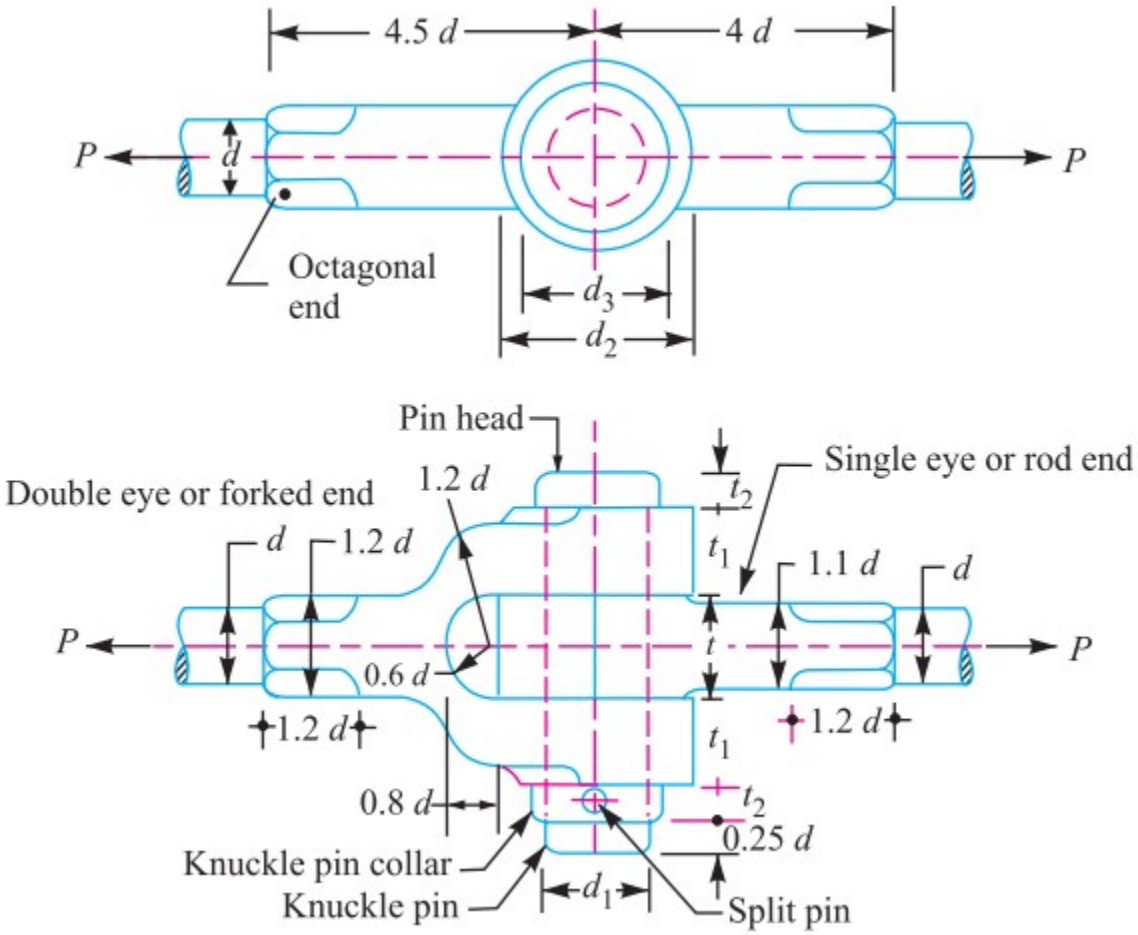
Standard size of Rod/Shaft/Tube/Bolts

Range of Size	Increment steps
0-10	1mm
10-24	2mm
24-45	3 mm
45-100	5 mm
>100	10 mm

Knuckle Joint

Design 1: Design a knuckle joint subjected to a tensile load of P=20/25/30/35 kN. The material of all the parts is 25C6 with σ_{UTS}= 430 MPa. Take FOS=6; τ_{per}=0.8 $(\sigma_t)_{per}$; $(\sigma_c)_{per}$= 1.3σ_t.



P = tensile force acting on rods (kN)

d = diameter of each rod (mm)

d_1= diameter of the pin (mm) = d

d_2= Outer diameter of eye (mm) = 2d

d_3= Diameter of knuckle pin head and collar (mm) = 1.5d

t =Thickness of single eye or rod end (mm) =1.25d

t_1= Thickness of fork (mm) = 0.75d

t_2 = Thickness of pin head (mm) = 0.5d

Design Steps:

1. Rod in Tension:

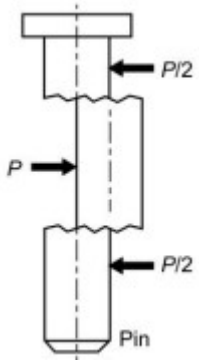
   $P = \sigma_t . \frac{\pi}{4} d^2 \Longrightarrow d$?

   Choose standard size of rod diameter from the table

2. Double shear of knuckle pin

   $$P = \tau . \frac{\pi}{2} d_1^2 \Longrightarrow d_1 \text{ ?}$$

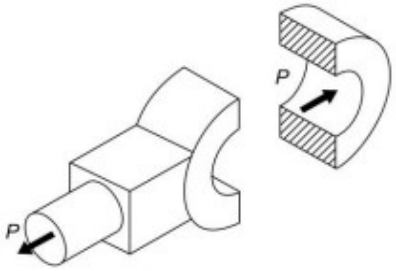
   Empirically, d_1=d



3. Eye in Tension

$$P = \sigma_t(d_2 - d_1)t \Longrightarrow d_2?\, take\ t = 1.25d$$

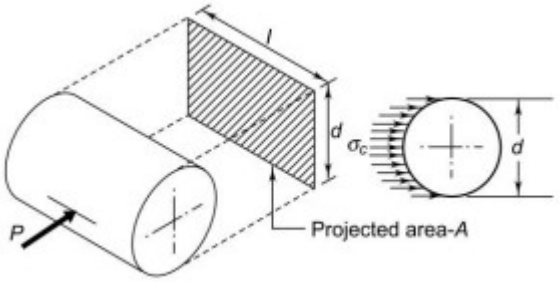
Empirically, d_2=2d



4. Eye in Compression

$$P = \sigma_{c_{ind}} d_1 t \Longrightarrow \sigma_{c_{ind}}?$$

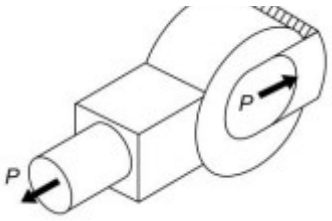
Check that $\sigma_{c_{ind}} < \sigma_{c_{per}}$



5. Eye in shear

$$P = \tau_{ind}.(d_2 - d_1)t$$

Check that $\tau_{ind} < \tau_{per}$



6. Fork in Tension

$$P = \sigma_{t_{ind}}(d_2 - d_1)2t_1 \Longrightarrow \sigma_{t_{ind}}?\ take\ t_1 = 0.75d$$

Check that $\sigma_{t_{ind}} < \sigma_{t_{per}}$

7. Fork in Compression

$$P = \sigma_{c_{ind}} d_1 2t_1 \Longrightarrow \sigma_{c_{ind}}?$$

Check that $\sigma_{c_{ind}} < \sigma_{c_{per}}$

8. Fork in shear

$$P = \tau_{ind}.(d_2 - d_1)2t_1$$

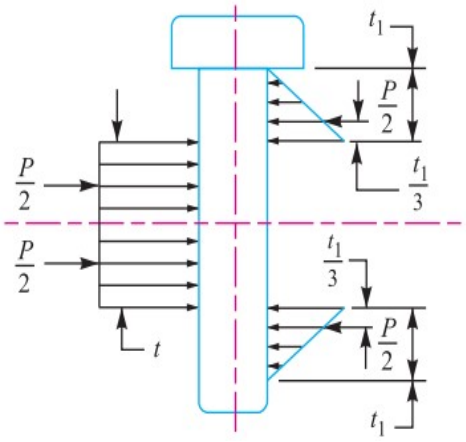
Check that $\tau_{ind} < \tau_{per}$

9. Bending of knuckle pin

$$M = \frac{P}{2}\left[\frac{t}{2} + \frac{t_1}{3} - \frac{t}{4}\right]$$

$$z = \frac{I}{y} = \frac{\pi d_1^4/64}{d/2} = \frac{\pi {d_1}^3}{32}$$

$$\therefore Bending\ stress, \sigma_b = \frac{M}{z}$$



Check that $\sigma_b < \sigma_{t_{per}}$ for safety of knuckle pin else knuckle pin is weak in bending.

VIVA QUESTIONS

Q1. When a Knuckle joint is subjected a tensile load, name the stresses produced in the EYE of the joint.

Q2. Why is the pin in a knuckle joint, the weakest part?

Q3.Name the stresses produced in the fork of the knuckle joint, when it is subjected to an axial tensile load.