



Penyelesaian Konstruksi

KAYU

Cipta Science Team

Rp 3000 /
Y 09301

KATA PENGANTAR

Buku ini merupakan perbaikan dari edisi lama - yang diterbitkan dengan sistim cetak offset.

Buku ini masih jauh dari sempurna tetapi penulis yakin buku ini dapat sedikit memberikan gambaran dari keseluruhan uraian dalam text book yang ada.

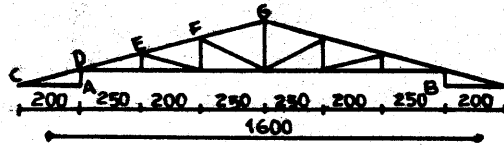
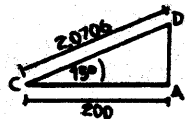
Oleh karena itu kritikan yang membangun dari para ahli sangat diharapkan demi perbaikan isi buku ini khususnya dan kepentingan kita semua pada umumnya.

September, 1986.

Penyusun

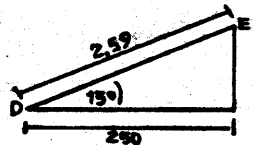
KETENTUAN-KETENTUAN :

1. Atap asbes bergelombang = 11 kg
2. Jarak kuda-kuda = 4 meter, K_1 & K_2
3. Kayu kruing
4. Sambungan baut, gigi, kokot bulldog.
5. Langit-langit eternit = 11 kg/m²

BEBAN ATAP

$$\cos 15^\circ = \frac{2}{CD} \quad CD = \frac{2}{\cos 15^\circ} = \frac{2}{0,9659}$$

$$CD = 2,0706 \text{ m.}$$



$$\cos 15^\circ = \frac{2,5}{DE} \quad DE = \frac{2,5}{\cos 15^\circ} = \frac{2,5}{0,9659}$$

$$DE = 2,59 \text{ m.}$$

$$EF = CD = 2,0706 \text{ m.}$$

$$FG = DE = 2,59 \text{ m.}$$

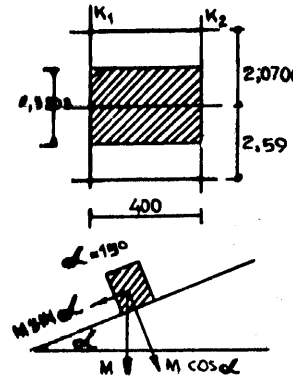
UKURAN GORDING

Diambil kayu kruing 8/12 Bj = 0,79

Chek gording

Diambil gording pada titik buhul E dengan 2,3203 m dan benteng 4 m yaitu antara K_1 & K_2 .

$$\begin{aligned} \text{Berat gording} &= 0,08.0,12.760 \longrightarrow = 7,5840 \text{ kg/m}^1 \\ \text{Muatan atap/asbes} &= 11.2,320 = 25,5233 \text{ kg/m}^1 \\ \text{Muatan angin} &= 35 [0,2.15 - 0,4] \cos 15^\circ = -3,3806 \text{ kg/m}^1 \\ q &= 29,7262 \text{ kg/m}^1 \end{aligned}$$



$$\begin{aligned} M &= 1/8.q.l^2 = 1/8.29,7262.4^2 = 5945,34 \text{ kgcm} \\ M \sin 15^\circ &= 0,2588.5945,34 = 1538,6539 \text{ kg cm} \\ M \cos 15^\circ &= 0,9659.5945,34 = 5742,6039 \text{ kg cm} \\ W_x &= 1/6.b.h^2 = 1/6.8.12^2 = 192 \text{ cm}^3 \\ W_y &= 1/6.b.h^2 = 1/6.12.8^2 = 128 \text{ cm}^3 \\ \tau_{\max} &= \frac{M \sin 15^\circ}{W_y} + \frac{M \cos 15^\circ}{W_x} \\ &= \frac{1538,6539}{128} + \frac{5742,6039}{192} \\ &= 12,02 + 29,909 = 41,929 < 100 \text{ kg/cm}^2 \text{ [OK]} \end{aligned}$$

Ukuran gording : 8/12 ; kayu gording, bj = 0,79

Berat gording pada tiap-tiap buhul = $0,08.0,12.0,79.4$
 $= 30,336 \text{ kg} < 31 \text{ kg/m}^1$

Joint C $\rightarrow P_c = \frac{1}{2}.2,0706.4.11 + 31 = 76,55 < 77 \text{ kg}$

Joint D $\rightarrow P_d = 77 + \frac{1}{2}.2,59.4.11 = 133,98 < 134 \text{ kg}$

Joint E $\rightarrow P_e = 2,33.4.11 + 31 = 133,52 < 134 \text{ kg}$

Joint F $\rightarrow P_f = P_e = 134 \text{ kg}$

Joint G $\rightarrow P_g = 2,59.4.11 + 31 = 144,96 < 145 \text{ kg}$

II. BEBAN LANGIT-LANGIT + PENGGANTUNG

Berat eternit = 11 kg/m¹

Berat penggantung = 7 kg/m¹

= 18 kg/m¹

Panjang AG = 7 meter

Berat semua = $7.4.18 = 540 \text{ kg}$

AC = $2.4.18 = 144 \text{ kg}$

Joint C $\rightarrow P_c = \frac{1}{2}.144 = 72 \text{ kg}$

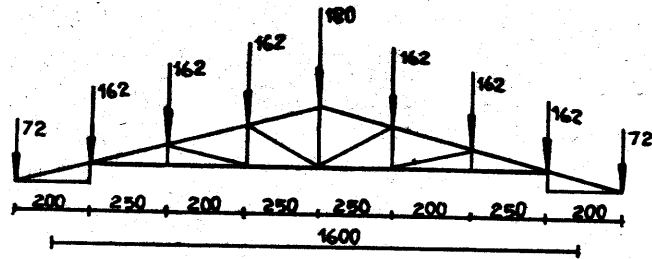
Joint D $\rightarrow P_d = \frac{1}{2}.144 + \frac{1}{2}.2,5.4.18 = 162 \text{ kg}$

Joint H $\rightarrow P_h = P_d = 162 \text{ kg}$

Joint I $\rightarrow P_i = P_h = 162 \text{ kg}$

Joint J $\rightarrow P_j = 2,5.4.18 = 180 \text{ kg}$

Konst. Kayu/4



III. BEBAN KUDA-KUDA

Panjang benteng = 16 meter.

Jarak kuda-kuda $b = 4$ meter

Berat kuda-kuda = $b \cdot l = 16 \cdot 4 = 64 \text{ kg/m}$

Joint C $\rightarrow P_c = \frac{1}{2} \cdot 2 \cdot 64 = 64 \text{ kg}$

Joint D $\rightarrow P_d = \frac{1}{2} \cdot [2 + 2,5] \cdot 64 = 144 \text{ kg}$

Joint E $\rightarrow P_e = P_d = 144 \text{ kg}$

Joint F $\rightarrow P_f = \frac{1}{2} \cdot [2,5 + 2] \cdot 64 = 144 \text{ kg}$

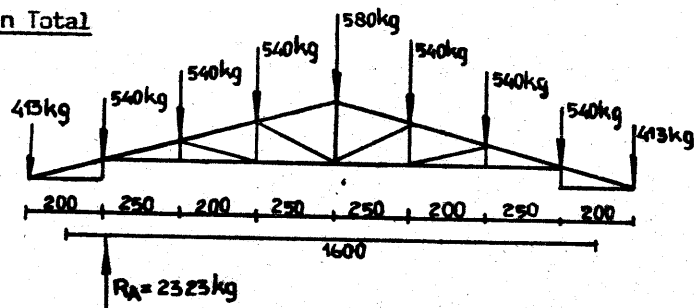
Joint G $\rightarrow P_g = \frac{1}{2} \cdot [2,5 + 2,5] \cdot 64 = 160 \text{ kg}$

TOTAL BEBAN MATI

Beban [kg]	C	D	E	F	G
Atap + gording	77	134	134	134	145
Langit-langit + penggantung	72	162	162	162	180
Kuda-kuda	64	144	144	144	160
Lain-lain	200	100	100	100	100
RA = RB	413	540	540	540	580

RA = RB = 2323 kg

Muatan Total



B. Kuda 3

Konst. Kayu/5

Muatan Angin

$P = \frac{V^2}{16} \text{ kg/m}^2$ Untuk perhitungan diambil $P = 35 \text{ kg/m}^2$

Miring atap 15° Koefisien = $[+0,02 - 0,4]$

Koefisien = $0,02 \cdot 15 - 0,4 = -0,1$ [isap] \rightarrow PMI 70

Dibulakang angin - 0,4 \rightarrow PMI 70

Jadi koefisien isap = $0,4 + 0,1 = 0,5$

Dibulakang angin [isapan]

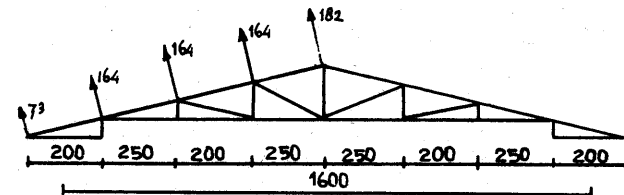
II = $\frac{1}{2} \cdot 2 \cdot 0,0706 \cdot 4 \cdot 35 \cdot [0,5] = 72,471 = 73 \text{ kg}$

III = $\frac{1}{2} \cdot [2 \cdot 0,0706 + 2,59] \cdot 4 \cdot 35 \cdot [0,5] = 163,121 = 164 \text{ kg}$

IV = $\frac{1}{2} \cdot [2 \cdot 0,0706 + 2,59] \cdot 4 \cdot 35 \cdot 0,5 = 163,121 = 164 \text{ kg}$

V = $\frac{1}{2} \cdot [2 \cdot 0,0706 + 2,59] \cdot 4 \cdot 35 \cdot 0,5 = 163,121 = 164 \text{ kg}$

VI = $\frac{1}{2} \cdot [2,59 + 2,59] \cdot 4 \cdot 35 \cdot 0,5 = 181,3 = 182 \text{ kg}$



TABEL KUDA-KUDA K_1

No.	MUATAN TETAP [I]	MUATAN ANGIN ISAP [II]	I + II Max.
1.	- 5840	- 1560	- 7400
2.	- 4880	- 1330	- 6210
3.	- 3680	- 1010	- 4690
4.	+ 5680	+ 1620	+ 7300
5.	+ 5580	+ 1620	+ 7300
6.	+ 4768	+ 1350	+ 6118
7.	0	0	0
8.	- 1930	- 280	- 2260
9.	+ 320	+ 95	+ 415

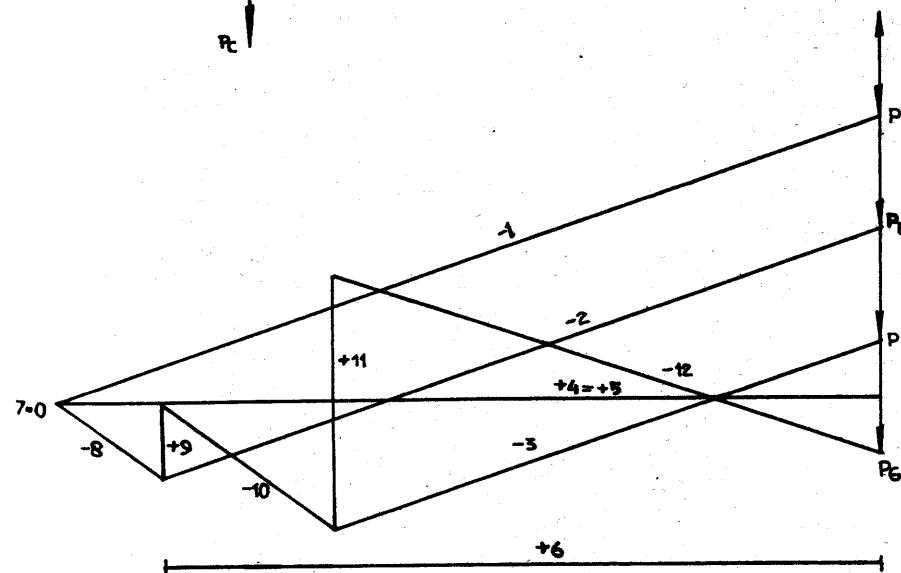
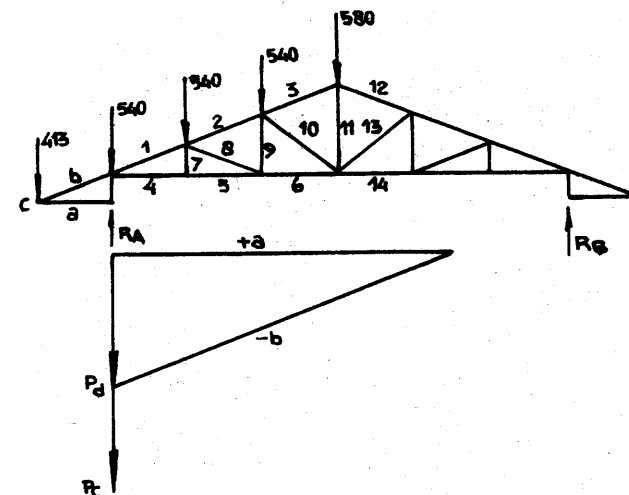
Konst. Kayu/6

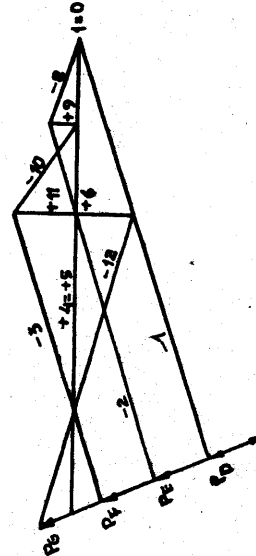
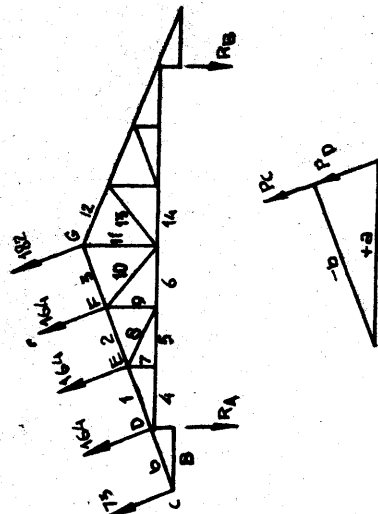
10.	- 1300	- 390	- 1690
11.	+ 1140	+ 370	+ 1210
12.	- 3680	- 1070	- 4705
a.	+ 2160	+ 625	+ 2885
b.	- 2220	- 625	- 2845

BEBAN MATI

No.	[+] tarik	[-] tekan kg
1	-	5840
2	-	4880
3	-	3680
4	5680	-
5	5680	-
6	4768	-
7.	-	980
8	-	980
9	320	-
10	-	1300
11	1140	-
12	-	3680
a	-	-
b	-	2220

Konst. Kayu/7

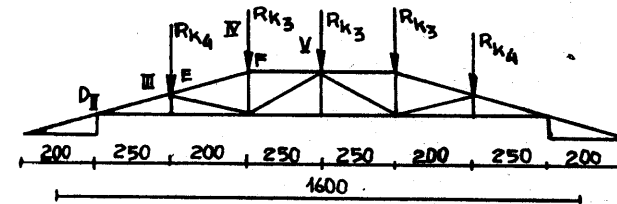




CREMONA ANGIN ISAP K₂

No.	Tarik [+]	Tekan [-]
1	-	1560
2	-	1330
3	-	1010
4	1620	-
5	1620	-
6	1350	-
7	-	-
8	-	280
9	95	-
10	-	390
11	370	-
12	-	1070
a	645	-
b	-	625

KUDA-KUDA K₂



Perhitungan berat K₃ & K₄ sama

Berat rata-rata = $\frac{1}{2} \cdot [2,5 + 2] \cdot 5 = 11,25 \text{ kg/m'}$

[kuda-kuda]

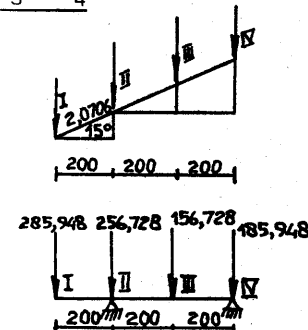
Berat atap [asbes gelombang] = 11 kg/m' [ketentuan] pmi 70

Berat eternit + penggantung = 18 kg/m' ✓

TABEL

No.	Kuda-kuda		Atap		Eternit		Muatan hidup + gording	Pi
	Panjang	Berat	Luas	Berat	Luas	Berat		
I	100	12	2,0706	22,78	2	36	215,168	285,94
II	200	24	4,15	45,56	4	72	115,168	256,73
III	200	24	4,15	45,56	4	72	115,168	256,73
IV	100	12	2,0706	22,78	2	36	215,168	285,94

K₃ & K₄



$$R_A = \frac{256,728 \cdot 2 + 256,728 \cdot 4 + 285,948 \cdot 6}{4}$$

$$= \frac{3256,054}{4} = 814,014 \text{ kg}$$

$$R_B = \frac{185,948 \cdot 4 + 256,728 \cdot 2 + 285,948 \cdot 2}{4}$$

$$= \frac{685,338}{4} = 171,338 \text{ kg}$$

$$\text{Jadi } K_3 + K_4 = R_B$$

I. BEBAN ATAP + GORDING

$$\text{Joint I} \quad P_I = \frac{1}{2} \cdot 2,0706 \cdot 4,11 + 31 = 76,88 \approx 77 \text{ kg}$$

$$\text{Joint II} \quad P_{II} = \frac{1}{2} \cdot [2,0706 + 2,59] \cdot 4,11 + 31 = 134 \text{ kg}$$

$$\text{Joint III} \quad P_{III} = \frac{1}{2} \cdot [2,0706 + 2,59] \cdot 4,11 + 31 = 134 \text{ kg}$$

$$\text{Joint IV} \quad P_{IV} = \frac{1}{2} \cdot [2,0706 + 2,5] \cdot 4,11 + 31 = 131,55 \approx 132 \text{ kg}$$

$$\text{Joint V} \quad P_V = \frac{1}{2} \cdot [2,5 + 2,5] \cdot 4,11 + 31 = 141 \text{ kg}$$

II. BEBAN LANGIT-LANGIT

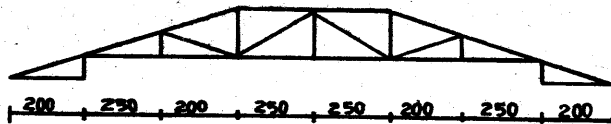
$$\text{Joint I} \rightarrow P_I = \frac{1}{2} \cdot [2 \cdot 4 \cdot 18] = 72 \text{ kg}$$

$$\text{Joint II} \rightarrow P_{II} = \frac{1}{2} \cdot [2 \cdot 4 \cdot 18] + \frac{1}{2} \cdot [2,5 \cdot 4 \cdot 18] = 162 \text{ kg}$$

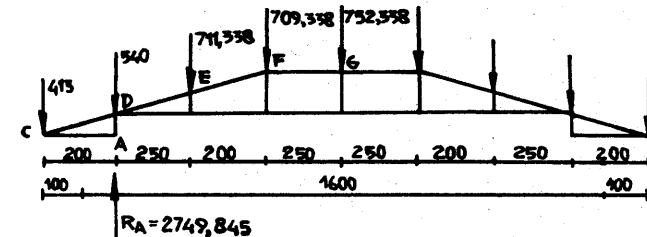
$$\text{Joint III} \rightarrow P_{III} = \frac{1}{2} \cdot [2 \cdot 4 \cdot 18] + \frac{1}{2} \cdot [2,5 \cdot 4 \cdot 18] = 162 \text{ kg}$$

$$\text{Joint IV} \rightarrow P_{IV} = \frac{1}{2} \cdot [2 \cdot 4 \cdot 18] + \frac{1}{2} \cdot [2,5 \cdot 4 \cdot 18] = 162 \text{ kg}$$

$$\text{Joint V} \rightarrow P_V = \frac{1}{2} \cdot [2,5 \cdot 4 \cdot 18] + \frac{1}{2} \cdot [2,5 \cdot 4 \cdot 18] = 180 \text{ kg}$$



BEBAN KUDA-KUDA



Panjang : $l = 16 \text{ m}$.

Jarak kuda-kuda = $b \cdot l = 16 \cdot 4 = 64 \text{ kg/m}$

$$\text{Joint I} \rightarrow P_I = \frac{1}{2} \cdot 2 \cdot 64 = 64 \text{ kg}$$

$$\text{Joint II} \rightarrow P_{II} = \frac{1}{2} \cdot [2 + 2,5] = 144 \text{ kg}$$

$$\text{Joint III} \rightarrow P_{III} = \frac{1}{2} \cdot [2 + 2,5] = 144 \text{ kg}$$

$$\text{Joint IV} \rightarrow P_{IV} = \frac{1}{2} \cdot [2 + 2,5] = 144 \text{ kg}$$

$$\text{Joint V} \rightarrow P_V = \frac{1}{2} \cdot [2,5 + 2,5] = 160 \text{ kg}$$

TOTAL BEBAN MATI [MAX]

Beban [kg]	I	II	III	IV	V
Atap + gording	77	134	134	132	141
Beban langit-langit + penggantung.	72	162	162	162	180
Beban kuda-kuda	64	144	144	144	160
Lain-lain	200	100	100	100	100
	413	540	540	538	581

Pada titik buhul III, IV, V ditambah beban RK_3 & RK_4

$$\text{III} \rightarrow 540 + 171,338 = 711,338 \text{ kg}$$

$$\text{IV} \rightarrow 538 + 171,338 = 709,338 \text{ kg}$$

$$\text{V} \rightarrow 581 + 171,338 = 752,338 \text{ kg}$$

$$R_A = R_B = 2749,845 \text{ kg}$$

MIJATAN ANGIN

$$P = \frac{V^2}{16} \text{ kg/m}^2 \rightarrow \text{Untuk perhitungan diambil } P = 35 \text{ kg/m}^2$$

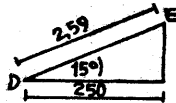
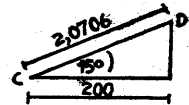
atau $P = 35 \text{ kg/m}^2$ [ditentukan]

Miring atap $15^\circ \rightarrow$ koefisien = $[+0,02 - 0,4]$

Koefisien = $0,02 \cdot 15 - 0,4 = -0,1$ [isap]

Dibelakang angin \rightarrow koefisien = $-0,4$

Koefisien angin isap = $0,4 + 0,1 = 0,5$



$$\cos 15^\circ = \frac{2}{CD} \quad CD = \frac{2}{\cos 15^\circ}$$

$$CD = \frac{2}{0,9659} = 2,0706 \text{ m}$$

$$\cos 15^\circ = \frac{2,5}{DE} \quad DE = \frac{2,5}{\cos 15^\circ}$$

$$DE = \frac{2,5}{0,9659} = 2,588 \Rightarrow 2,59 \text{ m}$$

$$EF = CD = 2,0706 \text{ m}$$

$$FG = DE = 2,59 \text{ m}$$

ANGIN ISAP

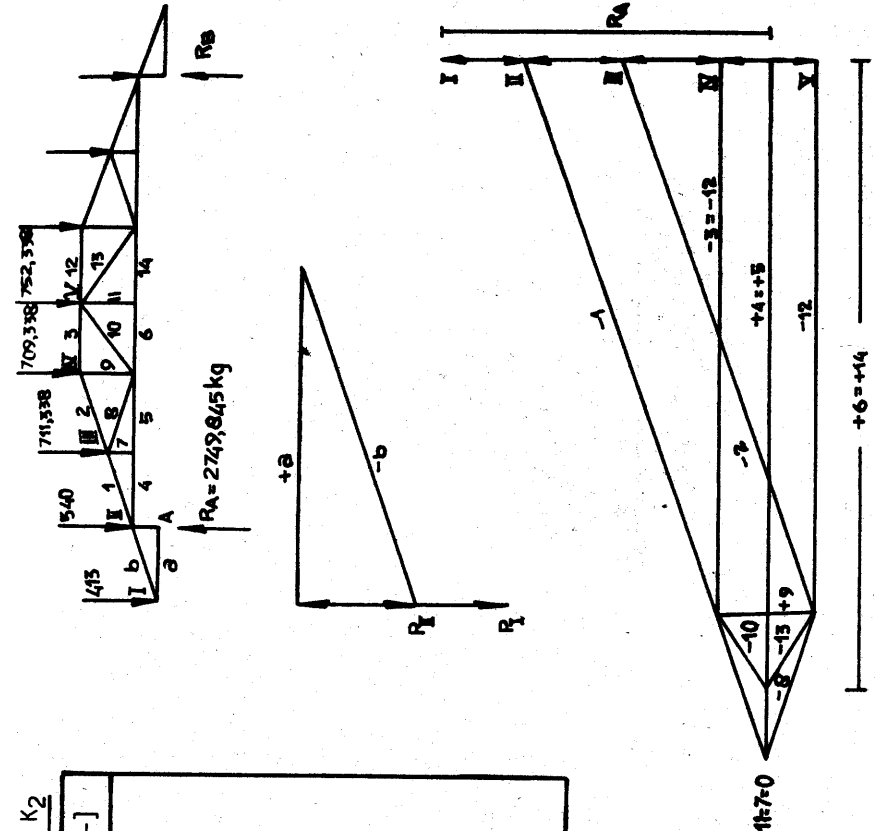
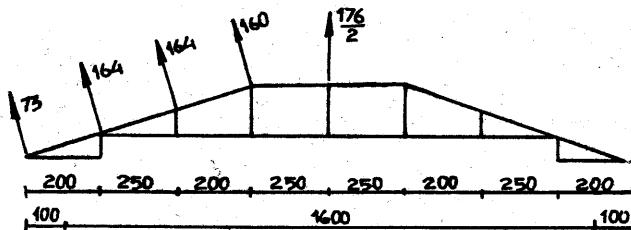
$$P_C = \frac{1}{2} \cdot [2,0706 \cdot 4] \cdot 35 \cdot 0,5 = 72,471 \Rightarrow 73 \text{ kg}$$

$$P_D = \frac{1}{2} \cdot [2,0706 + 2,59] \cdot 4 \cdot 35 \cdot [0,5] = 163,121 \Rightarrow 164 \text{ kg}$$

$$P_E = \frac{1}{2} \cdot [2,59 + 2,0706] \cdot 4 \cdot 35 \cdot [0,5] = 163,121 \Rightarrow 164 \text{ kg}$$

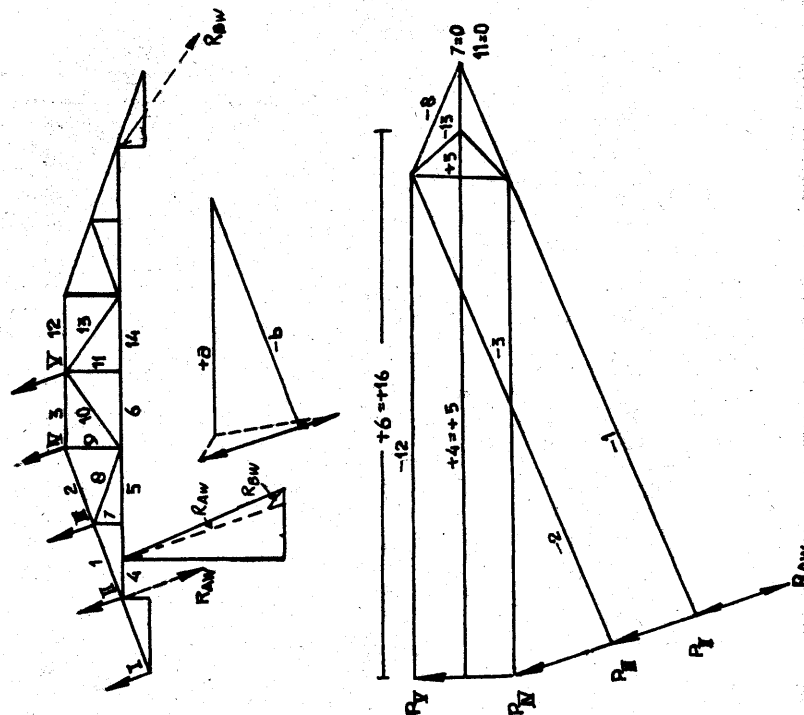
$$P_F = \frac{1}{2} \cdot [2,5 + 2,0706] \cdot 4 \cdot 35 \cdot [0,5] = 159,971 \Rightarrow 160 \text{ kg}$$

$$P_G = \frac{1}{2} \cdot 2,50 \cdot 4 \cdot 35 \cdot 0,5 = 87,5 \Rightarrow 88 \text{ kg}$$



CREMONA BEBAN MATI K2

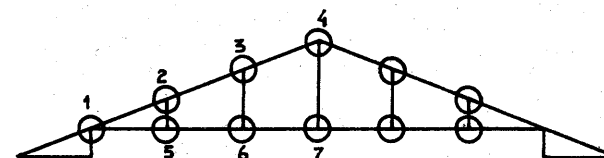
No.	Tarik [+]	Tekan [-]
1	-	7075
2	-	5825
3	-	2650
4	6825	-
5	6825	-
6	6400	-
7	-	-
8	-	1250
9	750	-
10	-	-
11	-	-
12	-	2650
a	2625	-
b	-	2750



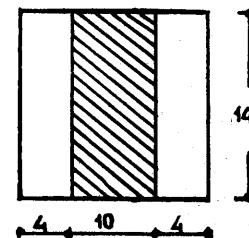
CREMONA ANGIN ISAP K ₂		
No.	Tarikan [+]	Tekan [-]
1	-	1500
2	-	1250
3	-	1250
4	1530	-
5	1530	-
6	1420	-
7	-	300
8	-	165
9	170	-
10	-	1250
11	-	-
12	430	-
a	-	450
b	-	-

No.	MUATAN TETAP [I]	MUATAN ANGIN ISAP [II]	MAX [I + II]
1	- 7075	- 1500	- 8575
2	- 5825	- 1250	- 7075
3	- 2650	- 1250	- 3900
4	+ 6825	+ 1350	+ 8355
5	+ 6825	+ 1350	+ 8355
6	+ 6400	+ 1420	+ 7820
7	0	0	0
8	- 1250	- 300	- 1550
9	+ 750	+ 170	+ 920
10	- 825	- 165	- 990
11	0	0	0
12	+ 2650	+ 1250	+ 3900
a	+ 2625	+ 430	+ 3055
b	- 2750	- 450	- 3200

PERHITUNGAN DEMENSI BATANG



Batang 1 = - 7400 kg.
Fbr = 10.12 = 120 cm



$$l_x = 0,289 \cdot h = 0,289 \cdot 12 = 3,468 \text{ cm}$$

$$1k = \frac{1}{\cos 15^\circ} = \frac{1}{0,9659} \cdot 250 = 258,82 \text{ cm}$$

$$= \frac{1k}{ix} = \frac{258,82}{3,468} = 74,63$$

$$\text{Daftar} = 19 \rightarrow w = 1,97$$

$$= 170 \cdot g = 170 \cdot 0,79 = 134,3 \text{ kg/cm}^2$$

$$= \frac{P \cdot W}{F_{br}} = \frac{7400 \cdot 1,97}{120} = 121,48 \text{ kg/cm}^2 < 134,3 \text{ kg/cm}^2$$

Jadi dipakai kayu mutu A kelas I

Batang 2. = - 6210 kg $\rightarrow l = 200 \text{ cm}$

$$lk = \frac{200}{0,9659} = 207,06 \text{ cm}$$

$$= \frac{lk}{ix} = \frac{207,06}{3,468} = 59,7 \quad \text{daftar 19} \rightarrow w = 1,67$$

$$= 0,75 \cdot 130 = 97,5 \text{ kg/cm}^2$$

$$= \frac{P \cdot W}{F_{br}} = \frac{6210 \cdot 1,67}{120} = 86,42 \text{ kg/cm}^2 < 97,5 \text{ kg/cm}^2$$

Jadi kayu mutu B kelas I

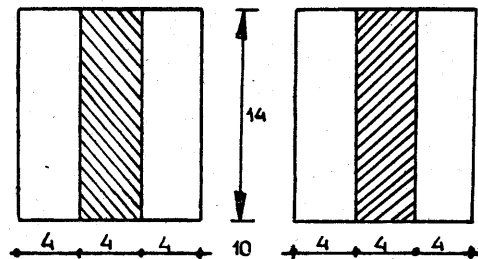
Batang 3. = - 4690 kg.

$$= \frac{4690 \cdot 1,97}{120} = 76,904 \text{ kg/cm}^2 < 97,5 \text{ kg/cm}^2$$

Jadi kayu mutu B kelas I

Batang 4. = + 7300 kg.

Ditinjau pada satu pihak.



$$\frac{1}{2} p = \frac{7300}{2} = 3650 \text{ kg}$$

$$F_n = 0,8 \cdot 4 \cdot 14 = 44,8 \text{ cm}^2$$

$$ix = 0,289 \cdot h = 0,289 \cdot 14 = 4,046 \text{ cm}$$

$$It = \frac{1}{12} \cdot 4^3 \cdot 14 + 4 \cdot 14 \cdot 10^2 = 74,6 + 5600 = 5674,6 \text{ cm}^4$$

$$Ig = \frac{1}{12} \cdot 4^3 \cdot 14 = 74,6 \text{ cm}^4$$

$$I_r = \frac{5674,6}{4} + \frac{3 \cdot 74,6}{4} = 1418,6 + 55,95 = 1474,55 \text{ cm}^4$$

$$I_y = \frac{I_r}{F_n} = \frac{1474,55}{44,8} = 32,91 = 5,54 \text{ cm}$$

$$l = 250 = \frac{l}{ix} = \frac{250}{4,046} = 61,78 \text{ cm}$$

Daftar 19 $\rightarrow w = 1,7$

$$= \frac{\frac{1}{2} P \cdot W}{F_n} = \frac{3650 \cdot 1,7}{44,8} = 132,8 \text{ kg/cm}^2 < 134,3 \text{ kg/cm}^2$$

Jadi dipakai kayu mutu A kelas aI

Batang 5. $l = 200 \text{ cm}$

$$= \frac{l}{ix} = \frac{200}{4,046} = 49,43 \text{ cm}$$

Daftar 19 $= 1,5$

$$= \frac{4650 \cdot 1,5}{44,8} = 122,2 \text{ kg/cm}^2 < 134,3 \text{ kg/cm}^2$$

Jadi dipakai kayu mutu A kelas I

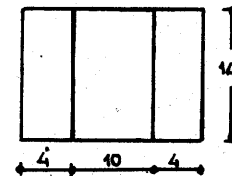
Batang 6 = 6118 $\frac{1}{2} P = 3059$

$$= \frac{\frac{1}{2} P \cdot W}{F_n} = \frac{3059 \cdot 1,7}{44,8} = 116,7 \text{ kg/cm}^2$$

Kayu dipakai mutu A kelas I.

Batang 7,9,11 $7 = 0$

Batang 9 = 415 kg, Batang 11 = 1210 kg



$$F_{br} = 120$$

$$F_n = 0,8 \cdot 120 = 76 \text{ cm}^2$$

$$ix = 0,289 \cdot 12 = 3,468$$

$$It = 2 \cdot 1 \cdot 12 \cdot 4^3 \cdot 12 + 2 \cdot 410 \cdot 12 = 128 + 9600 = 9728 \text{ cm}^4$$

$$Ig = \frac{1}{12} \cdot 12 \cdot 10^3 = 1000 \text{ cm}^4$$

$$I_r = \frac{1}{4} [It + 3 \cdot Ig] = \frac{1}{4} [9728 + 3000] = 3182 \text{ cm}^4$$

$$I_y = \frac{3182}{2 \cdot 4 \cdot 12} = \frac{3182}{96} = 33,25$$

$$\tan 15^\circ \times 650 = 174,135$$

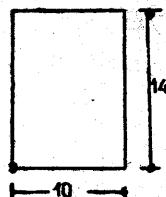
Dipakai $ix = 3,468$

$$= \frac{174,135}{3,468} = 50,2 \rightarrow w = 1,5$$

$$= \frac{P \cdot W}{F_{br}} = \frac{1210 \cdot 1,5}{120} = 15,12 \text{ kg/cm}^2$$

Batang 8,10 $\rightarrow 10/12$

Konst. Kayu/18



Batang 8 = -2260 ; batang 10 = -1690 kg

Tinjauan batang 8 = - 2280 kg

Fbr = 10 . 12 = 120

$$I_{min} = 0,289 \cdot 12 = 3,468$$

$$I_k = 210,9 \longrightarrow \frac{210,9}{3,468} = 60,8 < 61$$

$$\text{Daftar 19} \longrightarrow w = 1,69$$

$$= \frac{p \cdot w}{F_{br}} = \frac{2260 \cdot 1,69}{120} = 31,82 < 60 \text{ kg/cm}^2$$

KONTROL BERAT SENDIRI K₁

Batang	Ukuran [cm]			Volume [cm]	Tegangan yang timbul kg/cm ²	kg/cm ²
	l	b	h			
1	259	10	12	31080	121,48 kg/cm ²	170.g =134 ,3
2	207	10	12	24840		
3	259	10	12	31080		
4	250	4	14	14000		
	250	4	14	14000		
5	200	4	14	11200		
	200	4	14	11200		
6	250	4	14	14000		
	250	4	14	14000		
7	66,9	4	12	3211,2		
	66,9	4	12	3211,2		
8	210,9	10	12	25308		
9	120,9	4	12	5803,2		
	120,9	4	12	5803,2		
10	277,6	10	12	33312		
11	187,5	4	12	9000		
	187,5	4	12	9000		
280048,8						

Konst. Kayu/19

Bj Kayu kruwing rata-rata = 0,79 gram/cm³

Berat sendiri = 280048,8 . 0,79 = 221238,55 gram = 221,24 kg

Berat alat sambung = 3/8" = 0,62 kg/m'

1/2" = 1,08 kg/m'

5/8" = 1,58 kg/m'

3/4" = 1,89 kg/m'

7/8" = 2,2 kg/m'

Total = 7,37 kg/m'

Berat sendiri = $\frac{221,24}{14} = 15,8 \text{ kg/m'}$

Berat baut = 7,37 kg/m'

Berat total = 23,17 < 64 kg/m' [a m a n]

PERHITUNGAN SAMBUNGAN TITIK BUHUL

SAMBUNGAN TITIK BUHUL I

Dipakai : alat sambungan kokot bulldog.

Pelat sambungan berfungsi sebagai : klos, $2 \times 4/12$

$B_j = 0,79$, sudut $\alpha = 15^\circ$

Kayu mutu A kelas I

Gaya tekanan = 7400 kg.

Perhitungan :

$$P = \frac{P}{[1 - 0,25 \sin 15^\circ]} = \frac{7400}{[1 - 0,25 \cdot 0,2588]} = 7911,9 \text{ kg}$$

Kita pilih kokot bulat $2\frac{1}{2}$ baut $5/8"$

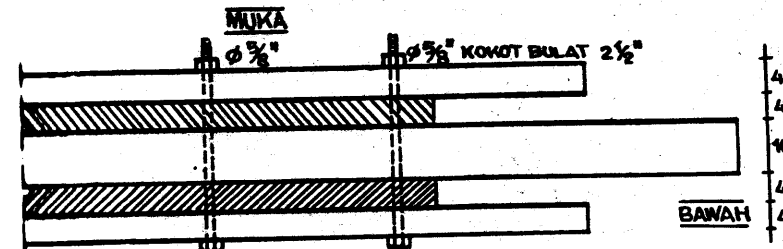
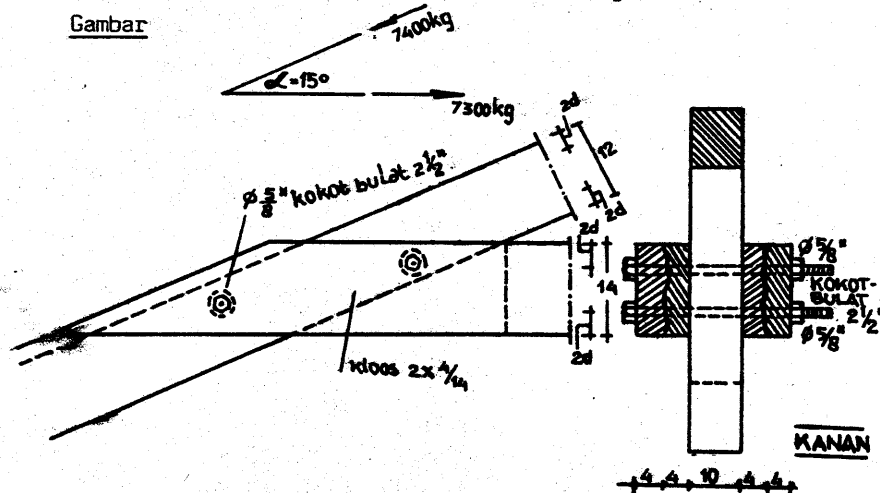
Daftar 18 $p = 0,6 \text{ ton} = 600 \text{ kg}$

$p = 600 \cdot 1,58 = 948 \text{ kg}$

$$n = \frac{P}{p} = \frac{7911,9}{948} = 2\frac{1}{2} \text{ baut } 5/8"$$

Jadi dipakai 8 buah kokot bulldog.

Gambar



SAMBUNGAN TITIK BUHUL II

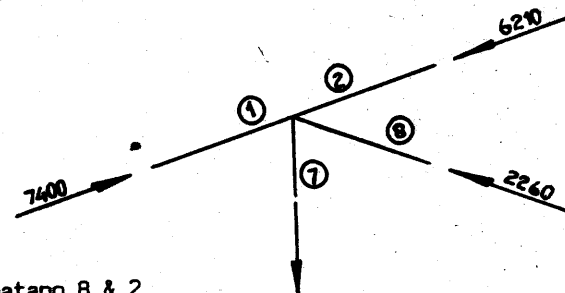
Antara batang 1 & 7

Dipakai : alat sambung bout, pelat sambung $2 \times 4/12$

sedang kayu yang dipakai mutu A kelas I.

= 75° gaya tarik = 0

Dipakai bout 2 buah $3/8"$



Antara batang 8 & 2

Sambungan gigi/takikan = $15^\circ + 18^\circ 30'$

= $33^\circ 30'$, beban tekan = 2260 kg.

Diperhitungkan :

$$t_v = \frac{8}{112 \cdot 0,6} = \frac{2260}{112 \cdot 10} = 2,017 \text{ cm} \approx 2,1 \text{ cm}$$

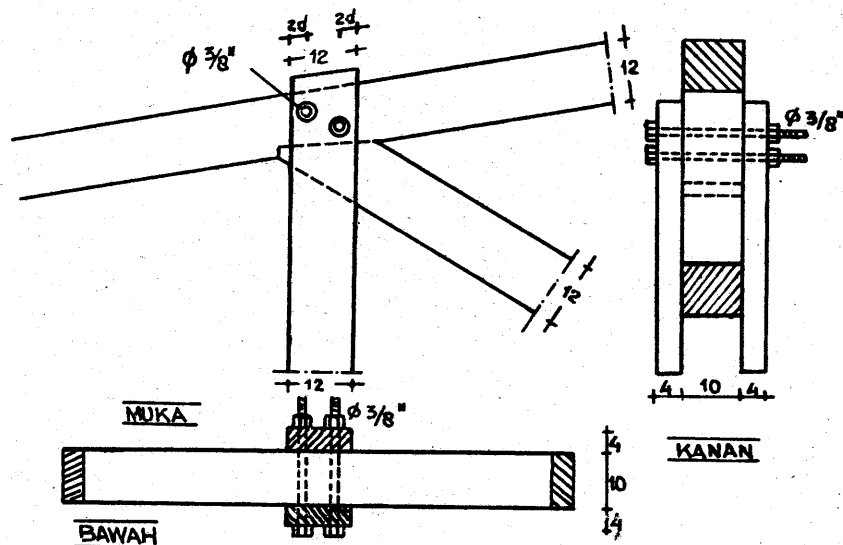
$$t_s = \frac{t_v}{\cos \frac{1}{2} \phi} = \frac{2,1}{\cos \frac{1}{2} [33^\circ 30']} = \frac{2,1}{0,9588} = 2,19 \text{ cm}$$

$$= \frac{s \cdot \cos \frac{1}{2} \phi}{2,19 \cdot 10} = \frac{2260 \cdot 0,9588}{2,19 \cdot 10}$$

$$= \frac{2166,888}{21,9} = 98,94 \text{ kg/cm}^2$$

Jadi = $98,94 \text{ kg/cm}^2 < 102,91 \text{ kg/cm}^2$

Gambar



SAMBUNGAN TITIK BUHUL III

Tinjau batang antara 2 & 9

Dipakai alat sambung bout kayu ; 2 x 4/12 sudut = 75°

Gaya tarik = 415 kg, kayu mutu A kelas II.

Diperhitungkan : golongan I tampang II.

$$P = 125 \cdot 0,95 \cdot 10 [1 - 0,6 \sin 75^\circ]$$

$$= 125 \cdot 0,95 \cdot 10 [1 - 0,6 \cdot 0,9659] = 1187,5 \cdot 0,386 = 458,8 \text{ kg}$$

$$P = 250 \cdot 0,95 \cdot 4 [1 - 0,6 \sin 75^\circ] = 250 \cdot 0,95 \cdot 4 [1 - 0,6 \cdot 0,9759]$$

$$= 366,7 \text{ kg}$$

$$P = 480 \cdot [0,95]^2 \cdot [1 - 0,35 \sin 75^\circ]$$

$$= 480 \cdot 0,902 \cdot 0,627 = 271,79 \text{ kg}$$

$$n = \frac{P}{p} = \frac{415}{271,79} = 1,52 \rightarrow 2 \text{ buah}$$

Jadi dipakai baut 3/8" → 2 buah

Antara batang 3 & 10

Dipakai alat sambungan "Kokot bulldog" sudut = 15° + 25°30' = 40°30'

$$\text{Koefisien} = \frac{0,79}{0,5} = 1,58$$

Gaya tekan = 1690 kg.

Diperhitungkan.

$$p = \frac{P}{[1 - 0,25 \sin 40^\circ 30']} = \frac{1690}{[1 - 0,25 \cdot 0,6494]}$$

$$= \frac{1690}{0,637} = 2019,1 \text{ kg}$$

Dipilih kokot bulat 2 1/2" baut 5/8"

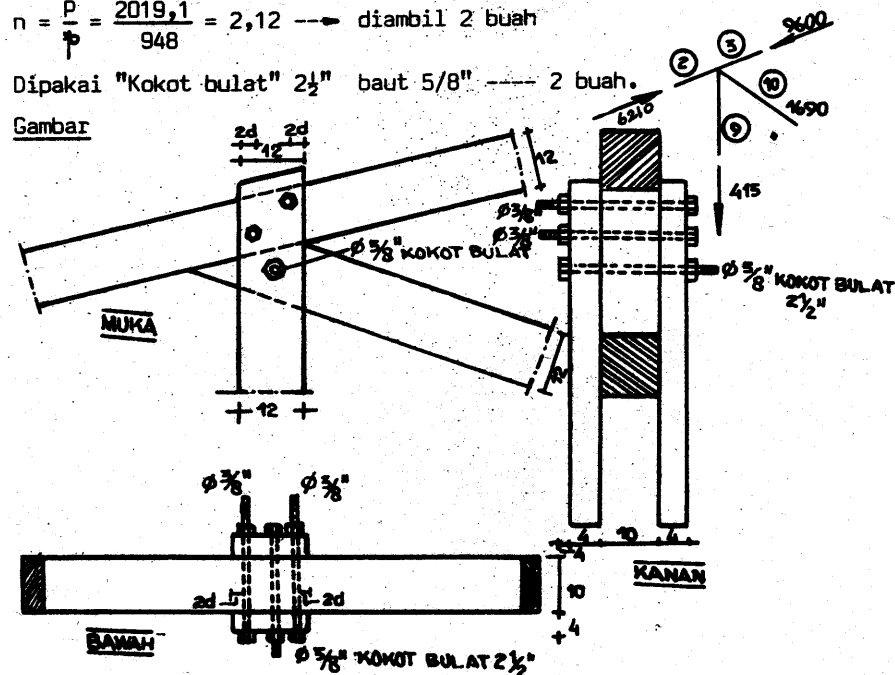
p = 0,6 ton = 600 kg

= 1,58 \cdot 600 = 948 kg.

$$n = \frac{P}{p} = \frac{2019,1}{948} = 2,12 \rightarrow \text{diambil 2 buah}$$

Dipakai "Kokot bulat" 2 1/2" baut 5/8" — 2 buah.

Gambar



SAMBUNGAN TITIK BUHUL IV

Dipakai alat sambungan "bout", kayu mutu B kelas II, sudut α = 75°

Gaya tarik = 1210 kg [p] m = 10 cm. l = 4 cm. kelas ukuran 10/12

Diperhitungkan :

Golongan II , tampang II

Dipilih baut $\frac{1}{2}$ "

$$P = 125.1,27.10 [1 - 0,6 \sin 75^\circ] \\ = 125.1,27.10.0,42046 = 667,48 \text{ kg}$$

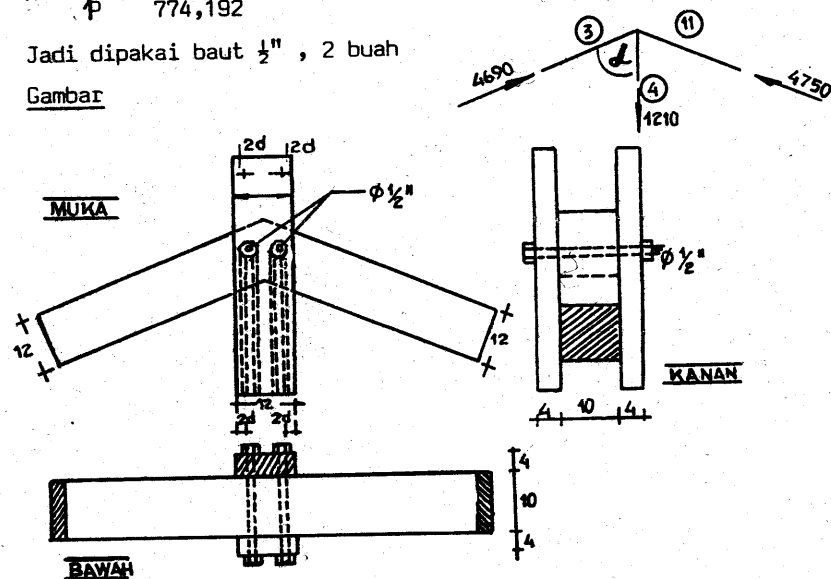
$$P = 250.1,27.4 [1 - 0,6.0,9695] \\ = 250.1,27.4.0,42046 = 333,98 \text{ kg}$$

$$P = 480.1,27^2 \cdot [1 - 0,35.0,9659] = 774,192 \text{ kg}$$

$$n = \frac{P}{p} = \frac{1210}{774,192} = 1,56 \text{ } \cup \text{ 2 buah}$$

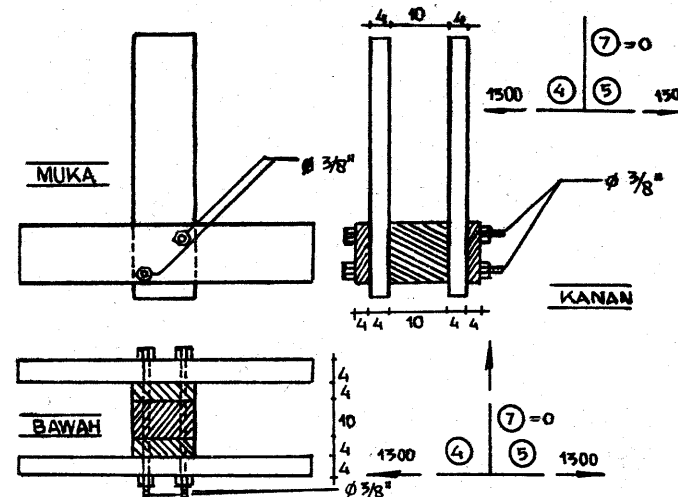
Jadi dipakai baut $\frac{1}{2}$ " , 2 buah

Gambar



SAMBUNGAN TITIK BUHUL V

Karena batang 7 = 0 , maka kita ambil saja 2 buah baut $\frac{3}{8}$ " dimana supaya konstruksi lebih aman.



SAMBUNGAN TITIK BUHUL VI

Antara batang 8 & 9

Dipakai alat sambung "Kokot bulldog" Bj kayu = 0,9 sedang sudut = $71,7^\circ$.

$$\text{Koefisien} : \frac{0,79}{0,5} \cdot 1 = 1,58 \text{ , gaya tekan} = 2260 \text{ kg}$$

Diperhitungkan :

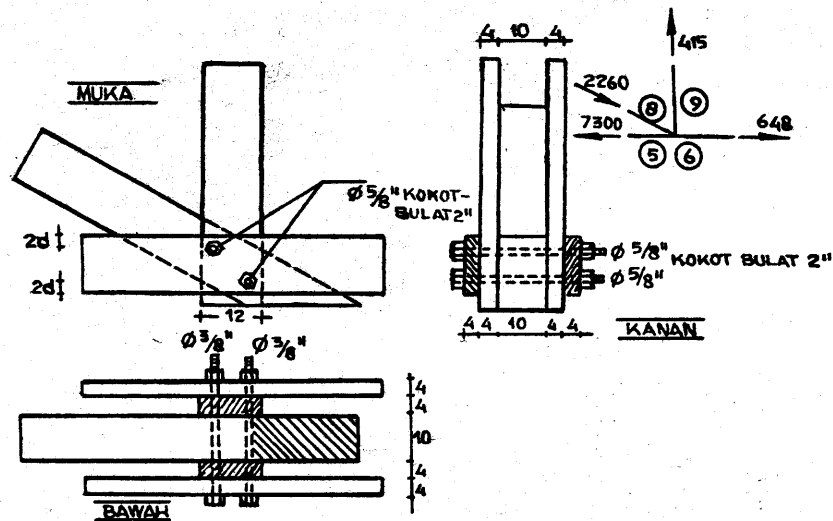
$$P = \frac{P}{[1 - 0,25 \sin 71,7^\circ]} = \frac{2260}{[1 - 0,25.0,9456]} = 2959,6 \text{ kg}$$

Dipilih kokot bulldog 2", baut $\frac{5}{8}$ " P = 0,5 ton = 500 kg

$$P = 1,58.500 = 790 \text{ kg.}$$

$$n = \frac{P}{p} = \frac{2959,66}{790} = 3,793 \text{ } \cup \text{ 4 buah. Diambil 4 buah.}$$

Gambar dibalik.



SAMBUNGAN TITIK BUHUL VII

Antara batang 11 & 13

Dipakai alat sambungan "kokot bulldog" Koefisien = $\frac{0,79}{0,5} \cdot 1 = 1,58$

Gaya tekanan = 1690 kg, sudut = $64^{\circ}30'$.

Diperhitungkan

$$P = \frac{P}{[1 - 0,25 \sin 64^{\circ}30']} = \frac{1690}{[1 - 0,25 \cdot 0,9026]} = 2182,61 \text{ kg}$$

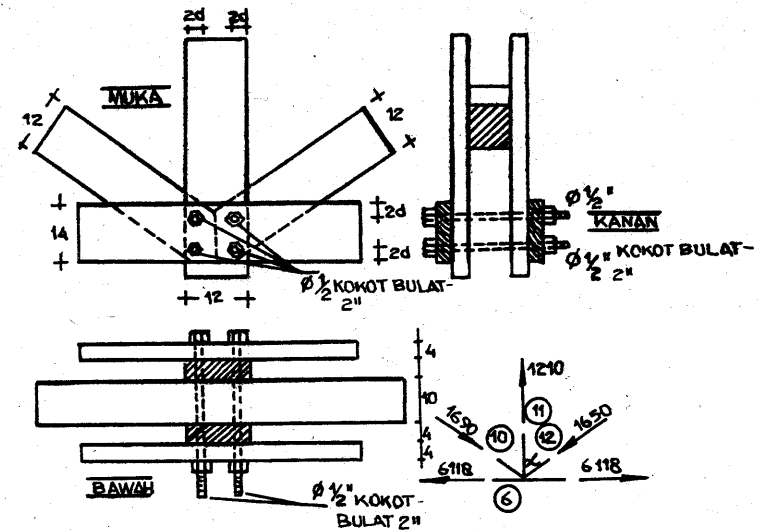
Dipilih kokot bulat 2" $\frac{1}{2}$ daftar 18 — P = 300 kg.

$$P = 300 \cdot 1,58 = 474 \text{ kg}$$

$$n = \frac{P}{P} = \frac{2182,61}{474} = 3,6 \quad \text{S } 4 \text{ buah}$$

Dipakai kokot bulat 2" baut $\frac{1}{2}$ " 4 buah [pihak lain dianggap sama]

Gambar disamping.



SAMBUNGAN KONSOL

Alat sambung baut pelat sambung 2 x 4/14

Kayu mutu A kelas I.

= 2885 kg sudut = 15°

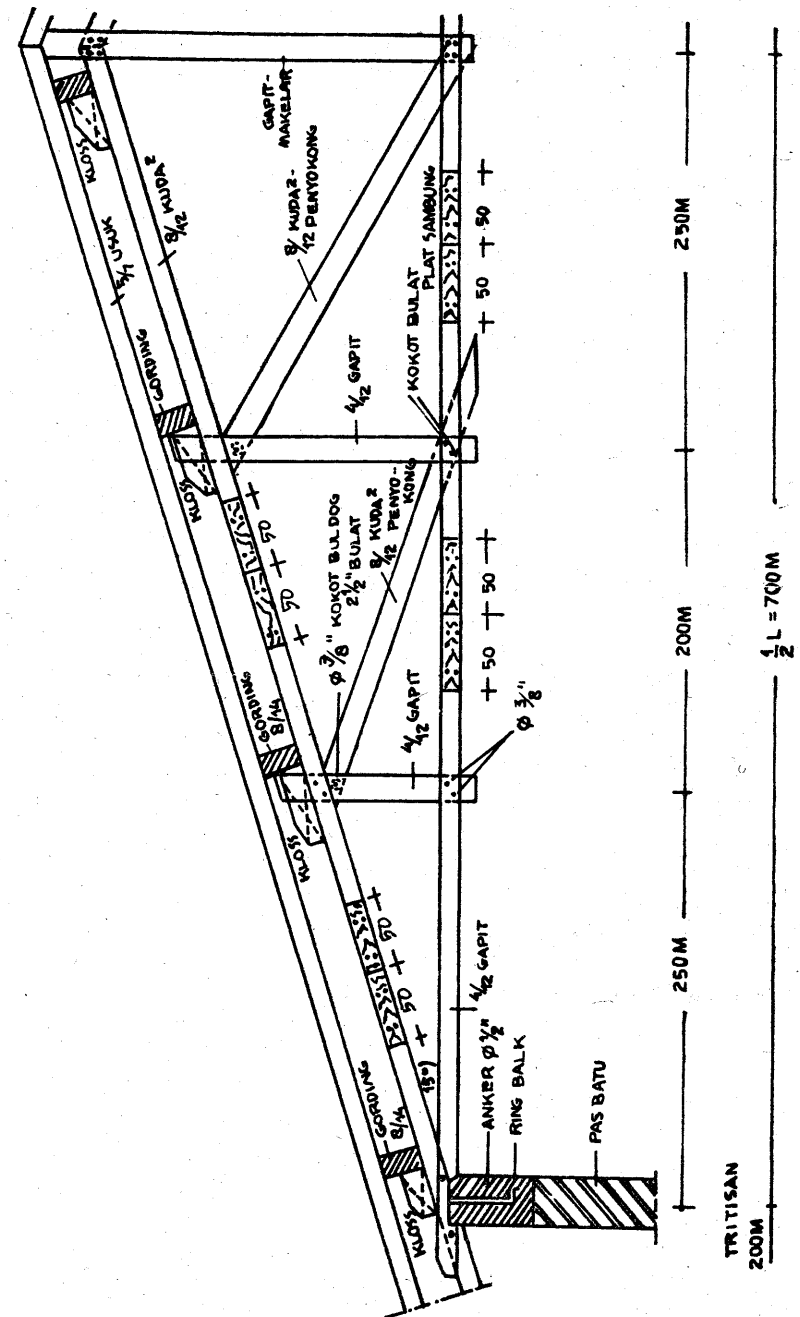
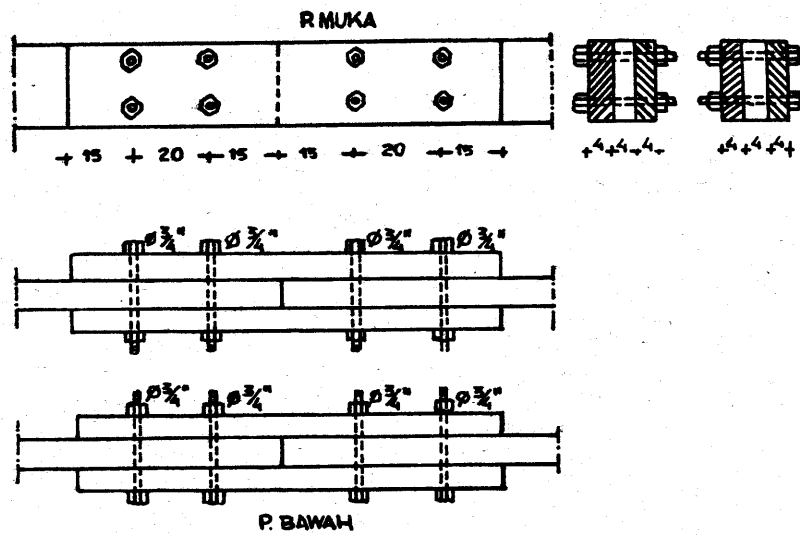
$$P = 125 \cdot 2,2 \cdot 10 [1 - 0,6 \sin 15^{\circ}] = 1858,3 \text{ kg [memenuhi]}$$

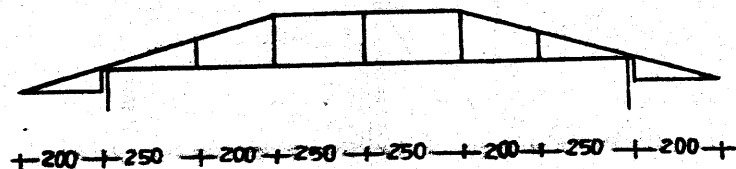
$$P = 250 \cdot 2,2 \cdot 10 [1 - 0,6 \sin 15^{\circ}] = 3716,6 \text{ kg}$$

$$P = 480 \cdot 2,2^2 \cdot [1 - 0,35 \sin 15^{\circ}] = 2113 \text{ kg}$$

Dipakai baut 7/8"

$$n = \frac{S}{P} = \frac{2885}{1858,3} = 1,55 \quad \text{dipakai 2 buah}$$



PERHITUNGAN KUDA-KUDA K₂

DIMENSSI TITIK BUHUL

TITIK BUHUL I

Dipakai alat sambung "kokot bulldog"
pelat sambung 2 x 4/12₂

Kayu mutu A kelas I ukuran kayu 10/12 = 1

Bj kayu = 0,79 Koefisien = $\frac{0,79}{0,5} \times 1 = 1,58$

Sudut = 15° gaya tekan = 8575 kg.

Diperhitungkan

$$P = \frac{P}{[1 - 0,25 \sin 15^\circ]} = \frac{8575}{[1 - 0,25 \cdot 0,2598]} = 9168,18 \text{ kg}$$

Dipilih kokot bulat 3" baut /8

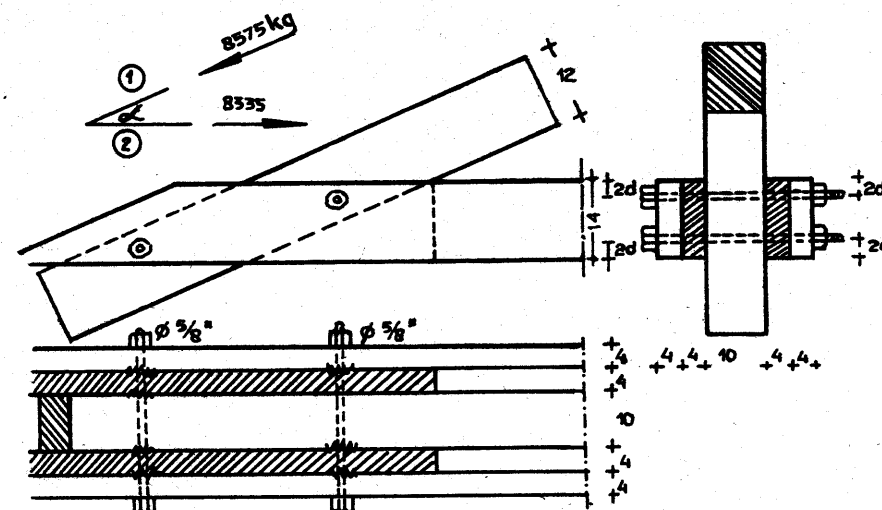
Daftar 18 P = 800 kg.

P = 1,58.800 = 1264 kg.

$$n = \frac{P}{1264} = \frac{9168,18}{1264} = 7,25 \rightarrow \text{diambil 8 buah.}$$

Jadi dipakai " kokot bulat" 3" baut 5/8" 8 buah.

GAMBAR



SAMBUNGAN TITIK BUHUL II

Antara batang 1 & 7

Karena batang tarik no 7 = 0 maka kita ambil saja baut 3/8" 1 buah.

Antara batang 2 & 8

Dipakai alat sambung "kokot bulldog" ukuran kayu 10/12

Ukuran kayu 10/12 = 1. Bj = 0,79, sudut = 33°30'

Koefisien = $\frac{0,79}{0,5} \cdot 1 = 1,58$. Gaya tekan = 1550 kg

Diperhitungkan :

$$P = \frac{P}{[1 - 0,25 \sin 33^\circ 30']]} = \frac{1550}{[1 - 0,25 \cdot 0,5519]} = 1798,14 \text{ kg.}$$

Dipilih kokot bulat 2 1/2" 3/8"

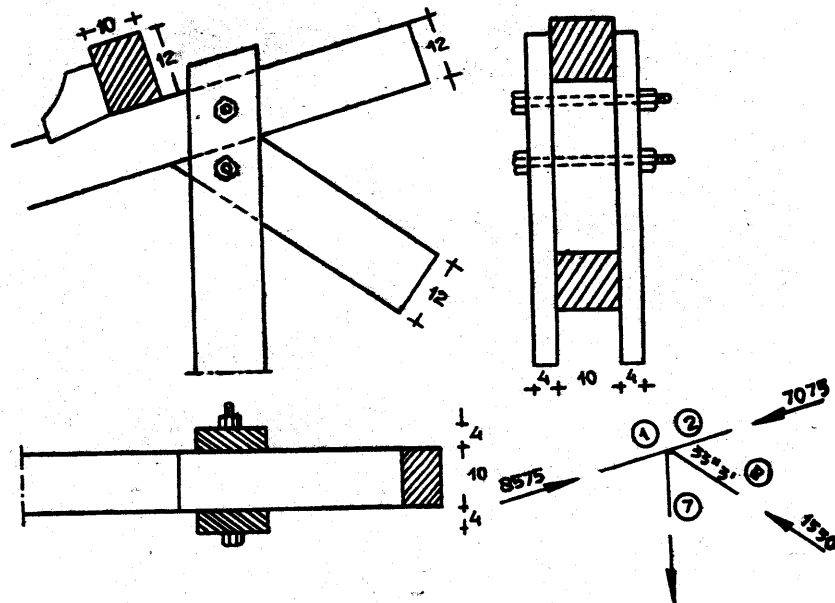
Daftar ; 18 P = 600 kg

P = 1,58.600 = 948 kg

$$n = \frac{P}{P} = \frac{1798,14}{948} = 1,896 \quad \text{diambil 2 buah}$$

Dipakai kokot bulat 2½" baut 5/8" 2 buah.

GAMBAR



SAMBUNGAN TITIK BULUL III

Antara batang 2 & 9

Dipilih alat sambung "kokot bulldog"

Ukuran kayu 10/12 ; Bj = 0,79 = 1

Sudut = 75°, koefisien = 1,58. Gaya tarik = 920 kg.

Diperhitungkan

$$P = \frac{P}{[1 - 0,25 \sin 75^\circ]} = \frac{920}{[1 - 0,25 \cdot 0,9659]} = 1212,92 \text{ kg.}$$

Dipilih kokot bulat 2" baut 5/8

Daftar 18 P = 500 kg.

$$P = 1,58 \cdot 500 = 790 \text{ kg.}$$

$$n = \frac{P}{P} = \frac{1212,92}{790} = 1,535 \quad \text{diambil 2 buah}$$

Jadi dipakai 2 baut 5/8 dua buah.

Antara 3 & 9

Dipakai alat sambung "kokot bulldog" = 90°

Gaya tarik = 900 kg.

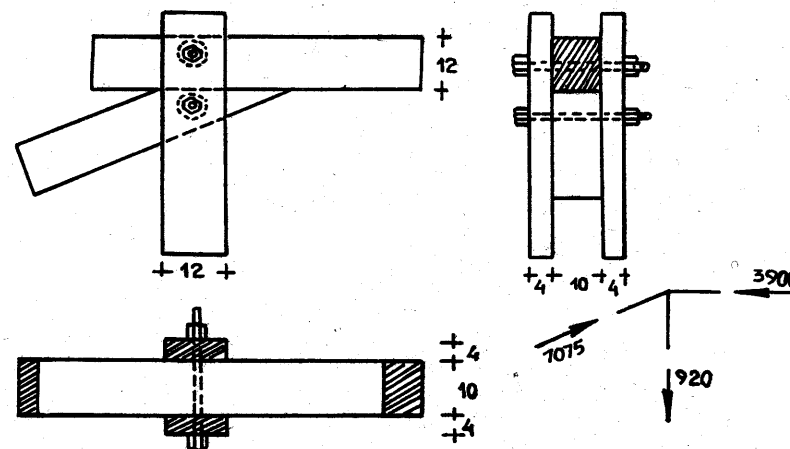
Diperhitungkan :

$$P = \frac{P}{[1 - 0,25 \sin 90^\circ]} = \frac{920}{0,75} = 1226,66 \text{ kg}$$

$$n = \frac{1226,66}{790} = 1,552 \quad \text{diambil 2 buah}$$

Dipakai "kokot bulat" 2" baut 5/8, dua buah.

GAMBAR :



SAMBUNGAN TITIK BUHUL IV.Sambungan antara 3 & 11.

Dipakai alat sambung " kokot bulldog " ukuran kayu 2 x 4/12

$b_j = 0,79$, sudut = 90°

Kayu mutu B ukuran 10/12 gaya tarik tekan = 3900 kg

Koeffisien = 1,58

Diperhitungkan :

$$P = \frac{P}{[1 - 0,25 \sin 90^\circ] \cdot 0,75} = \frac{3900}{0,75} = 5200 \text{ kg}$$

Dipilih " kokot persegi " ; $10 \times 10 \text{ cm}^2$ baut $3/4$

Daftar 18 = 1700 kg $P = 1,58 \cdot 1700 = 2685 \text{ kg}$

$$n = \frac{P}{p} = \frac{5200}{2685} = 1,935 \text{ diambil 2 buah.}$$

Dipakai " kokot persegi 10×10 baut $3/4$ " 2 buah.

Sambungan antara 11 & 13.

Kayu mutu B kelas kuat II ukuran 10/12 $B_j = 0,79$

Sudut = $64^\circ 30'$ dengan gaya tekan = 990 kg

Golongan I tampang II.

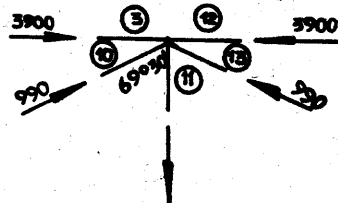
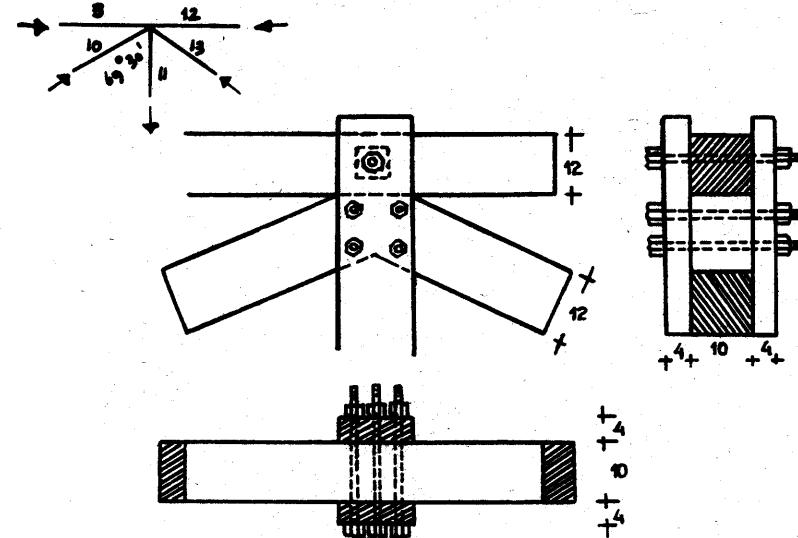
$$P = 125 \cdot 1,27 \cdot 10 [1 - 0,6 \sin 64^\circ 30'] = 733,5 \text{ kg}$$

$$P = 250 \cdot 1,27 \cdot 4 [1 - 0,6 \sin 64^\circ 30'] = 582,2 \text{ kg}$$

$$P = 480 \cdot [1,27]^2 [1 - 0,35 \cdot 0,9026] = 529,5 \text{ kg.}$$

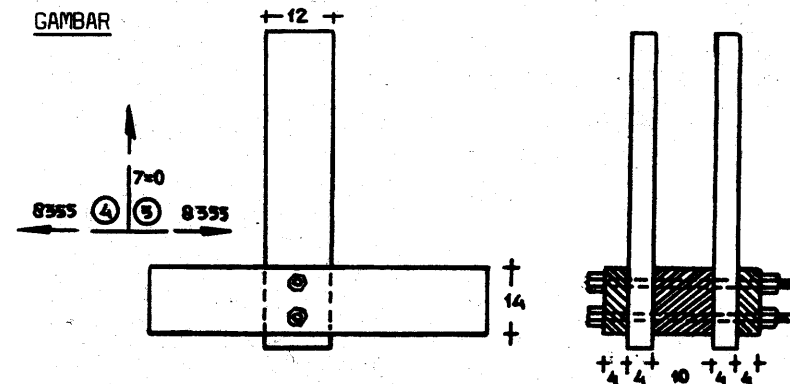
$$n = \frac{990}{529,5} = 1,869 \quad 2 \text{ buah}$$

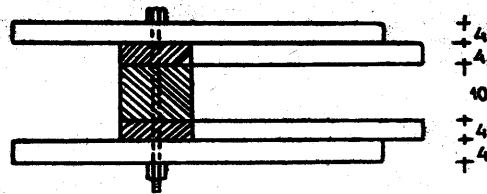
Jadi untuk batang 10 & 11 diambil jumlah baut 2 buah $\frac{1}{2}$ " 2 buah

GAMBARSAMBUNGAN TITIK BUHUL VSambungan antara 4 & 7

Karena gaya pada batang 7 = 0

Maka kita ambil baut $5/8$ " 2 buah supaya konstruksi lebih aman.

GAMBAR



SAMBUNGAN TITIK BUKUL VI

Sambungan antara 5 & 8

Dipakai alat sambung "baut" sudut = $18^{\circ}30'$
 Gaya tekan = 1550 kg.

Diperhitungkan :

Golongan I tampak II.

$$P = 125 \cdot 1,27 \cdot 10 [1 - 0,6 \sin 18^{\circ}30'] = 1285,2 \text{ kg}$$

$$P = 250 \cdot 1,27 \cdot 4 [1 - 0,6 \sin 18^{\circ}30'] = 1028,19 \text{ kg}$$

$$P = 480 \cdot 1,27^2 \cdot [1 - 0,35 \cdot 0,3173] = 688,2 \text{ kg}$$

$$n = \frac{1550}{688,2} = 2,3 \text{ diambil baut } \frac{1}{2}"$$

Sambungan antara 9 & 10

Gaya batang tekan = 990 kg sudut $64^{\circ}30'$

Diperhitungkan :

Golongan I tampak I.

$$P = 125 \cdot 1,27 \cdot 10 [1 - 0,6 \sin 64^{\circ}30'] = 733,5 \text{ kg}$$

$$P = 250 \cdot 1,27 \cdot 4 [1 - 0,6 \cdot 0,9026] = 582,2 \text{ kg}$$

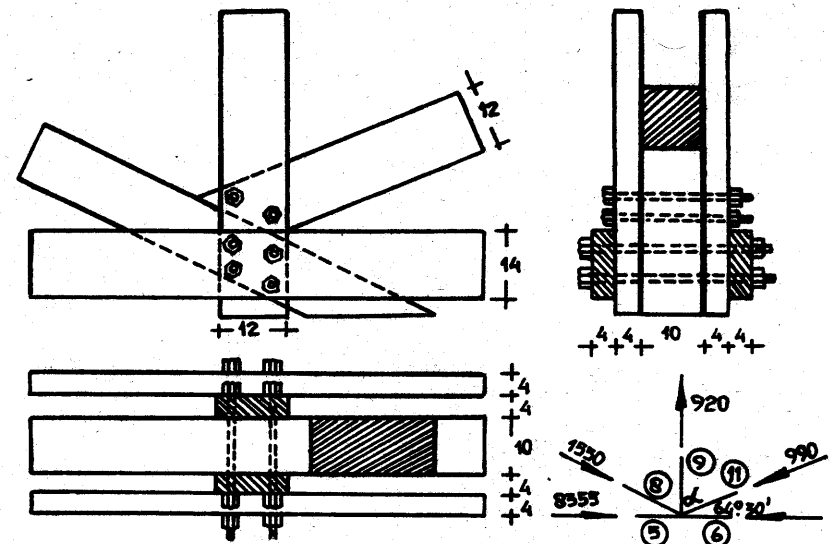
$$P = 480 \cdot 1,27^2 \cdot [1 - 0,35 \cdot 0,9026] = 529,5 \text{ kg}$$

Dipilih baut $\frac{1}{2}"$

$$n = \frac{P}{P'} = \frac{990}{529,5} = 1,869 \text{ diambil 2 buah}$$

Jadi dipakai baut $\frac{1}{2}"$ 2 buah.

GAMBAR



SAMBUNGAN KONSUL

Dipakai alat sambung "baut" pelat sambung $2 \times 4/14$

Kayu mutu A kelas I gaya $S = 3055 \text{ kg}$.

$$P = 125 \cdot 2,2 \cdot 10 [1 - 0,6 \sin 15^{\circ}] = 1858,3 \text{ kg}$$

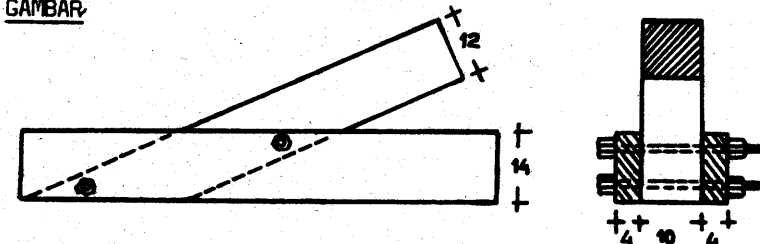
$$P = 250 \cdot 2,2 \cdot 10 [1 - 0,6 \sin 15^{\circ}] = 3716,6 \text{ kg}$$

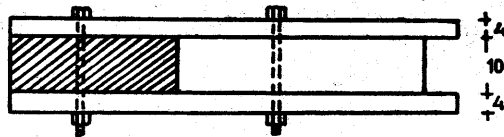
$$P = 480 \cdot [2,2]^2 [1 - 0,35 \cdot 0,2588] = 2113 \text{ kg}$$

$$n = \frac{S}{P} = \frac{3055}{1858,3} = 1,64 \text{ diambil 2 buah}$$

Jadi dipakai baut $7/8$ [diameter] 2 buah.

GAMBAR





SAMBUNGAN BALOK 10/12

Masing-masing gaya tekan s_1 & s_2 ; $s_1 = 8175$ kg , $s_2 = 7075$ kg.

Dipakai alat sambung "baut" pelat sambung 2 x 4/12

Kayu mutu A kelas kuat I.

$$P = 125 \cdot 1,91 \cdot 10 = 2387,5 \text{ kg}$$

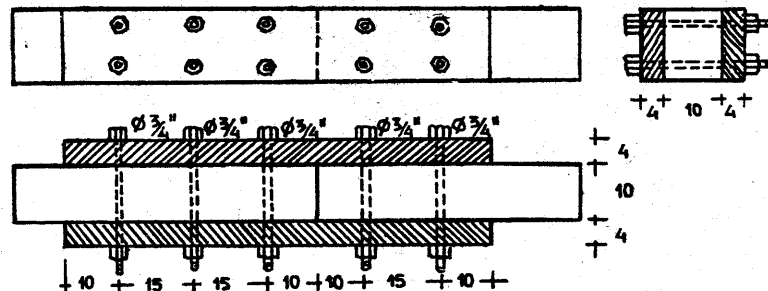
$$P = 250 \cdot 1,91 \cdot 4 = 1910 \text{ kg}$$

$$P = 480 \cdot [1,91]^2 = 1751,1 \text{ kg}$$

$$n = \frac{s_1}{P} = \frac{8175}{1751,1} = 4,66 \text{ diambil 6 buah}$$

$$n = \frac{s_2}{P} = \frac{7075}{1751,1} = 4,003 \text{ diambil 4 buah}$$

GAMBAR



SAMBUNGAN BALOK 4/14

Dipakai alat sambung "baut" pelat sambung 2 x 4/14

Kayu mutu A kelas kuat I gaya tarik $s_1 = 8355$ kg, $s_2 = 8355$ kg.

Golongan I irisan II.

$$P = 125 \cdot 2,2 \cdot 4 = 1100 \text{ kg}$$

$$P = 250 \cdot 2,2 \cdot 4 = 2200 \text{ kg}$$

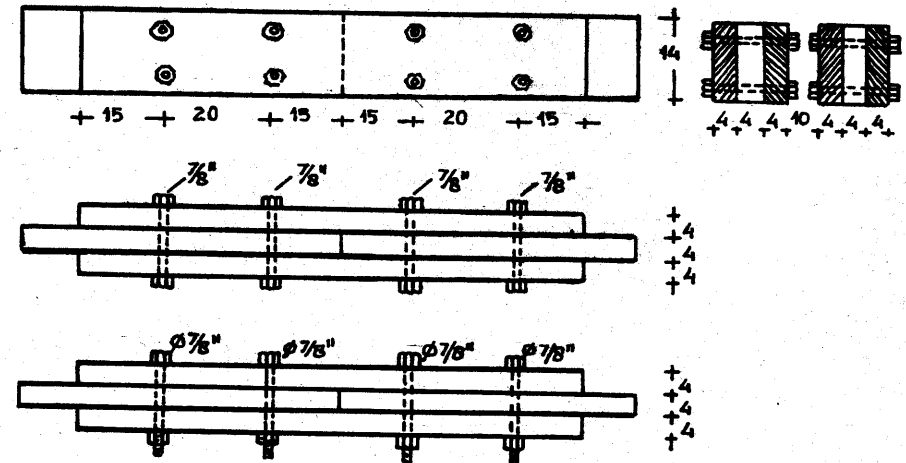
$$P = 480[2,2]^2 = 2323,2 \text{ kg}$$

Dipilih baut $7/8"$ untuk sepihak $S = \frac{1}{2} S$

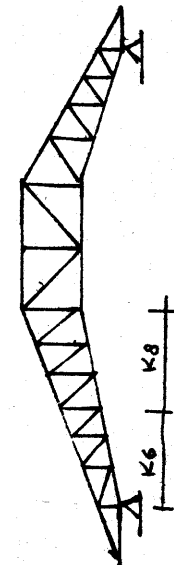
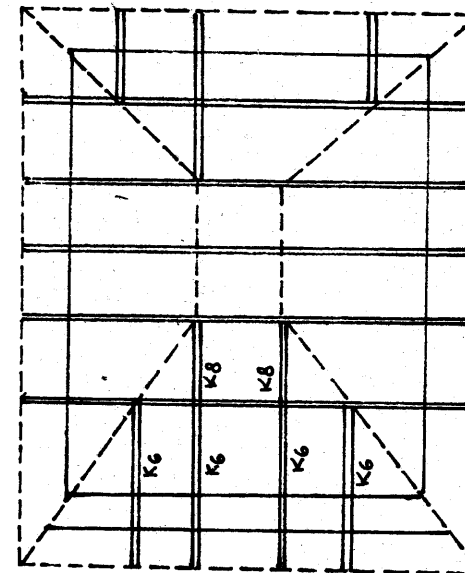
$$n = \frac{\frac{1}{2} S}{P} = \frac{\frac{1}{2} \cdot 8355}{1100} = 3,797 \text{ diambil 4 buah}$$

Jadi dipakai $7/8"$ 4 buah dan 4 buah [$S_1 = S_2$]

GAMBAR



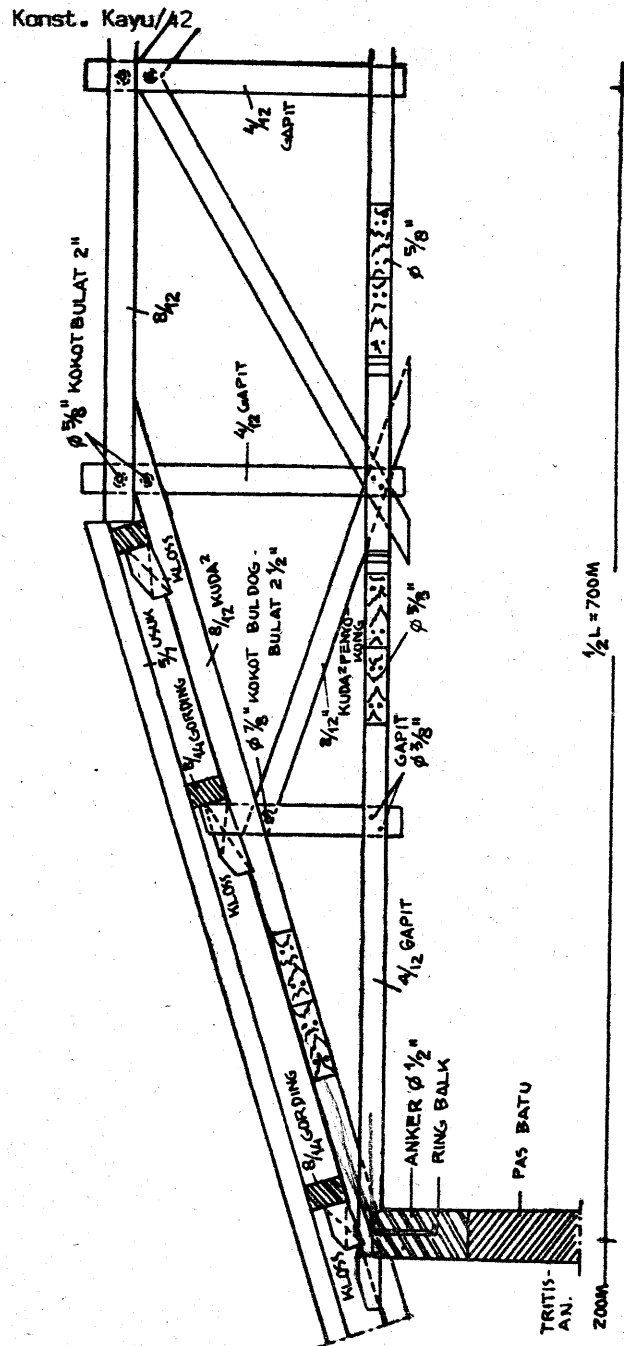
KONSTRUKSI RANGKA ATAP KAYU



KETENTUAN : - Kayu jati

- Sambungan baut dan gigi

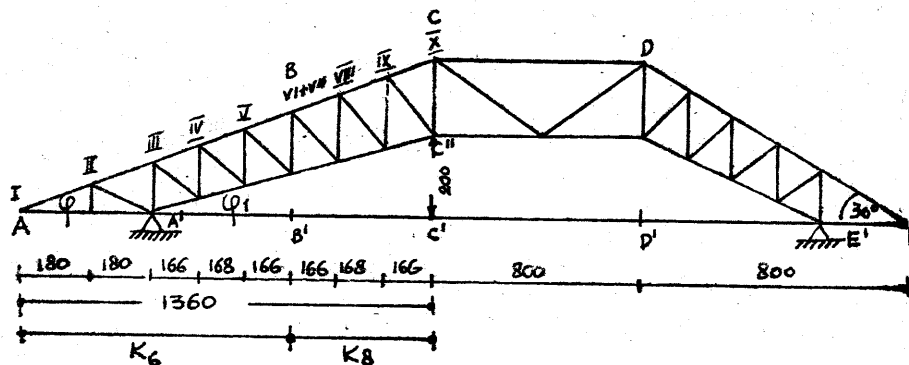
- Atap sirap, langit-langit kayu tebal - 1 cm.



SOAL : K₆ & K₈ (Rencana Kuda-kuda) Type I.

SYARAT : Dasar perhitungan : PMI 1970 N 1 - 18

PERHITUNGAN BAGIAN2 LUAS



$$AC' = 2.180 + 4.166 + 2.163 = 1360 \text{ cm}$$

$$C'D = 2.400 = 800 \text{ cm}$$

$$D'E = 4.150 + 200 = 800 \text{ cm}$$

$$\cos \varphi = \frac{1360}{14630,33} = 0,9468576$$

$$\varphi = 18^{\circ} 45'$$

$$\cos \varphi_1 = \frac{1000}{1049,8039} = 0,9805806$$

$$A'C'' = \sqrt{1000^2 + 200^2} = 1019,8039$$

$$DE = \frac{D'E}{0,8660} = 924 \text{ cm}$$

$$DD' = CC' = DE \sin 30^{\circ} = 462 \text{ cm}$$

$$AC = 1860^2 + 462 = 1438,33 \text{ cm}$$

= Beban atap yang dipikul = 3,5 m.

BAGIAN	PERHITUNGAN	PANJANG 1 m	LUAS 1 m ²
sisi atas K ₆ : I	0,90 0,9468576	0,95051251	3,3267977
II	1,73 0,9468576	1,9010252	6,6535882
III	1,67 0,9468576	1,8270962	6,3948367
IV	1,67 0,9468576	1,7637287	6,1730504
V	1,67 0,9468576	1,7637287	6,1730504
VI	0,83 0,9468576	0,87658376	3,0680431
sisi atas K ₈ : VII	0,83 0,9468576	0,87658376	3,0680432
VIII	1,76 0,9468576	1,7637287	6,1730504
IX	1,67 0,9468576	1,7637287	5,3363804
X	0,83 0,9468576	0,8765837	2,0297131

BAGIAN	PERHITUNGAN	PANJANG 1 m	LUAS 1 m ²
sisl bawah K ₆ : I	0,90	0,90	3,15
II	1,80	1,80	6,30
III	$\frac{0,83}{0,980806} + 0,90$	1,7462427	6,1118494
IV	$\frac{1,67}{0,980806}$	1,7026812	5,9593842
V	$\frac{1,67}{0,980806}$	1,7026812	5,9593842
VI	$\frac{0,83}{0,980806}$	0,84624278	2,9618497
VII	$\frac{0,83}{0,980}$	0,84624278	2,9618497
VIII	$\frac{1,67}{0,980806}$	1,7026812	5,9593842
IX	$\frac{1,67}{0,980806}$	1,7026812	5,9593842
X	$\frac{0,83}{0,980806}$	0,84624278	2,9618497

PERHITUNGAN MUATAN ANGIN.

$$\varphi = 18^{\circ}45' = 18,75^{\circ}$$

Menurut PMI tahun 1970 halaman 13.

$$\text{Koefisien beban} = 0,02 - 0,4 = 0,372 - 0,4 = -0,025 \text{ (isap juga).}$$

$$\text{Koefisien isap} = 0,4$$

$$\text{Jadi koefisien isap} = 0,4 + 0,025 = 0,425$$

$$\text{Muatan angin menurut PMI '70 halaman 11} \rightarrow 25 \text{ kg/m}^2$$

Jadi untuk :

$$K_6 : P_I = 0,425 \cdot 25 \cdot 3,3267937 = 35,347183 \text{ kg.}$$

$$P_{II} = 0,425 \cdot 25 \cdot 6,6535882 = 70,694374 \text{ kg.}$$

$$P_{III} = 0,425 \cdot 25 \cdot 6,3948367 = 67,945139 \text{ kg.}$$

$$P_{IV} = 0,425 \cdot 25 \cdot 6,1730504 = 65,58866 \text{ kg.}$$

$$P_V = 0,425 \cdot 25 \cdot 6,1730504 = 65,58866 \text{ kg.}$$

$$P_{VI} = 0,425 \cdot 25 \cdot 3,0680431 = 32,597957 \text{ kg.}$$

$$K_8 : P_{VII} = 0,425 \cdot 25 \cdot 3,0680431 = 32,597957 \text{ kg.}$$

$$P_{VIII} = 0,425 \cdot 25 \cdot 6,1730504 = 65,58866 \text{ kg.}$$

$$P_{IX} = 0,425 \cdot 25 \cdot 5,3363804 = 56,699041 \text{ kg.}$$

$$P_X = 0,425 \cdot 25 \cdot 2,0297131 = 21,565701 \text{ kg.}$$

$$\text{NB : Berat langit} = 0,082 \text{ t/m}^2 = 8,2 \text{ kg/m}^2.$$

$$\text{Penggantung langit-langit untuk } K_6 \text{ \& } K_8 = 7 \text{ kg.}$$

$$\begin{aligned} \text{Jadi berat langit-langit + pengganti untuk} \\ (K_6 \text{ \& } K_8) &= (8,2 + 7) \\ &= 15,2 \text{ kg.} \end{aligned}$$

Perhitungan muatan atap.

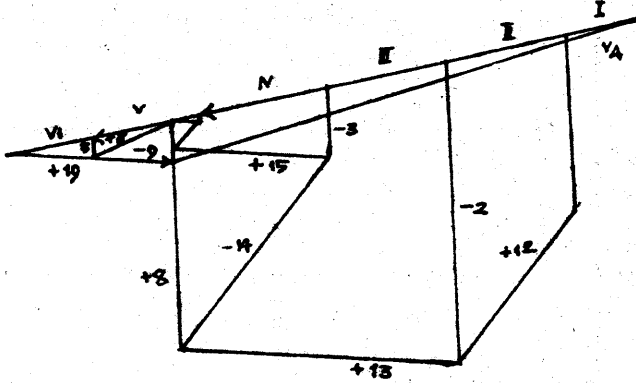
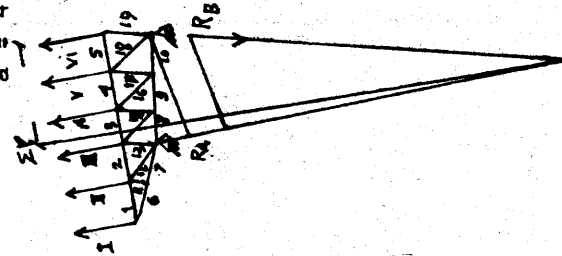
- atap sirap lengkap usuk atau reng = 40 kg/m^2 .
- berat kuda-kuda = 40 kg/m^2 (minimum)
- berat langit-langit = $1 \times 1 \times 0,01 \times 0,82 = 0,0082 \text{ t/m}^2$
= $8,2 \text{ kg/m}^2$.
- berat penggantung langit-langit 7 kg/m^2 (PMI '70)
- jadi berat langit-langit + penggantungnya
= $15,2 \text{ kg/m}^2$.
- berat gording --> kayu yang dipakai ukuran 8/14
gording diletakkan pada titik -
buhul.
Jadi berat gording = $0,08 \cdot 0,14 \cdot 3,5 \cdot 0,82 \cdot t$
= $0,032144 \text{ t} = 32,144 \text{ kg}$.
- muatan hidup untuk atap = $100 \text{ kg/titik buhul}$
(PMI '70)
- jadi pada tiap buhul ditambah muatan sebesar :
 $100 + 32,144 = 132,144 \text{ kg}$.

P	Panjang	Kuda kuda	Luas sisi atas	Penutup atap	Luas sisi bawah	Langit+ penggan- tungnya	Gording+ muatan hidup	Muatan P kg
I	0,9	36	3,326	133,07174	13,15	47,88	132,144	349,09574
II	1,8	72	6,653	266,14352	6,30	95,76	132,144	638,04752
III	1,73	69,2	6,394	255,79346	6,111	92,8872	132,144	550,02466
IV	1,67	66,8	6,173	246,92201	5,959	90,5768	132,144	536,44281
V	1,67	66,8	6,173	246,92201	5,959	90,5768	132,144	536,44281
VI	0,83	33,2	3,068	122,72172	2,968	45,1136	132,144	366,37932
VII	0,83	33,2	3,068	122,72172	2,961	45,0072	132,144	333,07296
VIII	1,67	66,8	6,173	246,92201	5,959	90,5768	132,144	536,44281
IX	1,67	66,8	6,173	213,45521	5,959	90,5768	132,144	502,97601
X	0,83	33,2	3,068	81,18852	2,961	45,0072	132,144	291,53972

K₆ KARENA MUATAN ANGIN ISAP

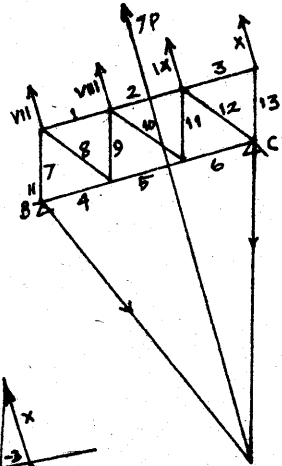
$$a = \frac{I.9,0087461 + II.7,14468541 + III.5,2806247}{337,76195} + \frac{IV.3,3221767 + V.1,1758448}{337,76195}$$

$$a = 4,5258638 \text{ m}$$

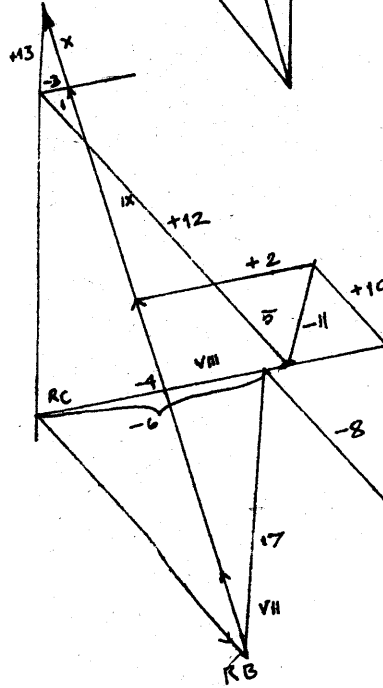


S	P (Kg)
1	-106,125
2	-194,375
3	-48,125
4	-7,5
5	-11,25
6	+107,50
7	+107,50
8	+112,50
9	-6,25
10	-24,375
11	0
12	+116,25
13	+175
14	-133,75
15	+86,25
16	-21,25
17	+15
18	+51,25
19	+85

K₈ KARENA MUATAN ANGIN ISAP

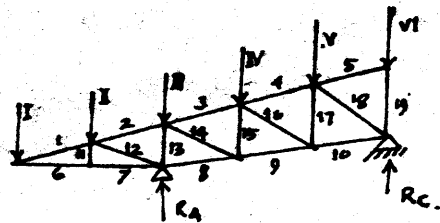


$$a = \frac{VII.5,2806247 + VII.3,5221767}{176,45135} + \frac{IX.1,758448}{176,45135} = 2,8498200 \text{ m.}$$

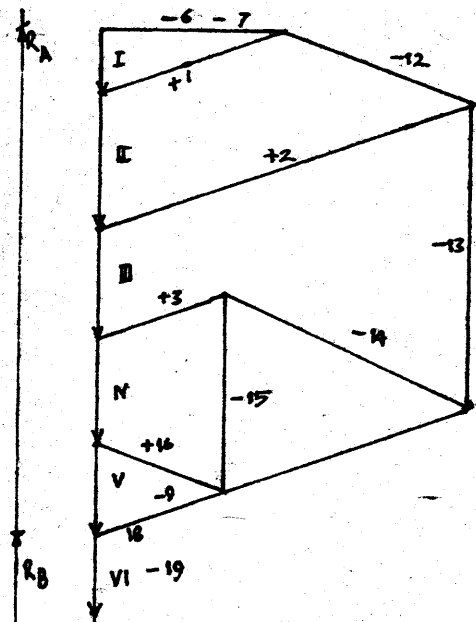


S	P (Kg)
1	+ 43
2	+ 41
3	- 7,25
4	- 59
5	- 89,25
6	- 65
7	+ 74
8	- 42
9	+ 35
10	+ 35,25
11	- 31
12	+ 93,75
13	+ 22,75

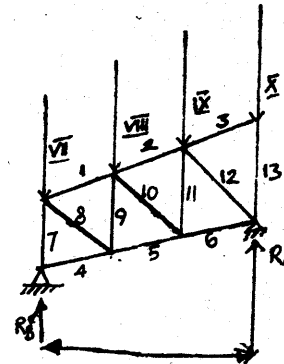
K₆ KARENA MUATAN ATAP



S	P (Kg)
1	+ 1300
2	+ 2,45
3	+ 585
4	0
5	+ 30
6	- 1040
7	- 1040
8	- 2085
9	- 560
10	0
11	0
12	- 1040
13	- 1840
14	+ 1700
15	- 1100
16	+ 660
17	- 475
18	- 70
19	- 366



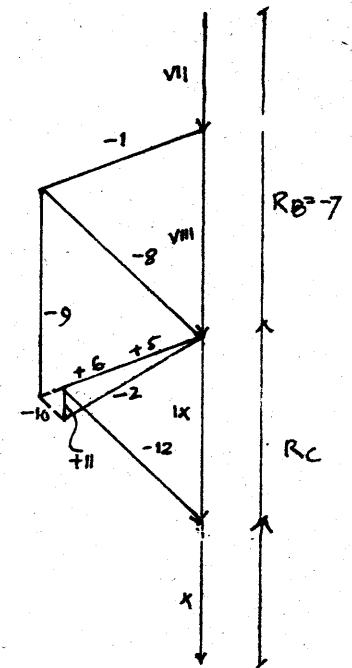
K₆ KARENA MUATAN ATAP



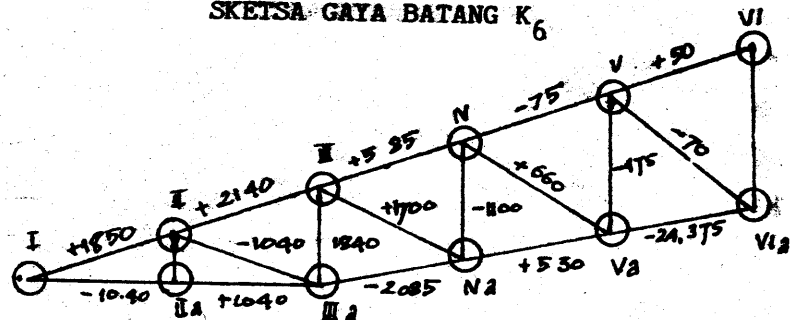
$$R_B = \frac{IX.166 + VIII.334 + VII.500}{500} = 858,40472 \text{ kg.}$$

$$R_C = \frac{VI.166 + IX.334 + IX.500}{500} = 805,62668 \text{ kg.}$$

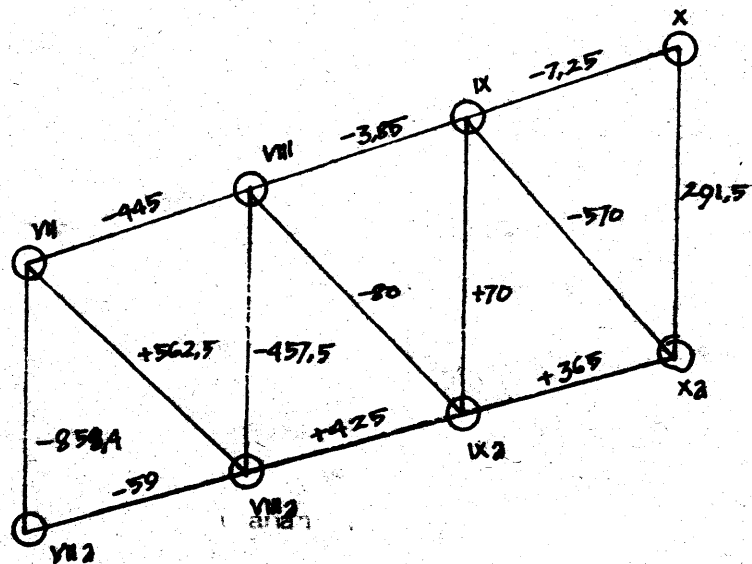
S	P (Kg)
1	- 445
2	- 385
3	0
4	0
5	+ 425
6	+ 365
7	- 858,4
8	+ 562,5
9	- 457,5
10	- 80
11	+ 70
12	- 570
13	- 291,5



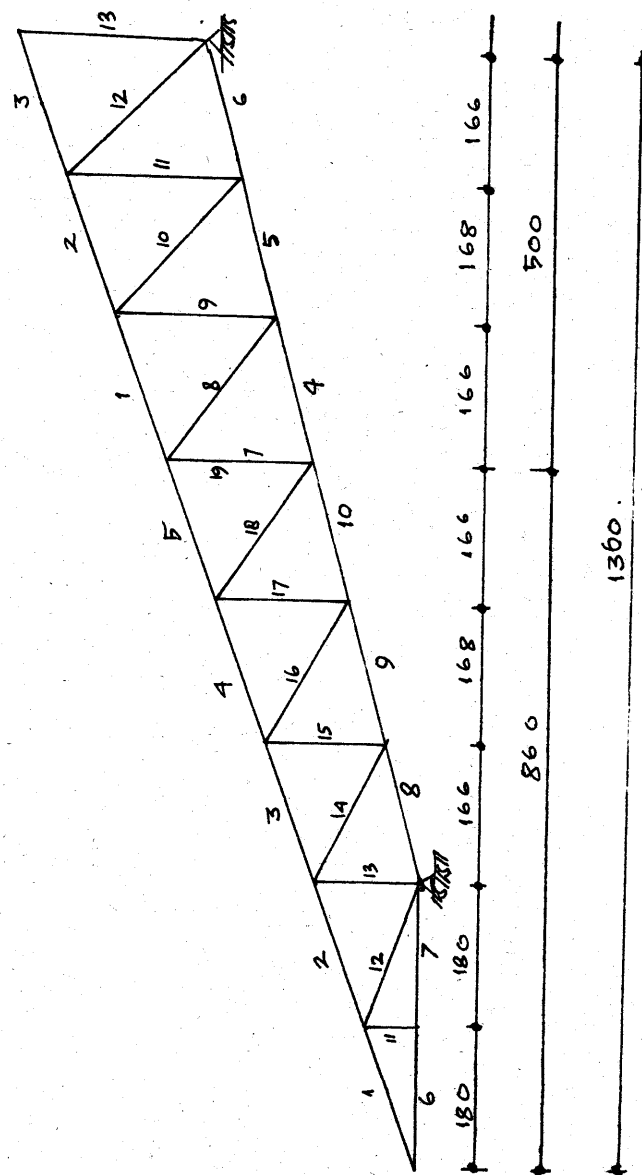
SKETSA GAYA BATANG K₆



SKETSA GAYA BATANG K₈



NOMOR MASING2 BATANG



Batang	MUATAN TETAP		MUATAN ANGIN		GAYA BATANG TERJELEK	
	TARIK	TEKAN	TARIK	TEKAN	TARIK	TEKAN
14	1700	1100	86,25	133,75	1700	1100
15	660	475	15	21,25	660	475
16		70	51,25			70
17		366	85			366
18		445	43			445
19		385	41			385
2		858,4	7,25			7,25
3	425		59			59
4	365		89,25			89,25
5			65			65
6			42			42
7	56215		74			74
8		457,5	35			35
9		30	35,25			35,25
10	70		31			31
11		570				570
12		291,5				291,5
13						

DIMENSI BATANG-BATANG.

- Untuk batang2 : K_6 1. + 1300 kg K_8 : 5 + 425 kg
2. + 2145 kg 6 + 365 kg
3. + 50 kg
4. + 560 kg

Diambil batang dengan ukuran 8/12 \rightarrow luas = 96 cm².
akibat perlemahan \rightarrow luas menjadi : 75% -- 96
= 72 cm².

$$\sigma_{tk} // \text{kayu jati} = 110. \text{ kg/cm}^2.$$

Kekuatan 72.110 = 7920 kg semua gaya batang - batang tersebut (aman).

- Untuk batang2 : K_6 : 4 = - 7,5 kg
8 = - 2085 kg
10 = - 24,375kg

$$K_8 : 1 = 445 \text{ kg} \\ 2 = - 385 \text{ kg} \\ 3 = - 7,25 \text{ kg} \\ 4 = - 59 \text{ kg}$$

Diambil batang dengan ukuran 8/12 Luas = 96 cm².
Kekuatan = 96x110 = 10560 kg semua gaya batang tersebut

- Untuk batang 4 : K_6

$$P = -7,5 \text{ kg} \quad F = 96 \text{ cm}^2 \quad l = 180 \text{ cm} \\ I = \frac{1}{12} 8.12^3 = 1152 \text{ cm}^4 \quad i = \frac{l}{F} \\ = 3,464 \text{ cm} \quad l_k = l = 180 \text{ cm} \\ = \frac{l_k}{i} = \frac{180}{3,464} = 51,963 \rightarrow w = 1,53$$

$$\sigma_{dip} = 56 \text{ kg/cm}^2 \text{ (tabel)} \\ = \frac{P \cdot w}{F} = \frac{7,5 \cdot 1,53}{96} = 0,1195 \text{ kg/cm}^2 < \sigma_{dip} \text{ (aman),}$$

- Untuk batang 8 K₆ : P = -2085 kg
F = 96 cm² = 1 = 165

$$I = 1152 \text{ cm}^4$$

$$i = 3,464 \text{ cm}$$

$$= \frac{165}{3,464} = 47,633 \longrightarrow w = 1,46633$$

$$\sigma_{\text{dip}} = 58 \text{ kg/cm}^2$$

$$= \frac{2085 \cdot 1,46633}{96} = 31,846854 \text{ kg/cm}^2 < \sigma_{\text{dip}} \text{ (aman)}$$

- Untuk batang 10 K₆

$$P = -24,375 \text{ kg} \quad F = 96 \text{ cm}^2 \quad l = 170 \text{ cm}$$

$$I = 1152 \text{ cm}^4 \quad i = 3,464$$

$$= \frac{170}{3,464} = 49,076212 \longrightarrow w = 1,49$$

$$\sigma_{\text{dip}} = 57 \text{ kg/cm}^2$$

$$= \frac{24,375 \cdot 1,49}{96} = 0,3783203 \text{ kg/cm}^2 < \sigma_{\text{dip}} \text{ (aman)}$$

- Untuk batang 1 K₈

$$P = -445 \text{ kg} \quad F = 96 \text{ cm}^2 \quad l = 175 \text{ cm}$$

$$I = 1152 \text{ cm}^4 \quad i = 3,464 \text{ cm}$$

$$= \frac{175}{3,464} = 50,51963 \longrightarrow w = 1,51$$

$$\sigma_{\text{dip}} = 56,5 \text{ kg/cm}^2$$

$$= \frac{445 \cdot 1,51}{96} = 6,999 \text{ kg/cm}^2 < \sigma_{\text{dip}} \text{ (aman)}$$

- Untuk batang 3 K₈

$$P = -385 \text{ kg} \quad F = 96 \text{ cm}^2 \quad l = 180 \text{ cm}$$

$$I = 1152 \text{ cm}^4 \quad i = 3,464 \text{ cm}$$

$$= \frac{180}{3,464} = 51,963 \longrightarrow w = 1,53$$

$$\sigma_{\text{dip}} = 56 \text{ kg/cm}^2$$

$$= \frac{385 \cdot 1,53}{96} = 6,136 \text{ kg/cm}^2 < \sigma_{\text{dip}} \text{ (aman)}$$

dan seterusnya (lihat tabel).

- Untuk batang 2 K₆ . 6 = 1040 kg
7 = 1040 kg

Diambil batang dengan ukuran 2 x 4/12 = Luas = 96cm
Kekuatan 96.110 = 10560 kg > 1940 kg
Perhitungan terhadap tekuk.

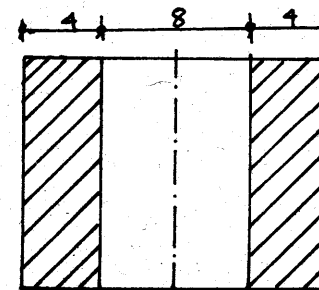
Batang 6 K₈

$$P_2 = -1040 \text{ kg} \quad F = 96 \text{ cm}^2 \quad l = 180 \text{ cm}$$

$$i = 1k = 180 \text{ cm}$$

$$h = 12 \text{ cm} \quad b = 4 \text{ cm} \quad a = 8 \text{ cm} \quad b' = 2.4 = 8 \text{ cm}$$

$$i_x = 0,289 \quad h = 0,289 \cdot 12 = 3,468 \text{ cm}$$



$$T_t = 2.1/12 b^3 h + 2.6k \left(\frac{a+b}{2}\right)^2$$

$$= 2.1/12 \cdot 4^3 \cdot 12 + 2.4 \cdot 12 \left(\frac{8+4}{2}\right)^2$$

$$= 128 + 3456 = 3584 \text{ cm}^4$$

$$I_y = \frac{1}{12} b^3 h = \frac{1}{12} 8^3 \cdot 12 = 512 \text{ cm}^4$$

$$I_F = \frac{1}{4} (I_t + 3I_y) = \frac{1}{4} (3584 + 512 \cdot 3)$$

$$= \frac{1}{4} (3584 + 1536) = 1280 \text{ cm}^4$$

$$i = \frac{1280}{96} = 3,65 \text{ cm}$$

$$= \frac{1k}{i} = \frac{180}{3,65} = 49,315 \longrightarrow w = 1,49315$$

$$\sigma_{\text{dip}} = 86,7 \text{ kg/cm}^2$$

$$= \frac{P \cdot w}{F} = \frac{1040 \cdot 1,49315}{96} = 16,175 \text{ kg/cm}^2$$

$$< \sigma_{\text{dip}} \text{ (aman)}$$

- Untuk batang2 K₆'

11	=	0	kg
12	=	1040	kg
13	=	1840	kg
15	=	1100	kg
17	=	475	kg
18	=	70	kg
19	=	315	kg

dan K₈'

	=	858,4	kg
9	=	457,5	kg
10	=	80	kg
12	=	570	kg
13	=	291,5	kg

Diambil batang 8/8 --- luas = 64 cm².

Kekuatan : 64.110 = 7240 semua gaya2 batang tersebut
Perhitungan teknik. lihat tabel.

- Untuk batang2 K₆'

14	=	+	1700	kg
16	=	+	660	kg

dan K₈'

8	=	+	562,5	kg
11	=	+	70	kg

Diambil batang ukuran 2 x 4/8 Luas = 64 cm².

Akibat perlemahan F = 75% . 64 = 48 cm².

Kekuatan 48.110 = 5280 kg semua gaya2 batang tersebut.

TABEL PERHITUNGAN TEKNIK $1k = l \text{ --- } \frac{P \cdot W}{F} \text{ kg/cm}^2$.

S	P (Kg)	l (cm)	Fbr (cm ²)	I (cm ²)	I (cm ⁴)	w	ttk dip	kg/cm ²	Ket			
K ₆	12	-	190	64	342	2,3	82,6	2,23	38	36,2375	aman	
	13	-	1840	120	64	2,3	52,12	1,53	56	43,9875	aman	
	15	-	1100	145	64	2,3	63	1,72	49	29,5625	aman	
	17	-	475	170	64	2,3	74	1,97	43	14,621	aman	
	18	-	70	210	64	2,3	91,3	2,55	51	2,7890	aman	
	19	-	366	190	64	2,3	82,6	2,23	38	12,7528	aman	
K ₈	3	-	7,25	175	96	1152	3,46	50,6	1,51	56	0,1140	aman
	4	-	59	170	96	1152	3,46	49,2	1,49	57	0,9157	aman
	7	-	858,4	190	64	342	2,3	82,6	2,23	38	29,9098	aman
	9	-	457,5	210	64	342	2,3	91,3	2,55	51	18,2285	aman
	10	-	80	245	64	342	2,3	106,5	3,46	24	4,325	aman
	12	-	570	260	96	1152	3,46	75	2	43	11,875	aman
13	-	291,5	260	64	342	2,3	113	3,97	41	18,0821	aman	

Joint-joint VI ; VI^a ; VII ; VII^a ; X ; X^a.

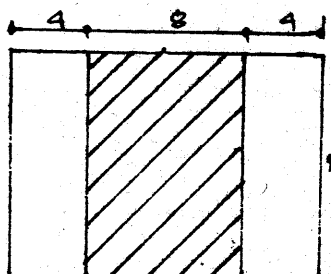
Catatan : untuk memudahkan konstruksi, batang 19 = K, dibuat dengan dimensi 2 x 4/8.

Perhitungan sebagai berikut :

$$P = 366 \text{ kg} \text{ --- dimensi batang} = 2 \times 4/8 = \text{Luas} = 64 \text{ cm}^2$$

$$\text{Kekuatan} = 64 \cdot 110 = 7040 \quad 366 \text{ kg} \text{ --- aman.}$$

Perhitungan terhadap tekuk.



$$P = 366 \text{ kg} \quad F = 64 \text{ cm}^2 \quad l = 190 \text{ cm}$$

$$h = 8 \text{ cm} \quad b = 4 \text{ cm} \quad a = 8 \text{ cm}$$

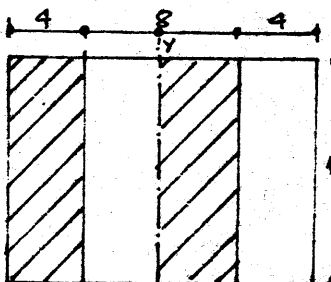
$$b' = 2 \cdot 4 = 8 \text{ cm}$$

$$x = 0,269 h = 0,269 \cdot 8 = 2,312 \text{ cm}$$

$$I_t = 2 \frac{1}{12} b^3 h + 2 \cdot b \cdot h \left(\frac{a+b}{2} \right)^2$$

$$= 2 \frac{1}{12} 4^3 8 + 2 \cdot 4 \cdot 8 \left(\frac{8+4}{2} \right)^2$$

$$= 85,33 + 2304 = 2389,33 \text{ cm}^4$$



$$I_g = \frac{1}{12} b^3 h = \frac{1}{12} 8^3 \cdot 8 = 341,33$$

$$I_p = \frac{1}{4} (I_t + 3I_g)$$

$$= \left(\frac{2389,33 + 1023,9999}{4} \right)$$

$$= \frac{3413,3299}{4} = 853,33247 \text{ cm}^4$$

$$i = \frac{I_p}{F} = \frac{853,33247}{64} = 13,333334640625$$

$$= \frac{L}{i} = \frac{190}{13,333334640625} = 14,25$$

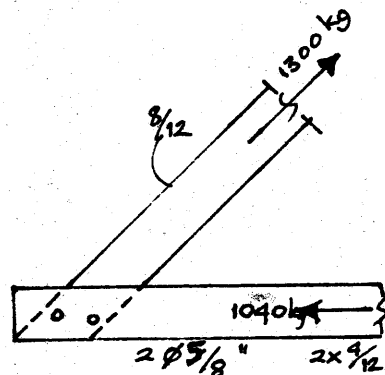
$$w = 1,53$$

$$= \frac{P \cdot w}{F} = \frac{366 \cdot 1,53}{64} = 8,75$$

$$\sigma_{dip} = 56 \text{ kg/cm}^3 = 8,75 \text{ kg/cm} < \sigma_{dip} \text{ (aman)}$$

$$\text{Analog batang 13 kg} \quad P = 291,5 \text{ kg} < 366 \text{ kg (aman).}$$

I. Perhitungan sambungan.



Diambil bout $\emptyset 5/8'' = 1,59 \text{ cm}$

$$P = 100 \cdot d \cdot m \cdot (1 - 0,6 \sin 18^\circ 45')$$

$$= 100 \cdot 1,59 \cdot 8 (1 - 0,6 \cdot 0,3214)$$

$$= 1026,7075 \text{ kg}$$

$$P = 430 \cdot d^2 (1 - 0,35 \sin 18^\circ 45')$$

$$= 430 (1,59)^2 (1 - 0,35 \cdot 0,3214)$$

$$= 964,7902 \text{ kg}$$

Diambil bout 2 $\emptyset 5/8''$
 $= 1929,594 > 1300 \text{ kg}$

Setelah dicoba tidak ada tempat pemasangannya, maka dipakai pelat besi dengan tebal 4mm dan lebar 6 cm.

$$= \frac{1300}{6 \cdot 8} = 27,08 \text{ kg/cm}^2$$

$$= // - (// - \perp) \sin 18^\circ 45'$$

$$= 110 - (110 - 30) 0,3843$$

$$= 84,284 \text{ kg/cm}^2 > 27,08 \text{ kg/cm}^2 \text{ (aman)}$$

Hubungan batang dengan pelat besi --> bert. satu

$$P = 40 \text{ dl} = 40 \cdot 1,59 \cdot 8 \text{ besi } 508,8 \text{ kg.}$$

$$P = 215 d^2 = 215 \cdot 1,59^2 \text{ besi } 341,85 \text{ kg}$$

Karena salah satu bertampang besi maka :

$$P = 341,85 \cdot 1,25 = 427,31 \text{ kg}$$

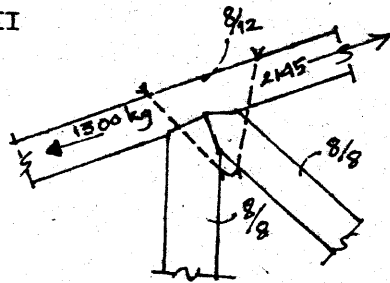
$$n = \frac{1300}{427,31} = 3,042$$

Dipakai 4 buah sebelah menyebelah sisi.

Ambil baut $\emptyset 5/8''$ sebanyak 2 buah (fungsi 1 baut bisa menahan sebelah menyebelah gaya).

Pada titik buhul dipakai 1 buah baut $\emptyset 3/8''$ sebagai baut pelengkap (tidak memikul gaya).

II



$$tv = \frac{s \cdot \cos \alpha}{b \cdot \sigma_{tk}} = \frac{1040 \cos 37^\circ}{8 \cdot \sigma_{tk}}$$

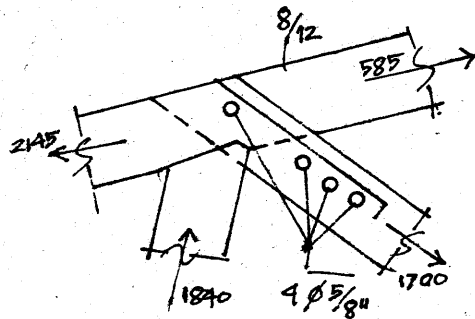
$$\sigma_{tk} = \sigma_{tk} - (\sigma_{tk} - \sigma_{tk}) \sin 37^\circ$$

$$= 110 - (110 - 30) \sin 37^\circ$$

$$= 110 - 80 \cdot 0.6018$$

$$= 61,856 \text{ kg/cm}^2.$$

III. SAMBUNGAN GIGI.



$$tv = \frac{s}{93 \cdot b} = \frac{1840}{93,8}$$

$$2,47 \text{ --- } 3 \text{ cm}$$

$$ts = \frac{B_v}{\cos \frac{1}{2}} = \frac{3}{0,9153}$$

$$= 3,27 = 3,5 \text{ cm}$$

$$tk^{\frac{1}{2}} = 76,2 \text{ kg/cm}^2 \text{ (tabel)}$$

$$tk^{\frac{1}{2}} = \frac{s \cos \frac{1}{2}}{t_s \cdot b}$$

$$= \frac{2145 \cdot 0,9153}{3,5 \cdot 8}$$

$$= 70,12 \text{ kg/cm}$$

$$< 76,2 \text{ kg/cm}^2 \text{ (aman)}$$

SAMBUNGAN BAUT.

Diambil baut $\emptyset 5/8" = 1,59 \text{ m}$

$$P = 100 \cdot 1,59 \cdot 8 (1 - 0,6 \sin 47^\circ 30') = 709,29 \text{ kg}$$

$$P = 430 \cdot d^2 (1 - 0,35 \sin 47^\circ 30') = 806,56 \text{ kg}$$

$$\text{Dipakai baut } 4 \emptyset 5/8" = 4,709,29 = 2837,16 > 2145 \text{ kg (aman)}$$

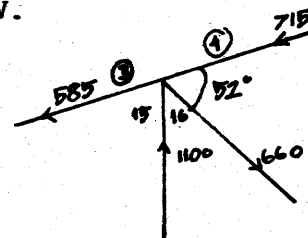
$$\text{Pelat besi ukuran } 40 \times 6 = \frac{2145}{6 \cdot 8} = 44,6875 \text{ kg/cm}^2.$$

$$= - (\quad) \sin 47^\circ 37' = 110 (110 - 30) 4,7373$$

$$= 51,016 \text{ kg/cm}^2.$$

Jadi $44,6875 < 51,016 \text{ kg/cm}^2$ (aman).

IV.



$$tv = \frac{1100}{93 \cdot 8} = 1,478 < 2 \text{ cm}$$

$$ts = \frac{tv}{\cos \frac{1}{2}} = \frac{2}{0,8980}$$

$$= 2,22 \text{ --- } 2,5 \text{ cm}$$

$$\sigma_{tk} = 76 \text{ kg/cm}^2$$

$$\sigma_{tk} = \frac{1100 \cdot 0,8988}{2 \cdot 5 \cdot 8}$$

$$= 49,434 < 76 \text{ kg (aman)}$$

SAMBUNGAN BOUT.

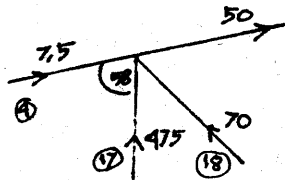
Diambil bout $\emptyset 5/8" = 1,59 \text{ cm}$

$$P = 100 \cdot d \cdot m (1 - 0,6 \sin 52^\circ) = 670,5984 \text{ kg}$$

$$P = 430 \cdot d^2 (1 - 0,35 \sin 52^\circ) = 787,2655 \text{ kg}$$

$$\text{Ambil } 2 \emptyset 5/8" = 1341,1968 > 1100 \text{ kg (aman)}$$

V.

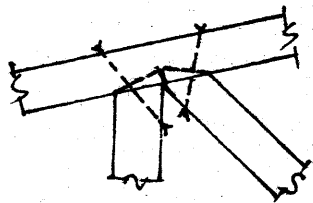


$$t_v = \frac{47,50}{93,8} = 2 \text{ cm}$$

$$t_s = 2,5 \text{ cm}$$

$$\sigma_{tk} = 70 \text{ kg/cm}^2$$

$$t_k = \frac{475 \cdot 0,8746}{2,5 \cdot 8} = 20,77 < 70 \text{ kg/cm}^2 \text{ (aman).}$$

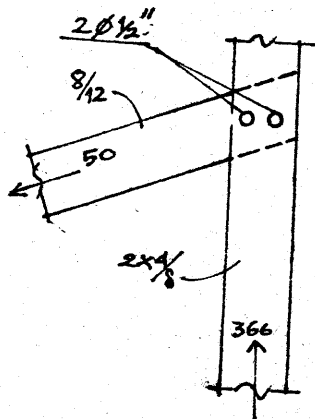


Perhitungan sebagai berikut :

$$t = - (-) \sin 70^\circ = 110 - 80 \cdot 0,9372 = 35,30 \text{ kg/cm}^2.$$

$$t_v = \frac{s \cos \alpha}{b \cdot \sigma_{tk}} = \frac{475 \cdot 0,3420}{8 \cdot 35,3} = 0,57 = 2 \text{ cm.}$$

VI.



SAMBUNGAN BOUT.

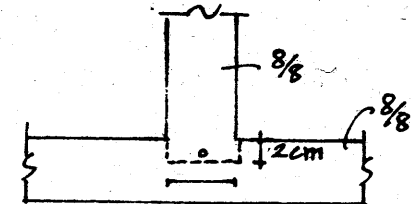
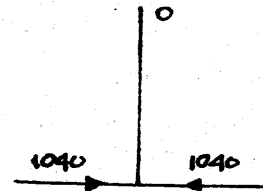
Diambil bout $\emptyset \frac{1}{2}" = 1,27 \text{ cm}$

$$P = 100 \text{ d.m} (1 - 0,6 \sin 70^\circ) = 584,22 \text{ kg}$$

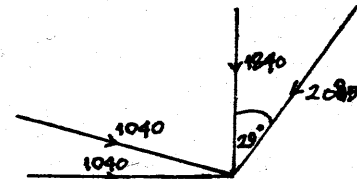
$$P = 430 \cdot d^2 (1 - 0,35 \sin 70^\circ) = 475,9 \text{ kg}$$

$$\text{Dipakai baut } 2 \emptyset \frac{1}{2}" = 850,78 \text{ kg} > 366 \text{ kg} \text{ (aman).}$$

II^s



III^s



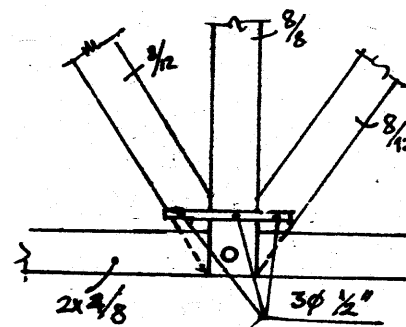
Karena ada dukungan maka bout diperhitungkan untuk juga mendatar.

Diambil bout $\emptyset 1" = 2,54 \text{ cm}$

$$P = 100 \cdot 2,54 = 2032 \text{ kg}$$

$$P = 430 \cdot d^2 = 430 \cdot 2,54^2 = 2774 \text{ kg}$$

$$\text{Dipakai } 1 \emptyset 1" = 2774 > 2085 \text{ kg}$$



$$t_v = \frac{5}{93,8} = \frac{1100}{93,8} = 1,478 \approx 2 \text{ cm}$$

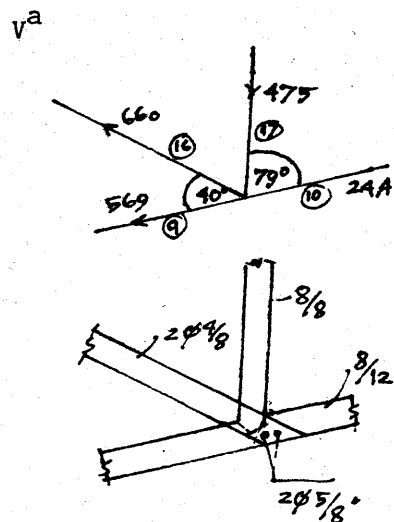
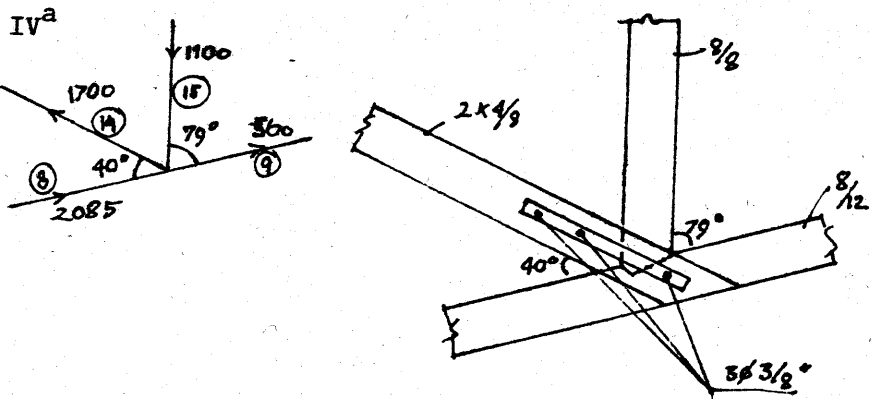
$$t_s = \frac{2}{0,7716} = 2,59 \approx 3 \text{ cm}$$

Diambil bout $\emptyset \frac{5}{8}" = 1,59 \text{ cm}$

$$P = 100 \cdot 1,59 \cdot 8 (1 - 0,6 \sin 40^\circ) = 781,41504 \text{ kg}$$

$$P = 430 \cdot 1,59^2 (1 - 0,35 \sin 40^\circ) = 842,51104 \text{ kg}$$

$$\text{Dipakai } 3 \emptyset \frac{5}{8}" = 2344,2451 \text{ kg} > 1700 \text{ kg (aman).}$$



$$t_v = \frac{s}{93.6} = \frac{475}{93.6} = 2 \text{ cm}$$

$$t_s = \frac{2}{0.7716} = 3 \text{ cm}$$

ambil bout $\emptyset 5/8" = 1,59 \text{ cm}$

$$P = 100.1,59.8(1 - 0,6 \sin 45^\circ) = 732,34128 \text{ kg}$$

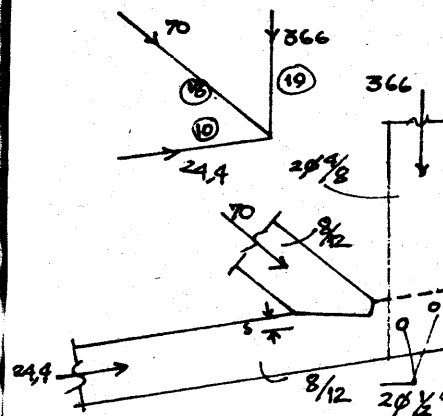
$$P = 430.1,59^2(1 - 0,35 \sin 45^\circ) = 818,04625 \text{ kg}$$

Dipakai bout 1 $\emptyset 5/8"$

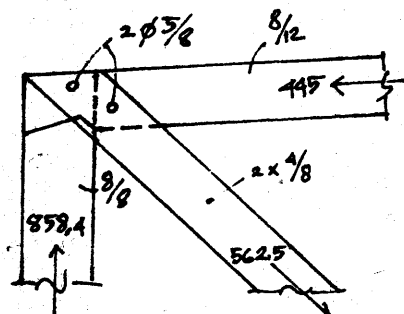
$$= 732,34 \text{ kg} > 660 \text{ kg} \text{ (aman).}$$

$$t_v = \frac{170}{93.8} = 0,09 < 2 \text{ cm}$$

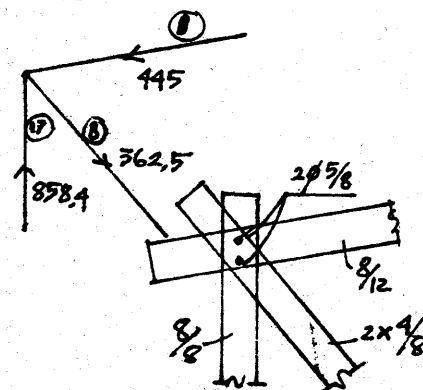
$$t_s = \frac{t_v}{\cos \frac{1}{2}} = \frac{2}{0,9063} = 2,20 < 2,5 \text{ cm.}$$



VIIa



Untuk K₈
VIII



ada dukungan sehingga baut diperhitungkan masuk gaya horizontal.

Diambil bout $\emptyset 1/2" = 1,27 \text{ cm}$

$$P = 100.1,27.8 = 2032 \text{ kg}$$

$$P = 430 d^2 = 430.127^2 = 692 \text{ kg} > 24,4 \text{ kg}$$

Dipakai 1 $\emptyset 1/2"$ cukup aman.
Dalam praktek dipakai 2 $\emptyset 1/2"$ (PKKI)

$$t_v = \frac{858,4}{93,8} = 1,19 = 2 \text{ cm}$$

$$t_s = \frac{t_v}{\cos \frac{1}{2}} = \frac{2}{0,5736} = 3,48 \text{ cm}$$

Diambil bout $\emptyset 5/8" = 1,59 \text{ cm}$

$$P = 100.1,59.8(1 - 0,6 \sin 62^\circ) = 598,17 \text{ kg}$$

$$P = 430.d^2(1 - 0,35 \sin 62^\circ) = 751,16 \text{ kg}$$

Dipakai bout 1 $\emptyset 5/8"$
 $= 598,2 < 562,5 \text{ kg (aman).}$

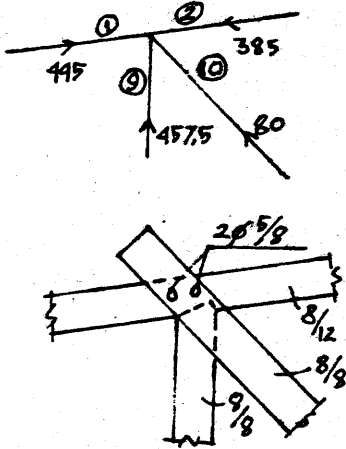
Diambil bout $\emptyset 5/8" = 1,59 \text{ cm}$

$$P = 100.1,59.8(1 - 0,6 \sin 62^\circ) = 598,17072 \text{ kg}$$

$$P = 430.d^2(1 - 0,35 \sin 62^\circ) = 751,15797 \text{ kg}$$

Dipakai bout 1 $\emptyset 5/8"$
 $= 598,2 < 562,5 \text{ kg (aman)}$

VIII.



$$tv = \frac{457,5}{93,8} = 0,6 = 2 \text{ cm}$$

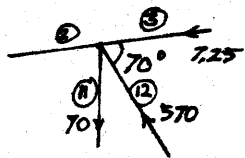
Dipilih baut $\emptyset 5/8'' = 1,59 \text{ cm}$

$$P = 100 \cdot 1,59 \cdot 8(-0,6 \sin 65^\circ) = 580,31184 \text{ kg}$$

$$P = 430(1,59)^2(1-0,35 \sin 65^\circ) = 742,25483 \text{ kg}$$

Pakai 1 baut $\emptyset 5/8''$
 $= 580 > 80 \text{ kg}$.

IX.

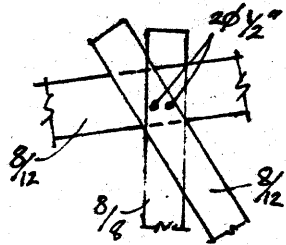


Dipilih baut $\emptyset \frac{1}{2}'' = 1,27 \text{ cm}$

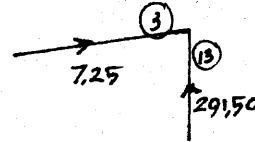
$$P = 100 \cdot 1,27 \cdot 8(1-0,6 \sin 70^\circ) = 443,158 \text{ kg}$$

$$P = 430(1,27)^2(1-0,35 \cdot 0,9397) = 465,442 \text{ kg}$$

Pakai baut 2 $\emptyset \frac{1}{2}''$
 $= 886,316 \text{ kg} > 570 \text{ kg}$



X.

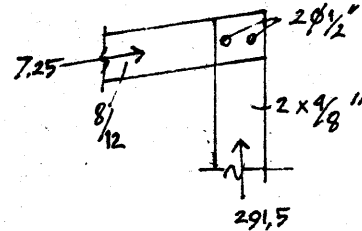


Dipilih baut $\emptyset \frac{1}{2}'' = 1,27 \text{ cm}$

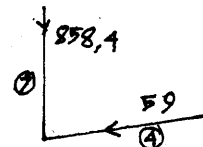
$$P = 100 \cdot 1,27 \cdot 10(1-0,6 \sin 70^\circ) = 584,2 \text{ kg}$$

$$P = 430 \cdot 1,27^2(1-0,5 \sin 70^\circ) = 475,29 \text{ kg}$$

Dipakai baut 2 $\emptyset \frac{1}{2}''$
 $= 85070 \text{ kg} > 291,5 \text{ kg}$
 (aman).



VII^a



Dipilih baut $\emptyset \frac{1}{2}'' = 1,27 \text{ cm}$

$$P_1 = 100 \cdot 1,27 \cdot 8(1-0,6 \sin 80^\circ)$$

$$P_2 = 430 \cdot 1,27^2(1-0,35 \sin 80^\circ)$$

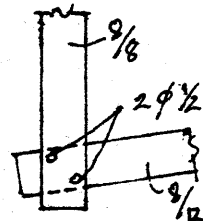
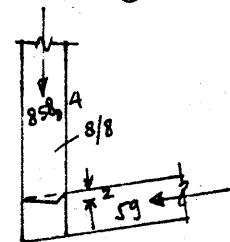
$$P_1 = 438,592 \text{ kg}$$

$$P_2 = 469,838 \text{ kg}$$

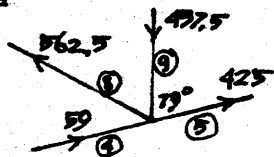
Pakai baut 2 $\emptyset \frac{1}{2}''$

$$= 867,184 \text{ kg}$$

(67,184 < 858,4 kg (aman)



VIII^a



$$tv = \frac{s}{93.b} = \frac{457,5}{93.8} \approx 2$$

Diambil baut $\emptyset 5/8"$
 $= 1,59 \text{ cm}$

$$P = 100.1,59.8(1 - 0,6\sin 40^\circ) \\ = 781,41504 \text{ kg}$$

$$P = 430.1,59^2(1 - 0,35\sin 40^\circ) \\ = 842,51104$$

Pakai 1 $\emptyset 5/8"$ = 781,41504
 $> 562,5 \text{ kg}$
 (aman)

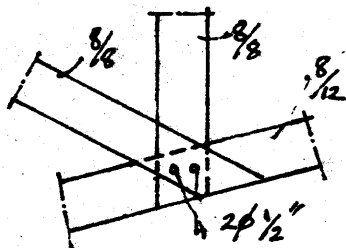
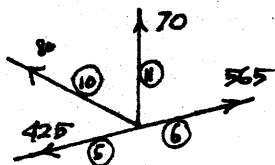
Pilih baut $\emptyset \frac{1}{2}" = 1,27$

$$P = 100.1,27.8(1 - 0,6\sin 60^\circ) \\ = 488,0864 \text{ kg}$$

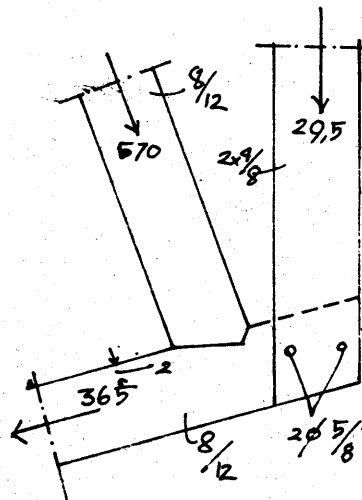
$$P = 430.1,27^2(1 - 0,35\sin 60^\circ) \\ = 483,3329 \text{ kg.}$$

Pakai baut 1 $\emptyset \frac{1}{2}"$
 $= 483,3329 < 80 \text{ kg}$
 (aman)

IX^a



X^a



$$tv = \frac{570}{93.8} = 0,76 \approx 2 \text{ cm.}$$

Dipilih baut $\emptyset 5/8" = 1,59 \text{ cm}$

$$P = 100.1,59.8(1 - 0,6\sin 60^\circ) \\ = 611,1 \text{ kg}$$

$$P = 430(1,59)^2(1 - 0,35\sin 60^\circ) \\ = 757,5882 \text{ kg}$$

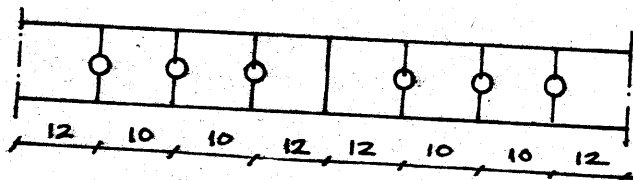
Dipakai baut 1 $\emptyset 5/6"$
 $= 611 < 570 \text{ kg}$

Dalam praktek dipakai :
 2 $\emptyset 5/8"$.

SAMBUNGAN2 YANG ADA PADA VAK WERK TERSEBUT

1. Sambungan antara II dan III.

$$P = +2145 \text{ kg}$$



$$\text{Diambil baut } \emptyset 5/8'' \quad P=100 \cdot d \cdot m = 100 \cdot 1,59 \cdot 8 = 1272 \text{ kg}$$

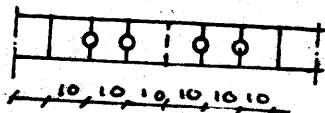
$$P=430 \cdot d^2 = 430 \cdot 2,53 = 1087 \text{ kg}$$

$$\text{Jadi pakai 3 baut } 5/8'' \rightarrow P = 3 \cdot 1087 = 3261 \text{ kg}$$

$$2145 \text{ kg (aman).}$$

Jelas penyambung diambil 2 x 4/12 cm.

2. Sambungan antara IV dan IV.



$$+P = -7,5 \text{ kg.}$$

diambil baut
 $\emptyset \frac{1}{2}''$

$$P = 100 \cdot 1,27 \cdot 8 = 1016 \text{ kg}$$

$$P = 430 \cdot 1,27^2 = 693,547 \text{ kg}$$

$$\text{Jadi pakai baut } 2 \emptyset \frac{1}{2}'' \rightarrow P = 693,5 \text{ kg} > 7,5 \text{ kg}$$

(aman)

Jelas penyambung diambil 4/12

3. Sambungan antara IVa & Va $\rightarrow P = +560 \text{ kg}$ idem 2.

$$\text{ambil baut } 2 \emptyset \frac{1}{2}'' = P = 693,5 \text{ kg} > 560 \text{ kg}$$

(aman).

4. Sambungan antara VIII & IX = P = -385 kg

$$\text{ambil baut } 2 \emptyset \frac{1}{2}'' = P = 693,5 \text{ kg} > 385 \text{ kg (aman)}$$

5. Sambungan antara VIIla & IXa = P = + 425 kg

$$\text{ambil baut } 2 \emptyset \frac{1}{2}'' = P = 693,5 \text{ kg} > 425 \text{ kg (aman)}$$

PERHITUNGAN BERAT KUDA-KUDA SESUNGGUHNYA

Batang	Ukuran	Luas (cm ²)	Panjang (cm ³)	Volume (cm ³)	Bj = 0,7 Berat(Kg)	KETERANGAN
14	2x ⁴ /8	64	190	12.160	8,512	
15	8/8	64	145	9.280	6,496	
16	2x ⁴ /8	64	200	12.800	8,96	
17	8/8	64	170	10.880	7,616	
18	8/8	64	210	13.440	9,048	
19	2x ⁴ /8	64	190	12.160	8,512	
K ₈						
1	8/12	96	175	16.800	11,76	
2	8/12	96	180	17.280	12,096	
3	8/12	96	175	16.800	11,76	
4	8/12	96	170	16.320	11,424	
5	8/12	96	175	16.800	11,76	
6	8/12	96	170	16.320	11,424	
7	8/8	64	190	12.160	8,512	

PERHITUNGAN BERAT KUDA-KUDA SESUNGGUHNYA

Batang	Ukuran	Luas (cm ²)	Panjang (cm ³)	Volume (cm ³)	Bj = 0,7 Berat(Kg)	Keterangan
K ₆						
1	8/12	96	190	18.240	35,768	NB: Bj Kayu Jati=0,7 Berat=Volx0,7 = gram = $\frac{1}{1000}$ kg
2	8/12	96	190	18.240	12,768	
3	8/12	96	175	16.800	11,76	
4	8/12	96	180	17.280	12,096	BATANG PENYAMBUNG. = 2x4/12=96(4,60+88) = 31488 cm ³ .
5	8/12	96	175	16.800	11,76	
6	2x ⁴ /12	96	180	17.280	12,096	
7	2x ⁴ /12	96	180	17.280	12,096	
8	8/12	96	170	16.320	11,424	
9	8/12	96	175	16.800	11,76	
10	8/12	96	170	16.320	11,424	
11	8/8	64	60	3.840	2,688	
12	8/8	64	190	12.160	8,512	
13	8/8	64	120	7.680	5,376	

Batang penyambung = $31488 \cdot 0,7/1000 = G_2 = 22,0416 \text{ kg}$

$$G_3 = \text{berat kelas joint III + IV}^a$$

$$= 2 \times 8 \times 12 \times 45 \times 0,7 = 8470 \cdot 0,7 = 6,048$$

Berat batang-batang kayu seluruhnya

$$G \text{ kayu} = G_1 + G_2 + G_3$$

Berat baut :

Baut	Banyak	Luas	Panjang	I s i
$\varnothing \frac{1}{2}$ "	20 buah	$1,26 \text{ cm}^2$	25 cm	640 cm^3
$\varnothing \frac{5}{8}$ "	24 buah	$2,00 \text{ cm}^2$	20 cm	1524 cm^3

Volume baut 2164 cm^3

Jadi berat seluruh baut = $2,64 \times 7,8 = 16,88 \text{ kg}$

Berat besi pelat $40 \times 6 \text{ mm}$

$$\text{Joint I} \quad 4 \times 0,6 \times 80 \text{ cm} = 211,2 \text{ cm}^3$$

$$\text{Joint III} \quad 4 \times 0,6 \times 126 = 302,4 \text{ cm}^3$$

$$\text{Joint IIIa} \quad 4 \times 0,6 \times 70 = 168 \text{ cm}^3$$

$$\text{Joint IVa} \quad 4 \times 0,6 \times 102 = 244,8 \text{ cm}^3$$

$$\text{Volume pelat} = 926,4 \text{ cm}^3$$

Jadi berat seluruh pelat = $926,4 \times 7,8 = 7,22 \text{ kg}$

$$\text{Berat besi seluruhnya} = \text{baut} + \text{pelat} = 16,88 + 7,22$$

$$= 24,1 \text{ kg.}$$

Berat seluruh konstruksi = $G \text{ kayu} + G \text{ besi}$

$$= (G_1 + G_2 + G_4) + G \text{ besi}$$

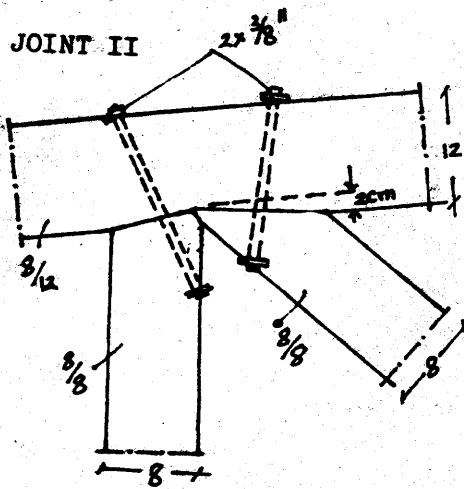
$$= 335,1042 + 22,0416 + 6,048 +$$

$$24,1 = 387,29 \text{ kg.}$$

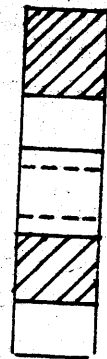
PERHITUNGAN BERAT KUDA-KUDA SESUNGCUHNYA

Batang	Ukuran	Luas (cm^2)	Panjang (cm^3)	Volume (cm^3)	Bj = 0,7 Berat(kg)	KETERANGAN
8	$2x \frac{4}{8}$	64	230	14.720	10,304	
9	$8/8$	64	210	13.440	9,408	
10	$8/8$	64	245	15.680	10,976	
11	$2x \frac{4}{8}$	64	235	15.040	10,528	
12	$8/12$	96	260	24.960	17,472	
13	$2x \frac{4}{8}$	64	260	16.640	11,648	

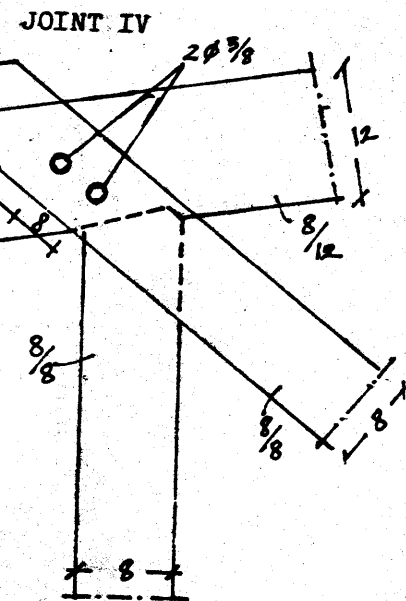
$$\text{JUMLAH } (G_1) = 335,1042 \text{ kg}$$



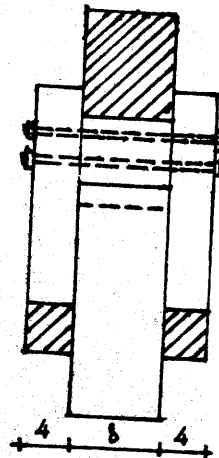
PAND. MUKA



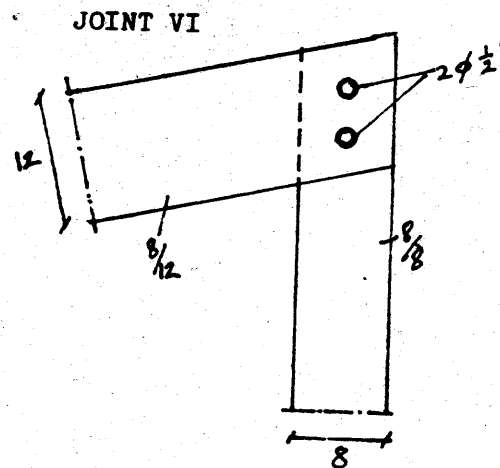
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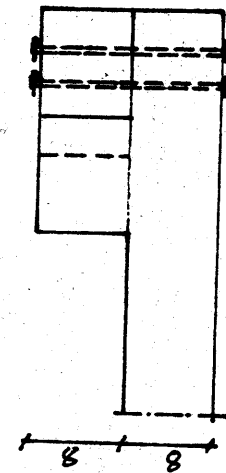
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PAND. SAMPING

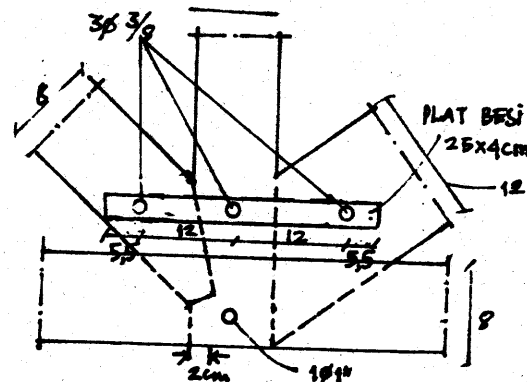


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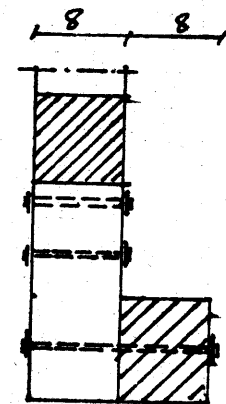


PAND. SAMPING

JOINT III^a

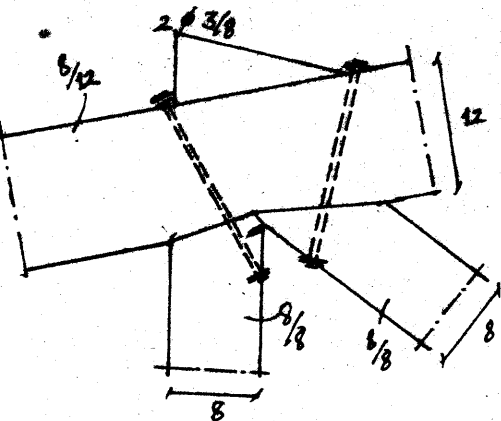


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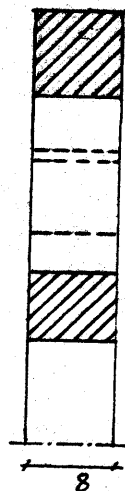


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JOINT V

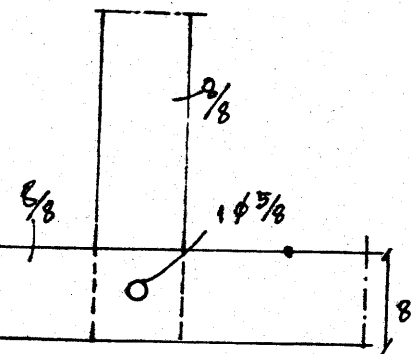


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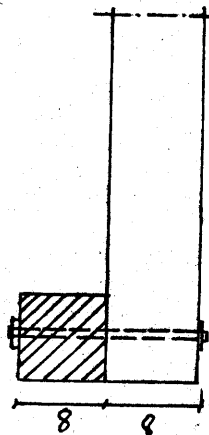


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JOINT II^a



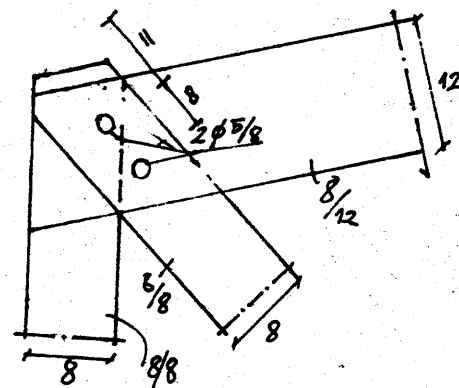
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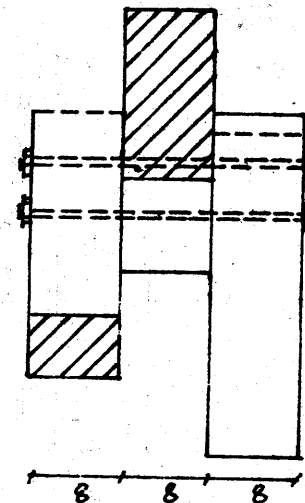
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KUDA-KUDA K₈

JOINT VIII

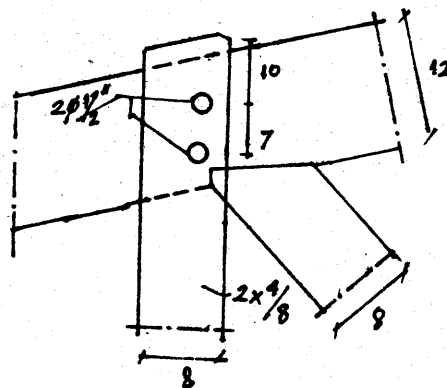


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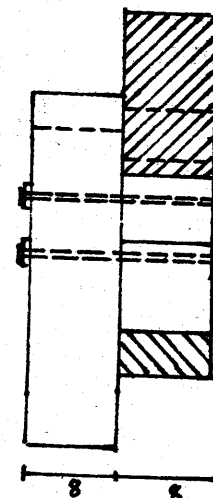


PAND.SAMPING

JOINT IX

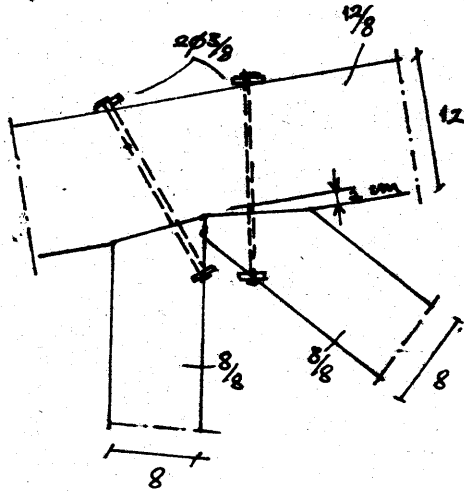


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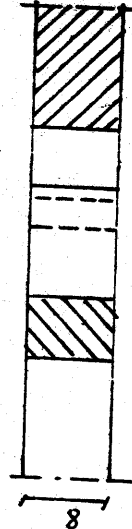


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JOINT VIII.

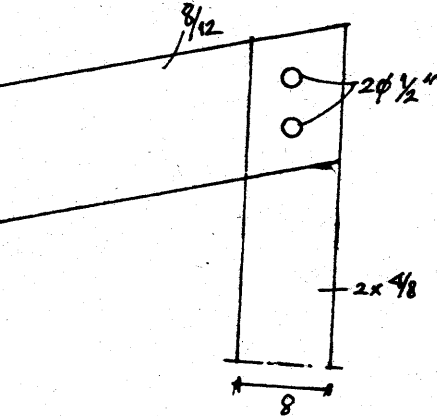


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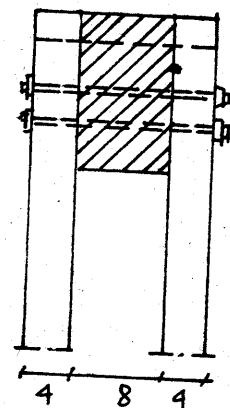


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JOINT X.

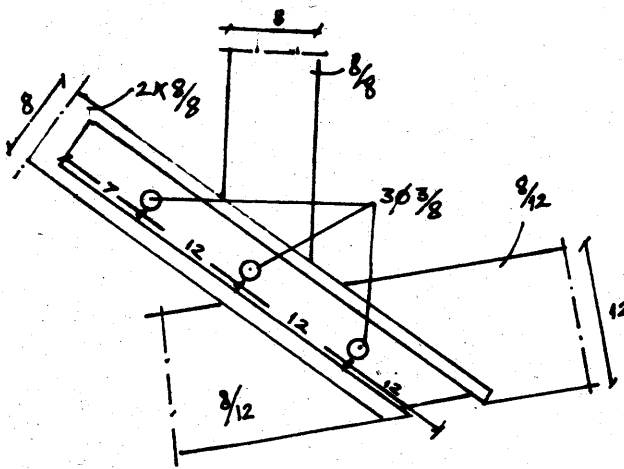


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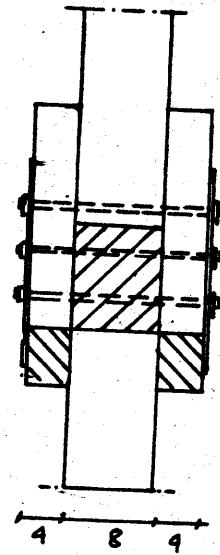


PAND.SAMPING

JOINT IV^a

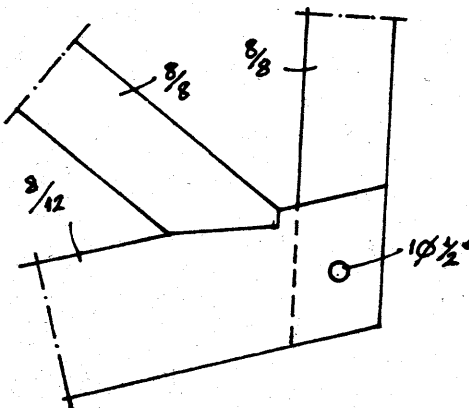


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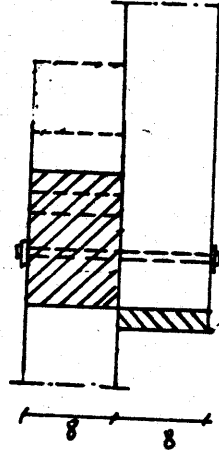


PAND.SAMPING

JOINT VI^a

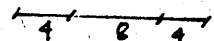
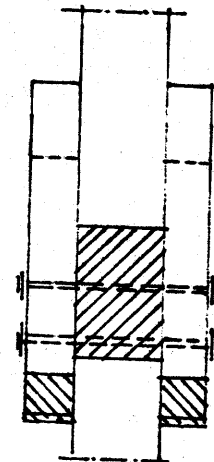
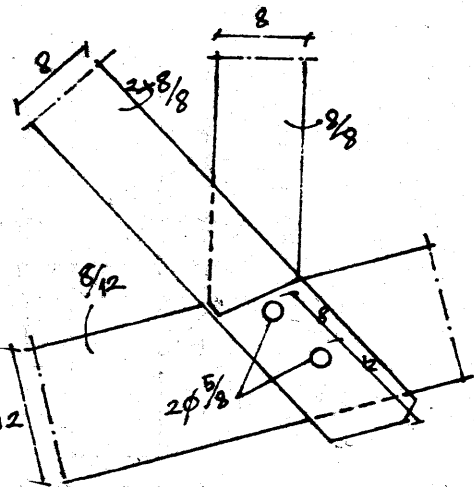


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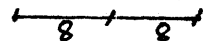
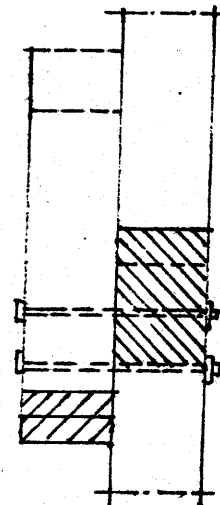
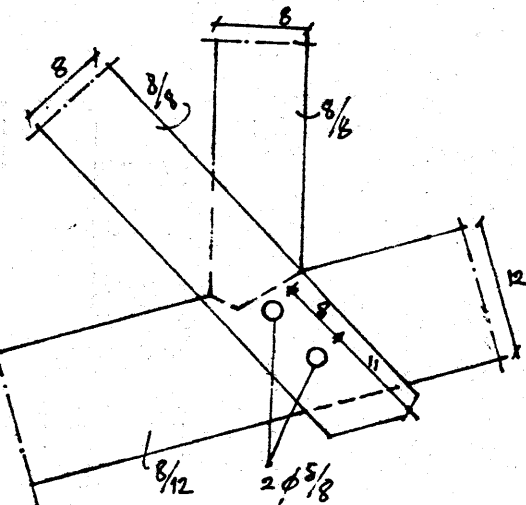
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JOINT V^a

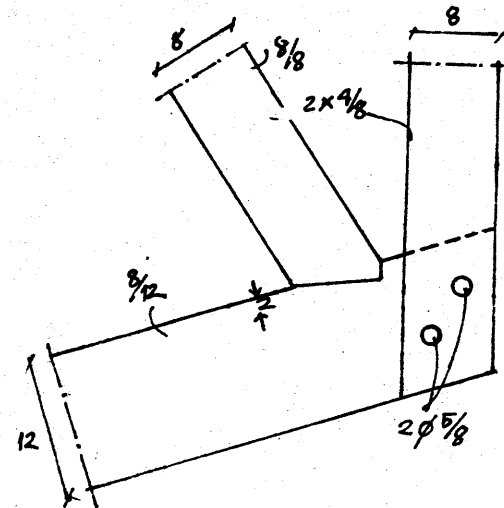


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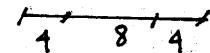
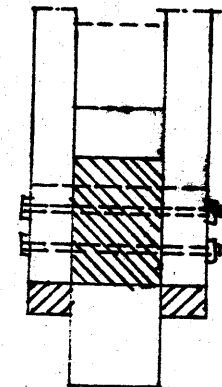
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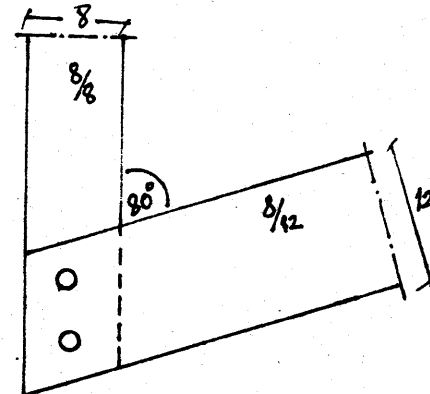
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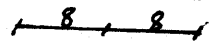
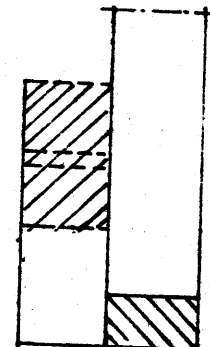
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SKALA 1:

JOINT VII

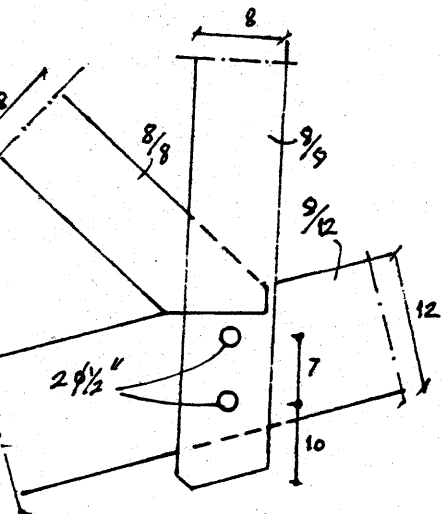


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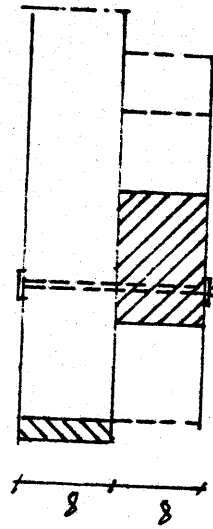


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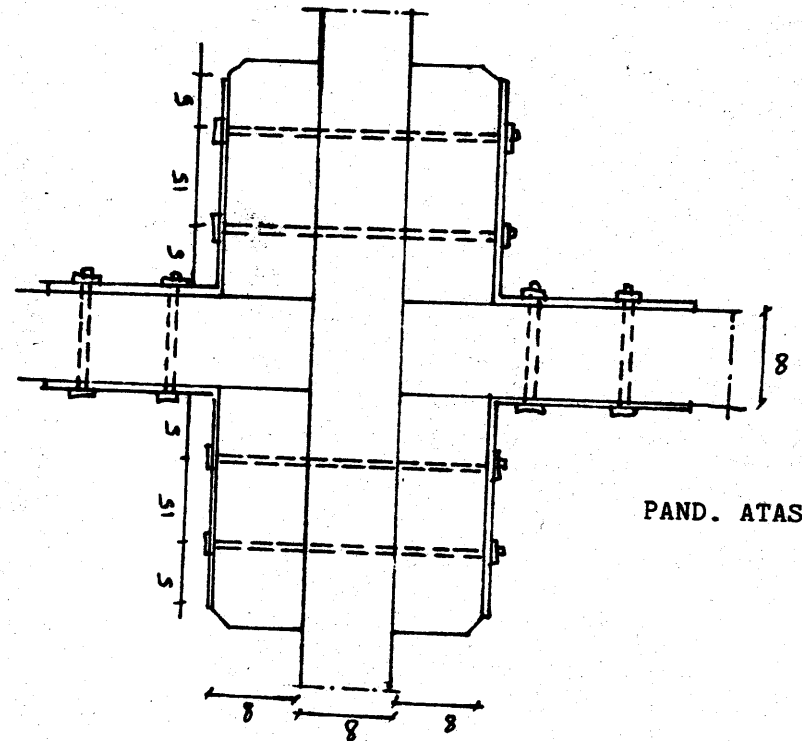
JOINT IX^a



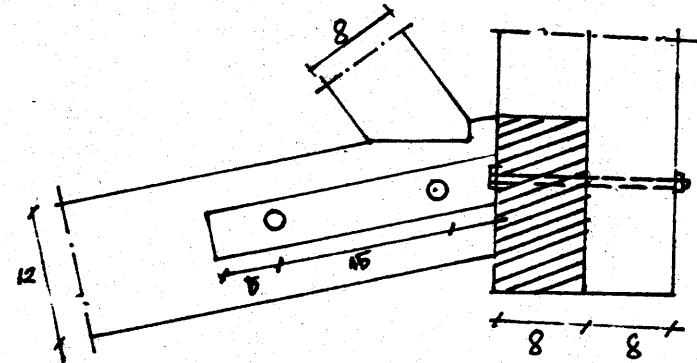
PAND.MUKA



PAND.SAMPING

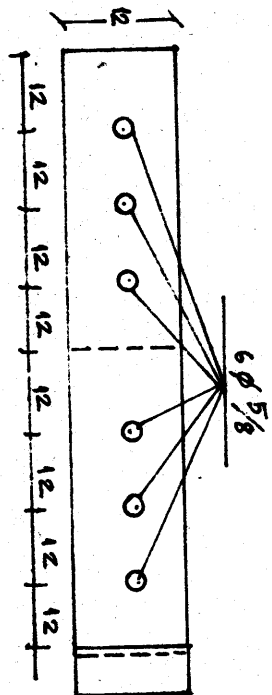


PAND. ATAS

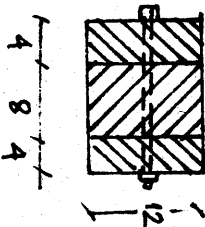


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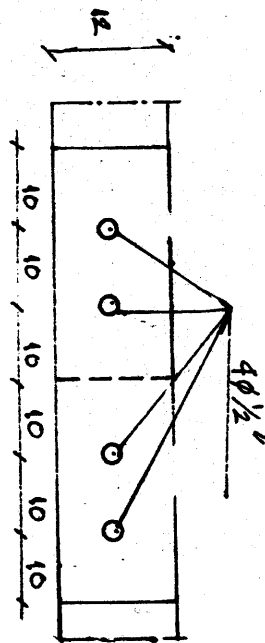
Sambungan antara Batang II & III.



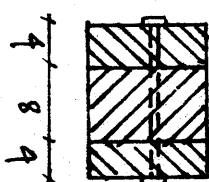
PAND. MUKA



PAND. SAMPIING



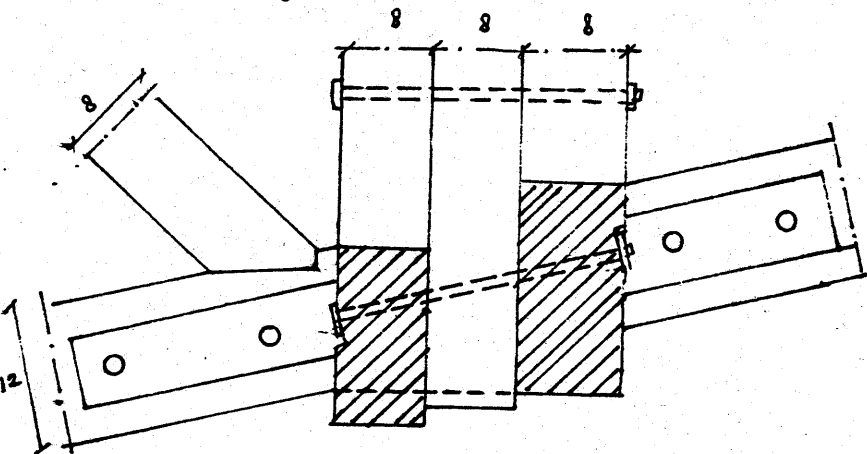
PAND. MUKA



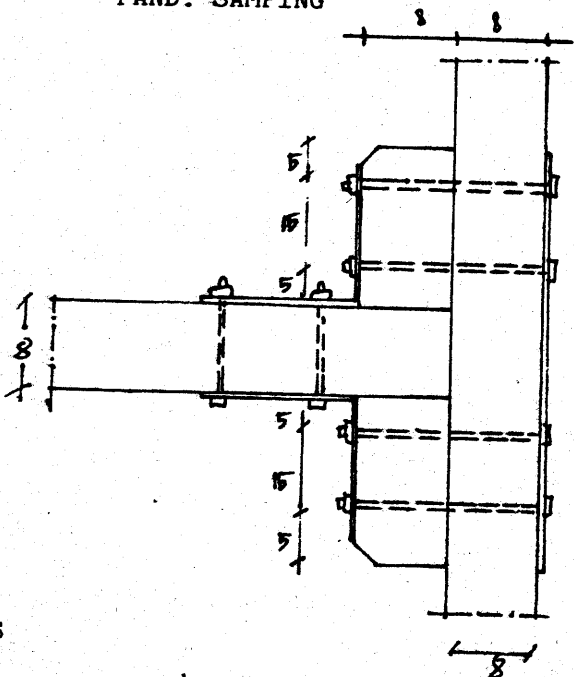
PAND. SAMPIING

Sambungan antara batang2 : IV dan V IV^a dan V^aVIII dan VIII dan IX, serta VIII^a & IX^a

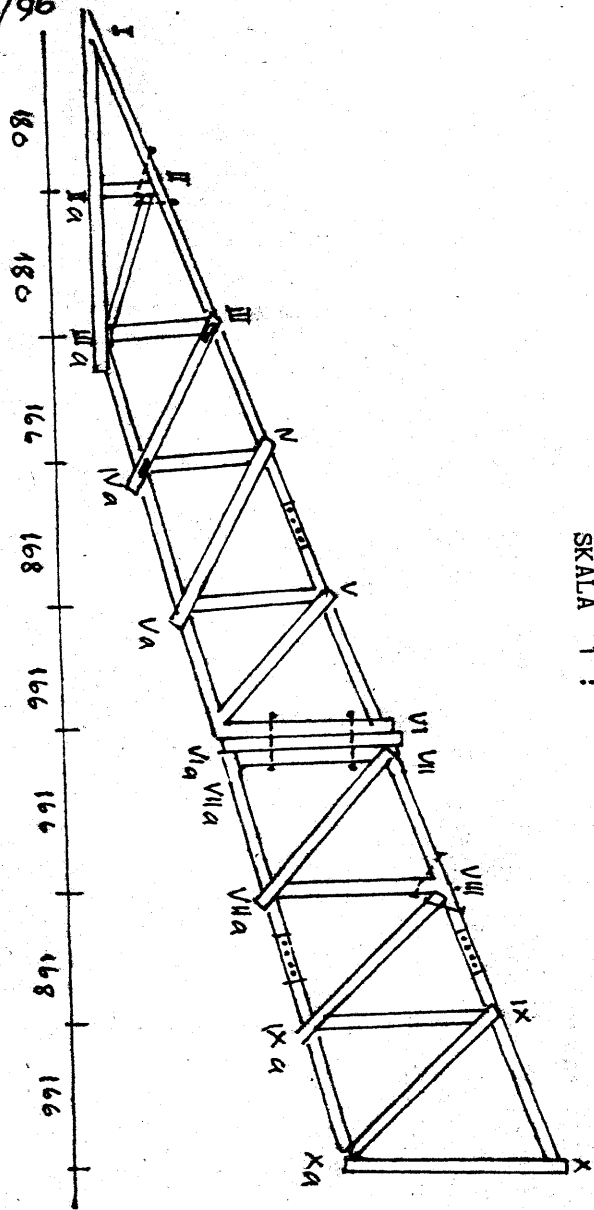
SAMBUNGAN K₆ & K₈



PAND. SAMPIING



PAND. ATAS



SKALA 1 :

TAMP. KUDA-KUDA