SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)

COIMBATORE-35.

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Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai.

DEPARTMENT OF AUTOMOBILE ENGINEERING

COURSE NAME : ENGINEERING MECHANICS

I YEAR / I SEMESTER

Topic – Support Reactions

Beam

A Beam is a horizontal structural member which carries a load, transverse (perpendicular) to its axis and transfers the load through support reactions to supporting columns or walls.

Frame

A structure made up of several members, riveted or welded together is known as frame.

Beams and frames are examples of coplanar force system in equilibrium.

8.2 Support reactions of Beam.

The force of resistance exerted by the support on the beam is called as support reactio

Support reaction of beam depends upon the type of loading and the type of support. Henc we will see the type of support and type of loading first.

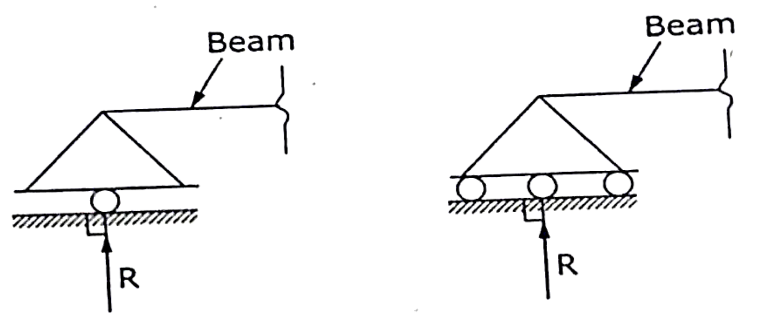
8.2.1 Types of supports

Following are the three important end supports of a beam.

1. Roller support 2. Hinged support 3. Fixed support

1. Roller support

This is the simplest type of support. In practice, it may consist of either a single rol or a group of rollers, as shown below. (fig. 8.1)

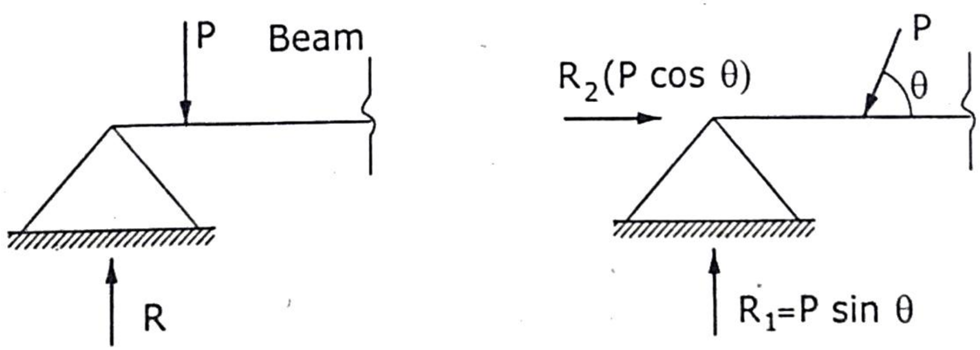


(a) Single roller (b) Group of rollers

Fig. 8.1

2. Hinged support

This type of support can withstand any type of force both horizontal and vertical. Hence, it has two reaction components, vertical and horizontal. It is to be noted that, if the load is vertical, even though it can offer two reaction forces, in this particular case, the reaction will be vertical only. Its horizontal reaction is zero. But if the load is inclined, then the reaction will also be inclined i.e, resolving we get vertical and horizontal components.



a) Vertical load *b) Inclined load*

Fig. 8.3 Hinged Support

Hinged support is also called pin-Joint support.

3. Fixed support

Both Roller and Hinged supports can resist only displacement (i.e, vertical and horizontal movement of beam at ends). but, rotation of beam is not resisted by both the supports. This can be given by the fixed support. Hence, fixed support has three reaction components. Horizontal reaction, vertical reaction and rotational reaction. Fixed support is considered as the strongest support.

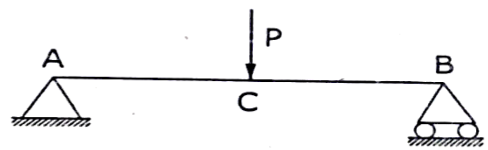
.2 Types of Loads

Following are the three important types of loads:

1. Point load
2. Uniformly distributed load (u.d.l)
3. Uniformly varying load (u.v.l)

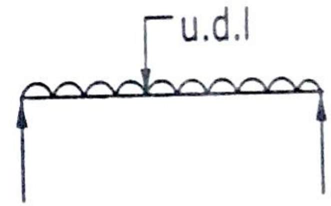
1. Point Load

A load, acting at a point on a beam is known as a point load. Fig 8.6 shows, a point load P acting at C.

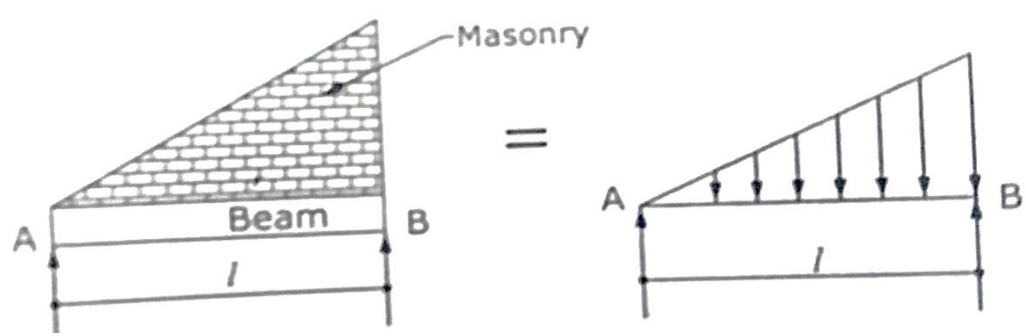


2. Uniformly distributed load

A load which is spread over a beam, in such a manner that each unit length of the beam carries same intensity of the load, is called uniformly distributed load. (briefly written as u.d.l)



3. Uniformly varying load



These three unknowns can be determined by using the equilibrium equations as describ below:

1. Apply $\Sigma H = 0$ to find H_A
2. Apply $\Sigma V = 0$ to find $(V_A + V_B)$
3. Apply $\Sigma M_A = 0$ to find V_B

   (or)

   Apply $\Sigma M_B = 0$ to find V_A
4. Then substitute V_B in $\Sigma V = 0$ equation and find V_A (or) substitute V_A in $\Sigma V = 0$ equation and find V_B

Example: 1.

Find the support reactions of a simply supported beam, shown in fig 8.13.

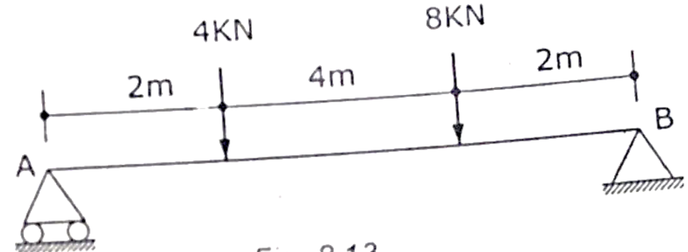
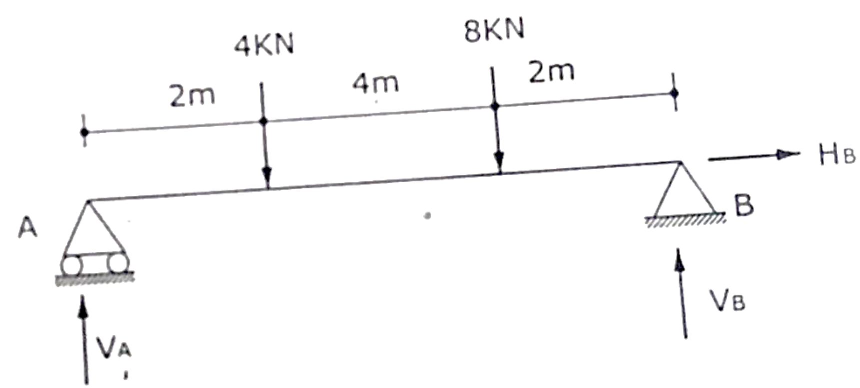


Fig. 8.13

Solution.



Applying $\Sigma H = 0$. $(\rightarrow +)$

Here there is no external horizontal force on the beam. Hence $H_B = 0$.

Applying $\Sigma V = 0$. $(\uparrow +)$

$$V_A + V_B - 4 - 8 = 0$$

$$\text{or} \quad V_A + V_B = 12\ KN \quad \text{--- (i)}$$

Now, taking moment of all forces about A and equating to zero. i.e., $\Sigma M_A = 0$ $(\curvearrowright +)$

$$(4 \times 2) + (8 \times 6) - (V_B \times 8) = 0$$

$$\text{solving,} \quad V_B = \frac{8 + 48}{8} = 7KN.$$

Substitute $V_B = 7\ KN$ in equation (i),

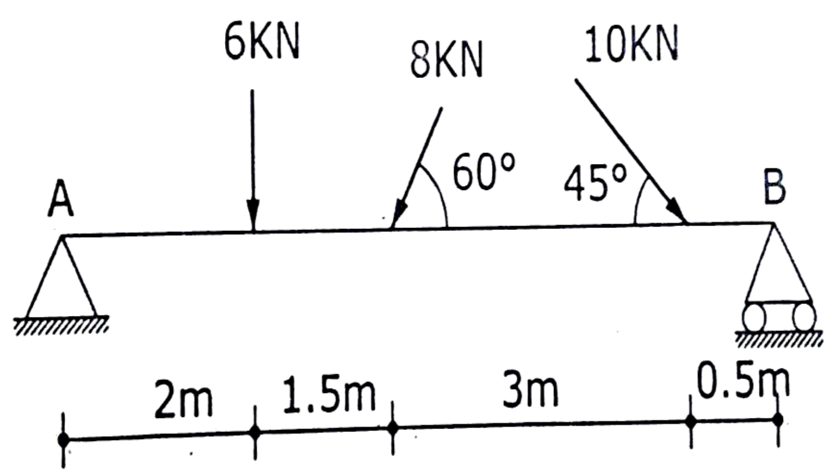
$$\text{i.e.,} \quad V_A + V_B = 12$$

$$\text{or} \quad V_A + 7 = 12 \quad \therefore \quad V_A = 5KN.$$

Result : $H_B = 0$; $V_A = 5KN\ (\uparrow)$ **and** $V_B = 7KN\ (\uparrow)$

(Here, both V_A and V_B values are positive. Hence, assumed directions of these reactions are correct).

Determine the support reactions of the beam shown in fig 8.15.



Solution

The assumed direction of reaction components are shown in fig 8.19.

For udl, total load is $(3 \times 4) = 12\,KN$, which acts at the mid-point of AC, i.e., at $\frac{4}{2} = 2m$ from A.

Applying $\Sigma H = 0$

As there is no external horizontal force, $H_B = 0$.

Applying $\Sigma V = 0$

$$V_A + V_B - 8 - 8 - (3 \times 4) = 0$$

$$\therefore V_A + V_B = 28 \quad \text{--- (i)}$$

Applying $\Sigma M_A = 0$

$$(8 \times 6) + (8 \times 8) + (3 \times 4 \times \frac{4}{2}) - (V_B \times 10) = 0$$

Solving $V_B = \mathbf{13.6\,KN\,(\uparrow)}$

Substituting $V_B = 13.6\,KN$ in equation (i), we get, $V_A = \mathbf{14.4KN\,(\uparrow)}$

Applying $\Sigma M_A = 0$ (↻+)

$$(6 \times 2) + (8 \sin 60 \times 3.5) + (10 \sin 45 \times 6.5) - (V_B \times 7) = 0$$

or $V_B \times 7 = 82.2$ $\therefore$ $V_B = 11.74 KN$

Substitute $V_B = 11.74$ in equation (i)

$$V_A + V_B = 20$$

or $V_A + 11.74 = 20$ $\therefore V_A = 8.26\ KN$

(Both V_A and V_B are positive. Hence, assumed directions are correct. Both are acti upwards).

Result :

$\therefore H_A = 3.07\ KN$ (←) ; $V_A = 8.26\ KN$ (↑) and $V_B = 11.74\ KN$ (↑)

Note :

In the above problem, if the resultant reaction and its direction at hinged support is required:

Example: 4.

A Beam AB of span 10m span is loaded as shown in fig. 8.19. Determine the reactions at A and B.

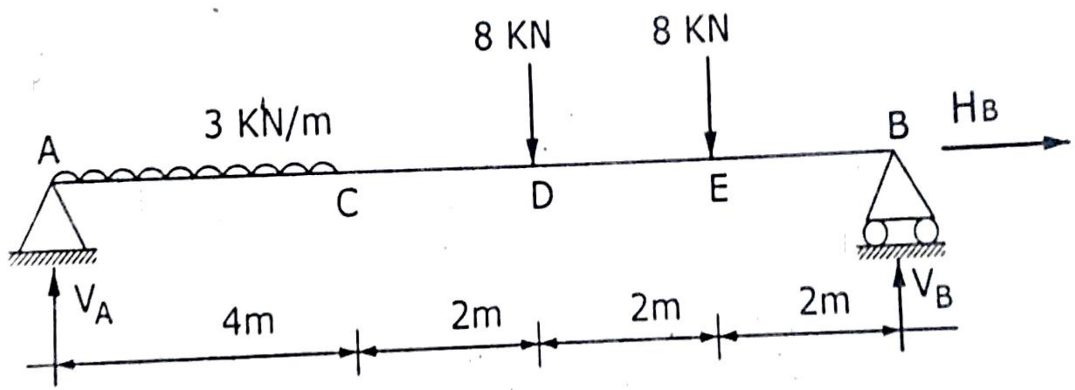


Fig. 8.19.

Solution

The assumed direction of reaction components are shown in fig 8.19.

For udl, total load is $(3 \times 4) = 12\,KN$, which acts at the mid-point of AC, i.e., at $\frac{4}{2} = 2m$ from A.

Applying $\Sigma H = 0$

As there is no external horizontal force, $H_B = 0$.

Applying $\Sigma V = 0$

$$V_A + V_B - 8 - 8 - (3 \times 4) = 0$$

$$\therefore V_A + V_B = 28 \quad \text{--- (i)}$$

Applying $\Sigma M_A = 0$

$$(8 \times 6) + (8 \times 8) + (3 \times 4 \times \frac{4}{2}) - (V_B \times 10) = 0$$

Solving $V_B = 13.6\,KN\,(\uparrow)$

Substituting $V_B = 13.6\,KN$ in equation (i), we get, $V_A = 14.4KN\,(\uparrow)$

Calculate the support reactions of a simply supported beam shown in fig 8.20.

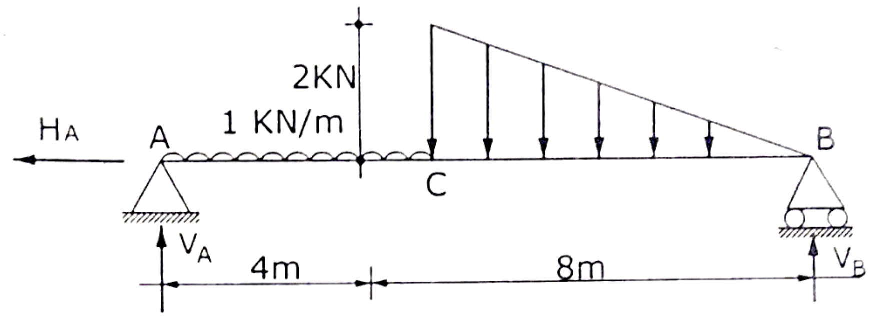


Fig. 8.20.

Solution.

Total downward load of *udl* is $(1 \times 4) = 4KN$, acts at mid point of AC, i.e., at $2m$ from A. Similarly, total downward load of triangular load is, area of triangle, i.e., $(\frac{1}{2} \times 8 \times 2) = 8KN$, acts at centroid of the triangle, at $(\frac{2}{3} \times 8) = 5.33\ m$ from B.

Applying $\Sigma H = 0$; $H_A = 0$

Applying $\Sigma V = 0$

$$V_A + V_B - (1 \times 4) - (\frac{1}{2} \times 8 \times 2) = 0$$

$$\therefore V_A + V_B = 12 \qquad \text{--- (i)}$$

Applying $\Sigma M_A = 0$

$$(1 \times 4 \times \frac{4}{2}) + [(\frac{1}{2} \times 8 \times 2) \times (12 - 5.33)] - (V_B \times 12) = 0$$

or $12\,V_B = 8 + 53.36$

$\therefore$ $V_B = 5.11\ KN\ (\uparrow)$

Substituting $V_B = 5.11\ KN$ in equation (i) $V_A = 6.89\ KN\ (\uparrow)$

Thank You !