Perhitungan

SERI BUKU TEKNIK SIPIL

KONSTRUKSI BAJA

Lengkap

OLEH: HADI Y. CE.

JUSTADI
Cipta Science Team

Perhitungan

"KONSTRUKSI BAJA" *Lengkap*

Untuk Mahasiswa Teknik Sipil

Disusun oleh :
Hadi Y. CE

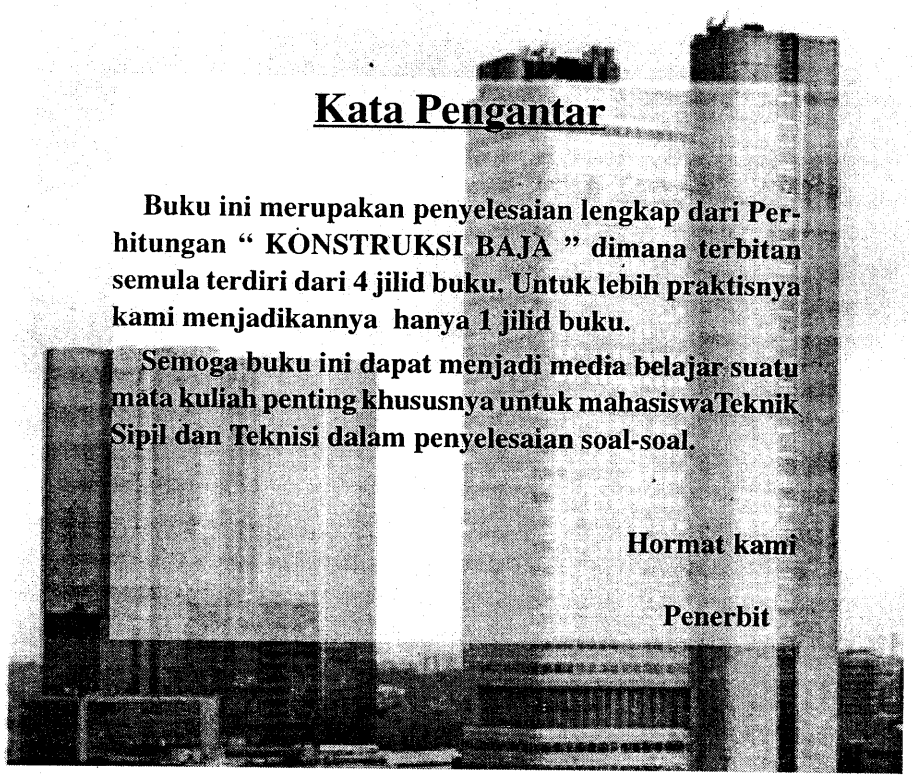
Perwajahan sampul :
Teguh Wahyudi

Setting dan lay out :
Bagian Produksi YUSTADI Offset Printing

Dicetak oleh :
YUSTADI Offset Printing

Cetakan Pertama :
1986

Cetakan Kedua :
2000



Kata Pengantar

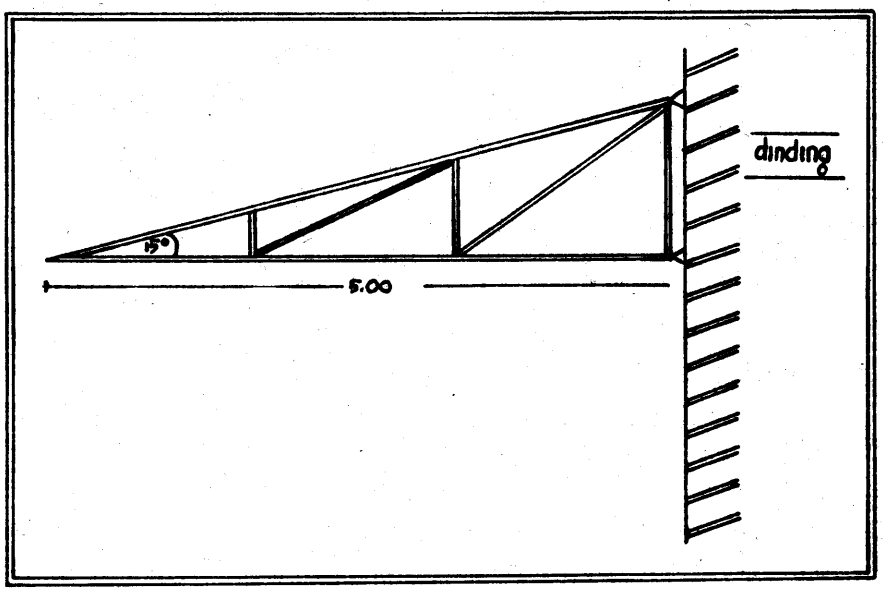
Buku ini merupakan penyelesaian lengkap dari Perhitungan " KONSTRUKSI BAJA " dimana terbitan semula terdiri dari 4 jilid buku. Untuk lebih praktisnya kami menjadikannya hanya 1 jilid buku.

Semoga buku ini dapat menjadi media belajar suatu mata kuliah penting khususnya untuk mahasiswa Teknik Sipil dan Teknisi dalam penyelesaian soal-soal.

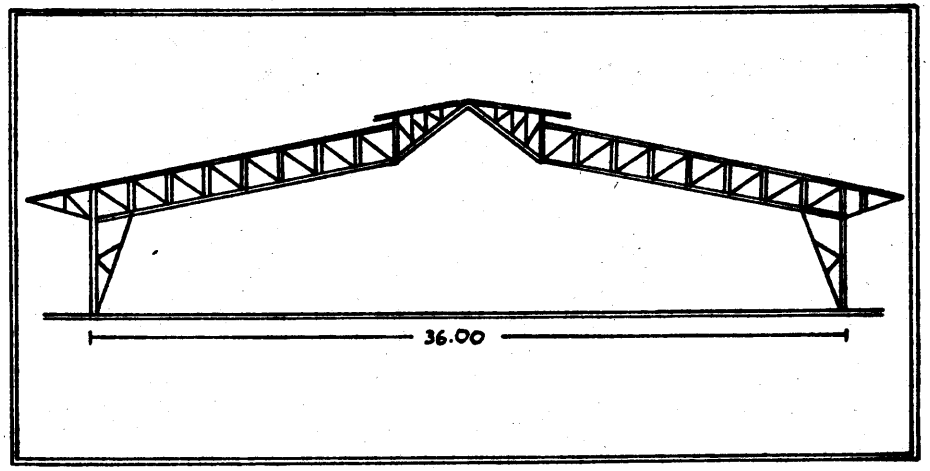
Hormat kami

Penerbit

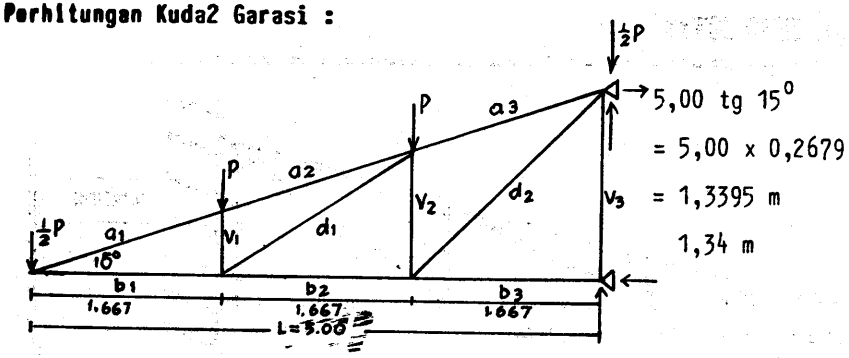
ATAP BAJA UNTUK TERAS



ATAP BAJA GUDANG 3 SENDI



Perhitungan Kuda2 Garasi :



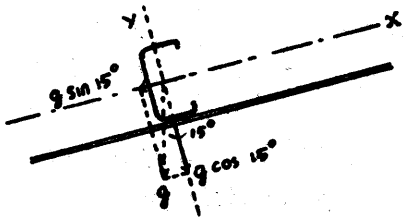
5,00 tg 15°
= 5,00 x 0,2679
= 1,3395 m
1,34 m

1. **Ketentuan2 :**

- Bentang Kuda2 : L = 5,00 meter.
- Jarak Kuda2 : 6,00 meter.
- Jarak gording = $\frac{1}{3}\left(\frac{5,00}{\cos 15^0}\right) = \frac{1}{3} \times \frac{5,00}{0,9659} = \frac{5,00}{2,8977} = 1,726$ m.
- Gording C 125 x 50 x 20 x 3,2
- $\alpha = 15^0$
- Atap dari B.W.G. 26
- Tidak pakai langit2 eternit.

Perhitungan Gording :

- Jarak Kuda2 = 6,00 meter.
- Jarak gording = 1,726 meter.
- Dipakai gording 125 x 50 x 20 x 3,2 dengan ketentuan2 :



F = 7,807 cm^2
g = 6,13 kg/m'
Ix = 181 cm^4
Wx = 29 cm^3
Iy = 26,6 cm^4
Wy = 8,02 cm^3

- Penutup atap dari seng gelombang : berat = 10 kg/m^2 (B.W.G. 26)

Beban2 :

a. **Beban mati :**

- Berat gording ——— = 6,13 kg/m'
- Berat atap (seng gelombang B.W.G. 26)
  1,726 x 10 x 1,00 ——— = 17,26 kg/m'

g = 23,39 kg/m'

Bout2 = 10 % — = 2,339 kg/m'

g = 25,729 kg/m' ⇝ 26 kg/m'

$Mx_1 = \frac{1}{8} g \cos\alpha \times (\ell \text{ gording})^2 = \frac{1}{8} \times 26 \cos 15^0 \times 6,00^2$

$= \frac{1}{8} \times 26 \times 0,96593 \times 36,00$

= 113,01 kg.m.

Diberi penggantung gording 1 buah di-tengah2 bentang gording.

$My_1 = \frac{1}{8} g \sin\alpha \ell^2 = \frac{1}{8} \times 26 \sin 15^0 \times \left(\frac{6,00}{2}\right)^2$

$= \frac{1}{8} \times 26 \times 0,5882 \times 9,00 = 7,57$ kg.m.

b. Beban angin :

Beban angin : $W = 40$ kg/m^2.

1. Dipihak angin : $C_1 = (+0,02 - 0,4) - 0,6 = (0,02 \times 15^0 - 0,4) = 0,6$
   (Angin dari kiri) $= - 0,1 - 0,6 = - 0,7$
2. Angin dari kanan : $C_2 = - 0,4 + 0,3 = - 0,1$

Beban angin dari kiri : $W_1 = C_1 \times 1,726 \times 40 = - 0,7 \times 1,726 \times 40$
$= - 48,328$ kg/m'.

Beban angin dari kanan : $W_2 = C_2 \times 1,726 \times 40 = - 0,1 \times 1,726 \times 40$
$= - 6,904$ kg/m'.

$Mx_2 = \frac{1}{8} \times - 48,328 \times 6,00^2 = - 217,5$ kg.m.

$Mx_2' = \frac{1}{8} \times - 6,904 \times 6,00^2 = - 31,1$ kg.m.

$My_2 = 0$ (tidak ada beban angin sb.y.).

c. Beban kebetulan / beban hidup.

Diperhitungkan pekerja P = 100 kg berada di-tengah2 bentang.

$Mx_3 = \frac{1}{4} P \cos \times 6,00 = \frac{1}{4} \times 100 \cos 15^0 \times 6,00 = \frac{1}{4} \times 100 \times 0,966 \times 6,00$
$= 144,9$ kg.m.

$My_3 = \frac{1}{4} P \sin 15^0 \times \frac{6,00}{2} = \frac{1}{4} \times 100 \sin 15^0 \times 3,00 = \frac{1}{4} \times 100 \times 0,259 \times 3,00$
$= 19,425$ kg.m.

Kombinasi pembebanan : (pada waktu angin bekerja, muatan orang tidak ada).

I. a + b

II. a + c

I. a + b ----> $Mx_1 + Mx_2 = 113,01 - 217,5 = - 104,49$ kg.m.
$Mx_1 + Mx_2' = 113,01 - 31,1 = 81,91$ kg.m.
$My_1 + My_2 = 7,57 + 0 = 7,57$ kg.m.
$My_1 + My_2' = 7,57 + 0 = 7,57$ kg.m.

II. a + c ----> $Mx_1 + Mx_3 = 113,01 + 144,9 = 257,91$ kg.m.
$My_1 + My_3 = 7,57 + 19,425 = 26,995$ kg.m.

M max : Mx = 257,91 kg.m. } yang menentukan
My = 26,995 kg.m. } kombinasi II : a + c

Tegangan yang terjadi :

$$\sigma = \frac{Mx}{Wx} + \frac{My}{Wy} = \frac{257,91 \times 10^2}{29} + \frac{26,995 \times 10^2}{8,02}$$

$$= \frac{25791}{29} + \frac{2699,5}{8,02}$$

$$= 889,345 + 336,596$$

$$= 1225,941 \text{ kg/cm}^2 < \bar{\sigma} \text{ baja} = 1400 \text{ kg/cm}^2.$$

Kontrole Lendutan :

$$f_y = \frac{5}{384} \frac{g \cos \alpha \ell^4}{E.Ix} + \frac{1}{48} \frac{P \cos \alpha \ell^3}{E.Ix}$$

$$= \frac{5}{384} \times \frac{26 \cos 15^0 (600)^4 \times 10^2}{2,1 \times 10^6 \times 181} + \frac{1}{48} \frac{100 \cos 15^0 (600)^3}{2,1 \times 10^6 \times 181}$$

$$= \frac{5 \times 26 \times 0,966 \times 6^4 \times 10^8 \times 10^{-2}}{384 \times 2,1 \times 10^6 \times 181} + \frac{100 \times 0,966 \times 6^3 \times 10^6}{48 \times 2,1 \times 10^6 \times 181}$$

$$= \frac{1.6.27,5168}{145958,4} + \frac{20.865,6}{18244,8}$$

$$= \frac{162751,68}{145958,4} + 1,144$$

$$= 1,115 + 1,144 = \underline{2,259 \text{ cm.}}$$

$$f_x = \frac{5}{384}\,\frac{g \sin\alpha\, \ell^4}{E.Iy} + \frac{1}{48}\,\frac{P \sin\alpha\, \ell^3}{E.Iy}$$

$$= \frac{5 \times 26 \sin 15^0 \times 300^4 \times 10^{-2}}{384 \times 2,1 \times 10^6 \times 26,6} + \frac{100 \sin 15^0 \cdot 300^3}{48 \cdot 2,1 \times 10^6 \times 26,6}$$

$$= \frac{5 \times 26 \times 0,259 \times 3^4 \times 10^8 \times 10^{-2}}{384 \times 2,1 \times 10^6 \times 26,6} + \frac{100 \times 0,259 \times 3^3 \times 10^6}{48 \times 2,1 \times 10^6 \times 26,6}$$

$$= \frac{2727,27}{21450,24} + \frac{699,3}{2681,28}$$

$$f = \sqrt{fx^2 + fy^2} = \sqrt{0,388^2 + 2,259^2}$$

$$= \sqrt{0,150544 + 5,1031}$$

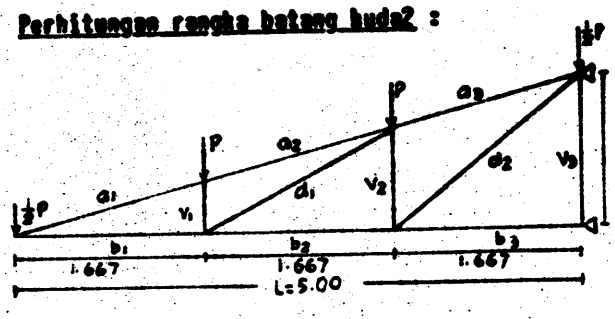
$$= \sqrt{5,253625} = 2,292 \text{ cm.}$$

$$\bar{f} = \frac{1}{250}\ell = \frac{1}{250} \times 600 = 2,4 \text{ cm.}$$

$f < \bar{f}$ (2,292 cm < 2,4 cm)

Jadi gording : C 125 x 50 x 20 x 3,2 dapat dipakai.

Perhitungan rangka batang kuda2 :



5,00 tg 15⁰
= 5,00 x 0,2679
= 1,34 m.

Beban2 yang bekerja :

1. Beban mati.
2. Beban angin - dari kiri
   - dari kanan.

1. Beban mati :

a. Beban atap + gording = 26 kg/m' x 6,00 m = 156 kg.

b. Berat sendiri rangka kuda2 :

- Batang atas : 2 ⊥L 30.30.3 = $2 \times \frac{5,00}{\cos 15^0} \times 1,36$

  $2 \times \frac{5,00}{0,966} \times 1,36 = \underline{14,08 \text{ kg.}}$

- Batang bawah : 2 ⊥L 40.40.4 = 2 x 5,00 x 2,42
  = $\underline{24,2 \text{ kg.}}$

- Batang vertikal : 2 ⊥L 40.40.4 = 2x(0,45+0,893+1,34) x 2,42
  = 2x2,683x2,42 = $\underline{12,986 \text{ kg.}}$

- Batang diagonal : 2 ⊥L 30.30.3 = 2x(1,89 + 2,14) x 1,36
  = 2 x 4,03 x 1,36 = $\underline{10,962 \text{ kg.}}$

G Kuda2 = 62,228 kg.

G Kuda2 = 62,228 kg

Berat2 + plat penyambung

= 20% = 0,20x62,228 = 12,4456 kg

G Kuda2 total = 74,6736 kg

c. Beban pekerja = 100 kg.

Tiap titik simpul menerima gaya $P = 156 + 100 + \frac{74,6736}{3}$

$P = 156 + 100 + 24,89$

$P = 280,89$ kg ≈ 281 kg.

2. Beban angin :

W = 40 kg/m

Angin bertiup dari kiri : $C_1 = (0,02-0,4)-0,6 = (0,02x15^0-0,4) - 0,6$

$= (0,3-0,4) - 0,6 = -0,1-0,6 = -0,70$

Dipihak angin : $W_1 = C_1 \times 1,726 \times 6,00 \times 40$

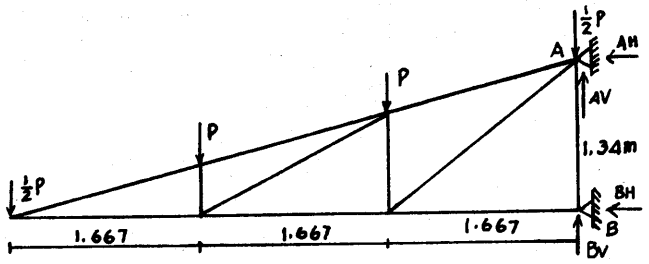
$= -0,70 \times 1,726 \times 6,00 \times 40 = -289,97$ kg

-290 kg

Angin bertiup dari kanan : $C_2 = -0,1$

Dibelakang angin : $W_2 = -0,1 \times 1,726 \times 6,00 \times 40 = -41,43$ kg.

Mencari gaya2 batang rangka akibat berat sendiri/berat mati.



$A_V + B_V = 3P = 3 \times 281 = 843$ kg.

$A_V = B_V = \frac{1}{2} \times 843 = 421,5$ kg.

$\sum M_B = 0$

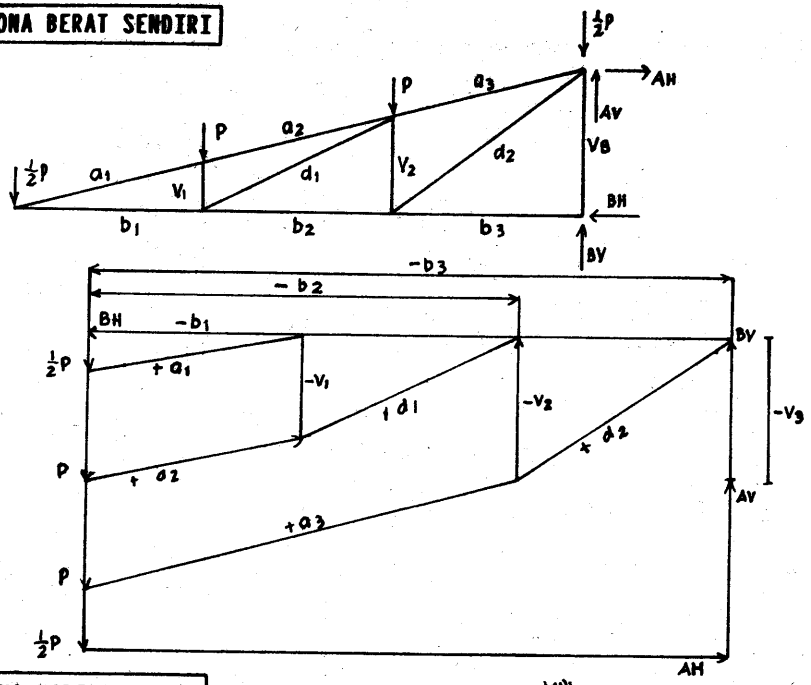
$A_H \times 1,34 - P \times 1,667 - P \times 3,334 - \frac{1}{2} P \times 5,00 = 0$

$$A_H = \frac{(1,667 + 3,334 + \frac{5.00}{2}) P}{1,34} = \frac{7,501\ P}{1,34} = 5,598\ P$$

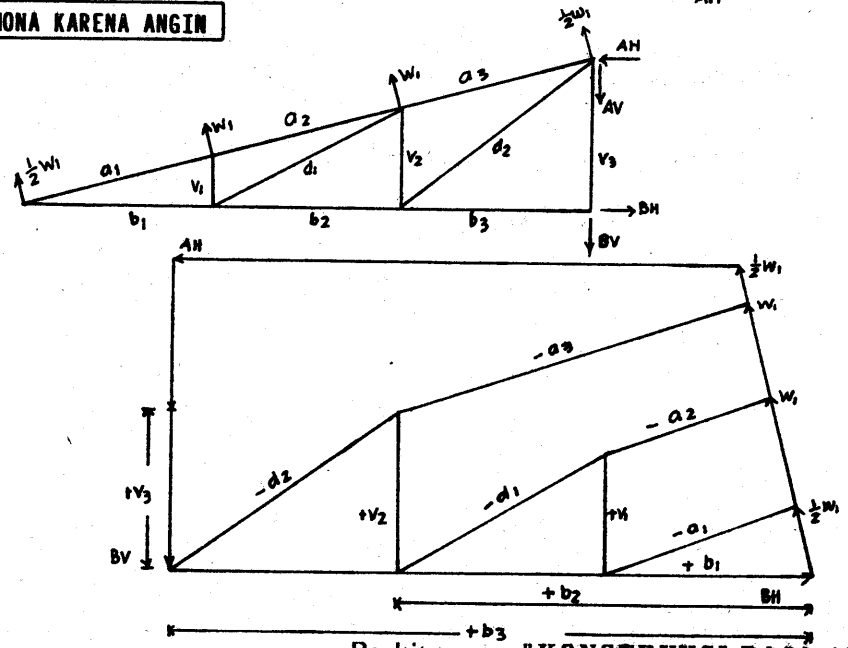
$A_H = 5,598 \times 281 = 1573,04$ kg

$B_H = A_H = 1573,04$ kg.

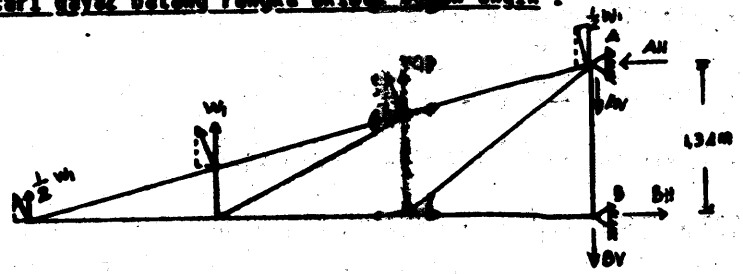
CREMONA BERAT SENDIRI



CREMONA KARENA ANGIN



Mencari gaya2 batang rangka akibat beban angin :



$\Sigma M_A = 0$

$B_H \times 1,34 + \frac{1}{2} W_1 \cos 15^0 \times 5,00 + W_1 \cos 15^0 \times 3,334 + W_1 \cos 15^0 \times 1,667$

$+ \frac{1}{2} W_1 \sin 15^0 \times (3 \times 1,667 \text{ tg } 15^0)$

$+ W_1 \sin 15^0 \times (2 \times 1,667 \text{ tg } 15^0)$

$+ W_1 \sin 15^0 \times (1 \times 1,667 \text{ tg } 15^0) = 0$

$B_H \times 1,34 = W_1 \cos 15^0 \left(\frac{5,00}{2} + 3,334 + 1,667 \right)$

$+ W_1 \sin 15^0 \text{ tg } 15^0 \times 1,667 \left(\frac{3}{2} + 2 + 1 \right)$

$B_H \times 1,34 = 290 \times 0,966(7,501) + 290 \times 0,259 \times 0,268 \times 1,667(4,50)$

$= 2101,33 + 151,00$

$= 2252,33$

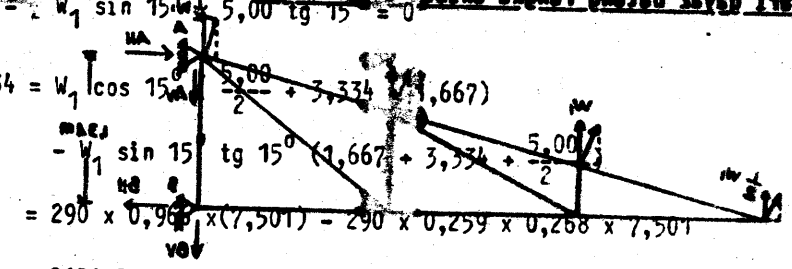
$B_H = 1680,80 \text{ kg.}$

$\Sigma M_B = 0$

$-A_H \times 1,34 + \frac{1}{2} W_1 \cos 15^0 \times 5,00 + W_1 \cos 15^0 \times \frac{2 \times 5,00}{3} + W_1 \cos 15^0 \times \frac{5,00}{3}$

$- W_1 \sin 15^0 \times \frac{5,00}{3} \text{ tg } 15^0 - W_1 \sin 15^0 \frac{2 \times 5,00}{3} \text{ tg } 15^0$

$= W_1 \sin 15^0 \times 5{,}00 \operatorname{tg} 15 = 0$



$A_H \times 1{,}34 = W_1 \cos 15^0 \left(\frac{5{,}00}{2} + 3{,}334 + 1{,}667\right)$

$- W_1 \sin 15^0 \operatorname{tg} 15^0 \left(1{,}667 + 3{,}334 + \frac{5{,}00}{2}\right)$

$= 290 \times 0{,}966 \times (7{,}501) - 290 \times 0{,}259 \times 0{,}268 \times 7{,}501$

$= 2101{,}33 - 150{,}99122 = 1950{,}34$ kg.

$A_H = \frac{1950{,}34}{1{,}34} = 1455{,}48$ kg

$A_V + B_V = 3\ W_1 \cos 15^0 = 3 \times 290 \times 0{,}966 = 840{,}42$ kg.

$A_V + B_V = \frac{1}{2} \times 840{,}42 = \underline{\underline{420{,}21 \text{ kg}}}$.

Beban mati :

$P = 281$ kg

$2 \text{ cm} = 281 \text{ kg}$ $\qquad 1 \text{ cm} = 140{,}5$ kg

a_1	= 3,90 cm	= 3,90	x 140,5	= + 547,95	kg
a_2	= 3,90 cm	= 3,90	x 140,5	= + 547,95	kg
a_3	= 7,80 cm	= 7,80	x 140,5	= + 1095,90	kg
b_1	= 3,78 cm	= 3,78	x 140,5	= - 531,09	kg
b_2	= 7,52 cm	= 7,52	x 140,5	= - 1056,56	kg
b_3	= 11,2 cm	= 11,196	x 140,5	= - 1573,04	kg
V_1	= 3,00 cm	= 3,00	x 140,5	= - 421,5	kg
V_2	= 3,00 cm	= 3,00	x 140,5	= - 421,5	kg
d_1	= 4,25 cm	= 4,25	x 140,5	= - 597,125	kg
d_2	= 4,65 cm	= 4,65	x 140,5	= + 653,325	kg

Angin dari kiri :

$W_1 = -290$ kg

$2 \text{ cm} = -290 \text{ kg}$ $\qquad 1 \text{ cm} = 145$ kg

a_1	= 3,80 cm	= 3,80	x 145	= - 551	kg
a_2	= 3,28 cm	= 3,28	x 145	= - 475,6	kg
a_3	= 6,80 cm	= 6,80	x 145	= - 986	kg
b_1	= 3,98 cm	= 3,98	x 145	= + 577,1	kg
b_2	= 7,90 cm	= 7,90	x 145	= + 1145,5	kg
b_3	= 11,592 cm	= 11,592	x 145	= + 1681	kg ($= B_H$)
V_1	= 2,10 cm	= 2,10	x 145	= + 304,5	kg
V_2	= 3,05 cm	= 3,05	x 145	= + 442,25	kg
V_3	= 2,948 cm	= 2,948	x 145	= + 420,21	kg ($= B_V$)
d_1	= 4,40 cm	= 4,40	x 145	= - 638	kg
d_2	= 4,79 cm	= 4,79	x 145	= - 694,55	kg

Angin dari kanan :

$W_2 = -41{,}43$ kg

$2 \text{ cm} = -41{,}43 \text{ kg}$ $\qquad 1 \text{ cm} = -20{,}715$ kg

a_1	= 3,80 cm	= 3,80	x 20,715	= - 78,717	kg
a_2	= 3,28 cm	= 3,28	x 20,715	= - 67,945	kg
a_3	= 6,80 cm	= 6,80	x 20,715	= - 140,862	kg
b_1	= 3,98 cm	= 3,98	x 20,715	= + 82,446	kg
b_2	= 7,90 cm	= 7,90	x 20,715	= + 163,648	kg
b_3	= 11,592cm	= 11,592	x 20,715	= + 240,128	kg ($= B_H$)
V_1	= 2,10 cm	= 2,10	x 20,715	= + 43,501	kg
V_2	= 3,05 cm	= 3,05	x 20,715	= + 63,181	kg

V_3 = 2,898 cm = 2,898 x 20,715 = + 60,032 kg

d_1 = 4,40 cm = 4,40 x 20,715 = - 91,146 kg

d_2 = 4,79 cm = 4,79 x 20,715 = - 99,225 kg

$1,34 \times B_H = 41,43 \times 0,966 \times 7,501 + 41,43 \times 0,259 \times 0,268 \times 1,667 \times 4,50$

$1,34 \times B_H = 300,200 + 21,572$

$= 321,772$

$B_H = \frac{321,772}{1,34} = 240,129$ kg.

$A_H \times 1,34 = 41,43 \times 0,966 \times 7,501 - 41,43 \times 0,259 \times 0,268 \times 7,501$

$= 300,200 - 21,571$

$= 278,629$

$A_H = 207,932$ kg.

$A_V = B_V = \frac{1}{2} \times 3 \times 41,43 \times 0,966 = 60,032$ kg.

Controle :

$A_H = B_H = 3 W_2 \sin 15^0 = 240,129 - 3 \times 41,43 \times 0,259$

$= 240,129 - 32,494$

$= 207,938$ kg $\simeq$ 207,932 kg (cocok)

Gaya2 Batang (dalam kg)

Nomor Batang	Beban			
	Mati	Angin dari kiri	Angin dari kanan	Maximum
a_1	+ 547,95	- 551	- 78,717	+ 547,45
a_2	+ 547,95	- 475,6	- 67,945	+ 547,95
a_3	+ 1095,90	- 986	- 140,862	+ 1095,90
b_1	- 531,09	+ 577,1	+ 82,446	- 531,09
b_2	- 1056,56	+ 1145,5	+ 163,648	- 1056,56
b_3	- 1573,04	+ 1681	+ 240,128	- 1573,04
V_1	- 281	+ 304,5	+ 43,501	- 281
V_2	- 421,5	+ 442,25	+ 63,181	- 421,5
V_3	- 421,5	+ 420,21	+ 60,032	- 421,5
d_1	+ 597,125	- 638	- 91,146	+ 579,125
d_2	+ 653,325	- 694,55	- 99,225	+ 653,325

Kontrole Kekuatan Sambungan :

Dipakai bout ∅ 8,5 mm (d)

Pelat simpul 4 mm (t)

Tekanan geser : $Kg = 2 \times \frac{1}{4}\pi \ d^2 \ . \ 0,6 \ . \bar{\sigma}$

$= \frac{1}{2}\pi \times 0,85^2 \times 0,6 \times 1400$

$= 952,833$ kg.

Tekanan tumpu : $Kt = t \ . \ d \ . \ 1,2 \ . \bar{\sigma}$

$= 0,4 \times 0,85 \times 1,2 \times 1400$

$= 571,2$ kg.

Kt < Kg -> Kt yang menentukan
Kt = 571,2 kg

Gaya tarik maximum = + 1095,90 kg

Banyaknya bout : $n = + \frac{1095,90}{571,2} = 1,92 \backsim 2$ bout.

Untuk batang tekan dipakai bout ∅ 11 mm (d)
Pelat simpul 4 mm (t)

Tekanan geser : $Kg = 2 \times \frac{1}{4}\pi \ d^2 \ . \ 0,6 \ . \bar{\sigma}$

$= 2 \times \frac{1}{4}\pi \times 1,1^2 \times 0,6 \times 1400$

$= \frac{1}{2}\pi \times 1,1^2 \times 0,6 \times 1400$

$= 1595,75$ kg.

Tekanan tumpu : $Kt = t \ . \ d \ . \ 1,2 \ . \bar{\sigma}$

$= 0,4 \times 1,1 \times 1,2 \times 1400$

$= 739,2$ kg

Kt < Kg ----> Kt yang menentukan
Kt = 739,2 kg

Gaya tekan maximum = - 1573,04 kg

Banyaknya bout : $n = \frac{1573,04}{739,2} = 2,13 \backsim 3$ bout.

Perhitungan tegangan, batang yang terjadi :

Batang atas dipakai : Profil ⊥ 30 . 30 . 3

Luas 1 profil = 1,74 cm^2

Luas netto = Luas profil - t.d.

$= 1,74 - 0,3 \times 0,85$

$= 1,74 - 0,255$

$= 1,485 \ cm^2$.

Gaya tarik maximum yang terjadi = + 1095,90 kg

(a_3 = + 1095,90 kg)

Baja yang terjadi $= \frac{a_3}{F \text{ netto}} = \frac{1095,90}{2 \times 1,485} = \frac{1095,90}{2,97}$

$= 368,99 \ kg/cm^2 < \bar{\sigma}$ baja $= 1400 \ kg/cm^2$ (safe)

Batang bawah dipakai : Profil ⊥ 40 . 40 . 4

Luas 1 profil = 3,08 cm^2

Gaya tekan maximum yang terjadi = - 1573,04 kg

(b_3 = - 1573,04 kg)

Panjang batang $= \left(\frac{5,00}{\cos 15^o} \right) \frac{1}{3} = \frac{5,00}{0,966} \times \frac{1}{3} = 1,726$ m = jarak gording

Panjang tekuk (ℓ_K) = 1,726 m = 172,6 cm.

i minimum = ix = 1,21 cm

$\lambda = \frac{\ell_K}{i \text{ min}} = \frac{172,6}{1,21} = 142,64$ ----> $\omega = 0,208$

$$\sigma \text{ tekan} = \frac{b_3}{2 \times F \text{ prof} \times \alpha} = \frac{- 1573,04}{2 \times 3,08 \times 0,208} = \frac{1573,04}{1,2813}$$

$= 1227,69 \text{ kg/cm}^2 < \bar{\sigma} \text{ baja} = 1400 \text{ kg/cm}^2$ (safe)

Perhitungan sambungan dengan kolom :

$A_H = H = 1573,04$ kg

$A_V = V = 421,5$ kg

Dipakai bout 1,4 --------> F bout $= \frac{1}{4} \pi d^2$

$= \frac{1}{4} \times 3,14 \times 1,4^2$

$= 1,54 \text{ cm}^2$

Tegangan Normal yang terjadi :

$$\sigma = \frac{H}{F} = \frac{1573,04 \text{ kg}}{2 \times 1,54} = 510,73 \text{ kg/cm}^2$$

Tegangan Geser yang terjadi :

$$\tau = \frac{V}{F} = \frac{421,5}{2 \times 1,54} = 136,85 \text{ kg/cm}^2.$$

σ yang terjadi $= \sqrt{\sigma^2 + 3\tau^2} = \sqrt{510,73^2 + 3 \times 136,85^2}$

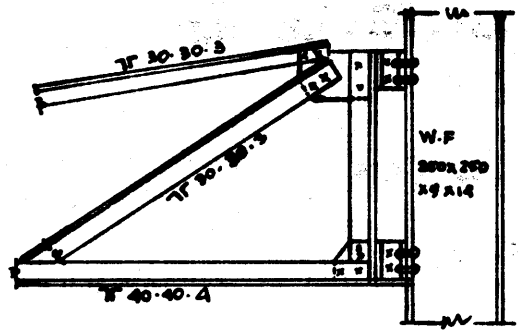
$= \sqrt{260.845,13 + 56183,766}$

$= \sqrt{317 \cdot 0,28 \cdot 89}$

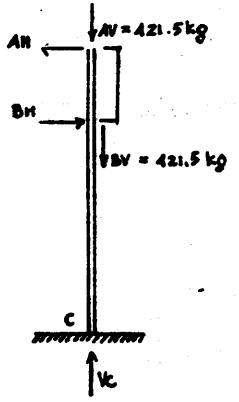
$= 563.053 \text{ kg/cm}^2$

<< $0,8 \bar{\sigma} = 0,8 \times 1400$

$= \underline{1120 \text{ kg/cm}^2}.$



Perhitungan Kolom :



$A_H = B_H = 1573,04$ kg

$A_V = B_V = 421,5$ kg

Dipakai profil W.F. 250x250x9x14

$W_x = 857 \text{ cm}^3$
$W_y = 292 \text{ cm}^3$
$i_x = 10,8$ cm
$i_y = 6,29$ cm
$g = 72,4$ kg/m
$F = 92,18$ cm2

M max = M di C $= A_H \times 6,00 - B_H (6,00 - 1,34)$

$= 1573,04 \times 6,00 - 1573,04 \times 4,66$

$= 9438,24 - 7330,366$

$= \underline{2107,874 \text{ kg.m.}}$

$V_C = A_V + B_V +$ berat sendiri profil W.F. 250 x 250 x 9 x 14

$= 421,5 + 421,5 + 6,00 \times 72,4$

$= 843 + 434,4 = \underline{1277,4 \text{ kg.}}$

$$Sn = (25 \times 1,4)\left(\frac{25}{2} - 0,7\right) + \frac{\left(\frac{25}{2} - 1,4\right) \times (0,9)\left(\frac{25}{2} - 1,4\right)}{2}$$

$= 35 \times 11,8 + 11,1 \times 0,9 \times 5,55$

$413 + 55,44$

$S(\frac{1}{2}\ profil) = 468,44\ cm^3$

$\sigma_t = \frac{M}{Wx} = \frac{210787,4}{857} = 245,96\ kg/cm^2$

$\sigma_K = \frac{P}{\alpha F} = \frac{1277,4}{\alpha \times 92,18}$

$\lambda = \frac{\ell K}{i\ min} = \frac{2 \times 600}{iy} = \frac{1200}{6,29} = 190,78 \backsim 191 \rightarrow \alpha = 0,116$

$\sigma_K = \frac{1277,4}{0,116 \times 92,18} = \frac{1277,4}{10,693} = 119,46\ kg/cm^2$

$\sigma = \sigma_t + \sigma_K = 245,96 + 119,46 = 365,42\ kg/cm^2$

$= A_H = B_H = 1573,04\ kg$

$\tau = \frac{D \times Sn}{b \times In}$

$In = Ix = 10.800\ cm^4$

$\tau = \frac{1573,04 \times 468,44}{0,90 \times 10.800} = \frac{736.874,85}{9720} = 75,810\ kg/cm^2$

σ yang terjadi $= \sqrt{\sigma^2 + 3\tau^2}$

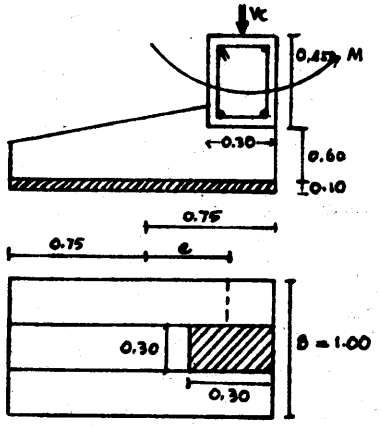
$= \sqrt{365,42^2 + 3 \times 75,810^2}$

$= \sqrt{133.531,77 + 17241,468}$

$= \sqrt{150.773,23}$

$= 388,30\ kg/cm^2 << \bar{\sigma}$ baja $= 1400\ kg/cm^2$ (safe)

Perhitungan Pondasi :



M kolom = 2107,874 kg.m.

Beban2 yang bekerja :

- V_C = 1277,4 kg ——— = 1277,4 kg
- Berat balok sloof 30/40 = 0,30x0,40x6,00x2400 = 1728 kg
- Berat kolom penyambung 0,20 m = 0,20 x 0,30 x 0,30 x 2400 ——— = 43,2 kg
- Balok Rib = $\left(\frac{0,30 + 1,50}{1,80}\right)\frac{0,50}{2} \times 0,30 \times 2400$ = 324 kg
- Berat alas pondasi = 0,10 x 1,50 x 1,50 x 2400 = 540 kg

V total = 3921,6 kg

$\backsim$ 3913 kg

M total = M kolom - V total x e

= 2107,874 - 3913 x (0,75 - 0,15)

= 2170,874 - 2347,8

= 239,926 kg.m. = 23992,6 kg.cm.

$$\sigma_{tanah} = \frac{V_{total}}{F} \pm \frac{M}{W}$$

$$= \frac{3913}{150 \times 100} \pm \frac{23992,6}{1/6 \times 100 \times 150^2}$$

$$= \frac{3913}{15.000} \pm \frac{23.992,6}{375.000}$$

$$= 0,216 \pm 0,064$$

$$= 0,325 \text{ kg/cm}^2 < \bar{\sigma}_{tanah} = 0,35 \text{ kg/cm}^2 \quad \text{(safe)}$$

Perhitungan penulangan pelat pondasi :

$\sigma_{tanah} = 0,35 \text{ kg/cm}^2 = 0,35 \times 10.000 \text{ kg/m}^2 = 3500 \text{ kg/m}^2$.

M pelat $= \sigma_{tanah} \times \frac{1}{2} B \times 1,00 \times \frac{1}{2} (\frac{1}{2} B)$

$= \frac{1}{2} \sigma_{tanah} \times (\frac{1}{2} B)^2$

$= \frac{1}{2} \times 3500 \times (\frac{1,00}{2})^2$

$= \frac{1}{2} \times 3500 \times 0,50^2$

$= 437,5 \text{ kg/m'}$

$$Ca = \frac{h}{\sqrt{\frac{n.M}{b \times a}}} = \frac{10 - 1,00 - 0,50}{\sqrt{\frac{24 \times 437,5}{1,00 \times 1400}}} = \frac{8,50}{2,7386}$$

$Ca = 3,1038$

$\delta = 0$ ----> n W = 0,1190

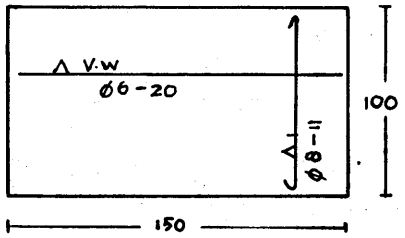
$\phi = 1,604 > \phi\ 0 = \frac{1400}{60 \times 24} = \frac{1400}{1440} = 0,9722$

$A = \frac{0,1190}{24} \times 100 \times 8,50 = 4,215 \text{ cm}^2$

Dipakai tulangan : ϕ 8 - 11,00 = 4,57 cm^2 > 4,215 cm^2

tulangan pembagi : V.W. = 20 % = 0,843 cm^2

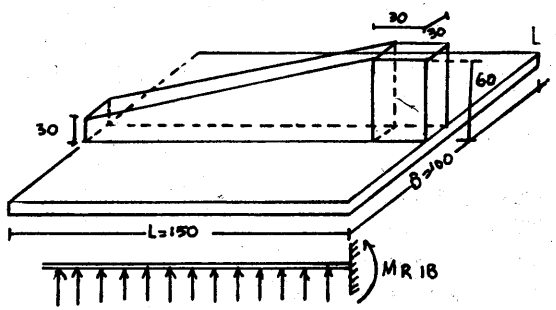
------> dipakai : tulangan : ϕ 6 - 20 = 1,41 cm^2 > 0,843 cm^2



Perhitungan Balok Rib : 30/60

B = lebar pelat pondasi

L = panjang pelat pondasi



M rib $= \sigma_{tanah} \times B \times L \times \frac{1}{2} L$

$= \frac{1}{2} \sigma_{tanah}\ B\ L^2$

D rib $= \sigma_{tanah} \times B \times L$

M rib $= \frac{1}{2} \times 3500 \times 1,00 \times 1,50^2 = 3937,5 \text{ kg.m.}$

D rib $= 3500 \times 1,00 \times 1,50 = 5250 \text{ kg}$

M rib = 3937,5 kg.m.

$$C_a = \frac{60 - 5}{\sqrt{\frac{3937,5 \times 24}{0,30 \times 1400}}} = \frac{55}{15} = 3,6667$$

$\delta = 0,4$ ----> n W = 0,08646

$\phi = 2,125 > \phi_o = 0,972$

$A = \frac{0,08646}{24} \times 30 \times 55 = 5,944 \text{ cm}^2$

Dipakai tulangan : $3\phi 16 = 6,03 \text{ cm}^2 > 5,944 \text{ cm}^2$

$A' = 0,4\ A = 0,4 \times 5,944 = 2,378 \text{ cm}^2$

Dipakai tulangan : $3\phi 12 = 3,39 \text{ cm}^2 > 2,378 \text{ cm}^2$.

Perhitungan geser :

D max = D rib = 5250 kg

$$\tau_b = \frac{D_{max}}{6 \times 7/8\ h} = \frac{5250}{30 \times 7/8 \times 55} = \frac{5250}{1443,75} = 3,64 \text{ kg/cm}^2.$$

Diberi tulangan geser praktis : tulangan miring ϕ 12 dan beugel ϕ6 - 15.

Direncanakan : Ukuran gudang 36 x 115 m^2
Tinggi : 700 m
Konstruksi : pelengkung 3 sendi (lihat gambar)
Tekanan angin : 100 kg/m2
Dinding : tak tahan lagi, tembok ½ bt
tertutup dengan pintu sorong.
Pintu sorong : 8 buah, ukuran 4,80 x 4,00 m^2
Atap : Harflex gelombang.

Gudang yang direncanakan : Panjang : 115 m
Bentang : 36 m

Kuda2 dibagi 24 bagian ----> a = 1,50 m

Jarak gording : $\frac{1,50}{0,94869} = 1,58$ m.

Ikhtisar :

I. **Perhitungan gording** : 1. Dimensi gording.
2. Kontrole terhadap $\bar{\sigma}$ dan penurunan.

II. **Perhitungan kuda2 dan kolom** :
1. Perhitungan beban (kombinasi pembebanan)
2. Perhitungan gaya2 batang (cremona)
3. Dimensi profil kuda2
4. Perhitungan jumlah baut dan kontrole terhadap excentrisitas.
5. Perhitungan sendi kuda2
6. Perhitungan anker kuda2

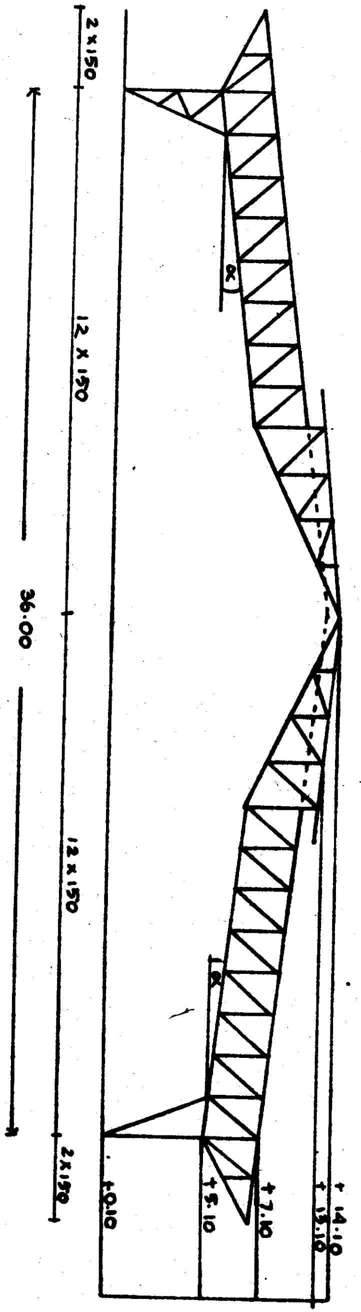
III. **Perhitungan untuk kopwand** : Pembebanan dan dimensi profil.

IV. **Perencanaan pondasi dan sloof dari pelat beton bertulang.**
1. Sloof memanjang
2. Pondasi kuda2
3. Penulangan kolom kopwand
4. Pondasi kolom kopwand
5. Sloof kopwand

= jarak gording : $\frac{1500}{0,9469}$ = 1581 mm = 1,58 m

= jarak kuda2 : 500 m

= digunakan atap harflex gelombang = 0,92 x 1,80 m^2



$\alpha = 18^0 26'$

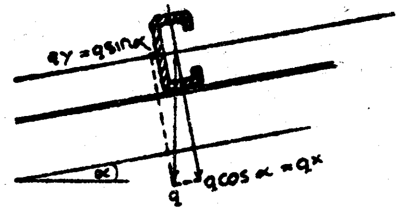
$\sin\alpha = \frac{1}{10}\sqrt{10} = 0,31623$

$\cos\alpha = \frac{3}{10}\sqrt{10} = 0,94869$

$\text{tg}\,\alpha = \frac{6}{18} = \frac{1}{3}$

I. Perhitungan gording :

I.1. Dimensi gording :



- Jarak kuda2 : 5,00 m.
- Jarak gording : 1,581 m.

Dipakai 1 penggantung gording.

$L_x = L$; $L_y = \frac{1}{2} L$.

Digunakan : [125x50x20x3,2

- Berat = 6,31 kg/m.
- $I_x = 181\ cm^4$, $I_y = 26,6\ cm^4$
- $W_x = 29,0\ cm^3$, $W_y = 8,02\ cm^3$
- $E = 2,1 \times 10^6\ kg/cm^2$.

I.2. Kontrole terhadap $\bar{\sigma}$ dan lendutan :

- Pembebanan arah ⊥ x.

1. Berat sendiri profil = 6,31 cos α = 6,31x0,94869 = 6 kg/m' } = qx
2. Berat atap harflex = 15 kg/m^2.

---> Tekanan pada gording = 15 x 1,581 x cos = 22,5 kg/m

$Mx_{12} = \frac{1}{8}(6 + 22,5)\ 5^2 = 89$ kgm.

3. Akibat angin : dipihak angin : C = 0,02.18,43-0,4 = 0,0313

---> Isapan angin : W1 = -0,0313 x 100 x 1,581 = -4,8 kg/m

Dibelakang angin C = -0,4 -> W_2 = 0,4x100x1,581 = -63,3 kg/M.

$Mx3\ W_1 = \frac{1}{8} \cdot -4,8 \cdot 5^2 = -15$ kgm.

$Mx3\ W_2 = \frac{1}{8} \cdot -63,3 \cdot 5^2 = -197,8$ kgm.

4. Beban hidup : ambil P = 100 kg di-tengah2 bentang gording

Px = 100 x 0,94869 = 95 kg

$Mx_4 = \frac{1}{4} \cdot 95,5 = 119$ kgm.

- **Pembebanan arah ! sumbu y :**

1. Berat sendiri = 5,31 . 0,31623 = 2 kg/m.
2. Berat atap = 15 x 1,581 x 0,31623 = 7,5 kg/m

} qy = 9,5 kg/m'

$$My_{12} = \frac{1}{8}(2 + 7{,}5)\left(\frac{5}{2}\right)^2 = 7{,}5 \text{ kgm.}$$

3. Beban angin = 0 ----> M = 0
4. Beban hidup = 100 x 0,31623 = 32 kg = Py

$My_4 = \frac{1}{4} \cdot 32 \cdot \frac{5}{2} = 20$ kgm ----> seharusnya = 0
32 kg = Py langsung diterima penggantung gording ditengah bentang.

Kombinasi pembebanan.

M max didapat akibat (1) , (2) & (4)

Mx = 89 + 119 = 208 kgm.

My = 7,5 + 20 = 27,5 kgm.

$$\sigma = \frac{Mx}{Wx} + \frac{My}{Wy} = \frac{20.800}{29} + \frac{2750}{802} = 717 + 343 = 1060 \text{ kg/cm}^2 < \bar{\sigma}$$

$\bar{\sigma} = 1400$ kg/cm^2

Memenuhi syarat kekuatan.

Kontrole terhadap lendutan.

$$fx = \frac{5}{384}\cdot\frac{qx.lx^4}{EIx} + \frac{Px.lx^3}{48\,EIx}$$

qx = 6 + 22,5 = 28,5 kg/m
= 0,285 kg/cm

$$= \frac{5}{384}\cdot\frac{0{,}285.500^4}{2{,}1.10^6.181} + \frac{47{,}5.500^3}{48.2{,}1.10^6.181}$$

$= 0{,}611 + 0{,}325 = 0{,}936$ cm.

Px = diambil 50% x 95 = 47,5 kg
qy = 2 + 7,5 = 9,5 kg/m = 0,095 kg/cm
Py = diambil 50% x 32 = 16 kg

$$fy = \frac{5}{384}\cdot\frac{qy.ly^4}{EIy} + \frac{Py.ly^3}{48\,EIy}$$

$$= \frac{5}{384}\cdot\frac{0{,}095\left(\frac{500}{2}\right)^4}{2{,}1\cdot10^6\cdot26{,}6} + \frac{16\left(\frac{500}{2}\right)^3}{48\cdot2{,}1\times10^6\cdot26{,}6}$$

$= 0{,}087 + 0{,}093 = 0{,}180$ cm

$$f = \sqrt{fx^2 + fy^2} = \sqrt{0{,}936^2 + 0{,}180^2} = \sqrt{0{,}9085} = \underline{0{,}953 \text{ cm.}}$$

-----> $< \bar{f} = \frac{1}{500}\, l = 1$ cm.

Memenuhi syarat lendutan !

Bila P = 100 kg --> Px = 95 kg ; Py = 32 kg --> f = 1,29 cm
$< \frac{1}{300}\, l = 1{,}666$ cm

Gording [125 x 50 x 20 x 3,2 bisa digunakan !

II. PERENCANAAN KUDA PELENGKUNG 3 SENDI

II.1. Perhitungan beban :

II.1. 1. Beban mati : A. Menghitung P_1

a. Berat sendiri kuda2 = 36 kg/m^2
Beban B.S. kuda2 tiap gording = 36 x 5 x 1,5 = 270 kg
b. Akibat berat sendiri gording = 5 x 6,31 = 31,55 kg
c. Akibat atap harflex = 5 x 1,581x15 = 118,58 kg
= 420,13 kg

$P_1 = \backsim 430$ kg.

B. Menghitung P_2 -----> beban pada gording tepi.

a. Beban B.S. Kuda2 = $\frac{1}{2}$ x 270 = 135 kg

b. Beban B.S. gording = = 31,55 kg

c. Beban atap harflex = $\frac{1}{2}$ x 118,58 = 59,29 kg

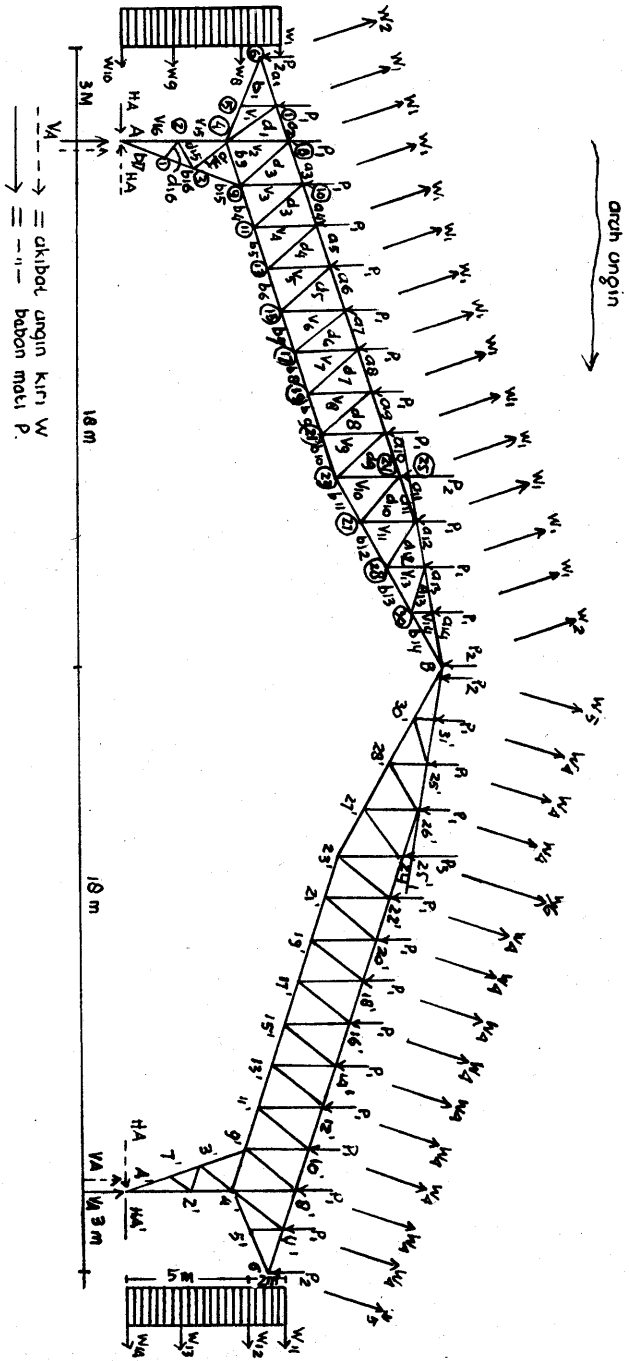
P_2 = 225,84 kg ≈ 230 kg.

C. Menghitung P_3.

a. Berat sendiri kuda2 = 36 x 1,5 x 5 = 270 kg

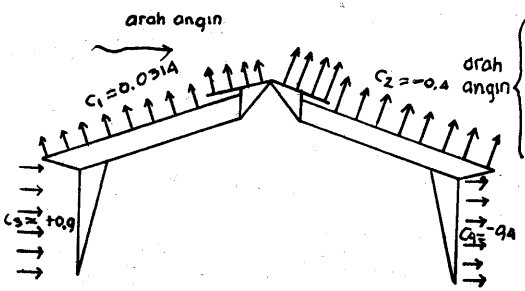
b. Berat 3 gording = 3 x 31,55 = 94,65 kg

c. Berat atap harflex = 15 x 5 x 2,75 = 570,90 kg ≈ 580 kg.



1.2. Beban Angin :

$C_1 = 0{,}02\alpha - 0{,}4 = 0{,}02(18{,}43) - 0{,}4$
$= 0{,}3686 - 0{,}4 = -0{,}0314$



$W_1 = -0{,}0314 \times 1{,}581 \times 5 \times 100 = -25$ kg

$W_2 = -0{,}0314 \times \frac{1{,}581}{2} \times 5 \times 100 = -12{,}5$ kg

$W_3 = -0{,}0314 \times 2{,}75 \times 5 \times 100 = -45$ kg

$W_4 = -0{,}4 \times 1{,}581 \times 5 \times 100 = -320$ kg

$W_5 = -0{,}4 \times \frac{1{,}581}{2} \times 5 \times 100 = -160$ kg

$W_6 = -0{,}4 \times 2{,}75 \times 100 = -550$ kg

(dibelakang angin)

$W_7 = +0{,}9 \times 100 \times 5 \times 1 = +450$ kg

$W_8 = +0{,}9 \times 100 \times 5 \times 2{,}25 = +1015$ kg

$W_9 = +0{,}9 \times 100 \times 5 \times 2{,}5 = +1125$ kg

$W_{10} = +0{,}9 \times 100 \times 5 \times 1{,}25 = +563$ kg

$W_{11} = -0{,}4 \times 100 \times 5 \times 1 = -200$ kg

$W_{12} = -0{,}4 \times 100 \times 5 \times 2{,}25 = -450$ kg

$W_{13} = -0{,}4 \times 100 \times 5 \times 2{,}5 = -500$ kg

$W_{14} = -0{,}4 \times 100 \times 5 \times 1{,}25 = -250$ kg

II.2. Perhitungan kekuatan/gaya batang :

II.2.1. Beban mati :

* $\Sigma V = 0$ ----> $V_A = V_A' = 12\,P_1 + 2\,P_2 + P_3$

$= 12.430 + 2.230 + 580$

$= 5160 + 460 + 580 = 6200$ kg

* $\Sigma M_B = 0$ ----> $V_A \times 18 - 14 \times H_A = 230 \times 21 + 430\,(19{,}5 + 18 + 16{,}5 + 15 + 13{,}5 + 12 + 10{,}5 + 9 + 7{,}5 + 4{,}5 + 3 + 1{,}5) + 580.6$

$14\,H_A = 111.600 - 4830 - 56115 - 3480 = 47175$

$H_A = \frac{47175}{14} = 3370$ kg (----->)

$H_A' = 3370$ kg (<-----)

* Free body separuh kuda2 : A - B.

$\Sigma H = 0$ ---> $H_B = 3370$ kg (<---) $H_B' = 3370$ kg (--->)

Kontrole $\Sigma M_A = 0$

$H_B.14 + 230.3 + 430.1{,}5 = 430(1{,}5 + 3 + 4{,}5 + 6 + 7{,}5 + 9 + 10{,}5 + 13{,}3 + 15 + 16{,}5) + 230.18 + 580.12$

$14\,H_B = 37410 + 4140 + 6960 - 690 - 645 = 47175$

$H_B = \frac{47175}{14} = 3370$ kg (<----) Cocok !

* Konstruksi simetris, pembebanan simetris ----> $V_B = 0$

* Cremona : (lihat gambar)

II.2.2. Beban angin (angin kiri).

* $\Sigma V = 0$ --> $V_A + V_A' = (12\,W_1 + 2W_2 + W_3)\cos\alpha + (12\,W_4 + 2W_5 + W_6)\cos\alpha$

$= \{(12)(-25) + (2)(-12{,}5) + (-45)\}\,0{,}94869 +$
$\{(12)(-320) + (2)(-160) + (-550)\}\,.\,0{,}94869$

$= (-300 - 25 - 45 - 3840 - 320 - 550)\,0{,}94869$

$= (-5080)\,.\,0{,}94869 = -4819$ kg ($\downarrow$) ..... (1)

* $\Sigma H = 0$ --> $H_A - H_A = -(12W_1 + 2W_2 + W_3)\sin\alpha + (12W_4 + 2W_5 + W_6)\sin\alpha + W_7 + W_8 + W_9 + W_{10} + W_{11} + W_{12} + W_{13} + W_{14}$

$= (-300 - 25 - 45 + 3840 + 320 + 550)(0,31623)$
$+ 450 + 1015 + 1125 + 563 + 200 + 450 + 500$
$+ 250.$

$= (4340.0,31623) + 4553$

$= + 5925$ kg (<----) ..... (2)

* Free body : - Bagian sebelah kiri konstruksi (A - B).

$\Sigma M_B = 0$ --> $H_A.14 + W_1.1,581(1 + 2 + 3) + W_1 [(1,581)(5 + 6 + 7 + 8$
$+ 9 + 10 + 11 + 12 + 13) + 9.0,31623] + W_2$
$(1,581.14 + 0,316) + W_3.1,581.4 + 18\ V_A - W_7.7 - W_8.9 -$
$W_9.11,5 - W_{10}.14 = 0$

$14\ H_A + 18\ V_A + 25\ (1,581.87 + 2,85) + 12,5 \times 22,45 + 45$
$\times 1,581 \times 4 - 450 \times 7 - 1015.9 - 1125 \times 11,5 - 563 \times 14 = 0.$

$14\ H_A + 18\ V_A + 3510 + 281 + 284 - 3150 - 9135 - 12983 - 7882 = 0.$

$14\ H_A + 18\ V_A = 29030$ --> $7\ H_A + 9\ V_A = 14,515$ ..... (3)

* Free body : - Bagian sebelah kanan konstruksi (A - B)

$\Sigma M_B = 0$ --> $14\ H_A' + 18\ V_A' + W_4 [1,581\ 1 + 2 + 3 + 4 + 5 + 6 + 7 +$
$8 + 9 + 10 + 11 + 12 + 13) + 9,031623] + W_5$
$(1,581.14 + 0,316) + W_6.1,581.4 + W_{11}.7 + W_{12}.9 + W_{13} \cdot$
$11,5 + W_{14}.14 = 0$

$14\ H_A + 18\ V_A' + 320\ (1,581 \times 87 + 2,85) + 160.22,452$
$+ 550.1,581.4 + 200.7 + 450.9 + 500.11,5 + 250.14 = 0$

$14\ H_A' + 18\ V_A' + 44.930 + 3592 + 3479 + 1400 + 4050$
$+ 5750 + 3500 = 0$

$14\ H_A' + 18\ V_A' = -66.701$ --> $7\ H_A' + 9\ V_A' = -33351$ ..... (4)

1. $V_A + V_A' = - 4819$ ---> $9\ V_A + 9\ V_A' = - 43.374$
2. $H_A - H_A' = + 5925$ ---> $7\ H_A - 7\ H_A' = + 41.478$
3. $7\ H_A + 9\ H_A = 14.515$
4. $7\ H_A' + 9\ V_A' = - 33.351$

1. $9\ V_A + 9\ V_A' = - 43.374$
2. $7\ H_A - 7\ H_A' = + 41478$
3. $9\ V_A + 7\ H_A = + 14.515$ +
   $9\ V_A' - 7\ H_A = - 57.889$ .. (5)
4. $9\ V_A' + 7\ H_A' = - 33351$ +
   $9\ V_A' + 7\ H_A = + 8127$ ... (6)

5. $9\ V_A' - 7\ H_A = - 57889$
6. $9\ V_A' + 7\ H_A = + 8127$ +
   $18\ V_A' = - 49762$ ----- $V_A' = - 2764$ kg (↓)

1. $V_A + V_A' = - 4819$ ---> $V_A = - 4819 + 2764 = - 2055$ kg (↓)
2. $H_A - H_A' = + 5925$ ---> $H_A' = 4715 - 5929 = -1210$ kg (<---)
3. $9\ V_A + 7\ H_A = \frac{14515 + 9.2055}{7} = + 4751$ kg (<---)

* Tinjauan bagian kiri konstruksi (A - B) : andaikan H_B + (--->)

V_B + (↑)

$\Sigma V = 0 : (12\ W_1 + 2\ W_2 + W_3) \cos\alpha + V_B - 2055 = 0$

$V_B = 2055 - (12.25 + 2.12{,}5 + 45)\ 0{,}94869$

$= 2055 - 370.0{,}94869$

$= 2055 - 351 = 1704$ kg (↑)

$\Sigma H = 0 : (12\ W_1 + 2\ W_2 + W_3) \sin - H_B + H_A - W_7 - W_8 - W_9 - W_{10} = 0$

$370.0{,}31623 - H_B + 4715 - 450 - 1015 - 1125 - 563 = 0$

$H_B = 117 + 4715 - 3153 = +1679$ kg (<---)

H_B' + (<---)

* Kontrole : Tinjau bagian kanan konstruksi (A - B) : ambil (↓)

$\Sigma V = 0$ ---> $(12\ W_4 + 2\ W_5 + W_6) \cos\alpha - V_B' - V_A' = 0$

$(12.320 + 2.160 + 550)\ 0{,}94869 - V_B' - 2764 = 0$

$V_B' = 4710.0{,}94869 - 2764 = +1704$ kg (↓)

$V_B + V_B = 1704 - 1704 = 0$. Cocok !!!

$\Sigma H = 0$ ---> $(12\ W_4 + 2\ W_5 + W_6) \sin\alpha - H_B' + W_{11} + W_{12} + W_{13} +$

$W_{14} - H_A' = 0$

$4710.0{,}31623 - H_B' + 200 + 450 + 500 + 250 - 1210 = 0$

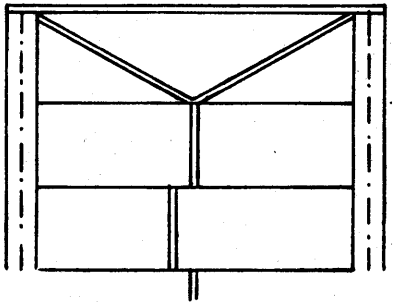
$H_B' = 1489 + 190 = +1679$ kg (<---)

$H_B + H_B' = 1679 - 1679 = 0$ ----> Cocok !!!

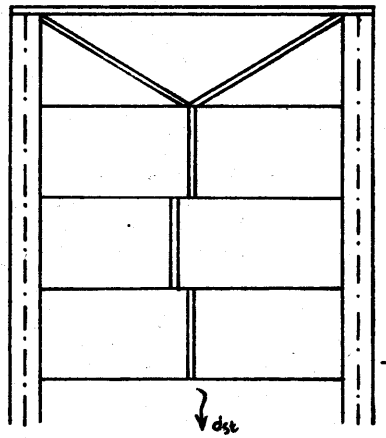
* **Cremona** (lihat gambar)

II.2.3. **Beban angin kanan.**

Dicari dengan cara analog dengan beban angin kiri.



* **Perhitungan penggantung gording.**



Beban tiap gording, arah sb y : qy = 9,5

Py = 32 kg (ditengah gording paling ber bahaya).

*** Tarikan pada penggantung gording - pergoding

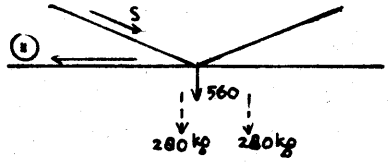
$= (\frac{1}{2}\ ql)\ 2 + P.$

$= 9{,}5 \cdot 5/2 + 32 = 56$ kg.

Banyaknya gording = 10 buah.

→ Gaya tarik penggantung gording teratas

$= 10 \times 56 = 560$ kg.

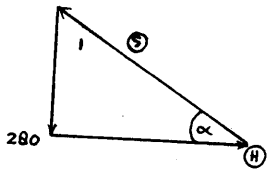


$\frac{560}{2} = S.\sin\alpha$ --> $S = \frac{560}{2} \cdot \frac{2{,}958}{1{,}581}$

$= 524$ kg.

$\bar{\sigma} = 1200$ kg/cm^2

$F = \frac{S}{\bar{\sigma}} = \frac{524}{1200} = 0{,}44$ cm^2.



Pakai penggantung gording $\phi\ \frac{1}{2}" = 1{,}27\ cm^2$.

$$\sin \alpha = \frac{1{,}581}{2{,}958}$$

$$\cos \alpha = \frac{2{,}500}{2{,}958}$$

II.3. Dimensi profil kuda2 :

1. Batang tarik :

- Diambil profil ⌐⌐ --> F ⌐⌐ = 2 x F ⌐ = F bruto.

  F netto = F bruto - 2 ϕ lubang baut x t (t = tebal besi siku)

  $\sigma_o = \frac{P}{F\ netto}$ ---> Syarat $\sigma_o < \bar{\sigma}_o = 1400\ kg/cm^2$.

NO BATANG	Tegangan yang terjadi akibat teg maximum: beban mati +	beban mati −	ANGIN KIRI +	ANGIN KIRI −	ANGIN KANAN +	ANGIN KANAN −	kombinasi beban +	kombinasi beban −	PROFIL YANG DI PAKAI	l = ℓk (cm)	F (cm²)	Fn (cm²)	Ix cm⁴	Iy cm⁴	ix cm	iy cm	λ	ω	σ̄ (kg/cm²)	σo (kg/cm²)	σ̄k (kg/cm²)	σk° kg/cm²
a1	370	−	−	18	−	220	370	−	TF 40x40x4	158.1	−	5.064	−	−	−	−	−	−	1400	73	−	−
a2	715	−	−	30	−	380	715	−	〃	〃	−	〃	−	−	−	−	−	−	1400	141	−	−
a3	6450	−	−	8910	3280	−	9730	2460	TF 60x60x6	〃	13.82	12.176	45.6	111.9	1.816	2.845	87	1.89	〃	799	741	178
a4	3640	−	−	7750	4600	−	8240	4110	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	677	〃	297
a5	1140	−	−	6600	5640	−	6780	5460	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	557	〃	395
a6	−	−	−	5480	6410	−	5410	6480	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	444	〃	469
a7	−	1000	−	4380	6920	−	4120	7180	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	338	〃	520
a8	−	2800	−	3310	7190	−	2990	7550	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	142	〃	546
a9	−	4240	−	2260	7150	−	1810	7600	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	149	〃	550
a10	−	5340	−	1220	6870	−	770	7320	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	63	〃	530
a11	−	6100	20	−	190	−	190	−	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	10	〃	−
a12	−	−	−	730	5550	−	600	5680	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	49	〃	411
a13	−	4950	−	700	6010	−	545	6665	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	45	〃	496
a14	−	5465	−	680	6120	−	655	6145	⊥ 40x40x4	〃	〃	〃	〃	〃	〃	1.206	131	4.06	1400	54	〃	449
b1	−	370	22	−	270	−	−	370	〃	〃	〃	〃	〃	25.1	1.206	1.206	131	4.06	1400	−	345	60
b2	−	370	22	−	270	−	−	370	⊥ 70x70x7	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	−	〃	60
b3	−	720	−	1620	1280	−	560	2340	〃	〃	18.8	16.64	84.8	199	2.124	2.124	74.4	1.58	〃	33	886	124
b4	−	100 10	10570	−	−	2810	560	12820	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	33	〃	682
b5	−	7180	9420	−	−	4030	2240	11210	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	133	〃	596
b6	−	4705	8280	−	−	4960	3575	9665	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	212	〃	514
b7	−	2575	7170	−	−	5620	4595	8195	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	215	〃	436
b8	−	790	6000	−	−	6030	5290	6820	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	314	〃	363
b9	680	−	5010	−	−	6170	5690	5490	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	398	〃	292
b10	1780	−	3960	−	−	6040	5740	4260	⊥ 60x60x6	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	341	〃	227
b11	3140	−	3630	−	−	6980	6770	3840	〃	195.3	13.82	12.76	46.6	111.9	1.816	2.845	108	2.76	〃	556	507	270

NO BATANG	Tegangan yang terjadi akibat: Beban mati +	Beban mati −	Angin kiri +	Angin kiri −	Angin kanan +	Angin kanan −	Teg maximum: kombinasi beban +	kombinasi beban −	PROFIL YANG DIPAKAI	ℓ = ℓk (cm)	F (cm²)	Fn (cm²)	Ix (cm⁴)	Iy (cm⁴)	ix (cm)	iy (cm)	λ	ω	σ̄ (kg/cm²)	σo (kg/cm²)	σ̄k (kg/cm²)	σk° kg/cm²
b12	1170	-	3090	-	-	4540	4260	3370	⊥ 60×60×6	195.3	13.82	12.76	45.6	111.9	1.816	2,845	108	2.76	1400	350	507	244
b13	1720	-	3050	-	-	5000	4770	3280	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-	392	-"-	237
b14	2360	-	3020	-	-	5440	5380	3080	⊥ 60×60×6	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-	442	-"-	223
b15	-	12820	13620	-	-	2685	800	15505	⊥ 80×80×8	162.7	24.6	21.9	144.6	332	2.424	3,674	68	7.46	-	37	959	630
b16	-	12820	15720	-	-	3620	2960	16440	-"-	203.7	-"-	-"-	-"-	-"-	-"-	-"-	84	1.81	-	135	773	668
b17	-	12820	15780	-	-	3620	2960	16440	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-"-	84	-"-	-	135	-"-	668
V1	-	-	-	-	-		-	-	⊥ 40×40×4	100	-	-	-	-	-	-	-	-	-	-	-	-
V2	6820	-	-	10640	4620		11440	3820	⊥ 60×60×6	200	13.82	12.176	45.6	111.9	1.816	2.845	110	2.86	1400	940	490	276
V3	-	4000	1500	-	1880	-	-	4000	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-	-	-"-	289
V4	-	3570	1480	-	1540	-	-	3570	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-	-	-"-	258
V5	-	3135	1450	-	1200	-	-	3135	⊥ 50×50×5	-"-	9.6	-	22	56.7	-"-	28	132	4.13	-	-	339	327
V6	-	2700	1420	-	860	-	-	2700	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-	-	"	281
V7	-	2265	1390	-	520	-	-	2265	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-	-	"	236
V8	-	1830	1360	-	180	-	-	1830	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-	-	"	191
V9	-	1400	1330	-	-	170	-	1570	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-	-	"	164
V10	-	2180	-	110	2200	-	20	2290	-"-	-"-	-"-	8.23	-"-	-"-	-"-	-"-	-"-	-"-	1400	2	"	239
V11	-	580	90	-	580	-	-	580	-"-	100	-"-	-	-"-	-"-	-"-	-"-	66	1,42	-	-	986	60
V12	2000	-	560	-	-	2480	2560	480	-"-	225	-"-	8.23	-"-	-"-	-"-	-"-	149	6,25	1400	811	267	50
V13	-	630	60	-	515	-	-	630	-"-	150	-"-	-	-"-	-"-	-"-	-"-	99	2,32	-	-	603	66
V14	-	430	30	-	345	-	-	430	-"-	75	-"-	-	-"-	-"-	-"-	-"-	90	1,2	-	-	1.167	45
V15	6170	-	-	11650	5600	-	11770	5490	⊥ 70×70×7	250	18.8	16.84	84.8	199	2,124	3,258	118	3.28	1400	699	427	292
V16	6170	-	-	13170	6260	-	12430	7000	"	"	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-"-	-"-	738	-"-	372
d1	-	465	28	-	370	-	-	465	⊥ 40×40×4	212.1	6.16	-	8.96	25.1	1.206	2,02	176	7.32	-	-	191	75

NO BATANG	Tegangan yang terjadi akibat: BEBAN MATI +	BEBAN MATI −	ANGIN KIRI +	ANGIN KIRI −	ANGIN KANAN +	ANGIN KANAN −	TEGANGAN MAXIMUM KOMBINASI BEBAN +	KOMBINASI BEBAN −	PROFIL YANG DIPAKAI	ℓ = ℓk (cm)	F (cm²)	Fn (cm²)	Ix (cm⁴)	Iy (cm⁴)	ix cm	iy cm	λ	ω	σ̄ kg/cm²	σo kg/cm²	σ̄k kg/cm²	σk° kg/cm²
d2		7700	11.190	-	-	4485	3490	12185	⊥ 80×80×8	212,1	24.6	21.9	144,6	332	2.424	3.674	87.5	1.9	1400	159	1307	490
d3	3790	-	-	1560		1640	3790	-	⊥ 50×50×5	-"-	-	8.23	-	-	-	-	-	-	-"-	461	-	-
d4	3340	-	-	1530		1270	3340	-	-"-	-"-	-	-"-	-	-	-	-	-	-	-"-	406	-	-
d5	2870	-	-	1500		910	2870	-	-"-	-"-	-	-"-	-	-	-	-	-	-	-"-	249	-	-
d6	2410	-	-	1470		560	2410	-	-"-	-"-	-	-"-	-	-	-	-	-	-	-"-	293	-	-
d7	1760	-	-	1440		195	1960	-	-"-	-"-	-	-"-	-	-	-	-	-	-	-"-	238	-	-
d8	1490	-	-	1410	175	-	1665	-	-"-	-"-	-	-"-	-	-	-	-	-	-	-"-	202	-	-
d9	1030	-	-	1380	530	-	1560	350	-"-	-"-	9.6	-"-	22	56,7	1,514	2.5	140.1	4.65	-"-	190	301	36
d10	-	1690	-	470	2090	-	400	2160	-"-	167.7	9.6	-"-	-"-	-"-	-"-	-"-	110.8	2.9	-"-	49	400	225
d11	-	6040	-	1050	6590	-	550	7090	⊥ 70×70×7	212,1	18.8	16.64	84,8	199	2.124	3.258	100	236	-"-	33	427	377
d12	500	-	-	40	-	420	500	-	⊥ 50×50×5	1803	-	8.23	-	-	-	-	-	-	-"-	61	-	-
d13	500	-	-	25	-	350	500	-	-"-	152.1	-	"	-	-	-	-	-	-	-"-	-"-	-	-
d14	-	-	810	-	-	375	810	375	-"-	182	9.6	8.23	22	56.7	1.514	2,4	100.4	2.38	-"-	98	588	39
d15	-	-	-	1910	840	-	840	1910	-"-	179	-"-	-"-	-"-	-"-	-"-	-"-	119,6	3.39	-"-	102	413	199
d16	-	-	-	-	-	-	-	-	-"-	76	-	-	-	-	-	-	-	-	-"-	-	-	-
d16'	-	-	-	-	-	1910	840	-	⊥ 50×50×5	76	-	-	-	-	-	-	-	-	1400	-	-	-
d15'	-	-	840	-	-		810	1910	-"-	179	916	8.23	22	56.7	1.514	2.4	149,6	3.39	-"-	102	413	199
d14'	-	-	-	375	810		500	375	-"-	152	"	-"-	-"-	-"-	-"-	-"-	100.4	2.38	-"-	98	588	39

No BATANG	TEGANGAN YANG TERJADI AKIBAT						TEG MAXIMUM		FROFIL YANG DIPAKAI	ℓ = ℓk	F	Fn	Ix	Iy	ix	iy	λ	ω	σ̄	σo	σ̄k	
	Baban mati		ANGIN KIRI		ANGIN KANAN		kombinasi baban			(cm)	(cm²)	(cm²)	(cm⁴)	(cm⁴)	cm	cm			kg/cm²	kg/cm²	kg/cm²	
	+	−	+	−	+	−	+	−														
d13'	500	−	−	350	−	25	500	−	⊓ 50x50x5	152.1	−	8.23	−	−	−	−	−	−	1400	61	−	−
d12'	500	−	−	420	−	40	550	−	− " −	180.3	−	−"−	−	−	−	−	−	−	−"−	61	−	−
d11'	−	6040	6390	−	−	1050	400	7090	⊓ 70x70x7	212.1	18.8	16.84	84.8	199	2,124	3.258	100	2.36	−"−	33	427	377
d10'	−	1690	2090	−	−	470	1560	2160	⊓ 50x50x5	167.7	9.6	8.23	22	56.7	1,514	2,4	110.8	2.9	−"−	49	403	225
d9'	1030	−	530	−	−	1380	1665	350	− " −	212.1	−"−	−"−	−"−	−"−	−"−	−"−	140,1	4.65	−"−	190	301	36
d8'	1490	−	175	−	−	1410	1665	−	− " −	−"−	−	−"−	−	−	−	−	−	−	−"−	202	−	−
d7'	1960	−	−	195	−	1440	1960	−	− " −	−"−	−	−"−	−	−	−	−	−	−	−"−	238	−	−
d6'	2410	−	−	560	−	1470	2410	−	− " −	−"−	−	−"−	−	−	−	−	−	−	−"−	293	−	−
d5'	2870	−	−	910	−	1500	2870	−	− " −	−"−	−	−"−	−	−	−	−	−	−	−"−	349	−	−
d4'	3340	−	−	1270	−	1530	3340	−	− " −	−"−	−	−"−	−	−	−	−	−	−	−"−	406	−	−
d3'	3790	−	−	1640	−	1560	3790	−	− " −	−"−	−	−"−	−	−	−	−	−	−	−"−	461	−	−
d2'	−	7700	−	4485	11.190	−	3490	12185	⊓ 80x80x8	−"−	24.6	21.9	144,6	332	2,424	3,674	87.5	1.9	−"−	139	737	495
d1'	−	−	370	−	28	−	−	465	⊓ 40x40x4	−"−	6.16	−	8.96	25.1	1,206	2,02	176	7.37	−	−	191	75
V16'	6170	465	−	−	−	13170	12430	7000	⊓ 70x70x7	250	18.8	16.84	896	199	2,124	3.258	118	3.28	1400	738	427	372
V15'	6170	−	6260	−	−	11660	11770	5490	− " −	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	699	−"−	292
V14'	−	−	5600	−	30	−	−	430	⊓ 50x50x5	75	9.6	22	22	56,7	1,514	2,4	50	1,2	−	−	1167	45
V13'	−	430	345	−	60	−	−	630	"	150	−"−	−	−"−	−"−	−"−	−"−	99	2.32	−	−	603	66
V12'	2000	630	515	2480	560	−	2560	480	"	225	−"−	8.23	−	"	−"−	−"−	1.49	5,25	1400	911	267	50
V11'	−	−	−	−	50	−	−	580	"	100	−"−	−	−"−	"	−"−	−"−	66	1,42	−	−	986	60
V10'	−	580	580	−	−	−	20	2290	"	200	−"−	8.23	−"−	"	−"−	−"−	132	4.13	1400	2	339	239
V9'	−	2180	2200	−	170	−	−	1570	"	−"−	−"−	−"−	−	"	−"−	−"−	"	−"−	−	−	−"−	164
V8'	−	1400	−	−	1360	−	−	1830	"	−"−	−"−	−	−"−	"	−"−	−"−	"	−"−	−	−	−"−	191
V7'	−	1839	180	−	1390	−	−	2265	"	−"−	−"−	−	−"−	"	−"−	−"−	"	−"−	−	−	−"−	236
V6'	−	2265	520	−	1420	−	−	2700	"	−"−	−"−	−	−"−	"	−"−	−"−	"	−"−	−	−	−"−	284
V5'	−	2700	860	−	1450	−	−	3135	"	−"−	−"−	−	−"−	"	−"−	−"−	"	−"−	−	−	−"−	324
V4'	−	3135	1200	−	1480	−	−	3570	⊓ 60x60x6	−"−	13.82	12.176	45.6	111.9	1.816	2.845	110	2.86	−	−	490	258

NO BATANG	TEGANGAN YANG TERJADI AKIBAT						TEGANGAN MAXIMUM		FROFIL YANG DIPAKAI	ℓ = ℓk	√F	Fn	Ix	Iy	ix	iy	λ	ω	σ̄	σo	σ̄k	σk
	BEBAN MATI		ANGIN KIRI		ANGIN KANAN		KOMBINASI BEBAN			(cm)	(cm²)	(cm²)	cm⁴	cm⁴	cm	cm			kg/cm²	kg/cm²	kg/cm²	kg/cm²
	+	−	+	−	+	−	+	−														
V3'	−	3570	1540	−	1500	−	−	4000	⊓ 60x60x6	200	13,82	12,176	45.6	111.9	1.816	2,845	110	2,86	−	−	490	289
V2'	6820	−	4620	−	−	10640	11 440	3820	−" −	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	1400	940	−"−	276
V1'	−	12820	−	−	−	−	−	−	⊓ 40x40x4	100	−	−	−	−	−	−	−	−	−	−	−	−
b17'	−	12820	−	3620	15780	−	2960	16440	⊔ 80x80x8	203.7	24.6	21.8	144.6	332	2,424	3,694	84	1,91	1400	135	773	668
b16'	−	12820	−	3620	15780	−	2960	16440	− " −	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	135	−"−	−"−
b15'	−	−	−	2685	13620	−	800	15505	− " −	182,7	−"−	−"−	−"−	−"−	−"−	−"−	68	1.46	−"−	37	959	630
b14'	2360	−	−	1,440	3020	−	5380	3080	⊔ 60x60x6	195,3	13,82	12.176	45.6	111.9	1,816	2,845	108	2,76	−"−	492	507	223
b13'	1720	−	−	5000	3050	−	4770	3280	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	392	−"−	237
b12'	1170	−	−	4540	3090	−	4260	3370	− " −	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	350	−"−	244
b11'	3140	−	−	6980	3630	−	6770	3840	− " −	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	556	−"−	278
b10'	1780	−	−	6040	3960	−	5740	4200	⊔ 70x70x7	158.1	18.8	1684	82.8	19.9	2,124	9,258	74.4	2.58	−"−	341	886	277
b9'	680	−	−	6170	5010	−	5690	5490	− " −	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	"	−"−	332	−"−	292
b8'	−	790	−	6030	6080	−	5290	6820	− " −	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	"	−"−	314	−"−	363
b7'		2575	−	5620	7170	−	4595	8195	− " −	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	"	−"−	273	−"−	496
b6'		4705	−	4960	8280	−	3575	9665	− " −	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	"	−"−	212	−"−	514
b5'		7180	−	4030	9420	−	2240	11210	− " −	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	"	−"−	133	−"−	596
b4'		1010	−	3810	10570	−	560	12820	− " −	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	"	−"−	33	−"−	682
b3'		720	1280	−	−	1620	560	2340	− " −	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	"	−"−	33	−"−	124
b2'		370	270	−	22	−	−	370	⊔ 40x40x4	−"−	6.16	−	8.96	25.1	1,206	202	1,31	4.06	−"−	−	345	60
b1'		270	270	−	22	−	−	370	−"−	−"−	−"−	−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−	−"−	60
a15'		5465	6120	−	−	680	655	6145	⊓ 60x60x6	−"−	13,82	12.176	45.6	111.9	1,816	2.845	87	1,89	−"−	54	741	445
a14'		5465	6010	−	−	700	545	6165	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	45	−"−	446
a12'		4950	5550	−	−	730	600	5680	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	−"−	49	−"−	411

NO BATANG	TEGANGAN YANG TERJADI AKIBAT: BEBAN MATI +	BEBAN MATI −	ANGIN KIRI +	ANGIN KIRI −	ANGIN KANAN +	ANGIN KANAN −	TEG. MAKSIMUM: KOMBINASI BEBAN +	KOMBINASI BEBAN −	PROFIL YANG DIPAKAI	ℓ = ℓk	F	FN	Ix	Iy	ix	iy	λ	ω	σ̄ kg/cm²	σo kg/cm²	σ̄k kg/cm²	σk° kg/cm²
a11'	−	−	−	−	−	−	−	−	⌐60x60x6	158,1	−	−	−	−	−	−	−	−	1400	16	−	−
a10'	−	6100	−	6870	−	12220	770	7320	〃	〃	13,82	45,6	41,9	1,816	2,845	87	1,89	〃	63	741	530
a9'	−	5340	−	7150	−	12260	1810	7600	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	149	〃	550
a8'	−	4240	−	7190	−	3310	2950	7550	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	242	〃	546
a7'	−	2800	−	6920	−	4380	4120	7180	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	338	〃	520
a6'	−	1000	−	6410	−	5480	5410	6480	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	444	〃	469
a5'	1140	−	−	5640	−	6600	6780	5460	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	547	〃	395
a4'	3640	−	−	4600	−	7150	8240	4110	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	677	〃	297
a3'	6450	−	−	3280	−	8910	9730	2460	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	799	〃	178
a2'	715	−	−	−	30	−	715	−	⌐40x40x4	−	5,09	−	−	−	−	−	−	−	141	−	−
a1'	370	−	−	−	18	−	570	−	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	73	−	−
VA	6200	↑	2055	↓	2764	↓															
HA	3370	→	4715	←	1210	→															
VB	−	−	1704	↑	1704	↓															
HB	3370	←	1679	→	1679	←															
HB'	3370	→	1679	←	1679	→															
VB'	−	−	1704	→	1704	↑															
HA'	3370	←	1210	←	4715	→															
VA'	6200	↑	2764	↓	2055	↓															

* Akibat beban mati : VA+HB = 3370 kg (←)
" " b.m + angin kiri : VB = 1704 kg (↑) HB = 1691 kg (←)

VB+HB$\sqrt{1704^2+1691^2}$ = 2401 kg

akibat bm + angin kanan VB = 1704 kg (↓) HB = 5049 kg (←)

VB+HB = $\sqrt{1704^2+5049^2}$ = 5329 kg

* Akibat beban mati : HA+VA = $\sqrt{6200^2+3370^2}$ = 7057 kg

" " b.m + a. kiri : VA = 6200 − 2055 = 4145 kg, HA = 3370 − 4715

VA+HA = $\sqrt{4145^2+1345^2}$ = 4358 kg = −1345 kg (←)

Contoh : Batang V_2 ----> tarikan = 11440 kg.

Panjang batang $l = l_k$ = 200 cm

Diambil profil ⌐ 60 x 60 x 6, baut Ø 5/8" = Ø 1,587 cm

lubang baut = 1,7 cm

F bruto = 2 x 6,91 cm^2 = 13,82 cm^2 (F ⌐ = 6,91 cm^2)

F netto = 13,82 − 2 x 1,7 x 0,6 = 11,78 cm^2

$$\sigma_o = \frac{11440}{11,78} = 971 \text{ kg/cm}^2 < \bar{\sigma}_e = 1400 \text{ kg/cm}^2.$$

----> memenuhi syarat.

2. Batang tekan :

- Diambil profil ⌐ ----> F ⌐ = 2 x F = F

$$\left.\begin{aligned} I_x \text{ ⌐} &= 2\, I_x \text{ ⌐} \\ I_y \text{ ⌐} &= 2(I_y + F.d^2) \end{aligned}\right\} \quad i_x = \sqrt{\frac{Ix}{F}} \;;\; i_y = \sqrt{\frac{Iy}{F}}$$

- Ambil i_x atau i_y yang terkecil ----> = i min.

$$\lambda = \frac{l_k}{i \text{ min}} = \ldots\ldots \text{ disini ujung2 batang = sendi - sendi}$$

$$l = l_k$$

Dari λ = ... , dari daftar tekuk baja didapat w = ... ;

$$\bar{\sigma}_k = \frac{\bar{\sigma}}{w}$$

$$\sigma_k{}^o = \frac{P}{F} \text{ ---> Syarat harus } < \bar{\sigma}_k = \frac{\bar{\sigma}}{w}$$

Contoh : batang b_4 ----> tekanan = 12820 kg

Panjang batang $l = l_k$ = 158,1 cm

Ambil profil ⌐ 65 x 65 x 7 (dalam tabel dimuka ⌐ 70x70x7)

F ⌐ = 2 x 8,7 = 17,4 cm^2 (F ⌐ = 8,7 cm^2).

$I_x \sqcap = I_y \sqcap = 33,4\ cm^4$; $S = 1,85$ cm ---> $d = 2,35$ cm

---> I_x ⊓ = $2 \times 33,4 = 66,8\ cm^4$

I_y ⊓ = $2(33,4 + 8,7.\overline{2,35}^2) = 163\ cm^4$

$i_x = \sqrt{\frac{66,8}{17,4}} = 1,959$ cm ; $i_y = \sqrt{\frac{163}{17,4}} = 3,06$ cm

$\longrightarrow \lambda = \frac{l_k}{i\ min} = \frac{158,1}{1,959} = 81$ ----> $w_o = 1,73$

$\bar{\sigma}_k = \frac{\bar{\sigma}}{w} = \frac{1400}{1,73} = 809\ kg/cm^2$.

$\bar{\sigma}_{k^o} = \frac{12820}{17,4} = 737\ kg/cm^2 < \bar{\sigma}_k$ ($\bar{\sigma}_k = 809\ kg/cm^2$)

Profil ini memenuhi syarat !!

I.4. Perhitungan Baut :

Digunakan baut : $\phi\ \frac{1}{2}"$ & $\phi\ \frac{5}{8}"$

Pelat buhul tebal 10 mm.

Kekuatan baut $\phi\ \frac{1}{2}" = 1,27$ cm

P geser = $2 \times \frac{1}{4}\pi\ d^2 \times 0,7\ \bar{\sigma}$

= $2 \times \frac{1}{4}.3,14.\overline{1,27}^2 \times 0,7.1400 = 2482$ kg = Ks

P tumpu = $t \times d \times 1,4\ \bar{\sigma}$

= $1 \times 1,27 \times 1,4.1400 = 2489$ kg = kg.

P yang menentukan ialah $\bar{P} = \underline{2482\ kg}$ (= P min).

Kekuatan baut $\phi\ \frac{5}{8}" = \phi\ 1,587$ cm

P geser = $2 \times \frac{1}{4}.3,14.\overline{1,587}^2 \times 0,7.1400 = 3875$ kg = Ks

P tumpu = $1 \times 1,587 \times 1,4 \times 1400 = 3111$ kg = kg

P yang menentukan : $\bar{P} = \underline{3111\ kg}$ (= P min).

Titik buhul A :

Batang V_{16} ----> P = 12430 kg --> baut $\phi\ \frac{5}{8}"$ --> $n = \frac{12430}{3111} \backsim 5$ baut $\phi\ \frac{5}{8}"$

Batang b_{17} ----> P = 16440 kg --> baut $\phi\ \frac{5}{8}"$ --> $n = \frac{16440}{3111} \backsim 6$ baut $\phi\ \frac{5}{8}"$

Titik buhul 1 :

Batang b_{17} ---> P = 16440 kg
Batang b_{16} ---> P = 16440 kg
} baut $\phi\ \frac{5}{8}"$ --> $n = \frac{16440 - 16440}{3111} = 0$
---> pakai 3 baut $\phi\ \frac{5}{8}"$

Batang d_{16} ---> P = ... kg ---> dipakai 2 baut $\phi\ \frac{1}{2}"$

Titik buhul 2 :

Batang V_{16} ---> P = 12430 kg
V_{15} ---> P = 11770 kg
} baut $\phi\ \frac{5}{8}"$ --> $n = \frac{12430 - 11770}{3111} \backsim 1$
---> ** pakai = 3 baut $\phi\ \frac{5}{8}"$

d_{15} ---> P = 1910 kg ---> baut $\phi\ \frac{1}{2}"$ -> $n = \frac{1910}{2482} \backsim$ 2baut $\phi\ \frac{1}{2}"$

d_{16} ---> P = —— ---> pakai 2 baut $\phi\ \frac{1}{2}"$

Titik buhul 3 :

Batang b_{16} ---> P = 16440 kg
b_{15} ---> P = 15505 kg
} baut $\phi\ \frac{5}{8}"$ -> $n = \frac{16440 - 15505}{3111} \backsim 1$
dipakai 3 baut $\phi\ \frac{5}{8}"$

d_{14} ---> P = 810 kg --> baut $\phi\ \frac{1}{2}"$ -> $n = \frac{310}{2482} \backsim 2$ baut $\phi\ \frac{1}{2}"$

d_{15} ---> P = 1910 kg --> baut $\phi\ \frac{1}{2}"$ -> $n = \frac{1910}{2412} \backsim 2$ baut $\phi\ \frac{1}{2}"$

Titik buhul 4 :

Batang d_{14} --> P = 810 kg --> baut $\phi \frac{1}{2}"$: $n = \frac{810}{2482} \backsim$ 2 baut $\phi \frac{1}{2}"$

V_{15} --> P = 11770 kg --> baut $\phi \frac{5}{8}"$: $n = \frac{11770}{3111} \backsim$ 4 baut $\phi \frac{5}{8}"$

b_2 --> P = 370 kg --> baut $\phi \frac{1}{2}"$: $n = \frac{370}{2482} \backsim$ 2 baut $\phi \frac{1}{2}"$

d_1 --> P = 465 kg --> baut $\phi \frac{1}{2}"$: $n = \frac{465}{2482} \backsim$ 2 baut $\phi \frac{1}{2}"$

V_2 --> P = 11440 kg --> baut $\phi \frac{5}{8}"$: $n = \frac{11440}{3111} \backsim$ 4 baut $\phi \frac{5}{8}"$

b_3 --> P = 2340 kg --> baut $\phi \frac{1}{2}"$: $n = \frac{2340}{2482} \backsim$ 2 baut $\phi \frac{1}{2}"$

Titik buhul 5 :

Ph_1 = 370 kg
P_2 = 370 kg
} ---> $n = \frac{370 - 370}{2482} \backsim$ 3 baut $\phi \frac{1}{2}"$.

Pv_1 = —— ---> pakai 2 baut $\phi \frac{1}{2}"$

Titik buhul 6 :

Pa_1 = 370 kg --> $n = 370/2482 \backsim$ 2 baut $\phi \frac{1}{2}"$

Pb_1 = 370 kg --> $n = 370/2482 \backsim$ 2 baut $\phi \frac{1}{2}"$

Titik buhul 7 :

Pa_1 = 370 kg
Pa_2 = 715 kg
} $n = \frac{-370 + 715}{2482} \backsim$ 3 baut $\phi \frac{1}{2}"$

Pd_1 = 465 kg --> $n = \frac{465}{2482} \backsim$ 2 baut $\phi \frac{1}{2}"$.

Pv_1 = —— --> n $\backsim$ 2 baut $\phi \frac{1}{2}"$

Titik buhul 8 :

Pa_2 = 715 kg ---> $n = \frac{715}{2482} \backsim$ 2 baut $\phi \frac{1}{2}"$

Pa_3 = 9730 kg ---> $n = \frac{9730}{3111} \backsim$ 4 baut $\phi \frac{5}{8}"$ --> $\phi \frac{1}{2}"$ tak memenuhi syarat exentrisitas.

Pd_2 = 12185 kg ---> $n = \frac{12185}{3111} \backsim$ 4 baut $\phi \frac{5}{8}"$

Pv_2 = 11440 kg ---> $n = \frac{11440}{3111} \backsim$ 4 baut $\phi \frac{5}{8}"$

Titik buhul 9 :

Pb_5 = 15505 kg ---> $n = \frac{15505}{3111} \backsim$ 6 baut $\phi \frac{5}{8}"$

Pb_3 = 560 kg
Pb_4 = 12820 kg
} --> $n = \frac{12820 + 560}{3111} \backsim$ 5 baut $\phi \frac{5}{8}"$

Pv_3 = 4000 kg --> $n = \frac{4000}{2482} \backsim$ 2 baut $\phi \frac{1}{2}"$

Pd_2 = 12185 kg --> $n = \frac{12185}{3111} \backsim$ 5 baut $\phi \frac{5}{8}"$

Titik buhul 10 :

Pa_3 = 9739 kg
Pa_4 = 8240 kg
} $n = \frac{9730 - 8240}{2482} \backsim$ 3 baut $\phi \frac{1}{2}"$

Pd_3 = 3790 kg --> $n = \frac{3790}{2482} \backsim$ 2 baut $\phi \frac{1}{2}"$

Pv_3 = 4000 kg --> $n = \frac{4000}{2482} \backsim$ 2 baut $\phi \frac{1}{2}"$

Titik buhul 11 :

Pb_5 = 11210 kg
Pb_4 = 12820 kg
--> $n = \frac{12820 - 11210}{3111}$ 4 baut ∅ $\frac{5}{8}$"

Pd_3 = 3790 kg --> $n = \frac{3790}{2482}$ 2 baut ∅ $\frac{1}{2}$"

Pv_4 = 3570 kg --> $n = \frac{3570}{2482}$ 2 baut ∅ $\frac{1}{2}$"

Titik buhul 12 :

Pa_4 = 8240 kg ---> $n = \frac{8240}{2482}$ 4 baut ∅ $\frac{1}{2}$"

Pa_5 = 6780 kg ---> $n = \frac{6780}{2482}$ 3 baut ∅ $\frac{1}{2}$"

Pd_4 = 3340 kg ---> $n = \frac{3340}{2482}$ 2 baut ∅ $\frac{1}{2}$"

Pv_4 = 3570 kg ---> $n = \frac{3570}{2482}$ 2 baut ∅ $\frac{1}{2}$"

Titik buhul 13 :

Pb_6 = 9665 kg ---> $n = \frac{9665}{3111}$ 4 baut ∅ $\frac{5}{8}$"

Pb_5 = 11210 kg ---> $n = \frac{11210}{3111}$ 4 baut ∅ $\frac{5}{8}$"

Pd_4 = 3340 kg ---> $n = \frac{3340}{2482}$ 2 baut ∅ $\frac{1}{2}$"

Pv_5 = 3135 kg ---> $n = \frac{3135}{2482}$ 2 baut ∅ $\frac{1}{2}$"

Titik buhul 14 :

Pa_5 = 6780 kg
Pa_6 = 5110 kg
---> $n = \frac{6780 - 5110}{2482}$ ≈ 3 baut ∅ $\frac{1}{2}$"

Pd_5 = 2870 kg ---> $n = \frac{2870}{2482}$ ≈ 2 baut ∅ $\frac{1}{2}$"

Pv_5 = 3135 kg ---> $n = \frac{3135}{2482}$ ≈ 2 baut ∅ $\frac{1}{2}$"

Titik buhul 15 :

Pb_7 = 8195 kg
Pb_6 = 9665 kg
---> $n = \frac{9665 - 8195}{3111}$ ≈ 4 baut ∅ $\frac{1}{2}$"

Pb_5 = 2870 kg ---> $n = \frac{2870}{2482}$ ≈ 2 baut ∅ $\frac{1}{2}$"

Pv_6 = 2700 kg ---> $n = \frac{2700}{2482}$ ≈ 2 baut ∅ $\frac{1}{2}$"

Titik buhul 16 :

Pa_6 = 6480 kg
Pa_7 = 7180 kg
---> $n = \frac{7180 - 6480}{2480}$ ≈ 3 baut ∅ $\frac{1}{2}$"

Pd_6 = 2410 kg ---> $n = \frac{2410}{2482}$ ≈ 2 baut ∅ $\frac{1}{2}$"

Pv_6 = 2700 kg ---> $n = \frac{2700}{2482}$ ≈ 2 baut ∅ $\frac{1}{2}$"

Titik buhul 17 :

Pb_8 = 6820 kg
Pb_7 = 8195 kg
---> $n = \frac{8195 - 6820}{2482}$ ≈ 4 baut ∅ $\frac{1}{2}$"

Pd_6 = 2410 kg ---> $n = \frac{2410}{2482}$ ≈ 2 baut ∅ ½"

Pv_7 = 2265 kg ---> $n = \frac{2265}{2482}$ ≈ 2 baut ∅ ½"

Titik buhul 18 :

Pa_7 = 7180 kg ---> $n = \frac{7180}{2482}$ ≈ 4 baut ∅ ½"

Pa_8 = 7550 kg --- > $n = \frac{7550}{2482}$ ≈ 4 baut ∅ ½"

Pd_7 = 1960 kg ---> $n = \frac{1960}{2482}$ ≈ 2 baut ∅ ½"

Pv_7 = 2265 kg ---> $n = \frac{2265}{2482}$ ≈ 2 baut ∅ ½"

Titik buhul 19 :

Pa_9 = 5690 kg ---> $n = \frac{5690}{2482}$ ≈ 3 baut ∅ ½"

Pb_8 = 6820 kg ---> $n = \frac{6820}{3111}$ ≈ 3 baut ∅ ½"

Pd_7 = 1960 kg ---> $n = \frac{1960}{2482}$ ≈ 2 baut ∅ ½"

Pv_8 = 1830 kg ---> $n = \frac{1830}{2482}$ ≈ 2 baut ∅ ½"

Titik buhul 20 :

Pa_8 = 7550 kg
Pa_9 = 7600 kg
} ---> $n = \frac{7600 - 7550}{2482}$ ≈ 3 baut ∅ ½"

Pd_8 = 1665 kg ---> $n = \frac{1665}{2482}$ ≈ 2 baut ∅ ½"

Pv_8 = 1830 kg ---> $n = \frac{1830}{2482}$ ≈ 2 baut ∅ ½"

Titik buhul 21 :

Ph_{10} = 5740 kg
Pb_9 = 5690 kg
} ---> $n = \frac{5740 - 5690}{2482}$ ≈ 4 baut

Pd_8 = 1665 kg ---> $n = \frac{1665}{2482}$ ≈ 2 baut ∅ ½"

Pv_9 = 1570 kg ---> $n = \frac{1570}{2482}$ ≈ 2 baut ∅ ½"

Titik buhul 22 :

Pa_9 = 7600 kg
Pa_{10} = 7320 kg
} ---> $n = \frac{7600 - 7320}{2482}$ ≈ 3 baut ∅ ½"

Pd_9 = 1560 kg ---> $n = \frac{1560}{2482}$ ≈ 2 baut ∅ ½"

Pv_9 = 1570 kg ---> $n = \frac{1570}{2482}$ ≈ 2 baut ∅ ½"

Titik buhul 23 :

Pb_{11} = 6770 kg ---> $n = \frac{6770}{2482}$ ≈ 3 baut ∅ ½"

Pb_{10} = 5740 kg ---> $n = \frac{5740}{2482}$ ≈ 3 baut ∅ ½"

Pd_7 = 1560 kg ---> $n = \frac{1560}{2482}$ ≈ 2 baut ∅ ½"

Pv_{10} = 2290 kg ---> $n = \frac{2290}{2482}$ ≈ 2 baut ∅ ½"

Titik buhul 24 :

Pd_{10} = 2160 kg ---> $n = \frac{2160}{2482}$ ≈ 2 baut ∅ ½"

Pa_{10} = 7320 kg ---> $n = \frac{7320}{2482}$ ≈ 4 baut ∅ ½"

Pv_{10} = 2290 kg ---> $n = \frac{2290}{2482}$ ≈ 2 baut ∅ ½"

Pv_{11} = 580 kg ---> $n = \frac{580}{2482}$ ≈ 2 baut ∅ ½"

Pd_{11} = 7090 kg ---> $n = \frac{7090}{2482}$ ≈ 3 baut ∅ ⅝"

Titik buhul 25 :

Pv_{11} = 580 kg ---> $n = \frac{580}{2482}$ ≈ 2 baut ∅ ½"

Pa_{11} = 190 kg ---> $n = \frac{190}{2482}$ ≈ 2 baut ∅ ½"

Titik buhul 26 :

Pd_{11} = 7090 kg ---> $n = \frac{7090}{3777}$ ≈ 3 baut ∅ ⅝"

Pa_{11} = 20 kg
Pa_{12} = 5680 kg
} ---> $n = \frac{5680 + 20}{2482}$ ≈ 3 baut ∅ ½"

Pd_{12} = 500 kg ---> $n = \frac{500}{2482}$ ≈ 2 baut ∅ ½"

Pv_{12} = 2560 kg ---> $n = \frac{2560}{2482}$ ≈ 2 baut ∅ ½"

Titik buhul 27 :

Pb_{12} = 4260 kg ---> $n = \frac{4260}{2482}$ ≈ 2 baut ∅ ½"

Pb_{11} = 6770 kg ---> $n = \frac{6770}{2482}$ ≈ 3 baut ∅ ½"

Pd_{10} = 2 60 kg ---> $n = \frac{2160}{2482}$ ≈ 2 baut ∅ ½"

Pv_{12} = 2560 kg ---> $n = \frac{2560}{2482}$ ≈ 2 baut ∅ ½"

Titik buhul 28 :

Pb_{13} = 4770 kg
Pb_{12} = 4260 kg
} ---> $n = \frac{4770 - 4260}{2482}$ ≈ 3 baut ∅ ½"

Pd_{12} = 500 kg ---> $n = \frac{500}{2482}$ ≈ 2 baut ∅ ½"

Pv_{13} = 630 kg ---> $n = \frac{630}{2482}$ ≈ 2 baut ∅ ½"

Titik buhul 29 :

Pa_{12} = 5680 kg
Pa_{13} = 6165 kg
} ---> $n = \frac{6165 - 5680}{2482}$ ≈ 3 baut ∅ ½"

Pd_{13} = 500 kg ---> $n = \frac{500}{2482}$ ≈ 2 baut ∅ ½"

Pv_{13} = 630 kg ---> $n = \frac{630}{2482}$ ≈ 2 baut ∅ ½"

Titik buhul 30 :

Pb_{14} = 5380 kg
Pb_{13} = 4770 kg
} ---> $n = \frac{5380 - 4770}{2482}$ ≈ 3 baut ∅ ½"

Pd_{13} = 500 kg ---> $n = \frac{500}{2482}$ ≈ 2 baut ∅ ½"

Pv_{14} = 430 kg ---> $n = \frac{430}{2482}$ ≈ 2 baut ∅ ½"

Titik buhul 31 :

Pa_{13} = 6165 kg ---> $n = \frac{6165}{2482}$ ≈ 3 baut ∅ ½"

Pa_{14} = 6145 kg ---> $n = \frac{6145}{2482}$ ≈ 3 baut ∅ ½"

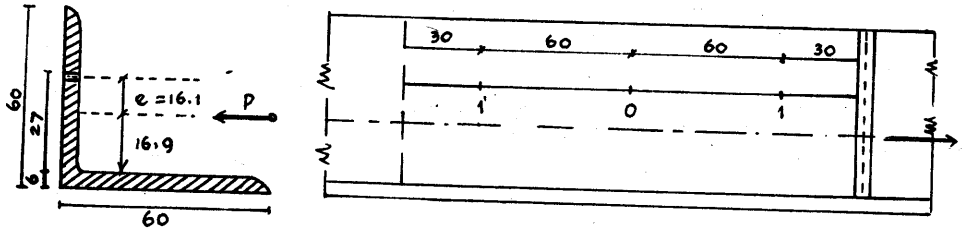
Pv_{14} = 430 kg ---> $n = \frac{430}{2482}$ ≈ 2 baut Ø ½"

Titik buhul B :

Pa_{14} = 6145 kg ---> $n = \frac{6145}{2482}$ ≈ 3 baut Ø ½"

Pb_{14} = 5380 kg ---> $n = \frac{5380}{2482}$ ≈ 3 baut Ø ½"

Kontrole excentrisitas baut terhadap garis sistim.



Batang 3 : ⌐ 60 x 60 x 6

P = + 9730 kg - 8240 kg = 1490 kg

e = (60 - 6) ½ + 6 - 16,9 = 16,1 mm 1,6 cm

M = P.e = 1490 x 1,61 = 2400 kg cm.

No. Baot	x	y	x^2	y^2
1'	-6	0	36	0
0	0	0	0	0
1	+6	0	36	0
		Total	72	0

$Kx = \frac{M.y}{\Sigma(x^2 + y^2)} = 0$

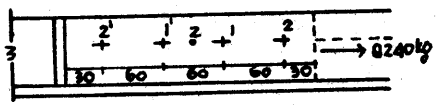
$Ky = \frac{M.x}{\Sigma(x^2 + y^2)} = \frac{2400 \times 6}{72} = 200$ kg.

$\frac{P}{n} = \frac{1490}{3} = 497$ kg. $K = \sqrt{200^2 + 497^2} = 536$ kg < Ks = 2482 kg < Kg = 2489 kg

----> memenuhi syarat.

Tinjau batang a_4 ----> P = + 8240 kg

M = 8240 x 1,61 = 13266 kg cm.



No.	x	y	x^2	y^2
2'	-9	0	81	0
1'	-3	0	9	0
.	+3	0	9	0
2	+9	0	81	0
			180	0

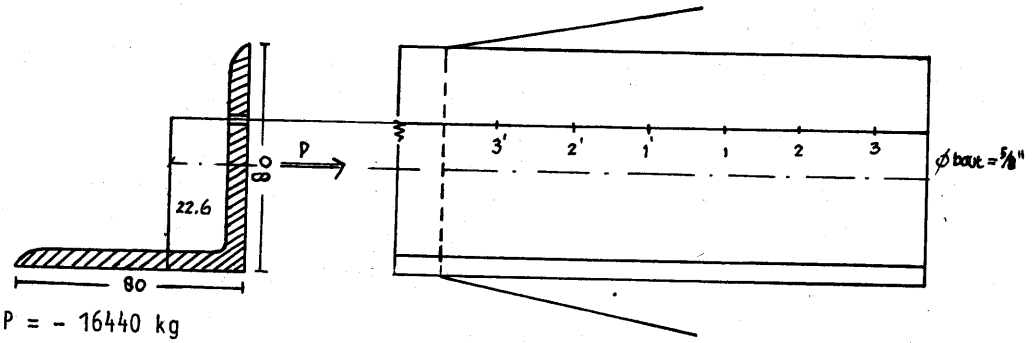
$Kx = \frac{M.y}{\Sigma(x^2 + y^2)} = 0$

$Ky = \frac{M.x}{\Sigma(x^2 + y^2)} = \frac{13266 \times 9}{180} = 663,3$ kg.

$\frac{P}{n} = \frac{8240}{4} = 2060$ kg

$K = \sqrt{2060^2 + 663,3^2} = 2164$ kg < Ks < Kg ---> memenuhi syarat.

Ditinjau batang b17 :



P = - 16440 kg

e = ½(80 - 8) + 8 - 22,6 = 44 - 22,6 = 21,4 mm = 2,14 cm

M = P.e = 16440 x 2,14 = 35182 kg.cm.

$Ky = \frac{35182 \times 15}{630} = 838$ kg

$\frac{P}{n} = \frac{16440}{6} = 2740$ kg

$K = \sqrt{2740^2 + 8382} = 2865$ kg

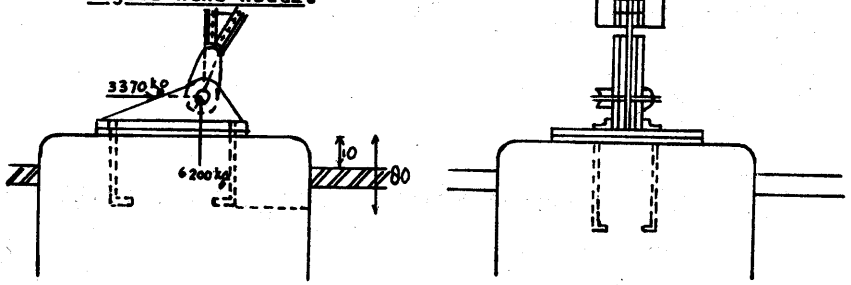
< Kg = 3111 kg < ks = 3875 kg

---> memenuhi syarat.

No.	x	x^2
3	15	225
2	9	81
1	3	9
1'	3	9
2'	9	81
3'	15	225
		630

II-5. **Merencanakan Sendi Kuda2.**

I. **Engsel kaki kuda2.**



Menghitung ϕ Splitpen :

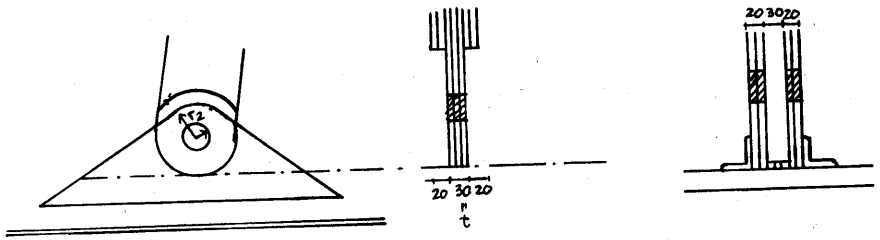
Ambil ϕ 1½" = 3,81 cm = 2 r_1

P geser = $2.\frac{1}{4}.\pi\ d^2.0,7\ \bar{\sigma} = 2.\frac{1}{4}.3,81^2.0,7.1400 = 22334$ kg

P tumpu = $t.d.1,4\ \bar{\sigma} = 3(3,81)(1,4)(1400) = 22403$ kg

} > $H_A + V_A$

$= \sqrt{3370^2 + 6200^2} = 7057$ kg



Perhitungan pelat sendi :

Digunakan rumus : $\sigma max = \alpha . \frac{8P}{\pi^2 . r_2 . t} \leq \bar{\sigma}$, ambil r_2 = 3" = 7,62 cm

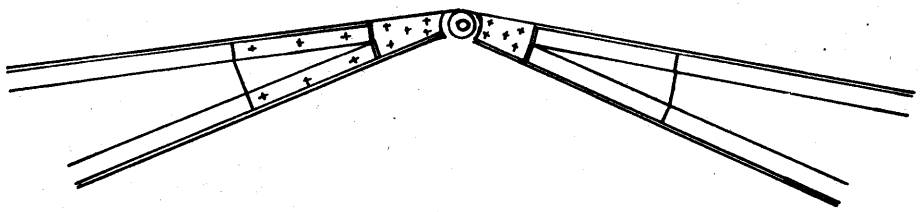
(dari buku Strength of Materials Timoshenko).

$\frac{r_2}{r_1} = 4$ ----> $\alpha = 4,39$ ---> σ max =

$4,39 \frac{8(7057)}{3,14^2.7,62.3} = 1100$ kg/cm^2 < $\bar{\sigma} = 1400$ kg/cm^2

** Sendi dan Splitpen ϕ 1½" & tebal pelat 3 cm dengan ujung r_3 = 3"

II. **Engsel nok kuda2 :**



Reaksi maximum : akibat B.m + angin kanan.

$V_B = 0 + 1704 \text{ kg} = 1704 \text{ kg} \ (\downarrow)$

$H_B = 3370 + 1679 = 5049 \text{ kg} \ (\leftarrow)$

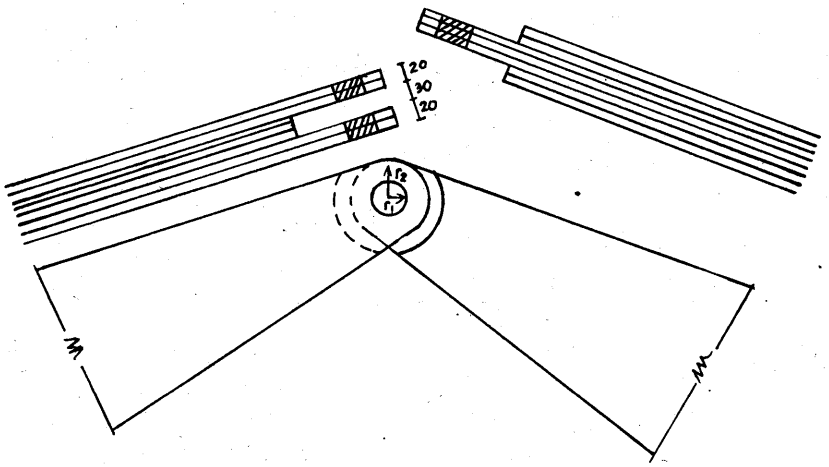
$V_B + H_B = \sqrt{1704^2 + 5049^2} = 5329 \text{kg}$

Menghitung ∅ Splitpen : ambil ∅ 1" = 2,54 cm

P geser = $2.\frac{1}{4}\pi d^2.0,7\bar{\sigma} = \frac{1}{2}.3,14.2,54.0,7.1400 = 9926$ kg

P tumpu = $t.d.1,4\bar{\sigma} = 3.2,54.1,4.1400 = 14935$ kg

$H_B + V_B = 5329 \text{kg}$



Perhitungan pelat sendi :

Diambil rumus :

$$\sigma_{max} = \alpha \frac{8P}{\pi^2 . r_2 . t} < \bar{\sigma}$$ ("Strength of materials by Timoshenko past. I, page 383).

$r_2 = 2" = 5,08$ cm.

$\frac{r_2}{r_1} = 2 \longrightarrow \alpha = 4,39$

$$\sigma_{max} = 4,39 \cdot \frac{8,5329}{3,14^2 . 5,08 . 3}$$

$= 1246 \text{ kg/cm}^2 < \bar{\sigma}$

$(\bar{\sigma} = 1400 \text{ kg/cm}^2)$

Split pen ∅ 1" dan pelat dengan r_2 – 2" dapat dipakai

II.6. Perhitungan anker kuda2.

M max = 4580 kg (akibat beban mati + angin kanan)
Dipakai anker ∅ 19 mm ----> 4 buah.

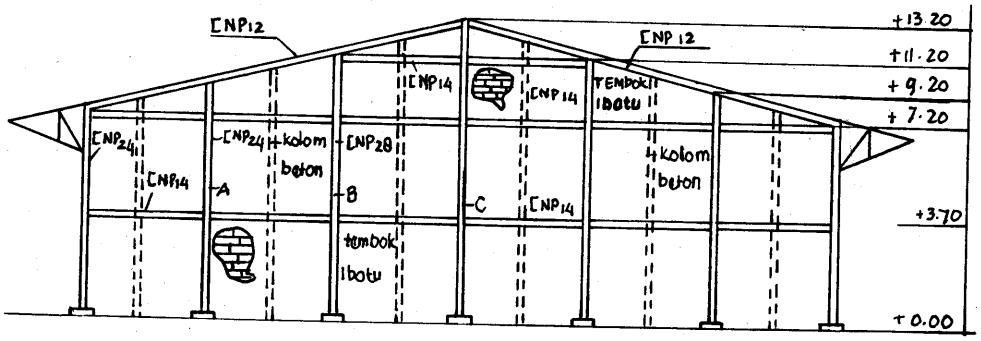
P geser 4 anker = $4 \times \frac{1}{4}\pi d^2.0,7\bar{\sigma} = 3,14.1,9^2.0,7.1400 = 11.109$ kg

> H max (H max = 4580 kg)

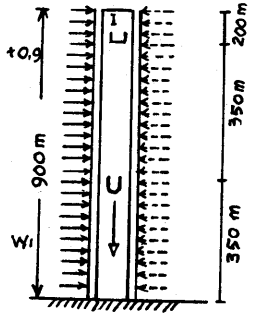
----> *** **Anker 4 ∅ 19 bisa digunakan.**

III. RENCANA KOPWAND.

- Diambil Regel tengah2 : [NP.14.
- Diambil Regel atas : [NP.12.
- Dinding tembok bata : ½ batu.



Perhitungan Kolom A :



Ambil profil : INP - 24.

P = Berat sendiri = 9 x 36,2 = 325,8 kg.

W_1 = + 0,9 x 100 x 1 = + 90 kg/m.

W_2 = - 0,4 x 100 x 1 = - 40 kg/m.

$M_1 = \frac{1}{2} \cdot 90 \cdot 9^2 = 3645$ kgm
$M_2 = \frac{1}{2} \cdot 40 \cdot 9^2 = 1620$ kgm
} Mmax = M_1

$$\lambda 1 = \frac{l\,k}{i} = \frac{2 \times 900}{9,59} = 187,7$$

$$\lambda 2 = \frac{2 \times 200}{2,2} = 181,8$$

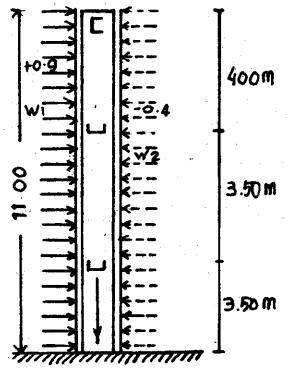
$$\lambda 3 = \frac{0,7 \times 350}{2,2} = 111,4$$

λ max = 187,7 ---> W = 8,33

$$\sigma = \frac{P.W.}{F} + \frac{M\,max}{Wx} = \frac{325,8 \times 8,33}{46,1} + \frac{364500}{354} = 59 + 1030 = 1089\ kg/cm^2.$$

---> $< \bar{\sigma} = 1400\ kg/cm^2$ ---> **INP. 24 bisa dipakai !**

Perhitungan kolom B :



Ambil profil : I N P - 28

P = berat sendiri = 11 x 48 = 528 kg

W_1 = 90 kg/m ; W_2 = 40 kg/m.

$M_1 = \frac{1}{2} \cdot 90 \cdot 11^2 = 5445$ kgm
$M_2 = -\frac{1}{2} \cdot 40 \cdot 11^2 = -2420$ kgm
} Mmax = M_1

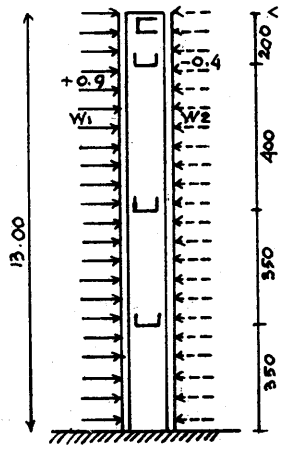
$$\lambda 1 = \frac{0,7 \times 400}{2,45} = 114,3$$

$$\lambda 2 = \frac{0,7 \times 350}{2,45} = 100$$

$$\lambda 3 = \frac{2 \times 100}{11,1} = 198,2$$

λmax = 198,2 ---> W = 9,29

$$\sigma = \frac{528 \times 9,29}{61,1} + \frac{544500}{542} = 80 + 1005 = 1085\ kg/cm^2.$$



$< \bar{\sigma}$ 1400 kg/cm^2 ---> **I N P - 28 bisa dipakai.**

Ambil profil I N P : 32

P = berat sendiri 13 x 61,1 = 794 kg

$M_1 = \frac{1}{2} \cdot 90 \cdot 13^2 = 7605$ kgm.

$M_2 = \frac{1}{2} \cdot 40 \cdot 13^2 = 3380$ kgm.

$$\lambda max = \frac{2 \times 1300}{12,7} = 205 \quad W = 9,95$$

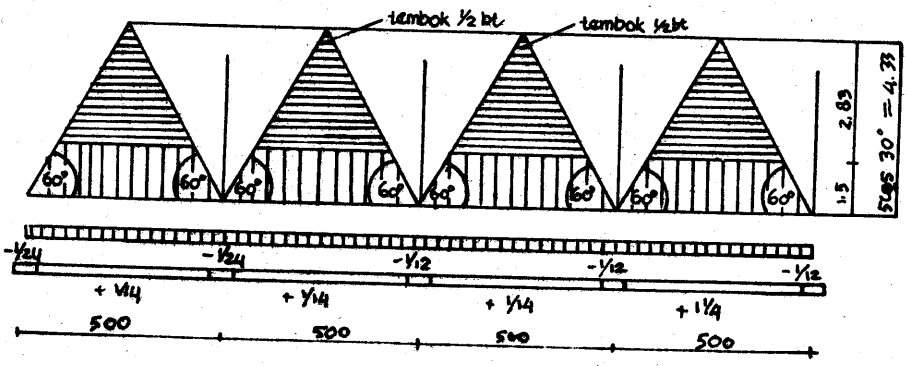
$$\sigma = \frac{794 \times 9,95}{77,8} + \frac{760500}{782} = 102 + 973$$

$= 1075\ kg/cm^2 < \bar{\sigma} = 1400\ kg/cm^2$

I N P - 32 bisa dipakai.

IV. PERHITUNGAN - PONDASI.

Perhitungan tulangan Sloof : (IV - 1)



- Berat tembok/lap = $\frac{1}{2}$ x 2,83 x ($\frac{2,83}{4,33}$ x 5) x 250 = 1156 kg
- Berat tembok beton/lap = $\frac{1}{2}$x1,5 $\left\{ 5 + \frac{2,83}{4,83} \times 5 \right\}$ x0,15x2400 = 2232 kg

= 3388 kg

$$q \text{ rata2/m2} = \frac{3388}{\frac{1}{2} \times 4,33 \times 5} = 313 \text{ kg/m}^2.$$

$$q_{eq} = \frac{2}{3} \cdot h \cdot q \text{ rata2} = \frac{2}{3} \times 4,33 \times 313 = 904 \text{ kg/m}$$

B.S. Sloof = 0,3 x 0,5 x 2400 = 360 kg/m'

q total = 904 + 360 = 1262 kg/m'.

$$M = \frac{1}{12} \times 1264 \times 5^2 = 2634 \text{ kgm.}$$

$$h' = 50 - 2 - 0,8 - 0,8 = 46,4 \text{ cm} = \alpha \sqrt{\frac{2634}{0,3}} \text{ ---> } \alpha = 0,496$$

---> σ bd = 31,6 kg/cm^2 ---> β = 0,185

$$Fy = 0,185 \sqrt{2634 \times 0,3} = 5,2 \text{ cm}^2 \text{ -----> Ambil : } \underline{3\not{\phi}16 = 6,03 \text{ cm}^2}.$$

D = 2,5 x 1264 = 3160 kg.

$$\tau = \frac{1,5 \times 3160}{30 \times 50} = 3,16 \text{ kg/cm}^2 < 5 \text{ kg/cm}^2 \text{ --> } \underline{\text{tak perlu tul.miring!}}$$

IV.2. PONDASI KUDA2 :

1. Akibat berat sendiri :

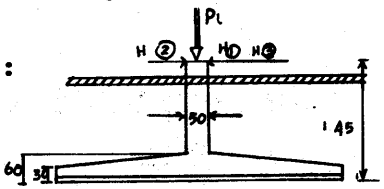
- Berat tembok = 4,5 x 5 x 250 ———— = 5625 kg
- Berat tembok beton = 1,5 x 5 x 0,15 x 2400 = 2700 kg
- P = V_A Kuda2 ———— = 6200 kg
- Berat Stek kolom = 0,85 x 0,4 x 0,5 x 2400 = 408 kg
- Berat Sloof = 0,3 x 0,5 x 5 x 2400 ———— = 1800 kg

P = 16733 kg

H = 3370 kg ---> M = 1,45 x 3370 = 4886,5 kgm.

- Berat rib = (0,3 x 0,45 x 2 x 2400) + (0,4 x 0,5 x 0,6 x 2400) = 936 kg.
- Berat pelat = 1,5 x 2,5 x 0,16 x 2400 = 1440 kg
- P total = 16733 + 936 + 1440 = 19109 kg.

Tinjauan terhadap σ perlawanan tanah :



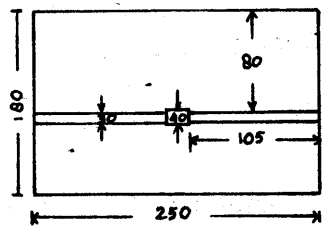
$$\sigma = \frac{P \text{ tot}}{F} + \frac{M}{W} = \frac{1 \,109}{180 \times 250} \pm \frac{488650}{\frac{1}{6} \cdot 180 \cdot 250^2}$$

$$= (0,424 \pm 0,621) \text{ kg/cm}^2$$

$$\sigma 1 = 0,424 + 0,261 = 0,685 \text{ kg/cm}^2$$

$$< \bar{\sigma}t = 0,75 \text{ kg/cm}^2$$

$$\sigma 2 = 0,424 - 0,261 = 0,161 \text{ kg/cm}^2 > 0$$



---> tak terjadi tarikan.

2. Akibat beban mati + angin kiri :

P = 5625 + 2700 + 408 + 1800 + 4145 = 14675 kg.

P total = 14678 + 936 + 1440 = 17054 kg

$M = 1{,}45 \times H_{A2} = 1{,}45 \times 1345 = 1950{,}25$ kgm = 195025 kgcm.

Tinjauan terhadap σ perlawanan tanah :

$$\sigma = \frac{17054}{180 \times 250} \pm \frac{195025}{\frac{1}{6} \cdot 180 \cdot 250^2} = (0{,}379 \pm 0{,}104)\ kg/cm^2.$$

$\sigma_1 < \bar{\sigma}_t = 0{,}75\ kg/cm^2$ ----->

$\sigma_2 > 0$ ---> tak terjadi tarikan pada pondasi.

3. Akibat beban mati + angin kanan :

P = 5625 + 2700 + 408 + 1800 + 3436 = 13969 kg

P total = 13969 + 936 + 1440 = 16345 kg

$M = 1{,}45 \times H_{A3} = 1{,}45 \times 4580 = 6641$ kgm = 664100 kg.cm.

* **Tinjauan terhadap σ perlawanan tanah :**

$$\sigma = \frac{16345}{180 \times 250} \pm \frac{664100}{\frac{1}{6} \cdot 180 \cdot 250^2} = 0{,}364 \pm 0{,}354$$

$\rightarrow \sigma_1 = 0{,}364 + 0{,}354 = 0{,}718\ kg/cm^2$ -----> $\bar{\sigma}_t = 0{,}75\ kg/cm^2$

σ_2 0 ---> tak terjadi tarikan pada pondasi.

Kesimpulan : Pondasi beton setempat dengan ukuran 1,80 x 2,50 m^2 bisa dipakai ---> memenuhi syarat pondasi & $\bar{\sigma}_t$.

Perhitungan momen pelat dan momen rib :

1. Akibat berat sendiri.

P pelat = 16733 + 936 = 17669 kg

$$\sigma_p = \frac{17669}{180 \cdot 2500} = 0{,}3926\ kg/cm^2$$

$$= \pm 0{,}2610\ kg/cm^2.$$

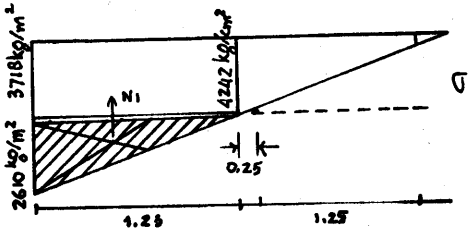


DIAGRAM TEG RIB (1)

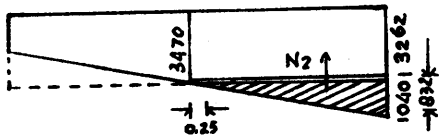
σ_M pelat I $= \frac{1}{2} ql^2 = \frac{1}{2}(3926+2610)(0{,}8)^2$
$= 2092$ kg m.

P rib = 16733 kg -> $\sigma_p = \frac{16733}{180 \times 250}$
$= 0{,}3718 kg/cm^2$

$N_1 = \frac{1}{2} \times (2610 - 522) \times 1{,}8 \times 1$
$= 1879$ kg.

M Rib I $= \frac{1}{2} ql^2 + N_1 . e$
$= \frac{1}{2}(4240 . 1.8) . 1{,}05^2$
$+ 1879 . \frac{2}{3} . 1{,}05$
$= 4207{,}14 + 1315{,}44$
$= \underline{5523\ kgm.}$

2. Akibat berat sendiri + angin kiri.



P pelat = 14678 + 936 = 15614 kg

$\sigma_p = \frac{15614}{180 \times 250} = 0{,}3470\ kg/cm^2.$

$\sigma_M = \pm 0{,}1040\ kg/cm^2.$

M pelat II $= \frac{1}{2}(3470 + 1040) . 0{,}8^2$
$= \underline{1443\ kgm.}$

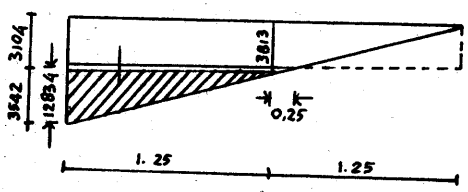
P rib = 14678 kg ----> $\sigma p = \frac{14678}{180 \times 250} = 0{,}3262$ kg/cm^2.

$N_2 = 832 \cdot 1 \cdot \frac{1}{2} \cdot 1{,}8 = 748{,}8$ kg.

M rib II = $\frac{1}{2}(3470.1{,}8)\ \overline{1{,}05}^2 + 748{,}8 \cdot \frac{2}{3} \cdot 1{,}05 = 3443{,}1 + 524{,}16$

= 3967,27 kgm.

3. Akibat berat sendiri + angin kanan :



P pelat = 13969 + 936 = 14905 kg

$\sigma p = \frac{14905}{180 \times 250} = 0{,}3312$ kg/cm^2.

$\sigma M = \pm\ 0{,}3542$ kg/cm^2

M pelat III = $\frac{1}{2}(3312 + 3542).0{,}8^2$

= 2193 kgm.

P rib = 13969 kg ----> $\sigma p = \frac{13969}{180 \times 250} = 0{,}3104$ kg/cm^2.

$N_3 = \frac{1}{2} \cdot 2834 \cdot 1 \cdot 1{,}8 = 2551$ kg.

M rib III = $\frac{1}{2}(3813 \cdot 1{,}8)\ \overline{1{,}05}^2 + 2551 \cdot \frac{2}{3} \cdot 1{,}05 = 3783 + 1786$

= 5569 kgm.

Maka M pelat max = 2193 kgm.

M rib max = 5569 kgm.

Perhitungan penulangan pelat :

M = 2193 ----> h = 19 ----> h' = 19 - 2 θ 0,6 = 16,4

$16{,}4 = \alpha \sqrt{\frac{M}{b}} = \alpha \sqrt{2193}$ ----> $\alpha = 0{,}350$

----> σ bd = 49 kg/cm^2 ; $\beta = 0{,}273$

Fy = $0{,}273 \sqrt{2193} = 12{,}8$ cm^2.

Dipakai : $\emptyset$ 12 - 8,5 = 13,3 cm^2.

Perhitungan penulangan rib :

M = 5569 kgm ----> h = 60 cm ----> h' = 60-2-1,2-0,8 = 56 cm

$56 = \alpha \sqrt{\frac{M}{b}} = \sqrt{\frac{5569}{0{,}3}}$ ----> $\alpha = 0{,}411$

----> σ bd = 40 kg/cm^2 ; $\beta = 0{,}228$

Fy = $0{,}228 \sqrt{5569 \times 0{,}3} = 9{,}32$ cm^2.

Ambil : 5 $\emptyset$ 16 = 10,05 cm^2.

D = 3813 x 1,8 x 1 + N = 6863 + 2551 = 9414 kg.

$\tau = \frac{3/2 \cdot 9414}{30 \times 60} = 7{,}85$ kg/cm^2 > 5 kg/cm^2 = $\bar{\tau}$

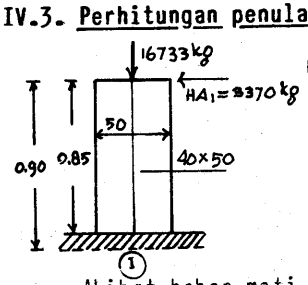
$\frac{y}{105} = \frac{7{,}85 - 5}{7{,}85}$ ----> y = 38,12 cm

Ts = $\frac{7{,}85 + 5}{2} \times 30 \times \frac{1}{2} \times 38{,}12 \times \sqrt{2} = 5195{,}5$ kg

Tulangan miring = $\frac{5195{,}5}{1200} = 4{,}33$ cm^2

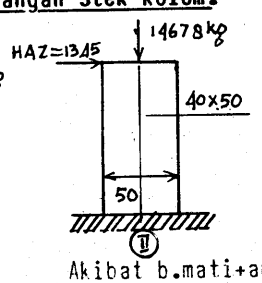
Ambil tulangan miring = -- { 2 $\emptyset$ 16 = 4,02 cm^2
{ 2 $\emptyset$ 10 = 0,79 cm^2 +
= 4,81 cm^2

IV.3. Perhitungan penulangan Stek kolom.



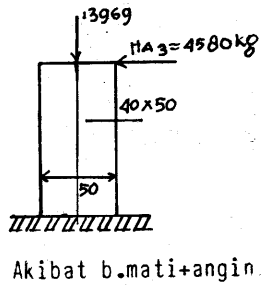
Akibat beban mati

M = 3370 x 0,9



Akibat b.mati+angin kiri

M = 1345 x 0,9



Akibat b.mati+angin kanan

M = 4580 x 0,9

Tinjau keadaan III.

$e = \frac{303300}{16733} = 18{,}12$ cm ---> $= \frac{18{,}12}{50} = 0{,}3625$

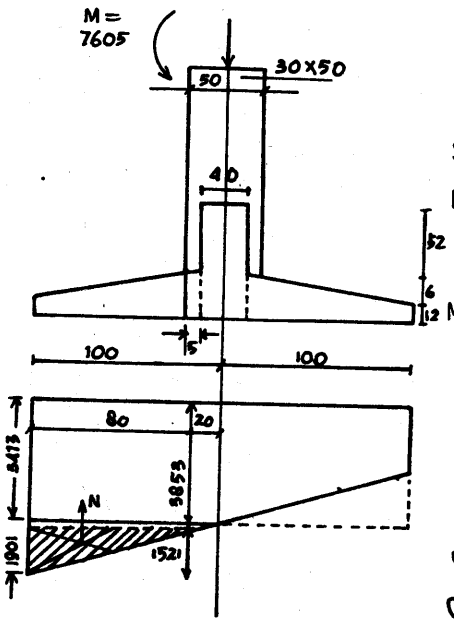
$\sigma b' = \frac{16733}{40 \times 50} = 8{,}4$ kg/cm^2.

$\mu = 0{,}004$ ---> $C = 3{,}06$ --> $\sigma b = 3{,}06 \times 8{,}4$ kg/cm^2

$= 20{,}4 < \bar{\sigma} b = 50$ kg/cm^2

Penulangan $6 \varnothing 19 = 17{,}04$ cm^2 ---> masih bisa memenuhi.

IV.4. PONDASI - KOPWAND.



B.S kolom ———— = 794 kg

Tembok = 6 x 13,5 x 450 —— = 36.450 kg

B.kolom= (0,3x0,1x0,5x2400)= 400 kg

+(0,3x0,5x1x2400)

Sloof = 0,4x0,7 x 6 x 2400 = 4.032 kg

B.Pelat= 0,15x6x1,6x2400 = 3.456 kg

P total = 45.132 kg

M = 7605 kgm.

σ Perlawanan tanah =

$$\frac{45132}{600 \times 200} \pm \frac{760500}{\frac{1}{6} \cdot 600 \cdot 200^2}$$

$(0{,}3761 \pm 0{,}1901)$ kg/cm^2.

$\sigma_1 = 0{,}5662$ kg/cm^2 $< \bar{\sigma}$ t.

$\sigma_2 = 0{,}1860$ kg/cm^2 > 0 --> tak terjadi tarikan pada pondasi.

P pelat = 45132 - 3456 = 41676 kg.

σ p pelat $= \frac{41676}{600 \times 200} = 0{,}3473$

σ M pelat $= 0{,}1901$ kg/cm^2

N = $\frac{1}{2}$.1521.0,80 = 608,4 kg

M pelat = $\frac{1}{2}$.3858.0,85^2 + 608,4.$\frac{2}{3}$.0,85

= 1737 kgm.

h = 18 cm --> h' = 18 - 2 - 0,6 = 15,4 = $\alpha\sqrt{1737}$ --> $\alpha = 0{,}3695$

$\sigma b = 46$ kg/cm^2 ; $\rho = 0{,}257$

Fy = $0{,}257\sqrt{1737} = 10{,}71$ cm^2 ---> Ambil : $\varnothing 12 - 10 = 11{,}30$ cm^2

IV.5. Perhitungan penulangan Sloof :

Tekanan keatas : P to = 45123 kg

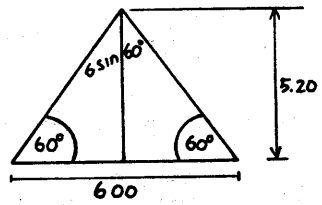
Tekanan kebawah:

Pelat = 3456 kg

Sloof = 4032 kg

Muatan tembok $\Delta = \frac{1}{2}$x5,20x6x450 = 7020 kg

14508 kg



$$q \text{ sloof} = \frac{45132 - 14508}{6} = 5104 \text{ kg/m'}.$$

$M = \frac{1}{12} ql^2 = \frac{1}{12} \cdot 5104 \cdot 6^2 = 15312$ kg/m.

a = 2 + 1,2 + 1,2 = 4,4 --> h = 70 cm --> h' = 65,6 cm

a' = 2 + 0,8 + 1 = 3,8 cm.

$65{,}6 = 0{,}345 \sqrt{\frac{M1}{0{,}4}}$ ---> $M_1 = 14462$ kgm.

$Fy_1 = 0{,}277 \sqrt{14462 \cdot 0{,}4} = 21{,}07$ cm^2.

M sisa = 15312 - 14462 = 850 kgm.

$Db = T_2 = \frac{850000}{65,6 - 3,8} = 1375$ kg --> $Fy_2 = \frac{1375}{1200} = 1,15\ cm^2$.

Tulangan tarik Fy = 21,07 + 1,15 = 22,22 cm^2.

Ambil $4\ \phi\ 23,5 + 2\ \phi\ 19 = 17,32 + 5,68 = 23\ cm^2$.

x = 0,385 . 65,6 = 25,26 cm

$\sigma yd = 15.50 . \frac{25,26 - 5}{25,26} = 602\ kg/cm^2$.

$Fy' = \frac{1375}{602} = 2,28\ cm^2$

** Tulangan tekan ambil $2\ \phi\ 19 = 5,68\ cm^2$.

D = 2,85 x 5104 = 14,546 kg.

$\rho = \frac{1,5 \times 14546}{40 \times 70} = 7,793\ kg/cm^2 > 5\ kg/cm^2$ --> pakai tul.miring.

$\frac{Y}{285} = \frac{7.793 + 5}{7.793}$ ---> Y = 102 cm

$Ts = \frac{7,793 + 5}{2} . 40 . \frac{1}{2} . 102 . 2 = 18480$ kg

$F_{tn} = \frac{18450}{1200} = 15,48\ cm^2$ ---> Ambil 4 ϕ 23,5 = 17,32 cm^2.

Kontrole terhadap puntir.

M puntir = 7605 - (45132 - 14508) 0,2 = 1480,2 kgm.

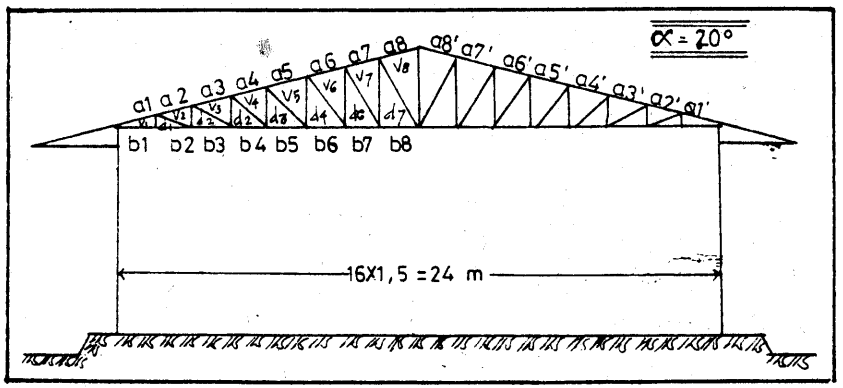
$\tau w\ max = \psi \frac{Mw}{b^2 h}$ $\qquad \psi = 3 + \frac{2,6}{0,45 + \frac{h}{b}} = 3 + \frac{2,6}{0,45 + \frac{70}{40}}$

$= \frac{4.182 \times 1480208/2}{40^2 . 70}$ $\qquad = 3 + \frac{2,6}{0,45 + 1,75} = 3 + \frac{2,6}{2,2}$

$= 4,182$

$= \frac{5,527}{2}\ kg/cm^2 < 4\ kg/cm^2$.

Tak perlu tulangan puntir !



RENCANAKAN : KUDA2 KONSTRUKSI BAJA DENGAN BENTUK KUDA2 SEPERTI TERGAMBAR.

DIKETAHUI :
- JARAK ANTARA KOLOM = 4,5 METER.
- BAHAN ATAP DARI ASBEST.
- DINDING TERBUKA.
- TINGGI KOLOM = 5.00 METER.

------oOo------

- Batang2 bawah (b) mempunyai panjang $b = \frac{24}{16} = 1,5$ m.

- Batang2 atas (a) mempunyai panjang $a = \frac{1,5}{\cos 20^0} = \frac{1,5}{0,9377} = 1,6$m

- Batang2 vertikal mempunyai panjang :

$V_1 = 1,5(tg.20^0) = 1,5(0,3640) = 0,546$ m.
$V_2 = 2(1,5\ tg.\ 20^0) = 1,092$
$V_3 = 3(1,5\ tg.\ 20^0) = 1,638$
$V_4 = 4(1,5\ tg.\ 20^0) = 2,184$
$V_5 = 5(1,5\ tg.\ 20^0) = 2,730$
$V_6 = 6(1,5\ tg.\ 20^0) = 3,276$
$V_7 = 7(1,5\ tg.\ 20^0) = 3,822$
$V_8 = 8(1,5\ tg.\ 20^0) = 4,368$

- Batang2 diagonal mempunyai panjang :

$d_1 = \sqrt{1,5^2 + 0,546^2} = \sqrt{2,548} = 1,6$ m.

$d_2 = \sqrt{1,5^2 + 1,092^2} = \sqrt{3,442} = 1,85$

$d_3 = \sqrt{1,5^2 + 1,638^2} = \sqrt{4,933} = 2,22$

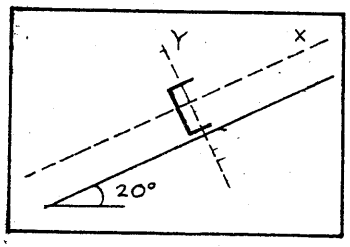
$d_4 = \sqrt{1,5^2 + 2,184^2} = \sqrt{6,864} = 2,62$

$d_5 = \sqrt{1,5^2 + 2,73^2} = \sqrt{9,70} = 3,12$

$d_6 = \sqrt{1,5^2 + 3,276^2} = \sqrt{12,98} = 3,66$

$d_7 = \sqrt{1,5^2 + 3,822^2} = \sqrt{16,86} = 4,11$

MENDIMENSI GORDING :

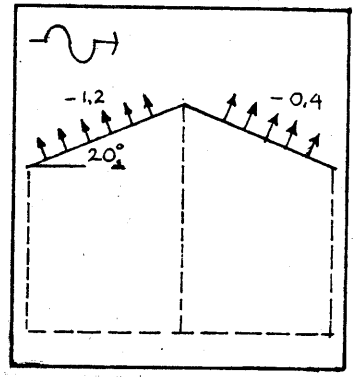


Apabila dipergunakan gording dari besi [10.
Maka : - berat gording = 10,6kg/m
- berat asbest + perlengkapannya = 17 kg/m2 persatuan panjang :
17(1,6)kg/m' = 27,2kg/m'

q_{tot} = (10,6+27,2) = 37,8 kg/m'.

BEBAN q DAPAT DIURAIKAN ATAS :

- Beban searah sb. y :



1. Beban gording + asbest gelombang
$q_y = 37,8 \cos 20^0 = 35,45$ kg/m'
$Mx = \frac{1}{8} .35,45.(4,5)^2 = 89,73$kg.m.

2. Karena angin : (lihat P.M.I)

$C_{AB} = -1,2$
$C_{BC} = -0,4$

Karena koefisien C = -, mana beban angin merupakan hisapan, sehingga untuk **mendimensi gording** tak diperhitungkan.

3. Beban tak terduga.
Untuk 1 orang (guna perbaikan/pemeliharaan) P = 100 kg.
$Mx = \frac{1}{4}.100 \cos 20^0(4,5) = 105$ kg.m.
Sehingga Mx tot = (89,73 + 105)
= 194,73 kg.m.

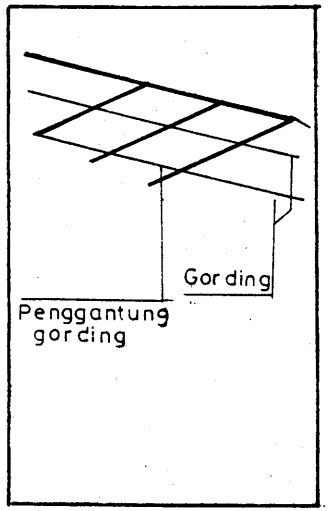
$$\sigma_x = \frac{Mx(tot)}{W}$$

(W dilihat dalam tabel baja=41,2)

$$\sigma_x = \frac{194,73}{41,2} = 472,64 \text{ kg/cm}^2.$$

- Beban searah sumbu x.

Apabila dipakai sebuah penggantung gording, maka :
$lx = \frac{1}{2}(4,5) = 2,25$ m.



1. Beban gording + asbest gelombang:
$37,8 \sin 20^0 = 12,93$ kg/m'
$My = \frac{1}{8}.(12,93)(2,25)^2 = 8,18$ kg.m

2. Beban angin --> tak diperhitungkan sebab merupakan hisapan.

3. Beban tak terduga :
P = 100 kg.
$My = \frac{1}{4}.100 \sin 20^0(2,25) = 19,25$
Sehingga My tot = (8,18 + 19,23)
= 27,41 kg.m.

$$\sigma_y = \frac{My}{Wy} = \frac{2741}{8,49} = 322,85 \text{ kg/cm2}.$$

$\sigma = \sigma_x + \sigma_y = (472,64+322,85)$
= 795,49 kg/cm2 < 1400 kg/cm2

PENYELIDIKAN TERHADAP PENURUNAN/KEKAKUAN.

$E = 2{,}1.10^6$ kg/cm^2.

$Ix = 206$ cm^4.

$$f = \frac{L}{500} = \frac{450}{500} = 0{,}9$$

$$f_y = \frac{5}{384} \cdot \frac{qy.l^4}{E.Ix} + \frac{Py}{48} \cdot \frac{l^3}{Ex}$$

Didalam tabel profil, diperoleh : $Ix = 206$

$qy = 0{,}3545$

$Py = 100 \cos 20^0$

$= 100(0{,}9397) = 93{,}97$

Sehingga : $$f_y = \frac{5}{384} \cdot \frac{0{,}3545.450^4}{2{,}1.10^6.206} + \frac{34{,}2.225^3}{48(2{,}1.10^6)(29{,}3)}$$

$= 0{,}4374 + 0{,}41$

$= 0{,}8474$ cm.

$$f_x = \frac{5}{384} \cdot \frac{qx.225^4}{2{,}1.10^6(Iy)} + \frac{Px.225^3}{48(2{,}1.10^6)(206)}$$

Didalam tabel profil, didapatkan $Iy = 29{,}3$

$q_x = 3780 \sin 20^0$

$= 3780(0{,}342) = 12{,}927$

$Px = 100 \sin 20^0$

$= 100(0{,}342) = 34{,}2$

Sehingga : $$f_x = \frac{5}{384} \cdot \frac{0{,}129.225^4}{2{,}1.10^6.29{,}3} + \frac{34{,}2.225^3}{48(2{,}1.10^6)(29{,}3)}$$

$= 0{,}07 + 0{,}13 = 0{,}2$ cm.

$$f = \sqrt{f_y^2 + f_x^2} = \sqrt{0{,}718 + 0{,}04} = 0{,}87 \text{ cm} < \bar{f} \ (0{,}9 \text{ cm}).$$

Jadi gording [10 dapat dipakai.

PERHITUNGAN BEBAN.

a. Beban sendiri :

- beban gording 10,6 kg/m' = 10,6(4,5) = 47,7 kg
- asbes gelombang 17 kg/m^2 = 17(4,5)(1,6) = 122,4 kg
- berat kuda2 (1+2)26kg/m^2 = 26(4,5)(1,6) = 187,2 kg

$W_1 = 257{,}3$ kg

1 titik buhul bawah menerima gaya = 357,3 kg.

Beban sendiri pada overstek :

- beban gording = 2(47,7) = 95,4 kg
- asbest gel. = 17(4,5)(1,6) = 122,4 kg
- berat kuda2 = ½(187,2) = 93,6 kg

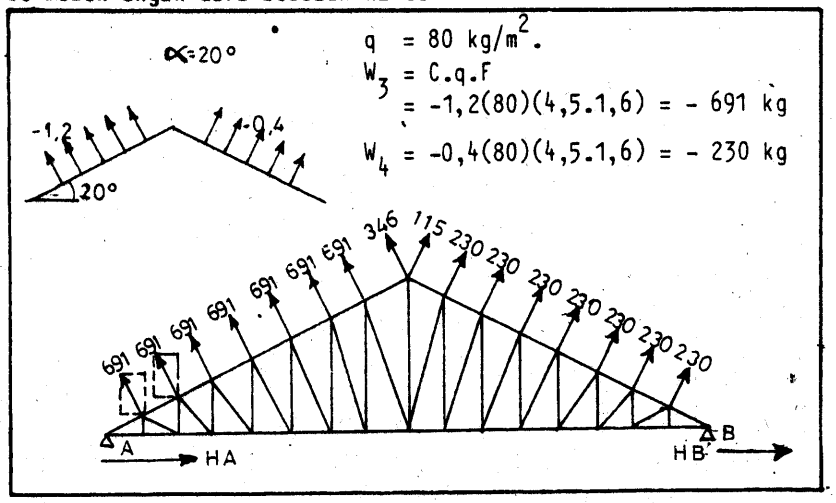
$W_2 = 311{,}4$ kg

$$V_A = V_B = \frac{15(357{,}3) + 2(311{,}4)}{2} = 2991{,}5 \text{ kg}$$

Pengertian : (15) adalah jumlah titik buhul kiri/kanan perletakkan.

(2) adalah titik buhul diatas perletakkan.

b. Beban angin dari sebelah kiri.



$q = 80$ kg/m^2.

$W_3 = C.q.F$

$= -1{,}2(80)(4{,}5.1{,}6) = -691$ kg

$W_4 = -0{,}4(80)(4{,}5.1{,}6) = -230$ kg

$H_A = H_B = \frac{1}{2}(691 \sin 20^0 - 230 \sin 20^0) \times 8,5$
$= \frac{1}{2}(461.0,342)(8,5)$

$H_A = H_B = 670$ kg (---->)

$\sum M_B = 0$ ---> $24\ V_A = 691 \cos 20^0(24 + 22,5 + 21 + 19,5 + 18 +$
$16,5 + 15 + 13,5 + \frac{1}{2}.12) + 230 \cos 20^0(\frac{1}{2} .$
$12 + 10.5 + 9 + 7,5 + 6 + 4,5 + 3 + 1,5) +$
$230 \sin 20^0 (\frac{1}{2}.4,368 + 3,822 + 3,276 +$
$2,730 + 2,184 + 1,638 + 1,092 + 0,546) - 691$
$\sin 20^0(\frac{1}{2}.4,468 + 3,822 + 3,276 + 2,730 +$
$2,184 + 1,638 + 1,092 + 0,546)$
$= 648(156) + 215,7(48) + 78,7(17,47) - 236,3$
$(17,47)$
$= 101088 + 10354 + .1375 - 4128 = 108689$

$V_A = 4529$ kg (↓)

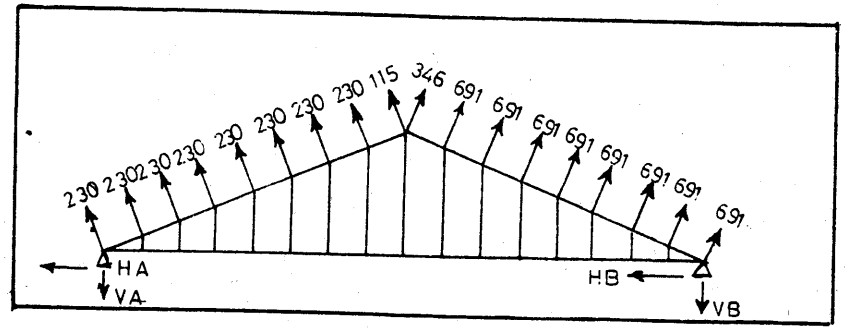
$V_B = 8,5(691 \cos 20^0 + 230 \cos 20^0) - 4529$
$= 2813$ kg (↓)

c. Beban angin dari kanan -- analog dengan beban angin dari kiri

$H_A = H_B = 670$ kg (←)

$V_B = 4529$ kg (↓)

$V_A = 2813$ kg (↓)



PERHITUNGAN GAYA BATANG DENGAN CREMONA.

a. Untuk mencari gaya batang akibat beban sendiri cukup dibuat setengah bagian dari konstruksi, karena bentuk konstruksi dan bebannya simetris.

b. Untuk beban angin hanya dibuat cremona dari angin kiri saja.

c. Untuk angin kanan dapat diambil kembalikan dari hasil cremona angin kiri.

Catatan : Perhitungan gaya2 batang dapat dilakukan dengan berbagai cara :

- cara Cremona.
- cara Ritter.
- Cara keseimbangan titik buhul.

Disini tidak diperlihatkan cara memperoleh gaya2 batang, karena para rekan2 mahasiswa kiranya tidak mengalami kesulitan.

Dari perhitungan analitis :

* akibat angin kiri : $H_A = H_B = 670$ kg (→)
$V_A = 4529$ kg (↓)
$V_B = 2813$ kg (↓)

Dari hasil Cremona :

* akibat angin kanan : $H_A = H_B = 670$ kg (→)
$V_A = 4550$ kg (↓)
$V_B = 2810$ kg (↓)

Dari hasil perbandingan pendapat antara hasil analitis dengan - hasil grapik Cremona, dapat dicari prosentase kesalahan.

Btg.	Berat sendiri		Angin kiri		Angin kanan		Extrim		Pjg.	Jml.baot
	tarik	tekan	tarik	tekan	tarik	tekan	tarik	tekan		
a_1		7940	11200		7735			7940	1,60	3
a_2		7460	10450		7350			7460	1,60	3
a_3		6840	9375		6950			6840	1,60	3
a_4		6140	8600		6600			6140	1,60	3
a_5		5800	7750		6300			5800	1,60	3
a_6		5290	6975		5945			5290	1,60	3
a_7		4790	6150		5650			4790	1,60	3
a_8		4240	5250		5400			4240	1,60	3
b_1	7300			11000		6600	7300		1,50	3
b_2	7300			11000		6600	7300		1,50	3
b_3	6850			10025		6450	6850		1,50	3
b_4	6260			8825		5700	6260		1,50	3
b_5	5980			7850		5300	5980		1,50	3
b_6	5480			6350		4900	5480		1,50	3
b_7	4980			5845		4500	4980		1,50	3

Btg.	Berat sendiri		Angin kiri		Angin kanan		Extrim		Pjg.	Jml.baot
	tarik	tekan	tarik	tekan	tarik	tekan	tarik	tekan		
b_8	4520			4850		4125	4520		1,50	3
V_1	0			0		0	0		0,55	2
V_2	180			425		100		245	1,09	2
V_3	340			675		200		335	1,64	2
V_4	500			1000		300		500	2,18	2
V_5	680			1400		350		720	2,73	2
V_6	880			1800		450		920	3,28	2
V_7	1060			2125		575		1065	3,82	2
V_8	2480			2450		2450	2480		4,37	2
d_1		490	1050		400			490	1,60	2
d_2		680	1390		500			680	1,85	2
d_3		700	1425		500			700	2,22	2
d_4		840	1750		525			840	2,62	2
d_5		1000	2050		600			1000	3,12	2
d_6		1150	2350		675			1150	3,66	2

Btg.	Berat sendiri		Angin kiri		Angin kanan		Extrim		Pjg.	Jml.baot
	tarik	tekan	tarik	tekan	tarik	tekan	tarik	tekan		
d_7		1330	2650		800			1330	4,11	2
a_1'		7940	7735		11200			7940	1,60	3
a_2'		7460	7350		10450			7460	1,60	3
a_3'		6840	6950		9375			6840	1,60	3
a_4'		6140	6600		8600			6140	1,60	3
a_5'		5800	6300		7750			5800	1,60	3
a_6'		5290	5945		6975			5290	1,60	3
a_7'		4790	5650		6150			4790	1,60	3
a_8'		4200	5400		5250			4200	1,60	3
b_1'	7300			6600		11000	7300		1,50	3
b_2'	7300			6600		11000	7300		1,50	3
b_3'	6850			6450		10025	6850		1,50	3
b_4'	6260			5700		8825	6260		1,50	3
b_5'	5980			5300		7850	5980		1,50	3
b_6'	5480			4900		6350	5480		1,50	3

Btg.	Berat sendiri		Angin kiri		Angin kanan		Extrim		Pjg.	Jml.baot
	tarik	tekan	tarik	tekan	tarik	tekan	tarik	tekan		
b_7'	4980			4500		5845	4980		1,50	3
b_8'	4520			4125		4850	4520		1,50	2
V_1'	0			0		0			0,55	2
V_2'	180			100		425		245	1,09	2
V_3'	340			200		675		335	1,64	2
V_4'	500			300		1000		500	2,18	2
V_5'	680			350		1400		720	2,73	2
V_6'	880			450		1800		920	3,28	2
V_7'	1060			575		2125		1065	3,82	2
d_1'		490	400		1050			490	1,60	2
d_2'		680	500		1390			680	1,85	2
d_3'		700	500		1425			700	2,22	2
d_4'		840	525		1750			840	2,62	2
d_5'		1000	600		2050			1000	3,12	2
d_6'		1150	675		2350			1150	3,66	2
d_7'		1350	800		2650			1330	4,11	2

D. MENDIMENSI KUDA2.

Batang2 atas yang ada : $a_1, a_2, a_3, a_4, a_5, a_6, a_7$ dan a_8

$a_1', a_2', a_3', a_4', a_5', a_6', a_7'$ dan a_8'

Dalam daftar didapatkan P ekstrim = - 7940 kg.

Direncanakan profil baja 2 L $\frac{60 \times 60}{6}$ dan Ø baot = 14 mm.

Diperoleh data2 : Fn = 2(5,89) = 11,78 cm^2.

$i_x = 1,82$ cm.

$\lambda = \frac{\ell}{i} = \frac{1,60}{1,82} = 87,9 \rightarrow \alpha = 0,530$

$\bar{\sigma}_k = \alpha . \bar{\sigma} = 0,530(1400) < 742$ kg/cm^2.

Sehingga profil ini dapat dipakai.

Batang2 bawah yang ada : $b_1, b_2, b_3, b_4, b_5, b_6, b_7$ dan b_8

$b_1', b_2', b_3', b_4', b_5', b_6', b_7'$ dan b_8'

P tarik = 7300 kg.

P tekan = 3700 kg.

Bila direncanakan profil 2 L $\frac{50 \times 50}{5}$ dan Ø baot = 14 mm.

Diperoleh data2 sbb : Fn total = 2(4,1) = 8,2 cm^2.

$i_x = 1,51$ cm.

$\lambda = \frac{\ell}{i_x} = \frac{1,50}{1,51} = 99,33 \rightarrow \alpha = 0,431$

$\bar{\sigma}_k = 0,431(1400) = 602$ kg/cm^2.

tekan yang terjadi : $\frac{3700}{8,2} = 451 < 602$ kg/cm^2.

Penyelidikan terhadap tarik P = 7300 kg

$\sigma = \frac{1,25(7300)}{8,2}$

= 1113 kg/cm2 < 1400 kg/cm2.

Sehingga profil 2 L $\frac{50 \times 50}{5}$ dapat dipakai.

Batang2 Vertikal : $V_1, V_2, V_3, V_4, V_5, V_6$ dan V_8

$V_1', V_2', V_3', V_4', V_5', V_6'$

Gaya2 batang diatas yang paling ekstrim = V_6 = - 920 kg.

Bila direncanakan profil 2 L $\frac{50 \times 50}{5}$

diperoleh data2 : Fn = 2(4,1) = 8,2 cm^2

$i_x = 1,51 \rightarrow \alpha = \frac{\ell}{i_x} = \frac{328}{151} = 217 > 120$

(dipakai rumus Euler).

$\bar{P} = \frac{\pi^2 . EI}{v.^2} = \frac{(3,14)^2(2,1.10^6)(2,11)}{3,5(328)^2} = 1209 > 920$ kg.

Sehingga profil 2 L $\frac{50 \times 50}{2}$ dapat dipakai.

Dimensi/Ukuran batang vertikal V_7.

P ekstrim = - 1065 kg.

Direncanakan profil baja 2 L $\frac{55 \times 55}{6}$ dan dipakai baot (Ø baot) = 14 mm.

Diperoleh data2 sbb : $I_x = 1,66$ cm

$\lambda = \frac{\ell}{i_x} = \frac{382}{1,66} = 230 > 120$

(dipakai Rumus Euler).

Ix = 2(17,3) = 34,6 cm^4.

Rumus Euler : $\bar{P} = \frac{\pi^2 . EIx}{v.l^2}$ dimana v adalah angka keamanan dengan nilai antara (3,5 - 5).

$\bar{P} = \frac{(3,14)^2(2,1.10^6)(2.17,3)}{3,5(382)^2} = 1400$ kg.

tekan yang terjadi = 1065 < 1400 kg.

Sehingga propil baja 2 L $\frac{55 \times 55}{6}$ dapat dipakai.

Batang2 diagonal : d_1, d_2 , d_3 , d_4 dan d_5

d_1' , d_2' , d_3' , d_4' dan d_5'

Gaya2 batang yang paling ekstrim adalah (P tekan) = 1000 kg.

Direncanakan profil baja 2 L $\frac{50 \times 50}{5}$

Diperoleh data2 : Fn = 2(4,1) = 8,2 cm^2.

i_x = 1,51 cm.

$\lambda = \frac{\ell}{i_x} = \frac{312}{1,51} = 206 > 120$ (Dipakai R.Euler).

$$\bar{P} = \frac{\pi^2 . E . Ix}{v . l^2} \longrightarrow \frac{(3,14)^2 (2,1.10^6)(2,11)}{3,5(312)^2} = 1340$$

tekan yang terjadi = 1000 kg < 1340

Sehingga propil 2 L $\frac{50 \times 50}{5}$ dapat dipakai.

Batang2 diagonal : d_6 , d_7 , d_6' dan d_7'

Gaya2 ekstrim yang terjadi = (tekan) = 1330 kg.

Direncanakan propil baja 2 L $\frac{60 \times 60}{6}$ dan Ø baot = 14 mm.

Diperoleh data2 : Fn = 2(5,89) = 11,78 cm^2.

i_x = 1,82 cm.

$\lambda = \frac{\ell}{i_x} = \frac{411}{1,82} = 225 > 120$ (R.Euler).

$$\bar{P} = \frac{\pi^2 . E . Ix}{v . l^2} \longrightarrow \frac{(3,14)^2 (2,1.10^6)(2.22,8)}{3,5(411)^2} = 1590 \text{ kg.}$$

tekan yang terjadi = 1330 < 1590 kg.

Sehingga propil 2 L $\frac{60 \times 60}{6}$ dapat dipakai.

E. PERHITUNGAN JUMLAH BAOT.

Dipakai plat simpul tebal = 10 mm.

Ø baot = 14 mm.

Jenis sambungan adalah : **Sebelah - Menyebelah.**

$\bar{P}$ geser = 2 . $\frac{1}{4}$ $(1,4)^2 (0,7\ \bar{\sigma})$

= 2 . $\frac{1}{4}$ $(3,14)(1,4)^2 (0,7.1400)$

= 3017 kg.

$\bar{P}$ tumpu = t.d. $(1,4\ \bar{\sigma})$

= 1(1,4)(1,4.1400)

= 2744 kg.

Yang menentukan adalah $\bar{P}$ tumpu = 2744 kg.

Gaya batang maximum yang terjadi = -7940 kg.

Sehingga jumlah baot yang diperlukan : $\frac{7940}{2744} = 2,89$ 3 baot.

Batang2 yang mempergunakan baot 2 bh. :

2 x 2744 = 5488 kg.

- Untuk batang2 yang menderita gaya tarik/tekan dibawah 5488 baot, memakai jumlah baot minimal = 2 bh.
- Untuk gaya2 batang 5488 < P < 7940 memakai baot 3 buah.

Catatan tambahan :

Bila terdapat misalnya gaya2 batang :

- akibat b. sendiri = - 10.000 kg.
- akibat angin kanan = + 15.000 kg.
- akibat angin kiri = + 12.000 kg.

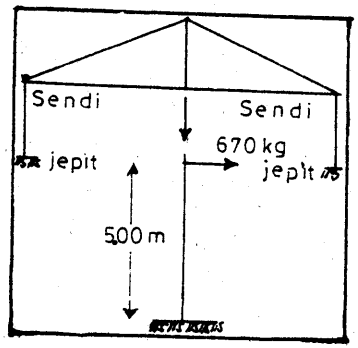
Maka gaya2 ekstrim adalah : P = -10.000 kg (bukan + 15.000)
Sebab antara b.sendiri + angin kanan terdapat jumlah gaya
= - 10.000 + 15.000 = + 5.000 kg < 10.000.

tetapi bilamana :

- akibat b. sendiri = + 10.000 kg
- akibat a. kanan = - 12.000 kg
- akibat a. kiri = + 12.000 kg

Maka P ekstrim yang terjadi : + 10.000 kg + 12.000 kg
= 22.000 kg.

F. PERHITUNGAN KOLOM.



M = 670 x 5,00 = 3350 kg.m.
Bila direncanakan dipakai DIN 18 ,
data2 : berat sendiri = 51,6 kg/m.

$W_x = 426 \text{ cm}^3$.
$F = 65,8 \text{ cm}^2$.
$i_x = 7,63$ cm.
$i_y = 4,6$ cm.

Sehingga P tot. = 2991,5 kg + (51,6.5)kg = 3249,5 kg.
M = 335.000 kg.cm.

$$\sigma_b = \frac{M}{W_x} = \frac{335.000}{426} = 786 \text{ kg/cm}^2.$$

$$\sigma_d = \frac{P}{F} = \frac{3249,5}{65,8} = 49,38 \text{ kg/cm}^2.$$

$$\frac{\sigma_d}{\sigma_b} = \frac{49,38}{786} < 1,5 \longrightarrow \text{dipakai rumus V.O.S.B.}$$

$$\lambda = \frac{\ell}{i_{min}} \longrightarrow \lambda = \frac{500}{4,6} = 108,7 \longrightarrow \alpha = 0,360$$

$$\omega = \frac{1}{0,360}$$

$$\omega = 2,77$$

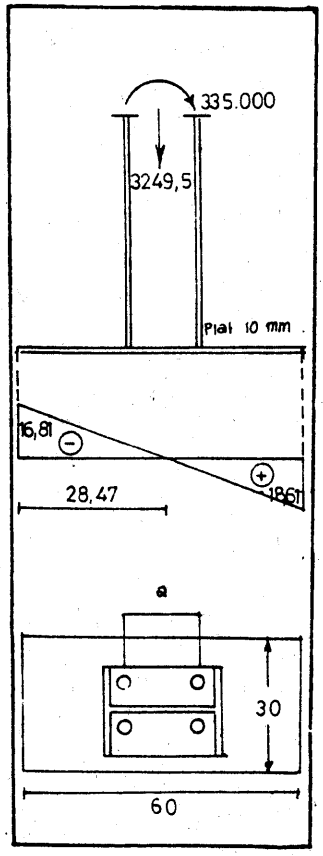
$$\sigma_d = \frac{2,77(3249,5)}{65,8} + \frac{335.000}{426}$$

$$= (137 + 786) \text{ kg/cm}^2.$$

σ_d = 923 kg/cm2 < 1400 kg/cm2.

*** **DIN 18 dapat dipakai sebagai kolom.**

G. PERHITUNGAN ANKER PERLETAKAN KOLOM.



Bila diambil plat baja tebal 10 mm
b (arah tegak lurus gambar) =30 cm
h = 60 cm.

$$\sigma_{max.} = \frac{P}{b.h} + \frac{M}{W}$$

$$= \frac{3249,5}{30(60)} + \frac{6(335.000)}{30.60^2}$$

$$= (1,80 + 18,61) \text{ kg/cm}^2$$

$$= 20,41 \text{ kg/cm}^2 < \bar{\sigma}_{beton}.$$

$\sigma_{min.}$ = (1,80 - 18,61) kg/cm2.
= -16,81 kg/cm2.

Tegangan minimum harus ditahan oleh - anker.

$$\frac{x}{60 - x} = \frac{16,81}{18,61}$$

$18,61x = 16,81 (60) - 16,81 x$
$x = 28,47$
$T = 28,47(30)(\frac{1}{2}.16,81)$
$= 7178$ kg.

$$F = \frac{T}{\bar{\sigma}}$$

$$= \frac{7178}{1400} = 5,12 \text{ cm}^2.$$

Dipergunakan anker 2 Ø 22 mm = 5,4 cm^2 letakkan pada sisi tarik.
Dalam praktek pada sisi tekan juga dipasang anker 2 Ø 22 mm.

Sehingga total 4 Ø 22 mm panjang 50 cm.

- check terhadap H = 670 kg.

H yang mampu dipikul = $4.\frac{1}{4}.\pi(2,2)^2.0,7(1400)$

= 14893,65 kg > 670 kg.

- check terhadap M = 3350 kg.m.

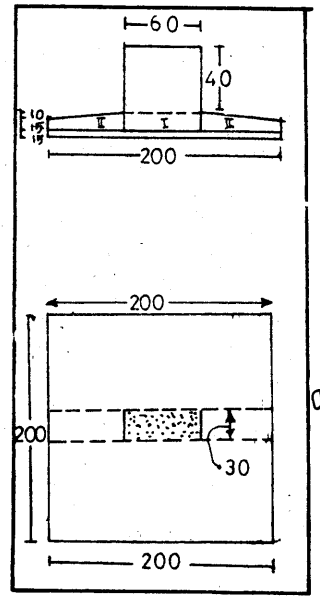
M yang dapat ditahan = $2(\frac{1}{4}\pi).2.2^2.0,5\,\bar{\tau}_b.(a)$

$= 2(\frac{1}{4})(3,14)2,2^2(0,5)(70000)(0,8)$

= 9671,2 kg.m > 33 kg.m.

H. PERHITUNGAN PONDASI.

Diambil pondasi setempat plat dengan ukuran 15 x 200 x 200



a). b.s. rib

= 0,6(0,3)(0,25)(2400) = 108kg (b.I)

= $\frac{1}{2}$(0,7)(0,25+0,15)(2)(0,3)(2400) = 202kg(b.II)

= 310kg

b). b.s. kolom

= 0,4(0,6)(0,3)(2400) = 115,2 kg

Jumlah = 425,2 kg < 426 kg.

M = 335.000 kg.cm.

σyang terjadi = $\frac{3250 + 426}{(200)(200)} + \frac{(335.000)(6)}{200.(200)^2}$

= 0,09 kg/cm^2 + 0,25 kg/cm^2

σ = 0,34 kg/cm^2 < 0,5 kg/cm^2 (σ_t).

- Momen pada plat pondasi : $\frac{1}{2}$ q . l^2 = $\frac{1}{2}$ (3400)$(1)^2$

= 1700 kg.m.

Apabila dipakai perhitungan sistem n, menurut P.B.I 71 diketahui :

$\bar{\sigma}_a$ = 1700 kg/cm^2 ; $\bar{\sigma}_b$ = 55 kg/cm^2 ; n = 24 - pembebanan - tetap.

maka $\phi_o = \frac{\bar{\sigma}_a}{n.\ \bar{b}} = \frac{1700}{24(55)} = 1,29$

h = ht - 2 = 15 - 2 = 13 cm.

$Ca = \frac{h}{\sqrt{\frac{n(M)}{b.\bar{\sigma}a}}} = \frac{13}{\sqrt{\frac{24(1700)}{1\ .\ 1700}}} = 2,66$ (lebar plat diambil per - 1.00 meter)

Sehingga untuk δ = 0 ---→ ϕ = 1,309 > ϕ_o (= 1,29)

100 n = 16,53 ---→ nw = 0,1653

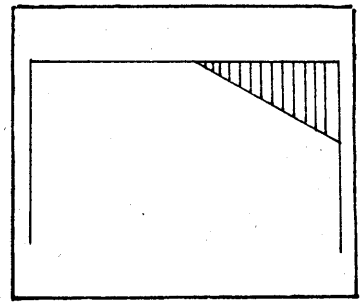
w = $\frac{0,1653}{24}$ = 0,0069

Dipakai tulangan tarik A = w.b.h

= (0,0069)(100)(13) = 9 cm^2

Ø 12 - 12,5 = 9,04 > 9 cm^2

- Momen pada rib.



p = 2.q.l_t = 2(3400)(1) = 6800

M pada rib = $\frac{1}{2}$(6800)(1)($\frac{2}{3}$)(1)

= 2267 kg.m.

h_t = 40 ---→ h = 35 cm , b = 0,3

$Ca = \frac{h}{\sqrt{\frac{n.\ M}{b.\bar{\sigma}a}}} = \frac{5}{\sqrt{\frac{24(2267)}{0,3(1700)}}} = 3,39$

Untuk δ = 0 ---→ ϕ = 1,8 > ϕ_o (=1,29)

100 nw = 9,9

nw = 0,099 ---→ w = $\frac{0,099}{24}$

$A = w.b.h \longrightarrow A = \frac{0,099}{24}(30)(35) = 4,33\ cm^2.$

Dipakai pembesian : 4 Ø 12 (= 4,52 cm^2) > 4,33 cm^2.

PERHITUNGAN JARAK KOPPLING./dipilih batang tekan yang terpanjang

1. $l' = 30 - 50\ i_{min}$

   Untuk baja L $\frac{60 \times 60}{6}$; $i_{min.} = 1,82$ cm.

   $l' = 50(1,82) = 91$ cm.

2. $l' = \frac{imin}{i_y} \cdot l_k$ dimana $i_y = \sqrt{8,09} = 2,84$

   $l' = \frac{1,82}{2,84} \cdot (1,60) = 102,53$ cm.

3. P untuk a_1 = 7940 kg.

   $P' = 0,7(7940) = 5558$ kg.

   $\sigma = \frac{P}{F} = \frac{5558}{13,82} = 402,17\ kg/cm^2.$

   (1400) $\alpha = 402$

   $\alpha = \frac{402}{1400} = 0,287$ ..... $\lambda = 121$

   $l' = \lambda \cdot i = 121(1,82) = 220$ cm

   Dari 3 cara memperoleh l' dipilih l' min. = 91 cm.

   Jarak kopling = $\frac{160}{2}$ = 80 cm < 91 (aman).

   Untuk baja L $\frac{50 \times 50}{5}$ ..... $i_{min} = 1,51$

1. $l' = 30 - 50\ i_{min}$

   $l' = 50(1,51) = 75,5$ cm.

2. $l' = \frac{i\ min}{i_y} \cdot l_k$ ..... $i_y = \sqrt{\frac{I}{F}}$

   $i_y = \sqrt{\frac{2(11) + 2(4,8)(1,9)^2}{2(4,8)}} = 2,43$

   $l' = \frac{1,51}{2,43}(3,28) = 203$ cm.

3. P untuk V_6 = 920 kg

   $P' = 0,7\ (920) = 644$ kg

   $\sigma = \frac{644}{9,6} = 67\ kg/cm^2.$

   $\alpha = \frac{67}{1400} = 0,047$ ..... $\lambda = 200$

   $l' = 200\ (1,51) = 300\ cm^2.$

   Dari 3 cara memperoleh l' dipilih hasil l' min. = 75,5 cm.

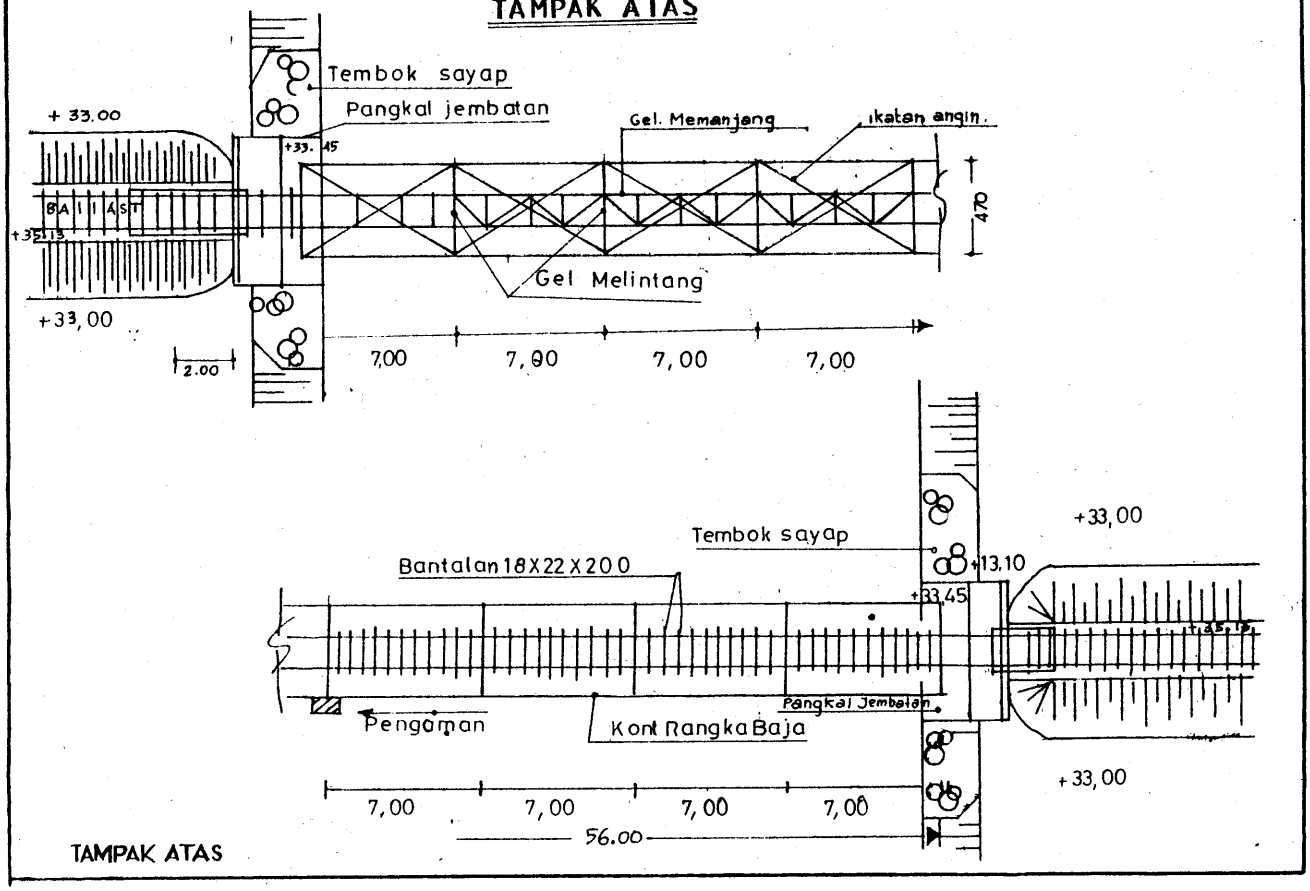
   Apabila dipakai 4 buah koppling : $\frac{3,28}{5}$ = 65,6 < 75,5 cm

   (a m a n).

   Untuk menentukan koppling dari batang diagonal d_7 yang mendapat tekan = 1330 kg ---→ dipakai koppling dengan jarak 80 cm seperti perhitungan teratas.

----oOo----

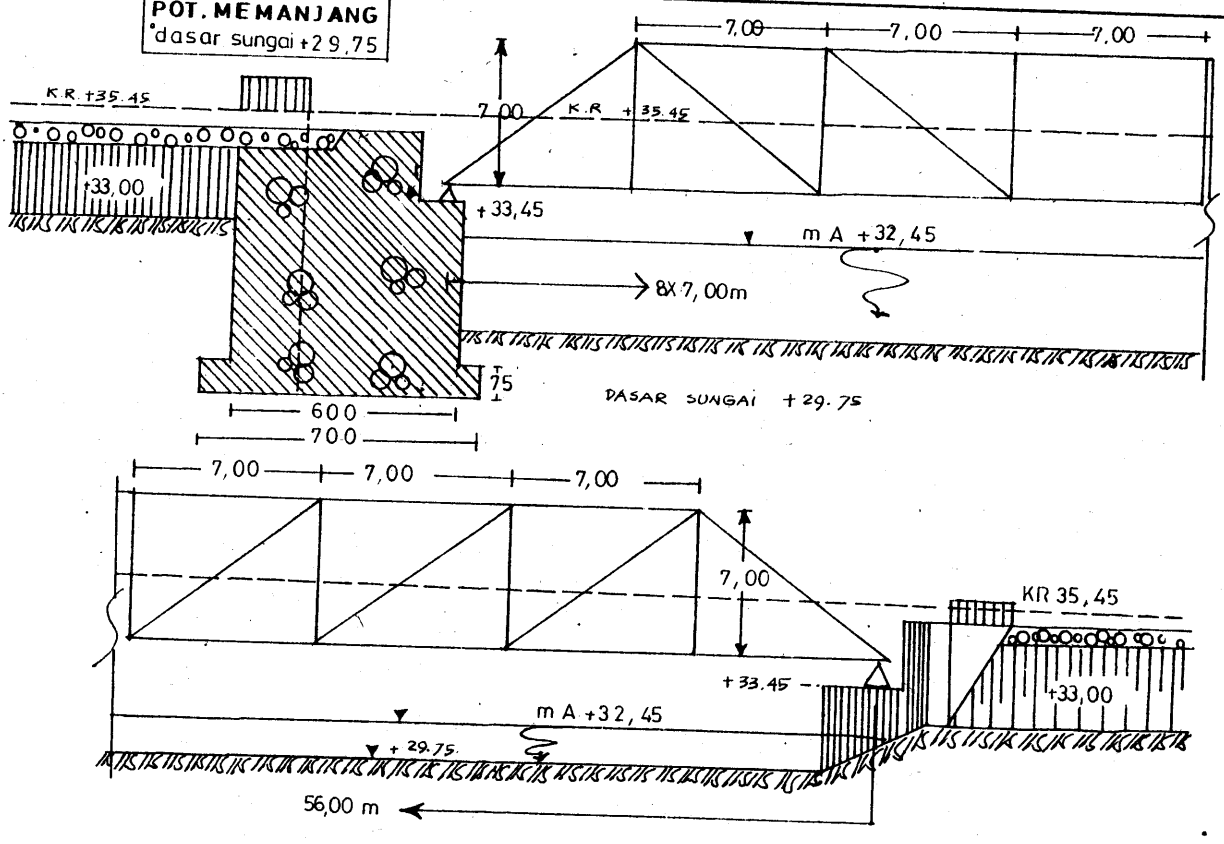
TAMPAK ATAS

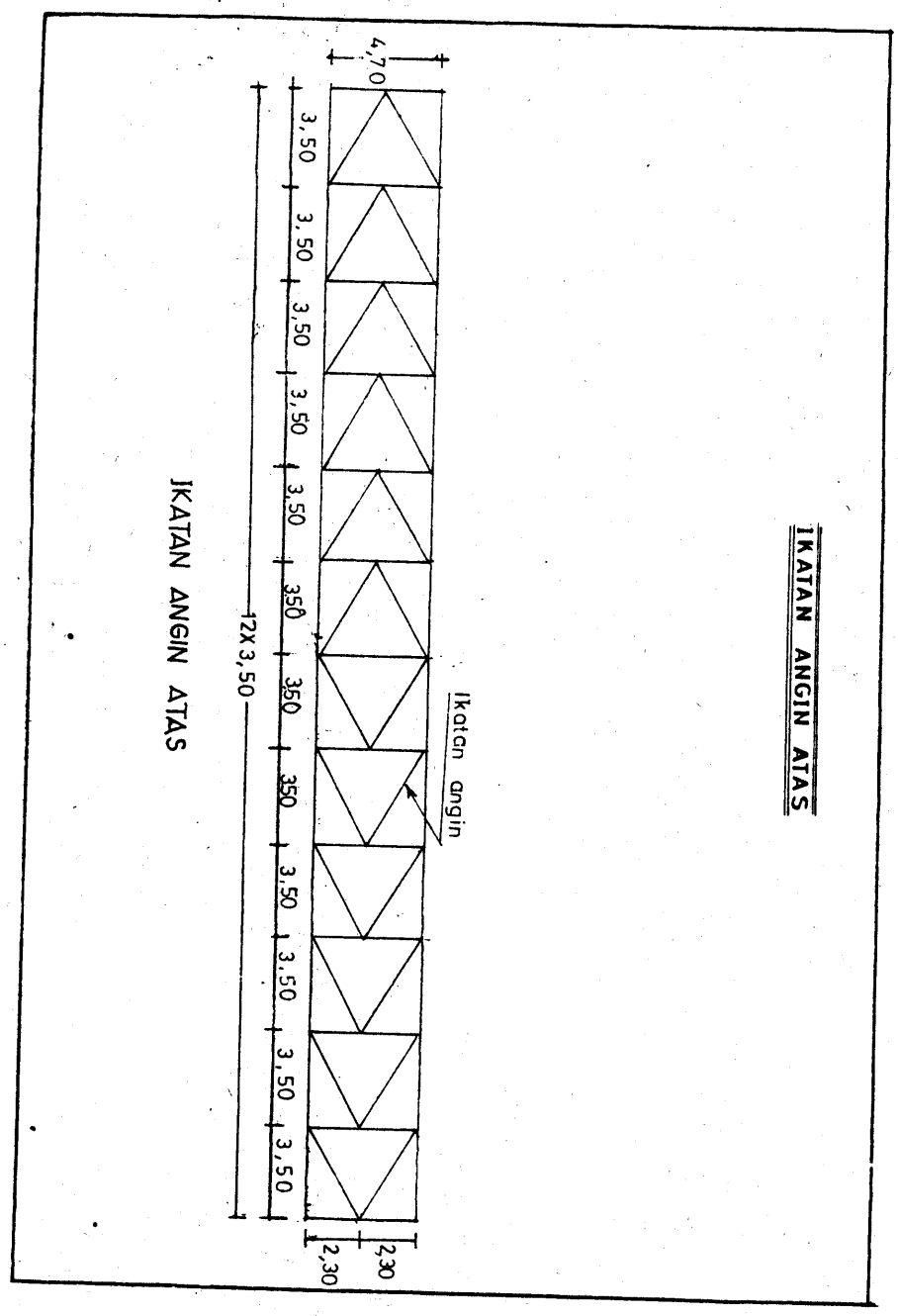


TAMPAK ATAS

POT. MEMANJANG

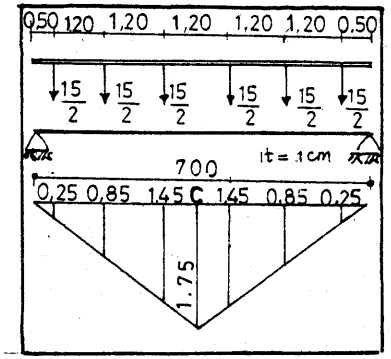
dasar sungai +29,75





IKATAN ANGIN ATAS

I. PERHITUNGAN GELAGAR MEMANJANG.



- Muatan : peraturan k s . 18
- Muatan pada gelagar memanjang 6 gandar a 15 t.
- Tekanan masing2 roda : $\frac{15}{2}$ = 7,5t
- Dipakai Rail no 3
- Bantalan kayu : 0,18x0,22x2 m^3.

* Digunakan untuk gelagar meman - jang DIN 55.

*** G.P. Tengah bentang ***

*** Beban mati :**

- b.s. profil DIN = 207 kg/m'
- Rail, bantalan & alat penambat = 230 kg/m'

g = 437 kg/m'

$$Mg = \frac{1}{8} . 437.7^2 = 2677 \text{ kgm} = 2,677 \text{ tm.}$$

*** Beban hidup :** muatan P bergerak.

- Banyak gandar = 6 ---> $P = \frac{15}{2}$ = 7,5 ton (K.S.18)
- Koef kejut : $Q = 1,20 + \frac{25}{L + 50}$

$$= 1,20 + \frac{25}{7 + 50} = 1,639$$

$$M_p = [7,5 \times \{2 \times (0,25+0,85+1,45)\} \times 1,639]$$

$$= 15 \times 2,55 \times 1,639 = 62,692 \text{ tm.}$$

$$M_q = Mg + Mp = 2,677 + 62,692 = 65,369 \text{ tm.}$$

*** Propil DIN 55 :** Ix = 140.340 cm^3 ; Wx = 5100 cm^3.

$$\sigma_o = \frac{M}{\omega} = \frac{65,369 . 10^5}{5100} = 1282 \text{ kg/cm}^2 < \bar{\sigma} = 1300 \text{ kg/cm}^2$$

(a m a n).

Kontrol lendutan :

$q = 0{,}437 + \frac{6 \times 7{,}5}{7} = 6{,}866$ ton/m = 68,66 kg/cm.

$f = \frac{5}{384} \cdot \frac{q \cdot L^4}{E.I} = \frac{5}{384} \times \frac{68{,}66 \times 700^4}{2.1 \times 10^6 \times 140.340} = \underline{0{,}728 \text{ cm.}}$

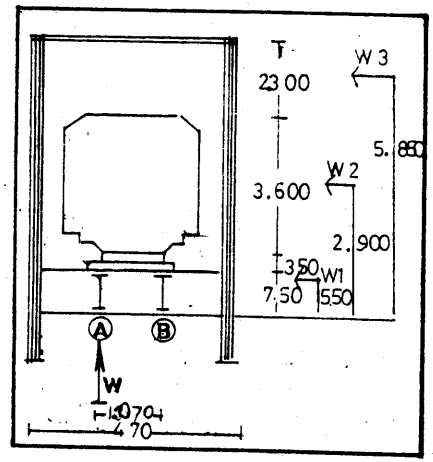
$\bar{f} = \frac{1}{800} \cdot L = \frac{1}{800} \cdot 700 = 0{,}875$ cm.

$f < \bar{f}$ ---> memenuhi syarat !.

*** Kontrol tambahan tegangan pada gelagar memanjang akibat angin dan tumbukan :**

1. Tambahan tegangan arah vertikal akibat angin :

Tekanan angin : $W = 100$ kg/m^2 (V.O.S.B.)



$\Sigma M_B = 0$

$\omega_v \cdot 1{,}07 = 3{,}6 \times 100 \times 2{,}9 + 0{,}55 \times 100 \times 1.1$

$\omega_v = \frac{1044 + 60{,}5}{1{,}07}$

$= 1032$ kg/m'.

$M_{\omega_v} = \frac{1}{8} \cdot 1032 \cdot 7^2$

$= 6322{,}48$ kgm.

$\sigma_1 = \frac{M \omega_v}{\omega} = \frac{632248}{5100}$

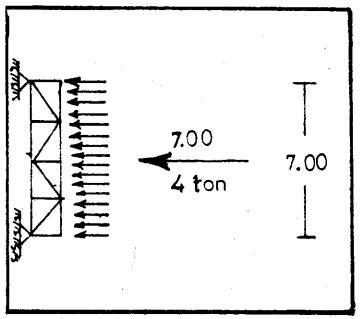
$= 124$ kg/cm^2.

2. Tambahan tegangan akibat angin arah horizontal :

$M = \frac{1}{8} \cdot q \cdot l^2$

$= \frac{1}{8} \cdot (3{,}6 \times 100) \cdot 7^2$

$= 2205$ kgm.



Letak ikatan tumbuk ditengah (diperhitungkan sebagai ikatan angin dengan pembebanan).

$P = \frac{M}{n} = \frac{2205}{1{,}07} = 2061$ kg.

$\sigma_2 = \frac{P}{F} = \frac{2061}{263} = 7{,}8$ kg/cm^2.

(DIN 55 --> F = 263 cm^2).

3. Tambahan tegangan akibat tumbukan :

Menurut V.O.S.B. ----> Gaya horizontal = 4

$M = \frac{1}{4} \cdot P \cdot L = \frac{1}{4} \times 4 \times 7 = 7$ tm = 7000 kgm.

$P = \frac{M}{n} = \frac{7000}{1{,}07} = 6542$ kg.

$\sigma_3 = \frac{P}{F} = \frac{6542}{263} = 24{,}9$ kg.

* Jumlah tegangan yang terjadi akibat : **beban mati, beban hidup & tambahan tegangan akibat angin dan tumbukan.**

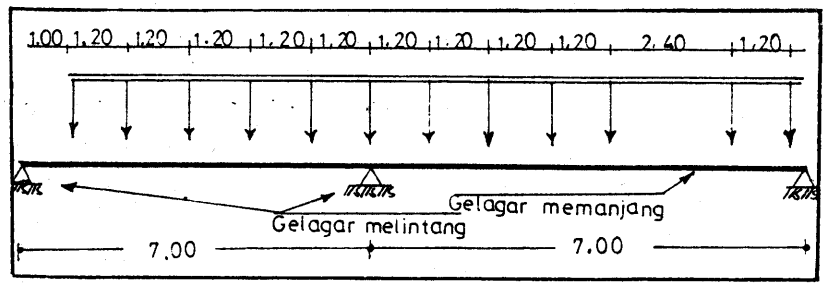
$\sigma_{total} = \sigma_0 + \sigma_1 + \sigma_2 + \sigma_3$

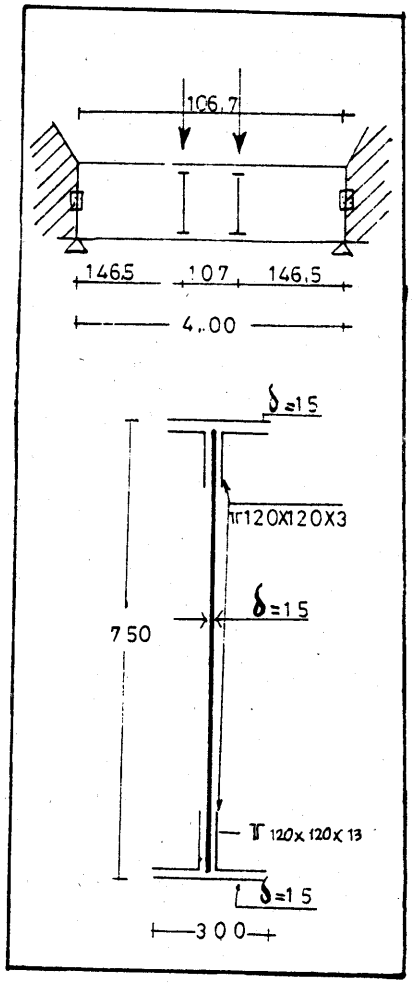
$= 1282 + 124 = 7{,}8 + 24{,}9 = 1438{,}7$ kg/cm^2

$< \bar{\sigma} = 1450$ kg/cm^2.

----> a m a n !.

II. PERHITUNGAN GELAGAR MELINTANG





*) Gelagar melintang dibuat dari kon dinding penuh.

PL.badan { - tinggi = 750 mm
- δ = 15 mm

PL.sayap { - lebar : 300 mm
- δ = 15 mm

baja siku -- 4L 120x120 x 13

L 120x120x13 -> { F = 29,7 cm^2
S = 3,44 cm
Ix= Iy = 344 cm^4.

- F gel.melintang
= (75x1,5)+(2x30x1,5)+(4x29,7)
= 321,3 cm2.

- Berat sendiri gelagar melin - tang = 0,03213 x 7,85
= 0,2522 t/m'.

a)Beban mati :

1. b.s.gel.melintang

$M_1 = 1/8.252,2.4^2 = 504,4$ kg.m

2. gelagar memanjang + bantalan+ rail = 437 x 7 = 3059 kg.
M_2 = 3059 x 1,815 = 5.522 kgm

b) beban hidup : beban bergerak seperti pada gambar.

Koef kejut : $Q = 1,2 + \frac{25}{4,7 + 50} = 1,657$

$$Q = \frac{15}{2}\left(1 + \frac{5,8}{7} + \frac{4,6}{7} + \frac{3,4}{7} + \frac{2,2}{7} + \frac{1,0}{7}\right) + \frac{15}{2}\left(\frac{5,8}{7} + \frac{4,6}{7} + \frac{3,4}{7} + \frac{2,2}{7}\right)$$

= 34,286 ton.

$M_p = 1,657 \cdot (34,286 \times 1,465) = 83,229$ tm.

$M_{total} = M_1 + M_2 + M_p$

= 504,4 + 5.552 = 83.229 = 89.285,4 kgm.

*). Momen inersia :

- plat badan : $\frac{1}{12} \cdot 75^3 \cdot 1,5$ = 52.734 cm^4.

- plat sayap : $(\frac{1}{12} \cdot 1,5^3 \cdot 30x2) + (2x1,5x30) \times 38,25^2$ = 131.693 cm^4.

- baja siku : 4 [394+29,7(37,5-3,44)^2] = 139.394 cm^4.

I total = 323.821 cm^4.

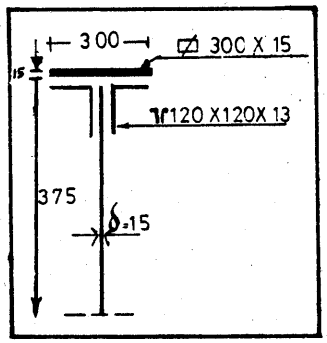
$\omega_{netto} = \frac{0,85 \times 323.821}{38,25}$ = 7196 cm^3.

σ yang terjadi = $\frac{M\ tot}{\omega\ net} = \frac{8.928,540}{7196}$

= 1241 kg/cm^2 < $\bar{\sigma}$ = 1400 kg/cm^2.

a m a n !

*). **Kontrol tegangan geser plat gelagar melintang :**



*) Statis momen terhadap garis tengah :

- plat sayap :
= 30x1,5x38,25 = 1721 cm^3

- plat badan :
= 37,5x1,5x18,75 = 1055 cm^3

- baja siku :
= 29,7x(37,5-3,44)[2] = 2023 cm^3

Sx = 4799 cm^3

*). Gaya lintang :

D = [(2 x 252,2) + 3059 + (34.286 x 1,657)] kg

= 60.375 kg.

$$\tau = \frac{D.Sx}{\delta.L\ net} = \frac{60.375 \times 4799}{1,5 \times 323.821 \times 0,85} = 702\ kg/cm^2.$$

$\bar{\tau} = 0,58 \times 1300 = 755\ kg/cm^2 > \tau$ a m a n !

*). **Perhitungan paku penahan garis pada baja siku dengan plat - badan.**

Dipakai paku keling Ø 26.

$kg = 2 . \frac{1}{4} . \pi . 2,6^2 . 0,8 . 1400 = 11.893\ kg$

$ks = 1,5 . 2,6 . 1,6 . 1400 = 8,736\ kg$

$\therefore \bar{K} = 8736\ kg = L$

Statis momen bagian yang bergambar (plat sayap dan baja siku) :

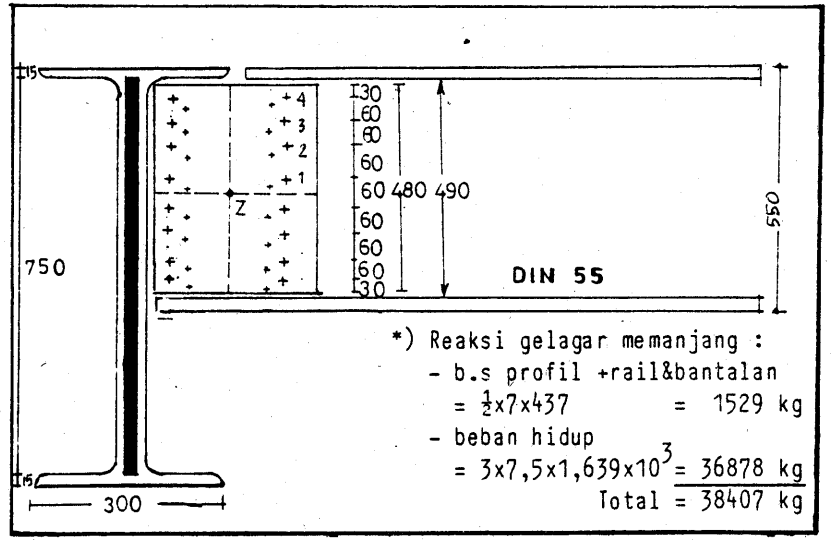
$Sx = (30 \times 1,5 \times 38,25) + (29,7 \times 2)(37,5 - 3,44)$

$= 3,744,4\ cm^3.$

$$t = \frac{L.I.nt}{D.S} = \frac{8736 \times 323.821 \times 0,85}{60.375 \times 3.744,4} = 10,64\ cm.$$

Dipakai $= 10\ cm$ (paku Ø 26).

III. SAMBUNGAN GELAGAR MEMANJANG DENGAN GELAGAR MELINTANG :



*) Reaksi gelagar memanjang :

- b.s profil +rail&bantalan
  $= \frac{1}{2} \times 7 \times 437 = 1529\ kg$
- beban hidup
  $= 3 \times 7,5 \times 1,639 \times 10^3 = 36878\ kg$

Total = 38407 kg

*) Dipakai profil penyambung : $\perp\!\!\!\perp \frac{75 \times 170}{14}$

momen yang terjadi pada titik Z
= 38.407 x 11,85 = 424.397 kg.cm.

no.	x	y	x^2	y^2
1	1	1	1	1
2	1	3	1	9
3	1	5	1	25
4	1	7	$\frac{1}{4}$	$\frac{49}{84}$

S = 3 cm

$4 \times \sum(x^2 + y^2) = 4 \times (4 + 84) = 352$

$kx = \frac{424.397 \times 7}{3 \times 352} = 2313\ kg$

$ky = \frac{424.397 \times 1}{3 \times 352} = 402\ kg$

$kn = \frac{P}{n} = \frac{38.407}{16} = 2400\ kg$

$k = \sqrt{2813^2 + (402 + 2400)^2} = 3970\ kg.$

Dipakai paku Ø 20.

$kg = 2 \times \frac{1}{4}\pi \times 2^2 \times 0,8 . 1400 = 7037\ kg$

$ks = 1,6 \times 2 \times 1,6 \times 1400 = 7168\ kg.$

$k < kg < ks$

a m a n

*) Sambungan profil penyambung dengan gelagar melintang :

$$N_4 = \frac{M . a_4}{2 \sum ai^2}$$

$$= \frac{424.397 \times 45}{2(45^2 + 39^2 + 33^2 + 27^2 + 21^2 + 15^2 + 9^2 + 3^2)}$$

$= 1560$ kg.

$$\sigma_1 = \frac{1560}{\frac{1}{4}.\pi.2^2} = 497 \text{ kg/cm}^2 < \bar{\sigma}_1 = 500 \text{ kg/cm}^2.$$

$$kn = \frac{P}{n} = \frac{38.407}{16} = 2.400 \text{ kg (tiap paku menahan).}$$

$$\tau = \frac{2400}{\frac{1}{4}.\pi.2^2} = 764 \text{ kg/cm}^2.$$

$$\sigma_{ideal} = \sqrt{\sigma_1^2 + \tau^2 . 1,56}$$

$$= \sqrt{497^2 + 764^2 . 1,56} = 1076 \text{ kg/cm}^2$$

$$< \bar{\sigma} = 1400 \text{ kg/cm}^2$$

aman !.

IV. PERHITUNGAN RANGKA - GELAGAR - UTAMA.

*** Tinjauan beban untuk ke 2 gelagar utama.**

I. Beban mati :

1. Berat rail, bantalan & alat2 penambat = 230 kg/m'
2. Berat gelagar memanjang : (2x207) + 10% = 455 kg/m'
3. Berat gelagar melintang :
   = 1/56 (9 x 4 x 253,2) + 10% = 178 kg/m'
4. b.s. gelagar rangka utama :

Untuk 1 gelagar rangka utama :

- bt.tepi atas : I NP 40 , l = 7,00 m
  ---> berat = [7 x 0,0291 x 7850] x 6 = 9.549 kg
- bt.tepi bawah : II NP 40 , l = 7,00 m
  ---> berat = [7 x 0,0258 x 7850] x 8 = 11.342 kg

- bt.diagonal tekan :][NP 40 , l = 9,90 m
  ------> berat = [9,9 x 0,0249x7850] x 2 = 3.870 kg
- bt.diagonal tarik :][NP 32 , l = 9,90 m
  ------> berat = [9,9x0,0156x7850] x 6 = 7.069 kg
- bt.vertikal : I DIN 25 , l = 7,00 m
  ----> berat = [7 x 0,01910 x 7850] x 7 = 7.347 kg

Total = 39.222 kg

*). Berat 2 rangka gelagar utama :

$= \{2 \times 39.222\} + 10\% = 86.288$ kg.

$= \frac{86.288}{56}$ = 1541 kg/m'

5. Berat ikatan angin atas = 50 kg/m'

   Berat ikatan angin bawah = 50 kg/m'
6. Berat ikatan tumbuk = 70 kg/m'

   Beban mati jembatan = 2574 kg/m'
   (diterima 2 gelagar utama).

*). Beban mati rangka gelagar utama :

$$q = \frac{2574}{2} = \underline{1287 \text{ kg/m'}}.$$

II. Beban hidup :

- muatan rangkaian K.A dengan beban2 terpusat = 12 ton (KS 18).

  $P = \frac{12}{2} = 6$ ton = 6000 kg (untuk 1 gelagar utama).
- koef.tumbuk : $Q = 1,2 + \frac{25}{56 + 50} = 1,436$

III. Beban angin : ($C = 100 \text{ kg/m}^2$).

1. Tekanan angin pada bidang dibawah kendaraan :

   $F_1 = 56 \times 1,1 = 61,6 \text{ m}^2$ --- $W_1 = 61,6 \times 100 = 6.160$ kg
2. Tekanan angin pada bidang kendaraan :

   $F_2 = 56 \times 3,6 = 201,6 \text{ m}^2$ --- $W_2 = 201,6 \times 100 = 20.160$ kg

3. Tekanan angin pada bidang diatas kendaraan

$F_3 = (2 \times 56 \times 2{,}3) \times 0{,}3 = 77{,}28\ m^2$ --- $W_3 = 77{,}28 \times 100 = 7.728$ kg.

*). Tekanan vertikal kebawah pada gelagar utama akibat angin = K

$K \times 4{,}70 = (W_1 \times 0{,}55) + (W_2 \times 2{,}40) + (W_3 \times 5{,}85)$

$= (6.160 \times 0{,}55) + (20.160 \times 2{,}9) + (7{,}728 \times 5{,}85)$

----> $K = \frac{3.388 + 58.464 + 45.209}{4{,}70} = 22.779$ kg.

- pada tiap titik buhul gelagar utama bekerja :

$k = \frac{22.779}{8} = \underline{\underline{2847\ kg.}}$.

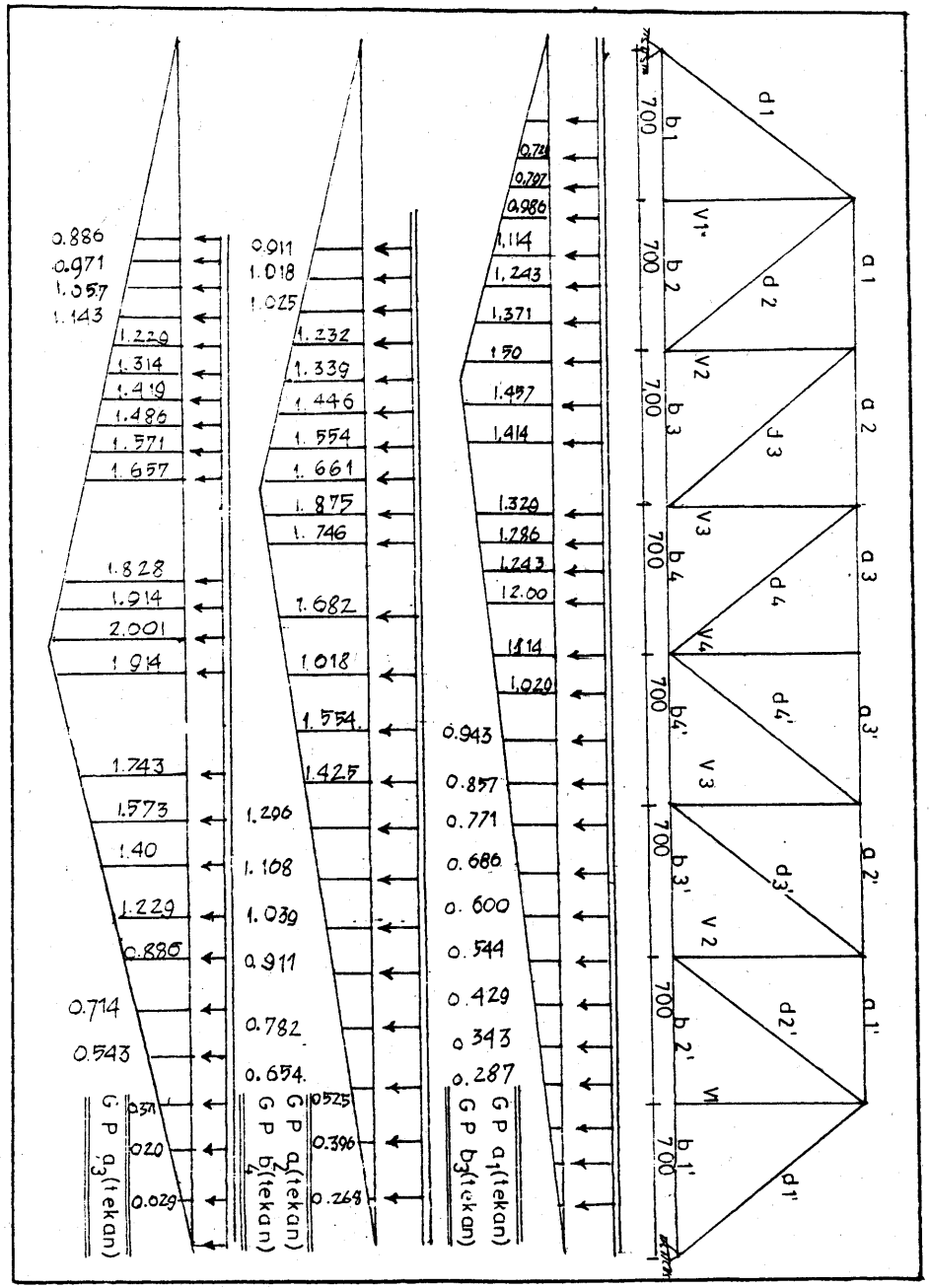
*). **KETERANGAN :**

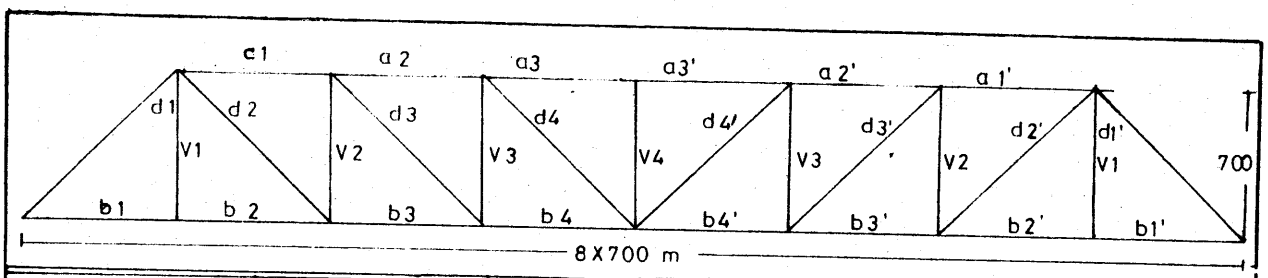
- Perhitungan mencari gaya2 batang max pada rangka gelagar utama, dicari dengan menggunakan garis pengaruh N masing2 batang (hal.bel).

1. untuk beban mati ------ merata = q kg/m'
   N_1 = q x luas bidang pengaruh.
2. untuk beban hidup ----- terpusat : P = 6000 kg
   $N_2 = Q \times P \times Yn\ \gamma n$
   $= 1{,}436 \times 6000 \times Yn = 8616 \times Yn$
3. untuk beban angin ----- sebagai muatan terpusat pada tiap titik buhul : k = 2847 kg.
   (pada tiap titik buhul ujung gelagar utama bekerja muatan terpusat = $\frac{1}{2}$ k).
   $N_3 = k \times \Sigma y = 2847 \times \Sigma y$

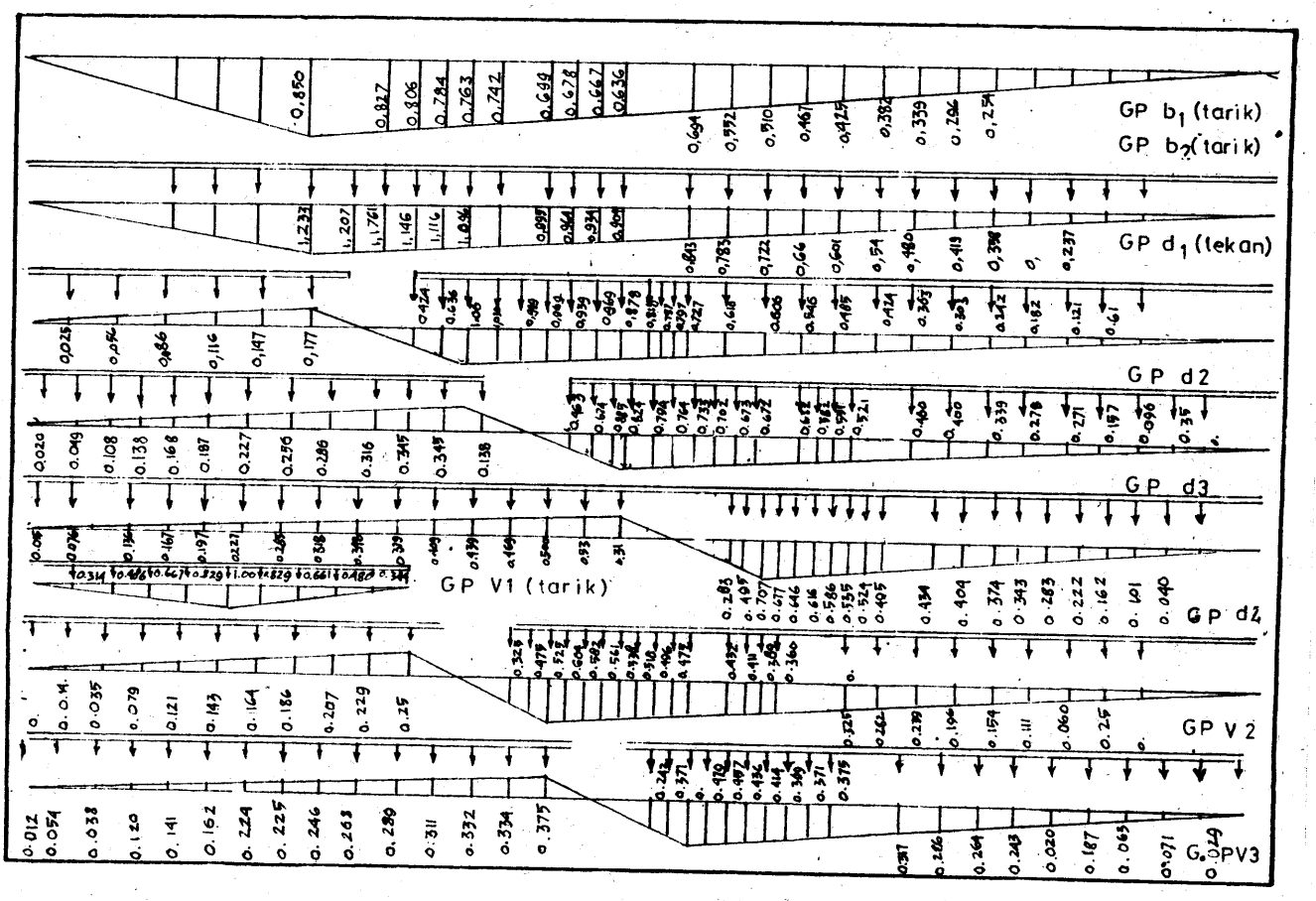
   Dimana Yn γn & y = ordinat garis pengaruh ditempat bekerjanya beban.

- Perhitungan gaya2 batang akibat masing2 beban dan kombinasi pembebanan untuk mencari N max bisa dilihat pada halaman - belakang.

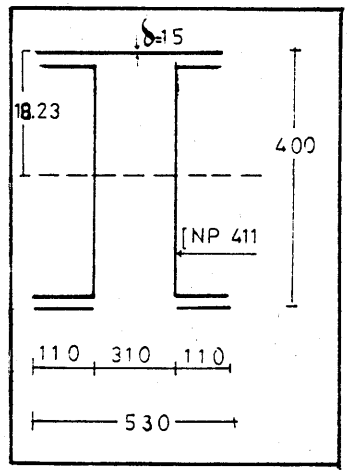




BATANG		Grs PENGARUH			Beban mati		beban hidup		Muatan angin		BMati Hidup		Komb Beban	
Keterangan	nomor batang	Beb. Mati Luas GP	Beb. Hidup Z yn	Muatan Angin Z y	Z = 1 287 t/m Tarik +	Tekan −	V 6t Q=1.436 Tarik +	Tekan −	K = 2 847 ton Tarik +	Tekan −	tanpa m angin Tarik +	Tekan −	gaya max(t) Tarik +	Tekan −
Batang atas	a1 = a1'	-42.00	-24.29	-6.00	—	54.2×1.287 = 54.054	—	207.695	—	17.082	—	261.949	—	279.03
	a2 = a2'	-52.50	-29.143	-7.500	—	67.567	—	251.096	—	21.352	—	318.663	—	340.015
	a3 = a3'	-56.00	-30.133	-8.000	—	72.072	—	259.454	—	22.776	—	331.526	—	354.50
Batang bawah	b1 = b1'	+24.50	+14.536	+3.500	31.531	—	125.242	—	9.964	—	156.773	—	166.737	—
	b2 = b2'	+24.50	+14.536	+3.500	31.531	—	125.242	—	9.964	—	156.773	—	166.737	—
	b3 = b3'	+42.00	+24.129	+6.000	54.054	—	207.808	—	17.082	—	261.949	—	279.031	—
	b4 = b4'	+52.50	-24.142	+7.500	67.567	—	231.096	—	21.352	—	318.663	—	340.017	—
Bat. Diagonal	d1 = d1'	-34.64	± 20.550	-4.950	—	44.582	—	177.079	—	14.093	—	221.641	—	235.73
	d2 = d2'	+24.73	+16.679 −0.671	+3.533	31.828	—	135.932	3.230	10.058	—	167.780	—	177.838	—
	d3 = d3'	+14.94	+11.618 −2.847	+2.137	19.228	—	100.075	19.360	6.084	—	119.303	0.132	123.387	0.132
	d4 = d4'	+4.95	+7.947 −4.816	+0.707	6.321	—	68.471	41.495	2.013	—	74.802	35.124	76.855	35.124
Bat. Vertikal	V1 = V1'	+7.00	± 5.572	+1.000	9.009	—	48.008	—	2.847	—	57.015	—	59.864	—
	V2 = V3'	-10.50	± 1.629 ± 8.20	-1.500	—	13.513	14.035	70.651	—	4.270	0.522	84.164	0.522	88.43
	V3 = V4'	-3.50	± 3.408 ± 2.821	-0.500	—	4.504	29.303	48.431	—	1.423	24.859	52.935	24.859	54.35
	V4	-0.00	0.00	0.00	—	—	—	—	—	—	—	—	—	—



1. Batang tepi atas = bt. a = bt. tekan :



- gaya batang max akibat beban mati& hidup :
  Po = 331,526 ton (tekan).
- gaya batang max akibat mati, hidup & angin :
  P_1 = 354,302 ton (tekan).
- l = 7.00 m.

Dipakai :

2 [40 + 1 plat 1,5x53 cm^2 = 79,5 cm^2
+ 2 plat 1,5x11 cm^2 = 33 cm^2

*) [NP 40 : Ix = 20350 cm^4
Iy = 846 cm^4
F = 91,5 cm^2
S = 26,5 mm
F gab(91,5x2) = 183 cm^2
(2 [40) = 295,5 cm^2

*) **Garis netral :**

$$Ix = \frac{(2x91,5x21,5) + (53x1,5x0,75) + (2x11x1,5x42,25)}{(2x91,5) + (53 \times 1,5) + 2(11x1,5)}$$

$$= \frac{5388,4}{295,5} = \underline{18,23 \text{ cm.}}$$

*) **Profil gabungan :**

$$Ix = \{2x20.350\} + (\tfrac{1}{12} \times 1,5^3 x53) + (1,5x53x18,23^2) + 2\{(\tfrac{1}{12} \times 1,5^3 x11) + (1,5x11x24,02^2)\}$$

$$= 86.181 \text{ cm}^4.$$

$$Iy = 2\{846 + (91,5x18,15^2)\} + \{\tfrac{1}{12} \times 53^3 \times 1,5\} + 2\{(\tfrac{1}{12} \times 11^3 \times 1,5) + (11 \times 1,5 \times 21^2)\} = 95.472 \text{ cm}^4$$

I min = Ix = 86.181 cm^4

$$\sqrt{\frac{Ix}{F}} = Imin = \sqrt{\frac{86.181}{295,5}} = 17,08$$

$$\lambda = \frac{7.00}{17,08} = 41 \rightarrow \alpha = 0,909$$

$$\omega = 1/\alpha = 1,111$$

---> $\omega = 1,111$

$$\sigma_o = \frac{P}{f}$$

*) Po = 331,526 ton.

$$\sigma_{K^o} = \frac{331,526}{295,5} = 1122 \text{ kg/cm}^2$$

$$\bar{\sigma}_{K^o} = \frac{1300}{1,111} = 1170 \text{ kg/cm}^2$$

$\sigma_{K^o} < \bar{\sigma}_{K^o}$

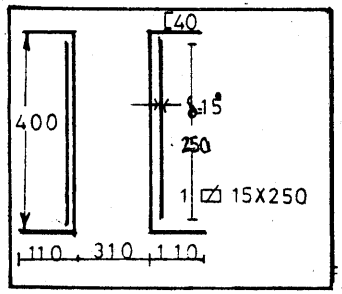
*) P_1 = 354,302 ton.

$$\sigma_{K_1} = \frac{354,302}{295,5} = 1199 \text{ kg/cm}^2$$

$$\bar{\sigma}_{K_1} = \frac{1450}{1,111} = 1305 \text{ kg/cm}^2$$

$\sigma_1 < \bar{\sigma}_1$ a m a n !.

2. Batang tepi bawah = bt. b = batang tarik.



- gaya batang max akibat beban mati& hidup :
  Po = 318,663 ton (tarik).
- gaya batang max akibat beban mati hidup & angin :
  P_1 = 340,015 ton (tarik)
- l = 7.00 m

*) **Dipakai profil :** 2 [NP 40 + 2 plat 1,5 x 25 cm^2

F_{gab} = (2 x 91,5) + (2 x 1,5 x 25) = 258 cm^2.

*) Po = 318.663 kg

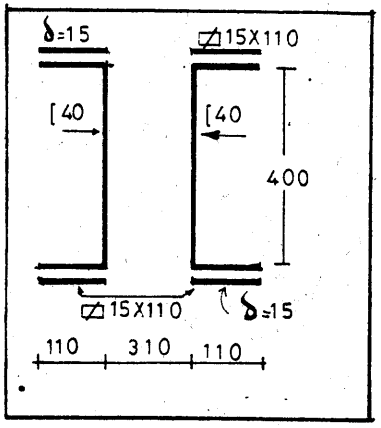
$$\sigma_o = \frac{318.663}{258} = 1235 \text{ kg/cm2} < \bar{\sigma}_o = 1300 \text{ kg/cm2}.$$

*) P_1 = 340.015 kg

$\sigma_1 = \frac{340.015}{258} = 1318\ kg/cm^2 < \bar{\sigma}_1 = 1450\ kg/cm^2$

a m a n !

3. Batang tekan diagonal (bt. d_1)



- gaya batang max akibat beban - mati & hidup :
  Po = 221,641 ton (tekan)
- gaya batang max akibat beban mati hidup & angin :
  P_1 = 235,734 ton (tekan)
- $l = \sqrt{7^2 + 7^2} = 9.90$ m.

Dipakai : 2 [40+4 plat 1,5x11cm^2

F_{gab} = (2x91,5)+(4x1,5x11)=249cm^2

$Ix = (2x20.850) + 4\left\{\left(\frac{1}{12} .1,5^3.11\right) + (1,5x11) \times 20,75^2\right\}$

$= 69.129\ cm^4$.

$Iy = \left\{(2x846) + 2(91,5 \times 18,85^2)\right\}$

$+ 4\left\{\left(\frac{1}{12} . 11^3 . 1,5\right) + (11 \times 1,5 \times 21^2)\right\}$

$= 91,748\ cm^4$.

$Imin = Ix = 69.129\ cm^4$; $\lambda = \frac{990}{16,66} = 59.42$

$imin = \sqrt{\frac{69.129}{249}} = 16,66$ --> $\omega = 1,364$

*) Po = - 221,641 ton

$K_o = \frac{221.641}{1,364} = 890\ kg/cm^2$

$K_o = \frac{1300}{1,364} = 953\ kg/cm^2$

*) P_1 = - 235,734 ton.

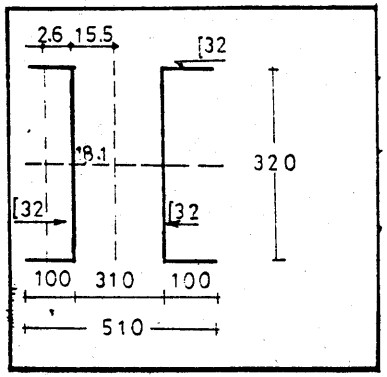
$\sigma_{K_1} = \frac{235.734}{249} = 947\ kg/cm^2$

$\bar{\sigma}_{K_1} = \frac{1450}{1,364} = 1063\ kg/cm^2$

} $\sigma_{k_1} < \bar{\sigma}_{k_1}$

a m a n !

4. Batang tarik diagonal (bt. d_4 , d_2 & d_3) :



- gaya batang max akibat beban mati & hidup :
  Po = + 167,78 ton(tarik)
  - 35,124ton(tekan)
- gaya batang max akibat beban - mati hidup & angin :
  P_1 = + 177,838 (tarik)
- l = 9.90 m

Dipakai : 2 [32

F = 2x75,8

= 151,6 cm^2

[32 : Ix = 10.870 cm^4

Iy = 597 cm^4

S = 2,6 cm

Ix = 12,1 cm

Ix = 2 x 10.870 = 21.740 cm^4.

Iy = 2 [597 + (75,8 x 18,1^2)] = 50.860 cm^4

Imin = Ix = 21.740 cm^4 ; $\lambda = \frac{990}{12} = 82,5$

Imin = $\frac{21.740}{151,6}$ ——— ω = 1,911

*) Po = + 167,78 ton (tarik) :

$\sigma_o = \frac{167.780}{151,6} = 1107\ kg/cm^2 < \bar{\sigma}_o = 1300\ kg/cm^2$.

*) Po = - 35,124 ton (tekan)

$$\sigma_{Ko} = \frac{35.124}{151,6} = 232 \text{ kg/cm}^2$$

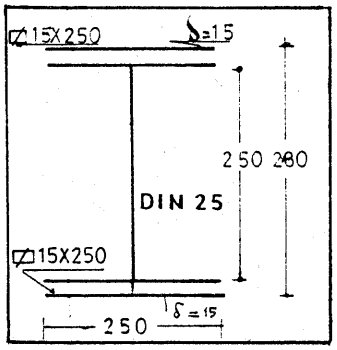
$$\bar{\sigma}_{Ko} = \frac{1300}{1,911} = 680 \text{ kg/cm}^2$$

$\sigma_{ko} < \bar{\sigma}_{ko}$

*) P_1 = + 177,838 ton (tarik)

$$\sigma_1 = \frac{177.838}{151,6} = 1173 \text{ kg/cm}^2 < \bar{\sigma}_1 = 1450 \text{ kg/cm}^2$$

5. **Batang vertikal (bt. V)** (l = 7.00 m).



- gaya batang max akibat beban mati & hidup :

$$Po = \begin{cases} + 57,017 \text{ t (tarik)} \\ - 84,163 \text{ t (tekan)} \end{cases}$$

- gaya batang max akibat beban mati - hidup & angin :

$$P_1 = \begin{cases} +59,864 \text{ ton (tarik)} \\ -88,484 \text{ ton (tekan)} \end{cases}$$

*) **Dipakai :** DIN 25 + 2 plat 1,5 x 25 x m^2

F DIN 25 = 116 cm^2 I x DIN 25 = 13.300 cm^4

I y DIN 25 = 4.690 cm^4

*) Profil gabungan :

F = 116 + 2 x 1,5 x 25 = 191 cm^2.

$$I \min = Iy = 4.690 + 2 \left\{ \left(\frac{1}{12} .1,5^3.25\right) + (1,5x25x0) \right\}$$

$$= 8.596 \text{ cm}^4.$$

$$imin = \sqrt{\frac{8.596}{191}} = 6,71$$

$$\lambda = \frac{700}{6,71} = 104,3 \text{ ---> } \omega = 2.941$$

*) Po = 57,017 ton (tarik)

$$\sigma_o = \frac{57.017}{191} = 299 \text{ kg/cm}^2 \text{ ---> } < \bar{\sigma}_o = 1300 \text{ kg/cm}^2.$$

Po = 84,164 ton (tekan)

$$\sigma_{Ko} = \frac{84.164}{191} = 441 \text{ kg/cm}^2$$

$$\bar{\sigma}_{Ko} = \frac{1300}{2,941} = 442 \text{ kg/cm}^2$$

$\sigma_{Ko} < \bar{\sigma}_{Ko}$

*) P_1 = 59,864 ton (tarik)

$$\sigma_1 = \frac{59.864}{191} = 313 \text{ kg/cm}^2 \text{ ---> } < \bar{\sigma}_1 = 1450 \text{ kg/cm}^2$$

P_1 = 88,434 ton (tekan)

$$\sigma_{K_1} = \frac{88.434}{191} = 463 \text{ kg/cm}^2$$

$$\bar{\sigma}_{K_1} = \frac{1450}{2,941} = 493 \text{ kg/cm}^2$$

$\sigma_{K_1} < \bar{\sigma}_{K_1}$

a m a n !.

PERHITUNGAN PAKU PADA GELAGAR RANGKA UTAMA

Dipakai paku keling Ø 26

Kg = $\frac{1}{4}$ x x $2{,}6^2$ x 0,8 x 1300 = 5.522 kg = 5,522 ton.

Ks = 1,5 x 2,6 x 1,6 x 1300 = 8.112 kg = 8,112 ton.

yang menentukan T = 5,522 ton.

*) **Bt. $a_1 = a_1'$** ----> P max = 279,031 ton

$$ng = \frac{279{,}031}{5{,}522} = 51 \text{ buah paku Ø 26}$$

1 sisi membutuhkan : $\frac{51}{2}$ = 26 buah paku.

*) **Bt. $a_2 = a_2'$** : P max = 340,015 ton

$$ng = \frac{340.015}{5{,}522} = 62 \text{ buah} \quad \text{---- 1 sisi} = \frac{62}{2} = 31 \text{ buah.}$$

*) **Bt. $a_3 = a_3'$** : P max = 354,302 ton

$$ng = \frac{354{,}302}{5{,}522} = 65 \text{ buah} \quad \text{---- 1 sisi} = \frac{65}{2} = 33 \text{ buah.}$$

*) **Bt. $b_1 = b_1' = b_2 = b_2'$** : P max = 166,737 ton.

$$ng = \frac{166{,}737}{5{,}522} = 31 \text{ buah} \quad \text{---- 1 sisi} = \frac{31}{2} = 16 \text{ buah.}$$

*) **Bt. $b_3 = b_3'$** : P max = 279,031 ton.

$$ng = \frac{279{,}031}{5{,}522} = 51 \text{ buah} \quad \text{---- 1 sisi} = \frac{51}{2} = 26 \text{ buah.}$$

*) **Bt. $b_4 = b_4'$** : P max = 340,015 ton.

$$ng = \frac{340{,}015}{5{,}522} = 62 \text{ buah} \quad \text{---- 1 sisi} = \frac{62}{2} = 31 \text{ buah.}$$

*) **Bt. $d_1 = d_1'$** : P max = 235,734 ton

$$ng = \frac{235{,}734}{5{,}522} = 43 \text{ buah} \quad \text{---- 1 sisi} = \frac{43}{2} = 22 \text{ buah.}$$

*) **Bt. $d_2 = d_2'$** : P max = 177,838 ton.

$$ng = \frac{177{,}838}{5{,}522} = 33 \text{ buah} \quad \text{---- 1 sisi} = \frac{33}{2} = 17 \text{ buah.}$$

*) **Bt. $d_3 = d_3'$** : P max = 125,387 ton.

$$ng = \frac{125{,}387}{5{,}522} = 23 \text{ buah} \quad \text{---- 1 sisi} = \frac{23}{2} = 12 \text{ buah.}$$

*) **Bt. $d_4 = d_4'$** : P max = 76,855 ton.

$$ng = \frac{76{,}855}{5{,}522} = 14 \text{ buah} \quad \text{---- 1 sisi} = \frac{14}{2} = 7 \text{ buah}$$

*) **Bt. $V_1 = V_1'$** : P max = 59,864 ton.

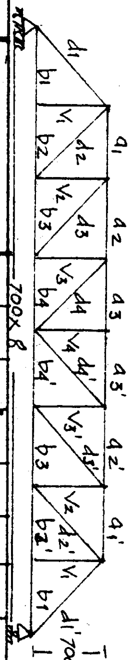
$$ng = \frac{39{,}864}{5{,}522} = 11 \text{ buah} \quad \text{---- 1 sisi} = \frac{11}{2} = 6 \text{ buah.}$$

*) **Bt. $V_2 = V_2'$** : P max = 86,434 ton.

$$ng = \frac{88{,}434}{5{,}522} = 17 \text{ buah} \quad \text{---- 1 sisi} = \frac{17}{2} = 9 \text{ buah.}$$

*) **Bt. $V_3 = V_3'$** : P max = 54,358 ton.

$$ng = \frac{54{,}358}{5{,}522} = 10 \text{ buah} \quad \text{---- 1 sisi} = \frac{10}{2} = 5 \text{ buah.}$$



NO BATANG	GAYA BATANG AKIBAT B. MATI + (ton)	GAYA BATANG AKIBAT B. MATI − (ton)	AKIBAT B. HIDUP + (ton)	AKIBAT B. HIDUP − (ton)	AKIBAT ANGIN + (ton)	AKIBAT ANGIN − (ton)	GAYA BATANG MAX KOMBINASI BEBAN MATI+HIDUP + (ton)	MATI+HIDUP − (ton)	MATI+HIDUP+ANGIN + (ton)	MATI+HIDUP+ANGIN − (ton)	PROFIL	Fbr cm^2	F nett cm^2	I min cm^4	i min cm.	λ	ω	AKIBAT B. MATI+B. HIDUP $\bar{\sigma}_0$ kg/cm²	$\bar{\sigma}_{k0}$ kg/cm²	σ_0 kg/cm²	AKIBAT BEBAN MATI+HIDUP+ANG $\bar{\sigma}_1$ kg/cm²	σ_{k1} kg/cm²	σ_1 kg/cm²	PAKU ∅16 Jml paku buah
$a_1=a_1'$	–	54.054	–	207.082	–	17.082	–	261.949	–	279.031	][NP40	262.5		74.945	16.9	41.43	1.116			998		12.99	10.60	26
$a_2=a_2'$	–	67.567	–	251.096	–	21.352	–	318.663	–	340.015	][NP40	295.5		86.181	17.08	41	1.111		11.70	10.78		13.05	11.51	31
$a_3=a_3'$	–	72.072	–	259.464	–	22.776	–	331.526	–	354.302	][NP40	295.5		86.181	17.08	41	1.111		11.70	11.22		13.05	11.99	33
$b_1=b_1'$	31.431	–	125.242	–	9.964	–	150.77	–	166.373	–	][NP40	–	183	–	–	–	–		–	0.57		–	911	16
$b_2=b_2'$	31.531	–	125.242	–	9.964	–		–	166.373	–	][NP40	–	183	–	–	–	–		–	857		–	911	16
$b_3=b_3'$	54.054	–	207.895	–	17.082	–	261.949	–	279.631	–	][NP40	–	258	–	–	–	–		–	10 15		–	10 82	26
$b_4=b_4'$	67.567	–	251.096	–	21.352	–	318.663	–	340.015	–	][NP40	–	258	–	–	–	–		–	12 35		–	13.18	31
$d_1=d_1'$	–	44.582	–	177.059	–	14.093	–	221.641	–	285.734	][NP40	249	–	69.129	16.66	59.4	1.364	1300 kg/cm²	953	800	1450 kg/cm²	10 63	947	22
$d_2=d_2'$	31.828	–	135.952	5.230	10.058	–	107.760	–	177.838	–	][NP32	–	151.6	21.749	12	82.5	1.911		–	1107		–	11 73	17
$d_3=d_3'$	19.228	–	100.075	19.360	6.084	–	119.303	0.132	125.387	0.132	][NP32	–	151.6	21.740	12	82.5	1.011		–	787		–	827	12
$d_4=d_4'$	6.371	–	68.471	41.495	2.013	–	74.842	35.124	76.855	35.12	][NP32	–	151.6	21.740	12	82.5	1.911		680	494/237		6.80	567/221	7
$V_1=V_1'$	9.009	–	48.008	–	2.847	–	57.017	–	59.864	–	I DIN28	–	141	–	–	–	–		–	404		–	425	6
$V_2=V_2'$	–	13.513	14.035	70.651	–	4.270	0.522	84.164	0.522	88.934	I DIN28	191	–	85.96	6.71	104.3	2.941		442	441		493	463	9
$V_3=V_3'$	–	1.504	29.363	18.431	–	1.429	24.859	52.935	24.859	54.358	I DIN28	191	–	85.96	6.71	104.3	2.941		442	130/277		493	130/285	5
V 4	–	–			–	–	–	–	–	–	I DIN28	141	–	–	–	–	–		–	–		–		5

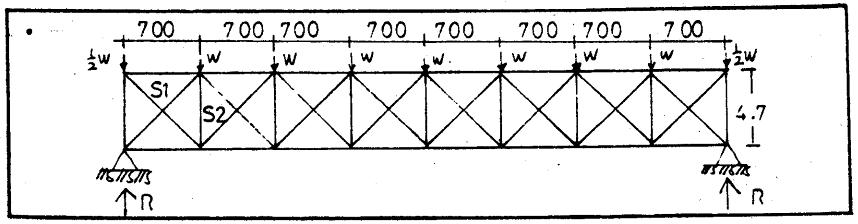
V. PERHITUNGAN IKATAN ANGIN

***) Tekanan angin :** (= 100 kg/cm²).

- Tinggi konst.lantai kendaraan
  = 1.50 m (dari sisi bawah gelagar utama tepi bawah).
  ---> tekanan angin = 1,5 x 56 x 100 = 8.400 kg
- Deretan K.A tinggi = 3,60 m
  ---> tekanan angin = 3,6 x 56 x 100 = 20.160 kg
- Rangka diatas kendaraan
  tinggi = 4,40 - 1,50 - 3,60 = 2,30 m
  ---> tekanan angin = 30% x 2,3 x 56 x 100 = 3.864 kg

W = Total tekanan angin = 32.424 kg

1) IKATAN - ANGIN - BAWAH :



$W = \frac{1}{8} W = \frac{1}{8} . 32 . 424 = 4.053$ kg (8 lapangan).

$\frac{1}{2} W = \frac{1}{2} \times 4.053 = 2.026,5$ kg

$R = \frac{1}{2} \times 32.424 = 16.212$ kg

Panjang batang ikatan angin : $S_1 = \sqrt{7^2 + 4,7^2} = 8.43$ m.

$\text{Sin } \alpha = \frac{4,70}{8,43} = 0,5574$

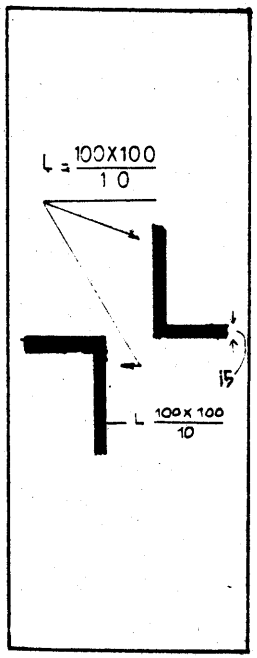
- Gaya batang $S = \frac{R - \frac{1}{2}W}{\sin \alpha} = \frac{16.212 - 2.0625}{0,5574} = 25.383$ kg.

- $F = \frac{25.383}{1300} = 19,5 \text{ cm}^2$.

---> pakai profil L 100 x 100 x 12

F = 22,7 cm²

*) **Batang S_2 :** ----> pakai profil 2 L 100 x 100 x 10



$Ix_L = Iy_L = 177\ cm^4$.

$F = 19,2\ cm^2$: $S = 2,82$ cm.

Profil gabungan :

$Ix = 2 \times 177 + 2(19,2)(3,57^2) = 884\ cm^4$

$imin = \sqrt{\frac{844}{2 \times F}} = \sqrt{\frac{844}{38,4}} = 4,7$ cm

$\lambda = \frac{470}{4,7} = 100$ ---> $\omega = 2,702$

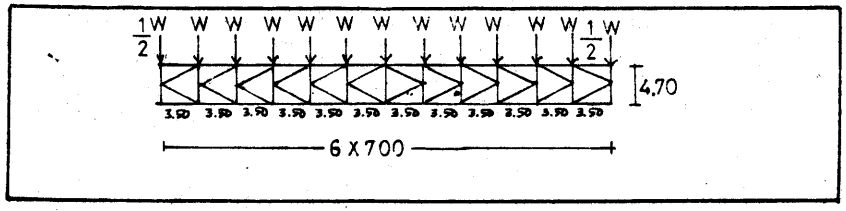
$\bar{\sigma}_K = \frac{1300}{2,702} = 481\ kg/cm^2$.

$P = W = 4.053$ kg

$\sigma_k = \frac{4.053}{38.4} = 106\ kg/cm^2 < \bar{\sigma}_K$

a m a n !.

2). **IKATAN ANGIN ATAS :**



$W = \frac{1}{12} \times 32.424 = 2702$ kg

$\frac{1}{2} W = 1351$ kg

} dibagi 12 lapangan.

Panjang batang $S_1 = \sqrt{3,5^2 + 2,35^2} = 4,216$ m.

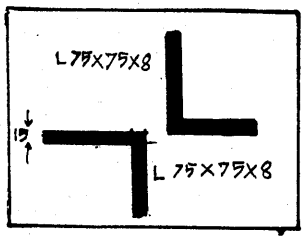
* **Gaya batang $S_1 = \frac{\omega}{\sin} = \frac{2.702}{2.3574,216} = 4848$ kg.**

$F_{S1} = \frac{4848}{1300} = 3,73\ cm^2$.

----> pakai profil minimum : L 75 x 75 x 8

$F = 11,5\ cm^2$.

* **Gaya batang $S_2 = \omega = 2702$ kg (tekan).**



pakai profil 2 L 75 x 75 x 8

L 75 x 75 x 8 : $Ix = 58,9\ cm^4$

$F = 11,5\ cm^2$

$S = 2,13$ cm

Profil gabungan : $Ix = (2 \times 58,9) + 2 \times 11,5 \times 2,88^2 = 309 cm^4$

$imin = \sqrt{\frac{309}{2 \times 11,5}} = 3,66$ cm.

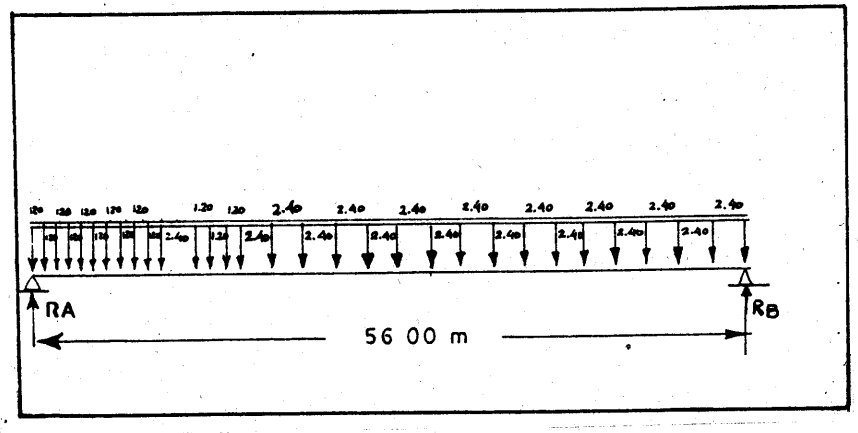
$\lambda = \frac{235}{3,66} . 64,2$ ---> $\omega = 1,451$

$\bar{\sigma}_K = \frac{1300}{1,451} = 896\ kg/cm^2$.

$\sigma_K = \frac{2702}{2 \times 11,5} = 118\ kg/cm^2 << \bar{\sigma}_K$

a m a n !

VI. PERHITUNGAN - LANDASAN.



***) Mencari reaksi perletakan max. :**

1. Akibat beban mati : q = 1287 kg/m'

$$R_{A1} = \tfrac{1}{2} \cdot 1287 \cdot 56 = 36.036 \text{ kg} = 36{,}036 \text{ ton.}$$

2. Akibat beban hidup : Rangkai K.A dengan beban terpusat.

$$P = \frac{12}{2} = 6 \text{ ton.}$$

Koef.kejut = 1.436

$$R_{A2} = 1{,}436 \times \left\{ \frac{6}{56} (56 + 54{,}8 + 53{,}6 + 52{,}4 + 51{,}2 + 50 + 48{,}8 + 47{,}6 + 46{,}4 + 45{,}2 + 42{,}8 + 41{,}6 + 40{,}4 + 39{,}2 + 36{,}8 + 34{,}4 + 32 + 29{,}6 + 27{,}2 + 24{,}8 + 22{,}4 + 20 + 17{,}6 + 15{,}2 + 12{,}8 + 10{,}4 + 8 + 5{,}6 + 3{,}2 + 0{,}8) \right\} = \underline{149{,}364 \text{ ton.}}$$

3. Akibat muatan angin : k = 2847 kg pada tiap titik buhul.

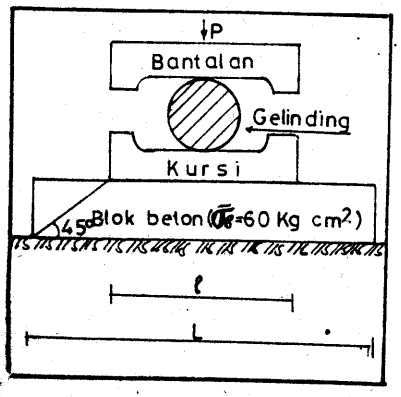
$$R_{A3} = 2847 \times 4 = 11.388 \text{ kg} = \underline{11{,}388 \text{ ton.}}$$

$$R_A \text{ total} = R_{A1} + R_{A2} + R_{A3}$$

$$= 36{,}036 + 149{,}364 + 11{,}388 = \underline{196{,}788 \text{ ton.}}$$

$$P \backsim \underline{197 \text{ ton.}}$$

A). Perhitungan Landasan Rol :



- ambil : b = panjang gelagar utama +2 x 35 = 53 + 7 = $\underline{60 \text{ cm.}}$

(b = lebar bantalan = lebar kursi).

P max = 197 ton.

F yang dibutuhkan blok beton :

$$F = \frac{P}{\sigma_b} = \frac{197000}{60} = 3284 \text{ cm}^2.$$

$$\text{Panjang kursi} = \ell = \frac{F}{b} = \frac{3284}{60} = 54{,}7$$

$$\longrightarrow \ell \backsim \underline{60 \text{ cm.}}$$

$$\text{Tebal kursi} = \text{tebal bantalan} = d = \tfrac{1}{2}\sqrt{\frac{3P}{b\bar{\sigma}}}$$

$\longrightarrow$ dimana $\bar{\sigma}$ = 1600 kg (baja Cor).

$$= \tfrac{1}{2}\sqrt{\frac{3.197000.60}{60 \cdot 1600}} = 9{,}6 \text{ cm} \backsim \underline{10 \text{ cm}}$$

B. Perhitungan demensi blok beton :

$L = l + 2T$

$B = b + 2T$

- L = panjang blok beton
- T = tinggi blok beton
- l = panjang kursi
- b = lebar kursi baru
- B = lebar blok beton

$L = 60 + 2T$

$B = 60 + 2T$

$\bar{\sigma}_{tembok} = 10 \text{ kg/cm}^2$

$$\frac{P}{\bar{\sigma}_{tembok}} = F = L \times B = (60 + 2T)^2 = 3600 + 4T^2 + 240T$$

$$P = 197.000 \text{ kg} = 10(3600 + 4T^2 + 240T)$$

$$= 40T^2 + 2400T + 36000$$

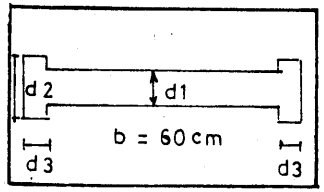
$$\text{atau} \quad = 40T^2 + 2400T - 181.000 = 0$$

$$T^2 + 60T - 4025 = 0$$

$$T = 40{,}18 \text{ cm} \backsim \underline{45 \text{ cm.}}$$

$$L = 60 + 2 \times 40{,}18 = \underline{1{,}40 \text{ m}} = B$$

***) Mencari ø gelinding :**



- Bahan gelinding : baja tempa
- Bahan kursi & bantalan : baja cor
- Baja tempa : $\bar{\sigma}$ = 9500 kg/cm^2
- Baja cor : $\bar{\sigma}$ = 1600 kg/cm^2

Rumus : $\sigma^2 = 0{,}75 \times 10^2 \times \frac{P.S}{b}$ $\qquad \sigma = \bar{\sigma}_{\text{baja tempa}}$

$$S = \frac{1}{2r} = \frac{1}{d_1}$$

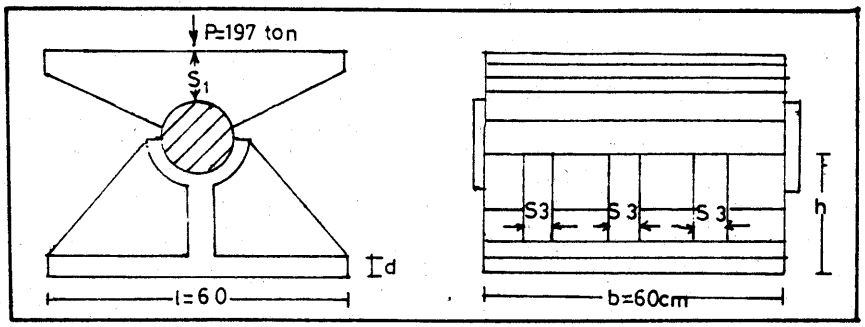
$$9500^2 = 0{,}75 \times 10^6 \times \frac{197.000}{60 \cdot d_1}$$

$$d_1 = 0{,}75 \times 10^6 \times \frac{197.000}{60 \times 9500^2} = 27{,}28 \text{ cm} \backsim \underline{30 \text{ cm.}}$$

$$d_2 = d_1 + 2 \times 2{,}5 = \underline{35 \text{ cm.}}$$

d_3 = diambil ----> $\underline{2{,}5 \text{ cm.}}$

C. Perhitungan :



- Tebal bantalan = S_1 = Tebal bantalan landasan Rol.

$S_1 = \underline{10 \text{ cm.}}$

$M = \frac{P}{2} \cdot \frac{1}{4} l = \frac{1}{2} \cdot 197000 \times 60 = 1.477.500$ kg.cm.

- Bahan : besi cor ---- $\bar{\sigma} = 1600$ kg/cm^2.

$$\omega = \frac{M}{\bar{\sigma}} = \frac{1.477.500}{1600} = 923{,}4 \text{ cm}^3.$$

- Digunakan daftar Muller Breslau.

h/d	$b/h.s_3$	ω
3	4,0	$0{,}2222 \cdot n \cdot S_3 \cdot h^2$
4	4,2	$0{,}2251 \cdot n \cdot S_3 \cdot h^2$
5	4,6	$0{,}2286 \cdot n \cdot S_3 \cdot h^2$
6	5	$0{,}2315 \cdot n \cdot S_3 \cdot h^2$

----> diambil h/d = 4 ----> $\frac{b}{h.S_3} = 4{,}2$, n = 3

$n \cdot S_3 = 3.S_3 = \frac{60}{4{,}2}$ ---> $S_3 = \frac{60}{4{,}2 \times 3} = 4{,}76$ cm $\backsim$ 5 cm.

$= 0{,}225 \cdot 1 \cdot n \cdot S_3 \cdot h^2$ ---> $923{,}4 = 0{,}2251.3.4{,}76.h^2$

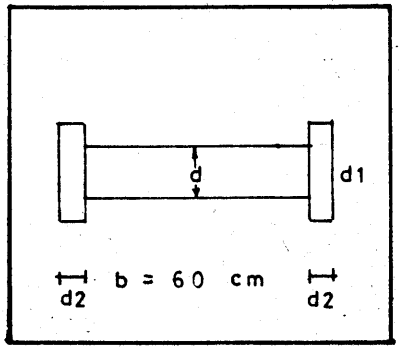
---> h = 16,94 cm $\backsim$ $\underline{20 \text{ cm.}}$

---> h/d = 4 ---> $\underline{d = 5 \text{ cm.}}$

$S_3 = \frac{1}{6} h = 3{,}35$ cm $\backsim$ $\underline{3{,}5 \text{ cm.}}$

$S_4 = \frac{1}{9} h = \frac{20}{9} \backsim \underline{2{,}5 \text{ cm.}}$

***) Mencari ⌀ gelinding sendi :**



- Diameter engsel gelinding

$$d = 2 \frac{0.8\,P}{\bar{\sigma}.b}$$

$$d = 2 \left(\frac{0{,}8}{1600} \cdot \frac{197000}{60}\right) = 3{,}23$$

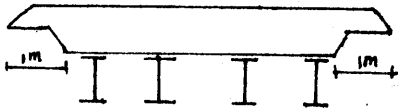
- Praktis diambil :

d = minimum = 7 cm.

$d_1 = 7 + 2 \times 2{,}5 = 12$ cm

$d_2 = \frac{1}{4}.d \backsim 2{,}5$ cm.

Diketahui :



bentang = 9 m
balok = 4 bh

Ditanya : Tegangan-tegangan yang timbul dan stud connector yang dipakai.

Jawab : Kita ambil DIN 60 A_s = 289 cm^2 S_s = 6030 cm^3

Is = 180800 cm^4 d = 60 cm.

2 b = 233 - 30 ⟶ b = 101,5 cm.

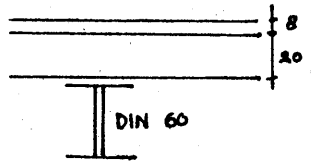
$\frac{b}{I} = \frac{101,5}{900} = 0,113$

$2\lambda + 30 = 203$ cm ⟶ λ = 86,5 cm

$\frac{\lambda}{b} = 0,85$

⟶ diambil lebar eff = 200 cm.

- Mencari beban-beban :



B.J. aspal = 2,5

B.J beton = 2,5

w_{DS} = 0,20.2,33.2,5 = 1,165 t/m

= 0,227 t/m +

1,392 t/m

$M_{DS} = \frac{1}{8} \cdot 1,392 \cdot 9^2 = 14,1$ t m = 1410000 kg cm.

M_{DC} = 0,08.2,33.2,5 = 0,466 t/m.

$M_{DC} = \frac{1}{8} \cdot 0,466.9^2 = 4,72$ t m = 472000 kg cm.

- Impact factor :

PUTL ⟶ $IF = 1 + \frac{20}{1 + 50} = 1 + \frac{20}{9 + 50} = 1,39$

λ = faktor penyebaran = $\frac{2,33 \text{ m}}{2,54.12}$

$\frac{}{5,5} = 1,39$

- Ditinjau 1 jalur [1 jalur = 2,75 m]
  Jembatan < 9 m ----▶ Q = 2,2 t/m
  P = 12 ton.

$M = \frac{1}{8} \cdot 2{,}2 \cdot 9^2 + \frac{1}{4} \cdot 12 \cdot 9 = 49{,}3$ t m

$M_{11} = \frac{2{,}33}{2{,}75} \cdot 49{,}3$ 1,339.1,39

12,7 t m = 7270000 kg cm.

Beban mati ; K = 3 [Dead Load]

$A_C = \frac{b.t}{k.n} = \frac{200.20}{3.10} = 133{,}3 \text{ cm}^2$

$K_C = \frac{A_C}{A_s + A_C} = \frac{133{,}3}{289 + 133{,}3} = 0{,}315$

$\bar{Y}_c = [Y_{ts} + ec]\, K_c = [30 + 10]\, 0{,}315 = 12{,}6$

$\bar{I}_c = [Y_{ts} + ec]\, \bar{Y}_c \cdot A_s + I_s + \frac{1}{12} \cdot t^2 \cdot A_c$

$= 40.12{,}6.280 + 180800 + \frac{1}{12} \cdot 20^2 \cdot 133{,}3$

$= 330730 \text{ cm}^4$.

$Y_{tc} = 30 - 12{,}6 = 17{,}4$ cm ----▶ $S_{tc} = 19.800 \text{ cm}^3$
$Y_{bc} = 30 + 12{,}6 = 42{,}6$ cm ----▶ $S_{bc} = 7760 \text{ cm}^3$
$Y_{cc} = 17{,}4 + 20 = 37{,}4$ cm ----▶ $S_{cc} = 6850 \text{ cm}^3$

Beban hidup K = 1

$A_c = \frac{200.20}{1{,}10} = 400$ $\quad K_c = \frac{A_c}{A_s + A_c} = \frac{400}{289 + 400} = 0{,}58$

$\bar{Y}_c = [30 + 10]\, 0{,}58 = 23{,}2$ cm

$I_c = 40.23{,}2.289 + 180800 + \frac{1}{12}.20^2.400 = 462100 \text{ cm}^4$

$Y_{tc} = 30 - 23{,}2 = 6{,}8$ cm ---▶ $S_{tc} = 6800 \text{ cm}^3$
$Y_{bc} = 30 + 23{,}2 = 53{,}2$ cm ---▶ $S_{bc} = 8680 \text{ cm}^3$
$Y_{cc} = 6{,}8 + 20 = 26{,}8$ cm ---▶ $S_{cc} = 17250 \text{ cm}^3$

	Baja [Top] Kg/cm^2	Baja [bottom] Kg/cm^2	Beton [Top] Kg/cm^2
D_3	$\frac{1410.000}{6030} = 234$	$\frac{1410.000}{6030} = 234$	-
D_C	$\frac{472000}{19000} = 25$	$\frac{472000}{7760} = 61$	$\frac{472000}{6850.3.10} = 1{,}78$
D_1	$\frac{727000}{68000} = \frac{107}{366}$	$\frac{727000}{8680} = \frac{838}{1133}$	$\frac{727000}{17250} = \frac{42{,}10}{43{,}88}$

---▶ a m a n.

Menentukan spacing connector & jumlah s. connector

S F_{max} dari $W_{DC} = \frac{1}{2} \cdot 0{,}466.9 = 2{,}1$ ton.

Live load 1,339 / 1,39 } $\emptyset = 1{,}339.1{,}39 = 1{,}86$

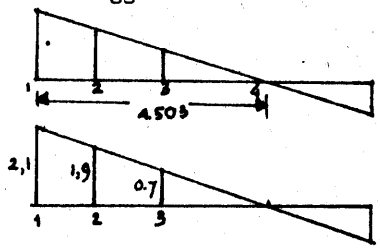
$q = 1{,}86.2{,}2 = \frac{2{,}33}{2{,}75} = 3{,}47$ t/m

$p = \frac{2{,}33}{2{,}75} \cdot 12.1{,}86 = 18{,}9$ ton.

L.L PS = 2,7 [1 + Cnc + Cmi Cs] - [Cnc + Cmi]

$Mmc = \frac{M_{DC}}{M_{LL}} = 0{,}065$ $\quad Cmc = \frac{M_{DS}}{M_{LL}} = 0{,}194$

$C_s = \frac{S_{bc}}{S_{bs}} = 1{,}44$



$V_1 = [\frac{9}{9}]^2\, 4{,}5.3{,}47 + 18{,}9 = 34{,}5$ ton.

$V_2 = [\frac{7{,}5}{9}]^2.15{,}6 + [\frac{7{,}5}{9}].18{,}9 = 26{,}6$ ton

$V_3 = [\frac{6}{9}]^2.15{,}6 + [\frac{6}{9}]^2 \cdot 16{,}9 = 19{,}6$ ton

$V_4 = [\frac{4{,}5}{9}]^2 \cdot 15{,}6\, [\frac{4{,}5}{9}] \cdot 18{,}9 = 13{,}35$ ton.

V_1 max = 34,5 + 2,1 = 36,6 ton ----▶ $C_v = \frac{2{,}1}{34{,}5} = 0{,}057$

V_2 max = 26,6 + 1,4 = 28,5 ton ----→ $C_v = \frac{1,4}{26,6} = 0,050$

V_3 max = 19,5 + 0,7 = 20,2 ton ----→ $C_v = \frac{0,7}{19,5} = 0,035$

V_4 max = 0 + 13,35 = 13,35 ton ---→ $C_v = 0$

LL FS = 2,7 [1+0,065 +0,194. 1,44] - [0,065 + 0,194] = 3,421

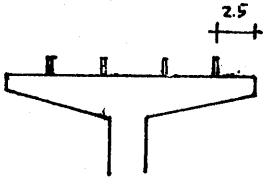
$S F_1 = \frac{3,421 + 0,057}{1 + 0,057} = 3,29$ $S F_2 = \frac{3,421 + 0,05}{1 + 0,05} = 3,30$

$S F_3 = \frac{3,421 + 0,035}{1 + 0,035} = 3,35$ $S F_4 = \frac{3,421 + 0}{1 + 0} = 3,421$

Dipakai paku -----→ Ø = 1" = 2,54 cm.
H = 6" = 15 cm

$Q_u = 55\ d^2 \sqrt{\sigma_{ba}}$ $= 55.2.50^2 \sqrt{60} = 2660$ kg

$Q = \frac{2660}{3,4} = 783$ kg



terlampau jauh

ambil 5 baris = 5 x 78^3
= 3915 ∽ 4 ton.

$M = A_c [Y_{tc} + ec] = 400. 16,8 = 6730$

$P = \frac{I_c}{m} \div \frac{Q}{V_{max}} = \frac{462100.4,0}{} = 8,....$

∽ 10 cm

Spacing diambil 10 cm.

1. Suatu konstruksi lantai berukuran 24' x 24', berupa konstruksi baja dengan composite system. Live Load = 125 psf, berat slab 50 psf. taksiran berat steel beam = 50 psf.

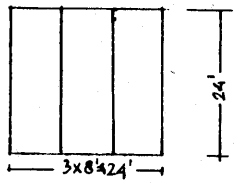
E = 30.000 ksi
f_c = 3000 psi
Pt = 24 ksi
$n = \frac{Es}{Ec} = 10$
fc' = 1,35 ksi

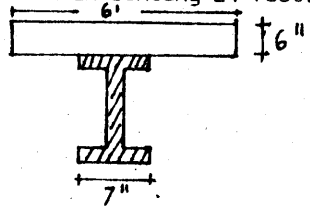
syarat b ≤ ¼ beam span length
b' ≤ ½ jarak balok satu dengan lain.
b' ≤ 8 x tebal slab
stud yang dipakai Ø 3/4 tinggi 2 ,5' dengan kekuatan 11,4 klp = Q

Ketentuan 16 W = 36 : a = 10,59 in^2 d = 15,85 in
Ss = 56,3 in^3 e' = 12"
I = 446,3 in^3

Pertanyaan

a. Selidikilah stel tension yang timbul pada irisan composite
b. Hitunglah jumlah shear connector untuk tentang 24 feet.





Penyelesaian :

Kita pandang satu gelagar seperti pada gambar.

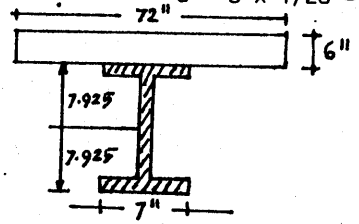
- Muatan hidup : q = 125 x 8 = 1000 lbs/ft = 1 k/ft
$M_{11} = 1/8\ ql^2 = 1/8.1.24.24 = 72$ k.ft.
- Muatan mati : disini pelaksanaan diusahakan stell tidak mendu - kung momen/ beban dahulu yaitu dengan jalan dibe ri penyangga-penyangga ---- langsung bekerja se bagai composite.

Berat slab : 50 x 8 lbs/ft = 400 lbs/ft = 0,4 K/ft
50 x 8 lbs = 400 lbs = 0,4 K/ft
0,8 K/ft

$Mc = 1/8\ ql^2 = 1/8 \times 0,8 \times 24^2 = 57,4$ Kft.

Kita cari lebar efective composite tersebut :

b = ¼. 24' = 6'
b'= ½.8' = 4'
b'= 8 x 1/28 = 4'
} diambil b = 6' = 72"



A = 10,59 in^2
Ss= 56,3 in^3
I = 446,3 in^4
d = 15,85 in

k = 1 : $Ac = \frac{b.t}{K.n} = \frac{72,6}{1.10} = 43,2$

$$Kc = \frac{Ac}{Ac + As} = \frac{43,2}{43,2+10,59} = \frac{43,2}{53,79} = 0,803$$

$$Yc = [Yts + ec]\ Kc = [7,925+3]\ 0,803 = 10,925.0,803 = 8,77$$

$$L_c = [Y_{ts} + e_c]\ Y_c AS + A_c \cdot \frac{t^2}{12} + Is$$

$$= [7,925+3]\ 8,77.1059 + 43,2\ \frac{6.6}{12} + 446,3]$$

$$= 10,95,8,77 \cdot 10,59 + 43,2.3 + 448,3 = 1016 + 129,5 + 446,3 = 1591,8$$

$$Ytc = Yts - Yc = 7,925 - 8,77 = 0,845$$

$$Stc = \frac{1591,8}{0,845} = 1885$$

$$Ybc = Ybs + Yc = 7,925 + 8,77 = 16,695 \dashrightarrow Sbc = \frac{1591.8}{16,695}$$

$$= 95,5$$

$$Ycc = Ytc + e_c + \tfrac{1}{2}t = -0,845 + 6 = 5,155 \dashrightarrow Scc = \frac{1591.8}{5,155} = 309$$

K = 3:

$$A_c = \frac{b.t}{k.n} = \frac{72.6}{3.10} = 14,4$$

$$K_c = \frac{A_c}{A_c + A_s} = \frac{14,4}{14,4 + 10,59} = \frac{14.4}{24,99} = 0,587$$

$$Y_c = [Y_{ts} + e_c]\ K_c + [7,925 + 3]0,587 = 10,925.0,587 = 6,42$$

$$I_c = [Y_{ts} = e_c]\ Y_c A_s = A_c \frac{t^2}{12} + Is = 10,925.6,42.10,59 + 14,4 \cdot \frac{6,6}{12} + 446,3$$

$$= 743 + 43,2 + 446,3 = 12725$$

$$Y_{tc} = Y_{ts} - Y_c = 7,925 - 6,42 = 1,505 \dashrightarrow Stc = \frac{1272,5}{1,505} = 845$$

$$Y_{bc} = Y_{ts} + Y_c = 7,925 + 6,42 = 14,345 \dashrightarrow S_{bc} = \frac{1272,5}{14,345} = 88,8$$

$$Y_{cc} = Y_{ts} + e_c + \tfrac{1}{2}\ t = 1,505 + 6 = 7,505 \dashrightarrow S_{cc} = \frac{1272,5}{7,505} = 169,5$$

	$Fc = \frac{Mc}{n.Scc}$	$ft = \frac{M}{Stc}$	$fb = \frac{M}{Sbc}$
DS	0	0	0
DC	$\frac{57,4 \cdot 12}{3,10 \cdot 309} = 0,136$	$\frac{57,4 \cdot 12}{8,45} = 0,815$	$\frac{57,4 \cdot 12}{88,8} = 7,75$
DL	$\frac{72,12}{1,10.309} = 0,280$	$\frac{72,12}{1885} = -0,459$	$\frac{72,12}{95,5} = 9,05$
	0,416	0,356 [tekan]	16,80 [tarik]
	< 1,35 ksi	< 24 ksi	< 24 ksi

steel tension memenuhi syarat

b. Jumlah shear connector

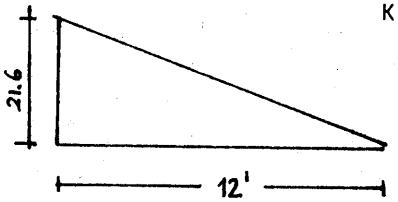
Yang dipergunakan untuk menghitung shear connector :

VDL + VLL kala Vs ada tak dipergunakan

$V_{DL} = \frac{1}{2}.0,8.24 = 9,60$ K

$V_{LL} = \frac{1}{2}.1.24 = 12,00$ K

Vtot = 21,6 K



K = 1 $\dashrightarrow$ $M = A_c[Y_{tc} + E_c]$

$= 43,2\ [-0,845 + 3]$

$= -43,2,2,155 = 93,1$

I = 1591,8

$S = \frac{M.V}{I} = \frac{93,1.21,6}{1591.8}$

= 1,265 K/in

$H = \frac{1}{2}.12.12.1,265$ K

= 91,00 K.

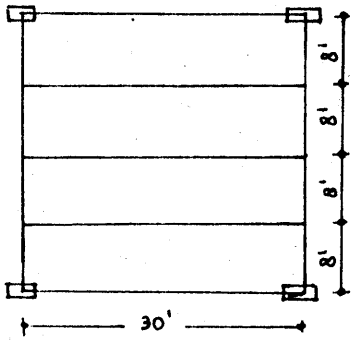
$n = \frac{H}{Q} = \frac{91}{11,4} = 8$ buah

Untuk seluruh batang = 16 buah.

Lantai dengan konstruksi composite tebal slab 4". Balok terdiri-dari 1.

16 W = 36 type baja A_{36}

Diperhitungkan beban hidup 125 psf.



Berat slab 50 psf, berat steel beam 50 p/f.

Es = 300000 ksi f_c = 1,35 ksi

f_c = 3000 psi F_t = 24 ksi

$n = \frac{E_s}{E_c} = 10$

16 W 36 --> A = 10,59 in^2

I = 446,3 in^4

Ss = 56,3 in^3

d = 15,85 in

Hitunglah : ft [stel tension flange]
fb [steel compression flange]
fc [compression flange]

Catatan : M_D = 589 K. in dan M_1 = 1350 K. in
Berapa stud yang diperlukan bila dipakai stud Ø ½" tinggi 21/2" dengan kekuatan 5,1 K/connector = Q

Penyelesaian :

a. Muatan mati : Disini kita hitung sejak perancah diambil --- beton langsung bekerja sebagai composite. Jadi pada pengeceran slab besi diberi tiang-tiang penyanggah sehingga tidak menahan momen lentur dulu.

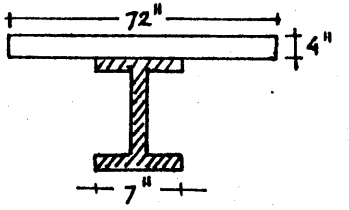
q slab = 50 x 8 = 400 lbs/ft = 0,4 k/ft
q steel = 50 = 0,05 k/ft

q tct= 0,45 k/ft

$M_{dl} = 1/8\ ql^2 = 1/8.0,45.30^2 = 50,6$ k ft = 607,5 k in.

Meskipun telah diketahui 589 --> dipakai 607,5 K.in
Muatan hidup q = 125 x 8 lb/ft = 1 k/ft.

$M = 1/8.\ 1.30^2 = \frac{900}{8}$ x 12 k in = 1350 k.in



A = 10,59 in^2
I = 446,3 in^4
Ss= 56,3 in^3
d = 15,85 in

K = 1 $Ac = \frac{b.t}{k.n}$ --> = 28,4

$Kc = \frac{Ac}{Ac+As} = \frac{28,4}{28,4+10,59} = \frac{28,4}{3899} = 0,728$

$Yc = [Ys + e_c]\ Kc = [7,925 + 2]\ 0,728 = 9,925.0,728 = 7,22$

$Ic = [Yts = e_c]\ Yc\ As + Ac\ \frac{t^2}{12} + Is$

$= 9,925.7,22.10,59 + 28,4\ \frac{4.4}{12} + 446.3 = 760 + 37.9 + 446,3$

$= 1244,2$

$Ytc = Yts - Yc = 7,925 - 7,22 = 0,705$ --> $Stc = \frac{1244,2}{0,705} = 1765$

$Ybc = Yts + Ytc = 7,925 + 7,2 = 15,145$ --> $Sbc = \frac{1244,2}{15,145} = 82,2$

$Ycc = Ytc + t = 0,705 + 4 = 4,705$ --> $Scc = \frac{1244,2}{4,705} = 265$

K = 3 :

$Ac = \frac{b.t}{k.n} = \frac{71,4}{3,10} = 9,46$

$K_c = \frac{Ac}{Ac + As} = \frac{9,46}{9,46 + 10,59} = \frac{9,46}{20,05} = 0,472$

$Yc = [Yts + e_c]\ K_c = [7,925 + 2]\ 6,472 = 9,9925.0,472 = 4,60$

$Ic = [Yts + e_c]\ YcAs + Ac\ \frac{t^2}{12} + Is$

$= 9,9925.4,68.1059 + 9,46\ \frac{4,4}{12} + 446,3 = 492 + 12,6 + 446,3$

$= 950,9$

$Ytc = Yts - Yc = 7,925 - 4,68 = 3,245$ --> $Ytc = \frac{950,9}{3,245} = 293$

$Ybc = Yts + Yc = 7,925 + 4,68 = 12,605$ --> $Ybc = \frac{950,99}{12,605} = 75,5$

$Ycc = Ytc + t = 3,425 + L = 7,425$ --> $Ycc = \frac{950,9}{7,425} = 131,5$

	$f_c = \frac{M}{k.n.s_c}$	$f_t = \frac{M}{St}$	$f_b = \frac{M}{Sb}$
D_s	0	0	0
D_C	$\frac{607,5}{3.10.131,5} = 0,154$	$\frac{607,5}{293} = 2,7$	$\frac{607,5}{75,5} = 8,05$
D_L	$\frac{1350}{1.10.265} = 0,509$	$\frac{1350}{1765} = 0,766$	$\frac{1350}{82,2} = 16,40$
	0,763	3,466	24,45
	< 1,35 ksi	< 24 ksi	< 24 ksi

Karena hanya lebih besar sedikit maka profil cukup kuat.

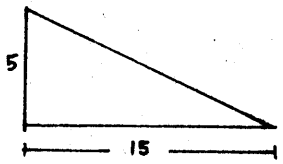
b. Jumlah connector :

$V_{DC} = \frac{1}{2}.\ 0,45.\ 30 = \frac{1}{2}.\ 13,5 = 6,75$

$V_{LL} = \frac{1}{2}.1.\ 30 = \frac{1}{2}.\ 30 = 15,00$

V tct = 21,75

K = 1 --> $M = Ac\ [Ytc + e_c] = 28,4\ [0,705 + 2] = 28,4.2,705 = 76,6$



$S = \frac{MV}{I} = \frac{76,6 \cdot 21,75}{1244,2} = 1,34$ k/in

$H = \frac{1}{2}.s.15 = \frac{1}{2}.1,34.15.12 = 120,5$ K

$n = \frac{120}{5,1} = 23,5 \backsim 24$ buah.

Satu batang : n = 48 buah.

Kalau disuruh mencari jaraknya

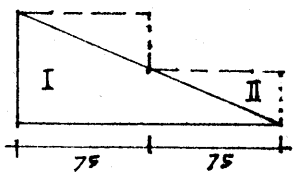
a] $P = \frac{N.O}{S} = \frac{2.5,1}{1,31}$ in = 7,75 in < 50 cm. [OK]

-----> $n = \frac{30.12}{7,75} = 2.46 = 92$ buah [kalau jarak sama]

b] Kalau jarak ada dua macam.

N = 2

$P_1 = 7,75$ $\qquad n_1 = 2\ \frac{15}{7,75} = 40$



$P_2 = \frac{2.5,1}{0,67} = 15,5$ in < 50 cm

$n_1 = 2.\frac{15}{7,75} = 40$

$n_2 = 2\ \frac{15}{15,5} = 20$ +

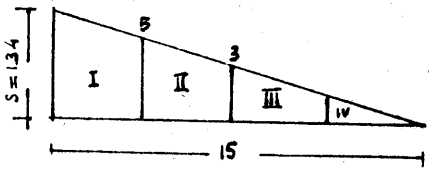
n = 60

CO. Hitungan seperti diatas -----> n = 48

Hitungan seperti diatas n = 48

Dibagi 4 bagian [$\frac{1}{2}$ bentang]

Bagian I -- $n = \frac{7}{16} \times 24 = 10,5$ --> n = 12



II-- $n = \frac{5}{16} \times 24 = 4,5$ --> n = 10

III-- $n = \frac{3}{16} \times 24 = 4,5$ --> n = 8

IV ---- $n = \frac{1}{16} \times 24 = 1,5$ --> n = 6

1 deret = 2 connector

Jarak pada bagian

$I = \frac{15}{4.\frac{12}{2}} = \frac{15}{24} = 0,625$

$II = \frac{15}{4 \times \frac{15}{3}} = \frac{15}{20} = 0,750$

$III = \frac{15}{4x4} = \frac{15}{16} = 0,940$

$IV = \frac{15}{4x3} = \frac{15}{12} = 1,250$

Soal

Suatu jembatan composite bentang 15 m lebar 7 m + [2 x 1]m
Direncanakan dengan 4 gelagar. Bila untuk ini dipakai pelat be
ton = 20 cm, tebal aspal 5 cm. Gelagar DIM 80
P muatan terbagi rata = 2.2 t/m'
P = muatan garis = 12 ton
1 jalur lalu lintas = 2,75 m.

Ketentuan-ketentuan lain : Bj beton bertulang = 2,40 T/m^3
Bj aspal = 2,20 T/m^3
28 hari beton = 200 kg/cm^2
$\bar{\sigma}$ beton = 60 kg/cm^2
$\bar{\tau}$ beton = 10 kg/cm^2
$\bar{\sigma}$ baja =1300 kg/cm^2

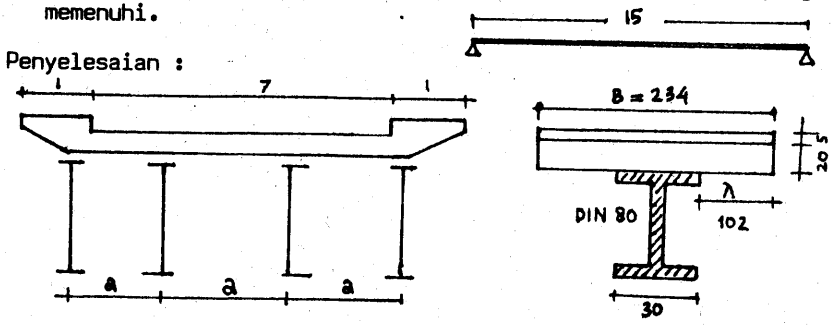
$n = \frac{Es}{Ec}$ $\bar{\tau}$ = 10 kg/cm^2

$LF = 1 + \frac{20}{L + 50}$

1] Tinjaulah apakah balok/gelagar tersebut memenuhi persyaratan tegangan.

2] Seandainya tak memenuhi syarat maka balok DIN berapakah yang memenuhi.

Penyelesaian :



Kita cari lebar effective dari compasite.
Kita pakai "tabel 5" karena moment-moment lantai mempunyai tan da tidak sama.

$\frac{b}{L} = \frac{2.34-30}{2 \times 15} = \frac{2.04}{30} = 0,068$

$\frac{\lambda}{b} = 1 - \frac{0,068 - 0,05}{0,10 - 0,05} \cdot 0,2 = 1 - \frac{0,018}{0,050} \cdot 0,2 = 1 - 0,072 = 0,928$

$\lambda = 0,928 \cdot 1,02 = 0,946$ cm.

Lebar effectiva = 0,946 + 0,946 + 0,30 = 1,892 + 0,30 = 2,20 m
Kalau dicari dengan tabel 4 ----▶

Lebar effectif = $\frac{b}{L} = \frac{1,02}{15} = 0,068$

$\frac{\lambda}{b} = 1 - \frac{0,068 - 0,05}{0,010 - 0,05} \cdot 0,11 = 1 - 0,04 = 0,96$

$\lambda = 0,96 \cdot 1,02 = 97$ cm.

Lebar effect : 2,97 ≠ 30 = 194 + 30 = 224 cm.

Muatan mati :

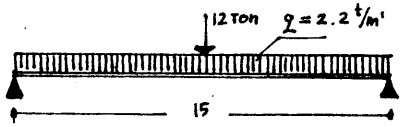
Muatan steel : beton : q = 2,34. 0,20.2,4 = 1,122 T/m'
Profil = 0,268
1,390 T/m'

$M_{DS} = 1/8\ QL^2 = 1/8.\ 1,39.15^2 = 3,91$ Tm.

Muatan composite :

dari lapis aspal :
q = 2,34.0,05.2,2 = 0,2575 T/m'
$M_{DC} = 1/8.\ 0,2575.\ 15^2 = 7,25$ Tm

Muatan hidup : $M = 1/8\ qL^2 + \frac{1}{4}\ bL$



M = 1/8.2,2.15^2 + ¼.12.15 =62 + 45 = 107 Tm.

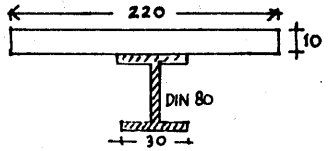
$IP = 1 + \frac{20}{L + 50} = 1 + \frac{20}{65} = 1,308$

2,34 m = $\frac{2,34}{2,34}$ in = 92 in = 7,68 ft

$\lambda = \frac{\text{beam spacing}}{5,5} = \frac{7,68}{5,5} = 1,395$

$M_{LL} = \frac{2,34}{2,75} \cdot 107. 1,308. 1,395 = 166$ Tm.

Tinjauan tegangan yang timbul :



A = 342 cm^2 S_x = 9160
d = 80 cm
Ix = 366400 cm^4

K = 1 ------ $Ac = \frac{b.t}{k.n} = \frac{220.24}{1 \times 10} = 440$

$$K_c = \frac{Ac}{Ac + As} = \frac{440}{440+342} = \frac{440}{782} = 0,562$$

$$Yc = [Yts + e_c]\ Kc = [40 + 10]0,562 = 50,0,562 = 28,1$$

$$Ic = [Yts + C_c]\ Yc.As + Ac\ \frac{t^2}{12} + Is$$

$$= 80.28,1.342 + 440.\ \frac{20 \times 20}{12} + 366400$$

$$= 480000 + 14700 + 366400 = 861100$$

$$Ytc = Yts - Yc = 40 - 28,1 = 11,9 \longrightarrow Stc = \frac{861100}{11,9} = 72400$$

$$Ybc = Yts + Yc = 40 + 28,1 = 68,1 \longrightarrow Sbc = \frac{861100}{68,1} = 1265$$

$$Ycc = Ytc + t = 11,9 + 20 = 31,9 \longrightarrow Scc = \frac{861100}{31,9} = 27000$$

K = 3

$$Ac = \frac{220 \times 20}{3 \times 10} = 146,5$$

$$Kc = \frac{Ac}{Ac+As} = \frac{146,5}{146,5+342} = \frac{146,5}{488,5} = 0,3$$

$$Yc = [Yts + e_c]\ Kc = [40 + 10]0,3 = 15$$

$$Ic = 50,15.342 + 146,5\ \frac{20 \times 20}{12} + 366400$$

$$= 256000 + 4880 + 366400 = 62728$$

$$Ytc = Yts - Yc = 40 - 15 = 25 \longrightarrow Stc = \frac{627280}{25} = 25100$$

$$Ybc = Yts + Yc = 40 + 15 = 55 \longrightarrow Sbc = \frac{627280}{55} = 11400$$

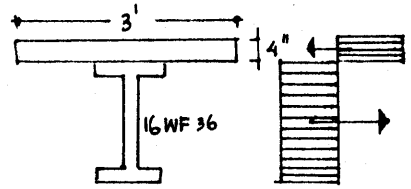
$$Ycc = 25 + 20 = 45 \longrightarrow Scc = \frac{627280}{45} = 13950$$

	$fc = \frac{M}{k.n.s}$	$ft = \frac{M}{St}$	$fb = \frac{M}{Sb}$
Ds	0	$\frac{391000}{9160} = 427$	427
Dc	$\frac{725000}{3.10.13950} = 1,73$	$\frac{725000}{25100} = 28,9$	$\frac{72500'}{11400} = 63,5$
D_L	$\frac{16600000}{} = 61,5$	$\frac{16600000}{} = 229$	$\frac{16600000}{} = 1375$
	63,23	684,9	1805,5
	60 kg/cm^2	1300 kg/cm^2	1300 kg/cm^2

Berarti DIN 80 tidak mencukupi :

b] Dicoba dengan DIN 100 [ternyata setelah dicek memenuhi]

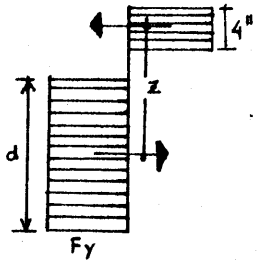
a.



Ketentuan :
Bentang = 32
Fy = 33 ksi
Ic = 3000 psi
d = 15,85 in
A = 10,59 in^2
I = 446,3 in^4
Ss = 56,3 in^3

Ditanyakan : a. Multimate
b. Jumlah shear connector kalau dipakai shear connector bentuk paku Ø 7/8" fs' = 65 ksi
1 baris ditaruh 2 paku saja.

Penyelesaian :



$$H = Fy.A = 33.10,59\ K = 350\ K$$

$$a.0,85\ f_c.b = 350\ K \text{ --- } a = \frac{350}{0,85.3-36} = 3,82$$

$$z = \tfrac{1}{2}\ d + t - \tfrac{1}{2}a = 7,925 + 4 - 1,91$$

$$z = 11,925" - 1,91"$$

$$z = 10,015"$$

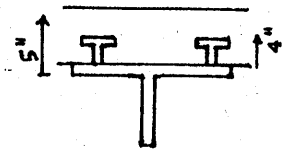
M ultimate = 350.10,015 = 3510 kin = $\frac{3510}{12}$ = 292 Kft

Jumlah shear connector :

- menurut geser : f's = 65 ksi

$q = \frac{1}{4} \pi d^2 . fs = \frac{1}{4} \pi [\frac{7}{8}]^2 . 65 = 39$ K

- menurut rumus : $h/d = \frac{3}{778} = 3,5 < 4,2$

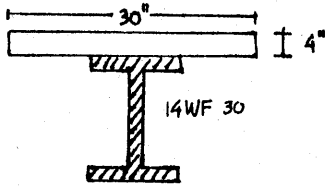


$Q = 80.h.ds \sqrt{fc} = \frac{80.3.7/8 \sqrt{3000}}{2100 \sqrt{30}} =$

= 11500 lbs = 11,5 K

----→ dipakai Q = 11,5 K

½ bentang $n = \frac{350}{11,5} = 30,5$ --- n = 30 ---→ 1 bentang 2 x 30 = 60



Suatu jembatan composite bentang 15 m = 49,2". Dengan irisan se - perti pada gambar.

d = 13,86 in

$As = 8,8 \text{ in}^2$

$I = 289,6 \text{ in}^4$

$s = 41,8 \text{ in}^3$

Dead Load = 0,18 k/ft

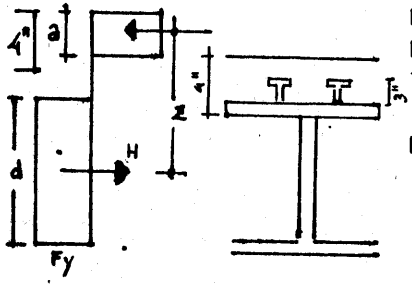
Ø stud = 3/4" tinggi terserah saudara.

Ditanyakan : 1. Jumlah stud yang diperlukan

2. Berapa M_d. M_L. M_{ult}, serta safety faktor dipaka i dalam perhitungan.

Penyelesaian :

a. Jumlah shear connector :



$Pt = 20.10^3$ psi -- $Fy = 33.10^3$ psi

H = Fy.A = 33.8,81 = 291 K

Tinggi stud diambil 3" [4" = t]

$h/d = \frac{3}{3/4} = 4 < 4,2$

$Q = 80.h_s.a_s \sqrt{fc'}$

$= 80.3.3/4. \sqrt{3000} = 9900$ pound

= 9,9 k/c onn.

½ bentang $n = \frac{H}{9,9} = \frac{291}{9,9} = 29,4 = 30$

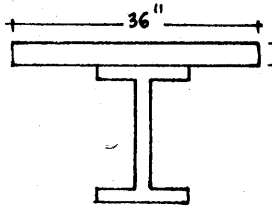
1 bentang n = 2 x 30 = 60 buah

b. $M_a = 1/8.q.l^2 = 1/8.0,18.49,2 = \frac{18}{8}. 4,92^2 = 54,4$ Kft

Multimate : gambar lihat atas

D = H --- a. 0,85. f'c.36 = 291 K

$a = \frac{291}{0,85.3.36} = 3,18"$



= ½a + 4" - ½a = 6,93 + 4 - 1,59

= 9,34"

M = 291. = 291.9,34 Kin

= 226,5 Kft

As = 8,81

a = 13,86

L = 289,6

s = 41,80 in^3

- Pelaksanaan composite : besi diberi penyangga sehingga tidak menahan momen lentur ---→ $M_{DS} = 0$

-- beban mati didukung oleh composite.

K = 8 --- $Ac = \frac{b.t}{k.n} = \frac{36,4}{3.10} = 4,8$

$Kc = \frac{Ac}{Ac+Az} = \frac{4,8}{4,8+8,81} = \frac{4,8}{13,61} = 0,353$

$Yc = [Yts + e_c] K_c = [6,93 + 2] 0,353 = 8,93.0,353 = 3,15$

$Ic = [Yts + e_c] Yc.As + Ac \frac{t^2}{12} + Is$

$Ic = [Yts + e_c] Yc.As + Ac \frac{t^2}{12} + Is$

$Ic = 8,93.3,15.8,81 + 4,8\,\frac{4,4}{12} + 289,6$

$= 248 + 6,4 + 289,6 + 544$

$Ytc = Yts - Yc = 6,93 - 3,15 = 3,78 \longrightarrow Stc = \frac{544}{3,78} = 144$

$Ybc = Yts + Yc = 6,93 + 3,15 = 10,08 \longrightarrow Sbc = \frac{544}{10,08} = 54$

$Ycc = 3,78 + 4 = 7,78 \longrightarrow Scc = \frac{544}{7,78} = 69,8$

	$f_c = \frac{M}{k.n.\,Scc}$	$ft = \frac{M}{St}$	$fb = \frac{M}{Sc}$
Tegangan yang diizinkan	1,35 ksi	20 ksi	20 ksi
Beban mati	$\frac{45,4.120}{3.10.69,8} = 0,3$ 12	$\frac{54.4.12}{144} =$ 4,53	$\frac{54.4.12}{54} = 12,1$
Δ	1,038 ksi	15,47 ksi	7,9 ksi

Untuk beban hidup :

$K = 1 \text{ --- } Ac = \frac{36,4}{1.10} = 14,4$

$Kc = \frac{Ac}{Ac + As} = \frac{14,4}{14,4 + 8,81} = 0,621$

$Yc = [Yts + e_c]\ Yc.As + Ac\,\frac{t^2}{12} + Ic$

$= 8,93.5,55.8,81 + 14,4\,\frac{4.4}{12} + 289,6 + 19,2 = 746,8$

$Ytc = Yts * Yc = 6,93 - 5,55 = 1,38 \longrightarrow Stc = \frac{746,8}{1,38} =$ 540

$Ybc = 6,93 + 5,55 = 12,48 \longrightarrow Sbc = \frac{746,8}{12,48} = 59,8$

$Ycc = 1,38 + 4 = 5,38 \longrightarrow Scc = \frac{746,8}{5,38} = 138,5$

$f_{tc} = \frac{M_L}{Stc} \longrightarrow M_L = f_{tc}.S_{tc} = 540.15,47 \longrightarrow$ besar

$f_{bc} = \frac{M_L}{} \longrightarrow M_L = fbc,Sbc = 59,8.7,9 = 473$ Kin.

$= \frac{473}{12} = 39,4 \longrightarrow$ menentukan.

$f_{ce} = \frac{M_L}{Kns_{cc}} \longrightarrow M_L = Scc.n.f_{cc} = 138,6.1,038.10 \longrightarrow$ besar

M = 39,4 Kft [diambil sudah dengan Impact faktor]

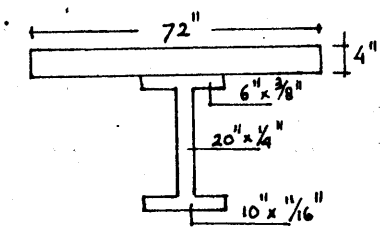
$\text{Safety factor} = \frac{M_{ult}}{M_L + M_D} = \frac{226,5}{39,4 + 54,4} = \frac{226,5}{93,8} = 2,41$

7. Suatu jembatan composite bentang 48 ft. Profil bajanya terdiri atas pelat dari A - 36 yang mempunyai Fy = 36 Ksi.
Flens atas pelat 6" x 3/8", badan 20" x ¼", sedang flens bawah 10" x 11/16". Slab beton tebal 4" [sisi bawah slab rata dengan sisi atas flens atas], dihubungkan dengan shear connector ber diameter 3/4". Compresive beton usia 28 hari = 3000 psi

$n = \frac{Es}{Ec} = 9$ ----- lebar effectif beton = 72"

Rencanakanlah lengkap dalam arti kata meninjau stress yang tim bul serta jumlah connector yang diperlukan bila maximum momen karena beban mati = 104,15 Kft, sedang maximum momen karena be ban hidup = 244,15.

Penyelesaian :



3/8" = 0,375"
¼" = 0,250"
11/16" = 0,688"

Irisan baja	d	AD	Ad^2	Ic	I
Flens atas 6x3/8 = 2,25	10,188	22,9	233	$\frac{1}{12}.6.0,375^3$ = 0,028	233,026
badan 20"x¼" = 5	0	0	0	$\frac{1}{12}\ 20\ \frac{31}{4}$ = 167	167,000
flens bawah 10 x 11/16 = 6,88	10344	-71,3	737	$\frac{1}{12}\ 100,688^3$ = 0,27	737,270
14,13		-48,4			1137,296

$\frac{Ad}{A} = ds = \frac{-48,4}{14,13} = -3,42$

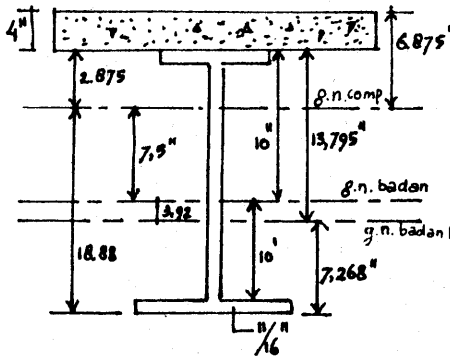
1-3,42.48,4 = - 166,000

Is = 971,296

Irisan composite	d	Ad	Ad^2	Ic	I
Irisan baja ´14,13	-3,42	-48,4			1137,296
slab $\frac{72 \times 4}{9}$ =32,00	12,375	396,2	4904	$\frac{1}{12}.\frac{72}{9}.64$ = 42,6	4946,600
46,131 in^2		347,2			6083,896

$\frac{Ad}{A} = dT = \frac{347,8}{46,13} = 7,5$ in - 7,5.347,8 = -2608

Ic=3475,896



Irisan baja :

Sec.Mod.terhadap sisi atas = $\frac{921,296}{13,795}$ = 70,3

sisi bawah = $\frac{971.296}{7,268}$ = 134

Irisan composite :

Sec. Mod terhadap sisi bawah baja = $\frac{3475,896}{18,188}$ = 191,0

sisi atas beton = $\frac{3475,896}{6,875}$ = 505,0

Tegangan-tegangan yang terjadi :

- beban mati : stress = $\frac{104,15x12}{70,3}$ = 17,8 ksi < 24 ksi

- total load :
  stress sisi bawah baja : $\frac{104,15 + 244,15}{191} = \frac{348,3x12}{191}$
  = 22,9 < 24 ksi

stress sisi atas slab beton = $\frac{348,3 \times 12}{9.0505}$ = 0,92 ksi < 1,35 ksi

------▶ Profil baja memenuhi syarat

b. Stood : hs/ds = $\frac{3}{3/44}$ = 4 < 4,2

Q = 80 hs.ds.f'c = 80.3.3/4 3000 = 9,85 K/ft

[dari tabel = 11,5 k/ft]

VH = $\frac{0,85.f'c.Ac}{2} = \frac{0,85.3000.72,4}{2}$ = 367000 pound

= 367 K

$V_H = \frac{1}{2}.As.Fy = \frac{14,13.36}{2}$ = 255 K

Jumlah stud = $\frac{255}{9,85}$ = 26 buah [untuk setengah bentang]

Sekarang dihitung menggunakan tabel

Is = 971,296 Yts = 13,795

Sts = 70,3 Ybs = 7,268

Sbs = 134 As = 14,13

K = 1 $As = \frac{b.t}{k.n} = \frac{72,4}{1.9} = 32$

$Kc = \frac{Ac}{Ac + As} = \frac{32}{32 + 14,13} = \frac{32}{46.13} = 0,964$

$Yc = [Yts + e_c]\ Kc = [13,795 + 2]\ 0,694$

$= 15,795.0,694 = 10,9$

$Ic = [Yts + e_c]\ Yc.As + Ac.\ \frac{t^2}{12} + Is$

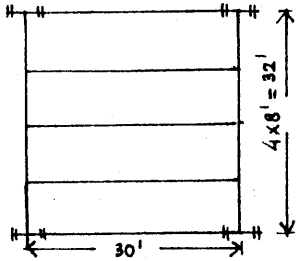
$= 15,795.10,9.14,13 + 32\ \frac{4,4}{12} + 971,296$

$= 2450 + 971,296 + 42,7 = 3464,0.$

$Ytc = Yts - Yc = 13,795 - 10,9 = 2,895 \rightarrow Stc = \frac{3464}{2,895} = 1195$

$Ybc = Ybs + Yc = 7,265 + 10,9 = 18,168 \rightarrow Sbc = \frac{3464}{18,168} = 191$

$Scc = Ytc + 4 = 2,895 + 4 = 6,895 \rightarrow Scc = \frac{3464}{6,895} = 503$



Lantai dengan konstruksi composite tebal x slab 4", balok terdiri dari 16 W = 36 type baja A 36 diperhitungkan beban hidup 125 psf, berat slab 50 psf, berat steel beam psf.

$Es = 30.000$ ksi

$f_c = 3000$ psi

$n = 10$

$f_c = 1,35$ ksi

$Ft = 24$ ksi

$A = 10,59\ in^2$

$I = 446,3\ in^4$

$Ss = 56,3\ in^3$

$d = 15,85$ in -- $\frac{1}{2}\ d = 7,93$

Hitunglah : ft [steel tension flange]
fb [steal compression flange]
fc [compression flange]

Catatan : $M_D = 589$ k.in dan $M_L = 1350$ k.in

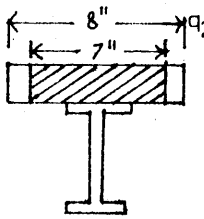
Ditanyakan : Berapa stud yang dipakai/ diperlukan bila dipakai - studber Ø ½" tinggi 2½" dengan kekuatan 5,1 k/connec tor.

Penyelesaian :

Beban hidup $q = 0,125 \times 8 = 1,0$ K/ft

$M_{LL} = 1/8.ql^2 = 1/8.1.30^2 = 112,50$ kft $= 112,50 \times 12$
$= 1350$ ki

Beban mati :



$ql = 0,05 \times 8 = 0,4$ [slab]

$q_2 =$ 0,05 [steel beam]

$q = 0,45$ k/ft

$M_D = 1/8.ql^2 = 1/8.0,45.30^2 = 9/8 \times 0,45 \times 100.$
$12 = 607$ kin.

$M_{11} = 1350$ kin

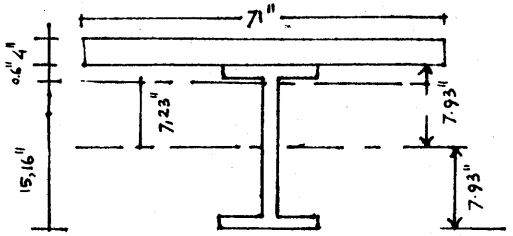
$M_D = 607$ kin [diambil yang besar --> bukan 589 kin]

Irisan comp	a	d	Ad	Ad^2	Ic	I
16 W = 36	10,59	0	0	0	446,3	446,3
slab = $\frac{71,4}{10}$	28,40	9,93	282	2800	$\frac{1}{12} . \frac{71,64}{10}$ = 37,8	2837,8
	38,90		282			3284,1

$ds = \frac{282}{38,99} = 7,23$

$-[7,23 \times 282]2040$

$I = 1244,1\ in^4$



Irisan composite : $Sbc = \frac{1244,1}{15,160} = 82,3$

$Stc = \frac{1244,16}{0,6} = 2070$

$$Scc = \frac{1244,1}{4,60} = 271$$

M Total load = 1350 + 607 = 1957 = $M_{LL} + M_D$

$$ft = \frac{1957}{2070} = 0,946 \text{ ksi}$$

$$fb = \frac{1957}{82,3} = 23,70 \text{ ksi}$$

$$sec = \frac{1957}{271.10} = 0,72 \text{ ksi}$$

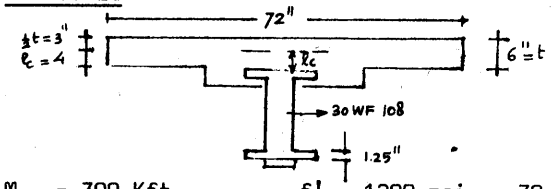
Jumlah stud :

Kekuatan stud = 5,1 K/conn
H beton = $\frac{1}{2}.4.71$
H profil = $\frac{1}{2}.10,59.36 = 190$ K

$$\text{----} \rightarrow n = \frac{190}{5,1} = 37,4 \text{ ----} \rightarrow 38 \text{ buah, untuk } \tfrac{1}{2} \text{ bentang}$$

Seluruh ben tang : n = 76 buah

9. Diketahui :



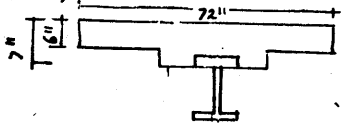
M_{DS} = 300 Kft
M_{DC} = 180 Kft
M_{LL} = 430 Kft

f' = 1200 psi
f_t = 18000 psi
n = 10

30 W108 : A = 31,77 in^2
d = 29,82 in
I_B = 4461 in^4
S_b = 299,2 in^3

Ditanyakan : a. Hitung cover plate yang diperlukan supaya memenuhi persyaratan yang ada.
b. Kontrol tegangan-tegangan yang timbul.

Penyelesaian :



$$\frac{S_B}{A_B} = \frac{299,2}{31,77} = 9,42$$

$$\frac{i_c}{d} = \frac{4}{29,82} = 0,134$$

K = 1 $\quad Ac = \frac{b.t}{k.n} = \frac{72.26}{1.10} = 43,2$

$$Kc = \frac{Ac}{Ac + As} = \frac{43,2}{43,2 + 31,77} = \frac{43,2}{74,97} = 0,576$$

$$\frac{S_{bc}}{As.d} = \frac{1}{\frac{1}{2} + [\frac{1}{2} + \frac{Ic}{a}] . Kc} \quad [\tfrac{1}{2} + \frac{Ic}{a}]^2 . Kc + 0,165$$

$$= \frac{1}{\frac{1}{2} + [\frac{1}{2} + 0,134]0,576} \quad [\tfrac{1}{2} + 0,134]^2 . 0,576 + 0,165$$

$$= \frac{1}{0,5 + 0,634 . 0,576} \quad [0,634^2 . 0,576 + 0,165]$$

$$= \frac{0,232 + 0,165}{0,5 + 0,365} = \frac{0,397}{0,865} = 0,46$$

$$\frac{Scc}{As.d} = \frac{1}{\frac{1}{2} - [\frac{1}{2} + \frac{Ic}{d}]. Kc} \quad [\tfrac{1}{2} + \frac{Ic}{Id}]^2 . Kc + 0,165 = \frac{0,397}{0,5 + 0,135}$$

$$= \frac{0,397}{0,135} = 2,94$$

K = 3 $\quad Ac = \frac{b.t}{k.n} = \frac{72,6}{3,10} = \frac{43,2}{3} = 14,4$

$$Kc = \frac{Ac}{Ac + As} = \frac{14,4}{14,4 + 31,77} = \frac{14,4}{46,17} = 0,312$$

$$\frac{S_{bc}}{As.d} = \frac{1}{\frac{1}{2} + [\frac{1}{2} + \frac{Ic}{d}] Kc} \quad [\tfrac{1}{2} + \frac{\ell c}{d}]^2 . Kc + 0,165$$

$$= \frac{0,364^2 . 0,132 + 0,165}{0,5 + 0,634 . 0,312} = \frac{0,1255 + 0,165}{0,5 + 0,198} = \frac{0,2905}{0,9680}$$

$$= 0,416$$

$$\frac{Stc}{Asd} = \frac{1}{\frac{1}{2} - [\frac{1}{2} + \frac{\ell c}{d}]Kc} \; [\frac{1}{2} + \frac{\ell c}{d}]^2 . \; Kc + 0,165$$

$$= \frac{0,2905}{0,5 - 0,198} = \frac{0,2905}{0,3020} = 0,96$$

Top flange :

$$A_{DS} = \frac{M_{DS}}{fb} \cdot \frac{As.d}{Ss} \cdot \frac{\ell}{d} = \frac{300.12}{18} \cdot \frac{1}{9,42} = 21,2$$

$$A_{DC} = \frac{M_{DC}}{fb} \cdot \frac{As.d}{Stc} \cdot \frac{\ell}{d} = \frac{180,12}{18} \cdot \frac{1}{0,96} \cdot \frac{1}{29,82} \cdot \frac{120}{0,96.2,98} = 4,2$$

$$A_{LL} = \frac{M_{LL}}{fb} \cdot \frac{As.d}{Stc} \cdot \frac{\ell}{d} = \frac{430,12}{18} \cdot \frac{1}{2,94} \cdot \frac{1}{29,82} = 3,27$$

$= 26,27$

$< 31,77 \; in^2$

tak perlu lover plate.

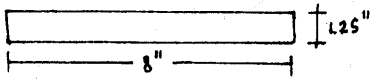
Beton flange :

$$A_{DS} = \frac{M_{DS}}{fb} \cdot \frac{As.d}{Ss} \; \frac{1}{d} = \frac{300,12}{18} \cdot \frac{1}{9,42} =$$

$$A_{DC} = \frac{M_{DC}}{fb} \cdot \frac{As.d}{Sbc} \; \frac{1}{d} = \frac{120}{9,416} \cdot \frac{1}{29,82} = \frac{120}{4,16.2,982} = 9,67$$

$$A_{LL} = \frac{M_{LL}}{fb} \cdot \frac{As.d}{Stc} \; \frac{1}{d} = \frac{430,12}{18} \cdot \frac{1}{2,94} \cdot \frac{1}{29,82} = 20,97$$

$As = 51,84$



A_B yang tersedia ... $= 31,77$

$[A_S - A_B]$ ..... $= 20,07$

Jadi $Ap = \frac{1}{2}[A_S - A_B]$ $= 10,035$

Cover plate yang diperlukan : 8" x 1,25" = --> Ap .. $= 10,000$

Irisan composite :

K = 3 $Ac = \frac{b.t}{k.n} = \frac{72,6}{3.10} = 14,4$

$$Kc = \frac{Ac}{Ac + As} = \frac{14,40}{14,4 + 41,8} = \frac{14,4}{56,2} = 0,256$$

$$Yc = [Yts + \ell c] \; Yc.As + \frac{Ac.t^2}{12} + Ic$$

$= 22,63.5,8.41,8 + 14,4. \frac{6,6}{12} + 6301 = 5470 + 43,2 +$

$6301 = 11814$

$Ytc = Yts - Yc = 18,63 - 5,8 = 12,83$ --> $Stc = \frac{11814}{12,83} = 920$

$Ybc = Ybs + Yc = 12,44 + 5,8 = 18,24$ --> $Sbc = \frac{11814}{18,24} = 648$

$Ycc = Ytc + \ell c + \frac{1}{2}t = 12,83 + 7 = 19,83$ --> $Scc = \frac{11814}{19,83} = 596$

K = 1

$Ac = \frac{b.t}{k.n} = \frac{72,6}{1.10} = 43,2$

$$Kc = \frac{Ac}{Ac + As} = \frac{43,2}{43,2 + 41,8} = \frac{43,2}{85} = 0,508$$

$Yc = [Yts + lc] \; Kc = 22,63.0,508 = 11,5$

$Ic = [Yts + lc] \; Yc.As + Ac. \frac{t^2}{12} + Ic$

$= 22,63.11,5.41,8 + 43,2.3 + 6301$

$= 10900 + 129,6 + 6301 = 17331$

$Ytc = Yts + Yc = 18,63 - 11,5 = 7,13$ --> $Stc = \frac{17331}{7,13} = 2430$

$Ybc = Ybs + Yc = 12,44 + 11,5 = 23,94$ --> $Sbc = \frac{17331}{23,94} = 725$

$Ycc = Ytc + 7 = 7{,}13 + 7 = 14{,}13$ --- $Scc = \frac{17331}{14{,}13} = 1230$

$f_c = \frac{M}{K.n.Sc}$ $\quad f_t = \frac{M}{St}$ $\quad f_b = \frac{M}{Sb}$

D_C	$\frac{180{,}12}{3.10.596}$	= 0,121	$\frac{180{,}12}{920}$	= 2,35	$\frac{180{,}12}{648}$	= 33,34	
D_S		0,000	$\frac{300{,}12}{338}$	= 10,65	$\frac{300{,}12}{506}$	= 7,10	
LL	$\frac{480.12}{1.10.1230}$	=0,420	$\frac{430{,}12}{2430}$	= 2,12	$\frac{430{,}12}{720}$	= 7,12	
		0,541		15,12		17,56	
		1,200		18,00		18,00	

10. Suatu jembatan composite :

- bentang 15 m
- Lebar 7 m + [2 x 1] m
- Direncanakan dengan 4 gelagar
- plate beton 20 cm
- tebal aspal 5 cm
- gelagar DIN 100
- P : muatan terbagi merata = 2,2 t/m'
- P : muatan garis = 12,00 ton
- 1 jalur lalu-lintas = 2,75 m

Ketentuan-ketentuan lain :

- Bj beton bertulang = 2,4 t/m^3
- Bj aspal = 2,2 t/m^3
- 28 hari beton = 200 kg/cm^2

σbeton = 60 kg/cm^2

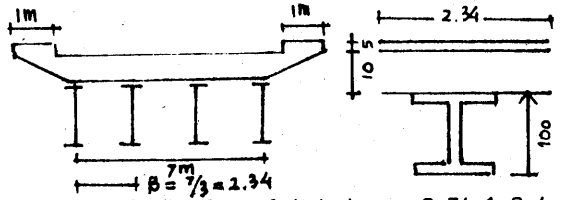
= 10 kg/cm^2

σbaja = 1300 kg/cm^2

- $n = \frac{Es}{Ec}$ = 10 kg/cm^2

Ditanyakan : a. tegangan-tegangan yang timbul
b. Stud yang dipakai Ø 3/4" h = 3"
Berapa jumlah stud yang diperlukan

Penyelesaian :



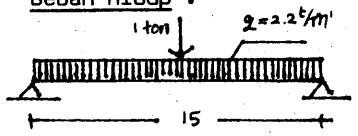
Ix = 644700 cm^4
Wx = 129000 cm^3
a = 400 cm^2
d = 100 cm
q = 314 kg/m'

Beban mati steel : slab beton = 2,34.1.2,4 = 1,122 T/m'
steel = 0,314 T/m'
q = 1,436 T/m'

$M = 1/8.q.l^2 = 1/8.1.436.225 = \underline{40{,}2\ Tm}$

Beban mati Comp : Aspal : 2,34.0,05.1.2,2 = 0,257 T/m'
$M = 1/8.q.l^2 = 1/8.0{,}257.225 = 7{,}25$ tm.

Beban hidup :



Impact factor = $1 + \frac{20}{15 + 50} = 1 + \frac{20}{65} = 1{,}208$

$W_L = \frac{7{,}7}{5{,}5} = 1{,}4$

2,34 m = $\frac{234}{2{,}54}$ in = $\frac{234}{2{,}54.12}$ ft = 7,7

$M' = \frac{1}{4}.PL + 1/8.ql^2 = \frac{1}{2}.12.15 + 1/8.2{,}2.225$

$= 45 + 62 = 107$

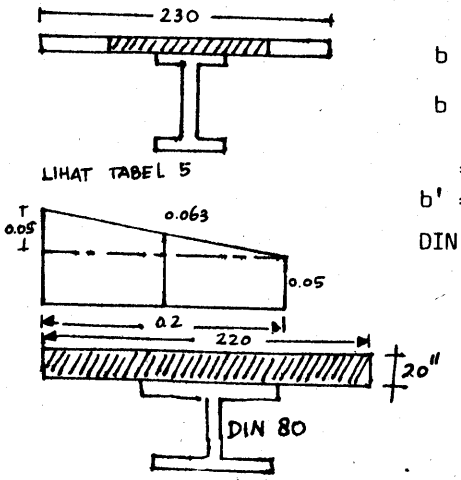
$M = 1{,}308.1{,}4.\frac{2{,}34}{2{,}75}.107 = 168$ Tm

$M_{DS} = 40{,}2$ tm
$M_{DC} = 7{,}25$ tm
$M_{LL} = 168{,}0$ tm

Tinjauan lebar effectif :

L = 15 m

$b = \frac{2{,}04}{2}$ $\quad b\text{-}L = \frac{1{,}02}{15} = 0{,}068$



b = 1,02

$b = 1 - \frac{0,018}{0,050} = 1 - 0,072 = 0,928$

$= 1,02.0,928 = 0,95$ m

$b' = 0,30 + 0,95 + 0,95 = 2,20$ m

DIN 100 : $Ix = 644700\ cm^4$

$Wx = 12900\ cm^3$

$A = 400\ cm^2$

$d = 100$

K = 1

$Ac = \frac{b.t}{k.n} = \frac{220.20}{1.10} = 440$

$Kc = \frac{Ac}{Ac + As} = \frac{440}{440 + 400} = \frac{440}{840} = 0,524$

$Yc = [Yts + lc].\ Kc = [50 + 10]\ 0,524 = 60.0,524$

$= 31,2$ cm

$Ic = [Yts + lc]\ Yc.As.\ Ac.\ \frac{t^2}{12} + is$

$= 60.31,2.400 = 440.\ \frac{20.20}{12} + 644700$

$= 6.3.12.4\ 10^4 + 440.6,67 + 644700$

$= 753000 + 2940 + 644700$

$= 1400640$

$Ytc = Yts - Yc = 50 - 31,2 = 18,8$ --- $Stc = \frac{1400640}{18,8} =$

$74400\ cm^3$

$Ybc = Ybs + Yc = 50 + 31,2 = 81,2$ --- $Scc = \frac{1400640}{38,8} =$

$36100\ cm^3$

K = 3

$Ac = \frac{b.t}{k.n} = \frac{220.20}{3.10} = \frac{440}{3} = 146,6$

$Kc = \frac{Ac}{Ac + As} = \frac{146,6}{146,6 + 400} = \frac{146,6}{546,6} = 0,268$

$Yc = Yts + lc.\ Kc = [50 + 10].0,268 = 60.0,268 = 16,1$ cm

$Ic = [Yts + lc]\ Yc.As + Ac.\ \frac{t^2}{12} + Is$

$= 60.16,1.400 + 146,6.6,67 + 644700$

$= 386000 + 980 + 644700 = 1031680$

$Ytc = Yts - Yc = 50 - 16,1 = 33,9$ --- $Stc = \frac{1031680}{33,90} = 30400$

$Ybc = Ybs + Yc = 50 + 16,1 = 66,1$ --- $Sbc = \frac{1031680}{66,10} = 15600$

$Ycc = Ytc + 20 = 33,9 + 20 = 53,9$ --- $Scc = \frac{1031680}{53,90} = 19100$

$F_{cc} = \frac{M}{k.n.Scc}$		$ft = \frac{M}{St}$	$fb = \frac{M}{Sb}$
D_S	0,00	$\frac{4020000}{12900} = 311,0$	$\frac{4020000}{12900} = 311,00$
D_C $\frac{725000}{3.10.19100}$	1,27	$\frac{725000}{30400} = 23,8$	$\frac{725000}{15600} = 46,40$
LL $\frac{168.10^5}{1.10.36100}$	46,50	$\frac{168.10^5}{7,44.10^4} = 226,0$	$\frac{168.10^5}{17250} = 973,00$
	47,77	560,8	1304,00

b. Shear connector :

H slab = $\frac{1}{2}$. 234.20.200 = 468000 kg

H = 4680000 kg

H profil = $\frac{1}{2}$.400.2400 = 480000 kg = 468 ton

Kekuatan stud : Ø 3/4", h = 3" h/d = $\frac{3}{3/4} = 4,42$

$Q = 80\ hs.ds.3000 = 80.3.\frac{3}{4}\ 3000 = 1803000$

Q = 9850 lbs = 4450 kg = 4,45 ton [1 lbs = 0,4536 kg]

$n = \frac{468}{4,450}$ = 105 buah [½ bentang]

n = 210 buah [1 bentang]

TENTAMEN BAJA IV

SOAL :

Suatu jembatan komposit bentang 15 m. Lebar 7 m + [2 x 1m] direncanakan dengan 4 gelagar. Bila untuk ini dipakai :
- tebal plat beton 20 cm.
- tebal aspal 5 cm
- gelagar DIN 80

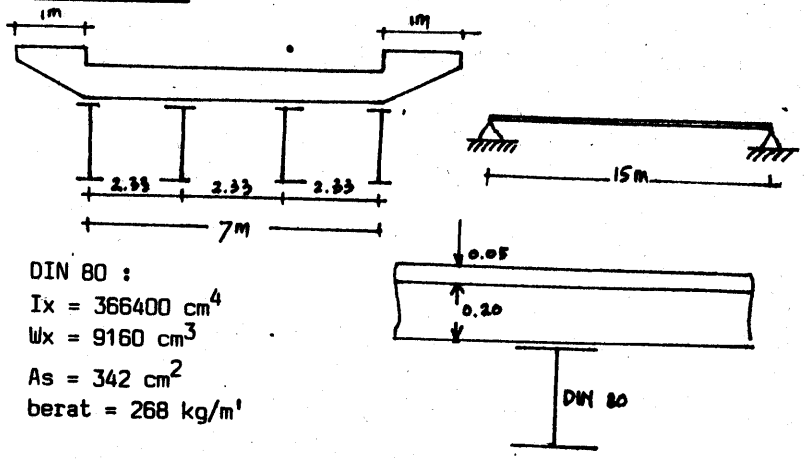
1] Tinjaulah apakah balok tersebut memenuhi syarat tegangan.
2] Seandainya tak memenuhi, berilah cover plate.

Ketentuan : B.j. beton bertulang = 2,4 ton/m^3
B.j. aspal = 2,2 ton/m^3
σ 28 hari = 200 kg/cm^2
$\bar{\sigma}_{b'}$ = 60 kg/cm^2
$\bar{\tau}$ = 0 kg/cm^2
$\bar{\sigma}$ baja =1300 kg/cm^2
n = 10

$$IF = 1 + \frac{20}{L + 50}$$

Untuk setiap jalur : p = muatan terbagi rata = 2,2 ton/m'
p = muatan garis = 12 ton.
lebar 1 jaluir = 11 = 2,75 meter.

PENYELESAIAN :



DIN 80 :
Ix = 366400 cm^4
Wx = 9160 cm^3
As = 342 cm^2
berat = 268 kg/m'

Dead Load : qDC = 0,05.1.2,333.2,2 = 0,25663 ton/m'

$$MDC = \frac{1}{8}.\ qDC.\ l^2 = \frac{1}{8}.\ 0,25663.\ 15^2 = 7,21772 \text{ ton m.}$$

Berat beton = 0,20. 1. 2,333. 2,4 = 1,11984 ton/m'

Berat DIN 80 = 0,268 ton/m' +

qDS = 1,38784 ton/m'

$$MDS = \frac{1}{8}.\ qDS.\ l^2 = \frac{1}{8}.\ 1,38784.\ 15^2 = 39,033 \text{ ton m.}$$

Live Load :

$$\text{Faktor kejut } K = 1 + \frac{20}{L + 50} = 1 + \frac{20}{15 + 50} = 1,3077$$

P = 2,2 ton/m' ----▶ 1 jalur 2,75 m.

P = 12 ton

$$q = \frac{2,333}{2,75}.\ 2,2.\ 1,3077 = 2,4407 \text{ ton/m'} \backsim 2,441 \text{ ton/m'}$$

$$MLL = \frac{1}{8}.\ ql^2 + \tfrac{1}{4}\ Q\ l = \frac{1}{8}.\ 2,441.\ 15^2 + \tfrac{1}{4}.13,313.\ 15$$

= 118,57687 ton m.

MT = MDC + MDS + MLL = 721772 + 3903300 + 11857687

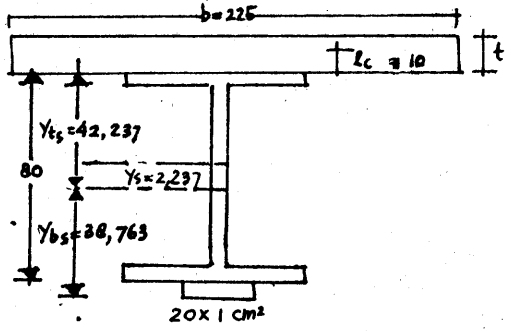
= 1648259 kg cm.

Menurut Lothers". $S = \frac{MT}{1,28.\ \acute{a}} = \frac{16482759}{1,28.\ 1300}$

$S = 9905,504\ cm^3 > Wx = 9160\ cm^3$

Jadi profil DIN 80 tidak memenuhi.

Maka harus diberi cover plate.



Lebar efectif

? b = 2,333 - 0,30 = 2,033 m ---▶ b = ½. 2,033 = 1,0165 m.

$\frac{b}{l} = \frac{1,0165}{15} = 0,0677$

Label 4 ---▶ $\frac{\lambda}{b} = 1 - \frac{0,0177}{0,05}.\ 0,11 = 0,961$

$\lambda = 0,961.\ 1,0165 = 0,977$

lebar efektif = $2\lambda + 0,30 = 2.\ 0,977 + 0,30 = 2,254$ m ≈ 2,25 m

Dead Load K = 3 n = 10

$$Ac = \frac{225.\ 20}{3.10} = 150 \text{ ---▶ } Kc = \frac{Ac}{Ac + As} = \frac{150}{150 + 342} = 0,305$$

$$\frac{Sbc}{As.d} = \frac{1}{\frac{1}{2} + [\frac{1}{2} + \frac{lc}{d}]\ .\ Kc}\ [\tfrac{1}{2} + \frac{lc}{d}]^2\ Kc + 0,165$$

$$= \frac{1}{\frac{1}{2} + [\frac{1}{2} + \frac{10}{80}]\ .\ 0,305}\left\{[\tfrac{1}{2} + \frac{10}{80}]^2.\ 0,305 + 0,165\right\} = 0,411\ 42$$

$$\frac{Stc}{Asd} = \frac{1}{\frac{1}{2} - [\frac{1}{2} + \frac{lc}{d}]\ .\ Kc}\left\{[\tfrac{1}{2} + \frac{lc}{d}]^2\ Kc + 0,165\right\}$$

$$= \frac{1}{\frac{1}{2} - [\frac{1}{2} + \frac{10}{80}].\ 0,305}\left\{[\tfrac{1}{2} + \frac{10}{80}]^2.\ 0,305 + 0,165\right\} = 0,91843$$

Live Load K = 1 . n = 10

$$Ac = \frac{225.\ 20}{1.10} = 450 \text{ ---▶ } Kc = \frac{450}{450 + 342} = 0,56818$$

$$\frac{Sbc}{Asd} = \frac{1}{\frac{1}{2} + [\frac{1}{2} + \frac{10}{80}].\ 0,56818}\left\{[\tfrac{1}{2} + \frac{10}{80}]^2.\ 0,56818 + 0,165\right\} = 0,4525$$

$$\frac{Stc}{Asd} = \frac{1}{\frac{1}{2} - [\frac{1}{2} + \frac{10}{80}]. 0,56818} \quad [\frac{1}{2} + \frac{10}{80}]^2 . 0,56818 + 0,165 = 2,67066$$

Top flange : $ADS = \frac{MDS}{ft} . \frac{As}{SB} = \frac{3903300}{1300} . \frac{342}{9160} = 112,1035$

$$ADC = \frac{MDC}{ft} . \frac{Asd}{Stc} . \frac{1}{d} = \frac{721772}{1300} . \frac{1}{0,91843} . \frac{1}{80} = 7,5565$$

$$ALL = \frac{MLL}{ft} . \frac{As.d}{Stc} . \frac{1}{d} = \frac{11857687}{1300} . \frac{1}{2,67066} . \frac{1}{80} = 42,692$$

As = 162,352.

Bottom flange :

$$ADS = \frac{MDS}{fb} . \frac{AS}{SB} = \frac{3903300}{1300} . \frac{342}{9160} = 112,1035$$

$$ADC = \frac{MDC}{ft} . \frac{As.d}{Sbc} . \frac{1}{d} = \frac{721772}{1300} . \frac{1}{0,41142} . \frac{1}{80} = 16,8687$$

$$ALL = \frac{MLL}{ft} . \frac{As.d}{Sbc} . \frac{1}{d} = \frac{11857687}{1300} . \frac{1}{0,4525} . \frac{1}{80} = 251,9695$$

As= 381 > AB = 342

$Ap = \frac{1}{2} [As - AB] = \frac{1}{2} [381 - 342] = \frac{1}{2} . 39 = 19,5 \approx 20 \text{ cm}^2$

UKuran coverplate ambil 20 x 1 cm^2

$As = 342 + 20 = 362 \text{ cm}^2$

$Ys = \frac{-20. 40,5}{362} = -2,237$ cm.

Ybs = 41 - 2,237 = 38,763 cm.

Yts = 40 + 2,237 = 42,237 cm.

$Is = 366400 + 342 [2,237]^2 + \frac{}{12} . 20. 1^3 + 20. 1 [38,263]^2$

$= 397394,2356 \text{ cm}^4$.

Dengan adanya cover plate maka qDS akan bertambah.

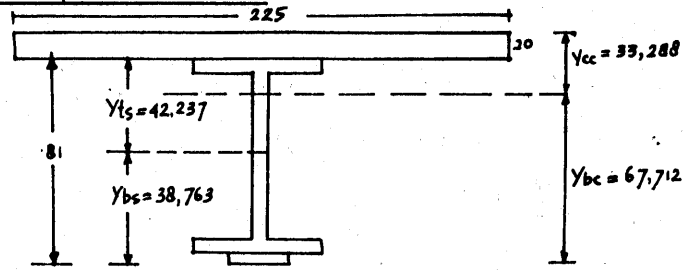
Misalnya berat besi = 7 ton/m^3.

Berat cover plate = 0,20. 0,01. 7 = 0,014 ton/m'

qDS = 1,38784 + 0,014 = 1,40184 ton/m'

$MDS = \frac{1}{8} . 1,40184 . 15^2 = 39,42675$ ton m.

Beban hidup k = 1 . n = 10



$Ac = \frac{225. 20}{10} + 362 = 812 \text{ cm}^2$

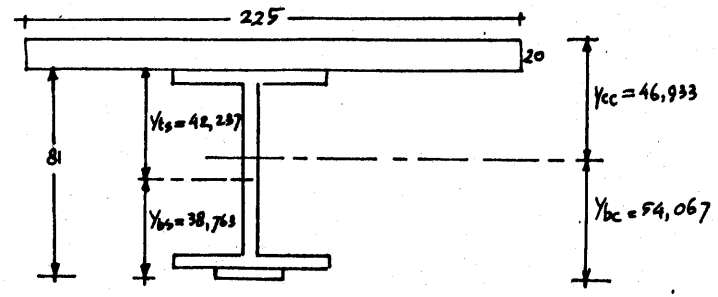
$Ybc = \frac{450. 91 + 362. 38,763}{812} = 67,712$ cm.

Ycc = 81 + 20 - 67,712 = 33,288 cm.

$Ic = 397394,2356 + 362 [67,712 - 38,763]^2 + \frac{1}{12} . \frac{225}{10} . 20^3 + 450$

$[33,288 - 10] = 959815,3059 \text{ cm}^4$.

Beban mati k = 3 n = 10



$Ac = \frac{225. 20}{30} + 362 = 150 + 362 = 512 \text{ cm}^2$.

$$Ybc = \frac{150.\ 91 + 362.\ 38,763}{512} = 54,067 \text{ cm.}$$

$$Ycc = 81 + 20 - 54,067 = 46,953 \text{ cm.}$$

$$Ic = 387394,2356 + 362\ [54,067 - 38,763]^2 + \frac{1}{12}.\ \frac{225}{30}.\ 20^3 + 150\ [46,933 - 10]^2 = 691786,1034 \text{ cm}^4.$$

$$\sigma_b = \frac{MDC\ YCC}{Ic\ k.n} + \frac{MLL.\ YCC}{Ic.\ k.n}$$

$$= \frac{721772.\ 46,933}{691786,\ 1034.30} + \frac{11857687.\ 33,288}{959815,3059.\ 10} = 42,76 \text{ kg/cm}^2 < \sigma_b\ 60\text{"} \text{ kg/cm}^2$$

$$\sigma_a = \frac{MDS.\ Ybs}{Is} + \frac{MDS.\ Ybc}{Ic} + \frac{MLL.\ Ybc}{Ic}$$

$$= \frac{3942675.\ 38,763}{397394,2356} + \frac{721772.\ 54,067}{691786,1034} + \frac{11857687.\ 67,712}{959815,3059}$$

$$= 1277,514 \text{ kg/cm}^2 < \sigma \text{ baja} = 1300 \text{ kg/cm}^2$$

A m a n.

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5 - 2 - 1979. Waktu : 2½ jam

SOAL :

1. Suatu jembatan jalan raya bentang 16,50 m, lebar jalan 7,00m ditambah trotoir 2 x 1,00 m.

Ketentuan : direncanakan dengan sistim komposit dan dipakai 4 buah gelagar induk. Tebal slab beton 0,20 m, tebal-aspal = 0,05 m. berat jenis beton bertulang 2,4 b.j aspal 2,2.

E baja = $2.\ 10^6$ kg/cm^2

E beton = $0,2.\ 10^6$ kg/cm^2

σ 28 hari = 200 kg/cm^2 = 60 kg/cm^2

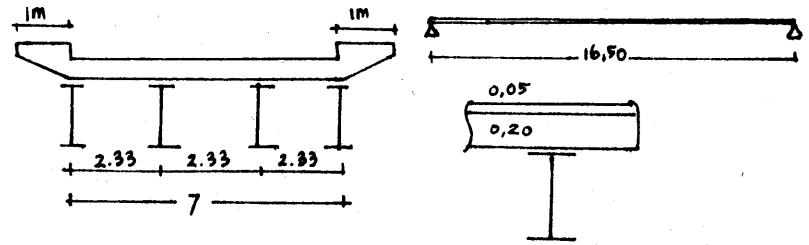
τ = 10 kg/cm^2

Tekanan gandar mengikuti spesifikasi dari Dept. P.U

1.1. Hitunglah "stress" yang timbul.

1.2. Hitunglah jumlah stud, paku yang diperlukan tiap gelagar - dan spacingnya [Ø stud 2,54 cm dan tinggi stud 15 cm]

PENYELESAIAN



Beban-beban :

Dead Load : berat aspal.qDC = $0,05.\ 2,33.\ 1.\ 2,2$

= 0,2563 ton/m'

$$MDC = \frac{1}{8}.\ qDC.\ 1^2 = \frac{1}{8}.\ 0,2563.\ 16,5^2 = 8,72221 \text{ ton m.}$$

Beban hidup [Live Load]

Menurut PUTL 1970. Untuk perhitungan kekuatan gelagar digunakan-muatan D :

P = 12 ton
P = 2,2 ton/m' } untuk 1 jalur [2,75 m]

Faktor kejut $K = 1 + \frac{20}{50 + 1} = 1 + \frac{20}{50 + 16,5} = 1,3$

Beam spacing diabaikan saja.

$Q = \frac{2,33}{2,75} . 12 . 1,3 = 13,217$ ton

$q = \frac{2,33}{2,75} . 2,2 . 1,3 = 2,423$ ton/m'

$MLL = \frac{1}{8} ql^2 + \frac{1}{4} Ql = \frac{1}{8} . 2,423 . 16,5^2 + \frac{1}{4} . 13,217 . 16,5$

$= 136,97784$ ton m.

Berat sendiri [komposit]

Misalnya digunakan profil DIN 100

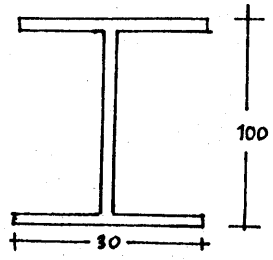
data-data =

berat profil = 314 kg/m'

$Ix = 644700$ cm^4

$Wx = 12890$ cm^3

$As = 400$ cm^2



berat beton = 0,20 . 2,33 . 1 . 2,4 = 1,1184 ton/m'

berat DIN 100 = 0,314

qDS = 1,4324 ton/m'

$MDS = \frac{1}{8} . qDS . l^2 = \frac{1}{8} . 1,4324 . 16,5^2 = 48,74636$ ton m.

Di chek dulu menurut "Lothers" $S = \frac{MT}{1,28 \sigma i}$

MT = MDC + MLL + MDS = 8,72221 + 136,97784 + 48,74636

= 194,44641 ton m.

$S = \frac{194,44641 . 10^5}{1,28 . 1300} = 11685,48$ cm^3 < $Wx = 12890$ cm^3.

terlalu aman.

Dipakai saja profil DIN 95 : berat profil = 307 kg/m'

$Ix = 573000$ cm^4

$Wx = 12060$ cm^3

$As = 391$ cm^2

qDS = 1,1184 + 0,307 = 1,4254 ton/m'

$MDS = \frac{1}{8} . qDS . l^2 = \frac{1}{8} . 1,4254 . 16,5^2 = 48,50814$ ton m.

Ditinjau tegangan-tegangan yang timbul :

Lebar effektif :

$2b = 233 - 30 = 203$ cm --> $b = \frac{203}{2} = 101,5$ cm.

$\frac{b}{L} = \frac{1,015}{16,5} = 0,0615$

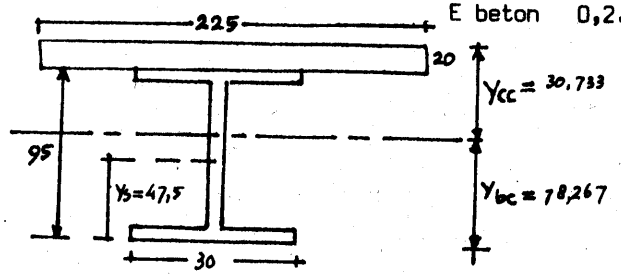
tabel 4 --> $\frac{\lambda}{b} = 1 - \frac{0,0115}{0,05} . 0,11 = 0,9747$

$\lambda = 0,9747 . 101,5 = 98,93$

Lebar efectif = $2\lambda + b = 2 . 98,93 + 30 = 227,86$ cm.

ambil = 225 cm.

Beban hidup k.n = 1 . 10 = 10 $n = \frac{E\ bqa}{E\ beton} = \frac{2 . 10^6}{0,2 . 10^6}$



$Ac = \frac{225 . 20}{10} + 391 = 841$ cm^2

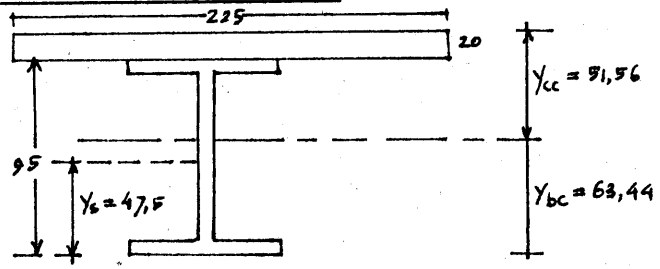
$Ybc = \frac{\frac{225 . 20}{10} . 105 + 391 . 47,5}{841} = 78,267$ cm.

Ycc = 20 + 95 - 78,267 = 36,733 cm.

$Ic = 573000 + 391 . [78,267 - 47,5]^2 + \frac{1}{12} . \frac{225}{10} . 20^3 + \frac{225.20}{10}$

$[36,733.50]^2 = 1279717,82$ cm^4.

Beban mati : k.n = 3. 10 = 30



$$Ac = \frac{225.\ 20}{30} + 391 = 541\ cm^2$$

$$Ybc = \frac{\frac{225.\ 20}{30}.\ 105 + 391.\ 47,5}{541} = 63,44\ cm.$$

$$Ycc = 20 + 95 - 63,64 = 51,56\ cm.$$

$$c = 573000 + 391.\ [63,44 - 47,5]^2 + \frac{1}{12}.\ \frac{225}{30}.\ 20^3 + \frac{225.\ 20}{30}[51,56 - 10]^2 = 936431,7276\ cm^4.$$

$$fc = \frac{MLL.\ Ycc}{Ic.k.n} + \frac{MDC\ .\ Ycc}{Ic.\ k.n}$$

$$= \frac{13697784.\ 36,733}{1279717,82.10} + \frac{872221,\ 51,56}{936431,7276.\ 30} = 40,92\ kg/cm^2 \qquad b=60\ kg/cm^2$$

$$fs = \frac{MDS.\ Ys}{Is} + \frac{MLL.\ Ybc}{Ic} + \frac{MDC.\ Ybc}{Ic}$$

$$= \frac{4850814.\ 47,5}{573000} + \frac{13697784.\ 78,267}{1279717,82} + \frac{872221.\ 63,44}{936431,7276}$$

$= 1298,96\ kg/cm^2 \qquad i = 1300\ kg/cm^2.$

A m a n.

[tinjauan stress untuk baja, cukup kita tinjau yang bagian ba wah saja, sebab disitu tegangan lebih besar dari pada bagian-atas].

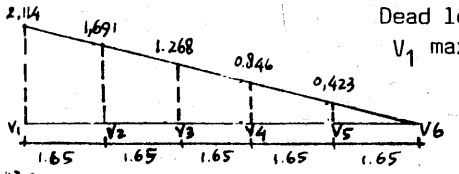
1.2. Perencanaan stud :

Ø stud = 2,54 cm

tinggi h = 15 cm ⟶ $\frac{hs}{ds} = \frac{15}{2,54} = 5,9 > 5,5$

$$Q = 55\ ds^2\ \sqrt{\sigma b} = 55.\ 2,54^2.\ \sqrt{60}$$
$$= 27\ 48,56\ kg$$
$$= 2748\ kg$$

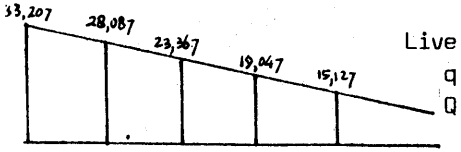
S.F maximum :



Dead load : qDC = 0,2563 t/m'

V_1 max = ½. 0,2563. 16,5

= 2,114 ton.

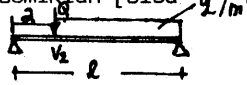


Live Load :

q = 2,423 t/m'

Q = 13,217 ton.

Prinsip mencari V max yaitu muatan ditempatkan sedemikian [bisa terputus].



Misalnya : V_2 max

$$V_2\ max = \left[\frac{1-a}{1}\right]^2 . \tfrac{1}{2}\ q\ l + \left[\frac{1-a}{1}\right] Q$$

V_1 ⟶ $= \frac{1}{2}\ q\ l + Q = \frac{1}{2}.\ 2,423.\ 16,5 + 13,217$

$= 19,99 + 13,217 = 33,207$ ton.

$$V_2 = \left[\frac{16,5 - 1,65}{16,5}\right]^2 . 19,99 + \frac{16,5 - 1,65}{16,5}.\ 13,217 = 28,087\ ton$$

$$V_3 = \left[\frac{16,5 - 3,3}{16,5}\right]^2 . 19,99 + \frac{16,5 - 3,3}{16,5}.\ 13,217 = 23,367\ ton.$$

$$V_4 = \left[\frac{16,5 - 4,95}{16,5}\right]^2 . 19,99 + \frac{16,5 - 4,95}{16,5}.\ 13,217 = 19,047\ ton$$

$$V_5 = \left[\frac{16,5 - 6,6}{16,5}\right]^2 . 19,99 + \frac{16,5 - 6,6}{16,5}.\ 13,217 = 15,127\ ton.$$

Vc total adalah dead load + live load.

$Vc_1 = 2,114 + 33,207 = 35,321$ ton.

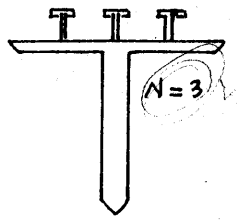
$Vc_2 = 1,691 + 28,087 = 19,778$ ton.

Beban P

$V_3 = 1{,}268 + 23{,}367 = 24{,}635$ ton.

$V_4 = 0{,}846 + 19{,}047 = 19{,}893$ ton.

$V_5 = 0{,}423 + 15{,}127 = 15{,}55$ ton.



$$S = \frac{Vc \cdot m}{Ic}$$

$$p = \frac{N \cdot Q}{S} = \frac{N.Q.Ic}{Vc.m}$$

Momen statis beton terhadap garis netral komposit.

$$m = \frac{225 \cdot 20}{10} \cdot [36{,}733 - 10] = 12029{,}85 \text{ cm}^3$$

$Ic = 1279717{,}82 \text{ cm}^4$.

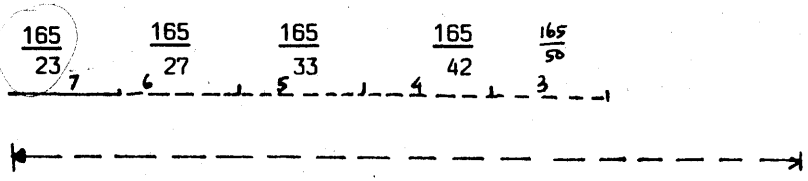
$$P_{1-2} = \frac{3 \cdot 2748 \cdot 1279717{,}82}{35321 \cdot 12029{,}85} = 24{,}82 \text{ s} \quad 23 \text{ cm}.$$

$$P_{2-3} = \frac{3 \cdot 2748 \cdot 1279717{,}82}{29778 \cdot 12029{,}85} = 29{,}45 \text{ s} \quad 27 \text{ cm}$$

$$P_{3-4} = \frac{3 \cdot 2748 \cdot 1279717{,}82}{24635 \cdot 12029{,}85} = 35{,}6 \text{ s} \quad 33 \text{ cm}$$

$$P_{4-5} = \frac{3 \cdot 2748 \cdot 1279717{,}82}{19893 \cdot 12029{,}85} = 44{,}08 \text{ s} \quad 42 \text{ cm}$$

$$P_{5-6} = \frac{3 \cdot 2748 \cdot 1279717{,}82}{15550 \cdot 12029{,}85} = 56{,}4 \text{ s} \quad 50 \text{ cm}$$



Jumlah stud untuk 1 gelagar = $3 \cdot 2[7 + 6 + 5 + 4 + 3]$

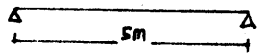
$= 6 \cdot 25 = 150$ buah.

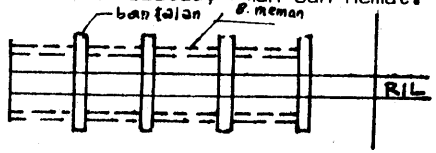
SOAL :

Suatu jalur jalan kereta api melintas parit lebar 5,00 m. Rencana muatan yang dipakai ialah R M 1921. Adapun tegangan yang dipakai seperti pada kuliah. Agar diperhatikan pemilihan angka kejut ["impact factor"].

2.1. Pilihlah atas dasar hitungan gelagar memanjang yang diper siapkan untuk konstruksi tersebut diatas, aman dan hemat.

PENYELESAIAN :



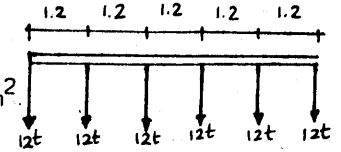


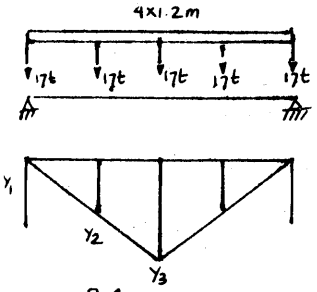
Darikuliah : $\sigma_a = 1300 \text{ kg/cm}^2$

$\sigma = 780 \text{ kg/cm}^2$

$E = 2{,}1 \cdot 10^6 \text{ kg/cm}^2$

$$IF = 1{,}2 + \frac{25}{50 + L}$$





Tekanan gandar yang masuk ada 5 buah. Maka diperhitungkan 17 ton tiap gandar.

$$Y_3 = \frac{1}{2} \cdot \frac{5}{2} = 1{,}25$$

$$Y_2 = \frac{1{,}3}{2{,}5} \cdot 1{,}25 = 0{,}65$$

$$Y_1 = \frac{0{,}1}{2{,}5} \cdot 1{,}25 = 0{,}05$$

$M = 2 \cdot 17 \cdot Y_1 + 2 \cdot 17 \cdot Y_2 + 17 \cdot Y_3$

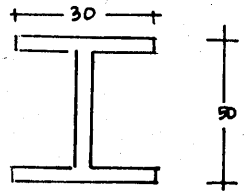
$= 2 \cdot 17 \cdot 0{,}05 + 2 \cdot 17 \cdot 0{,}65 + 17 \cdot 1{,}25$

$= 45{,}05$ ton m.

$$IF = 1{,}2 + \frac{25}{50 + 15} = 1{,}6545$$

M dynamis $= 45{,}05 \cdot 1{,}6545 = 74{,}53727$ ton m.

Beban statis :



Ditaksir profil DIN 50

Ix = 113200 cm^4

Wx = 4530 cm^3

berat = 200 kg/m'

berat profil [2 buah] = 0,400 ton/m'

berat ril = 0,230 ton/m'

q = 0,630 ton/m'

M statis = $\frac{1}{8}$. q.l^2 = $\frac{1}{8}$. 0,630. 5^2 = 1,96875 ton m.

Perlemahan diambil 1,20

M total = 1,20 [M dyn + M statis]

1,20 [7453727 + 196875] = 9180722 kg cm.

M_1 gelagar = $\frac{1}{2}$. 9180722 = 4590361 kg cm.

$\sigma = \frac{M}{W} = \frac{45\ 90361}{4530}$ = 1013,325 kg/cm^2 < $\bar{\sigma}$ a = 1300 kg/cm^2

terlalu aman.

Dipakai saja profil DIN 45 :

Ix = 84220 cm^4

Wx = 3740 cm^3

berat = 182 kg/m'

S = 2110 cm^3

b = 1,5 cm.

q statis = 0,230 + 2. 0,182 = 0,594 ton/m'

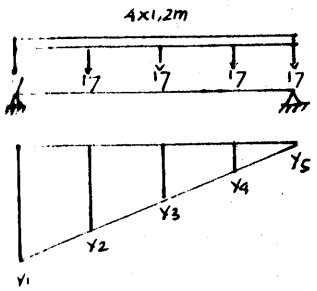
M statis = $\frac{1}{8}$. q.l^2 = $\frac{1}{8}$. 0,594. 5^2 = 1,85625 ton m.

M_1 gelagar = $\frac{1}{2}$. 1,20 [7453727 + 185625] = 4583611,2 kgcm.

$\sigma = \frac{4583611,2}{3740}$ = 1225,56 kg/cm^2 < $\bar{\sigma}$a = 1300 kg/cm^2

a m a n.

Ditinjau gaya lintang



Y_1 = 1

$Y_2 = \frac{3,8}{5}$. 1 = 0,76

$Y_3 = \frac{2,6}{5}$. 1 = 0,52

$Y_4 = \frac{1,4}{5}$. 1 = 0,28

$Y_5 = \frac{0,20}{5}$. 1 = 0,04

D dynamis = 17 [1+0,76+0,52+0,28+0,04] =44,2 ton = 44200 kg.

D statis = $\frac{1}{2}$. q l = $\frac{1}{2}$. 0,594. 5

= 0,1485 ton.

D max 1 gelagar = $\frac{1}{2}$[44200 + 148,5] = 22174,25 kg.

$\tau = \frac{D.\ s.}{b.\ l.} = \frac{22174,25.\ 2100}{1,5.\ 84220}$ = 368,60 kg/cm^2 < $\bar{\sigma}$ = 780 kg/cm^2

A m a n.

Jadi profil DIN 45 dapat digunakan dengan aman dan hemat.

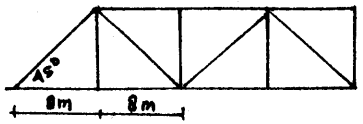
--oOo--

PENYELESAIAN UJIAN SISIPAN

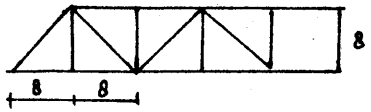
KONSTRUKSI BAJA III 20 MEI 1982

SOAL :

1. Lebar jembatan PJKA 4,8 m bentang 64 m, R M 1921.
   Tegangan-tegangan izin seperti pada kuliah. E = $2{,}1.10^6$ kg / cm^2, Tiupan angin mengikuti P M I 1970.
   Rencanakanlah "Stringer"-dari jembatan tersebut de mikian pula "Floor Beam " nya.



PENYELESAIAN :



L = 64 m

$\phi = 1{,}2 + \frac{25}{50+64} = 1{,}4193$

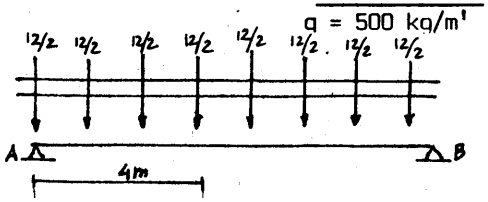
b = 4,8 m

R M 1921

PERENCANAAN GELAGAR MEMANJANG :

- Berat bantalan + rel = 230 kg/m'
- Berat pertambatan = 120 kg/m'
- Berat profil [taksir] = 150 kg/m'

q = 500 kg/m'



Masuk 7 gandar = 12 ton.

$R_A = \frac{12.7}{2.2} = 21$ ton.

M max = 21.4 - 6.12 - 6.2,4 - 6.3,6 = 40,8 Tm.

M = M max. 1,2 = 40,8. 1,2. 1,4193 = 69,488928 tm.

= 6948892,8 kg cm

$M_q = \frac{1}{8}. ql^2 = \frac{1}{8}. 0{,}5. 8^2. \frac{1}{2} = 2$ tm = 20000 kg cm

M design = 6948892,8 + 200000 = 7148892,8 kg cm.

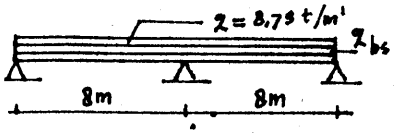
$W_x = \frac{7148892{,}8}{1300} = 5499{,}15\ cm^3 = 335{,}58\ cm^3$

Dipakai 30 WF 124 --> $W_x = 354{,}6\ in^3$

$I_x = 5347{,}1\ in^4 = 222653\ cm^4$

$f' = \frac{5}{48} . \frac{M_{design} . L^2}{EI}$

$= \frac{5}{48} . \frac{7148892{,}8 . 800^2}{2{,}1 . 10 . 222653} = 1{,}019\ cm < \frac{1}{600L} = 1{,}333\ cm$



14x12 t = 10x 12 + 4x12 = 168 t

L = 19,20 m

$q = \frac{168}{19{,}2} = 8{,}75$ t/m'

Tiap gelagar = $\frac{1}{2}$. 8,75 = 4,375 t/m'

M max = $\frac{1}{8}$. 4,375 ,8^2 = 35 cm

M = 1,2. 35. 1,4193 = 59,6106 tm

Mq = $\frac{1}{8}$. 0,5.64. $\frac{1}{2}$ = 2 tm

M design = 61,6106 tm

$W_x = \frac{61{,}6106 . 10^5}{7300} = 4739{,}3\ cm^3 = 289{,}21\ m^3$

Dipakai : 24 WF 120 : $W_x = 299{,}1\ in^3$

$I_x = 3625{,}3\ in^4 = 151312{,}61\ cm^4$

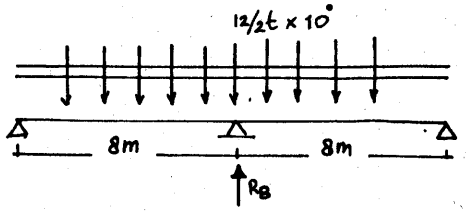
Defleksi = $\frac{5}{48} . \frac{ML^2}{EI} = \frac{5}{48} . \frac{61{,}6106.10^5 . 800^2}{2{,}1.10 . 151312{,}61}$

$= 1{,}3346\ cm < \frac{1}{600L} = 1{,}333$ cm.

lebih hemat.

PERENCANAAN GELAGAR MELINTANG

b = 4,80 m.



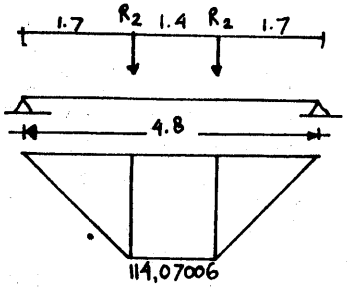
$$\phi = 1{,}2 + \frac{25}{50+4{,}82} = 1{,}6562$$

$R_B = 12/2 + 6/8.\ [0{,}8+2+3{,}2+4{,}4+6{,}0+7{,}2] + 6/8.[0{,}8+2+4{,}4+6+7{,}2]$
$= 39$ ton.

$R_B = 39.\ 1{,}6562 \quad = 64{,}5918$ tm

$R_{Bq} = 0{,}5\ .\ 0{,}5.\ 8 = 2$ tm

$R_B = 66{,}5918$ tm



Ditaksir q gelagar lintang

qbs = 0,300 t/m'

$M_{LS} = \frac{1}{8}.\ 0{,}3.\ 4{,}8^2 = 0{,}864$ tm

$M_I = 66{,}5917.\ 2{,}7 = 113{,}20606$ tm

$M = 114{,}07006$ tm

M design = 1,2. 114,07006
= 136,884072 tm.

$W_x = \frac{1368840{,}72}{1300} = 10529{,}544\ cm^3$
$= 642{,}552\ m^3$

Dipakai 30 WF 210 $W_x = 649{,}9\ m^3$

$I_x = 9872{,}4\ m^4 = 410920{,}3126\ cm^4$.

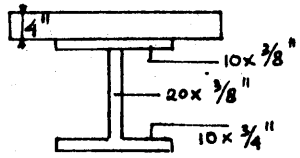
$\text{Defleksi} = \frac{5}{48}.\ \frac{Ml^2}{EI}$

$= \frac{5}{48}\ .\ \frac{13688407.2.800^2}{2{,}1.10.410920{,}31} = 1{,}0575 > \frac{1}{6001}$

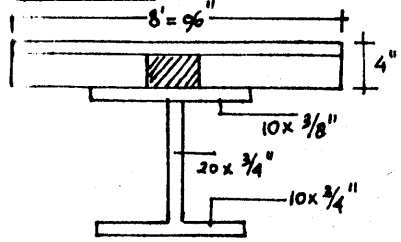
SOAL:

2. Jembatan komposit bentang 34 ft. Gelagar induk terdiri dari - plat baja type A-36, tebal slab 4". Fy = 36 ksi.
Shear connector bentuk paku tinggi 3", diameter 3/4"
σ 28 hari = 3 Ksi Es = 9 Ec
Hasil hitungan mekanika M max [beban mati] = 101 Kft.
M max [beban hidup] = 222 Kft b eff = 8'

a. Hitunglah stress yang timbul pada konstruksi ksi jembatan
b. Berapa jumlah connector yang diperlukan per gelagar.



Penyelesaian :



L = 34 ft

$\phi = 1 + \frac{50}{125 + 34} = 1{,}314$

$A_{36} = F_y = 36$ ksi

$F_b = 24$ ksi

$M_D = 101$ kft

$M_{LL} = 222$ kft

Dari tabel USS dan AASHO, MLL sudah termasuk koefisien kejut.

Steel beam :

Mencari garis netral profil

Statis momen terhadap sisi atas.

$y\ [10.\ 3/8 + 20.\ 3/8 + 10.3/4] = \underbrace{10.3/8.3/16+20.3/8[10+3/8]+\ [20}_{\frac{3}{8}+\frac{3}{8}]}$

$Y_{ts} = \frac{234{,}14}{18{,}75} = 12{,}487$ in = 12,49 in

$Y_{bs} = 8{,}635$ in

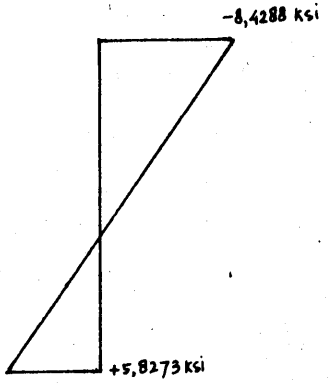
I profil :	$1/12.\ 10\ [3/8]^3$	$= 0{,}0439\ in^4$
	$10.3/8\ [12{,}49-0{,}1875]^2$	$= 567{,}568\ in^4$
	$1/12.\ 3/8.\ 20^3$	$= 250\ in^4$
	$20.\ 3/8.\ [7{,}885]^2$	$= 466{,}299\ in^4$
	$1/12.\ 10\ [3/4]^3$	$= 0{,}352\ in^4$
	$10.\ 3/4.\ [8{,}26]^2$	$= 511{,}707\ in^4$ +
	I profil	$= 1795{,}97\ in^4$

$$Stc = \frac{1795,97}{12,49} = 143,793 \text{ in}^3$$

$$Sbc = \frac{1795,97}{8,635} = 207,987 \text{ in}^3$$

$$fts = \frac{101,12}{143,793} = 8,4288 \text{ ksi}$$

$$fbs = \frac{101,12}{207,987} = 5,8273 \text{ ksi}$$



Composit beam : K = 1

Luas eq beton dengan baja $= \frac{8.12.4}{9} = 42,667 \text{ in}^2$

$= 18,75 \text{ in}^2$ +

A comp $= 61,417 \text{ in}^2$

$\bar{Y}c \cdot 61,417 = 42,667\ [2 + 12,49]$

$\bar{y}c = \frac{618,2448}{61,417} = 10,066$ in

$y_t = 12,49-10,066 = 2,424$ in

$y_{cc} = y_{tc} + 4 = 6,424$ in.

$y_{bc} = 12,49 + 10,066 = 22,556$ in

$I_{pr\ sendiri}$	$= 1795,97 \text{ in}^4$
$18,75\ [10,866]^2$	$= 1899,83 \text{ in}^4$
$1/9.1/12.96.4^3$	$= 56,89 \text{ in}^4$
$42,667.[2+2,424]^2$	$= 835,07 \text{ in}^4$
I composit	$= 4587,76 \text{ in}^4$

$$S_{tc} = \frac{4587,76}{2,424} = 1892,64 \text{ in}^3$$

$$S_{bc} = \frac{4587,76}{22,556} = 203,394 \text{ in}^3$$

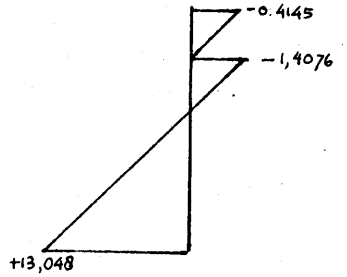
$$S_{cc} = \frac{4587,76.9}{6,424} = 6427,43 \text{ in}^3$$

Stress yang timbul sesudah composit :

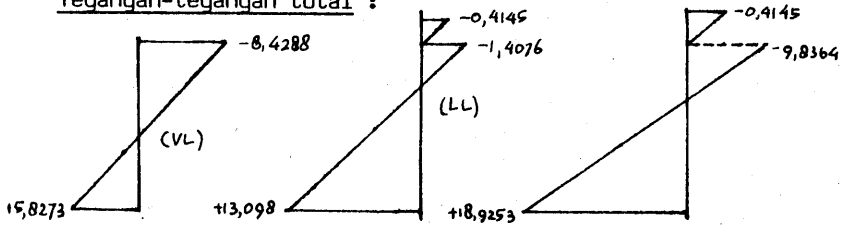
$$f_{cc} = \frac{12.222}{6427,43} = 0,4145 \text{ ksi}$$

$$f_{tc} = \frac{12.222}{1892,64} = 1,4076 \text{ ksi}$$

$$f_{bc} = \frac{12.222}{203,394} = 13,098 \text{ ksi}$$



Tegangan-tegangan total :



Tegangan max baja = 18,9253 ksi < 24 ksi ---► O.K.

Tegangan max beton = 0,4145 ksi < 1,35 ksi --► O.K.

Shear connector :

$\emptyset$ = 3/4" --► $Qu = 165.[3/4]^2.\sqrt{3000} = 5,083$ ksi

As.Fy = 18,75. 36 = 675 kip

0,85. 3000. 96,4 = 979,2 kip

Qu = 5,083 kip/stud

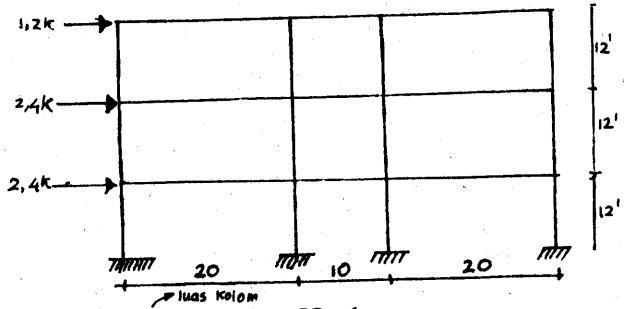
SF = 1,5 --► Q = 3,389 kip/stud

Dibuat perbaris = 3 stud = 3. 3,389 = 10,186 kip

$$N = \frac{675}{10,166} = 66,397 \backsim 68 \text{ buah}$$

$$\text{Spacing} = \frac{L/2}{N/2} = \frac{34.12/2}{68/2} = 12 \text{ in} = \underline{30 \text{ cm.}}$$

Hitung pengaruh gaya angin pada konstruksi



1. $X = \frac{20.1 + 30.1 + 60.1}{4} = 27,5$

2. Momen inersia

$I = [27,5^2 + 7,5^2 + 2,5^2 + 32,5^2]1^2 = 1875\ ft^4$

3. Cari besarnya momen yang diakibatkan oleh muatan H

M = 1,2. 6 = 7,2 kft.
M = 1,2. 18 + 2,4 . 6 = 36 kft
M = 1,2. 30 + 2,4 [18+6] = 93,6 kft.

4. Dicari besarnya direct shear [S]

$S = M.\frac{C}{I}$

$S_1' = 7,2.\frac{27,5}{1875} = 0,1056$ $\quad S_1'' = 36.\frac{27,5}{1875} = 0,528$

$S_2' = 0,1056.\frac{7,5}{275} = 0,0288$ $\quad S_2'' = 0,528.\frac{7,5}{27,5} = 0,144$

$S_3' = 0,1056.\frac{2,5}{27,5} = -0,0096$ $\quad S_3'' = 0,528.\frac{2,5}{27,5} = -0,048$

$S_4' = 0,1056.\frac{32,5}{27,5} = -0,1248$ $\quad S_4'' = 0,528.\frac{32,5}{27,5} = -0,024$

$S_1''' = 93,6.\frac{27,5}{1875} = 1,3728$

$S_2''' = 1,3728.\frac{7,5}{27,5} = 0,3744$

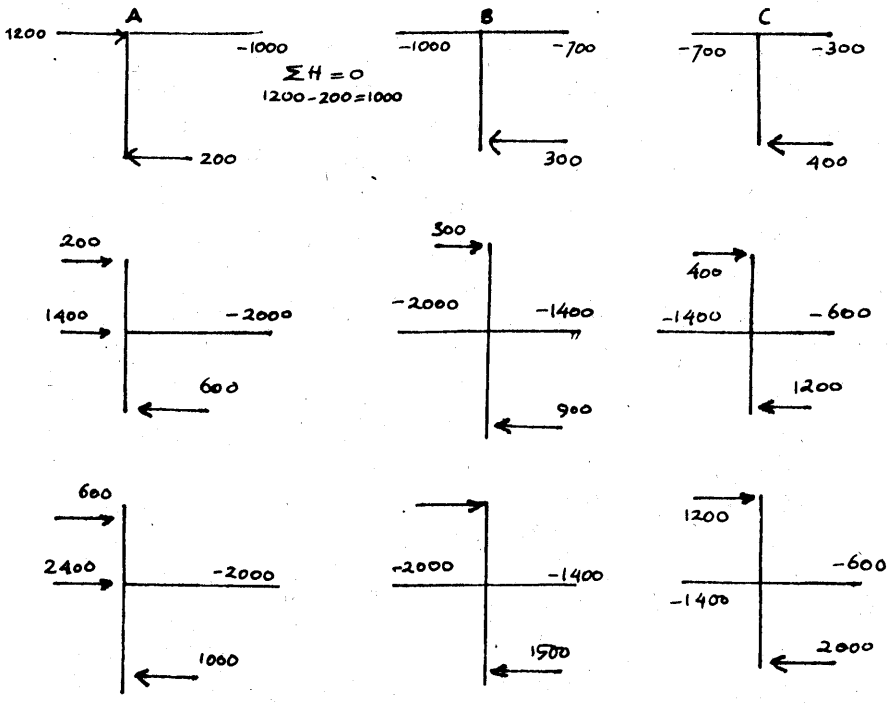
$S_3''' = 1,3728 . \frac{2,5}{27,5} = -0,1248$

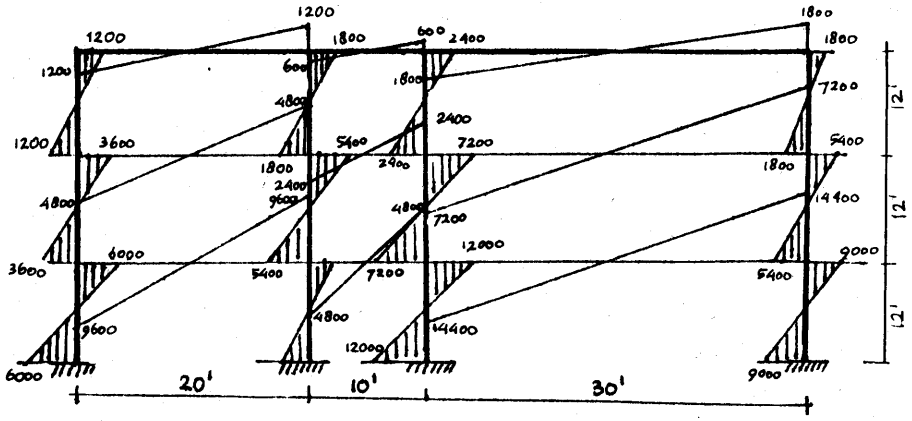
$S_4''' = 1,3728.\frac{2,5}{27,5} = -1,6224$

5. Gaya normal pada kolom

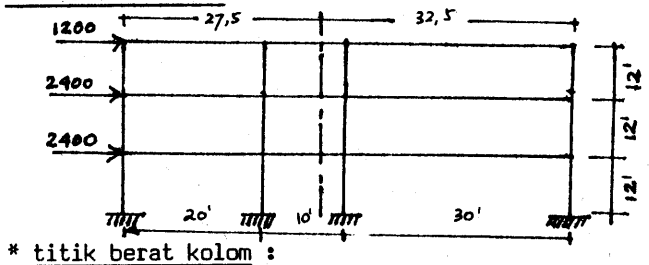
$S_1' = 120$	$S_1'' = 0$	$S_1''' = 0$	$S_1^{IV} = -120$
$S_2' = 120 + 480 = 600$	$S_2'' = 0$	$S_2''' = 0$	$S_2^{IV} = -600$
$S_3' = 600 + 960 = 1560$	$S_3'' = 0$	$S_3''' = 0$	$S_3^{IV} = -1560$

6. Gaya normal pada gelagar





Cantilever Method



* titik berat kolom :

$$\lambda = \frac{20.1 + 30.1 + 60.1}{4} = 27,5 \text{ ft.}$$

* Momen inersia

$I = [27,5^2 + 7,5^2 + 2,5^2 + 32,5^2].1^2 = 1875$ ft.

M = 1200.6 = 7200 ft lbs

M = 1200.18 + 2400.6 = 36.000 ft lbs

M = 1200.30 + 2400 [18+6] = 93600 ft lbs

* Direct stress pada kolom

105,6	+28,8		-9,6	-124,8
528	144		-48	-624
1873	374		-125	-1622

$$f = M.\frac{C}{I}$$

$$f_1 = \frac{7200.27,5}{1875} = 105,6 \; ; \; f_1 = \frac{36000.275}{1875} = 528 \; ; \; f_1 = \frac{93600.27,5}{1875} = 1373$$

$$f_2 = \frac{7,5}{27,5} \times 105,6 = 28,8 \; : \; f_2 = \frac{7,5}{27,5} \times 528 = 144 \; ; \; f_2 = \frac{7,5}{27,5} \times 1773 = 374.$$

$$f_3 = \frac{2,5}{27,5} \times 105,6 = -9,6 \; ; \; f_3 = \frac{2,5}{27,5} \times 528 = -48 \; ; \; f_3 = -125$$

$$f_4 = \frac{32,5}{27,5} \times 105,6 = -124,8 \; ; \; f_4 = \frac{32,5}{27,5} \times 528 = -624 \; ; \; f_4 = -1622$$

*Momen pada gelagar :

$M_1' = 105,6.10 = 1056$ $\quad M_1'' = [528-105,6].10 = 4224$

$M_2 = [105,6 + 28,8].5 = 672$ $\quad M_2'' = [528-105,6]+[144-28,8] = 2688$

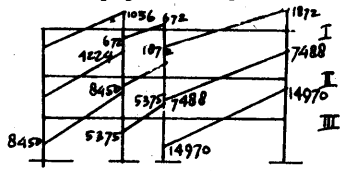
$M_3 = [105,6+28,8-9,6].15 = 1872$

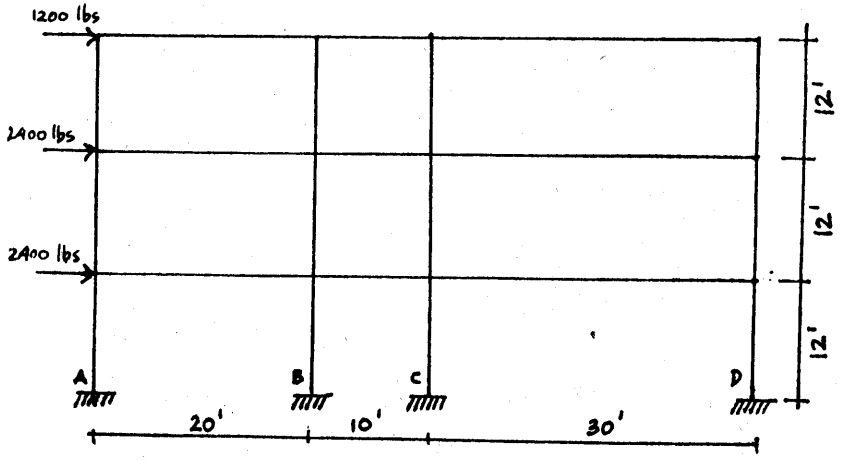
$M_3'' = [528-105,6]+[144-28,8]-[48+9,6]\ 15 = 7488$

$M_1''' = [1373-528].\ 10 = 8450$

$M_2''' = \{[1373-528]+[374-144]\}\ 5 = 5375$

$M_3''' = \{[1373-528]+[374-144]\ +48-125\}\ 15 = 14970.$





Jawab : 1. V [SF pada kolom] Metode portal

$V_1' = \frac{10}{60} \times 1200 = 200$ $V_1'' = \frac{10}{60} \times 3600 = 600$ $V_1''' = \frac{10}{60} \times 6000 = 1000$

$V_2' = \frac{15}{60} \times 1200 = 300$ $V_2'' = \frac{15}{60} \times 3600 = 900$ $V_2''' = \frac{15}{60} \times 600 = 1500$

$V_3' = \frac{20}{60} \times 1200 = 400$ $V_3'' = \frac{20}{60} \times 3600 = 1200$ $V_3''' = \frac{20}{60} \times 600 = 2000$

$V_4' = \frac{15}{60} \times 1200 = 300$ $V_4'' = \frac{15}{60} \times 3600 = 900$ $V_4''' = \frac{15}{60} \times 6000 = 1500$

2. Moment pada kolom

$N_1' = 200.6 = 1200$ $M_1'' = 3600$ $M_1''' = 6000$

$M_2' = 1800$ $M_2'' = 5400$ $M_2''' = 9000$

$M_3' = 2400$ $M_3'' = 7200$ $M_3''' = 12000$

$M_4' = 1800$ $M_4'' = 5400$ $M_4''' = 9000$

3. Moment pada gelagar

3 ---> $M_{a1} = 1200$ ---> $M_{a1} = 1200 + 3600 = 4800$

$M_{a2} = 1800 - 1200 = 600$ $M_{a2} = 1800 + 5400 - 4800 = 2400$

$M_{a3} = 2400 - 600 = 1800$ $M_{a3} = 4200 + 2400 - 2400 = 7200$

1 ---> $M_{a1} = 600 + 3600 = 9600$

$M_{a2} = 9000 + 5400 - 9600 = 4800$

$M_{a3} = 1200 + 7200 - 4800 = 1440$

4. V pada gelagar [$V = \frac{Mgel}{\frac{1}{2}L}$]

$V_1' = \frac{1200}{10} = 120$ $V_1'' = \frac{4800}{10} = 480$ $V_1''' = \frac{9600}{10} = 960$

$V_2' = \frac{600}{5} = 120$ $V_2'' = \frac{2400}{5} = 480$ $V_2''' = \frac{4800}{5} = 960$

$V_3' = \frac{1800}{15} = 120$ $V_3'' = \frac{7200}{15} = 480$ $V_3''' = \frac{14400}{15} = 960$

5. M pada gelagar

$M_1' = 0,1056.10 = 1,056$ kft $M_1'' = 4,224$ kft $M_1''' = 8,448$ kft

$M_2' = 0,672$ kft $M_2'' = 2,688$ kft $M_2''' = 5,376$ kft

$M_3' = 1,872$ kft $M_3'' = 7,488$ kft $M_3''' = 14,976$ kft

6. V pada gelagar

$V_1' = 0,1056$ k $V_1'' = 0,4224$ k $V_1''' = 0,8448$ k

$V_2' = 0,1344$ k $V_2'' = 0,5376$ k $V_2''' = 1,0752$ k

$V_3' = 0,1248$ k $V_3'' = 0,4992$ k $V_3''' = 0,9984$ k

7. M pada kolom

$M_1' = 1,056$ kft $M_1'' = 3,168$ kft $M_1''' = 5,28$ kft

$M_2' = 1,728$ kft $M_2'' = 5,184$ kft $M_2''' = 8,64$ kft

$M_3' = 2,544$ kft $M_3'' = 7,632$ kft $M_3''' = 12,72$ kft

$M_4' = 1872$ kft $M_4'' = 5,616$ kft $M_4''' = 9,36$ kft

8. V pada kolom

$V_1' = 0,176$ k $V_1'' = 0,528$ k $V_1''' = 0,88$ k

$V_2' = 0,288$ k $V_2'' = 0,864$ k $V_2''' = 1,44$ k

$V_3' = 0,424$ k $V_3'' = 1,272$ k $V_3''' = 2,119$ k

$V_4' = 0,312$ k $V_4'' = 0,936$ k $V_4''' = 1,559$ k

9. Gaya normal pada kolom

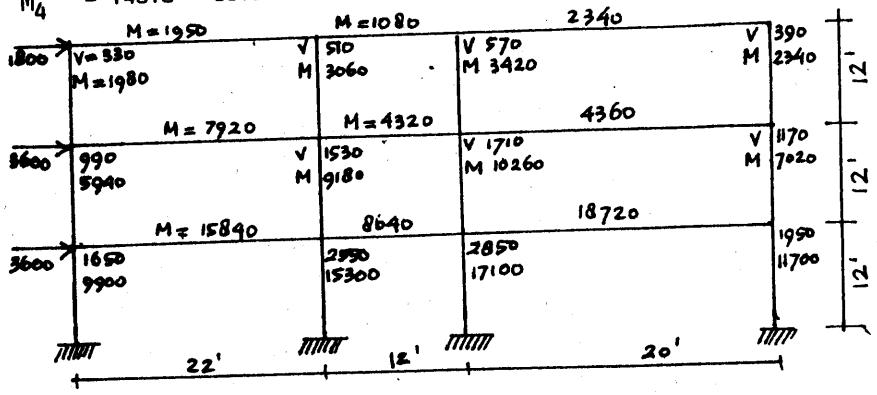
$V_1 = 0,176.$ K

* Momen pada kolom :

$M_1' = 1056$
$M_2 = 1056 + 672 = 1728$
$M_3 = 672 + 1872 = 2544$
$M_4 = -1872$

$M_1' = 4224 - 1056 = 3268$
$M_2' = 4224 + 2688 - 1728 = 5184$
$M_3' = 2688 + 9488 - 2544 = 7632$
$M_4' = 7488 - 1872 = 5616$

$M_1''' = 8450 - 3168 = 5182$
$M_2''' = 8450 + 5375 = 8641$
$M_3''' = 5375 + 14,970 - 7632 = 12713$
$M_4''' = 14970 - 5616 = 9354$



* V pada kolom

$V_1' = \frac{11}{60} \times 1800 = 330$ $V_1'' = \frac{11}{60} \times 5400 = 990$

$V_2' = \frac{17}{60} \times 1800 = 510$ $V_2'' = \frac{17}{60} \times 5400 = 1530$

$V_3' = \frac{19}{60} \times 1800 = 570$ $V_3'' = \frac{19}{60} \times 5400 = 1710$

$V_4' = \frac{13}{60} \times 1800 = 390$ $V_4'' = \frac{13}{60} \times 5400 = 1170$

$V_1''' = \frac{11}{60} \times 9000 = 1650$ $V_2''' = \frac{17}{60} \times 9000 = 2550$

$V_3''' = \frac{19}{60} \times 9000 = 2850$ $V_4''' = \frac{13}{60} \times 9000 = 1950$

* M pada kolom : [v x ½ L]

$M_1' = 1980$	$M_1'' = 5940$	$M_1''' = 9900$
$M_2' = 3060$	$M_2'' = 9280$	$M_2''' = 15300$
$M_3' = 3420$	$M_3'' = 10260$	$M_3''' = 17100$
$M_4' = 2340$	$M_4'' = 7029$	$M_4''' = 11700$

* M pada gelagar :

$M_1' = 1980$	$M_1'' = 7920$	$M_1''' = 15840$
$M_2' = 1080$	$M_2'' = 4320$	$M_2''' = 8640$
$M_3' = 2340$	$M_3'' = 9360$	$M_3''' = 18720$

* V pada gelagar :

$V_1 = \frac{M}{\frac{1}{2} L}$

$V_1' = \frac{1980}{11} = 180$ $V_1'' = \frac{7920}{11} = 720$ $V_1''' = \frac{15840}{11} = 1440$

$V_2' = \frac{1080}{6} = 180$ $V_2'' = \frac{4320}{6} = 720$ $V_2''' = \frac{8640}{6} = 1440$

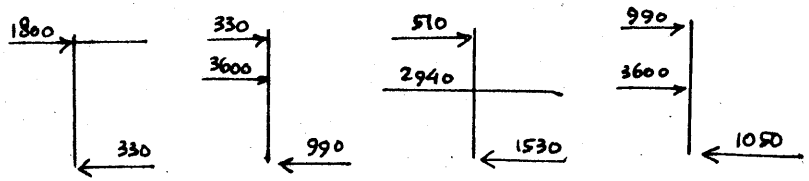
$V_3' = \frac{2340}{13} = 180$ $V_3'' = \frac{9360}{13} = 720$ $V_3''' = \frac{18720}{13} = 1440$

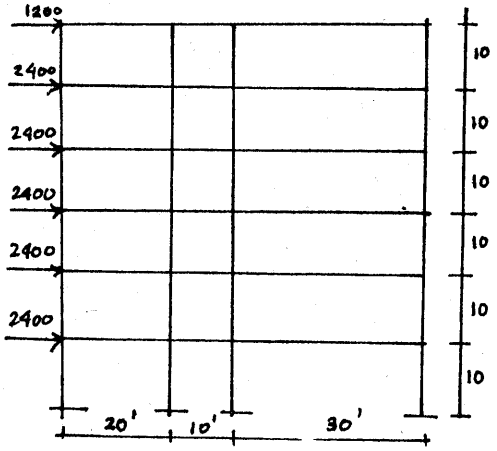
* Gaya normal pada kolom :

$S_1 = 180$	$S_1'' = 180 + 720 = 900$	$S_1''' = 900+1440 = 2340$
$S_2 = 0$	S_2	S_2
$S_3 = 0$	S_3	S_3
$S_4 = 180$	$S_4 = -900$	$S_4 = -2340$

Chek : $S = \frac{1800.\ 30 + 3600\ [18+6]}{60} = 2340$

* Gaya normal pada gelagar :





Metode portal :

1. V pada kolom

$V_1' = \frac{10}{60} \times 1200 = 200$

$V_2' = \frac{16}{60} \times 1200 = 320$

$V_3' = \frac{20}{60} \times 1200 = 400$

$V_4' = \frac{14}{60} \times 1200 = 780$

$V_1'' = \frac{10}{60} \times 3600 = 600$ $V_1''' = \frac{10}{60} \times 6000 = 1000$ $V_1^{iv} = \frac{10}{60} \times 8400 = 1400$

$V_2'' = \frac{16}{60} \times 3600 = 960$ $V_2''' = \frac{16}{60} \times 6000 = 1600$ $V_2^{iv} = 2239,99$

$V_3'' = \frac{20}{60} \times 3600 = 1200$ $V_3''' = \frac{20}{60} \times 6000 = 2000$ $V_3^{iv} = 2800$

$V_4'' = \frac{14}{60} \times 3600 = 840$ $V_4''' = \frac{14}{60} \times 6000 = 1400$ $V_4^{iv} = 1960$

$V_1^{v} = \frac{10}{60} \times 10800 = 1800$ $V_1^{vi} = \frac{10}{60} \times 13200 = 2200$

$V_2^{v} = 2880$ $V_2^{vi} = 3510$

$V_3^{v} = 3600$ $V_3^{vi} = 4400$

$V_4^{v} = 2520$ $V_4^{vi} = 3080$

2. M pada kolom

$M_1' = 1000$	$M_1'' = 3000$	$M_1''' = 5000$	$M_1^{iv} = 7000$
$M_2' = 1600$	$M_2'' = 4800$	$M_2''' = 8000$	$M_2^{iv} = 11199,95$
$M_3' = 2000$	$M_3'' = 6000$	$M_3''' = 10000$	$M_3^{iv} = 14000$
$M_4' = 1400$	$M_4'' = 4200$	$M_4''' = 4000$	$M_4^{iv} = 9800$

$M_1^{v} = 9000$	$M_1^{vi} = 11000$
$M_2^{v} = 14400$	$M_2^{vi} = 17600$
$M_3^{v} = 18000$	$M_3^{vi} = 22000$
$M_4^{v} = 12600$	$M_4^{vi} = 15400$

3. M pada gelagar

$M_1' = 1000$	$M_1'' = 4000$	$M_1''' = 8000$
$M_2' = 600$	$M_2'' = 2400$	$M_2''' = 4800$
$M_3' = 1400$	$M_3'' = 5000$	$M_3''' = 11200$

$M_1^{iv} = 12000$	$M_1^{v} = 16000$	$M_1^{vi} = 20000$
$M_2^{iv} = 7199,95$	$M_2^{v} = 9599,95$	$M_2^{vi} = 12000$
$M_3^{iv} = 16800$	$M_3^{v} = 22400$	$M_3^{vi} = 28000$

4. V pada gelagar

$V_1' = 100$	$V_1'' = 400$	$V_1''' = 800$
$V_2 = 100$	$V_2'' = 400$	$V_2''' = 800$
$V_3' = 100$	$V_3'' = 400$	$V_3''' = 800$

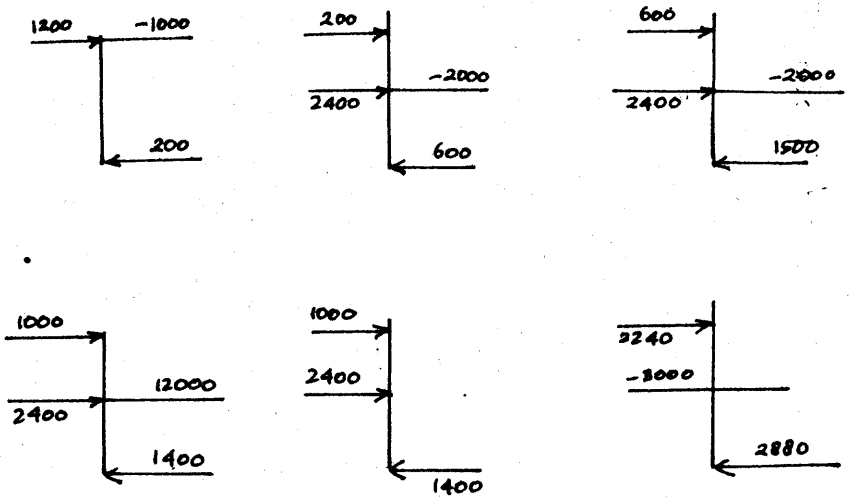
$V_1^{iv} = 1200$	$V_1^{v} = 1600$	$V_1^{vi} = 2000$
$V_2^{iv} = 1199,99$	$V_2^{v} = 1599,99$	$V_2^{vi} = 2000$
$V_3^{iv} = 1200$	$V_3^{v} = 1600$	$V_3^{vi} = 2000$

5. Gaya normal pada kolom :

$S_1' = 100$ $S_1'' = 500$ $S_1''' = 1300$

$S_2' = 0$	$S_2 = 0$	0
$S_3' = 0$	$S_3 = 0$	0
$S_4' = -100$	$S_4'' = 500$	$S_4''' = -1200$
$S_1^{iv} = 2500$	$S_1^{v} = 4000$	$S_1^{vi} = 6000$
0	0	0
0	0	0
$S_4^{iv} = -2400$	$S_4^{v} = 4000$	$S_4^{vi} = -6000$

6. Gaya normal pada gelagar



KONSTRUKSI BAJA IV

1. Suatu konstruksi kontur berukuran 24' x 24' beru pa konst.baja dengan composite system line load = 125 psf. Berat slab 50 psf. Takaran berat steel beam 50 psf.

E = 30.000 ksi
fc' = 3.000 psi syarat b $\leq \frac{1}{4}$ beam spanlength
Ft = 24 ksi b' $\leq \frac{1}{2}$ jarak balok satu - sama lain.

$n = \frac{E_s}{E_c} = 10$ b' $\leq$ 8 x tebal slab

fc' = 1,35 Stud yang dipakai Ø $\frac{3}{4}$ tinggi 2,5" dengan kekuatan 11,4 kip.

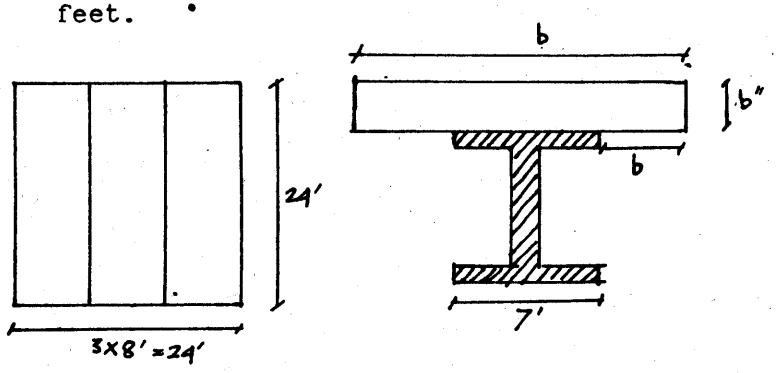
Ketentuan :

16 WF 36 : A = 10,59 m^2 d = 15,25 m
S_s = 56,3 m^3 e' = 12"
I^s = 446,3 m^3

Pertanyaan :

a. Selidikilah steel tension yang timbul pada iri san composite.

b. Hitung jumlah shear conector untuk bentang 24 feet.



Penyelesaian :

Kita pandang satu gelagar dapat pada gambar.

= Muatan hidup : $q = 125 \times 8 = 1000$ lbs/ft $= 1$ K/ft

$$M_{11} = \frac{1}{8} q l^2 = \frac{1}{8} . 1 . 24 . 24$$

$$= 72 \text{ kft.}$$

= Muatan mati :
Disini pelaksanaan diusahakan steel tidak mendu - kung momen/beban dahulu yaitu dengan jalan diberi penyangga-penyangga ---> langsung bekerja sebagai composite.

Berat slab : 50x8 lbs/ft = 400 lbs/ft = 0,4 k/ft

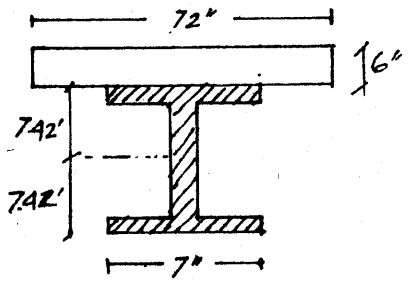
50x8 lbs/ft = 400 lbs/ft = 0,4 k/ft

= 0,8 k/ft

$$M_c = \frac{1}{8} . q . L^2 = \frac{1}{8} . 0,8 . 24 . 24 = 57,4 \text{ k/ft}$$

= Kita cari lebar effective dari composite tersebut.

b = $\frac{1}{4}$. 24' = 6 ft
b' = $\frac{1}{2}$. 8' = 4'
b' = 8 x $\frac{1}{2}$' = 4'
} diambil b = 6' = 72"



A = 10,59 in^2
S_s = 56,3 in^3
I = 446,3 in
d = 15,85

K = 1 : $A_c = \frac{b}{K} . \frac{t}{n} = \frac{72}{1} . \frac{6}{10} = 43,2$

$$K_c = \frac{A_c}{A_c + A_s} = \frac{43,2}{43,2 + 10,59} = \frac{43,2}{53,79}$$

$$= 0,803$$

$$\bar{Y}_c = (Y_{ts} + l_c) . K_c = (7,915 + 3) . 0,803$$

$$= 10,925 . 0,803 = 8,77$$

$$I_c = (Y_{ts} + l_c) \bar{Y}_c A_s + A_c . \frac{t^2}{12} + I_s$$

$$= (7,425+3)\ 8,77 . 10,19 + 43,2 . \frac{6}{12} . \frac{6}{} + 446,3$$

$$= 1016 + 127,5 + 446,3 = 1591,8$$

$$Y_{tc} = Y_{ts} - \bar{Y}_c = 7,925 - 8,77 = 0,845$$

$$S_{tc} = -\frac{1591,8}{0,845} = -1885$$

$$Y_{cc} = Y_{bs} + Y_c = 7,925 + 8,77 = 16,695$$

$$S_{bc} = \frac{1591,8}{16,695} = 95,5$$

$$Y_{cc} = Y_{ts} + l_c + \frac{1}{2} Y = -0,845 + 6$$

$$= 5,155$$

$$S_{cc} = \frac{1591,8}{5,155} = 308,78$$

K = 3 : $A_c = \frac{bt}{Kn} = \frac{72}{3} . \frac{6}{10} = 14,4$

$$K_c = \frac{A_c}{A_c + A_s} = \frac{14,4}{14,4 + 10,59} = \frac{14,4}{24,99}$$

$$= 0,587$$

$$\bar{Y}_c = (Y_{ts} + 1_c) \cdot K_c = (7{,}925 + 3)\ 0{,}587$$

$$= 10{,}925 \cdot 0{,}587 = 6{,}42$$

$$I_c = (Y_{ts} + 1_c)\ \bar{Y}_c\ A_s + A_c \frac{t^2}{12} + I_s$$

$$= 10{,}925.6{,}42.10{,}59 + 14{,}4 \cdot \frac{6 \cdot 6}{12} + 446{,}3$$

$$= 7{,}43 + 43{,}2 + 446{,}3 = 1272{,}5$$

$$Y_{tc} = Y_{ts} - \bar{Y}_c = 7{,}925 - 6{,}42 = 1{,}505$$

$$S_{tc} = \frac{1272{,}5}{1{,}505} = 845$$

$$Y_{bc} = Y_{ts} + \bar{Y}_c = 7{,}925 + 6{,}42 = 14{,}345$$

$$S_{cc} = \frac{1272{,}5}{14{,}345} = 88{,}8$$

$$Y_{cc} = Y_{ts} + 1_c + \tfrac{1}{2}\,t = 1{,}505 + 6 = 7{,}525$$

$$S_{cc} = \frac{1272{,}5}{7{,}505} = 169{,}5$$

	$f_c = \frac{M_c}{K.M\ S_{cc}}$	$f_t = \frac{M}{S_{tc}}$	$f_b = \frac{M}{S_{bc}}$	
DS	0	0	0	
DC	$\frac{57{,}4.12}{3.10.169{,}5} = 0{,}136$	$\frac{57{,}4.12}{845} = 0{,}815$	$\frac{57{,}4.12}{88{,}8} = 7{,}75$	
DL	$\frac{72 \cdot 12}{1.10.309} = 0{,}28$	$\frac{72 \cdot 12}{1885} = -0{,}459$	$\frac{72 \cdot 12}{95{,}5} = 9{,}05$	
	$= 0{,}416$	$= 0{,}356$ ksi (tekan)	$= 16{,}80$ ksi	
	1,35 ksi	24 ksi	24 ksi	

Jadi steel tension memenuhi persyaratan.

b. Jumlah shear conector.

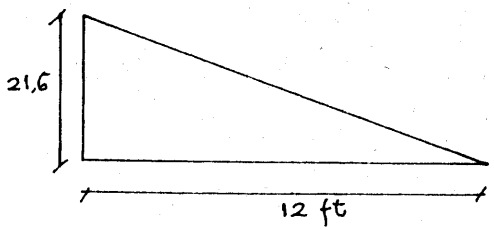
Dipergunakan untuk menghitung shear conector.

$V_{DC} + V_{LL}$ (Kalau V_s ada tak dipergunakan)

$V_{DC} = \frac{1}{2} \cdot 0,8 \cdot 24 = 9,6$ k

$V_{LL} = \frac{1}{2} \cdot 1 \cdot 24 = 12$ k

$V_{total} = 21,6$ k



k = 1

$M = A_c (Y_{tc} + 1_c)$

$= 43,2 (-0,845 + 3)$

$= 93,1$

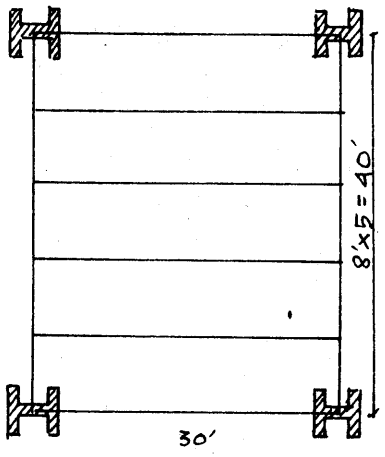
fc = 1591,8

$S = \frac{M \cdot V}{I_c} = \frac{93,1 \cdot 21,6}{1591,8}$ k/in = 1,165 k/in

$H = \frac{1}{2} \cdot 12 \cdot 12 \cdot 1,265$ k = 91 k

$n = \frac{M}{Q} = \frac{91 \text{ k}}{11,4} = 8$ buah

Untuk seluruh bentang = 16 buah



Lantai dengan konstruksi - composite tebal slab 4". Balok terdiri dari 16 WF 36 - tipe baja A_{36}.

Diperhitungkan beban hidup 125 psf, berat slab 50 psf berat steel beam 50 p/f.

$E_s = 30.000$ ksi $f_c = 1,35$ksi

fc' = 3.000 psi $f_t = 24$ ksi

$n = \frac{E_s}{E_c} = 10$

16 WF 36 → A = 10,59 in^2.

I = 446,3 in^4.

S_5 = 56,3 in^2.

d = 15,35 in .

Hitunglah : f_t (steel tension flange)
f_b (steel compression flange)
f_c (compression flange)
} dengan catatan lebar eff = 71"

Catatan : $M_D = 589$ k/in dan $M_L = 1350$ k/in

Berapa stud yang diperlukan bila dipakai stud ber Ø ½" tinggi 2½" dengan kekuatan 5,1 k/conector.

Penyelesaian :

a. Muatan mati : disini kita hitung sejak perancah - diambil --> beton langsung bekerja sebagai composite. Jadi pada penge coran slab besi diberi tiang- tiang penyangga sehingga tidak menahan mo men lentur dahulu.

q slab = 50 x 8 = 400 lbs/ft = 0,4 k/ft

q steel= 50 = 0,05 k/ft

q = 0,45 k/ft

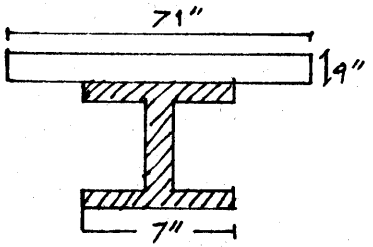
$M_{DC} = \frac{1}{8} \cdot q\, l^2 = \frac{1}{8} \cdot 0{,}45 \cdot 30^2$

$= \frac{4{,}5 \cdot 9 \cdot 10}{8} = 50{,}6$ k/ft = 607,5 k/in

Meskipun telah diketahui 589 → dipakai 607,5 k/in.

Muatan hidup : q = 125 x 8 lb/ft = 1 k/ft

$M = \frac{1}{8} \cdot 1 \cdot 50^2 \cdot \frac{900}{8}$ x 12 k/in = 1350 k/in



A = 10,59 in^2

I = 446,3 in^4

S_s = 56,3 in^3

d = 15,85 in

K = 1 $A_c = \frac{b}{k} \cdot \frac{t}{n} = \frac{71}{1} \cdot \frac{4}{10} = 28{,}4$

$K_c = \frac{A_c}{A_c + A_s} = \frac{28{,}4}{28{,}4 + 10{,}59} = \frac{28{,}4}{38{,}99} = 0{,}728$

$\bar{Y}_c = (Y_{ts} + 1_c)\, K_c = (7{,}925 + 2)\, 0{,}728$

$= 9{,}925 \cdot 0{,}728 = 7{,}22$

$I_c = (Y_{ts} + 1_c)\, \bar{Y}_c\, A_s + A_c \cdot \frac{t^2}{12} + I_s$

$= 9{,}925 \cdot 7{,}22 \cdot 10{,}59 + 28{,}4 \cdot \frac{4 \cdot 4}{12} + 446{,}3$

$= 760 + 37{,}9 + 446{,}3 = 1244{,}2$

$Y_{tc} = Y_{ts} - \bar{Y}_c = 7{,}925 - 7{,}22 = 0{,}705$

$S_{tc} = \frac{1244{,}2}{0{,}705} = 1765$

$Y_{bc} = Y_{ts} + \bar{Y}_c = 7{,}925 + 7{,}22 = 15{,}145$

$Y_{bc} = \frac{1244{,}2}{15{,}145} = 82{,}2$

$Y_{cc} = Y_{tc} + t = 0{,}705 + 4 = 4{,}705$

$Y_{cc} = \frac{1244{,}2}{4{,}705} = 265$

K = 3 $A_c = \frac{b}{K} \cdot \frac{t}{n} = \frac{71}{3} \cdot \frac{4}{10} = 9{,}46$

$K_c = \frac{A_c}{A_c + A_s} = \frac{9{,}46}{9{,}46 + 10{,}59} = \frac{9{,}46}{20{,}05} = 0{,}472$

$\bar{Y}_c = (Y_{ts} + 1_c)\, K_c = (7{,}925 + 2)\, 0{,}472$

$= 9{,}925 \cdot 0{,}472 = 4{,}68$

$I_c = (Y_{ts} + 1_c)\, \bar{Y}_c\, A_s + A_c \cdot \frac{t^2}{12} + I_s$

$= 9{,}925 \cdot 4{,}68 \cdot 10{,}59 - 9{,}46 \cdot \frac{4 \cdot 4}{12} + 446{,}3$

$= 492 + 12{,}6 + 446{,}3 = 950{,}9$

$Y_{tc} = Y_{ts} - \bar{Y}_c = 7{,}925 - 4{,}68 = 3{,}245$

$Y_{tc} = \frac{950{,}9}{3{,}245} = 293$

$Y_{bc} = Y_{ts} + \bar{Y}_c = 7{,}925 + 4{,}68 = 12{,}605$

$Y_{bc} = \frac{950{,}9}{12{,}605} = 75{,}5$

$Y_{cc} = Y_{tc} + t = 3{,}245 + 4 = 7{,}245$

$Y_{cc} = \frac{950{,}9}{7{,}245} = 131{,}5$

	$f_c = \frac{M}{kn\,S_c}$	$f_t = \frac{M}{S_t}$	$f_b = \frac{M}{S_t}$	Kalau M = 589
DS	0	0	0	
D_C	$\frac{607,5}{3.10.131,5}$ = 0,154	$\frac{607,5}{243}$ = 2,7	$\frac{607,5}{75,5}$ = 8,05	$\frac{589}{75,5}$ = 7,8
D_L	$\frac{1350}{1.10.265}$ =	$\frac{1350}{1765}$ =	$\frac{1350}{82,2}$ =	16,4 = $\frac{16,4}{24,2}$
	0,763 ksi 1,35 ksi	3,466ksi 24 ksi	24,45ksi 24 ksi	

Jadi karena hanya lebih sedikit maka profil cukup - kuat.

b. Jumlah Conector.

$V_{DC} = \frac{1}{2} . 0,45 . 30 = \frac{1}{2} . 13,5 = 6,75$

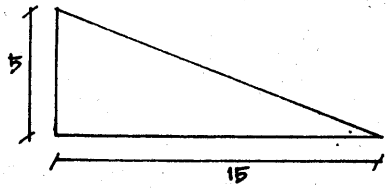
$V_{LL} = \frac{1}{2} . 1 . 30 = \frac{1}{2} . 30 = 15$

$V_{total} = 21,75$

$K = 1$ ..... $m = A_c (Y_{tc} + 1_c)$

$= 28,4 (0,705 + 2)$

$= 28,4.2,705 = 76,6$



$S = \frac{m\,V}{I} = \frac{76,6 . 21,75}{1244,2}$

$= 1,34$ k/in.

$H = \frac{1}{2} . S . 15 = \frac{1}{2} . 1,34 . 15 . 12 = 120,5$ k

$n = \frac{120}{5,1} = 23,5$

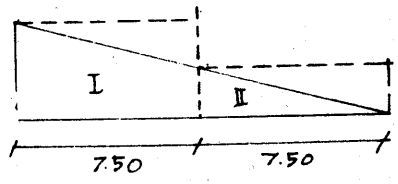
Satu bentang : n = 48 buah.

Kalau disuruh mencari jaraknya :

a. $P = \frac{NQ}{S} = \frac{2 . 5,1}{1,31}$ in = 7,75 in < 50 cm O.K.

$n = 2 . \frac{30 . 12}{7,75} = 2 . 46 = 92$ buah (kalau jarak dibuat sama).

b. Kalau jarak ada 2 macam.



N = 2

$P_1 = 7,75$ -- $n_1 = 2 . \frac{15}{7,75} = 60$

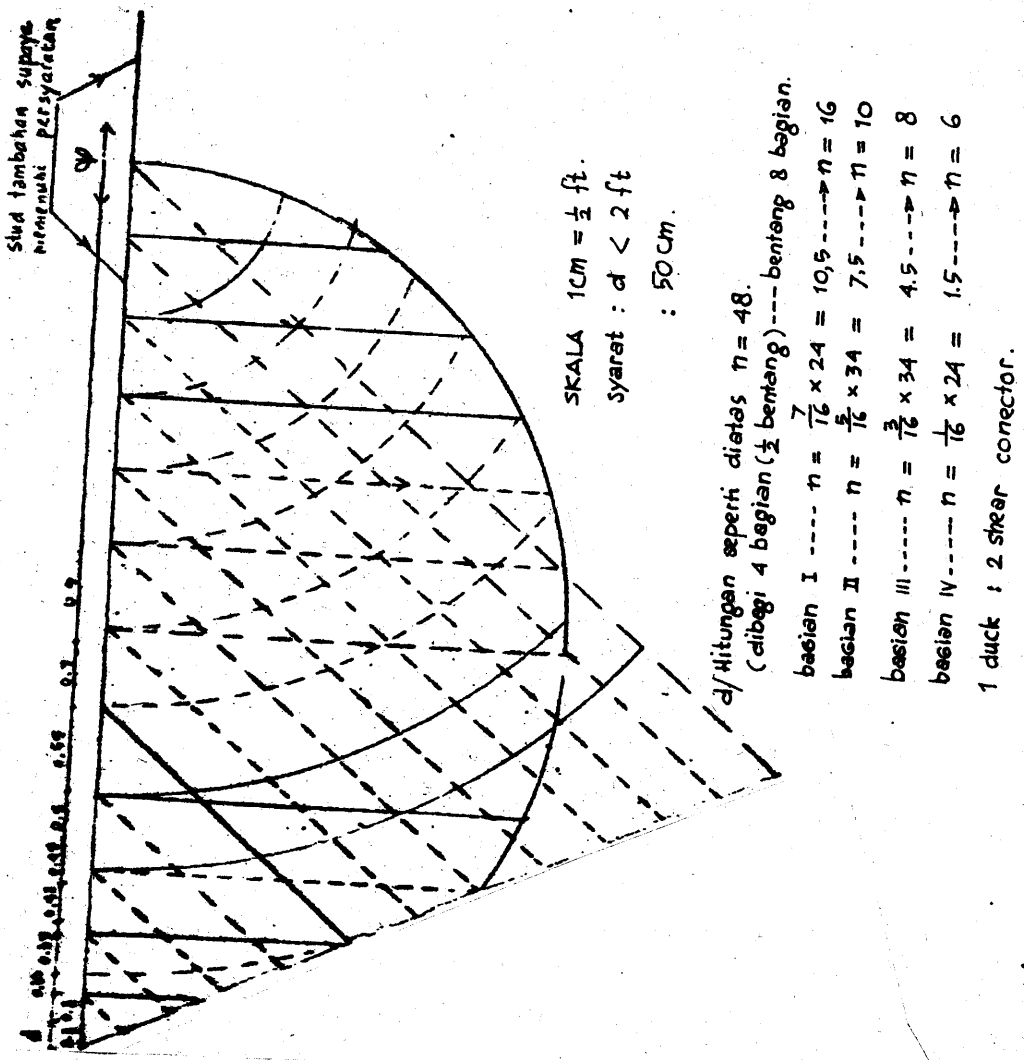
$P_2 = \frac{2.5,1}{0,67} = 15,5$ in <

50cm --> $n_2 = 2 . \frac{15}{15,5} = 20$

n = 60

c. Hitungan seperti diatas ---> n = 48

Pada pemasangan dari shear conector yaitu satu - baris ada 2 shear conector.



Jarak pada bagian I $= \frac{15}{4 \cdot \frac{12}{2}} = \frac{15}{24} = 0{,}625'$

II $= \frac{15}{4 \cdot 5} = \frac{15}{20} = 0{,}75'$

III $= \frac{15}{4 \cdot 4} = \frac{15}{16} = 0{,}74'$

IV $= \frac{15}{4 \cdot 3} = \frac{15}{12} = 1{,}25'$

3. Suatu jembatan composite bentang 15 m lebar 7 m - (2 x 1) m direncanakan dengan 4 gelagar. Bila untuk ini dipakai plate beton = 20 cm , tebal aspal 5 cm. Gelagar DIN 80.
   p = muatan terbagi merata = 2,2 t/m'
   p = muatan garis = 12 ton
   1 jalur lalu lintas = 2,75 in

   Ketentuan-ketentuan lain :

   Bj beton bertulang = 2,4 T/m^3
   Bj aspal = 2,2 T/m^3
   σ_{28} hasil beton = 200 kg/cm^2
   σ_{beton} = 60 kg/cm^2
   σ_{beton} = 10 kg/cm^2
   σ_{baja} = 1300 kg/cm^2

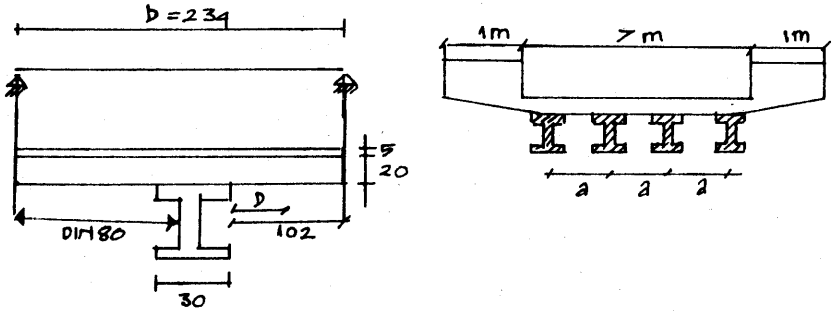
   $n = \frac{E_s}{E_c} = 10$

   $IF = 1 + \frac{20}{L + 50}$

Ditanyakan :

1. Tinjaulah apakah balok tersebut memenuhi per - syaratan tegangan ?
2. Seandainya tak memenuhi syarat, maka balok DIN dengan tinggi berapakah yang memenuhi ?

Penyelesaian :



Kita cari lebar effectif dari composite kita pakai - **"tabel 5"** karena momen-momen lantai mempunyai tanda tidak sama.

$$\frac{b}{L} = \frac{2,34\ (-30)}{2\ .\ 15} = \frac{2,04}{30} = 0,068$$

$$\frac{\lambda}{b} = 1 - \frac{0,068 - 0,05}{0,10 - 0,05}\ .\ 0,2 = 1 - \frac{0,018}{0,05}\ .\ 0,2$$

$$= 1 - \frac{1,8\ .\ 0,2}{5} = 1 - 0,072 = 0,928$$

$$\lambda = 0,928\ .\ 1,02 = 0,446 \text{ cm}$$

Lebar effectif = 0,446 + 0,946 + 0,30

= 1,892 + 0,30 = 1,90 + 0,30 - 2,20 m

Kalau dicari dengan tabel 4 :

Lebar effectif : $\frac{b}{L} = \frac{1,02}{15} = 0,068$

$$\frac{\lambda}{b} = 1 - \frac{0,068 - 0,05}{0,10 - 0,05}\ .\ 0,11$$

= 1 - 0,54 = 0,96

= 0,96 . 1,02 = 97 cm

Lebar effectif = x + 30 = 194 + 30 = 224 cm.

Muatan mati :

= Muatan steel :

beton q = 2,34 . 0,20 . 2,4 = 1,122 ton/m'

profil q = 0,268 ton/m'

= 1,390 ton/m'

$$M_{DS} = \frac{1}{8}\ .\ q\ l^2 = \frac{1}{8}\ .\ 1,39\ .\ 15^2 = 39,1 \text{ tm}$$

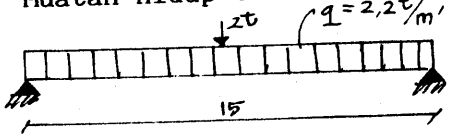
= Muatan composite :

dari lapis aspal : q = 2,34 . 0,05 . 2,2

= 0,2575 t/m'

$$M_{DC} = \frac{1}{8}\ q\ l^2 = \frac{1}{8}\ .\ 0,2575\ .\ 15^2 = 7,25 \text{ tm.}$$

Muatan hidup :



$$M_h = \frac{1}{8}\ q\ l^2 + \frac{1}{4}\ PL$$

$$= \frac{1}{8}\ .\ 2,2.15^2 + \frac{1}{4}\ .12$$

= 62 + 45 = 107 tm

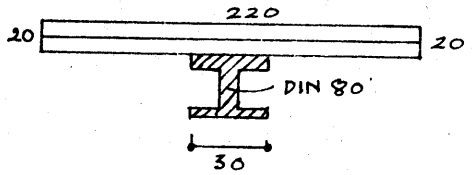
$$IF = 1 + \frac{20}{L + 50} = 1 + \frac{20}{65} = 1,308$$

$$2,34 \text{ m} = \frac{2,34}{2,54} \text{ in} = 92 \text{ in} = 7,68 \text{ ft}$$

$$\lambda = \frac{\text{beam spacing}}{5,5} = \frac{7,08}{5,5} = 1,395 \qquad M_{LL} = M_{max}.IF.M_L$$

$$M_{LL} = \frac{2,34}{2,75}\ .\ 107\ .\ 1,308\ .\ 1,395 = 166 \text{ tm}$$

Tinjauan tegangan yang timbul.



$A = 342\ cm^2$ $I_x = 3664$

$d = 80\ cm$ $S_x = 9160$

$K = 1 \rightarrow A_c = \frac{b\ t}{k\ n} = \frac{220 \cdot 20}{1 \cdot 10} = 440$

$K_c = \frac{A_c}{A_c + A_s} = \frac{440}{440 + 342} = \frac{440}{782,0} = 0,562$

$\overline{Y}_c = (Y_{ts} + 1_c)\ K_c = (40+10)0,562$

$= 50 \cdot 0,562 = 28,1$

$I_c = (Y_{ts} + 1_c)\ \overline{Y}_c\ A_s + A_c \cdot \frac{t^2}{12} + I_s$

$= 50.28,1.342 + 440 \cdot \frac{20.20}{12} - 366400$

$= 480000 + 14700 + 366400 = 861100$

$Y_{tc} = Y_{ts} - \overline{Y}_c = 40 - 28,1 = 11,9$

$S_{tc} = \frac{861100}{11,9} = 72400$

$Y_{bc} = Y_{bs} + \overline{Y}_c = 40 + 28,1 = 68,1$

$\rightarrow S_{bc} = \frac{861100}{68,1} = 12650$

$Y_{cc} = Y_{tc} + t = 11,9 + 20 = 31,9$

$\rightarrow S_{cc} = \frac{861100}{31,9} = 27000$

$K = 3 \rightarrow A_c = \frac{b \cdot t}{k \cdot n} = \frac{220 \cdot 20}{3 \cdot 10} = 146,5$

$K_c = \frac{A_c}{A_c + A_s} = \frac{146,5}{146,5 + 342} = \frac{146,5}{488,5} = 0,3$

$\overline{Y}_c = (Y_{ts} + 1_c)\ K_c = (40 + 10)\ 0,3$

$= 0,3 \cdot 50 = 15$

$I_c = 50 \cdot 15 \cdot 342 + 146,5 \cdot \frac{20 \cdot 20}{12} + 366400$

$= 5 \cdot 1,5 \cdot 3,42 \cdot 10^4 + \frac{14,65}{3} \cdot 10^3 + 366400$

$= 627280$

$Y_{tc} = Y_{ts} - \overline{Y}_c = 40 - 15 = 25$

$\rightarrow S_{tc} = \frac{627280}{25} = 25100$

$Y_{bc} = Y_{bs} + \overline{Y}_c = 40 + 15 = 55 \rightarrow S_{bc} = \frac{627280}{55}$

$= 11400$

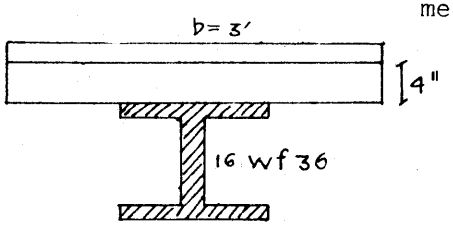
$Y_{cc} = 25 + 20 = 45 \rightarrow S_{cc} = \frac{627280}{45}$

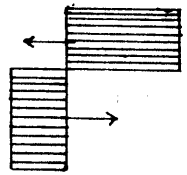
$= 13950$

$f_c = \frac{M}{k.n.S_{cc}}$	$f_t = \frac{M}{S_t}$	$f_b = \frac{M}{S_b}$
63,23 kg/cm^2	684,9 kg/cm^2 < 1300 kg/cm^2	1805,5 kg/cm^2 > 1300
DS 0 DC $\frac{7,25 . 10^{+5}}{3.10.1,3050.10^4} =$ 1,73 DL $\frac{166 . 10^{+5}}{1.10.2.7.10^4} =$ 61,4	$\frac{39,1.10^{-3}}{9,160.10^3} = 427$ $\frac{7,25.10^{+5}}{2,5100.10^4} =$ 28,9 $\frac{166 . 10^{+5}}{7,2400 .10^4} =$ 229	427 $\frac{7,25 . 10^{-5}}{1,1400.10^4} =$ 63,5 $\frac{166 . 10^{+5}}{1,2650 .10^4} =$ 1315

Berarti DIN 80 tidak memenuhi,

b. Dicoba dengan DIN 100 --- ternyata setelah dichek memenuhi.





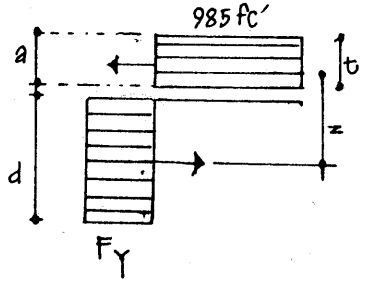
Ketentuan :

tentang = 32'
Fy = 33 ksi
fc' = 3000 psi
d = 15,85 in
A = 10,59 in^2
I = 446,3 in^4
S_6 = 56,3 in^3

Ditanyakan :

a. Multimate
b. Jumlah shear conector kalau dipakai shear co - nector bentuk paku Ø $\frac{4}{8}$ "
f_c' = 65 ksi. 1 baris ditanah 2 paku saja.

Penyelesaian :



FY.A = 33 . 10,59 k
= 350 k

a.0,85 f_c' . b = 350 k.

$a = \frac{350}{0,85.3.36} = 3,82$ "

$Z = \frac{1}{2} d + t - \frac{1}{2} a$
= 7,925 + 4 - 1,91
= 10,015

M_{ult} = 350.10,015 k/in = 3510 k/in = $\frac{3510}{12}$

= 292 k/ft.

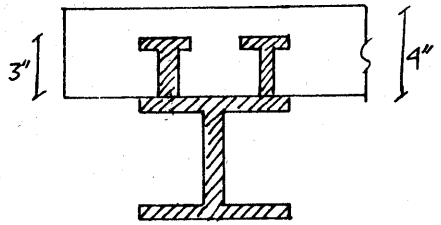
b. Jumlah shear conectors.

= menurut geser : f'_s = 65 ksi

$Q = \frac{1}{4} . \pi . d^2 . fs = \frac{1}{4} \pi . (\frac{7}{8})^2 . 65$

$= \frac{\pi . 4,9 . 65}{4 . 6,4} = 39$ K

= menurut rumus : $\frac{h}{d} = \frac{3}{7/8} = 3,5 < 4,2$



Q = 80.hs.ds $\sqrt{fi}$

= 80 . 3 . $\frac{7}{8}$ $\sqrt{3000}$

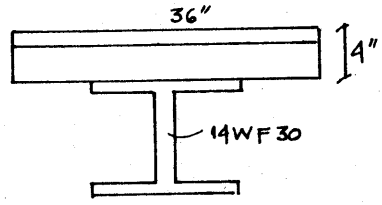
= 11550 lbs

= 11,5 k

--- dipakai -> Q=11,5 k

$\frac{1}{2}$ bentang : n = $\frac{350}{11,5}$ = 30,5 ---> n = 30

satu bentang : n = 30 x 2 = 60 buah.



Suatu jembatan composite, bentang = 15 in ≈ 49,2" dengan irisan seperti gam bar.

d = 13,86 in_2

A_s = 8,81 in_4

I^s = 289,6 in_3

S = 41,8 in^3

f_c' = 3 . 10^3 psi

f_t = 20 . 10^3 psi

n = 10

Dead load = 0,18 k/ft

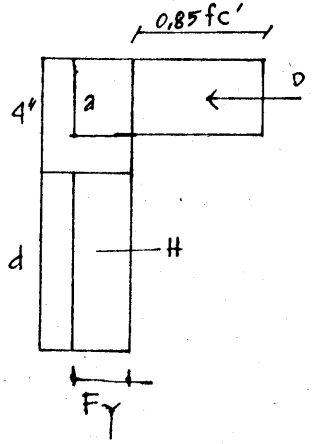
Ø stud = $\frac{3}{4}$ " , tinggi terserah saudara.

Ditanyakan :

1. Jumlah stud yang diperlukan.
2. Berapa M_D , M_L dan M ultimate serta safety faktor dipakai dalam perhitungan.

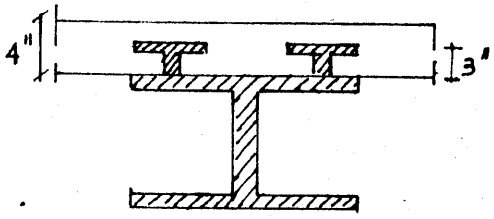
Penyelesaian :

a. Jumlah shear conector.



F_t = 20.10^3 psi

--> F_y = 33.10^3 psi



H = F_y . A = 33.8,81

= 291 k

Tinggi stud diambil 3"

(4" = t)

$\frac{h}{d} = \frac{3}{3/4} = 4 < 4,2$

Q = 80 . hs . ds . $\sqrt{f_c'}$

= 80 . 3 . $\frac{3}{4}$ $\sqrt{3000}$ = 9900 prinds = 9,9 k/conn

$\frac{1}{2}$ bentang : n = $\frac{H}{9,9} = \frac{291}{9,9}$ = 29,4 ≈ 30

Satu bentang : n = 2 x 30 = 60 buah.

b. $= M_D = \frac{1}{8} \cdot q \cdot l' = \frac{1}{8} \cdot 0,18 \cdot 49,2^2$

$= \frac{18}{8} \cdot 4,92^2 = 54,4$ k/A

$= M_{ultimate}$

Gambar lihat atas :

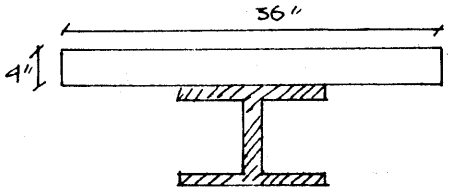
D = H ---> a . 0,85 f_c' 36 = 291 k

$$a = 291 \cdot \frac{1}{0,85 \cdot 3 \cdot 36} = \frac{291}{2,55 \cdot 36}$$

$= 3,18"$

$Z = \frac{1}{2} d + 4" - \frac{1}{2} a$

$= 6,93 + 4 - 1,59 = 10,93 - 1,59 = 9,34"$



$A_s = 8,11$

$d = 13,86$

$I = 289,6$

$S = 41,8\ m^3$

Pelaksanaan komposite.

Besi diberi penyangga sehingga tidak akan mena - han momen lentur ----> $M_{DS} = 0$

----> Beban mati didukung oleh composite.

$K = 3$ ----> $A_c = \frac{bt}{kn} = \frac{36}{3} \cdot \frac{4}{10} = 4,8$

$$\overline{Y}_c = (Y_{bs} + l_c)\ K_c = (6,43 + 2)0,353$$

$= 3,15$

$$I_C = (Y_{ts} + l_c)\ \overline{Y}_c\ A_s + A_c \cdot \frac{t^2}{12} + I_s$$

$= 8,93.3,15.8,81 + 4,8 \cdot \frac{4}{12} \cdot \frac{4}{1} +$ 289,6

$= 544$

$Y_{tc} = Y_{ts} - \overline{Y}_c = 6,93 - 3,15 = 3,78$ --> $S_{tc} = \frac{544}{3,78} = 144$

$Y_{bc} = Y_{ts} + \overline{Y}_c = 6,93 + 3,15 = 10,08$ --> $S_{bc} = \frac{544}{10,08} = 54$

$Y_{cc} = 3,78 + 4 = 7,78$ --> $S_{cc} = \frac{544}{7,78} = 69,8$

	Tegangan yang diijinkan	Beban mati	
$f_c = \frac{M}{kn\ S_{cc}}$	1,35 ksi	$\frac{54,4 \cdot 12}{3 \cdot 10 \cdot 69,8}$	1,038 ksi
$f_t = \frac{M}{S_t}$	20 ksi	$\frac{54,4 \cdot 12}{144}$	15,47 ksi
$f_b = \frac{M}{S_b}$	20 ksi	$\frac{54,4 \cdot 12}{54}$	7,9 ksi

Untuk beban hidup :

$K = 1 \rightarrow A_c = \frac{bt}{kn} = \frac{36,4}{1.10} = 14,4$

$K_c = \frac{A_c}{A_c + A_s} = \frac{14,4}{14,4 + 8,81} = 0,621$

$\bar{Y}_c = (Y_{ts} - l_c)\, K_c = (6,93 + 2)\, 0,621$

$= 0,93 \cdot 0,621 = 5,55$

$I_c = (Y_{ts} - l_c)\, \bar{Y}_c \cdot A_s + A_c \cdot \frac{t^2}{12} - I$

$= 8,43.5,15.8,81 + 14,4 \cdot \frac{4.4}{12} - 289,6$

$= 438 - 289,6 + 19,2 - 746,8$

$Y_{tc} = Y_{ts} - Y_c = 6,43 - 5,55 = 1,38$

$\dashrightarrow S_{tc} = \frac{746,8}{1,38} = 540$

$Y_{bc} = Y_{ts} + \bar{Y}_c = 6,43 + 5,55 = 12,48$

$\dashrightarrow S_{bc} = \frac{746,8}{12,48} = 59,8$

$Y_{cc} = 1,38 + 4 = 5,38. \rightarrow S_{cc} = \frac{746,8}{5,38} = 138,5$

$f_{tc} = \frac{ML}{S_{tc}} \rightarrow ML = f_{tc} \cdot S_{tc} = 540 \cdot 15,47$

$\rightarrow$ besar

$f_{bc} = \frac{ML}{S_{bc}} \rightarrow ML = f_{bc} \cdot S_{bc} = 59,8 \cdot 7,9$ k/in

$\rightarrow$ menentukan

$= 473$ k/in $= \frac{473}{12} = 39,4$ k/in

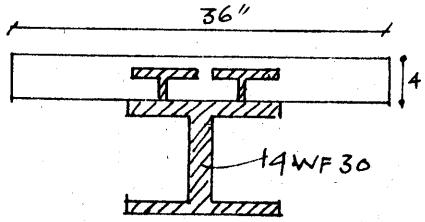
$f_{cc} = \frac{ML}{kn\, S_{cc}} \rightarrow ML = S_{cc}.n.f_{cc} = 138,5.1,038.10$ k/in

$\rightarrow$ besar

Jadi ML = 39,4 in

Jadi safety factor $= \frac{M_{ult}}{M_L + M_D} = \frac{226,5}{39,4 + 54,4} = \frac{226,5}{93,8}$

$= 2,41$



Irisan tersebut direncanakan untuk suatu bentang 32 ft. Gaya dukung tiap stud sebesar :

$q = 165\, ds^2$ ft

Profil : 14 WF 30

d = 13,86 in

A = 8,81 in^2

I = 289,6 in^4

S = 41,8 in^2

W_D = 180 lb/ft

f'_c = 3 ksi

F_t = 20 ksi

f_c = 1,35 ksi (bila perlu).

Hitunglah :

a. Muatan hidup terbagi rata (uniform line load)untuk konstruksi tersebut ?

b. Berapa jarak korector yang diperlukan ?

Penyelesaian :

$q = 0,8 \rightarrow M_D = \frac{1}{8} q\, l^2 = \frac{1}{8} \cdot 0,8 \cdot 32^2$

$= 23$ kft $= 276$ km

Akibat beban mati :

$K = 3 \rightarrow A_c = \frac{b\, t}{K\, n} = \frac{36}{3} \cdot \frac{4}{10} = 4,8$

$$K_c = \frac{A_c}{A_c + A_s} = \frac{4,8}{4,8 + 8,81} = 0,353$$

$$\bar{Y}_c = (Y_{ts} + 1_c)\, K_c = (6,43 + 2)\, 0,353$$
$$= 8,43 \cdot 0,353 = 3,15$$

$$I_c = (Y_{ts} + 1_c)\, \bar{Y}_c\, A_s + A_c \cdot \frac{t^2}{12} + I_s$$

$$= 8,43.3,15.8,81 + 4,8 \cdot \frac{4 \cdot 4}{12} + 289,6$$

$$= 248 + 6,45 + 289,6 = 544,0$$

$$Y_{tc} = Y_{ts} - \bar{Y}_c = 6,93 - 3,15 = 3,78$$

$$\longrightarrow S_{tc} = \frac{544}{3,78} = 148$$

$$Y_{bc} = Y_{bs} + \bar{Y}_c = 6,93 + 3,15 = 10,03$$

$$\longrightarrow S_{bc} = \frac{544}{10,08} = 54$$

$$Y_{cc} = Y_{tc} + t = 3,78 + 4 = 7,78 \longrightarrow S_{cc} = \frac{544}{7,78}$$
$$= 65,8$$

Untuk muatan hidup :

$$K = 1 \longrightarrow A_c = \frac{b\,t}{K\,n} = \frac{36 \cdot 4}{1 \cdot 10} = 14,4$$

$$K_c = \frac{A_c}{A_c + A_s} = \frac{14,4}{14,4 + 8,81} = \frac{14,4}{23,21} = 0,62$$

$$\bar{Y}_c = (Y_{bs} + 1_c)\, K_c = 8,9 \cdot 3 \cdot 0,62 = 5,54$$

$$I_c = (8,93)\, 5,54 \cdot 8,81 + 14,4 \cdot \frac{4^2}{12} + 289,6$$
$$= 436 + 19,2 + 289,6 - 744,8$$

$$Y_{tc} = 6,93 - 5,54 = 1,39 \longrightarrow S_{tc} = \frac{744,8}{1,39} = 535$$

$$Y_{bc} = 6,93 + 5,54 = 12,47 \longrightarrow S_{bc} = \frac{744,8}{12,47} = 60$$

$$Y_{cc} = 1,39 \cdot 4 = 5,39 \longrightarrow S_{cc} = \frac{744,8}{5,39} = 139$$

	yang diizinkan	beban mati	Δ
$f_c = \frac{M}{k\,n\,S_{cc}}$	1,35 ksi	$\frac{276}{3 \cdot 10 \cdot 69,8} = 0,132$	1,218 ksi
$f_t = \frac{M_c}{S_t}$	20 ksi	$\frac{276}{148} = 1,87$	18,13 ksi
$f_b = \frac{M}{S_b}$	20 ksi	$\frac{276}{54} = 5,1$	14,9 ksi

$f_{tc} = \frac{ML}{S_{tc}} \rightarrow ML = f_{tc} \cdot S_{tc} = 18,13.535 = 9750$ km

$f_{bc} = \frac{ML}{S_b} \rightarrow ML = 14,9 \cdot 60 = 895$ k/in

$f_{cc} = \frac{ML}{k\ n\ S_{cc}} \rightarrow M_c = 1,218.139.10,1 = 1700$ k/in.

$\rightarrow ML = 895$ k/in $= \frac{895}{12} = 74,5$ k/ft

$\frac{1}{8} q\ l^2 = 74,5 \rightarrow q = \frac{74,5}{32} \cdot \frac{8}{32} = \frac{74,5}{128}$

$= 0,583$ k/ft

b. Jarak conector.

$q = 0,18 + 0,583 = 0,763 \rightarrow V = \frac{1}{2} ql = \frac{1}{2}.0,763.32$

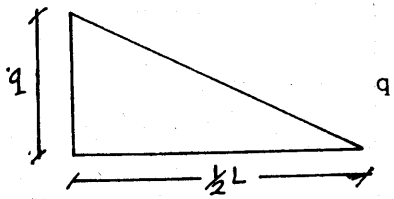
$= 12,2$ K

$m = A_c\ (Y_{tc} + l_c) = 14,4\ (1,39 + 2) = 14,4 \cdot 3,39$

$= 48,8$

$K = 1 \quad I_c = 744,8$

$S = \frac{m\ v}{I} = \frac{48,8}{744,8} \cdot \frac{12,2}{} = 0,8$ k/in



$H = \frac{1}{2} L \cdot \frac{1}{2} S = \frac{1}{2}.32.12.\frac{1}{2}.0,8$

$= 76,8$ k

$q = 165 \cdot ds^2 \quad 3000$

$= 165 \cdot \frac{9}{16} \quad 3000 = 5100$lbs

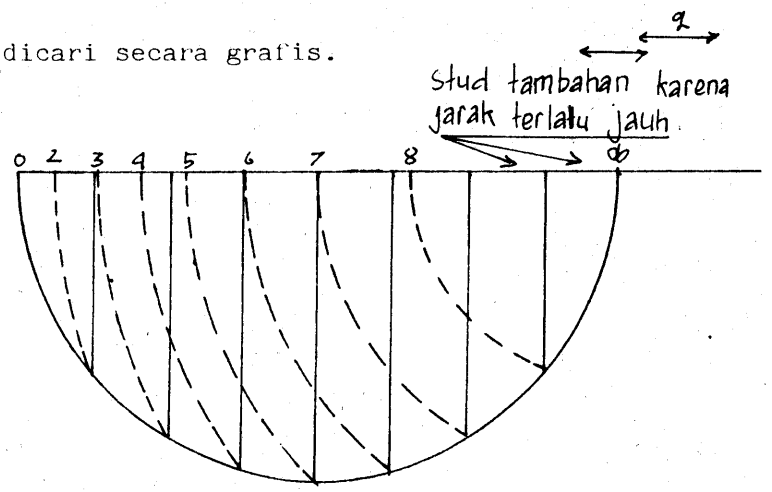
$= 5,2$ k

$ds = \frac{3}{4}$ "

½ bentang $M = \frac{76,8}{5,1} = 15 \rightarrow$ diambil 16

1 baris ada 2 stud ---- ada 8 baris.

Jarak dicari secara grafis.



Skala : 1 cm = 1 ft

Tetapi cara grafis seperti tadi jarang dilaksanakan , karena dalam pelaksanaan sulit. Maka supaya dalam pelaksanaan mudah dan tidak keliru dalam pengukuran jarak ---- jarak diambil sama seperti pada perletakan .

$p = \frac{N\ Q}{S} = \frac{25,1}{0,8} \cdot \frac{}{0,4} = 12,75$ in $= 1,06$ ft

Catatan :

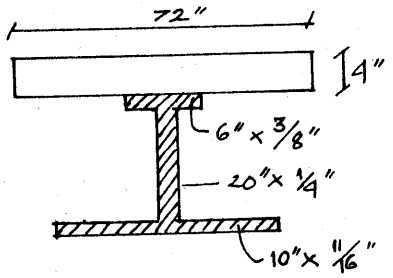
1. Pada perencanaan jembatan harus diingat wheel lo - sed dan impact factor.
2. Pada perencanaan lantai rumah tak diperlukan im - pact.
3. Pada perhitungan jarak/jumlah stud.
   a. Impact harap dimasukkan (pada beban hidup) juga wheel load.
   b. Muatan steel tak perlu dimasukkan (untuk amanya dimasukkan).

c. Yang diperhitungkan V_2 dan V_c.

4. Apabila tak ada ketentuan apa-apa lalu disuruh menghitung shear conector --→ pakai diagram - (bukan ultimate).

7. Suatu jembatan composite bentang 40 ft. Profil ba janya terdiri atas pelat dari baja A.36, yang mem punyai F_y = 36 ksi.
Flens atas pelat 6" x $\frac{3}{8}$ ". Badan 20" x $\frac{1}{4}$". Sedang flens bawah 10" x $\frac{11}{16}$". Slab beton tebal 4" (sisi bawah slab rata dengan sisi atas flens atas) dihu bungkan dengan shear conector berdasarkan $\frac{3}{4}$" ting gi 3".
Compresive strength beton usia 28 hari = 3000 psi
$n = \frac{E_s}{E_k} = 9$ ---> **lebar effektif beton** = 72".
Rencanakanlah lengkap dalam arti kata meninjau - streas yang timbul serta jumlah conectors yang di perlukan bila max momen karena beban mati =104,15 Kft sedang max momen karena beban hidup = 244 ,15 Kft.

Penyelesaian :



$\frac{3}{8}$" = 0,375
$\frac{1}{4}$" = 0,25
$\frac{11}{16}$" = 0,688

Irisan baja.

	A	d	Ad	Ad^2	I_o	I
flens atas 6" x $\frac{3}{8}$"	2,25	16,188	22,9	233	$\frac{1}{12} \cdot 60375^2$	233,026
badan 20" x $\frac{1}{4}$"	5	0	0	0	$\frac{1}{12} \cdot 20^3 \cdot \frac{1}{4} = 167$	107
flens 10" x $\frac{11}{16}$"	6,88	10,544	-71,3	+737	$\frac{1}{12} \cdot 10.0,625^3$	727,27
	$14,13 m^2$		-48,4			1137,296

$ds = \frac{-48,4}{14,13} = -3,42$

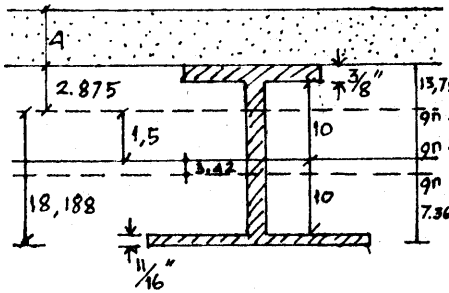
$I_o - 3,42 \cdot 48,4$

-166,0

$I_s = 971,296$

Irisan Composite	A	d	Ad	Ad^2	I_o	I
Irisan baja	14,13	-3,42	-48,4	-	-	1137,296
Slab 72"x4" $\frac{72.4}{9}$ = 32, 0		12,375	396,2	4904	$\frac{1}{12}$.72.64 = 42,6	4946,6
46,13 in^2			347,8		9	6083,896
			-7,5 . 347,8 =			-2608
						I= 3475,896

$d_1 = \frac{347,8}{46,13} = 7,5$ in



Irisan baja.

S_{tc} Mud terhadap sisi atas = $\frac{971,296}{13,725}$ = 70,3

sisi bawah = $\frac{971,296}{7,268}$

= 134

Irisan Composite.

S_{tc} Mud terhadap sisi bawah baja = $\frac{3475,896}{18,188}$ = 191,0

Sisi atas beton = $\frac{3475,896}{6,875}$ = 505

Tegangan-tegangan yang terjadi :

= Beban mati = strees = $\frac{104,15 \times 12}{70,3}$ = 17,8 kn < 24ksi

= Total load = stress sisi bawah baja = $\frac{104,15+244,15}{191}$

= $\frac{348,3 \cdot 12}{191}$ = 22,9 ksi < 24 ksi.

Strees sisi atas slab beton = $\frac{348,3 \times 12}{9 \cdot 505}$ = 0,92 ksi <

= 1,35 ksi .

Jadi profil baja memenuhi syarat.

b. Sloed.

$\frac{h_s}{d_s} = \frac{3}{374} = 4 < 4,2$

$Q_{nc} = 80\ h_s \cdot d_s \sqrt{f_c}$

= 80 . 3 . $\frac{3}{4}\sqrt{3000}$ = 9,85 K/ft (dari tabel = 11,5 K/ft)

$V_H = \frac{0,85 \cdot fc' \cdot Ac}{2} = \frac{0,85 \cdot 3000 \cdot 72 \cdot 4}{2}$ = 367 K

$V_H = \frac{1}{2} A_s \cdot F_y = \frac{14,13 \cdot 36}{2,0} = 255$ K

Jumlah stud = $\frac{255}{9,85} = 26$ buah (untuk setengah bentang)

Sekarang dihitung menggunakan tabel.

$I_s = 971,296$ $\quad Y_{ts} = 13,795$

$S_{ts} = 70,3$ $\quad Y_{bs} = 7,268$

$S_{bs} = 134$ $\quad A_s = 14,13$

K = 1 --- $A_c = \frac{b\ t}{k\ n} = \frac{72 \cdot 4}{1 \cdot 9} = 32$

$K_c = \frac{A_c}{A_c + A_s} = \frac{32}{32 + 14,13} = \frac{32}{46,13} = 0,694.$

$\bar{Y}_c = (Y_{ts} + 1_c)\ K_c = (13,795+2)0,694 = 10,9$

$I_c = (Y_{ts} + 1_c)\ \bar{Y}_c . A_s + A_c \cdot \frac{t^2}{12} + I_s$

$= 15,795 . 10,9 . 14,13 + 32 . \frac{4 . 15}{16} + 971,296$

$= 34640$

$Y_{tc} = Y_{ts} - \bar{Y}_c = 13,795 - 10,9 = 2,895$

$\longrightarrow S_{tc} = \frac{3,264}{2,845} = 1145$

$Y_{bc} = Y_{bs} + \bar{Y}_c = 7,268 + 10,9 = 18,168$

$\longrightarrow S_{bc} = \frac{3464}{18,168} = 191$

$S_{cc} = Y_{tc} + 4 = 2,895 + 4 = 6,895$

$\longrightarrow S_{cc} = \frac{3464}{6,895} = 503$

K = 3 $\longrightarrow A_c = \frac{b\ t}{k\ n} = \frac{72}{3} \cdot \frac{4}{9} = 10,67$

$K_c = \frac{A_c}{A_c + A_s} = \frac{10,67}{10,67 + 14,13} = \frac{10,67}{24,8} = 0,43$

$\bar{Y}_c = (Y_{ts} + 1_c)\ K_c = 15,795 . 0,43 = 6,8$

$I_c = (Y_{ts} + 1_c)\ \bar{Y}_c\ A_s + A_c \cdot \frac{t^2}{12} + I_s$

$= 15,795 . 6,8 . 14,13 + 10,67 . \frac{4}{3} + 971,296$

$= 2505,5$

$Y_{tc} = Y_{ts} - \bar{Y}_c = 13,795 - 6,8 = 7$

$\longrightarrow S_{tc} = \frac{2505,5}{7} = 358$

$Y_{bc} = Y_{bs} + \bar{Y}_c = 7,268 + 6,8 = 14,068 \longrightarrow S_{bc} = \frac{2505,5}{14,068}$

$= 178$

$Y_{cc} = 7 + 4 = 11 \longrightarrow S_{cc} = \frac{2505,5}{11} = 228$

$f_c = \frac{M}{K\,n\,S_c}$	DS
0	DS
$\frac{104,15}{3} \cdot \frac{12}{9} \cdot \frac{12}{228} = 0,203$	
$\frac{244.15}{9} \cdot \frac{12}{503} = 0,647$	
0,85	
$f_t = \frac{M}{S_t}$	
0	
$\frac{104,15}{358} \cdot \frac{12}{} = 3,5$	
$\frac{244,15}{1195} \cdot \frac{12}{} = 2,46$	
7,96191	
$f_s = \frac{M}{S_t}$	
0	
$\frac{104,15}{178} = 7,03$	
$\frac{244,15 \cdot 16}{191} = 15,4$	
22,43	

b. Steed : M_{total} = 348,3 Kft.

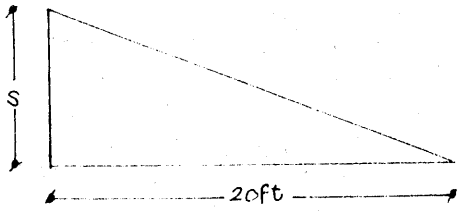
$M = \frac{1}{8} q l^2 \longrightarrow \frac{1}{8} \cdot q \cdot 40^2 = 348,3$

$q = \frac{348,3}{40} \cdot \frac{8}{40} = \frac{348,3}{200} = 1,7415$ K/ft

$V_A = \frac{1}{2} h l = \frac{1}{2} \cdot 1,7415 \cdot 40 = 34,83$ K

$K = 1 \quad m = A_c (Y_{tc} + 1_c) = (2,895+2)\ 32 = 4,895 \cdot 32 = 157$

$S = \frac{m}{I_c} \cdot v = \frac{157}{3464} \cdot 34,83 = 1,575$ k/in.



$H = \frac{1}{2} S \cdot \frac{1}{2} \cdot L$

$= \frac{1}{2} \cdot 1,575 \cdot 20$

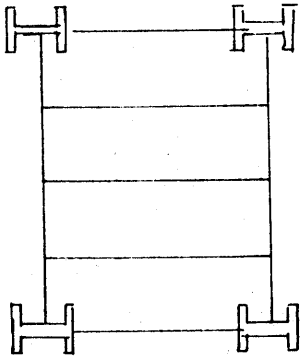
$= 15,75$

$n = \frac{15,75}{2} \cdot \frac{12}{9,85} = 40$

$Q_{nc} = 80 \cdot h_s \cdot ds \quad 3000 = 9,85$

Safety factor = 2 (untuk seluruh bentang = 80)

8.



Lantai dengan konstruksi - composite tebal slab 4" ba lok terdiri dari 16 WF 36 type baja A_{36}.

Diperhitungkan belum hidup 125 psf.

Berat slab 50 psf, berat - steel beam 50 p/f.

E_s = 30.000 ksi

f^c = 3.000 psi

n^c = 10

f_c = 1,35 ksi

F^c_t = 24 ksi

16 WF 36

A = 10,59 in^2

I = 446,3 in^4

S_s = 56,3 in^3

d = 15,85 in ---> $\frac{1}{2}$ d = 7,93

Hitunglah : f_t (steel tension flange)

f_b (steel compresion flange)

f_c (compression flange)

(Catatan : M_D = 589 k/in dan M_b = 1350 k/in)

Beberapa stud yang diperlukan bila dipakai stud ber Ø $\frac{1}{2}$" tinggi $2\frac{1}{2}$" dengan kekuatan 5,1 k/connector.

Penyelesaian :

Beban hidup : q = 0,125 k/ft x 8 = 1 k/ft

$$M_{LL} = \frac{1}{8} q l^2 = \frac{1}{8} . 0,125 . 30^2$$

$$= 1,25^2 . 90 K = 112,5 = 112,5 . 12$$

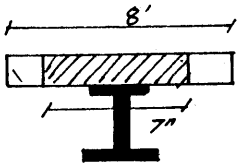
$$= 1350 \text{ k/in}$$

Beban mati :

q_1 = 0,050 x 8 = 0,4

q_2 = 0,050 = 0,05

q = 0,45 k/ft



$$M_D = \frac{1}{8} q l^2 = \frac{1}{8} . 0,45 . 30^2$$

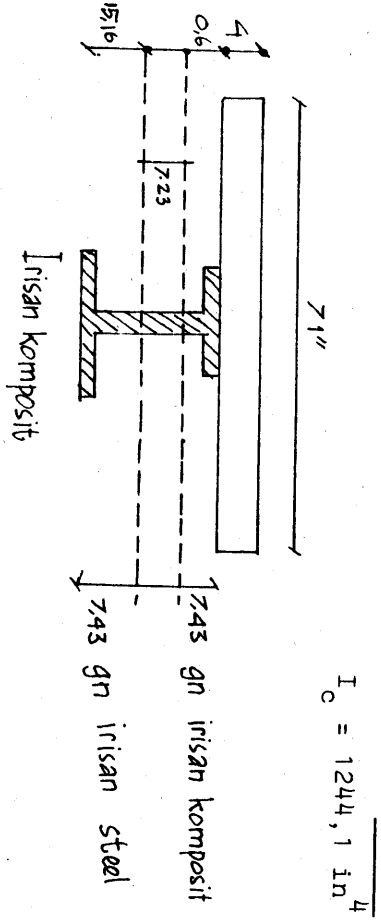
$$= 607 \text{ k/in.}$$

Jadi M_{LL} = 1350 k/in .

M_D = 607 k/in

(diambil yang besar ---→ bahan 589 k/in)

Irisan Composite	A	d	Ad	Ad^2	I_o	I
16 WF 36	10,59	0	0	0	446,3	446,3
Slab $\frac{71}{10}$. 4	28,4	9,93	282	2800	$\frac{1}{12} . \frac{71.64}{10}$ = 37,8	2837,8
	38,99		282			3284,1



$$ds = \frac{282}{38,99} = 7,23 \qquad 7,23 . 282 = 2040$$

$$I_c = 1244,1 \text{ in}^4$$

Irisan Composite : $S_{bc} = \frac{1244,1}{15,16} = 82,3 \text{ in}^3$

$S_{tc} = \frac{1244,1}{0,6} = 2070 \text{ in}^3$

$S_{cc} = \frac{1244,1}{4,6} = 271 \text{ in}^3$

Total load = 1350 + 607 = 1957

$f_t = \frac{1957}{2070} = 0,945 \text{ ksi} = \frac{P \text{ K in}}{\text{in}^3} = \text{K/in}^2 = \text{ksi}$

$f_b = \frac{1957}{82,3} = 23,7 \text{ ksi}$

$S_{cc} = \frac{1257}{271 \cdot 10} = 0,72 \text{ ksi}$

Jumlah Stoed :

Kekuatan stoed = 5,1 K/connector

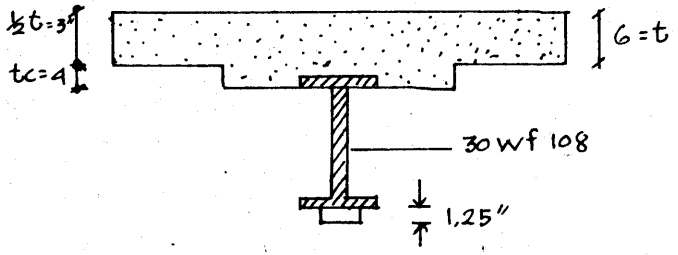
$H_{beton} = \frac{1}{2} \cdot 4^2 \cdot 71 \cdot 3 = 420 \text{ K}$

$H_{profil} = \frac{1}{2} \cdot 10,59 \cdot 36 = 190 \text{ K}$

----> $n = \frac{190}{5,1} = 27,4$ ---> dipakai 38 buah

n bentang = 76 buah.

9. **Diketahui :**



M_{DS} = 300 Kft

M_{DC} = 180 Kft

M_{LL} = 430 Kft

f_c' = 1200 psi

f_t = 18000 psi

n = 10

30 WF 108 :

A_s = 31,77 in^2

d = 29,82

I_B = 4461

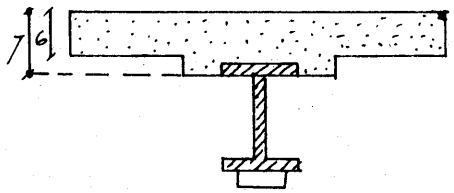
S_b = 299,2 in

Ditanyakan :

a. Hitung composite yang diperlukan supaya memenuhi persyaratan yang ada.

b. Kontrol tegangan-tegangan yang timbul.

Penyelesaian :



$\frac{S_B}{A} = \frac{299,2}{31,77} = 9,42$

$\frac{l_c}{d} = \frac{4}{29,82} = 0,134$

K = 1 $\quad A_c = \frac{b\,t}{k\,n} = \frac{72 \cdot 6}{1 \cdot 10} = 43,2$

$K_c = \frac{A_c}{A_c + A_s} = \frac{43,2}{43,2+31,77} = \frac{43,2}{74,97} = 0,576$

$= \frac{S_{bc}}{A_s \cdot d} \quad \frac{1}{\frac{1}{2} + (\frac{1}{2} + \frac{l_c}{d}) K_c} \left[(\frac{1}{2} + \frac{l_c}{d})^2 \cdot K_c + 0,165\right]$

$= \frac{1}{\frac{1}{2}+(\frac{1}{2}+0,134)\,0,576} \left[(\frac{1}{2}+0,134)^2 . 0,576 + 0,165\right]$

$= \frac{0,397}{0,865} = 0,46$

$$= \frac{S_{tc}}{A_s \cdot d} = \frac{1}{\frac{1}{2} - (\frac{1}{2} + \frac{1_c}{d}) K_c} [(\frac{1}{2} + \frac{1_c}{d})^2 K_c + 0,165]$$

$$= \frac{0,397}{0,5 - 0,365} = 2,94$$

K = 3 $\quad A_c = \frac{b \cdot t}{k \, n} = \frac{72 \cdot 6}{3 \cdot 10} = 14,4$

$$K_c = \frac{A_c}{A_c + A_s} = \frac{14,4}{14,4 + 31,77} = 0,312$$

$$= \frac{S_{bc}}{A_s \cdot d} = \frac{1}{\frac{1}{2} + (\frac{1}{2} + \frac{1_c}{d}) K_c} [(\frac{1}{2} + \frac{1_c}{d})^2 K_c + 0,165]$$

$$= \frac{0,634^2 \cdot 0,312 + 0,165}{\frac{1}{2} + 0,634 \cdot 0,312}$$

$$= \frac{0,1255 + 0,165}{0,5 + 0,198} = \frac{0,2905}{0,698} = 0,416$$

$$\frac{S_{tc}}{A \cdot d} = \frac{1}{\frac{1}{2} - (\frac{1}{2} + \frac{1_c}{d})^2 \cdot K_c} [(\frac{1}{2} + \frac{1_c}{d})^2 K_c + 0,165)]$$

$$= \frac{0,2905}{0,5 - 0,198} = 0,96$$

Top flange :

$$A_{DS} = \frac{M_{DS}}{f_b} \cdot \frac{A_s \cdot d}{S_s} \cdot \frac{1}{d} = \frac{300 \cdot 12}{18} \cdot \frac{1}{9,42} = 21,2$$

$$A_{DC} = \frac{M_{DC}}{f_b} \cdot \frac{A_s \cdot d}{S_{tc}} \cdot \frac{1}{d}$$

$$= \frac{180 \cdot 12}{18} \cdot \frac{1}{0,96} \cdot \frac{1}{29,82} = \frac{120}{0,96 \cdot 2,982} = 4,2$$

$$A_{LL} = \frac{M_{LL}}{f_b} \cdot \frac{A_s \cdot d}{S_{tc}} \cdot \frac{1}{d}$$

$$= \frac{430 \cdot 12}{18} \cdot \frac{1}{2,94} \cdot \frac{1}{29,82} = \frac{860}{3 \cdot 2,94 \cdot 2,982} = 3,27$$

28,67

< 31,77 in ..... OK

Botom flange :

$$A_{DS} = \frac{M_{DS}}{f_b} \cdot \frac{A_s \cdot d}{S_s} \cdot \frac{1}{d} = \frac{300 \cdot 12}{18} \cdot \frac{1}{9,42} = 21,20$$

$$A_{DC} = \frac{M_{DC}}{f_b} \cdot \frac{A_s \cdot d}{S_{bc}} \cdot \frac{1}{d}$$

$$= \frac{120}{0,416} \cdot \frac{1}{29,82} = \frac{120}{4,16 \cdot 2,982} = 9,66$$

$$A_{LL} = \frac{M_{LL}}{f_b} \cdot \frac{A_s \cdot d}{S_{bc}} \cdot \frac{1}{d}$$

$$= \frac{430 \cdot 12}{18} \cdot \frac{1}{0,46} \cdot \frac{1}{29,82} = \frac{860}{3 \cdot 4,6 \cdot 2,982} = 20,98$$

= 51,74

$A_s = 51,84$

A_B yang tersedia $= 31,77$

$(A_s - A_B) = 20,07$

Jadi $A_p = \frac{1}{2}(A_s - A_B) = 10,035$

Cover plate yang diperlukan B" x 1,25" --> $\Delta p = 10,00$

b. Irisan baja.

$$K_s = \frac{\Delta p}{\Delta s} = \frac{10,035}{31,77 + 10,035} = \frac{10,035}{41,805} = 0,24$$

$$\bar{Y}_s = \frac{1}{2}(d + t_p) K_s = \frac{1}{2}(29,82 + 1,25) \cdot 0,24$$

$$= \frac{1}{2} \cdot 31,07 \cdot 0,24 = 3,12 \text{ in}$$

$$I_s = \frac{1}{2}(d + t_p) \bar{Y}_s A_B + I_B = \frac{1}{2} \cdot 31,07.31,77 + 4461$$

$$= 1940 + 4461 = 6301$$

$$Y_{ts} = \frac{1}{2} d + \bar{Y}_s = 14,91 + 3,72 = 18,63 \rightarrow S_{ts} = \frac{6301}{18,63}$$

$$= 338 \text{in}^3$$

$$Y_{DS} = \frac{1}{2} d + t_p - \bar{Y}_s = 14,91 + 1,25 - 3,72 = 12,44$$

$$\text{----> } S_{bs} = \frac{6301}{12,44} = 506 \text{ in}^3$$

Irisan Composite.

$$K = 3 : A_c = \frac{b}{k} \cdot \frac{t}{n} = \frac{72}{3} \cdot \frac{6}{10} = 14,4$$

$$K_c = \frac{A_c}{A_c + A_s} = \frac{14,4}{14,4 + 41,8} = \frac{14,4}{56,2} = 0,256$$

$$\bar{Y}_c = (Y_{ts} + l_c) K_c = (18,63 + 4)\, 0,256$$

$$= 22,63.0,256 = 5,8$$

$$I_c = (Y_{ts} + l_c) \bar{Y}_c A_s + A_c \cdot \frac{t^2}{12} + I_s$$

$$= 22,63.5,8.41,8 + 14,4 \cdot \frac{6 \cdot 6}{12} + 6301$$

$$= 5470 + 43,2 + 6301 = 11814$$

$$Y_{tc} = Y_{ts} - \bar{Y}_c = 18,63 - 5,8 = 12,83$$

$$\text{----> } S_{tc} = \frac{11814}{12,83} = 920$$

$Y_{bc} = Y_{bs} + \bar{Y}_c = 12,44 + 5,8 = 18,24 \rightarrow S_{bc} = \frac{11814}{18,24} = 648$

$Y_{cc} = Y_{tc} + l_c + \frac{1}{2} t = 12,83 + 7 = 19,83$

$$\text{-----> } S_{cc} = \frac{11814}{19,83} = 596$$

$$K = 1 : A_c = \frac{b}{k} \cdot \frac{t}{n} = \frac{72}{20} \cdot \frac{6}{} = 43,2$$

$$K_c = \frac{A_c}{A_c + A_s} = \frac{43,2}{43,2 + 41,8} = \frac{43,2}{85} = 0,508$$

$$\bar{Y}_c = (Y_{ts} + l_c) K_c = 22,63.0,508 = 11,5$$

$$I_c = (Y_{ts} + l_c) \bar{Y}_c . A_s + A_c \cdot \frac{t^2}{12} + I_s$$

$$= 22,63.11,5.41,8 + 43,2.3 + 6301$$

$$= 10900 + 129,6 + 6301 = 17331$$

$$Y_{tc} = Y_{ts} - \bar{Y}_c = 19,63 - 11,5 = 7,13 \text{ --->}$$

$$S_{tc} = \frac{17331}{7,13} = 2430$$

$$Y_{bc} = Y_{bs} + \bar{Y}_c = 12,44 + 11,5 = 20,94$$

$$\text{---> } S_{bc} = \frac{17331}{23,94} = 725$$

10. Suatu jembatan composite.

- bentang 15 cm
- lebar 7 m + (2 x 1) m
- direncanakan dengan 4 gelagar
- plate beton 20 cm
- tebal aspal 5 cm
- gelagar DIN . 100

p = muatan terbagi rata = 2,2 t/m'
p = muatan garis = 12 ton
1 jalur lalu lintas = 2,75 m

Ketentuan-ketentuan lain :

Bj beton bertulang = 2,4 t/m^3 $1F = 1 + \frac{20}{L=50}$

Bj aspal = 2,2 t/m^3

$\bar{\sigma}$ 28 hari beton = 200 kg/cm^2

$\bar{\sigma}$ beton = 60 kg/cm^2

τ = 10 kg/cm^2

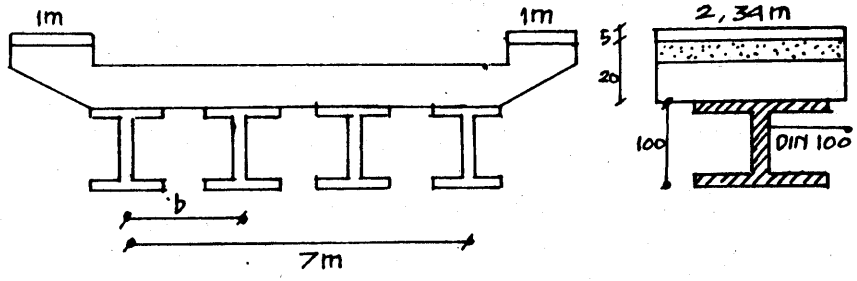
σ_{baja} = 1300 kg/cm^2

$n = \frac{E_s}{E_c}$ = 10

Ditanyakan :

a. Tegangan-tegangan yang timbul.
b. Stud yang dipakai Ø ¾" h = 3"
   Berapa jumlah stud yang diperlukan.

Penyelesaian : Beban mati.



$Y_{cc} = Y_{tc} + 7 = 7,13 + 7 = 14,13 \rightarrow S_{cc} = \frac{17331}{14,13} = 1230$

	$f_c = \frac{M}{K\,n\,S_{cc}}$	$f_t = \frac{M}{S_t}$	$f_b = \frac{M}{S_b}$
DS	0	$\frac{300 \cdot 12}{3,38} = 10,65$	$\frac{300 \cdot 12}{5,06} = 7,1$
DC	$\frac{1,80}{300} \cdot \frac{12}{5,46} = 0,121$	$\frac{1,80 \cdot 12}{9,20} = 2,35$	$\frac{1,80 \cdot 12}{6,48} = 3,34$
LL	$\frac{4,30}{1.10} \cdot \frac{12}{12,30} = 0,42$	$\frac{4,30 \cdot 12}{2,430} = 2,12$	$\frac{4,30 \cdot 12}{7,25} = 7,12$
	$0,541 < 1,2$	$15,12 < 18$	$17,56 < 18$

$b = \frac{7}{3} = 2{,}34$ m

DIN. 100

$I_x = 644700$ cm d = 100 cm

$W_x = 12900$ cm^3 q=314kg/m'

A = 400

= Beban mati Slab beton=2,34.0,20.1.2,4 =1,122T/m'

Steel Steel =0,314T/m'

q =1,436T/m'

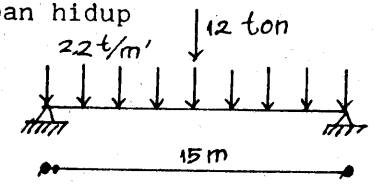
$M = \frac{1}{8} q l^2 = \frac{1}{8} . 1{,}436 . 225 = 40{,}2$ Tm

= Beban mati composite.

aspal = 2,34.0,05.1.2,2 T/m' = 0,257 T/m'

$\dashrightarrow M_{DC} = \frac{1}{8} . 0{,}257.225 = 7{,}25$ Tm

= Beban hidup



$2{,}34 \text{ m} = \frac{234}{2{,}54}$ m

$= \frac{234}{2.54.12}$ ft

$= 7{,}7$

$M' = \frac{1}{4} PL + \frac{1}{8} q l^2 = \frac{1}{4} . 12 . 15 + \frac{1}{8} . 2{,}2 . 225$

$M_{LL} = 1{,}308.1{,}4 . \frac{2{,}34}{2{,}75} . 107 = 168$ Tm

$M_{DS} = 40{,}2$ Tm

$M_{DC} = 7{,}25$ Tm

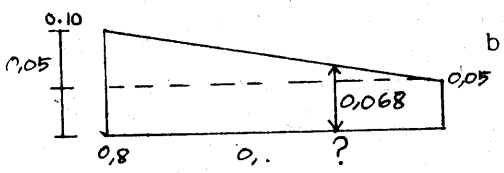
$M_{LL} = 168$ Tm

$IF = 1 + \frac{20}{2 + 50}$

$= 1 + \frac{20}{15 + 50}$

$= 1{,}3077$

Tinjauan lebar effectif.

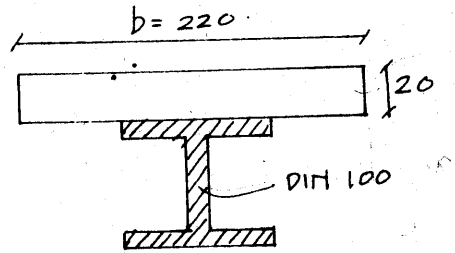


l = 15 m

$b = \frac{2{,}64}{2} = 1{,}02$

$b/L = \frac{1{,}02}{15} = 0{,}068$

Lihat tabel 5



$\frac{\lambda}{b} = 1 - \frac{0{,}018}{0{,}05} . 0{,}2$

$= 1 - 0{,}072 = 0{,}928$

$\lambda = 1{,}02 . 0{,}928 = 0{,}95$ m

b' = 0,30 + 0,95 + 0,95 = 2,20 m

DIN 100 $I_x = 644700$

$W_x = 12400$

A = 400 cm

d = 100

$K = 1 : A_c = \frac{b\ t}{k\ n} = \frac{220 . 20}{1 . 10} = 440$

$K_c = \frac{A_c}{A_c + A_s} = \frac{440}{440 + 400} = \frac{440}{840} = 0{,}524$

$\overline{Y}_c = (Y_{ts} + l_c) K_c = (50 + 10)\ 0{,}514$

$= 60 . 0{,}524 = 31{,}2$ cm.

$$I_c = (Y_{ts} + 1_c)\,\overline{Y}_c \cdot A_s + A_c \cdot \frac{t^2}{12} + I_s$$

$$I_c = 60.31,2.400 + 440.\frac{20}{2}\cdot\frac{20}{} + 644700$$

$$= 6.3,12.4.10^4 + 440.6,61 + 644700$$

$$= 753000 + 2940 + 644700 = 1400640$$

$$Y_{tc} = Y_{ts} - \overline{Y}_c = 50 - 31,2 = 18,8$$

$$\longrightarrow S_{tc} = \frac{1400640}{18,8} = 74450\ cm^3$$

$$Y_{bc} = Y_{bs} + \overline{Y}_c = 50 + 31,2 = 81,2$$

$$\longrightarrow S_{bc} = \frac{1400640}{81,2} = 17250\ cm^3$$

$$Y_{cc} = Y_{tc} + 20 = 18,8 + 20 = 38,8$$

$$\longrightarrow S_{cc} = \frac{1400640}{38,8} = 36100\ cm^3$$

K = 3 : $A_c = \frac{b}{K}\frac{t}{n} = \frac{220}{3}\cdot\frac{20}{10} = \frac{440}{3} = 146,6$

$$K_c = \frac{A_c}{A_c + A_s} = \frac{146,6}{146,6 + 400} = \frac{146,6}{546,6} = 0,268$$

$$\overline{Y}_c = (Y_{ts} + 1_c)\,K_c = (50+10)\ 0,268$$

$$= 60\ .\ 0,268 = 16,1\ cm$$

$$I_c = (Y_{ts} + 1_c)\,\overline{Y}_c\,A_s + A_c \cdot \frac{t^2}{12} + I_s$$

$$= 60.16,1.400 + 146,6\ .\ 6,67 + 644700$$

$$= 38600 + 980 + 644700 = 1031680$$

$$Y_{tc} = Y_{ts} - \overline{Y}_c = 50 - 18,1 = 35,9 \longrightarrow S_{tc} = \frac{1031680}{33,9} = 30400$$

$$Y_{bc} = Y_{bs} + \overline{Y}_c = 50 + 16,1 = 66,1 \longrightarrow S_{bc} = \frac{1031680}{66,1} = 15600$$

$$Y_{cc} = Y_{tc} + 20 = 35,9 + 20 = 53,9 \longrightarrow S_{cc} = \frac{1031680}{53,9} = 19100$$

	$f_{cc} = \frac{M}{k\,n\,S_{cc}}$	$f_t = \frac{M}{S_t}$	$f_b = \frac{M}{S_b}$
DS	0	$\frac{40,2\cdot 10^5}{1,2900.10^4} = 311$	$\frac{40,2\cdot 10^5}{1,2900.10^4} = 311$
DC	$\frac{7,25\cdot 10^3}{3.10.1,9110.10^{-4}} =$ 1,17	$\frac{7,25\cdot 10^5}{3,04\ .\ 10^4} = 238$	$\frac{7,25\cdot 10^5}{1,56\ .\ 10^4} = 46,4$
LL	$\frac{168\cdot 10^5}{1.10.3,61.10^4}$ 47,77	$\frac{168\cdot 10^5}{7,44\ .\ 10^4} = 226$ 586,5	$\frac{168\cdot 10^5}{1,725.\ 10^4} = 473$ 12,04

b. Shear connector.

$H_{slab} = \frac{1}{2}.234.20.200 = 468000$ kg

$H_{profil} = \frac{1}{2}.400.2400 = 480000$ kg

$H = 468000$ kg $= 468$ ton.

Kekuatan stud Ø ¾" h = 3" : $\frac{h}{d} = \frac{3.4}{3} = 4 < 4,2$

$Q = 80\ h_s\ d_s \sqrt{3000} = 80 \cdot 3 \cdot \frac{3}{4} \sqrt{3000}$

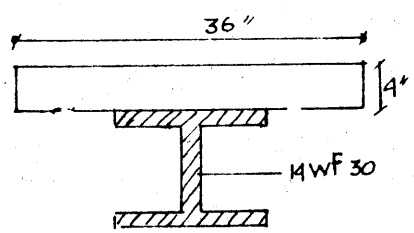
$= 4850$ lbs

1 lbs = 0,4536 kg ----→ Q = 4450 kg = 4,45 ton

$n = \frac{468}{4,45} = 105$ buah (½ bentang)

n = 210 buah (1 bentang)

11. Ketentuan : Suatu jembatan composite dengan ben - tang 15 m 49,2". Dengan irisan seper- ti pada gambar.



$fc' = 3.10^3$ psi

$f_t = 20.10^3$ psi

n = 10

Dead load = 0,18 k/ft

Q stard ¾", tinggi ter serah saudara.

14 WF 30 :

d = 13,86 in

$A_s = 8,81$ in^2

$S = 41,8$ in^3

$I = 289,6$ in^2

Ditanyakan :

a. Jumlah stud yang diperlukan.

b. Berapa M_D, M_B dan M ultimate serta safety factor yang dipakai dalam perhitungan.

Penyelesaian :

a. $H_{slab} = \frac{1}{2} \cdot 06" \cdot 4" \cdot 3 = 216$ k

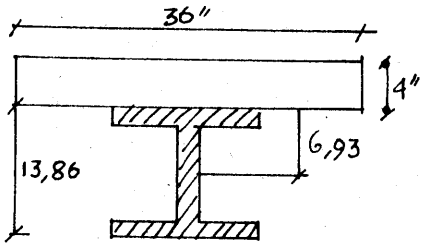
$H_{steel} = \frac{1}{2} \cdot 8,81 \cdot 33 = 145$ k

S buah Ø ¾" h = 3" --> $Q = 80 \cdot h_s\ d_s \sqrt{f_c'} = 9,9$ k

$n = \frac{145}{9,9} = 15$ buah (½ bentang)

n = 30 buah (1 bentang)

b.



$M_D = \frac{1}{8} q\ l^2$

$= \frac{1}{8} \cdot 0,18\ (49,2)$

$= \frac{1,8 \cdot 4,92^2 \cdot 60}{8}$

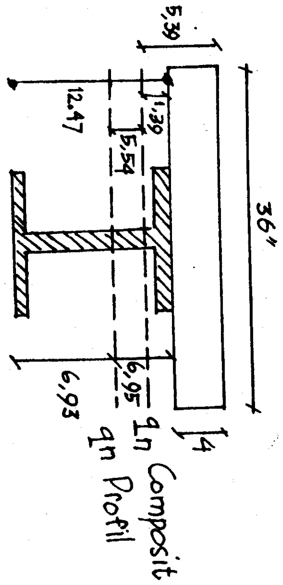
$= 54,5$ Kft

Irisan	A	d	Ad	Ad^2	I_o	I
Composite 14 WF 30	8,81	0	0	0	289,6	289,6
Slab $\frac{4,36}{10}$	14,4	8,43	128,5	1147	$\frac{1}{12} \cdot \frac{36.64}{10} = 19,2$	1166,8
	23,21		128,5			1455,8

$$d_s = + \frac{128,5}{23,21} = 5,54$$

$$6,54 \;.\; 128,5 \qquad -\;713$$

$$I_c = 742,8$$



Composite.

$$S_{tc} = \frac{742,8}{1,39} = 534 \text{ in}$$

$$S_{bc} = \frac{742,8}{12,47} = 59,5$$

$$S_{cc} = \frac{742,8}{5,39} = 138$$

Terhadap top flange :

$$f_{tc} = \frac{M_D + M_{LL}}{S_{tc}} \longrightarrow 20 = \frac{(54,5 + M_{LL})\;12}{534}$$

$$\longrightarrow M_{LL} = \frac{10680}{12} - 54,5 = 840 - 54,5$$

$$= 835,5$$

$$f_{bc} = \frac{M_D + M_{LL}}{S_{bc}} \longrightarrow 20 = \frac{(54,5 + M_{LL})\;12}{59,5}$$

$$M_{LL} = \frac{20 \;.\; 54,5}{12} - 54,5$$

$$= 99 - 14,5 = 44,5$$

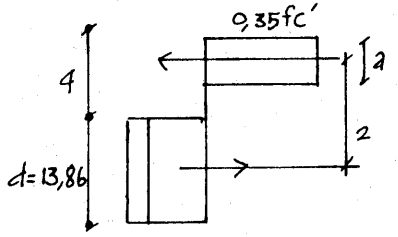
$$f_{cc} = \frac{M_D + M_{LL}}{S_{cc}} \longrightarrow 1,2 = \frac{(54,5 + M_{L1})\;12}{10 \;.\; 138}$$

$$\longrightarrow M_{LL} = \frac{12.138}{12} - 54,5 = 83,5$$

Dipilih yang kecil.

Jadi M_L = 44,5 Kft.

c. M ultimate.



$T = A_s \cdot F_y = 8,81 \cdot 33$

$= 291$ k

$H = T \longrightarrow a.0,85.3.36$

$= 291$

$a = \frac{291}{0,85 \cdot 3,36}$

$= 3,18$ in

$Z = \frac{1}{2} d + t - \frac{1}{2} a = 6,93 + 4 - 1,59$

$= 10,93 - 1,59 = 9,34$

$M_{ult} = TZ = 9,34 \cdot 291 = 2710$ k/in $= 226$ Kft

$M_{ult} = 226$ K/ft

Safety factor $= \frac{M_{ult}}{M_D + M_b} = \frac{226}{44,5 - 54,5} = \frac{226}{99} = 2,28$

SF = 2,28

12. Suatu konstruksi lantai berukuran 24' x 24' berupa konstruksi baja dengan composite system.
Live load = 125 psf benda slab = 50 psr , taksiran berat steel beam 50 psf.
E = 30000 psi , Ft = 24 ksi , fe' = 1,35 ksi , fe' = 300 psi.

$n = \frac{E_s}{E_c} = 10$

Stud 1/8 dipakai Ø 3/4" tinggi 2,5" dengan kekua - tan 11,4 kip.

16 WF 36 : $A = 10,59$ in^2

$S_s = 56,3$ in^3

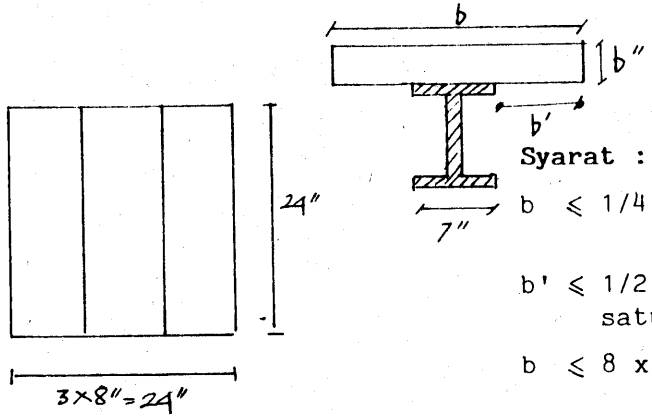
$I = 446,3$ in^3

$d = 15,85$ in

Pertanyaan :

a. Selidikilah steel tension yang timbul pada irisan composite.

b. Hitung jumlah shear conector untuk bentang 24feet



Syarat :

b ≤ 1/4 beam span-length.

b' ≤ 1/2 jarak balok satu sama lain.

b ≤ 8 x tebal slab.

Penyelesaian :

Kita cari lebar effektif.

b = 1/4 beam spanlength = 1/4 x 24' = 6' --> b = 6'

b' = 1/2 jarak balok satu sama lain = 4' --> b =8'7'

b' = 8 x tebal slab = 8 x 6" = 48" = 4' --> 8'7'

Muatan mati :

slab beam = 50.8 p/ft = 400 p/ft' = 0,4 K/ft'

berat steel= 50.8 p/ft = 0,4 K/ft'

q = 0,8 K/ft'

$M_D = 1/8\ ql^2 = 1/8.0,8.24^2 = 57,6$ Kft.

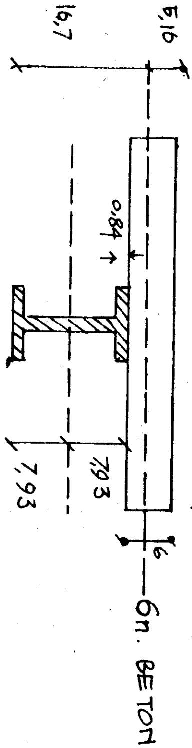
Muatan hidup : q = 8 x 125 p/ft = 1000 p/ft = 1 K/ft

$M_1 = 1/8\ ql^2 = 1/8.1.24.24 = 72K/ft$

Irisan Composite	A	d	Ad	Ad^2	I_o	I
16 WF 36	10,59	0	0	0	446,3	446,3
Slab $\frac{726}{10}$	43,2	10,93	472	5160	12.366 =130	5240,0
	53,79		472		12.40	5736,3

$ds = \frac{472}{53,79} = 8,77$ $- 8,77 \cdot 472$ $- 4140$

$I_c = 1596,3$



Composite :

$S_{tc} = \frac{1596,3}{0,84} = 1900$

$S_{bc} = \frac{1596,3}{16,7} = 95,5$

$S_{cc} = \frac{1596,3}{5,16} = 308$

Steel : $f_{ts} = f_{bs} = \frac{57,6 \cdot 12}{56,3} = 12,3$ Ksi < 24

Composite :

$M_{total\ load} = 57,6 + 72 = 129,6$ Kft

$f_{tc} = \frac{129,6 \cdot 12}{1900} = 0,82$ Ksi ..... < 24

$f_{bc} = \frac{129,6 \cdot 12}{45,5} = 16,3$ Ksi ..... < 24 .... OK

$f_{cc} = \frac{129,6 \cdot 12}{10.308} = 0,505$ Ksi .... < 24

Jadi konst. memenuhi syarat tegangan.

Jumlah shear conector :

H slab = $\frac{1}{2} \cdot 7^2 \cdot b \cdot 3$ ksi = 9 . 72 = 648 K

H steel = $\frac{1}{2}$ 10,59 . 36 = 190 K

$M = \frac{190}{11,4} = 16,7$ dipakai n = 17 buah (untuk ½ bentang)

Untuk bentang 24' ----> n = 34 buah

Peringatan :

1. Baca soal secara teliti.
2. Arahkan penyelesaian sebaik mungkin.
3. Bekerjalah secara teliti.
4. Apabila memenuhi hal-hal yang janggal dalam perhi tungan langsung dikontrol.

Soal Midtem UGM.

Suatu jenis comp L = 15 m (btg) lebar = 7 m + 2x 1 m 4 gelagar bila dipakai tebal pelat beton 20 cm tebal aspal = 5 cm , gelagar DIN 80.

1. Tinjaulah apakah balok memenuhi persyaratan tega ngan.
2. Seandainya tidak memenuhi syarat, maka dengan ti nggi balok berapa memenuhi.

Ketentuan :

Bj beton = 2,4 t/m^2 — p muatan terbagi rata =2,2t/m^2 - 1 jalur

Bj aspal = 2,2 t/m^2 — p muatan garis p = 12 ton

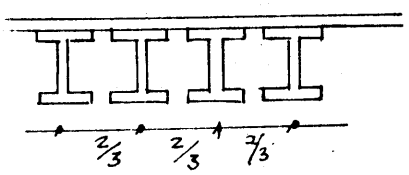
28 m = 200 kg/cm^2 — 1 jalur LL = 2,75 m

τ = 10 kg/cm^2 — σ_{bj} = 1300 kg/cm^2

n = 10

$$Q = 1 + \frac{20}{L + 50}$$

Jawab :

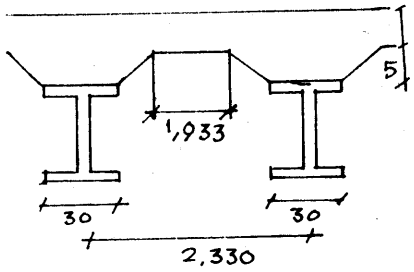


DIN 80 h = 80 b = 30 cm

b = 263kg/m Sx= 9160 cm^3.

As = 342 cm Ix= 366390 cm^4.

$$b/L = \frac{1,9335}{2.15} = 0,061$$



$$\sigma/b = 0,89 + \frac{0,014}{0,05} \cdot 0,11$$

$$= 0,9208$$

$$x = 0,9208 \cdot \frac{1,933}{2} = 0,89 \text{ m}$$

$$b_{eff} = 30+2.5+2,89 = 218 \text{ cm}.$$

DS :

Plat 0,2 . 2,333 . 2,4 = 1,1198 t/m'

Toube + haneli (0,3 + 0,4) 0,05.½.24 = 0,0420 t/m'

bout profil sendiri = 0,268 t/m'

W_{DS} = 1,4298 t/m'

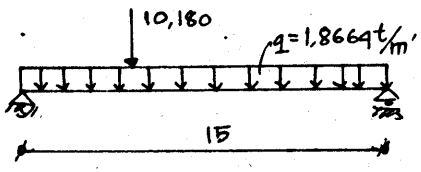
DC :

Berat aspal = 0,05 x 2,333 . 2,2 = 0,2566 t/m'

LL :

q = 2,2 t/m' - 1 jalur $q_1 = \frac{2,333}{2,75} \cdot 2,2 = 1,8664$t/m'

p = 12 ton - 1 jalur $P_1 = \frac{2,333}{2,95} \cdot 12 = 10,180$ ton

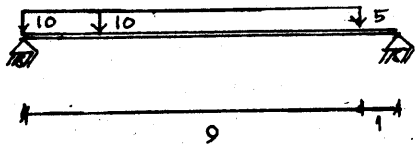


$$M_{LL} = \frac{1}{8} \cdot 1,8664 \cdot 15^2 + \frac{1}{4} \cdot 10,180 \cdot 15$$

$$= 90,6675 \text{ tm}$$

$$IF = 1 + \frac{20}{15 + 50} = 1,3 \cdot 8$$

Ventical shear pada centerdine dukungan.



$$V_{LL} = 10.1,25+(5.1+10.5) \cdot \frac{1,342}{10} = 20,156 \text{ ton.}$$

$$\text{Pengaruh IF} = \frac{20}{50+10} \text{ x}20,156$$

$$= 6,719 \text{ ton.}$$

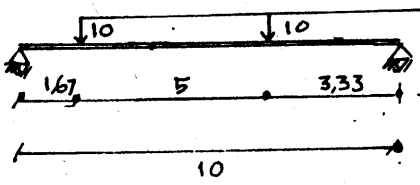
$$\text{Jadi LL+IF} = 20,156 + 6,719$$

$$= 26,875 \text{ ton}$$

$$V_{DC} = \tfrac{1}{2}.0,779.10 = 3,845 \text{ ton}$$

$$\text{Masa } V_c = 30,77 \text{ ton}$$

Muatan bergeser 1,67 m dari centerdine dukungan ke - kanan.



$$V_{LL} = (10.3,33+10,8,33) \cdot \frac{1,392}{10} = 16,231 \text{ ton.}$$

$$F = 33,33\%.16,231=5,410 \text{ t}$$

$$\text{Jadi LL + IF} = 16,231+5,410$$

$$= 21,641 \text{ ton.}$$

$V_{DC} = \frac{1}{2}.0,779.10 - 1,67.0,779 = 2,594$ ton.

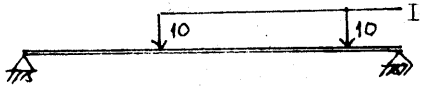
Jadi masa V_c = 21,641 ton + 2,594 ton

= 24,235 ton

Muatan bergeser 3,34 m kekanan dari centerdine duku - ngan.

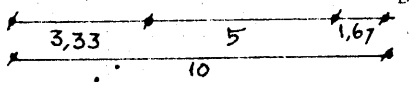
$$V_{LL} = (10.1,66+10.6,66) \frac{1,392}{10} \cdot$$

$$= 11,581 \text{ton}$$



$$IF = 33,33\% \text{x} 11,581 = 3,860 \text{ton}$$

$$LL + IF = 15,441 \text{ton}$$



$$V_{DC} = 0,779.10-3,34. 0,779 = 1,293 \text{ton}$$

$$\text{Masa } V_C = 16,734 \text{ton}$$

Safety Factor (FS).

$$FS = \frac{A(1 + C_{me} + C_{mi}.C_s) - (C_{me} + C_{mi}) + Cv}{1 + Cv}$$

$$FS = \frac{LLFS + Cv}{1 + Cv} \qquad LLFS = A\ (1+ C_{me}+ C_{mi}\ C_s)-(C_{me}+C_{mi})$$

$$C_{me} = \frac{M_{oc}}{M_{LL}} = \frac{9,7375}{48,24} = 0,202 \qquad C_{mi} = \frac{M_{os}}{M_{LL}} = \frac{17,3625}{48,84} = 0,36$$

$$C_s = \frac{S_{bc}}{S_{bs}} = \frac{9327,24}{3410} = 2,735$$

$$LLFS = 2,7\ (1+0,202+0,356.2,735)-(0,202+0,36) = 5,342$$

$$FS = \frac{5,342 + Cv}{1 + Cv}$$

Pada centerdine dukungan.

$$Cv = \frac{V_{DC}}{V_{LL} + IF} = \frac{3,845}{} = 0,143 \rightarrow FS = \frac{5,342 + 0,143}{1 + 0,143}$$

$$= 4,799$$

Pada point 1,67 ini dari centerdine dukungan.

$$CV = \frac{V_{De}}{V_{LL} + IF} = \frac{2,544}{21,645} = 0,1199 \rightarrow FS = \frac{5,342+0,1199}{1 + 0,1199} = 4,877$$

Pada point 3,34 m dari centerdine dukungan.

$$Cv = \frac{V_{oc}}{V_{LL} + IF} = \frac{1,293}{15 + 41} = 0,084 \rightarrow FS = \frac{5,342+0,084}{1 + 0,084} = 5,005$$

- Xct serta selidikilah stness yang timbul pada konst. tersebut.

K = 1 --- LL

$$Ae = \frac{213,48.20}{13 \cdot 1} = 328,435^2$$

K = 3 --- DL

$$Ae = \frac{bt}{kn} = \frac{213,48 \cdot n}{13 \cdot 3} = 112 \text{ cm}^2.$$

$$Kc = \frac{Ac}{Ac + tg} = \frac{328,43}{328,411\ 289^2}\ 0,532$$

$$Yc = (Y_{ts} + l_c)\ Kc\ (30 + 15)\ 0,532 = 23,94 \text{ cm}$$

$$Dc = (Y_{ts} + l_c)\ Y_c\ ts + A_c \frac{t^2}{12} + Is$$

$$= 45,233\ 24.289 + 328,43 \cdot \frac{20}{12} + 180830$$

$$= 50\ 3117,30 \text{ cm}^4$$

$$Y_{tc} = Y_{ts} - Y_c = 30 - 23,94 = 6,06 \text{ cm}$$

$$Y_{bc} = Y_{bc} + Y_c = 30 + 23,94 = 53,94 \text{ cm}$$

$$Y_{cc} = Y_{tc} + l_c + \tfrac{1}{2} t = 6,06 + 15 + 10 = 31,06 \text{ cm}$$

$$m = tc\ (Y_{tc} + l_c) = 328,43\ (6,06 + 15)$$

$$= 6916,74 \text{ cm}^3$$

$$S_{tc} = \frac{Dc}{y_{tc}} = \frac{50.3117,36}{6,06} = 8302467 \text{ cm}^3$$

$$S_{bc} = \frac{Dc}{y_{bc}} = \frac{50.3117,36}{53,24} = 9327,34 \text{ cm}^3$$

$$S_{cc} = \frac{Dc}{y_{cc}} = \frac{50.3117,36}{31,06} = 16198,22 \text{ cm}^3$$

$$S_{tc} = \frac{Dc}{y_{tc}} = \frac{347.841,1}{17,445} = 19939,3 \text{ cm}^3$$

$$S_{bc} = \frac{Dc}{y_{bc}} = \frac{347.841,1}{42,555} = 8173,92$$

$$S_{cc} = \frac{Dc}{y_{cc}} = \frac{347.841,1}{42,445} = 8195,10$$

$$Kc = \frac{Ae}{Ac + As} = \frac{112}{112 + 289} = 0,1279$$

$$Y_c = (Y_{ts} + l_c)\ K_c = (30+15)\ 0,279 = 12,555 \text{ cm}$$

$$x = (Y_{ts} + l_c)\ Y_c\ A_s + A_c \cdot \frac{t^2}{12}$$

$$I_s = 45.12,555 \cdot 289 + 112 \cdot \frac{24^2}{12} + 18053$$

$$= 347841,1 \text{ cm}^4.$$

$$Y_{tc} = Y_{ts} - Y_c = 30 - 12,555 = 17,445$$

$$Y_{bc} = Y_{bs} + Y_c = 30 + 12,555 = 42,555$$

$$Y_{cc} = Y_{tc} + l_c + \tfrac{1}{2} = 17,445 + 25 = 42,445$$

Tegangan-tegangan yang timbul :

$$\sigma_{Dc} = \frac{M_{Ds}}{S_{Ds}} + \frac{M_{Dc}}{S_{bc}} + \frac{M_{LL}}{S_{bc}} = \frac{1736250}{3410} + \frac{9737,50}{8173,92} + \frac{4824000}{9327,34}$$

$$= 1145,48 \qquad 1100$$

$$\sigma_{LL} = \frac{M_{Ds}}{S_{bs}} + \frac{M_{Dc}}{S_{tc}} + \frac{M_{LL}}{S_{tc}} = \frac{1736250}{3410} + \frac{973750}{19934,3} + \frac{4824000}{83022,67}$$

$$= 616,10 \qquad 1300$$

$$\sigma_{cc} = 0 + \frac{M_{Dc}}{Kn\ S_{cc}} + \frac{M_{LL}}{Cn\ S_{cc}} = \frac{973750}{3.13.8195,10} +$$

$$\frac{7824000}{1.13.16198,22} = 25,96 \text{ kg/cm} < 60 \text{ kg/cm}$$

Hitung shear connector yang berupa stud terhingga - jaraknya.

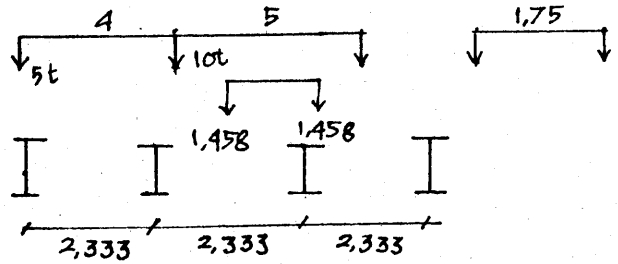
LL distribusi untuk momen =

$$\frac{\text{Beam spacing (fit)}}{5,5} \quad \text{(Tasito)}$$

$$= \frac{7}{3} \cdot \frac{1}{0,3048} \cdot \frac{1}{5,5} = 1,392$$

Distribusi muatan pada gelagar.

$$= \frac{1,458}{2,333} + \frac{1,458}{2,333} = 1,28$$



Live load dist. $\lambda = \frac{\text{beam spacing}}{5,5}$ (ft) (tasito)

$$= 7/3 \cdot \frac{1}{0,3048} \cdot \frac{1}{5,5} = 1,392$$

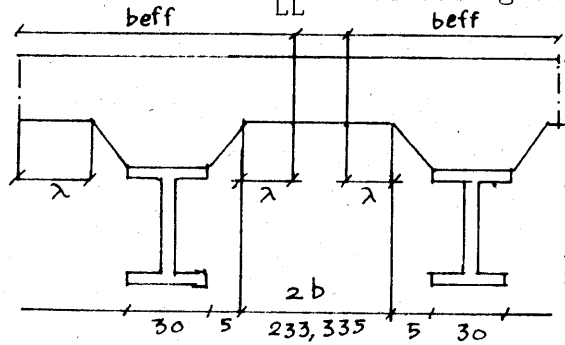
$M_{LL} = M_L \cdot 2F \cdot x$

$= 26 \cdot 1,333 \cdot 1,392 = 48,24$ tm

$M_{Ds} = 1736250$ kg cm

$M_{Dc} = 973750$ kg cm

$M_{LL} = 4824000$ kg cm



$2b = 2,333 - 0,3 - 0,10$

$= 1,933$

$b = 0,9665$ m

$\frac{b}{e} = \frac{0,9665}{10}$

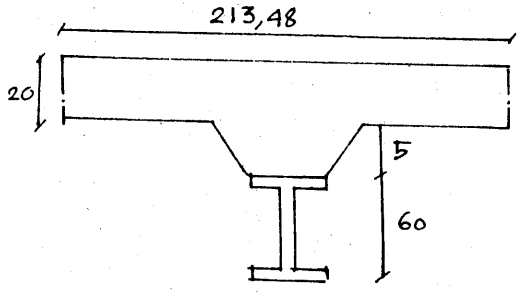
$= 0,09665$

$\frac{\lambda}{b} = 1 - \frac{0,09665 - 0,05}{0,05}$ (0,1)

$\lambda' = 0,897$

$\lambda' = 0,897 \cdot 0,9665$

$= 0,09919$



beff = 30+10+2.89,74

= 213,48 cm

$n = \frac{E\ \text{baja}}{E\ \text{beton}} = \frac{2,1.10^5}{1,6.10^4}$

$= 13$

LL Kn = 13

$Al = \frac{bt}{Kn} = \frac{213,48 \cdot 20}{13} = 328,43\ cm^2$

$Kc = \frac{Ac}{Ac + As} = \frac{328,43}{328,43 + 289} = 0,532$

$\frac{lc}{d} = \frac{15}{60} = 0,25$

$\frac{S_{bc}}{A_s d} = \frac{(\frac{1}{2}+lc/d)^2 . Lc+0,165}{\frac{1}{2}+(\frac{1}{2}+lc/dc)\,kc} = \frac{0,73^2 . 0,832+0,165}{\frac{1}{2} . 0,7510,532} = 0,516$

$A_{Ds} = \frac{M_{Ds}}{fb} \cdot \frac{As_d}{S_{bs}} \frac{\ell}{d} = \frac{1736250}{1300} \cdot \frac{289}{1300} = 113,191\ cm^2$

DL K = 3 ----→ Kn = 39

$tc = \frac{213,48 . 20}{39} = 112\ cm^2$

$kc = \frac{112}{112+289} = 0,279$

$\frac{lc}{d} = 15/60 = 0,25$

$\frac{S_{bc}}{As_d} = \frac{(\frac{1}{2}+lc)^2 . tc+0,165}{\frac{1}{2} . (\frac{1}{2}+\frac{le}{d})\,kc} = \frac{0,75^2 . 0,279+0,165}{\frac{1}{2} . 0,75 . 0,249} = 0,454$

$A_{Dc} = \frac{M_{Dc}}{t_b} \cdot \frac{A_s d}{S_{bc}} \cdot \frac{1}{d} = \frac{973750}{1300} \cdot \frac{1}{0,954} \cdot \frac{1}{60} = 27,487 cm^2$

$A_{cc} = \frac{M_{LL}}{t_b} \cdot \frac{A_s d}{S_{bc}} \cdot \frac{1}{d^2} = \frac{4824000}{1300} \cdot \frac{1}{0,516} \cdot \frac{1}{60} = 119,859$

Jadi dapat dipakai DIN 60 tg = 260,557 < 289

As cukup kecil (8)

LL ----→ Kn = 10 $Kc = \frac{Ac}{Ac+As} = \frac{436}{436+372} = 0,5396$

$Ac = \frac{bt}{kn} = \frac{218 . 20}{0,5} = 436\ cm^2$

$yc = (\frac{1}{2} d + lc)\,kc = (42,5+15)\ 0,5396 = 31,027\ cm$

$Ic = (\frac{1}{2} d + lc)\,yc . As + Ac . \frac{t^2}{12} + Dg$

$= (42,5+15) . 31,027 . 372 + 436 . \frac{20^2}{12} + 443890$

$= 1122095,6\ cm^4.$

$y_{tc} = y_{ts} - y_c = 42,5 - 31,027 = 11,473\ cm$

$y_{bc} = y_{bs} + y_c = 42,5 + 31,027 = 73,527\ cm$

$y_{cc} = y_{tc} + lc + \frac{1}{2} t = 11,473 + 15 + 10 = 36,473\ cm$

$S_{tc} = \frac{Ic}{y_{tc}} = \frac{1128.095,6}{11.473} = 97803,156\ cm^3$

$S_{bc} = \frac{Ic}{y_{bc}} = \frac{1122095,6}{73,527} = 15261\ cm^3$

$S_{cc} = \frac{Ic}{y_{cc}} = \frac{1122095,6}{56,473} = 30765,1\ cm^3$

	Stress of top steel (kg/cm^2)		
Ds	$\frac{MD_s}{S_{bs}} = \frac{4021300}{9160} = 439.006$	$\frac{MD_s}{S_{bs}} = \frac{4021300}{9160} = 439.006$	
Dc	$\frac{MD_c}{S_{tc}} = \frac{721700}{28805,66} = 25,054$	$\frac{MD_c}{S_{bc}} = \frac{721700}{12051,98} = 59,582$	$\frac{MD_c}{S_{cc}} = \frac{721700}{31.13987,32} = 1,720$
LL	$\frac{M_{LL}}{S_{tc}} = \frac{11859300}{104377,31} = 113,620$	$\frac{M_{LL}}{S_{bc}} = \frac{11859300}{13563,154} = 874,376$	$\frac{M_{LL}}{S_{cc}} = \frac{11859300}{10.28078,10} = 42,237$
Total	578,273 1300	< 1373,26 1300	> 43,957 < 60

	PT Ot Top st	Lihat tabel depan	
Ds	$\frac{MD_s}{M_x} = \frac{40.888,2}{10 + 0} = 391,649$	$\frac{MD_s}{W} = \frac{4088812}{10440} = 391,649$	
Dc	$\frac{MD_c}{S_{tc}} = \frac{721700}{30145,7} = 23,940$	$\frac{MD_c}{S_{bc}} = \frac{727700}{13541,456} = 53,295$	$\frac{MD_c}{nS_{cc}} = \frac{721700}{30.15468,26} = 1555$
LL	$\frac{M_{LL}}{S_{tc}} = \frac{11859300}{91803,156} = 121,257$	$\frac{M_{LL}}{S_{bc}} = \frac{11859300}{15201} = 777,098$	$\frac{M_{LL}}{nS_{cc}} = \frac{11859300}{10.30765,1}$
Total	536,846 < 1300 pakai DIN 85	1222,042 < 1300	40,1029 < 60 kg/m

Balok composite diatas tidak aman.

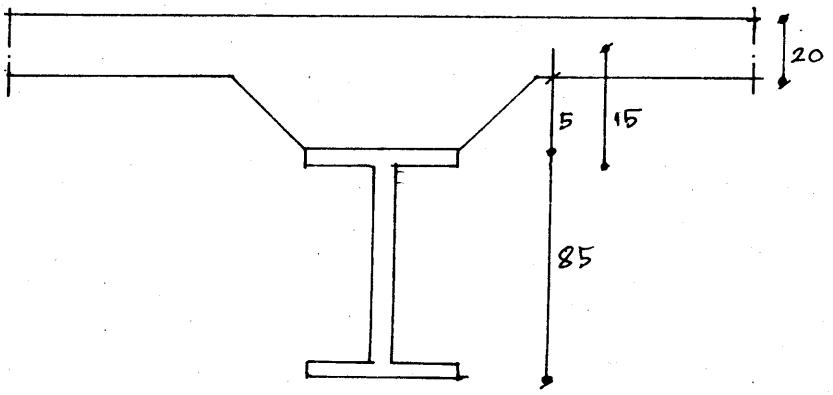
Ukuran dirubah.

Dicoba DIN 85 h = 85 cm b = 30 cm W = 242 kg/cm^2

As = 372cm^2 Ir = 443890cm^4 W_x=10440cm

W_{Ds} = 1,4298 + 0,292 - 0,268 = 1,4588 t/m'

M_{Ds} = 1/8 . 1,4588 . 15^2 = 40,8881,2 tm



Dead load K = 3 n = 10

$$Ae = \frac{bt}{kn} = \frac{218 \cdot 20}{30} = 145,33 \text{ cm}^2$$

$$Kc = \frac{Ac}{Ac + As} = \frac{145,33}{145,33 + 372} = 0,281$$

yc = ($\frac{1}{2}$ d + lc) kc = (42,5 + 15) 0,281 = 16,153 cm

$$yc = (\tfrac{1}{2} d + lc)\, yc\, As + Ac \cdot \frac{t^2}{12} + Is$$

$$= (42,5+15) \cdot 16,153 \cdot 372 + 145,33 \cdot \frac{20^2}{12} + 443890$$

= 794248,79 cm^4.

$y_{tc} = y_{ts} - y_c = 42,5 - 16,153 = 26,347$ cm

$y_{bc} = y_{ts} + y_c = 42,5 + 16,153 = 58,653$ cm

$y_{cc} = y_{tc} + l_c + \frac{1}{2} t = 26,347+15+10 = 51,347$ cm

$$S_{tc} = \frac{Ic}{y_{tc}} = \frac{794248,79}{36,347} = 30145,7 \text{ cm}$$

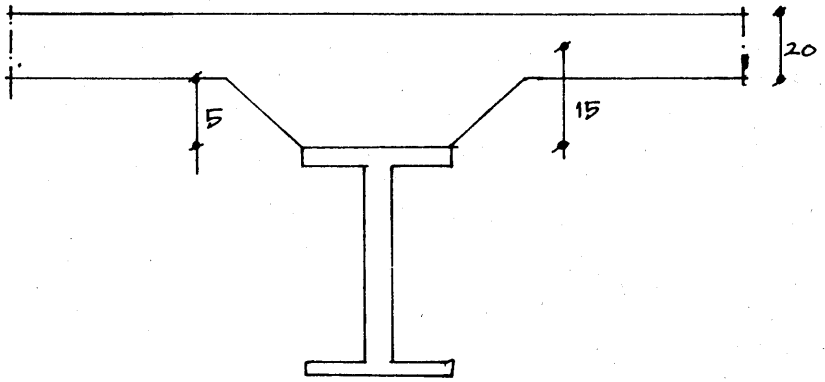
$$S_{bc} = \frac{Ic}{y_{bc}} = \frac{794248,79}{58,653} = 13541,486 \text{ cm}^4$$

$$S_{cc} = \frac{Ic}{y_{cc}} = \frac{794248,79}{51,347} = 15468,260 \text{ cm}^4$$

M_{LL} = IF = 1,300 . 90,6675 = 118,593 tm

M_{Ds} = 1/8 . 1,4295 . 15^2 = 40,213 tm

A_{Dc} = 1/8 . 0,2566 . 15^2 = 7,217 tm



Dead load K = 3 ---- n = 10

$Ae = \frac{bt}{kn} = \frac{218 \cdot 20}{30} = 145,33\ cm^2.$

$Kc = \frac{Ac}{Ac + As} = \frac{145,33}{145,33 + 342} = 0,298$

$y_c = (Y_{ts} + lc)\ Kc = (40 + 15)\ 0,298 = 16,402$

$y_c = (Y_{ts} + lc)\ y_c\ A_s + Ac \cdot \frac{t^2}{12} + Is$

$= (40 + 15)\ 16,400.342 + 145,33 \frac{20^2}{12} + 366390$

$= 679755,96\ cm^4$

$Y_{tc} = y_{ts} - y_c = 40 - 16,402 = 23,598\ cm$

$y_{bc} = y_{bs} + y_c = 40 + 16,402 = 56,402\ cm$

$y_{cc} = y_{tc} + lc + \frac{1}{2} t = 23,598+15+10 = 48,598\ cm$

$S_{tc} = \frac{Ic}{y_{tc}} = \frac{679755,96}{23,598} = 28805,66\ cm^3$

$S_{bc} = \frac{Ic}{y_{bc}} = \frac{679755,96}{56,402} = 12051,98\ cm^3$

$S_{cc} = \frac{Ic}{y_{cc}} = \frac{679755,96}{48,598} = 13987,32\ cm^3$

Live load k = 1 n = 10.

$tc = \frac{bt}{kn} = \frac{218 \cdot 80}{10} = 436\ cm^2$

$kc = \frac{Ac}{Ac + As} = \frac{436}{436 + 342} = 0,360$

$y_c = (y_{ts} + l_o)\ kc = (40 + 19)\ 0,560 = 30,8\ cm$

$Ac = (I_{ts} + lc)\ yc\ As + Ac \cdot \frac{t^2}{12} + Is$

$= (10+15)\ 30,8.342 + 436 \cdot \frac{20^2}{12} + 366390$

$= 960271,33\ cm^4.$

$y_{tc} = y_{ts} - y_c = 40 - 30,8 = 4,2\ cm$

$y_{bc} = y_{bs} + y_c = 40 + 30,8 = 70,8cm$

$I_{cc} = I_{tc} + lc + \frac{1}{2} t = 9,2 + 15 + \frac{1}{2} \cdot 20 = 342\ cm$

$S_{tc} = \frac{Ic}{I_{cc}} = \frac{960271,33}{9,2} = 104371,31\ cm^3$

$S_{bc} = \frac{Ic}{I_{bc}} = \frac{960271,33}{70,8} = 135631,57$

$S_{cc} = \frac{Ic}{y_{cc}} = 460271,33 = 28070,107$

Ujian Negara, 12-01-1976 (125 menit).

Direncanakan sebuah jembatan composite bentang = 10m
lebar = 9 m terus ke trotoir 2 x 100 m
Dipakai 4 gelagar induk jembatan masing-masing 7.00.
Tebal slab beton = 20 cm , tebal aspal 5 cm
Tekanan beban rs = 10 ton

bj beton = 2,4 $E_{baja} = 2,1.10^6$ $E_{beton} = 16.10^4\ kg/cm$

$\sigma_{28} = 200\ kg/cm^2$ $\sigma = 60 kg/cm^2$ $\tau = 10\ kg/cm^2$

bentuk gelagar yang dipakai :

Dicoba DIN 60 :

$As = 289\ m^2$, q = 227kg/cm , b = 60cm , $S_{bs} = S_{ts}$
$= 3410\ cm^3$

I_s = 180800 cm^4 , b = 30 cm

DLS slab 7/3 . 0,2 . 2,4 = 412

beban profit = 0,227

Hanneh $(0,3+0,4)\frac{1}{2}.0,05.2,4$ = 0,042

W_{Ds} = 1,389 t/m'

Ms $M_{Ds} = 1/8.\ 1,389.10^2$ = 17,3625

DL_c Railing 2 0,030 . 1/4 = 0,015 t/m'

Parafat $(101,3 + 0,4)\ \frac{1}{2}.0,45.2,4.2.1/4$ = 0,189

Safety walk $(0,25+0,28)\frac{1}{2}$. 2,4 . 2,4 = 0,318

lap.aspal 0,05 . 7/3 x 2,2 = 0,257

0,779 t/m'

$M_{Dc} = 1/8.0,779.10^2$ = 9,7375 tm

$R_A = \frac{25}{10} \cdot \frac{4,4}{} = 11$ ton

M_L = 115 - 5,,4.6 - 10.0,6 = 26 tm

$IF = 1 + \frac{20'}{50 + L} = 1 + \frac{20}{50 + 10} = 1,333$