

TUGAS AKHIR KONSTRUKSI KAYU BANGUNAN GUDANG

Dosen Pembimbing

Ir. RUSLAN DJAJADI, M.ENG

Disusun Oleh :

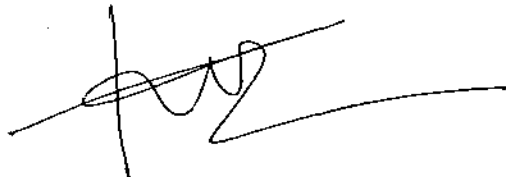
DEWA PUTU SEDAYA A. Nrp. 21391614
SUNINGSIH Nrp. 21391618



**FAKULTAS TEKNIK
JURUSAN TEKNIK SIPIL DIPLOMA 3
UNIVERSITAS KRISTEN PETRA
SURABAYA
1996**

**TUGAS AKHIR
KONSTRUKSI KAYU
BANGUNAN GUDANG**

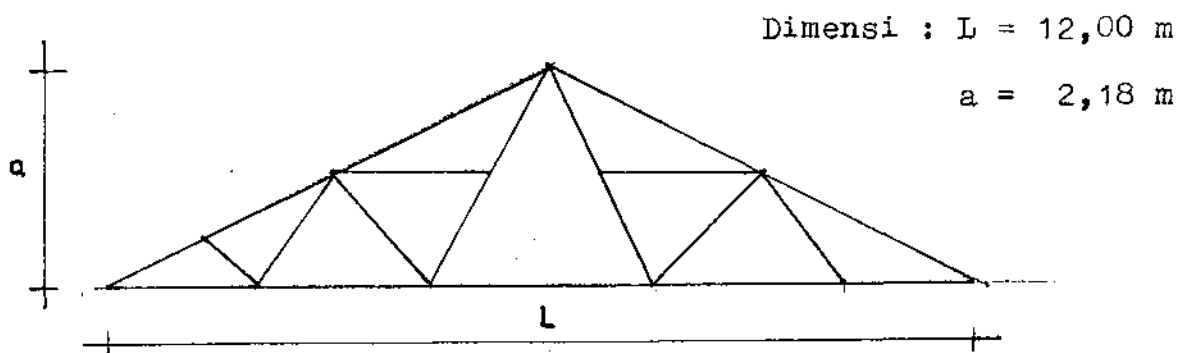
Dosen Pembimbing,

A handwritten signature in black ink, consisting of a series of loops and a long horizontal stroke extending to the right.

(Ir. RUSLAN DJAJADI, M. ENG)

!	TUGAS	!	Nama Mhs.: 1. DEWA PUTU S.A. Nrp. 21391614	!	Diberikan
!	KONST. KAYU	!	: 2. SUNINGSIH Nrp. 21391618	!	!
!		!		!	!
!		!	Asisten : Ir. RUSLAN DJAJADI M, Eng.	!	Selesai
!		!	Paraf :	!	!

Rencanakan bangunan Gudang dengan konstruksi seperti dibawah ini :



Macam kayu : : KK II
Penutup atap : Genteng beton
Dinding : Tembok 1/2 bata
Panjang bangunan : 3 m x 10

Perhitungan meliputi :

- 1). Setiap elemen struktur dari konstruksi tsb diatas, termasuk sambungan-sambungannya
- 2). Pondasi yang digunakan sesuai data dibawah ini :

$$\sigma_t = 1,0 \text{ kg/cm}^2$$

DAFTAR ASISTENSI TUGAS KONSTRUKSI KAYU

Nama Mahasiswa : DEWI PUTU S.A. & SUNINGSIH
Dosen Pembimbing : Ir. RUSLAM DJAJADI M.ENG

NO.	TGL.	KEGIATAN ASISTENSI	TANDA TANGAN	
			MAHASISWA	PEMBIMBING
1	26/9'94	Pemberian tugas	<i>Handya Suningsih</i>	<i>[Signature]</i>
2	3/10'94	Pencapaian garbling	<i>Handya Suningsih</i>	<i>[Signature]</i>
3	17/10'94	Pelubangan Gajuh		<i>[Signature]</i>
4	14/11'94	Rekap gajuh max, Fly Deval		<i>[Signature]</i>
5	21/11'94	" $\sigma = 85 \text{ kg/cm}^2$ 4) Pemasangan gajuh kany-		<i>[Signature]</i>
6	28/11'94	Seleksi deval		<i>[Signature]</i>
7	12/12'94	Gambar		<i>[Signature]</i>
	19/12'94	Konstruksi diselesaikan		<i>[Signature]</i>
	24/12'94	diselesaikan		<i>[Signature]</i>
	3/1'95	Lesan		<i>[Signature]</i>

DAFTAR ISI

Halaman

LEMBAR PENGESAHAN	
KATA PENGANTAR	
DAFTAR ISI	
INFORMASI PERENCANAAN	
IDEALISASI STRUKTUR	
 BAB I : BALOK GORDING.....	1
- Beban yang bekerja.....	1
- Kontrol lentur.....	3
- Kontrol geser.....	4
 BAB II : PERHITUNGAN KUDA-KUDA	6
- Beban yang bekerja.....	6
- Kontrol kekuatan batang.....	8
 BAB III : PERHITUNGAN SAMBUNGAN	10
- Detail 1.....	10
- Detail 2.....	11
- Detail 3.....	13
- Detail simpul 7.....	15
- Detail simpul 8.....	16
- Simpul 9.....	19
- Simpul 14.....	20
- Simpul 10.....	22
- Detail 11.....	23
- Sambungan berpenampang dua.....	23

BAB IV : PERHITUNGAN KOLOM	25
- Beban yang bekerja.....	25
BAB V : PERHITUNGAN BALOK RIB	28
- Beban yang bekerja.....	28
- Kuat geser beton.....	29
BAB VI : PERHITUNGAN PLAT PONDASI.....	30
- Pondasi batu kali.....	31

DAFTAR ASISTENSI

LAMPIRAN-LAMPIRAN

 - Gambar



FAKULTAS TEKNIK SIPIL
UNIVERSITAS KRISTEN PETRA

TUGAS KONSTRUKSI KAYU

JENIS STRUKTUR : Gudang

INFORMASI PERENCANAAN

DIBUAT OLEH :

DEWA POTU S.A

DIPERIKSA OLEH :

- Peraturan Konstruksi Kayu Indonesia 1961
- Tata cara Perhitungan Struktur Beton Untuk Bangunan Gedung SK SNI T-15-1991-03
- Peraturan Pembebanan Indonesia Untuk Gedung 1983

PERATURAN-PERATURAN
YANG DIPAKAI

KEMUNGKINAN PENGEMBANG-
AN DAN PERUBAHAN

SYARAT-SYARAT
KETAHANAN TERHADAP
KEBAKARAN

- Beban Mati : Berat Penutup atap = $56,28 \text{ kg/m}^2$
: Berat sendiri kayu
- Beban hidup : Beban terpusat = 100 kg

PEMBAHATAN

KECEPATAN

FAKTOR-FAKTOR LAH

Tekanan Angin (Tiup) = 25 kg/m^2

BEBAN ANGIN

FAKTOR DACRAH

FAKTOR KEPENTINGAN

FAKTOR TITIK STRUKTUR

BEBAN GEMPA

PENGARUH LINGKUNGAN

- = $1,0 \text{ kg/cm}^2$

KONDISI TANAH

- Pondasi Plat Setempat
- Pondasi Batu Kali

TIPE PONDASI

- Mutu Kayu Kelas Kuat II

DATA BAHAN

LAIN-LAIN



FAKULTAS TEKNIK SIPIL
UNIVERSITAS KRISTEN PETRA

TUGAS KONSTRUKSI KAYU

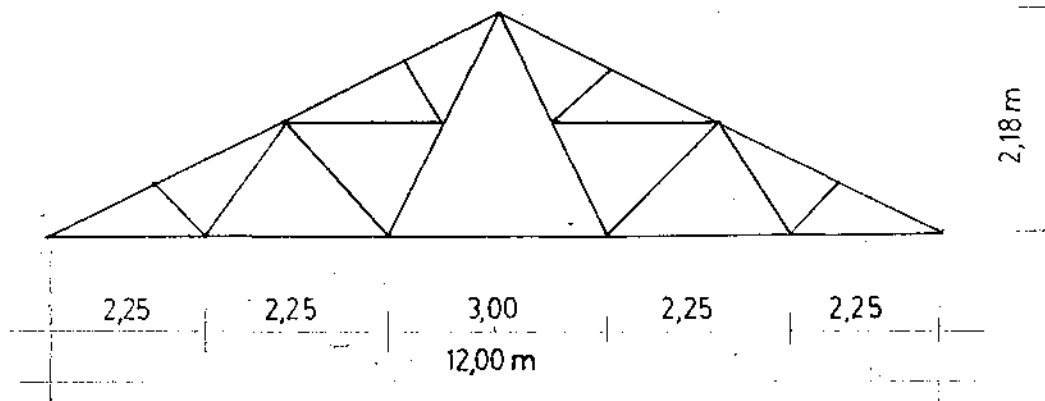
JENIS STRUKTUR :

RINGKASAN/IDEALISASI STRUKTUR

DIBUAT OLEH :

DIPERIKSA OLEH :

Kuda-kuda



Luas bangunan = 12,00 × 30,00 m
Atap genteng beton
Kemiringan atap = 20°
Jarak gording = 1,60 m



PERHITUNGAN

PERHITUNGAN BALOK GORDING

Kayu pengikat kelas kuat 2

BD kering udara $0,9195/\text{cm}^2 = 910 \text{ kg/m}^3$

Dimensi/ukuran $8 \times 15 \text{ cm}^2$

Beban yang bekerja:

* *Beban mati:*

- Berat sendiri balok = $0,08 \times 0,15 \times 910 = 10,92 \text{ kg/m}$
 - Penutup atap = $56,83 \times 1,60 = 90,83 \text{ kg/m}$
- 101,90

* *Beban hidup:*

- Beban terpusat = 100 kg.
- $\therefore$ Momen max = $1/4 \cdot p \cdot l$
 $= 1/4 \cdot 100 \cdot 3 = 75 \text{ kgm.}$
- Beban air hujan = $20 - 08 \alpha$
 $= 20 - 08 \cdot 20 = 24 \text{ kg/m}^2 > 20 \text{ kg/m}^2$
 $q = 20 \cdot 1,60 = 32$
 $\therefore$ Momen max = $1/8 \cdot 2 \cdot l^2$
 $= 1/8 \cdot 32 \cdot 3^2 = 36 \text{ kgm.}$

Dipakai beban hidup $P = 100 \text{ kg.}$



PERHITUNGAN

Kontrol Lendutan:

$$f = \frac{1}{200} \cdot l$$
$$= \frac{1}{200} \cdot 300 = 1,5 \text{ cm}$$

Modulus elastisitas (E) = 10^5 kg/cm^2

$$I_x = 1/12 \cdot b \cdot h^3 = 1/12 \cdot 8 \cdot 15^3 = 2250 \text{ cm}^4$$

$$I_y = 1/12 \cdot b^3 \cdot h = 1/12 \cdot 8^3 \cdot 15 = 640 \text{ cm}^4$$

Beban $\perp$ sumbu x

$$q_x = 101,90 \times \cos 20^\circ = 95,75 \text{ g.}$$

$$p_x = 100 \times \cos 20^\circ = 93,97 \text{ kg.}$$

Beban $\perp$ sumbu y

$$q_y = 101,90 \times \sin 20^\circ = 34,85 \text{ g.}$$

$$p_y = 100 \times \sin 20^\circ = 34,20 \text{ kg.}$$

$$f_x = \frac{5}{384} \cdot \frac{q_x \cdot (L)^4}{E \cdot I_x} + \frac{1}{48} \cdot \frac{P_x (L)^3}{E \cdot I_x}$$
$$f_x = \frac{5}{384} \cdot \frac{0,9575 \cdot (300)^4}{10^5 \cdot 2250} + \frac{1}{48} \cdot \frac{P_x (L)^3}{E \cdot I_x}$$
$$= 0,425 + 0,23$$
$$= 0,67 \text{ cm}$$



PERHITUNGAN

$$\begin{aligned}
 f_x &= \frac{5}{384} \cdot \frac{q_y \cdot (L)^4}{E \cdot I_y} + \frac{1}{48} \cdot \frac{P_y (L)^3}{E \cdot I_y} \\
 &= \frac{5}{384} \cdot \frac{0,3442 \cdot (300)^4}{10^5 \cdot 640} + \frac{1}{48} \cdot \frac{34,20 (300)^3}{10^5 \cdot 640} \\
 &= 0,56 + 0,30 \\
 &= 0,86
 \end{aligned}$$

$$\begin{aligned}
 f_t &= \sqrt{f_x^2 + f_y^2} < f \\
 &= \sqrt{(0,70)^2 + (0,59)^2} \\
 &= 1,09 \text{ cm} < 1,5 \text{ cm}
 \end{aligned}$$

KONTROL LENTUR

MOMEN LENTUR

* Akibat beban mati:

$$\begin{aligned}
 - M_{mx_1} &= 1/8 \cdot q \cdot \cos x \cdot L^2 \\
 &= 1/8 \cdot 101,90 \cdot \cos 20^\circ (3)^2 \\
 &= 107,72 \text{ kgm} \quad 107,72 \text{ kg cm.} \\
 - M_{my_1} &= 1/8 \cdot q \cdot \sin x \cdot L^2 \\
 &= 1/8 \cdot 101,90 \cdot \sin 20^\circ (3)^2 \\
 &= 39,20 \text{ kgm} \quad 3920 \text{ kg cm.}
 \end{aligned}$$



PERHITUNGAN

* Akibat beban hidup:

$$\begin{aligned} - M_{hx_2} &= 1/4 \cdot p \cdot \cos x \cdot L \\ &= 1/4 \cdot 100 \cdot \cos 20^\circ \cdot 3 \\ &= 70,47 \text{ kgm} \quad 7047 \text{ kg cm} \end{aligned}$$

$$\begin{aligned} - M_{hy_2} &= 1/4 \cdot p \cdot \sin x \cdot L \\ &= 1/4 \cdot 100 \cdot \sin 20^\circ \cdot 3 \\ &= 25,65 \text{ kgm} \quad 2565 \text{ kg cm.} \end{aligned}$$

$$M_{x_t} = M_{mx_1} + M_{hx_2} = 10772 + 7047 = 17819 \text{ kg cm.}$$

$$M_{y_t} = M_{my_1} + M_{hy_2} = 3920 + 2565 = 6485 \text{ kg cm.}$$

$$W_x = 1/6 \cdot b \cdot h^2 = 1/6 \cdot 8 \cdot 15^2 = 300 \text{ cm}^3$$

$$W_y = 1/6 \cdot b^2 \cdot h = 1/6 \cdot 8^2 \cdot 15 = 160$$

$$\begin{aligned} \sigma_{\max} &= \frac{M_{x_t}}{W_x} + \frac{M_{y_t}}{W_y} = \frac{17819}{300} + \frac{6485}{160} < \sigma_{lt} \\ &= 59,39 + 40,53 < 100 \text{ kg/cm}^2 \\ &= 99,93 \text{ kg/cm}^2 < 100 \text{ kg/cm}^2 \end{aligned}$$

KONTROL GESER

$$\begin{aligned} V &= 1/2 \cdot q \cdot \cos \alpha \cdot 1 + 1/2 P \cos \alpha \\ &= 1/2 \cdot 112,04 \cdot \cos 20^\circ \cdot 3 + 1/2 \cdot 100 \cos 20^\circ \\ &= 157,92 \text{ kg} + 47 = 204,92 \text{ kg.} \end{aligned}$$

$$\begin{aligned} I_x &= 1/12 \cdot b \cdot h^3 \\ &= 1/12 \cdot 8 \cdot (15)^3 \\ &= 2250 \text{ cm}^4 \end{aligned}$$



FAKULTAS TEKNIK SIPIL
UNIVERSITAS KRISTEN PETRA

TUGAS KONSTRUKSI KAYU

HALAMAN :

5

BAGIAN STRUKTUR :

NO. GAMBAR :

NRP :

21391614

21391618

PERHITUNGAN

$$\begin{aligned} Q &= b \cdot \frac{1}{4}h \cdot \frac{1}{2}h \\ &= 8 \cdot 3,75 \cdot 7,5 \\ &= 225 \text{ cm}^3 \end{aligned}$$

$$\begin{aligned} \max &= \frac{V \cdot Q}{b \cdot I_x} < \\ &= \frac{204,92 \cdot 225}{8 \cdot 2250} \\ &= 2,60 \text{ kg/cm}^2 < 12 \text{ kg/cm}^2 \end{aligned}$$



PERHITUNGAN

PERHITUNGAN KUDA-KUDA

Beban Yang Bekerja:

- Berat sendiri kuda-kuda:

$$0,08 \times 0,15 \times 910 \times 37,3 = 411,68 \text{ kg}$$

$$0,05 \times 0,12 \times 910 \times (7,2 \times 2) = 78,62 \text{ kg}$$

$$\underline{\hspace{10em}} \\ 490,3 \text{ kg}$$

- Berat alat penampang:

$$10\% \times kd = 10\% \times 490,3 = 49,03 \text{ kg}$$

- Berat plafond:

$$11 \text{ kg/m}^2 \times 12 \times 3 = 396 \text{ kg}$$

$$\underline{\hspace{10em}} \\ 539,33 \text{ kg}$$

- Beban atap:

$$0,08 \times 0,15 \times 3,00 \times 910 = 32,76$$

$$56,83 \times 1,60 \times 300 = 272,78$$

$$\underline{\hspace{10em}} \\ 305,54 \text{ kg}$$

Beban Mati Untuk Tiap Perletakan Gording:

$$\frac{539,33}{8} + 305,8 = 343,60 \text{ kg}$$

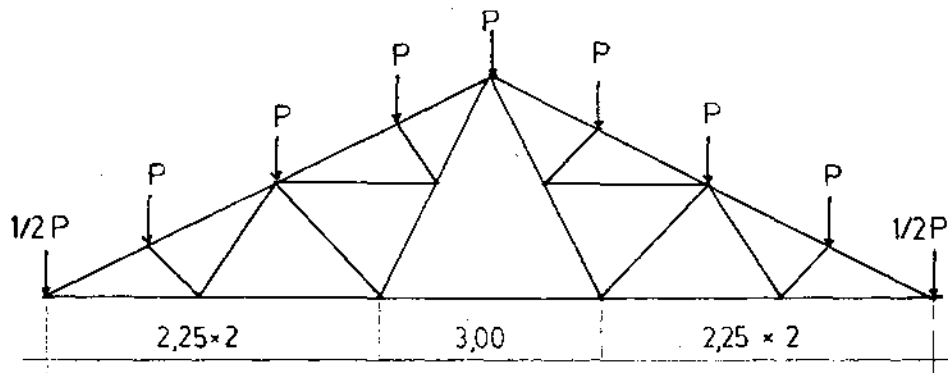
Beban hidup P = 100 kg.

Beban angin $\alpha = 20\%$, ditentukan oleh di belakang angin

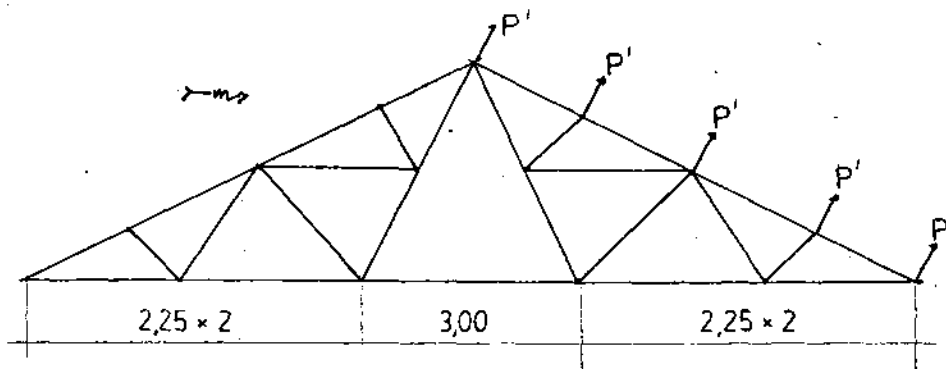
$$(-0,4) \times 25 \times 1,60 \times 3,00 = -48 \text{ kg.}$$



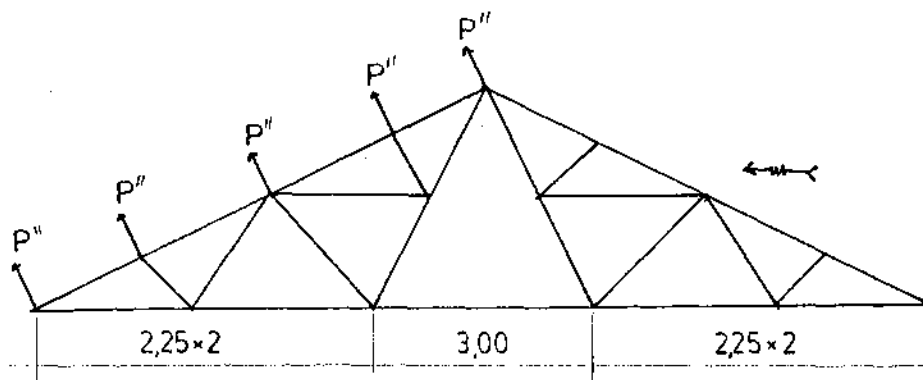
PERHITUNGAN



BEBAN MATI
 $P = 343,60 \text{ kg}$



BEBAN ANGIN KIRI
 $P' = 48 \text{ kg}$



BEBAN ANGIN KANAN
 $P'' = 48 \text{ kg}$



PERHITUNGAN

KOMBINASI PEMBEBANAN

NO	BEBAN TETAP		BEBAN A KIRI		BEBAN A KANAN		BEBAN BAK (KG)	
	+	-	+	-	+	-	+	-
1	3279,8			92,135		383,55	3279,8	
2	2811,3			92,135		313,83	2811,3	
3	1891,4			93,732		175,83	1891,4	
4	2811,3			231,73		174,24	2811,3	
5	3279,8			301,45		174,24	3279,8	
6		-3493,3	185,58		338,57			3493,3
7		-3160,6	185,58		306,55			3160,6
8		-2775,1	183,35		268,21			2775,1
9		-2448,6	184,92		236,03			2448,6
10		-2448,6	236,03		184,92			2448,6
11		-2775,1	268,21		183,36			2775,1
12		-3160,6	306,55		185,58			3160,6
13		-3493,3	338,57		185,58			3493,3
14		-387,36		0,0014	57,64			387,36
15	277,23			0,0024		41,256	277,23	
16		743,95		1,293	111,61			745,24
17	544,03		0,944				81,607	544,90
18	544,03			81,609	0,946		544,90	
19		743,95	111,60			1,293		745,24
20	277,23			41,255		0,0034	277,23	
21		387,36	57,638		0,00096			387,36
22	394,16		3,124			60,825	397,28	
23	394,16			60,827	3,128			397,284
24		360,11		2,677	55,44			362,78
25	767,38		2,719			116,08	770,09	
26	767,38			116,08	2,67		770,09	
27		360,11	55,444			2,67		362,78



PERHITUNGAN

KONTROL KEKUATAN BATANG

1. Batang dengan gaya tekan terbesar adalah:

- Batang 6 dan batang 13, masing-masing 3493,3 kg.

- Ujung-ujung dianggap sendi-sendi.

$$l_k = 160 \text{ cm}$$

$$i_y = 0,289 \cdot b = 0,289 \cdot 8 = 2,312$$

$$= \frac{l_k}{i_y} = \frac{160}{2,312} = 70 \text{ -----} \rightarrow W = 1,87$$

$$\sigma_{tk} = \frac{S \cdot W}{b \cdot h} = \frac{3493,3 \cdot 1,87}{8 \cdot 15} = 52,40 \text{ kg/cm}^2 < 85 \text{ kg/cm}^2$$

Dimensi batang 8 x 15 cm² bisa dipakai.

2. Batang tekan dengan panjang batang terbesar batang 3

dengan lebar 175,83 kg.

$$l_k = 300 \text{ cm.}$$

$$i_y = 0,289 \cdot h = 2,312$$

$$= \frac{l_k}{i_y} = \frac{300}{2,312} = 130 \text{ -----} \rightarrow W = 5,84$$

$$\sigma_{tk} = \frac{S \cdot W}{b \cdot h} = \frac{175,83 \cdot 5,84}{8 \cdot 15} = 8,6 \text{ kg/cm}^2 < 85 \text{ kg/cm}^2$$

Dimensi barang 8 x 15 cm² bisa dipakai.



PERHITUNGAN

3. Batang dengan gaya tarik terbesar:

- 1 dan 5 dengan gaya tarik masing-masing 3279,8 kg.
- Sambungan baut/gigi ----> perluasan 25%

$$F_{\text{netto}} = 8 \times 15 \times 0,75 \\ = 90 \text{ cm}^2$$

$$\sigma = 85 \text{ kg/cm}^2$$

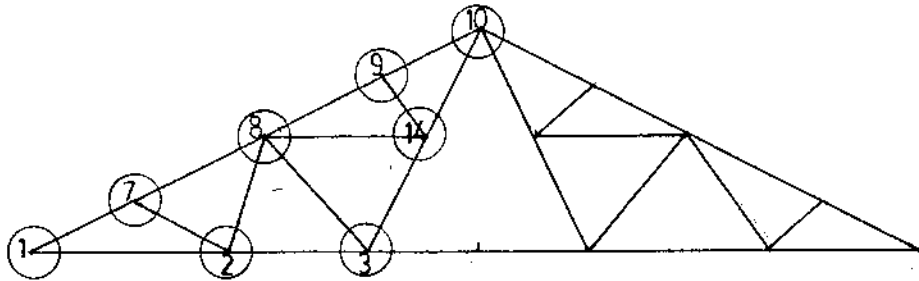
$$\sigma = \frac{S}{F_{\text{netto}}} = \frac{3279,8}{90} = 36 \text{ kg/cm}^2 < 85 \text{ kg/cm}^2$$

Jadi dimensi batang $8 \times 15 \text{ cm}^2$ dapat dipakai.



PERHITUNGAN

PERHITUNGAN SAMBUNGAN



DETAIL 1

Batang 6

$$\alpha = 20^\circ$$

$$S = 3493,3 \text{ kg}$$

$$b = 8$$

$$h = 15$$

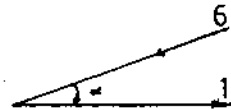
$$\begin{aligned} \delta t_k &= 85 - (85 - 25) \sin 10^\circ T1 = 12 \text{ kg/cm}^2 \\ &= 74,58 \text{ kg/cm}^2 \end{aligned}$$

$$\text{Diambil } S2 = 1/2 S$$

$$= 1746,65 \text{ kg.}$$

$$\delta t_k \alpha = 85 - (85 - 25) \sin 10 = 74,58 \text{ kg/cm}^2$$

$$\begin{aligned} t_{v2} &= \frac{S2 \cdot \cos x}{b \cdot \delta t_k \alpha} = \frac{1746,65 \cdot \cos 20}{8 \cdot 74,58} = 3,18 \sim 3,5 \\ &= 3,15 \leq 1/4 \cdot 15 = 3,75 \text{ cm.} \end{aligned}$$





PERHITUNGAN

$$ts_2 = \frac{tv_2}{\cos \alpha} = \frac{3,5}{\cos 20^\circ} = 3,70 \text{ cm}$$

Maka kedua gigi kedua dapat menahan gaya.

$$\begin{aligned} S_2 &= b \times ts_2 \times \delta tk \alpha \\ &= 8 \times 3,5 \times 64,48 = 1805,44 \text{ kg.} \end{aligned}$$

$$\begin{aligned} S_1 &= S - S_2 \\ &= 3493,3 - 1805,44 = 1687,86 \text{ kg} \end{aligned}$$

$$tv_1 = \frac{S}{73 b} = \frac{1687,86}{73 \cdot 8} = 2,89 \text{ cm} \sim 3 \text{ cm}$$

$$Lm = \frac{S \cdot \cos \alpha}{t \cdot b} = \frac{1746,65 \cdot \cos 15}{12 \cdot 8} = 17,5 \sim 20 \text{ cm}$$

Simpul
DETAIL 2

Batang (15)

$$\alpha = 56^\circ$$

$$\text{Baut} = 1,27 \text{ cm}^2$$

Dipakai plat tegel 4 x 400 mm



Pada batang b luas bidang tekan:

$$8 \times 4 = 32 \text{ cm}^2$$

$$\delta tk = \frac{S}{A} = \frac{277,23}{32} = 8,66 \text{ kg/cm}^2$$

$$\delta tk (1) = 25 \text{ kg/cm}^2 \text{ ----> PPK I ----> KK II.}$$



PERHITUNGAN

Jadi:

$$\delta tk = 8,66 \text{ kg/cm}^2 < 25 \text{ kg/cm}^2$$

Misal memakai baut $\phi 1/2'' \sim 1,27 \text{ cm}$

Batang 15

$$\begin{aligned} S &= 40 \cdot d \cdot b \cdot (1 - 0,6 \sin \alpha) \\ &= 40 \cdot 1,27 \cdot 8 (1 - 0,6 \sin 56^\circ) \\ &= 204,25 \text{ kg.} \end{aligned}$$

$$\begin{aligned} S &= 215 \cdot d^2 \cdot b \cdot (1 - 0,35 \sin \alpha) \\ &= 215 \cdot 1,27^2 \cdot 8 (1 - 0,35 \sin 56^\circ) \\ &= 246,20 \text{ kg.} \end{aligned}$$

Diambil gaya terkecil

$$S = 204,25 \text{ kg.}$$

Kekuatan baja dinaikkan 25%

$$\begin{aligned} S &= 1,25 \cdot 204,25 \text{ kg.} \\ &= 255,31 \text{ kg.} \end{aligned}$$

$$n = \frac{277,23}{255,31} = 1,02 \sim 2$$

Jadi baut yang diperlukan 2 $\phi 1/2''$

Batang 14 (D1)

$$tv = \frac{3}{73 \cdot b} = \frac{387,36}{73 \cdot 8} = 0,6 \text{ cm} \sim 2 \text{ cm}$$



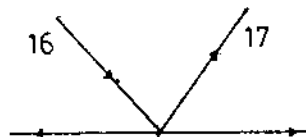
PERHITUNGAN

$$t_s = \frac{t_u}{\cos 1/2 \cdot \alpha} = \frac{2}{\cos 1/2 \cdot 36^\circ} = 2,1 \sim 2,5 \text{ cm}$$

$$\begin{aligned} \delta t_k \cdot 1/2 \alpha &= \delta t_{k_{II}} - (\delta t_{k_{II}} - \delta t_{k_I}) \sin 1/2 \delta \\ &= 85 - (85 - 25) \sin 1/2 \cdot 36 \\ &= 66,45 \text{ kg/cm}^2 \end{aligned}$$

$$\begin{aligned} \delta t_k \cdot 1/2 \alpha &= \frac{S \cdot \cos 1/2 \alpha}{t_s \cdot b} = \frac{387,36 \cdot \cos 1/2 \cdot 36}{25} \\ &= 18,42 \text{ kg/cm}^2 > 66,45 \text{ kg/cm}^2 \end{aligned}$$

DETAIL 3



Batang 17 dengan batang horizontal

$$\alpha = 55^\circ$$

Baut = $\varnothing$ 1/2 cm

Flat begel 4 x 400 mm

Pada batang b luas bidang tekan:

$$8 \times 4 = 32 \text{ cm}^2$$



PERHITUNGAN

δ_{tk} pada batang A akibat tekan begel

$$\delta_{tk} = \frac{S}{A} = \frac{544,03}{32} = 17,00 \text{ kg/cm}^2$$

$$\delta_{tk} (\downarrow) = 17 \text{ kg/cm}^2 > 25 \text{ kg/cm}^2$$

$$\begin{aligned} S &= 40 \cdot d \cdot b_1 \cdot (1 - 0,6 \sin \alpha) \\ &= 40 \cdot 1,27 \cdot 8 (1 - 0,6 \sin 56^\circ) \\ &= 206,66 \text{ kg.} \end{aligned}$$

$$\begin{aligned} S &= 215 \cdot d^2 \cdot b \cdot (1 - 0,35 \sin \alpha) \\ &= 215 \cdot 1,27^2 \cdot 8 (1 - 0,35 \sin 55^\circ) \\ &= 247,35 \text{ kg.} \end{aligned}$$

Diambil 206,66 kg.

Kekuatan baja dinaikkan 25% -----> PPK I

$$\begin{aligned} S &= 206,66 \text{ kg} \cdot 1,25 \\ &= 258,325 \text{ kg} \end{aligned}$$

$$n = \frac{544,03}{258,325} = 2,1 \sim 3$$

Jadi baut yang diperlukan 3 $\varnothing$ 1/2"

Batang 16 (D3) dengan batang horizontal

$$t_v = \frac{3}{73 \cdot b} = \frac{343,95}{73 \cdot 8} = 1,27 \sim 2 \text{ cm}$$

$$t_s = \frac{t_u}{\cos 1/2 \cdot \alpha} = \frac{2}{\cos 1/2 \cdot 35^\circ} = 2,09 \sim 2,5 \text{ cm}$$

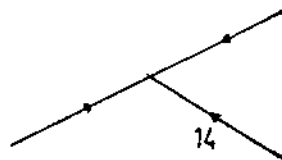


PERHITUNGAN

$$\begin{aligned}\delta t_k \cdot 1/2 \alpha &= \delta t_{k_{II}} - (\delta t_{k_{II}} - \delta t_{k_I}) \sin 1/2 \delta \\ &= 85 - (85 - 25) \sin 1/2 \cdot 35 \\ &= 66,45 \text{ kg/cm}^2\end{aligned}$$

$$\begin{aligned}\delta t_k \cdot 1/2 \alpha &= \frac{S \cdot \cos 1/2 \alpha}{t_s \cdot b} \\ &= \frac{387,36 \cdot \cos 1/2 \cdot 36}{25 \cdot 8} \\ &= 35 \text{ kg/cm}^2 < 66,95 \text{ kg/cm}^2\end{aligned}$$

DETAIL simpul 7



Batang 14

$$\alpha = 57^\circ \quad b = 8$$

$$S = 387,36 \text{ (-)} \quad m = 15$$

$$t_v = \frac{S}{73 \cdot b} = \frac{387,36}{73 \cdot 8} = 0,66 \text{ cm} \sim 2 \text{ cm}$$

$$t_s = \frac{t_u}{\cos 1/2 \cdot \alpha} = \frac{2}{\cos 1/2 \cdot 57^\circ} = 2,3 \sim 2,5 \text{ cm}$$

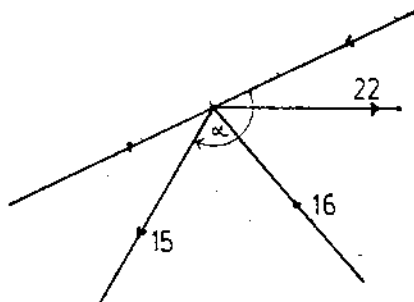


PERHITUNGAN

$$\begin{aligned}\delta t_k \cdot 1/2 \alpha &= \delta t_{k_{II}} - (\delta t_{k_{II}} - \delta t_{k_I}) \sin 1/2 \delta \\ &= 85 - (85 - 25) \sin 1/2 \cdot 1/2 57 \\ &= 56,37 \text{ kg/cm}^2\end{aligned}$$

$$\begin{aligned}\delta t_k \cdot 1/2 \alpha &= \frac{S \cdot \cos 1/2 \alpha}{t_s \cdot b} \\ &= \frac{387,36 \cdot \cos 1/2 \cdot 57}{25 \cdot 8} \\ &= 17,02 \text{ kg/cm}^2 < 56,37 \text{ kg/cm}^2\end{aligned}$$

~~DETAIL~~ simpul 8



Batang 15 dan A, $\alpha = 146^\circ$

Dipakai plat begel $4 \times 400 \text{ mm}^2$

Pada batang A luas, bidang tekan

$$8 \times 4 = 32$$

δt_k pada batang A akibat tekanan begel



PERHITUNGAN

$$\delta_{tk} = \frac{S}{A} = \frac{277,23}{8 \times 4} = 8,66 \text{ kg/cm}^2$$

. $\delta_{tk} \perp = 25 \text{ kg/cm}^2 \text{ ----> KK II}$

Jadi:

$$\delta_{tk} = 8,66 \text{ kg/cm}^2 < 25 \text{ kg/cm}^2$$

Misal memakai baut $\phi 1/2'' \sim 1,27 \text{ cm}$

Batang 15

$$\begin{aligned} S &= 40 \cdot d \cdot b_1 \cdot (1 - 0,6 \sin \alpha) \\ &= 40 \cdot 1,27 \cdot 8 (1 - 0,6 \sin 146^\circ) \\ &= 270,05 \text{ kg.} \end{aligned}$$

$$\begin{aligned} S &= 215 \cdot d^2 \cdot b \cdot (1 - 0,35 \sin \alpha) \\ &= 215 \cdot 1,27^2 \cdot (1 - 0,35 \sin 146^\circ) \\ &= 278,90. \end{aligned}$$

Diambil gaya terkecil

$$S = 270,05 \text{ kg.}$$

Kekuatan baja dinaikkan 25% -----> PPK I

$$\begin{aligned} S &= 1,25 \cdot 270,05 \text{ kg.} \\ &= 337,60 \text{ kg.} \end{aligned}$$

$$n = \frac{277,23}{337,60} = 0,8 \sim 2$$

Jadi baut yang diperlukan 2 $\phi 1/2''$



PERHITUNGAN

Batang A dengan batang 22

Batang 22

$$\alpha = 90$$

$$\begin{aligned} P &= 200 \cdot d \cdot b_1 (1 - 0,6 \sin \alpha) \\ &= 200 \cdot 1,27 \cdot 5 (1 - 0,6 \sin 90) \\ &= 500 \text{ kg.} \end{aligned}$$

$$\begin{aligned} P &= 430 \cdot d^2 \cdot (1 - 0,35 \sin \alpha) \\ &= 430 \cdot 1,27^2 \cdot (1 - 0,35 \sin 90) \\ &= 450,80 \text{ kg.} \end{aligned}$$

Batang B

$$\alpha = 20^\circ$$

$$\begin{aligned} P &= 100 \cdot d \cdot b_3 (1 - 0,6 \sin \alpha) \\ &= 100 \cdot 1,27 \cdot 8 (1 - 0,16 \sin 20) \\ &= 807,50 \text{ kg.} \end{aligned}$$

$$\begin{aligned} P &= 430 \cdot d^2 \cdot (1 - 0,35 \sin 20) \\ &= 610,52 \text{ kg/cm}^2 \end{aligned}$$

Jumlah baut yang dibutuhkan:

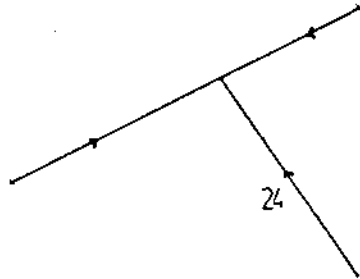
$$\frac{394,16}{450,80} = 0,8 \sim 1 \text{ baut}$$



PERHITUNGAN

SIMPUL 9

Batang 24



$$t_v = \frac{S}{73 \cdot b} = \frac{360,11}{73 \cdot 8} = 0,6 = 2 \text{ cm}$$

$$t_s = \frac{t_u}{\cos 1/2 \cdot \alpha} = \frac{2}{\cos 1/2 \cdot 56^\circ} = 2,26 \sim 2,5 \text{ cm}$$

$$\begin{aligned} \delta t_k \cdot 1/2 \alpha &= \delta t_{k_{II}} - (\delta t_{k_{II}} - \delta t_{k_I}) \sin 1/2 \alpha \\ &= 85 - (85 - 25) \sin 1/2 \cdot 56 \\ &= 56,83 \text{ kg/cm}^2 \end{aligned}$$

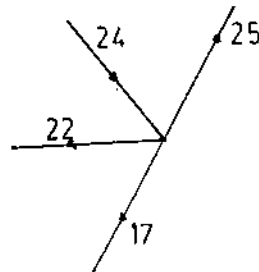
$$\begin{aligned} \delta t_k \cdot 1/2 \alpha &= \frac{S \cdot \cos 1/2 \alpha}{t_s \cdot b} \\ &= \frac{360,11 \cdot \cos 1/2 \cdot 56}{25 \cdot 8} \\ &= 15,89 \text{ kg/cm}^2 \end{aligned}$$

$$\delta t_k \cdot 1/2 \alpha = 15,89 < \delta T_k = 56,83 \text{ kg/cm}^2$$



PERHITUNGAN

SIMPUL 14



$$t_v = \frac{S}{73 \cdot b} = \frac{360,11}{73 \cdot 8} = 0,6 \sim 1 \text{ cm}$$

$$t_s = \frac{t_u}{\cos 1/2 \cdot \alpha} = \frac{1}{\cos 1/2 \cdot 34} = 1,04 \sim 1,5 \text{ cm}$$

$$\begin{aligned} \delta t_k 1/2 \alpha &= \delta t_{k_{II}} - (\delta t_{k_{II}} - \delta t_{k_I}) \sin 1/2 \alpha \\ &= 85 - (85 - 25) \sin 1/2 \cdot 1/2 \cdot 34 \\ &= 67,69 \text{ kg/cm}^2 \end{aligned}$$

$$\begin{aligned} \delta t_k 1/2 \alpha &= \frac{S \cdot \cos 1/2 \alpha}{t_s \cdot b} \\ &= \frac{360,11 \cdot \cos 1/2 \cdot 34}{1,5 \cdot 8} \\ &= 28,69 \text{ kg/cm}^2 < 67,45 \text{ kg/cm}^2 \end{aligned}$$

Batang 22

$$\alpha = 35^\circ$$

$$P = 100 \cdot d \cdot b_1 (1 - 0,6 \sin \alpha)$$

$$= 100 \cdot 1,27 \cdot 8 (1 - 0,6 \sin 55) = 516,64 \text{ kg.}$$



PERHITUNGAN

$$= 500 \text{ kg.}$$

$$\begin{aligned} P &= 430 \cdot d^2 \cdot (1 - 0,35 \sin \alpha) \\ &= 430 \cdot 1,27^2 \cdot (1 - 0,35 \sin 55) \\ &= 494,70 \text{ kg.} \end{aligned}$$

• Batang Horizontal

$$\alpha = 90^\circ$$

$$\begin{aligned} P &= 100 \cdot d \cdot b_3 (1 - 0,6 \sin \alpha) \\ &= 100 \cdot 1,27 \cdot 5 (1 - 0,6 \sin 90) \\ &= 254 \text{ kg.} \end{aligned}$$

$$\begin{aligned} P &= 430 \cdot d^2 \cdot (1 - 0,35 \sin 20) \\ &= 430 \cdot 1,27 (1 - 0,35 \sin 90) \\ &= 354,97 \end{aligned}$$

Jumlah baut yang diperlukan:

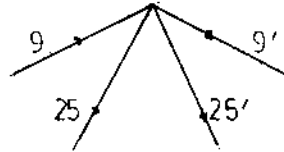
$$\frac{354,97}{254} = 1,3 \sim 2 \text{ baut}$$



PERHITUNGAN

SIMPUL 10

Batang 9



$$t_v = \frac{S}{73 \cdot b} = \frac{2448,6}{73 \cdot (8 + 2 \cdot (3))} = 2,39 \text{ cm} \sim 2,5 \text{ cm}$$

$$t_s = \frac{t_u}{\cos 1/2 \cdot \alpha} = \frac{2,5}{\cos 1/2 \cdot 70^\circ} = 300 \text{ cm}$$

$$\begin{aligned} \delta t_k 1/2 \alpha &= \delta t_{kII} - (\delta t_{kII} - \delta t_{kI}) \sin 1/2 \alpha \\ &= 85 - (85 - 25) \sin 1/2 \cdot 70 = 50,58 \text{ kg/cm}^2 \end{aligned}$$

$$\begin{aligned} \delta t_k 1/2 \alpha &= \frac{S \cdot \cos 1/2 \alpha}{t_s \cdot b} \\ &= \frac{2448 \cdot \cos 1/2 \cdot 70}{3 \cdot 14} \\ &= 47,76 \text{ kg/cm}^2 < 50,58 \text{ kg/cm}^2 \end{aligned}$$

Batang 25

$$\alpha = 34^\circ$$

$$\begin{aligned} S &= 40 \cdot d \cdot b \cdot (1 - 0,6 \sin \alpha) \\ &= 40 \cdot 1,27 \cdot 8 \cdot (1 - 0,6 \sin 34) \\ &= 260,05 \text{ kg.} \end{aligned}$$

$$\begin{aligned} S &= 215 \cdot d^2 \cdot (1 - 0,35 \sin \alpha) \\ &= 215 \cdot 1,27^2 \cdot 8 \cdot (1 - 0,35 \sin 34) \\ &= 278,90 \text{ kg.} \end{aligned}$$

Diambil gaya yang terkecil

$$S = 270,05 \text{ kg.}$$



PERHITUNGAN

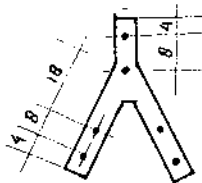
Kekuatan baja dinaikan 25%

$$S = 1,25 / 270,05 \text{ kg.}$$

$$= 337,60 \text{ kg.}$$

$$n = \frac{267,38}{337,60} = 2,3 \sim 3 \text{ baut}$$

Cek tegangan baja yang terjadi + kekuatan



Plat begel 4 x 60 mm

$$A = 240 \text{ mm}^2 = 2,4 \text{ cm}$$

$$P =$$

$$\sigma = \frac{767,38}{2,21} = 319,74 \text{ kg/cm}^2$$

$$< 1666 \text{ kg/cm}^2$$

∴ Diameter baut 1 dan 2 masing-masing $\phi 1/2"$

$$1,27 \text{ cm}$$

$$P = 1085 \text{ kg}$$

$$P = 2 (1/4 \pi d^2) \cdot 0,58 \cdot 1666$$

$$1085 = 2 (1/4 \cdot 3,14 \cdot d^2) 0,58 \cdot 1666$$

$$d = 0,8 \text{ cm} \sim 1,27 \text{ cm}$$

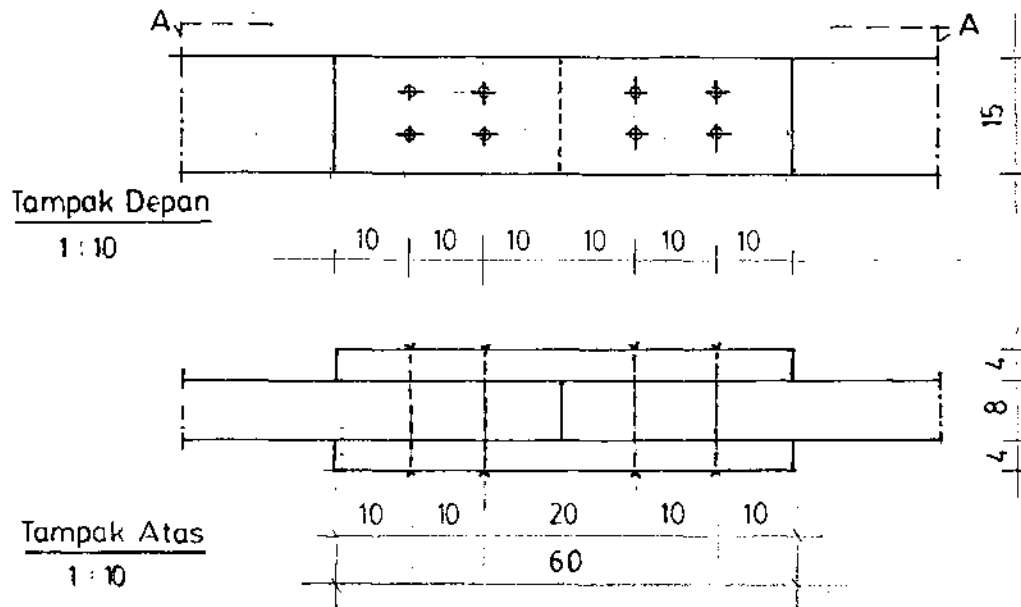
DETAIL 11

$$P = 2811,3 \text{ kg}$$

$$\text{Baut } \phi 1/2" \quad \alpha = 0$$



PERHITUNGAN



Sambungan berpenampang dua

$$\begin{aligned}
 S &= 100 \cdot d \cdot b^3 \cdot (1 - 0,6 \sin \alpha) \\
 &= 100 \cdot 1,27 \cdot 8 (1 - 0,6 \sin 0) \\
 &= 10,16 \text{ kg.}
 \end{aligned}$$

$$\begin{aligned}
 S &= 200 \cdot d \cdot b^1 \cdot (1 - 0,6 \sin \alpha) \\
 &= 200 \cdot 1,27 \cdot 9 (1 - 0,6 \sin 0) \\
 &= 10,16 \text{ kg.}
 \end{aligned}$$

$$\begin{aligned}
 S &= 430 \cdot d^2 \cdot b^3 \cdot (1 - 0,35 \sin \alpha) \\
 &= 430 \cdot 1,27^2 \cdot (1 - 0,35 \sin 0) \\
 &= 693,55 \text{ kg.}
 \end{aligned}$$

$$n = \frac{693,55 \times 4}{2811,3} = 0,9 \sim 4 \text{ } \phi 1/2"$$



PERHITUNGAN

PERHITUNGAN KOLOM

Perletakan Sendi-sendi

$$f_c = 25 \text{ MPa}$$

$$f_y = 400 \text{ MPa}$$

Dimensi 20 x 20

Beban yang bekerja

$$\text{- Reaksi perletakan} = 1374,4 \text{ kg.}$$

$$\text{- Beban hidup} = 100 \text{ kg.}$$



$$\begin{aligned} \text{- } M &= 1/2 \cdot q \cdot l^2 \\ &= 1/2 \cdot 101,90 \cdot 0,8^2 \\ &= 32,6 \text{ kgm} \\ &= 3,26 \text{ kn} \end{aligned}$$

$$\begin{aligned} P_u &= 1,2 \times d + 1,6 \times L \\ &= 1,2 \times 1374,4 + 1,6 \times 100 \\ &= 1649,28 + 1,6 \times 100 \\ &= 1809,28 \text{ kg} = 18,09 \text{ knm} \end{aligned}$$

$$\begin{aligned} M_u &= 1,2 (3,26) \\ &= 3,912 \text{ knm} \end{aligned}$$



PERHITUNGAN

$$e = \frac{M_u}{P_u} = \frac{3,912}{18,00} = 0,22 \text{ m} = 220 \text{ mm}$$

$$\frac{P_u}{\phi A_g s \cdot 0,85 \cdot f_c} \times e/h = \frac{18,090}{0,8 \cdot (200 \times 200) \cdot 0,85 \cdot 25} \left[\frac{200}{200} \right] = 0,033$$

$$\frac{P_u}{\phi A_g s \cdot 0,85 \cdot f_c} = \frac{18,090}{0,8 \cdot (200 \times 200) \cdot 0,85 \cdot 25} \left[\frac{200}{200} \right] = 0,033$$

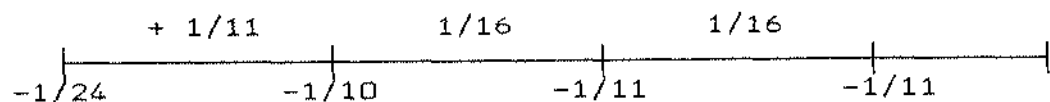
$$\begin{array}{l} 0,03 \quad \uparrow \\ 0,033 \quad \downarrow \end{array} \quad \} \text{-----} \rightarrow 0,006$$

$$\rho = r \cdot \beta = 0,006 \cdot 1,0$$

$$A_s = 0,006 \cdot 200 \cdot 200$$

$$= 240 \text{ mm}^2 \text{-----} \rightarrow (4 \text{ } \phi \text{ } 12 = 4,52 \text{ mm}^2)$$

$$\text{Sloof : } 20/25 \text{ cm}^2$$



Pembebanan

$$\text{- Berat sendiri sloof } 0,20 \times 0,25 \times 1 \times 2400 = 120 \text{ kg.}$$

$$\text{- Berat dinding } 1/2 \text{ bata } 0,15 \times 1 \times 1700 = 225 \text{ kg.}$$

$$q = 375 \text{ kg.}$$



PERHITUNGAN

Diambil momen terbesar:

$$\begin{aligned}M_{tumpu} &= 1/10 \cdot q \cdot l^2 \\&= 1/10 \cdot 375 \cdot 3^2 \\&= 337,5 \text{ kg.} \\&= 33,75 \text{ knm}\end{aligned}$$

$$\begin{aligned}M_{lap} &= 1/11 \cdot q \cdot l^2 \\&= 1/11 \cdot 375 \cdot 3^2 \\&= 306,82 \text{ kgm.} \\&= 30,682 \text{ knm.}\end{aligned}$$

$$\begin{aligned}M_{n_{tp}} &= \frac{33,75}{0,8} \\&= 42,18 \text{ knm}\end{aligned}$$

$$\begin{aligned}M_{n_{lap}} &= \frac{30,682}{0,8} \\&= 38,35 \text{ knm}\end{aligned}$$

$$\begin{aligned}d &= 250 - 40 - 1/2 \cdot 12 \\&= 196 \text{ mm} = 0,196\end{aligned}$$

Rasio Perlawanan

$$\begin{aligned}R_{u_{tp}} &= \frac{M_n}{b \cdot d^2} \\&= \frac{42,18}{0,2 \cdot 0,196} \\&= 1076 \text{ kn}\end{aligned}$$

$$\begin{aligned}R_{u_{lap}} &= \frac{M_n}{b \cdot d^2} \\&= \frac{38,35}{0,2 \cdot 0,196} \\&= 978,32 \text{ kn}\end{aligned}$$

$$f_c = 25 \text{ Mpa} \quad f_y = 240 \text{ Mpa}$$

Didapat:

$$\min = 0,58\%$$

$$\begin{aligned}A_s &= \rho \cdot b \cdot d = 0,58\% \cdot 200 \cdot 196 = 227,36 \text{ mm}^2 \\(3 \varnothing 12 &= 339 \text{ mm}^2)\end{aligned}$$



PERHITUNGAN

PERHITUNGAN BALOK RIB

Beban yang bekerja:

$$\begin{aligned} V &= \text{Reaksi kolom} + \text{bs kolom} + \text{bs rib} \\ &= 1374,4 + 0,2 \times 0,2 \times 4,25 \times 2400 + 0,20 \times 0,25 \times 1,00 \times 2400 \\ &= 1374,4 + 4,08 + 180 \\ &= 1962,4 \text{ kg.} \end{aligned}$$

$$q_{\text{rib}} = \frac{1962,4}{1,00 \times 1,00} = 1962,4 \text{ kg/m}^2$$

$$\begin{aligned} M_{\text{max}} &= 1/2 \cdot q \cdot l^2 \\ &= 1/2 \cdot 1962,4 \cdot 0,65^2 \\ &= 182,25 \text{ kgm.} \end{aligned}$$

$$M_n = \frac{182,25}{0,8} \cdot \frac{9,81}{1000} = 2,235$$

$$\begin{aligned} d &= 250 - 70 - 1/2 \cdot 12 \\ &= 172 \text{ mm} \end{aligned}$$

$$R_n = \frac{M_u}{b \cdot d^2} \cdot \frac{2,235}{0,20 \cdot 0,172^2} = 377,74 \text{ kn}$$

Dari tabel 2.2.

Dipakai $\rho_{\text{min}} = 0,58\%$

$$A_s = 0,58\% \times 20 \times 17,2 = 1,99 \text{ cm}^2 \quad (2 \text{ } \varnothing 12 = 4,53 \text{ cm}^2)$$



PERHITUNGAN

$$\begin{aligned} A_s^1 &= 0,25\% \times 1,49 \\ &= 0,5 \text{ cm}^2 \quad (2 \text{ } \varnothing 12 = 4,53 \text{ cm}^2) \end{aligned}$$

TULANGAN SENGKANG

$$\begin{aligned} Q &= 872,18 \times 0,65 (U_u) \\ &= 566,92 \text{ kg} \\ &= 5,6692 \text{ kn} \end{aligned}$$

Kuat geser beton

$$\begin{aligned} V_c &= \frac{\sqrt{f_c}}{6} \cdot b \cdot d \\ &= \frac{\sqrt{25}}{6} \cdot \frac{200 \cdot 172}{1000} = 28,67 \end{aligned}$$

$$V_n = \frac{V_u}{0,6} = \frac{5,6692}{0,6} = 9,45 \text{ kn}$$

$$V_u \leq V_c \text{ -----} \rightarrow \text{SKSNI 3.45 - 5.1}$$

Dipasang tulangan geser minimum $\varnothing 6 - 20 \text{ cm}$.



PERHITUNGAN

PERHITUNGAN PLAT PONDASI

$$F_c = 25 \text{ MPa}$$

$$F_y = 240 \text{ MPa}$$

$$\begin{aligned} E_v1 &= 1474,4 + 0,02 \times 0,2 \times 5,80 \times 2400 + 0,25 \times 0,20 \times 0,16 \times 2400 \\ &\quad + 0,12 \times 1,5 \times 10 \times 2400 \\ &= 1374 + 556,8 + 78 + 648 \\ &= 2657,2 \text{ kg.} \end{aligned}$$

$$q_{\text{plat}} = \frac{2657,2}{1 \times 1} = 2657,2 \text{ kg/m}^2$$

$$\begin{aligned} M_u &= 1/2 \cdot 2657,2 \cdot 0,65^2 \\ &= 863,59 \text{ kg.} \end{aligned}$$

$$\begin{aligned} M_n &= \frac{M_u}{\phi} = \frac{(863,59)}{0,8} \times \frac{9,81}{1000} \\ &= 10,58 \text{ knm} \end{aligned}$$

$$\begin{aligned} d &= 120 - 70 - 1/2 \cdot 10 \\ &= 45 \text{ mm} \end{aligned}$$

$$R_n = \frac{M_n}{b \cdot d^2} = \frac{10,58}{(1) \cdot (0,045)^2} = 5224,6 \text{ kg}$$



PERHITUNGAN

Dari tabel 2.2. didapat:

1400 ----> 2,53

1600 ----> 2,65

$$= \frac{5224,6 - 5200}{5400 - 5200} (2,65 - 2,53) + 2,53 = 2,545\%$$

$$As = . b . d$$

$$= 2,545\% . 100 . 4,5$$

$$= 11,45 \text{ cm}^2 (\phi - 5 \text{ cm} = 15,71 \text{ cm}^2)$$

PONDASI BATU KALI

Beban yang bekerja:

$$- \text{Berat ring balk } 0,15 \times 0,20 \times 1 \times 2400 = 72 \text{ kg}$$

$$- \text{Berat tembok } 0,15 \times 4,00 \times 1 \times 1700 = 1020 \text{ kg}$$

$$- \text{Berat sloof } 0,2 \times 0,25 \times 1 \times 2400 = 1200 \text{ kg}$$

$$- \text{Bs. Pondasi } 0,80 \frac{(0,3 + 0,8)}{2} \times 1 \times 2200 = 968 \text{ kg}$$

$$- \text{Berat tanah } \frac{168+120}{2} \times 1,35 \times 1 \times 1700 = 5248,8 \text{ kg}$$

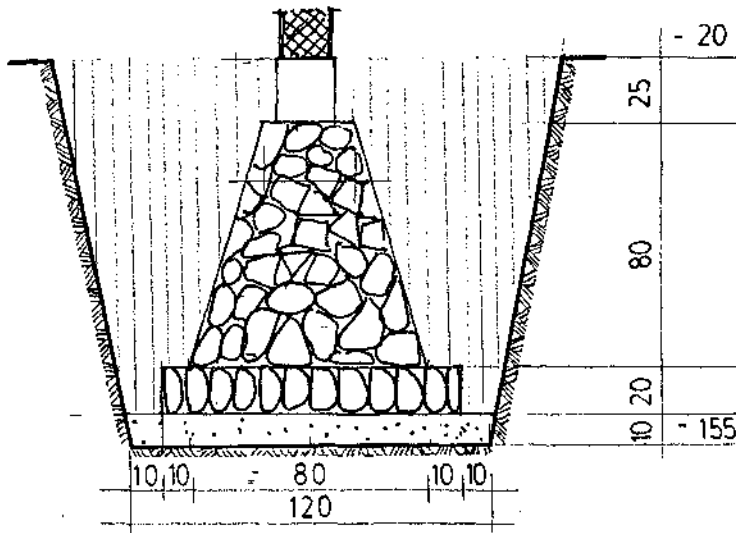
$$- \text{Berat anstamping } 0,20 \times 1,20 \times 1,00 \times 2200 = 528 \text{ kg}$$

$$\Sigma G = 7956,8 \text{ kg}$$



PERHITUNGAN

$$\delta_{\text{tanah}} = 1,00 \text{ kg/cm}^2$$



$$\delta = \frac{\Sigma G}{A} = \frac{7957,2}{100 \times 80} = 0,92 \text{ kg/cm}^2$$

$$\delta \leq \delta_t$$

$$0,92 \text{ kg/cm}^2 \leq 1 \text{ kg/cm}^2$$