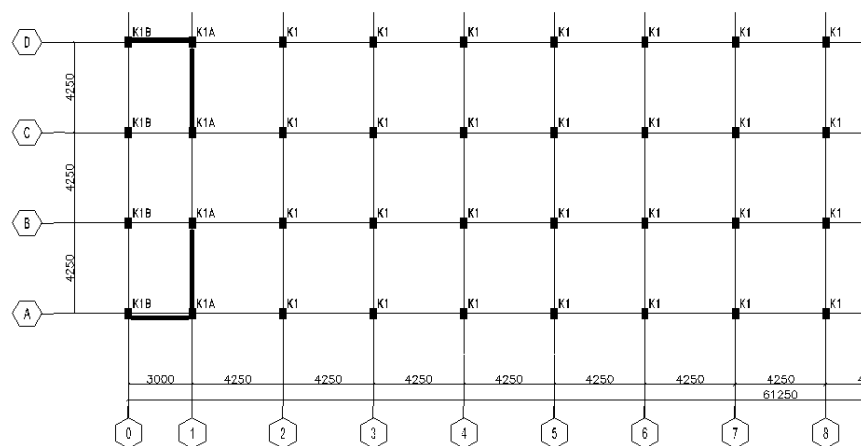


## BAB V

### PENINJAUAN KOLOM

#### 5.1 Dasar Peninjauan

Kolom merupakan struktur utama yang menerima beban bangunan dan beban lainnya, fungsi dari pada kolom sendiri adalah sebagai penerus beban ke pondasi. Struktur kolom sendiri menggunakan beton bertulang, karena kolom tegak lurus atau vertikal maka membutuhkan material yang tahan terhadap tekan dan tarik oleh karena itu digunakan beton bertulang. Dalam perencanaan kolom ini menggunakan mutu beton  $f_c' = 30$  MPa dan mutu tulangan  $f_y = 400$  MPa.



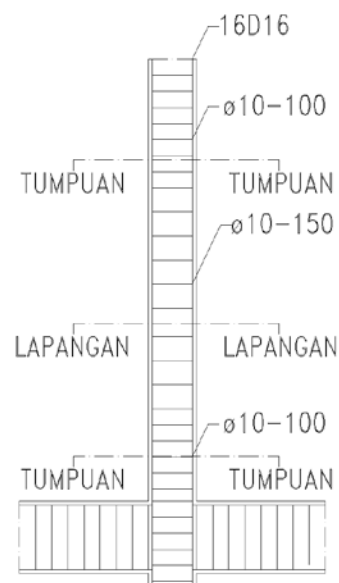
**Gambar 5.1** Denah Kolom Lantai 2-4

## 5.2 Perhitungan Kolom

### Perhitungan Kolom K-1A

Data umum perencanaan:

- Mutu Beton ( $f_c'$ ) : 30 Mpa
- Mutu Baja ( $f_y$ ) : 400 Mpa
- Tulangan pokok : D 16
- Tulangan Bagi : D 10
- Ukuran Rencana Kolom : 500 x 300



TYPE KOLOM	TYPE KOLOM K-1A	
	TUMPUAN	LAPANGAN
DIMENSI	300X500	
TUL ATAS	16D16	16D16
TUL SEKGANG	D10-100	D10-150

**Gambar 5.2** Detail Kolom K-1A

- ❖ Kolom dengan dimensi 500 x 300 dan tulangan pokok 16D16 maka,

$$\begin{aligned} A_s' = A_s &= 0,25 \times \pi \times D^2 \times 16 \\ &= 0,25 \times \pi \times 16^2 \times 16 = 1024 \text{ mm}^2 \end{aligned}$$

Dipakai tulangan = 16D16 ( $A_s = 3217 \text{ mm}^2$ )

$$\begin{aligned} d' &= t_s + (\frac{1}{2} \times D \text{ tul pokok}) + D \text{ tul sengkang} \\ &= 25 + (\frac{1}{2} \times 16) + 10 \\ &= 43 \leq 70 \text{ OK} \end{aligned}$$

$$\begin{aligned} d &= h - d' \\ &= 500 - 43 \\ &= 457 \text{ mm} \end{aligned}$$

- ❖ Mencari Mu

$$0,7225 \times b \times c \times f_c' = A_s \times f_y$$

$$0,7225 \times 300 \times c \times 30 = 3217 \times 400$$

$$6502,5 \quad \quad \quad = 1286800$$

$$c = 197,893 \text{ mm}$$

$$\begin{aligned} Mu &= A_s \times 0,8 \times f_y \times (d - 0,425 \times c) \\ &= 3217 \times 0,8 \times 400 \times (457 - 0,425 \times 197,893) \\ &= 383873517,8 \text{ Nmm} \\ &= 383,873 \text{ kNm} \end{aligned}$$

- ❖ Mencari Pu

(Pu) belum diketahui, oleh sebab itu perlu asumsi nilai (e) untuk mendapatkan nilai (Pu), (e) = 900 mm

$$\begin{aligned} \text{Jadi, } e &= \frac{Mu}{Pu} \cdot 10^3 \\ 900 &= \frac{383,873 \cdot 10^3}{Pu} \\ Pu &= 426,525 \text{ kn} \end{aligned}$$

Jumlah penulangan diperkirakan 2%

Ukuran kolom 500 mm x 300 mm,  $d'=25$  mm

$$P_o = 0,85 f_c' (A_g - A_{st}) + f_y \cdot A_{st}$$

$$P_o = A_g \cdot (0,85 \cdot f_c' (1-p) + f_y \cdot p)$$

$$P_o = A_g (0,85 \cdot 30 (1-2\%) + 400 \cdot 2\%)$$

$$P_n = 0,8 P_o \rightarrow \text{Kolom Beugeul}$$

$$P_u/\Phi = 0,8 A_g (0,85 \cdot 30 (1-0,02) + 400 \cdot 0,02)$$

$$P_u = \Phi 0,8 A_g (0,85 \cdot 30 (1-0,02) + 400 \cdot 0,02)$$

$$426,525 = 0,65 \cdot 0,8 A_g (0,85 \cdot 30 (1-0,02) + 400 \cdot 0,02)$$

$$A_g = \frac{426,525}{0,65 \cdot 0,8 \cdot (0,85 \cdot 29,2 + 8)} = 2499,208 \text{ mm}^2$$

Dicoba dengan tulangan 16D16 pada masing-masing sisi kolom ( $A =$

$3217 \text{ mm}^2$ )

$$\rho = \frac{3217}{500 \times 300} = 0,0214$$

❖ Pemeriksaan  $P_u$  Terhadap beban seimbang  $P_{ub}$

$$d = 300 - 25 = 275 \text{ mm}$$

$$C_b = \frac{500 (d)}{500 + f_y} = \frac{500 (275)}{500 + 400} = 152,777 \text{ mm}$$

$$\beta_1 = 0,85 \text{ (faktor reduksi)}$$

$$a_b = \beta_1 \cdot C = 0,85 \cdot 152,777 = 129,861 \text{ mm}$$

$$\epsilon_s' = \frac{152,777 - 40}{152,777} \cdot 0,003 < \frac{f_y}{E_s}$$

$$= 0,0022 < \frac{400}{200000}$$

$= 0,0022 > 0,0020$  jadi, tulangan mencapai luluh ketika beton

hancur

10.5.2 SNI 03-2847-2002,  
modulus elastisitas baja  
tulangan non pratekan  $E_s$   
dapat diambil sebesar  
200.000 MPa

$$f_s' = E_s \cdot \epsilon_s' = 200000 \cdot 0,0022 = 440 \text{ MPa}$$

$$f_s' > f_y = 440 \text{ MPa} > 400 \text{ MPa}$$

$$\begin{aligned} P_{nb} &= 0,65 (0,85 \cdot F_c' \cdot ab \cdot b + A_s \cdot F_s' - A_s \cdot F_y) \\ &= 0,65 [(0,85 \cdot 30 \cdot 129,861 \cdot 300) + (3217 \cdot 440) \\ &\quad - (3217 \cdot 400)] (10)^{-4} \\ &= 2061181,653 \text{ N} \\ &= 2061,181 \text{ kN} \end{aligned}$$

$$\begin{aligned} \emptyset P_{nb} &= 0,65 (2061,181) > P_u \\ &= 1339,767 \text{ kN} > 2061,181 \text{ kN (aman)} \end{aligned}$$

❖ Memeriksa kekuatan penampang

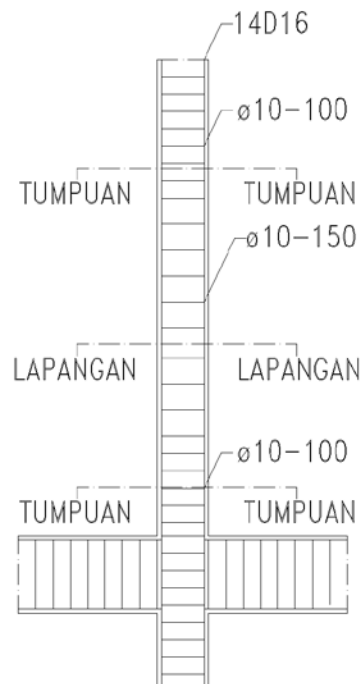
$$\begin{aligned} P_n &= \frac{A_s' f_y}{\frac{e}{(d-d')} + 0,5} + \frac{b h f_c'}{\frac{3he}{d^2} + 1,18} \\ &= \frac{3217 \cdot 400}{\frac{900}{(457-43)} + 0,5} + \frac{500 \times 300 \times 30}{\frac{3 \times 500 \times 900}{457^2} + 1,18} \\ &= 481242,27 + 588696,99 \\ &= 1069939,264 \text{ N} \\ &= 10699,392 \text{ kN} \end{aligned}$$

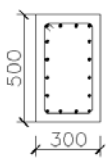
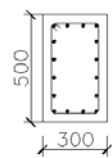
$$\begin{aligned} \emptyset P_{nb} &= 0,65 (10699,392) > P_u \\ &= 6954,604 \text{ kN} > 426,525 \text{ kN (aman)} \end{aligned}$$

### Perhitungan Kolom K-I

Data umum perencanaan:

- Mutu Beton ( $f_c'$ ) : 30 Mpa
- Mutu Baja ( $f_y$ ) : 400 Mpa
- Tulangan pokok : D 16
- Tulangan Bagi : D 10
- Ukuran Rencana Kolom : 500 x 300



TYPE KOLOM	TYPE KOLOM K-1	
	TUMPUAN	LAPANGAN
		
DIMENSI	300X500	
TUL ATAS	14D16	14D16
TUL SEKGANG	D10-100	D10-150

**Gambar 5.3** Detail Kolom K-1

- ❖ Kolom dengan dimensi 500 x 300 dan tulangan pokok 14D16 maka,

$$\begin{aligned} A_s' &= A_s = 0,25 \times \pi \times D^2 \times 16 \\ &= 0,25 \times \pi \times 16^2 \times 16 = 1024 \text{ mm}^2 \end{aligned}$$

Dipakai tulangan = 14D16 ( $A_s = 2815 \text{ mm}^2$ )

$$\begin{aligned} d' &= t_s + (\frac{1}{2} \times D \text{ tul pokok}) + D \text{ tul sengkang} \\ &= 25 + (\frac{1}{2} \times 16) + 10 \\ &= 43 \leq 70 \quad \mathbf{OK} \end{aligned}$$

$$\begin{aligned} d &= h - d' \\ &= 500 - 43 \\ &= 457 \text{ mm} \end{aligned}$$

- ❖ Mencari Mu

$$\begin{aligned} 0,7225 \times b \times c \times f_c' &= A_s \times f_y \\ 0,7225 \times 300 \times c \times 30 &= 2815 \times 400 \\ 6502,5 &= 1126000 \\ c &= 173 \text{ mm} \end{aligned}$$

$$\begin{aligned} Mu &= A_s \times 0,8 \times f_y \times (d - 0,425 \times c) \\ &= 2815 \times 0,8 \times 400 \times (457 - 0,425 \times 173) \\ &= 345434280 \text{ Nmm} \\ &= 345,434 \text{ kNm} \end{aligned}$$

- ❖ Mencari Pu

(Pu) belum diketahui, oleh sebab itu perlu asumsi nilai (e) untuk mendapatkan nilai (Pu), (e) = 900 mm

$$\begin{aligned} \text{Jadi, } e &= \frac{Mu}{Pu} \cdot 10^3 \\ 900 &= \frac{345,434 \cdot 10^3}{Pu} \\ Pu &= 383,815 \text{ kn} \end{aligned}$$

Jumlah penulangan diperkirakan 2%

Ukuran kolom 500 mm x 300 mm,  $d'=25$  mm

$$P_o = 0,85 f_c' (A_g - A_{st}) + f_y \cdot A_{st}$$

$$P_o = A_g \cdot (0,85 \cdot f_c' (1-p) + f_y \cdot p)$$

$$P_o = A_g (0,85 \cdot 30 (1-2\%) + 400 \cdot 2\%)$$

$$P_n = 0,8 P_o \rightarrow \text{Kolom Beugul}$$

$$P_u/\Phi = 0,8 A_g (0,85 \cdot 30 (1-0,02) + 400 \cdot 0,02)$$

$$P_u = \Phi 0,8 A_g (0,85 \cdot 30 (1-0,02) + 400 \cdot 0,02)$$

$$383,815 = 0,65 \cdot 0,8 A_g (0,85 \cdot 30 (1-0,02) + 400 \cdot 0,02)$$

$$A_g = \frac{383,815}{0,65 \cdot 0,8 \cdot (0,85 \cdot 29,2 + 8)} = 2248,95 \text{ mm}$$

Dicoba dengan tulangan 14D16 pada masing-masing sisi kolom ( $A =$

$2815\text{mm}^2$ )

$$\rho = \frac{2815}{500 \times 300} = 0,0187$$

❖ Pemeriksaan  $P_u$  Terhadap beban seimbang  $P_{ub}$

$$d = 300 - 25 = 275 \text{ mm}$$

$$C_b = \frac{500 (d)}{500 + f_y} = \frac{500 (275)}{500 + 400} = 152,777 \text{ mm}$$

$$\beta_1 = 0,85 \text{ (faktor reduksi)}$$

$$a_b = \beta_1 \cdot C = 0,85 \cdot 152,777 = 129,861 \text{ mm}$$

$$\epsilon_s' = \frac{152,777 - 40}{152,777} \cdot 0,003 < \frac{f_y}{E_s}$$

$$= 0,0022 < \frac{400}{200000}$$

$= 0,0022 > 0,0020$  jadi, tulangan mencapai luluh ketika beton

hancur

10.5.2 SNI 03-2847-2002,  
modulus elastisitas baja  
tulangan non pratekan  $E_s$   
dapat diambil sebesar  
200.000 MPa



$$f_s' = E_s \cdot \epsilon_s' = 200000 \cdot 0,0022 = 440 \text{ MPa}$$

$$f_s' > f_y = 440 \text{ MPa} > 400 \text{ MPa}$$

$$\begin{aligned} P_{nb} &= 0,65 (0,85 \cdot F_c' \cdot ab \cdot b + A_s \cdot F_s' - A_s \cdot F_y) \\ &= 0,65 [(0,85 \cdot 30 \cdot 129,861 \cdot 300) + (3217 \cdot 440) \\ &\quad - (3217 \cdot 400)] (10)^{-4} \\ &= 2061181,653 \text{ N} \\ &= 2061,181 \text{ kN} \end{aligned}$$

$$\begin{aligned} \emptyset P_{nb} &= 0,65 (2061,181) > P_u \\ &= 1339,767 \text{ kN} > 2061,181 \text{ kN (aman)} \end{aligned}$$

❖ Memeriksa kekuatan penampang

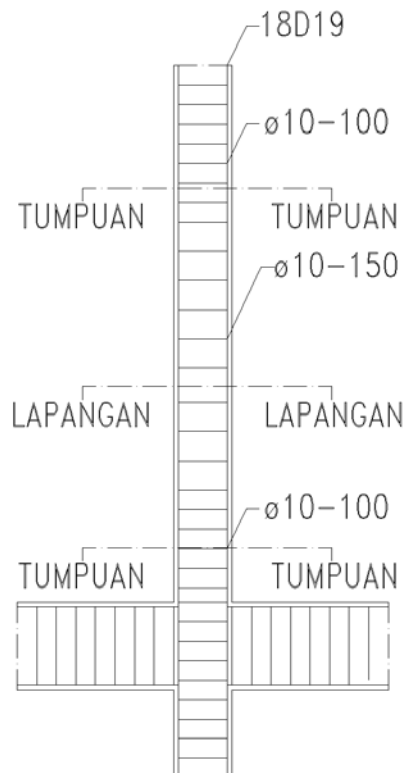
$$\begin{aligned} P_n &= \frac{A_s' f_y}{\frac{e}{(d-d')} + 0,5} + \frac{b h f_c'}{\frac{3he}{d^2} + 1,18} \\ &= \frac{2815 \cdot 400}{\frac{900}{(457-43)} + 0,5} + \frac{500 \times 300 \times 30}{\frac{3 \times 500 \times 900}{457^2} + 1,18} \\ &= 421105,69 + 588696,99 \\ &= 1009802,68 \text{ N} \\ &= 10098,0268 \text{ kN} \end{aligned}$$

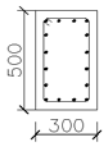
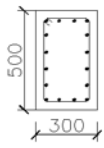
$$\begin{aligned} \emptyset P_{nb} &= 0,65 (10098,0268) > P_u \\ &= 6563,71 \text{ kN} > 383,815 \text{ kN (aman)} \end{aligned}$$

### Perhitungan Kolom K-I B

Data umum perencanaan:

- Mutu Beton ( $f_c'$ ) : 30 Mpa
- Mutu Baja ( $f_y$ ) : 400 Mpa
- Tulangan pokok : D 19
- Tulangan Bagi : D 10
- Ukuran Rencana Kolom : 500 x 300



TYPE KOLOM	TYPE KOLOM K-1B	
	TUMPUAN	LAPANGAN
		
DIMENSI	300X500	
TUL ATAS	18D19	18D19
TUL SEGKANG	D10-100	D10-150

**Gambar 5.4** Detail Kolom K-1B

- Kolom dengan dimensi 500 x 300 dan tulangan pokok 18D19 maka,

$$\begin{aligned} A_s' = A_s &= 0,25 \times \pi \times D^2 \times 16 \\ &= 0,25 \times \pi \times 19^2 \times 16 = 9068,32 \text{ mm}^2 \end{aligned}$$

Dipakai tulangan = 18D19 ( $A_s = 5104 \text{ mm}^2$ )

$$\begin{aligned} d' &= t_s + (\frac{1}{2} \times D \text{ tul pokok}) + D \text{ tul sengkang} \\ &= 25 + (\frac{1}{2} \times 19) + 10 \\ &= 44,5 \leq 70 \text{ OK} \end{aligned}$$

$$\begin{aligned} d &= h - d' \\ &= 500 - 44,5 \\ &= 455,5 \text{ mm} \end{aligned}$$

- Mencari Mu

$$\begin{aligned} 0,7225 \times b \times c \times f_c' &= A_s \times f_y \\ 0,7225 \times 300 \times c \times 30 &= 5104 \times 400 \\ 6502,5 &= 2041600 \\ c &= 313,97 \text{ mm} \end{aligned}$$

$$\begin{aligned} Mu &= A_s \times 0,8 \times f_y \times (d - 0,425 \times c) \\ &= 5104 \times 0,8 \times 400 \times (455,5 - 0,425 \times 313,97) \\ &= 526018648,3 \text{ Nmm} \\ &= 526,018 \text{ kNm} \end{aligned}$$

- Mencari Pu

(Pu) belum diketahui, oleh sebab itu perlu asumsi nilai (e) untuk mendapatkan nilai (Pu), (e) = 900 mm

$$\begin{aligned} \text{Jadi, } e &= \frac{Mu}{Pu} \cdot 10^3 \\ 900 &= \frac{526,018 \cdot 10^3}{Pu} \\ Pu &= 584,464 \text{ kn} \end{aligned}$$

Jumlah penulangan diperkirakan 2%

Ukuran kolom 500 mm x 300 mm,  $d'=25$  mm

$$P_o = 0,85 f_c' (A_g - A_{st}) + f_y \cdot A_{st}$$

$$P_o = A_g \cdot (0,85 \cdot f_c' (1-p) + f_y \cdot p)$$

$$P_o = A_g (0,85 \cdot 30 (1-2\%) + 400 \cdot 2\%)$$

$$P_n = 0,8 P_o \rightarrow \text{Kolom Beugul}$$

$$P_u/\Phi = 0,8 A_g (0,85 \cdot 30 (1-0,02) + 400 \cdot 0,02)$$

$$P_u = \Phi 0,8 A_g (0,85 \cdot 30 (1-0,02) + 400 \cdot 0,02)$$

$$584,464 = 0,65 \cdot 0,8 A_g (0,85 \cdot 30 (1-0,02) + 400 \cdot 0,02)$$

$$A_g = \frac{584,464}{0,65 \cdot 0,8 \cdot (0,85 \cdot 29,2 + 8)} = 3424,647 \text{ mm}^2$$

Dicoba dengan tulangan 18D19 pada masing-masing sisi kolom ( $A = 5104 \text{ mm}^2$ )

$$\rho = \frac{5104}{500 \times 300} = 0,0340$$

- Pemeriksaan  $P_u$  Terhadap beban seimbang  $P_{ub}$

$$d = 300 - 25 = 275 \text{ mm}$$

$$C_b = \frac{500 (d)}{500 + f_y} = \frac{500 (275)}{500 + 400} = 152,777 \text{ mm}$$

$$\beta_1 = 0,85 \text{ (faktor reduksi)}$$

$$a_b = \beta_1 \cdot C = 0,85 \cdot 152,777 = 129,861 \text{ mm}$$

$$\epsilon_s' = \frac{152,777 - 40}{152,777} \cdot 0,003 < \frac{f_y}{E_s}$$

$$= 0,0022 < \frac{400}{200000}$$

$$= 0,0022 > 0,0020 \text{ jadi, tulangan mencapai luluh ketika beton}$$

hancur

10.5.2 SNI 03-2847-2002, modulus elastisitas baja tulangan non pratekan  $E_s$  dapat diambil sebesar 200.000 MPa

$$f_s' = E_s \cdot \epsilon_s' = 200000 \cdot 0,0022 = 440 \text{ MPa}$$

$$f_s' > f_y = 440 \text{ MPa} > 400 \text{ MPa}$$

$$\begin{aligned} P_{nb} &= 0,65 (0,85 \cdot F_c' \cdot ab \cdot b + A_s \cdot F_s' - A_s \cdot F_y) \\ &= 0,65 [(0,85 \cdot 30 \cdot 129,861 \cdot 300) + (5104 \cdot 440) \\ &\quad - (5104 \cdot 400)] (10)^{-4} \\ &= 2891289,663 \text{ N} \\ &= 2891,289 \text{ kN} \end{aligned}$$

$$\begin{aligned} \emptyset P_{nb} &= 0,65 (2891,289) > P_u \\ &= 1879,33 \text{ kN} > 584,464 \text{ kN (aman)} \end{aligned}$$

- Memeriksa kekuatan penampang

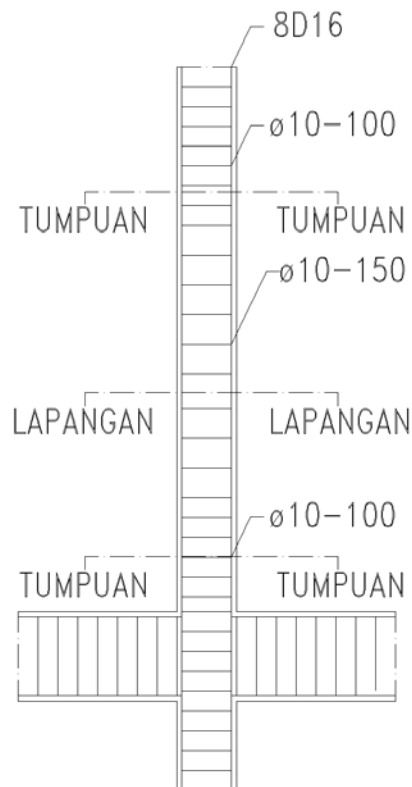
$$\begin{aligned} P_n &= \frac{A_s' f_y}{\frac{e}{(d-d')} + 0,5} + \frac{b h f_c'}{\frac{3he}{d^2} + 1,18} \\ &= \frac{5104 \cdot 400}{\frac{900}{(455,5 - 44,5)} + 0,5} + \frac{500 \times 300 \times 30}{\frac{3 \times 500 \times 900}{455,5^2} + 1,18} \\ &= 759020,89 + 585431,08 \\ &= 1344451,97 \text{ N} \\ &= 1344,451 \text{ kN} \end{aligned}$$

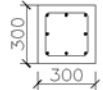
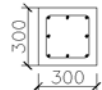
$$\begin{aligned} \emptyset P_{nb} &= 0,65 (1344,451) > P_u \\ &= 873,893 \text{ kN} > 584,464 \text{ kN (aman)} \end{aligned}$$

### Perhitungan Kolom K-2

Data umum perencanaan:

- Mutu Beton ( $f_c'$ ) : 30 Mpa
- Mutu Baja ( $f_y$ ) : 400 Mpa
- Tulangan pokok : D 16
- Tulangan Bagi : D 10
- Ukuran Rencana Kolom : 300 x 300



TYPE KOLOM	TYPE KOLOM K-2	
	TUMPUAN	LAPANGAN
		
DIMENSI	300X300	
TUL ATAS	8D16	8D16
TUL SEKGANG	D10-100	D10-150

**Gambar 5.5** Detail Kolom K-2

- ❖ Kolom dengan dimensi 300 x 300 dan tulangan pokok 8D16 maka,

$$\begin{aligned} A_s' = A_s &= 0,25 \times \pi \times D^2 \times 16 \\ &= 0,25 \times \pi \times 16^2 \times 16 = 1024 \text{ mm}^2 \end{aligned}$$

Dipakai tulangan = 8D16 ( $A_s = 1608 \text{ mm}^2$ )

$$\begin{aligned} d' &= t_s + \left(\frac{1}{2} \times D \text{ tul pokok}\right) + D \text{ tul sengkang} \\ &= 25 + \left(\frac{1}{2} \times 16\right) + 10 \\ &= 43 \leq 70 \quad \mathbf{OK} \end{aligned}$$

$$\begin{aligned} d &= h - d' \\ &= 500 - 43 \\ &= 457 \text{ mm} \end{aligned}$$

- ❖ Mencari Mu

$$\begin{aligned} 0,7225 \times b \times c \times f_c' &= A_s \times f_y \\ 0,7225 \times 300 \times c \times 30 &= 1608 \times 400 \\ 6502,5 &= 643200 \\ c &= 98,915 \text{ mm} \end{aligned}$$

$$\begin{aligned} Mu &= A_s \times 0,8 \times f_y \times (d - 0,425 \times c) \\ &= 1608 \times 0,8 \times 400 \times (457 - 0,425 \times 98,915) \\ &= 213522396,5 \text{ Nmm} \\ &= 213,522 \text{ kNm} \end{aligned}$$

- ❖ Mencari Pu

(Pu) belum diketahui, oleh sebab itu perlu asumsi nilai (e) untuk mendapatkan nilai (Pu), (e) = 900 mm

$$\begin{aligned} \text{Jadi, } e &= \frac{Mu}{Pu} \cdot 10^3 \\ 900 &= \frac{213,522 \cdot 10^3}{Pu} \\ Pu &= 237,246 \text{ kn} \end{aligned}$$

Jumlah penulangan diperkirakan 2%

Ukuran kolom 300 mm x 300 mm,  $d'=25$  mm

$$P_o = 0,85 f_c' (A_g - A_{st}) + f_y \cdot A_{st}$$

$$P_o = A_g \cdot (0,85 \cdot f_c' (1-p) + f_y \cdot p)$$

$$P_o = A_g (0,85 \cdot 30 (1-2\%) + 400 \cdot 2\%)$$

$$P_n = 0,8 P_o \rightarrow \text{Kolom Beugul}$$

$$P_u/\Phi = 0,8 A_g (0,85 \cdot 30 (1-0,02) + 400 \cdot 0,02)$$

$$P_u = \Phi 0,8 A_g (0,85 \cdot 30 (1-0,02) + 400 \cdot 0,02)$$

$$237,246 = 0,65 \cdot 0,8 A_g (0,85 \cdot 30(1-0,02) + 400 \cdot 0,02)$$

$$A_g = \frac{237,246}{0,65 \cdot 0,8 \cdot (0,85 \cdot 29,2 + 8)} = 2248,95 \text{ mm} \quad 1390,135$$

Dicoba dengan tulangan 8D16 pada masing-masing sisi kolom ( $A = 1608\text{mm}^2$ )

$$\rho = \frac{1608}{300 \times 300} = 0,0178$$

❖ Pemeriksaan  $P_u$  Terhadap beban seimbang  $P_{ub}$

$$d = 300 - 25 = 275 \text{ mm}$$

$$C_b = \frac{500(d)}{500 + f_y} = \frac{500(275)}{500 + 400} = 152,777 \text{ mm}$$

$$\beta_1 = 0,85 \text{ (faktor reduksi)}$$

$$a_b = \beta_1 \cdot C = 0,85 \cdot 152,777 = 129,861 \text{ mm}$$

$$\epsilon_s' = \frac{152,777 - 40}{152,777} \cdot 0,003 < \frac{f_y}{E_s}$$

$$= 0,0022 < \frac{400}{200000}$$

$= 0,0022 > 0,0020$  jadi, tulangan mencapai luluh ketika beton

hancur

10.5.2 SNI 03-2847-2002,  
modulus elastisitas baja  
tulangan non pratekan  $E_s$   
dapat diambil sebesar  
200.000 MPa



$$f_s' = E_s \cdot \epsilon_s' = 200000 \cdot 0,0022 = 440 \text{ MPa}$$

$$f_s' > f_y = 440 \text{ MPa} > 400 \text{ MPa}$$

$$\begin{aligned} P_{nb} &= 0,65 (0,85 \cdot F_c' \cdot ab \cdot b + A_s \cdot F_s' - A_s \cdot F_y) \\ &= 0,65 [(0,85 \cdot 30 \cdot 129,861 \cdot 300) + (1608 \cdot 440) \\ &\quad - (1608 \cdot 400)] (10)^{-4} \\ &= 1353189,503 \text{ N} \\ &= 1353,189 \text{ kN} \end{aligned}$$

$$\begin{aligned} \emptyset P_{nb} &= 0,65 (1353,189) > P_u \\ &= 879,572 \text{ kN} > 237,246 \text{ kN (aman)} \end{aligned}$$

❖ Memeriksa kekuatan penampang

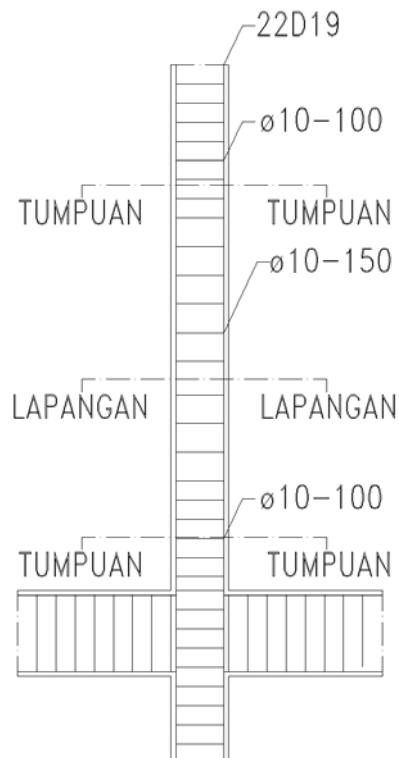
$$\begin{aligned} P_n &= \frac{A_s' f_y}{\frac{e}{(d-d')} + 0,5} + \frac{b h f_c'}{\frac{3he}{d^2} + 1,18} \\ &= \frac{1608 \cdot 400}{\frac{900}{(457-43)} + 0,5} + \frac{300 \times 300 \times 30}{\frac{3 \times 300 \times 900}{457^2} + 1,18} \\ &= 240546,34 + 533765,59 \\ &= 774311,93 \text{ N} \\ &= 774,311 \text{ kN} \end{aligned}$$

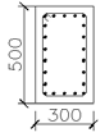
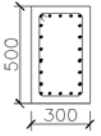
$$\begin{aligned} \emptyset P_{nb} &= 0,65 (774,311) > P_u \\ &= 503,302 \text{ kN} > 237,246 \text{ kN (aman)} \end{aligned}$$

### Perhitungan Kolom K-0B

Data umum perencanaan:

- Mutu Beton ( $f_c'$ ) : 30 Mpa
- Mutu Baja ( $f_y$ ) : 400 Mpa
- Tulangan pokok : D 19
- Tulangan Bagi : D 10
- Ukuran Rencana Kolom : 500 x 300



TYPE KOLOM	TYPE KOLOM K-0B	
	TUMPUAN	LAPANGAN
		
DIMENSI	300X300	
TUL ATAS	22D19	22D19
TUL SEGKANG	D10-100	D10-150

**Gambar 5.6** Detail Kolom K-0B

- ❖ Kolom dengan dimensi 500 x 300 dan tulangan pokok 22D19 maka,

$$\begin{aligned} A_s' = A_s &= 0,25 \times \pi \times D^2 \times 16 \\ &= 0,25 \times \pi \times 19^2 \times 16 = 4534,16 \text{ mm}^2 \end{aligned}$$

Dipakai tulangan = 22D19 ( $A_s = 6238 \text{ mm}^2$ )

$$\begin{aligned} d' &= t_s + (\frac{1}{2} \times D \text{ tul pokok}) + D \text{ tul sengkang} \\ &= 25 + (\frac{1}{2} \times 19) + 10 \\ &= 44,5 \leq 70 \text{ OK} \end{aligned}$$

$$\begin{aligned} d &= h - d' \\ &= 500 - 44,5 \\ &= 455,5 \text{ mm} \end{aligned}$$

- ❖ Mencari Mu

$$0,7225 \times b \times c \times f_c' = A_s \times f_y$$

$$0,7225 \times 300 \times c \times 30 = 6238 \times 400$$

$$6502,5 \quad \quad \quad = 2495200$$

$$c = 383,729 \text{ mm}$$

$$\begin{aligned} M_u &= A_s \times 0,8 \times f_y \times (d - 0,425 \times c) \\ &= 6238 \times 0,8 \times 400 \times (455,5 - 0,425 \times 383,729) \\ &= 583707475,7 \text{ Nmm} \\ &= 583,707 \text{ kNm} \end{aligned}$$

- ❖ Mencari Pu

(Pu) belum diketahui, oleh sebab itu perlu asumsi nilai (e) untuk mendapatkan nilai (Pu), (e) = 900 mm

$$\text{Jadi, } e = \frac{M_u}{P_u} \cdot 10^3$$

$$900 = \frac{583,707 \cdot 10^3}{P_u}$$

$$P_u = 648,563 \text{ kn}$$

Jumlah penulangan diperkirakan 2%

Ukuran kolom 500 mm x 300 mm,  $d'=25$  mm

$$P_o = 0,85 f_c' (A_g - A_{st}) + f_y \cdot A_{st}$$

$$P_o = A_g \cdot (0,85 \cdot f_c' (1-p) + f_y \cdot p)$$

$$P_o = A_g (0,85 \cdot 30 (1-2\%) + 400 \cdot 2\%)$$

$$P_n = 0,8 P_o \rightarrow \text{Kolom Beugel}$$

$$P_u/\Phi = 0,8 A_g (0,85 \cdot 30 (1-0,02) + 400 \cdot 0,02)$$

$$P_u = \Phi 0,8 A_g (0,85 \cdot 30 (1-0,02) + 400 \cdot 0,02)$$

$$648,563 = 0,65 \cdot 0,8 A_g (0,85 \cdot 30(1-0,02) + 400 \cdot 0,02)$$

$$A_g = \frac{648,563}{0,65 \cdot 0,8 \cdot (0,85 \cdot 29,2 + 8)} = 3800,233 \text{ mm}^2$$

Dicoba dengan tulangan 22D19 pada masing-masing sisi kolom ( $A = 6238\text{mm}^2$ )

$$\rho = \frac{6238}{500 \times 300} = 0,0415$$

❖ Pemeriksaan  $P_u$  Terhadap beban seimbang  $P_{ub}$

$$d = 300 - 25 = 275 \text{ mm}$$

$$C_b = \frac{500 (d)}{500 + f_y} = \frac{500 (275)}{500 + 400} = 152,777 \text{ mm}$$

$$\beta_1 = 0,85 \text{ (faktor reduksi)}$$

$$a_b = \beta_1 \cdot C = 0,85 \cdot 152,777 = 129,861 \text{ mm}$$

$$\epsilon_s' = \frac{152,777 - 40}{152,777} \cdot 0,003 < \frac{f_y}{E_s}$$

$$= 0,0022 < \frac{400}{200000}$$

$$= 0,0022 > 0,0020 \text{ jadi, tulangan mencapai luluh ketika beton}$$

hancur

10.5.2 SNI 03-2847-2002, modulus elastisitas baja tulangan non pratekan  $E_s$  dapat diambil sebesar 200.000 MPa

$$f_s' = E_s \cdot \varepsilon_s' = 200000 \cdot 0,0022 = 440 \text{ MPa}$$

$$f_s' > f_y = 440 \text{ MPa} > 400 \text{ MPa}$$

$$\begin{aligned} P_{ub} &= 0,65 (0,85 \cdot F_c' \cdot ab \cdot b + A_s \cdot F_s' - A_s \cdot F_y) \\ &= 0,65 [(0,85 \cdot 30 \cdot 129,861 \cdot 300) + (6238 \cdot 440) \\ &\quad - (6238 \cdot 400)] (10)^{-4} \\ &= 3390204,303 \text{ N} \\ &= 3390,204 \text{ kN} \end{aligned}$$

$$\begin{aligned} \emptyset P_{nb} &= 0,65 (3390,204) > P_u \\ &= 2203,63 \text{ kN} > 648,563 \text{ kN (aman)} \end{aligned}$$

❖ Memeriksa kekuatan penampang

$$\begin{aligned} P_n &= \frac{A_s' f_y}{\frac{e}{(d-d')} + 0,5} + \frac{b h f_c'}{\frac{3he}{d^2} + 1,18} \\ &= \frac{6238 \cdot 400}{\frac{900}{(455,5 - 44,5)} + 0,5} + \frac{500 \times 300 \times 30}{\frac{3 \times 500 \times 900}{455,5^2} + 1,18} \\ &= 927659,15 + 585431,08 \\ &= 1513090,23 \text{ N} \\ &= 1513,090 \text{ kN} \end{aligned}$$

$$\begin{aligned} \emptyset P_{nb} &= 0,65 (1513,090) > P_u \\ &= 983,508 \text{ kN} > 648,563 \text{ kN (aman)} \end{aligned}$$