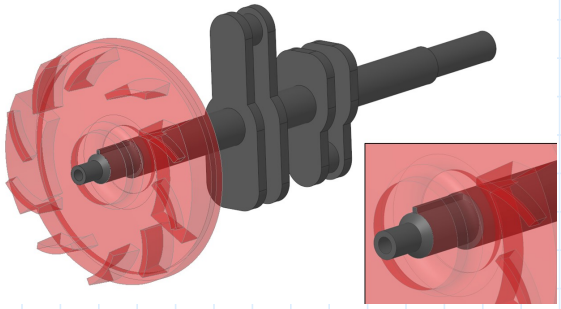
Shaft Key Calculations

A key is a mechanical component used to transfer power between a rotating shaft and a machine component.



Service Factor

$$K_s = \frac{K_a \cdot K_d}{K_f}$$

$\begin{bmatrix} K_d \\ gar1 \end{bmatrix} :=$ Design Factor: "Fixed (close fit) loaded"

Design Factor

$K_d = 1$

$\begin{bmatrix} K_f \\ gar2 \end{bmatrix} :=$ Cycles: 10,000,000

Fatigue Life Factor for Unidirectional Loading

$K_f = 0.3$

$K_a := 1$

Application factor
Uniform power source, Uniform load

Disable these next 2 Math Regions if you want to use the Combo Boxes. This may affect Chart Component formatting / appearance as axes values have been explicitly defined.

$K_d := 1$ *Design factor for fixed (close fit) loaded*

$K_f := 0.3$ *Fatigue life factor for 10 million cycles*

$$K_s := \frac{K_a \cdot K_d}{K_f} = 3.333$$

Operating Conditions

$T := 150 \cdot N \cdot m$ Torque

Key Dimensions

$w := 12.5 \cdot mm$ Width

$l := 50 \cdot mm$ Length

$h := 10 \cdot mm$ Height

Shaft dimensions

$d := 50 \cdot mm$ Nominal diameter

$d_{re} := d - \frac{h}{2} = 45\ mm$ Reduced diameter

$\sigma_{max} := 250 \cdot MPa$ Steel yield strength

Material Properties

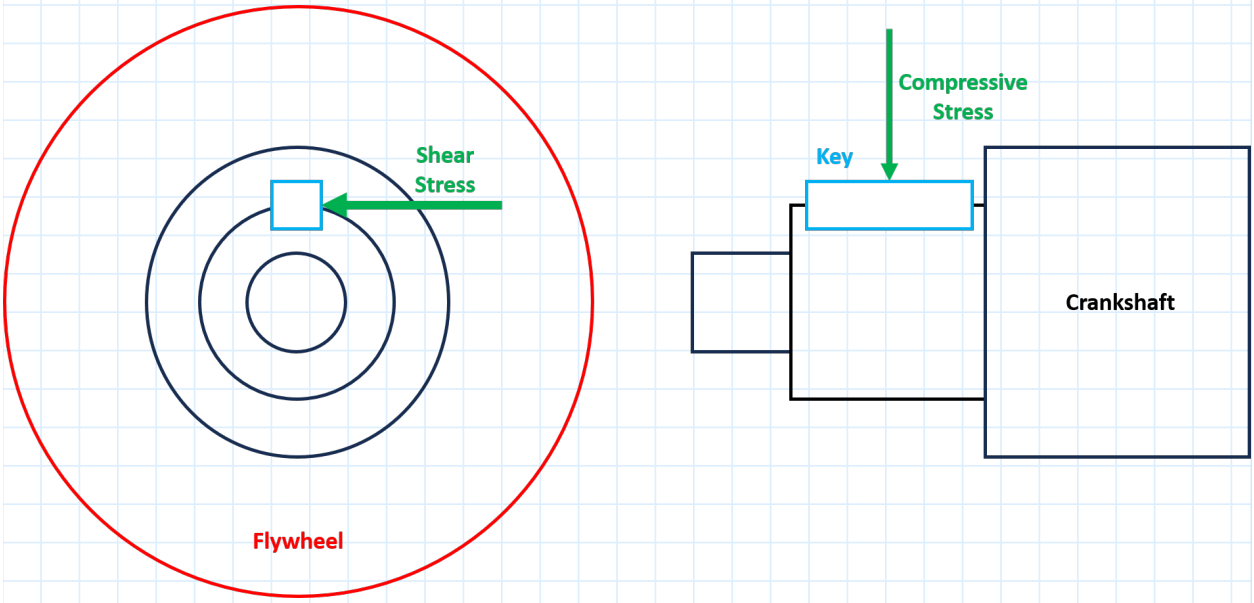
$Yield := 250 \cdot MPa$

Calculation of Torque for Reduced Diameter

$$T_{max} = \frac{\left(\frac{\sigma_{max}}{2}\right) \cdot I}{\frac{d_{re}}{2}} \qquad T_{max} = \frac{\sigma_{max} \cdot I}{d_{re}}$$

$$I := \frac{\pi}{4} \cdot \left(\frac{d_{re}}{2}\right)^4 = \left(2.013 \cdot 10^5\right)\ mm^4$$

$$T_{max} := \frac{\sigma_{max} \cdot I}{d_{re}} = 1118.3\ N \cdot m$$



Stress Calculations

Shear Stress

$$\tau(length, width) := \frac{T \cdot K_s}{length \cdot width \cdot \frac{d_{re}}{2}}$$

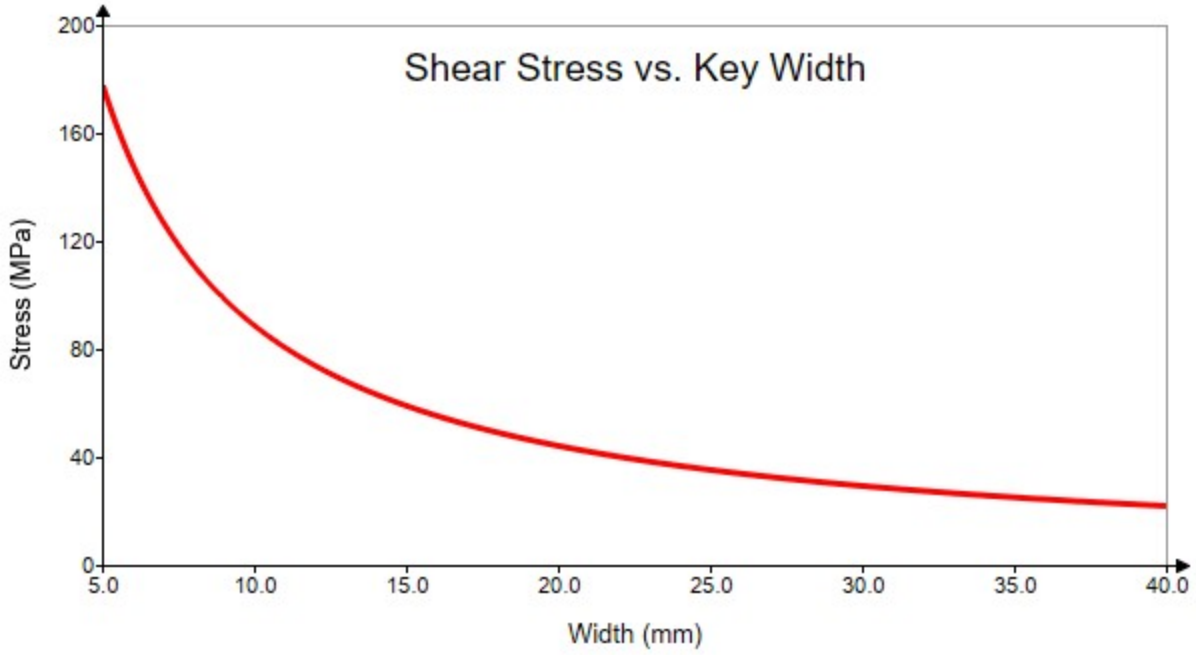
$\tau(l, w) = 35.6\ MPa$

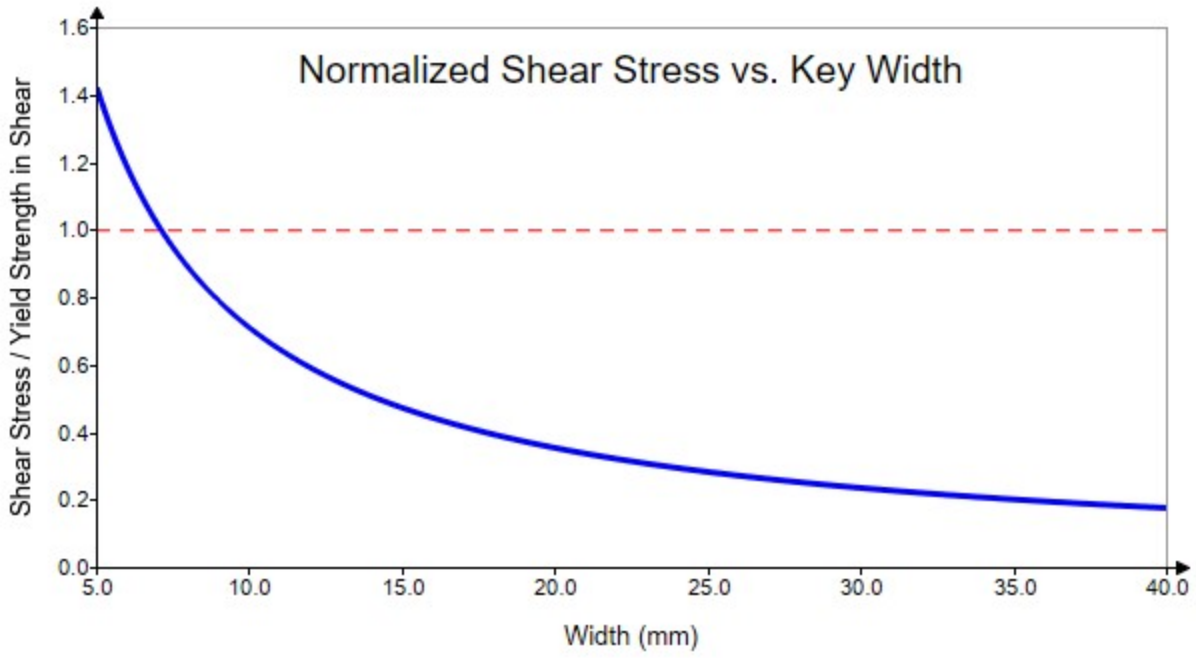
Compressive Stress

$$\sigma_c(length, height) := \frac{T \cdot K_s}{\left(\frac{height}{2}\right) \cdot length \cdot \frac{d_{re}}{2}}$$

$\sigma_c(l, h) = 88.9\ MPa$

Range Variable $range_{width} := 5.0 \cdot mm, 5.1 \cdot mm .. 40 \cdot mm$


Shear Stress vs. Key Width
Stress (MPa)
200
160
120
80
40
0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
Width (mm)


Normalized Shear Stress vs. Key Width
Shear Stress / Yield Strength in Shear
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
Width (mm)