

BAB III

ESTIMASI STRUKTUR

3.1 Estimasi Balok

Menurut tabel 9.5(a) SNI 2847-2013, perencanaan tinggi minimum dan lebar balok dapat direncanakan sebagai berikut:

1. Untuk bentang (L) = 8000 mm

- Balok Induk

$$\text{Tinggi minimum } (h_{min}) = \frac{L}{16} = \frac{8000}{16} = 500 \text{ mm}$$

Dipakai $h = 650$ mm

$$\text{Lebar balok induk } (b) = \frac{2}{3} h = \frac{2}{3} 650 = 433,3333 \text{ mm}$$

Dipakai $b = 400$ mm

Jadi digunakan dimensi balok induk 400/650

2. Untuk bentang (L) = 7750 mm

- Balok Induk

$$\text{Tinggi minimum } (h_{min}) = \frac{L}{16} = \frac{7750}{16} = 484,375 \text{ mm}$$

Dipakai $h = 650$ mm

$$\text{Lebar balok induk } (b) = \frac{2}{3} h = \frac{2}{3} 650 = 433,3333 \text{ mm}$$

Dipakai $b = 400$ mm

Jadi digunakan dimensi balok induk 400/650

3. Untuk bentang (L) = 7500 mm

- Balok Induk

$$\text{Tinggi minimum } (h_{min}) = \frac{L}{16} = \frac{7500}{16} = 468,75 \text{ mm}$$

Dipakai $h = 650 \text{ mm}$

$$\text{Lebar balok induk } (b) = \frac{2}{3} h = \frac{2}{3} 650 = 433,3333 \text{ mm}$$

Dipakai $b = 400 \text{ mm}$

Jadi digunakan dimensi balok induk 400/650

4. Untuk bentang (L) = 6000 mm

- Balok Induk

$$\text{Tinggi minimum } (h_{min}) = \frac{L}{16} = \frac{6000}{16} = 375 \text{ mm}$$

Dipakai $h = 550 \text{ mm}$

$$\text{Lebar balok induk } (b) = \frac{2}{3} h = \frac{2}{3} 550 = 366,6667 \text{ mm}$$

Dipakai $b = 350 \text{ mm}$

Jadi digunakan dimensi balok induk 350/550

- Balok Anak

$$\text{Tinggi minimum } (h_{min}) = \frac{L}{21} = \frac{6000}{21} = 285,7143 \text{ mm}$$

Dipakai $h = 400 \text{ mm}$

$$\text{Lebar balok induk } (b) = \frac{2}{3} h = \frac{2}{3} 400 = 266,67 \text{ mm}$$

Dipakai $b = 300 \text{ mm}$

Jadi digunakan dimensi balok anak 300/400

5. Untuk bentang (L) = 5500 mm

- Balok Induk

$$\text{Tinggi minimum } (h_{min}) = \frac{L}{16} = \frac{5500}{16} = 343,75 \text{ mm}$$

Dipakai $h = 500 \text{ mm}$

$$\text{Lebar balok induk } (b) = \frac{2}{3} h = \frac{2}{3} 500 = 333,3333 \text{ mm}$$

Dipakai $b = 300 \text{ mm}$

Jadi digunakan dimensi balok induk 300/500

6. Untuk bentang (L) = 5000 mm

- Balok Induk

$$\text{Tinggi minimum } (h_{min}) = \frac{L}{16} = \frac{5000}{16} = 312,5 \text{ mm}$$

Dipakai $h = 500 \text{ mm}$

$$\text{Lebar balok induk } (b) = \frac{2}{3} h = \frac{2}{3} 500 = 333,3333 \text{ mm}$$

Dipakai $b = 300 \text{ mm}$

Jadi digunakan dimensi balok induk 300/500

- Balok Anak

$$\text{Tinggi minimum } (h_{min}) = \frac{L}{21} = \frac{5500}{21} = 238,0952 \text{ mm}$$

Dipakai $h = 400 \text{ mm}$

$$\text{Lebar balok induk } (b) = \frac{2}{3} h = \frac{2}{3} 400 = 266,6667 \text{ mm}$$

Dipakai $b = 250 \text{ mm}$

Jadi digunakan dimensi balok anak 250/400

7. Untuk bentang (L) = 4500 mm

- Balok Induk

$$\text{Tinggi minimum } (h_{min}) = \frac{L}{16} = \frac{4500}{16} = 281,25 \text{ mm}$$

Dipakai $h = 450 \text{ mm}$

$$\text{Lebar balok induk } (b) = \frac{2}{3} h = \frac{2}{3} 450 = 300 \text{ mm}$$

Dipakai $b = 300 \text{ mm}$

Jadi digunakan dimensi balok induk 300/450

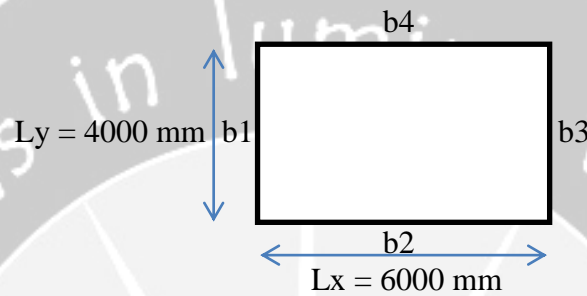
Dengan demikian, estimasi untuk dimensi balok dapat digunakan ukuran seperti pada tabel 3.1 Estimasi dimensi balok.

Tabel 3.1 Estimasi dimensi balok

No	Bentang (mm)	Nama Balok	b (mm)	h (mm)
1	8000	BI1	400	650
2	7750	BI1	400	650
3	7500	BI1	400	650
4	6000	BI2	350	550
5	6000	BA1	300	400
6	5500	BI3	300	500
7	5000	BI3	300	500
8	5000	BA2	250	400
9	4500	BI4	300	450

3.2 Estimasi Tebal Pelat

Tebal pelat lantai di hitung dari pelat terbesar dan harus memenuhi syarat ketebalan minimum pelat pada SNI 2847-2013 pasal 9.5.3.3.



Gambar 3.1 Bentang pelat terbesar

$$\text{Balok } b1 = b3 = 400/650$$

$$\text{Balok } b2 = 300/450$$

$$\text{Balok } b4 = 550/350$$

$$\text{Nilai } \beta_1 = \frac{L_y}{L_x} = \frac{6000}{4000} = 1,5 \text{ digunakan pelat dua arah}$$

Diasumsikan tebal pelat 120 mm

$$\text{Maka nilai } \alpha_{fm} = \frac{E_{cb} \cdot I_b}{E_{cs} \cdot I_s} \text{ karena } E_{cb} = E_{cs} \text{ maka } \alpha_{fm} = \frac{I_b}{I_s}$$

$$\alpha_1 = \alpha_3 = \frac{\frac{1}{12} \times 400 \times 650^3}{\frac{1}{12} \times 4000 \times 120^3} = 15,8927$$

$$\alpha_2 = \frac{\frac{1}{12} \times 300 \times 450^3}{\frac{1}{12} \times 6000 \times 120^3} = 2,6367$$

$$\alpha_4 = \frac{\frac{1}{12} \times 350 \times 550^3}{\frac{1}{12} \times 6000 \times 120^3} = 5,6164$$

$$\alpha_m = \frac{\sum \alpha}{4} = \frac{15,8927 + 2,6367 + 5,6164}{4} = 6,0365$$

Menurut SNI 2847-2013 pasal 9.5.3.3, untuk $\alpha_{fm} > 2,0$ maka digunakan rumus:

$$h = l_n \frac{\left(0,8 + \frac{f_y}{1400}\right)}{36 + 9\beta} \geq 90 \text{ mm}$$

dengan:

$$l_n = 6000 - (350/2) - (300/2) = 5675$$

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

$$\beta = \frac{5675}{4000 - \left(\frac{350}{2}\right) - \left(\frac{300}{2}\right)} = 1,5764$$

$$h = 5675 \times \frac{\left(0,8 + \frac{240}{1400}\right)}{36 + (9 \times 1,5764)} = 109,8452 \geq 90 \text{ mm ...OK!}$$

Maka digunakan tebal pelat lantai 120 mm

3.3 Pembebanan Pelat

Pembebanan pelat meliputi beban mati (DL) dan beban hidup (LL) untuk pelat lantai dan pelat atap.

- Pelat atap

Beban mati

$$\text{Berat sendiri pelat} = 0,12 \times 24 = 2,88 \text{ KN/m}^2$$

$$\text{Berat pasir} = 0,03 \times 18 = 0,54 \text{ KN/m}^2$$

$$\text{Berat spesi} = 0,02 \times 21 = 0,42 \text{ KN/m}^2$$

$$\text{Berat plafond dan penggantung} = 0,11 + 0,07 = 0,18 \text{ KN/m}^2$$

Berat mekanikal dan elektrik	= 0,15 KN/m ²
Q_{DL}	= 4,17 KN/m²

Beban hidup

Beban hidup pelat atap	= 1 KN/m ²
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- Pelat lantai

Beban mati

Berat sendiri pelat	= 0,12 x 24	= 2,88 KN/m ²
Berat pasir	= 0,03 x 18	= 0,54 KN/m ²
Berat penutup lantai	= 0,01 x 24	= 0,24 KN/m ²
Berat spesi	= 0,02 x 21	= 0,42 KN/m ²
Berat plafond dan penggantung		= 0,18 KN/m ²
Berat mekanikal dan elektrik		= 0,15 KN/m ²
Q_{DL}		= 4,41 KN/m²

Beban hidup

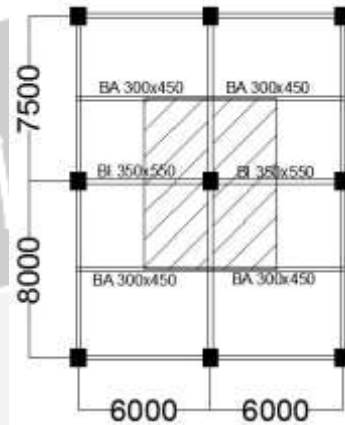
Beban hidup untuk ruang hunian	= 1,92 KN/m ²
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Beban hidup untuk ruang koridor	= 4,79 KN/m ²
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Beban hidup untuk atap	= 1,00 KN/m ²
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3.4 Estimasi Kolom

Untuk estimasi kolom di tinjau dari kolom yang memikul beban paling besar.



Gambar 3.2 Gambar *tributary area* kolom

Diketahui data:

$$f'_c = 30 \text{ MPa}$$

$$f_y = 420 \text{ MPa}$$

$$\emptyset = 0,65 \text{ (untuk pengikagat sengkang)}$$

Tulangan diasumsikan 3% A_g atau $0,003A_g$

- Untuk kolom lantai 12B

$$\text{Beban mati pelat} = 6 \times 7,75 \times 4,17 = 193,905 \text{ KN}$$

$$\text{Beban BI (0,35x0,55)} = 0,35 \times (0,55 - 0,12) \times 6 \times 24 = 21,672 \text{ KN}$$

$$\text{Beban BI (0,40x0,65)} = 0,4 \times (0,65 - 0,12) \times 4 \times 24 = 20,352 \text{ KN}$$

$$\text{Beban BI (0,40x0,65)} = 0,4 \times (0,65 - 0,12) \times 3,75 \times 24 = 19,08 \text{ KN}$$

$$\text{Beban BA (0,30x0,45)} = 0,3 \times (0,45 - 0,12) \times 12 \times 24 = 28,512 \text{ KN}$$

$$N_{DL} = 283,521 \text{ KN}$$

$$\text{Beban Hidup} = 1 \times 6 \times 7,75 = 46,5 \text{ KN}$$

$$N_{LL} = 46,5 \text{ KN}$$

$$\begin{aligned}
 P_u &= 1,2N_{DL} + 1,6N_{DL} \\
 &= (1,2 \times 283,51) + (1,6 \times 46,5) \\
 &= 414,6252 \text{ KN}
 \end{aligned}$$

$$\phi P_n = P_u$$

$$\begin{aligned}
 P_n &= \frac{P_u}{\phi} \\
 &= \frac{414,6252}{0,65} \\
 &= 637,8849 \text{ KN}
 \end{aligned}$$

$$\begin{aligned}
 P_n &= 0,80 [0,85 \times f'_c \times (A_g - A_{st}) + f_y \times A_{st}] \\
 &= 0,80 [0,85 \times 29 (A_g - 0,03A_g) + 420 \times 0,03A_g] \\
 &= 0,80 [23,8A_g - 0,714A_g + 12,6A_g] \\
 &= 28,5488A_g
 \end{aligned}$$

$$\begin{aligned}
 A_g &= \frac{P_n}{28,5488} \\
 &= \frac{637,8849 \times 10^3}{28,5488} \\
 &= 22343,6685 \text{ mm}^2
 \end{aligned}$$

Diasumsikan $b = 0,8h$

$$\begin{aligned}
 h &= \sqrt{\frac{22343,6685}{0,8}} \\
 &= 167,1215 \text{ mm}
 \end{aligned}$$

Jadi digunakan dimensi kolom $b = 300$ dan $h = 550$

- Untuk kolom lantai 12A

$$\text{Beban mati pelat} = 6 \times 7,75 \times 4,41 = 205,065 \text{ KN}$$

$$\text{Beban BI (0,35x0,55)} = 0,35 \times (0,55 - 0,12) \times 6 \times 24 = 21,672 \text{ KN}$$

$$\text{Beban BI (0,40x0,65)} = 0,4 \times (0,65 - 0,12) \times 4 \times 24 = 20,352 \text{ KN}$$

$$\text{Beban BI (0,40x0,65)} = 0,4 \times (0,65 - 0,12) \times 3,75 \times 24 = 19,08 \text{ KN}$$

$$\text{Beban BA (0,30x0,45)} = 0,3 \times (0,45 - 0,12) \times 12 \times 24 = 28,512 \text{ KN}$$

$$\text{Beban kolom di atasnya} = (0,3 \times 0,4 \times 3,25 \times 24) + 283,521 = 292,881 \text{ KN}$$

$$N_{DL} = 587,562 \text{ KN}$$

$$\text{Beban Hidup} = 1,92 \times 6 \times 7,75 = 93 \text{ KN}$$

$$\text{Beban hidup lantai di atasnya} = 46,5 \text{ KN}$$

$$N_{LL} = 139,5 \text{ KN}$$

$$\begin{aligned} P_u &= 1,2N_{DL} + 1,6N_{LL} \\ &= (1,2 \times 587,562) + (1,6 \times 139,5) \\ &= 928,2744 \text{ KN} \end{aligned}$$

$$\phi P_n = P_u$$

$$P_n = \frac{P_u}{\phi}$$

$$= \frac{924,8184}{0,65}$$

$$= 1428,1145 \text{ KN}$$

$$P_n = 0,80 [0,85 \times f'_c \times (A_g - A_{st}) + f_y \times A_{st}]$$

$$= 0,80 [0,85 \times 29 (A_g - 0,03A_g) + 420 \times 0,03A_g]$$

$$= 0,80 [23,8A_g - 0,714A_g + 12,6A_g]$$

$$= 28,5488A_g$$

$$A_g = \frac{P_n}{28,5488}$$

$$= \frac{1428,1145 \times 10^3}{28,5488}$$

$$= 50023,6249 \text{ mm}^2$$

Diasumsikan $b = 0,8h$

$$h = \sqrt{\frac{50023,6249}{0,8}}$$

$$= 250,00591 \text{ mm}$$

Jadi digunakan dimensi kolom $b = 300$ dan $h = 550$

- Untuk kolom lantai 11

$$\text{Beban mati pelat} = 6 \times 7,75 \times 4,41 = 205,065 \text{ KN}$$

$$\text{Beban BI (0,35x0,55)} = 0,35 \times (0,55 - 0,12) \times 6 \times 24 = 21,672 \text{ KN}$$

$$\text{Beban BI (0,40x0,65)} = 0,4 \times (0,65 - 0,12) \times 4 \times 24 = 20,352 \text{ KN}$$

$$\text{Beban BI (0,40x0,65)} = 0,4 \times (0,65 - 0,12) \times 3,75 \times 24 = 19,08 \text{ KN}$$

$$\text{Beban BA (0,30x0,45)} = 0,3 \times (0,45 - 0,12) \times 12 \times 24 = 28,512 \text{ KN}$$

$$\text{Beban kolom di atasnya} = (0,3 \times 0,4 \times 3,25 \times 24) + 584,682 = 290,001 \text{ KN}$$

$$N_{DL} = 891,603 \text{ KN}$$

$$\text{Beban Hidup} = 1,92 \times 6 \times 7,75 = 93 \text{ KN}$$

$$\text{Beban hidup lantai di atasnya} = 139,5 \text{ KN}$$

$$N_{LL} = 232,5 \text{ KN}$$

$$P_u = 1,2N_{DL} + 1,6N_{LL}$$

$$= (1,2 \times 891,603) + (1,6 \times 232,5)$$

$$= 1441,9236 \text{ KN}$$

$$\phi P_n = P_u$$

$$P_n = \frac{P_u}{\phi}$$

$$= \frac{1441,9236}{0,65}$$

$$= 2218,344 \text{ KN}$$

$$P_n = 0,80 [0,85 \times f'_c \times (A_g - A_{st}) + f_y \times A_{st}]$$

$$= 0,80 [0,85 \times 29 (A_g - 0,03A_g) + 420 \times 0,03A_g]$$

$$= 0,80 [23,8A_g - 0,714A_g + 12,6A_g]$$

$$= 28,5488A_g$$

$$A_g = \frac{P_n}{28,5488}$$

$$= \frac{2218,344 \times 10^3}{28,5488}$$

$$= 77703,5812 \text{ mm}^2$$

Diasumsikan $b = 0,8h$

$$h = \sqrt{\frac{77703,5812}{0,8}}$$

$$= 311,6560 \text{ mm}$$

Jadi digunakan dimensi kolom $b = 400$ dan $h = 550$

- Untuk kolom lantai 10

$$\text{Beban mati pelat} = 6 \times 7,75 \times 4,41 = 205,065 \text{ KN}$$

$$\text{Beban BI (0,35x0,55)} = 0,35 \times (0,55 - 0,12) \times 6 \times 24 = 21,672 \text{ KN}$$

$$\text{Beban BI (0,40x0,65)} = 0,4 \times (0,65 - 0,12) \times 4 \times 24 = 20,352 \text{ KN}$$

$$\text{Beban BI (0,40x0,65)} = 0,4 \times (0,65 - 0,12) \times 3,75 \times 24 = 19,08 \text{ KN}$$

$$\text{Beban BA (0,30x0,45)} = 0,3 \times (0,45 - 0,12) \times 12 \times 24 = 28,512 \text{ KN}$$

$$\text{Beban kolom di atasnya} = (0,4 \times 0,5 \times 3,25 \times 24) + 891,603 = 907,203 \text{ KN}$$

$$N_{DL} = 1201,884 \text{ KN}$$

$$\text{Beban Hidup} = 1,92 \times 6 \times 7,75 = 93 \text{ KN}$$

$$\text{Beban hidup lantai di atasnya} = 232,5 \text{ KN}$$

$$N_{LL} = 325,5 \text{ KN}$$

$$P_u = 1,2N_{DL} + 1,6N_{LL}$$

$$= (1,2 \times 1201,884) + (1,6 \times 325,5)$$

$$= 1963,0608 \text{ KN}$$

$$\phi P_n = P_u$$

$$P_n = \frac{P_u}{\phi}$$

$$= \frac{1963,0608}{0,65}$$

$$= 3020,0935 \text{ KN}$$

$$P_n = 0,80 [0,85 \times f'_c \times (A_g - A_{st}) + f_y \times A_{st}]$$

$$= 0,80 [0,85 \times 29 (A_g - 0,03A_g) + 420 \times 0,03A_g]$$

$$= 0,80 [23,8A_g - 0,714A_g + 12,6A_g]$$

$$= 28,5488A_g$$

$$A_g = \frac{P_n}{28,5488}$$

$$= \frac{3020,0935 \times 10^3}{28,5488}$$

$$= 105787,0572 \text{ mm}^2$$

Diasumsikan $b = 0,8h$

$$h = \sqrt{\frac{105787,0572}{0,8}}$$

$$= 363,64 \text{ mm}$$

Jadi digunakan dimensi kolom $b = 400$ dan $h = 550$

- Untuk kolom lantai 9

Beban mati pelat	$= 6 \times 7,75 \times 4,41$	$= 205,065 \text{ KN}$
Beban BI (0,35x0,55)	$= 0,35 \times (0,55 - 0,12) \times 6 \times 24$	$= 21,672 \text{ KN}$
Beban BI (0,40x0,65)	$= 0,4 \times (0,65 - 0,12) \times 4 \times 24$	$= 20,352 \text{ KN}$
Beban BI (0,40x0,65)	$= 0,4 \times (0,65 - 0,12) \times 3,75 \times 24$	$= 19,08 \text{ KN}$
Beban BA (0,30x0,45)	$= 0,3 \times (0,45 - 0,12) \times 12 \times 24$	$= 28,512 \text{ KN}$
Beban kolom di atasnya	$= (0,4 \times 0,5 \times 3,25 \times 24) + 1201,884$	$= 1217,484 \text{ KN}$
		<hr/>
		$N_{DL} = 1512,165 \text{ KN}$
Beban Hidup	$= 1,92 \times 6 \times 7,75$	$= 93 \text{ KN}$
Beban hidup lantai di atasnya		$= 325,5 \text{ KN}$
		<hr/>
		$N_{LL} = 418,5 \text{ KN}$

$$P_u = 1,2N_{DL} + 1,6N_{LL}$$

$$= (1,2 \times 1512,165) + (1,6 \times 418,5)$$

$$= 2484,198 \text{ KN}$$

$$\phi P_n = P_u$$

$$P_n = \frac{P_u}{\phi}$$

$$= \frac{2484,198}{0,65}$$

$$= 3821,8431 \text{ KN}$$

$$P_n = 0,80 \cdot [0,85 \cdot f'_c \cdot (A_g - A_{st}) + f_y \cdot A_{st}]$$

$$= 0,80 \cdot [0,85 \cdot 28 \cdot (A_g - 0,03A_g) + 420 \cdot 0,03A_g]$$

$$= 0,80 \cdot [23,8A_g - 0,714A_g + 12,6A_g]$$

$$= 28,5488A_g$$

$$A_g = \frac{P_n}{28,5488}$$

$$= \frac{3821,8431 \times 10^3}{28,5488}$$

$$= 133870,5332 \text{ mm}^2$$

Diasumsikan $b = 0,8h$

$$h = \sqrt{\frac{133870,5332}{0,8}}$$

$$= 409,07 \text{ mm}$$

Jadi digunakan dimensi kolom $b = 500$ dan $h = 600$

- Untuk kolom lantai 8

$$\text{Beban mati pelat} = 6 \times 7,75 \times 4,41 = 205,065 \text{ KN}$$

$$\text{Beban BI (0,35x0,55)} = 0,35 \times (0,55 - 0,12) \times 6 \times 24 = 21,672 \text{ KN}$$

$$\begin{aligned} \text{Beban BI (0,40x0,65)} &= 0,4 \times (0,65 - 0,12) \times 4 \times 24 = 20,352 \text{ KN} \\ \text{Beban BI (0,40x0,65)} &= 0,4 \times (0,65 - 0,12) \times 3,75 \times 24 = 19,08 \text{ KN} \\ \text{Beban BA (0,30x0,45)} &= 0,3 \times (0,45 - 0,12) \times 12 \times 24 = 28,512 \text{ KN} \\ \text{Beban kolom di atasnya} &= (0,4 \times 0,5 \times 3,25 \times 24) + 1512,165 = 1535,565 \text{ KN} \end{aligned}$$

$$N_{DL} = 1830,246 \text{ KN}$$

$$\text{Beban Hidup} = 1,92 \times 6 \times 7,75 = 93 \text{ KN}$$

$$\text{Beban hidup lantai di atasnya} = 418,5 \text{ KN}$$

$$N_{LL} = 511,5 \text{ KN}$$

$$\begin{aligned} P_u &= 1,2N_{DL} + 1,6N_{LL} \\ &= (1,2 \times 1830,246) + (1,6 \times 511,5) \\ &= 3014,6952 \text{ KN} \end{aligned}$$

$$\phi P_n = P_u$$

$$\begin{aligned} P_n &= \frac{P_u}{\phi} \\ &= \frac{3014,6952}{0,65} \end{aligned}$$

$$= 4637,9926 \text{ KN}$$

$$\begin{aligned} P_n &= 0,80 [0,85 \times f'_c \times (A_g - A_{st}) + f_y \times A_{st}] \\ &= 0,80 [0,85 \times 29 (A_g - 0,03A_g) + 420 \times 0,03A_g] \\ &= 0,80 [23,8A_g - 0,714A_g + 12,6A_g] \\ &= 28,5488A_g \end{aligned}$$

$$A_g = \frac{P_n}{28,5488}$$

$$= \frac{4637,9926 \times 10^3}{28,5488}$$

$$= 162458,4086 \text{ mm}^2$$

Diasumsikan $b = 0,8h$

$$h = \sqrt{\frac{162458,4086}{0,8}}$$

$$= 450,64 \text{ mm}$$

Jadi digunakan dimensi kolom $b = 500$ dan $h = 600$

- Untuk kolom lantai 7

$$\text{Beban mati pelat} = 6 \times 7,75 \times 4,41 = 205,065 \text{ KN}$$

$$\text{Beban BI (0,35x0,55)} = 0,35 \times (0,55 - 0,12) \times 6 \times 24 = 21,672 \text{ KN}$$

$$\text{Beban BI (0,40x0,65)} = 0,4 \times (0,65 - 0,12) \times 4 \times 24 = 20,352 \text{ KN}$$

$$\text{Beban BI (0,40x0,65)} = 0,4 \times (0,65 - 0,12) \times 3,75 \times 24 = 19,08 \text{ KN}$$

$$\text{Beban BA (0,30x0,45)} = 0,3 \times (0,45 - 0,12) \times 12 \times 24 = 28,512 \text{ KN}$$

$$\text{Beban kolom di atasnya} = (0,4 \times 0,5 \times 3,25 \times 24) + 1830,246 = 1853,646 \text{ KN}$$

$$N_{DL} = 2148,327 \text{ KN}$$

$$\text{Beban Hidup} = 1,92 \times 6 \times 7,75 = 93 \text{ KN}$$

$$\text{Beban hidup lantai di atasnya} = 511,5 \text{ KN}$$

$$N_{LL} = 604,5 \text{ KN}$$

$$P_u = 1,2N_{DL} + 1,6N_{LL}$$

$$= (1,2 \times 2148,327) + (1,6 \times 604,5)$$

$$= 3545,1924 \text{ KN}$$

$$\phi P_n = P_u$$

$$P_n = \frac{P_u}{\phi}$$

$$= \frac{3545,1924}{0,65}$$

$$= 5454,1422 \text{ KN}$$

$$\begin{aligned} P_n &= 0,80 [0,85 \times f'_c \times (A_g - A_{st}) + f_y \times A_{st}] \\ &= 0,80 [0,85 \times 29 (A_g - 0,03A_g) + 420 \times 0,03A_g] \\ &= 0,80 [23,8A_g - 0,714A_g + 12,6A_g] \\ &= 28,5488A_g \end{aligned}$$

$$\begin{aligned} A_g &= \frac{P_n}{28,5488} \\ &= \frac{5454,1422 \times 10^3}{28,5488} \\ &= 191046,284 \text{ mm}^2 \end{aligned}$$

Diasumsikan $b = 0,8h$

$$\begin{aligned} h &= \sqrt{\frac{191046,284}{0,8}} \\ &= 488,68 \text{ mm} \end{aligned}$$

Jadi digunakan dimensi kolom $b = 550$ dan $h = 650$

- Untuk kolom lantai 6

$$\text{Beban mati pelat} = 6 \times 7,75 \times 4,41 = 205,065 \text{ KN}$$

$$\text{Beban BI (0,35x0,55)} = 0,35 \times (0,55 - 0,12) \times 6 \times 24 = 21,672 \text{ KN}$$

$$\text{Beban BI (0,40x0,65)} = 0,4 \times (0,65 - 0,12) \times 4 \times 24 = 20,352 \text{ KN}$$

$$\text{Beban BI (0,40x0,65)} = 0,4 \times (0,65 - 0,12) \times 3,75 \times 24 = 19,08 \text{ KN}$$

$$\text{Beban BA (0,30x0,45)} = 0,3 \times (0,45 - 0,12) \times 12 \times 24 = 28,512 \text{ KN}$$

$$\text{Beban kolom di atasnya} = (0,4 \times 0,5 \times 3,25 \times 24) + 2148,327 = 2176,212 \text{ KN}$$

	N_{DL}	= 2470,327 KN
Beban Hidup	= $1,92 \times 6 \times 7,75$	= 93 KN
Beban hidup lantai diatasnya		= 604,5 KN
	N_{LL}	= 697,5 KN

$$\begin{aligned}
 P_u &= 1,2N_{DL} + 1,6N_{LL} \\
 &= (1,2 \times 2470,327) + (1,6 \times 697,5) \\
 &= 4081,0716 \text{ KN}
 \end{aligned}$$

$$\phi P_n = P_u$$

$$\begin{aligned}
 P_n &= \frac{P_u}{\phi} \\
 &= \frac{4081,0716}{0,65} \\
 &= 6278,5717 \text{ KN}
 \end{aligned}$$

$$\begin{aligned}
 P_n &= 0,80 [0,85 \times f'_c \times (A_g - A_{st}) + f_y \times A_{st}] \\
 &= 0,80 [0,85 \times 29 (A_g - 0,03A_g) + 420 \times 0,03A_g] \\
 &= 0,80 [23,8A_g - 0,714A_g + 12,6A_g] \\
 &= 28,5488A_g
 \end{aligned}$$

$$\begin{aligned}
 A_g &= \frac{P_n}{28,5488} \\
 &= \frac{6278,5717 \times 10^3}{28,5488} \\
 &= 219924,1892 \text{ mm}^2
 \end{aligned}$$

Diasumsikan $b = 0,8h$

$$h = \sqrt{\frac{219924,1892}{0,8}}$$

$$= 524,31 \text{ mm}$$

Jadi digunakan dimensi kolom $b = 550$ dan $h = 650$

- Untuk kolom lantai 5

Beban mati pelat	$= 6 \times 7,75 \times 4,41$	$= 205,065 \text{ KN}$
Beban BI (0,35x0,55)	$= 0,35 \times (0,55 - 0,12) \times 6 \times 24$	$= 21,672 \text{ KN}$
Beban BI (0,40x0,65)	$= 0,4 \times (0,65 - 0,12) \times 4 \times 24$	$= 20,352 \text{ KN}$
Beban BI (0,40x0,65)	$= 0,4 \times (0,65 - 0,12) \times 3,75 \times 24$	$= 19,08 \text{ KN}$
Beban BA (0,30x0,45)	$= 0,3 \times (0,45 - 0,12) \times 12 \times 24$	$= 28,512 \text{ KN}$
Beban kolom di atasnya	$= (0,4 \times 0,5 \times 3,25 \times 24) + 2470,327$	$= 2497,893 \text{ KN}$
		<hr/>
	N_{DL}	$= 2793,459 \text{ KN}$
Beban Hidup	$= 1,92 \times 6 \times 7,75$	$= 93 \text{ KN}$
Beban hidup lantai di atasnya		$= 697,5 \text{ KN}$
		<hr/>
	N_{LL}	$= 790,5 \text{ KN}$

$$\begin{aligned}
 P_u &= 1,2N_{DL} + 1,6N_{LL} \\
 &= (1,2 \times 2793,459) + (1,6 \times 697,5) \\
 &= 4616,9508 \text{ KN}
 \end{aligned}$$

$$\phi P_n = P_u$$

$$\begin{aligned}
 P_n &= \frac{P_u}{\phi} \\
 &= \frac{4616,9508}{0,65}
 \end{aligned}$$

$$= 7103,0012 \text{ KN}$$

$$P_n = 0,80 [0,85 \times f'_c \times (A_g - A_{st}) + f_y \times A_{st}]$$

$$\begin{aligned}
 &= 0,80 [0,85 \times 29 (A_g - 0,03A_g) + 420 \times 0,03A_g] \\
 &= 0,80 [23,8A_g - 0,714A_g + 12,6A_g] \\
 &= 28,5488A_g
 \end{aligned}$$

$$\begin{aligned}
 A_g &= \frac{P_n}{28,5488} \\
 &= \frac{7103,0012 \times 10^3}{28,5488} \\
 &= 248802,0943 \text{ mm}^2
 \end{aligned}$$

Diasumsikan $b = 0,8h$

$$\begin{aligned}
 h &= \sqrt{\frac{248802,0943}{0,8}} \\
 &= 557,68 \text{ mm}
 \end{aligned}$$

Jadi digunakan dimensi kolom $b = 600$ dan $h = 700$

- Untuk kolom lantai 4

Beban mati pelat	$= 6 \times 7,75 \times 4,41$	$= 205,065 \text{ KN}$
Beban BI (0,35x0,55)	$= 0,35 \times (0,55 - 0,12) \times 6 \times 24$	$= 21,672 \text{ KN}$
Beban BI (0,40x0,65)	$= 0,4 \times (0,65 - 0,12) \times 4 \times 24$	$= 20,352 \text{ KN}$
Beban BI (0,40x0,65)	$= 0,4 \times (0,65 - 0,12) \times 3,75 \times 24$	$= 19,08 \text{ KN}$
Beban BA (0,30x0,45)	$= 0,3 \times (0,45 - 0,12) \times 12 \times 24$	$= 28,512 \text{ KN}$
Beban kolom di atasnya	$= (0,4 \times 0,5 \times 3,25 \times 24) + 2793,459$	$= 2826,219 \text{ KN}$
		$N_{DL} = 3120,9 \text{ KN}$
Beban Hidup	$= 1,92 \times 6 \times 7,75$	$= 93 \text{ KN}$
Beban hidup lantai di atasnya		$= 790,5 \text{ KN}$

$$N_{LL} = 883,5 \text{ KN}$$

$$\begin{aligned} P_u &= 1,2N_{DL} + 1,6N_{DL} \\ &= (1,2 \times 3120,9) + (1,6 \times 883,5) \\ &= 5158,68 \text{ KN} \end{aligned}$$

$$\phi P_n = P_u$$

$$\begin{aligned} P_n &= \frac{P_u}{\phi} \\ &= \frac{5158,68}{0,65} \\ &= 7936,4308 \text{ KN} \end{aligned}$$

$$\begin{aligned} P_n &= 0,80 [0,85 \times f'_c \times (A_g - A_{st}) + f_y \times A_{st}] \\ &= 0,80 [0,85 \times 29 (A_g - 0,03A_g) + 420 \times 0,03A_g] \\ &= 0,80 [23,8A_g - 0,714A_g + 12,6A_g] \\ &= 28,5488A_g \end{aligned}$$

$$\begin{aligned} A_g &= \frac{P_n}{28,5488} \\ &= \frac{7936,4308 \times 10^3}{28,5488} \\ &= 277995,2492 \text{ mm}^2 \end{aligned}$$

Diasumsikan $b = 0,8h$

$$\begin{aligned} h &= \sqrt{\frac{277995,2492}{0,8}} \\ &= 589,49 \text{ mm} \end{aligned}$$

Jadi digunakan dimensi kolom $b = 600$ dan $h = 700$

- Untuk kolom lantai 3

$$\text{Beban mati pelat} = 6 \times 7,75 \times 4,41 = 205,065 \text{ KN}$$

$$\text{Beban BI (0,35x0,55)} = 0,35 \times (0,55 - 0,12) \times 6 \times 24 = 21,672 \text{ KN}$$

$$\text{Beban BI (0,40x0,65)} = 0,4 \times (0,65 - 0,12) \times 4 \times 24 = 20,352 \text{ KN}$$

$$\text{Beban BI (0,40x0,65)} = 0,4 \times (0,65 - 0,12) \times 3,75 \times 24 = 19,08 \text{ KN}$$

$$\text{Beban BA (0,30x0,45)} = 0,3 \times (0,45 - 0,12) \times 12 \times 24 = 28,512 \text{ KN}$$

$$\text{Beban kolom di atasnya} = (0,4 \times 0,5 \times 3,25 \times 24) + 3120,9 = 3153,66 \text{ KN}$$

$$N_{DL} = 3448,341 \text{ KN}$$

$$\text{Beban Hidup} = 1,92 \times 6 \times 7,75 = 93 \text{ KN}$$

$$\text{Beban hidup lantai di atasnya} = 883,5 \text{ KN}$$

$$N_{LL} = 976,5 \text{ KN}$$

$$P_u = 1,2N_{DL} + 1,6N_{LL}$$

$$= (1,2 \times 3448,341) + (1,6 \times 976,5)$$

$$= 5700,4092 \text{ KN}$$

$$\phi P_n = P_u$$

$$P_n = \frac{P_u}{\phi}$$

$$= \frac{5700,4092}{0,65}$$

$$= 8769,8603 \text{ KN}$$

$$P_n = 0,80 [0,85 \times f'_c \times (A_g - A_{st}) + f_y \times A_{st}]$$

$$= 0,80 [0,85 \times 29 (A_g - 0,03A_g) + 420 \times 0,03A_g]$$

$$= 0,80 [23,8A_g - 0,714A_g + 12,6A_g]$$

$$= 28,5488A_g$$

$$A_g = \frac{P_n}{28,5488}$$

$$= \frac{8769,8603 \times 10^3}{28,5488}$$

$$= 307188,404 \text{ mm}^2$$

Diasumsikan $b = 0,8h$

$$h = \sqrt{\frac{307188,404}{0,8}}$$

$$= 619,67 \text{ mm}$$

Jadi digunakan dimensi kolom $b = 650$ dan $h = 750$

- Untuk kolom lantai 2

Beban mati pelat	$= 6 \times 7,75 \times 4,41$	$= 205,065 \text{ KN}$
Beban BI (0,35x0,55)	$= 0,35 \times (0,55 - 0,12) \times 6 \times 24$	$= 21,672 \text{ KN}$
Beban BI (0,40x0,65)	$= 0,4 \times (0,65 - 0,12) \times 4 \times 24$	$= 20,352 \text{ KN}$
Beban BI (0,40x0,65)	$= 0,4 \times (0,65 - 0,12) \times 3,75 \times 24$	$= 19,08 \text{ KN}$
Beban BA (0,30x0,45)	$= 0,3 \times (0,45 - 0,12) \times 12 \times 24$	$= 28,512 \text{ KN}$
Beban kolom di atasnya	$= (0,4 \times 0,5 \times 3,25 \times 24) + 3448,341$	$= 3486,366 \text{ KN}$
		<hr/>
		$N_{DL} = 3781,047 \text{ KN}$
Beban Hidup	$= 1,92 \times 6 \times 7,75$	$= 93 \text{ KN}$
Beban hidup lantai di atasnya		$= 976,5 \text{ KN}$
		<hr/>
		$N_{LL} = 1069,5 \text{ KN}$

$$P_u = 1,2N_{DL} + 1,6N_{LL}$$

$$= (1,2 \times 3781,047) + (1,6 \times 1069,5)$$

$$= 6248,4564 \text{ KN}$$

$$\phi P_n = P_u$$

$$P_n = \frac{P_u}{\phi}$$

$$= \frac{6248,4564}{0,65}$$

$$= 9613,0098 \text{ KN}$$

$$P_n = 0,80 [0,85 \times f'_c \times (A_g - A_{st}) + f_y \times A_{st}]$$

$$= 0,80 [0,85 \times 29 (A_g - 0,03A_g) + 420 \times 0,03A_g]$$

$$= 0,80 [23,8A_g - 0,714A_g + 12,6A_g]$$

$$= 28,5488A_g$$

$$A_g = \frac{P_n}{28,5488}$$

$$= \frac{9613,0098 \times 10^3}{28,5488}$$

$$= 336722,0285 \text{ mm}^2$$

Diasumsikan $b = 0,8h$

$$h = \sqrt{\frac{336722,0285}{0,8}}$$

$$= 648,77 \text{ mm}$$

Jadi digunakan dimensi kolom $b = 650$ dan $h = 750$

- Untuk kolom lantai 1

$$\text{Beban mati pelat} = 6 \times 7,75 \times 4,41 = 205,065 \text{ KN}$$

$$\text{Beban BI (0,35x0,55)} = 0,35 \times (0,55 - 0,12) \times 6 \times 24 = 21,672 \text{ KN}$$

$$\begin{aligned}
 \text{Beban BI (0,40x0,65)} &= 0,4 \times (0,65 - 0,12) \times 4 \times 24 &= 20,352 \text{ KN} \\
 \text{Beban BI (0,40x0,65)} &= 0,4 \times (0,65 - 0,12) \times 3,75 \times 24 &= 19,08 \text{ KN} \\
 \text{Beban BA (0,30x0,45)} &= 0,3 \times (0,45 - 0,12) \times 12 \times 24 &= 28,512 \text{ KN} \\
 \text{Beban kolom di atasnya} &= (0,4 \times 0,5 \times 4 \times 24) + 3781,047 &= 3827,847 \text{ KN}
 \end{aligned}$$

$$N_{DL} = 4122,528 \text{ KN}$$

$$\text{Beban Hidup} = 4,79 \times 6 \times 7,75 = 186 \text{ KN}$$

$$\text{Beban hidup lantai di atasnya} = 1069,5 \text{ KN}$$

$$N_{LL} = 1255,5 \text{ KN}$$

$$\begin{aligned}
 P_u &= 1,2N_{DL} + 1,6N_{LL} \\
 &= (1,2 \times 4122,528) + (1,6 \times 1255,5) \\
 &= 6955,8336 \text{ KN}
 \end{aligned}$$

$$\phi P_n = P_u$$

$$\begin{aligned}
 P_n &= \frac{P_u}{\phi} \\
 &= \frac{6955,8336}{0,65}
 \end{aligned}$$

$$= 10701,282 \text{ KN}$$

$$\begin{aligned}
 P_n &= 0,80 [0,85 \times f'_c \times (A_g - A_{st}) + f_y \times A_{st}] \\
 &= 0,80 [0,85 \times 29 (A_g - 0,03A_g) + 420 \times 0,03A_g] \\
 &= 0,80 [23,8A_g - 0,714A_g + 12,6A_g] \\
 &= 28,5488A_g
 \end{aligned}$$

$$A_g = \frac{P_n}{28,5488}$$

$$= \frac{10701,182 \times 10^3}{28,5488}$$

$$= 374841,7608 \text{ mm}^2$$

Diasumsikan $b = 0,8h$

$$h = \sqrt{\frac{374841,7608}{0,8}}$$

$$= 684,51 \text{ mm}$$

Jadi digunakan dimensi kolom $b = 700$ dan $h = 800$

- Untuk kolom lantai semi basement

$$\text{Beban mati pelat} = 6 \times 7,75 \times 4,41 = 205,065 \text{ KN}$$

$$\text{Beban BI (0,35x0,55)} = 0,35 \times (0,55 - 0,12) \times 6 \times 24 = 21,672 \text{ KN}$$

$$\text{Beban BI (0,40x0,65)} = 0,4 \times (0,65 - 0,12) \times 4 \times 24 = 20,352 \text{ KN}$$

$$\text{Beban BI (0,40x0,65)} = 0,4 \times (0,65 - 0,12) \times 3,75 \times 24 = 19,08 \text{ KN}$$

$$\text{Beban BA (0,30x0,45)} = 0,3 \times (0,45 - 0,12) \times 12 \times 24 = 28,512 \text{ KN}$$

$$\text{Beban kolom di atasnya} = (0,4 \times 0,5 \times 3,5 \times 24) + 4122,528 = 4169,568 \text{ KN}$$

$$N_{DL} = 4464,249 \text{ KN}$$

$$\text{Beban Hidup} = 1,92 \times 6 \times 7,75 = 93 \text{ KN}$$

$$\text{Beban hidup lantai di atasnya} = 1255,5 \text{ KN}$$

$$N_{LL} = 1348,5 \text{ KN}$$

$$P_u = 1,2N_{DL} + 1,6N_{LL}$$

$$= (1,2 \times 4464,249) + (1,6 \times 1348,5)$$

$$= 7514,6988 \text{ KN}$$

$$\phi P_n = P_u$$

$$P_n = \frac{P_u}{\phi}$$

$$= \frac{7514,6988}{0,65}$$

$$= 11561,075 \text{ KN}$$

$$\begin{aligned} P_n &= 0,80 [0,85 \times f'_c \times (A_g - A_{st}) + f_y \times A_{st}] \\ &= 0,80 [0,85 \times 29 (A_g - 0,03A_g) + 420 \times 0,03A_g] \\ &= 0,80 [23,8A_g - 0,714A_g + 12,6A_g] \\ &= 28,5488A_g \end{aligned}$$

$$\begin{aligned} A_g &= \frac{P_n}{28,5488} \\ &= \frac{11561,075 \times 10^3}{28,5488} \\ &= 404958,3547 \text{ mm}^2 \end{aligned}$$

Diasumsikan $b = 0,8h$

$$\begin{aligned} h &= \sqrt{\frac{404958,3547}{0,8}} \\ &= 711,48 \text{ mm} \end{aligned}$$

Jadi digunakan dimensi kolom $b = 750$ dan $h = 850$

- Untuk kolom lantai basement

$$\text{Beban mati pelat} = 6 \times 7,75 \times 4,41 = 205,065 \text{ KN}$$

$$\text{Beban BI (0,35x0,55)} = 0,35 \times (0,55 - 0,12) \times 6 \times 24 = 21,672 \text{ KN}$$

$$\text{Beban BI (0,40x0,65)} = 0,4 \times (0,65 - 0,12) \times 4 \times 24 = 20,352 \text{ KN}$$

$$\text{Beban BI (0,40x0,65)} = 0,4 \times (0,65 - 0,12) \times 3,75 \times 24 = 19,08 \text{ KN}$$

$$\text{Beban BA (0,30x0,45)} = 0,3 \times (0,45 - 0,12) \times 12 \times 24 = 28,512 \text{ KN}$$

$$\text{Beban kolom di atasnya} = (0,4 \times 0,5 \times 3,5 \times 24) + 4464,249 = 4517,799 \text{ KN}$$

	N_{DL}	= 4812,48 KN
Beban Hidup	= $1,92 \times 6 \times 7,75$	= 93 KN
Beban hidup lantai diatasnya		= 1348,5 KN
	N_{LL}	= 1441,5 KN

$$\begin{aligned}
 P_u &= 1,2N_{DL} + 1,6N_{LL} \\
 &= (1,2 \times 4812,48) + (1,6 \times 1441,5) \\
 &= 8081,376 \text{ KN}
 \end{aligned}$$

$$\phi P_n = P_u$$

$$\begin{aligned}
 P_n &= \frac{P_u}{\phi} \\
 &= \frac{8081,376}{0,65} \\
 &= 12432,886 \text{ KN}
 \end{aligned}$$

$$\begin{aligned}
 P_n &= 0,80 [0,85 \times f'_c \times (A_g - A_{st}) + f_y \times A_{st}] \\
 &= 0,80 [0,85 \times 29 (A_g - 0,03A_g) + 420 \times 0,03A_g] \\
 &= 0,80 [23,8A_g - 0,714A_g + 12,6A_g] \\
 &= 28,5488A_g
 \end{aligned}$$

$$\begin{aligned}
 A_g &= \frac{P_n}{28,5488} \\
 &= \frac{12432,886 \times 10^3}{28,5488} \\
 &= 435495,9282 \text{ mm}^2
 \end{aligned}$$

Diasumsikan $b = 0,8h$

$$h = \sqrt{\frac{435495,9282}{0,8}}$$

$$= 737,81 \text{ mm}$$

Jadi digunakan dimensi kolom $b = 750$ dan $h = 850$

Dengan demikian, untuk estimasi dimensi kolom dapat digunakan sesuai dengan tabel 4.2 tabel estimasi dimensi kolom

Tabel 4.2 Estimasi dimensi kolom

No	Lantai	Nama Kolom	b (mm)	h (mm)
1	12B	K1	300	550
2	12A	K1	300	550
3	11	K2	400	550
4	10	K2	400	550
5	9	K3	500	600
6	8	K3	500	600
7	7	K4	550	650
8	6	K4	550	650
9	5	K5	600	700
10	4	K5	600	700
11	3	K6	650	750
12	2	K6	650	750
13	1	K7	700	800
14	B1	K8	750	850
15	B2	K8	750	850