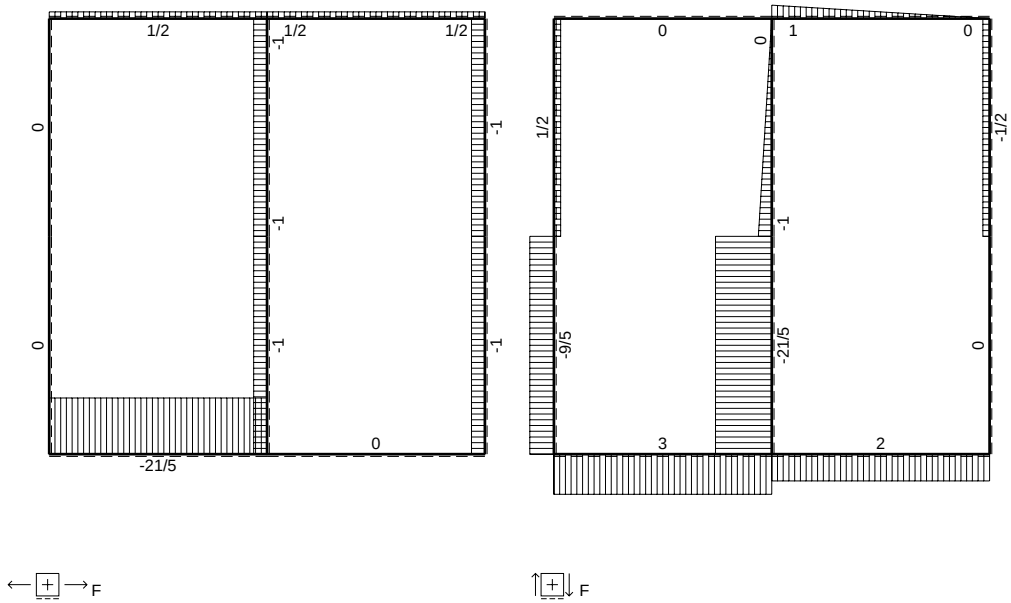
13/10Fb
3F
E
21/5F
17/10Fb
3F
E
2Fb
2F
F
2F


1/2
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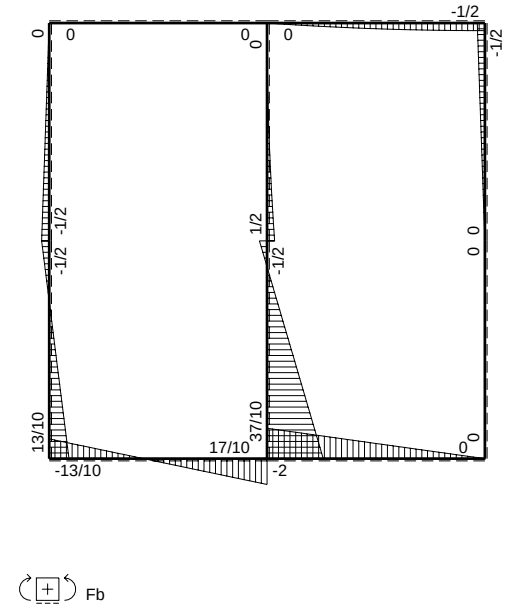
1/2
1/2
0
-1
-1
-1
-1
-21/5
0
F
0
0
1
0
1/2
-1/2
-1
-9/5
-21/5
0
3
2
F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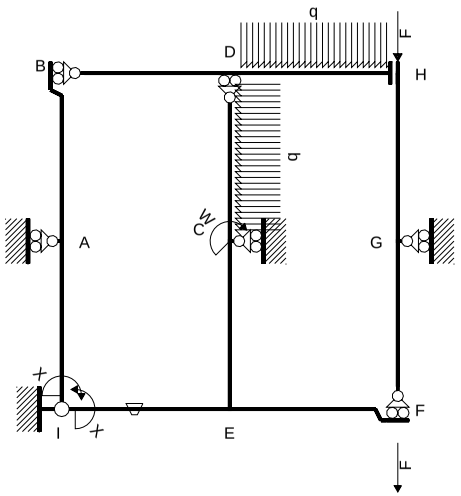
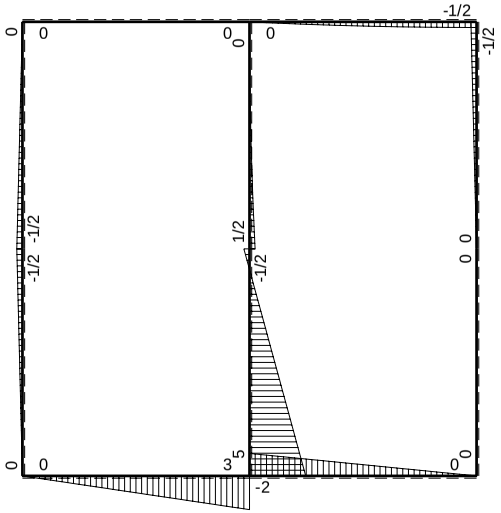
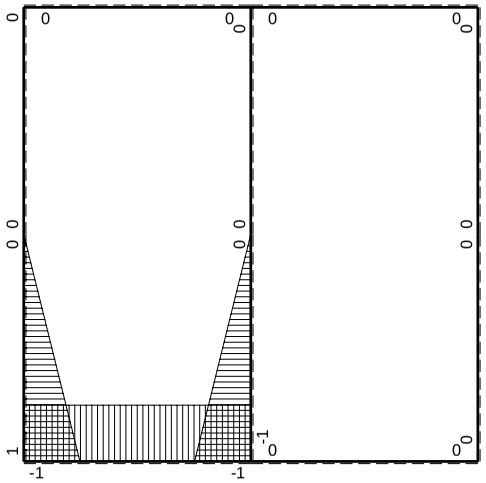
0
0
0
0
-1/2
-1/2
-1/2
1/2
-1/2
0
0
0
0
13/10
37/10
-13/10
17/10
-2
0
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 253587 CI07.xxxx.155

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PROCEDIMENTO E RISULTATI 253587 CI07.xxxx.155

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	-1/2Fx	0	0	0	0	0+0	0
HG b	0	1/2Fb-1/2Fx	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-11/2Fx	0	$-5Fb+21/2Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-19/12+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	1/2Fb-11/2Fx	0	$1/2Fx-11/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-13/6Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						13/10Fb	

Sviluppi di calcolo iperstatica

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$L^{XX}_{IE} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EI} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EC} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{CE} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{IA} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{AI} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{Xo}_{IE} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L^{Xo}_{EI} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L^{Xo}_{EC} = \int_o^b (-5 + 21/2\ x/b - 11/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 21/4\ x^2/b - 11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 21/4\ b - 11/6\ b\ )\ Fb\ 1/EJ\ = -19/12\ Fb^2/EJ$

$L^{Xo}_{CE} = \int_o^b (1/2\ x/b - 11/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/4\ x^2/b - 11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (1/4\ b - 11/6\ b\ )\ Fb\ 1/EJ\ = -19/12\ Fb^2/EJ$

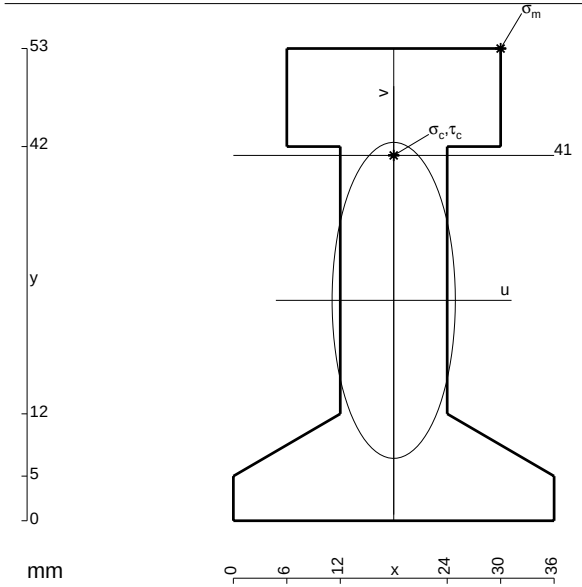
$L^{Xo}_{IA} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

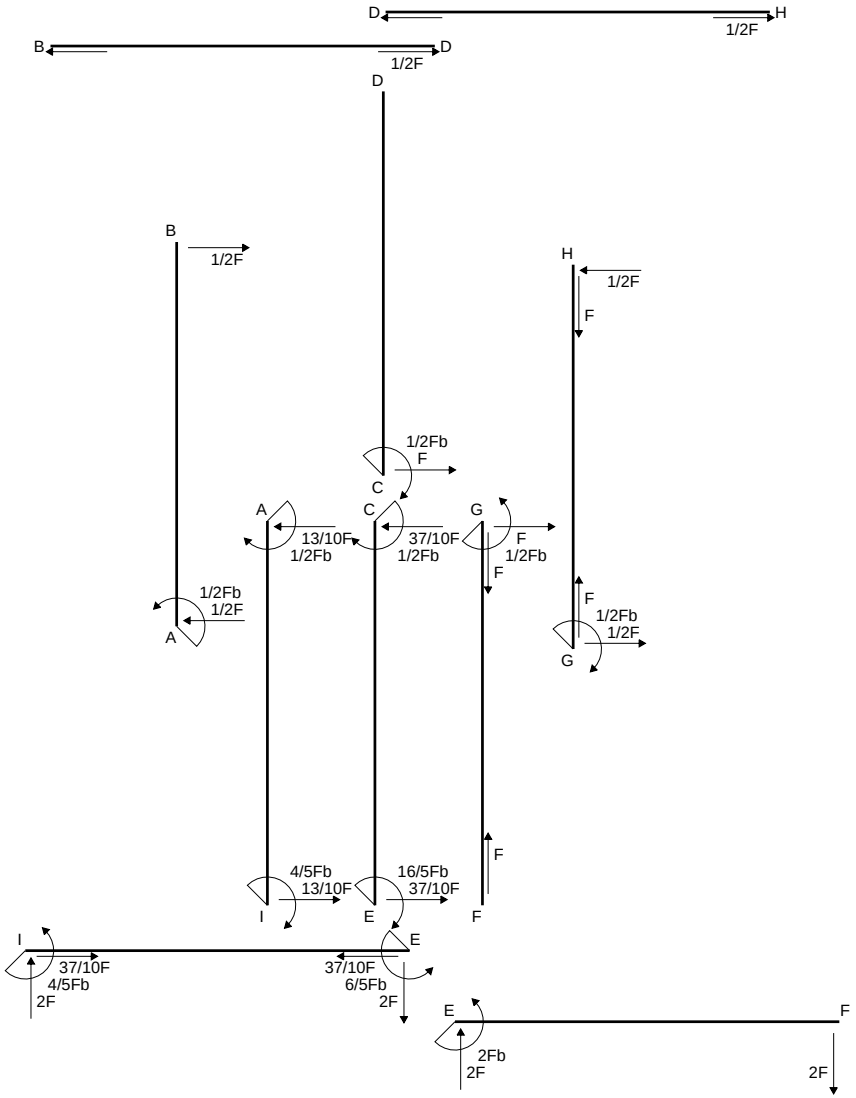
$L^{Xo}_{AI} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

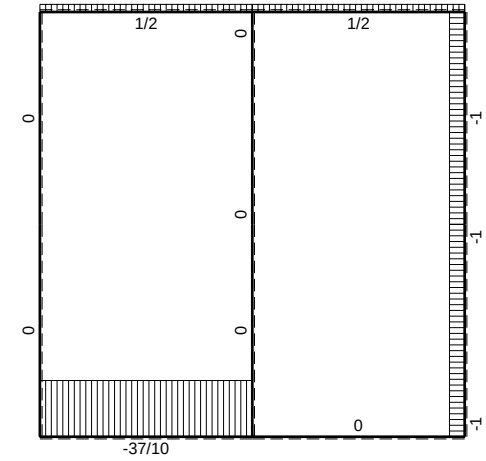
$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 253587 CI07.xxxx.155



A = 972. mm^2
J_u = 305841. mm^4
J_v = 46512. mm^4
y_g = 24.73 mm
T_y = 2720. N
M_x = -2148800. Nmm
x_m = 30. mm
y_m = 53. mm
u_m = 12. mm
v_m = 28.27 mm
$\sigma_m = -Mv/J_u$ = 198.6 N/mm^2
x_c = 18. mm
y_c = 41. mm
v_c = 16.27 mm
$\sigma_c = -Mv/J_u$ = 114.3 N/mm^2
τ_c = 4.604 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 114.6 N/mm^2
S^* = 6212. mm^3


D
H
1/2F
B
D
1/2F
D
B
1/2F
H
1/2F
F
1/2Fb
F
C
A
C
G
13/10F
1/2Fb
37/10F
1/2Fb
F
1/2Fb
F
F
1/2Fb
1/2F
A
F
1/2Fb
1/2F
G
4/5Fb
13/10F
16/5Fb
37/10F
F
I
E
F
I
E
37/10F
4/5Fb
2F
37/10F
6/5Fb
2F
E
F
2Fb
2F
2F


1/2
1/2
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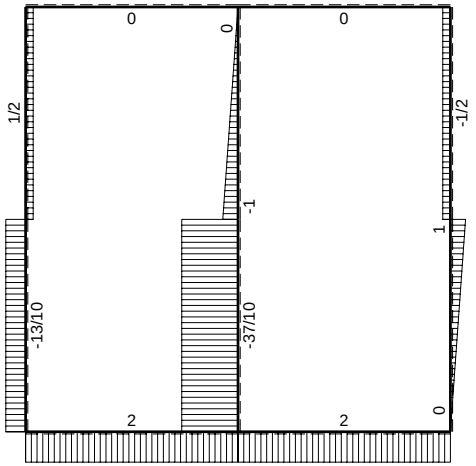
0
-1
-1
-1
0
-37/10


0
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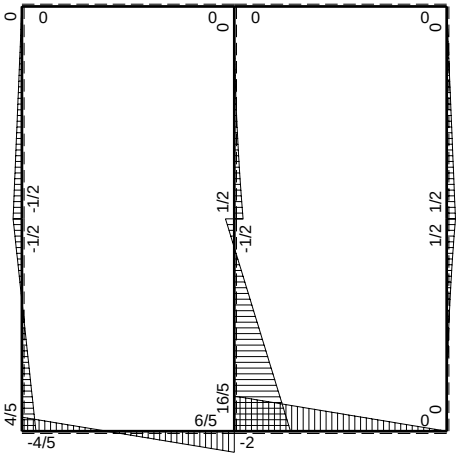
0
1/2
-1/2
-1
1
-13/10
-37/10
2
2
0

F

F


0
0
0
0
0
-1/2
-1/2
1/2
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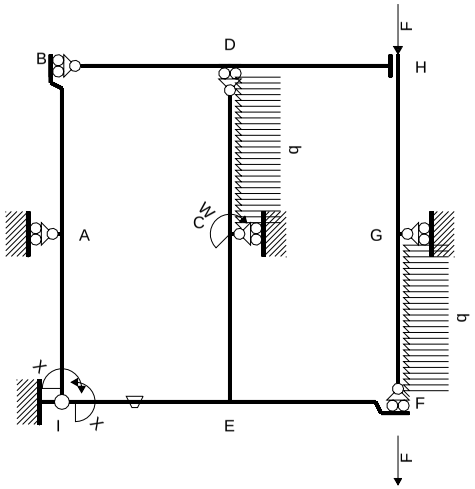
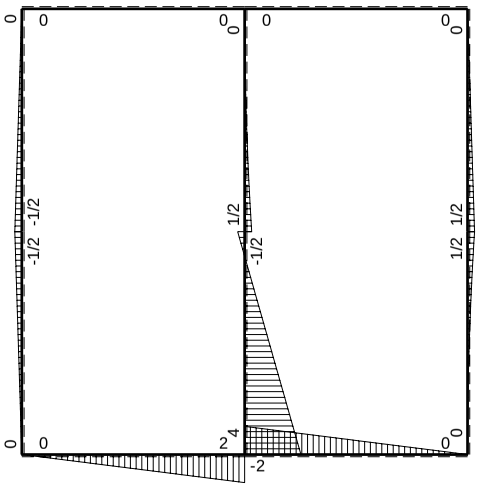
1/2
1/2
4/5
16/5
6/5
0
0
-4/5
-2

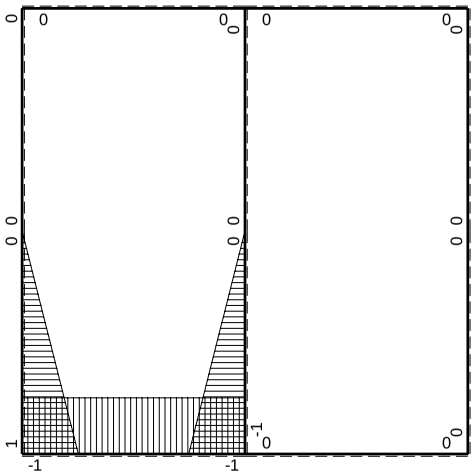
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 212582 CI07.xxxx.156

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PROCEDIMENTO E RISULTATI 212582 CI07.xxxx.156

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0
BA b	0	$1/2Fx$	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fx$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$4Fb-9/2Fx$	0	$-4Fb+17/2Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/4+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$1/2Fb-9/2Fx$	0	$1/2Fx-9/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-4/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$4/5Fb$	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L_{EI}^{Xo} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L_{EC}^{Xo} = \int_o^b (-4 + 17/2\ x/b - 9/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4\ x + 17/4\ x^2/b - 3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-4\ b + 17/4\ b - 3/2\ b\ )\ Fb\ 1/EJ\ = -5/4\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (1/2\ x/b - 9/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [1/4\ x^2/b - 3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

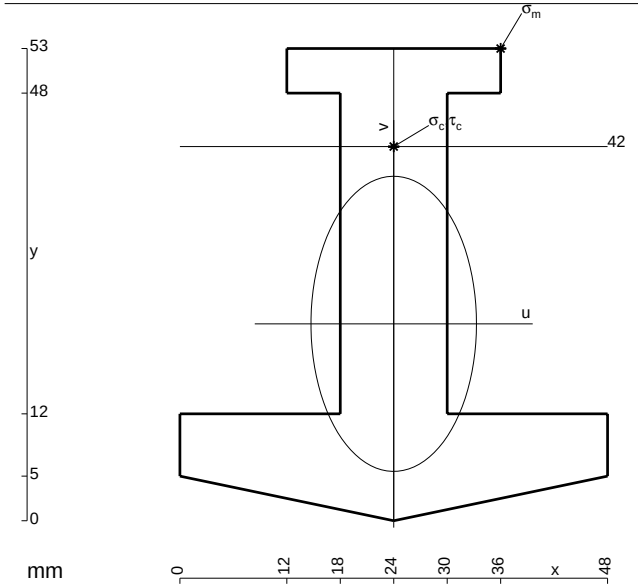
$= (1/4\ b - 3/2\ b\ )\ Fb\ 1/EJ\ = -5/4\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

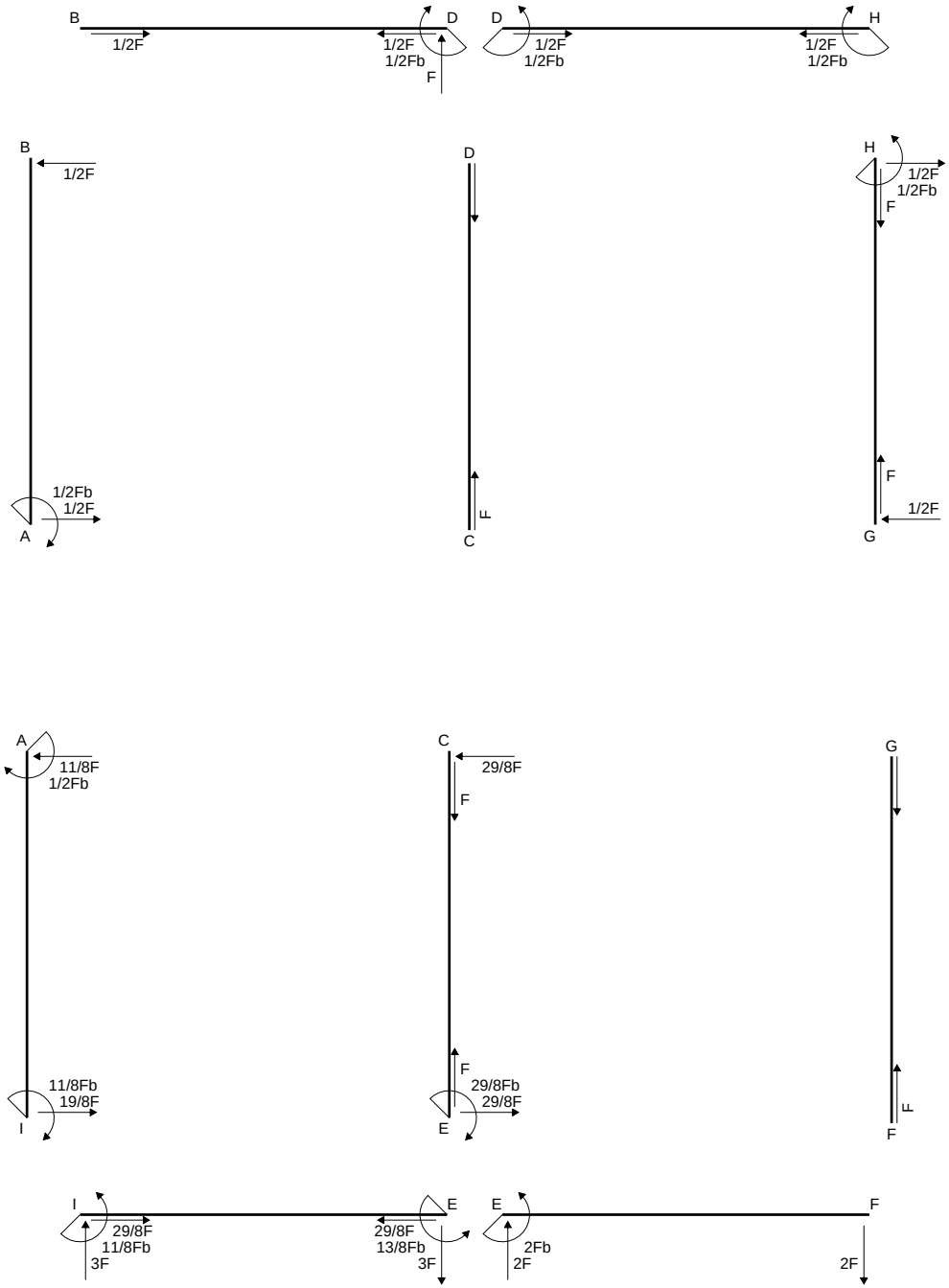
$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

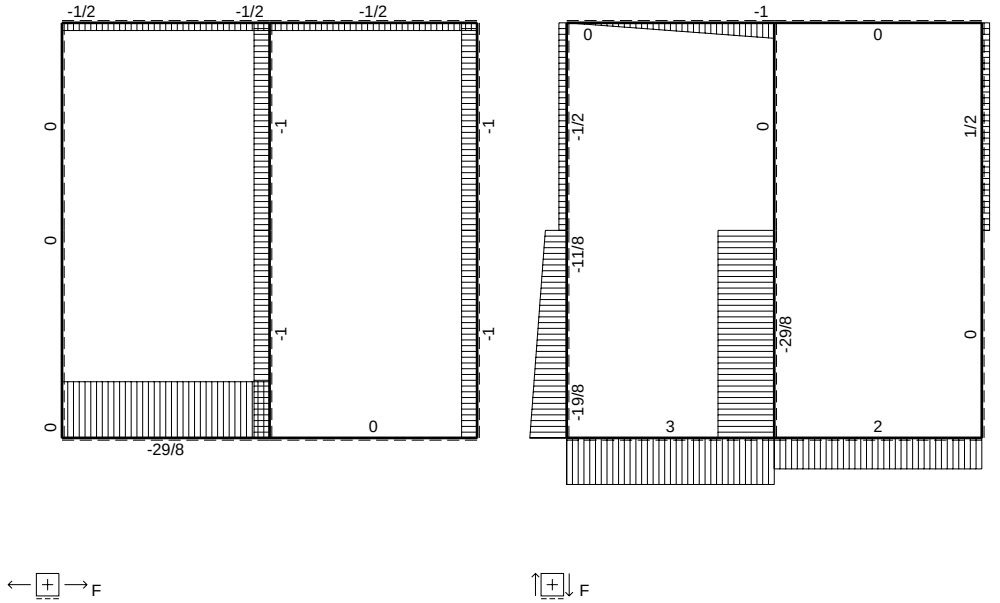
$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$



A = 1008. mm^2
J_u = 276602. mm^4
J_v = 86976. mm^4
y_g = 22.1 mm
T_y = 2220. N
M_x = -1864800. Nmm
x_m = 36. mm
y_m = 53. mm
u_m = 12. mm
v_m = 30.9 mm
$\sigma_m = -Mv/J_u$ = 208.3 N/mm^2
x_c = 24. mm
y_c = 42. mm
v_c = 19.9 mm
$\sigma_c = -Mv/J_u$ = 134.2 N/mm^2
τ_c = 3.382 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 134.3 N/mm^2
S^* = 5057. mm^3


B
1/2F
D
1/2F
1/2Fb
F
D
1/2F
1/2Fb
H
1/2F
1/2Fb
B
1/2F
1/2Fb
1/2F
A
D
F
C
H
1/2F
1/2Fb
F
F
1/2F
G
A
11/8F
1/2Fb
11/8Fb
19/8F
I
C
29/8F
F
F
29/8Fb
29/8F
E
G
F
F
I
29/8F
11/8Fb
3F
E
29/8F
13/8Fb
3F
E
2Fb
2F
F
2F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-1
-1
-29/8
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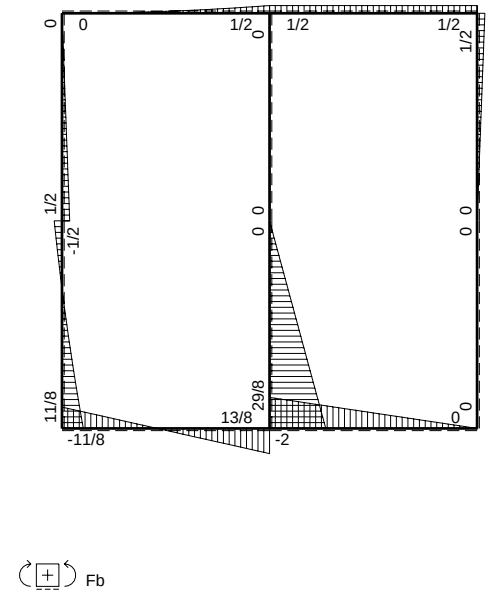
0
0
-1/2
0
1/2
-11/8
-29/8
-19/8
0
3
2
F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1/2
1/2
1/2
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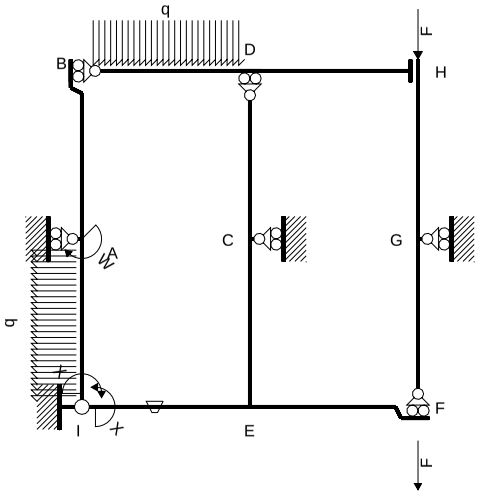
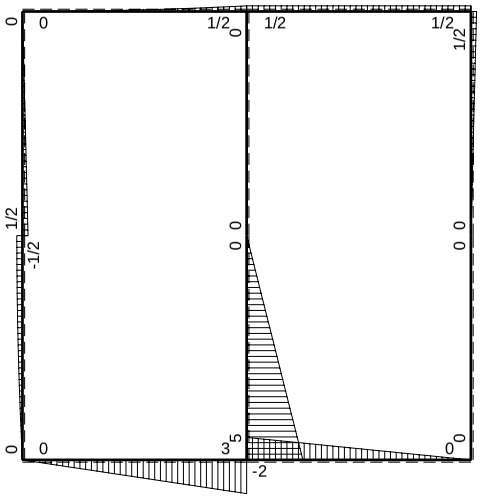
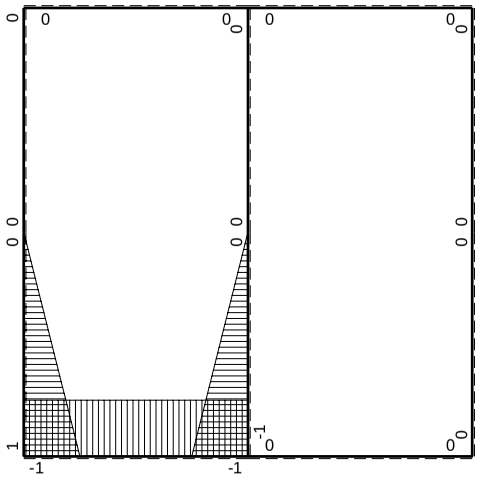
1/2
-1/2
0 0
0 0
11/8
29/8
13/8
0
0
-11/8
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 215365 CI07.xxxx.157

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PROCEDIMENTO E RISULTATI 215365 CI07.xxxx.157

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
BA b	0	-1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fb+1/2Fx	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-5Fx	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-5Fx	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	$-Fx+1/2qx^2$	0	$-Fx+3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-1/8+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	$1/2Fb-1/2qx^2$	0	$-1/2Fx+1/2qx^3/b$	0	x^2/b^2		
	totali						$-55/24Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						11/8Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

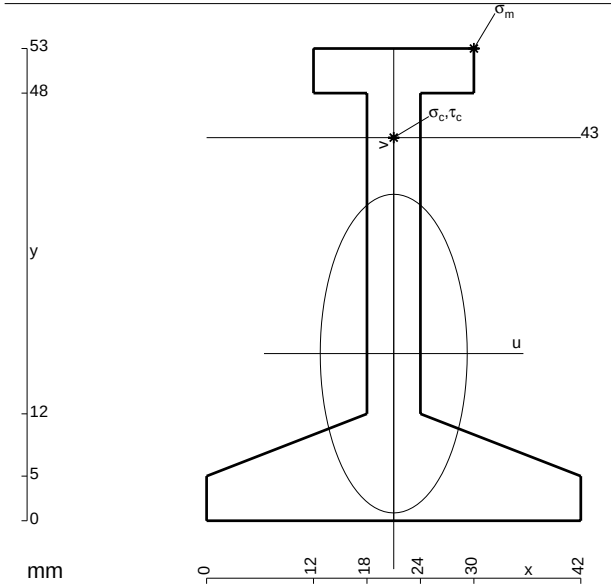
$L_{IA}^{Xo} = \int_o^b (-\ x/b + 3/2\ x^2/b^2 - 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/2\ x^3/b^2 - 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/2\ b - 1/8\ b\ )\ Fb\ 1/EJ\ = -1/8\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/8\ b\ )\ Fb\ 1/EJ\ = -1/8\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 215365 CI07.xxxx.157



A = 684. mm^2
J_u = 218819. mm^4
J_v = 46548. mm^4
y_g = 18.76 mm
T_y = 1560. N
M_x = -1404000. Nmm
x_m = 30. mm
y_m = 53. mm
u_m = 9. mm
v_m = 34.24 mm
$\sigma_m = -Mv/J_u$ = 219.7 N/mm^2
x_c = 21. mm
y_c = 43. mm
v_c = 24.24 mm
$\sigma_c = -Mv/J_u$ = 155.5 N/mm^2
τ_c = 4.348 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 155.7 N/mm^2
S^* = 3659. mm^3

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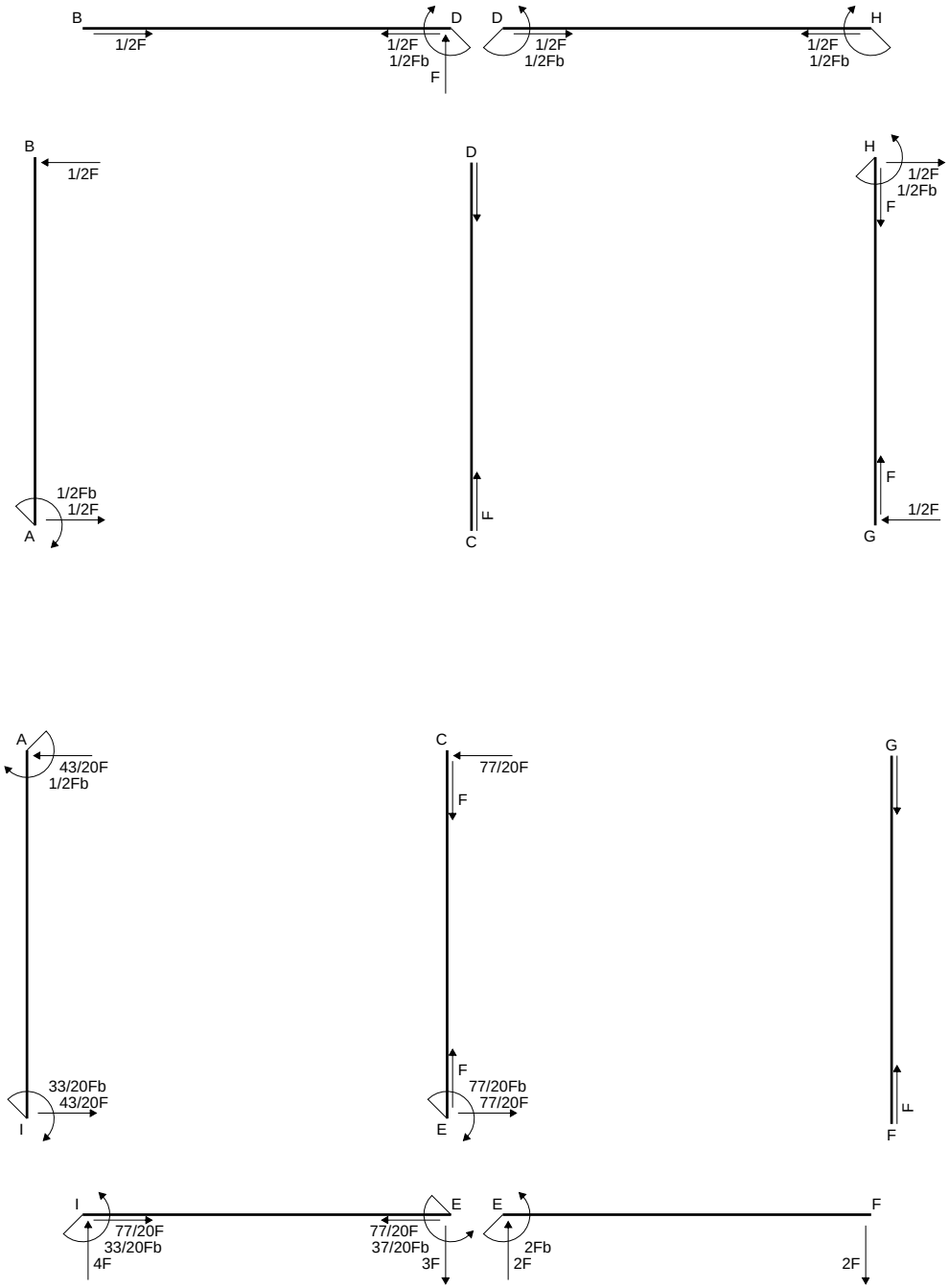
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1/2Fb
F
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1/2Fb
H
1/2F
1/2Fb
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A
D
F
C
H
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1/2Fb
F
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1/2F
G
A
43/20F
1/2Fb
33/20Fb
43/20F
I
C
77/20F
F
F
77/20Fb
77/20F
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G
F
F
I
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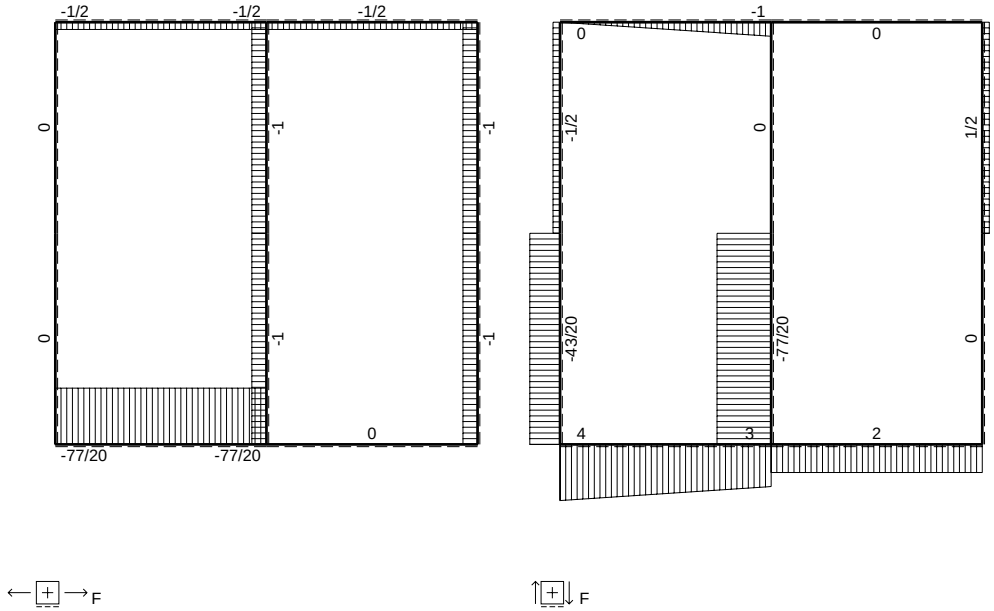
E
77/20F
37/20Fb
3F
E
2Fb
2F
F
2F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-43/20
-77/20
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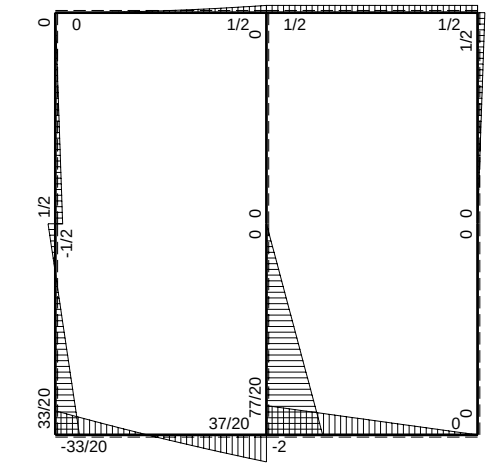
3
2
F


0
0
1/2
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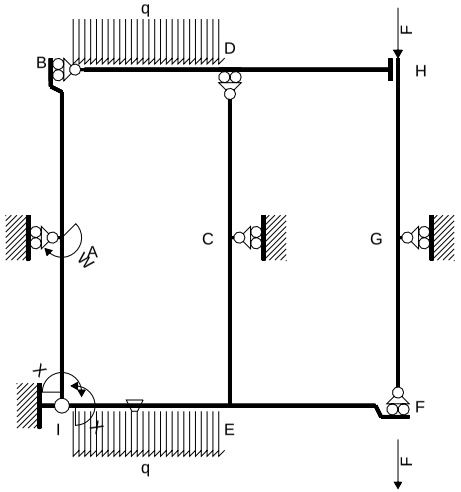
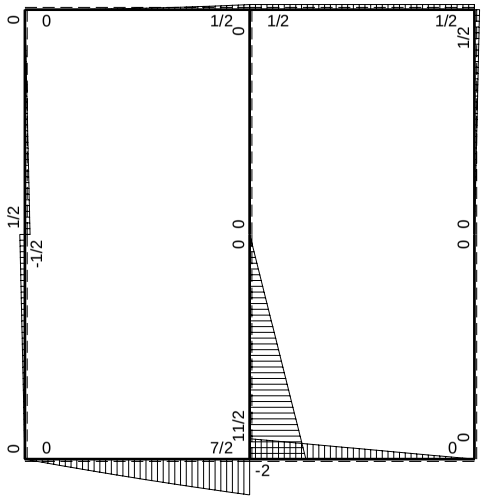
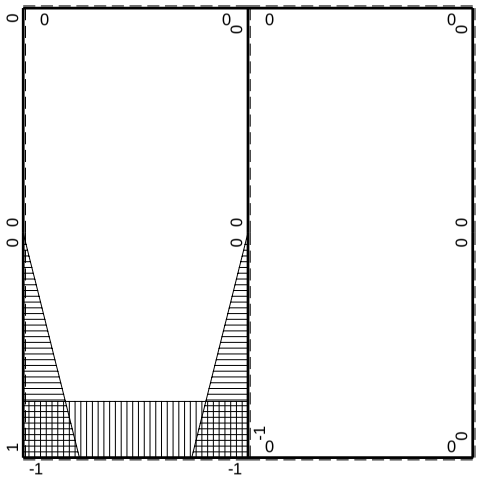
1/2
-1/2
0
0
33/20
77/20
37/20
0
-33/20
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 211795 CI07.xxxx.158

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PROCEDIMENTO E RISULTATI 211795 CI07.xxxx.158

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
BA b	0	-1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fb+1/2Fx	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$4Fx-1/2qx^2$	-Fb/EJ	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	$-1+x/b$	11/2Fb-11/2Fx	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-11/2Fx	0	$-11/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	1/2Fb-1/2Fx	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-11/4Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						33/20Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-4\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-7/2 + 3\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx$

$= [-7/2\ x + 3/2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-7/2\ b + 3/2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-11/2 + 11\ x/b - 11/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-11/2\ x + 11/2\ x^2/b - 11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-11/2\ b + 11/2\ b - 11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-11/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

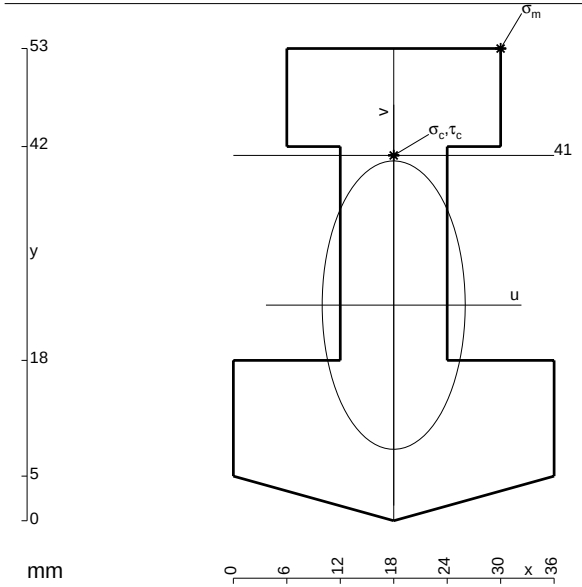
$= (-11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

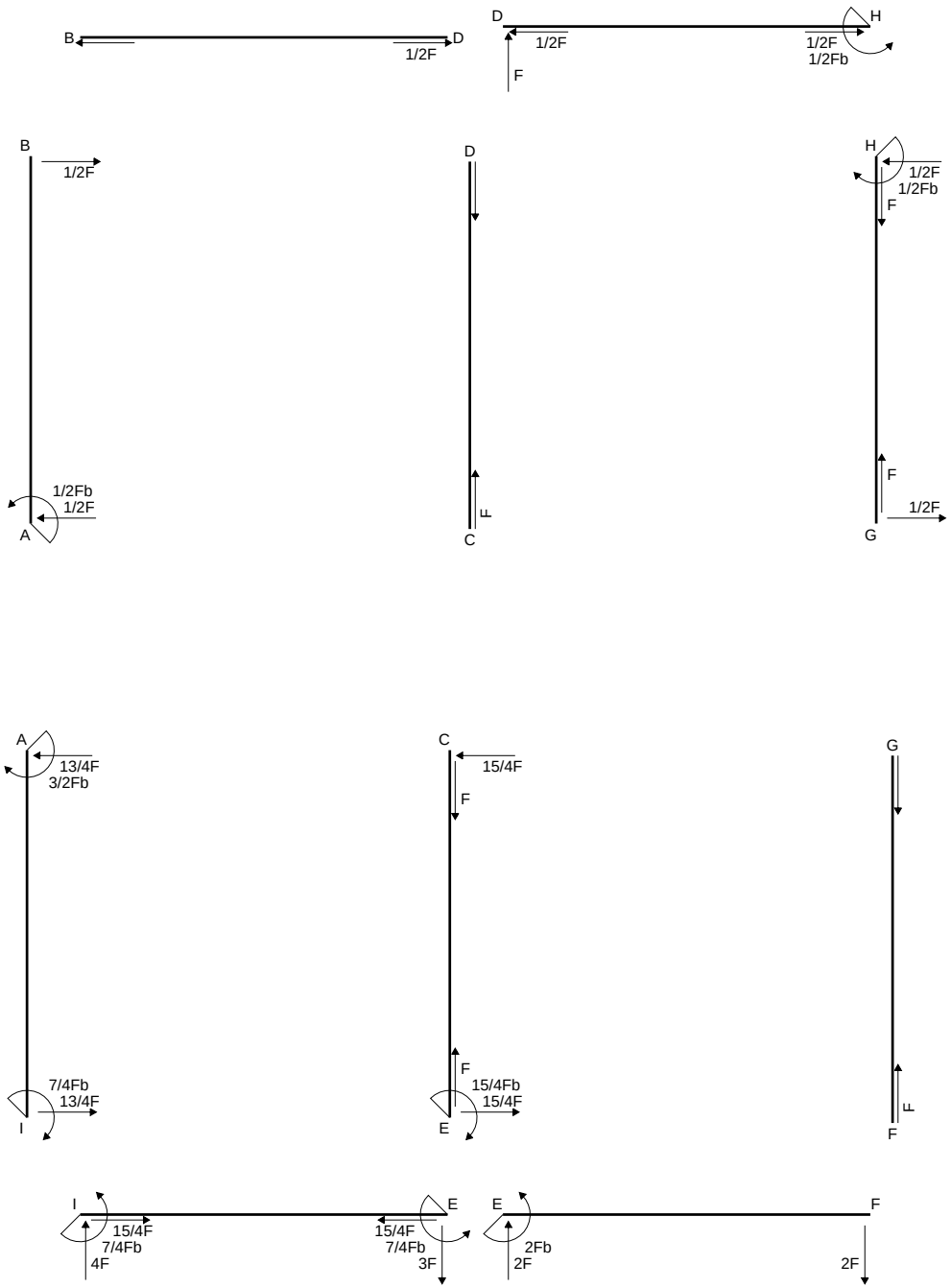
$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

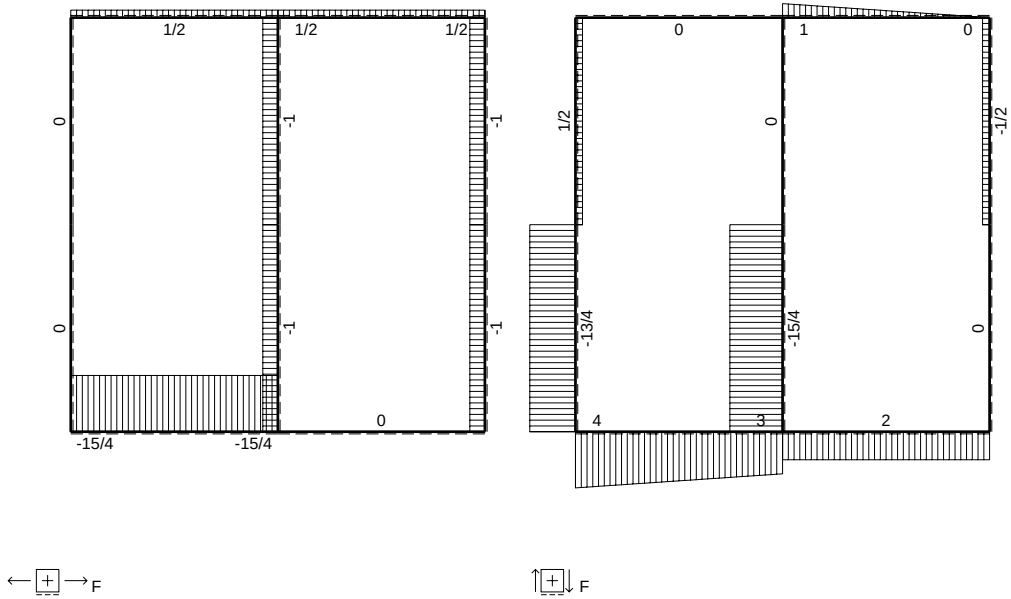
$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

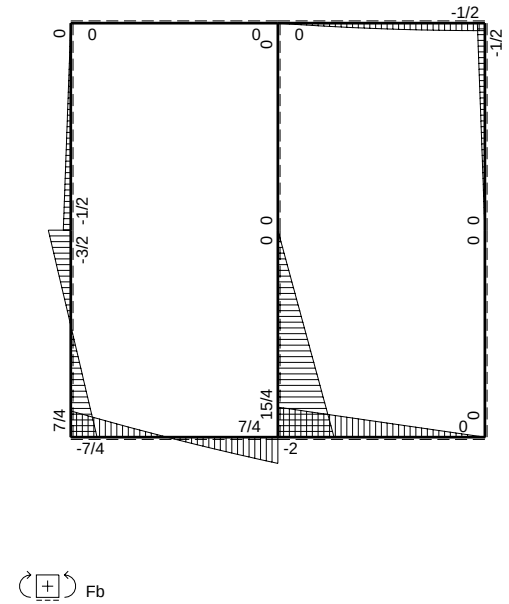
$= (-1/4\ b + 1/6\ b\ )\ Fb\ 1/EJ\ = -1/12\ Fb^2/EJ$

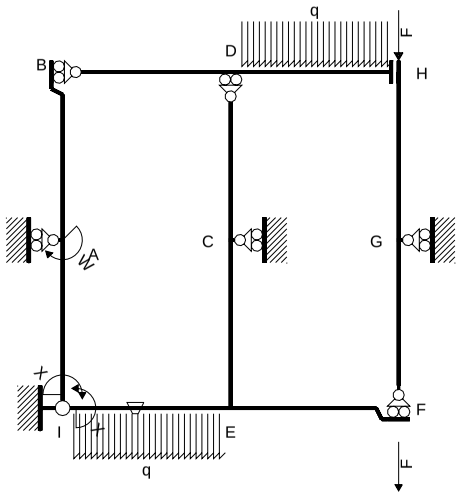


A = 1110. mm^2
J_u = 290885. mm^4
J_v = 71532. mm^4
y_g = 24.2 mm
T_y = 2440. N
M_x = -2318000. Nmm
x_m = 30. mm
y_m = 53. mm
u_m = 12. mm
v_m = 28.8 mm
$\sigma_m = -Mv/J_u$ = 229.5 N/mm^2
x_c = 18. mm
y_c = 41. mm
v_c = 16.8 mm
$\sigma_c = -Mv/J_u$ = 133.9 N/mm^2
τ_c = 4.445 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 134.1 N/mm^2
S^* = 6359. mm^3

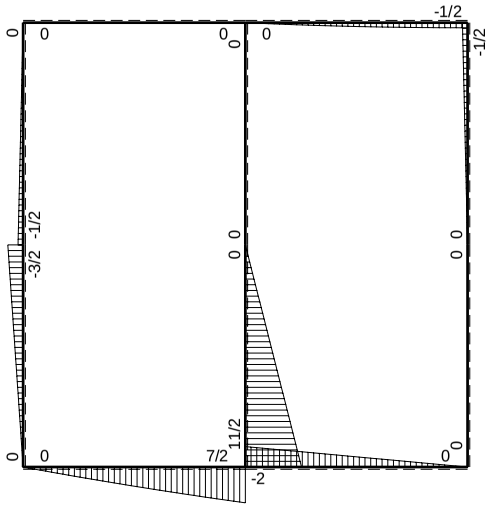

B
D
1/2F
F
H
1/2Fb
A
C
G
13/4F
3/2Fb
7/4Fb
I
15/4F
15/4Fb
E
2Fb
2F
4F
3F


1/2
-1
0
-15/4
-13/4
4
3
2
-1/2
F

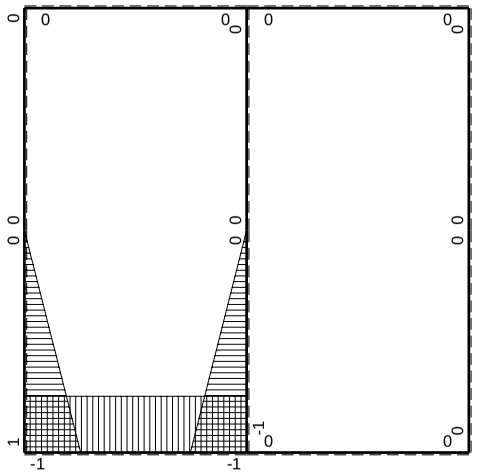

-1/2
-3/2
7/4
15/4
-7/4
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 986216 CI07.xxxx.159

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	-1/2Fx	0	0	0	0	0+0	0
HG b	0	1/2Fb-1/2Fx	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$4Fx-1/2qx^2$	-Fb/EJ	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	-1+x/b	11/2Fb-11/2Fx	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-11/2Fx	0	$-11/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-3/2Fx	0	$-3/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/4+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	3/2Fb-3/2Fx	0	$-3/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-35/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						7/4Fb	

Sviluppi di calcolo iperstatica

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$L^{XX}_{IE} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EI} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EC} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{CE} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{IA} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{AI} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{Xo}_{IE} = \int_o^b (-4\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L^{Xo}_{EI} = \int_o^b (-7/2 + 3\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx$

$= [-7/2\ x + 3/2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-7/2\ b + 3/2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -5/6\ Fb^2/EJ$

$L^{Xo}_{EC} = \int_o^b (-11/2 + 11\ x/b - 11/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-11/2\ x + 11/2\ x^2/b - 11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-11/2\ b + 11/2\ b - 11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

$L^{Xo}_{CE} = \int_o^b (-11/2\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-11/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-11/6\ b\ )\ Fb\ 1/EJ\ = -11/6\ Fb^2/EJ$

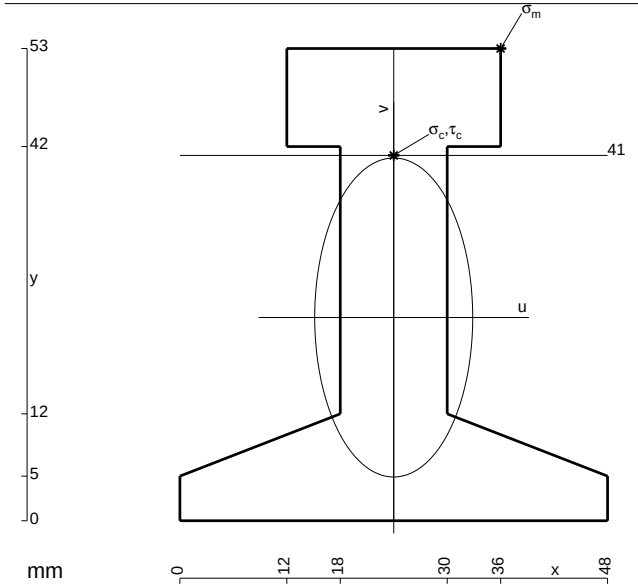
$L^{Xo}_{IA} = \int_o^b (-3/2\ x/b + 3/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-3/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-3/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = -1/4\ Fb^2/EJ$

$L^{Xo}_{AI} = \int_o^b (-3/2\ x/b + 3/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-3/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-3/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = -1/4\ Fb^2/EJ$

PROCEDIMENTO E RISULTATI 986216 CI07.xxxx.159



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J_u = 344482. mm^4
J_v = 84492. mm^4
y_g = 22.81 mm
T_y = 2720. N
M_x = -2720000. Nmm
x_m = 36. mm
y_m = 53. mm
u_m = 12. mm
v_m = 30.19 mm
$\sigma_m = -Mv/J_u$ = 238.4 N/mm^2
x_c = 24. mm
y_c = 41. mm
v_c = 18.19 mm
$\sigma_c = -Mv/J_u$ = 143.6 N/mm^2
τ_c = 4.436 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 143.8 N/mm^2
S^* = 6742. mm^3

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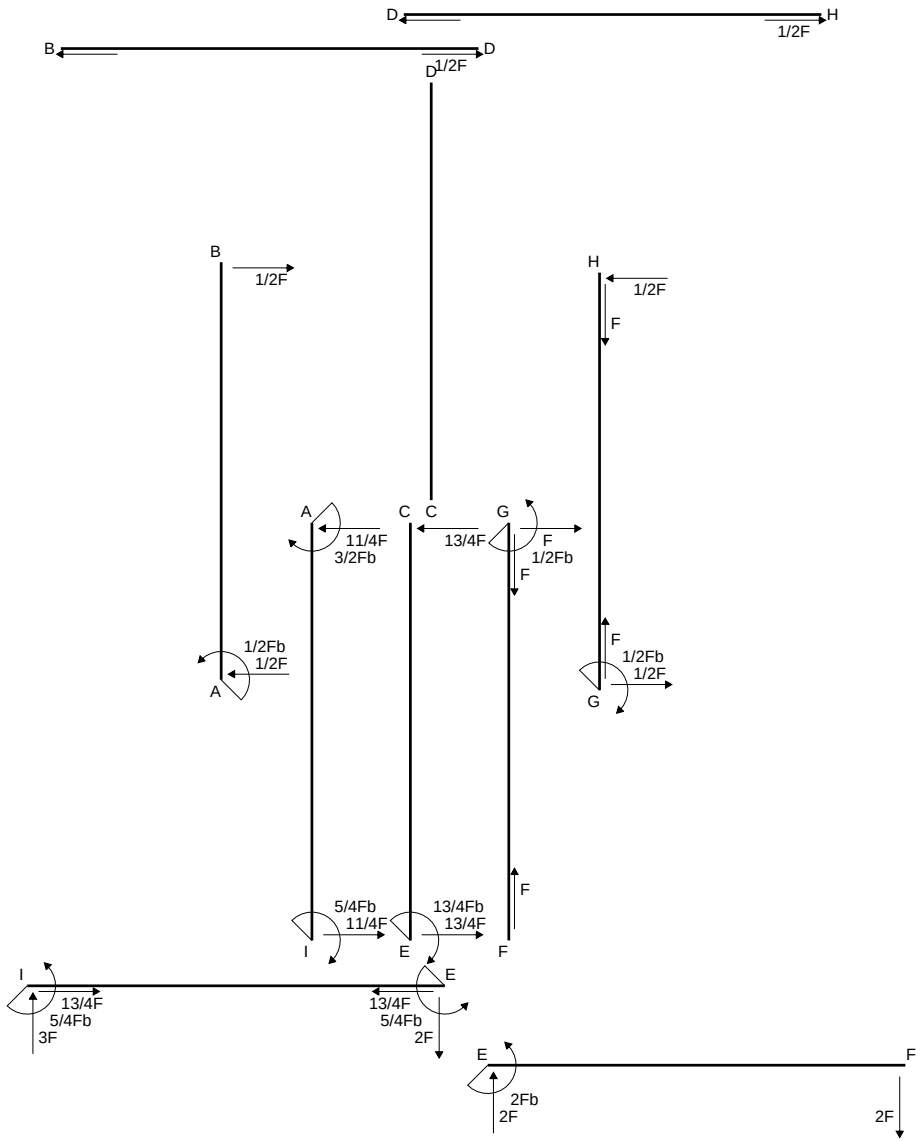
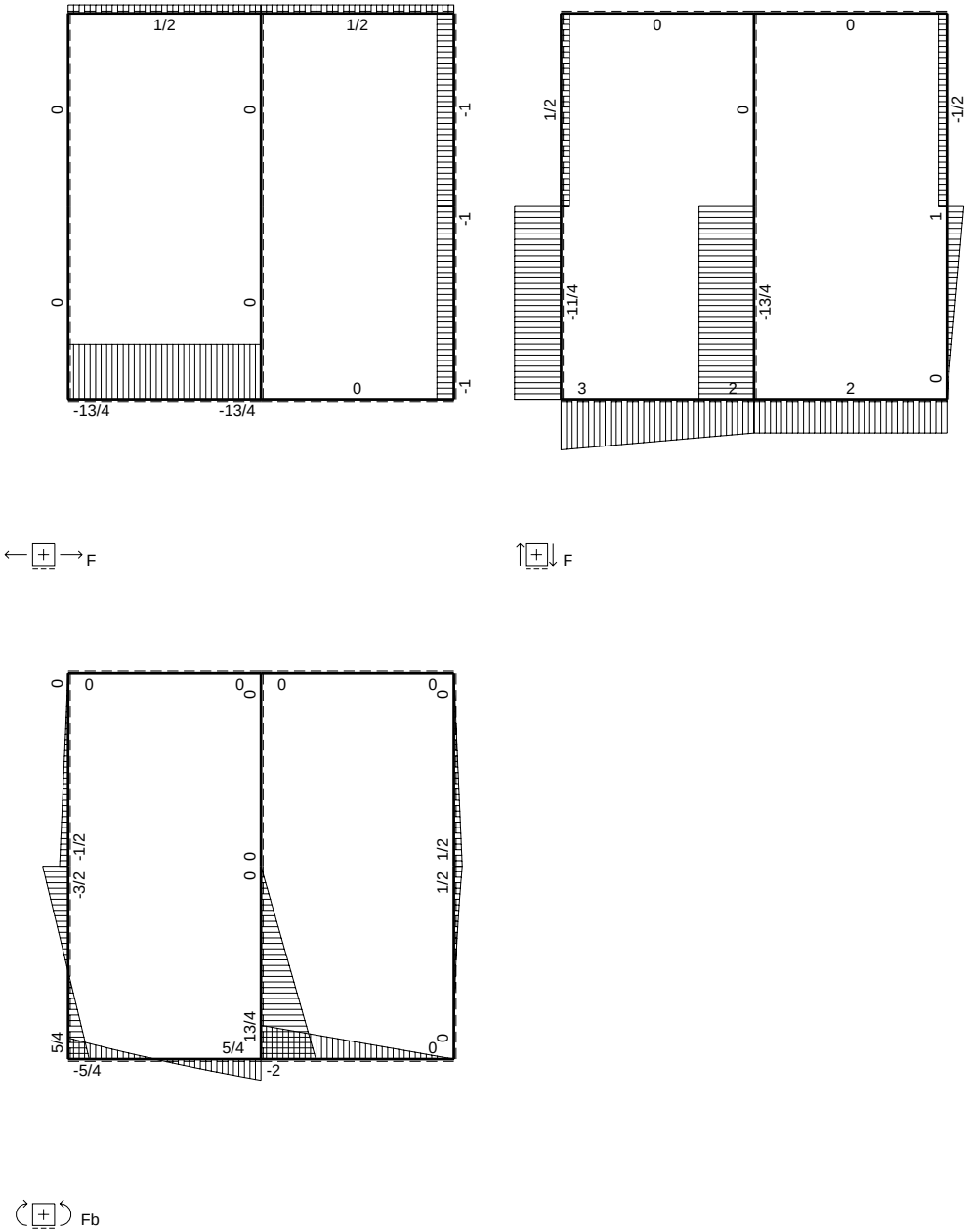

D
H
1/2F
B
D
D 1/2F
B
1/2F
H
1/2F
F
A
C C
G
11/4F
3/2Fb
13/4F
F
1/2Fb
F
1/2Fb
1/2F
A
F
1/2Fb
1/2F
G
F
5/4Fb
11/4F
13/4Fb
13/4F
I
E
F
I
E
13/4F
5/4Fb
3F
13/4F
5/4Fb
2F
E
F
2Fb
2F
2F


1/2
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-1
-1
-1
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-13/4
0
0
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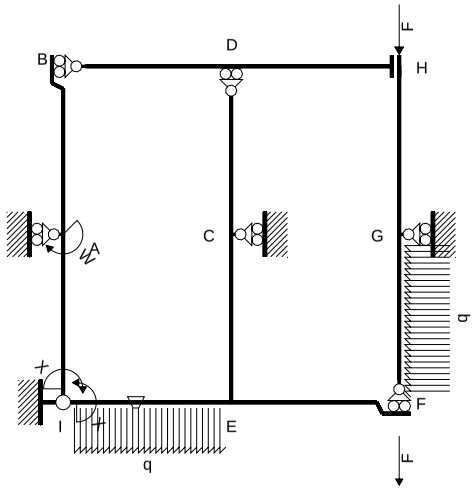
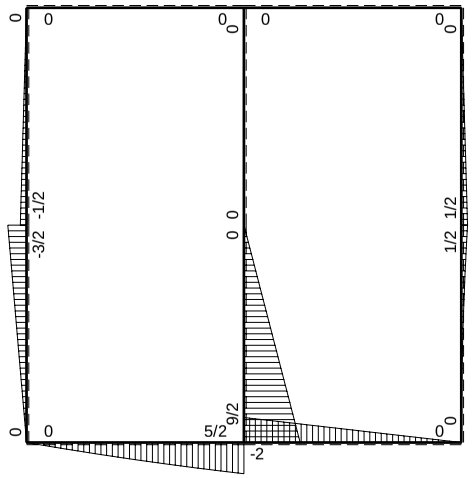
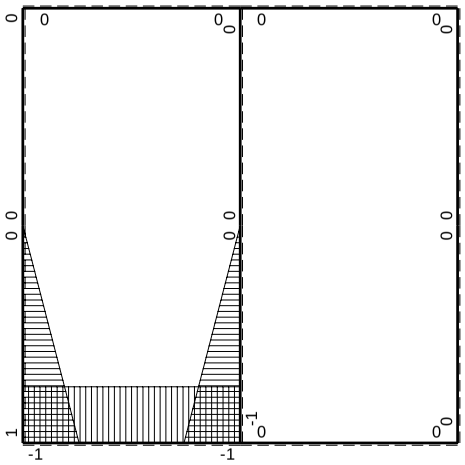
1/2
0
-1/2
-11/4
-13/4
1
3
2
2
0
F
F
0
0
0
0
0
0
0
0
0
0
-3/2
-1/2
1/2
1/2
5/4
13/4
5/4
0
-5/4
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 210779 CI07.xxxx.160

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PROCEDIMENTO E RISULTATI 210779 CI07.xxxx.160

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0
BA b	0	1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx-1/2qx^2$	-Fb/EJ	$-3Fx+1/2Fx^2/b$	Fb/EJ	1	$(-4/3+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-5/2Fb+2Fx+1/2qx^2$	Fb/EJ	$-5/2Fb+2Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	-1+x/b	9/2Fb-9/2Fx	0	$-9/2Fb+9Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-9/2Fx	0	$-9/2Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-3/2Fx	0	$-3/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/4+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	3/2Fb-3/2Fx	0	$-3/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-25/12Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						5/4Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b + 1/6\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/3\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-5/2 + 2\ x/b + 1/2\ x^2/b^2)\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx$

$= [-5/2\ x + x^2/b + 1/6\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-5/2\ b + b + 1/6\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/3\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-9/2 + 9\ x/b - 9/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-9/2\ x + 9/2\ x^2/b - 3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-9/2\ b + 9/2\ b - 3/2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-9/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-3/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

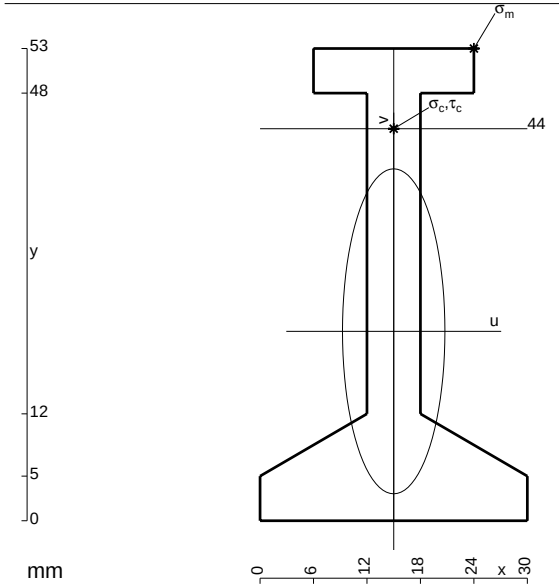
$= (-3/2\ b\ )\ Fb\ 1/EJ\ = -3/2\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-3/2\ x/b + 3/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-3/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

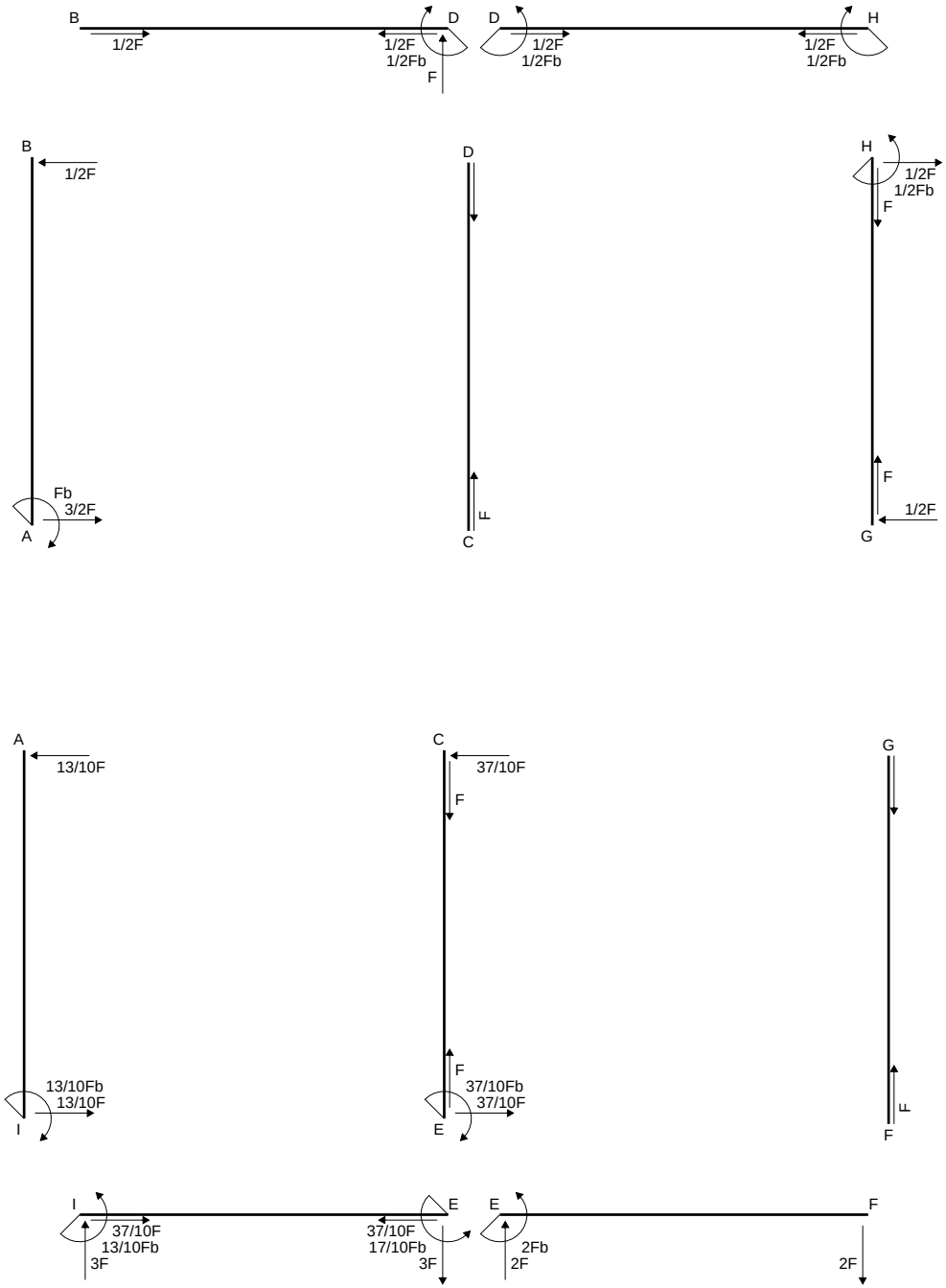
$= (-3/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = -1/4\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-3/2\ x/b + 3/2\ x^2/b^2)\ Fb\ 1/EJ\ dx = [-3/4\ x^2/b + 1/2\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-3/4\ b + 1/2\ b\ )\ Fb\ 1/EJ\ = -1/4\ Fb^2/EJ$



A = 582. mm^2
J_u = 193597. mm^4
J_v = 19242. mm^4
y_g = 21.26 mm
T_y = 2300. N
M_x = -1219000. Nmm
x_m = 24. mm
y_m = 53. mm
u_m = 9. mm
v_m = 31.74 mm
$\sigma_m = -Mv/J_u$ = 199.9 N/mm^2
x_c = 15. mm
y_c = 44. mm
v_c = 22.74 mm
$\sigma_c = -Mv/J_u$ = 143.2 N/mm^2
τ_c = 6.387 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 143.6 N/mm^2
S^* = 3225. mm^3


B
D
D
H
1/2F
1/2F
1/2Fb
F
1/2F
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1/2F
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D
H
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Fb
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G
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C
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E
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17/10Fb
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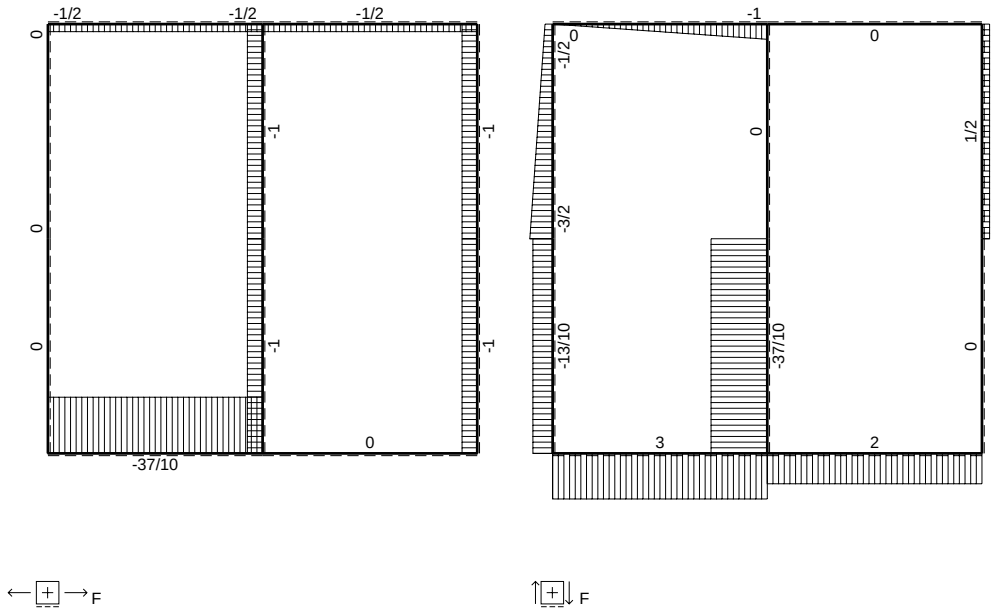
2F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F
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-1/2
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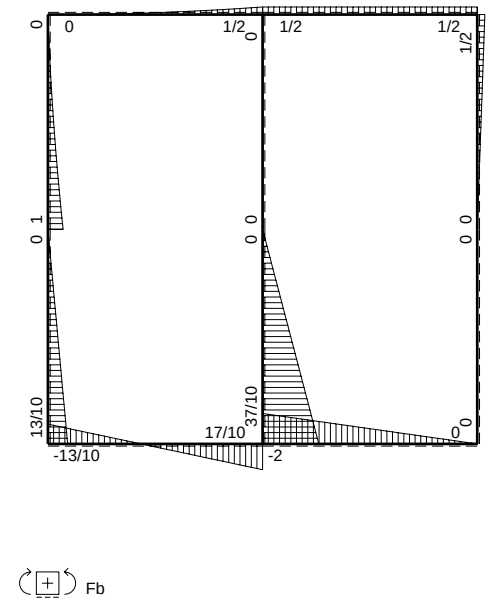
1/2
-3/2
-13/10
-37/10
0
3
2
F


0
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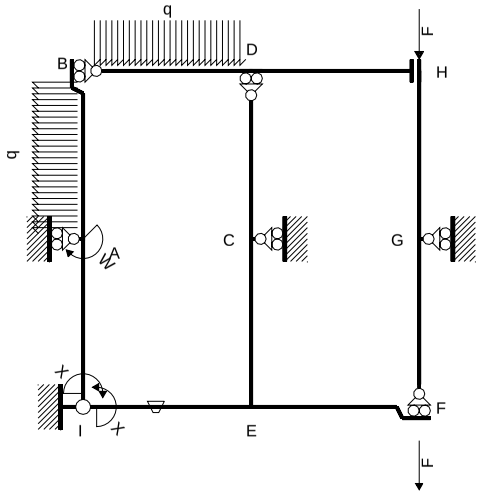
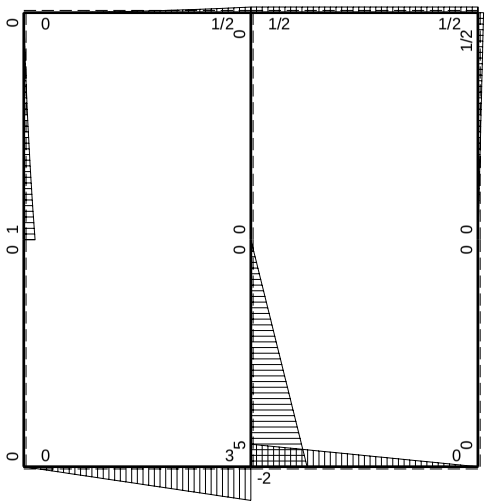
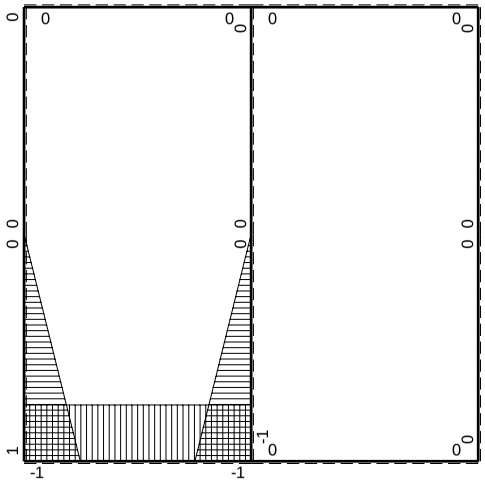
1/2
1/2
1/2
0
0
0
0 1
0 0
0 0
13/10
37/10
0
17/10
-13/10
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 215862 CI07.xxxx.161

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$Fb-3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$-1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-5Fx$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
AI b	$-x/b$	0	0	0	0	x^2/b^2		
	totali						$-13/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						13/10Fb	

Sviluppi di calcolo iperstatica

PROCEDIMENTO E RISULTATI 215862 CI07.xxxx.161

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

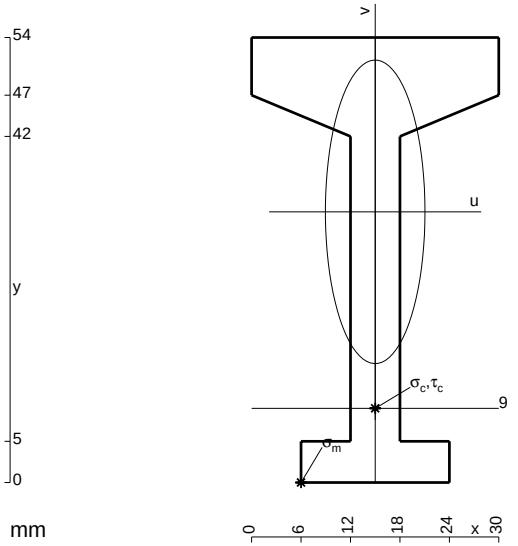
$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$



$A = 612.\ mm^2$

$J_u = 207668.\ mm^4$

$J_v = 22356.\ mm^4$

$y_g = 32.85\ mm$

$T_y = 2240.\ N$

$M_x = -1321600.\ Nmm$

$x_m = 6.\ mm$

$u_m = -9.\ mm$

$v_m = -32.85\ mm$

$\sigma_m = -Mv/J_u = -209.\ N/mm^2$

$x_c = 15.\ mm$

$y_c = 9.\ mm$

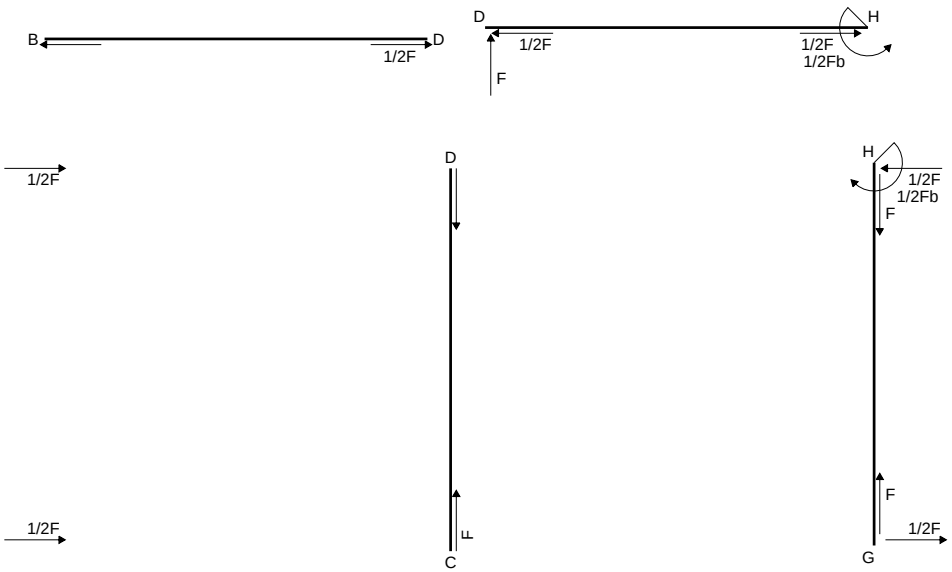
$v_c = -23.85\ mm$

$\sigma_c = -Mv/J_u = -151.8\ N/mm^2$

$\tau_c = 6.025\ N/mm^2$

$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 152.1\ N/mm^2$

$S^* = 3351.\ mm^3$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1/2F
1/2F
1/2Fb
F
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1/2F
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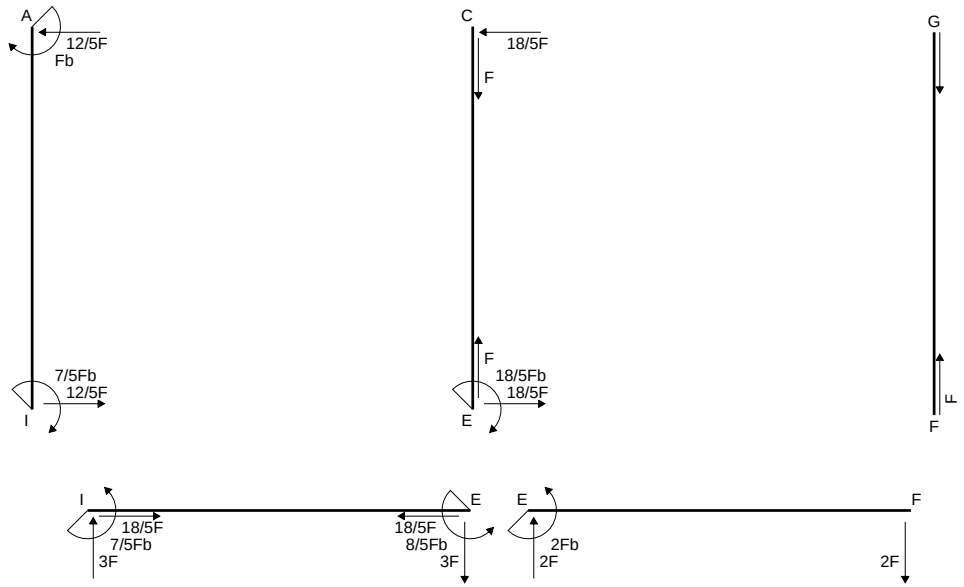
F
G
1/2F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Fb
7/5Fb
12/5F
I
C
18/5F
F
F
18/5Fb
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G
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8/5Fb
3F
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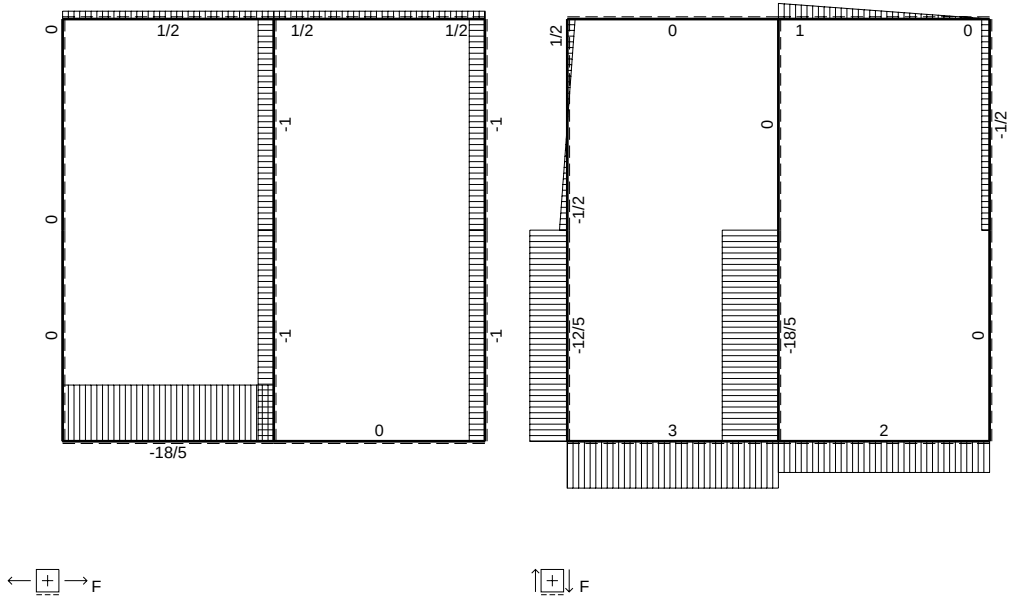
2F
F
2F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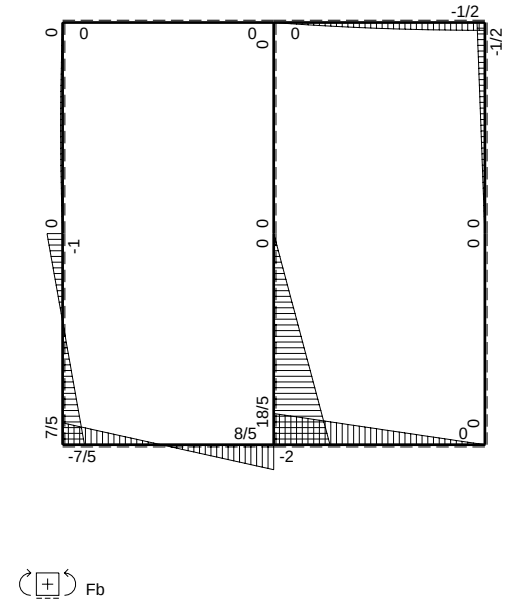
-12/5
-18/5
0
3
2
F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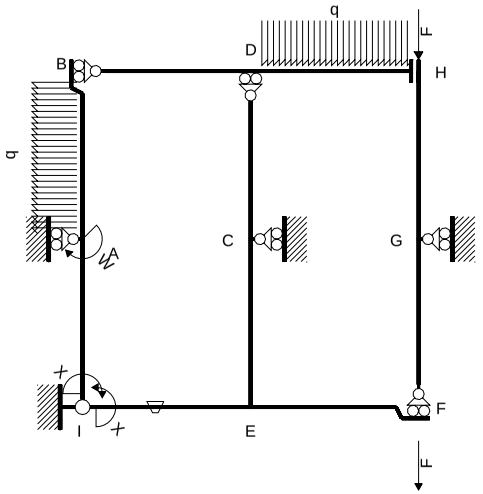
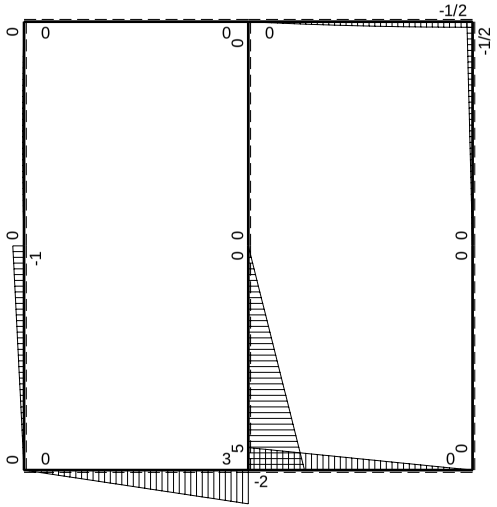
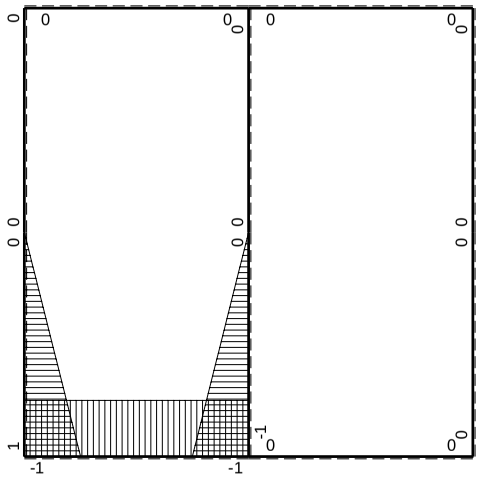
7/5
-7/5
8/5
18/5
-2
0
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 987222 CI07.xxxx.162

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	-1/2Fx	0	0	0	0	0+0	0
HG b	0	1/2Fb-1/2Fx	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-5Fx	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-5Fx	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-Fx	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	Fb-Fx	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-7/3Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						7/5Fb	

PROCEDIMENTO E RISULTATI 987222 CI07.xxxx.162

Sviluppi di calcolo iperstatica

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$L_{lE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{El}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{lA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{Al}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{lE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{El}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

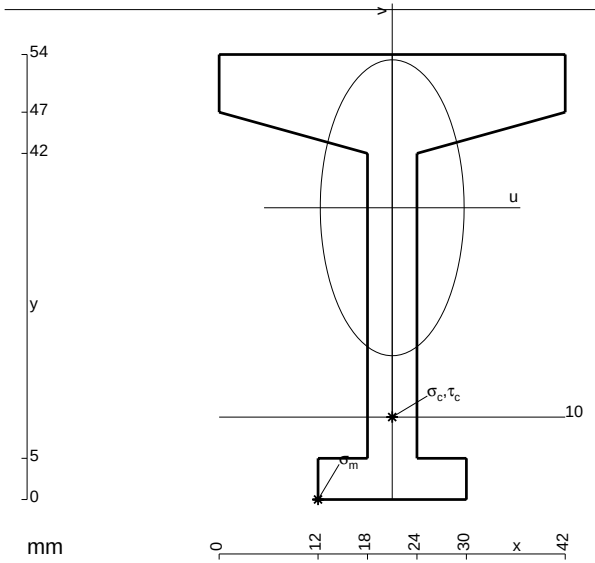
$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{lA}^{Xo} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

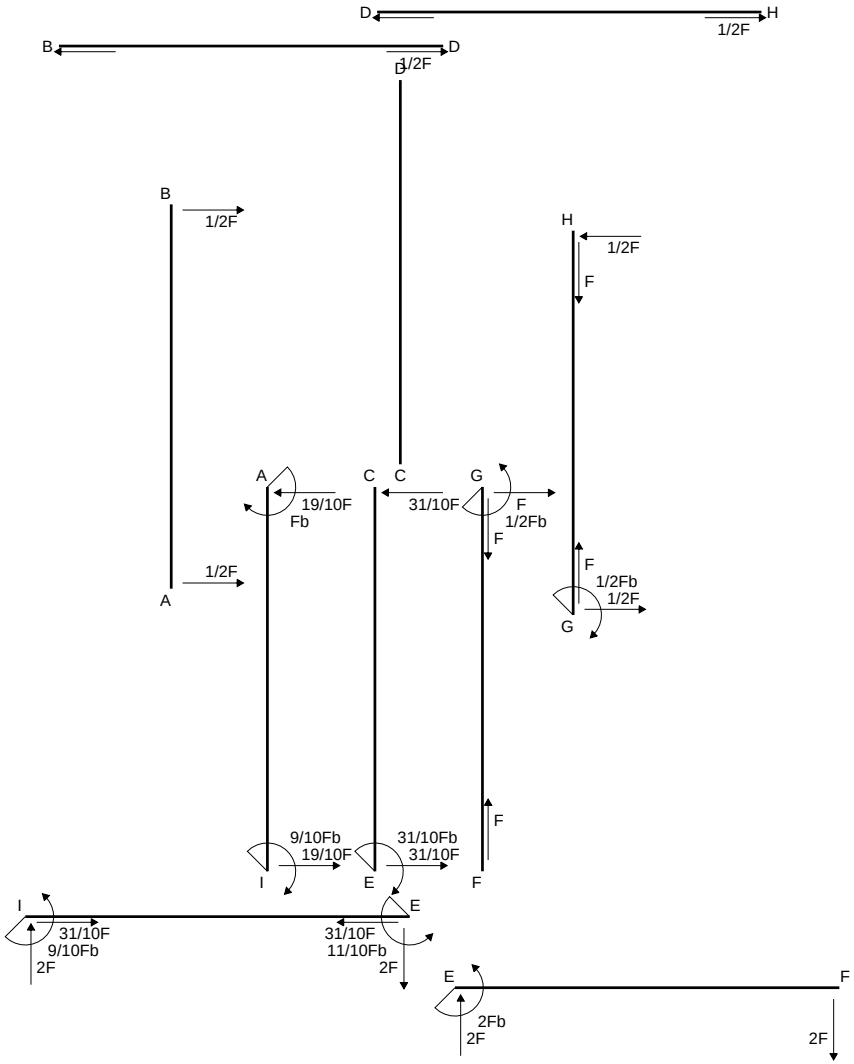
$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$

$L_{Al}^{Xo} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$



A = 726. mm^2
J_u = 234156. mm^4
J_v = 55314. mm^4
y_g = 35.4 mm
T_y = 2260. N
M_x = -1446400. Nmm
x_m = 12. mm
u_m = -9. mm
v_m = -35.4 mm
$\sigma_m = -Mv/J_u$ = -218.7 N/mm^2
x_c = 21. mm
y_c = 10. mm
v_c = -25.41 mm
$\sigma_c = -Mv/J_u$ = -156.9 N/mm^2
τ_c = 6.11 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 157.3 N/mm^2
S^* = 3799. mm^3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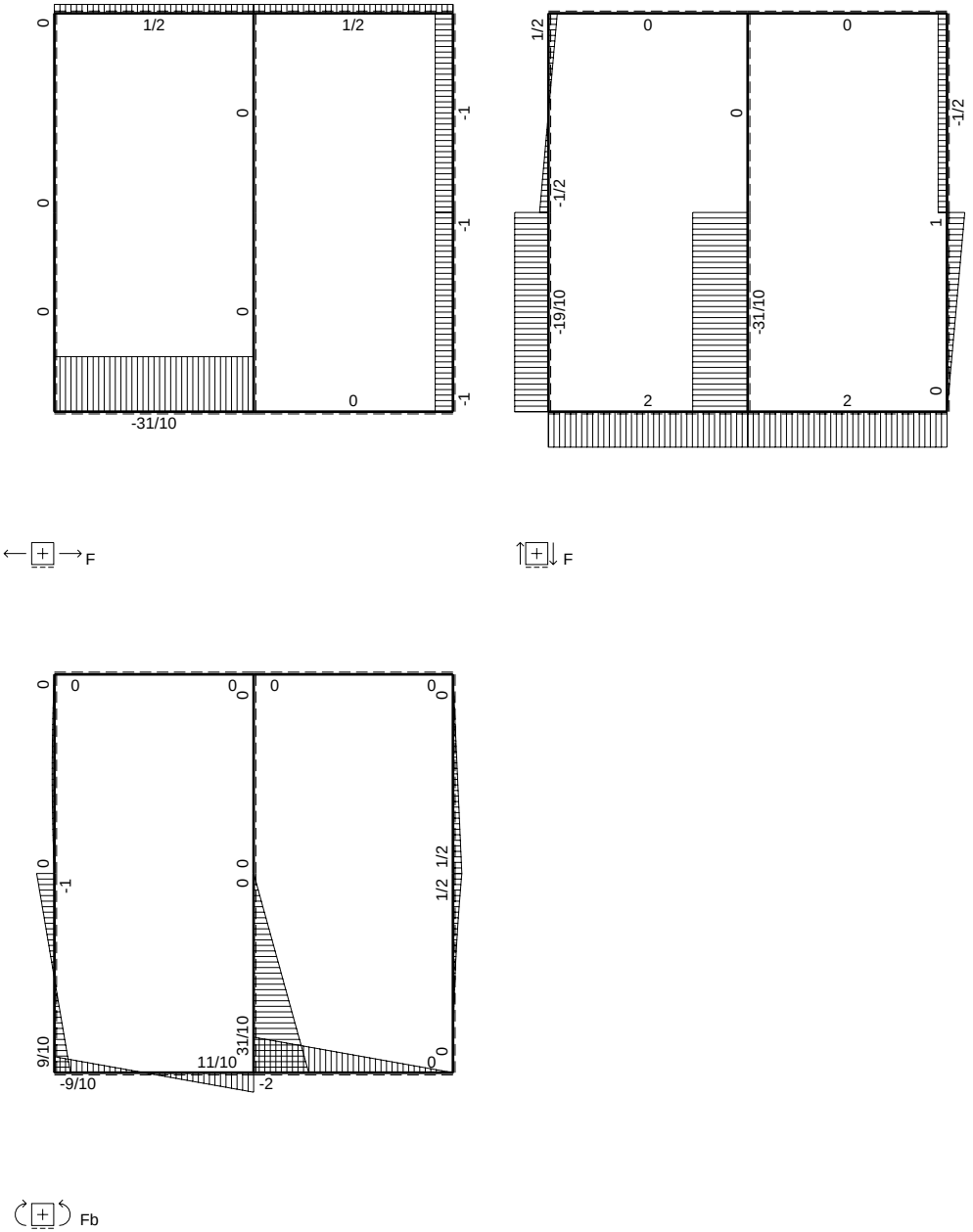
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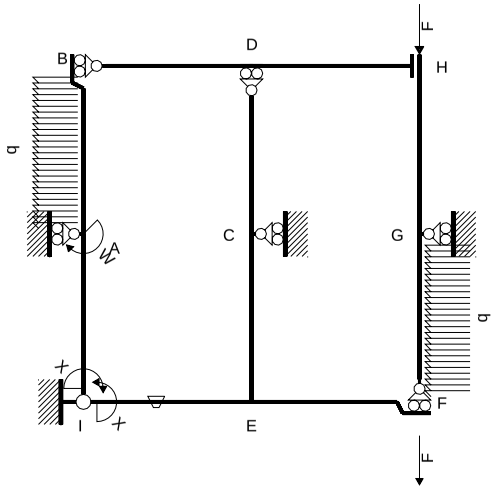
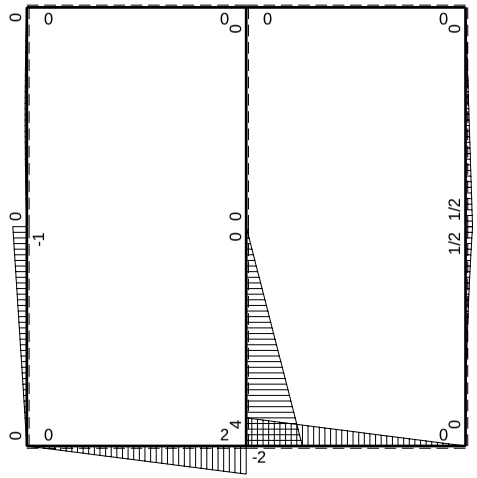
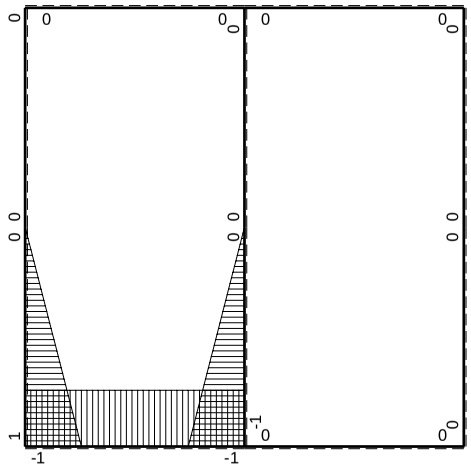
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

PROCEDIMENTO E RISULTATI 254309 CI07.xxxx.163

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	-1+x/b	4Fb-4Fx	0	$-4Fb+8Fx-4Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-4/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	-4Fx	0	$-4Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	-Fx	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	Fb-Fx	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-3/2Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						9/10Fb	

PROCEDIMENTO E RISULTATI 254309 CI07.xxxx.163

Sviluppi di calcolo iperstatica

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$L^{XX}_{IE} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EI} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L^{XX}_{EC} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{CE} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{IA} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{XX}_{AI} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L^{Xo}_{IE} = \int_o^b (-2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = 0$

$L^{Xo}_{EI} = \int_o^b (-2 + 2\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-2\ x + x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-2\ b + b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = 0$

$L^{Xo}_{EC} = \int_o^b (-4 + 8\ x/b - 4\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4\ x + 4\ x^2/b - 4/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-4\ b + 4\ b - 4/3\ b\ )\ Fb\ 1/EJ\ = -4/3\ Fb^2/EJ$

$L^{Xo}_{CE} = \int_o^b (-4\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-4/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

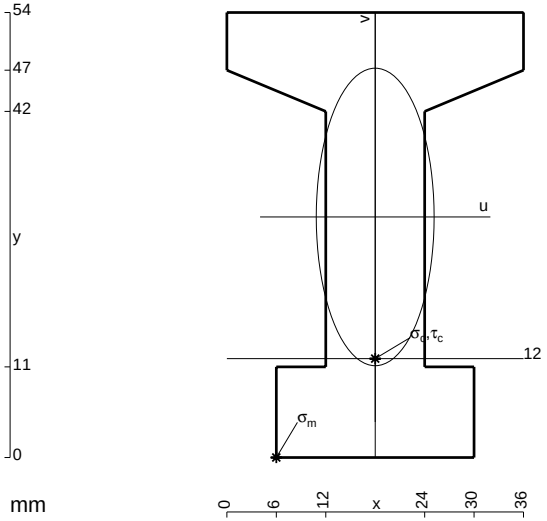
$= (-4/3\ b\ )\ Fb\ 1/EJ\ = -4/3\ Fb^2/EJ$

$L^{Xo}_{IA} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$

$L^{Xo}_{AI} = \int_o^b (-\ x/b + x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/3\ b\ )\ Fb\ 1/EJ\ = -1/6\ Fb^2/EJ$



$A = 1008.\ mm^2$

$J_u = 328681.\ mm^4$

$J_v = 51552.\ mm^4$

$y_g = 29.19\ mm$

$T_y = 3680.\ N$

$M_x = -2576000.\ Nmm$

$x_m = 6.\ mm$

$u_m = -12.\ mm$

$v_m = -29.19\ mm$

$\sigma_m = -Mv/J_u = -228.8\ N/mm^2$

$x_c = 18.\ mm$

$y_c = 12.\ mm$

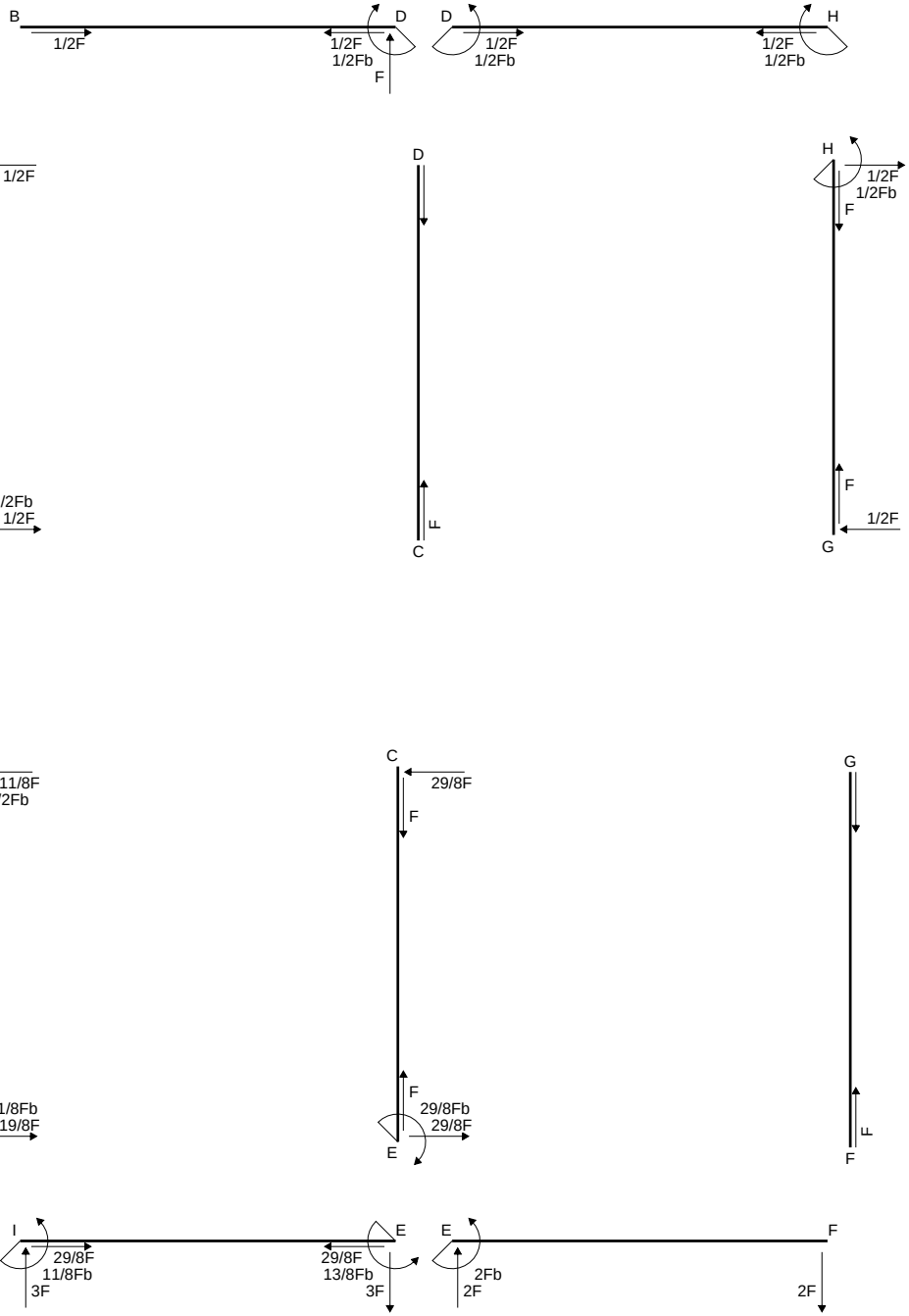
$v_c = -17.19\ mm$

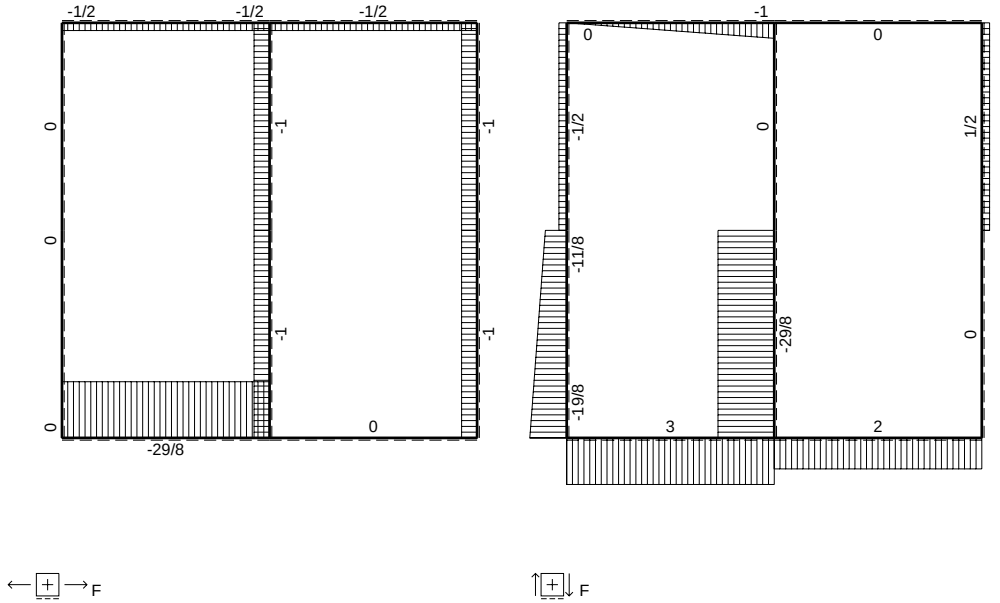
$\sigma_c = -Mv/J_u = -134.7\ N/mm^2$

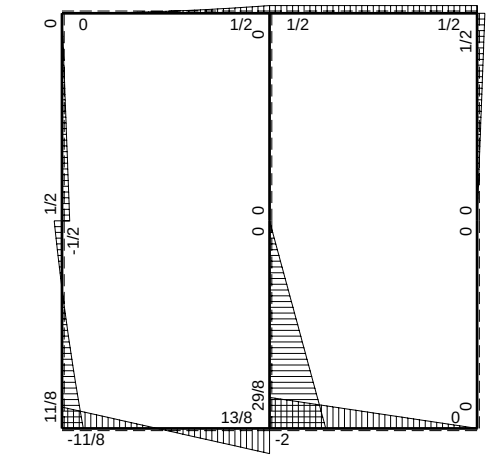
$\tau_c = 6.034\ N/mm^2$

$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 135.1\ N/mm^2$

$S^* = 6467.\ mm^3$


B
1/2F
D
1/2F
1/2Fb
F
D
1/2F
1/2Fb
H
1/2F
1/2Fb
B
1/2F
1/2Fb
1/2F
A
D
F
C
H
1/2F
1/2Fb
F
F
1/2F
G
A
11/8F
1/2Fb
11/8Fb
19/8F
I
C
29/8F
F
F
29/8Fb
29/8F
E
G
F
F
I
29/8F
11/8Fb
3F
E
29/8F
13/8Fb
3F
E
2Fb
2F
F
2F


-1/2
-1/2
-1/2
0
0
0
-1
-1
-1
-1
-1
-29/8
0
F
-1
0
0
-1/2
0
1/2
-11/8
-29/8
0
-19/8
3
2
F


0
0
1/2
1/2
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1/2
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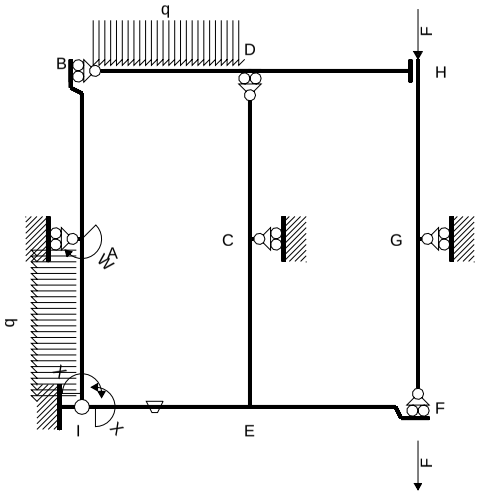
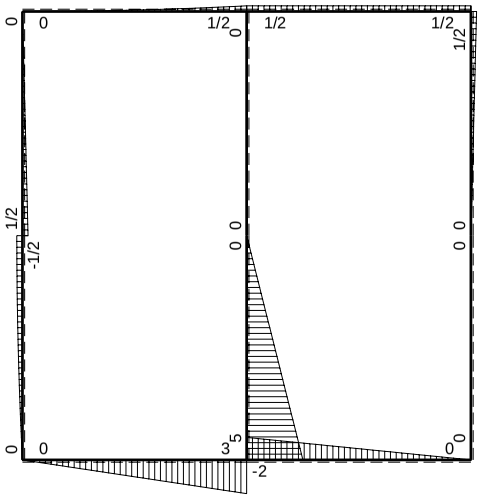
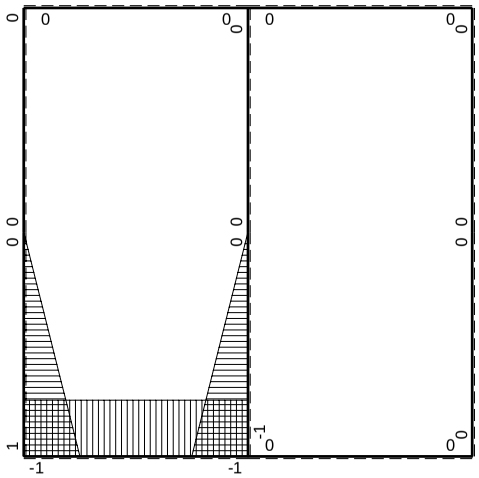
0
1/2
-1/2
11/8
29/8
13/8
0
0
-11/8
-2
Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

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Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	M_xM_o	$M_x\theta$	M_xM_x	$\int M_x(M_o/EJ+\theta)dx$	$\int XM_xM_x/EJdx$
AB b	0	1/2Fb-1/2Fx	0	0	0	0	0+0	0
BA b	0	-1/2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	1/2Fx	0	0	0	0	0+0	0
HG b	0	-1/2Fb+1/2Fx	0	0	0	0		
HD b	0	1/2Fb	0	0	0	0	0+0	0
DH b	0	-1/2Fb	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	-1+x/b	5Fb-5Fx	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-5Fx^2/b$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	1-x/b	$-Fx+1/2qx^2$	0	$-Fx+3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-1/8+0)Fb^2/EJ$	1/3Xb/EJ
AI b	-x/b	$1/2Fb-1/2qx^2$	0	$-1/2Fx+1/2qx^3/b$	0	x^2/b^2		
	totali						$-55/24Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						11/8Fb	

Sviluppi di calcolo iperstatica

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$L_{IE}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EI}^{XX} = \int_o^b (1)\ 1/EJ\ dx = [\ x\ ]_o^b\ 1/EJ$

$= (\ b\ )\ 1/EJ\ =\ b/EJ$

$L_{EC}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{CE}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IA}^{XX} = \int_o^b (1 - 2\ x/b + x^2/b^2)\ 1/EJ\ dx = [\ x - x^2/b + 1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (\ b - b + 1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{AI}^{XX} = \int_o^b (\ x^2/b^2\ )\ 1/EJ\ dx = [1/3\ x^3/b^2\ ]_o^b\ 1/EJ$

$= (1/3\ b\ )\ 1/EJ\ = 1/3\ b/EJ$

$L_{IE}^{Xo} = \int_o^b (-3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (1)\ \theta\ dx = [-3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [\ x\ ]_o^b\ \theta$

$= (-3/2\ b\ )\ Fb\ 1/EJ\ + (\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EI}^{Xo} = \int_o^b (-3 + 3\ x/b\ )\ Fb\ 1/EJ\ dx + \int_o^b (-1)\ \theta\ dx = [-3\ x + 3/2\ x^2/b\ ]_o^b\ Fb\ 1/EJ\ + [-\ x\ ]_o^b\ \theta$

$= (-3\ b + 3/2\ b\ )\ Fb\ 1/EJ\ + (-\ b\ )\ \theta\ = -1/2\ Fb^2/EJ$

$L_{EC}^{Xo} = \int_o^b (-5 + 10\ x/b - 5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5\ x + 5\ x^2/b - 5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5\ b + 5\ b - 5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{CE}^{Xo} = \int_o^b (-5\ x^2/b^2\ )\ Fb\ 1/EJ\ dx = [-5/3\ x^3/b^2\ ]_o^b\ Fb\ 1/EJ$

$= (-5/3\ b\ )\ Fb\ 1/EJ\ = -5/3\ Fb^2/EJ$

$L_{IA}^{Xo} = \int_o^b (-\ x/b + 3/2\ x^2/b^2 - 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx = [-1/2\ x^2/b + 1/2\ x^3/b^2 - 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

$= (-1/2\ b + 1/2\ b - 1/8\ b\ )\ Fb\ 1/EJ\ = -1/8\ Fb^2/EJ$

$L_{AI}^{Xo} = \int_o^b (-1/2\ x/b + 1/2\ x^3/b^3\ )\ Fb\ 1/EJ\ dx = [-1/4\ x^2/b + 1/8\ x^4/b^3\ ]_o^b\ Fb\ 1/EJ$

$= (-1/4\ b + 1/8\ b\ )\ Fb\ 1/EJ\ = -1/8\ Fb^2/EJ$

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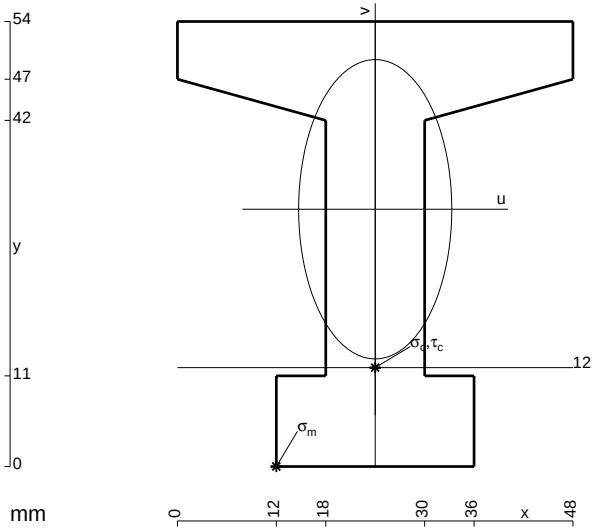

A = 1122. mm^2
J_u = 370409. mm^4
J_v = 96948. mm^4
y_g = 31.22 mm
T_y = 3780. N
M_x = -2835000. Nmm
x_m = 12. mm
u_m = -12. mm
v_m = -31.22 mm
$\sigma_m = -Mv/J_u$ = -238.9 N/mm^2
x_c = 24. mm
y_c = 12. mm
v_c = -19.22 mm
$\sigma_c = -Mv/J_u$ = -147.1 N/mm^2
τ_c = 5.975 N/mm^2
$\sigma_o = \sqrt{\sigma^2 + 3\tau^2}$ = 147.5 N/mm^2
S^* = 7027. mm^3

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