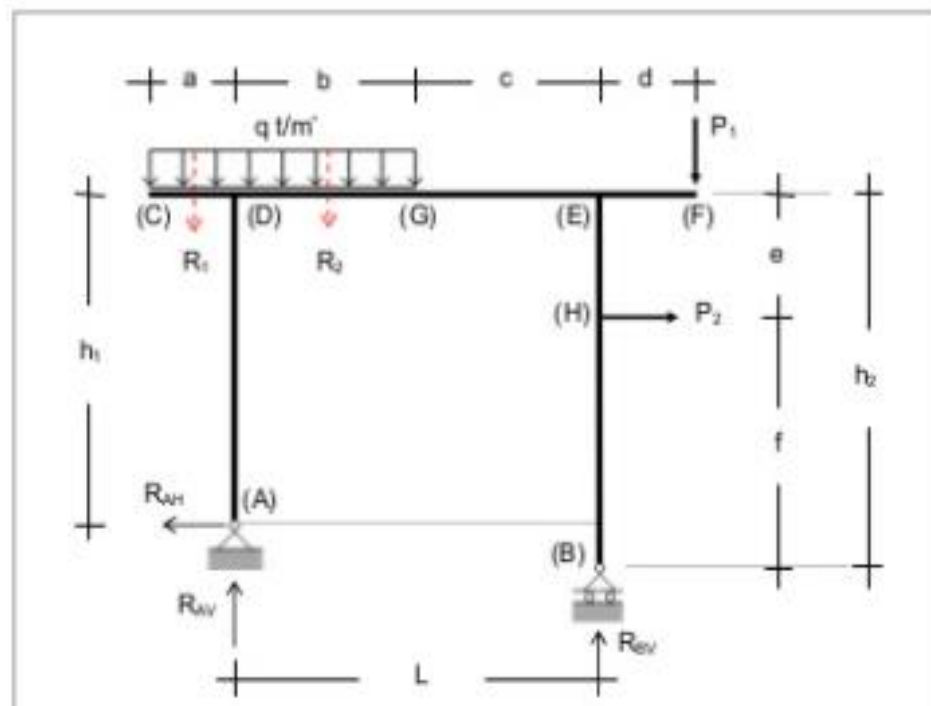


- c). Kolom tinggi sebelah, balok overhang, memikul muatan terbagi rata, terpusat vertikal dan horisontal.



Diketahui : Konstruksi seperti tergambar.

$L = 10 \text{ m}$, $h_1 = 5 \text{ m}$, $h_2 = 6 \text{ m}$, $a = 1 \text{ m}$, $b = 4 \text{ m}$, $c = 6 \text{ m}$, $d = 2 \text{ m}$,
 $e = 2 \text{ m}$, $f = 4 \text{ m}$, $q = 1 \text{ t/m'}$, $P_1 = 5 \text{ ton}$, $P_2 = 2 \text{ ton}$.

Diminta : Hitung dan gambarkan M, D dan N pada seluruh bentang.

Penyelesaian :

a. Reaksi Perletakan.

$$R_1 = q \cdot a = 1 \cdot 1 = 1 \text{ ton.}$$

$$R_2 = q \cdot b = 1 \cdot 4 = 4 \text{ ton.}$$

$$\Sigma H = 0,$$

$$-R_{AH} + P_2 = 0$$

$$R_{AH} = +P_2 = 2 \text{ ton (kekiri).}$$

$$\Sigma M_B = 0,$$

$$R_{AV} \cdot L - R_{AH} \cdot (h_2 - h_1) - R_1 \cdot (L + \frac{1}{2}a) - R_2 \cdot (L - \frac{1}{2}b) + P_1 \cdot d + P_2 \cdot f = 0$$

$$R_{AV} = R_{AH} \cdot (h_2 - h_1)/L + R_1 \cdot (L + \frac{1}{2}a)/L + R_2 \cdot (L - \frac{1}{2}b)/L - P_1 \cdot d/L - P_2 \cdot f/L$$

$$= 2 \cdot (6 - 5)/10 + 1 \cdot (10 + \frac{1}{2} \cdot 1)/10 + 4 \cdot (10 - \frac{1}{2} \cdot 4)/10 - 5 \cdot 2/10 - 2 \cdot 4/10$$

$$= 0,2 + 1,05 + 3,2 - 1 - 0,8$$

$$R_{AV} = +2,65 \text{ ton (keatas).}$$

$$\Sigma M_A = 0,$$

$$-R_{BV} \cdot L + P_1 \cdot (L + d) + P_2 \cdot (h_1 - e) - R_1 \cdot \frac{1}{2}a + R_2 \cdot \frac{1}{2}b = 0$$

$$R_{BV} = P_1 \cdot (L + d)/L + P_2 \cdot (h_1 - e)/L - R_1 \cdot \frac{1}{2}a/L + R_2 \cdot \frac{1}{2}b/L$$

$$= 5 \cdot (10 + 2)/10 + 2 \cdot (5 - 2)/10 - 1 \cdot \frac{1}{2} \cdot 1/10 + 4 \cdot \frac{1}{2} \cdot 4/10$$

$$= 6 + 0,6 - 0,05 + 0,8$$

$$R_{BV} = + 7,35 \text{ ton (keatas).}$$

Kontrol :

$$\sum V = 0,$$

$$R_{AV} + R_{BV} - R_1 - R_2 - P_1 = 0$$

$$2,65 + 7,35 - 1 - 4 - 5 = 0 \dots (\text{memenuhi}).$$

b. Gaya lintang.

$$D_{A-D} = + R_{AH} = + 2 \text{ ton.}$$

$$D_{D-A} = D_{A-D} = + 2 \text{ ton.}$$

$$D_{DC} = - q \cdot a = - 1 \cdot 1 = - 1 \text{ ton.}$$

$$D_{DG} = + R_{AV} + D_{DC} = + R_{AV} - q \cdot a = + 2,65 - 1 = + 1,65 \text{ ton.}$$

$$D_{G-E} = D_{DG} - q \cdot b = + R_{AV} - q \cdot (a + b) = + 2,65 - 1 \cdot (1 + 4) = - 2,35 \text{ ton.}$$

$$D_{E-G} = D_{G-E} = - 2,35 \text{ ton.}$$

$$D_{E-F} = D_{E-G} + R_{BV} = + R_{AV} - q \cdot (a + b) + R_{BV} = - 2,35 + 7,35 = + 5 \text{ ton.}$$

Atau,

$$D_{E-F} = + P_1 = + 5 \text{ ton.}$$

$$D_{E-G} = - R_{AH} = - 2 \text{ ton.}$$

Atau,

$$D_{E-G} = - 2 \text{ ton.}$$

c. Momen.

$$M_A = 0$$

$$M_{DA} = + R_{AH} \cdot h = + 2 \cdot 5 = + 10 \text{ t.m'}.$$

$$M_{DC} = - \frac{1}{2} q \cdot a^2 = - \frac{1}{2} \cdot 1 \cdot 1^2 = - 0,50 \text{ t.m'}.$$

$$M_{DG} = + R_{AH} \cdot h - \frac{1}{2} q \cdot a^2 = + 2 \cdot 5 - \frac{1}{2} \cdot 1 \cdot 1 = + 9,50 \text{ t.m'}.$$

$$M_G = + R_{AV} \cdot b + R_{AH} \cdot h - \frac{1}{2} q \cdot (a + b)^2 \\ = + 2,65 \cdot 4 + 2 \cdot 5 - \frac{1}{2} \cdot 1 \cdot (1 + 4)^2 = + 10,60 + 10 - 12,50$$

$$M_G = + 8,10 \text{ t.m'}.$$

$$M_{EG} = + R_{AV} \cdot L + R_{AH} \cdot h_1 - R_1 \cdot (L + \frac{1}{2} a) - R_2 \cdot (L - \frac{1}{2} b) \\ = + 2,65 \cdot 10 + 2 \cdot 5 - 1 \cdot (10 + \frac{1}{2} \cdot 1) - 4 \cdot (10 - \frac{1}{2} \cdot 4) \\ = + 26,5 + 10 - 10,5 - 32$$

$$M_{EG} = - 6 \text{ t.m'}.$$

$$M_{EF} = - P_1 \cdot d = - 5 \cdot 2 = - 10 \text{ t.m'}.$$

$$M_{EB} = + R_{AV} \cdot L + R_{AH} \cdot h_1 - R_1 \cdot (L + \frac{1}{2} a) - R_2 \cdot (L - \frac{1}{2} b) + P_1 \cdot d \\ = + 2,65 \cdot 10 + 2 \cdot 5 - 1 \cdot (10 + \frac{1}{2} \cdot 1) - 4 \cdot (10 - \frac{1}{2} \cdot 4) + 5 \cdot 2 \\ = + 26,5 + 10 - 10,5 - 32 + 10$$

$$M_{EB} = + 4 \text{ t.m'}.$$

Atau,

$$M_{EB} = + P_2 \cdot e = + 2 \cdot 2 = + 4 \text{ t.m'}.$$

$$M_{HI} = + R_{AV} \cdot L + R_{AH} \cdot (h_1 - e) - R_1 \cdot (L + \frac{1}{2} a) - R_2 \cdot (L - \frac{1}{2} b) + P_1 \cdot d \\ = + 2,65 \cdot 10 + 2 \cdot (5 - 2) - 1 \cdot (10 + \frac{1}{2} \cdot 1) - 4 \cdot (10 - \frac{1}{2} \cdot 4) + 5 \cdot 2 \\ = + 26,5 + 6 - 10,5 - 32 + 10$$

$$M_{HI} = 0 \text{ t.m'}.$$

$$M_F = 0 \text{ t.m'}.$$

$$M_B = 0 \text{ t.m'}.$$

Momen maksimum positif pada daerah D-E,

$$M_{XI} = R_{AV} \cdot x_1 + R_{AH} \cdot h_1 - R_1 \cdot (a + x_1) - \frac{1}{2} \cdot q \cdot x_1^2$$

$$D_{XI} = dM_{XI}/dx_1 = 0$$

$$R_{AV} - R_1 - q \cdot x_1 = 0$$

$$x_1 = (R_{AV} - R_1)/q$$

$$x_1 = (2,65 - 1)/1$$

$$x_1 = 1,65 \text{ m (dari D)}$$

$$M_{maks} = 2,65 \cdot 1,65 + 2 \cdot 5 - 1 \cdot (1 + 1,65) - \frac{1}{2} \cdot 1 \cdot (1,65)^2$$

$$= +10,36125 \text{ tm'}$$

Letak titik dimana momen sama dengan nol (dari kiri),

$$M_{x_2} = R_{AV} \cdot (b + x_2) + R_{AH} \cdot h_1 - R_1 \cdot (\frac{1}{2} \cdot a + b + x_2) - R_2 \cdot (\frac{1}{2} \cdot b + x_2) = 0$$

$$2,65 \cdot (4 + x_2) + 2 \cdot 5 - 1 \cdot (\frac{1}{2} \cdot 1 + 4 + x_2) - 4 \cdot (\frac{1}{2} \cdot 4 + x_2) = 0$$

$$2,65 x_2 - x_2 - 4 x_2 + 2,65 \cdot 4 + 2 \cdot 5 - 1 \cdot 4,5 - 4 \cdot 2 = 0$$

$$-2,35 x_2 + 10,6 + 10 - 4,5 - 8 = 0$$

$$x_2 = (20,6 - 12,5)/2,35$$

$$= 3,45 \text{ m (dari G)}$$

Maka letak momen sama dengan nol dari titik D,

$$x_3 = b + x_2 = 4 + 3,45 = 7,45 \text{ m}$$

Apabila letak momen sama dengan nol ini dihitung dari kanan kekiri,

$$M_{x_4} = R_{BV} \cdot x_4 + P_2 \cdot e - P_1 \cdot (d + x_4) = 0$$

$$7,35 \cdot x_4 + 2 \cdot 2 - 5 \cdot (2 + x_4) = 0$$

$$7,35 x_4 - 5 x_4 + 4 - 10 = 0$$

$$2,35 x_4 - 6 = 0$$

$$x_4 = 6/2,35 = 2,55 \text{ m (dari E)}$$

$$(L - x_4) = 10 - 2,55 = 7,45 \text{ m (dari D)} \quad \dots(\text{memenuhi})$$

d. Gaya Normal.

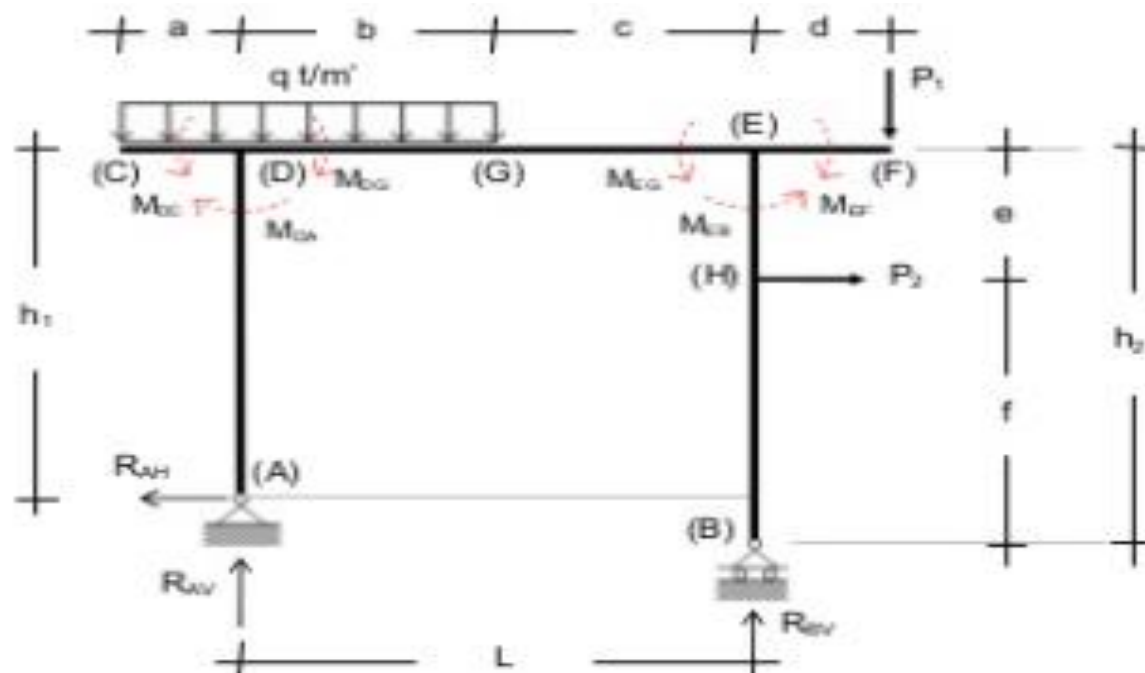
$$N_{A-D} = -R_{AV} = -2,65 \text{ ton (tekan)}$$

$$N_{C-D} = 0$$

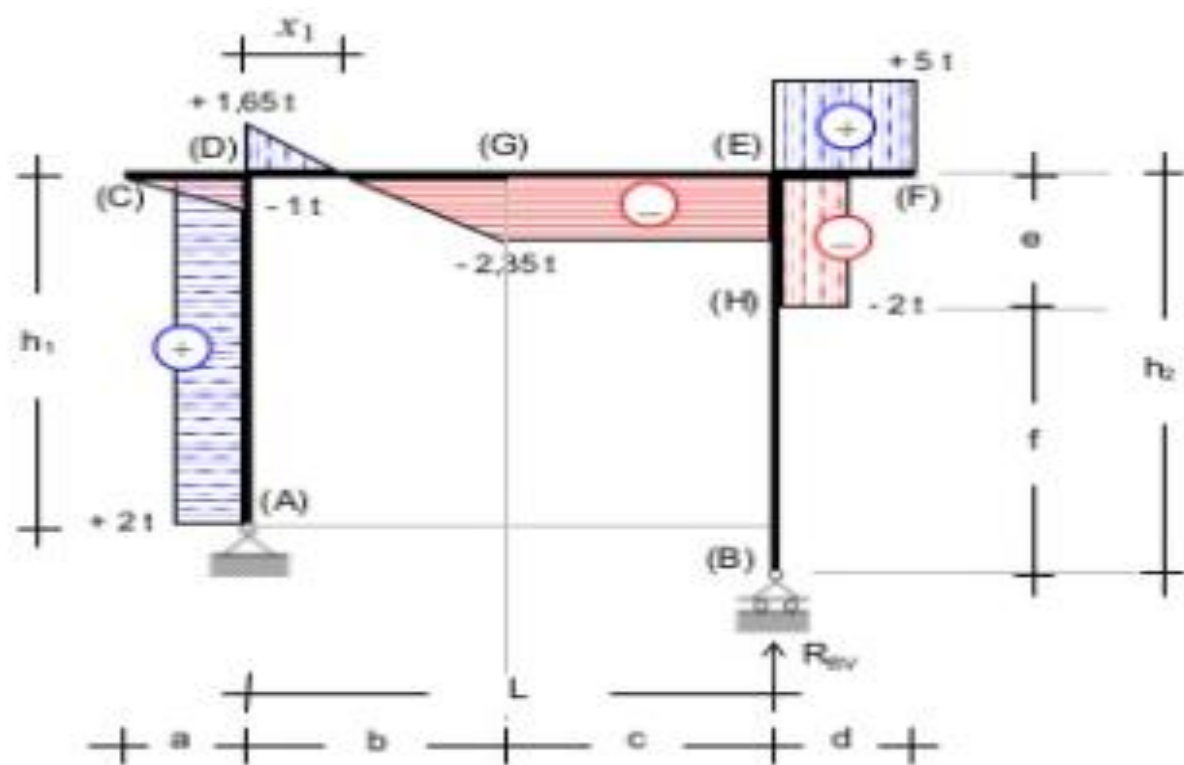
$$N_{D-E} = +R_{AH} = +2 \text{ ton (tarik)}$$

$$N_{E-B} = -R_{BV} = -7,35 \text{ ton (tekan)}$$

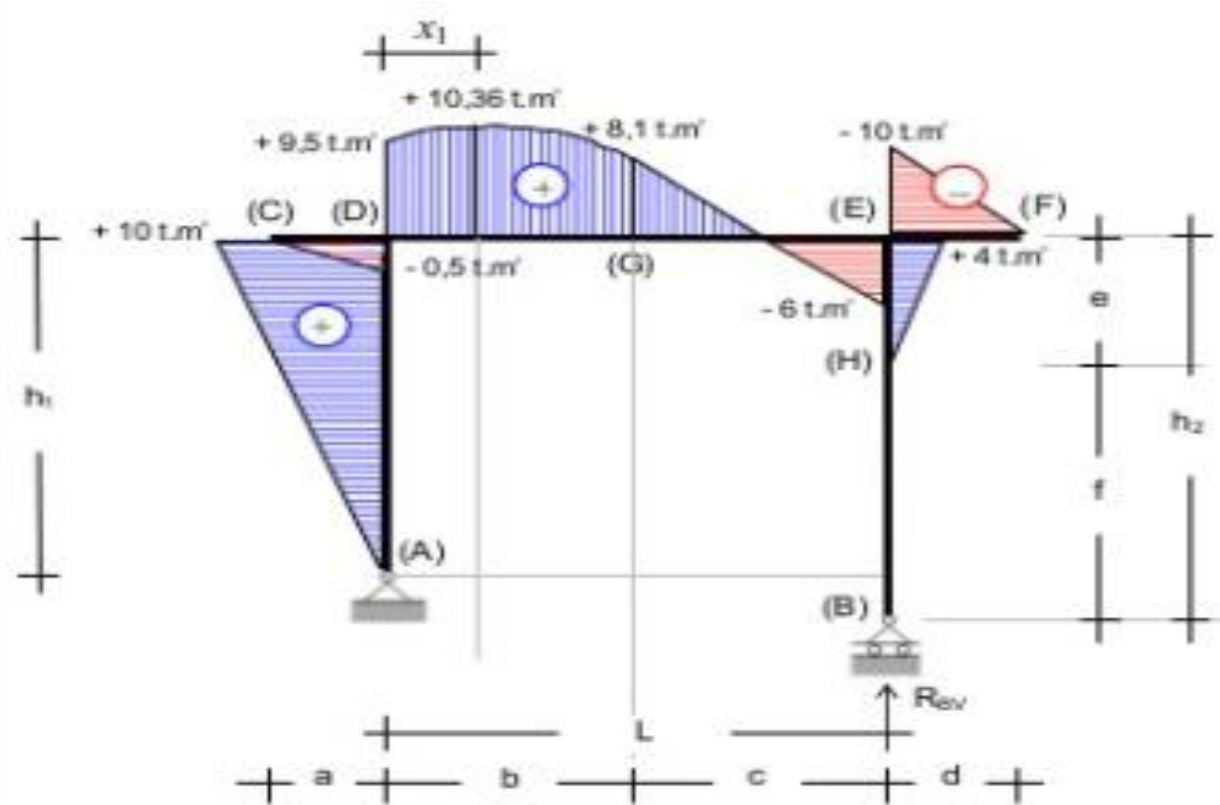
$$N_{E-F} = 0$$



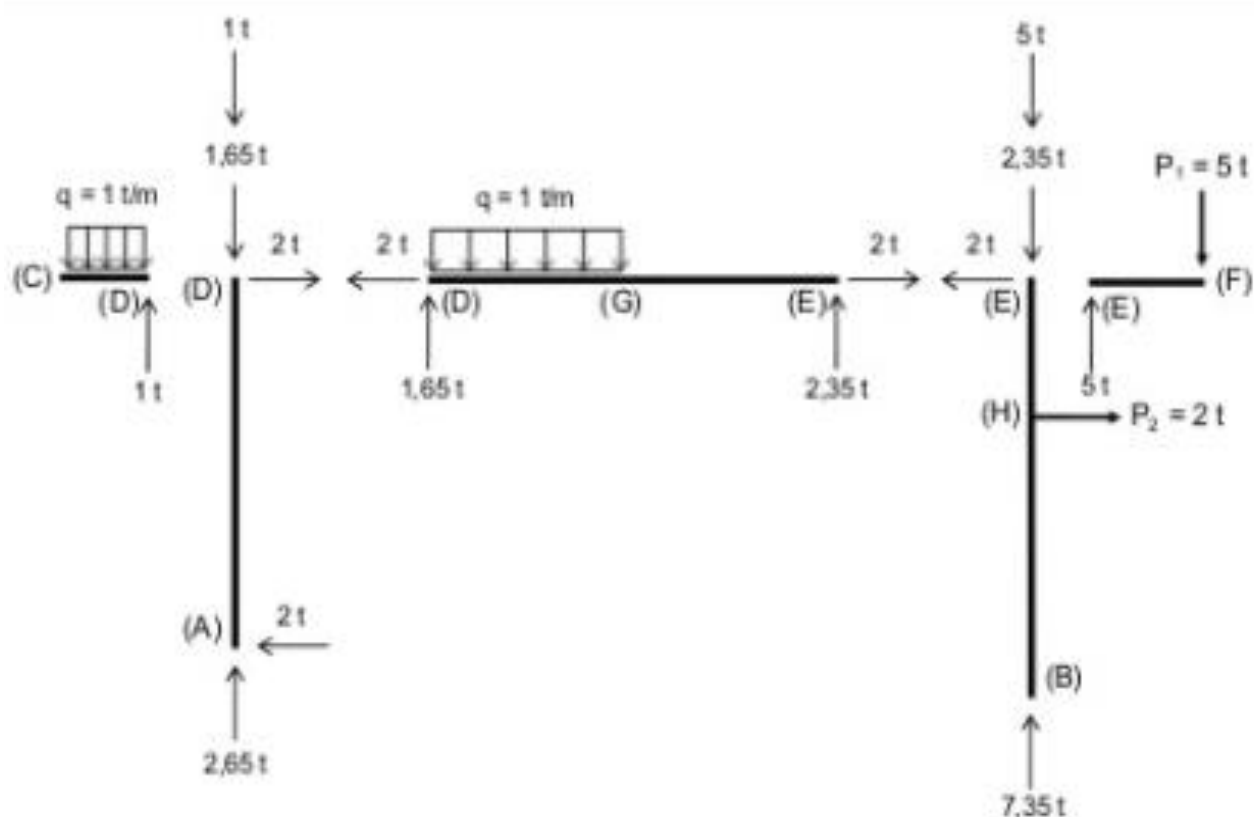
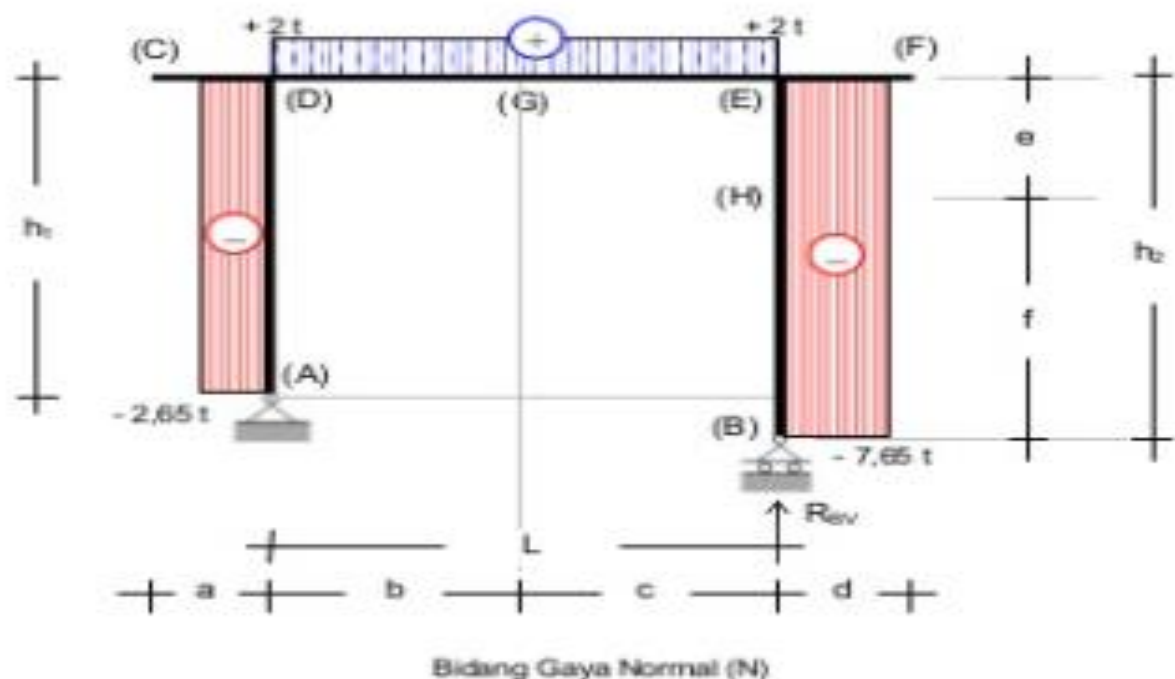
Gambar 17 : Putaran momen pada titik D dan titik E.



Bidang Gaya Lintang (D)



Bidang Momen (M)



Gambar 19 : Distribusi gaya-gaya pada elemen struktur (balok/kolom) dengan cara freebody.