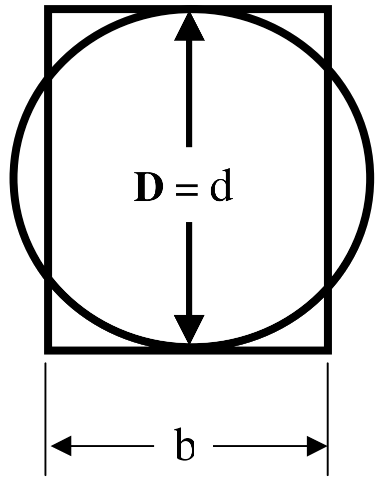
Rectangular Section equivalent to a Circular Section

Circle: $I = \frac{\pi D^4}{64}$

Rectangle: $I = \frac{bd^3}{12}$



Setting the values of I equal,
and the rectangle depth d = D:

$$\frac{\pi D^4}{64} = \frac{bd^3}{12} \text{, and } b = \frac{3\pi D}{16}$$

Circle: $A = \frac{\pi D^2}{4}$ Rectangle: $A = bd$

Substituting equivalent Circle values,

Rectangle $A = \frac{3\pi D^2}{16}$

Setting the values of I equal, and d = D, ensures both beams have equal resisting moments and deflections.*

c, the distance from the neutral axis to the extreme fibre, is also equal for both sections.

These conditions are satisfied if $D = \sqrt[3]{\frac{32M}{\pi F_b}}$

Comparing the two areas, the rectangle area is only 3/4 of the area of the circle. The maximum shear stress of the circular section is 2/3 that of the rectangular section.

* For a uniformly loaded beam, supported at the ends:

$$M_r = \frac{F_b I}{c} \text{, and deflection } = \frac{5w\boldsymbol{l}^4}{384\,EI}$$