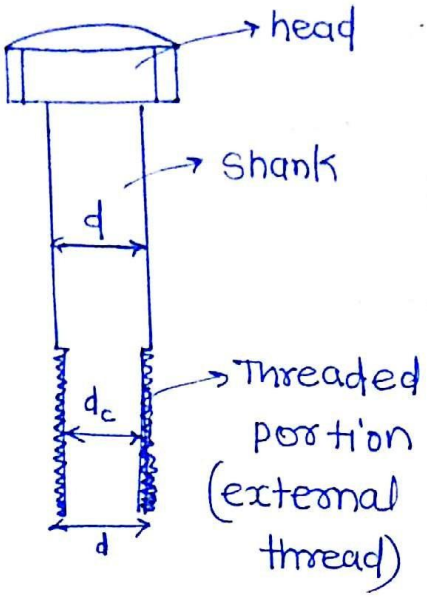
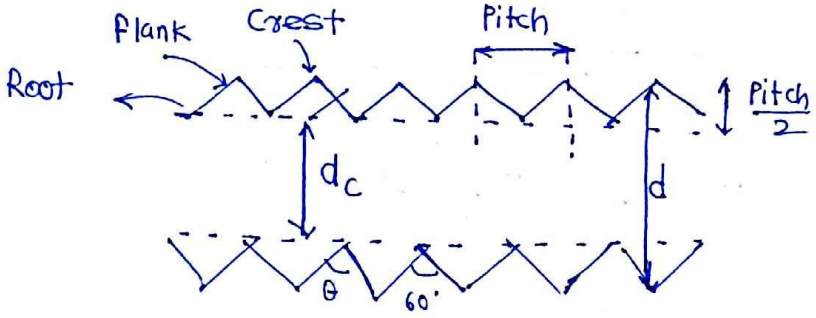
Bolted Joint



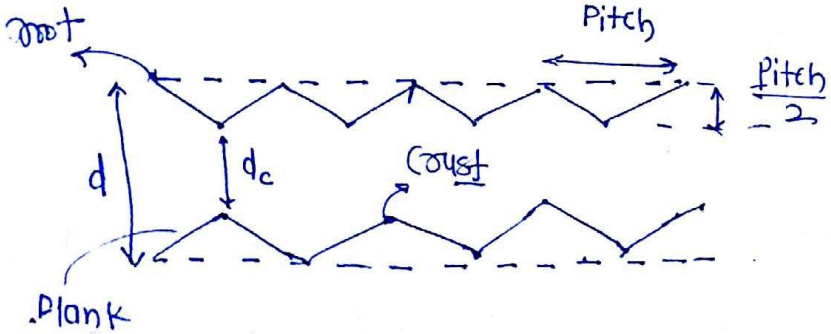
d = Major dia/Nominal dia/ dia of bolt/shank dia

d_c = Core dia/ Minor dia

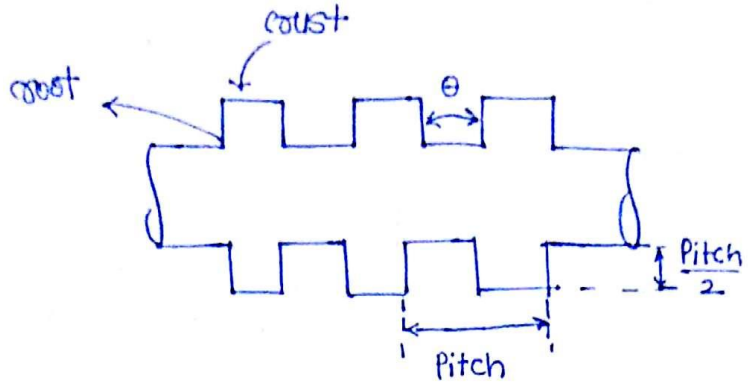
Threads → External thread
Threads → Internal thread



θ = thread angle
θ = 60° Vee-shape used for fastening purpose.



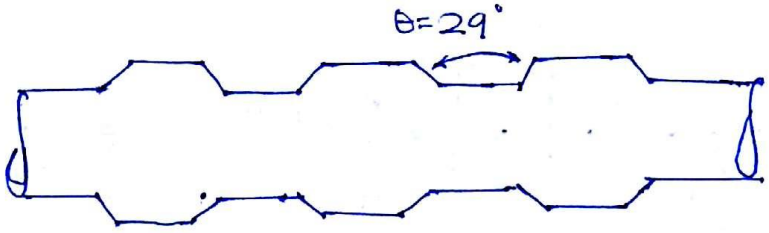
Square Thread :-



$\theta = 0^\circ$

- Maximum efficiency among all thread (η_{max})
- Manu. is very difficult
- Cost high
- Strength less
- Used in screw Jack. (self locking)

ACME thread :-



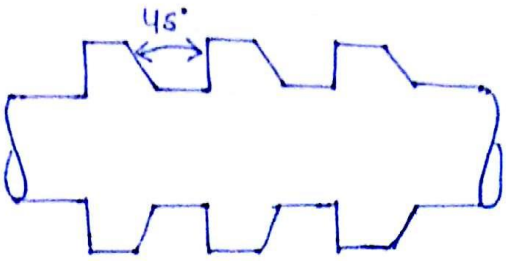
- Best to transmit power in both dirn
- Manufacturing Simple
- Most commonly used
- Strength more
- $\eta_{ACME} < \eta_{square}$
- Used in lead screw of lathe

$\theta = 30^\circ$

trapezoidal thread

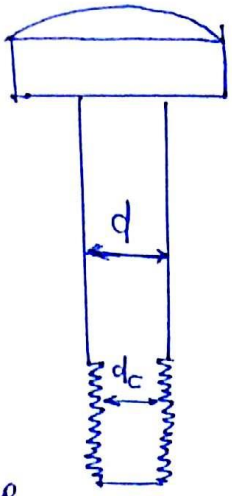
A type of ACME thread

Butteres thread :-



* Used to transmit power in one direction only
- power jack press, screw jack. (self

Bolt :- Aim → tension (mainly used to wear tension) load



Jug Bolt of Non-Uniform Strength

Bolt dia = ? Nagar dia ⇒ d = ?

$$\sigma_{shank} = \frac{P}{\frac{\pi}{4} d^2}$$

$$\sigma_{max} = \sigma_{core} = \frac{P}{\frac{\pi}{4} d_c^2}$$

Safe condⁿ

$$\sigma_{max} \leq \sigma_{per.}$$

$$\frac{P}{\frac{\pi}{4} d_c^2} \leq \sigma_{per.}$$

d_c = known

$$d = \frac{d_c}{0.84}$$

d = ?

$$\boxed{d_c = 0.84\, d}$$

Conclusion:-

- For the safe design of bolt core dia d_c is taken in consideration because core is weakes portion of bolt

Imp ⇒ for Gate bolt ≃ Rivet

$d \simeq d_c$

don't use $d_c = 0.84d$ X

- $M_{20\times2}$ → Pitch (Fine pitch) 2mm — Fine pitch
  - 20mm = Nominal dia

- M_{20} → Pitch (coarse pitch) = 10mm
  - 20mm = major dia.

Pitch → / bolt dia	2 mm	4mm	6mm	8mm	10mm
20mm	✓	✓	✓	✓	✓ Coarse pitch
24 mm	✓	X	✓	✓ coarse	X

fine

fine

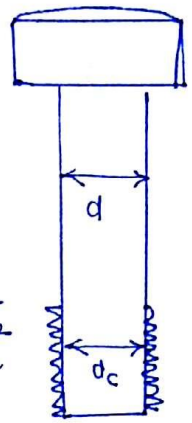
- largest pitch available for a particular bolt is called coarse pitch.

Bolt of uniform strength:-

A bolt is said to be a uniform strength bolt when stress induced in a bolt is equal at each point.

Method-1

Uniform strength →



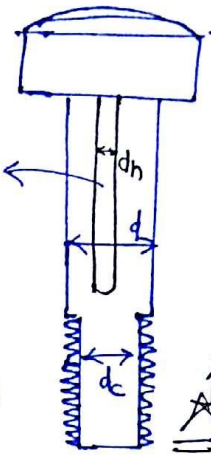
$d = d_c$

$\sigma_{shank} = \sigma_{core} = \frac{P}{\frac{\pi}{4} d_c^2}$

$\sigma_{shank} = \sigma_{core}$

hole dia $d_h = 0.542\, d$

Method 2



→ Uniform strength

hole ←

$\frac{\pi}{4}(d^2 - d_h^2) = \frac{\pi}{4} d_c^2$

$d_c = 0.84\, d$

$d_h = 0.542\, d$

$\sigma_{core} = \sigma_{shank}$

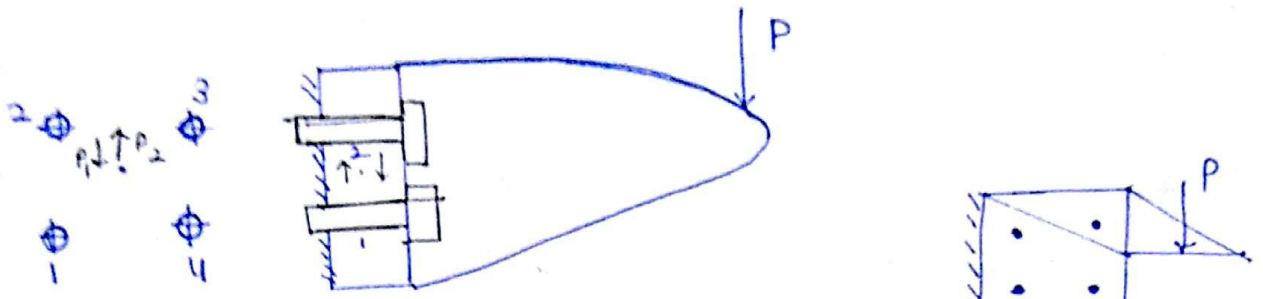
- Bolt of uniform strength

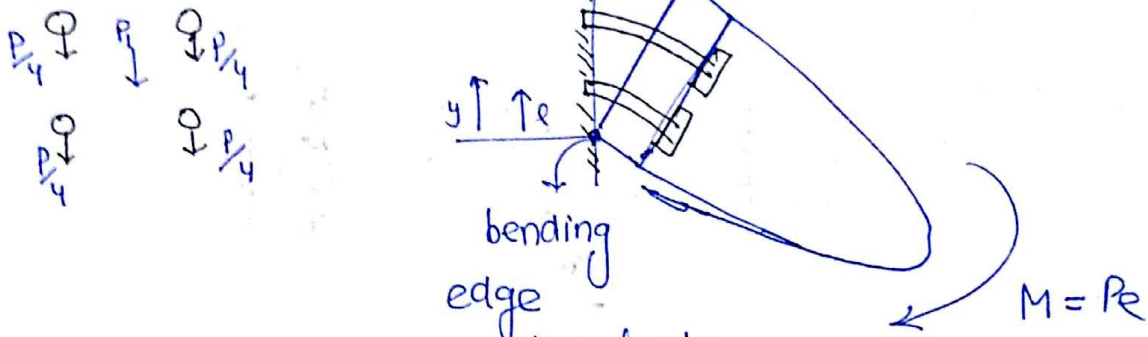
$$SE\uparrow = \frac{\sigma^2}{\partial E}\uparrow (Vol.)$$

↳ More strain energy

∴ Hence:- Uniform strength bolt can bear more impact and fatigue as compare to normal bolt.

Design of bolted joint Under eccentric loading :-





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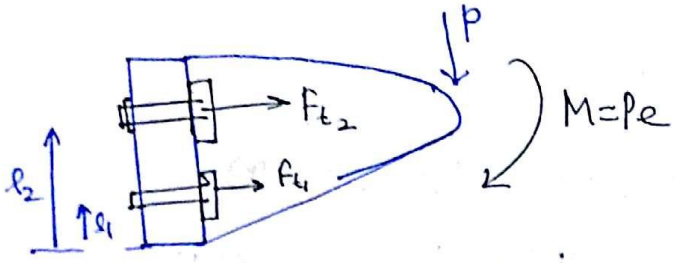


$l_1 = l_4 < l_2 = l_3$

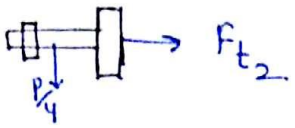
$F_{t_1} = F_{t_4} < F_{t_2} = F_{t_3}$

$F_t \propto l$

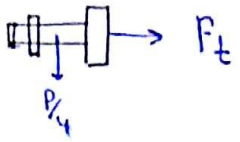
$F_{t_1} l_1 + F_{t_2} l_2 + F_{t_3} l_3 + F_4 l_3 = Pe$

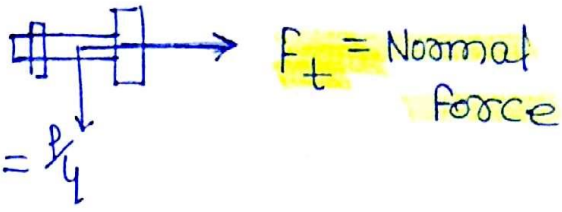
$\frac{F_{t_1}}{l_1}\left[l_1^2 + l_2^2 + l_3^2 + l_4^2\right] = Pe$

$F_{t_1}, F_{t_2}, F_{t_3}, F_{t_4}$ ≠ known



Critical bold = 2 & 3





Hence bolt is in combined safe Cond^n

Thories failure

Bolt are made of brittle material

use MSST, MDET

MSST $\sqrt{\sigma_x^2 + 4\tau_{xy}^2} \leq \frac{S_{yt}}{N}$

MDET $\sqrt{\sigma_x^2 + 3\tau_{xy}^2} \leq \frac{S_{yt}}{N}$

MSST

$$\sqrt{\left(\frac{F_t}{\frac{\pi}{4}d_c^2}\right)^2 + 4\left(\frac{P/4}{\frac{\pi}{4}d_c^2}\right)^2} \leq \frac{S_{yt}}{N}$$

d_c = known

$d = \frac{d_c}{0.84}$ = ?