3.4 Types of Supports

While drawing F.B.D. the most important step to master is the determination of the support reactions. The structure in the field may be various types such as beam, truss, frame, levers ladder etc. They are supported with specific arrangements.

Generally the support offers reactions. Different types of supports and its reactions are classified as follows.

1. **Smooth Surface Contact :** When a body is in contact with smooth (frictionless) surface at only one point, the reaction is a force normal to the surface, acting at the point of contact.

(i)

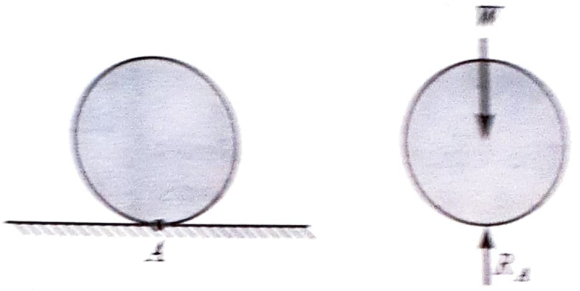


Fig. 3.12(i)

(ii)

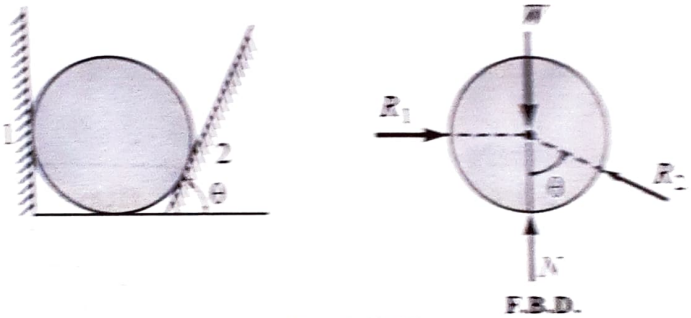


Fig. 3.12(ii)

(iii)

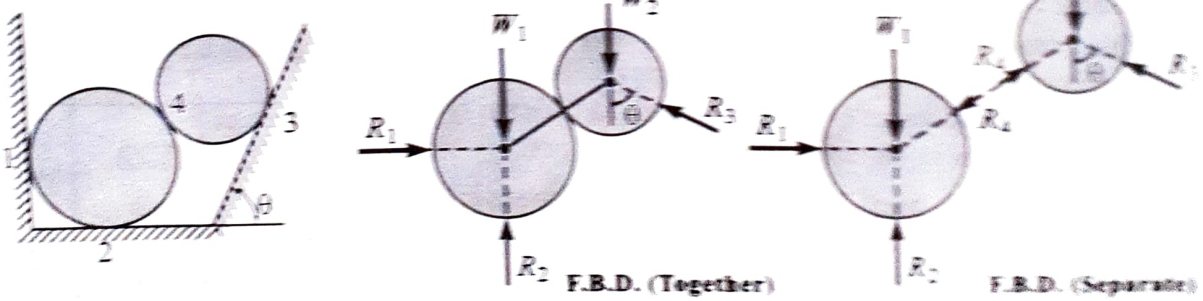


Fig. 3.12(iii)

(iv)

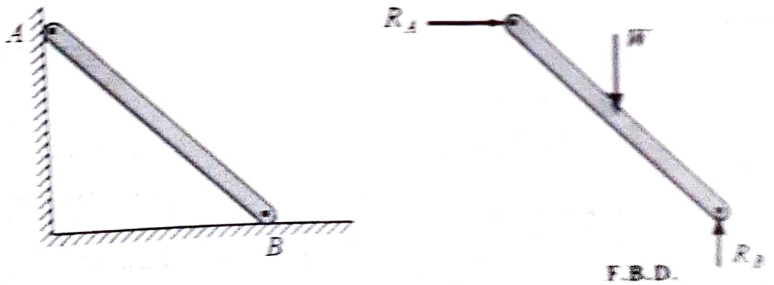


Fig. 3.12(iv)

2. **Roller Support :** A roller support is equivalent to a frictionless surface. It can only exert a force that is perpendicular to the supporting surface. The magnitude of the force is then the only unknown force introduced in a F.B.D. when the support is removed. The roller support is free to roll along the surface on which it rests. Since the linear displacement in normal direction to surface of roller is restricted, it offers a reaction in normal direction to surface of roller. E.g. Slidding door slides smoothly with help of roller support, conveyer belt move smoothly on roller support.

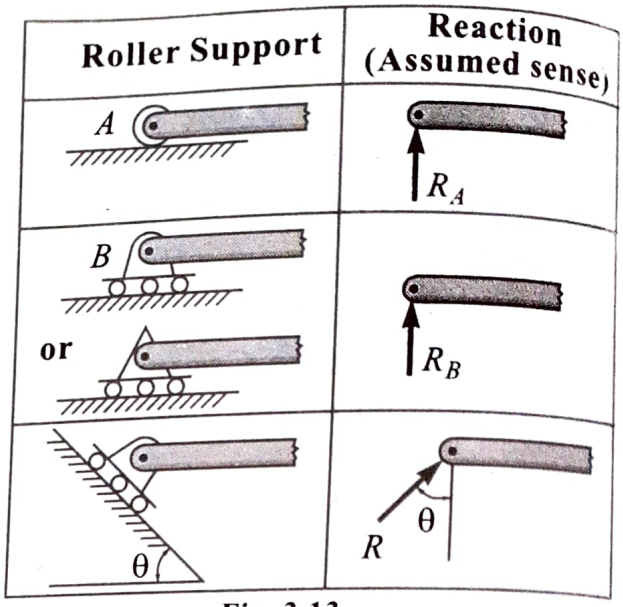


Fig. 3.13

3. **Pin (Hinge) Support :** The hinge support allows free rotation about the pin end but it does not allows linear displacement of that end. Since linear displacement are restricted in horizontal and vertical directions the reaction offered at hinge support (say R_A at θ) is resolved into two component i.e. H_A and V_A. The direction of these two components are uncertain Therefore they are initially assumed in F.B.D.

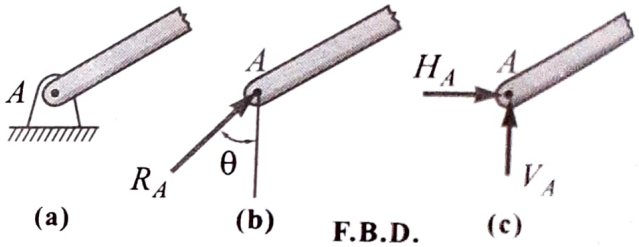
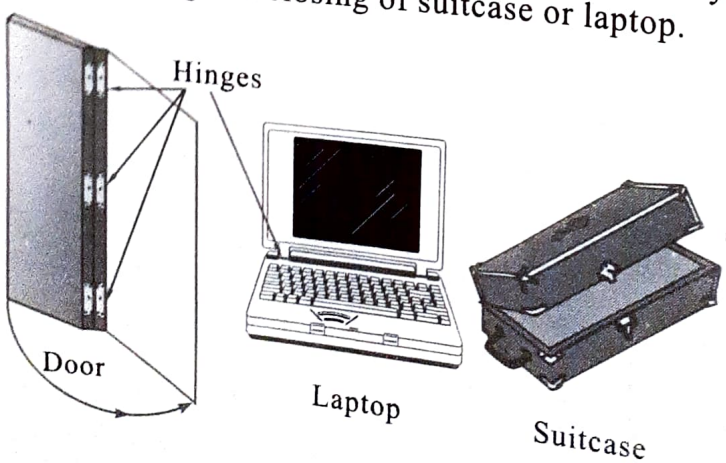
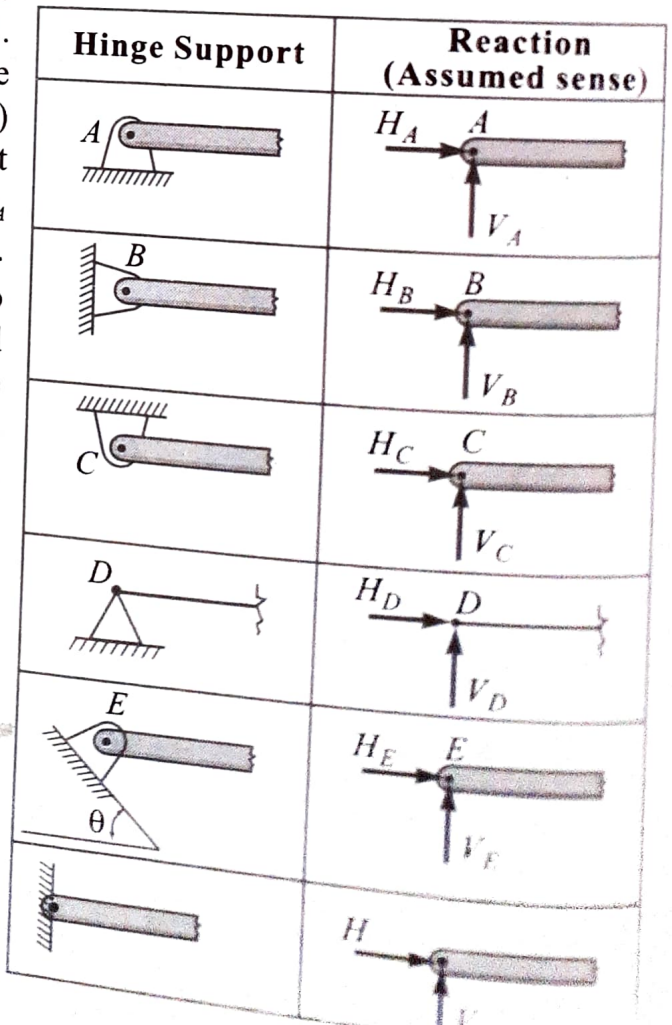


Fig. 3.14

A pin is cylinder that is slightly smaller than the hole into which it is inserted [refer *figure 3.14(a)*]. Neglecting friction, the pin can only exert a force that is normal to the contact surface (say at point *A*) shown as R_A [refer *figure 3.14(b)*]. *A* pin support thus introduces two unknown, the magnitude of R_A and the angle θ that specifies the direction of R_A. This reaction R_A at θ can be resolved into two components i.e. horizontal components (H_A) and vertical component (V_A). One should identify the figures given in *figure 3.15* as pin support.

E.g. Opening and closing of door is possible by hinges. Opening and closing of suitcase or laptop.





4. **Fixed (Built in) Support :** When the end of a beam is fixed (built in) then that support is said to be fixed support. Fixed support neither allows linear displacement nor rotation of a beam. Due to these restrictions the components reaction offered at fixed supports are horizontal component H_A, vertical component V_A and couple component M_A. These components are shown in assumed direction. Refer *figure 3.16.*

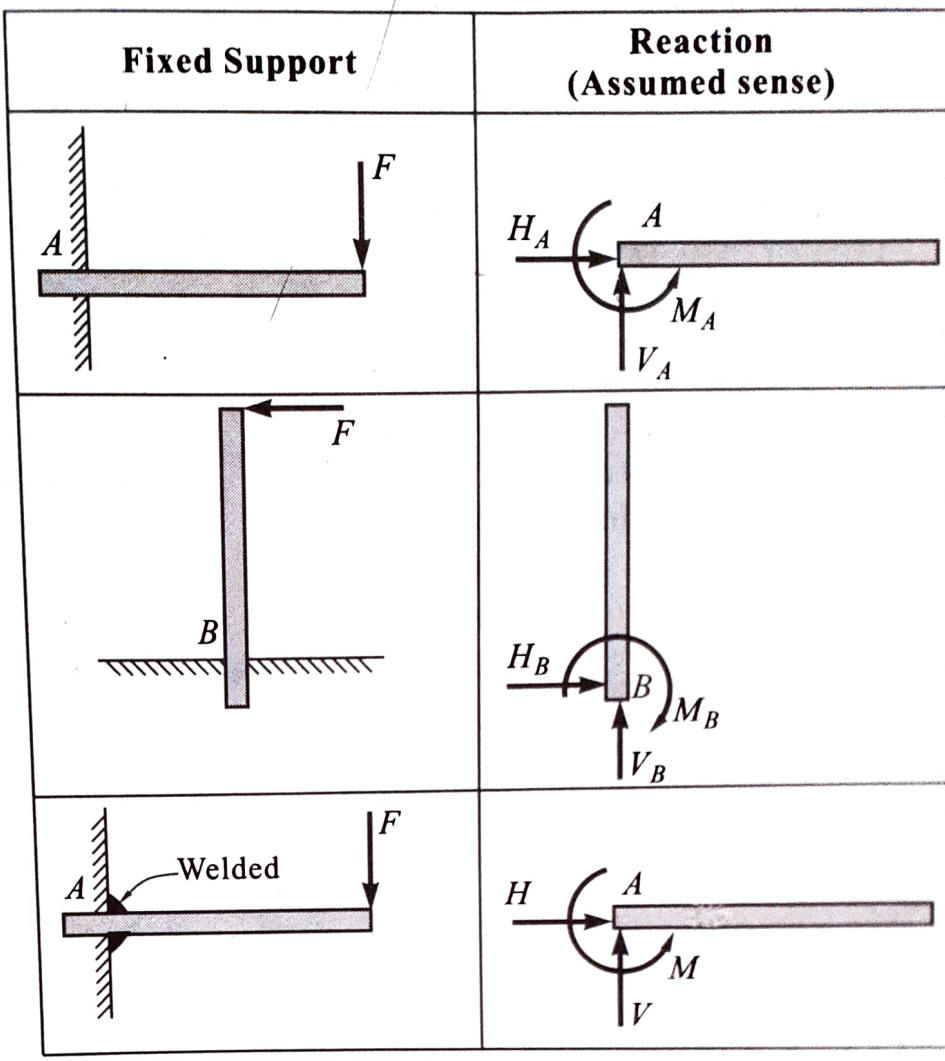


Fig. 3.16

5. **Freely Sliding Guide :** Collar or slider free to move along smooth guides can support force normal to guide only.

   eg. Slider is free to move along horizontal slot.

   eg. Collar is free to move along vertical rod (guide).

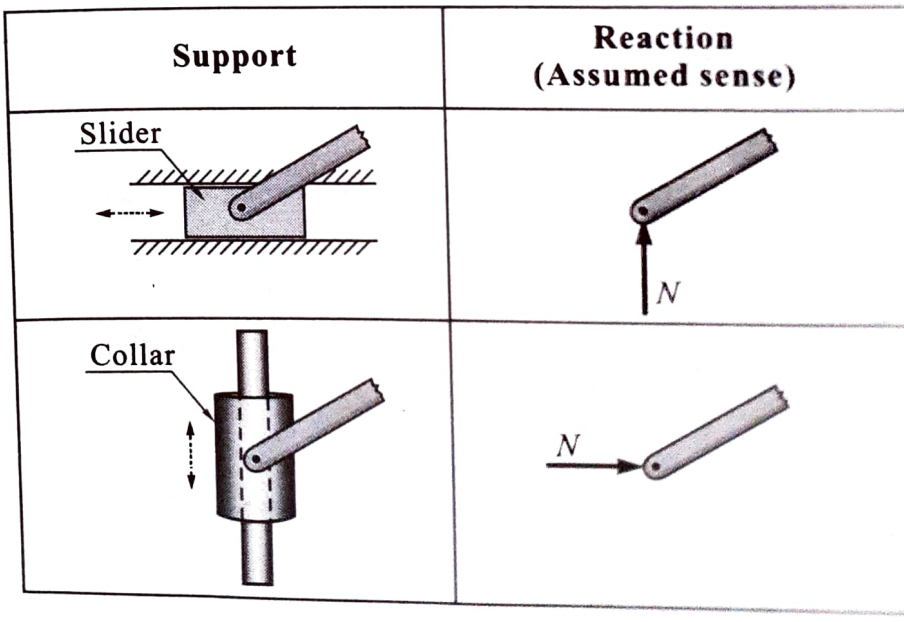
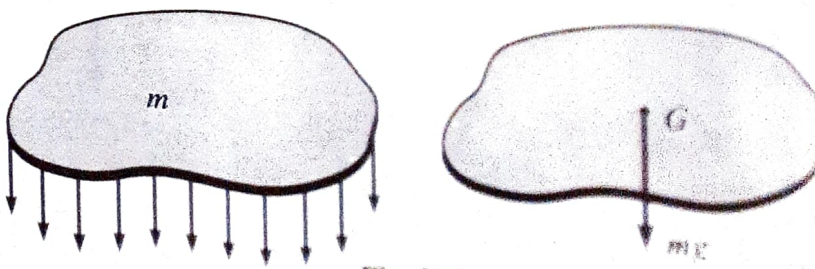


Fig. 3.17

6. **Gravitational Attraction :** The resultant of gravitational attraction on all elements of a body of mass m is ... and acts ...



3.11 *Solved Problems on Support Reactions of Beams*

Problem 49

Find the reactions at the supports of the beam applying conditions of equilibrium.

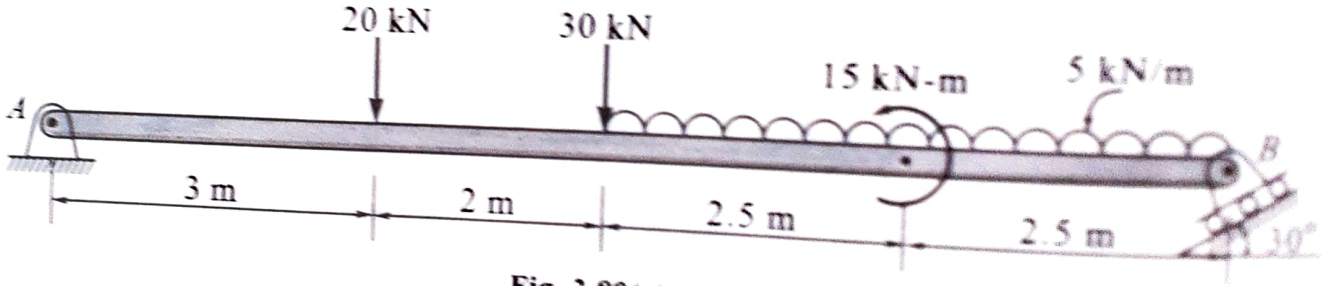


Fig. 3.89(a)

Solution

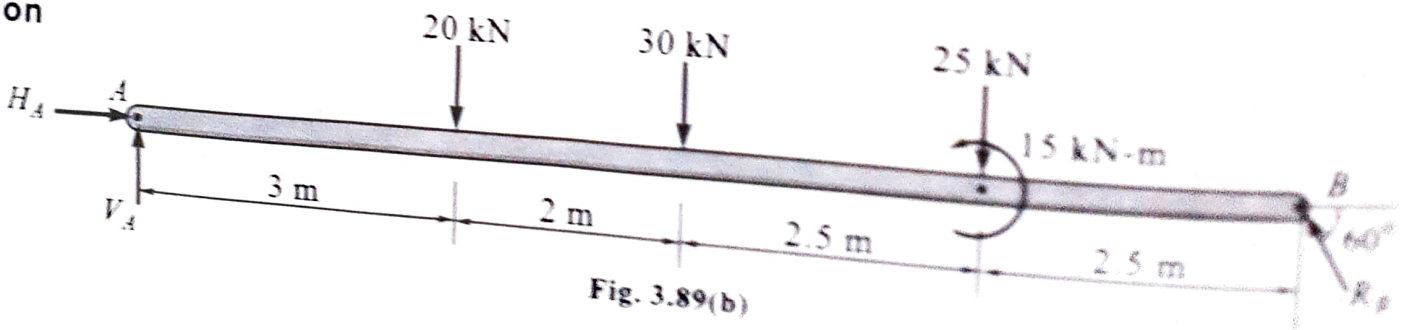


Fig. 3.89(b)

(i) Consider the F.B.D. of beam AB [*figure 3.89(b)*]

(ii) $\Sigma M_A = 0$

$-20 \times 3 - 30 \times 5 - 25 \times 7.5 + 15 + R_B \sin 60 \times 10 = 0$

$R_B = 44.17$ kN $(60°\angle)$

(iii) $\Sigma F_x = 0$

$H_A - R_B \cos 60 = 0$

$H_A = 44.17 \cos 60 \quad \therefore H_A = 22.09$ kN $(\rightarrow)$

(iv) $\Sigma F_y = 0$

$V_A + R_B \sin 60 - 20 - 30 - 25 = 0$

$V_A = 36.75$ kN $(\uparrow)$

(v) Or $R_A = \sqrt{H_A^2 + V_A^2} \quad \therefore R_A = 42.88$ kN

$\theta = \tan^{-1}\left(\frac{V_A}{H_A}\right) \quad \therefore \theta = 58.99°$

$R_A = 42.88$ kN $(\angle\theta = 58.99°)$ ***Ans.***

Problem 50

Calculate support reactions for the following beam shown in *figure 3.90(a)*.

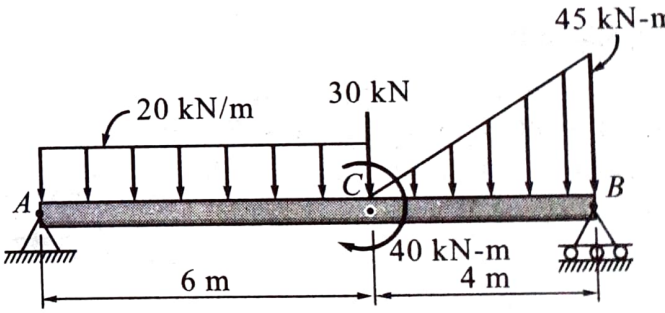


Fig. 3.90(a)

Solution

(i) Consider the F.B.D. of beam AB [*figure 3.90(b)*]

(ii) $\Sigma M_A = 0$

$-120 \times 3 - 30 \times 6 - 40 - 90 \times 8.67 + R_B \times 10 = 0$

$R_B = 136.03$ kN $(\uparrow)$

(iii) $\Sigma F_x = 0$

$H_A = 0$

($\because$ there is no horizontal force acting)

(iv) $\Sigma F_y = 0$

$V_A - 120 - 30 - 90 + 136.03 = 0$

$V_A = 103.97$ kN $(\uparrow)$ ***Ans.***

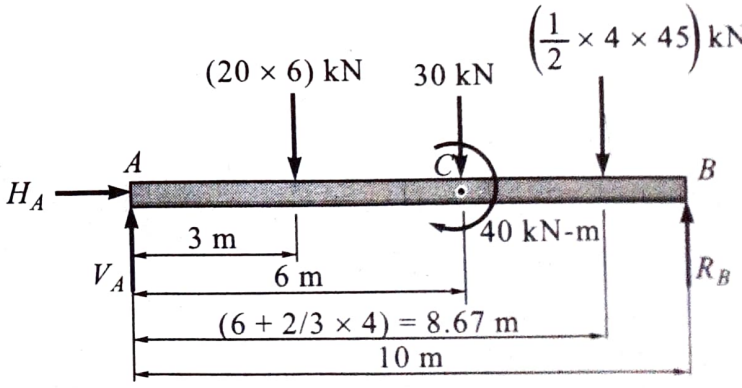


Fig. 3.90(b)

Problem 51

Find the support reactions at A and B for the beam loaded as shown in *figure 3.91(a)*.

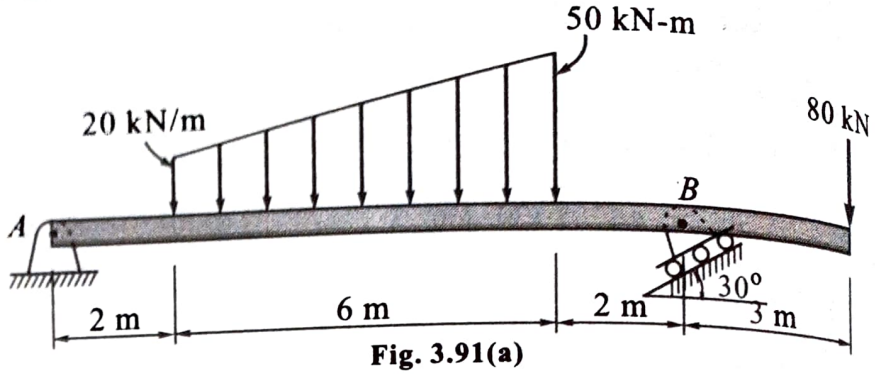


Fig. 3.91(a)

Solution

(i) Consider the F.B.D. of beam AB [*figure 3.91(b)*]

(ii) $\Sigma M_A = 0$

$R_B \sin 60 \times 10 - 120 \times 5 - 90 \times 6 - 80 \times 13 = 0$

$R_B = 251.73$ kN $(60°\nwarrow)$

(iii) $\Sigma F_x = 0$

$H_A - 251.73 \cos 60 = 0$

$H_A = 125.87$ kN $(\rightarrow)$

(iv) $\Sigma F_y = 0$

$V_A - 120 - 90 + 251.73 \sin 60 - 80 = 0$

$V_A = 72$ kN $(\uparrow)$ ***Ans.***

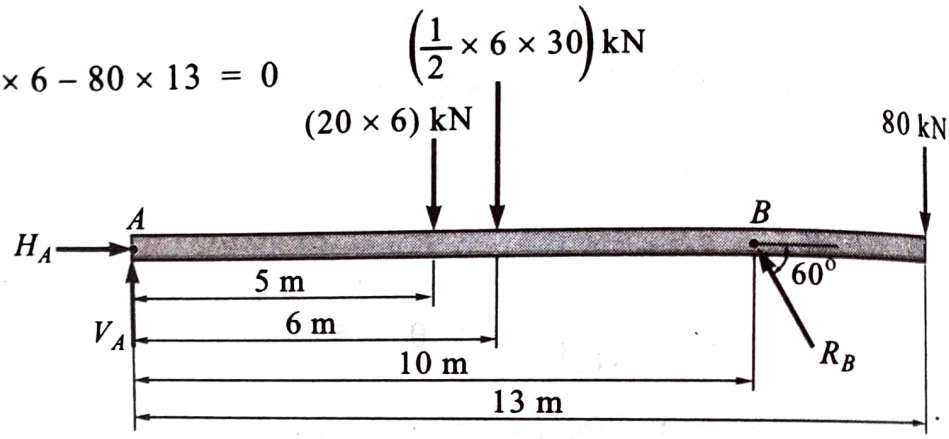


Fig. 3.91(b)

Problem 52

Find analytically the support reaction at B and the load P, for the beam shown in *figure 3.92(a)*, if reaction of support A is zero.

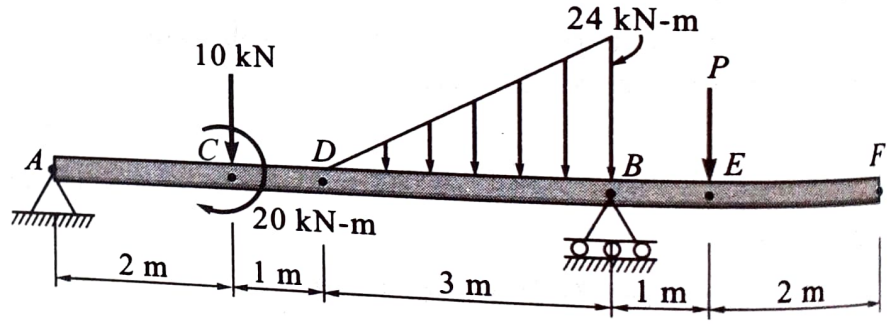


Fig. 3.92(a)

Solution

(i) Consider the F.B.D. of beam AF

(ii) $\Sigma F_y = 0$

$V_A + R_B - 10 - 36 - P = 0$ ($V_A = 0$ given)

$R_B - P = 46$ ...(I)

(iii) $\Sigma M_A = 0$

$R_B \times 6 - 10 \times 2 - 20 - 36 \times 5 - P \times 7 = 0$

$6 R_B - 7 P = 220$ ...(II)

(iv) Solving equations (I) and (II)

$R_B = 102$ kN $(\uparrow)$ ***Ans.***

(v) From equation (I)

$P = 102 - 46$

$P = 56$ kN $(\downarrow)$ ***Ans.***

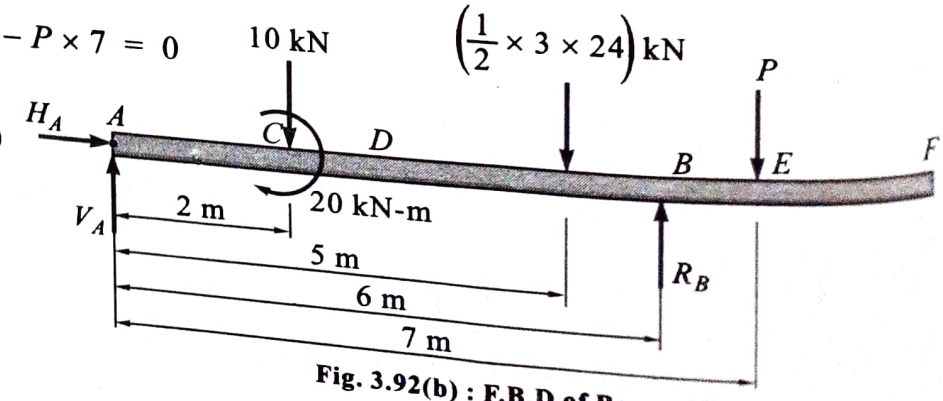


Fig. 3.92(b) : F.B.D of Beam *AF*