



## Design of Knuckle Joint Formulas

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## List of 45 Design of Knuckle Joint Formulas

## Design of Knuckle Joint 🕑

#### Eye 🖸

1) Bending Stress in Knuckle Pin given Bending Moment in Pin 🚰

$$f_{\mathbf{X}} \sigma_{\mathrm{b}} = \frac{32 \cdot \mathrm{M}_{\mathrm{b}}}{\pi \cdot \mathrm{d}^{3}}$$

$$e_{\mathbf{X}} 90.49143 \mathrm{N/mm^{2}} = \frac{32 \cdot 450000 \mathrm{N*mm}}{\pi \cdot (37 \mathrm{mm})^{3}}$$

$$Open Calculator \square$$

2) Bending Stress in Knuckle Pin given Load, Thickness of Eyes and Pin Diameter

$$\sigma_{\rm b} = \frac{32 \cdot \frac{\rm L}{2} \cdot \left(\frac{\rm b}{4} + \frac{\rm a}{3}\right)}{\pi \cdot {\rm d}^3}$$

$$ex 90.2275 \text{N/mm}^2 = \frac{32 \cdot \frac{45000 \text{N}}{2} \cdot \left(\frac{44.3 \text{mm}}{4} + \frac{26.6 \text{mm}}{3}\right)}{\pi \cdot (37 \text{mm})^3}$$

$$Open Calculator Constraints of the second s$$



# 3) Compressive Stress in Pin Inside Eye of Knuckle Joint given Load and Pin Dimensions

$$\label{eq:scalar} \texttt{fx} \ensuremath{\sigma_c} = \frac{L}{b \cdot d} \ensuremath{\textcircled{}}{} \texttt{Open Calculator} \ensuremath{\textcircled$$

## 4) Compressive Stress in Pin Inside Fork of Knuckle Joint given Load and Pin Dimensions

fx 
$$\sigma_{\rm c} = rac{{
m L}}{2\cdot{
m a}\cdot{
m d}}$$

ex 
$$22.86121 \mathrm{N/mm^2} = rac{45000 \mathrm{N}}{2 \cdot 26.6 \mathrm{mm} \cdot 37 \mathrm{mm}}$$

# 5) Max Bending Moment in Knuckle Pin given Load, Thickness of Eye and Fork

$$\begin{array}{l} \text{fx} \ \mathbf{M}_{b} = \frac{\mathbf{L}}{2} \cdot \left(\frac{\mathbf{b}}{4} + \frac{\mathbf{a}}{3}\right) \end{array}$$

$$\begin{array}{l} \text{Open Calculator Gradients}\\ \text{ex} \ 448687.5\mathrm{N*mm} = \frac{45000\mathrm{N}}{2} \cdot \left(\frac{44.3\mathrm{mm}}{4} + \frac{26.6\mathrm{mm}}{3}\right) \end{array}$$





Open Calculator

# 6) Shear Stress in Eye of Knuckle Joint given Load, Outer Diameter of Eye and its Thickness

$$\mathbf{k} \quad \mathbf{\tau}_{e} = \frac{\mathbf{L}}{\mathbf{b} \cdot (\mathbf{d}_{o} - \mathbf{d})}$$

$$\mathbf{ex} \quad 23.62329 \text{N/mm}^{2} = \frac{45000 \text{N}}{44.3 \text{mm} \cdot (80 \text{mm} - 37 \text{mm})}$$

$$\mathbf{fx} \quad \mathbf{c}_{g} = \frac{\mathbf{L}}{2 \cdot \mathbf{a} \cdot (\mathbf{d}_{o} - \mathbf{d})}$$

$$\mathbf{fx} \quad \mathbf{c}_{f} = \frac{\mathbf{L}}{2 \cdot \mathbf{a} \cdot (\mathbf{d}_{o} - \mathbf{d})}$$

$$\mathbf{fx} \quad \mathbf{c}_{f} = \frac{\mathbf{L}}{2 \cdot \mathbf{a} \cdot (\mathbf{d}_{o} - \mathbf{d})}$$

$$\mathbf{fx} \quad \mathbf{c}_{f} = \frac{\mathbf{L}}{2 \cdot \mathbf{a} \cdot (\mathbf{d}_{o} - \mathbf{d})}$$

$$\mathbf{fx} \quad \mathbf{c}_{g} = \frac{45000 \text{N}}{2 \cdot 26.6 \text{mm} \cdot (80 \text{mm} - 37 \text{mm})}$$

$$\mathbf{fx} \quad \mathbf{c}_{g} = \frac{2 \cdot \mathbf{L}}{\pi \cdot \mathbf{d}^{2}}$$

$$\mathbf{fx} \quad \mathbf{c}_{g} = \frac{2 \cdot \mathbf{L}}{\pi \cdot \mathbf{d}^{2}}$$

$$\mathbf{fx} \quad \mathbf{c}_{g} = \frac{2 \cdot \mathbf{L}}{\pi \cdot \mathbf{d}^{2}}$$

$$\mathbf{fx} \quad \mathbf{c}_{g} = \frac{2 \cdot 45000 \text{N}}{\pi \cdot (37 \text{mm})^{2}}$$



# 9) Tensile Stress in Eye of Knuckle Joint given Load, Outer Diameter of Eye and its Thickness

$$fx \quad \sigma_{te} = \frac{L}{b \cdot (d_o - d)}$$

$$ex \quad 23.62329 \text{N/mm}^2 = \frac{45000 \text{N}}{44.3 \text{mm} \cdot (80 \text{mm} - 37 \text{mm})}$$
10) Tensile Stress in Fork of Knuckle Joint given Load, Outer Diameter of Eye and Pin Diameter **C**

$$fx \quad \sigma_{tf} = \frac{L}{2 \cdot a \cdot (d_o - d)}$$

$$ex \quad 19.67127 \text{N/mm}^2 = \frac{45000 \text{N}}{2 \cdot 26.6 \text{mm} \cdot (80 \text{mm} - 37 \text{mm})}$$
11) Tensile Stress in Rod of Knuckle Joint **C**

$$fx \quad \sigma_t = \frac{4 \cdot L}{\pi \cdot d_{r1}^2}$$

$$ex \quad 59.621 \text{N/mm}^2 = \frac{4 \cdot 45000 \text{N}}{\pi \cdot (31 \text{mm})^2}$$





1

12) Thickness of Eye End of Knuckle Joint given Bending Moment in Pin

$$f_{\mathbf{X}} \mathbf{b} = 4 \cdot \left(2 \cdot \frac{101}{\mathrm{L}} - \frac{a}{3}\right)$$

$$e_{\mathbf{X}} 44.53333 \mathrm{mm} = 4 \cdot \left(2 \cdot \frac{450000\mathrm{N*mm}}{45000\mathrm{N}} - \frac{26.6\mathrm{mm}}{3}\right)$$

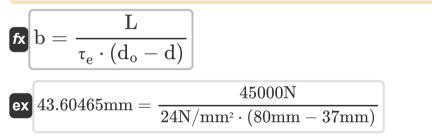
M.

13) Thickness of Eye End of Knuckle Joint given Bending Stress in Pin

$$\mathbf{fx} \mathbf{b} = 4 \cdot \left( \frac{\pi \cdot \mathbf{d}^3 \cdot \sigma_{\mathbf{b}}}{16 \cdot \mathbf{L}} - \frac{\mathbf{a}}{3} \right)$$
 Open Calculator C

ex 44.09888mm = 
$$4 \cdot \left( \frac{\pi \cdot (37 \text{mm})^3 \cdot 90 \text{N/mm}^2}{16 \cdot 45000 \text{N}} - \frac{26.6 \text{mm}}{3} \right)$$

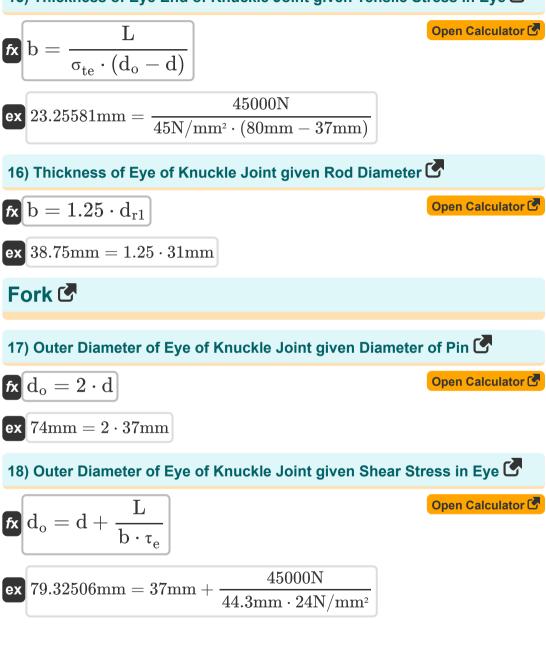
14) Thickness of Eye End of Knuckle Joint given Shear Stress in Eye 🗹



Open Calculator

Open Calculator

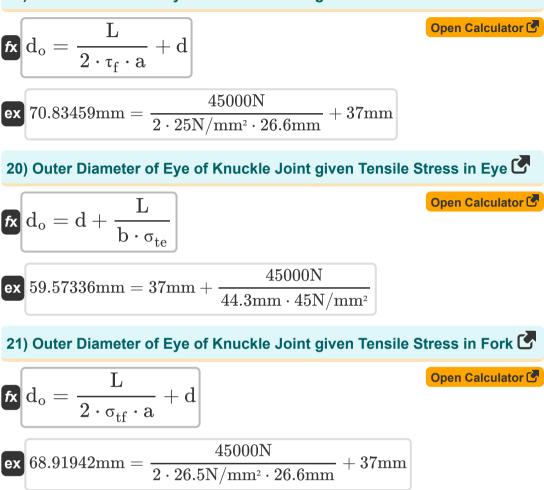
15) Thickness of Eye End of Knuckle Joint given Tensile Stress in Eye







19) Outer Diameter of Eye of Knuckle Joint given Shear Stress in Fork







22) Thickness of Fork Eye of Knuckle Joint given Bending Moment in Pin

$$f_{\mathbf{X}} \mathbf{a} = 3 \cdot \left( 2 \cdot \frac{M_{b}}{L} - \frac{b}{4} \right)$$

$$e_{\mathbf{X}} 26.775 \text{mm} = 3 \cdot \left( 2 \cdot \frac{450000 \text{N*mm}}{45000 \text{N}} - \frac{44.3 \text{mm}}{4} \right)$$

$$Open Calculator C$$

23) Thickness of Fork Eye of Knuckle Joint given Bending Stress in Pin 🕑

$$f_{\mathbf{X}} \mathbf{a} = 3 \cdot \left( \frac{\pi \cdot d^3 \cdot \sigma_b}{16 \cdot L} - \frac{b}{4} \right)$$
Open Calculator C

ex 26.44916mm = 
$$3 \cdot \left( \frac{\pi \cdot (37 \text{mm})^3 \cdot 90 \text{N/mm}^2}{16 \cdot 45000 \text{N}} - \frac{44.3 \text{mm}}{4} \right)$$

24) Thickness of Fork Eye of Knuckle Joint given Compressive Stress in Pin Inside Fork End

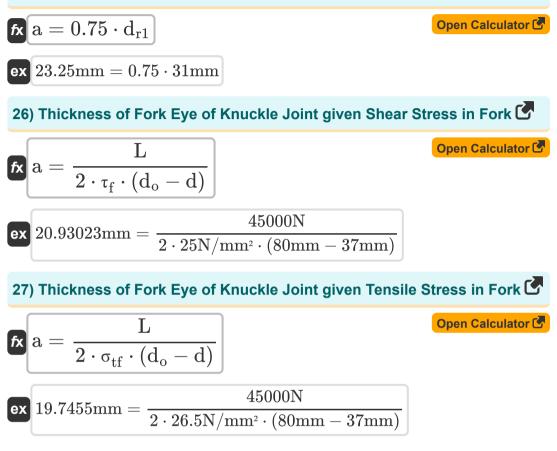
fx 
$$a = \frac{L}{2 \cdot \sigma_c \cdot d}$$
  
ex  $20.27027mm = \frac{45000N}{2 \cdot 30N/mm^2 \cdot 37mm}$ 

Open Calculator 🕑





#### 25) Thickness of Fork Eye of Knuckle Joint given Rod Diameter 🕑





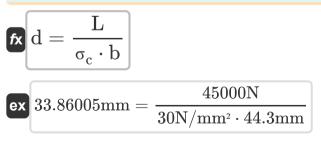
()

### Pin 🕑

#### 28) Diameter of Knuckle Pin given Bending Moment in Pin 🕑

$$fx \quad d = \left(\frac{32 \cdot M_{b}}{\pi \cdot \sigma_{b}}\right)^{\frac{1}{3}}$$
ex  $37.06722 \text{mm} = \left(\frac{32 \cdot 450000 \text{N*mm}}{\pi \cdot 90 \text{N/mm}^{2}}\right)^{\frac{1}{3}}$ 
29) Diameter of Knuckle Pin given Bending Stress in Pin C
$$fx \quad d = \left(\frac{32 \cdot \frac{\text{L}}{2} \cdot \left(\frac{\text{b}}{4} + \frac{\text{a}}{3}\right)}{\pi \cdot \sigma_{b}}\right)^{\frac{1}{3}}$$
Open Calculator C
ex  $37.03115 \text{mm} = \left(\frac{32 \cdot \frac{45000 \text{N}}{2} \cdot \left(\frac{44.3 \text{mm}}{4} + \frac{26.6 \text{mm}}{3}\right)}{\pi \cdot 90 \text{N/mm}^{2}}\right)^{\frac{1}{3}}$ 

# 30) Diameter of Pin of Knuckle Joint given Compressive Stress in Eye End Portion of Pin



Open Calculator 🕑





$$f_{\mathbf{X}} d = \frac{L}{2 \cdot \sigma_{c} \cdot a}$$
Open Calculator

ex 
$$28.19549 \mathrm{mm} = rac{45000 \mathrm{N}}{2 \cdot 30 \mathrm{N/mm^2} \cdot 26.6 \mathrm{mm}}$$

#### 32) Diameter of Pin of Knuckle Joint given Diameter of Pinhead 子

fx 
$$d = \frac{d_1}{1.5}$$
 Open Calculator C

$$ex \ 40mm = \frac{60mm}{1.5}$$

## 33) Diameter of Pin of Knuckle Joint given Load and Shear Stress in Pin

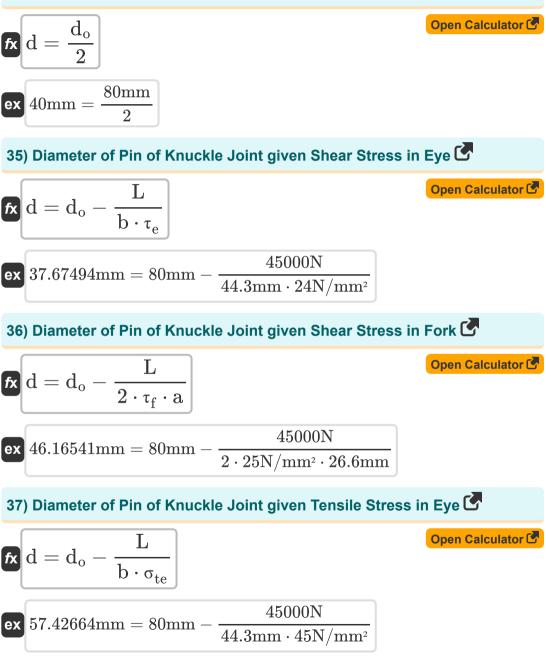
fx 
$$d = \sqrt{\frac{2 \cdot L}{\pi \cdot \tau_p}}$$
  
ex  $35.14005 \text{mm} = \sqrt{\frac{2 \cdot 45000 \text{N}}{\pi \cdot 23.2 \text{N/mm}^2}}$ 

Open Calculator 🕑

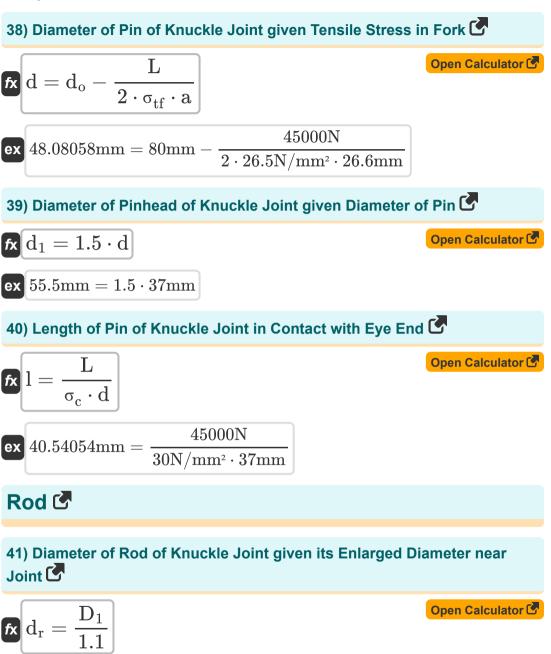




#### 34) Diameter of Pin of Knuckle Joint given Outer Diameter of Eye 🗹











42) Diameter of Rod of Knuckle Joint given Tensile Stress in Rod 🕑

$$fx \quad d_r = \sqrt{\frac{4 \cdot L}{\pi \cdot \sigma_t}}$$
Open Calculator (\*)
(\*)
$$fx \quad d_r = \sqrt{\frac{4 \cdot 45000N}{\pi \cdot 50N/mm^2}}$$
43) Enlarged Diameter of Rod of Knuckle Joint near Joint (\*)
(\*)
$$D_1 = 1.1 \cdot d_r$$
Open Calculator (\*)
(\*)
$$39mm = 1.1 \cdot 35.45455mm$$
44) Rod Diameter of Knuckle Joint given Thickness of Eye (\*)
(\*)
$$d_r = \frac{b}{1.25}$$
(\*)
$$35.44mm = \frac{44.3mm}{1.25}$$
45) Rod Diameter of Knuckle Joint given Thickness of Fork Eye (\*)
(\*)
$$d_r = \frac{a}{0.75}$$
Open Calculator (\*)
(\*)
$$35.46667mm = \frac{26.6mm}{0.75}$$



### Variables Used

- **a** Thickess of Fork Eye of Knuckle Joint (*Millimeter*)
- **b** Thickess of Eye of Knuckle Joint (Millimeter)
- d Diameter of Knuckle Pin (Millimeter)
- d<sub>1</sub> Diameter of Knuckle Pin Head (Millimeter)
- **D<sub>1</sub>** Enlarged Diameter of Knuckle Joint Rod (*Millimeter*)
- **d**<sub>o</sub> Outer Diameter of Eye of Knuckle Joint (*Millimeter*)
- **d**<sub>r</sub> Diameter of Knuckle Joint (*Millimeter*)
- d<sub>r1</sub> Diameter of Rod of Knuckle Joint (Millimeter)
- Length of Knuckle Pin in Eye End (Millimeter)
- L Load on Knuckle Joint (Newton)
- Mb Bending Moment in Knuckle Pin (Newton Millimeter)
- σ<sub>b</sub> Bending Stress in Knuckle Pin (Newton per Square Millimeter)
- σ<sub>c</sub> Compressive Stress in Knuckle Pin (Newton per Square Millimeter)
- σ<sub>t</sub> Tensile Stress in Knuckle Joint Rod (Newton per Square Millimeter)
- σ<sub>te</sub> Tensile Stress in Eye of Knuckle Joint (Newton per Square Millimeter)
- σ<sub>tf</sub> Tensile Stress in Fork of Knuckle Joint (Newton per Square Millimeter)
- Te Shear Stress in Eye of Knuckle Joint (Newton per Square Millimeter)
- Tf Shear Stress in Fork of Knuckle Joint (Newton per Square Millimeter)
- Tp Shear Stress in Knuckle Pin (Newton per Square Millimeter)



#### **Constants, Functions, Measurements used**

- Constant: pi, 3.14159265358979323846264338327950288 Archimedes' constant
- Function: sqrt, sqrt(Number) A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.
- Measurement: Length in Millimeter (mm) Length Unit Conversion
- Measurement: Force in Newton (N) Force Unit Conversion
- Measurement: Torque in Newton Millimeter (N\*mm)
   Torque Unit Conversion
- Measurement: Stress in Newton per Square Millimeter (N/mm<sup>2</sup>) Stress Unit Conversion



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- Design of Cotter Joint Formulas
- Design of Knuckle Joint Formulas
- Packing Formulas G
- Retaining Rings and Circlips
   Formulas

- Riveted Joints Formulas
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