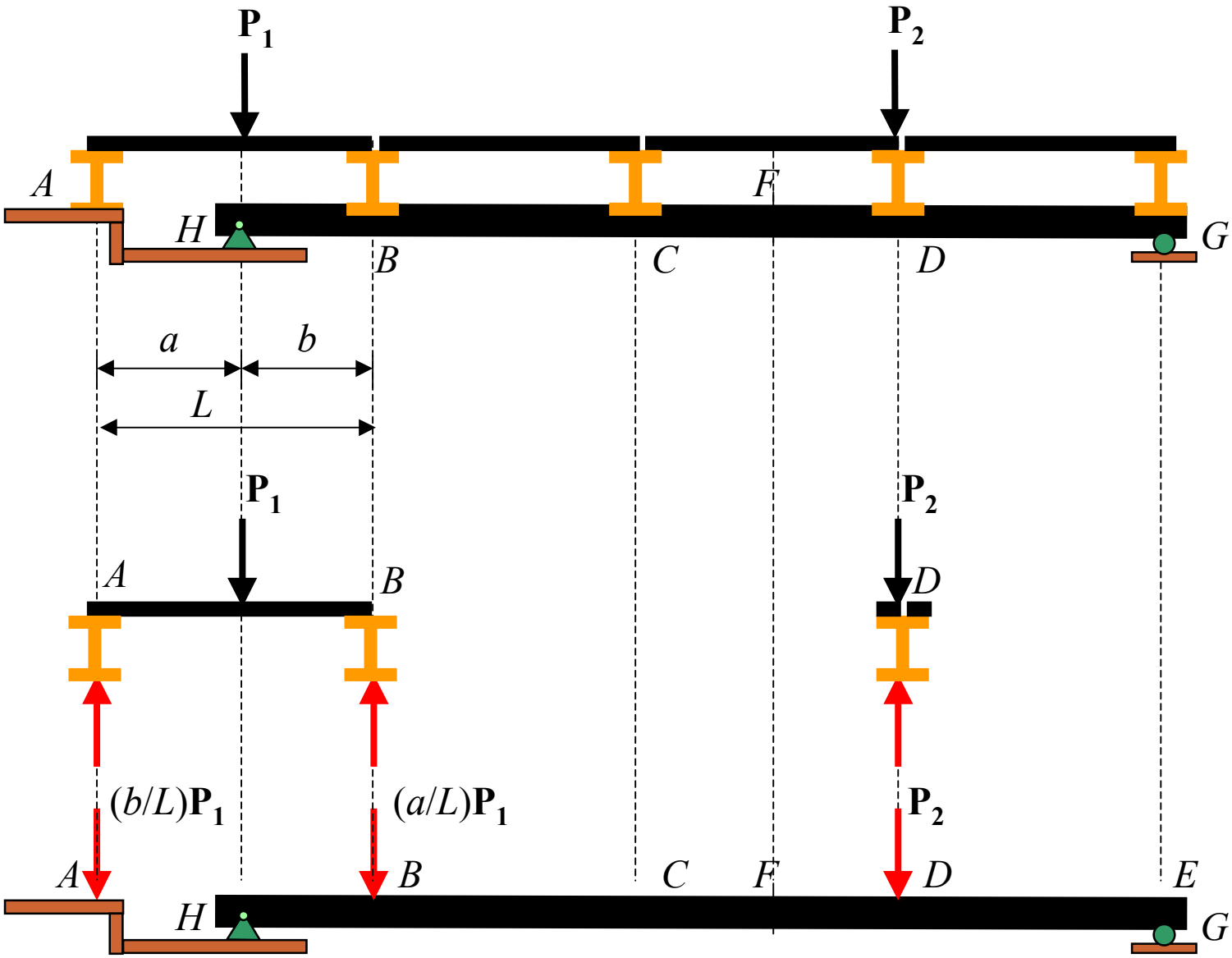
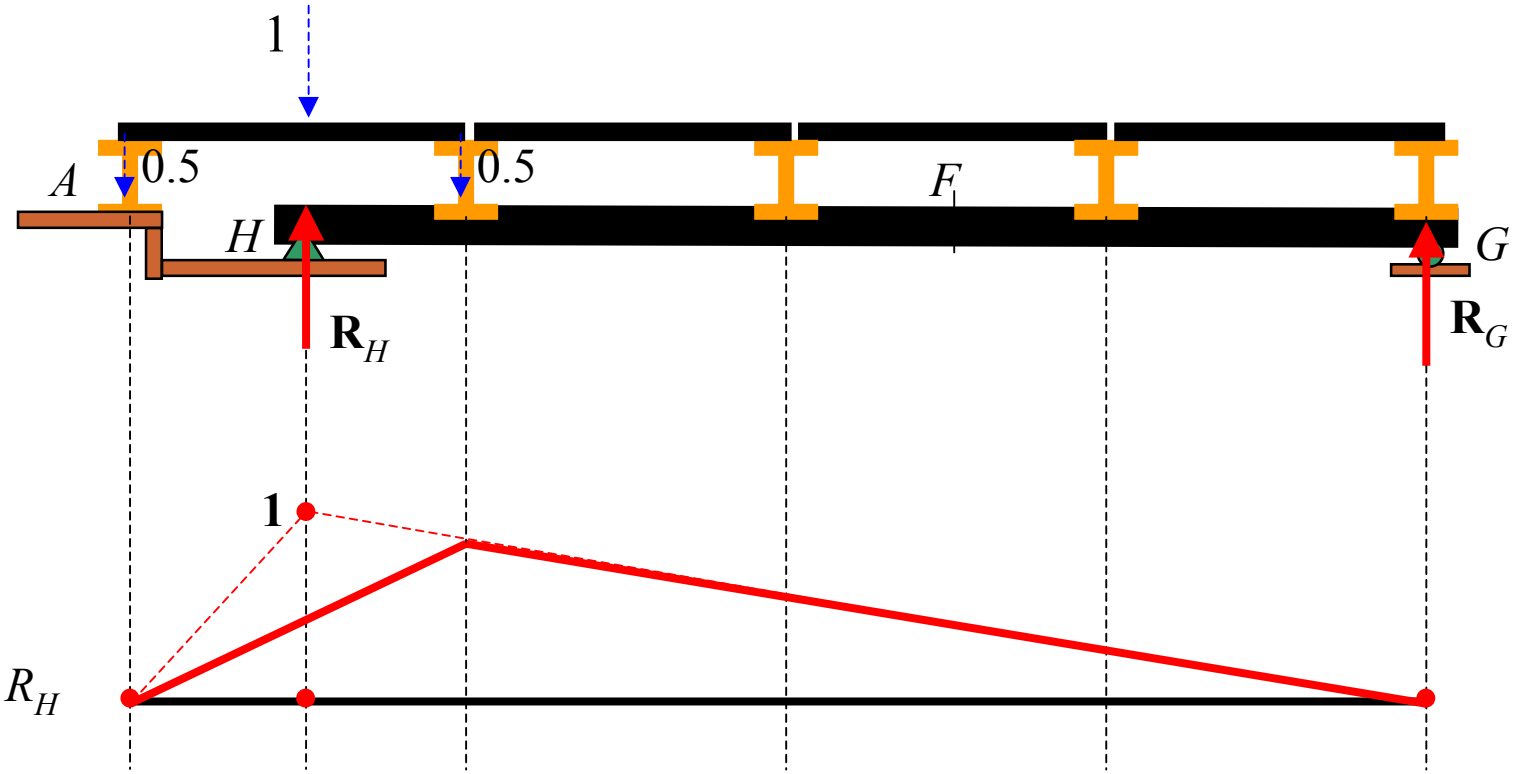
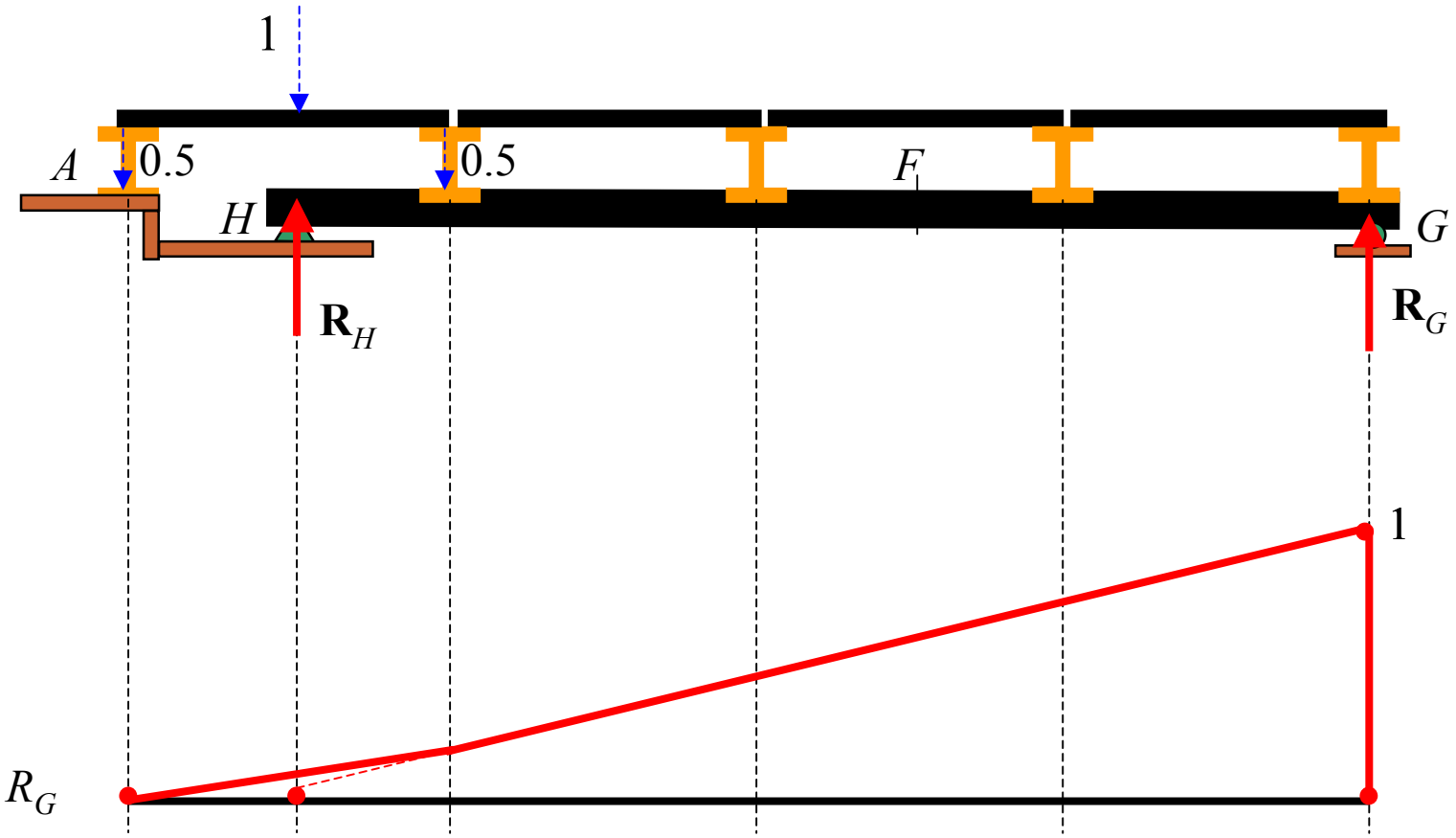
# Influence Line for Girder

- **Forces Apply to the Girder**

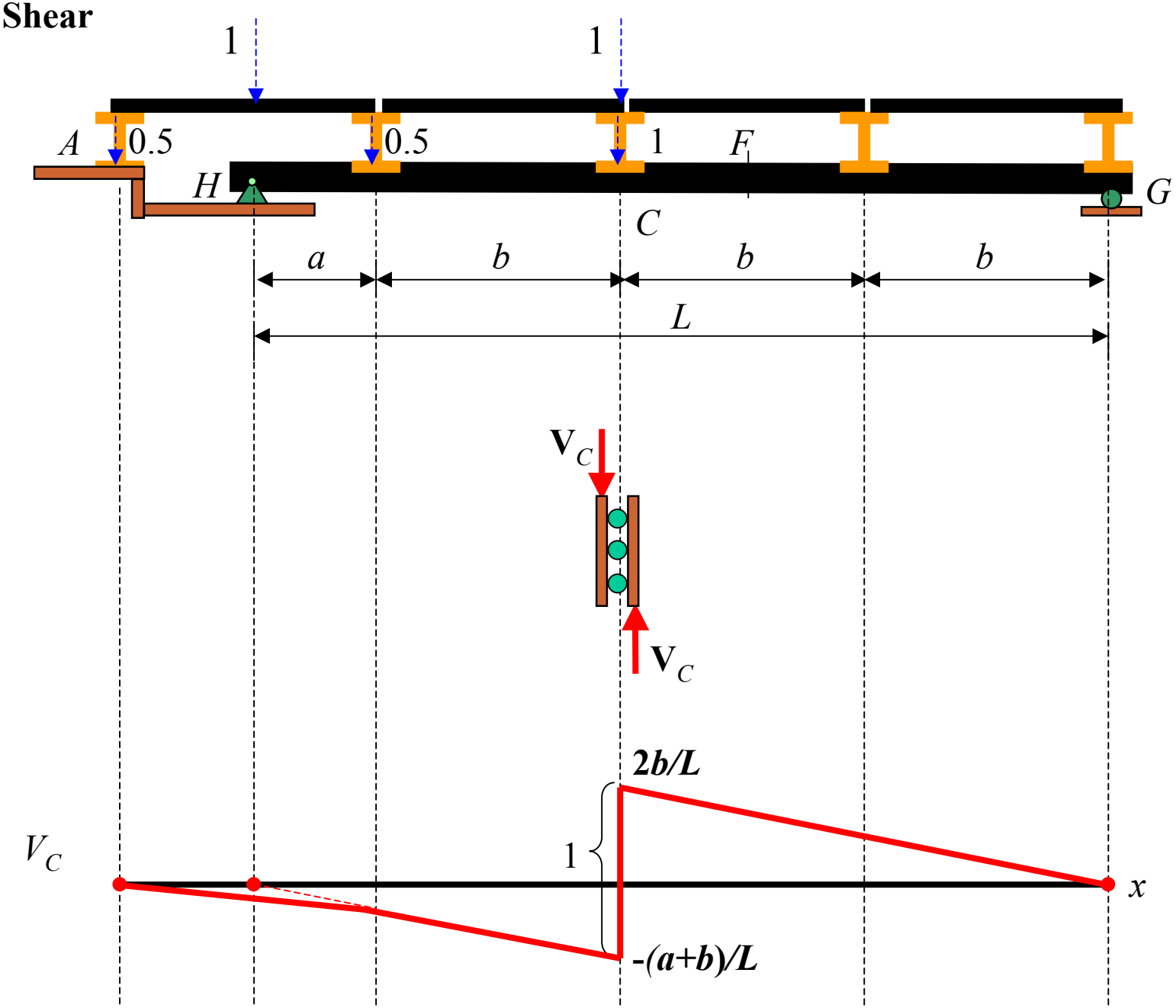


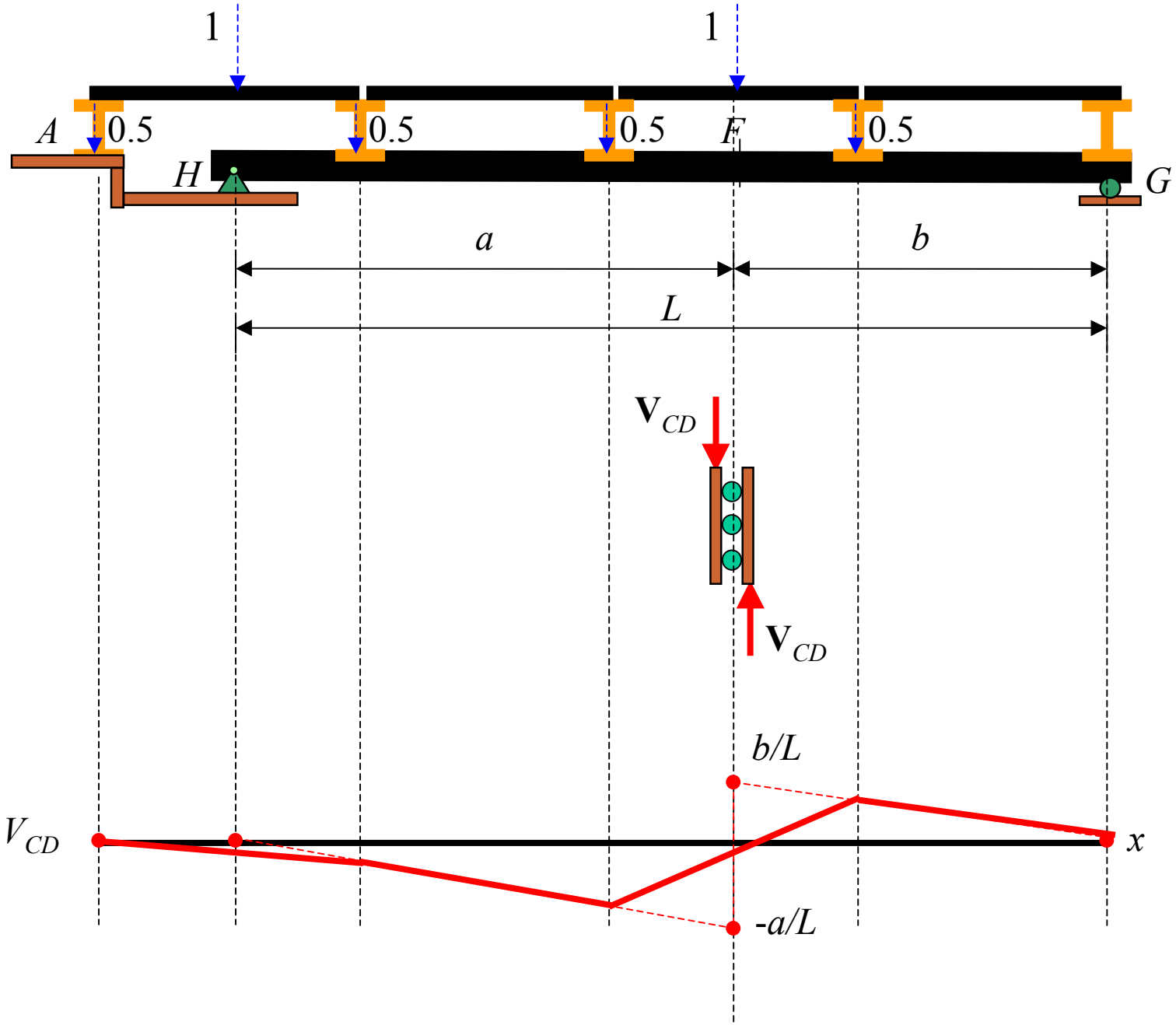
• **Reaction**



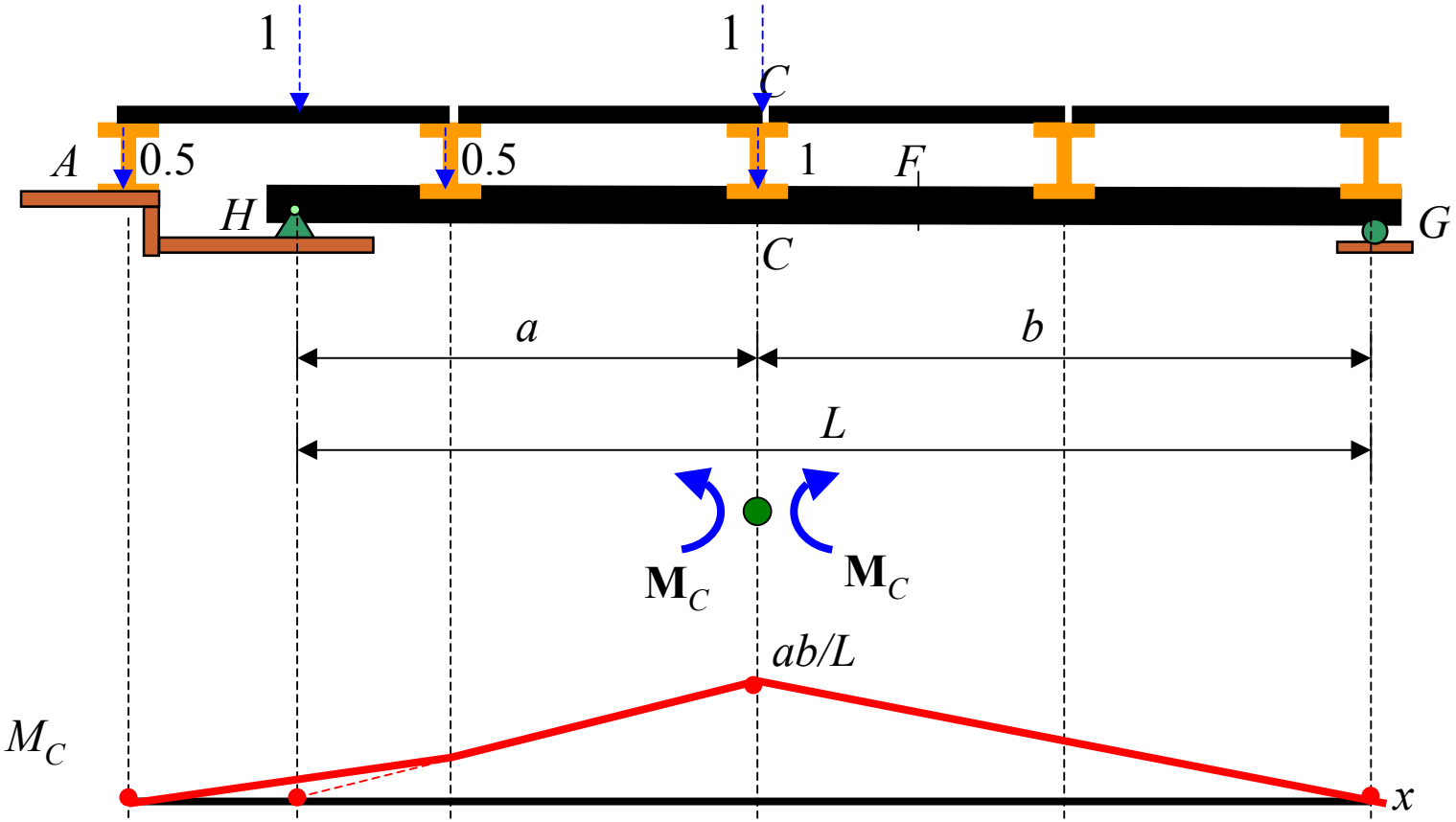

1
A
0.5
0.5
F
H
G
$\mathbf{R}_H$
$\mathbf{R}_G$
1
$R_G$

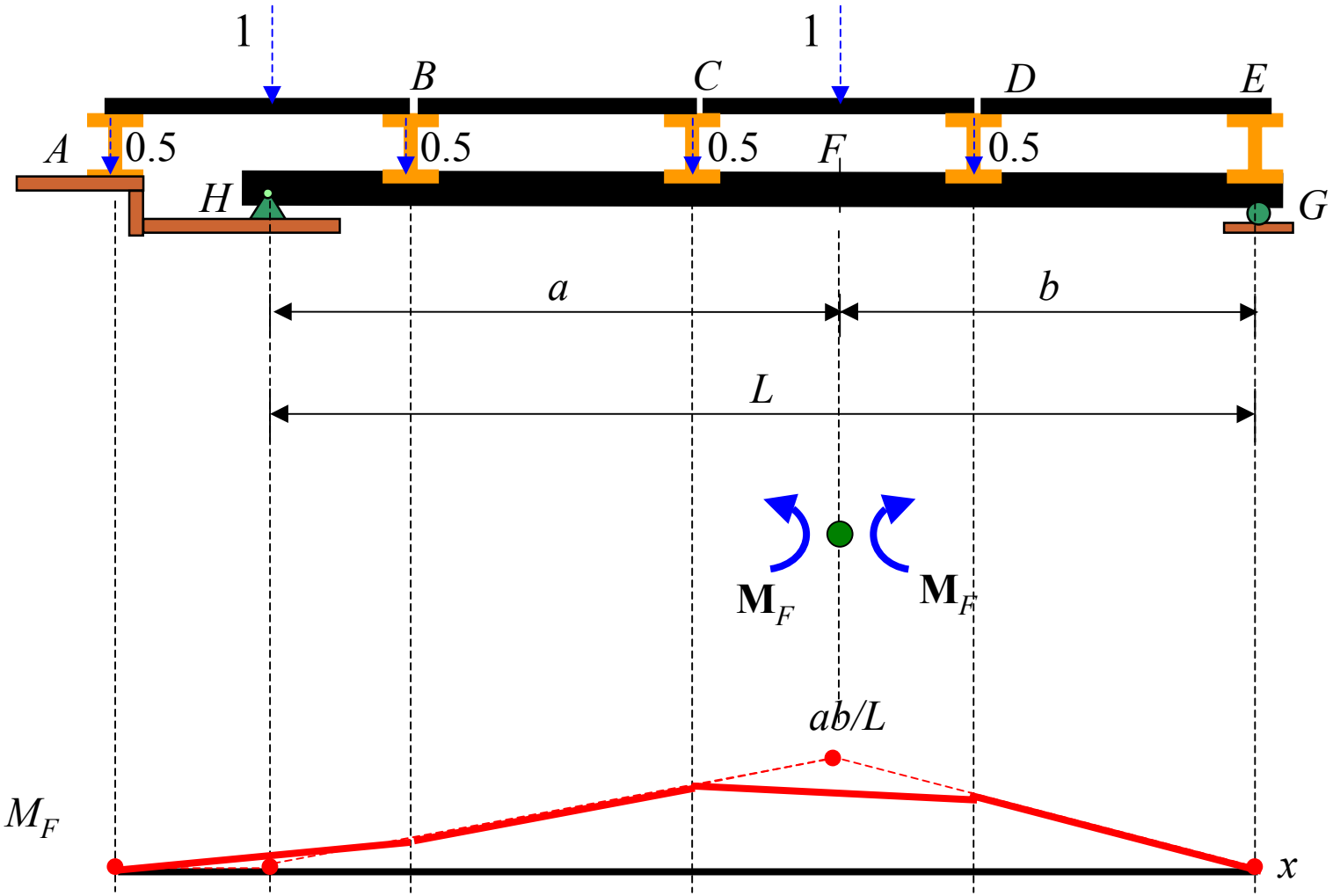
• **Shear**




1
1
A
0.5
0.5
0.5
F
0.5
H
G
a
b
L
V_CD
V_CD
b/L
V_CD
x
-a/L

• **Bending Moment**

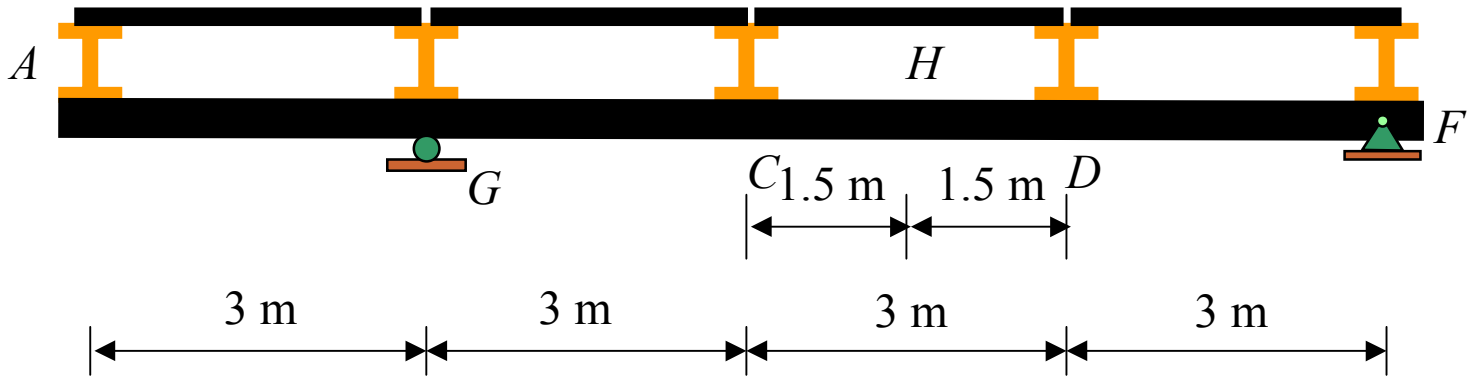


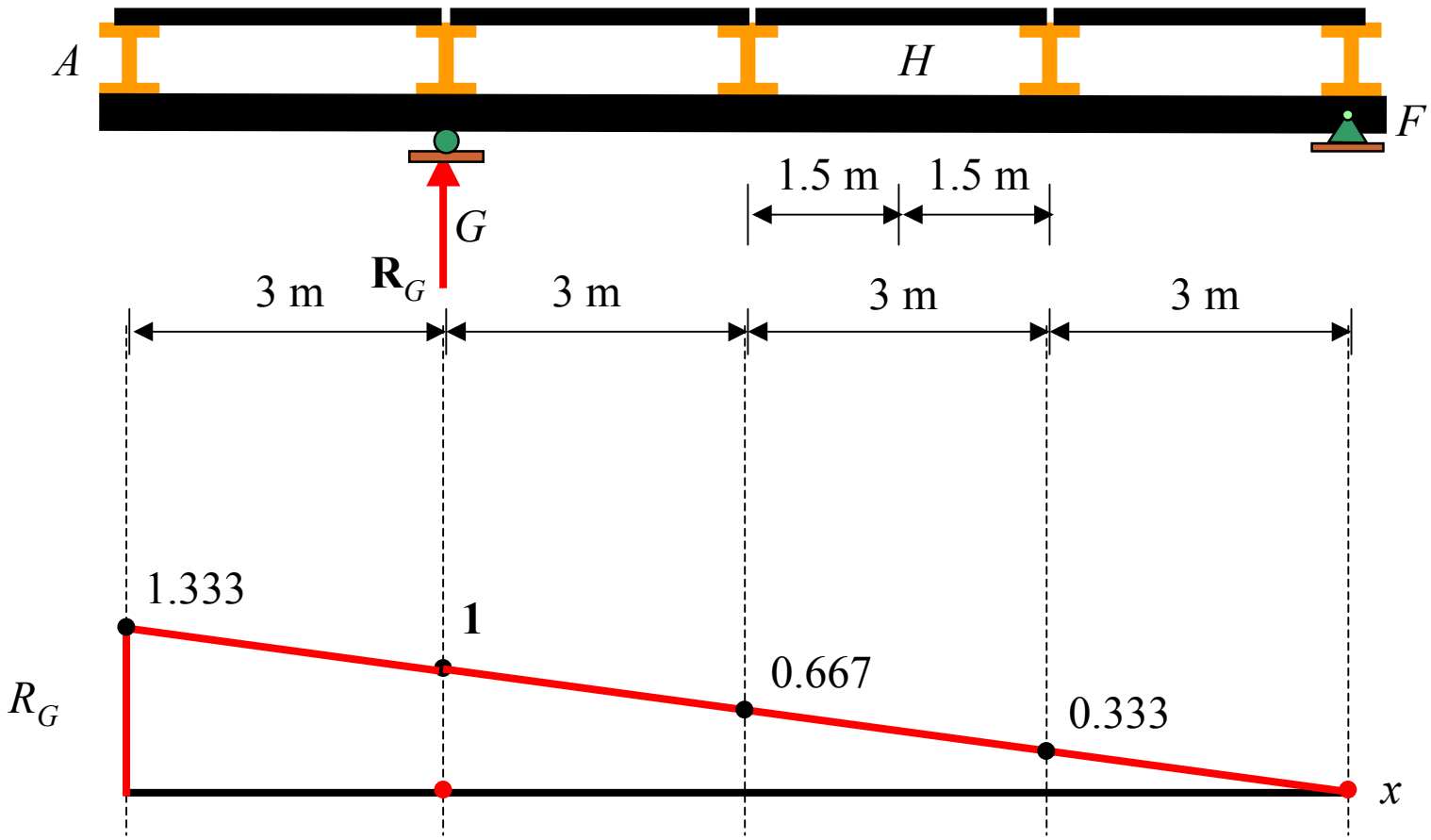

1
1
A
B
C
D
E
F
G
H
0.5
0.5
0.5
0.5
a
b
L
$\mathbf{M}_F$
$\mathbf{M}_F$
ab/L
$M_F$
x

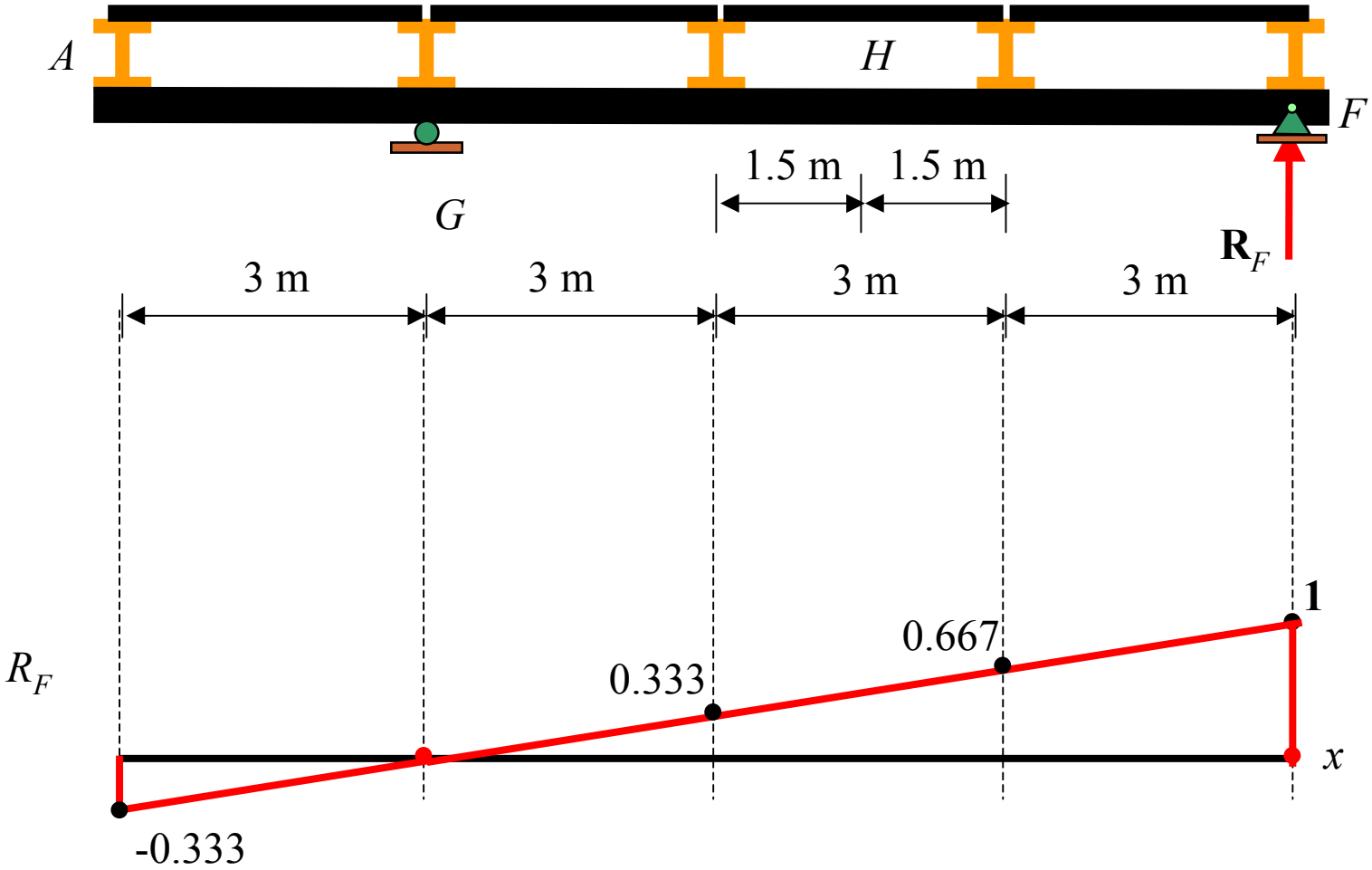
## Example 6-5

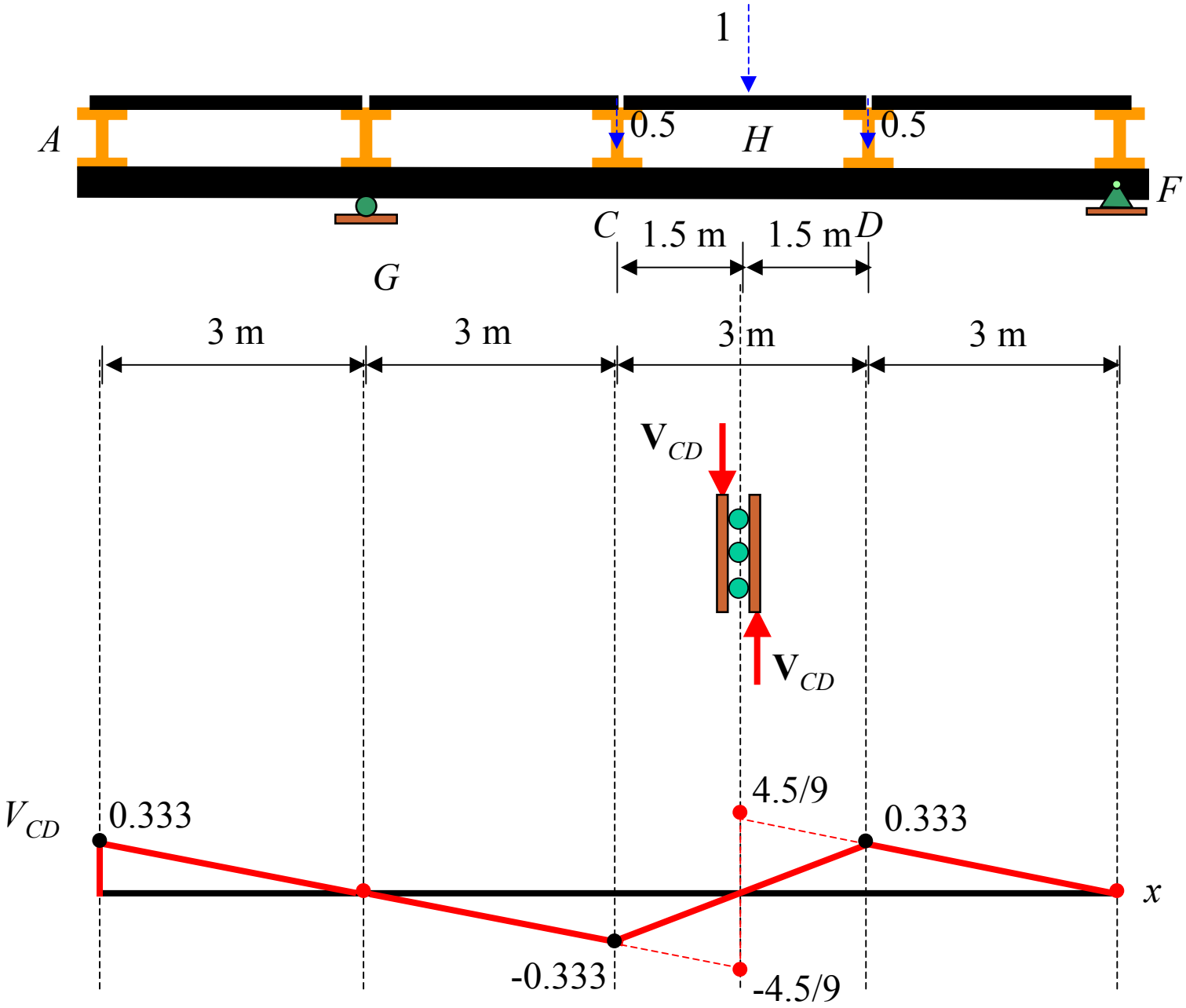
Draw the influence for

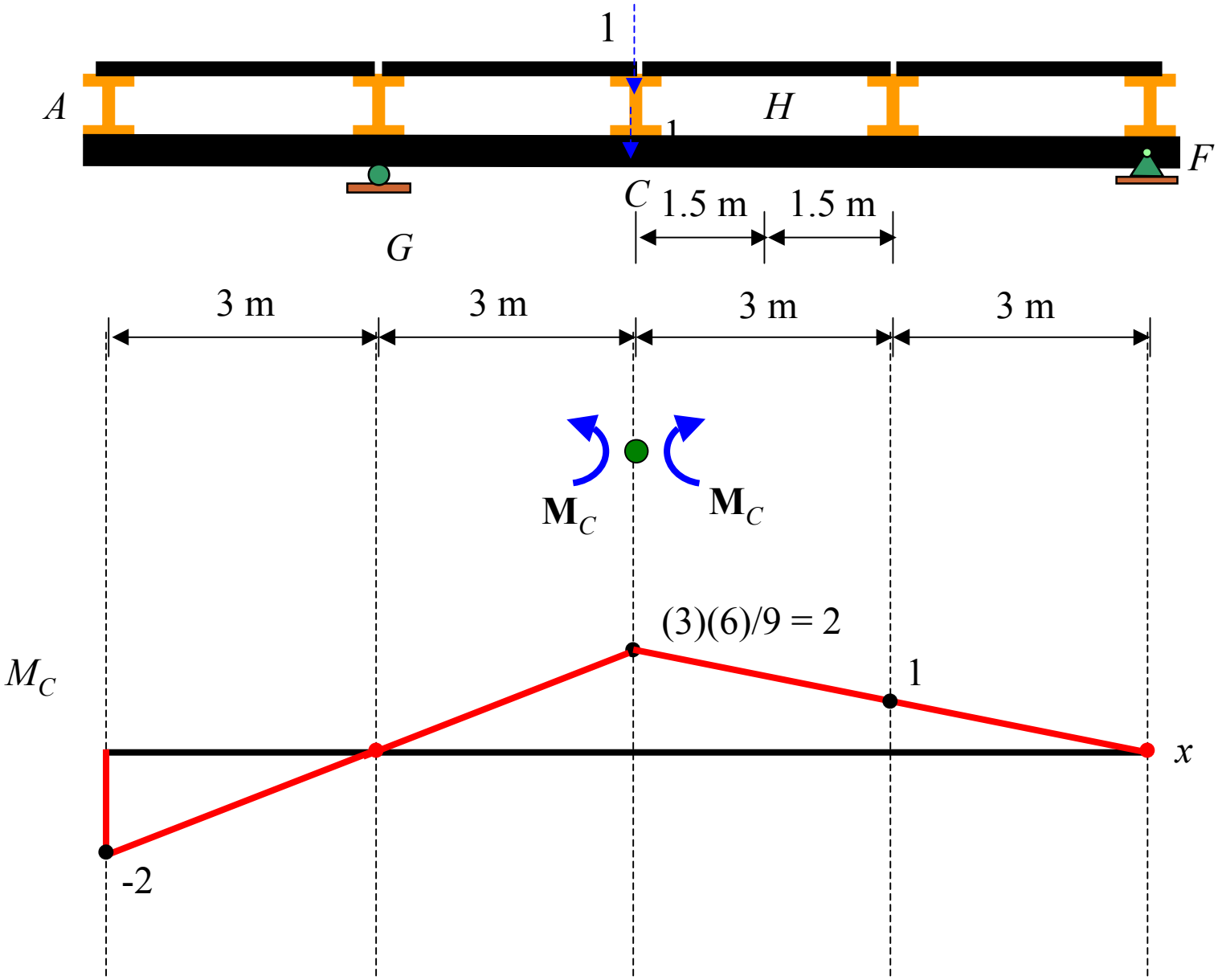
- the Reaction $R_G$ and $R_F$
- Shear $V_{CD}$
- the moment $M_C$ and $M_H$

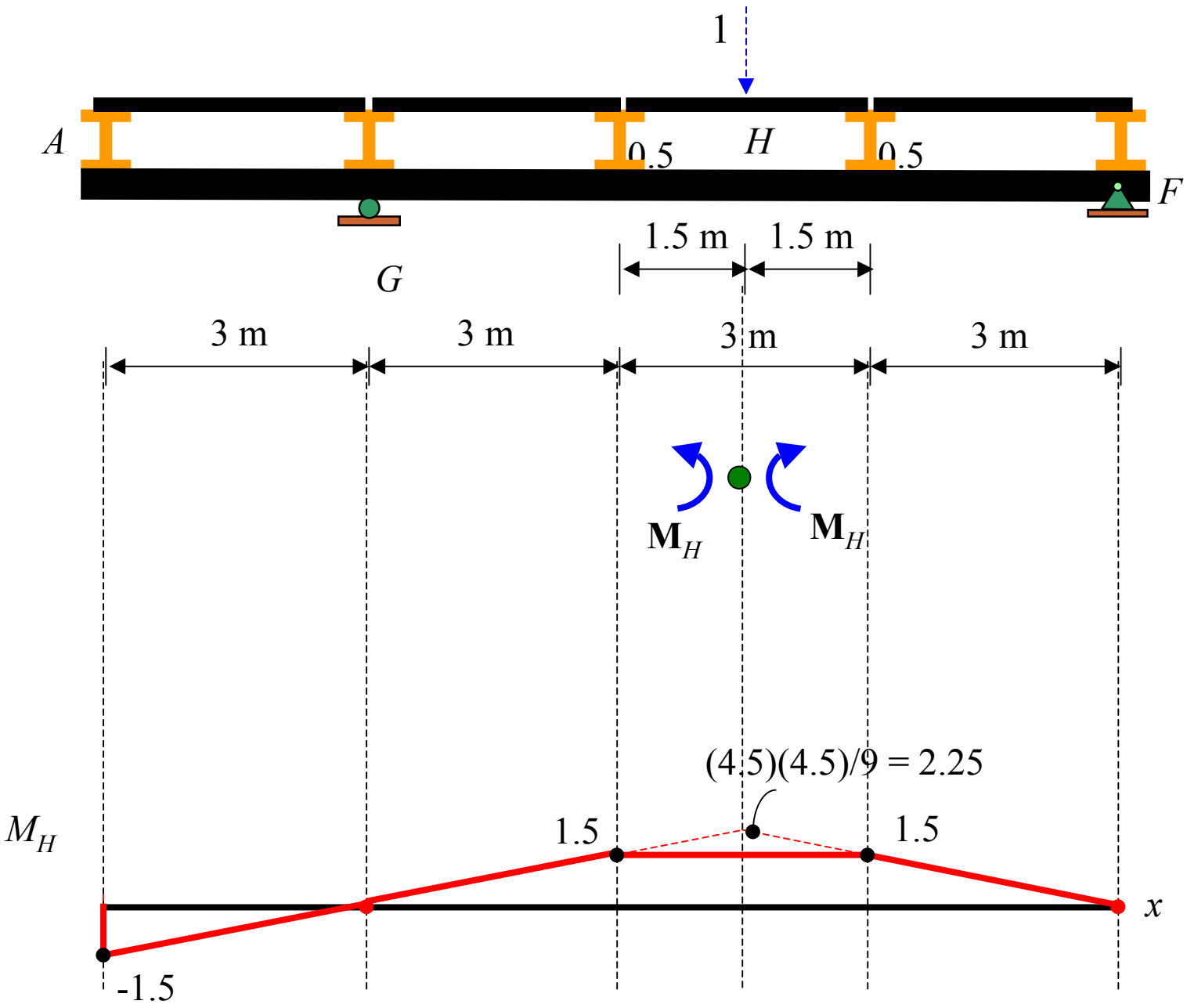



A
H
F
G
$\mathbf{R}_G$
1.5 m
1.5 m
3 m
3 m
3 m
3 m
1.333
1
0.667
0.333
$R_G$
x


A
H
F
G
1.5 m
1.5 m
$\mathbf{R}_F$
3 m
3 m
3 m
3 m
1
0.667
0.333
$R_F$
x
-0.333


1
A
0.5
H
0.5
F
G
C
1.5 m
1.5 m
D
3 m
3 m
3 m
3 m
V_CD
V_CD
V_CD
0.333
4.5/9
0.333
x
-0.333
-4.5/9

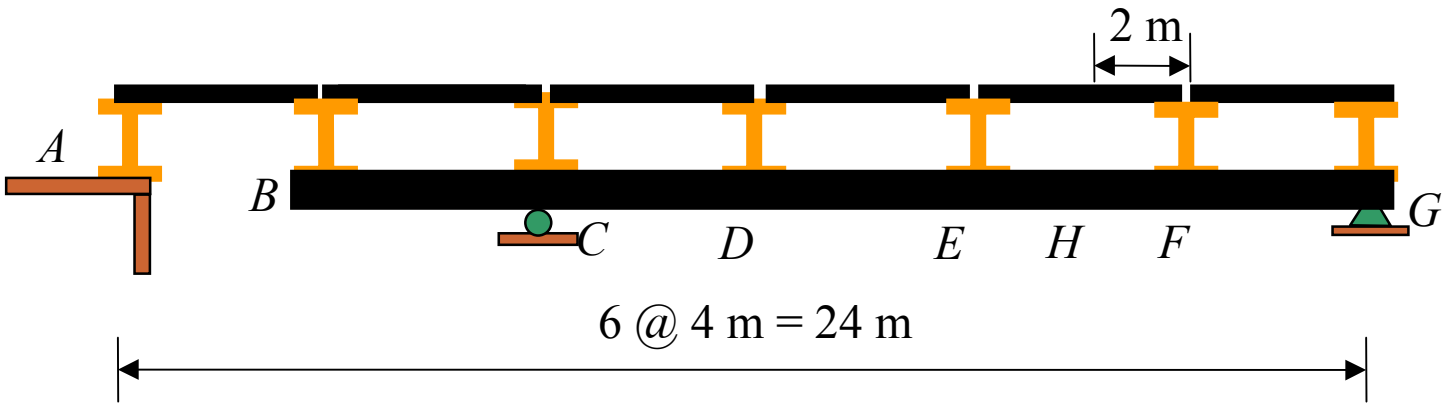

1
A
H
1
F
C
1.5 m
1.5 m
G
3 m
3 m
3 m
3 m
M_C
M_C
(3)(6)/9 = 2
M_C
1
x
-2


1
A
0.5
H
0.5
F
G
1.5 m
1.5 m
3 m
3 m
3 m
3 m
M_H
M_H
(4.5)(4.5)/9 = 2.25
M_H
1.5
1.5
x
-1.5

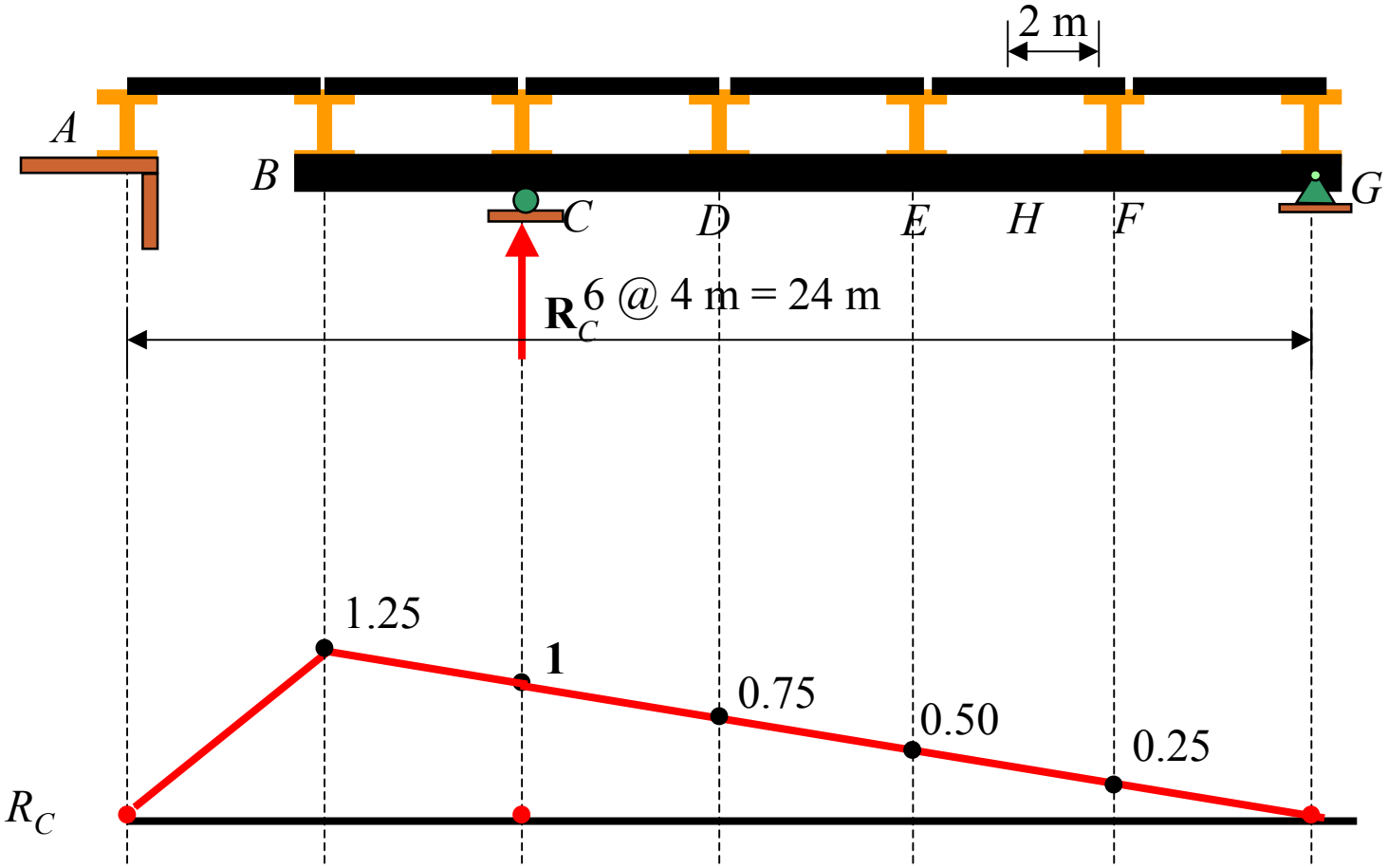
## Example 6-6

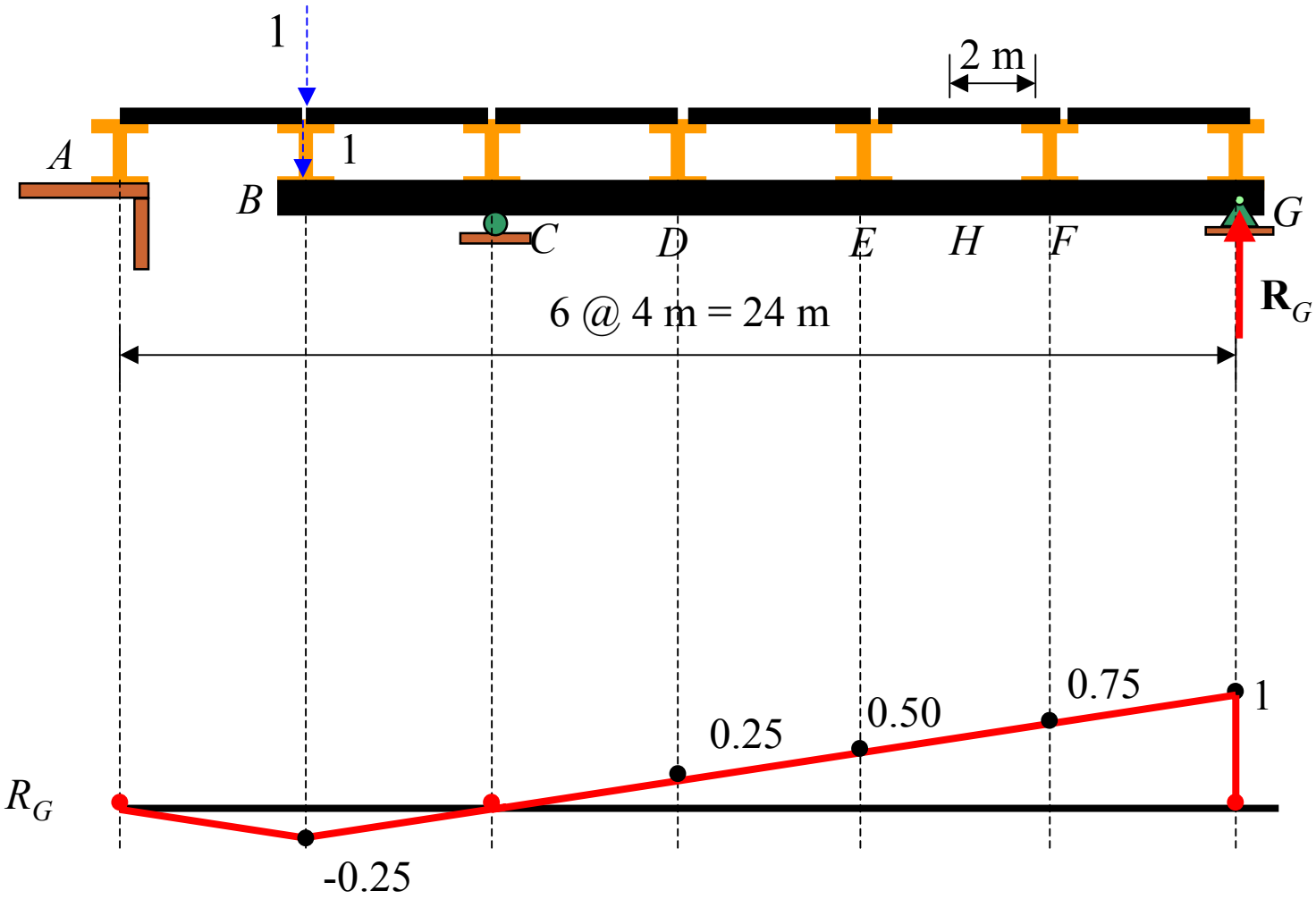
Draw the influence line diagrams of girder for

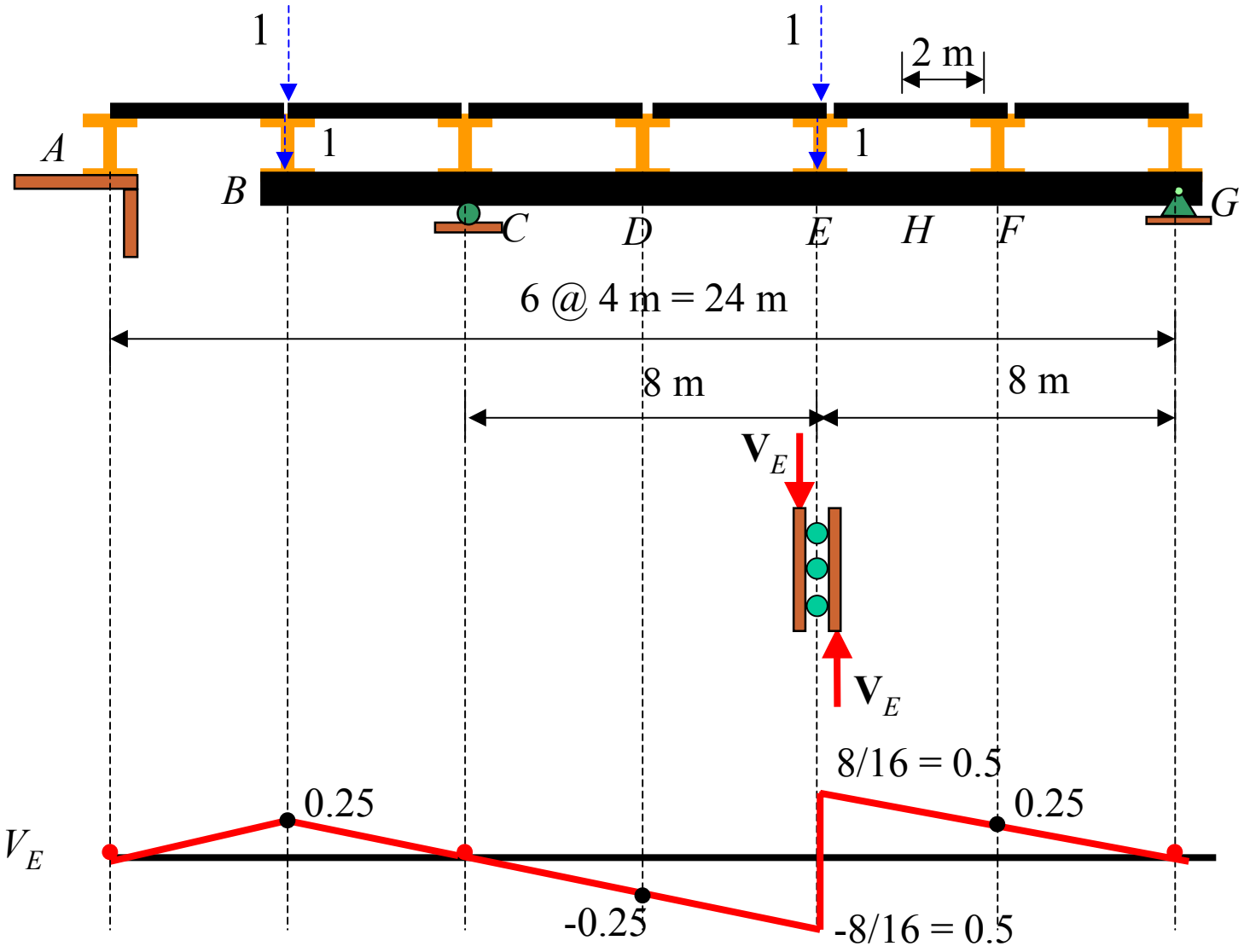
- the reaction at *C* and *G*,
- shear at *E* and *H*,
- bending moment at *H*.

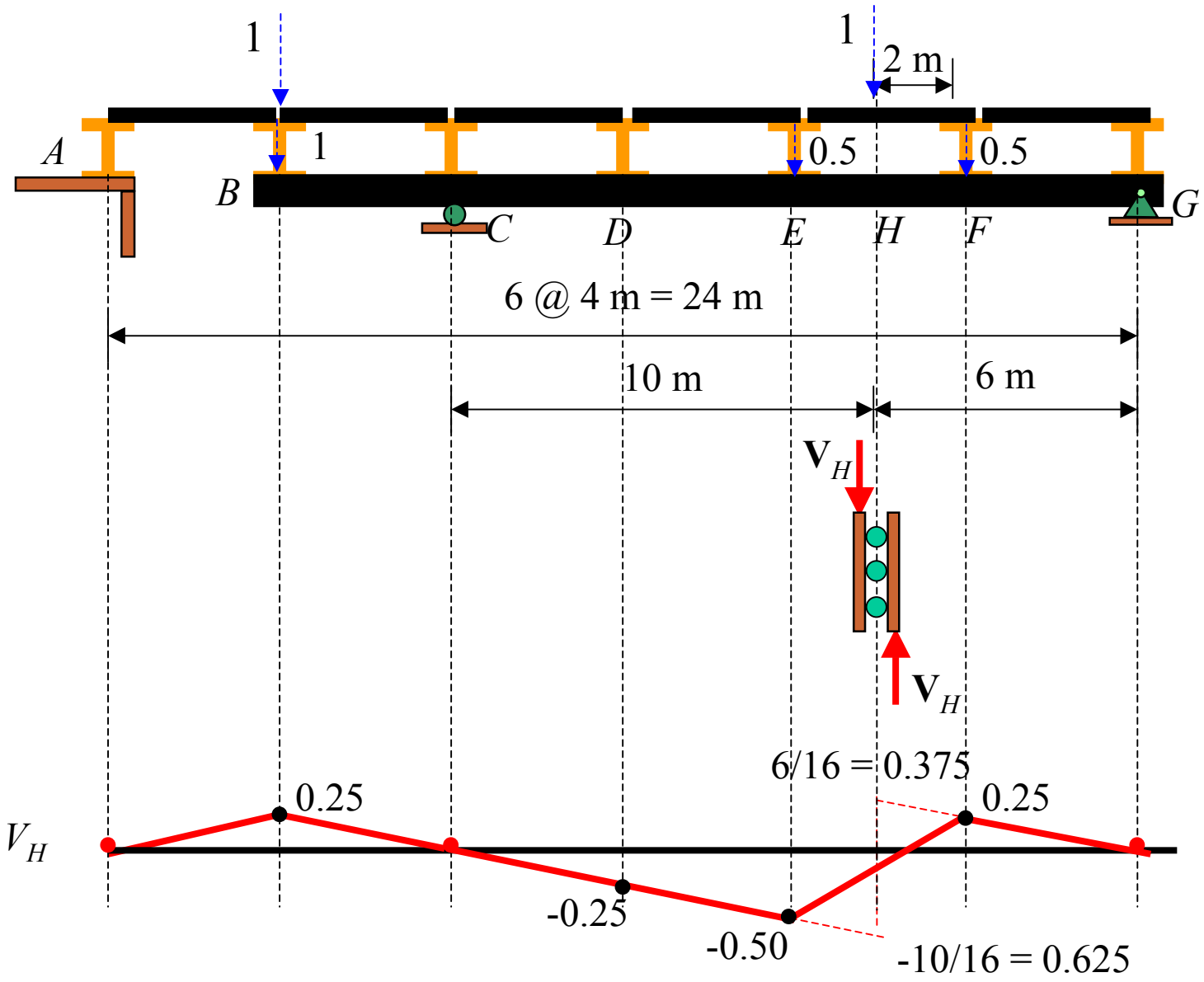


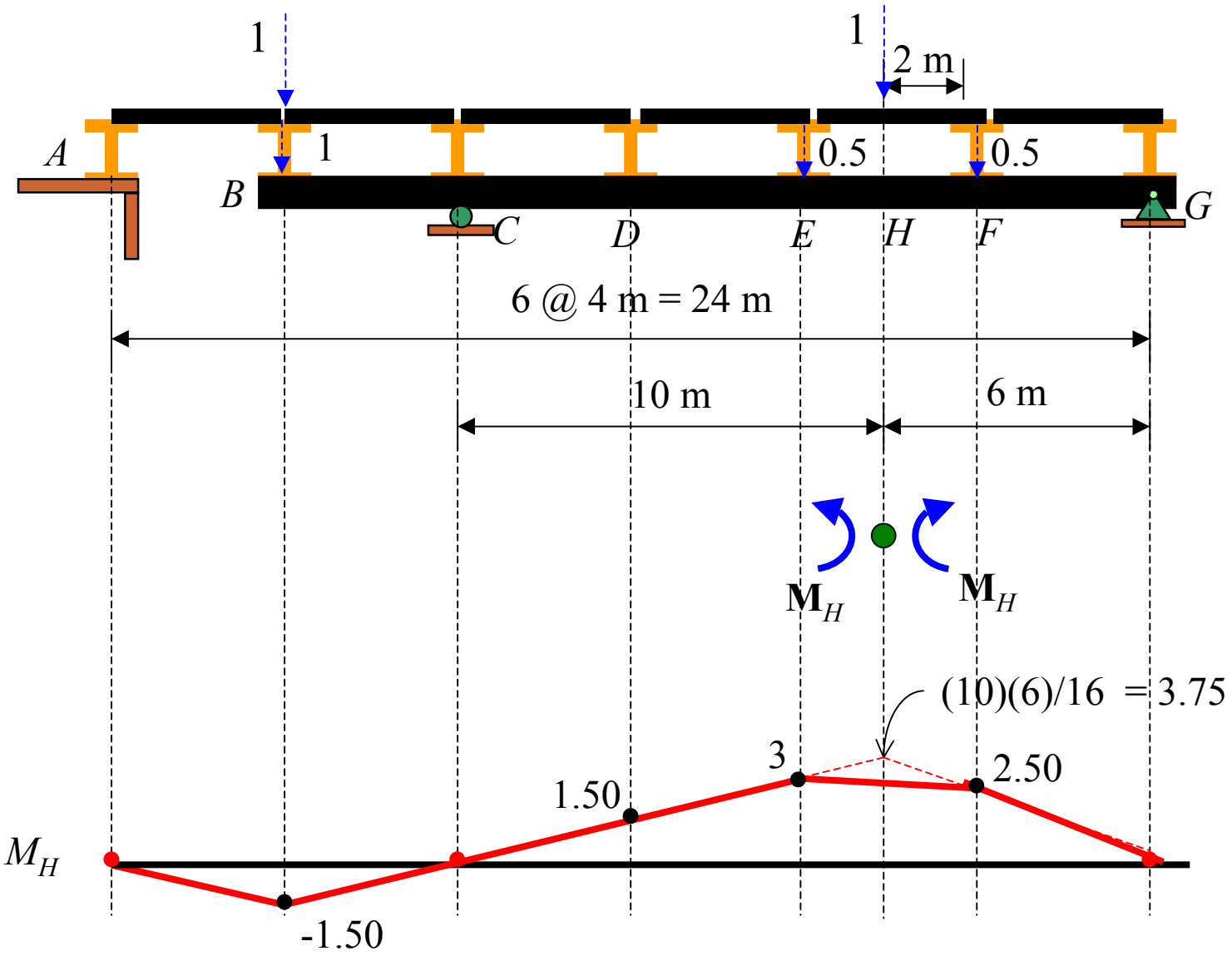
## SOLUTION



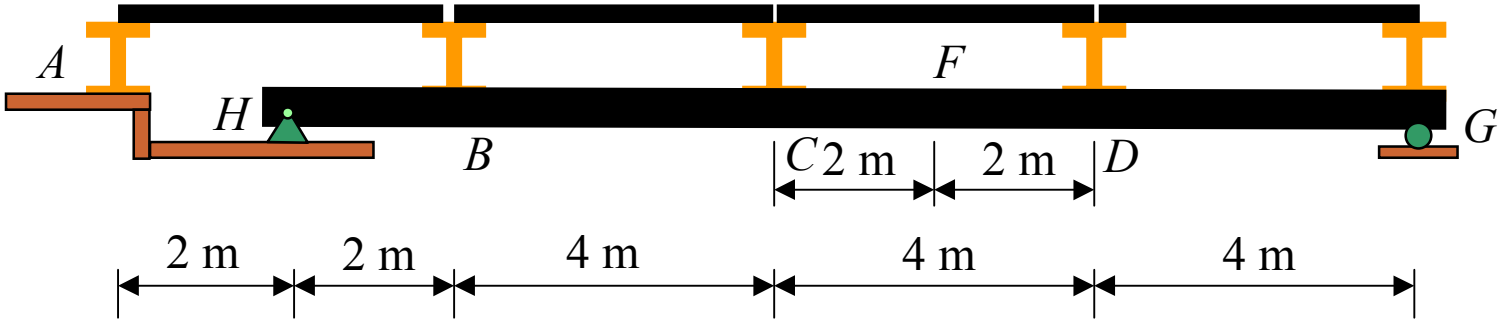

1
2 m
1
A
B
C
D
E
H
F
G
$\mathbf{R}_G$
6 @ 4 m = 24 m
$R_G$
0.25
0.50
0.75
1
-0.25


1
1
2 m
1
1
A
B
C
D
E
H
F
G
6 @ 4 m = 24 m
8 m
8 m
$\mathbf{V}_E$
$\mathbf{V}_E$
8/16 = 0.5
0.25
0.25
$V_E$
-0.25
-8/16 = 0.5


1
1
2 m
A
1
B
0.5
0.5
G
C
D
E
H
F
6 @ 4 m = 24 m
10 m
6 m
$V_H$
$V_H$
6/16 = 0.375
0.25
0.25
$V_H$
-0.25
-0.50
-10/16 = 0.625


1
1
2 m
A
1
0.5
0.5
B
C
D
E
H
F
G
6 @ 4 m = 24 m
10 m
6 m
M_H
M_H
(10)(6)/16 = 3.75
3
2.50
1.50
M_H
-1.50

## Example 6-7




Draw the influence for

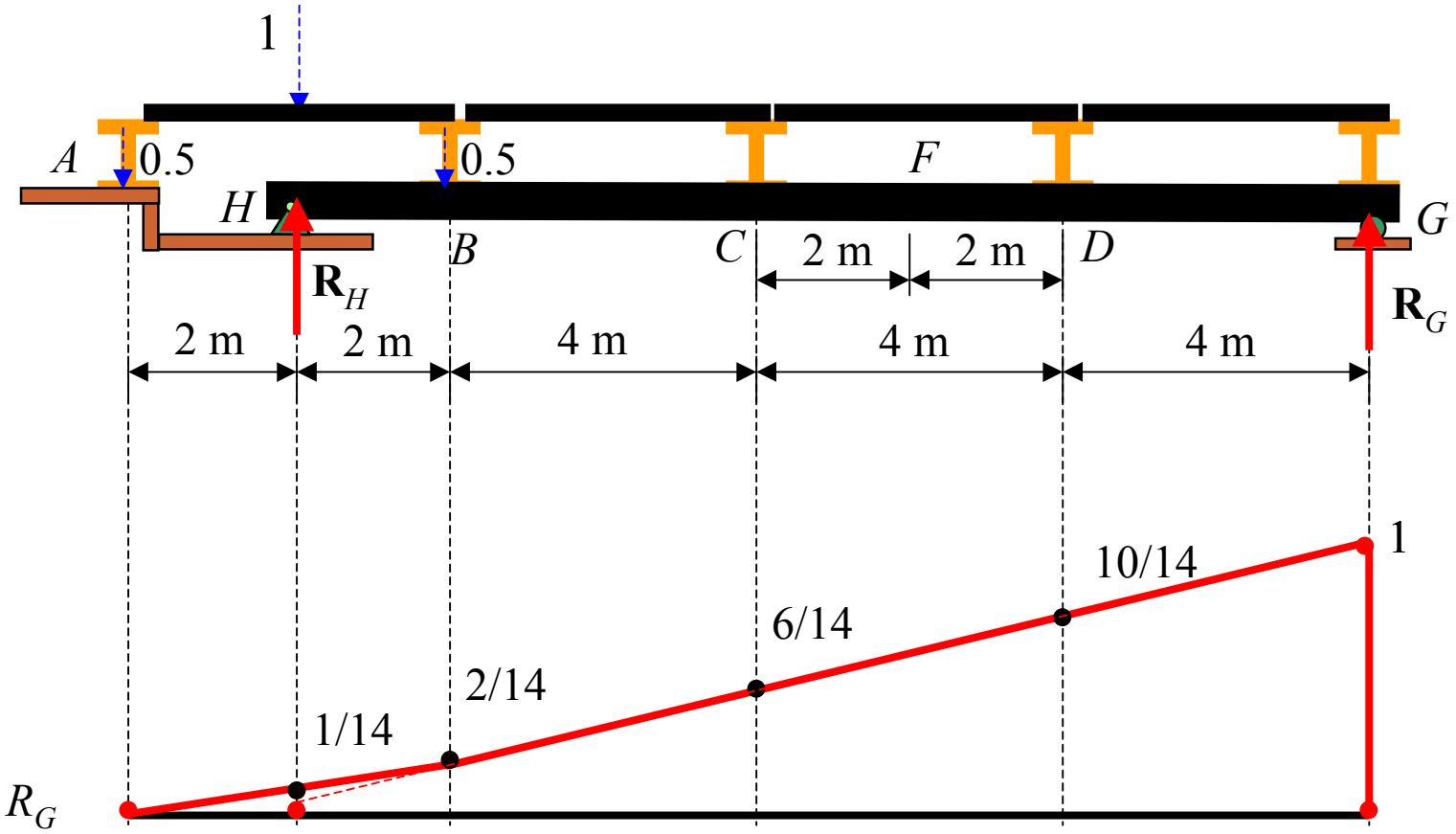
- the Reaction $R_G$ and $R_H$
- Shear $V_C$ and $V_{CD}$
- the moment $M_C$, $M_D$, and $M_F$

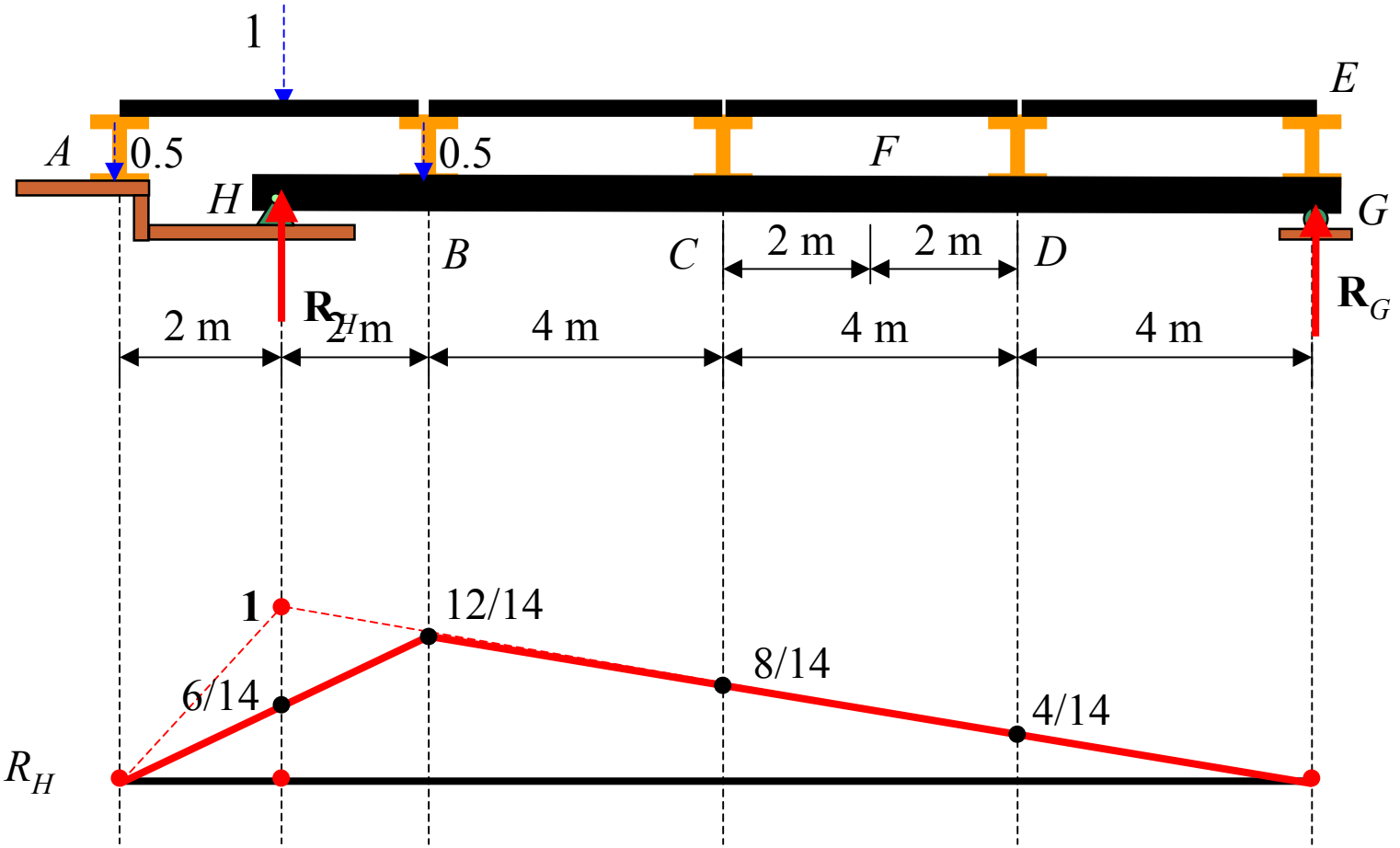
and determine the maximum for

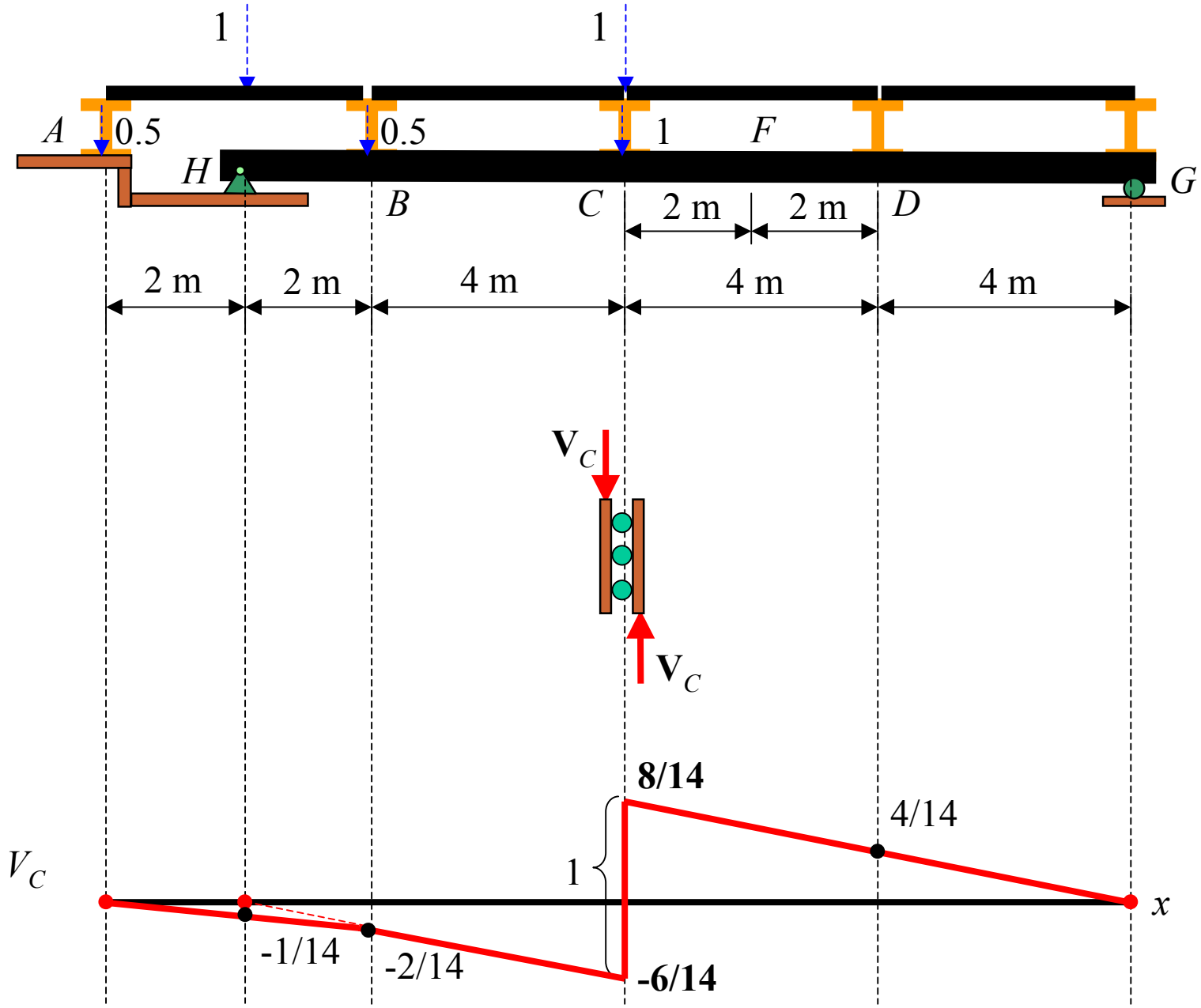
- the Reaction $(R_G)_{max}$ and $(R_H)_{max}$
- Shear $(V_{CD})_{max}$

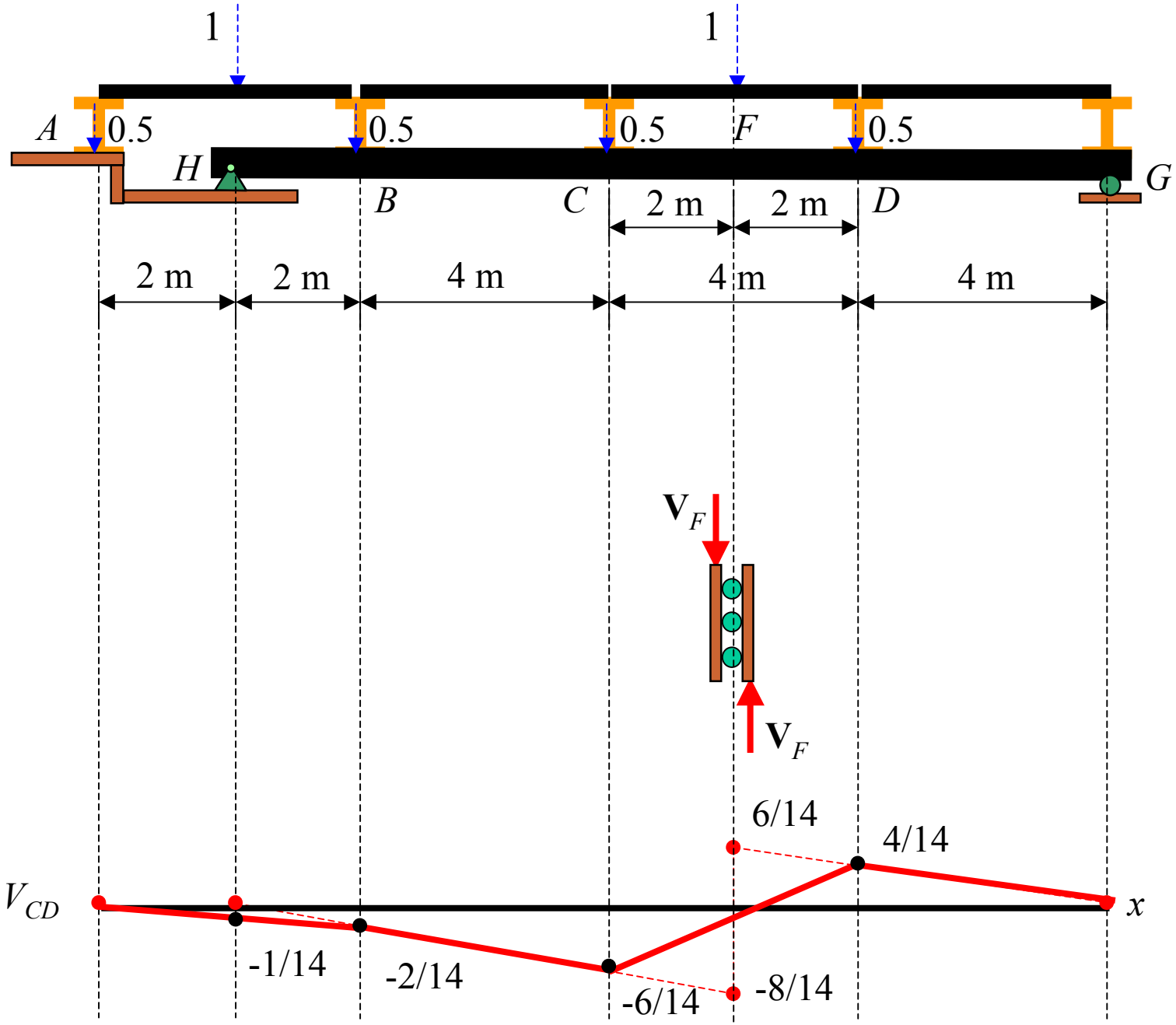
due to

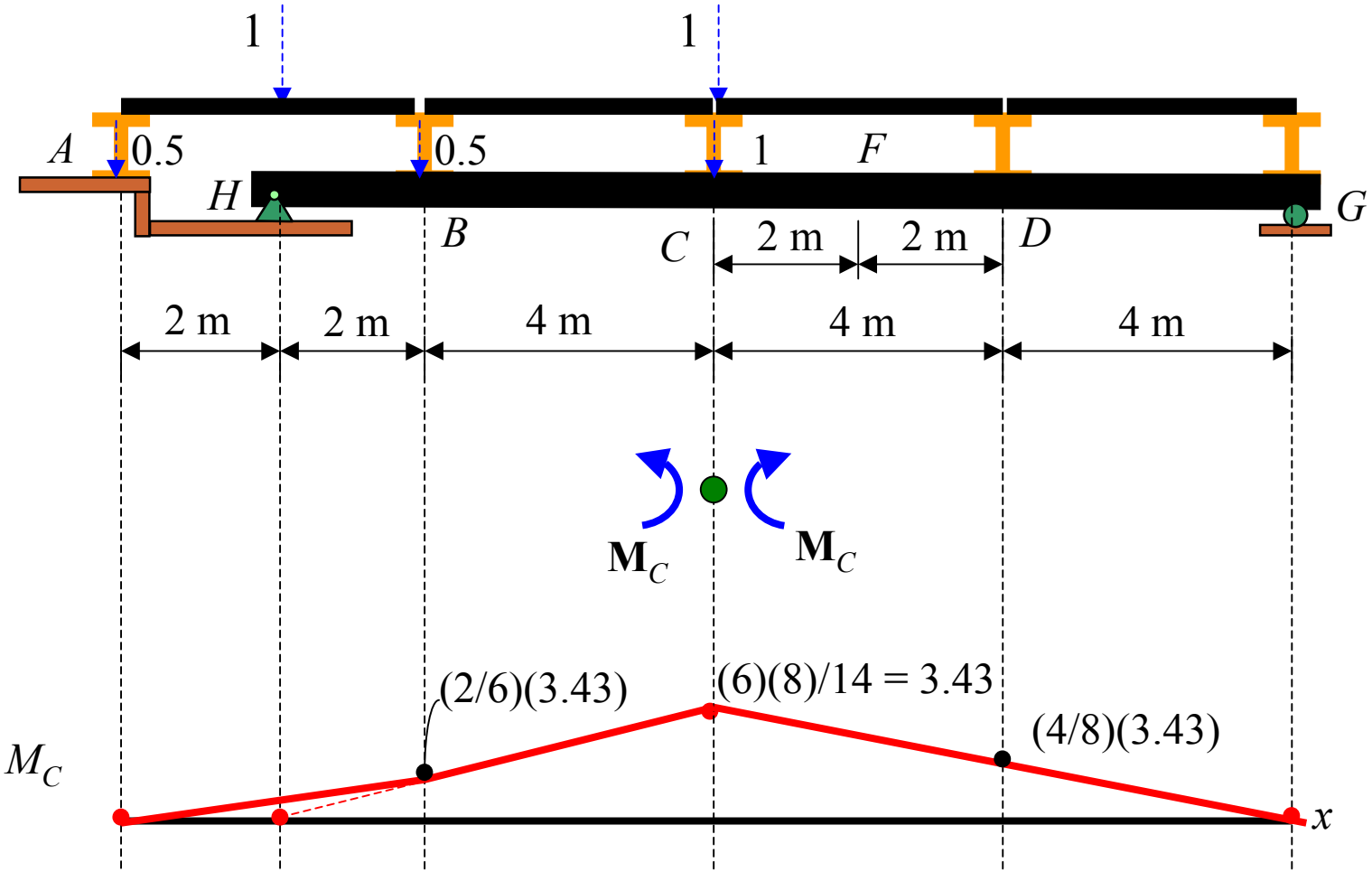
- a uniform dead load 2 kN/m
- a uniform live load 5 kN/m
- a concentrated live load 50 kN

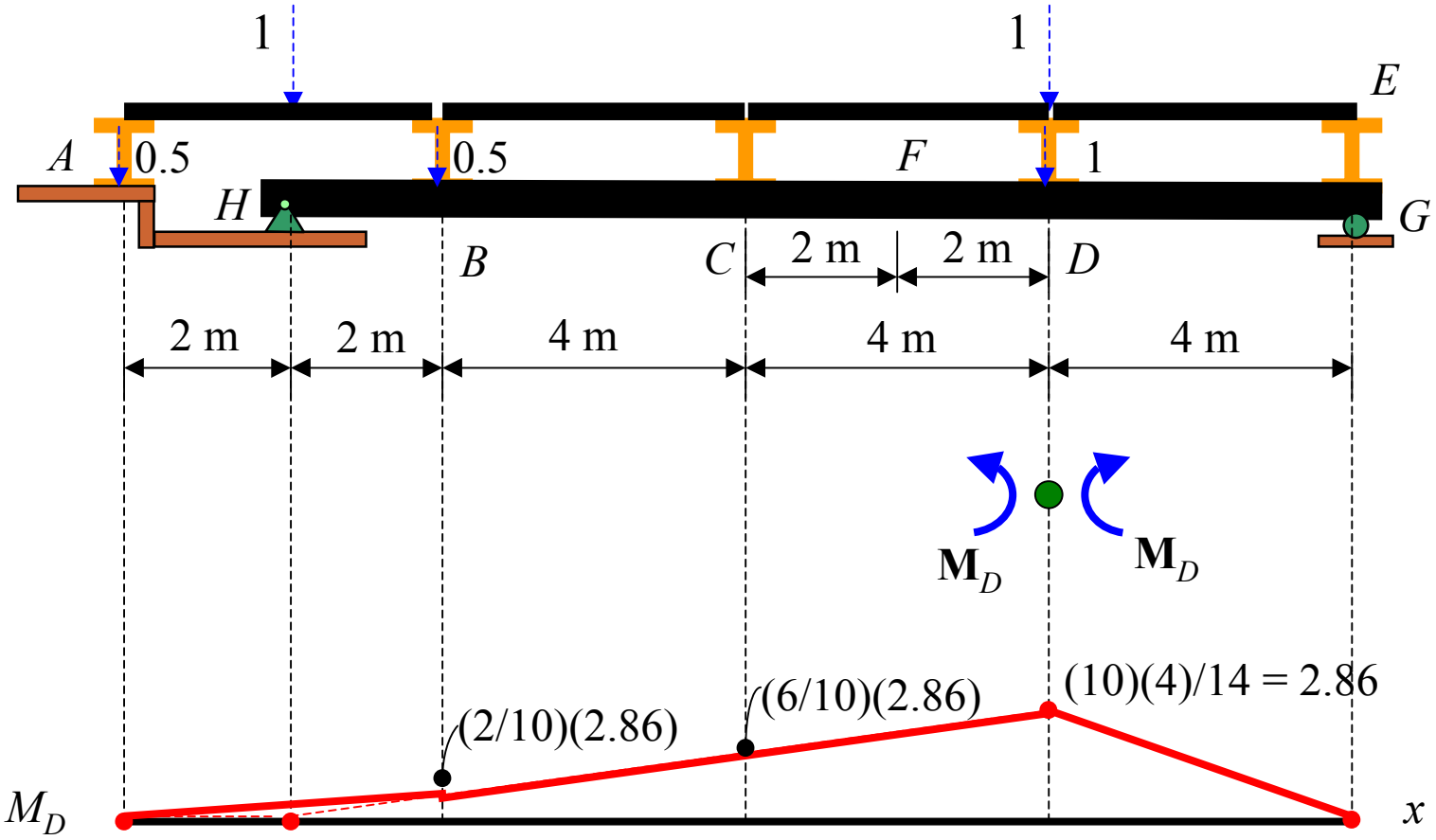

1
A
0.5
0.5
F
H
G
B
C
2 m
2 m
D
$\mathbf{R}_H$
$\mathbf{R}_G$
2 m
2 m
4 m
4 m
4 m
1
10/14
6/14
2/14
1/14
$R_G$

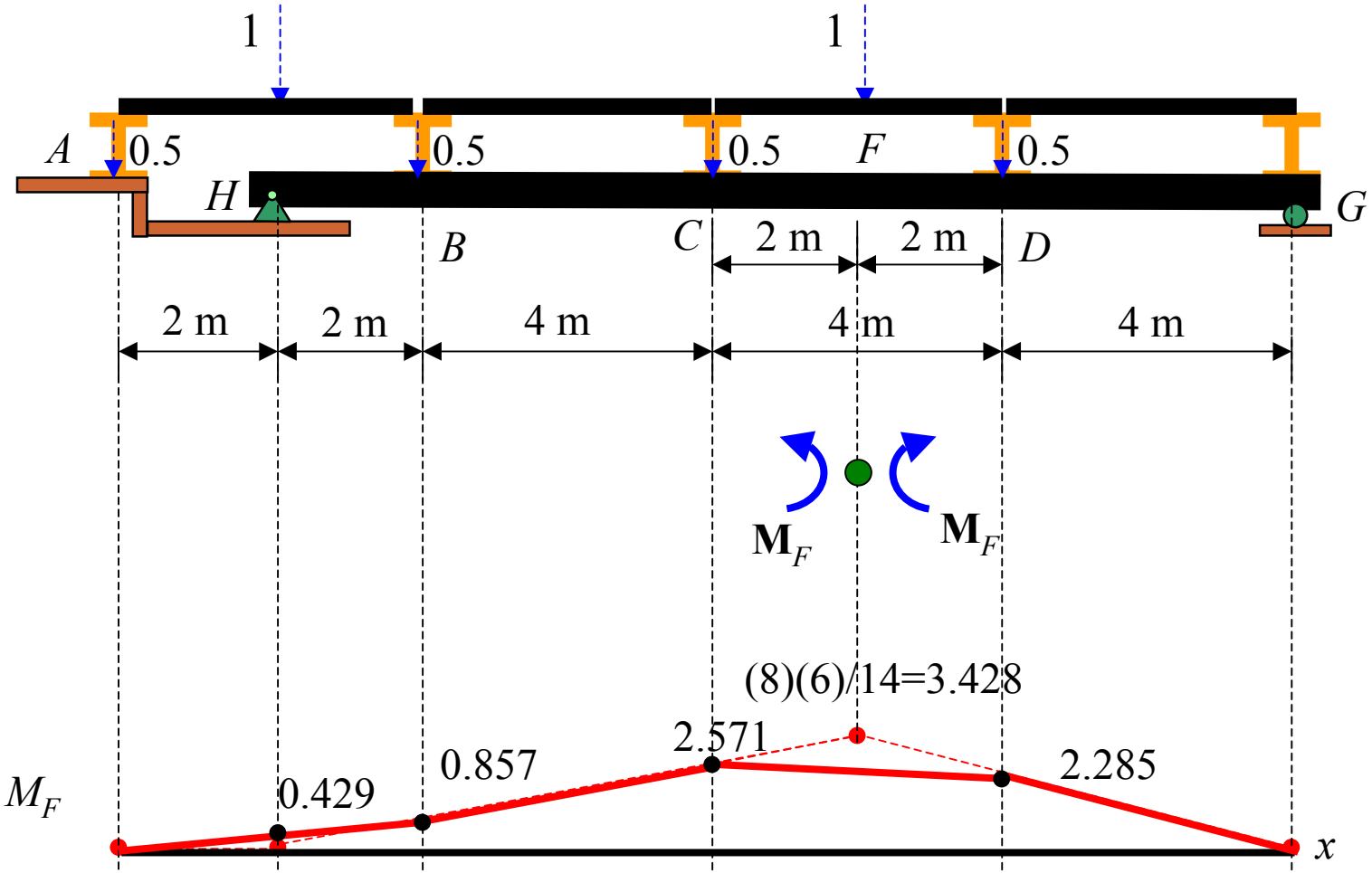

1
A
0.5
0.5
H
B
C
F
E
G
D
2 m
2 m
2 m
4 m
4 m
4 m
$\mathbf{R}_H$
$\mathbf{R}_G$
1
12/14
8/14
6/14
4/14
$R_H$


1
1
A
0.5
0.5
1
F
H
B
C
2 m
2 m
D
G
2 m
2 m
4 m
4 m
4 m
$V_C$
$V_C$
$V_C$
8/14
4/14
1
x
-1/14
-2/14
-6/14

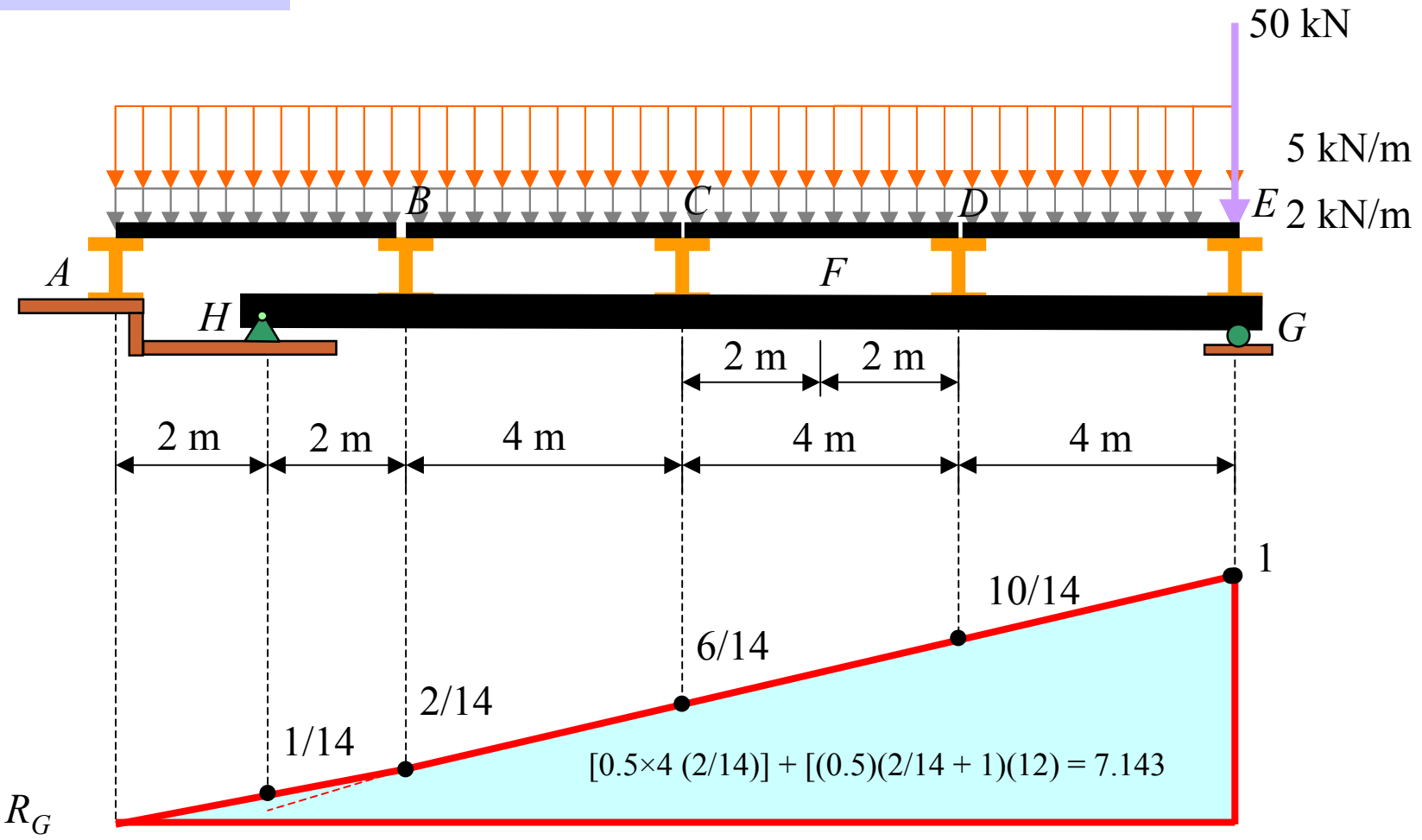

1
1
A
0.5
0.5
0.5
F
0.5
H
B
C
2 m
2 m
D
G
2 m
2 m
4 m
4 m
4 m
V_F
V_F
6/14
4/14
V_CD
x
-1/14
-2/14
-6/14
-8/14


1
1
A
0.5
0.5
1
F
H
B
C
2 m
2 m
D
G
2 m
2 m
4 m
4 m
4 m
M_C
M_C
(2/6)(3.43)
(6)(8)/14 = 3.43
(4/8)(3.43)
M_C
x


1
1
E
A
0.5
0.5
F
1
H
G
B
C
2 m
2 m
D
2 m
2 m
4 m
4 m
4 m
$\mathbf{M}_D$
$\mathbf{M}_D$
(2/10)(2.86)
(6/10)(2.86)
(10)(4)/14 = 2.86
$M_D$
x


1
1
A
0.5
0.5
0.5
F
0.5
H
G
B
C
2 m
2 m
D
2 m
2 m
4 m
4 m
4 m
M_F
M_F
(8)(6)/14=3.428
2.571
0.857
2.285
M_F
0.429
x

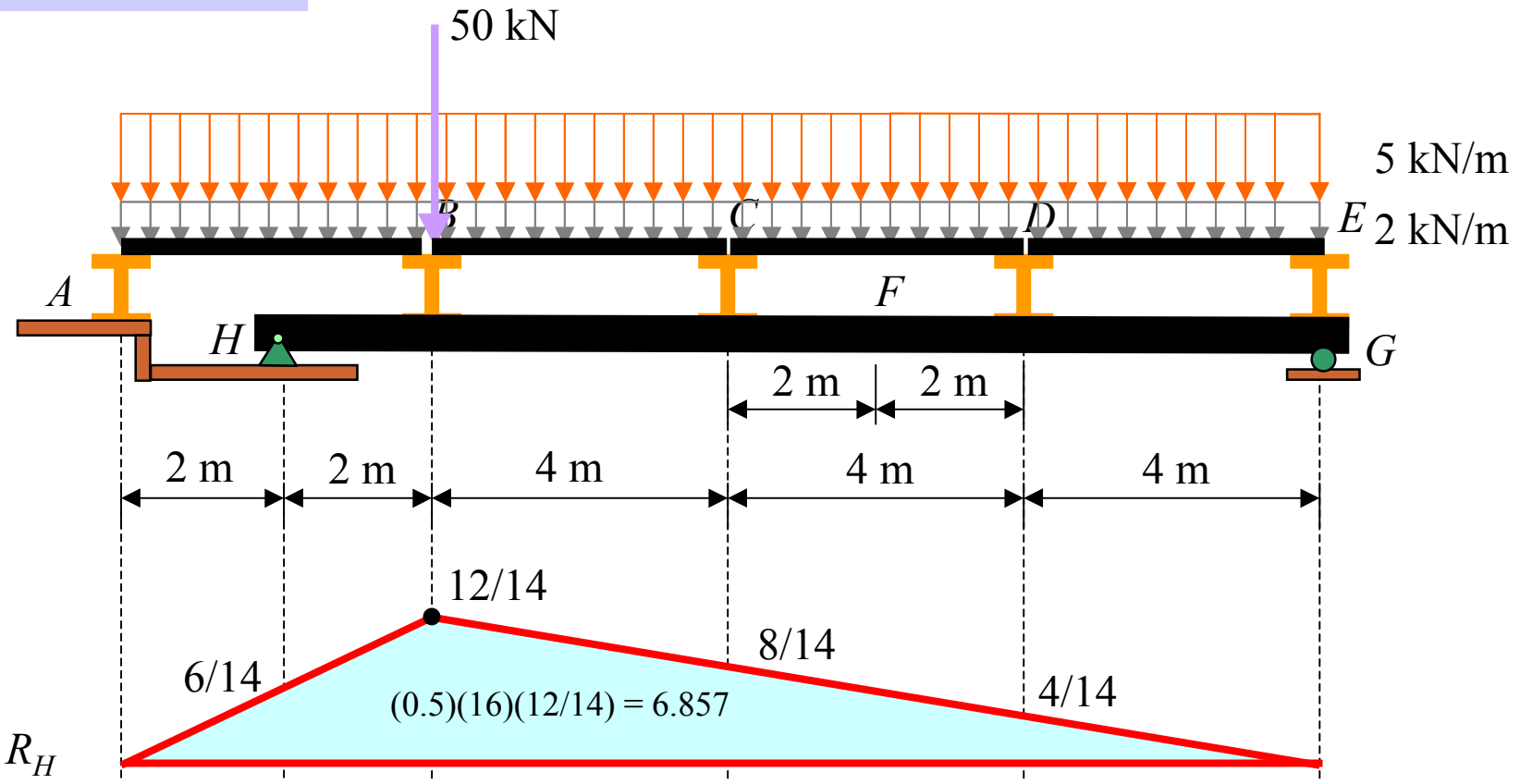
## Maximum Reaction




$$(R_G)_{max} = (2)(7.143) + (5)(7.143) + (50)(1)$$

$$= 100 \text{ kN}$$

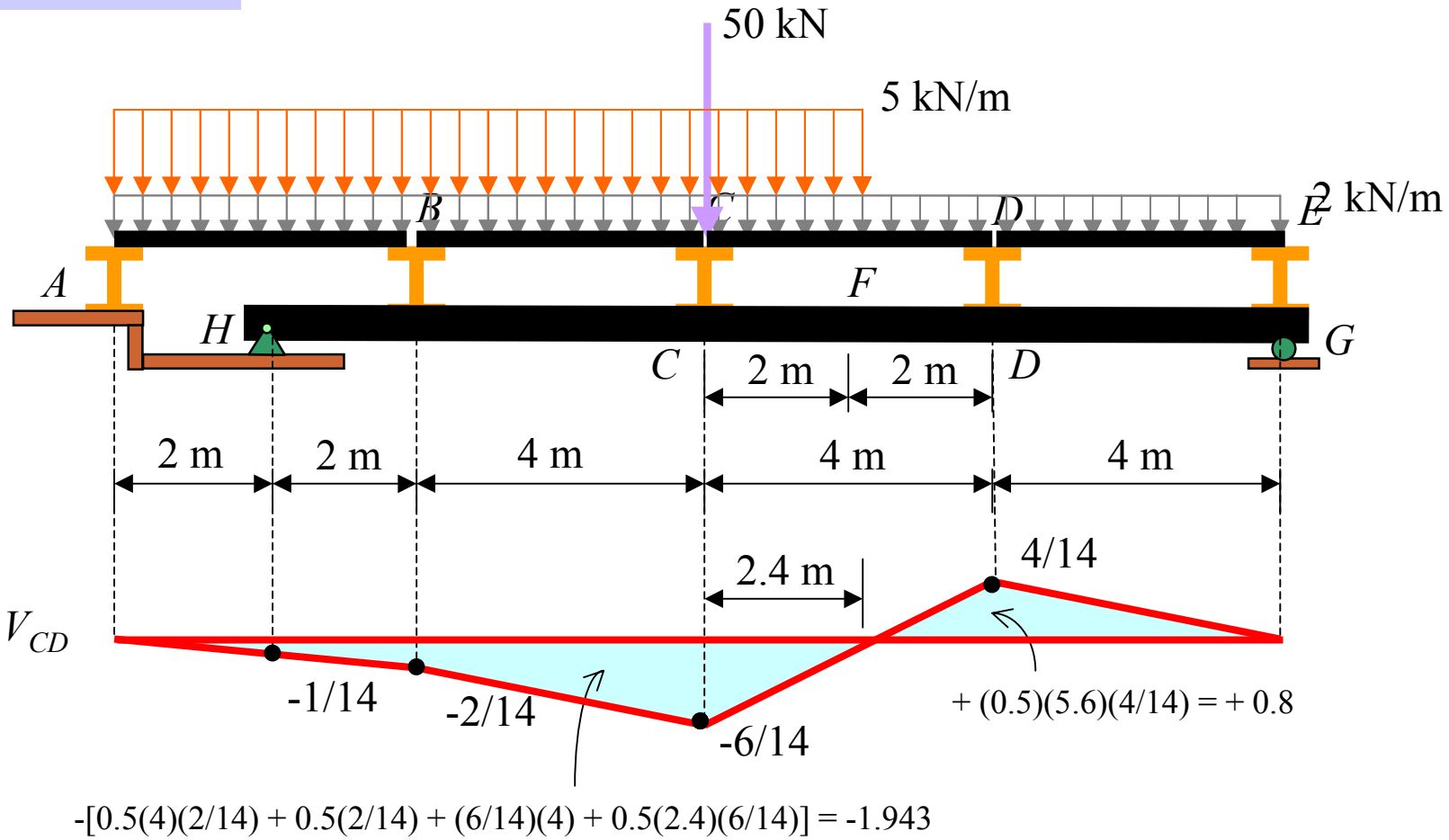
## Maximum Reaction




$$(R_H)_{\max} = \quad (2)(6.857) \quad + (5)(6.857) \quad + (50)(12/14)$$

$$= 90.86 \text{ kN}$$

## Maximum Shear




$$(V_{CD})_{max} = (2)(-1.943 + 0.8) \quad (5)(-1.943) \quad + (50)(-6/14)$$

$$= -33.43 \text{ kN}$$

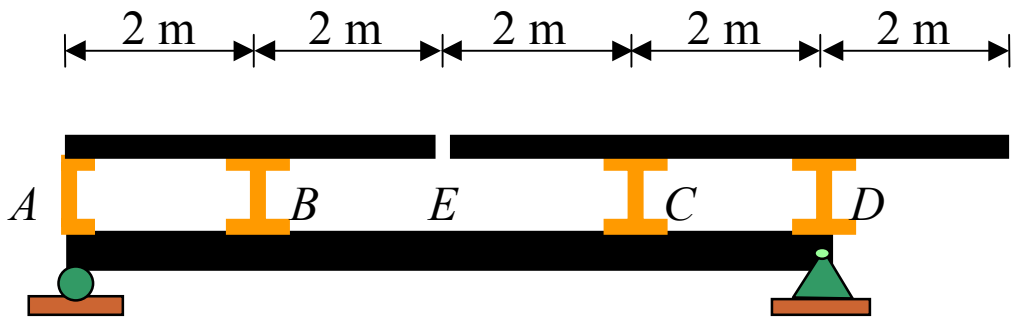
**SP 6-1**

Draw the influence line for

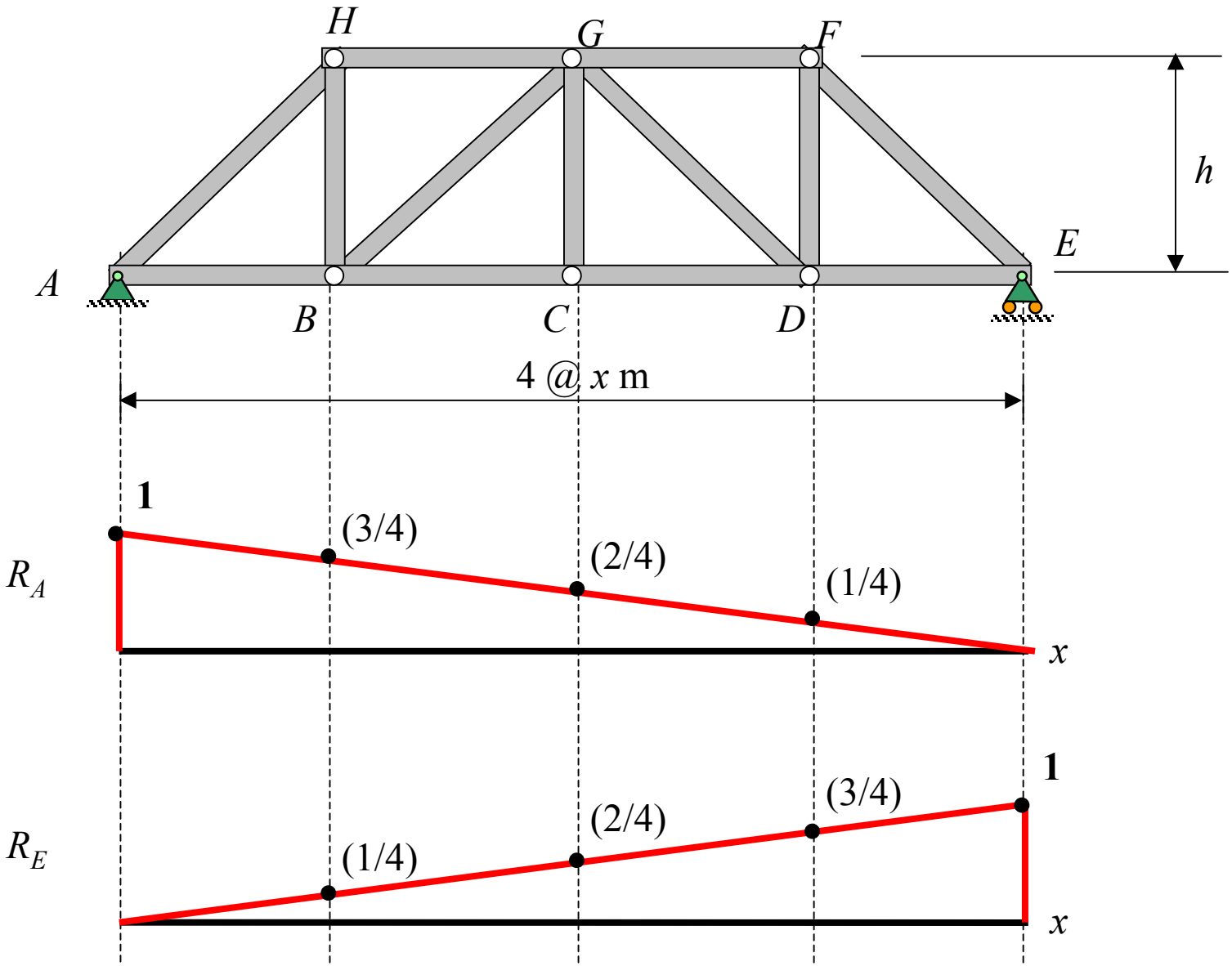
-the reaction at support *A* and *D*

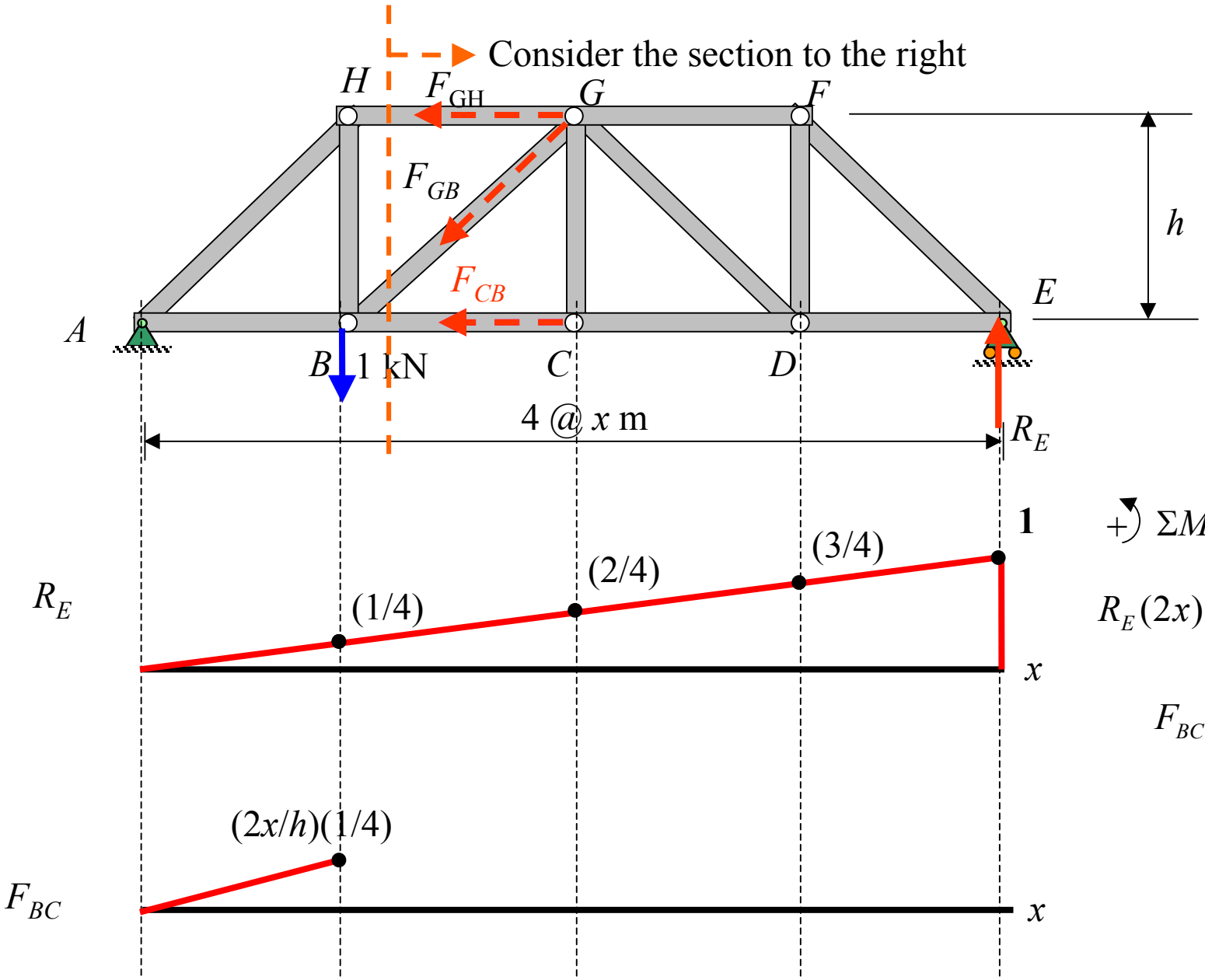
-the shear and moment at *E*

- the moment at *B* and *C* .



# Influence Line for Trusses

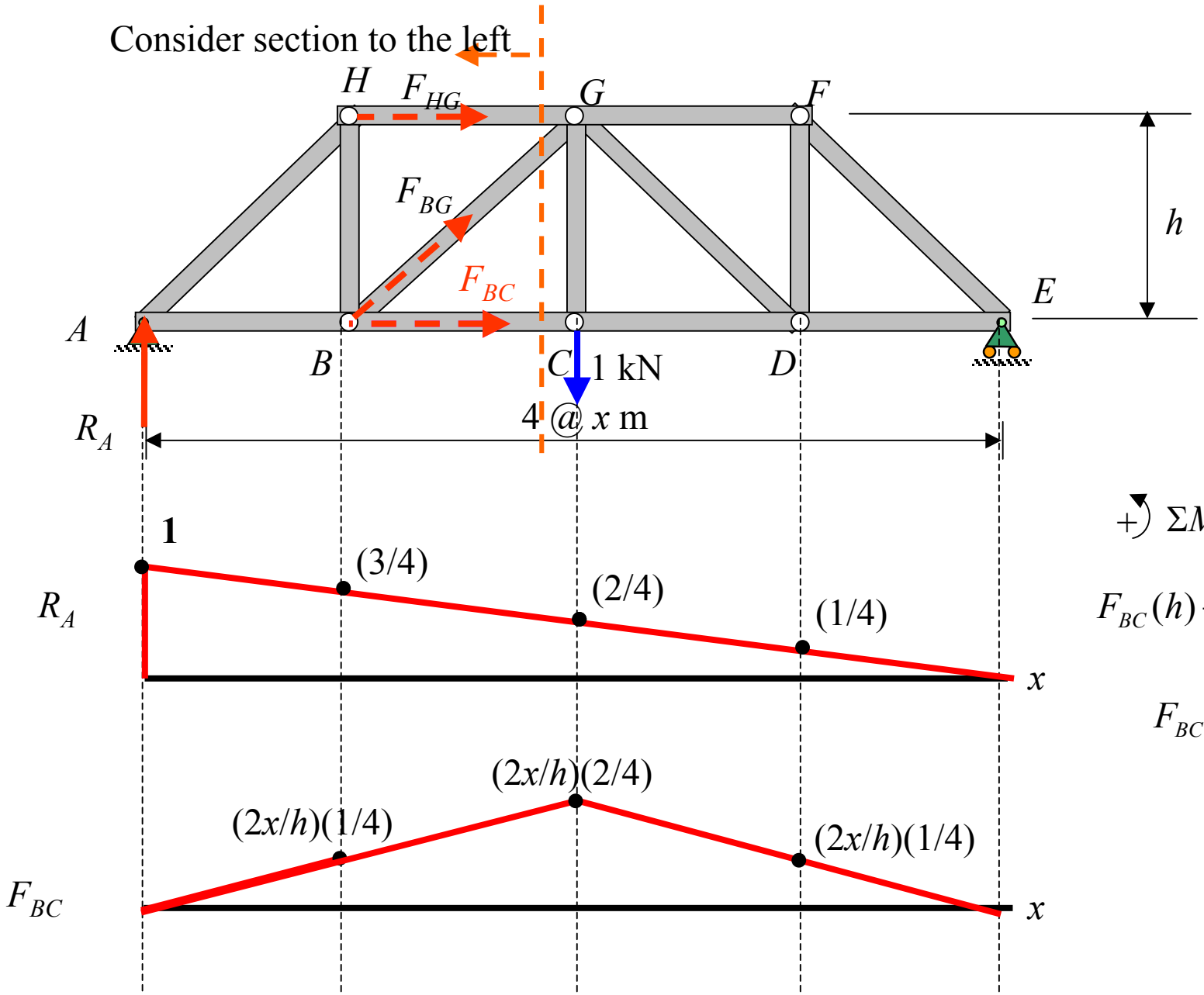





$+\circlearrowleft \Sigma M_G = 0$:

$$R_E(2x) - F_{BC}(h) = 0$$

$$F_{BC} = \frac{2x}{h} R_E$$

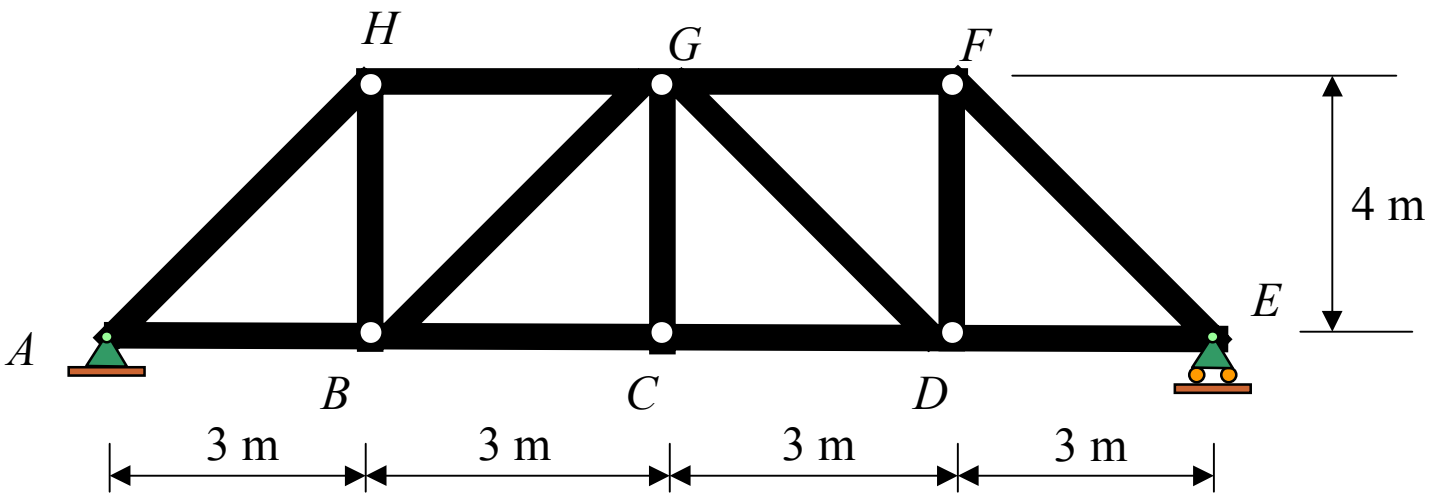


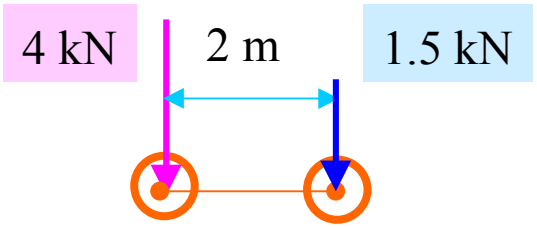

$+\circlearrowleft \Sigma M_G = 0$:

$$F_{BC}(h) - R_A(2x) = 0$$

$$F_{BC} = \frac{2x}{h} R_A$$

## Example 6-8-1

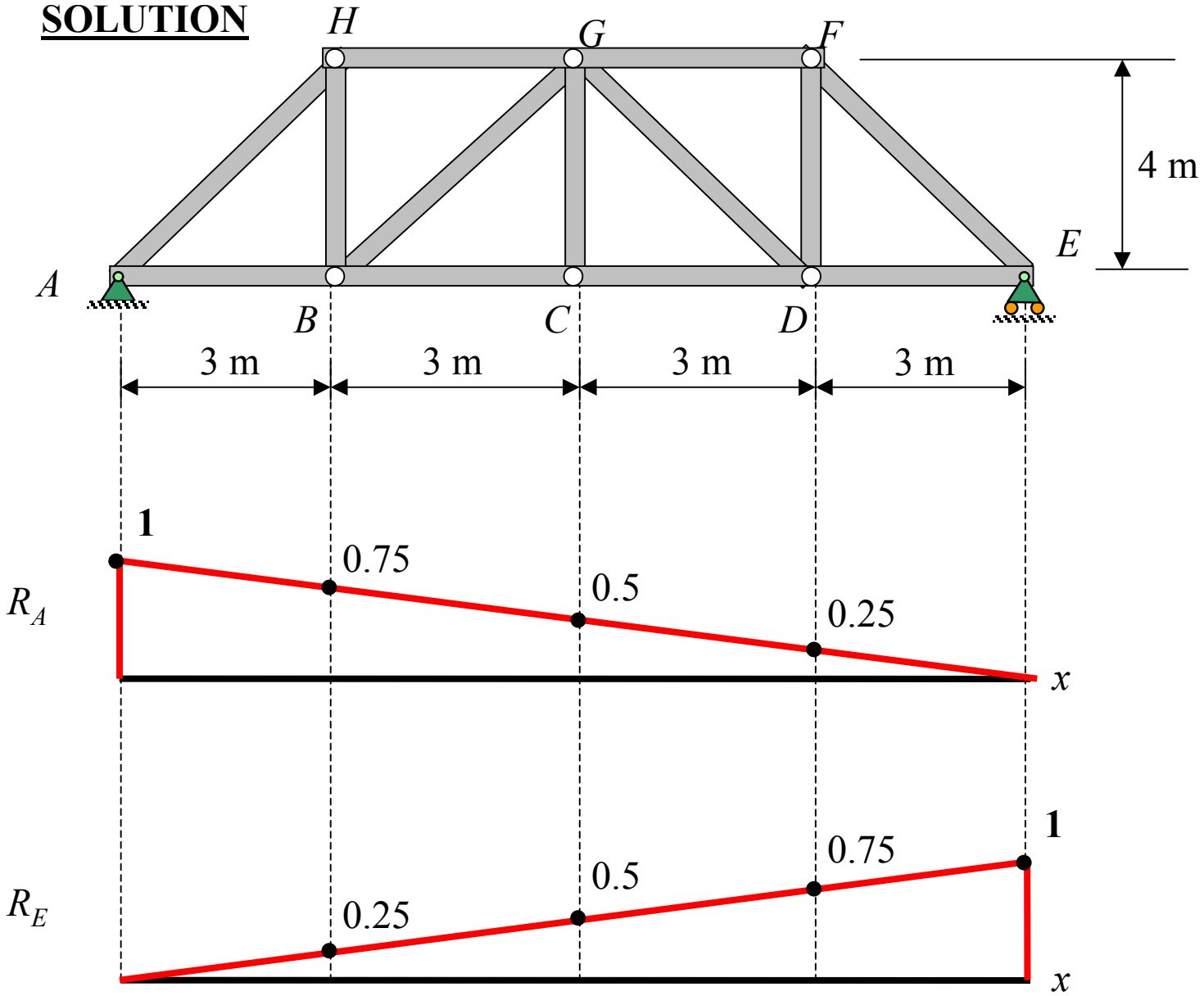


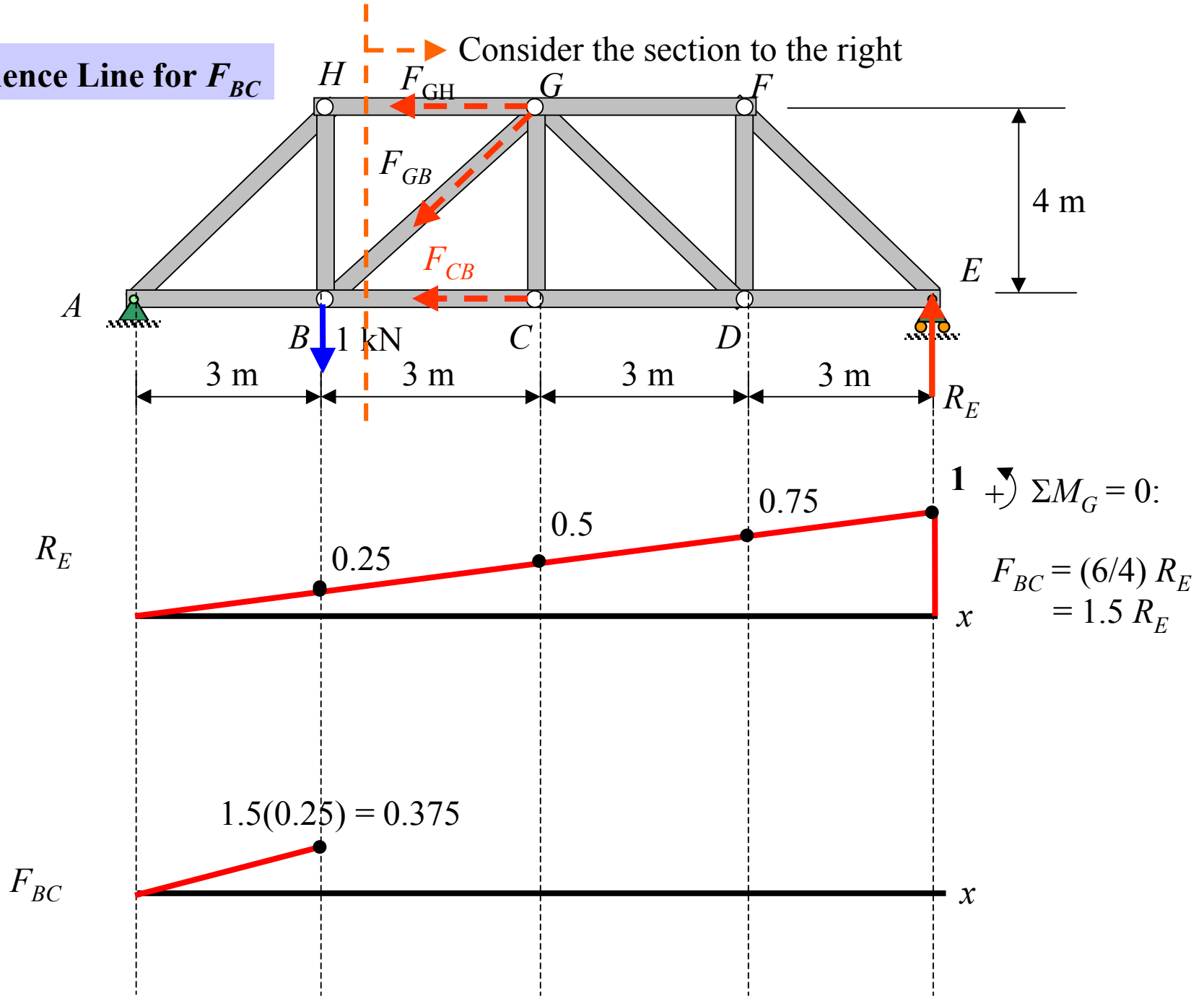

the wheel loads of the car

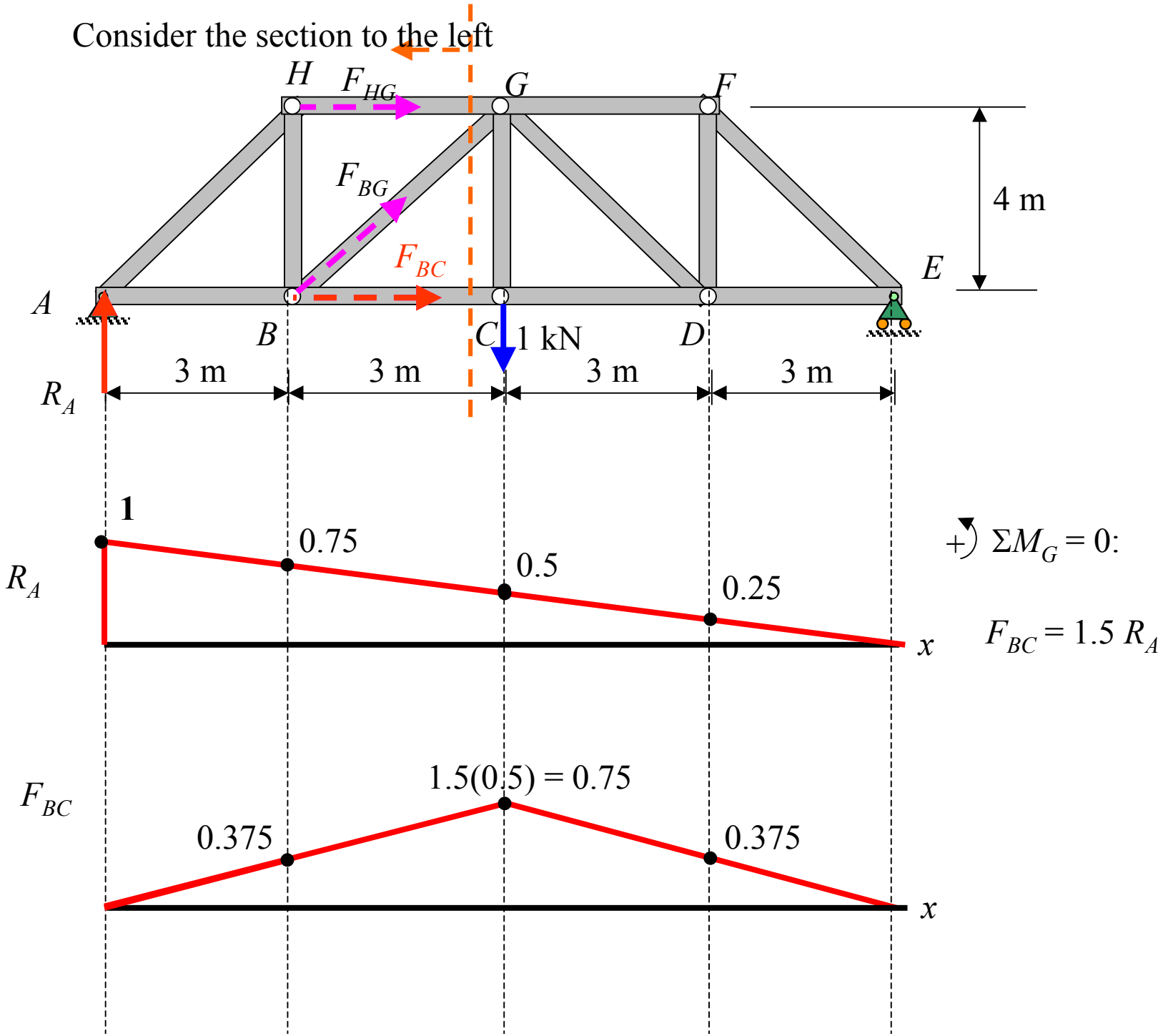
Determine the **maximum force** developed in member *BC* , *BG,* and *CG* of the truss due to the wheel loads of the car. Assume the loads are applied directly to the truss.

**SOLUTION**

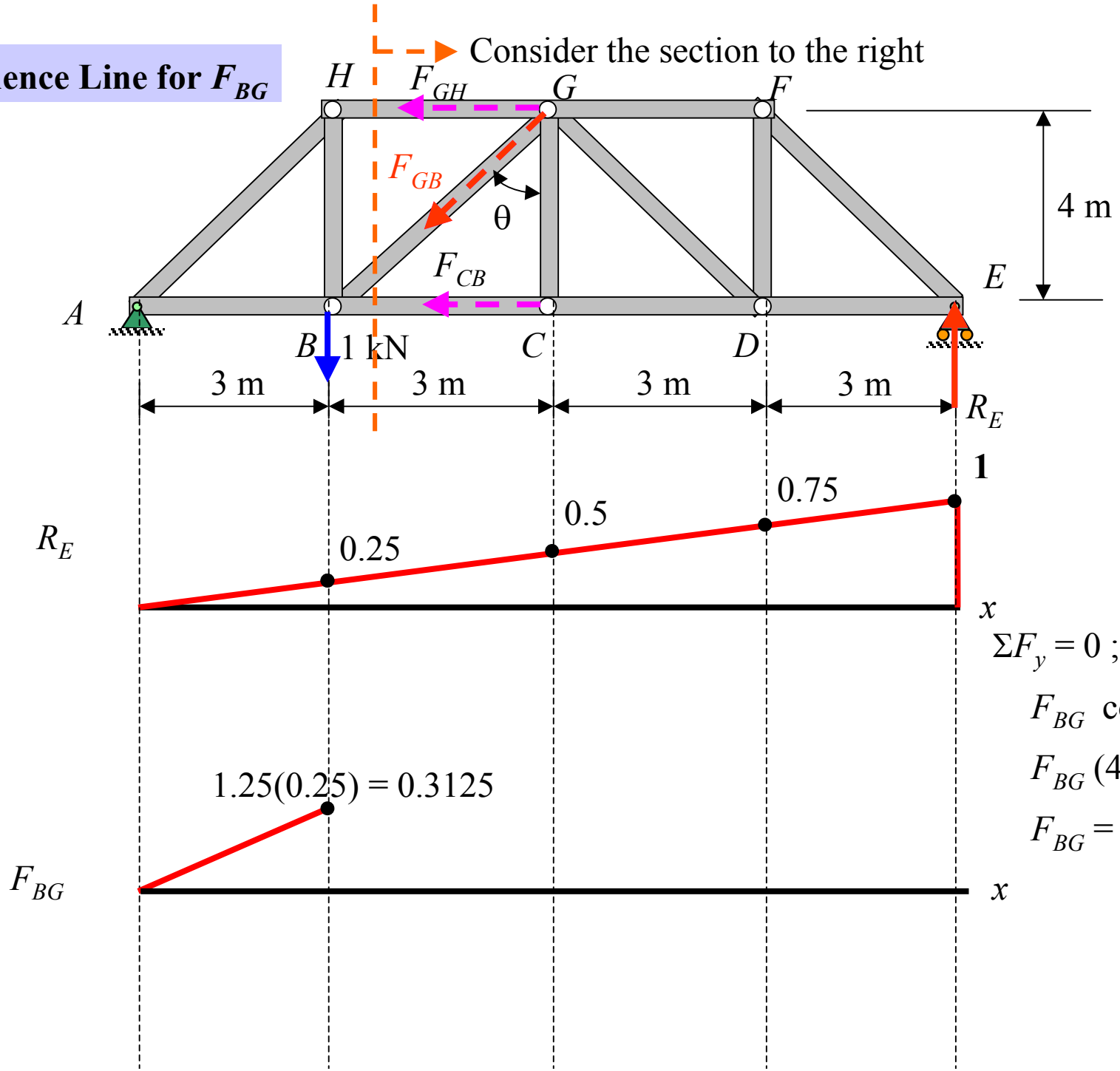


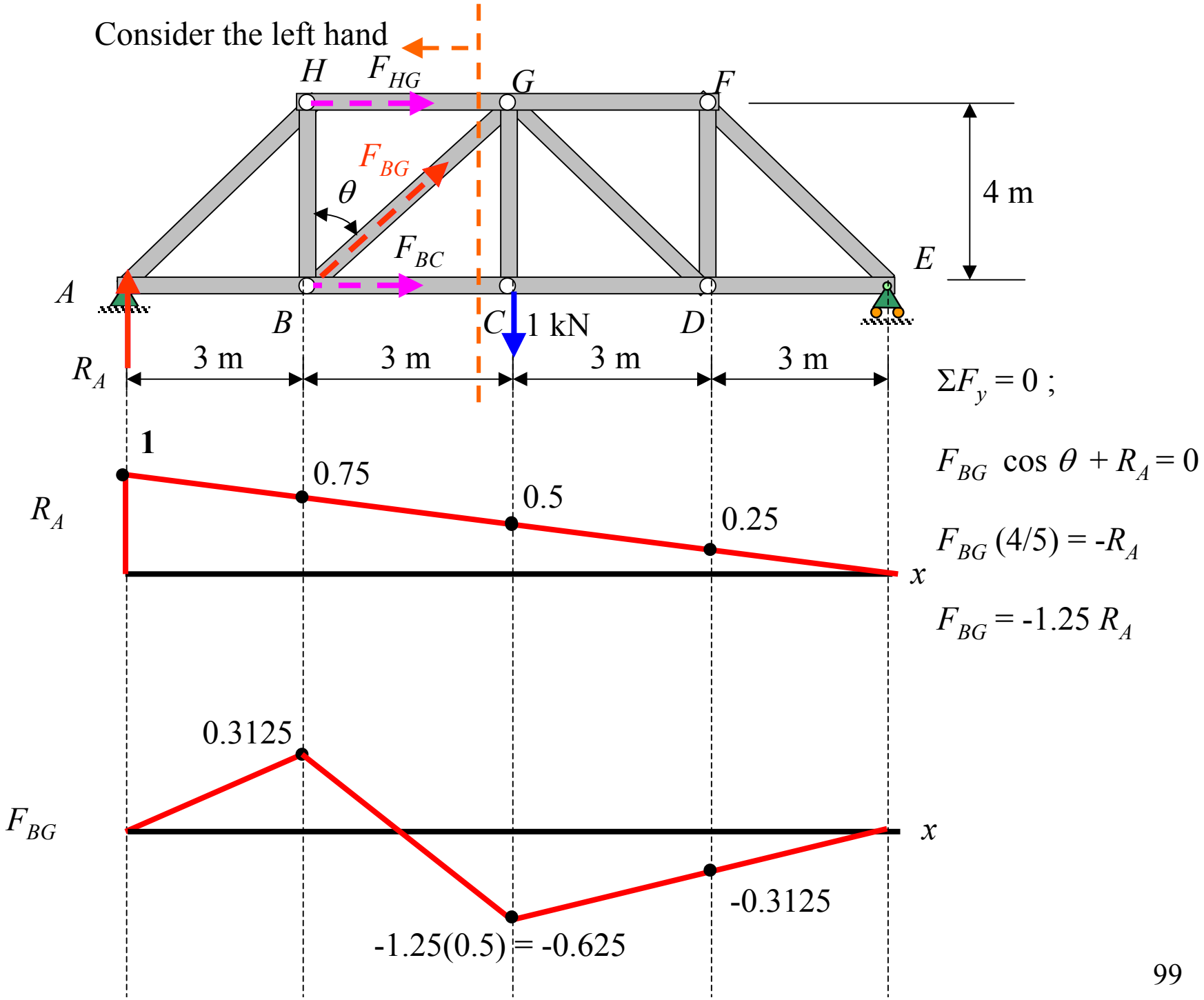
## Influence Line for $F_{BC}$




Consider the section to the left
H
$F_{HG}$
G
F
$F_{BG}$
$F_{BC}$
4 m
E
A
B
C
1 kN
D
3 m
3 m
3 m
3 m
$R_A$
1
0.75
0.5
0.25
x
$R_A$
$+\circlearrowleft \Sigma M_G = 0$:
$F_{BC} = 1.5\ R_A$
$F_{BC}$
1.5(0.5) = 0.75
0.375
0.375
x

## Influence Line for $F_{BG}$





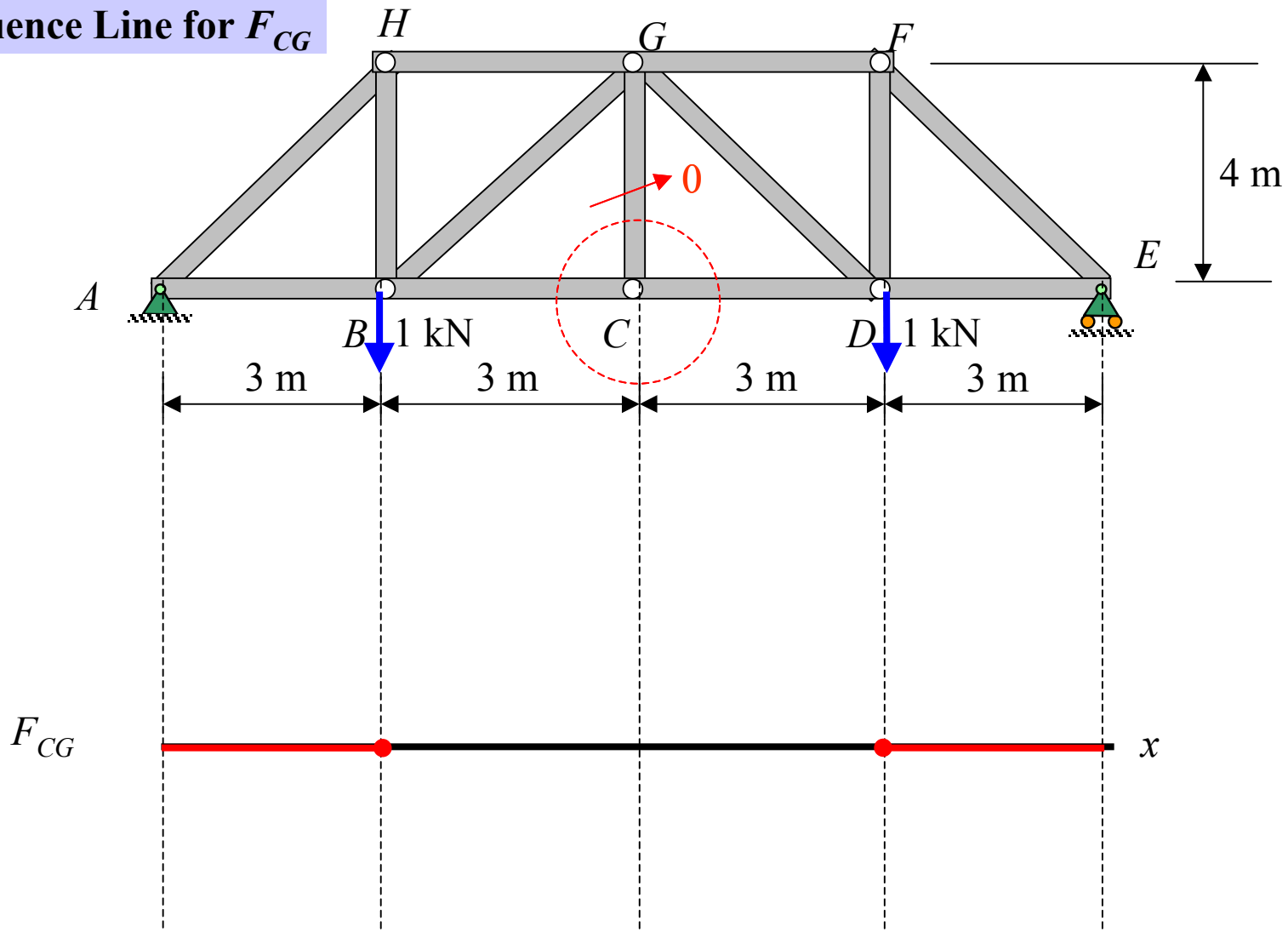

$\Sigma F_y = 0$ ;

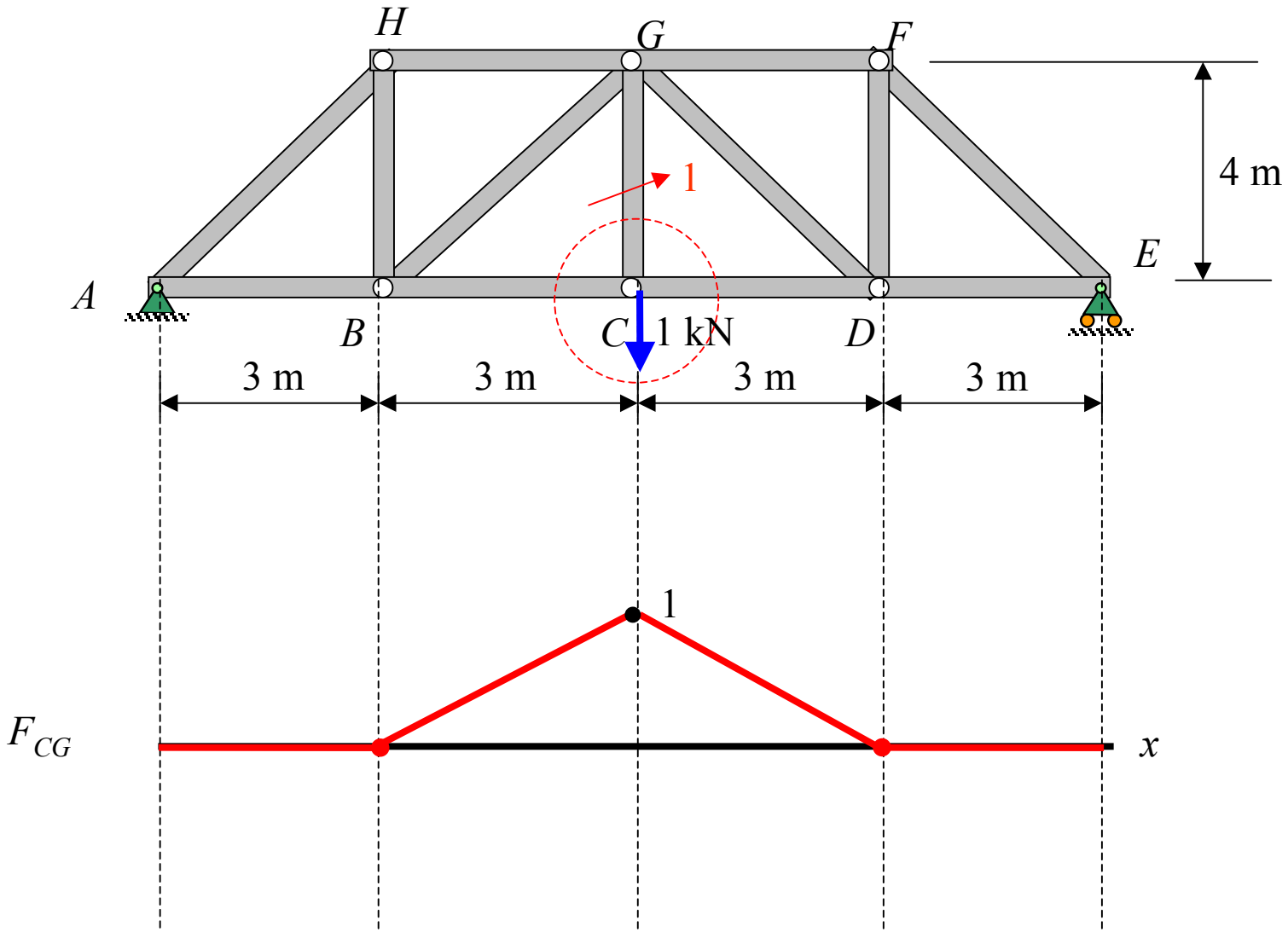
$F_{BG} \cos\theta + R_A = 0$

$F_{BG}\,(4/5) = -R_A$

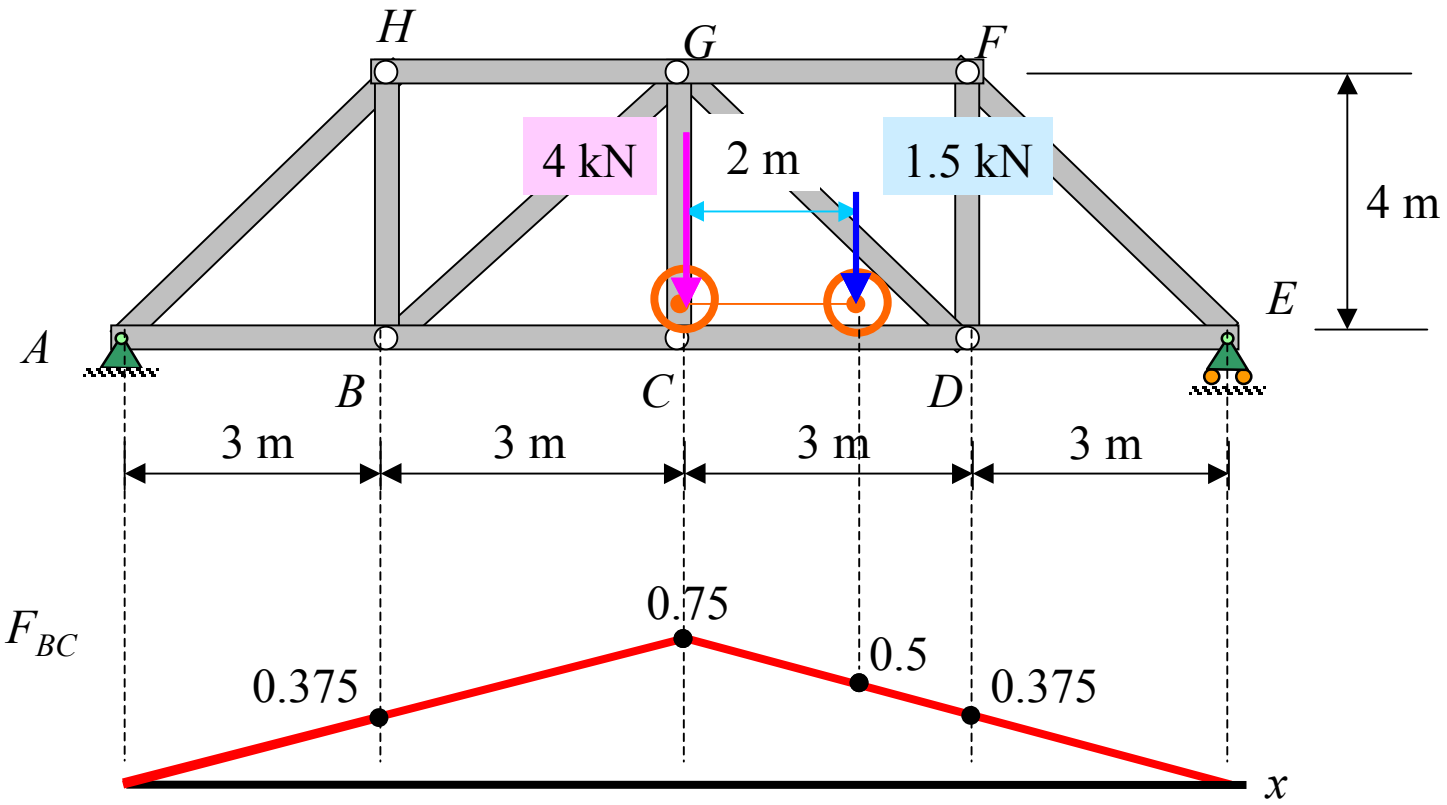
$F_{BG} = -1.25\,R_A$

## Influence Line for $F_{CG}$




H
G
F
E
A
B
C
D
1
1 kN
4 m
3 m
3 m
3 m
3 m
1
$F_{CG}$
x

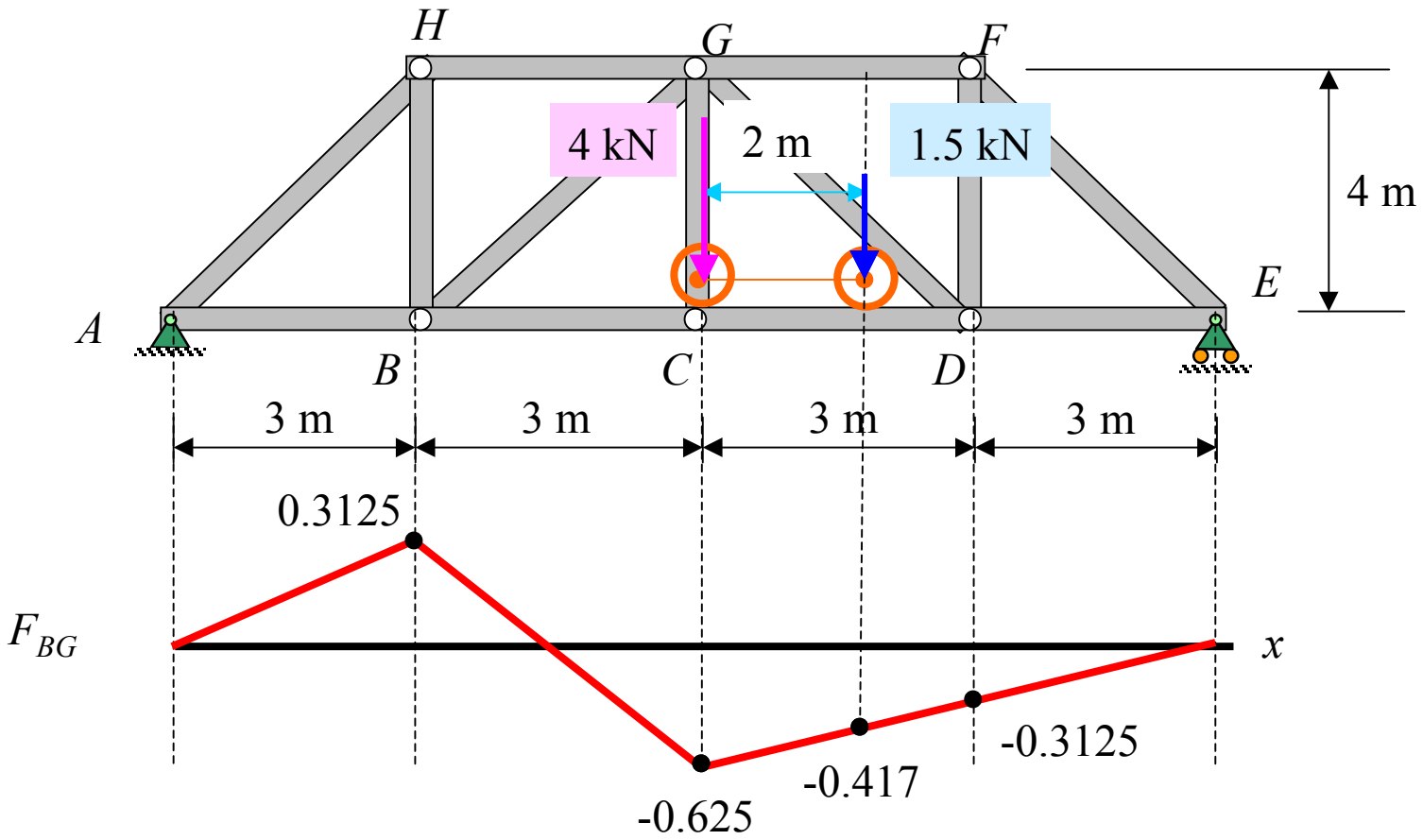
## $(F_{BC})_{max}$ by Loads




$(F_{BC})_{max}$ = (4)(0.75) + (1.5)(0.5)

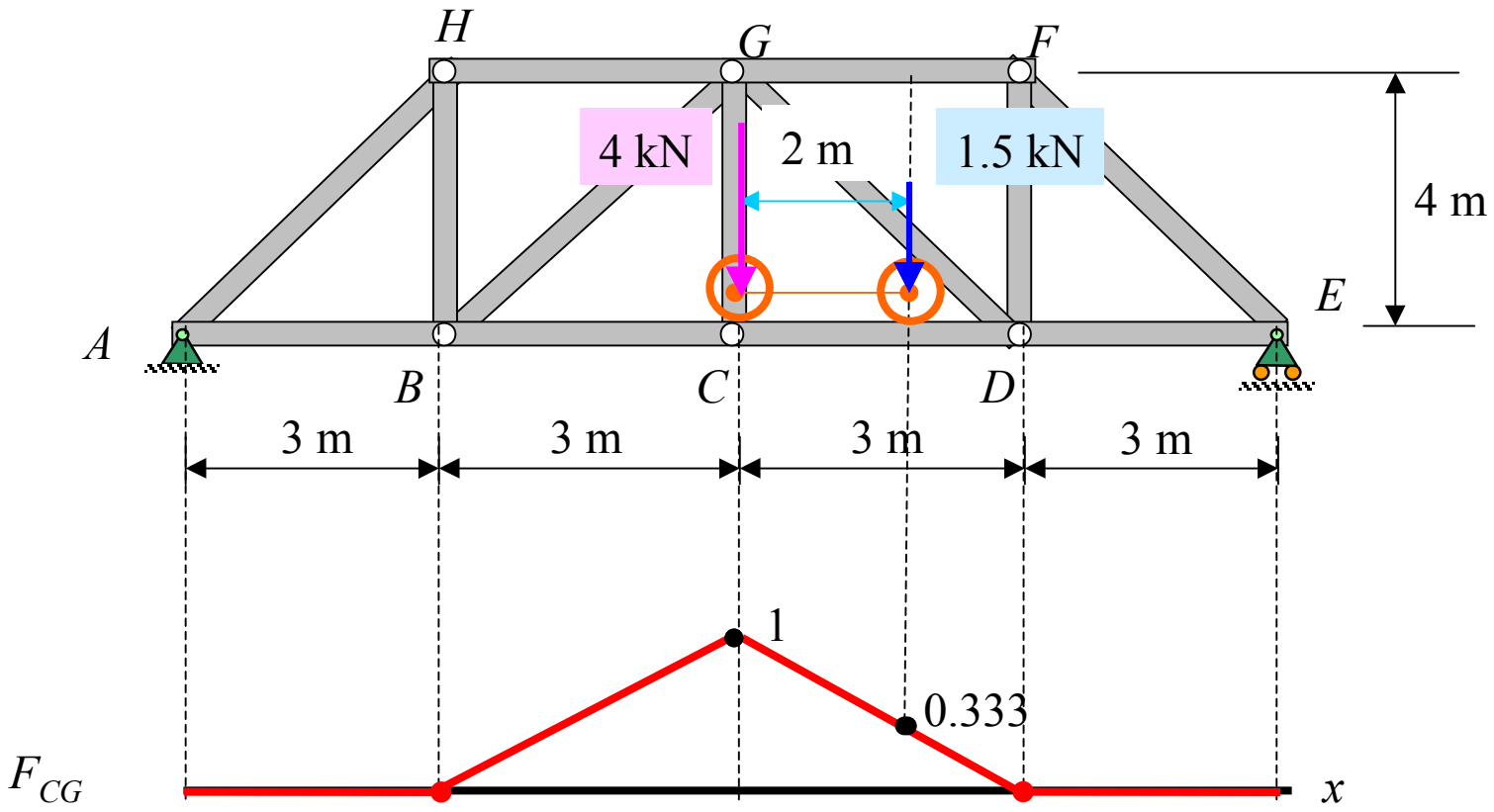
= 3.75 kN (T)

## $(F_{BG})_{max}$ by Loads



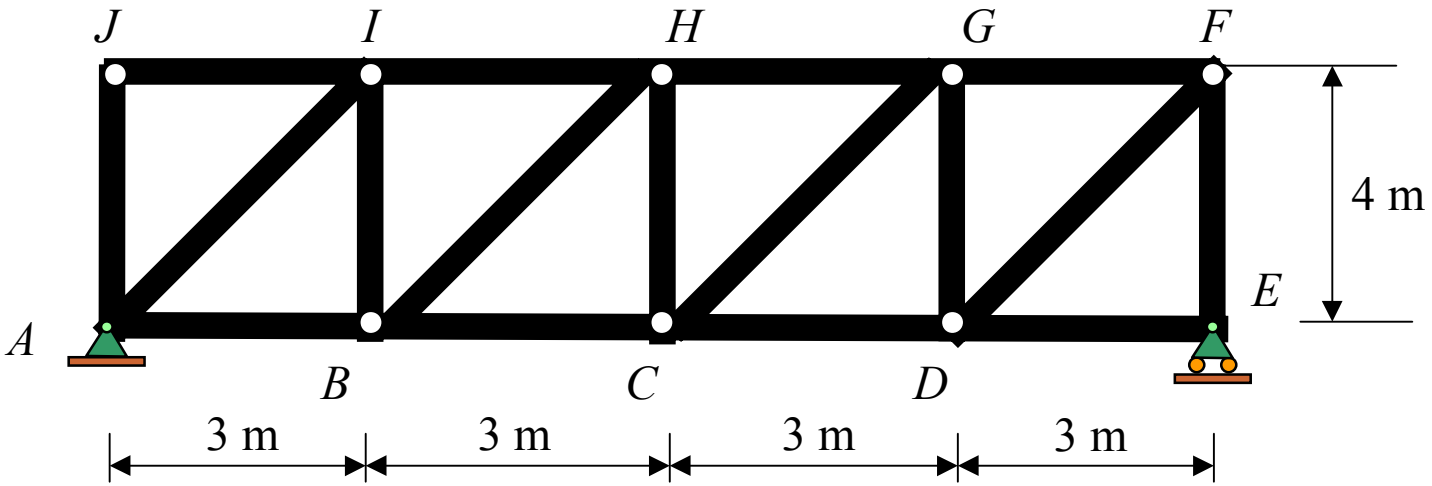

$(F_{BG})_{max}$ = (4)(-0.625) + (1.5)(-0.417) = -3.126 kN (C)

## $(F_{CG})_{max}$ by Loads



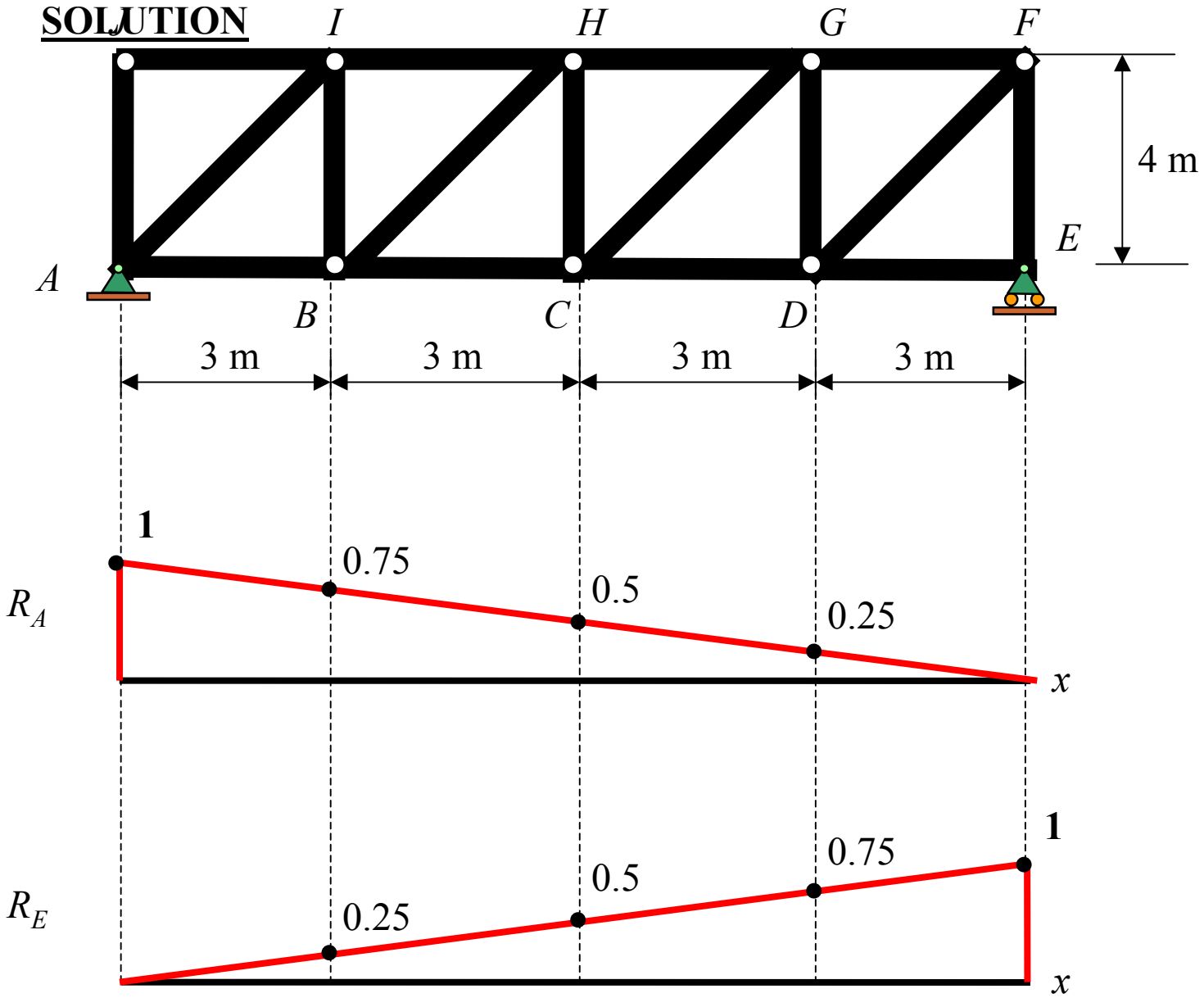

$$(F_{CG})_{max} = (4)(1) + (1.5)(0.333) = 4.50 \text{ kN (T)}$$

**Example 6-8-2**

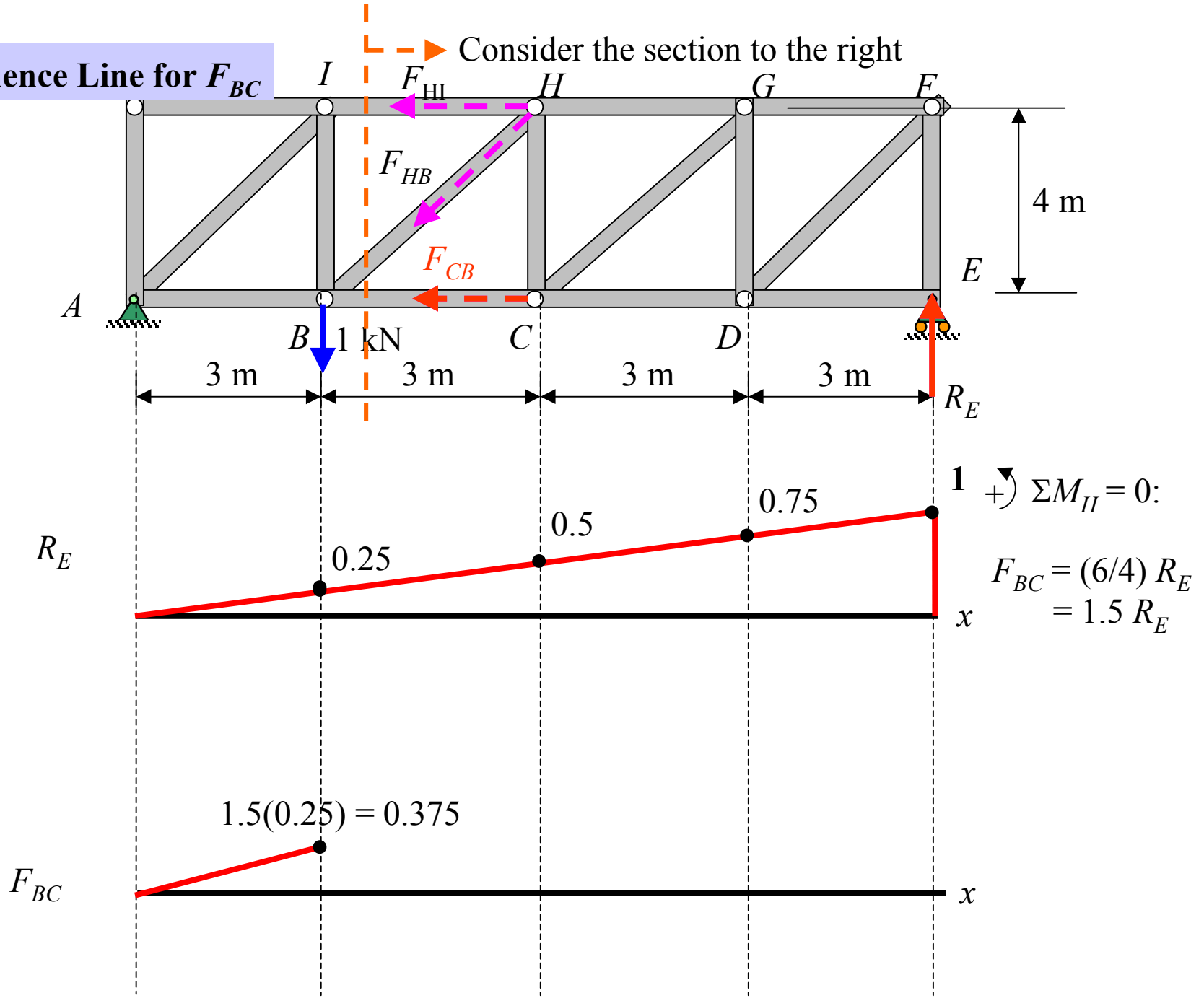


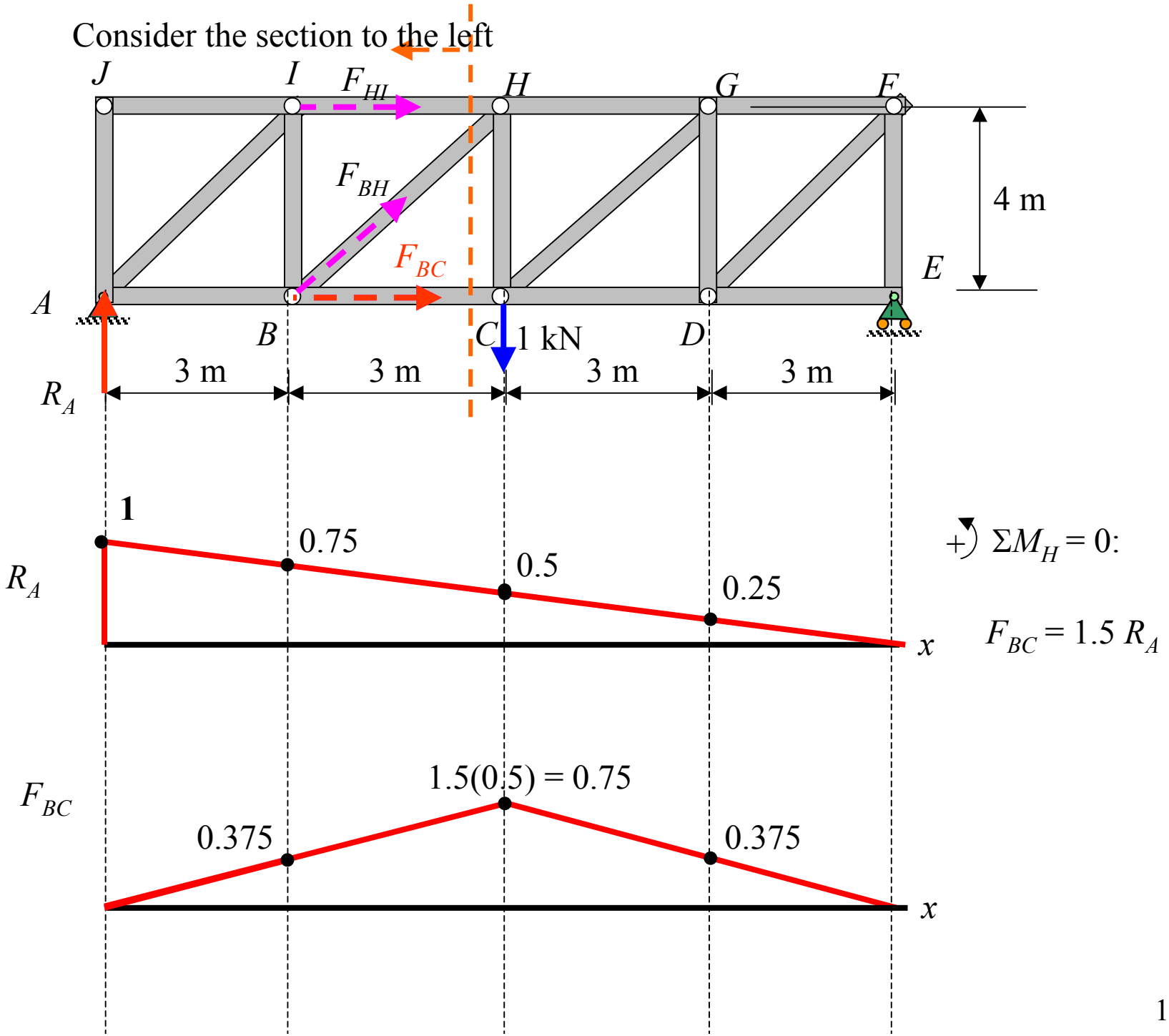

Draw the influence line for $F_{BC}$, $F_{BH}$, and $F_{CH}$.

**SOLUTION**

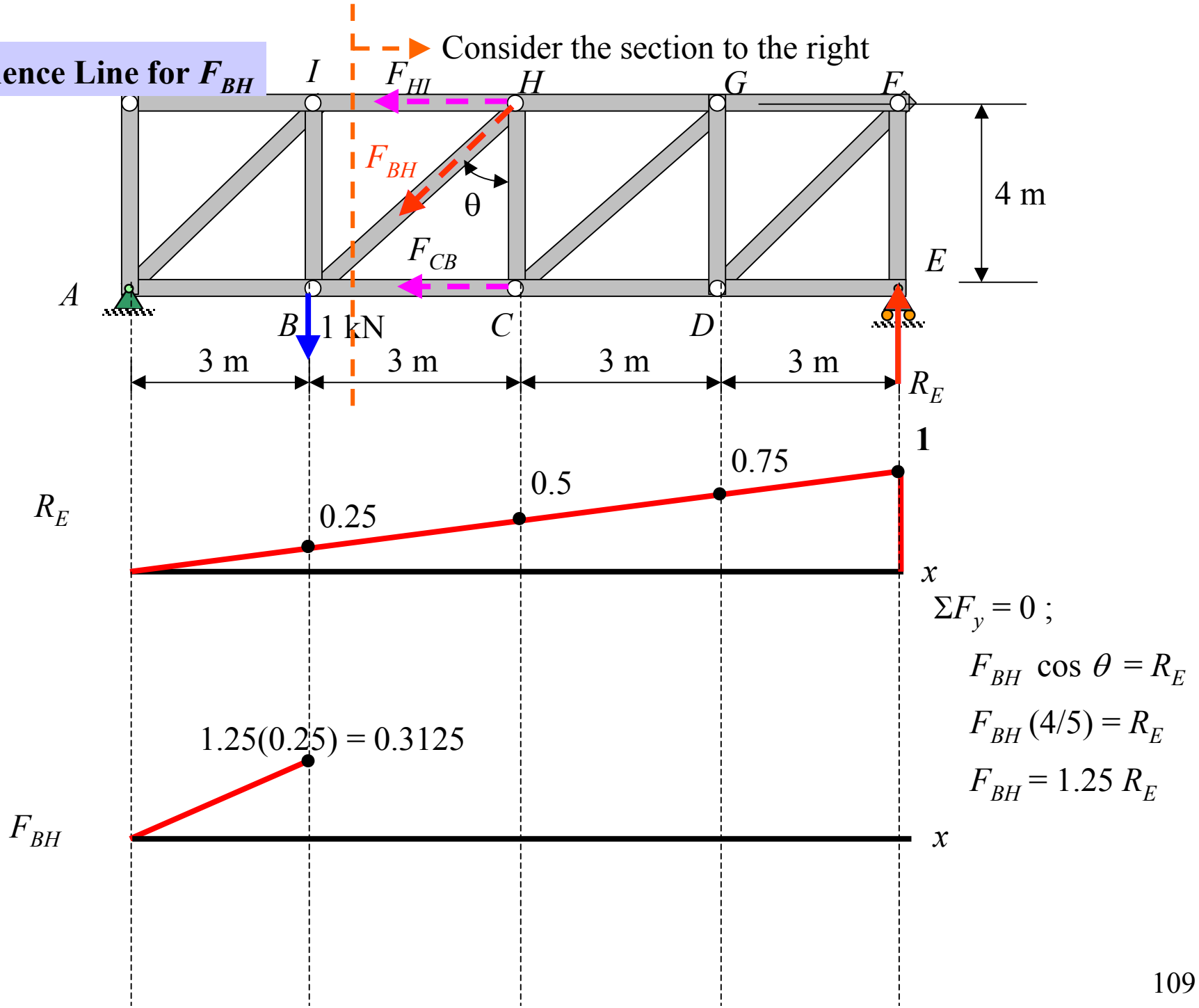


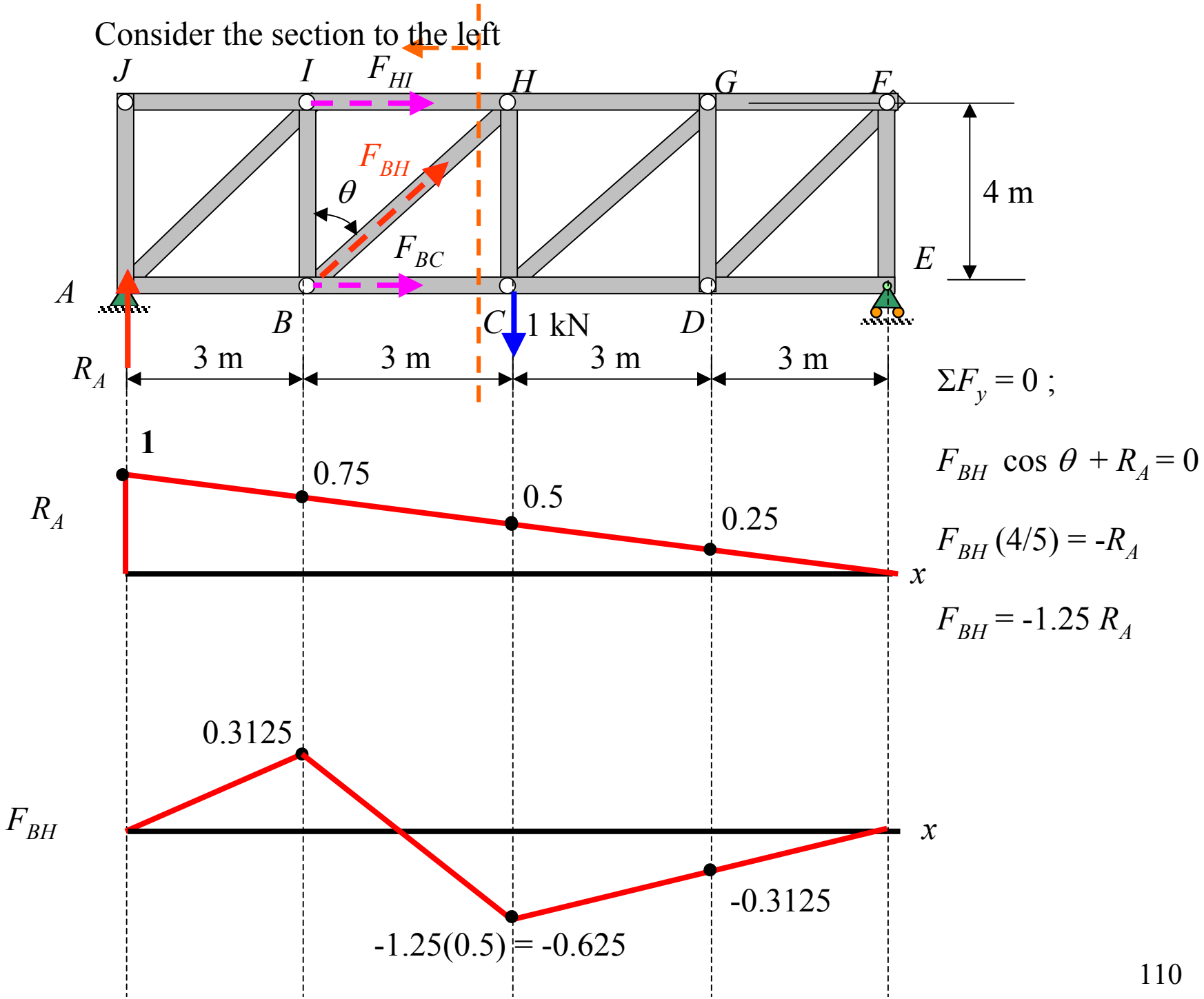
## Influence Line for $F_{BC}$



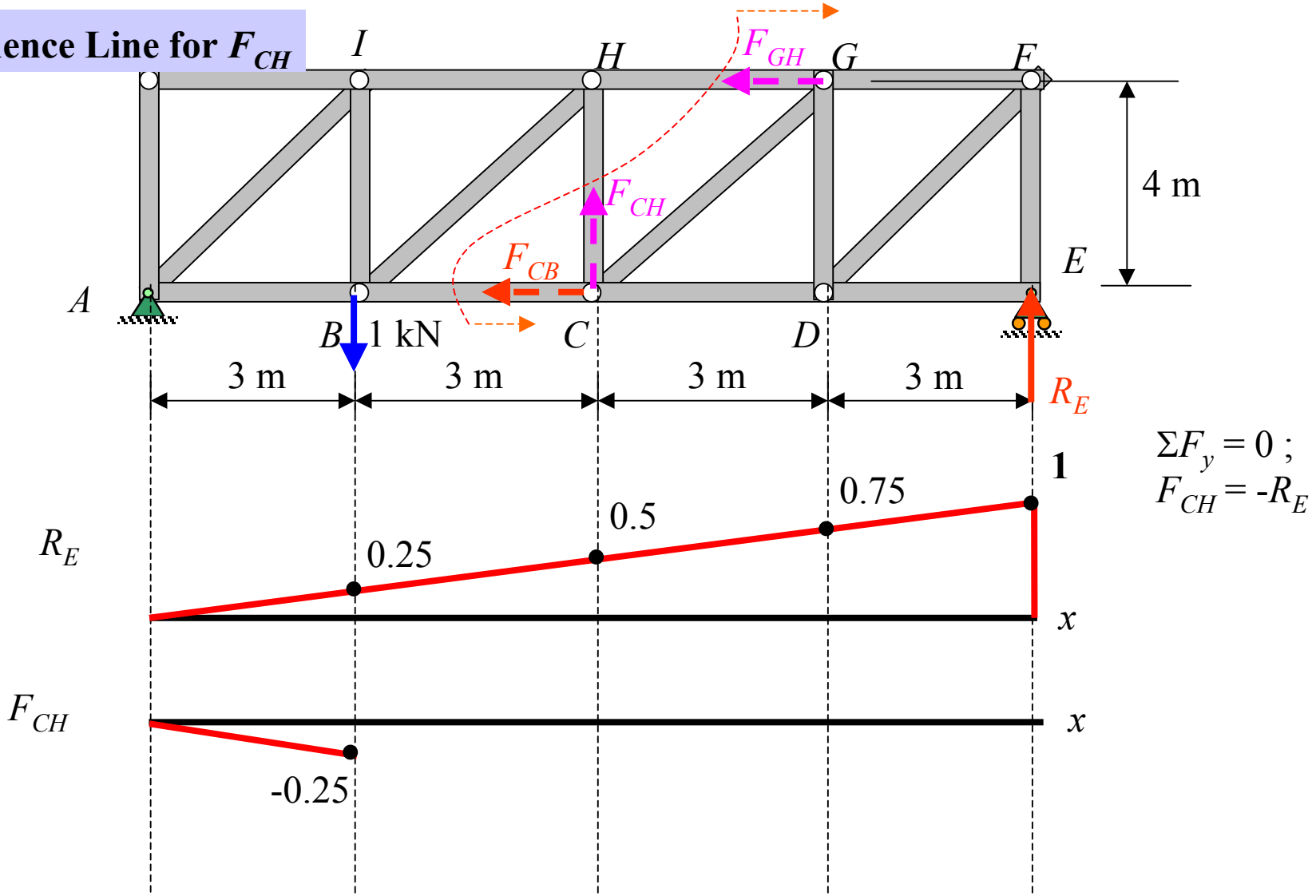

Consider the section to the left
J
I
$F_{HI}$
H
G
F
$F_{BH}$
$F_{BC}$
4 m
E
A
B
C
1 kN
D
3 m
3 m
3 m
3 m
$R_A$
1
0.75
0.5
0.25
$R_A$
x
$+\circlearrowleft \Sigma M_H = 0$:
$F_{BC} = 1.5\ R_A$
$F_{BC}$
1.5(0.5) = 0.75
0.375
0.375
x

## Influence Line for $F_{BH}$

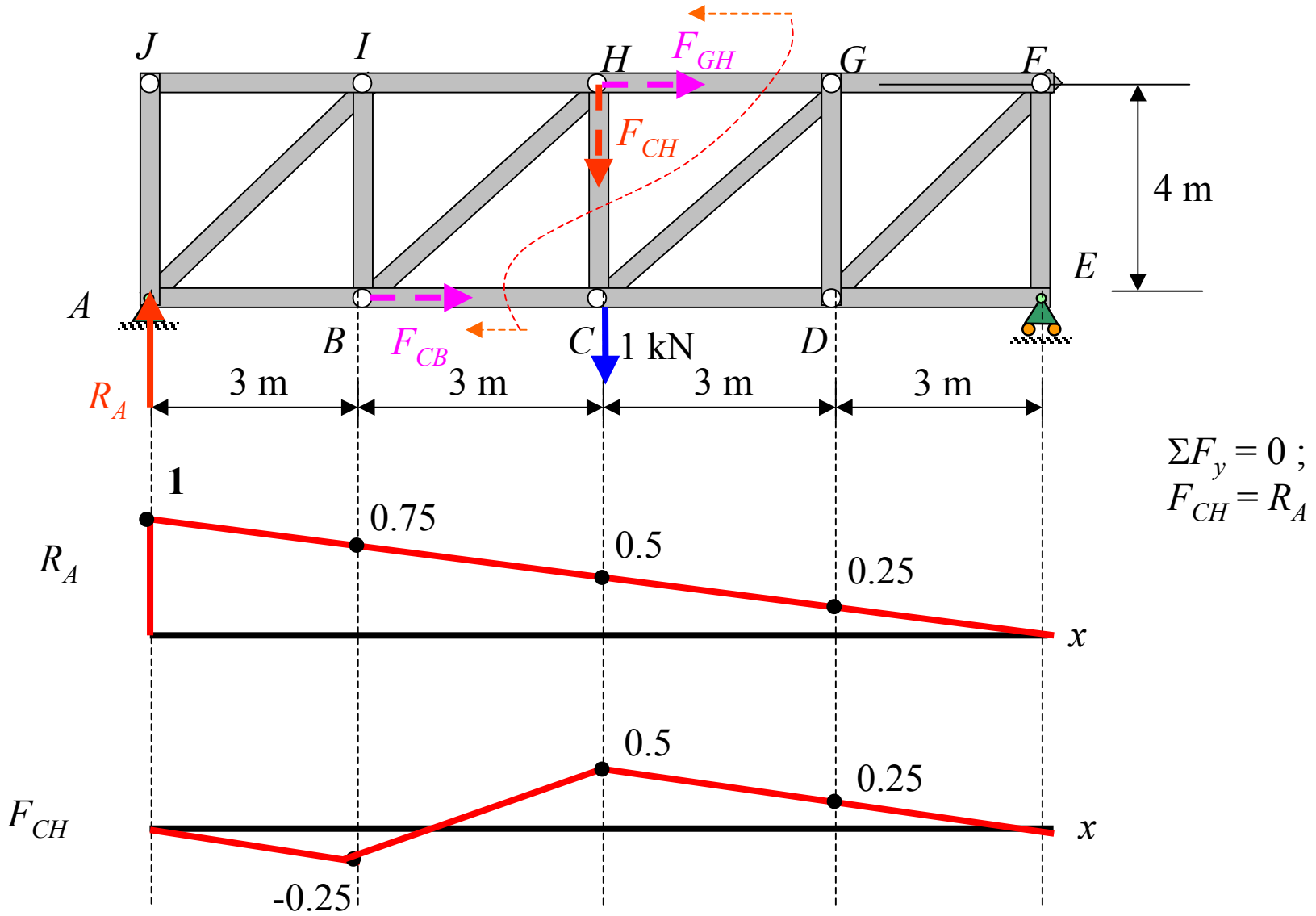



Consider the section to the left
J
I
$F_{HI}$
H
G
F
$F_{BH}$
$\theta$
$F_{BC}$
4 m
E
A
B
C
1 kN
D
$R_A$
3 m
3 m
3 m
3 m
$\Sigma F_y = 0$ ;
$F_{BH} \cos\theta + R_A = 0$
$F_{BH}\,(4/5) = -R_A$
$F_{BH} = -1.25\,R_A$
1
0.75
0.5
0.25
$R_A$
x
0.3125
$F_{BH}$
x
-0.3125
-1.25(0.5) = -0.625

## Influence Line for $F_{CH}$

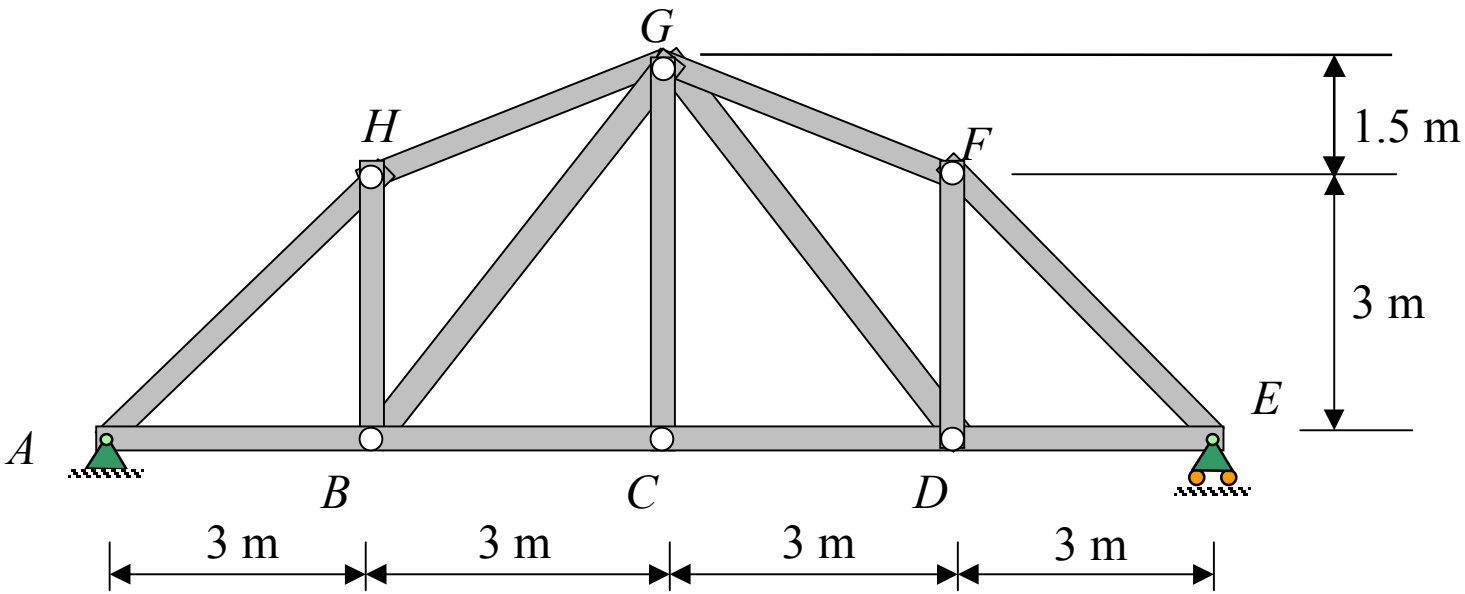



$\Sigma F_y = 0$ ;
$F_{CH} = -R_E$



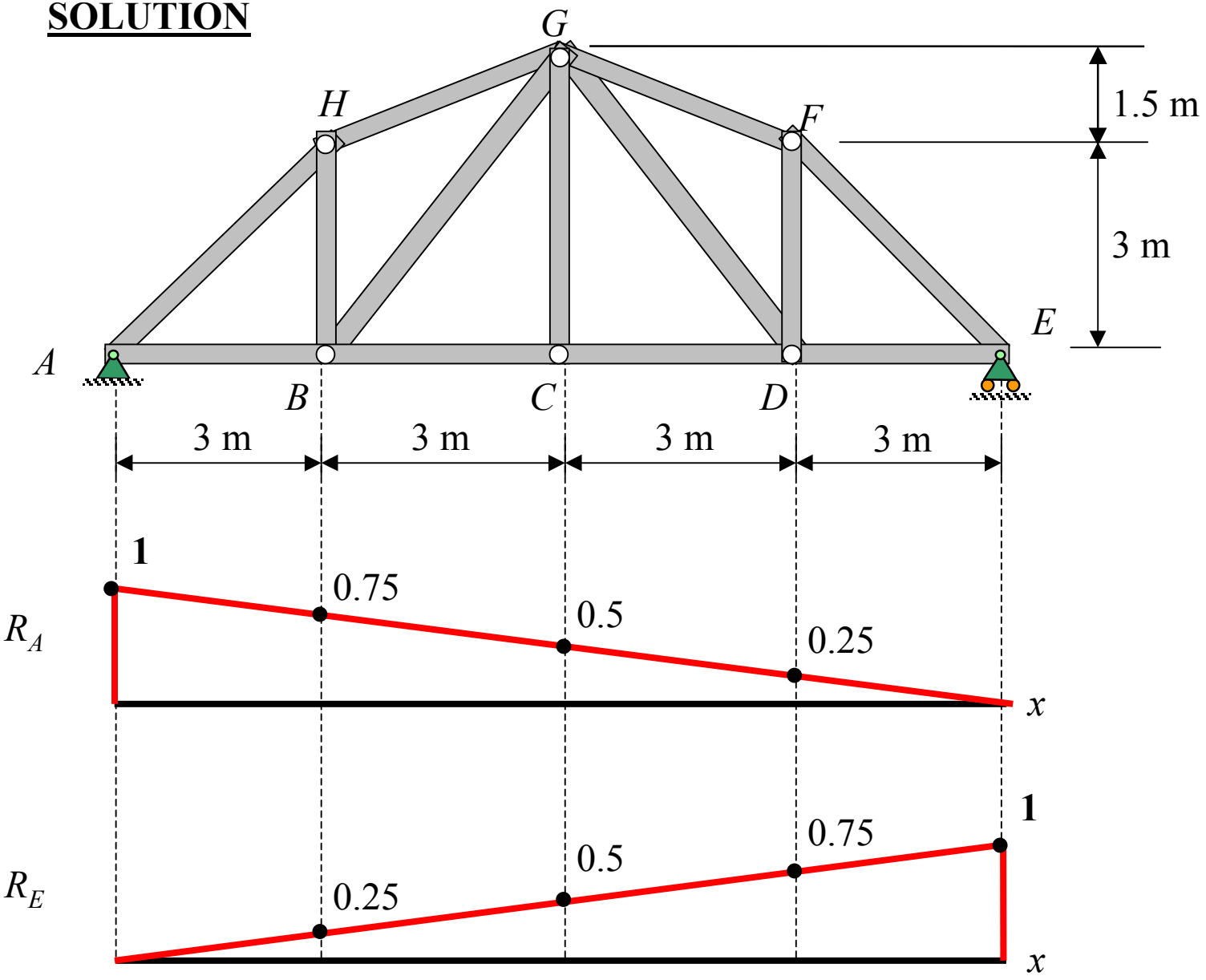

$\Sigma F_y = 0$ ;
$F_{CH} = R_A$

**Example 6-8-3**

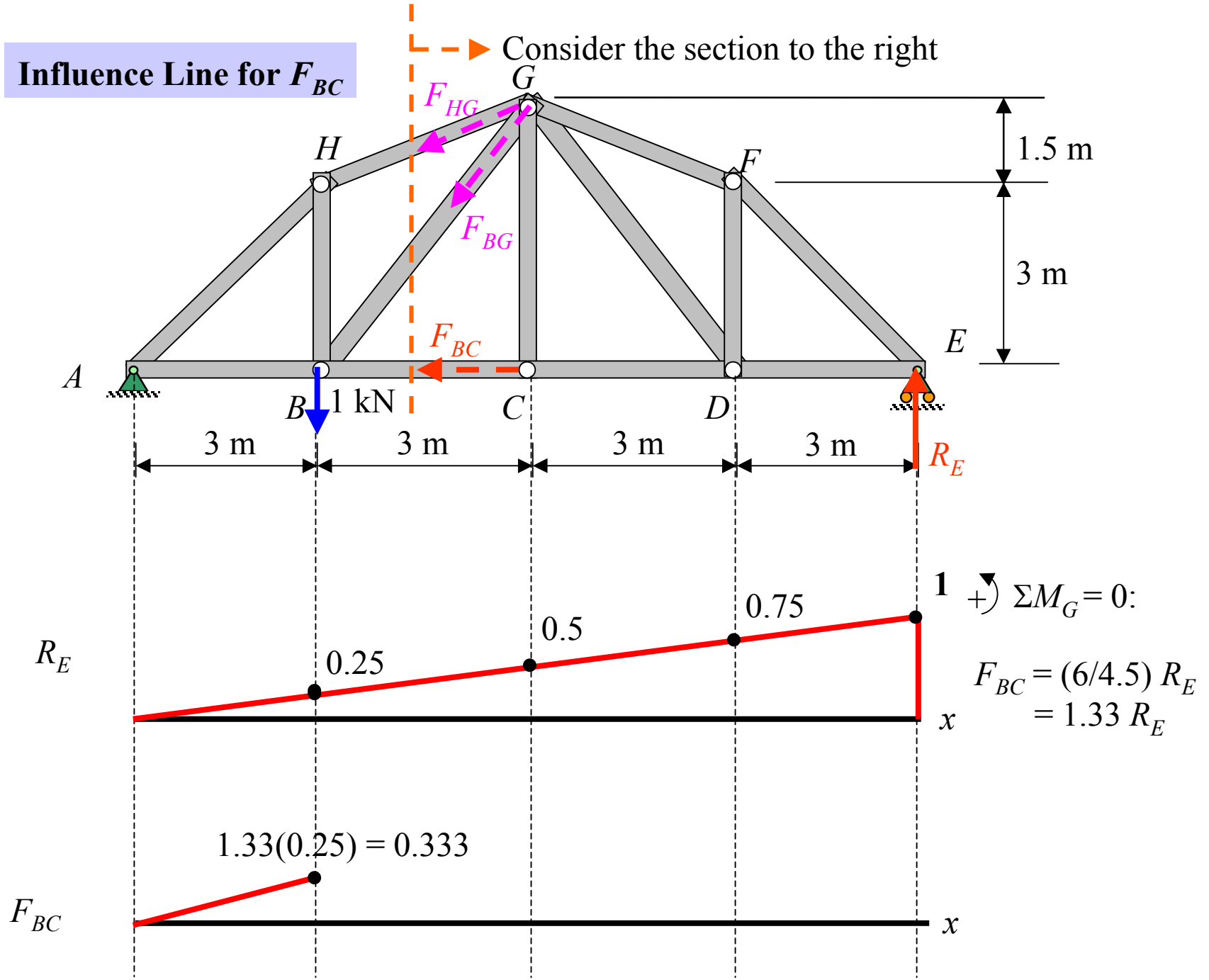



Draw the influence line for $F_{BC}$ , $F_{BG}$, and $F_{HG}$.

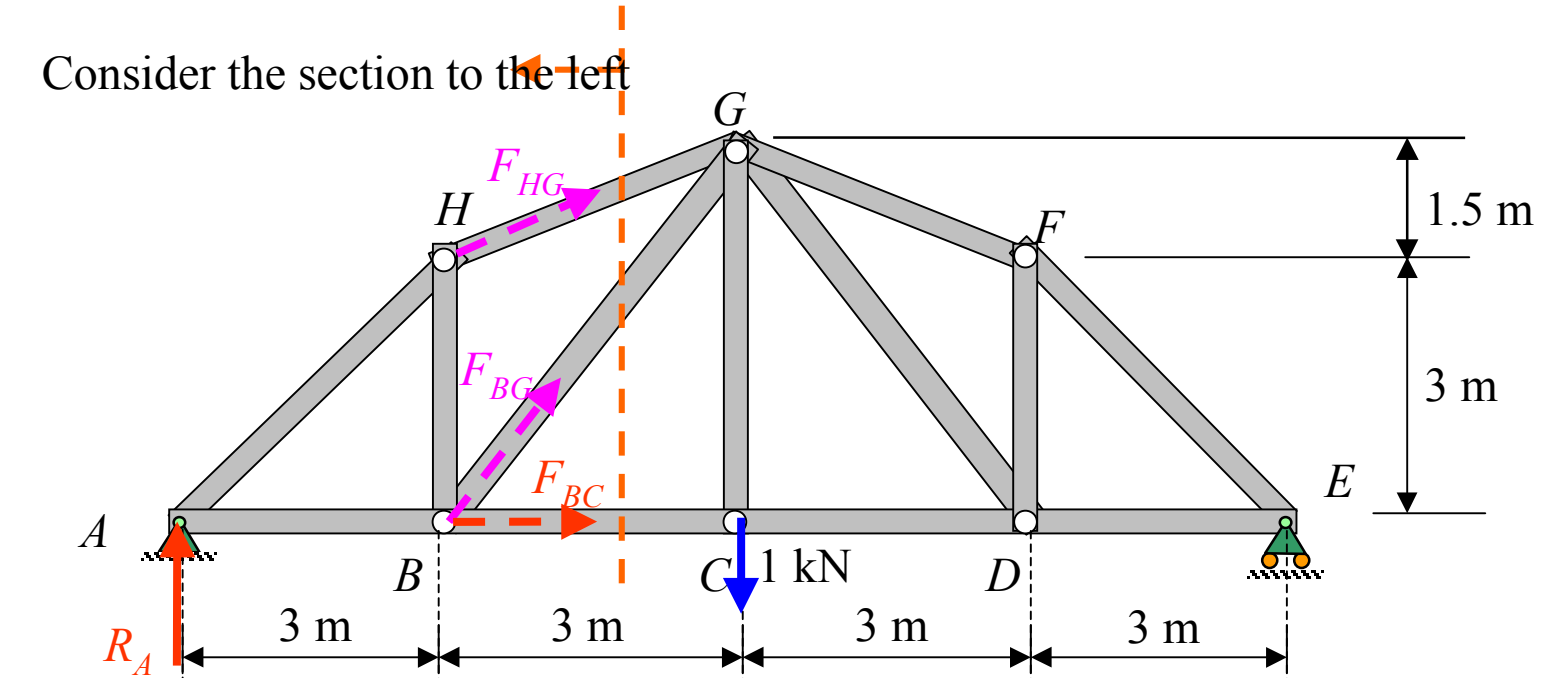
**SOLUTION**

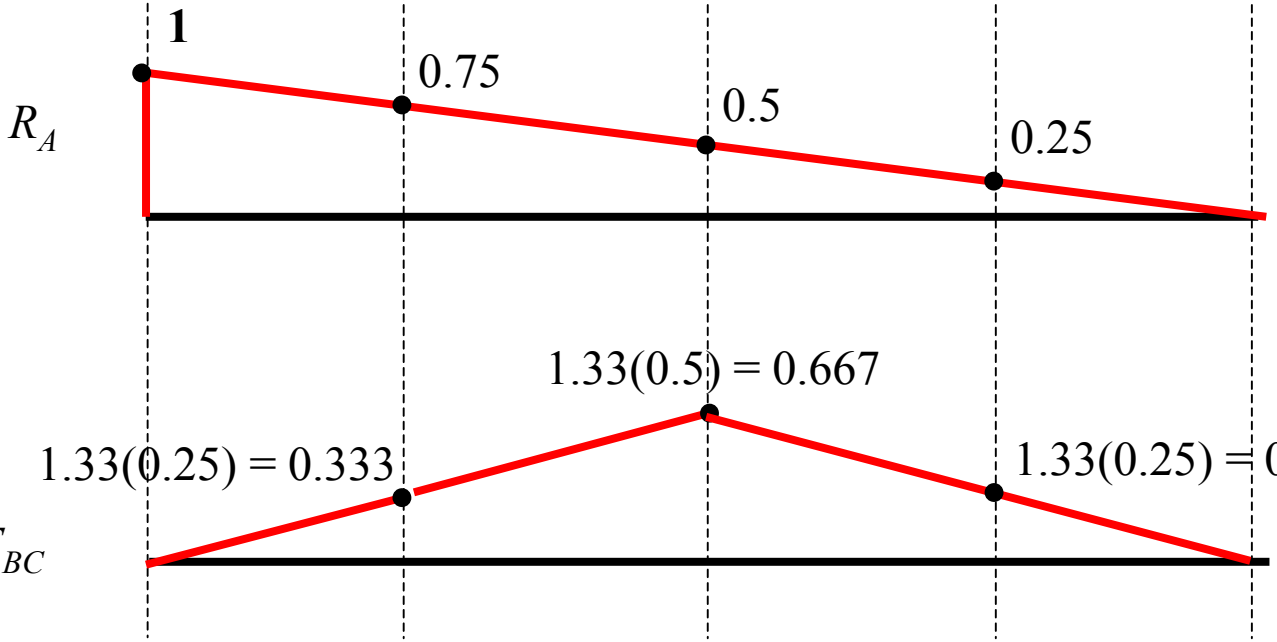


## Influence Line for $F_{BC}$



Consider the section to the left

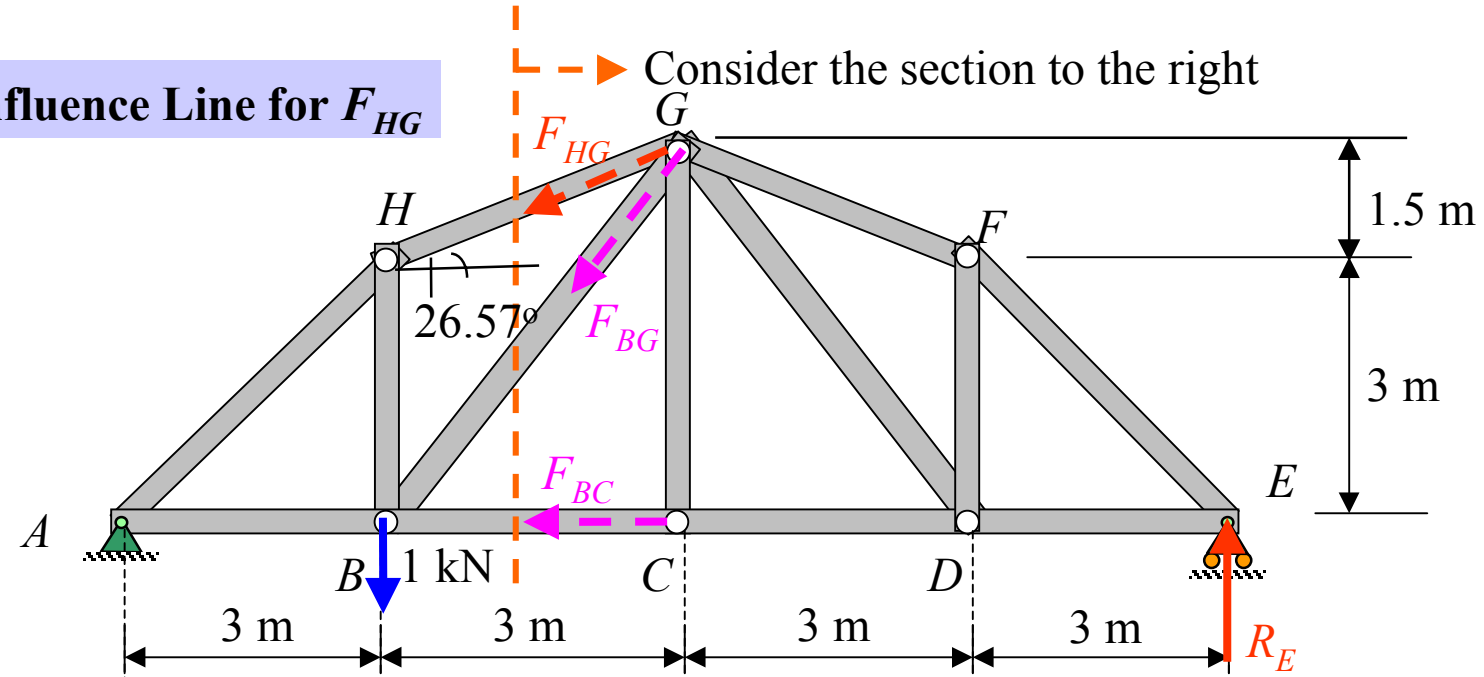


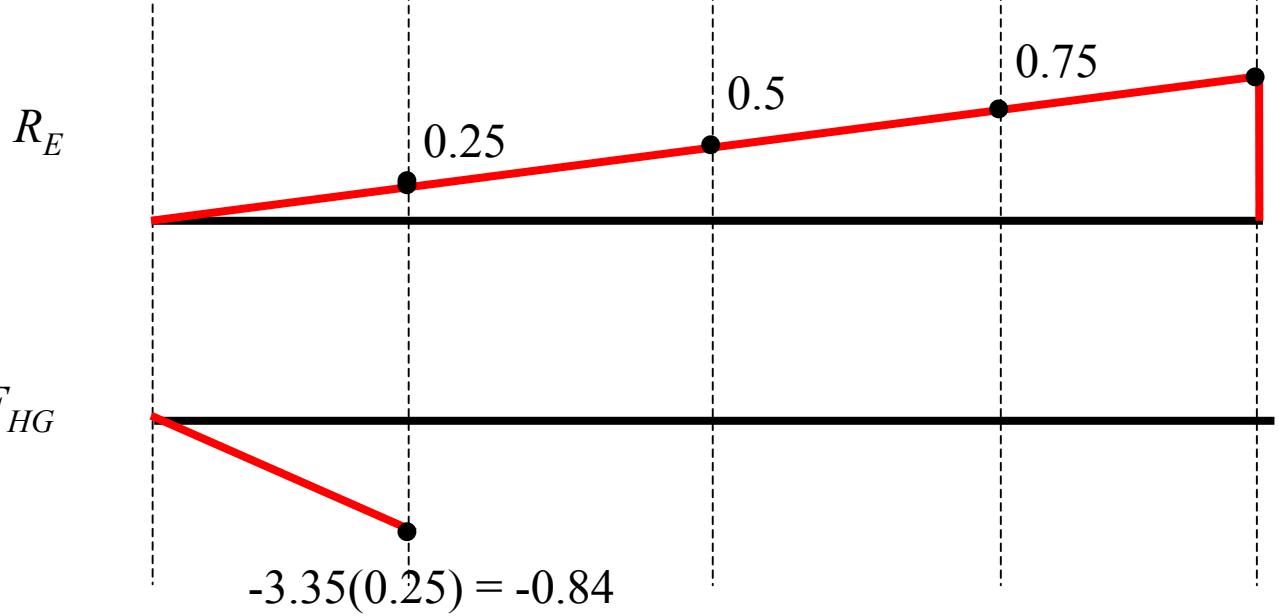




$+\circlearrowleft \Sigma M_G = 0$:

$F_{BC} = (6/4.5)\, R_A$
$= 1.33\, R_A$

## Influence Line for $F_{HG}$



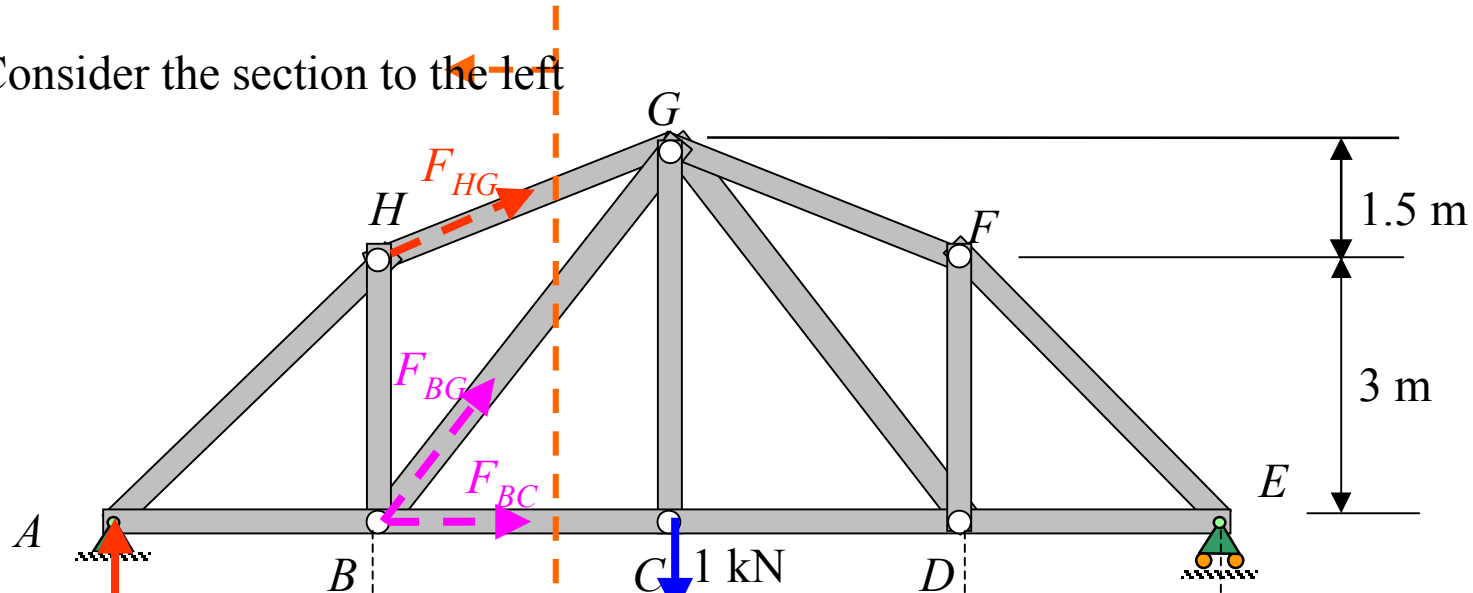



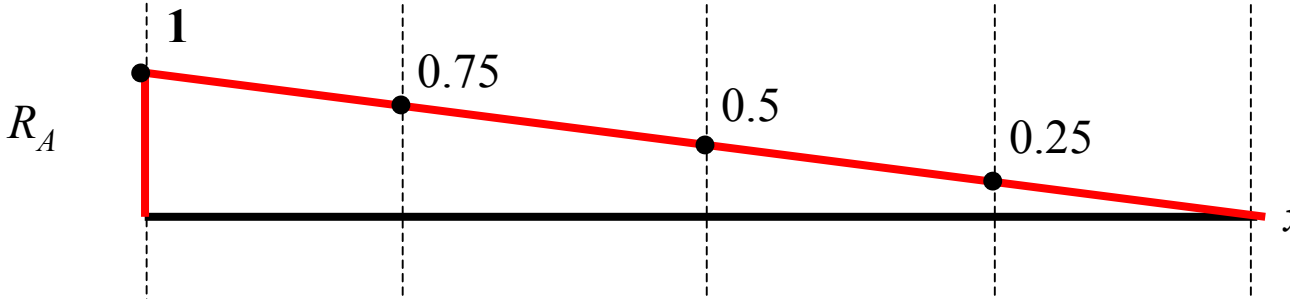

**1** $+\circlearrowleft \Sigma M_B = 0$:

$(F_{HG} \cos 26.57)(3) = -9R_E$

$F_{HG} = -3.35R_E$

Consider the section to the left

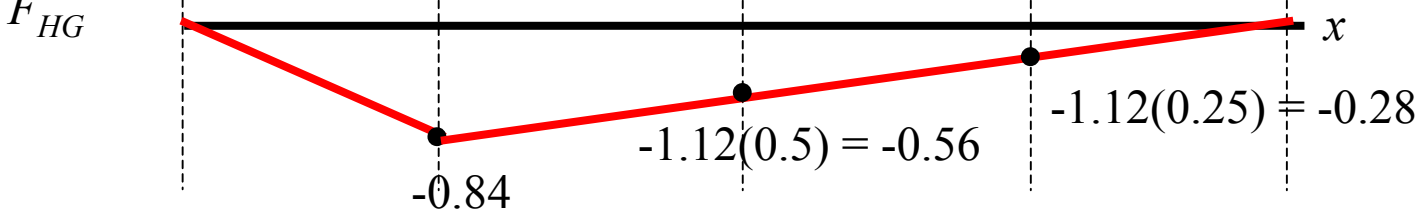


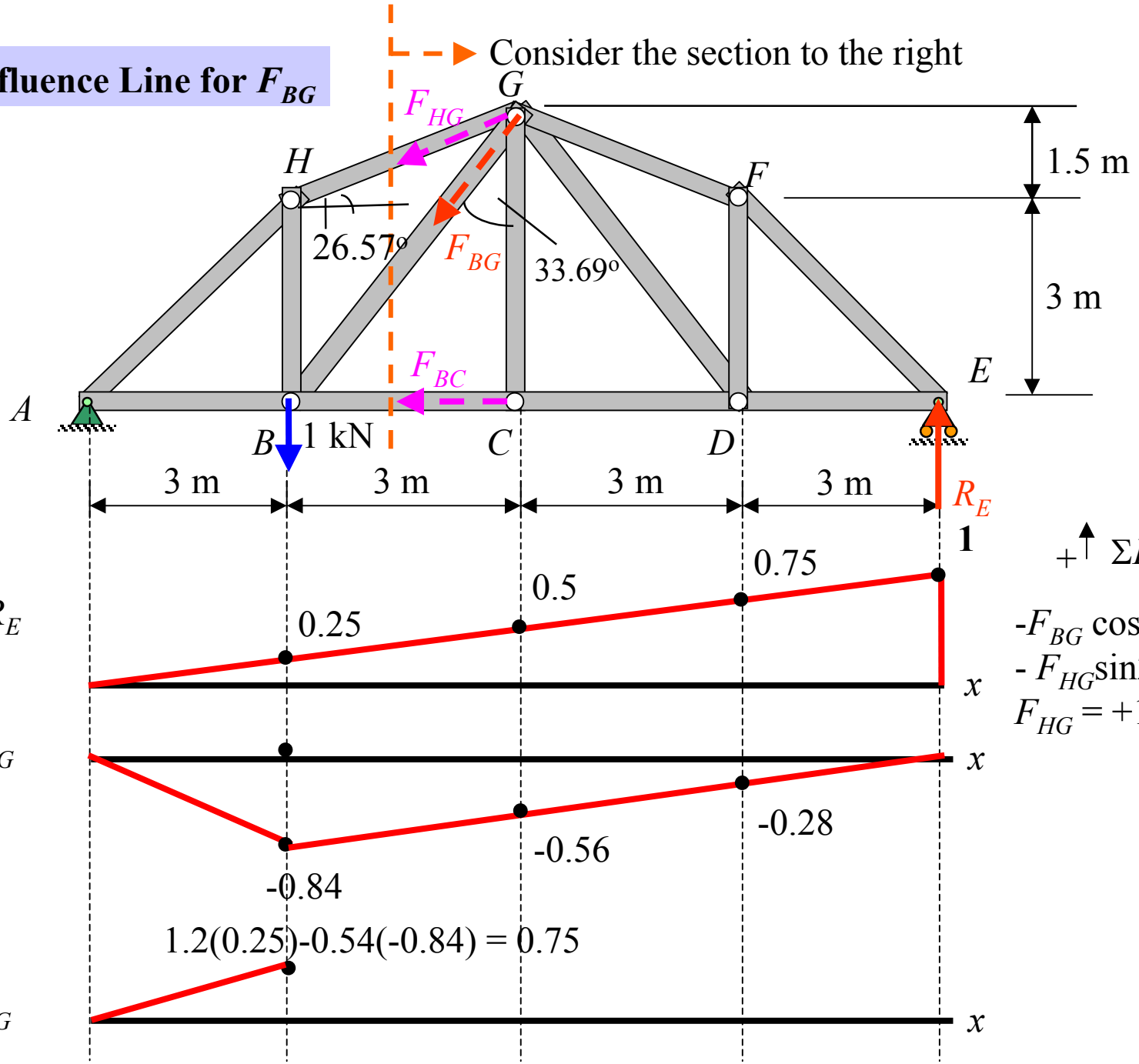

$+\circlearrowleft \Sigma M_B = 0$:

$(F_{HG} \cos 26.57)(3) = -3R_A$

$F_{HG} = -1.12R_A$



## Influence Line for $F_{BG}$



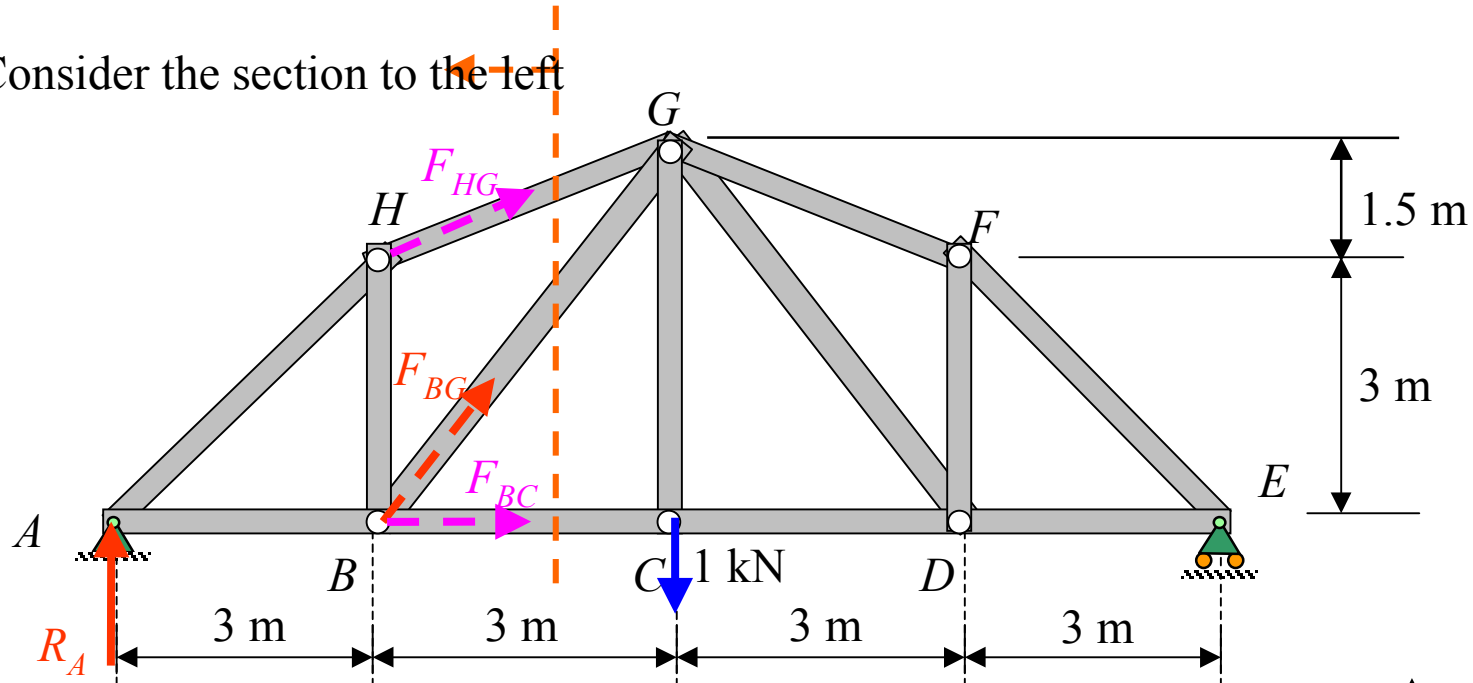

$+\uparrow \Sigma F_y = 0$:

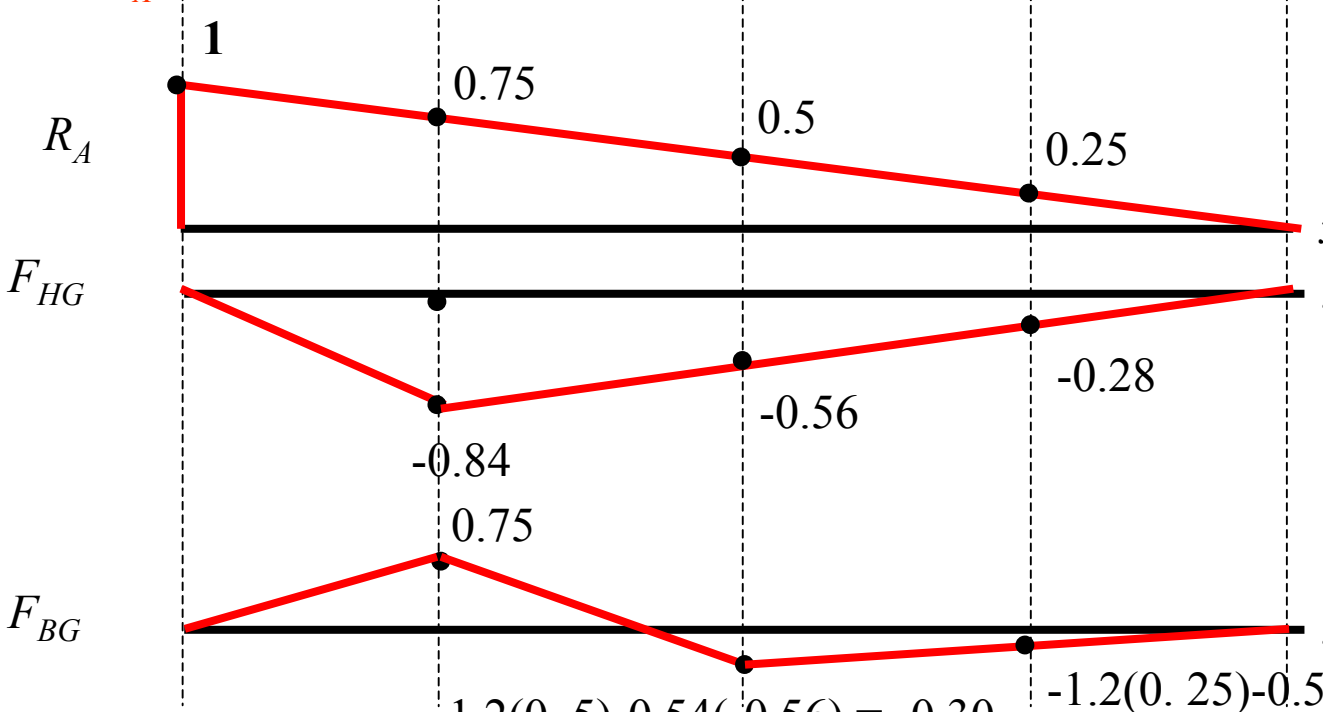
$-F_{BG} \cos 33.69$

$- F_{HG} \sin 26.57 + R_E = 0$

$F_{HG} = +1.2R_E - 0.54\, F_{HG}$

Consider the section to the left




$+\uparrow \Sigma F_y = 0$:

$R_A + F_{BG}\cos 33.69 + F_{HG}\sin 26.57 = 0$

$F_{BG} = -1.2R_A - 0.54F_{HG}$