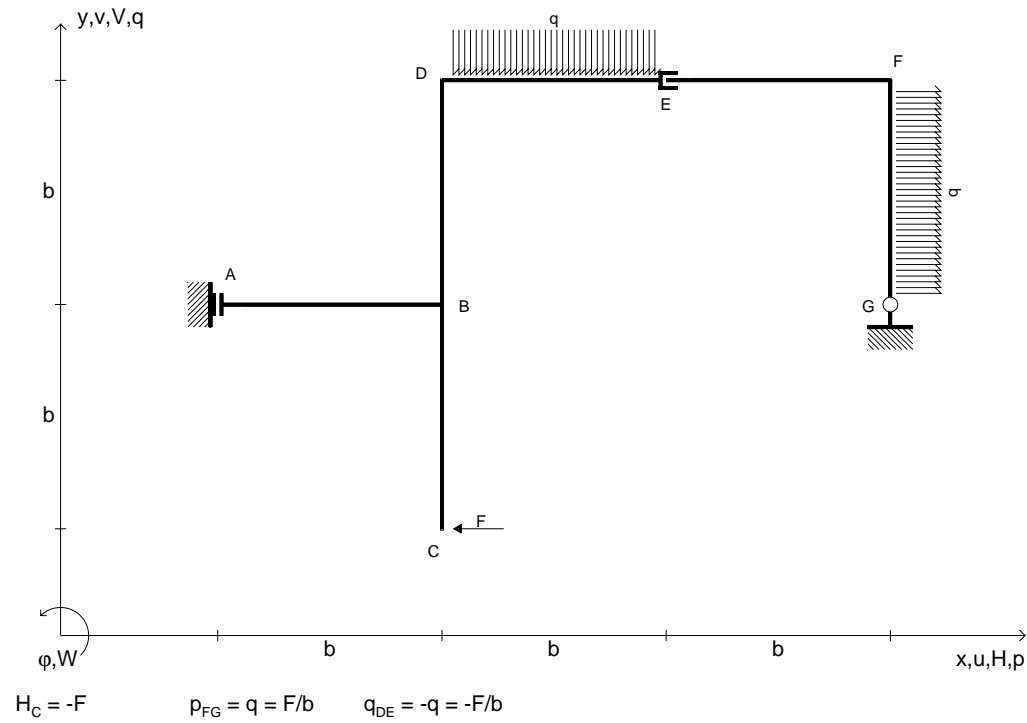


Carichi e deformazioni date hanno verso efficace in disegno.
Calcolare reazioni vincolari della struttura e delle aste.
Tracciare i diagrammi delle azioni interne nelle aste.
@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.30.11.06



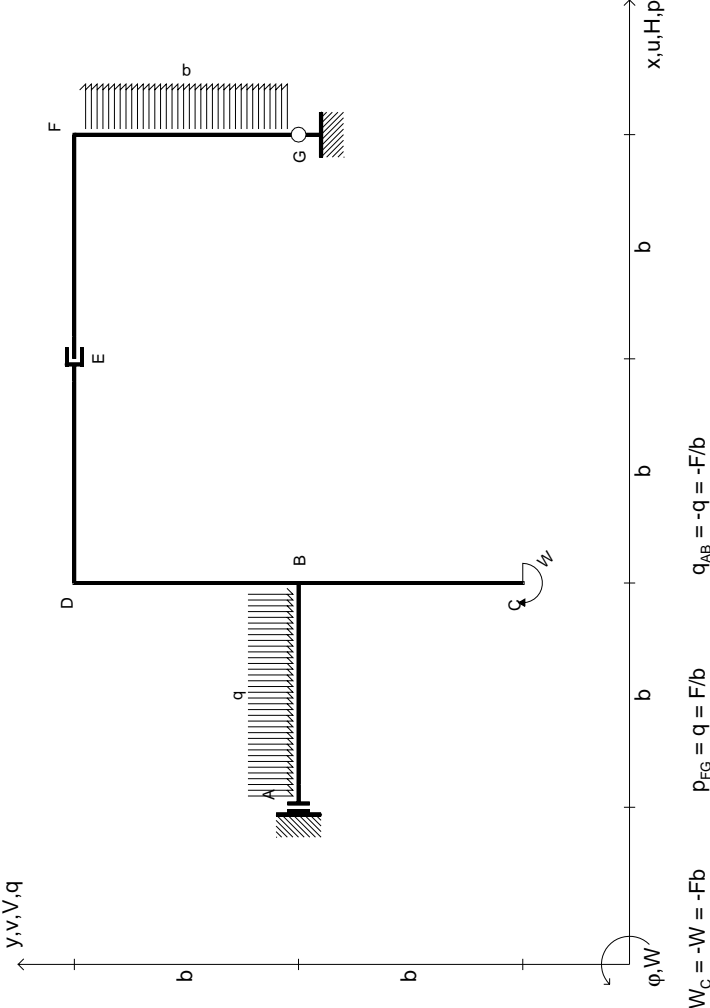
Carichi e deformazioni date hanno verso efficace in disegno.

Calcolare reazioni vincolari della struttura e delle aste.

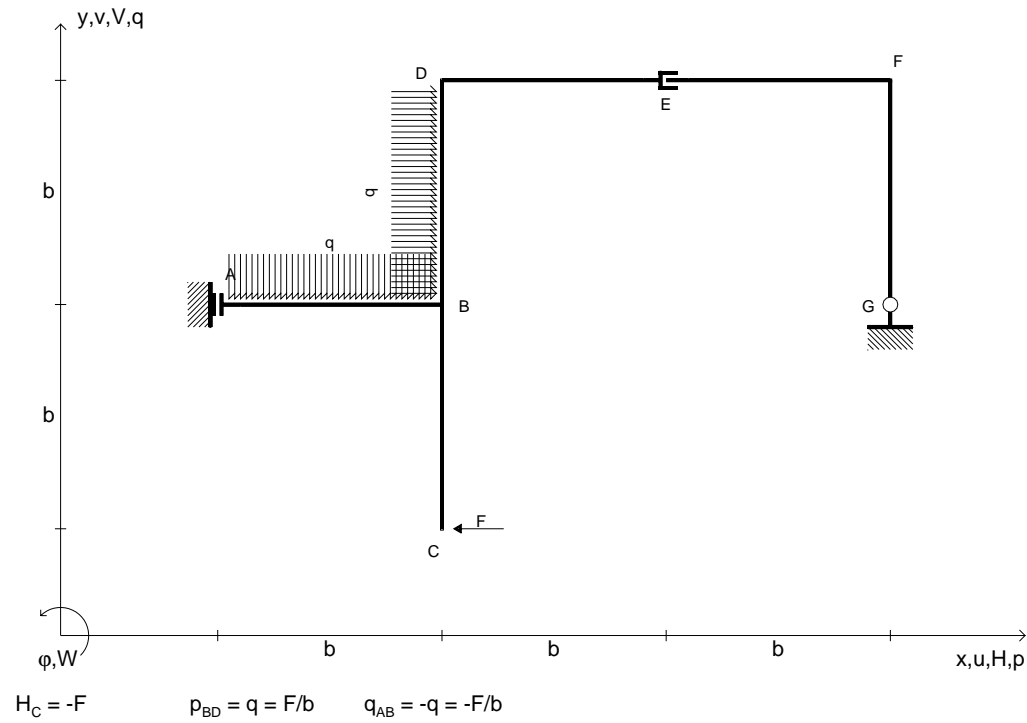
Tracciare i diagrammi delle azioni interne nelle aste.

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.30.11.06

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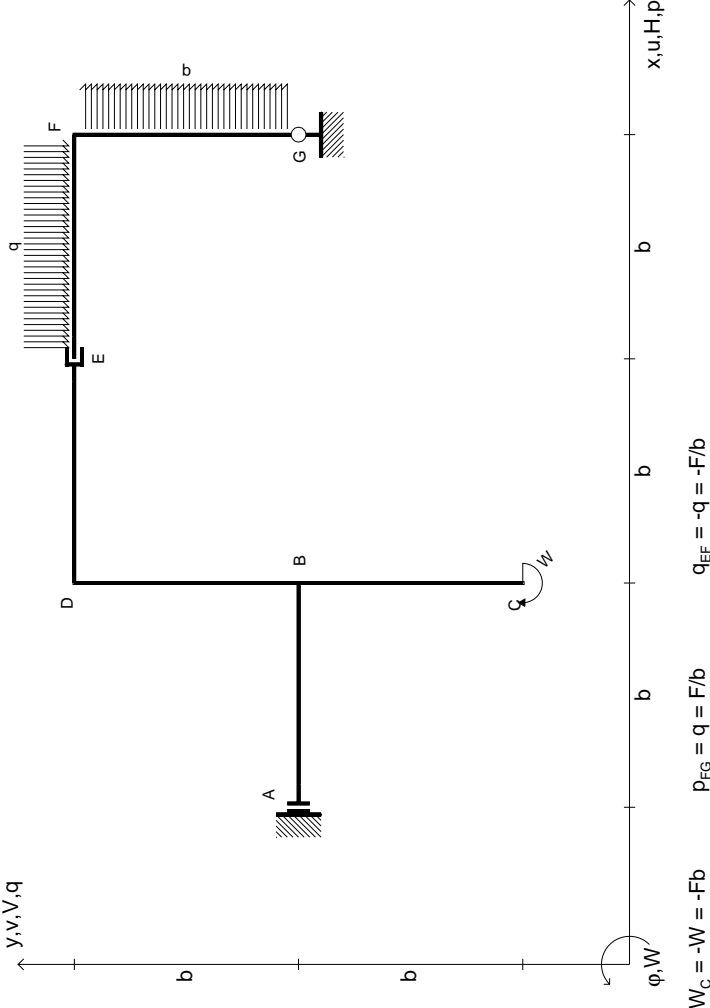
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Calcolare reazioni vincolari della struttura e delle aste.

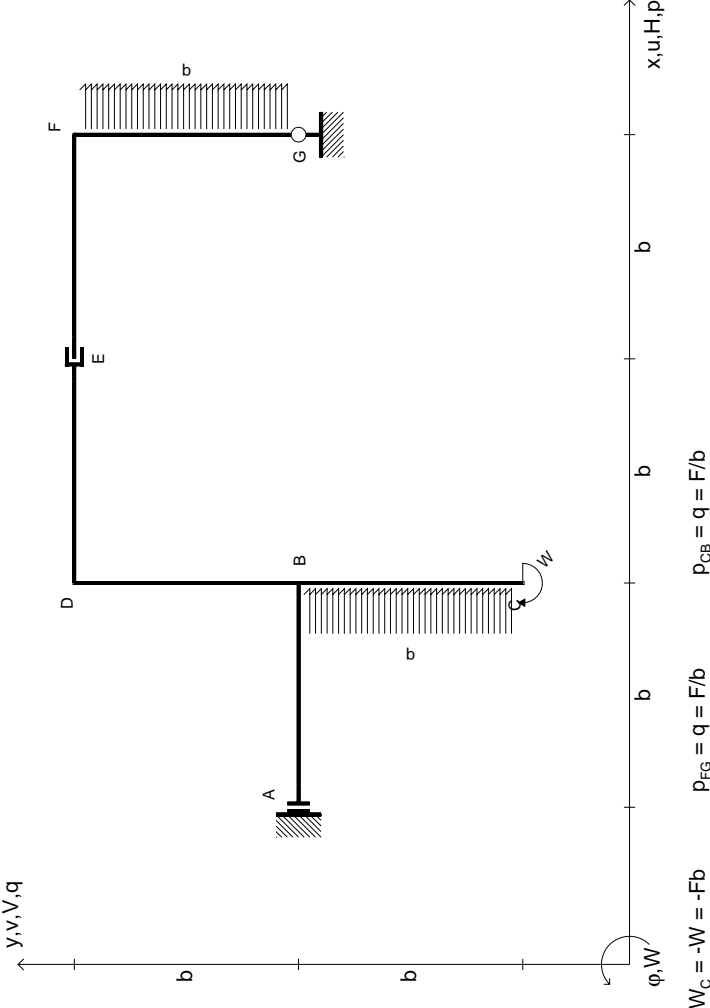
Tracciare i diagrammi delle azioni interne nelle aste.

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.30.11.06

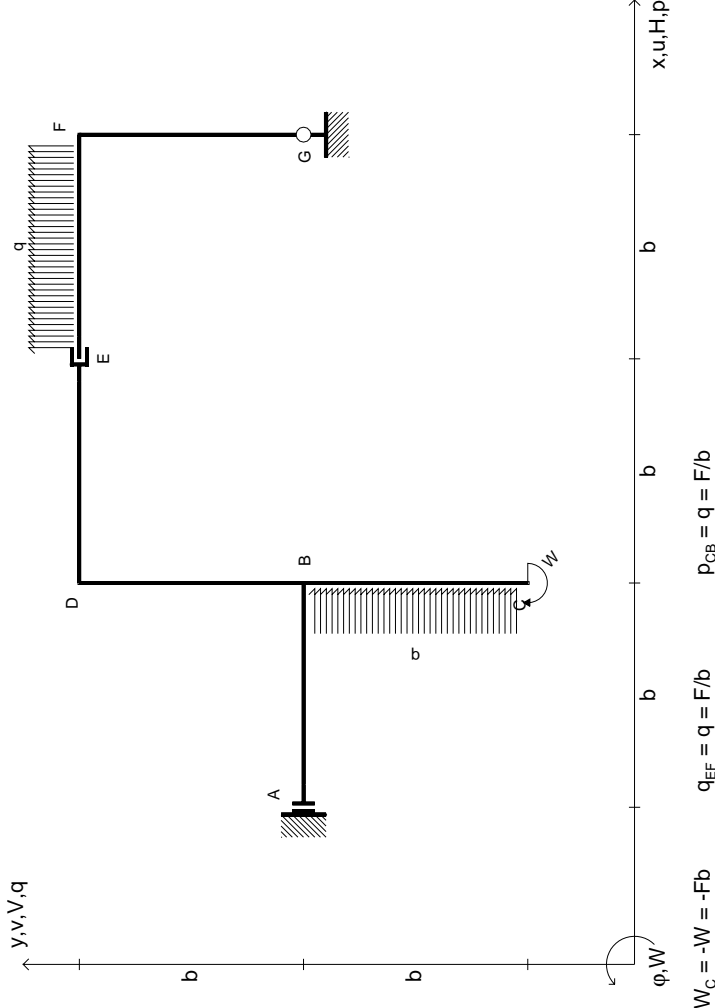
@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.30.11.06



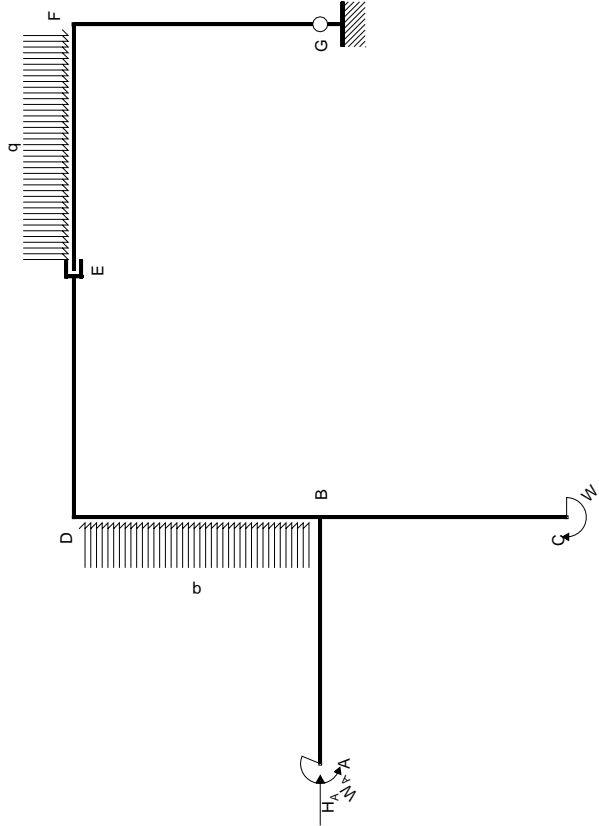
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EQUAZIONI DI EQUILIBRIO
Rotazione globale intorno a G
 $W_A = W$
Traslazione orizzontale: aste ED DB BA BC
 $H_A = -qb$

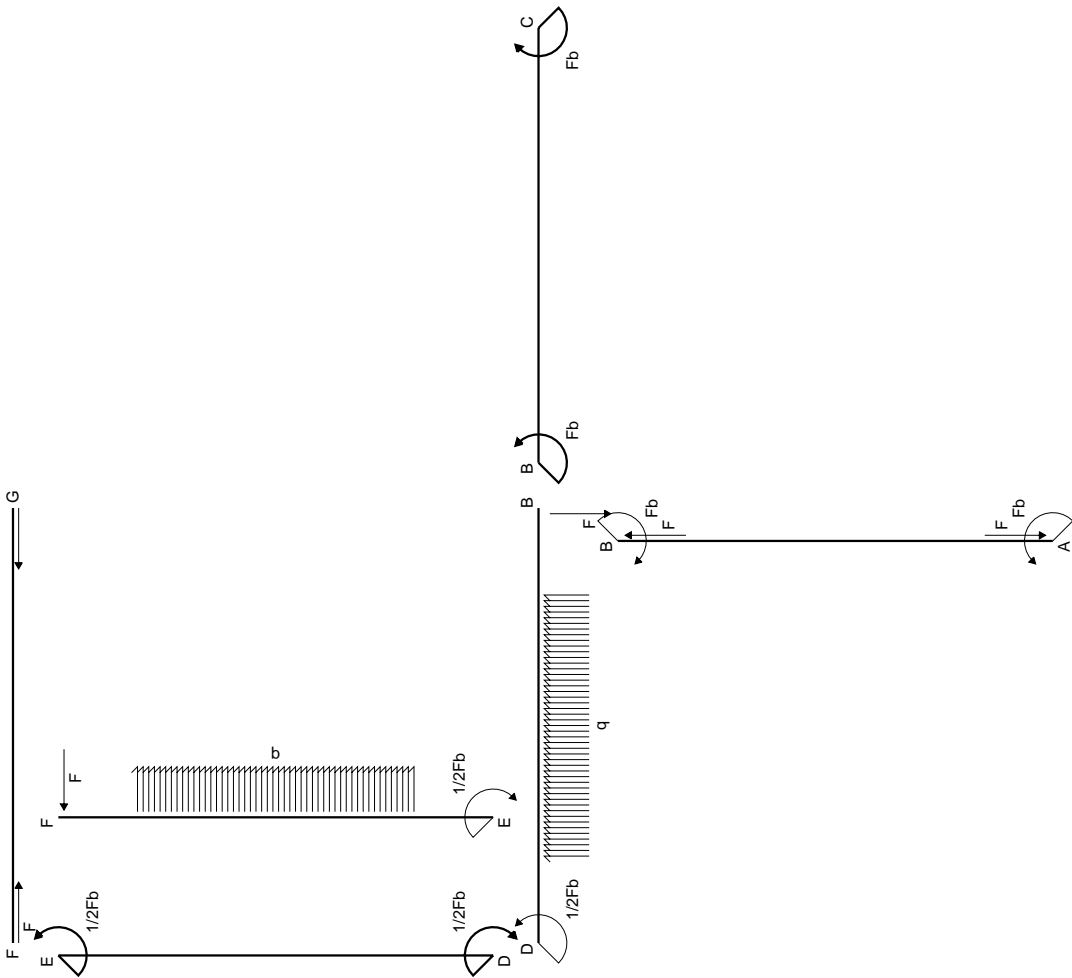
Matrice di equilibrio

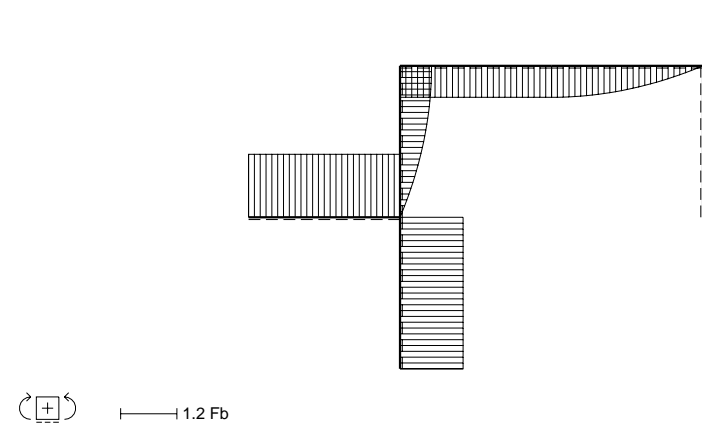
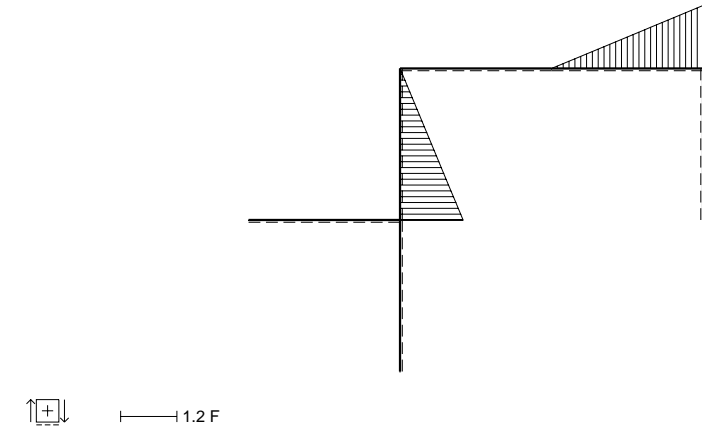
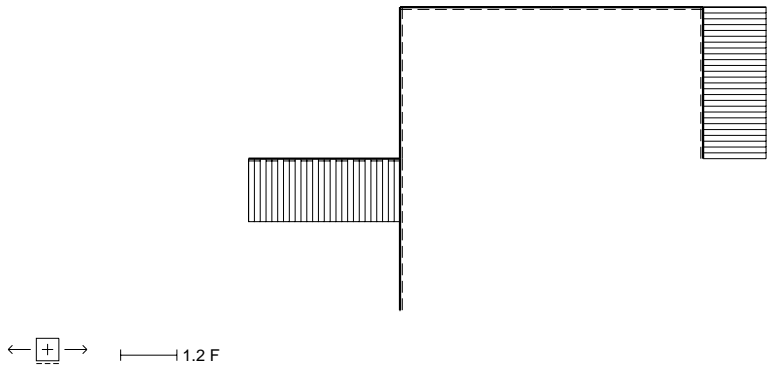
$$\begin{bmatrix} H_A b & W_A \end{bmatrix} \begin{bmatrix} W & qb^2 \\ 1 & 0 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ 1 & 0 \\ 1 & 0 \end{bmatrix}$$

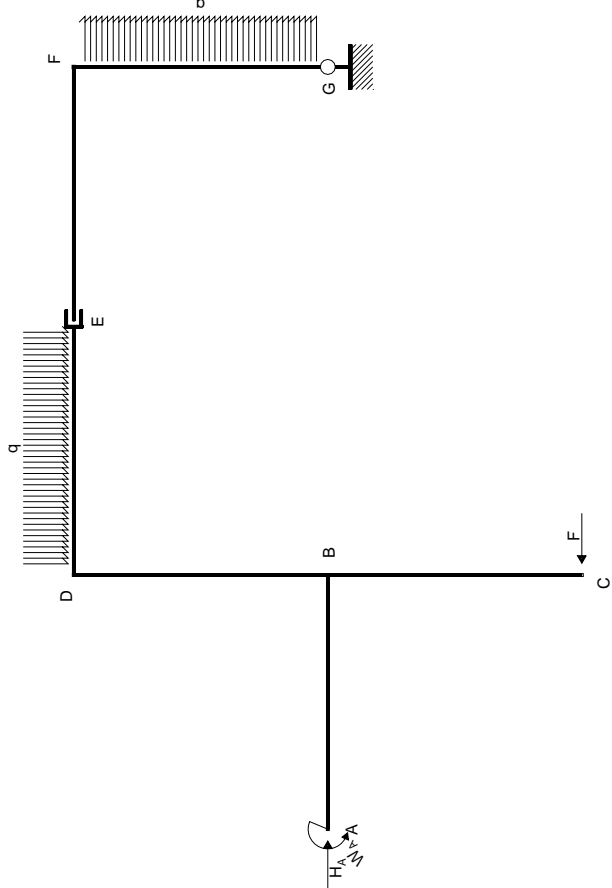
φ_G
 u_{ED}

Soluzione del sistema

$$\begin{bmatrix} W_A \\ H_A b \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix} \begin{bmatrix} W & qb^2 \\ 1 & 0 \end{bmatrix}$$







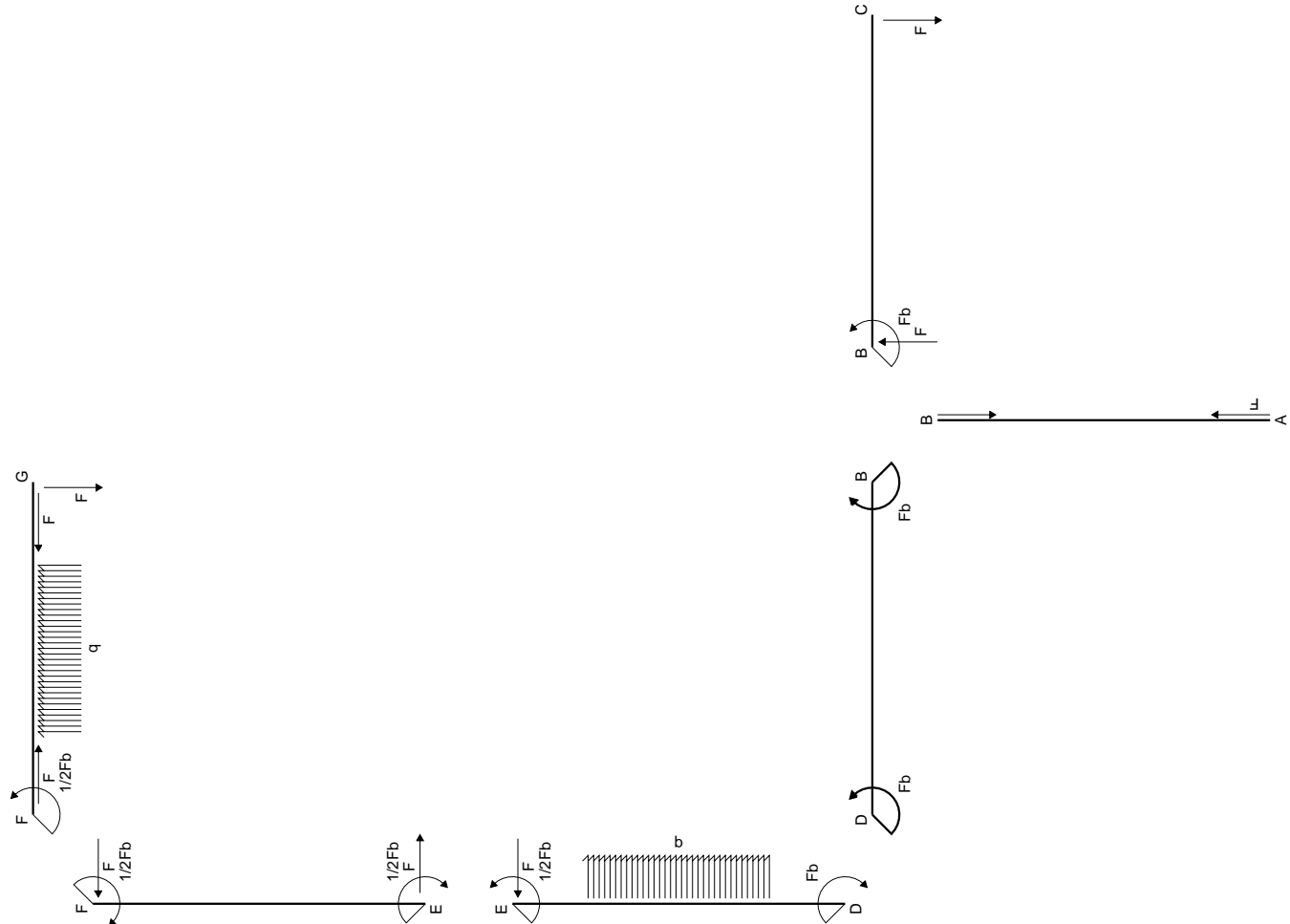
EQUAZIONI DI EQUILIBRIO
Rotazione globale intorno a G
 $W_A = Fb - qb^2$
Traslazione orizzontale: aste ED DB BA BC
 $H_A = F$

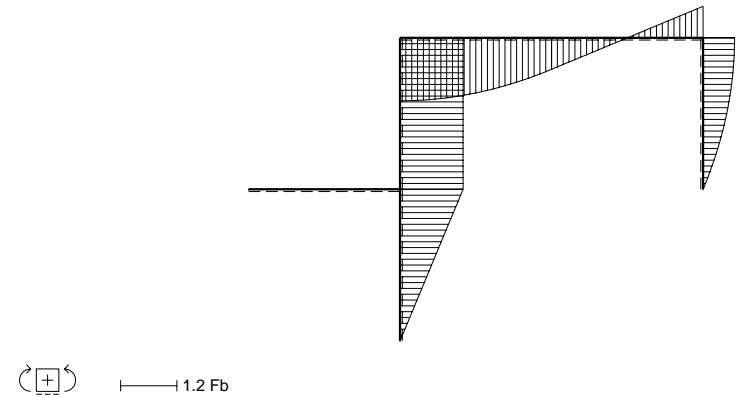
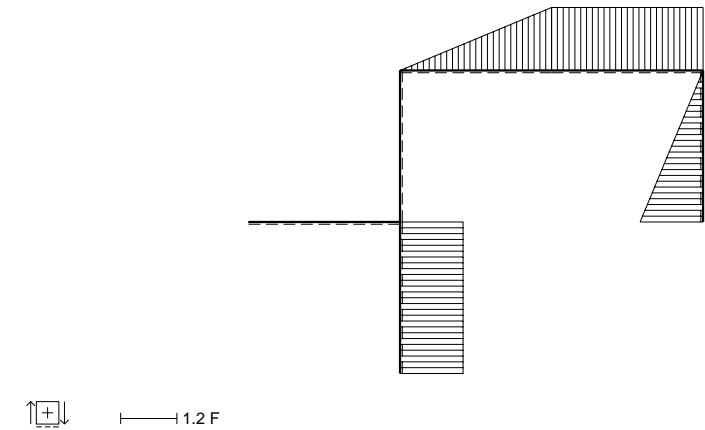
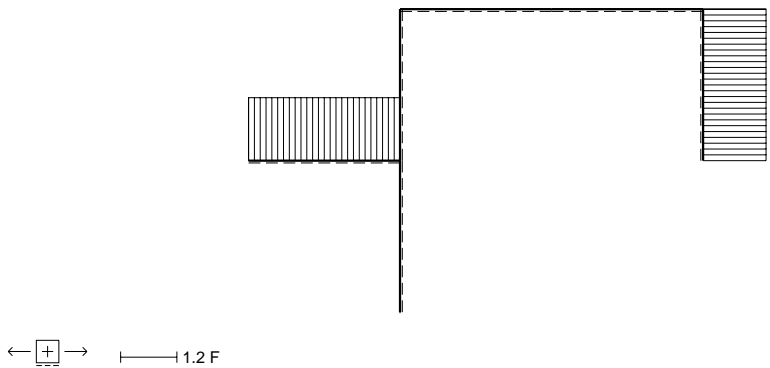
Matrice di equilibrio

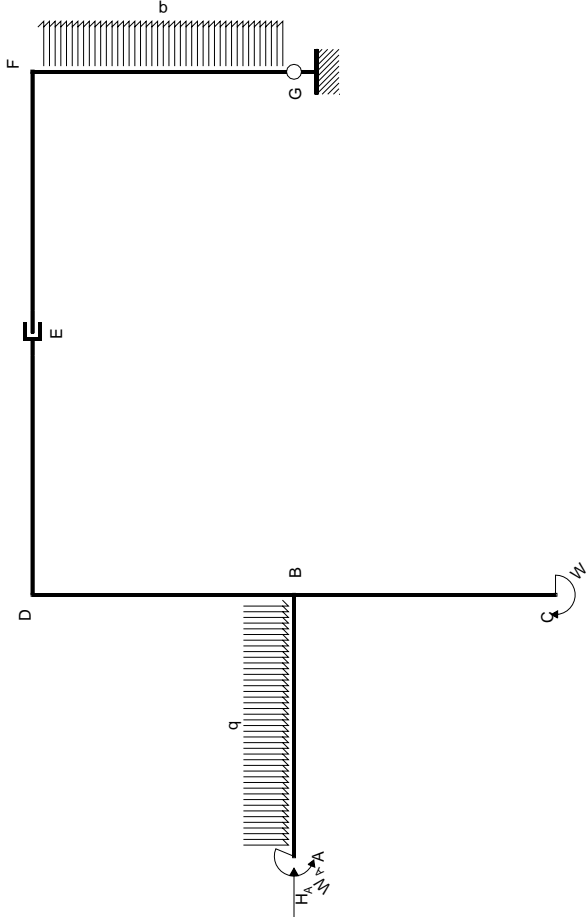
$$\begin{bmatrix} H_A b & W_A \end{bmatrix} \begin{bmatrix} Fb & qb^2 \\ 1 & -1 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 1 & 0 \end{bmatrix}$$

Soluzione del sistema

$$\begin{bmatrix} W_A \\ H_A b \end{bmatrix} = \begin{bmatrix} 1 & -1 \\ 1 & 0 \end{bmatrix}$$







EQUAZIONI DI EQUILIBRIO

Rotazione globale intorno a G

$W_A = W - 2qb^2$

Traslazione orizzontale: aste ED DB BA BC

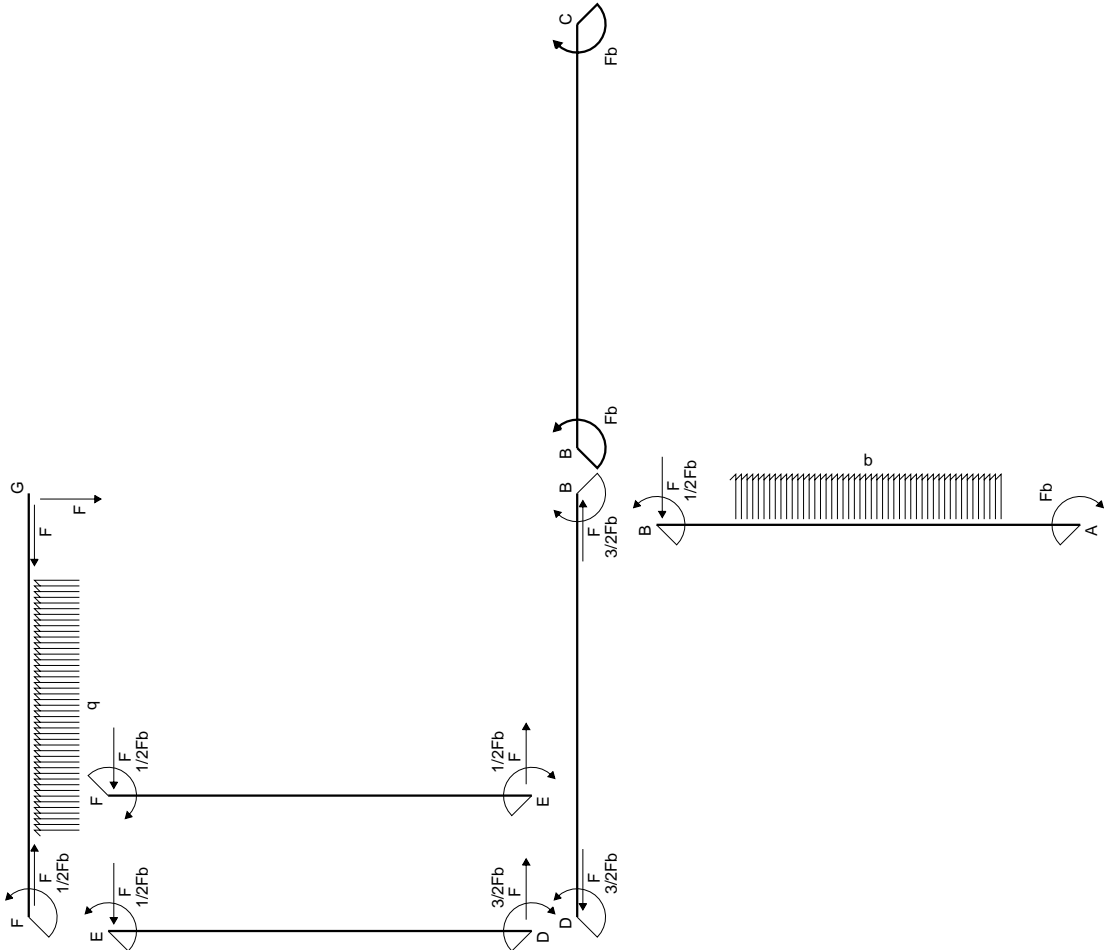
$H_A = 0$

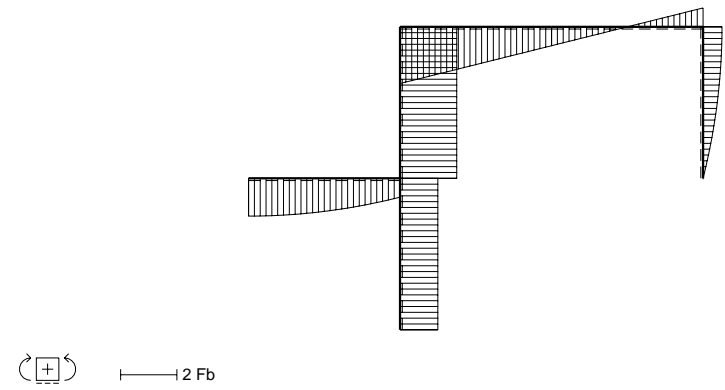
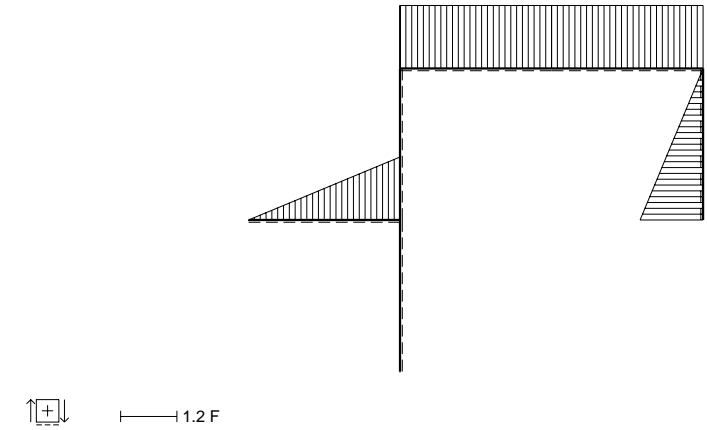
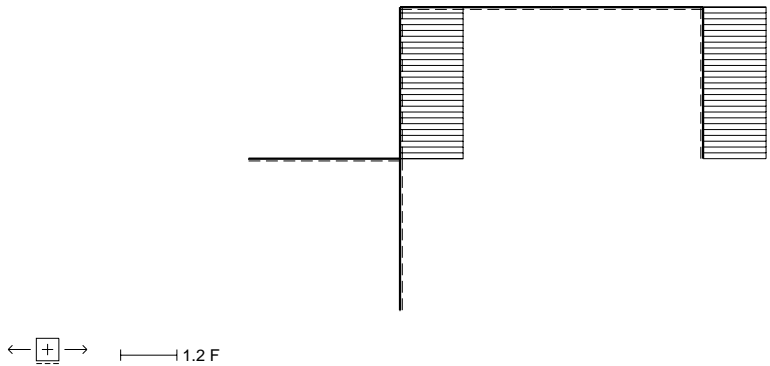
Matrice di equilibrio

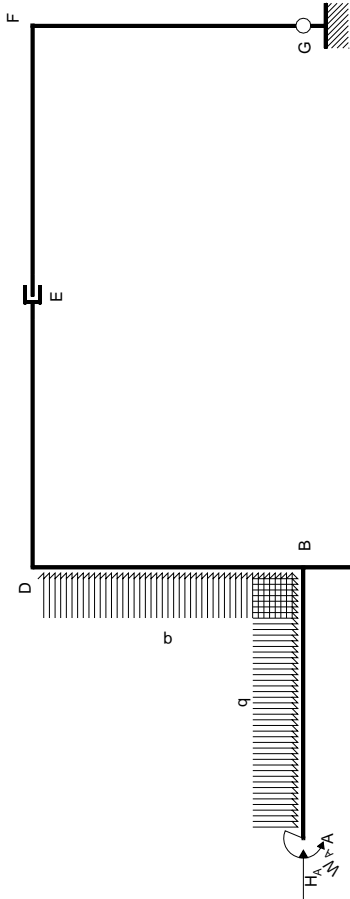
$$\begin{bmatrix} H_A b & W_A \end{bmatrix} \begin{bmatrix} W & qb^2 \\ 1 & -2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$$

Soluzione del sistema

$$\begin{bmatrix} W_A \\ H_A b \end{bmatrix} = \begin{bmatrix} W & qb^2 \\ 1 & -2 \\ 0 & 0 \end{bmatrix}$$







EQUAZIONI DI EQUILIBRIO

Rotazione globale intorno a G

$W_A = Fb - 2qb^2$

Traslazione orizzontale: aste ED DB BA BC

$H_A = F - qb$

Matrice di equilibrio

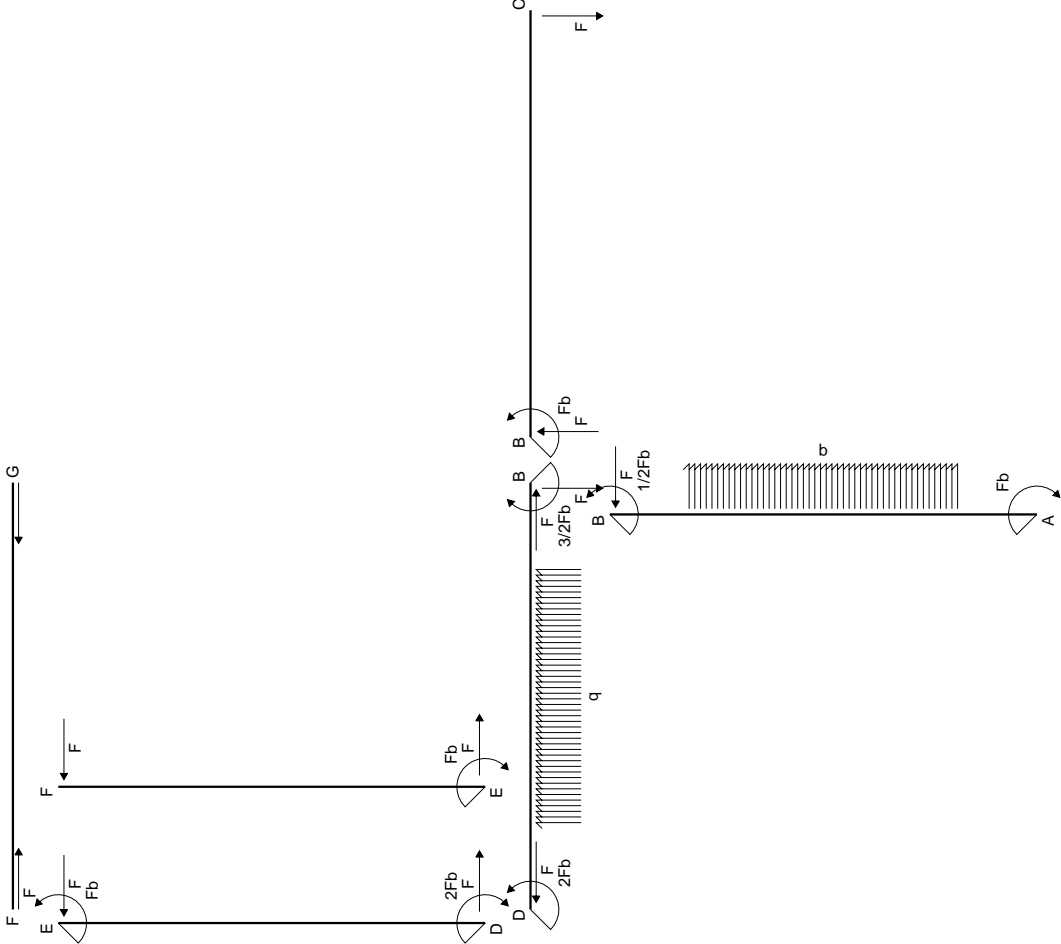
$$\begin{bmatrix} H_A b & W_A \end{bmatrix} \begin{bmatrix} Fb & qb^2 \\ 1 & -2 \\ 1 & -1 \end{bmatrix}$$

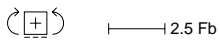
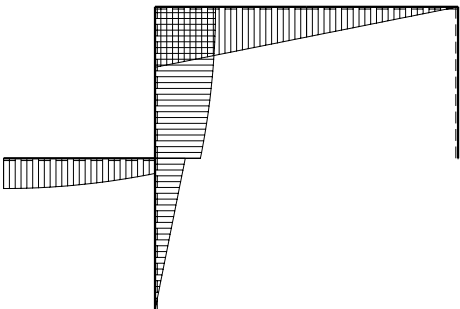
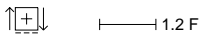
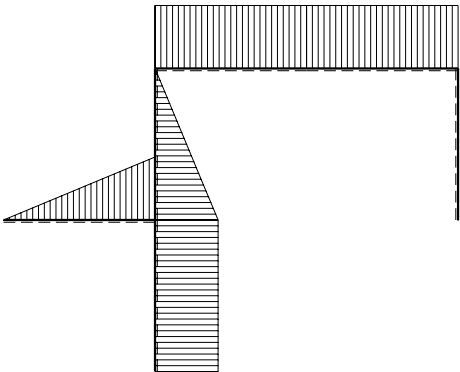
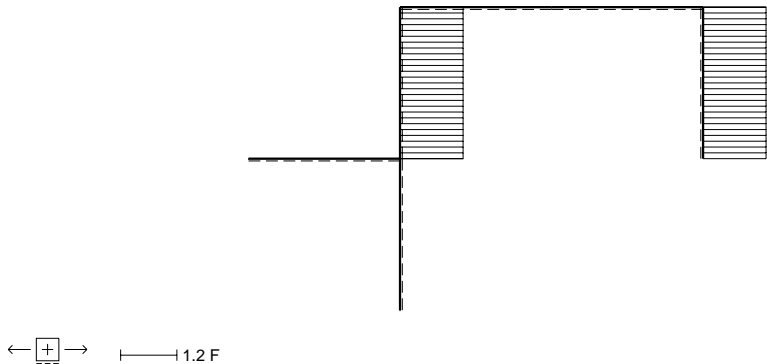
$\varphi_G \begin{bmatrix} 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & -2 \\ 1 & -1 \end{bmatrix}$

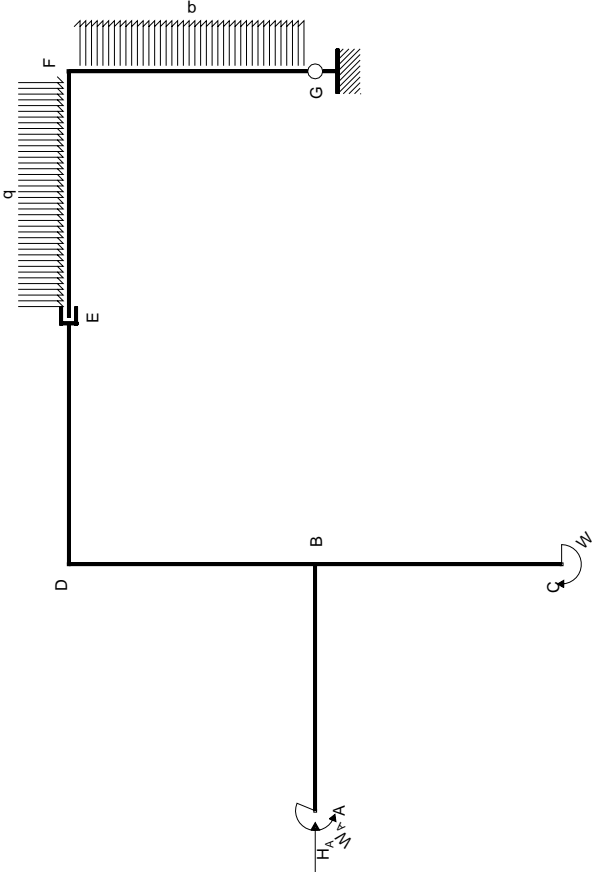
$u_{ED} \begin{bmatrix} 1 & 0 \end{bmatrix} = \begin{bmatrix} 1 & -1 \end{bmatrix}$

Soluzione del sistema

$$\begin{bmatrix} W_A \\ H_A b \end{bmatrix} = \begin{bmatrix} 1 & -2 \\ 1 & -1 \end{bmatrix} \begin{bmatrix} Fb & qb^2 \\ 1 & -2 \\ 1 & -1 \end{bmatrix}$$







EQUAZIONI DI EQUILIBRIO

Rotazione globale intorno a G

$W_A = W$

Traslazione orizzontale: aste ED DB BA BC

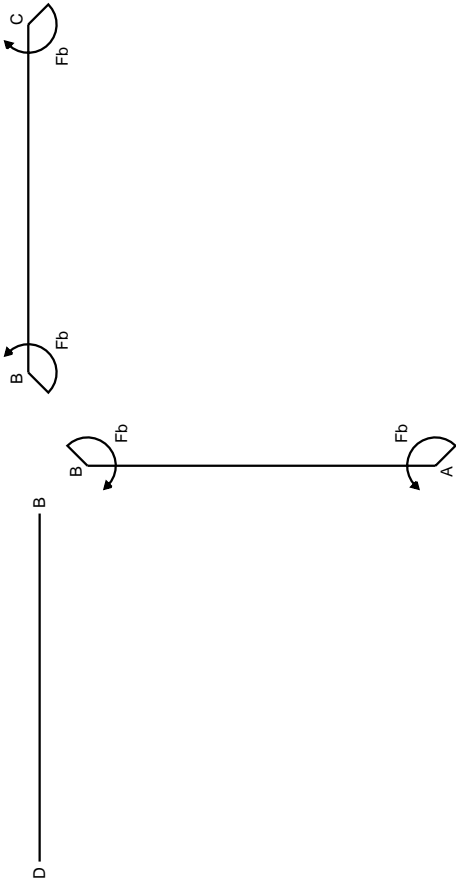
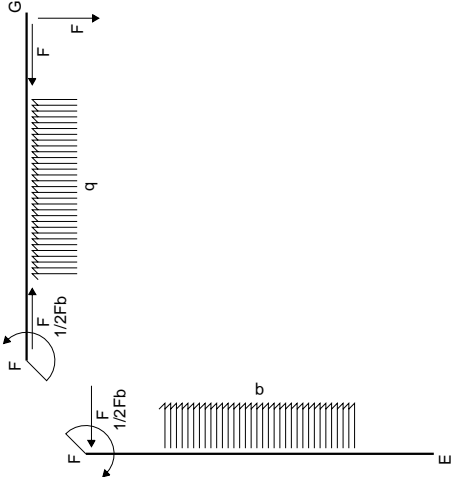
$H_A = 0$

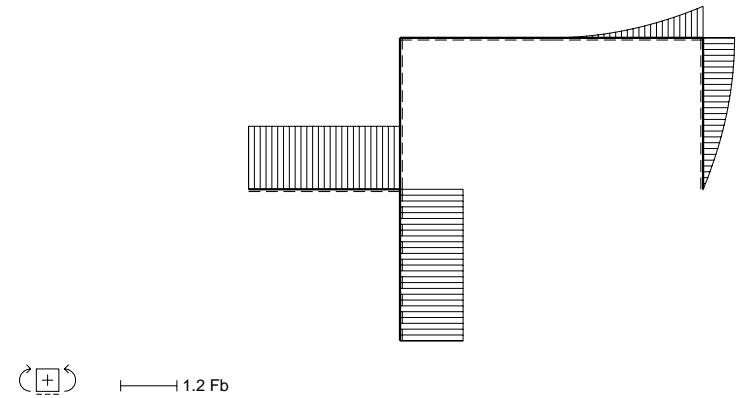
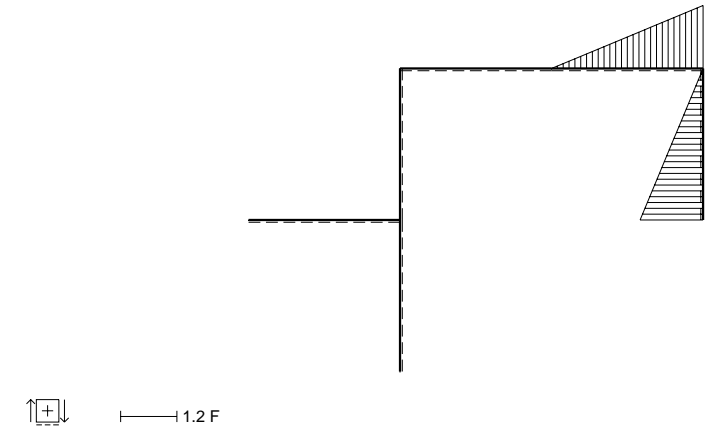
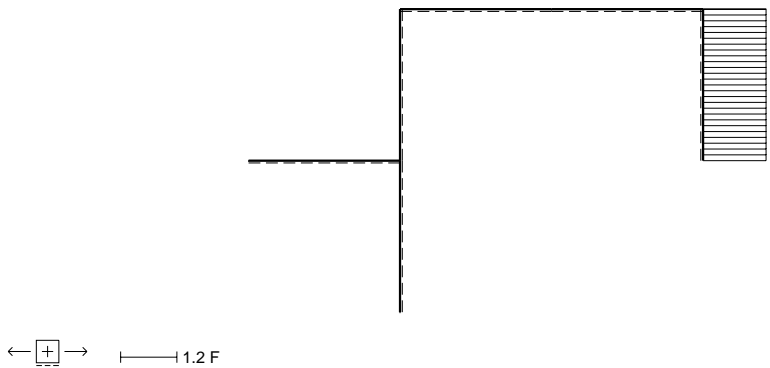
Matrice di equilibrio

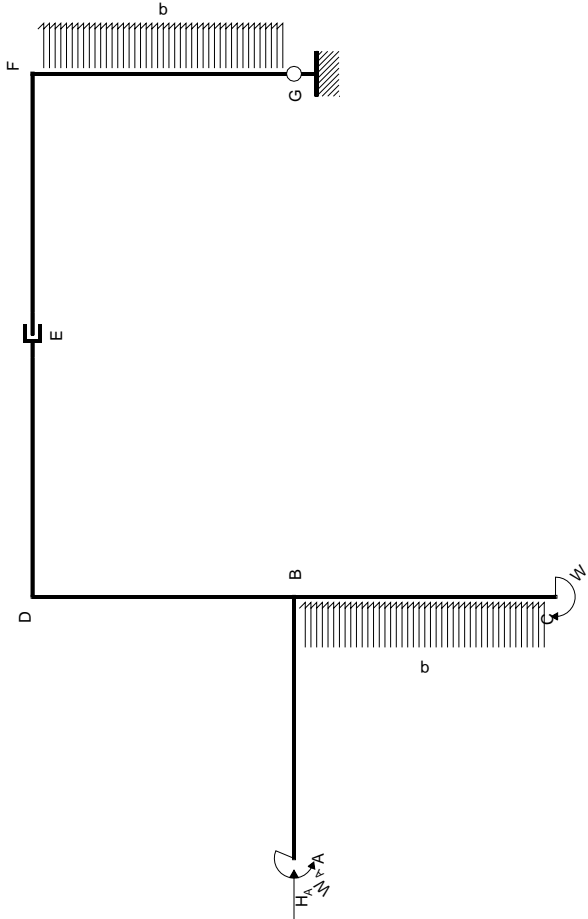
$$\begin{bmatrix} H_A b & W_A \end{bmatrix} \begin{bmatrix} W & qb^2 \\ 1 & 0 \\ 0 & 0 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}$$

Soluzione del sistema

$$\begin{bmatrix} W_A \\ H_A b \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}$$







EQUAZIONI DI EQUILIBRIO

Rotazione globale intorno a G

$W_A = W$

Traslazione orizzontale: aste ED DB BA BC

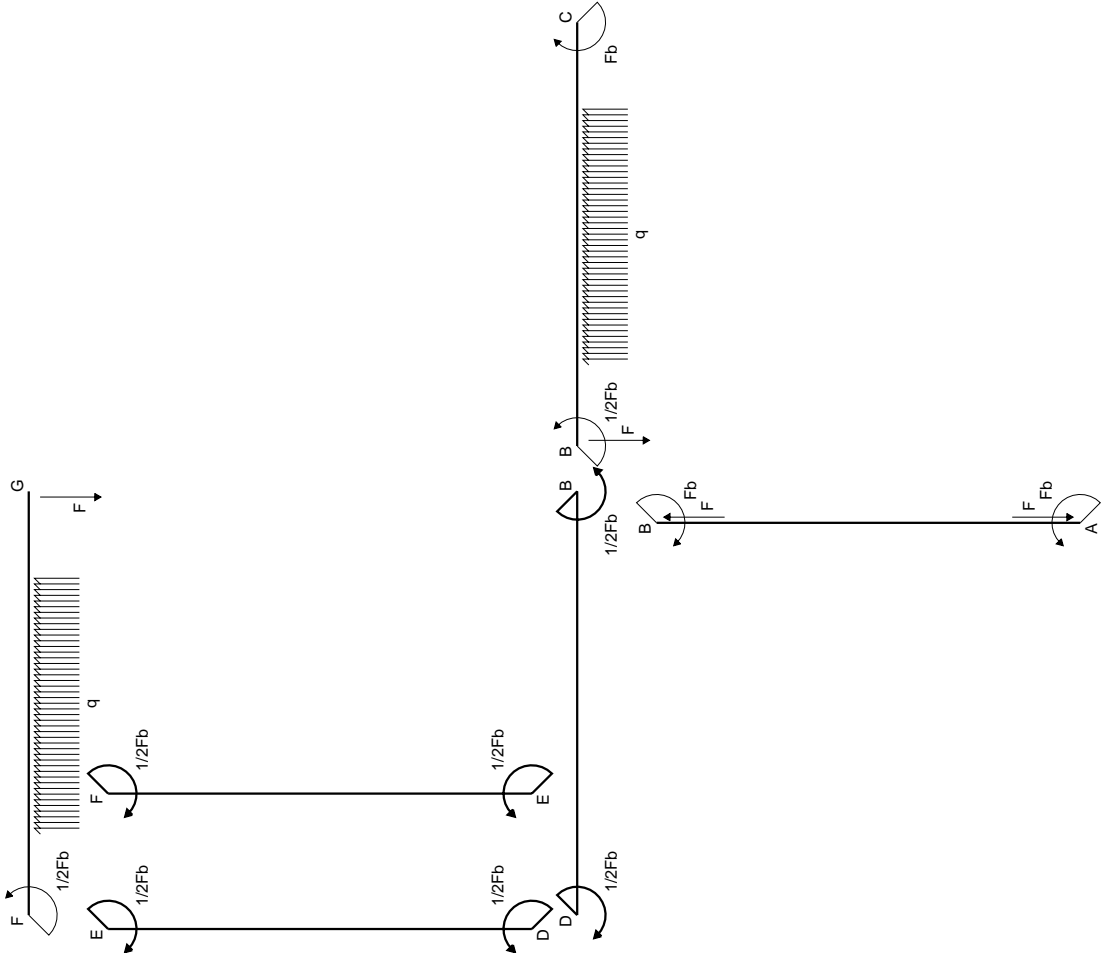
$H_A = -qb$

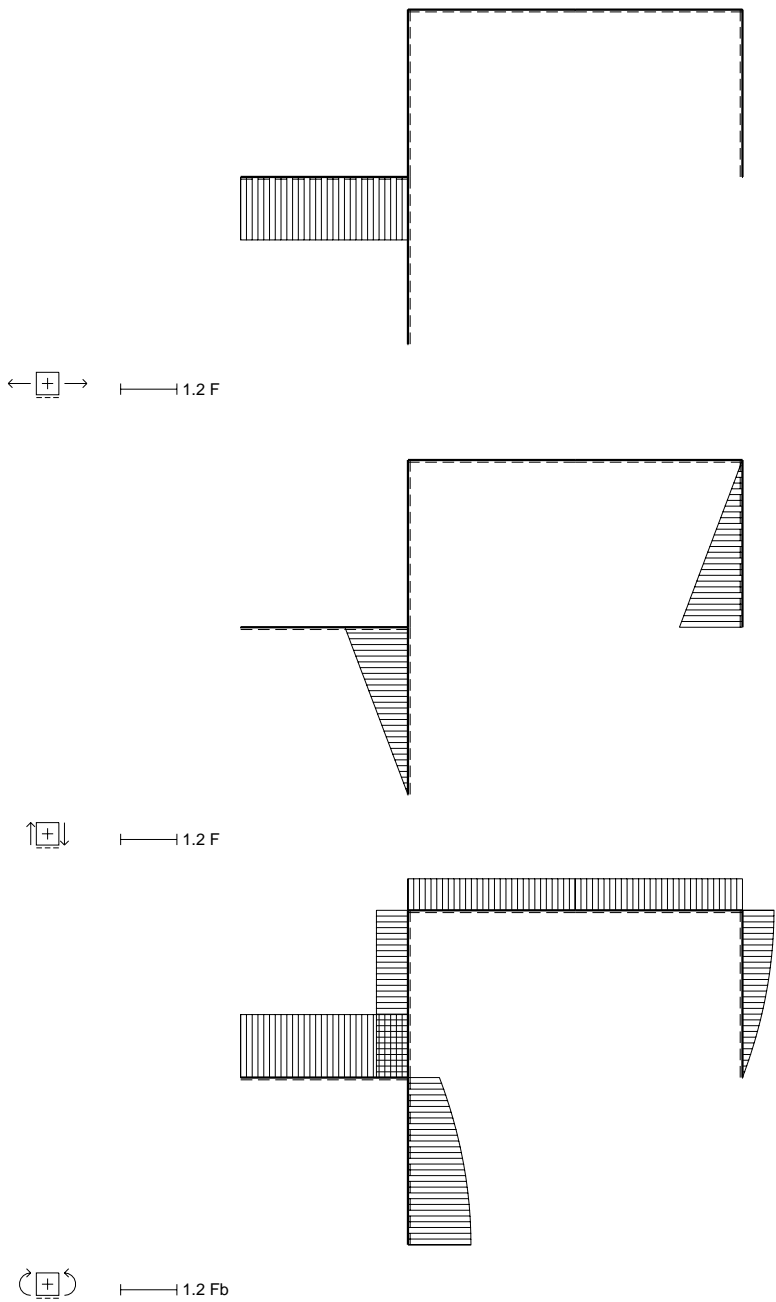
Matrice di equilibrio

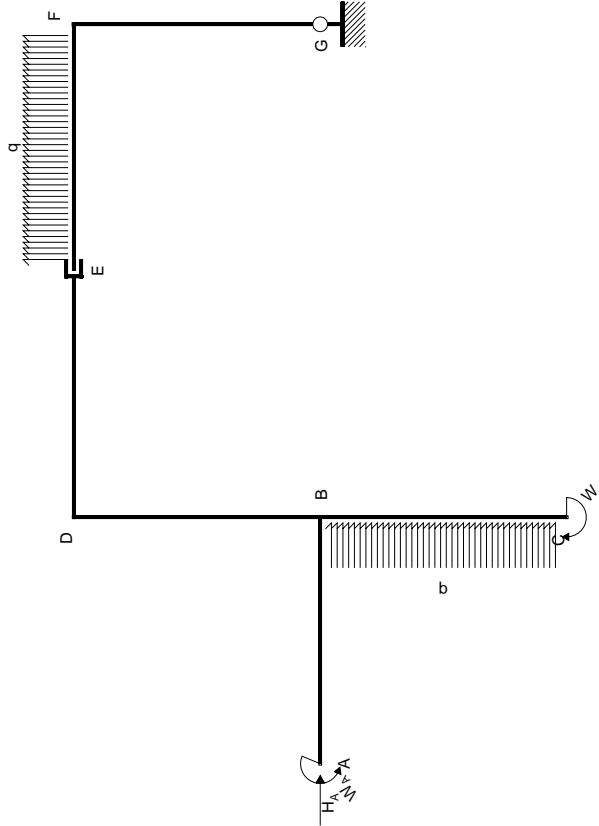
$$\begin{bmatrix} H_A b & W_A \end{bmatrix} \begin{bmatrix} W & qb^2 \\ 1 & 0 \\ 0 & -1 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$$

Soluzione del sistema

$$\begin{bmatrix} W_A \\ H_A b \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix} \begin{bmatrix} W & qb^2 \\ 1 & 0 \end{bmatrix}$$







EQUAZIONI DI EQUILIBRIO
Rotazione globale intorno a G
 $W_A = W$
Traslazione orizzontale: aste ED DB BA BC
 $H_A = -qb$

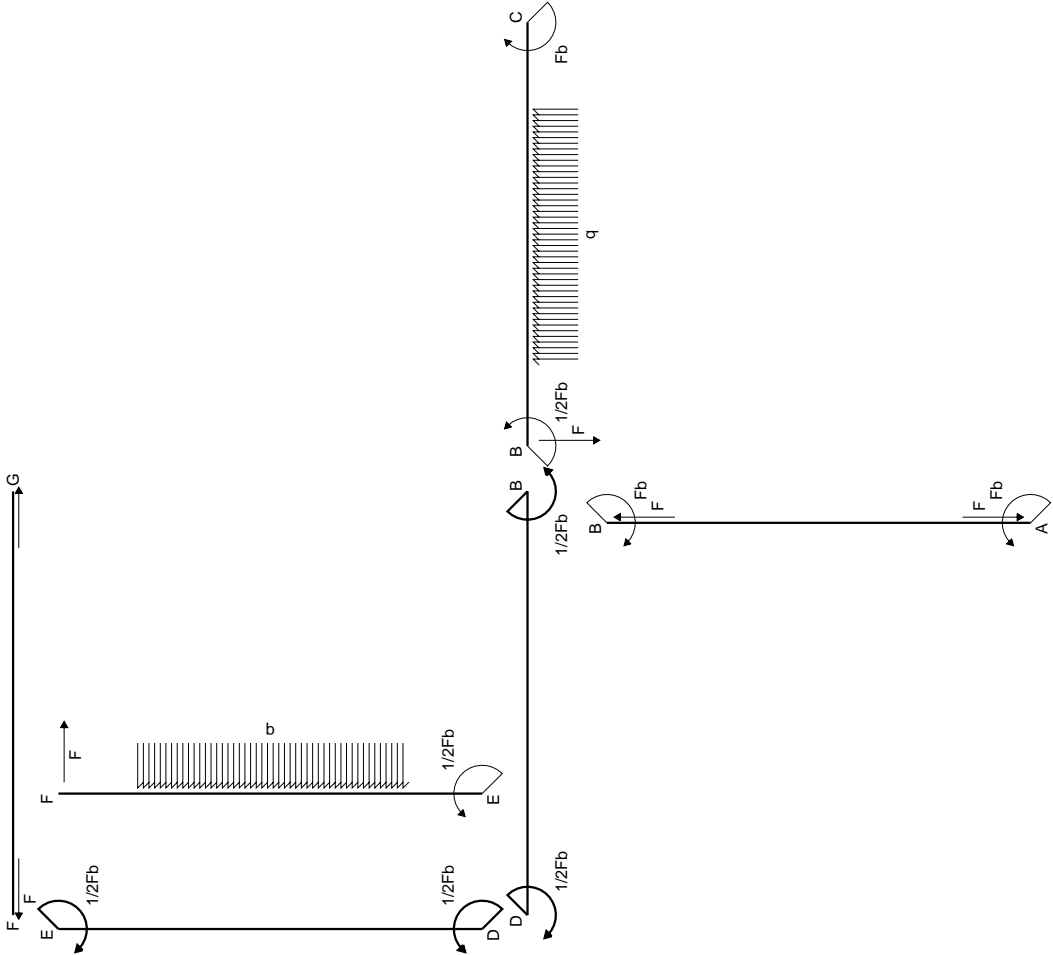
Matrice di equilibrio

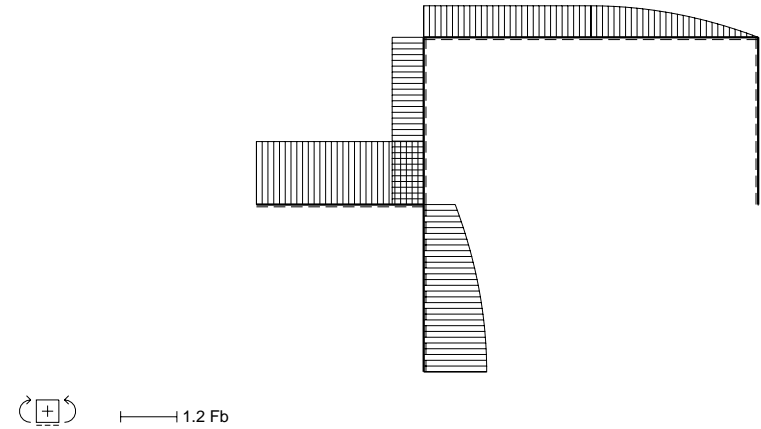
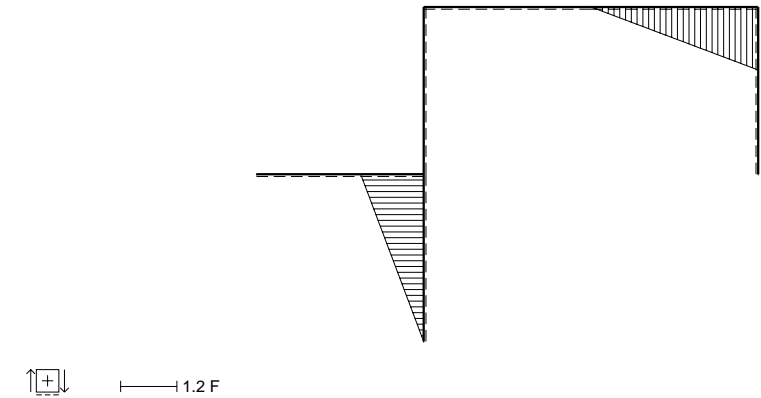
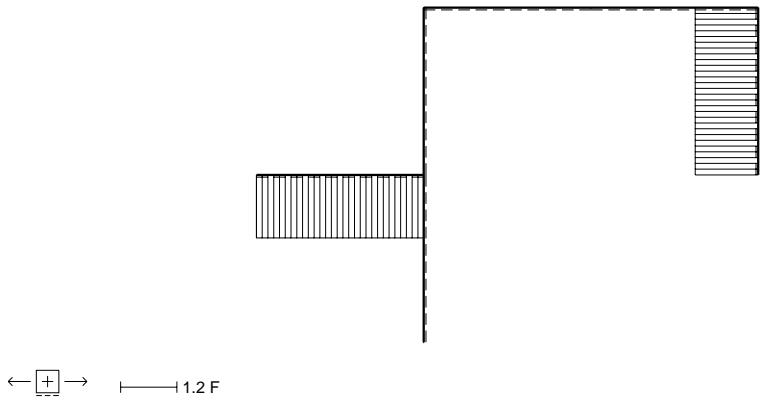
$$\begin{bmatrix} H_A b & W_A \end{bmatrix} \begin{bmatrix} W & qb^2 \\ 1 & 0 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ 1 & 0 \\ 1 & 0 \end{bmatrix}$$

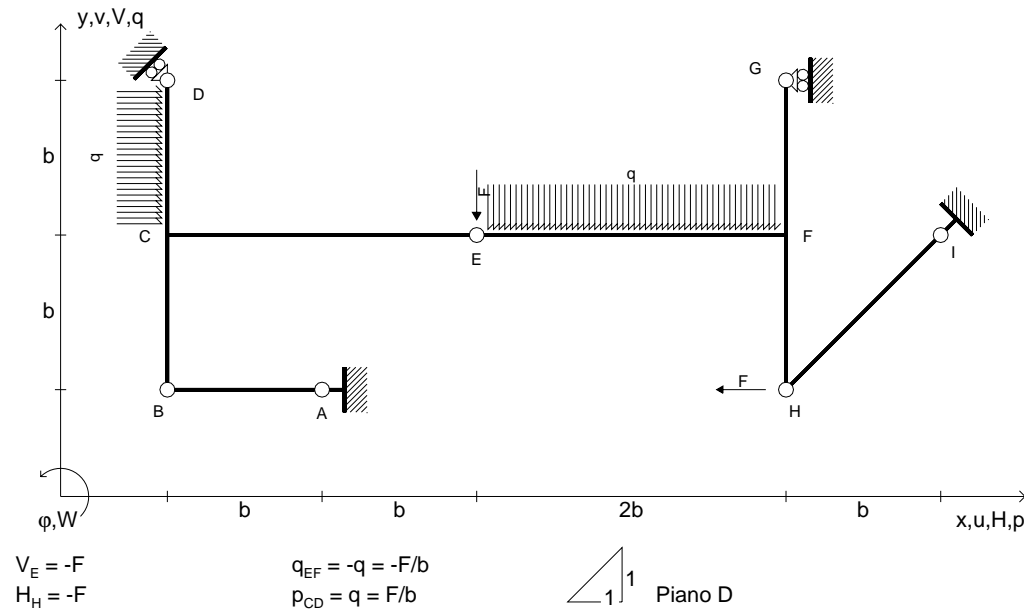
φ_G
 u_{ED}

Soluzione del sistema

$$\begin{bmatrix} W_A \\ H_A b \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix} \begin{bmatrix} W & qb^2 \\ 1 & 0 \end{bmatrix}$$







Carichi e deformazioni date hanno verso efficace in disegno.

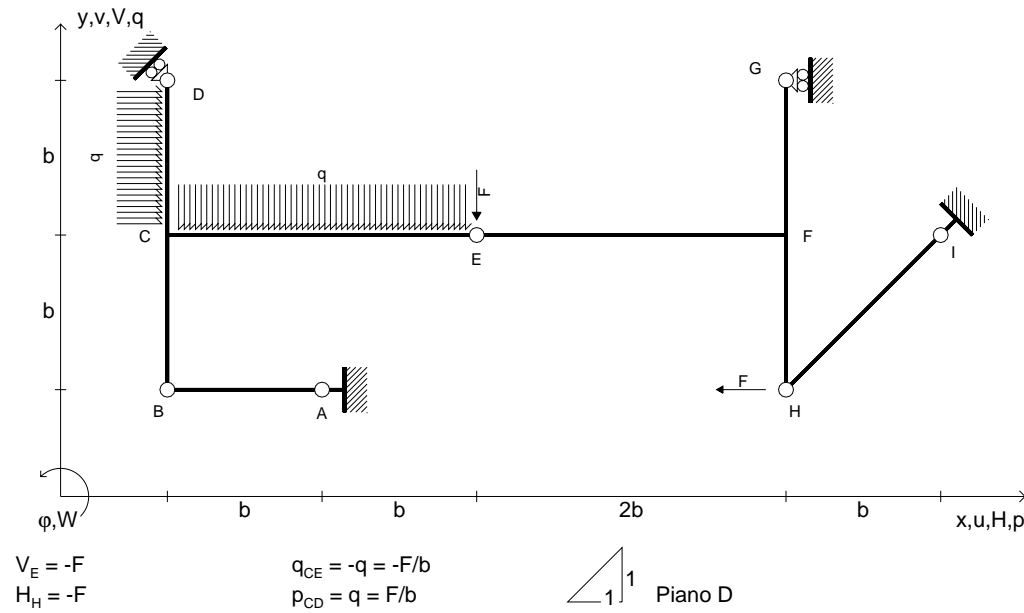
Calcolare reazioni vincolari della struttura e delle aste.

Tracciare i diagrammi delle azioni interne nelle aste.

Piano di scorrimento del vincolo con inclinazione assegnata.

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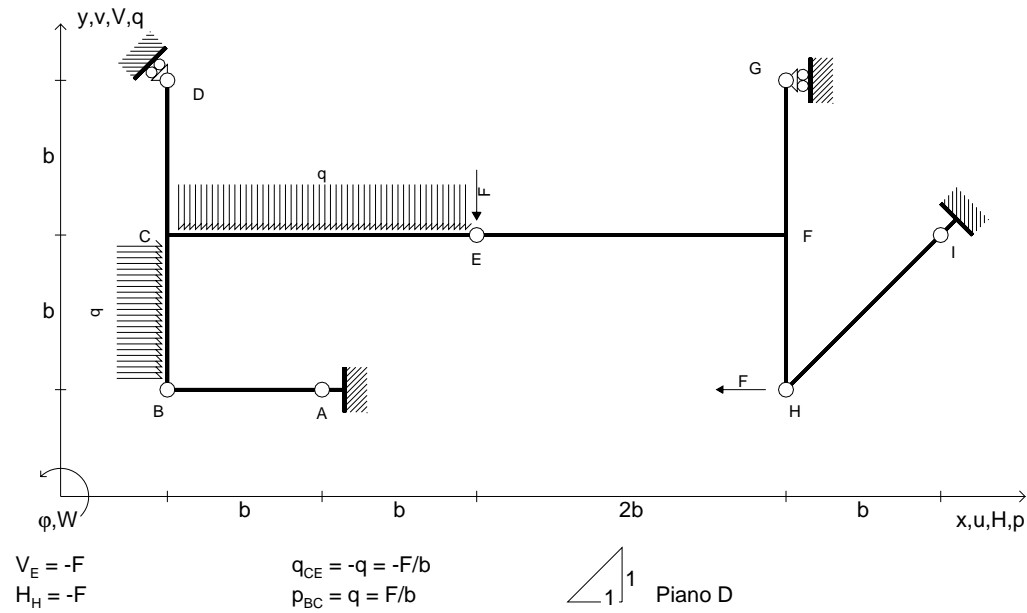
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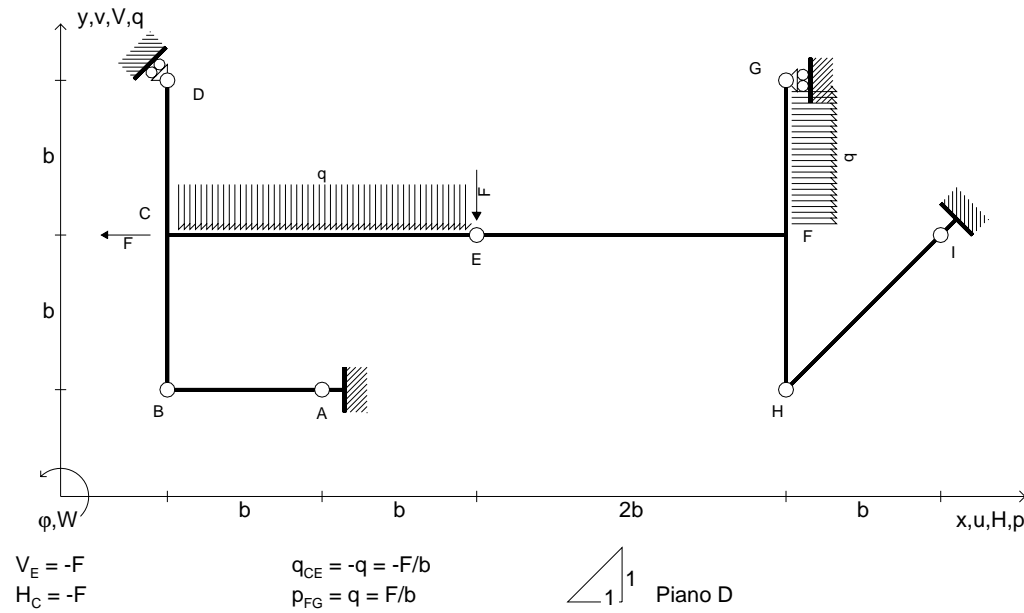
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Calcolare reazioni vincolari della struttura e delle aste.

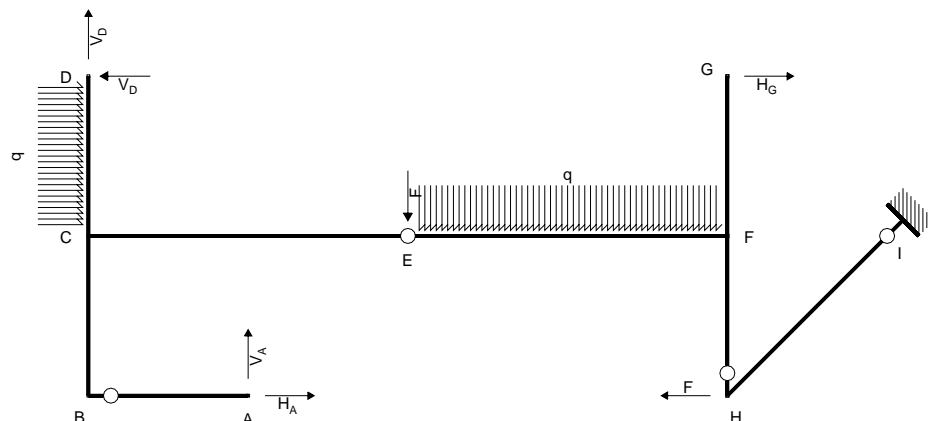
Tracciare i diagrammi delle azioni interne nelle aste.

Piano di scorrimento del vincolo con inclinazione assegnata.

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EQUAZIONI DI EQUILIBRIO

Rotazione globale intorno a I

$$H_A b - 4V_A b - 4V_D b - H_G b = -2Fb - 7/2qb^2$$

Rotazione intorno a H: aste HF FE FG EC CB CD BA

$$-3V_A b - 2V_D b - 2H_G b = -2Fb - 1/2qb^2$$

Rotazione intorno a E: aste EC CB CD BA

$$H_A b - V_A b - V_D b = 1/2qb^2$$

Rotazione intorno a B: aste BA

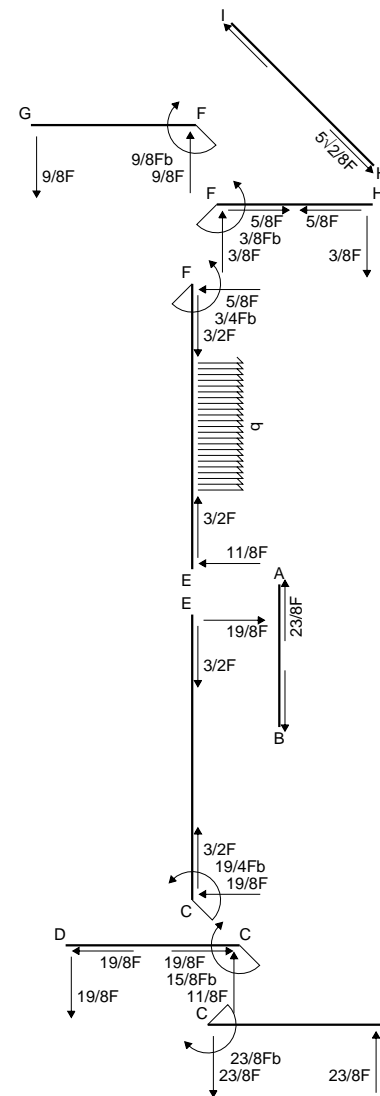
$$V_A b = 0$$

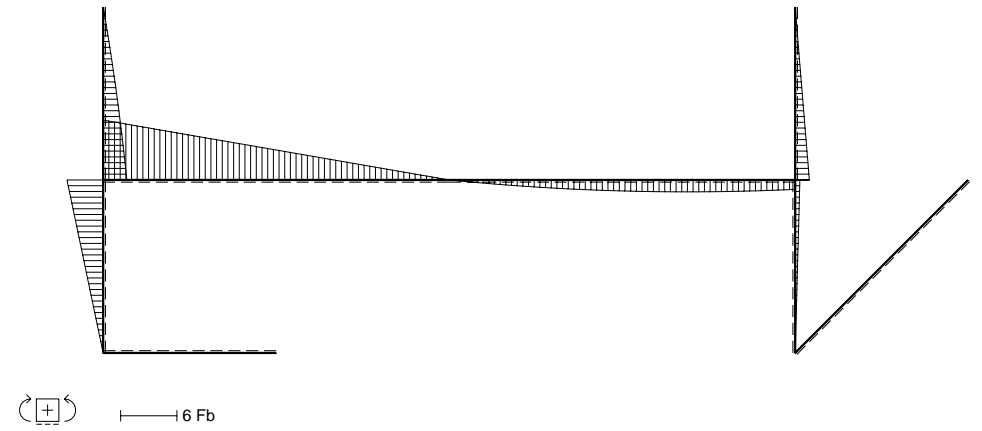
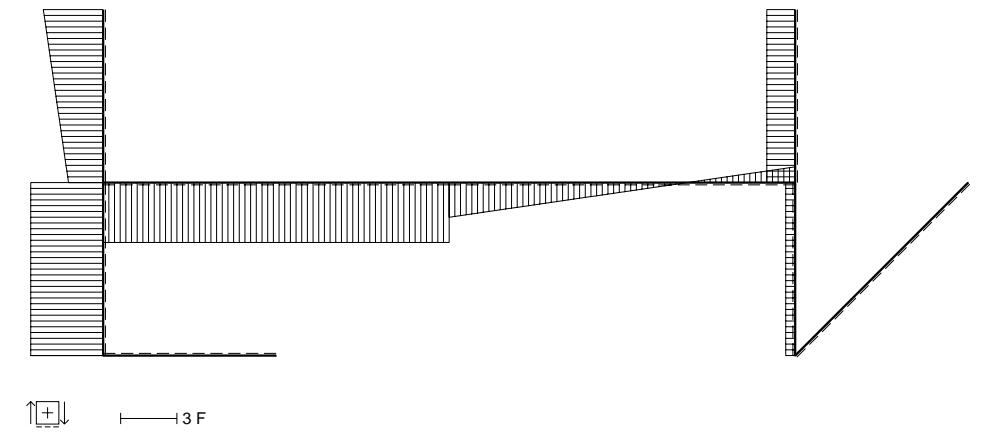
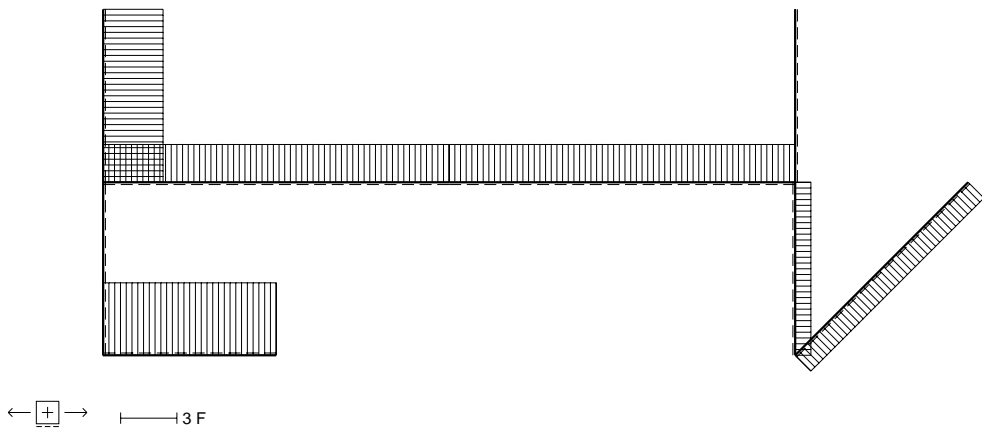
Matrice di equilibrio

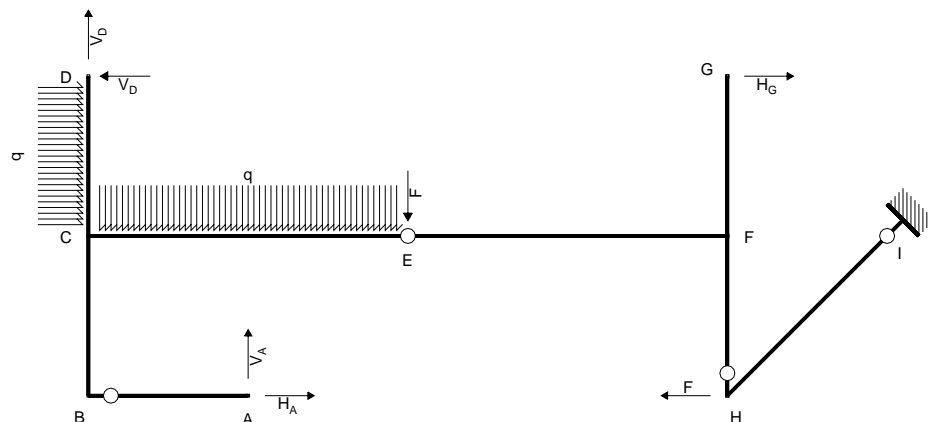
$$\begin{bmatrix} \varphi_I \\ \varphi_{HF} \\ \varphi_{EC} \\ \varphi_{BA} \end{bmatrix} \begin{bmatrix} H_A b & V_A b & V_D b & H_G b \\ 1 & -4 & -4 & -1 \\ 0 & -3 & -2 & -2 \\ 1 & -1 & -1 & 0 \\ 0 & 1 & 0 & 0 \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ -2 & -7/2 \\ -2 & -1/2 \\ 0 & 1/2 \\ 0 & 0 \end{bmatrix}$$

Soluzione del sistema

$$\begin{bmatrix} H_A b \\ V_A b \\ V_D b \\ H_G b \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ 1/2 & 19/8 \\ 0 & 0 \\ 1/2 & -13/8 \end{bmatrix}$$







EQUAZIONI DI EQUILIBRIO

Rotazione globale intorno a I

$$H_A b - 4V_A b - 4V_D b - H_G b = -2Fb - 15/2qb^2$$

Rotazione intorno a H: aste HF FE FG EC CB CD BA

$$-3V_A b - 2V_D b - 2H_G b = -2Fb - 9/2qb^2$$

Rotazione intorno a E: aste EC CB CD BA

$$H_A b - V_A b - V_D b = -3/2qb^2$$

Rotazione intorno a B: aste BA

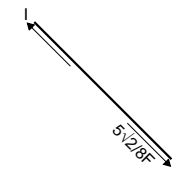
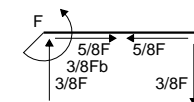
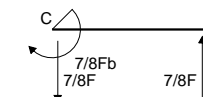
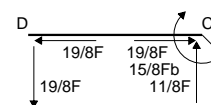
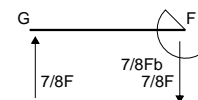
$$V_A b = 0$$

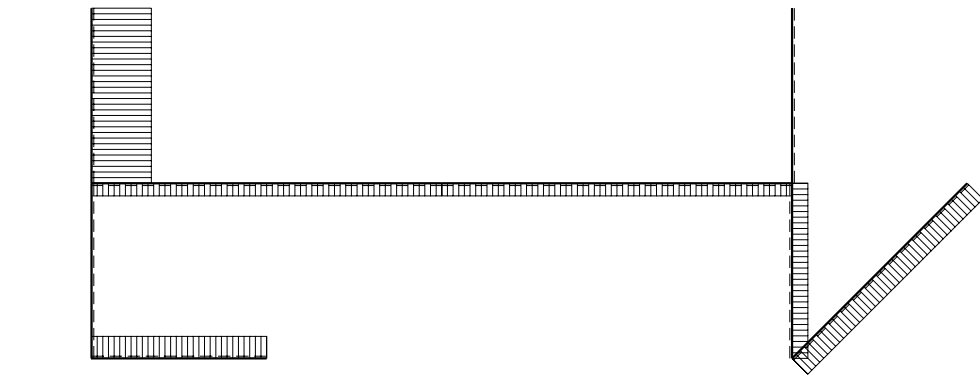
Matrice di equilibrio

$$\begin{bmatrix} \phi_I \\ \phi_{HF} \\ \phi_{EC} \\ \phi_{BA} \end{bmatrix} \begin{bmatrix} H_A b & V_A b & V_D b & H_G b \\ 1 & -4 & -4 & -1 \\ 0 & -3 & -2 & -2 \\ 1 & -1 & -1 & 0 \\ 0 & 1 & 0 & 0 \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ -2 & -15/2 \\ -2 & -9/2 \\ 0 & -3/2 \\ 0 & 0 \end{bmatrix}$$

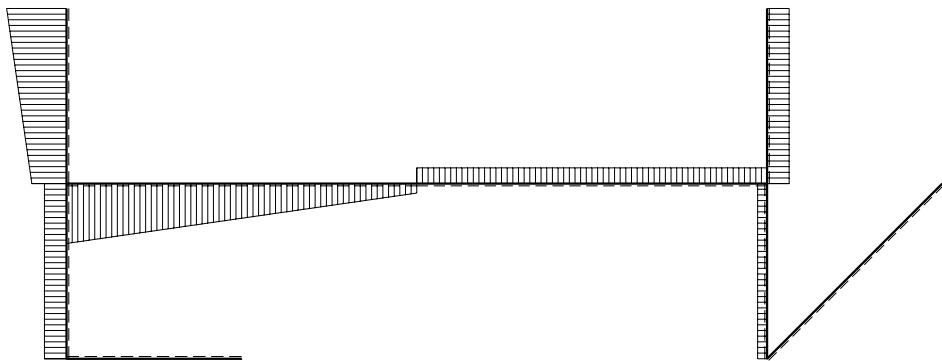
Soluzione del sistema

$$\begin{bmatrix} H_A b \\ V_A b \\ V_D b \\ H_G b \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ 1/2 & 3/8 \\ 0 & 0 \\ 1/2 & 15/8 \\ 1/2 & 3/8 \end{bmatrix}$$

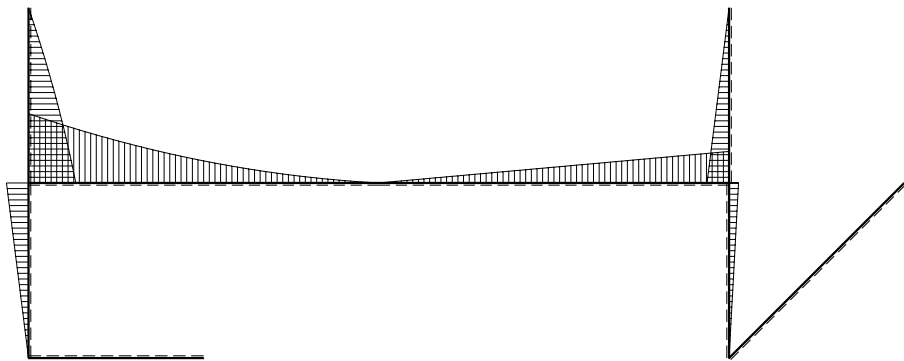




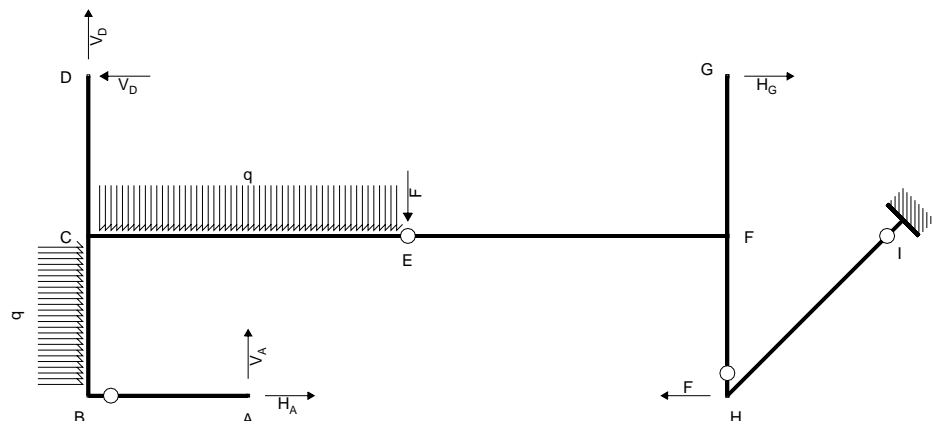
← + → $\parallel 3 F$



↑ + ↓ $\parallel 3 F$



↺ + ↻ $\parallel 3 F_b$



EQUAZIONI DI EQUILIBRIO

Rotazione globale intorno a I

$$H_A b - 4V_A b - 4V_D b - H_G b = -2Fb - 17/2qb^2$$

Rotazione intorno a H: aste HF FE FG EC CB CD BA

$$-3V_A b - 2V_D b - 2H_G b = -2Fb - 11/2qb^2$$

Rotazione intorno a E: aste EC CB CD BA

$$H_A b - V_A b - V_D b = -5/2qb^2$$

Rotazione intorno a B: aste BA

$$V_A b = 0$$

Matrice di equilibrio

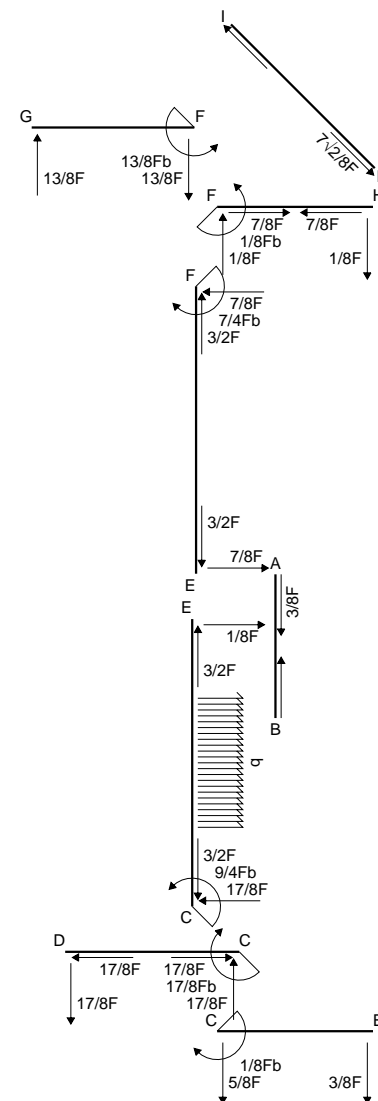
$$\begin{bmatrix} \phi_I \\ \phi_{HF} \\ \phi_{EC} \\ \phi_{BA} \end{bmatrix} \begin{bmatrix} H_A b & V_A b & V_D b & H_G b \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \end{bmatrix}$$

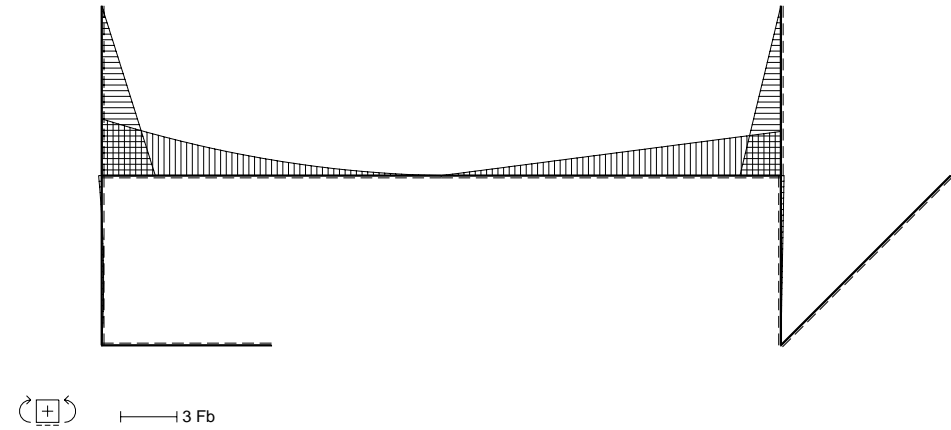
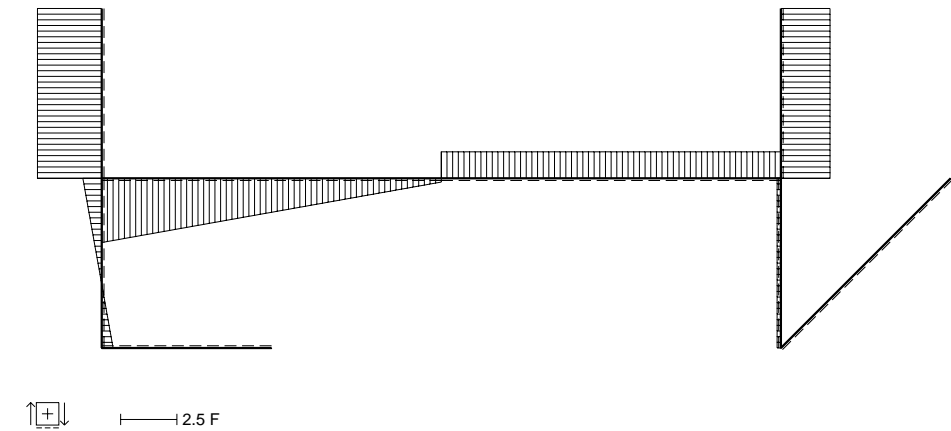
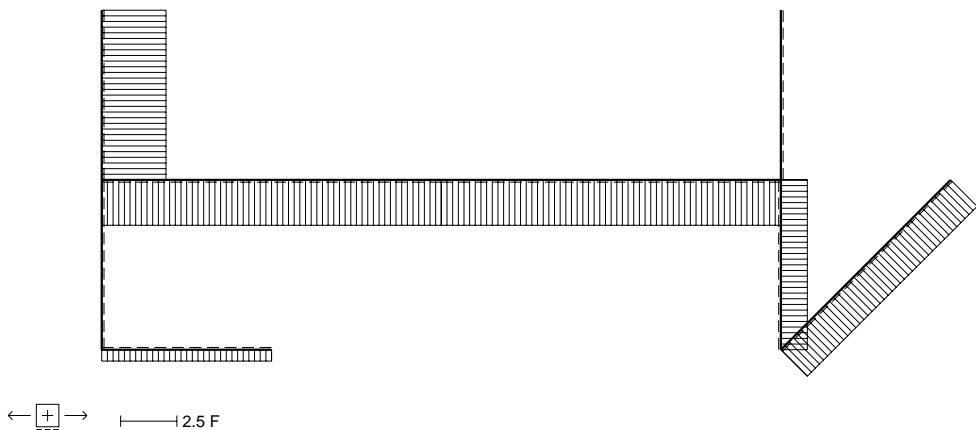
$$\begin{bmatrix} 1 & -4 & -4 & -1 \\ 0 & -3 & -2 & -2 \\ 1 & -1 & -1 & 0 \\ 0 & 1 & 0 & 0 \end{bmatrix} = \begin{bmatrix} -2 & -17/2 \\ -2 & -11/2 \\ 0 & -5/2 \\ 0 & 0 \end{bmatrix}$$

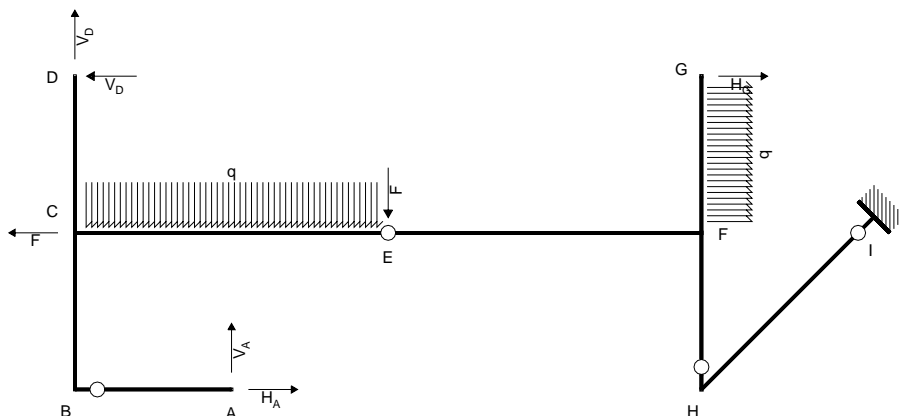
Soluzione del sistema

$$\begin{bmatrix} H_A b \\ V_A b \\ V_D b \\ H_G b \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \end{bmatrix}$$

$$\begin{bmatrix} 1/2 & -7/8 \\ 0 & 0 \\ 1/2 & 13/8 \\ 1/2 & 9/8 \end{bmatrix}$$







EQUAZIONI DI EQUILIBRIO

Rotazione globale intorno a I

$$H_A b - 4V_A b - 4V_D b - H_G b = -3Fb - 15/2qb^2$$

Rotazione intorno a H: aste HF FE FG EC CB CD BA

$$-3V_A b - 2V_D b - 2H_G b = -3Fb - 9/2qb^2$$

Rotazione intorno a E: aste EC CB CD BA

$$H_A b - V_A b - V_D b = -2qb^2$$

Rotazione intorno a B: aste BA

$$V_A b = 0$$

Matrice di equilibrio

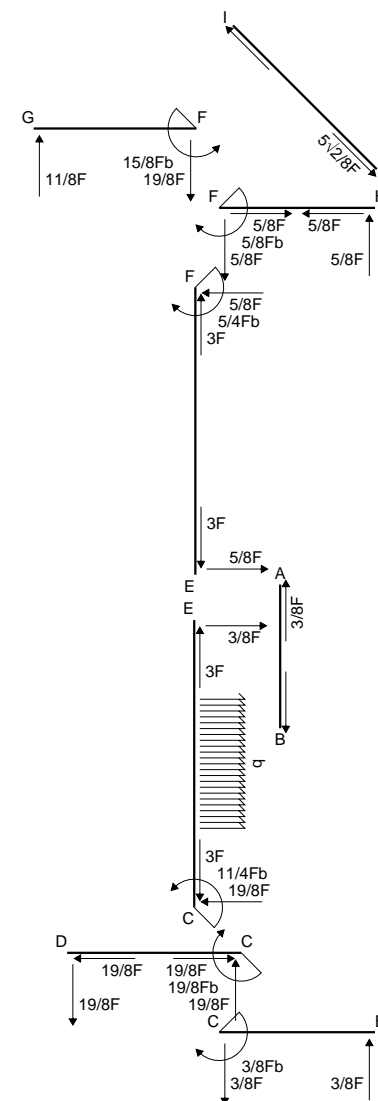
$$\begin{bmatrix} \varphi_I \\ \varphi_{HF} \\ \varphi_{EC} \\ \varphi_{BA} \end{bmatrix} \begin{bmatrix} H_A b & V_A b & V_D b & H_G b \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \end{bmatrix}$$

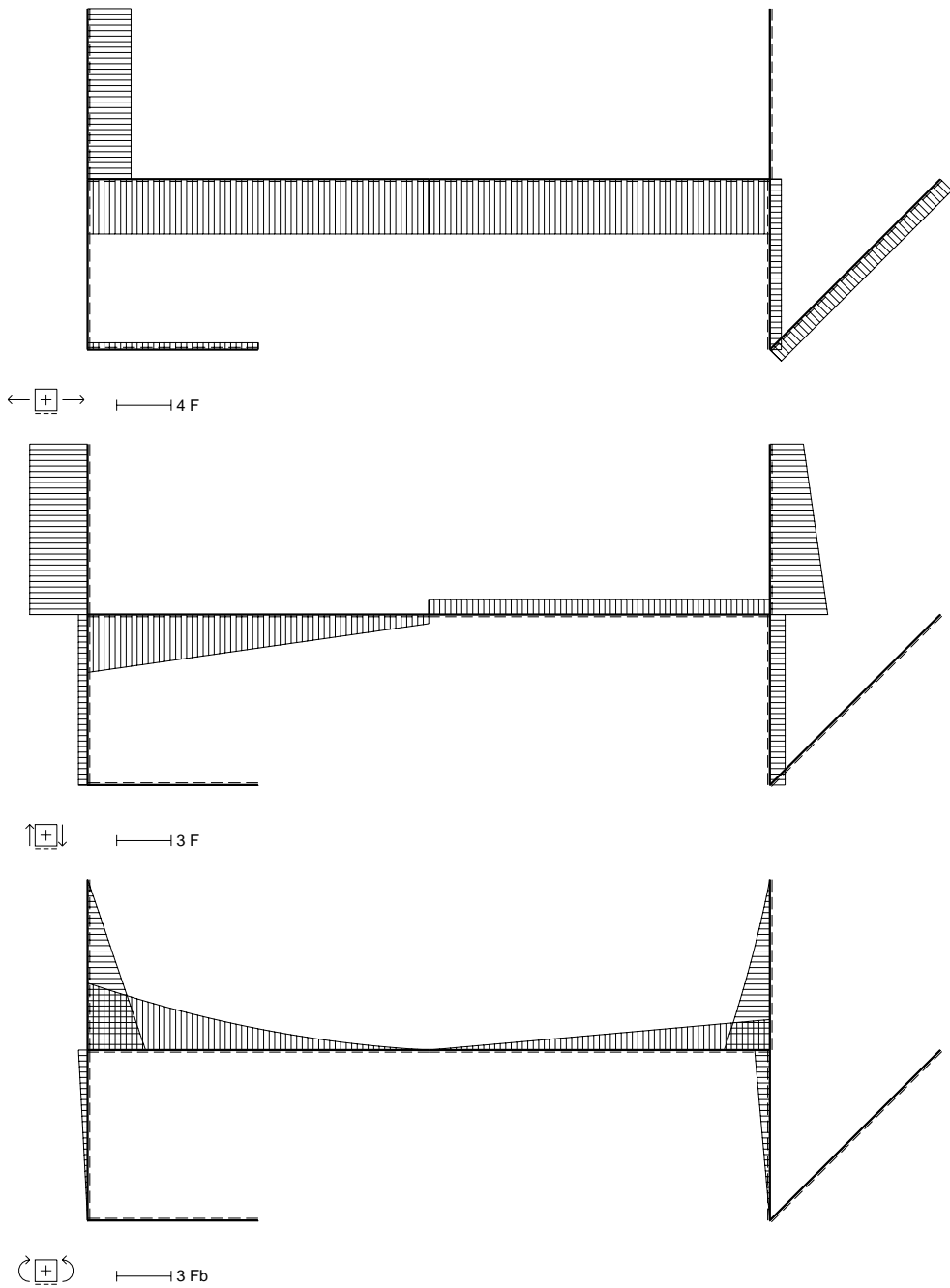
$$\begin{bmatrix} 1 & -4 & -4 & -1 \\ 0 & -3 & -2 & -2 \\ 1 & -1 & -1 & 0 \\ 0 & 1 & 0 & 0 \end{bmatrix} = \begin{bmatrix} -3 & -15/2 \\ -3 & -9/2 \\ 0 & -2 \\ 0 & 0 \end{bmatrix}$$

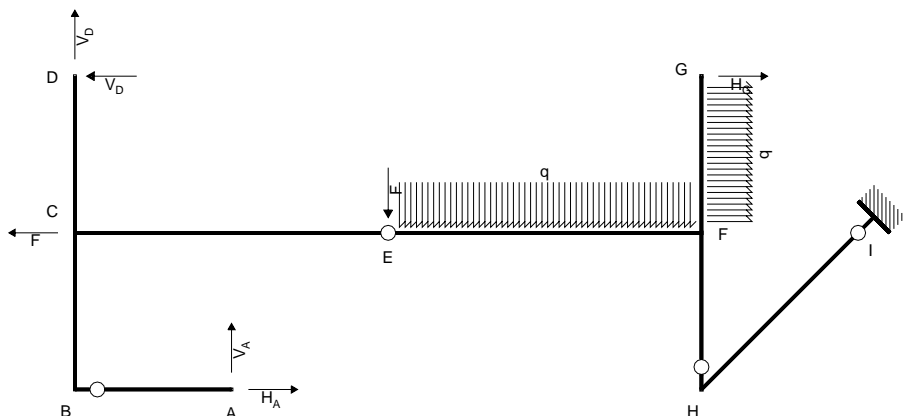
Soluzione del sistema

$$\begin{bmatrix} H_A b \\ V_A b \\ V_D b \\ H_G b \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \end{bmatrix}$$

$$\begin{bmatrix} H_A b \\ V_A b \\ V_D b \\ H_G b \end{bmatrix} = \begin{bmatrix} 3/4 & -3/8 \\ 0 & 0 \\ 3/4 & 13/8 \\ 3/4 & 5/8 \end{bmatrix}$$







EQUAZIONI DI EQUILIBRIO

Rotazione globale intorno a I

$$H_A b - 4V_A b - 4V_D b - H_G b = -3Fb - 7/2qb^2$$

Rotazione intorno a H: aste HF FE FG EC CB CD BA

$$-3V_A b - 2V_D b - 2H_G b = -3Fb - 1/2qb^2$$

Rotazione intorno a E: aste EC CB CD BA

$$H_A b - V_A b - V_D b = 0$$

Rotazione intorno a B: aste BA

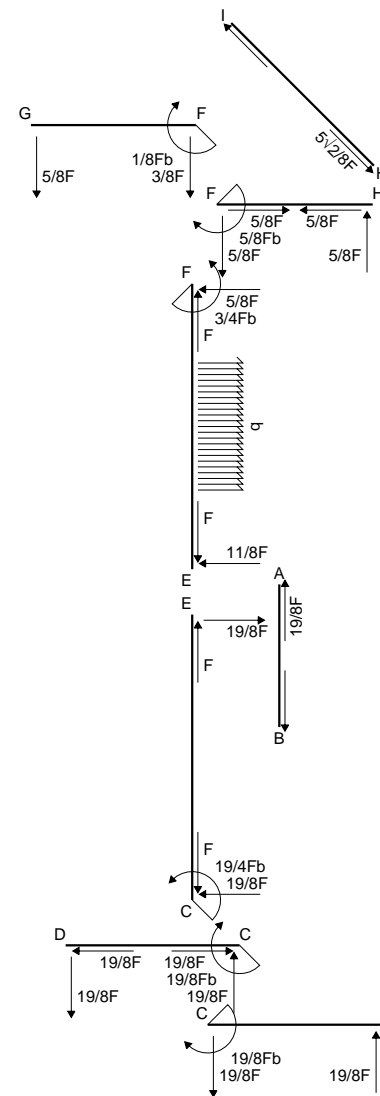
$$V_A b = 0$$

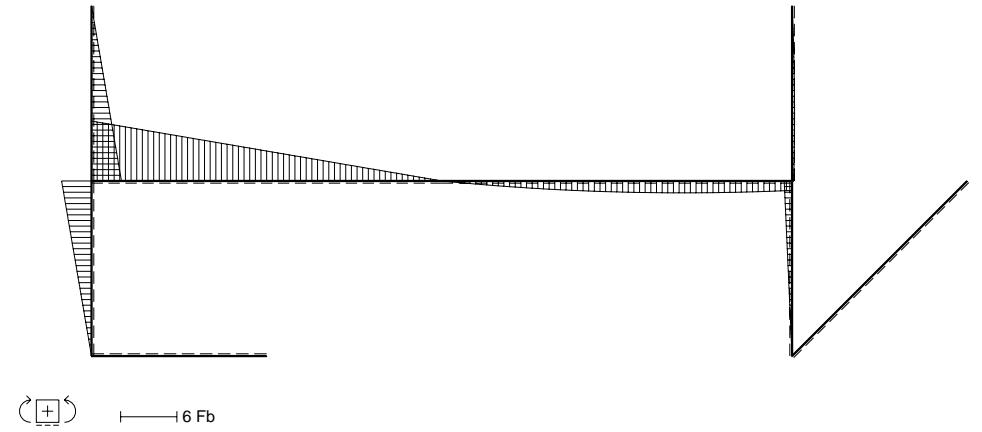
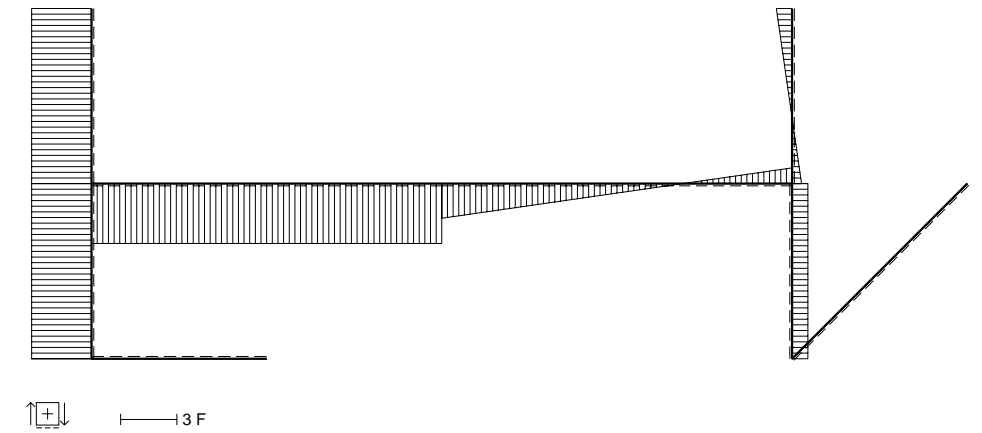
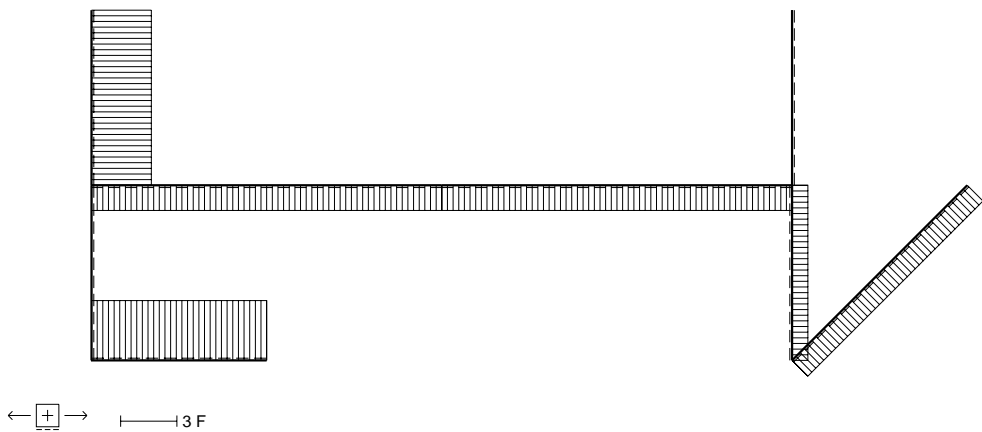
Matrice di equilibrio

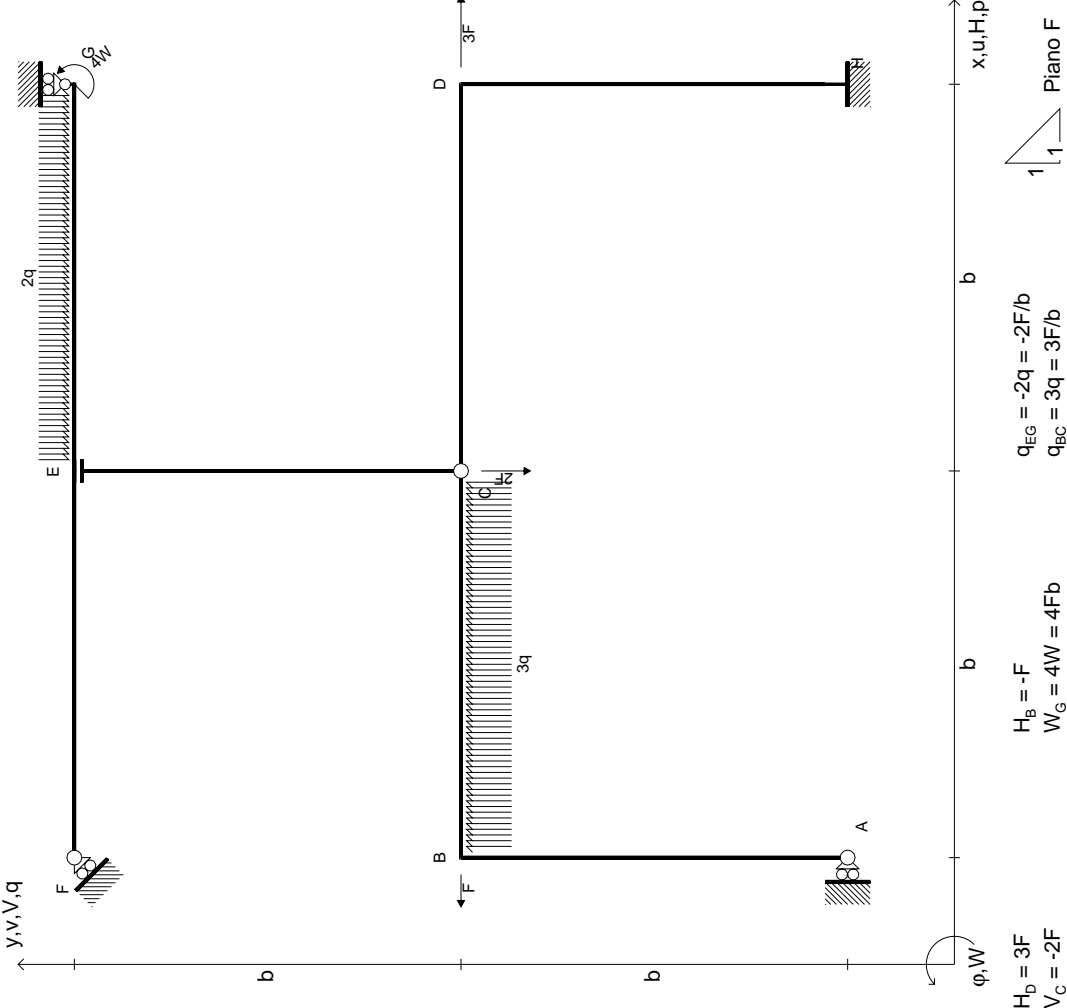
$$\begin{bmatrix} \varphi_I \\ \varphi_{HF} \\ \varphi_{EC} \\ \varphi_{BA} \end{bmatrix} \begin{bmatrix} H_A b & V_A b & V_D b & H_G b \\ 1 & -4 & -4 & -1 \\ 0 & -3 & -2 & -2 \\ 1 & -1 & -1 & 0 \\ 0 & 1 & 0 & 0 \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ -3 & -7/2 \\ -3 & -1/2 \\ 0 & 0 \\ 0 & 0 \end{bmatrix}$$

Soluzione del sistema

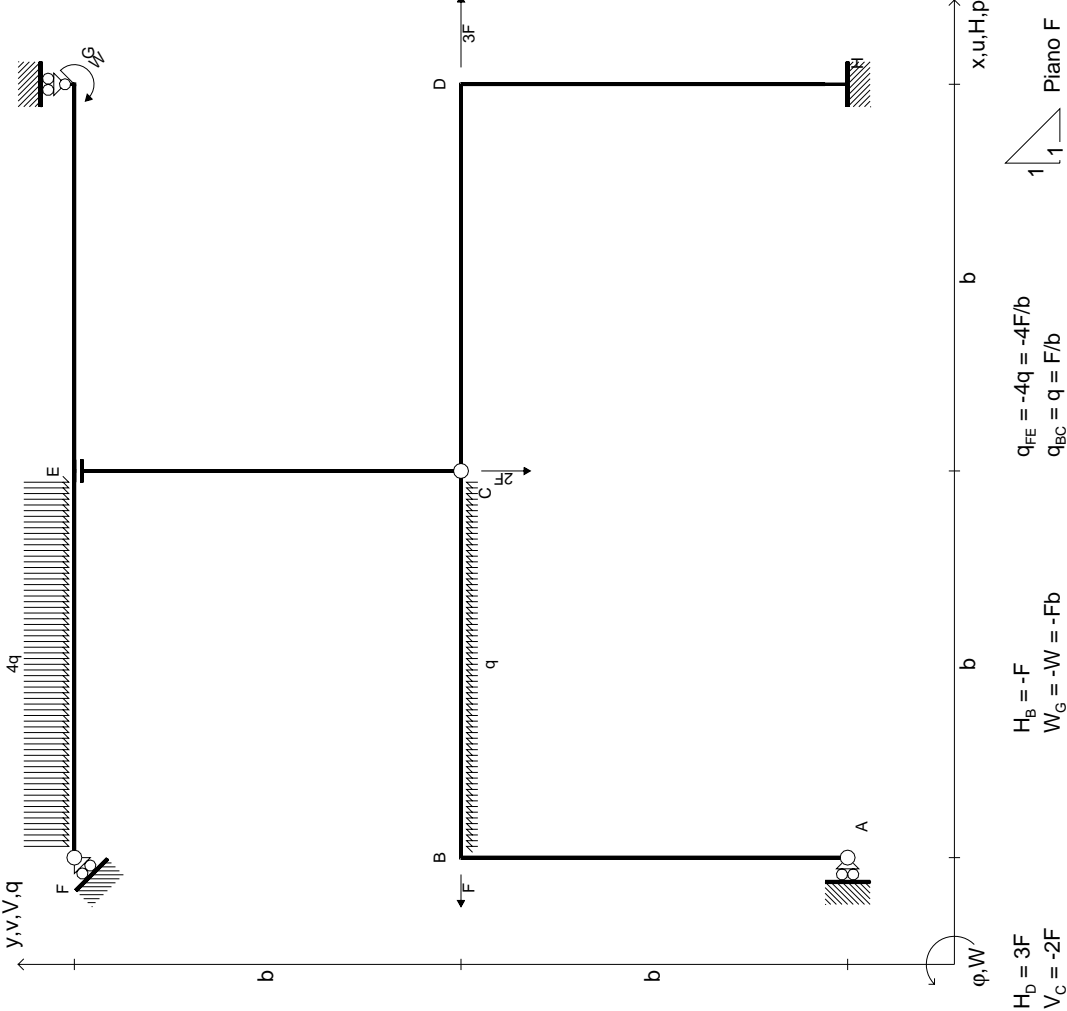
$$\begin{bmatrix} H_A b \\ V_A b \\ V_D b \\ H_G b \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ 3/4 & 13/8 \\ 0 & 0 \\ 3/4 & -11/8 \end{bmatrix}$$



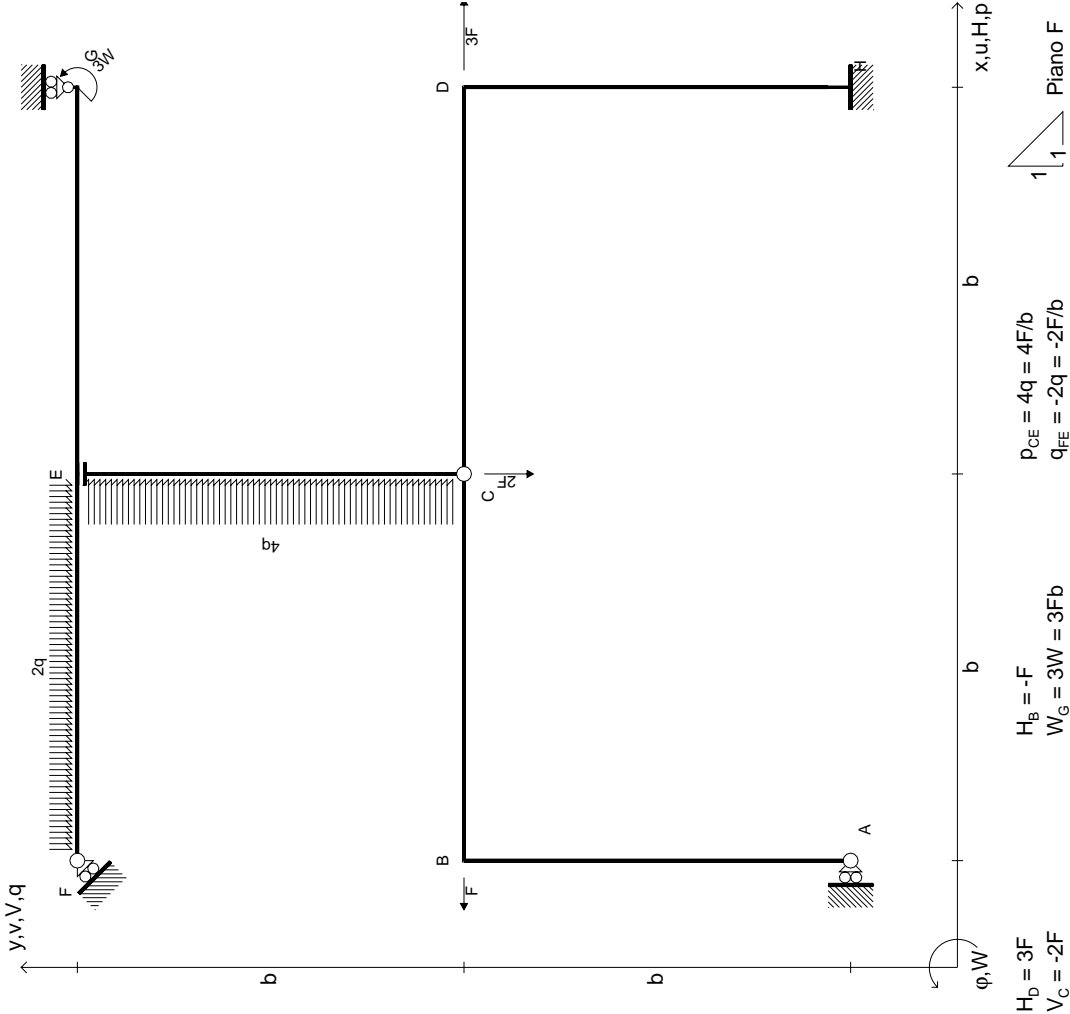




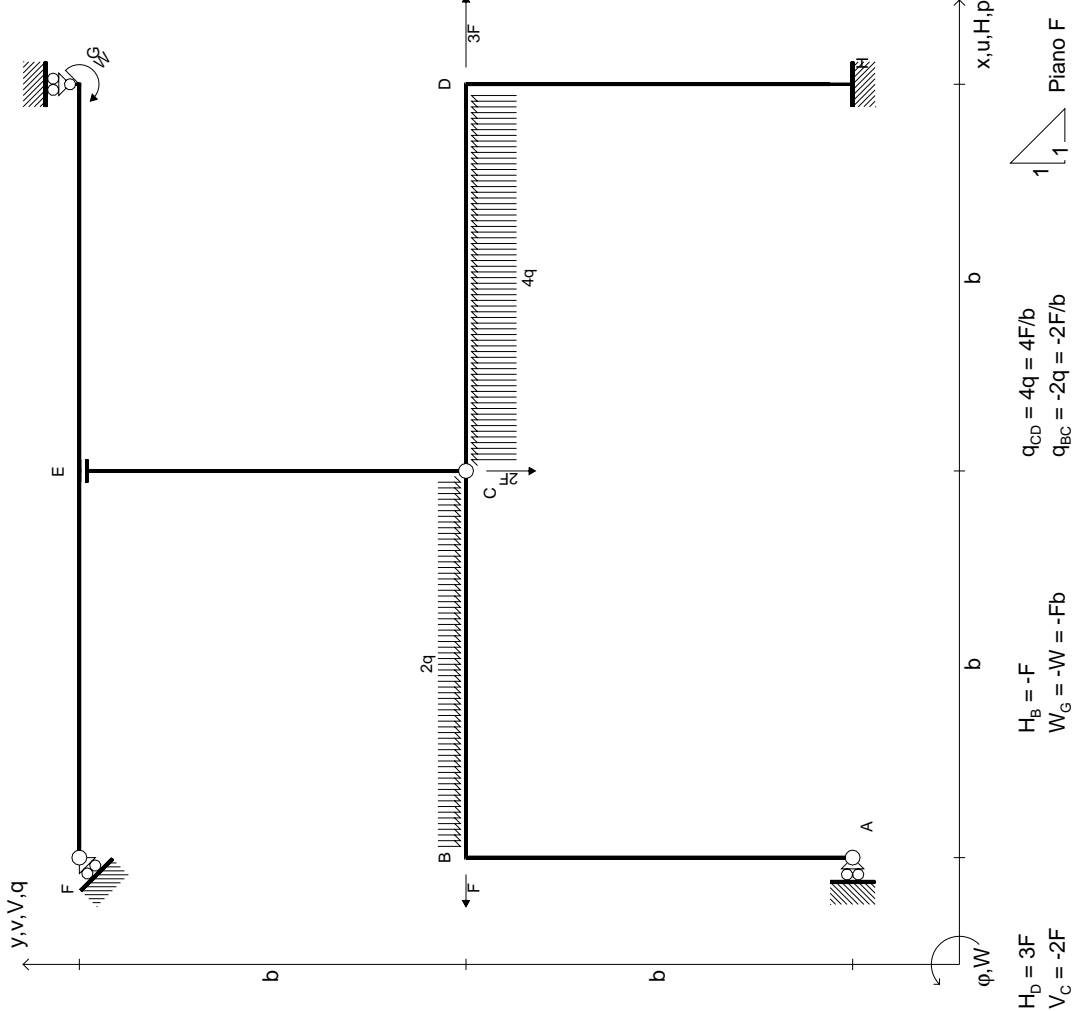
Carichi e deformazioni date hanno verso efficace in disegno.
Calcolare reazioni vincolari della struttura e delle aste.
Tracciare i diagrammi quotati delle azioni interne nelle aste.
Piano di scorrimento del vincolo con inclinazione assegnata.
@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.24.08.06



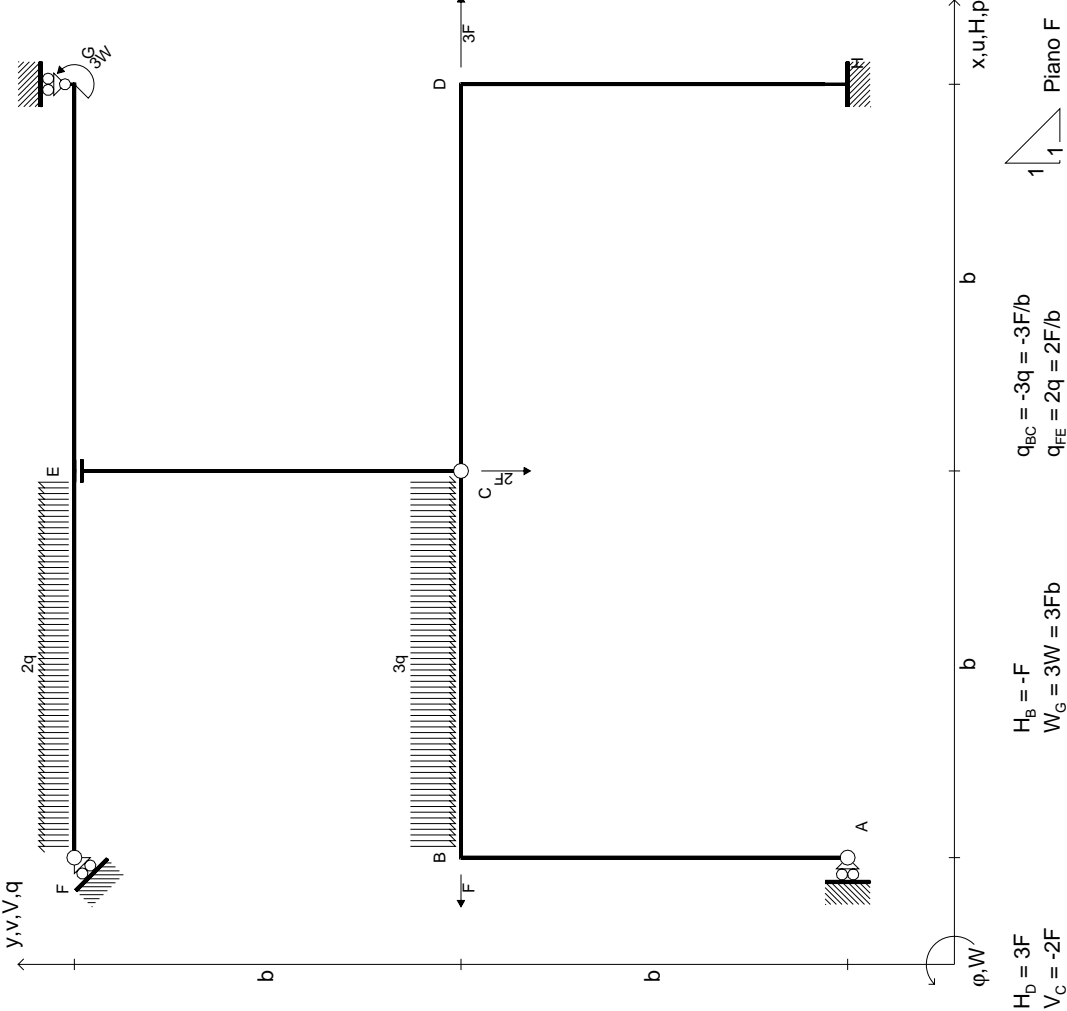
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@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.24.08.06



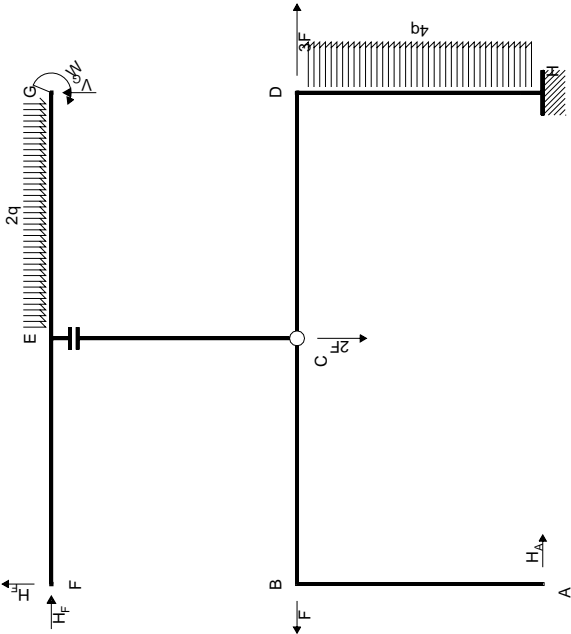
Carichi e deformazioni date hanno verso efficace in disegno.
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@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.24.08.06



Carichi e deformazioni date hanno verso efficace in disegno.
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Carichi e deformazioni date hanno verso efficace in disegno.
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Piano di scorrimento del vincolo con inclinazione assegnata.
@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.24.08.06



EQUAZIONI DI EQUILIBRIO

Rotazione intorno a C: aste CB BA

$H_A \cdot b = 0$

Rotazione intorno a C: aste CE EF EG

$-2H_F \cdot b + V_G \cdot b = W + qb^2$

Traslazione orizzontale: aste EF EG

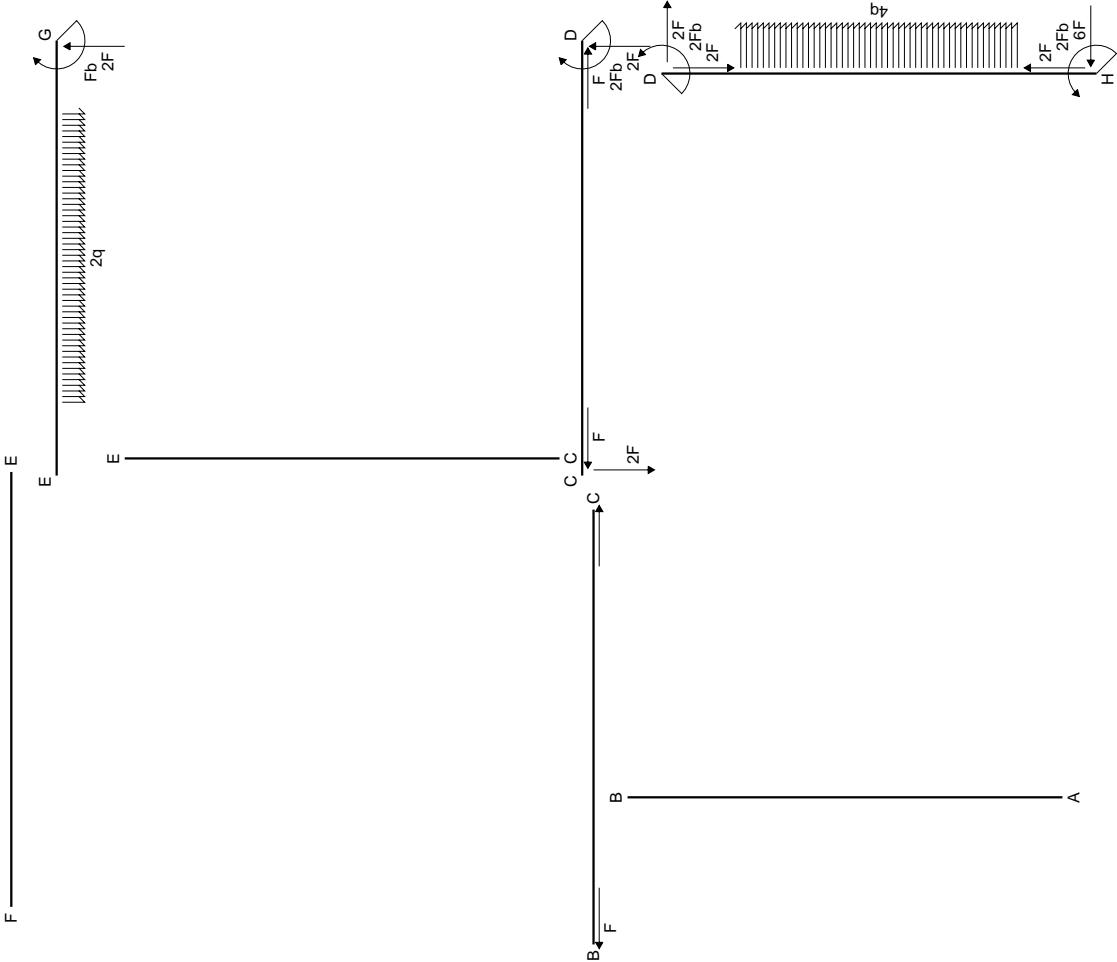
$H_F = 0$

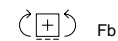
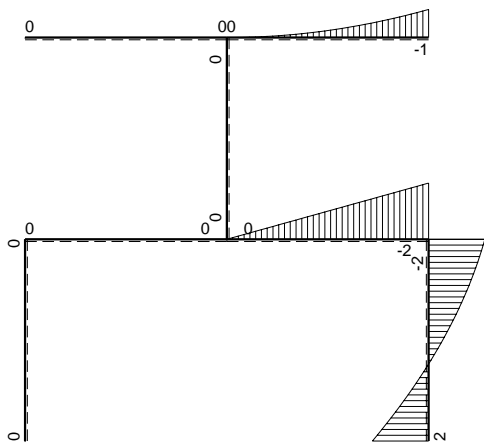
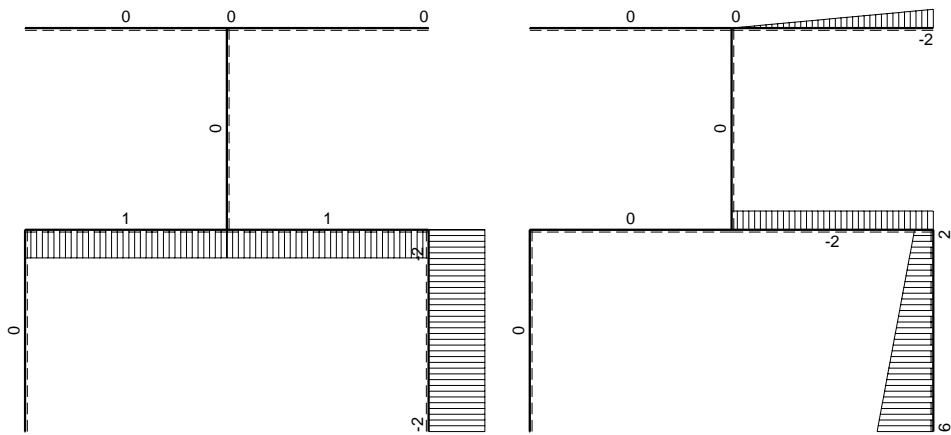
Matrice di equilibrio

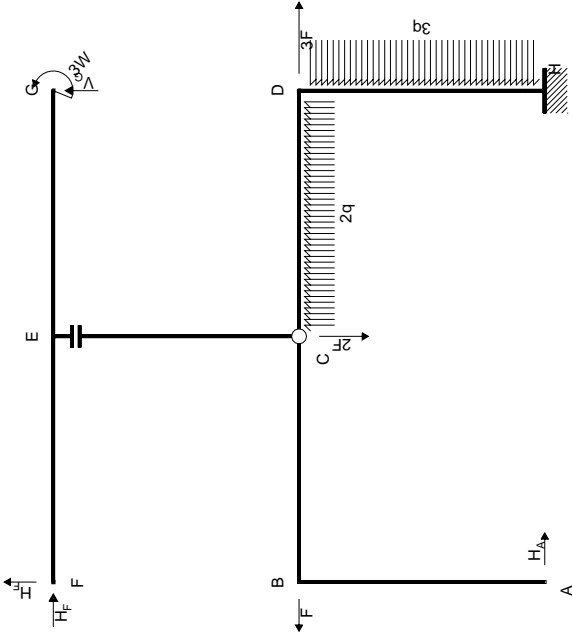
$$\begin{bmatrix} H_A \cdot b & H_F \cdot b & V_G \cdot b \\ \varphi_{CB} & 1 & 0 & 0 \\ \varphi_{CE} & 0 & -2 & 1 \\ u_{EF} & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} F_b & W & qb^2 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 1 & 1 \\ 0 & 0 & 0 \end{bmatrix}$$

Soluzione del sistema

$$\begin{bmatrix} H_A \cdot b \\ H_F \cdot b \\ V_G \cdot b \end{bmatrix} = \begin{bmatrix} F_b & W & qb^2 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 1 & 1 \end{bmatrix}$$







EQUAZIONI DI EQUILIBRIO

Rotazione intorno a C: aste CB BA

$H_A b = 0$

Rotazione intorno a C: aste CE EF EG

$-2H_F b + V_C b = -3W$

Traslazione orizzontale: aste EF EG

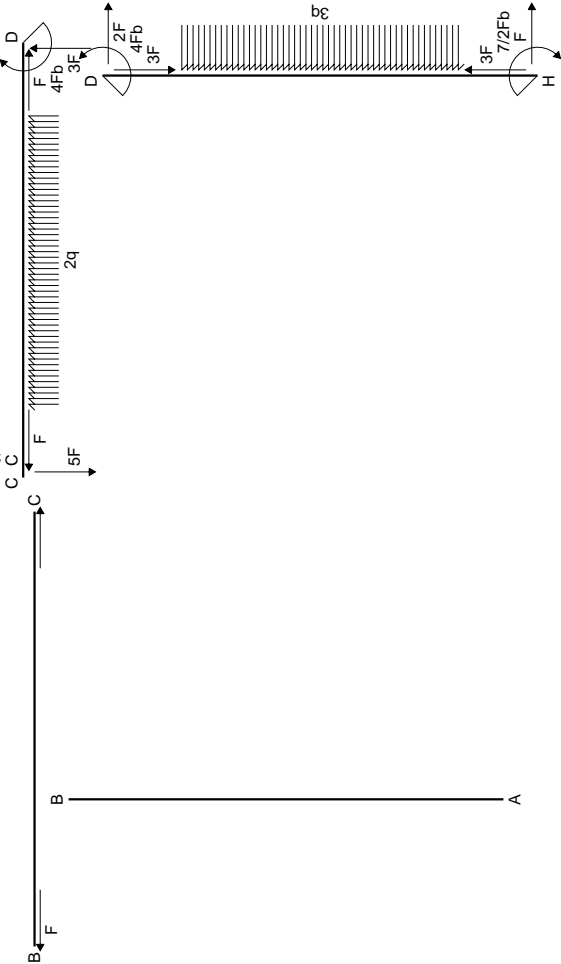
$H_F = 0$

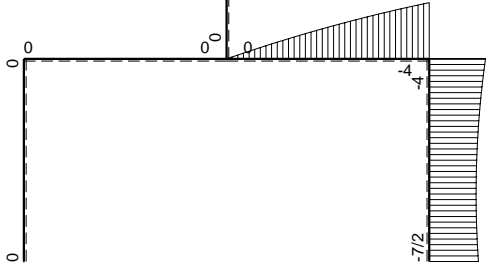
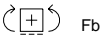
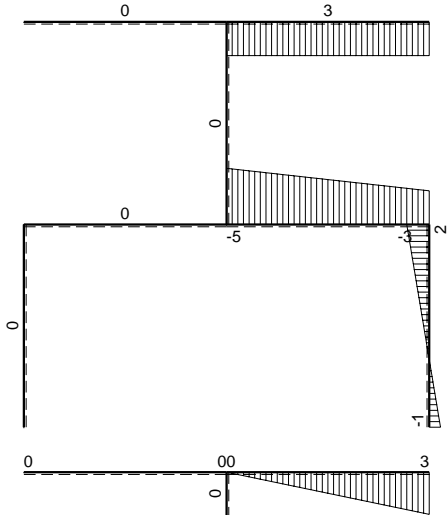
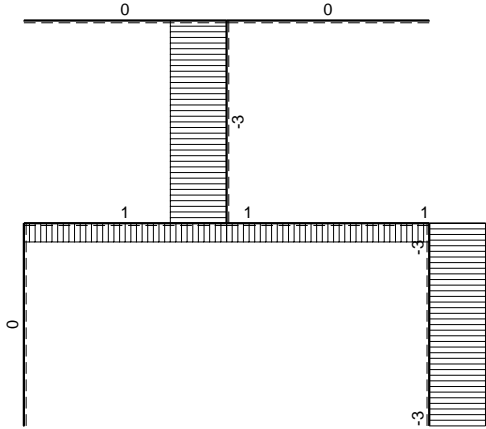
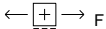
Matrice di equilibrio

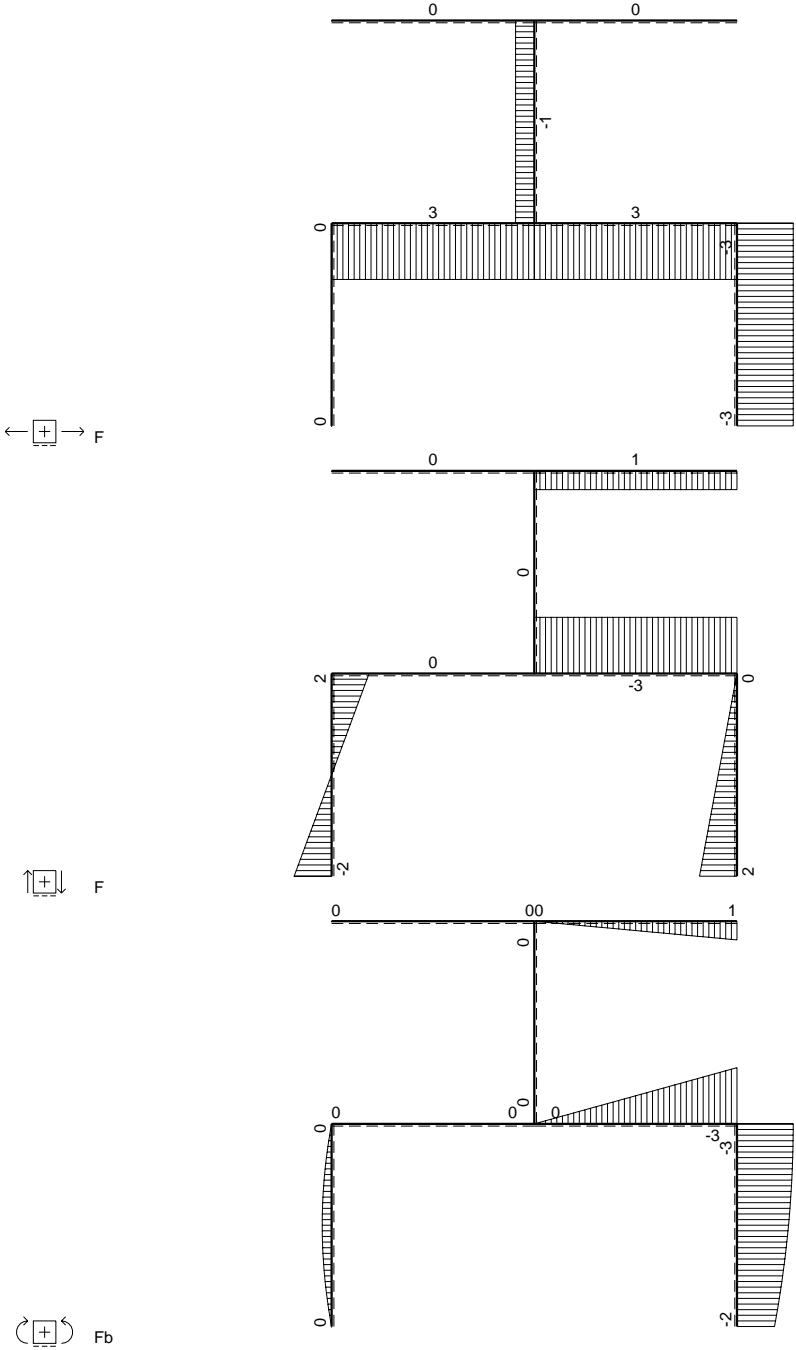
$$\begin{bmatrix} H_A b & H_F b & V_C b \\ 1 & 0 & 0 \\ 0 & -2 & 1 \\ 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} F_b & W & q b^2 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & -3 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

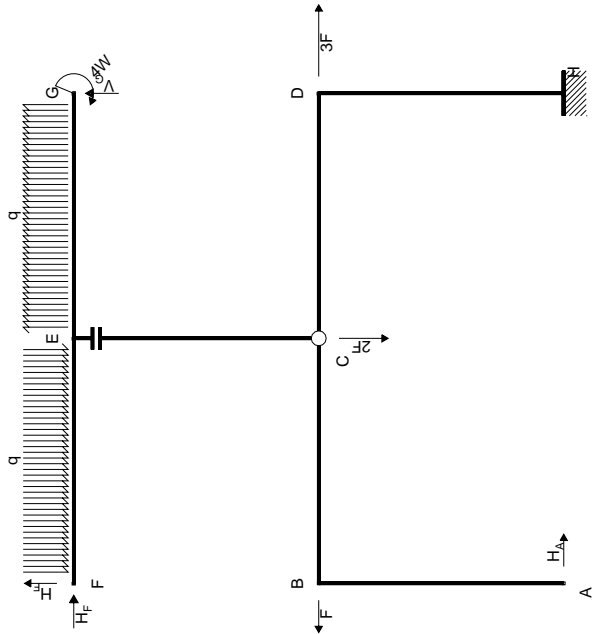
Soluzione del sistema

$$\begin{bmatrix} H_A b \\ H_F b \\ V_C b \end{bmatrix} = \begin{bmatrix} F_b & W & q b^2 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & -3 & 0 \end{bmatrix}$$









EQUAZIONI DI EQUILIBRIO

Rotazione intorno a C: aste CB BA

$H_A \cdot b = 0$

Rotazione intorno a C: aste CE EF EG

$-2H_F \cdot b + V_G \cdot b = 4W \cdot -qb^2$

Traslazione orizzontale: aste EF EG

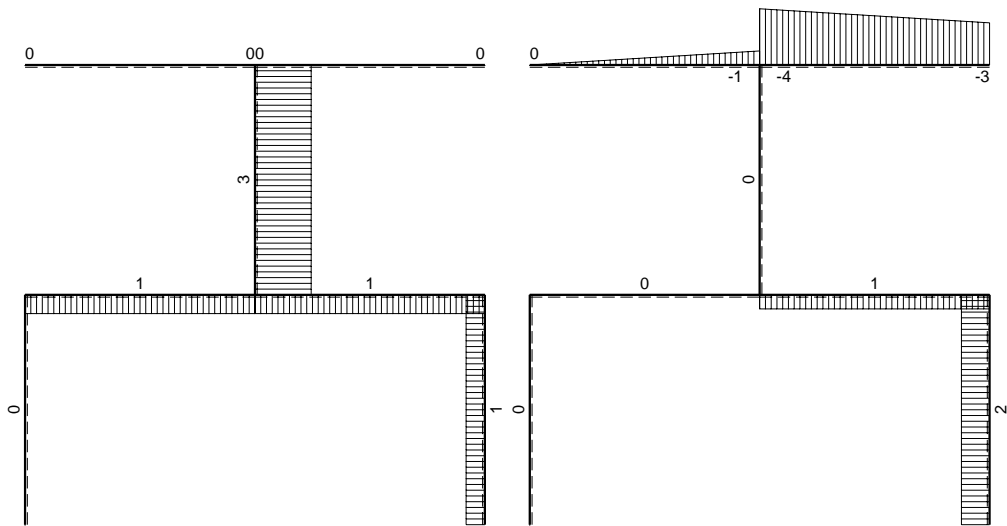
$H_F = 0$

Matrice di equilibrio

$$\begin{bmatrix} H_A \cdot b & H_F \cdot b & V_G \cdot b \\ 1 & 0 & 0 \\ 0 & -2 & 1 \\ 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} Fb & W & qb^2 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 4 \\ 0 & 4 & -1 \\ 0 & 0 & 0 \end{bmatrix}$$

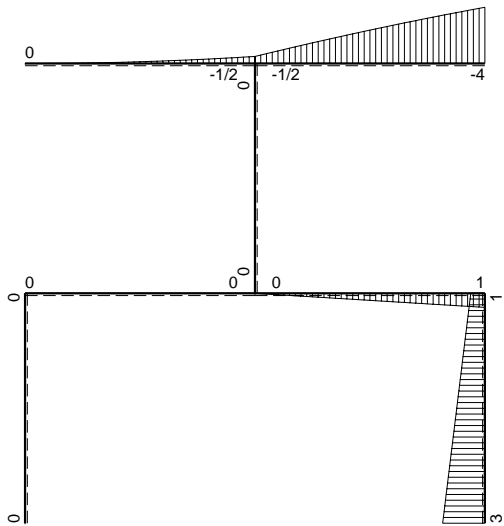
Soluzione del sistema

$$\begin{bmatrix} H_A \cdot b \\ H_F \cdot b \\ V_G \cdot b \end{bmatrix} = \begin{bmatrix} Fb & W & qb^2 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 4 & -1 \end{bmatrix}$$

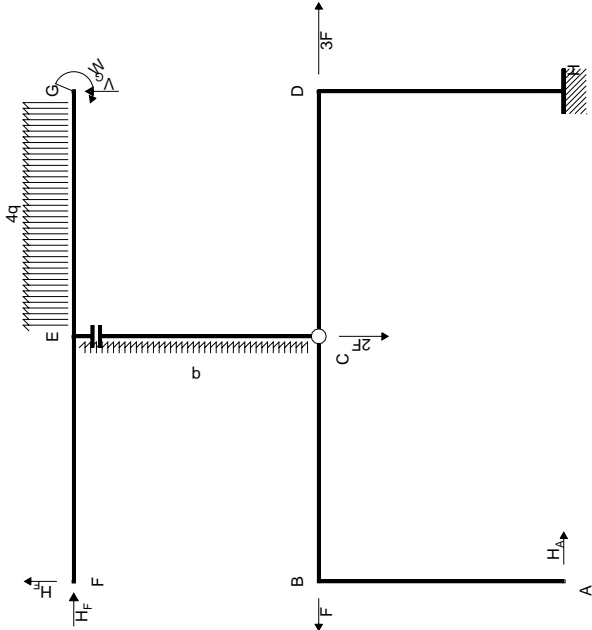


← $\boxed{+}$ → F

$\uparrow \boxed{+} \downarrow F$



$\curvearrowright \boxed{+} \curvearrowleft F_b$



EQUAZIONI DI EQUILIBRIO

Rotazione intorno a C: aste CB BA

$H_A b = 0$

Rotazione intorno a C: aste CE EF EG

$-2H_F b + V_G b = W - 3/2qb^2$

Traslazione orizzontale: aste EF EG

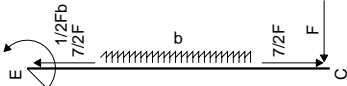
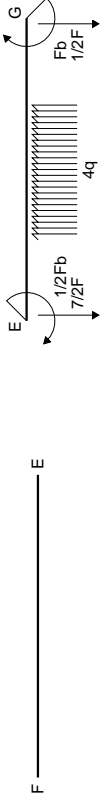
$H_F = 0$

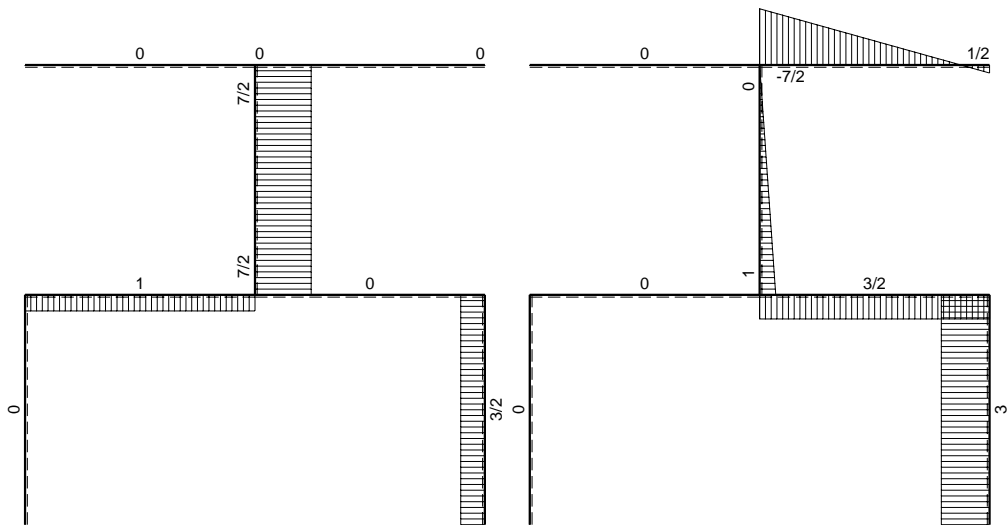
Matrice di equilibrio

$$\begin{bmatrix} H_A b & H_F b & V_G b \end{bmatrix} \begin{bmatrix} F_b & W & qb^2 \end{bmatrix}$$
$$\varphi_{CB} \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} 0 & 0 & 0 \end{bmatrix}$$
$$\varphi_{CE} \begin{bmatrix} 0 & -2 & 1 \end{bmatrix} = \begin{bmatrix} 0 & 1 & -3/2 \end{bmatrix}$$
$$u_{EF} \begin{bmatrix} 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} 0 & 0 & 0 \end{bmatrix}$$

Soluzione del sistema

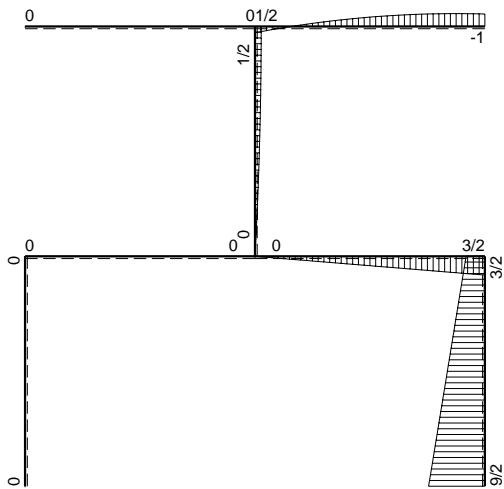
$$\begin{bmatrix} H_A b \\ H_F b \\ V_G b \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 1 & -3/2 \end{bmatrix} \begin{bmatrix} F_b & W & qb^2 \end{bmatrix}$$



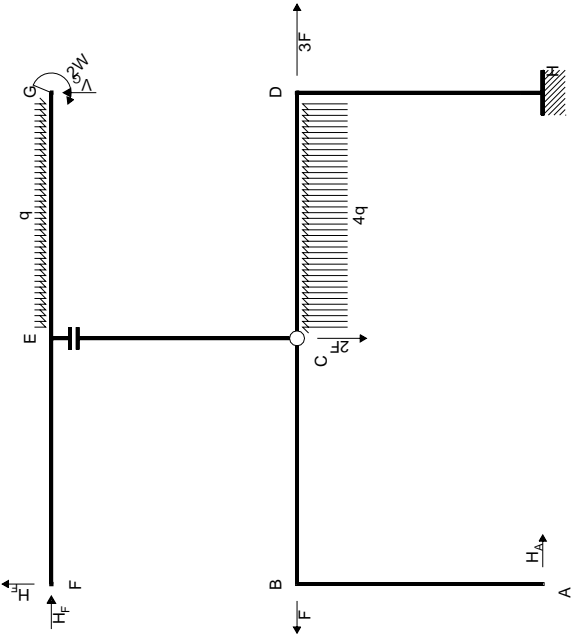


← $\boxed{+}$ → F

$\uparrow \boxed{+} \downarrow F$



$\curvearrowright \boxed{+} \curvearrowleft F_b$



EQUAZIONI DI EQUILIBRIO

Rotazione intorno a C: aste CB BA

$H_A b = 0$

Rotazione intorno a C: aste CE EF EG

$-2H_F b + V_G b = 2W + 1/2qb^2$

Traslazione orizzontale: aste EF EG

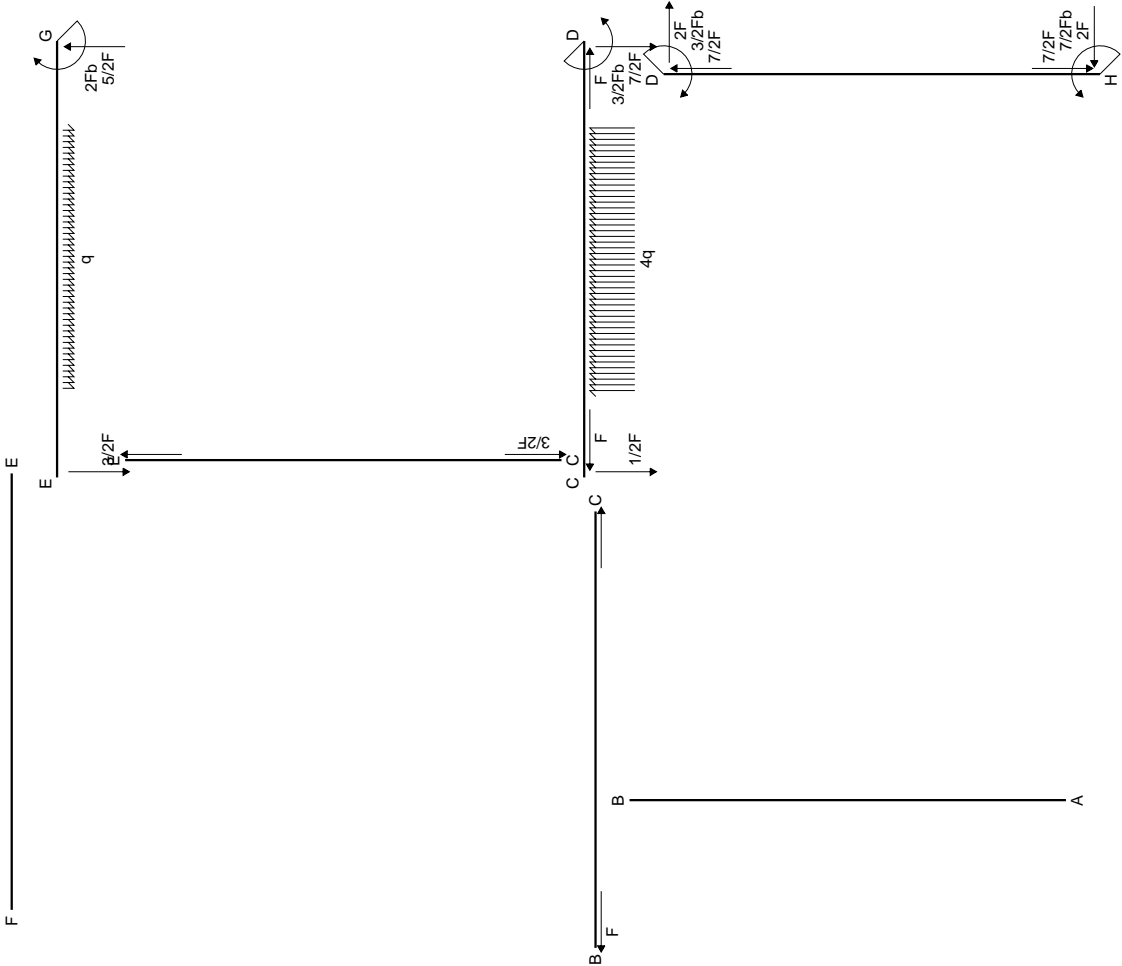
$H_F = 0$

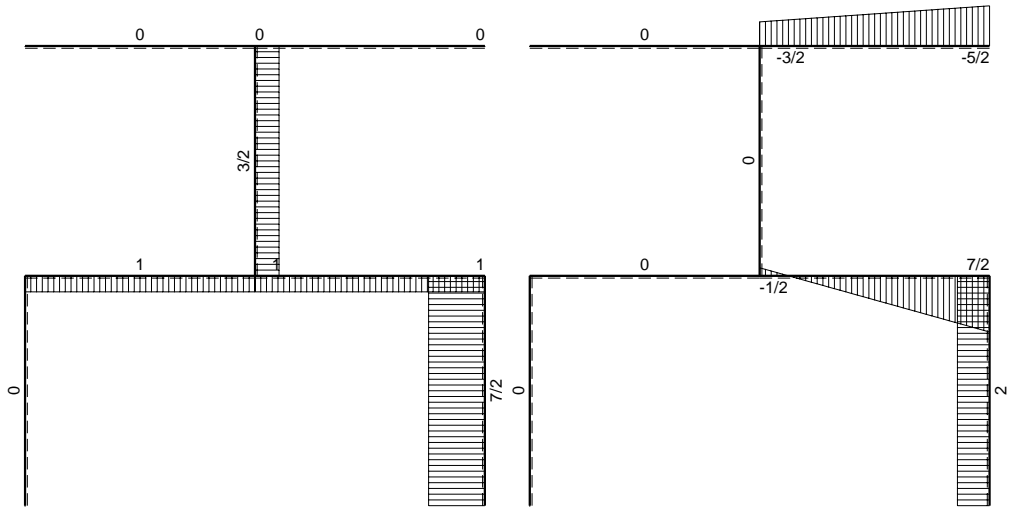
Matrice di equilibrio

$$\begin{bmatrix} H_A b & H_F b & V_G b \end{bmatrix} \begin{bmatrix} Fb & W & qb^2 \end{bmatrix}$$
$$\begin{bmatrix} \varphi_{CB} \\ \varphi_{CE} \\ u_{EC} \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & -2 & 1 \\ 0 & 1 & 0 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 2 & 1/2 \\ 0 & 0 & 0 \end{bmatrix}$$

Soluzione del sistema

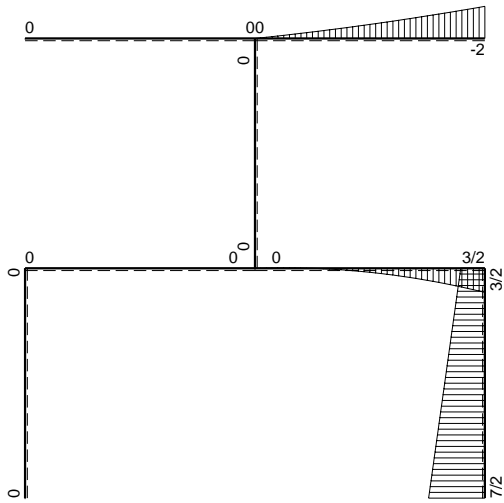
$$\begin{bmatrix} H_A b \\ H_F b \\ V_G b \end{bmatrix} = \begin{bmatrix} Fb & W & qb^2 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$
$$\begin{bmatrix} H_A b \\ H_F b \\ V_G b \end{bmatrix} = \begin{bmatrix} 0 & 2 & 1/2 \end{bmatrix}$$



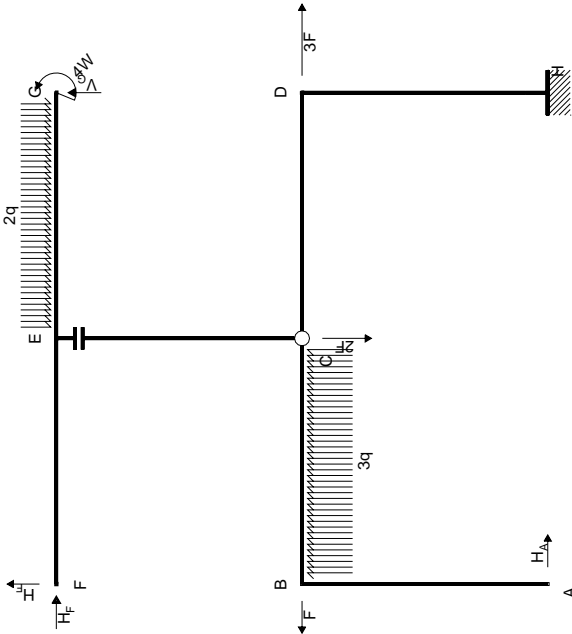


← $\boxed{+}$ → F

$\boxed{+}$ ↓ F



↺ $\boxed{+}$ ↻ F_b



EQUAZIONI DI EQUILIBRIO

Rotazione intorno a C: aste CB BA

$$H_A b = 3/2 q b^2$$

Rotazione intorno a C: aste CE EF EG

$$-2H_F b + V_C b = -4W + q b^2$$

Traslazione orizzontale: aste EF EG

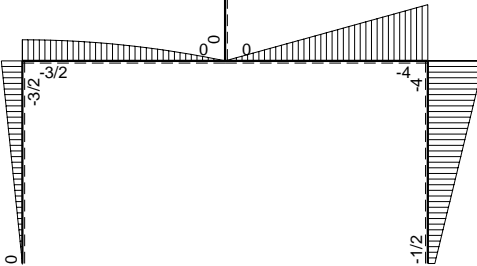
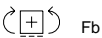
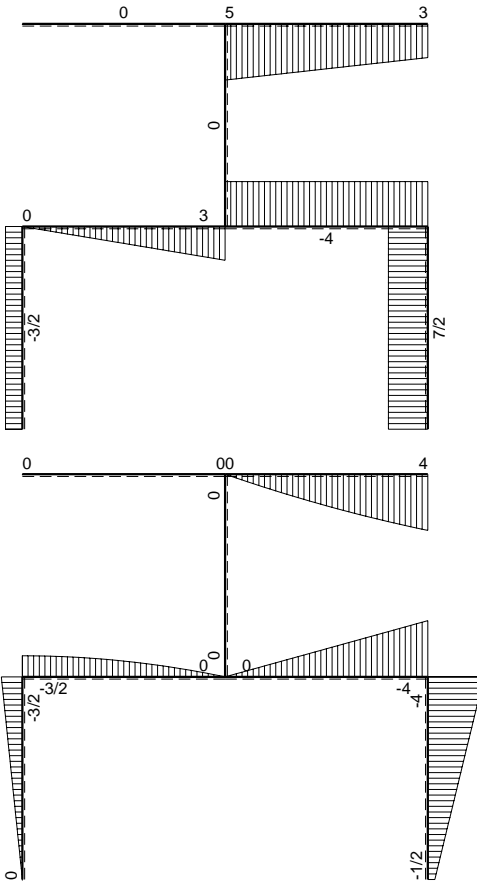
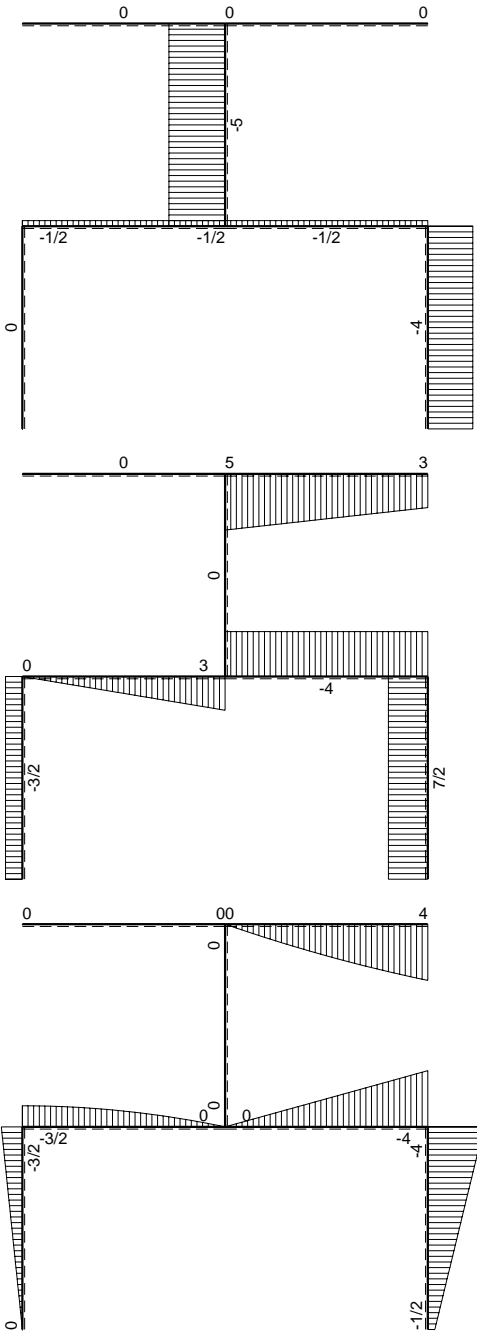
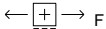
$$H_F = 0$$

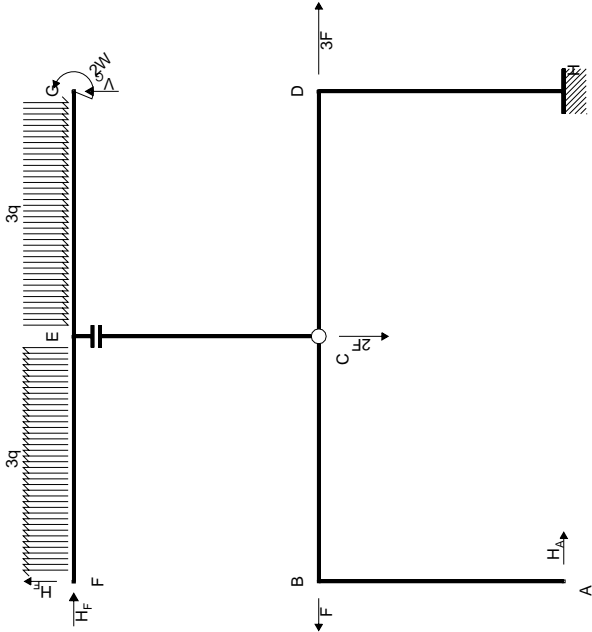
Matrice di equilibrio

$$\begin{bmatrix} H_A b & H_F b & V_C b \\ \varphi_{CB} & 1 & 0 & 0 \\ \varphi_{CE} & 0 & -2 & 1 \\ u_{EC} & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} F_b & W & q b^2 \\ 0 & 0 & 3/2 \\ 0 & -4 & 1 \\ 0 & 0 & 0 \end{bmatrix}$$

Soluzione del sistema

$$\begin{bmatrix} H_A b \\ H_F b \\ V_C b \end{bmatrix} = \begin{bmatrix} F_b & W & q b^2 \\ 0 & 0 & 3/2 \\ 0 & 0 & 0 \\ 0 & -4 & 1 \end{bmatrix}$$





EQUAZIONI DI EQUILIBRIO

Rotazione intorno a C: aste CB BA

$H_A \cdot b = 0$

Rotazione intorno a C: aste CE EF EG

$-2H_F \cdot b + V_C \cdot b = -2W + 3qb^2$

Traslazione orizzontale: aste EF EG

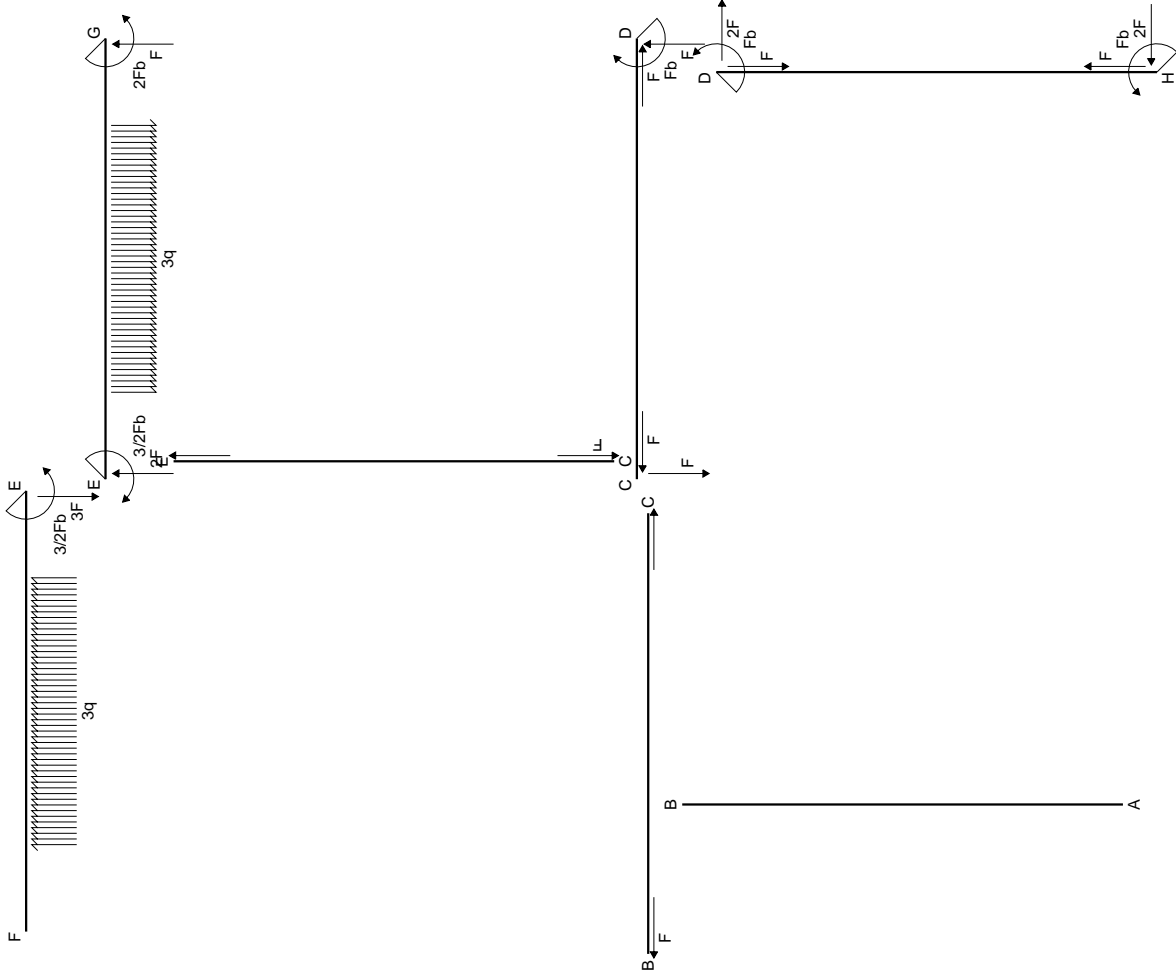
$H_F = 0$

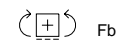
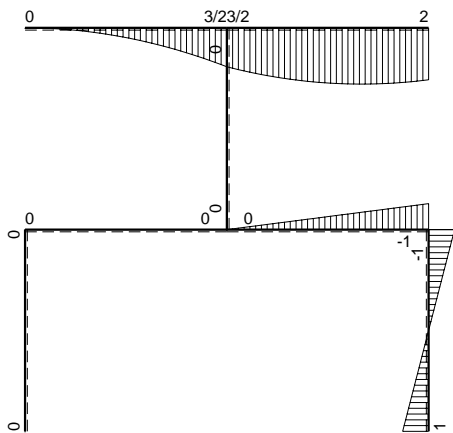
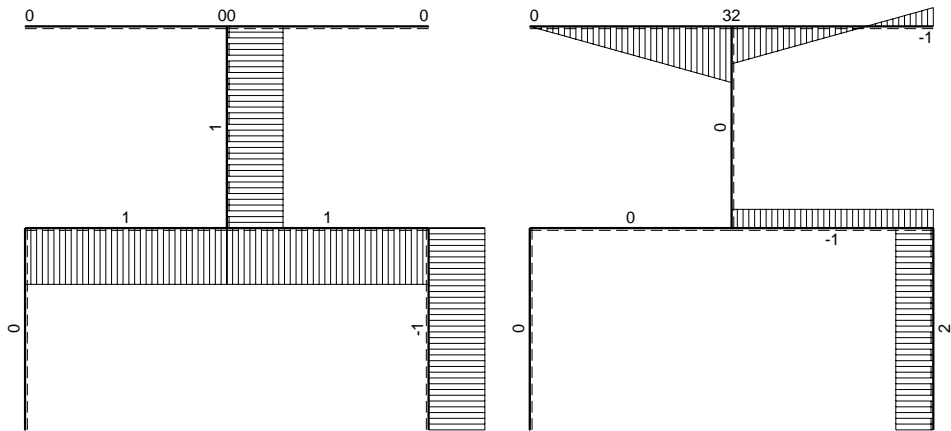
Matrice di equilibrio

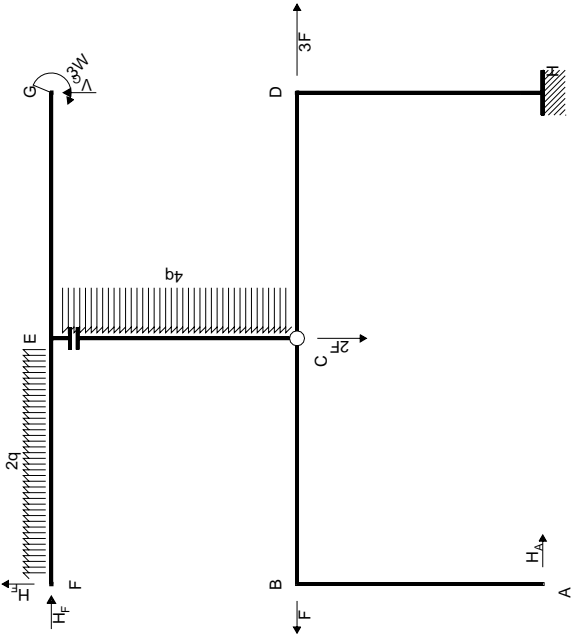
$$\begin{bmatrix} H_A \cdot b & H_F \cdot b & V_C \cdot b \\ 1 & 0 & 0 \\ 0 & -2 & 1 \\ 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} F_b & W & qb^2 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & -2 & 3 \\ 0 & 0 & 0 \end{bmatrix}$$

Soluzione del sistema

$$\begin{bmatrix} H_A \cdot b \\ H_F \cdot b \\ V_C \cdot b \end{bmatrix} = \begin{bmatrix} F_b & W & qb^2 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & -2 & 3 \end{bmatrix}$$







EQUAZIONI DI EQUILIBRIO

Rotazione intorno a C: aste CB BA

$H_A \cdot b = 0$

Rotazione intorno a C: aste CE EF EG

$-2H_F \cdot b + V_G \cdot b = 3W - qb^2$

Traslazione orizzontale: aste EF EG

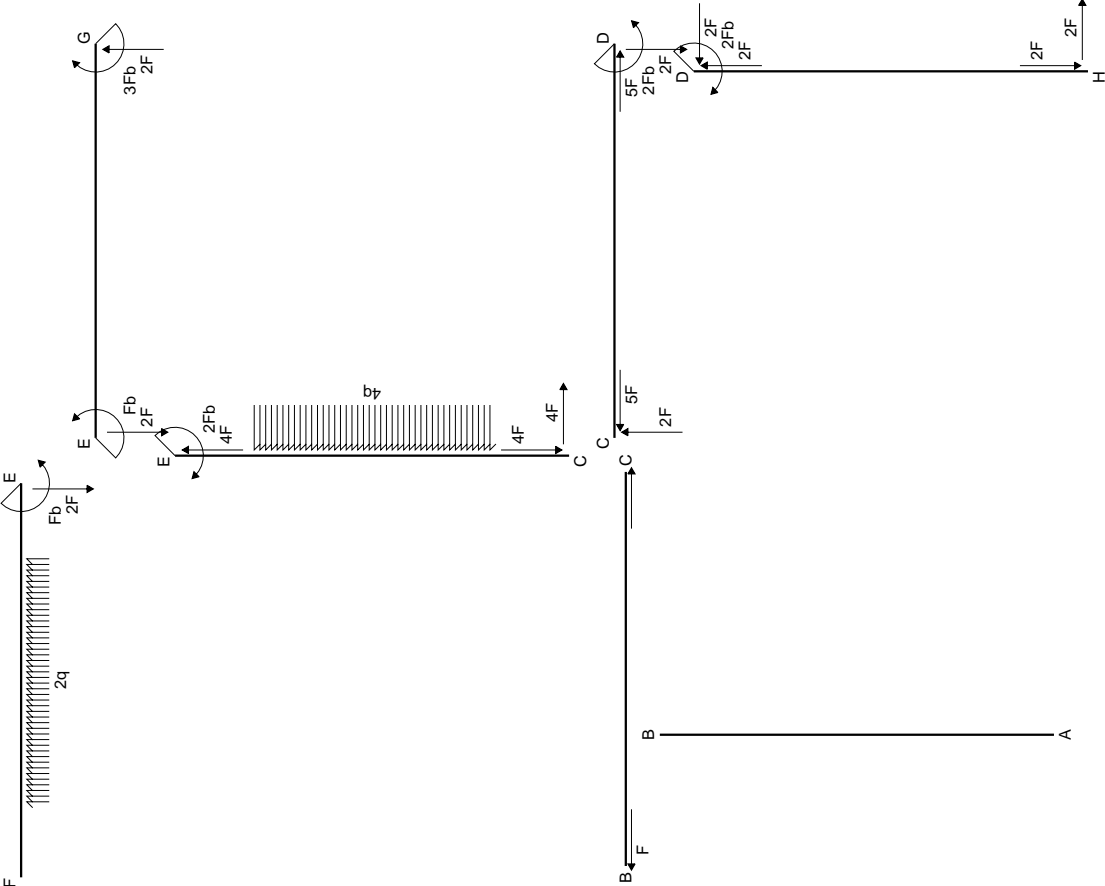
$H_F = 0$

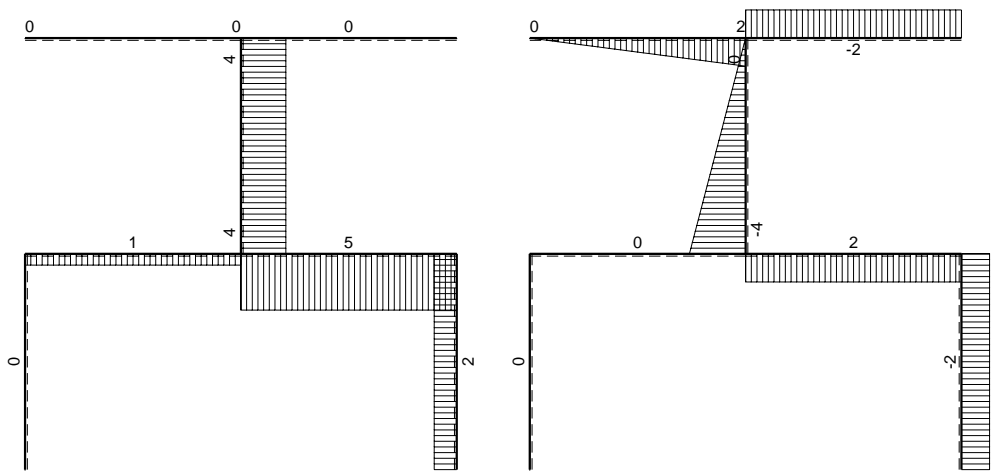
Matrice di equilibrio

$$\begin{bmatrix} H_A \cdot b & H_F \cdot b & V_G \cdot b \\ 1 & 0 & 0 \\ 0 & -2 & 1 \\ 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} F_b & W & qb^2 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 3 & -1 \\ 0 & 0 & 0 \end{bmatrix}$$

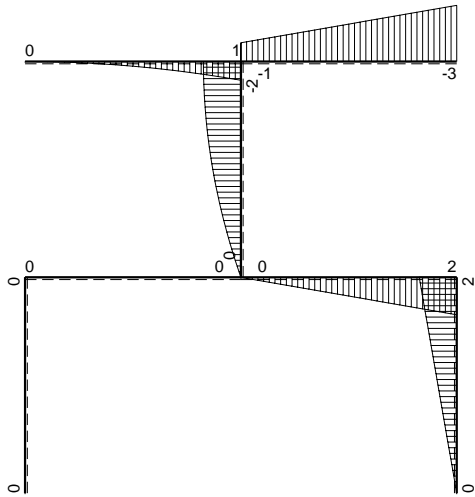
Soluzione del sistema

$$\begin{bmatrix} H_A \cdot b \\ H_F \cdot b \\ V_G \cdot b \end{bmatrix} = \begin{bmatrix} F_b & W & qb^2 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 3 & -1 \end{bmatrix}$$

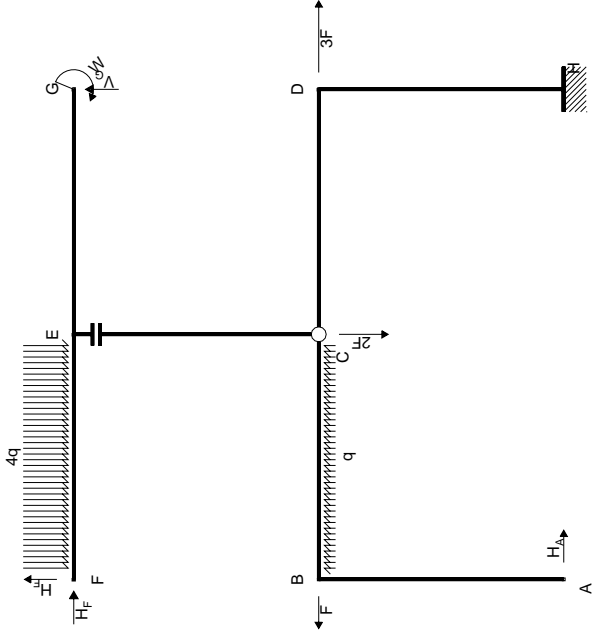




← $\boxed{+}$ → F



↺ $\boxed{+}$ ↻ F_b



EQUAZIONI DI EQUILIBRIO

Rotazione intorno a C: aste CB BA

$H_A b = 1/2 q b^2$

Rotazione intorno a C: aste CE EF EG

$-2H_F b + V_C b = W - 2q b^2$

Traslazione orizzontale: aste EF EG

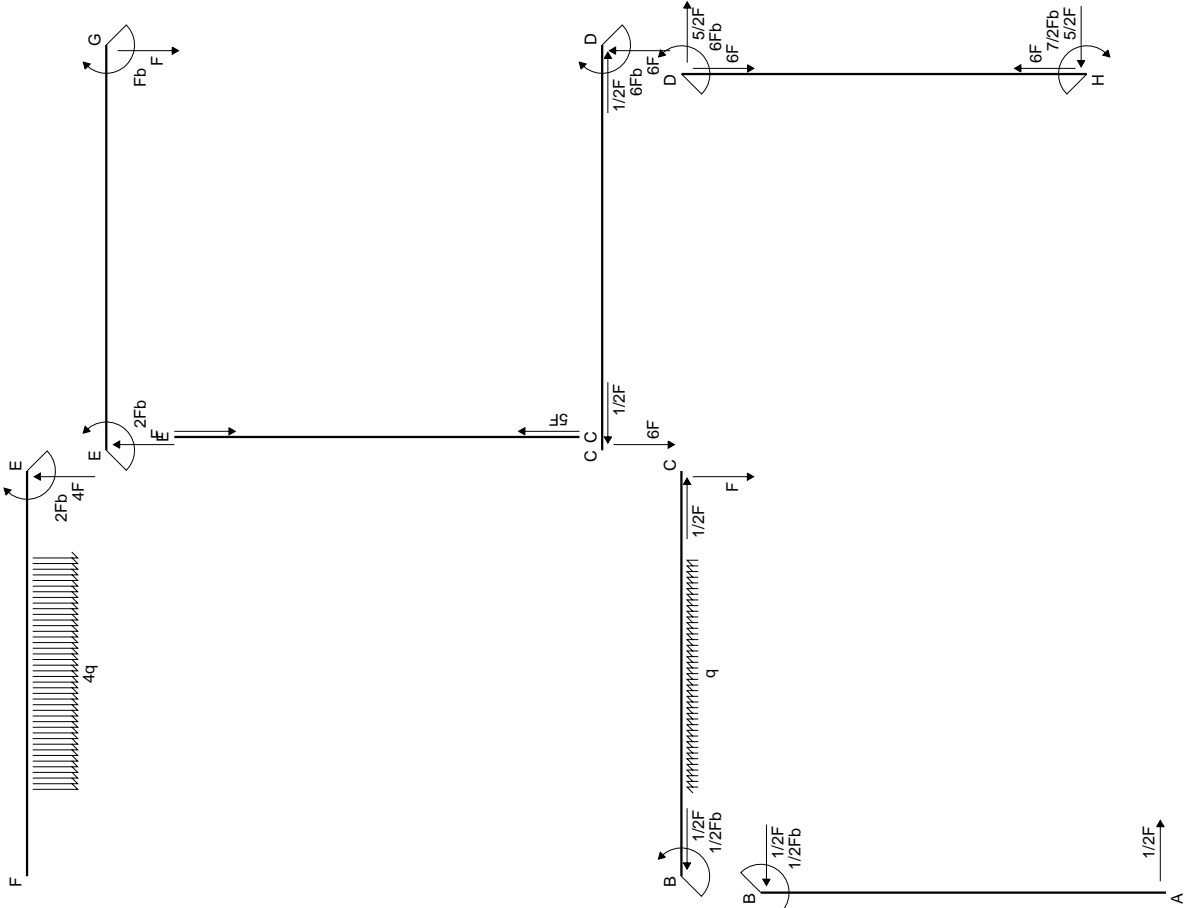
$H_F = 0$

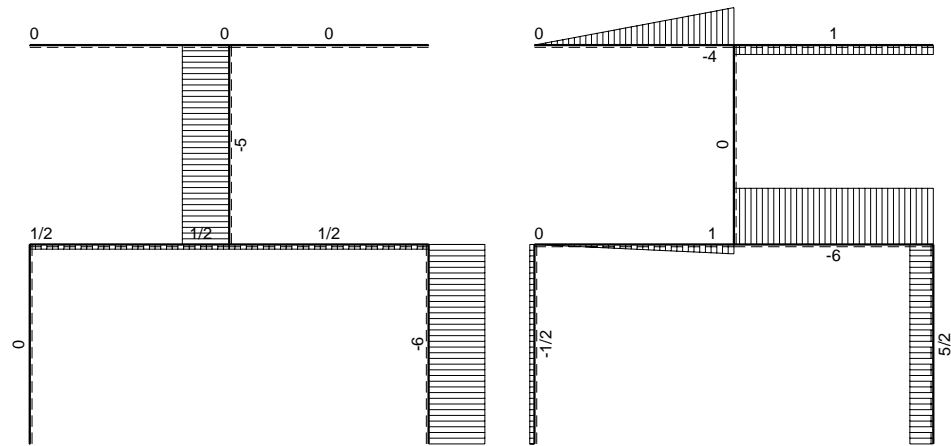
Matrice di equilibrio

$$\begin{bmatrix} H_A b & H_F b & V_C b \end{bmatrix} \begin{bmatrix} Fb & W & q b^2 \end{bmatrix}$$
$$\varphi_{CB} \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} 0 & 0 & 1/2 \end{bmatrix}$$
$$\varphi_{CE} \begin{bmatrix} 0 & -2 & 1 \end{bmatrix} = \begin{bmatrix} 0 & 1 & -2 \end{bmatrix}$$
$$u_{EC} \begin{bmatrix} 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} 0 & 0 & 0 \end{bmatrix}$$

Soluzione del sistema

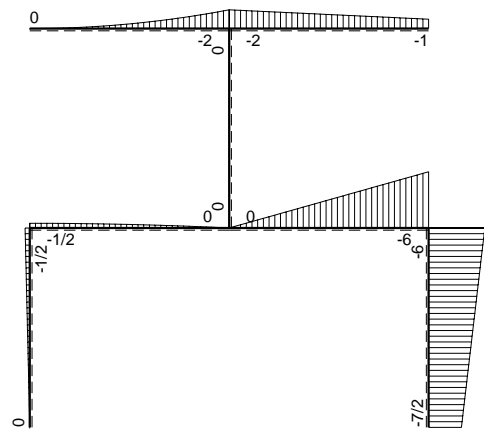
$$\begin{bmatrix} H_A b \\ H_F b \\ V_C b \end{bmatrix} = \begin{bmatrix} Fb & W & q b^2 \end{bmatrix} \begin{bmatrix} 0 & 0 & 1/2 \\ 0 & 1 & -2 \\ 0 & 1 & -2 \end{bmatrix}$$



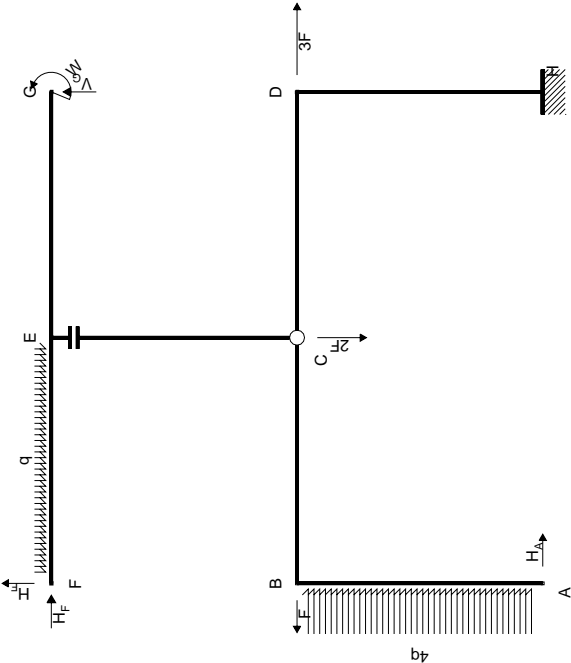


← $\boxed{+}$ → F

$\boxed{+}$ ↓ F



↺ $\boxed{+}$ ↻ F_b



EQUAZIONI DI EQUILIBRIO

Rotazione intorno a C: aste CB BA

$H_A b = -2qb^2$

Rotazione intorno a C: aste CE EF EG

$-2H_F b + V_G b = -W \cdot 1/2qb^2$

Traslazione orizzontale: aste EF EG

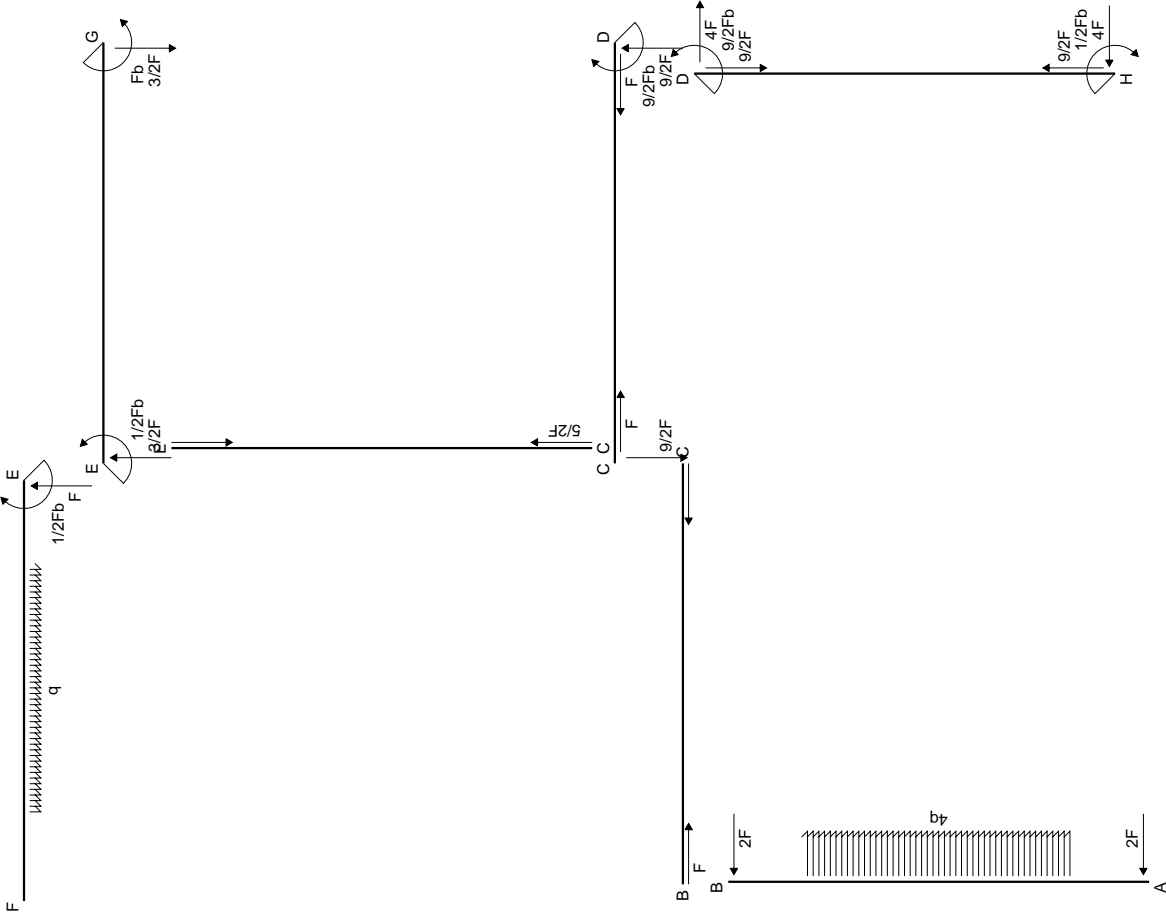
$H_F = 0$

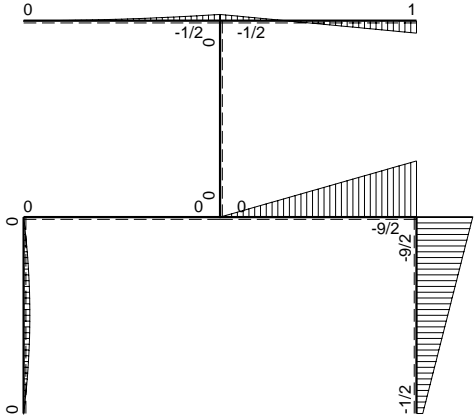
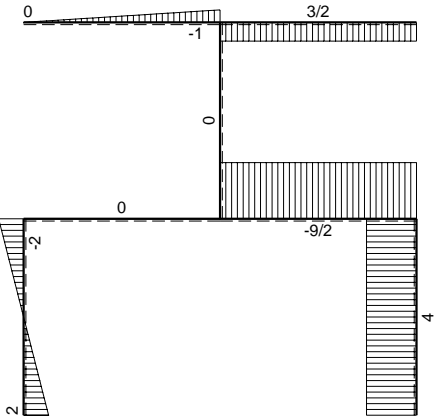
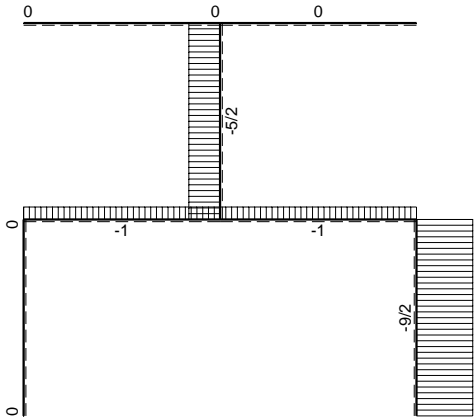
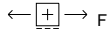
Matrice di equilibrio

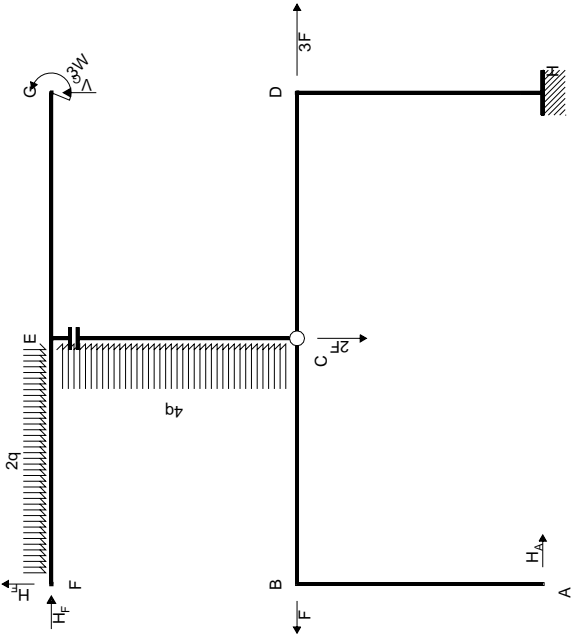
$$\begin{bmatrix} H_A b & H_F b & V_G b \\ \varphi_{CB} & 1 & 0 & 0 \\ \varphi_{CE} & 0 & -2 & 1 \\ u_{EC} & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} F_b \\ W \\ qb^2 \end{bmatrix} = \begin{bmatrix} 0 & 0 & -2 \\ 0 & 0 & 0 \\ 0 & -1 & -1/2 \\ 0 & 0 & 0 \end{bmatrix}$$

Soluzione del sistema

$$\begin{bmatrix} H_A b \\ H_F b \\ V_G b \end{bmatrix} = \begin{bmatrix} F_b \\ W \\ qb^2 \end{bmatrix} \begin{bmatrix} 0 & 0 & -2 \\ 0 & 0 & 0 \\ 0 & -1 & -1/2 \end{bmatrix}$$







EQUAZIONI DI EQUILIBRIO

Rotazione intorno a C: aste CB BA

$H_A \cdot b = 0$

Rotazione intorno a C: aste CE EF EG

$-2H_F \cdot b + V_C \cdot b = -3W + qb^2$

Traslazione orizzontale: aste EF EG

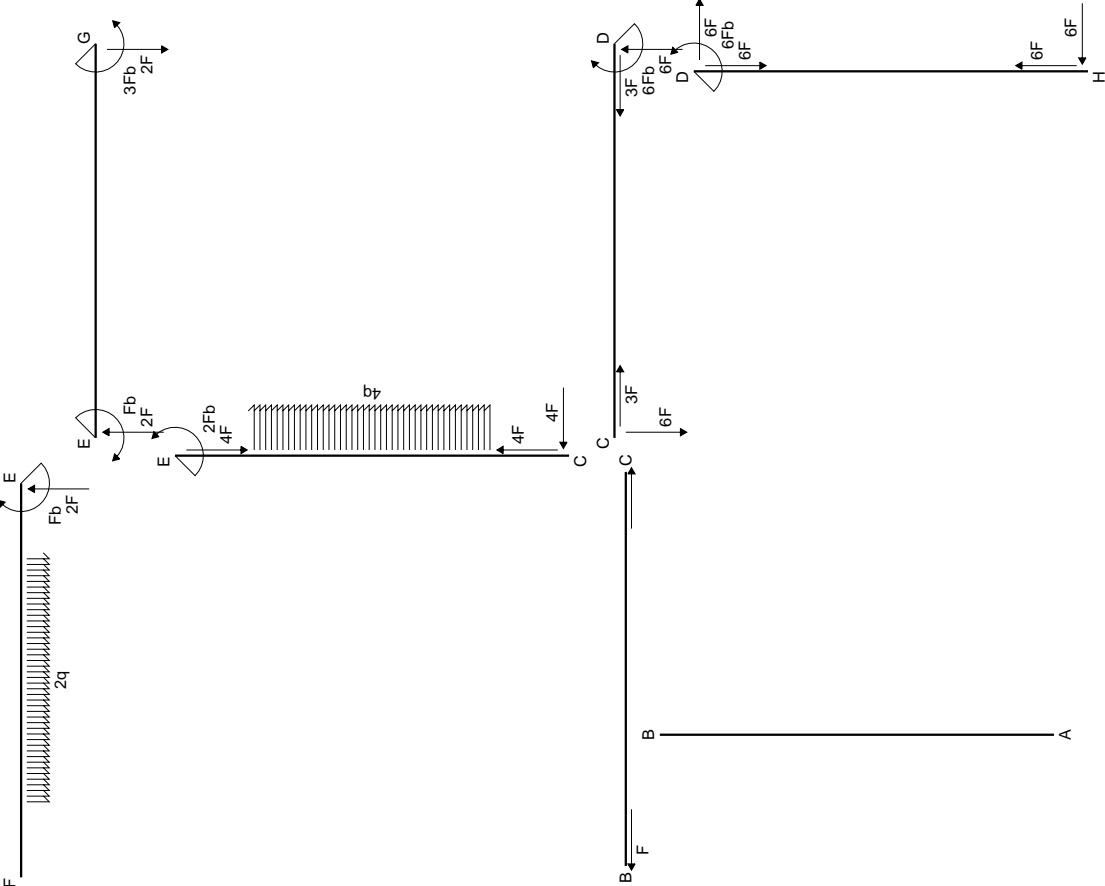
$H_F = 0$

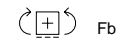
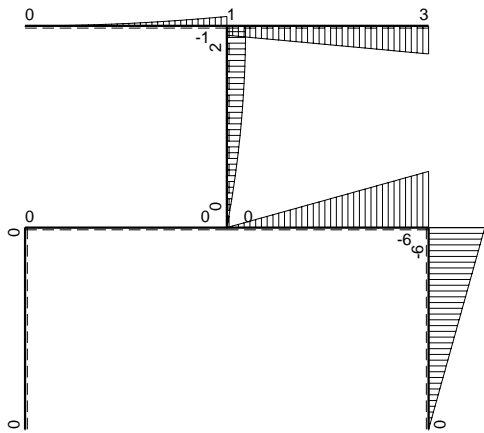
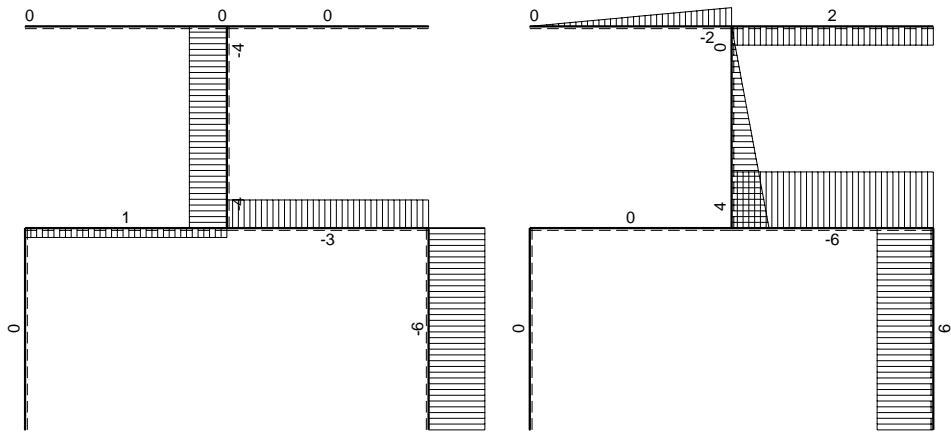
Matrice di equilibrio

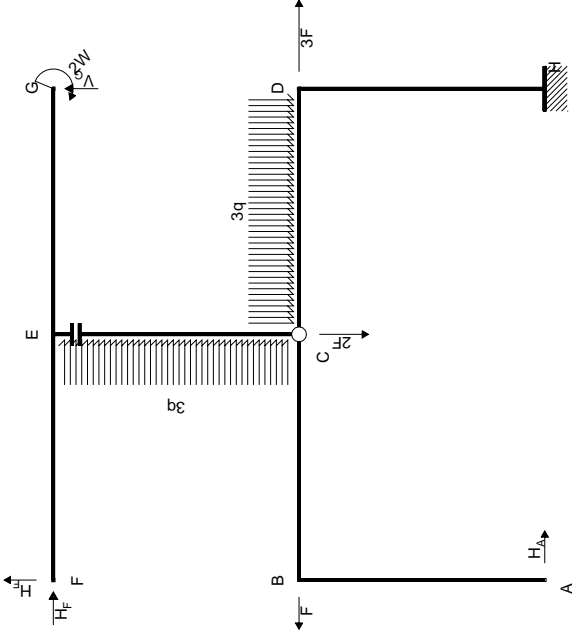
$$\begin{bmatrix} H_A \cdot b & H_F \cdot b & V_C \cdot b \end{bmatrix} \begin{bmatrix} Fb & W & qb^2 \end{bmatrix}$$
$$\begin{bmatrix} \varphi_{CB} \\ \varphi_{CE} \\ u_{EC} \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & -2 & 1 \\ 0 & 1 & 0 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & -3 & 1 \\ 0 & 0 & 0 \end{bmatrix}$$

Soluzione del sistema

$$\begin{bmatrix} H_A \cdot b \\ H_F \cdot b \\ V_C \cdot b \end{bmatrix} = \begin{bmatrix} Fb & W & qb^2 \\ 0 & 0 & 0 \\ 0 & -3 & 1 \end{bmatrix}$$







EQUAZIONI DI EQUILIBRIO

Rotazione intorno a C: aste CB BA

$H_A \cdot b = 0$

Rotazione intorno a C: aste CE EF EG

$-2H_F \cdot b + V_C \cdot b = 2W + 3/2qb^2$

Traslazione orizzontale: aste EF EG

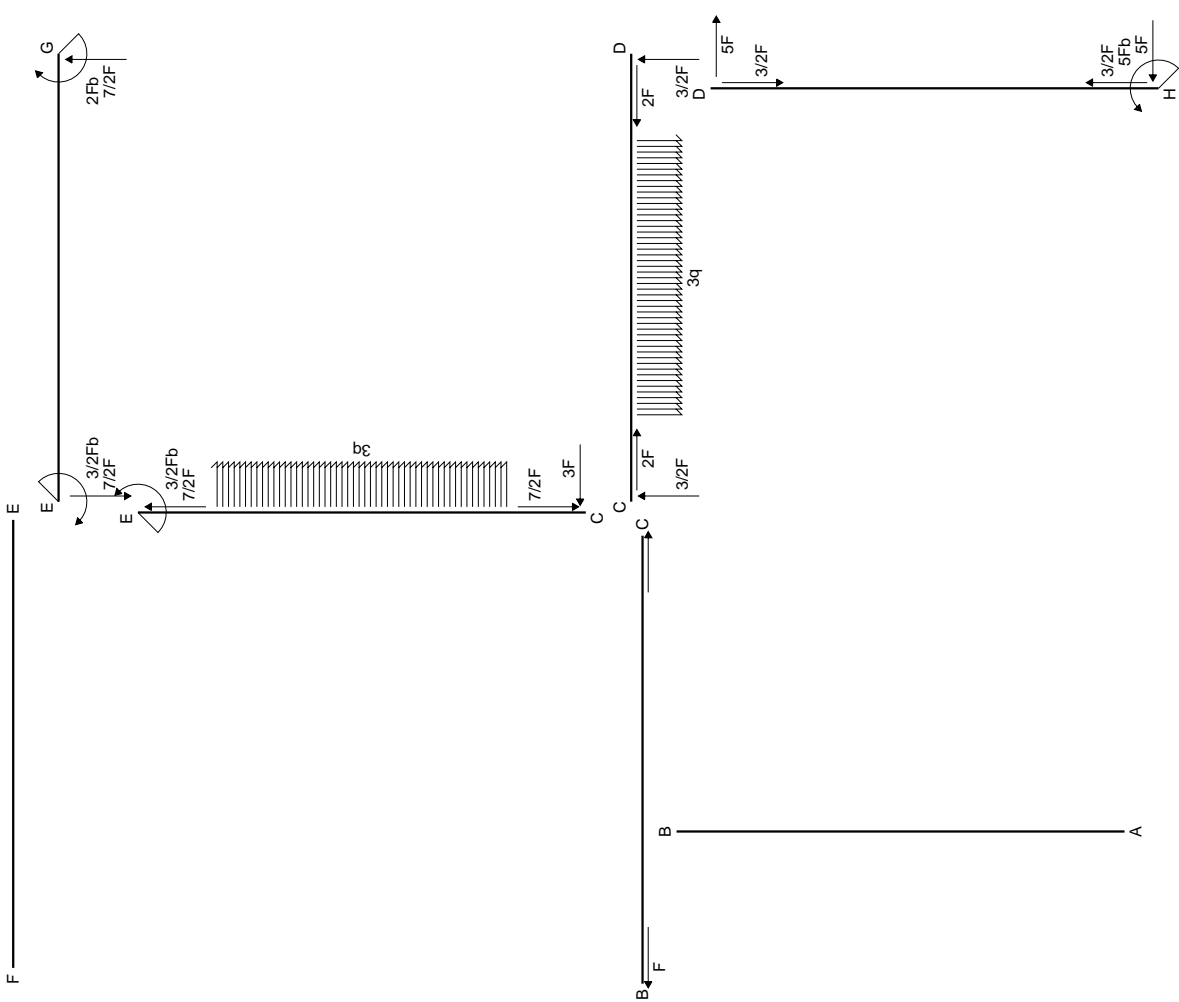
$H_F = 0$

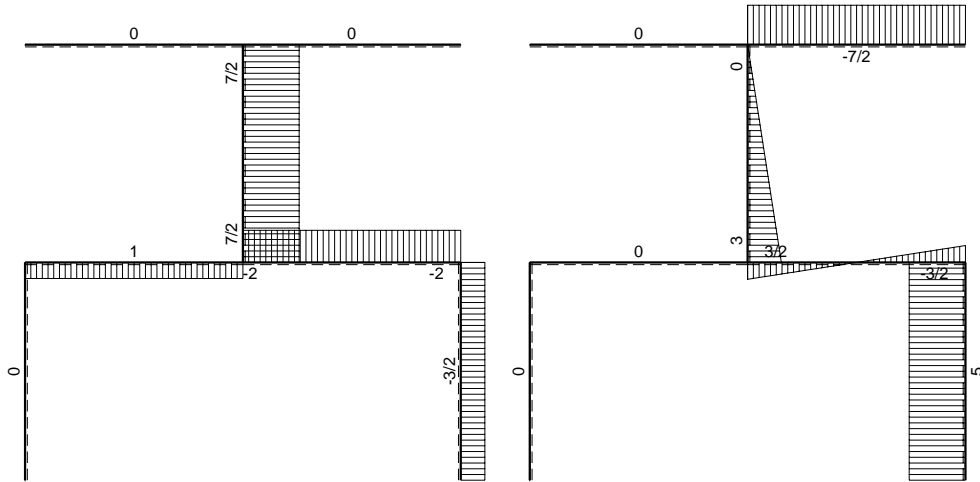
Matrice di equilibrio

$$\begin{bmatrix} H_A \cdot b & H_F \cdot b & V_C \cdot b \\ \varphi_{CB} & 1 & 0 & 0 \\ \varphi_{CE} & 0 & -2 & 1 \\ u_{EC} & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} F_b & W & qb^2 \\ 0 & 0 & 0 \\ 0 & 2 & 3/2 \\ 0 & 0 & 0 \end{bmatrix}$$

Soluzione del sistema

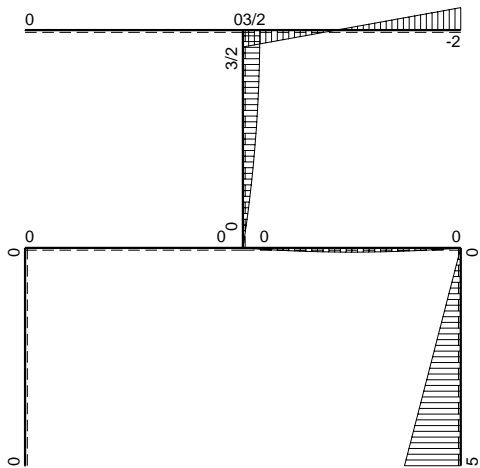
$$\begin{bmatrix} H_A \cdot b \\ H_F \cdot b \\ V_C \cdot b \end{bmatrix} = \begin{bmatrix} F_b & W & qb^2 \\ 0 & 0 & 0 \\ 0 & 2 & 3/2 \end{bmatrix}$$



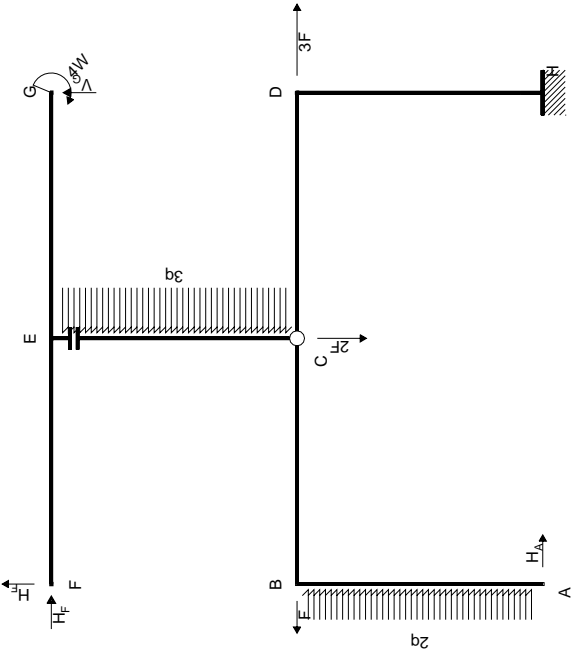


← $\boxed{+}$ → F

$\uparrow \boxed{+} \downarrow$ Mb



$\curvearrowright \boxed{+} \curvearrowleft$ Mb



EQUAZIONI DI EQUILIBRIO

Rotazione intorno a C: aste CB BA

$H_A b = -q b^2$

Rotazione intorno a C: aste CE EF EG

$-2H_F b + V_G b = 4W - 3/2 q b^2$

Traslazione orizzontale: aste EF EG

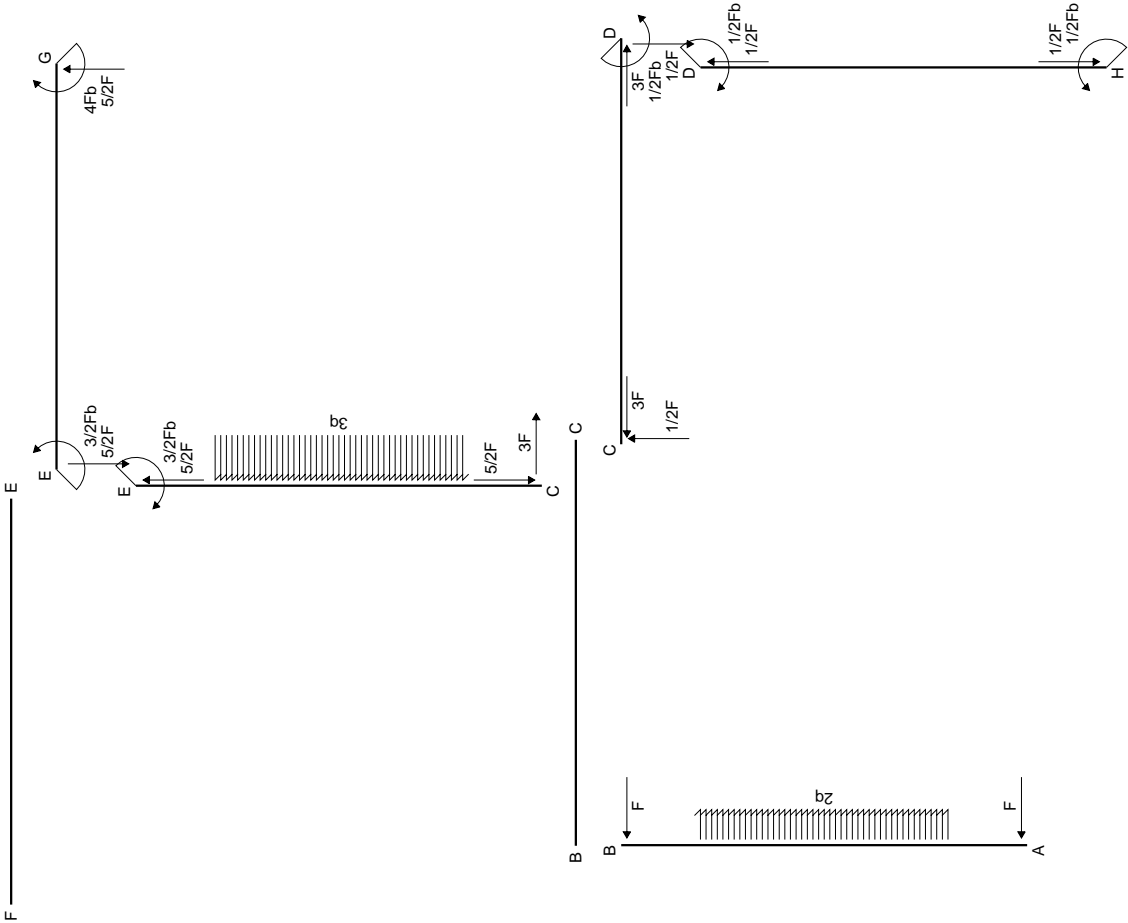
$H_F = 0$

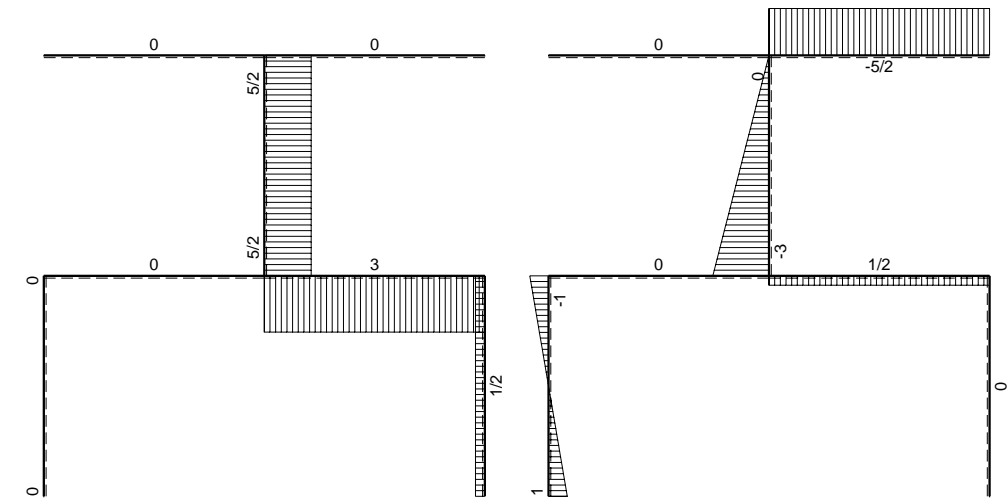
Matrice di equilibrio

$$\begin{bmatrix} H_A b & H_F b & V_G b \end{bmatrix} \begin{bmatrix} Fb & W & q b^2 \end{bmatrix}$$
$$\begin{bmatrix} \varphi_{CB} \\ \varphi_{CE} \\ u_{EC} \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & -2 & 1 \\ 0 & 1 & 0 \end{bmatrix} = \begin{bmatrix} 0 & 0 & -1 \\ 0 & 4 & -3/2 \\ 0 & 0 & 0 \end{bmatrix}$$

Soluzione del sistema

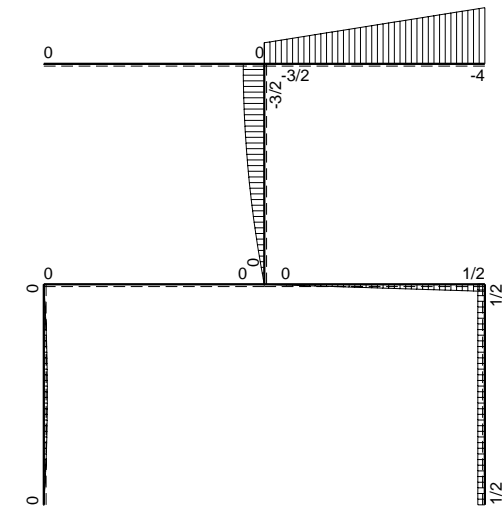
$$\begin{bmatrix} H_A b \\ H_F b \\ V_G b \end{bmatrix} = \begin{bmatrix} 0 & 0 & -1 \\ 0 & 0 & 0 \\ 0 & 4 & -3/2 \end{bmatrix}$$



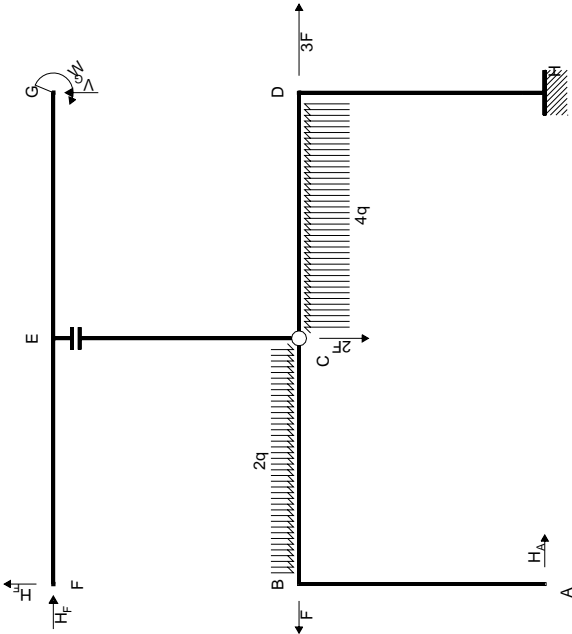


← $\boxed{+}$ → F

$\boxed{+}$ ↓ F



$\boxed{+}$ ↺ F_b



EQUAZIONI DI EQUILIBRIO

Rotazione intorno a C: aste CB BA

$H_A b = -qb^2$

Rotazione intorno a C: aste CE EF EG

$-2H_F b + V_G b = W$

Traslazione orizzontale: aste EF EG

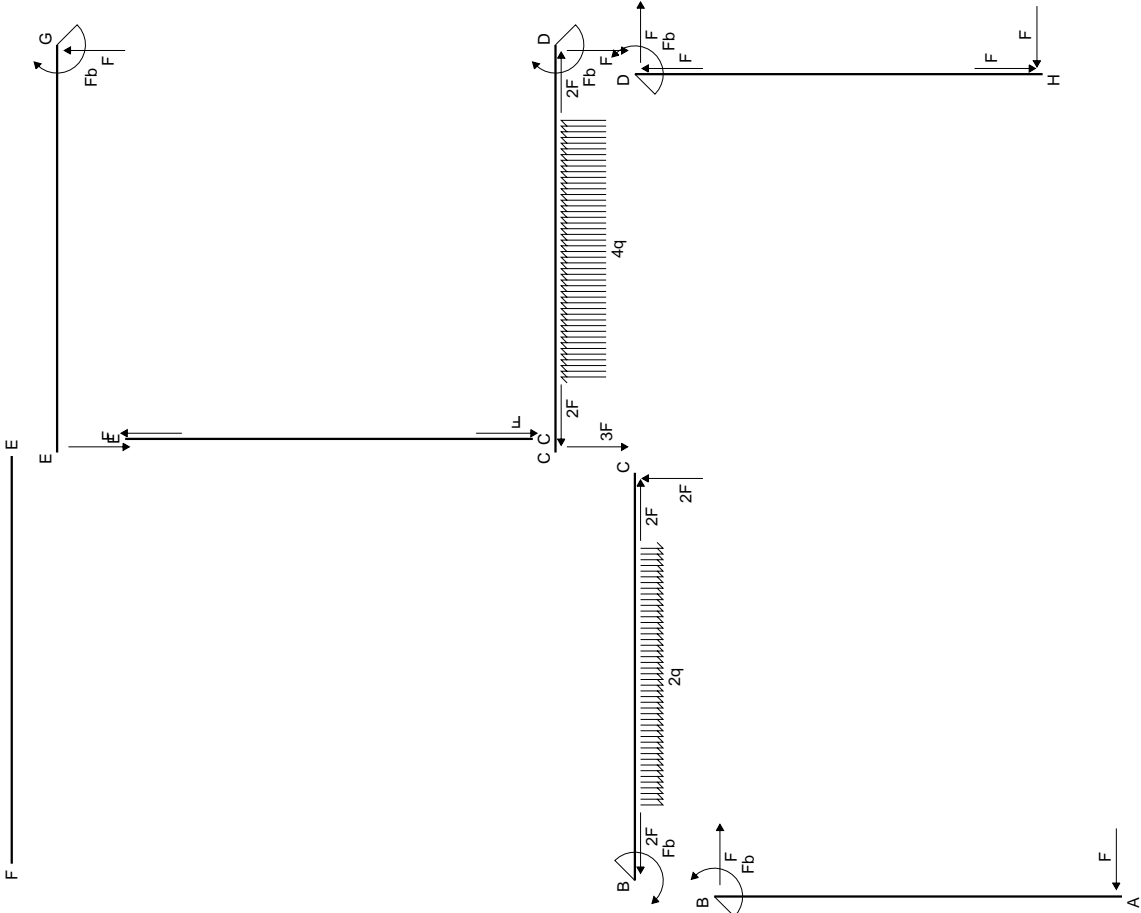
$H_F = 0$

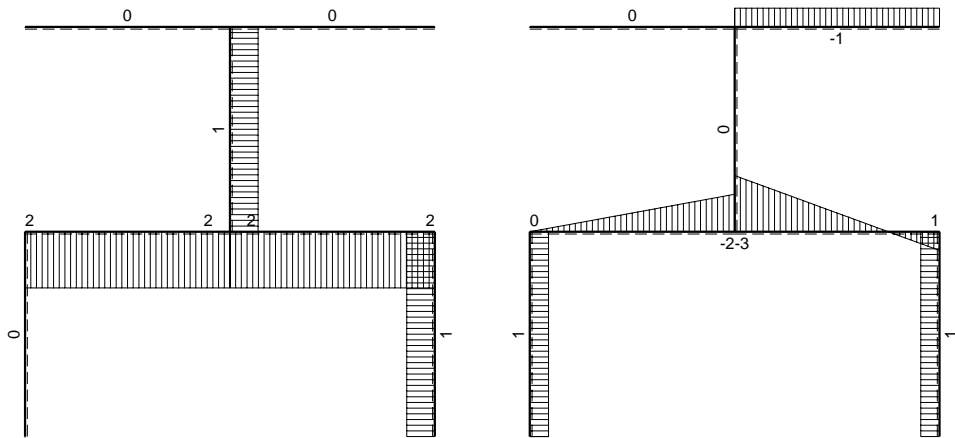
Matrice di equilibrio

$$\begin{bmatrix} H_A b & H_F b & V_G b \\ \varphi_{CB} & 1 & 0 & 0 \\ \varphi_{CE} & 0 & -2 & 1 \\ u_{EG} & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} Fb & W & qb^2 \\ 0 & 0 & -1 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

Soluzione del sistema

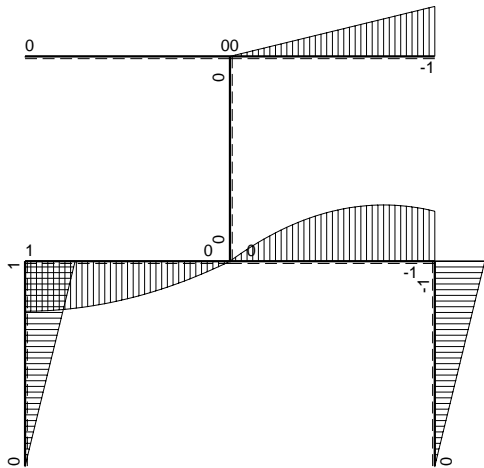
$$\begin{bmatrix} H_A b \\ H_F b \\ V_G b \end{bmatrix} = \begin{bmatrix} Fb & W & qb^2 \\ 0 & 0 & -1 \\ 0 & 1 & 0 \end{bmatrix}$$



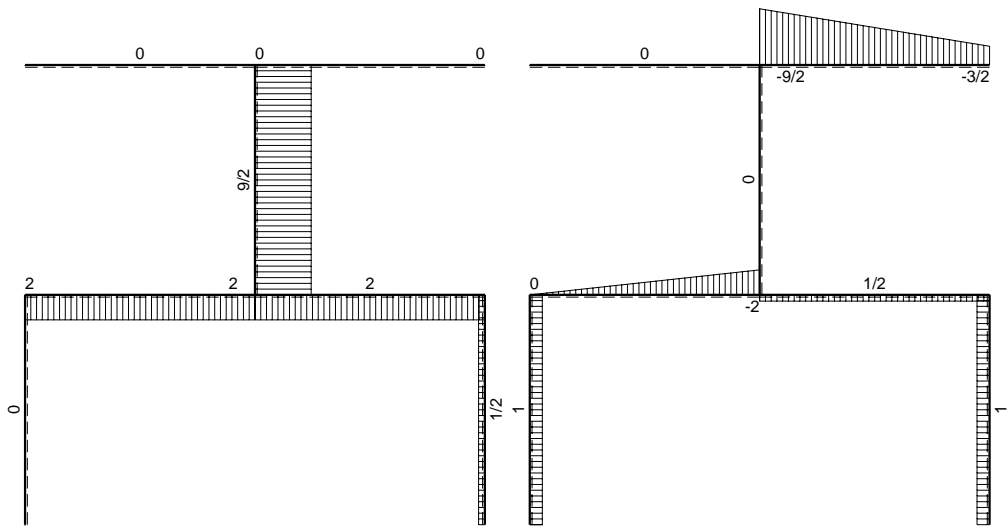


← → F

↓ F

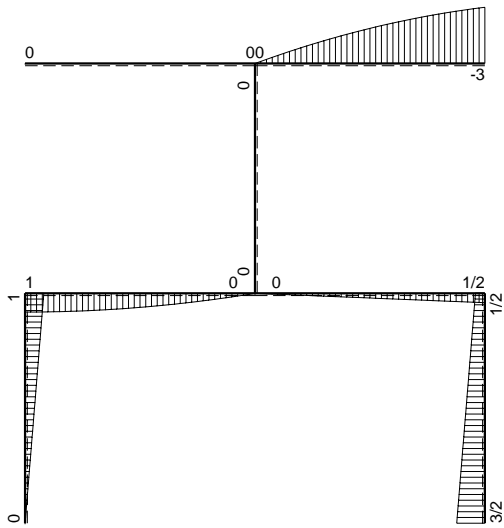


Fb

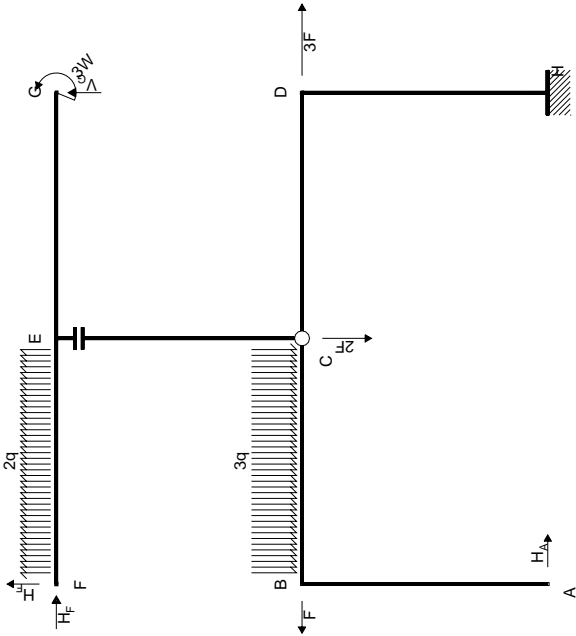


← $\boxed{+}$ → F

↑ $\boxed{+}$ ↓ F



↺ $\boxed{+}$ ↻ F_b



EQUAZIONI DI EQUILIBRIO

Rotazione intorno a C: aste CB BA

$H_A b = -3/2 q b^2$

Rotazione intorno a C: aste CE EF EG

$-2H_F b + V_F b = -3W + q b^2$

Traslazione orizzontale: aste EF EG

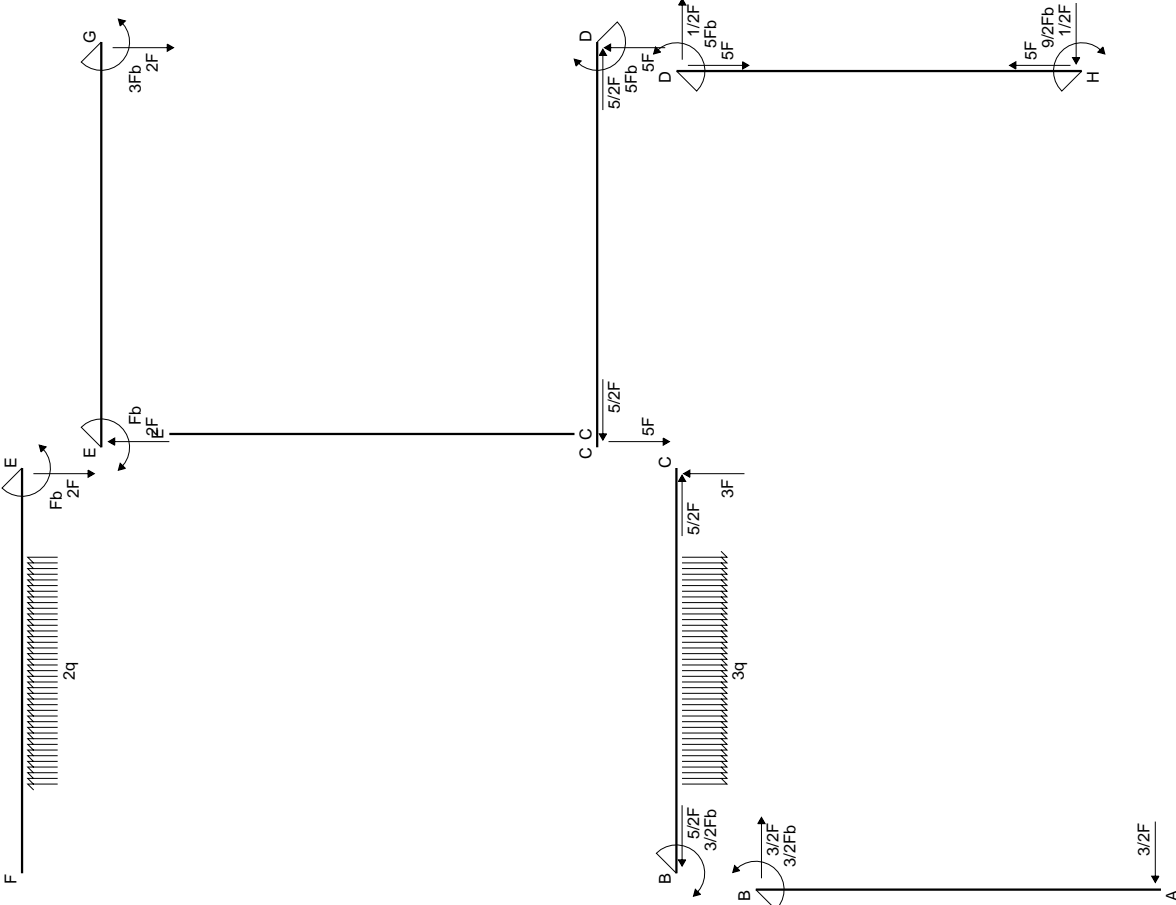
$H_F = 0$

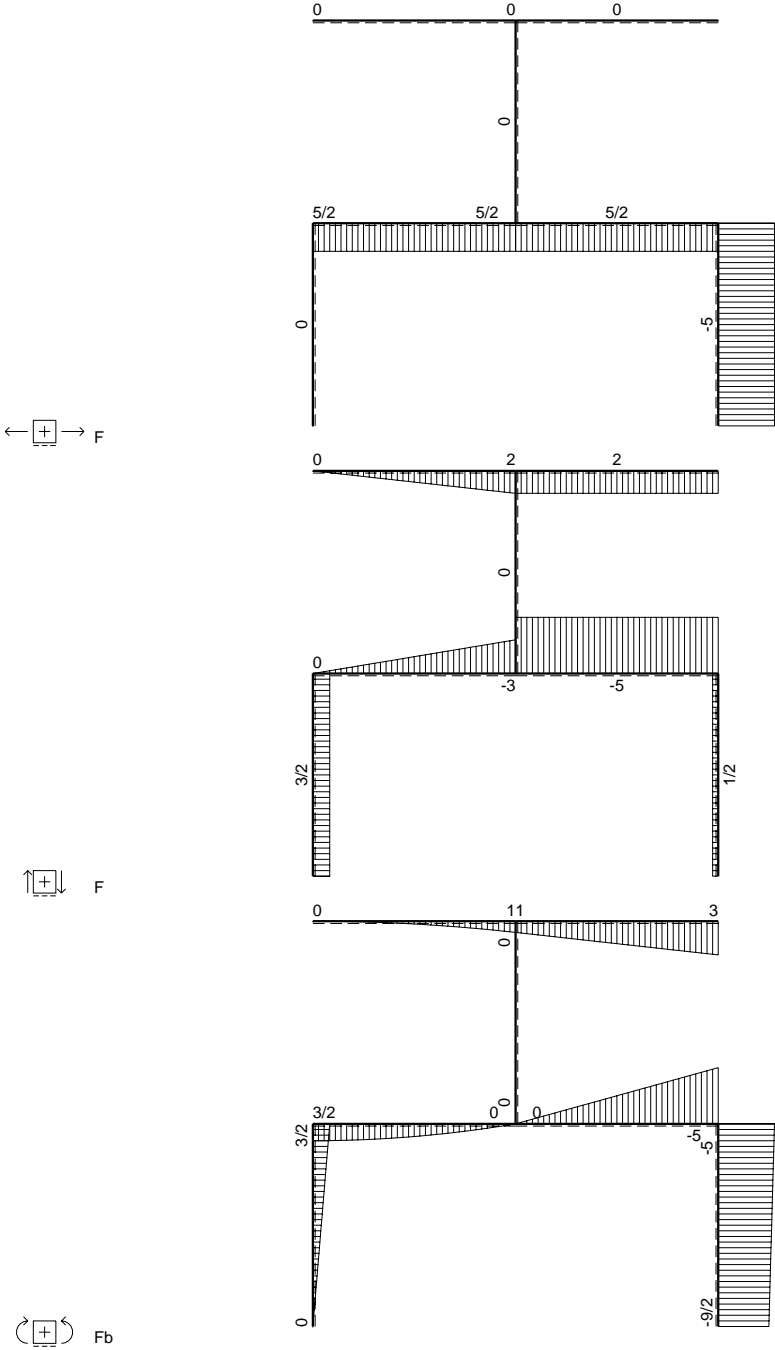
Matrice di equilibrio

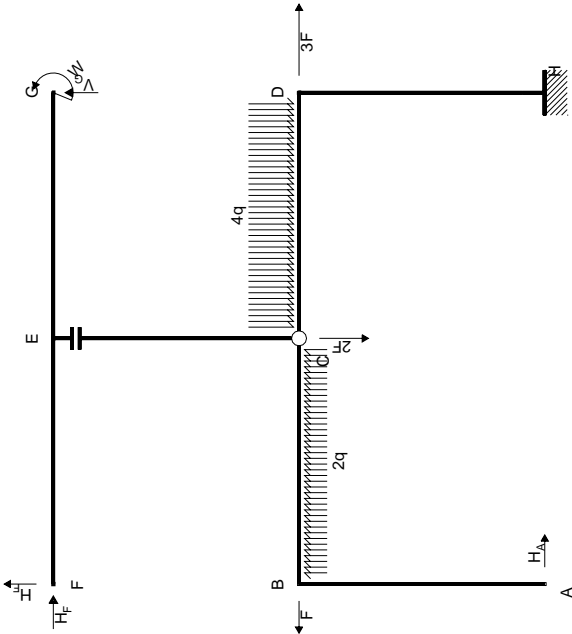
$$\begin{bmatrix} H_A b & H_F b & V_F b \\ \varphi_{CB} & 1 & 0 & 0 \\ \varphi_{CE} & 0 & -2 & 1 \\ u_{EC} & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} F_b \\ W \\ q b^2 \end{bmatrix} = \begin{bmatrix} 0 & 0 & -3/2 \\ 0 & 0 & -3 \\ 0 & 0 & 0 \end{bmatrix}$$

Soluzione del sistema

$$\begin{bmatrix} H_A b \\ H_F b \\ V_F b \end{bmatrix} = \begin{bmatrix} 0 & 0 & -3/2 \\ 0 & 0 & 0 \\ 0 & -3 & 1 \end{bmatrix} \begin{bmatrix} F_b \\ W \\ q b^2 \end{bmatrix}$$







EQUAZIONI DI EQUILIBRIO

Rotazione intorno a C: aste CB BA

$$H_A b = q b^2$$

Rotazione intorno a C: aste CE EF EG

$$-2H_F b + V_G b = -W$$

Traslazione orizzontale: aste EF EG

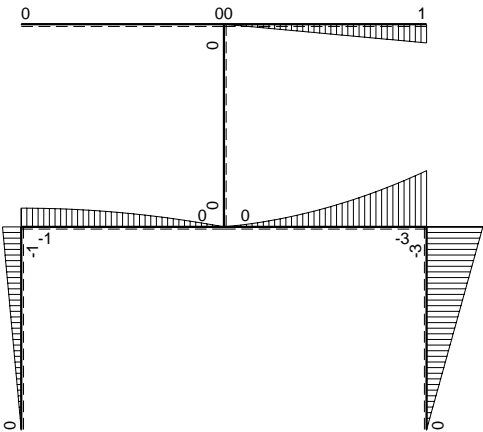
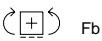
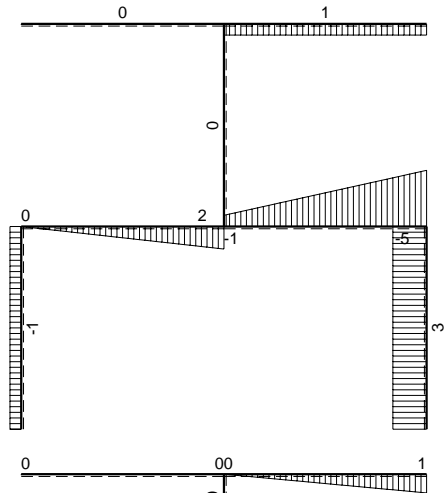
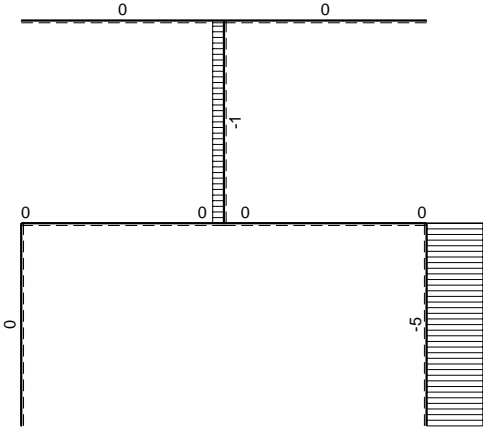
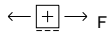
$$H_F = 0$$

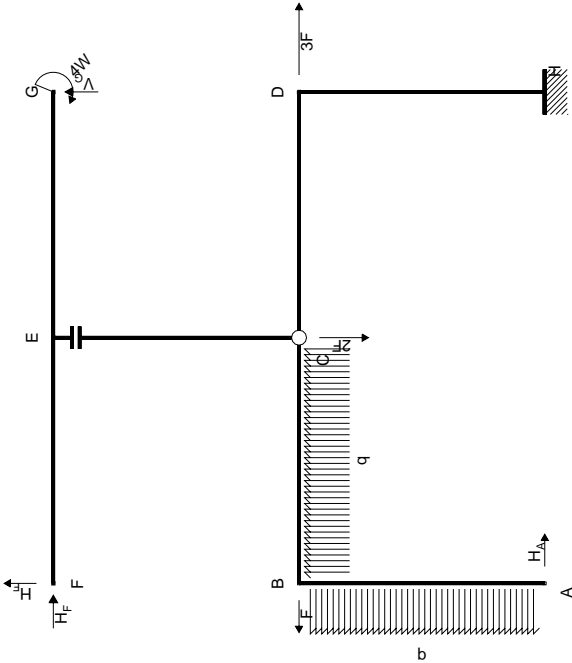
Matrice di equilibrio

$$\begin{bmatrix} H_A b & H_F b & V_G b \end{bmatrix} \begin{bmatrix} F b & W & q b^2 \end{bmatrix} \\ \varphi_{CB} \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} 0 & 0 & 1 \end{bmatrix} \\ \varphi_{CE} \begin{bmatrix} 0 & -2 & 1 \end{bmatrix} \begin{bmatrix} 0 & -1 & 0 \end{bmatrix} \\ u_{EC} \begin{bmatrix} 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} 0 & 0 & 0 \end{bmatrix}$$

Soluzione del sistema

$$\begin{bmatrix} H_A b \\ H_F b \\ V_G b \end{bmatrix} = \begin{bmatrix} F b & W & q b^2 \\ 0 & 0 & 1 \\ 0 & 0 & 0 \\ 0 & -1 & 0 \end{bmatrix}$$





EQUAZIONI DI EQUILIBRIO

Rotazione intorno a C: aste CB BA

$H_A \cdot b = qb^2$

Rotazione intorno a C: aste CE EF EG

$-2H_F \cdot b + V_G \cdot b = 4W$

Traslazione orizzontale: aste EF EG

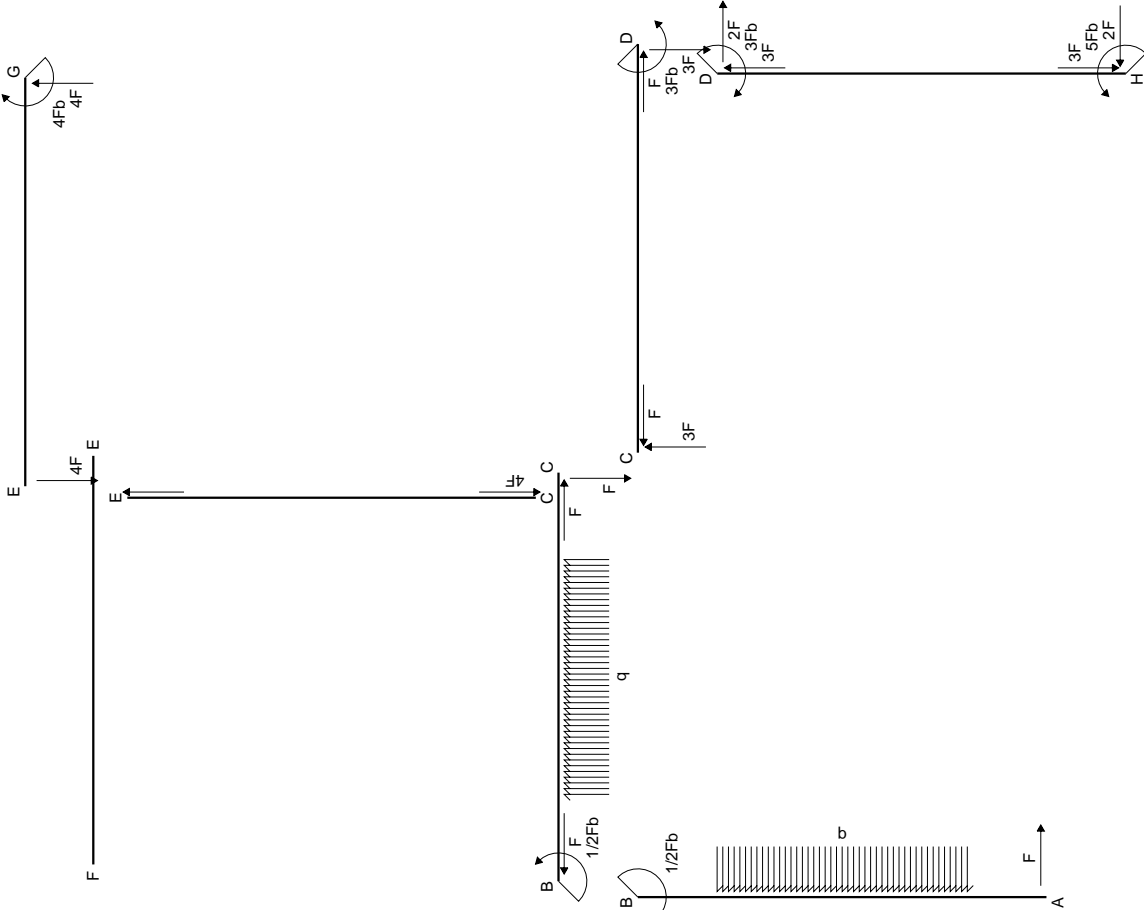
$H_F = 0$

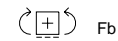
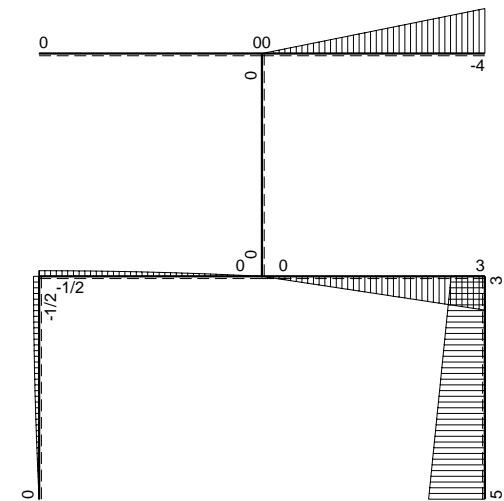
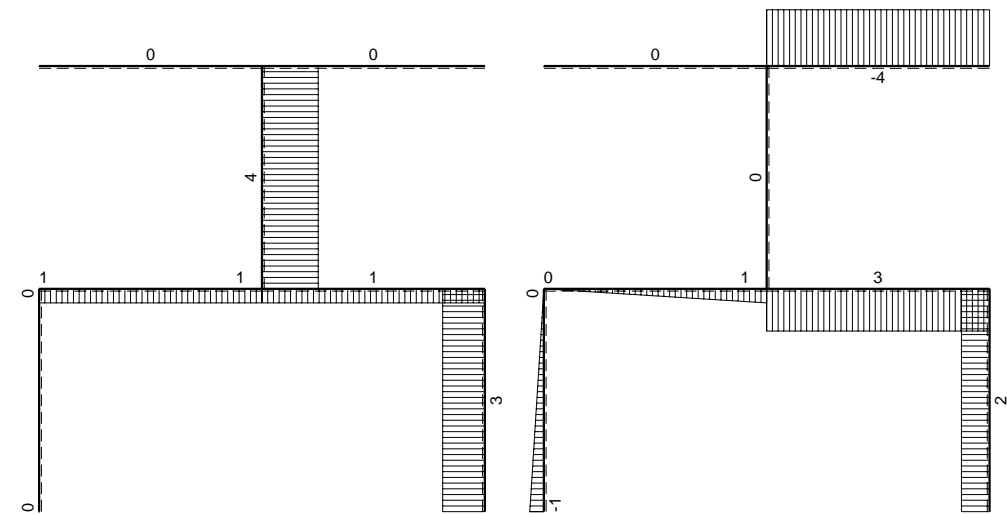
Matrice di equilibrio

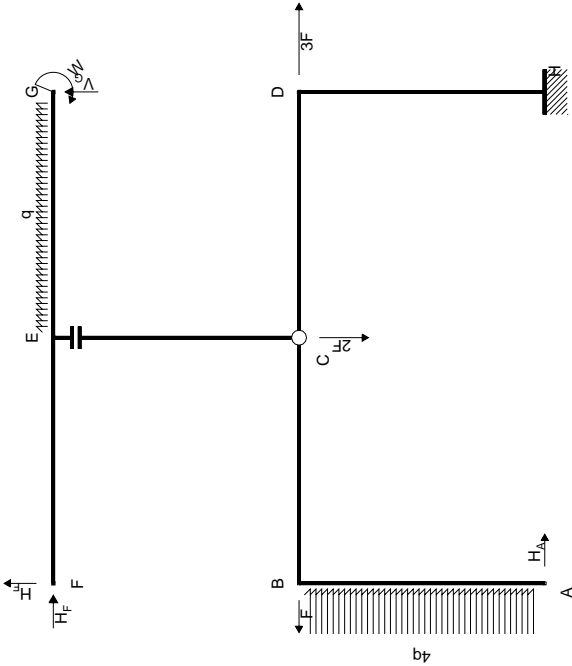
$$\begin{bmatrix} H_A \cdot b & H_F \cdot b & V_G \cdot b \end{bmatrix} \begin{bmatrix} Fb & W & qb^2 \end{bmatrix}$$
$$\begin{bmatrix} \varphi_{CB} \\ \varphi_{CE} \\ u_{EC} \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & -2 & 1 \\ 0 & 1 & 0 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 \\ 0 & 4 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

Soluzione del sistema

$$\begin{bmatrix} H_A \cdot b \\ H_F \cdot b \\ V_G \cdot b \end{bmatrix} = \begin{bmatrix} Fb & W & qb^2 \\ 0 & 0 & 1 \\ 0 & 0 & 0 \\ 0 & 4 & 0 \end{bmatrix}$$







EQUAZIONI DI EQUILIBRIO

Rotazione intorno a C: aste CB BA

$$H_A b = -2qb^2$$

Rotazione intorno a C: aste CE EF EG

$$-2H_F b + V_G b = W - 1/2qb^2$$

Traslazione orizzontale: aste EF EG

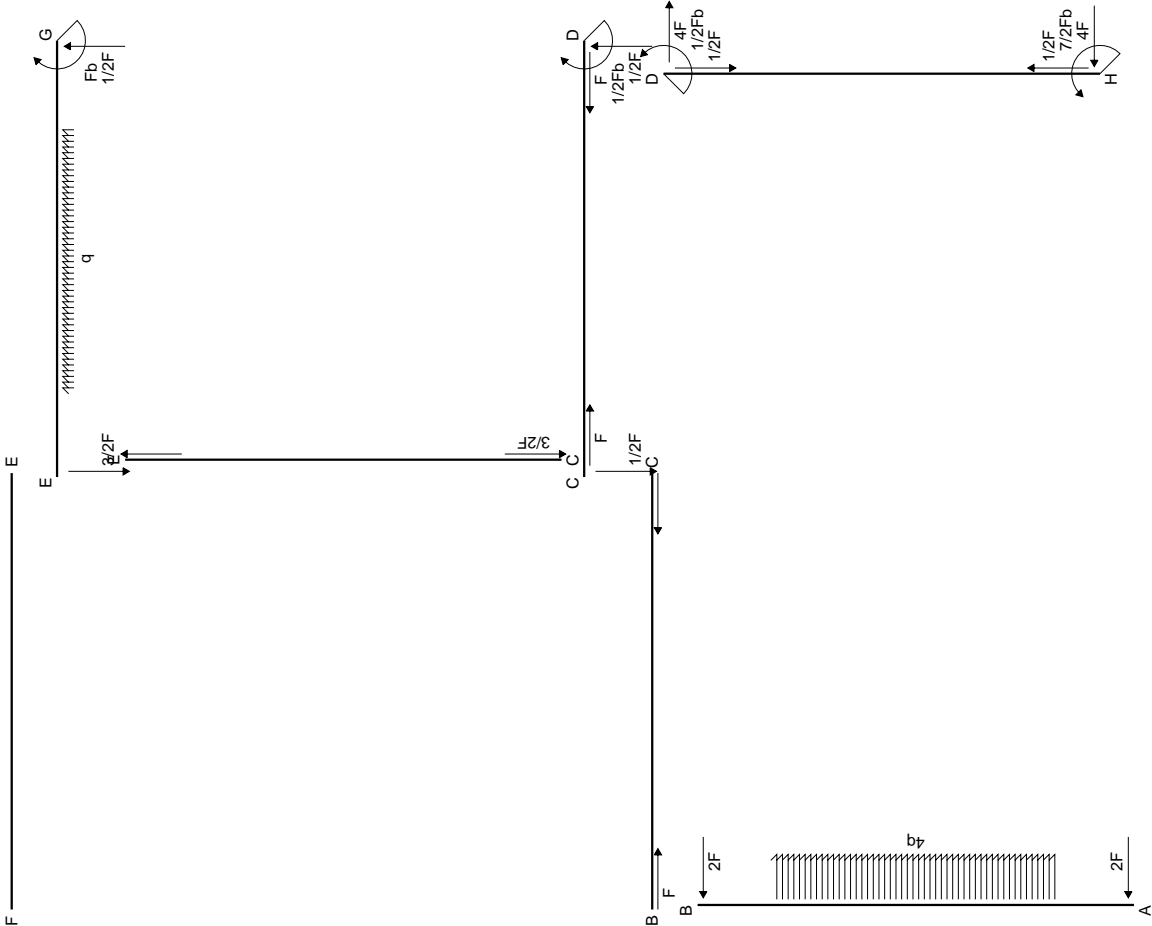
$$H_F = 0$$

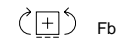
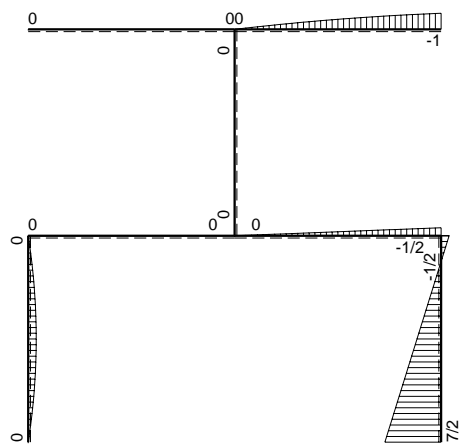
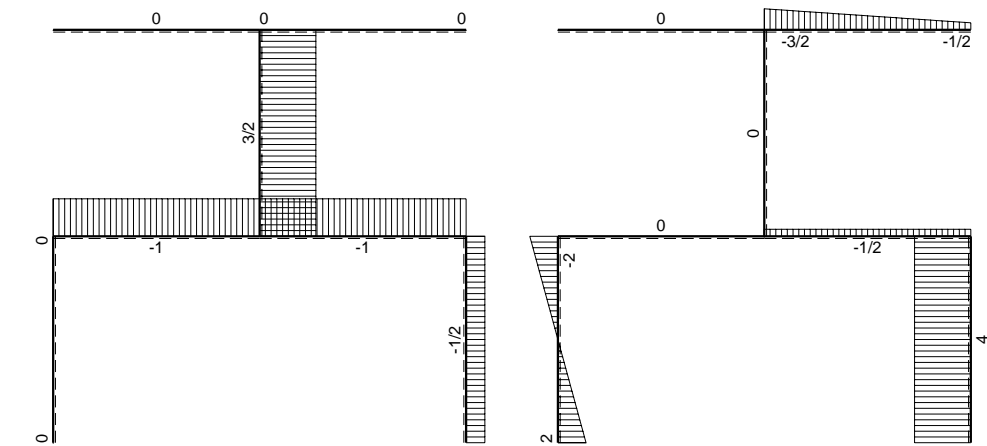
Matrice di equilibrio

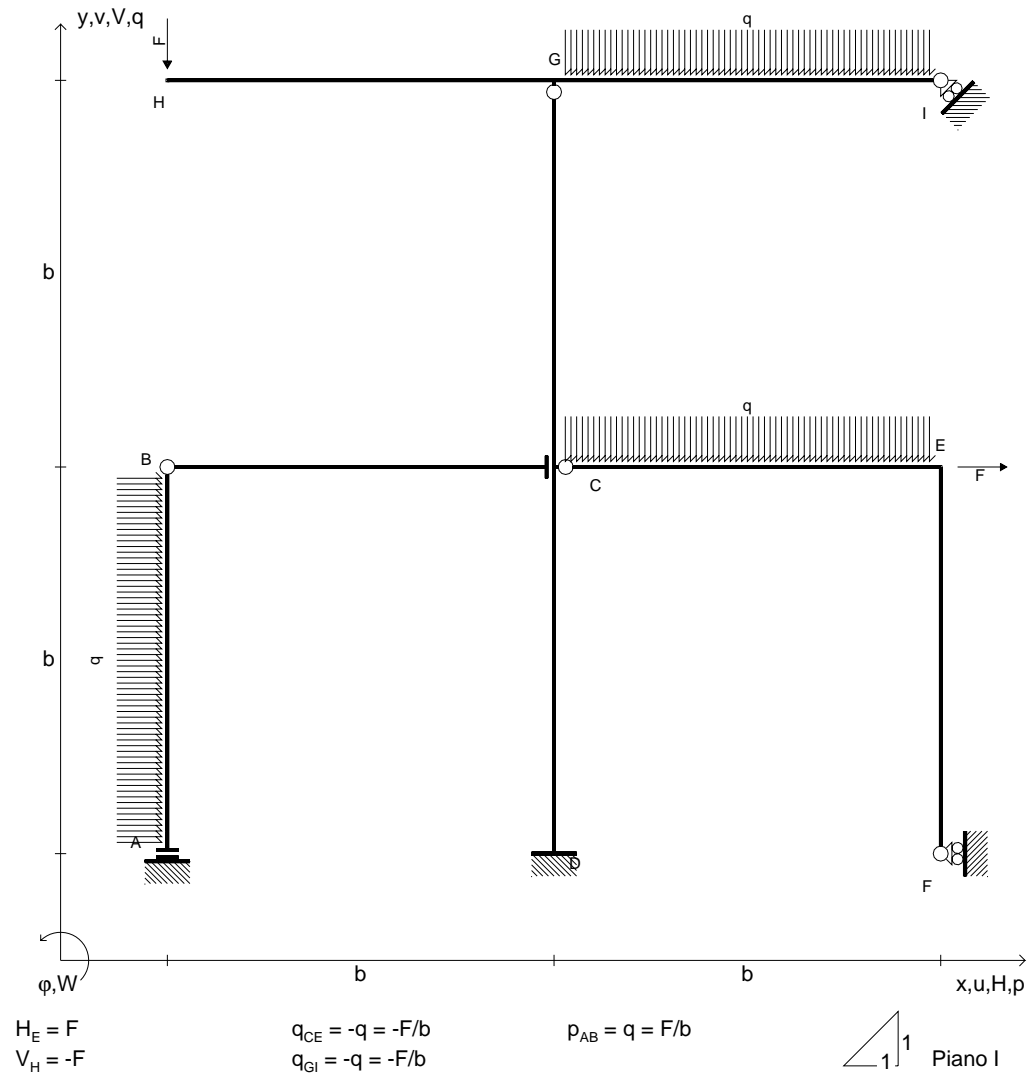
$$\begin{bmatrix} H_A b & H_F b & V_G b \end{bmatrix} \begin{bmatrix} Fb & W & qb^2 \end{bmatrix}$$
$$\varphi_{CB} \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} 0 & 0 & -2 \end{bmatrix}$$
$$\varphi_{CE} \begin{bmatrix} 0 & -2 & 1 \end{bmatrix} = \begin{bmatrix} 0 & 1 & -1/2 \end{bmatrix}$$
$$u_{EC} \begin{bmatrix} 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} 0 & 0 & 0 \end{bmatrix}$$

Soluzione del sistema

$$\begin{bmatrix} H_A b \\ H_F b \\ V_G b \end{bmatrix} = \begin{bmatrix} 0 & 0 & -2 \\ 0 & 0 & 0 \\ 0 & 1 & -1/2 \end{bmatrix} \begin{bmatrix} Fb & W & qb^2 \end{bmatrix}$$







Carichi e deformazioni date hanno verso efficace in disegno.

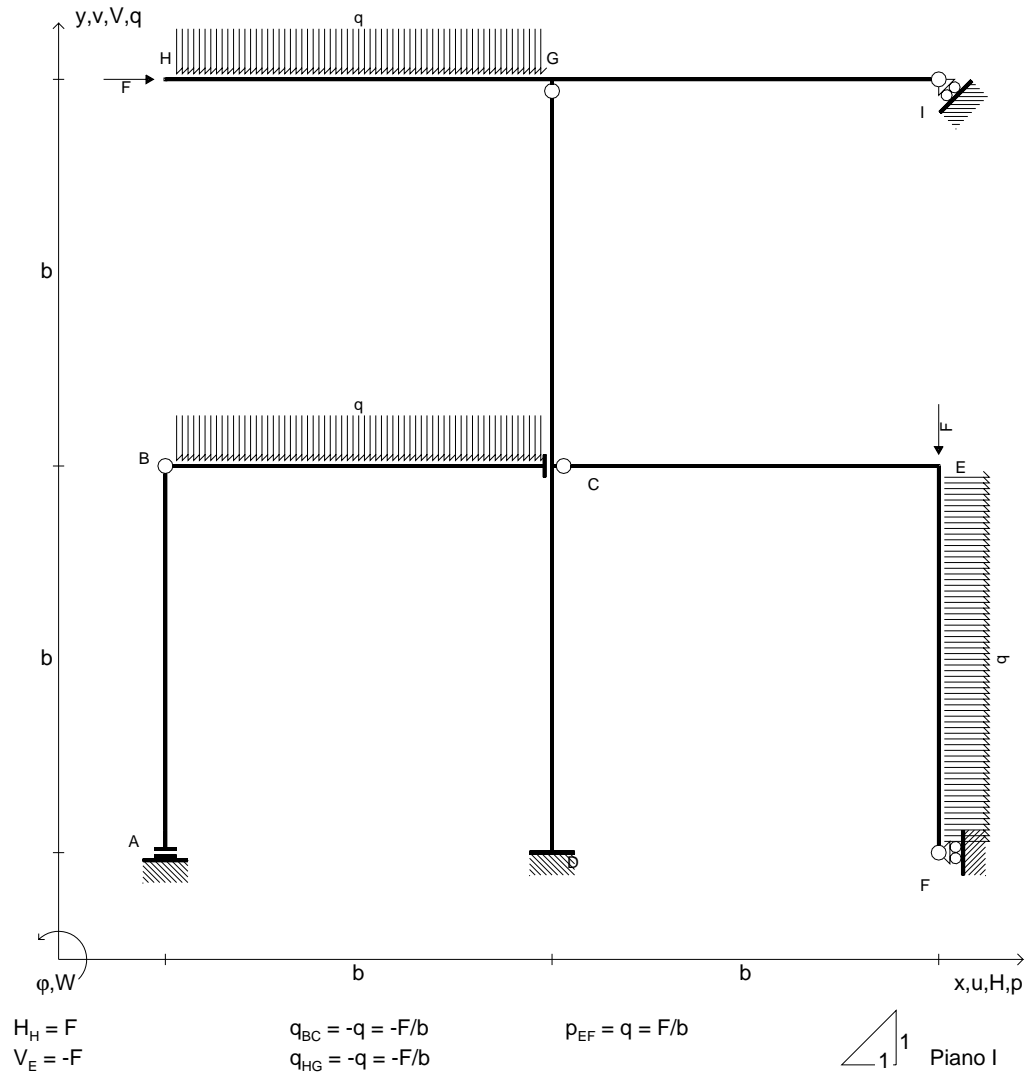
Calcolare reazioni vincolari della struttura e delle aste.

Tracciare i diagrammi quotati delle azioni interne nelle aste.

Piano di scorrimento del vincolo con inclinazione assegnata.

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.15.07.08

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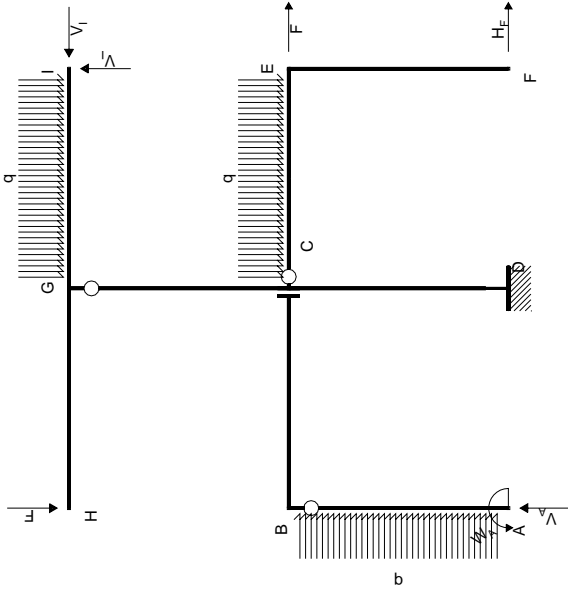
Carichi e deformazioni date hanno verso efficace in disegno.

Calcolare reazioni vincolari della struttura e delle aste.

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Piano di scorrimento del vincolo con inclinazione assegnata.

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EQUAZIONI DI EQUILIBRIO

Traslazione verticale: aste CB BA

$V_A = 0$

Rotazione intorno a C: aste CE EF

$H_F b = 1/2 q b^2$

Rotazione intorno a G: aste GH GI

$V_I b = -F b + 1/2 q b^2$

Rotazione intorno a B: aste BA

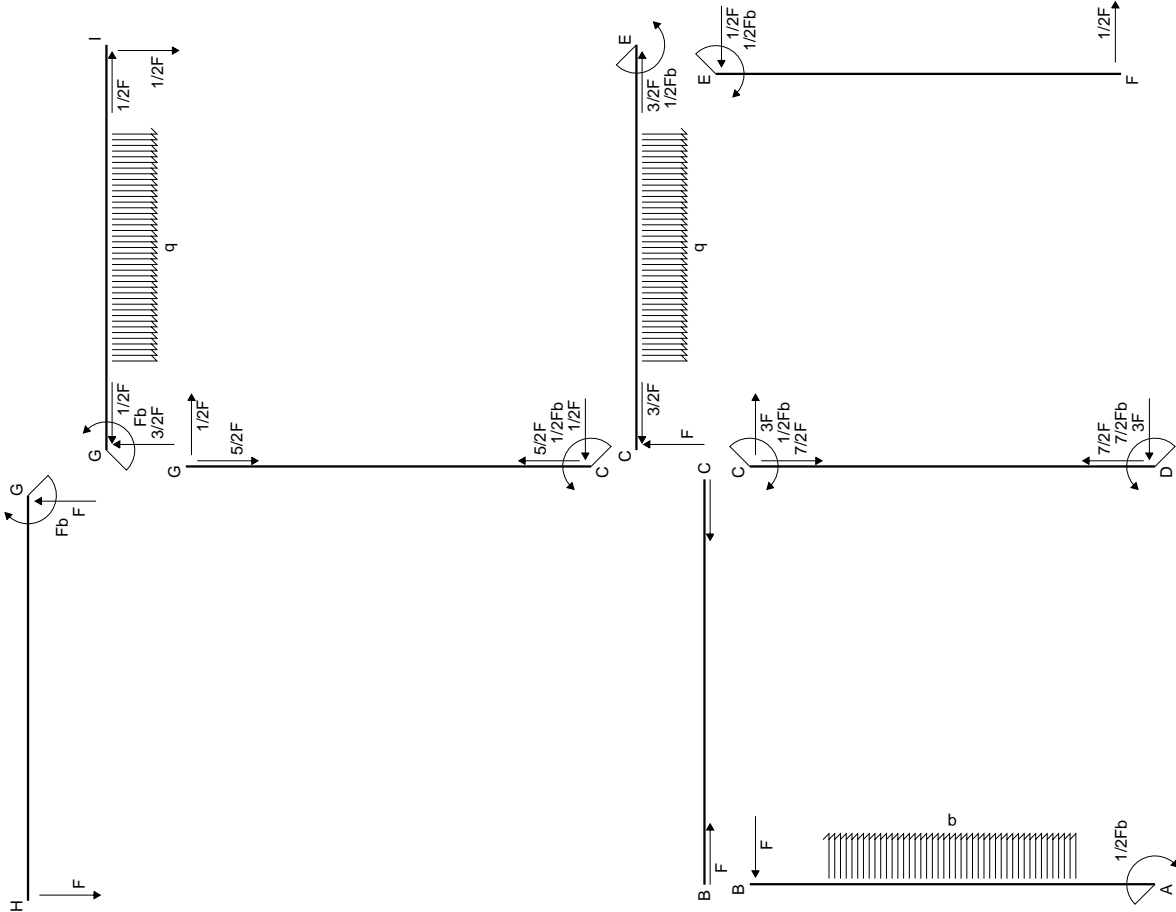
$W_A = -1/2 q b^2$

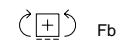
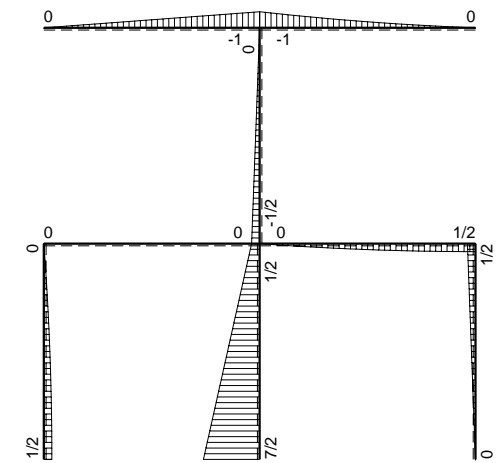
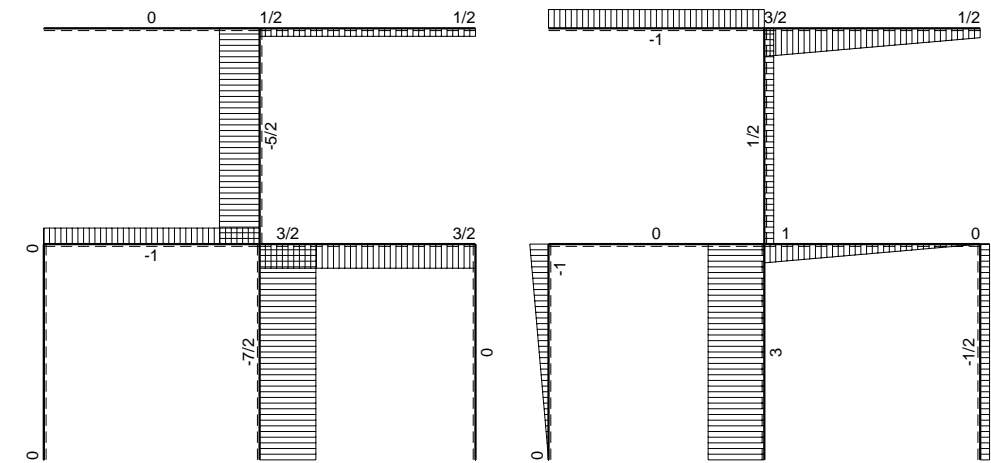
Matrice di equilibrio

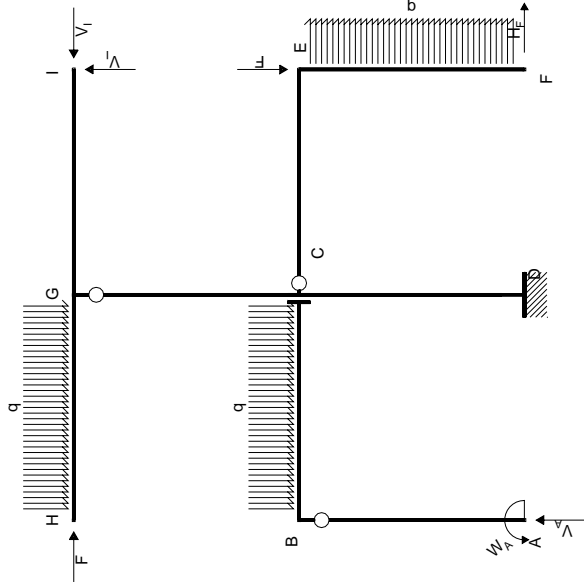
$$\begin{bmatrix} V_{A,b} & W_A & H_{F,b} & V_{I,b} \end{bmatrix} \begin{bmatrix} Fb & qb^2 \end{bmatrix}$$
$$\begin{bmatrix} V_{CB} \\ \varphi_{CE} \\ \varphi_{GC} \\ \varphi_{BA} \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 0 & 1/2 \\ -1 & 1/2 \\ 0 & -1/2 \end{bmatrix}$$

Soluzione del sistema

$$\begin{bmatrix} V_A^b \\ H_F^b \\ V_I^b \\ W_A \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \end{bmatrix} \begin{bmatrix} 0 & 0 \\ 0 & 1/2 \\ -1 & 1/2 \\ 0 & -1/2 \end{bmatrix}$$







EQUAZIONI DI EQUILIBRIO

Traslazione verticale: aste CB BA

$V_A = qb$

Rotazione intorno a C: aste CE EF

$H_F b = Fb - 1/2qb^2$

Rotazione intorno a G: aste GH GI

$V_I b = -1/2qb^2$

Rotazione intorno a B: aste BA

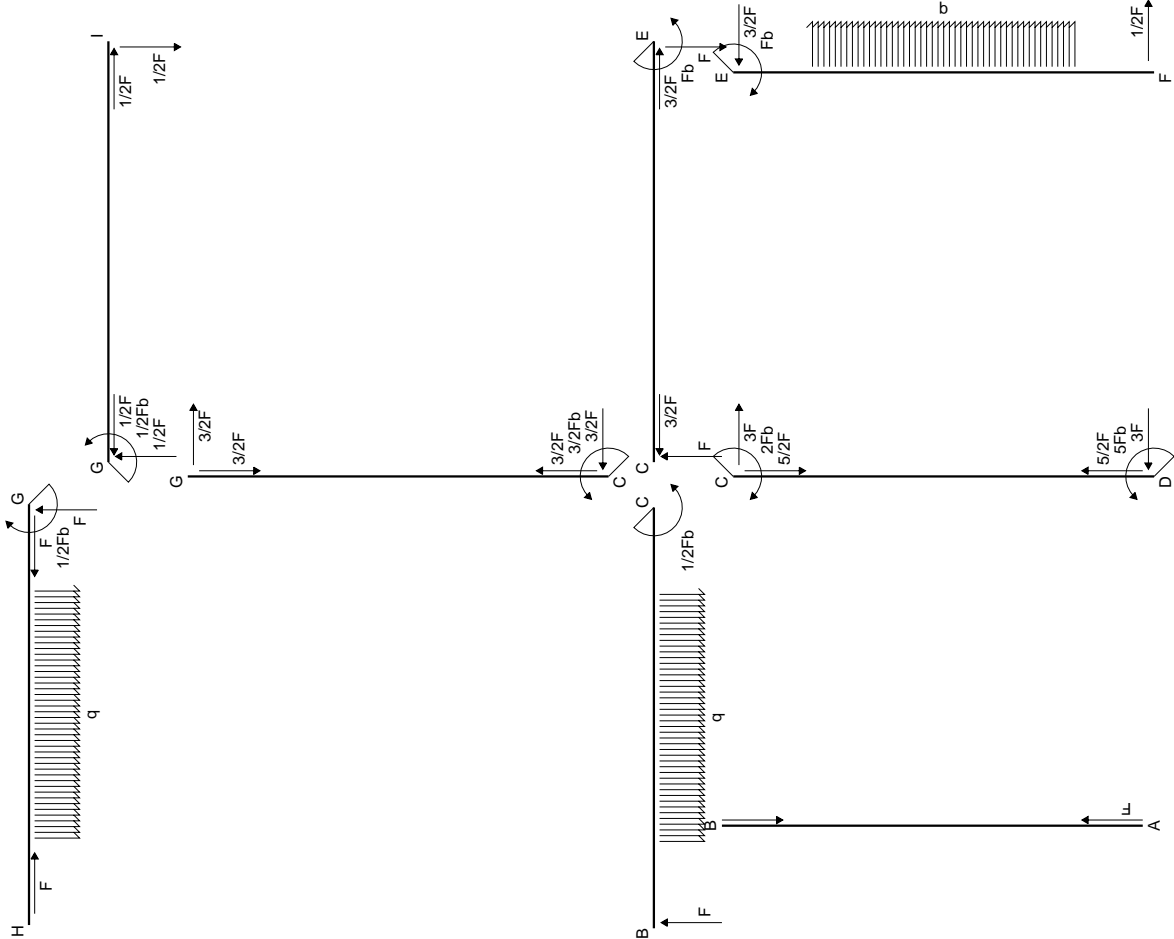
$W_A = 0$

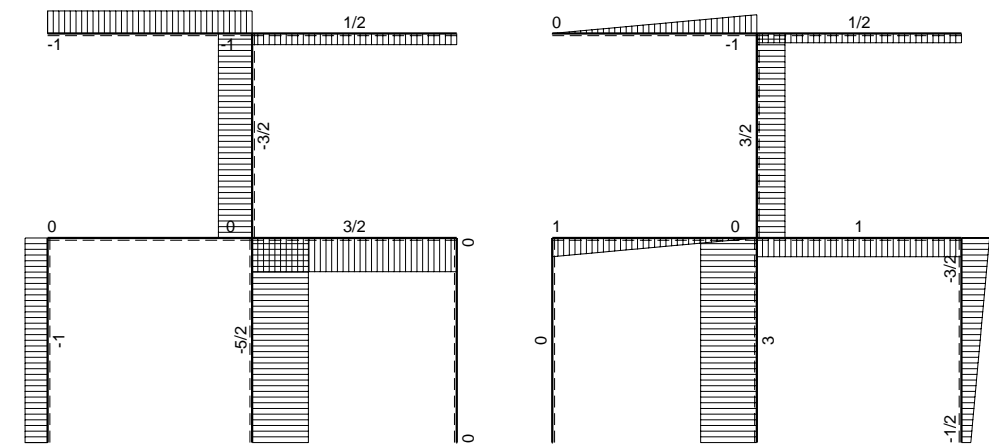
Matrice di equilibrio

$$\begin{bmatrix} V_A b & W_A & H_F b & V_I b \end{bmatrix} \begin{bmatrix} Fb & qb^2 \end{bmatrix}$$
$$\begin{bmatrix} V_{CB} \\ \varphi_{CE} \\ \varphi_{GC} \\ \varphi_{BA} \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ 1 & -1/2 \\ 0 & -1/2 \\ 0 & 0 \end{bmatrix}$$

Soluzione del sistema

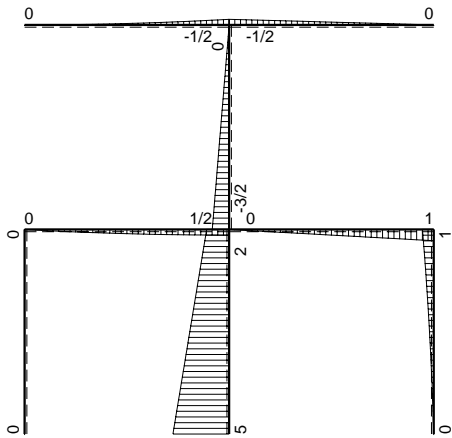
$$\begin{bmatrix} V_A b \\ H_F b \\ V_I b \\ W_A \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ 0 & 1 \\ 0 & -1/2 \\ 0 & 0 \end{bmatrix}$$



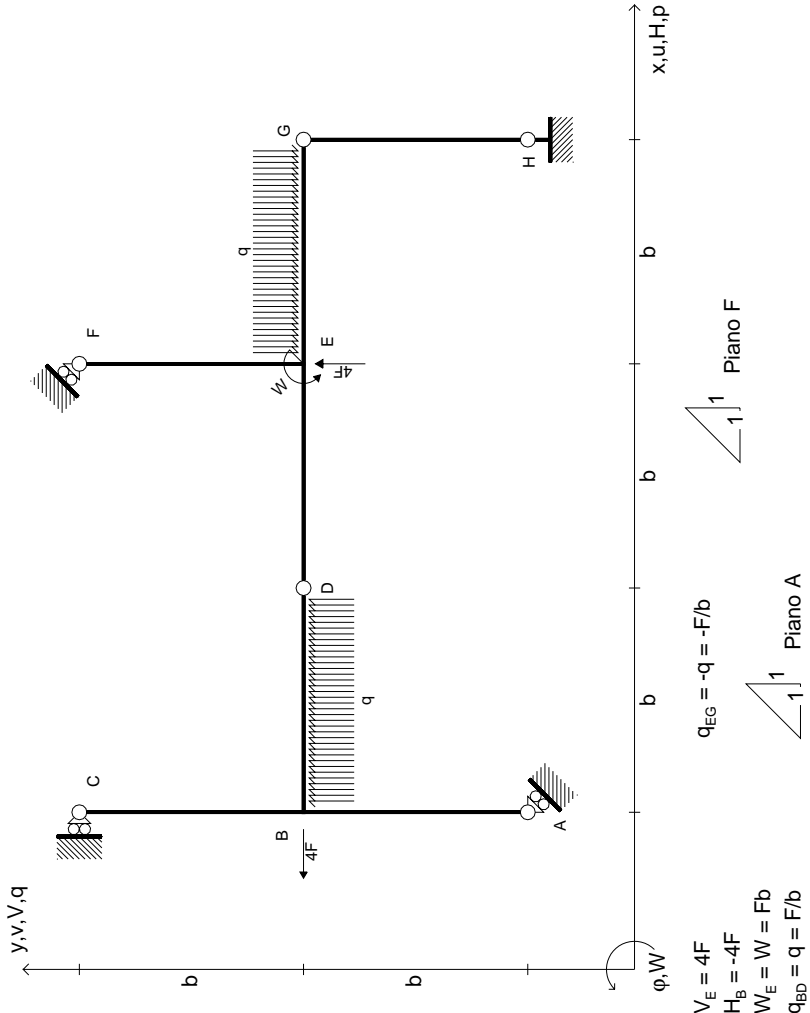


← $\boxed{+}$ → F

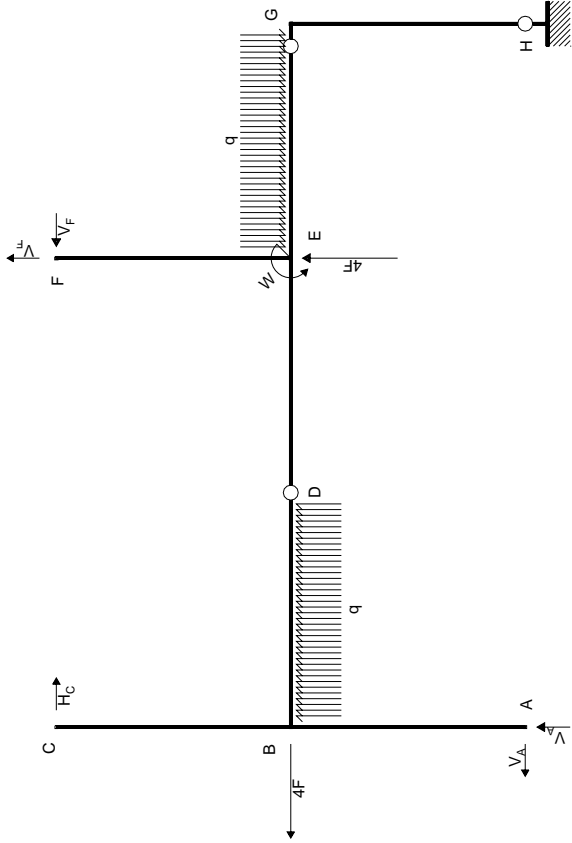
↑ $\boxed{+}$ ↓ F



↺ $\boxed{+}$ ↻ F_b



Carichi e deformazioni date hanno verso efficace in disegno.
Calcolare reazioni vincolari della struttura e delle aste.
Tracciare i diagrammi quotati delle azioni interne nelle aste.
Piano di scorrimento del vincolo con inclinazione assegnata.
@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.12.12.08



EQUAZIONI DI EQUILIBRIO

Rotazione globale intorno a H

$-3V_A b - 2H_C b + V_F b = -W + 2qb^2$

Rotazione intorno a G: aste GE ED EF DB BA BC

$-4V_A b - H_C b = 4Fb - W + 2qb^2$

Rotazione intorno a D: aste DB BA BC

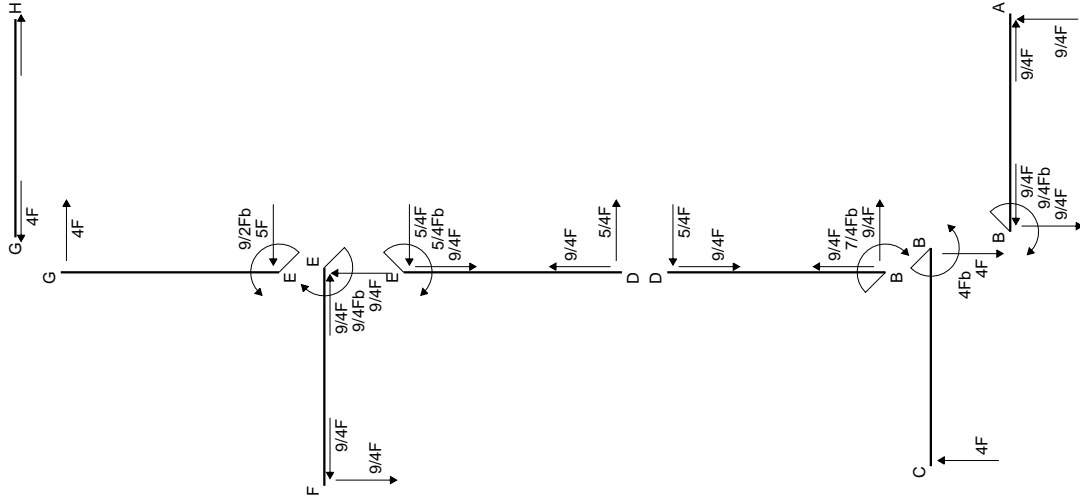
$-2V_A b - H_C b = 1/2qb^2$

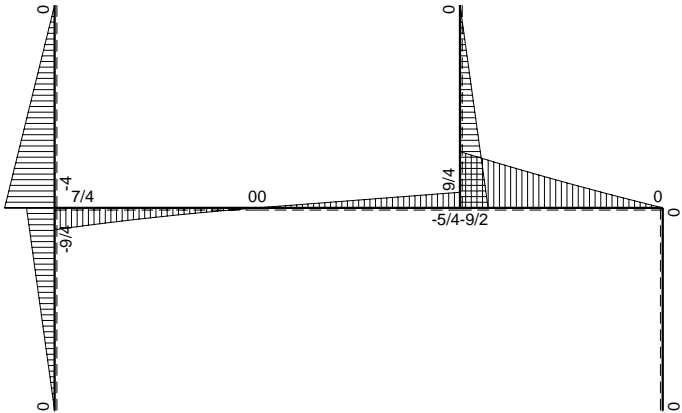
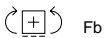
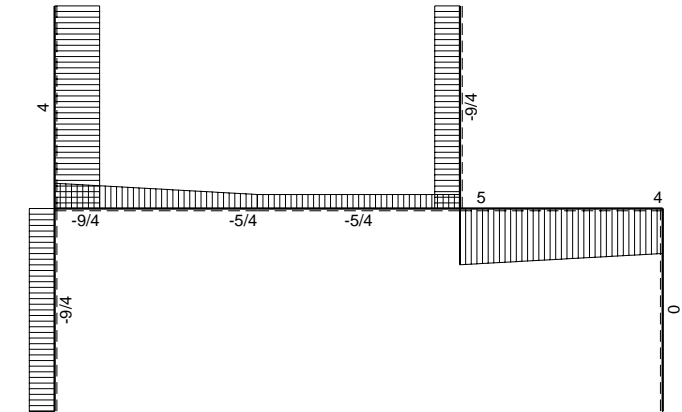
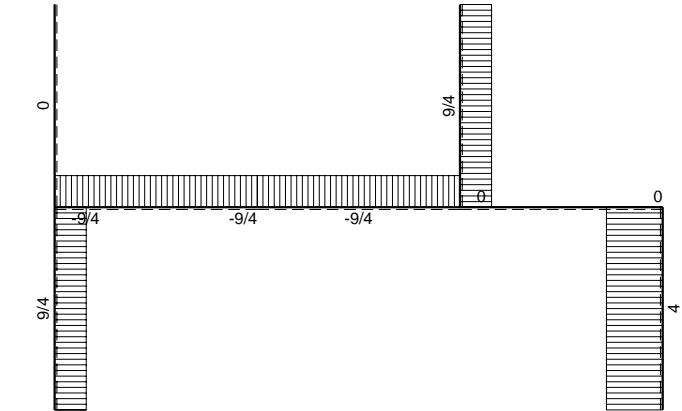
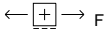
Matrice di equilibrio

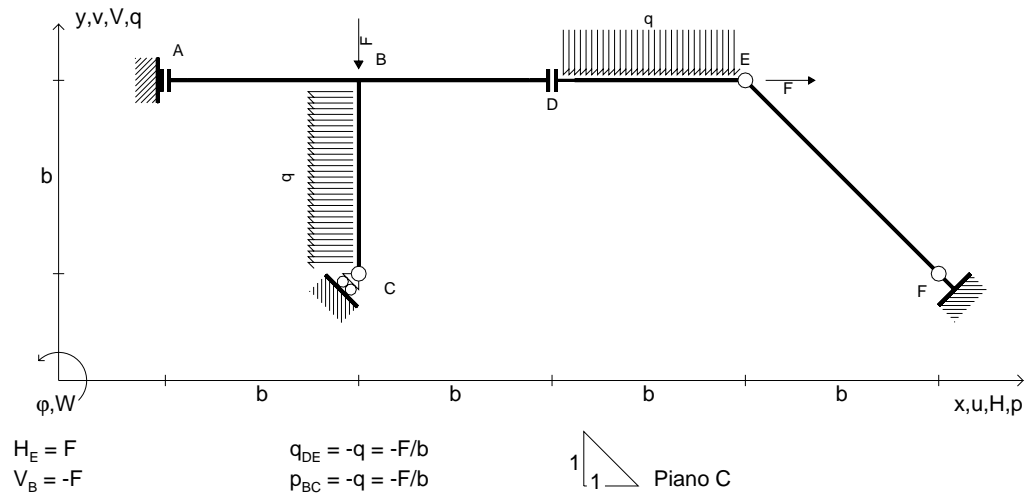
$$\begin{bmatrix} V_A b & H_C b & V_F b \end{bmatrix} \begin{bmatrix} Fb & W & qb^2 \end{bmatrix}$$
$$\varphi_H \begin{bmatrix} -3 & -2 & 1 \end{bmatrix} \begin{bmatrix} 0 & -1 & 2 \end{bmatrix}$$
$$\varphi_{GE} \begin{bmatrix} -4 & -1 & 0 \end{bmatrix} = \begin{bmatrix} 4 & -1 & 2 \end{bmatrix}$$
$$\varphi_{DB} \begin{bmatrix} -2 & -1 & 0 \end{bmatrix} \begin{bmatrix} 0 & 0 & 1/2 \end{bmatrix}$$

Soluzione del sistema

$$\begin{bmatrix} V_A b \\ H_C b \\ V_F b \end{bmatrix} = \begin{bmatrix} -2 & 1/2 & -3/4 \\ 4 & -1 & 1 \\ 2 & -3/2 & 7/4 \end{bmatrix} \begin{bmatrix} Fb \\ W \\ qb^2 \end{bmatrix}$$







Carichi e deformazioni date hanno verso efficace in disegno.

Calcolare reazioni vincolari della struttura e delle aste.

Tracciare i diagrammi quotati delle azioni interne nelle aste.

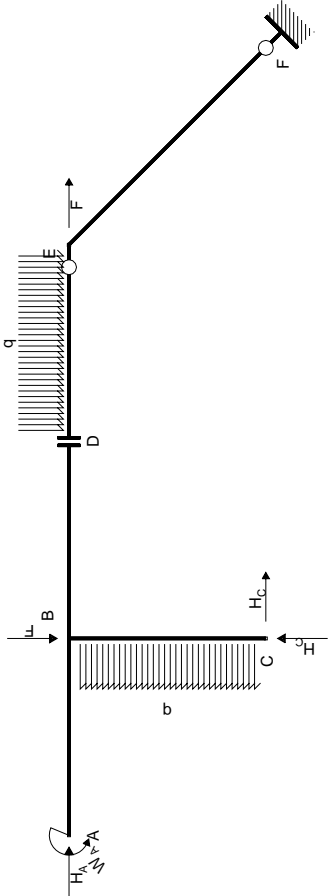
Piano di scorrimento del vincolo con inclinazione assegnata.

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.03.02.09

04.02.09

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.03.02.09

04.02.09



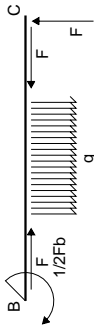
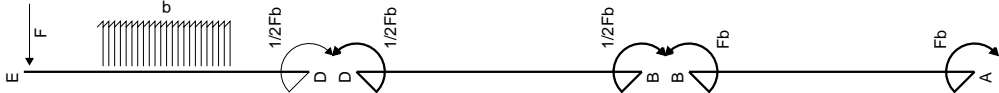
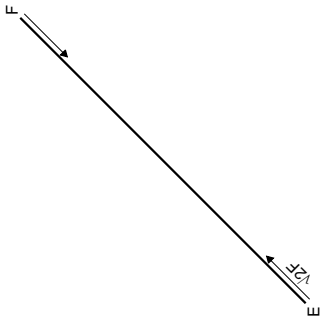
EQUAZIONI DI EQUILIBRIO
Rotazione globale intorno a F
 $-H_A \cdot b + W_A \cdot 3H_C \cdot b = -2Fb - 2qb^2$
Rotazione intorno a E: aste ED DB BA BC
 $W_A \cdot H_C \cdot b = -2Fb$
Traslazione verticale: aste DB BA BC
 $H_C = F$

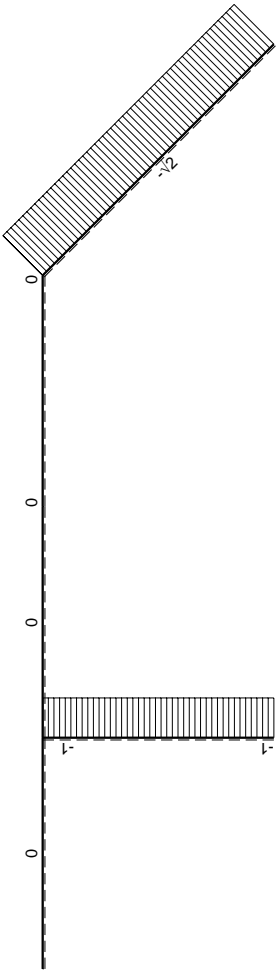
Matrice di equilibrio


$$\begin{bmatrix} H_A \cdot b & W_A & H_C \cdot b \end{bmatrix} \begin{bmatrix} Fb & qb^2 \end{bmatrix}$$
$$\varphi_F \begin{bmatrix} -1 & 1 & -3 \end{bmatrix} \begin{bmatrix} -2 & -2 \end{bmatrix}$$
$$\varphi_{ED} \begin{bmatrix} 0 & 1 & -1 \end{bmatrix} = \begin{bmatrix} -2 & 0 \end{bmatrix}$$
$$V_{DB} \begin{bmatrix} 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 \end{bmatrix}$$

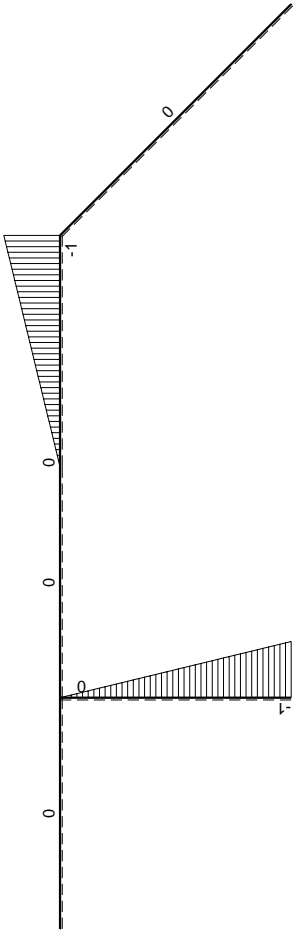
Soluzione del sistema

$$\begin{bmatrix} H_A \cdot b \\ W_A \\ H_C \cdot b \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ -2 & 2 \\ -1 & 0 \\ 1 & 0 \end{bmatrix}$$

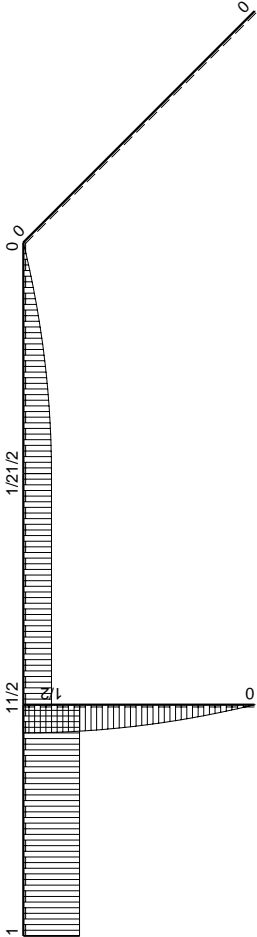




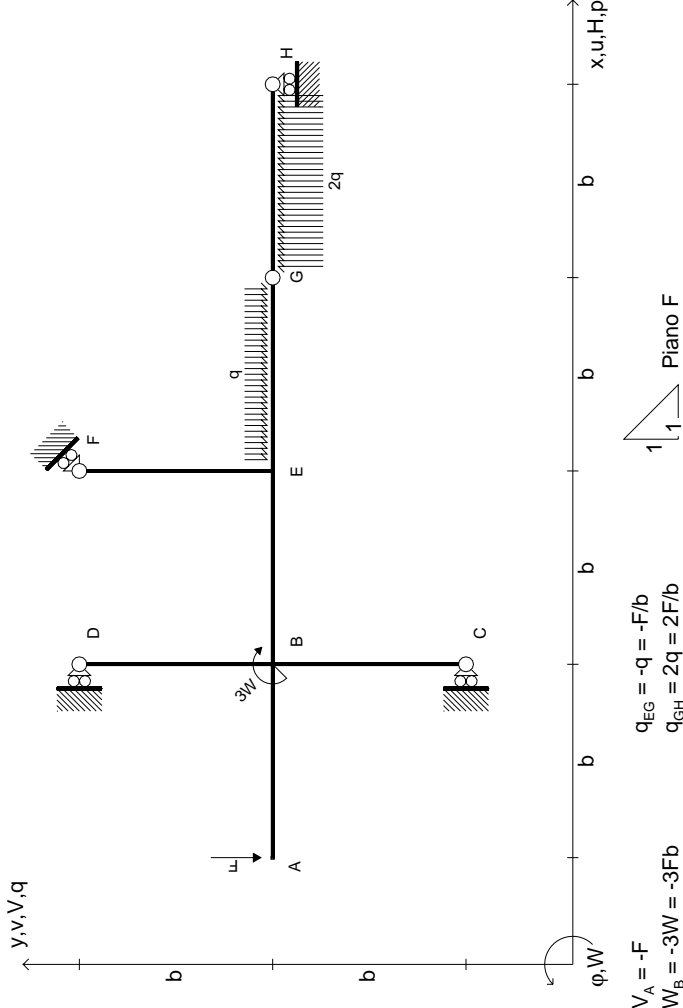
←  → F



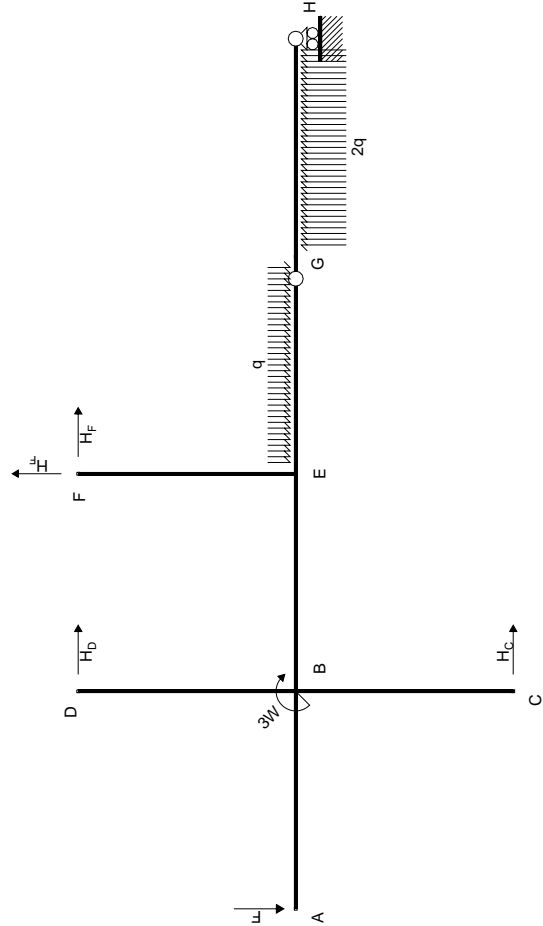
↑  ↓ F



↺  ↻ F_b



Carichi e deformazioni date hanno verso efficace in disegno.
Calcolare reazioni vincolari della struttura e delle aste.
Tracciare i diagrammi quotati delle azioni interne nelle aste.
Piano di scorrimento del vincolo con inclinazione assegnata.
@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.16.02.09



EQUAZIONI DI EQUILIBRIO

Traslazione orizzontale globale

$H_C + H_D + H_F = 0$

Rotazione globale intorno a H

$H_C \cdot b - H_D \cdot b - 3H_F \cdot b = -4Fb + 3W \cdot -1/2qb^2$

Rotazione intorno a G: aste GE EB EF BA BC BD

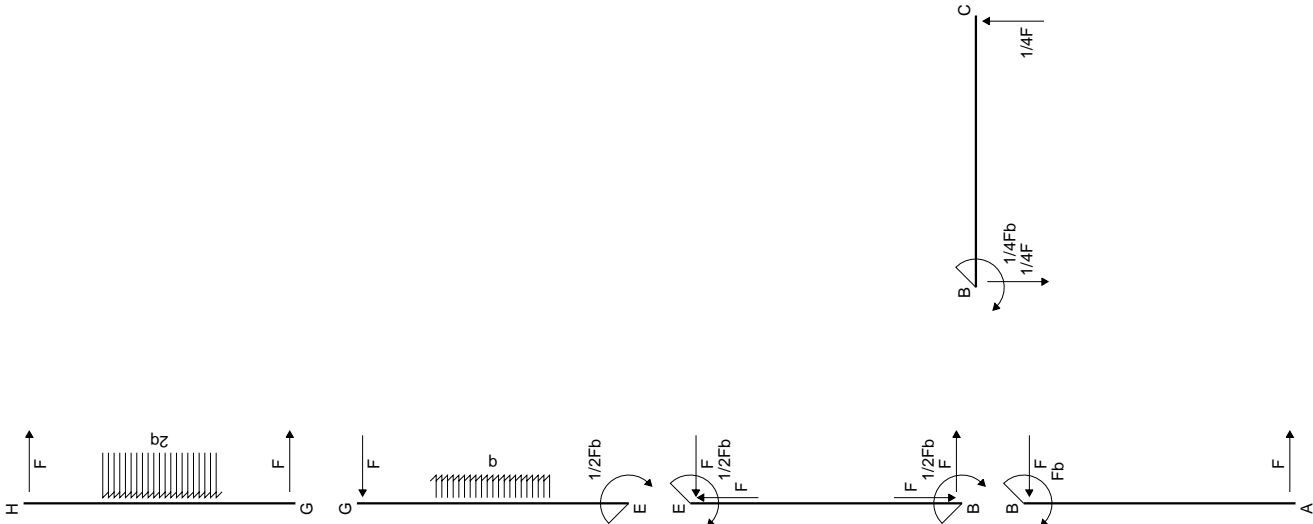
$H_C \cdot b - H_D \cdot b - 2H_F \cdot b = -3Fb + 3W \cdot -1/2qb^2$

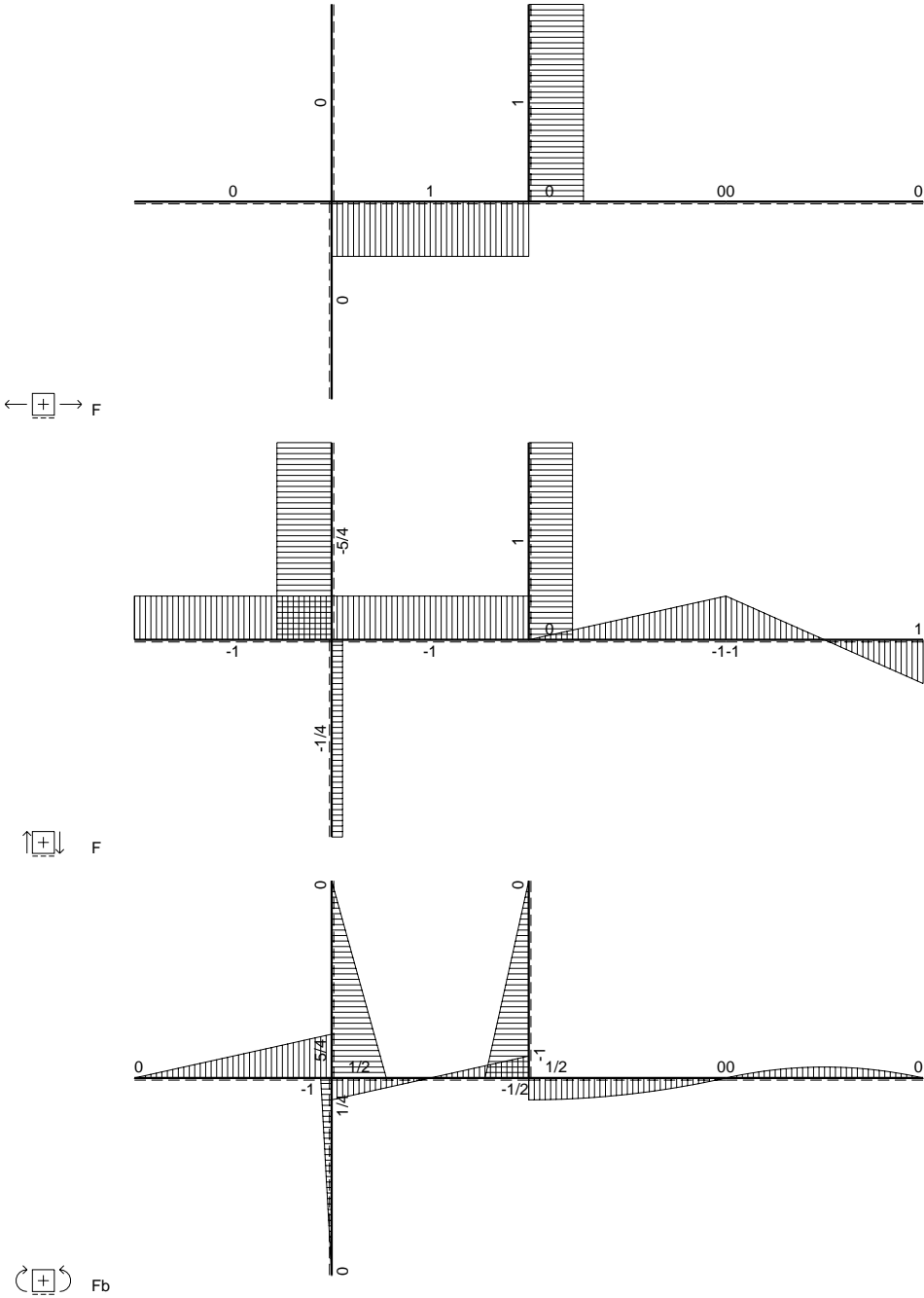
Matrice di equilibrio

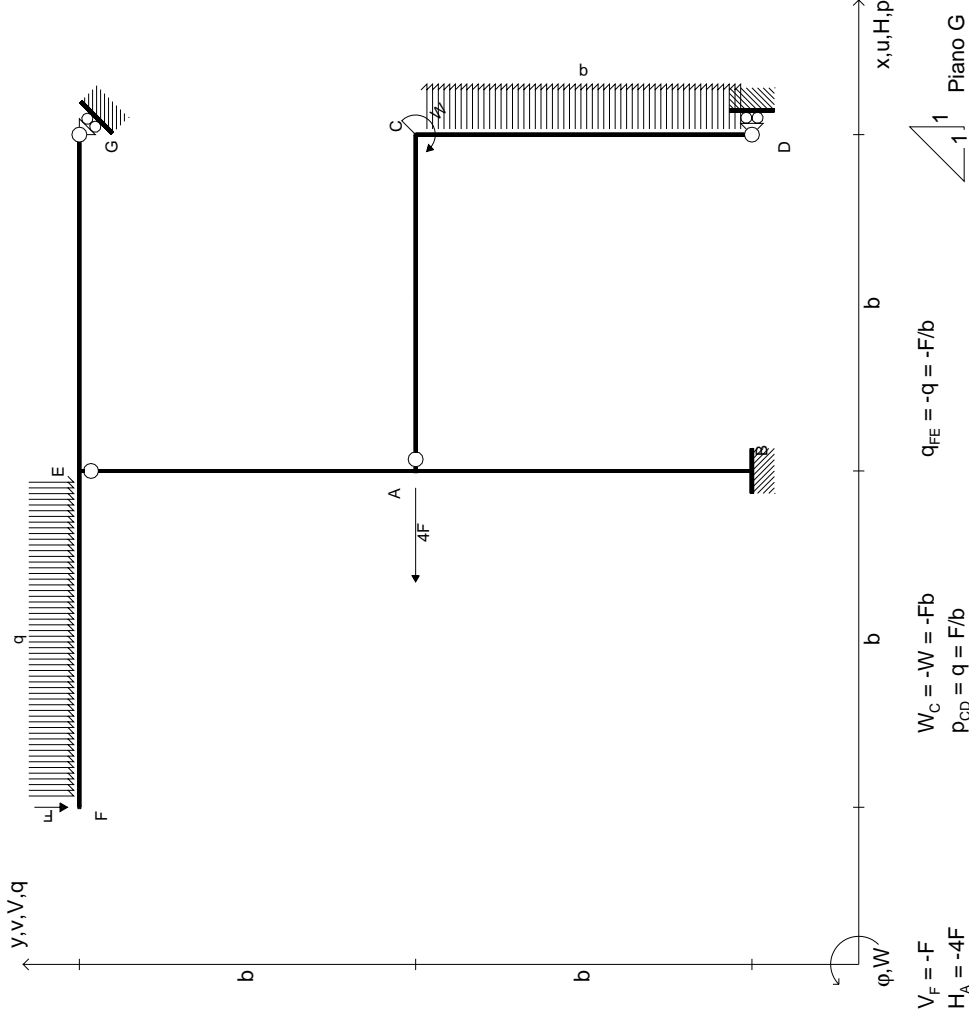
$$\begin{bmatrix} H_C \cdot b & H_D \cdot b & H_F \cdot b \end{bmatrix} \begin{bmatrix} Fb & W & qb^2 \end{bmatrix}$$
$$u_H \begin{bmatrix} 1 & 1 & 1 \end{bmatrix} \begin{bmatrix} 0 & 0 & 0 \end{bmatrix}$$
$$\varphi_H \begin{bmatrix} 1 & -1 & -3 \end{bmatrix} = \begin{bmatrix} -4 & 3 & -1/2 \end{bmatrix}$$
$$\varphi_{GE} \begin{bmatrix} 1 & -1 & -2 \end{bmatrix} \begin{bmatrix} -3 & 3 & -1/2 \end{bmatrix}$$

Soluzione del sistema

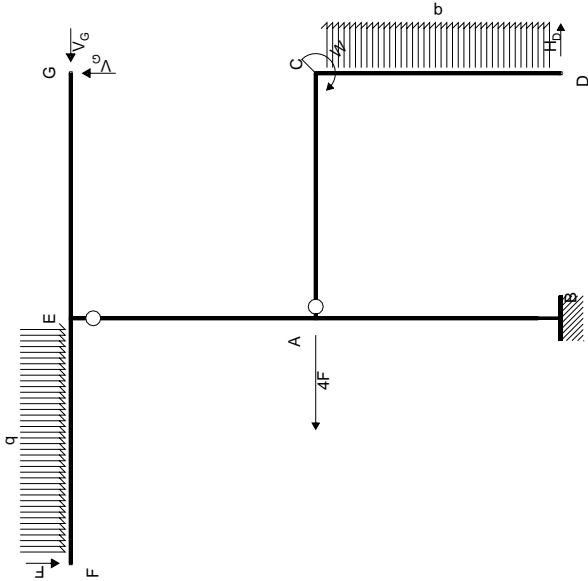
$$\begin{bmatrix} H_C \cdot b \\ H_D \cdot b \\ H_F \cdot b \end{bmatrix} = \begin{bmatrix} -1 & 3/2 & -1/4 \\ 0 & -3/2 & 1/4 \\ 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} Fb & W & qb^2 \end{bmatrix}$$







Carichi e deformazioni date hanno verso efficace in disegno.
Calcolare reazioni vincolari della struttura e delle aste.
Tracciare i diagrammi quotati delle azioni interne nelle aste.
Piano di scorrimento del vincolo con inclinazione assegnata.
@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.23.06.09



EQUAZIONI DI EQUILIBRIO

Rotazione intorno a A: aste AC CD

$H_b b = W - 1/2 q b^2$

Rotazione intorno a E: aste EF EG

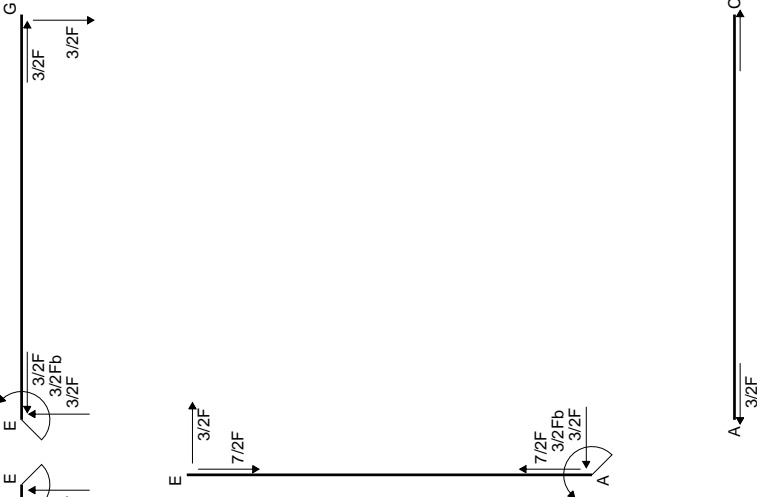
$V_g b = -F b - 1/2 q b^2$

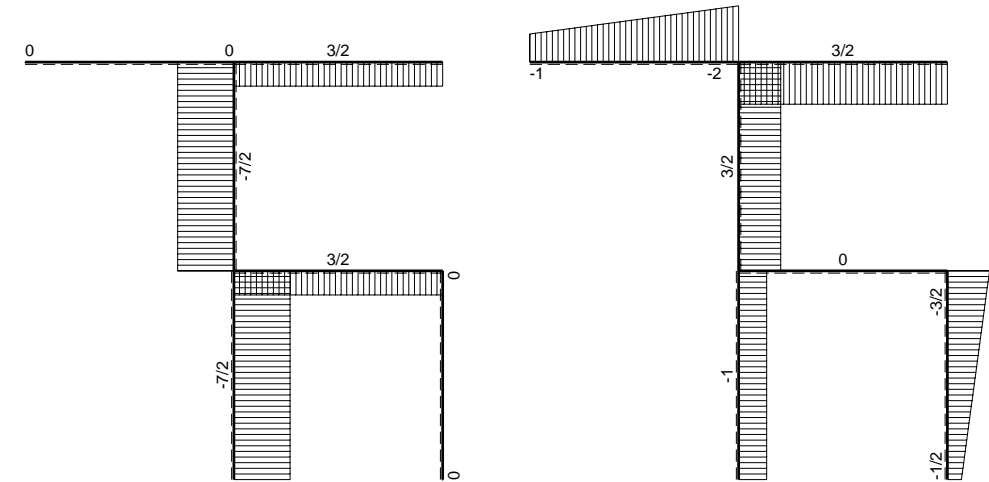
Matrice di equilibrio

$$\begin{bmatrix} H_b b & V_g b \end{bmatrix} \begin{bmatrix} F b & W & q b^2 \\ 1 & 0 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 0 & 1 & -1/2 \\ -1 & 0 & -1/2 \end{bmatrix}$$

Soluzione del sistema

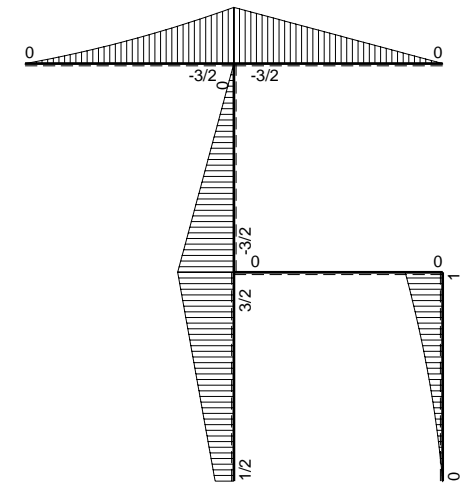
$$\begin{bmatrix} H_b b \\ V_g b \end{bmatrix} = \begin{bmatrix} F b & W & q b^2 \\ 0 & 1 & -1/2 \\ -1 & 0 & -1/2 \end{bmatrix}$$



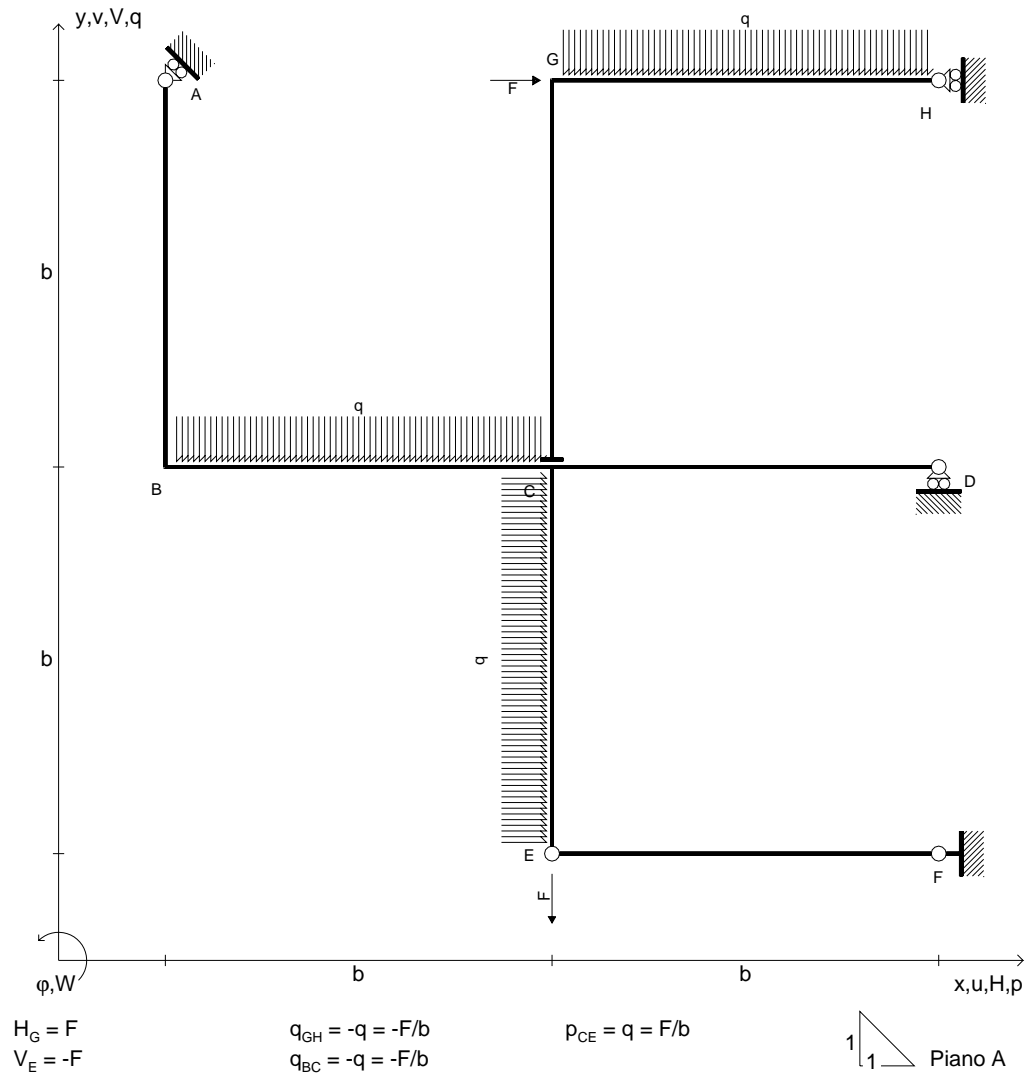


← ⊕ → F

↑ ⊕ ↓ Mb



↺ ⊕ ↻ Mb



Carichi e deformazioni date hanno verso efficace in disegno.

Calcolare reazioni vincolari della struttura e delle aste.

Tracciare i diagrammi quotati delle azioni interne nelle aste.

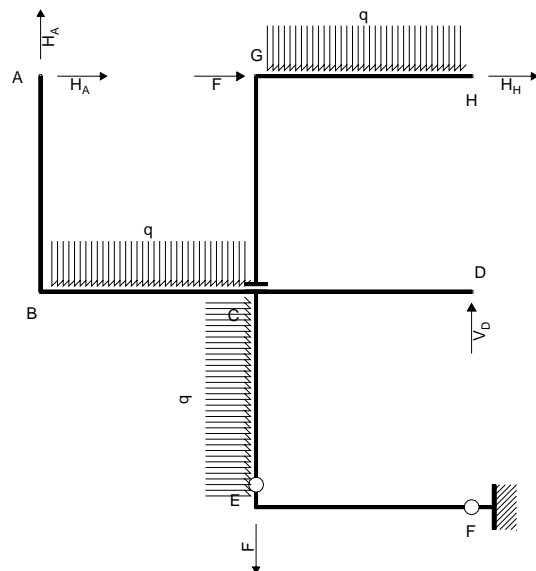
Piano di scorrimento del vincolo con inclinazione assegnata.

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.05.07.09

15.09.09

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.05.07.09

15.09.09



EQUAZIONI DI EQUILIBRIO

Rotazione globale intorno a F

$$-4H_A b - 2H_H b = Fb - 3/2qb^2$$

Rotazione intorno a E: aste EC CB CD CG BA GH

$$-3H_A b + V_D b - 2H_H b = 2Fb + 1/2qb^2$$

Traslazione orizzontale: aste CG GH

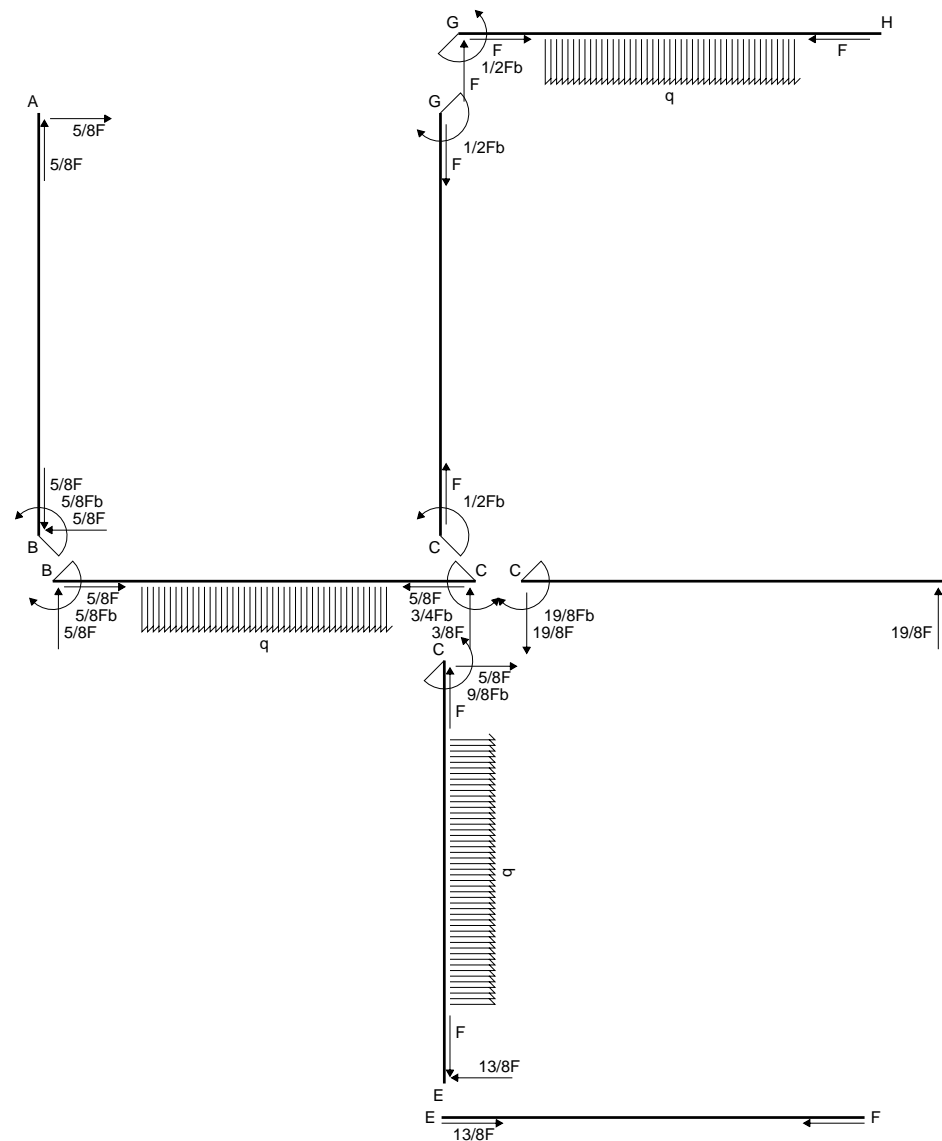
$$H_H = -F$$

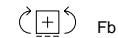
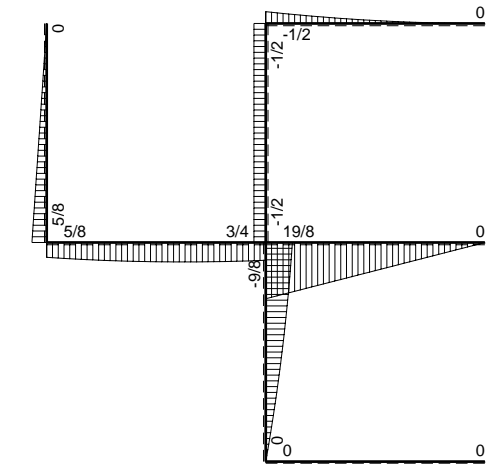
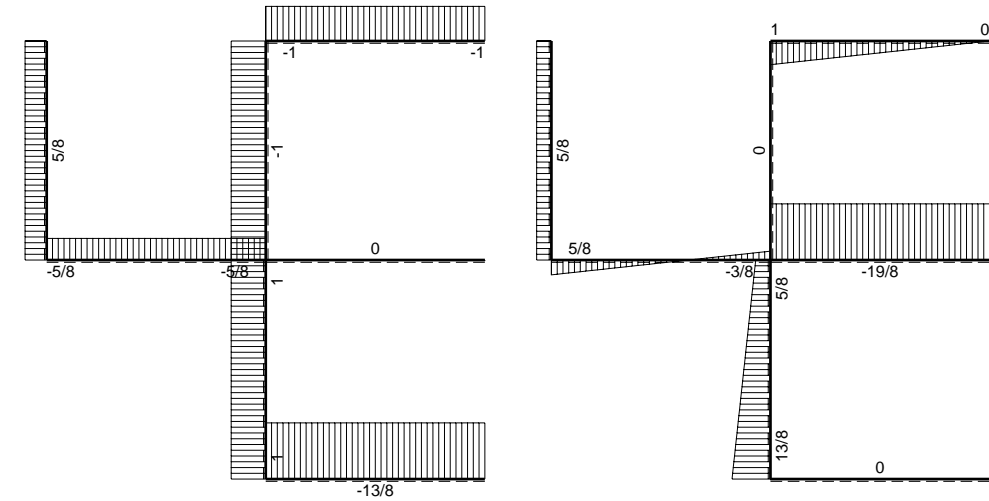
Matrice di equilibrio

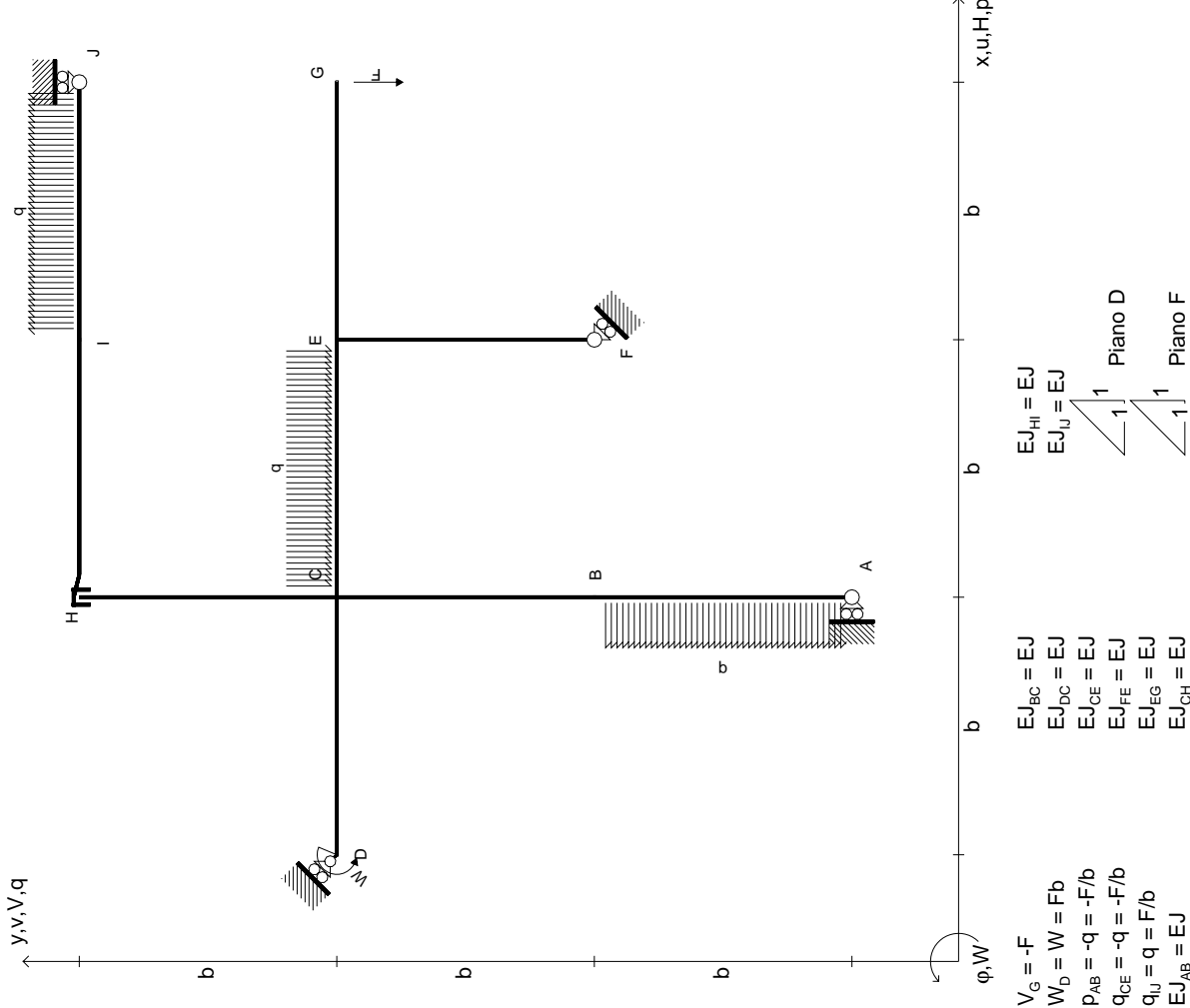
$$\begin{bmatrix} \varphi_F \\ \varphi_{EC} \\ u_{CG} \end{bmatrix} \begin{bmatrix} H_A b & V_D b & H_H b \\ -4 & 0 & -2 \\ -3 & 1 & -2 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ 1 & -3/2 \\ 2 & 1/2 \\ -1 & 0 \end{bmatrix}$$

Soluzione del sistema

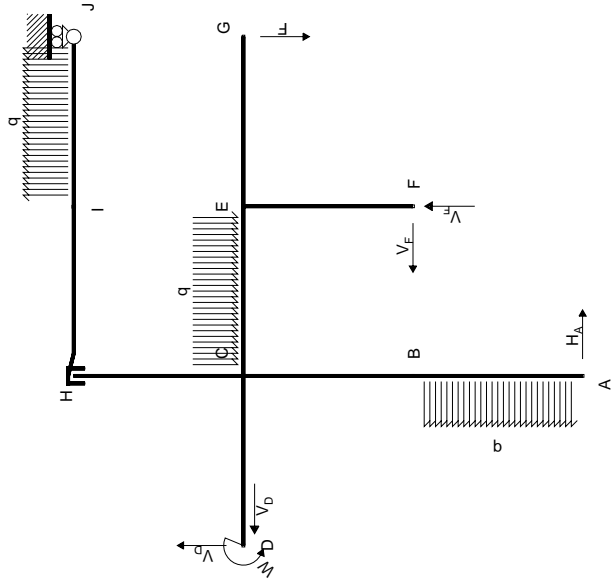
$$\begin{bmatrix} H_A b \\ V_D b \\ H_H b \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ 1/4 & 3/8 \\ 3/4 & 13/8 \\ -1 & 0 \end{bmatrix}$$







Carichi e deformazioni date hanno verso efficace in disegno.
Calcolare reazioni vincolari della struttura e delle aste.
Tracciare i diagrammi quotati delle azioni interne nelle aste.
 $J_{YZ} - X_{YZ} - \theta_{YZ}$ riferimento locale asta YZ con origine in Y.
Piano di scorrimento del vincolo con inclinazione assegnata.
@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.14.11.09



EQUAZIONI DI EQUILIBRIO

Traslazione orizzontale globale

$$H_A - V_D - V_F = qb$$

Rotazione globale intorno a J

$$3H_A b - 4V_D b - 3V_F b = -W + 3/2 qb^2$$

Traslazione verticale: aste HC CB CD CE BA EF EG

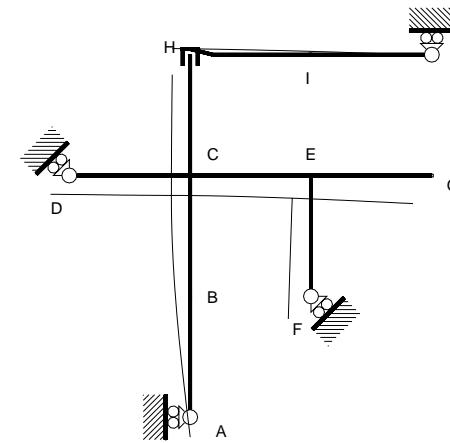
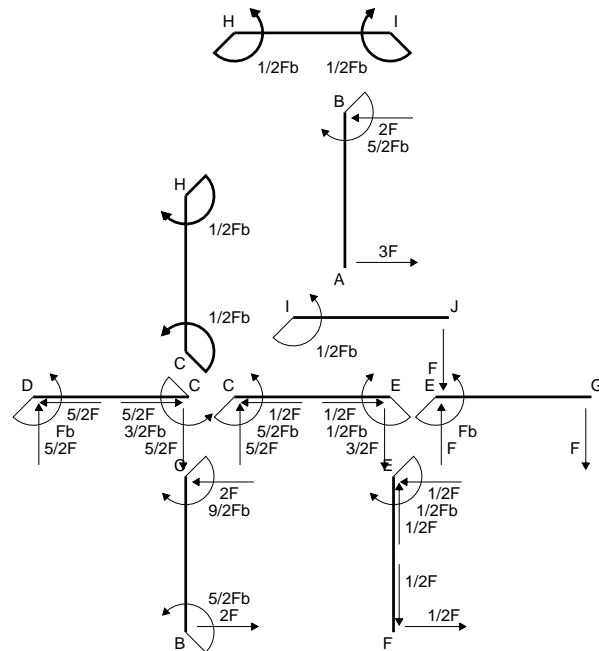
$$V_D + V_F = F + qb$$

Matrice di equilibrio

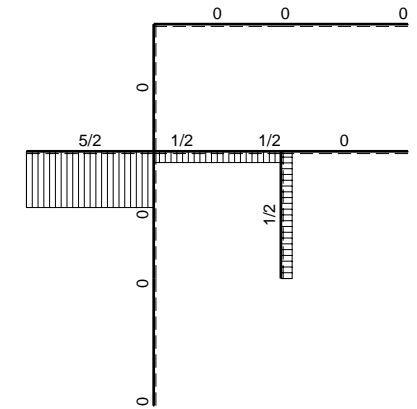
$$\begin{bmatrix} H_A b & V_D b & V_F b \end{bmatrix} \begin{bmatrix} Fb & W & qb^2 \end{bmatrix}$$
$$u_j \begin{bmatrix} 1 & -1 & -1 \end{bmatrix} \begin{bmatrix} 0 & 0 & 1 \end{bmatrix}$$
$$\varphi_j \begin{bmatrix} 3 & -4 & -3 \end{bmatrix} = \begin{bmatrix} 0 & -1 & 3/2 \end{bmatrix}$$
$$v_{Hj} \begin{bmatrix} 0 & 1 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 1 \end{bmatrix}$$

Soluzione del sistema

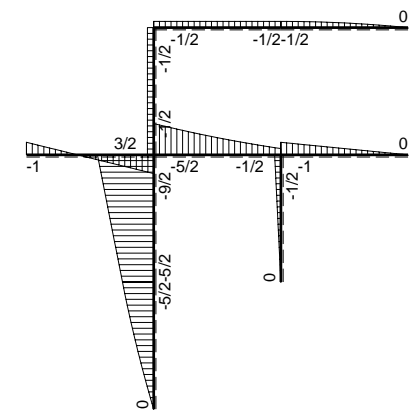
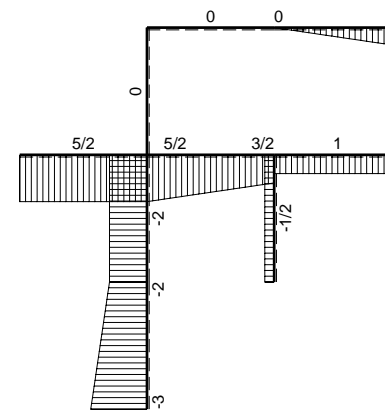
$$\begin{bmatrix} H_A b \\ V_D b \\ V_F b \end{bmatrix} = \begin{bmatrix} 1 & 0 & 2 \\ 0 & 1 & 3/2 \\ 1 & -1 & -1/2 \end{bmatrix} \begin{bmatrix} Fb & W & qb^2 \end{bmatrix}$$



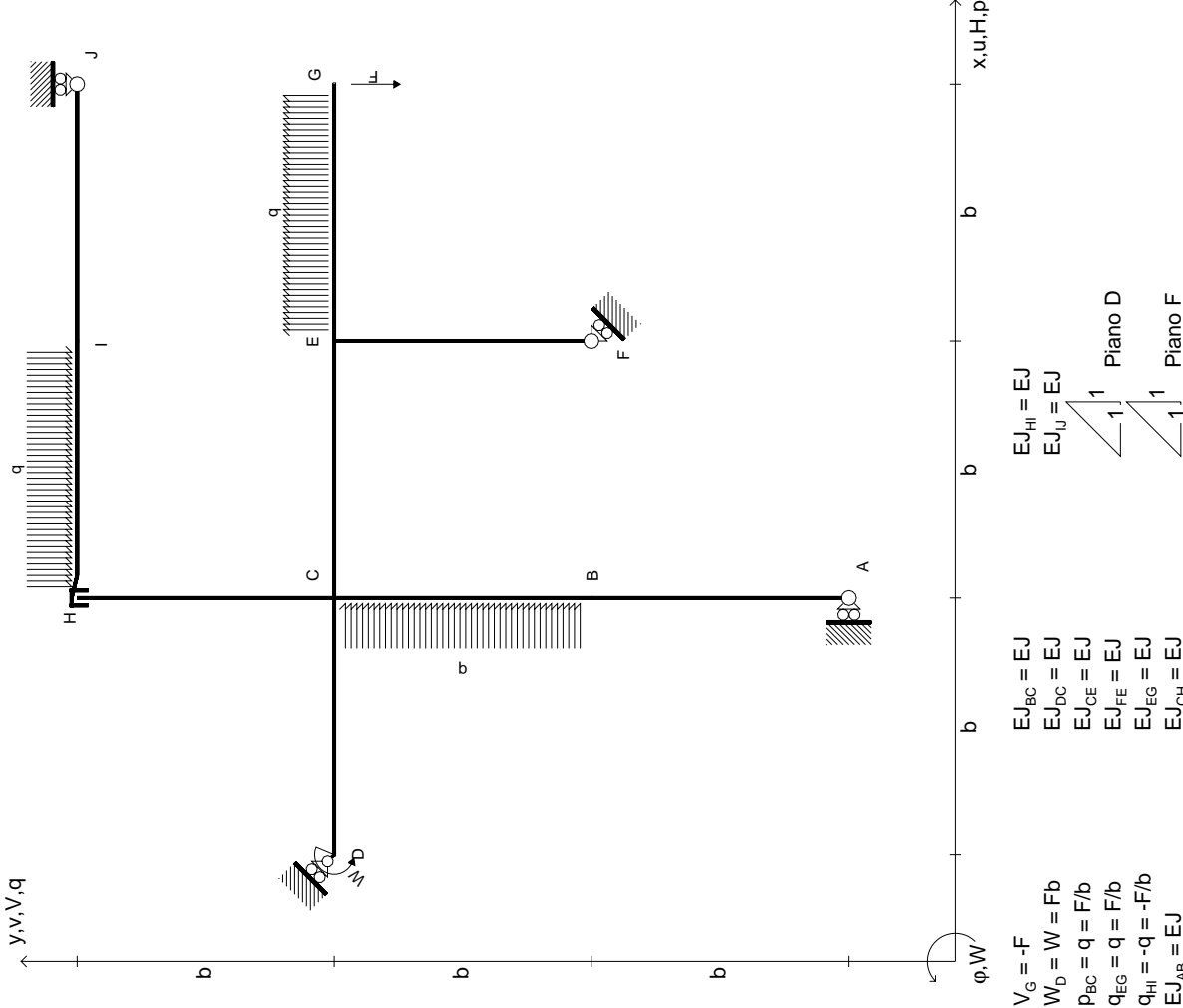
— 25 Fb³/EJ



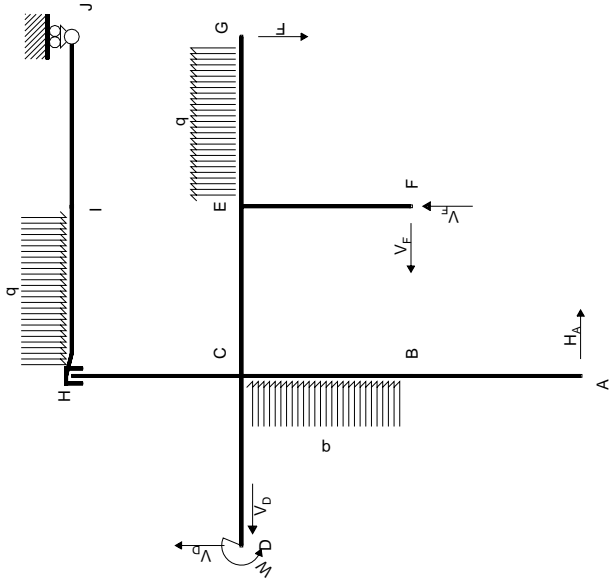
A diagram showing a positive charge, represented by a square box with a '+' sign inside. Below the box are three horizontal dashed lines. To the left of the box is a horizontal arrow pointing left. To the right of the box is a horizontal arrow pointing right, labeled with the letter 'F'.



A square element is shown with a positive normal stress (+) acting on its faces. Shear stress F_b is also indicated acting on the faces.



Carichi e deformazioni date hanno verso efficace in disegno.
Calcolare reazioni vincolari della struttura e delle aste.
Tracciare i diagrammi quotati delle azioni interne nelle aste.
 $J_{YZ} - X_{YZ} - \theta_{YZ}$ riferimento locale asta YZ con origine in Y.
Piano di scorrimento del vincolo con inclinazione assegnata.
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EQUAZIONI DI EQUILIBRIO

Traslazione orizzontale globale

$H_A - V_D - V_F = -qb$

Rotazione globale intorno a J

$3H_A b - 4V_D b - 3V_F b = -W - 5/2qb^2$

Traslazione verticale: aste HC CB CD CE BA EF EG

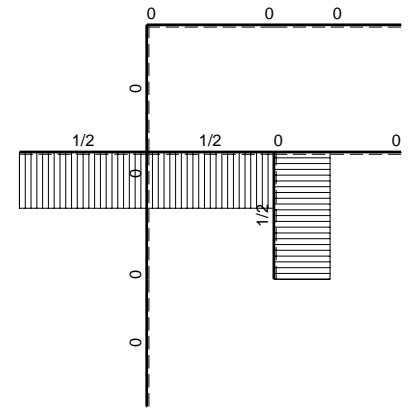
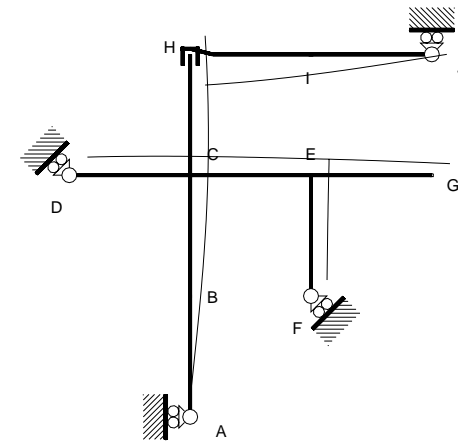
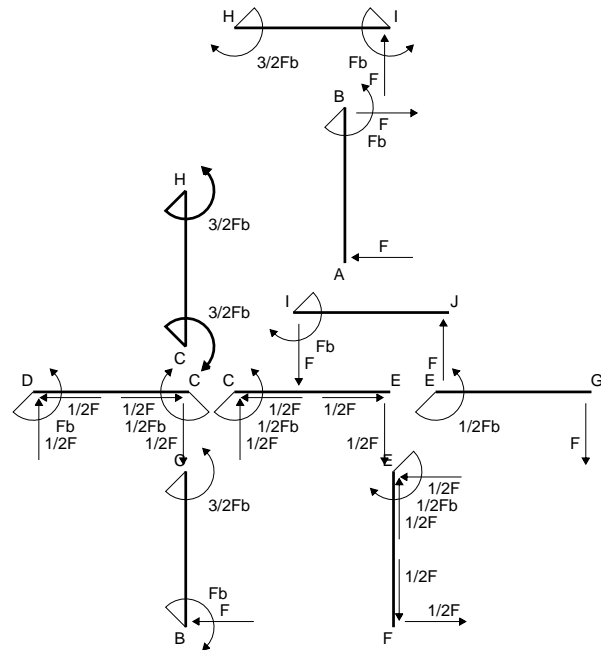
$V_D + V_F = F - qb$

Matrice di equilibrio


$$\begin{bmatrix} H_A b & V_D b & V_F b \end{bmatrix} \begin{bmatrix} Fb & W & qb^2 \end{bmatrix}$$
$$u_j \begin{bmatrix} 1 & -1 & -1 \end{bmatrix} = \begin{bmatrix} 0 & 0 & -1 \end{bmatrix}$$
$$\phi_j \begin{bmatrix} 3 & -4 & -3 \end{bmatrix} = \begin{bmatrix} 0 & -1 & -5/2 \end{bmatrix}$$
$$v_{Hl} \begin{bmatrix} 0 & 1 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & -1 \end{bmatrix}$$

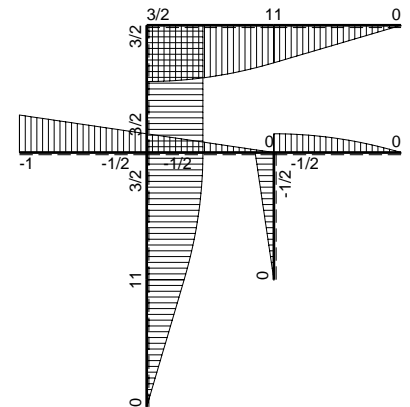
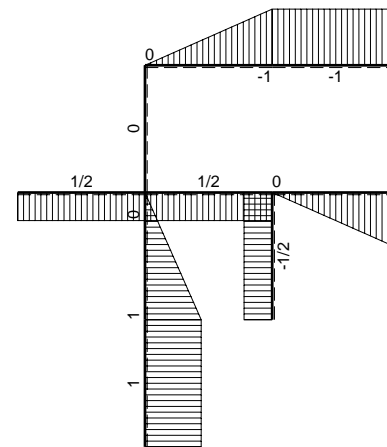
Soluzione del sistema

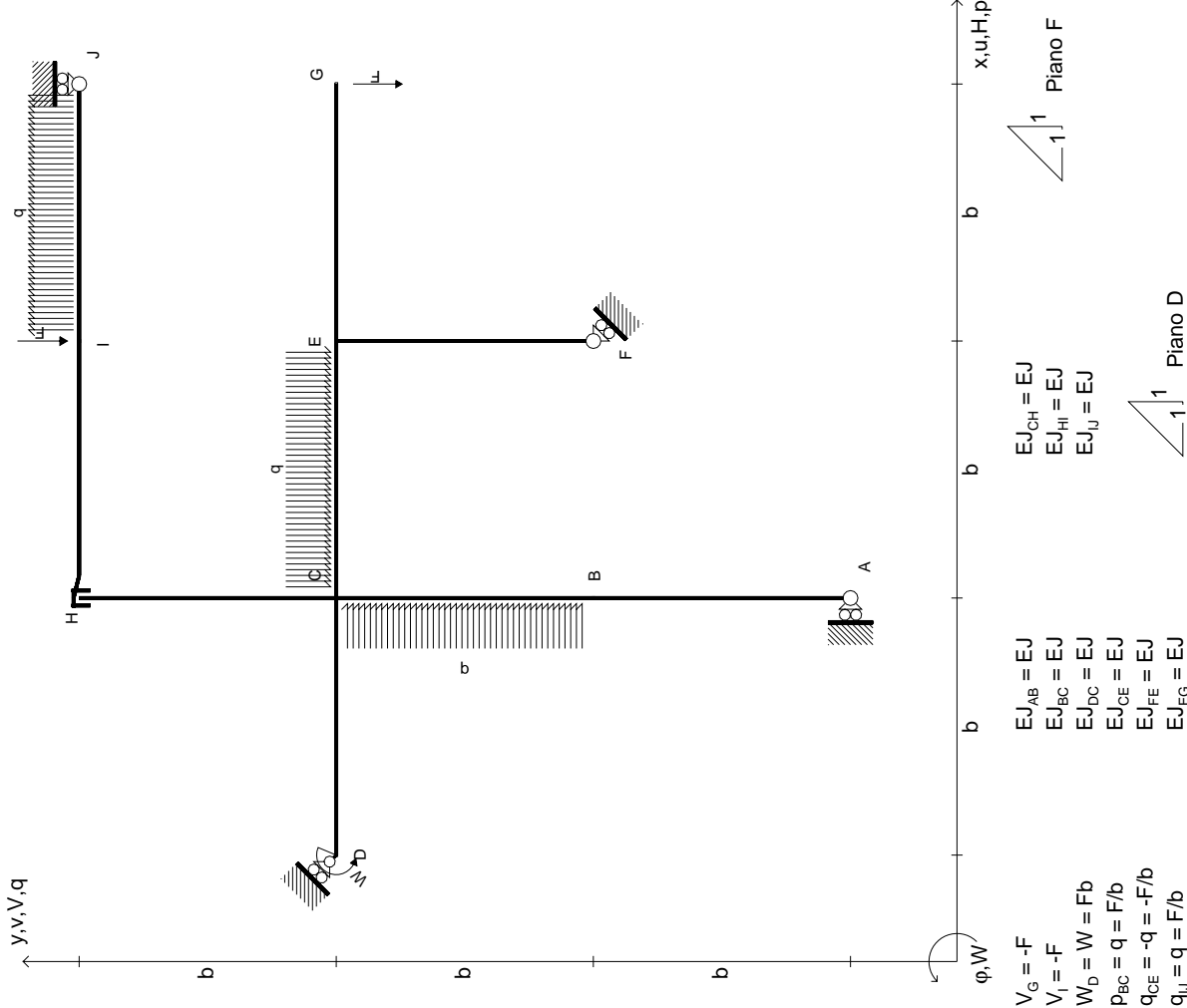
$$\begin{bmatrix} H_A b \\ V_D b \\ V_F b \end{bmatrix} = \begin{bmatrix} 1 & 0 & -2 \\ 0 & 1 & -1/2 \\ 1 & -1 & -1/2 \end{bmatrix} \begin{bmatrix} Fb & W & qb^2 \end{bmatrix}$$



12 Fb³/EJ

←  → F





Carichi e deformazioni date hanno verso efficace in disegno.
Calcolare reazioni vincolari della struttura e delle aste.
Tracciare i diagrammi quotati delle azioni interne nelle aste.
 $J_{YZ} - X_{YZ} - \theta_{YZ}$ riferimento locale asta YZ con origine in Y.
Piano di scorrimento del vincolo con inclinazione assegnata.
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EQUAZIONI DI EQUILIBRIO

Traslazione orizzontale globale

$$H_A - V_D - V_F = -qb$$

Rotazione globale intorno a J

$$3H_A b - 4V_D b - 3V_F b = -Fb - W - 5/2 qb^2$$

Traslazione verticale: aste HC CB CD CE BA EF EG

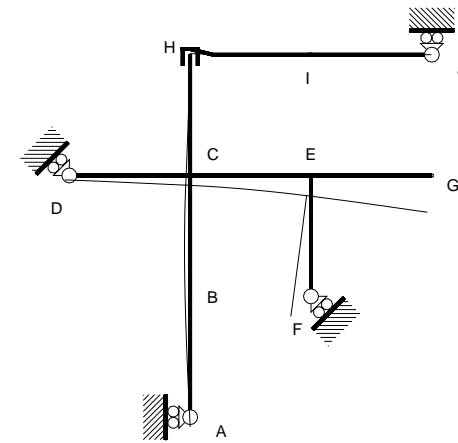
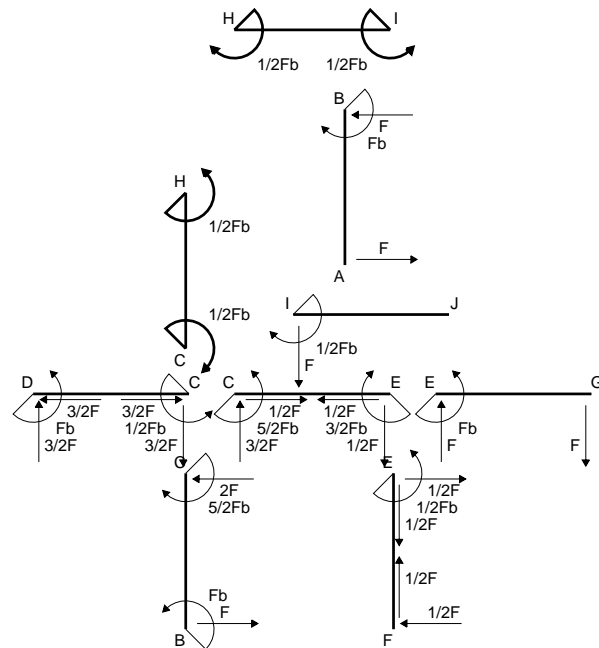
$$V_D + V_F = F + qb$$

Matrice di equilibrio

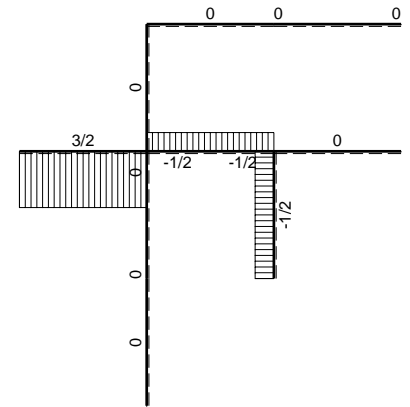
$$\begin{bmatrix} H_A b & V_D b & V_F b \end{bmatrix} \begin{bmatrix} Fb & W & qb^2 \end{bmatrix}$$
$$u_j \begin{bmatrix} 1 & -1 & -1 \end{bmatrix} \begin{bmatrix} 0 & 0 & -1 \end{bmatrix}$$
$$\phi_j \begin{bmatrix} 3 & -4 & -3 \end{bmatrix} = \begin{bmatrix} -1 & -1 & -5/2 \end{bmatrix}$$
$$v_{Hj} \begin{bmatrix} 0 & 1 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 1 \end{bmatrix}$$

Soluzione del sistema

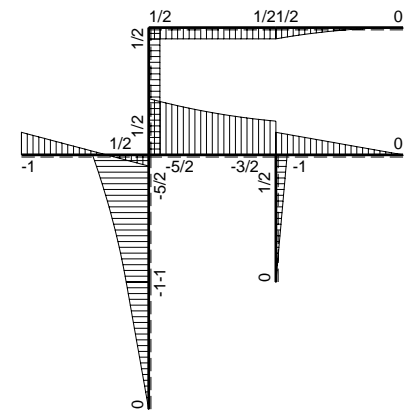
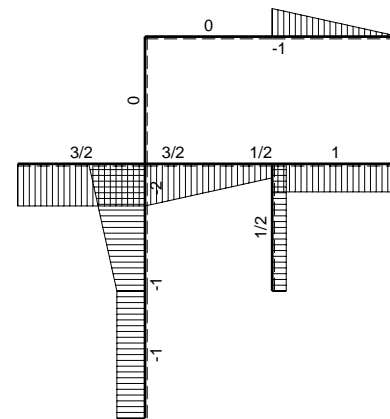
$$\begin{bmatrix} H_A b \\ V_D b \\ V_F b \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 1 & 1 & -1/2 \\ 0 & -1 & 3/2 \end{bmatrix} \begin{bmatrix} Fb & W & qb^2 \end{bmatrix}$$



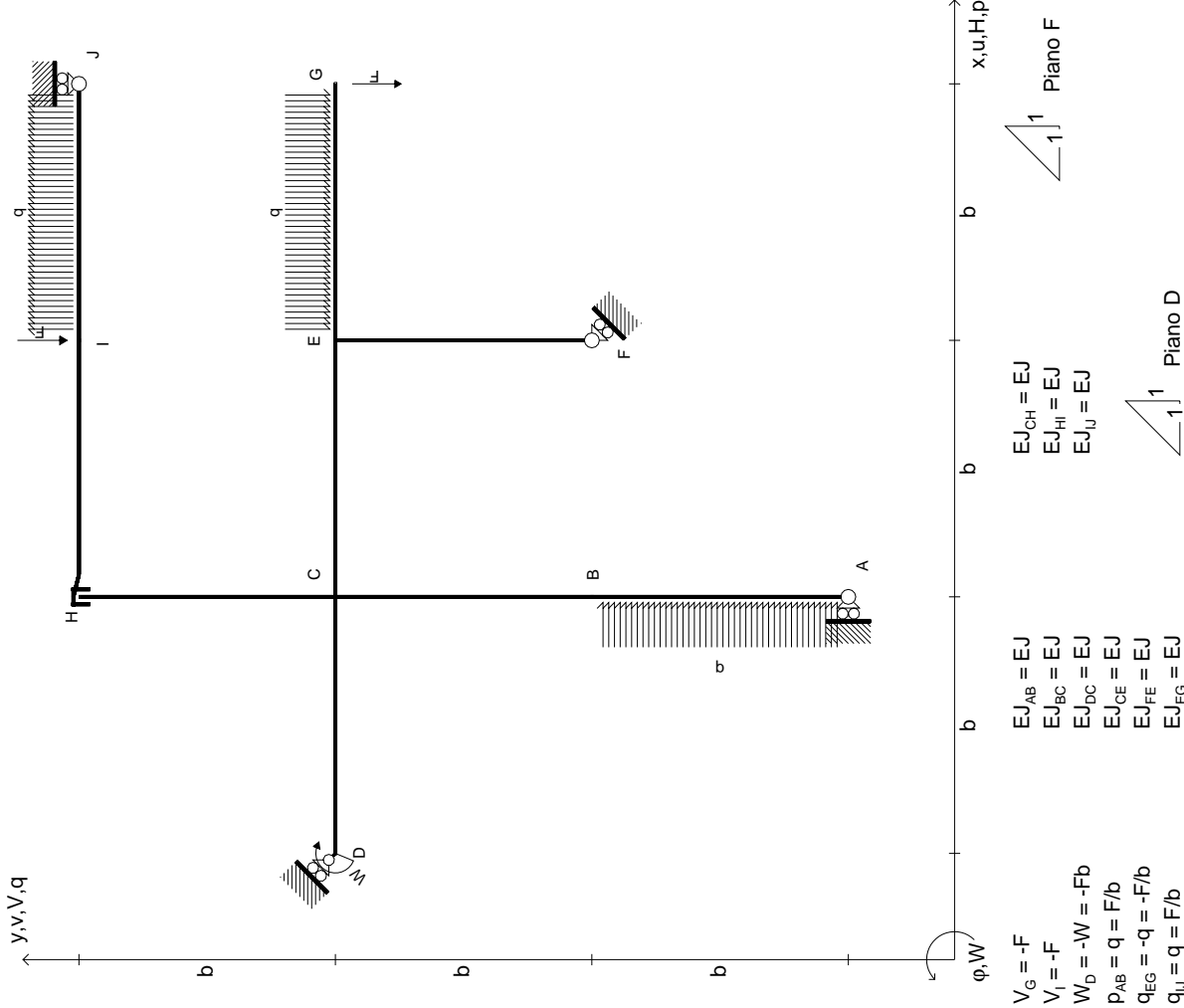
15 Fb³/EJ



A diagram showing a positive charge, represented by a square box with a '+' sign inside. A horizontal arrow points to the left from the charge, and another horizontal arrow points to the right from the charge towards the letter 'F'. Below the charge box, there are three short horizontal dashed lines.



A square element is shown with a positive normal stress (+) and a shear stress (Fb) acting on its right face. The shear stress is represented by a curved arrow pointing downwards.



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Piano di scorrimento del vincolo con inclinazione assegnata.
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EQUAZIONI DI EQUILIBRIO

Traslazione orizzontale globale

$$H_A - V_D - V_F = -qb$$

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$$3H_A b - 4V_D b - 3V_F b = -Fb + W - 5/2 qb^2$$

Traslazione verticale: aste HC CB CD CE BA EF EG

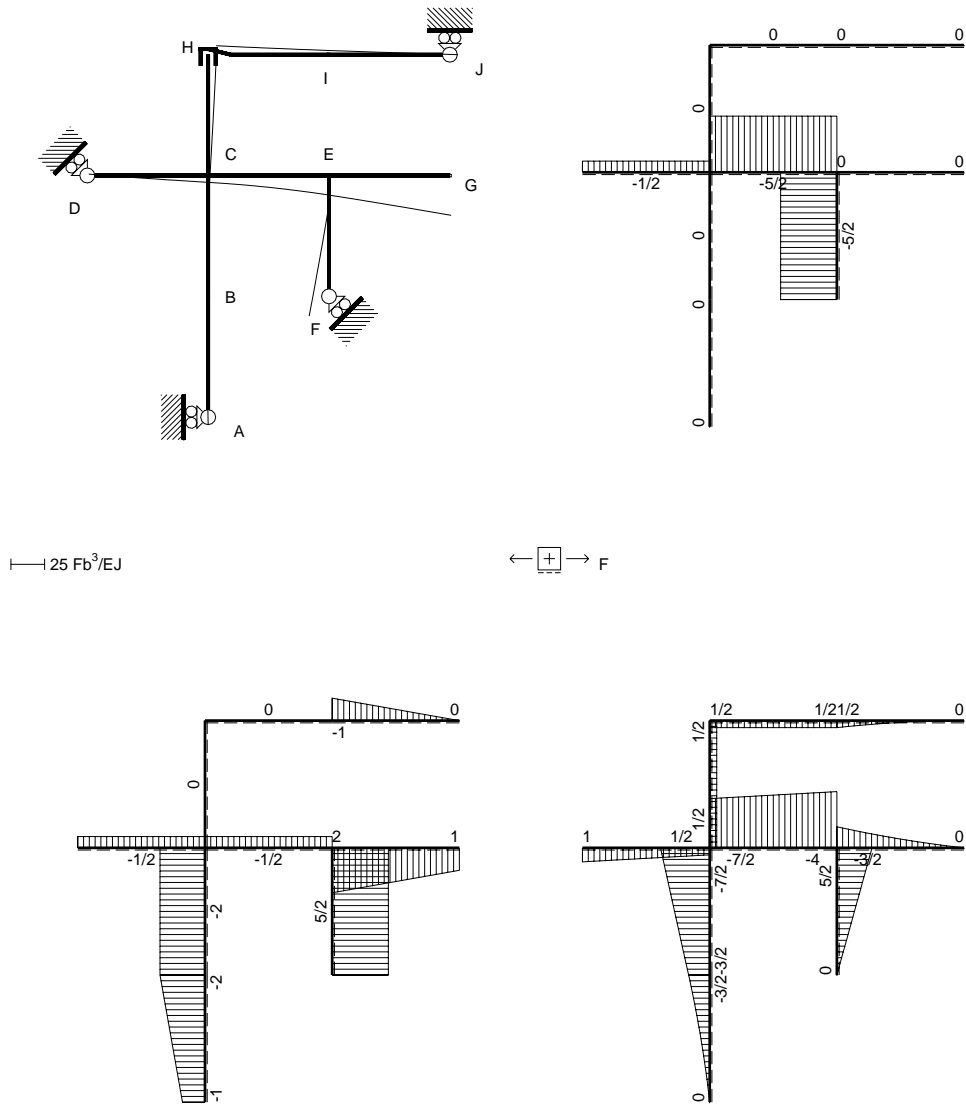
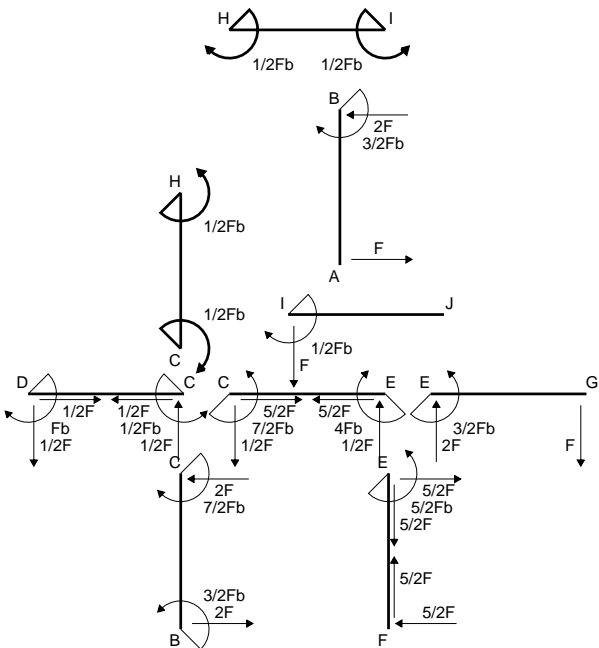
$$V_D + V_F = F + qb$$

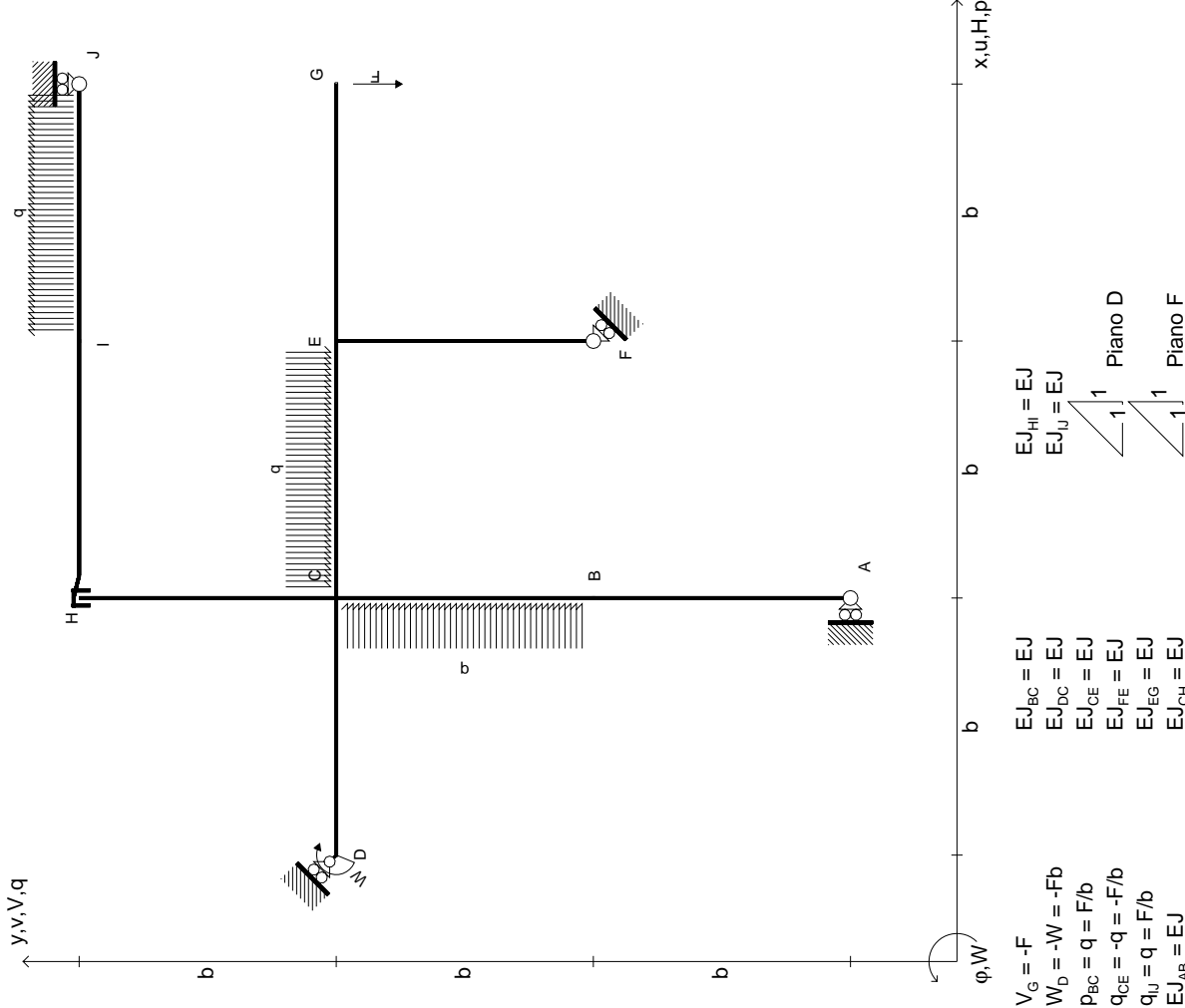
Matrice di equilibrio

$$\begin{bmatrix} H_A b & V_D b & V_F b \end{bmatrix} \begin{bmatrix} Fb & W & qb^2 \end{bmatrix}$$
$$u_j \begin{bmatrix} 1 & -1 & -1 \end{bmatrix} \begin{bmatrix} 0 & 0 & -1 \end{bmatrix}$$
$$\phi_j \begin{bmatrix} 3 & -4 & -3 \end{bmatrix} = \begin{bmatrix} -1 & 1 & -5/2 \end{bmatrix}$$
$$v_{Hj} \begin{bmatrix} 0 & 1 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 1 \end{bmatrix}$$

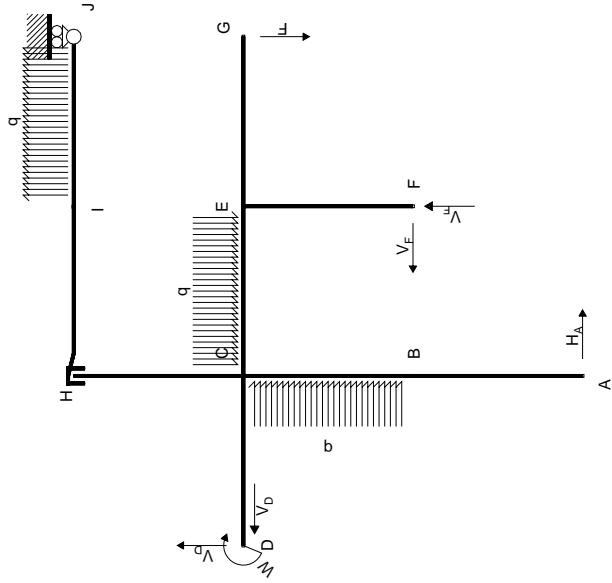
Soluzione del sistema

$$\begin{bmatrix} H_A b \\ V_D b \\ V_F b \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 1 & -1 & -1/2 \\ 0 & 1 & 3/2 \end{bmatrix} \begin{bmatrix} Fb & W & qb^2 \end{bmatrix}$$





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EQUAZIONI DI EQUILIBRIO

Traslazione orizzontale globale

$$H_A - V_D - V_F = -qb$$

Rotazione globale intorno a J

$$3H_A b - 4V_D b - 3V_F b = W \cdot 5/2qb^2$$

Traslazione verticale: aste HC CB CD CE BA EF EG

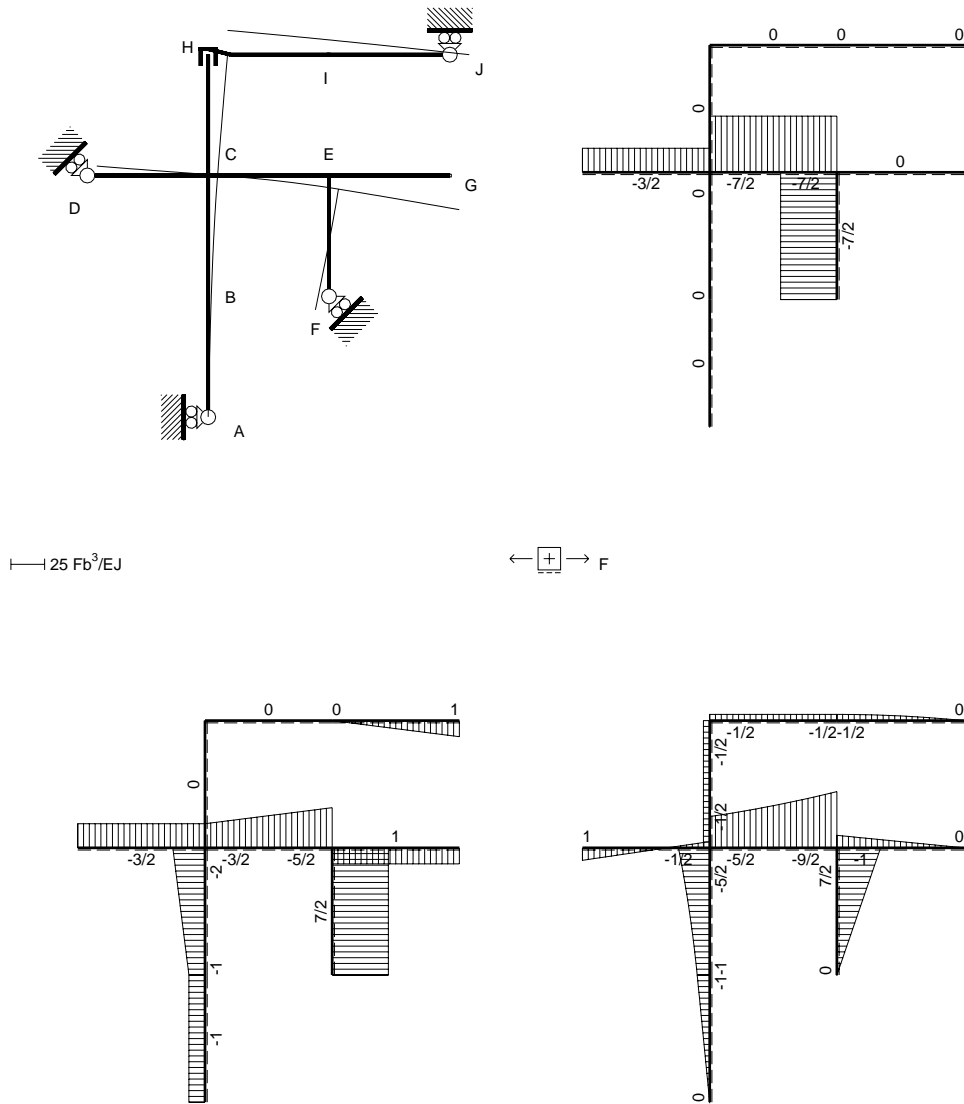
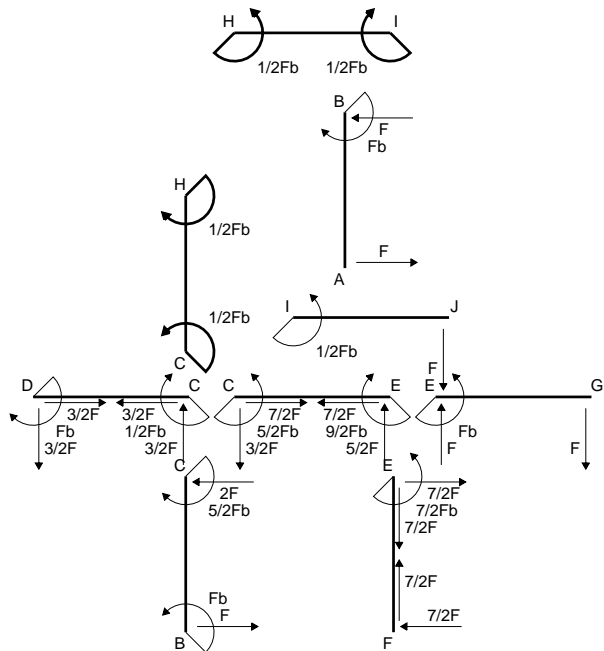
$$V_D + V_F = F + qb$$

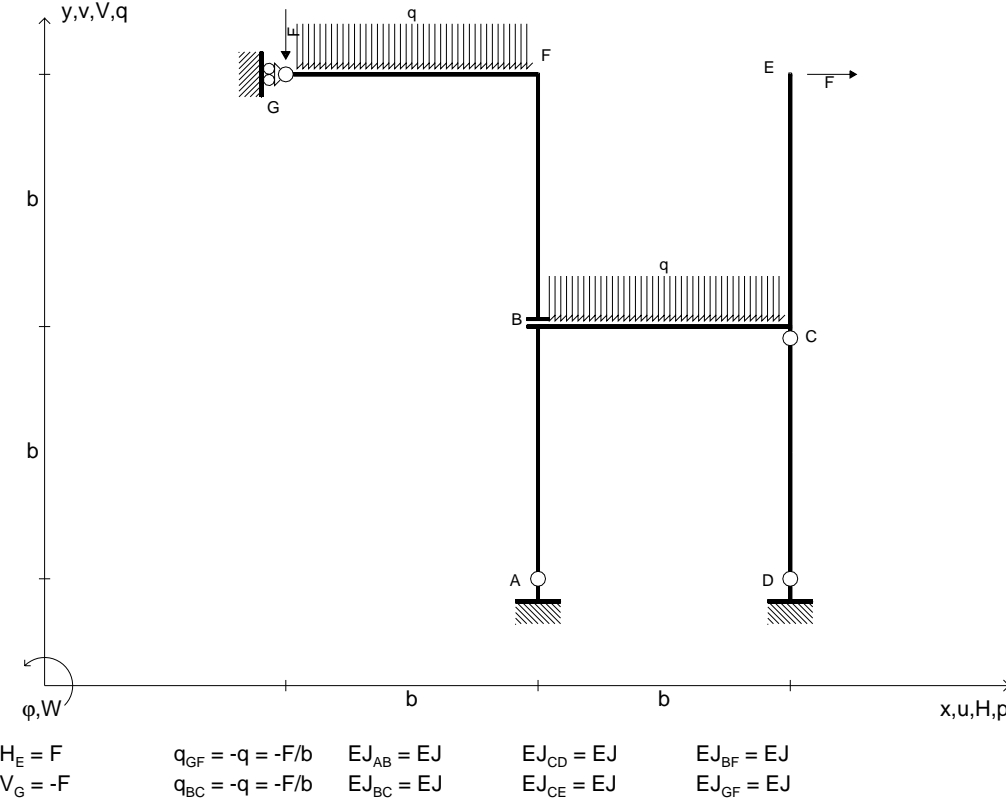
Matrice di equilibrio

$$\begin{bmatrix} H_A b & V_D b & V_F b \end{bmatrix} \begin{bmatrix} Fb & W & qb^2 \end{bmatrix}$$
$$u_j \begin{bmatrix} 1 & -1 & -1 \end{bmatrix} = \begin{bmatrix} 0 & 0 & -1 \end{bmatrix}$$
$$\phi_j \begin{bmatrix} 3 & -4 & -3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & -5/2 \end{bmatrix}$$
$$v_{Hj} \begin{bmatrix} 0 & 1 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 1 \end{bmatrix}$$

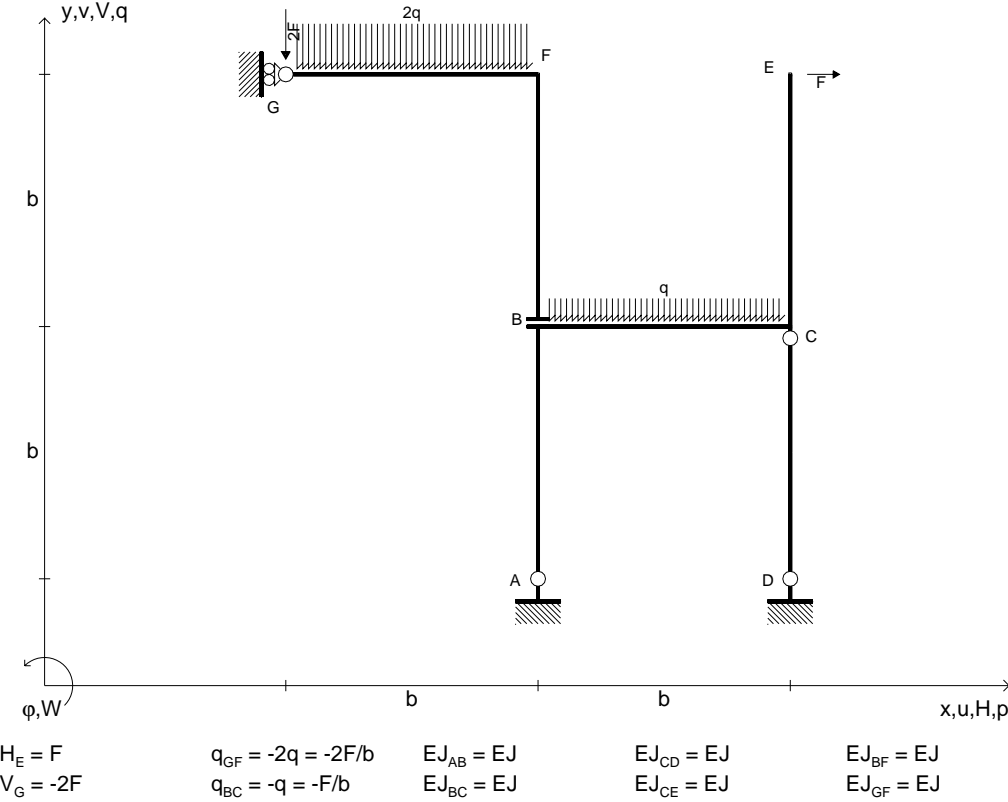
Soluzione del sistema

$$\begin{bmatrix} H_A b \\ V_D b \\ V_F b \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & -1/2 \\ 1 & 1 & 3/2 \end{bmatrix} \begin{bmatrix} Fb & W & qb^2 \end{bmatrix}$$

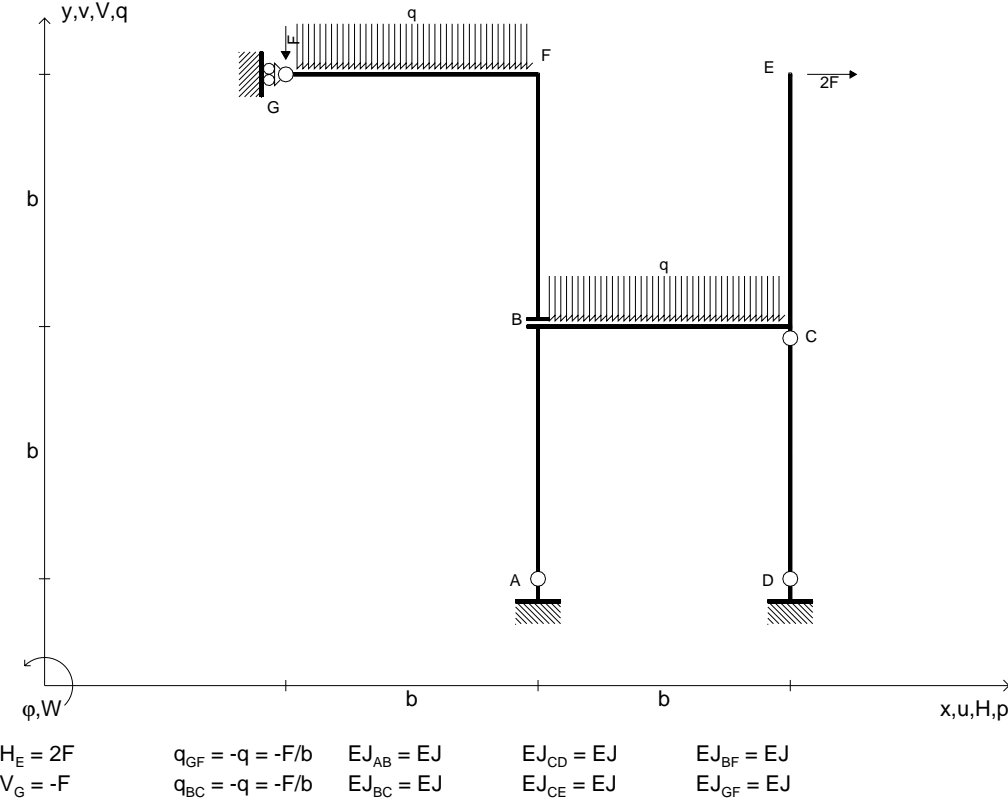




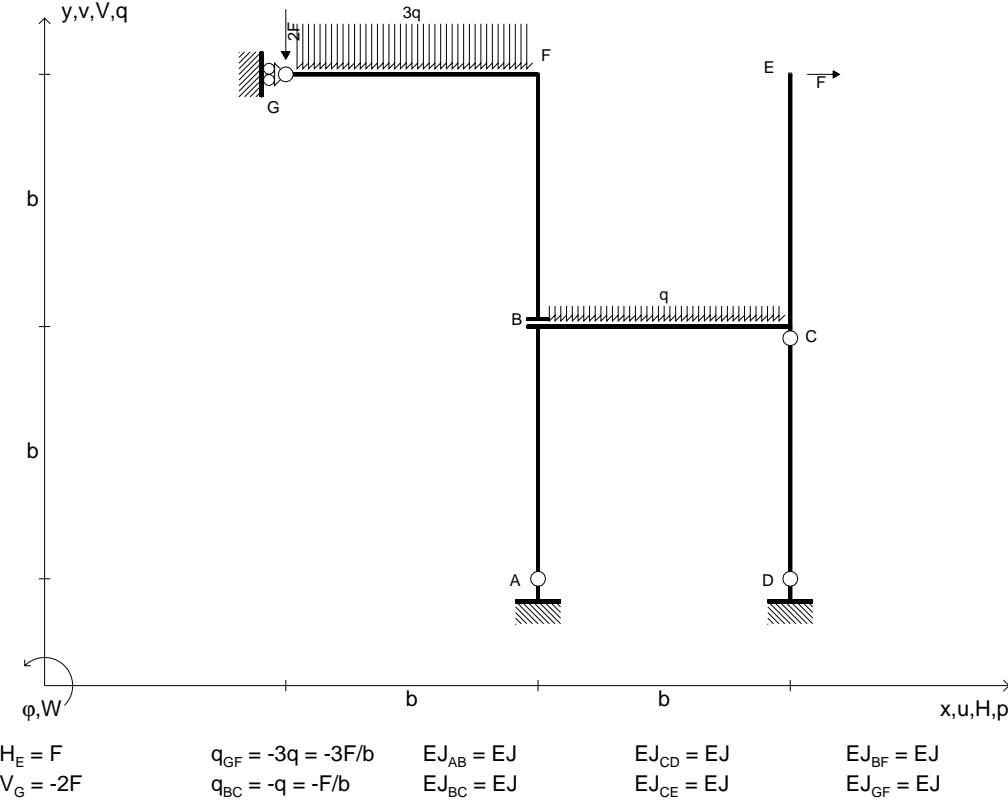
Carichi e deformazioni date hanno verso efficace in disegno.
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@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.15.09.10



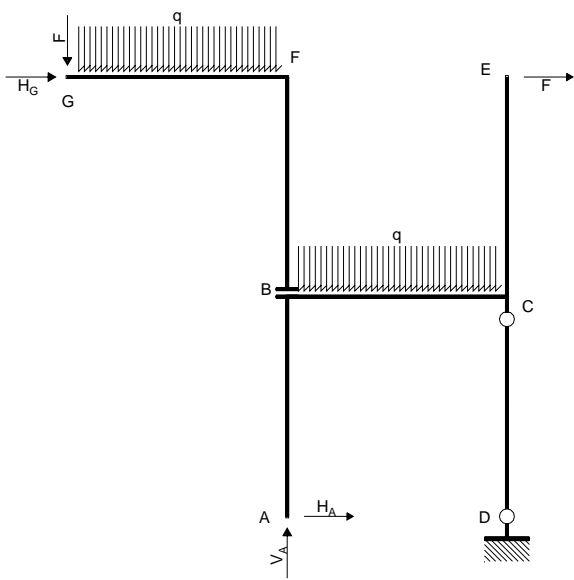
Carichi e deformazioni date hanno verso efficace in disegno.
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EQUAZIONI DI EQUILIBRIO

Rotazione globale intorno a D

$-V_A b - 2H_G b = -2qb^2$

Rotazione intorno a C: aste CB CE BA BF FG

$H_A b - V_A b - H_G b = -Fb - 2qb^2$

Traslazione orizzontale: aste BF FG

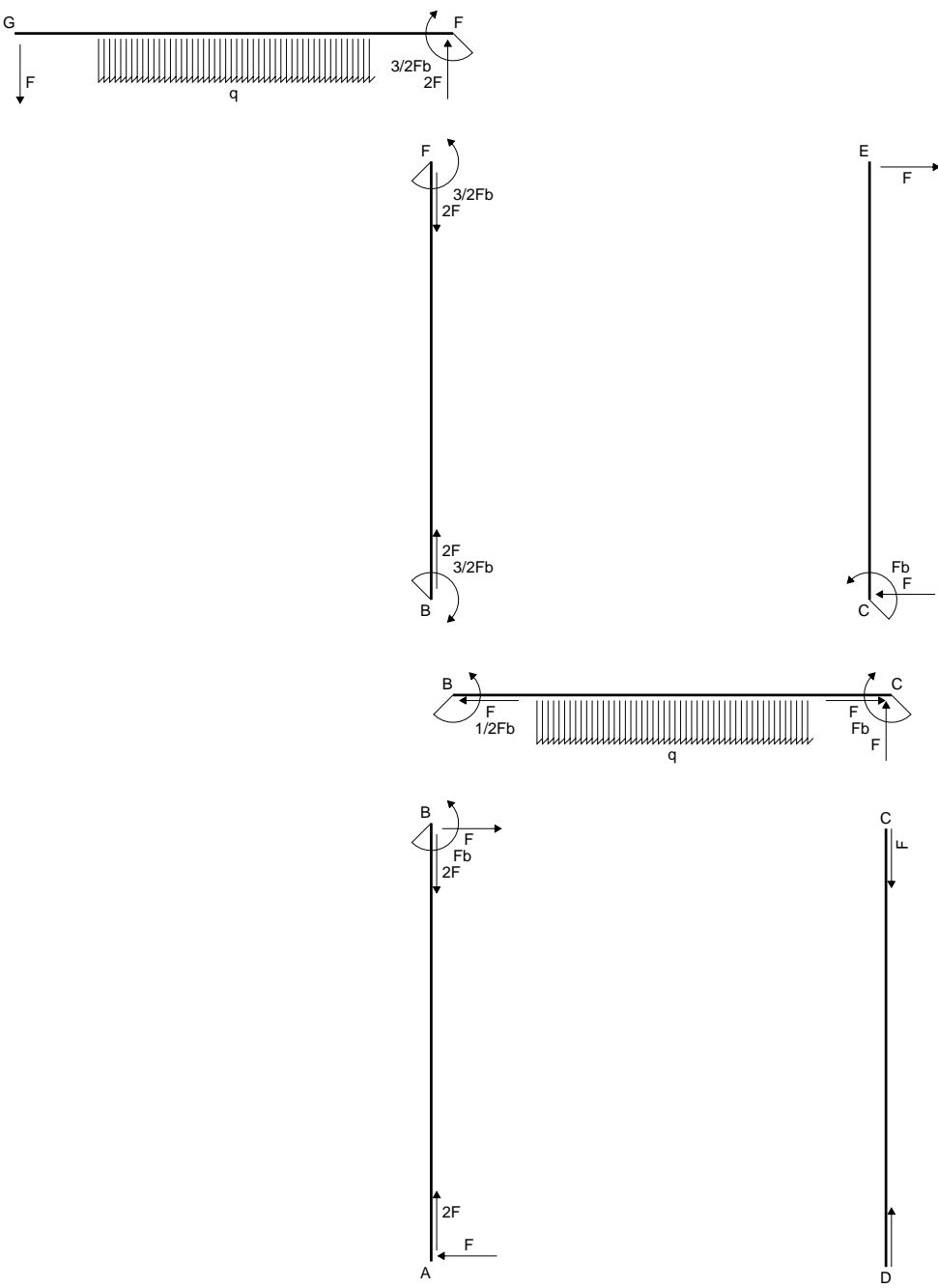
$H_G = 0$

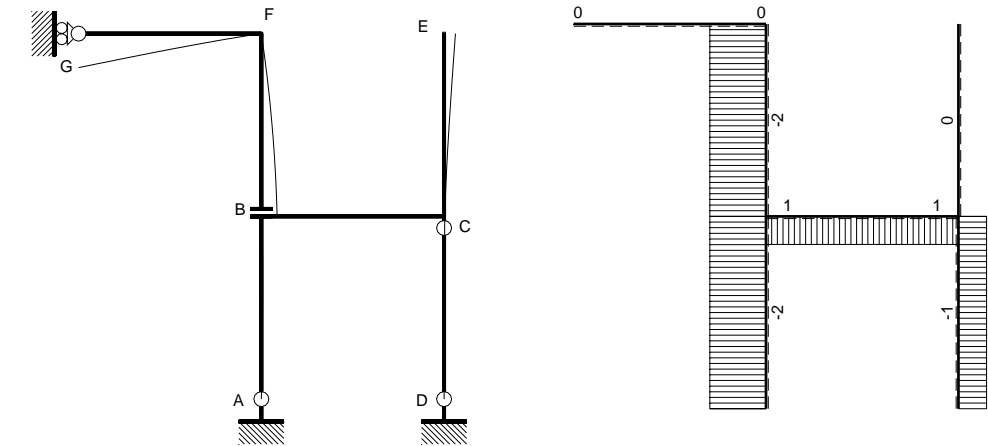
Matrice di equilibrio

$$\begin{matrix} \varphi_D \\ \varphi_{CD} \\ u_{BF} \end{matrix} \begin{bmatrix} H_A b & V_A b & H_G b \\ 1 & -1 & -1 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ -1 & -2 \\ 0 & 0 \end{bmatrix}$$

Soluzione del sistema

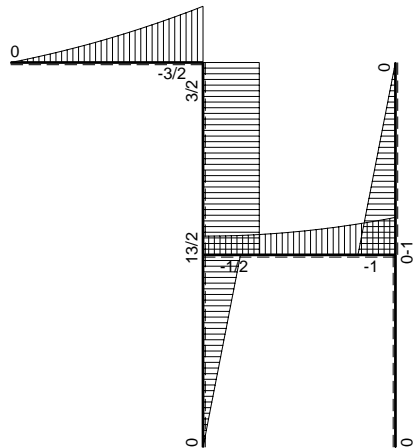
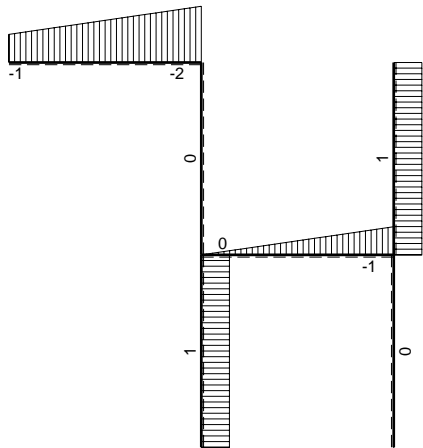
$$\begin{bmatrix} V_A b \\ H_A b \\ H_G b \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ 0 & 2 \\ 0 & 0 \end{bmatrix}$$





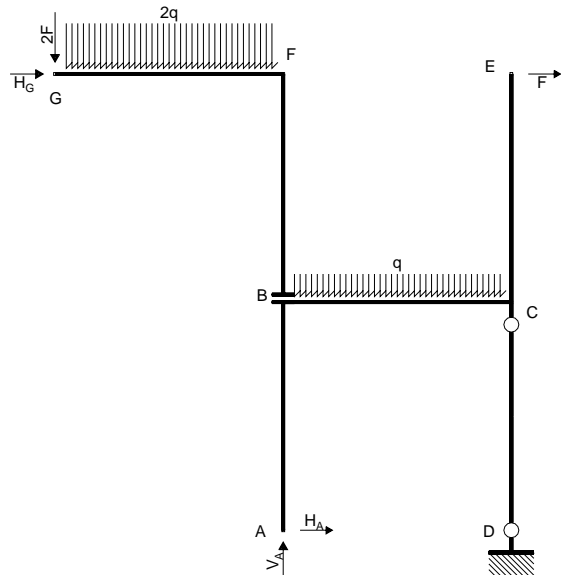
$\frac{1}{5} F b^3 / EJ$

$\leftarrow \boxed{+} \rightarrow F$



$\uparrow \boxed{+} \downarrow F$

$\curvearrowright \boxed{+} \curvearrowleft F_b$



EQUAZIONI DI EQUILIBRIO

Rotazione globale intorno a D

$$-V_A b - 2H_G b = -2Fb - 7/2qb^2$$

Rotazione intorno a C: aste CB CE BA BF FG

$$H_A b - V_A b - H_G b = -3Fb - 7/2qb^2$$

Traslazione orizzontale: aste BF FG

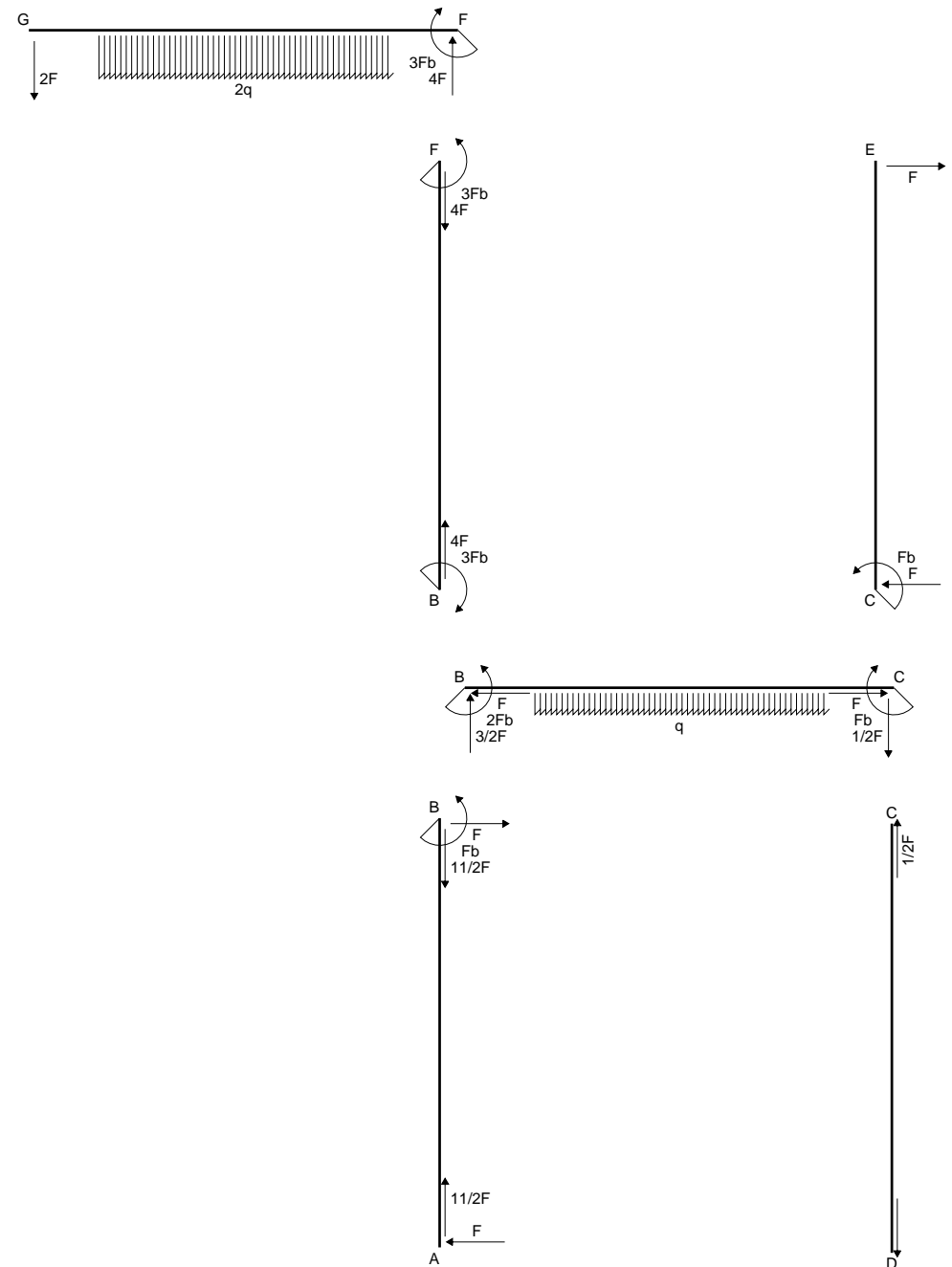
$$H_G = 0$$

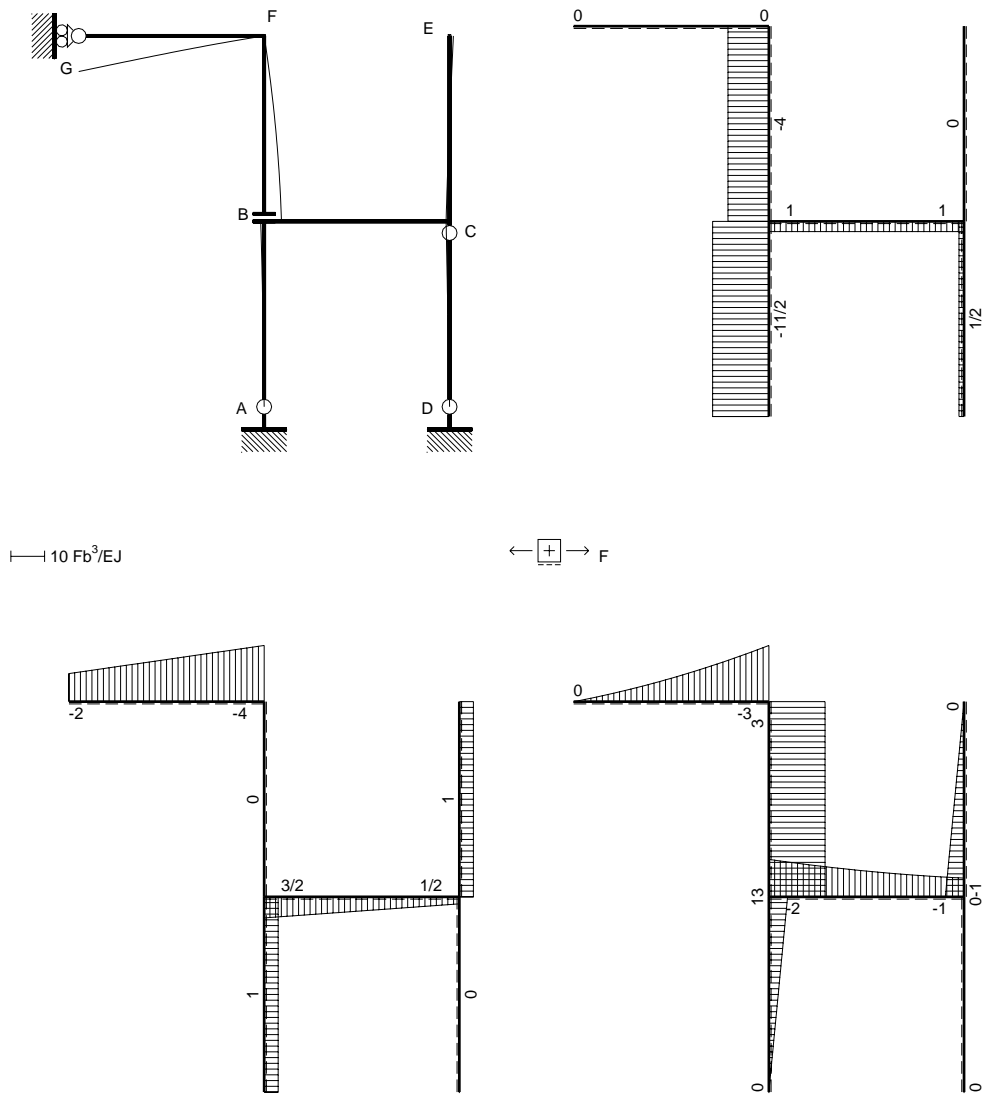
Matrice di equilibrio

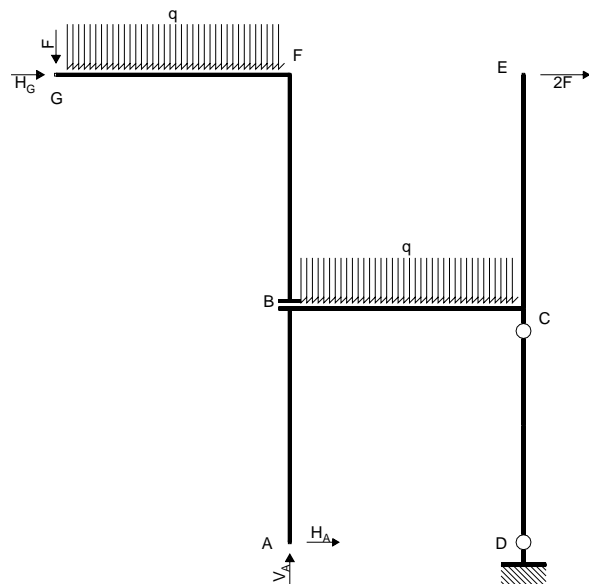
$$\begin{bmatrix} \Phi_D \\ \Phi_{CD} \\ u_{BF} \end{bmatrix} \begin{bmatrix} H_A b & V_A b & H_G b \\ 0 & -1 & -2 \\ 1 & -1 & -1 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ -2 & -7/2 \\ -3 & -7/2 \\ 0 & 0 \end{bmatrix}$$

Soluzione del sistema

$$\begin{bmatrix} V_{Ab} \\ H_{Ab} \\ H_{Gb} \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ 2 & 7/2 \\ -1 & 0 \\ 0 & 0 \end{bmatrix}$$







EQUAZIONI DI EQUILIBRIO

Rotazione globale intorno a D

$$-V_A b - 2H_G b = 2Fb - 2qb^2$$

Rotazione intorno a C: aste CB CE BA BF FG

$$H_A b - V_A b - H_G b = -2qb^2$$

Traslazione orizzontale: aste BF FG

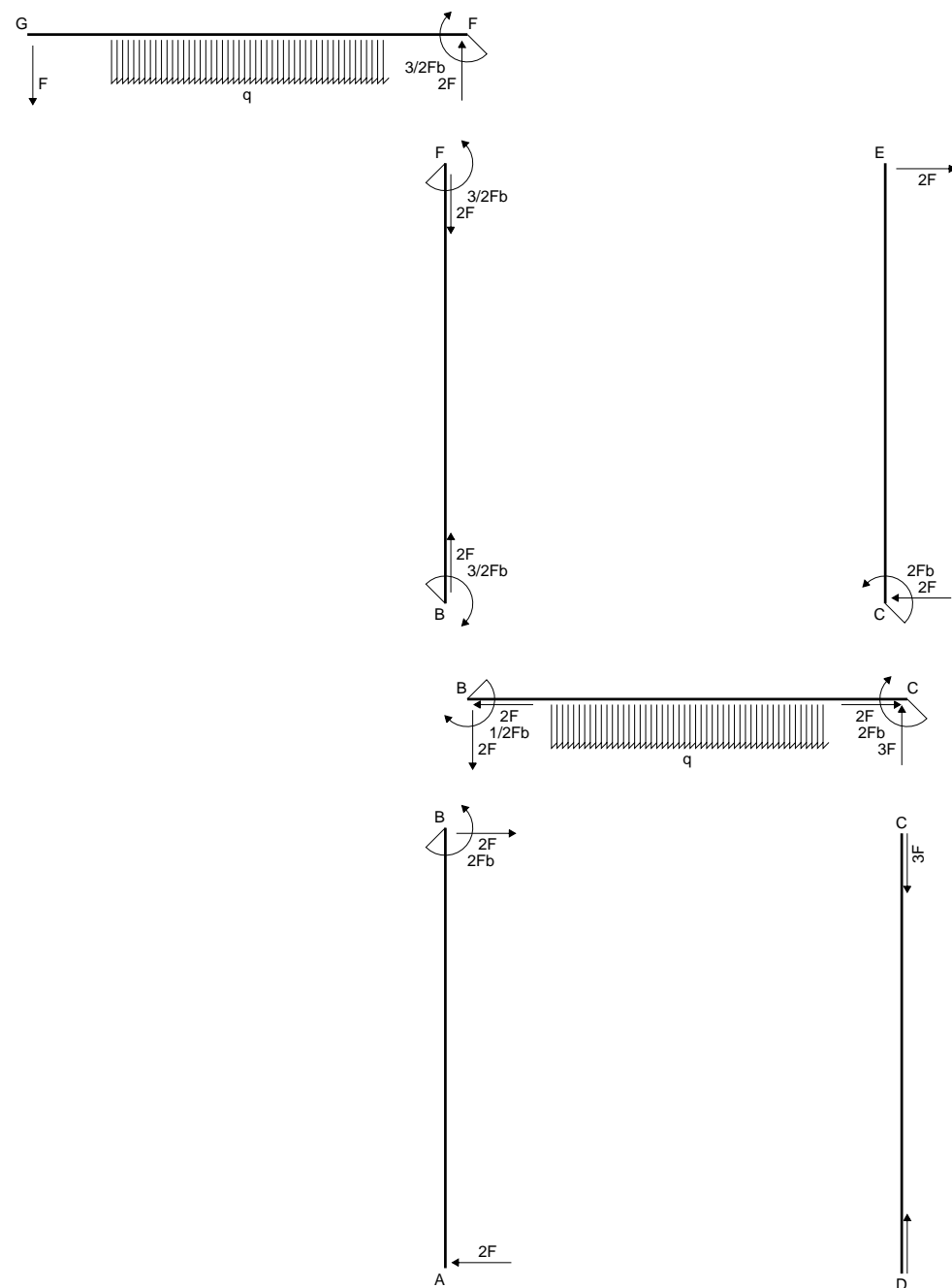
$$H_G = 0$$

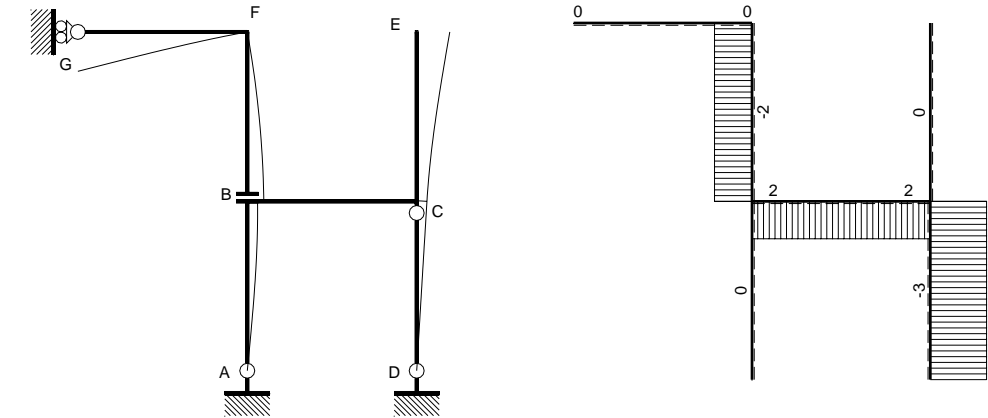
Matrice di equilibrio

$$\begin{bmatrix} \varphi_D \\ \varphi_{CD} \\ u_{BF} \end{bmatrix} \begin{bmatrix} H_A b & V_A b & H_G b \\ 1 & -1 & -1 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ 0 & -2 \\ 0 & 0 \end{bmatrix}$$

Soluzione del sistema

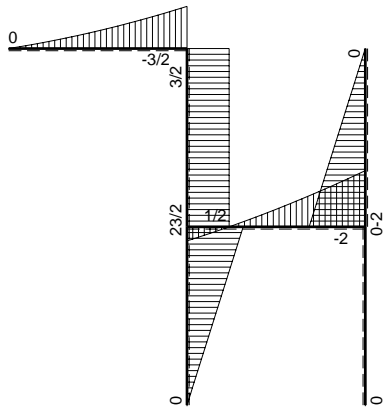
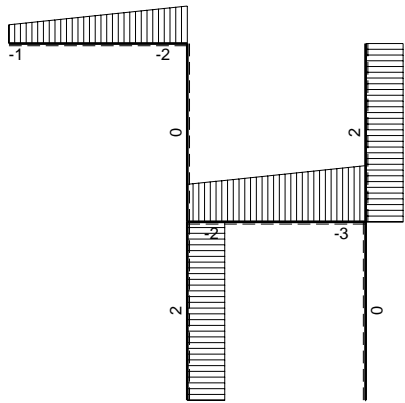
$$\begin{bmatrix} V_A b \\ H_A b \\ H_G b \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ -2 & 2 \\ 0 & 0 \end{bmatrix}$$





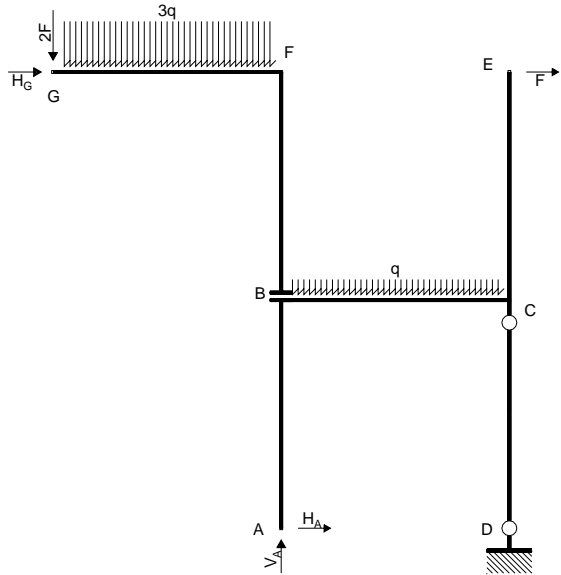
$\frac{1}{4} F b^3 / EJ$

$\leftarrow \boxed{+} \rightarrow F$



$\uparrow \boxed{+} \downarrow F$

$\curvearrowright \boxed{+} \curvearrowleft F_b$



EQUAZIONI DI EQUILIBRIO

Rotazione globale intorno a D

$$-V_A b - 2H_G b = -2Fb - 5qb^2$$

Rotazione intorno a C: aste CB CE BA BF FG

$$H_A b - V_A b - H_G b = -3Fb - 5qb^2$$

Traslazione orizzontale: aste BF FG

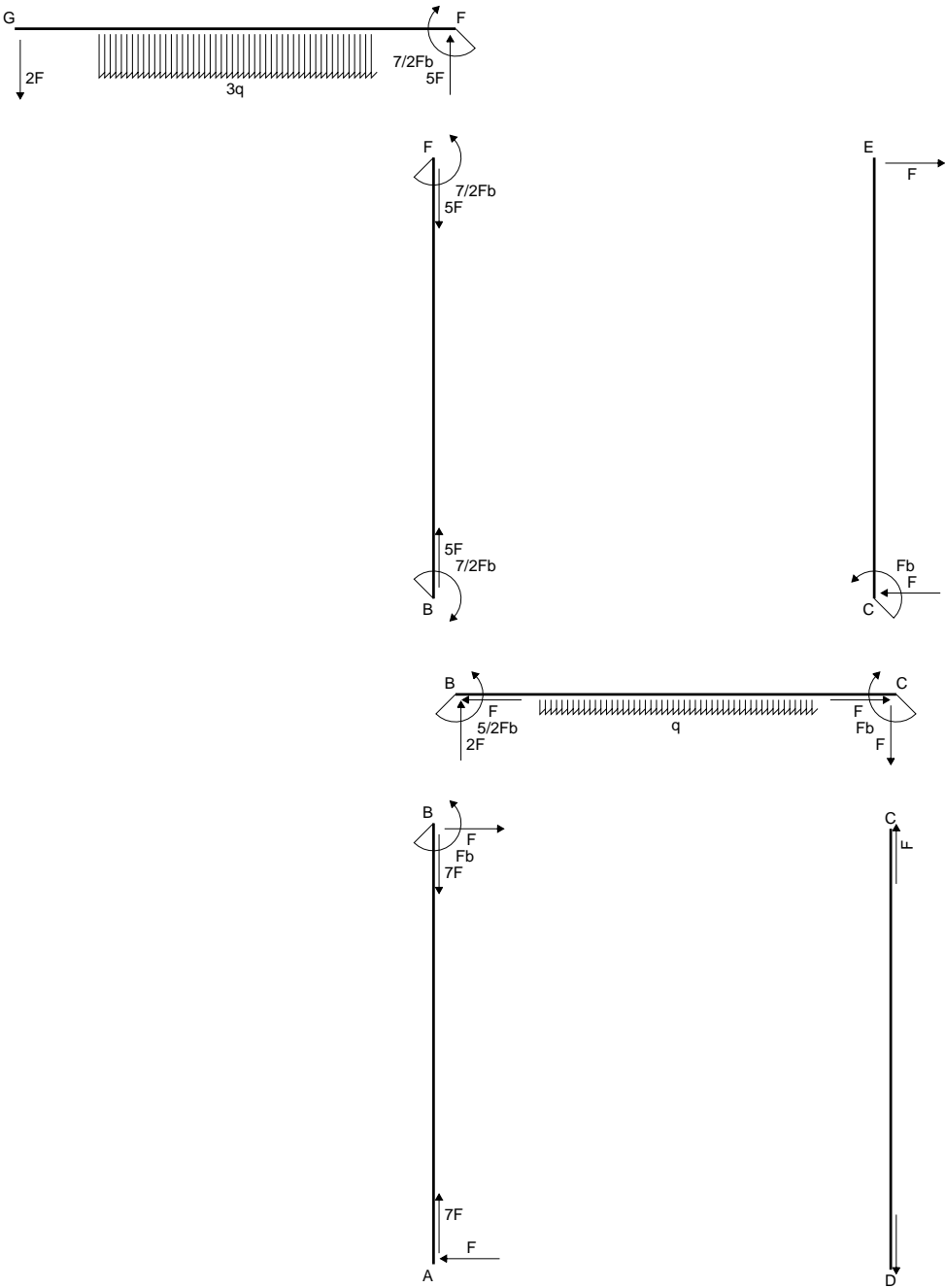
$$H_G = 0$$

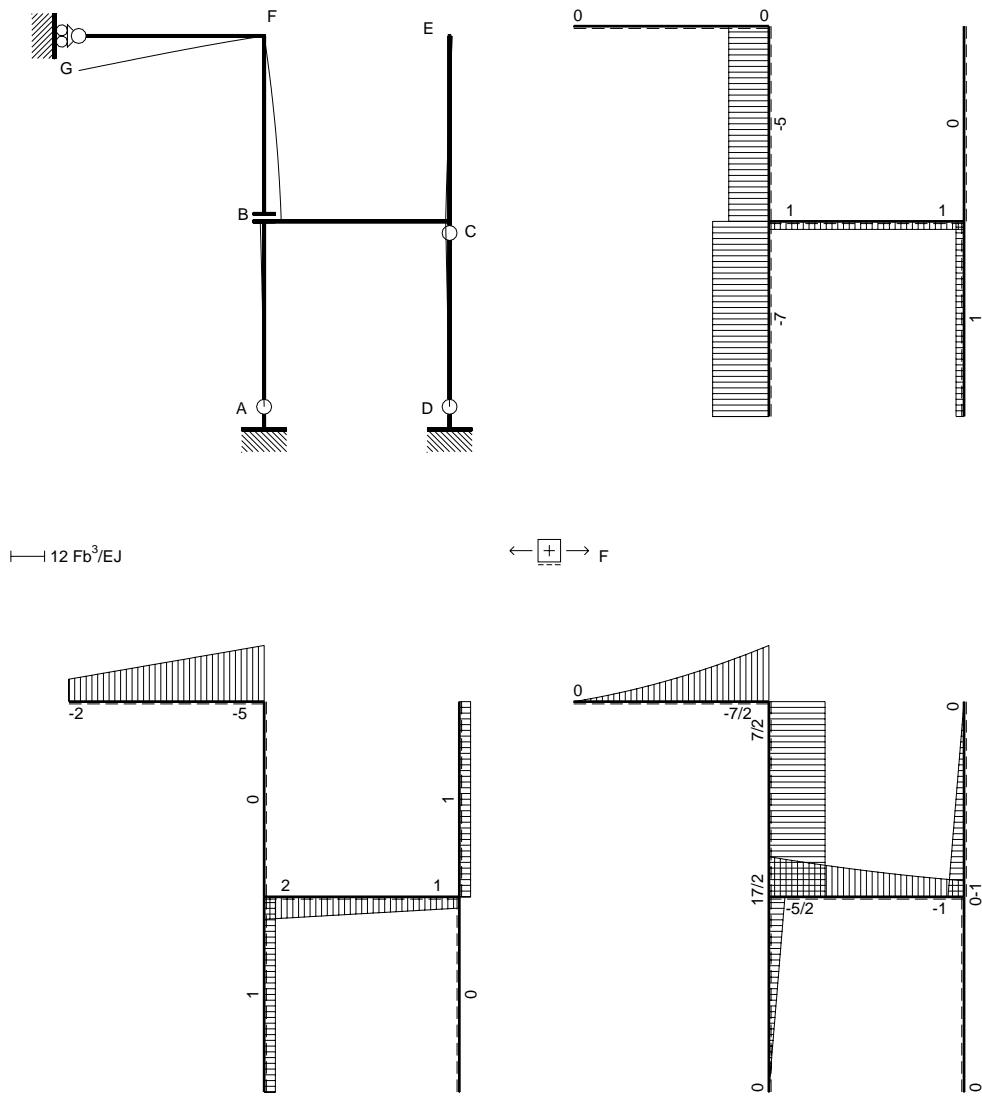
Matrice di equilibrio

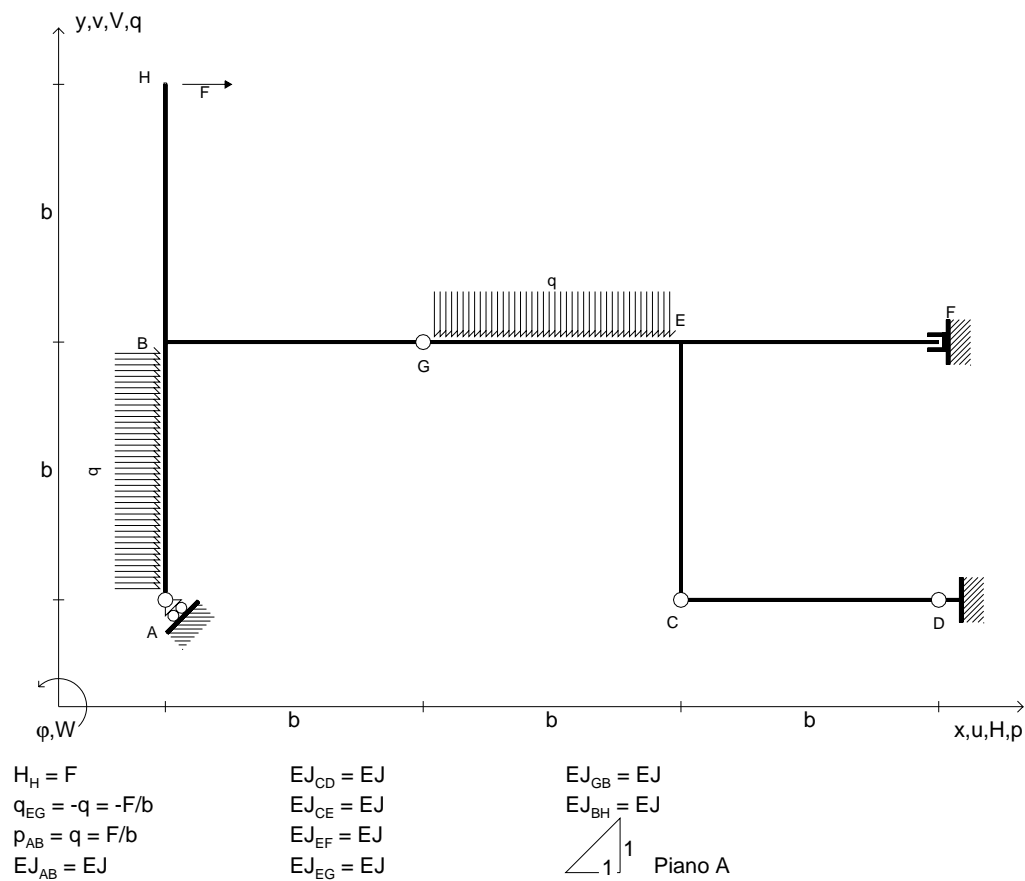
$$\begin{matrix} \varphi_D \\ \varphi_{CD} \\ u_{BF} \end{matrix} \begin{bmatrix} H_A b & V_A b & H_G b \\ 1 & -1 & -1 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ -2 & -5 \\ 0 & 0 \end{bmatrix}$$

Soluzione del sistema

$$\begin{bmatrix} V_A b \\ H_A b \\ H_G b \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ 2 & 5 \\ -1 & 0 \\ 0 & 0 \end{bmatrix}$$







Carichi e deformazioni date hanno verso efficace in disegno.

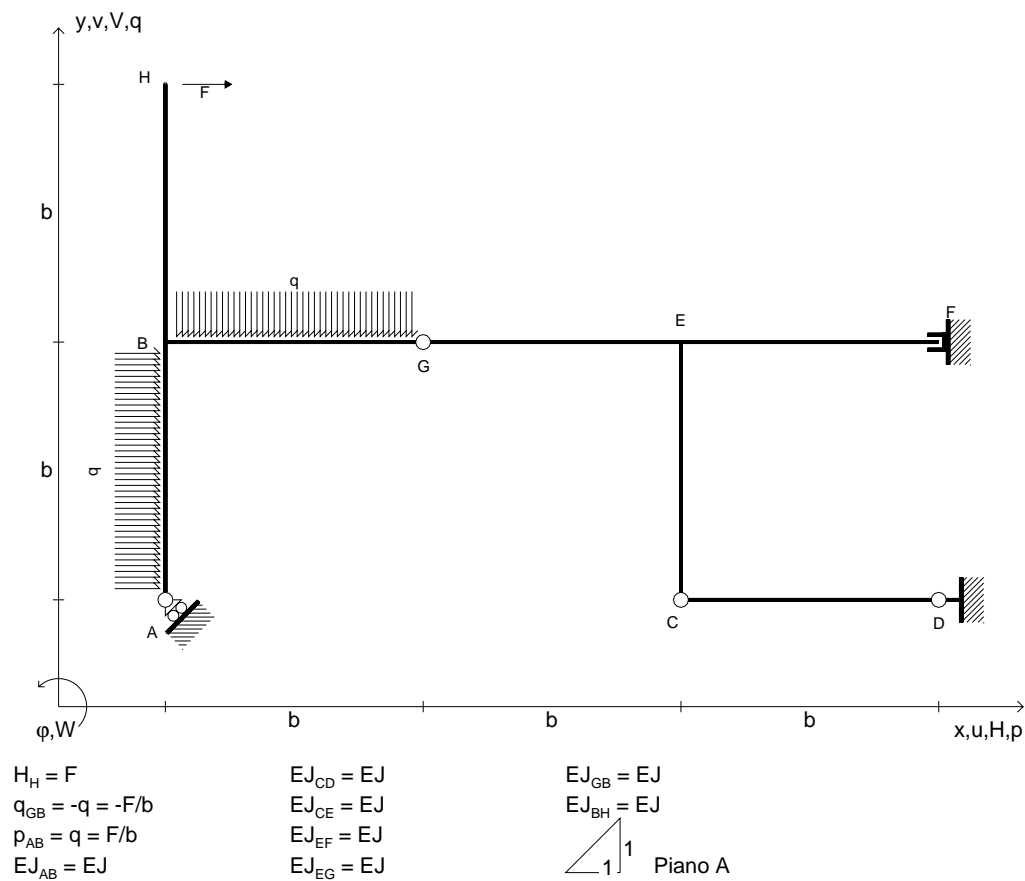
Calcolare reazioni vincolari della struttura e delle aste.

Tracciare i diagrammi quotati delle azioni interne nelle aste.

$J_{YZ} - x_{YZ} - \theta_{YZ}$ riferimento locale asta YZ con origine in Y.

Piano di scorrimento del vincolo con inclinazione assegnata.

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.31.01.10



Carichi e deformazioni date hanno verso efficace in disegno.

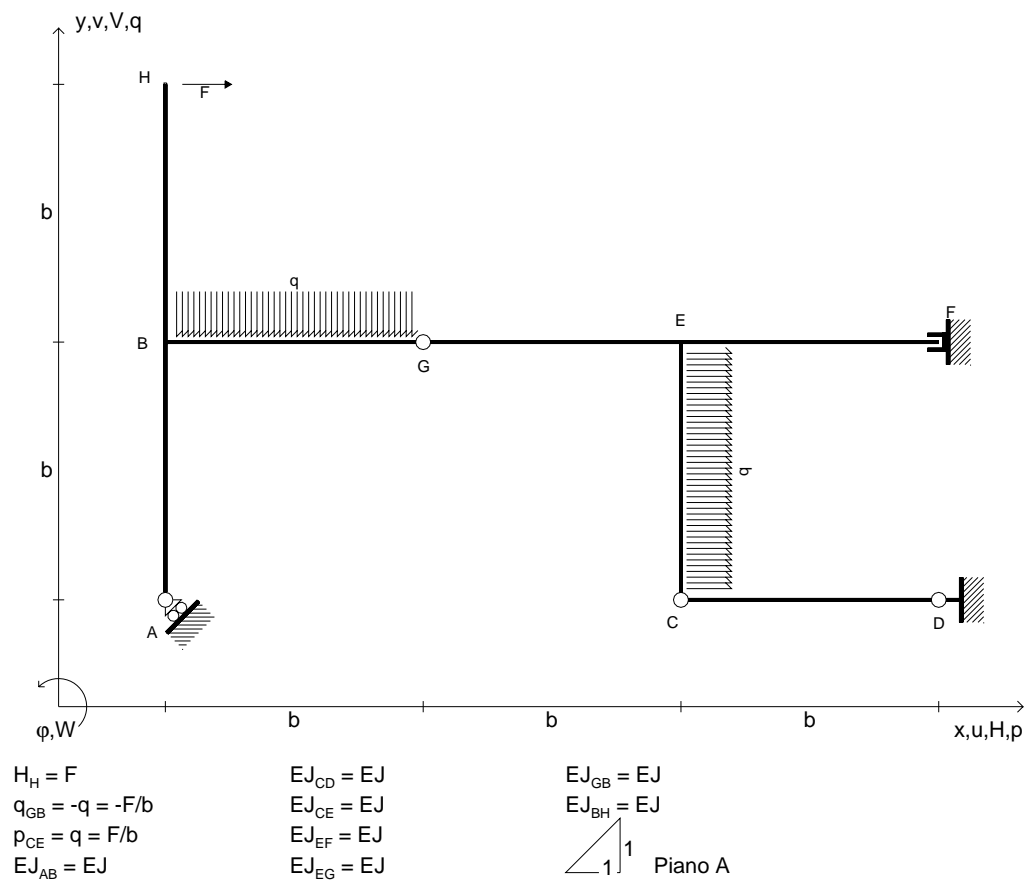
Calcolare reazioni vincolari della struttura e delle aste.

Tracciare i diagrammi quotati delle azioni interne nelle aste.

$J_{YZ} - x_{YZ} - \theta_{YZ}$ riferimento locale asta YZ con origine in Y.

Piano di scorrimento del vincolo con inclinazione assegnata.

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.31.01.10



Carichi e deformazioni date hanno verso efficace in disegno.

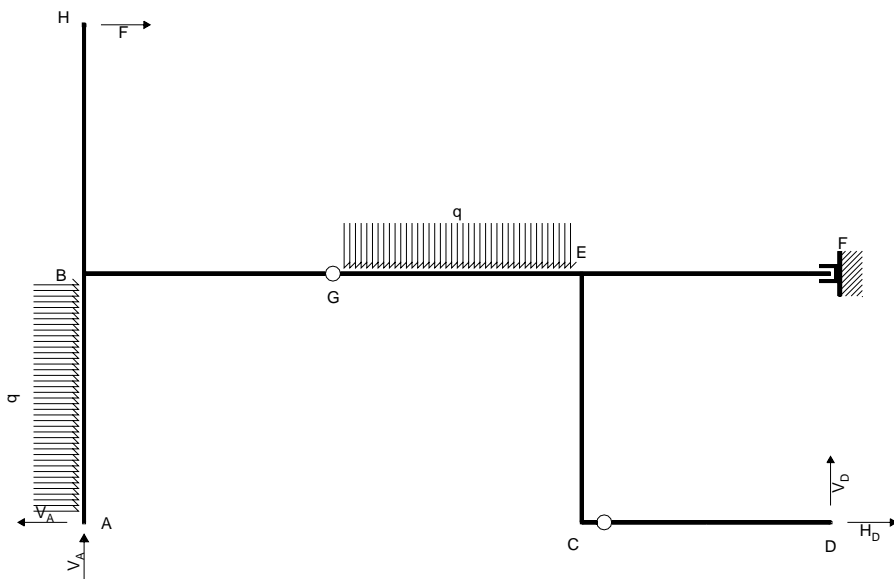
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EQUAZIONI DI EQUILIBRIO

Traslazione orizzontale globale

$$-V_A + H_D = -F - qb$$

Rotazione intorno a G: aste GB BA BH

$$-2V_A b = Fb - 1/2 qb^2$$

Rotazione intorno a C: aste CD

$$V_D b = 0$$

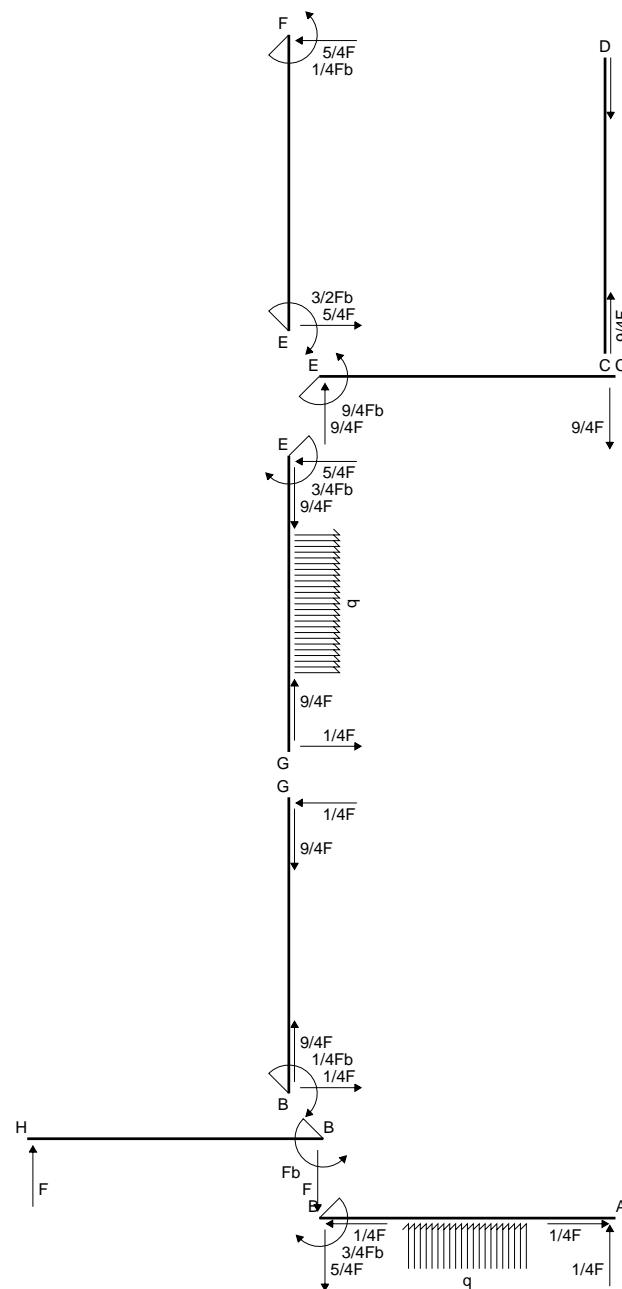
Matrice di equilibrio

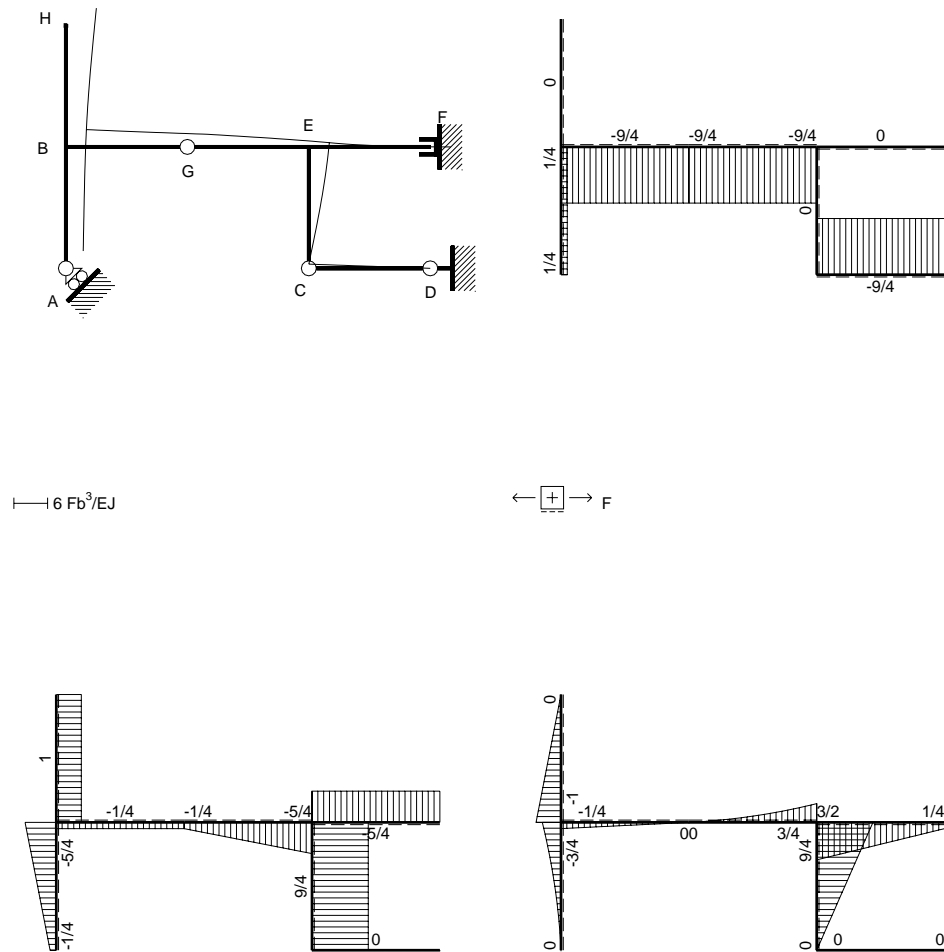
$$u_F \begin{bmatrix} V_A b & H_D b & V_D b \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \end{bmatrix}$$

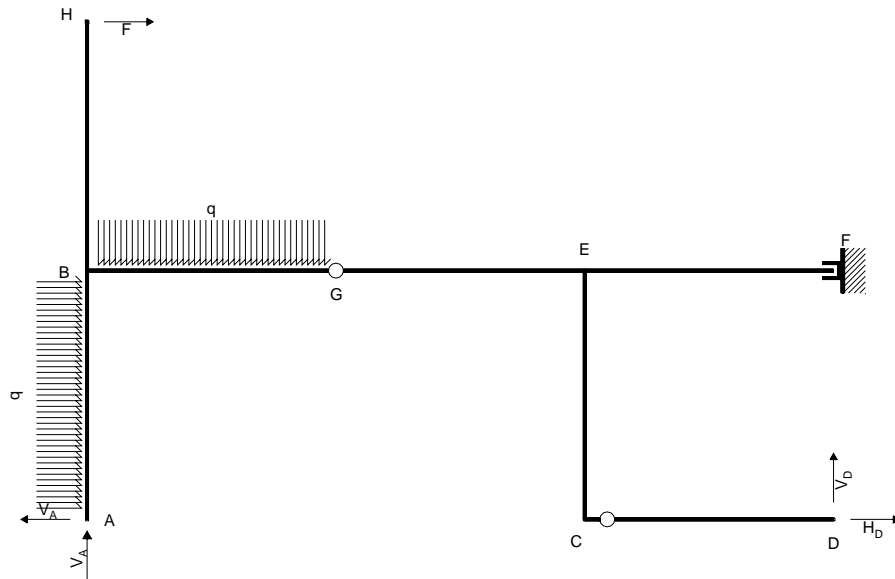
$$\begin{bmatrix} \phi_{GE} \\ \phi_{CD} \end{bmatrix} \begin{bmatrix} -1 & 1 & 0 \\ -2 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} -1 & -1 \\ 1 & -1/2 \\ 0 & 0 \end{bmatrix}$$

Soluzione del sistema

$$\begin{bmatrix} V_A b \\ H_D b \\ V_D b \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ -1/2 & 1/4 \\ -3/2 & -3/4 \\ 0 & 0 \end{bmatrix}$$







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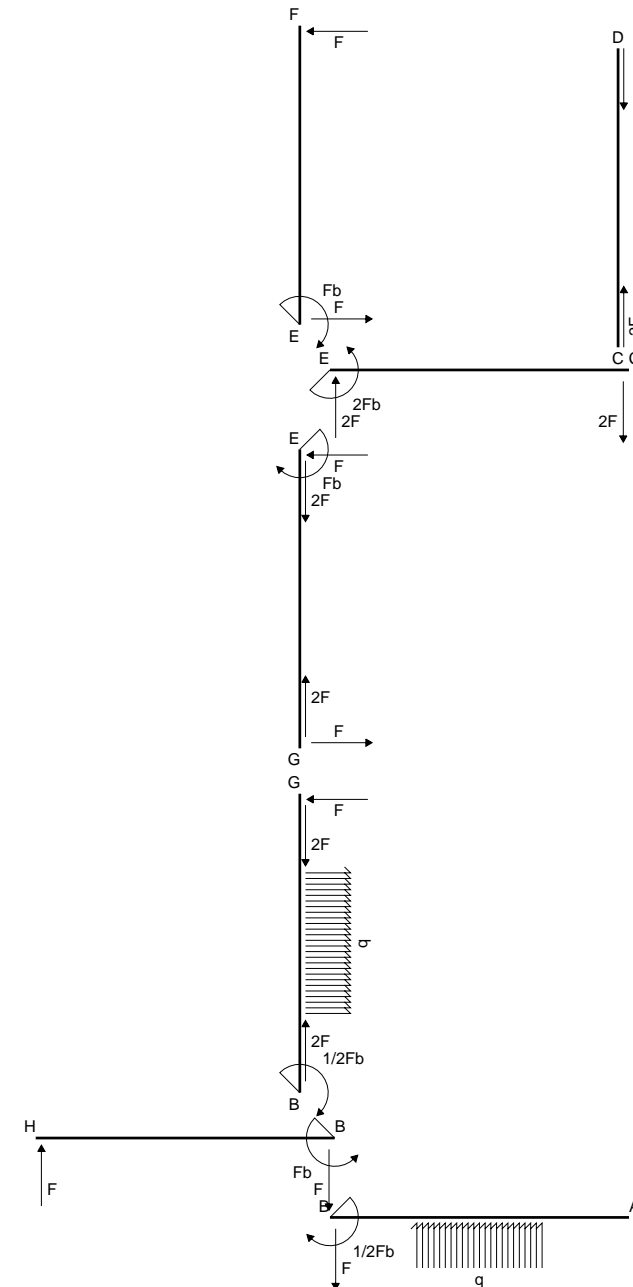
Matrice di equilibrio

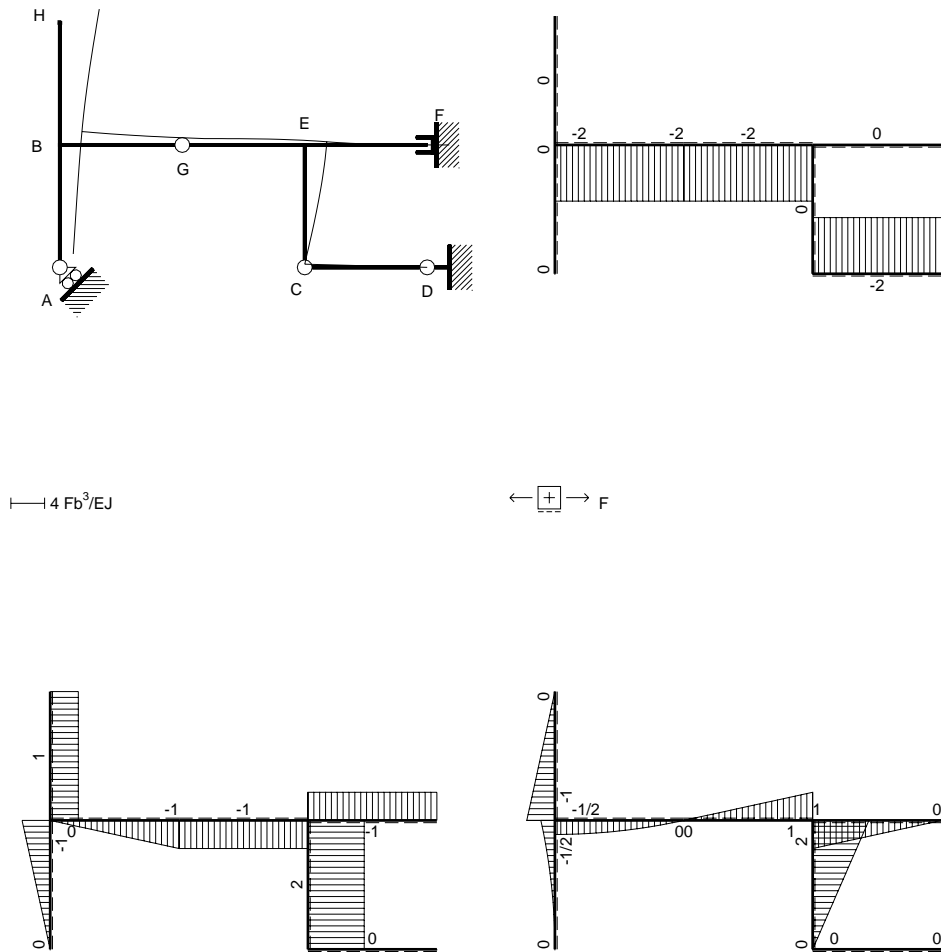
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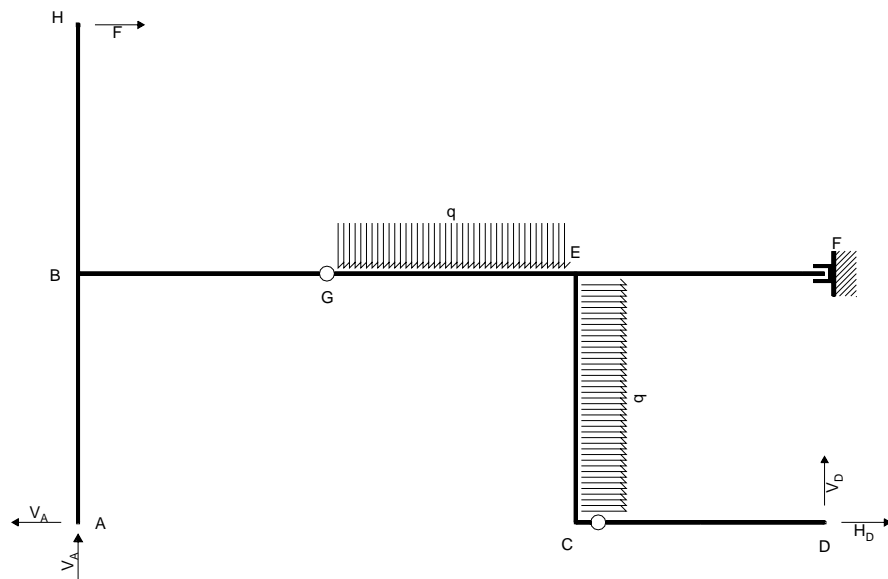
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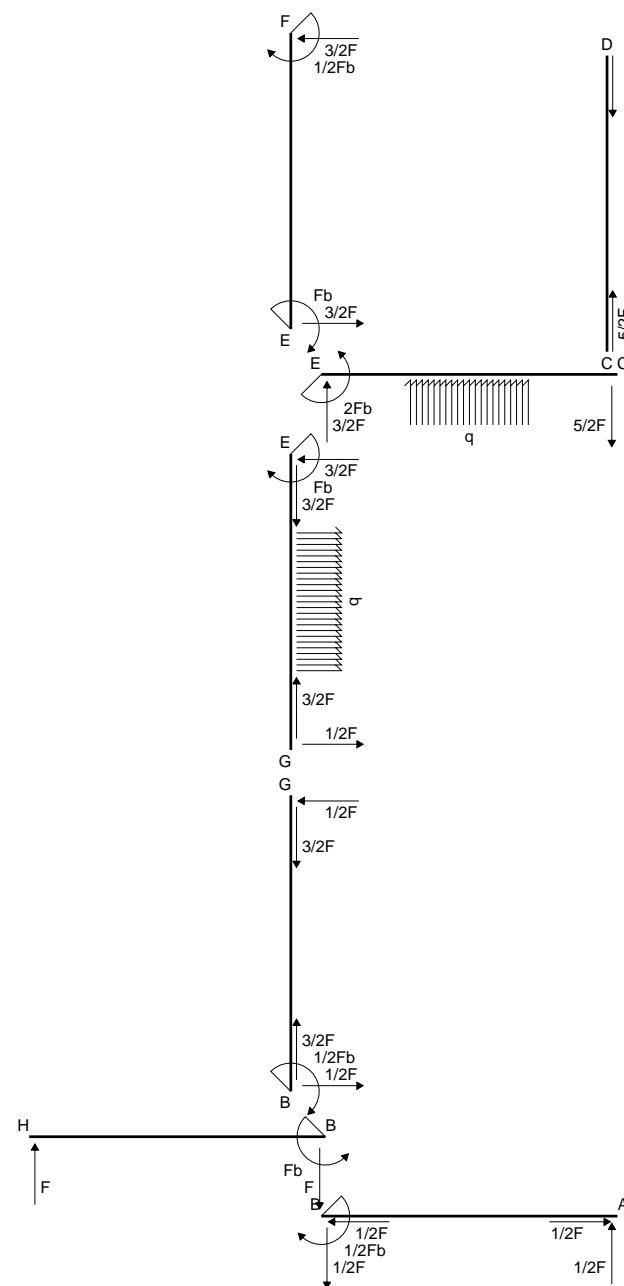
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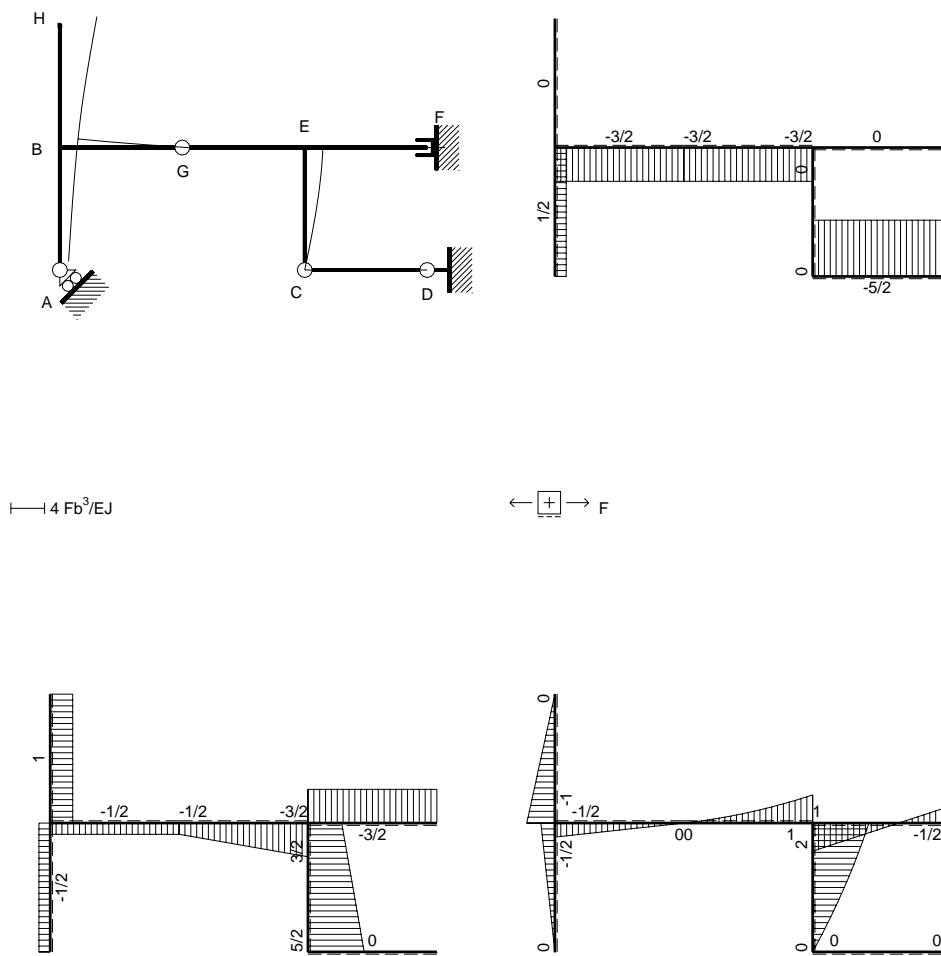
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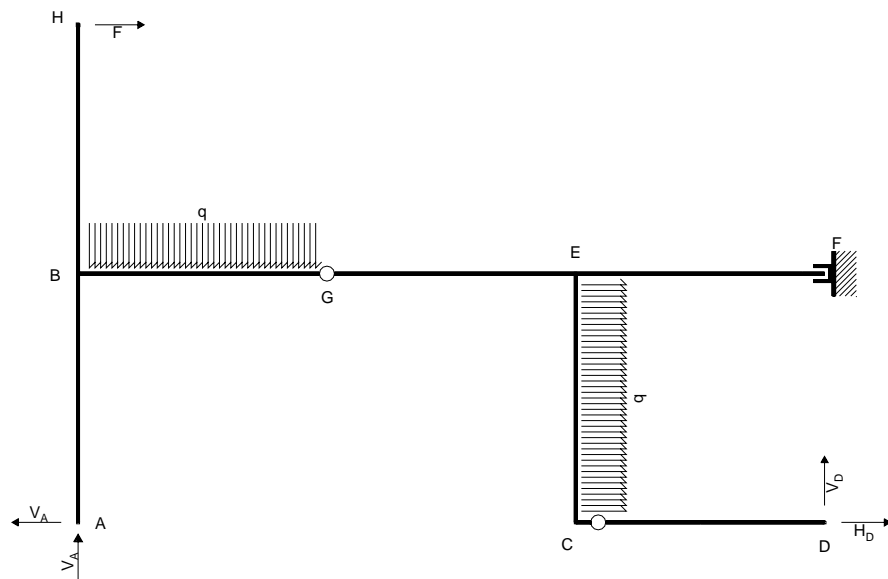
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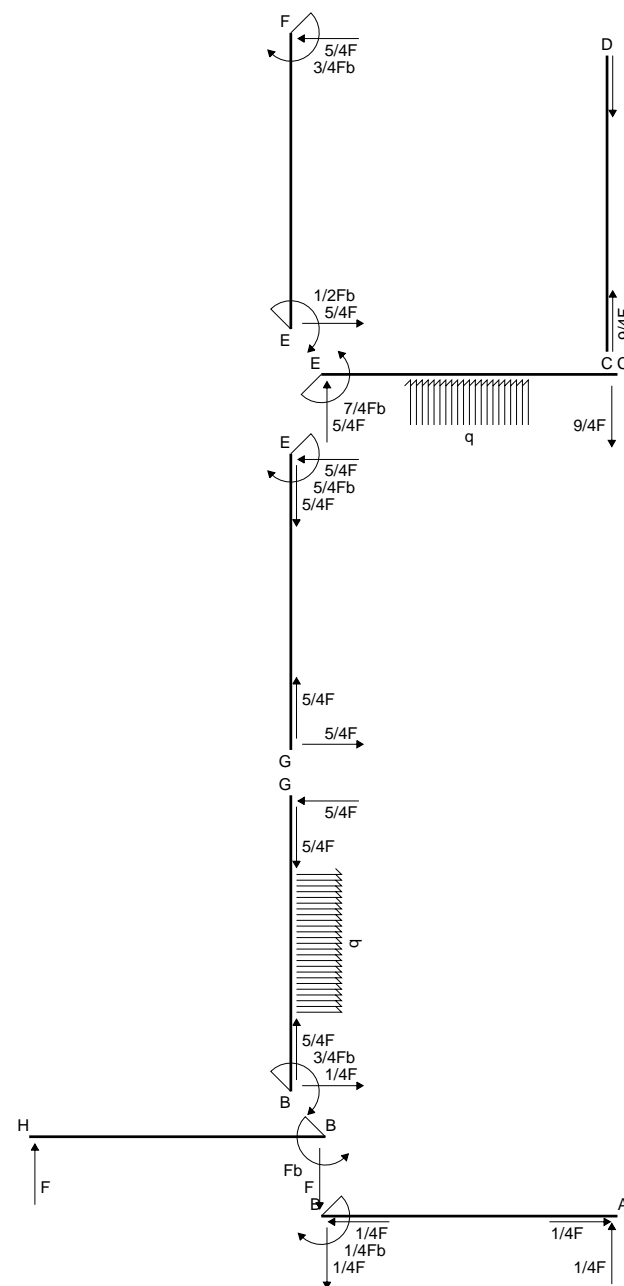
$$V_D b = 0$$

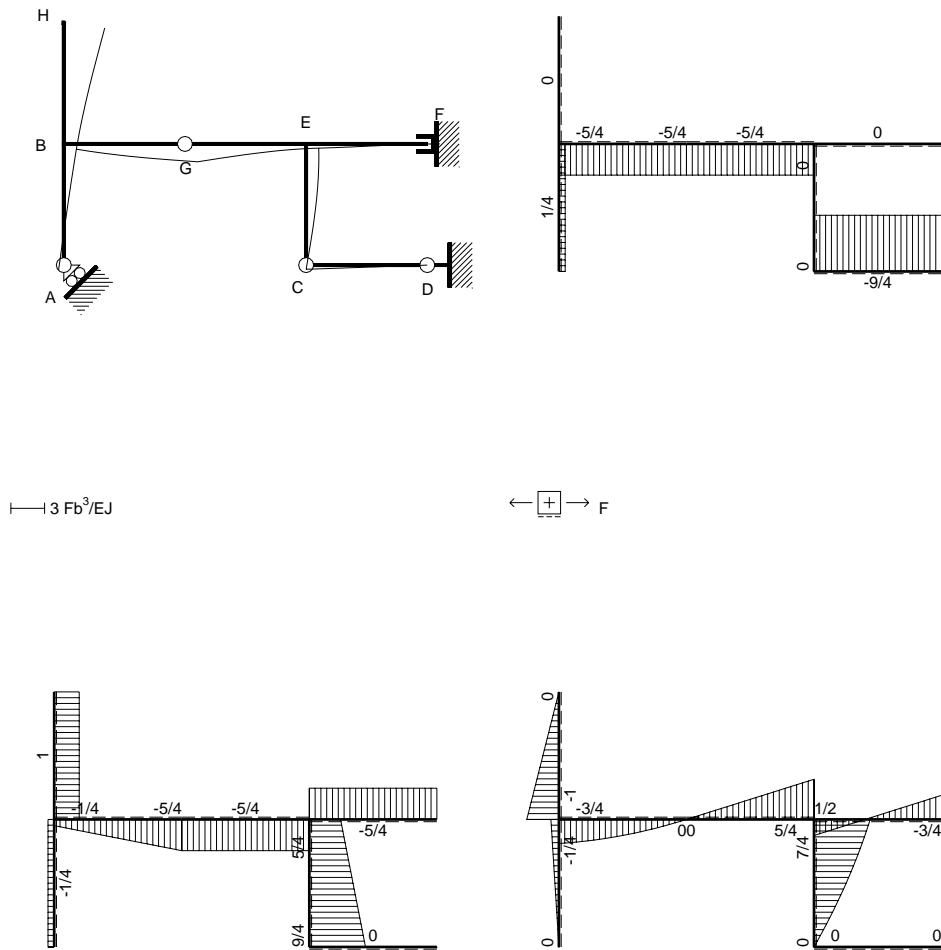
Matrice di equilibrio

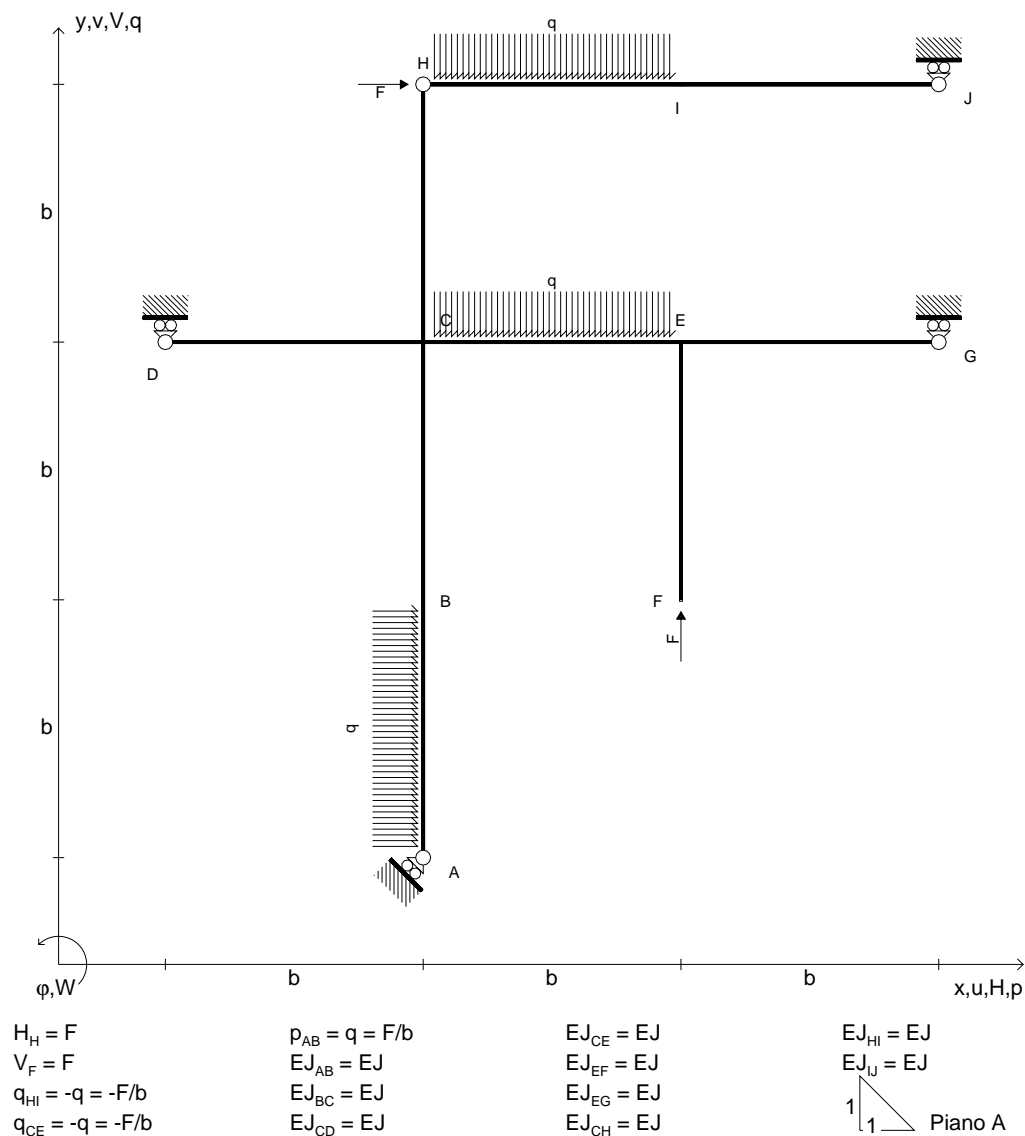
$$u_F \begin{bmatrix} V_A b & H_D b & V_D b \\ \phi_{GE} & & \\ \phi_{CD} & & \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ -1 & -1 \\ 0 & 0 \end{bmatrix}$$

Soluzione del sistema

$$\begin{bmatrix} V_A b \\ H_D b \\ V_D b \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ -1/2 & 1/4 \\ -3/2 & -3/4 \end{bmatrix}$$







Carichi e deformazioni date hanno verso efficace in disegno.

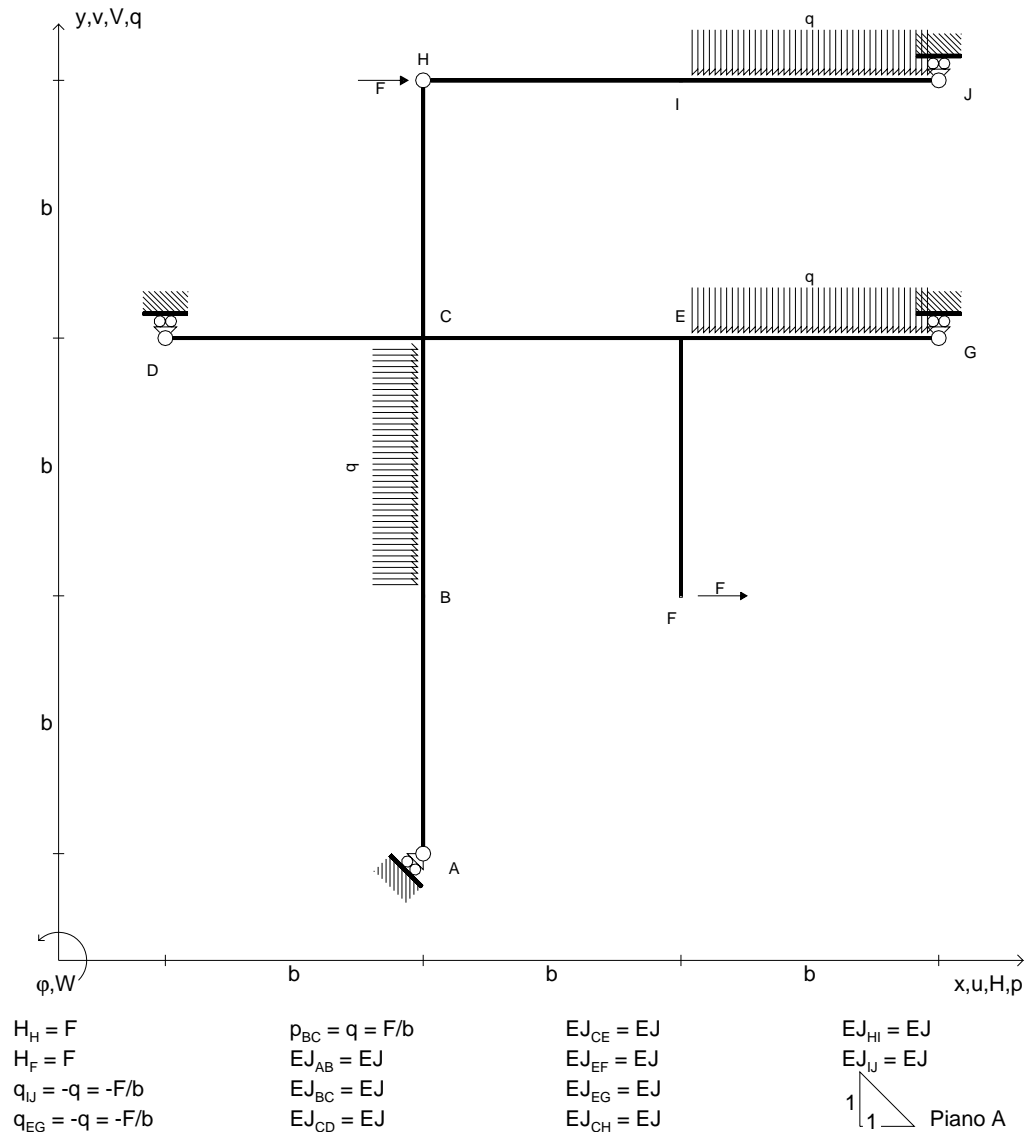
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@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.12.12.09



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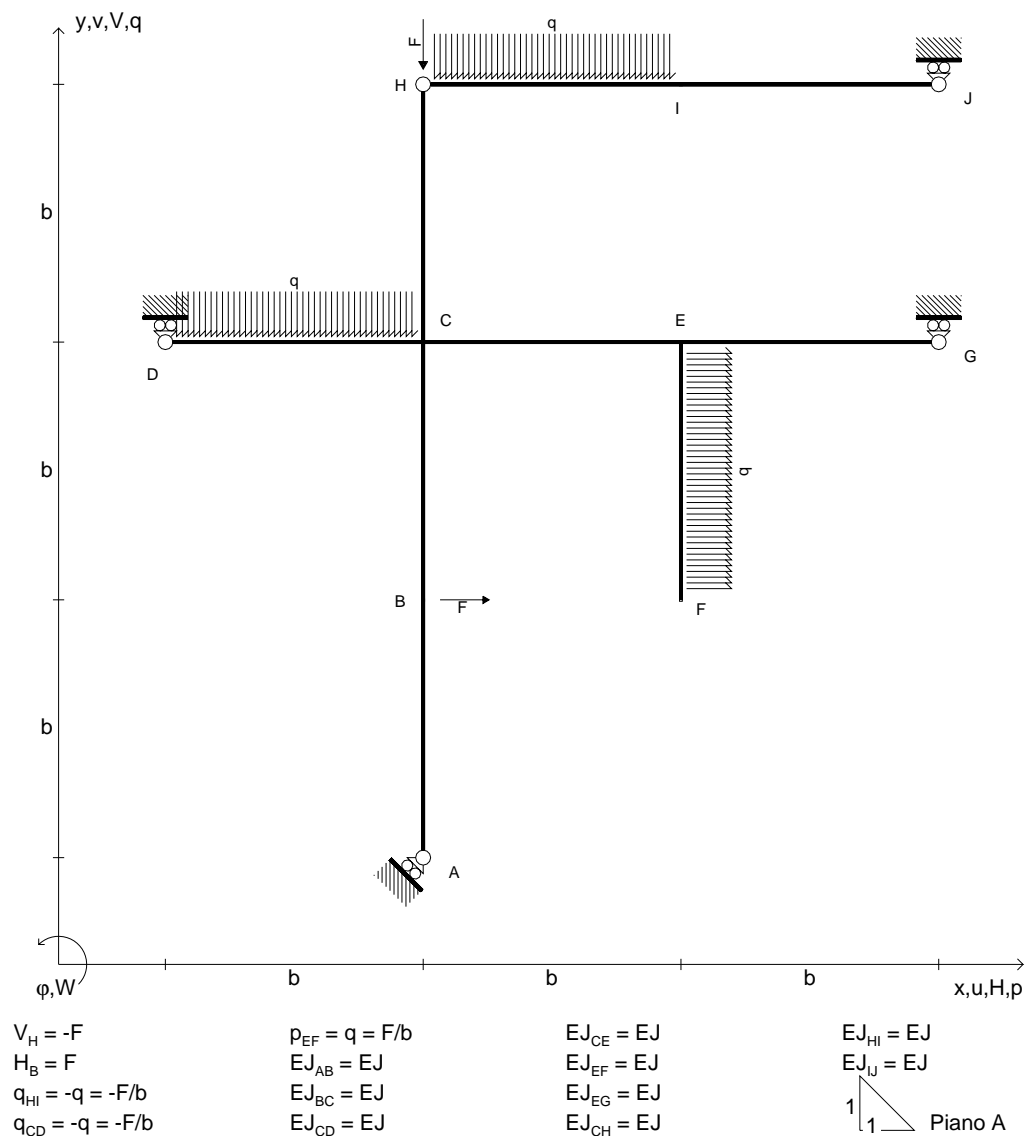
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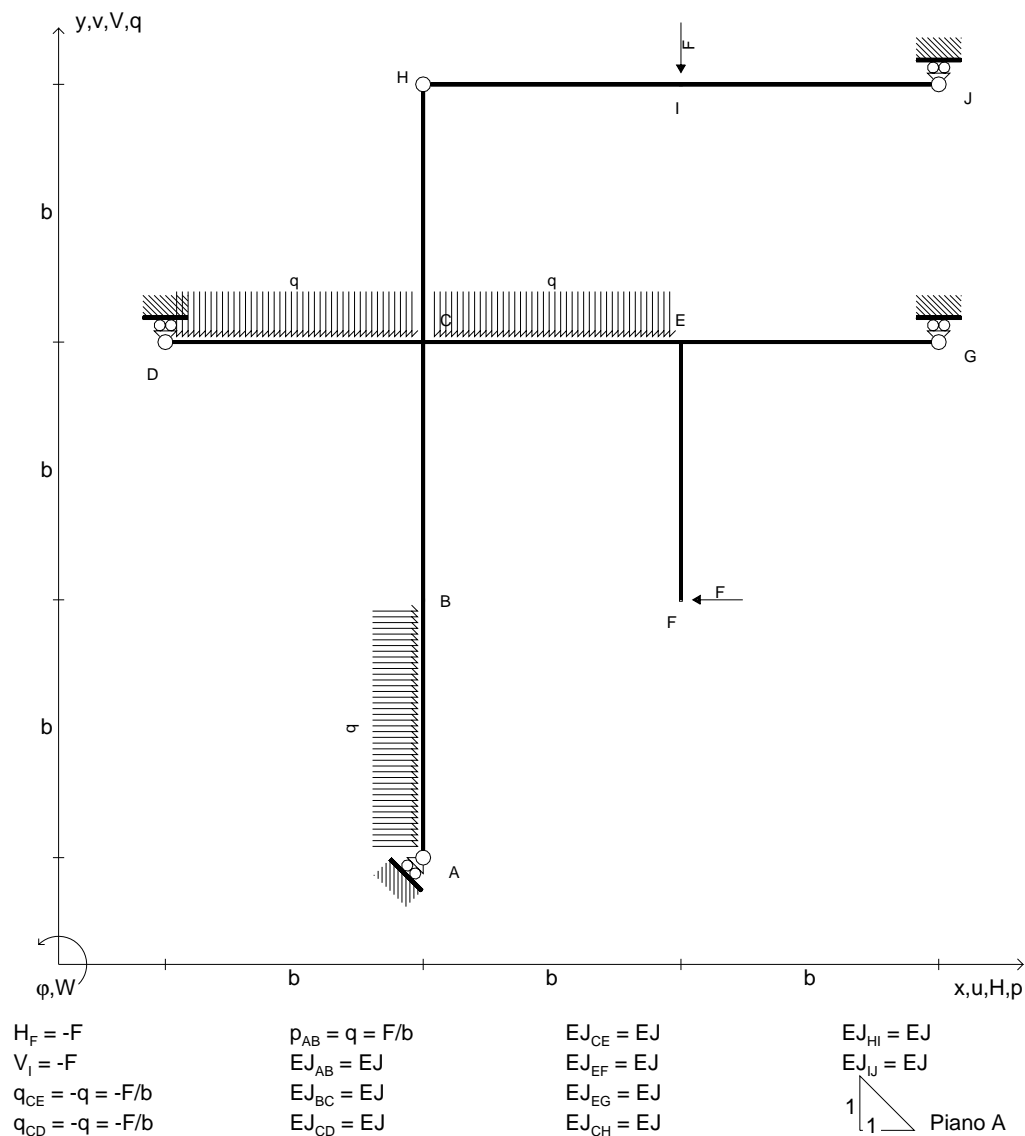
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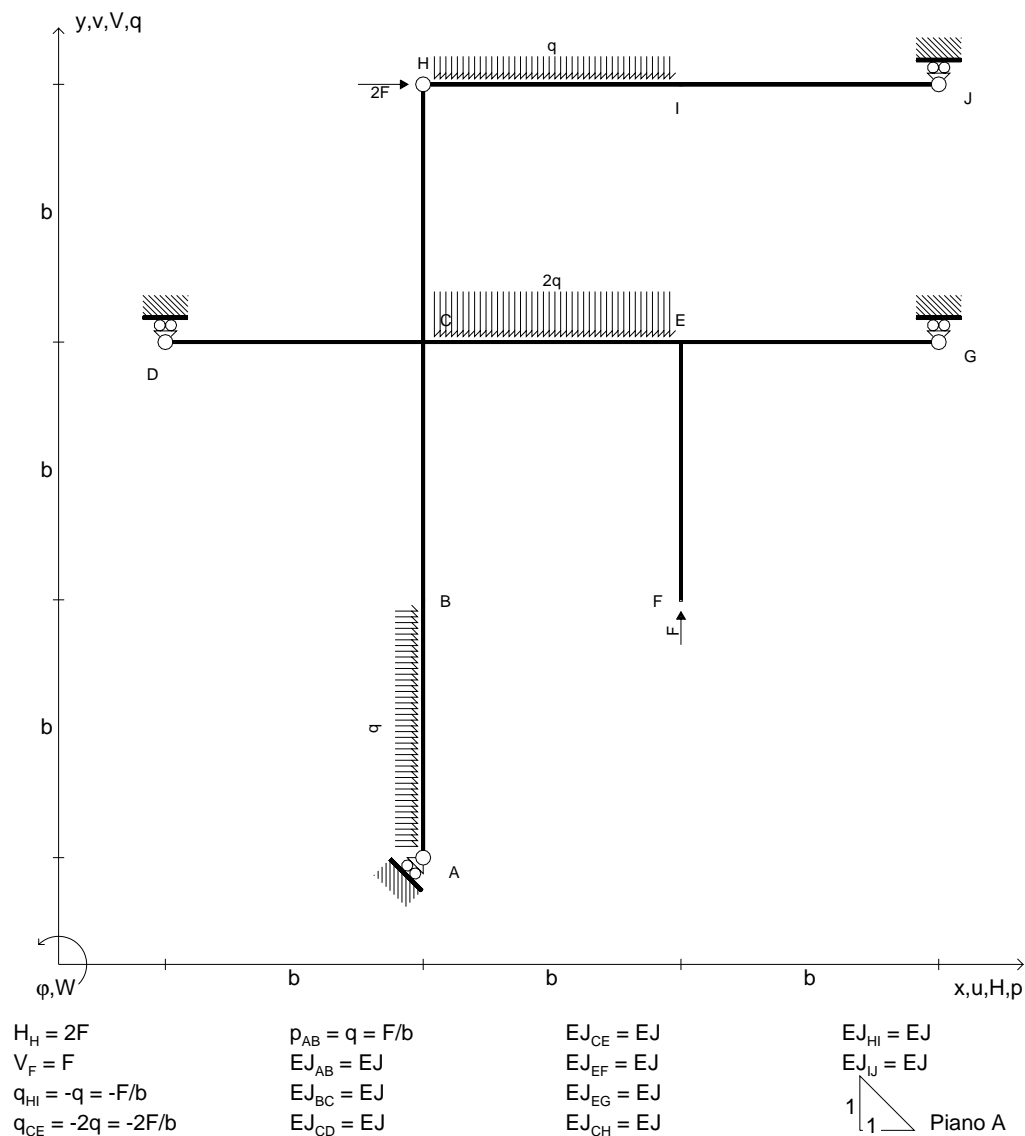
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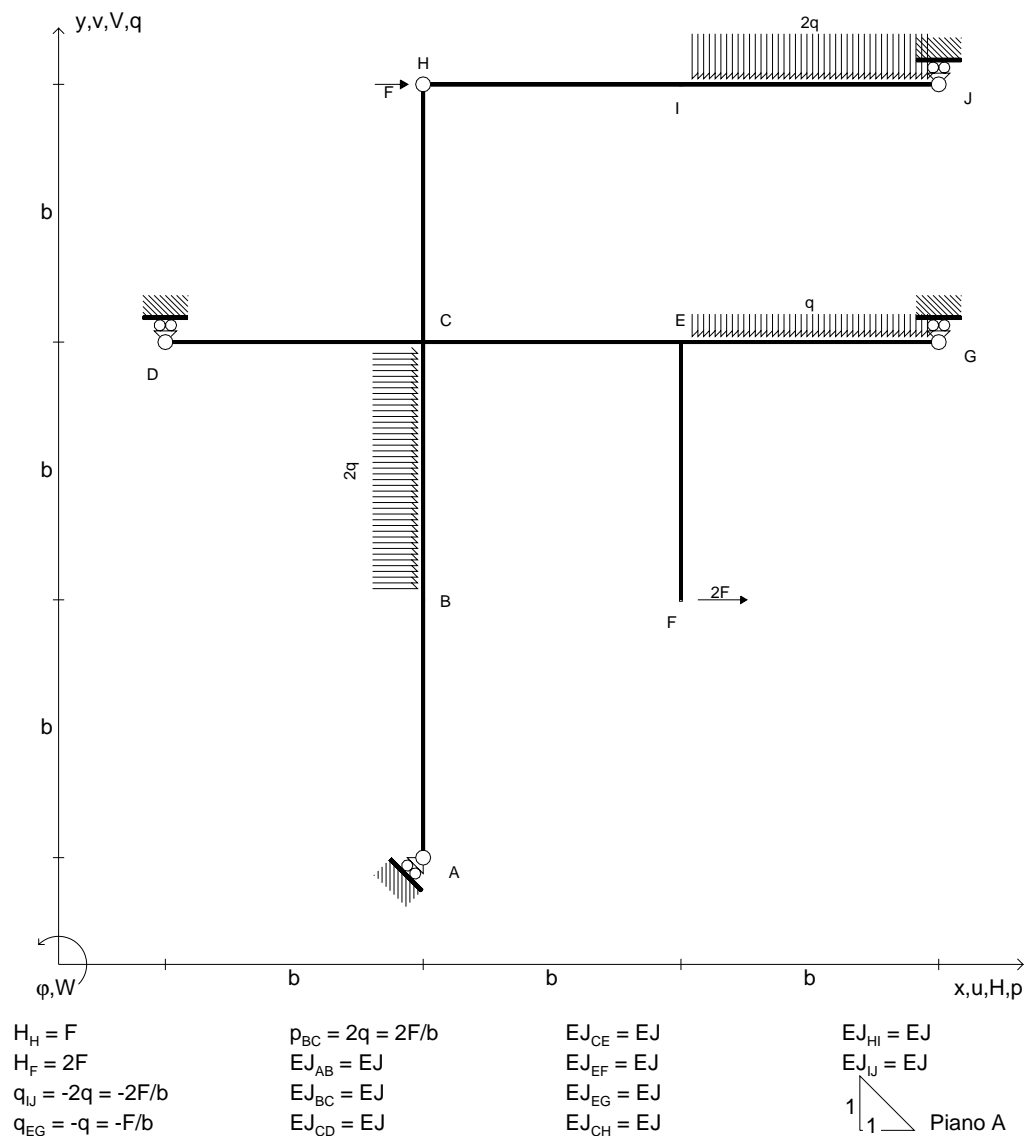
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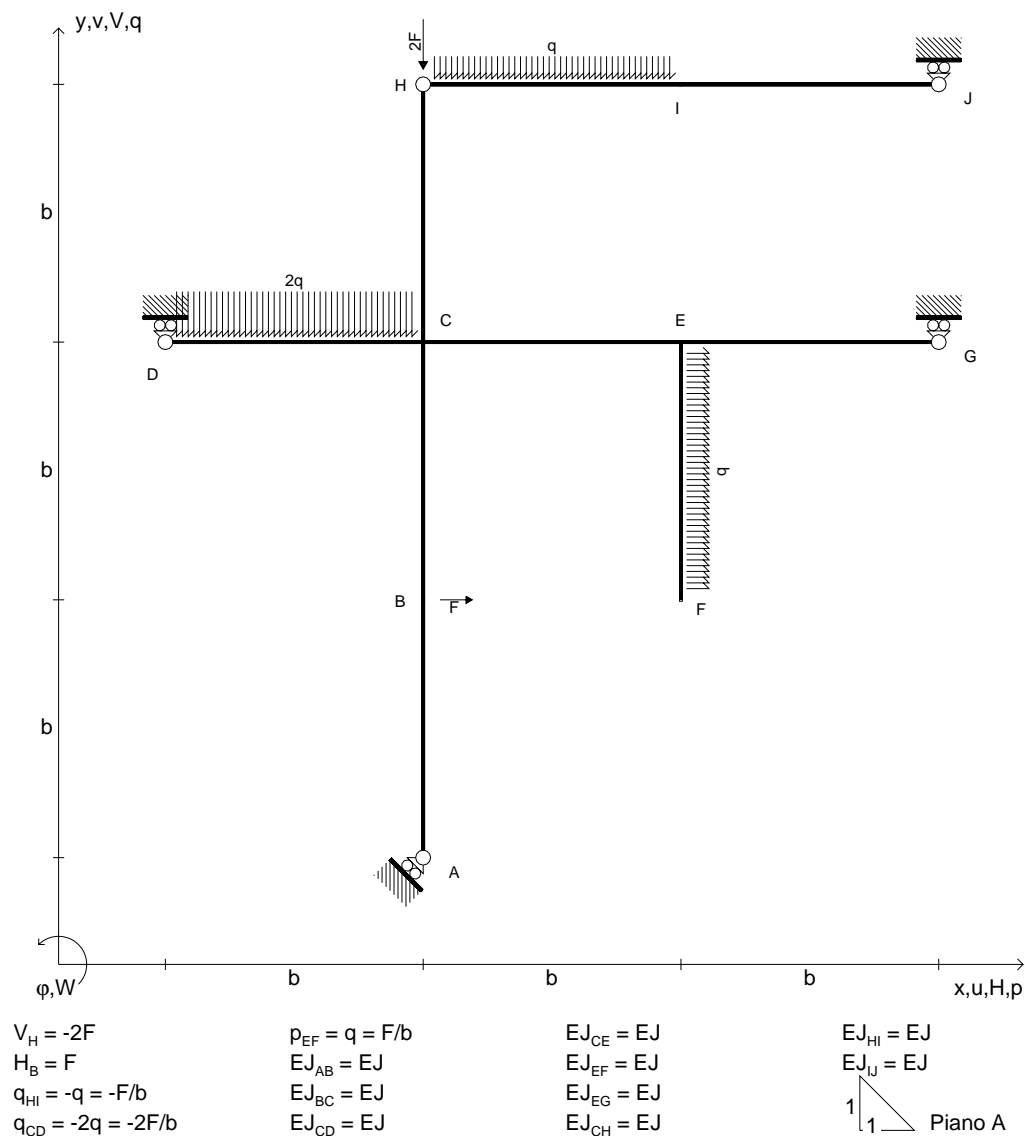
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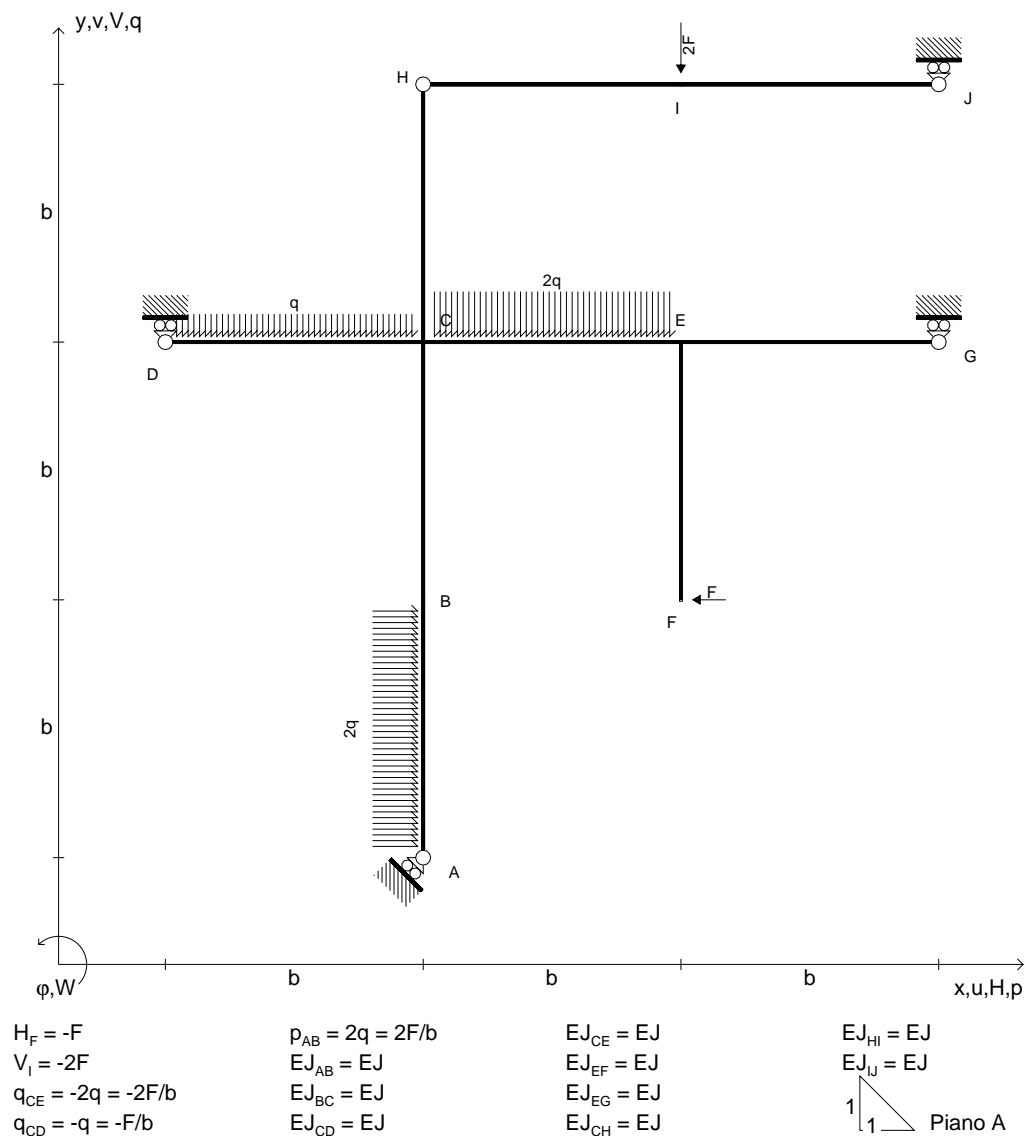
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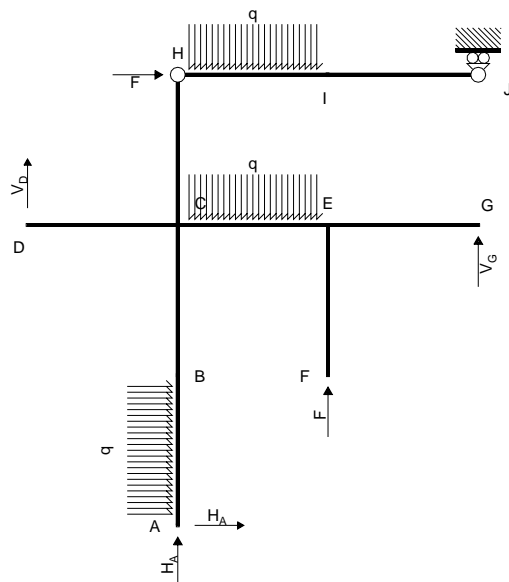
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EQUAZIONI DI EQUILIBRIO

Traslazione orizzontale globale

$$H_A = -F - qb$$

Rotazione globale intorno a J

$$H_A b - 3V_D b = Fb - 11/2 qb^2$$

Rotazione intorno a H: aste HC CB CD CE BA EF EG

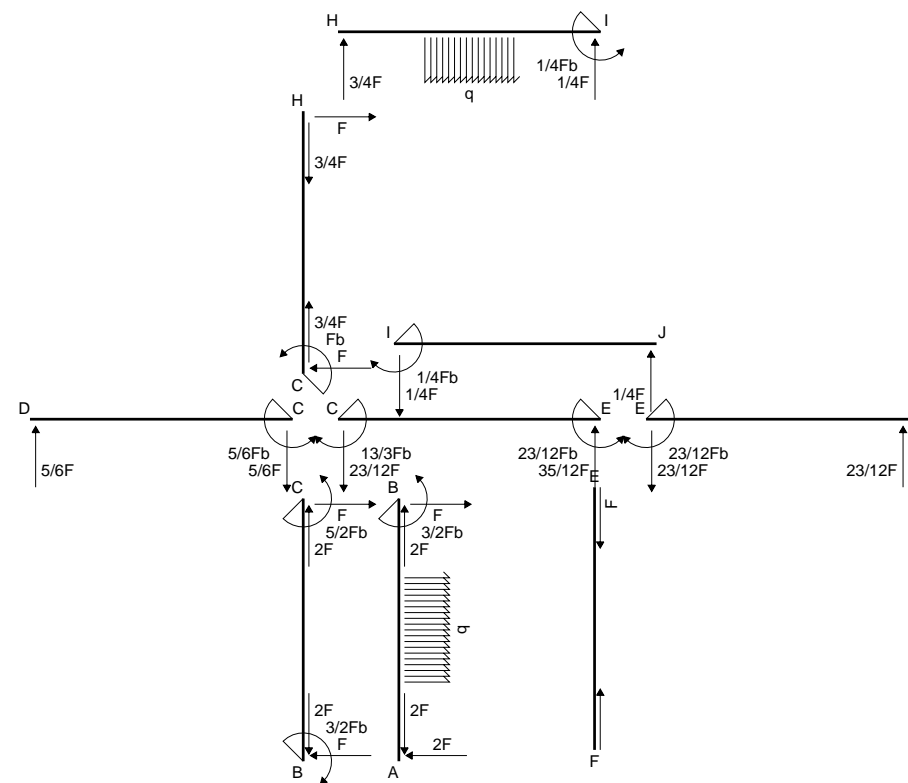
$$3H_A b - V_D b + 2V_G b = -Fb - 2qb^2$$

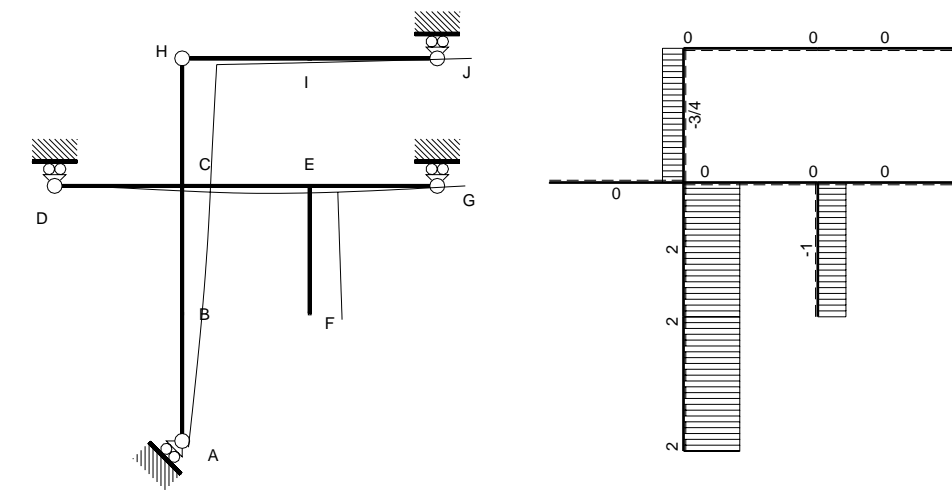
Matrice di equilibrio

$$\begin{bmatrix} H_A b & V_D b & V_G b \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 1 & -3 & 0 \\ 3 & -1 & 2 \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ -1 & -1 \\ 1 & -11/2 \\ -1 & -2 \end{bmatrix}$$

Soluzione del sistema

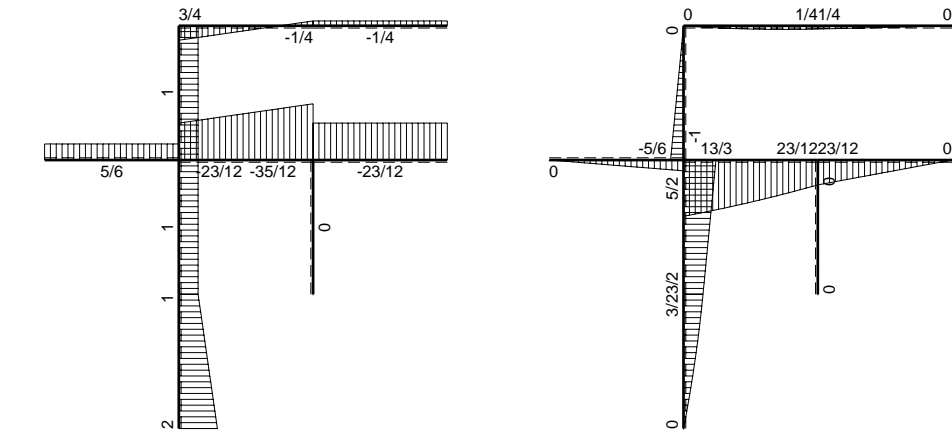
$$\begin{bmatrix} H_A b \\ V_D b \\ V_G b \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ -1 & -1 \\ -2/3 & 3/2 \\ 2/3 & 5/4 \end{bmatrix}$$





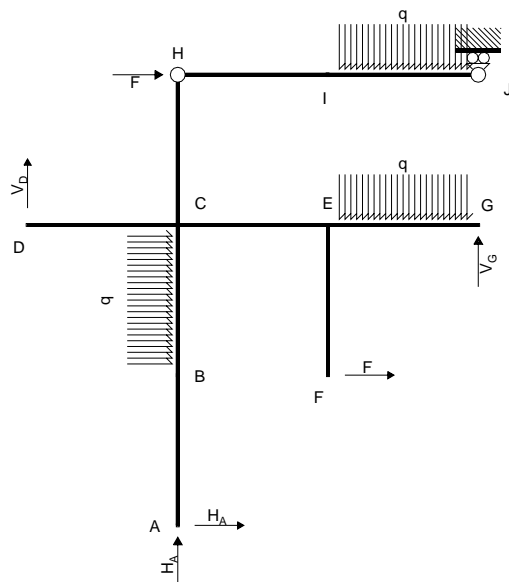
$\frac{1}{25} \frac{Fb^3}{EJ}$

$\leftarrow \boxed{+} \rightarrow F$



$\uparrow \boxed{+} \downarrow F$

$\leftarrow \boxed{+} \rightarrow F_b$



EQUAZIONI DI EQUILIBRIO

Traslazione orizzontale globale

$$H_A = -2F - qb$$

Rotazione globale intorno a J

$$H_A b - 3V_D b = -2Fb - 5/2 qb^2$$

Rotazione intorno a H: aste HC CB CD CE BA EF EG

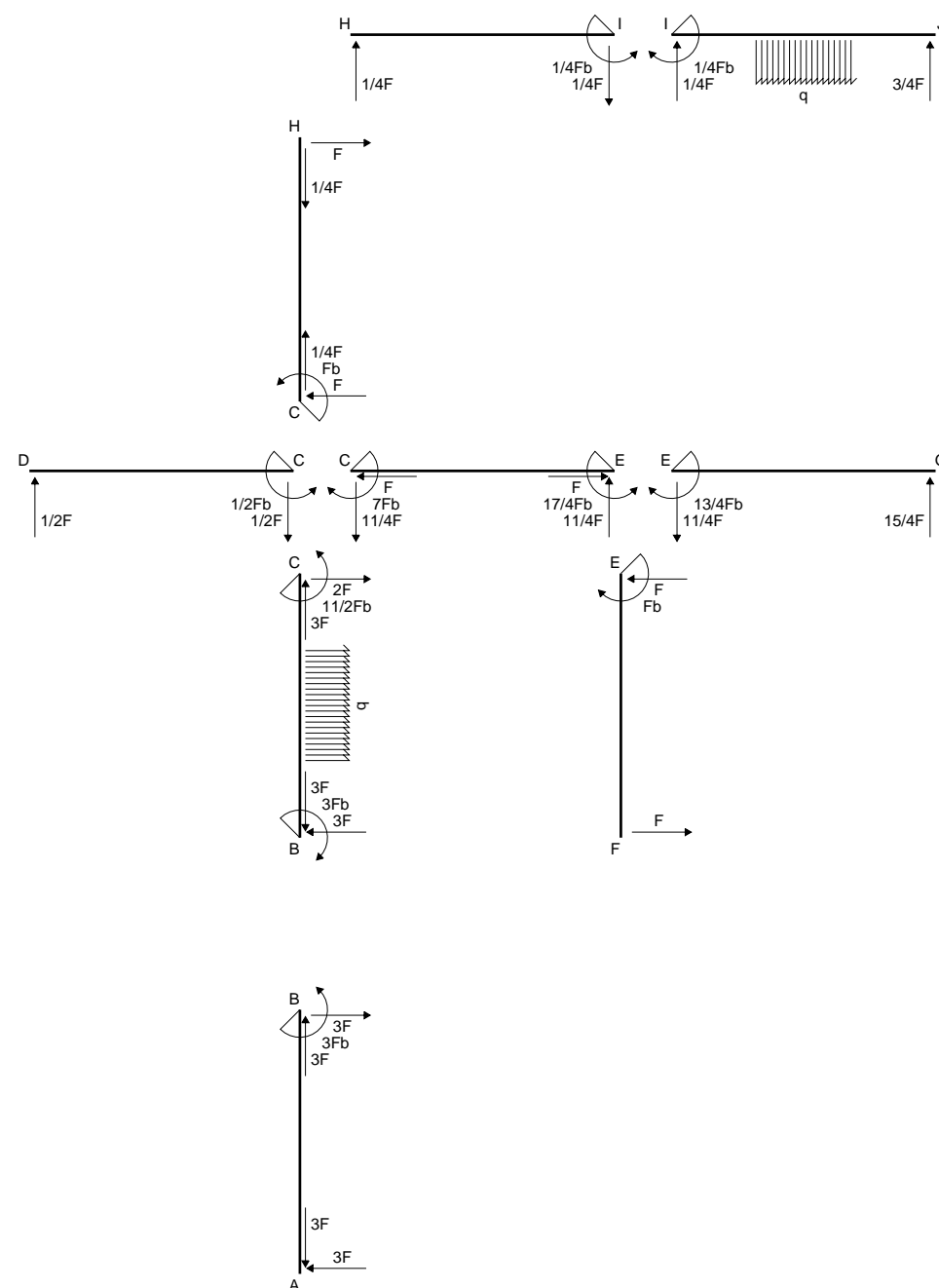
$$3H_A b - V_D b + 2V_G b = -2Fb$$

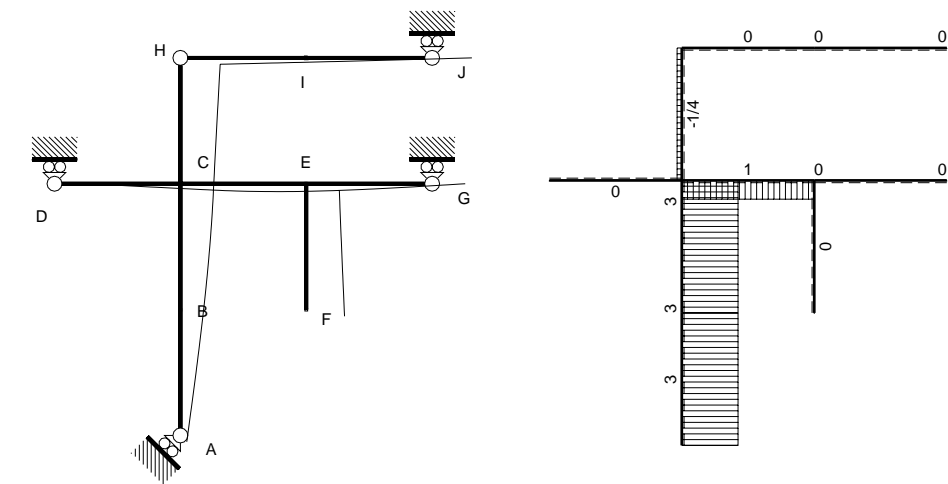
Matrice di equilibrio

$$\begin{bmatrix} H_A b & V_D b & V_G b \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 1 & -3 & 0 \\ 3 & -1 & 2 \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ -2 & -1 \\ -2 & -5/2 \end{bmatrix}$$

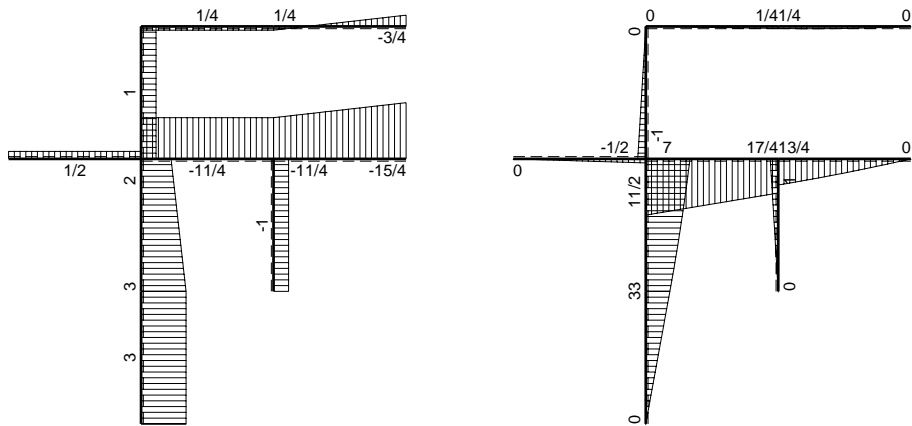
Soluzione del sistema

$$\begin{bmatrix} H_A b \\ V_D b \\ V_G b \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ -2 & -1 \\ 2 & 7/4 \end{bmatrix}$$

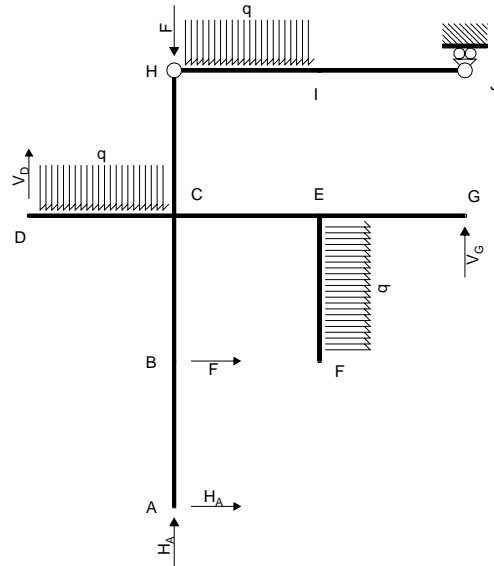




$\frac{1}{40} \frac{Fb^3}{EJ}$ $\leftarrow \boxed{+} \rightarrow F$



$\uparrow \boxed{+} \downarrow F$ $\leftarrow \boxed{+} \rightarrow Fb$



EQUAZIONI DI EQUILIBRIO

Traslazione orizzontale globale

$$H_A = -F - qb$$

Rotazione globale intorno a J

$$H_A b - 3V_D b = -4Fb - 11/2qb^2$$

Rotazione intorno a H: aste HC CB CD CE BA EF EG

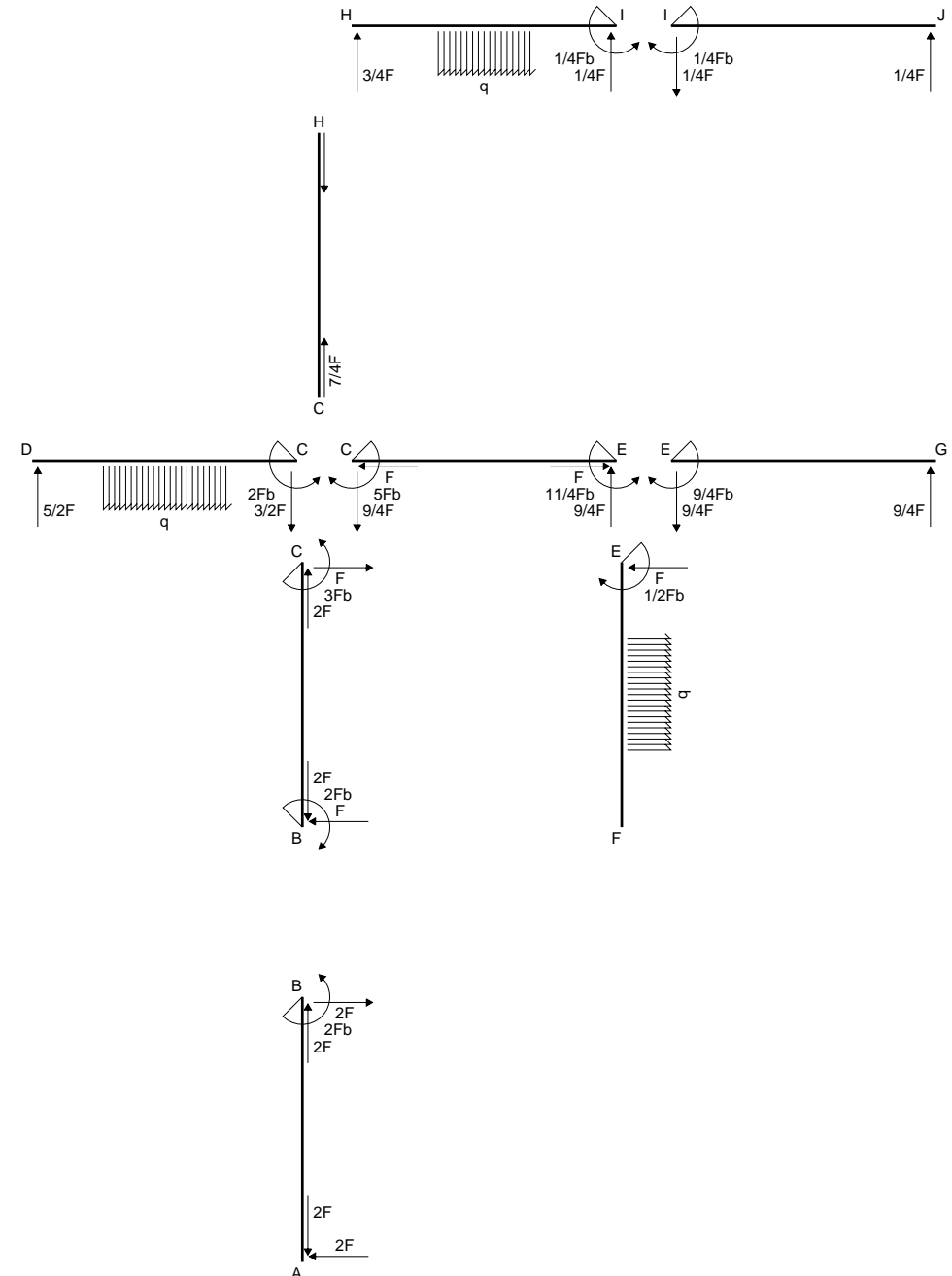
$$3H_A b - V_D b + 2V_G b = -2Fb - 2qb^2$$

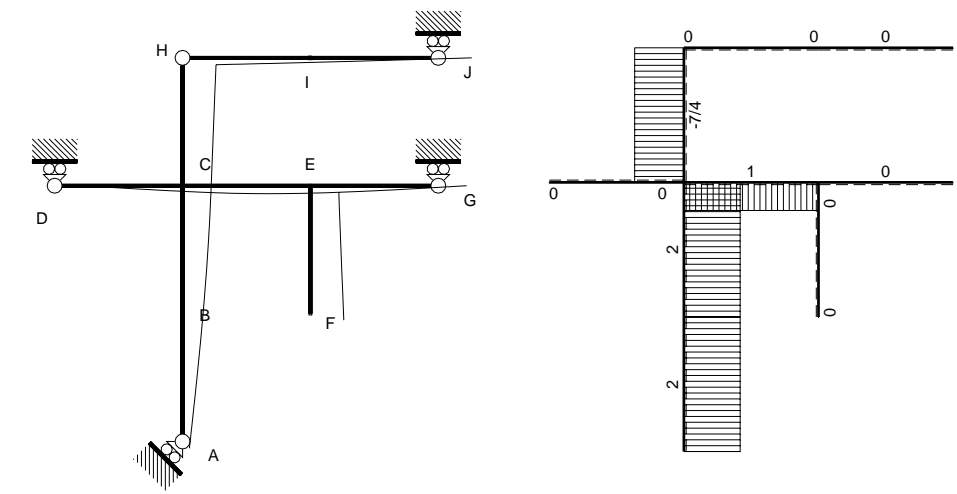
Matrice di equilibrio

$$\begin{bmatrix} u_J \\ \varphi_J \\ \varphi_{HC} \end{bmatrix} \begin{bmatrix} H_A b & V_D b & V_G b \\ 1 & 0 & 0 \\ 1 & -3 & 0 \\ 3 & -1 & 2 \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ -1 & -1 \\ -4 & -11/2 \\ -2 & -2 \end{bmatrix}$$

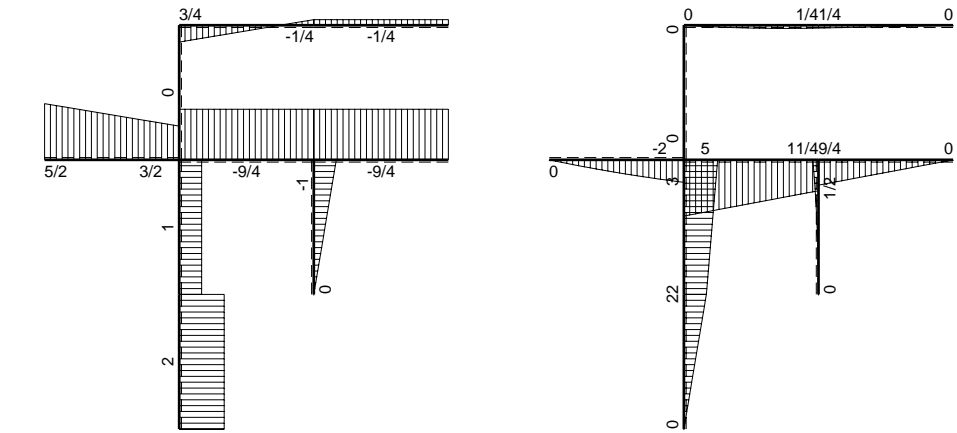
Soluzione del sistema

$$\begin{bmatrix} H_A b \\ V_D b \\ V_G b \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ -1 & -1 \\ 1 & 3/2 \\ 1 & 5/4 \end{bmatrix}$$

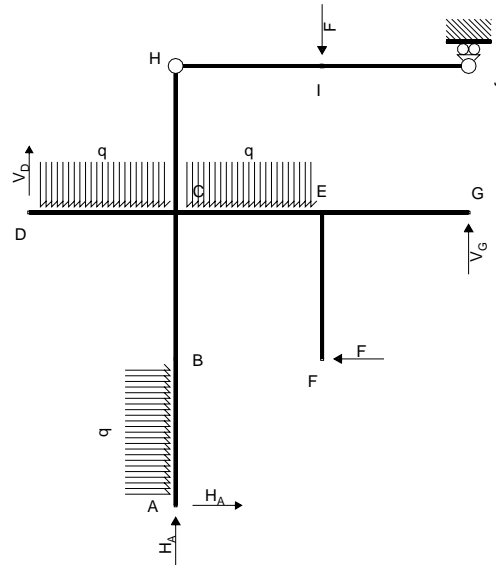




$\frac{1}{30} \frac{Fb^3}{EJ}$ $\leftarrow \boxed{+} \rightarrow F$



$\uparrow \boxed{+} \downarrow F$ $\leftarrow \boxed{+} \rightarrow Fb$



EQUAZIONI DI EQUILIBRIO

Traslazione orizzontale globale

$$H_A = F - qb$$

Rotazione globale intorno a J

$$H_A b - 3V_D b = Fb - 13/2qb^2$$

Rotazione intorno a H: aste HC CB CD CE BA EF EG

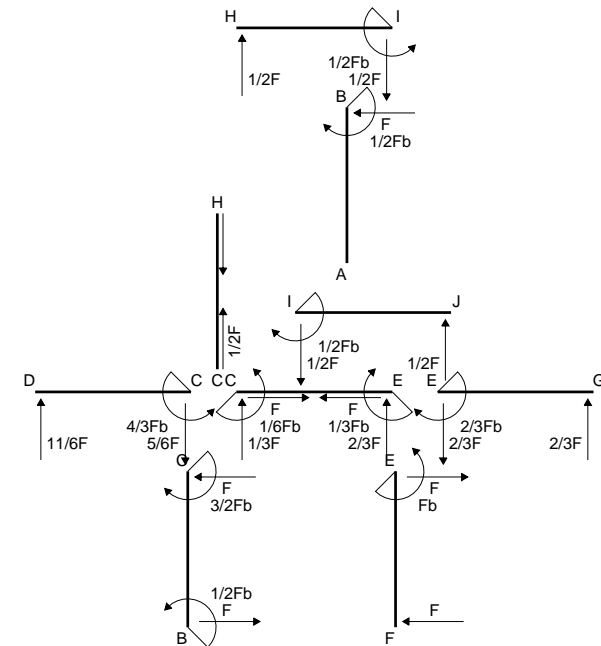
$$3H_A b - V_D b + 2V_G b = 2Fb - 5/2qb^2$$

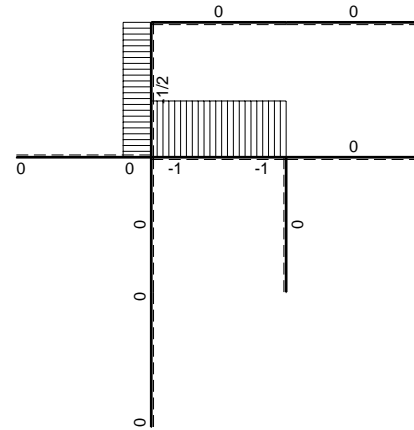
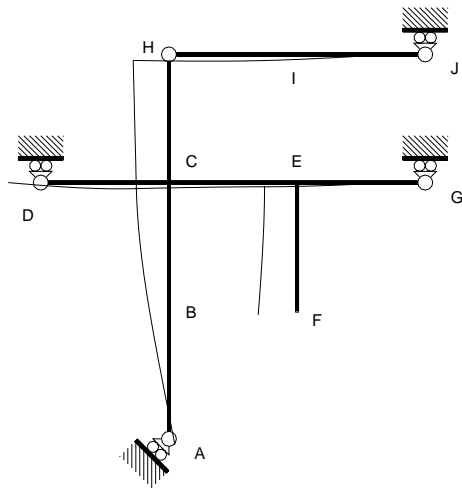
Matrice di equilibrio

$$\begin{bmatrix} u_J \\ \phi_J \\ \phi_{HC} \end{bmatrix} \begin{bmatrix} H_A b & V_D b & V_G b \\ 1 & 0 & 0 \\ 1 & -3 & 0 \\ 3 & -1 & 2 \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ 1 & -1 \\ 1 & -13/2 \\ 2 & -5/2 \end{bmatrix}$$

Soluzione del sistema

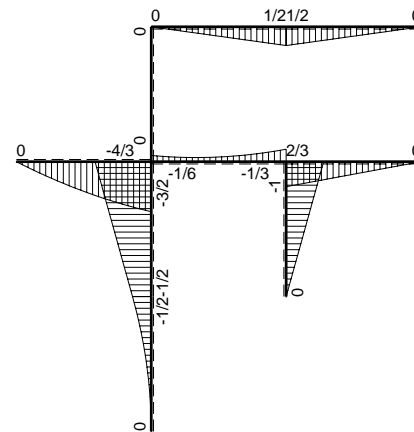
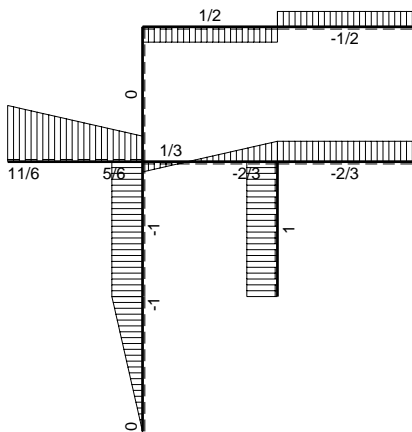
$$\begin{bmatrix} H_A b \\ V_D b \\ V_G b \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ 1 & -1 \\ 0 & 11/6 \\ -1/2 & 7/6 \end{bmatrix}$$

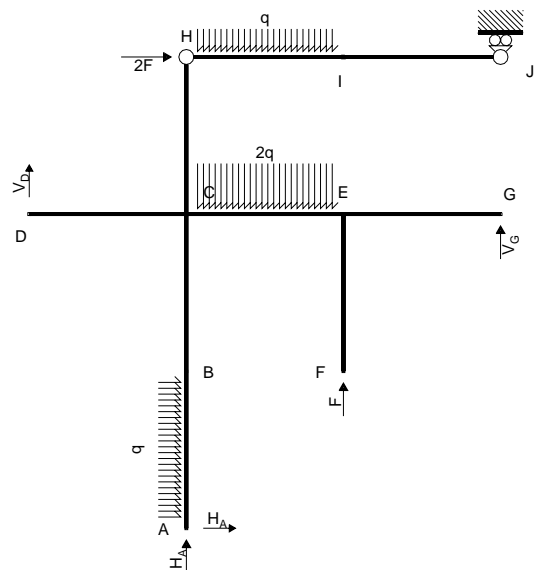




4 Fb³/EJ

$$\leftarrow \boxed{+} \rightarrow F$$





EQUAZIONI DI EQUILIBRIO

Traslazione orizzontale globale

$$H_A = -2F - qb$$

Rotazione globale intorno a J

$$H_A b - 3V_D b = Fb - 7qb^2$$

Rotazione intorno a H: aste HC CB CD CE BA EF EG

$$3H_A b - V_D b + 2V_G b = -Fb - 3/2 qb^2$$

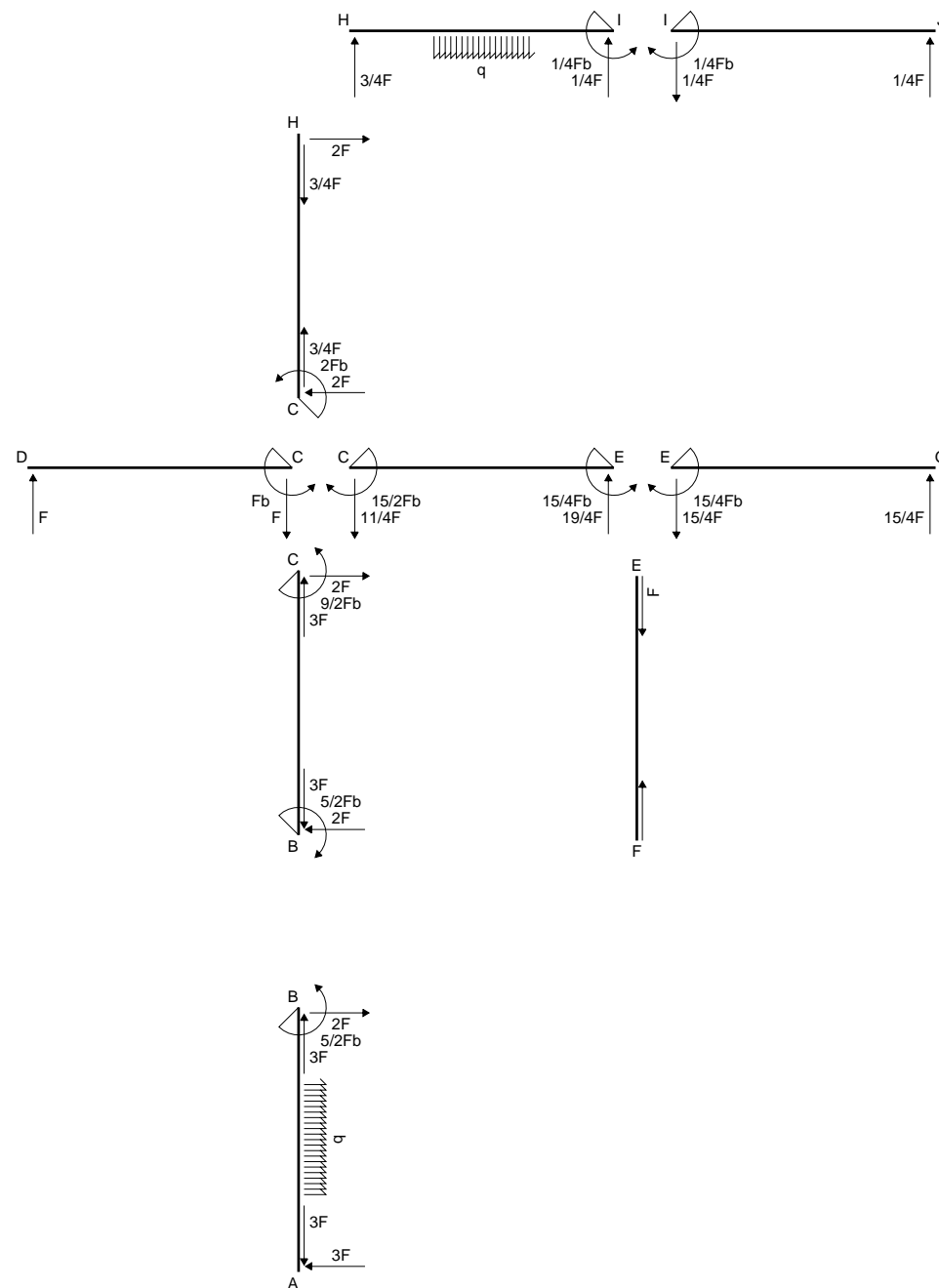
Matrice di equilibrio

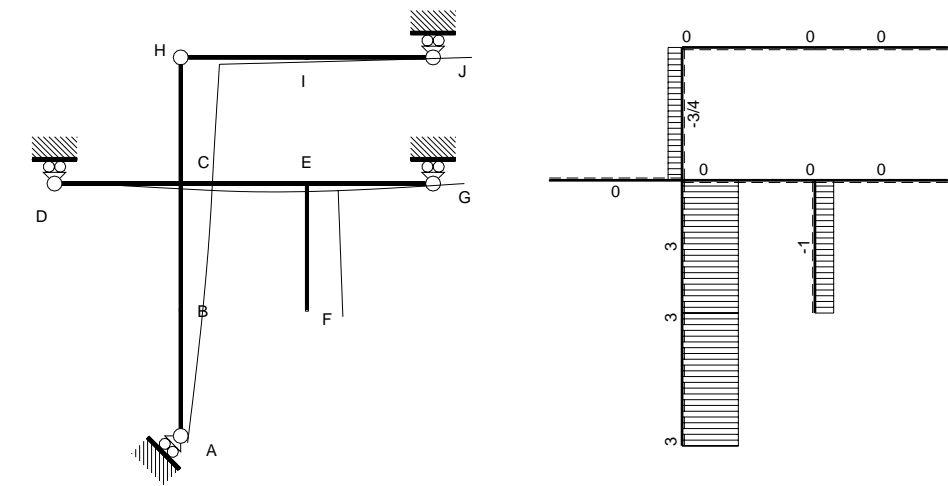
$$u_J \begin{bmatrix} H_A b & V_D b & V_G b \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 0 & 0 \\ 1 & -3 & 0 \\ 3 & -1 & 2 \end{bmatrix} = \begin{bmatrix} -2 & -1 \\ 1 & -7 \\ -1 & -3/2 \end{bmatrix}$$

Soluzione del sistema

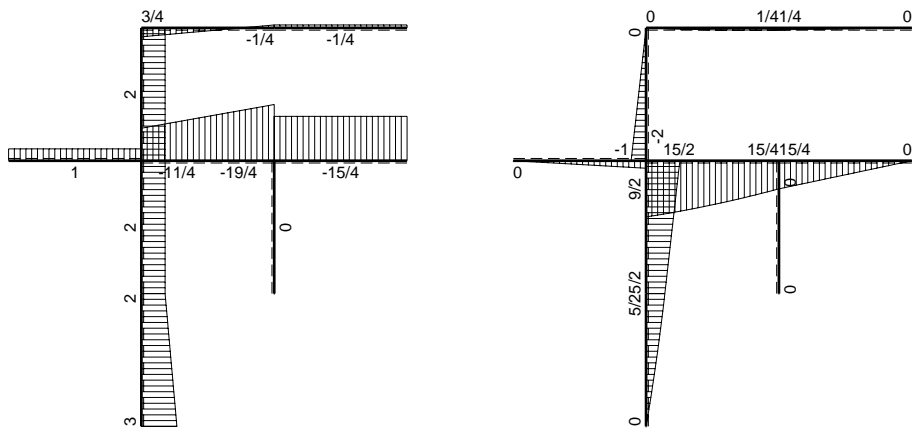
$$\begin{bmatrix} H_A b \\ V_D b \\ V_G b \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ -2 & -1 \\ -1 & 2 \\ 2 & 7/4 \end{bmatrix}$$





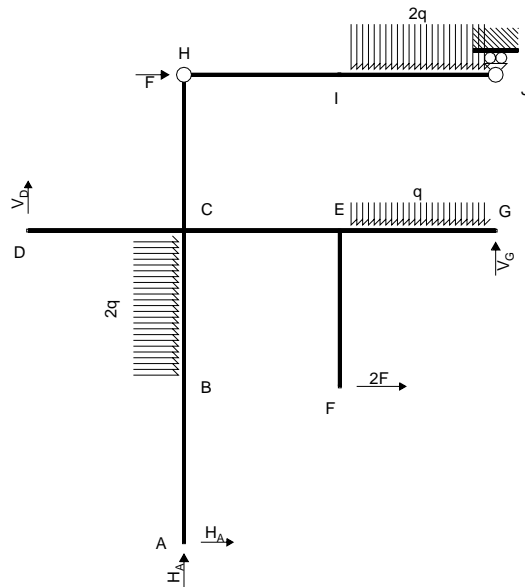
$\frac{1}{40} \frac{Fb^3}{EJ}$

$\leftarrow \boxed{+} \rightarrow F$



$\uparrow \boxed{+} \downarrow F$

$\leftarrow \boxed{+} \rightarrow Fb$



EQUAZIONI DI EQUILIBRIO

Traslazione orizzontale globale

$$H_A = -3F - 2qb$$

Rotazione globale intorno a J

$$H_A b - 3V_D b = -4Fb - 9/2qb^2$$

Rotazione intorno a H: aste HC CB CD CE BA EF EG

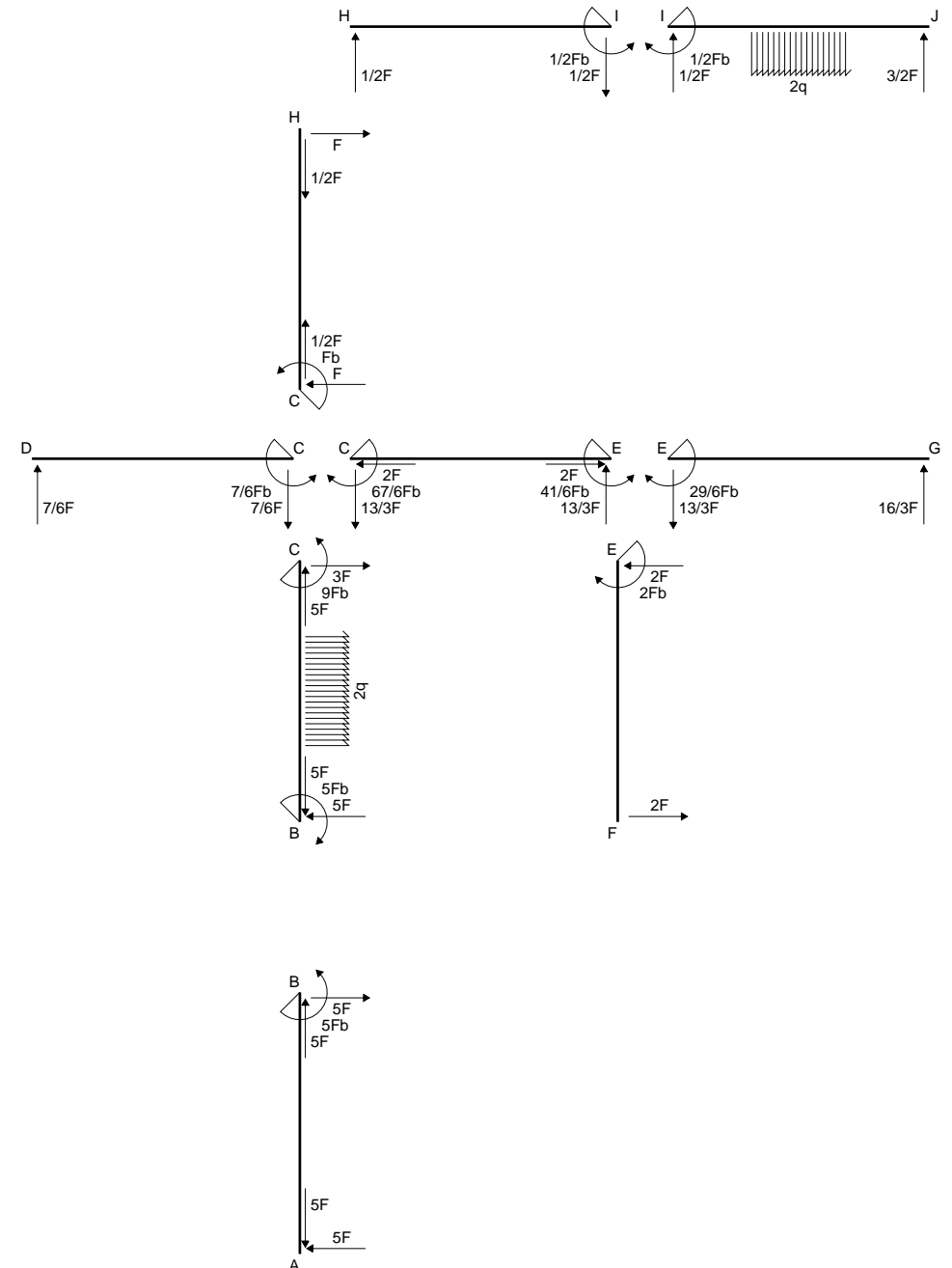
$$3H_A b - V_D b + 2V_G b = -4Fb - 3/2qb^2$$

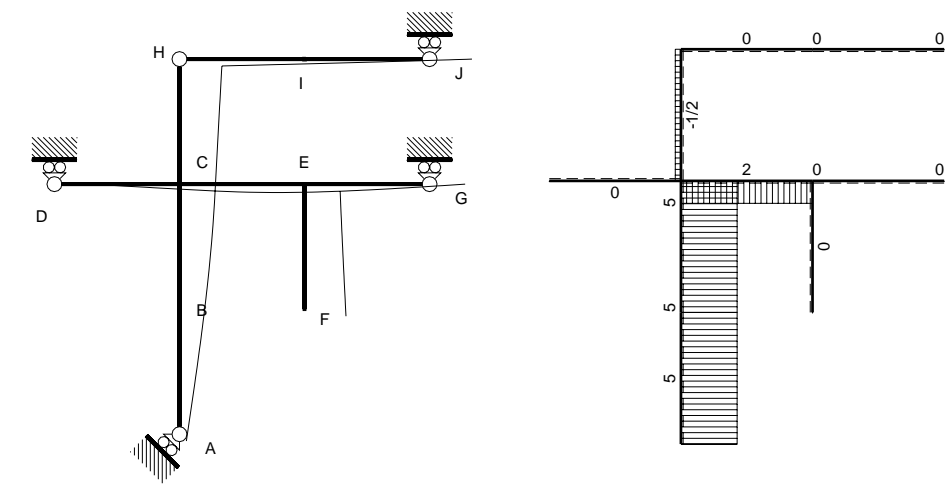
Matrice di equilibrio

$$\begin{matrix} & \begin{bmatrix} H_A b & V_D b & V_G b \end{bmatrix} \\ \begin{matrix} u_J \\ \varphi_J \\ \varphi_{HC} \end{matrix} & \begin{bmatrix} 1 & 0 & 0 \\ 1 & -3 & 0 \\ 3 & -1 & 2 \end{bmatrix} \end{matrix} = \begin{bmatrix} Fb & qb^2 \\ -3 & -2 \\ -4 & -9/2 \\ -4 & -3/2 \end{bmatrix}$$

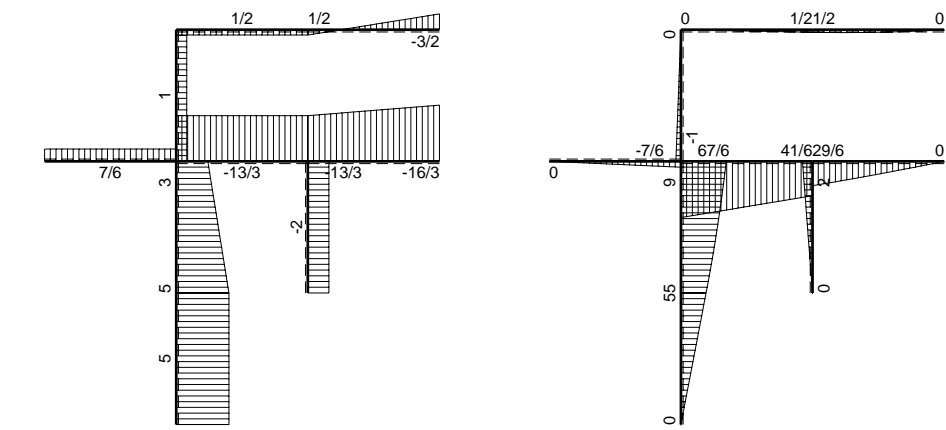
Soluzione del sistema

$$\begin{bmatrix} H_A b \\ V_D b \\ V_G b \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ -3 & -2 \\ 1/3 & 5/6 \\ 8/3 & 8/3 \end{bmatrix}$$

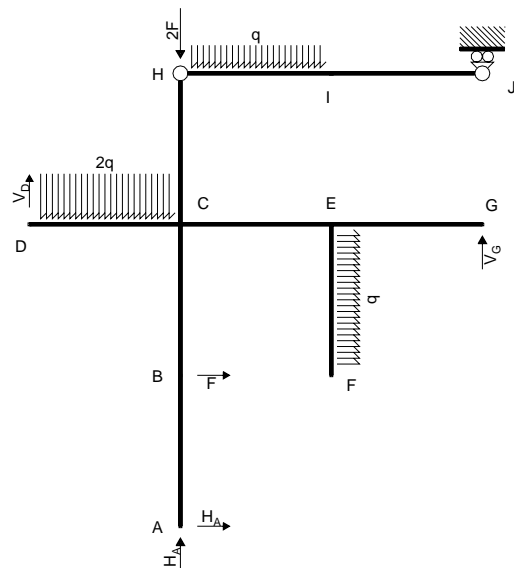




$\frac{1}{60} \frac{Fb^3}{EJ}$ $\leftarrow \boxed{+} \rightarrow F$



$\uparrow \boxed{+} \downarrow F$ $\uparrow \boxed{+} \downarrow F_b$



EQUAZIONI DI EQUILIBRIO

Traslazione orizzontale globale

$$H_A = -F - qb$$

Rotazione globale intorno a J

$$H_A b - 3V_D b = -6Fb - 8qb^2$$

Rotazione intorno a H: aste HC CB CD CE BA EF EG

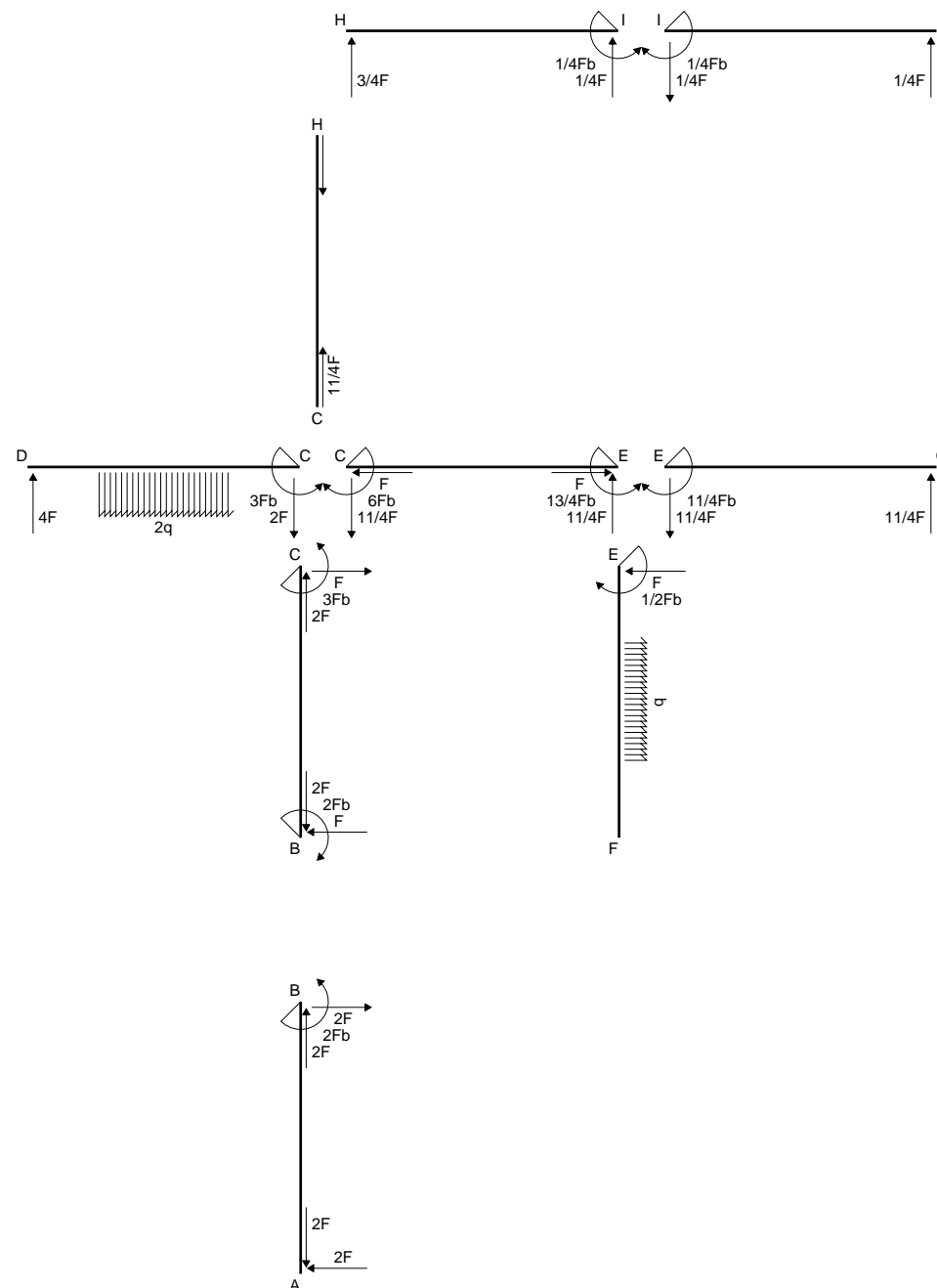
$$3H_A b - V_D b + 2V_G b = -2Fb - 5/2qb^2$$

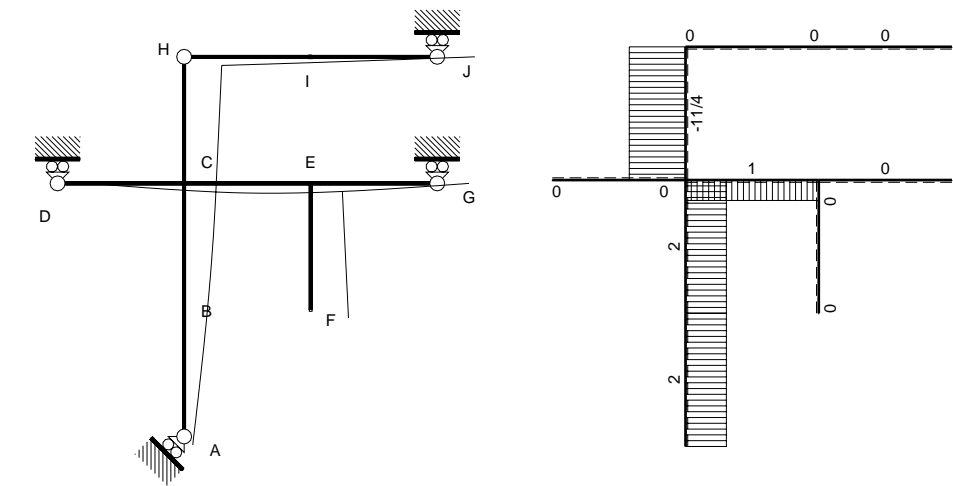
Matrice di equilibrio

$$\begin{bmatrix} H_A b & V_D b & V_G b \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 1 & -3 & 0 \\ 3 & -1 & 2 \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ -1 & -1 \\ -6 & -8 \\ -2 & -5/2 \end{bmatrix}$$

Soluzione del sistema

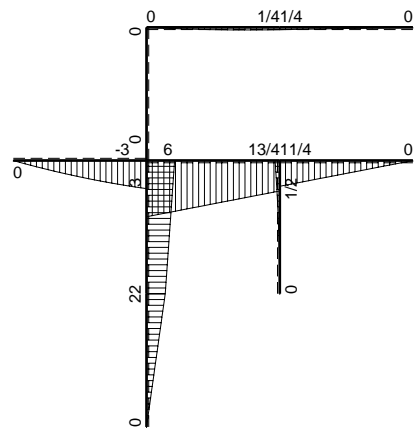
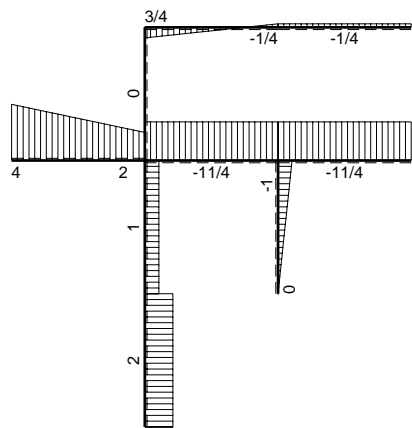
$$\begin{bmatrix} H_A b \\ V_D b \\ V_G b \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ -1 & -1 \\ 5/3 & 7/3 \\ 4/3 & 17/12 \end{bmatrix}$$





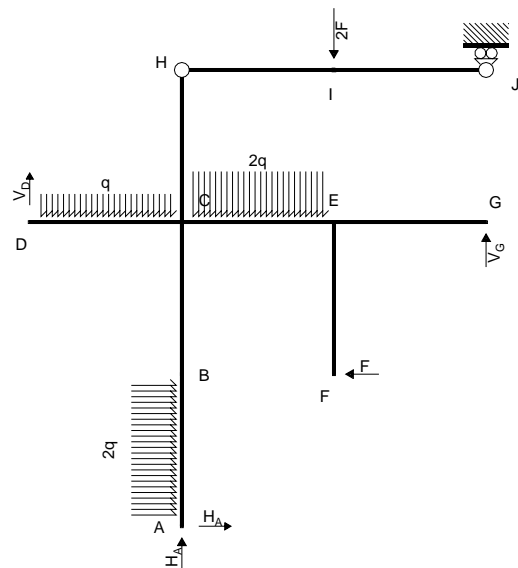
$\text{---} 30 Fb^3/EJ$

$\leftarrow \boxed{+} \rightarrow F$



$\uparrow \boxed{+} \downarrow F$

$\curvearrowright \boxed{+} \curvearrowleft Fb$



EQUAZIONI DI EQUILIBRIO

Traslazione orizzontale globale

$$H_A = F - 2qb$$

Rotazione globale intorno a J

$$H_A b - 3V_D b = -21/2 qb^2$$

Rotazione intorno a H: aste HC CB CD CE BA EF EG

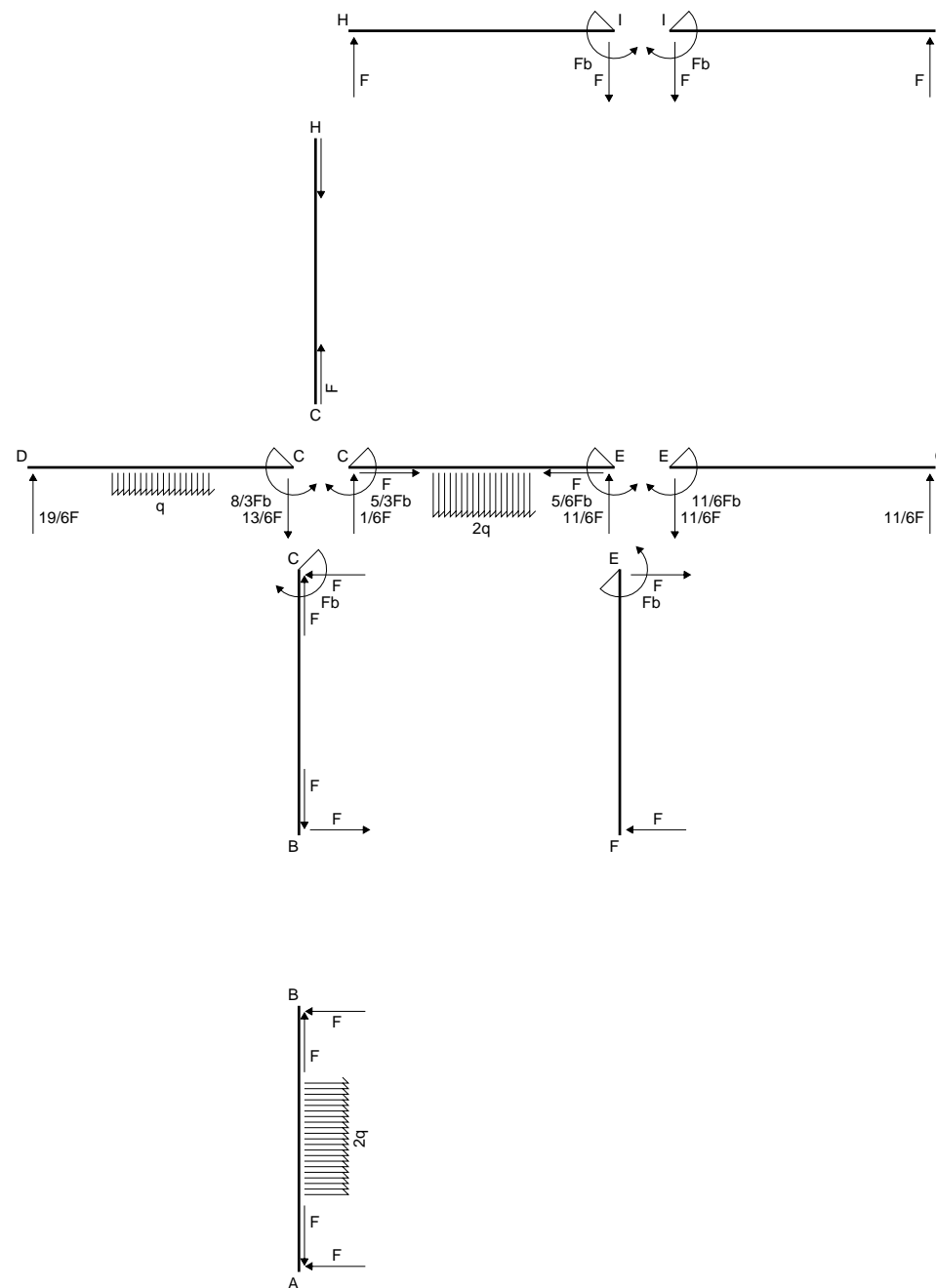
$$3H_A b - V_D b + 2V_G b = 2Fb - 9/2 qb^2$$

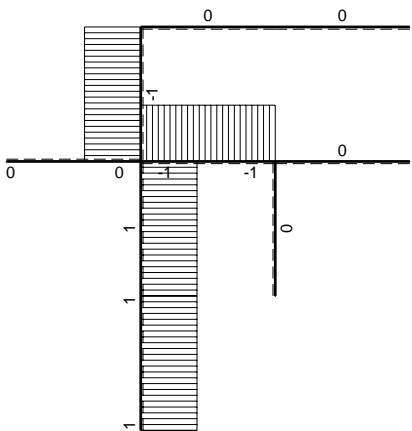
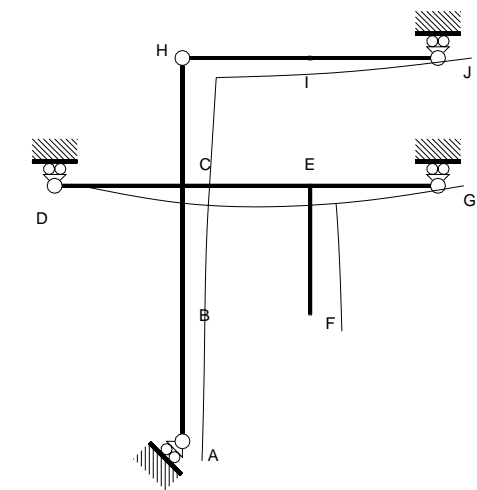
Matrice di equilibrio

$$\begin{bmatrix} H_A b & V_D b & V_G b \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 1 & -3 & 0 \\ 3 & -1 & 2 \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ 1 & -2 \\ 0 & -21/2 \\ 2 & -9/2 \end{bmatrix}$$

Soluzione del sistema

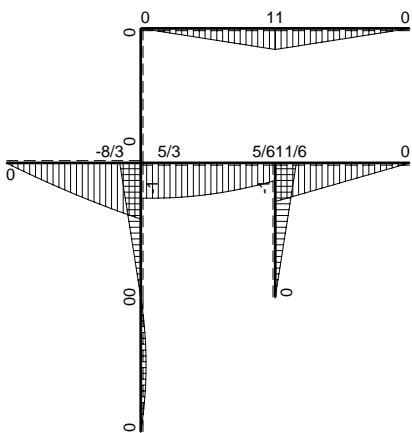
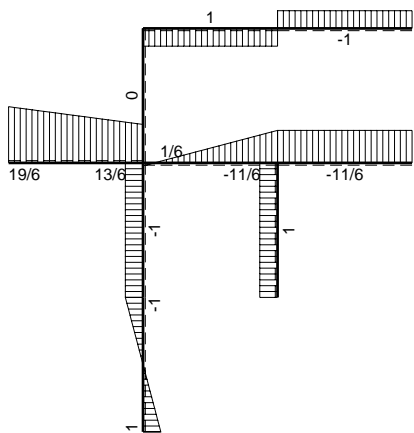
$$\begin{bmatrix} H_A b \\ V_D b \\ V_G b \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ 1 & -2 \\ 1/3 & 17/6 \\ -1/3 & 13/6 \end{bmatrix}$$





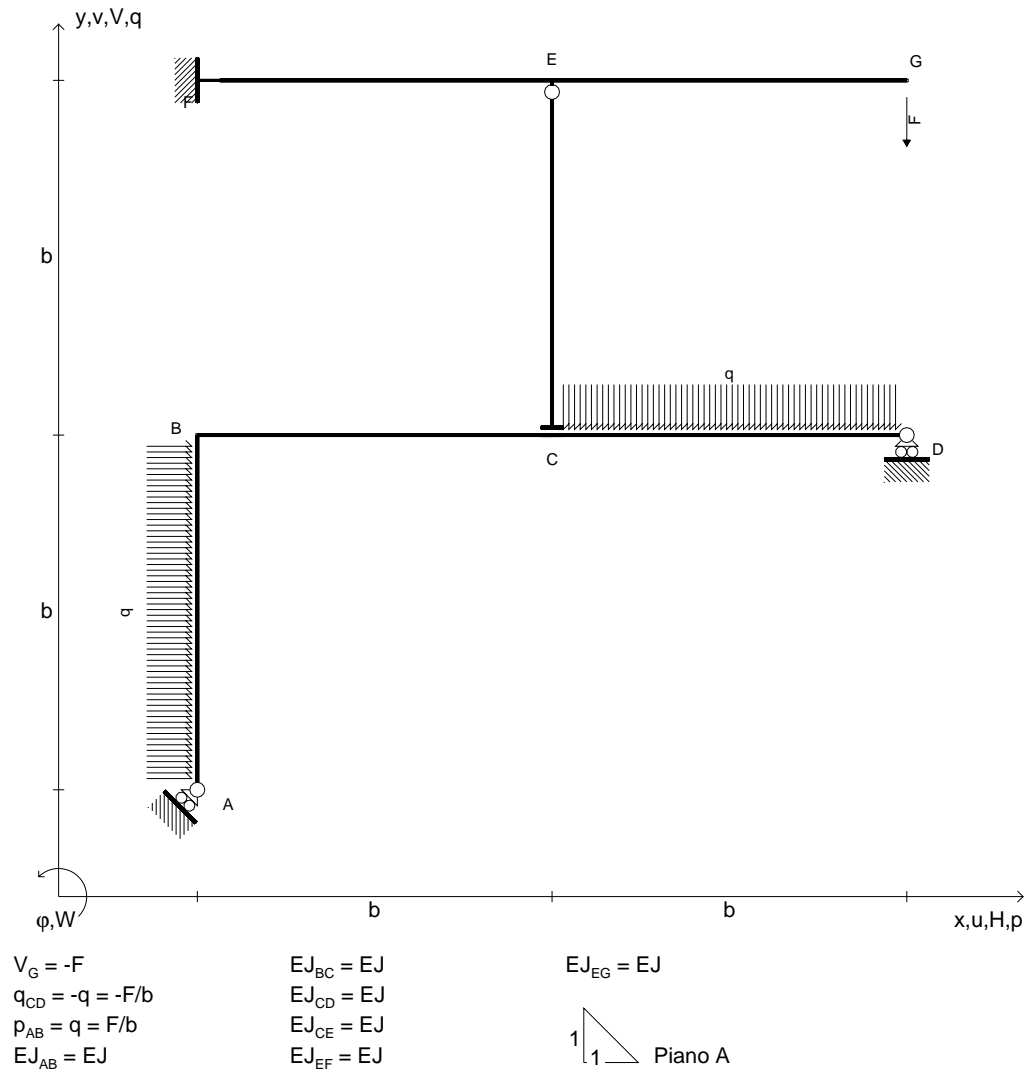
$\delta = 6 F b^3 / EJ$

$\leftarrow \boxed{+} \rightarrow F$



$\uparrow \boxed{+} \downarrow F$

$\curvearrowright \boxed{+} \curvearrowleft F_b$



Carichi e deformazioni date hanno verso efficace in disegno.

Calcolare reazioni vincolari della struttura e delle aste.

Tracciare i diagrammi quotati delle azioni interne nelle aste.

$J_{YZ} - x_{YZ} - \theta_{YZ}$ riferimento locale asta YZ con origine in Y .

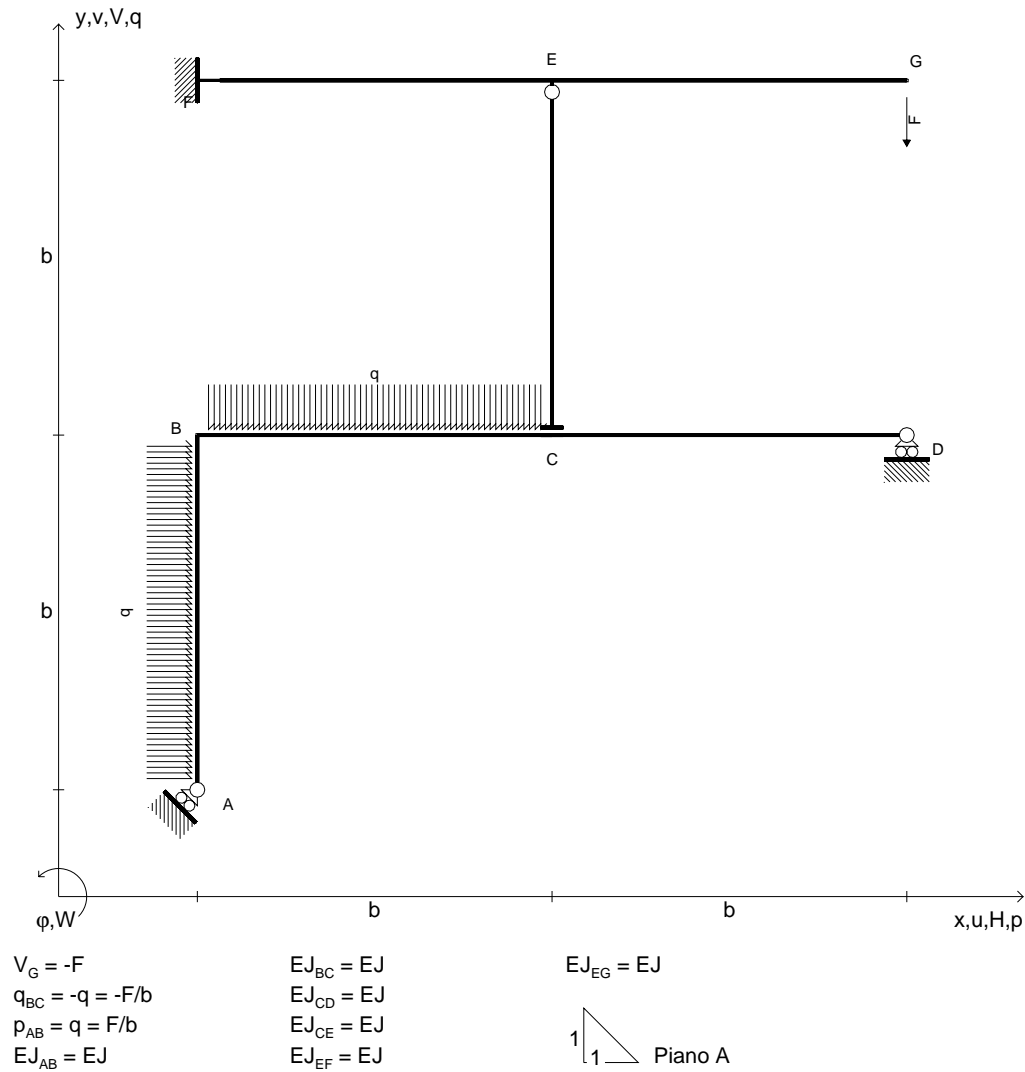
Piano di scorrimento del vincolo con inclinazione assegnata.

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.10.02.10

23.02.10

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.10.02.10

23.02.10



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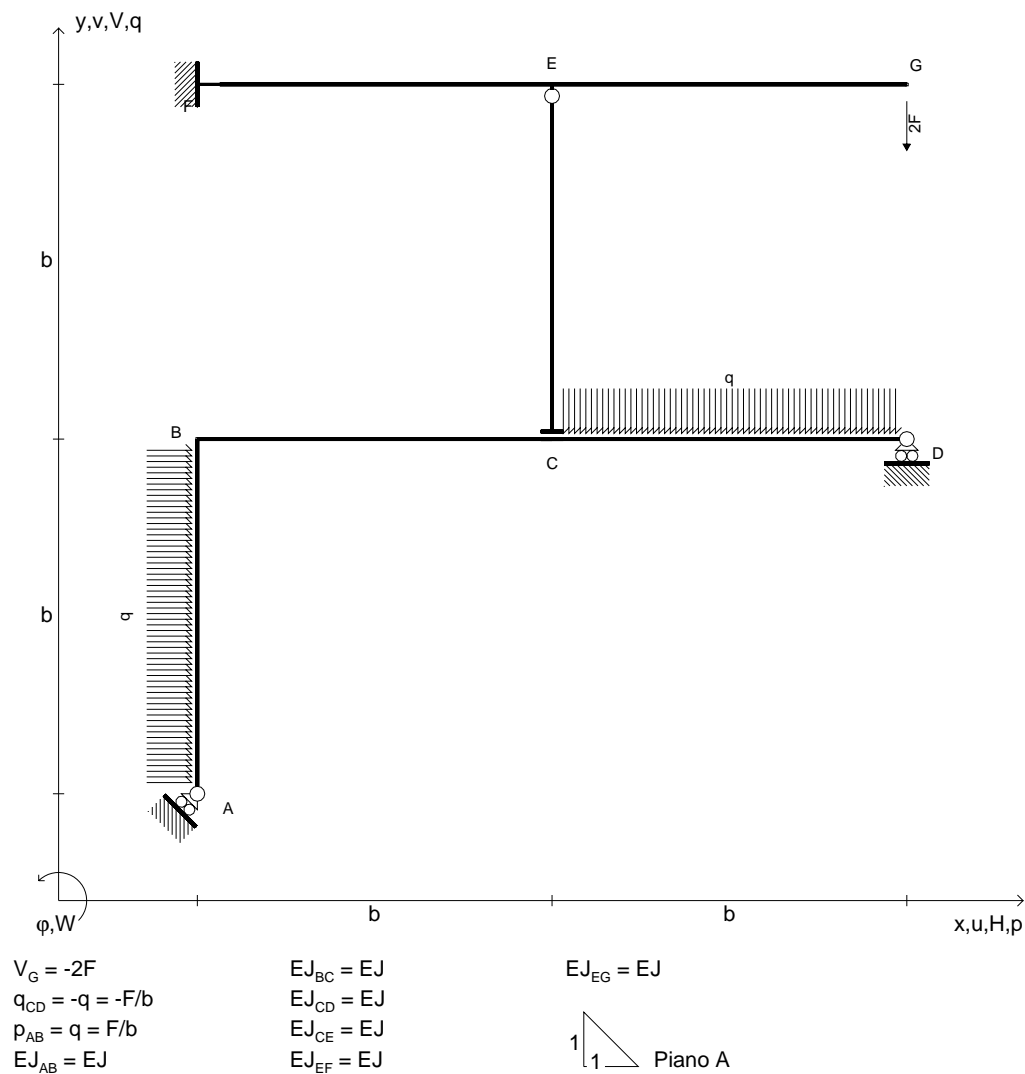
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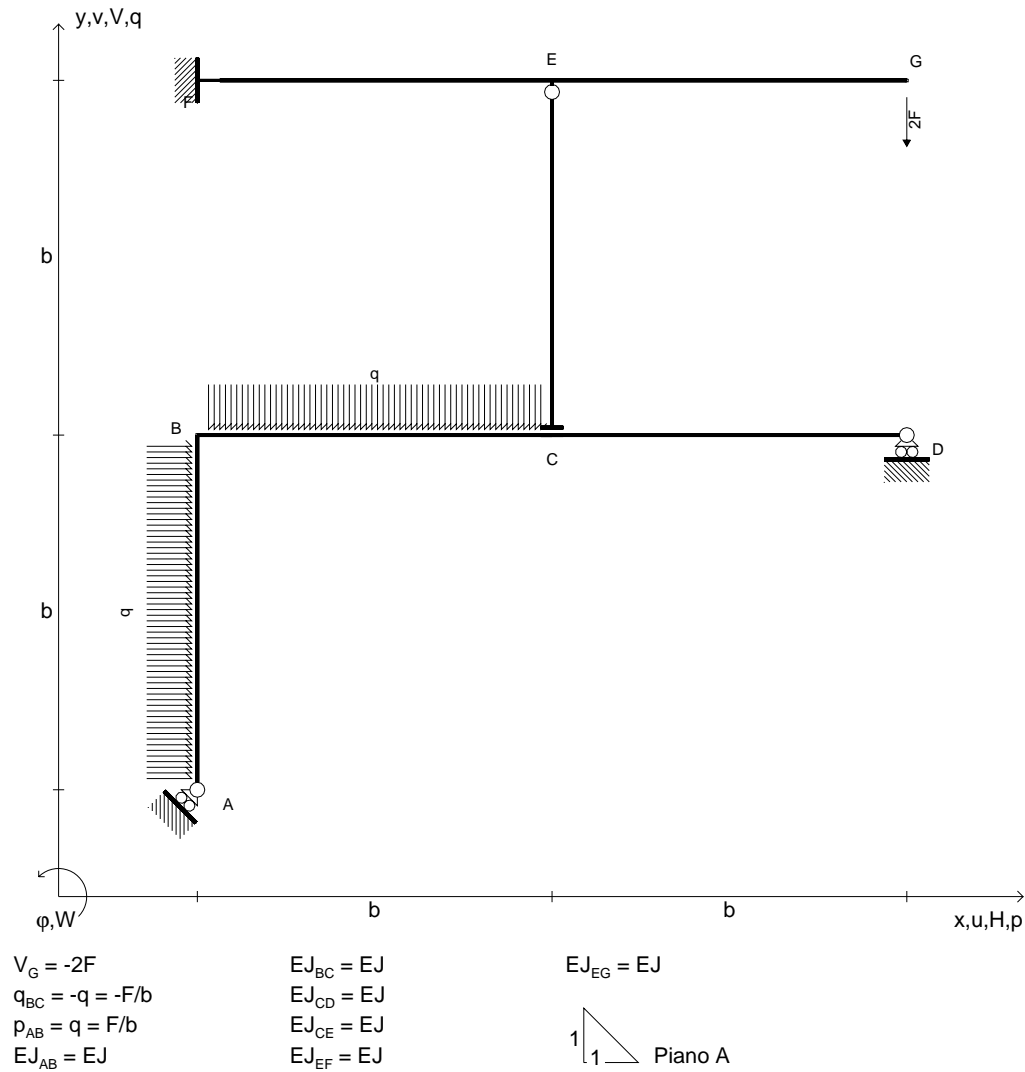
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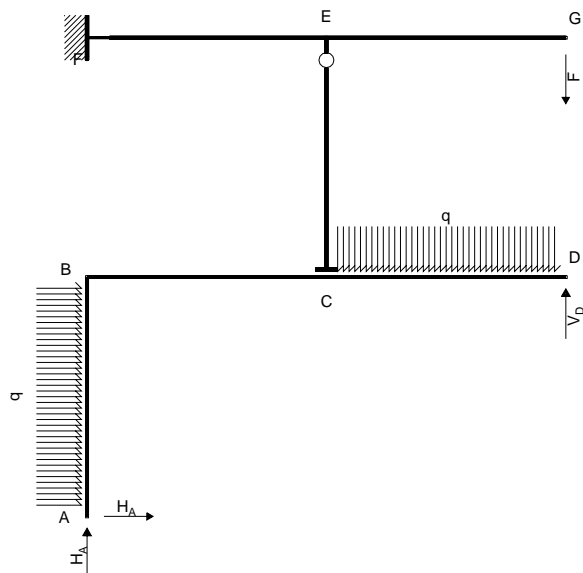
Piano di scorrimento del vincolo con inclinazione assegnata.

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23.02.10

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23.02.10



EQUAZIONI DI EQUILIBRIO

Traslazione orizzontale: aste CB CD BA

$$H_A = -qb$$

Rotazione intorno a E: aste EC CB CD BA

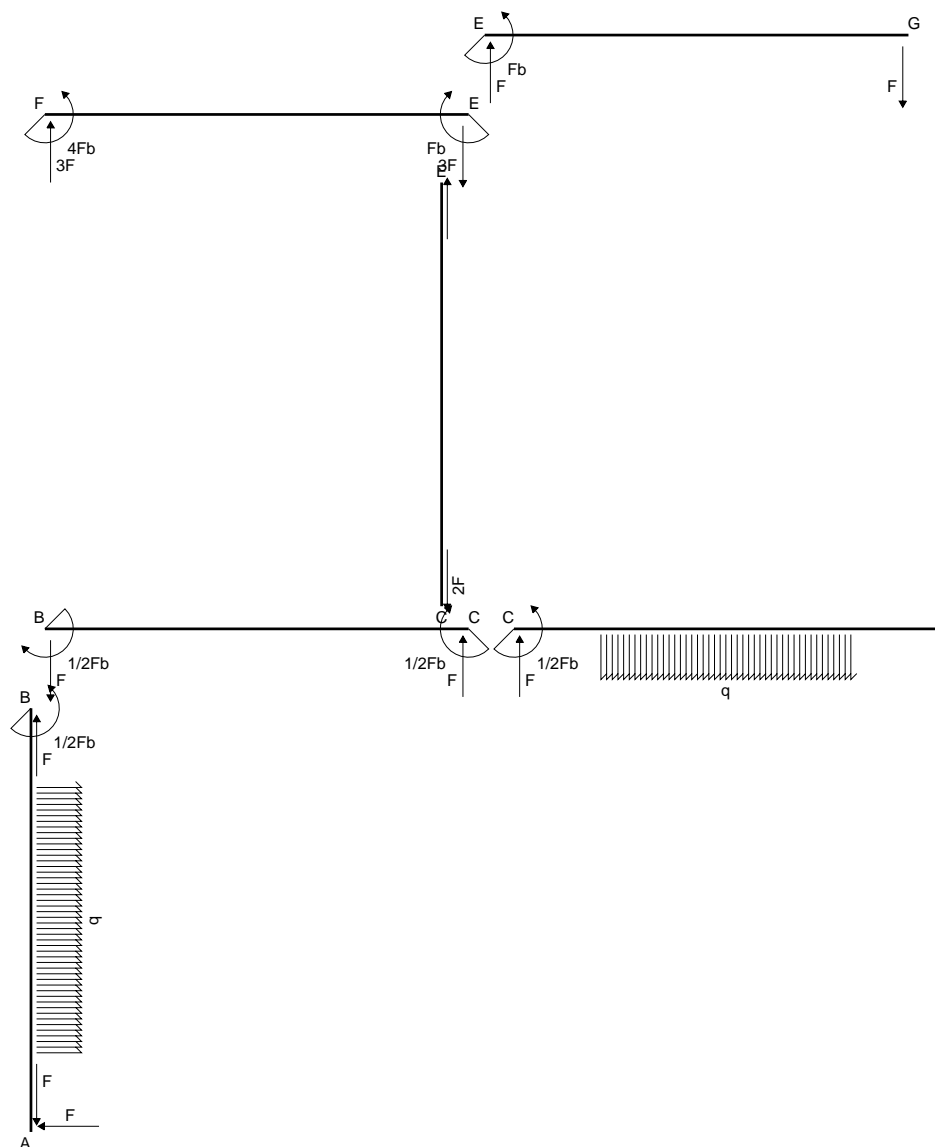
$$H_A b + V_D b = -qb^2$$

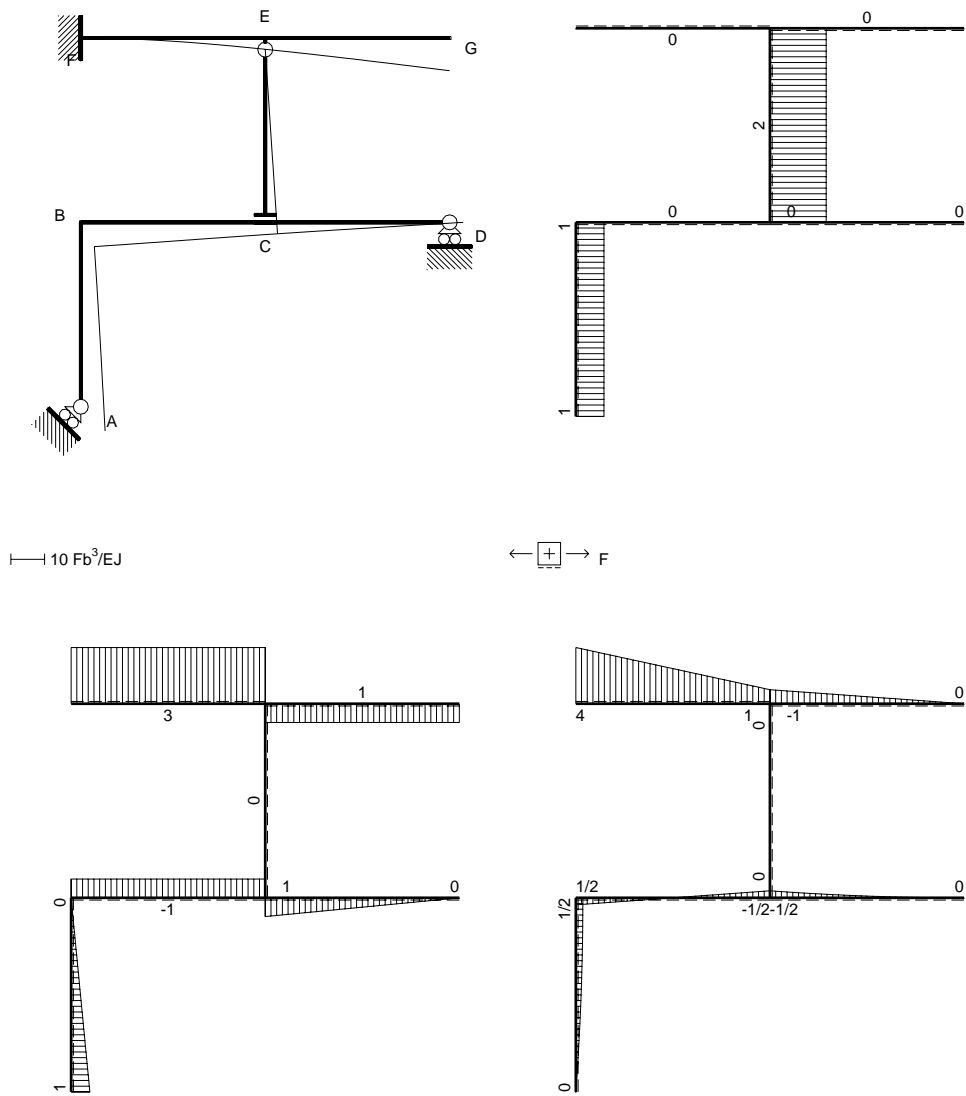
Matrice di equilibrio

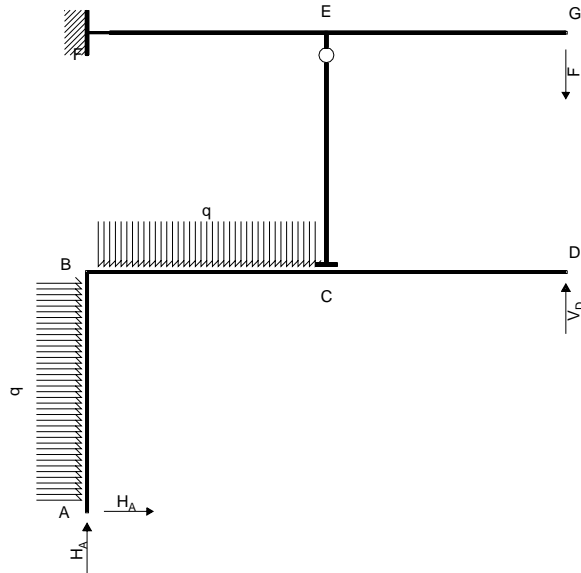
$$\begin{bmatrix} H_A b & V_D b \end{bmatrix} \begin{bmatrix} u_{CE} \\ \phi_{EC} \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ 0 & -1 \end{bmatrix}$$

Soluzione del sistema

$$\begin{bmatrix} H_A b \\ V_D b \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ 0 & -1 \end{bmatrix}$$







EQUAZIONI DI EQUILIBRIO

Traslazione orizzontale: aste CB CD BA

$$H_A = -qb$$

Rotazione intorno a E: aste EC CB CD BA

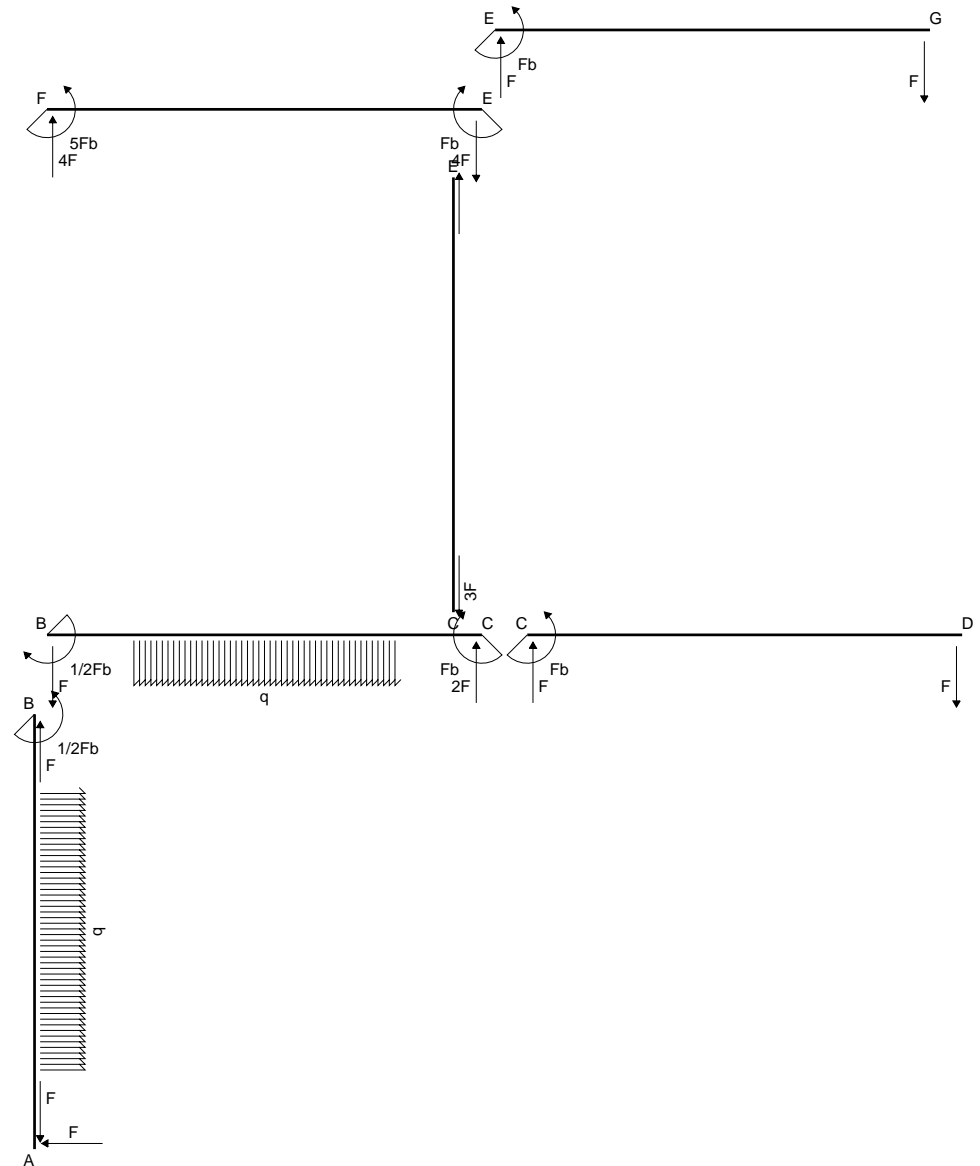
$$H_A b + V_D b = -2qb^2$$

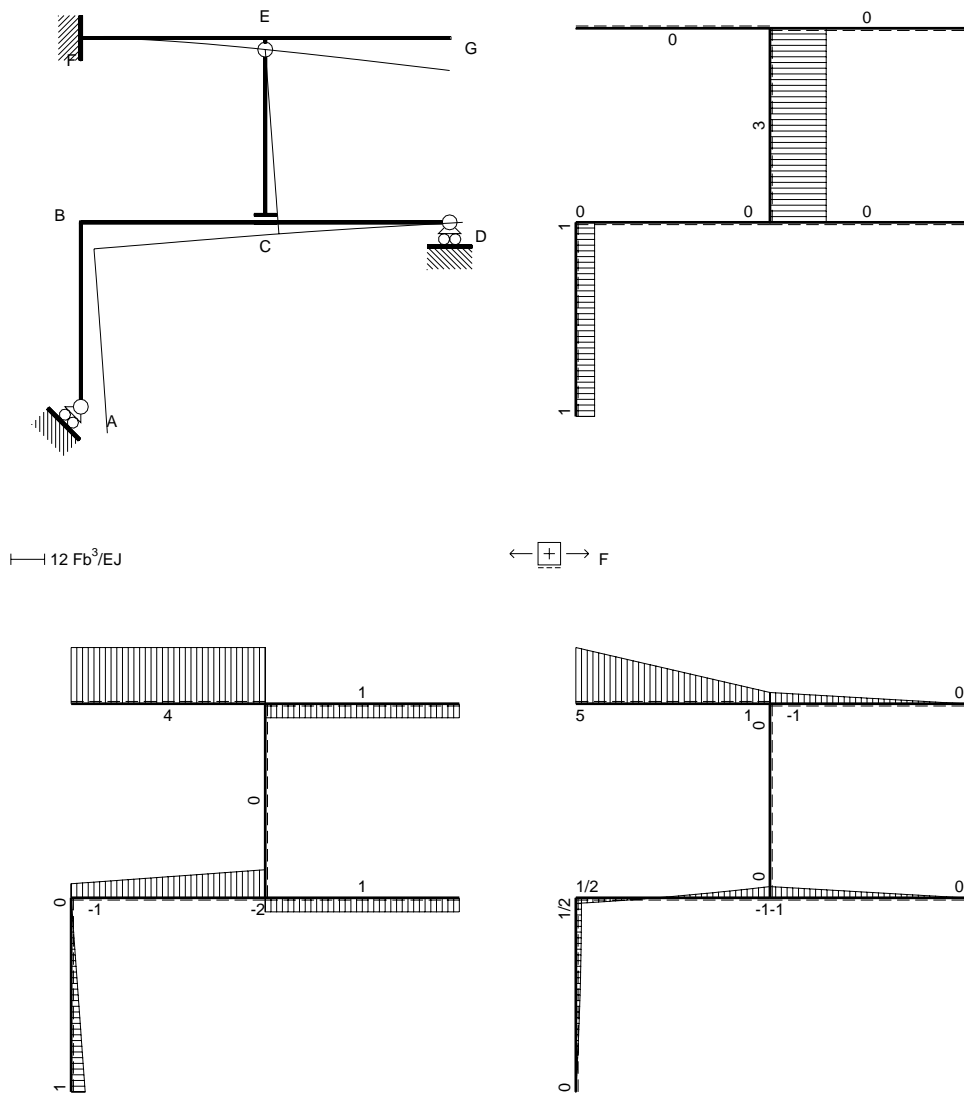
Matrice di equilibrio

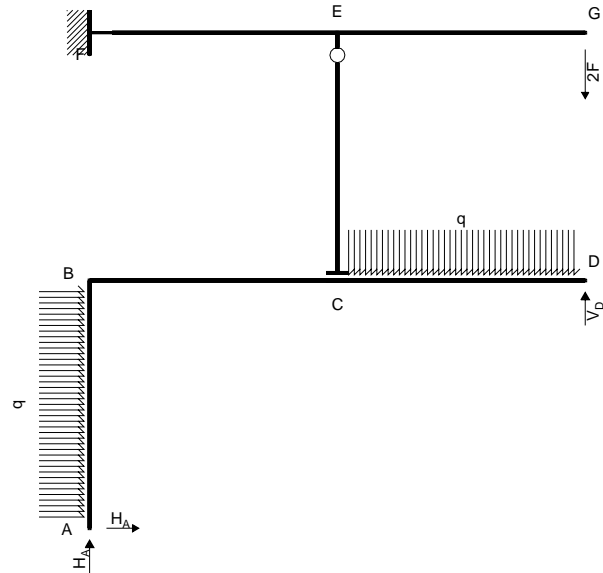
$$\begin{bmatrix} H_A b & V_D b \end{bmatrix} \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ 0 & -1 \\ 0 & -2 \end{bmatrix}$$

Soluzione del sistema

$$\begin{bmatrix} H_A b \\ V_D b \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ 0 & -1 \\ 0 & -1 \end{bmatrix}$$







EQUAZIONI DI EQUILIBRIO

Traslazione orizzontale: aste CB CD BA

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Rotazione intorno a E: aste EC CB CD BA

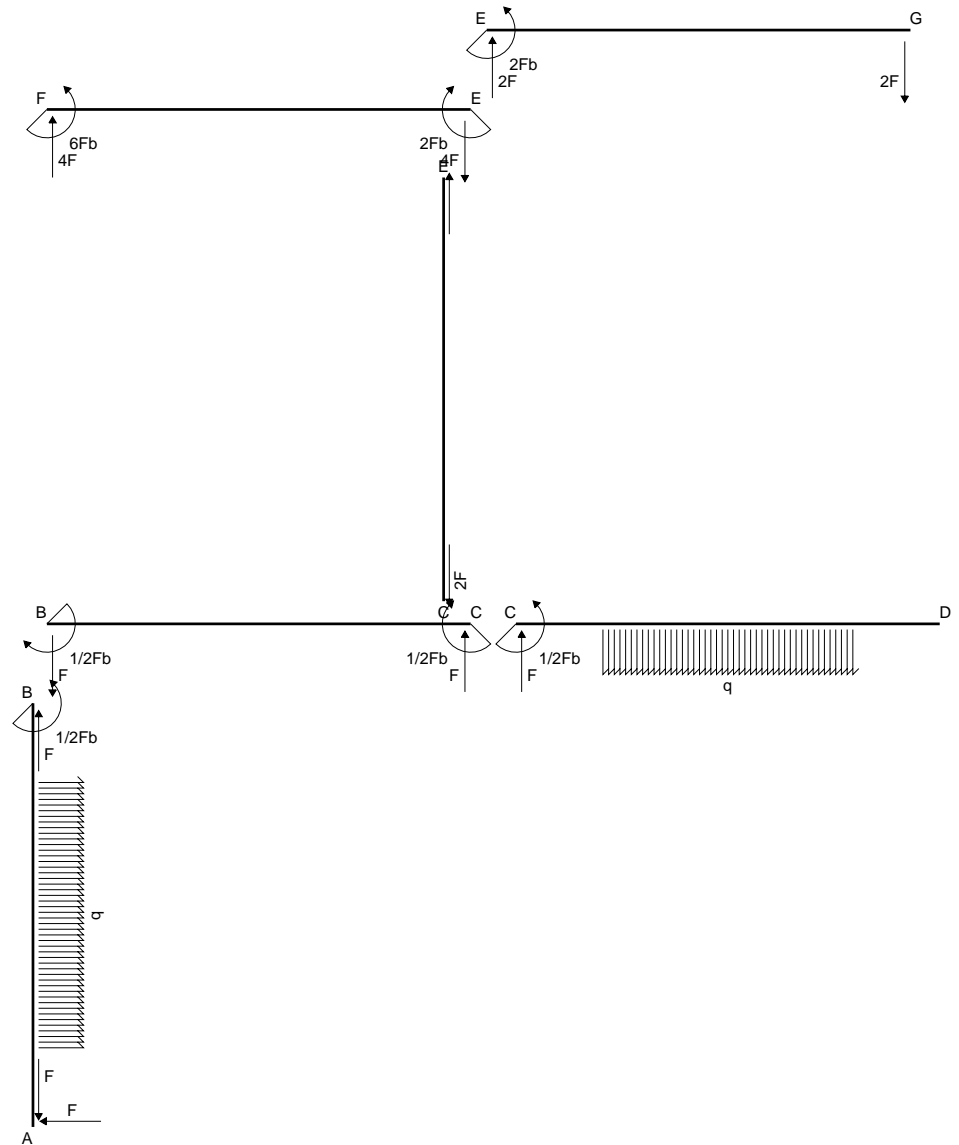
$$H_A b + V_D b = -qb^2$$

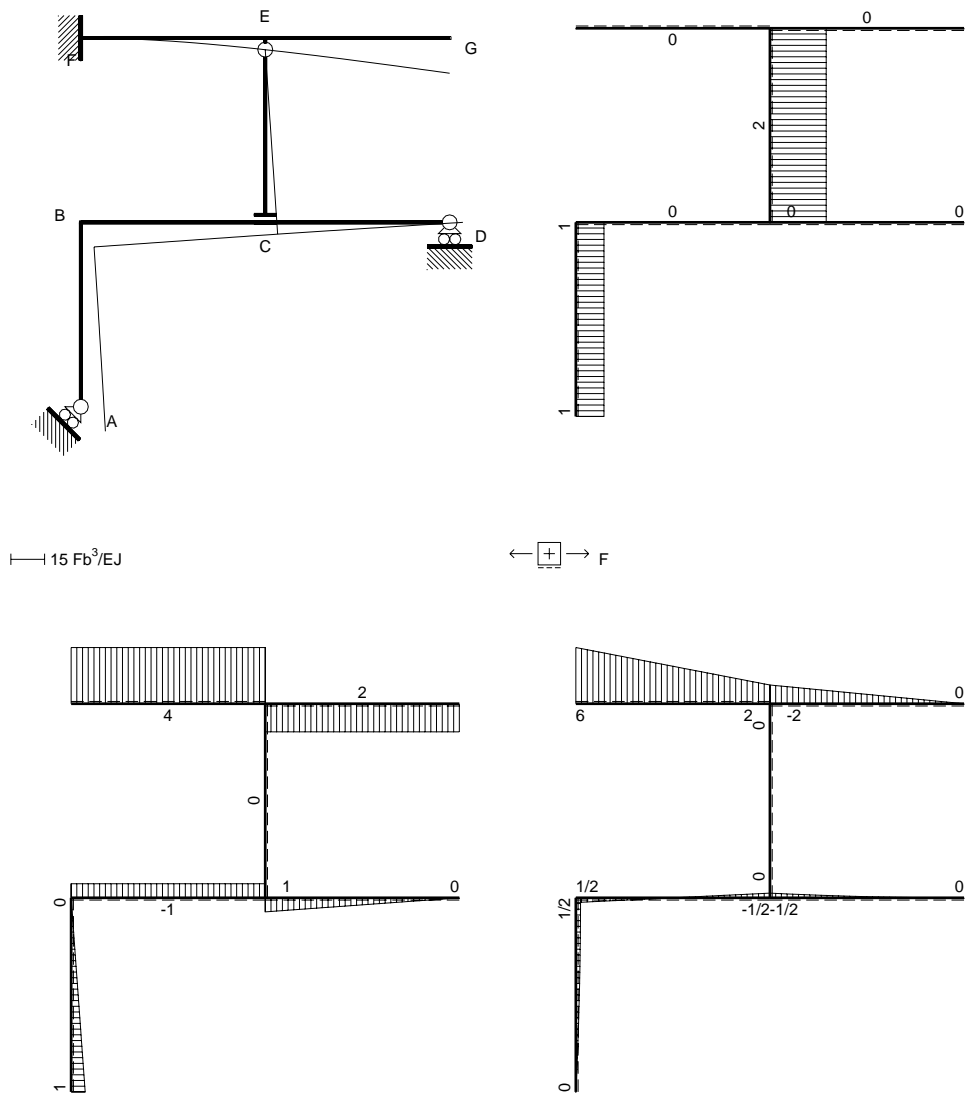
Matrice di equilibrio

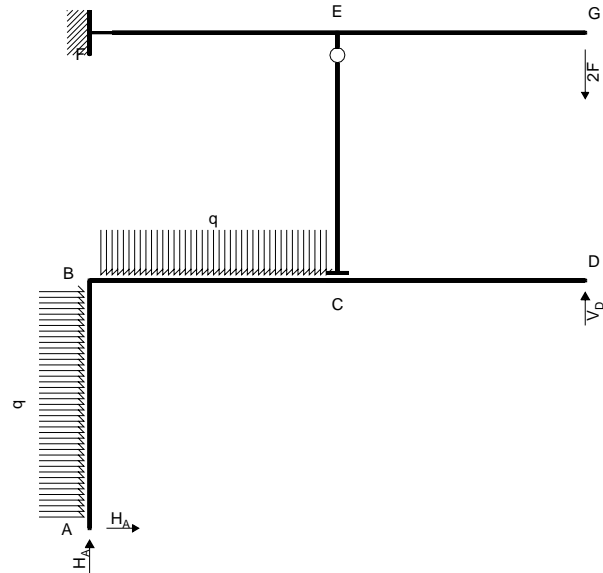
$$\begin{bmatrix} H_A b & V_D b \end{bmatrix} \begin{bmatrix} \phi_{CE} \\ \phi_{EC} \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ 0 & -1 \end{bmatrix}$$

Soluzione del sistema

$$\begin{bmatrix} H_A b \\ V_D b \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ 0 & -1 \end{bmatrix}$$







EQUAZIONI DI EQUILIBRIO

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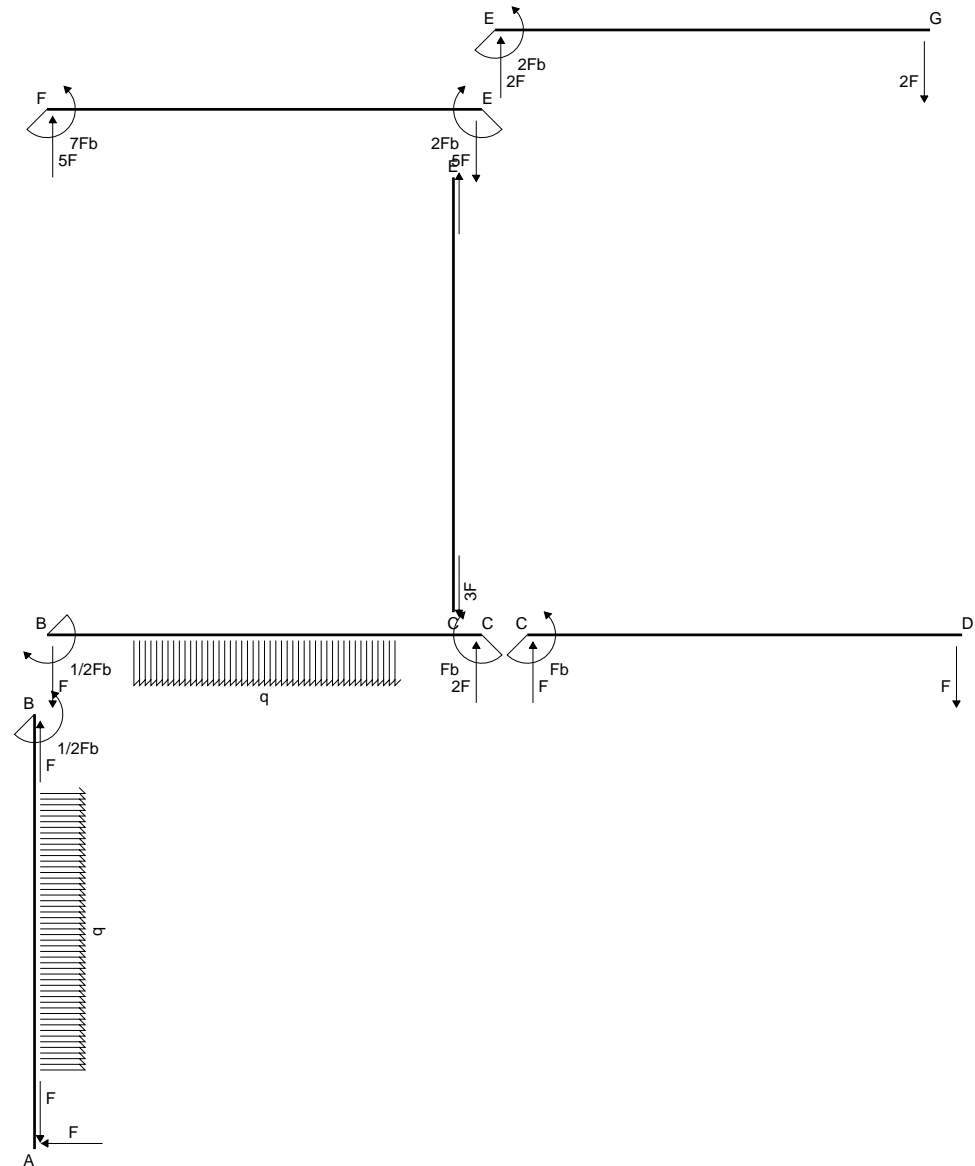
$$H_A b + V_D b = -2qb^2$$

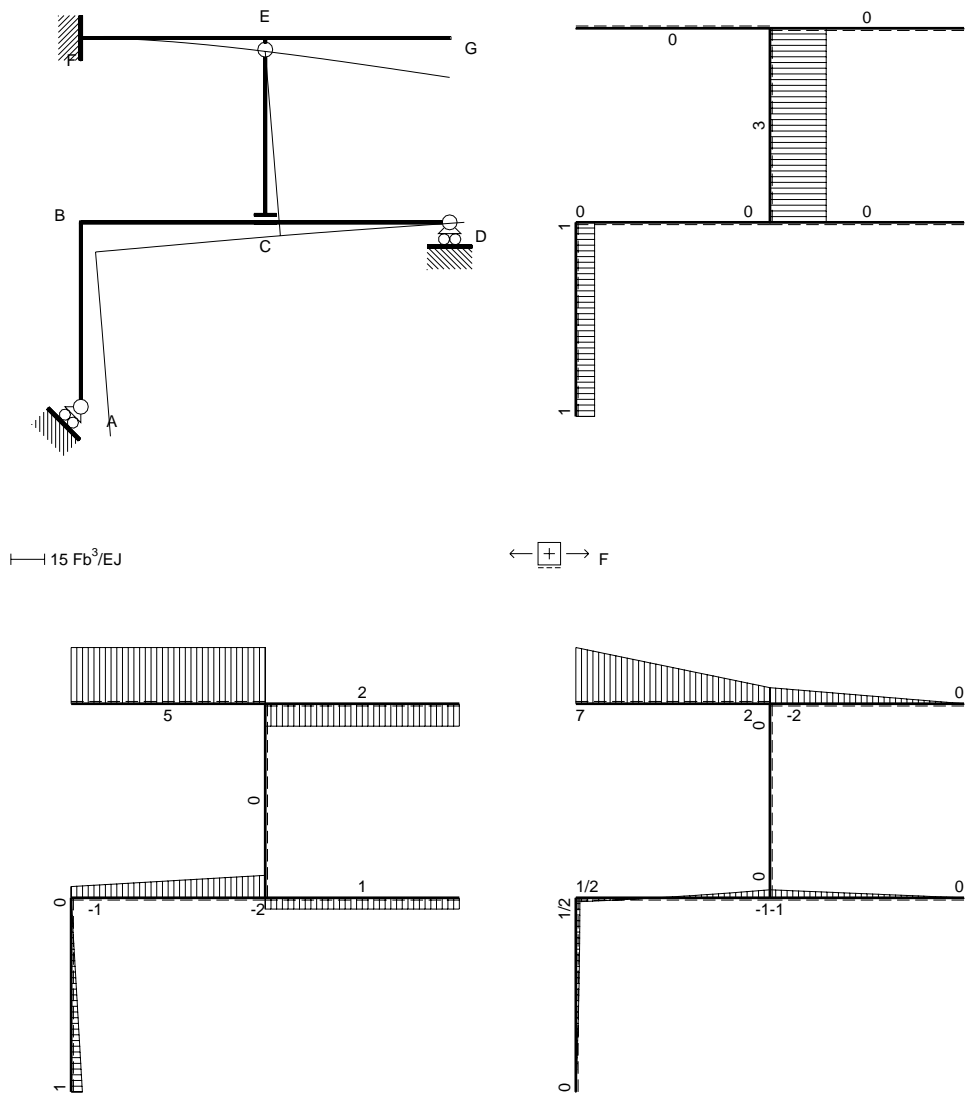
Matrice di equilibrio

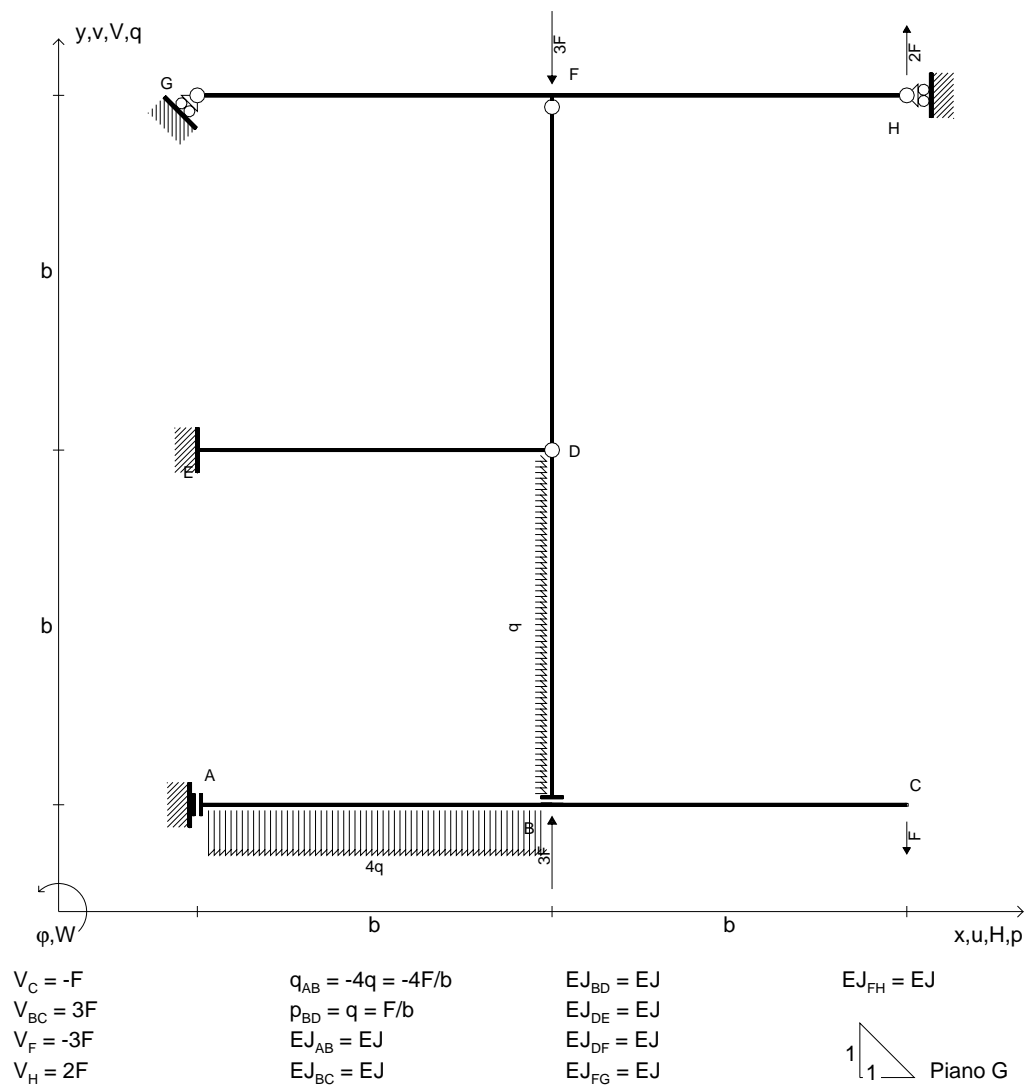
$$\begin{bmatrix} H_A b & V_D b \end{bmatrix} \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ 0 & -1 \\ 0 & -2 \end{bmatrix}$$

Soluzione del sistema

$$\begin{bmatrix} H_A b \\ V_D b \end{bmatrix} = \begin{bmatrix} Fb & qb^2 \\ 0 & -1 \\ 0 & -1 \end{bmatrix}$$







Carichi e deformazioni date hanno verso efficace in disegno.

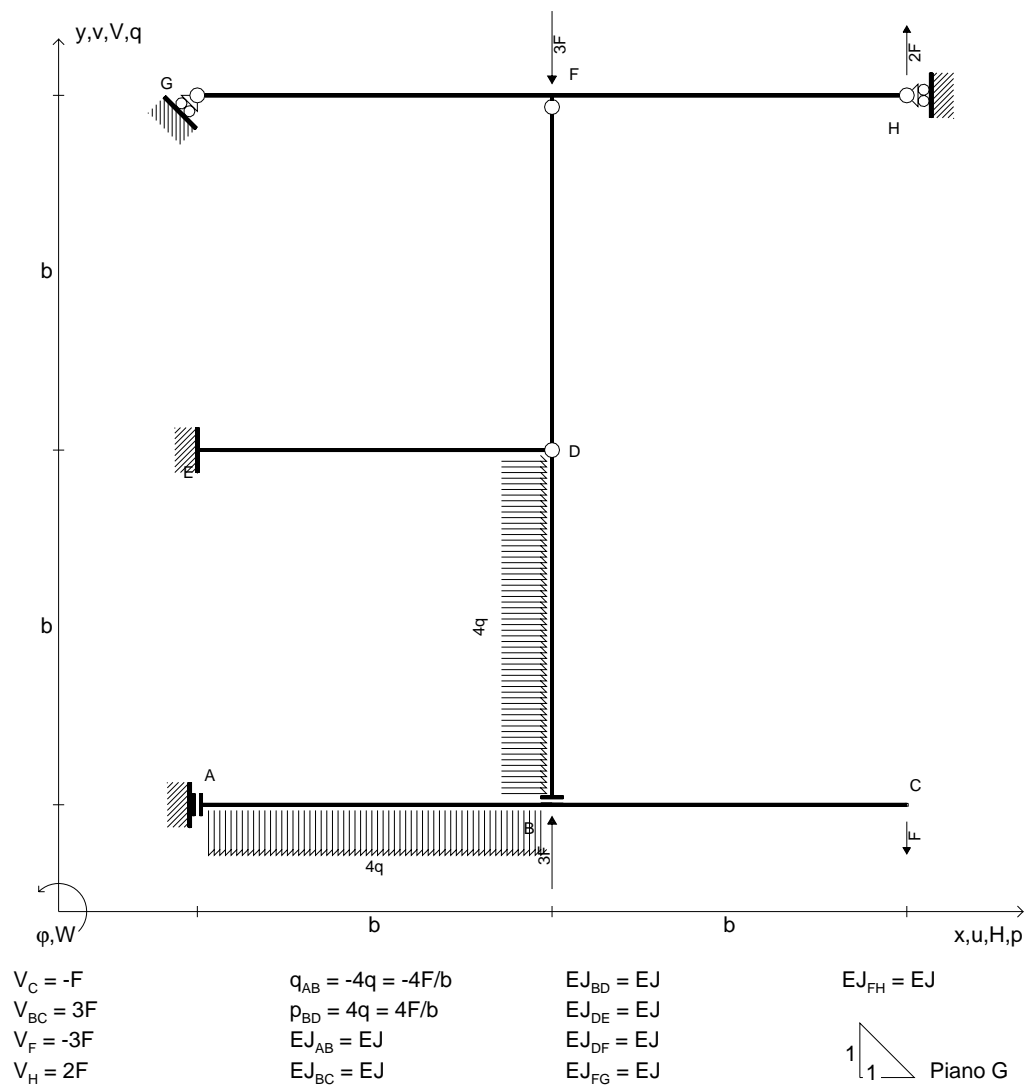
Calcolare reazioni vincolari della struttura e delle aste.

Tracciare i diagrammi quotati delle azioni interne nelle aste.

$J_{YZ} - x_{YZ} - \theta_{YZ}$ riferimento locale asta YZ con origine in Y.

Piano di scorrimento del vincolo con inclinazione assegnata.

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.07.09.10



Carichi e deformazioni date hanno verso efficace in disegno.

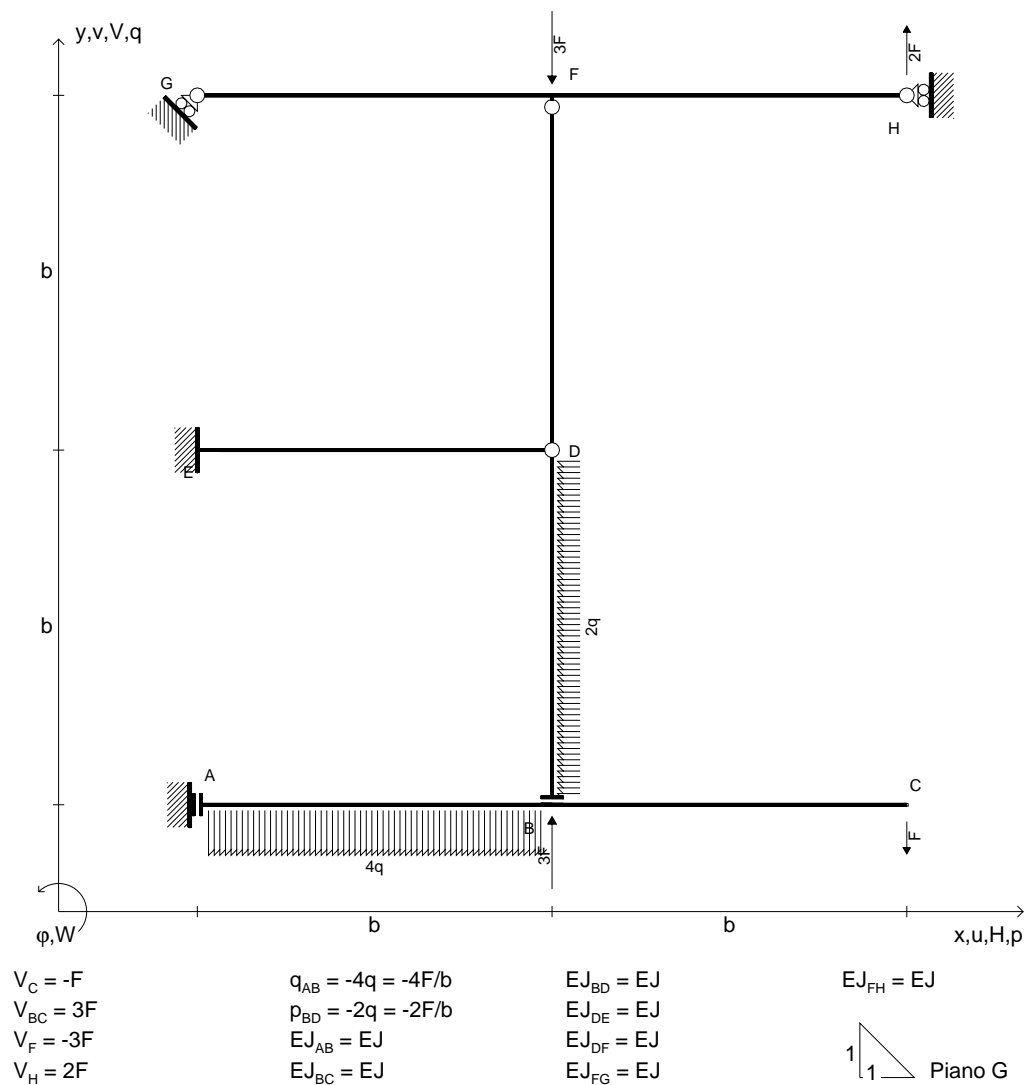
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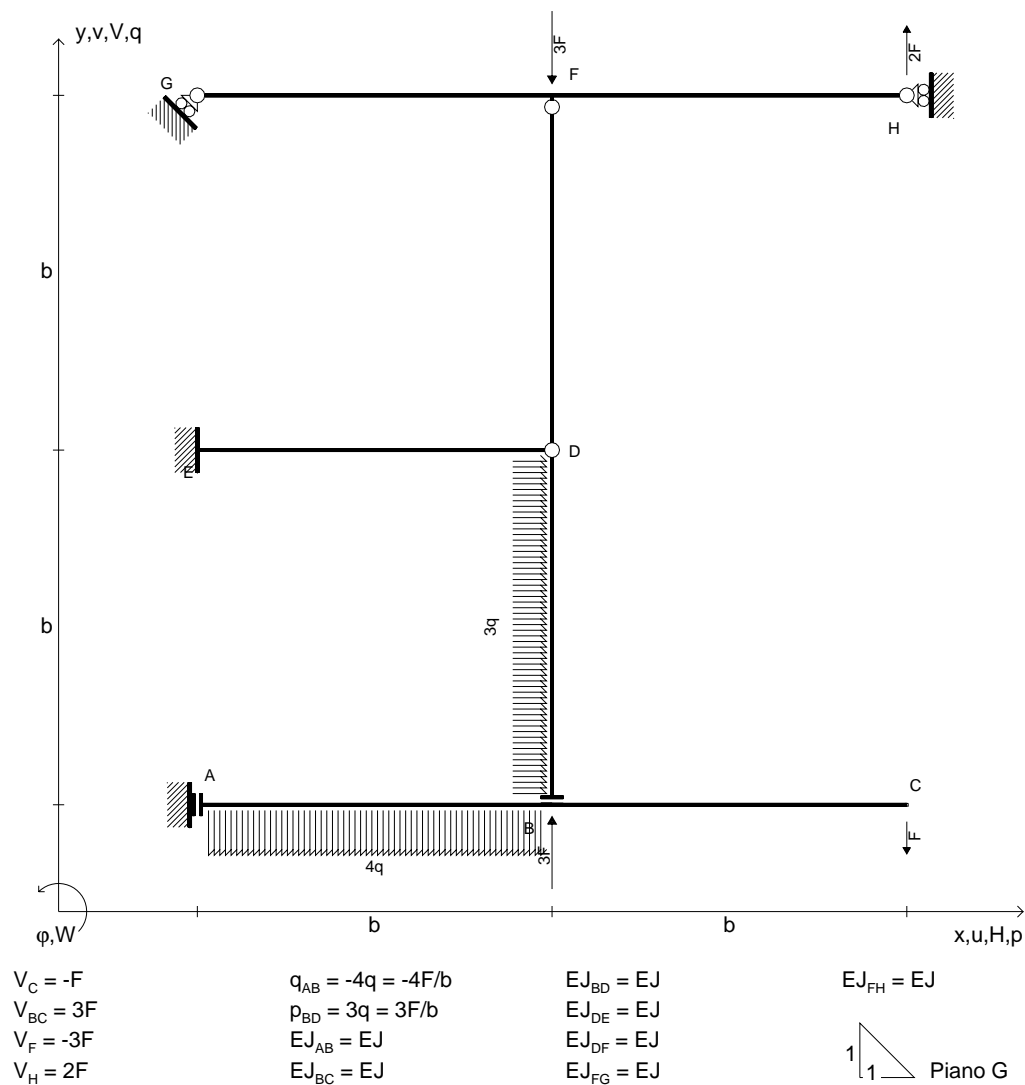
Piano di scorrimento del vincolo con inclinazione assegnata.

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.07.09.10

09.09.10

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.07.09.10

09.09.10



Carichi e deformazioni date hanno verso efficace in disegno.

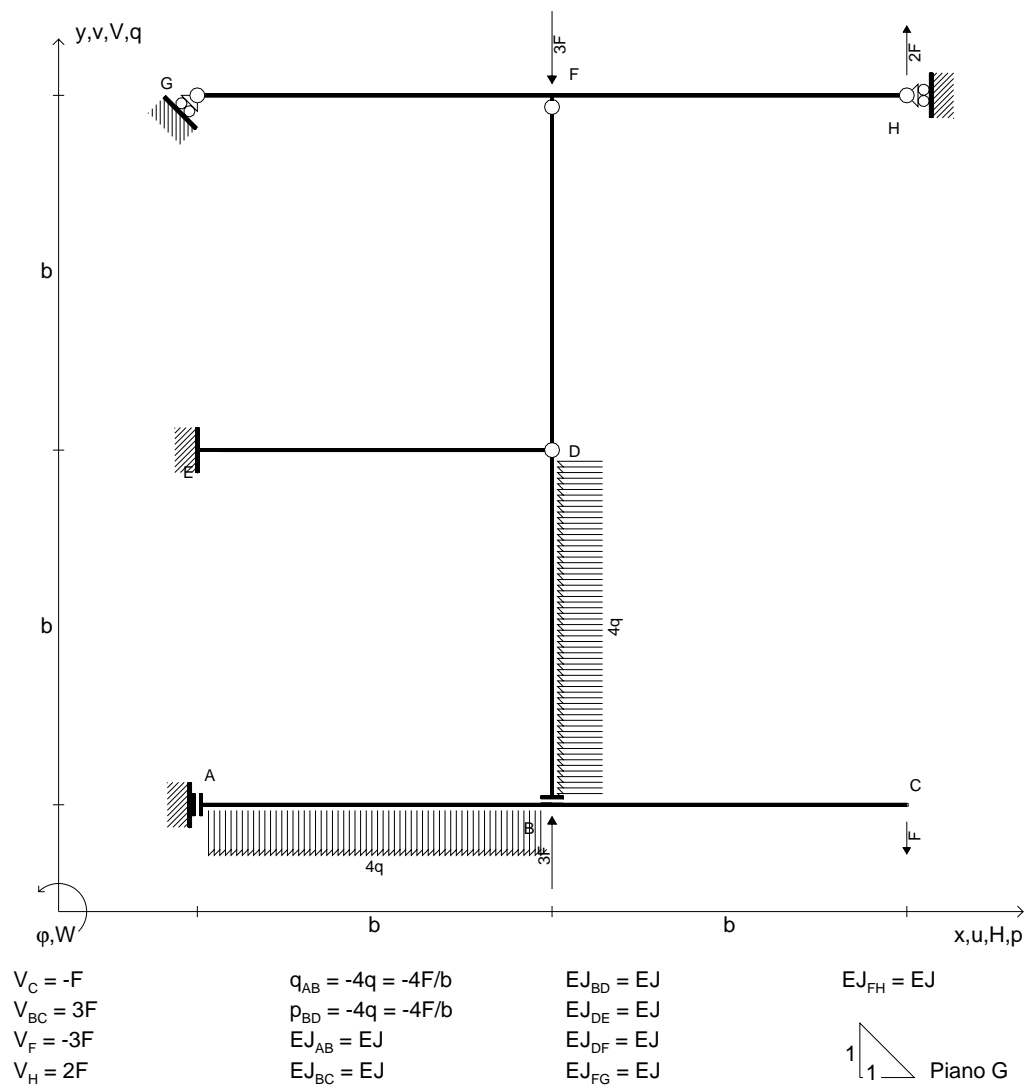
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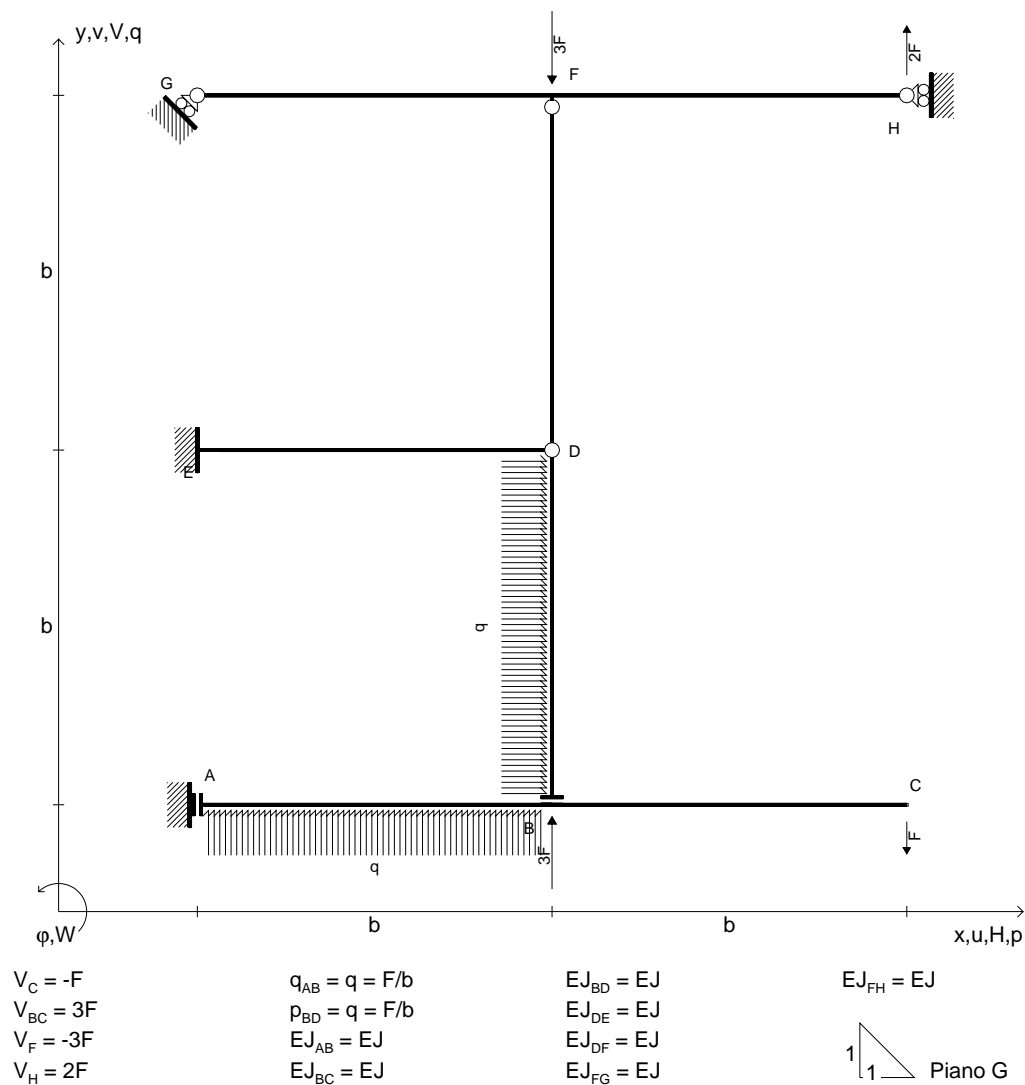
Calcolare reazioni vincolari della struttura e delle aste.

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Carichi e deformazioni date hanno verso efficace in disegno.

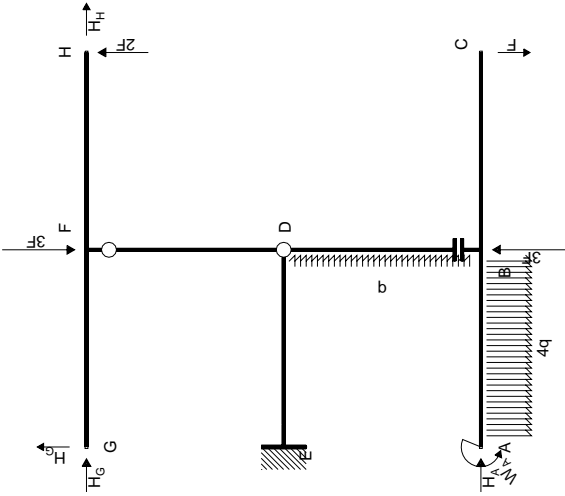
Calcolare reazioni vincolari della struttura e delle aste.

Tracciare i diagrammi quotati delle azioni interne nelle aste.

J_{YZ} - x_{YZ} - θ_{YZ} riferimento locale asta YZ con origine in Y .

Piano di scorrimento del vincolo con inclinazione assegnata.

@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.07.09.10



EQUAZIONI DI EQUILIBRIO

Traslazione orizzontale: aste BA BC

$H_A = 0$

Rotazione intorno a D: aste DB BA BC

$H_A b + W_A = Fb - 5/2qb^2$

Rotazione intorno a D: aste DF FG FH

$-2H_G b - H_H b = -2Fb$

Rotazione intorno a F: aste FG FH

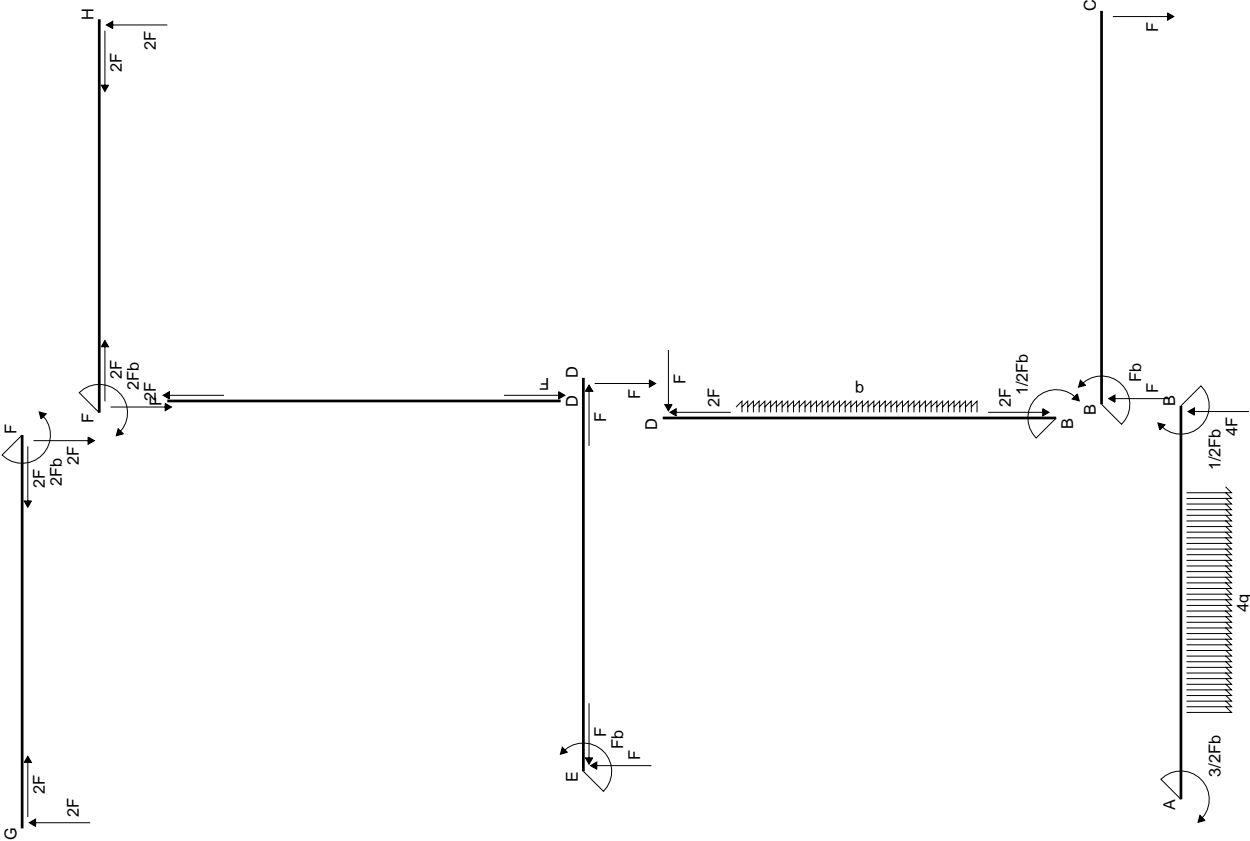
$-H_G b = -2Fb$

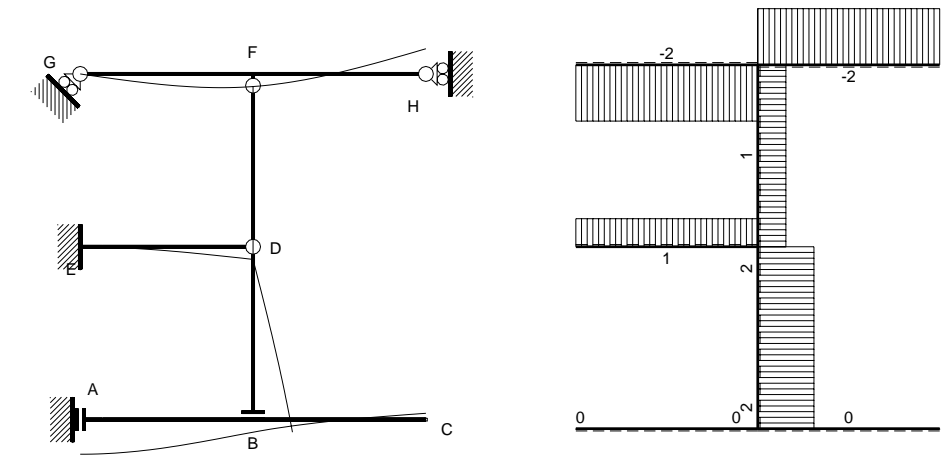
Matrice di equilibrio

$$\begin{bmatrix} H_A b & W_A & H_G b & H_H b \end{bmatrix} \begin{bmatrix} Fb & qb^2 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 0 & 0 & -2 & -1 \\ 0 & 0 & -1 & 0 \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 1 & -5/2 \\ -2 & 0 \\ -2 & 0 \end{bmatrix}$$

Soluzione del sistema

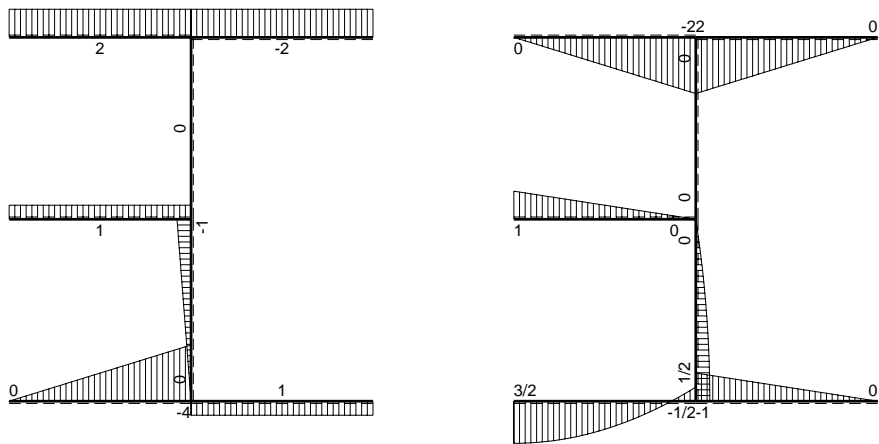
$$\begin{bmatrix} H_A b \\ W_A \\ H_G b \\ H_H b \end{bmatrix} \begin{bmatrix} Fb & qb^2 \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 1 & -5/2 \\ 2 & 0 \\ -2 & 0 \end{bmatrix}$$





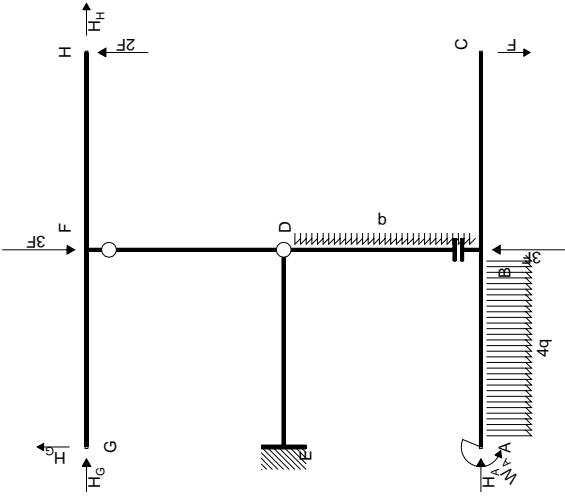
$\frac{1}{2} F b^3 / EJ$

$\leftarrow \boxed{+} \rightarrow F$



$\uparrow \boxed{+} \downarrow F$

$\curvearrowright \boxed{+} \curvearrowleft Fb$



EQUAZIONI DI EQUILIBRIO

Traslazione orizzontale: aste BA BC

$H_A = 0$

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$H_A b + W_A = Fb - 3/2 q b^2$

Rotazione intorno a D: aste DF FG FH

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Rotazione intorno a F: aste FG FH

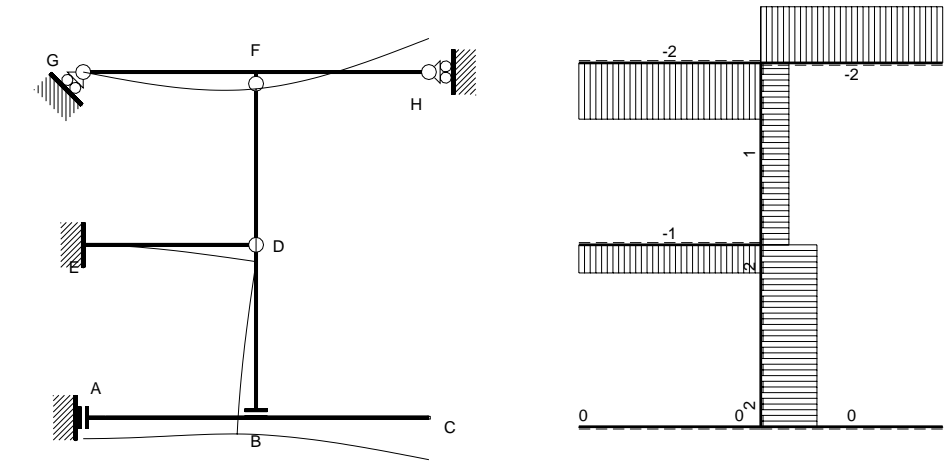
$-H_G b = -2Fb$

Matrice di equilibrio

$$\begin{bmatrix} H_A b & W_A & H_G b & H_H b \end{bmatrix} \begin{bmatrix} Fb & qb^2 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 0 & 0 & -2 & -1 \\ 0 & 0 & -1 & 0 \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 1 & -3/2 \\ -2 & 0 \\ -2 & 0 \end{bmatrix}$$

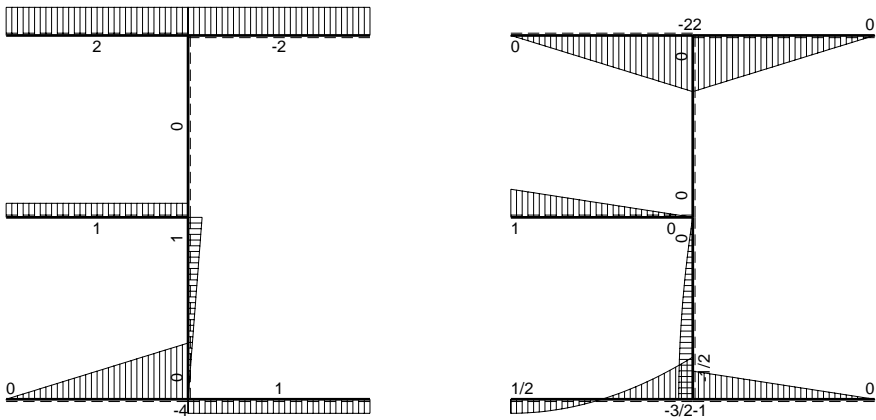
Soluzione del sistema

$$\begin{bmatrix} H_A b \\ W_A \\ H_G b \\ H_H b \end{bmatrix} \begin{bmatrix} Fb & qb^2 \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 1 & -3/2 \\ 2 & 0 \\ -2 & 0 \end{bmatrix}$$



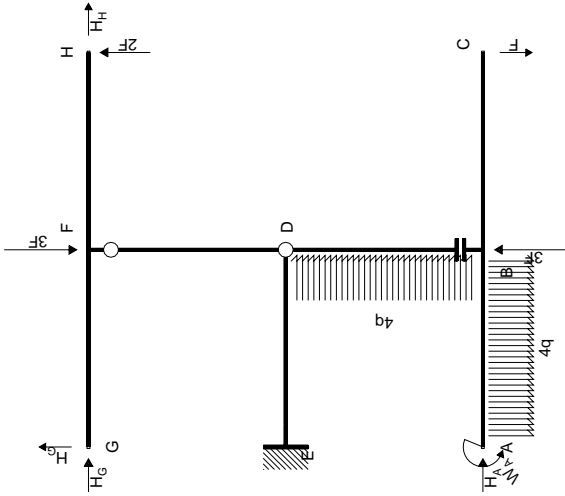
$\lvert \text{---} \rvert 1.5 Fb^3/EJ$

$\leftarrow \boxed{+} \rightarrow F$



$\uparrow \boxed{+} \downarrow F$

$\curvearrowright \boxed{+} \curvearrowleft Fb$



EQUAZIONI DI EQUILIBRIO

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$H_A = 0$

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$H_A b + W_A = Fb - 4qb^2$

Rotazione intorno a D: aste DF FG FH

$-2H_G b - H_H b = -2Fb$

Rotazione intorno a F: aste FG FH

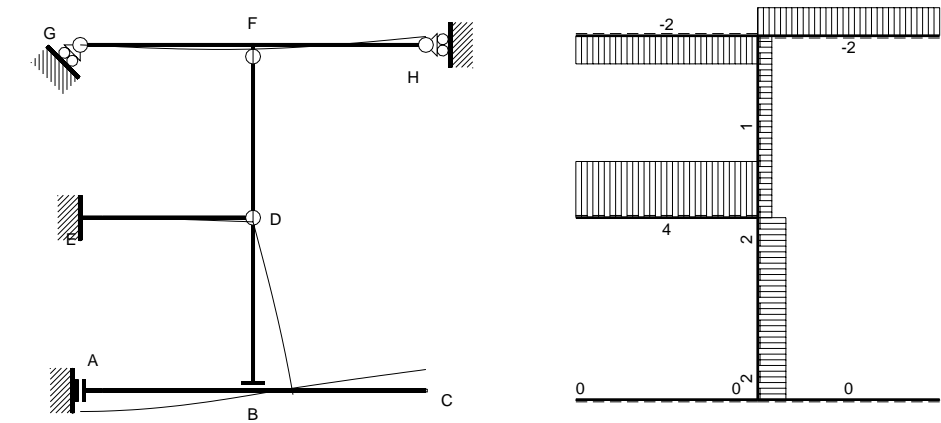
$-H_G b = -2Fb$

Matrice di equilibrio

$$\begin{bmatrix} H_A b & W_A & H_G b & H_H b \end{bmatrix} \begin{bmatrix} Fb & qb^2 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 0 & 0 & -2 & -1 \\ 0 & 0 & -1 & 0 \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 1 & -4 \\ -2 & 0 \\ -2 & 0 \end{bmatrix}$$

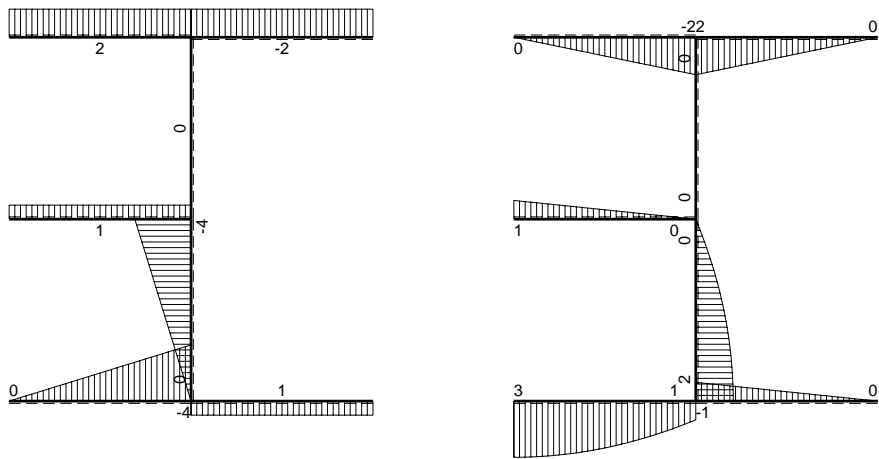
Soluzione del sistema

$$\begin{bmatrix} H_A b \\ W_A \\ H_G b \\ H_H b \end{bmatrix} \begin{bmatrix} Fb & qb^2 \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 1 & -4 \\ 2 & 0 \\ -2 & 0 \end{bmatrix}$$



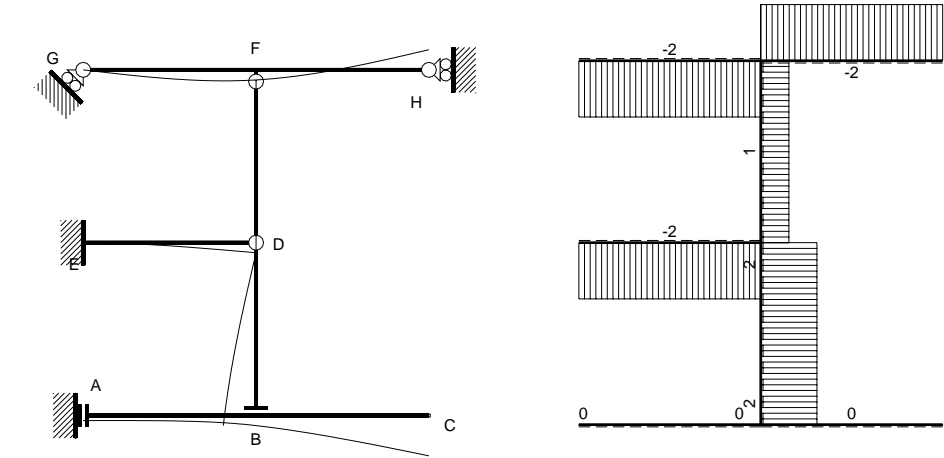
$\frac{1}{6} F b^3 / EJ$

$\leftarrow \boxed{+} \rightarrow F$



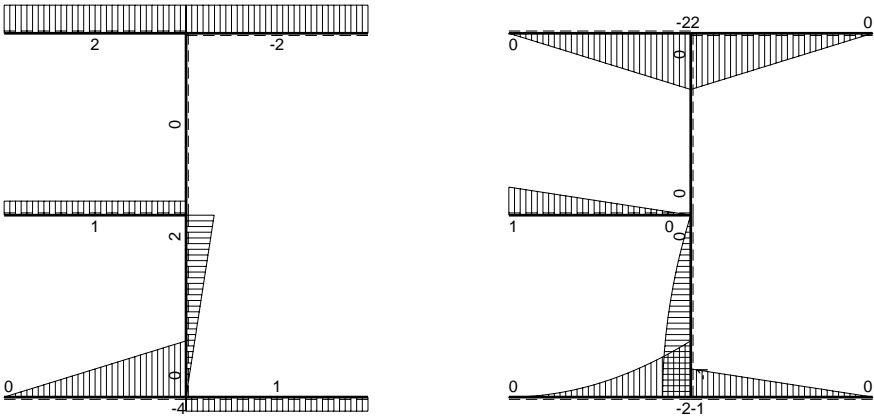
$\uparrow \boxed{+} \downarrow F$

$\curvearrowright \boxed{+} \curvearrowleft F_b$



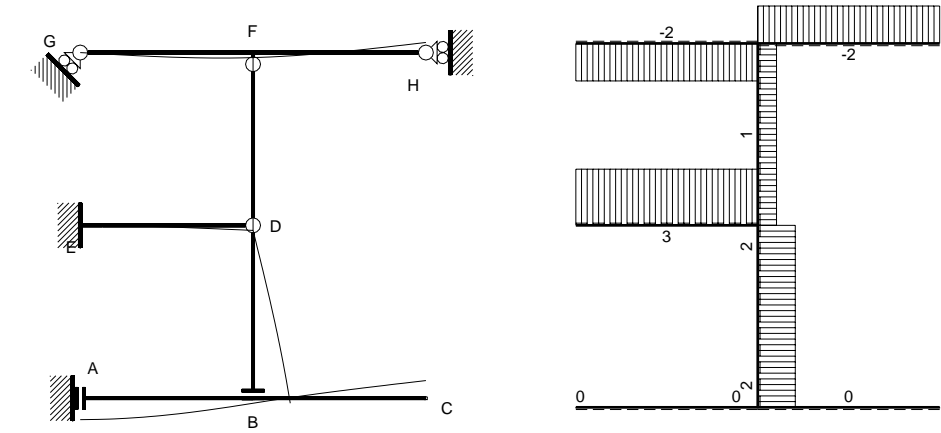
$1 \text{ m} = 2.5 Fb^3/EJ$

$\leftarrow \boxed{+} \rightarrow F$



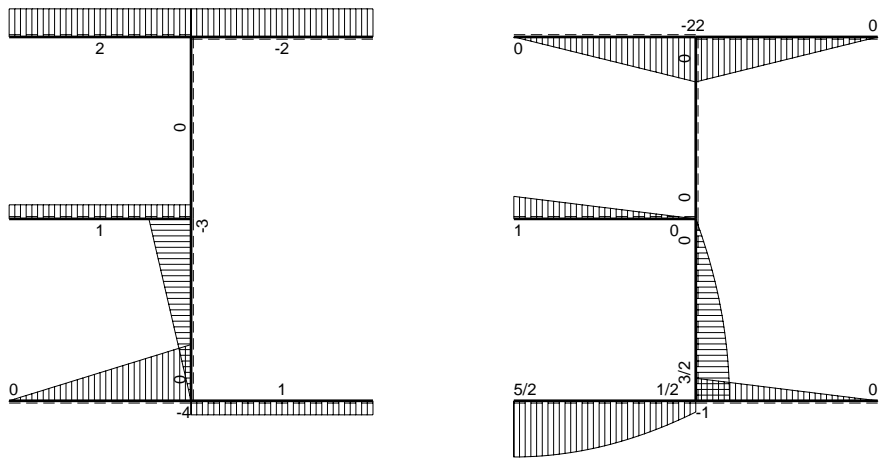
$\uparrow \boxed{+} \downarrow F$

$\leftarrow \boxed{+} \rightarrow Fb$



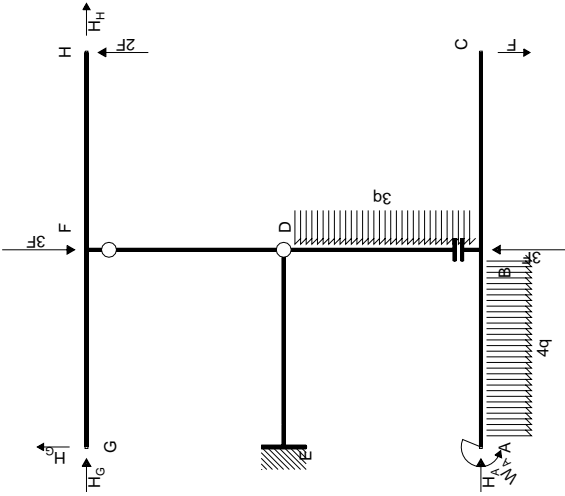
$\frac{1}{EI} \rightarrow 5 F b^3 / EJ$

$\leftarrow \boxed{+} \rightarrow F$



$\uparrow \boxed{+} \downarrow F$

$\curvearrowright \boxed{+} \curvearrowleft Fb$



EQUAZIONI DI EQUILIBRIO

Traslazione orizzontale: aste BA BC

$H_A = 0$

Rotazione intorno a D: aste DB BA BC

$H_A b + W_A = Fb - 1/2 qb^2$

Rotazione intorno a D: aste DF FG FH

$-2H_G b - H_H b = -2Fb$

Rotazione intorno a F: aste FG FH

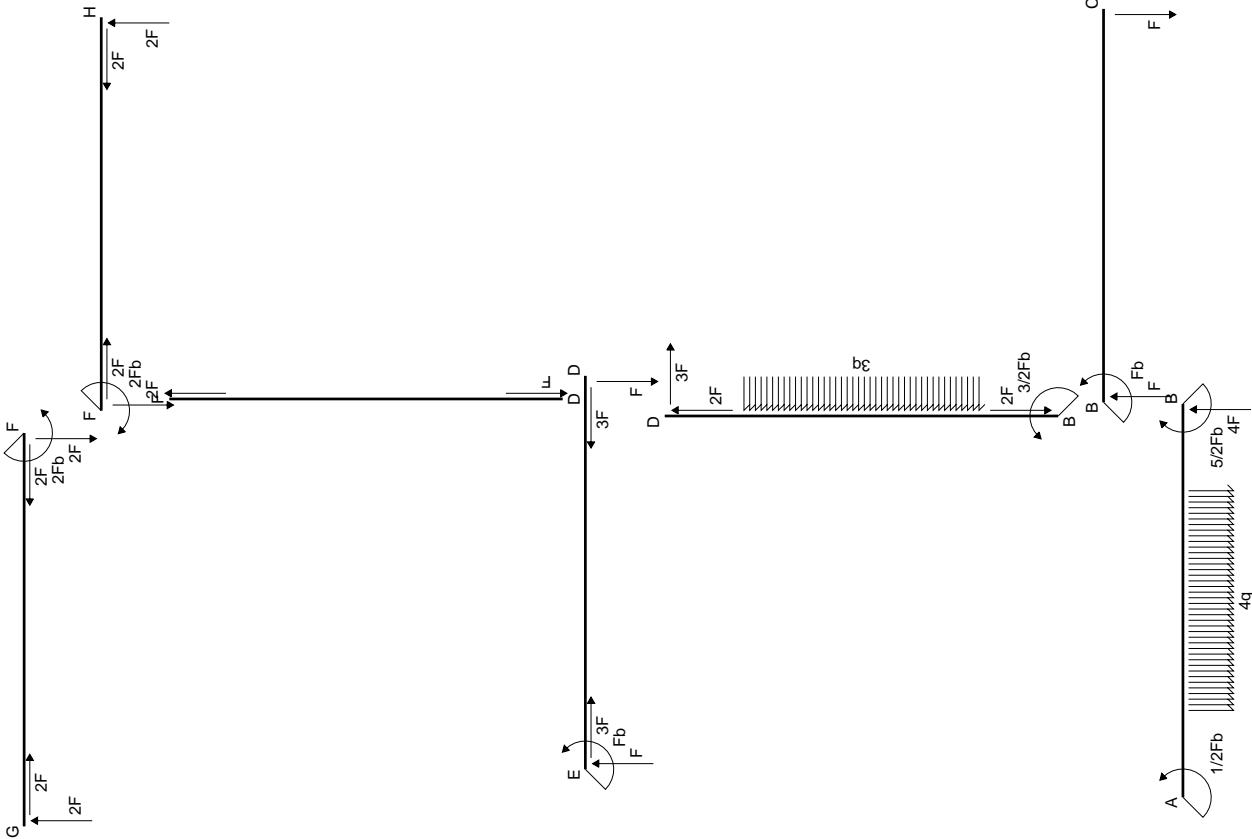
$-H_G b = -2Fb$

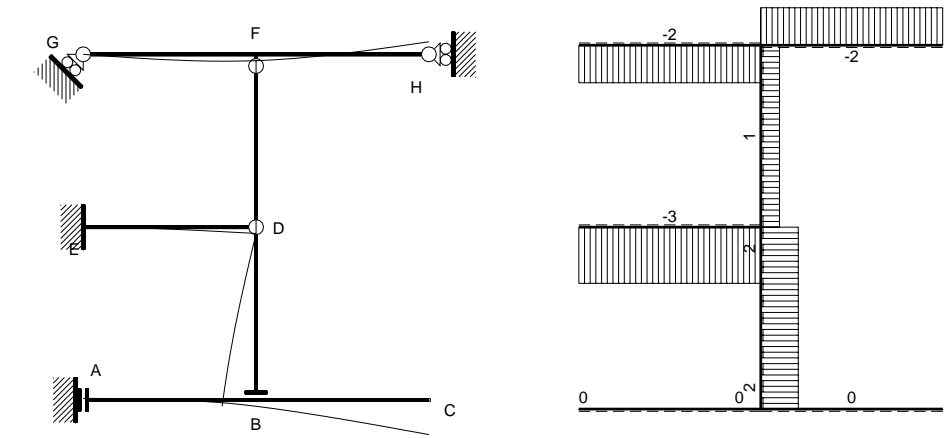
Matrice di equilibrio

$$\begin{bmatrix} H_A b & W_A & H_G b & H_H b \end{bmatrix} \begin{bmatrix} Fb & qb^2 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 0 & 0 & -2 & -1 \\ 0 & 0 & -1 & 0 \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 1 & -1/2 \\ -2 & 0 \\ -2 & 0 \end{bmatrix}$$

Soluzione del sistema

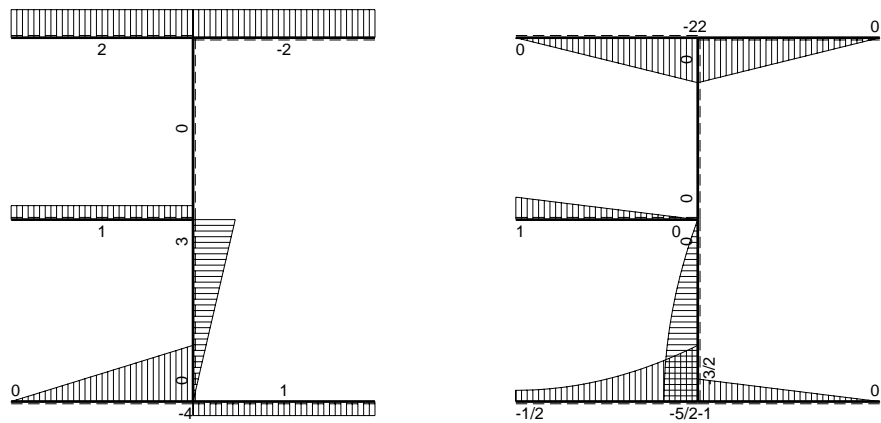
$$\begin{bmatrix} H_A b \\ W_A \\ H_G b \\ H_H b \end{bmatrix} \begin{bmatrix} Fb & qb^2 \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 1 & -1/2 \\ 2 & 0 \\ -2 & 0 \end{bmatrix}$$





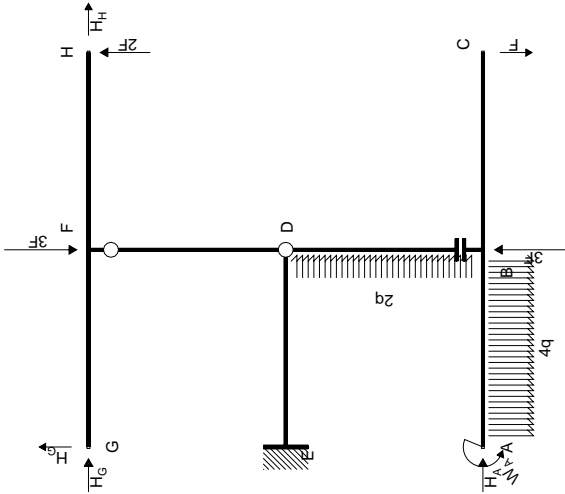
$\frac{1}{4} F b^3 / EJ$

$\leftarrow \boxed{+} \rightarrow F$



$\uparrow \boxed{+} \downarrow F$

$\leftarrow \boxed{+} \rightarrow F_b$



EQUAZIONI DI EQUILIBRIO

Traslazione orizzontale: aste BA BC

$H_A = 0$

Rotazione intorno a D: aste DB BA BC

$H_A b + W_A = Fb - 3qb^2$

Rotazione intorno a D: aste DF FG FH

$-2H_D b - H_D b = -2Fb$

Rotazione intorno a F: aste FG FH

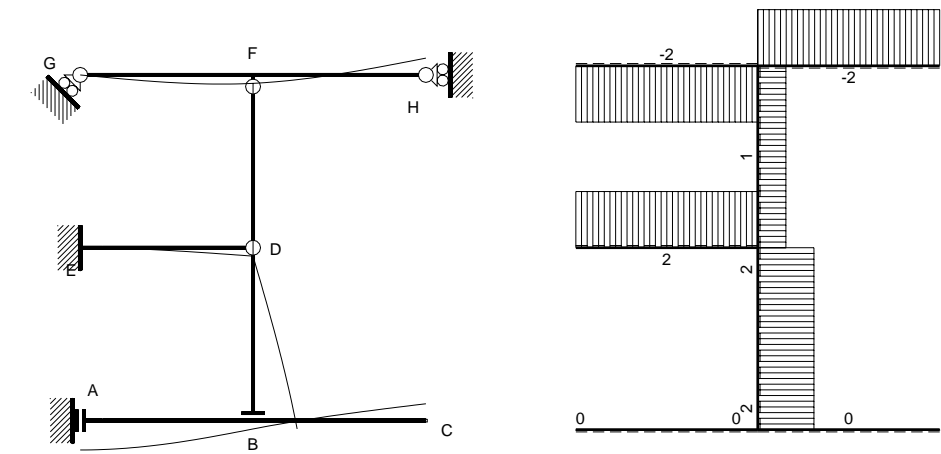
$-H_G b = -2Fb$

Matrice di equilibrio

$$\begin{bmatrix} H_A b & W_A & H_D b & H_D b \end{bmatrix} \begin{bmatrix} Fb & qb^2 \end{bmatrix}$$
$$u_{BD} \begin{bmatrix} 1 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} 0 & 0 \end{bmatrix}$$
$$\varphi_{DB} \begin{bmatrix} 1 & 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} 1 & -3 \end{bmatrix}$$
$$\varphi_{DF} \begin{bmatrix} 0 & 0 & -2 & -1 \end{bmatrix} \begin{bmatrix} -2 & 0 \end{bmatrix}$$
$$\varphi_{FD} \begin{bmatrix} 0 & 0 & -1 & 0 \end{bmatrix} \begin{bmatrix} -2 & 0 \end{bmatrix}$$

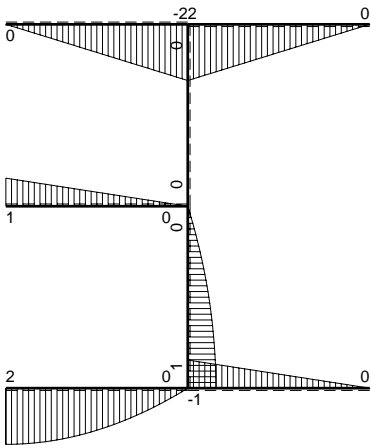
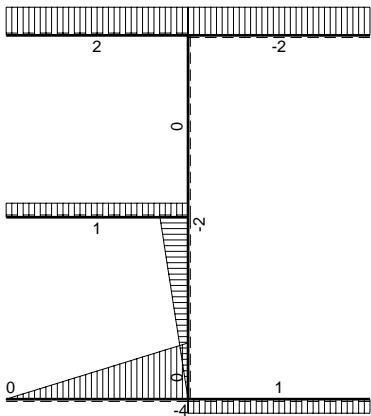
Soluzione del sistema

$$\begin{bmatrix} H_A b \\ W_A \\ H_D b \\ H_D b \end{bmatrix} \begin{bmatrix} Fb & qb^2 \end{bmatrix}$$
$$\begin{bmatrix} 0 & 0 \\ 1 & -3 \\ 2 & 0 \\ -2 & 0 \end{bmatrix}$$



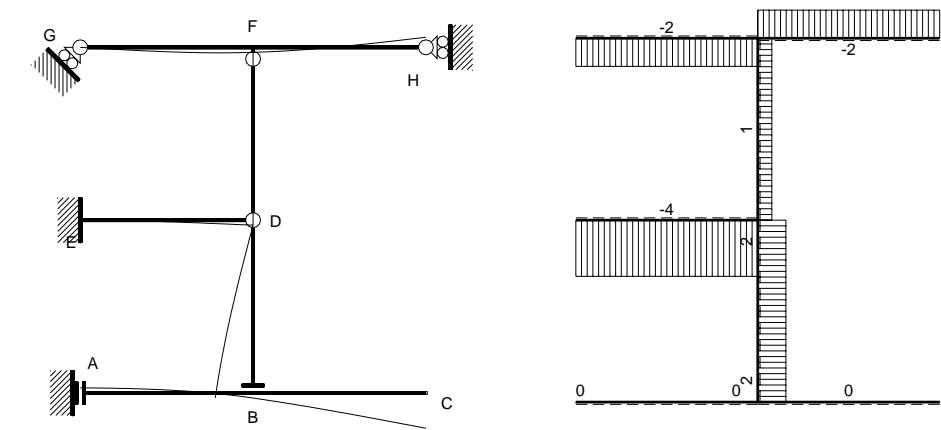
$\frac{1}{3} F b^3 / EJ$

$\leftarrow \boxed{+} \rightarrow F$



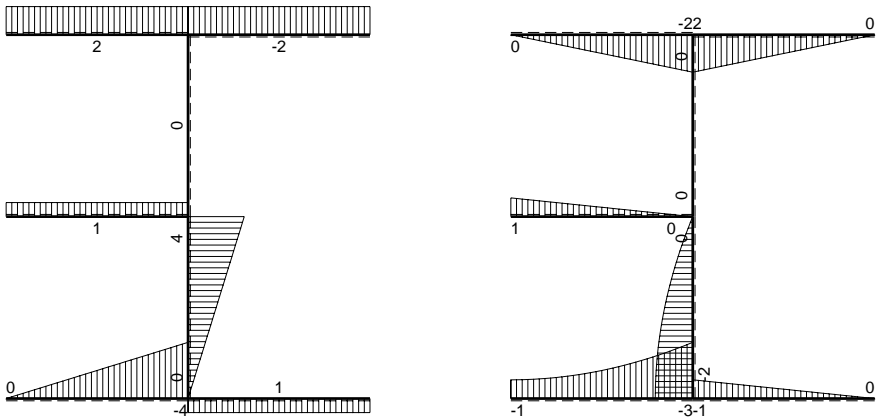
$\uparrow \boxed{+} \downarrow F$

$\leftarrow \boxed{+} \rightarrow F_b$



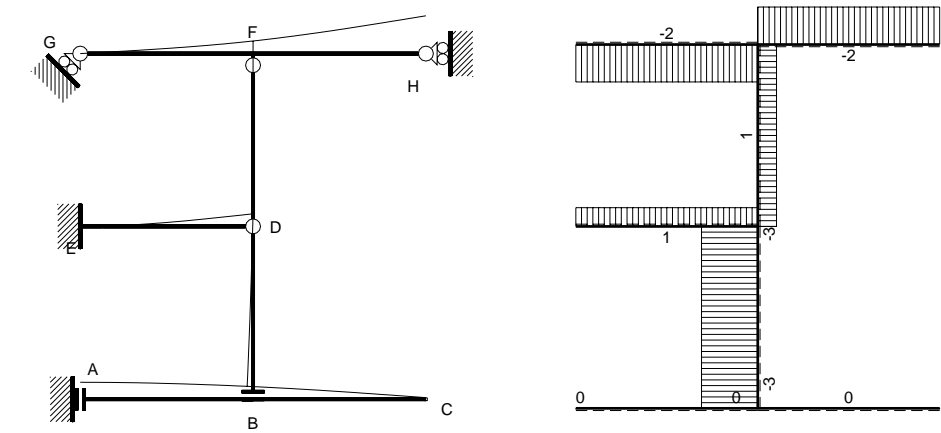
$\frac{1}{5} F b^3 / E J$

$\leftarrow \boxed{+} \rightarrow F$



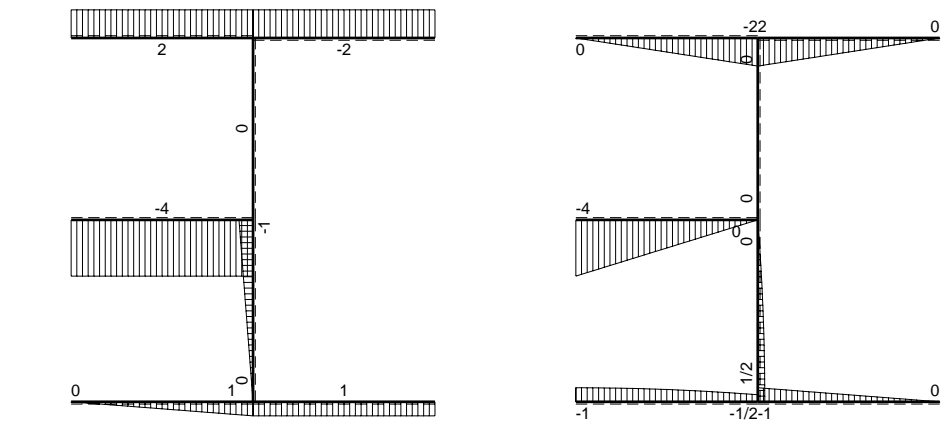
$\uparrow \boxed{+} \downarrow F$

$\curvearrowright \boxed{+} \curvearrowleft F_b$



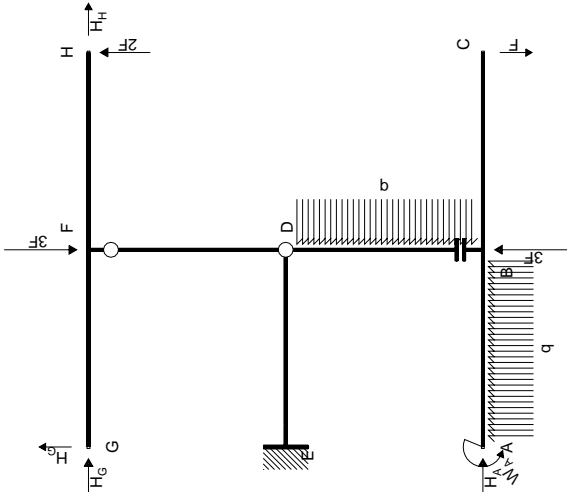
$\delta Fb^3/EJ$

$\leftarrow \boxed{+} \rightarrow F$



$\uparrow \boxed{+} \downarrow F$

$\curvearrowright \boxed{+} \curvearrowleft Fb$



EQUAZIONI DI EQUILIBRIO

Traslazione orizzontale: aste BA BC

$H_A = 0$

Rotazione intorno a D: aste DB BA BC

$H_A b + W_A = Fb + qb^2$

Rotazione intorno a D: aste DF FG FH

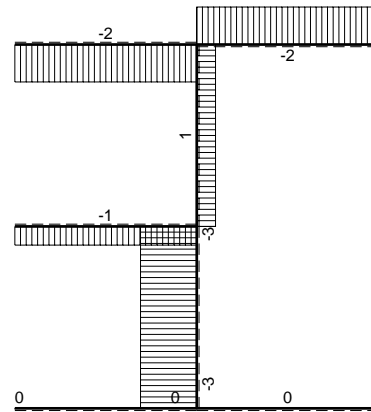
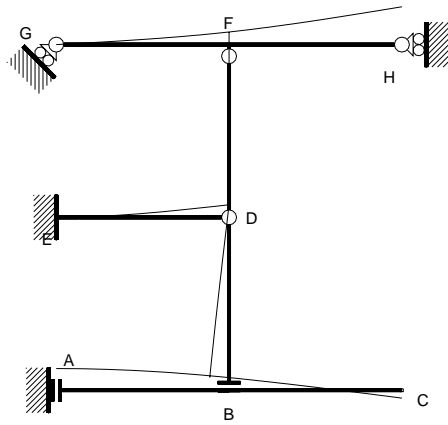
$-2H_G b - H_H b = -2Fb$

Rotazione intorno a F: aste FG FH

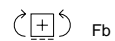
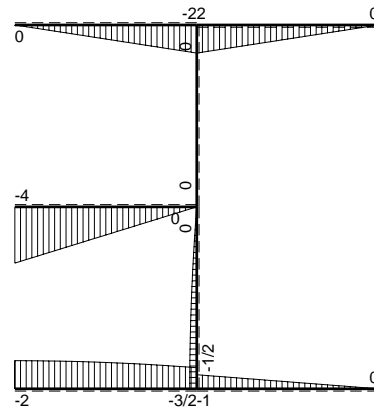
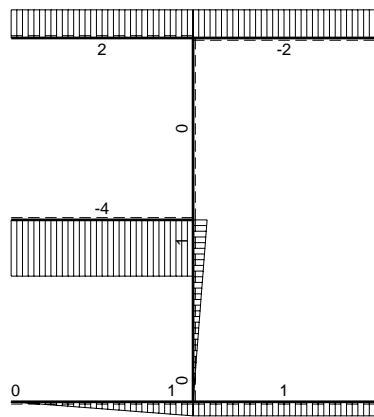
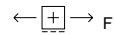
$-H_G b = -2Fb$

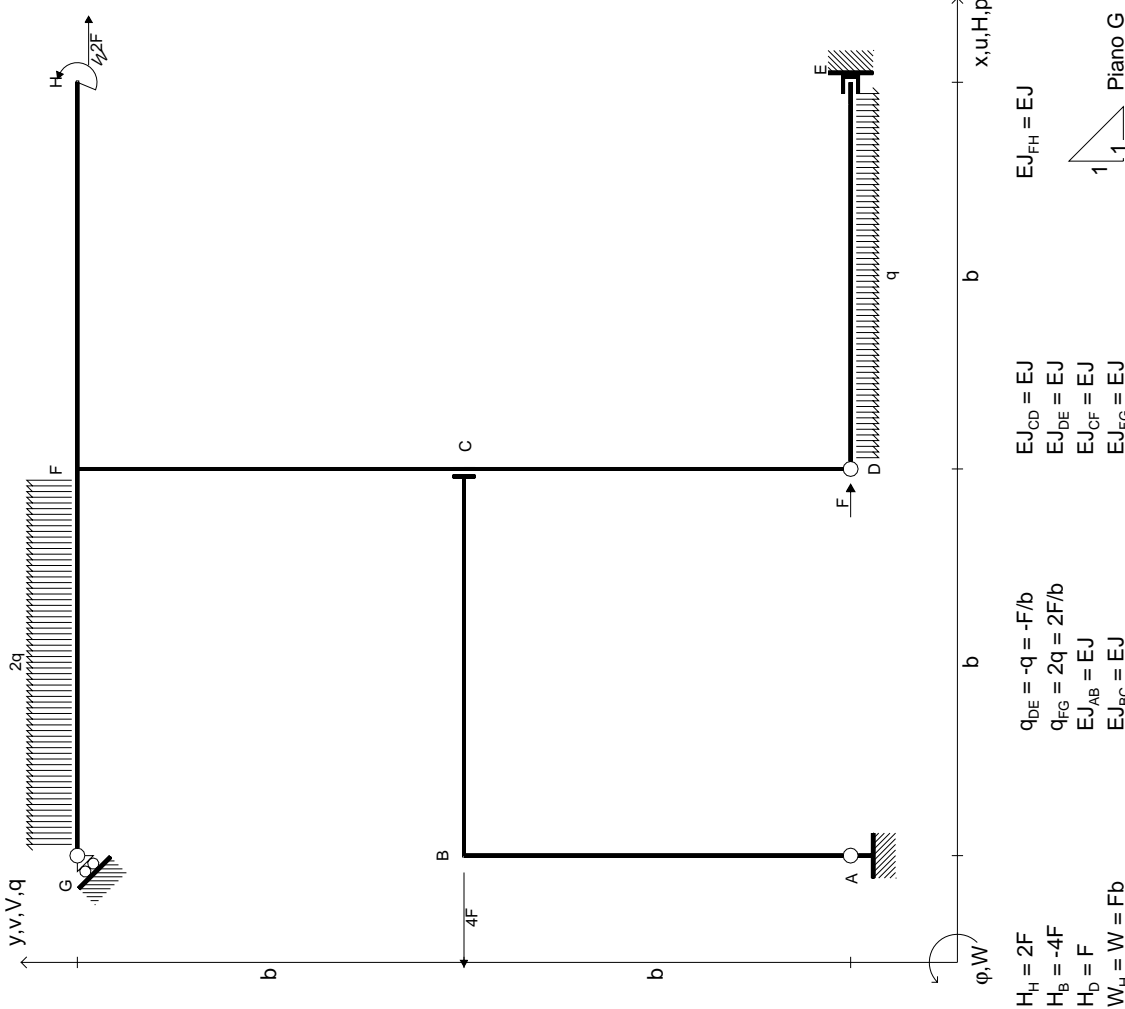
Matrice di equilibrio

$$\begin{bmatrix} H_A b & W_A & H_G b & H_H b \end{bmatrix} \begin{bmatrix} Fb & qb^2 \end{bmatrix}$$
$$u_{BD} \begin{bmatrix} 1 & 0 & 0 & 0 \end{bmatrix} = \begin{bmatrix} 0 & 0 \end{bmatrix}$$
$$\varphi_{DB} \begin{bmatrix} 1 & 1 & 0 & 0 \end{bmatrix} = \begin{bmatrix} 1 & 1 \end{bmatrix}$$
$$\varphi_{DF} \begin{bmatrix} 0 & 0 & -2 & -1 \end{bmatrix} = \begin{bmatrix} -2 & 0 \end{bmatrix}$$
$$\varphi_{FD} \begin{bmatrix} 0 & 0 & -1 & 0 \end{bmatrix} = \begin{bmatrix} -2 & 0 \end{bmatrix}$$

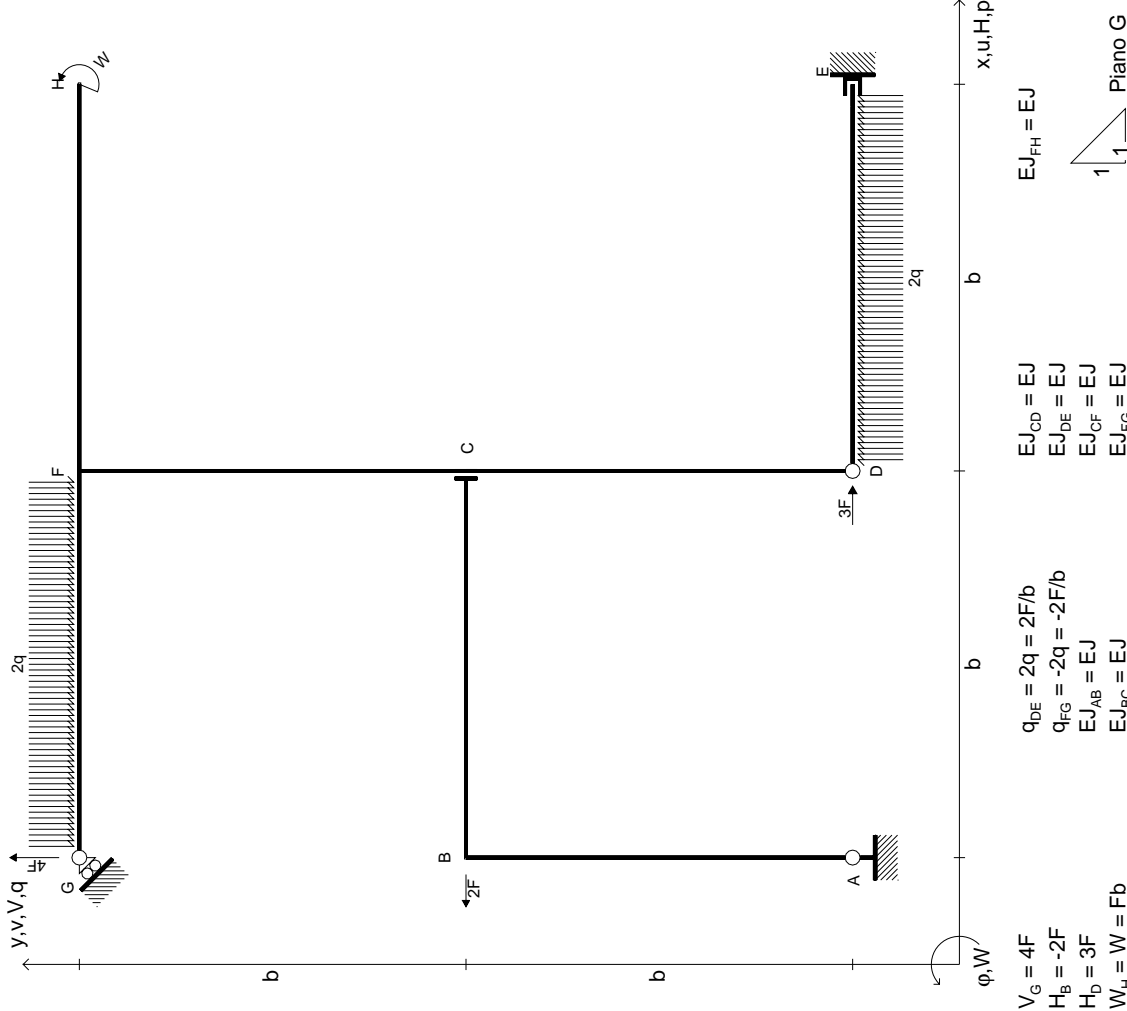


8 Fb³/EJ

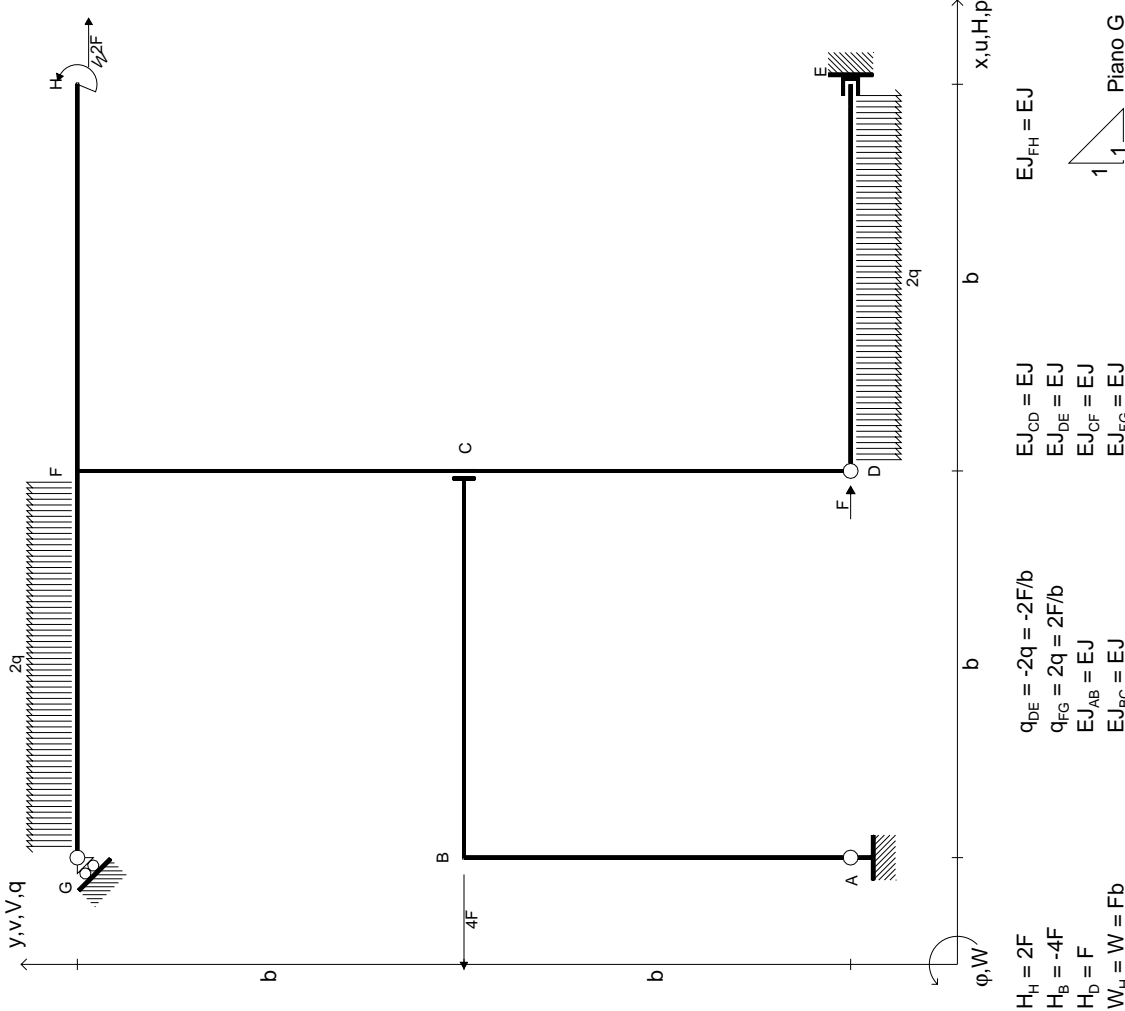




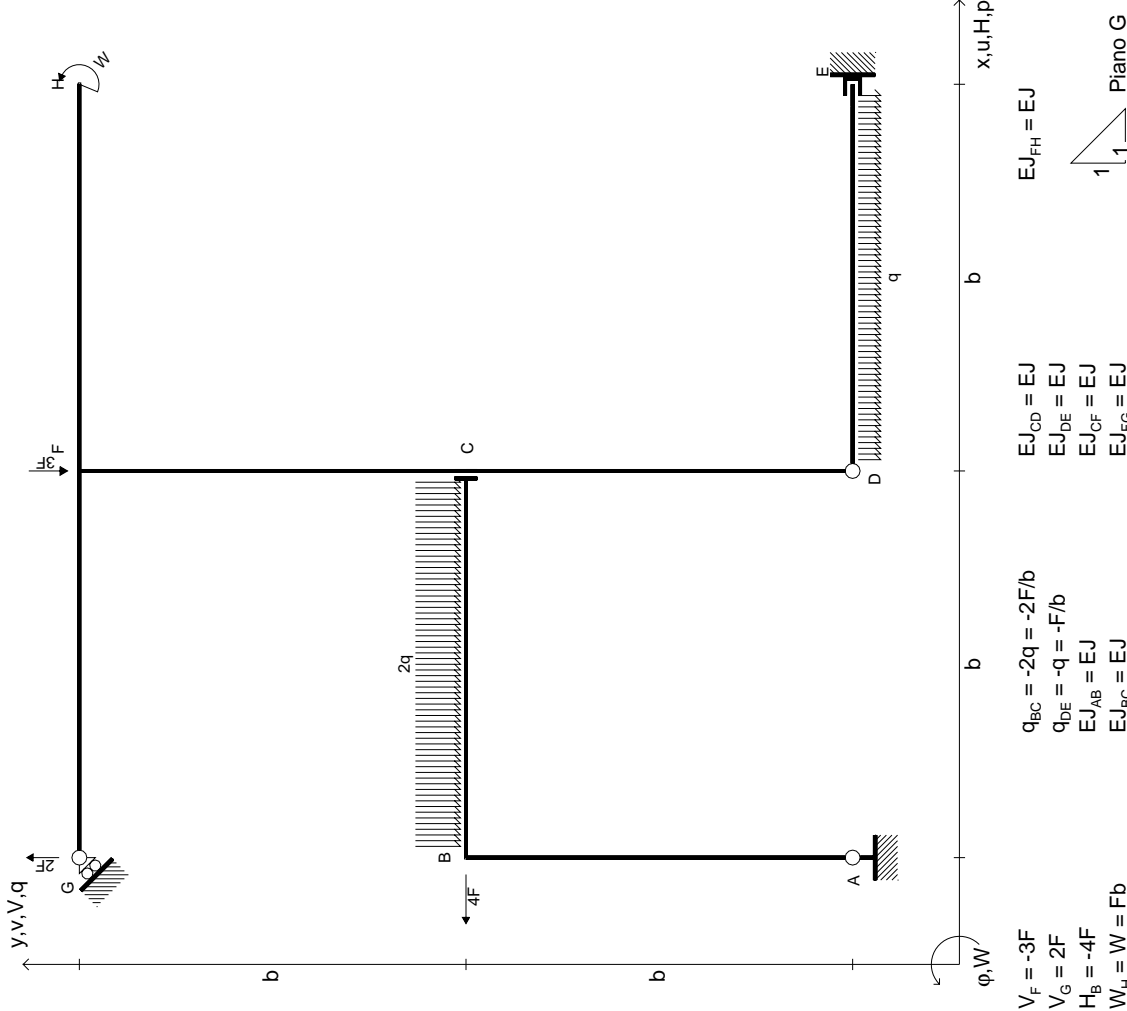
Carichi e deformazioni date hanno verso efficace in disegno.
Calcolare reazioni vincolari della struttura e delle aste.
Tracciare i diagrammi quotati delle azioni interne nelle aste.
 $J_{YZ} - X_{YZ} - \theta_{YZ}$ riferimento locale asta YZ con origine in Y.
Piano di scorrimento del vincolo con inclinazione assegnata.
@ Adolfo Zavelani Rossi, Politecnico di Milano, vers.07.07.10



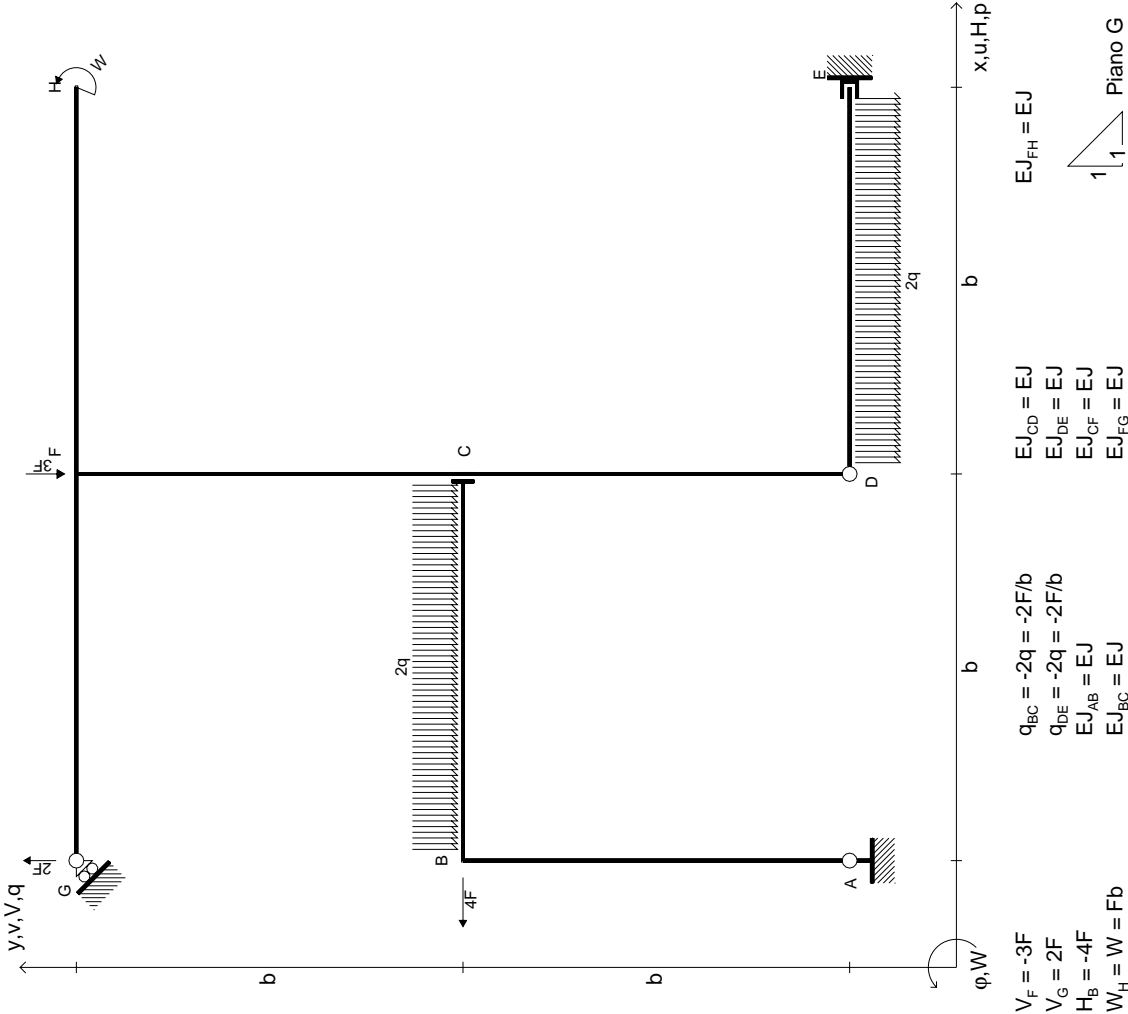
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Calcolare reazioni vincolari della struttura e delle aste.
Tracciare i diagrammi quotati delle azioni interne nelle aste.
 $J_{YZ} - x_{YZ} - \theta_{YZ}$ riferimento locale asta YZ con origine in Y .
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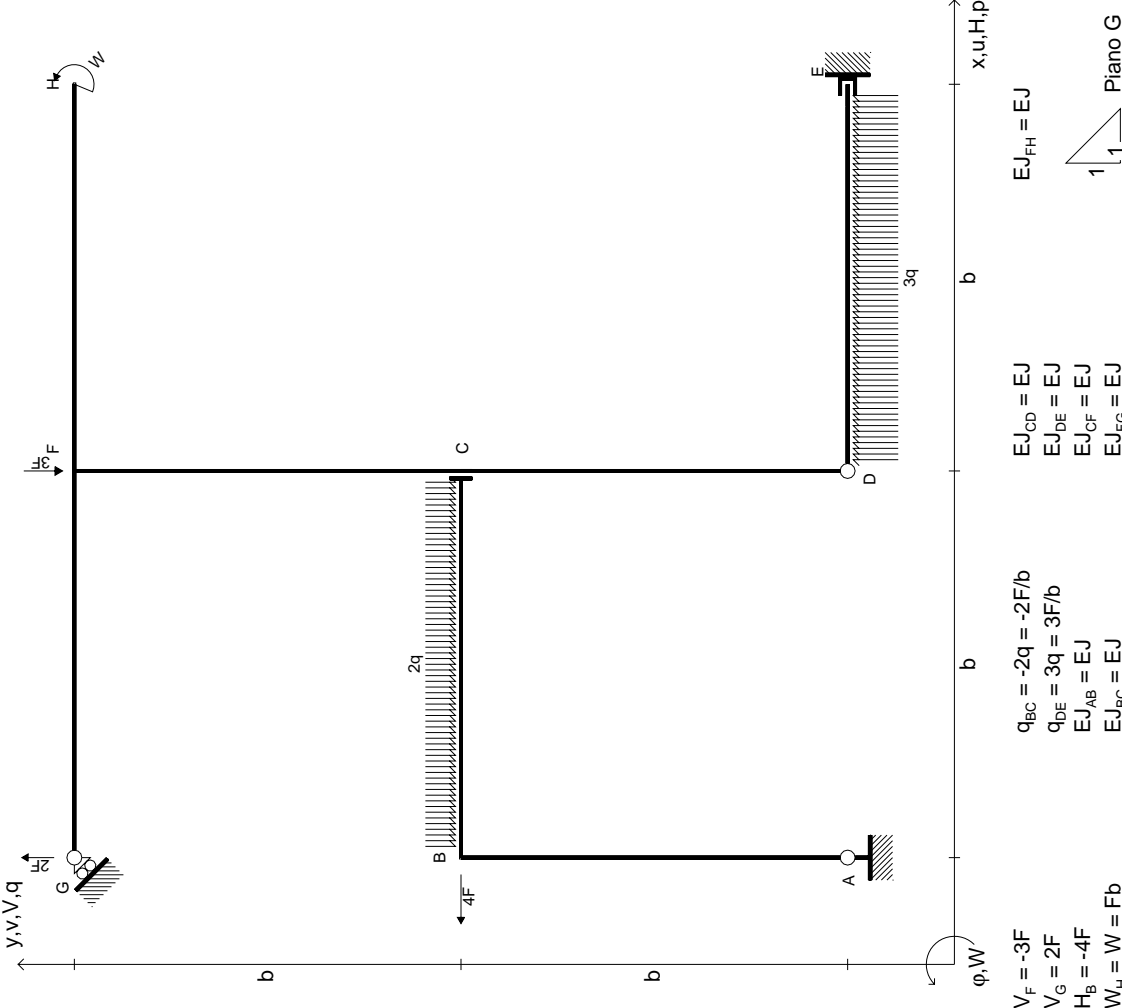
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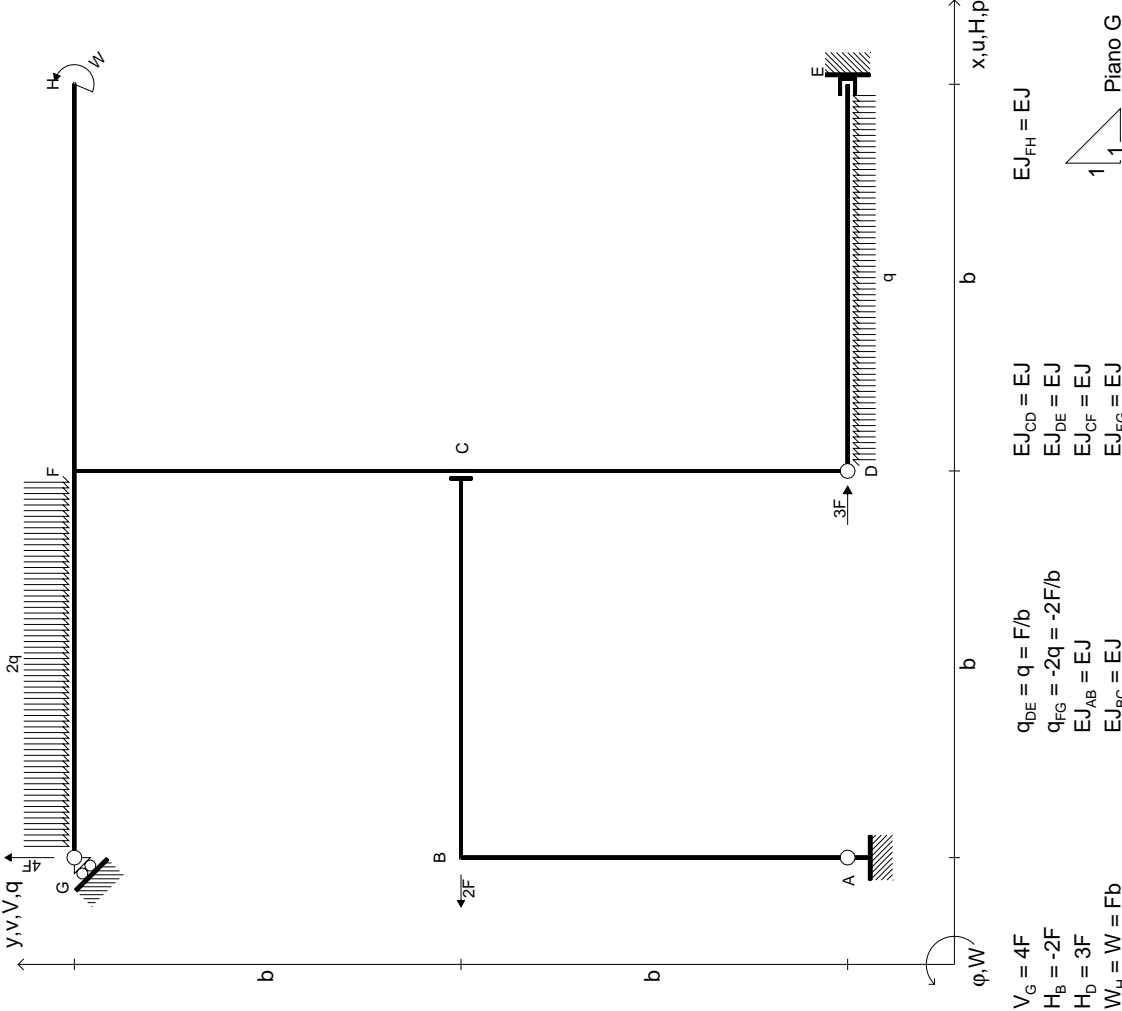
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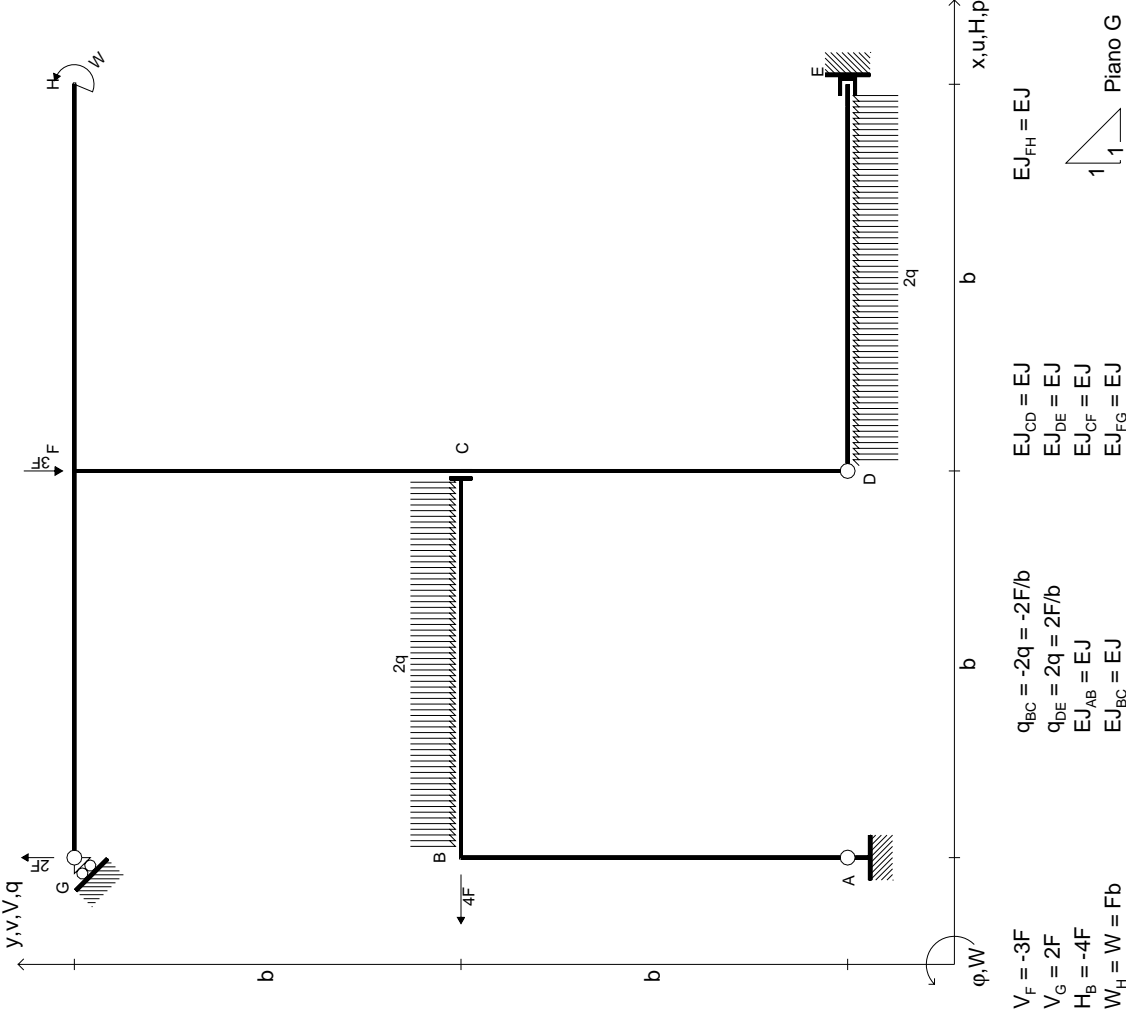
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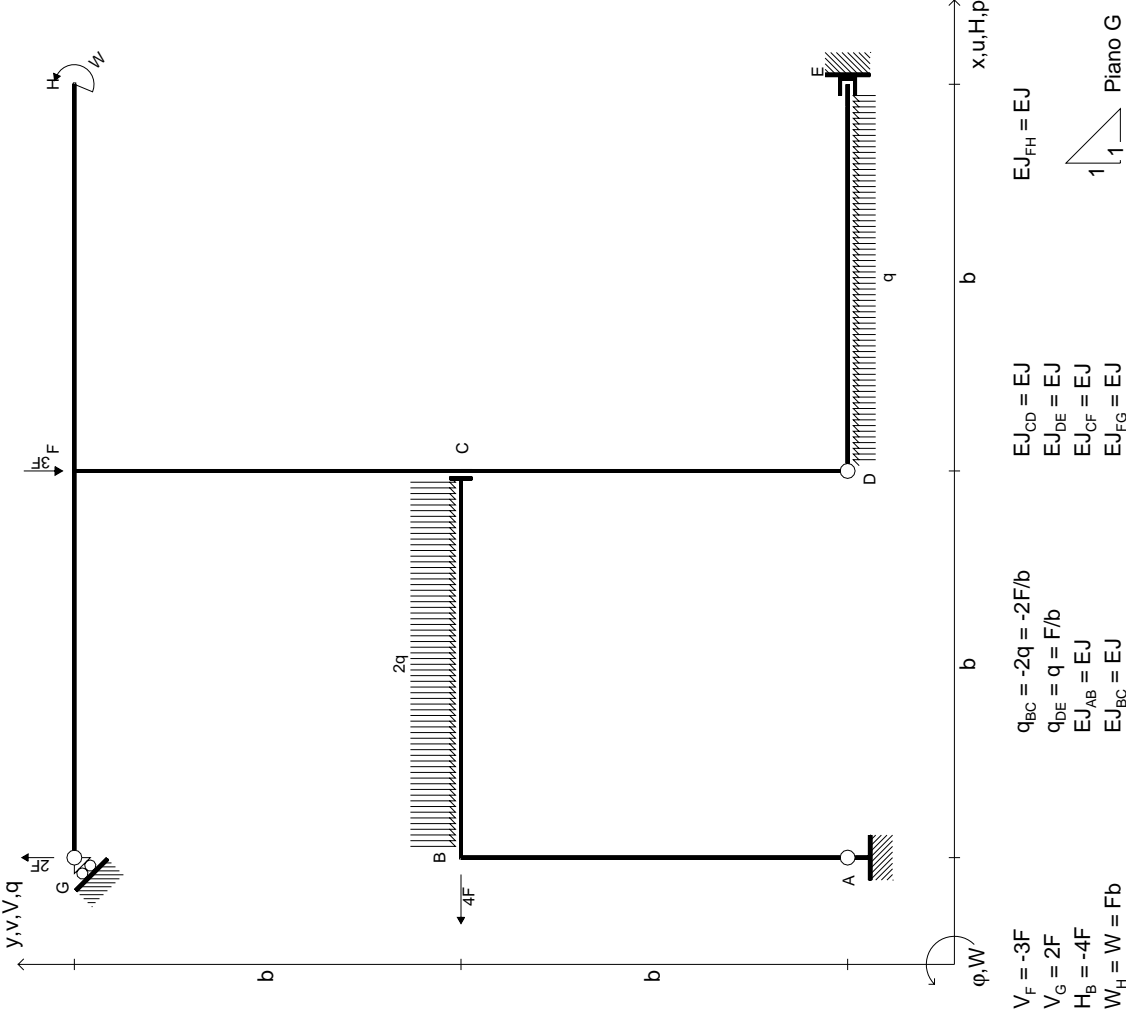
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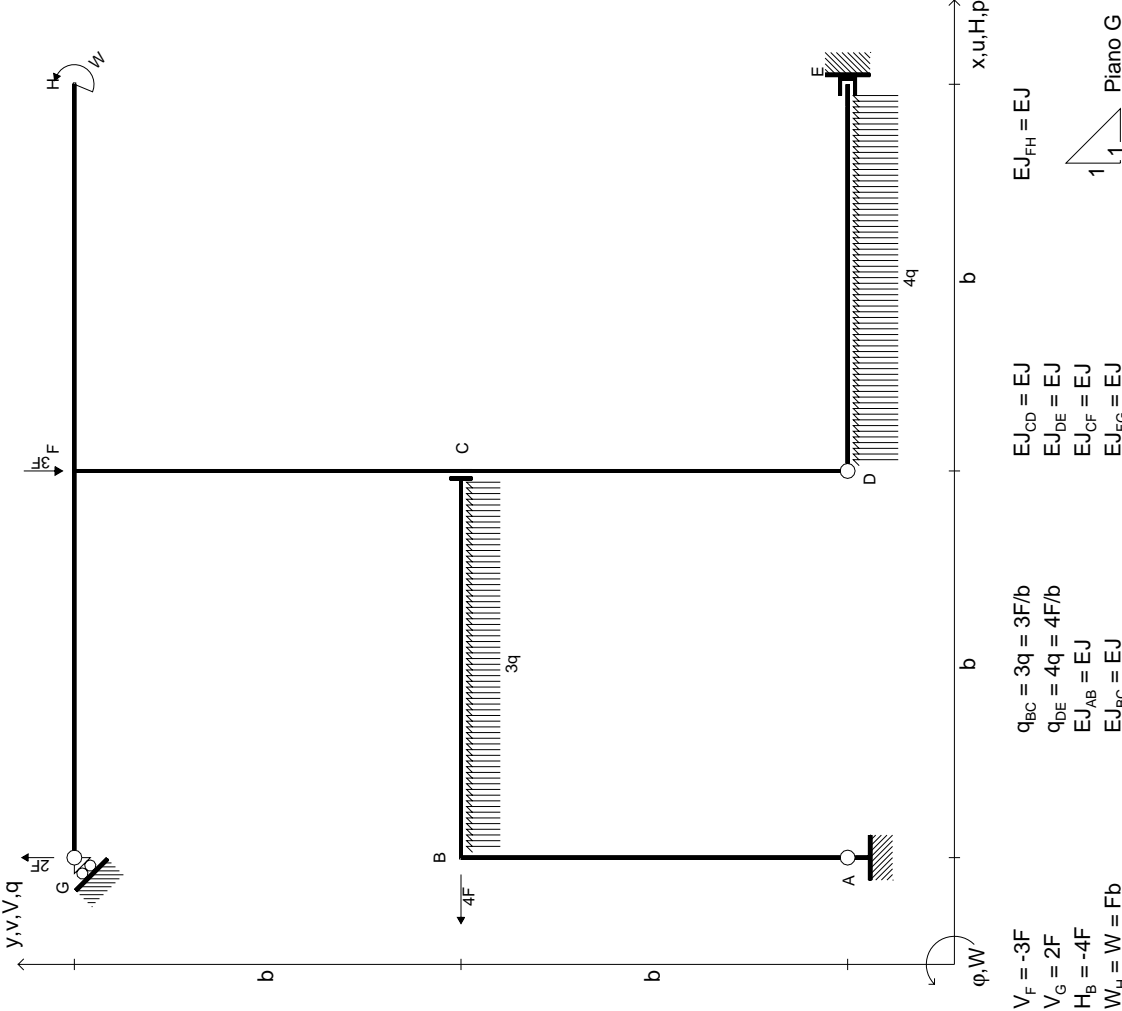
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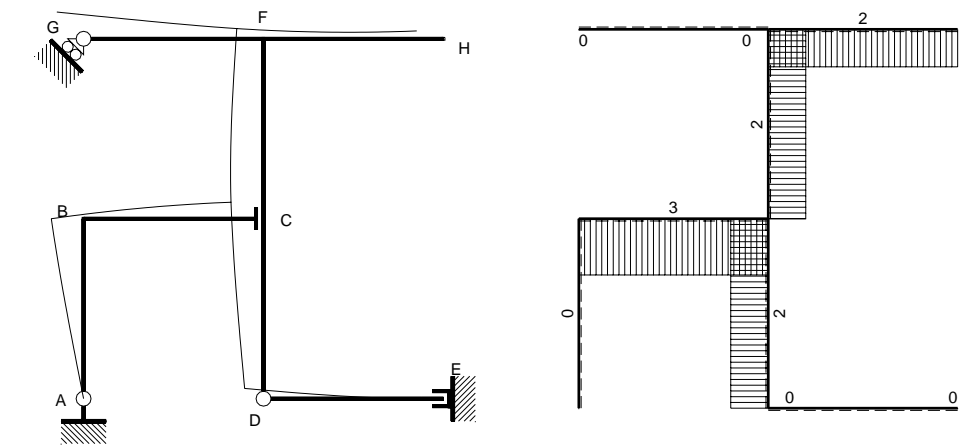
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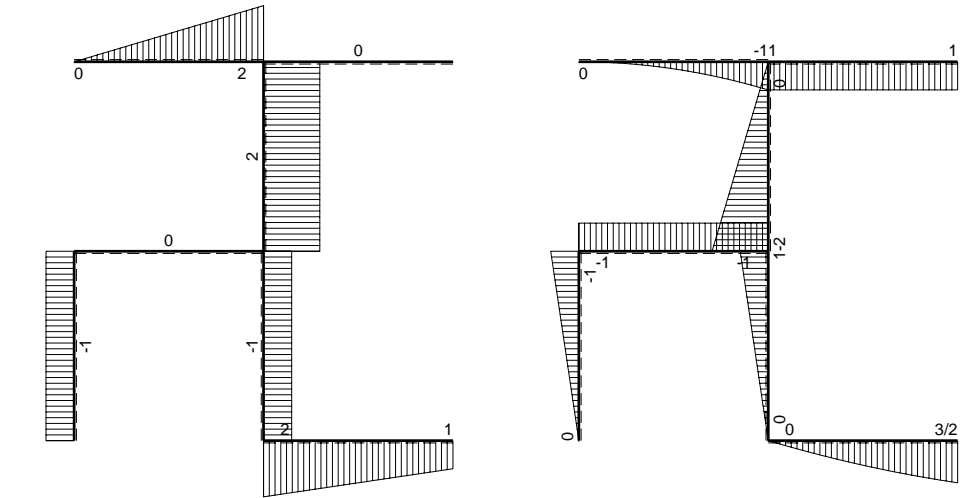


Carichi e deformazioni date hanno verso efficace in disegno.
Calcolare reazioni vincolari della struttura e delle aste.
Tracciare i diagrammi quotati delle azioni interne nelle aste.
 $J_{YZ} - X_{YZ} - \theta_{YZ}$ riferimento locale asta YZ con origine in Y .
Piano di scorrimento del vincolo con inclinazione assegnata.
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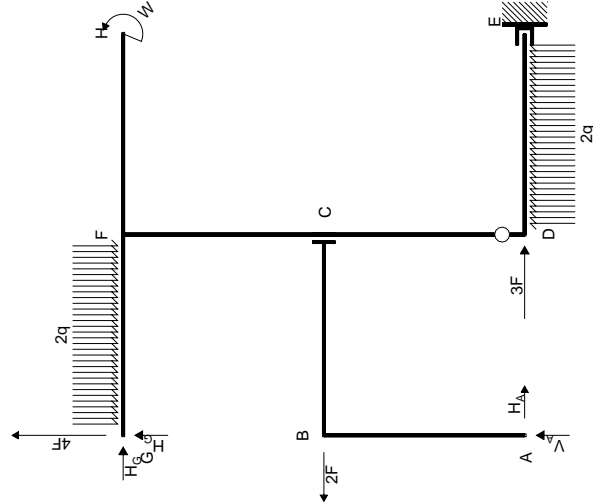
$\frac{1}{4} F b^3 / E J$

$\leftarrow \boxed{+} \rightarrow F$



$\uparrow \boxed{+} \downarrow F$

$\leftarrow \boxed{+} \rightarrow F_b$



EQUAZIONI DI EQUILIBRIO

Traslazione orizzontale globale

$H_A + H_G = -F$

Rotazione intorno a D: aste DC CB CF BA FG FH

$-V_A b - 3H_G b = 2Fb - W - qb^2$

Traslazione verticale: aste CB BA

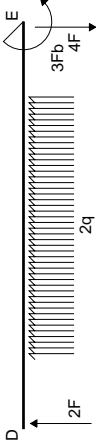
$V_A = 0$

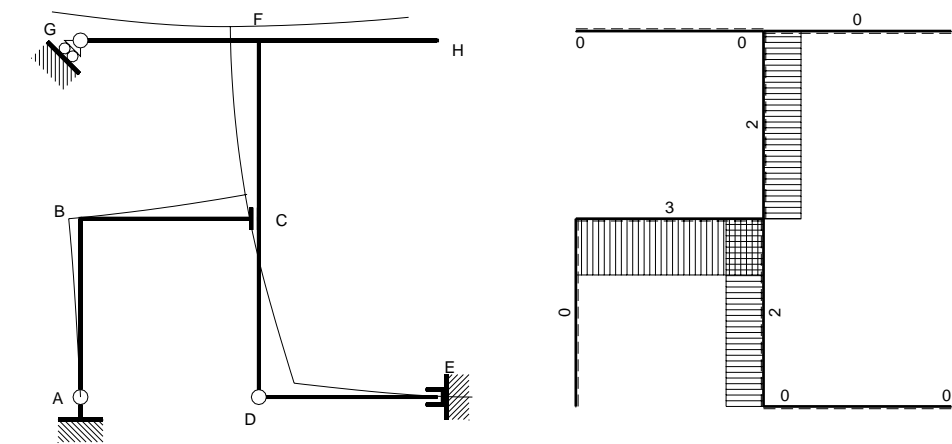
Matrice di equilibrio

$$\begin{bmatrix} H_A b & V_A b & H_G b \end{bmatrix} \begin{bmatrix} Fb & W & qb^2 \end{bmatrix}$$
$$u_E \begin{bmatrix} 1 & 0 & 1 \end{bmatrix} \begin{bmatrix} -1 & 0 & 0 \end{bmatrix}$$
$$\varphi_{DC} \begin{bmatrix} 0 & -1 & -3 \end{bmatrix} = \begin{bmatrix} 2 & -1 & -1 \end{bmatrix}$$
$$V_{CB} \begin{bmatrix} 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} 0 & 0 & 0 \end{bmatrix}$$

Soluzione del sistema

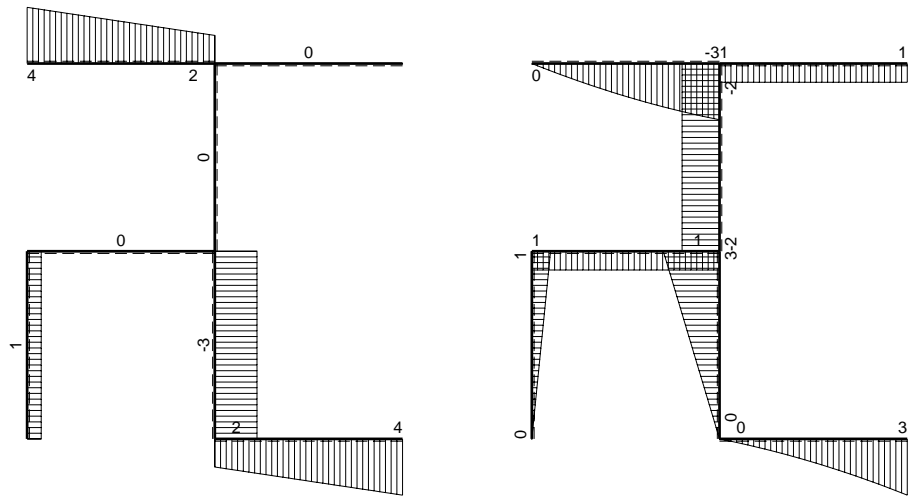
$$\begin{bmatrix} H_A b \\ V_A b \\ H_G b \end{bmatrix} = \begin{bmatrix} -1/3 & -1/3 & -1/3 \\ 0 & 0 & 0 \\ -2/3 & 1/3 & 1/3 \end{bmatrix} \begin{bmatrix} Fb \\ W \\ qb^2 \end{bmatrix}$$





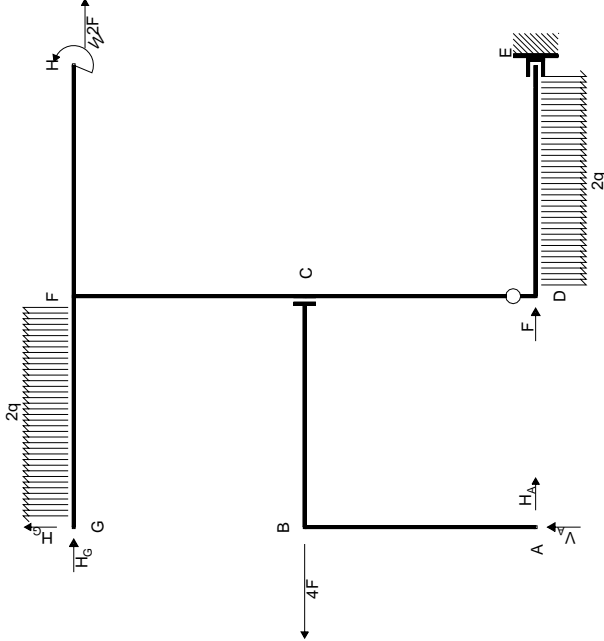
$\frac{1}{5} F b^3 / EJ$

$\leftarrow \boxed{+} \rightarrow F$



$\uparrow \boxed{+} \downarrow F$

$\curvearrowright \boxed{+} \curvearrowleft Fb$



EQUAZIONI DI EQUILIBRIO

Traslazione orizzontale globale

$H_A + H_G = F$

Rotazione intorno a D: aste DC CB CF BA FG FH

$-V_A b - 3H_G b = -W + qb^2$

Traslazione verticale: aste CB BA

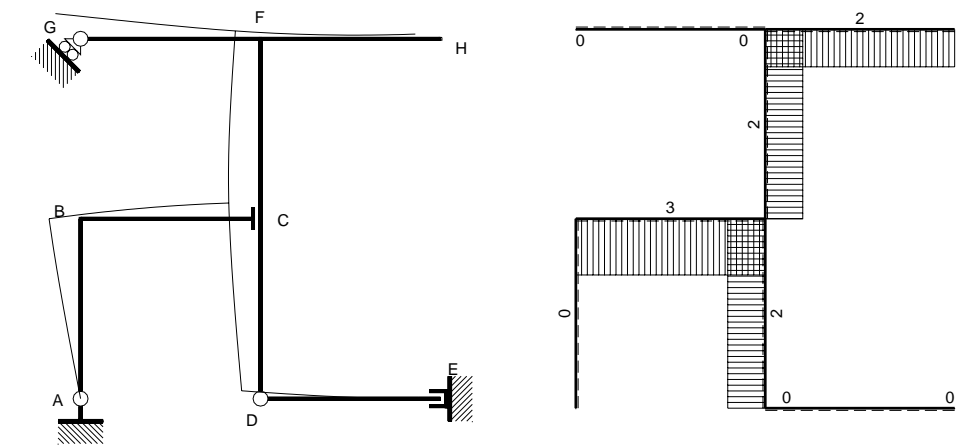
$V_A = 0$

Matrice di equilibrio

$$\begin{bmatrix} H_A b & V_A b & H_G b \end{bmatrix} \begin{bmatrix} Fb & W & qb^2 \end{bmatrix}$$
$$u_E \begin{bmatrix} 1 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \end{bmatrix}$$
$$\varphi_{DC} \begin{bmatrix} 0 & -1 & -3 \end{bmatrix} = \begin{bmatrix} 0 & -1 & 1 \end{bmatrix}$$
$$V_{CB} \begin{bmatrix} 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} 0 & 0 & 0 \end{bmatrix}$$

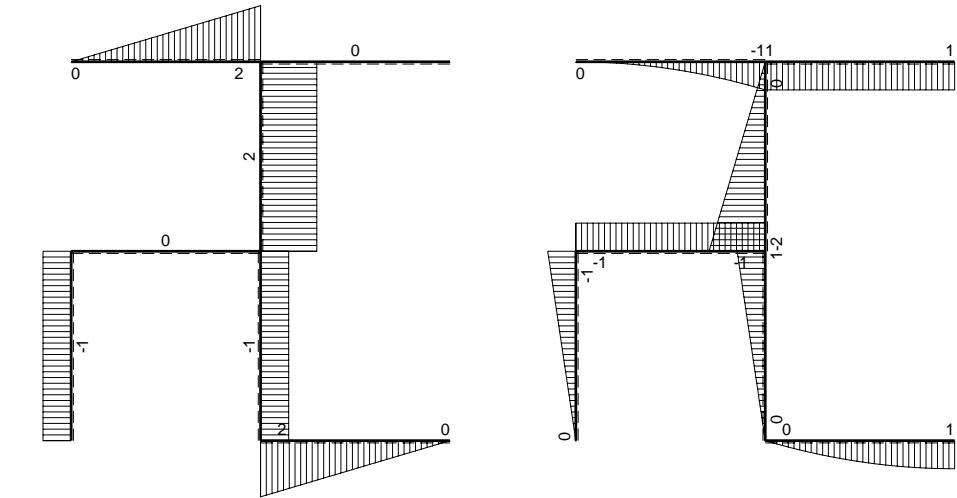
Soluzione del sistema

$$\begin{bmatrix} H_A b \\ V_A b \\ H_G b \end{bmatrix} = \begin{bmatrix} 1 & -1/3 & 1/3 \\ 0 & 0 & 0 \\ 0 & 1/3 & -1/3 \end{bmatrix} \begin{bmatrix} Fb & W & qb^2 \end{bmatrix}$$



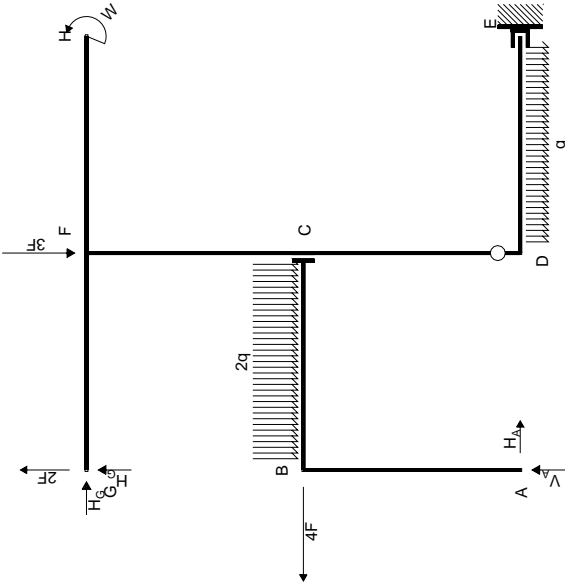
$\frac{1}{4} F b^3 / E J$

$\leftarrow \boxed{+} \rightarrow F$



$\uparrow \boxed{+} \downarrow F$

$\curvearrowright \boxed{+} \curvearrowleft F_b$



EQUAZIONI DI EQUILIBRIO

Traslazione orizzontale globale

$H_A + H_G = 4F$

Rotazione intorno a D: aste DC CB CF BA FG FH

$-V_A b - 3H_G b = -2Fb - W \cdot qb^2$

Traslazione verticale: aste CB BA

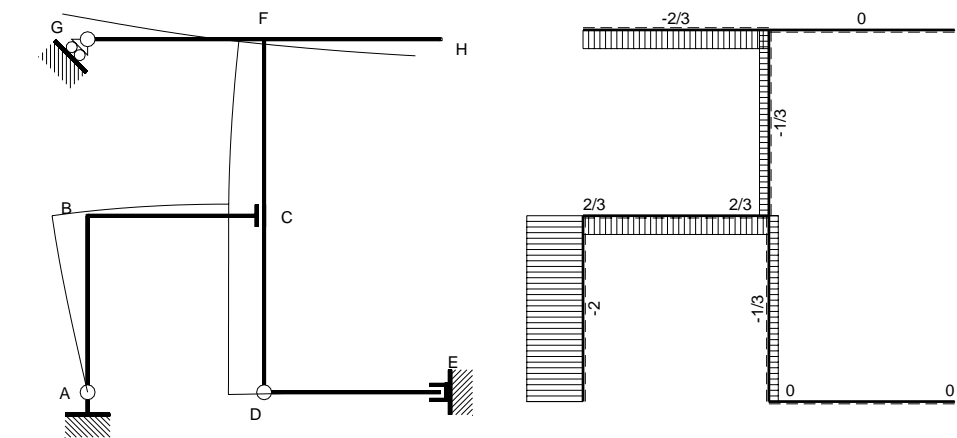
$V_A = 2qb$

Matrice di equilibrio

$$\begin{bmatrix} H_A b & V_A b & H_G b \end{bmatrix} \begin{bmatrix} Fb & W & qb^2 \end{bmatrix}$$
$$u_E \begin{bmatrix} 1 & 0 & 1 \end{bmatrix} \begin{bmatrix} 4 & 0 & 0 \end{bmatrix}$$
$$\varphi_{DC} \begin{bmatrix} 0 & -1 & -3 \end{bmatrix} = \begin{bmatrix} -2 & -1 & -1 \end{bmatrix}$$
$$V_{CB} \begin{bmatrix} 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} 0 & 0 & 2 \end{bmatrix}$$

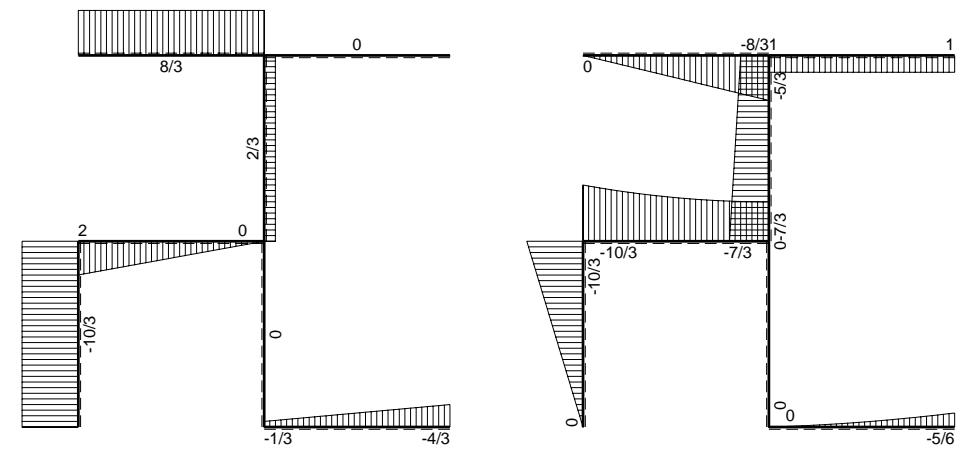
Soluzione del sistema

$$\begin{bmatrix} H_A b \\ V_A b \\ H_G b \end{bmatrix} \begin{bmatrix} Fb & W & qb^2 \end{bmatrix}$$
$$\begin{bmatrix} H_A b \\ V_A b \\ H_G b \end{bmatrix} = \begin{bmatrix} 10/3 & -1/3 & 1/3 \\ 0 & 0 & 2 \\ 2/3 & 1/3 & -1/3 \end{bmatrix}$$



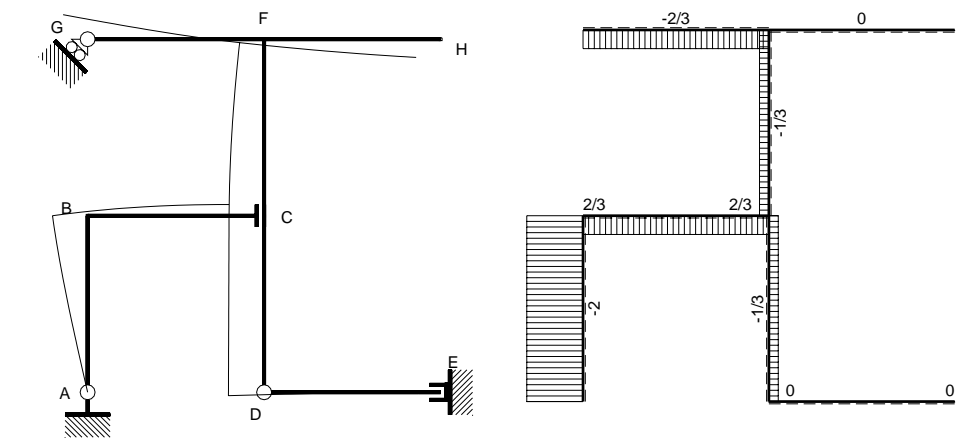
$\delta Fb^3/EJ$

$\leftarrow \boxed{+} \rightarrow F$



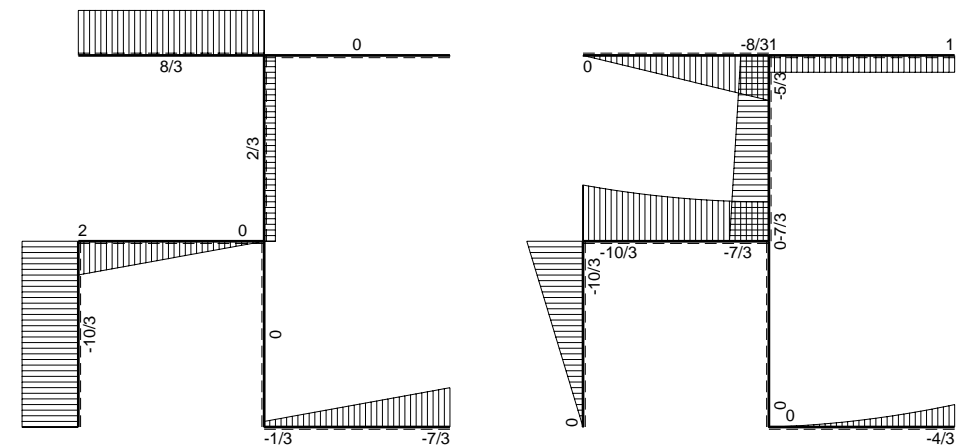
$\uparrow \boxed{+} \downarrow F$

$\leftarrow \boxed{+} \rightarrow Fb$



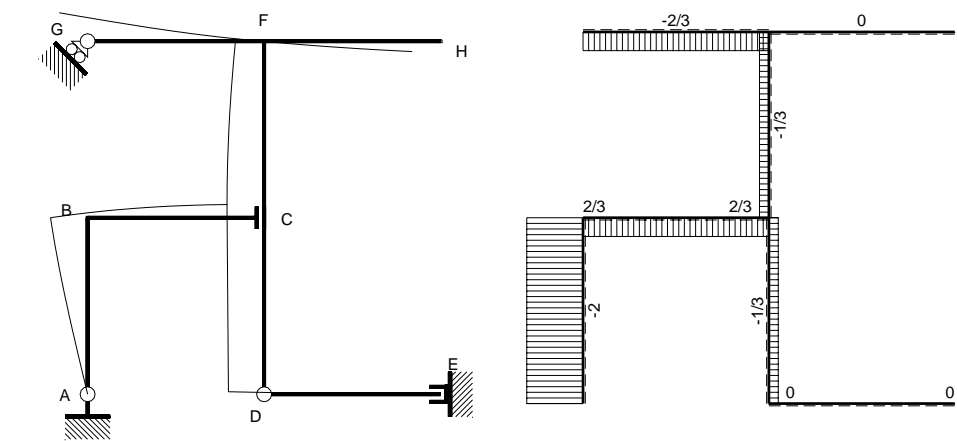
$\delta Fb^3/EJ$

$\leftarrow \boxed{+} \rightarrow F$



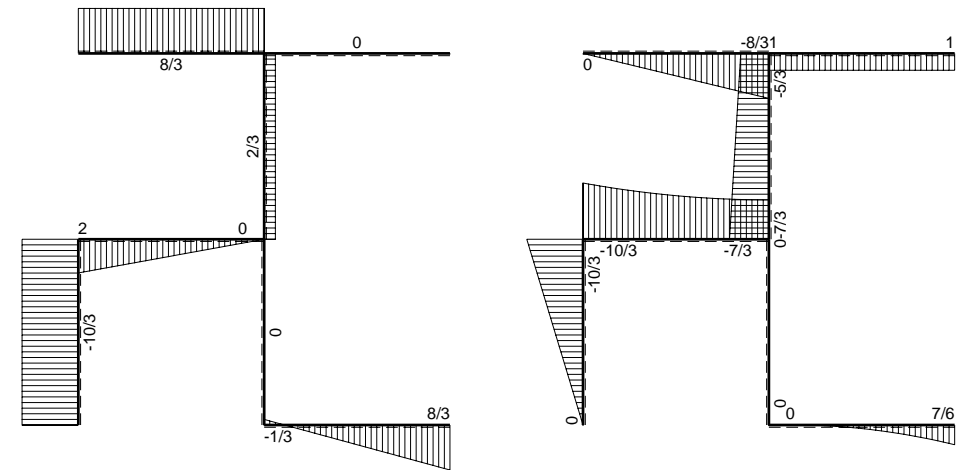
$\uparrow \boxed{+} \downarrow F$

$\leftarrow \boxed{+} \rightarrow Fb$



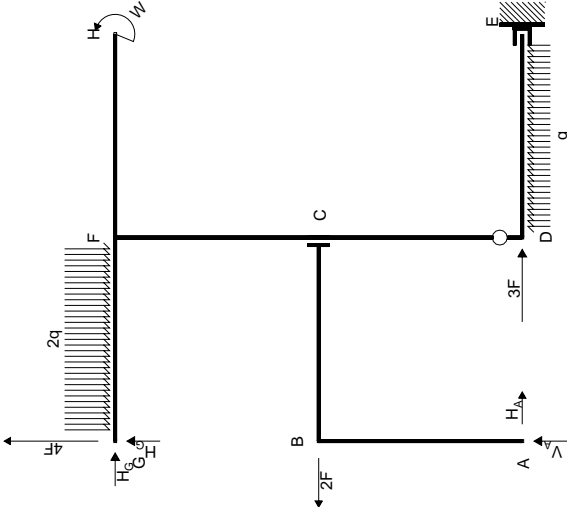
$\delta Fb^3/EJ$

$\leftarrow \boxed{+} \rightarrow F$



$\uparrow \boxed{+} \downarrow F$

$\leftarrow \boxed{+} \rightarrow Fb$



EQUAZIONI DI EQUILIBRIO

Traslazione orizzontale globale

$H_A + H_G = -F$

Rotazione intorno a D: aste DC CB CF BA FG FH

$-V_A b - 3H_G b = 2Fb - W - qb^2$

Traslazione verticale: aste CB BA

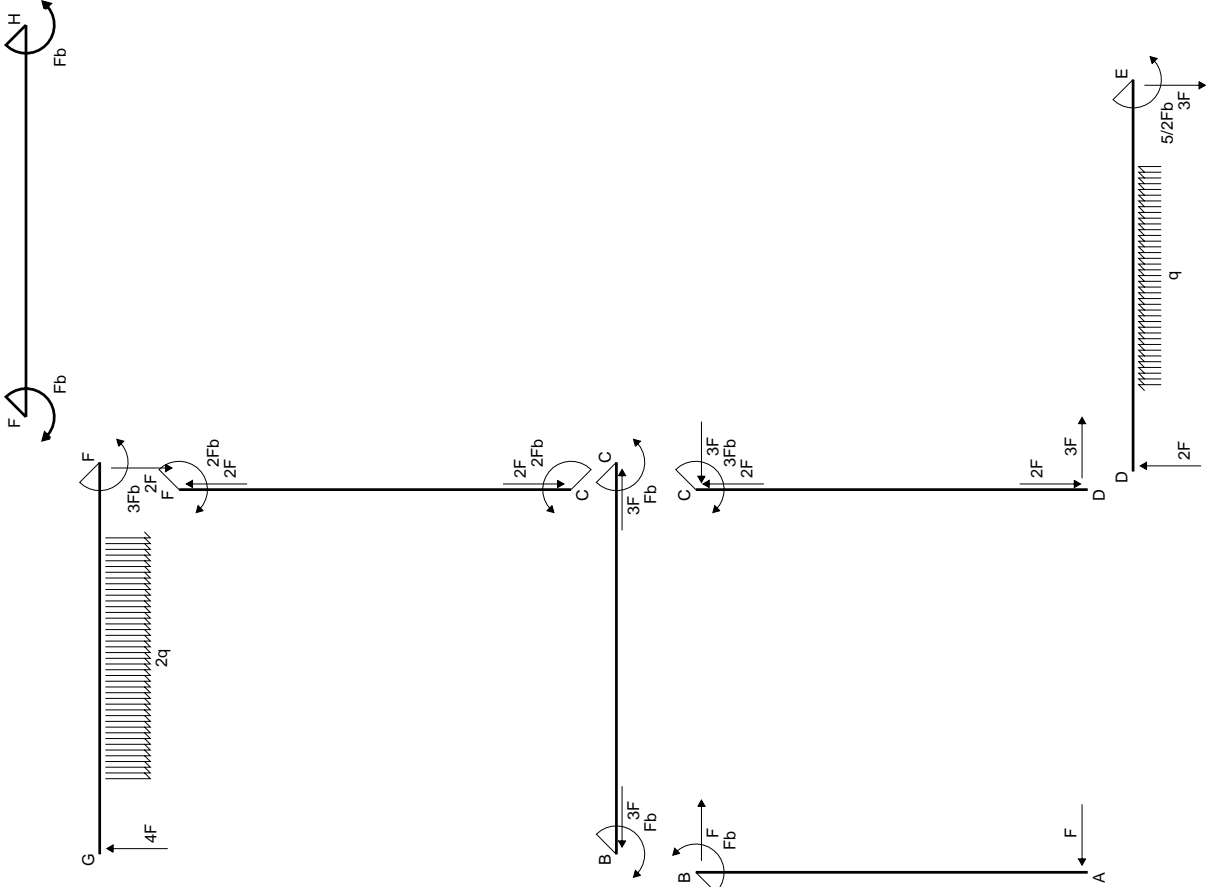
$V_A = 0$

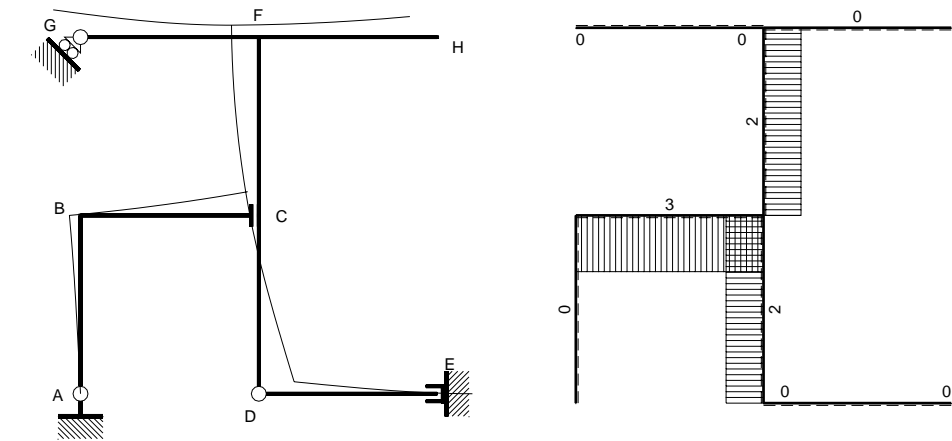
Matrice di equilibrio

$$\begin{bmatrix} H_A b & V_A b & H_G b \end{bmatrix} \begin{bmatrix} Fb & W & qb^2 \end{bmatrix}$$
$$u_E \begin{bmatrix} 1 & 0 & 1 \end{bmatrix} \begin{bmatrix} -1 & 0 & 0 \end{bmatrix}$$
$$\varphi_{DC} \begin{bmatrix} 0 & -1 & -3 \end{bmatrix} = \begin{bmatrix} 2 & -1 & -1 \end{bmatrix}$$
$$V_{CB} \begin{bmatrix} 0 & 1 & 0 \end{bmatrix}$$

Soluzione del sistema

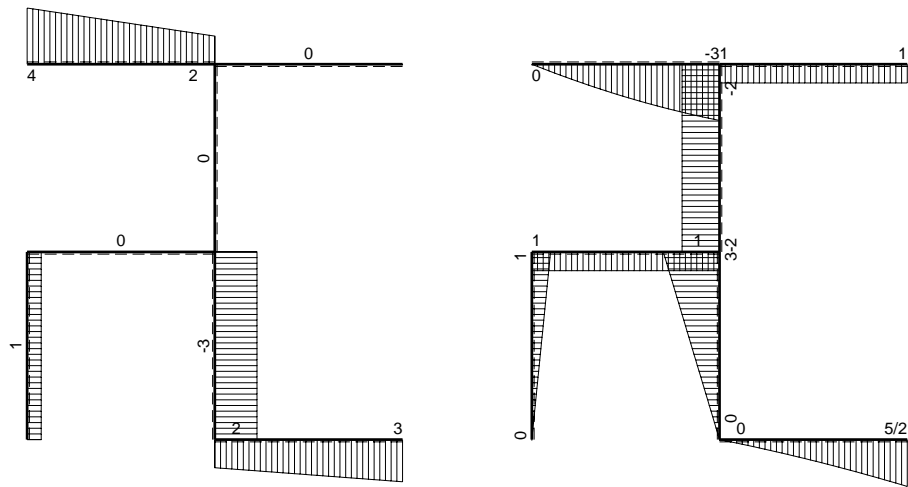
$$\begin{bmatrix} H_A b \\ V_A b \\ H_G b \end{bmatrix} = \begin{bmatrix} Fb & W & qb^2 \\ -1/3 & -1/3 & -1/3 \\ 0 & 0 & 0 \\ -2/3 & 1/3 & 1/3 \end{bmatrix}$$





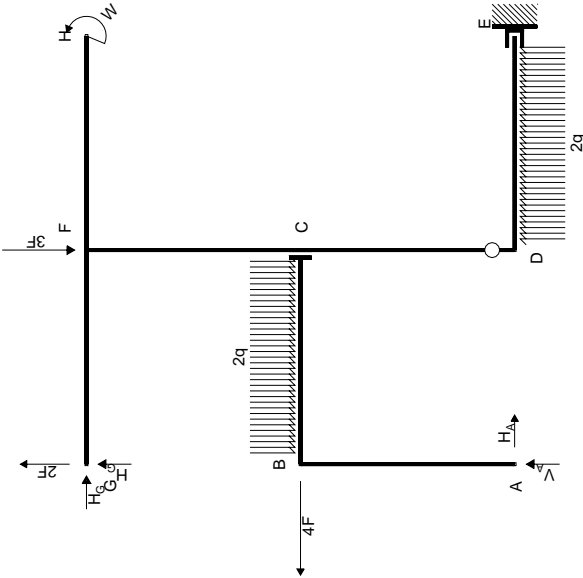
$\frac{1}{5} F b^3 / EJ$

$\leftarrow \boxed{+} \rightarrow F$



$\uparrow \boxed{+} \downarrow F$

$\curvearrowright \boxed{+} \curvearrowleft Fb$



EQUAZIONI DI EQUILIBRIO

Traslazione orizzontale globale

$H_A + H_G = 4F$

Rotazione intorno a D: aste DC CB CF BA FG FH

$-V_A b - 3H_G b = -2Fb - W \cdot qb^2$

Traslazione verticale: aste CB BA

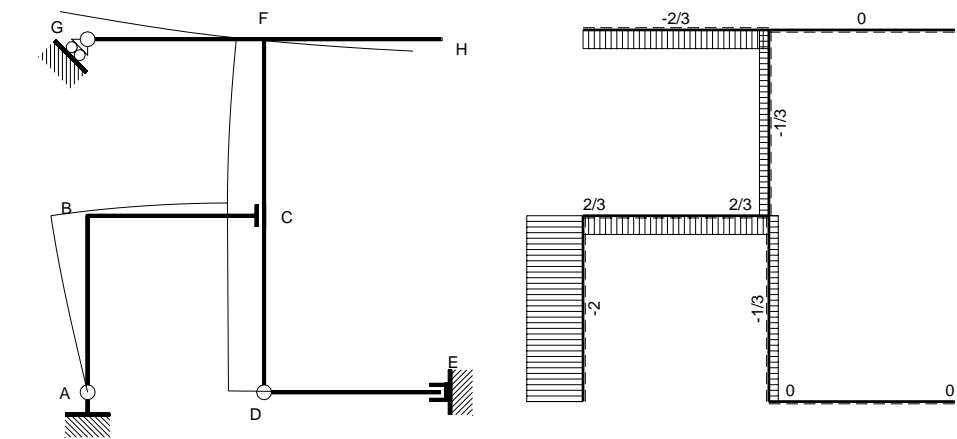
$V_A = 2qb$

Matrice di equilibrio

$$\begin{bmatrix} H_A b & V_A b & H_G b \end{bmatrix} \begin{bmatrix} Fb & W & qb^2 \end{bmatrix}$$
$$u_E \begin{bmatrix} 1 & 0 & 1 \end{bmatrix} \begin{bmatrix} 4 & 0 & 0 \end{bmatrix}$$
$$\varphi_{DC} \begin{bmatrix} 0 & -1 & -3 \end{bmatrix} = \begin{bmatrix} -2 & -1 & -1 \end{bmatrix}$$
$$V_{CB} \begin{bmatrix} 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} 0 & 0 & 2 \end{bmatrix}$$

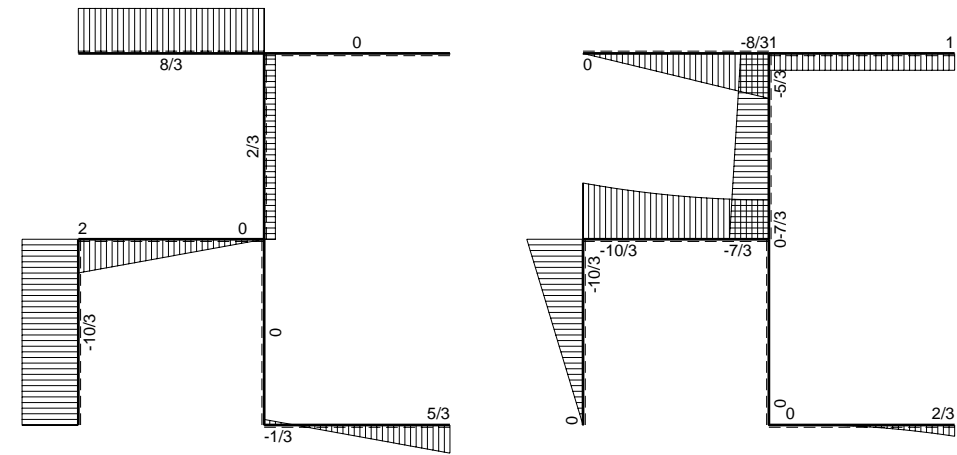
Soluzione del sistema

$$\begin{bmatrix} H_A b \\ V_A b \\ H_G b \end{bmatrix} \begin{bmatrix} Fb & W & qb^2 \end{bmatrix}$$
$$\begin{bmatrix} H_A b \\ V_A b \\ H_G b \end{bmatrix} = \begin{bmatrix} 10/3 & -1/3 & 1/3 \\ 0 & 0 & 2 \\ 2/3 & 1/3 & -1/3 \end{bmatrix}$$



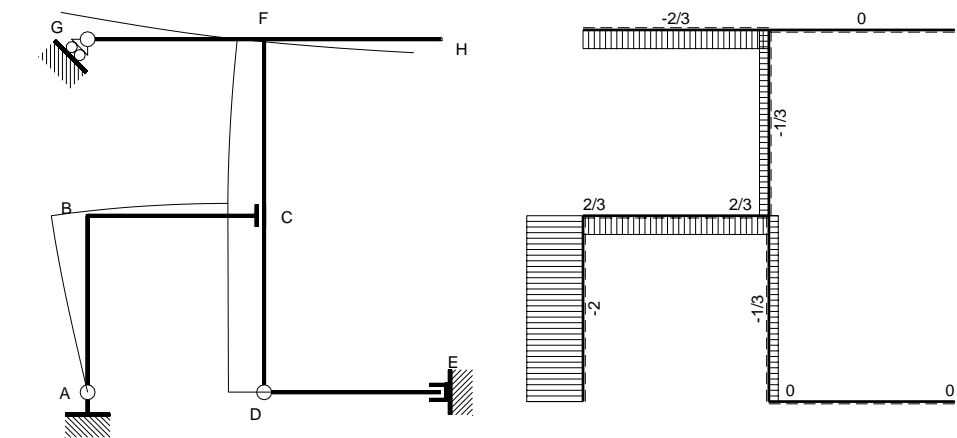
$\frac{1}{8} F b^3 / EJ$

$\leftarrow \boxed{+} \rightarrow F$



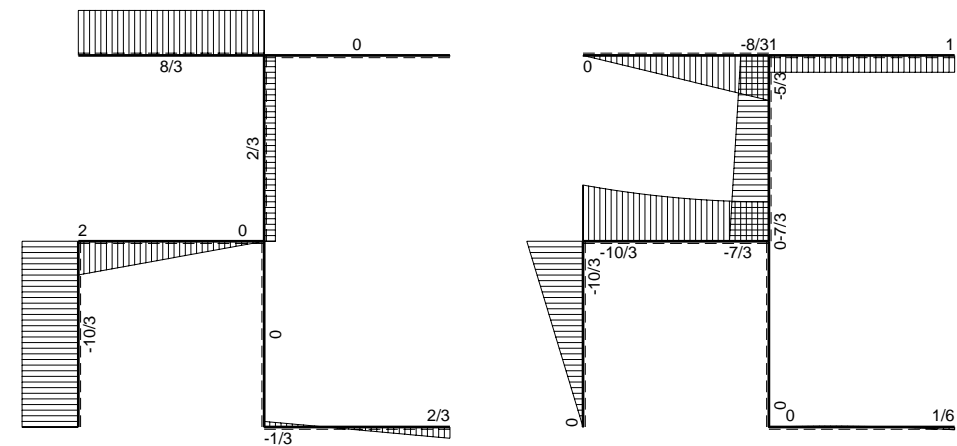
$\uparrow \boxed{+} \downarrow F$

$\leftarrow \boxed{+} \rightarrow F_b$



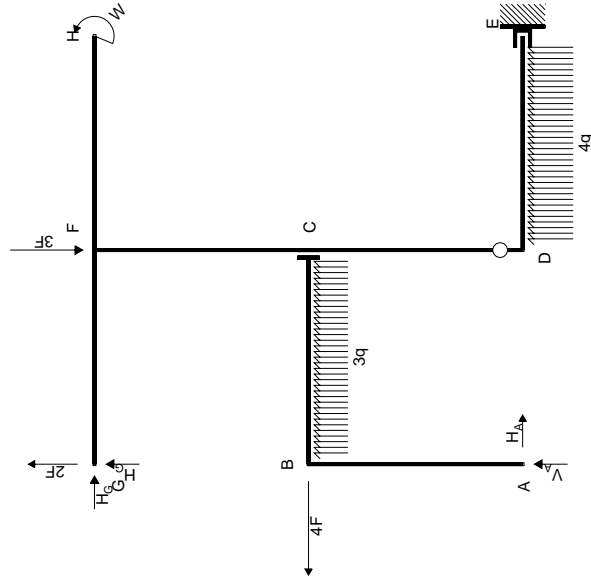
$\frac{1}{8} F b^3 / EJ$

$\leftarrow \boxed{+} \rightarrow F$



$\uparrow \boxed{+} \downarrow F$

$\leftarrow \boxed{+} \rightarrow F_b$



EQUAZIONI DI EQUILIBRIO

Traslazione orizzontale globale

$H_A + H_G = 4F$

Rotazione intorno a D: aste DC CB CF BA FG FH

$-V_A b - 3H_G b = -2Fb - W + 3/2qb^2$

Traslazione verticale: aste CB BA

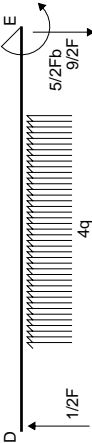
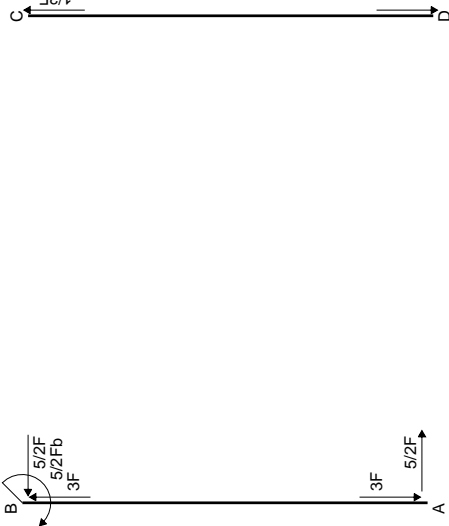
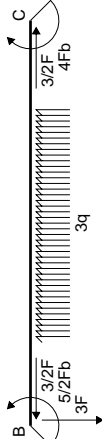
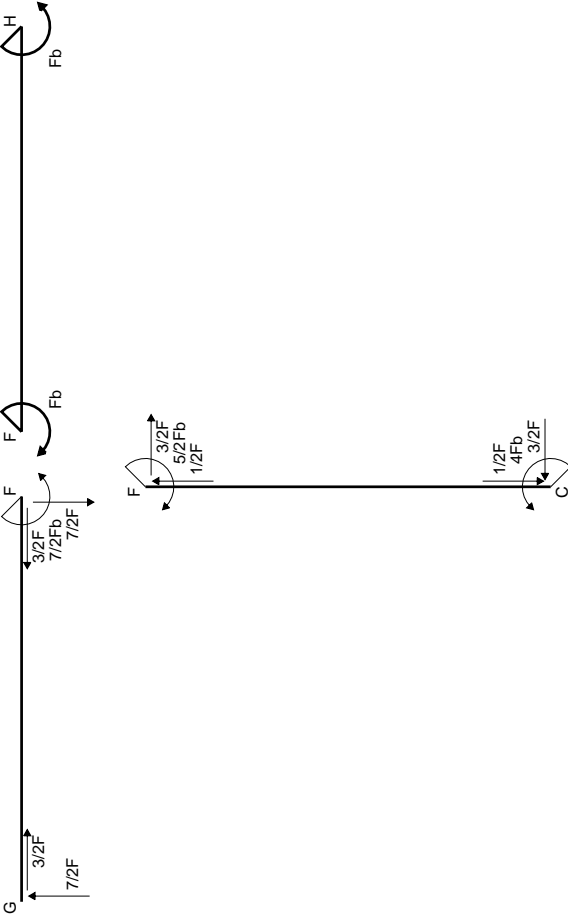
$V_A = -3qb$

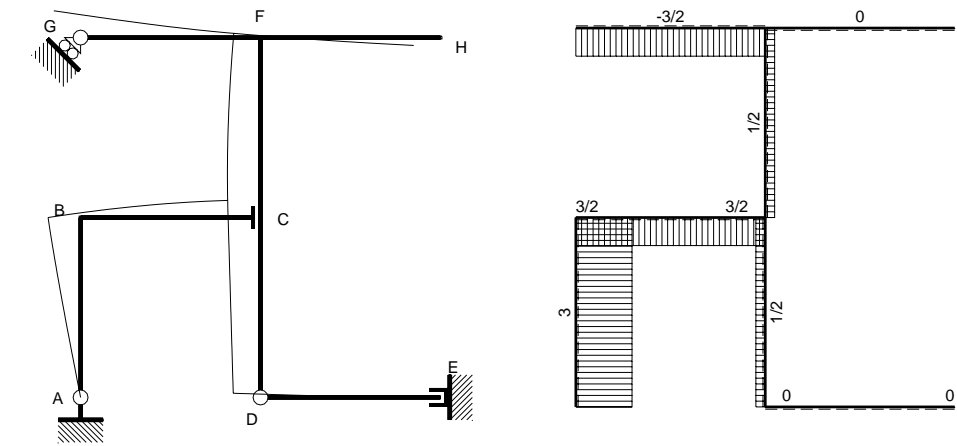
Matrice di equilibrio

$$\begin{bmatrix} H_A b & V_A b & H_G b \end{bmatrix} \begin{bmatrix} Fb & W & qb^2 \end{bmatrix}$$
$$u_E \begin{bmatrix} 1 & 0 & 1 \end{bmatrix} \begin{bmatrix} 4 & 0 & 0 \end{bmatrix}$$
$$\varphi_{DC} \begin{bmatrix} 0 & -1 & -3 \end{bmatrix} = \begin{bmatrix} -2 & -1 & 3/2 \end{bmatrix}$$
$$V_{CB} \begin{bmatrix} 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} 0 & 0 & -3 \end{bmatrix}$$

Soluzione del sistema

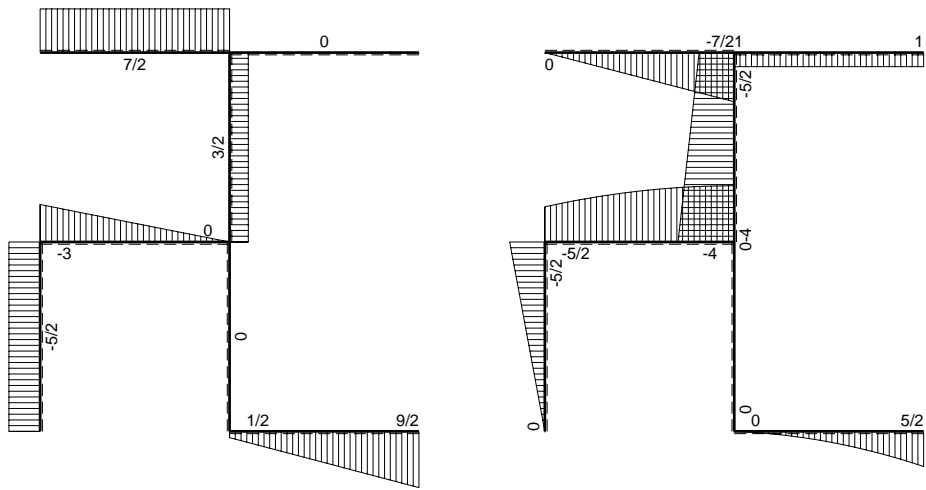
$$\begin{bmatrix} H_A b \\ V_A b \\ H_G b \end{bmatrix} \begin{bmatrix} Fb & W & qb^2 \end{bmatrix}$$
$$\begin{bmatrix} H_A b \\ V_A b \\ H_G b \end{bmatrix} = \begin{bmatrix} 10/3 & -1/3 & -1/2 \\ 0 & 0 & -3 \\ 2/3 & 1/3 & 1/2 \end{bmatrix}$$





$\frac{1}{12} F b^3 / E J$

$\leftarrow \boxed{+} \rightarrow F$



$\uparrow \boxed{+} \downarrow F$

$\leftarrow \boxed{+} \rightarrow F_b$