BAB VI
KESIMPULAN

Praktik Perancangan Bangunan Gedung merancang bangunan apartemen 4 lantai yang berlokasi di Yogyakarta dengan jenis konstruksi struktur beton bertulang. Bentuk atap segitiga dengan tebal 2,3 mm dengan sambungan kuda-kuda diameter 12 mm berjumlah 2. Panjang bordes 2000 mm dengan jumlah anak tangga 20 buah.

Praktik Perancangan Biaya & Waktu direncanakan memiliki volume kolom K1 25,049 m^3 & kolom praktis 5,8401 m^3. Volume balok 0,43 m^3, sloof 2,31 m^3, bordes 1,65 m^3 & tangga 2,939 m^3. Untuk total RAB dari lantai 1-3 sebesar Rp 9.000.876.621,00.

Praktik Perancangan Jalan bertujuan untuk merancang jalan yang dimana tahapan perancangan yang telah mahasiswa laksanakan yaitu merancang trase pada jalan, melakukan perencanaan tikungan ,menghitung cut and fill, menentukan elevasi tepi jalan, dan menghitung profil melintang, setiap tahap dilakukan agar proses perancangan dapat berjalan dengan baik dan benar.

Praktik Perancangan Bangunan Air memiliki luasan DAS sungai Progo sebesar 1835,46 km^2 dengan debit banjir rencana sebesar 1409,2938 m^3/detik. Rencana struktur bendungan tersebut terdapat pada lempira. Analisis stabilitas semua gaya yang terjadi pada bendungan aman.

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LAMPIRAN

Lampiran 1

Praktik Perancangan Bangunan Gedung

# BAB I
PERENCANAAN ATAP
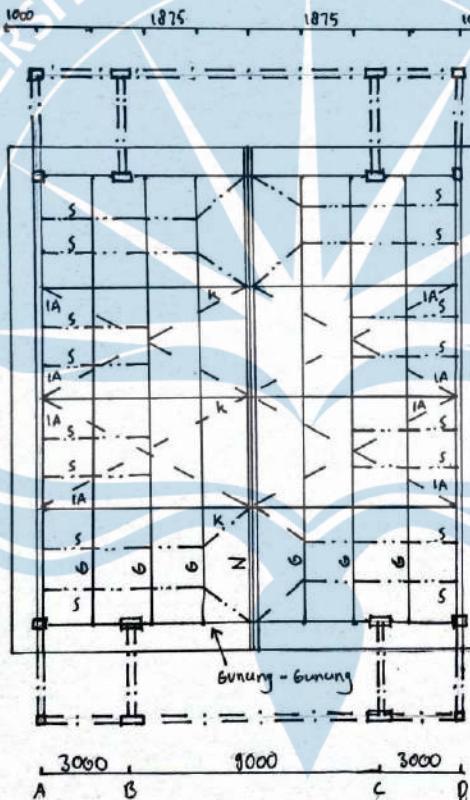
keterangan :

G = Gording C
N = Nok 2C
IA = Ikatan Angin
S = Sag rod
k = kuda-kuda baja siku

Denah rencana atap
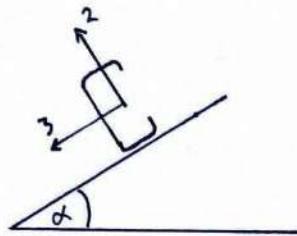
○ Digunakan profil C 150 × 65 ×20 dengan tebal 2,3 mm.

- $W_3 = Zu = 33,0$ cm³
- $W_2 = Zy = 9,4$ cm³
- $Iu = 248$ cm⁴
- $Iy = 41$ cm⁴
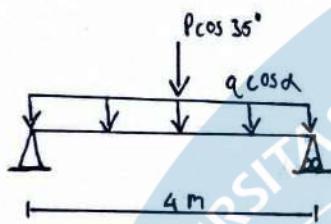
○ Cek defleksi gording

$$\delta_2 = \frac{5}{384} \cdot \frac{1,615 \cos 35 \,(4000)^4}{2.10^5 \cdot 248 \cdot 10^4} + \frac{1}{48} \frac{1.10^3 \cdot \cos 35 \,(4000)^3}{2.10^5 \cdot 248 \cdot 10^4}$$

$$= 11,1$$

$$\delta_3 = \frac{5}{384} \frac{1,615 \sin 35}{2.10^5 \cdot 41 \cdot 10^4} \cdot \left(\frac{4000}{3}\right)^4 + \frac{1}{48} \cdot \frac{1.10^3 \sin 35}{2.10^5 \cdot 41 \cdot 10^4} \left(\frac{4000}{3}\right)^3$$

$$= 0,809$$
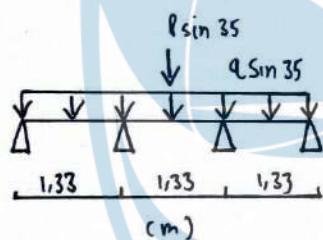
$$\delta = \sqrt{\delta_3^2 + \delta_2^2}$$

$$= \sqrt{0,809^2 + 11,1^2}$$

$$= 11,13 \text{ mm} \leq \frac{1}{240} \cdot L_1$$

$$= 11,13 \text{ mm} \leq 16,67 \text{ mm}$$

○ Hitungan Sag-rod

- Gaya Sag-rod :

$$-Ft,0 = n\left[\frac{4}{3} \cdot q \cdot \sin a\right]$$

$$= 4\left[\frac{4}{3} \cdot 1,615 \cdot \sin 35\right]$$

$$= 4,94 \text{ kN}$$

$\bullet$ $F_{t,L} = \dfrac{n}{2} \cdot P \cdot \sin \alpha$

$\qquad = \dfrac{4}{2} \cdot 1 \cdot \sin 35 \qquad = 1{,}147 \text{ kN}$

$\odot$ kombinasi beban :

- $F_{t,U} = 1{,}4 \cdot F_{t,D}$

$\qquad = 1{,}4 \cdot 4{,}94$

$\qquad = 6{,}916 \text{ kN}$

Pilih yang besar

$F_{t,U} = 7{,}806 \text{ kN}$

- $F_{t,U} = 1{,}2 \cdot F_{t,D} + 1{,}6 \, F_{t,L}$

$\qquad = 1{,}2 \cdot 4{,}94 + 1{,}6 \cdot 1{,}147$

$\qquad = 7{,}806 \text{ kN}$

$\bullet$ Luas batang sag-rod

- $A_{sr} = \dfrac{F_t \cdot 10^3}{\phi \, F_y} \text{ mm}^2 \longrightarrow$ pilih diameter sag-rod

$\qquad = \dfrac{7{,}806 \cdot 10^3}{0{,}9 \cdot 240}$

$\qquad = 36{,}138 \text{ mm}^2$

1.2 Rencana Beban kuda-kuda
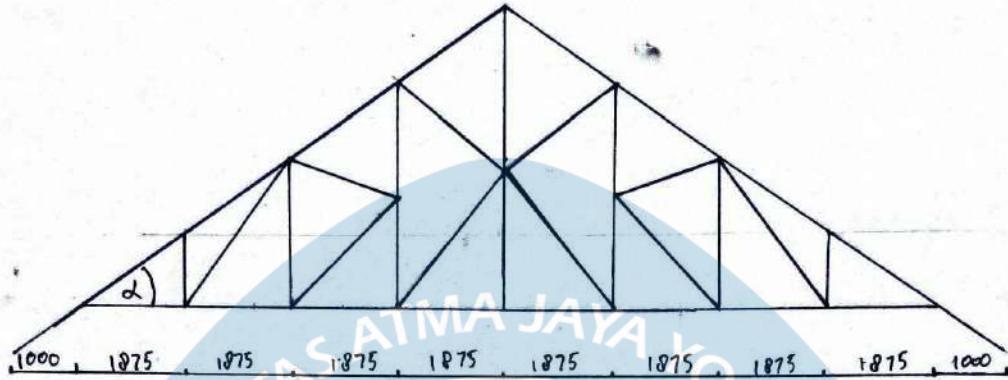
Beban P_1 :
- berat sendiri kuda-kuda $= \dfrac{1,875}{2} \times 0,5$ $= 0,468$ kN
- berat gording $= 4 \times 0,500$ $= 2,2$ kN
- berat atap $= 4 \times \left(\dfrac{1,875}{2} + 1\right) \times \dfrac{0,5}{\cos 35°}$ $= 4,730$ kN
- berat plafon $= 4 \times \left(\dfrac{1,875}{2} + 1\right) \times 0,2$ $= 1,55$ kN $+$

$$\text{Beban } P_1 = 8,948 \text{ kN}$$

Beban P_2 :
- berat sendiri kuda-kuda $= 1,875 \times 0,5$ $= 0,9375$ kN
- berat gording $= 4 \times 0,550$ $= 2,2$ kN
- berat atap $= 4 \times \dfrac{1,875}{\cos 35} \times 0,5$ $= 4,578$ kN
- berat plafon $= 4 \times 1,875 \times 0,2$ $= 1,5$ kN $+$

$$\text{Beban } P_2 = 9,2155 \text{ kN}$$

Beban P_3 :
- berat sendiri kuda-kuda $= 1,875 \times 0,5$ $= 0,9375$ kN
- berat gording $= 2 \times 4 \times 0,550$ $= 4,4$ kN
- berat atap $= 4 \times \dfrac{1,875}{\cos 35} \times 0,5$ $= 4,578$ kN
- berat plafon $= 4 \times 1,875 \times 0,2$ $= 1,5$ kN $+$

$$\text{Beban } P_3 = 11,4155 \text{ kN}$$
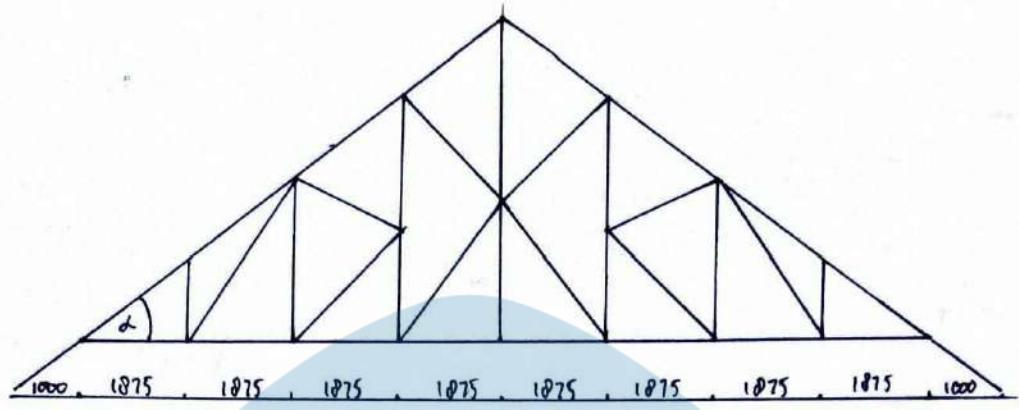
a. Koefisien beban angin
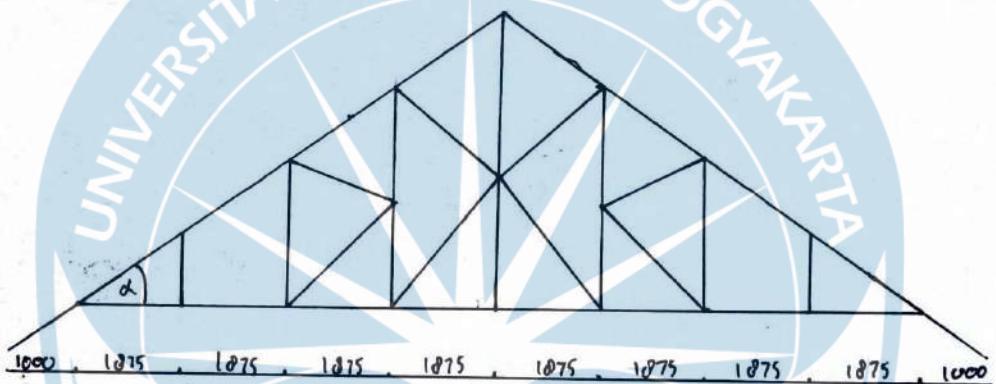
b. Beban angin dari kiri pada joint
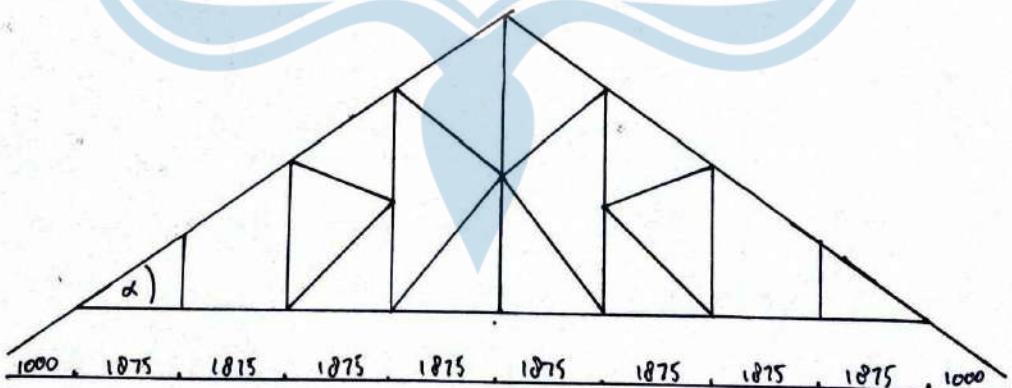
c. Beban angin dari kanan pada joint

- Beban $W_1 = \dfrac{\left(\dfrac{a}{2}+b\right)}{\cos \alpha} \times Cti \times Li \times Qw$

$$= \dfrac{\left(\dfrac{1,875}{2}+1\right)}{\cos 35} \times 0,4 \times 4 \times 0,40 \qquad = 1,514 \ kN$$

- Beban $W_2 = \dfrac{a}{\cos \alpha} \times Cti \times Li \times Qw$

$$= \dfrac{1,875}{\cos 35} \times 0,4 \times 4 \times 0,40 \qquad = 1,465 \ kN$$

- Beban $W_3 = \dfrac{1}{2} \cdot \dfrac{a}{\cos \alpha} \times Cti \times Li \times Qw$

$$= \dfrac{1}{2} \cdot \dfrac{1,875}{\cos 35} \times 0,4 \times 4 \times 0,40 \qquad = 0,732 \ kN$$

- Beban $W_4 = \dfrac{1}{2} \cdot \dfrac{a}{\cos \alpha} \times Cis \times Li \times Qw$

$$= \dfrac{1}{2} \cdot \dfrac{1,875}{\cos 35} \times 0,6 \times 4 \times 0,40 \qquad = 1,098 \ kN$$

- Beban $W_5 = \dfrac{a}{\cos \alpha} \times Cis \times Li \times Qw$

$$\dfrac{1,875}{\cos 35} \times 0,6 \times 4 \times 0,40 = 2,197 \ kN$$

- Beban $W_6 = \dfrac{\left(\dfrac{a}{2}+b\right)}{\cos \alpha} \times Cis \times Li \times Qw$

$$= \dfrac{\left(\dfrac{1,875}{2}+1\right)}{\cos 35} \times 0,6 \times 4 \times 0,40 = 2,271 \ kN$$

1.3 Rencana Elemen kuda - kuda

a) Sketsa profil batang $60 \times 60 \times 6$ dengan $t = 6$
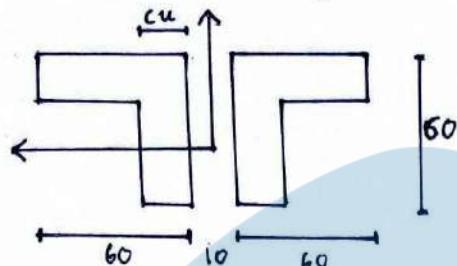
$A = 691$ mm²
$I_u = 22,79 . 10^4$ mm⁴
$I_y = 22,79 . 10^4$ mm⁴
$i_u = i_y = 18,20$ mm
$c_y = c_u = 17$ mm

Inersia gabungan

$A_g = 2 \times 691 = 1382$ mm²

$I_{gu} = 2 (I_{ou} + d_u^2 . A)$
$\quad = 2 (22,79 . 10^4 + 0,691)$
$I_{gu} = 45,58 . 10^4$ mm⁴

$I_{gy} = 2 (I_{oy} + d_y^2 . A)$
$\quad = 2 (22,79 . 10^4 + (17 + \frac{10}{2})^2 \times 691)$
$I_{gy} = 112,468 . 10^4$ mm⁴

$i_u = r_u = \sqrt{\dfrac{45,58 . 10^4}{2 \times 691}} = 18,22$ mm

$i_y = r_y = \sqrt{\dfrac{112,468 . 10^4}{2 \times 691}} = 28,53$ mm

$\therefore r_u < r_y$
$r_u = r_{min}$

Syarat batang tarik !

$\dfrac{\ell_k}{r_{min}} . \leq 240$

$\ell_k \leq 1,5 \times 240$

$\ell_k \leq 360$

Rencana gaya batang tarik

Gaya batang tarik adalah gaya yang bernilai positif, batang dengan gaya positif adalah gaya batang dengan nomor 14-21, 28-34, 36, 38, 40-41, 43.

Cek tegangan

$Fy = 240$ Mpa

$$Ft = \frac{Nv}{\phi \cdot Ag} \leq 240$$

$$= \frac{70,2072 \cdot 10^3}{0,9 \times 1382}$$

$$= 56,45 \leq 240$$

Syarat kelangsingan

$$\lambda = \frac{Lk}{r} \leq 240$$

$$= \frac{1875}{18,2} \leq 240$$

$$= 103,02 \leq 240 \rightarrow \text{memenuhi syarat}$$

Rencana gaya batang tekan

Gaya batang tekan adalah gaya batang dengan nomor 6-13, 22-23, 26-27, 35, 37, 39, 42

Cek tegangan

$$F'c = \frac{W \cdot Nv}{\phi \cdot Ag} \leq Fy$$

$$= \frac{2,38 \cdot 68,5095 \cdot 10^3}{0,85 \cdot 1382}$$

$$= 186,627 \leq 240$$

$$\lambda = \frac{1}{\pi} \cdot \frac{Lu}{r} \cdot \sqrt{\frac{Fy}{E}}$$

$$= \frac{1}{\pi} \cdot \frac{2288,73}{18,2} \cdot \sqrt{\frac{240}{2 \cdot 10^5}}$$

$$= 1,38$$

$$W = 1,25 \cdot (\lambda c)^2$$

$$= 1,25 \cdot (1,3)^2$$

$$= 2,38$$

$\lambda c =$

Syarat kelangsingan

$$\lambda = \frac{Lu}{r} \leq 200$$

$$= \frac{2288,73}{18,2}$$

$$= 125,48 \leq 200 \quad \text{(memenuhi syarat)}$$

b) Sketsa profil batang $50 \times 50 \times 5$ dengan $t = 5$
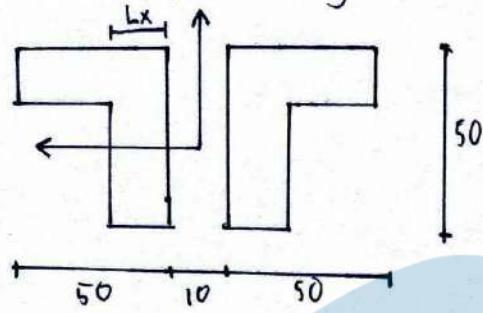
$A = 480,2 \ mm^2$

$I_u = 11,1 \times 10^4 \ mm^4$

$I_y = 11,1 \times 10^4 \ mm^4$

$i_u = i_y = 15,2 \ mm$

$C_y = C_u = 14,1 \ mm$

Inersia gabungan

$A_g = 2 \times 480,2 = 960,4$

$I_{xg} = 2 \left(I_{ox} + du^2 . A \right)$

$\quad = 2 \left(11,1 . 10^4 + 0,480_{,}2 \right)$

$\quad = 22,20 . 10^4 \ mm^4$

$I_{yg} = 2 \left(I_{oy} + dy^2 . A \right)$

$\quad = 2 \left(11,1 . 10^4 + \left(14.1 + \dfrac{10}{2} \right)^2 . 480,2 \right)$

$\quad = 57,236 . 10^4 \ mm^4$

$i_x = r_x = \sqrt{\dfrac{22,2 . 10^4}{2 \times 240,2}}$

$\qquad = 15,2 \ mm$

$i_y = r_y = \sqrt{\dfrac{57,236 . 10^4}{2 \times 480,2}}$

$\qquad = 24,4 \ mm$

$\therefore \lambda x < r_y$

$r_u = min$

Syarat batang tarik :

$\dfrac{\lambda_u}{r_{min}} \leq 240$

$\lambda_u \leq 1,5 . 240$

$\lambda_u \leq 360$

Bencana gaya batang tarik pada profil 50 × 50 × 5

Cek tegangan

$f_y = 240$ Mpa

$f_t = \dfrac{Nu}{\phi \cdot Ag} = \dfrac{27,9776 \cdot 10^3}{0,9 \times 960,4} = 32,367$ kN

Syarat kelangsingan

$\lambda = \dfrac{Lk}{r} \leq 240$

$= \dfrac{3225,87}{15,2} = 212,23 \leq 240$ (memenuhi syarat)

Rencana gaya batang tekan pada profil 50 × 50 × 5

Cek tegangan

$f_c = \dfrac{W \cdot Nu}{\phi \cdot Ag} \leq f_y$

$= \dfrac{3,44 \cdot 5,22 \cdot 10^3}{0,85 \cdot 960,4} \leq 240$

$= 84,1226 \leq 240$

$\lambda c = \dfrac{1}{\pi} \cdot \dfrac{Lk}{r} \cdot \sqrt{\dfrac{F_y}{E}}$

$= \dfrac{1}{\pi} \cdot \dfrac{26,25}{15,2} \cdot \sqrt{\dfrac{240}{2 \cdot 10^5}}$

$= 1,9$

$W = 1,25 \cdot (\lambda_c)^2$

$= 1,25 \cdot (1,9)^2$

$= 4,512$

Syarat kelangsingan

$\lambda = \dfrac{Lk}{r} \leq 200 = \dfrac{2625}{15,2} = 172,7 \leq 200$ (memenuhi syarat)

1.4 Rencana Sambungan Elemen kuda-kuda

Menggunakan diameter baut 12 mm

$Vd = \phi \cdot F \cdot r_1 \cdot Fub \cdot Ab$

$\quad = 0{,}75 \cdot 0{,}4 \cdot 560 \ (1/4 \ \pi \cdot d^2)$

$\quad = 0{,}75 \cdot 0{,}4 \cdot 560 \ (1/4 \cdot \pi \cdot 12^2)$

$\quad = 19000{,}3524 \ N \rightarrow 2Vd = 38000{,}7048 \ N$

$Rd = 2{,}4 \cdot \phi f \cdot db \cdot tp \cdot Fu$

$\quad = 2{,}4 \cdot 0{,}75 \cdot 12 \cdot 8 \cdot 240$

$\quad = 41472 \ N$

Dipilih gaya rencana terbesar $= 70{,}2072$

Jumlah baut $(nb) = \dfrac{Nu}{2Vd}$

$\qquad\qquad = \dfrac{70{,}2072}{2 \times 19000{,}3524}$

$\qquad\qquad = 1{,}84 \approx 2 \ baut$

HITUNGAN GAYA BATANG KUDA - KUDA

Beban LL KN		Kanan Wka KN	1	,2.DL + 1,6.LL	,2.DL + 1,3.Wki + 0	0,5.LL	Gaya Rencana KN	Tarik atau Tekan
4	5	6	7	8	9			
		8.248	-10.814	66.4910	64.9672	70.2072	45.4260	70.2072	TARIK
		6.983	-8.924	57.5414	56.1836	60.5436	39.8646	60.5436	TARIK
		5.703	-7.004	48.272	47.0896	50.5754	34.0563	50.5754	TARIK
		3.890	-5.157	46.6704	45.5072	46.7919	35.019	46.7919	TARIK
		3.897	-5.155	46.6704	45.5072	46.7893	35.021	46.7893	TARIK
		2.508	-3.81	48.272	47.0896	48.272	38.2085	48.272	TARIK
	0.59		-2.532	57.5414	52.2327	57.5414	48.1741	57.5414	TARIK
		-1.305	-1.261	66.4916	57.7883	66.4916	57.8455	66.4916	TARIK
	-0.003247	0.0005766	0.0322	0.0296124	0.0246419	0.0322	0.0024641	0.0322	TARIK
-0.186	-0.6	-1.242	27.9776	27.4656	24.2898	27.9776	23.455	27.9776	TARIK
		1.942	-1.88	-2.2792	-2.2512	0.478	-4.4906	0.478	TARIK
		-0.738	-0.093	10.6442	10.4292	10.6442	9.4107	10.6442	TARIK
		-2.523	2.585	-2.2792	-5.3265	1.3139	1.3139	1.3139	TARIK
		-0.734	-9.70E-02	10.6442	8.5774	10.6442	9.4055	10.6442	TARIK
		3.103	2.309	2.7454	-0.6314	-0.6314			TARIK
		-2.774	-3.176	2.7454	6.4990	6.4991	-1.6630	6.4991	TARIK
	1.82		1.848	13.3952	8.3944	14.403	14.403	14.403	TARIK
		2.169	-2.778	13.3952	14.3666	14.3666	8.3892	14.3666	TARIK
		-3.238	-3.236	15.3062	16.5328	16.5328	9.5065	16.5328	TARIK
		1.993	2.17	15.3062	9.5027	16.5354	16.5354	16.5354	TARIK
0.084		2.654	-1.332	-9.5354	-5.9518	-5.9518	-1740.142	-5.9518	TEKAN
6.086		0.486	-1.774	-12.6883	-7.9174	-7.9174	-2317.5676	-7.9174	TEKAN
6.072		-0.528	3.175	-81.193	-72.0052	-68.5099	-68.5099	-66.3858	TEKAN
4.353		1.542	4.691	-81.0222	-73.1705	-66.3858	-66.3858	-66.3858	TEKAN
3.755		1.423	1.597	-58.9008	-50.6603	-50.588	-50.588	-50.5888	TEKAN
4.355		0.153	0.715	-38.3754	-32.4078	-32.4078	-33.341	-32.4078	TEKAN
5.073		1.595	1.999	-38.3754	-34.0718	-31.6772	-31.677	-31.6772	TEKAN
6.086		4.694	1.544	-58.9008	-50.5914	-50.5914	-50.657	-50.5914	TEKAN
0.720		3.182	-0.531	-81.022	-66.3810	-66.3810	-73.1744	-66.3810	TEKAN
		-1.355	0.470	-81.137	-68.452	-68.4524	-71.9663	-68.4524	TEKAN
		1.775	1.966	-9.5354	-10.3043	-5.9860	-5.9860	-5.9860	TEKAN
1.793		2.980	2.655	-12.6883	-13.675	-7.9161	-7.9161	-7.9161	TEKAN
1.793		0.915	1.48E+00	-20.5001	14.4868	14.4868	-20.2835	14.4868	TEKAN
		2.034	2.417	-20.5001	19.5516	19.5516	-15.2	-15.2	TEKAN
		1.353	1.355	9.8166	6.1507	6.1507	-10.5564	-6.1507	TEKAN
			2.032	9.8166	10.5530	6.1533	-6.1533	-6.1533	TEKAN

PROFIL 50X50X5

PROFIL 60X60X6

No Batang	Panjang mm	Beban DL KN
1	2	3
14	1875	47.494
15	1875	41.101
16	1875	34.48
17	1875	33.336
18	1875	33.336
19	1875	34.48
20	1875	41.101
21	1875	47.494
24	2625	0.023
25	2625	19.984
26	1968.75	-1.628
27	1968.75	7.603
28	1968.75	-1.628
29	1968.75	7.603
30	3225.87	1.961
32	3225.87	1.961
34	2718.75	9.568
36	2718.75	9.568
38	3225.87	10.933
40	3225.87	10.933
3	2625	-6.811
4	1312.5	-9.063
6	2288.73	-57.995
7	2288.73	-57.873
8	2288.73	-42.072
9	2288.73	-27.411
10	2288.73	-27.411
11	2288.73	-42.072
12	2288.73	-57.873
13	2288.73	-57.955
22	2625	-6.811
23	1312.5	-9.063
31	2288.73	-14.643
33	2288.73	-14.643
35	1986.53	-7.012
37	1986.53	-7.012
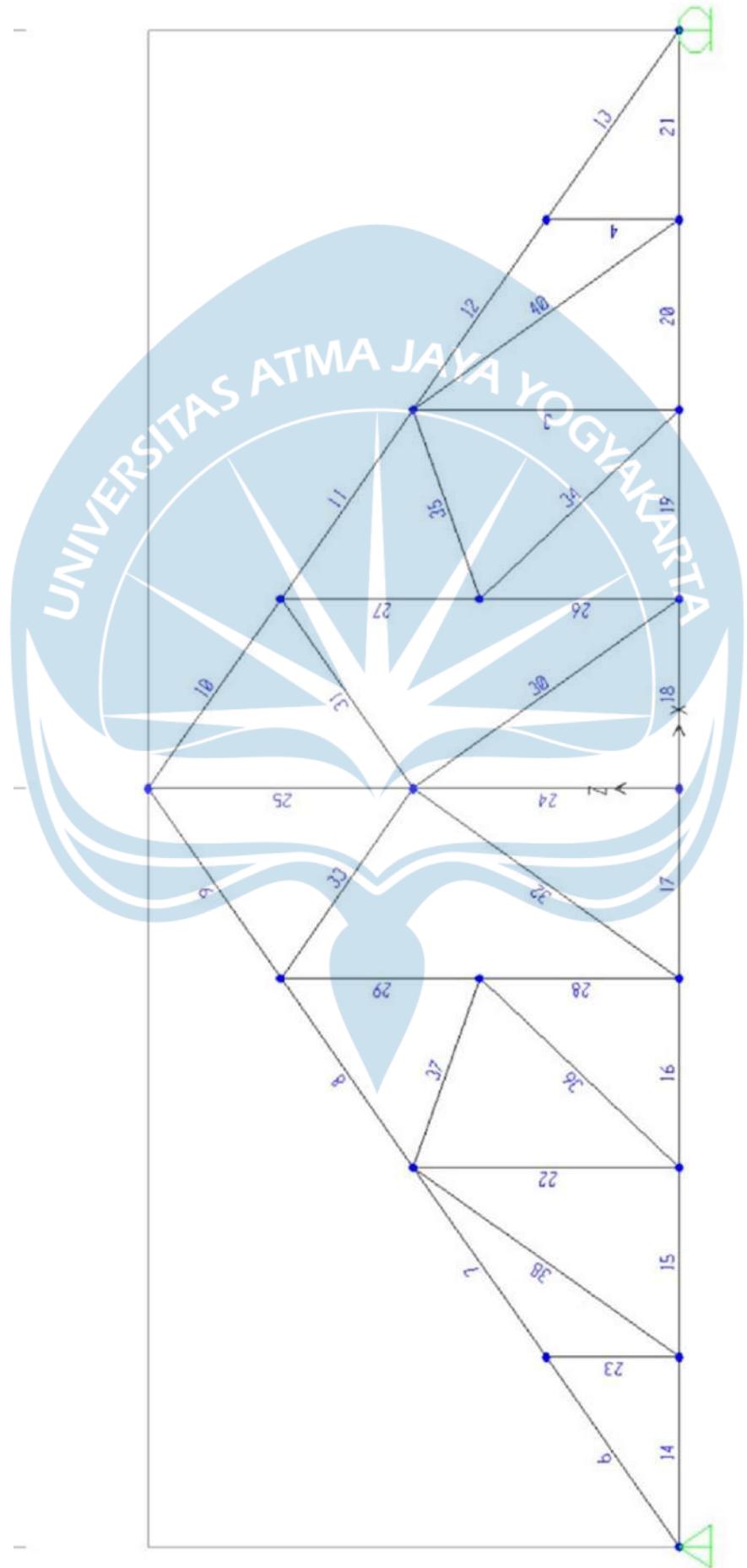
BAB II
PERENCANAAN TANGGA DAN PELAT

2.1 Denah Ruang Tangga
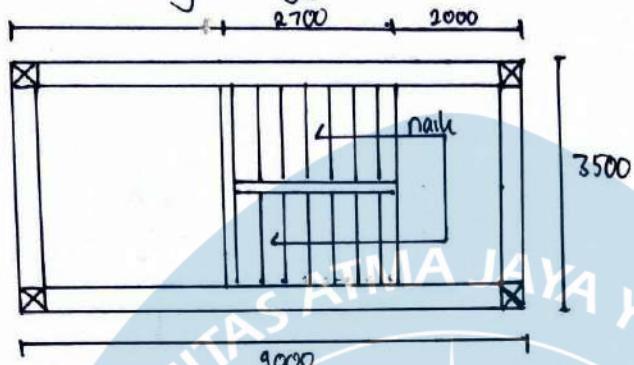
(a) Denah ruang tangga

- Bordes $= \frac{1}{2} \cdot L_1$

  $= \frac{1}{2} \cdot 4000$

  $= 2000 \text{ mm}$

- Jumlah Tangga

$A = 300 \text{ mm}$

$O = 185 \text{ mm}$

$h_{tg} = 150 \text{ mm}$

$n_{tg} = \dfrac{h_{lt}}{O} = \dfrac{3700}{185} = 20 \text{ buah}$
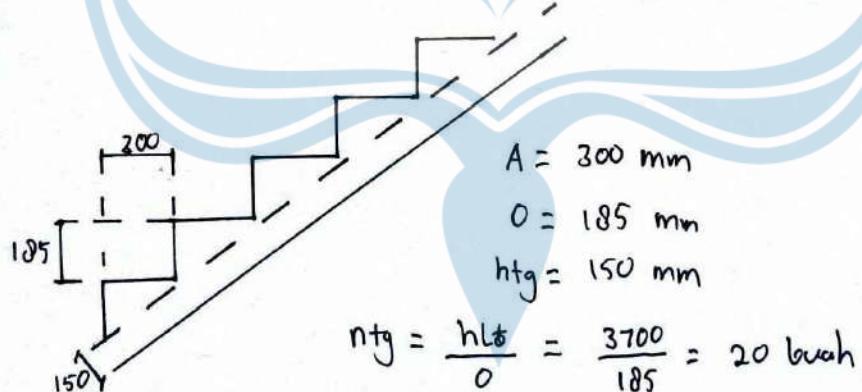
(b) Detail anak tangga

- Lebar tangga

  $L_{tg} = \left(\frac{1}{2} \frac{h_{lt}}{O} - 1 \right) \cdot A$

  $= \left(\frac{1}{2} \cdot \frac{3700}{185} - 1 \right) \cdot 300$

  $L_{tg} = 2700 \text{ mm}$

- Sudut · kemiringan

$$\alpha = \tan^{-1}\left(\frac{O}{A}\right)$$
$$= \tan^{-1}\left(\frac{185}{300}\right)$$
$$= 31{,}6°$$

2.2 Rencana Beton Tangga
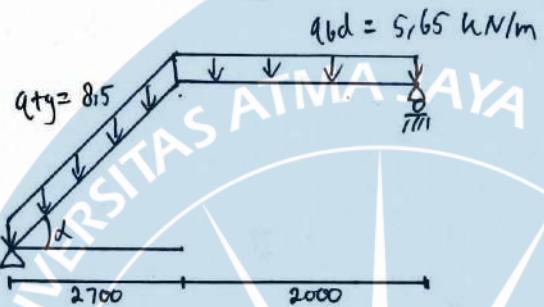
Gambar 2.2 Potongan 1 tangga dan beban tangga

Beban q tg : - Berat sendiri tangga $= \dfrac{htg}{\cos\alpha} \times$ berat volume beton

$$= \dfrac{0{,}15}{\cos 31{,}6} \times 2{,}4 \qquad = 4{,}23 \text{ kN/m}^2$$

- Berat anak tangga $= \frac{1}{2} . O \times$ berat vol beton

$$\frac{1}{2} . 0{,}185 \times 2{,}4 \qquad = 2{,}22 \text{ kN/m}^2$$

- Berat ubin dan spesi $= 0{,}05 \times$ berat volume ubin

$$= 0{,}05 \times 21 \qquad = 1{,}05 \text{ kN/m}^2$$

- Berat railing $\qquad\qquad\qquad = 1{,}00 \text{ kN/m}^2$ +
_____

Beban q tg $= 8{,}5 \text{ kN/m}^2$

Beban q bd : - Berat sendiri tangga $= htg \times$ berat volume beton

$$= 0{,}15 \times 24 \qquad = 3{,}6 \text{ kN/m}^2$$

- Berat ubin dan spesi $= 0{,}05 \times$ berat volum ubin

$$= 0{,}05 \times 21 \qquad = 1{,}05 \text{ kN/m}^2$$

- Berat railing $\qquad\qquad\qquad = 1{,}00 \text{ kN/m}^2$ +
_____

Beban q bd $= 5{,}65 \text{ kN/m}^2$

Dari pemodelan Sap 2000 diperoleh SFD + BMD dan realisi tumpuan

- Akibat beban hidup (LIVE)

SFD

BMD

- Akibat beban mati (DEAD)

SFD

BMD

- MDL = 21,2447
- VDL = 18,998
- MLL = 13,89
- VLL = 12,20
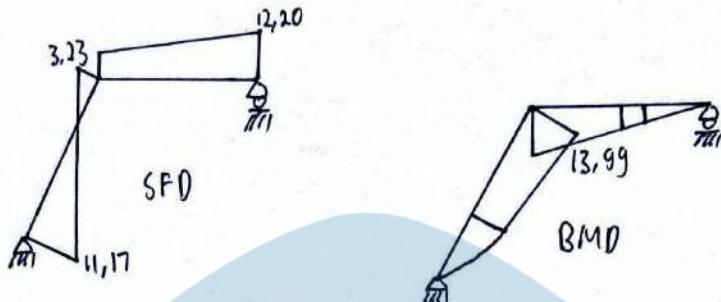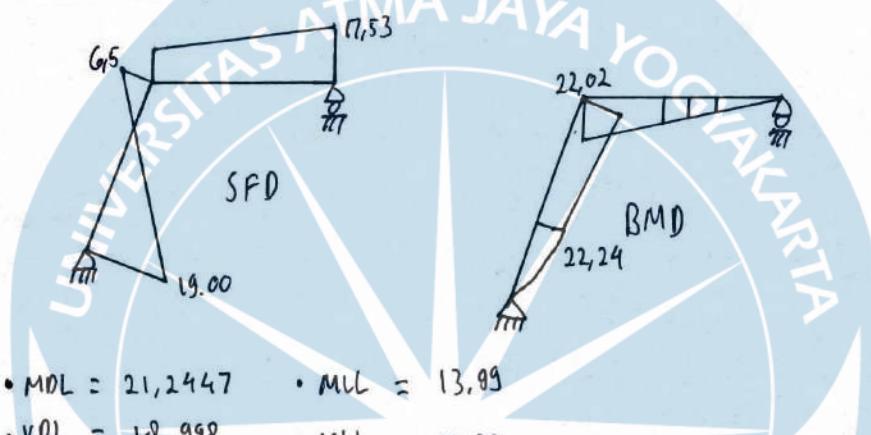
Gambar 2.3 Gambar SFD dan BMD tangga dari SAP 2000

2.3 Rencana Penulangan

- $M_u = 1,4 \, MDL = 31,1425$

- $M_v = 1,2 \, MDL + 1,6 \, MLL = 49,08$

- $V_u = 1,4 \, VDL = 26,5972$

- $V_v = 1,2 \, VDL + 1,6 \, MLL = 45,184$

Sehingga :

$M_{ur} = 49,08 \, kN_m$

$V_{ur} = 45,184 \, kN_m$

2.3.1 Rencana Penulangan Tangga Tumpuan

$$M_{ux} = 0,5 \cdot M_{ur} = 0,5 \cdot 49,08 = 24,54 \text{ kN}$$

Direncanakan

Tulangan pokok $= D_{16} \cdot A_s = \frac{1}{4}\, a \cdot 16^2 = 201,06 \text{ mm}^2$

Tulangan susut $= P_8 \cdot A_s = \frac{1}{4}\, \pi \cdot 8^2 = 50,265 \text{ mm}^2$

$F'_c = 20 \text{ Mpa}$

$b = 1000 \text{ mm}$

$n = 150 \text{ mm}$

F_y tulangan pokok $= 420 \text{ Mpa}$

F_y tulangan susut $= 240 \text{ Mpa}$

Selimut $= 20 \text{ mm}$ $\qquad \phi = 0,9$

$$d_s = 150 - (20 + (0,5 \times 16))$$
$$= 122 \text{ mm}$$

- R_n perlu $= \dfrac{M_u}{\phi\, b\, d^2} = \dfrac{24,54 \cdot 10^6}{0,9 \cdot 1000 \cdot 122^2} = 1,83 \text{ Mpa}$

- P perlu $= \dfrac{0,85\, F'_c}{F_y} \cdot \left(1 - \sqrt{1 - \dfrac{2 R_n}{0,85 \cdot F'_c}}\right)$

$$= \dfrac{0,85 \cdot 20}{420} \cdot \left(1 - \sqrt{1 - \dfrac{2 \cdot 1,83}{0,85 \cdot 20}}\right)$$

$$= 0,0046$$

- $P_{min} = \dfrac{1,4}{F_y} = \dfrac{1,4}{420} = 0,0033$

- $P_{max} = 0,75 \left(\dfrac{0,85 \cdot B_1 \cdot F_c}{F_y}\right)\left(\dfrac{600}{600 + F_y}\right)$

$$= 0,75 \left(\dfrac{0,85 \cdot 0,85 \cdot 20}{420}\right)\left(\dfrac{600}{600 + 420}\right)$$

$$= 0,0151$$

$P_{min} < P$ perlu $< P_{max}$

$0,0033 < 0,0046 < 0,0151$ (AMAN)

- As perlu $= \rho_{perlu} \cdot b \cdot d$

  $= 0,0046 \cdot 1000 \cdot 122$

  $= 561,2$

  $S = \dfrac{As\ tul}{As\ perlu} \cdot b$

  $= \dfrac{201,06}{561,2} \cdot 1000 =$

  $= 358,26 \approx 300\ mm$

  $\therefore$ Digunakan D16 - 300

- Cek terhadap geser

  $V_c = \dfrac{1}{6}\sqrt{f'c} \cdot b \cdot d$

  $= \dfrac{1}{6}\sqrt{20} \cdot 1000 \cdot 122$

  $= 90933,4\ N = 90,933\ kN$

  $\phi V_c = 0,75 \times 90,933$

  $= 68,20$

  $\phi V_c > V_u$

  $68,20 > 45,184$

- Tulangan susut

  As min $= \rho_{min} \cdot b \cdot d$

  $= 0,0033 \cdot 1000 \cdot 122$

  $= 402,6$

  As tul $= 50,265\ mm^4$

  $S = \dfrac{As\ tul}{As\ min} \cdot b = \dfrac{50,265}{402,6} \cdot 1000 = 124 \approx 100\ mm$

  $\therefore$ Digunakan P8 - 100

- As $= \rho_{perlu} \cdot b \cdot d > As\ min$

  $= 0,0046 \cdot 1000 \cdot 122 > As\ min$

  $= 561,2 \quad > 402,6\ mm^2$

2.3.2 Rencana Penulangan Tangga Lapangan

$$M_{ux} = 0,8 \ M_{ur}$$
$$= 0,8 \cdot 49,08$$
$$= 39,264 \ kNm$$

$$V_u = 45,184 \ kNm.$$

- $R_n \ perlu = \dfrac{M_u}{0,9 \cdot b \cdot d^2}$

$$= \dfrac{39,264 \cdot 10^6}{0,9 \cdot 1000 \cdot 122^2}$$

$$= 2,93 \ Mpa$$

- $\rho \ perlu = \dfrac{0,85 \cdot 20}{420} \left(1 - \sqrt{1 - \dfrac{2 \cdot 2,93}{0,85 \cdot 20}} \right)$

$$= 0,00771$$

- $\rho_{min} = \dfrac{1,4}{420}$

$$= 0,0033$$

- $\rho_{max} = 0,75 \left(\dfrac{0,85 \cdot 0,85 \cdot 20}{420} \right) \left(\dfrac{600}{600 + 420} \right)$

$$= 0,0151$$

$$\rho_{min} \ < \ \rho \ perlu \ < \ \rho_{max}$$
$$0,0033 \ < \ 0,00771 \ < \ 0,0151$$

- $As \ perlu = \rho \ perlu \cdot b \cdot d$

$$= 0,00771 \cdot 1000 \cdot 122$$

$$= 940,62 \ mm^2$$

- $As \ min = \rho_{min} \cdot b \cdot d$

$$= 0,0033 \cdot 1000 \cdot 122$$

$$= 402,6 \ mm^2$$

$$\therefore \ \text{Dipilih As terbesar} : As = 940,62 \ mm^2$$

$$S = \frac{201,06}{940,62} \cdot 1000$$

$$= 213,75 \approx 200 \text{ mm}^2$$

$$\therefore \text{ Digunakan } D16 - 200$$

2.4 Balok bordes Tangga

·) Pembebanan bordes

- Dinding $= \left(\frac{3,7}{2} - 0,2\right) \cdot 2,5 = 4,125$ kN/m
- Reaksi DL tumpuan border $= 17,53$ kN/m
- Berat sendiri $= 1,44$ kN/m +

$$\overline{}$$

$$Q_{DL} = 23,10 \text{ kN/m}$$

$$Q_{LL} = 12,20 \text{ kN/m}$$

• $q_u = 1,2 DL + 1,6 LL$

$= 1,2 (23,10) + 1,6 (12,20)$

$= 47,24$ kN/m

• $M_u = \frac{1}{8} \cdot q_u \cdot (L)^2$

$= \frac{1}{8} \cdot 47,24 (3,5)^2$

$= 72,34$ kNm

·) Tulangan geser

$V_u = \frac{1}{2} \cdot 47,24 \cdot 3,5$

$= 82,67$ kN

$V_c = \frac{1}{6} \cdot \sqrt{Fc'} \cdot b \cdot d$

$= \frac{1}{6} \sqrt{20} \cdot 200 \cdot 264$

$= 39354,8 \text{ N} = 39,35 \text{ kN}$

$\phi V_C > V_u$

$0,75 \cdot 39,35 > 82,67$

$29,51 > 82,67 \longrightarrow \text{ SALAH}$

•> Maka

$$V_s = \frac{V_v}{\phi} - V_c \, \phi$$

$$= \frac{92,67}{0,75} - 39,85 \cdot 0,75$$

$$= 80,71 \text{ kN}$$

- $V_s \leq 0,66 \sqrt{Fc'} \cdot b \cdot d$

  $V_s \leq 0,66 \sqrt{20} \cdot 200 \cdot 244$

  $80,71 \leq 144,038 \text{ kN}$

- $S = \dfrac{Av \cdot Fy \cdot d}{V_s}$

  $$= \frac{1/4 \cdot \pi \cdot 8^2 \cdot 420 \cdot 264}{80,71}$$

  $$= 69055,1 \text{ N} \approx 69 \text{ kN}$$

- $S_{max} = 1/2 \, d$ karena $V_s \leq 0,33 \sqrt{Fc'} \cdot b \cdot d$

  $= 1/2 \cdot 264 \qquad\qquad = 0,33 \sqrt{20} \cdot 200 \cdot 264$

  $= 132 \text{ mm} \qquad\qquad = 77922,5 \text{ N}$

  $\approx 100 \text{ mm} \qquad\qquad = 77,9 \text{ kN}$

  $\therefore$ Digunakan $P\delta - 100 \text{ mm}$

- $Mu \text{ tumpuan} = 0,5 \cdot Mu$

  $= 0,5 \cdot 72,34$

  $= 36,17 \text{ kNm}$

- $Mu \text{ lapangan} = 0,8 \cdot Mu$

  $= 0,8 \cdot 72,34$

  $= 57,87 \text{ kNm}$

•> Dimensi balok bordes

- digunakan (asumsi) → $b = 200$ mm
  $h = 300$ mm

  ϕ sengkang $= 8$ mm
  ϕ tulangan $= 16$ mm
  Selimut beton $= 20$ mm
  $Fy = 420$ Mpa
  $d = h - d_i$
  $= 300 - (20 + 8 + \frac{1}{2} \cdot 16)$
  $= 264$

•> Tulangan tumpuan

Asumsi $\phi = 0,9$

$Rn = \dfrac{Mu \; tumpuan}{\phi \cdot b \cdot d^2}$

$= \dfrac{36,17}{0,9 \cdot 200 \cdot 264^2}$

$= 2,88$ Mpa

$P perlu = \dfrac{0,85 \cdot Fc'}{Fi} \left(1 - \sqrt{1 - \dfrac{2Rn}{0,85 Fc'}}\right)$

$= \dfrac{0,85 \cdot 20}{420} \left(1 - \sqrt{1 - \dfrac{2 \cdot 2,88}{0,85 \cdot 20}}\right)$

$= 0,00756$

$P min = \dfrac{\sqrt{Fc'}}{4 Fy} = \dfrac{\sqrt{20}}{4 \cdot 420} = 0,0026$

$P max = 0,429 \left(\dfrac{0,85 \cdot P_1 \cdot Fc'}{Fy}\right)$

$= 0,429 \left(\dfrac{0,85 \cdot 0,85 \cdot 20}{420}\right)$

$= 0,0147$

$Pmin < Pperlu < Pmax$
$0,0026 < 0,00756 < 0,0147$ (Pakai tulangan tunggal)

- Jumlah tulangan $(n) = \ldots$?

$$n = \frac{As\ perlu}{As\ tul} = \frac{\rho \cdot b \cdot d}{\frac{1}{4} \cdot \pi \cdot D^2}$$

$$= \frac{0,00756 \cdot 200 \cdot 264}{\frac{1}{4} \cdot \pi \cdot 16^2}$$

$$= 1,98 \qquad \approx 2\ \text{Tulangan}$$

$$\therefore \text{Digunakan}\ 2D16$$

- Cek jarak bawah

$$X = \frac{200 - (20.2 + 8.2 + 16.2)}{2}$$

$$= 56\ mm$$

$$X \geqslant db$$

$$56\ mm \geqslant 25\ mm \ldots\ ok!$$
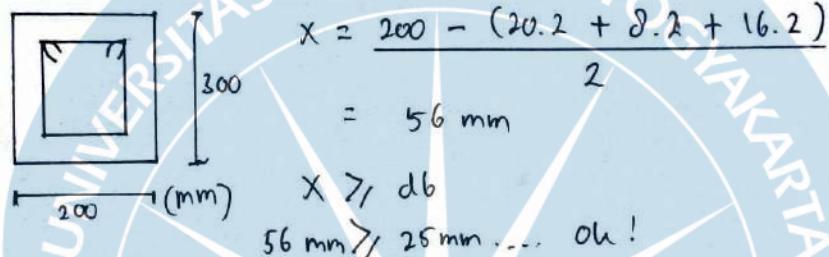
- $As = n\left(\frac{1}{4}\,\pi \cdot D^2\right)$

$$= 2\left(\frac{1}{4} \cdot \pi \cdot 16^2\right)$$

$$= 402,124\ mm^2$$

$$ds = 20 + 8 + \frac{1}{2} \cdot 16$$

$$= 36$$

- Cek $\phi Mn > Mu$

$$Cc = Ts$$

$$0,85 \cdot Fc' \cdot a \cdot b = As \cdot Fy$$

$$a = \frac{As \cdot Fy}{Fc' \cdot 0,85 \cdot b}$$

$$= \frac{402,124 \cdot 420}{20 \cdot 0,85 \cdot 200}$$

$$= 49,67\ mm$$

- $Z = d - \dfrac{a}{2}$

$\qquad = 264 - \dfrac{49,67}{2}$

$\qquad = 239,165 \text{ mm}$

- $Mn = TS \cdot Z$

$\qquad = As \cdot Fy \cdot Z$

$\qquad = 402,124 \cdot 420 \cdot 239,165$

$\qquad = 40393074,3 \text{ Nmm}$

$\qquad = 40,4 \text{ kNm}$

$\phi Mn \geqslant Mu$

$0,9 (40,39) \geqslant 36,17$

$36,36 \geqslant 36,17 \ldots \text{ ok!}$

•➔ Tulangan lapangan

$Rn = \dfrac{Mu \cdot lap}{\phi \cdot b \cdot d^2}$

$\qquad = \dfrac{57,87}{0,9 \cdot 200 \cdot 264^2}$

$\qquad = 4,613 \text{ Mpa}$

$P_{min} = \dfrac{1,4}{Fy} = \dfrac{1,4}{420} = 0,0033$

$P_{min} = \dfrac{\sqrt{Fc'}}{4 Fy} = \dfrac{\sqrt{20}}{4 \cdot 420} = 0,00266$

$P_{perlu} = \dfrac{0,85 \cdot Fc'}{Fy} \cdot \left(1 - \sqrt{1 - \dfrac{2Rn}{0,85 \cdot Fc'}}\right)$

$\qquad = \dfrac{0,85 \cdot 20}{420} \cdot \left(1 - \sqrt{1 - \dfrac{2 \cdot 4,613}{0,85 \cdot 20}}\right) = 0,013$

$$P_{max} = 0,429 \left(\frac{0,85 \cdot \beta_1 \cdot Fc'}{Fy} \right)$$

$$= 0,429 \left(\frac{0,85 \cdot 0,85 \cdot 20}{420} \right)$$

$$= 0,0147$$

$P_{perlu} < P_{max}$

$0,013 < 0,0147 \longrightarrow$ menggunakan tulang tunggal

- Jumlah tulangan (n)

$$n = \frac{As \, perlu}{As \, tul}$$

$$= \frac{P \cdot b \cdot d}{\frac{1}{4} \cdot \pi \cdot 16^2}$$

$$= \frac{0,013 \cdot 200 \cdot 264}{\frac{1}{4} \, \pi \cdot 16^2} = 3,4 \quad \approx \quad 4 \, \text{tulangan}$$

$$X = \frac{200 - (20 \cdot 2 + 8 \cdot 2 + 16 \cdot 4)}{3}$$

$$X = 26,6 \, mm$$

$$X \geqslant db$$

$$26,6 \, mm \geqslant 25 \, mm \ldots \, ok!$$
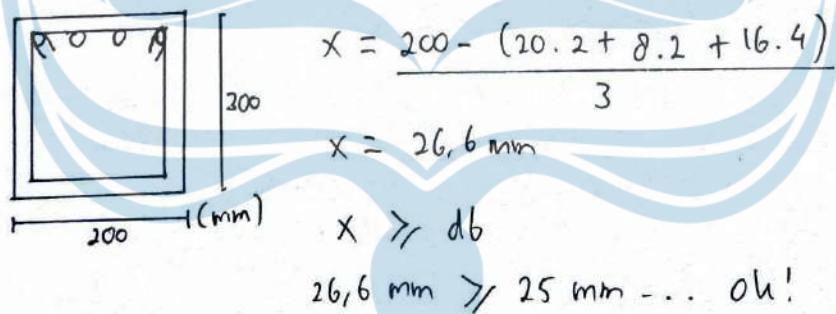
- $As = n \left(\frac{1}{4} \pi \cdot \emptyset^2 \right)$

$$= 4 \left(\frac{1}{4} \cdot \pi \cdot 16^2 \right)$$

$$= 804,25 \, mm^2$$

$ds = 20 + 8 + \frac{1}{2} \cdot 16$

$\quad = 36 \, mm$

$\emptyset \, Mn > Mu$

$$C_1 = T_S$$

$$0.85 . Fc' . a . b = As \, F_1$$

$$a = \frac{As . Fy}{0.85 . Fc' . b}$$

$$= \frac{804.25 . 420}{0.85 . 20 . 200}$$

$$= 99.34$$

$$Z = d - \frac{a}{2}$$

$$= 264 - \frac{99.34}{2}$$

$$= 214.33$$

$$Mn = T_S . Z$$

$$= As . Fy . Z$$

$$= 804.25 . 420 . 214.33$$

$$= 72397459.05 \, Nmm$$

$$= 72.39 \, kNm$$

- $Mn \, \emptyset > Mu$

$$0.9 . 72.39 \geqslant 57.87$$

$$65.15 \geqslant 57.87 \dots \, ok!$$

2.5 | Pondasi Tangga

- DL tangga $= 17,53$ kN/m
- LL tangga $= 12,20$ kN/m
- Beban dinding $= 0,15 . 1,80 .24 = 6,48$ kN/m +

$$Qtg = 36,21 \text{ kN/m}$$

$d = 1,00 \text{ m}$

$h \text{ pondasi} = 0,15 \text{ m}$

$\ell = \frac{1}{6} . b = \frac{1}{6} . 1 = 0,167$

$B \text{ pondasi} = 1 \text{ m}$

$\delta \text{ tanah} = 17,0 \text{ kN/m}^3$

$\sigma \text{ tanah} = 15,0 \text{ kN/m}^3$

$\sigma \text{ netto} = \sigma \text{ tanah} - (d - H) . \delta \text{ tanah} - (h - \delta \text{ beton})$

$\qquad = 150 - (1,8 - 0,15) . 17 - (0,15 - 24)$

$\qquad = 145,8$

- karena adanya ekstisitas yang besar, maka :

$$\frac{Qtg}{B} = \frac{36,21}{1} = 36,21 \text{ kN/m}^2$$

$\sigma \text{ max} = \dfrac{Qtg}{B} + 6 . \dfrac{Qtg . (e)}{B^2} \quad < \sigma \text{ netto}$

$\qquad = \dfrac{36,21}{1} + \dfrac{6 . 36,21 . (0,167)}{1^2} \leqslant 145,8$

$\qquad = 72,5 \quad < 145,8$

$\sigma \text{ min} = \dfrac{36,21}{B} - \dfrac{6 . 36,21 (0,167)}{1^2} \geqslant 0$

$\qquad = 0 \qquad \geqslant 0 \quad \dots \text{ ok!}$

2.5.1 Penulangan Plat Pondasi Tangga

- DL tangga $= 1,2 \cdot 17,53 = 21,036$ kN/m
- LL tangga $= 1,6 \cdot 12,20 = 19,52$ kN/m²
- Beban dinding $= 1,2 \cdot 6,48 = 7,776$ kN/m $+$

$$q_{tg} = 48,332 \text{ kN/m}$$

$$\sigma_{max} = \frac{48,332}{1} + 6 \cdot \frac{48,332 \cdot (0,167)}{1} = 96,76$$

$$\sigma_{min} = \frac{48,332}{1} - 6 \cdot \frac{48,332 \,(0,167)}{1} = 0$$

$$Mu = \frac{1}{2} \cdot \left(\frac{\sigma_{max} + \sigma_{min}}{2} \right) \left(\frac{B}{2} + e - \frac{1}{2} b_{tg} \right)^2$$

$$= \frac{1}{2} \cdot \left(\frac{96,76 + 0}{2} \right) \left(\frac{1}{2} + 0,167 - \frac{1}{2} \cdot 0,15 \right)^2$$

$$= 0,5$$

- D13 tulangan pokok, $Fy = 420$ Mpa, Selimut beton $= 20$ mm
  P10 tulangan susut, $Fy = 240$ Mpa, H pondasi $= 150$ mm

$$d = 150 - 20 - \frac{1}{2} \cdot 13$$
$$= 123,5 \text{ mm}$$

$$Rn \text{ perlu} = \frac{Mu}{0,9 \cdot 1000 \cdot d^2} = \frac{0,5 \cdot 10^6}{0,9 \cdot 1000 \cdot 123,5^2} = 0,634 \text{ Mpa}$$

$$\rho \text{ perlu} = \left(\frac{B_1 \cdot Fc'}{Fy} \right) \left(1 - \sqrt{1 - \left(\frac{2 Rn}{0,85 \cdot Fc'} \right)} \right)$$

$$= \left(\frac{0,85 \cdot 20}{420} \right) \left(1 - \sqrt{1 - \left(\frac{2 \cdot 0,634}{0,85 \cdot 20} \right)} \right)$$

$$= 0,00158$$

$$\rho_{min} = \frac{1,4}{Fy} = \frac{1,4}{420} = 0,0033$$

dipakai $\rho = 0,0033$

- As perlu $= P_{min} \cdot b \cdot d$

  $= 0.0033 \cdot 1000 \cdot 122$

  $= 402.6 \text{ mm}^2$

$$S = \frac{As \cdot tul}{As \ perlu} \times 1000$$

$$= \frac{132.73}{402.6} \cdot 1000$$

$$= 329.68 \longrightarrow \text{dipakai } D16 - 300$$

- Cek terhadap geser

$$Vc = \frac{1}{6} \sqrt{Fc'} \cdot b \cdot d$$

$$= \frac{1}{6} \sqrt{20} \cdot 1000 \cdot 123.5$$

$$= 90933.431 \text{ N}$$

$$= 90.933 \text{ kN}$$

$$\phi Vc = 0.75 \cdot 90.933 = 68.2 \text{ kN}$$

$$Vu = \frac{(Vu \ max + Vu \ min)}{2} \cdot \left(\frac{B}{2} + l - \frac{1}{2} b \ tg \right)$$

$$= \frac{(96.76 + 0)}{2} \cdot \left(\frac{1}{2} + (l \ 0.167) - \frac{1}{2} \cdot 0.15 \right)$$

$$= 28.64 \text{ kN}$$

$$\phi Vc > Vu$$

$$68.2 \text{ kN} > 28.64 \text{ kN} \dots \text{ ok!}$$

- Tulangan baju menggunakan $P8$

  As min $= 0.0033 \cdot 1000 \cdot 150$

  $= 495 . \text{mm}^2$

$$S = \frac{As \ tul}{As \ min} \cdot 1000$$

$$= \frac{50.26}{495} \cdot 1000$$

$$= 101.5 \text{ mm} \longrightarrow \text{digunakan } P8 - 100$$

2.6. Rencana Pelat Lantai dan Atap

2.6.1 Menghitung beban mati pada pelat lantai

- Beban mati pada pelat Atap (Wd) = 4,22 kN/m²

- Beban hidup pelat atap (WL) = 1 kN/m²

- $Wu = 1,2 \ Wd + 1,6 \ WL$

  $= 1,2 \cdot 4,22 + 1,6 \cdot 1$

  $= 6,66 \ kN/m^2$

2.6.2 Cek luasan terbesar

$$\frac{Ly}{Lx} = \frac{3,5}{5} = 1,17 \rightarrow 2 \ arah$$

- Lantai tebal plat = 165 mm
- Tebal pelat = 150 mm
- Selimut beton = 20 mm
- $\beta = 0,85$
- $Fc' = 20 \ Mpa$
- ϕ Tulangan = 8 mm
- $Fy = 240 \ Mpa$
- $dv = 150 - 20 - \frac{1}{2} \cdot 8 = 126 \ mm$
- $dy = 150 - 20 - 8 \cdot \frac{1}{2} \cdot 8 = 118 \ mm$

2.6.3 Menghitung momen

- $MLx_1 = 0,001 \cdot Wu \cdot Lu^2 \cdot u$

  $= 0,001 \cdot 6,66 \cdot 3^2 \cdot 46$

  $= 2,757 \ kNm$

- $MLu_2 = 0,001 \cdot 6,66 \cdot 3^2 \cdot 38$

  $= 2,278 \ kNm$

  } Pilih yang terkecil

- $My = 0,001 \cdot Wu \cdot Ly^2 \cdot u$

  $= 0,001 \cdot 6,66 \cdot 3^2 \cdot 38$

  $= 2,278 \ kNm$

$MLu = Mtu$

$MLy = Mty$

2.6.4 Cek kuat Geser

$$\phi v_c > V_u$$

- $V_u = 1,15 \times W_u \times \dfrac{L_u}{2}$

  $= 1,15 \cdot 6,66 \cdot \dfrac{3}{2}$

  $= 11,489 \text{ kNm}$

- $V_c = \dfrac{1}{6} \cdot \sqrt{Fc'} \cdot b \cdot dv$

  $= \dfrac{1}{6} \cdot \sqrt{20} \cdot 1000 \cdot 126$

  $= 93914,86 \approx 93,914 \text{ kN}$

$$\phi v_c > V_u$$

$$\phi\, 93,914 > 11,489 \text{ kNm}$$

- $Pnm = 0,429 \cdot \dfrac{0,85 \cdot Fc' \cdot P}{Fy}$

  $= 0,429 \cdot \dfrac{0,85 \cdot 20 \cdot 0,85}{240}$

  $= 0,025$

- $A_{min} = 0,002 \cdot b \cdot h$

  $= 0,002 \cdot 1000 \cdot 150$

  $= 300 \text{ mm}^2$

- Spesi max $= 2 \cdot h = 2 \cdot 100 = 300 \text{ mm}$

2.6.5 Penulangan Arah sumbu X

- Tumpuan $= \phi = 0,9$

  - $Mtu = 2,278 \text{ MNm}$

  - $Rn = \dfrac{Mu}{\phi \cdot b \cdot d_v^2} = \dfrac{2,278 \cdot 10^6}{0,9 \cdot 1000 \cdot 126^2} = 0,159 \approx 0,16$

- $P = \dfrac{0,85 \cdot Fc}{Fy}\left(1 - \sqrt{1 - \dfrac{2\,Rn}{0,85 \cdot Fc'}}\right)$

  $= \dfrac{0,85 \cdot 20}{240}\left(1 - \sqrt{1 - \dfrac{2 \cdot 0,16}{0,85 \cdot 20}}\right)$

  $= 0,00067$

- $Ast = P \cdot b \cdot dy$

  $= 0,00067 \cdot 1000 \cdot 126 = 84,42 \text{ mm}^2$

  $Ast < As\,min$

  $\therefore$ digunakan As min $= 300 \text{ mm}^2$

- $S_{perlu} = \dfrac{\frac{1}{4} \cdot \pi \cdot d^2}{As\,min} \cdot b$

    $= \dfrac{\frac{1}{4} \cdot \pi \cdot 8^2}{300} \cdot 1000$

    $= 167,552 \approx 150\ mm$

    $S_{perlu} \leq S_{max} \dots$ oh!

    Sehingga menggunakan tulangan P8 - 150

2.6.6 Penulangan Arah sumbu Y

- My Tumpuan $= \phi = 0,9$

    - $M_{ty} = 2,278\ kNm$

    - $Rn = \dfrac{M_u}{\phi \cdot b \cdot d_y^2} = \dfrac{2,278 \cdot 10^6}{0,9 \cdot 1000 \cdot 1,8^2} = 0,18\ Mpa$

- $\rho = \dfrac{0,85 \cdot 20}{240} \left(1 - \sqrt{1 - \dfrac{2 \cdot 0,18}{0,85 \cdot 20}}\right) = 0,00075$

- $Ast = \rho \cdot b \cdot d_j = 0,00075 \cdot 1000 \cdot 1,8 = 22,5$

    $Ast \leq As\,min \rightarrow$ digunakan $300\ mm^2$

- $S_{perlu} = \dfrac{\frac{1}{4} \cdot \pi \cdot 8^2 \cdot 1000}{300} = 167,5516\ mm \approx 150\ mm$

    $S_{perlu} < S_{max} \dots$ oh! $\rightarrow$ digunakan P8 - 150 mm

2.6.7 Tulangan Susut / Bagi

diameter $= 6\ mm$

- $As = 0,002 \cdot 1000 \cdot 150 = 300\ mm^2$

- $S_{perlu} = \dfrac{\frac{1}{4} \cdot \pi \cdot 8^2 \cdot 1000}{240} = 209,44\ mm \approx 200\ mm$

    $S_{perlu} \leq S_{max}$

    $S_{max} = 2 \cdot h$

    $= 2 \cdot 150 = 300\ mm$

    $\therefore$ Digunakan P8 - 200 mm

2.6.8 Analisis Tulangan

- Analisis Tulangan u
  - Tulangan pada tumpuan = lapangan $(2.P8-200)$
  - As aktual $= \dfrac{\frac{1}{4} \cdot \pi \cdot 8^2}{200} \cdot 1000 = 251,327 \text{ mm}^2$
  - $a = \dfrac{As \cdot Fy}{0,85 \cdot fc' \cdot b} = \dfrac{251,327 \cdot 240}{0,85 \cdot 20 \cdot 1000} = 3,548$

    $\bullet\ C = \dfrac{3,548}{0,85}$

    $C = 4,174 \text{ mm}$

  - $\varepsilon_t = \dfrac{du - c}{c} \cdot 0,003 = \dfrac{126 - 4,174}{4,174} \cdot 0,003 = 0,087$
  - $Mn = As \cdot Fy \cdot (du - a/2)$

    $= 251,327 \cdot 240 \left(126 \cdot \dfrac{3,548}{2}\right)$

    $= 7.493123 \ N \approx 7,49 \text{ kNm}$
  - $\phi Mn \ \geqslant \ Mu$

    $0,9 \cdot 7,49 \geqslant 2,278$

    $6,7311 \geqslant 2,278 \ \ldots \ Ok!$

- Analisis Sumbu Y
  - As aktual $= 251,327 \text{ mm}^2$
  - $a = 3,548$
  - $C = \dfrac{3,548}{0,85} = 4,174 \text{ mm}$
  - $\varepsilon_t = \dfrac{dy - c}{c} \cdot 0,003 = \dfrac{118 - 4,174}{4,174} \cdot 0,003 = 0,0818$
  - $Mn = As \cdot Fy \cdot (dy - a/2)$

    $= 251,327 \cdot 240 \cdot \left(118 - \dfrac{3,548}{2}\right) \cdot$

    $= 7010572 \ N \approx 7,01 \text{ kNm}$

    $\phi Mn > Mu = 6,309 > 2,278 \ \ldots \ Ok!$

Pembebanan pada masing-masing fungsi pelat

FUNGSI PELAT	MACAM" PEMBEBANAN	TEBAL mm	B. VOLUME kN/m2	DL kN/m2	DL PELAT kN/m2	LL kN/m2	Wu=1,2D+1,6L kN/m2
ATAP	Beban sendiri	150	24	3,6			
	Beban pasir						
	Beban ubin + spesi						
	Beban plafon			0,2			
	Lain" : Finishing (WP)	20	21	0,42			
	TOTAL			4,22	0,62	1	6,664
LANTAI	Beban sendiri	165	24	3,96			
	Beban pasir	50	18	0,9			
	Beban ubin + spesi	50	21	1,05			
	Beban plafon			0,2			
	Lain-lain						
	TOTAL			6,11	2,15	2,5	11,332
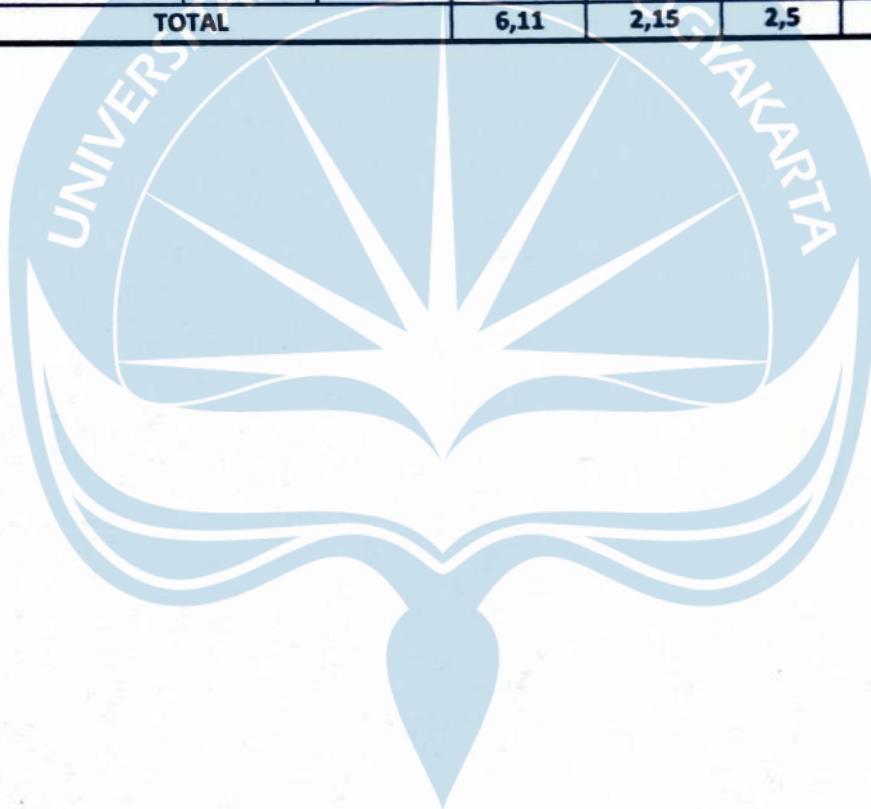
Analisa Penulangan Pelat

Tipe Pelat	Kondisi Tumpuan	Ly/Lx	Arah	Koef. 0.001x	Mu kNm	Vu kN	o Vc kN	A mm2	T. Pokok	Dipasang mm2	T. Bagi
Atap A Wu= 6,66 kN/m2	Ly = 3,5 Lx = 3 ht = 150	1,167	Mlx Mtx	46 46	2,757	11,489	70,436	300	P8-200	117,8	P6-150
			Mly Mty	38 38	2,278			300	P8-200		
Atap B Wu= 6,66 kN/m2	Ly = 9 Lx = 3,5 ht = 150	2,571	Mlx Mtx	63 63	5,140	13,403	70,436	300	P8-200	117,8	P6-150
			Mly Mty	38 38	3,100			300	P8-200		
Lantai C Wu= 11,33 kN/m2	Ly = 3,5 Lx = 3 ht = 165	1,167	Mlx Mtx	46 46	4,691	19,544	78,820	330	P8-150	117,8	P6-150
			Mly Mty	38 38	3,875			330	P8-150		
Lantai D Wu= 11,33 kN/m2	Ly = 9 Lx = 3,5 ht = 165	2,571	Mlx Mtx	63 63	8,744	22,802	78,820	330	P8-150	117,8	P6-150
			Mly Mty	38 38	5,274			330	P8-150		
Lantai E Wu= 11,33 kN/m2	Ly = 4 Lx = 3 ht = 165	1,3	Mlx Mtx	50 50	5,099	19,544	78,820	330	P8-150	117,8	P6-150
			Mly Mty	38 38	3,875			330	P8-150		
Lantai F Wu= 11,33 kN/m2	Ly = 9 Lx = 4 ht = 165	1,2	Mlx Mtx	46 46	8,339	26,059	78,820	330	P8-150	117,800	P6-150
			Mly Mty	38 38	6,889			330	P8-150		

No Batang	Panjang (mm)	Beban DL (KN)	Beban LL (KN)	Beban Angin Kiri Wki (KN)	Beban Angin Kanan Wka (KN)	1,4,DL	1,2,DL + 1,6,LL	1,2,DL + 1,3,Wki + 0,5,LL	1,2,DL + 1,3,Wka + 0,5,LL	Gaya Rencana (KN)	Tarik atau Tekan
1	2	3	4	5	6	7	8	9	10	11	12
14	1875	47,494	4,984	8,248	-10,814	66,4916	64,9672	70,2072	45,4266	70,2072	TARIK
15	1875	41,101	4,289	6,983	-8,924	57,5414	56,1836	60,5436	39,8645	60,5436	TARIK
16	1875	34,48	3,571	5,703	-7,004	48,272	47,0896	50,5754	34,0563	50,5754	TARIK
17	1875	33,336	3,44	3,899	-5,157	46,6704	45,5072	46,7919	35,0191	46,7919	TARIK
18	1875	33,336	3,44	3,897	-5,155	46,6704	45,5072	46,7893	35,0217	46,7893	TARIK
19	1875	34,48	3,571	2,508	-3,81	48,272	47,0896	46,4219	38,2085	48,272	TARIK
20	1875	41,101	4,289	0,59	-2,532	57,5414	56,1836	52,2327	48,1741	57,5414	TARIK
21	1875	47,494	4,984	-1,305	-1,261	66,4916	64,9672	57,7883	57,8455	66,4916	TARIK
24	2625	0,023	0,002526	-0,003247	0,0005765	0,0322	0,0316416	0,0246419	0,02961245	0,0322	TARIK
25	2625	19,984	2,178	-0,6	-1,242	27,9776	27,4656	24,2898	23,4552	27,9776	TARIK
26	1968,75	-1,628	-0,186	1,942	-1,88	-2,2792	-2,2512	0,478	-4,4906	0,478	TARIK
27	1968,75	7,603	0,816	-0,739	-0,093	10,6442	10,4292	8,5709	9,4107	10,6442	TARIK
28	1968,75	-1,628	-0,186	-2,523	2,585	-2,2792	-2,2512	-5,3265	1,3139	1,3139	TARIK
29	1968,75	7,603	0,816	-0,734	-9,70E-02	10,6442	10,4292	8,5774	9,4055	10,6442	TARIK
30	3225,87	1,961	0,224	-2,382	2,309	2,7454	2,7116	-0,6314	5,4669	5,4669	TARIK
32	3225,87	1,961	0,224	3,103	-3,176	2,7454	2,7116	6,4991	-1,6636	6,4991	TARIK
34	2718,75	9,558	1,038	-2,774	1,848	13,3952	13,1424	8,3944	14,403	14,403	TARIK
36	2718,75	9,558	1,038	1,82	-2,778	13,3952	13,1424	14,3666	8,3892	14,3666	TARIK
38	3225,87	10,933	1,187	2,169	-3,236	15,3062	15,0188	16,5328	9,5063	16,5328	TARIK
40	3225,87	10,933	1,187	-3,238	2,171	15,3062	15,0188	9,5037	16,5354	16,5354	TARIK
3	2625	-6,811	-0,739	1,993	-1,332	-9,5354	-9,3556	-5,9518	-1740,1427	-5,9518	TEKAN
4	1312,5	-9,063	-0,984	2,654	-1,774	-12,6882	-12,45	-7,9174	-2317,5676	-7,9174	TEKAN
6	2288,73	-57,995	-6,086	0,486	3,175	-81,193	-79,3316	-72,0052	-68,5095	-68,5095	TEKAN
7	2288,73	-57,873	-6,073	-0,528	4,691	-81,0222	-79,1644	-73,1705	-66,3858	-66,3858	TEKAN
8	2288,73	-42,072	-4,357	1,542	1,597	-58,9008	-57,4576	-50,6603	-50,5888	-50,5888	TEKAN
9	2288,73	-27,411	-2,755	1,433	0,715	-38,3754	-37,3012	-32,4078	-33,3412	-32,4078	TEKAN
10	2288,73	-27,411	-2,755	0,153	1,995	-38,3754	-37,3012	-34,0718	-31,6772	-31,6772	TEKAN
11	2288,73	-42,072	-4,357	1,595	1,544	-58,9008	-57,4576	-50,5914	-50,6577	-50,5914	TEKAN
12	2288,73	-57,873	-6,073	4,694	-0,531	-81,0222	-79,1644	-66,3819	-73,1744	-66,3819	TEKAN
13	2288,73	-57,955	-6,086	3,182	0,479	-81,137	-79,2836	-68,4524	-71,9663	-68,4524	TEKAN
22	2625	-6,811	-0,739	-1,355	1,966	-9,5354	-9,3556	-10,3042	-5,9869	-5,9869	TEKAN
23	1312,5	-9,063	-0,984	-1,775	2,655	-12,6882	-12,45	-13,6751	-7,9161	-7,9161	TEKAN
31	2288,73	-14,643	-1,581	2,981	-1,48E+00	-20,5002	-20,1012	-14,4868	-20,2835	-14,4868	TEKAN
33	2288,73	-14,643	-1,581	-0,915	2,417	-20,5002	-20,1012	-19,5516	-15,22	-15,22	TEKAN
35	1986,53	-7,012	-0,761	2,034	-1,355	-9,8168	-9,632	-6,1507	-10,5564	-6,1507	TEKAN
37	1986,53	-7,012	-0,761	-1,353	2,032	-9,8168	-9,632	-10,5538	-6,1533	-6,1533	TEKAN

PROFIL 50X50X5

PROFIL 60X60X6

BAB III
PERMODELAN 3D (3 DIMENSI)

3.1 Preliminary Design

* Balok Induk
  - Bentang B_1 = 3,00 m
    Balok Lt2 dan Lt3 → b×h = 300 × 400 (mm)
    Balok dag dan ring → b×h = 250 × 300 (mm)

  - Bentang B_2 = 9,00 m
    Balok Lt2 dan Lt3 → b×h = 300 × 650 (mm)
    Balok Dag dan ring → b×h = 250 × 500 (mm)

  - Bentang L_1 = 4,00 m
    Balok Lt2 dan Lt3 → b×h = 300 × 400 (mm)
    Balok Dag dan ring → b×h = 250 × 300 (mm)

  - Bentang L_2 = 3,50 m
    Balok Lt2 dan Lt3 → b×h = 300 × 400 (mm)
    Balok Dag dan Ring → b×h = 250 × 300 (mm)

* kolom
  Untuk kolom digunakan ukuran 400 × 400 dan 450 × 600 (mm)

* Sloof
  Untuk sloof digunakan ukuran 250 × 500 (mm)

3.2 Beban

Beban yang dimasukkan ke dalam program ETABS.V.92 terdiri dari:

- Beban mati (DL dan SDL)
- Beban hidup (LL)
- Beban gempa (E)

Berikut beban-beban yang diinputkan:

a) Beban kuda-kuda

diperoleh dari SAP 2000, didapat LL = -4,5 kN ; SDL = -42,3 kN

b) Beban gunung-gunung

tinggi kuda-kuda (H) = 4330 mm

Beban gunung-gunung diambil sebesar 2/3 H

$q_{SD} = 2,5 \times \frac{2}{3} \times 4,330 = 7,216$ kN/m (Beban merata)

c) Beban garding

SD = 1,62 kN

LL = 1 kN

d) Beban dinding

Berat volume dinding menggunakan 2,5 kN/m²

Dinding 1m → SD = 1 × 2,5 kN/m = 2,5 kN/m²

Dinding 3m → SD = 3 × 2,5 kN/m = 7,5 kN/m²

e) Beban reaksi tangga

SD = 14,15 kN/m

LL = 19,52 kN/m

f) Beban plat

* Lt 2 dan Lt 3
  SD = 2,5 kN/m
  LL = 1 kN/m²

* Dag
  SD = 0,6 kN/m²
  LL = 1 kN/m²

g) Beban gempa

Bangunan terletak di kota Flores, maka beban gempa menggunakan respon spektrum kota Flores yang didapat dari web.puskim.pu.go.id

3.3 Data Tambahan

Fungsi bangunan : kantor
Tanah : sedang
Mutu Beton : 20 Mpa
Mutu Baja sengkang : 240 Mpa
(f_{yt}) (d ≤ 13 mm)

Mutu Baja lentur : 420 Mpa
(f_y) (d ≥ 13 mm)
$E_c = 4700 . \sqrt{f'c}$ (satuan Mpa)

Catatan :
1) Beban DL → Berat sendiri (Dead) dan super dead (sDead)
2) Beban LL → Sesuai SNI 1727 : 2013
3) Beban gempa → Sesuai SNI 1726 : 2012, dengan memasukkan
nilai S_s dan S_1 pada kurva respon spektrum.

Cek hasil analisis
1). Mode 1 dan 2 harus translasi
2). Rasio Vol N3 > 85%
3) Lalu dilakukan analisis struktur, gaya gaya batang dicatat
untuk merancang balok, kolom, sloof dan pondasi.

- Mass Source

LOAD	Multiplier
LIVE	0,25
SDEAD	1

- Static Load Case
EX → base shear coefficient, C : 0,11
Ey → base shear coefficient, C : 0,102

3.4 Pemodelan

Berdasarkan data-data yang ada, lakukan pemodelan pada ETABS V.9.20

3-D View Frame Span Loads (SDEAD)

3-D View Frame Span Loads (LIVE)
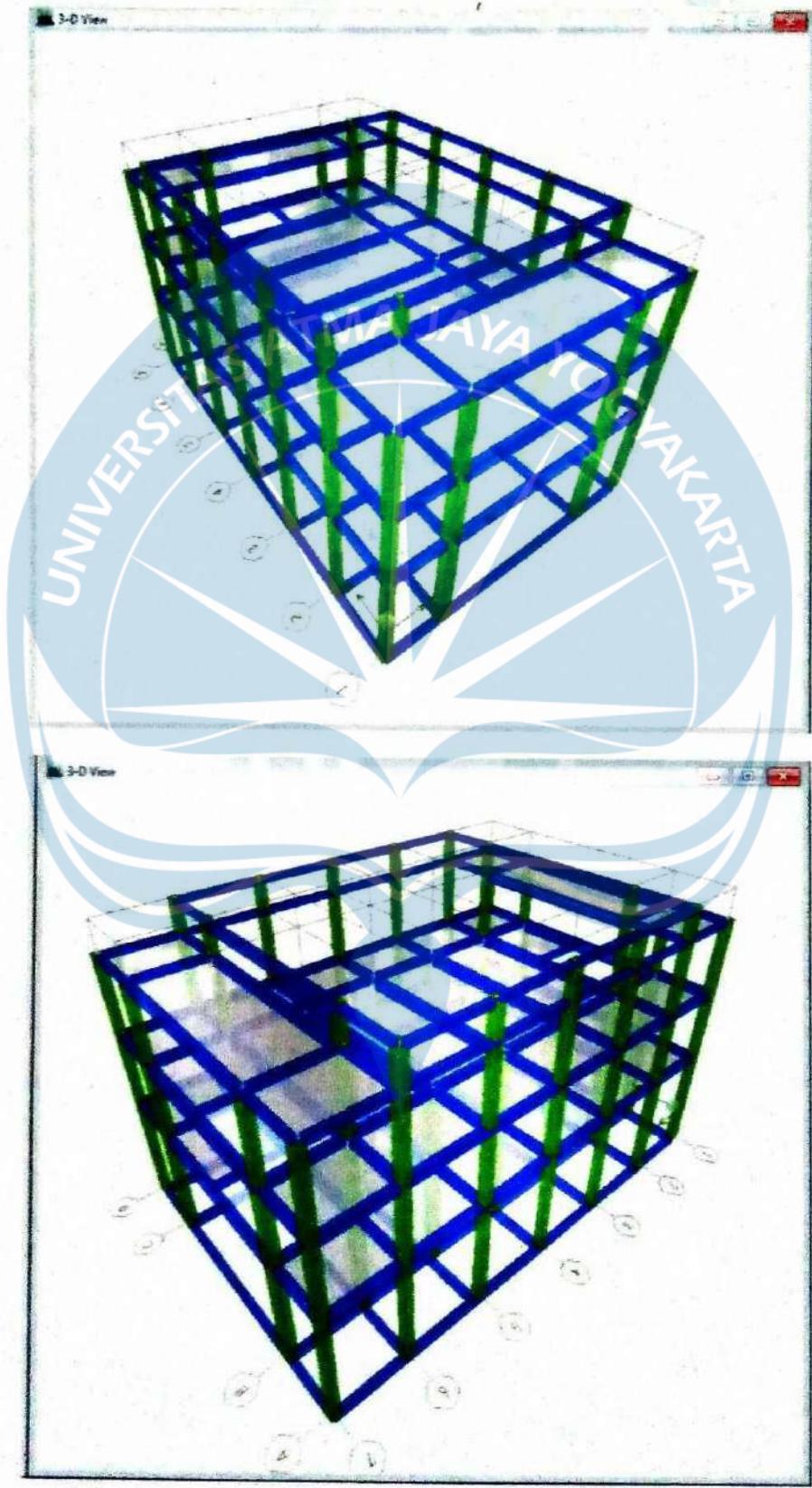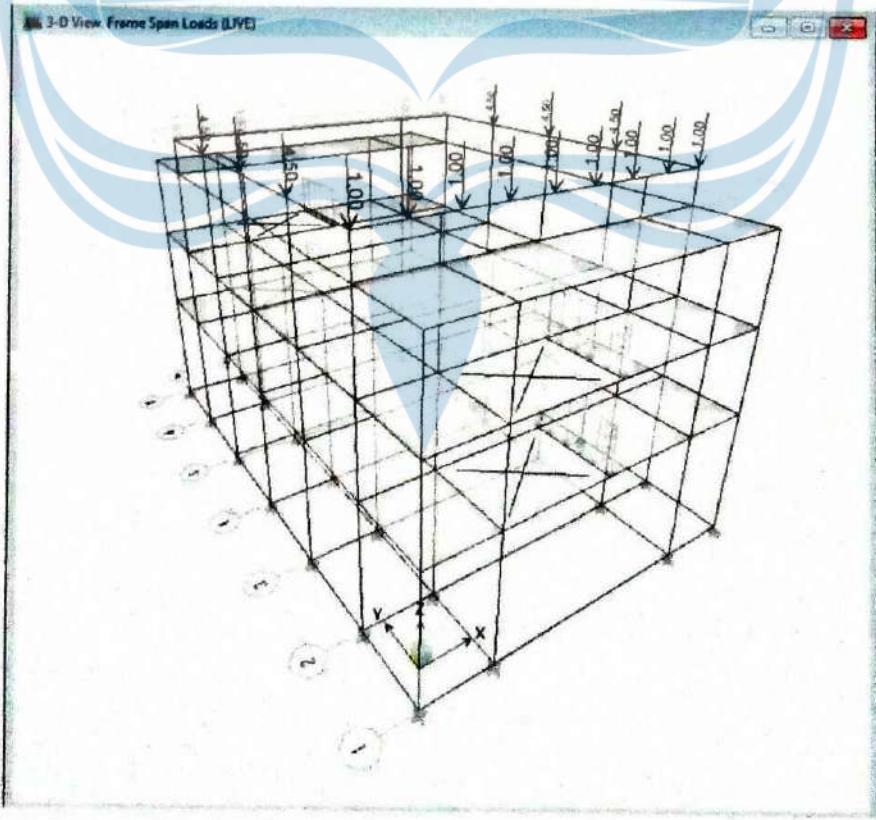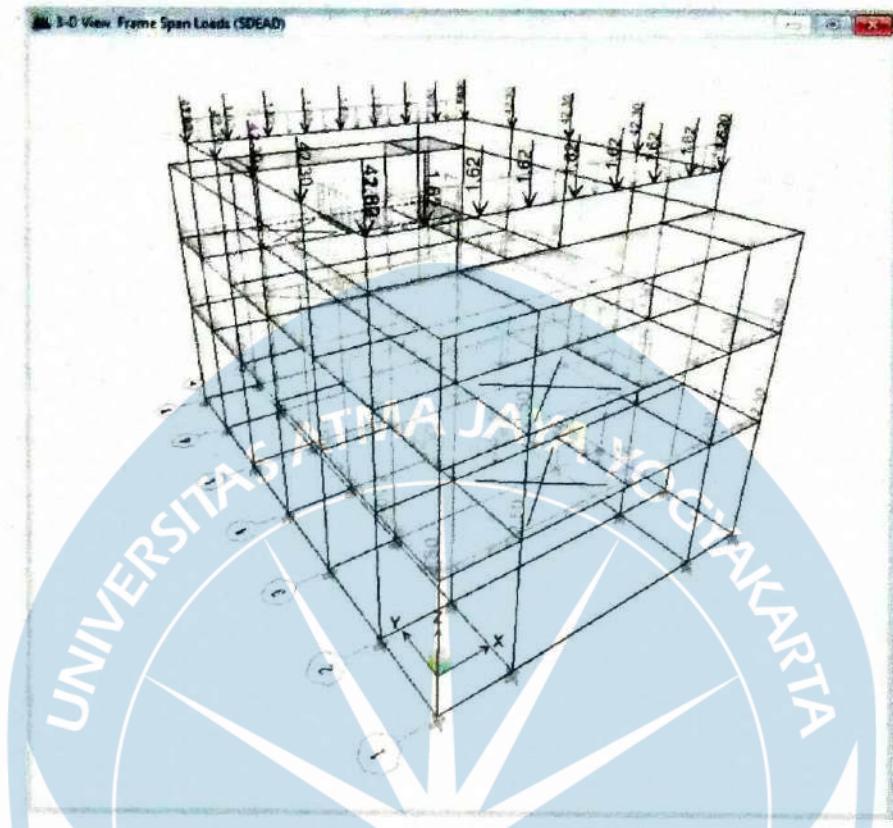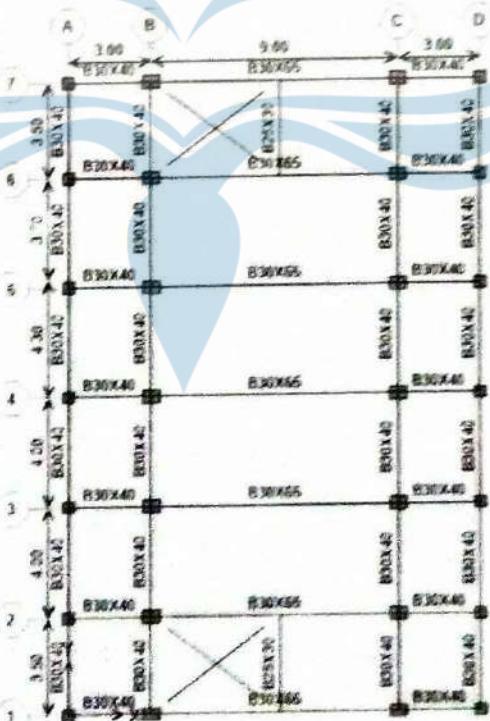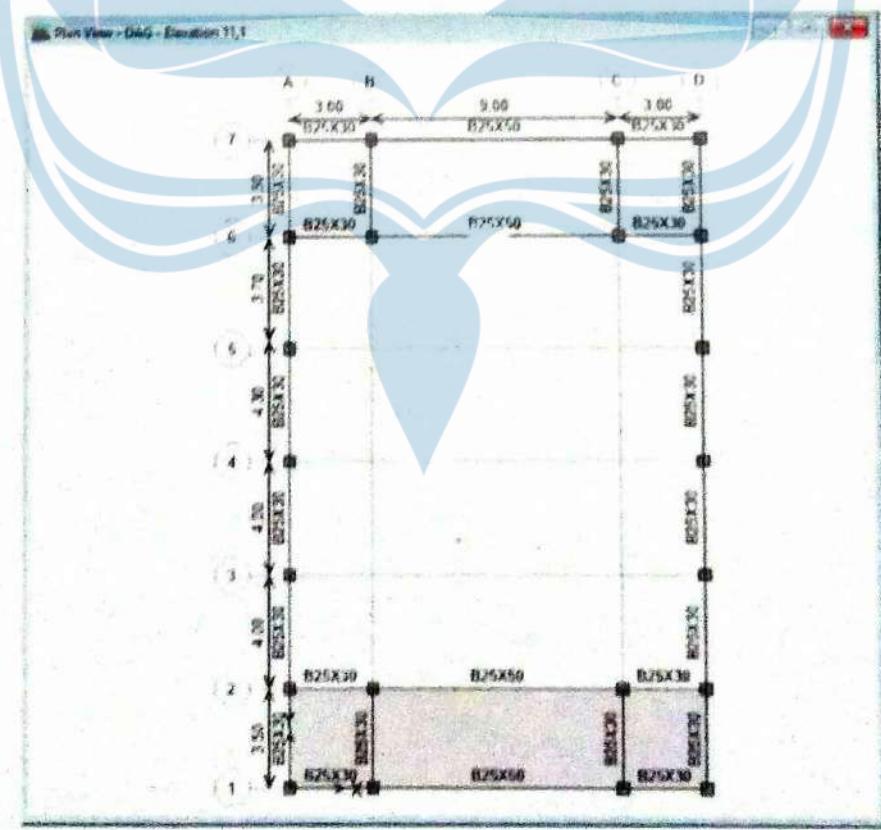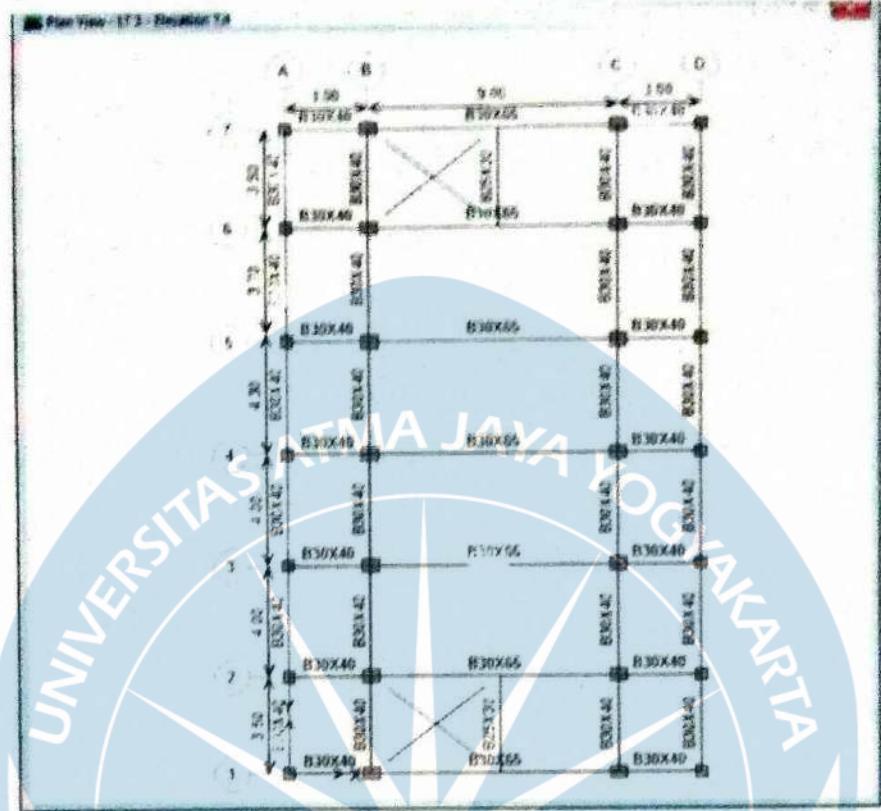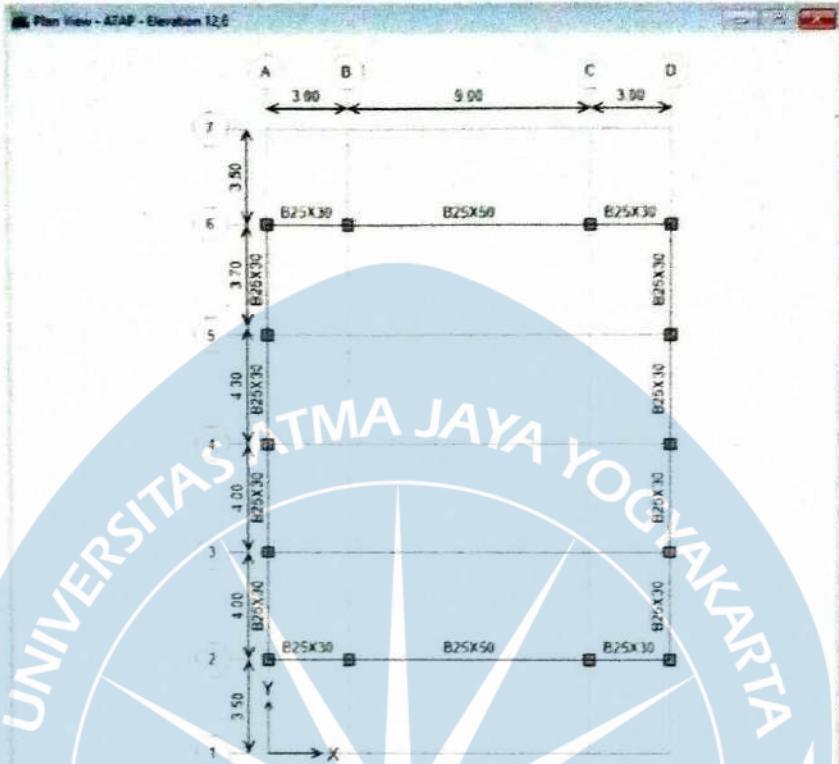
Beban Plat

* LT2 dan LT3

$$SD = 2{,}5 \ kN/m^2$$
$$LL = 1 \ kN/m^2$$

* Dag

$$SD = 0{,}6 \ kN/m^2$$
$$LL = 1 \ kN/m^2$$

Elevation View - 1 Frame Span Loads (LIVE)

Elevation View - 2 Frame Span Loads (SDEAD)

Elevation View - 2 Frame Span Loads (LIVE)

Elevation View - 3 Frame Span Loads (SDEAD)
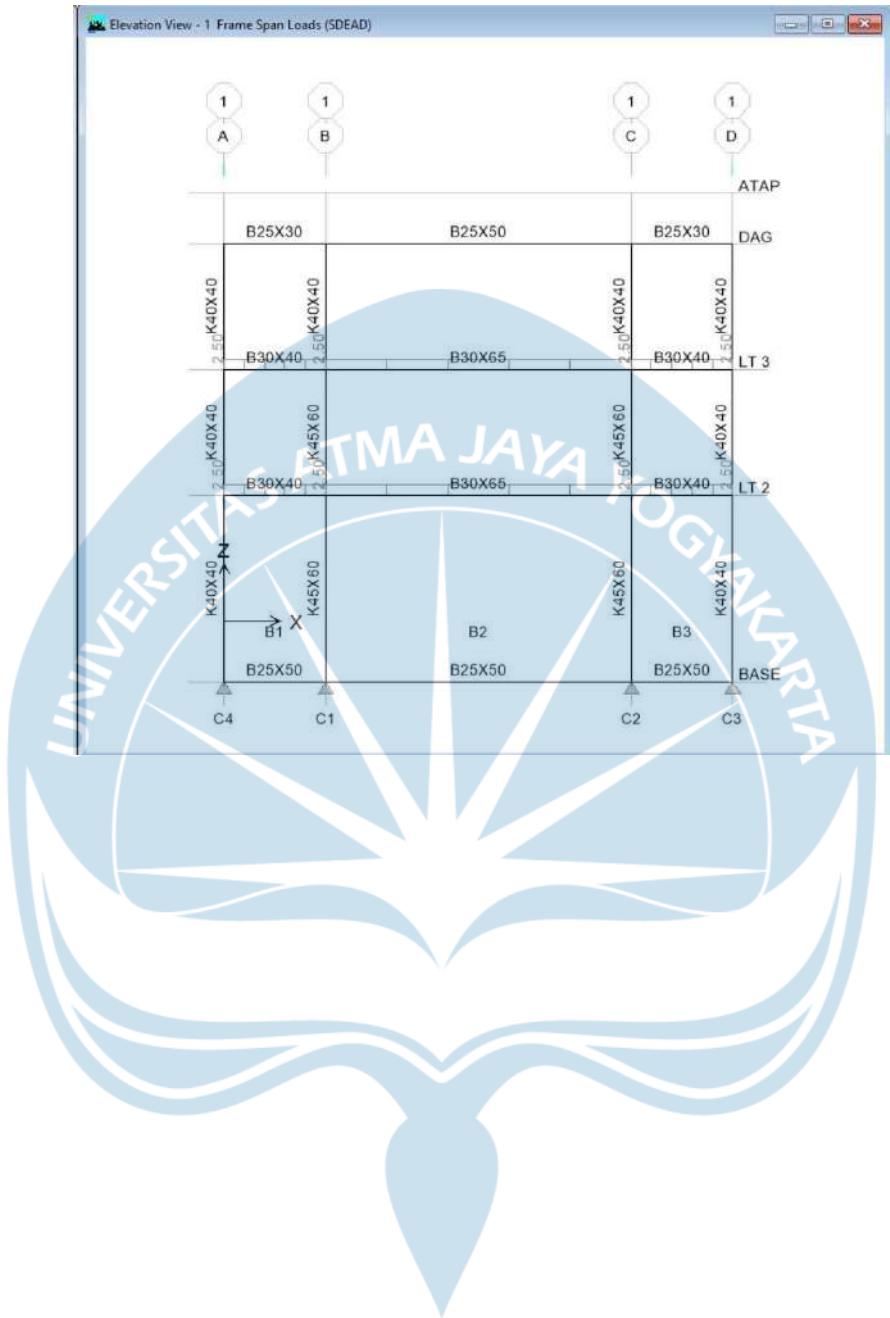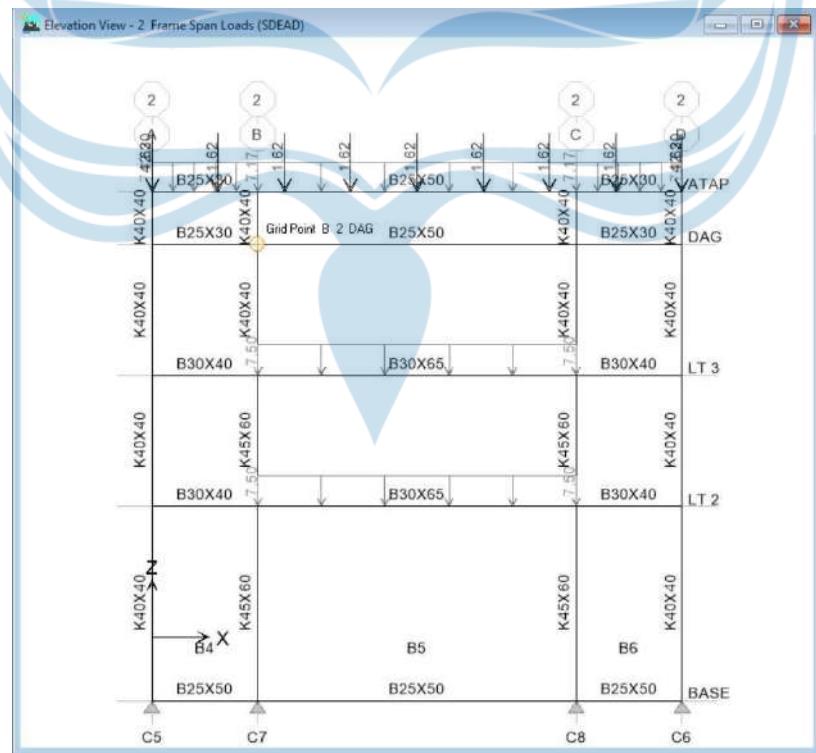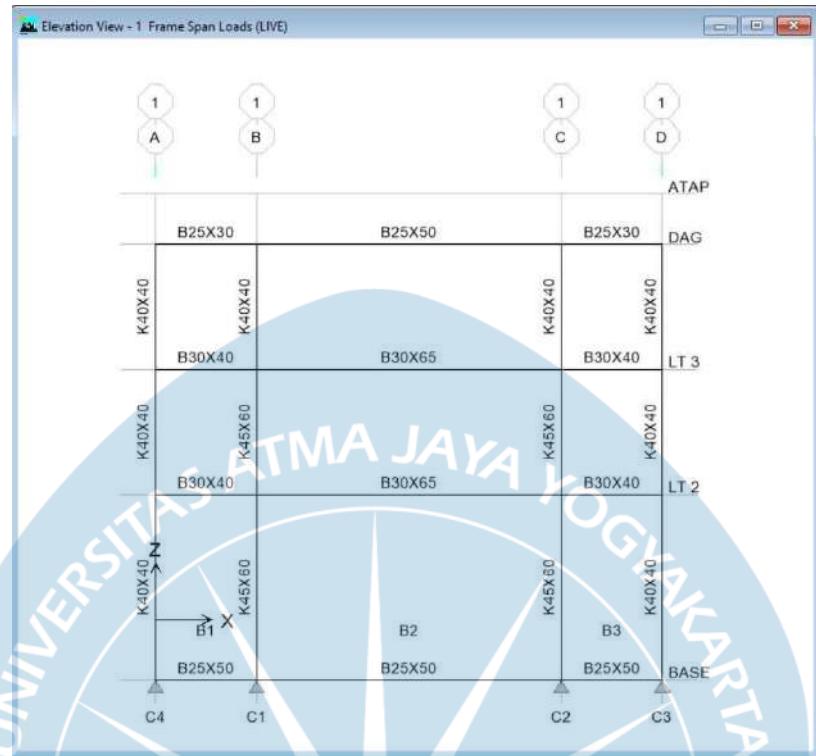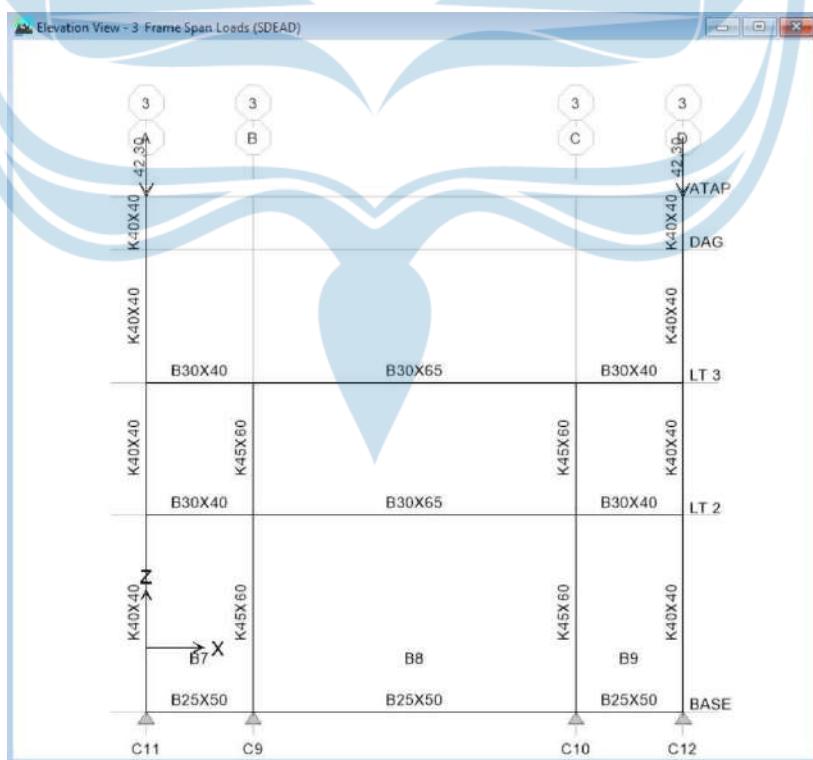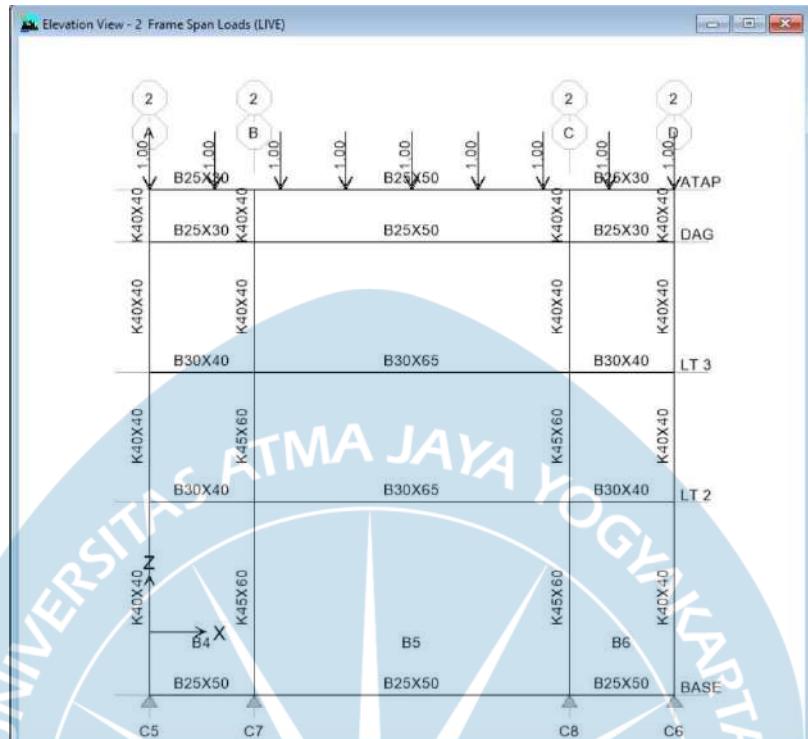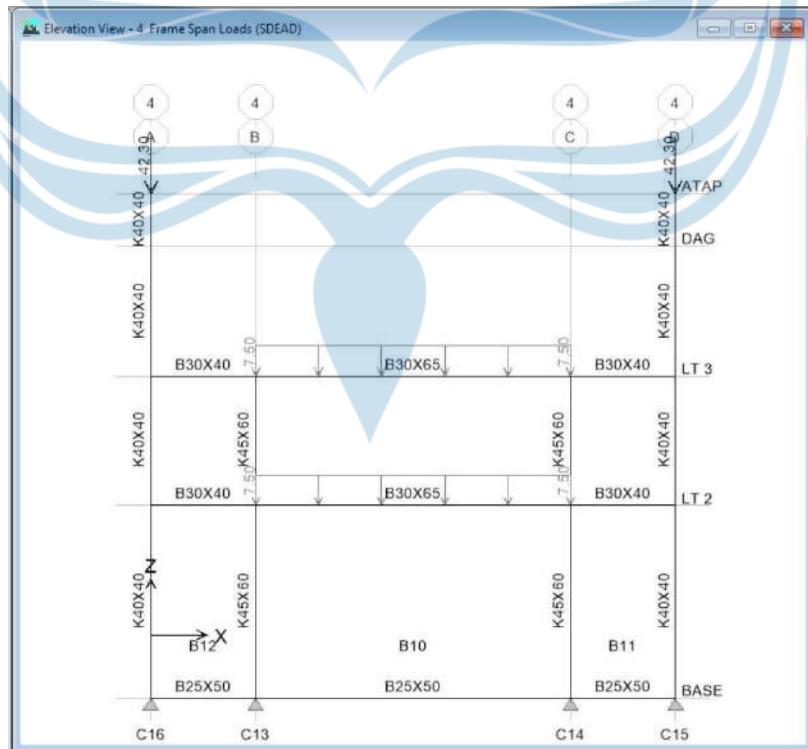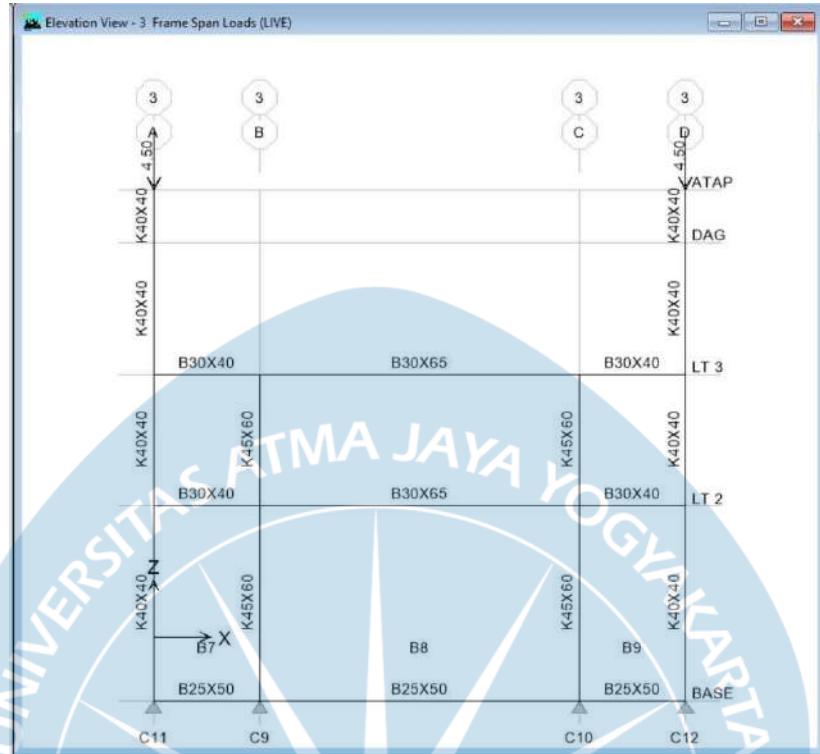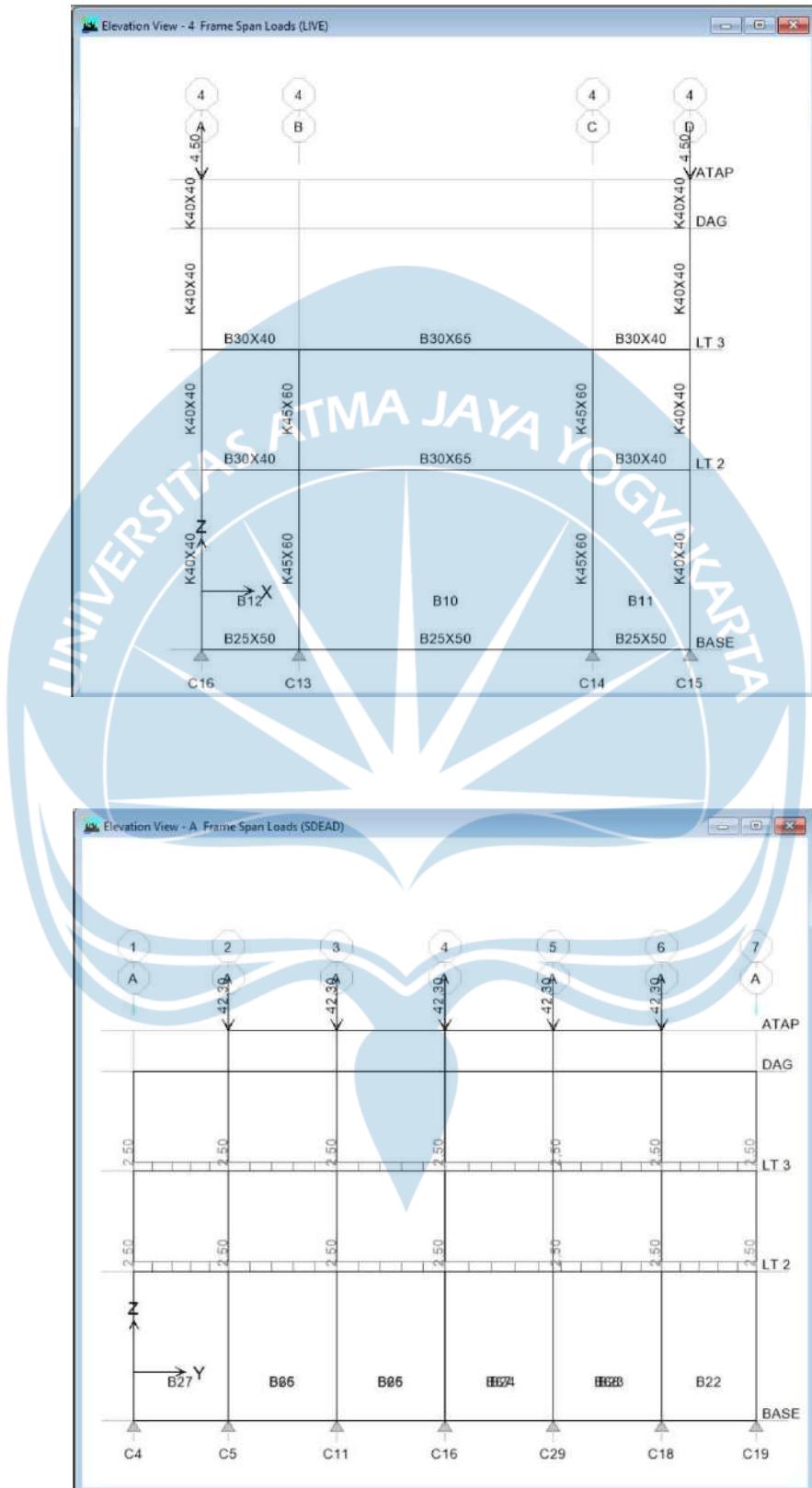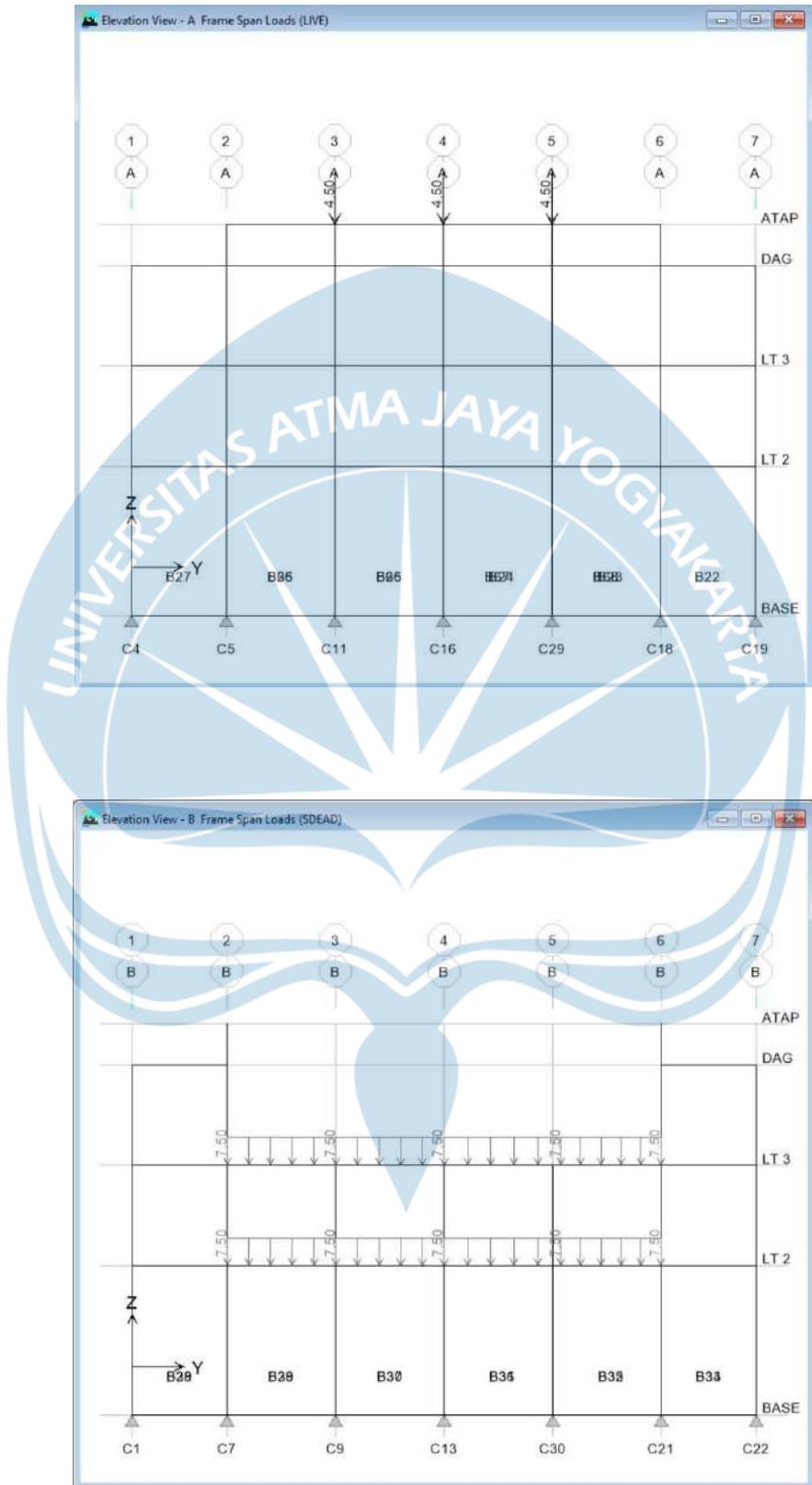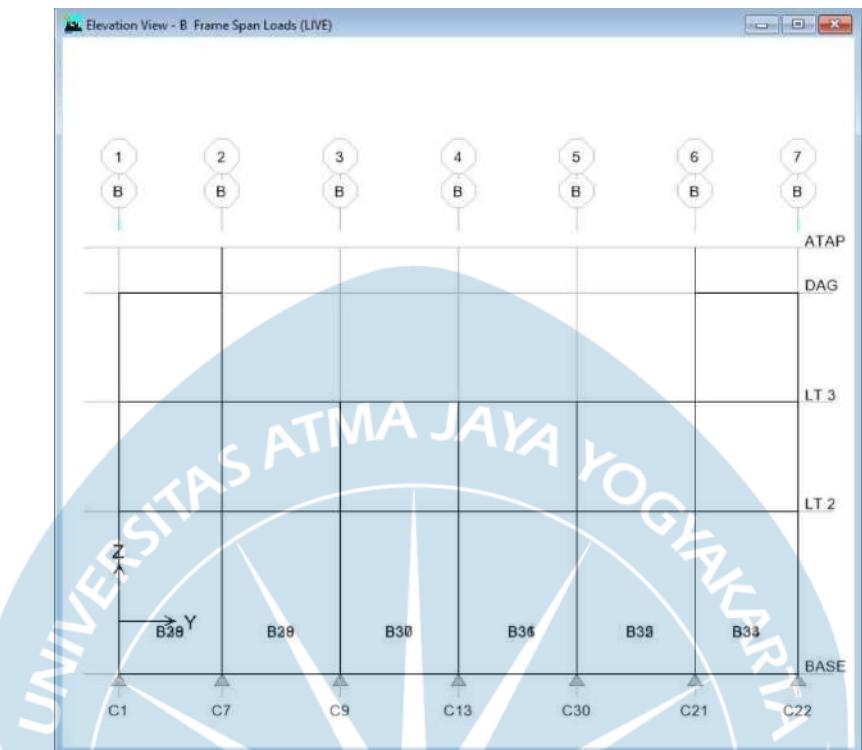
KURVA RESPON SPEKTRUM

Sesuai SNI : 1726-2012 (Tata Cara Perencanaan Ketahanan Gempa untuk Struktur Bangunan Gedung dan Non Gedung), kurva respon spektrum ditentukan dengan :

$$T_S = \frac{S_{D1}}{S_{DS}}$$

$$T_0 = 0,2.\frac{S_{D1}}{S_{DS}}$$

$$S_a = \frac{S_{D1}}{T}$$
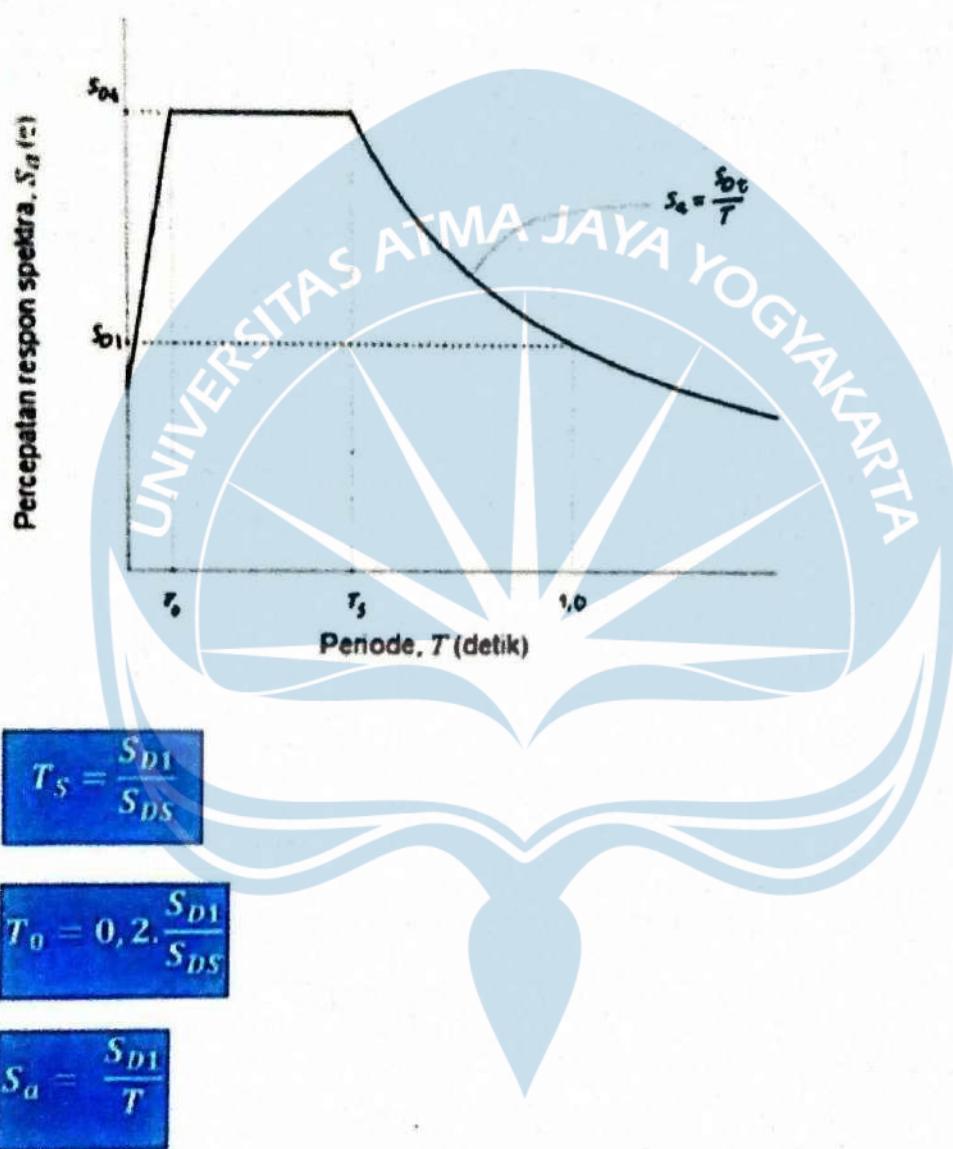
RESPON SPEKTRUM FLORES

Lintang :	-8.66677797697249
Bujur :	120.637862735976
Jenis Batuan :	Tanah Sedang (D)

SDS (g) =	1.33
SD1 (g) =	0.6

T	Accl
0.00	0.532
0.09	1.33 To
0.45	1.33 Ts
1.00	0.6
1.20	0.500
1.40	0.429
1.60	0.375
1.80	0.333
2.00	0.300
2.20	0.273
2.40	0.250
2.60	0.231
2.80	0.214
3.00	0.200
3.20	0.188
3.40	0.176
3.60	0.167
3.80	0.158
4.00	0.150
4.20	0.143
4.40	0.136
4.60	0.130
4.80	0.125
5.00	0.120

VARIABEL	NILAI
PGA (g)	0.446
S_S (g)	0.973
S_1 (g)	0.381
C_{RS}	1.05
C_{R1}	0.978
F_{PGA}	1.054
F_A	1.111
F_V	1.638
PSA (g)	0.47
S_{MS} (g)	1.081
S_{M1} (g)	0.624
S_{DS} (g)	1.33
S_{D1} (g)	0.6
T_0 (detik)	0.09
T_S (detik)	0.45

RESPON SPEKTRUM - FLORES (TANAH SEDANG)
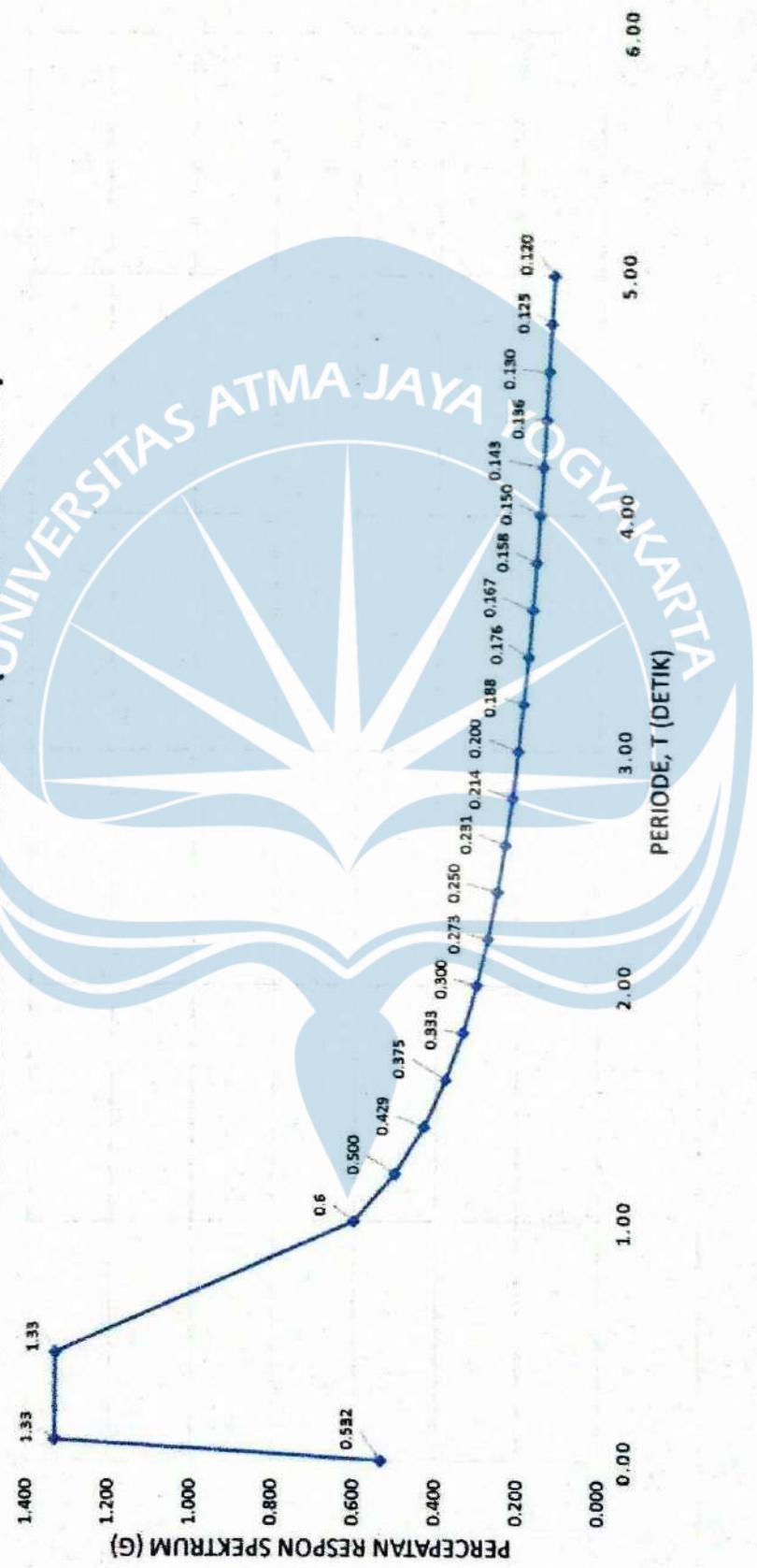
BAB IV
PERANCANGAN BALOK & KOLOM

4.1 Perencanaan Balok

4.1.1 Perancangan Balok B30 x 40 Lantai 2 dan 3

- $F'c$ = 20 Mpa
- Fy = 420 Mpa
- Fys = 240 Mpa
- $b \times h$ = 300 x 400 mm

- d asumsi = 16 mm
- As tulangan = 201,062 mm²
- Selimut beton = 40 mm
- P sengkang = 10 mm

* Dari ETABS diperoleh

- Mu tumpuan = -63,651 kNm
- Mu lapangan = 2,260 kNm

- $d = 400 - (40 + 10 + \frac{16}{2})$
  = 342 mm

•) Tulangan tumpuan

$$Rn = \frac{63,651 \times 10^6}{0,9 \times 300 \times 342^2} = 2,016$$

$$P_{min} = 0,0033$$

$$P_{maks} = 0,429 \cdot \frac{0,85 \times 0,85 \times 20}{420} = 0,0147$$

$$P_{perlu} = \frac{0,85 \times 20}{420}\left(1 - \sqrt{1 - \frac{2 \times 2,016}{0,85 \cdot 20}}\right) = 0,0051$$

$\left.\begin{array}{l} \\ \\ \\ \\ \end{array}\right\}$ digunakan P perlu

$$As_{perlu} = 300 \times 342 \times 0,0051 = 523,26 \text{ mm}^2$$

$$n_{tulangan} = \frac{523,26}{201,062} = 2,602 \approx 3 \text{ digunakan } 3 \, D16$$

$$X = \frac{300 - (2 \cdot 40 + 2 \cdot 10 + 3 \cdot 16)}{3-1} = 76 > 25$$

$$As \text{ aktual} = \frac{1}{4} \cdot \pi \cdot 16^2 \cdot 3 = 603,186 \text{ mm}^2$$

cek $\phi Mn > Mu$

$$a = \frac{603,186 \cdot 420}{0,85 \cdot 20 \cdot 300} = 49,674$$

$$z = 342 - \frac{49,674}{2} = 317,163$$

$$Ts = 603,186 \cdot 420 = 253338,12 \, N$$

$$\phi Mn = 0,9 \cdot 253338,12 \cdot 317,163$$

$$= 72,314 \; kNm \; > 63,651 \; kNm$$

• > Tulangan lapangan

$$Rn = \frac{2,260 \times 10^6}{0,9 \times 300 \times 342^2} = 0,0716$$

$$\rho_{min} = 0,0033$$
$$\rho_{maks} = 0,0147$$
$$\rho_{perlu} = \frac{0,85 \times 20}{420}\left(1 - \sqrt{1 - \frac{2 \times 0,0716}{0,85 \cdot 20}}\right) = 0,00017$$

$$As\, perlu = 300 \times 342 \times 0,00017 = 17,442$$

$$n\, tulangan = \frac{17,442}{201,062} = 0,087 \approx 2 \; \text{Digunakan } 2\,D16$$

$$x = 300 - (2.40 + 2.10 + 2.16) = 168 > 25$$

$$As\, aktual = \frac{1}{4}\, a.16^2 \cdot 2 = 402,124 \; mm^2$$

cek $\phi Mn > Mu$

$$a = \frac{402,124 \cdot 420}{0,85 \cdot 20 \cdot 300} = 33,116$$

$$z = 342 - \frac{33,116}{2} = 325,442$$

$$Ts = 402,124 \cdot 420 = 168892,08 \, N$$

$$\phi mn = 49,468 \; kNm \; > 2,260 \; kNm$$

$$\phi Mn \qquad > Mu \qquad (ok!)$$

•) Tulangan Geser

$$V_c = \frac{1}{6}\sqrt{f'c}\cdot b\cdot d = \frac{1}{6}\sqrt{20}\cdot 300\cdot 342\cdot 10^{-3} = 76,473$$

$$V_u = 38,66 \text{ kN}$$

$$V_s = \frac{38,66}{0,75} - 76,473 = -24,93$$

$$V_{smax} = \frac{1}{3}\sqrt{20}\cdot 300\cdot 342\cdot 10^{-3} = 152,947$$

Misal digunakan P10

$$A_v = \frac{1}{4}\pi\, d^2 = \frac{1}{4}\cdot \pi\cdot 10^2 = 78,539 \text{ mm}^2$$

$$S = \frac{A_v\cdot f_{ys}\cdot d}{V_s} = \frac{78,539\cdot 240\cdot 342}{-24,93} = 258,58 \text{ mm}$$

$$S_{max} = \frac{342}{2} = 171 \text{ mm}$$

digunakan P10 - 150

3D16   2D16

P10-150   400   P10-150

300   300

BI Tumpuan   BI Lapangan
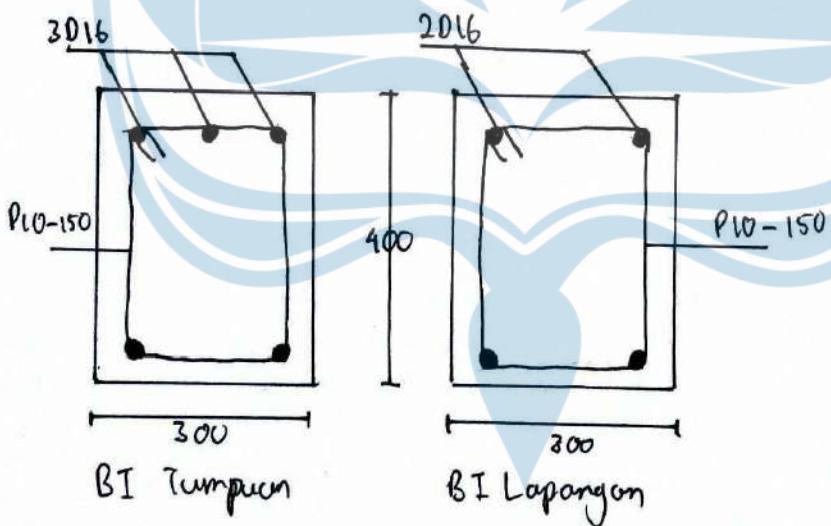
4.1.2 Perancangan Balok B 30×65 Lantai 2 dan 3

- F'_c = 20 Mpa
- Fy = 420 Mpa
- Fys = 240 Mpa
- b × h = 300 × 650 mm

- d asumsi = 16 mm
- As tulangan = 201,062 mm²
- Selimut beton = 40 mm
- P sengkang = 10 mm

✻ Dari ETABS diperoleh

- Mu tumpuan = -248,51
- Mu lapangan = 176,356

$-d = 650 - (40 + 10 + \frac{16}{2})$
$= 592$ mm

•) Tulangan tumpuan

$$Rn = \frac{248,51 \times 10^6}{0,9 \times 300 \times 592^2} = 2,626$$

$P min = 0,0033$

$$P maks = 0,429 \cdot \frac{0,85 \times 0,85 \times 20}{420} = 0,0147$$

$$P perlu = \frac{0,85 \times 20}{420}\left(1 - \sqrt{1 - \frac{2 \times 2,626}{0,85 \cdot 20}}\right) = 0,0068$$

$\left.\begin{array}{l}\\ \\ \end{array}\right\}$ digunakan P perlu

$As perlu = 300 \times 592 \times 0,0068 = 1207,68$ mm²

$$n\ tulangan = \frac{1207,68}{201,062} = 6,0 \quad \text{Digunakan } 6\,D16$$

$$X = \frac{300 - (2 \cdot 40 + 2 \cdot 10 + 4 \cdot 16)}{4 - 1} = 45,3 > 25$$

$As\ aktual = \frac{1}{4} \cdot \pi \cdot 16^2 \cdot 6 = 1206,37$ mm²

cek $\emptyset Mn > Mu$

$$a = \frac{1206,37 \cdot 420}{0,85 \cdot 20 \cdot 300} = 89,348$$

$$Z = 592 - \frac{89,348}{2} = 542,326$$

$Ts = 1206,37 \cdot 420 = 506675,4$ N

$\emptyset Mn = 0,9 \cdot 506675,4 \times 542,326 = 249,3 \quad$ ok !

•) Tulangan Lapangan

$$Rn = \frac{176,356 \times 10^6}{0,9 \times 300 \times 592^2} = 1,864$$

$$P_{min} = 0,0033$$

$$P_{maks} = 0,0147$$

$$P_{perlu} = \frac{0,85 \times 20}{420}\left(1-\sqrt{1-\frac{2 \times 1,864}{0,85 \times 20}}\right) = 0,0047 \left.\right\}\text{ digunakan } P_{perlu}$$

$$A_{sperlu} = 300 \times 592 \times 0,0047 = 834,72$$

$$n\text{ tulangan} = \frac{834,72}{201,062} = 4,15 \approx 5 \text{ digunakan } 5\,\varnothing16$$

$$X = \frac{300 - (2.40 + 2.10 + 5.16)}{5-1} = 30 > 25$$

$$As\ aktual = \tfrac{1}{4}\,\pi.16^2.5 = 1005,31\ mm^2$$

cek $\varnothing Mn > Mu$

$$a = \frac{1005,31 \cdot 420}{0,85 . 20 . 300} = 82,79$$

$$z = 592 - \frac{82,79}{2} = 550,6$$

$$Ts = 1005,31 . 420 = 422230,2\ N$$

$$\varnothing Mn = 0,9 . 422230,2 \times 550,6 \geqslant Mr$$
$$= 209,232\ kNm > 176,356\ kNm \quad (Ok!)$$

•) Tulangan geser

$$Vc = \tfrac{1}{6}\sqrt{Fc}.b.d = \tfrac{1}{6}\sqrt{20}.300.592.10^{-3} = 132,37$$

$$Vu = 118,482\ kN$$

$$Vs = \frac{118,482}{0,75} - 132,37 = 25,606$$

$$Vsmax = \tfrac{1}{3}\sqrt{20}.300.592.10^{-3} = 264,75$$

Misal digunakan P10

$$A_v = \tfrac{1}{4}\,\pi \cdot d^2 = \tfrac{1}{4}\,\pi \cdot 10^2 = 78{,}589 \text{ mm}^2$$

$$S = \frac{A_v \cdot F_{ys} \cdot d}{V_s} = \frac{78.539 \cdot 240 \cdot 592}{25{,}606} = 435{,}79 \text{ mm}$$

$$S_{max} = \frac{592}{2} = 296 \text{ mm}$$

Digunakan   P10 - 250

6D16

P10-250

650

P10 - 250

5D16

300

(mm)
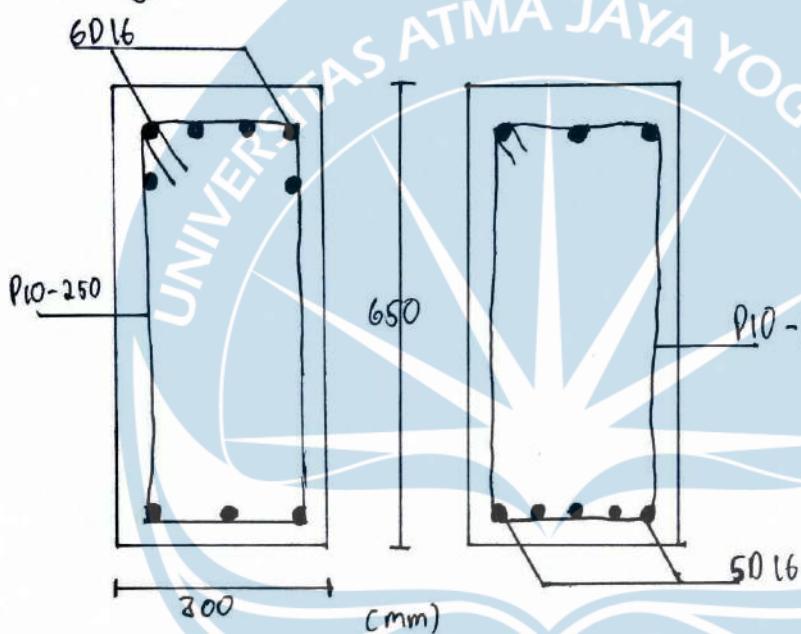
4.1.3 Perancangan Balok B25 x 30 (bagian Dag)

- F'c = 20 Mpa
- Fy = 430 Mpa
- Fys = 240 Mpa
- b x h = 250 x 300 mm

- d asumsi = 13 mm
- As tulangan = 132,73 mm²
- Selimut beton = 30 mm
- P sengkang = 10 mm

*Dari ETABS diperoleh

- Mu tumpuan = -20,09 kNm
- Mu lapangan = 1,89 kNm

$$- d = 300 - (30 + 10 + \tfrac{13}{2})$$
$$= 253{,}5 \text{ mm}$$

• Tulangan Tumpuan

$$Rn = \frac{20,09 \times 10^6}{0,9 \times 250 \times 253,5^2} = 1,389$$

$Pmin = 0,0033$

$Pmaks = 0,0147$

$$Pperlu = \frac{0,85 \times 20}{420}\left(1 - \sqrt{1 - \frac{2 \times 1,389}{0,85 \cdot 20}}\right) = 0,0035$$ } Digunakan Pperlu

$As \, perlu = 250 \times 253,5 \times 0,0035 = 221,81 \, mm^2$

$$n \, tulangan = \frac{221,81}{132,73} = 1,67 \approx 2 \, Digunakan \, 2D13$$

$X = 250 - (2.30 + 2.10 + 2.13) = 144 > 25$

$As \, aktual = \frac{1}{4} \cdot \pi \cdot 13^2 \cdot 2 = 265,465 \, mm^2$

Cek $\phi Mn > Mu$

$$a = \frac{265,465 \cdot 420}{0,85 \cdot 20 \cdot 250} = 26,234$$

$$2 = 253,5 - \frac{26,234}{2} = 240,38$$

$TS = 265,465 \cdot 420 = 111495,3 \, N$

$\phi Mn = 0,9 \cdot 111495,3 \cdot 240,38 \quad > Mu$

$\quad = 241,21 \, kNm > 20,09 \, kNm \quad (Ok!)$

• Tulangan lapangan

$$Rn = \frac{1,89 \times 10^6}{0,9 \times 250 \times 253,5^2} = 0,13$$

$Pmin = 0,0033$

$As \, perlu = 250 \times 253,5 \times 0,0033 = 209,1375$

$$n \, tulangan = \frac{209,1375}{132,73} = 1,576 \approx 2 \, Digunakan \, 2D13$$

$X = 144 > 25$

$As \, aktual = 265,465 \, mm^2$

•> Tulangan geser

$$V_c = \frac{1}{6}\sqrt{20} \cdot 250 \cdot 253,5 \cdot 10^{-3} = 47,24$$

$$V_u = 15,504$$

$$V_s = \frac{15,504}{0,75} - 47,24 = -26,568$$

$$V_{s\,max} = \frac{1}{3}\sqrt{20} \cdot 250 \cdot 253,5 \cdot 10^{-3} = 94,47$$

Misal digunakan P10

$$A_v = \frac{1}{4}\pi \cdot d^2 = \frac{1}{4} \cdot \pi \cdot 10^2 = 78,539 \text{ mm}^2$$

$$S = \frac{78,539 \cdot 240 \cdot 253,5}{15,504} = 308,12 \text{ mm}$$

$$S_{max} = \frac{253,5}{2} = 126,75 \text{ mm}$$

digunakan P10 - 100

2D13

P10-100   300   P10-100

250   (mm)   2D13
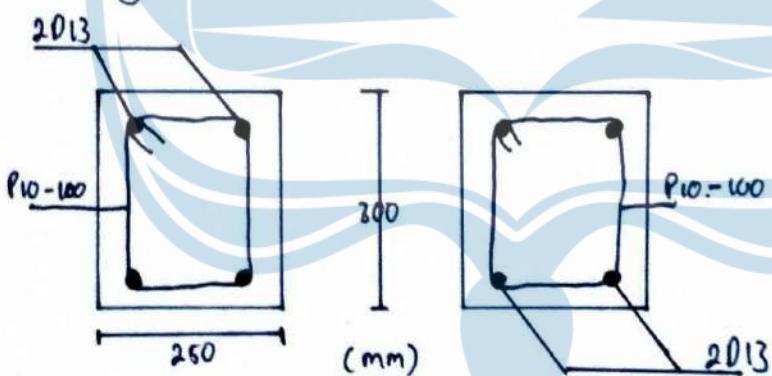
4.1.4 Perancangan Balok B25 x 50 (Dag)

- f'c = 20 Mpa
- Fy = 420 Mpa
- fys = 240 Mpa
- b x h = 250 x 500 mm

- d asumsi = 13 mm
- As tulangan = 132,73 mm²
- Selimut beton = 30 mm
- P sengkang = 10 mm

* Dari ETABS diperoleh
- Mu tumpuan = -50,655 kNm
- Mu lapangan = 14,866 kNm

$$-d = 500 - (30 + 10 + \frac{13}{2})$$
$$= 453,5 \text{ mm}$$

•) Tulangan Tumpuan

$$Rn = \frac{50,655 \times 10^6}{0,9 \times 250 \times 453,5^2} = 1,095$$

$P_{min} = 0,0033$

$P_{maks} = 0,0147$

$$P_{perlu} = \frac{0,85 \times 20}{420}\left(1-\sqrt{1-\frac{2 \times 1,095}{0,85 \cdot 20}}\right) = 0,0027$$

$As_{perlu} = 250 \times 453,5 \times 0,0027 = 306,1125$

$n \, tulangan = \frac{306,1125}{132,73} = 2,31 \rightarrow$ Digunakan 3D13

$$x = \frac{250 - (2.30 + 2.10 + 3.13)}{3-1} = 66,5 > 25$$

$As \, aktual = \frac{1}{4} \, \pi \cdot 13^2 \cdot 3 = 398,197 \, mm^2$

cek $\phi Mn > Mu$

$$a = \frac{398,197 \cdot 420}{0,85 \cdot 20 \cdot 250} = 39,35$$

$$z = 453,5 - \frac{39,35}{2} = 433,825$$

$Ts = 398,197 \cdot 420 = 167.242,74 \, N$

$\phi Mn = 0,9 \cdot 167242,74 \cdot 433,825 \qquad > Mu$

$\qquad = 65,298 \, kNm \qquad > 50,655 \, kNm$ (Ok!)

•) Tulangan Lapangan

$$Rn = \frac{14,966 \times 10^6}{0,9 \times 250 \times 453,5^2} = 0,323$$

$P_{min} = 0,0033$

$P_{max} = 0,0147$

$P_{perlu} = 0,00077$

$As_{perlu} = 250 \times 453,5^2 \times 0,0033 = 374,099$

$n \, tulangan = \frac{374,099}{132,73} = 2,83 \approx 3$ digunakan 3D13

$$X = 65,5 \; > 25$$

As aktual $= 398,197 \; mm^2$

cek $\phi Mn > Mu$

$\phi Mn = 65,298 \; kNm \; > 14,966 \; kNm \quad (ok!)$

o) Tulangan geser

$Vc = \frac{1}{6}\sqrt{20} \cdot 250 \cdot 453,5 \cdot 10^{-3} = 84,504$

$Vu = 21,43$

$Vs = \dfrac{21,43}{0,75} - 84,504 = -55,93$

$Vsmax = \frac{1}{3}\sqrt{20} \cdot 250 \cdot 453,5 \cdot 10^{-3} = 169$

Misal digunakan P10

$Av = \frac{1}{4}\pi \cdot 10^2 = 78,539 \; mm^2$

$S = \dfrac{78,539 \cdot 240 \cdot 453,5}{21,43} = 398,88 \; mm$

$Smax = \dfrac{453,5}{2} = 226,75 \; mm$

digunakan P10 - 200

3D13

P10-200   500   P10-200

3D13

260   (mm)
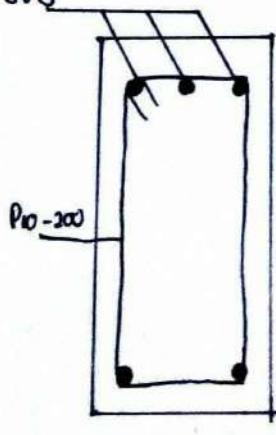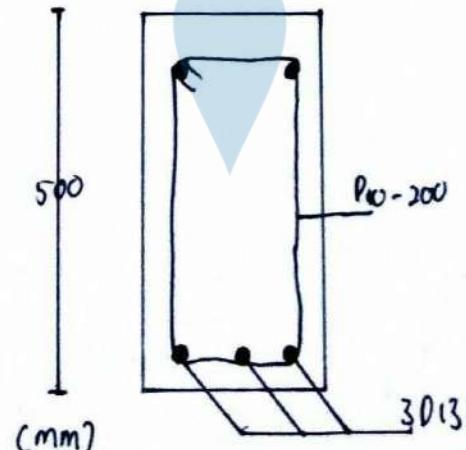
B Tumpuan   B Lapangan

4.1.5 Perancangan Balok B25 × 30 (Bagian ring)

- $F'c$ = 20 Mpa
- Fy = 420 Mpa
- Fys = 240 Mpa
- $b \times h$ = 250 × 300 mm

- d asumsi = 13 mm
- As tulangan = 132,73 mm²
- Selimut beton = 30 mm
- P sengkang = 10 mm

* Dari ETABS diperoleh

- Mu tumpuan = -31,72 kNm
- Mu lapangan = 2,804 kNm

$-d = 300 - (30 + 10 + \frac{13}{2})$

$= 253,5$ mm

•) Tulangan Tumpuan

$$Rn = \frac{31,72 \times 10^6}{0,9 \times 250 \times 253,5^2} = 2,194$$

$\rho min = 0,0033$

$\rho maks = 0,0147$

$$\rho perlu = \frac{0,85 \times 20}{420}\left(1 - \sqrt{1 - \frac{2 \times 2,194}{0,85 \cdot 20}}\right) = 0,0056$$
$\left.\begin{array}{c}\\\\\end{array}\right\}$ digunakan ρ perlu

As perlu = 250 × 253,5 × 0,0056 = 354,9

n tulangan = $\frac{354,9}{132,73}$ = 2,67 ≈ 3 digunakan 3 D13

$X = \frac{250 - (2.30 + 2.10 + 3.13)}{3 - 1} = 65,5 > 25$

As aktual = ¼ π. 13². 3 = 398,197 mm²

cek ∅Mn > Mu

a = 89,35

z = 233,825

Ts = 398,197 . 420 = 167242.74 N

∅Mn = 65,288 kNm > 31,72 kNm   (OK!)

•) Tulangan lapangan

$$Rn = \frac{2,804 \times 10^6}{0,9 \times 250 \times 253,5^2} = 0,194$$

$Pmin = 0,0033$

$Pmax = 0,0147$

$$Pperlu = \frac{0,85 \times 20}{420} \times \left(1 - \sqrt{1 - \frac{2 \times 0,194}{0,85 \times 20}}\right) = 0,00046$$

$Asperlu = 250 \times 253,5 \times 0,0033 = 209,14$

$$ntulangan = \frac{209,14}{132,73} = 1,57 \approx 2 \text{ D}13$$

$x = 250 - (2.30 + 2.10 + 2.13) = 144 > 25$

$As aktual = \frac{1}{4} \pi . 13^2 . 2 = 265,46 \text{ mm}^2$

Cek $\emptyset Mn > Mu$

$$a = \frac{265,46 . 420}{0,85 \times 20 . 250} = 26,233$$

$$z = 253,5 - \frac{26,233}{2} = 240,38$$

$Ts = 265,46 . 420 = 111493,2 \text{ N}$

$\emptyset Mn = 0,9 . 111493,2 . 240,38 \qquad > Mu$

$\qquad = 24,12 \text{ kNm} \qquad > 2,804 \text{ kNm}$

•) Tulangan Geser

$Vc = \frac{1}{6} \sqrt{20} . 250 . 253,5 . 10^{-3} = 47,24$

$Vu = 29,206$

$$Vs = \frac{29,206}{0,75} - 47,24 = -8,298$$

$Vsmax = \frac{1}{3} \sqrt{20} . 250 . 253 . 10^{-3} = 94,47$

Misal digunakan P10

$$AV = \tfrac{1}{4}\pi \cdot 10^2 = 78,539 \text{ mm}^2$$

$$S = \frac{78,539 \cdot 240 \cdot 253,5}{29,206} = 163,607 \text{ mm}$$

$$Smax = \frac{253,5}{2} = 126,75$$

digunakan P10 - 100

250   (mm)   2013

B Tumpuan   B Lapangan
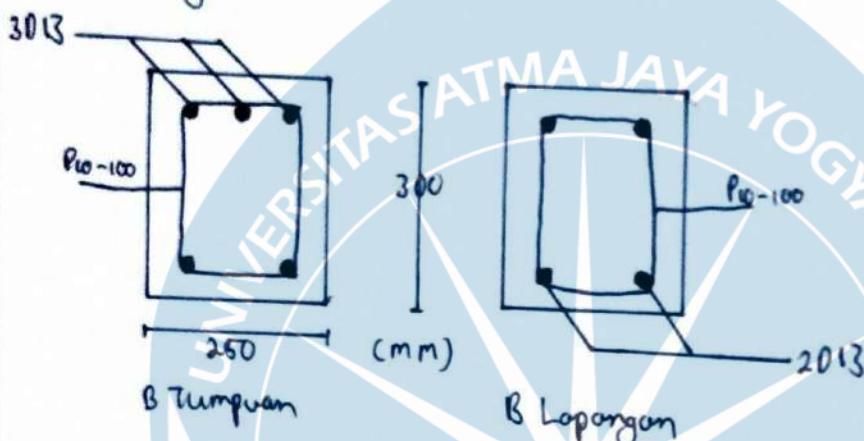
4.1.6 Perancangan Balok B 250x 500 (Bagian ring)

- $f'c$ = 20 Mpa
- fy = 430 Mpa
- fys = 240 Mpa
- $b \times h$ = 250 x 500 mm

- d asumsi = 13 mm
- As tulangan = 132,73 mm²
- Selimut beton = 30 mm
- Ø sengkang = 10 mm

* Dari ETABS diperoleh
- Mu tumpuan = -106,63 kNm
- Mu lapangan = 61,432 kNm

$$-d = 500 - \left(30 + 10 + \frac{13}{2}\right)$$
$$= 453,5 \text{ mm}$$

•> Tulangan tumpuan

$$Rn = \frac{106,63 \times 10^6}{0,9 \times 250 \times 453,5^2} = 2,304$$

$$Pmin = 0,0033$$

$$Pmaks = 0,0147$$

$$P perlu = \frac{0,85 \times 20}{430}\left(1 - \sqrt{1 - \frac{2 \times 2,304}{0,85 \times 20}}\right) = 0,0059 \quad \Big\} \begin{array}{l} \text{digunakan} \\ \text{P perlu} \end{array}$$

As perlu $= 250 \times 453,5 \times 0,0059 = 668,91$

n tulangan $= \dfrac{668,91}{132,73} = 5,04 \approx 6$ digunakan 6D13

$X = \dfrac{250 - (2.30 + 2.10 + 4.13)}{4-1} = 39,33 > 25$

As aktual $= \frac{1}{4} \pi . 13^2 . 6 = 796,39$ mm²

cek $\phi Mn > Mu$

$a = \dfrac{796,39 \quad . \quad 420}{0,85 \cdot 20 \cdot 250} = 78,7$

$z = 453,5 - \dfrac{78,7}{2} = 414,15$

$Ts = 796,39 \cdot 420 = 334483,8$ N

$\phi Mn = 0,9 . 334483,8 . 414,15 \quad > Mu$

$= 124,673$ kNm $> 106,63$ kNm (ok!)

• Tulangan lapangan

$Rn = \dfrac{61,432 \times 10^6}{0,9 \times 250 \times 453,5^2} = 1,327$

$\rho min = 0,0033$

$\rho maks = 0,0147$

$\rho perlu = \dfrac{0,85 \times 20}{420} \times \left(1 - \sqrt{1 - \dfrac{2 \times 1,327}{0,85 \times 20}}\right) = 0,0033$ } digunakan ρ perlu

As perlu $= 250 \times 453,5 \times 0,0033 = 374,137$

n tulangan $= \dfrac{374,137}{132,73} = 2,82 \approx 3$ digunakan 3D13

$X = \dfrac{250 - (2.30 + 2.10 + 3.13)}{3-1} = 65,5 > 25$

As aktual $= \frac{1}{4} . \pi . 13^2 . 3 = 398,7$

cek $\phi Mn > Mu$

$$a = \frac{398,7 \cdot 420}{0,85 \times 20 \cdot 250} = 39,4$$

$$z = 453,5 - \frac{39,4}{2} = 433,8$$

$$TS = 398,7 \cdot 420 = 167454$$

$$\phi Mn = 0,9 \cdot 167454 \cdot 433,8 > Mu$$

$$65,377 \qquad > 61,432 \text{ kNm (ok!)}$$

•) Tulangan geser

$$Vc = \frac{1}{6}\sqrt{20} \cdot 250 \cdot 453,5 \cdot 10^{-3} = 84,5$$

$$Vu = 66,62$$

$$Vs = \frac{66,62}{0,75} - 84,5 = 4,326$$

$$Vsmax = 169,0$$

Misal digunakan P10

$$Av = \frac{1}{4} \pi \cdot 10^2 = 78,539 mm^2$$

$$S = \frac{78,539 \cdot 240 \cdot 453,5}{66,62} = 128,312 \text{ mm}$$

$$Smax = \frac{453,5}{2} = 226,75 \text{ mm}$$

digunakan P10 - 200

6D13

P10 - 200

500

P10 - 200

250

(mm)

3D13

B Tumpuan

B Lapangan
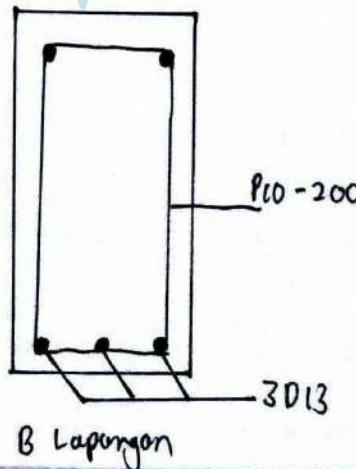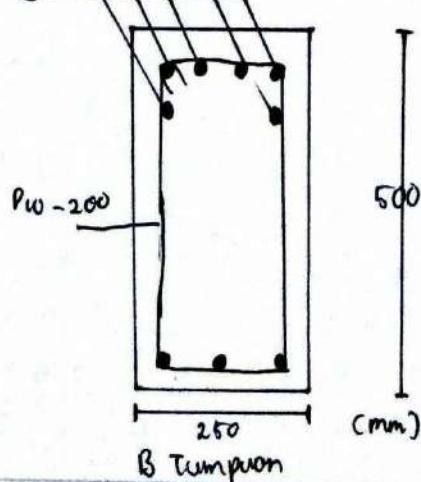
KOMBINASI MOMEN RENCANA BALOK

Dead	SDead				Komb. 1	Komb. 2 ,2 DL + 1,6	Komb. 3 ,2 DL + 1,0 LL + 1,0 Ex	Komb. 4 ,2 DL + 1,0 LL 1,0 Ex	Komb. 5 ,9 DL + ,0 Ex	Komb. 6 - Ex
-4.825	-7.798	-12.623	-3.661	44.842	-17.672	-21.005	26.033	-63.651	33.481	-56.203
0.200			0		2.260	2.257	2.137	2.137		
-39.772	-66.143	-105.915	-34.043	87.367	-148.281	-181.567	-73.774	-248.508	-7.956	-182.691
31.94		89.950		0	125.930	176.356	150.700	150.700	80.955	80.955
-2.281	-	-3.941	-0.77	14.591	-5.517	-5.961	9.092	-20.090	11.044	-18.138
			0.112 0	0						
-19.372	-1.613	-20.985	-0.331	25.142	-29.379	-25.712	-0.371	-50.655	6.256	-44.029
0	0		0	0	14.966	12.828	12.828	12.828		
-	-11.708	-13.651	-0.748	14.591	-19.111	-17.578	-2.538	-31.720	2.305	-26.877
			0	0	2.730	2.804	2.630	2.630		
-18.509	-49.501	-68.01	-3.366	21.656	-95.214	-86.998	-63.322	-106.634	-39.553	-82.865
32.34	32.34	43.88	0	0	61.432	56.480	55.046	55.046	39.492	39.492

Lantai	Bentang	Posisi	
2 & 3	A-B / C-D	Tumpuan	Lapangan
2 & 3	B-C	Tumpuan	Lapangan
Dag	A-B / C-D	Tumpuan	Lapangan
Dag	B-C	Tumpuan	Lapangan
Ring	A-B / C-D	Tumpuan	Lapangan
Ring	B-C	Tumpuan	Lapangan

KOMBINASI GESER RENCANA BALOK

Dead	SDead	Komb. 1 1,4 DL		Komb. 2 1,2 DL + 1,6 LL		Komb. 3 1,2 DL + 1,0 LL + 1,0 Ex		Komb. 4 1,2 DL + 1,0 LL - 1,0 Ex		Komb. 5 0,9 DL + 1,0 Ex		Komb. 6 0,9 DL - 1,0 Ex	
	27.78	11.34	0	11.576	0	38.66	0	-	0	35.07	0	-20.49	0
	19.66	95.704	0			118.482	0	79.162	0	81.184	0	41.864	0
16.79		6.468	0	6.488	0	15.504	0	-3.236	0	13.528	0	-5.212	0
	0	18.48	0	15.84	0	21.43	0	10.25	0				
	68.360	24.262	0	21.676	0	29.206	0	13.486	0	23.457	0	7.737	0
17.33		69.23	0	63.292	0	66.62	0			49.315	0	39.695	0
43.160													
0													
14.59													
36.25													

Lantai	Bentang	Posisi	
		Tumpuan	Lapangan
S &	A-B / C-D		
S &	B-C		
Dag	A-B / C-D		
Dag	B-C		
Ring	A-B / C-D		
Ring	B-C		

4.2 Perencanaan kolom

4.2.1 Perencanaan Balok kolom C5, C6 (400 × 400) mm.

$$Mu = -55,582 \ kNm$$
$$Pu = 182,579 \ kN$$
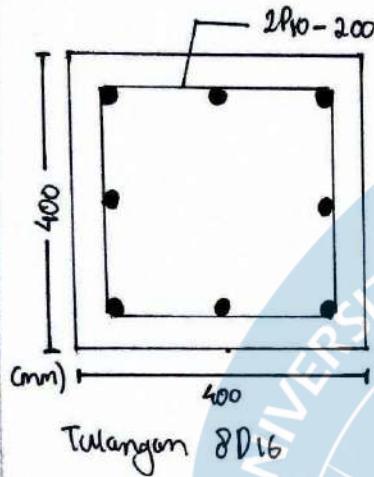
Tulangan 8D16

$b = 400 \ mm$

$h = 400 \ mm$

$Dtul = 16 \ mm$

$Dsengkang = 10 \ mm$

$Selimut \ beton = 30 \ mm$

$d' = 30 + 10 + 16/2 = 48 \ mm$

$d = 400 - 48 = 352 \ mm$

$f'c = 20 \ Mpa$

Jumlah tulangan yang diperlukan :

$$\emptyset 16 = \tfrac{1}{4} \cdot \pi \cdot 16^2 = 201,061 \ mm^2$$

Direncanakan menggunakan 8 tulangan

$$8 \emptyset 16 = 8 \times 201,061 = 1608,495 \ mm^2$$

$$Ptul = 1608,495 \ / 400 \ / 400 \times 100$$
$$= 1,005 \ \%$$

$$X = \frac{400 - (2.30 + 2.10 + 4.16)}{4-1} = 85,33 \ mm$$

> Perencanaan geser kolom berdasar kapasitas

$V_2 = 20,54 \ kN$ $\rightarrow Nu = 242,31 \ kN$

$V_3 = 29,66 \ kN$ $\rightarrow Nu = 242,31 \ kN \rightarrow$ digunakan V3

$Mnk = 138 \ kN$ $hn = 3700 - 400 = 3300 \ mm$

$$Vu = \frac{Mnk + Mnk}{hn}$$

$$Vu = \frac{138 + 138}{3,3} = 83,636 \ kNm$$

$$Vc = 0,17 \cdot \left(1 + \frac{Nu}{14.Ag}\right) \cdot \lambda \cdot \sqrt{F'c} \cdot b \cdot d$$

$$= 0,17 \cdot \left(1 + \frac{242,311 \cdot 10^3}{14.400.400}\right) \cdot 1 \cdot \sqrt{20} \cdot 400 \cdot 352$$

$$= 118624,5485 \ N \approx 118,624 \ kN$$

$$V_c \text{ pakai} = 0{,}5 \cdot V_c$$
$$= 0{,}5 \cdot 118{,}624$$
$$= 59{,}312 \text{ kN} < V_u \quad \left\{ \begin{array}{c} \text{Dicoba} \\ 2P10 \end{array} \right\} A_v = 157{,}08 \text{ mm}^2$$

$$V_s = \frac{V_u}{\phi} - V_c = \frac{83{,}636}{0{,}65} - 59{,}312 = 69{,}358 \text{ kN}$$

$$S_{perlu} = \frac{A_v \cdot F_y \cdot d}{V_s} = \frac{157{,}240 \cdot 352}{69{,}358} = 191{,}230 \text{ mm}$$

$$S_{max} = \frac{400}{2} = 200 \text{ mm}$$

Sehingga digunakan sengkang 2P10 – 200

4.2.2 Perencanaan Balok kolom C7, C8 (450 × 600) mm

$$M_u = -211{,}01 \text{ kNm}$$
$$P_u = 743{,}77 \text{ kN}$$

2P10-75

600

(mm) 450
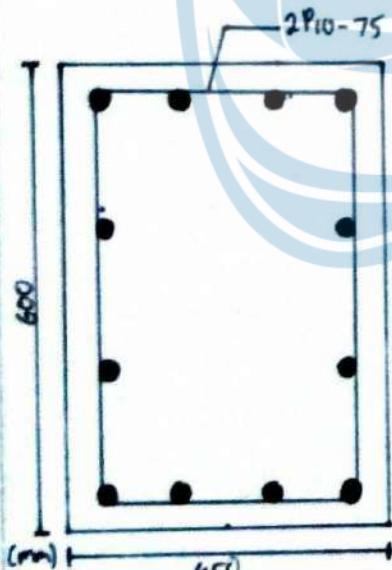
Tulangan 12 D19

$b = 450$ mm

$h = 600$ mm

$D_{tul} = 19$ mm

$D_{sengkang} = 10$ mm

Selimut beton = 30 mm

$d' = 30 + 10 + \frac{19}{2}$
$\quad = 49{,}5$ mm

$d = 600 - 49{,}5 = 550{,}5$ mm

$P'c = 20$ Mpa

$F_{ys} = 240$ Mpa

Jumlah tulangan yang diperlukan :

$$\phi_{19} = \tfrac{1}{4} \cdot a \cdot 19^2 = 283{,}528 \text{ mm}^2$$

Direncanakan menggunakan 12 tulangan

$$12 \, \phi_{19} = 12 \times 283{,}528 = 3402{,}345 \text{ mm}^2$$

$$P_{kul} = 3402{,}345 / 450 / 600 \times 100 = 1{,}26 \%$$

$$X_x = \frac{450 - (2 \cdot 30 + 2 \cdot 10 + 4 \cdot 19)}{4-1} = 98 \text{ mm}$$

$$X_y = \frac{600 - (2 \cdot 30 + 2 \cdot 10 + 4 \cdot 19)}{4-1} = 148 \text{ mm}$$

•) Perencanaan geser kolom berdasarkan kapasitas

$V_2 = 65,37$ kN $\longrightarrow NU = 655,29$ kN

$V_3 = 60,27$ kN $\longrightarrow NU = 602,78$ kN

$Mnk = 510$ kN

$hn = 3700 - 600 = 3100$ mm $\qquad$ { Cek sumbu 2 }

$Vu = \dfrac{Mnk + Mnk}{hn} = \dfrac{510 + 510}{3,1} = 329,032$

$Vc = 0,17 \cdot \left(1 + \dfrac{655,29 \cdot 10^3}{14.450.600} \right) \cdot 1 \cdot \sqrt{20} \cdot 450 \cdot 550,5$

$\qquad = 220985,60$ N $\approx 220,985$ kN

Vc pakai $= 0,5 \cdot Vc \qquad < Vu$

$\qquad = 110,493 \qquad < 329,032 \qquad$ (Butuh senglang)

Dicoba senglang 2P10

$Av = 2 \cdot \frac{1}{4} \pi \cdot 10^2 = 157,08$ mm²

$Vs = \dfrac{Vu}{\varphi} - Vc = \dfrac{329,032}{0,65} - 110,493 = 395,71$ kN

S posi perlu $= \dfrac{157 \cdot 240 \cdot 550,5}{395,71} = 52,49$ mm

$Smax = 0,25 \cdot b$

$\qquad = 0,25 \cdot 450 = 112,5$ mm

sehingga digunakan

Cek sumbu 3

$d = 450 - 49,5 = 400,5$ mm

$Vu = 329,032$

$Vc = 0,17 \left(1 + \dfrac{602,78 \cdot 10^3}{14.460.600} \right) \cdot 1 \cdot \sqrt{20} \cdot 600 \cdot 400,5$

$Vc = 221824,1934$ N $\approx 221,824$ kN

Vc pakai $= 0,5 \cdot 221,824 \qquad < Vu$

$\qquad = 110,912 \qquad < 329,032 \qquad$ (Butuh senglang)

Dicoba 2P10

$A_v = 157,08 \text{ mm}^2$

$$V_S = \frac{V_u}{\varphi} - V_c = \frac{329,032}{0,65} - 110,912 = 395,291 \text{ kN}$$

$$\text{Sposi parlu} = \frac{157 . 240 . 400,5}{395,291} = 38,176 \text{ mm}$$

$$S \text{ max} = 112,5 \text{ mm}$$

Digunakan tulangan geser minimum

Misal digunakan Sposi 75

$$A_{v \text{ min}} = 0,062 . \sqrt{f'c} . \frac{bw . S}{Fy} > \frac{0,35 . bw . s}{400}$$

$$= 0,062 . \sqrt{20} . \frac{600 . 75}{240} > \frac{0,35 . 600 . 75}{400}$$

$$= 51,988 > 39,375$$

Dipakai $A_{v \text{ min}} = 51,988 \text{ mm}^2$

$A_v = 157,08 \text{ mm}^2 > 51,988 \text{ mm}^2$ (ok!)

Maka digunakan 2P10 - 75

SD	DL	LL	Ex	Ey	Komb 1	Komb 2	Komb 3	Komb 4	Komb 5	Komb 6	Komb 7	Komb 8	Komb 9	Komb 10
0.03	-0.2	-0.00203	55.22	0.4		0.242	55.660		55.202	55.580	55.160	54.920	-55.280	55.520
93	242.23	12.92	115.65	17.89		211.149	424.613				230.000	232.500	107.724	
-0.16	0.16	-0.11	-38.44	-0.41	0.224	0.016	-38.481	-38.235			-38.419	38.172	38.461	38.707
93	223	12.92	115.65	17.89	212.209	398.272	401.537	390.803	170.237		321.717	310.080	90.417	
-8.7	-14.78	-5.63	187.57	0.26	-20.692	26.704	164.126	164.761	-211.014	-210.858	174.10	174.346	-200.95	200.794
252.06	602.79	83.75	69.57	20.83		857.335	967.906	870.407	743.765	731.267	619.231	605.833	479.181	
14.24	24.29	9.11	-94.4	1.59		43.774	55.665	-56.619	113.135	132.181	77.062	73.016	116.738	115.784
252.06	571.93	83.75	69.57	20.01		820.315	845.845	823.387	706.745	694.247	580.556	538.058	451.416	
0.77	-0.06	0.23	29.7	0.32	-0.080		-24.331	29.762	29.446	-29.638	-29.742	29.55	-29.658	-29.85
72.6	171.99	8.75	61.14	6.99	240.708			274.211		151.931	217.009	217.064	95.718	91.584
-1.07	-0.46	-0.26	-23.45	0.23	-0.644		-24.331	-24.193		22.707	-23.933	-23.795	22.967	23.105
72.6	153.55	8.75	61.14	6.99	214.97		256.217	253.081	201.402	179.903	201.402	197.260	79.122	
-46	46.81	-26.54	54.82	-5.26	-65.562	60.66	29.494	-26.338	-139.134	-135.978	11.095	14.251	-98.545	-95.389
155.73	370.02	48.12	26.91	20.33		521.076	525.153	532.055	461.453	449.255	276.011	233.814	223.112	290.114
37.68	39.39	19.6	-61.55	2.41		77.308	4.721	3.275	127.821	126.375	-26.366	-27.812	96.730	
155.73	350.67	48.12	26.91	20.33		497.796	511.873	499.675	428.171	425.975	258.550	246.354	254.852	272.654
0.9	0.13	0.11	26.53	-0.04	0.182	0.332	35.000	26.698	-26.376	26.252	26.735	26.759	-26.525	-26.501
55.36	100.08	5.11	24.68	0.75	140.112	128.272	150.111	149.661	100.751	100.202	114.977	114.527	65.617	65.167
0.16	0.83	0.28	-16.96	0.22	1.162	1.444	-15.618	-15.75		18.17	-16.147	-16.279	17.773	17.641
55.36	87.27	5.11	24.68	0.75	122.178	112.9	134.739	124.299		84.000	102.419	102.008	54.098	
-9.13	-16.7	-5.49	30.72	0.62	-27.569	-28.824	5.991	5.376	-56.436	-56.064	15.504	15.875	-45.936	-45.564
52.84	143.16	12.22	13.69	19.66	200.424	191.344	203.396	193.656	175.929	164.715	148.141	136.927	120.761	109.547
-0.95	3.19	1.11	-19.91	0.17	4.466	5.604	14.021	-15.023	24.600	24.797	-16.988	17.00	22.73	22.73
52.84	131.1	12.22	13.69	18.50	183.54	176.872	188.924	177.623	161.453	150.243	137.287	126.073		

Lantai	No. Elm/Posis	As		Dead
Lt-1	C5	A = D		
	Bawah		Momen M	-0.23
			Aksial P	149.23
	Atas		Momen M	0.32
			Aksial P	130
	C7	B = C		
	Bawah		Momen M	-6.08
			Aksial P	350.72
	Atas		Momen M	9.95
			Aksial P	319.87
Lt-2	C5	A = D		
	Bawah		Momen M	-0.83
			Aksial P	99.39
	Atas		Momen M	0.61
			Aksial P	80.95
	C7	B = C		
	Bawah		Momen M	-0.83
			Aksial P	214.34
	Atas		Momen M	0.61
			Aksial P	194.94
Dag & Atap	C5	A = D		
	Bawah		Momen M	-0.77
			Aksial P	44.72
	Atas		Momen M	0.67
			Aksial P	31.91
	C7	B = C		
	Bawah		Momen M	-7.57
			Aksial P	90.32
	Atas		Momen M	4.14
			Aksial P	78.26

KOMBINASI GESER RENCANA KOLOM

Lantai	No. Elm/Posisi	As	Dead	SD	DL	LL	Ex	Ey	Komb. 1	Komb. 2	Komb. 3	Komb. 4	Komb. 5	Komb. 6	Komb. 7	Komb. 8	Komb. 9	Komb. 10
Lt-1	C5	A = D																
		Geser	-0.11	0.04	-0.07	0.02	18.37	0.16	0	0	18	18	-18	-18	18	18	-18	-18
	C7	B = C																
		Geser	-3.3	-4.75	-8.05	-3.04	58.14	-0.38	-11.27	-14.524	45.326	45.554	-70.954	-70.726	50.781	51.009	-65.499	-65.271
Lt-2	C5	A = D																
		Geser	-0.44	0.56	0.12	0.15	16.11	0.17	0.168	0.384	16.455	16.353	-15.765	-15.867	16.269	16.167	-15.951	-16.053
	C7	B = C																
		Geser	-16	-27.44	-43.44	-15.13	38.15	-2.52	-60.816	-76.336	-29.864	-28.352	-106.164	-104.652	-1.702	-0.19	-78.002	-76.49
Dag & Atap	C5	A = D																
		Geser	-0.42	0.22	-0.2	-0.05	12.82	-0.08	-0.28	-0.32	12.506	12.554	-13.134	-13.086	12.616	12.664	-13.024	-12.976
	C7	B = C																
		Geser	-3.66	-2.55	-6.21	-2.06	15.82	-0.25	-8.694	-10.748	6.233	6.383	-25.407	-25.257	10.156	10.306	-21.484	-21.334

DIAGRAM INTERAKSI KOLOM SEGI-EMPAT BETON BERTULANG
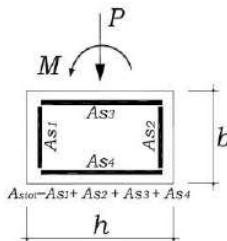
f'c = 20 MPa *b* = 400 mm *fy* = 420 MPa *h* = 400 mm

r_{tul} = 1.00 %   Selimut beton = 30   mm f>*0.1 Po* = 0.65 b₁= 0.85

f*sengkang* = 10   mm f<*0.1 Po* = 0.80

Catatan: *Astot* -> tulangan disebar merata ke-empat sisi kolom
(*Astot = As1 + As2 + As3 + As4*)

Mn (kNm)	Pn (kN)
0.00	-672.00
22.14	-556.40
68.69	-268.92
105.94	-29.28
131.70	148.34
153.42	335.01
171.57	515.11
186.08	676.78
196.07	844.80
201.90	1004.84
205.89	1156.00
203.41	1330.53
197.04	1513.22
189.76	1685.59
181.35	1849.85
171.64	2007.62
147.86	2308.27
117.72	2594.31
80.79	2869.90
36.79	3137.77
0.00	3392.00

DIAGRAM INTERAKSI KOLOM BETON SEGI-EMPAT

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Aksial (kN)

Momen (kNm)
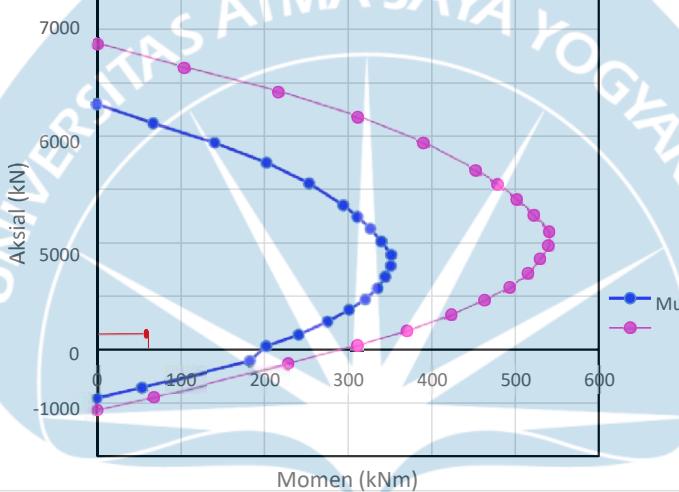
Mu (kNm)	Pu (kN)
0	-538
18	-445
55	-215
85	-23
86	119
100	268
112	412
121	541
127	676
131	804
134	925
132	1064
128	1211
123	1348
118	1480
112	1606
96	1847
77	2075
53	2296
24	2510
0	2714

Lt-1/C5	M	-55.58
	P	182.58

DIAGRAM INTERAKSI KOLOM SEGI-EMPAT BETONBERTULANG
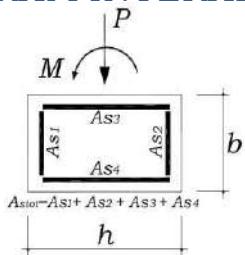
$f'c$ = 20 MPa b = 450 mm fy = 420 MPa h = 600 mm

r_{tul} = 1.00   %   Selimut beton = 30   mm f>0.1 Po = 0.65 b1= 0.85

    $f sengkang$ =   10   mm f<0.1 Po = 0.80

Catatan: Astot -> tulangan disebar merata ke-empat sisi kolom
(Astot = As1 + As2 + As3 + As4)

Mn (kNm)	Pn (kN)
0.00	-1134.00
67.52	-893.26
228.30	-262.02
310.95	78.45
370.35	346.22
423.32	654.83
463.06	927.22
493.13	1168.61
514.98	1425.60
529.46	1695.68
539.32	1950.75
540.57	2210.40
522.01	2521.59
501.53	2814.92
478.48	3094.22
452.38	3362.28
389.67	3872.65
311.39	4357.71
216.30	4824.69
103.61	5278.30
0.00	5724.00

DIAGRAM INTERAKSI KOLOM BETON SEGI-EMPAT

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Lt-1/C7	M	-211.01
	P	743.77
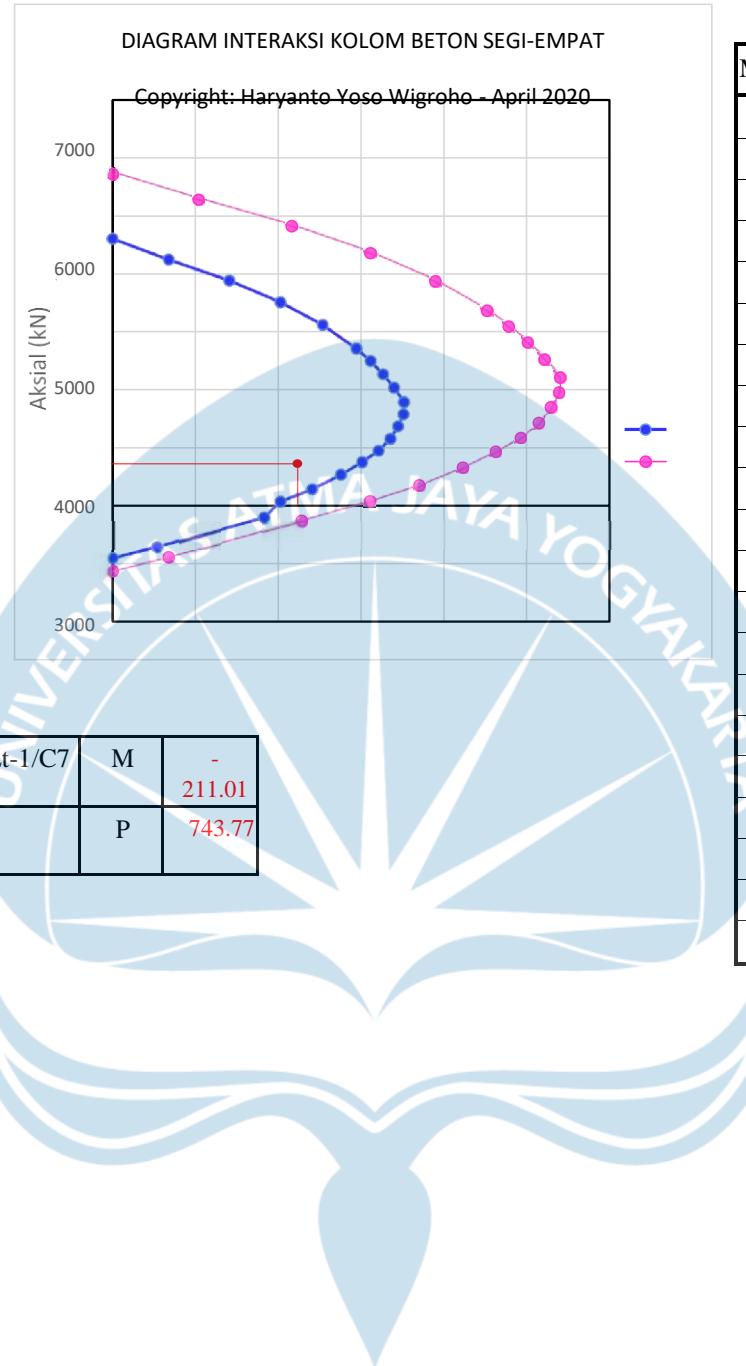
Mu (kNm)	Pu (kN)
0	-907
54	-715
183	-210
202	63
241	277
275	524
301	742
321	935
335	1140
344	1357
351	1561
351	1768
339	2017
326	2252
311	2475
294	2690
253	3098
202	3486
141	3860
67	4223
0	4579

BAB V
Rancangan Pondasi

5.1 Perencanaan Pondasi P_1 dan P_2

    5.1.1 Perhitungan Pondasi P_1 (400 x 400) C_5, C_6

    Kedalaman tanah (d) = 1,8 m

    Daya dukung tanah (σ) = 150 kN/m²

    Gaya Vertikal (P) = 503,50 kN

    Tebal pondasi (h) = 400 mm

    Selimut beton = 40 mm

    Diameter tulangan = 16 mm

    Lebar kolom = 400 mm

    Tinggi kolom = 400 mm

    $P'c$ = 20 Mpa

    Py = 420 Mpa

a. Dimensi Pondasi

$$A = \frac{P}{\sigma} = \frac{503,5}{150} = 3,356 \text{ mm}^2$$
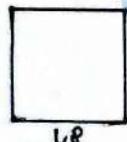
$$B = H = \sqrt{A} = \sqrt{3,356} = 1,8 \text{ m}$$

$$B = 1,8 \text{ m} \qquad H = 1,8 \text{ m}$$

b. kontrol geser 1 arah

$$ds = 40 + 16 + \frac{16}{2} = 64 \text{ mm}$$

$$d = 400 - 75 - 64 = 261 \text{ mm}$$

$$qu = \frac{P}{A} = \frac{503,5}{1,8 \times 1,8} = 155,4 \text{ kN/m}^2$$
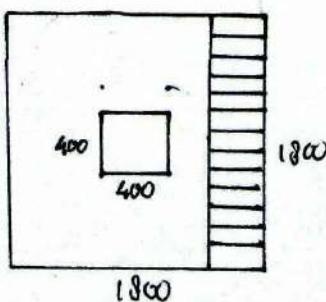
$$du = \frac{1800 - 400}{2} - 261 = 439 \text{ mm} \approx 0,44 \text{ m}$$

$$Vu = qu \cdot A'$$
$$= 155,4 \cdot 1,8 \cdot 0,44 = 123,07 \text{ kN}$$

$$Vc = 0,17 \cdot \lambda \cdot \sqrt{P'c} \cdot bw \cdot d =$$
$$0,17 \cdot 1 \cdot \sqrt{20} \cdot 1800 \cdot 261 \cdot 10^{-3} = 357,17 \text{ kN}$$

$$\phi Vc = 0,75 \cdot 357,17 = 267,87 \text{ kN}$$

$$\phi Vc > Vu \rightarrow \text{Aman}$$

c. kontrol geser 2 arah
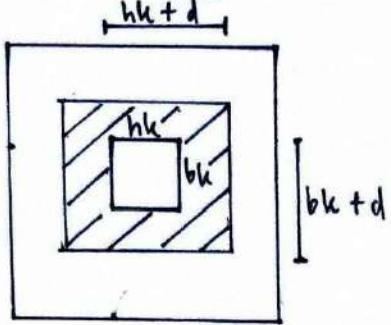
- $hk+d = 400 + 261 = 661$ mm
- $bk+d = 661$ mm
- $Vu = qu \cdot A'$
  $= 155,4 \cdot (1,8^2 - 0,661^2)$
  $= 435,598$ kN
- $\alpha_s = 30$

- $bo = 2(661) + 2(661) = 2644$ mm

- $\beta = 400/400 = 1$

- $Vc = 0,17 \left(1 + \frac{2}{\beta}\right) \cdot \lambda \cdot \sqrt{f'c} \cdot bo \cdot d$
  $= 0,17 \left(1 + \frac{2}{1}\right) \cdot 1 \cdot \sqrt{20} \cdot 2644 \cdot 261 \cdot 10^{-3}$
  $= 1573,936$ kN

- $Vc = 0,083 \left(\frac{\alpha_s \cdot d}{bo} + 2\right) \cdot \lambda \cdot \sqrt{f'c} \cdot bo \cdot d$
  $= 0,083 \left(\frac{30 \cdot 261}{2644} + 2\right) \cdot 1 \cdot \sqrt{20} \cdot 2644 \cdot 261$
  $= 1270,87$ kN

- $Vc = 0,33 \cdot 1 \cdot \sqrt{20} \cdot 2644 \cdot 261 \cdot 10^{-3}$
  $= 1018,429$ kN

Dipilih Vc terkecil $\rightarrow 1018,429$ kN

$\phi Vc = 0,75 \cdot 1018,429 = 763,822$ kN

$\phi Vc > Vu$
$763,822 > 435,598$ kN (ok!)

d. Tulangan Lentur
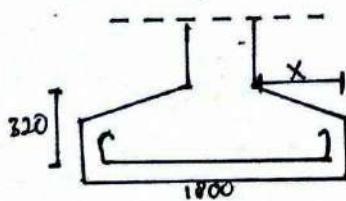
- $x = \frac{1800 - 400}{2} = 700$ mm $\approx 0,7$ m

- Per 1m lebar
  $qu = 155,4 \cdot 1 = 155,4$ kN/m^2

- $Mu = \frac{1}{2} \cdot qu \cdot x^2 = \frac{1}{2} \cdot 155,4 \cdot 0,7^2 = 38,073$ kNm

- Diasumsikan $\phi = 0,9$

  $k = \frac{Mu}{\phi \cdot b \cdot d^2} = \frac{38,073 \cdot 10^6}{0,9 \cdot 1800 \cdot 261^2} = 0,62$

- $\rho = \dfrac{0,85 \cdot f'c}{f_y} \cdot \left(1 - \sqrt{1 - \dfrac{2h}{0,85 \cdot f_c}}\right)$

$= \dfrac{0,85 \cdot 20}{420} \cdot \left(1 - \sqrt{1 - \dfrac{2 \cdot 0,62}{0,85 \cdot 20}}\right) = 0,0015$

- $As = \rho \cdot b \cdot d = 0,0015 \cdot 1000 \cdot 320 = 487,5 \ mm^2$

- $As_{min} = 0,0018 \cdot b \cdot h = 0,0018 \cdot 1000 \cdot 400 = 720 \ mm^2$

- Dipilih As terbesar $= 720 \ mm^2$

Digunakan D16

$S = \dfrac{\frac{1}{4} \cdot \pi \cdot b \cdot d^2}{As} = \dfrac{\frac{1}{4} \cdot \pi \cdot 1000 \cdot 16^2}{720} = 279,25 \approx 250 \ mm$

$\therefore$ Digunakan D16 - 250

Cek :

As aktual : $\dfrac{\frac{1}{4} \cdot \pi \cdot 16^2 \cdot 1000}{400} = 502,655 \ mm^2$

$a : \dfrac{As \cdot f_y}{0,85 \cdot f'c \cdot b} = \dfrac{502,655 \cdot 420}{0,85 \cdot 20 \cdot 1000} = 12,418 \ mm$

$Mn : As \cdot f_y \left(d - \dfrac{a}{2}\right) = 502,655 \cdot 420 \left(261 - \dfrac{12,418}{2}\right) \cdot 10^{-6}$

$= 53,79 \ kNm$

- $c = \dfrac{a}{\beta} = \dfrac{12,418}{0,85} = 14,609 \ mm$

$\varepsilon_t = \dfrac{d-c}{c} \cdot 0,003 = \dfrac{261 - 14,609}{14,609} \times 0,003 = 0,05$

$\varepsilon_t > 0,005 \rightarrow$ terkendali tarik $\phi = 0,9 \rightarrow ok!$

e. Tulangan susut

Digunakan P10

Tulangan susut $= \dfrac{\frac{1}{4} \cdot \pi \cdot 10^2 \cdot 1000}{\frac{1}{2} \cdot 450} = 349,06 \approx 300 \ mm$

$\therefore$ Digunakan 2P10 - 300

f. $Y = \dfrac{2}{3} \cdot$ tebal pondasi $= \dfrac{2}{3} \cdot 400 = 266,66 \approx 300 \ mm$

5.1.2 Perencanaan Pondasi kolom (450 × 600). P_2

kedalaman tanah (d) = 1,8 m
Daya dukung tanah (σ) = 150 kN/m²
Gaya vertikal (P) = 964,75 kN
Tebal Pondasi (h) = 450 mm
selimut Beton = 40 mm
Diameter tulangan = 16 mm
Lebar kolom = 450 mm
Tinggi kolom = 600 mm
F'c = 20 Mpa
Py = 420 Mpa

a. Dimensi Pondasi

$$A = \frac{P}{\sigma} = \frac{964,75}{150} = 6,432 \text{ mm}^2$$

$B = 0,75 \cdot H \longrightarrow BH \longrightarrow 6,43$

$B = 0,75 \cdot 3,93$ $0,75 \cdot H^2 = 6,43$
$B = 2,2 \text{ m}$ $H = \sqrt{\dfrac{6,43}{0,75}}$
$B = 2 \text{ m}$

$H = 2,93 \text{ m} \cong 3 \text{ m}$

[diagram: rectangle labeled 3 m (width) and 2 m (height)]
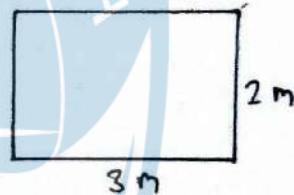
b. kontrol geser 1 arah

$$ds = 40 + 16 + \frac{16}{2} = 64 \text{ mm}$$

$$d = 450 - 75 - 64 = 311 \text{ mm}$$

$$qu = \frac{P}{A} = \frac{964,75}{2 \times 3} = 160,791 \text{ kN/m}^2$$

$$dx = \frac{3000 - 600}{2} - 311 = 889 \text{ mm} = 0,9 \text{ m}$$

$Vu = qu \cdot A'$
$= 160,791 \cdot 0,9 \cdot 2 = 289,42 \text{ kN}$

$Vc = 0,17 \cdot 1 \cdot \sqrt{20} \cdot 3000 \cdot 311 \cdot 10^{-3}$
$= 709,325 \text{ kN}$

$\phi Vc = 0,75 \cdot 709,325 \quad > Vu$
$= 531,994 \quad > 289,42 \text{ kN} \quad (\text{Aman})$

c. kontrol geser 2 arah
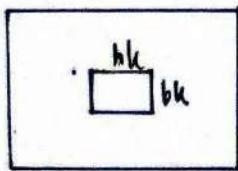
- $bk + d = 450 + 311 = 761$ mm
- $hk + d = 600 + 311 = 911$ mm
- $Vu = qu \cdot A'$

$$= 160,791 (2.3 - 0,761 \cdot 0,911)$$

$$= 853,274 \text{ kN}$$

$bo = 2(761) + 2(911)$

$= 3344$ mm

$ds = 40$

$\beta = \dfrac{600}{450} = 1,33$

- $Vc = 0,17 \cdot (1 + \dfrac{2}{1,33}) \cdot 1 \cdot \sqrt{20} \cdot 3344 \cdot 311 = 1979,626$ kN

- $Vc = 0,083 \cdot (\dfrac{40 \cdot 311}{3344} + 2) \cdot 1 \cdot \sqrt{20} \cdot 3344 \cdot 311 = 2208,121$ kN

- $Vc = 0,33 \cdot 1 \cdot \sqrt{20} \cdot 3344 \cdot 311 = 1534,813$ kN

Ambil yang terkecil, maka $Vc = 1534,813$ kN

$\phi Vc = 0,75 \cdot 1534,813 \qquad > Vu$

$= 1151,11$ kN $\qquad > 853,274$ kN (Aman)

d. Tulangan lentur
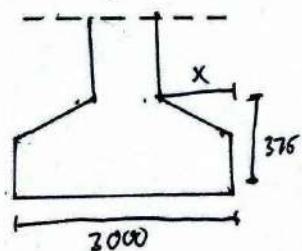
- $y = \dfrac{2000 - 600}{2} = 700$ mm
- $x = \dfrac{3000 - 600}{2} = 1200$ mm
- per 1 m lebar

$qu = 160,791$ kN/m²

- $Muy = \dfrac{1}{2} \cdot qu \cdot x^2 = \dfrac{1}{2} \cdot 160,791 \cdot 1,2^2 = 115,769$ kNm
- $Mux = \dfrac{1}{2} \cdot 160,791 \cdot (0,7)^2 = 39,394$ kNm

$My > Mx$

- Asumsi $\phi = 0,9$

$k = \dfrac{Mu}{\phi b \cdot d^2} = \dfrac{115,769}{0,9 \cdot 1000 \cdot 311^2} = 1,33$

$P = \dfrac{0,85 \cdot 20}{420} \left(1 - \sqrt{1 - \dfrac{2 \cdot 1,33}{0,85 \cdot 20}}\right) = 0,0033$

$As = P \cdot b \cdot d = 0,0033 \cdot 1000 \cdot 311 = 1026,3$ mm²

$As \min = 0,0018 \cdot 1000 \cdot 450 = 810$ mm

· Digunakan D16

$$S = \frac{\frac{1}{4}\pi . 16^2 . 1000}{1026,3} = 195.9 \approx 150 \text{ mm}$$

Digunakan D16-150

cek :

$$\text{As aktual} = \frac{\frac{1}{4}\pi . 16^2 . 1000}{150} = 1340,412 \text{ mm}^2$$

$$a = \frac{1026,3 . 450}{0,85 . 20 . 1000} = 27,1667 \text{ mm}$$

$$Mn = As . Fy . \left(d - \frac{a}{2}\right)$$

$$= 1340,412 . 420 \left(311 - \frac{27,1667}{2}\right) = 167,43$$

$$c = \frac{a}{\beta} = \frac{27,1667}{0,85} = 31,96 \text{ mm}$$

$$\varepsilon t = \frac{d-c}{c} . 0,003 = \frac{311 - 31,96}{31,96} . 0,003 = 0,026$$

$\phi Mn > Mu$

$0,9 . 167,43 > 115,769$

$150,687 > 115,769$ (AMAN)

2. Tulangan Susut

Digunakan P16

$$= \frac{\frac{1}{4}\pi . 10^2 . 1000}{0,5 . 1340,412} = 117,187 \approx 100 \text{ mm}$$

Digunakan 2P10 - 100

$$P. y = \frac{2}{3} \text{ tebal pondasi}$$

$$= \frac{2}{3} . 450$$

$$= 300 \text{ mm}$$

Dimensi dan Perulangan Pondasi
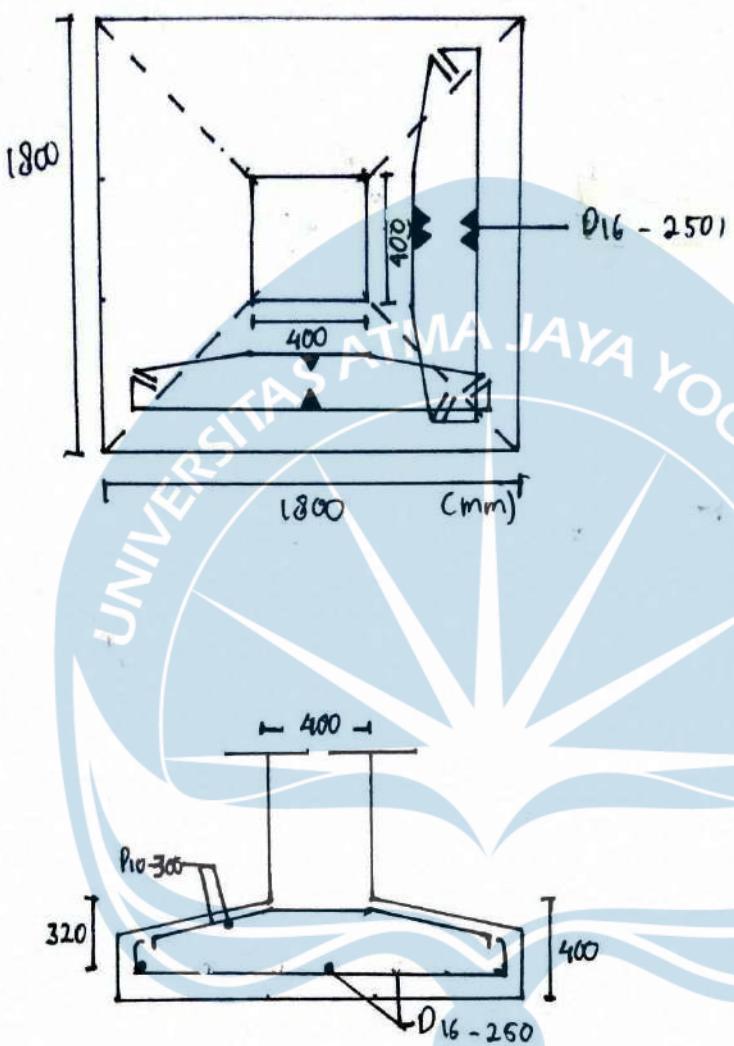
• Pondasi P1

Dimensi Pondasi = 1800 × 1800
Tulangan   = D16 - 250
Tebal Telapak = 400 mm
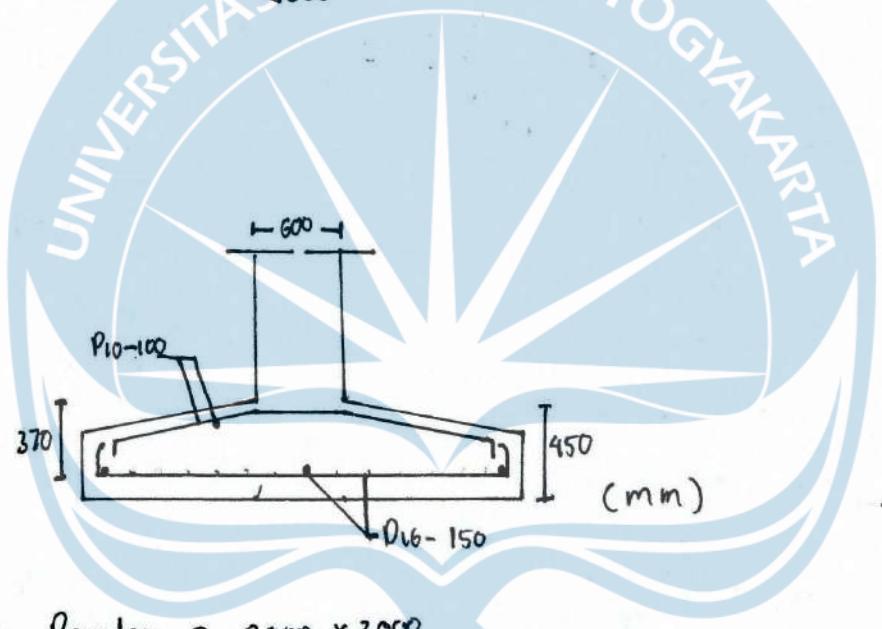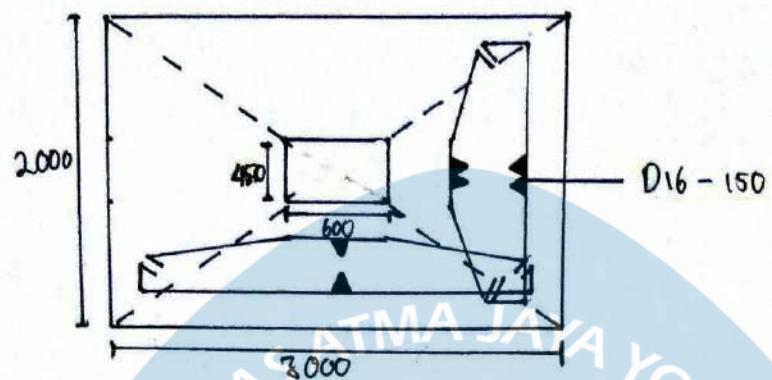
- Pondasi P2

Dimensi Pondasi = 2000 × 3000
Tulangan = D16 - 150
Tebal telapak = 450 mm
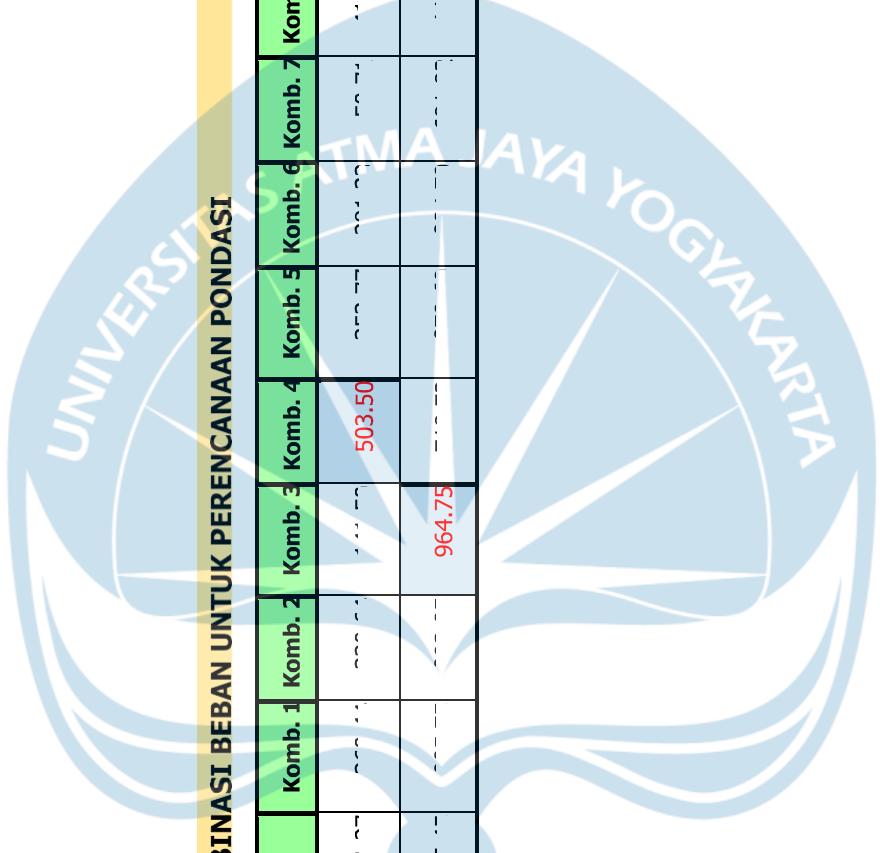
KOMBINASI BEBAN UNTUK PERENCANAAN PONDASI

			LL		Komb. 1	Komb. 2	Komb. 3	Komb. 4	Komb. 5	Komb. 6	Komb. 7	Komb. 8	Komb. 9	Komb. 10
								503.50						
							964.75							

AS / No. Elemen	Dead	SD
AS-A=D C5		
AS-B=C C7		

5.2 Perencanaan Balok Sloof (SL)

5.2.1 perhitungan Balok sloof (250 x 500)

Dari perhitungan etabs : Tulangan tumpuan

$$M_U = -49,482$$
$$V_U = -25,83$$

- Tulangan lentur

d asumsi : Ø19

$$d = 500 - (40 + 10 + \tfrac{1}{2} \cdot 19)$$
$$= 440,5 \text{ mm}$$

$$R_n \text{ perlu} = \frac{49,482 \cdot 10^6}{0,8 \cdot 250 \cdot 440,5^2} = 1,27$$

$$P \text{ perlu} = \frac{0,85 \cdot 20}{420} \left(1 - \sqrt{1 - \frac{2 \cdot 1,27}{0,85 \cdot 20}} \right)$$
$$= 0,0031$$

$$P_{min} = 0,0033$$
$$P_{max} = 0,0147$$

digunakan $P_{min} = 0,0033$

$$As \text{ perlu} = 250 \cdot 440,5 \cdot 0,0033$$
$$= 363,41 \text{ mm}^2$$

$$\text{Jumlah tulangan} = \frac{363,41}{\tfrac{1}{4} \cdot \pi \cdot 19^2} = 1,28 \approx 2\,Ø19$$

$$As \text{ terpasang} = 2 \cdot \tfrac{1}{4} \cdot \pi \cdot 19^2 = 567,057 \text{ mm}^2$$

- Cek momen nominal

$$\alpha = \frac{567,057 \cdot 420}{0,85 \cdot 20 \cdot 250} = 56,038$$

$$\phi M_n = 0,8 \cdot 567,057 \cdot 420 \cdot \left(440,5 - \frac{56,038}{2} \right)$$
$$= 78,59 \cdot 10^6 \text{ Nmm}$$

$$\phi M_n > M_U \quad ; \quad 78,59 > 49,482 \quad (AMAN)$$

- Tulangan geser

$$V_c = 0{,}17 \cdot 1 \cdot \sqrt{20} \cdot 250 \cdot 440{,}5 \cdot 10^{-3} = 83{,}72$$

$$\phi V_c = 0{,}75 \cdot 83{,}72 = 62{,}79$$

$$0{,}5 \, \phi V_c \quad > \quad V_u$$

$$31{,}4 \quad > 25{,}83 \quad (\text{tidak perlu sengkang})$$

Dipasang $D10 - 100$

- Dari perhitungan Etabs ; Tulangan lapangan

$$M_u = 14{,}134$$
$$V_u = 0$$

$$Rn \ perlu = \frac{14{,}134 \cdot 10^6}{0{,}8 \cdot 250 \cdot 440{,}5^2} = 0{,}364$$

$$P \ perlu = \frac{0{,}85 \cdot 20}{420}\left(1 - \sqrt{1 - \frac{2 \cdot 0{,}364}{0{,}85 \cdot 20}}\right)$$

$$= 0{,}00687$$

$$P \ min = 0{,}0033 \rightarrow \text{digunakan}$$

$$P \ max = 0{,}0147$$

$$As \ perlu = 250 \cdot 440{,}5 \cdot 0{,}0033 = 363{,}41 \ mm^2$$

$$Jumlah \ tulangan = \frac{363{,}41}{\frac{1}{4} \cdot \pi \cdot 19^2} = 1{,}18 \approx 2D19$$

- Cek nominal momen

$$a = 56{,}038$$

$$\phi Mn = 78{,}59 \cdot 10^6 \ N \ mm$$

$$\phi Mn \quad > \quad M_u \quad (AMAN)$$
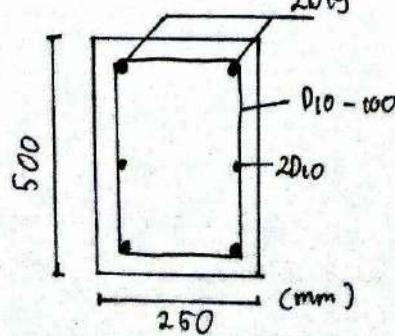
KOMBINASI MOMEN RENCANA BALOK SLOOF

SDead			Komb. 1 1,4 DL	Komb. 2 1,2 DL + 1,6	Komb. 3 1,2 DL + 1,0 LL + 1,0 Ex	Komb. 4 1,2 DL + 1,0 LL 1,0 Ex	Komb. 5 0,9 DL + 1,0	Komb. 6 0,9 DL - Ex	Dipilih kNm
-6.348		-0.71	-5.058	-5.472	-42.446	32.354	-40.652	34.148	-42.4456
-1.624		0							
-19.156	-0.576	-0.372	-27.625	-24.274	-49.482	11.748	-43.191		-49.4824
10.657	-0.561	-0.37	14.134	11.528	11.748				14.1344
		-37.4							
		0							
-3.613									
10.096									

KOMBINASI GESER RENCANA BALOK SLOOF

			Komb. 1 1,4 DL	Komb. 2 1,2 DL + 1,6	Komb. 3 1,2 DL + 1,0 LL + 1,0 Ex	Komb. 4 1,2 DL + 1,0 LL 1,0 Ex	Komb. 5 0,9 DL + 1,0	Komb. 6 0,9 DL - Ex	Dipilih kNm
		-0.71			61.462	-50.018	60.564	-50.916	61.462
		0	0	0	0	0	0	0	0
-18.56828	-0.003	-0.00064	-13.263	-15.916690	-6.006312	-25.826312	-2.026754	-21.846754	-2.026754
-13.26			0	0	0	0	0	0	0
		-1.08							

Lantai	Bentang	Posisi
Lt 1	A	Tumpuan
Lt 1	B-C	Tumpuan / Lapa...

Lantai	Bentang	Posisi
Lt 1	A-B / C-D	Tumpuan / Lapangan
Lt 1	B-C	Tumpuan / Lapangan

Lampiran 2
Praktik Perancangan Biaya dan Waktu

Volume Kolom

PERHITUNGAN VOLUME KOLOM

NO.	URAIAN PEKERJAAN					PERHITUNGAN VOLUME						VOLUME		KETERANGAN
K1	Kolom K1	Beton K250 (dari RKS)				Panjang		Lebar		Tinggi		**Total**		
						0,40	x	0,40	x	4,12	x	**0,6592**	m3	
						Panjang (m)		Berat Tul.(BJ)		Banyak		Jumlah Kolom		
	Tulangan Utama	Besi 12D16 mm	0,016	selimut beton	0,05	4,76	x	1,578	x	12	x	38	**90,15** kg	BJ Baja = 7850
	Sengkang	Besi Ø 10 mm	0,01	jarak sengkang tumpuan	0,2	1,28	x	0,617	x	22,00	x		**17,36** kg	
		Besi Ø 10 mm	0,01	jarak sengkang lapangan	0,15	1,28	x	0,617	X	29,00	x		**22,88587416** kg	
													130,402 kg	
													197,8187692 Kg/m3	
	Bekisting					0,40	+	0,40	x	4,12	x	x 2,000	**6,59** m2	
Kp	Kolom Praktis	Beton K250 (dari RKS)				Panjang		Lebar		Tinggi		Jumlah Kolom		
						0,15	x	0,15	x	4,12	x	63	**0,0927** m3	
						Panjang		Berat Tul		Banyak				
	Tulangan Utama	Besi 4P10 mm	0,01	selimut beton	0,015	4,12	x	0,617	x	4	x		**2,466150233** Kg	
	Sengkang	Besi Ø 6 mm	0,006	jarak sengkang	0,15	0,44	x	0,222	x	29	x		**2,832126928** Kg	
													5,298277161 kg	
													57,15509343 Kg/m3	
	Bekisting					0,15	+	0,15	x	4,12	x	x 2	**2,472** m2	

BJ Baja = 7850 → 0,000201062

130,4021326439

197,82 kg/m3

Jumlah Kolom	K1	Kp
Lantai 1	38	63
Lantai 2	36	93
Lantai 3	36	90
Total	110	246

Total Kebutuhan Tulangan K1	21760,0646 Kg	
Total Kebutuhan Tulangan Kp	14060,153 Kg	
Total kebutuhan Bekesting K1	725,12	m2
Total kebutuhan Bekesting Kp	608,112	m2

12,76

total bekisting lt 1		lt2	lt3
k1	250,50	237,31	237,31
kp	155,736	229,896	222,48

tripleks
1,22
2,44
2,9768 m2

total tul lt1		lt2	lt3
k1	4.955,28	4.694,48	4.694,48
kp	333,7914611	492,739776	476,844944

kolom 40x40   kolom 40x40

keb tripleks/ kolom   keb tripleks/ kolom
-    lbr tripleks 12mm   -   lbr tripleks 12mm

K1	Kolom K1	Beton K250 (dari RKS)					Panjang		Lebar		Tinggi		Jumlah Kolom			Total		
							0,40	x	0,40	x	4,12	x	36			0,6592	m3	
							Panjang		Berat Tul.		Banyak		Jumlah Kolom					
	Tulangan Utama	Besi 12D16 mm	0,016	selimut beton	0,05		4,76	x	1,578	x	12	x	36			3245,56	kg	BJ Baja = 7850
	Sengkang	Besi Ø 10 mm	0,01	jarak sengkang tumpuar	0,2		1,42	x	0,617	x	22,00	x	36			693,38	kg	
		Besi Ø 10 mm	0,01	jarak sengkang lapangar	0,15		1,02		0,617	X	29,00	x	36			656,538515	KG	
																6971,306894	Kg/m3	
	Bekisting						0,40	+	0,40	x	4,12	x	36	x	2,000	237,31	m2	
Kp	Kolom Praktis	Beton K250 (dari RKS)					Panjang		Lebar		Tinggi		Jumlah Kolom					
							0,15	x	0,15	x	4,12	x	93			8,6211	m3	
							Panjang		Berat Tul		Banyak		Jumlah Kolom					
	Tulangan Utama	Besi 4P10 mm	0,01	selimut beton	0,05		0,55	x	0,617	x	4	x	93			126,1435844	Kg	
	Sengkang	Besi Ø 6 mm	0,006	jarak sengkang	0,15		0,42	x	0,222	x	29	x	93			251,4156314	Kg	
																572,75	Kg/m3	
	Bekisting						0,15	+	0,15	x	4,12	x	93	x	2	229,896	m2	
	Lantai 3																	
K1	Kolom K1	Beton K250 (dari RKS)					Panjang		Lebar		Tinggi		Jumlah Kolom			Total		
							0,40	x	0,40	x	3,6	x	36			20,7360	m3	
							Panjang		Berat Tul.		Banyak		Jumlah Kolom					
	Tulangan Utama	Besi 12D16 mm	0,016	selimut beton	0,05		4,24	x	1,578	x	12	x	36			2891,01	kg	BJ Baja = 7850
	Sengkang	Besi Ø 10 mm	0,01	jarak sengkang tumpuar	0,2		1,42	x	0,617	x	19,00	x	36			598,83	kg	
		Besi Ø 10 mm	0,01	jarak sengkang lapangar	0,15		1,02		0,617	X	25,00	x	36			565,9814785	KG	
																195,5931152	Kg/m3	
	Bekisting						0,40	+	0,40	x	3,60	x	36	x	2,000	207,36	m2	
Kp	Kolom Praktis	Beton K250 (dari RKS)					Panjang		Lebar		Tinggi		Jumlah Kolom					
							0,15	x	0,15	x	3,6	x	90			7,29	m3	
							Panjang		Berat Tul		Banyak		Jumlah Kolom					
	Tulangan Utama	Besi 4P10 mm	0,01	selimut beton	0,05		0,55	x	0,617	x	4	x	90			122,0744365	Kg	
	Sengkang	Besi Ø 6 mm	0,006	jarak sengkang	0,15		0,42	x	0,222	x	25	x	90			209,7460773	Kg	
																16,00	Kg/m3	
	Bekisting						0,15	+	0,15	x	3,6	x	90	x	2	194,4	m2	

Balok ,Sloof ,dan Bordes

Tingkatan lantai	Jenis Balok	Lebar Balok	Tinggi Balok	Tebal Selimut Beton		Panjang Bentang Balok	Luas Penampang Balok	Keliling Penampang Balok	Jumlah Tulangan Atas	Diameter Tulangan Atas	berat tulangan per meter	panjang tumpuan	panjang overlap tulangan	jumlah berat tulangan atas pada tumpuan	Jumlah Tulangan Atas	Diameter Tulangan Atas	berat tulangan per meter	panjang lapangan	jumlah berat tulangan atas pada lapangan	Jumlah Tulangan Atas	Diameter Tulangan Atas	berat tulangan per meter	panjang tumpuan	panjang overlap tulangan	jumlah berat tulangan atas pada tumpuan			
		Dimensi							**Reinforcing**																				
															Tulangan Atas														
											T Tumpu						**T Lapang**						**T Tumpu**					
Level	**Type**	**w (mm)**	**d (mm)**	**dₛ (mm)**	**Jumlah (Buah)**	**l (mm)**	**A (mm²)**	**K (mm)**	**n**	**Dia. (mm)**	**Berat (kg/m)**	**l/4 (mm)**	**Lap (mm)**	**Berat Total (kg)**	**n**	**Dia. (mm)**	**Berat (kg/m)**	**l/2 (mm)**	**Berat Total (kg)**	**n**	**Dia. (mm)**	**Berat (kg/m)**	**l/4 (mm)**	**Lap (mm)**	**Berat Total (kg)**			
											BALOK																	
LT.2,3	B1	300	500	50		6000	150000	1600	4	16	1,58	1500	360	11,75	4	16	1,58	3000	18,95	4	16	1,58	1500	360	11,75			
		300	500	50		3000	150000	1600	4	16	1,58	750	360	7,01	4	16	1,58	1500	9,47	4	16	1,58	750	360	7,01			
		300	500	50		2000	150000	1600	4	16	1,58	500	360	5,43	4	16	1,58	1000	6,32	4	16	1,58	500	360	5,43			
		300	500	50		1750	150000	1600	4	16	1,58	437,5	360	5,04	4	16	1,58	875	5,53	4	16	1,58	437,5	360	5,04			
		300	500	50		1500	150000	1600	4	16	1,58	375	360	4,64	4	16	1,58	750	4,74	4	16	1,58	375	360	4,64			

		300	500	50		1250	150000	1600	4	16	1,58	312,5	360	4,25	4	16	1,58	625	3,95	4	16	1,58	312,5	360	4,25
		300	500	50		1000	150000	1600	4	16	1,58	250	360	3,85	4	16	1,58	500	3,16	4	16	1,58	250	360	3,85
LT.2,3,4	B2	200	400	50		6000	80000	1200	4	13	1,04	1500	292,5	7,47	3	13	1,04	3000	9,38	4	13	1,04	1500	292,5	7,47
		200	400	50		4250	80000	1200	4	13	1,04	1062,5	292,5	5,65	3	13	1,04	2125	6,65	4	13	1,04	1062,5	292,5	5,65
		200	400	50		3000	80000	1200	4	13	1,04	750	292,5	4,35	3	13	1,04	1500	4,69	4	13	1,04	750	292,5	4,35
		200	400	50		2000	80000	1200	4	13	1,04	500	292,5	3,30	3	13	1,04	1000	3,13	4	13	1,04	500	292,5	3,30
		200	400	50		1750	80000	1200	4	13	1,04	437,5	292,5	3,04	3	13	1,04	875	2,74	4	13	1,04	437,5	292,5	3,04
		200	400	50		1500	80000	1200	4	13	1,04	375	292,5	2,78	3	13	1,04	750	2,35	4	13	1,04	375	292,5	2,78
		200	400	50		1000	80000	1200	4	13	1,04	250	292,5	2,26	3	13	1,04	500	1,56	4	13	1,04	250	292,5	2,26
4	B3	150	250	50		6000	37500	800	3	13	1,04	1500	292,5	5,61	2	13	1,04	3000	6,25	3	13	1,04	1500	292,5	5,61
		150	250	50		4250	37500	800	3	13	1,04	1062,5	292,5	4,24	2	13	1,04	2125	4,43	3	13	1,04	1062,5	292,5	4,24
		150	250	50		3000	37500	800	3	13	1,04	750	292,5	3,26	2	13	1,04	1500	3,13	3	13	1,04	750	292,5	3,26
		150	250	50		2000	37500	800	3	13	1,04	500	292,5	2,48	2	13	1,04	1000	2,08	3	13	1,04	500	292,5	2,48
SLOOF																							
Sloof	S1	200	300	50		6000	60000	1000	3	13	1,04	1500	292,5	5,61	2	13	1,04	3000	6,25	3	13	1,04	1500	292,5	5,61
		200	300	50		3000	60000	1000	3	13	1,04	750	292,5	3,26	2	13	1,04	1500	3,13	3	13	1,04	750	292,5	3,26
		200	300	50		2000	60000	1000	3	13	1,04	500	292,5	2,48	2	13	1,04	1000	2,08	3	13	1,04	500	292,5	2,48
Sloof	SP	150	200	50		6000	30000	700	2	16	1,58	1500	360	5,87	2	16	1,58	3000	9,47	2	16	1,58	1500	360	5,87
Praktis		150	200	50		3000	30000	700	2	16	1,58	750	360	3,51	2	16	1,58	1500	4,74	2	16	1,58	750	360	3,51
		150	200	50		1750	30000	700	2	16	1,58	437,5	360	2,52	2	16	1,58	875	2,76	2	16	1,58	437,5	360	2,52
		150	200	50		1500	30000	700	2	16	1,58	375	360	2,32	2	16	1,58	750	2,37	2	16	1,58	375	360	2,32
		150	200	50		1250	30000	700	2	16	1,58	312,5	360	2,12	2	16	1,58	625	1,97	2	16	1,58	312,5	360	2,12
		150	200	50		1000	30000	700	2	16	1,58	250	360	1,93	2	16	1,58	500	1,58	2	16	1,58	250	360	1,93
BALOK LATEI																							
LT.1	BL1	120	120	50		6000	14400	480	2	10	0,62	1500	225	2,13	2	10	0,62	3000	3,70	2	10	0,62	1500	225	2,13
		120	120	50		3000	14400	480	2	10	0,62	750	225	1,20	2	10	0,62	1500	1,85	2	10	0,62	750	225	1,20
		120	120	50		2000	14400	480	2	10	0,62	500	225	0,89	2	10	0,62	1000	1,23	2	10	0,62	500	225	0,89
		120	120	50		1500	14400	480	2	10	0,62	375	225	0,74	2	10	0,62	750	0,93	2	10	0,62	375	225	0,74
		120	120	50		1250	14400	480	2	10	0,62	312,5	225	0,66	2	10	0,62	625	0,77	2	10	0,62	312,5	225	0,66
		120	120	50		1000	14400	480	2	10	0,62	250	225	0,59	2	10	0,62	500	0,62	2	10	0,62	250	225	0,59
LT.2	BL2	120	120	50		3000	14400	480	2	10	0,62	750	225	1,20	2	10	0,62	1500	1,85	2	10	0,62	750	225	1,20
		120	120	50		2000	14400	480	2	10	0,62	500	225	0,89	2	10	0,62	1000	1,23	2	10	0,62	500	225	0,89
		120	120	50		1500	14400	480	2	10	0,62	375	225	0,74	2	10	0,62	750	0,93	2	10	0,62	375	225	0,74
		120	120	50		1250	14400	480	2	10	0,62	312,5	225	0,66	2	10	0,62	625	0,77	2	10	0,62	312,5	225	0,66
		120	120	50		1000	14400	480	2	10	0,62	250	225	0,59	2	10	0,62	500	0,62	2	10	0,62	250	225	0,59
LT.3	BL3	120	120	50		3000	14400	480	2	10	0,62	750	225	1,20	2	10	0,62	1500	1,85	2	10	0,62	750	225	1,20
		120	120	50		2000	14400	480	2	10	0,62	500	225	0,89	2	10	0,62	1000	1,23	2	10	0,62	500	225	0,89
		120	120	50		1000	14400	480	2	10	0,62	250	225	0,59	2	10	0,62	500	0,62	2	10	0,62	250	225	0,59
BALOK BORDES																							
+1.80	BB1	300	500	50		3000	150000	1600	4	13	1,04	750	292,5	4,35	3	13	1,04	1500	4,69	4	13	1,04	750	292,5	4,35
+3.60	BB1	300	500	50		3000	150000	1600	4	13	1,04	750	292,5	4,35	3	13	1,04	1500	4,69	4	13	1,04	750	292,5	4,35
+5.40	BB2	250	400	50		3000	100000	1300	4	13	1,04	750	292,5	4,35	3	13	1,04	1500	4,69	4	13	1,04	750	292,5	4,35
+7.20	BB1	300	500	50		3000	150000	1600	4	13	1,04	750	292,5	4,35	3	13	1,04	1500	4,69	4	13	1,04	750	292,5	4,35

Tulangan Bawah																Sengkang																				
B Tumpu					B Lapang						B Tumpu					Tumpuan							Lapangan							Tumpuan						
n	Dia. (mm)	Berat (kg/m)	l/4 (mm)	Berat Total (kg)	n	Dia. (mm)	Berat (kg/m)	l/2 (mm)	Lap (mm)	Berat Total (kg)	n	Dia. (mm)	Berat (kg/m)	l/4 (mm)	Berat Total (kg)	Dia. (mm)	Jarak (mm)	p (mm)	Berat (kg/m)	l/4 (mm)	n	Berat Total (kg)	Dia. (mm)	Jarak (mm)	p (mm)	Berat (kg/m)	l/2 (mm)	n	Berat Total (kg)	Dia. (mm)	Jarak (mm)	p (mm)	Berat (kg/m)	l/4 (mm)	n	Berat Total (kg)
4	16	1,58	1500	9,47	4	16	1,58	3000	720	23,50	4	16	1,58	1500	9,47	10	150	1360	0,62	1500	10	8,39	10	200	1360	0,62	3000	15	12,58	10	150	1360	0,62	1500	10	8,39
4	16	1,58	750	4,74	4	16	1,58	1500	720	14,02	4	16	1,58	750	4,74	10	150	1360	0,62	750	5	4,19	10	200	1360	0,62	1500	8	6,71	10	150	1360	0,62	750	5	4,19
4	16	1,58	500	3,16	4	16	1,58	1000	720	10,86	4	16	1,58	500	3,16	10	150	1360	0,62	500	4	3,36	10	200	1360	0,62	1000	5	4,19	10	150	1360	0,62	500	4	3,36
4	16	1,58	437,5	2,76	4	16	1,58	875	720	10,07	4	16	1,58	437,5	2,76	10	150	1360	0,62	437,5	3	2,52	10	200	1360	0,62	875	5	4,19	10	150	1360	0,62	437,5	3	2,52
4	16	1,58	375	2,37	4	16	1,58	750	720	9,28	4	16	1,58	375	2,37	10	150	1360	0,62	375	3	2,52	10	200	1360	0,62	750	4	3,36	10	150	1360	0,62	375	3	2,52
4	16	1,58	312,5	1,97	4	16	1,58	625	720	8,49	4	16	1,58	312,5	1,97	10	150	1360	0,62	312,5	3	2,52	10	200	1360	0,62	625	4	3,36	10	150	1360	0,62	312,5	3	2,52
4	16	1,58	250	1,58	4	16	1,58	500	720	7,71	4	16	1,58	250	1,58	10	150	1360	0,62	250	2	1,68	10	200	1360	0,62	500	3	2,52	10	150	1360	0,62	250	2	1,68
3	16	1,58	1500	7,11	4	16	1,58	3000	720	23,50	3	16	1,58	1500	7,11	10	150	960	0,62	1500	10	5,92	10	200	960	0,62	3000	15	8,88	10	150	960	0,62	1500	10	5,92
3	16	1,58	1062,5	5,03	4	16	1,58	2125	720	17,97	3	16	1,58	1062,5	5,03	10	150	960	0,62	1062,5	8	4,74	10	200	960	0,62	2125	11	6,51	10	150	960	0,62	1062,5	8	4,74
3	16	1,58	750	3,55	4	16	1,58	1500	720	14,02	3	16	1,58	750	3,55	10	150	960	0,62	750	5	2,96	10	200	960	0,62	1500	8	4,74	10	150	960	0,62	750	5	2,96
3	16	1,58	500	2,37	4	16	1,58	1000	720	10,86	3	16	1,58	500	2,37	10	150	960	0,62	500	4	2,37	10	200	960	0,62	1000	5	2,96	10	150	960	0,62	500	4	2,37
3	16	1,58	437,5	2,07	4	16	1,58	875	720	10,07	3	16	1,58	437,5	2,07	10	150	960	0,62	437,5	3	1,78	10	200	960	0,62	875	5	2,96	10	150	960	0,62	437,5	3	1,78
3	16	1,58	375	1,78	4	16	1,58	750	720	9,28	3	16	1,58	375	1,78	10	150	960	0,62	375	3	1,78	10	200	960	0,62	750	4	2,37	10	150	960	0,62	375	3	1,78
3	16	1,58	250	1,18	4	16	1,58	500	720	7,71	3	16	1,58	250	1,18	10	150	960	0,62	250	2	1,18	10	200	960	0,62	500	3	1,78	10	150	960	0,62	250	2	1,18
2	13	1,04	1500	3,13	3	13	1,04	3000	585	11,21	2	13	1,04	1500	3,13	8	150	528	0,39	1500	10	2,08	8	200	528	0,39	3000	15	3,13	8	150	528	0,39	1500	10	2,08
2	13	1,04	1062,5	2,22	3	13	1,04	2125	585	8,47	2	13	1,04	1062,5	2,22	8	150	528	0,39	1062,5	8	1,67	8	200	528	0,39	2125	11	2,29	8	150	528	0,39	1062,5	8	1,67
2	13	1,04	750	1,56	3	13	1,04	1500	585	6,52	2	13	1,04	750	1,56	8	150	528	0,39	750	5	1,04	8	200	528	0,39	1500	8	1,67	8	150	528	0,39	750	5	1,04
2	13	1,04	500	1,04	3	13	1,04	1000	585	4,96	2	13	1,04	500	1,04	8	150	528	0,39	500	4	0,83	8	200	528	0,39	1000	5	1,04	8	150	528	0,39	500	4	0,83
2	13	1,04	1500	3,13	3	13	1,04	3000	585	11,21	2	13	1,04	1500	3,13	8	150	728	0,39	1500	10	2,87	8	200	728	0,39	3000	15	4,31	8	150	728	0,39	1500	10	2,87
2	13	1,04	750	1,56	3	13	1,04	1500	585	6,52	2	13	1,04	750	1,56	8	150	728	0,39	750	5	1,44	8	200	728	0,39	1500	8	2,30	8	150	728	0,39	750	5	1,44
2	13	1,04	500	1,04	3	13	1,04	1000	585	4,96	2	13	1,04	500	1,04	8	150	728	0,39	500	4	1,15	8	200	728	0,39	1000	5	1,44	8	150	728	0,39	500	4	1,15
2	16	1,58	1500	4,74	2	16	1,58	3000	720	11,75	2	16	1,58	1500	4,74	8	100	428	0,39	1500	15	2,53	12	200	428	0,89	3000	15	5,70	8	100	428	0,39	1500	15	2,53
2	16	1,58	750	2,37	2	16	1,58	1500	720	7,01	2	16	1,58	750	2,37	8	100	428	0,39	750	8	1,35	12	200	428	0,89	1500	8	3,04	8	100	428	0,39	750	8	1,35
2	16	1,58	437,5	1,38	2	16	1,58	875	720	5,04	2	16	1,58	437,5	1,38	8	100	428	0,39	437,5	5	0,84	12	200	428	0,89	875	5	1,90	8	100	428	0,39	437,5	5	0,84
2	16	1,58	375	1,18	2	16	1,58	750	720	4,64	2	16	1,58	375	1,18	8	100	428	0,39	375	4	0,68	12	200	428	0,89	750	4	1,52	8	100	428	0,39	375	4	0,68
2	16	1,58	312,5	0,99	2	16	1,58	625	720	4,25	2	16	1,58	312,5	0,99	8	100	428	0,39	312,5	4	0,68	12	200	428	0,89	625	4	1,52	8	100	428	0,39	312,5	4	0,68
2	16	1,58	250	0,79	2	16	1,58	500	720	3,85	2	16	1,58	250	0,79	8	100	428	0,39	250	3	0,51	12	200	428	0,89	500	3	1,14	8	100	428	0,39	250	3	0,51
2	10	0,62	1500	1,85	2	10	0,62	3000	450	4,26	2	10	0,62	1500	1,85	6	100	176	0,22	1500	15	0,59	6	150	176	0,22	3000	20	0,78	6	100	176	0,22	1500	15	0,59
2	10	0,62	750	0,93	2	10	0,62	1500	450	2,41	2	10	0,62	750	0,93	6	100	176	0,22	750	8	0,31	6	150	176	0,22	1500	10	0,39	6	100	176	0,22	750	8	0,31
2	10	0,62	500	0,62	2	10	0,62	1000	450	1,79	2	10	0,62	500	0,62	6	100	176	0,22	500	5	0,20	6	150	176	0,22	1000	7	0,27	6	100	176	0,22	500	5	0,20
2	10	0,62	375	0,46	2	10	0,62	750	450	1,48	2	10	0,62	375	0,46	6	100	176	0,22	375	4	0,16	6	150	176	0,22	750	5	0,20	6	100	176	0,22	375	4	0,16
2	10	0,62	312,5	0,39	2	10	0,62	625	450	1,33	2	10	0,62	312,5	0,39	6	100	176	0,22	312,5	4	0,16	6	150	176	0,22	625	5	0,20	6	100	176	0,22	312,5	4	0,16
2	10	0,62	250	0,31	2	10	0,62	500	450	1,17	2	10	0,62	250	0,31	6	100	176	0,22	250	3	0,12	6	150	176	0,22	500	4	0,16	6	100	176	0,22	250	3	0,12
2	10	0,62	750	0,93	2	10	0,62	1500	450	2,41	2	10	0,62	750	0,93	6	100	176	0,22	750	8	0,31	6	150	176	0,22	1500	10	0,39	6	100	176	0,22	750	8	0,31
2	10	0,62	500	0,62	2	10	0,62	1000	450	1,79	2	10	0,62	500	0,62	6	100	176	0,22	500	5	0,20	6	150	176	0,22	1000	7	0,27	6	100	176	0,22	500	5	0,20
2	10	0,62	375	0,46	2	10	0,62	750	450	1,48	2	10	0,62	375	0,46	6	100	176	0,22	375	4	0,16	6	150	176	0,22	750	5	0,20	6	100	176	0,22	375	4	0,16
2	10	0,62	312,5	0,39	2	10	0,62	625	450	1,33	2	10	0,62	312,5	0,39	6	100	176	0,22	312,5	4	0,16	6	150	176	0,22	625	5	0,20	6	100	176	0,22	312,5	4	0,16
2	10	0,62	250	0,31	2	10	0,62	500	450	1,17	2	10	0,62	250	0,31	6	100	176	0,22	250	3	0,12	6	150	176	0,22	500	4	0,16	6	100	176	0,22	250	3	0,12
2	10	0,62	750	0,93	2	10	0,62	1500	450	2,41	2	10	0,62	750	0,93	6	100	176	0,22	750	8	0,31	6	150	176	0,22	1500	10	0,39	6	100	176	0,22	750	8	0,31
2	10	0,62	500	0,62	2	10	0,62	1000	450	1,79	2	10	0,62	500	0,62	6	100	176	0,22	500	5	0,20	6	150	176	0,22	1000	7	0,27	6	100	176	0,22	500	5	0,20
2	10	0,62	250	0,31	2	10	0,62	500	450	1,17	2	10	0,62	250	0,31	6	100	176	0,22	250	3	0,12	6	150	176	0,22	500	4	0,16	6	100	176	0,22	250	3	0,12
3	13	1,04	750	2,35	4	13	1,04	1500	585	8,69	3	13	1,04	750	2,35	10	150	1360	0,62	750	5	4,19	10	200	1360	0,62	1500	8	6,71	10	150	1360	0,62	750	5	4,19
3	13	1,04	750	2,35	4	13	1,04	1500	585	8,69	3	13	1,04	750	2,35	10	150	1360	0,62	750	5	4,19	10	200	1360	0,62	1500	8	6,71	10	150	1360	0,62	750	5	4,19
3	13	1,04	750	2,35	4	13	1,04	1500	585	8,69	3	13	1,04	750	2,35	10	150	1060	0,62	750	5	3,27	10	200	1060	0,62	1500	8	5,23	10	150	1060	0,62	750	5	3,27
3	13	1,04	750	2,35	4	13	1,04	1500	585	8,69	3	13	1,04	750	2,35	10	150	1360	0,62	750	5	4,19	10	200	1360	0,62	1500	8	6,71	10	150	1360	0,62	750	5	4,19

Diameter tulangan samping	jumlah tulangan	panjang tulangan	berat tulangan per meter	jumlah berat tulangan samping	Total berat pembesian	Total volume beton balok	Total berat/1m3 pembesian	Total Berat Kg/m3Pembesiar	Total Luas Bekisting Balok		
		Tulangan Samping			Total Penulangan (kg)	Total Volume Beton (m³)	Total Penulangan (Kg/m³)	Total Penulangan (Kg)	Total Luas Bekisting (m²)	Tripleks 1.22x2.44 (m2)	Kebutuhan Tripleks (lbr)
Dia. (mm)	n	l (mm)	Berat (kg/m)	Berat Total (kg)							
10	2	6000	0,62	7,40	121,65	0,90	135,16		7,80		
10	2	3000	0,62	3,70	65,79	0,45	146,20		3,90		
10	2	2000	0,62	2,47	47,73	0,30	159,10		2,60		
10	2	1750	0,62	2,16	42,59	0,26	162,23		2,28	2,98	8,00
10	2	1500	0,62	1,85	38,28	0,23	170,14		1,95		
10	2	1250	0,62	1,54	34,81	0,19	185,68		1,63		
10	2	1000	0,62	1,23	28,83	0,15	192,21		1,30		
10	2	6000	0,62	7,40	90,16	0,48	187,83		6,00		
10	2	4250	0,62	5,24	67,21	0,34	197,67		4,25		
10	2	3000	0,62	3,70	48,87	0,24	203,62		3,00		
10	2	2000	0,62	2,47	35,50	0,16	221,88		2,00	2,98	7,00
10	2	1750	0,62	2,16	31,71	0,14	226,53		1,75		
10	2	1500	0,62	1,85	28,52	0,12	237,67		1,50		
10	2	1000	0,62	1,23	21,54	0,08	269,25		1,00		
8	2	6000	0,39	4,74	46,96	0,23	208,72		3,90		
8	2	4250	0,39	3,36	34,79	0,16	218,30		2,76	2,98	6,00
8	2	3000	0,39	2,37	25,41	0,11	225,91		1,95		
8	2	2000	0,39	1,58	18,37	0,08	244,95		1,30		
8	2	6000	0,39	4,74	49,72	0,36	138,12		4,80		
8	2	3000	0,39	2,37	26,84	0,18	149,09		2,40	2,98	6,00
8	2	2000	0,39	1,58	19,40	0,12	161,64		1,60		
8	2	6000	0,39	4,74	57,95	0,18	321,95		3,30		
8	2	3000	0,39	2,37	31,61	0,09	351,20		1,65		
8	2	1750	0,39	1,38	20,57	0,05	391,85		0,96	2,98	3,00
8	2	1500	0,39	1,18	18,08	0,05	401,73		0,83		
8	2	1250	0,39	0,99	16,30	0,04	434,70		0,69		
8	2	1000	0,39	0,79	13,81	0,03	460,23		0,55		
6	2	6000	0,22	2,66	20,53	0,09	237,63		2,16		
6	2	3000	0,22	1,33	10,86	0,04	251,39		1,08		
6	2	2000	0,22	0,89	7,60	0,03	263,79		0,72	2,98	3,00
6	2	1500	0,22	0,67	5,99	0,02	277,09		0,54		
6	2	1250	0,22	0,56	5,26	0,02	292,07		0,45		
6	2	1000	0,22	0,44	4,41	0,01	306,41		0,36		
6	2	3000	0,22	1,33	10,86	0,04	251,39		1,08		
6	2	2000	0,22	0,89	7,60	0,03	263,79		0,72		
6	2	1500	0,22	0,67	5,99	0,02	277,09		0,54	2,98	2,00
6	2	1250	0,22	0,56	5,26	0,02	292,07		0,45		
6	2	1000	0,22	0,44	4,41	0,01	306,41		0,36		
6	2	3000	0,22	1,33	10,86	0,04	251,39		1,08		
6	2	2000	0,22	0,89	7,60	0,03	263,79		0,72	2,98	5,00
6	2	1000	0,22	0,44	4,41	0,01	306,41		0,36		

10	2	3000	0,62	3,70	45,57	0,45	101,26		3,90		
10	2	3000	0,62	3,70	45,57	0,45	101,26		3,90	2,98	5,00
10	2	3000	0,62	3,70	42,24	0,30	140,79		3,15		
10	2	3000	0,62	3,70	45,57	0,45	101,26		3,90		

Tangga

LANTAI 1

VOLUME TANGGA

NAMA	Panjang (mm)	Volume (m3)				Jumlah anak tangga	Bulatkan
		Anak tangga	Pelat Borders	Pelat tangga	Borders		
L1	2400					18	18
L2	1200	0,783	0,432	1,2744	0,45	ANTRADE	8
L3	3000					9	9
Antrade	300						
Optrade	200						
Tinggi bangunan	3600						
Spasi antar tangga	100						
Tebal Pelat bordes	120						
Tebal pelat tangga	150						
Tinggi miring tangga	2930						
Balok Borders	300						
	500						
CEK Tinggi	3600		Total Volume		2,9394	m3	

PENULANGAN TANGGA

			Nama	Diameter	Jumlah	Panjang/spasi	Panjang terpakai (m')	Tambahan (m')	Berat Tulangan (kg)	Berat total Tulangan (kg)
L1	2400		Tulangan Memendek	8	17	2400	1450	96	0,3947	20,7493
L2	1200		Tulangan longitudinal	12	9	1450	2400	144	0,8882	40,6711
L3	3000		Tulangan plat bordes memendek	8	9	1200	1200	96	0,3947	9,2086
Spasi antar tangga	100		Tulangan plat bordes longitudinal	12	21	3000	3000	144	0,8882	117,2813
			Tulangan tumpuan	12	16	1450	1800	144	0,8882	55,2514
			kebutuhan tulngn tot (kg/m3)	82,7259						243,1616
				165,4518						486,3232

LANTAI 2

VOLUME TANGGA

NAMA	Panjang (mm)	Volume (m3)				Jumlah anak tangga	Bulatkan
		Anak tangga	Pelat Borders	Pelat tangga	Borders		
L1	2400					18	18
L2	1200	0,783	0,432	1,2744	0,45	ANTRADE	8
L3	3000					9	9
Antrade	300						
Optrade	200						
Tinggi bangunan	3600						
Spasi antar tangga	100						
Tebal Pelat bordes	120						
Tebal pelat tangga	150						
Tinggi miring tangga	2930						
Balok Borders	300						
	500						
CEK Tinggi	3600		Total Volume		2,9394	m3	

PENULANGAN TANGGA

			Nama	Diameter	Jumlah	Panjang/spasi	Panjang terpakai (m')	Tambahan (m')	Berat Tulangan (kg)	Berat total Tulangan (kg)
L1	2400		Tulangan Memendek	8	17	2400	1450	96	0,3947	20,7493
L2	1200		Tulangan longitudinal	12	9	1450	2400	144	0,8882	40,6711
L3	3000		Tulangan plat bordes memendek	8	9	1200	1200	96	0,3947	9,2086
Spasiantartangga	100		Tulangan plat bordes longitudinal	12	21	3000	3000	144	0,8882	117,2813
			Tulangan tumpuan	12	16	1450	1800	144	0,8882	55,2514
			kebutuhan tulngn tot (kg/m3)	82,7259						243,1616
				165,4518						486,3232

LT1 & LT2

tripleks	
1,22	
2,44	
2,9768	m2

pelat pijakan			bordes			PLAT BORDES		
3,48	m2		3,6	m2		3,6	M2	
keb tripleks/ plat lantai			keb tripleks/ plat lantai					
2,00	lbr tripleks 12mm		2,00	lbr tripleks 12mm				

Atap

RANGKA ATAP											
lebar	14,45	m									
tinggi	5,1	m									
sisi miring	8,84367712	m									
hitung luasan :											
segitiga	36,8475	mm2									
trapesium	140,9895	m2									
Total Luasan	355,674	m2									
panjang kuda-kuda segitiga	69	m	2001	m		kebutuhan baja ringan kuda-kuda	182 batang				
panjang kuda-kuda segitiga kecil	74,46	m	967,98	m			88 batang				
kebutuhan Kaso/usuk (vertikal)		=	2393,6	m				Jumlah kaso	136	buah	
kebutuhan gording			266,4	m							
kebutuhan reng		=	1729,52	m		kebutuhan baja ringan	289 batang	jumlah reng	52	buah	
kebutuhan talang jurai			67,63377	m							
kebutuhan sekrup genteng		=									
Kebutuhan sekrup baja		=									

Daftar Upah Pekerja

HARGA SATUAN DI DAERAH DIY			
NOMOR	URAIAN	SATUAN	UPAH (Rp)
1	PEKERJA	OH	Rp60.000,00
2	MANDOR	OH	Rp75.000,00
3	KEPALA TUKANG BATU	OH	Rp75.000,00
4	TUKANG BATU	OH	Rp70.000,00
5	KEPALA TUKANG KAYU	OH	Rp80.000,00
6	TUKANG KAYU KASAR	OH	Rp70.000,00
7	TUKANG KAYU HALUS	OH	Rp75.000,00
8	PEMBANTU TUKANG KAYU	OH	Rp60.000,00
9	TUKANG PASANG KERAMIK	OH	Rp80.000,00
10	KEPALA TUKANG BESI	OH	Rp80.000,00
11	TUKANG BESI	OH	Rp70.000,00
12	KEPALA TUKANG CAT	OH	Rp75.000,00
13	PEMBANTU TUKANG BESI	OH	Rp60.000,00
14	TUKANG CAT / POLITUR	OH	Rp75.000,00
15	TUKANG LISTRIK	OH	Rp75.000,00
16	TENAGA INSTALASI LISTRIK	OH	Rp80.000,00
17	TUKANG GALI SUMUR	OH	Rp100.000,00
18	TUKANG PIPA	OH	Rp75.000,00
19	TUKANG PIPA AIR BERSIH	OH	Rp80.000,00
20	KEPALA TUKANG ASPAL	OH	Rp80.000,00
21	JURU GODOK ASPAL	OH	Rp70.000,00
22	JURU SEMPROT ASPAL	OH	Rp70.000,00
23	MEKANIK TERLATIH	OH	Rp80.000,00
24	PEMBANTU MEKANIK	OH	Rp70.000,00
25	OPERATOR TERLATIH	OH	Rp75.000,00
26	OPERATOR SEMI TERLATIH	OH	Rp70.000,00
27	PEMBANTU OPERATOR	OH	Rp65.000,00
28	OPERATOR ALAT BERAT	OH	Rp75.000,00
29	TUKANG BONGKAR	OH	Rp70.000,00
30	PEKERJA GALI DAN URUG	OH	Rp70.000,00
31	TUKANG ALUMUNIUM/KACA	OH	Rp80.000,00

Daftar Harga

NOMOR	URAIAN	SATUAN	HARGA (Rp)
1	Pasir Pasang Progo	m3	Rp308.000,00
2	Batu Bata Merah	bh	Rp1.000,00
3	Tiga Roda Portland Semen	kg	Rp2.000,00
4	Pasir Urug	m3	Rp223.000,00
5	Semen Warna	kg	Rp13.000,00
6	Keramik 20/30 Berglazur	m2	Rp67.000,00
7	Keramik 20/20 Texture Kasar	m2	Rp71.000,00
8	Stepnosing	bh	Rp15.000,00
9	Keramik 20/25	m2	Rp71.000,00
10	Keramik 20/20	m2	Rp71.000,00
11	Keramik 40/40	m2	Rp68.000,00
12	Kayu Dolken Diameter 8-10 cm	btg	Rp14.000,00
13	Kayu 5/7 x 4 m kayu kruing	m3	Rp137.000,00
14	Kayu Jati Kelas III	m3	Rp18.762.000,00
15	Kayu balok 5/7 x 4 m Meranti	m3	Rp10.128.000,00
16	Kayu Papan 2/20 Meranti	m3	Rp8.571.000,00
17	Kayu Kelas III(Terentang)	m3	Rp1.800.000,00
18	Balok Kayu Klas II (Borneo)	m	Rp5.500.000,00
19	Seng Gelombang 3-5"	lbr	Rp75.000,00
20	Koral Beton	m3	Rp261.000,00
21	Paku biasa besar sedang 2-5"	kg	Rp22.000,00
22	Meni Besi	kg	Rp26.000,00
23	Besi Strip	kg	Rp12.000,00
24	Pasir Beton	kg	Rp201.000,00
25	Seng Plat	m'	Rp30.000,00
26	Jendela Nako	bh	Rp12.500,00
27	Kaca Polos	m2	Rp59.000,00
28	Kunci Tanam	bh	Rp33.000,00
29	Engsel	bh	Rp4.500,00
30	Plywood tebal 9 mm	lbr	Rp90.000,00
31	Plywood tebal 4 mm	lbr	Rp57.000,00
32	Besi Beton (polos/Ulir)	kg	Rp11.000,00
33	Kawat Beton	kg	Rp17.000,00
34	Beton Ready Mix K-300	m3	Rp1.400.000,00
35	Kloset Duduk Putih Toto	bh	Rp1.684.000,00
36	Floor Drain	bh	Rp109.000,00
37	Wastafel Standard INA	bh	Rp294.000,00
38	Shower Spray Toto THX20NB	bh	Rp274.000,00
39	Kran Air Toto T23B13	bh	Rp286.000,00
40	Urinoir type U57	bh	Rp2.670.000,00
41	Profil Aluminium	m'	Rp85.000,00
42	Allumunium Strip	m'	Rp5.000,00
43	Skrup Fixer	bh	Rp1.600,00
44	Sealant	tube	Rp50.000,00
45	Pintu Allumunium	m'	Rp85.000,00
46	Profil Kaca	m'	Rp6.000,00
47	Rangka Metal Hollow 40.40.2,3m	m'	Rp17.500,00
48	Aksesoris (perkuatan; las dll)		Rp70.000,00
49	Cat Plamir Afatex	kg	Rp18.000,00
50	Cat Tembok Dulux Dalam	kg	Rp57.000,00
51	Cat Tembok Dulux Luar	kg	Rp93.000,00
52	Cat Besi Zinc Chromate Primer	kg	Rp57.000,00
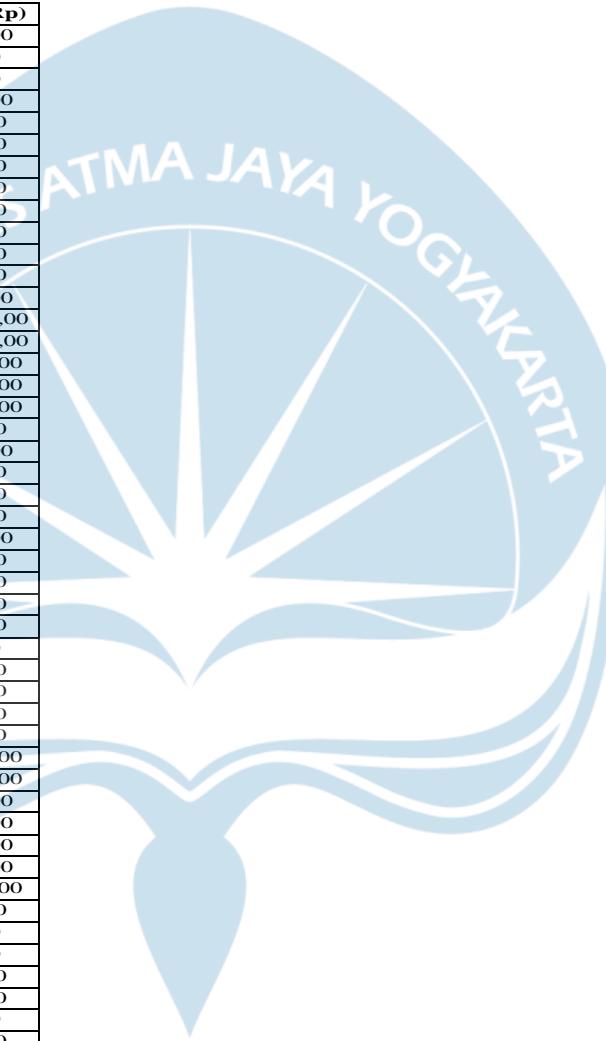
53	Cat Jotun Gradex Glossy	kg	Rp85.000,00
54	Cat Nippon Paint Beer Brand Junio	kg	Rp52.000,00
55	Kunci Pintu Aluminium Swing Dek	bh	Rp175.000,00
56	Minyak Bekisting	lt	Rp10.000,00

57	Bata Ringan Hebel 125x200x600	bh	Rp9.300,00
58	Mortar Utama (MU-200)	kg	Rp4.000,00
59	Mortar Utama (MU-380)	kg	Rp3.750,00
60	Hollow diameter 75mm, tebal 3,2r	m	Rp161.400,00
61	Hollow diameter 50mm, tebal 3,2r	m	Rp119.000,00
62	Pipa Stainless Steel Dia.2"	btg	Rp184.000,00
63	Round Bar Stainless Steel	m	Rp38.000,00
64	Kawat Las Listrik	kg	Rp23.000,00
65	Solar	lt	Rp5.150,00
66	Minyak Pelumas Motul	lt	Rp85.000,00
67	Aqua Waterproof	kg	Rp43.000,00
68	Polyester Mesh Aquaproof	kg	Rp11.000,00
69	Kunci Tanam Besar	bh	Rp27.000,00
70	Kunci Tanam Kecil	bh	Rp33.000,00
71	Door Closer	bh	Rp350.000,00
72	Patch Fitting Lock Type PT 10	bh	Rp619.000,00
73	Kaca Tempered 12mm	m2	Rp460.000,00
74	Floor Hinge Dorma BTS 84	bh	Rp1.189.000,00
75	Handle Pintu Stainless Steel SUS3	bh	Rp593.000,00
76	Kayu Kelas II (Kamper), Papan	m'	Rp14.025.000,00
77	Kayu Kelas II (Kamper), Balok	m'	Rp9.779.000,00
78	Lem Kayu	lt	Rp20.000,00
79	Kunci Tanam Kamar Mandi	bh	Rp95.000,00
80	Lever Handle Stainless Steel	bh	Rp195.000,00
81	Besi Siku L.30.30.3	kg	Rp14.000,00
82	Besi Siku L.50.50.5	kg	Rp15.000,00
83	Besi Plat Baja	kg	Rp14.000,00
84	Gypsum Board	lbr	Rp57.000,00
85	Paku Sekrup	bh	Rp1.000,00
86	Paku 0.5-1"	kg	Rp20.000,00
87	Atap Zincalume 1219 0.5mm	m2	Rp82.000,00
88	List Gypsum Profil	m	Rp11.000,00
89	Teoung Gypsum	kg	Rp5.000,00
90	Plint Ubin Granit	bh	Rp13.000,00
91	Keramik 33x33cm	bh	Rp6.444,00
92	Keramik 20x20cm	bh	Rp2.240,00
93	Pipa PVC dia2"	m'	Rp18.333,00
94	Pipa PVC dia4"	m'	Rp50.000,00
95	Pipa PVC dia6"	m'	Rp72.200,00
96	Pipa Galvanis dia 1.5"	m'	Rp69.000,00
97	Pipa Tanah	bh	Rp12.000,00
98	Philips 20 watt	unit	Rp21.900,00
99	Kabel NYM 3x2.5	m	Rp303.200,00
100	Engkel Out Bow-Broco Saklar	bh	Rp20.700,00
101	Serie In Bow-Merter	bh	Rp68.600,00
102	Stop Kontak In Bouw-Broco	bh	Rp25.400,00
103	Panel Kontrol MCB 8 Group	unit	Rp493.500,00
104	Downlight Compact 9W	bh	Rp282.900,00
105	Flood Light 50W	bh	Rp1.331.600,00
106	Street Light 50 W	bh	Rp3.332.700,00
107	Residu	ltr	Rp10.000,00
108	Kawat Duri	m'	Rp3.000,00
109	sirtu	m3	Rp109.000,00

111	Batu kali		Rp257.000,00
112	Batu belah		Rp197.000,00

113	Kerikil		Rp226.000,00
114	Batu Split		Rp333.000,00
115	kawat beton		Rp21.000,00
116	paku beton5 cm	bh	Rp1.000,00
117	minyak bekisting		Rp10.000,00
118	Politur		Rp40.000,00
119	Politur jadi		Rp80.000,00
120	Ampelas		Rp8.000,00
121	Vernis		Rp55.000,00
122	Dempul		Rp8.000,00
123	Plamuur		Rp8.000,00
124	*Wall paper*		Rp65.000,00
125	Lem		Rp40.000,00
126	Kwas		Rp8.000,00
127	kloset jongkok		Rp225.000,00
128	Bathup		Rp3.800.000,00
129	Bak fibreglass		Rp425.000,00
130	Bak cuci piring		Rp450.000,00
131	*Waterdrain*		Rp25.000,00
132	*Roof drain*		Rp85.000,00
133	Paku 10 cm		Rp21.000,00
134	Engsel pintu		Rp15.500,00
135	Engsel kupu-kupu		Rp10.000,00
136	Kait angin (jendela)		Rp11.000,00
137	kunci slot		Rp50.000,00
138	Kaca 3 mm		Rp95.000,00
139	kaca 5 mm		Rp106.000,00
140	cat menie		Rp50.000,00
141	tinner		Rp35.000,00
142	Cat dasar kayu		Rp50.000,00
143	cat penutup kayu		
144	Paving Block	m2	Rp110.000,00
145	Kawat las listrik	kg	Rp55.000,00
146	Besi hollow 40x40x2	m	Rp150.000,00
147	Aksesoris stop kontak	Ls	Rp2.000,00
148	Stop kontak AC	bh	Rp55.000,00
149	upah pemasangan ac	unit	Rp35.000,00
150	Kayu 6/12 profil (kayu kelas 1)	m'	Rp80.000,00
151	Dudukan railing besi hollow 50x50	btg	Rp215.000,00
152	Pipa Konduit	bh	Rp11.000,00
153	Pemasangan 1 bh Stop kontak	bh	Rp10.000,00
154	Stop kontak	bh	Rp25.000,00
155	Pemasangan 1 bh Saklar Ganda	bh	Rp10.000,00
156	Saklar Ganda	bh	Rp35.000,00
157	Saklar tunggal	bh	Rp25.000,00

158	Bak cuci piring	unit	Rp450.000,00
159	Waterdrain	bh	Rp25.000,00
160	Floor drain	unit	Rp120.000,00
161	Roof drain	unit	Rp155.000,00
162	Pasir pasang	m3	Rp244.000,00
163	Pasir beton	m3	Rp201.000,00
164	Kerikil	m3	Rp225.000,00
165	Baja tulangan	kg	Rp12.000,00
166	Sealtape	bh	Rp7.500,00
167	Pipa galvanis 3/4	m	Rp205.000,00
168	Pipa galvanis ½	m	Rp160.000,00
169	perlengkapan pipa galvanis	%	Rp15.000,00
170	Pipa galvanis 1	m	Rp305.000,00
171	Pipa PVC 1/2	m	Rp3.000,00
172	Pipa PVC 3/4	m	Rp4.000,00
173	Pipa PVC 1	m	Rp7.000,00
174	Pipa PVC 11/2	m	Rp15.000,00
175	Pipa PVC 2	m	Rp22.000,00
176	Pipa PVC 3	m	Rp45.000,00
177	Pipa PVC 4	m	Rp64.000,00
178	upah Pemancangan 1 m' mini pile s	m'	Rp150.000,00
179	Mini pile segitiga uk. 32 x 32 cm	m'	Rp200.000,00
180	Kusen aluminium (silver) - 4 inch (	M'	Rp120.000,00
181	Pemasangan 1 bh Lampu	unit	Rp25.000,00
182	Raam aluminium silver	m'	Rp55.000,00
183	Teakwood rangkap	m2	Rp100.000,00
184	Kaca bening tbl. 5 mm	m2	Rp100.000,00
185	Sealant pinggir kusen	m'	Rp5.000,00
186	Karet penjepit kaca	m'	Rp5.000,00
187	Engsel pintu 4	bh	Rp25.000,00
188	Grendel 10 cm	bh	Rp18.000,00
189	Kunci tanam mutu baik	bh	Rp150.000,00
190	Calsiboard rangkap	m2	Rp100.000,00
191	Kaca rayban tbl. 5 mm	m2	Rp80.000,00
192	Folding gate	m2	Rp420.000,00
193	Engsel jendela 3	bh	Rp15.000,00
194	Pemasangan 1 unit Biofil BF-04 ka	unit	Rp250.000,00
195	Biofil BF-04 kapasitas 1850 liter	unit	Rp10.000.000,00
196	Biofil BF-06 kapasitas 2145 liter	unit	Rp12.000.000,00
197	Biaya penyambungan	va	Rp33.000,00
198	ujl	va	Rp33.000,00
199	upah Pemasangan 1 unit Panel Pene	unit	Rp250.000,00
200	Kotak panel uk (80 x 60 x 20)	bh	Rp800.000,00
201	Lampu indikator	bh	Rp20.000,00
202	Fuse	bh	Rp50.000,00
203	MCCB 3 phase 80 A	bh	Rp550.000,00
204	MCCB 3 phase 60 A	bh	Rp530.000,00
205	MCCB 3 phase 6 A	bh	Rp60.000,00
206	Arde BC 16 mm2	unit	Rp250.000,00
207	Accessories	Ls	Rp200.000,00
208	MCCB 3 phase 35 A	bh	Rp460.000,00
209	upah Pemasangan 1 m' Kabel NYY	unit	Rp15.000,00
210	Kabel NYY 4x25 mm2	unit	Rp150.000,00
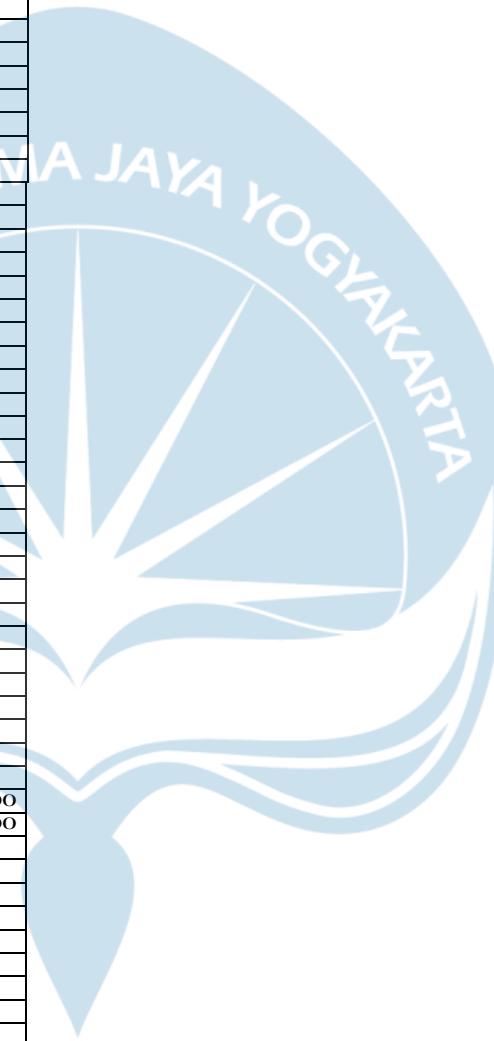
211	Kabel NYY 4x16 mm2	unit	Rp100.000,00
212	Kabel NYY 4x10 mm2	unit	Rp70.000,00
213	upah Pemasangan 1 titik instalasi li	unit	Rp80.000,00
214	Kabel NYA 3x2,5 mm2	unit	Rp15.000,00
215	upah Pemasangan 1 bh Lampu TL 2	unit	Rp30.000,00
216	Lampu TL 2x18 Watt	bh	Rp230.000,00
217	Aksesoris		Rp23.000,00
218	Lampu SL 14 Watt	bh	Rp25.000,00
219	MCCB 3 phase 80 A	bh	Rp550.000,00
220	MCCB 3 phase 60 A	bh	Rp530.000,00
221	MCCB 3 phase 6 A	bh	Rp60.000,00
222	Arde BC 16 mm2	unit	Rp250.000,00
223	Accessories	Ls	Rp200.000,00
224	MCCB 3 phase 35 A	bh	Rp460.000,00

Rancangan Anggaran Biaya Lantai 1

RENCANA ANGGARAN BIAYA
PEMBANGUNAN GEDUNG DIKLAT & FASILITAS PENDUKUNG LAINNYA
PEMERINTAH KABUPATEN MUARA ENIM-SUMATERA SELATAN

URAIAN PEKERJAAN		VOL	SAT	HARGA SATUAN		JUMLAH HARGA		TOTAL	
PEKERJAAN PERSIAPAN									
Pembersihan Lapangan		774,00	m2	Rp	9.750,00	Rp	7.546.500,00		
Uitzet dan Bouwplank		123,00	m'	Rp	43.655,00	Rp	5.369.565,00		
						Total		**Rp**	**12.916.065,00**
PEKERJAAN GALIAN DAN URUGAN									
Galian tanah		219,65	m3	Rp	68.025,00	Rp	14.941.691,25		
Urugan kembali		73,22	m3	Rp	38.750,00	Rp	2.837.145,83		
						Total		**Rp**	**17.778.837,08**
PEKERJAAN PASANGAN DAN PLESTERAN									
Pasangan Bata		690,76	m2	Rp	931.925,00	Rp	643.740.324,57		
Plesteran		1381,53	m2	Rp	46.779,00	Rp	64.626.506,73		
Acian		1381,53	m2	Rp	29.645,00	Rp	40.955.402,90		

						Total	**Rp**	**749.322.234,20**
	PEKERJAAN STRUKTUR BETON							
	Pekerjaan Tiang Pancang							
Pek. Pemancangan		89,10	m'	Rp	270.000,00	Rp 24.057.000,00		

URAIAN PEKERJAAN	VOL	SAT	HARGA SATUAN	JUMLAH HARGA	TOTAL
PEKERJAAN PERSIAPAN					
Pembersihan Lapangan	774,00	m2	Rp 9.750,00	Rp 7.546.500,00	
Uitzet dan Bouwplank	123,00	m'	Rp 43.655,00	Rp 5.369.565,00	
				Total	**Rp** **12.916.065,00**
PEKERJAAN GALIAN DAN URUGAN					
Galian tanah	219,65	m3	Rp 68.025,00	Rp 14.941.691,25	
Urugan kembali	73,22	m3	Rp 38.750,00	Rp 2.837.145,83	
				Total	**Rp** **17.778.837,08**
PEKERJAAN PASANGAN DAN PLESTERAN					
Pasangan Bata	690,76	m2	Rp 931.925,00	Rp 643.740.324,57	
Plesteran	1381,53	m2	Rp 46.779,00	Rp 64.626.506,73	
Acian	1381,53	m2	Rp 29.645,00	Rp 40.955.402,90	
				Total	**Rp** **749.322.234,20**
PEKERJAAN STRUKTUR BETON					
Pekerjaan Tiang Pancang					
Pek. Pemancangan	89,10	m'	Rp 270.000,00	Rp 24.057.000,00	

Pekerjaan Beton Struktur						
Pilecap PC 1						
Beton K-400		24,30	m3	Rp	1.414.631,40	Rp	34.375.543,02
Bekisting		113,40	m2	Rp	133.030,00	Rp	15.085.602,00
Pembesian dengan besi polos dan ulir		28,51	kg	Rp	12.931,00	Rp	368.633,20
Sloof S1 20 x 30						
Beton K-250		0,66	m3	Rp	1.167.722,72	Rp	770.697,00
Bekisting		8,80	m2	Rp	142.030,00	Rp	1.249.864,00
Pembesian dengan besi polos dan ulir		95,96	kg	Rp	12.801,00	Rp	1.228.349,57
Kolom K1 40x40						
Beton K-250		0,66	m3	Rp	1.167.722,72	Rp	769.762,82
Bekisting		250,50	m2	Rp	218.345,00	Rp	54.694.549,12
Pembesian dengan besi polos dan ulir		130,40	kg	Rp	12.801,00	Rp	1.669.277,70
Plat bordes tebal 15 cm						
Beton K-250		0,43	m3	Rp	1.167.722,72	Rp	504.456,22
Bekisting		3,60	m2	Rp	240.765,00	Rp	866.754,00
Pembesian dengan besi polos dan ulir		126,49	kg	Rp	12.801,00	Rp	1.619.196,21
Plat tangga tebal 15 cm						
Beton K-250		1,27	m3	Rp	1.167.722,72	Rp	1.488.104,28
Bekisting		3,48	m2	Rp	240.765,00	Rp	837.862,20
Pembesian dengan besi polos dan ulir		116,67	kg	Rp	12.801,00	Rp	1.493.515,43

Pekerjaan Beton Praktis							
Sloof praktis 15x 20							
Beton K-175		0,44	m3	Rp	1.059.811,51	Rp	461.018,01
Bekisting		7,98	m2	Rp	142.030,00	Rp	1.132.689,25
Pembesian dengan besi polos dan ulir		158,32	kg	Rp	12.801,00	Rp	2.026.602,67
Kolom praktis 15x15							
Beton K-175		0,0927	m3	Rp	1.059.811,51	Rp	98.244,53
Bekisting		2,47	m2	Rp	218.345,00	Rp	539.748,84
Pembesian dengan besi polos dan ulir		5,30	kg	Rp	12.801,00	Rp	67.823,25
Pekerjaan Beton Rabat dan Lantai Kerja							
Pek. Lantai kerja beton K-175 tebal 10 cm		11,98	m3	Rp	1.059.811,51	Rp	12.696.541,87
Pek. Plat lantai 1	K250	99,80	m3	Rp	1.059.811,51	Rp	105.769.188,49
						Total	**Rp** 263.871.023,66

PEKERJAAN KUSEN PINTU DAN JENDELA						
Kusen dan daun pintu P1 + Aksesoris	4,00	unit	Rp	1.737.805,00	Rp	6.951.220,00	
Kusen dan daun pintu P2 + Asesoris	12,00	unit	Rp	2.164.105,00	Rp	25.969.260,00	
Kusen dan daun pintu P3+ Aksesoris	8,00	unit	Rp	1.642.805,00	Rp	13.142.440,00	
Kusen dan daun pintu P6 + Aksesoris	4,00	unit	Rp	881.905,00	Rp	3.527.620,00	
Kusen dan daun pintu P7 + Aksesoris	1,00	unit	Rp	6.016.500,00	Rp	6.016.500,00	
Kusen dan daun pintu jendela PJ1 + Aksesoris	1,00	unit	Rp	6.016.500,00	Rp	6.016.500,00	
Kusen dan daun jendela J1 + Aksesoris	15,00	unit	Rp	3.322.905,00	Rp	49.843.575,00	
Kusen dan daun jendela J2 + Aksesoris	8,00	unit	Rp	1.355.105,00	Rp	10.840.840,00	
BV 1 + Aksesoris	10,00	unit	Rp	305.605,00	Rp	3.056.050,00	
	Total				**Rp**	**125.364.005,00**
PEKERJAAN PELAPIS LANTAI, PELAPIS DINDING , REALING DAN PLIN						
Keramik lantai ukuran 60 x 60	331,80	m2	Rp	370.935,00	Rp	123.076.233,00	
Keramik lantai KM/WC ukuran 20 x 20	39,20	m2	Rp	181.317,00	Rp	7.108.351,67	
Plin keramik ukuran 10 x 30	33,18	m'	Rp	65.186,09	Rp	2.162.874,30	
	Total				**Rp**	**132.347.458,97**

PEKERJAAN PLAFON								
Langit-langit gypsumboard	756,00	m2	Rp	42.085,00	Rp	31.816.260,00		
Rangka besi hollow 40x40x2 mm, modul 60 x 60, plafon	756,00	m2	Rp	356.560,00	Rp	269.559.360,00		
			Total				Rp	301.375.620,00
PEKERJAAN MEKANIKAL ELEKTRIKAL								
INSTALASI AIR BERSIH								
Pembuatan Sumur bor lengkap + Pompa air (submersible)	1,00	unit	Rp	25.000.000,00	Rp	25.000.000,00		
Rooftank kapasitas 1000L	4,00	unit	Rp	3.800.000,00	Rp	15.200.000,00		
Jaringan pipa air bersih dengan pipa PVC 2"	53,16	m'	Rp	561.795,00	Rp	29.865.022,20		
Jaringan pipa air bersih dengan pipa PVC 3/4"	28,42	m'	Rp	777.930,00	Rp	22.108.770,60		
			Sub total A				Rp	92.173.792,80
PEKERJAAN INSTALASI AIR KOTOR								
Jaringan air kotor, pipa PVC dia. 3"	65,64	m'	Rp	594.555,00	Rp	39.026.590,20		
Bak Air Kotor	6,00	unit	Rp	17.100.214,40	Rp	102.601.286,40		
Biofil BF-04 kap.1850 lt	2,00	unit	Rp	10.250.000,00	Rp	20.500.000,00		
Biofil BF-06 kap.2145 lt	4,00	unit	Rp	12.250.000,00	Rp	49.000.000,00		
Sumur peresapan	6,00	unit	Rp	3.000.000,00	Rp	18.000.000,00		
Jaringan air kotor, pipa PVC dia. 4"	27,14	m'	Rp	617.355,00	Rp	16.755.014,70		
			Sub total B				Rp	245.882.891,30

PEKERJAAN ELEKTRIKAL							
Instalasi listrik titik lampu dan stop kontak	154,00	titik	Rp	95.000,00	Rp	14.630.000,00	
Instalasi AC 1 PK	1,00	titik	Rp	400.000,00	Rp	400.000,00	
Instalasi AC 1,5 PK	5,00	titik	Rp	400.000,00	Rp	2.000.000,00	
Pemasangan stop kontak	20,00	bh	Rp	69.000,00	Rp	1.380.000,00	
Pemasangan stop kontak AC	6,00	bh	Rp	124.000,00	Rp	744.000,00	
Pas. Lampu TL 2x18 W	90,00	bh	Rp	257.300,00	Rp	23.157.000,00	
Pas. Lampu SL 14 W	33,00	bh	Rp	57.300,00	Rp	1.890.900,00	
Pas. Saklar tunggal	10,00	bh	Rp	69.000,00	Rp	690.000,00	
Pas. Saklar ganda / double	27,00	bh	Rp	79.000,00	Rp	2.133.000,00	
kabel roll NYY 4x25mm	593,11	m'	Rp	160.000,00	Rp	94.897.600,00	
					Sub total C	**Rp**	**141.922.500,00**
	Total					**Rp**	**479.979.184,10**
PEKERJAAN PENGECATAN							
Cat dinding dalam	690,76	m2	Rp	80.000,00	Rp	55.261.127,20	
Cat dinding luar	690,76	m2	Rp	80.000,00	Rp	55.261.127,20	
Cat Plafond	756,00	m2	Rp	26.327,50	Rp	19.903.590,00	
	Total					**Rp**	**130.425.844,40**
PEKERJAAN SANITAIR							
Pasang Kran air 3/4"	8,00	bh	Rp	317.962,50	Rp	2.543.700,00	
Pasang Closet Duduk	8,00	unit	Rp	426.840,00	Rp	3.414.720,00	
Pasang Floor drain	8,00	bh	Rp	128.675,00	Rp	1.029.400,00	
	Total					**Rp**	**6.987.820,00**

			PEKERJAAN DRAINASE									
	Saluran drainase			851,40	m'	Rp	595.884,76	Rp	507.336.287,90			
	Bak kontrol			6,00	m'	Rp	377.255,00	Rp	2.263.530,00			
				Total							**Rp**	**509.599.817,90**
								Total Seluruh Pekerjaan Lantai 1			**Rp**	**2.729.967.910,31**

Rancangan Anggaran Biaya Lantai 2

			RENCANA ANGGARAN BIAYA					
			PEMBANGUNAN GEDUNG DIKLAT & FASILITAS PENDUKUNG LAINNYA					
			PEMERINTAH KABUPATEN MUARA ENIM-SUMATERA SELATAN					
	URAIAN PEKERJAAN		**VOL**	**SAT**	**HARGA SATUAN**		**JUMLAH HARGA**	**TOTAL**
	PEKERJAAN PASANGAN DAN PLESTERAN							
	Pasangan Bata		1901,73	m2	Rp	931.925,00	Rp 1.772.270.311,77	
	Plesteran		3803,46	m2	Rp	54.143,00	Rp 205.930.802,35	
	Acian		3803,46	m2	Rp	29.645,00	Rp 112.753.608,70	
						Total	**Rp**	**2.090.954.722,82**
	PEKERJAAN STRUKTUR BETON							
	Pekerjaan Beton Struktur							
	Kolom K1 40x40							
	Beton K-250		0,66	m3	Rp	1.167.722,72	Rp 769.762,82	
	Bekisting		6,59	m2	Rp	218.345,00	Rp 1.439.330,24	
	Pembesian dengan besi polos dan ulir		130,40	kg	Rp	12.801,00	Rp 1.669.277,70	
	Balok B1							
	Beton K-250		2,48	m3	Rp	1.167.722,72	Rp 2.890.113,74	
	Bekisting		21,45	m2	Rp	302.365,00	Rp 6.485.729,25	
	Pembesian dengan besi polos dan ulir		379,68	kg	Rp	12.801,00	Rp 4.860.289,52	
	Balok B2							

Beton K-250		1,56	m3	Rp	1.167.722,72	Rp	1.821.647,45
Bekisting		19,50	m2	Rp	302.365,00	Rp	5.896.117,50
Pembesian dengan besi polos dan ulir		323,51	kg	Rp	12.801,00	Rp	4.141.288,98
Plat lantai tebal 12 cm							
Beton K-250		3,25	m3	Rp	1.167.722,72	Rp	3.792.389,74
Bekisting		16,24	m2	Rp	565.105,00	Rp	9.176.401,03
Pembesian dengan besi polos dan ulir		3057,76	kg	Rp	12.801,00	Rp	39.142.397,78
Plat bordes tebal 15 cm							
Beton K-250		0,43	m3	Rp	1.167.722,72	Rp	504.456,22
Bekisting		3,60	m2	Rp	240.765,00	Rp	866.754,00
Plat tangga tebal 15 cm							
Beton K-250		1,27	m3	Rp	1.167.722,72	Rp	1.488.104,28
Bekisting		3,48	m2	Rp	240.765,00	Rp	837.862,20
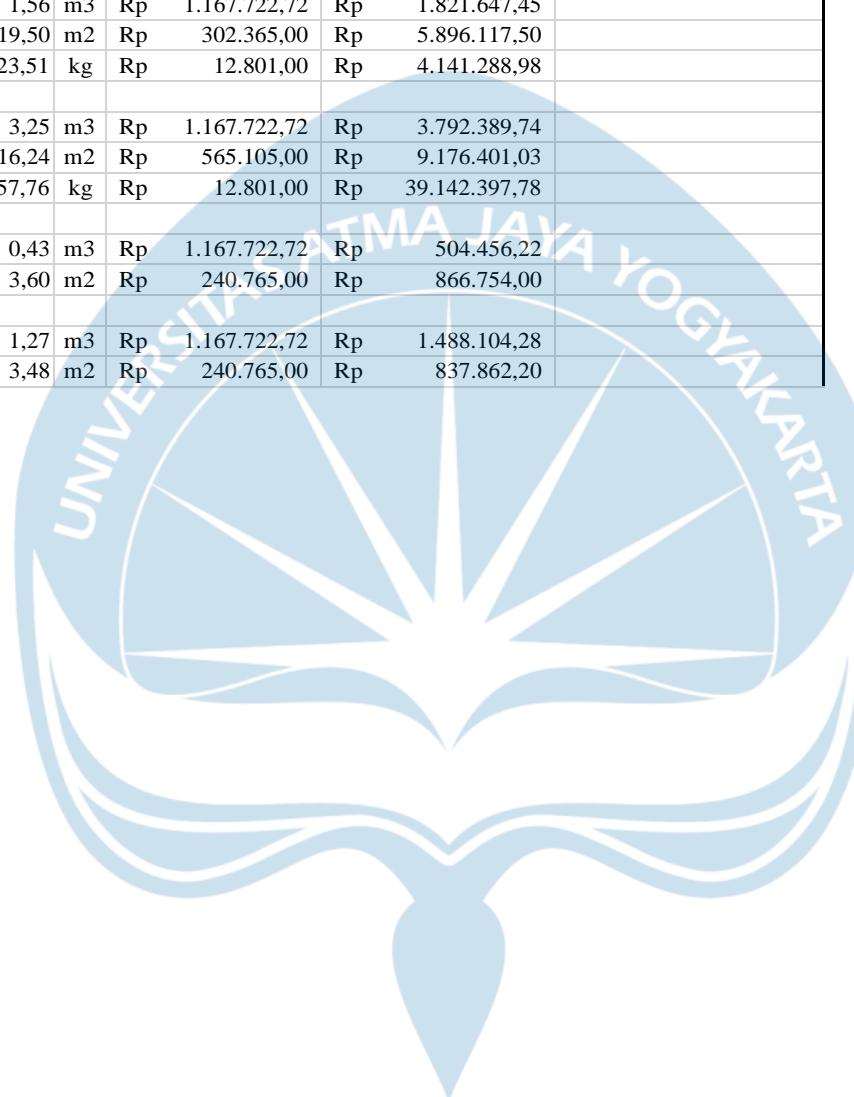
Pekerjaan Beton Praktis							
Kolom praktis 15x15							
Beton K-175		0,09	m3	Rp	1.059.811,51	Rp	98.244,53
Bekisting		2,47	m2	Rp	218.345,00	Rp	539.748,84
Pembesian dengan besi polos dan ulir		5,30	kg	Rp	12.801,00	Rp	67.823,25
						Total	**Rp**	**86.487.739,07**
PEKERJAAN KUSEN PINTU DAN JEN							
Kusen dan daun pintu P1 + Aksesoris		18,00	unit	Rp	1.737.805,00	Rp	31.280.490,00
Kusen dan daun pintu P2 + Asesoris		12,00	unit	Rp	2.164.105,00	Rp	25.969.260,00
Kusen dan daun pintu P4+ Aksesoris		2,00	unit	Rp	2.261.405,00	Rp	4.522.810,00
Kusen dan daun pintu P6 + Aksesoris		1,00	unit	Rp	881.905,00	Rp	881.905,00
Kusen dan daun pintu P7 + Aksesoris		4,00	unit	Rp	6.016.500,00	Rp	24.066.000,00
Kusen dan daun jendela PJ2 + Aksesoris		6,00	unit	Rp	6.016.500,00	Rp	36.099.000,00
Kusen dan daun jendela J1 + Aksesoris		5,00	unit	Rp	3.322.905,00	Rp	16.614.525,00
Kusen dan daun jendela J2 + Aksesoris		7,00	unit	Rp	1.355.105,00	Rp	9.485.735,00
Kusen dan daun jendela J3 + Aksesoris		15,00	unit	Rp	2.372.205,00	Rp	35.583.075,00
BV 1 + Aksesoris		3,00	unit	Rp	305.605,00	Rp	916.815,00
BV 2 + Aksesoris		2,00	unit	Rp	557.505,00	Rp	1.115.010,00
						Total	**Rp**	**186.534.625,00**

PEKERJAAN PELAPIS LANTAI, PELAPIS DINDING , REALING DAN PLIN								
Keramik lantai ukuran 60 x 60	363,30	m2	Rp	370.935,00	Rp	134.760.685,50		
Keramik lantai KM/WC ukuran 20 x 20	78,41	m2	Rp	181.317,00	Rp	14.216.703,34		
Plin keramik ukuran 10 x 30	36,33	m'	Rp	65.186,09	Rp	2.368.210,47		
						Total	**Rp**	**151.345.599,30**
PEKERJAAN PLAFON								
Langit-langit gypsumboard	756,00	m2	Rp	42.085,00	Rp	31.816.260,00		
Rangka besi hollow 40x40x2 mm, modul 6	756,00	m2	Rp	-	Rp	-		
						Total	**Rp**	**31.816.260,00**
PEKERJAAN MEKANIKAL ELEKTRIKAL								
INSTALASI AIR BERSIH								
Jaringan pipa air bersih dengan pipa PVC 3	212,56	m'	Rp	777.930,00	Rp	165.356.800,80		
						Sub total A	**Rp**	**165.356.800,80**
PEKERJAAN INSTALASI AIR KOTOR								
Jaringan air kotor, pipa PVC 3"	162,76	m'	Rp	594.555,00	Rp	96.769.771,80		
Jaringan air kotor, pipa PVC 4"	184,04	m'	Rp	617.355,00	Rp	113.618.014,20		
						Sub total B	**Rp**	**210.387.786,00**

PEKERJAAN ELEKTRIKAL							
Instalasi listrik titik lampu dan stop kontak	180,00	titik	Rp	95.000,00	Rp	17.100.000,00	
Instalasi AC 1 PK	12,00	titik	Rp	400.000,00	Rp	4.800.000,00	
Pemasangan stop kontak	12,00	bh	Rp	69.000,00	Rp	828.000,00	
Pemasangan stop kontak AC	31,00	bh	Rp	124.000,00	Rp	3.844.000,00	
Pas. Lampu TL 2x18 W	21,00	bh	Rp	257.300,00	Rp	5.403.300,00	
Pas. Lampu SL 14 W	116,00	bh	Rp	57.300,00	Rp	6.646.800,00	
Pas. Saklar tunggal	7,00	bh	Rp	69.000,00	Rp	483.000,00	
Pas. Saklar ganda / double	41,00	bh	Rp	79.000,00	Rp	3.239.000,00	
kabel roll NYY 4X16mm	633,30	m'	Rp	115.000,00	Rp	72.829.500,00	
					Sub total C	**Rp**	**115.173.600,00**
					Total	**Rp**	**490.918.186,80**
PEKERJAAN PENGECATAN							
Cat dinding	1901,73	m2	Rp	80.000,00	Rp	152.138.449,92	
Cat Plafond	756,00	m2	Rp	26.327,50	Rp	19.903.590,00	
					Total	**Rp**	**172.042.039,92**
PEKERJAAN SANITAIR							
Pasang Kran air 3/4"	12,00	bh	Rp	317.962,50	Rp	3.815.550,00	
Pasang Closet Duduk	12,00	unit	Rp	426.840,00	Rp	5.122.080,00	
Pasang Floor drain	12,00	bh	Rp	128.675,00	Rp	1.544.100,00	
Westafel	4,00	bh	Rp	590.920,00	Rp	2.363.680,00	
					Total	**Rp**	**12.845.410,00**
				Total Seluruh PekerjaanLantai 2		**Rp**	**3.222.944.582,91**

Rancang Anggaran Biaya Lantai 3

URAIAN PEKERJAAN	VOL	SAT	HARGA SATUAN		JUMLAH HARGA		TOTAL
RENCANA ANGGARAN BIAYA							
PEMBANGUNAN GEDUNG DIKLAT & FASILITAS PENDUKUNG LAINNYA							
PEMERINTAH KABUPATEN MUARA ENIM-SUMATERA SELATAN							
PEKERJAAN PASANGAN DAN PLESTERAN							
Pasangan Bata	1751,77	m2	Rp	931.925,00	Rp	1.632.518.257,25	
Plesteran	3503,54	m2	Rp	54.143,00	Rp	189.692.112,08	
Acian	3503,54	m2	Rp	29.645,00	Rp	103.862.413,66	
					Total	**Rp**	**1.926.072.782,98**
PEKERJAAN STRUKTUR BETON							
Pekerjaan Beton Struktur							
Kolom K1 40x40							
Beton K-250	0,66	m3	Rp	1.167.722,72	Rp	769.762,82	
Bekisting	6,59	m2	Rp	218.345,00	Rp	1.439.330,24	
Pembesian dengan besi polos dan ulir	130,40	kg	Rp	12.801,00	Rp	1.669.277,70	
Balok B1							
Beton K-250	2,48	m3	Rp	1.167.722,72	Rp	2.890.113,74	
Bekisting	21,45	m2	Rp	302.365,00	Rp	6.485.729,25	
Pembesian dengan besi polos dan ulir	379,68	kg	Rp	12.801,00	Rp	4.860.289,52	
Balok B2							
Beton K-250	1,56	m3	Rp	1.167.722,72	Rp	1.821.647,45	
Bekisting	19,50	m2	Rp	302.365,00	Rp	5.896.117,50	
Pembesian dengan besi polos dan ulir	323,51	kg	Rp	12.801,00	Rp	4.141.288,98	
Plat lantai tebal 12 cm							
Beton K-250	3,25	m3	Rp	1.167.722,72	Rp	3.792.389,74	
Bekisting	16,24	m2	Rp	565.105,00	Rp	9.176.401,03	
Plat atap tebal 10 cm							
Beton K-250	0,22	m3	Rp	1.167.722,72	Rp	255.380,96	
Bekisting	16,24	m2	Rp	565.105,00	Rp	9.176.401,03	
Pekerjaan Beton Praktis							
Kolom praktis 15x15							
Beton K-250	0,09	m3	Rp	1.167.722,72	Rp	108.247,90	
Bekisting	2,47	m2	Rp	218.345,00	Rp	539.748,84	
Pembesian dengan besi polos dan ulir	5,30	kg	Rp	12.801,00	Rp	67.823,25	
					Total	**Rp**	**53.089.949,96**

PEKERJAAN KUSEN PINTU DAN JENDELA								
Kusen dan daun pintu P1 + Aksesoris		18,00	unit	Rp	1.737.805,00	Rp	31.280.490,00	
Kusen dan daun pintu P3 + Asesoris		8,00	unit	Rp	1.642.805,00	Rp	13.142.440,00	
Kusen dan daun pintu P6 + Aksesoris		4,00	unit	Rp	881.905,00	Rp	3.527.620,00	
Kusen dan daun jendela PJ2 + Aksesoris		8,00	unit	Rp	6.016.500,00	Rp	48.132.000,00	
Kusen dan daun jendela J1 + Aksesoris		8,00	unit	Rp	3.322.905,00	Rp	26.583.240,00	
Kusen dan daun jendela J2 + Aksesoris		2,00	unit	Rp	1.355.105,00	Rp	2.710.210,00	
Kusen dan daun jendela J3 + Aksesoris		2,00	unit	Rp	2.372.205,00	Rp	4.744.410,00	
BV 1 + Aksesoris		8,00	unit	Rp	305.605,00	Rp	2.444.840,00	
BV 2 + Aksesoris		5,00	unit	Rp	557.505,00	Rp	2.787.525,00	
						Total	**Rp**	**135.352.775,00**
PEKERJAAN PELAPIS LANTAI, PELAPIS DINDING , REALING DAN PLIN								
Keramik lantai ukuran 60 x 60		483,37	m2	Rp	370.935,00	Rp	179.298.850,95	
Keramik lantai KM/WC ukuran 20 x 20		53,73	m2	Rp	181.317,00	Rp	9.742.887,68	
Plin keramik ukuran 10 x 30		48,34	m'	Rp	65.186,09	Rp	3.150.899,79	
						Total	**Rp**	**192.192.638,42**
PEKERJAAN RANGKA ATAP DAN PENUTUP ATAP								
Rangka Atap Baja Ringan		355,67	m2	Rp	71.280,00	Rp	25.352.442,72	
Pemasangan Atap Genteng Metal berpasir		355,67	m2	Rp	81.042,50	Rp	28.824.710,15	
Lisplank ukuran 3 x 20 cm		142,00	m'	Rp	87.515,80	Rp	12.427.243,60	
						Total	**Rp**	**66.604.396,47**
PEKERJAAN PLAFON								
Langit-langit gypsumboard		756,00	m2	Rp	42.085,00	Rp	31.816.260,00	
Rangka besi hollow 40x40x2 mm, modul 60 x 60, plafon		756,00	m2	Rp	356.560,00	Rp	269.559.360,00	
						Total	**Rp**	**301.375.620,00**

PEKERJAAN MEKANIKAL ELEKTRIKAL							
INSTALASI AIR BERSIH							
Jaringan pipa air bersih dengan pipa PVC	47,79	m'	Rp	777.930,00	Rp	37.177.274,70	
					Total	**Rp**	**920.916,15**
PEKERJAAN INSTALASI AIR KOTOR							
Jaringan air kotor, pipa PVC 3"	31,14	m'	Rp	594.555,00	Rp	18.514.442,70	
Jaringan air kotor, pipa PVC 4"	20,61	m'	Rp	617.355,00			
					Total	**Rp**	**18.514.442,70**
PEKERJAAN ELEKTRIKAL							
Instalasi listrik titik lampu dan stop kontak	161,00	titik	Rp	95.000,00	Rp	15.295.000,00	
Instalasi AC 1 PK	16,00	titik	Rp	400.000,00	Rp	6.400.000,00	
Pemasangan stop kontak	37,00	bh	Rp	69.000,00	Rp	2.553.000,00	
Pemasangan stop kontak AC	17,00	bh	Rp	124.000,00	Rp	2.108.000,00	
Pas. Lampu TL 2x18 W	21,00	bh	Rp	257.300,00	Rp	5.403.300,00	
Pas. Lampu SL 14 W	100,00	bh	Rp	57.300,00	Rp	5.730.000,00	
Pas. Saklar tunggal	2,00	bh	Rp	69.000,00	Rp	138.000,00	
Pas. Saklar ganda / double	38,00	m'	Rp	79.000,00	Rp	3.002.000,00	
kabel roll NYY 4X10mm	431,86	m'	Rp	85.000,00	Rp	36.708.100,00	
					Sub total C	**Rp**	**40.629.300,00**
					Total	**Rp**	**60.064.658,85**
PEKERJAAN PENGECATAN							
Cat dinding dalam	1751,77	m2	Rp	80.000,00	Rp	140.141.568,00	
Cat dinding luar	1751,77	m2	Rp	80.000,00	Rp	140.141.568,00	
Cat Plafond	756,00	m2	Rp	26.327,50	Rp	19.903.590,00	
					Total	**Rp**	**300.186.726,00**

PEKERJAAN SANITAIR							
Pasang Kran air 3/4"		8,00	bh	Rp	317.962,50	Rp	2.543.700,00
Pasang Closet Duduk		8,00	unit	Rp	426.840,00	Rp	3.414.720,00
Pasang Floor drain		8,00	bh	Rp	128.675,00	Rp	1.029.400,00
Pasang Wastafel		8,00	bh	Rp	590.920,00	Rp	4.727.360,00
						Total **Rp**	**11.715.180,00**
PEKERJAAN DRAINASE							
Pemasangan Roofdrain		8,00	bh	Rp	163.675,00	Rp	1.309.400,00
						Total **Rp**	**1.309.400,00**
					Total Seluruh Pekerjaan Lantai 3	**Rp**	**3.047.964.127,67**
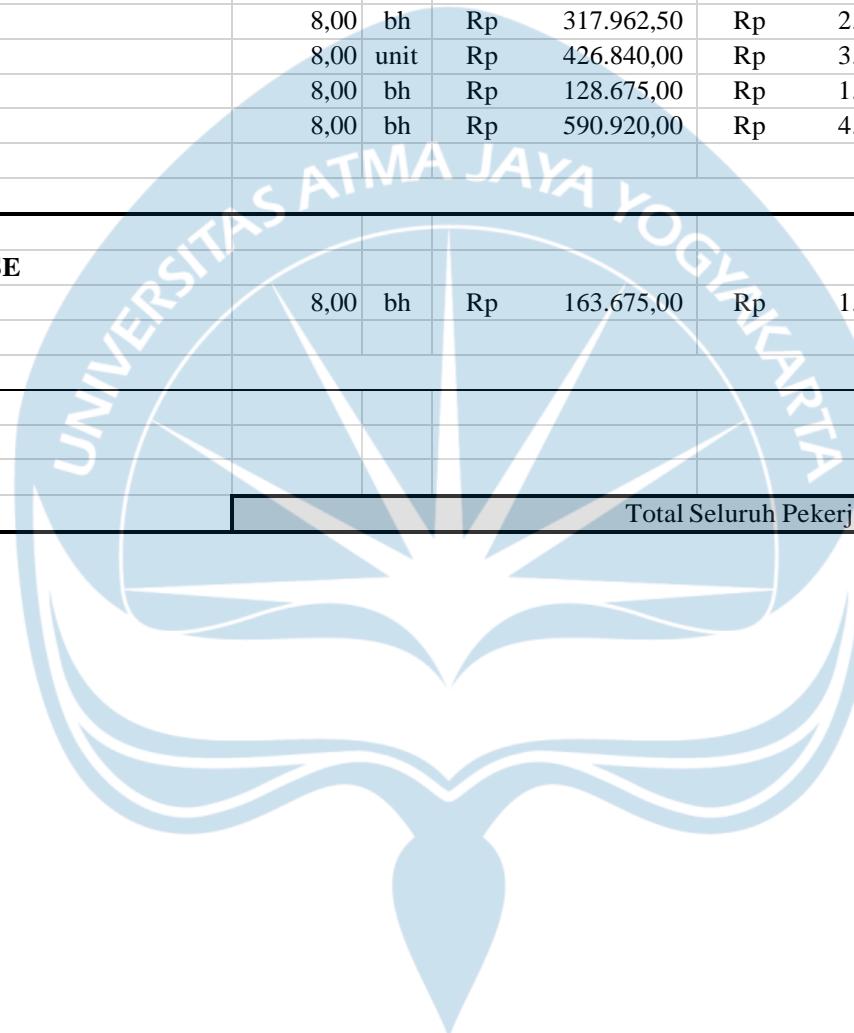
Lampiran 3

Praktik Perancangan Jalan

Trase Jalan

No	STA		Koordinat		Elevasi		
			X	Y	Kiri	CL	Kanan
A	10 +	195	9,700	4,750	61,05	61,15	61,15
1	10 +	205	10,399	5,465	60.3	60.4	60.5
2	10 +	215	11,098	6,111	60.3	60.4	60.5
3	10 +	225	11,797	6,826	61	61.1	61.2
4	10 +	235	12,496	7,541	62	62.5	62.7
5	10 +	245	13,195	8,256	62	62.8	63.2
6	10 +	255	13,789	8,864	62.8	63	63.1
7	10 +	265	14,626	9,124	64.5	63.5	63.5
8	10 +	275	15,509	8,898	66.5	66.5	67
9	10 +	285	16,054	8,320	66.4	66.5	67
10	10 +	295	16,740	7,592	67.5	66.5	66.4
11	10 +	305	17.74	6,849	67.5	66.5	65.5
12	10 +	315	18,123	6,124	65	65.3	65
13	10 +	325	18,809	5,396	63	62.9	62.8
14	10 +	335	19,495	4,668	62.5	62.5	62.5
15	10 +	345	20,181	3,940	63.4	63.2	62.8
16	10 +	355	20,865	3,210	62.7	63	63.3
17	10 +	365	21,442	2,723	62.6	63	63.1
18	10 +	375	22,422	2,624	62.7	62.7	62.7
19	10 +	385	23,422	2,624	63.3	63.5	63.9
20	10 +	395	24,422	2,624	64.3	64.4	64
21	10 +	405	25,422	2,624	64.3	64.1	64

22	10 +	415	26,422	2,624	64	64	64
23	10 +	425	27,422	2,624	64	64.2	64.5
24	10 +	435	28,422	2,624	64.6	64.7	64.8
25	10 +	445	29,422	2,624	64.8	64.8	64.8
26	10 +	455	30,422	2,624	65.7	65.6	65.5
27	10 +	465	31,422	2,624	67	66.8	66.5
28	10 +	475	32,222	2,624	67.2	67.1	67
29	10 +	485	32,979	2,793	67.1	67.2	67.3
30	10 +	495	33,677	3,011	65	65	65
31	10 +	505	33,255	3,244	65.5	65.3	65
32	10 +	515	34,046	3,880	64.3	64.3	64.3
33	10 +	525	34,829	4,510	62.8	62.8	62.8
34	10 +	535	35,610	5,138	62	62	62
B	10 +	545	36,194	5,608	62.4	62.2	62

Perencanaan Tikungan

Tabel Rencana Lengkung Vertikal Tikungan Pertama

Lengkung Vertikal Cembung 1			S<L	elevasi titik 6 dan 10
A	=	-3.7	%	
L	=	28.6	m	
x	=	7	m	
v	=	-0.0317	m	
S	=	16	m	
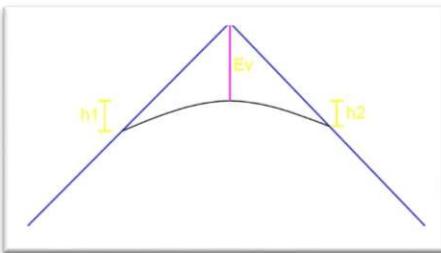
Ev	=	-6.482		m
h1	=	-0.2504		m
h2	=	-0.216		m
L	=	-2.374		m

Gambar Rencana Tikungan
Pertama

<p style="text-align:center">Tabel Rencana Lengkung Vertikal Tikungan
Kedua</p>

	Lengkung Vertikal Cembung 2				elevasi titik 17 dan 19			
	A	=	0.5	%				
	L	=	32.4	m				
	x	=	7	m				
	v	=	0.00378	m				
	S	=	16	m				
	Ev	=	0.992	m				
						Gambar Rencana Tikungan Kedua		
titik 17	elevasi	=	63					
	elevasi tangen	=	63.8	8%	g1			
	elevasi sumbu	=	63.815					
					h1	=	0.021	m
titik 18	elevasi	=	63		h2	=	0.004	m
	elevasi sumbu	=	63.062		L	=	0.321	m
titik 19	elevasi	=	62.5					
	elevasi tangen	=	62.3	2%	g2			
	elevasi sumbu	=	62.315					
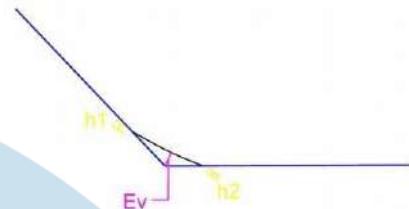
Perhitungan pada tikungan tikungan ketiga dilakukan dengan menggunakan dasar teori yang sama dengan tikungan pertama dan kedua. Berikut ini perhitungan untuk tikungan ketiga:

<p style="text-align:center">Tabel Vertikal Cembung</p>

	Lengkung Vertikal Cembung 3				Jarak Pandang<L
	A	=	2.3	%	elevasi titik 29 dan 31
	L	=	26.5	m	
	x	=	7	m	
	v	=	0.021	m	
	S	=	18.6	m	
	Ev	=	3.73	m	

titik 29	elevasi	=	67.3
titik 30	elevasi	=	67
titik 31	elevasi	=	65
	DB	=	0.305
	D'B'	=	0.15
	L	=	4.299

Gambar rencana Tikungan Ketiga

h1	=	0.119	m
h2	=	0.021	m
L	=	1.994	m

STA	Luas (m^2)		Jarak (m)	Volume (m^3)	
	Cut	Fill		Cut	Fill
A	0	0.102			
			10	0	5,61
1	0	1.02			
			10	0	12.895
2	0	1.559			
			10	0	16.54
3	0	1.749			
			10	0	14.935
4	0	1.238			
			10	0	10.83
5	0	0.928			
			10	0	10.73
6	0	1.218			
			10	0.357	8.545
7	0.107	0.491			
			10	7.94	1.637
8	1.481	0			
			10	17.31	0
9	1.981	0			
			10	18.56	0
10	1.731	0			
			10	17.735	0
11	1.816	0			
			10	16.055	0
12	1.395	0			
			10	7.83	1.513
13	0.171	0.454			
			10	0.57	10.605
14	0	1.667			

			10	0	15.87
15	0	1.507			
			10	0	13.765
16	0	1.246			

			10	0	12.91
17	0	1.336			
			10	0	14.56
18	0	1.576			
			10	0	15.705
19	0	1.565			
			10	0	11.1
20	0	0.655			
			10	0	4.23
21	0	0.191			
			10	0	4.175
22	0	0.644			
			10	0	8.2
23	0	0.996			
			10	0	9.875
24	0	0.979			
			10	0	8.95
25	0	0.811			
			10	0	6.055
26	0	0.4			
			10	2.63	1.333
27	0.789	0			
			10	12.14	0
28	1.639	0			
			10	16.555	0
29	1.672	0			
			10	12.485	0
30	0.825	0			
			10	6.46	0
31	0.467	0			
			10	4.43	0
32	0.419	0			
			10	1.397	0.817
33	0	0.245			
			10	0.000	4.335
34	0	0.622			
			10	0.000	4.990

B	0	0.376				

Total	142.453	230,7
Selisih Cut & Fill		88,247

penampang alinement vertikal

Skala 1: 20
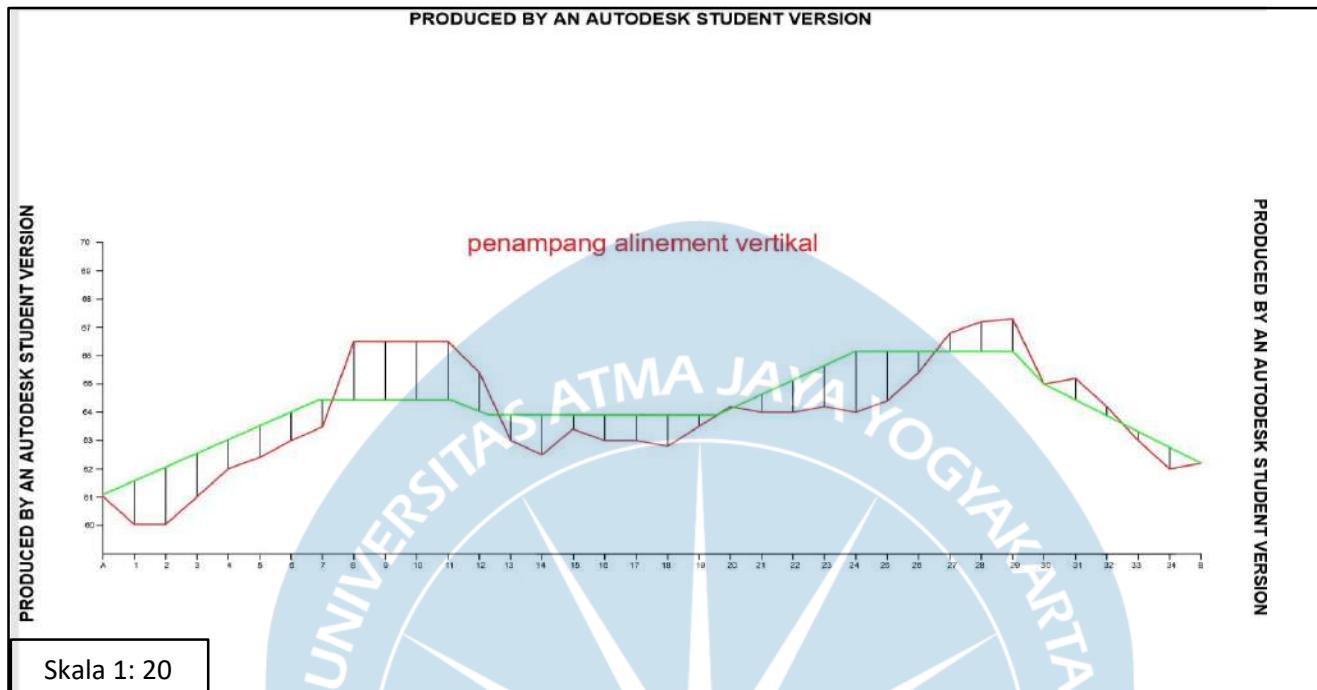
Elevasi Tepi Jalan

No	STA		Koordinat		Elevasi		
			X	Y	Kiri	CL	Kanan
A	10 +	195	9,700	4,750	61,05	61,15	61,15
1	10 +	205	10,399	5,465	60.3	60.4	60.5
2	10 +	215	11,098	6,111	60.3	60.4	60.5
3	10 +	225	11,797	6,826	61	61.1	61.2
4	10 +	235	12,496	7,541	62	62.5	62.7
5	10 +	245	13,195	8,256	62	62.8	63.2
6	10 +	255	13,789	8,864	62.8	63	63.1
7	10 +	265	14,626	9,124	64.5	63.5	63.5
8	10 +	275	15,509	8,898	66.5	66.5	67
9	10 +	285	16,054	8,320	66.4	66.5	67
10	10 +	295	16,740	7,592	67.5	66.5	66.4
11	10 +	305	17.74	6,849	67.5	66.5	65.5
12	10 +	315	18,123	6,124	65	65.3	65
13	10 +	325	18,809	5,396	63	62.9	62.8

14	10 +	335	19,495	4,668	62.5	62.5	62.5
15	10 +	345	20,181	3,940	63.4	63.2	62.8
16	10 +	355	20,865	3,210	62.7	63	63.3
17	10 +	365	21,442	2,723	62.6	63	63.1
18	10 +	375	22,422	2,624	62.7	62.7	62.7
19	10 +	385	23,422	2,624	63.3	63.5	63.9
20	10 +	395	24,422	2,624	64.3	64.4	64
21	10 +	405	25,422	2,624	64.3	64.1	64
22	10 +	415	26,422	2,624	64	64	64
23	10 +	425	27,422	2,624	64	64.2	64.5
24	10 +	435	28,422	2,624	64.6	64.7	64.8
25	10 +	445	29,422	2,624	64.8	64.8	64.8
26	10 +	455	30,422	2,624	65.7	65.6	65.5
27	10 +	465	31,422	2,624	67	66.8	66.5
28	10 +	475	32,222	2,624	67.2	67.1	67
29	10 +	485	32,979	2,793	67.1	67.2	67.3
30	10 +	495	33,677	3,011	65	65	65
31	10 +	505	33,255	3,244	65.5	65.3	65
32	10 +	515	34,046	3,880	64.3	64.3	64.3
33	10 +	525	34,829	4,510	62.8	62.8	62.8
34	10 +	535	35,610	5,138	62	62	62
B	10 +	545	36,194	5,608	62.4	62.2	62

No	STA		Koordinat		Elevasi rencana		
			X	Y	Kiri	CL	Kanan
A	10 +	195	9,700	4,750	61,142	61,15	61,142
1	10 +	205	10,399	5,465	61,682	61,68	60.682
2	10 +	215	11,098	6,111	62,2216	62,63	62,2216
3	10 +	225	11,797	6,826	62,7616	62,77	62,7616
4	10 +	235	12,496	7,541	63,3016	63,31	63,3016
5	10 +	245	13,195	8,256	63,8416	63,85	63,8416
6	10 +	255	13,789	8,864	64,3816	63,5	64,3816
7	10 +	265	14,626	9,124	62,7616	62,77	62,7616
8	10 +	275	15,509	8,898	64,262	64,27	64,262
9	10 +	285	16,054	8,320	64,7	64,79	64,7
10	10 +	295	16,740	7,592	64,7	64,79	64,7
11	10 +	305	17.74	6,849	64,7	64,79	64,7
12	10 +	315	18,123	6,124	64,33	64,4	64,33
13	10 +	325	18,809	5,396	64,28	64,37	64,28
14	10 +	335	19,495	4,668	64,28	64,36	64,28
15	10 +	345	20,181	3,940	64,27	64,35	64,27
16	10 +	355	20,865	3,210	64,256	64,34	64,256
17	10 +	365	21,442	2,723	64,246	64,33	64,246
18	10 +	375	22,422	2,624	64,436	64,52	64,436
19	10 +	385	23,422	2,624	64,726	64,81	64,726
20	10 +	395	24,422	2,624	64,356	64,44	64,356
21	10 +	405	25,422	2,624	64,356	64,44	64,356
22	10 +	415	26,422	2,624	64,866	64,95	64,866
23	10 +	425	27,422	2,624	64,166	65,25	64,166
24	10 +	435	28,422	2,624	65,526	65,81	65,526
25	10 +	445	29,422	2,624	65,426	65,51	65,426
26	10 +	455	30,422	2,624	65,426	65,51	65,426
27	10 +	465	31,422	2,624	65,23	65,31	65,23
28	10 +	475	32,222	2,624	65,23	65,31	65,23
29	10 +	485	32,979	2,793	65,56	65,64	65,56
30	10 +	495	33,677	3,011	64,82	64,9	64,82
31	10 +	505	33,255	3,244	64,38	64,46	64,38
32	10 +	515	34,046	3,880	64,3	64.33	64,3

Tabel Perhitungan Luas per-Stasiun

STA	Luas (m²)		STA	Cut	Fill
	Cut	Fill	17	0	1.336
A	0	0.102	18	0	1.576
1	0	1.02	19	0	1.565
2	0	1.559	20	0	0.655
3	0	1.749	21	0	0.191
4	0	1.238	22	0	0.644
5	0	0.928	23	0	0.996
6	0	1.218	24	0	0.979
7	0.107	0.491	25	0	0.811
8	1.481	0	26	0	0.4
9	1.981	0	27	0.789	0
10	1.731	0	28	1.639	0
11	1.816	0	29	1.672	0
12	1.395	0	30	0.825	0
13	0.171	0.454	31	0.467	0
14	0	1.667	32	0.419	0
15	0	1.507	33	0	0.245
16	0	1.246	34	0	0.622
			B	0	0,376

penampang alinement vertikal

Gambar Profil Melintang setiap jarak 50 meter pada bagian lurus dan 25 meter pada bagian lengkung

Lampiran 4

Praktik Perancangan Bangunan Air

Gambar Rancangan Bendung
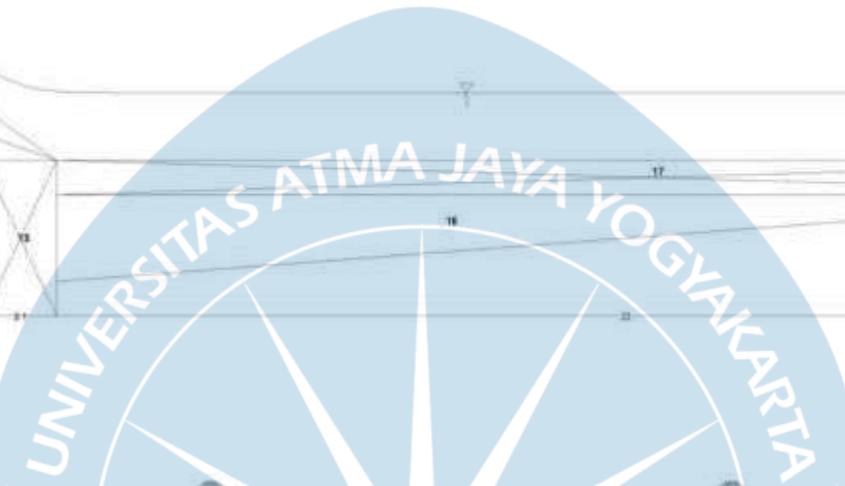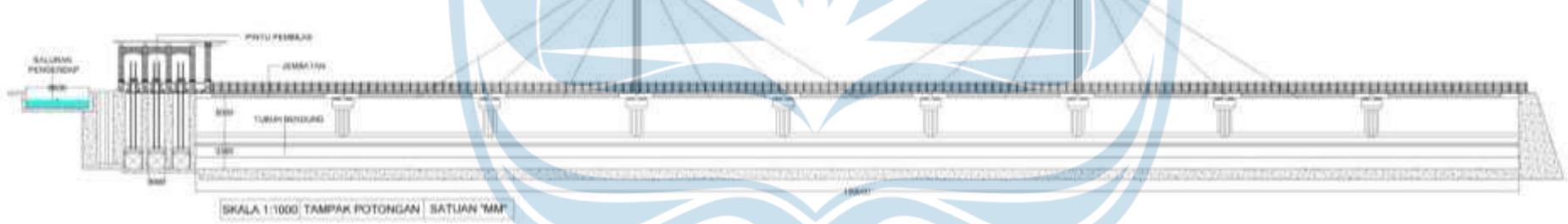
Saluran induk, pintu pembilas dan pintu air *intake*
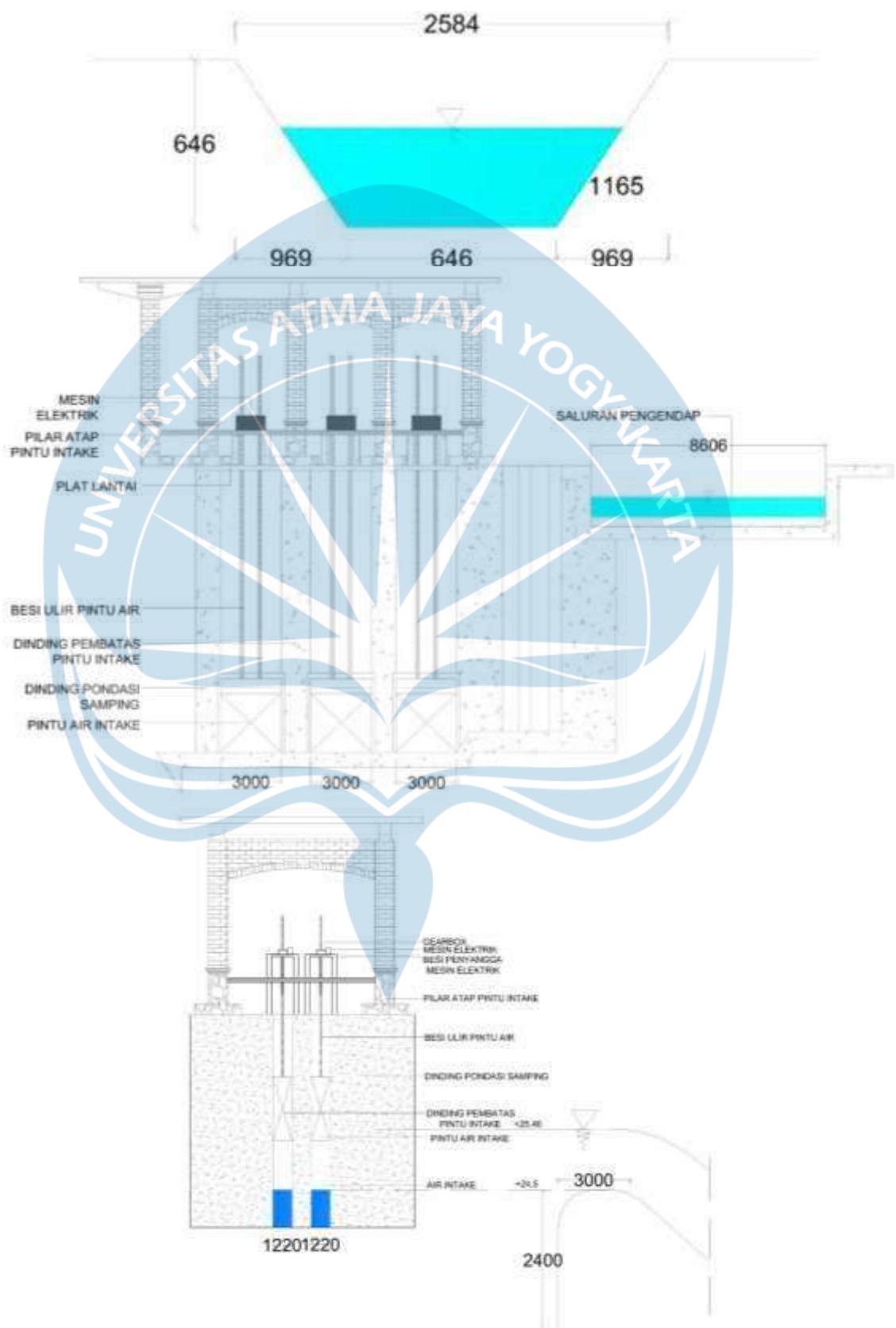
DAFTAR SINGKATAN & LAMBANG

Praktik Perancangan Bangunan Gedung

fc' = Mutu Beton (MPa)

fy = Tegangan Leleh (MPa)

fu = Kuat Tarik (MPa)

δ = Pertambahan Panjang (mm)

f_t = Tegangan Tarik (MPa)

N_u = Gaya Akibat Beban Luar

$\emptyset$ = Diameter (mm)

A_g = Luas Penampang Kotor (mm^2)

EI = Kekakuan lentur yang diperlukan

n_{tg} = jumlah anak tangga

h_{lt} = Tinggi lantai (mm)

Mu = Momen Ultimate (Nm)

MDL = Momean Dead Load (Nm)

Mv =

MLL = Momen Live Load (Nm)

W_D = Beban Mati (kN)

W_L = Beban hidup (kN)

M_L = Momen akibat beban hidup (Nm)

W = Beban (Nm)

A_s = Luas tulangan yang diperlukan (mm^2)

Vc = Kuat Geser Beton (N)

Vu = Gaya geser terfaktor pada penampang (N)

ε_t = Regangan tarik neto dalam lapisan terjauh baja tarik longitudinal pada kuat nominal

Praktik Perancangan Jalan

Vr = Kecepatan rencana, km/jam

e max = Kemiringan maksimum

S = Spiral

C = Circle

Ls = Panjang Lengkusng Spiral, meter

Θs = Sudut lengkung Spiral

Δc = Sudut lengkung lingkaran

Δ = Total sudut tikugan

Lc = Panjang lengkung lingkaran

Xs = Jarak horizontal dari titik TS

Ys = Jarak antara ujung garis horizontal Xs dan lengkungan tikungan

K = Jarak horizontal dari titik TS

P = Jarak antara ujung garis horizontal k dan lengkungan tikungan

Ts = Peralihan bagian lurus menuju tikungan

Es = Jarak vertikal dari titik belok jalan

Praktik Perencanaan Biaya & Waktu

S = Kemiringan saluran

Cs = Koefisien kemencengan

Ck = Koefisien keruncingan

Cv = Koefisien Variasi

Of = Jumlah nilai pengamatan

Ef = Jumlah nilai teoritis

H = Tinggi energi di atas mercu (m)

L1 = Panjang sumbu besar elips (Km)

L2 = Panjang sumbu kecil elips (Km)

nF = Luas elips (km^2)

α = Koefisien aliran

I = Momen inersia (kg.m^2)

β = Koefisien reduksi

Q_{50} = Debit banjir rancangan 50 tahun (m^3/det)

Q = Debit aliran (m^3/det)

V = Gaya yang melawan (m)

Tc = Waktu tiba banjir (jam)

B = Lebar efektif bendung (m)

R_T = Hujan maksimum sehari (m^3/dt/km^2)

R = Jari-jari hidrolis (m)

Fr = Angka froude

q = Hujan maksimum setempat (m^3/dt.km^2)

H = Gaya yang mendorong (m)

SF = Safety Factor

Mp = Momen penahan guling (kNm)

Mg = Momen penggulingan (kNm)

w = Tinggi jagaan (m)

Fy = Total gaya angkat (kN/m)