OKEMENTRIAN PENDIDIKAN, KEBUDAYAAN,
RISET DAN TEKNOLOGI
UNIVERSITAS LAMPUNG
FAKULTAS TEKNIK
JURUSAN TEKNIK SIPIL

TUGAS BESAR STATIKA (SIP 620104)
SEMESTER GANJIL 2023/2024

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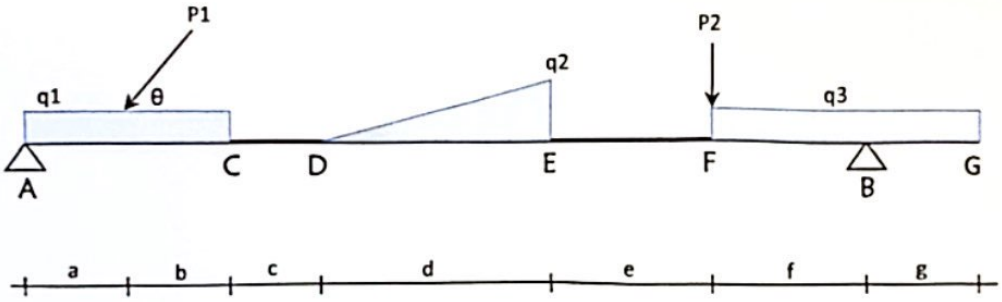
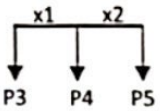
SOAL NO. 1

Diketahui struktur *simple beam* dengan beban seperti tergambar.



Data-data sebagai berikut:

Perletakan		Beban		Jarak		Beban berjalan	
A	Sendi	P1	12 kN	a	2,4 m	P3	22 kN
B	Rol	P2	15 kN	b	1,6 m	P4	16 kN
		q1	11 kN/m'	c	2,5 m	P5	20 kN
		q2	12 kN/m'	d	3,8 m		
		q3	12 kN/m'	e	2,8 m		
				f	2,9 m		
				g	3 m		
				Sudut □	37 °	x1	2,5 m
						x2	2 m

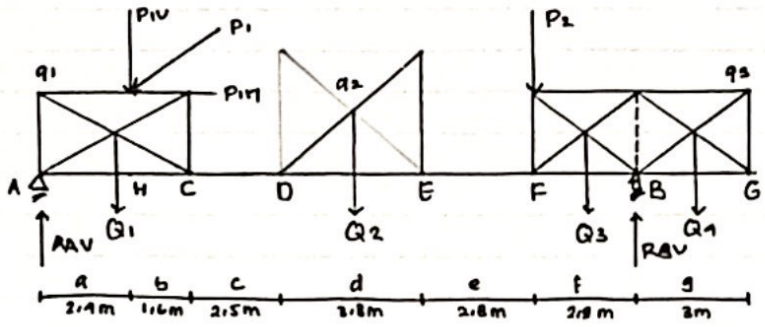
Pertanyaan:

a. Hitung dan gambarkan bidang momen, lintang dan normal akibat beban tetap (seperti tergambar).
b. Hitung dan gambar garis pengaruh momen dan lintang akibat beban jika P = 1 kN bergerak dari tumpuan A ke B pada potongan C, D, E dan F.
c. Hitung nilai momen ekstrim dan lintang ekstrim pada potongan C, D, E, dan F akibat rangkaian beban berjalan (P3, P4, P5) dari A ke B.

Asisten Responsi,

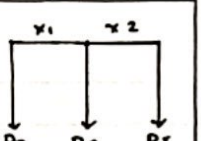
ANANG MA'RUF
NPM. 2115011122

1. Diketahui struktur simple beam dengan seperti tergambar.



Skala
1 : 2

Data - data sebagai berikut

Perletakan		Beban		Jarak		Beban Bejalan	
A	Sendi	P_1	12 kN	a	2,4 m	P_3	22 kN
B	Rol	P_2	15 kN	b	1,6 m	P_4	16 kN
		q_1	11 kN/m	c	2,5 m	P_5	20 kN
		q_2	12 kN/m	d	3,8 m		
		q_3	12 kN/m	e	2,8 m		
				F	2,9 m		
				g	3 m		
				θ	37°	x_1	2,5 m
						x_2	2 m

Pertanyaan :

a. Hitungan dan gambarkan bidang momen, lintang dan normal akibat beban tetap (seperti tergambar)

1. Q_1

$Q_1 = q_1 . (2,4 + 1,6)\,m$
$= 11\,kN . 4m$
$= 44\,kN$

2. Q_2

$Q_2 = \frac{q_2 . 3,8\,m}{2}$
$= \frac{12\,kN/m . 3,8\,m}{2}$
$= 22,8\,kN$

3. Q_3

$Q_3 = q_3 . 2,9\,m$
$= 12\,kN/m . 2,9\,m$
$= 34,8\,kN$

4. Q_4

$Q_4 = q_3 . 3m$
$= 12\,kN/m . 3m$
$= 36\,kN$

5. $P_{IV} = P_1 . \sin 37°$
$= 12\,kN \sin 37°$
$= 7,2218\,kN$

6. $P_{IH} = P_1 \cos 37°$
$= 12\,kN \cdot \cos 37°$
$= 9,5836\,kN$

7. $Q_{AH} = q_1 . 2,4m$
$= 11\,kN/m . 2,4m$
$= 26,4\,kN$

8. Q_{H-C}
$= q_1 . 1,6m$
$= 17,6\,kN$

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Reaksi Peletakan

$\Sigma MB = 0$

$R_{AV}.(2{,}9+1{,}6+2{,}5+3{,}8+2{,}8+2{,}9)m - Q_1.(\frac{1}{2}(2{,}9+1{,}6)+2{,}5+3{,}8+2{,}8+2{,}9)m - P_{IV}.(1{,}6+2{,}5+3{,}8+2{,}8+2{,}9)m - Q_2.(\frac{1}{3}.3{,}8+2{,}8+2{,}9)m - P_2.2{,}9m - Q_3.(\frac{1}{2}.2{,}9)m + Q_4.(\frac{1}{2}.3)m = 0$

$R_{AV}.16m - 44kN.14m - 7{,}2218kN.13{,}6m - 22{,}8kN.6{,}9667m - 15kN.2{,}9m - 34{,}8kN.1{,}45m + 36kN.1{,}5m = 0$

$R_{AV}.16m - 616kN.m - 98{,}2165kN.m - 158{,}8408kN.m - 43{,}5kN.m - 50{,}46kN.m + 54kN.m = 0$

$R_{AV}.16m = 913{,}0173\ kN.m$

$R_{AV} = 57{,}0636\ kN\ (\uparrow)$

$\Sigma MA = 0$

$-R_{BV}.(2{,}9+2{,}8+3{,}8+2{,}5+1{,}6+2{,}4)m + Q_4(\frac{1}{2}3+2{,}9+2{,}8+3{,}8+2{,}5+1{,}6+2{,}4)m + Q_3.(\frac{1}{3}2{,}9+2{,}8+3{,}8+2{,}5+1{,}6+2{,}4)m + P_2.(2{,}8+3{,}8+2{,}5+1{,}6+2{,}4)m + Q_2.(\frac{2}{3}3{,}8+2{,}5+1{,}6+2{,}4)m + Q_1.(\frac{1}{2}.(2{,}4)+1{,}6) + P_{IV}.2{,}4m = 0$

$-R_{BV}.16m + 36kN.17{,}5m + 34{,}8kN.14{,}55m + 15kN.13{,}1m + 22{,}8kN.9{,}0333m + 44kN.2m + 7{,}2218kN.2{,}4m = 0$

$-R_{BV}.16m + 630\ kN.m + 506{,}34\ kN.m + 196{,}5\ kN.m + 205{,}9592\ kN.m + 88\ kN.m + 171{,}3323\ kN.m = 0$

$-R_{BV}.16m = -1644{,}315\ kN.m$

$R_{BV} = 102{,}7582\ kN$

Checking

$\Sigma V = 0$

$R_{AV} + R_{BV} - Q_1 - Q_2 - Q_3 - Q_4 - P_{IV} - P_2 = 0$

$57{,}0636\ kN + 102{,}7582\ kN - 44\ kN - 22{,}8\ kN - 34{,}8\ kN - 36kN - 7{,}2218\ kN - 15\ kN = 0$

$159{,}8218\ kN - 159{,}8128\ kN = 0$

$0 = 0$ (Ok!)

Gaya normal

$R_{A-H} = P_{IH}$

$= 9{,}5836\ (\rightarrow)$ Tertekan

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Reaksi Lintang

$D_A = R_{AV} = 57{,}0636\ kN$

D_H kiri $= R_{AV} - D_{AH}$
$= 57{,}0636\ kN - 26{,}4\ kN$
$= 30{,}6636\ kN$

$D_H = R_{AV} - D_{AH} - P_{1V}$
$= 57{,}0636\ kN - 26{,}4\ kN - 7{,}2218\ kN$
$= 23{,}4418\ kN$

D_C kiri $= R_{AV} - Q_1 - P_{1V}$
$= 57.0636\ kN - 44\ kN - 7{,}2218\ kN$
$= 5{,}8418\ kN$

D_D kiri $= R_{AV} - Q_1 - P_{1V}$
$= 57{,}0636\ kN - 44\ kN - 7{,}2218\ kN$
$= 5{,}8418\ kN$

D_E kiri $= R_{AV} - Q_1 - P_{1V} - Q_2$
$= 57{,}0636\ kN - 44\ kN - 7{,}2218\ kN - 22{,}8\ kN$
$= -16{,}9582\ kN$

D_F kiri $= R_{AV} - Q_1 - P_{1V} - Q_2$
$= 57{,}0636\ kN - 44\ kN - 7{,}2218\ kN - 22{,}8\ kN$
$= -16{,}9582\ kN$

$D_F = R_{AV} - Q_1 - P_{1V} - Q_2 - P_2$
$= 57{,}0636\ kN - 44\ kN - 7{,}2218\ kN - 22{,}8\ kN - 15\ kN$
$=$

D_B kiri $= R_{AV} - Q_1 - P_{1V} - Q_2 - P_2 - Q_3$
$= 57{,}0636\ kN - 44\ kN - 7{,}2218\ kN - 22{,}8\ kN - 15\ kN - 34{,}8\ kN$
$= -66{,}7582\ kN$

$D_B = R_{AV} - Q_1 - P_{1V} - Q_2 - P_2 - Q_3 + R_{BV}$
$= 57{,}0636\ kN - 44\ kN - 7{,}2218\ kN - 22{,}8\ kN - 15\ kN - 34{,}8\ kN +$
$102{,}7582\ kN$
$= 36\ kN$

D_G kiri $= R_{AV} - Q_1 - P_{1V} - Q_2 - P_2 - Q_3 + R_{BV} - Q_4$
$= 57{,}0636\ kN - 44\ kN - 7{,}2218\ kN - 22{,}8\ kN - 15\ kN - 34{,}8\ kN$
$+ 102{,}7582\ kN - 36\ kN$
$= 0\ kN$

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Bidang Momen

$M_A = R_{AV} \cdot 0m$
$= 0\ kN.m$

$M_C = R_{AV} \cdot (2{,}4 + 1{,}6)m - Q_1 \left(\frac{1}{2}(2{,}4 + 1{,}6)\right)m - P_{1V} \cdot 1{,}6\ m$
$= 57{,}0636\ kN \cdot 4m - 44\ kN \cdot 2m - 7{,}2218\ kN \cdot 1{,}6m$
$= 128{,}6991\ kN.m$

$M_d = R_{AV} \cdot (2{,}4 + 1{,}6 + 2{,}5)m - Q_1 \left(\frac{1}{2}(2{,}4 + 1{,}6) + 2{,}5\right)m - P_{1V} \cdot (1{,}6 + 2{,}5)m$
$= 57{,}0636\ kN \cdot 6{,}5m - 44\ kN \cdot 4{,}5m - 7{,}2218\ kN \cdot 4{,}1m$
$= 143{,}3040\ kN.m$

$M_E = R_{AV} \cdot (2{,}4 + 1{,}6 + 2{,}5 + 3{,}8)m - Q_1 \left(\frac{1}{2}(2{,}4 + 1{,}6) + 3{,}8 + 2{,}5\right)m - P_{1V} \cdot (1{,}6 + 2{,}5 + 3{,}8)m - Q_2 \cdot \left(\frac{1}{3} \cdot 3{,}8\right)m$
$= 57{,}0636\ kN \cdot 10{,}3m - 44\ kN \cdot 8{,}3m - 7{,}2218\ kN \cdot 7{,}9m - 228\ kN\ 1{,}2667\ m$
$= 136{,}6221\ kN.m$

$M_F = R_{AV} \cdot (2{,}4 + 1{,}6 + 2{,}5 + 3{,}8 + 2{,}8)m - Q_1 \left(\frac{1}{2}(2{,}4 + 1{,}6) + 3{,}8 + 2{,}5 + 2{,}8\right)m - P_{1V} \cdot (1{,}6 + 2{,}5 + 3{,}8 + 2{,}8)m - Q_2 \cdot \left(\frac{1}{3} \cdot 3{,}8 + 2{,}8\right)m$
$= 57{,}0636\ kN \cdot 13{,}1m - 44\ kN \cdot 11{,}1m - 7{,}2218\ kN \cdot 10{,}7m - 22{,}8\ kN \cdot 4{,}0667\ m$
$= 89{,}1391\ kN.m$

$M_B = R_{AV} \cdot (2{,}4 + 1{,}6 + 2{,}5 + 3{,}8 + 2{,}8 + 2{,}9)m - Q_1 \left(\frac{1}{2}(2{,}4 + 1{,}6) + 3{,}8 + 2{,}5 + 2{,}8 + 2{,}9\right)m - P_{1V} (1{,}6 + 2{,}5 + 3{,}8 + 2{,}8 + 2{,}9)m - Q_2 \left(\frac{1}{3} \cdot 3{,}8 + 2{,}8 + 2{,}9\right)m - P_2 \cdot 2{,}9m - Q_3 \cdot \left(\frac{1}{2} \cdot 2{,}9\right)m$
$= 57{,}0636\ kN \cdot 16\ m - 44\ kN \cdot 14m - 7{,}2218\ kN \cdot 13{,}6\ m - 22{,}8\ kN \cdot 6{,}9667\ m - 15\ kN \cdot 2{,}9m - 34{,}8\ kN \cdot 1{,}45m$
$= -53{,}9996\ kN.m$

$M_G = R_{AV} \cdot (2{,}4 + 1{,}6 + 2{,}5 + 3{,}8 + 2{,}8 + 2{,}9 + 3)m - Q_1 \cdot \left(\frac{1}{2}(2{,}4 + 1{,}6) + 2{,}5 + 3{,}8 + 2{,}8 + 2{,}9 + 3\right)m - P_{1V} \cdot (1{,}6 + 2{,}5 + 3{,}8 + 2{,}8 + 2{,}9 + 3)m - Q_2 \left(\frac{1}{3} \cdot 3{,}8 + 2{,}8 + 2{,}9 + 3\right)m - P_2 \cdot (2{,}9 + 3)m - Q_3 \cdot \left(\frac{1}{2}\ 2{,}9 + 3\right)m + R_{BV} \cdot 3m - Q_4 \cdot \left(\frac{1}{2} \cdot 3\right)m$
$= 57{,}0636\ kN \cdot 19\ m - 44\ kN \cdot 17m - 7{,}2218\ kN \cdot 16{,}6m - 22{,}8\ kN \cdot 9{,}9667\ m - 15\ kN \cdot 5{,}9m - 34{,}8\ kN \cdot 4{,}45m + 102{,}7582\ kN\ 3m - 36\ kN \cdot 1{,}5m$
$= 0{,}0004\ kN.m$

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Momen maximum

$M_{max} = M_x$

$= R_{AV} \cdot (a+b+c\ x) - Q_1 \left(\left(\frac{a+b}{2}\right) + b + x\right) - P_{IV} \cdot (b+c+x) - \left(\frac{1}{2} \cdot \left(\frac{1}{3} q_2 x^2\right)\right)\left(\frac{1}{3}x\right)$

$= R_{AV} \cdot (a+b+c+x) - Q_1 \left(\left(\frac{a+b}{2}\right) + b + x\right) - P_{IV} (b+c+x) - \left(\frac{1}{2} q_2 x^2\right)\left(\frac{1}{3}x\right)$

$\frac{dm_x}{dx} = 0$

$0 = R_{AV} - Q_1 - P_{IV} - \left(\frac{1}{6} q_2 x^2\right)$

$\frac{1}{6} q_2 x^2 = R_{AV} - Q_1 - P_{IV}$

$x^2 = \frac{R_{AV} - Q_1 - P_{IV}}{\frac{1}{6} q_2}$

$x = \sqrt{\frac{57,0636 - 49 - 7,2218}{\frac{1}{6} \cdot 12}}$

$x = 1,7091\ m$

$M_{max} = R_{AV}\ (2,4 + 1,6 + 2,5 + 1,7091) - Q_1 \left(\frac{2,4+1,6}{2} + 2,5 + 1,7091\right) - P_{IV}\ (1,6 + 2,5 + 1,7091) - \left(\frac{1}{6} \cdot q_2 \cdot (1,7091)^2\right)\left(\frac{1}{3} \cdot 1,7091\right)$

$= 57,0636 \cdot 8,2091 - 49 \cdot 7,4091 - 7,2218 \cdot 5,8091 - 5,8418 \cdot 0,5697$

$= 468,4387 - 273,1988 - 41,9519 - 3,3280$

$= 149,96\ KN.m$

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Beban Merata Segitiga

Bentang DE ($6{,}5 \leq x \leq 10{,}3$)

$$Dx = RAV - Q_1 - P_1V - \frac{q_2 x^2}{2 \cdot DE}$$

$$D_{6,5} = 57{,}0636\ kN - 44\ kN - 7{,}2218\ kN - \frac{12\ kN/m\,(0)^2}{2 \cdot 3{,}8}$$

$$= 5{,}8418\ kN - 0\ kN$$
$$= 5{,}8418\ kN$$

$$D_{7,5} = 57{,}0636\ kN - 44\ kN - 7{,}2218\ kN - \frac{12\ kN/m\ (1)^2}{2 \cdot 3{,}8}$$

$$= 5{,}8418\ kN - 1{,}5789\ kN$$
$$= 4{,}2629\ kN$$

$$D_{8,9} = 57{,}0636\ kN - 44\ kN - 7{,}2218\ kN - \frac{12\ kN/m \cdot (1{,}9)^2}{2 \cdot 3{,}8}$$

$$= 5{,}8418\ kN - 5{,}7\ kN$$
$$= 0{,}1418\ kN$$

$$D_{9,5} = 57{,}0636\ kN - 44\ kN - 7{,}2218\ kN - \frac{12\ kN/m \cdot (3)^2}{2 \cdot 3{,}8}$$

$$= 5{,}8418\ kN - 14{,}2105\ kN$$
$$= -8{,}3687\ kN$$

$$D_{10,3} = 57{,}0636\ kN - 44\ kN - 7{,}2218\ kN - \frac{12\ kN/m \cdot (9{,}8)^2}{2 \cdot 3{,}8}$$

$$= 5{,}8418\ kN - 22{,}8\ kN$$
$$= -16{,}9582\ kN$$

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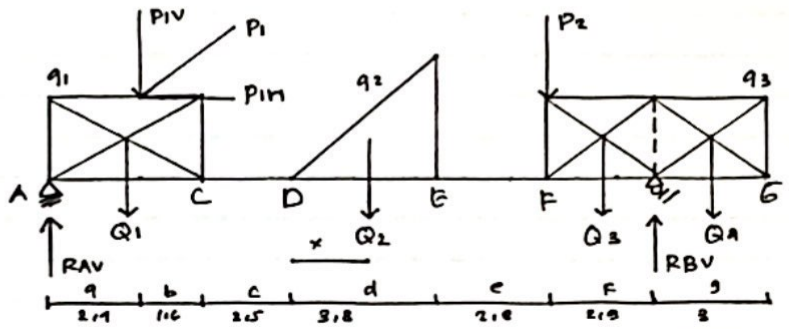
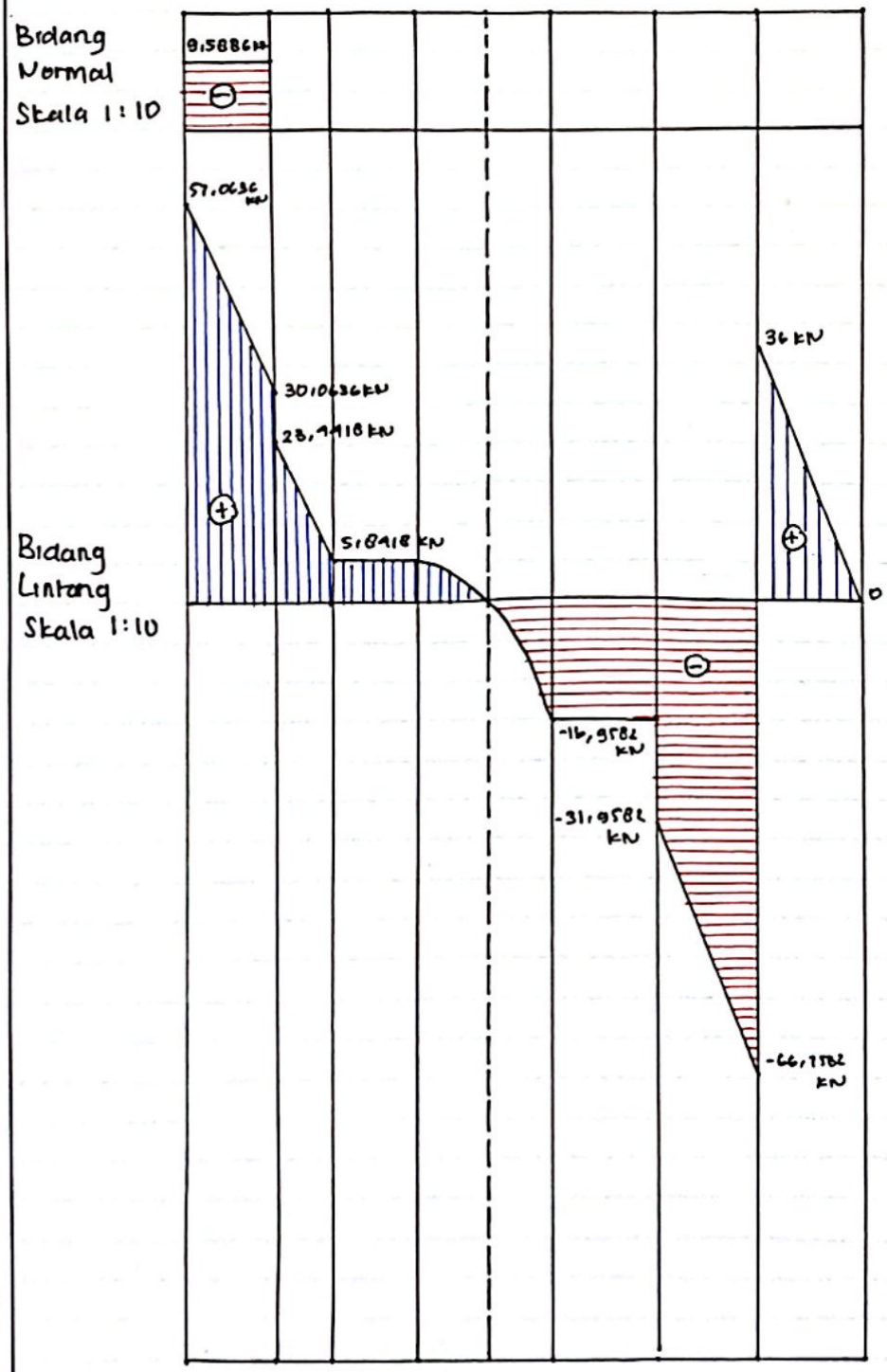
Gambar bidang Normal dan Lintang





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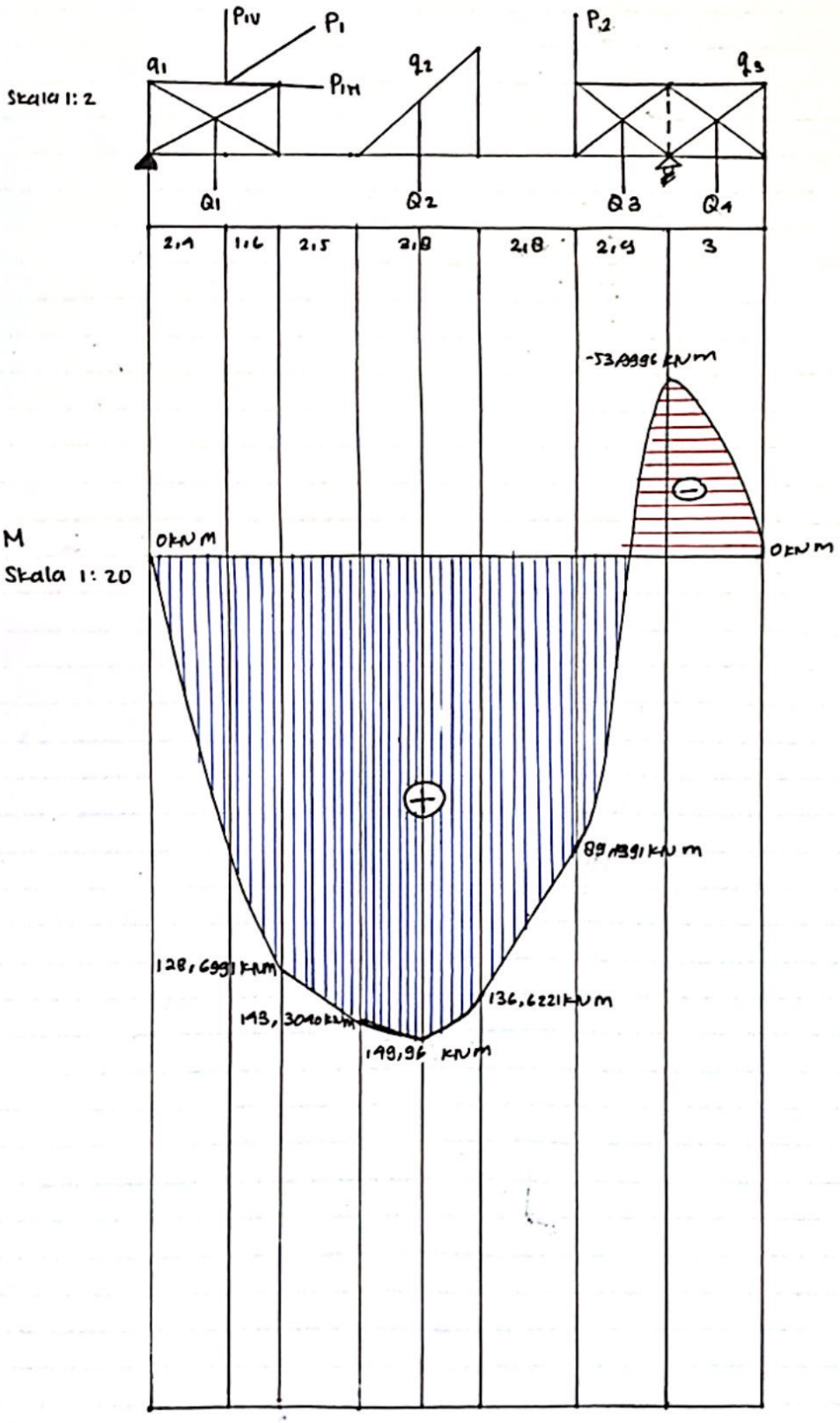
Gambar Bidang Momen



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B. Garis Pengaruh Lintang

Titik C

$$y+ = \frac{c+d+e+f}{a+b+c+d+e+F} = \frac{12}{16} = 0{,}175$$

$$y- = \frac{a+b}{a+b+c+d+e+F} = \frac{4}{16} = 0{,}125$$

Titik D

$$y+ = \frac{d+e+F}{a+b+c+d+e+F} = \frac{9{,}5}{16} = 0{,}5938$$

$$y- = \frac{a+b+c}{a+b+c+d+e+F} = \frac{6{,}5}{19} = 0{,}4062$$

Titik E

$$y+ = \frac{e+F}{a+b+c+d+e+F} = \frac{5{,}7}{16} = 0{,}3562$$

$$y- = \frac{a+b+c+d}{a+b+c+d+e+f} = \frac{10{,}3}{16} = 0{,}6438$$

Titik F

$$y+ = \frac{F}{a+b+c+d+e+F} = \frac{2{,}9}{16} = 0{,}1812$$

$$y- = \frac{a+b+c+d+e}{a+b+c+d+e+f} = \frac{13{,}1}{16} = 0{,}8188$$

Garis Pengaruh lintang titik G

GPDC

$$y = \frac{g \cdot y+}{c+d+e+F} = \frac{3 \cdot 0{,}75}{12} = 0{,}1875$$

GPDD

$$y = \frac{g \cdot y+}{d+e+F} = \frac{3 \cdot 0{,}5938}{9{,}5} = 0{,}1875$$

GPDE

$$y = \frac{g \cdot y+}{e+F} = \frac{3 \cdot 0{,}3562}{5{,}7} = 0{,}1875$$

GPDF

$$y = \frac{g \cdot y+}{f} = \frac{3 \cdot 0{,}1812}{2{,}9} = 0{,}1875$$

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Garis Pengaruh Bidang Momen

Garis Pengaruh momen A

$y = 0m$

$M_A = R_A \cdot y - P \cdot y$

$= R_A \cdot 0 - P \cdot 0$

$= 0\ kN.m$

Garis Pengaruh momen C

$y_1 = \frac{AB - AC}{AB} \cdot AC = \frac{16m - 4m}{16m} \cdot 4m = 3m$

$M_C = P \cdot y_1 = 1kN \cdot 3m = 3\ kN.m$

$y_2 = \frac{AB - AG}{AB} \cdot AC = \frac{16m - 19m}{16m} 4m = -0{,}75m$

$M_C = P \cdot y_2 = 1kN \cdot -0{,}75m = -0{,}75\ kN.m$

Garis Pengaruh Momen D

$y_1 = \frac{AB - AD}{AB} \cdot AD = \frac{16m - 6{,}5m}{16m} \cdot 6{,}5m = 3{,}8594\ m$

$M_D = P \cdot y_1 = 1kN \cdot 3{,}8594\ m = 3{,}8594\ kN.m$

$y_2 = \frac{AB - AG}{AB} \cdot AD = \frac{16m - 19m}{16m} \cdot 6{,}5m = -1{,}2188\ m$

$M_D = P \cdot y_2 = 1kN \cdot -1{,}2188m = -1{,}2188\ kN.m$

Garis Pengaruh Momen E

$y_1 = \frac{AB - AE}{AB} \cdot AE = \frac{16m - 10{,}3m}{16m} \cdot 10{,}3m = 3{,}6694\ m$

$M_E = P \cdot y_1 = 1kN \cdot 3{,}6694\ m = 3{,}6694\ kN.m$

$y_2 = \frac{AB - AG}{AB} \cdot AE = \frac{16m - 19m}{16m} \cdot 10{,}3m = -1{,}9313\ m$

$M_E = P \cdot y_2 = 1kN \cdot -1{,}9313m = -1{,}9313\ kN.m$

Garis Pengaruh Momen F

$y_1 = \frac{AB - AF}{AB} \cdot AF = \frac{16m - 13{,}1m}{16m} \cdot 13{,}1m = 2{,}3744\ m$

$M_F = P \cdot y_1 = 1kN \cdot 2{,}3744\ m = 2{,}3744\ kN.m$

$y_2 = \frac{AB - AG}{AB} \cdot AF = \frac{16m - 19m}{16m} \cdot 13{,}1m = -2{,}4563\ m$

$M_F = P \cdot y_2 = 1kN \cdot -2{,}4563\ m = -2{,}4563\ kN.m$

Garis Pengaruh Momen B

$y = 0m$

$M_B = R_B \cdot y - P \cdot y$

$= R_B \cdot 0 - P \cdot 0$

$= 0\ kN.m$

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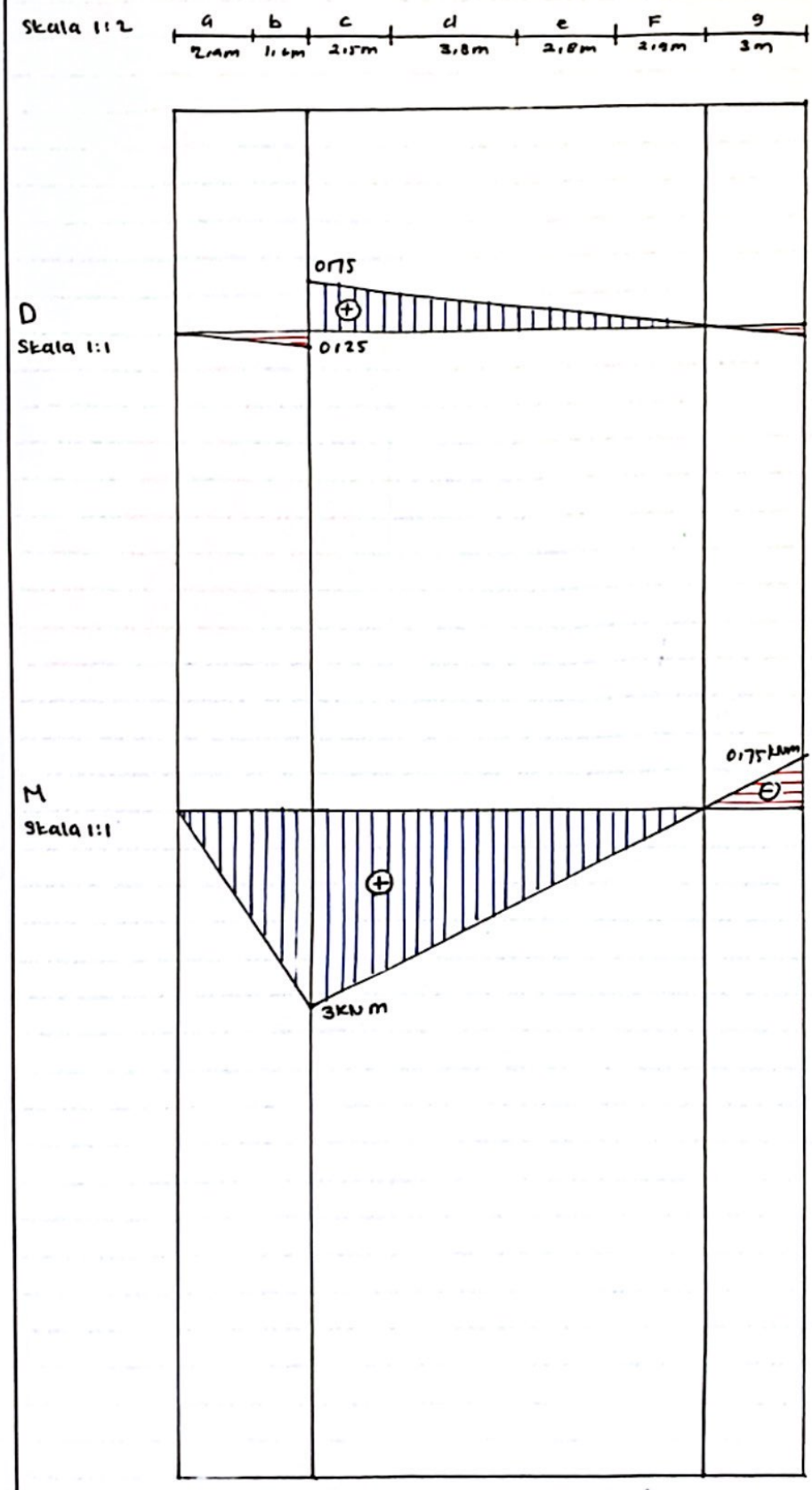
Gambar garis pengaruh Bidang lintang dan momen hrk C



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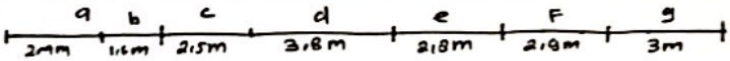
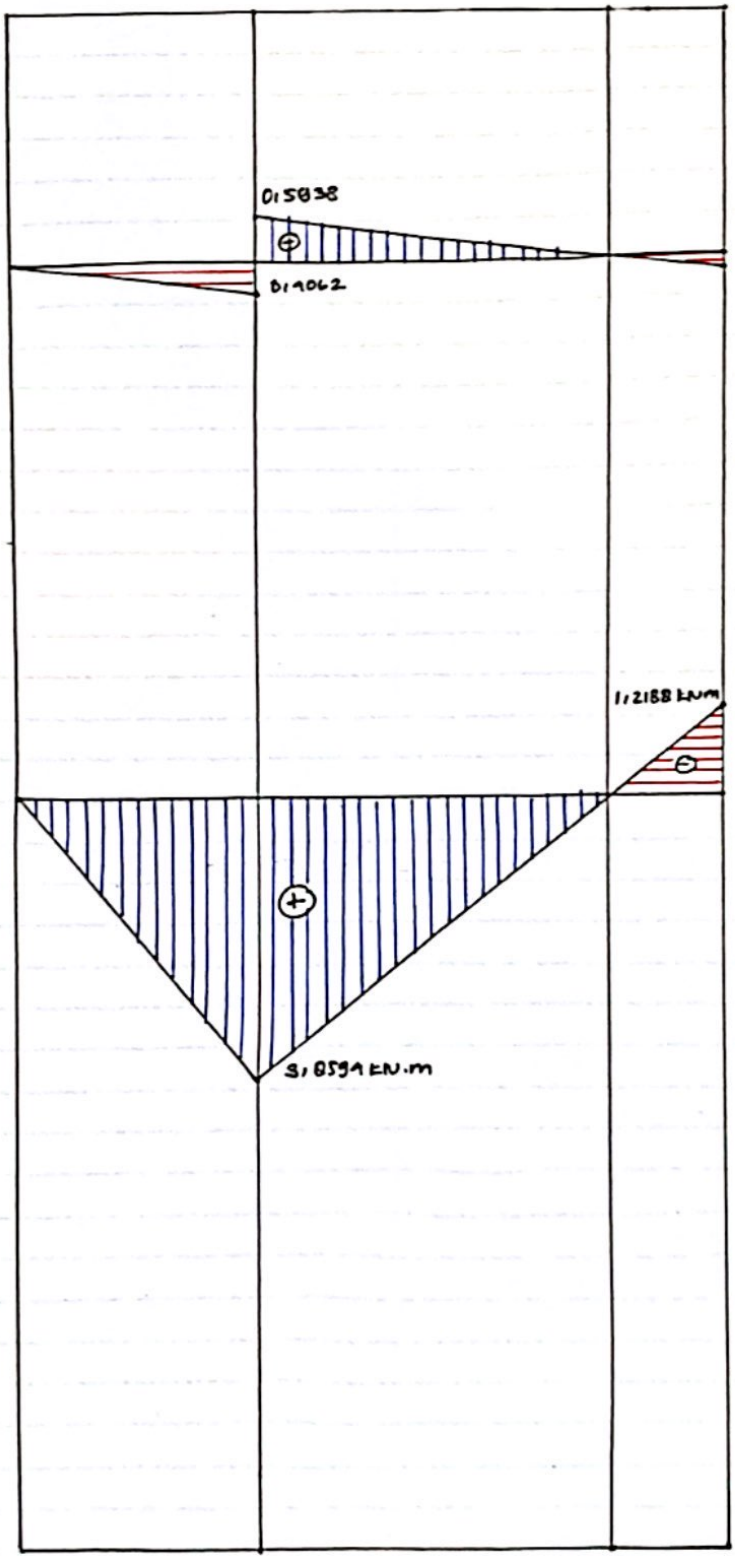
Gambar garis pengaruh Bidang lintang dan Momen titik D





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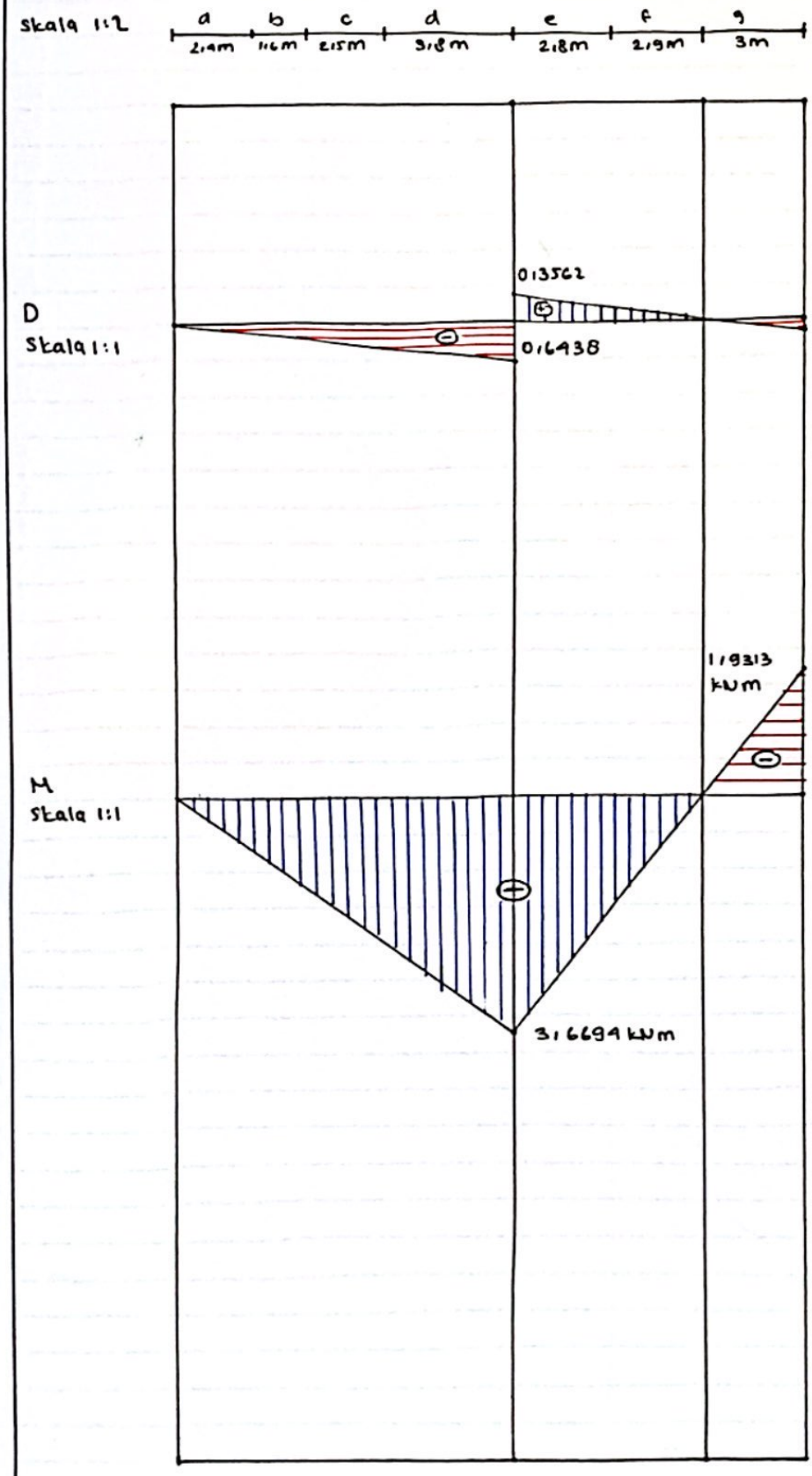
Gambar garis Bidang lintangan dan momen hhlc E



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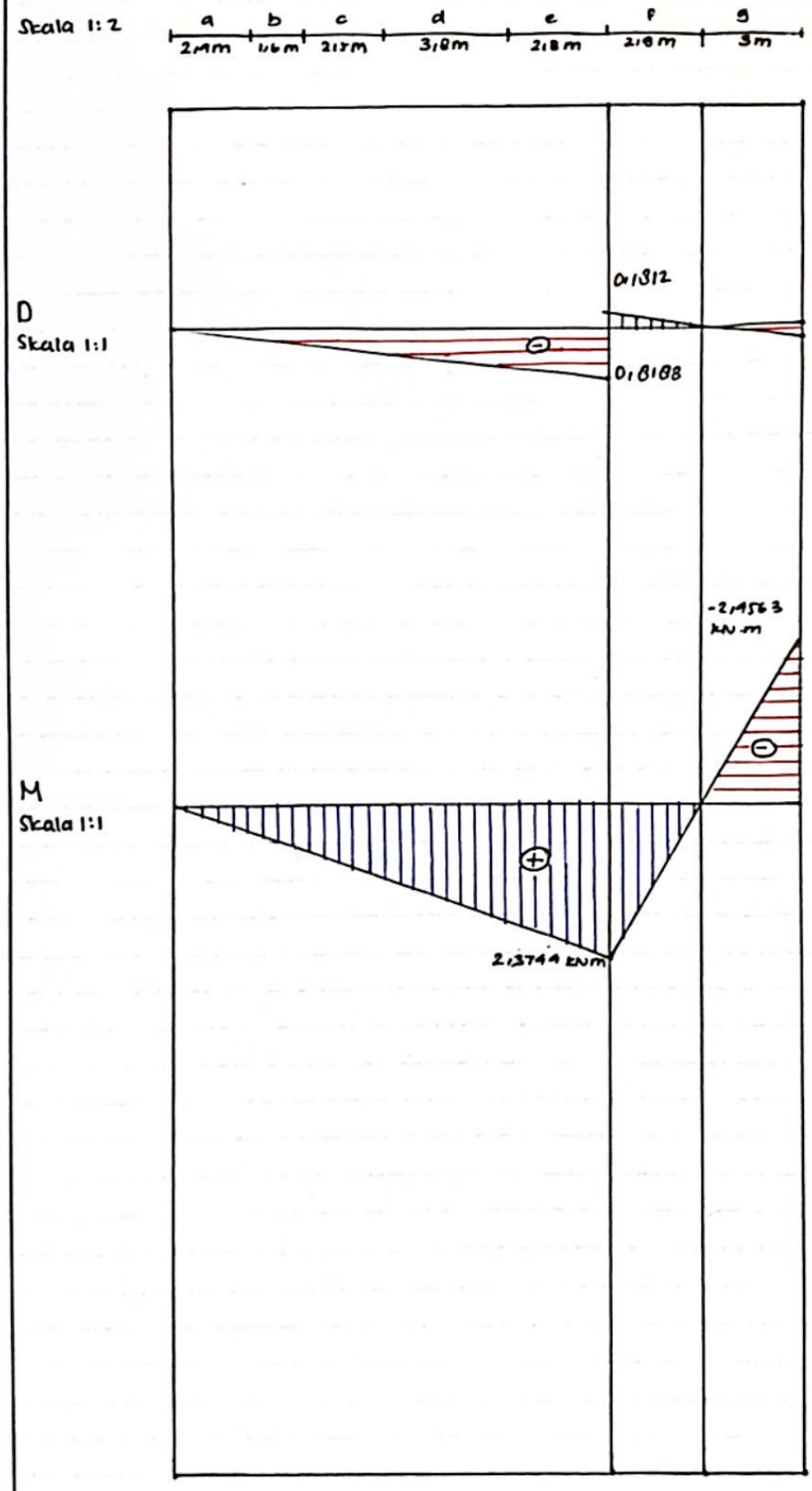
Gambar gans pengaruh lintang dan momen hhk F



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C. Hitunglah nilai momen ekstrim dan Lintang ekstrim pada potongan B, D, E dan F akibat rangkaian beban bergalan (P3, P4 dan P5) dari A ke B

Momen Ekstrim dan Lintang Ekstrim di titik C

Perhitungan GPDC (kondisi 1)

GPD Positif

$P_{SC1} = y_1 \cdot P_5$

$= 0{,}75 \cdot 20\,kN$

$= 15\,kN$

GPD Negatif

$P_{SC2} = y_2 \cdot P_5$

$= -0{,}25 \cdot 20\,kN$

$= -5\,kN$

$P_{4C} = \frac{y_2\,(AC - X_2)}{AC} P_4$

$= \frac{-0{,}25\,(4-2)}{4} \cdot 16\,kN$

$= -2\,kN$

Perhitungan GPMC (kondisi 1)

GPM Positif

$P_{SC} = y_1 \cdot P_5$

$= 3m \cdot 20\,kN$

$= 60\,kN.m$

$P_{4C} = \frac{y_1 \cdot (AC - X_2)}{AC} \cdot P_4$

$= \frac{3m\,(4-2)}{4} \cdot 16\,kN$

$= 24\,kN.m$

Perhitungan Lintang dan momen ekstrim (kondisi 1)

GPDC

Positif = $P_{SC1} = 15\,kN$

Negatif = $P_{SC2} + P_{4C}$

$= -5\,kN - 2\,kN$

$= -7\,kN$

GPMC

Positif = $P_{SC1} + P_{4C}$

$= 60\,kN.m + 24\,kN.m$

$= 84\,kN.m$

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Perhitungan GPD (kondisi 2)

GPD Positif

$P_4C_1 = y_1 \cdot P_4$
$= 0{,}75 \cdot 16\,kN$
$= 12\,kN$

$P_5C = \frac{y_1 (CB - X_2)}{CB} P_5$
$= \frac{0{,}75 (12-2)}{12} 20\,kN$
$= 12{,}5\,kN$

GPD Negatif

$P_4C_2 = y_2 - P_4$
$= -0{,}25 - 16\,kN$
$= -4\,kN$

$P_3C = \frac{y_2 (AC - X_1)}{AC} P_3$
$= \frac{-0{,}25 (4-2{,}5)}{4} 22\,kN$
$= -2{,}0625\,kN$

Perhitungan GPM (kondisi 2)

GPM Positif

$P_4C_1 = y_1 \cdot P_4$
$= 3m \cdot 16\,kN$
$= 48\,kN.m$

$P_5C = \frac{y_1 (CB - X_2)}{CB} P_5$
$= \frac{3m \cdot (12-2)}{12} 20\,kN$
$= 50\,kN.m$

$P_3C = \frac{y_1 (AC - X_1)}{AC} P_3$
$= \frac{3m (4-2{,}5)}{4} \cdot 22\,kN$
$= 24{,}75\,kN.m$

Perhitungan Lintang dan Momen ekstrim (kondisi 2)

GPDC

Positif $= P_4C_1 + P_5C$
$= 12\,kN + 12{,}5\,kN$
$= 24{,}5\,kN$

Negatif $= P_4C_2 + P_3C$
$= -4\,kN + (-2{,}0625\,kN$
$= -6{,}0625\,kN$

GPMC

Positif $= P_4C_1 + P_5C + P_3C$
$= 48\,kN.m + 50\,kN.m + 24{,}75\,kN.m$
$= 122{,}75\,kN.m$

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Perhitungan GPDC (kondisi 3)

GPD Positif

$P_3C_1 = y_1 \cdot P_3$
$= 0{,}175 \cdot 22\ kN$
$16{,}5\ kN$

$P_4C = \frac{y_1 \cdot (CB - x_1)}{CB} P_4$
$= \frac{0{,}175 \cdot (12 - 12{,}5)}{12} 16\ kN$
$= 9{,}5\ kN$

$P_5C = \frac{y_1 \cdot (CB - x_2 - x_1)}{CB} P_4$
$= \frac{0{,}175 \cdot (12 - 2{,}5 - 2)}{12} 20\ kN$
$= 9{,}375\ kN$

GPD Negatif

$P_3C_2 = y_2 \cdot P_3$
$= 0{,}25 \cdot 22\ kN$
$= 5{,}5\ kN$

Perhitungan GPM (kondisi 3)

GPM Positif

$P_3C_1 = y_1 \cdot P_3$
$= 3m \cdot 22\ kN$
$= 66\ kN.m$

$P_4C = \frac{y_1 \cdot (CB - x_1)}{CB} P_4$
$= \frac{3m\ (12 - 2{,}5)}{12} 16\ kN$
$= 38\ kN \cdot m$

$P_5C = \frac{y_1 \cdot (CB - x_1 - x_2)}{CB} P_5$
$= \frac{3m \cdot (12 - 2{,}5 - 2)}{12} 20\ kN$
$= 37{,}5\ kN \cdot m$

Perhitungan Lintang dan momen ekstrim (kondisi 3)

GPDC

Positif = $P_3C_1 + P_4C + P_5C$
$= 16{,}5\ kN + 9{,}5\ kN + 9{,}375\ kN$
$= 35{,}375\ kN$

Negatif = P_3C_2
$= 5{,}5\ kN$

GPMC

Positif = $P_3C_1 + P_4C + P_5C$
$= 66\ kN.m + 38\ kN.m + 37{,}5\ kN.m$
$= 141{,}5\ kN.m$

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Gambar Lintang Ekstrim dan Momen Ekstrim di titik C

GPDC

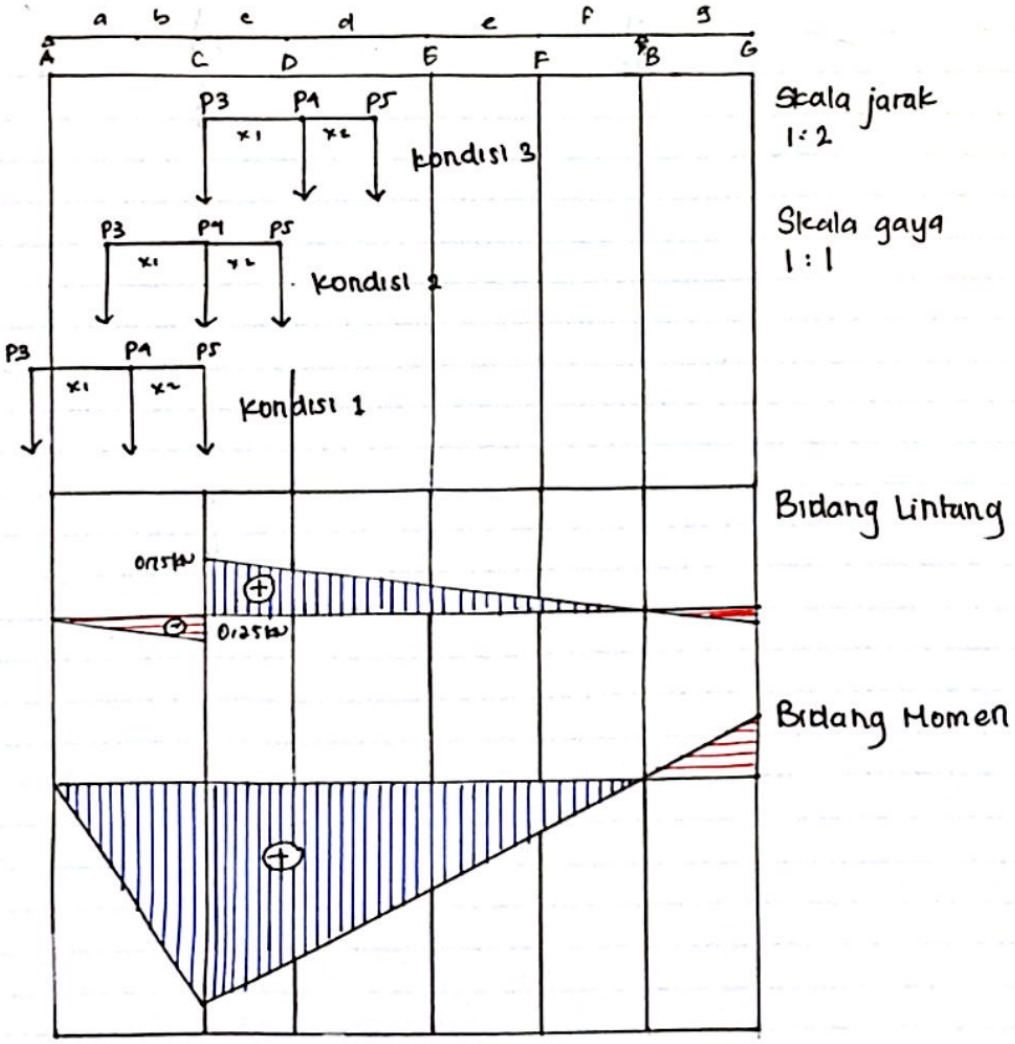
(+) kondisi 1 = 15 kN
kondisi 2 = 24,5 kN
kondisi 3 = 35,375 kN

(-) kondisi 1 = -7 kN
kondisi 2 = -6,0625 kN
kondisi 3 = -5,5 kN

GPMC

(+) kondisi 1 = 84 kN.m
kondisi 2 = 122,75 kN.m
kondisi 3 = 141,5 kN.m

Lintang positif (Dc max) terjadi pada kondisi 3 sebesar 35,375 kN
Lintang negatif (Dc min) terjadi pada kondisi 1 sebesar -7 kN
Momen positif (Mc max) terjadi pada kondisi 3 sebesar 141,5 kN.m



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Momen Ekstrim dan Lintang Ekstrim di titik D

Perhitungan GPDD (kondisi 1)

GPDD Positif

$P_5D_1 = y_1 . P_5$

$= 0,5938 \cdot 20\,kN$

$= 11,876\,kN$

GPDD Negatif

$P_5D_2 = y_2 . P_5$

$= -0,4062 . 20\,kN$

$= -8,124\,kN$

$P_4D = \frac{y_2 . (AD - x_2)}{AD} P_4$

$= \frac{-0,4062 . (6,5 - 2)}{6,5} 16\,kN$

$= -4,4995\,kN$

$P_3D = \frac{y_2 . (AD - x_2 - x_1)}{AD} P_3$

$= \frac{-0,4062 . (6,5 - 2 - 2,5)}{6,5} 22\,kN$

$= -2,749\,kN$

Perhitungan GPM (kondisi 1)

GPMD Positif

$P_5D_1 = y_1 . P_5$

$= 3,8594 . 20\,kN$

$= 77,188\,kN.m$

$P_4D = \frac{y_1 . (AD - x_2)}{AD} P_1$

$= \frac{3,8594\,m . (6,5 - 2)}{6,5} 16\,kN$

$= 42,7503\,kN.m$

$P_3D = \frac{y_1 . (AD - x_2 - x_1)}{AD} P_3$

$= \frac{3,8594\,m (6,5 - 2 - 2,5)}{6,5} 22\,kN$

$= 26,1252\,kN.m$

Perhitungan Momen dan Lintang Ekstrim (kondisi 1)

GPDD

Positif = $P_5D_1 = 11,876\,kN$

Negatif = $P_5D_2 + P_4D + P_3D$

$= -8,124\,kN + (-4,4995)\,kN + (-2,749)\,kN$

$= -15,3725\,kN$

GPMD

Positif = $P_5D_1 + P_4D + P_3D$

$= 77,188\,kN.m + 42,7503\,kN.m + 26,1252\,kN.m$

$= 146,0635\,kN.m$

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Perhitungan GPDD (kondisi 2)

GPD Positif

$P_1D_1 = y_1 \cdot P_1$
$= 0{,}5938 \cdot 16\,kN$
$= 9{,}5008\,kN$

$P_5D = y_1 \cdot (DB - x_2)\, P_5$
DB
$= \frac{0{,}5938 \cdot (9{,}5 - 2)}{9{,}5} \cdot 20\,kN$
$= 9{,}3758\,kN$

GPD Negatif

$P_1D_2 = y_2 \cdot P_1$
$= -0{,}4062 \cdot 16\,kN$
$= -6{,}4992\,kN$

$P_3D = \frac{y_2 \cdot (AD - x_1)}{AD} P_3$
$= \frac{-0{,}4062\,(6{,}5 - 2{,}5)}{6{,}5} 22\,kN$
$= -5{,}4993\,kN$

Perhitungan GPM (kondisi 2)

GPM Positif

$P_1D_1 = y_1 \cdot P_1$
$= -3{,}8594\,m \cdot 16\,kN$
$= 61{,}7504\,kN \cdot m$

$P_3M = \frac{y_1 \cdot (AD - x_1)}{AD} P_3$
$= \frac{3{,}8594\,m \cdot (6{,}5 - 2{,}5)}{6{,}5} \cdot 22\,kN$
$= 36{,}916\,kN \cdot m$

$P_5M = \frac{y_1 \cdot (DB - x_2)}{DB} P_5$
$= \frac{3{,}8594\,m \cdot (9{,}5 - 2)}{9{,}5} 20\,kN$
$62{,}925\,kN \cdot m$

Perhitungan Lintang dan momen Ekstrim (kondisi 2)

GPDD

Positif $= P_1D_1 + P_5D$
$= 9{,}5008\,kN + 9{,}3758\,kN$
$= 18{,}8766\,kN$

Negatif $= P_1D_2 + P_3D$
$= -6{,}4992\,kN + (-5{,}4993)\,kN$
$= -11{,}9985\,kN$

GPMD

Positif $= P_1D_1 + B_5D + P_3D$
$= 61{,}7504\,kN \cdot m + 62{,}925\,kN \cdot m + 36{,}916\,kN \cdot m$
$= 161{,}5914\,kN \cdot m$

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Perhitungan GPDD (kondisi 3)

GPD Positif

$P_3D_1 = y_1 \cdot P_3$
$= 0{,}5938 \cdot 22\ kN$
$= 13{,}0636\ kN$

$P_4D = \frac{y_1 \cdot (DB - x_1)}{DB} P_4$
$= \frac{0{,}5938 \cdot (9{,}5 - 2{,}5)}{9{,}5} 16\ kN$
$= 7{,}0006\ kN$

$P_5D = \frac{y_1 \cdot (DB - x_1 - x_2)}{DB} P_5$
$= \frac{0{,}5938 \cdot (9{,}5 - 2{,}5 - 2)}{9{,}5} 20\ kN$
$= 62{,}505\ kN$

GPD Negatif

$P_3D_2 = y_2 \cdot P_3$
$= -0{,}4062 \cdot 22\ kN$
$= -8{,}9364\ kN$

Perhitungan GPM (kondisi 3)

GPM Positif

$P_3M = y_1 \cdot P_3$
$= 3{,}8594\ m \cdot 22\ kN$
$= 84{,}9068\ kN.m$

$P_4M = \frac{y_1 \cdot (DB - x_1)}{DB} P_4$
$= \frac{3{,}8594\ m\ (9{,}5 - 2{,}5)}{9{,}5} 16\ kN$
$= 45{,}5003\ kN.m$

$P_5M = \frac{y_1 \cdot (DB - x_1 - x_2)}{DB} P_5$
$= \frac{3{,}8594\ m\ (9{,}5 - 2{,}5 - 2)}{9{,}5} 20\ kN$
$= 48{,}7503\ kN.m$

Perhitungan Lintang dan Momen Ekstrim (kondisi 3)

GPDD

Positif $= P_3D_1 + P_4D + P_5D$
$= 13{,}0636\ kN + 62{,}505\ kN + 7{,}0006\ kN$
$= 26{,}3147\ kN$

Negatif $= P_3D_2$
$= -8{,}9364\ kN$

GPMD

Positif $= P_3M + P_4M + P_5M$
$= 84{,}9068\ kN.m + 45{,}5003\ kN.m + 48{,}7503\ kN.m$
$= 179{,}1574\ kN.m$

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Momen Ekstrim dan Lintang Ekstrim di titik E

Perhitungan GPDE (kondisi 1)

GPD Positif

$P_5E_1 = y_1 \cdot P_5$

$= 0,3562 \cdot 20\,kN$

$= 7,124\,kN$

GPD Negatif

$P_5E_2 = y_2 \cdot P_5$

$= -0,6438 \cdot 20\,kN$

$= -12,876\,kN$

$P_1E = \frac{y_2 \cdot (AE - x_2)}{AE} P_1$

$= \frac{-0,6438 \cdot (10,3 - 2)}{10,3} \cdot 16\,kN$

$= -8,3006\,kN$

$P_3E = \frac{y_2 \cdot (AE - x_2 - x_1)}{AF} P_5$

$= \frac{-0,6438 \cdot (10,3 - 2,5\ 2,5)}{10,3} 20\,kN$

$= -7,2506\,kN$

Perhitungan GPM (kondisi 1)

GPM Positif

$P_5M = y_1 \cdot P_5$

$= 3,6691\,m \cdot 20\,kN$

$= 73,388\,kN.m$

$P_1M = \frac{y_1 \cdot (AE - x_2)}{AE} P_1$

$= \frac{3,6691\,m \cdot (10,3 - 2)}{10,3} 16\,kN$

$= 47,3103\,kN.m$

$P_3M = \frac{y_1 \cdot (AE - x_2 - x_1)}{AE} P_3$

$= \frac{3,6691m\ (10,3 - 2 - 2,5)}{10,3} 22\,kN$

$= 45,4578\,kN.m$

Perhitungan lintang dan Momen Ekstrim (kondisi 1)

GPDE

Positif = $P_5E_1 = 7,124\,kN$

Negatif = $P_5E_2 + P_1E + P_5E$

$= -12,876\,kN - 8,3006\,kN - 7,2506\,kN$

$= -28,4272\,kN$

GPME

Positif = $P_5M + P_1M + P_3M$

$= 73,388\,kN.m + 47,3103\,kN.m + 45,4578\,kN.m$

$= 166,1561\,kN\,m$

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Perhitungan GPDE (kondisi 2)

GPD Positif

$P_4E_1 = y_1 \cdot P_4$
$= 0{,}3562 \cdot 16\ kN$
$= 5{,}6992\ kN$

$P_5E = \frac{y_1 \cdot (EB - x_2)}{EB} P_5$
$= \frac{0{,}3562 \cdot (5{,}7 - 2)}{5{,}7} 20 kN$
$= 4{,}6249\ kN$

GPD Negatif

$P_4E_2 = y_2 \cdot P_4$
$= -0{,}6438 \cdot 16\ kN$
$= -10{,}3008\ kN$

$P_3E = \frac{y_2 \cdot (AE - x_1)}{AE} P_3$
$= \frac{-0{,}6438 \cdot (10{,}3 - 2{,}5)}{10{,}3} 22 kN$
$= -10{,}7258\ kN$

Perhitungan GPME (kondisi 2)

GPM Positif

$P_4M = y_1 \cdot P_4$
$= 3{,}6694m \cdot 16 kN$
$= 58{,}7104\ kN \cdot m$

$P_3M = \frac{y_1 \cdot (AE - x_1)}{AE} P_3$
$= \frac{3{,}6694m \cdot (10{,}3 - 2{,}5)}{10{,}3} 22 kN$
$= 61{,}1329\ kN \cdot m$

$P_5M = \frac{y_1 \cdot (EB - x_2)}{EB} P_5$
$= \frac{3{,}6694m \cdot (5{,}7 - 2)}{5{,}7} 20 kN$
$= 47{,}6378\ kN \cdot m$

Perhitungan lintang dan momen ekstrim (kondisi 2)

GPDE

Positif $= P_4E_1 + P_5E$
$= 5{,}6992\ kN + 4{,}6249\ kN$
$= 10{,}3236\ kN$

Negatif $= P_4E_2 + P_3E$
$= -10{,}3008\ kN - 10{,}7258\ kN$
$= 21{,}0266\ kN$

GPME

Positif $= P_4M + P_5M + P_3M$
$= 58{,}7104\ kN.m + 47{,}6378\ kN.m + 61{,}1329\ kN.m$
$= 167{,}4811\ kN.m$

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Perhitungan GPDE (kondisi 3)

GPD Positif

$P_3E_1 = y_1 . P_3$
$= 0{,}3562 . 22\,kN$
$= 7{,}8364\ kN$

$P_4E = \frac{y_1 . (EB - x_1)}{EB} P_4$
$= \frac{0{,}3562 . (5{,}7 - 2{,}15)}{5{,}7} 16\,kN$
$= 3{,}1996\ kN$

$P_5E = \frac{y_1 (EB - x_1 - x_2)}{EB} p_5$
$= \frac{0{,}3562 . (5{,}7 - 2{,}15 - 2)}{5{,}7} 20\,kN$
$= 1{,}6498\ kN$

GPD Negatif

$P_3E_2 = y_2 . P_3$
$= -0{,}6438 . 22\,kN$
$= -14{,}1636\ kN$

Perhitungan GPME (kondisi 3)

GPM Positif

$P_3E = y_1 . P_3$
$= 3{,}6694\,m . 22\,kN$
$= 80{,}7268\ kN.m$

$P_4E = \frac{y_1 . (EB - x_1)}{EB} P_4$
$= \frac{3{,}6694\,m . (5{,}7 - 2{,}15)}{5{,}7} 16\,kN$
$= 32{,}9602\ kN.m$

$P_5E = \frac{y_1 . (EB - x_1 - x_2)}{EB} P_5$
$= \frac{3{,}6694\,m . (5{,}7 - 2{,}15 - 2)}{5{,}7} 20\,kN$
$= 16{,}9951\ kN.m$

Perhitungan lintang dan momen ekstrim (kondisi 3)

GPDE

Positif $= P_3E_1 + P_4E + P_5E$
$= 7{,}8364\ kN + 3{,}1996\ kN + 1{,}6498\ kN$
$= 12{,}6858\ kN$

Negatif $= P_3E_2 = -14{,}1636\ kN$

GPME

Positif $= P_3E + P_4E + P_5E$
$= 80{,}7268\ kN.m + 32{,}9602\ kN.m + 16{,}9951\ kN.m$
$= 130{,}6821\ kN.m$

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Momen dan lintang Ekstrim di titik F

Perhitungan GPDE (kondisi 1)

GPD Positif

$P_5F_1 = y_1 \cdot P_5$
$= 0{,}1812 \cdot 20\,kN$
$= 3{,}624\,kN$

GPD Negatif

$P_5F_2 = y_2 \cdot P_5$
$= -0{,}8188 \cdot 20\,kN$
$= -16{,}376\,kN$

$P_4F = \frac{y_2 \cdot (AF - x_2)}{AF} P_4$
$= \frac{-0{,}8188 \cdot (13{,}1 - 2)}{13{,}1} 16\,kN$
$= -11{,}1007\,kN$

$P_3F = \frac{y_2 \cdot (AF - x_2 - x_1)}{AF} \cdot P_5$
$= \frac{0{,}8188 \cdot (13{,}1 - 2{,}5 - 2)}{13{,}1} 22\,kN$
$= -11{,}8257\,kN$

Perhitungan GPMF (kondisi 1)

GPM Positif

$P_5F = y_1 \cdot P_5$
$= 2{,}3744\,m \cdot 20\,kN$
$= 47{,}488\,kN.m$

$P_4F = \frac{y_1 \cdot (AF - x_2)}{AF} P_4$
$= \frac{2{,}3744m\,(13{,}1 - 2)}{13{,}1} 16\,kN$
$= 32{,}1903\,kN.m$

$P_3F = \frac{y_1\,(AF - x_2 - x_1)}{AF} P_5$
$= \frac{2{,}3744m\,(13{,}1 - 2 - 2{,}5)}{13{,}1} 22\,kN$
$= 39{,}7929\,kN.m$

Perhitungan lintang dan momen ekstrim (kondisi 1)

GPDF

Positif = $P_5F_1 = 3{,}624\,kN$

Negatif = $P_5F_1 + P_4F + P_3F$
$= -16{,}376\,kN - 11{,}1007\,kN - 11{,}8257\,kN$
$= 39{,}3024\,kN$

GPMF

Positif = $P_5F + P_4F + P_3F$
$= 47{,}488\,kN.m + 32{,}1903\,kN.m + 39{,}3024\,kN.m$
$= 118{,}9807\,kN.m$

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Perhitungan GPDF (kondisi 2)

GPD Positif

$P_5F_1 = y_1 \cdot P_4$
$= 0{,}1812 \cdot 16\ kN$
$= 2{,}8992\ kN$

$P_5F = \frac{y_1 \cdot (FB - x_2)}{FB} P_5$
$= \frac{0{,}1812 \cdot (2{,}9 - 2)}{2{,}9} 20\ kN$
$= 1{,}1247\ kN$

GPD Negatif

$P_4F_2 = y_2 \cdot P_4$
$= -0{,}8188 \cdot 16\ kN$
$= -13{,}1008\ kN$

$P_3F = \frac{y_2 \cdot (AF - x_1)}{AF} P_3$
$= \frac{-0{,}8188 \cdot (13{,}1 - 2{,}5)}{13{,}1} 22\ kN$
$= -14{,}5759\ kN$

Perhitungan GPMF (kondisi 2)

GPM Positif

$P_3M = y_1 \cdot P_4$
$= 2{,}3749\ m \cdot 16\ kN$
$= 37{,}9904\ kN \cdot m$

$P_3M = \frac{y_1 \cdot (AF - x_1)}{AF} P_3$
$= \frac{2{,}3749\ m \cdot (13{,}1 - 2{,}5)}{13{,}1} 22\ kN$
$= 42{,}2680\ kN \cdot m$

$P_5M = \frac{y_1 \cdot (FB - x_2)}{FB} P_5$
$= \frac{2{,}3749\ m \cdot (2{,}9 - 2)}{2{,}9} 20\ kN$
$= 14{,}7377\ kN \cdot m$

Perhitungan lintang dan momen Ets'm'm (kondisi 2)

GPDF

Positif $= P_4F_1 + P_5F$
$= 2{,}8992\ kN + 1{,}1247\ kN$
$= 4{,}0239\ kN$

Negatif $= P_4F_2 + P_3F$
$= -13{,}1008\ kN - 14{,}5759\ kN$
$= -27{,}6767\ kN$

GPMF

Positif $= P_4M + P_5M + P_3M$
$= 37{,}9904\ kN.m + 14{,}7377\ kN.m + 42{,}2680\ kN \cdot m$
$= 94{,}9961\ kN \cdot m$

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Perhitungan GPDF (kondisi 3)

GPD Positif

$P_{3F1} = y_1 \cdot P_3$
$= 0{,}1812 \cdot 22\,kN$
$= 3{,}9864\,kN$

$P_{4F} = \frac{y_1 \cdot (FB - x_1)}{FB} P_4$
$= \frac{0{,}1812 \cdot (2{,}9 - 2{,}5)}{2{,}9} \cdot 16\,kN$
$= 0{,}3999\,kN$

GPD Negatif

$P_{3F2} = y_2 \cdot P_3$
$= -0{,}8188 \cdot 22\,kN$
$= -18{,}0136\,kN$

Perhitungan GPMF (kondisi 3)

GPD Positif

$P_{3F} = y_1 \cdot P_3$
$= 2{,}3744\,m \cdot 22\,kN$
$= 52{,}2368\,kN.m$

$P_{4F} = \frac{y_1 \cdot (FB - x_1)}{FB} P_4$
$= \frac{2{,}3744\,m \cdot (2{,}9 - 2{,}5)}{2{,}9} 16\,kN$
$= 5{,}2401\,kN.m$

GPD Negatif

$P_{5F} = \frac{y_1 \cdot (FB - x_1 - x_2)}{FB} P_5$
$= \frac{2{,}3744\,m \cdot (2{,}9 - 2{,}5 - 2)}{2{,}9} 20\,kN$
$= -26{,}2003\,kN.m$

Perhitungan lintang dan momen ekstrim (kondisi 3)

GPDF

Positif = $P_{3F1} + P_{4F}$
$= 3{,}9864\,kN + 0{,}3999\,kN$
$= 4{,}3863\,kN$

Negatif = $P_{3F2} = -18{,}0136\,kN$

GPMF

Positif = $P_{3F} + P_{4F}$
$= 52{,}2368\,kN.m + 5{,}2401\,kN.m$
$= 57{,}4769\,kN.m$

Negatif = $P_{5F} = -26{,}2003\,kN.m$

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Gambar Perhitungan Ekstrim Ekstrim dan Lintang Ekstrim di Titik D

GPDQ

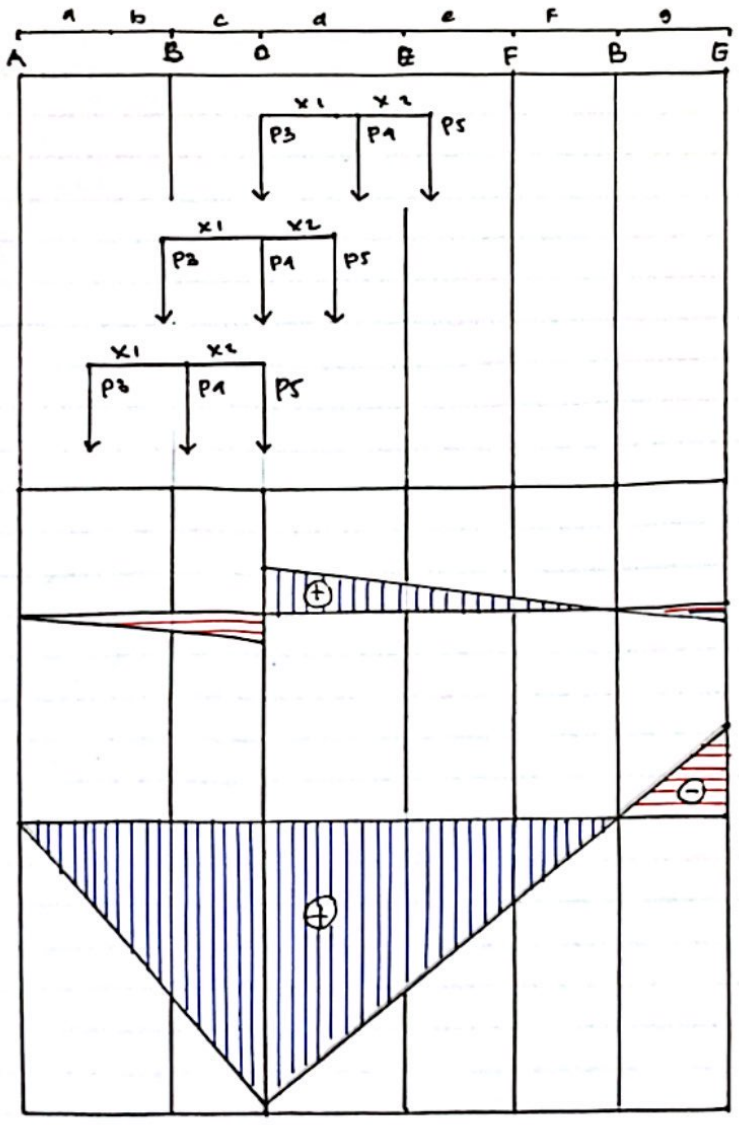
(+) kondisi 1 = 11,876 kN
kondisi 2 = 18,8766 kN
kondisi 3 = 26,3147 kN

(-) kondisi 1 = -15,3725 kN
kondisi 2 = -11,9985 kN
kondisi 3 = -8,9364 kN

GPMD

(+) kondisi 1 = 196,0635 kN.m
kondisi 2 = 161,5914 kN.m
kondisi 3 = 179,1574 kN.m

Lintang positif (Dmax) terjadi di kondisi 3 sebesar 26,3147 kN
Lintang Negatif (Dmin) terjadi pada kondisi 1 sebesar -15,3725 kN
Momen positif (MD max) terjadi pada kondisi 3 sebesar 179,1574 kN.m



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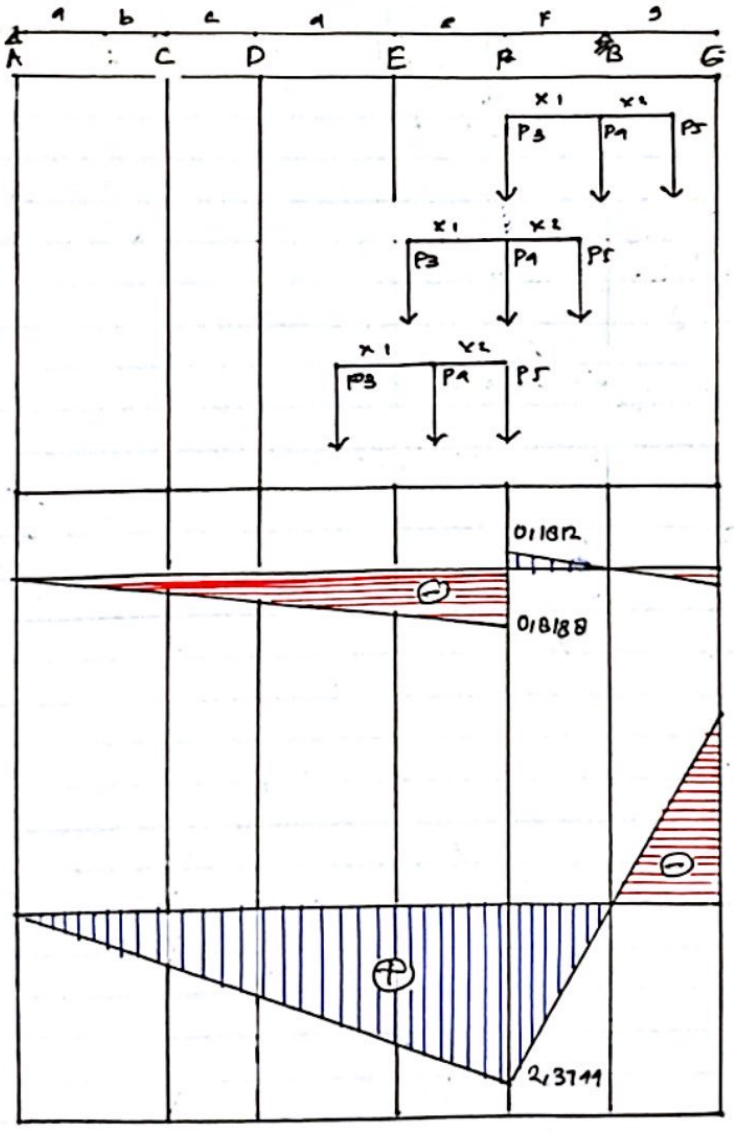
Gambar perhitungan Lintang Ekstrim dan Momen Ekstrim di titik F

GPDF
(+) kondisi 1 = 3,624 kN
kondisi 2 = 1,0239 kN
kondisi 3 = 1,3863 kN
(-) kondisi 1 = -39,3024 kN
kondisi 2 = -27,6767 kN
kondisi 3 = -18,0136 kN

GPMF
(+) kondisi 1 = 118,9807 kN.m
kondisi 2 = 91,9961 kN.m
kondisi 3 = 57,1769 kN.m
(-) kondisi 3 = -26,2003 kN.m

Lintang positif (DFmax) terjadi pada kondisi 3 sebesar 1,3863 kN
Lintang Negatif (DFmin) terjadi pada kondisi 1 sebesar -39,3024 kN
Momen positif (DFmax) terjadi pada kondisi 1 sebesar 118,9807 kN.m



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Gambar perhitungan Lintang Ekstrim dan Momen Ekstrim di titik E

GPDE

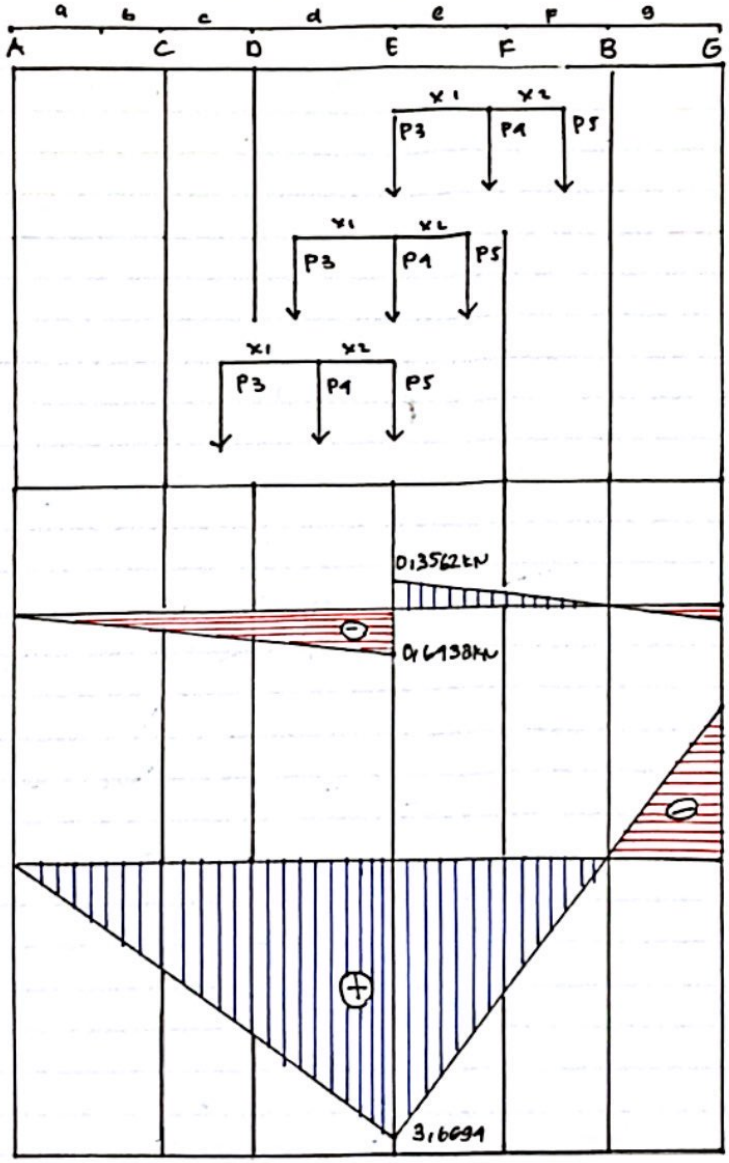
(+) kondisi 1 = 7,124 kN
kondisi 2 = 10,3236 kN
kondisi 3 = 12,6858 kN

(-) kondisi 1 = -28,4272 kN
kondisi 2 = -21,0266 kN
kondisi 3 = -14,1636 kN

GPME

(+) kondisi 1 = 166,1561 kN.m
kondisi 2 = 167,4811 kN.m
kondisi 3 = 130,6821 kN.m

Lintang positif (DEmax) terjadi kondisi 3 sebesar 12,6858 kN
Lintang negatif (DEmax) terjadi pada kondisi 1 sebesar -28,4272 kN
Momen positif (MEmax) terjadi pada kondisi 2 sebesar 167,4811 kN.m



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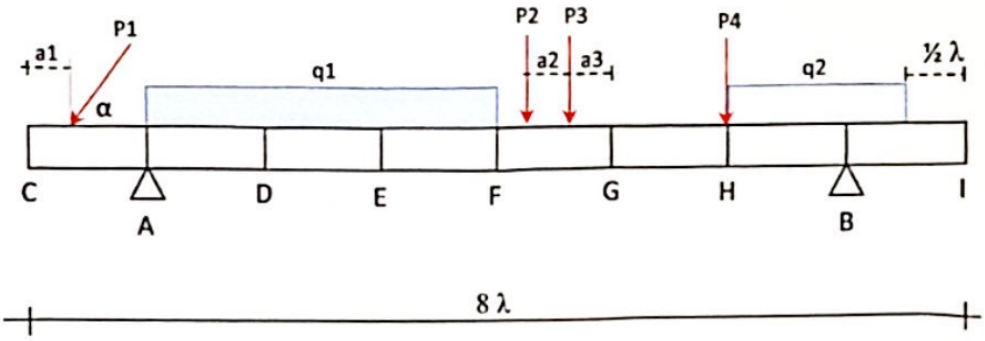
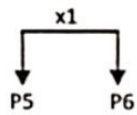
NAMA : ALYA WAFIQ FADHILAH
NPM : 2315011058

SOAL NO. 2

Diketahui struktur *simple beam* dengan beban tak langsung seperti tergambar.



Data-data sebagai berikut:

Perletakan		Beban		Jarak		Beban berjalan	
A	Rol	q_1	1,1 kN/m'	λ	3,3 m	P_5	3,7 kN
B	Sendi	q_2	2,2 kN/m'	a_1	1,6 m	P_6	5,5 kN
		P_1	3,9 kN	a_2	2,1 m		
		P_2	3,7 kN	a_3	1 m		
		P_3	2,7 kN	Sudut α	32 °		
		P_4	3,1 kN				
						x_1	1 m

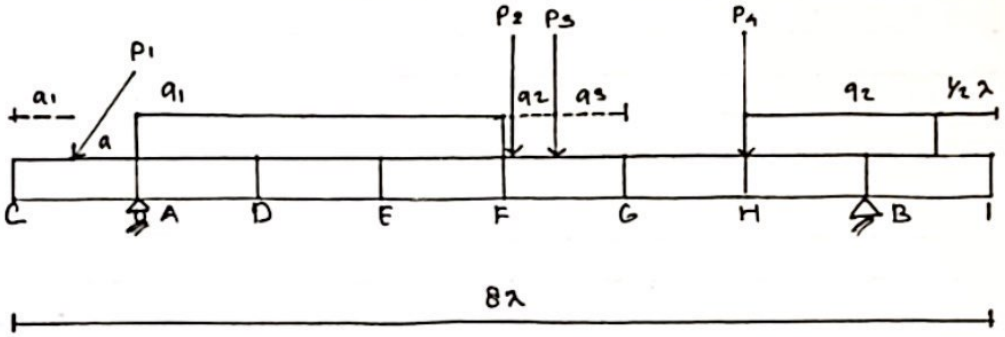
Pertanyaan:

a. Hitung dan gambarkan bidang momen, lintang dan normal secara analitis akibat beban yang bekerja (seperti tergambar).
b. Hitung dan gambar garis pengaruh momen dan lintang akibat beban jika P = 1 kN bergerak dari tumpuan A ke B pada potongan/titik F, G, dan 0,7 m ke kanan dari titik H
c. Hitung besar momen ekstrim dan lintang ekstrim pada point (b) akibat rangkaian beban berjalan (P5, P6) dari A ke B.

Asisten Responsi,

ANANG MA'RUF
NPM. 2115011122

1. Diketahui struktur simple beam dengan beban tak langsung seperti tergambar



Data-data sebagai berikut

Perletakan		Beban		Jarak		Beban Jalan	
A	Rol	q_1	1,1 kN/m	λ	3,3 m	P_5	kN
B	sendi	q_2	2,2 kN/m	a_1	1,6 m	P_6	kN
		P_1	3,9 kN	a_2	2,1 m	x1	
		P_2	3,7 kN	a_3	1 m		
		P_3	2,7 kN	α	32°		
		P_4	3,1 kN				
						x_1	m

Pertanyaan:

a. Hitunglah dan gambarkan bidang momen, lintang dan normal secara analitis akibat beban yang bekerja (seperti tergambar).

$P_{1V} = P_1 \cdot \sin 32°$
$= 3,9\ kN \cdot \sin 32°$
$= 2,0667\ kN$

$P_{1H} = P_1 \cdot \cos 32°$
$= 3,9\ kN \cdot \cos 32°$
$= 3,3074\ kN$

$Q_1 = q_1 \cdot (3\lambda)$
$= 1,1\ kN/m\ (3 \cdot 3,3\ m)$
$= 1,1\ kN/m \cdot 9,9\ m$
$= 10,89\ kN$

$Q_2 = q_2 \cdot (1,5\lambda)$
$= 2,2\ kN/m \cdot (1,5 \cdot 3,3\ m)$
$= 2,2\ kN/m \cdot 4,95\ m$
$= 10,89\ kN$

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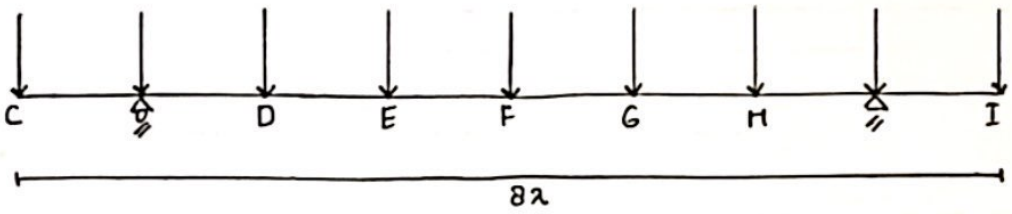
Gambar Distribusi Beban



Distribusi Beban

$$P_C = P_{IV} \cdot \frac{\lambda - q_1}{\lambda} = 2{,}0667\ kN \cdot \frac{3{,}3m - 1{,}6m}{3{,}3m} = 1{,}0647\ kN$$

$$P_A = \frac{q_1}{\lambda} P_{IV} + \frac{\lambda \cdot q_1}{2} = \frac{1{,}6m}{3{,}3m} \cdot 2{,}0667\ kN + \frac{3{,}3m \cdot 1{,}1\ kN/m}{2}$$
$$= 2{,}817\ kN$$

$$P_D = \frac{q_1 \cdot \lambda}{2} \cdot 2 = \frac{1{,}1\ kN/m \cdot 3{,}3m}{2} \cdot 2 = 3{,}63\ kN$$

$$P_E = \frac{q_1 \cdot \lambda}{2} \cdot 2 = \frac{1{,}1\ kN/m \cdot 3{,}3m}{2} \cdot 2 = 3{,}63\ kN$$

$$P_F = \frac{q_1 \cdot \lambda}{2} + \frac{P_2 \cdot (q_2 + q_3)}{\lambda} + \frac{P_3 \cdot q_3}{\lambda}$$
$$= \frac{1{,}1\ kN/m \cdot 3{,}3m}{2} + \frac{3{,}7\ kN \cdot (2{,}1 + 1)m}{3{,}3m} + \frac{2{,}7\ kN \cdot 1m}{3{,}3m}$$
$$= 6{,}1089\ kN$$

$$P_H = P_4 + \frac{q_2 \cdot \lambda}{2} = 3{,}1\ kN + \frac{2{,}2\ kN/m \cdot 3{,}3m}{2} = 6{,}73\ kN$$

$$P_B = \frac{q_2 \cdot \lambda}{2} + \frac{3}{4}\left(\frac{q_2 \cdot \lambda}{2}\right) = \frac{2{,}2\ kN/m \cdot 3{,}3m}{2} + \frac{3}{4}\left(\frac{2{,}2\ kN/m \cdot 3{,}3m}{2}\right)$$
$$= 6{,}3525\ kN$$

$$P_I = \frac{1}{4} \frac{q_2 \cdot \lambda}{2} = \frac{1}{4} \cdot \frac{2{,}2\ kN/m \cdot 3{,}3m}{2} = 0{,}9075\ kN$$

$$P_G = \frac{P_2 \cdot (\lambda - a_2 - a_3)}{\lambda} + \frac{P_3 \cdot (\lambda - a_3)}{\lambda}$$
$$= \frac{3{,}7\ kN\ (3{,}3 - 2{,}1 - 1)m}{3{,}3m} + \frac{2{,}7\ kN \cdot (3{,}3 - 1)m}{3{,}3m}$$
$$= 2{,}1061\ kN$$

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Checking Distribusi Beban

$\Sigma P_A = \Sigma P_B$

$\Sigma P_A - \Sigma P_B = 0$

$P_{IV} + Q_1 + P_2 + P_3 + P_4 - Q_2 - P_A + P_B - P_C - P_D - P_E - P_F - P_G - P_H - P_I = 0$

$2{,}0667\ kN + 10{,}89\ kN + 3{,}7\ kN + 2{,}7\ kN + 3{,}1\ kN + 10{,}89\ kN - 2{,}817\ kN - 6{,}3525\ kN - 1{,}0647\ kN - 3{,}63\ kN - 3{,}63\ kN - 2{,}1061\ kN - 6{,}73\ kN - 0{,}9075\ kN - 6{,}1089 = 0$

$33{,}3467 - 33{,}3467 = 0$

$0 = 0$ (OK!!!)

Reaksi Peletakan

$\Sigma M_B = 0$

$R_{AV}(6 \cdot \lambda) - P_C(7 \cdot \lambda) - P_A(6 \cdot \lambda) - P_D(5 \cdot \lambda) - P_E(4 \cdot \lambda) - P_F(3 \cdot \lambda) - P_G(2 \cdot \lambda) - P_H \cdot (\lambda) + P_I(\lambda) = 0$

$R_{AV} \cdot (6{,}3{,}3)m - 1{,}0647\ kN(7 \cdot 3{,}3)m - 2{,}817\ kN(6{,}3{,}3)m - 3{,}63\ kN(5 \cdot 3{,}3)m - 3{,}63\ kN(4 \cdot 3{,}3)m - 6{,}1089\ kN(3 \cdot 3{,}3)m - 2{,}1061\ kN(2 \cdot 3{,}3)m - 6{,}73\ kN(3{,}3)m + 0{,}9075\ kN(3{,}3)m = 0$

$R_{AV} \cdot 19{,}8m - 21{,}5946\ kN \cdot m - 55{,}7766\ kN \cdot m - 59{,}895\ kN \cdot m - 47{,}916\ kN \cdot m - 60{,}4781\ kN \cdot m - 13{,}9003\ kN \cdot m - 22 \cdot 209\ kN \cdot m + 2{,}9946\ kN \cdot m = 0$

$R_{AV} \cdot 19{,}8m = 281{,}775\ kN \cdot m$

$R_{AV} = 14{,}2311\ kN$

$\Sigma M_A = 0$

$-R_{BV}(6\lambda) + P_I(7\lambda) + P_B(6\lambda) + P_H(5\lambda) + P_G(4\lambda) + P_F(3\lambda) + P_E(2\lambda) + P_D(\lambda) - P_C(\lambda) = 0$

$-R_{BV}(6{,}3{,}3)m + 0{,}9075\ kN(7 \cdot 3{,}3)m + 6{,}3525\ kN(6 \cdot 3{,}3)m + 6{,}73\ kN(5 \cdot 3{,}3)m + 2{,}1061\ kN(4 \cdot 3{,}3)m + 6{,}1089\ kN(3 \cdot 3{,}3)m + 3{,}63\ kN(2 \cdot 3{,}3)m + 3{,}63\ kN(3{,}3)m - 1{,}0647\ kN \cdot 3{,}3m = 0$

$-R_{BV} \cdot 19{,}8m + 20{,}9633\ kN \cdot m + 125{,}7795\ kN \cdot m + 111{,}045\ kN \cdot m + 27{,}8005\ kN \cdot m + 60{,}4781\ kN \cdot m + 23{,}958\ kN \cdot m + 11{,}979\ kN \cdot m - 3{,}5135\ kN \cdot m = 0$

$-R_{BV} \cdot 19{,}8m = -378{,}4899\ kN \cdot m$

$R_{BV} = 19{,}1156\ kN$

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Checking Reaksi Peletakan

$\Sigma V = 0$

$R_{AV} + R_{BV} - P_C - P_A - P_D - P_E - P_F - P_G - P_H - P_B - P_I = 0$

$14,2311\ kN + 19,1156\ kN - 1,0647\ kN - 2,817\ kN - 3,163\ kN - 3163\ kN - 6,1089\ kN - 2,1061\ kN - 6,173\ kN - 6,3525\ kN - 0,9075\ kN = 0$

$33,3467kN - 33,3467\ kN = 0$

$0 = 0$ (ok!!!)

Bidang Normal

$\Sigma H = 0$

$R_{BH} - P_{IH} = 0$

$R_{BH} = P_{IH}$

$R_{BH} = 3,3074\ kN\ (\rightarrow)$ (tarik)

Bidang lintang

$D_C = -P_C = -1,0647\ kN$

$D_A = D_C - P_A + R_{AV}$

$= -1,0647\ kN - 2,817\ kN + 14,2311\ kN$

$= 10,3494\ kN$

$D_D = D_A - P_D$

$= 10,3494\ kN - 3,163\ kN$

$= 6,7194\ kN$

$D_E = D_D - P_E$

$= 6,7194\ kN - 3,163\ kN$

$= 3,0894\ kN$

$D_F = D_E - P_F$

$= 3,0894\ kN - 6,1089\ kN$

$= -3,0195\ kN$

$D_G = D_F - P_G$

$= -3,0195\ kN - 2,1061\ kN$

$= -5,1256\ kN$

$D_H = D_G - P_H$

$= -5,1256\ kN - 6,173\ kN$

$= -11,8556\ kN$

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$D_B = D_H - P_3 + R_{BV}$
$= -11,8556\ kN - 6,3525\ kN + 19,1156\ kN$
$= 0,9075\ kN$

$D_I = D_B - P_J$
$= 0,9075\ kN - 0,9075\ kN$
$= 0\ kN$

Bidang Momen

$M_C = M_I = 0\ kN.m$

$M_A = -P_C(\lambda) = -1,0647\ kN\ (3,3)m = -3,5135\ kN.m$

$M_D = -P_C(2\lambda) - P_A(\lambda) + R_{AV}(\lambda)$
$= -1,0647\ kN.\ (2.3,3)m - 2,817\ kN(3,3)m + 14,2311\ kN.$
$(3,3)m$
$= 30,6395\ kN.m$

$M_E = -P_C(3\lambda) - P_A(2\lambda) + R_{AV}(2\lambda) - P_D(\lambda)$
$= -1,0647\ kN.\ (3.3,3)m - 2,817\ kN(2.3,3)m + 14,2311\ kN$
$(2.3,3)m - 3,63\ kN.\ (3,3)m$
$= 52,8135\ kN.m$

$M_F = -P_C(4\lambda) - P_A(3\lambda) + R_{AV}(3\lambda) - P_D(2\lambda) - P_E(\lambda)$
$= -1,0647\ kN.\ (4.3,3)m - 2,817\ kN.\ (3.3,3)m + 14,2311\ kN$
$(3.3,3)m - 3,63\ kN(2.3,3)m - 3,63\ kN\ (3,3)m$
$= 63,0086\ kN.m$

$M_G = -P_C(5\lambda) - P_A(4\lambda) + R_{AV}(4\lambda) - P_D(3\lambda) - P_E(2\lambda) - P_F(\lambda)$
$= -1,0647\ kN.\ (5.3,3)m - 2,817\ kN.\ (4.3,3)m + 14,2311\ kN$
$(4.3,3)m - 3,63\ kN(3.3,3)m - 3,63\ kN\ (2.3,3)m -$
$6,1089\ kN.\ (3,3)m$
$= 53,0442\ kN.m$

$M_H = -P_I(2\lambda) + R_{BV}(\lambda) - P_B(\lambda)$
$= -0,9025\ kN\ (2.3,3)m + 19,1156\ kN.(3,3)m - 6,3525\ kN$
$(3,3)m$
$= 36,1617\ kN.m$

$M_B = -P_I(\lambda)$
$= -0,9025\ kN.\ (3,3)m$
$= -2,9948\ kN.m$

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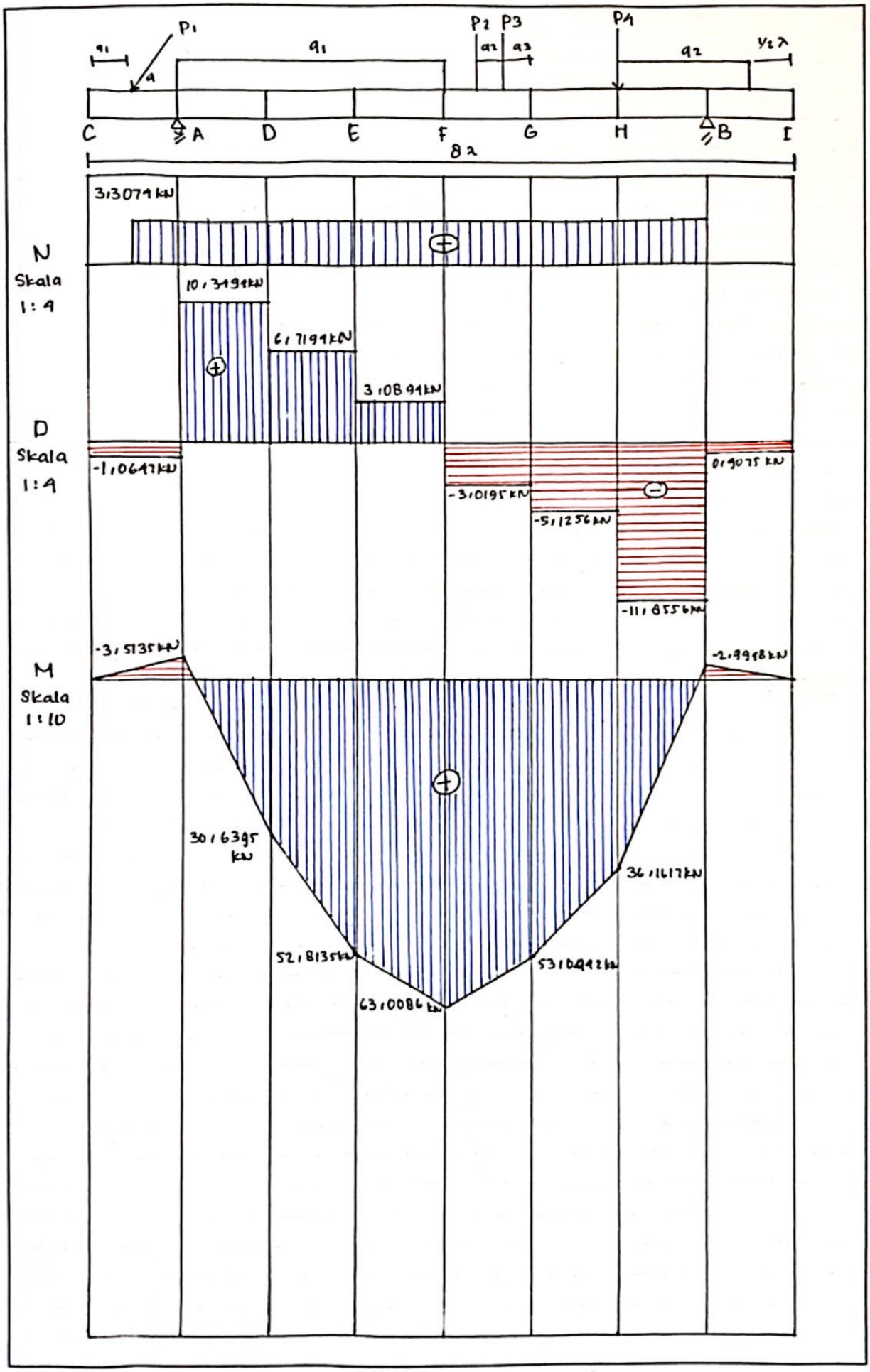

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2B. Gans pengaruh lintang dan momen akibat beban jika P = 1 kN bergerak dari tumpuan A ke B pada potongan / titik F, G, dan 0,7 m ke kanan dari titik H.

ö' Gans pengaruh lintang di titik F.

- y Positif

$$D_F = 1 - \frac{AF}{AB}$$
$$= 1 - \frac{9,9}{19,8}$$
$$= 1 - 0,5$$
$$= 0,5$$

- y Negatif

$$D_f = -\frac{AF}{AB}$$
$$= -\frac{9,9}{19,8}$$
$$= -0,5$$

ö' Gans pengaruh momen di titik F.

$$M_F = \frac{(AB - AF)}{AB} AF = \frac{(19,8 - 9,9)}{19,8} 9,9 = \frac{98,01}{19,8} = 4,95 \text{ kNm}$$

- Momen negatif

$$-M_C = \frac{-(AB - AF)}{AB} AC = -\frac{(19,8 - 9,9)}{19,8} 3,3 = -\frac{32,67}{19,8} = -1,65 \text{ kNm}$$

$$-M_I = -\frac{(AF)(BI)}{AB} = -\frac{(9,9)(3,3)}{19,8} = -\frac{32,67}{19,8} = -1,65 \text{ kNm}$$

ö' Gans pengaruh lintang di titik G

- y Positif

$$D_G = 1 - \frac{AG}{AB}$$
$$= 1 - \frac{13,2}{19,8}$$
$$= 1 - 0,6667$$
$$= 0,3333 \text{ kN}$$

- y Negatif

$$D_G = -\frac{AG}{AB}$$
$$= -\frac{13,2}{19,8}$$
$$= -0,6667 \text{ kN}$$

ö' Gans pengaruh momen di titik G

$$M_G = \frac{(AB - AG)}{AB} AG = \frac{(19,8 - 13,2)}{19,8} 13,2 = \frac{87,12}{19,8} = 4,4 \text{ kN.m}$$

- Momen negatif

$$-M_C = -\frac{(AB - AG)}{AB} AC = -\frac{(19,8 - 13,2)}{19,8} 3,3 = -\frac{21,78}{19,8} = -1,1 \text{ kNm}$$

$$-M_I = -\frac{(AG)(BI)}{AB} = -\frac{(13,2)(3,3)}{19,8} = -\frac{43,56}{19,8} = -2,2 \text{ kNm}$$

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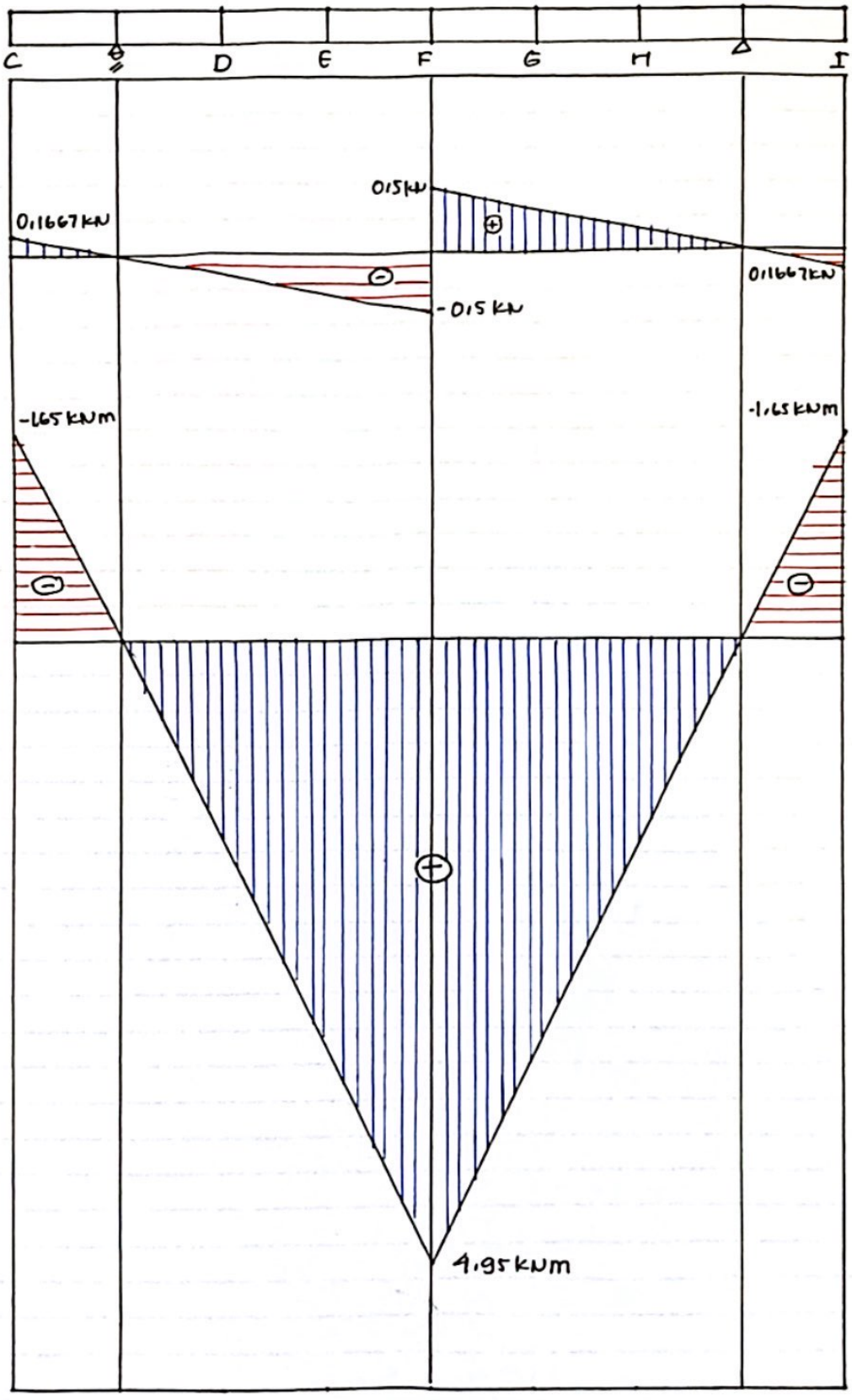
Titik F

Skala jarak 1 : 2

Bid. Lintang 2 : 1 kN

Bid. Momen 2 : 1 kN



ALYA WAFIQ FADHILAH
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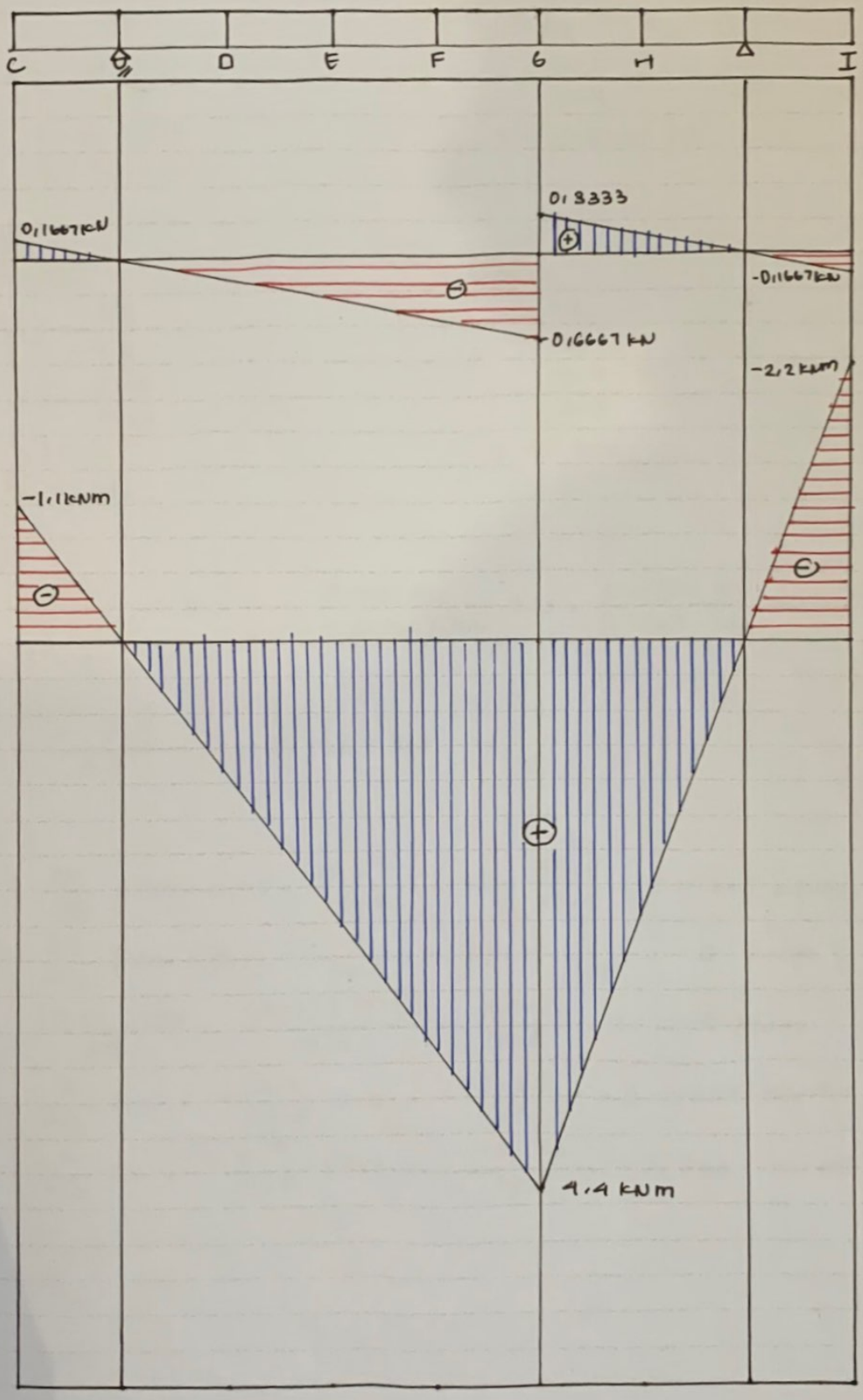
Titik G

Skala jarak 1 : 2

bid. Lintang 2 : 1

bid. momen 2 : 1



ALYA WAFIQ FADHILAH
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ö Gans pengaruh lintang dan momen di titik antara H - B 0,7 dari H

- GPDH

y Positif

$DH = 1 - \frac{AH}{AB}$

$= 1 - \frac{16,5}{19,8}$

$= 1 - 0,8333$

$= 0,1667$ kN

- y Negatif

$DH = -\frac{AH}{AB}$

$= -\frac{16,5}{19,8}$

$= -0,8333$ kN

- GPDB

y Positif

$DB = 1 - \frac{AB}{AB}$

$= 1 - \frac{19,8}{19,8}$

$= 1 - 1$

$= 0$ kN

- y Negatif

$DB = -\frac{AB}{AB}$

$= -\frac{19,8}{19,8}$

$= -1$ kN

- GPDx

$P = \frac{DH}{DB + DH} \cdot \lambda = \frac{0,1667 \text{ kN}}{0 \text{ kN} + 0,1667 \text{ kN}} 3,3 = \frac{0,5501 \text{ kN}}{0,1667 \text{ kN}}$

$= 3,3$ m dari H

$Dx = \frac{-0}{3,3} = -0,1667$ kN

- GPM

$MH = \frac{AH}{AB}(BH - 0,7) = \frac{16,5}{19,8}(2,6) = \frac{42,9}{19,8} = 2,1667$ kNm

$MB = \frac{BB}{AB}(AH + 0,7) = \frac{0}{19,8}(17,2) = \frac{0}{19,8} = 0$ kNm

$Mx = \frac{(Bx)(Ax)}{AB} = \frac{(2,6)(17,2)}{19,8} = \frac{44,72}{19,8} = 2,2586$ kNm

$Mc = \frac{-\lambda}{AB} Bx = -\frac{3,3}{19,8} 2,6 = -\frac{8,58}{19,8} = -0,4333$ kNm

$MI = \frac{-\lambda}{AB} Ax = -\frac{3,3}{19,8} 17,2 = -\frac{56,76}{19,8} = -2,8667$ kNm

ALYA WAFIQ FADHILAH
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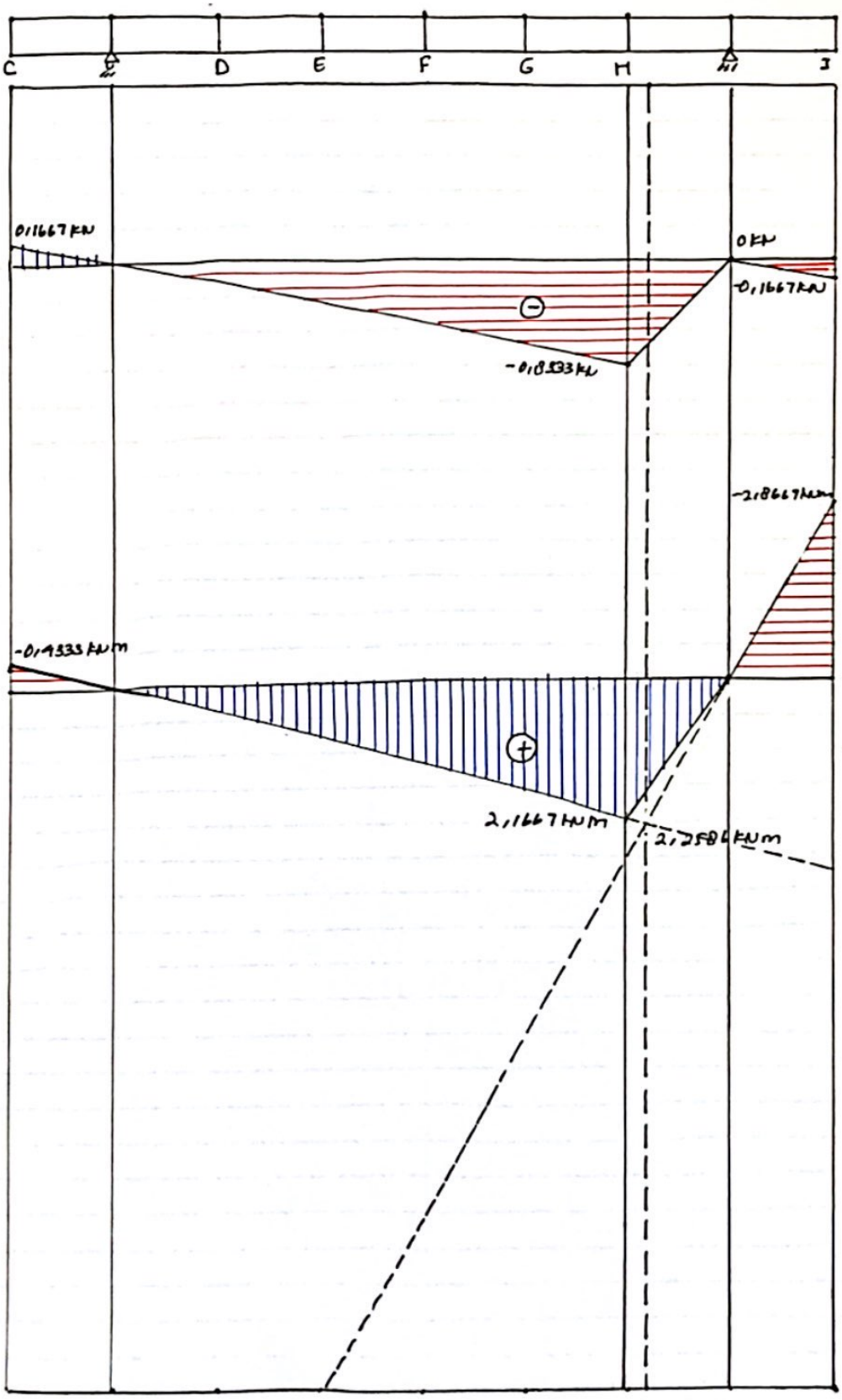
GP Lintang dan momen diantara H - B 0,7 dari H

Skala jarak 1 : 2

Bid. Lintang 2 : 1

Bid. Momen 1 : 1



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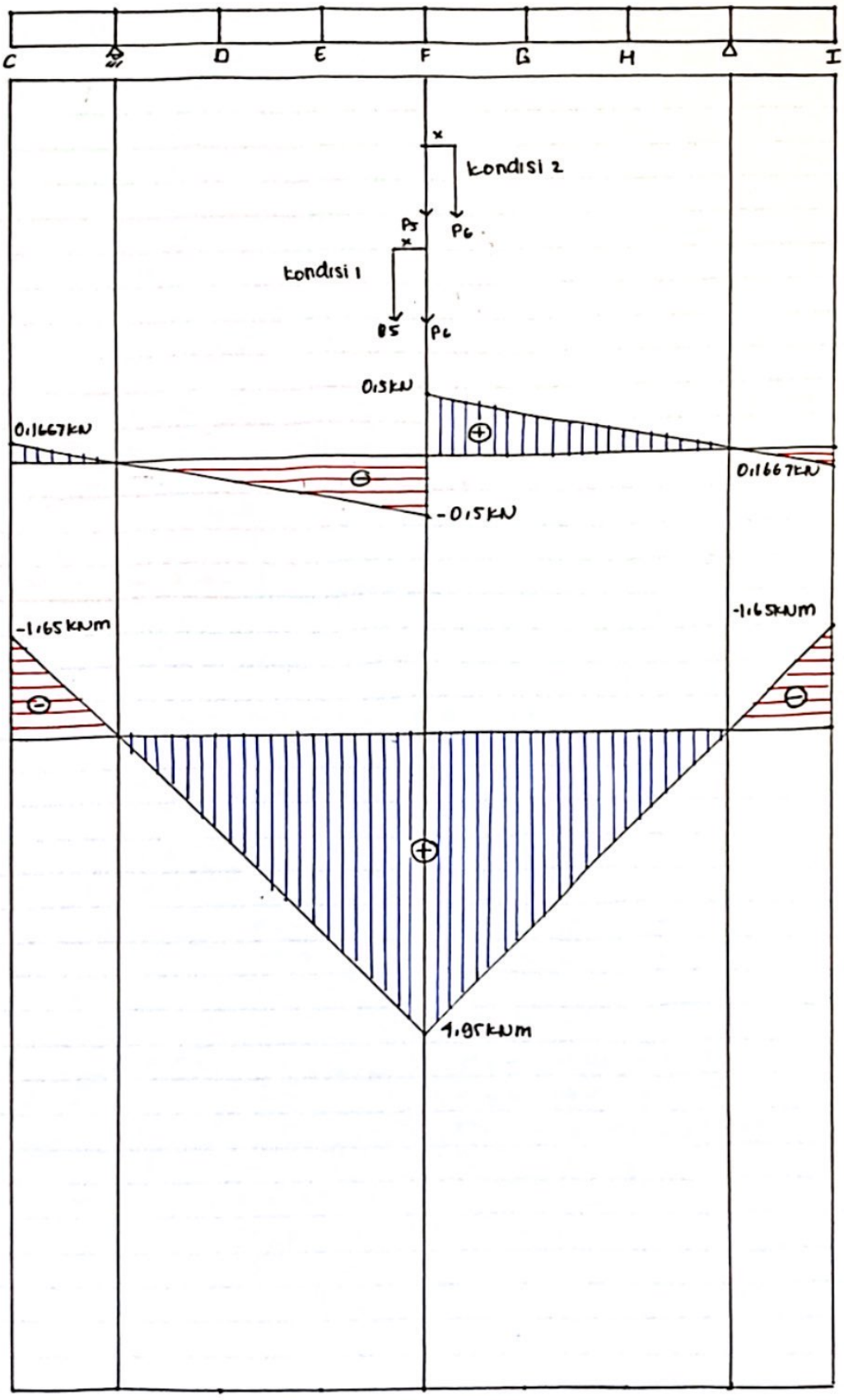
Lintang ekstrim dan momen ekstrim di titik F

Skala jarak 1 : 2

bid. lintang 2 : 1

bid. momen 1 : 1



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2C

Lintang ekstrim positif di titik F

· kondisi 2

$y_1 = \frac{AB - AF}{AB} = \frac{19{,}8 - 9{,}9}{19{,}8} = 0{,}5$ kN

$y_2 = \frac{AB - (AF + x)}{AB} = \frac{19{,}8 - 10{,}9}{19{,}8} = 0{,}4495$ kN

Lintang 1 = 0,5 . 3,7 = 1,85 kN

Lintang 2 = 0,4495 . 5,5 = 2,4723 kN

Lintang = 1,85 + 2,4723

= 4,3223 kN

· kondisi 1

$y_1 = \frac{AF - x}{AB} = \frac{9{,}9 - 1}{19{,}8} = 0{,}4495$ kN

$y_2 = \frac{AB - AF}{AB} = \frac{19{,}8 - 9{,}9}{19{,}8} = 0{,}5$ kN

Lintang 1 = 0,4495 . 3,7 = 1,6632 kN

Lintang 2 = 0,5 . 5,5 = 2,75 kN

Lintang = 1,6632 + 2,75

= 4,4132 kN

Lintang ekstrim positif di titik F = 4,4132 kN

Lintang ekstrim negatif di titik F

· kondisi 2

$y_1 = \frac{-AF}{AB} = \frac{-9{,}9}{19{,}8} = -0{,}5$ kN

$y_2 = \frac{AB - (AF + x)}{AB} = \frac{19{,}8 - 10{,}9}{19{,}8} = 0{,}4495$ kN

Lintang 1 : -0,5 . 3,7 = -1,85 kN

Lintang 2 : 0,4495 . 5,5 = 2,4723 kN

Lintang : -1,85 + 2,4723

: 0,6223 kN

· kondisi 1

$y_1 = \frac{-(AF - x)}{AB} = \frac{-(9{,}9 - 1)}{19{,}8} = -0{,}4495$ kN

$y_2 = \frac{-AF}{AB} = \frac{-9{,}9}{19{,}8} = -0{,}5$ kN

Lintang 1 : -0,4495 . 3,7 = -1,6632 kN

Lintang 2 : -0,5 . 5,5 = -2,75 kN

Lintang : -1,6632 - 2,75

: -4,4132 kN

Lintang ekstrim negatif di titik F = -4,4132 kN

Momen ekstrim di titik F

· kondisi 2

$y_1 = \frac{AF}{AB} BF = \frac{9{,}9}{19{,}8} 9{,}9 = 4{,}95$ m

$y_2 = \frac{AB - (AF + x)}{AB} AF = \frac{19{,}8 - 10{,}9}{19{,}8} 9{,}9$

$= 4{,}45$ m

Momen 1 : 4,95 . 3,7 = 18,315 kNm

Momen 2 : 4,4501 . 5,5 = 24,475 kNm

Momen : 18,315 + 24,475

: 42,79 kNm

· kondisi 1

$y_1 = \frac{(AF - 1)}{AB} BF = \frac{9{,}9 - 1}{19{,}8} 9{,}9 = 4{,}45$m

$y_2 = \frac{AF}{AB} BF = \frac{9{,}9}{19{,}8} 9{,}9 = 4{,}95$m

Momen 1 : 4,45 . 3,7 = 16,465 kN.m

Momen 2 : 4,95 . 5,5 = 27,225 kN.m

Momen : 16,465 + 27,225

: 43,69 kNm

Momen ekstrim di titik F = 43,69 kNm

ALYA WAFIQ FADHILAH
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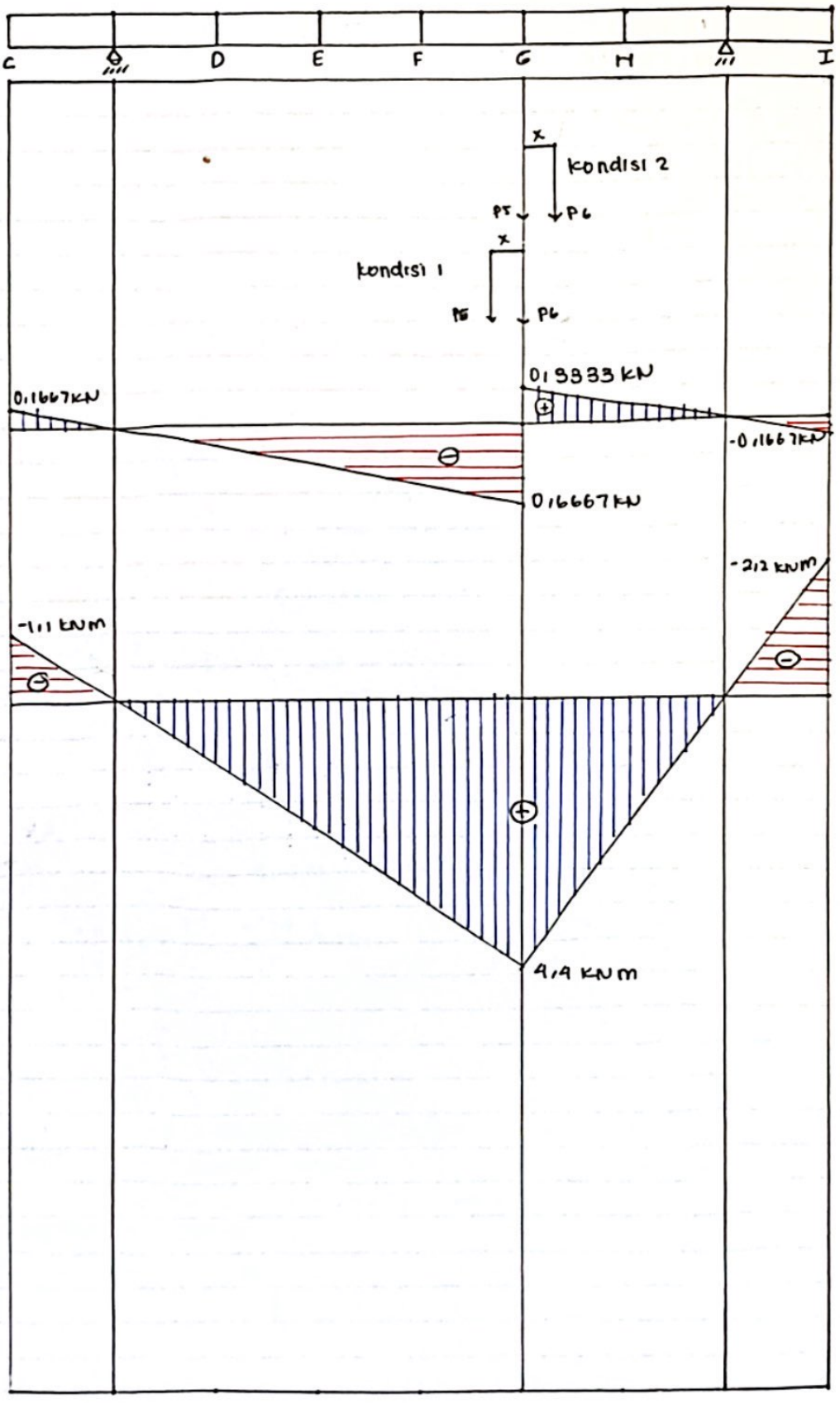
Lintang ekstrim dan momen ekstrim di titik G

Skala jarak 1:1

bid. lintang 2:1

bid. momen 1:1



ALYA WAFIQ FADHILAH
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Lintang ekstrim positif di titik G

· kondisi 2

$y_1 = \frac{AB - AG}{AB} \cdot \frac{19{,}8 - 13{,}2}{19{,}8} = 0{,}3333$ kN

$y_2 = \frac{AB - (AG + x)}{AB} \cdot \frac{19{,}8 - 14{,}2}{19{,}8} = 0{,}2828$ kN

Lintang 1 : 0,3333 . 3,7 = 1,2332 kN
Lintang 2 : 0,2828 . 5,5 = 1,5554 kN
Lintang : 1,2332 + 1,5554
: 2,7886 kN

· kondisi 1

$y_1 = \frac{AG - x}{AB} = \frac{13{,}2 - 1}{19{,}8} = 0{,}6161$ kN

$y_2 = \frac{AB - AG}{AB} = \frac{19{,}8 - 13{,}2}{19{,}8} = 0{,}3333$ kN

Lintang 1 : 0,6161 . 3,7 = 2,2796 kN
Lintang 2 : 0,3333 . 5,5 = 1,8332 kN
Lintang : 2,2796 + 1,8332
: 4,1128 kN

Lintang ekstrim positif di titik G = 4,1128 kN

Lintang ekstrim negatif di titik G

· kondisi 2

$y_1 = -\frac{AG}{AB} = -\frac{13{,}2}{19{,}8} = -0{,}6667$ kN

$y_2 = \frac{AB - (AG + x)}{AB} = \frac{19{,}8 - 14{,}2}{19{,}8} = 0{,}2828$ kN

Lintang 1 : -0,6667 . 3,7 = -2,4668 kN
Lintang 2 : 0,2828 . 5,5 = 1,5554 kN
Lintang : -2,4668 + 1,5554
: -0,9114 kN

· kondisi 1

$y_1 = \frac{-(AG - x)}{AB} = \frac{-(13{,}2 - 1)}{19{,}8} = -0{,}6161$ kN

$y_2 = \frac{-AG}{AB} = \frac{-13{,}2}{19{,}8} = -0{,}6667$ kN

Lintang 1 : -0,6161 . 3,7 = -2,2796 kN
Lintang 2 : -0,6667 . 5,5 = -3,6669 kN
Lintang : -2,2796 - 3,6669
: -5,9465 kN

Lintang ekstrim negatif di titik G = -5,9465 kN

Momen ekstrim di titik G

· kondisi 2

$y_1 = \frac{AG}{AB} BC = \frac{13{,}2}{19{,}8} 6{,}6 = 4{,}4$ m

$y_2 = \frac{AB - (AG + x)}{AB} AG = \frac{19{,}8 - 14{,}2}{19{,}8} \cdot 13{,}2$

$= 3{,}7333$ m

Momen 1 : 4,4 . 3,7 = 16,28 kN.m
Momen 2 : 3,7333 . 5,5 = 20,5332 kN.m
Momen : 16,28 + 20,5332
: 36,8132 kN.m

· kondisi 1

$y_1 = \frac{AG - x}{AB} BG = \frac{13{,}2 - 1}{19{,}8} 6{,}6 = 4{,}0667$ m

$y_2 = \frac{AG}{AB} BG = \frac{13{,}2}{19{,}8} 6{,}6 = 4{,}4$ m

Momen 1 : 4,0667 . 3,7 = 15,0468 kNm
Momen 2 : 4,4 . 5,5 = 24,2 kN.m
Momen : 15,0468 + 24,2
: 39,2468 kN.m

Momen ekstrim di titik G = 39,2468 kN.m

ALYA WAFIQ FADHILAH
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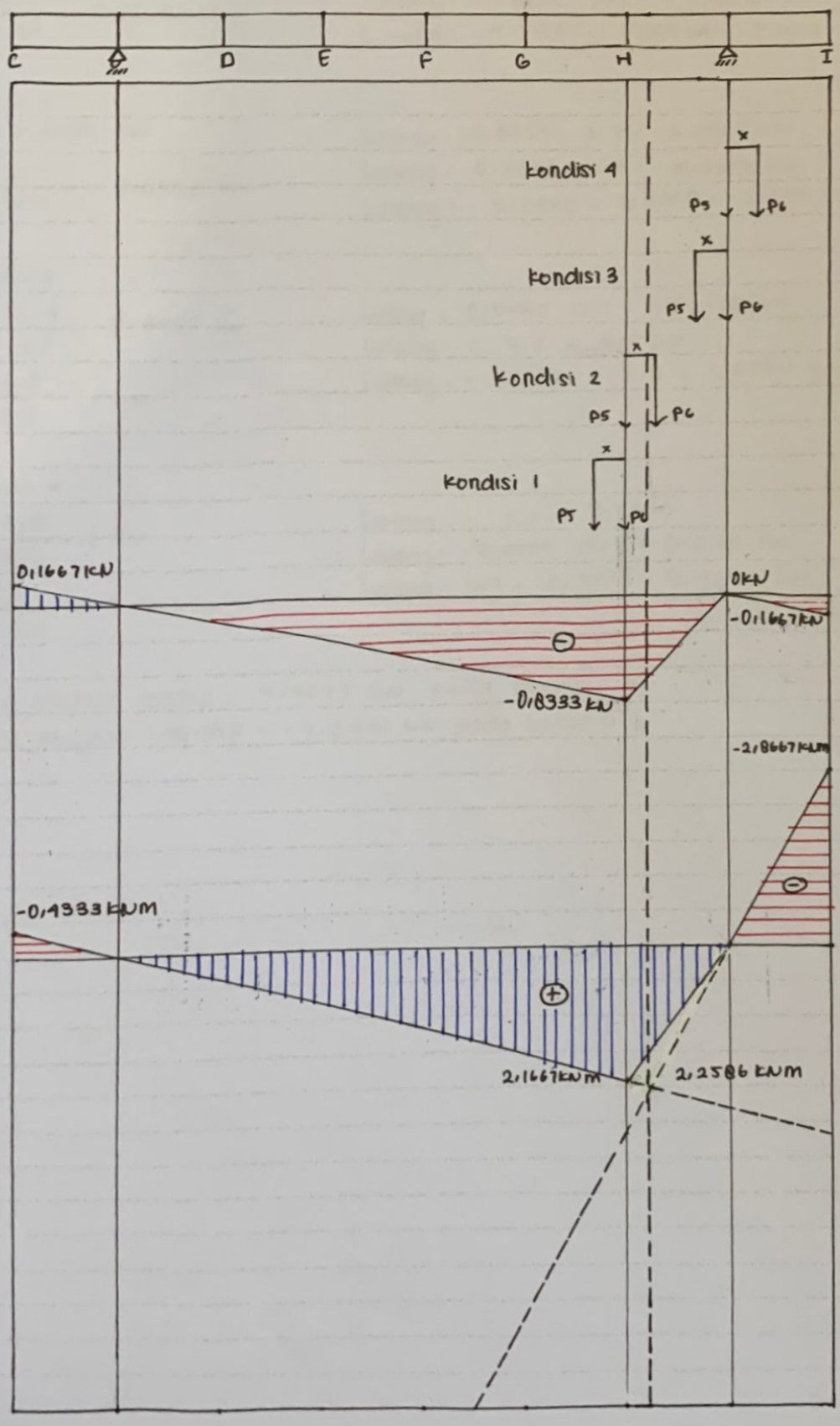
Lintang ekstrim dan momen ekstrim diantara H-B 0,7 dari H

Skala jarak 1:2

bid. lintang 2:1

bid. momen 1:1



ALYA WAFIQ FADHILAH

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Lintang ekstrim dihitik 0m dari H

· kondisi 1

$y_2 = -0{,}8333$ kN

$y_1 = -\frac{15{,}5}{19{,}8} = -0{,}7828$ kN

Lintang = $-0{,}8333 \cdot 5{,}5 = -4{,}5832$ kN

Lintang = $-0{,}7828 \cdot 3{,}7 = -2{,}8964$ kN

Lintang = $-4{,}5832 - 2{,}8964 = -7{,}4796$ kN

· kondisi 2

$y_1 = -0{,}8333$ kN

$y_2 = -\frac{17{,}5}{19{,}8} = -0{,}8838$ kN

Lintang = $-0{,}8333 \cdot 3{,}7 = -3{,}0832$ kN

Lintang = $-0{,}8838 \cdot 5{,}5 = -4{,}8609$ kN

Lintang = $-3{,}0832 - 4{,}8609 = -7{,}9441$ kN

· kondisi 3

$y_1 = \frac{-18{,}8}{19{,}8} = -0{,}9495$ kN

$y_2 = \frac{19{,}8}{19{,}8} = 1$ kN

Lintang = $-0{,}9495 \cdot 3{,}7 = -3{,}5131$ kN

Lintang = $1 \cdot 5{,}5 = 5{,}5$ kN

Lintang = $-3{,}5131 + 5{,}5 = 1{,}9869$ kN

· kondisi 4

$y_1 = \frac{19{,}8}{19{,}8} = 1$ kN

$y_2 = \frac{-1}{19{,}8} = -0{,}0505$ kN

Lintang = $1 \cdot 3{,}7 = 3{,}7$ kN

Lintang = $-0{,}0505 \cdot 5{,}5 = -0{,}2778$ kN

Lintang = $3{,}7 - 0{,}2778 = 3{,}4222$ kN

Lintang ekstrim positif = 3,4222 kN pada kondisi 4

Lintang ekstrim negatif = −7,9441 kN pada kondisi 2

ALYA WAFIQ FADHILAH
2315011058

Momen ekstrim dihitik 0,7 m dari H

- kondisi 1

$y_2 = 2,1667$ m

$y_1 = \frac{15,5 \cdot 2,1667}{16,5} = 2,0354$ m

Momen

$= 2,1667 \cdot 5,5 + 2,0354 \cdot 3,7$

$= 19,4478$ kN.m

- kondisi 2

$y_1 = 2,1667$ m

$y_2 = \frac{2,3 \cdot 2,1667}{3,3} + 0 = 1,5101$ m

Momen

$= 2,1667 \cdot 3,7 + 1,5101 \cdot 5,5$

$= 16,3223$ kN.m

- kondisi 3

$y_1 = \frac{3 \cdot 2,1667}{3,3} + 0 = 1,9697$ m

$y_2 = 0$ m

Momen

$= 1,9697 \cdot 3,7 + 0 \cdot 5,5$

$= 7,2879$ kN.m

- kondisi 4

$y_1 = 0$ m

$y_2 = \frac{2,3 \cdot 0}{2,6} = 0$ m

Momen

$= 0 \cdot 3,7 + 0 \cdot 5,5$

$= 0$ kN.m

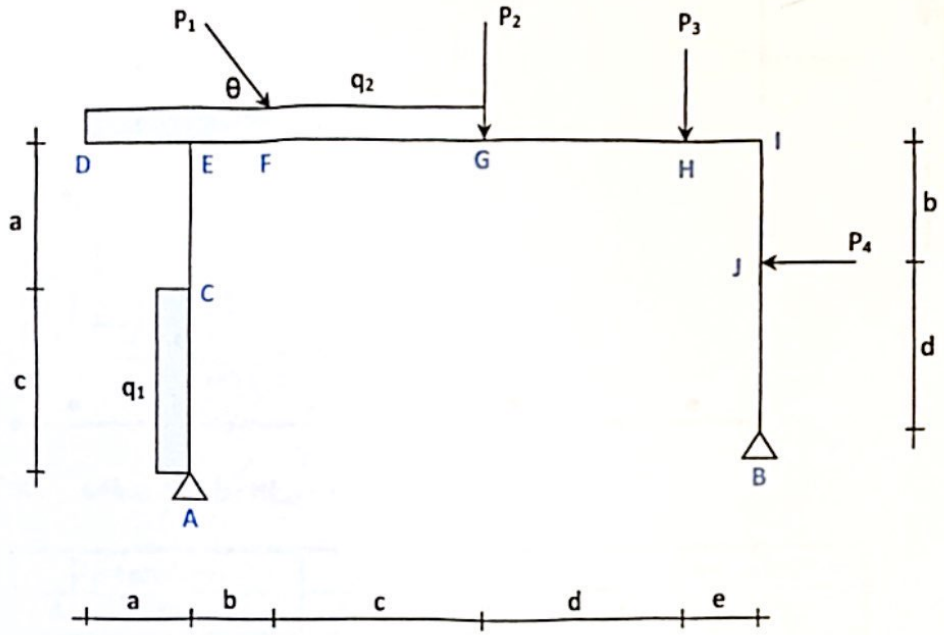
Momen ekstrim dihitik 0,7 dari H adalah 19,4478 kN.m

ALYA WAFIQ FADHILAH
2315011058

NAMA : ALYA WAFIQ FADHILAH
NPM : 2315011058

SOAL NO. 3

Diketahui struktur portal dengan beban seperti tergambar.



Data-data sebagai berikut:

Perletakan		Beban		Jarak	
A	Rol	q_1	5,9 kN/m	a	7 m
B	Sendi	q_2	6 kN/m	b	5 m
		P_1	6,8 kN	c	12 m
		P_2	6,4 kN	d	10 m
		P_3	6,3 kN	e	8 m
		P_4	6,2 kN	Sudut θ	49 °

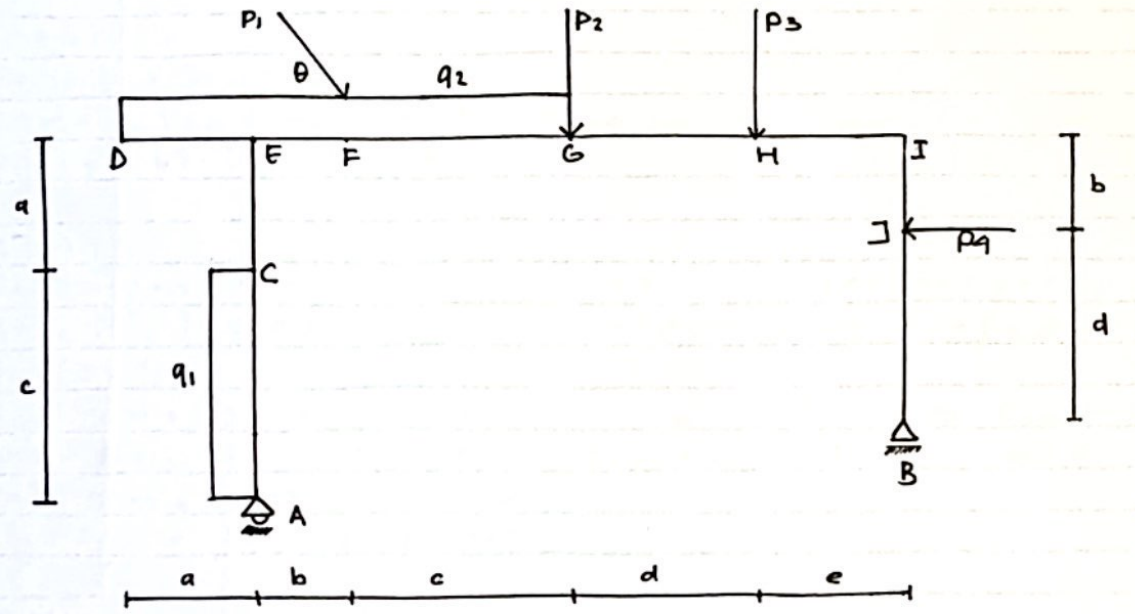
Pertanyaan:

Hitung dan gambarkan bidang momen, lintang dan normal secara analitis.

Asisten Responsi,

ANANG MA'RUF
NPM. 2115011122

Diketahui struktur portal dengan beban seperti tergambar.



Data - data sebagai berikut :

Perletakan		Beban		Jarak	
A	Rol	q_1	5,9 kN/m	a	7m
B	Sendi	q_2	6 kN/m	b	5m
		P_1	6,8 kN	c	12m
		P_2	6,4 kN	d	10m
		P_3	6,3 kN	e	8m
		P_4	6,2 kN	θ	49°

Hitunglah dan gambarkan bidang momen, lintang dan normal secara analitis.

$Q_1 = q_1 . c$
$= 5,9\ kN/m . 12m$
$= 70,8\ kN$

$Q_{2a} = q_2 . a$
$= 6\ kN/m . 7m$
$= 42\ kN$

$Q_{2b} = q_2 . b$
$= 6\ kN/m . 5m$
$= 30\ kN$

$Q_{2c} = q_2 . c$
$= 6\ kN/m . 12m$
$= 72\ kN$

$Q_{2bc} = q_2 . (b + c)$
$= 6\ kN/m . 17m$
$= 102\ kN$

$P_{1V} = P_1 \sin \theta$
$= 6,8\ kN \sin 49°$
$= 5,1320\ kN$

$P_{1H} = P_1 \cos \theta$
$= 6,8\ kN \cos 49°$
$= 4,4612\ kN$

ALYA WAFIQ FADHILAH
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Reaksi Peletakan

$\Sigma H = 0$

$R_{BH} - P_4 + Q_1 + P_{1H} = 0$

$R_{BH} - 6{,}2\,kN + 70{,}8\,kN + 4{,}4615\,kN = 0$

$R_{BH} = -69{,}0615\,kN\ (\leftarrow)$

$\Sigma M_B = 0$

$R_{AV}(b+c+d+e) + Q_1((b+d) - (\frac{1}{2}c+a)) - Q_{2a}(\frac{1}{2}a+b+c+d+e) - Q_{2bc}((\frac{b+c}{2})+d+e) - P_{1V}(c+d+e) - P_2(d+e) - P_3.(e+d) - P_4.d + P_{1H}.(b+d) = 0$

$R_{AV}.35m + 70{,}8\,kN.2m - 42\,kN.38{,}5m - 102\,kN.26{,}5m - 5{,}1320\,kN.30m - 6{,}4\,kN.18m - 6{,}3\,kN.8m - 6{,}2\,kN.10m + 4{,}4615\,kN.15m = 0$

$R_{AV}.35m = 4493{,}0375\,kN.m$

$R_{AV} = 128{,}3725\,kN\ (\uparrow)$

$\Sigma M_A = 0$

$-R_{BV}(b+c+d+e) - R_{BH}((a+c)-(b+d)) - P_4((a+c)-b) + P_3(b+c+d) + P_2(b+c) + P_{1V}(b) + Q_{2bc}(\frac{b+c}{2}) - Q_2.(\frac{a}{2}) + Q_1(\frac{c}{2}) + P_{1H}(a+c) = 0$

$-R_{BV}.35m - 69{,}0615\,kN.1m - 6{,}2\,kN.14m + 6{,}3\,kN\,27m + 6{,}4\,kN\,17m + 5{,}1320\,kN.5m + 102\,kN.8{,}5m - 42\,kN.3{,}5m + 70{,}8\,kN.6m + 4{,}4615\,kN.19m = 0$

$-R_{BV}.35m = -1171{,}0825\,kN.m$

$R_{BV} = 33{,}4595\,kN$

$\Sigma V = 0$

$R_{AV} + B_{BV} - Q_{2a} - Q_{2bc} \cdot P_{1V} - P_2 - P_3 = 0$

$128{,}3725\,kN + 33{,}4595\,kN - 42\,kN - 102\,kN - 5{,}1320\,kN \div 6{,}4\,kN - 6{,}3\,kN = 0$

$161{,}8320 - 161{,}8320 = 0$

$0 = 0$ (ok!!!)

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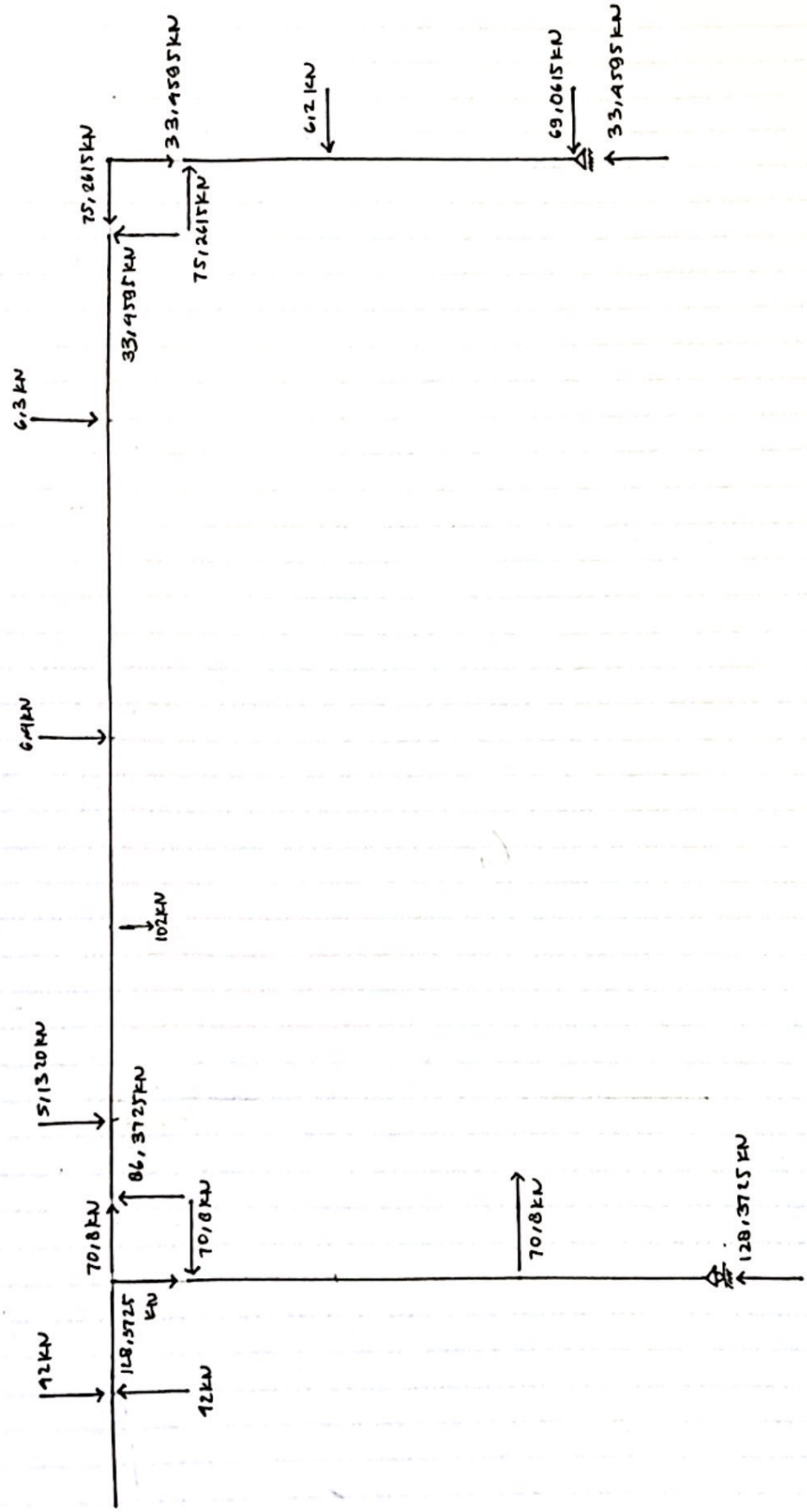
Free Body

Skala jarak 1 : 2



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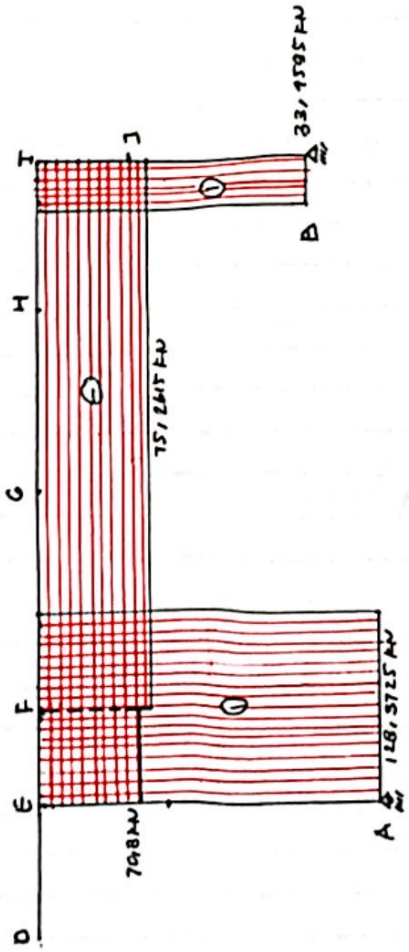
Gambar Bidang Normal

N_{AE} = 1281 3725 kN (→ ←)
N_{FE} = 7018 kN (→ ←)
N_{FI} = 75, 2615 kN (→ ←)
N_{CB} = 33, 4595 kN (→ ←)



Skala jarak 1 : 4
bid. normal 1 : 50

ALYA WAFIQ FADHILAH
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Bidang Lintang

Bentang A - E

D_A : 0 kN

D_C : -70,8 kN

$D_{C-DE\,kiri}$: D_C = -70,8 kN

$D_{E\,kanan}$: D_C + 70,8 kN = -70,8 kN + 70,8 kN = 0 kN

Bentang D - E

$D_{D\,kanan}$: 0 kN

$D_{E\,kiri}$: $-Q_{2a}$ = -42 kN

$D_{E\,kanan}$: $D_{E\,kiri} + P_{AV}$ = -42 kN + 128,3725 kN = 86,3725 kN

Bentang E - I

$D_{E\,kanan}$: 86,3725 kN

$D_{F\,kiri}$: $D_{E\,kanan} - Q_{2b}$ = 86,3725 kN - 30 kN = 56,3725 kN

$D_{F\,kanan}$: $D_{F\,kiri} - P_{IV}$ = 56,3725 kN - 5,1320 kN = 51,2405 kN

$D_{G\,kiri}$: $D_{F\,kanan} - Q_{2c}$ = 51,2405 kN - 72 kN = -21,1595 kN

$D_{G\,kanan - DH\,kiri}$: -27,1595 kN

$D_{H\,kanan}$: $D_{G\,kanan} - P_3$ = -27,595 kN - 6,3 kN = -33,4595 kN

$D_{H\,kanan - DI\,kiri}$: -33,4595 kN

$D_{I\,kanan}$: $D_{H\,kanan} + R_{BV}$ = -33,4595 kN + 33,4595 kN = 0 kN

Bentang I - B

D_I : $Q_1 + P_{IH}$ = 70,8 + 4,4612 kN = 75,2612 kN

$D_{J\,kiri}$ = D_I = 75,2612 kN

$D_{J\,kanan}$ = $D_{J\,kiri} - P_4$ = 75,2612 kN - 6,2 kN = 69,0615 kN

$D_{B\,kiri}$ = $D_{J\,kanan}$ = 69,0615 kN

$D_{B\,kanan}$ = $D_{B\,kiri} - R_{BH}$ = 69,0165 - 69,0165 = 0 kN

ALYA WAFIQ FADHILAH
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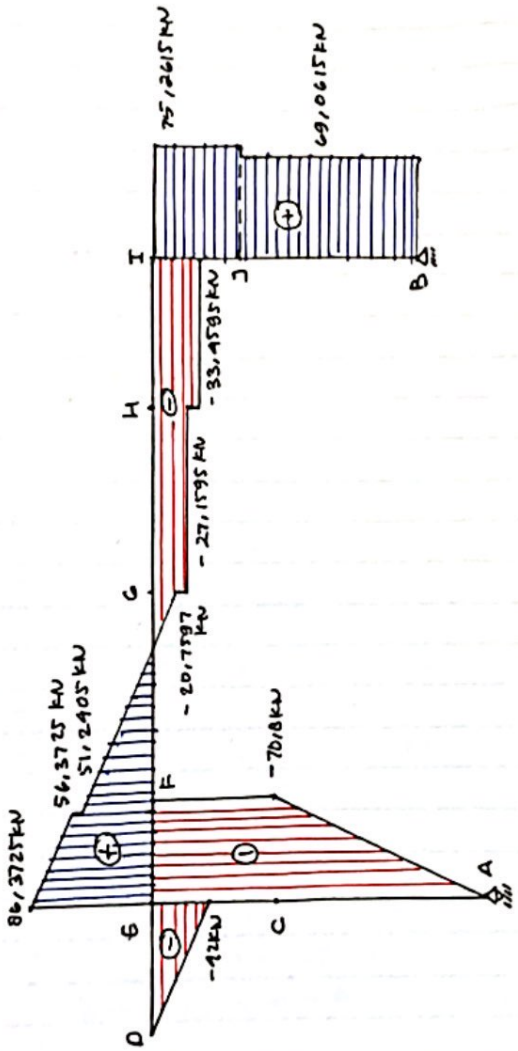
Gambar Bidang Lintang



Skala gambar 1:2
bid. Lintang 1:50

ALYA WAFIQ FADHILAH
2315011058

Bidang Momen

Bentang A - E

$M_A = 0$ kN.m

$M_C = -Q_1 \left(\frac{c}{2}\right) = -70{,}8$ kN. 6m $= -424{,}8$ kN.m

$M_E = -Q_1 \left(\frac{c}{2} + a\right) = -70{,}8$ kN. 13m $= -920{,}4$ kN.m

Bentang D - E

$M_D = 0$ kNm

$M_{DE} = -Q_{2a} \left(\frac{a}{2}\right) = -42$ kN. 3,5m $= -147$ kN.m

Bentang E - I

$M_{EB} = R_{BV}(b+c+d+e) - R_{BH}(b+d) - P_4(b) - P_3(b+c+d) - P_2(b+c) - P_{1V}(b) - Q_{2bc}\left(\frac{b+c}{2}\right)$

$= 33{,}4595$ kN. 35m $- 69{,}0615$ kN. 15m $- 6{,}2$ kN. 5m $- 6{,}3$ kN. 27m $- 6{,}4$ kN. 17m $- 5{,}1320$ kN. $- 102$ kN. 8,5m

$= -1067{,}4$ kN.m

$M_F = -Q_1 \left(\frac{c}{2} + a\right) - Q_{2a}\left(\frac{a}{2} + b\right) + R_{AV} \cdot b - Q_{2b}\left(\frac{b}{2}\right)$

$= -70{,}8$ kN. 13m $- 42$ kN. 8,5m $+ 128{,}3725$ kN. 5m $- 30$ kN. 2,5m

$= -710{,}5375$ kN.m

$M_G = -Q_1 \left(\frac{c}{2} + a\right) - Q_{2a}\left(\frac{a}{2} + b + c\right) + R_{AV}(b+c) - Q_{2bc}\left(\frac{b}{2} + c\right) - P_{1V} \cdot c$

$= -70{,}8$ kN. 13m $- 42$ kN. 20,5m $+ 128{,}3725$ kN. 17m $- 102$ kN. 8,5m $- 5{,}1320$ kN. 12m

$= -527{,}6515$ kN.m

$M_H = -Q_1 \left(\frac{c}{2} + a\right) - Q_{2a}\left(\frac{a}{2} + b + c + d\right) + R_{AV}(b+c+d) - Q_{2bc}\left(\frac{b}{2} + c + d\right) - P_{1V}(c+d) - P_2 \cdot d$

$= -70{,}8$ kN. 13m $- 42$ kN. 30,5m $+ 128{,}3725$ kN. 27m $- 102$ kN. 18,5m $- 5{,}1320$ kN. 22m $- 6{,}4$ kN. 10m

$= -799{,}2465$ kNm

$M_I = -Q_1 \left(\frac{c}{2} + a\right) - Q_{2a}\left(\frac{a}{2} + b + c + d + e\right) + R_{AV}(b+c+d+e) - Q_{2bc}\left(\frac{b}{2} + c + d + e\right) - P_{1V}(c+d+e) - P_2(d+e) - P_3 \cdot e$

$= -70{,}8$ kN. 13m $- 42$ kN. 38,5m $+ 128{,}3725$ kN. 35m $- 102$ kN. 26,5m $- 5{,}1320$ kN. 30m $- 6{,}4$ kN. 18m $- 6{,}3$ kN. 8m

$= -1066{,}9225$ kNm

Bentang I - B

$M_B = 0$ kNm

$M_J = -R_{BH} \cdot a = -69{,}0615$ kN. 10m $= -690{,}615$ kN.m

$M_I = -R_{BH}(a+b) - P_4 \cdot b$

$= -69{,}0615$ kN. 15m $- 6{,}2$ kN. 5m

$= -1066{,}9225$ kNm

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Momen Max

$$Mx = R_{AV}(b+x) - Q_1\left(\tfrac{a}{2}+d\right) - Q_{2a}\left(\tfrac{a}{2}+b+x\right) - Q_{2b}\left(\tfrac{b}{2}+x\right) - P_{IV}(x) - q_{2x}\tfrac{1}{2}x$$

$$\frac{dMx}{dx} = 0$$

$$\frac{dMx}{dx} = R_{AV} - Q_{2a} - Q_{2b} - P_{IV} - q_{2x}$$

$$q_{2x} = 128{,}3725\,kN - 42kN - 30\,kN - 5{,}1320\,kN$$

$$x = \frac{51{,}2405}{6}$$

$$x = 8{,}5401\,m \text{ dari F ke kanan}$$

$$Mmax = 128{,}3725\,kN\,(5+8{,}5401)\,m - 70{,}8\,kN.\,13m - 42kN.\,(3{,}5+5+8{,}5401)\,m - 30\,kN.\,(2{,}5+8{,}5401)\,m - 5{,}1320\,kN.\,8{,}5401\,m - 3\,kN.\,8{,}5401\,m$$

$$= -491{,}7384\,kNm$$

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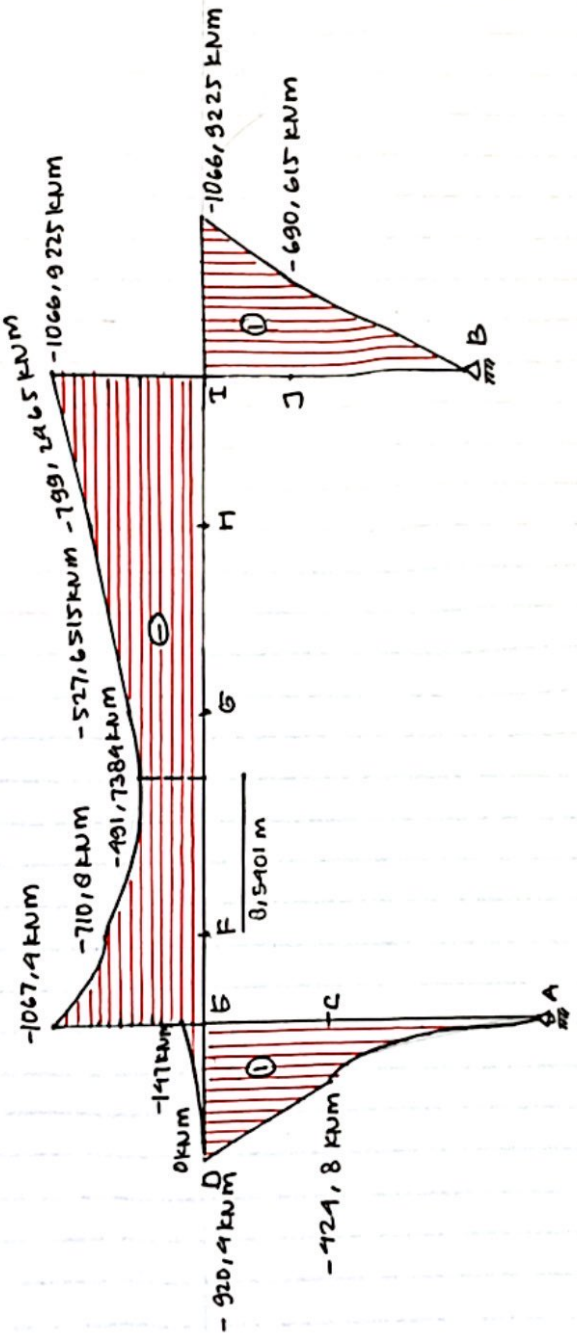
Gambar bidang Momen



Skala jarak 1 : 4
bid. momen 1 : 500

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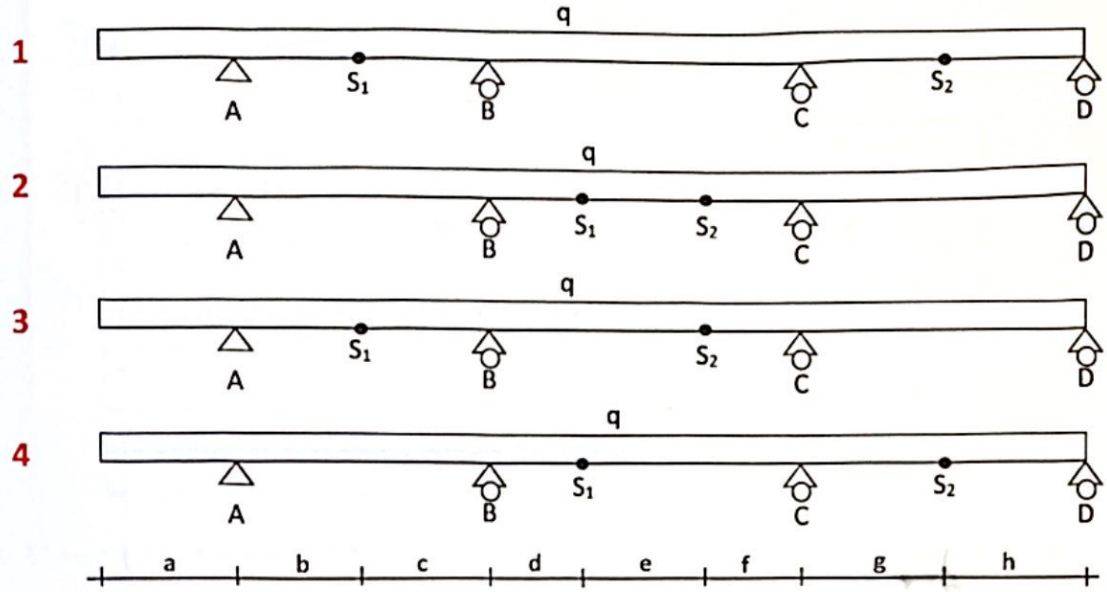
NAMA : ALYA WAFIQ FADHILAH
NPM : 2315011058

SOAL NO. 4

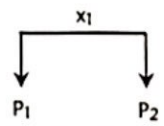
Diketahui struktur balok gerber



dengan beban seperti tergambar.

Data-data sebagai berikut:

Jenis Balok Gerber		Jarak		Beban berjalan	
4		a	1,5 m	P_1	2,4 kN
		b	2,6 m	P_2	3,1 kN
		c	3,3 m		
Beban		d	2,9 m		
q	5,1 kN/m'	e	3,5 m		
		f	3,3 m		
		g	3,5 m		
		h	1,4 m	x_1	3 m



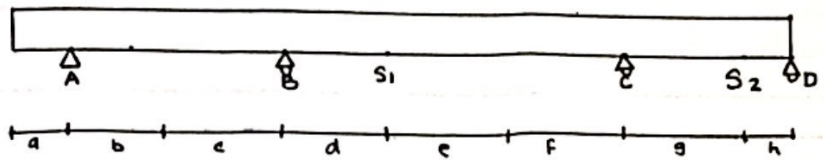
Pertanyaan:

a. Hitung dan gambarkan bidang momen dan lintang akibat beban tetap yang bekerja.
b. Hitung dan gambar garis pengaruh monen dan lintang akibat beban jika P = 1 kN bergerak dengan arah dari tumpuan A ke B, pada titik potongan:
   - I : 1 m dari titik A
   - II : 2,4 m dari titik B
   - III : 3,8 m dari titik C
c. Hitung besar momen ekstrim dan lintang ekstrim pada point (b) akibat rangkaian beban berjalan (P_1 dan P_2) dengan arah dari A ke B.

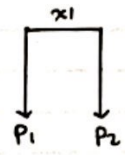
Asisten Responsi,

ANANG MA'RUF
NPM. 2115011122

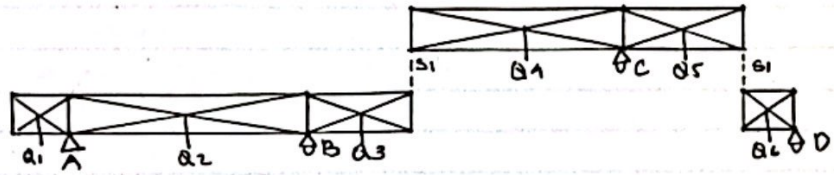
Diketahui Struktur Balok Gerber



Data-data sebagai berikut

Jenis Balok		Jarak		Beban Berjalan	
4		a	1,5 m	P1	2,4 kN
		b	2,6 m	P2	3,1 kN
		c	3,3 m		
Beban		d	2,9 m		
q	5,1 kN/m	e	3,5 m		
		f	3,3 m		
		g	3,5 m		
		h	1,4 m	x1	3 m

a. Hitung dan gambarkan bidang momen dan lintang akibat beban tetap yang bekerja.



$Q_1 = q.a$
$= 5,1\ kN/m \cdot 1,5m$
$= 7,65\ kN$

$Q_2 = q.\left(\frac{b+c}{2}\right)$
$= 5,1\ kN/m \cdot 2,95m$
$= 15,045\ kN$

$Q_3 = q.d$
$= 5,1\ kN/m \cdot 2,9m$
$= 14,79\ kN$

$Q_4 = q.\left(\frac{e+f}{2}\right)$
$= 5,1\ kN/m \cdot 3,4m$
$= 19,34\ kN$

$Q_5 = q.e$
$= 5,1\ kN/m \cdot 3,5m$
$= 17,85\ kN$

$Q_6 = q.h$
$= 5,1\ kN/m \cdot 1,4m$
$= 7,14\ kN$

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Reaksi Peletakan

Bentang $S_2 - D$

$\Sigma M_D = 0$
$S_2 \cdot h - Q_6 \cdot (\frac{h}{2}) = 0$
$S_2 \cdot 1{,}4m - 7{,}14\,kN \cdot 0{,}7m = 0$
$S_2 \cdot 1{,}4m = 4{,}998\,kN.m$
$S_2 = 3{,}57\,kN$

$\Sigma M_{S2} = 0$
$-R_{DV} \cdot h + Q_6 \cdot (\frac{h}{2}) = 0$
$-R_{DV} \cdot 1{,}4m + 7{,}14\,kN \cdot 0{,}7m = 0$
$-R_{DV} \cdot 1{,}4m = -4{,}998\,kN.m$
$R_{DV} = 3{,}57\,kN$

Checking
$\Sigma V = 0$
$S_2 + R_{DV} - Q_6 = 0$
$3{,}57\,kN + 3{,}57\,kN - 7{,}14\,kN = 0$
$0 = 0$ (Ok!!!)

Bentang $S_1 - C$

$\Sigma M_C = 0$
$S_1 \cdot (e+F) - Q_4 \cdot (\frac{e+F}{2}) + Q_5 \cdot (\frac{g}{2}) + S_1 \cdot g = 0$
$S_1 \cdot 6{,}8m - 17{,}34\,kN \cdot 3{,}4m + 17{,}85\,kN \cdot 1{,}75m + 3{,}57\,kN \cdot 3{,}5m = 0$
$S_1 \cdot 6{,}8m = 15{,}2235\,kN.m$
$S_1 = 2{,}2387\,kN$

$\Sigma S_1 = 0$
$-R_{CV} \cdot (e+F) + S_2 \cdot (e+F+g) + Q_5 \cdot (e+F+g/2) + Q_4 \cdot (\frac{e+F}{2}) = 0$
$-R_{CV} \cdot 6{,}8m + 3{,}57\,kN \cdot 10{,}3m + 17{,}85\,kN \cdot 8{,}55m + 17{,}34\,kN \cdot 3{,}4m = 0$
$-R_{CV} \cdot 6{,}8m = -248{,}3445\,kN.m$
$R_{CV} = 36{,}5213\,kN$

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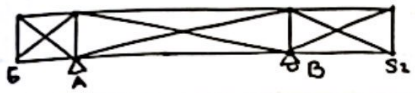
Checking

$\Sigma V = 0$
$S_1 + R_{CV} - Q_4 - Q_5 - S_2 = 0$
$2,2387\ kN + 36,5213\ kN - 17,34\ kN - 17,85\ kN - 3,57\ kN = 0$
$0 = 0$ (ok!!!)

Bentang A - B



$\Sigma MB = 0$
$R_{AV}.(b+c) - Q_1.(\frac{a}{2} + b + c) - Q_2.(\frac{b+c}{2}) + Q_3.(\frac{a}{2}) + S_1.d = 0$
$R_{AV}.\ 5,9m - 7,65\ kN.\ 6,65\ m - 15,045\ kN.\ 2,95\ m + 14,79\ kN.$
$1,45\ m + 2,2387\ kN.\ 2,0m = 0$
$R_{AV}.\ 5,9m - 67,3775\ kN.m$
$R_{AV} = 11,4098\ kN$

$\Sigma MA = 0$
$-R_{BV}.(b+c) + S_1.(b+c+d) + Q_3.(b+c+\frac{a}{2}) + Q_2.(\frac{b+c}{2}) - Q_1.(\frac{a}{2}) = 0$
$-R_{BV}.\ 5,9m + 2,2387\ kN.\ 8,8\ m + 14,79\ kN.\ 7,35\ m + 15,045\ kN.$
$2,95m - 7,65\ kN.\ 0,75\ m = 0$
$-R_{BV}.\ 5,9m = -167,0523\ kN.m$
$R_{BV} = 28,3139\ kN$

Checking
$R_{AV} + R_{BV} - Q_1 - Q_2 - Q_3 - S_1 = 0$
$11,9098\ kN + 28,3139\ kN - 7,65\ kN - 15,045\ kN - 14,79\ kN -$
$2,2387\ kN = 0$
$0 = 0$ (ok!!!)

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Bidang Lintang

$D_E = 0 kN$

D_A kiri $= -Q_1$
$= -7,65 kN$

D_A kanan $= -Q_1 + R_{AV}$
$= -7,65 kN + 11,4098 kN$
$= 3,7598 kN$

D_B kiri $= D_A$ kanan $- Q_2$
$= 3,7598 kN - 15,045 kN$
$= -11,2852 kN$

D_B kanan $= D_B$ kiri $+ R_{BV}$
$= -11,2852 kN + 28,3139 kN$
$= 17,0287 kN$

$D_{S1} = D_B$ kanan $- Q_3$
$= 17,0287 kN - 14,79 kN$
$= 2,2387 kN$

D_C kiri $= D_{S1} - Q_4$
$= 2,2387 kN - 17,34 kN$
$= -15,1013 kN$

D_C kanan $= D_C$ kiri $- Q_5$
$= -15,1013 kN + 36,5213 kN$
$= 21,42 kN$

$D_{S2} = D_C$ kanan $- Q_5$
$= 21,42 kN - 17,85 kN$
$= 3,57 kN$

D_D kiri $= D_{S2} - Q_6$
$= 3,57 kN - 7,14 kN$
$= -3,57 kN$

D_D kanan $= D_D$ kiri $+ R_{DV}$
$= -3,57 kN + 3,57 kN$
$= 0 kN$

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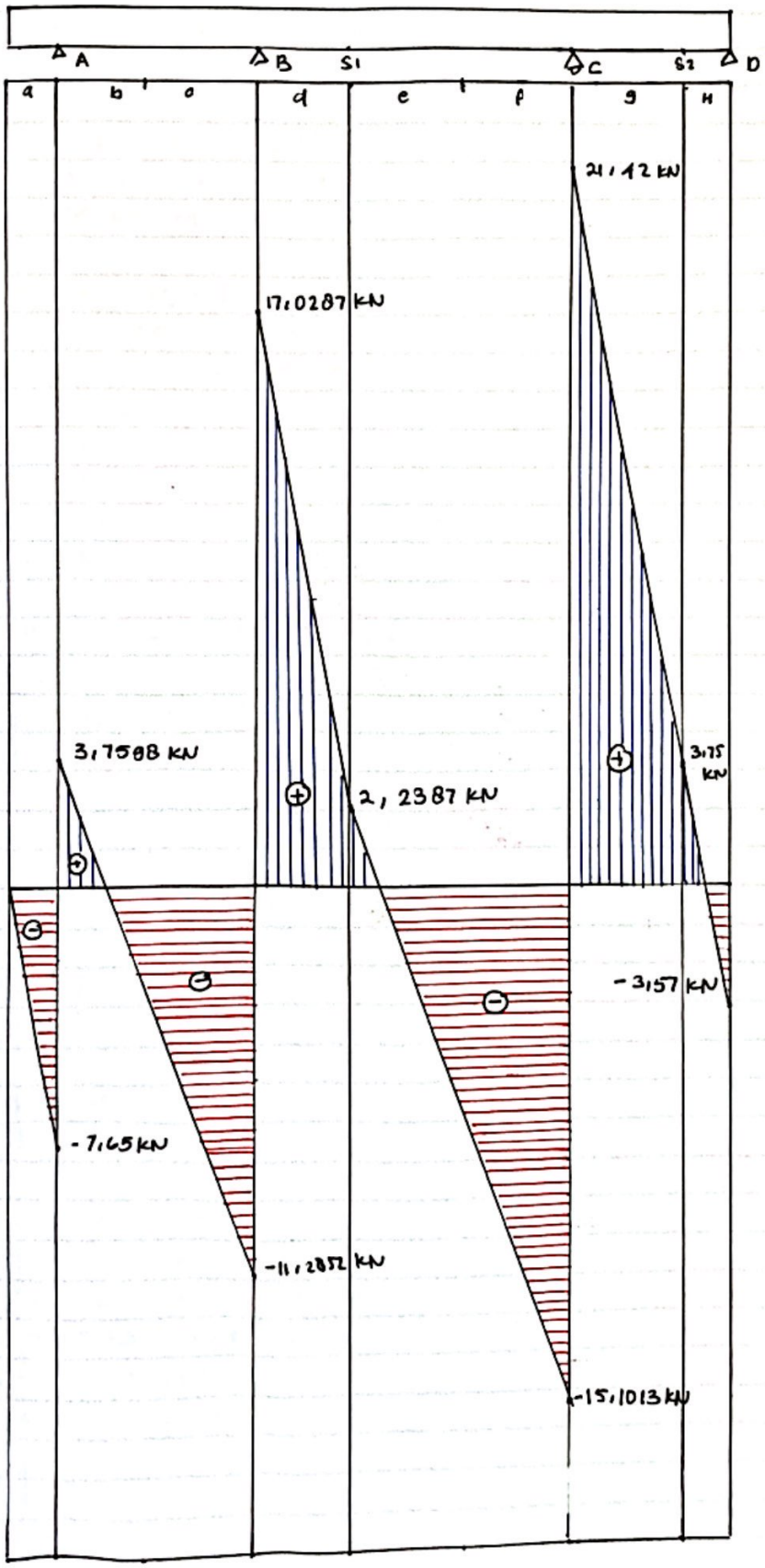
Bidang Lintang
Skala jarak 1 : 2
bidang lintang 1 : 2



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Bidang Momen

$M_E = 0\ kN.m$

$M_A = -Q_2 . (\frac{a}{2})$
$= -7,65\ kN . 0,75m$
$= -5,7375\ kN.m$

$M_D = -Q_1 (\frac{a}{2} + b + c) + R_{AV}(b+c) - Q_2 (\frac{b+c}{2})$
$= -7,65\ kN . 6,65m + 11,4098\ kN . 5,9m - 15,045\ kN . 2,95m$
$= -27,8374\ kN.m$

$M_{S1} = -Q_1 (\frac{a}{2} + b + c + d) + R_{AV}(b+c+d) - Q_2 (\frac{b+c}{2} + d) + R_{BV} . d - Q_3 (\frac{d}{2})$
$= -7,65\ kN . 9,55m + 11,4098\ kN . 8,8m - 15,045\ kN . 5,85m +$
$28,3139\ kN . 2,8m - 14,79\ kN . 1,45m$
$= 0,0003\ kN.m$

$M_C = R_{S1}(e+F) - Q_4 . (\frac{e+F}{2})$
$= 2,2387\ kN . 6,8m - 17,34\ kN . 3,4m$
$= -43,7328\ kN.m$

$M_{S2} = R_{S1}(e+F+g) - Q_4 (\frac{e+F}{2} + g) + R_{CV} . g - Q_5 : (\frac{g}{2})$
$= 2,2387\ kN . 10,3m - 17,34\ kN . 6,9m + 86,5213\ kN . 3,5m -$
$17,85\ kN . 1,75\ m$
$= -0,0003\ kN.m$

$M_D = 0\ kN.m$

Momen Maksimum
· Bentang A – B

$M_x = -Q_1 (\frac{a}{2} + x) + R_{AV} . x - \frac{1}{2} q x^2$

$\frac{dm_x}{dx} = 0$

$0 = -Q_1 + R_{AV} - qx$

$x = \frac{-Q_1 + R_{AV}}{q}$

$x = \frac{-7,65\ kN + 11,4098\ kN}{5,1\ kN/m}$

$x = 0,7372\ m$ dari kanan A

$M_{max} = -7,65\ kN . 1,4872\ m + 11,4098\ kN . 0,7372\ m - 2,55\ kN/m . (0,7372)^2 m$

$M_{max} = -4,3516\ kN.m$

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Bentang S1 - C

$Mx = R_{S1} \cdot (x) - \frac{1}{2} q x^2$

$\frac{dmx}{dx} = 0$

$0 = R_{S1} - qx$

$x = \frac{R_{S1}}{q}$

$x = \frac{2,2387\ kN}{511\ kN/m}$

$x = 0,439\ m$ dari kanan S_1

$Mmax = 2,2387\ kN \cdot 0,439\ m - 2,55\ kN/m \cdot (0,439\ m)^2$

$Mmax = 0,4914\ kN.m$

. Bentang S2 - D

$Mx = R_{S2} \cdot (x) - \frac{1}{2} q x^2$

$\frac{dmx}{dx} = 0$

$0 = R_{S2} - qx$

$x = \frac{R_{S2}}{q}$

$x = \frac{3,57\ kN}{511\ kN/m}$

$x = 0,7\ m$ dari kanan S_2

$Mmax = 3,57\ kN \cdot 0,7\ m - 2,55\ kN/m \cdot (0,7)^2$

$Mmax = 1,3755\ kN.m$

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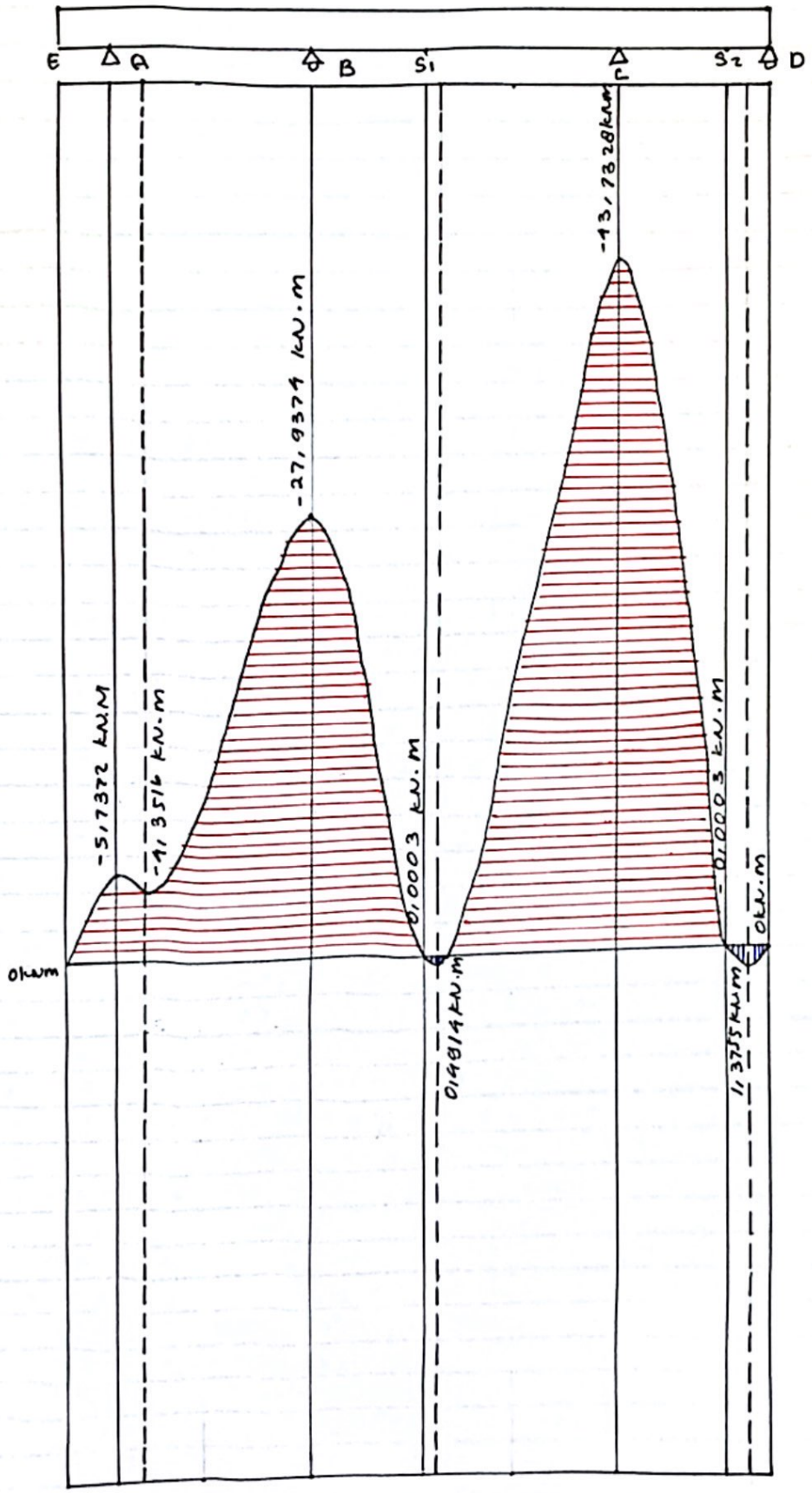
Gambar Bidang Momen
Skala jarak 1 :
Bid. Momen 1 : 1



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b. Hitunglah dan gambar garis pengaruh momen dan lintang akibat beban jika P = 1 kN bergerak dengan arah dari tumpuan A ke B, pada titik potong :

I : 1m dari titik A

II : 2,4m dari titik B

III : 3,8m dari titik C

Garis pengaruh pada titik potong I (1m dari titik A)

Lintang

$y_1 = \frac{a \cdot 1kN}{b+c} = \frac{1,5 \cdot 1\,kN}{2,6+3,3} = 0,2542\ kN$

$y_2 = \frac{-(1 \cdot 1kN)}{b+c} = \frac{-(1,4)}{2,6+3,3} = -0,1695\ kN$

$y_3 = \frac{b+c-1}{b+c} = \frac{2,6+3,3-1}{2,6+3,3} = 0,8305\ kN$

$y_4 = \frac{-d \cdot 1kN}{b+c} = \frac{-2,9 \cdot 1kN}{2,6+3,3} = -0,4915\ kN$

$y_5 = \frac{y_4 \cdot g}{e+F} = \frac{0,4915 \cdot 3,5}{3,5+3,3} = 0,2530\ kN$

Momen

$y_1 = \frac{-a \cdot (b+c-1)}{b+c} = \frac{-1,5 \cdot (2,6+3,3-1)}{2,6+3,3} = -1,2458\ kN.m$

$y_2 = \frac{1 \cdot (b+c-1)}{b+c} = \frac{1 \cdot (2,6+3,3-1)}{2,6+3,3} = 0,8305\ kN.m$

$y_3 = \frac{1 \cdot -d}{b+c} = \frac{1 \cdot -2,9}{2,6+3,3} = -0,4915\ kNm$

$y_4 = \frac{y_3 \cdot g}{e+F} = \frac{0,4915}{3,5+3,3} = 0,2530\ kN.m$

Garis pengaruh pada titik potong II (2,4m dari titik B)

Lintang

$y_1 = \frac{e+F-(2,4-d)}{e+F} = \frac{3,5+3,3-(2,4-2,9)}{3,5+3,3} = 1,1029\ kN$

$y_2 = \frac{y_1 \cdot g}{e+F-(2,4-d)} = \frac{1,1029 \cdot 3,5}{3,5+3,3-(2,4-2,9)} = 0,5288\ kN$

Momen

$y_1 = \frac{(2,9-2,4) \cdot 6,8}{7,3} = 0,4658\ kNm$

$y_2 = \frac{0,4658 \cdot 3,5}{3,5+3,3-(2,4-2,9)} = 0,2233\ kNm$

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Garis Pengaruh pada titik potong III (3,8m titik C)

Lintang

$$y_1 = \frac{-(3{,}8-9)}{h} = \frac{-(3{,}8-3{,}5)}{1{,}9} = -0{,}2143\ kN$$

$$y_2 = \frac{h-(3{,}8-9)}{h} = \frac{1{,}9-(3{,}8-3{,}5)}{1{,}9} = 0{,}7857\ kN$$

Momen

$$y_1 = \frac{h-(3{,}8-9)}{h} \cdot (3{,}8-9) = \frac{1{,}9-(3{,}8-3{,}5)}{1{,}9}(3{,}8-3{,}5)$$

$$y_1 = 0{,}2357\ kN.m$$

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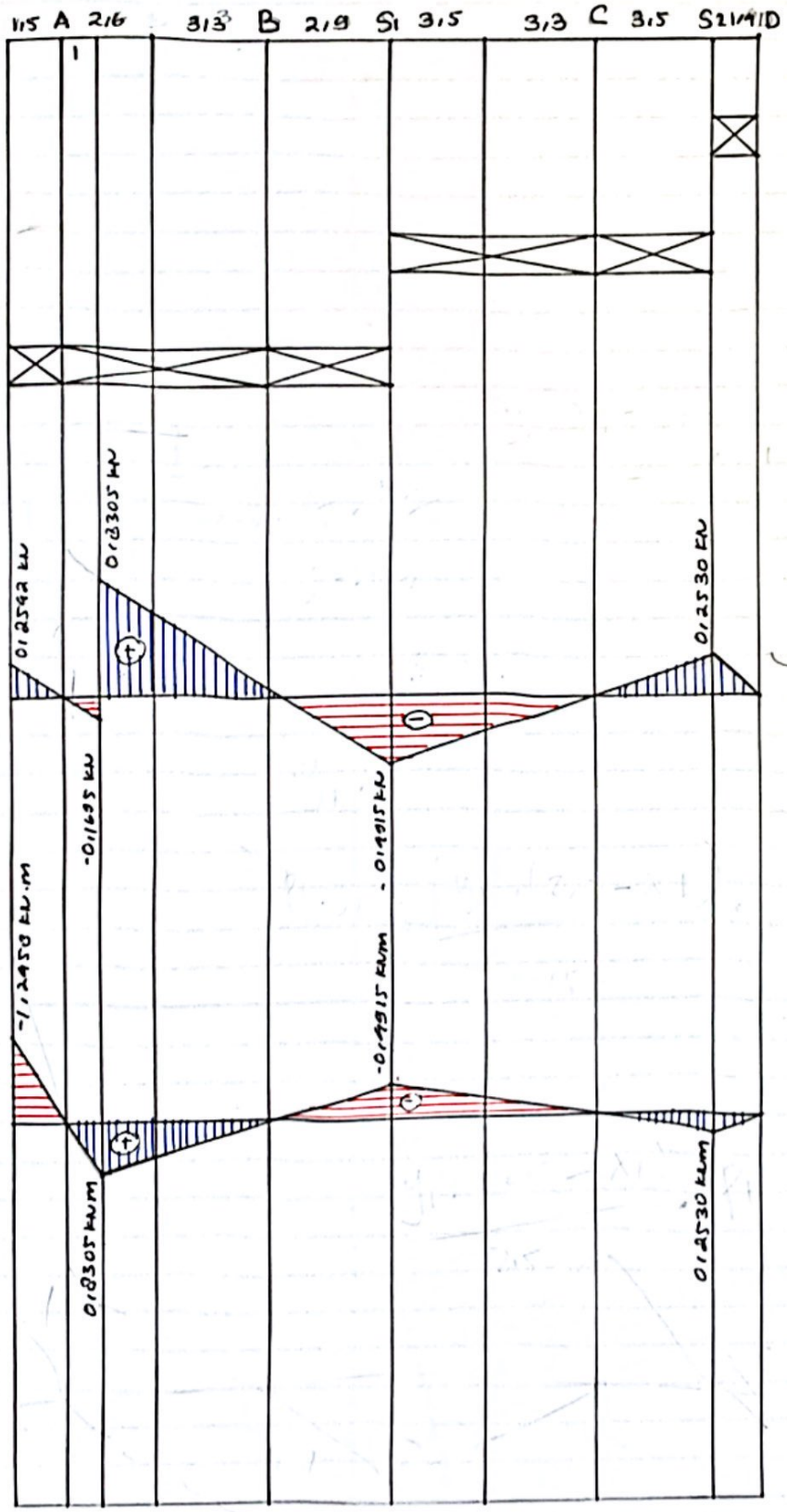
Gambar bidang lintang dan momen potongan I
Jarak 1 : 2
Bid. lintang 2 : 1
Bid. momen 1 : 1



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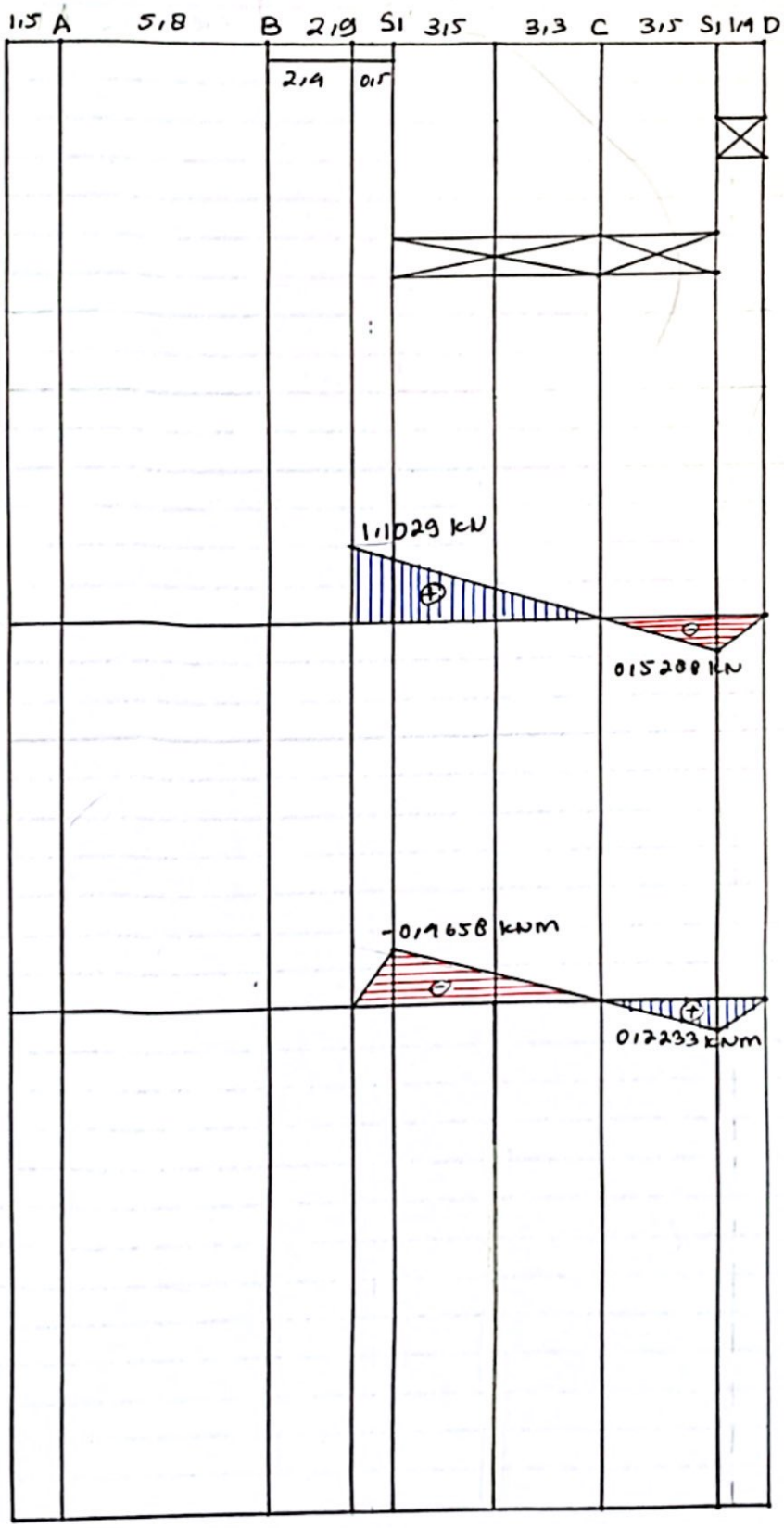
Gambar bidang lintang dan momen potongan II

Jatak 1 : 2

Bid. lintang 1 : 1

Bid. momen 2 : 1



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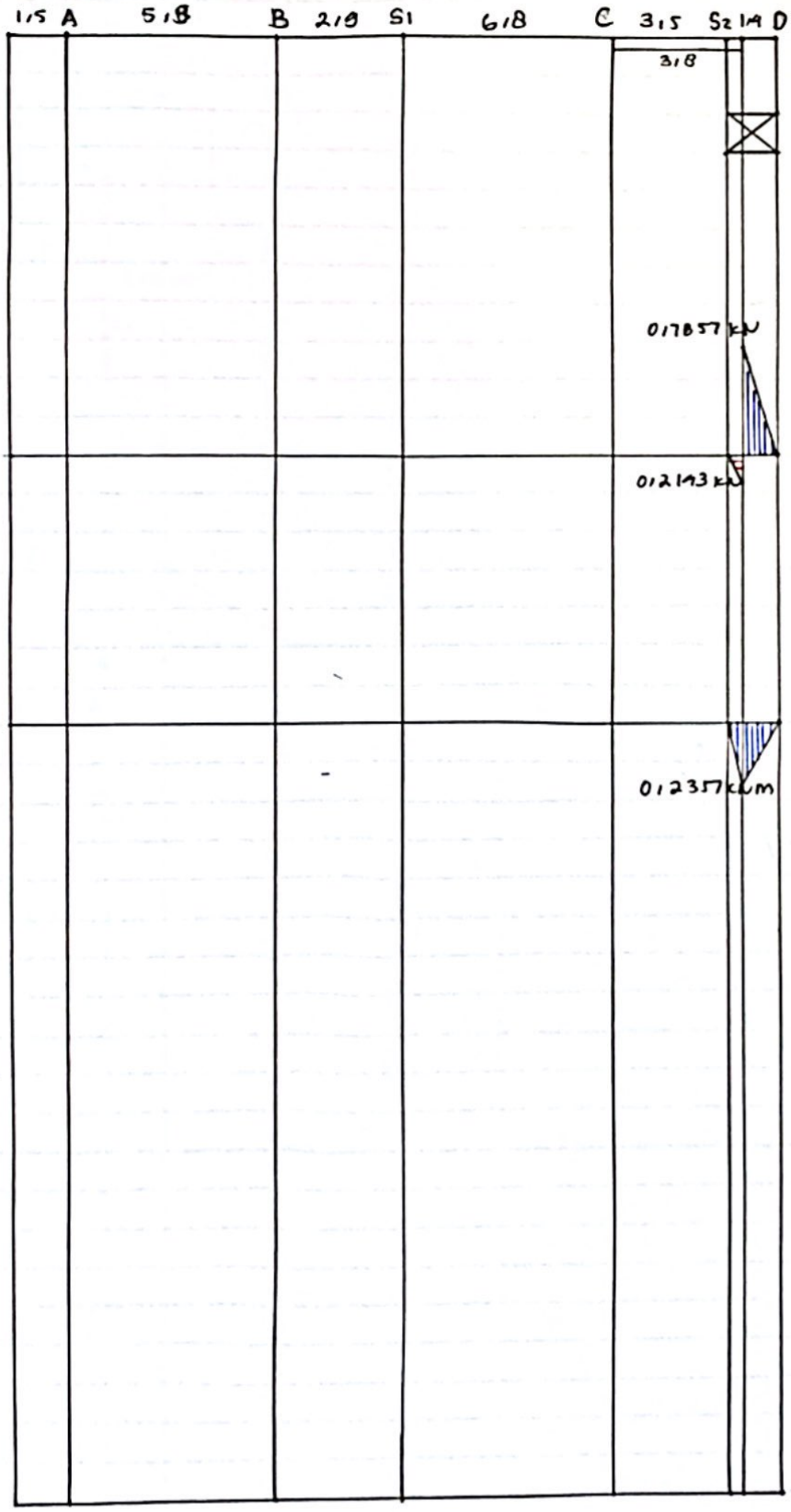
Gambar bidang lintang dan momen potongan III

Jarak 1:2

Bid. lintang 2:1

Bid. momen 1:1



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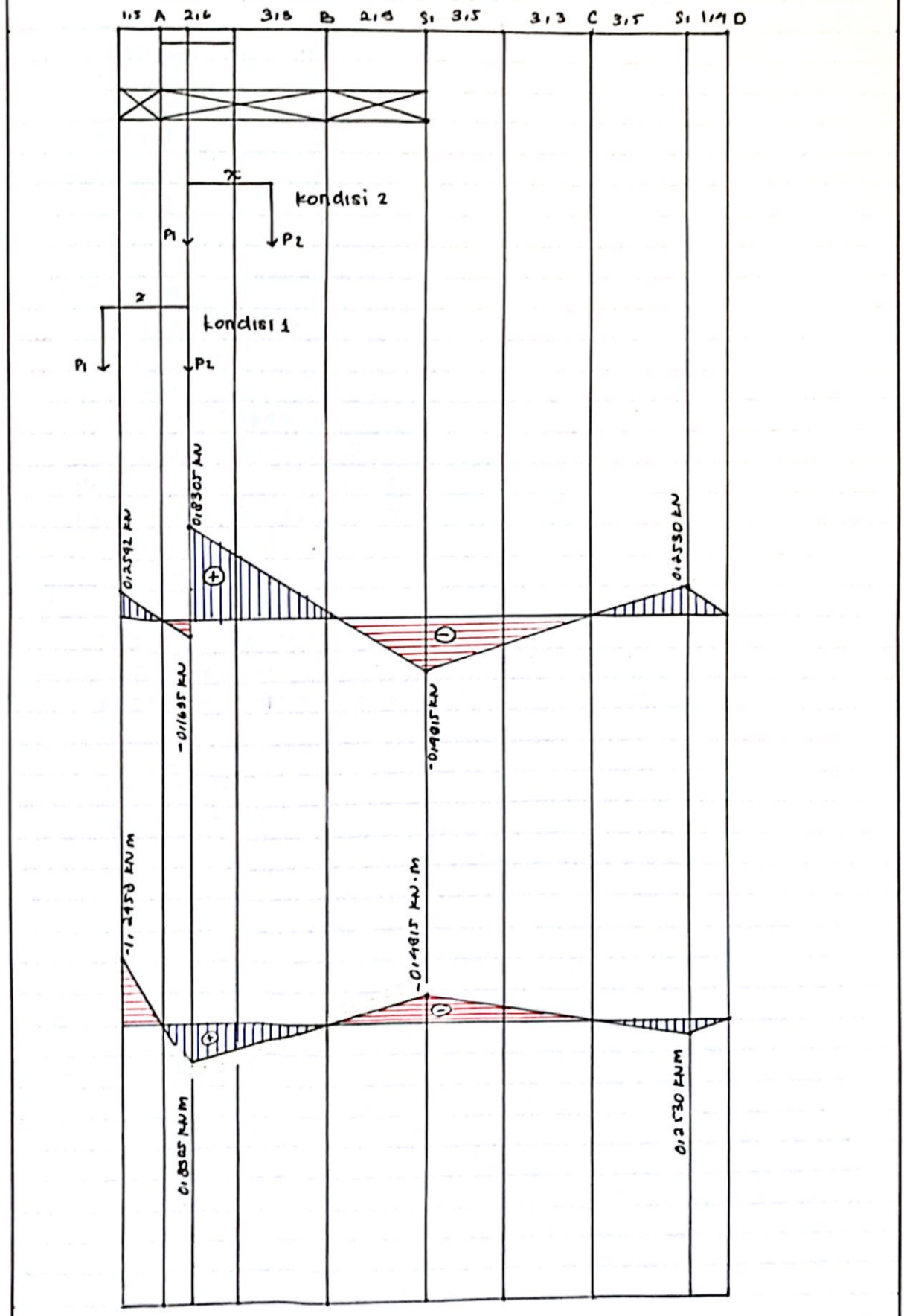

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c. Hitunglah besar momen ekstrim dan lintang ekstrim pada point (b) akibat rangkaian beban berjalan (P_1 dan P_2) dengan arah dari A ke B

Besar momen dan lintang ekstrim di titik I

Lintang

$y_1 = 0,1695$

$y_2 = 0,8305$

$y_3 = \frac{1,9 \cdot 0,8305}{4,9} = 0,3220$

kondisi I

$D(+) = P_2 \cdot y_2$
$= 3,1\ kN \cdot 0,8305$
$= 2,5746\ kN$

$D(-) = P_2 \cdot y_1$
$= 3,1\ kN \cdot 0,1695$
$= 0,5255\ kN$

kondisi II

$D(+) = P_1 \cdot y_2 + P_2 \cdot y_3$
$= 2,4\ kN \cdot 0,8305 + 3,1\ kN \cdot 0,3220$
$= 2,9914\ kN$

$D(-) = P_1 \cdot y_1$
$= 2,4\ kN \cdot 0,1695$
$= 0,4068\ kN$

Lintang ekstrim terletak pada kondisi II sebesar 2,9914 kN

Momen

$y_1 = 0,8305\ m$

$y_2 = \frac{1,9 \cdot 0,8305}{4,9} = 0,322$

kondisi I

$M(+) = P_2 \cdot y_1$
$= 3,1\ kN \cdot 0,8305\ m$
$= 2,5746\ kN \cdot m$

kondisi II

$M(+) = P_1 \cdot y_1 + P_2 \cdot y_2$
$= 2,4\ kN \cdot 0,8305\ m + 3,1\ kN \cdot 0,322\ m$
$= 2,9914\ kN\ m$

Momen ekstrim terletak pada kondisi II sebesar 2,9914 kN.m

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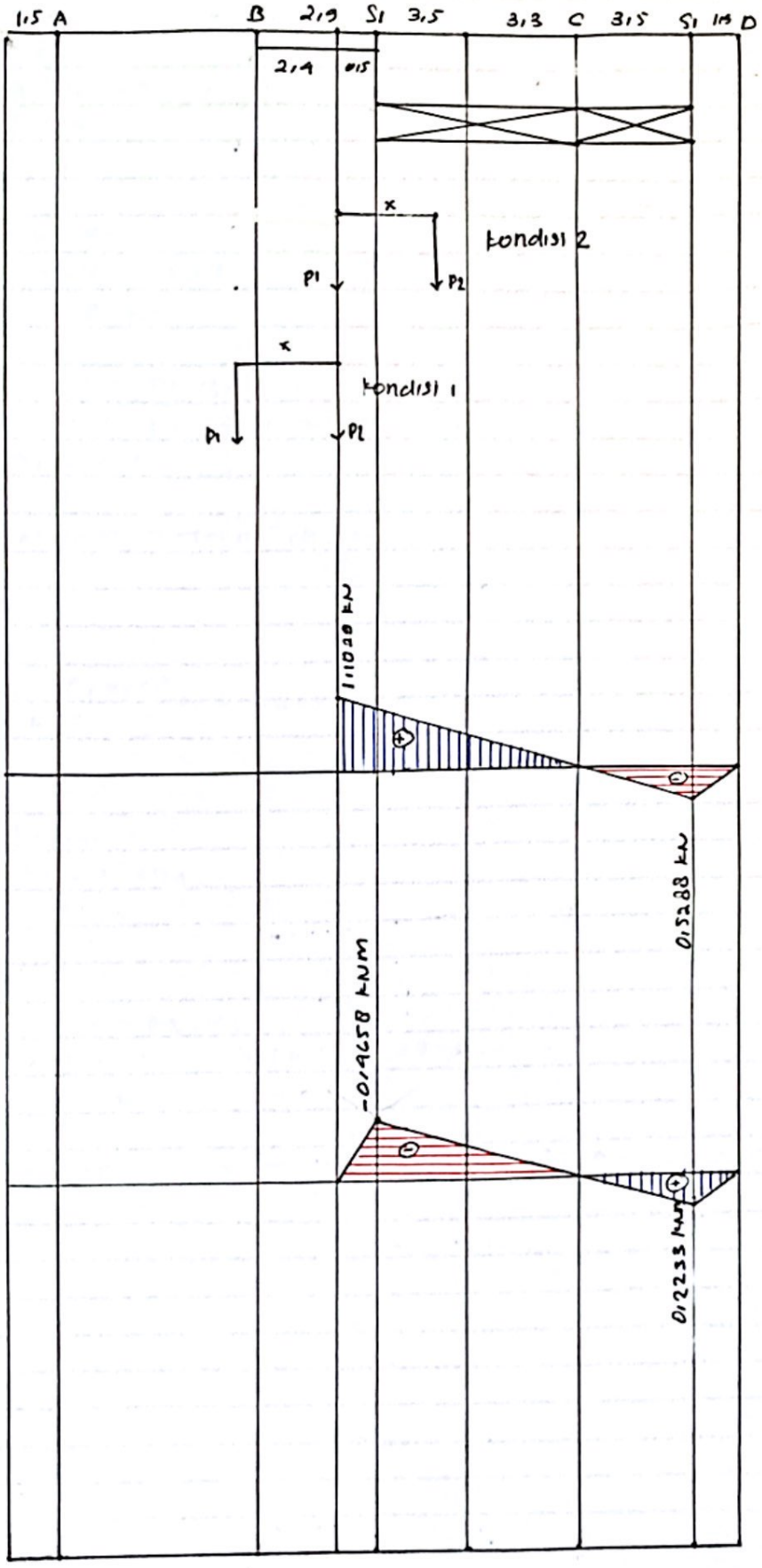

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Besar momen dan lintang ekstrim diplot ||

Lintang

$y_1 = 1,1029$

$y_2 = \frac{4,3 \cdot 1,1029}{7,3} = 0,6497$

kondisi 1

$D(+) = P_2 \cdot y_1$

$= 3,1\ kN \cdot 1,1029$

$= 3,419\ kN$

kondisi II

$D(+) = P_1 \cdot y_1 + P_2 \cdot y_2$

$= 2,4\ kN \cdot 1,1029 + 3,1\ kN \cdot 0,6497$

$= 4,6610\ kN$

Lintang ekstrim terdapat di kondisi II sebesar 4,6610 kN

Momen

$y_1 = 0\ m$

$y_2 = \frac{4,3 \cdot 0,4658}{6,8} = 0,2946$

kondisi I

$M(-) = P_2 \cdot y_1$

$= 3,1\ kN \cdot 0\ m$

$= 0\ kN.m$

kondisi II

$M(-) = P_1 \cdot y_1 + P_2 \cdot y_2$

$= 2,4\ kN \cdot 0\ m + 3,1\ kN \cdot 0,2946\ m$

$= 0,9133\ kN.m$

Momen negatif berdapat di kondisi II sebesar 0,9133 kN.m

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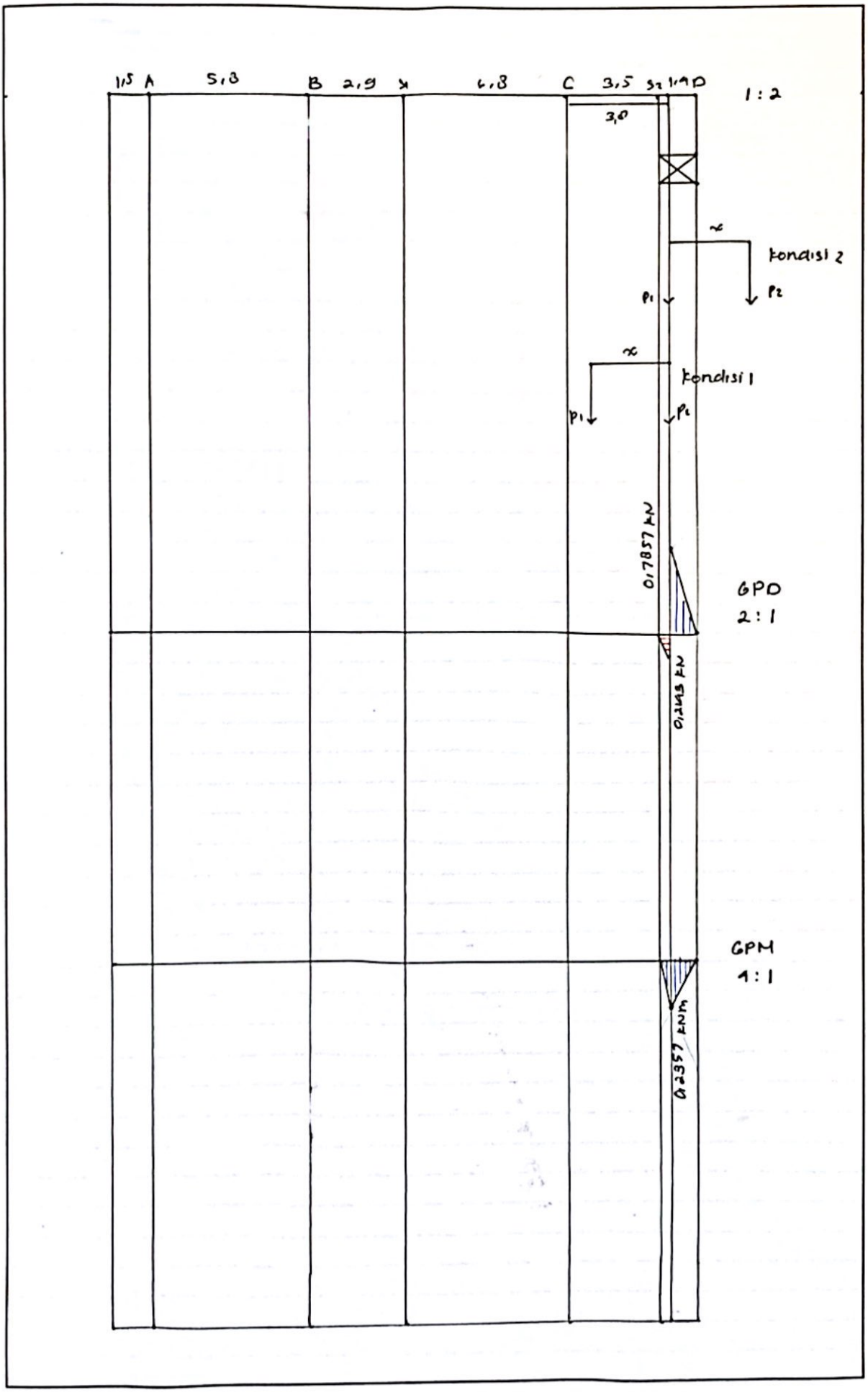

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Besar momen dan lintang ekstrm di titik II

Lintang

$y_1 = 0,2143$

$y_2 = 0,7857$

kondisi I

$D(+) = P_2 . y_2$

$= 3,1\ kN . 0,7857$

$= 2,4357\ kN$

$D(-) = P_2 . y_1$

$= 3,1\ kN . 0,2143$

$= 0,6643\ kN$

kondisi II

$D(+) = P_1 . y_2$

$= 2,1\ kN . 0,7857$

$= 1,6857\ kN$

$D(-) = P_1 . y_1$

$= 2,1\ kN . 0,2143$

$= 0,5143\ kN$

Lintang ekstrm terdapat di kondisi I sebesar 2,4357 kN

Momen

$y_1 = 0,2357\ m$

kondisi I

$M(+) = P_2 . y_1$

$= 3,1\ kN . 0,2357\ m$

$= 0,7307\ kN.m$

kondisi II

$M(+) = P_1 . y_1$

$= 2,1\ kN . 0,2357\ m$

$= 0,5657\ kNm$

Momen ekstrm terdapat di kondisi I sebesar 0,7307 kN.m

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