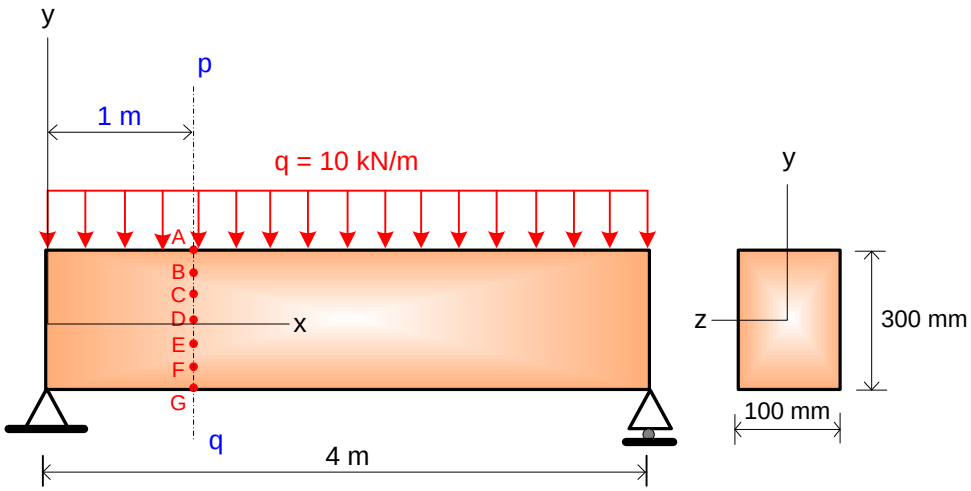
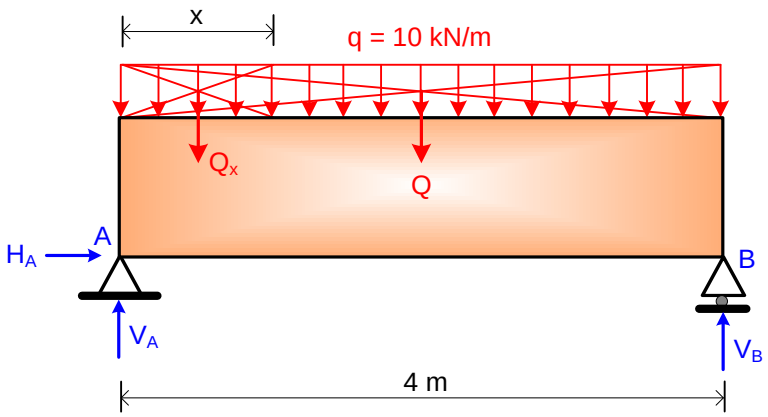
4.5. Penerapan Tegangan Bidang pada Balok

Contoh 4.6

Suatu balok sederhana dengan beban terbagi merata seperti tergambar. Balok ini terbuat dari baja dengan penampang berbentuk persegi panjang. Selidikilah tegangan utama dan tegangan geser maksimum di potongan melintang pq, yang terletak pada jarak x = 1 m dari titik A.



Penyelesaian :



Syarat :

$\sum M = 0$ $\qquad Q = q.L$

$\sum V = 0$ $\qquad Q = 10kN/m \times 4m = 40kN$

$\sum H = 0$ $\qquad Q_x = q.x = 10x$

Reaksi perletakan :

$\sum M_A = 0$ $\qquad\qquad$ $\sum M_B = 0$

$Q.2 - V_B.4 = 0$ $\qquad\qquad$ $V_A.4 - Q.2 = 0$

$40.2 - 4V_B = 0$ $\qquad\qquad$ $V_A.4 - 40.2 = 0$

$V_B = 20\,kN$ $\qquad\qquad$ $V_A = 20\,kN$

Kontrol : $\sum V = 0$

$V_A + V_B - P = 0$

$20\,kN + 20\,kN - 40\,kN = 0$

$0 = 0 \rightarrow$ Ok!!!

$\sum H = 0$

$H_A = 0$

Perhitungan bidang momen (M_x) dan lintang (Q_x)

Batang AB : $0 \le x \le 4\,m$ diukur dari titik A

$$M_X = V_A.x - Q_x.\frac{1}{2}x$$

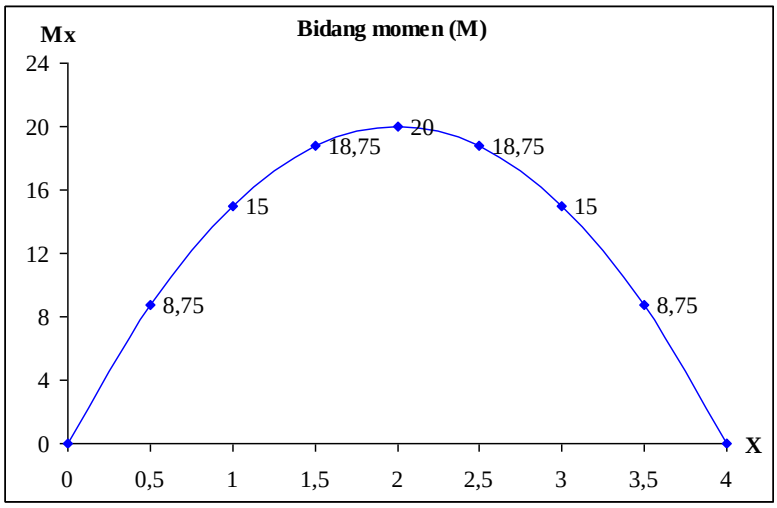
$$M_X = 20.x - 10x.\frac{1}{2}x$$

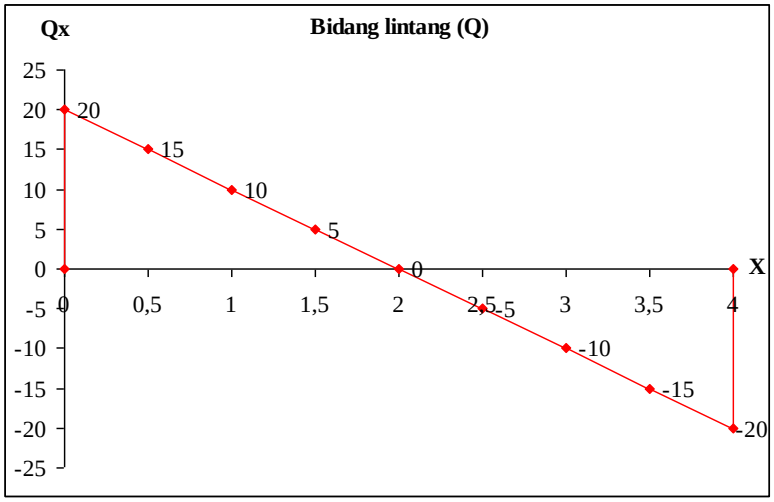
$$M_X = 20.x - 5x^2$$

x (m)	0	0,5	**1**	1,5	2	2,5	3	3,5	4
M_X (kN-m)	0	8,75	**15**	18,75	20	18,75	15	8,75	0

$$Q_X = \frac{dM_X}{dx} = 20 - 10x$$

x (m)	0	0,5	**1**	1,5	2	2,5	3	3,5	4
Q_X (kN)	20	15	**10**	5	0	-5	-10	-15	-20





Tegangan normal di potongan melintang pq

$$\sigma_x = -\frac{My}{I} = -\frac{My}{\frac{1}{12}bh^3}$$

$$\sigma_x = -\frac{\left(15.10^6\right)y}{\frac{1}{12}(100)\left(300^3\right)} = -0{,}067y$$

Tegangan geser di potongan melintang pq

$$Q = b\left(\frac{h}{2} - y\right)\left(y + \frac{h/2 - y}{2}\right)$$

$$Q = \frac{b}{2}\left(\frac{h^2}{4} - y^2\right)$$

$$\tau = \frac{VQ}{Ib}$$

$$\tau = \frac{V\left[\frac{b}{2}\left(\frac{h^2}{4} - y^2\right)\right]}{\left(\frac{1}{12}bh^3\right)b} = -\frac{6V}{bh^3}\left(\frac{h^2}{4} - y^2\right)$$

$$\tau = -\frac{6(10^4)}{100 \times 300^3}\left(\frac{300^2}{4} - y^2\right)$$

$$\tau = -2{,}22 \times 10^{-5}\left(22500 - y^2\right)$$

Tegangan utama dan tegangan geser maksimum

Tegangan utama : $$\sigma_{1,2} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

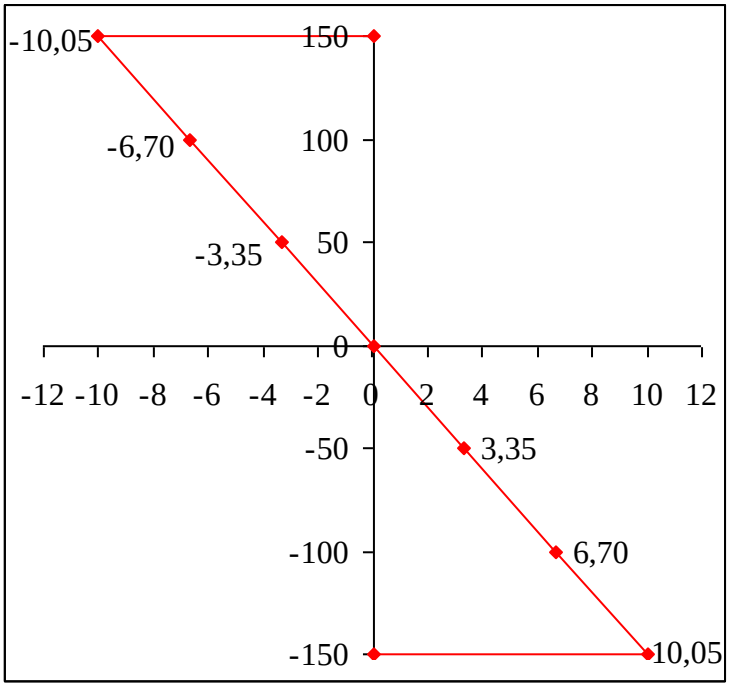
Karena tidak ada tegangan normal dalam arah y, maka :

$$\sigma_{1,2} = \frac{\sigma_x}{2} \pm \sqrt{\left(\frac{\sigma_x}{2}\right)^2 + \tau_{xy}^2}$$

Tegangan geser maksimum : $$\tau_{maks} = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$\tau_{maks} = \sqrt{\left(\frac{\sigma_x}{2}\right)^2 + \tau_{xy}^2}$$

Titik	**y (mm)**	σ_x	τ_{xy}	σ_1	σ_2	τ_{maks}
A	150	-10,05	0	0	-10,05	5,03
B	100	-6,70	-0,28	0,01	-6,71	3,36
C	50	-3,35	-0,44	0,06	-3,41	1,73
D	0	0	-0,50	0,50	-0,50	0,50
E	-50	3,35	-0,44	3,41	-0,06	1,73
F	-100	6,70	-0,28	6,71	-0,01	3,36
G	-150	10,05	0	10,05	0,00	5,03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150
-6,70
100
-3,35
50
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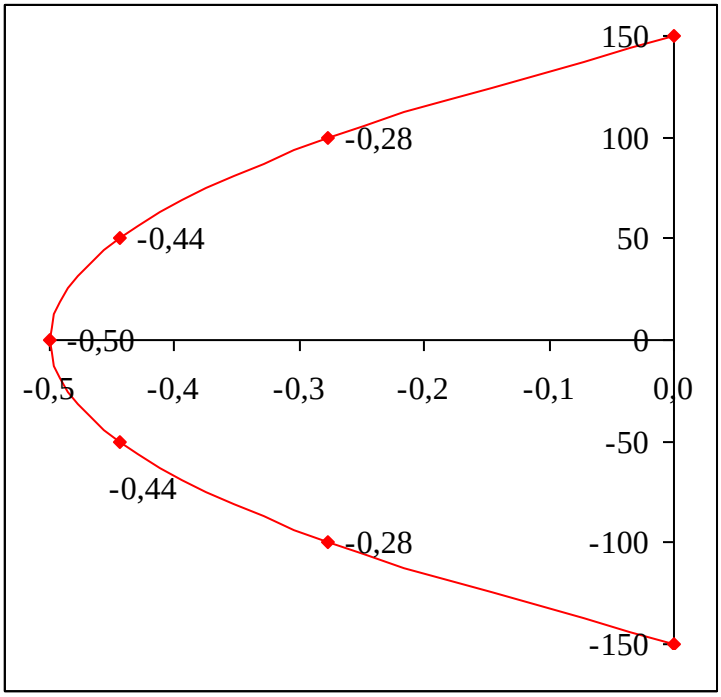
-12 -10 -8 -6 -4 -2 0 2 4 6 8 10 12
-50
3,35
-100
6,70
-150
10,05


150
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-0,44
50
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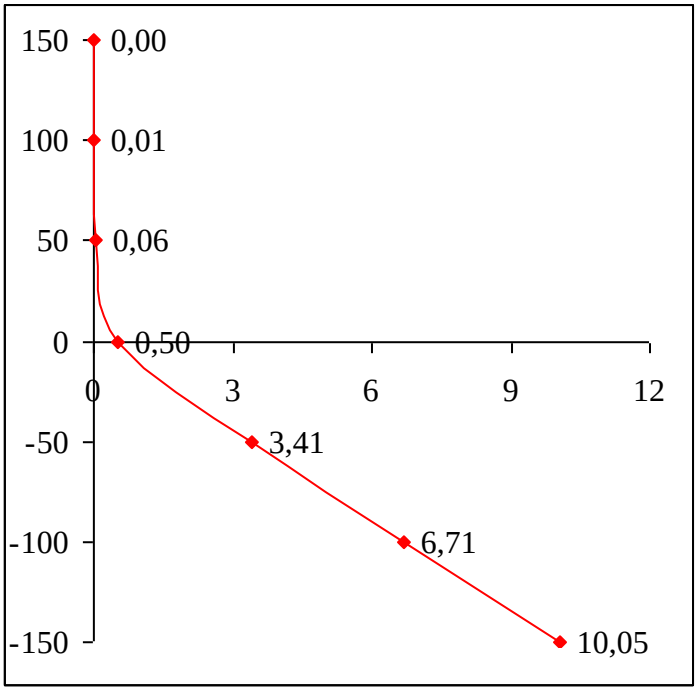
-0,5 -0,4 -0,3 -0,2 -0,1 0,0
-50
-0,44
-0,28
-100
-150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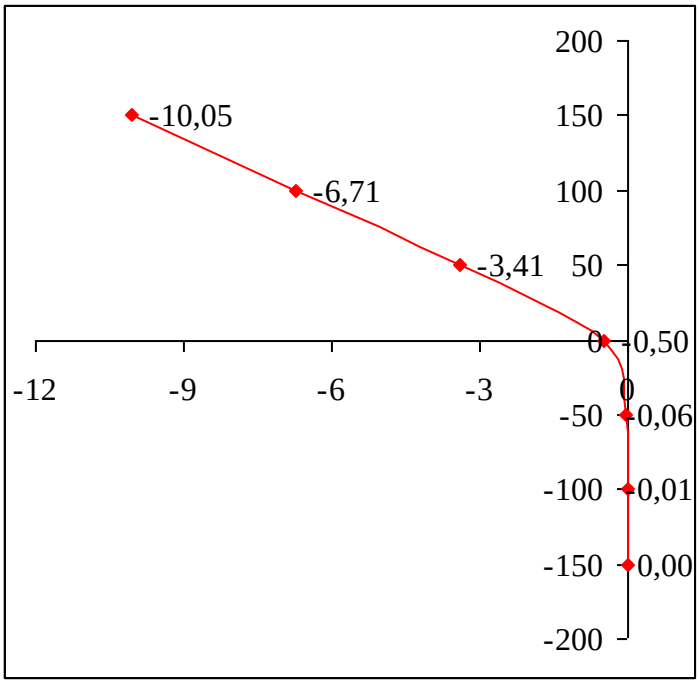
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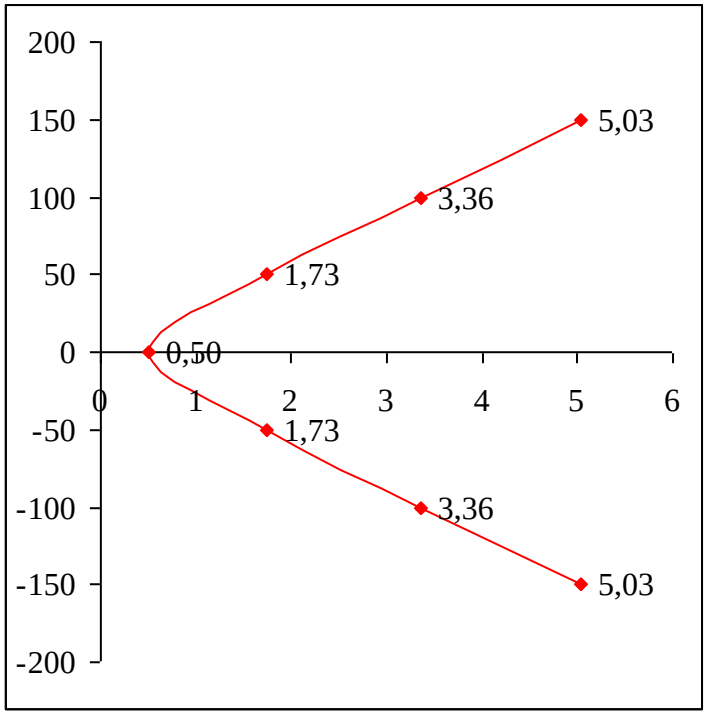
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0,50
1,73
3,36
5,03