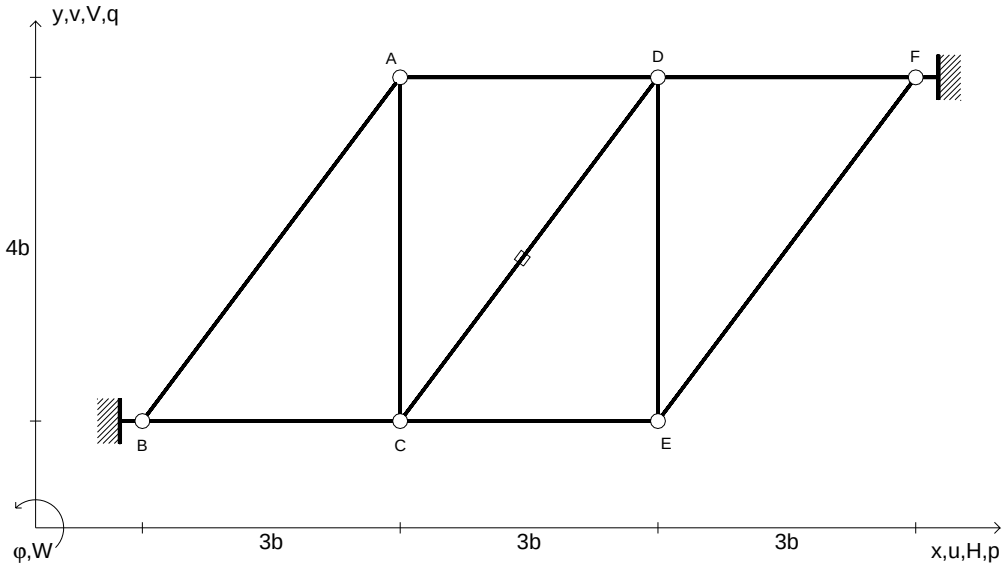
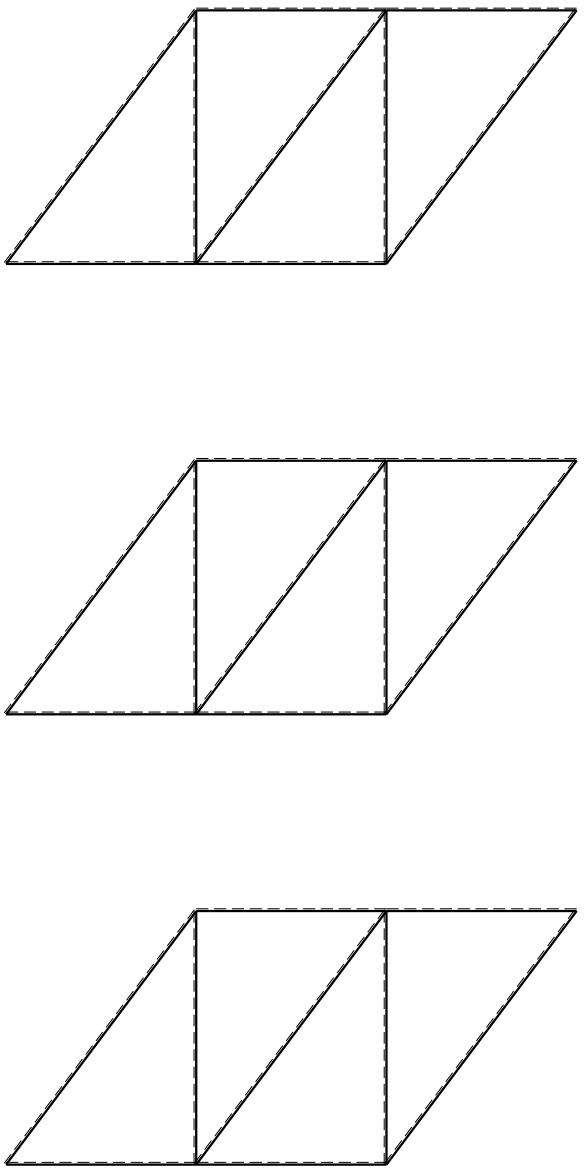
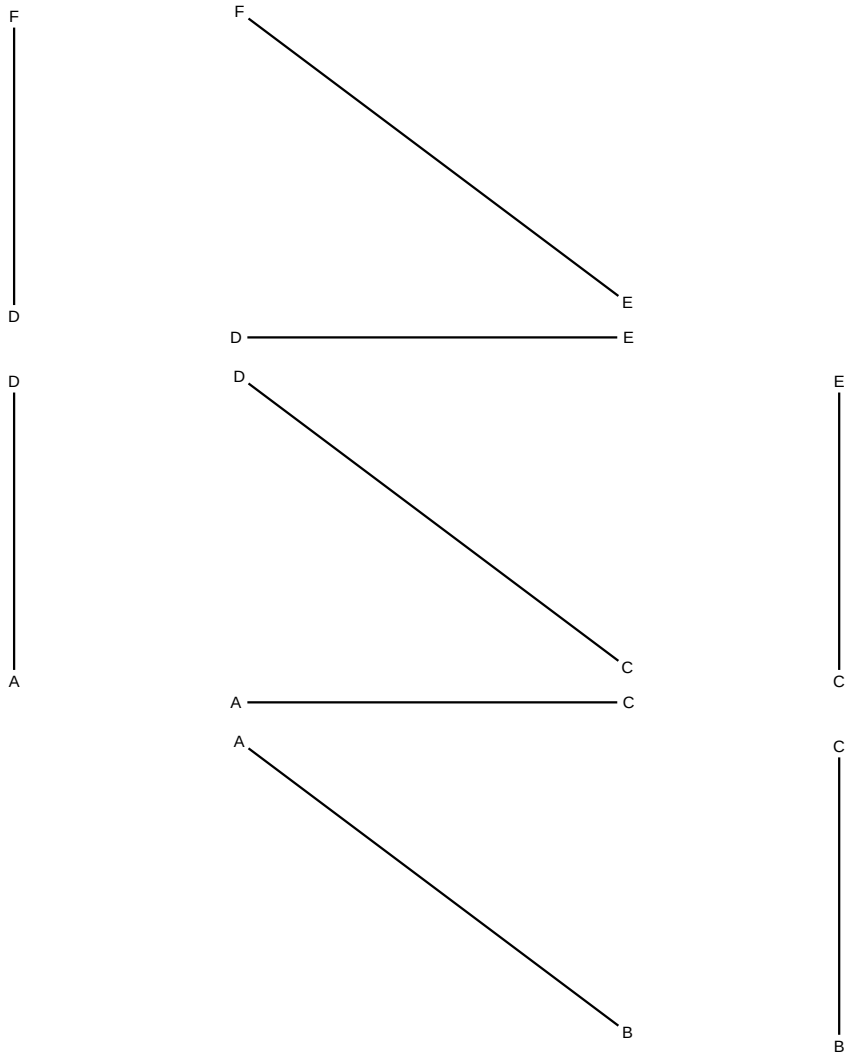


$\varepsilon_{DC} = 2\alpha T$ $EA_{CB} = 4EA$ $EA_{DA} = 3EA$ $EA_{EC} = 2EA$ $EA_{DE} = EA$
$EA_{AB} = 5EA$ $EA_{AC} = 4EA$ $EA_{DC} = 3EA$ $EA_{FE} = 2EA$ $EA_{FD} = EA$

Svolgere l'analisi cinematica.
Riportare la soluzione su questo foglio.
Carichi e deformazioni date hanno verso efficace in disegno.
Calcolare reazioni vincolari della struttura e delle aste.
Tracciare i diagrammi delle azioni interne nelle aste.
Calcolare spostamento e rotazione di tutti i nodi.
A_{YZ} - x_{YZ} - θ_{YZ} riferimento locale asta YZ con origine in Y.
Allungamento termico assegnato ε su asta DC.





REAZIONI

H_B = V_B = H_F = V_F =

N_{AB} = N_{CB} = N_{AC} = N_{DA} =

N_{DC} = N_{EC} = N_{FE} = N_{DE} =

N_{FD} =

SPOSTAMENTI NODALI

u_A = u_B = u_C = u_D = u_E =
v_A = v_B = v_C = v_D = v_E =

u_F =
v_F =

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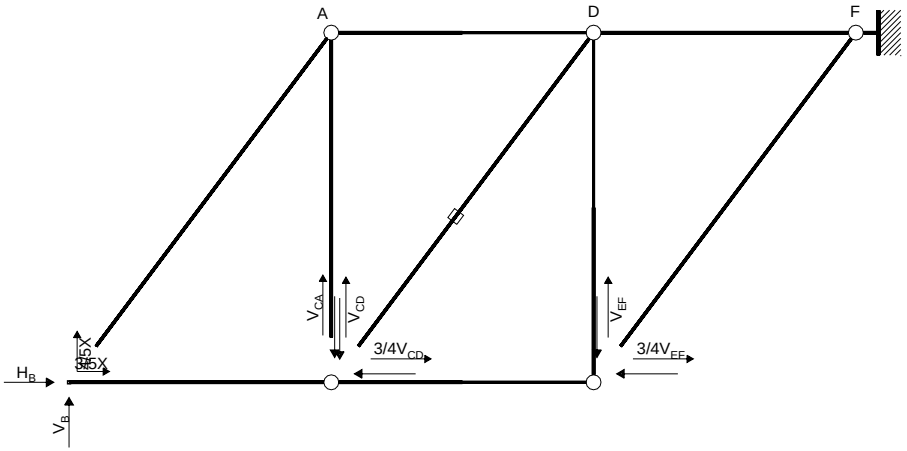


EQUAZIONI DI EQUILIBRIO

Rotazione intorno a F: aste FD DA DC DE AB AC EC CB

$4H_Bb - 9V_Bb = 24/5Xb$

Rotazione intorno a D: aste DA AB AC

$-3V_{CA}b = 12/5Xb$

Rotazione intorno a D: aste DE EC CB

$4H_Bb - 6V_Bb + 3V_{CA}b - 3V_{EF}b = 0$

Rotazione intorno a E: aste EC CB

$-6V_Bb + 3V_{CA}b + 3V_{CD}b = 0$

Rotazione intorno a C: aste CB

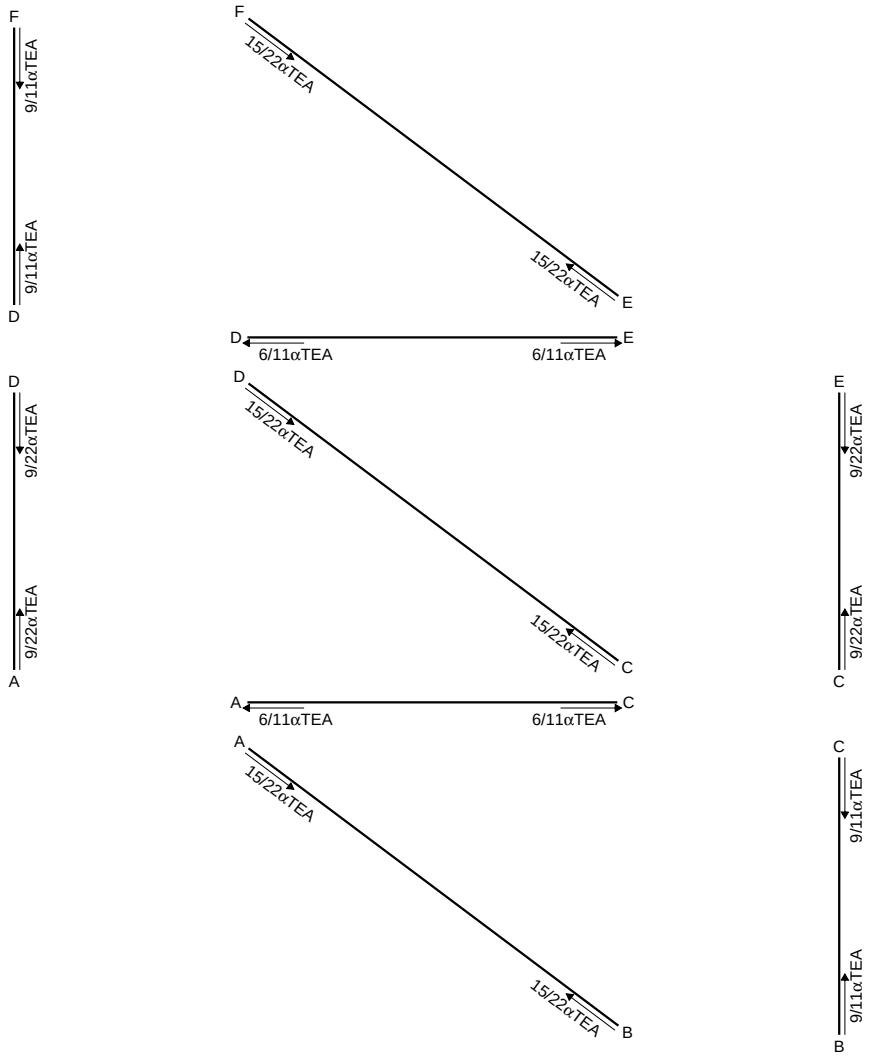
$-3V_Bb = 0$

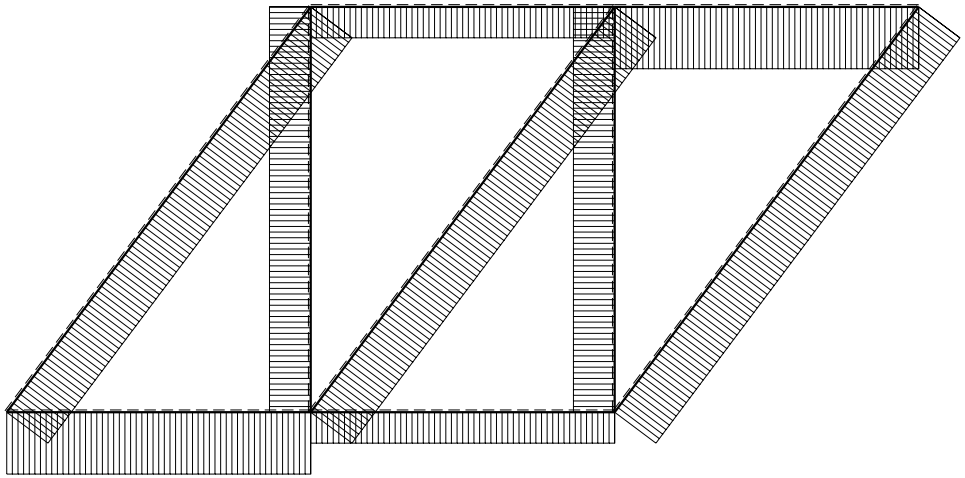
Matrice di equilibrio

$$\begin{array}{c} \\ \varphi_{FD} \\ \varphi_{DA} \\ \varphi_{DE} \\ \varphi_{EC} \\ \varphi_{CB} \end{array} \begin{bmatrix} H_Bb & V_Bb & V_{CA}b & V_{CD}b & V_{EF}b \\ 4 & -9 & 0 & 0 & 0 \\ 0 & 0 & -3 & 0 & 0 \\ 4 & -6 & 3 & 0 & -3 \\ 0 & -6 & 3 & 3 & 0 \\ 0 & -3 & 0 & 0 & 0 \end{bmatrix} = \begin{bmatrix} Xb \\ 24/5 \\ 12/5 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

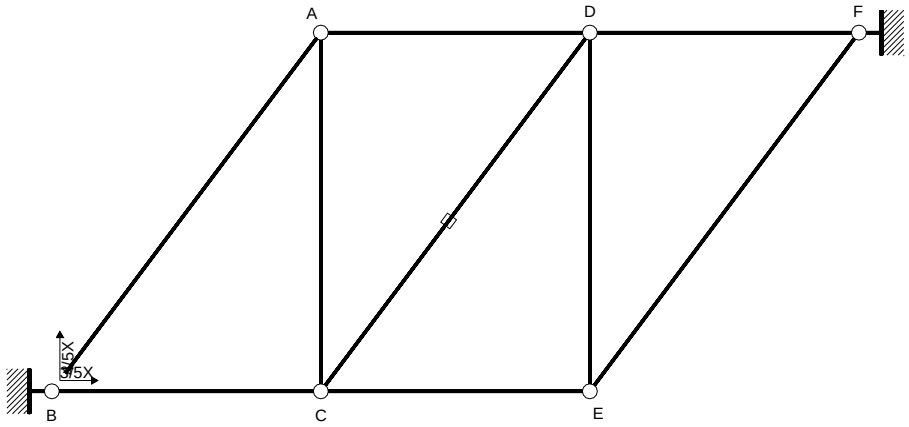
Soluzione del sistema

$$\begin{bmatrix} H_Bb \\ V_{CA}b \\ V_Bb \\ V_{CD}b \\ V_{EF}b \end{bmatrix} = \begin{bmatrix} Xb \\ 6/5 \\ -4/5 \\ 0 \\ 4/5 \\ 4/5 \end{bmatrix}$$





1 αTEA



REAZIONI IPERSTATICHE

$X = V_{BA}$

CALCOLO DELLE REAZIONI IPERSTATICHE

$L^{XX}_{AB} = N^{X}_{AB}\ N^{X}_{AB}\ l_{AB}/EA_{AB} = -1\ (-1)\ 5\ 1/5\ Fb/EA = Fb/EA$

$L^{XX}_{CB} = N^{X}_{CB}\ N^{X}_{CB}\ l_{CB}/EA_{CB} = -6/5\ (-6/5)\ 3\ 1/4\ Fb/EA = 27/25\ Fb/EA$

$L^{XX}_{AC} = N^{X}_{AC}\ N^{X}_{AC}\ l_{AC}/EA_{AC} = 4/5\ 4/5\ 4\ 1/4\ Fb/EA = 16/25\ Fb/EA$

$L^{XX}_{DA} = N^{X}_{DA}\ N^{X}_{DA}\ l_{DA}/EA_{DA} = -3/5\ (-3/5)\ 3\ 1/3\ Fb/EA = 9/25\ Fb/EA$

$L^{XX}_{DC} = N^{X}_{DC}\ N^{X}_{DC}\ l_{DC}/EA_{DC} + N^{X}_{DC}\ \varepsilon_{DC}\ l_{DC} = -1\ (-1)\ 5\ 1/3\ Fb/EA - 1\ 2\ 5\ Fb/EA = 5/3\ Fb/EA$

$L^{XX}_{EC} = N^{X}_{EC}\ N^{X}_{EC}\ l_{EC}/EA_{EC} = -3/5\ (-3/5)\ 3\ 1/2\ Fb/EA = 27/50\ Fb/EA$

$L^{XX}_{FE} = N^{X}_{FE}\ N^{X}_{FE}\ l_{FE}/EA_{FE} = -1\ (-1)\ 5\ 1/2\ Fb/EA = 5/2\ Fb/EA$

$L^{XX}_{DE} = N^{X}_{DE}\ N^{X}_{DE}\ l_{DE}/EA_{DE} = 4/5\ 4/5\ 4\ 1\ Fb/EA = 64/25\ Fb/EA$

$L^{XX}_{FD} = N^{X}_{FD}\ N^{X}_{FD}\ l_{FD}/EA_{FD} = -6/5\ (-6/5)\ 3\ 1\ Fb/EA = 108/25\ Fb/EA$

$L^{Xo}_{DC} = N^{X}_{DC}\ N^{o}_{DC}\ l_{DC}/EA_{DC} + N^{X}_{DC}\ \varepsilon_{DC}\ l_{DC} = -1 - 1\ 2\ 5\ Fb/EA = -10\ Fb/EA$

Contributi nulli elementi

$L^{Xo}_{AB}\ L^{Xo}_{CB}\ L^{Xo}_{AC}\ L^{Xo}_{DA}\ L^{Xo}_{EC}\ L^{Xo}_{FE}\ L^{Xo}_{DE}\ L^{Xo}_{FD}$

Contributi nulli nodi vincolati
L_B^{XX} L_F^{XX} L_B^{Xo} L_F^{Xo}

Espressione risolvente
$\left(L_{AB}^{XX} + L_{CB}^{XX} + L_{AC}^{XX} + L_{DA}^{XX} + L_{DC}^{XX} + L_{EC}^{XX} + L_{FE}^{XX} + L_{DE}^{XX} + L_{FD}^{XX} \right) X = - \left(L_{DC}^{Xo} \right)$

$\left(1 + 27/25 + 16/25 + 9/25 + 5/3 + 27/50 + 5/2 + 64/25 + 108/25 \right) X = \left(10 \right) F$

$44/3\ X = 10\ F$

Soluzione
$X = 6/11\ F$

REAZIONI
$H_B = 27/22\alpha TEA$ $V_B = 6/11\alpha TEA$ $H_F = -27/22\alpha TEA$ $V_F = -6/11\alpha TEA$

$N_{AB} = -15/22\alpha TEA$ $N_{CB} = -9/11\alpha TEA$ $N_{AC} = 6/11\alpha TEA$ $N_{DA} = -9/22\alpha TEA$

$N_{DC} = -15/22\alpha TEA$ $N_{EC} = -9/22\alpha TEA$ $N_{FE} = -15/22\alpha TEA$ $N_{DE} = 6/11\alpha TEA$

$N_{FD} = -9/11\alpha TEA$

SPOSTAMENTI NODALI

$u_A = 63/22\alpha Tb$	$u_B = 0$	$u_C = -27/44\alpha Tb$	$u_D = 27/11\alpha Tb$	$u_E = -27/22\alpha Tb$
$v_A = -3\alpha Tb$	$v_B = 0$	$v_C = -39/11\alpha Tb$	$v_D = 921/176\alpha Tb$	$v_E = 537/176\alpha Tb$

$u_F = 0$
$v_F = 0$

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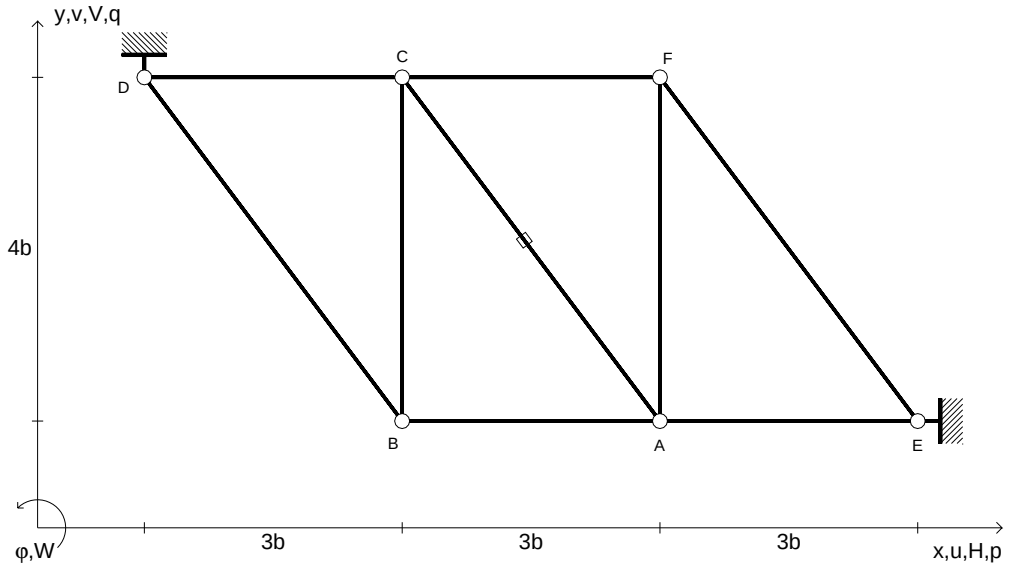
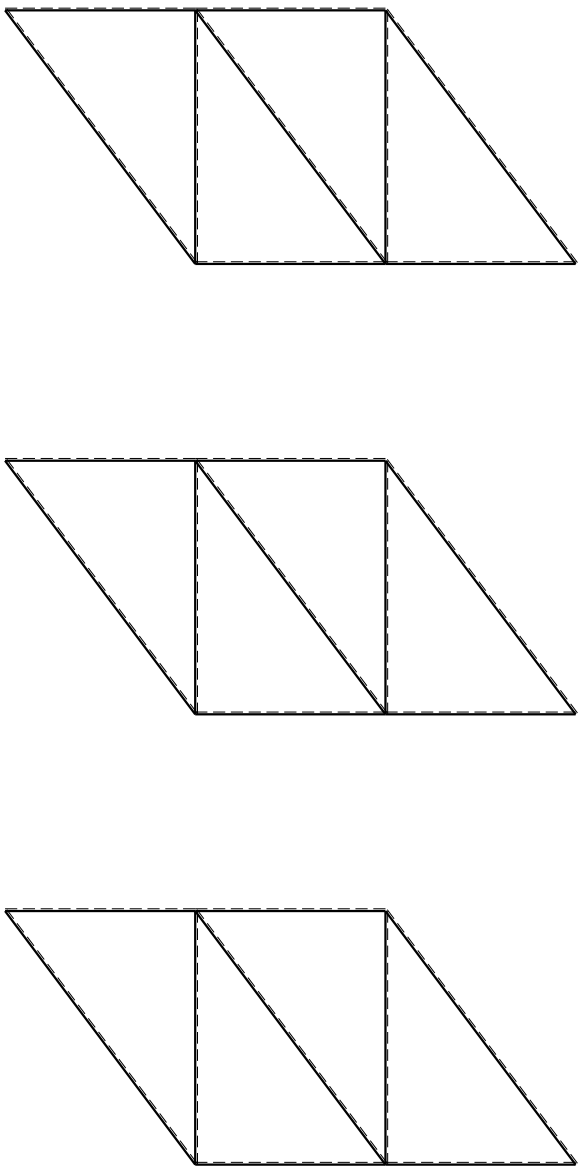
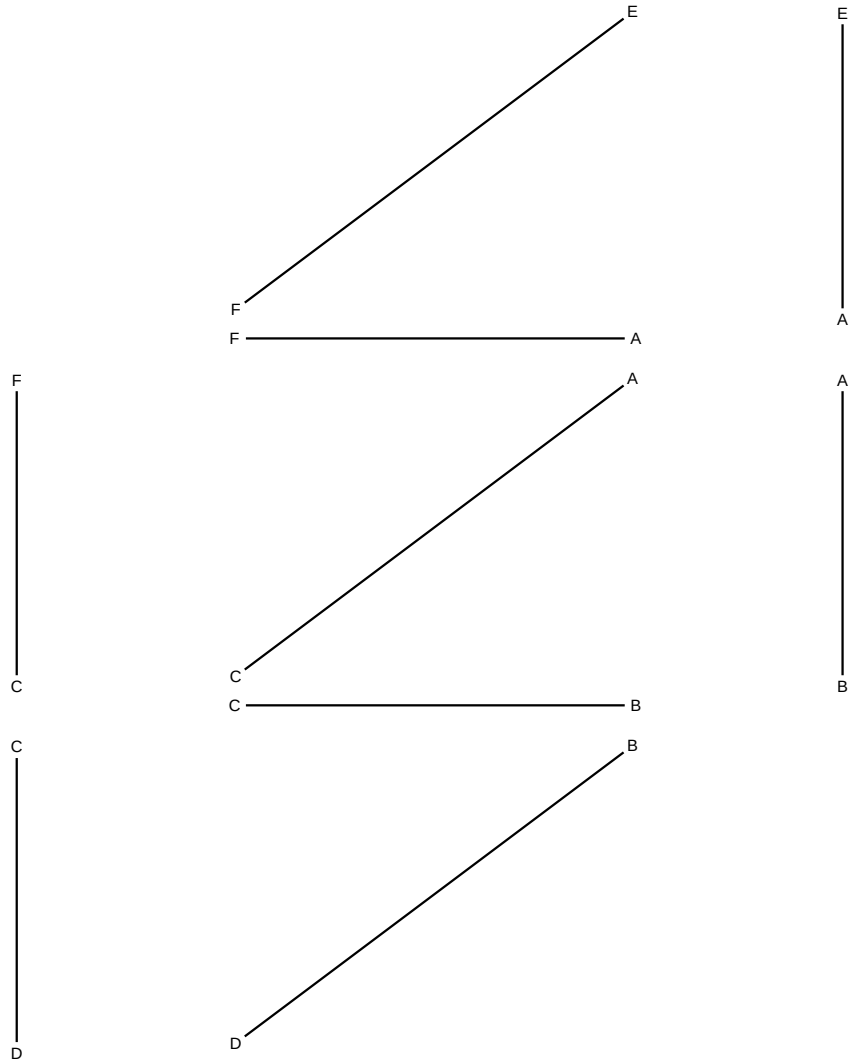


$\varepsilon_{AC} = 2\alpha T$ $EA_{BC} = 4EA$ $EA_{BD} = 5EA$ $EA_{AF} = EA$ $EA_{FC} = 2EA$
$EA_{AB} = 3EA$ $EA_{CD} = 4EA$ $EA_{EA} = EA$ $EA_{EF} = 2EA$ $EA_{AC} = 3EA$

Svolgere l'analisi cinematica.
Riportare la soluzione su questo foglio.
Carichi e deformazioni date hanno verso efficace in disegno.
Calcolare reazioni vincolari della struttura e delle aste.
Tracciare i diagrammi delle azioni interne nelle aste.
Calcolare spostamento e rotazione di tutti i nodi.
A_{YZ} - x_{YZ} - θ_{YZ} riferimento locale asta YZ con origine in Y.
Allungamento termico assegnato ε su asta AC.





REAZIONI

H_D = V_D = H_E = V_E =

N_{AB} = N_{BC} = N_{CD} = N_{BD} =

N_{EA} = N_{AF} = N_{EF} = N_{FC} =

N_{AC} =

SPOSTAMENTI NODALI

u_A = u_B = u_C = u_D = u_E =
v_A = v_B = v_C = v_D = v_E =

u_F =
v_F =

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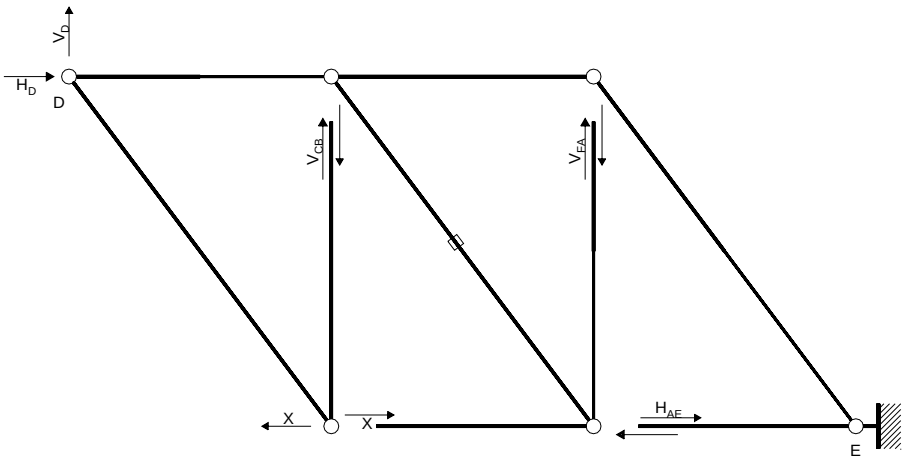


EQUAZIONI DI EQUILIBRIO

Rotazione intorno a E: aste EF FC CD CA AB DB AF BC

$-4H_Db - 9V_Db = 0$

Rotazione intorno a F: aste FC CD CA AB DB AF BC

$-6V_Db - 4H_{AE}b = 0$

Rotazione intorno a C: aste CD DB BC

$-3V_Db = 4Xb$

Rotazione intorno a C: aste CA AB AF

$-4H_{AE}b + 3V_{FA}b = -4Xb$

Rotazione intorno a D: aste DB BC

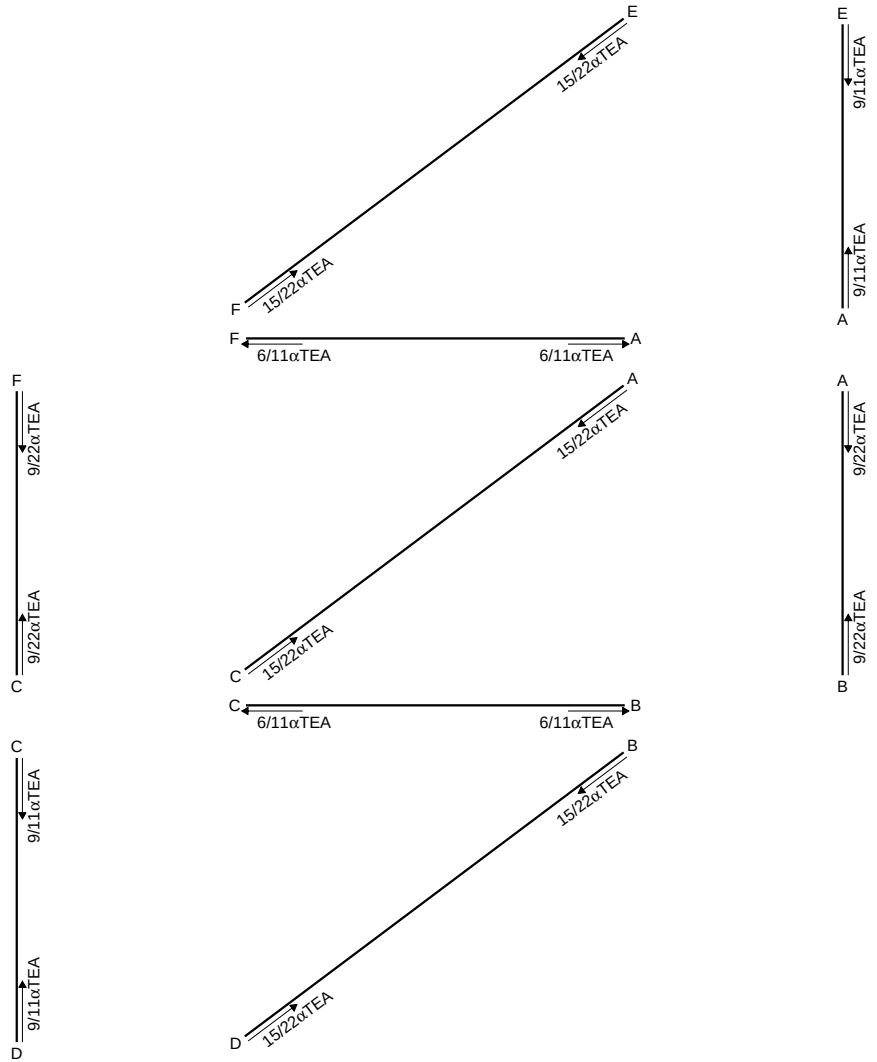
$3V_{CB}b = 4Xb$

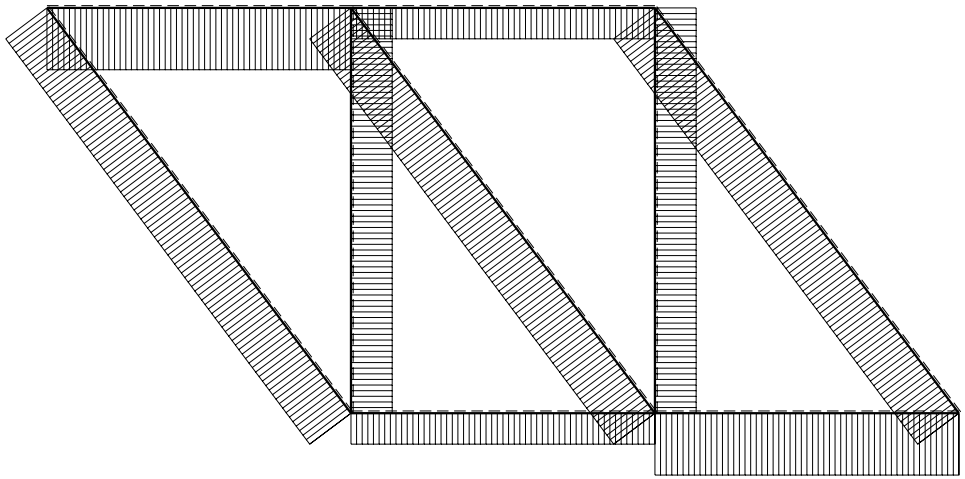
Matrice di equilibrio

$$\begin{array}{c} \\ \varphi_{EF} \\ \varphi_{FC} \\ \varphi_{CD} \\ \varphi_{CA} \\ \varphi_{DB} \end{array} \begin{bmatrix} H_Db & V_Db & V_{CB}b & H_{AE}b & V_{FA}b \\ -4 & -9 & 0 & 0 & 0 \\ 0 & -6 & 0 & -4 & 0 \\ 0 & -3 & 0 & 0 & 0 \\ 0 & 0 & 0 & -4 & 3 \\ 0 & 0 & 3 & 0 & 0 \end{bmatrix} = \begin{bmatrix} Xb \\ 0 \\ 0 \\ 4 \\ -4 \\ 4 \end{bmatrix}$$

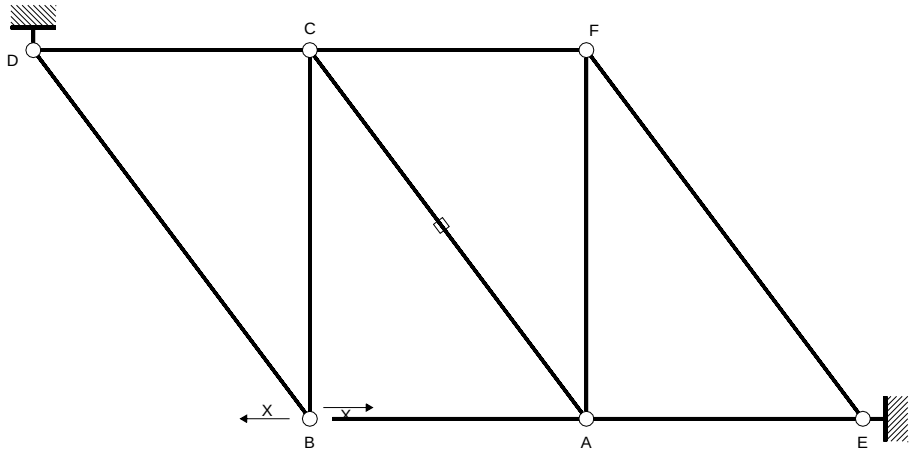
Soluzione del sistema

$$\begin{bmatrix} H_Db \\ V_Db \\ H_{AE}b \\ V_{FA}b \\ V_{CB}b \end{bmatrix} = \begin{bmatrix} Xb \\ 3 \\ -4/3 \\ 2 \\ 4/3 \\ 4/3 \end{bmatrix}$$





1 αTEA



REAZIONI IPERSTATICHE

$X = H_{BA}$

CALCOLO DELLE REAZIONI IPERSTATICHE

$L_{AB}^{XX} = N_{AB}^{X}\ N_{AB}^{X}\ l_{AB}/EA_{AB} = -1\ (-1)\ 3\ 1/3\ Fb/EA = Fb/EA$

$L_{BC}^{XX} = N_{BC}^{X}\ N_{BC}^{X}\ l_{BC}/EA_{BC} = 4/3\ 4/3\ 4\ 1/4\ Fb/EA = 16/9\ Fb/EA$

$L_{CD}^{XX} = N_{CD}^{X}\ N_{CD}^{X}\ l_{CD}/EA_{CD} = -2\ (-2)\ 3\ 1/4\ Fb/EA = 3\ Fb/EA$

$L_{BD}^{XX} = N_{BD}^{X}\ N_{BD}^{X}\ l_{BD}/EA_{BD} = -5/3\ (-5/3)\ 5\ 1/5\ Fb/EA = 25/9\ Fb/EA$

$L_{EA}^{XX} = N_{EA}^{X}\ N_{EA}^{X}\ l_{EA}/EA_{EA} = -2\ (-2)\ 3\ 1\ Fb/EA = 12\ Fb/EA$

$L_{AF}^{XX} = N_{AF}^{X}\ N_{AF}^{X}\ l_{AF}/EA_{AF} = 4/3\ 4/3\ 4\ 1\ Fb/EA = 64/9\ Fb/EA$

$L_{EF}^{XX} = N_{EF}^{X}\ N_{EF}^{X}\ l_{EF}/EA_{EF} = -5/3\ (-5/3)\ 5\ 1/2\ Fb/EA = 125/18\ Fb/EA$

$L_{FC}^{XX} = N_{FC}^{X}\ N_{FC}^{X}\ l_{FC}/EA_{FC} = -1\ (-1)\ 3\ 1/2\ Fb/EA = 3/2\ Fb/EA$

$L_{AC}^{XX} = N_{AC}^{X}\ N_{AC}^{X}\ l_{AC}/EA_{AC} + N_{AC}^{X}\ \varepsilon_{AC}\ l_{AC} = -5/3\ (-5/3)\ 5\ 1/3\ Fb/EA - 5/3\ 2\ 5\ Fb/EA = 125/27\ Fb/EA$

$L_{AC}^{Xo} = N_{AC}^{X}\ N_{AC}^{o}\ l_{AC}/EA_{AC} + N_{AC}^{X}\ \varepsilon_{AC}\ l_{AC} = -5/3 - 5/3\ 2\ 5\ Fb/EA = -50/3\ Fb/EA$

Contributi nulli elementi
L^{Xo}_{AB} L^{Xo}_{BC} L^{Xo}_{CD} L^{Xo}_{BD} L^{Xo}_{EA} L^{Xo}_{AF} L^{Xo}_{EF} L^{Xo}_{FC}

Contributi nulli nodi vincolati
L^{XX}_{D} L^{XX}_{E} L^{Xo}_{D} L^{Xo}_{E}

Espressione risolvente
$\left(L^{XX}_{AB} + L^{XX}_{BC} + L^{XX}_{CD} + L^{XX}_{BD} + L^{XX}_{EA} + L^{XX}_{AF} + L^{XX}_{EF} + L^{XX}_{FC} + L^{XX}_{AC} \right) X = - \left(L^{Xo}_{AC} \right)$

$\left(1 + 16/9 + 3 + 25/9 + 12 + 64/9 + 125/18 + 3/2 + 125/27 \right) X = \left(50/3 \right) F$

$1100/27\ X = 50/3\ F$

Soluzione
$X = 9/22\ F$

REAZIONI
$H_D = 27/22\alpha TEA$ $V_D = -6/11\alpha TEA$ $H_E = -27/22\alpha TEA$ $V_E = 6/11\alpha TEA$

$N_{AB} = -9/22\alpha TEA$ $N_{BC} = 6/11\alpha TEA$ $N_{CD} = -9/11\alpha TEA$ $N_{BD} = -15/22\alpha TEA$

$N_{EA} = -9/11\alpha TEA$ $N_{AF} = 6/11\alpha TEA$ $N_{EF} = -15/22\alpha TEA$ $N_{FC} = -9/22\alpha TEA$

$N_{AC} = -15/22\alpha TEA$

SPOSTAMENTI NODALI

$u_A = 27/11\alpha Tb$ $u_B = 63/22\alpha Tb$ $u_C = -27/44\alpha Tb$ $u_D = 0$ $u_E = 0$
$v_A = -921/176\alpha Tb$ $v_B = 3\alpha Tb$ $v_C = 39/11\alpha Tb$ $v_D = 0$ $v_E = 0$

$u_F = -27/22\alpha Tb$
$v_F = -537/176\alpha Tb$

Es.N.036

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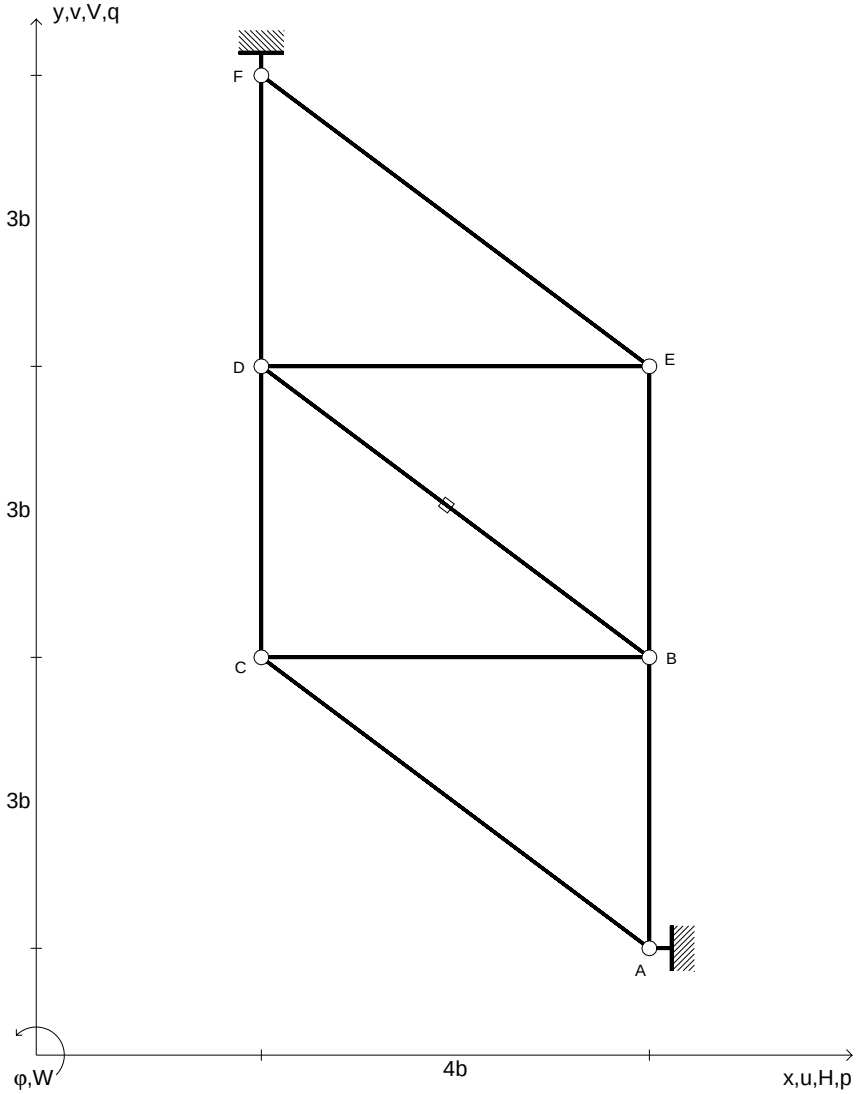
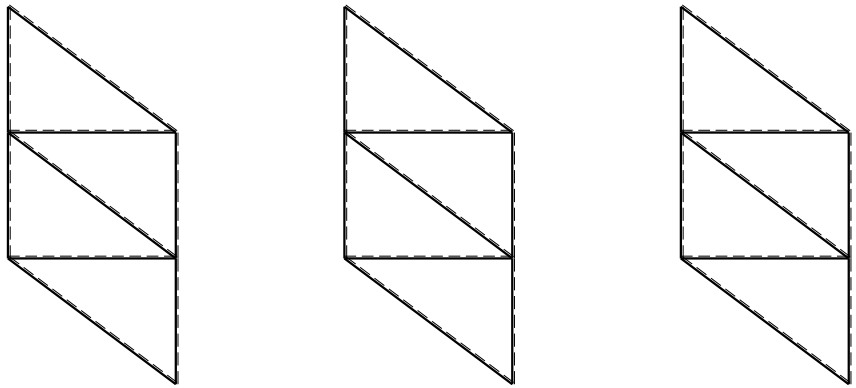
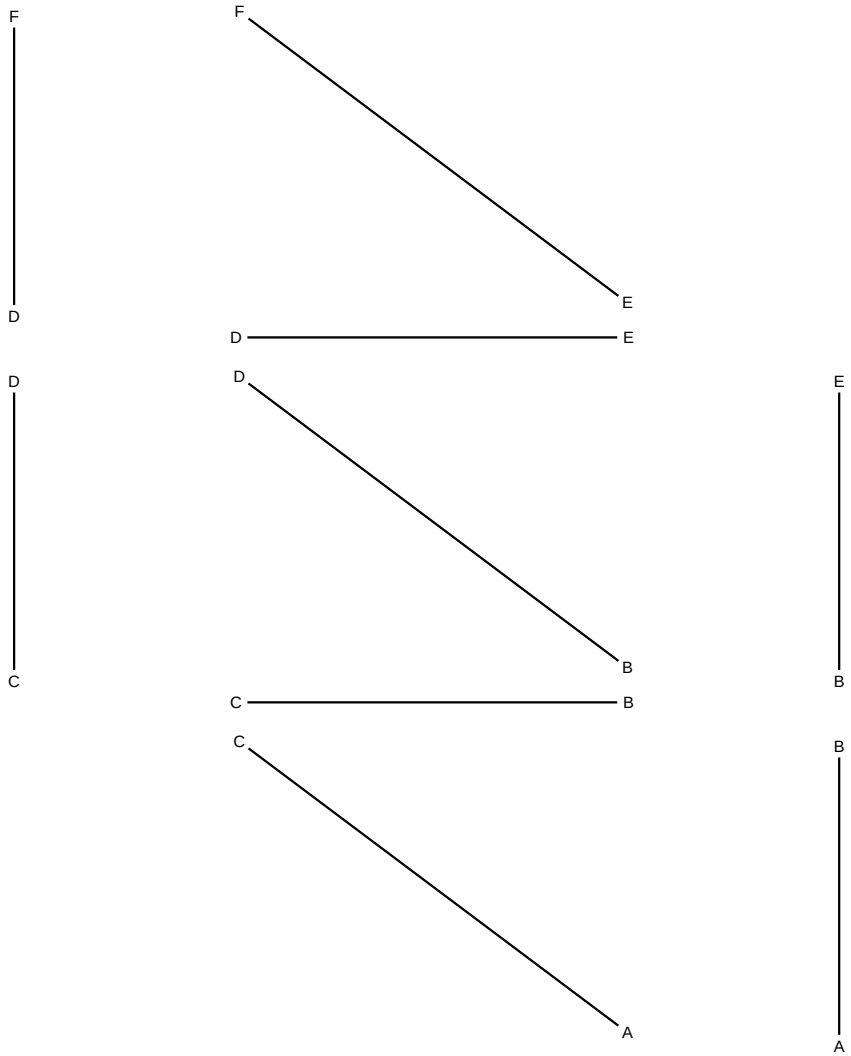
$\varepsilon_{BD} = 2\alpha T$
$EA_{AB} = EA$
$EA_{BC} = EA$
$EA_{AC} = 2EA$
$EA_{CD} = 2EA$
$EA_{BD} = 3EA$
$EA_{BE} = 3EA$
$EA_{ED} = 4EA$
$EA_{DF} = 4EA$
$EA_{EF} = 5EA$



Svolgere l'analisi cinematica.
Riportare la soluzione su questo foglio.
Carichi e deformazioni date hanno verso efficace in disegno.
Calcolare reazioni vincolari della struttura e delle aste.
Tracciare i diagrammi delle azioni interne nelle aste.
Calcolare spostamento e rotazione di tutti i nodi.
A_{YZ} - x_{YZ} - θ_{YZ} riferimento locale asta YZ con origine in Y.
Allungamento termico assegnato ε su asta BD.





REAZIONI

H_A = V_A = H_F = V_F =

N_{AB} = N_{BC} = N_{AC} = N_{CD} =

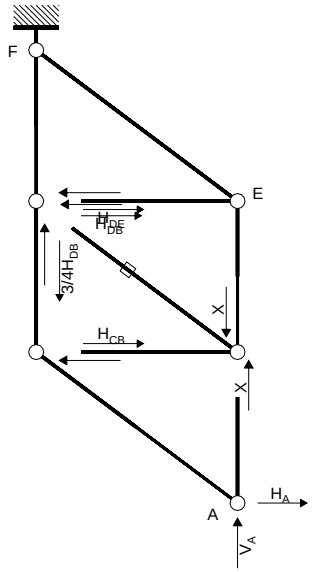
N_{BD} = N_{BE} = N_{ED} = N_{DF} =

N_{EF} =

SPOSTAMENTI NODALI

u_A = u_B = u_C = u_D = u_E =
v_A = v_B = v_C = v_D = v_E =

u_F =
v_F =



EQUAZIONI DI EQUILIBRIO

Rotazione intorno a F: aste FD DC CA AB

$9H_Ab + 4V_Ab - 6H_{CB}b - 3H_{DB}b - 3H_{DE}b = -4Xb$

Rotazione intorno a F: aste FE EB ED BC BD

$6H_{CB}b + 3H_{DB}b + 3H_{DE}b = 4Xb$

Rotazione intorno a D: aste DC CA AB

$6H_Ab + 4V_Ab - 3H_{CB}b = -4Xb$

Rotazione intorno a E: aste EB BC BD

$3H_{CB}b + 3H_{DB}b = 0$

Rotazione intorno a C: aste CA AB

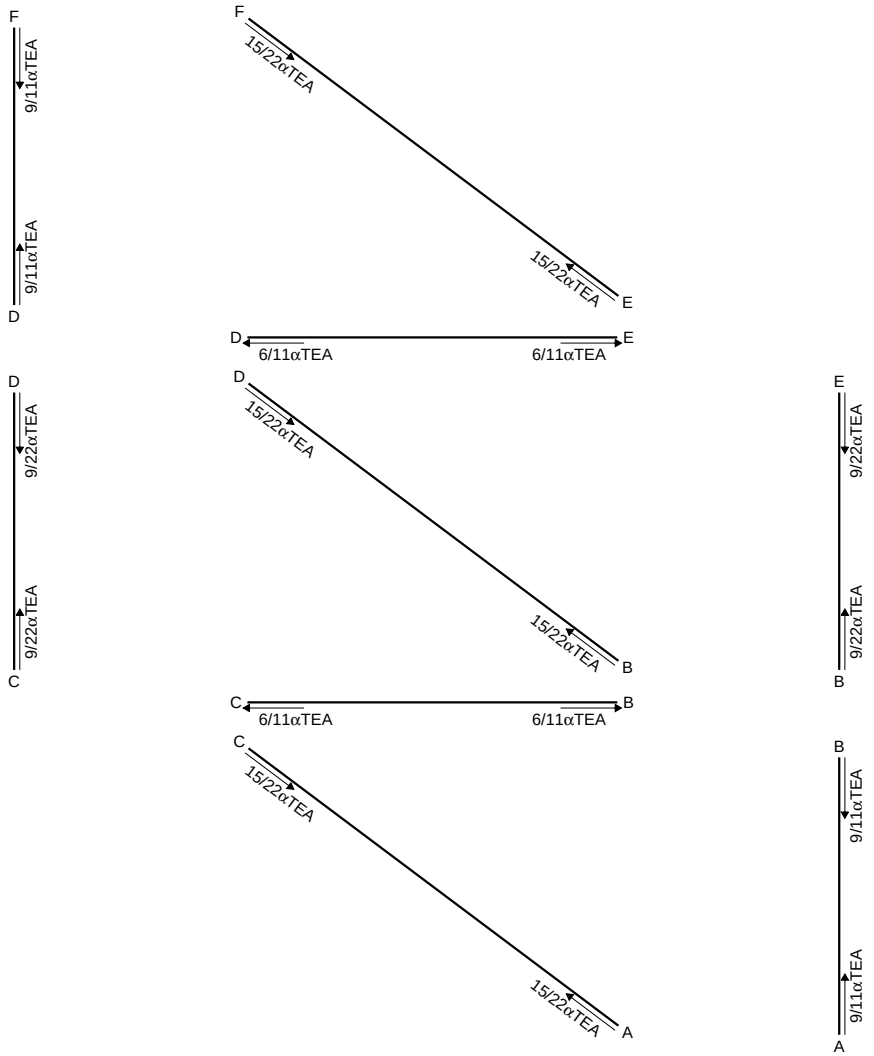
$3H_Ab + 4V_Ab = -4Xb$

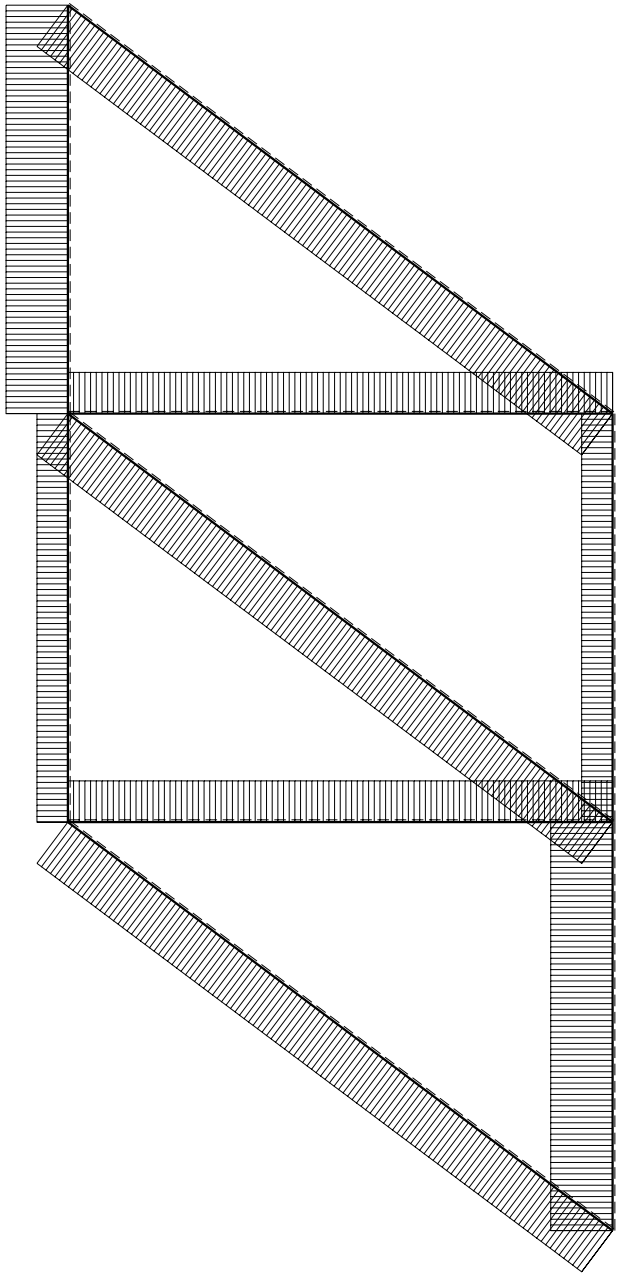
Matrice di equilibrio

	H_Ab	V_Ab	$H_{CB}b$	$H_{DB}b$	$H_{DE}b$		Xb
φ_{FD}	9	4	-6	-3	-3		-4
φ_{FE}	0	0	6	3	3		4
φ_{DC}	6	4	-3	0	0	=	-4
φ_{EB}	0	0	3	3	0		0
φ_{CA}	3	4	0	0	0		-4

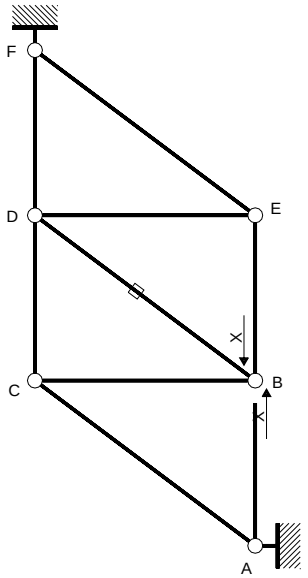
Soluzione del sistema

		Xb
H_Ab		2/3
$H_{CB}b$		2/3
V_Ab	=	-3/2
$H_{DB}b$		-2/3
$H_{DE}b$		2/3





1 αTEA



REAZIONI IPERSTATICHE

$X = V_{BA}$

CALCOLO DELLE REAZIONI IPERSTATICHE

$L^{XX}_{AB} = N^{X}_{AB}\ N^{X}_{AB}\ l_{AB}/EA_{AB} = 1\ 1\ 3\ 1\ Fb/EA = 3\ Fb/EA$

$L^{XX}_{BC} = N^{X}_{BC}\ N^{X}_{BC}\ l_{BC}/EA_{BC} = -2/3\ (-2/3)\ 4\ 1\ Fb/EA = 16/9\ Fb/EA$

$L^{XX}_{AC} = N^{X}_{AC}\ N^{X}_{AC}\ l_{AC}/EA_{AC} = 5/6\ 5/6\ 5\ 1/2\ Fb/EA = 125/72\ Fb/EA$

$L^{XX}_{CD} = N^{X}_{CD}\ N^{X}_{CD}\ l_{CD}/EA_{CD} = 1/2\ 1/2\ 3\ 1/2\ Fb/EA = 3/8\ Fb/EA$

$L^{XX}_{BD} = N^{X}_{BD}\ N^{X}_{BD}\ l_{BD}/EA_{BD} + N^{X}_{BD}\ \varepsilon_{BD}\ l_{BD} = 5/6\ 5/6\ 5\ 1/3\ Fb/EA + 5/6\ 2\ 5\ Fb/EA = 125/108\ Fb/EA$

$L^{XX}_{BE} = N^{X}_{BE}\ N^{X}_{BE}\ l_{BE}/EA_{BE} = 1/2\ 1/2\ 3\ 1/3\ Fb/EA = 1/4\ Fb/EA$

$L^{XX}_{ED} = N^{X}_{ED}\ N^{X}_{ED}\ l_{ED}/EA_{ED} = -2/3\ (-2/3)\ 4\ 1/4\ Fb/EA = 4/9\ Fb/EA$

$L^{XX}_{DF} = N^{X}_{DF}\ N^{X}_{DF}\ l_{DF}/EA_{DF} = 1\ 1\ 3\ 1/4\ Fb/EA = 3/4\ Fb/EA$

$L^{XX}_{EF} = N^{X}_{EF}\ N^{X}_{EF}\ l_{EF}/EA_{EF} = 5/6\ 5/6\ 5\ 1/5\ Fb/EA = 25/36\ Fb/EA$

$L_{BD}^{Xo} = N_{BD}^{X} N_{BD}^{o} l_{BD}/EA_{BD} + N_{BD}^{X} \varepsilon_{BD} l_{BD} = 5/6\ 5/6\ 2\ 5\ Fb/EA = 25/3\ Fb/EA$

Contributi nulli elementi
$L_{AB}^{Xo}\ L_{BC}^{Xo}\ L_{AC}^{Xo}\ L_{CD}^{Xo}\ L_{BE}^{Xo}\ L_{ED}^{Xo}\ L_{DF}^{Xo}\ L_{EF}^{Xo}$

Contributi nulli nodi vincolati
$L_{A}^{XX}\ L_{F}^{XX}\ L_{A}^{Xo}\ L_{F}^{Xo}$

Espressione risolvente
$\left(L_{AB}^{XX} + L_{BC}^{XX} + L_{AC}^{XX} + L_{CD}^{XX} + L_{BD}^{XX} + L_{BE}^{XX} + L_{ED}^{XX} + L_{DF}^{XX} + L_{EF}^{XX} \right) X = - \left(L_{BD}^{Xo} \right)$

$\left(3 + 16/9 + 125/72 + 3/8 + 125/108 + 1/4 + 4/9 + 3/4 + 25/36 \right) X = \left(- 25/3 \right) F$

$275/27\ X = - 25/3\ F$

Soluzione
$X = -9/11\ F$

REAZIONI
$H_A = -6/11\alpha TEA$ $V_A = 27/22\alpha TEA$ $H_F = 6/11\alpha TEA$ $V_F = -27/22\alpha TEA$

$N_{AB} = -9/11\alpha TEA$ $N_{BC} = 6/11\alpha TEA$ $N_{AC} = -15/22\alpha TEA$ $N_{CD} = -9/22\alpha TEA$

$N_{BD} = -15/22\alpha TEA$ $N_{BE} = -9/22\alpha TEA$ $N_{ED} = 6/11\alpha TEA$ $N_{DF} = -9/11\alpha TEA$

$N_{EF} = -15/22\alpha TEA$

SPOSTAMENTI NODALI

$u_A = 0$	$u_B = 921/176\alpha Tb$	$u_C = 537/176\alpha Tb$	$u_D = -39/11\alpha Tb$	$u_E = -3\alpha Tb$
$v_A = 0$	$v_B = -27/11\alpha Tb$	$v_C = 27/22\alpha Tb$	$v_D = 27/44\alpha Tb$	$v_E = -63/22\alpha Tb$

$u_F = 0$
$v_F = 0$

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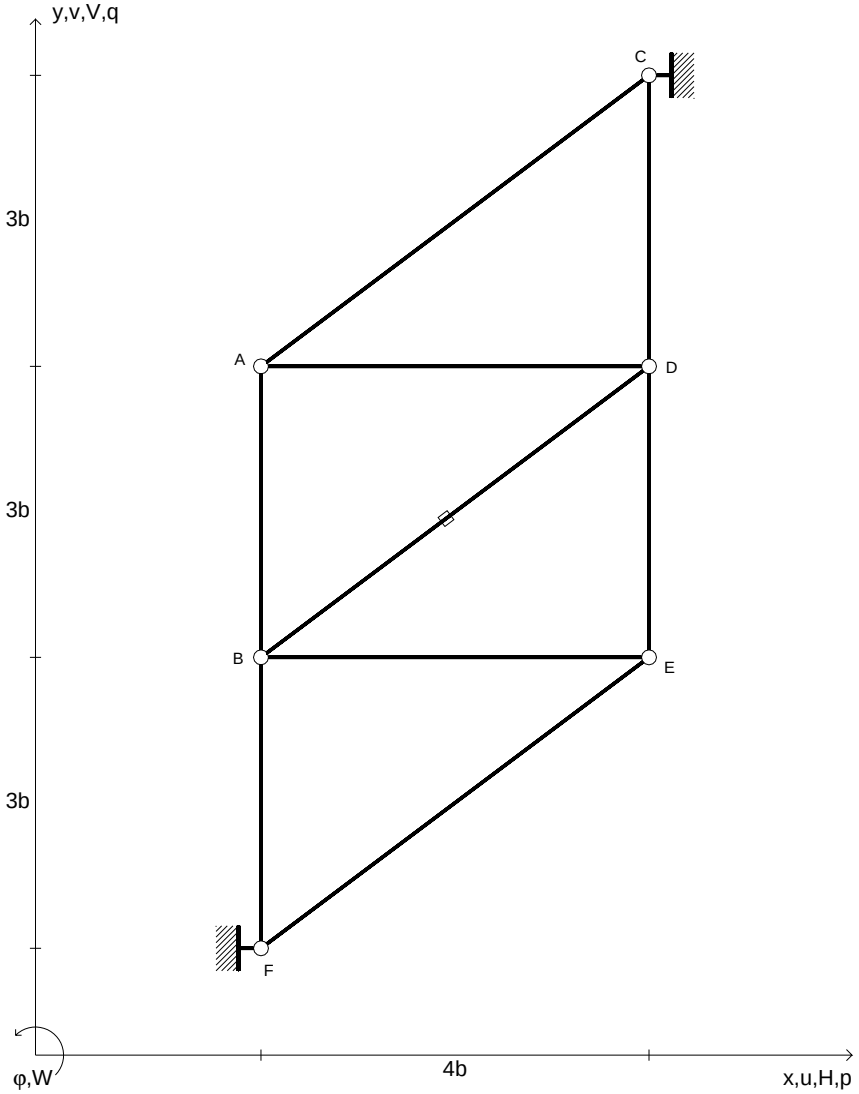
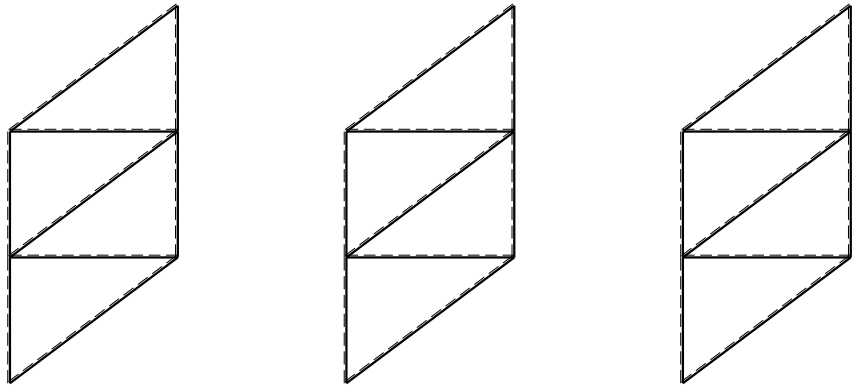
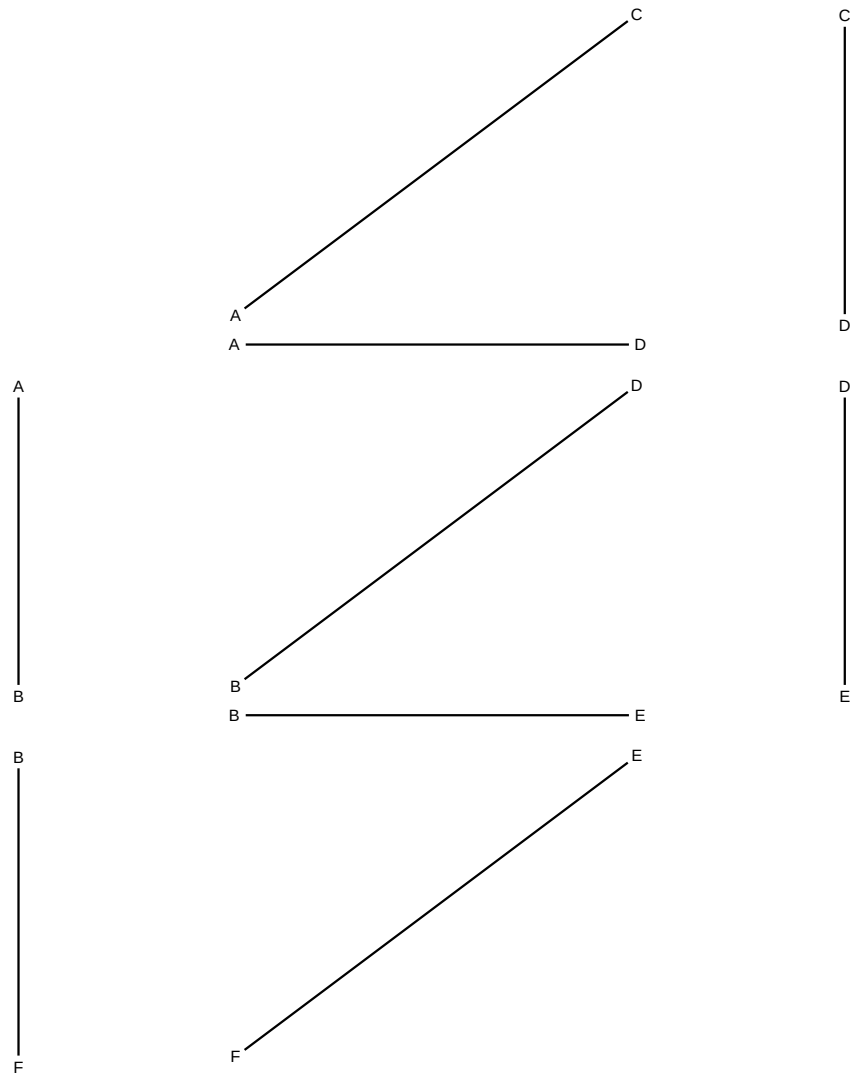
$\varepsilon_{DB} = 2\alpha T$
$EA_{AB} = 2EA$
$EA_{CA} = 2EA$
$EA_{DA} = EA$
$EA_{CD} = EA$
$EA_{EF} = 5EA$
$EA_{BF} = 4EA$
$EA_{EB} = 4EA$
$EA_{DE} = 3EA$
$EA_{DB} = 3EA$



Svolgere l'analisi cinematica.
Riportare la soluzione su questo foglio.
Carichi e deformazioni date hanno verso efficace in disegno.
Calcolare reazioni vincolari della struttura e delle aste.
Tracciare i diagrammi delle azioni interne nelle aste.
Calcolare spostamento e rotazione di tutti i nodi.
A_{YZ} - x_{YZ} - θ_{YZ} riferimento locale asta YZ con origine in Y.
Allungamento termico assegnato ε su asta DB.





REAZIONI

H_C = V_C = H_F = V_F =

N_{AB} = N_{CA} = N_{DA} = N_{CD} =

N_{EF} = N_{BF} = N_{EB} = N_{DE} =

N_{DB} =

SPOSTAMENTI NODALI

u_A = u_B = u_C = u_D = u_E =
v_A = v_B = v_C = v_D = v_E =

u_F =
v_F =

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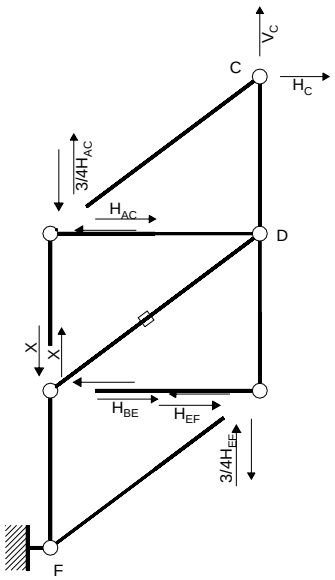


EQUAZIONI DI EQUILIBRIO

Rotazione intorno a F: aste FB BD DA DC DE AB CA EB

$-9H_Cb +4V_Cb = 0$

Rotazione intorno a B: aste BD DA DC DE AB CA EB

$-6H_Cb +4V_Cb -3H_{EF}b = 0$

Rotazione intorno a D: aste DA AB

$3H_{AC}b = 4Xb$

Rotazione intorno a D: aste DC CA

$-3H_Cb -3H_{AC}b = 0$

Rotazione intorno a D: aste DE EB

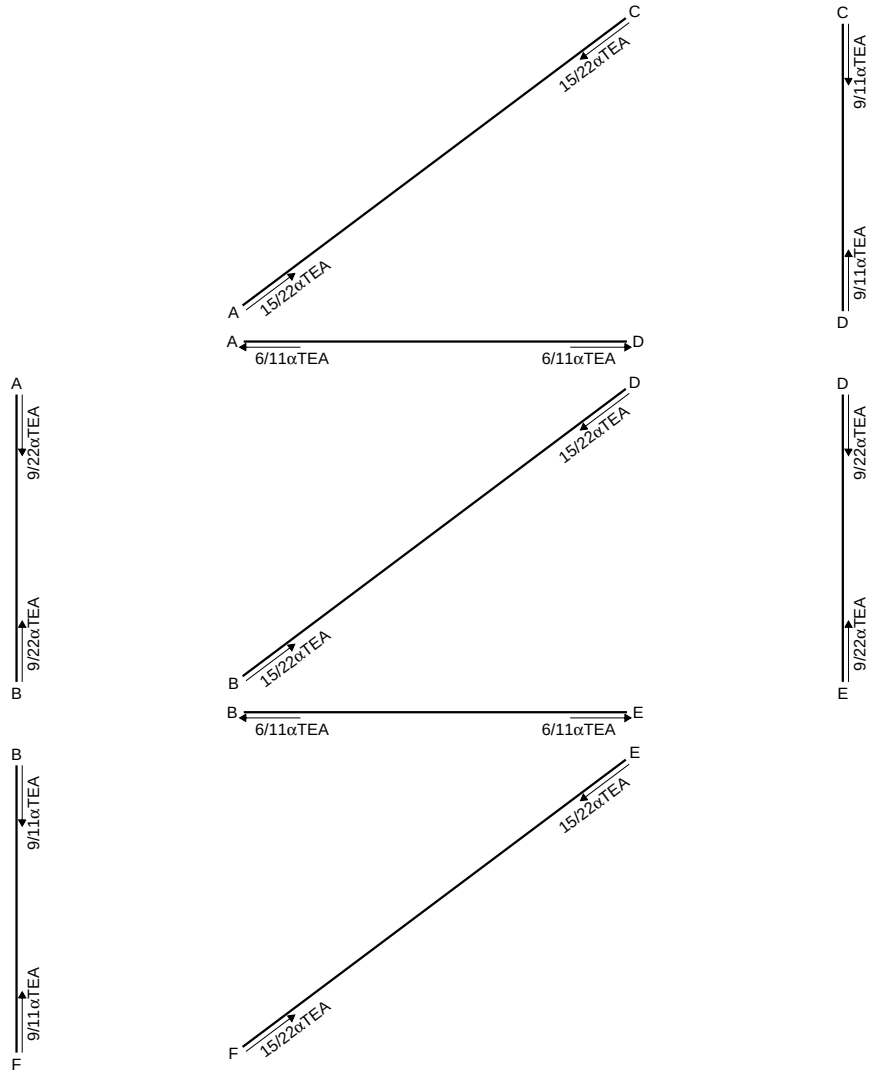
$-3H_{EF}b +3H_{BE}b = 0$

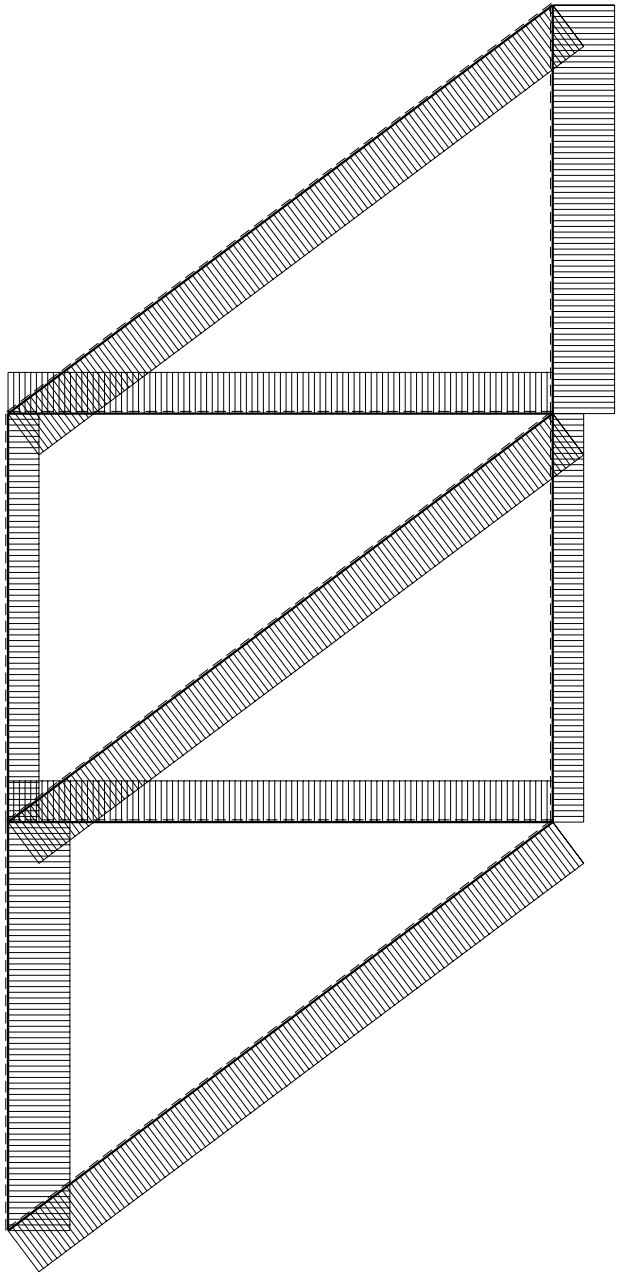
Matrice di equilibrio

$$\begin{array}{c} \\ \varphi_{FB} \\ \varphi_{BD} \\ \varphi_{DA} \\ \varphi_{DC} \\ \varphi_{DE} \end{array} \begin{array}{c} \begin{bmatrix} H_Cb & V_Cb & H_{AC}b & H_{EF}b & H_{BE}b \end{bmatrix} \\ \begin{bmatrix} -9 & 4 & 0 & 0 & 0 \\ -6 & 4 & 0 & -3 & 0 \\ 0 & 0 & 3 & 0 & 0 \\ -3 & 0 & -3 & 0 & 0 \\ 0 & 0 & 0 & -3 & 3 \end{bmatrix} \end{array} = \begin{array}{c} \begin{bmatrix} Xb \end{bmatrix} \\ \begin{bmatrix} 0 \\ 0 \\ 4 \\ 0 \\ 0 \end{bmatrix} \end{array}$$

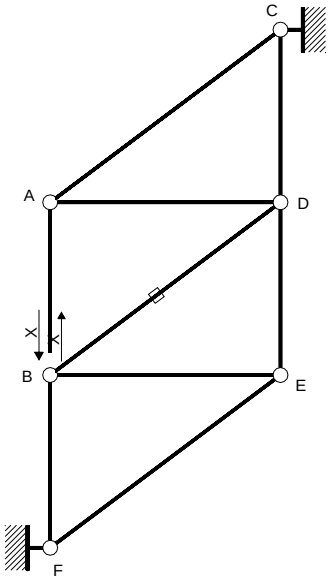
Soluzione del sistema

$$\begin{array}{c} \begin{bmatrix} H_Cb \\ V_Cb \\ H_{AC}b \\ H_{EF}b \\ H_{BE}b \end{bmatrix} \end{array} = \begin{array}{c} \begin{bmatrix} Xb \end{bmatrix} \\ \begin{bmatrix} -4/3 \\ -3 \\ 4/3 \\ -4/3 \\ -4/3 \end{bmatrix} \end{array}$$





1 αTEA



REAZIONI IPERSTATICHE

$X = V_{BA}$

CALCOLO DELLE REAZIONI IPERSTATICHE

$L^{XX}_{AB} = N^{X}_{AB}\ N^{X}_{AB}\ l_{AB}/EA_{AB} = -1\ (-1)\ 3\ 1/2\ Fb/EA = 3/2\ Fb/EA$

$L^{XX}_{CA} = N^{X}_{CA}\ N^{X}_{CA}\ l_{CA}/EA_{CA} = -5/3\ (-5/3)\ 5\ 1/2\ Fb/EA = 125/18\ Fb/EA$

$L^{XX}_{DA} = N^{X}_{DA}\ N^{X}_{DA}\ l_{DA}/EA_{DA} = 4/3\ 4/3\ 4\ 1\ Fb/EA = 64/9\ Fb/EA$

$L^{XX}_{CD} = N^{X}_{CD}\ N^{X}_{CD}\ l_{CD}/EA_{CD} = -2\ (-2)\ 3\ 1\ Fb/EA = 12\ Fb/EA$

$L^{XX}_{EF} = N^{X}_{EF}\ N^{X}_{EF}\ l_{EF}/EA_{EF} = -5/3\ (-5/3)\ 5\ 1/5\ Fb/EA = 25/9\ Fb/EA$

$L^{XX}_{BF} = N^{X}_{BF}\ N^{X}_{BF}\ l_{BF}/EA_{BF} = -2\ (-2)\ 3\ 1/4\ Fb/EA = 3\ Fb/EA$

$L^{XX}_{EB} = N^{X}_{EB}\ N^{X}_{EB}\ l_{EB}/EA_{EB} = 4/3\ 4/3\ 4\ 1/4\ Fb/EA = 16/9\ Fb/EA$

$L^{XX}_{DE} = N^{X}_{DE}\ N^{X}_{DE}\ l_{DE}/EA_{DE} = -1\ (-1)\ 3\ 1/3\ Fb/EA =\ Fb/EA$

$L^{XX}_{DB} = N^{X}_{DB}\ N^{X}_{DB}\ l_{DB}/EA_{DB} + N^{X}_{DB}\ \varepsilon_{DB}\ l_{DB} = -5/3\ (-5/3)\ 5\ 1/3\ Fb/EA - 5/3\ 2\ 5\ Fb/EA = 125/27\ Fb/EA$

$L^{Xo}_{DB} = N^{X}_{DB} N^{o}_{DB} l_{DB}/EA_{DB} + N^{X}_{DB} \varepsilon_{DB} l_{DB} = -5/3 - 5/3\ 2\ 5\ Fb/EA = -50/3\ Fb/EA$

Contributi nulli elementi
$L^{Xo}_{AB}\ L^{Xo}_{CA}\ L^{Xo}_{DA}\ L^{Xo}_{CD}\ L^{Xo}_{EF}\ L^{Xo}_{BF}\ L^{Xo}_{EB}\ L^{Xo}_{DE}$

Contributi nulli nodi vincolati
$L^{XX}_{C}\ L^{XX}_{F}\ L^{Xo}_{C}\ L^{Xo}_{F}$

Espressione risolvente
$\left(L^{XX}_{AB} + L^{XX}_{CA} + L^{XX}_{DA} + L^{XX}_{CD} + L^{XX}_{EF} + L^{XX}_{BF} + L^{XX}_{EB} + L^{XX}_{DE} + L^{XX}_{DB} \right) X = - \left(L^{Xo}_{DB} \right)$

$\left(3/2 + 125/18 + 64/9 + 12 + 25/9 + 3 + 16/9 + 1 + 125/27 \right) X = \left(50/3 \right) F$

$1100/27\ X = 50/3\ F$

Soluzione
$X = 9/22\ F$

REAZIONI
$H_C = -6/11\alpha TEA$ $V_C = -27/22\alpha TEA$ $H_F = 6/11\alpha TEA$ $V_F = 27/22\alpha TEA$

$N_{AB} = -9/22\alpha TEA$ $N_{CA} = -15/22\alpha TEA$ $N_{DA} = 6/11\alpha TEA$ $N_{CD} = -9/11\alpha TEA$

$N_{EF} = -15/22\alpha TEA$ $N_{BF} = -9/11\alpha TEA$ $N_{EB} = 6/11\alpha TEA$ $N_{DE} = -9/22\alpha TEA$

$N_{DB} = -15/22\alpha TEA$

SPOSTAMENTI NODALI

$u_A = 537/176\alpha Tb$ $u_B = -39/11\alpha Tb$ $u_C = 0$ $u_D = 921/176\alpha Tb$ $u_E = -3\alpha Tb$
$v_A = -27/22\alpha Tb$ $v_B = -27/44\alpha Tb$ $v_C = 0$ $v_D = 27/11\alpha Tb$ $v_E = 63/22\alpha Tb$

$u_F = 0$
$v_F = 0$

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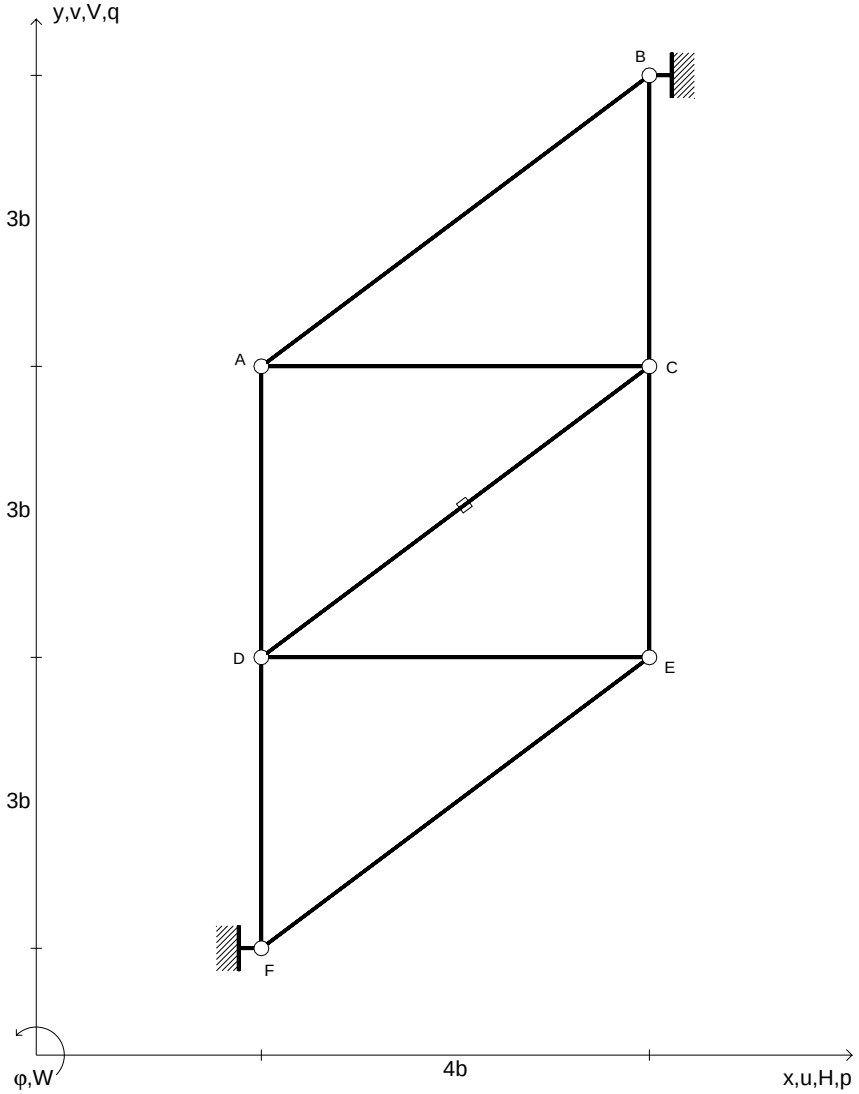
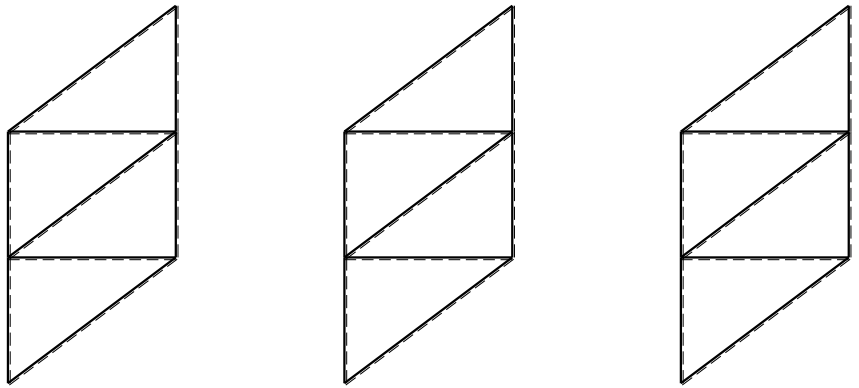
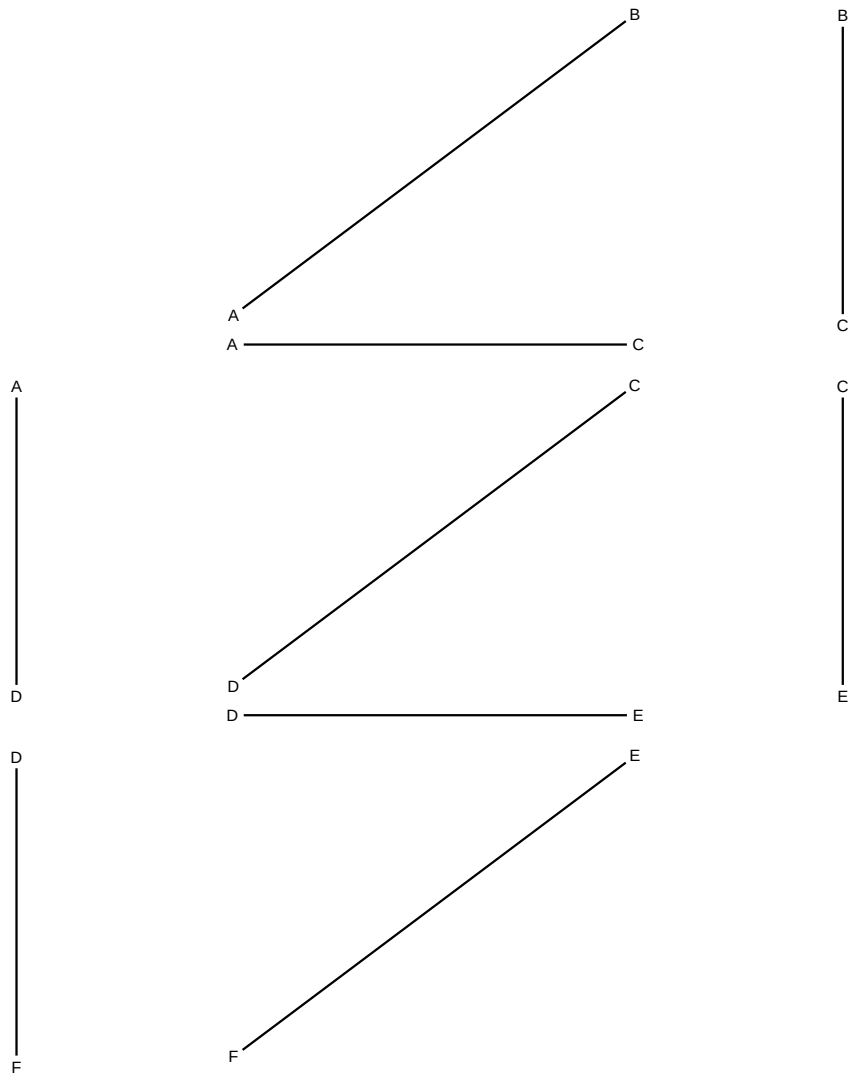
$\varepsilon_{DC} = 2\alpha T$
$EA_{AB} = 5EA$
$EA_{CB} = 4EA$
$EA_{AC} = 4EA$
$EA_{DA} = 3EA$
$EA_{DC} = 3EA$
$EA_{EC} = 2EA$
$EA_{FE} = 2EA$
$EA_{DE} = EA$
$EA_{FD} = EA$



Svolgere l'analisi cinematica.
Riportare la soluzione su questo foglio.
Carichi e deformazioni date hanno verso efficace in disegno.
Calcolare reazioni vincolari della struttura e delle aste.
Tracciare i diagrammi delle azioni interne nelle aste.
Calcolare spostamento e rotazione di tutti i nodi.
A_{YZ} - x_{YZ} - θ_{YZ} riferimento locale asta YZ con origine in Y.
Allungamento termico assegnato ε su asta DC.





REAZIONI

H_B = V_B = H_F = V_F =

N_{AB} = N_{CB} = N_{AC} = N_{DA} =

N_{DC} = N_{EC} = N_{FE} = N_{DE} =

N_{FD} =

SPOSTAMENTI NODALI

u_A = u_B = u_C = u_D = u_E =
v_A = v_B = v_C = v_D = v_E =

u_F =
v_F =

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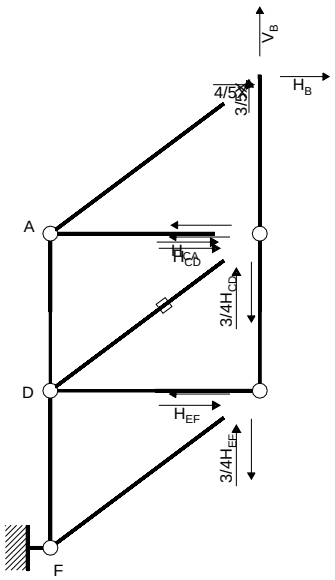


EQUAZIONI DI EQUILIBRIO

Rotazione intorno a F: aste FD DA DC DE AB AC EC CB

$-9H_Bb +4V_Bb = 24/5Xb$

Rotazione intorno a D: aste DA AB AC

$-3H_{CA}b = 12/5Xb$

Rotazione intorno a D: aste DE EC CB

$-6H_Bb +4V_Bb +3H_{CA}b -3H_{EF}b = 0$

Rotazione intorno a E: aste EC CB

$-6H_Bb +3H_{CA}b +3H_{CD}b = 0$

Rotazione intorno a C: aste CB

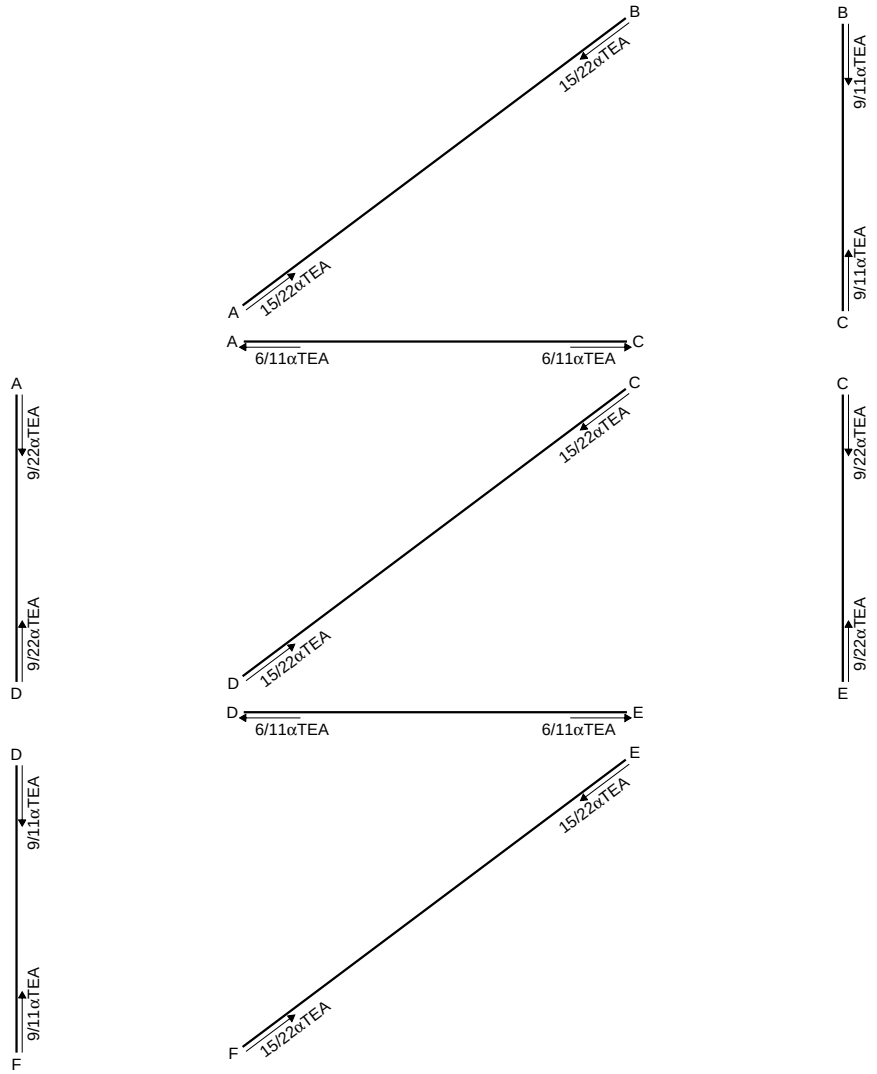
$-3H_Bb = 0$

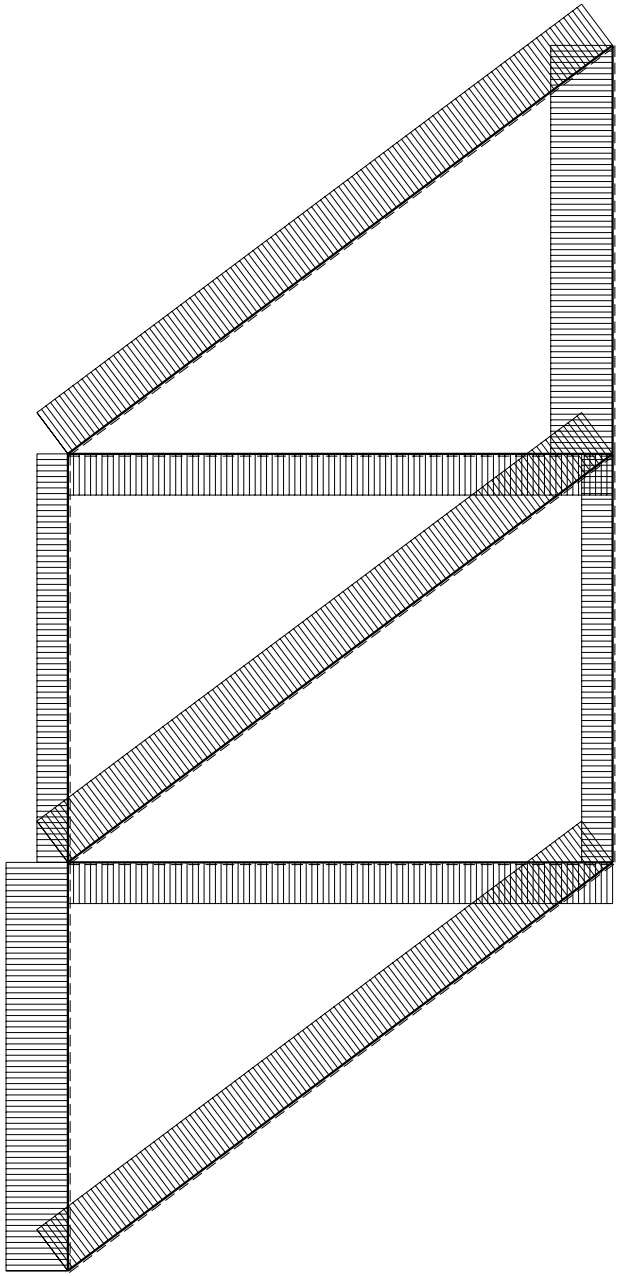
Matrice di equilibrio

$$\begin{array}{c} \\ \varphi_{FD} \\ \varphi_{DA} \\ \varphi_{DE} \\ \varphi_{EC} \\ \varphi_{CB} \end{array} \begin{bmatrix} H_Bb & V_Bb & H_{CA}b & H_{CD}b & H_{EF}b \\ -9 & 4 & 0 & 0 & 0 \\ 0 & 0 & -3 & 0 & 0 \\ -6 & 4 & 3 & 0 & -3 \\ -6 & 0 & 3 & 3 & 0 \\ -3 & 0 & 0 & 0 & 0 \end{bmatrix} = \begin{bmatrix} Xb \\ 24/5 \\ 12/5 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

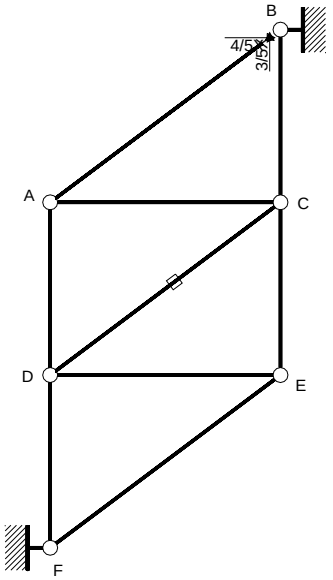
Soluzione del sistema

$$\begin{bmatrix} H_Bb \\ H_{CA}b \\ V_Bb \\ H_{CD}b \\ H_{EF}b \end{bmatrix} = \begin{bmatrix} Xb \\ 0 \\ -4/5 \\ 6/5 \\ 4/5 \\ 4/5 \end{bmatrix}$$





1 αTEA



REAZIONI IPERSTATICHE

$X = H_{BA}$

CALCOLO DELLE REAZIONI IPERSTATICHE

$L^{XX}_{AB} = N^{X}_{AB}\ N^{X}_{AB}\ l_{AB}/EA_{AB} = 1\ 1\ 5\ 1/5\ Fb/EA = Fb/EA$

$L^{XX}_{CB} = N^{X}_{CB}\ N^{X}_{CB}\ l_{CB}/EA_{CB} = 6/5\ 6/5\ 3\ 1/4\ Fb/EA = 27/25\ Fb/EA$

$L^{XX}_{AC} = N^{X}_{AC}\ N^{X}_{AC}\ l_{AC}/EA_{AC} = -4/5\ (-4/5)\ 4\ 1/4\ Fb/EA = 16/25\ Fb/EA$

$L^{XX}_{DA} = N^{X}_{DA}\ N^{X}_{DA}\ l_{DA}/EA_{DA} = 3/5\ 3/5\ 3\ 1/3\ Fb/EA = 9/25\ Fb/EA$

$L^{XX}_{DC} = N^{X}_{DC}\ N^{X}_{DC}\ l_{DC}/EA_{DC} + N^{X}_{DC}\ \varepsilon_{DC}\ l_{DC} = 1\ 1\ 5\ 1/3\ Fb/EA + 1\ 2\ 5\ Fb/EA = 5/3\ Fb/EA$

$L^{XX}_{EC} = N^{X}_{EC}\ N^{X}_{EC}\ l_{EC}/EA_{EC} = 3/5\ 3/5\ 3\ 1/2\ Fb/EA = 27/50\ Fb/EA$

$L^{XX}_{FE} = N^{X}_{FE}\ N^{X}_{FE}\ l_{FE}/EA_{FE} = 1\ 1\ 5\ 1/2\ Fb/EA = 5/2\ Fb/EA$

$L^{XX}_{DE} = N^{X}_{DE}\ N^{X}_{DE}\ l_{DE}/EA_{DE} = -4/5\ (-4/5)\ 4\ 1\ Fb/EA = 64/25\ Fb/EA$

$L^{XX}_{FD} = N^{X}_{FD}\ N^{X}_{FD}\ l_{FD}/EA_{FD} = 6/5\ 6/5\ 3\ 1\ Fb/EA = 108/25\ Fb/EA$

$L_{DC}^{Xo} = N_{DC}^{X} N_{DC}^{o} l_{DC}/EA_{DC} + N_{DC}^{X} \varepsilon_{DC} l_{DC} = 1\ 1\ 2\ 5\ Fb/EA = 10\ Fb/EA$

Contributi nulli elementi
$L_{AB}^{Xo}\ L_{CB}^{Xo}\ L_{AC}^{Xo}\ L_{DA}^{Xo}\ L_{EC}^{Xo}\ L_{FE}^{Xo}\ L_{DE}^{Xo}\ L_{FD}^{Xo}$

Contributi nulli nodi vincolati
$L_{B}^{XX}\ L_{F}^{XX}\ L_{B}^{Xo}\ L_{F}^{Xo}$

Espressione risolvente
$\left(L_{AB}^{XX} + L_{CB}^{XX} + L_{AC}^{XX} + L_{DA}^{XX} + L_{DC}^{XX} + L_{EC}^{XX} + L_{FE}^{XX} + L_{DE}^{XX} + L_{FD}^{XX} \right) X = - \left(L_{DC}^{Xo} \right)$

$\left(1 + 27/25 + 16/25 + 9/25 + 5/3 + 27/50 + 5/2 + 64/25 + 108/25 \right) X = \left(- 10 \right) F$

$44/3\ X = - 10\ F$

Soluzione
$X = -6/11\ F$

REAZIONI
$H_B = -6/11\alpha TEA$ $V_B = -27/22\alpha TEA$ $H_F = 6/11\alpha TEA$ $V_F = 27/22\alpha TEA$

$N_{AB} = -15/22\alpha TEA$ $N_{CB} = -9/11\alpha TEA$ $N_{AC} = 6/11\alpha TEA$ $N_{DA} = -9/22\alpha TEA$

$N_{DC} = -15/22\alpha TEA$ $N_{EC} = -9/22\alpha TEA$ $N_{FE} = -15/22\alpha TEA$ $N_{DE} = 6/11\alpha TEA$

$N_{FD} = -9/11\alpha TEA$

SPOSTAMENTI NODALI

$u_A = 3\alpha Tb$	$u_B = 0$	$u_C = 39/11\alpha Tb$	$u_D = -921/176\alpha Tb$	$u_E = -537/176\alpha Tb$
$v_A = -63/22\alpha Tb$	$v_B = 0$	$v_C = 27/44\alpha Tb$	$v_D = -27/11\alpha Tb$	$v_E = 27/22\alpha Tb$

$u_F = 0$
$v_F = 0$

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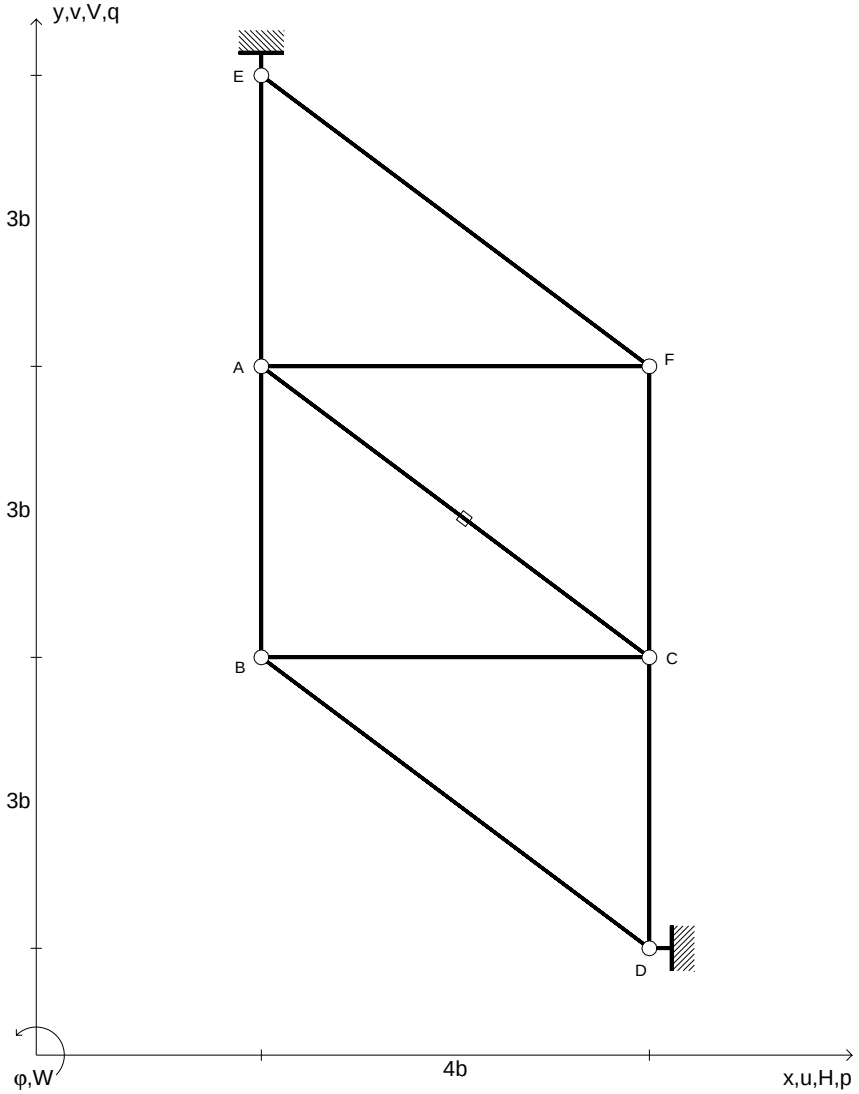
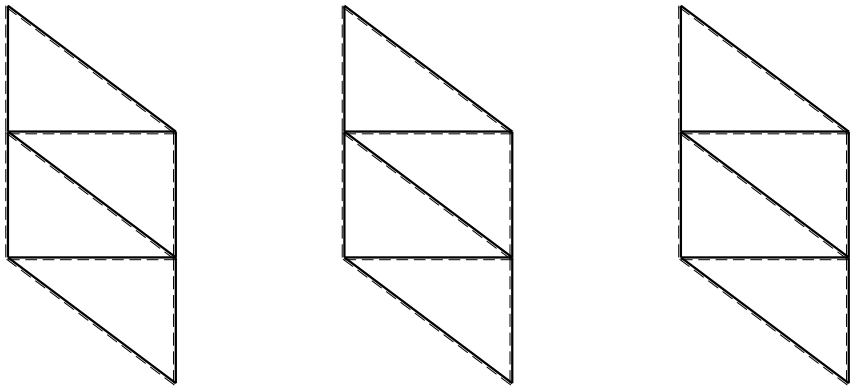
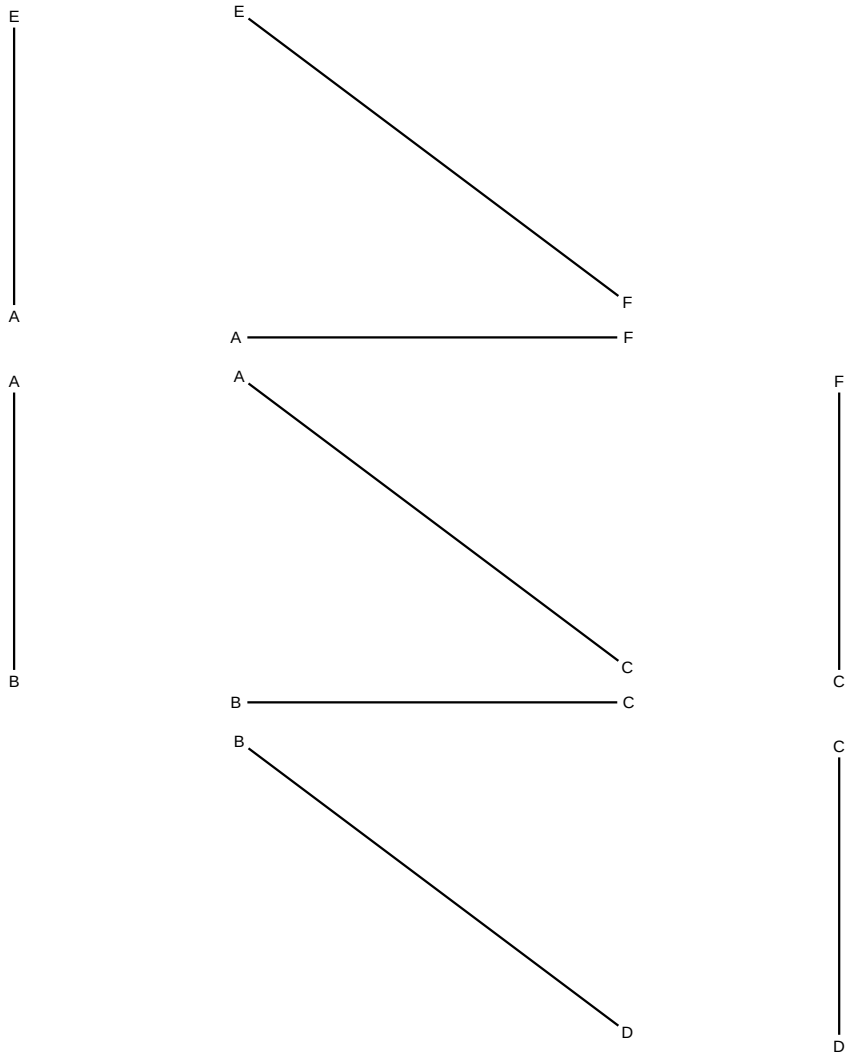
$\varepsilon_{AC} = 2\alpha T$
$EA_{AB} = 3EA$
$EA_{BC} = 4EA$
$EA_{CD} = 4EA$
$EA_{BD} = 5EA$
$EA_{EA} = EA$
$EA_{AF} = EA$
$EA_{EF} = 2EA$
$EA_{FC} = 2EA$
$EA_{AC} = 3EA$



Svolgere l'analisi cinematica.
Riportare la soluzione su questo foglio.
Carichi e deformazioni date hanno verso efficace in disegno.
Calcolare reazioni vincolari della struttura e delle aste.
Tracciare i diagrammi delle azioni interne nelle aste.
Calcolare spostamento e rotazione di tutti i nodi.
A_{YZ} - x_{YZ} - θ_{YZ} riferimento locale asta YZ con origine in Y.
Allungamento termico assegnato ε su asta AC.





REAZIONI

H_D = V_D = H_E = V_E =

N_{AB} = N_{BC} = N_{CD} = N_{BD} =

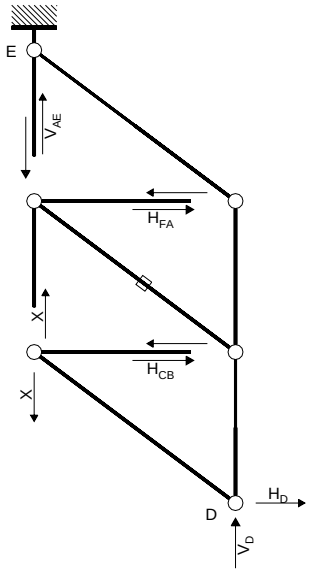
N_{EA} = N_{AF} = N_{EF} = N_{FC} =

N_{AC} =

SPOSTAMENTI NODALI

u_A = u_B = u_C = u_D = u_E =
v_A = v_B = v_C = v_D = v_E =

u_F =
v_F =



EQUAZIONI DI EQUILIBRIO

Rotazione intorno a E: aste EF FC CD CA AB DB AF BC

$9H_Db + 4V_Db = 0$

Rotazione intorno a F: aste FC CD CA AB DB AF BC

$6H_Db + 4V_{AE}b = 0$

Rotazione intorno a C: aste CD DB BC

$3H_Db = -4Xb$

Rotazione intorno a C: aste CA AB AF

$4V_{AE}b - 3H_{FA}b = 4Xb$

Rotazione intorno a D: aste DB BC

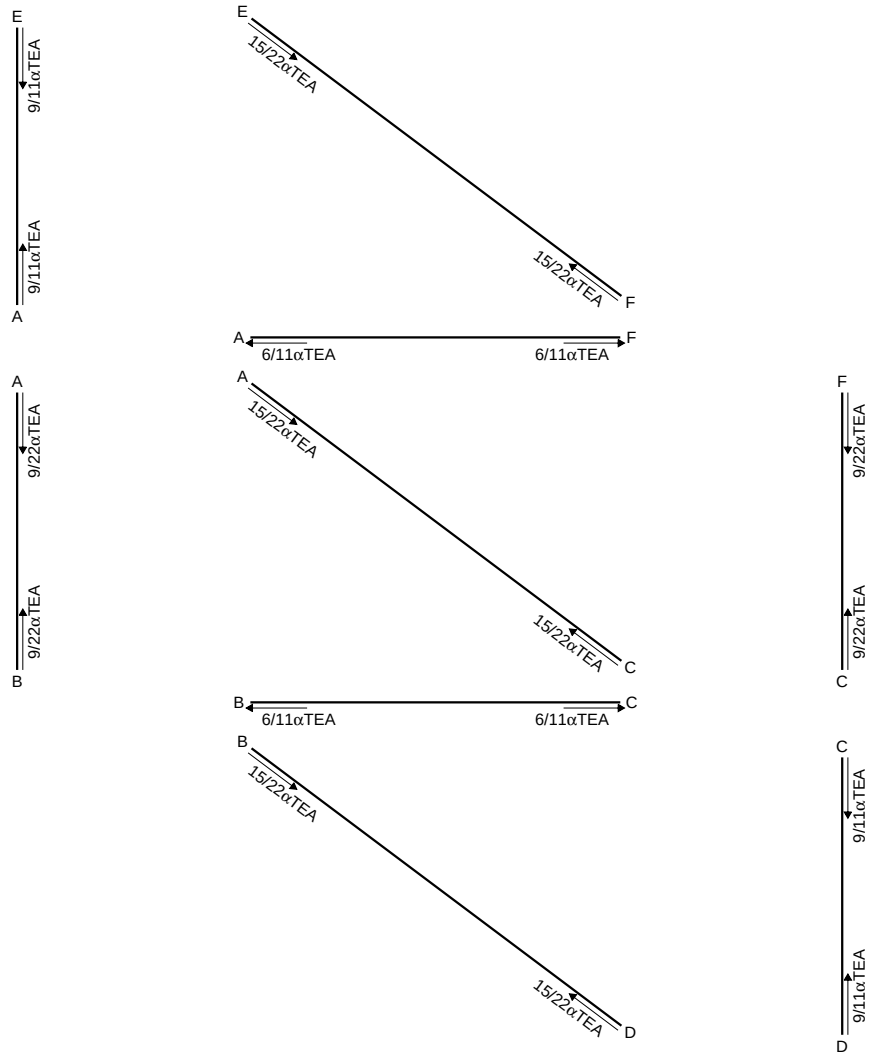
$-3H_{CB}b = -4Xb$

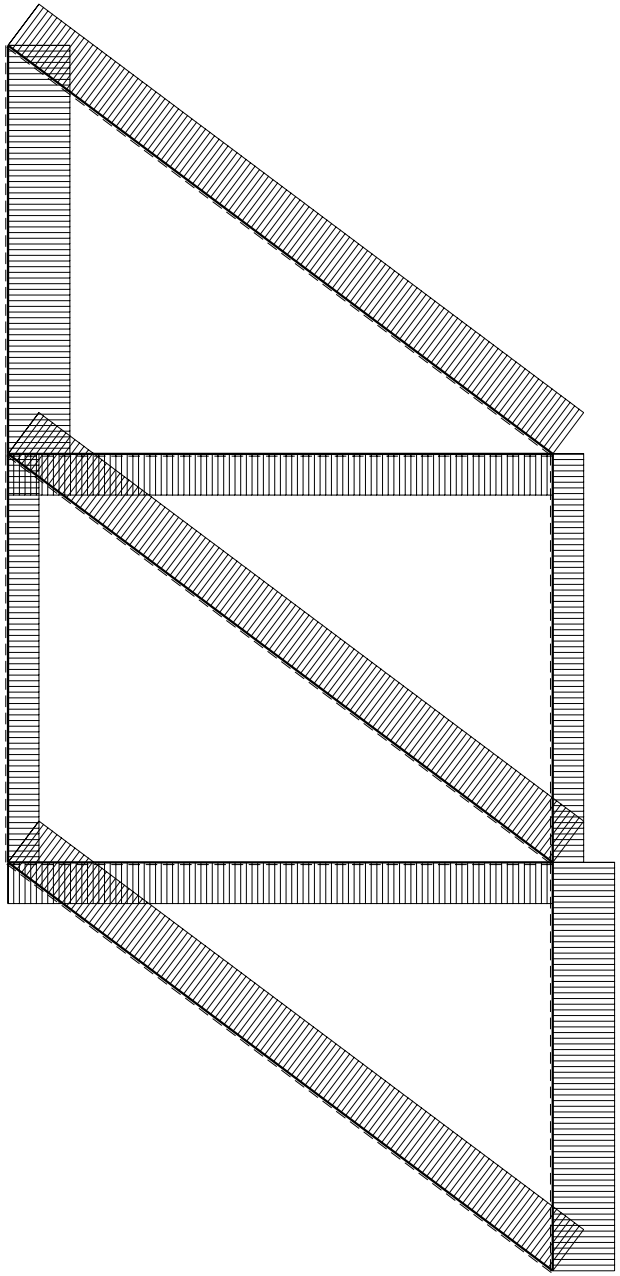
Matrice di equilibrio

	H_Db	V_Db	$H_{CB}b$	$V_{AE}b$	$H_{FA}b$		Xb
φ_{EF}	9	4	0	0	0		0
φ_{FC}	6	0	0	4	0		0
φ_{CD}	3	0	0	0	0	=	-4
φ_{CA}	0	0	0	4	-3		4
φ_{DB}	0	0	-3	0	0		-4

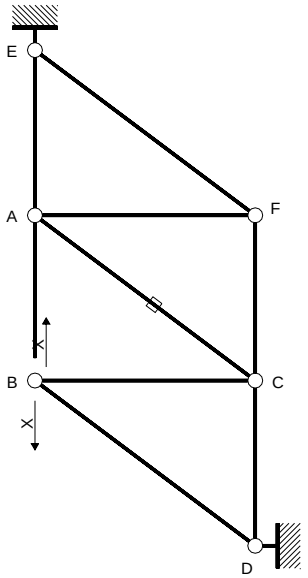
Soluzione del sistema

		Xb
H_Db		-4/3
V_Db		3
$V_{AE}b$	=	2
$H_{FA}b$		4/3
$H_{CB}b$		4/3





1 αTEA



REAZIONI IPERSTATICHE

$X = V_{BA}$

CALCOLO DELLE REAZIONI IPERSTATICHE

$L^{XX}_{AB} = N^{X}_{AB}\ N^{X}_{AB}\ l_{AB}/EA_{AB} = -1\ (-1)\ 3\ 1/3\ Fb/EA = Fb/EA$

$L^{XX}_{BC} = N^{X}_{BC}\ N^{X}_{BC}\ l_{BC}/EA_{BC} = 4/3\ 4/3\ 4\ 1/4\ Fb/EA = 16/9\ Fb/EA$

$L^{XX}_{CD} = N^{X}_{CD}\ N^{X}_{CD}\ l_{CD}/EA_{CD} = -2\ (-2)\ 3\ 1/4\ Fb/EA = 3\ Fb/EA$

$L^{XX}_{BD} = N^{X}_{BD}\ N^{X}_{BD}\ l_{BD}/EA_{BD} = -5/3\ (-5/3)\ 5\ 1/5\ Fb/EA = 25/9\ Fb/EA$

$L^{XX}_{EA} = N^{X}_{EA}\ N^{X}_{EA}\ l_{EA}/EA_{EA} = -2\ (-2)\ 3\ 1\ Fb/EA = 12\ Fb/EA$

$L^{XX}_{AF} = N^{X}_{AF}\ N^{X}_{AF}\ l_{AF}/EA_{AF} = 4/3\ 4/3\ 4\ 1\ Fb/EA = 64/9\ Fb/EA$

$L^{XX}_{EF} = N^{X}_{EF}\ N^{X}_{EF}\ l_{EF}/EA_{EF} = -5/3\ (-5/3)\ 5\ 1/2\ Fb/EA = 125/18\ Fb/EA$

$L^{XX}_{FC} = N^{X}_{FC}\ N^{X}_{FC}\ l_{FC}/EA_{FC} = -1\ (-1)\ 3\ 1/2\ Fb/EA = 3/2\ Fb/EA$

$L^{XX}_{AC} = N^{X}_{AC}\ N^{X}_{AC}\ l_{AC}/EA_{AC} + N^{X}_{AC}\ \varepsilon_{AC}\ l_{AC} = -5/3\ (-5/3)\ 5\ 1/3\ Fb/EA - 5/3\ 2\ 5\ Fb/EA = 125/27\ Fb/EA$

$L^{Xo}_{AC} = N^{X}_{AC} N^{o}_{AC} l_{AC}/EA_{AC} + N^{X}_{AC} \varepsilon_{AC} l_{AC} = - 5/3 - 5/3 \ 2 \ 5 \ Fb/EA = -50/3 \ Fb/EA$

Contributi nulli elementi
$L^{Xo}_{AB} \ L^{Xo}_{BC} \ L^{Xo}_{CD} \ L^{Xo}_{BD} \ L^{Xo}_{EA} \ L^{Xo}_{AF} \ L^{Xo}_{EF} \ L^{Xo}_{FC}$

Contributi nulli nodi vincolati
$L^{XX}_{D} \ L^{XX}_{E} \ L^{Xo}_{D} \ L^{Xo}_{E}$

Espressione risolvente
$\left(L^{XX}_{AB} + L^{XX}_{BC} + L^{XX}_{CD} + L^{XX}_{BD} + L^{XX}_{EA} + L^{XX}_{AF} + L^{XX}_{EF} + L^{XX}_{FC} + L^{XX}_{AC} \right) X = - \left(L^{Xo}_{AC} \right)$

$\left(1 + 16/9 + 3 + 25/9 + 12 + 64/9 + 125/18 + 3/2 + 125/27 \right) X = \left(50/3 \right) F$

$1100/27 \ X = 50/3 \ F$

Soluzione
$X = 9/22 \ F$

REAZIONI
$H_D = -6/11\alpha TEA \quad V_D = 27/22\alpha TEA \quad H_E = 6/11\alpha TEA \quad V_E = -27/22\alpha TEA$

$N_{AB} = -9/22\alpha TEA \quad N_{BC} = 6/11\alpha TEA \quad N_{CD} = -9/11\alpha TEA \quad N_{BD} = -15/22\alpha TEA$

$N_{EA} = -9/11\alpha TEA \quad N_{AF} = 6/11\alpha TEA \quad N_{EF} = -15/22\alpha TEA \quad N_{FC} = -9/22\alpha TEA$

$N_{AC} = -15/22\alpha TEA$

SPOSTAMENTI NODALI

$u_A = -921/176\alpha Tb \quad u_B = 3\alpha Tb \quad u_C = 39/11\alpha Tb \quad u_D = 0 \quad u_E = 0$
$v_A = 27/11\alpha Tb \quad v_B = 63/22\alpha Tb \quad v_C = -27/44\alpha Tb \quad v_D = 0 \quad v_E = 0$

$u_F = -537/176\alpha Tb$
$v_F = -27/22\alpha Tb$

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