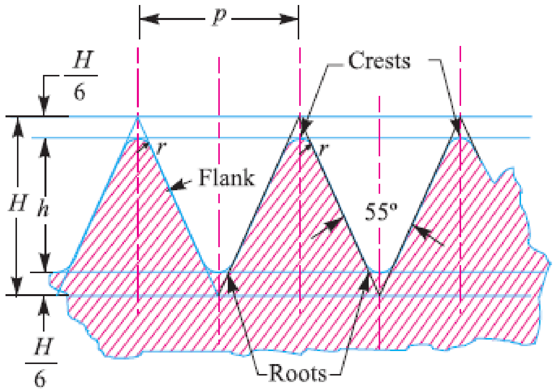
Elemen Mesin 1

Sambungan Baut

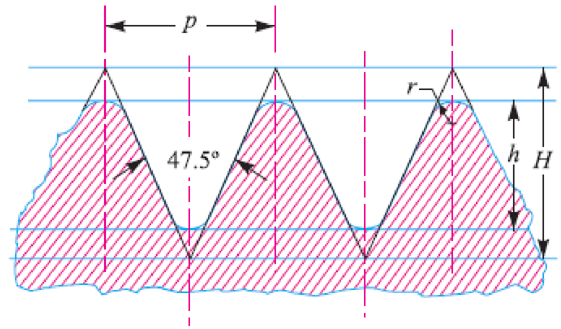
Satworo Adiwidodo, ST., M.T.

Bentuk Ulir



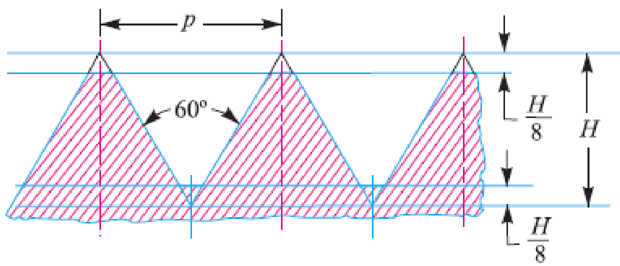
$H = 0.96\,p\;;\;h = 0.64\,p\;;\;r = 0.1373\,p$

Fig. 11.2. British standard whitworth (B.S.W) thread.



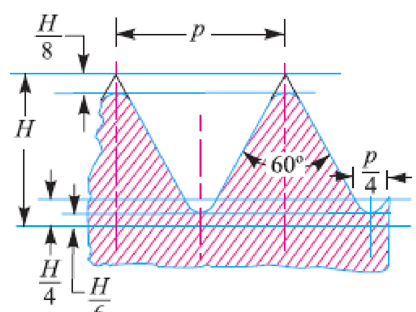
$H = 1.13634\,p\;;\;h = 0.6\,p\;;r = 0.18083\,p$

Fig. 11.3. British association (B.A.) thread.



$H = 0.866\,p$

Fig. 11.4. American national standard thread.



$H = 0.866\,p$

Fig. 11.5. Unified standard thread.

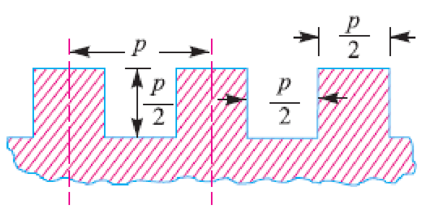


Fig. 11.6. Square thread.

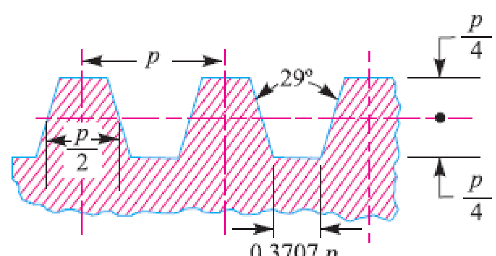


Fig. 11.7. Acme thread.

Profil Ulir

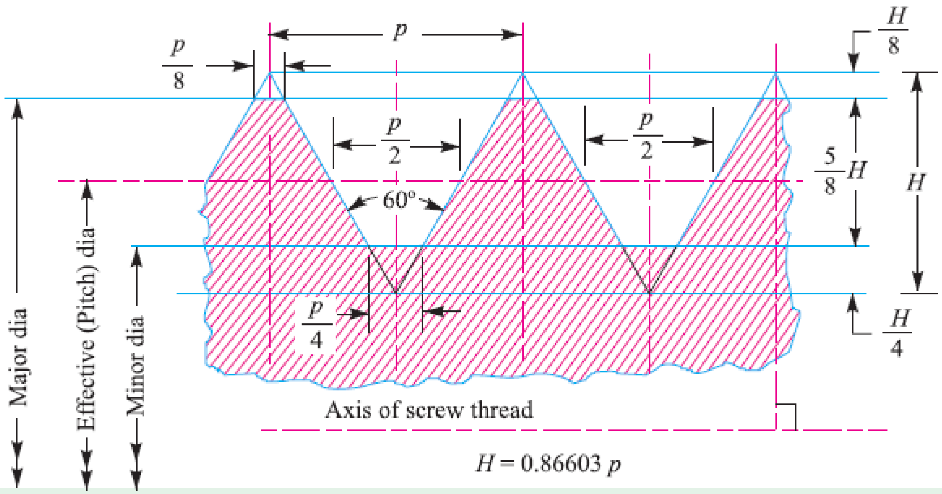
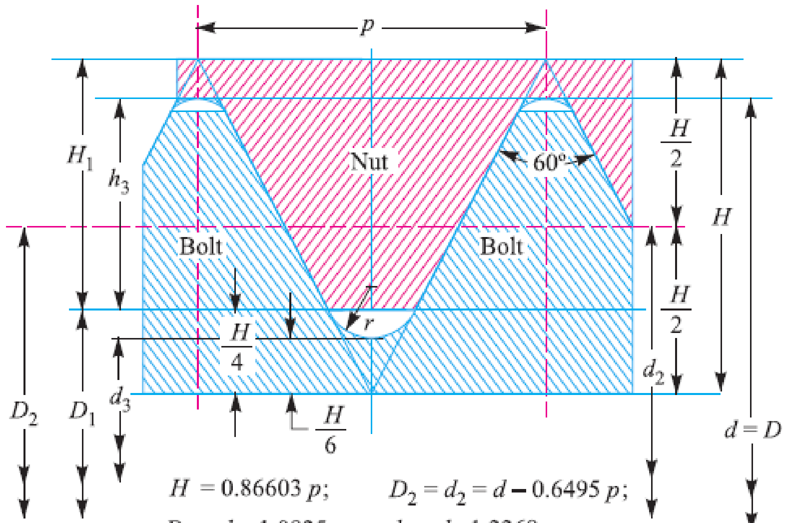


Fig. 11.10. Basic profile of the thread.



$H = 0.86603\,p$; $D_2 = d_2 = d - 0.6495\,p$;

$D_1 = d - 1.0825\,p$; $d_3 = d - 1.2268\,p$;

$H_1 = \frac{5}{8}H$; $h_3 = \frac{17}{24}H$; $r = \frac{H}{6}$

d = Diameter of nut; D = Diameter of bolt.

Fig. 11.11. Design profile of the nut and bolt.

Table 11.1. Design dimensions of screw threads, bolts and nuts according to IS : 4218 (Part III) 1976 (Reaffirmed 1996) (Refer Fig. 11.1)

Designation	*Pitch mm*	*Major or nominal diameter Nut and Bolt (d = D) mm*	*Effective or pitch diameter Nut and Bolt (d_p) mm*	*Minor or core diameter (d_c) mm*		*Depth of thread (bolt) mm*	*Stress area mm²*
				Bolt	*Nut*		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Coarse series							
M 0.4	0.1	0.400	0.335	0.277	0.292	0.061	0.074
M 0.6	0.15	0.600	0.503	0.416	0.438	0.092	0.166
M 0.8	0.2	0.800	0.670	0.555	0.584	0.123	0.295
M 1	0.25	1.000	0.838	0.693	0.729	0.153	0.460
M 1.2	0.25	1.200	1.038	0.893	0.929	0.158	0.732
M 1.4	0.3	1.400	1.205	1.032	1.075	0.184	0.983
M 1.6	0.35	1.600	1.373	1.171	1.221	0.215	1.27
M 1.8	0.35	1.800	1.573	1.371	1.421	0.215	1.70
M 2	0.4	2.000	1.740	1.509	1.567	0.245	2.07
M 2.2	0.45	2.200	1.908	1.648	1.713	0.276	2.48
M 2.5	0.45	2.500	2.208	1.948	2.013	0.276	3.39
M 3	0.5	3.000	2.675	2.387	2.459	0.307	5.03
M 3.5	0.6	3.500	3.110	2.764	2.850	0.368	6.78
M 4	0.7	4.000	3.545	3.141	3.242	0.429	8.78
M 4.5	0.75	4.500	4.013	3.580	3.688	0.460	11.3
M 5	0.8	5.000	4.480	4.019	4.134	0.491	14.2
M 6	1	6.000	5.350	4.773	4.918	0.613	20.1

Table 11.1. Design dimensions of screw threads, bolts and nuts according to IS : 4218 (Part III) 1976 (Reaffirmed 1996) (Refer Fig. 11.1)

Designation	*Pitch mm*	*Major or nominal diameter Nut and Bolt (d = D) mm*	*Effective or pitch diameter Nut and Bolt (d_p) mm*	*Minor or core diameter (d_c) mm*		*Depth of thread (bolt) mm*	*Stress area mm²*
				Bolt	*Nut*		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
M 7	1	7.000	6.350	5.773	5.918	0.613	28.9
M 8	1.25	8.000	7.188	6.466	6.647	0.767	36.6
M 10	1.5	10.000	9.026	8.160	8.876	0.920	58.3
M 12	1.75	12.000	10.863	9.858	10.106	1.074	84.0
M 14	2	14.000	12.701	11.546	11.835	1.227	115
M 16	2	16.000	14.701	13.546	13.835	1.227	157
M 18	2.5	18.000	16.376	14.933	15.294	1.534	192
M 20	2.5	20.000	18.376	16.933	17.294	1.534	245
M 22	2.5	22.000	20.376	18.933	19.294	1.534	303
M 24	3	24.000	22.051	20.320	20.752	1.840	353
M 27	3	27.000	25.051	23.320	23.752	1.840	459
M 30	3.5	30.000	27.727	25.706	26.211	2.147	561
M 33	3.5	33.000	30.727	28.706	29.211	2.147	694
M 36	4	36.000	33.402	31.093	31.670	2.454	817
M 39	4	39.000	36.402	34.093	34.670	2.454	976
M 42	4.5	42.000	39.077	36.416	37.129	2.760	1104
M 45	4.5	45.000	42.077	39.416	40.129	2.760	1300
M 48	5	48.000	44.752	41.795	42.587	3.067	1465
M 52	5	52.000	48.752	45.795	46.587	3.067	1755
M 56	5.5	56.000	52.428	49.177	50.046	3.067	2022
M 60	5.5	60.000	56.428	53.177	54.046	3.374	2360

Table 11.1. Design dimensions of screw threads, bolts and nuts according to IS : 4218 (Part III) 1976 (Reaffirmed 1996) (Refer Fig. 11.1)

Designation	*Pitch mm*	*Major or nominal diameter Nut and Bolt (d = D) mm*	*Effective or pitch diameter Nut and Bolt* (d_p) *mm*	*Minor or core diameter* (d_c) *mm*		*Depth of thread (bolt) mm*	*Stress area* mm^2
				Bolt	*Nut*		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Fine series							
M 8 × 1	1	8.000	7.350	6.773	6.918	0.613	39.2
M 10 × 1.25	1.25	10.000	9.188	8.466	8.647	0.767	61.6
M 12 × 1.25	1.25	12.000	11.184	10.466	10.647	0.767	92.1
M 14 × 1.5	1.5	14.000	13.026	12.160	12.376	0.920	125
M 16 × 1.5	1.5	16.000	15.026	14.160	14.376	0.920	167
M 18 × 1.5	1.5	18.000	17.026	16.160	16.376	0.920	216
M 20 × 1.5	1.5	20.000	19.026	18.160	18.376	0.920	272
M 22 × 1.5	1.5	22.000	21.026	20.160	20.376	0.920	333
M 24 × 2	2	24.000	22.701	21.546	21.835	1.227	384
M 27 × 2	2	27.000	25.701	24.546	24.835	1.227	496
M 30 × 2	2	30.000	28.701	27.546	27.835	1.227	621
M 33 × 2	2	33.000	31.701	30.546	30.835	1.227	761
M 36 × 3	3	36.000	34.051	32.319	32.752	1.840	865
M 39 × 3	3	39.000	37.051	35.319	35.752	1.840	1028

Note : In case the table is not available, then the core diameter (d_c) may be taken as 0.84 *d*, where *d* is the major diameter.

Initial Stresses due to Screwing up Forces

1. ***Tensile stress due to stretching of bolt.***

$P_i = 2840\, d$ N

P_i = Initial tension in a bolt, and

d = Nominal diameter of bolt, in mm.

melibatkan fluida, misal uap bertekanan

$P_i = 1420\, d$ N

The small diameter bolts may fail during tightening, therefore bolts of smaller diameter (less than M 16 or M 18) are not permitted in making fluid tight joints.

P = Permissible stress × Cross-sectional area at bottom of the thread (*i.e.* stress area)

The stress area may be obtained from Table 11.1 or it may be found by using the relation

$$\text{Stress area} = \frac{\pi}{4}\left(\frac{d_p + d_c}{2}\right)^2$$

where d_p = Pitch diameter, and

d_c = Core or minor diameter.

Initial Stresses due to Screwing up Forces

2. Torsional shear stress caused by the frictional resistance of the threads during its tightening.

$$\frac{T}{J} = \frac{\tau}{r}$$

$$\tau = \frac{T}{J} \times r = \frac{T}{\frac{\pi}{32}(d_c)^4} \times \frac{d_c}{2} = \frac{16\,T}{\pi\,(d_c)^3}$$

τ = Torsional shear stress,

T = Torque applied, and

d_c = Minor or core diameter of the thread.

Initial Stresses due to Screwing up Forces

3. Shear stress across the threads.

$$\tau_s = \frac{P}{\pi d_c \times b \times n}$$

screw

b = Width of the thread section at the root.

$$\tau_n = \frac{P}{\pi d \times b \times n}$$

nut

d = Major diameter.

Initial Stresses due to Screwing up Forces

4. Compression or crushing stress on threads.

$$\sigma_c = \frac{P}{\pi\,[d^2 - (d_c)^2]\,n}$$

d = Major diameter,

d_c = Minor diameter, and

n = Number of threads in engagement.

Contoh

- *Tentukan beban tarik yang aman untuk baut M 30, dengan asumsi tegangan tarik yang aman 42 MPa.*
- Diketahui : d = 30 mm ; σt = 42 MPa = 42 N/mm^2
- Beban tarik yang aman = Stress area × σt

  = 561 mm^2 × 42 N/mm^2

  = 23 562 N

  = 23.562 kN

Contoh

- *Tentukan beban tarik yang aman untuk baut M 30, dengan asumsi tegangan tarik yang aman 42 MPa.*
- Diketahui : d = 30 mm ; σt = 42 MPa = 42 N/mm^2
- Beban tarik yang aman = Stress area × σt

  = 561 mm^2 × 42 N/mm^2

  = 23 562 N

  = 23.562 kN

Contoh

- *Dua bagian mesin disambung dengan baut 24 mm. Berapa tegangan pengetatan awal*
- Diketahui : d = 24 mm, M 24 is $d_c = 20.32$ mm.

$$P = 2840\,d = 2840 \times 24 = 68\ 160\ \text{N}$$

$$68\ 160 = \frac{\pi}{4}(d_c)^2\,\sigma_t = \frac{\pi}{4}(20.30)^2\,\sigma_t = 324\,\sigma_t$$

$$\sigma_t = 68\ 160 / 324 = 210\ \text{N/mm}^2 = 210\ \text{MPa}$$

Stresses due to External Forces

1. *Tensile stress.*

d_c = Root or core diameter of the thread, and
σ_t = Permissible tensile stress for the bolt material.

$$P = \frac{\pi}{4}(d_c)^2 \; \sigma_t \qquad\qquad d_c = \sqrt{\frac{4\,P}{\pi\,\sigma_t}}$$

Now from Table 11.1, the value of the nominal diameter of bolt corresponding to the value of d_c may be obtained or stress area $\left[\frac{\pi}{4}(d_c)^2\right]$ may be fixed.

Notes: (*a*) If the external load is taken up by a number of bolts, then

$$P = \frac{\pi}{4}(d_c)^2 \; \sigma_t \times n$$

(*b*) In case the standard table is not available, then for coarse threads, $d_c = 0.84\,d$, where d is the nominal diameter of bolt.

Stresses due to External Forces

2. *Shear stress.*

d = Major diameter of the bolt, and

n = Number of bolts.

$$P_s = \frac{\pi}{4} \times d^2 \times \tau \times n \quad \text{or} \quad d = \sqrt{\frac{4\,P_s}{\pi\,\tau\,n}}$$

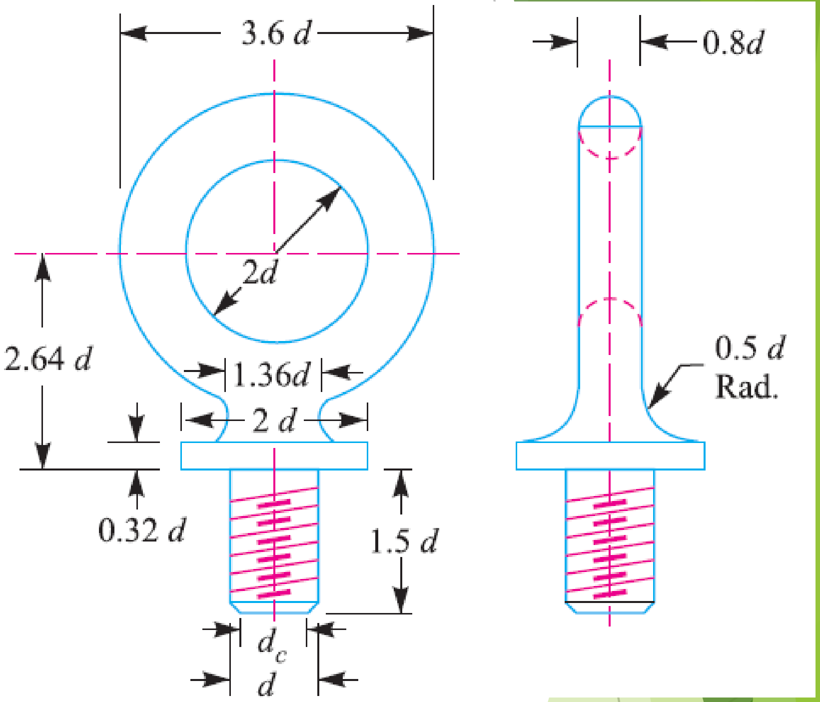
3. *Combined tension and shear stress.*

Maximum principal shear stress $$\tau_{max} = \frac{1}{2}\sqrt{(\sigma_t)^2 + 4\tau^2}$$

Maximum principal tensile stress $$\sigma_{t(max)} = \frac{\sigma_t}{2} + \frac{1}{2}\sqrt{(\sigma_t)^2 + 4\tau^2}$$

Contoh

- *Baut mata harus digunakan untuk mengangkat beban 60 kN. Temukan diameter nominalnya dari baut, jika tegangan tarik tidak melebihi 100 MPa Asumsikan ulir kasar.*
- Diketahui : P = 60 kN = 60 × 10^3 N ;σt = 100 MPa = 100 N/mm^2



Eccentric Load Acting Parallel to the Axis of Bolts

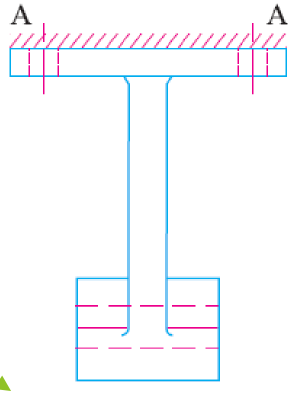
Beban kombinasi tarik dan tarik karena momen

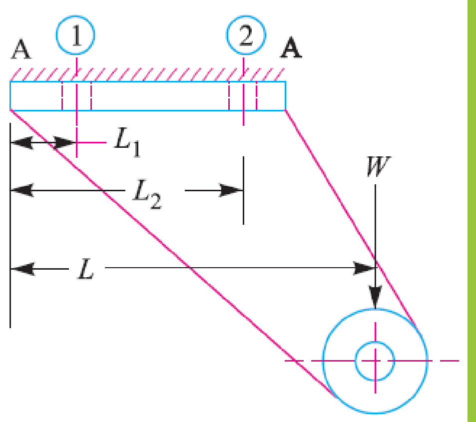
Tarik karena beban ke bawah

$$W_{t1} = \frac{W}{n}$$

Beban tarik pada jarak L_1 dan L_2

$$W_1 = w.L_1$$
$$W_2 = w.L_2$$





Momen

$$= W_1 \times L_1 = w(L_1)^2$$
$$= W_2 \times L_2 = w(L_2)^2$$

Persamaan momen

$$= 2w(L_1)^2 + 2w(L_2)^2$$

$$W.L = 2w(L_1)^2 + 2w(L_2)^2 \qquad w = \frac{W.L}{2[(L_1)^2 + (L_2)^2]}$$

$$W_{t2} = W_2 = w.L_2 = \frac{W.L.L_2}{2[(L_1)^2 + (L_2)^2]}$$

Total beban yang ditahan oleh baut

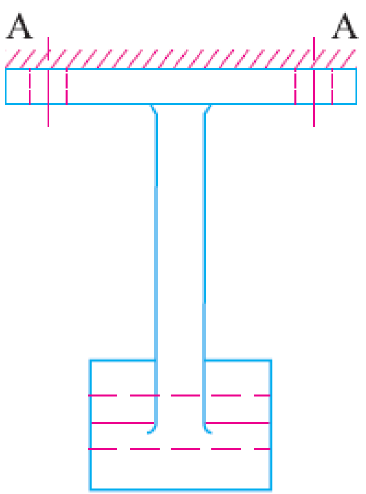
$$W_t = W_{t1} + W_{t2} \qquad W_t = \frac{\pi}{4} \cdot (d_c)^2 \sigma_t$$

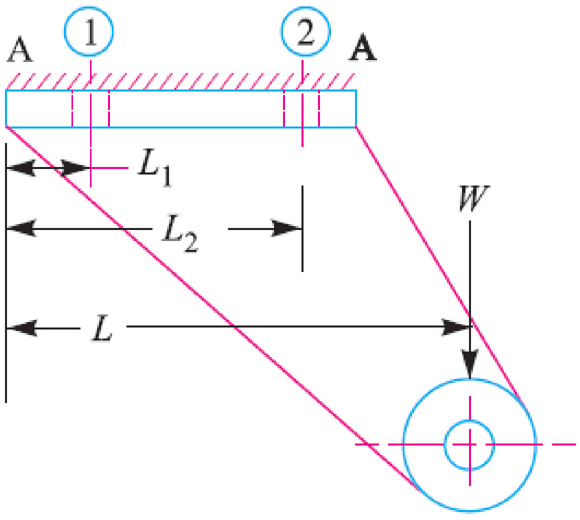
Eccentric Load Acting Parallel to the Axis of Bolts

Beban kombinasi tarik dan tarik karena momen

Contoh

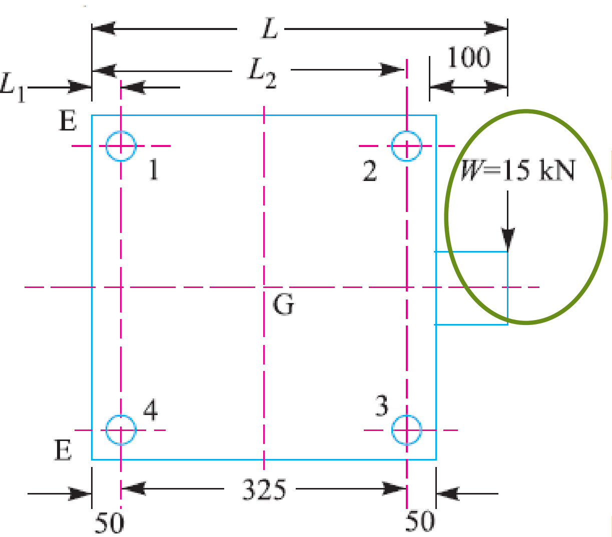
- *Braket, seperti ditunjukkan pada Gambar mendukung beban 30 kN. Tentukan ukuran baut, jika tegangan tarik maksimum yang diijinkan pada bahan baut adalah 60 MPa. Jaraknya adalah: L1 = 80 mm, L2 = 250 mm, dan L = 500 mm.*





Eccentric Load Acting Parallel to the Axis of Bolts

Beban kombinasi tarik dan tarik karena momen



Diketahui

$d = 25$ mm

Berapa tegangan maksimum yang mampu diterima baut

Beban geser ke bawah untuk setiap baut

$$W_{t1} = \frac{W}{n} = \frac{15 \times 10^3}{4} = 3750 \text{ N}$$

Persamaan momen

$$w = \frac{W \cdot L}{2\,[(L_1)^2 + (L_2)^2\,]} = \frac{15 \times 10^3\ (100 + 50 + 325 + 50)}{2\,[(50)^2 + (375)^2]} = 27.5 \text{ N/mm}$$

$$W_{t2} = w \times L_2 = 27.5 \times 375 = 10312 \text{ N}$$

Beban total yang diterima baut

$$W_t = W_{t1} + W_{t2} = 3750 + 10312 = 14062 \text{ N}$$

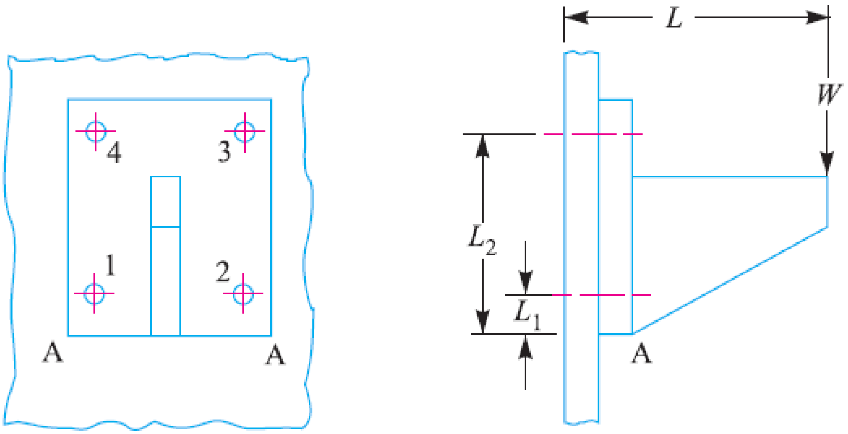
Jika diketahui diameter minor baut, $d_c = 0{,}84\ d$; $d = 25$ mm

$$14062 = \frac{\pi}{4}\,(d_c)^2 \sigma_{tb} = \frac{\pi}{4}\,(0.84 \times 25)^2 \sigma_{tb} = 346.4\,\sigma_{tb}$$

$$\sigma_{tb} = 14062/346.4 = 40.6 \text{ N/mm}^2 = 40.6 \text{ MPa}$$

Eccentric Load Acting Perpendicular to the Axis of Bolts

Beban kombinasi geser dan tarik karena momen



Beban geser ke bawah untuk setiap baut

$$W_s = W/n$$

Persamaan momen

$$W_{t2} = W_t = \frac{W.L.L_2}{2[(L_1)^2 + (L_2)^2]}$$

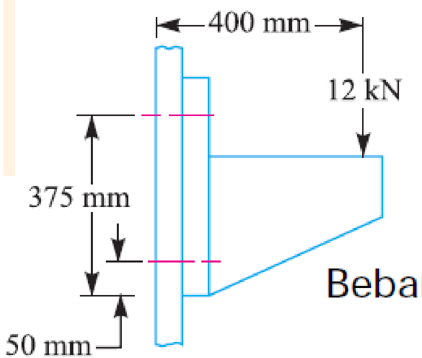
$$W_{sc} = \frac{1}{2}\left[W_t + \sqrt{(W_t)^2 + 4(W_s)^2}\right] \longrightarrow W_{te} = \frac{1}{2}\left[W_t + \sqrt{(W_t)^2 + 4(W_s)^2}\right]$$

$$W_{sc} = \frac{1}{2}\left[\sqrt{(W_t)^2 + 4(W_s)^2}\right] \longrightarrow W_{se} = \frac{1}{2}\left[\sqrt{(W_t)^2 + 4(W_s)^2}\right]$$

Eccentric Load Acting Perpendicular to the Axis of Bolts

Beban kombinasi geser dan tarik karena momen

Contoh



Diketahui : W = 12 kN = 12 × 10^3 N ; L = 400 mm ;
L_1 = 50 mm ; L_2 = 375 mm ; σ_t = 84 MPa = 84 N/mm^2 ; n = 4

Ditanya : diameter baut

Beban geser ke bawah untuk setiap baut

$$W_s = \frac{W}{n} = \frac{12}{4} = 3 \text{ kN}$$

Persamaan momen

$$W_t = \frac{W.L.L_2}{2[(L_1)^2 + (L_2)^2]} = \frac{12 \times 400 \times 375}{2[(50)^2 + (375)^2]} = 6.29 \text{ kN}$$

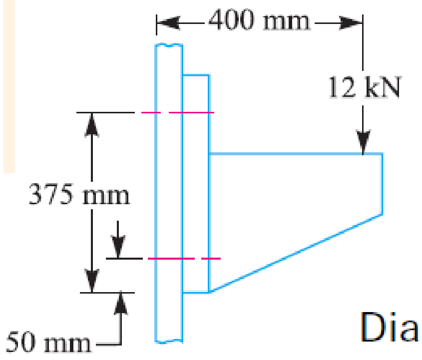
$$W_{sc} = \frac{1}{2}\left[W_t + \sqrt{(W_t)^2 + 4(W_s)^2}\right] = \frac{1}{2}\left[6.29 + \sqrt{(6.29)^2 + 4 \times 3^2}\right] \text{kN}$$

$$= \frac{1}{2}(6.29 + 8.69) = 7.49 \text{ kN} = 7490 \text{ N}$$

Eccentric Load Acting Perpendicular to the Axis of Bolts

Beben kombinasi geser dan tarik karena momen

Contoh



Diketahui : $W = 12$ kN $= 12 \times 10^3$ N ; $L = 400$ mm ;
$L_1 = 50$ mm ; $L_2 = 375$ mm ; $\sigma_t = 84$ MPa $= 84$ N/mm^2 ; $n = 4$

Ditanya : Ukuran baut

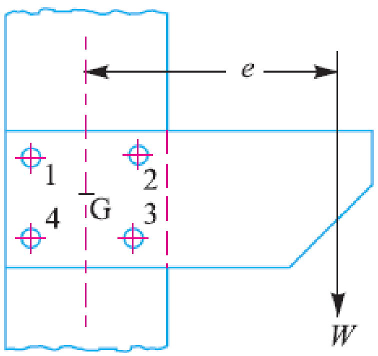
Diameter minor baut yang diperlukan

$$7490 = \frac{\pi}{4} (d_c)^2 \sigma_t = \frac{\pi}{4} (d_c)^2 84 = 66 (d_c)^2$$

$$(d_c)^2 = 7490 / 66 = 113.5 \quad \text{or} \quad d_c = 10.65 \text{ mm}$$

Dari tabel 11.1 (coarse series), dc = 11.546 mm dan ukuran baut adalah M 14.

Eccentric Load Acting in the Plane Containing the Bolts

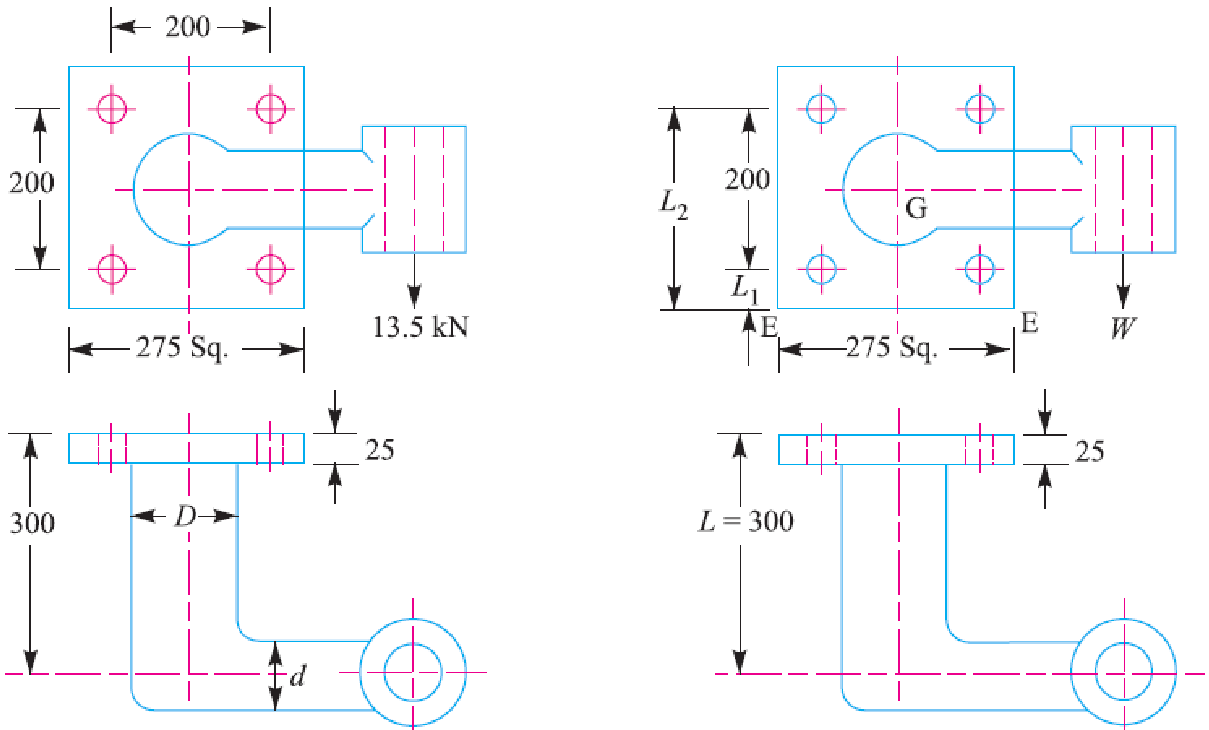


Beban kombinasi geser dan tarik karena momen dan geser karena torsi

Beban Geser, dilakukan prosedur yang sama seperti pengerjaan pada rivet/paku keling

Eccentric Load Acting in the Plane Containing the Bolts

Beban kombinasi geser dan tarik karena momen dan geser karena torsi



Diketahui : W = 13.5 kN = 13 500 N ; σ_t = 110 MPa = 110 N/mm^2 ; τ = 65 MPa = 65 N/mm^2

Eccentric Load Acting in the Plane Containing the Bolts

Beban kombinasi geser dan tarik karena momen dan geser karena torsi

Diketahui : W = 13.5 kN = 13 500 N ; σ_t = 110 MPa = 110 N/mm^2 ; τ = 65 MPa = 65 N/mm^2

Ditanya : Beban tarik masing baut bagian atas dan gaya geser maksimum tiap baut

Beban tarik

Tarik karena momen untuk kedua baut yang atas

$= 2(w.L_1)\ L_1 + 2(w.L_2)\ L_2 = 2w\ [(L_1)^2 + (L2)^2]$

$= 2w\ [(37.5)^2 + (237.7)^2] = 115625\ w$N-mm

L1 = 37.5 mm and L2 = 237.5 mm

$= W.L = 13500 \times 300 = 4050 \times 10^3$ N-mm

$w = 4050 \times 10^3 / 115625 = 35.03$ N/mm

$= w.L_2 = 35.03 \times 237.5 = 8320$ N

Gaya geser maksimum

Geser ke bawah

$$W_{s1} = \frac{W}{n} = \frac{13500}{4} = 3375 \text{ N}$$

Geser karena torsi

Eccentric Load Acting in the Plane Containing the Bolts

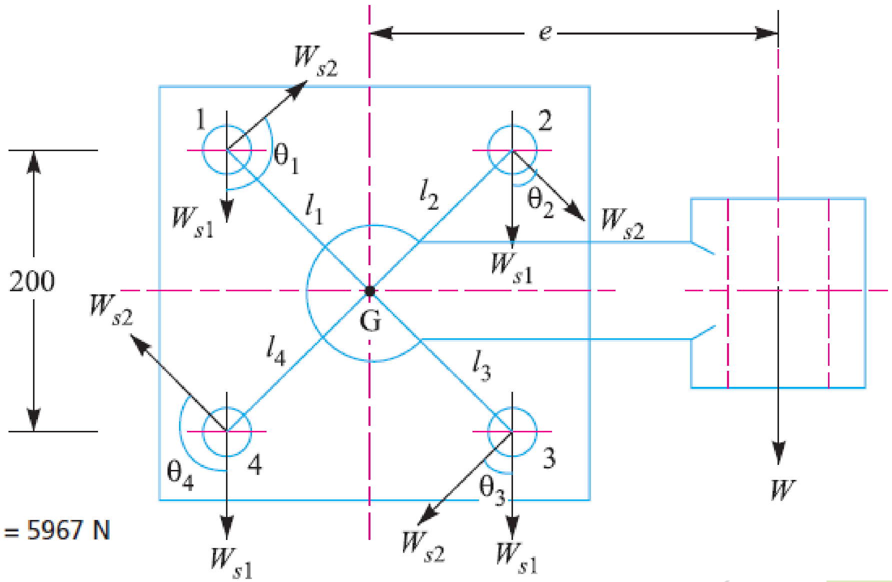
Beban kombinasi geser dan tarik karena momen dan geser karena torsi

Diketahui : W = 13.5 kN = 13 500 N ; σ_t = 110 MPa = 110 N/mm^2 ; τ = 65 MPa = 65 N/mm^2

Ditanya : Beban tarik masing baut bagian atas dan gaya geser maksimum tiap baut

Gaya geser maksimum

$$l_1 = l_2 = l_3 = l_4 = \sqrt{(100)^2 + (100)^2} = 141.4 \text{ mm}$$



Geser ke bawah

$$W_{s1} = \frac{W}{n} = \frac{13500}{4} = 3375 \text{ N}$$

Geser karena torsi

$$W_{s2} = \frac{W.e.l_1}{(l_1)^2 + (l_2)^2 + (l_3)^3 + (l_4)^2} = \frac{13500 \times 250 \times 141.4}{4\,(141.4)^2} = 5967 \text{ N}$$

$\theta_1 = \theta_4 = 135°$, and $\theta_2 = \theta_3 = 45°$

Eccentric Load Acting in the Plane Containing the Bolts

Beban kombinasi geser dan tarik karena momen dan geser karena torsi

Diketahui : W = 13.5 kN = 13 500 N ; σ_t = 110 MPa = 110 N/mm^2 ; τ = 65 MPa = 65 N/mm^2

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Gaya geser maksimum

Geser ke bawah

$$W_{s1} = \frac{W}{n} = \frac{13500}{4} = 3375 \text{ N}$$

Geser karena torsi

$$W_{s2} = \frac{W.e.l_1}{(l_1)^2 + (l_2)^2 + (l_3)^3 + (l_4)^2} = \frac{13500 \times 250 \times 141.4}{4\,(141.4)^2} = 5967 \text{ N}$$

$\theta_1 = \theta_4 = 135^\circ$, and $\theta_2 = \theta_3 = 45^\circ$

Beban maksimum geser pada baut no 1 dan 4

$$= \sqrt{(W_{s1})^2 + (W_{s2})^2 + W_{s1} \times W_{s2} \times \cos 45^\circ}$$

$$= \sqrt{(3375)^2 + (5967)^2 + 2 \times 3375 \times 5967 \times 0.7071} = 8687 \text{ N}$$

Beban maksimum geser pada baut no 2 dan 3

$$= \sqrt{(W_{s1})^2 + (W_{s2})^2 + 2\, W_{s1} \times W_{s2} \times \cos 135^\circ}$$

$$= \sqrt{(3375)^2 + (5967)^2 - 2 \times 3375 \times 5967 \times 0.7071} = 4303 \text{ N}$$

Eccentric Load Acting in the Plane Containing the Bolts

Beban kombinasi geser dan tarik karena momen dan geser karena torsi

Diketahui : W = 13.5 kN = 13 500 N ; σ_t = 110 MPa = 110 N/mm^2 ; τ = 65 MPa = 65 N/mm^2

Ditanya : Beban tarik masing baut bagian atas dan gaya geser maksimum tiap baut

Beban tarik

Tarik karena momen untuk kedua baut yang atas

$= 2(w.L_1)\ L_1 + 2(w.L_2)\ L_2 = 2w\ [(L_1)^2 + (L2)^2]$

$= 2w\ [(37.5)^2 + (237.7)^2] = 115625\ w$N-mm

L1 = 37.5 mm and L2 = 237.5 mm

$= W.L = 13500 \times 300 = 4050 \times 10^3$ N-mm

$w = 4050 \times 10^3 / 115625 = 35.03$ N/mm

$= w.L_2 = 35.03 \times 237.5 = 8320$ N

Gaya geser maksimum

Beban maksimum geser pada baut no 1 dan 4

$$= \sqrt{(W_{s1})^2 + (W_{s2})^2 + W_{s1} \times W_{s2} \times \cos 45^\circ}$$

$$= \sqrt{(3375)^2 + (5967)^2 + 2 \times 3375 \times 5967 \times 0.7071} = 8687 \text{ N}$$

Beban maksimum geser pada baut no 2 dan 3

$$= \sqrt{(W_{s1})^2 + (W_{s2})^2 + 2\ W_{s1} \times W_{s2} \times \cos 135^\circ}$$

$$= \sqrt{(3375)^2 + (5967)^2 - 2 \times 3375 \times 5967 \times 0.7071} = 4303 \text{ N}$$

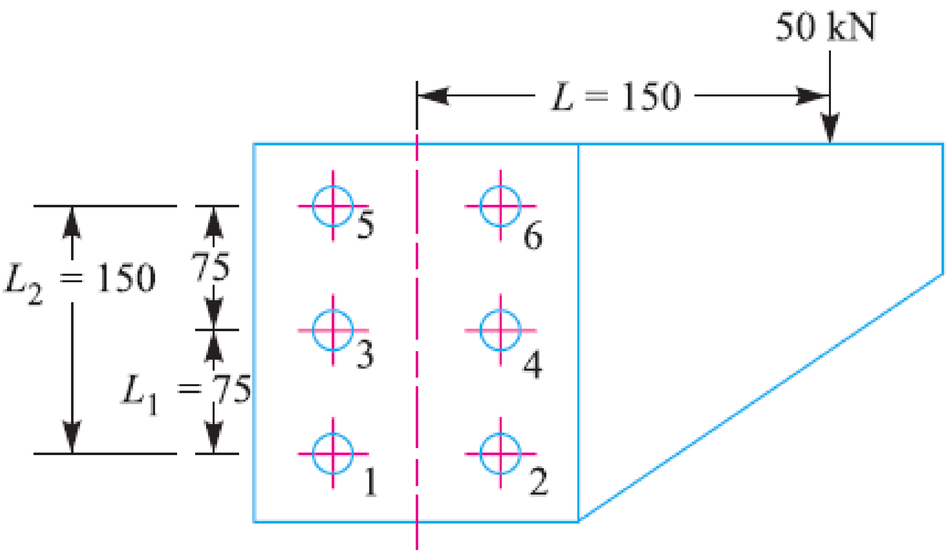
Kombinasi beban menjadi tegangan tarik σ_t

$$= \frac{1}{2}\sigma_1 + \frac{1}{2}\sqrt{(\sigma_1)^2 + 4\tau^2}$$

Kombinasi beban menjadi tegangan geser

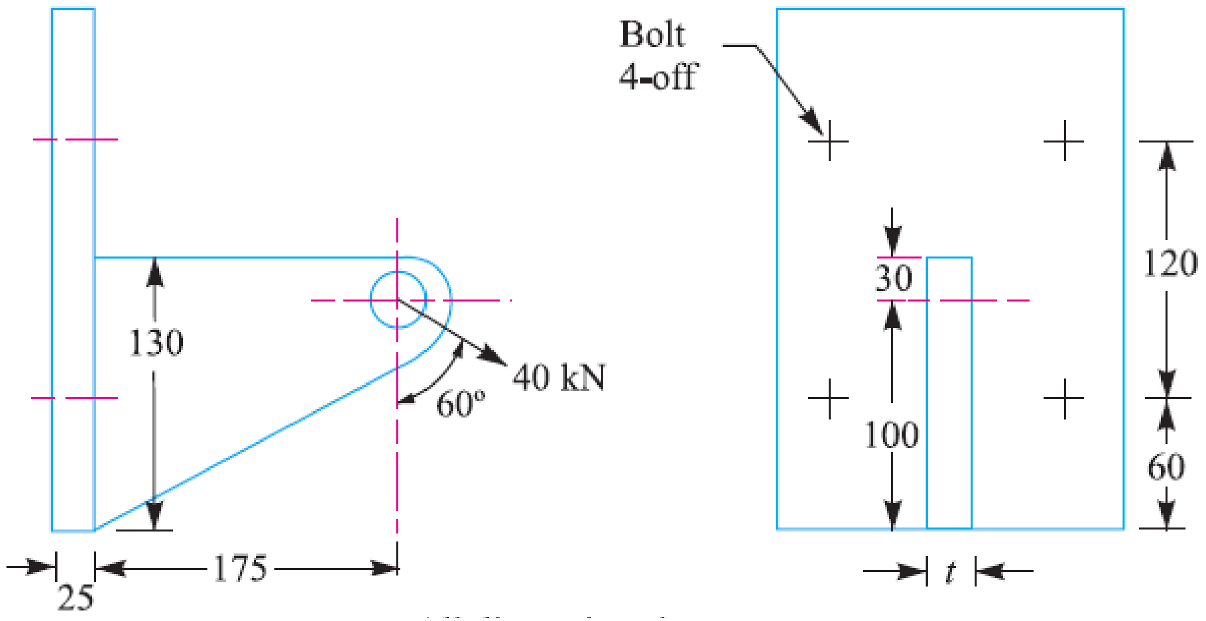
$$\tau_{max} = +\frac{1}{2}\sqrt{(\sigma_1)^2 + 4\tau^2}$$

Latihan



Braket dengan 6 baut dengan ukuran sama. Beban 50kN pada jarak 150 mm dari tengah kolom. Jika tegangan maksimum baut 150 MPa, tentukan diameter bautnya.

Latihan



Diketahui : W = 40 kN = 40 × 10^3N ; σ_t = 70 MPa = 70N/mm^2 ; τ = 50 Mpa = 50 N/mm^2; σ_c = 105 MPa = 105 N/mm^2

Ditanya : digunakan baut ukuran berapa? (M berapa)