

## LAMPIRAN 1

### PRELIMINARY DESAIN

#### L1.1 Preliminary Pelat Lantai

. - Kombinasi Pembebanan

$$- q_{ult1} = 1,4 q_{DL} = 1,4 (104) = 145,6 \text{ kg/m}^2$$

$$- q_{ult2} = 1,2 q_{DL} + 1,6 q_{LL} = 1,2 (104) + 1,6(400) = 764,8 \text{ kg/m}^2$$

$$\therefore \text{Digunakan } q_{ult2} = 764,8 \text{ kg/m}^2$$

#### Menentukan Profil Pelat Prategang

- HCS

Type : 150.07.12

Spesifikasi : - Tebal = 150 mm

- Diameter Lubang = 7 mm

- Jumlah Lubang = 12 Buah

- Daya Dukung = 380 kg/m<sup>2</sup>

- Panjang Bentang = 6,75 m

(Notes : Berat sendiri Pelat Beton Prategang 29%-42% lebih ringan dari pelat lantai beton konvensional)

#### L1.2 Preliminary Balok

##### 1. Balok (A-D-6 lt.1)

##### Beban Mati

Beban yang bekerja pada balok akibat pelat lantai,

$$\text{Berat sendiri HCS}(t=15\text{cm}=0,15 \text{ m})=0,15 \times 2400 \text{ kg/m}^3 \times 70\% = 252 \text{ kg/m}^2$$

$$\text{Finishing, ME, Ducting} = 104 \text{ kg/m}^2$$

$$q_{Plat} = 356 \text{ kg/m}^2$$

$$q_{SDL1} = q_{Plat} \times (0,5 \times 4)$$

$$= 356 \times 2 = 712 \text{ kg/m}$$

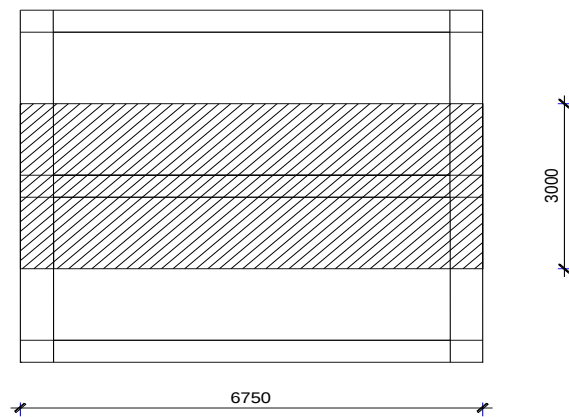
Beban yang bekerja pada balok akibat dinding,

Berdasarkan perhitungan pembebanan, beban dinding yang bekerja pada balok,

$$q_{SDL2} = 334 \text{ kg/m}^2 \times 3,96\text{m} = 1322,64 \text{ kg/m}$$

$$\begin{aligned} q_{SDL} &= q_{SDL1} + q_{SDL2} \\ &= 712 + 1322,64 \\ &= 2034,64 \text{ kg/m} \end{aligned}$$

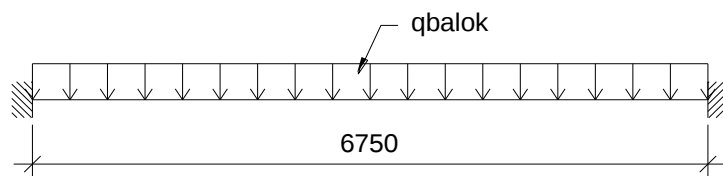
### **Beban hidup**



**Gambar L1.1 Gambar balok yang ditinjau**

$$q_{LL} = 400 \text{ kg/m}^2$$

$$\begin{aligned} q_{Balok} &= 1.2 q_{SDL} + 1.6 q_{LL} \\ &= 1.2 (2034,64) + 1.6 (400) \\ &= 3081,568 \text{ kg/m}^2 \end{aligned}$$



**Gambar L1.2 Gaya yang bekerja pada balok**

$$M_{\max} = \frac{1}{12} * (q_{ek}) * 6^2 = \frac{1}{12} * (3081,568) * 36$$

$$= 9244,704 \text{ kgm} = 92447040 \text{ Nmm} = 92,45 \text{ KNm}$$

$$M_{\text{ult}} = \phi \cdot Z_x \cdot f_y$$

$$92447040 = 0.9 \times Z_x \times 250$$

$$Z_x = 410875,7 \text{ mm}^3 = 410,9 \text{ cm}^3$$

Diambil profil :

CSHC 600.200.8.13 (*IWF 400.200.8.13*)

$$Z_x = 1283,585 \text{ cm}^3 = 1283,5 \times 10^3 \text{ mm}^3 \geq 410875,7 \text{ mm}^3$$

$$\text{Data profil : } A_{\max} (\text{Gross}) = 100,12 \text{ cm}^2$$

$$A_{\min} (\text{Net}) = 67,68 \text{ cm}^2$$

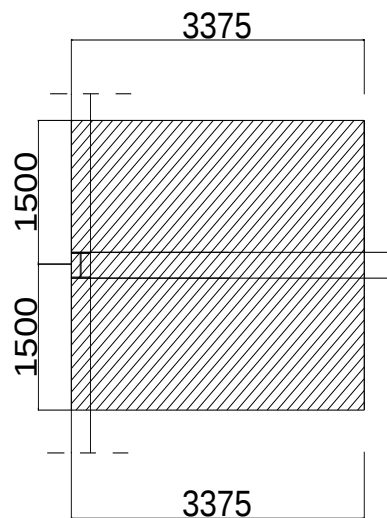
$$W = 66 \text{ kg/m}$$

$$I_x = 55683,6 \text{ cm}^4$$

$$Z_x = 1283,585 \text{ cm}^3$$

### L1.3 Preliminary Kolom

(Kolom A-5 lt. 3)



**Gambar L1.3 Gambar kolom lantai 3 yang ditinjau**

### **Beban Mati**

#### **Beban yang bekerja pada kolom lantai akibat balok,**

Balok B1&B5 diasumsikan menggunakan profil CSHC 600.200.8.13 dengan berat sendiri = 66kg/m

$$\begin{aligned}V_{SDL\text{Balok}} &= 2x (\text{BS Balok} \times 1,5) + (\text{BS Balok} \times 3,375 \text{ m}) \\&= 2x (66 \times 1,5) + (66 \times 3,375) \\&= 420,75 \text{ kg}\end{aligned}$$

#### **Beban yang bekerja pada kolom lantai akibat pelat lantai,**

Berat sendiri pelat beton ( $t = 15\text{cm} = 0.15\text{m}$ ) =  $0.5 \times 2400 \times 70\% = 252 \text{ kg/m}^2$

$$q_{\text{Pelat}} = 252 \text{ kg/m}^2$$

$$V_{SDL\text{Pelat}} = 252 \times 3,375 \times 3 = 2551,5 \text{ kg}$$

#### **Beban yang bekerja pada kolom lantai akibat pelat,**

$$V_{SDL\text{Kolom Lt3}} = 66 \times (3,375) = 222,75 \text{ kg}$$

$$\begin{aligned}V_{SDL} &= V_{SDL\text{Balok}} + V_{SDL\text{Pelat}} + V_{SDL\text{Kolom Lt.3}} \\&= 420,75 + 2551,5 + 222,75 \\&= 3195 \text{ kg}\end{aligned}$$

### **Beban hidup**

$$V_{LL} = 400 \text{ kg/m}^2 \times 3,375 \times 3 = 4050 \text{ kg}$$

$$\begin{aligned}N_{\text{ult}} &= 1.2V_{SDL} + 1.6 V_{LL} \\&= 1.2 (3195) + 1.6 (4050) \\&= 10314 \text{ kg} = 103140 \text{ N} = 103,14 \text{ KN}\end{aligned}$$

Profil kolom komposit :

IWF 600.200.11.17

$$\text{Data profil : } A = 134,4 \text{ cm}^2$$

$$W = 106 \text{ kg/m}$$

$$I_x = 77600 \text{ cm}^4$$

$$S_x (\text{Modulus Penampang Elastis}) = 2590 \text{ cm}^3$$

$$\text{Luas penampang beton, } A_c = 800 \times 400 = 320000 \text{ mm}^2$$

Luas penampang profil baja,  $A_s = 13440 \text{ mm}^2$

Periksa terhadap syarat luas minimum profil baja:

$$\frac{A_s}{A_c} = \frac{13440}{320000} \times 100\% = 4,2\% > 4\%$$

Periksa syarat jarak sengkang/pengikat lateral:

$$\text{Jarak sengkang} = 250 \text{ mm} < 2/3 \times 500 = 333,3 \text{ mm}$$

Periksa syarat luas tulangan longitudinal:

$$\begin{aligned} \text{Jarak antar tulangan longitudinal} &= 800 - 2(40) - 2(10) - 22 \\ &= 678 \text{ mm} \end{aligned}$$

$$\begin{aligned} \text{Luas tulangan longitudinal} &= \frac{1}{4} \times \pi \times 22^2 \\ &= 380,13 \text{ mm}^2 > 0,18 \text{ mm}^2/\text{mm} (678 \text{ mm}) \\ &= 122,04 \text{ mm}^2 \end{aligned}$$

Periksa syarat tulangan lateral:

$$\begin{aligned} \text{Luas tulangan sengkang} &= \frac{1}{4} \times \pi \times 10^2 \\ &= 78,54 \text{ mm}^2 > 0,18 \text{ mm}^2/\text{mm} (250 \text{ mm}) \\ &= 45 \text{ mm}^2 \end{aligned}$$

Hitung tegangan leleh modifikasi:

$$\text{Luas total tulangan longitudinal, } A_r = 4(380,13) = 1520,52 \text{ mm}^2$$

$$\text{Luas netto beton, } A_c = 320000 - 13440 - 1520,52 = 305039,48 \text{ mm}^2$$

Untuk profil baja yang diberi selubung beton, maka:

$$c_1 = 0,7 \quad c_2 = 0,6 \quad c_3 = 0,2$$

$$\begin{aligned} f_{my} &= f_y + c_1 \cdot f_{yr} \cdot \left( \frac{A_r}{A_s} \right) + c_2 \cdot f'_c \cdot \left( \frac{A_c}{A_s} \right) \\ &= 240 + 0,7 \cdot (400) \cdot \left( \frac{1520,52}{13440} \right) + 0,6 \cdot (25) \cdot \left( \frac{305039,48}{13440} \right) \\ &= 612,12 \text{ MPa} \end{aligned}$$

Hitung modulus elastisitas modifikasi:

$$E_m = E + c_3 \cdot E_c \cdot \left( \frac{A_c}{A_s} \right)$$

$$= 200000 + 0,2 \cdot (24100) \cdot \left( \frac{305039,48}{13440} \right)$$

$$= 309396,60 \text{ MPa}$$

Jari-jari girasi kolom komposit diambil dari nilai terbesar antara:

$$\begin{aligned} 0,3b &= 0,3(400) = 120 \text{ mm} \\ r_y &= 41,2 \text{ mm} \end{aligned} \quad \} r_m = 120 \text{ mm}$$

Kuat tekan kolom komposit:

$$\lambda_c = \frac{k_c \cdot L}{r_m \cdot \pi} \sqrt{\frac{f_{my}}{E_m}} = \frac{3600}{120 \times \pi} \sqrt{\frac{612,12}{309396,6}} = 0,339$$

Karena  $0,25 < \lambda_c < 1,2$ , maka

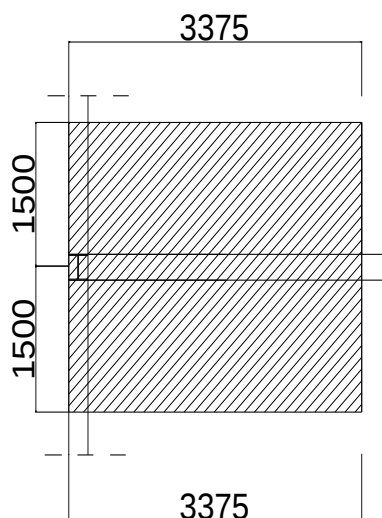
$$\omega = \frac{1,43}{1,6 - 0,67\lambda_c} = \frac{1,43}{1,6 - 0,67(0,339)} = 1,04$$

$$f_{cr} = \frac{f_{my}}{\omega} = \frac{612,12}{1,04} = 588,58 \text{ MPa}$$

$$N_n = A_s \cdot f_{cr} = 13440(588,58) = 7910515,2 \text{ N}$$

$$\phi N_n = 0,85(7910515,2) = 6723937,92 \text{ N} > N_{ult} = 103140 \text{ N}$$

(Kolom A-5 lt.2)



**Gambar L1.4 Gambar kolom lantai 2 yang ditinjau**

### **Beban Mati**

Beban yang bekerja pada kolom lantai akibat balok,

Balok B1&B5 diasumsikan menggunakan profil CSHC 600.200.8.13 dengan berat sendiri = 66kg/m

$$\begin{aligned}V_{SDLBalok} &= 2x (BS \text{ Balok} \times 1,5) + (BS \text{ Balok} \times 3,375 \text{ m}) \\&= 2x (66 \times 1,5) + (66 \times 3,375) \\&= 420,75 \text{ kg}\end{aligned}$$

Beban yang bekerja pada kolom lantai akibat pelat lantai,

Berat sendiri pelat beton ( $t = 15\text{cm} = 0.15\text{m}$ ) =  $0.5 \times 2400 \times 70\% = 252 \text{ kg/m}^2$

$$q_{Pelat} = 252 \text{ kg/m}^2$$

$$V_{SDLPelat} = 252 \times 3,375 \times 3 = 2551,5 \text{ kg}$$

Beban yang bekerja pada kolom lantai akibat pelat,

$$\begin{aligned}V_{SDLKolom Lt2} &= 66 \times (3,375) = 222,75 \text{ kg} \\V_{SDL} &= V_{SDLBalok} + V_{SDLPelat} + V_{SDLKolom Lt.2} + N_{kolom Lt.3} \\&= 420,75 + 2551,5 + 222,75 + 10314 \\&= 13509 \text{ kg}\end{aligned}$$

### **Beban hidup**

$$V_{LL} = 400 \text{ kg/m}^2 \times 3,375 \times 3 = 4050 \text{ kg}$$

$$\begin{aligned}N_{ult} &= 1.2V_{SDL} + 1.6 V_{LL} \\&= 1.2 (13509) + 1.6 (4050) \\&= 22690 \text{ kg} = 226900 \text{ N}\end{aligned}$$

Profil kolom komposit :

IWF 600.200.11.17

Data profil :  $A = 134,4 \text{ cm}^2$

$W = 106 \text{ kg/m}$

$I_x = 77600 \text{ cm}^4$

$S_x (\text{Modulus Penampang Elastis}) = 2590 \text{ cm}^3$

Luas penampang beton,  $A_c = 800 \times 400 = 320000 \text{ mm}^2$

Luas penampang profil baja,  $A_s = 13440 \text{ mm}^2$

Periksa terhadap syarat luas minimum profil baja:

$$\frac{A_s}{A_c} = \frac{13440}{320000} \times 100\% = 4,2\% > 4\%$$

Periksa syarat jarak sengkang/pengikat lateral:

$$\text{Jarak sengkang} = 250 \text{ mm} < \frac{2}{3} \times 500 = 333,3 \text{ mm}$$

Periksa syarat luas tulangan longitudinal:

$$\begin{aligned} \text{Jarak antar tulangan longitudinal} &= 800 - 2(40) - 2(10) - 22 \\ &= 678 \text{ mm} \end{aligned}$$

$$\begin{aligned} \text{Luas tulangan longitudinal} &= \frac{1}{4} \times \pi \times 22^2 \\ &= 380,13 \text{ mm}^2 > 0,18(678) = 122,04 \text{ mm}^2 \end{aligned}$$

Periksa syarat tulangan lateral:

$$\begin{aligned} \text{Luas tulangan sengkang} &= \frac{1}{4} \times \pi \times 10^2 \\ &= 78,54 \text{ mm}^2 > 0,18(250) = 45 \text{ mm}^2 \end{aligned}$$

Hitung tegangan leleh modifikasi:

$$\text{Luas total tulangan longitudinal, } A_r = 4(380,13) = 1520,52 \text{ mm}^2$$

$$\text{Luas netto beton, } A_c = 320000 - 13440 - 1520,52 = 305039,48 \text{ mm}^2$$

Untuk profil baja yang diberi selubung beton, maka:

$$c_1 = 0,7 \quad c_2 = 0,6 \quad c_3 = 0,2$$

$$\begin{aligned} f_{my} &= f_y + c_1 \cdot f_{yr} \cdot \left( \frac{A_r}{A_s} \right) + c_2 \cdot f'_c \cdot \left( \frac{A_c}{A_s} \right) \\ &= 240 + 0,7 \cdot (400) \cdot \left( \frac{1520,52}{13440} \right) + 0,6 \cdot (25) \cdot \left( \frac{305039,48}{13440} \right) \\ &= 612,12 \text{ MPa} \end{aligned}$$

Hitung modulus elastisitas modifikasi:

$$E_m = E + c_3 \cdot E_c \cdot \left( \frac{A_c}{A_s} \right)$$

$$= 200000 + 0,2 \cdot (24100) \cdot \left( \frac{305039,48}{13440} \right)$$

$$= 309396,60 \text{ MPa}$$

Jari-jari girasi kolom komposit diambil dari nilai terbesar antara:

$$\begin{aligned} 0,3b &= 0,3(400) = 120\text{mm} \\ r_y &= 41,2\text{mm} \end{aligned} \quad \} r_m = 120\text{mm}$$

Kuat tekan kolom komposit:

$$\lambda_c = \frac{k_c \cdot L}{r_m \cdot \pi} \sqrt{\frac{f_{my}}{E_m}} = \frac{3600}{120 \times \pi} \sqrt{\frac{612,12}{309396,6}} = 0,339$$

Karena  $0,25 < \lambda_c < 1,2$ , maka

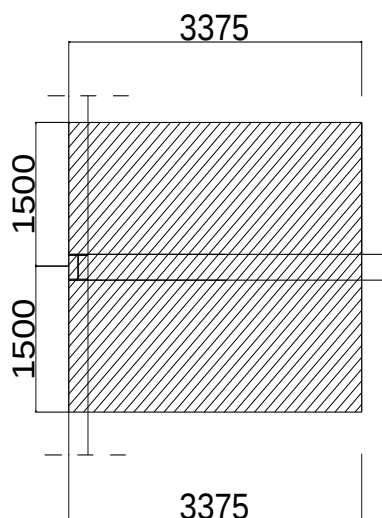
$$\omega = \frac{1,43}{1,6 - 0,67\lambda_c} = \frac{1,43}{1,6 - 0,67(0,339)} = 1,04$$

$$f_{cr} = \frac{f_{my}}{\omega} = \frac{612,12}{1,04} = 588,58 \text{ MPa}$$

$$N_n = A_s \cdot f_{cr} = 13440(588,58) = 7910515,2 \text{ N}$$

$$\phi N_n = 0,85(7910515,2) = 6723937,92 \text{ N} > N_{ult} = 226900 \text{ N}$$

(Kolom A-5 lt.1)



**Gambar L1.5 Gambar kolom lantai 1 yang ditinjau**

### **Beban Mati**

Beban yang bekerja pada kolom lantai akibat balok,

Balok B1&B5 diasumsikan menggunakan profil CSHC 600.200.8.13 dengan berat sendiri = 66kg/m

$$\begin{aligned}V_{SDLBalok} &= 2x (BS \text{ Balok} \times 1,5) + (BS \text{ Balok} \times 3,375 \text{ m}) \\&= 2x (66 \times 1,5) + (66 \times 3,375) \\&= 420,75 \text{ kg}\end{aligned}$$

Beban yang bekerja pada kolom lantai akibat pelat lantai,

Berat sendiri pelat beton ( $t = 15\text{cm} = 0.15\text{m}$ ) =  $0.5 \times 2400 \times 70\% = 252 \text{ kg/m}^2$

$$q_{Pelat} = 252 \text{ kg/m}^2$$

$$V_{SDLPelat} = 252 \times 3,375 \times 3 = 2551,5 \text{ kg}$$

Beban yang bekerja pada kolom lantai akibat pelat,

$$V_{SDLKolom Lt1} = 66 \times (3,375) = 222,75 \text{ kg}$$

$$\begin{aligned}V_{SDL} &= V_{SDLBalok} + V_{SDLPelat} + V_{SDLKolom Lt.1} + N_{kolom Lt2} \\&= 420,75 + 2551,5 + 222,75 + 22690 \\&= 25885 \text{ kg}\end{aligned}$$

### **Beban hidup**

$$V_{LL} = 400 \text{ kg/m}^2 \times 3,375 \times 3 = 4050 \text{ kg}$$

$$\begin{aligned}N_{ult} &= 1.2V_{SDL} + 1.6 V_{LL} \\&= 1.2 (25885) + 1.6 (4050) \\&= 37542 \text{ kg} = 375420 \text{ N}\end{aligned}$$

Profil kolom komposit :

IWF 600.200.11.17

Data profil :  $A = 134,4 \text{ cm}^2$

$W = 106 \text{ kg/m}$

$I_x = 77600 \text{ cm}^4$

$S_x (\text{Modulus Penampang Elastis}) = 2590 \text{ cm}^3$

Luas penampang beton,  $A_c = 800 \times 400 = 320000 \text{ mm}^2$

Luas penampang profil baja,  $A_s = 13440 \text{ mm}^2$

Periksa terhadap syarat luas minimum profil baja:

$$\frac{A_s}{A_c} = \frac{13440}{320000} \times 100\% = 4,2\% > 4\%$$

Periksa syarat jarak sengkang/pengikat lateral:

$$\text{Jarak sengkang} = 250 \text{ mm} < \frac{2}{3} \times 500 = 333,3 \text{ mm}$$

Periksa syarat luas tulangan longitudinal:

$$\begin{aligned} \text{Jarak antar tulangan longitudinal} &= 800 - 2(40) - 2(10) - 22 \\ &= 678 \text{ mm} \end{aligned}$$

$$\begin{aligned} \text{Luas tulangan longitudinal} &= \frac{1}{4} \times \pi \times 22^2 \\ &= 380,13 \text{ mm}^2 > 0,18(678) = 122,04 \text{ mm}^2 \end{aligned}$$

Periksa syarat tulangan lateral:

$$\begin{aligned} \text{Luas tulangan sengkang} &= \frac{1}{4} \times \pi \times 10^2 \\ &= 78,54 \text{ mm}^2 > 0,18(250) = 45 \text{ mm}^2 \end{aligned}$$

Hitung tegangan leleh modifikasi:

$$\text{Luas total tulangan longitudinal, } A_r = 4(380,13) = 1520,52 \text{ mm}^2$$

$$\text{Luas netto beton, } A_c = 320000 - 13440 - 1520,52 = 305039,48 \text{ mm}^2$$

Untuk profil baja yang diberi selubung beton, maka:

$$c_1 = 0,7 \quad c_2 = 0,6 \quad c_3 = 0,2$$

$$\begin{aligned} f_{my} &= f_y + c_1 \cdot f_{yr} \cdot \left( \frac{A_r}{A_s} \right) + c_2 \cdot f'_c \cdot \left( \frac{A_c}{A_s} \right) \\ &= 240 + 0,7 \cdot (400) \cdot \left( \frac{1520,52}{13440} \right) + 0,6 \cdot (25) \cdot \left( \frac{305039,48}{13440} \right) \\ &= 612,12 \text{ MPa} \end{aligned}$$

Hitung modulus elastisitas modifikasi:

$$E_m = E + c_3 \cdot E_c \cdot \left( \frac{A_c}{A_s} \right)$$

$$= 200000 + 0,2 \cdot (24100) \cdot \left( \frac{305039,48}{13440} \right)$$

$$= 309396,60 \text{ MPa}$$

Jari-jari girasi kolom komposit diambil dari nilai terbesar antara:

$$\begin{aligned} 0,3b &= 0,3(400) = 120 \text{ mm} \\ r_y &= 41,2 \text{ mm} \end{aligned} \quad \} r_m = 120 \text{ mm}$$

Kuat tekan kolom komposit:

$$\lambda_c = \frac{k_c \cdot L}{r_m \cdot \pi} \sqrt{\frac{f_{my}}{E_m}} = \frac{3600}{120 \times \pi} \sqrt{\frac{612,12}{309396,6}} = 0,339$$

Karena  $0,25 < \lambda_c < 1,2$ , maka

$$\omega = \frac{1,43}{1,6 - 0,67\lambda_c} = \frac{1,43}{1,6 - 0,67(0,339)} = 1,04$$

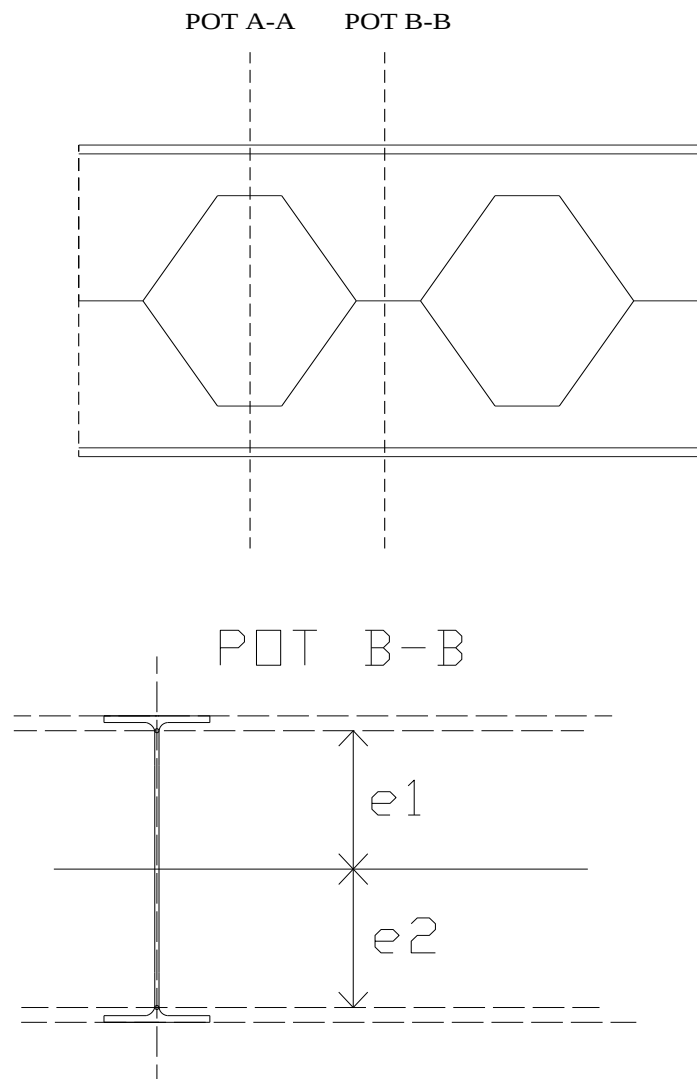
$$f_{cr} = \frac{f_{my}}{\omega} = \frac{612,12}{1,04} = 588,58 \text{ MPa}$$

$$N_n = A_s \cdot f_{cr} = 13440(588,58) = 7910515,2 \text{ N}$$

$$\phi N_n = 0,85(7910515,2) = 6723937,92 \text{ N} > N_{ult} = 375420 \text{ N}$$

### L1.4 Modulus Penampang Plastis (Z) Castellated Beam “Honey Comb”

Profil CSHC 600.200.8.13



Arah X (POT B-B)

| No | A (Luas) | y (titik berat) | $\Delta y = A \cdot y$ |
|----|----------|-----------------|------------------------|
| 1  | 2600     | 293,5           | 763100                 |
| 2  | 2296     | 143,5           | 329476                 |
|    | 4896     |                 | 1092576                |

$$y = \Delta y / A = 1092576/4896$$

$$y_1 = y_2 = 223,1569 \text{ mm} = 22,31569 \text{ cm}$$

$$Z_x = 0,5A_t \cdot (y_1 + y_2)$$

$$Z_x = 100,12 \cdot 22,31569$$

$$Z_x = 2234,2469 \text{ cm}^3$$

Arah Y (POT B-B)

| No | A (Luas) | x (titik berat) | $\Delta x = A \cdot x$ |
|----|----------|-----------------|------------------------|
| 1  | 1300     | 50              | 65000                  |
| 2  | 2296     | 2               | 4592                   |
| 3  | 1300     | 50              | 65000                  |
|    | 4896     |                 | 134592                 |

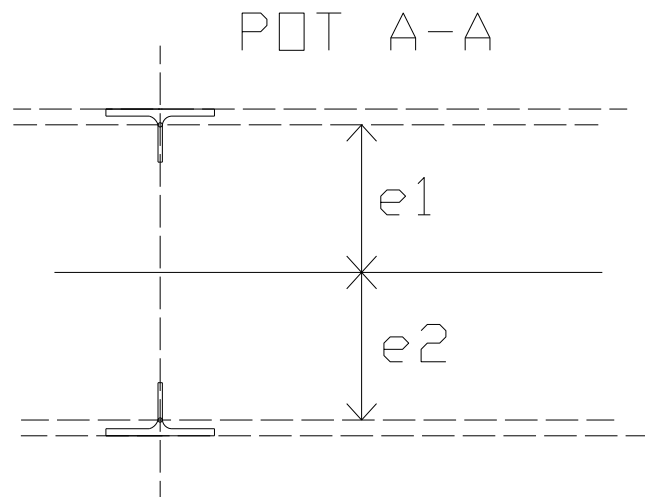
$$x = \Delta x / A = 134592/4896$$

$$x_1 = x_2 = 27,4902 \text{ mm} = 2,74902 \text{ cm}$$

$$Z_y = 0,5A_t \cdot (x_1 + x_2)$$

$$Z_y = 100,12 \cdot 2,74902$$

$$Z_y = 275,2319 \text{ cm}^3$$



Arah X (POT A-A)

| No | A (Luas) | y (titik berat) | $\Delta y = A \cdot y$ |
|----|----------|-----------------|------------------------|
| 1  | 2600     | 293,5           | 763100                 |
| 2  | 676      | 244,75          | 165451                 |
|    | 3276     |                 | 928551                 |

$$y = \Delta y / A = 928551/3276$$

$$y_1 = y_2 = 283,4405 \text{ mm} = 28,34405 \text{ cm}$$

$$Z_x = 0,5A_t \cdot (y_1 + y_2)$$

$$Z_x = 67,68 \cdot 28,34405$$

$$Z_x = 1918,325 \text{ cm}^3$$

Arah Y (POT A-A)

| No | A (Luas) | x (titik berat) | $\Delta x = A \cdot x$ |
|----|----------|-----------------|------------------------|
| 1  | 1300     | 50              | 65000                  |
| 2  | 338      | 2               | 676                    |

|   |      |    |        |
|---|------|----|--------|
| 3 | 1300 | 50 | 65000  |
| 4 | 338  | 2  | 676    |
|   | 3276 |    | 131352 |

$$x = \Delta x / A = 131352/3276$$

$$x_1 = x_2 = 40,095 \text{ mm} = 4,0095 \text{ cm}$$

$$Z_y = 0,5 A_t \cdot (x_1 + x_2)$$

$$Z_y = 67,68 \cdot 4,0095$$

$$Z_y = 271,36 \text{ cm}^3$$

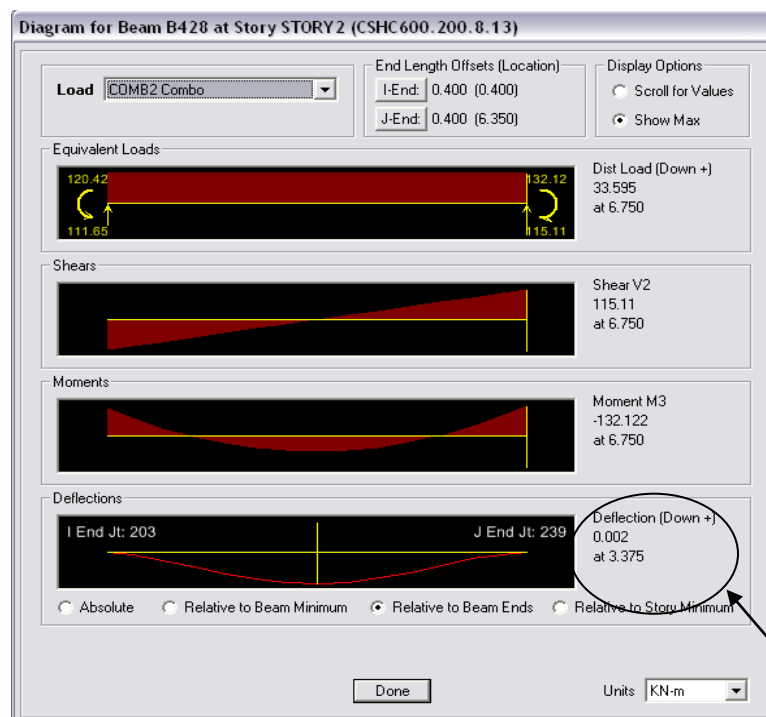
## LAMPIRAN 2

### HASIL *OUTPUT* PERANGKAT LUNAK

#### L2.1 Hasil Analisis Struktur

##### a Mengecek Lendutan

*Click* kanan pada balok yang akan dicek lendutannya, maka muncul tampilan seperti dibawah ini. Ubah satuan sesuai dengan yang diinginkan. Angka yang terdapat pada *Deflection* adalah lendutan yang dihasilkan.



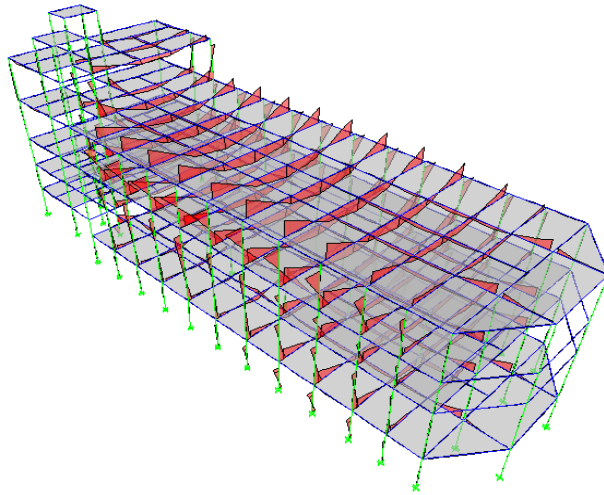
**Gambar L2.1.1. Mengecek Lendutan Pada Balok**

Menurut Tabel 2.4.2 tentang batas lendutan maksimum, balok biasa yang tidak memikul beban dinding mempunyai batas maksimum  $L/240 = 6,75/240 = 0,028$  m  
 $0,002 \text{ m} < 0,028 \text{ m} \rightarrow (\text{ok})$

## b . Analisis

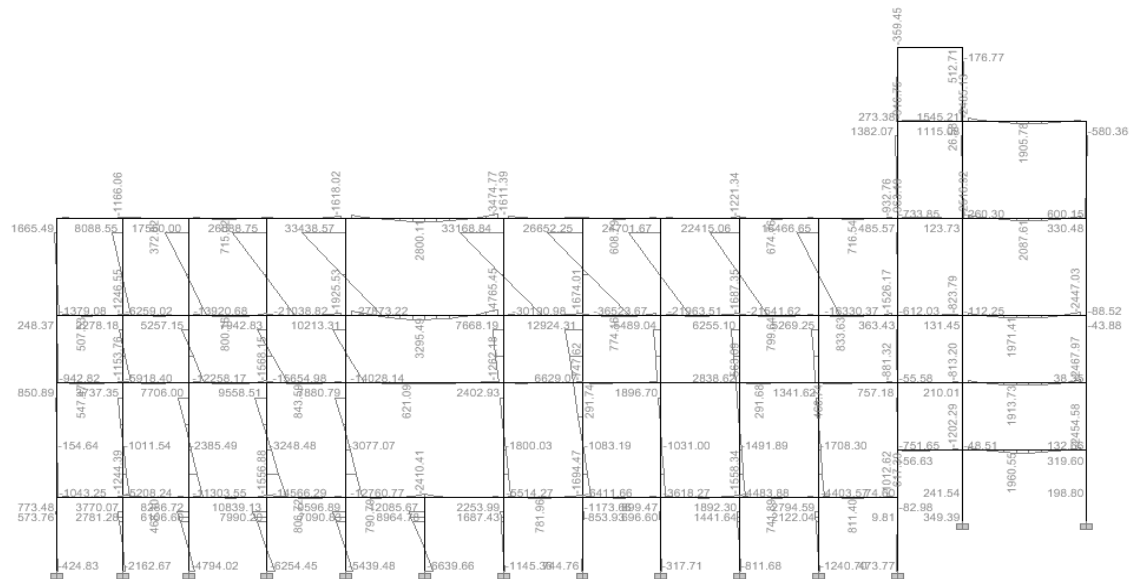
### Moment 3-3

Tampilan hasil analisis Moment 3-3, Tampak 3 Dimensi



**Gambar L2.1.2. Hasil Analisis *Moment* 3-3, Tampak 3**

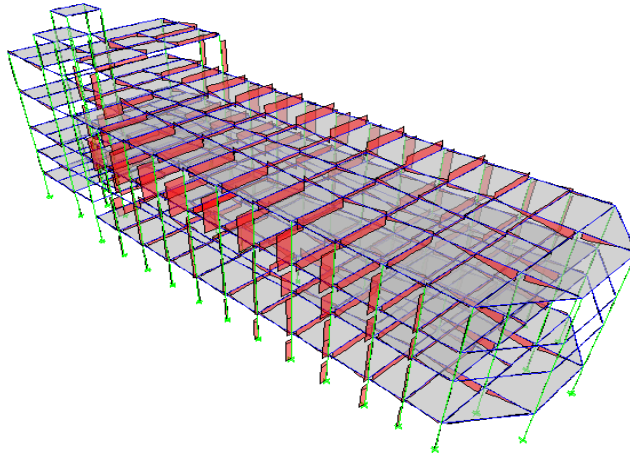
Tampilan hasil analisis Moment 3-3, Potongan A



**Gambar L2.1.3. Hasil Analisis *Moment* 3-3, Potongan A**

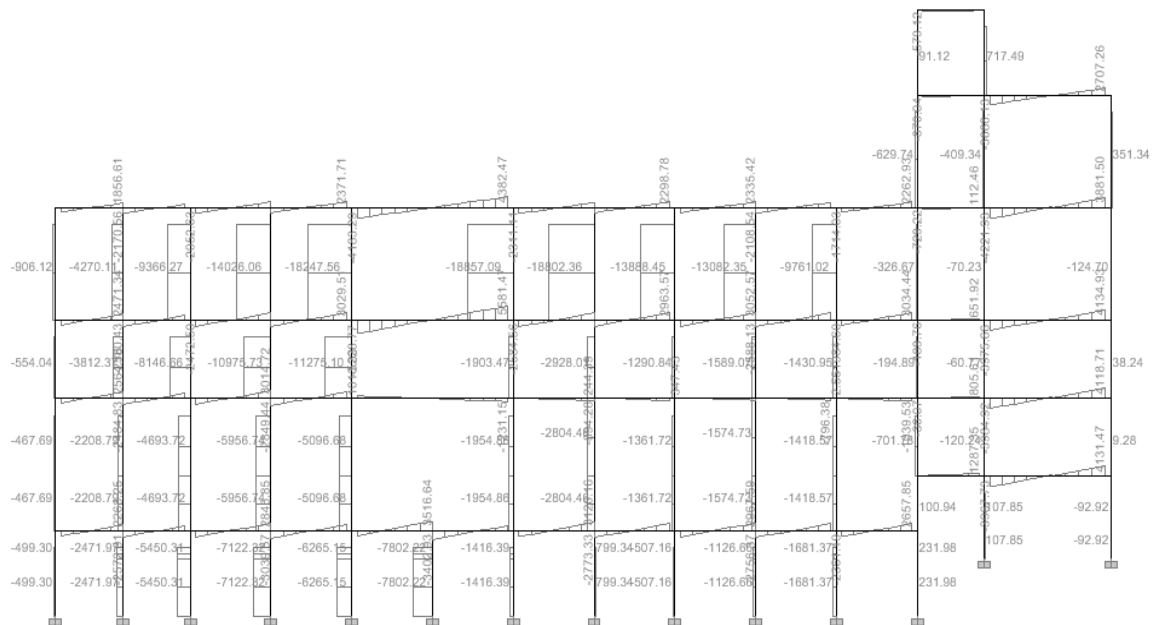
## Shear 2-2

Tampilan hasil analisis Shear 2-2, Tampak 3 Dimensi



**Gambar L2.1.4. Hasil Analisis *Shear 2-2*, Tampak 3**

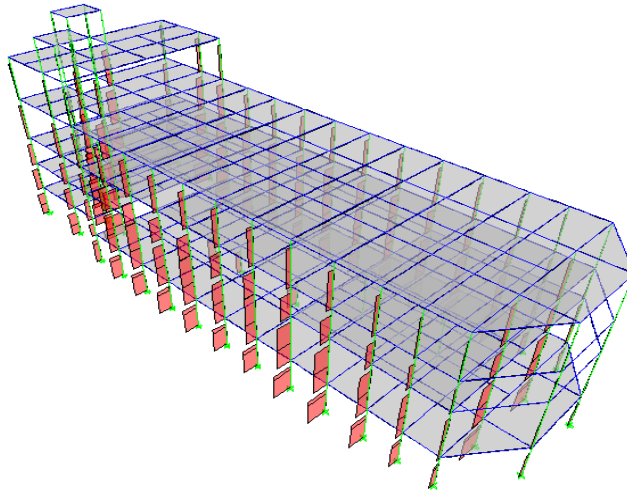
Tampilan hasil analisis Shear 2-2, Potongan A



**Gambar L2.1.5. Hasil Analisis *Shear 2-2*, Potongan A**

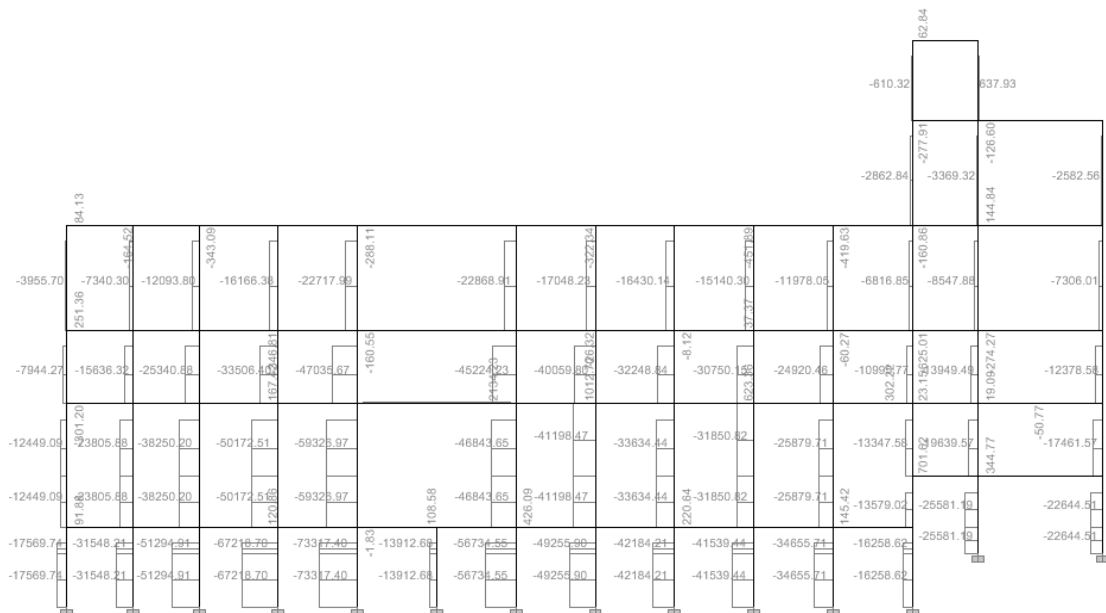
## Axial Forces

Tampilan hasil analisis Axial Forces, Tampak 3 Dimensi



**Gambar L2.1.6. Hasil Analisis *Axial Forces*, Tampak 3**

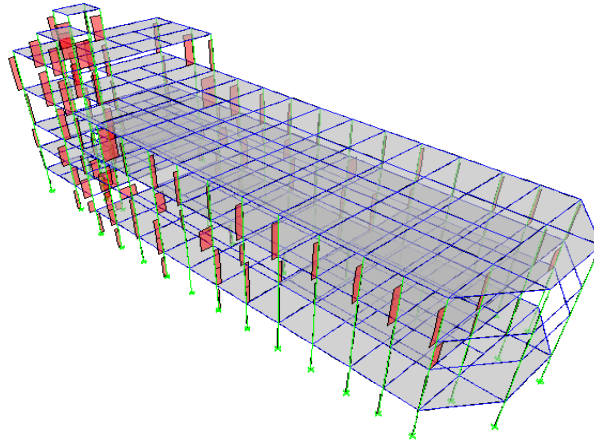
Tampilan hasil analisis Axial Forces, Potongan A



**Gambar L2.1.7. Hasil Analisis *Axial Forces*, Potongan A**

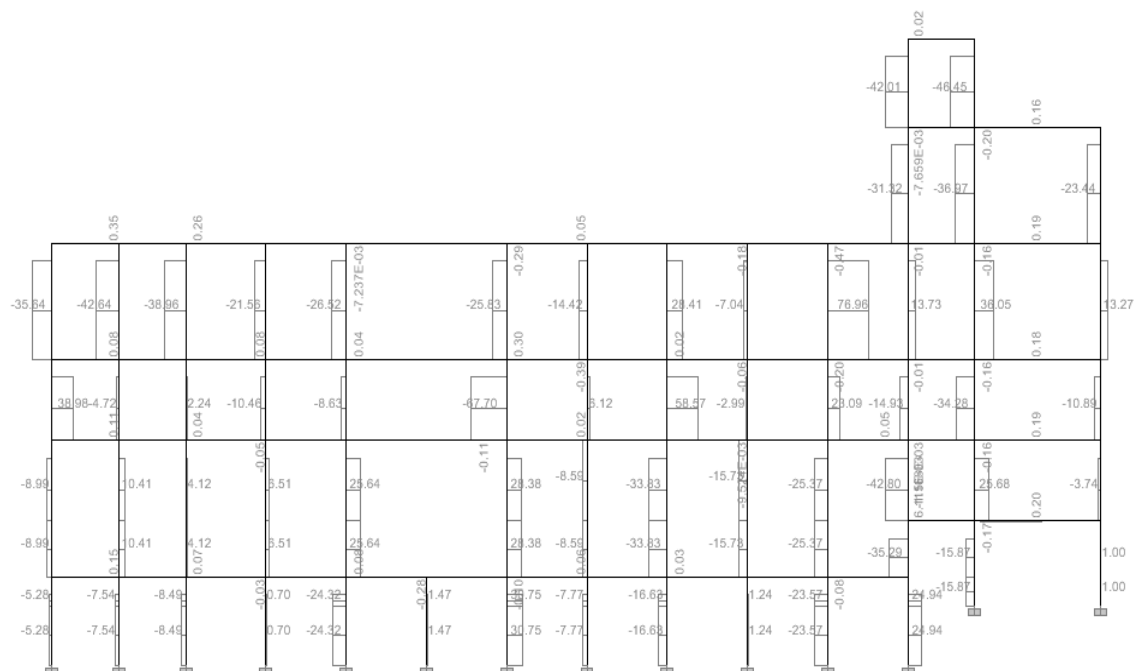
## Torsion

Tampilan hasil analisis Torsion, Tampak 3 Dimensi



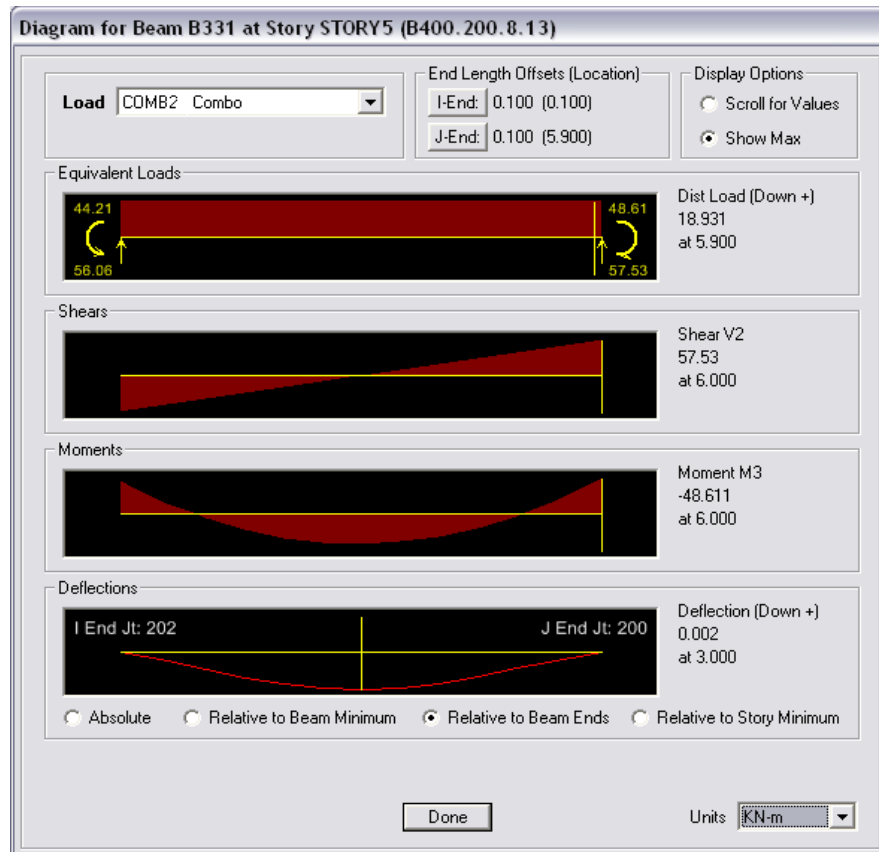
**Gambar L2.1.8. Hasil Analisis *Torsion*, Tampak 3 Dimensi**

Tampilan hasil analisis Torsion, Potongan A



**Gambar L2.1.9. Hasil Analisis *Torsion*, Potongan A**

## L2.2 Kontrol kekuatan & stabilitas balok IWF 400.200.8.13



**Gambar L2.2 Output gaya-gaya dalam yang bekerja**

Output ETABS :  $V_u = 57,53 \text{ KNm}$

$M_u = 48,611 \text{ KNm}$

Dipakai profil : IWF 400.200.8.13

$Z_x = 1326,26 \text{ cm}^3$

Mutu Baja : Bj-41 ;  $f_y = 250 \text{ MPa} = 2500 \text{ kg/cm}^2$

Kelangsingan penampang

Sayap

$$\lambda_s = \frac{b}{2t_1} = \frac{200}{2 \times 13} = 7,69$$

$$\lambda_{ps} = \frac{170}{\sqrt{f_y}} = \frac{170}{\sqrt{250}} = 10,75$$

$$\lambda_{rs} = \frac{370}{\sqrt{f_y - f_r}} = 27,6$$

$\lambda_s = 7,69 < \lambda_{ps} = 10,75 \rightarrow$  sayap Kompak

Badan

$$\lambda_b = \frac{h'}{tw} = \frac{400 - 2(13 + 16)}{8} = 42,75$$

$$\lambda_{pb} = \frac{1680}{\sqrt{f_y}} = \frac{1680}{\sqrt{250}} = 106,25$$

$$\lambda_{rb} = \frac{2550}{\sqrt{f_y}} = \frac{2550}{\sqrt{250}} = 161,3$$

$$\lambda_b = 42,75 < \lambda_{pb} = 106,25 \rightarrow \text{badan Kompak}$$

→ Penampang Kompak

maka Mn dihitung dengan persamaan,

$$M_n = M_p$$

Momen Nominal Balok

Analisis Plastis

$$M_p = f_y \times Z_x = 250 \times 1326,26 \times 10^3 = 331565000 \text{ Nmm} = 331,565 \text{ KNm}$$

Analisis Plastis

$$\phi M_n = M_p$$

$$\phi M_n = 0,9 \times 331,565 = 298,408 \text{ KNm}$$

$$\phi M_n = 298,408 \text{ KNm} \geq M_u = 48,611 \text{ KNm} \rightarrow (\text{ok})$$

Kuat geser penampang

Modulus penampang elastisitas baja (E) = 200000 Mpa

$$\frac{h'}{tw} = \frac{400 - 2(13+16)}{8} = 42,75$$

$$1,10 \sqrt{\frac{k_n \times E}{f_y}} \rightarrow k_n = 5 + 5/(a/h')^2 = 5 + 5/(1500/570)^2 = 6,6245$$

$$1,10 \sqrt{\frac{6,6245 \times 200000}{250}} = 71,0047$$

$$\frac{h'}{tw} \leq 1,10 \sqrt{\frac{k_n \times E}{f_y}} \rightarrow V_n = 0,6 \times f_y \times A_w$$

$$A_w = 6768 - (2 \times 200 \times 13) = 1568 \text{ mm}^2 = 15,68 \text{ cm}^2$$

$$V_n = 0,6 \times f_y \times A_w = 0,6 \times 250 \times 1568 = 225792 \text{ N}$$

$$\phi V_n = 0,9 \times 225792 = 203212,8 \text{ N} = 203,2128 \text{ KN}$$

$$\phi V_n = 203,2128 \text{ KN} \geq V_u = 57,53 \text{ KNm} \rightarrow (\text{ok})$$

Kondisi Batas Tekuk Lateral

Batas-batas jarak pengekang lateral (*TCPSB Tabel 8.3-2*)

$$L = 6 \text{ m} \quad r_y = 5,1 \text{ cm} \quad f_L = f_y - f_r = 250 - 70 = 180 \text{ MPa}$$

$$L_p = 1,76 r_y \sqrt{\frac{E}{f_y}} = 1,76 \cdot 51 \cdot \sqrt{\frac{2 \cdot 10^5}{250}} = 2538,8 \text{ mm} = 2,5 \text{ m}$$

$$J = 1/3 [(2b \cdot t_s^3) + ((h - 2t_s) \cdot t_b^3)] = 1/3 [(400 \cdot 13^3) + ((600 - 26) \cdot 8^3)] = 390896$$

$$I_w/I_y = [1/2 (600 - 13)]^2 = 38285,44$$

$$X_1 = \frac{\pi}{S} \sqrt{\frac{EGJA}{2}} = \frac{\pi}{1190 \cdot 10^3} \sqrt{\frac{2 \cdot 10^5 \cdot 0,8 \cdot 10^5 \cdot 390896 \cdot 10012}{2}} = 8632,45$$

$$X_2 = 4 \left( \frac{S}{GJ} \right) \frac{I_w}{I_y} = 4 \cdot \left( \frac{1190 \cdot 10^3}{0,8 \cdot 10^5 \cdot 390896} \right) \cdot 38285,44 = 8,7684$$

$$L_r = r_y \left( \frac{X_1}{f_L} \right) \sqrt{1 + \sqrt{1 + X_2 \cdot f_L^2}} = 51 \cdot \left( \frac{8632,45}{180} \right) \sqrt{1 + \sqrt{1 + 8,7684 \cdot 180^2}} = 6542,5 \text{ mm} = 6,5 \text{ m}$$

$L_p < L < L_r \rightarrow$  bentang menengah

$$M_n = C_b \left[ M_r + (M_p - M_r) \frac{(L_r - L)}{(L_r - L_p)} \right] \leq M_p$$

$$M_r = S(f_y - f_r) = 1190 \cdot 10^3 (180) = 214200000 \text{ Nmm}$$

$$C_b = \frac{12,5 M_{\max}}{2,5 M_{\max} + 3 M_A + 4 M_B + 3 M_C} \leq 2,3$$

SNI 03-1729-2002 pasal 8.3.1] dengan  $M_{\max}$  adalah momen maksimum pada bentang yang ditinjau, serta  $M_A$ ,  $M_B$ , dan  $M_C$  adalah momen pada  $1/4$  bentang, tengah bentang, dan  $3/4$  bentang komponen struktur yang ditinjau.

$$M_{\max} = 48,611 \text{ KNm}$$

$$M_A = 44,209 \text{ KNm} \quad \rightarrow \text{ dari ETABS}$$

$$M_B = 48,611 \text{ KNm}$$

$$M_C = 44,209 \text{ Nmm}$$

$$C_b = \frac{12,5(48,611)}{2,5(48,611) + 3(44,209) + 4(48,611) + 3(44,209)} = 1,045 \leq 2,3$$

$$M_n = 1,045 \left[ 214,2 + (331,565 - 214,2) \frac{(6,5 - 6)}{(6,5 - 2,5)} \right] = 239,17 \text{ KNm} \leq M_p$$

Momen Nominal Balok

Analisis Plastis

$$M_p = f_y \times Z_x = 250 \times 1326,26 \times 10^3 = 331565000 \text{ Nmm} = 331,565 \text{ KNm}$$

Analisis Plastis

$$\phi M_n \geq M_u$$

$$\phi M_n = 0,9 \times 239,17 = 215,253 \text{ KNm}$$

$$\phi M_n = 215,253 \text{ KNm} \geq M_u = 48,611 \text{ KNm} \rightarrow (\text{ok})$$

**Tabel L2.1 Hasil perbandingan kuat lentur nominal**

| Profil     | CSHC 600.200.8.13<br>(IWF 400.200.8.13) | IWF 400.200.8.13 |
|------------|-----------------------------------------|------------------|
| $\Phi.M_n$ | 503,2 KNm                               | 215,2 KNm        |

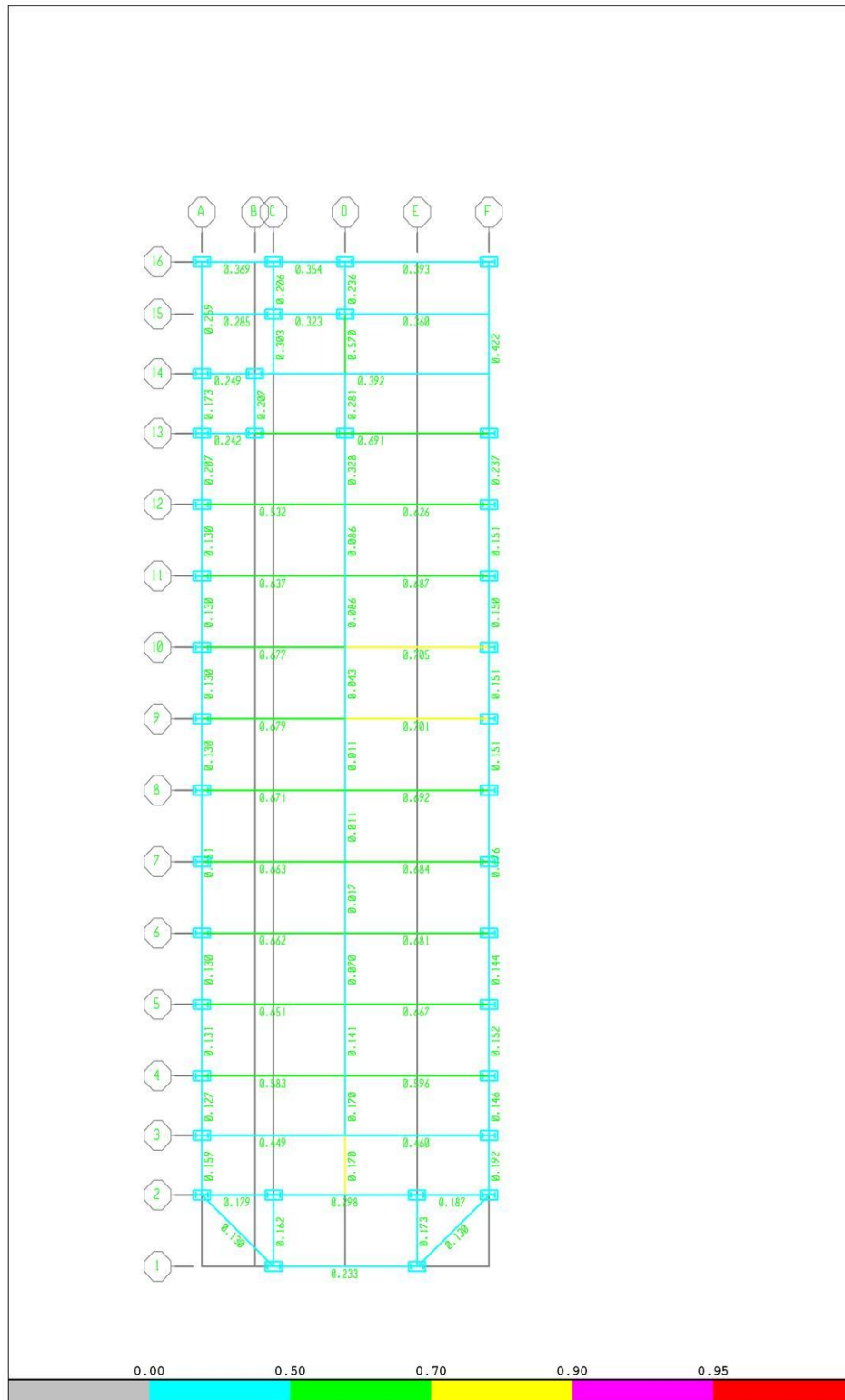
$\Phi.M_n$  = kuat lentur nominal [SNI 03-1729-2002 pasal 8.1.3]

Hasil perbandingan kuat lentur nominal balok *Honey Comb* dan balok IWF :

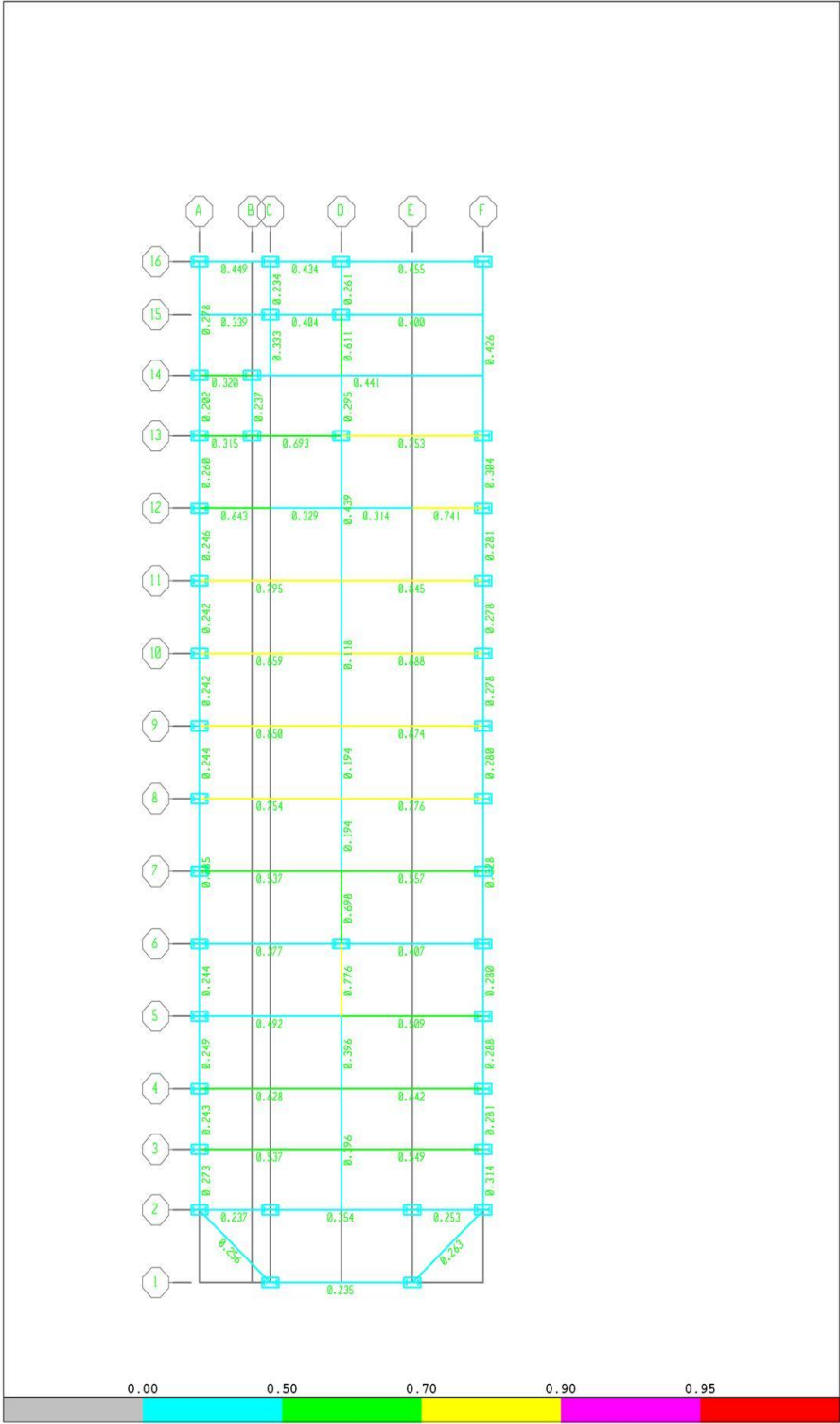
$$\frac{503,2 - 215,2}{503,2} \times 100\% = 57,23\%$$

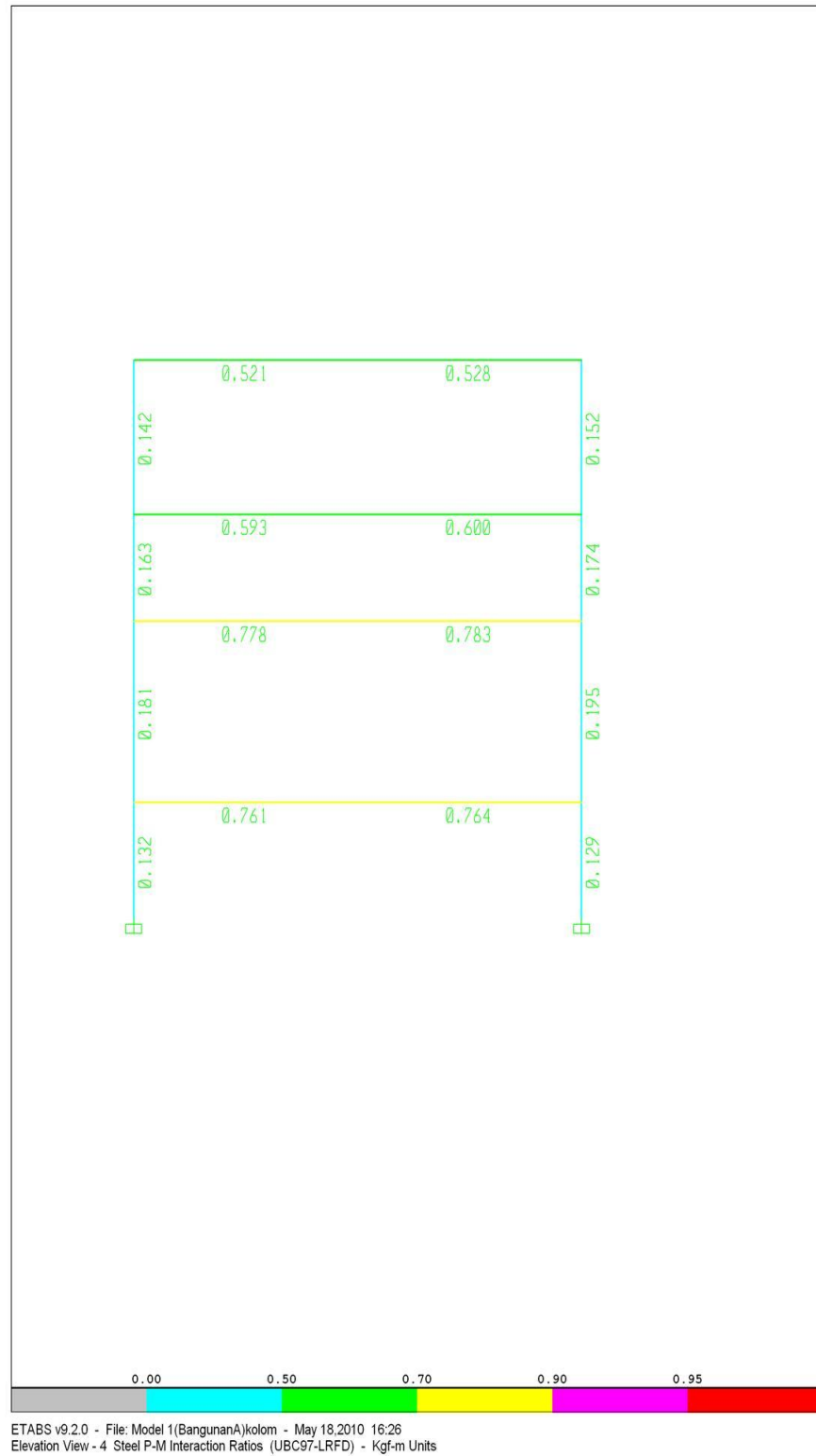
→ kuat lentur nominal balok *Honey Comb* lebih tinggi 57,23% dari balok IWF .

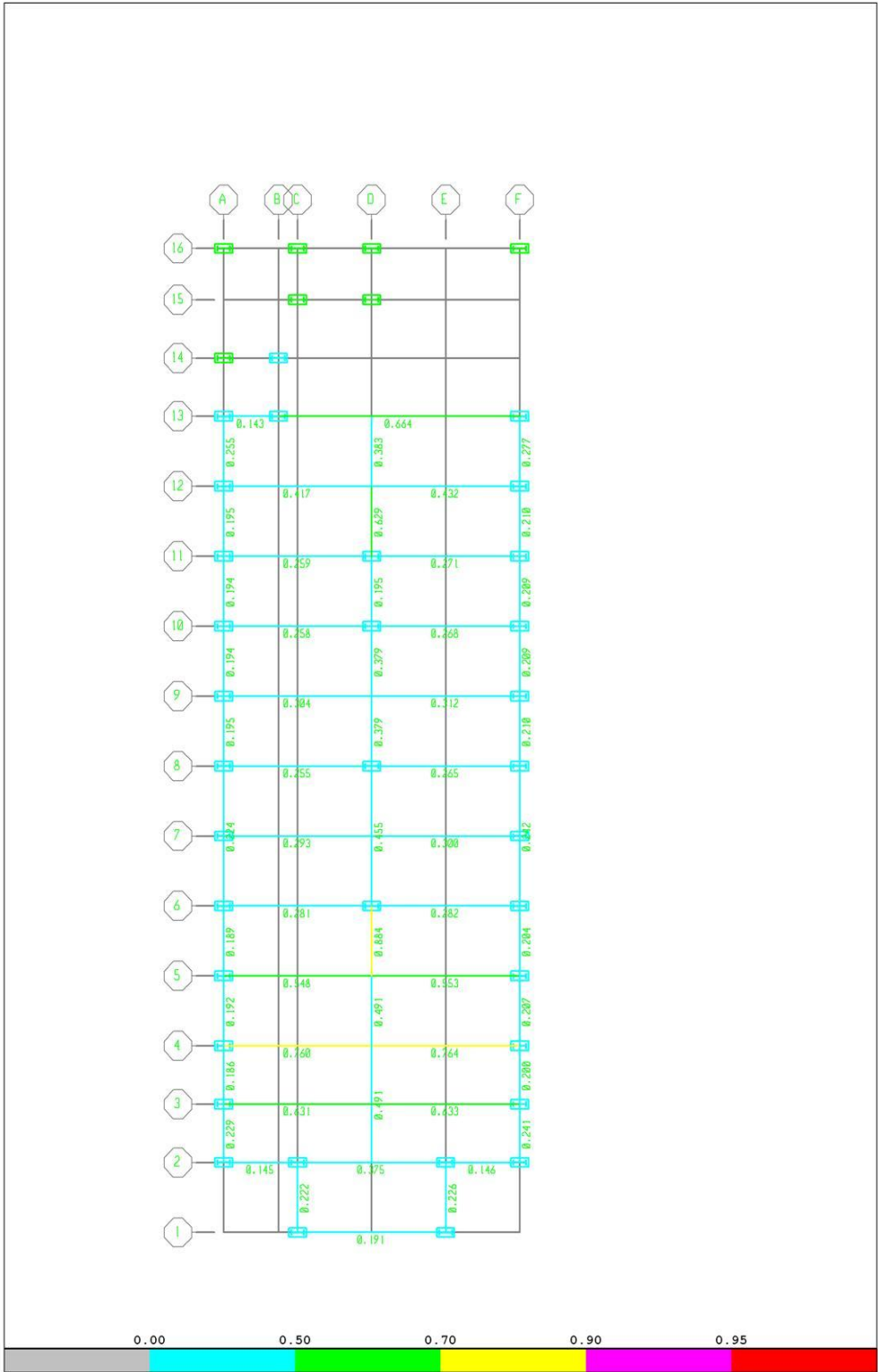
**LAMPIRAN 3 GAMBAR ARSITEKTUR, GAMBAR STRUKTUR,  
BROSUR, DAN LAIN-LAIN**



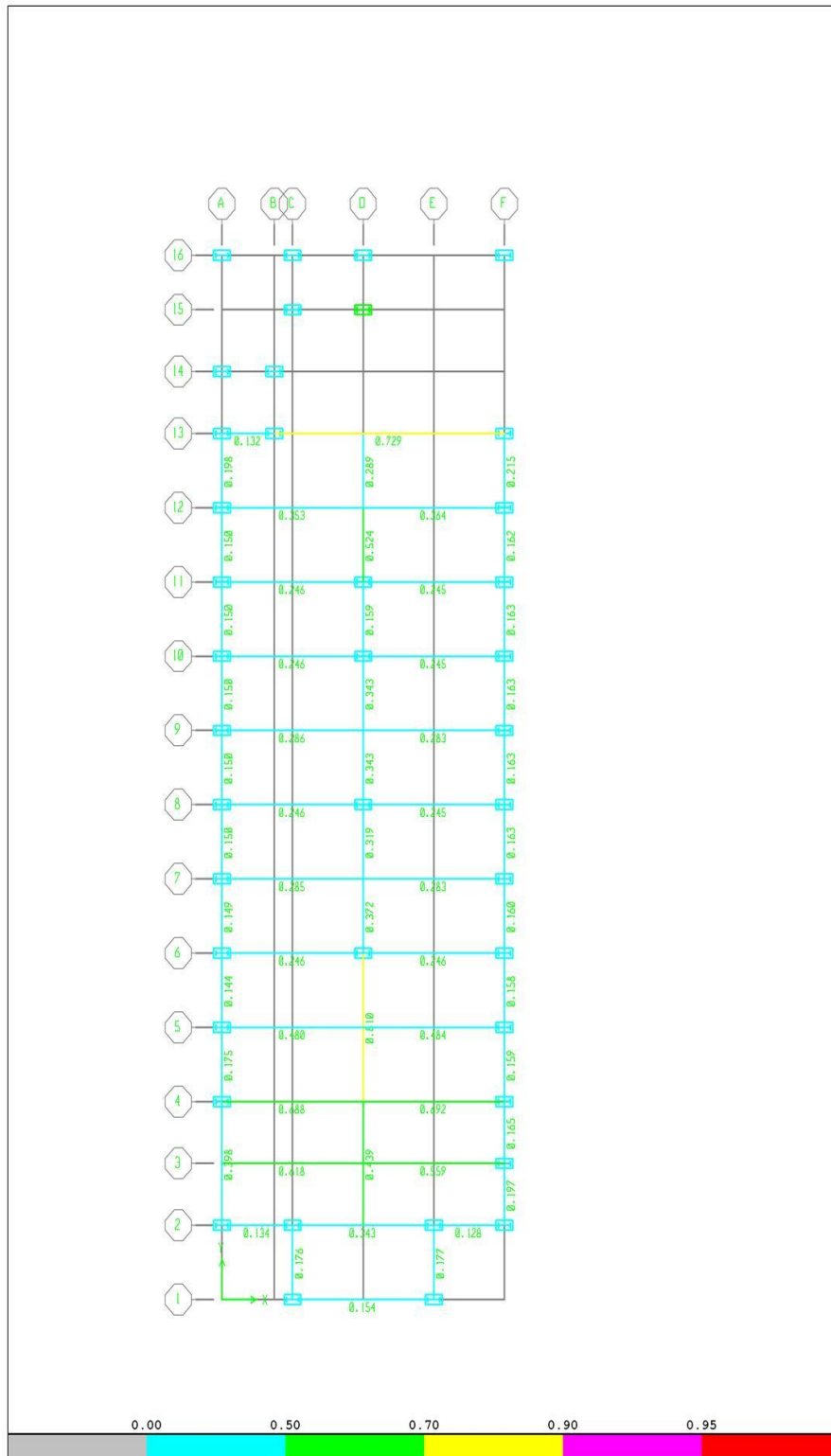
ETABS v9.2.0 - File: Model 1(BangunanA) - May 18,2010 9:22  
 Plan View - STORY6 - Elevation 14.36 Steel P-M Interaction Ratios (UBC97-LRFD) - Kgf-m Units



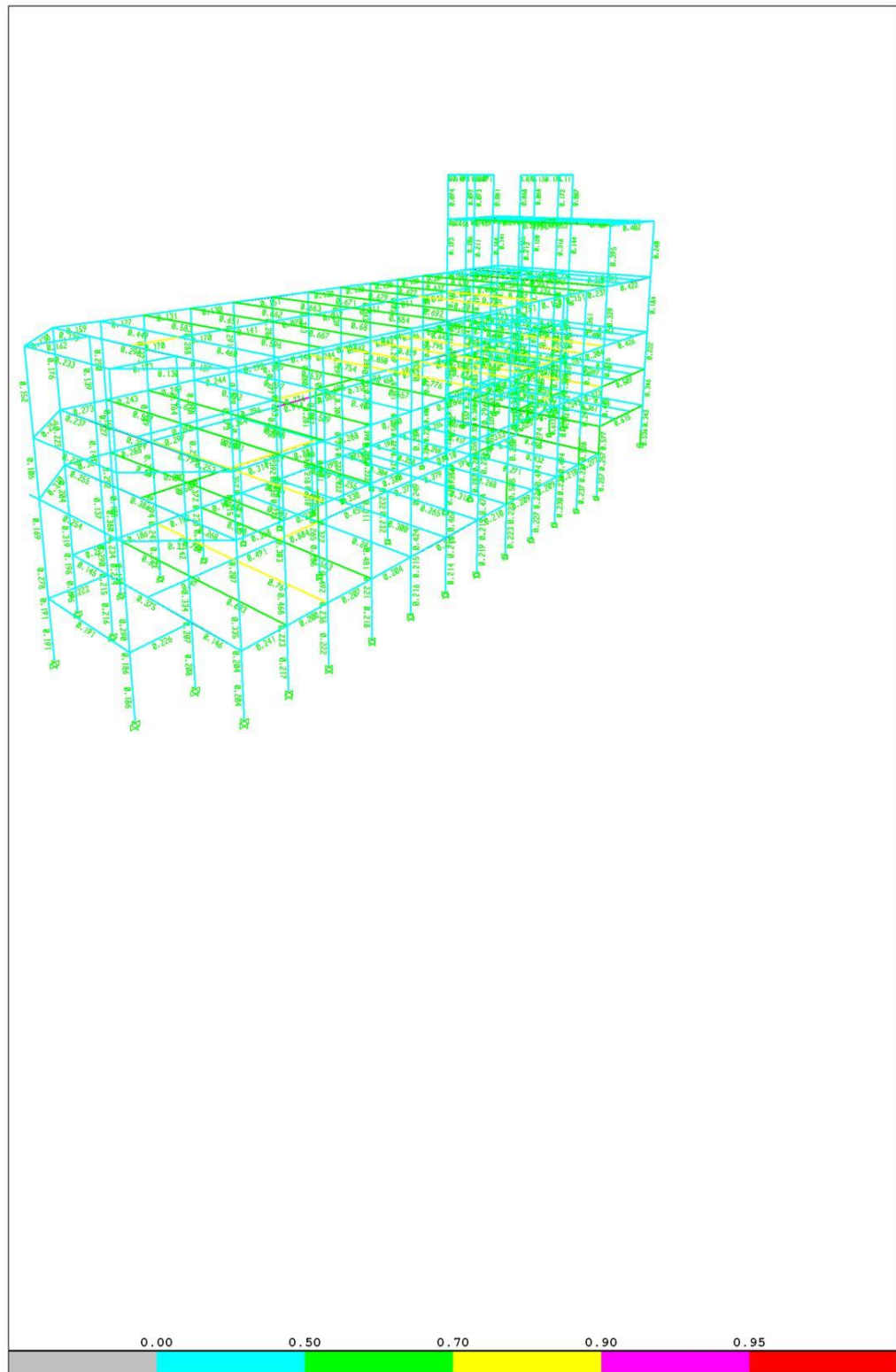




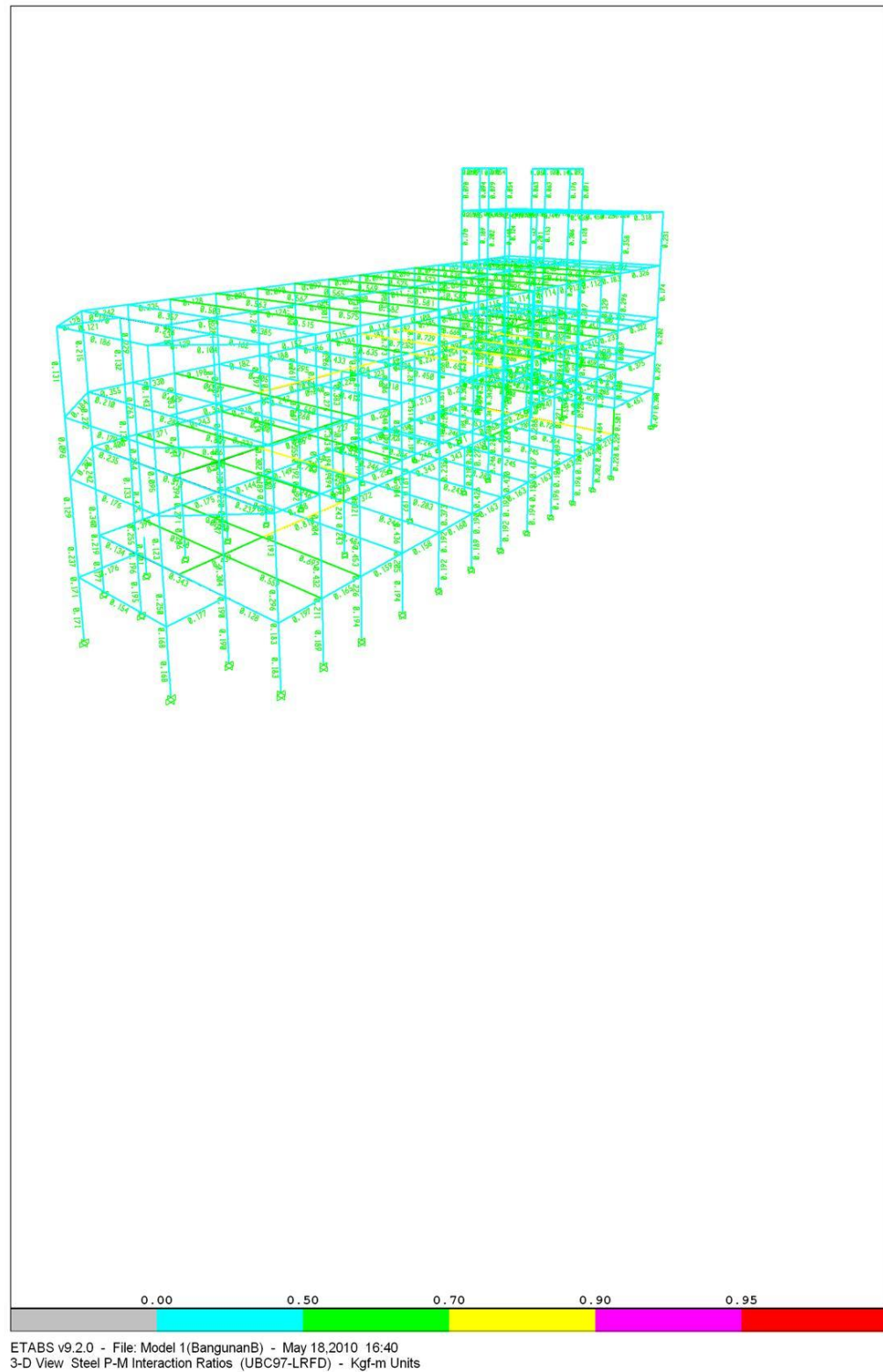
ETABS v9.2.0 - File: Model 1(BangunanA) - May 18,2010 16:29  
Plan View - STORY2 - Elevation 3 Steel P-M Interaction Ratios (UBC97-LRFD) - Kgf-m Units



ETABS v9.2.0 - File: Model 1(BangunanB) - May 18,2010 16:32  
 Plan View - STORY2 - Elevation 3 Steel P-M Interaction Ratios (UBC97-LRFD) - Kgf-m Units

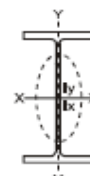
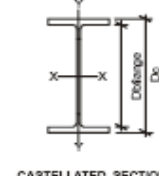
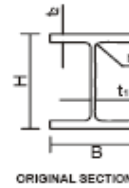
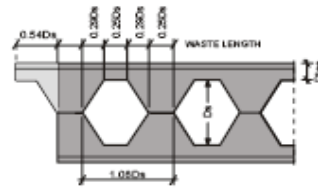
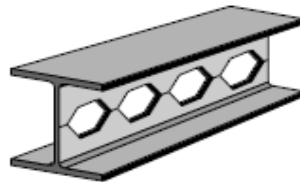


ETABS v9.2.0 - File: Model 1(BangunanA) - May 18,2010 16:37  
 3-D View Steel P-M Interaction Ratios (UBC97-LRFD) - Kgf-m Units



## Castellated Shape Honey Comb

### Product Specifications



Metric Size

| Sectional Index |             | Weight | Depth of Section |             | Width of Section | Thickness |                | Corner Radius | Depth of Castellated Hole | Depth of Castellated Tee | Depth Between Flanges | Section Area    |                 | Moment of Inertia |                 | Radius of Gyration |      | Modulus of Section |                 |
|-----------------|-------------|--------|------------------|-------------|------------------|-----------|----------------|---------------|---------------------------|--------------------------|-----------------------|-----------------|-----------------|-------------------|-----------------|--------------------|------|--------------------|-----------------|
| Original        | Castellated |        | Original         | Castellated |                  | Web       | Flange         |               |                           |                          |                       | Max             | Min             |                   |                 |                    |      |                    |                 |
|                 |             |        | H                | DC          |                  | B         | t <sub>1</sub> |               |                           |                          |                       | t <sub>2</sub>  | r               |                   |                 |                    |      |                    |                 |
| mm              | mm          | Kg/m   | mm               | mm          | mm               | mm        | mm             | mm            | mm                        | mm                       | mm                    | cm <sup>2</sup> | cm <sup>2</sup> | cm <sup>4</sup>   | cm <sup>4</sup> | cm                 | cm   | cm <sup>3</sup>    | cm <sup>3</sup> |
| 100 x 100       | 150 x 100   | 17.2   | 100              | 150         | 100              | 6         | 8              | 10            | 105                       | 22.5                     | 134                   | 24.9            | 18.57           | 905.3             | 134             | 7                  | 2.7  | 120.7              | 26.8            |
| 150 x 75        | 225 x 75    | 14     | 150              | 225         | 75               | 5         | 7              | 8             | 154                       | 35.5                     | 211                   | 21.6            | 13.85           | 1579.7            | 49.5            | 10.7               | 1.9  | 140.4              | 13.2            |
| 150 x 150       | 225 x 150   | 31.5   | 150              | 225         | 150              | 7         | 10             | 11            | 154                       | 35.5                     | 205                   | 45.39           | 34.54           | 3889.6            | 583             | 10.6               | 4    | 345.7              | 75.1            |
|                 | 300 x 100   | 21.3   | 200              | 300         | 100              | 5.5       | 8              | 11            | 205                       | 47.5                     | 284                   | 32.66           | 21.36           | 4308.8            | 134             | 14.2               | 2.5  | 287.1              | 26.8            |
| 200 x 100       | 297 x 99    | 18.2   | 198              | 297         | 99               | 4.5       | 7              | 11            | 202                       | 47.5                     | 283                   | 27.64           | 18.5            | 3843.9            | 114             | 14                 | 2.5  | 245.4              | 23              |
|                 | 300 x 200   | 49.9   | 200              | 300         | 200              | 8         | 12             | 13            | 205                       | 47.5                     | 276                   | 71.53           | 55.09           | 11139             | 1600.1          | 14.2               | 5.4  | 742.6              | 160             |
| 250 x 125       | 375 x 125   | 29.6   | 250              | 375         | 125              | 6         | 9              | 12            | 254                       | 60.5                     | 357                   | 45.16           | 29.86           | 9491.5            | 294.1           | 17.8               | 3.1  | 506.2              | 47              |
|                 | 372 x 124   | 25.7   | 248              | 372         | 124              | 5         | 8              | 12            | 253                       | 59.5                     | 356                   | 38.88           | 26.21           | 8189.6            | 255             | 17.7               | 3.1  | 440.3              | 41.1            |
| 250 x 250       | 375 x 250   | 72.4   | 250              | 375         | 250              | 9         | 14             | 16            | 254                       | 60.5                     | 347                   | 103.43          | 80.48           | 25477.5           | 3650.2          | 17.8               | 6.7  | 1358.8             | 292             |
| 300 x 150       | 450 x 150   | 36.7   | 300              | 450         | 150              | 6.5       | 9              | 13            | 305                       | 72.5                     | 432                   | 56.53           | 36.67           | 16895.1           | 508.1           | 21.5               | 3.7  | 750.9              | 67.7            |
|                 | 447 x 149   | 32     | 298              | 447         | 149              | 5.5       | 8              | 13            | 302                       | 72.5                     | 431                   | 49              | 32.33           | 14664             | 442             | 21.3               | 3.7  | 656.1              | 59.3            |
| 300 x 300       | 450 x 300   | 94     | 300              | 450         | 300              | 10        | 15             | 18            | 305                       | 72.5                     | 420                   | 134.8           | 104.25          | 47854.8           | 6750.3          | 21.4               | 8    | 2126.9             | 450             |
| 350 x 175       | 525 x 175   | 49.6   | 350              | 525         | 175              | 7         | 11             | 14            | 354                       | 85.5                     | 503                   | 75.39           | 50.54           | 31847.5           | 984.1           | 25.1               | 4.4  | 1213.2             | 112.5           |
|                 | 519 x 174   | 41.4   | 346              | 519         | 174              | 6         | 9              | 14            | 350                       | 84.5                     | 501                   | 63.06           | 42              | 25819.2           | 792.1           | 24.8               | 4.3  | 995                | 91              |
| 350 x 350       | 525 x 350   | 137    | 350              | 525         | 350              | 12        | 19             | 20            | 354                       | 85.5                     | 487                   | 194.9           | 152.3           | 95013.1           | 13600.6         | 25                 | 9.4  | 3619.5             | 777.2           |
| 400 x 200       | 600 x 200   | 66     | 400              | 600         | 200              | 8         | 13             | 16            | 405                       | 97.5                     | 574                   | 100.12          | 67.68           | 55683.6           | 1740.2          | 28.7               | 5.1  | 1856.1             | 174             |
|                 | 594 x 199   | 56.6   | 396              | 594         | 199              | 7         | 11             | 16            | 401                       | 96.5                     | 572                   | 86.02           | 57.92           | 46656.1           | 1450.1          | 28.4               | 5    | 1570.9             | 145.7           |
| 450 x 200       | 675 x 200   | 76     | 450              | 675         | 200              | 9         | 14             | 18            | 454                       | 110.5                    | 647                   | 117.01          | 76.06           | 78747.4           | 1870.3          | 32.2               | 5    | 2333.3             | 187             |
| 500 x 200       | 750 x 200   | 89.6   | 500              | 750         | 200              | 10        | 16             | 20            | 505                       | 122.5                    | 718                   | 139.2           | 88.65           | 122855.7          | 2140.5          | 35.7               | 4.9  | 3009.5             | 214             |
| 600 x 200       | 900 x 200   | 106    | 600              | 900         | 200              | 11        | 17             | 22            | 605                       | 147.5                    | 886                   | 167.4           | 100.8           | 184103            | 2280.8          | 42.7               | 4.8  | 4091.2             | 228.1           |
| 588 x 300       | 882 x 300   | 151    | 588              | 882         | 300              | 12        | 20             | 28            | 593                       | 144.5                    | 842                   | 227.78          | 156.56          | 274632.9          | 9021            | 41.9               | 7.6  | 6225.2             | 601.4           |
| 400 x 400       | 600 x 400   | 172    | 400              | 600         | 400              | 13        | 21             | 22            | 405                       | 97.5                     | 558                   | 244.7           | 191.99          | 156913.2          | 22400.8         | 28.6               | 10.8 | 5230.4             | 1120            |
| 700 x 300       | 1050 x 300  | 185    | 700              | 1050        | 300              | 13        | 24             | 28            | 705                       | 172.5                    | 1002                  | 281             | 189.29          | 473222.7          | 10801.5         | 50                 | 7.6  | 9013.8             | 720.1           |
| 800 x 300       | 1200 x 300  | 210    | 800              | 1200        | 300              | 14        | 26             | 28            | 805                       | 197.5                    | 1148                  | 323.4           | 210.63          | 690341.9          | 11702.2         | 67.2               | 7.5  | 11506.7            | 780.1           |

## Castellated Shape Honey Comb

### Product Specifications

#### Dimensional Tolerance

| Flange Width (B)<br>(mm) | Depth<br>(Dc)<br>(mm) |           |            | Depth of Castellated Hole<br>(Ds)<br>(mm) |
|--------------------------|-----------------------|-----------|------------|-------------------------------------------|
|                          | Under 400             | 400 - 600 | 600 & over |                                           |
| + 3.0                    | + 4.0                 | + 5.0     | + 6.0      | + 3.0                                     |

#### Mechanical Properties

| Classification      | Yield Point<br>N/mm <sup>2</sup> |         | Tensile Strength<br><br>N/mm <sup>2</sup> | Elongation %   |        |         |
|---------------------|----------------------------------|---------|-------------------------------------------|----------------|--------|---------|
|                     | Thickness (mm)                   |         |                                           | Thickness (mm) |        |         |
|                     | 16 or under                      | Over 16 |                                           | 5 or under     | 5 to 6 | Over 16 |
| JIS G 3101<br>SS400 | 245                              | 235     | 400 - 510                                 | 21             | 17     | 21      |

#### Chemical Composition

| Grade  | Chemical Composition (%) |    |    |          |          |
|--------|--------------------------|----|----|----------|----------|
|        | C                        | Si | Mn | P        | S        |
| SS 400 | -                        | -  | -  | 0.05 max | 0.05 max |

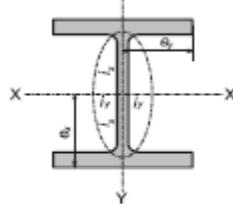
#### Welding

- As per AWS
- Welding material : E 6013

## Wide Flange Shape

### Product Specifications

Hot Rolled



Geometrical moment of inertia

$$I = Ai^2$$

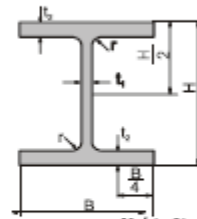
Radius of gyration of area

$$I = \sqrt{I/A}$$

Modulus of section

$$z = I/e$$

(A = sectional area)



According JIS G 3192

Metric Size

| Standard Sectional Dimension |             |          |          |         | Section Area<br>A<br>cm <sup>2</sup> | Unit Weight<br>kg/m | Informative Reference                                                        |        |                                                   |       |                                                                   |         |
|------------------------------|-------------|----------|----------|---------|--------------------------------------|---------------------|------------------------------------------------------------------------------|--------|---------------------------------------------------|-------|-------------------------------------------------------------------|---------|
| Nominal Dimensional<br>mm    | H x B<br>mm | t1<br>mm | t2<br>mm | r<br>mm |                                      |                     | Geometrical Moment Of inertia<br>Ix<br>cm <sup>4</sup> Iy<br>cm <sup>4</sup> |        | Radius Of Gyration Of Area<br>ix<br>cm   iy<br>cm |       | Modulus Of Section<br>Zx<br>cm <sup>3</sup> Zy<br>cm <sup>3</sup> |         |
| 100 x 100                    | 100 x 100   | 6        | 8        | 10      | 21.90                                | 17.20               | 383                                                                          | 134    | 4.18                                              | 2.47  | 76.90                                                             | 26.7    |
| 125 x 125                    | 125 x 125   | 6.5      | 9        | 10      | 30.31                                | 23.80               | 847                                                                          | 293    | 6.29                                              | 3.11  | 136.00                                                            | 47.00   |
| 150 x 75                     | 150 x 75    | 5        | 7        | 8       | 17.95                                | 14.00               | 666                                                                          | 50     | 6.11                                              | 1.66  | 8.88                                                              | 13.20   |
| 150 x 100                    | 150 x 100   | 6        | 9        | 11      | 26.84                                | 21.10               | 1,020                                                                        | 151    | 6.17                                              | 2.37  | 138.00                                                            | 30.10   |
| 150 x 150                    | 150 x 150   | 7        | 10       | 11      | 40.14                                | 31.50               | 1,640                                                                        | 563    | 6.39                                              | 3.75  | 219.00                                                            | 75.10   |
| 175 x 175                    | 175 x 175   | 7.5      | 11       | 12      | 51.21                                | 40.20               | 2,880                                                                        | 984    | 7.50                                              | 4.38  | 330.00                                                            | 112.00  |
| 200 x 100                    | 198 x 99    | 4.5      | 7        | 11      | 23.18                                | 18.20               | 1,580                                                                        | 114    | 8.26                                              | 2.21  | 160.00                                                            | 23.00   |
| 200 x 100                    | 200 x 100   | 5.5      | 8        | 11      | 27.16                                | 21.30               | 1,840                                                                        | 134    | 8.24                                              | 2.22  | 184.00                                                            | 26.80   |
| 200 x 150                    | 194 x 150   | 6        | 9        | 12      | 38.80                                | 30.60               | 2,675                                                                        | 507    | 8.30                                              | 3.60  | 275.80                                                            | 67.60   |
| 200 x 200                    | 200 x 200   | 8        | 12       | 13      | 63.53                                | 49.90               | 4,720                                                                        | 1,600  | 8.62                                              | 5.02  | 472.00                                                            | 160.00  |
| 250 x 125                    | 248 x 124   | 5        | 8        | 12      | 32.68                                | 25.70               | 3,540                                                                        | 255    | 10.40                                             | 2.79  | 285.00                                                            | 41.10   |
| 250 x 125                    | 250 x 125   | 6        | 9        | 12      | 37.66                                | 29.60               | 4,050                                                                        | 294    | 10.40                                             | 2.79  | 324.00                                                            | 47.00   |
| 250 x 250                    | 250 x 250   | 9        | 14       | 16      | 92.18                                | 72.40               | 10,800                                                                       | 3,650  | 10.80                                             | 6.29  | 867.00                                                            | 292.00  |
| 300 x 150                    | 298 x 149   | 5.5      | 8        | 13      | 40.80                                | 32.00               | 6,320                                                                        | 442    | 12.40                                             | 3.29  | 434.00                                                            | 59.30   |
| 300 x 150                    | 300 x 150   | 6.5      | 9        | 13      | 46.78                                | 36.70               | 7,210                                                                        | 508    | 12.40                                             | 3.29  | 481.00                                                            | 67.70   |
| 300 x 300                    | 300 x 300   | 10       | 15       | 18      | 119.80                               | 94.00               | 20,400                                                                       | 6,750  | 13.10                                             | 7.51  | 1,360.00                                                          | 450.00  |
| 350 x 175                    | 346 x 174   | 6        | 9        | 14      | 52.68                                | 41.40               | 11,100                                                                       | 792    | 14.50                                             | 3.88  | 641.00                                                            | 91.00   |
| 350 x 175                    | 350 x 175   | 7        | 11       | 14      | 63.14                                | 49.60               | 13,600                                                                       | 984    | 14.70                                             | 3.95  | 775.00                                                            | 112.00  |
| 350 x 350                    | 350 x 350   | 12       | 19       | 20      | 173.9                                | 137.00              | 40,300                                                                       | 13,600 | 15.20                                             | 8.84  | 2,300.00                                                          | 776.00  |
| 400 x 200                    | 396 x 199   | 7        | 11       | 16      | 72.16                                | 56.60               | 20,000                                                                       | 1,450  | 16.70                                             | 4.48  | 1,010.00                                                          | 145.00  |
| 400 x 200                    | 400 x 200   | 8        | 13       | 16      | 84.1                                 | 66.00               | 23,700                                                                       | 1,740  | 16.80                                             | 4.54  | 1,190.00                                                          | 174.00  |
| 400 x 400                    | 400 x 400   | 13       | 21       | 22      | 218.7                                | 172.00              | 66,600                                                                       | 22,400 | 17.50                                             | 10.10 | 3,330.00                                                          | 1120.00 |
| 450 x 200                    | 450 x 200   | 9        | 14       | 18      | 96.8                                 | 76.00               | 33,500                                                                       | 1,870  | 18.60                                             | 4.40  | 1,480.00                                                          | 187.00  |
| 500 x 200                    | 500 x 200   | 10       | 16       | 20      | 114.2                                | 89.60               | 47,800                                                                       | 2,140  | 20.50                                             | 4.33  | 1,910.00                                                          | 214.00  |
| 600 x 200                    | 600 x 200   | 11       | 17       | 22      | 134.4                                | 106.00              | 77,600                                                                       | 2,280  | 24.00                                             | 4.12  | 2,590.00                                                          | 228.00  |
| 600 x 200                    | 588 x 300   | 12       | 20       | 28      | 192.5                                | 151.00              | 118,000                                                                      | 9,020  | 24.80                                             | 6.85  | 4,020.00                                                          | 601.00  |
| 700 x 300                    | 700 x 300   | 13       | 24       | 28      | 235.5                                | 185.00              | 201,000                                                                      | 10,800 | 29.30                                             | 6.78  | 5,760.00                                                          | 722.00  |
| 800 x 300                    | 800 x 300   | 14       | 26       | 28      | 267.4                                | 210.00              | 292,000                                                                      | 11,700 | 33.00                                             | 6.62  | 7,290.00                                                          | 782.00  |
| 900 x 300                    | 900 x 300   | 16       | 28       | 28      | 309.8                                | 243.00              | 411,000                                                                      | 12,600 | 36.40                                             | 6.39  | 9,140.00                                                          | 843.00  |

## Wide Flange Shape

### Dimensional Tolerances

According JIS G 3192

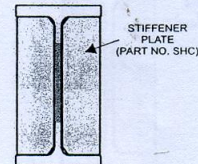
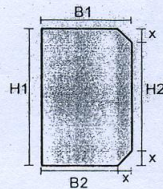
| Item, mm (in.)         |                                                       | Tolerance                                                                  | Remarks                                                     |
|------------------------|-------------------------------------------------------|----------------------------------------------------------------------------|-------------------------------------------------------------|
| Width (B)              |                                                       | $\pm 3.0$ (0.118)                                                          |                                                             |
| Depth (H)              | Nominal depth of under 400 (15.748)                   | $\pm 3.0$ (0.118)                                                          |                                                             |
|                        | 400 to 600 (23.622), excl.                            | $\pm 4.0$ (0.157)                                                          |                                                             |
|                        | 600 and over                                          | $\pm 5.0$ (0.197)                                                          |                                                             |
| Thickness              | Flange $t_f$                                          | Under 16                                                                   | $\pm 1.5$ (0.059)                                           |
|                        |                                                       | 16 or over to and excl. 25                                                 | $\pm 2.0$ (0.079)                                           |
|                        |                                                       | 25 or over to and excl. 40                                                 | $\pm 2.5$ (0.098)                                           |
|                        |                                                       | 40 or over                                                                 | $\pm 3.0$ (0.118)                                           |
|                        | Web $t_w$                                             | Under 16                                                                   | $\pm 1.0$ (0.039)                                           |
|                        |                                                       | 16 or over to and excl. 25                                                 | $\pm 1.5$ (0.024)                                           |
|                        |                                                       | 25 or over to and excl. 40                                                 | $\pm 2.0$ (0.079)                                           |
|                        |                                                       | 40 or over                                                                 | $\pm 2.5$ (0.098)                                           |
| Length                 | 7 m or under                                          | $+ 40$ (1.575)<br>- 0                                                      |                                                             |
|                        | Over 7 m                                              | 40 (1.575) plus 5 (0.197) for each additional meter or fraction thereof    |                                                             |
| Out-of-Square (T)      | Nominal depths 300 (11.811) or under in nominal depth | Not more than 1.2 percent of flange width B or 2.0 (0.079) at minimum.     |                                                             |
|                        | Nominal depths Over 300 (11.811) in nominal depth     | Not more than 1.5 percent of flange width B or 2.0 (0.079) at minimum.     |                                                             |
| Chamber of Sweep       | Nominal depths 300 (11.811) and under                 | Not more than 0.20 percent of Length.                                      | Horizontal or Vertical Curvature in the direction of length |
|                        | Nominal depths Over 300 (11.811)                      | Not more than 0.10 percent of Length.                                      |                                                             |
| Web Off Centre (S)     | Nominal depths 300 (11.811) and under                 | $\pm 3.0$ (0.118)                                                          | $S = \frac{b_1 - b_2}{2}$                                   |
|                        | Nominal depths Over 300 (11.811)                      | $\pm 4.5$ (0.117)                                                          |                                                             |
| Ends Out of Square (e) |                                                       | 1.6% or under of width B or of depth H, provided that 3.0mm is the minimum |                                                             |



P.T. GUNUNG GARUDA  
Steel Is Our Business

# STIFFENER

FOR HONEY COMB



## DIMENSIONAL PROPERTIES

METRIC SIZE

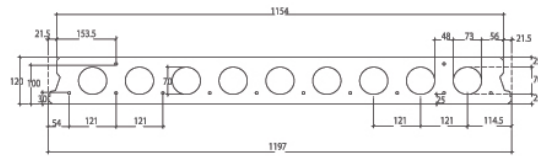
| PART NO. | H1     | H2     | B1    | B2    | x  | t  | WEIGHT | FOR CASTELLATED |
|----------|--------|--------|-------|-------|----|----|--------|-----------------|
|          | mm     | mm     | mm    | mm    | mm | mm | kg     |                 |
| SHC - 01 | 130.0  | 106.0  | 45.0  | 33.0  | 12 | 6  | 0.269  | 150 x 100       |
| SHC - 02 | 130.0  | 106.0  | 45.0  | 33.0  | 12 | 8  | 0.358  | 150 x 100       |
| SHC - 03 | 207.0  | 187.0  | 33.0  | 23.0  | 10 | 6  | 0.317  | 225 x 75        |
| SHC - 04 | 207.0  | 187.0  | 33.0  | 23.0  | 10 | 8  | 0.423  | 225 x 75        |
| SHC - 05 | 201.0  | 175.0  | 70.0  | 57.0  | 13 | 6  | 0.655  | 225 x 150       |
| SHC - 06 | 201.0  | 175.0  | 70.0  | 57.0  | 13 | 8  | 0.873  | 225 x 150       |
| SHC - 07 | 280.0  | 254.0  | 45.0  | 32.0  | 13 | 6  | 0.586  | 300 x 100       |
| SHC - 08 | 280.0  | 254.0  | 45.0  | 32.0  | 13 | 8  | 0.781  | 300 x 100       |
| SHC - 09 | 279.0  | 253.0  | 45.0  | 32.0  | 13 | 6  | 0.583  | 297 x 99        |
| SHC - 10 | 279.0  | 253.0  | 45.0  | 32.0  | 13 | 8  | 0.778  | 297 x 99        |
| SHC - 11 | 272.0  | 242.0  | 94.0  | 79.0  | 15 | 8  | 1.592  | 300 x 200       |
| SHC - 12 | 272.0  | 242.0  | 94.0  | 79.0  | 15 | 10 | 1.989  | 300 x 200       |
| SHC - 13 | 353.0  | 325.0  | 58.0  | 44.0  | 14 | 8  | 1.273  | 375 x 125       |
| SHC - 14 | 353.0  | 325.0  | 58.0  | 44.0  | 14 | 10 | 1.592  | 375 x 125       |
| SHC - 15 | 352.0  | 324.0  | 58.0  | 44.0  | 14 | 8  | 1.270  | 372 x 124       |
| SHC - 16 | 352.0  | 324.0  | 58.0  | 44.0  | 14 | 10 | 1.587  | 372 x 124       |
| SHC - 17 | 343.0  | 307.0  | 119.0 | 101.0 | 18 | 8  | 2.543  | 375 x 250       |
| SHC - 18 | 343.0  | 307.0  | 119.0 | 101.0 | 18 | 10 | 3.179  | 375 x 250       |
| SHC - 19 | 428.0  | 398.0  | 70.0  | 55.0  | 15 | 6  | 1.401  | 450 x 150       |
| SHC - 20 | 428.0  | 398.0  | 70.0  | 55.0  | 15 | 8  | 1.867  | 450 x 150       |
| SHC - 21 | 427.0  | 397.0  | 70.0  | 55.0  | 15 | 6  | 1.397  | 447 x 149       |
| SHC - 22 | 427.0  | 397.0  | 70.0  | 55.0  | 15 | 8  | 1.863  | 447 x 149       |
| SHC - 23 | 416.0  | 376.0  | 143.0 | 123.0 | 20 | 10 | 4.638  | 450 x 300       |
| SHC - 24 | 416.0  | 376.0  | 143.0 | 123.0 | 20 | 12 | 5.566  | 450 x 300       |
| SHC - 25 | 499.0  | 467.0  | 82.0  | 66.0  | 16 | 6  | 1.915  | 525 x 175       |
| SHC - 26 | 499.0  | 467.0  | 82.0  | 66.0  | 16 | 8  | 2.554  | 525 x 175       |
| SHC - 27 | 497.0  | 465.0  | 82.0  | 66.0  | 16 | 6  | 1.907  | 519 x 174       |
| SHC - 28 | 497.0  | 465.0  | 82.0  | 66.0  | 16 | 8  | 2.543  | 519 x 174       |
| SHC - 29 | 483.0  | 439.0  | 167.0 | 145.0 | 22 | 10 | 6.294  | 525 x 350       |
| SHC - 30 | 483.0  | 439.0  | 167.0 | 145.0 | 22 | 12 | 7.553  | 525 x 350       |
| SHC - 31 | 570.0  | 534.0  | 94.0  | 76.0  | 18 | 8  | 3.344  | 600 x 200       |
| SHC - 32 | 570.0  | 534.0  | 94.0  | 76.0  | 18 | 10 | 4.181  | 600 x 200       |
| SHC - 33 | 568.0  | 532.0  | 94.0  | 76.0  | 18 | 8  | 3.333  | 594 x 199       |
| SHC - 34 | 568.0  | 532.0  | 94.0  | 76.0  | 18 | 10 | 4.166  | 594 x 199       |
| SHC - 35 | 643.0  | 603.0  | 94.0  | 74.0  | 20 | 10 | 4.713  | 675 x 200       |
| SHC - 36 | 643.0  | 603.0  | 94.0  | 74.0  | 20 | 12 | 5.656  | 675 x 200       |
| SHC - 37 | 714.0  | 670.0  | 93.0  | 71.0  | 22 | 10 | 5.175  | 750 x 200       |
| SHC - 38 | 714.0  | 670.0  | 93.0  | 71.0  | 22 | 12 | 6.209  | 750 x 200       |
| SHC - 39 | 862.0  | 814.0  | 93.0  | 69.0  | 24 | 10 | 6.248  | 900 x 200       |
| SHC - 40 | 862.0  | 814.0  | 93.0  | 69.0  | 24 | 12 | 7.497  | 900 x 200       |
| SHC - 41 | 856.0  | 796.0  | 142.0 | 112.0 | 30 | 12 | 11.125 | 882 x 300       |
| SHC - 42 | 856.0  | 796.0  | 142.0 | 112.0 | 30 | 14 | 13.260 | 882 x 300       |
| SHC - 43 | 554.0  | 506.0  | 192.0 | 168.0 | 24 | 14 | 11.627 | 600 x 400       |
| SHC - 44 | 554.0  | 506.0  | 192.0 | 168.0 | 24 | 16 | 13.287 | 600 x 400       |
| SHC - 45 | 998.0  | 938.0  | 142.0 | 112.0 | 30 | 14 | 15.476 | 1050 x 300      |
| SHC - 46 | 998.0  | 938.0  | 142.0 | 112.0 | 30 | 16 | 17.686 | 1050 x 300      |
| SHC - 47 | 1144.0 | 1084.0 | 141.0 | 111.0 | 30 | 14 | 17.628 | 1200 x 300      |
| SHC - 48 | 1144.0 | 1084.0 | 141.0 | 111.0 | 30 | 16 | 20.147 | 1200 x 300      |

HEAD OFFICE  
AND FACTORY

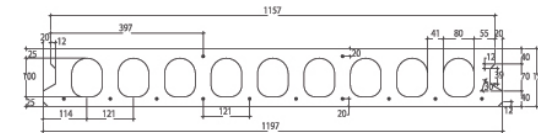
Imam Bonjol 4, Warung Bongkok, Suka Danau, Cibitung, Bekasi, West Java, INDONESIA  
Phone : 62-21-8900111, Sales Dept. 62-21-8900666, ESC Dept. 62-21-4713000  
Fax. 62-21-8900555, URL : <http://www.grdsteel.com>, E-mail : [gunung@grdsteel.com](mailto:gunung@grdsteel.com)

47

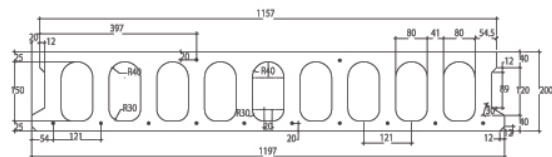
## Hollow Core Slab - Details



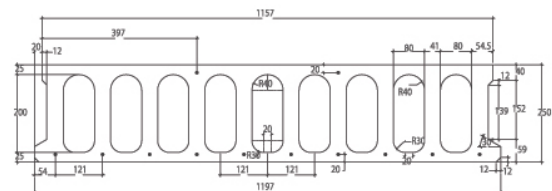
Cross section HCS 120 MM



Cross section HCS 150 MM



Cross section HCS 200 MM



Cross section HCS 250 MM

| Type    | Area<br>(cm <sup>2</sup> ) | Self Load | Rongga |
|---------|----------------------------|-----------|--------|
| HCS 120 | 990.88                     | 206.42    | 26%    |

| Type    | Area<br>(cm <sup>2</sup> ) | Self Load | Rongga |
|---------|----------------------------|-----------|--------|
| HCS 150 | 1117.18                    | 223       | 35.80% |

| Type    | Area<br>(cm <sup>2</sup> ) | Self Load | Rongga |
|---------|----------------------------|-----------|--------|
| HCS 200 | 1323.68                    | 265       | 42.60% |

| Type    | Area<br>(cm <sup>2</sup> ) | Self Load | Rongga |
|---------|----------------------------|-----------|--------|
| HCS 250 | 1530.18                    | 206       | 46.70% |

### Hollow Core Slab - Load Capacity Table

| LOAD CAPACITY OF HCS (Kg/m2)<br>Without Topping                     |                                                                         |          |          |          |          |          |          |          |          |          |          |        |        |        |        |        |        |
|---------------------------------------------------------------------|-------------------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|--------|--------|--------|--------|--------|--------|
| TIME<br>(t.d.n)                                                     | DAYA DUKUNG MAXIMAL (Kg/m2)<br>(Netto, setelah dikurangi berat sendiri) |          |          |          |          |          |          |          |          |          |          |        |        |        |        |        |        |
| Bentang<br>(m)                                                      | 4,00                                                                    | 4,25     | 4,50     | 4,75     | 5,00     | 5,25     | 5,50     | 5,75     | 6,00     | 6,25     | 6,50     | 6,75   | 7,00   | 7,25   | 7,50   | 7,75   | 8,00   |
| 120.05.12                                                           | 590,00                                                                  | 500,00   | 420,00   | 355,00   | 300,00   | 250,00   |          |          |          |          |          |        |        |        |        |        |        |
| 120.05.14                                                           | 690,00                                                                  | 585,00   | 500,00   | 425,00   | 360,00   | 310,00   | 260,00   |          |          |          |          |        |        |        |        |        |        |
| 120.05.16                                                           | 790,00                                                                  | 675,00   | 575,00   | 495,00   | 425,00   | 365,00   | 315,00   | 270,00   |          |          |          |        |        |        |        |        |        |
| 150.05.12                                                           | 905,00                                                                  | 775,00   | 665,00   | 570,00   | 490,00   | 425,00   | 365,00   | 310,00   | 265,00   |          |          |        |        |        |        |        |        |
| 150.05.14                                                           | 1.040,00                                                                | 895,00   | 770,00   | 670,00   | 580,00   | 500,00   | 435,00   | 375,00   | 325,00   | 280,00   |          |        |        |        |        |        |        |
| 150.05.16                                                           | 1.180,00                                                                | 1.015,00 | 880,00   | 765,00   | 665,00   | 580,00   | 510,00   | 445,00   | 385,00   | 340,00   | 295,00   |        |        |        |        |        |        |
| 150.07.12                                                           | 1.530,00                                                                | 1.330,00 | 1.160,00 | 1.015,00 | 890,00   | 785,00   | 695,00   | 615,00   | 545,00   | 480,00   | 425,00   | 380,00 | 335,00 | 295,00 |        |        |        |
| 150.07.14                                                           | 1.800,00                                                                | 1.565,00 | 1.370,00 | 1.205,00 | 1.060,00 | 940,00   | 835,00   | 731,66   | 643,96   | 569,74   | 506,49   | 452,28 | 405,53 | 365,01 |        |        |        |
| 200.05.12                                                           | 1.470,00                                                                | 1.270,00 | 1.100,00 | 960,00   | 840,00   | 735,00   | 645,00   | 565,00   | 495,00   | 435,00   | 380,00   | 330,00 | 285,00 |        |        |        |        |
| 200.05.14                                                           | 1.670,00                                                                | 1.445,00 | 1.255,00 | 1.100,00 | 965,00   | 850,00   | 745,00   | 660,00   | 580,00   | 515,00   | 455,00   | 400,00 | 350,00 | 310,00 |        |        |        |
| 200.05.16                                                           | 1.865,00                                                                | 1.620,00 | 1.415,00 | 1.240,00 | 1.090,00 | 960,00   | 850,00   | 755,00   | 670,00   | 595,00   | 530,00   | 470,00 | 415,00 | 370,00 | 325,00 | 285,00 |        |
| 200.07.12                                                           | 2.370,00                                                                | 2.065,00 | 1.810,00 | 1.595,00 | 1.415,00 | 1.255,00 | 1.120,00 | 1.000,00 | 895,00   | 800,00   | 720,00   | 645,00 | 580,00 | 520,00 | 470,00 | 420,00 | 375,00 |
| 200.07.14                                                           | 2.755,00                                                                | 2.410,00 | 2.120,00 | 1.870,00 | 1.660,00 | 1.480,00 | 1.325,00 | 1.185,00 | 1.065,00 | 960,00   | 865,00   | 780,00 | 705,00 | 640,00 | 580,00 | 525,00 | 475,00 |
| 200.07.16                                                           | 3.145,00                                                                | 2.750,00 | 2.425,00 | 2.145,00 | 1.910,00 | 1.705,00 | 1.525,00 | 1.375,00 | 1.235,00 | 1.120,00 | 1.010,00 | 915,00 | 835,00 | 755,00 | 690,00 | 625,00 | 570,00 |
| t = tebal pelat (mm); d = diameter PC-WIRE (mm); n = jumlah PC-WIRE |                                                                         |          |          |          |          |          |          |          |          |          |          |        |        |        |        |        |        |

## Technical Specification :

- Plank Thickness : 120, 150, 200, 250 mm
- Plank Width : 1200 mm
- Weight : 198, 223, 265, 306 kg/m<sup>2</sup>
- Plank length : can be customized
- Reinforcement : PC-Wire Ø5 and Ø7 mm
- Concrete Quality : K - 450
- Surface : expose

## Advantages :

- **Tension process conducted accurately, to assure the requirements of pre-stress.**
- **Hollow-core floor plank** is 29-42% lighter from traditional concrete, thus increasing load capacity.
- **Plank deflection effect** of full load capacity is very small, caused by chamber created by the tension force.
- **Faster and easy installation**, can be done without propping structure.
- **Unfinished bottom surface** can be used as exposed concrete.
- **The "Pre-compression Effect"** on pre-stressed concrete gives pre-stressed concrete high temperature protection compared to traditional concrete.
- **The hollow cores decrease structural load.**