

**UTS**

**Struktur Beton Bertulang**

Dosen Pengampu : Agung Kristiawan ST, MT



Disusun Oleh :

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NPM : 20640072

Kelas : 3C Teknik Sipil

**PROGRAM STUDI TEKNIK SIPIL**

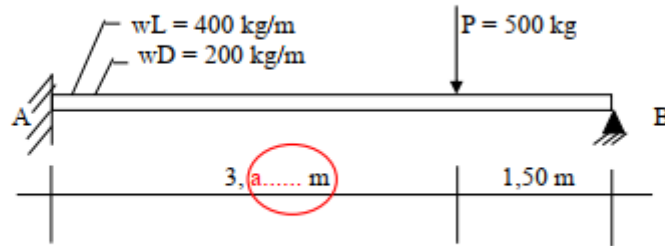
**FAKULTAS TEKNIK DAN INFORMATIKA**

**UNIVERSITAS PGRI SEMARANG**

**2021**

**SOAL :**

1. Diketahui gelagar seperti pada gambar.



a = 2 angka dibelakang NPM

Beban mati merata (WD = 200 kg/m) sudah termasuk berat sendiri balok.  
Beban hidup merata (WL = 400 kg/m), serta beban hidup terpusat P = 500 kg  
Mutu beton  $f'_c = 35$  Mpa dan Baja  $f_y = 400$  Mpa.  
 $\phi = 0,8$  ;  $d' = 50$  mm

Hitung : a. Mu

- b. Dimensi Balok dan penulangannya.  
c. Gambar sket penulangannya.

**Selamat Bekerja**

Mengetahui,  
Ketua Prodi Teknik Sipil,

**AGUNG KRISTIAWAN, S.T., M.T.**  
NPP. 137001386

Diperiksa tanggal, 25 Oktober 2021  
SUPMPS / Kelompok Bidang Ilmu

**Dr. PUTRI ANGGI PERMATA S, S.T., M.T.**  
NPP. 138201421

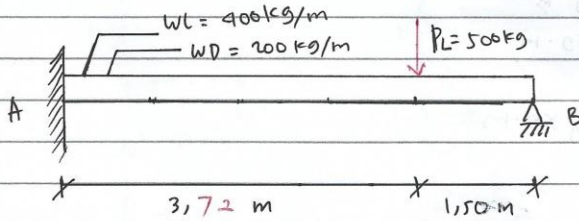
Nama : Melfika Prima F.

# UTS STRUKTUR BETON BERTULANG #

Kelas : III C / Teknik Sipil

NPM : 20640072

*filan*



$P_L = 500 \text{ kg}$

kuat beton  $f'_c = 35 \text{ MPa}$

kuat baja  $f_y = 400 \text{ MPa}$

$\phi = 0.8$

$d' = 50 \text{ mm}$

$W_D = 200 \text{ kg/m}$  (sudah termasuk berat sendiri balok)

$W_L = 400 \text{ kg/m}$

$$L = 3.72 \text{ m} + 1.50 \text{ m} = 5.22 \text{ m}$$

tentukan : Mu, Dimensi Balok dan penulangannya, Gambar skat penulangan

# Mencari Dimensi Balok #

$$h = \left( \frac{1}{8} \text{ s.d. } \frac{1}{16} \right) L$$

$$b = \left( \frac{1}{2} \text{ s.d. } \frac{2}{3} \right) h$$

$$b_{\min} = 150 \text{ mm}$$

$$h = \frac{1}{16} \times 5.22 \text{ m}$$

$$b = \frac{2}{3} \times 0.33 \text{ m}$$

$$h = 0.33 \text{ m}$$

$$b = 0.22 \text{ m}$$

$$h = 330 \text{ mm}$$

$$b = 220 \text{ mm}$$

# Pembebanan Balok ( $W_u$ )

faktor beban hidup = 1.6

$$W_u = 1.2 W_D + 1.6 W_L$$

faktor beban mati = 1.2

$$= 1.2 \times 200 \text{ kg/m} + 1.6 \times 400 \text{ kg/m}$$

$$= 240 \text{ kg/m} + 640 \text{ kg/m}$$

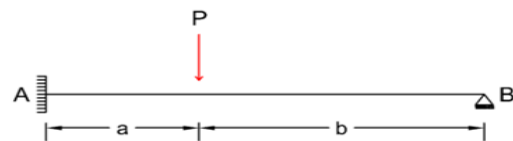
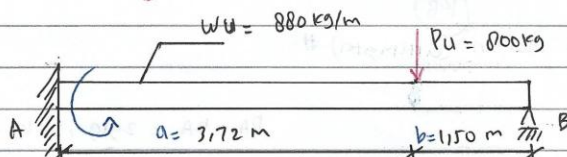
$$= 880 \text{ kg/m}$$

karena  $W_D$  sudah termasuk berat sendiri balok, maka berat sendiri balok tidak dimasukkan dalam perhitungan

$$P_u = 1.6 \times P_L$$

$$= 1.6 \times 500 \text{ kg}$$

$$= 800 \text{ kg}$$



$$M_{AB} = \frac{Pb(L^2 - b^2)}{2L^2}$$

\* Momen tumpuan jepit-sendi dan beban terpusat diambil dari tabel momen primer

\* Balok jepit-sendi, Momen hanya di titik jepit saja. titik sendi tidak dapat menerima momen.

$$M_{AB} = \frac{q \cdot L^2}{16} + \frac{Pb(L^2 - b^2)}{2L^2}$$

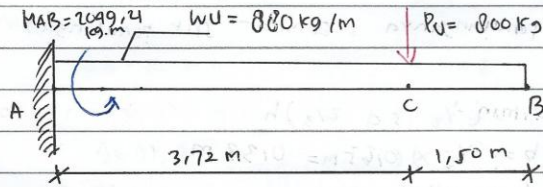
$$M_{AB} = \frac{880 \text{ kg/m} \times (5.22 \text{ m})^2}{16} + \frac{800 \text{ kg} \times 1.50 \text{ m}}{2 \times (5.22 \text{ m})^2} \times ((5.22 \text{ m})^2 - (1.50 \text{ m})^2)$$

(KKY)

→

$$\begin{aligned}
 MAB &= \frac{880 \text{ kg/m} \times 27,25 \text{ m}^2}{16} + \frac{800 \text{ kg} \times 1,50 \text{ m}}{2 \times 27,25 \text{ m}^2} \times (27,25 \text{ m}^2 - 2,125 \text{ m}^2) \\
 &= \frac{23980 \text{ kg} \cdot \text{m}}{16} + \frac{1200 \text{ kg} \cdot \text{m}}{54,5 \text{ m}^2} \times 25 \text{ m}^2 \\
 &= \frac{23980 \text{ kg} \cdot \text{m}}{16} + \frac{30000 \text{ kg} \cdot \text{m}}{54,5} \\
 &= 1498,75 \text{ kg} \cdot \text{m} + 550,46 \text{ kg} \cdot \text{m} \\
 &= 2049,21 \text{ kg} \cdot \text{m}
 \end{aligned}$$

# mencari Reaksi Tumpuan #



$$\begin{aligned}
 \frac{PU \cdot 1,50}{5,22} \\
 &= \frac{800 \text{ kg} \cdot 1,50 \text{ m}}{5,22 \text{ m}} \\
 &= 229,89 \text{ kg}
 \end{aligned}$$

$$\begin{aligned}
 \frac{PU \cdot 3,72 \text{ m}}{5,22} \\
 &= \frac{800 \text{ kg} \cdot 3,72 \text{ m}}{5,22 \text{ m}} \\
 &= 570,11 \text{ kg}
 \end{aligned}$$

# kontrol :

$$PU + (WU \times L) = RA + RB$$

$$800 + (880 \times 5,22) = 2919,26 + 2474,34$$

$$800 + 4593,6 = 5393,6$$

$$5393,6 = 5393,6 \text{ (OK)}$$

$$\begin{aligned}
 \frac{WU \cdot L}{2} \\
 &= \frac{880 \text{ kg/m} \times 5,22 \text{ m}}{2} \\
 &= 2296,8 \text{ kg}
 \end{aligned}$$

$$\begin{aligned}
 MAB / L \\
 &= 2049,21 \text{ kg} \cdot \text{m} / 5,22 \text{ m} \\
 &= 392,57 \text{ kg}
 \end{aligned}$$

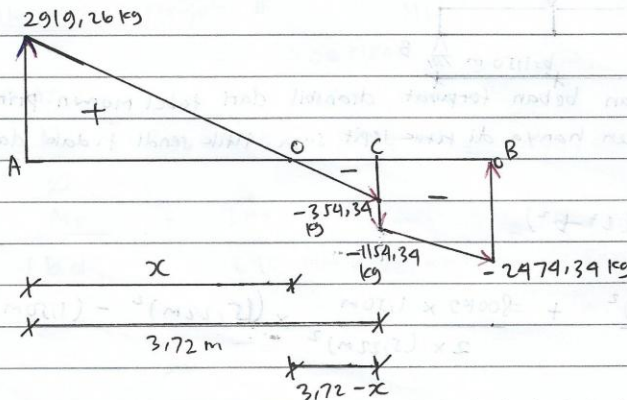
$$\uparrow 2919,26 \text{ kg}$$

(RA)

$$\uparrow 2474,34 \text{ kg}$$

(RB)

# Bidang D (mencari titik x untuk momen lapangan) #



$$DA = RA = 2919,26 \text{ kg}$$

$$\begin{aligned}
 D_{C \text{ kiri}} &= RA - WU \times 3,72 \\
 &= 2919,26 - (880 \times 3,72) \\
 &= 2919,26 - 3273,6 \\
 &= -354,34 \text{ kg}
 \end{aligned}$$

$$\begin{aligned}
 D_C &= D_{C \text{ kiri}} - PU \\
 &= -354,34 - 800 \\
 &= -1154,34 \text{ kg}
 \end{aligned}$$

$$\begin{aligned}
 D_{C \text{ kanan}} &= D_C - WU \times 1,50 \\
 &= -1154,34 - (880 \times 1,50) \\
 &= -1154,34 - 1320 \\
 &= -2474,34 \text{ kg}
 \end{aligned}$$

$$\begin{aligned}
 D_B &= D_{C \text{ kanan}} + RB \\
 &= -2474,34 \text{ kg} + 2474,34 \text{ kg} \\
 &= 0
 \end{aligned}$$



$$\begin{aligned}
 x &= (3,72 - x) \\
 2919,26 &= 354,34x \\
 354,34x &= 2919,26 (3,72 - x) \\
 354,34x &= 10859,6472 - 2919,26x \\
 354,34x + 2919,26x &= 10859,6472 \\
 3273,6x &= 10859,6472 \\
 x &= \frac{10859,6472}{3273,6} \\
 x &= 3,32 \text{ m} \quad (\text{dari titik A})
 \end{aligned}$$

#  $M_x = M_{\text{lapangan}}$

$$\begin{aligned}
 &= R_A \cdot x - W_U \cdot x \cdot \frac{1}{2} \cdot x - M_{AB} \\
 &= 2919,26 \text{ kg} \cdot 3,32 \text{ m} - \left( \frac{1}{2} \cdot 880 \text{ kg/m} \cdot (3,32 \text{ m})^2 \right) - 2049,21 \text{ kg} \cdot \text{m} \\
 &= 9691,94 \text{ kg} \cdot \text{m} - \left( \frac{1}{2} \cdot 880 \text{ kg/m} \cdot 11,02 \text{ m}^2 \right) - 2049,21 \text{ kg} \cdot \text{m} \\
 &= 9691,94 \text{ kg} \cdot \text{m} - 4848,8 \text{ kg} \cdot \text{m} - 2049,21 \text{ kg} \cdot \text{m} \\
 &= 2793,93 \text{ kg} \cdot \text{m}
 \end{aligned}$$

# Momen Ultimate (Mu) / Momen Maximum

$$M_{\text{Bumpuan}} = M_{AB} = 2049,21 \text{ kg} \cdot \text{m}$$

$$= 2049,21 \cdot 10 \text{ N} \cdot \text{m}$$

$$M_{\text{lapangan}} = M_x = 2793,93 \text{ kg} \cdot \text{m}$$

$$= 2793,93 \cdot 10 \text{ N} \cdot \text{m}$$

# Data :

$$h = 330 \text{ mm}$$

$$b = 220 \text{ mm}$$

$$d' = 50 \text{ mm}$$

$$d = h - d' = 330 \text{ mm} - 50 \text{ mm} = 280 \text{ mm}$$

$$\phi = 0,8$$

$$f_c = 35 \text{ Mpa}$$

$$f_y = 400 \text{ Mpa}$$

$$\rho_{\min} = 1,4 / f_y = 1,4 / 400 = 0,0035$$

$$\rho_{\max} (\text{lihat tabel}) = 0,0284$$

$$p = 25 \text{ mm}$$

$$\phi \text{ sengkang} = 8 \text{ mm}$$

# penulangan lapangan #

$$M_L = 2793,93 \text{ kg} \cdot \text{m}$$

$$1 \text{ kg} = 10 \text{ N}$$

$$m = \frac{f_y}{0,85 \cdot f_c} = \frac{400 \text{ Mpa}}{0,85 \times 35 \text{ Mpa}} = 13,45$$

$$M_n = \frac{M_u}{\phi} = \frac{2793,93 \text{ kg} \cdot \text{m}}{0,8} = 3492,41 \text{ kg} \cdot \text{m}$$

$$R_n = \frac{M_n}{(b \cdot d^2)} = \frac{3492,41 \text{ kg} \cdot \text{m}}{220 \text{ mm} \times (280 \text{ mm})^2} = \frac{3492,41 \cdot 10^3 \cdot 10 \text{ Nmm}}{220 \text{ mm} \times 784 \cdot 10^3 \text{ mm}^2} = 2,02 \text{ N/mm}^2$$

$$\rho = \frac{1}{m} \left( 1 - \sqrt{1 - \frac{(2 \cdot m \cdot R_n)}{f_y}} \right)$$

$$= \frac{1}{13,45} \left( 1 - \sqrt{1 - \left( \frac{2 \times 13,45 \times 2,02}{400} \right)} \right)$$

$$= \frac{1}{13,45} \left( 1 - \sqrt{1 - \left( \frac{54,34}{400} \right)} \right)$$

$$= \frac{1}{13,45} \left( 1 - \sqrt{1 - 0,14} \right)$$

$$= \frac{1}{13,45} \left( 1 - \sqrt{0,86} \right)$$

$$= \frac{1}{13,45} (1 - 0,93)$$

$$= \frac{1}{13,45} \times 0,07$$

$$= 0,0052$$

Syarat :

$$\rho_{min} < \rho$$

$$0,0035 < 0,0052 \text{ (OK!)}$$

$$\rho_{max} > \rho$$

$$0,0284 > 0,0052 \text{ (OK!)}$$

# luas tulangan yang dibutuhkan : (tulangan tertarik di lapangan)

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

$$= 0,0052 \times 220 \text{ mm} \times 280 \text{ mm}$$

$$= 320,32 \text{ mm}^2$$

# tulangan pokok yg dipakai D 12 mm

$$\text{jumlah tulangan (n)} = A_s / (1/4 \cdot \pi \cdot D^2)$$

$$= 320,32 \text{ mm}^2$$

$$0,25 \times 3,14 \times (12 \text{ mm})^2$$

$$= 2,83$$

$$= 3 \text{ buah}$$

Syarat  $S > 25 \text{ mm}$

$$S = (b - (2p + 2 \phi sk + n \phi TP)) / (n - 1)$$

$$= (220 \text{ mm} - (2 \times 25 \text{ mm}) + (2 \times 8 \text{ mm}) + (3 \times 12)) / (3 - 1)$$

$$= (220 \text{ mm} - (50 \text{ mm} + 16 \text{ mm} + 36 \text{ mm})) / 2$$

$$= (220 \text{ mm} - 102) / 2$$

$$= 118 \text{ mm} / 2$$

$$= 59 \text{ mm}$$

→

$$S > 25 \text{ mm}$$

$$59 \text{ mm} > 25 \text{ mm} \text{ (OK!)}$$

Sesuai tabel luas penampang,

syarat D12 dengan jumlah tulangan (n) 3 batang, luas = 339,43 mm<sup>2</sup>

maka luas tulangan diatas memenuhi syarat : 320,32 mm<sup>2</sup> ≤ 339,43 mm<sup>2</sup>



# Tulangan tertekan di lapangan

$$\begin{aligned} A_s' &= 0,15 \times A_s \\ &= 0,15 \times 320,32 \text{ mm}^2 \\ &= 160,16 \text{ mm}^2 \end{aligned}$$

Tulangan pokok yang dipakai D12 mm

$$\begin{aligned} \text{Jumlah tulangan } (n) &= A_s' / (0,25 \times \pi \cdot D^2) \\ &= 160,16 \text{ mm}^2 / (0,25 \times 3,14 \times (12 \text{ mm})^2) \\ &= 160,16 \text{ mm}^2 / 113,04 \text{ mm}^2 \\ &= 1,42 \text{ buah} \\ &= 2 \text{ buah} \end{aligned}$$

# penulangan tumpuan #  $M_{AB} = 2045,21 \text{ kg.m}$

$$m = \frac{f_y}{0,85 \cdot f_c} = \frac{400 \text{ MPa}}{0,85 \times 35 \text{ MPa}} = 13,45$$

$$M_n = \frac{M_u}{\phi} = \frac{2049,21 \text{ kg.m}}{0,8} = 2561,51 \text{ kg.m}$$

$$\begin{aligned} R_n &= \frac{M_n}{(b \cdot d^2)} = \frac{2561,51 \text{ kg.m}}{220 \text{ mm} \times (280 \text{ mm})^2} = \frac{2561,51 \cdot 10 \cdot 10^3 \text{ N.mm}}{220 \text{ mm} \times 78,4 \cdot 10^3 \text{ mm}^2} \\ &= 1,49 \text{ N/mm}^2 \end{aligned}$$

$$\rho = \frac{1}{m} \left( 1 - \sqrt{1 - \left( \frac{2 \cdot M_n \cdot R_n}{f_y} \right)} \right)$$

$$= \frac{1}{13,45} \times \left( 1 - \sqrt{1 - \left( \frac{2 \times (13,45 \times 1,49)}{400} \right)} \right)$$

$$= \frac{1}{13,45} \times \left( 1 - \sqrt{1 - 0,10} \right)$$

$$= \frac{1}{13,45} \times \left( 1 - \sqrt{0,9} \right)$$

$$= \frac{1}{13,45} \times (1 - 0,95)$$

$$= \frac{1}{13,45} \times 0,05$$

$$= 0,0037$$

syarat :

$$\rho_{\min} < \rho$$

$$0,0035 < 0,0037 \text{ (OK!)}$$

$$\rho_{\max} > \rho$$

$$0,0204 > 0,0037 \text{ (OK!)}$$

# luas tulangan yang dibutuhkan (tulangan tarik di tumpuan) :

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

$$= 0,0037 \times 220 \text{ mm} \times 280 \text{ mm}$$

$$= 227,92 \text{ mm}^2$$

Tulangan pokok yang dipakai D12 mm

$$\text{jumlah tulangan } (n) = A_s / (0,25 \times 3,14 \times (12 \text{ mm})^2)$$

$$= 227,92 \text{ mm}^2 / 113,04$$

$$= 2,016$$

$$= 3 \text{ buah}$$

Syarat :  $s > 25 \text{ mm}$

$$s = (220 \text{ mm} - ((2 \times 25 \text{ mm}) + (2 \times 8 \text{ mm}) + (3 \times 12 \text{ mm}))) / (3 - 1)$$

$$s = (220 \text{ mm} - (50 \text{ mm} + 16 \text{ mm} + 36 \text{ mm})) / 2$$

$$s = (220 \text{ mm} - 102 \text{ mm}) /$$

$$s = 118 \text{ mm} / 2$$

$$s > 25 \text{ mm}$$

$$s = 59 \text{ mm}$$

$$59 \text{ mm} > 25 \text{ mm} \quad (\text{OK!})$$

sesuai tabel luas penampang, syarat D12 dengan jumlah tulangan (n) 3 buah/batang,

(luas =  $339,43 \text{ mm}^2$  . maka luas tulangan diatas memenuhi syarat

$$227,92 \leq 339,43 \text{ mm}^2 \quad (\text{OK!})$$

# tulangan tekukan di tumpuan

$$A_s' = 0,5 \times A_s$$

$$= 0,5 \times 227,92 \text{ mm}^2$$

$$= 113,96 \text{ mm}^2$$

tulangan pokok yang dipakai D12 mm

$$\text{jumlah tulangan (n)} = A_s' / (0,25 \times 3,14 \times (12 \text{ mm})^2)$$

$$= 113,96 \text{ mm}^2 / (113,04 \text{ mm}^2)$$

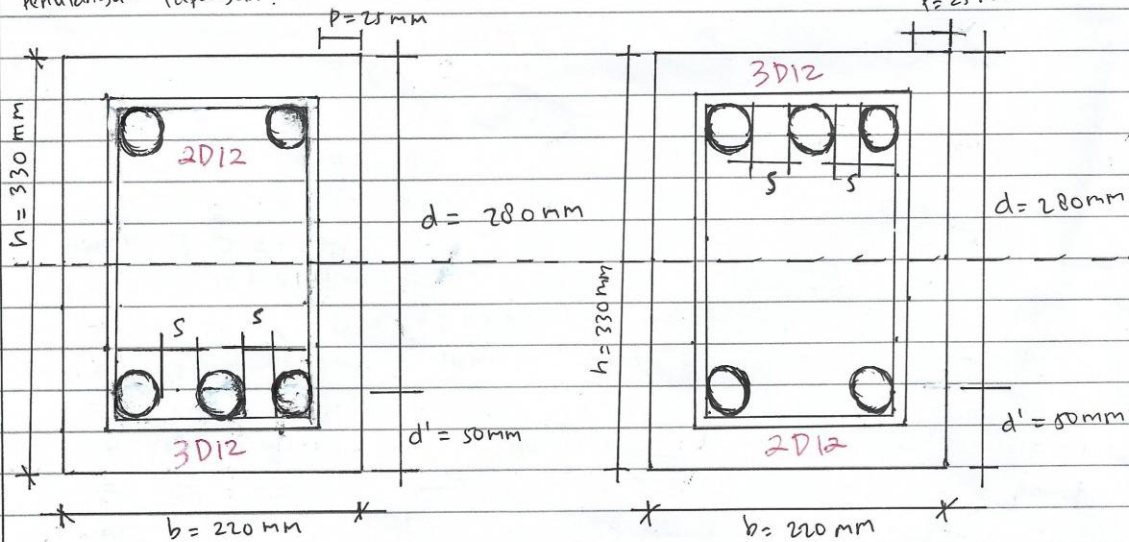
$$= 1,01 \text{ buah}$$

$$\text{minimal jumlah tulangan} = 2 \text{ buah}$$

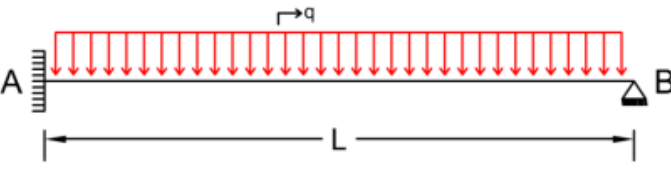
# GAMBAR SKET PENULANGAN #

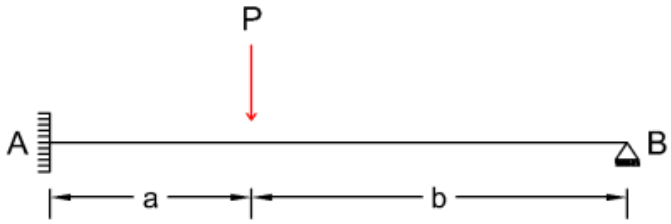
Penulangan lapangan:

Penulangan Tumpuan:





No	Pembebanan	Momen Primer
1		$M_{AB} = \frac{qL^2}{16}$

25		$M_{AB} = \frac{Pb(L^2 - b^2)}{2L^2}$
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## Tabel Konstanta Perencanaan

Tulangan Baja			Mutu Beton											
Mutu Baja BJTP BJTD	fy	$\rho_{min}$	fc' =17		fc' =20		fc' =25		fc' =30		fc' =35		fc' =40	
			$\beta_1 =0,85$		$\beta_1 =0,85$		$\beta_1 =0,85$		$\beta_1 =0,85$		$\beta_1 =0,85$		$\beta_1 =0,77$	
			$\rho_{max}$	$\rho_{sm}$	$\rho_{max}$	$\rho_{sm}$	$\rho_{max}$	$\rho_{sm}$	$\rho_{max}$	$\rho_{sm}$	$\rho_{max}$	$\rho_{sm}$	$\rho_{max}$	$\rho_{sm}$
24	240	0,0058	0,0274	0,0132	0,0323	0,0156	0,0403	0,0198	0,0484	0,0239	0,0564	0,0269	0,0584	0,0313
30	300	0,0047	0,0205	0,0107	0,0241	0,0127	0,0301	0,0159	0,0361	0,0195	0,0421	0,0221	0,0436	0,0251
35	350	0,0040	0,0166	0,0093	0,0196	0,0107	0,0244	0,0132	0,0293	0,0163	0,0342	0,0183	0,0354	0,0214
40	400	0,0035	0,0138	0,0083	0,0163	0,0092	0,0203	0,0117	0,0244	0,0142	0,0284	0,0160	0,0295	0,0185
50	500	0,0028	0,0100	0,0070	0,0118	0,0074	0,0148	0,0098	0,0177	0,0113	0,0207	0,0126	0,0214	0,0143

# Tabel Tulangan Baja

Diameter Tulangan (mm)	Luas Penampang (mm <sup>2</sup> )									
	Jumlah tulangan (n) batang									
	1	2	3	4	5	6	7	8	9	10
6	28,29	56,57	84,86	113,14	141,43	169,71	198,00	226,29	254,57	282,86
8	50,29	100,57	150,86	201,14	251,43	301,71	352,00	402,29	452,57	502,86
10	78,57	157,14	235,71	314,29	392,86	471,43	550,00	628,57	707,14	785,71
12	113,14	226,29	339,43	452,57	565,71	678,86	792,00	905,14	1018,29	1131,43
14	154,00	308,00	462,00	616,00	770,00	924,00	1078,00	1232,00	1386,00	1540,00
16	201,14	402,29	603,43	804,57	1005,71	1206,86	1408,00	1609,14	1810,29	2011,43
19	283,64	567,29	850,93	1134,57	1418,21	1701,86	1985,50	2269,14	2552,79	2836,43
22	380,29	760,57	1140,86	1521,14	1901,43	2281,71	2662,00	3042,29	3422,57	3802,86
25	491,07	982,14	1473,21	1964,29	2455,36	2946,43	3437,50	3928,57	4419,64	4910,71
28	616,00	1232,00	1848,00	2464,00	3080,00	3696,00	4312,00	4928,00	5544,00	6160,00
32	804,57	1609,14	2413,71	3218,29	4022,86	4827,43	5632,00	6436,57	7241,14	8045,71