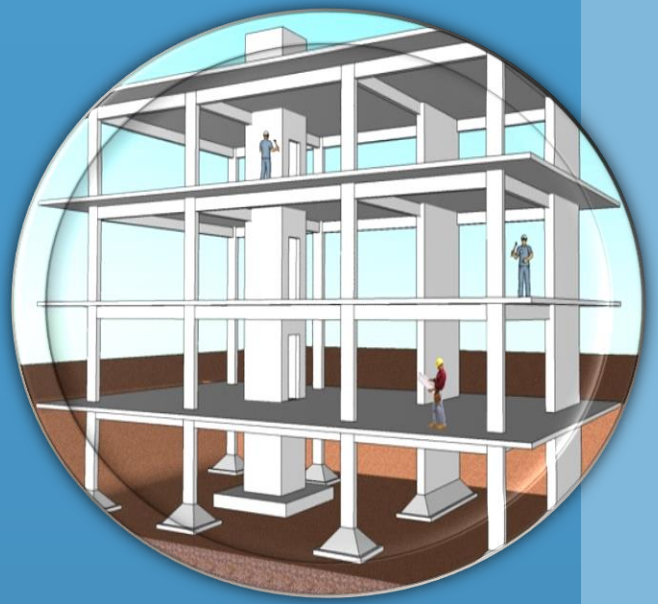
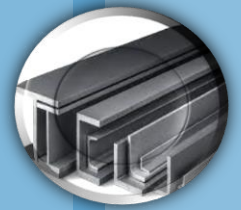
UNIVERSITY OF ZAMBIA
School of Engineering
Department of Civil & Environmental Eng.

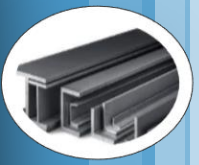


CEE 3222: THEORY OF STRUCTURES

Lecture 2.2

INFLUENCE LINES FOR STATICALLY DETERMINATE STRUCTURES- GIRDERS

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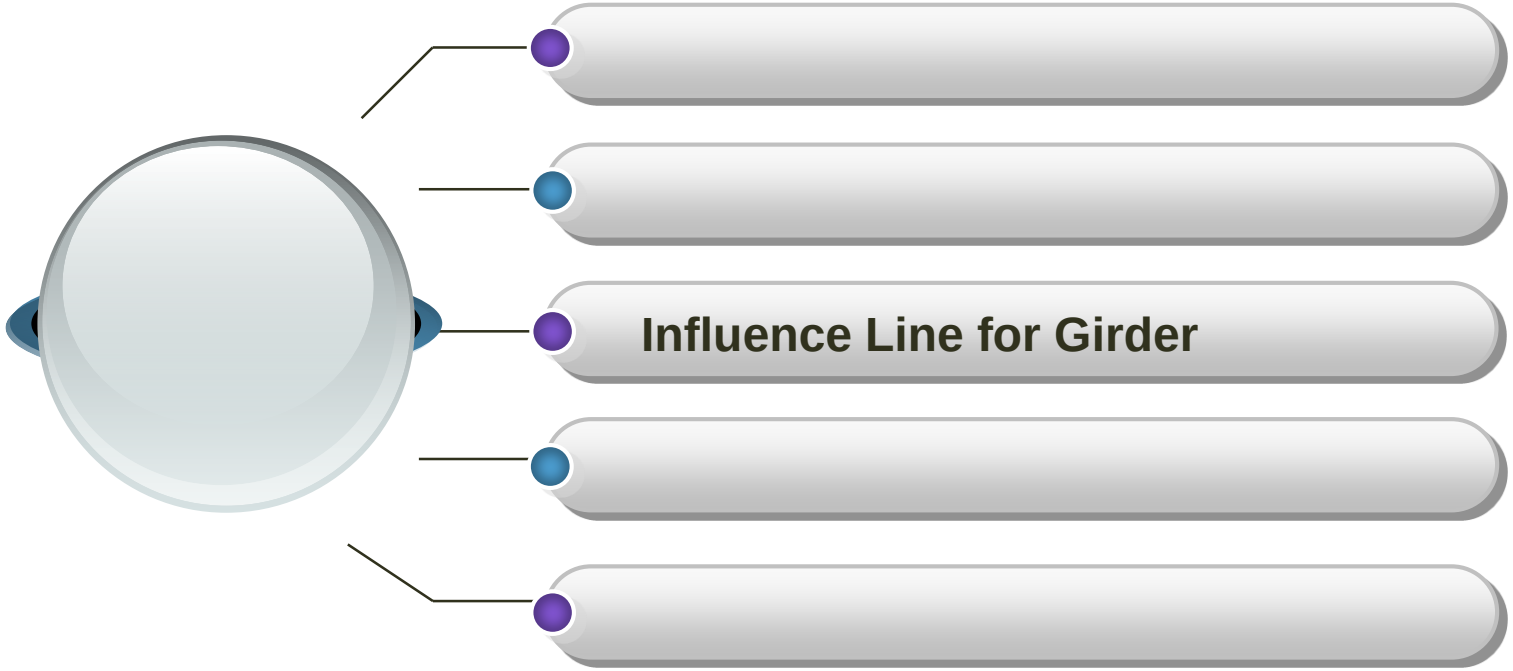
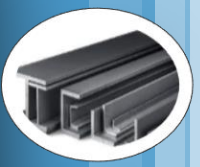
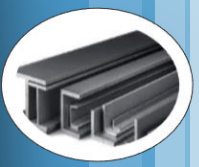



Influence Line for Girder

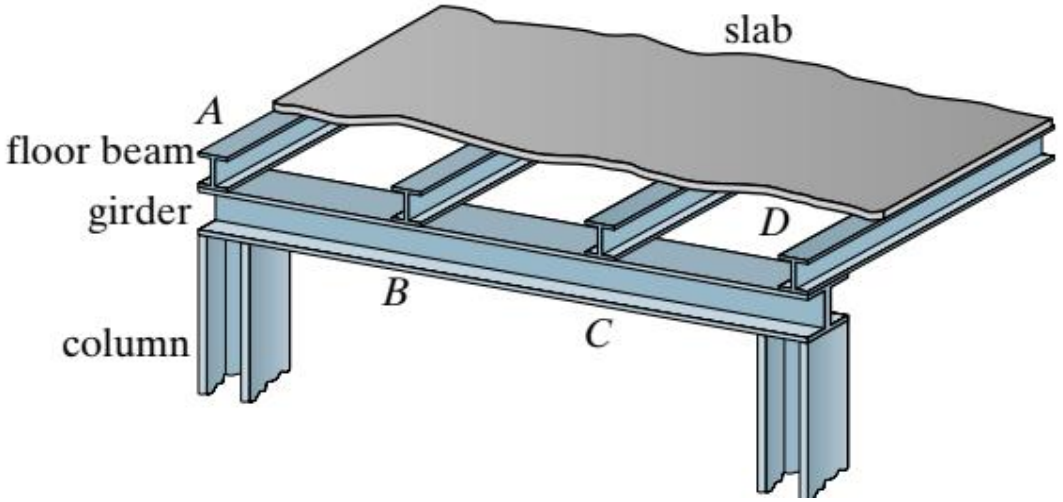
- Although the procedure for constructing an influence line is rather basic, one should clearly be aware of the difference between constructing an influence line and constructing a shear or moment diagram.

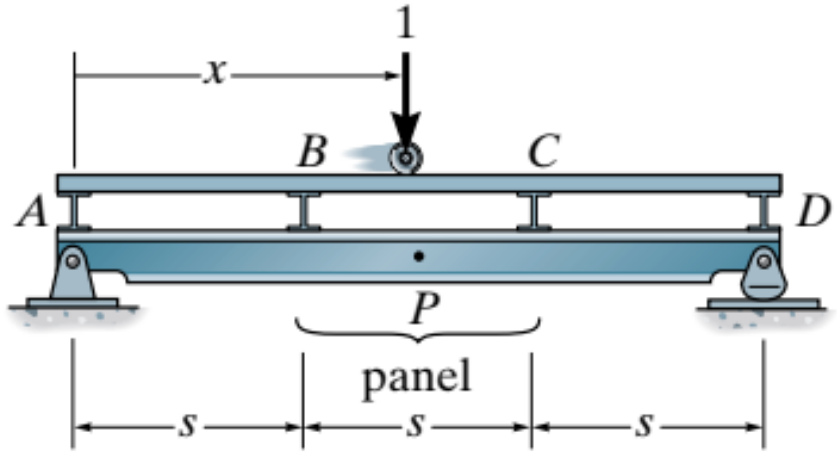
- Influence lines represent the effect of a moving load only at a specified point on a member, whereas shear and moment diagrams represent the effect of fixed loads at all points along the axis of the member.

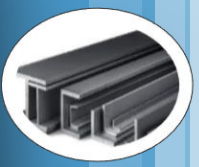




Influence Line for Girder

- Occasionally, floor systems are constructed as shown, where it can be seen that floor loads are transmitted from slabs to floor beams, then to side girders, and finally supporting columns.
- Here the slab is assumed to be a one-way slab and is segmented into simply supported spans resting on the floor beams.
- Since the girders are main load-carrying members in this system, it is sometimes necessary to construct their shear and moment influence lines.

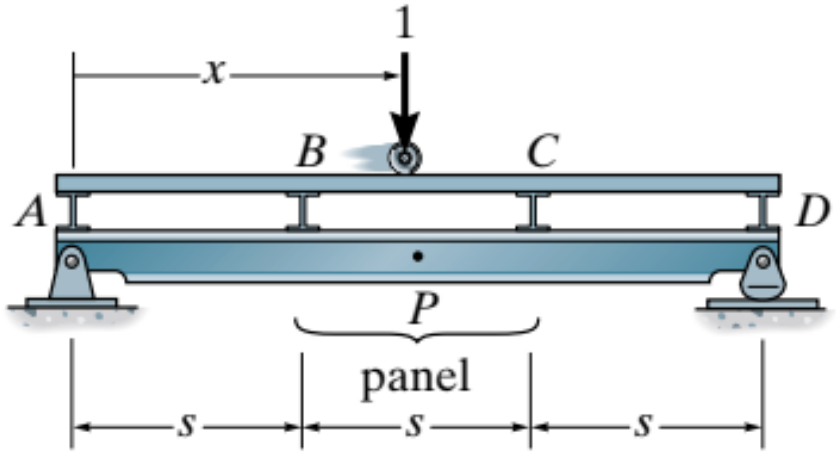


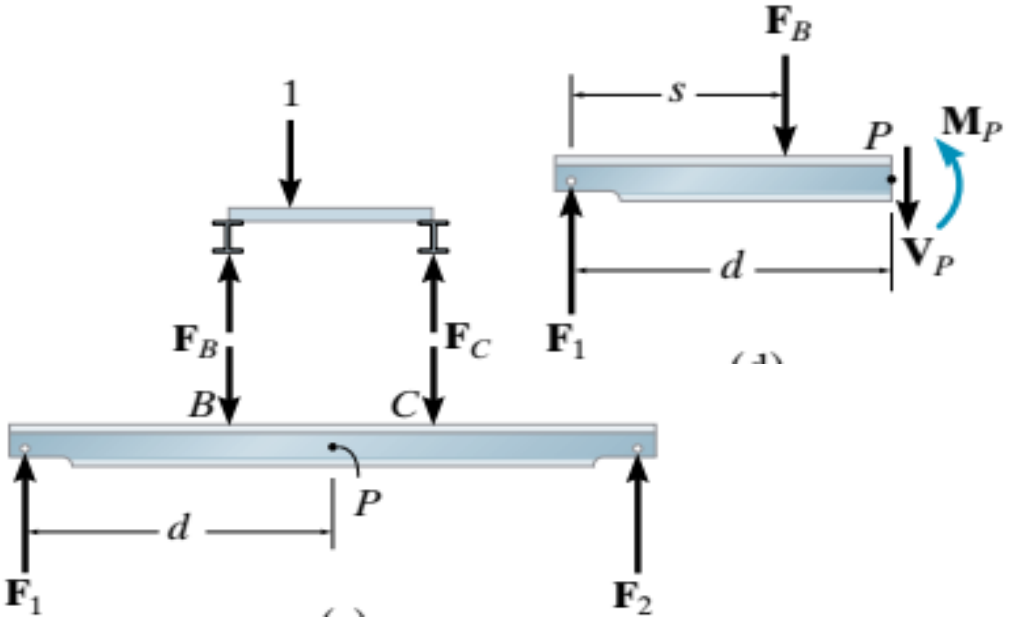


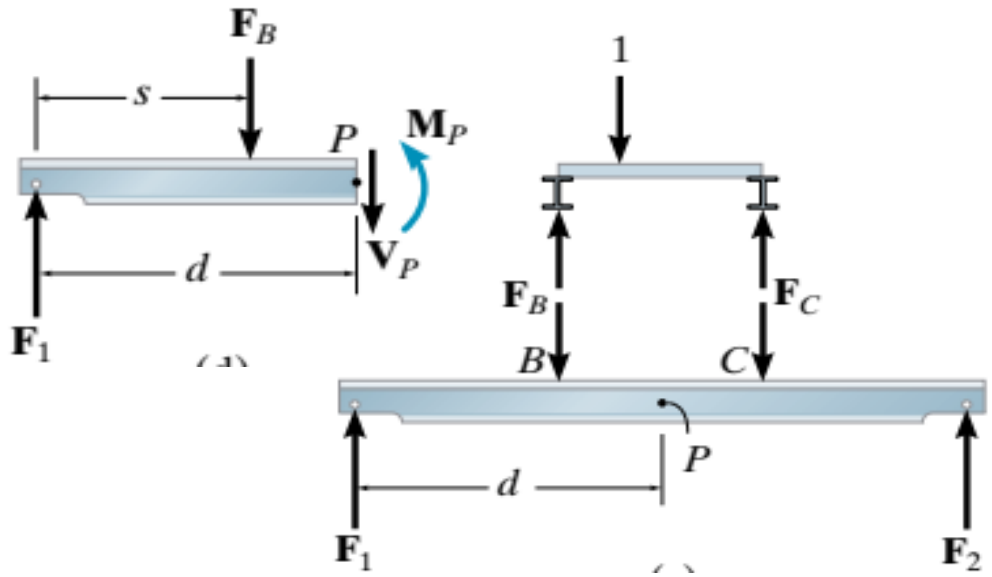

Influence Line for Girder

- A unit load on the floor slab is transferred to the girder only at points where it is in contact with the floor beams, i.e., points A, B, C, and D.
- These points are called panel points, and the region between these points is called a panel, such as BC
- The value for the internal moment in a girder panel will depend upon where point *P* is chosen for the influence line, since the magnitude of $\mathbf{M}_P$ depends upon the point's location from the end of the girder.
- If the unit load acts on the floor slab as shown, one first finds the reactions $\boldsymbol{F_B}$ and $\boldsymbol{F_C}$ on the slab, then calculates the support reactions $\boldsymbol{F_1}$ and $\boldsymbol{F_2}$ on the girder.





Influence Line for Girder



- The internal moment at P is then determined by the method of sections.

$$M_P = F_1 d - F_B(d - s)$$

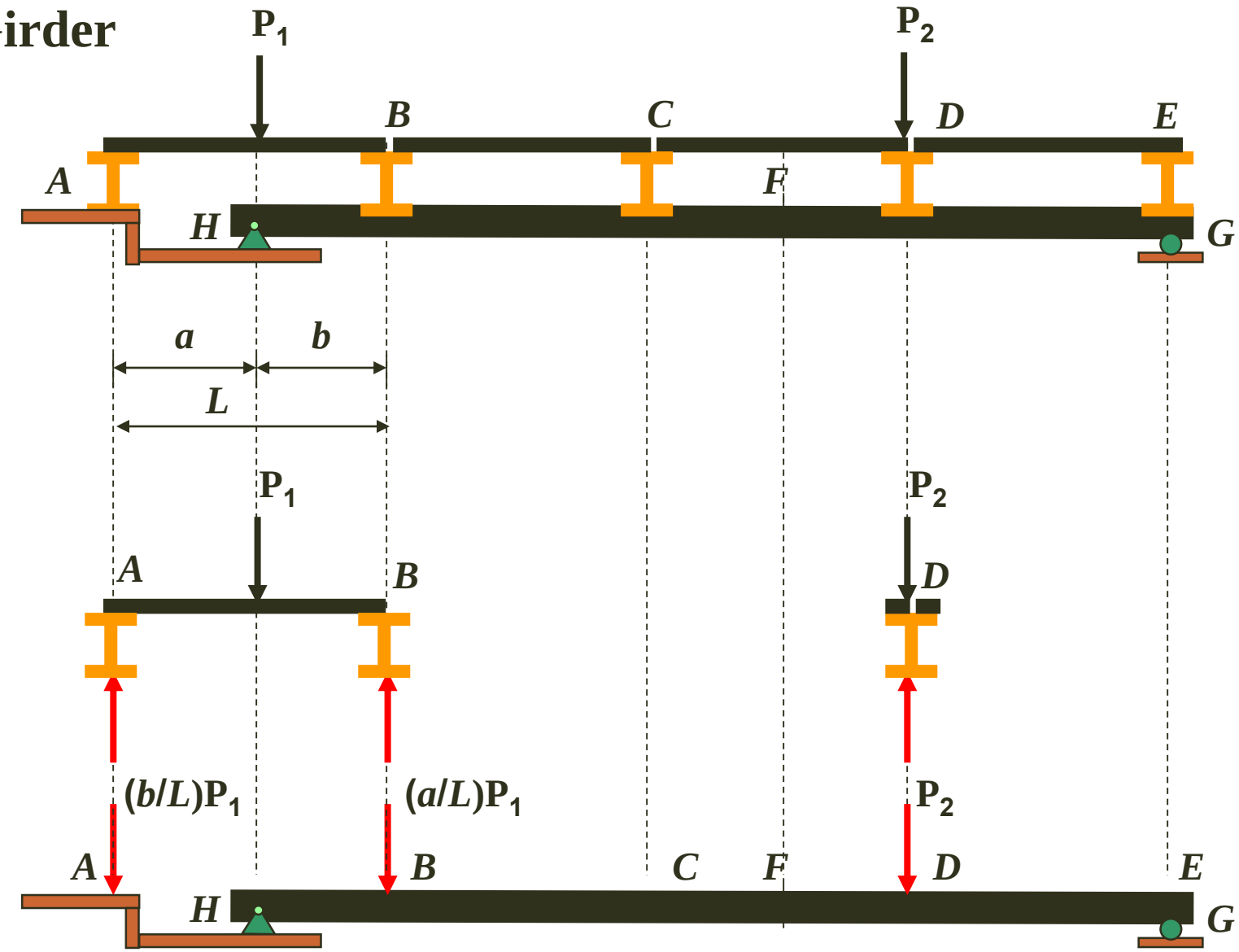
- Using a similar analysis, the internal shear $\mathbf{V}_p$ can be determined. $\mathbf{V}_p$ will be constant throughout the panel BC.

$$\mathbf{V}_p = \boldsymbol{F}_1 - \boldsymbol{F}_B$$

- So it does not depend upon the exact location d of P within the panel.
- Thus, influence lines for shear in floor girders are specified for panels in the girder and not specific points along the girder. The shear is then referred to as **panel shear.**
- Since the girder is affected only by the loadings transmitted by the floor beams, the unit load is generally placed at each floor-beam location to establish the necessary data used to draw the influence line.

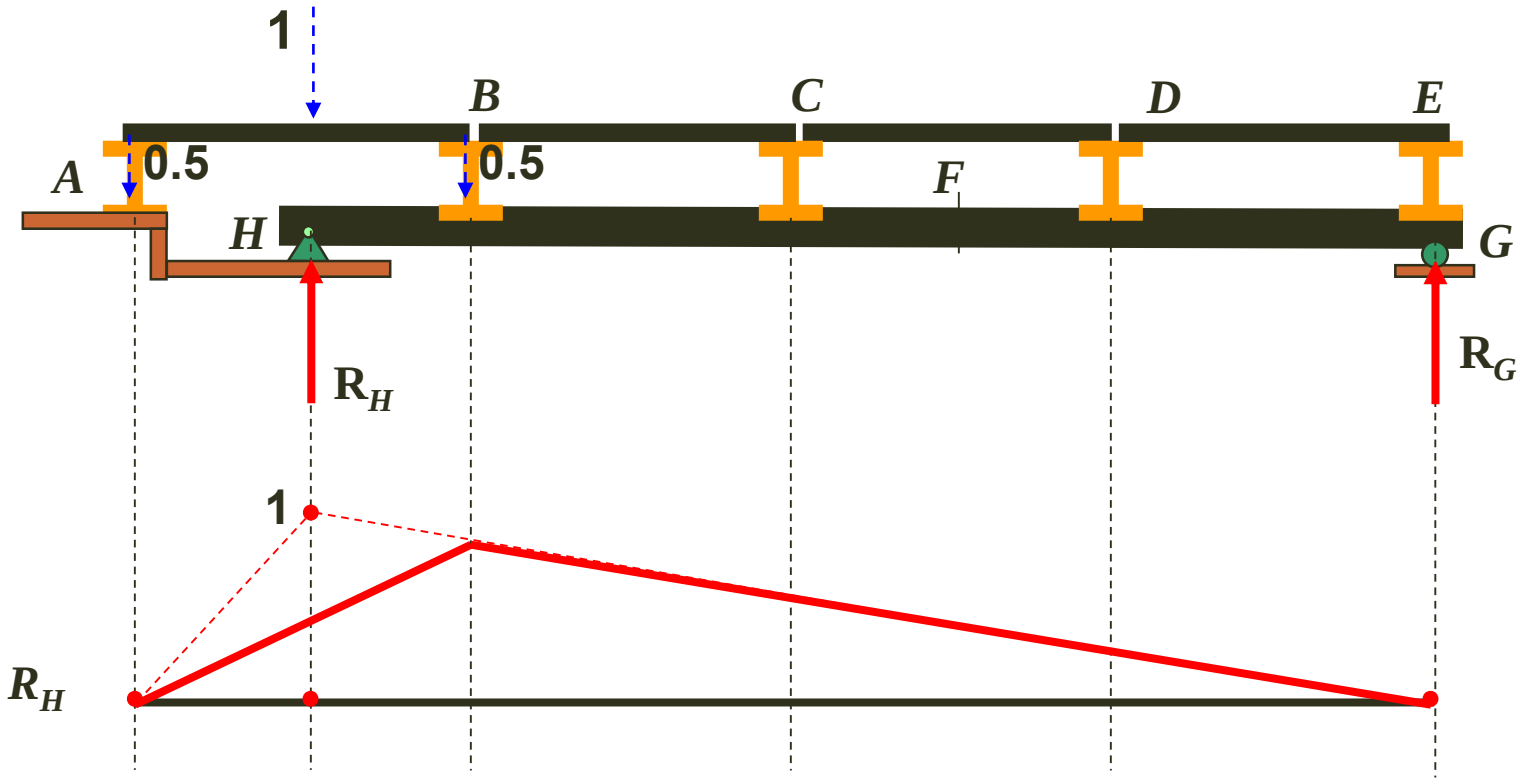
Influence Line for Girder

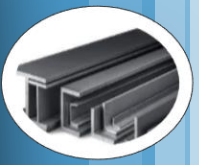
- Forces Apply to the Girder



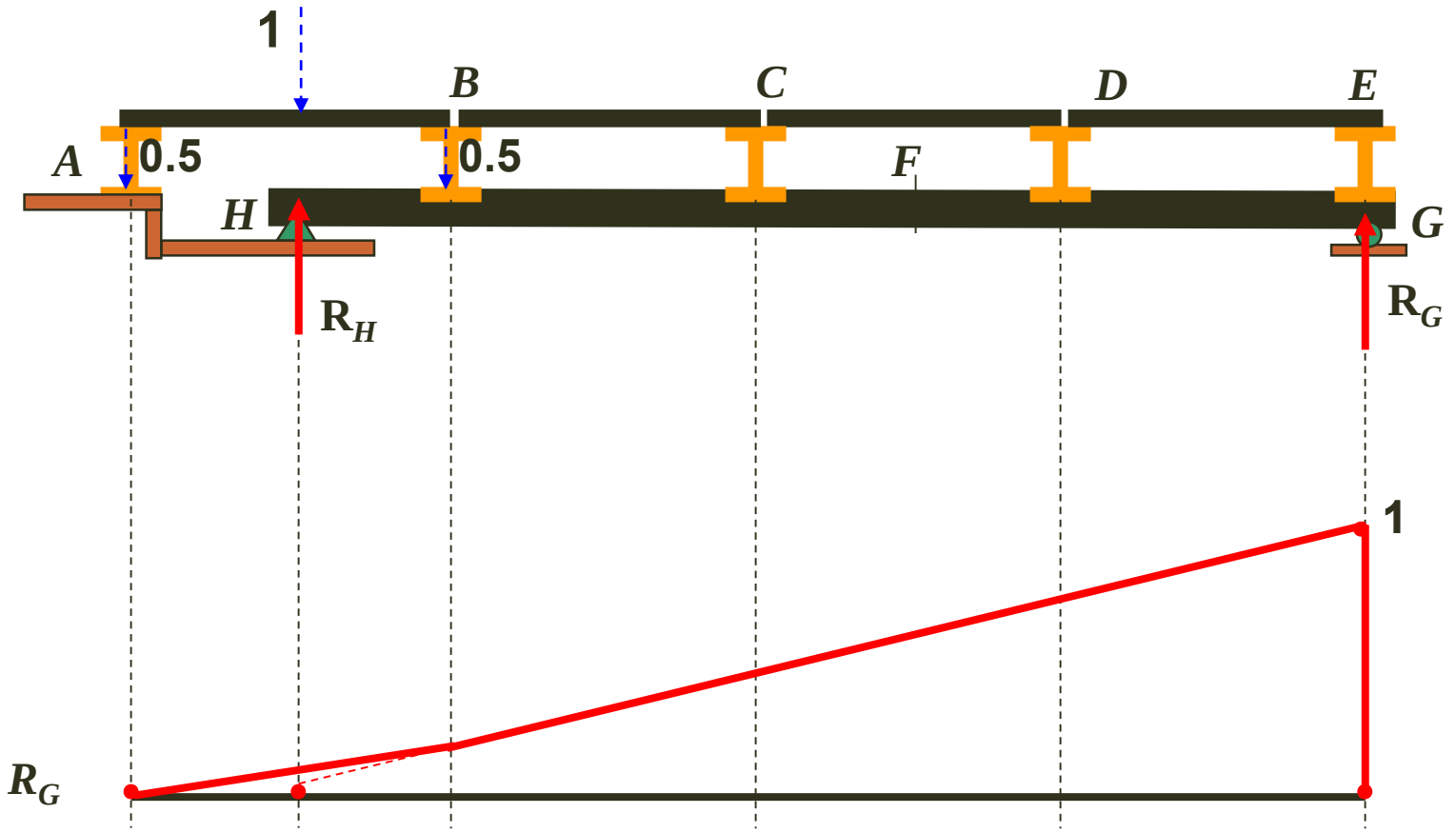
Influence Line for Girder

- **Reaction**



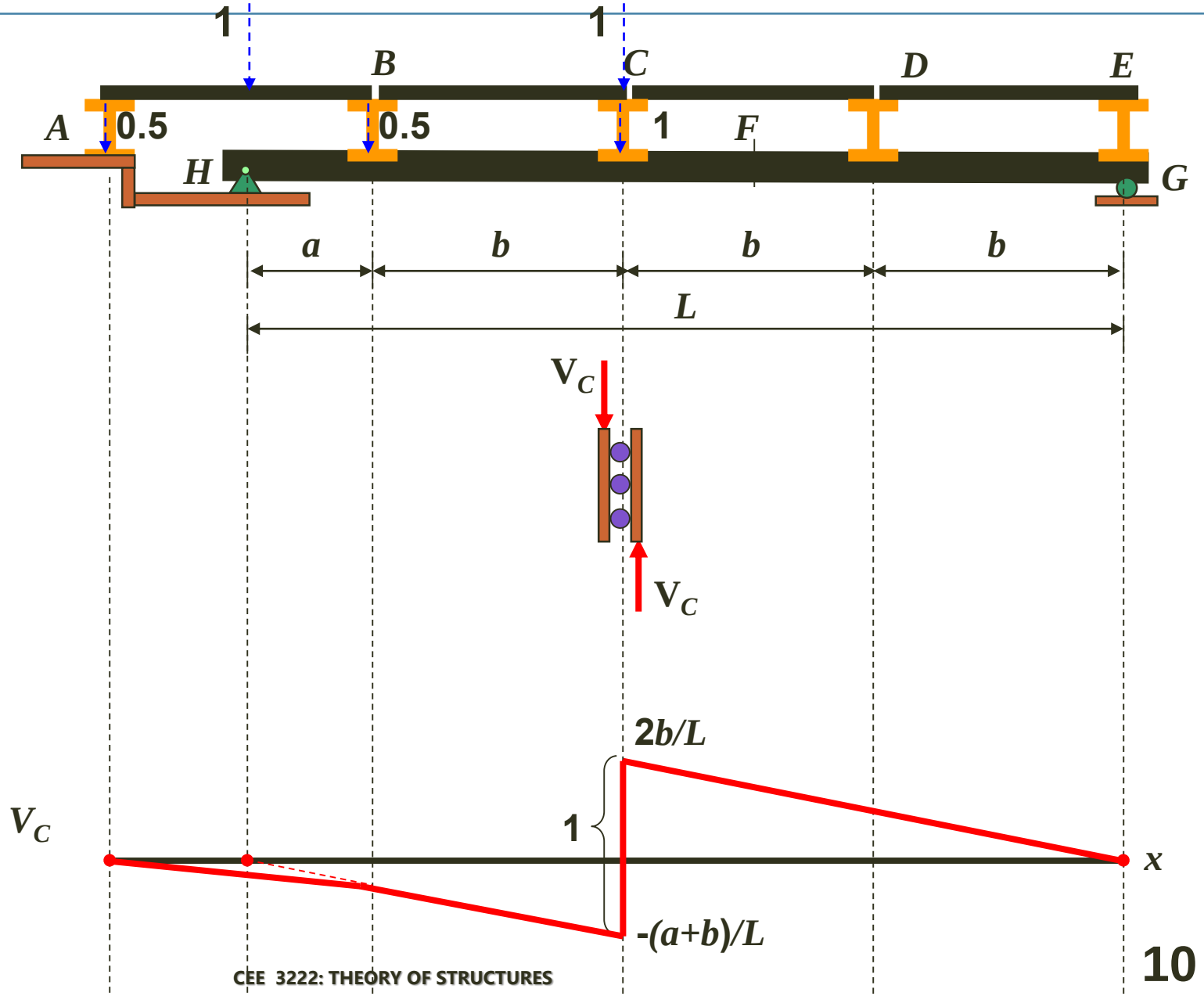




Influence Line for Girder

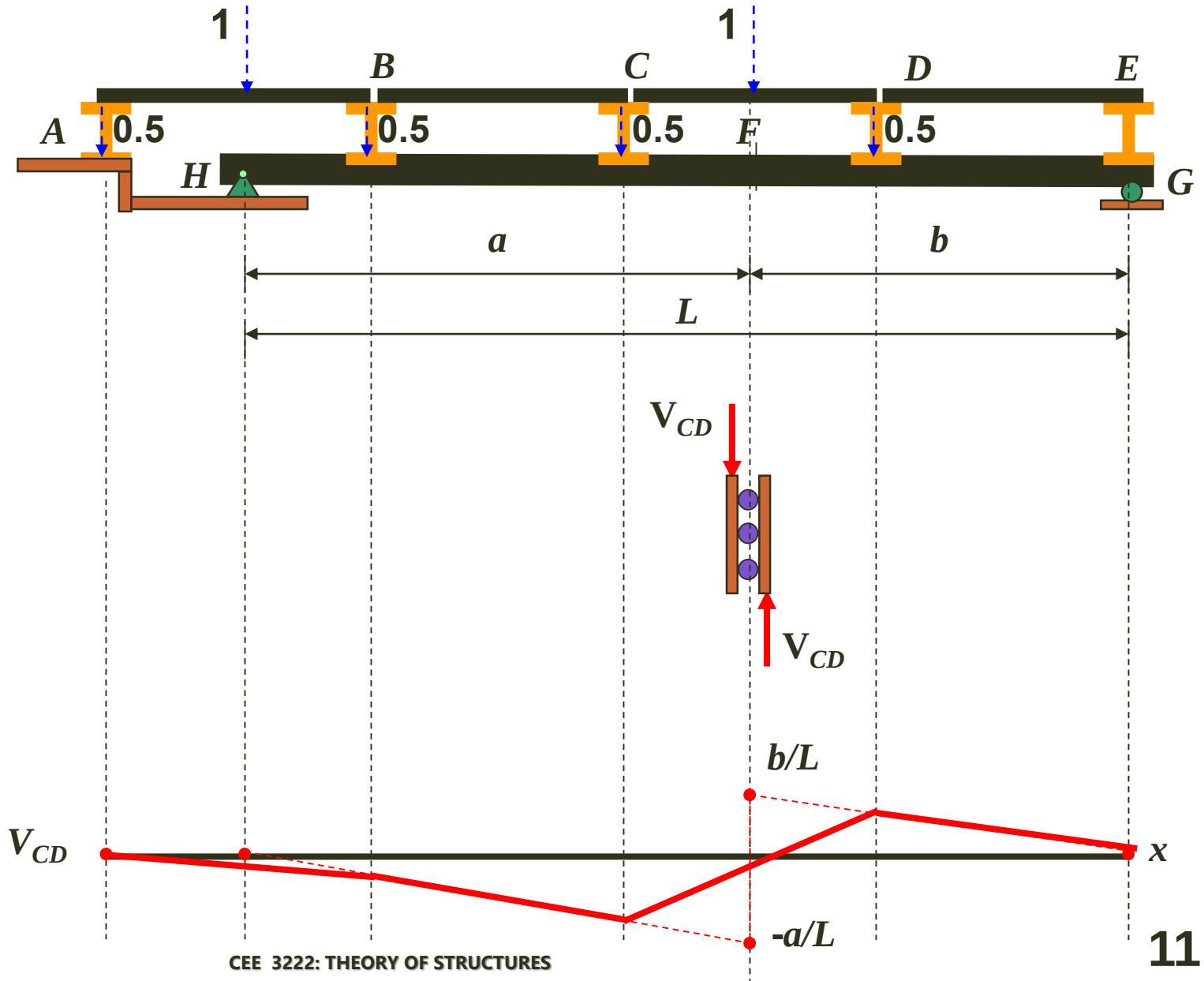


Influence Line for Girder

- Shear

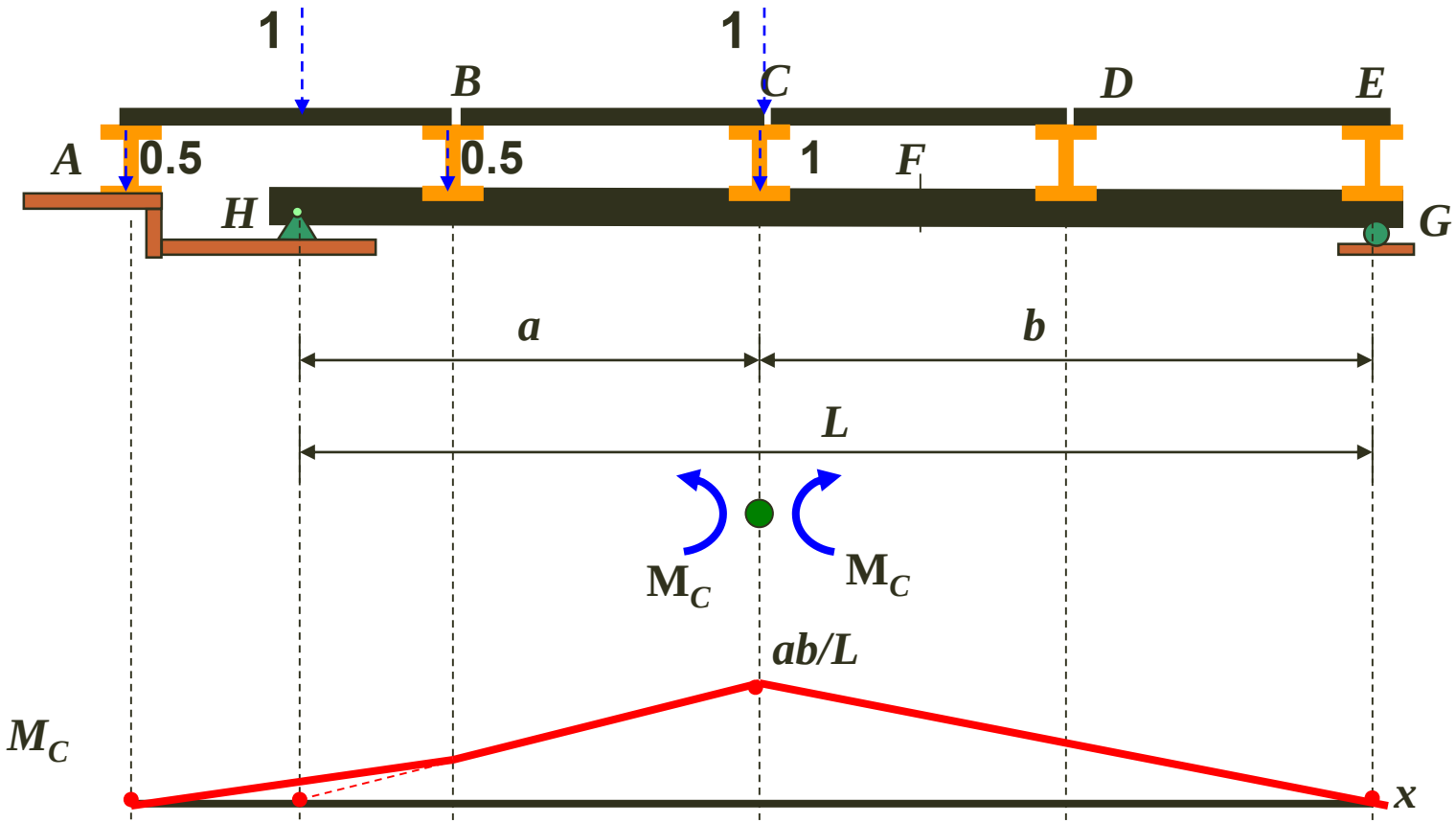


Influence Line for Girder

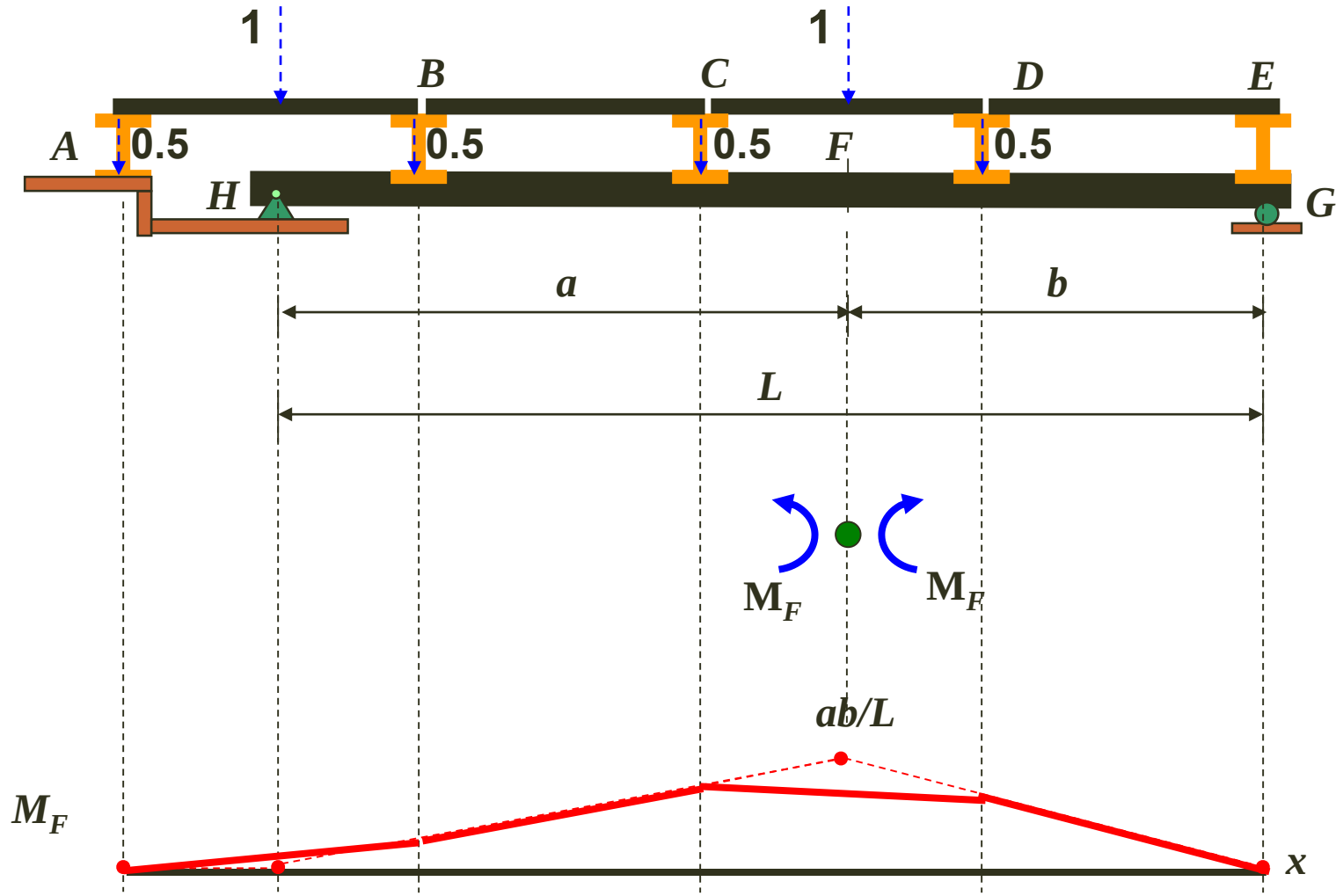


Influence Line for Girder

- Bending Moment



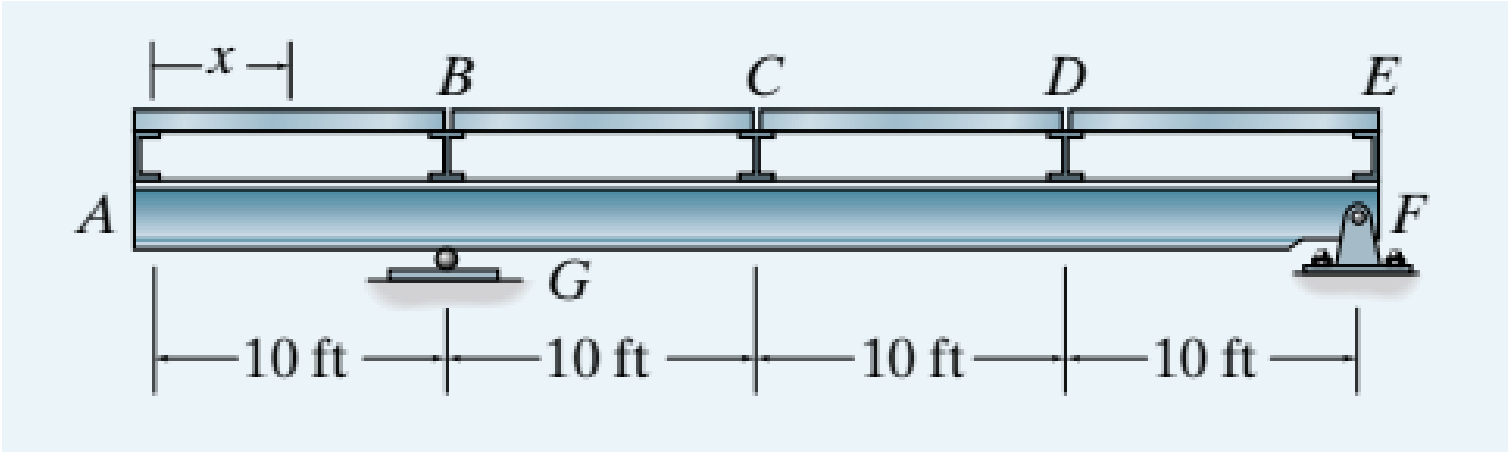
Influence Line for Girder



Influence Line for Girder

Example 1:

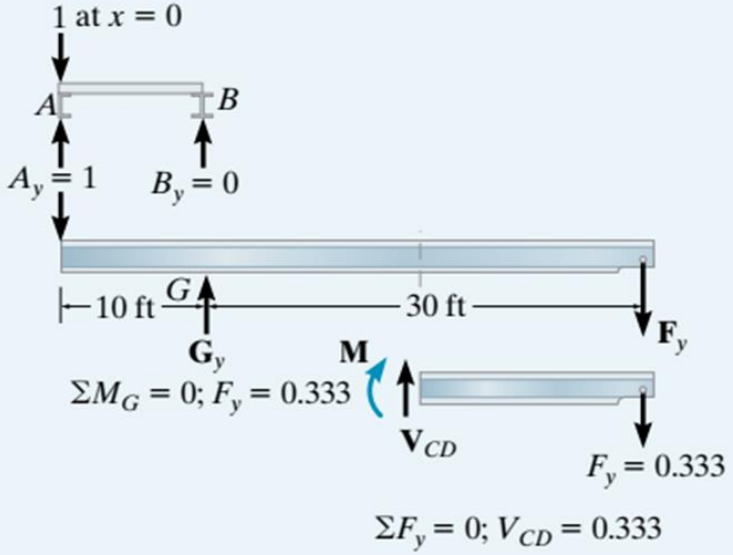
- Draw the influence line for the shear in panel CD of the floor girder?



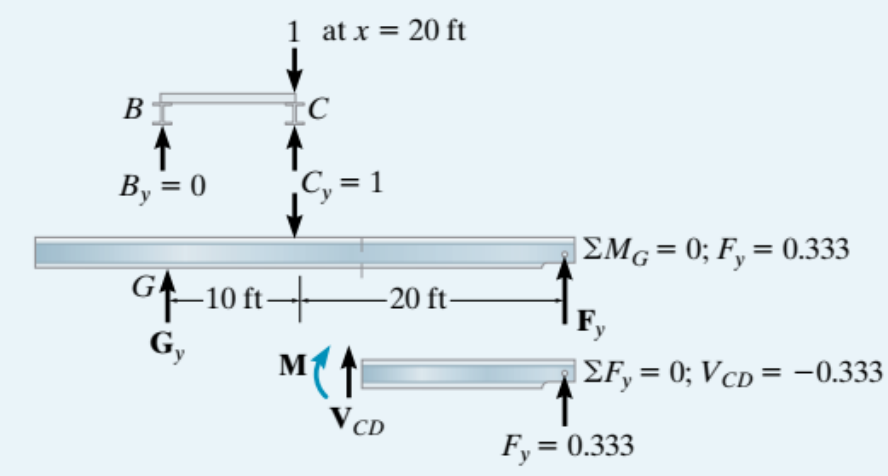
Influence Line for Girder

Solution 1:

- Notice that in each case the reactions of the floor beams on the girder are calculated first, followed by a determination of the girder support reaction at F (Gy is not needed), and finally, a segment of the girder is considered and the internal panel shear VCD is calculated.

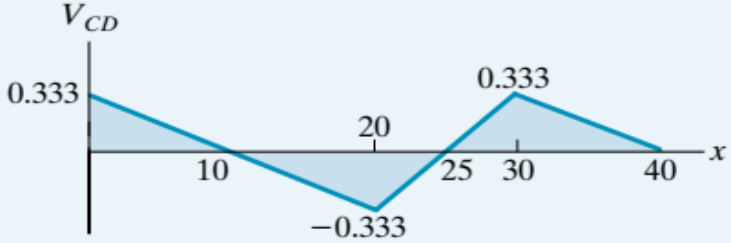


$x = 0$



$x = 20$

x	V_{CD}
0	0.333
10	0
20	−0.333
30	0.333
40	0

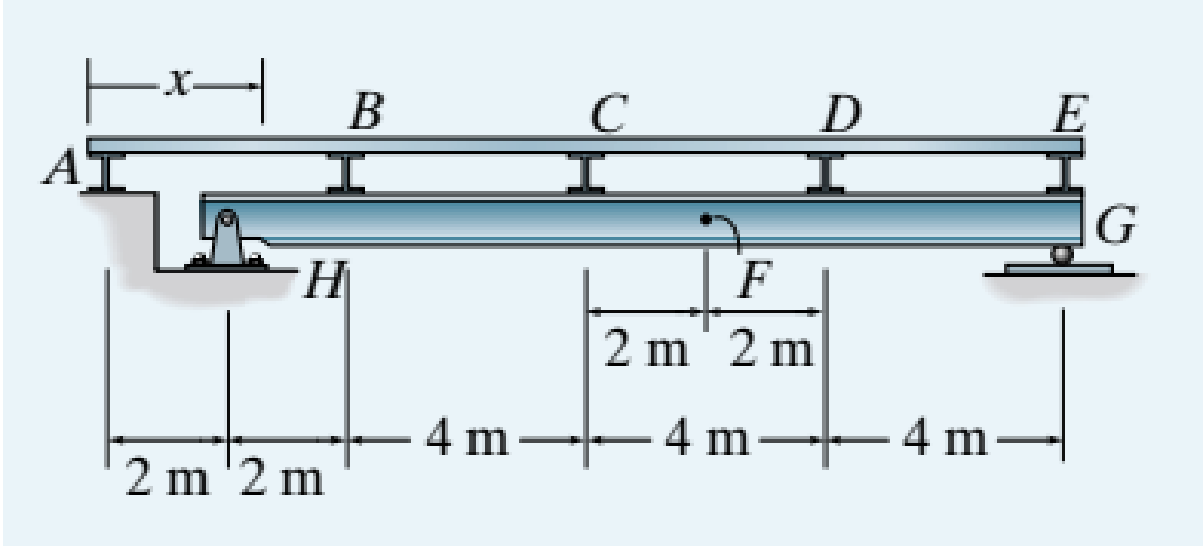


influence line for V_{CD}

Influence Line for Girder

Example 2:

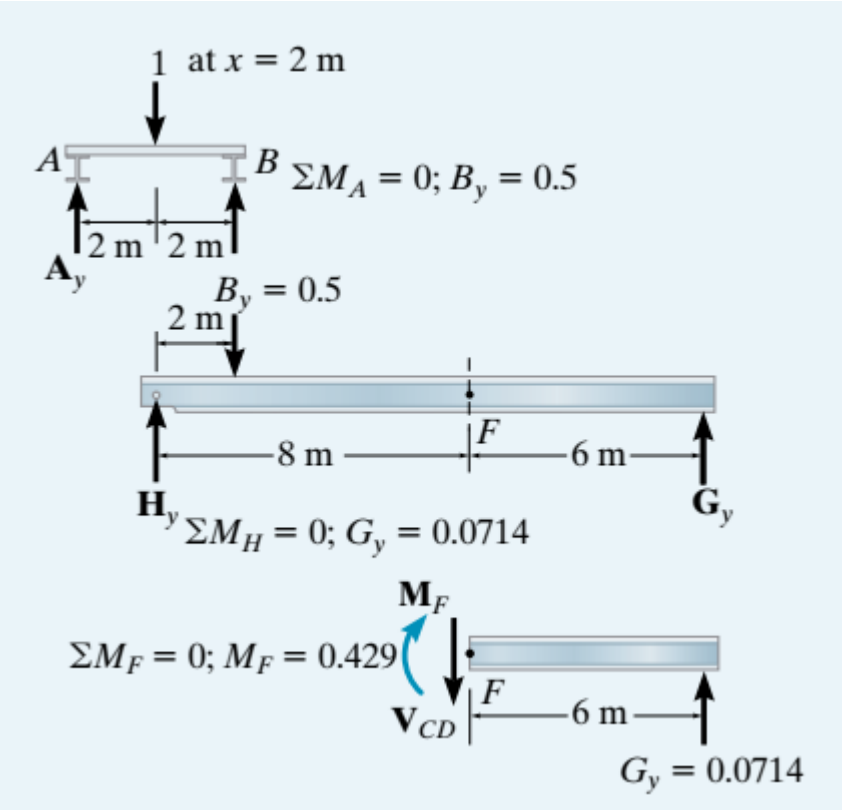
- Draw the influence line for the moment at point F for the floor girder?



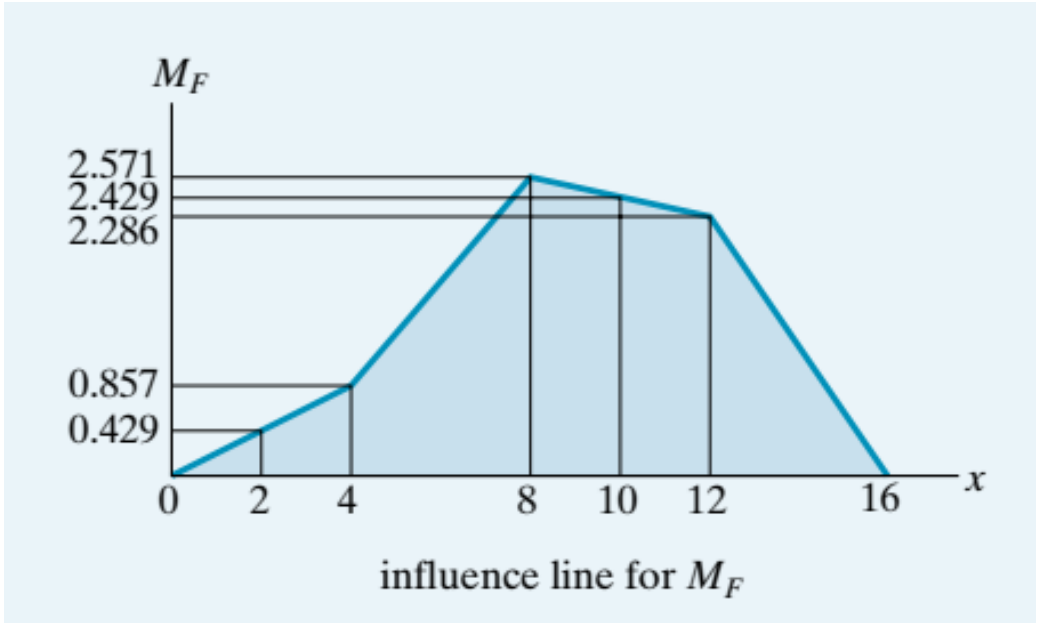
Influence Line for Girder

Solution 2:

- It is first necessary to determine the reactions of the floor beams on the girder, followed by a determination of the girder support reaction G_y (H_y is not needed), and finally segment GF of the girder is considered and the internal moment MF is calculated. Lets calculate for the others.



$x = 2$



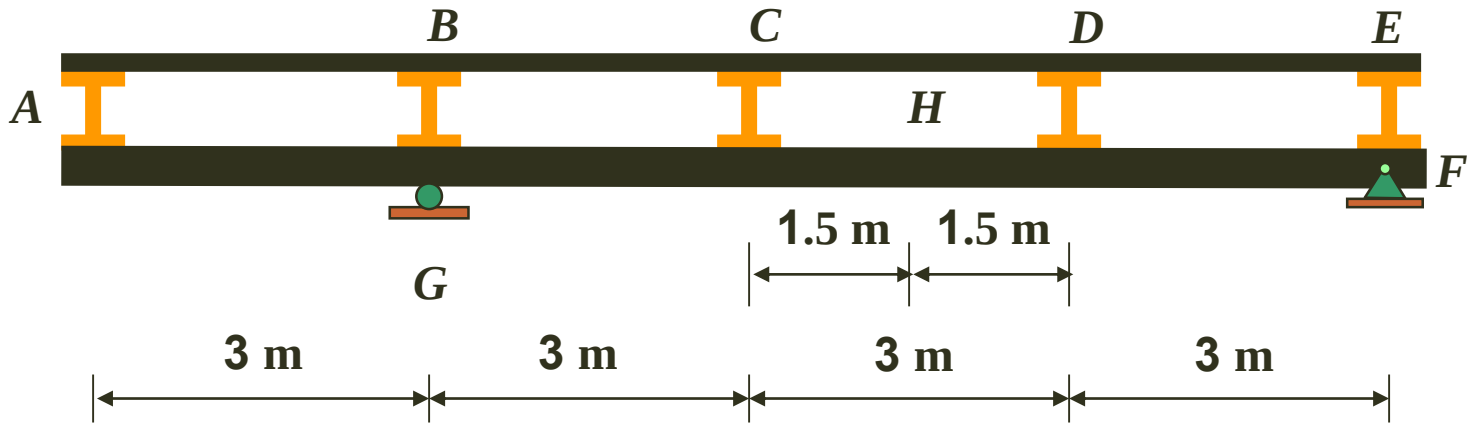
influence line for M_F

Influence Line for Girder

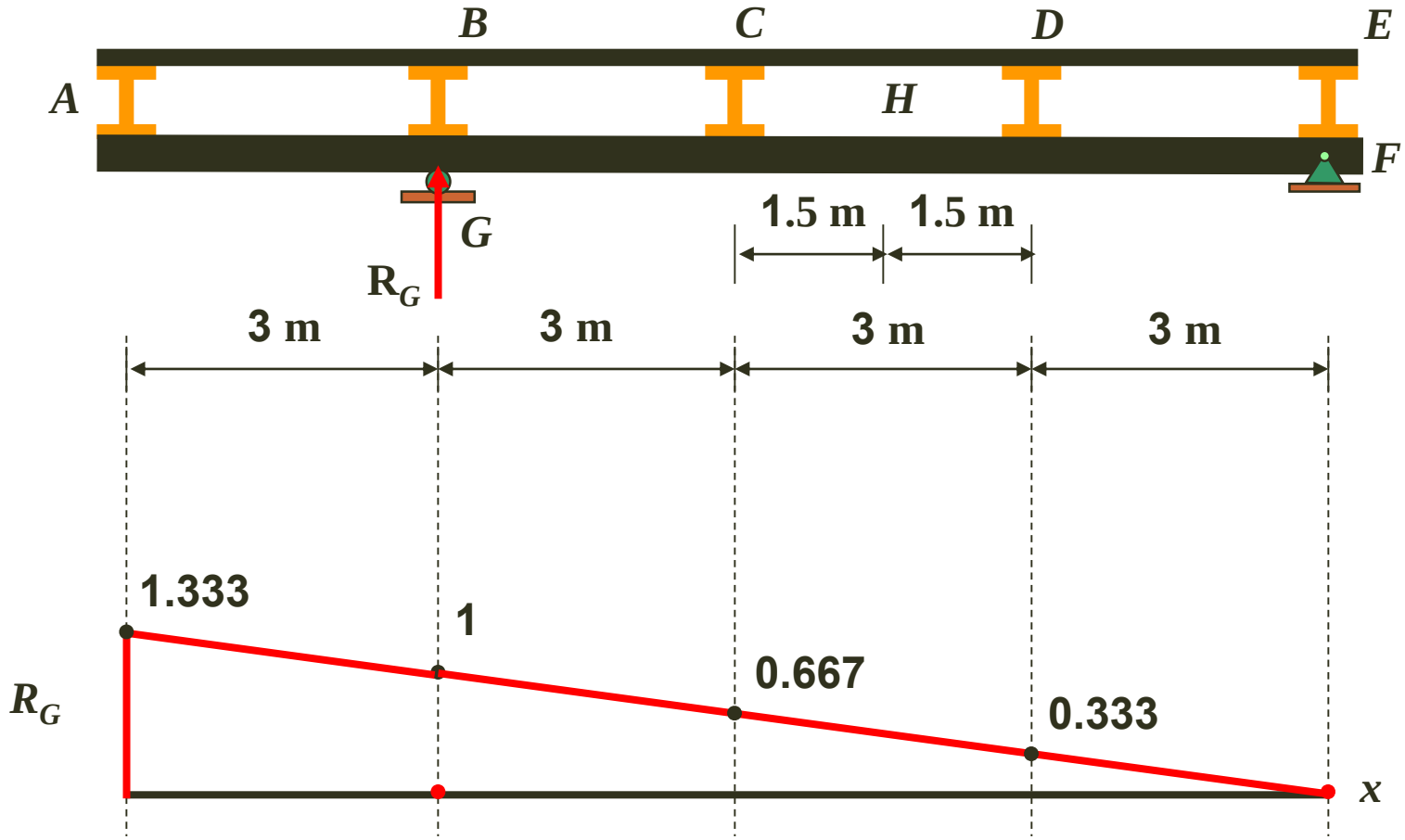
Example 6-5

Draw the influence for

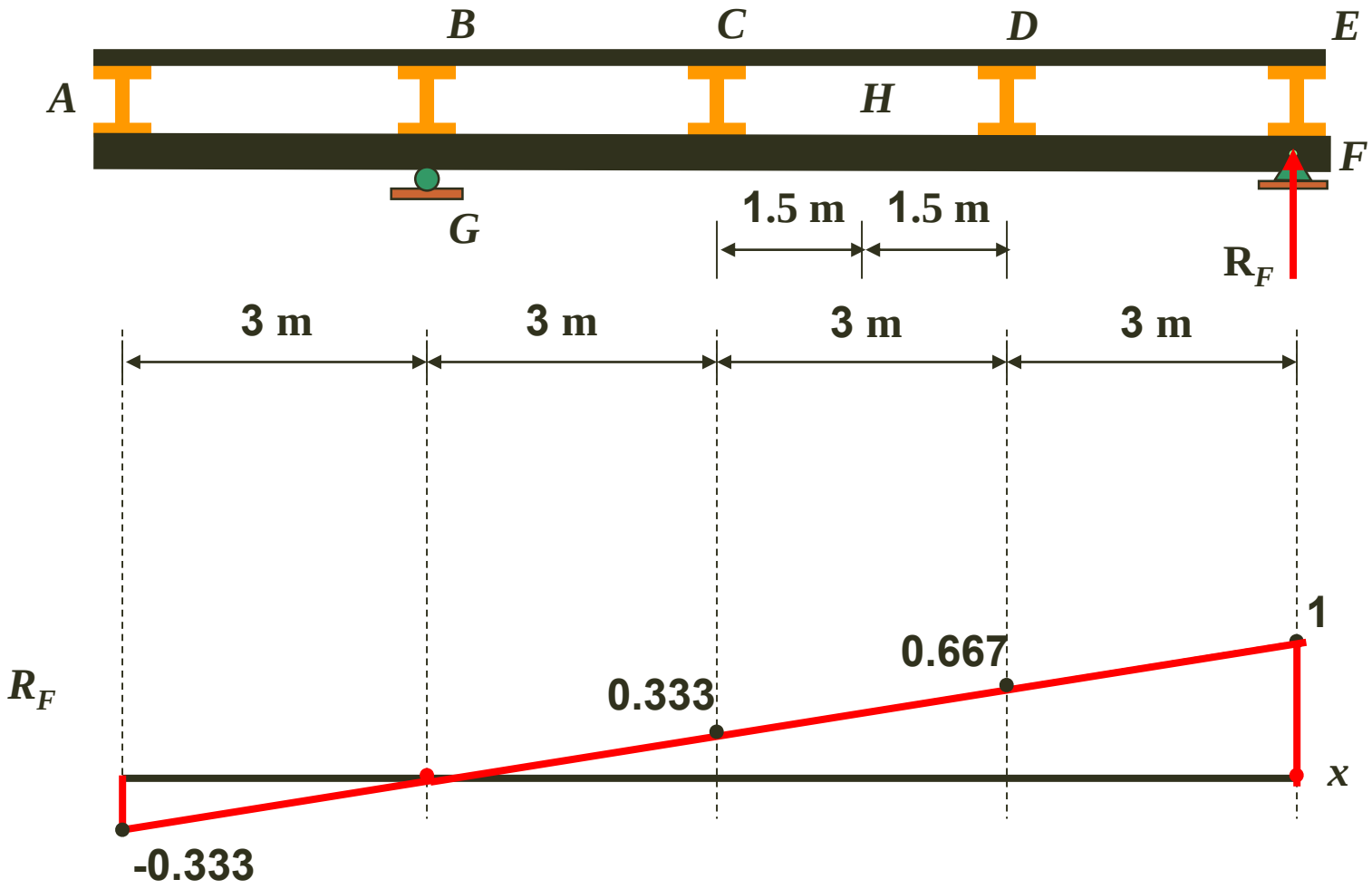
- **the Reaction R_G and R_F**
- **Shear V_{CD}**
- **the moment M_C and M_H**



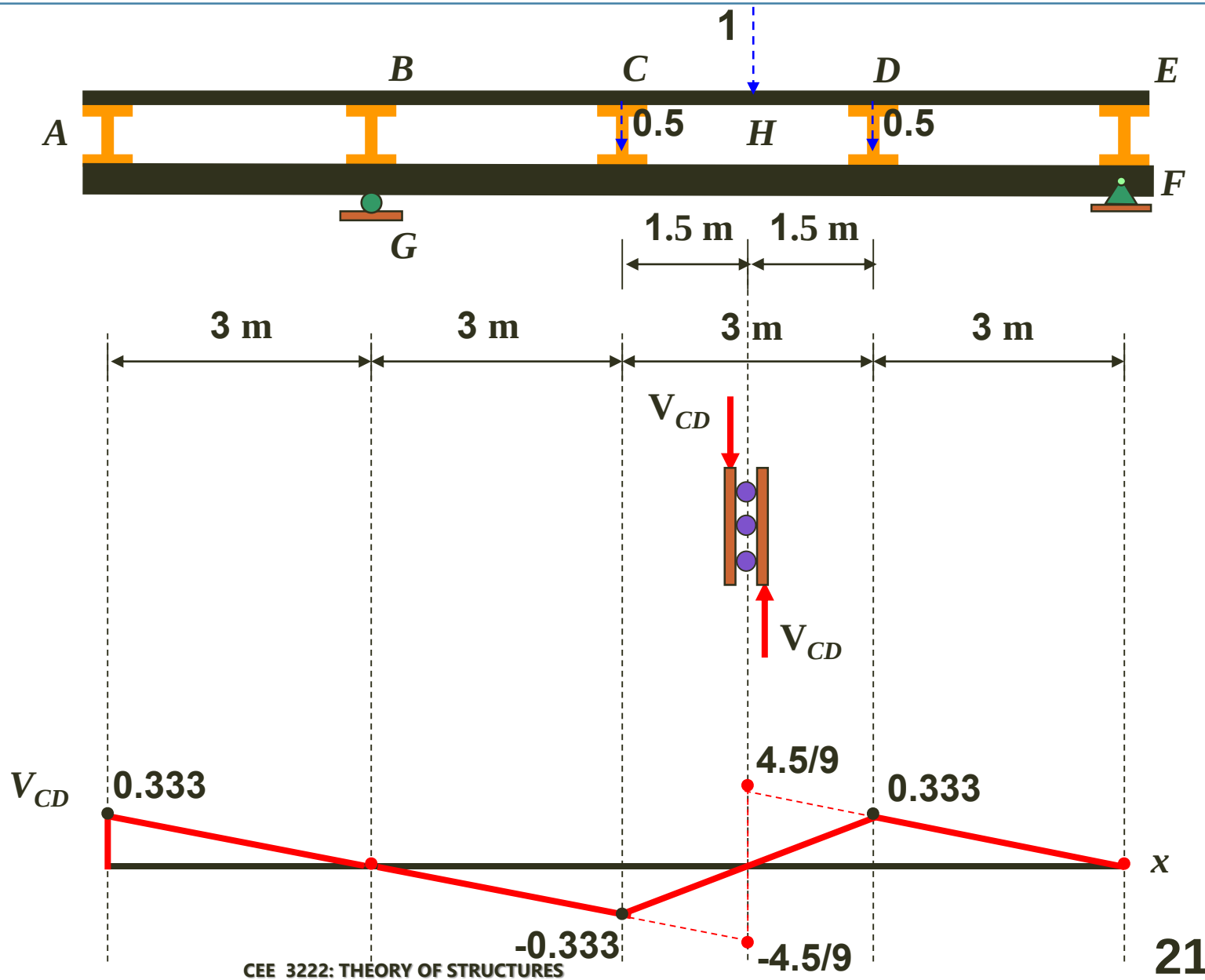
Influence Line for Girder



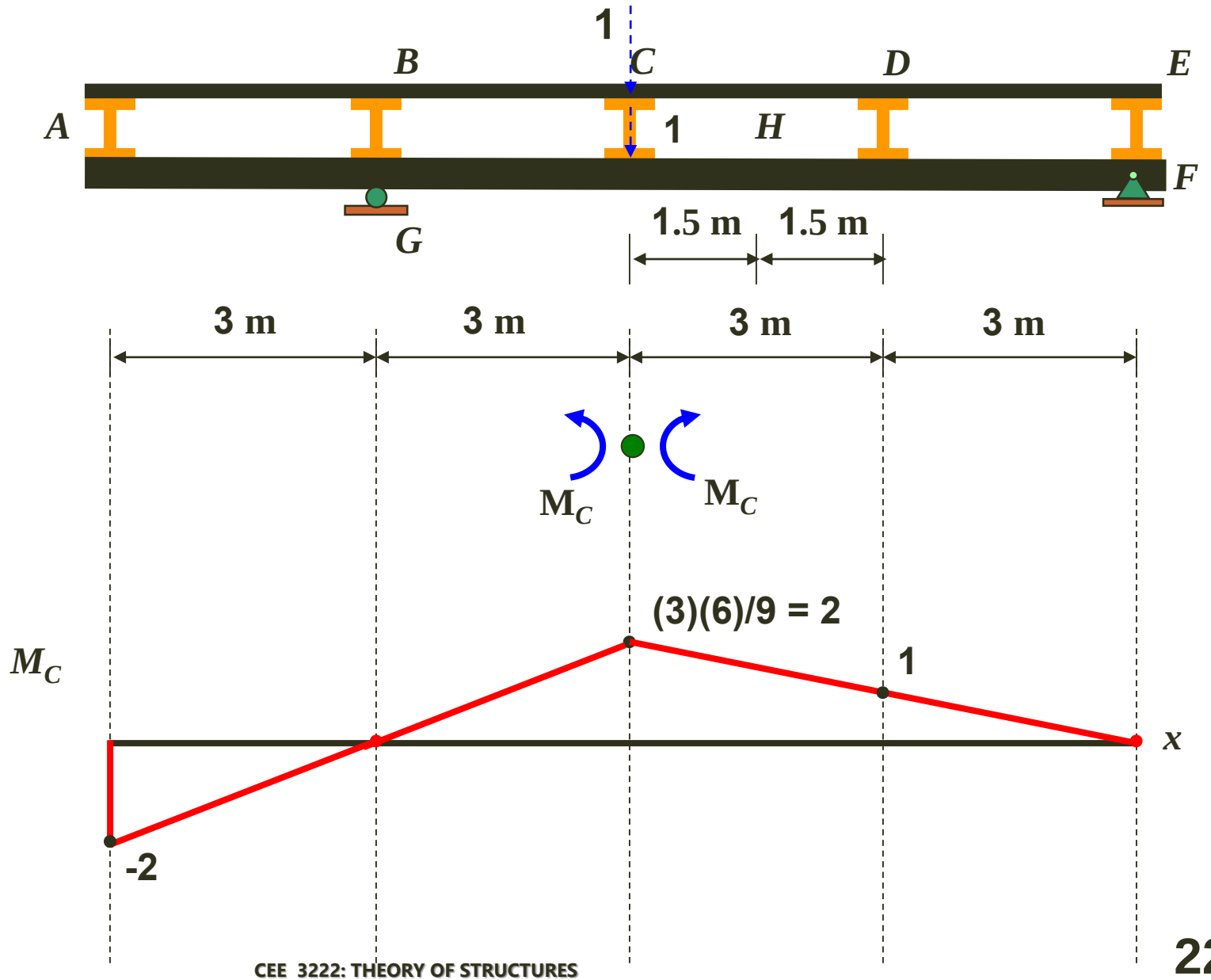
Influence Line for Girder



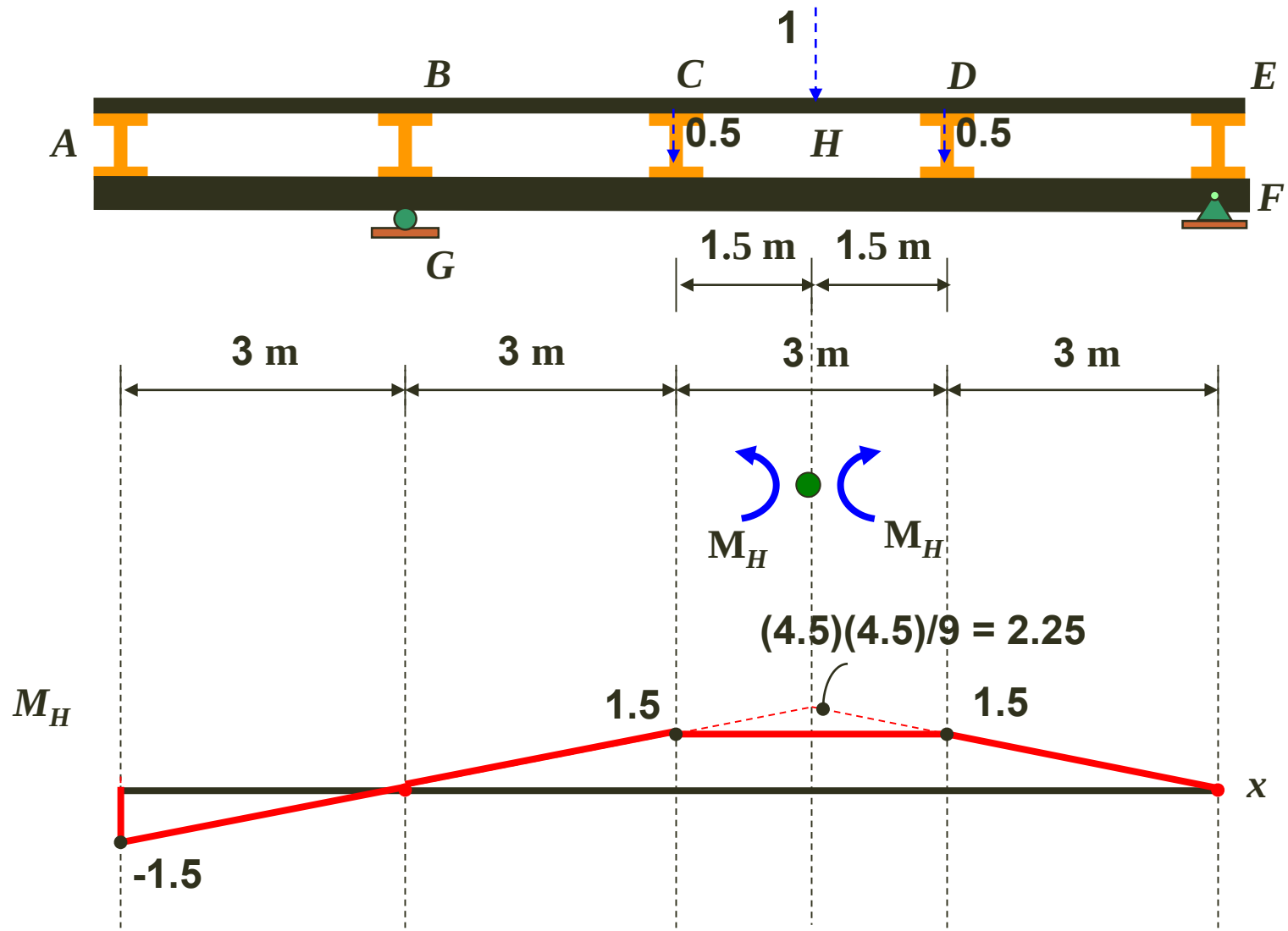
Influence Line for Girder



Influence Line for Girder



Influence Line for Girder

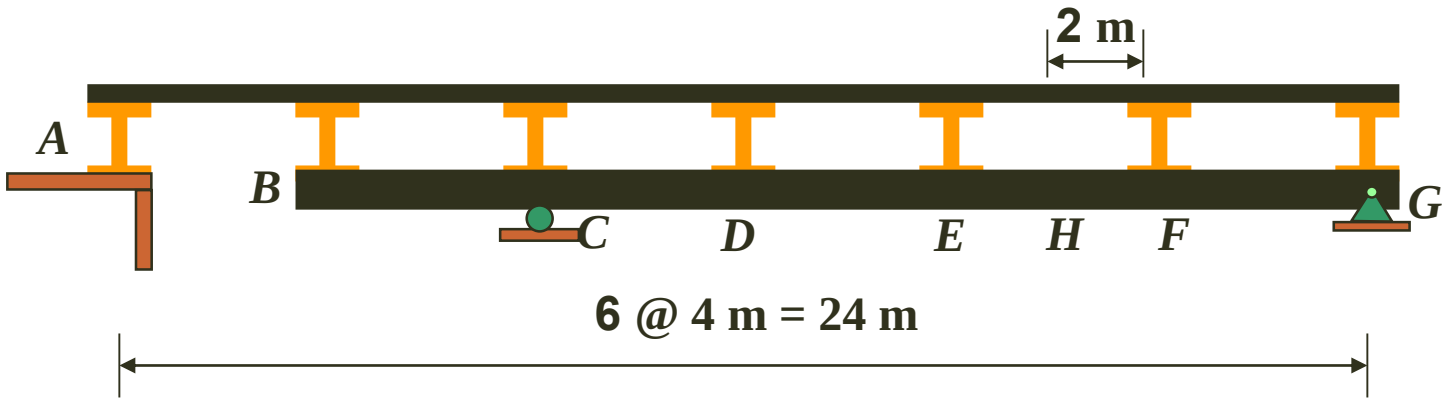


Influence Line for Girder

Example 6-6

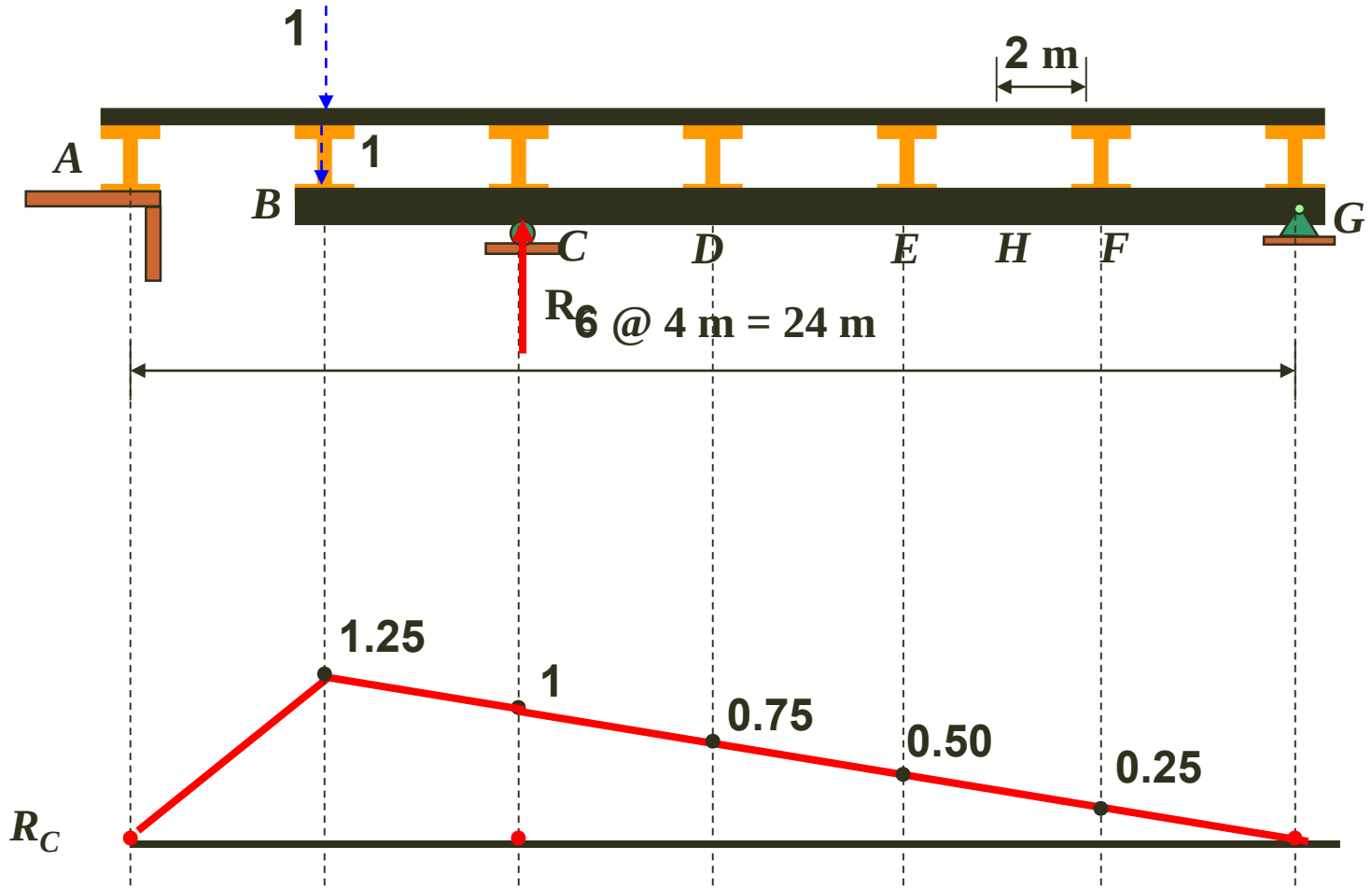
Draw the influence line diagrams of girder for

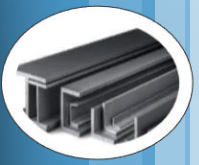
- the reaction at *C* and *G* ,
- shear at *E* and *H*,
- bending moment at *H*.



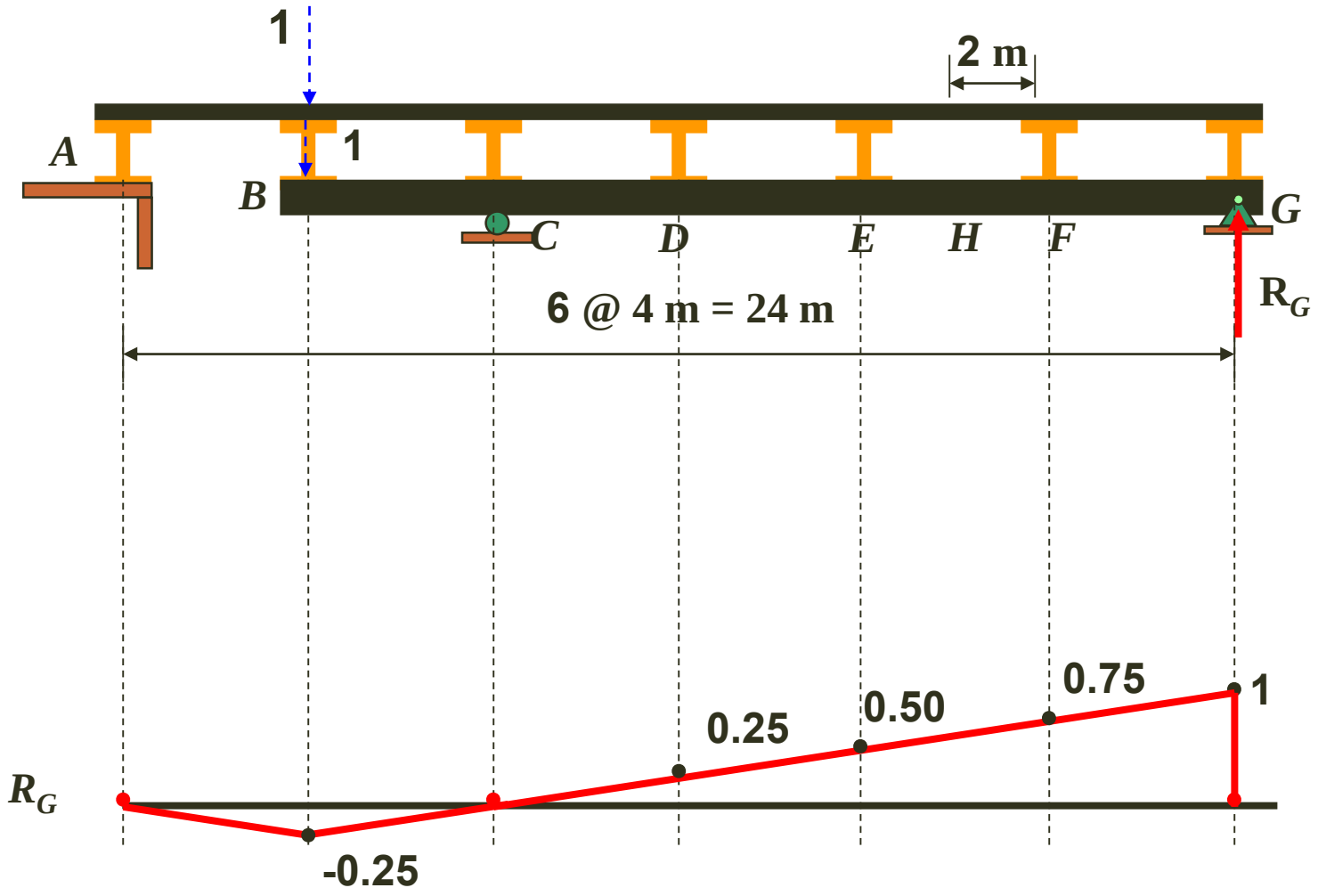
Influence Line for Girder

SOLUTION

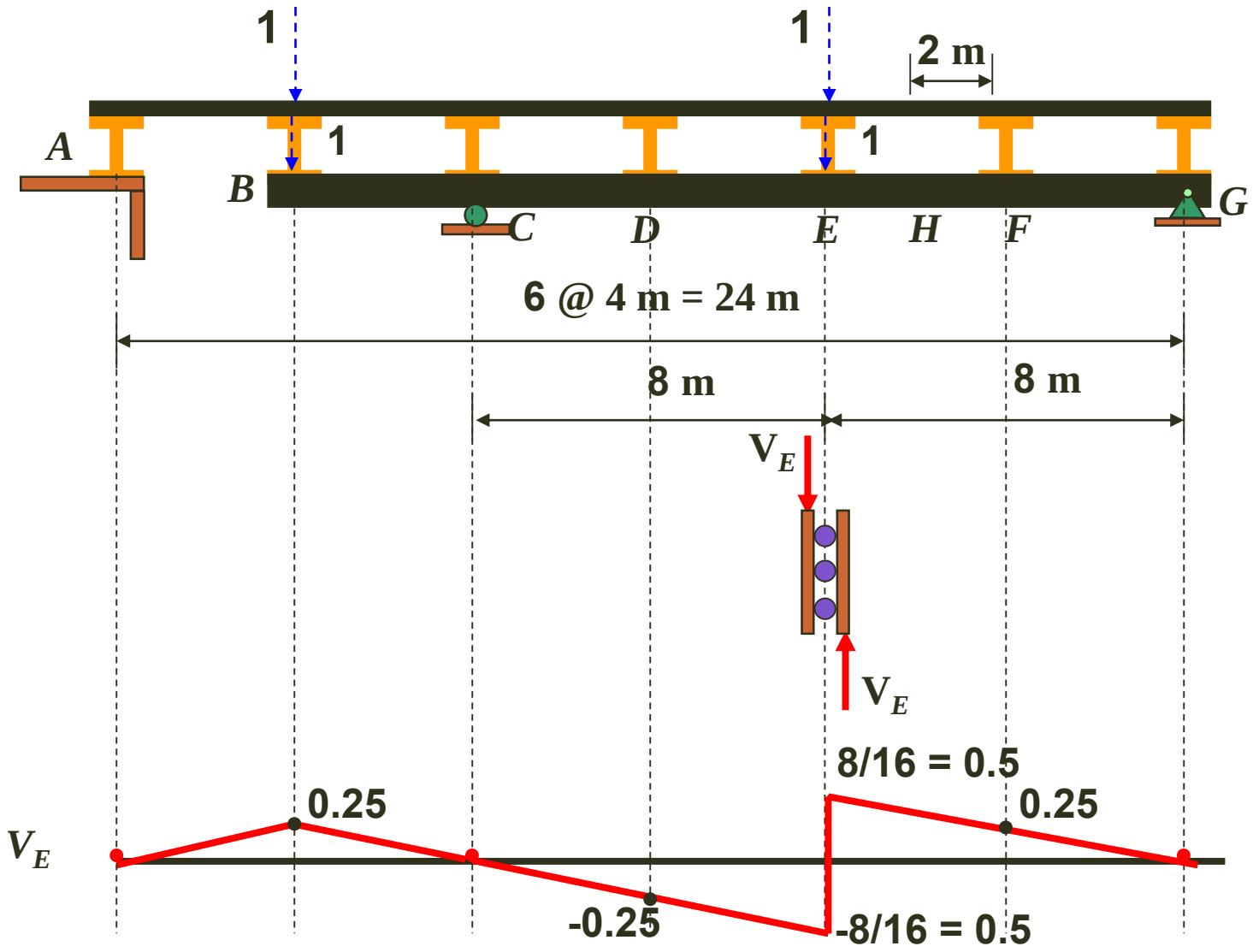


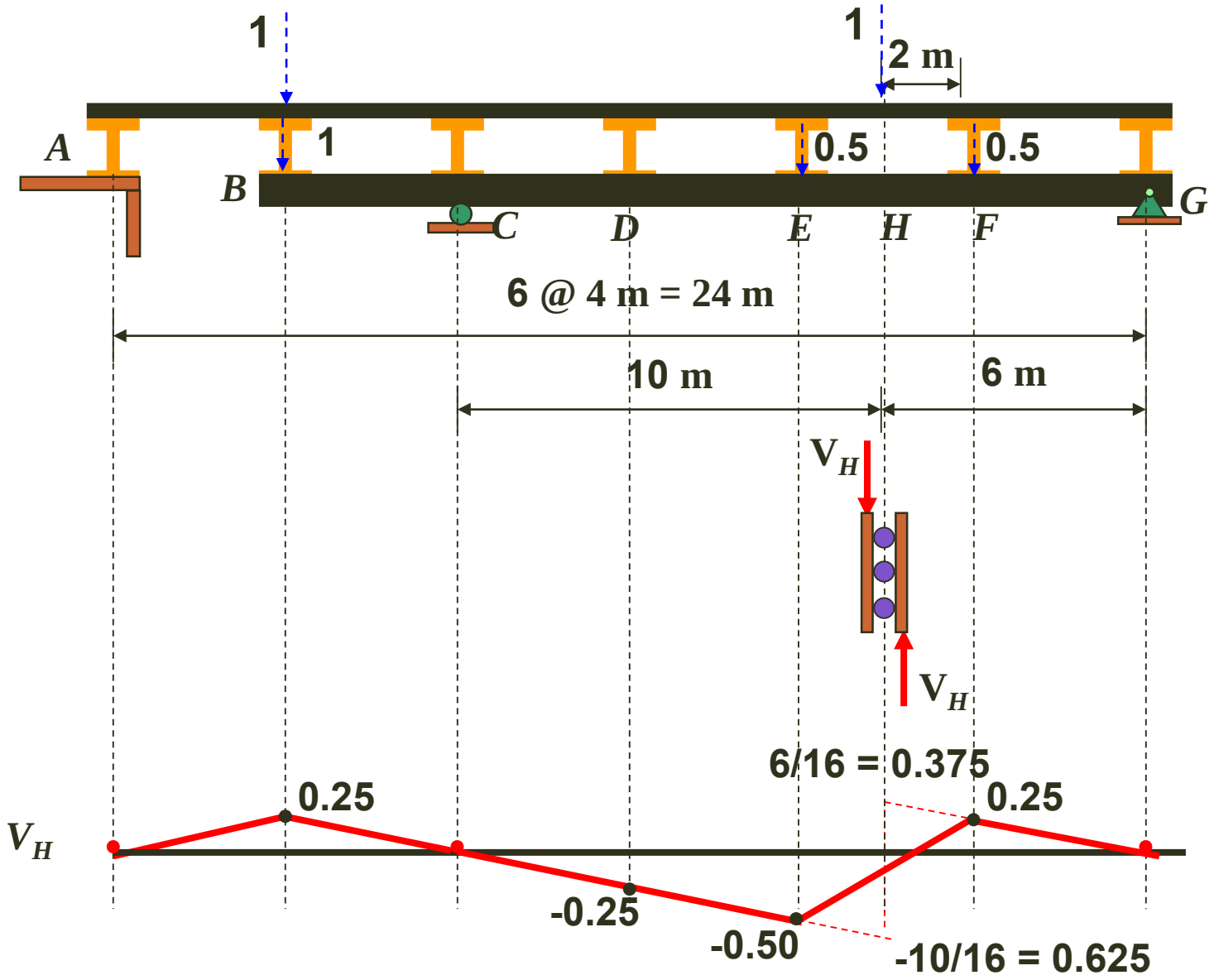

Influence Line for Girder



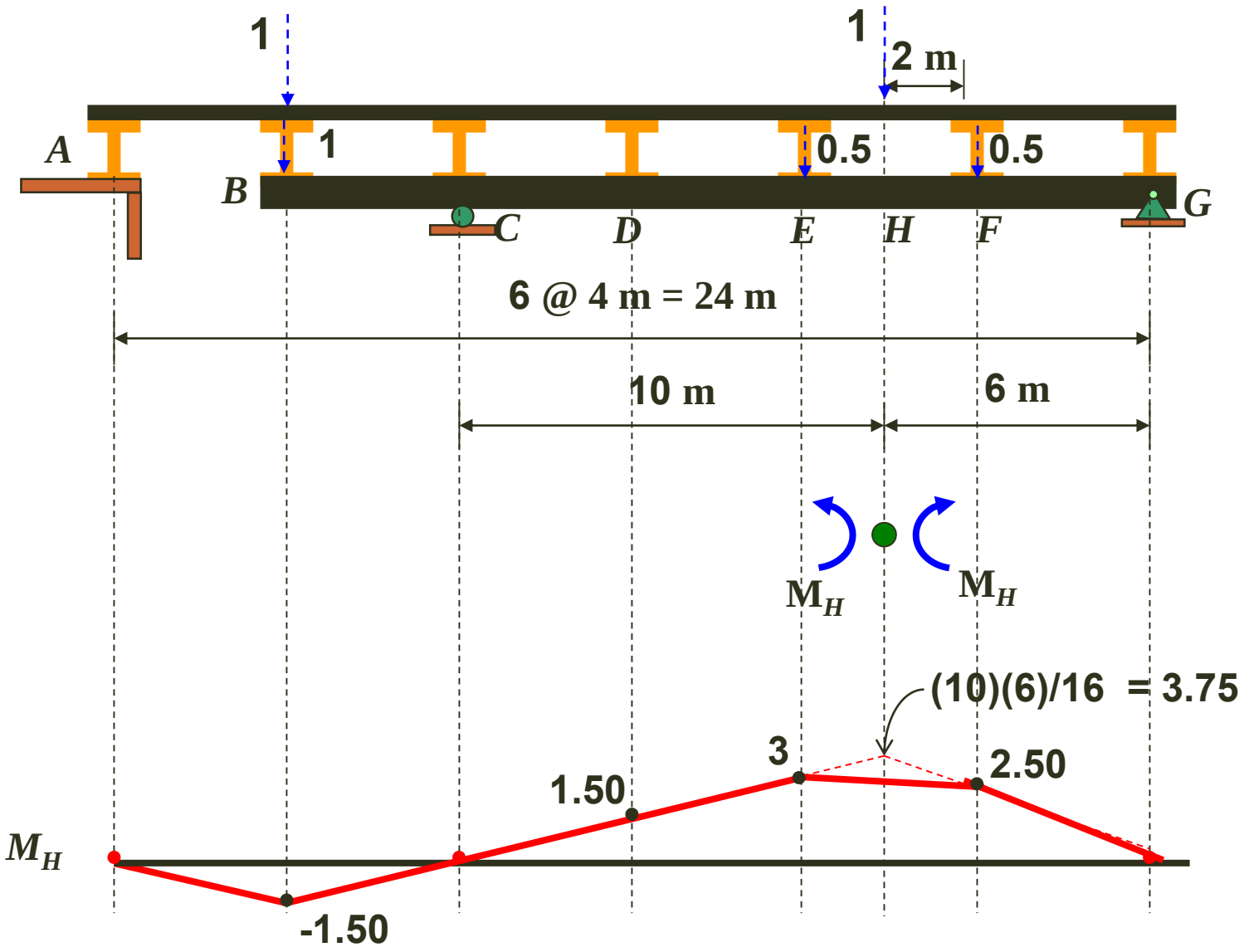
Influence Line for Girder



Influence Line for Girder



Influence Line for Girder



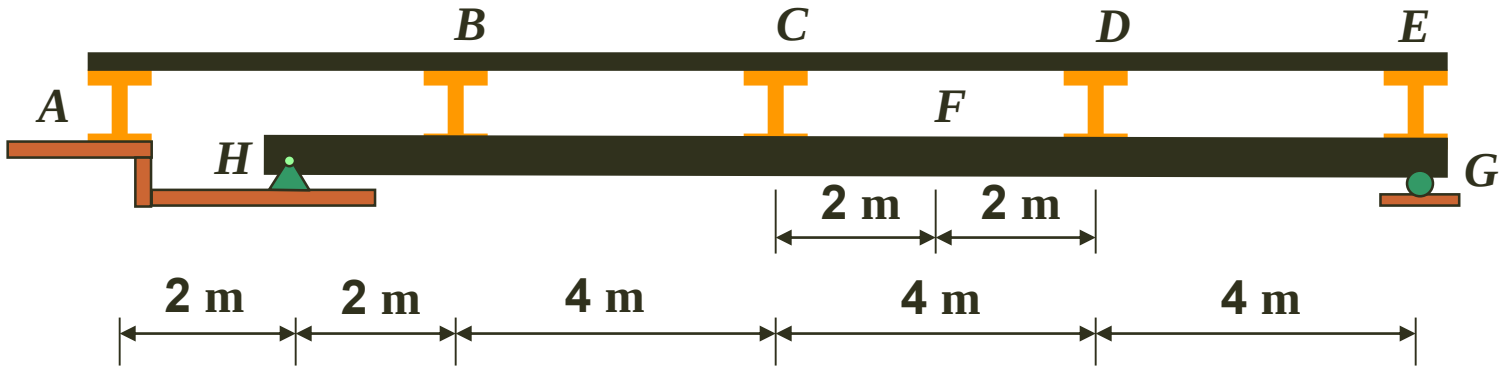
Influence Line for Girder

Example 6-7

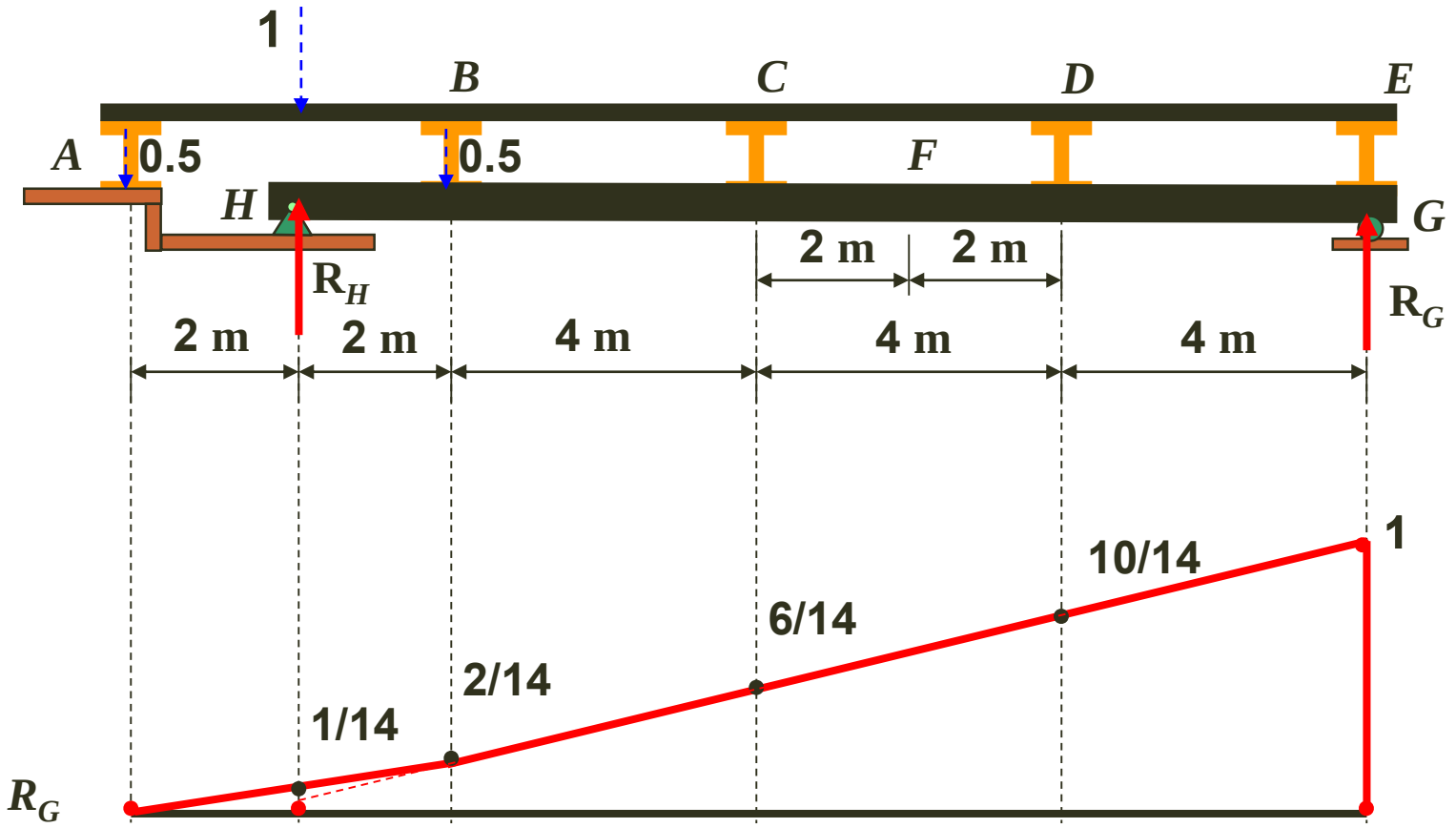
Draw the influence for
- the Reaction R_G and R_H
- Shear V_C and V_{CD}
- the moment M_C, M_D, and M_F

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

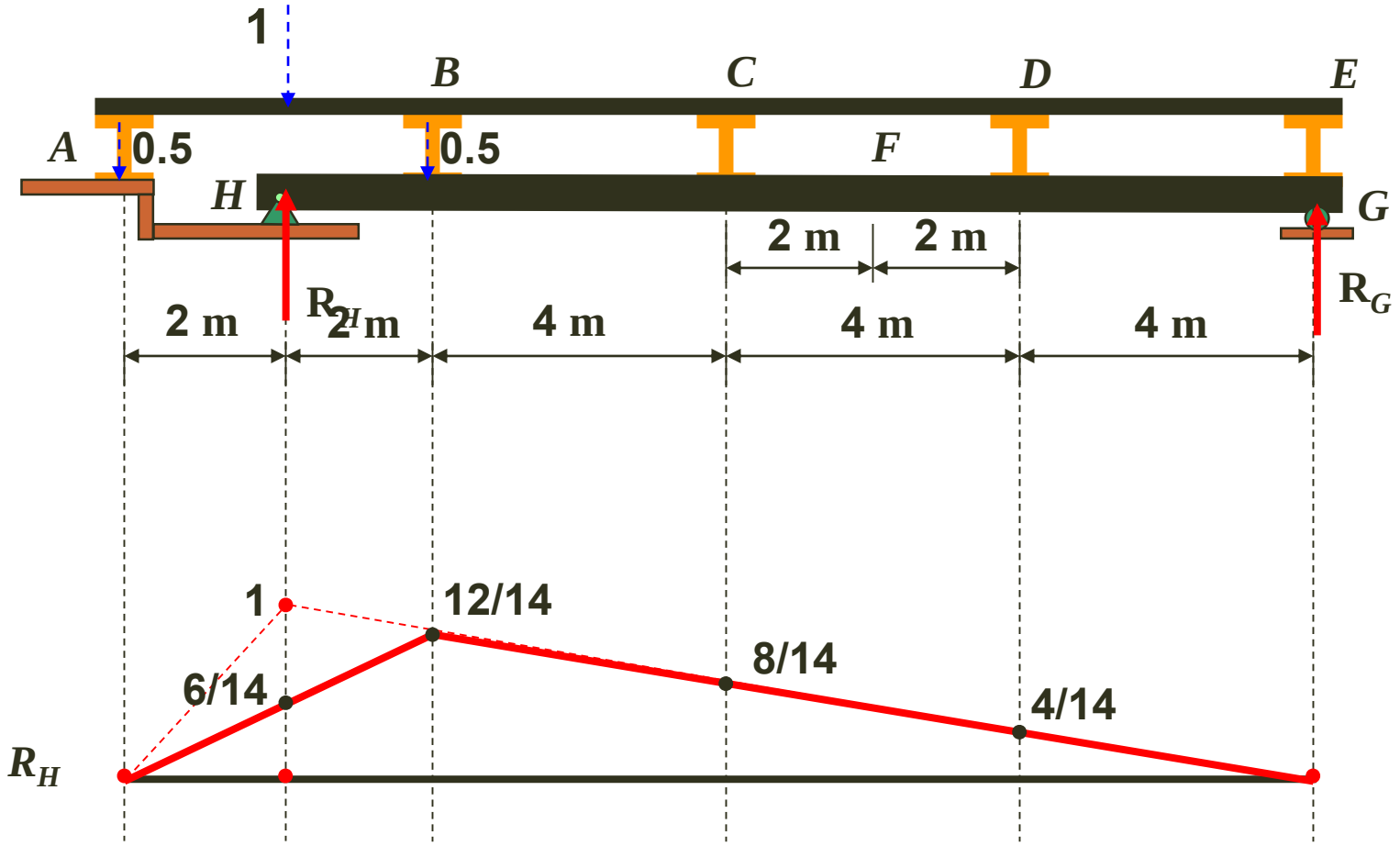
due to
- a uniform dead load 2 kN/m
- a uniform live load 5 kN/m
- a concentrated live load 50 kN



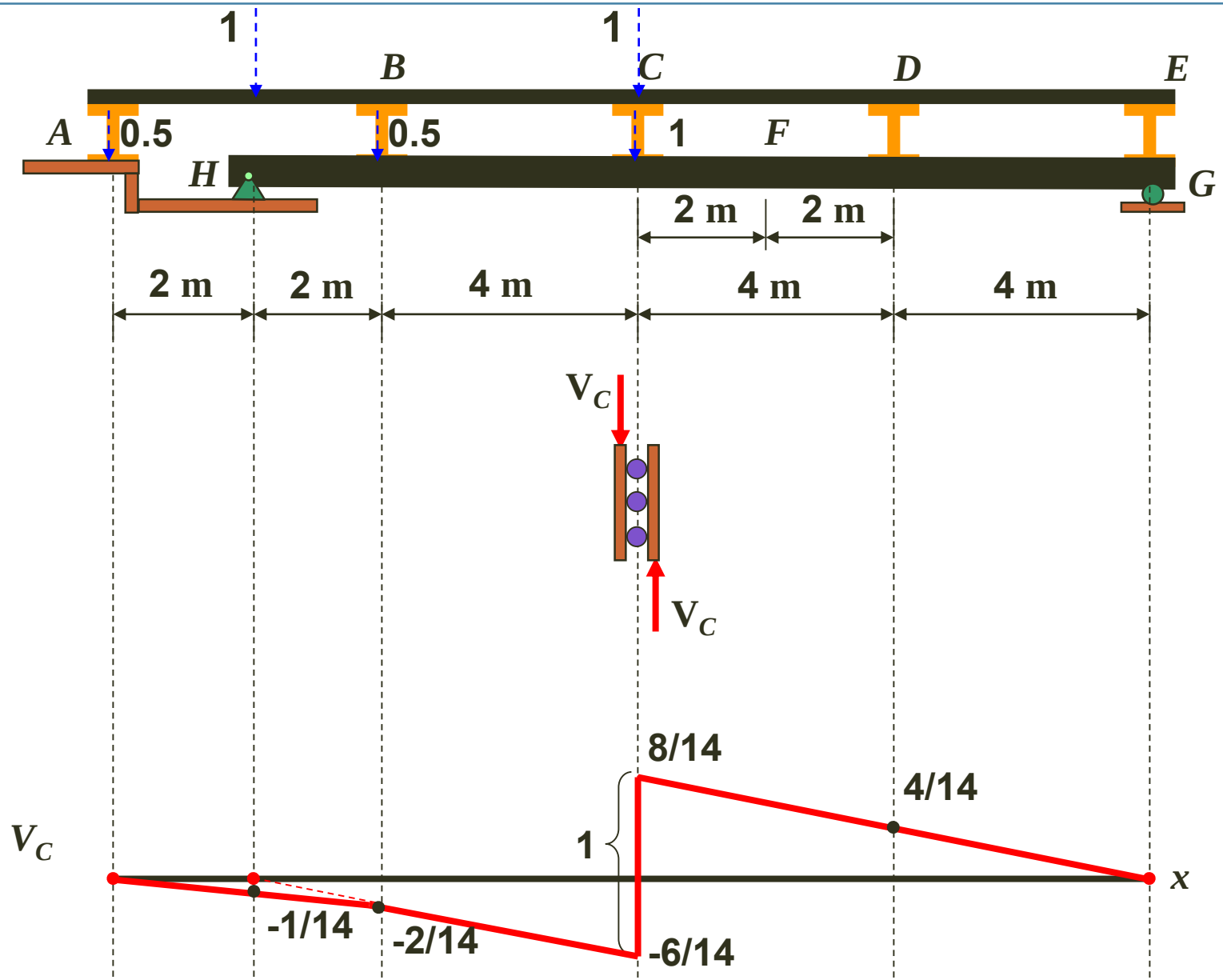
Influence Line for Girder



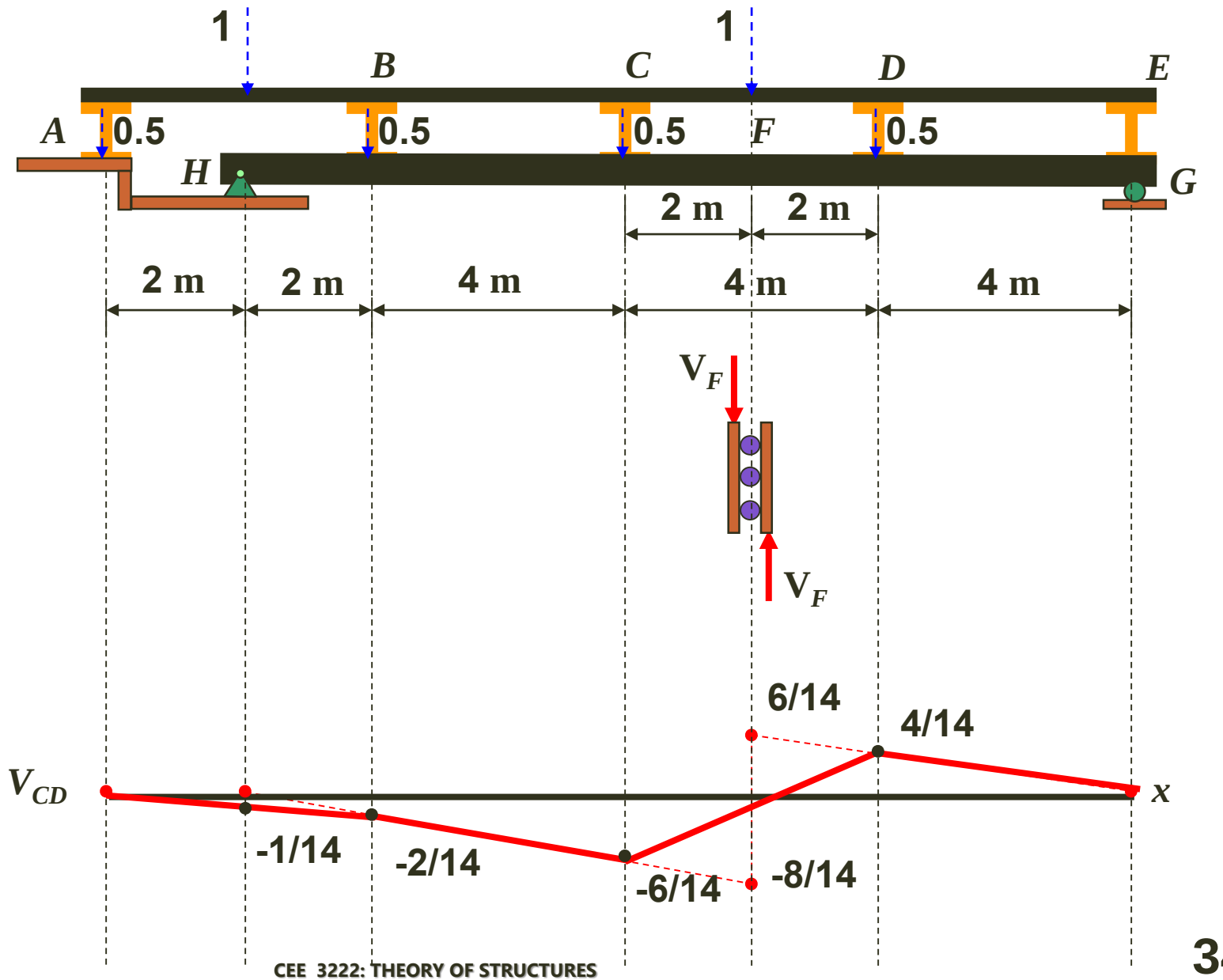
Influence Line for Girder



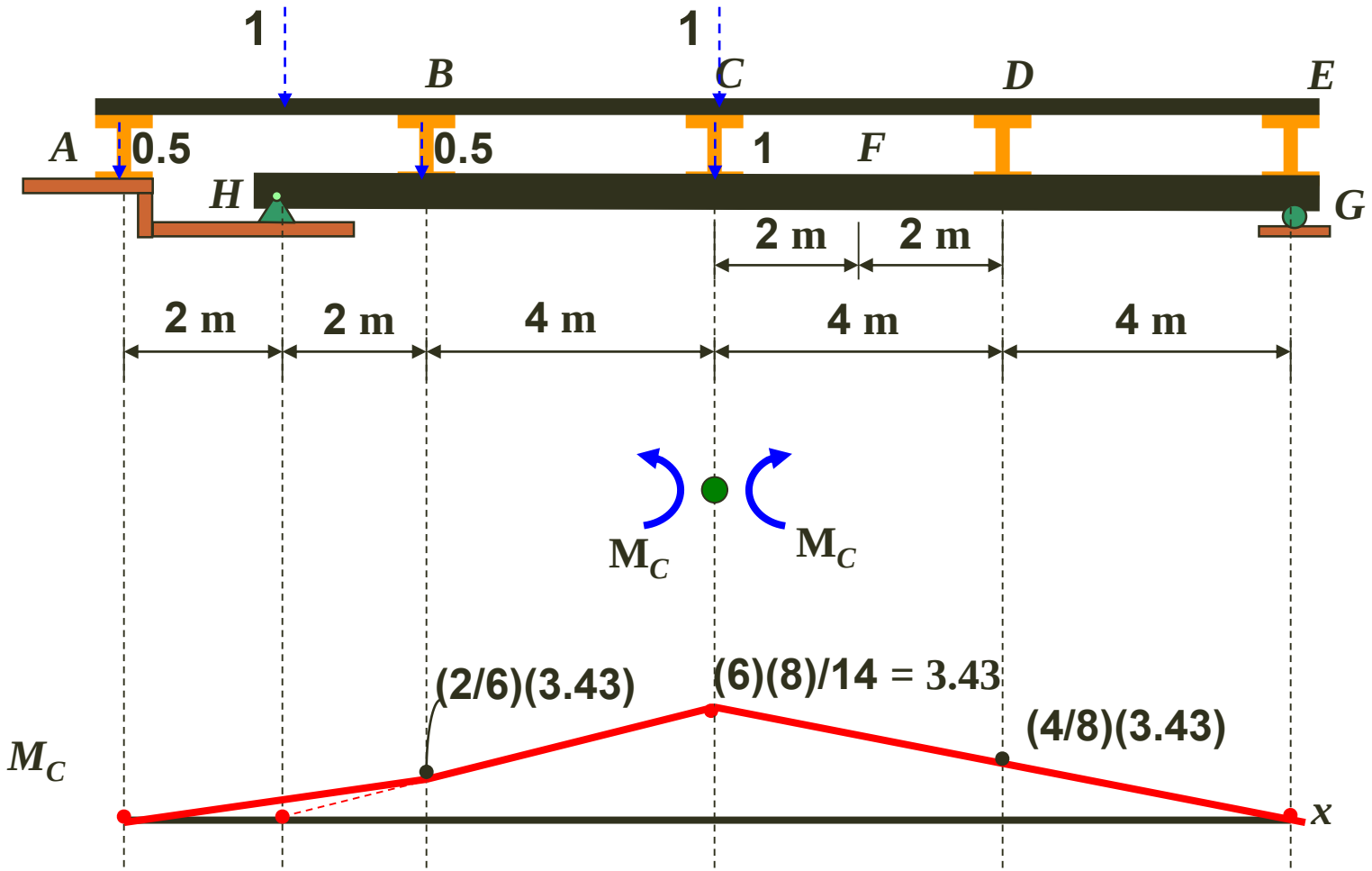
Influence Line for Girder



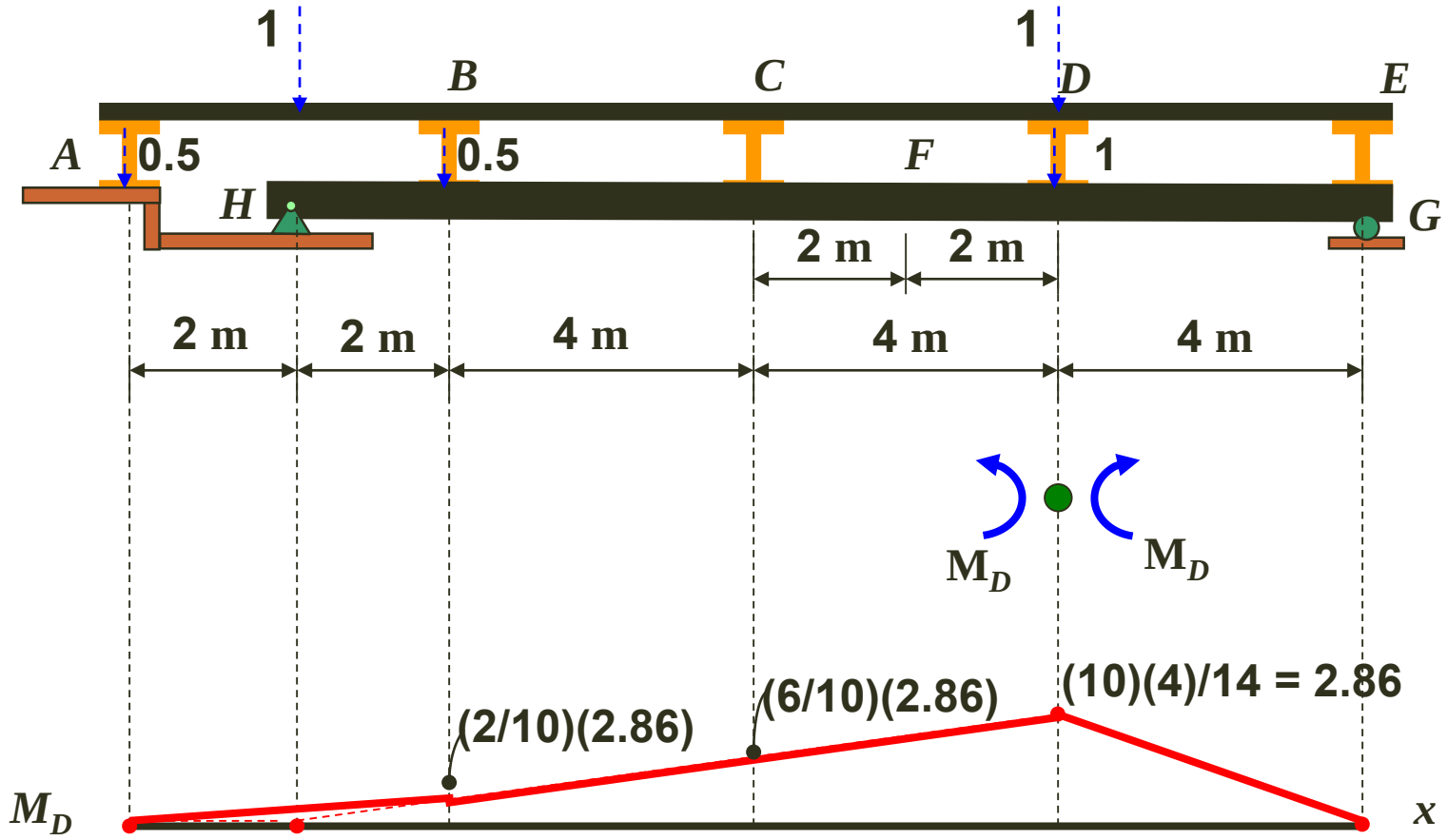
Influence Line for Girder



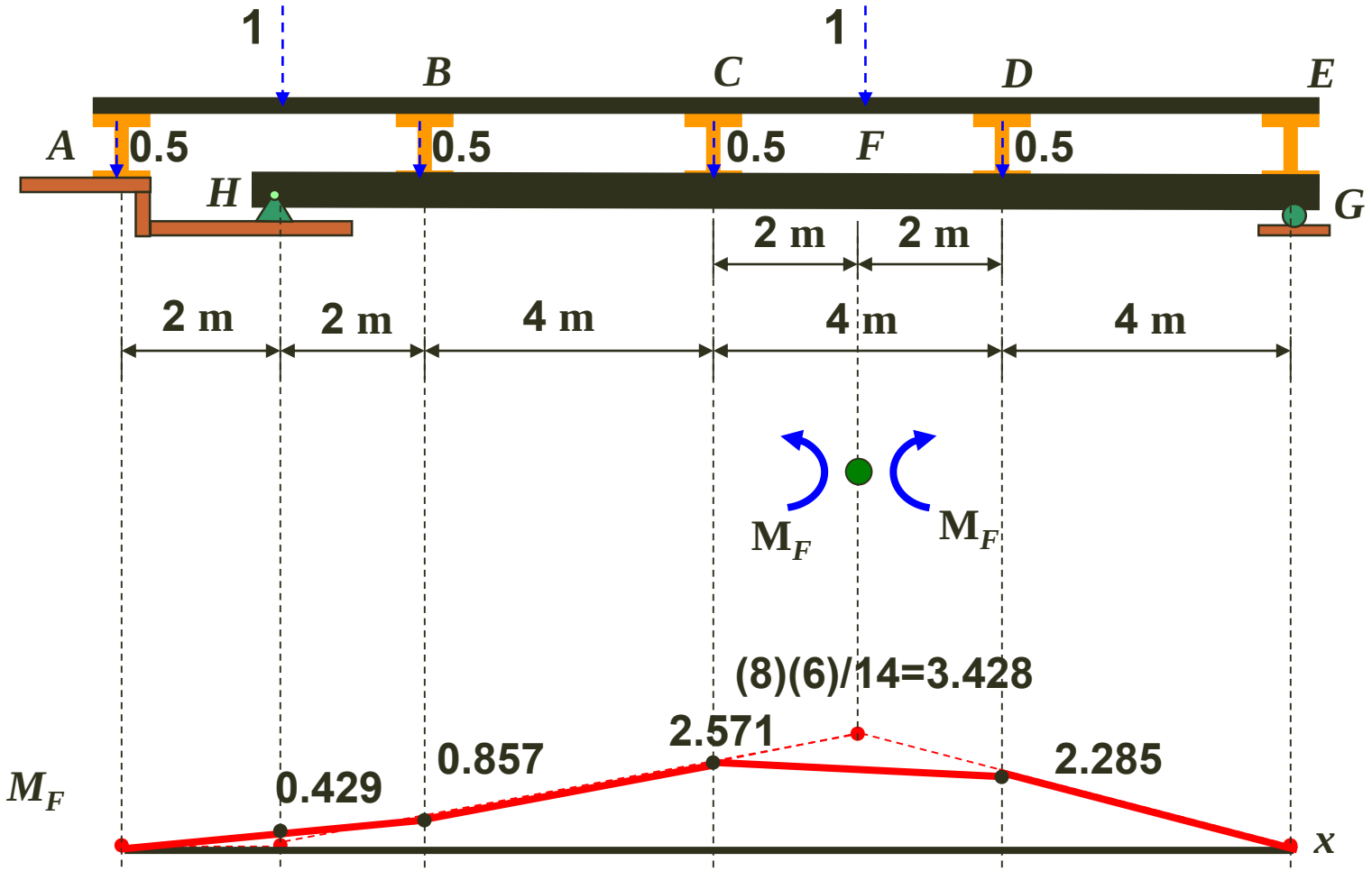
Influence Line for Girder



Influence Line for Girder

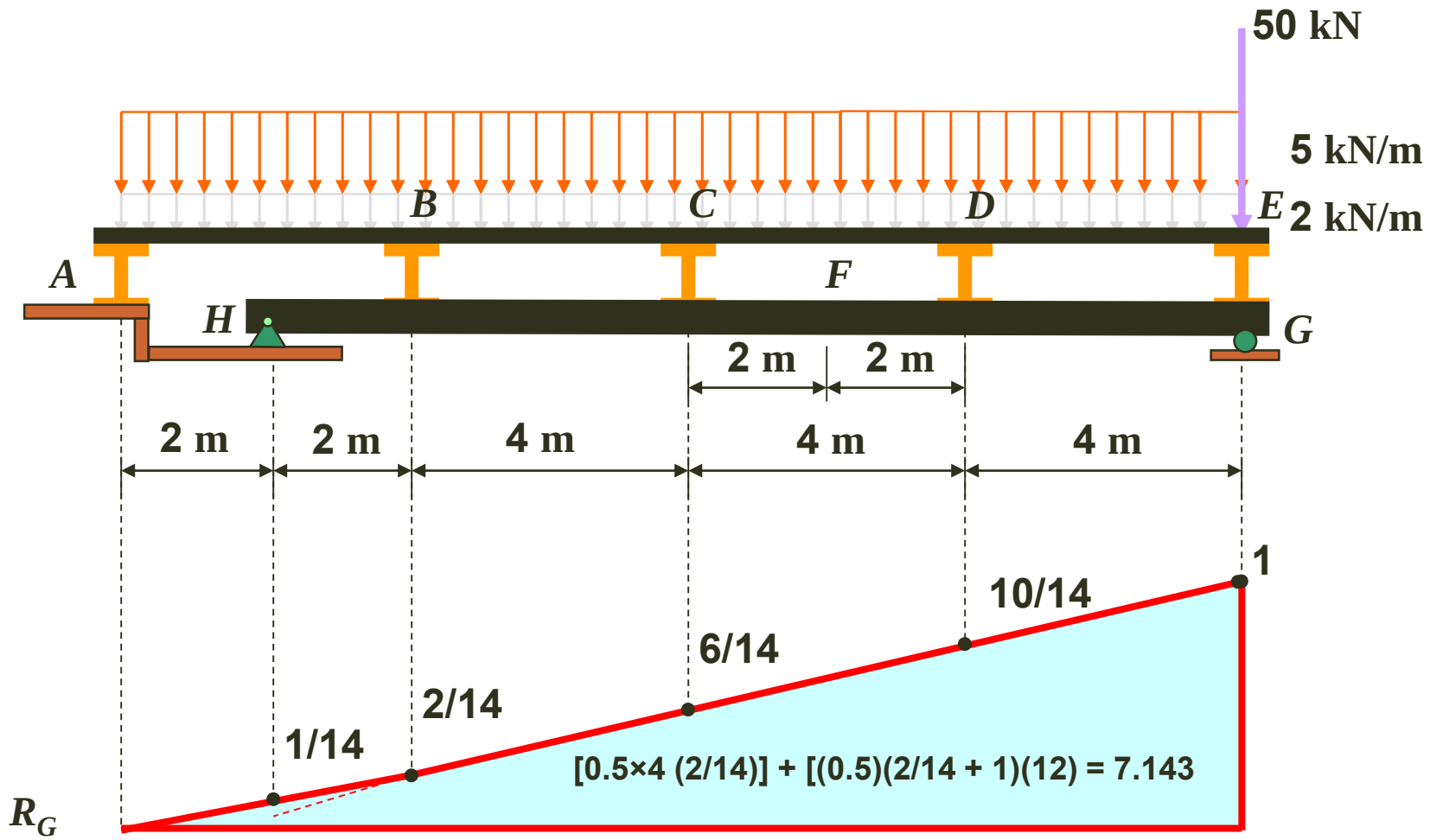


Influence Line for Girder

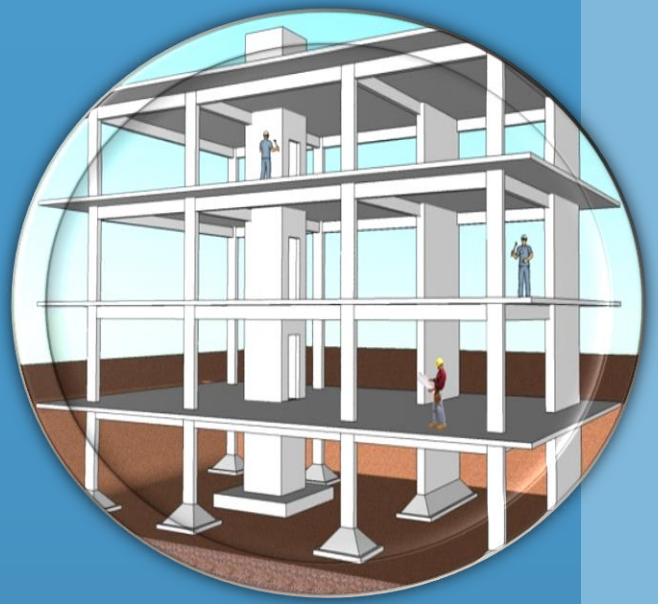


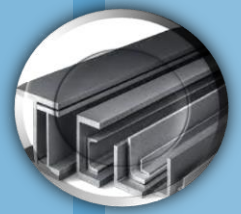
Influence Line for Girder

Maximum Reaction



$$(R_G)_{max} = (2)(7.143) + (5)(7.143) + (50)(1) = 100 \text{ kN}$$





Thank You!