

### 3.6 Perhitungan Balok Induk

#### 3.6.1 Perhitungan balok induk pada portal melintang as A Perencanaan Balok Induk Pada Atap:

Ukuran balok = 300 mm x 550 mm

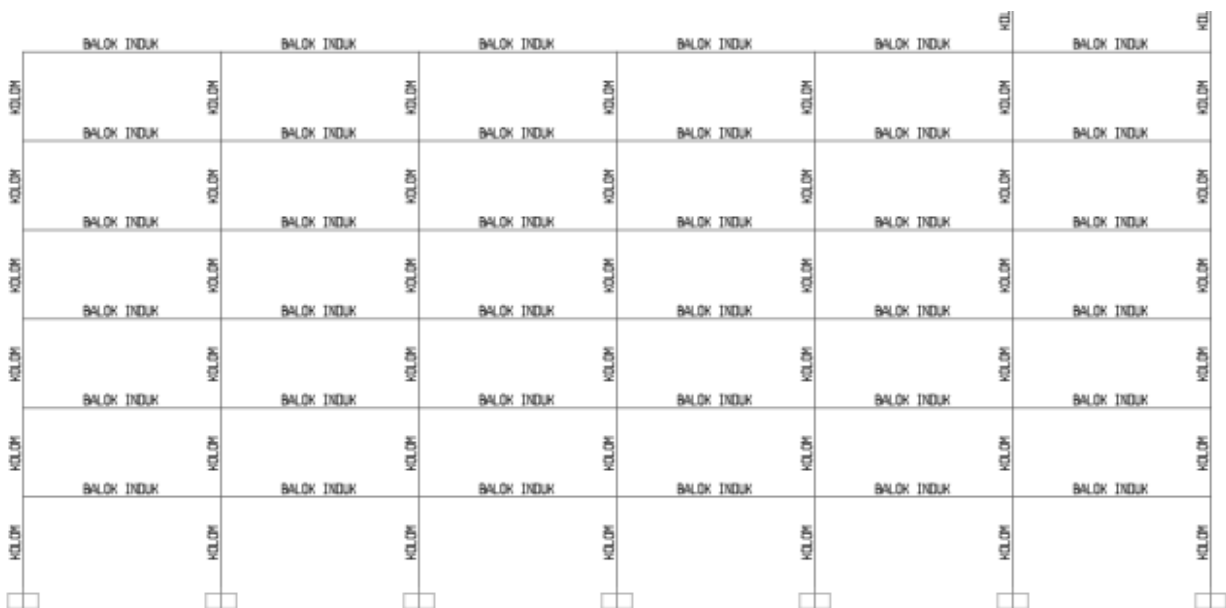
Tulangan pokok = D19

Tulangan sengkang =  $\phi$  10 mm

$F_c'$  = 25 Mpa

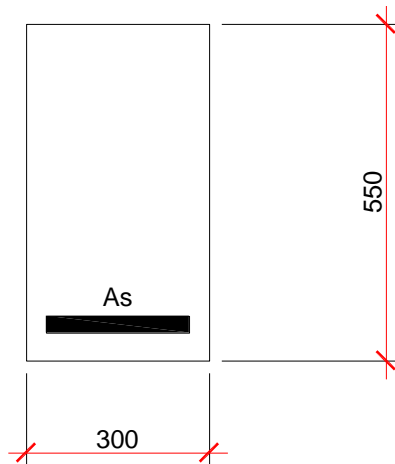
$F_y$  = 400 Mpa

Selimut beton = 40 mm



Gambar 3.6.1 Penamaan kolom dan balok portal melintang potongan

### a. Penulangan Lapangan



$$\begin{aligned}
 \text{Dimensi balok} &= 300\text{mm} \times 550\text{mm} \\
 M_{\text{tumpuan}} &= 134,61 \rightarrow \text{diambil paling besar} \\
 d_{\text{eff}} &= h - p - \varnothing_{\text{sengakang}} - \frac{1}{2} \cdot \varnothing_{\text{tulangan pokok}} \\
 &= 550\text{mm} - 40\text{mm} - 10\text{mm} - \frac{1}{2} \cdot 19\text{mm} \\
 &= 490,5 \text{ mm} \\
 M_{R_{\text{maks}}} &= \varnothing \cdot b \cdot d_{\text{eff}}^2 \times k_{\text{maks}} \\
 &= 0,8 \times 300 \times 490,5^2 \times 6,5639 \\
 &= 379010482,1 \text{ Nmm} \\
 &= 397,010 \text{ KNm}
 \end{aligned}$$

$M_{R_{\text{maks}}} (379,010) > M_u (134,61)$ , maka direncanakan balok bertulangan Tarik saja

$$\begin{aligned}
 K &= \frac{M_u}{\varnothing \cdot b \cdot d^2} \\
 &= \frac{134,61 \times 10^6}{0,8 \times 300\text{mm} \times (490,5\text{mm})^2} = 2,33124
 \end{aligned}$$

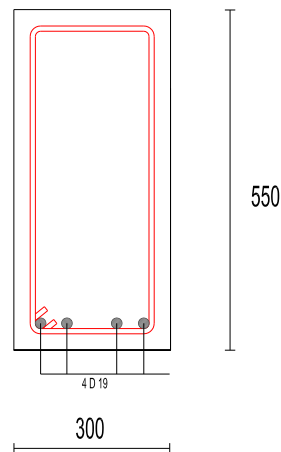
Dari tabel A-28 Rasio penulangan, didapat  $\rho = 0,0062$

$$\begin{aligned}
 A_s &= \rho \cdot b \cdot d \\
 &= 0,0062 \times 300\text{mm} \times 490,5\text{mm} \\
 &= 912,33
 \end{aligned}$$

$$n_{\text{tulangan}} = \frac{A_s}{\frac{1}{4} \cdot \pi \cdot D^2}$$

$$= \frac{912,33 \text{ mm}^2}{\frac{1}{4} \times \pi \times (19 \text{ mm})^2} = 3,217 \sim 4 \text{ buah}$$

**Dipakai tulangan 4 D19 ( $A_{s\text{pakai}} = 1134,1$ )**



**Kontrol Lebar Balok :**

Cek 1 lapis

Syarat,  $b_{\text{perlu}} < b_{\text{ada}}$

$$\begin{aligned} b_{\text{perlu}} &= 2 \cdot P + 2 \cdot \emptyset_{\text{sengkang}} + 4 \cdot \emptyset_{\text{tulangan poko}} + 3 \cdot \text{Jarak antar tulangan} \\ &= 2 \times 40 \text{ mm} + 2 \times 10 \text{ mm} + 4 \times 19 \text{ mm} + 3 \times 25 \text{ mm} \\ &= 251 \text{ mm} \end{aligned}$$

$b_{\text{perlu}} (251 \text{ mm}) < b_{\text{ada}} (300 \text{ mm})$  "Oke"

Cek momen minimal

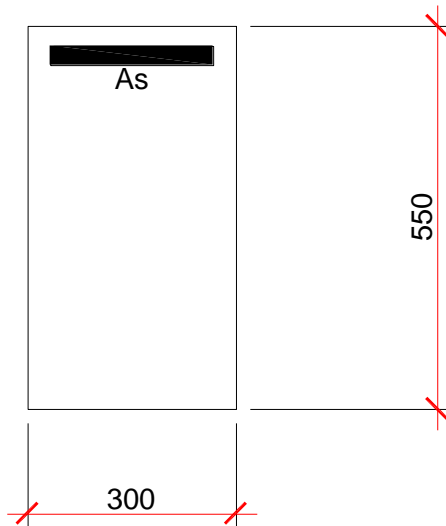
$$\alpha = \frac{a \cdot f_y}{0,85 \cdot f_c \cdot b} = \frac{1134,1 \times 400}{0,85 \times 25 \times 300} = 71,159$$

$$\begin{aligned} \emptyset Mn &= \emptyset \cdot A_s \cdot F_y \cdot \left( d - \frac{\alpha}{2} \right) \\ &= 0,8 \times 1134,1 \times 400 \times \left( 490,5 - \frac{71,159}{2} \right) \\ &= 165,09 \times 10^6 \text{ Nmm} \end{aligned}$$

Syarat :  $\emptyset Mn > Mu$

$$165,09 \times 10^6 \text{ Nmm} > 134,61 \times 10^6 \text{ Nmm}$$

### b. Penulangan Tumpuan



Masuki gambar yg belom dimasukii ck kak galih!

$$\text{Dimensi balok} = 300\text{mm} \times 550\text{mm}$$

$$M_{\text{Lapangan}} = 89,80 \rightarrow \text{diambil paling besar}$$

$$\begin{aligned} d_{\text{eff}} &= h - p - \phi_{\text{sengakang}} - \frac{1}{2} \cdot \phi_{\text{tulagnn pokok}} \\ &= 550\text{mm} - 40\text{mm} - 10\text{mm} - \frac{1}{2} \cdot 19\text{mm} \\ &= 490,5 \text{ mm} \end{aligned}$$

$$\begin{aligned} M_{\text{Rmaks}} &= \phi \cdot b \cdot d_{\text{eff}}^2 \times k_{\text{maks}} \\ &= 0,8 \times 300 \times 490,5^2 \times 6,5639 \\ &= 379010482,1 \text{ Nmm} \\ &= 379,010 \text{ KNm} \end{aligned}$$

$M_{\text{Rmaks}} (379,010) > M_u (89,80)$ , maka direncanakan balok bertulangan Tarik saja

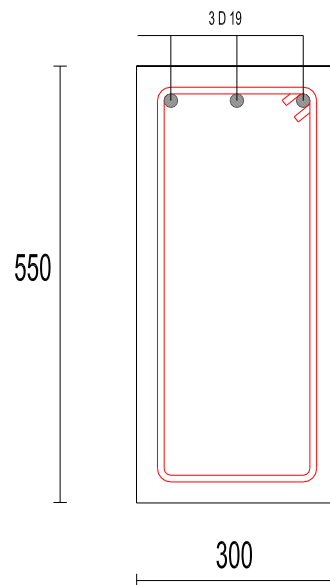
$$\begin{aligned} K &= \frac{M_u}{\phi \cdot b \cdot d^2} \\ &= \frac{89,80 \times 10^6}{0,8 \times 300\text{mm} \times (490,5\text{mm})^2} = 1,555 \end{aligned}$$

Dari tabel A-28 Rasio penulangan, didapat  $\rho = 0,0041$

$$\begin{aligned}
 A_s &= \rho \cdot b \cdot d \\
 &= 0,0041 \times 300\text{mm} \times 490,5\text{mm} \\
 &= 603,315
 \end{aligned}$$

$$\begin{aligned}
 n_{\text{tulangan}} &= \frac{A_s}{\frac{1}{4} \cdot \pi \cdot D^2} \\
 &= \frac{603,315 \text{ mm}^2}{\frac{1}{4} \times \pi \times (19\text{mm})^2} = 2,127 \sim 3 \text{ buah}
 \end{aligned}$$

**Dipakai tulangan 3 D19 ( $A_{s\text{pakai}} = 850,58$ )**



### **Kontrol Lebar Balok :**

Cek 1 lapis

Syarat,  $b_{\text{perlu}} < b_{\text{ada}}$

$$\begin{aligned}
 b_{\text{perlu}} &= 2 \cdot P + 2 \cdot \emptyset_{\text{senggang}} + 4 \cdot \emptyset_{\text{tulangan pako}} + 3 \cdot \text{Jarak antar tulangan} \\
 &= 2 \times 40\text{mm} + 2 \times 10\text{mm} + 3 \times 19\text{mm} + 2 \times 25\text{mm} \\
 &= 207 \text{ mm}
 \end{aligned}$$

$b_{\text{perlu}} (207 \text{ mm}) < b_{\text{ada}} (300\text{mm})$  "Oke"

Cek momen minimal

$$\alpha = \frac{a \cdot f_y}{0,85 \cdot f_c \cdot b} = \frac{850,58 \times 400}{0,85 \times 25 \times 300} = 53,370$$

$$\begin{aligned}
 \phi Mn &= \phi \cdot As \cdot Fy \cdot (d - \frac{\alpha}{2}) \\
 &= 0,8 \times 850,58 \times 400 \times (490,5 - \frac{53,370}{2}) \\
 &= 126,243 \times 10^6 \text{ Nmm}
 \end{aligned}$$

Syarat :  $\phi Mn > Mu$

$$126,243 \times 10^6 \text{ Nmm} > 89,80 \times 10^6 \text{ Nmm}$$

### c. Penulangan Geser

Dimensi Balok : 300 mm × 550 mm

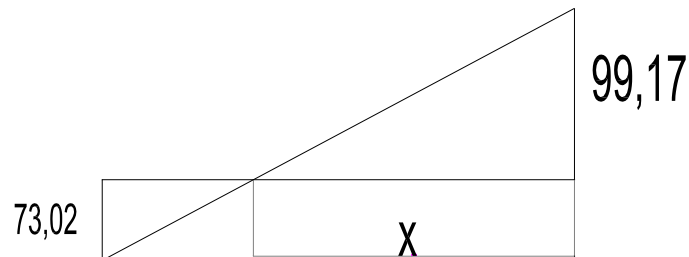
L : 3900 mm

deff : 490,5 mm

Vu : 99,17 KN

$$p = d + \frac{1}{2} \text{ Kolom} = 490,5 + \frac{1}{2} 300 = 640,5 \text{ mm}$$

Dari gambar didapat nilai gaya lintang yang terbesar sebagai berikut :



$$x = \frac{99,17}{99,17 + 73,02} \times 3,9 = 2,246$$

$$Vu \text{ max} = 99,17$$

$$Vu \text{ rencana} = \frac{Vu(x-p)}{x} = \frac{99,17 \times (2,246 - 0,640)}{2,246} = 70,91 \text{ KN}$$

$$\begin{aligned}
 \phi Vc &= \frac{1}{6} \times \sqrt{fc'} \times bw \times d \\
 &= \frac{1}{6} \times \sqrt{25} \times 300 \times 490,5 \\
 &= 122,625 \text{ Mpa}
 \end{aligned}$$

$$V_u \text{ rencana} > \frac{1}{2} \phi V_c$$

$$70,91 > \frac{1}{2} \times 0,75 \times 122,625$$

70,91 < 122,625 (tidak diperlukan tulangan geser jadi digunakan sengkang praktis)

Digunakan tulangan sengkang  $\phi 10$

$$A_v = \frac{\pi \times d^2}{2} = \frac{\pi \times 10^2}{2} = 157,08$$

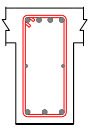
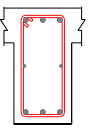
$$V_s = \frac{V_u \text{ rencana}}{\phi} - V_c = \frac{70,91}{0,75} - 122,625 = -28,078$$

$$S = \frac{A_v \cdot F_y \cdot d}{V_s} = \frac{157,08 \cdot 400 \cdot 490,5}{28,078} = 1097624,332 \text{ mm}$$

$$S_{\text{max}} = \frac{d}{2} = \frac{490,5}{2} = 245,2$$

**Karena  $S < S_{\text{maks}}$ , Jadi digunakan tulangan sengkang  $\phi 8 - 200 \text{ mm}$**

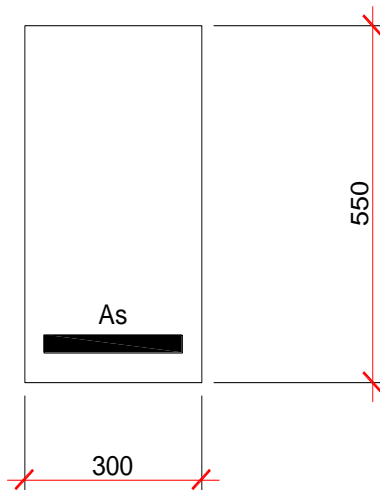
Tabel 3.6.1 Balok Induk 1

TIPE BALOK	B1	
LETAK POTONGAN	LAPANGAN	TUMPUAN
PENAMPANG		
DIMENSI	300 X 550	
T. ATAS	4 D 19	3 D 19
T. BAWAH	3 D 19	3 D 19
SENGKANG	SK.D8-200	SK.D8-200

**Perencanaan Balok Induk Pada Lantai:**

Ukuran balok	= 300 mm x 550 mm
Tulangan pokok	= D19
Tulangan sengkang	= $\varnothing$ 10 mm
Fc'	= 25 Mpa
Fy	= 400 Mpa
Selimit beton	= 40 mm

**a. Penulangan Lapangan**



Dimensi balok	= 300mm x 550mm
$M_{tumpuan}$	= 142,19 $\rightarrow$ diambil paling besar
$d_{eff}$	= $h - p - \varnothing_{sengkang} - \frac{1}{2} \cdot \varnothing_{tulangan\ pokok}$ = 550mm - 40mm - 10mm - $\frac{1}{2} \cdot 19$ mm = 490,5 mm
$M_{Rmaks}$	= $\varnothing \cdot b \cdot d_{eff}^2 \times k_{maks}$ = 0,8 x 300 x 490,5 <sup>2</sup> x 6,5639 = 37901482,1Nmm = 379,010 KNm

$M_{Rmaks}$  (379,010) >  $M_u$  (142,19), maka direncanakan balok bertulangan Tarik saja

$$K = \frac{M_u}{\varnothing \cdot b \cdot d^2}$$



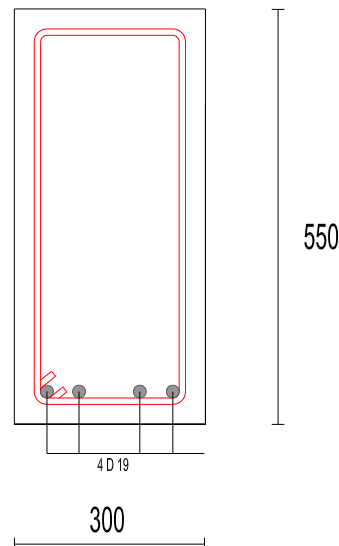
$$= \frac{142,19 \times 10^6}{0,8 \times 300 \text{ mm} \times (490,5 \text{ mm})^2} = 2,4625$$

Dari tabel A-28 Rasio penulangan, didapat  $\rho = 0,0066$

$$\begin{aligned} A_s &= \rho \cdot b \cdot d \\ &= 0,0066 \times 300 \text{ mm} \times 490,5 \text{ mm} \\ &= 971,19 \end{aligned}$$

$$\begin{aligned} n_{\text{tulangan}} &= \frac{A_s}{\frac{1}{4} \pi \cdot D^2} \\ &= \frac{971,19 \text{ mm}^2}{\frac{1}{4} \times \pi \times (19 \text{ mm})^2} = 3,452 \sim 4 \text{ buah} \end{aligned}$$

Dipakai tulangan 4 D19 ( $A_{s\text{pakai}} = 1134,11$ )



### Kontrol Lebar Balok :

Cek 1 lapis

Syarat,  $b_{\text{perlu}} < b_{\text{ada}}$

$$\begin{aligned} b_{\text{perlu}} &= 2 \cdot P + 2 \cdot \emptyset_{\text{sengkang}} + 4 \cdot \emptyset_{\text{tulangan poko}} + 3 \cdot \text{Jarak antar tulangan} \\ &= 2 \times 40 \text{ mm} + 2 \times 10 \text{ mm} + 4 \times 19 \text{ mm} + 3 \times 25 \text{ mm} \\ &= 251 \text{ mm} \end{aligned}$$

$b_{\text{perlu}} (251 \text{ mm}) < b_{\text{ada}} (300 \text{ mm})$  "Oke"

Cek momen minimal

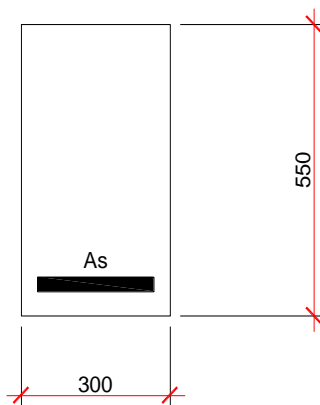
$$\alpha = \frac{as.fy}{0,85.fc.b} = \frac{1134,11 \times 400}{0,85 \times 25 \times 300} = 71,16$$

$$\begin{aligned} \phi Mn &= \phi . As . Fy . \left( d - \frac{\alpha}{2} \right) \\ &= 0,8 \times 1134,11 \times 400 \times \left( 490,5 - \frac{71,160}{2} \right) \\ &= 165,097 \times 10^6 \text{ Nmm} \end{aligned}$$

Syarat :  $\phi Mn > Mu$

$$165,097 \times 10^6 \text{ Nmm} > 142,19 \times 10^6 \text{ Nmm}$$

### b. Penulangan Lapangan



$$\text{Dimensi balok} = 300\text{mm} \times 550\text{mm}$$

$$M_{\text{Lapangan}} = 73,02 \rightarrow \text{diambil paling besar}$$

$$\begin{aligned} d_{\text{eff}} &= h - p - \phi_{\text{sengakang}} - \frac{1}{2} \cdot \phi_{\text{tulagnn pokok}} \\ &= 550\text{mm} - 40\text{mm} - 10\text{mm} - \frac{1}{2} \cdot 19\text{mm} \\ &= 490,5\text{mm} \end{aligned}$$

$$\begin{aligned} M_{R_{\text{maks}}} &= \phi . b . d_{\text{eff}}^2 \times k_{\text{maks}} \\ &= 0,8 \times 300 \times 490,5^2 \times 6,5639 \\ &= 379010482,1\text{Nmm} \\ &= 379,010 \text{ KNm} \end{aligned}$$

$M_{Rmaks} (379,010) > Mu (73,02)$ , maka direncanakan balok bertulangan Tarik saja

$$K = \frac{Mu}{\phi \cdot b \cdot d^2}$$

$$= \frac{72.02 \times 10^6}{0,8 \times 300 \text{mm} \times (490,5 \text{mm})^2} = 1,264$$

Dari tabel A-28 Rasio penulangan, didapat  $\rho = 0,0035$

$$As = \rho \cdot b \cdot d$$

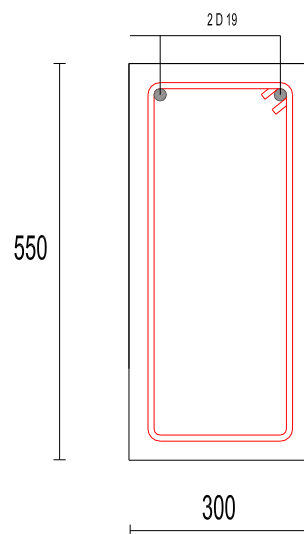
$$= 0,0035 \times 300 \text{mm} \times 490,5 \text{mm}$$

$$= 515,025$$

$$n_{tulangan} = \frac{As}{\frac{1}{4} \cdot \pi \cdot D^2}$$

$$= \frac{515,025 \text{ mm}^2}{\frac{1}{4} \times \pi \times (19 \text{mm})^2} = 1,816 \sim 24 \text{ buah}$$

Dipakai tulangan 2 D19 ( $As_{pakai} = 567,05$ )



### Kontrol Lebar Balok :

Cek 1 Lapis

Syarat,  $b_{perlu} < b_{ada}$

$$b_{perlu} = 2 \cdot P + 2 \cdot \phi_{senggang} + 4 \cdot \phi_{tulangan \text{ poko}} + 3 \cdot \text{Jarak antar tulangan}$$

$$= 2 \times 40 \text{mm} + 2 \times 10 \text{mm} + 2 \times 19 \text{mm} + 1 \times 25 \text{mm}$$

$$= 163 \text{ mm}$$

$b_{\text{perlu}} (163 \text{ mm}) < b_{\text{ada}} (300 \text{ mm})$  “Oke”

Cek momen minimal

$$\alpha = \frac{as.fy}{0,85.fc.b} = \frac{567,05 \times 400}{0,85 \cdot 25 \cdot 300} = 35,579$$

$$\begin{aligned} \phi Mn &= \phi \cdot As \cdot Fy \cdot \left(d - \frac{\alpha}{2}\right) \\ &= 0,8 \times 567,05 \times 400 \times \left(490,5 - \frac{35,579}{2}\right) \\ &= 85,776 \times 10^6 \text{ Nmm} \end{aligned}$$

Syarat :  $\phi Mn > Mu$

$$85,776 \times 10^6 \text{ Nmm} > 72,19 \times 10^6 \text{ Nmm}$$

### c. Penulangan Geser

Dimensi Balok : 300 mm × 550 mm

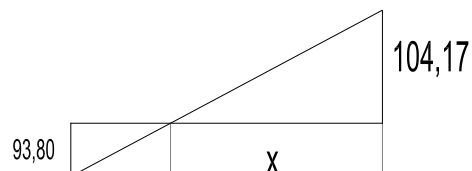
L : 3900 mm

deff : 490,5 mm

Vu : 104,56 KN

$$p = d + \frac{1}{2} \text{ Kolom} = 490,5 + \frac{1}{2} 300 = 640,5 \text{ mm}$$

Dari gambar didapat nilai gaya lintang yang terbesar sebagai berikut :



$$x = \frac{104,17}{104,17 + 93,80} \times 3,9 = 2,052$$

$$Vu \text{ max} = 104,17$$

$$Vu \text{ rencana} = \frac{Vu (x-p)}{x} = \frac{104,17 \times (2,052 - 0,640)}{2,052} = 71,68 \text{ KN}$$

$$\begin{aligned} \phi Vc &= \frac{1}{6} \times \sqrt{fc'} \times bw \times d \\ &= \frac{1}{6} \times \sqrt{25} \times 300 \times 490,5 \\ &= 122,625 \text{ Mpa} \end{aligned}$$

$$V_u \text{ rencana} > \frac{1}{2} \phi V_c$$

$$71,68 > \frac{1}{2} \times 0,75 \times 122,26$$

71,68 < 122,625 (tidak diperlukan tulangan geser jadi digunakan sengkang praktis)

Digunakan tulangan sengkang  $\phi 10$

$$A_v = \frac{\pi \times d^2}{2} = \frac{\pi \times 10^2}{2} = 157,08$$

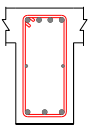
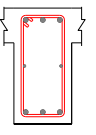
$$V_s = \frac{V_u \text{ rencana}}{\phi} - V_c = \frac{71,68}{0,75} - 122,625 = -27,054$$

$$S = \frac{A_v \cdot F_y \cdot d}{V_s} = \frac{157,08 \cdot 400 \cdot 490,5}{27,054} = 1139169,661 \text{ mm}$$

$$S_{\text{max}} = \frac{d}{2} = \frac{490,5}{2} = 245,2$$

**Karena  $S < S_{\text{maks}}$ , Jadi digunakan tulangan sengkang  $\phi 8 - 200 \text{ mm}$**

Tabel 3.6.2 Tabel balok induk 2

TIPE BALOK	B1	
LETAK POTONGAN	LAPANGAN	TUMPUAN
PENAMPANG		
DIMENSI	300 X 550	
T. ATAS	4 D 19	3 D 19
T. BAWAH	3 D 19	3 D 19
SENGKANG	SK.D8-200	SK.D8-200

### 3.6.2. Perhitungan balok induk pada portal melintang as B Perencanaan Balok Induk Pada Atap:

Ukuran balok = 300 mm x 550 mm

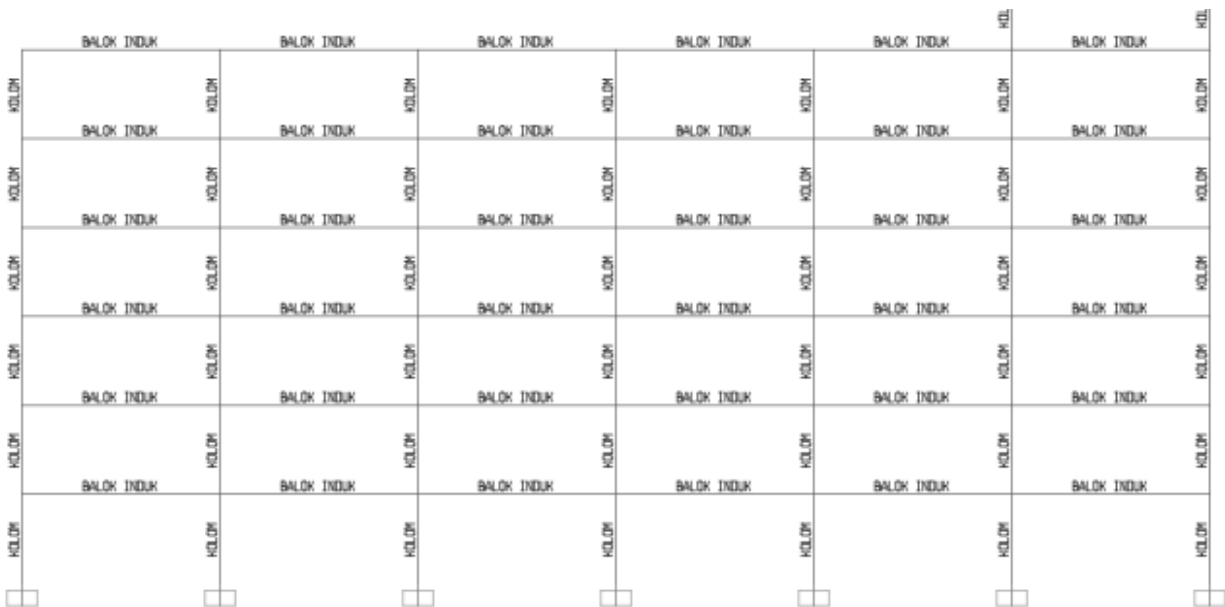
Tulangan pokok = D19

Tulangan sengkang =  $\phi$  10 mm

$F_c'$  = 25 Mpa

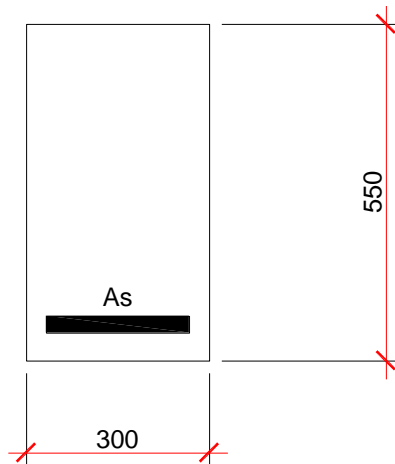
$F_y$  = 400 Mpa

Selimit beton = 40 mm



**Gambar 3.6.2** Penamaan kolom dan balok portal melintang potongan

#### d. Penulangan Lapangan



$$\begin{aligned}
 \text{Dimensi balok} &= 300\text{mm} \times 550\text{mm} \\
 M_{\text{tumpuan}} &= 134,61 \rightarrow \text{diambil paling besar} \\
 d_{\text{eff}} &= h - p - \varnothing_{\text{sengakang}} - \frac{1}{2} \cdot \varnothing_{\text{tulagn pokok}} \\
 &= 550\text{mm} - 40\text{mm} - 10\text{mm} - \frac{1}{2} \cdot 19\text{mm} \\
 &= 490,5 \text{ mm} \\
 M_{\text{Rmaks}} &= \varnothing \cdot b \cdot d_{\text{eff}}^2 \times k_{\text{maks}} \\
 &= 0,8 \times 300 \times 490,5^2 \times 6,5639 \\
 &= 379010482,1 \text{ Nmm} \\
 &= 397,010 \text{ KNm}
 \end{aligned}$$

$M_{\text{Rmaks}} (379,010) > M_u (134,61)$ , maka direncanakan balok bertulangan Tarik saja

$$\begin{aligned}
 K &= \frac{M_u}{\varnothing \cdot b \cdot d^2} \\
 &= \frac{134,61 \times 10^6}{0,8 \times 300\text{mm} \times (490,5\text{mm})^2} = 2,33124
 \end{aligned}$$

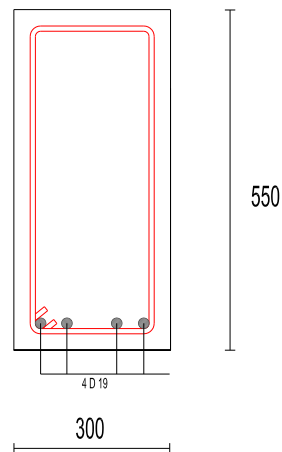
Dari tabel A-28 Rasio penulangan, didapat  $\rho = 0,0062$

$$\begin{aligned}
 A_s &= \rho \cdot b \cdot d \\
 &= 0,0062 \times 300\text{mm} \times 490,5\text{mm} \\
 &= 912,33
 \end{aligned}$$

$$n_{\text{tulangan}} = \frac{A_s}{\frac{1}{4} \cdot \pi \cdot D^2}$$

$$= \frac{912,33 \text{ mm}^2}{\frac{1}{4} \times \pi \times (19 \text{ mm})^2} = 3,217 \sim 4 \text{ buah}$$

**Dipakai tulangan 4 D19 ( $A_{s\text{pakai}} = 1134,1$ )**



**Kontrol Lebar Balok :**

Cek 1 lapis

Syarat,  $b_{\text{perlu}} < b_{\text{ada}}$

$$\begin{aligned} b_{\text{perlu}} &= 2.P + 2.\emptyset_{\text{sengkang}} + 4. \emptyset_{\text{tulangan poko}} + 3.\text{Jarak antar tulangan} \\ &= 2 \times 40 \text{ mm} + 2 \times 10 \text{ mm} + 4 \times 19 \text{ mm} + 3 \times 25 \text{ mm} \\ &= 251 \text{ mm} \end{aligned}$$

$b_{\text{perlu}} (251 \text{ mm}) < b_{\text{ada}} (300 \text{ mm})$  "Oke"

Cek momen minimal

$$\alpha = \frac{as.fy}{0,85.f.c.b} = \frac{1134,1 \times 400}{0,85 \times 25 \times 300} = 71,159$$

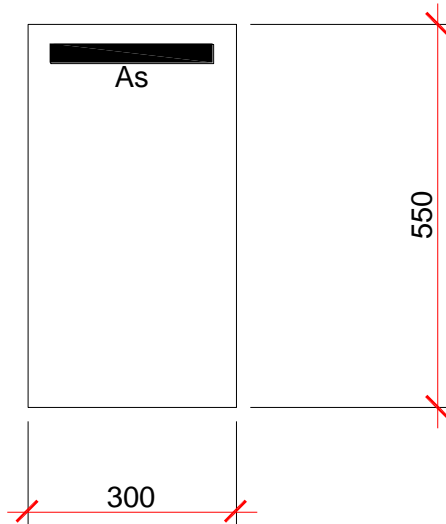
$$\begin{aligned} \emptyset Mn &= \emptyset . As . Fy . \left( d - \frac{\alpha}{2} \right) \\ &= 0,8 \times 1134,1 \times 400 \times \left( 490,5 - \frac{71,159}{2} \right) \\ &= 165,09 \times 10^6 \text{ Nmm} \end{aligned}$$

Syarat :  $\emptyset Mn > Mu$

$$165,09 \times 10^6 \text{ Nmm} > 134,61 \times 10^6 \text{ Nmm}$$



### e. Penulangan Tumpuan



Masuki gambar yg belom dimasukii ck kak galih!

$$\text{Dimensi balok} = 300\text{mm} \times 550\text{mm}$$

$$M_{\text{Lapangan}} = 89,80 \rightarrow \text{diambil paling besar}$$

$$\begin{aligned} d_{\text{eff}} &= h - p - \phi_{\text{sengakang}} - \frac{1}{2} \cdot \phi_{\text{tulagnn pokok}} \\ &= 550\text{mm} - 40\text{mm} - 10\text{mm} - \frac{1}{2} \cdot 19\text{mm} \\ &= 490,5 \text{ mm} \end{aligned}$$

$$\begin{aligned} M_{\text{Rmaks}} &= \phi \cdot b \cdot d_{\text{eff}}^2 \times k_{\text{maks}} \\ &= 0,8 \times 300 \times 490,5^2 \times 6,5639 \\ &= 379010482,1 \text{ Nmm} \\ &= 379,010 \text{ KNm} \end{aligned}$$

$M_{\text{Rmaks}} (379,010) > M_u (89,80)$ , maka direncanakan balok bertulangan Tarik saja

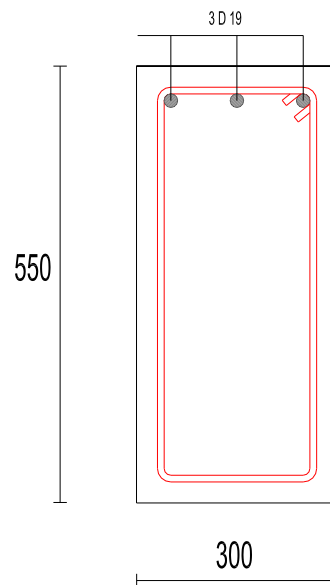
$$\begin{aligned} K &= \frac{M_u}{\phi \cdot b \cdot d^2} \\ &= \frac{89,80 \times 10^6}{0,8 \times 300\text{mm} \times (490,5\text{mm})^2} = 1,555 \end{aligned}$$

Dari tabel A-28 Rasio penulangan, didapat  $\rho = 0,0041$

$$\begin{aligned}
 A_s &= \rho \cdot b \cdot d \\
 &= 0,0041 \times 300\text{mm} \times 490,5\text{mm} \\
 &= 603,315
 \end{aligned}$$

$$\begin{aligned}
 n_{\text{tulangan}} &= \frac{A_s}{\frac{1}{4} \cdot \pi \cdot D^2} \\
 &= \frac{603,315 \text{ mm}^2}{\frac{1}{4} \times \pi \times (19\text{mm})^2} = 2,127 \sim 3 \text{ buah}
 \end{aligned}$$

**Dipakai tulangan 3 D19 ( $A_{s\text{pakai}} = 850,58$ )**



### **Kontrol Lebar Balok :**

Cek 1 lapis

Syarat,  $b_{\text{perlu}} < b_{\text{ada}}$

$$\begin{aligned}
 b_{\text{perlu}} &= 2 \cdot P + 2 \cdot \emptyset_{\text{senggang}} + 4 \cdot \emptyset_{\text{tulangan poko}} + 3 \cdot \text{Jarak antar tulangan} \\
 &= 2 \times 40\text{mm} + 2 \times 10\text{mm} + 3 \times 19\text{mm} + 2 \times 25\text{mm} \\
 &= 207 \text{ mm}
 \end{aligned}$$

$b_{\text{perlu}} (207 \text{ mm}) < b_{\text{ada}} (300\text{mm})$  "Oke"

Cek momen minimal

$$\alpha = \frac{a \cdot f_y}{0,85 \cdot f_c \cdot b} = \frac{850,58 \times 400}{0,85 \times 25 \times 300} = 53,370$$

$$\begin{aligned}
 \phi Mn &= \phi \cdot As \cdot Fy \cdot \left(d - \frac{a}{2}\right) \\
 &= 0,8 \times 850,58 \times 400 \times \left(490,5 - \frac{53,370}{2}\right) \\
 &= 126,243 \times 10^6 \text{ Nmm}
 \end{aligned}$$

Syarat :  $\phi Mn > Mu$

$$126,243 \times 10^6 \text{ Nmm} > 89,80 \times 10^6 \text{ Nmm}$$

#### f. Penulangan Geser

Dimensi Balok : 300 mm × 550 mm

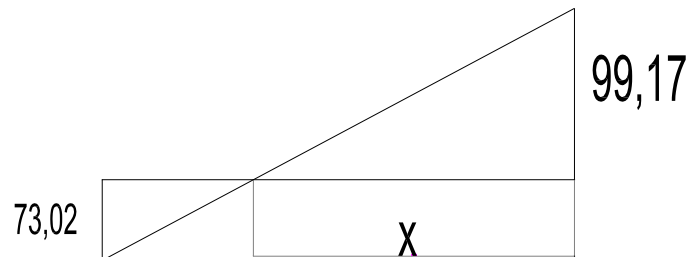
L : 3900 mm

deff : 490,5 mm

Vu : 99,17 KN

$$p = d + \frac{1}{2} \text{ Kolom} = 490,5 + \frac{1}{2} 300 = 640,5 \text{ mm}$$

Dari gambar didapat nilai gaya lintang yang terbesar sebagai berikut :



$$x = \frac{99,17}{99,17 + 73,02} \times 3,9 = 2,246$$

$$Vu \text{ max} = 99,17$$

$$Vu \text{ rencana} = \frac{Vu(x-p)}{x} = \frac{99,17 \times (2,246 - 0,640)}{2,246} = 70,91 \text{ KN}$$

$$\begin{aligned}
 \phi Vc &= \frac{1}{6} \times \sqrt{fc'} \times bw \times d \\
 &= \frac{1}{6} \times \sqrt{25} \times 300 \times 490,5 \\
 &= 122,625 \text{ Mpa}
 \end{aligned}$$

$$V_u \text{ rencana} > \frac{1}{2} \phi V_c$$

$$70,91 > \frac{1}{2} \times 0,75 \times 122,625$$

70,91 < 122,625 (tidak diperlukan tulangan geser jadi digunakan sengkang praktis)

Digunakan tulangan sengkang  $\phi 10$

$$A_v = \frac{\pi \times d^2}{2} = \frac{\pi \times 10^2}{2} = 157,08$$

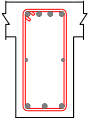
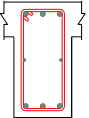
$$V_s = \frac{V_u \text{ rencana}}{\phi} - V_c = \frac{70,91}{0,75} - 122,625 = -28,078$$

$$S = \frac{A_v \cdot F_y \cdot d}{V_s} = \frac{157,08 \cdot 400 \cdot 490,5}{28,078} = 1097624,332 \text{ mm}$$

$$S_{\text{max}} = \frac{d}{2} = \frac{490,5}{2} = 245,2$$

**Karena  $S < S_{\text{maks}}$ , Jadi digunakan tulangan sengkang  $\phi 8 - 200 \text{ mm}$**

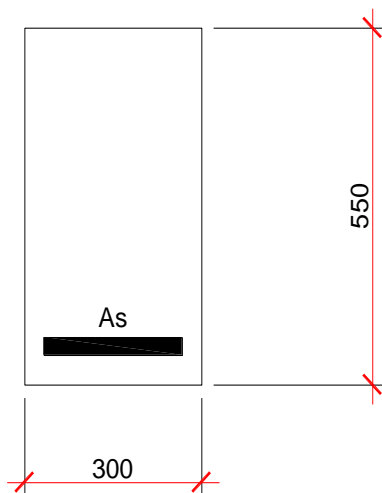
Tabel 3.6.2 Balok Induk 1

TIPE BALOK	B1	
LETAK POTONGAN	LAPANGAN	TUMPUAN
PENAMPANG		
DIMENSI	300 X 550	
T. ATAS	4 D 19	3 D 19
T. BAWAH	3 D 19	3 D 19
SENGKANG	SK.D8-200	SK.D8-200

**Perencanaan Balok Induk Pada Lantai:**

Ukuran balok	= 300 mm x 550 mm
Tulangan pokok	= D19
Tulangan sengkang	= $\phi$ 10 mm
Fc'	= 25 Mpa
Fy	= 400 Mpa
Selimit beton	= 40 mm

**d. Penulangan Lapangan**



$$\begin{aligned}
 \text{Dimensi balok} &= 300\text{mm} \times 550\text{mm} \\
 M_{\text{tumpuan}} &= 142,19 \rightarrow \text{diambil paling besar} \\
 d_{\text{eff}} &= h - p - \phi_{\text{sengkang}} - \frac{1}{2} \cdot \phi_{\text{tulangan pokok}} \\
 &= 550\text{mm} - 40\text{mm} - 10\text{mm} - \frac{1}{2} \cdot 19\text{mm} \\
 &= 490,5 \text{ mm} \\
 M_{\text{Rmaks}} &= \phi \cdot b \cdot d_{\text{eff}}^2 \times k_{\text{maks}} \\
 &= 0,8 \times 300 \times 490,5^2 \times 6,5639 \\
 &= 37901482,1\text{Nmm} \\
 &= 379,010 \text{ KNm}
 \end{aligned}$$

$M_{\text{Rmaks}} (379,010) > M_u (142,19)$ , maka direncanakan balok bertulangan Tarik saja

$$K = \frac{M_u}{\phi \cdot b \cdot d^2}$$

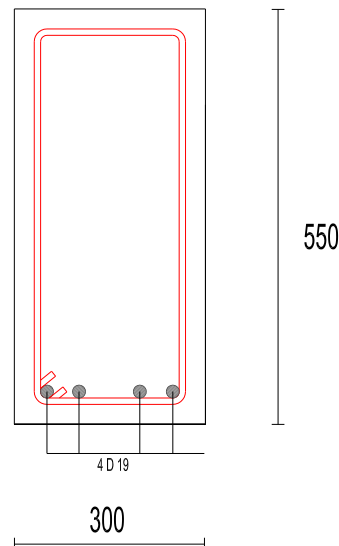
$$= \frac{142,19 \times 10^6}{0,8 \times 300 \text{ mm} \times (490,5 \text{ mm})^2} = 2,4625$$

Dari tabel A-28 Rasio penulangan, didapat  $\rho = 0,0066$

$$\begin{aligned} A_s &= \rho \cdot b \cdot d \\ &= 0,0066 \times 300 \text{ mm} \times 490,5 \text{ mm} \\ &= 971,19 \end{aligned}$$

$$\begin{aligned} n_{\text{tulangan}} &= \frac{A_s}{\frac{1}{4} \pi \cdot D^2} \\ &= \frac{971,19 \text{ mm}^2}{\frac{1}{4} \times \pi \times (19 \text{ mm})^2} = 3,452 \sim 4 \text{ buah} \end{aligned}$$

Dipakai tulangan 4 D19 ( $A_{s\text{pakai}} = 1134,11$ )



### Kontrol Lebar Balok :

Cek 1 lapis

Syarat,  $b_{\text{perlu}} < b_{\text{ada}}$

$$\begin{aligned} b_{\text{perlu}} &= 2 \cdot P + 2 \cdot \emptyset_{\text{sengkang}} + 4 \cdot \emptyset_{\text{tulangan pako}} + 3 \cdot \text{Jarak antar tulangan} \\ &= 2 \times 40 \text{ mm} + 2 \times 10 \text{ mm} + 4 \times 19 \text{ mm} + 3 \times 25 \text{ mm} \\ &= 251 \text{ mm} \end{aligned}$$

$b_{\text{perlu}} (251 \text{ mm}) < b_{\text{ada}} (300 \text{ mm})$  "Oke"

Cek momen minimal

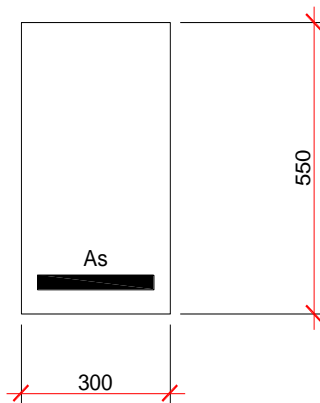
$$\alpha = \frac{as.fy}{0,85.fc.b} = \frac{1134,11 \times 400}{0,85 \times 25 \times 300} = 71,16$$

$$\begin{aligned} \phi Mn &= \phi . As . Fy . \left( d - \frac{\alpha}{2} \right) \\ &= 0,8 \times 1134,11 \times 400 \times \left( 490,5 - \frac{71,160}{2} \right) \\ &= 165,097 \times 10^6 \text{ Nmm} \end{aligned}$$

Syarat :  $\phi Mn > Mu$

$$165,097 \times 10^6 \text{ Nmm} > 142,19 \times 10^6 \text{ Nmm}$$

### e. Penulangan Lapangan



Dimensi balok = 300mm x 550mm

$M_{Lapangan} = 73,02 \rightarrow$  diambil paling besar

$$\begin{aligned} d_{eff} &= h - p - \phi_{sengakang} - \frac{1}{2} \cdot \phi_{tulagn \text{ pokok}} \\ &= 550\text{mm} - 40\text{mm} - 10\text{mm} - \frac{1}{2} \cdot 19\text{mm} \\ &= 490,5\text{mm} \end{aligned}$$

$$\begin{aligned} M_{Rmaks} &= \phi . b . d_{eff}^2 \times k_{maks} \\ &= 0,8 \times 300 \times 490,5^2 \times 6,5639 \\ &= 379010482,1\text{Nmm} \\ &= 379,010 \text{ KNm} \end{aligned}$$

$M_{Rmaks} (379,010) > Mu (73,02)$ , maka direncanakan balok bertulangan Tarik saja

$$K = \frac{Mu}{\phi \cdot b \cdot d^2}$$

$$= \frac{72.02 \times 10^6}{0,8 \times 300 \text{mm} \times (490,5 \text{mm})^2} = 1,264$$

Dari tabel A-28 Rasio penulangan, didapat  $\rho = 0,0035$

$$As = \rho \cdot b \cdot d$$

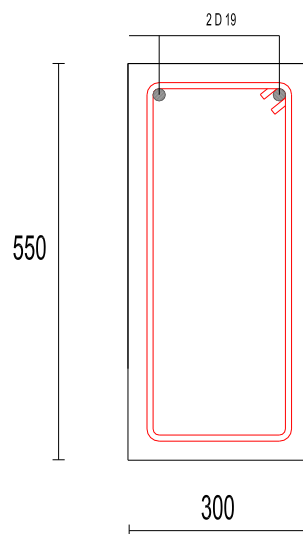
$$= 0,0035 \times 300 \text{mm} \times 490,5 \text{mm}$$

$$= 515,025$$

$$n_{tulangan} = \frac{As}{\frac{1}{4} \cdot \pi \cdot D^2}$$

$$= \frac{515,025 \text{ mm}^2}{\frac{1}{4} \times \pi \times (19 \text{mm})^2} = 1,816 \sim 24 \text{ buah}$$

Dipakai tulangan 2 D19 ( $As_{pakai} = 567,05$ )



### **Kontrol Lebar Balok :**

Cek 1 Lapis

Syarat,  $b_{perlu} < b_{ada}$

$$b_{perlu} = 2 \cdot P + 2 \cdot \phi_{senggang} + 4 \cdot \phi_{tulangan \text{ poko}} + 3 \cdot \text{Jarak antar tulangan}$$

$$= 2 \times 40 \text{mm} + 2 \times 10 \text{mm} + 2 \times 19 \text{mm} + 1 \times 25 \text{mm}$$

$$= 163 \text{ mm}$$



$b_{\text{perlu}} (163 \text{ mm}) < b_{\text{ada}} (300 \text{ mm})$  “Oke”

Cek momen minimal

$$\alpha = \frac{a.s.f_y}{0,85.f_c.b} = \frac{567,05 \times 400}{0,85.25.300} = 35,579$$

$$\begin{aligned} \phi Mn &= \phi . As . Fy . \left( d - \frac{\alpha}{2} \right) \\ &= 0,8 \times 567,05 \times 400 \times \left( 490,5 - \frac{35,579}{2} \right) \\ &= 85,776 \times 10^6 \text{ Nmm} \end{aligned}$$

Syarat :  $\phi Mn > Mu$

$$85,776 \times 10^6 \text{ Nmm} > 72,19 \times 10^6 \text{ Nmm}$$

#### f. Penulangan Geser

Dimensi Balok : 300 mm × 550 mm

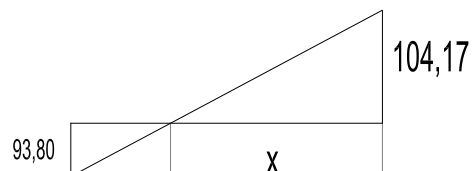
L : 3900 mm

deff : 490,5 mm

Vu : 104,56 KN

$$p = d + \frac{1}{2} \text{ Kolom} = 490,5 + \frac{1}{2} 300 = 640,5 \text{ mm}$$

Dari gambar didapat nilai gaya lintang yang terbesar sebagai berikut :



$$x = \frac{104,17}{104,17+93,80} \times 3,9 = 2,052$$

$$Vu \text{ max} = 104,17$$

$$Vu \text{ rencana} = \frac{Vu (x-p)}{x} = \frac{104,17 \times (2,052 - 0,640)}{2,052} = 71,68 \text{ KN}$$

$$\begin{aligned} \phi Vc &= \frac{1}{6} \times \sqrt{f_c'} \times b_w \times d \\ &= \frac{1}{6} \times \sqrt{25} \times 300 \times 490,5 \\ &= 122,625 \text{ Mpa} \end{aligned}$$

$$V_u \text{ rencana} > \frac{1}{2} \phi V_c$$

$$71,68 > \frac{1}{2} \times 0,75 \times 122,26$$

71,68 < 122,625 (tidak diperlukan tulangan geser jadi digunakan sengkang praktis)

Digunakan tulangan sengkang  $\phi 10$

$$A_v = \frac{\pi \times d^2}{2} = \frac{\pi \times 10^2}{2} = 157,08$$

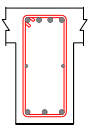
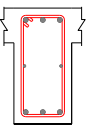
$$V_s = \frac{V_u \text{ rencana}}{\phi} - V_c = \frac{71,68}{0,75} - 122,625 = -27,054$$

$$S = \frac{A_v \cdot F_y \cdot d}{V_s} = \frac{157,08 \cdot 400 \cdot 490,5}{27,054} = 1139169,661 \text{ mm}$$

$$S_{\max} = \frac{d}{2} = \frac{490,5}{2} = 245,2$$

**Karena  $S < S_{\max}$ , Jadi digunakan tulangan sengkang  $\phi 8 - 200 \text{ mm}$**

Tabel 3.6.3 Tabel balok induk 2

TIPE BALOK	B1	
LETAK POTONGAN	LAPANGAN	TUMPUAN
PENAMPANG		
DIMENSI	300 X 550	
T. ATAS	4 D 19	3 D 19
T. BAWAH	3 D 19	3 D 19
SENGKANG	SK.D8-200	SK.D8-200

### 3.6.3 Perhitungan balok induk pada portal memanjang as 1 Perencanaan Balok Induk Lantai Atap

Ukuran balok = 300 mm x 550 mm

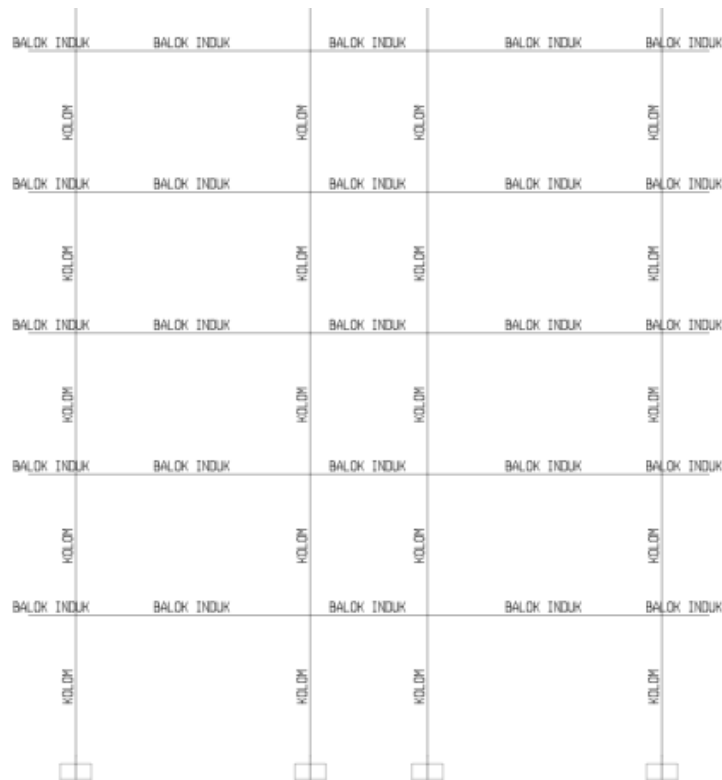
Tulangan pokok = D19

Tulangan sengkang =  $\varnothing$  10 mm

$F_c'$  = 25 Mpa

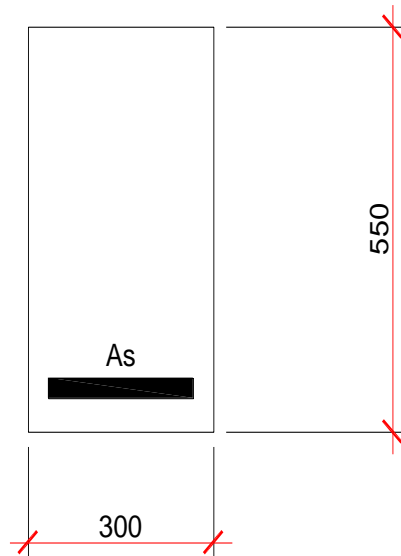
$F_y$  = 400 Mpa

Selimut beton = 40 mm



Gambar 3.6.3 Penamaan kolom dan balok portal melintang potongan  
AS 1

### a. Penulangan Lapangan



$$\text{Dimensi balok} = 300\text{mm} \times 550\text{mm}$$

$$M_{\text{tumpuan}} = 61,20 \rightarrow \text{diambil paling besar}$$

$$\begin{aligned} d_{\text{eff}} &= h - p - \phi_{\text{sengakang}} - \frac{1}{2} \cdot \phi_{\text{tulangan pokok}} \\ &= 550\text{mm} - 40\text{mm} - 10\text{mm} - \frac{1}{2} \cdot 19\text{mm} \\ &= 490,5 \text{ mm} \end{aligned}$$

$$\begin{aligned} M_{R_{\text{maks}}} &= \phi \cdot b \cdot d_{\text{eff}}^2 \times k_{\text{maks}} \\ &= 0,8 \times 300 \times 490,5^2 \times 6,5639 \\ &= 379010482,1 \text{ Nmm} \\ &= 379,010 \text{ KNm} \end{aligned}$$

$M_{R_{\text{maks}}} (379,010) > M_u (61,20)$ , maka direncanakan balok bertulangan Tarik saja

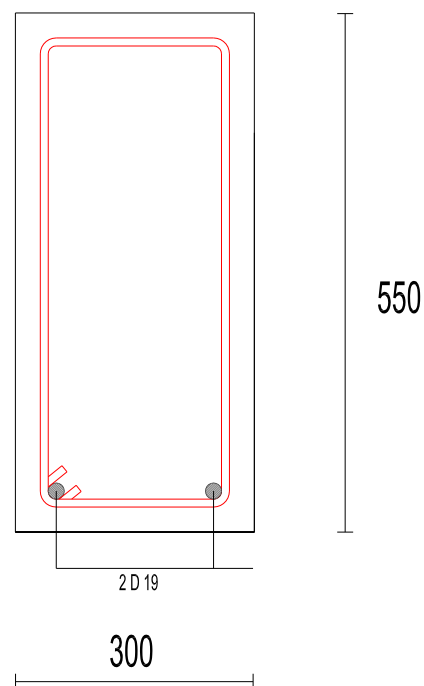
$$\begin{aligned} K &= \frac{M_u}{\phi \cdot b \cdot d^2} \\ &= \frac{61,20 \times 10^6}{0,8 \times 300\text{mm} \times (490,5\text{mm})^2} = 1,060 \end{aligned}$$

Dari tabel A-28 Rasio penulangan, didapat  $\rho = 0,0035$

$$\begin{aligned}
 A_s &= \rho \cdot b \cdot d \\
 &= 0,0035 \times 300\text{mm} \times 490,5\text{mm} \\
 &= 515,025
 \end{aligned}$$

$$\begin{aligned}
 n_{\text{tulangan}} &= \frac{A_s}{\frac{1}{4} \cdot \pi \cdot D^2} \\
 &= \frac{515,022 \text{ mm}^2}{\frac{1}{4} \times \pi \times (19\text{mm})^2} = 1,816 \sim 2 \text{ buah}
 \end{aligned}$$

**Dipakai tulangan 2 D19 ( $A_{s\text{pakai}} = 567,05$ )**



### **Kontrol Lebar Balok :**

Cek 1 lapis

Syarat,  $b_{\text{perlu}} < b_{\text{ada}}$

$$\begin{aligned}
 b_{\text{perlu}} &= 2 \cdot P + 2 \cdot \emptyset_{\text{sengkang}} + 4 \cdot \emptyset_{\text{tulangan poko}} + 3 \cdot \text{Jarak antar tulangan} \\
 &= 2 \times 40\text{mm} + 2 \times 10\text{mm} + 2 \times 19\text{mm} + 1 \times 25\text{mm} \\
 &= 163 \text{ mm}
 \end{aligned}$$

$b_{\text{perlu}} (163 \text{ mm}) < b_{\text{ada}} (300\text{mm})$  "Oke"

Cek momen minimal

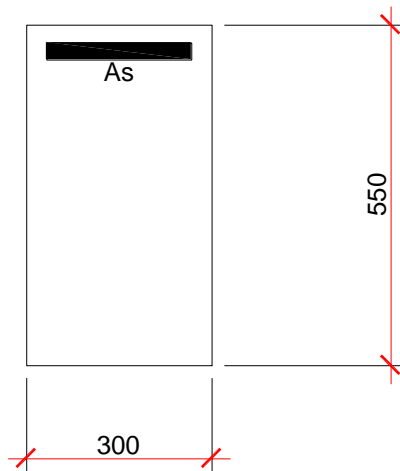
$$\alpha = \frac{as.fy}{0,85.fc.b} = \frac{567,05 \times 400}{0,85 \times 25 \times 300} = 35,580$$

$$\begin{aligned} \phi Mn &= \phi . As . Fy . \left(d - \frac{\alpha}{2}\right) \\ &= 0,8 \times 567,05 \times 400 \times \left(490,5 - \frac{35,580}{2}\right) \\ &= 85,776 \times 10^6 \text{ Nmm} \end{aligned}$$

Syarat :  $\phi Mn > Mu$

$$85,776 \times 10^6 \text{ Nmm} > 61,20 \times 10^6 \text{ Nmm}$$

## b. Penulangan Tumpuan



Dimensi balok = 300mm x 550mm

$M_{Lapangan}$  = 88,65 → diambil paling besar

$$\begin{aligned} d_{eff} &= h - p - \phi_{sengakang} - \frac{1}{2} \cdot \phi_{tulangan\ pokok} \\ &= 550\text{mm} - 40\text{mm} - 10\text{mm} - \frac{1}{2} \cdot 19\text{mm} \\ &= 490,5\text{mm} \end{aligned}$$

$$\begin{aligned}
 M_{Rmaks} &= \phi \cdot b \cdot d_{\text{eff}}^2 \times k_{\text{maks}} \\
 &= 0,8 \times 300 \times 490,5^2 \times 6,5639 \\
 &= 379010482,1 \text{ Nmm} \\
 &= 379,010 \text{ KNm}
 \end{aligned}$$

$M_{Rmaks} (379,010) > Mu (88,65)$ , maka direncanakan balok bertulangan Tarik saja

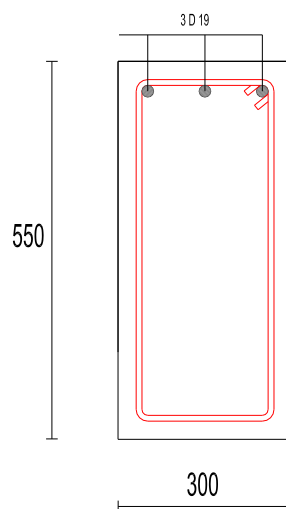
$$\begin{aligned}
 K &= \frac{Mu}{\phi \cdot b \cdot d^2} \\
 &= \frac{88,65 \times 10^6}{0,8 \times 300 \text{mm} \times (490,5 \text{mm})^2} = 1,5352
 \end{aligned}$$

Dari tabel A-28 Rasio penulangan, didapat  $\rho = 0,0040$

$$\begin{aligned}
 A_s &= \rho \cdot b \cdot d \\
 &= 0,0040 \times 300 \text{mm} \times 490,5 \text{mm} \\
 &= 588,6
 \end{aligned}$$

$$\begin{aligned}
 n_{\text{tulangan}} &= \frac{A_s}{\frac{1}{4} \pi \cdot D^2} \\
 &= \frac{588,6 \text{mm}^2}{\frac{1}{4} \times \pi \times (19 \text{mm})^2} = 2,076 \sim 3 \text{ buah}
 \end{aligned}$$

**Dipakai tulangan 3 D19 ( $A_{s\text{pakai}} = 850,58$ )**



### **Kontrol Lebar Balok :**

Cek 1 lapis

Syarat,  $b_{\text{perlu}} < b_{\text{ada}}$

$$\begin{aligned}
 b_{\text{perlu}} &= 2.P + 2.\emptyset_{\text{sengkang}} + 4.\emptyset_{\text{tulangan poko}} + 3.\text{Jarak antar tulangan} \\
 &= 2 \times 40 \text{ mm} + 2 \times 10 \text{ mm} + 3 \times 19 \text{ mm} + 2 \times 25 \text{ mm} \\
 &= 207 \text{ mm}
 \end{aligned}$$

$$b_{\text{perlu}} (207 \text{ mm}) < b_{\text{ada}} (300 \text{ mm}) \text{ "Oke"}$$

Cek momen minimal

$$\alpha = \frac{as.fy}{0,85.fc.b} = \frac{850,58 \times 400}{0,85 \times 25 \times 300} = 53,370$$

$$\begin{aligned}
 \emptyset Mn &= \emptyset . As . Fy . \left( d - \frac{\alpha}{2} \right) \\
 &= 0,8 \times 850,58 \times 400 \times \left( 490,5 - \frac{53,370}{2} \right) \\
 &= 126,243 \times 10^6 \text{ Nmm}
 \end{aligned}$$

$$\text{Syarat : } \emptyset Mn > Mu$$

$$126,243 \times 10^6 \text{ Nmm} > 88,65 \times 10^6 \text{ Nmm}$$

### c. Penulangan Geser

$$\text{Dimensi Balok} : 300 \text{ mm} \times 550 \text{ mm}$$

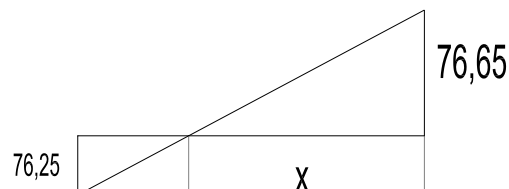
$$L : 3900 \text{ mm}$$

$$d_{\text{eff}} : 490,5 \text{ mm}$$

$$V_u : 76,65 \text{ KN}$$

$$p = d + \frac{1}{2} \text{ Kolom} = 490,5 + \frac{1}{2} 300 = 640,5 \text{ mm}$$

Dari gambar didapat nilai gaya lintang yang terbesar sebagai berikut :



$$x = \frac{76,65}{76,65 + 76,25} \times 3,9 = 1,960$$

$$V_u \text{ max} = 76,65$$

$$V_u \text{ rencana} = \frac{V_u (x-p)}{x} = \frac{76,65 \times (1,960 - 0,640)}{1,960} = 51,62 \text{ KN}$$

$$\emptyset V_c = \frac{1}{6} \times \sqrt{f_c'} \times b_w \times d$$



$$= \frac{1}{6} \times \sqrt{25} \times 300 \times 490,5$$

$$= 122,625 \text{ Mpa}$$

$$V_u \text{ rencana} > \frac{1}{2} \phi V_c$$

$$70,84 > \frac{1}{2} \times 0,75 \times 122,625$$

70,84 < 122,625 (tidak diperlukan tulangan geser jadi digunakan sengkang praktis)

Digunakan tulangan sengkang  $\phi 10$

$$A_v = \frac{\pi \times d^2}{2} = \frac{\pi \times 10^2}{2} = 157,08$$

$$V_s = \frac{V_u \text{ rencana}}{\phi} - V_c = \frac{70,84}{0,75} - 122,625 = -28,171$$

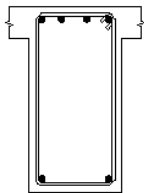
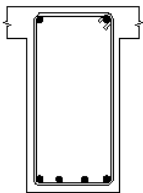
$$S = \frac{A_v \cdot F_y \cdot d}{V_s} = \frac{157,08 \cdot 400 \cdot 490,5}{28,171} = 1094000,781 \text{ mm}$$

$$S_{\max} = \frac{d}{2} = \frac{490,5}{2} = 245,2$$

**Karena  $S < S_{\max}$ , Jadi digunakan tulangan sengkang  $\phi 8 - 200 \text{ mm}$**

**Tabel 3.12.**

Tabel balok induk 1

<b>T :</b>	<b>B-1</b>	
<b>P :</b>	TUMPUAN	LAPANGAN
<b>UB :</b>	400x700	
		
<b>TA :</b>	4 D22	2 D22
<b>TB :</b>	2 D22	4 D22
<b>SK :</b>	$\phi 10 - 200$	$\phi 10 - 200$

### Direncanakan Balok Induk Pada Lantai:

Ukuran balok	= 300 mm x 550 mm
Tulangan pokok	= D19
Tulangan sengkang	= $\phi$ 10 mm
Fc'	= 25 Mpa
Fy	= 400 Mpa
Selimut beton	= 40 mm

#### a. Penulangan Lapangan



Dimensi balok = 300mm x 550mm

$M_{tumpuan}$  = 173,06 → diambil paling besar

$d_{eff}$  =  $h - p - \phi_{sengkang} - \frac{1}{2} \cdot \phi_{tulangan\ pokok}$   
 = 550mm - 40mm - 10mm -  $\frac{1}{2} \cdot 19$ mm  
 = 490,5 mm

$M_{Rmaks}$  =  $\phi \cdot b \cdot d_{eff}^2 \times k_{maks}$   
 = 0,8 x 300 x 490,5<sup>2</sup> x 6,5639  
 = 379010482,1 Nmm  
 = 379,010 KNm

$M_{Rmaks} (379,010) > M_u (173,06)$ , maka direncanakan balok bertulangan Tarik saja

$$K = \frac{M_u}{\phi \cdot b \cdot d^2}$$

$$= \frac{173,06 \times 10^6}{0,8 \times 300 \text{mm} \times (490,5 \text{mm})^2} = 2,997$$

Dari tabel A-28 Rasio penulangan, didapat  $\rho = 0,0082$

$$A_s = \rho \cdot b \cdot d$$

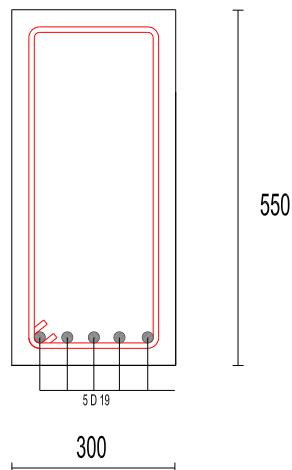
$$= 0,0082 \times 300 \text{mm} \times 490,5 \text{mm}$$

$$= 1206,3$$

$$n_{\text{tulangan}} = \frac{A_s}{\frac{1}{4} \pi \cdot D^2}$$

$$= \frac{1206,3 \text{ mm}^2}{\frac{1}{4} \times \pi \times (19 \text{mm})^2} = 4,254 \sim 5 \text{ buah}$$

Dipakai tulangan 5 D19 ( $A_{s\text{pakai}} = 1417,6$ )



### Kontrol Lebar Balok :

Cek 1 lapis

Syarat,  $b_{\text{perlu}} < b_{\text{ada}}$

$$b_{\text{perlu}} = 2 \cdot P + 2 \cdot \phi_{\text{sengkang}} + 4 \cdot \phi_{\text{tulangan poko}} + 3 \cdot \text{Jarak antar tulangan}$$

$$= 2 \times 40 \text{ mm} + 2 \times 10 \text{ mm} + 5 \times 19 \text{ mm} + 4 \times 25 \text{ mm}$$

$$= 295 \text{ mm}$$

$b_{\text{perlu}} (295 \text{ mm}) < b_{\text{ada}} (300 \text{ mm})$  "Oke"

Cek momen minimal

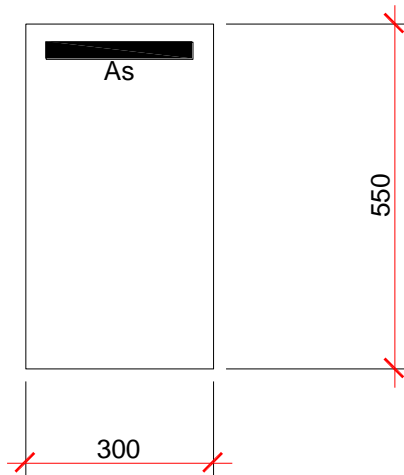
$$\alpha = \frac{as \cdot fy}{0,85 \cdot fc \cdot b} = \frac{1417,6 \times 400}{0,85 \cdot 25 \cdot 300} = 88,947$$

$$\begin{aligned} \phi Mn &= \phi \cdot As \cdot Fy \cdot \left(d - \frac{\alpha}{2}\right) \\ &= 0,8 \times 1417,6 \times 400 \times \left(490,5 - \frac{88,947}{2}\right) \\ &= 202,331 \times 10^6 \text{ Nmm} \end{aligned}$$

Syarat :  $\phi Mn > Mu$

$$202,331 \times 10^6 \text{ Nmm} > 173,06 \times 10^6 \text{ Nmm}$$

## b. Penulangan Tumpuan



Dimensi balok = 300 mm x 550 mm

$M_{\text{Lapangan}} = 92,32 \rightarrow$  diambil paling besar

$$\begin{aligned} d_{\text{eff}} &= h - p - \phi_{\text{sengakang}} - \frac{1}{2} \cdot \phi_{\text{tulagn pokok}} \\ &= 550 \text{ mm} - 40 \text{ mm} - 10 \text{ mm} - \frac{1}{2} \cdot 19 \text{ mm} \\ &= 490,5 \text{ mm} \end{aligned}$$

$$M_{\text{Rmaks}} = \phi \cdot b \cdot d_{\text{eff}}^2 \times k_{\text{maks}}$$

$$\begin{aligned}
 &= 0,8 \times 300 \times 490,5^2 \times 6,5639 \\
 &= 379010482,1 \text{ Nmm} \\
 &= 379,010 \text{ KNm}
 \end{aligned}$$

$M_{Rmaks} (379,101) > M_u (92,32)$ , maka direncanakan balok bertulangan Tarik saja

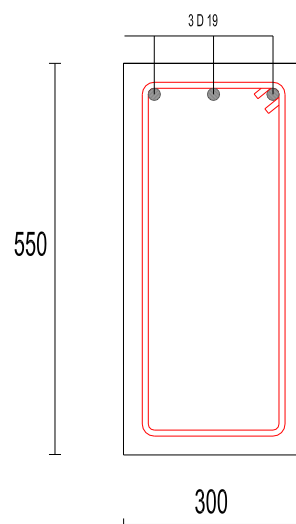
$$\begin{aligned}
 K &= \frac{M_u}{\phi \cdot b \cdot d^2} \\
 &= \frac{92,32 \times 10^6}{0,8 \times 300 \text{mm} \times (490,5 \text{mm})^2} = 1,560
 \end{aligned}$$

Dari tabel A-28 Rasio penulangan, didapat  $\rho = 0,0042$

$$\begin{aligned}
 A_s &= \rho \cdot b \cdot d \\
 &= 0,0042 \times 300 \text{mm} \times 490,5 \text{mm} \\
 &= 618,03
 \end{aligned}$$

$$\begin{aligned}
 n_{\text{tulangan}} &= \frac{A_s}{\frac{1}{4} \pi \cdot D^2} \\
 &= \frac{618,03 \text{ mm}^2}{\frac{1}{4} \times \pi \times (19 \text{mm})^2} = 2,179 \sim 3 \text{ buah}
 \end{aligned}$$

**Dipakai tulangan 3 D19 ( $A_{s\text{pakai}} = 850,5$ )**



### **Kontrol Lebar Balok :**

Cek 1 lapis

Syarat,  $b_{\text{perlu}} < b_{\text{ada}}$

$$\begin{aligned}
 b_{\text{perlu}} &= 2.P + 2.\emptyset_{\text{senggang}} + 4.\emptyset_{\text{tulangan poko}} + 3.\text{Jarak antar tulangan} \\
 &= 2 \times 40 \text{ mm} + 2 \times 10 \text{ mm} + 3 \times 19 \text{ mm} + 2 \times 25 \text{ mm} \\
 &= 207 \text{ mm}
 \end{aligned}$$

$$b_{\text{perlu}} (207 \text{ mm}) < b_{\text{ada}} (300 \text{ mm}) \text{ "Oke"}$$

Cek momen minimal

$$\alpha = \frac{as.fy}{0,85.fc.b} = \frac{850,5 \times 400}{0,85 \cdot 25 \cdot 300} = 53,364$$

$$\begin{aligned}
 \emptyset Mn &= \emptyset . As . Fy . \left( d - \frac{\alpha}{2} \right) \\
 &= 0,8 \times 850,5 \times 400 \times \left( 490,5 - \frac{53,364}{2} \right) \\
 &= 134,12 \times 10^6 \text{ Nmm}
 \end{aligned}$$

Syarat :  $\emptyset Mn > Mu$

$$134,12 \times 10^6 \text{ Nmm} > 92,32 \times 10^6 \text{ Nmm}$$

### c. Penulangan Geser

Dimensi Balok : 300 mm × 550 mm

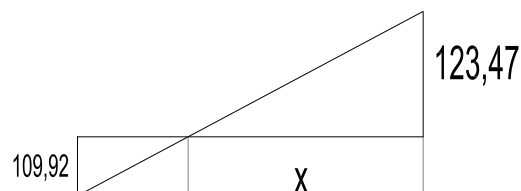
L : 3900 mm

d<sub>eff</sub> : 490,5 mm

V<sub>u</sub> : 123,47 KN

$$p = d + \frac{1}{2} \text{ Kolom} = 490,5 + \frac{1}{2} \cdot 300 = 640,5 \text{ mm}$$

Dari gambar didapat nilai gaya lintang yang terbesar sebagai berikut :



$$x = \frac{123,47}{23,47 + 109,92} \times 3,9 = 2,063$$

$$V_{u \text{ max}} = 123,47$$

$$V_u \text{ rencana} = \frac{V_u (x-p)}{x} = \frac{123,47 \times (2,063 - 0,640)}{2,063} = 85,166 \text{KN}$$

$$\begin{aligned} \phi V_c &= \frac{1}{6} \times \sqrt{f_c'} \times b_w \times d \\ &= \frac{1}{6} \times \sqrt{25} \times 300 \times 490,5 \\ &= 122,625 \text{ Mpa} \end{aligned}$$

$$V_u \text{ rencana} > \frac{1}{2} \phi V_c$$

$$85,16 > \frac{1}{2} \times 0,75 \times 122,625$$

85,16 < 122,625 (tidak diperlukan tulangan geser jadi digunakan sengkang praktis)

Digunakan tulangan sengkang  $\phi 10$

$$A_v = \frac{\pi \times d^2}{2} = \frac{\pi \times 10^2}{2} = 157,08$$

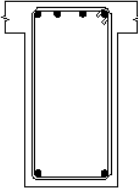
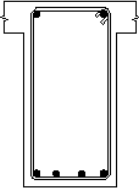
$$V_s = \frac{V_u \text{ rencana}}{\phi} - V_c = \frac{85,16}{0,75} - 122,625 = -9,078$$

$$S = \frac{A_v \cdot f_y \cdot d}{V_s} = \frac{157,08 \cdot 400 \cdot 490,5}{9,078} = 3394921,348 \text{ mm}$$

$$S_{\text{max}} = \frac{d}{2} = \frac{490,5}{2} = 245,2$$

**Jadi digunakan tulangan sengkang  $\phi 8 - 200 \text{ mm}$**

**Tabel 3.13.** Tabel balok induk 1

<b>T :</b>	<b>B-1</b>	
<b>P :</b>	TUMPUAN	LAPANGAN
<b>UB :</b>	400x700	
		
<b>TA :</b>	4 D22	2 D22
<b>TB :</b>	2 D22	4 D22
<b>SK :</b>	$\phi 10 - 200$	$\phi 10 - 200$