Lecture # 5.2

Cotter Joints-Spigot and Socket Type

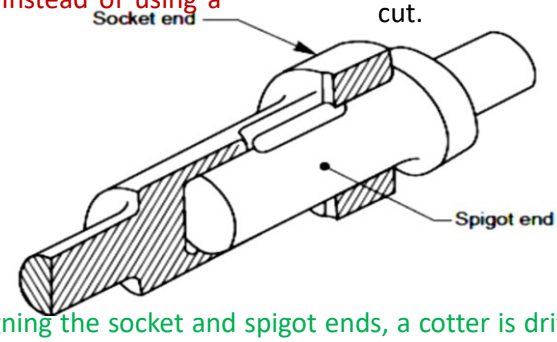
1

Cotter Joints

Cotter Joint With Spigot & Socket End

This joint is used to fasten two circular rods.
In this, the rod ends are modified instead of using a sleeve.

One end of the rod is formed into a socket and the other into a spigot and slots are cut.

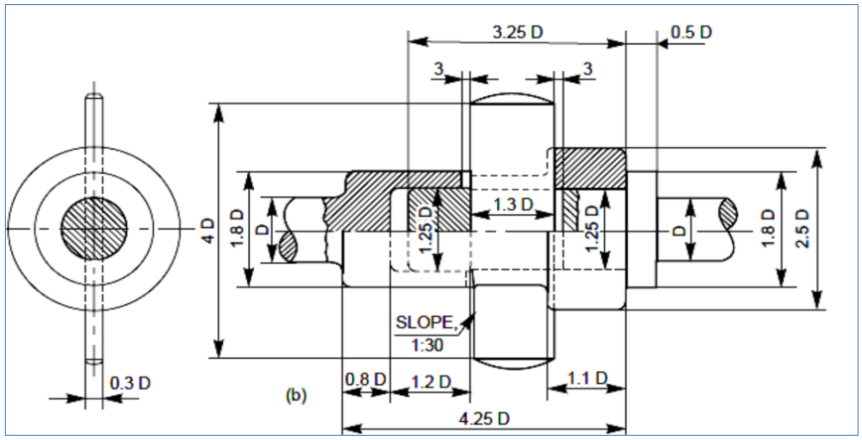


After aligning the socket and spigot ends, a cotter is driven-in through the slots, forming the joint.

2

Cotter Joints

2D Representaion of Cotter Joint With Spigot & Socket End



3

Cotter Joints

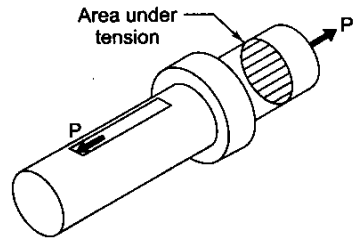
Design of Spigot and Socket type cotter joint

If the allowable stresses in tension, compression and shear for the socket, rod and cotter be σ_t, σ_c and τ respectively,

assuming that they are all made of the same material, we may write the following failure criteria:

1. Tension Failure of rod at diameter d

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

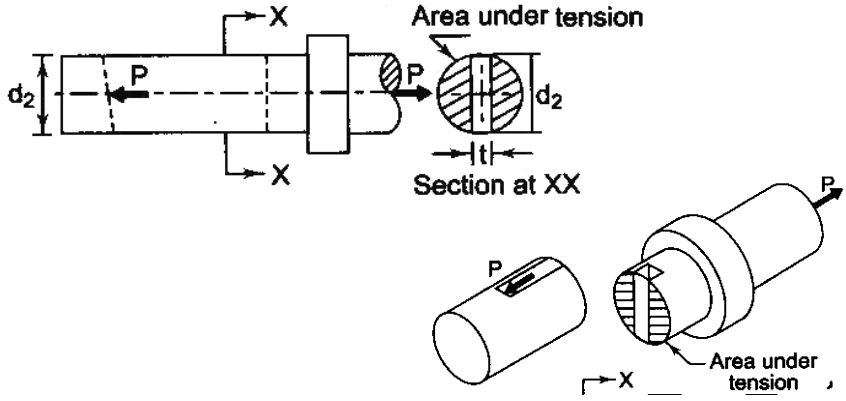


4

Cotter Joints

2. Tension Failure of rod across slot

$$(\frac{\pi}{4}d_2^2 - d_2 t)\sigma_t = \mathrm{P}$$

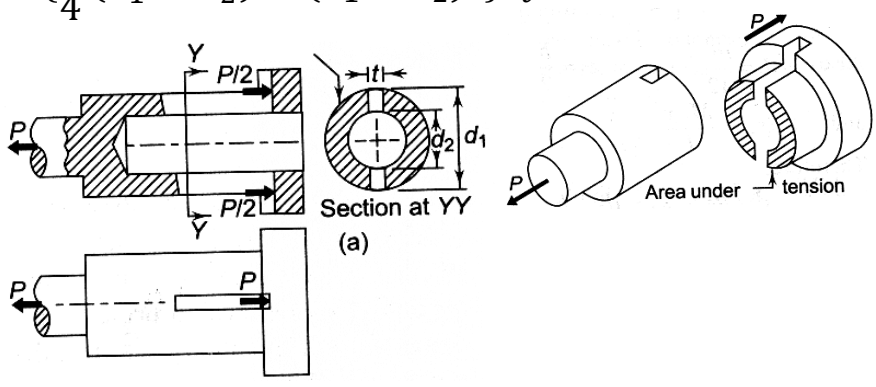


5

Cotter Joints

3. Tension Failure of Socket across slot

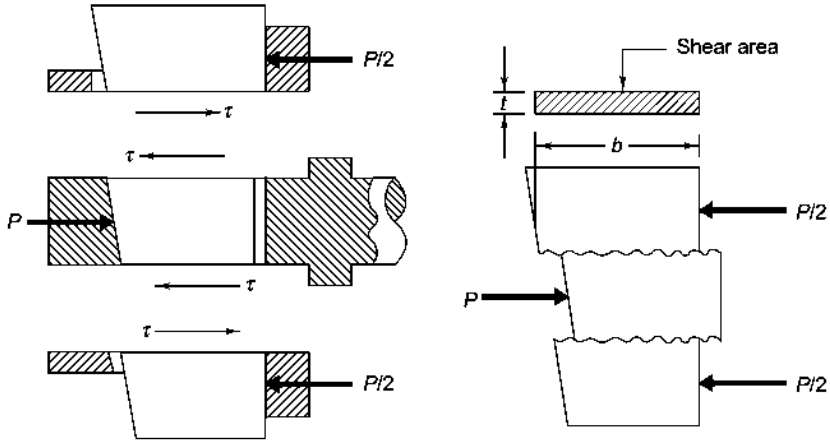
$$\{\frac{\pi}{4}(d_1^2 - d_2^2) - (d_1 - d_2)t\}\sigma_t = \mathrm{P}$$



6

Cotter Joints

4. Shear Failure of Cotter



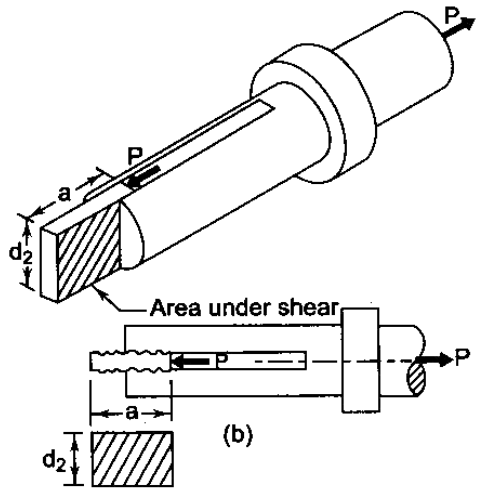
$$2bt\tau = \mathrm{P}$$

7

Cotter Joints

5. Shear Failure of spigot rod end

$$2ad_2\tau = \mathrm{P}$$

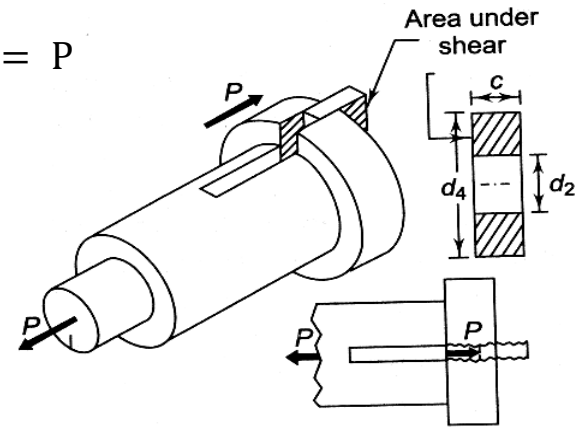


8

Cotter Joints

6. Shear Failure of Socket end

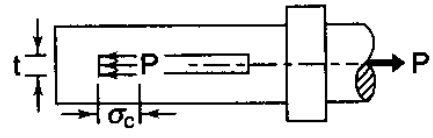
$$2(d_4 - d_2)c\tau = \text{P}$$



Cotter Joints

7. Crushing Failure of rod or cotter

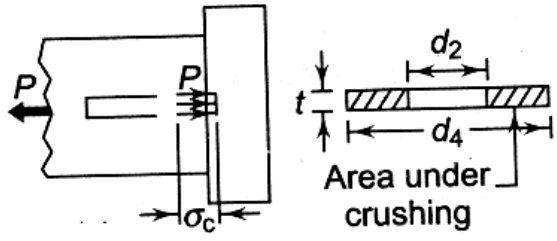
$$d_2 t\sigma_c = \text{P}$$



Cotter Joints

8. Crushing Failure of socket or cotter

$$(d_4 - d_2)t\sigma_c = \text{P}$$

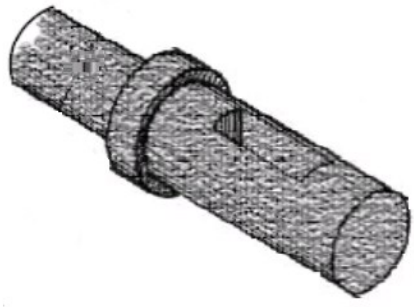


11

Cotter Joints

9. Crushing Failure of collar of spigot and Socket

$$\frac{\pi}{4}(d_3^2 - d_2^2)\sigma_c = \text{P}$$

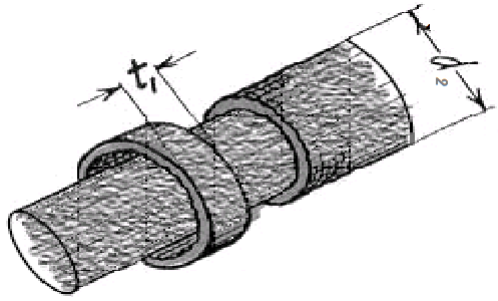


12

Cotter Joints

10. Shear Failure of collar of spigot

$$(\pi d_2 t_1)\tau = \mathrm{P}$$

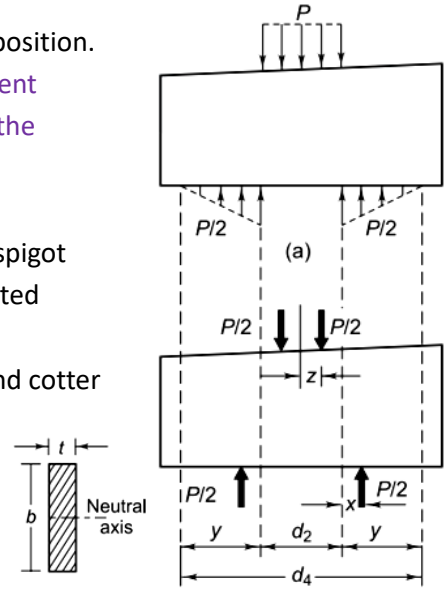


13

Cotter Joints

Cotters may bend when driven into position. When this occurs, the bending moment cannot be correctly estimated since the pressure distribution is not known.

The force P between the cotter and spigot end is assumed as uniformly distributed over the length d_2.
The force between the socket end and cotter is assumed to be varying linearly from zero to maximum with triangular distribution.



14

Cotter Joints

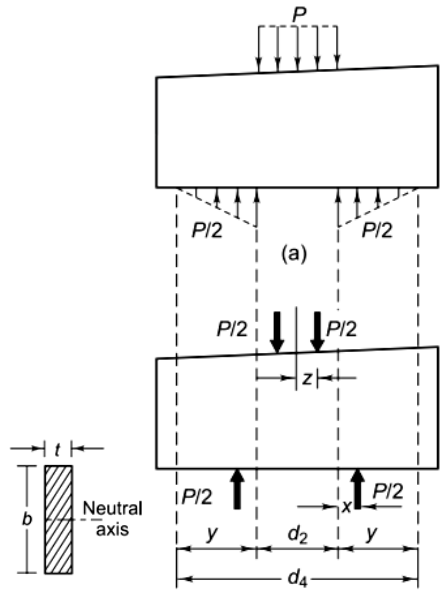
$$x = \frac{1}{3}y \qquad = \frac{1}{3}\left(\frac{d_4 - d_2}{2}\right) \quad = \left(\frac{d_4 - d_2}{6}\right)$$

$$M_b = \frac{P}{2}\left[\frac{d_2}{2} + x\right] - \frac{P}{2}(z)$$

$$M_b = \frac{P}{2}\left[\frac{d_2}{2} + \frac{d_4 - d_2}{6}\right] - \frac{P}{2}\left[\frac{d_2}{4}\right]$$

$$M_b = \frac{P}{2}\left[\frac{d_2}{4} + \frac{d_4 - d_2}{6}\right]$$

$$M_b = \frac{P}{2}\left[\frac{d_2}{4} + \frac{d_4 - d_2}{6}\right]$$



15

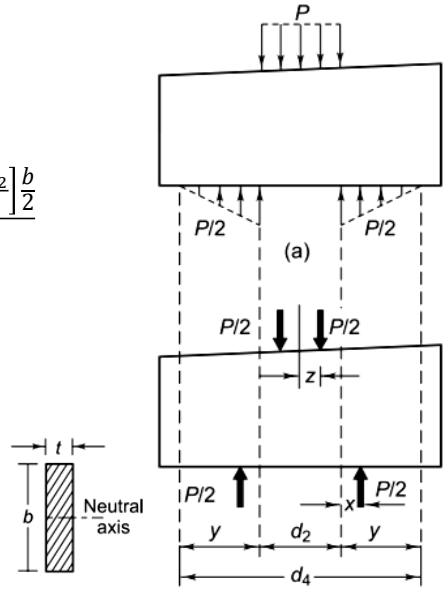
Cotter Joints

Also $I = \frac{tb^3}{12}$ $y = \frac{b}{2}$

And $\sigma_b = \frac{M_b y}{I}$

therefore $\sigma_b = \frac{\frac{P}{2}\left[\frac{d_2}{4} + \frac{d_4 - d_2}{6}\right]\frac{b}{2}}{\left(\frac{tb^3}{12}\right)}$

$$\sigma_b = \frac{3P\left[\frac{d_2}{4} + \frac{d_4 - d_2}{6}\right]}{tb^2}$$



16

Cotter Joints

Tightening of cotter introduces initial stresses which are again difficult to estimate.

Sometimes therefore it is necessary to use empirical proportions to design the joint.

A design based on empirical relation may be checked using the formulae based on failure mechanisms.

17

Cotter Joints

Problem 1

Two rod ends of a pump are joined by means of a cotter joints, making spigot & socket at the ends. Design joint for an axial load of 30 kN which is alternately tensile & compressive.

18

References

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V. B. Bhandari, Design of Machine Elements, Third Ed., The McGraw-Hills Companies, New Delhi

R. S. KHURMI and J.K.GUPTA, A Textbook of Machine Design, S. Chand and company ltd., New Delhi, 2000.

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