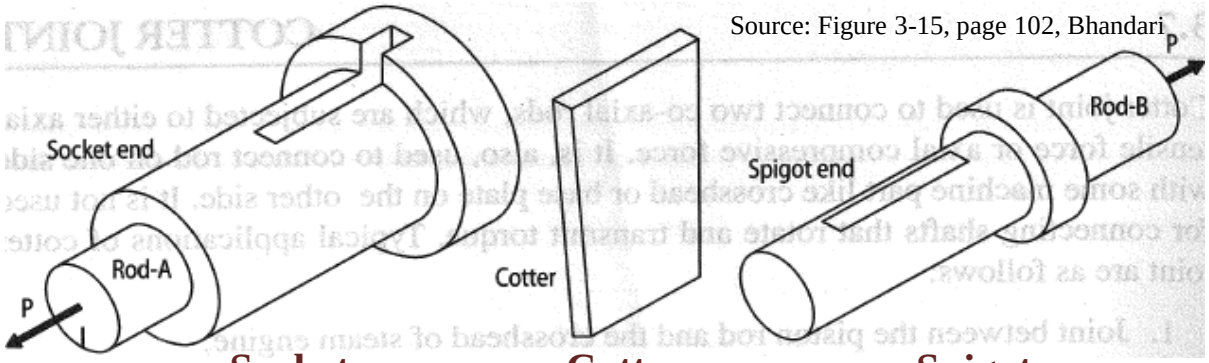
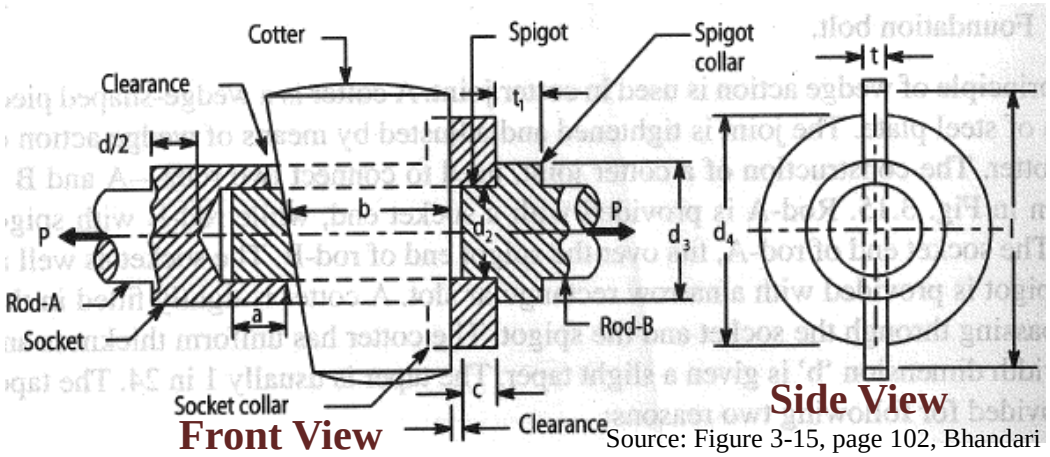
Cotter Joint

Reference: Chapter # 3 Bhandari



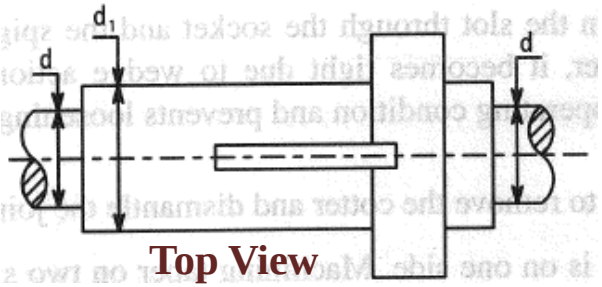
Source: Figure 3-15, page 102, Bhandari

Socket **Cotter** **Spigot**



Front View **Side View**

Source: Figure 3-15, page 102, Bhandari



Top View

- ***P***: applied force
- ***d***: diameter of rods A & B
- d_1: outside diameter of socket
- d_2: diameter of spigot
- d_3: diameter of spigot-collar
- d_4: diameter of socket-collar
- ***a***: distance from the end of slot the end of spigot on rod-B
- ***b***: mean width of cotter
- ***c***: axial distance from slot to end of socket collar
- ***t***: thickness of cotter
- t_1: thickness of spigot-collar
- ***l***: length of cotter

Typical applications:

- Joint between connecting rod and cross head of steam engine
- Foundation bolts

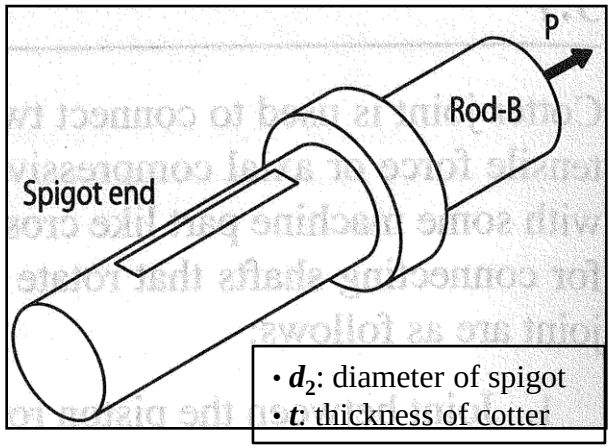
1. Tensile failure of rods

$$\sigma_t = \frac{P}{\pi d^2/4} \qquad \text{or} \qquad d = \sqrt{\frac{4P}{\pi \sigma_t}}$$

σ_t = Allowable tensile stress Thickness of collar is usually taken as $t = 0.31d$

2. Tensile failure of spigot

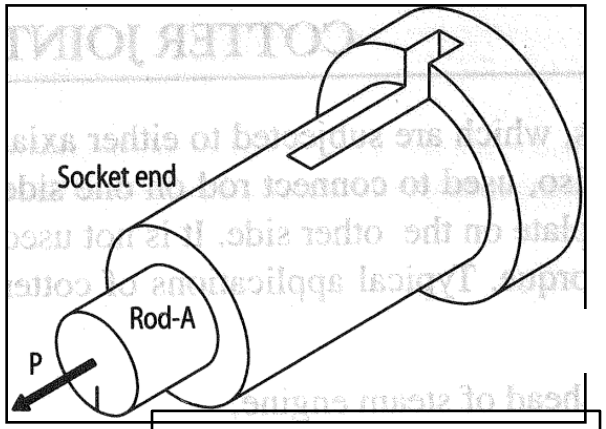
$$\sigma_t = \frac{P}{\left[\pi d_2^2/4 - d_2 t\right]}$$



- d_2: diameter of spigot
- t: thickness of cotter

3. Tensile failure of socket

$$\sigma_t = \frac{P}{\left[\pi\left(d_1^2 - d_2^2\right)/4 - \left(d_1 - d_2\right)t\right]}$$

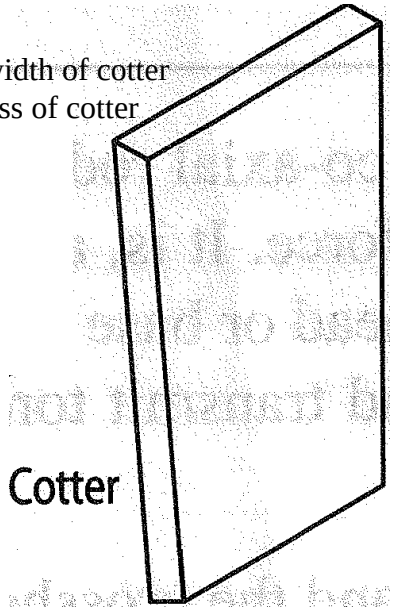


- d_1: outside diameter of socket
- d_2: inside diameter of socket

4. Shear failure of cotter

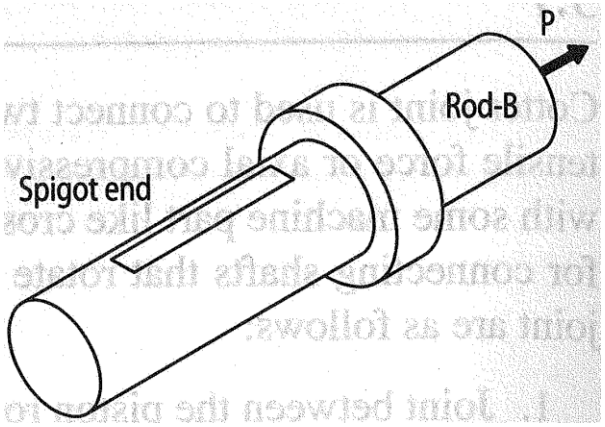
$$\tau = \frac{P/2}{(tb)}$$

τ = Allowable shear stress



5. Shear failure of spigot end

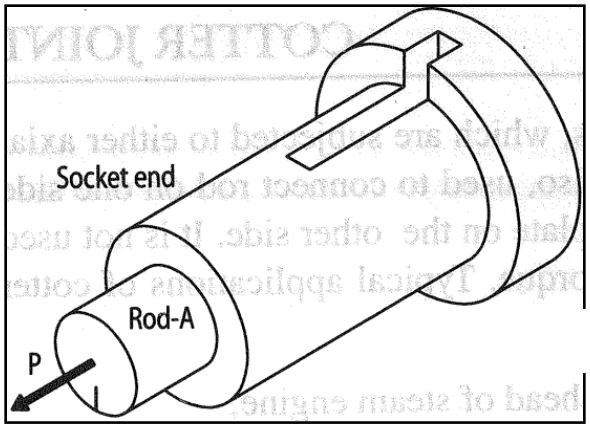
$$P = 2\tau a d_2$$



• d_2: diameter of spigot
• a: distance from the end of slot the end of spigot on rod-B

6. Shear failure of socket end

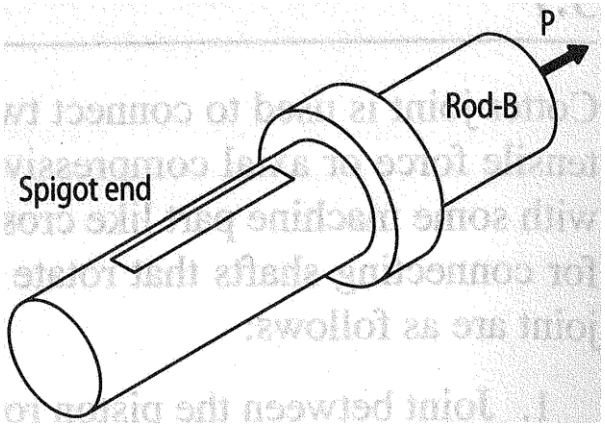
$$P = 2\tau(d_4 - d_2)c$$



- d_1: outside diameter of socket
- d_4: diameter of socket-collar
- c: axial distance from slot to end of socket collar

7. Crushing failure of spigot end

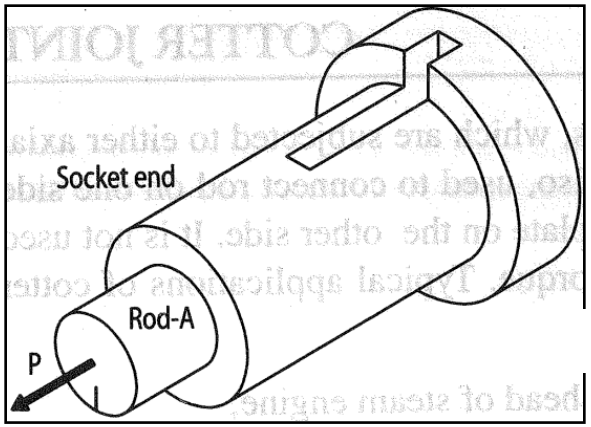
$$\sigma_c = \frac{P}{td_2}$$



- d_2: diameter of spigot
- t: thickness of cotter

8. Crushing failure of socket end

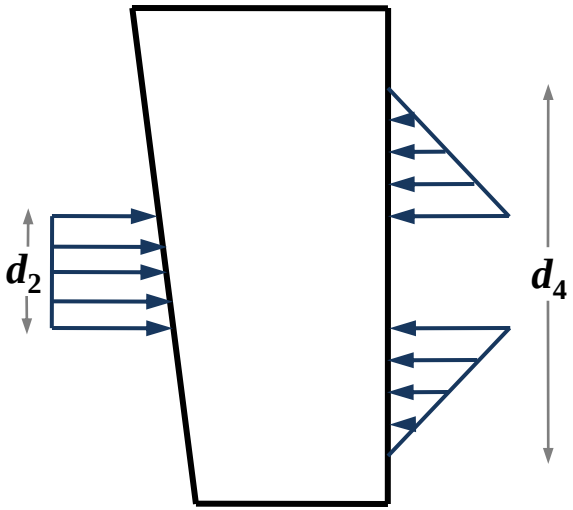
$$P = \sigma_c (d_4 - d_2) t$$



- d_1: outside diameter of socket
- d_4: diameter of socket-collar
- c: axial distance from slot to end of socket collar

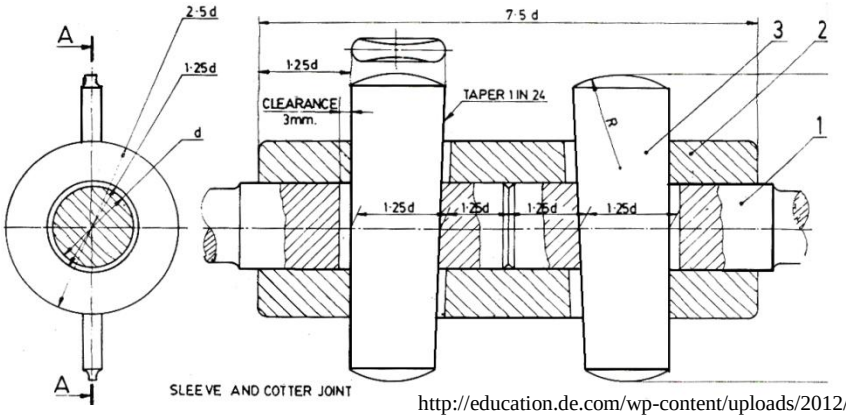
9. Bending failure of cotter

$$\sigma_b = \frac{P}{tb^2}\left(\frac{d_2}{4} + \frac{d_4}{2}\right)$$



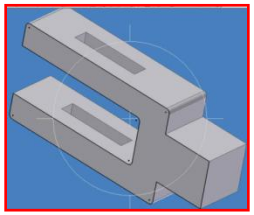
- b: mean width of cotter
- t: thickness of cotter

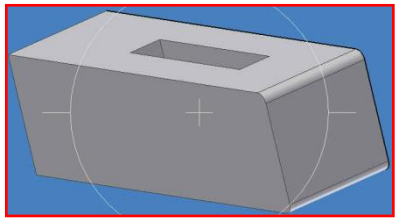
Sleeve and cotter joint



http://education.de.com/wp-content/uploads/2012/09/Full-Section-of-Sleeve-and-Cotter-Joint.png

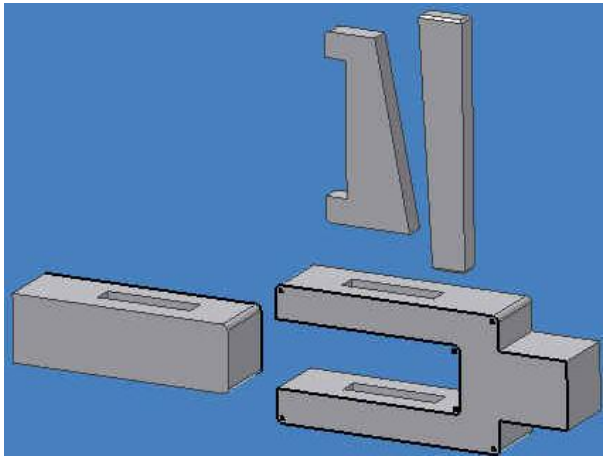
Gib and cotter joint



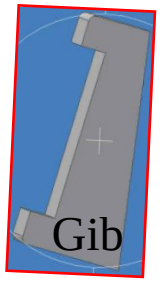


One rod end with strap

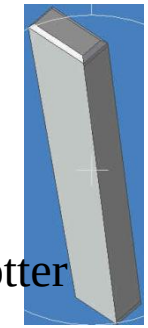
Assembly



http://cadcam4u.tripod.com/assembly/assembly1.htm

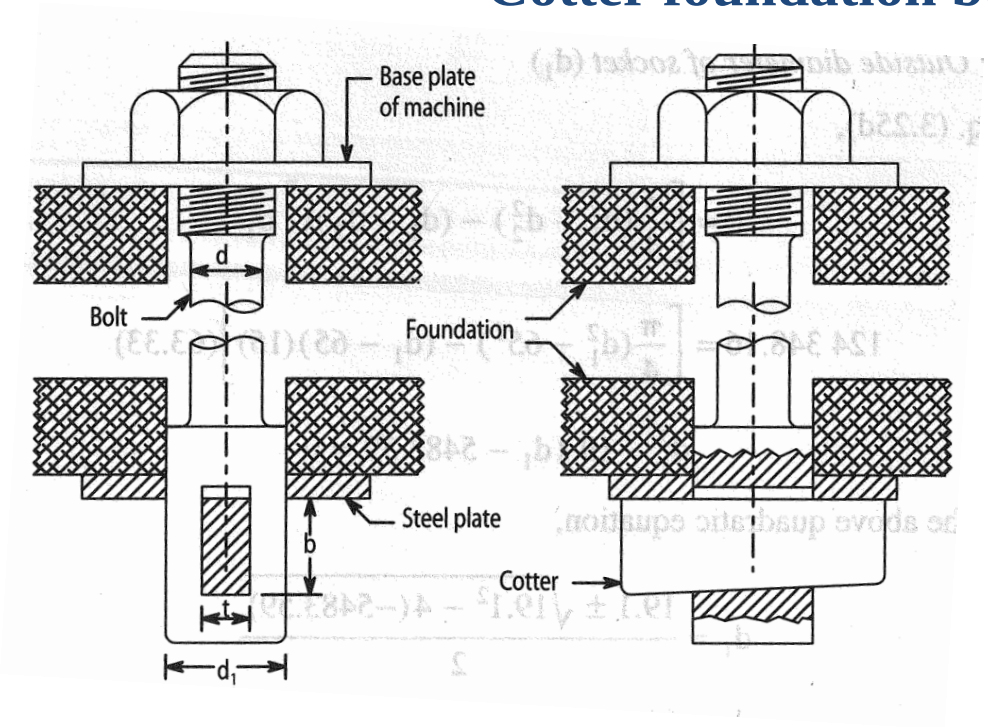


Gib



Cotter

Cotter foundation bolt



- ***d***: diameter of the bolt
- d_1: enlarged diameter of bolt
- ***t***: thickness of cotter
- ***b***: width of cotter

Application:

- Hold down the base plate of machine tool to concrete foundation of shop floor

1. Tensile failure of bolt

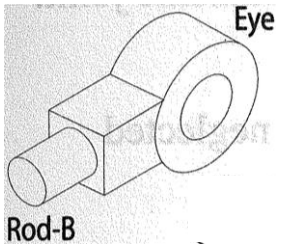
$$\sigma_t = \frac{P}{\pi d^2/4} \qquad \text{or} \qquad d = \sqrt{\frac{4P}{\pi \sigma_t}}$$

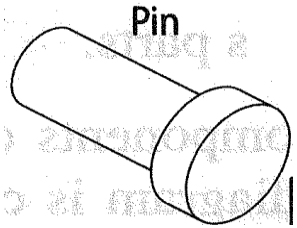
2. Tensile failure of enlarged area of bolt

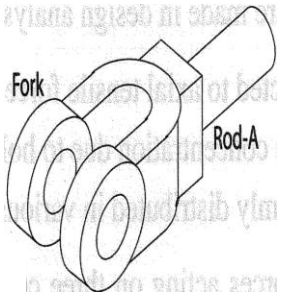
$$\sigma_t = \frac{P}{\left(\pi d_1^2/4 - d_1 t\right)}$$

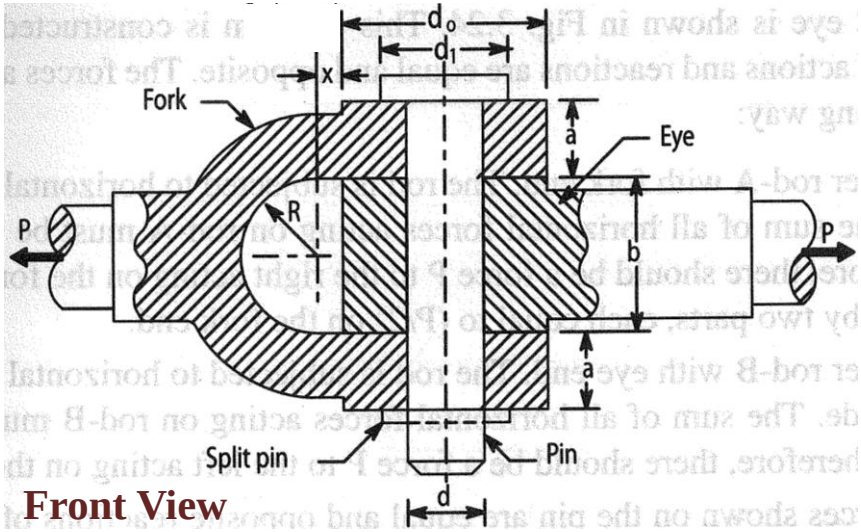
Knuckle Joint

Reference: Chapter # 3 Bhandari

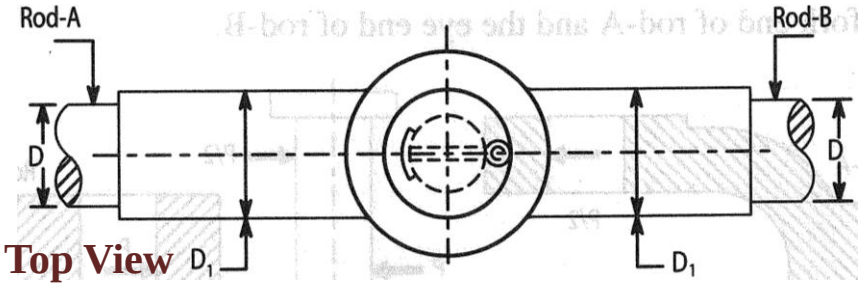








Front View



Top View

- ***P***: applied force
- ***D***: diameter of each rod
- D_1: enlarged diameter of each rod
- ***d***: diameter of knuckle pin
- d_0: outside diameter of eye of fork pin
- ***a***: thickness of each eye of fork
- ***b***: thickness of eye-end of rod-B
- d_1: diameter of pin head
- ***x***: distance of the centre of fork radius ***R*** from the eye

Typical applications:

- Joint in valve mechanism of reciprocating engine
- Fulcrum for levers
- Joint between links of bicycle chain

1. Tensile failure of rods

$$\sigma_t = \frac{P}{\pi D^2/4} \quad \text{or} \quad D = \sqrt{\frac{4P}{\pi \sigma_t}}$$

- $\boldsymbol{\sigma_t}$ = Allowable tensile stress
- Enlarged diameter is usually taken as $\boldsymbol{D_1 = 1.1D}$

2. Shear failure of pin

$$\tau = \frac{P/2}{\pi d^2/4} \quad \text{or} \quad d = \sqrt{\frac{2P}{\pi \tau}}$$

$\boldsymbol{\tau}$ = Allowable shear stress
$\boldsymbol{d}$ = diameter of knuckle pin

3. Crushing failure of pin in eye

$$\sigma_c = \frac{P}{bd}$$

$\boldsymbol{\sigma_c}$ = Allowable compressive stress
$\boldsymbol{d}$ = thickness of eye-end of rod-B

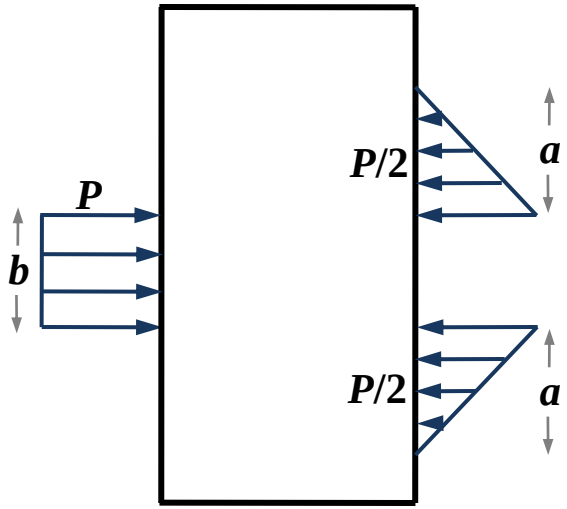
4. Crushing failure of pin in fork

$$\sigma_c = \frac{P/2}{ad} \quad \text{or} \quad a = \frac{P}{2d\sigma_c}$$

$\boldsymbol{a}$ = thickness of each eye of fork

5. Bending failure of pin

$$\sigma_b = 16\frac{P}{\pi d^3}\left(\frac{b}{4}+\frac{a}{3}\right)$$



- ***P***: applied force
- ***d***: diameter of knuckle pin
- ***a***: thickness of each eye of fork
- ***b***: thickness of eye-end of rod-B

6. Tensile failure of eye

$$\sigma_t = \frac{P}{(d_0 - d)b}$$

- ***d***: diameter of knuckle pin
- $\boldsymbol{d_0}$: outside diameter of eye of fork pin
- ***b***: thickness of eye-end of rod-B

7. Shear failure of eye

$$\tau = \frac{P}{(d_0 - d)b}$$

8. Tensile failure of fork

$$\sigma_t = \frac{P}{2(d_0 - d)a}$$

- ***d***: diameter of knuckle pin
- $\boldsymbol{d_0}$: outside diameter of eye of fork pin
- ***a***: thickness of each eye of fork

7. Shear failure of fork

$$\tau = \frac{P}{2(d_0 - d)a}$$