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# Design of Knuckle Joint Formulas

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# List of 45 Design of Knuckle Joint Formulas

## Design of Knuckle Joint

### Diameter of Pin of Knuckle joint

#### 1) Diameter of Knuckle Pin given Bending Moment in Pin

$$\text{fx } d = \left( \frac{32 \cdot M_b}{\pi \cdot \sigma_b} \right)^{\frac{1}{3}}$$

[Open Calculator !\[\]\(de95854c7ee024cfadc48187bbb781b2\_img.jpg\)](#)

$$\text{ex } 38.23545\text{mm} = \left( \frac{32 \cdot 450000\text{N} \cdot \text{mm}}{\pi \cdot 82\text{N}/\text{mm}^2} \right)^{\frac{1}{3}}$$

#### 2) Diameter of Knuckle Pin given Bending Stress in Pin

$$\text{fx } d = \left( \frac{32 \cdot \frac{L}{2} \cdot \left( \frac{b}{4} + \frac{a}{3} \right)}{\pi \cdot \sigma_b} \right)^{\frac{1}{3}}$$

[Open Calculator !\[\]\(6a9b39b98eb945faa14c645ec99e4eaa\_img.jpg\)](#)

$$\text{ex } 38.70179\text{mm} = \left( \frac{32 \cdot \frac{50000\text{N}}{2} \cdot \left( \frac{40\text{mm}}{4} + \frac{26\text{mm}}{3} \right)}{\pi \cdot 82\text{N}/\text{mm}^2} \right)^{\frac{1}{3}}$$



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

$$\text{fx } d = \frac{L}{\sigma_c \cdot b}$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235\_img.jpg\)](#)

$$\text{ex } 41.66667\text{mm} = \frac{50000\text{N}}{30\text{N/mm}^2 \cdot 40\text{mm}}$$

### 4) Diameter of Pin of Knuckle Joint given Compressive Stress in Fork End Portion of Pin

$$\text{fx } d = \frac{L}{2 \cdot \sigma_c \cdot a}$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0\_img.jpg\)](#)

$$\text{ex } 32.05128\text{mm} = \frac{50000\text{N}}{2 \cdot 30\text{N/mm}^2 \cdot 26\text{mm}}$$

### 5) Diameter of Pin of Knuckle Joint given Diameter of Pinhead

$$\text{fx } d = \frac{d_1}{1.5}$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f\_img.jpg\)](#)

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



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

[Open Calculator !\[\]\(dfbd6b3763a6d1d9afaa974f64e2e4b5\_img.jpg\)](#)

$$\text{fx } d = \sqrt{\frac{2 \cdot L}{\pi \cdot \tau_{\text{pin}}}}$$

$$\text{ex } 37.04086\text{mm} = \sqrt{\frac{2 \cdot 50000\text{N}}{\pi \cdot 23.2\text{N/mm}^2}}$$

## 7) Diameter of Pin of Knuckle Joint given Outer Diameter of Eye

[Open Calculator !\[\]\(ec9132f1d27c8919987d92907322654d\_img.jpg\)](#)

$$\text{fx } d = \frac{d_o}{2}$$

$$\text{ex } 40\text{mm} = \frac{80\text{mm}}{2}$$

## 8) Diameter of Pin of Knuckle Joint given Shear Stress in Eye

[Open Calculator !\[\]\(758ebdf4629c903da74c2e079717ae32\_img.jpg\)](#)

$$\text{fx } d = d_o - \frac{L}{b \cdot \tau_{\text{eye}}}$$

$$\text{ex } 27.91667\text{mm} = 80\text{mm} - \frac{50000\text{N}}{40\text{mm} \cdot 24\text{N/mm}^2}$$



### 9) Diameter of Pin of Knuckle Joint given Shear Stress in Fork

$$fx \quad d = d_o - \frac{L}{2 \cdot \tau_{fork} \cdot a}$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a\_img.jpg\)](#)

$$ex \quad 41.53846mm = 80mm - \frac{50000N}{2 \cdot 25N/mm^2 \cdot 26mm}$$

### 10) Diameter of Pin of Knuckle Joint given Tensile Stress in Eye

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

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021\_img.jpg\)](#)

$$ex \quad 52.22222mm = 80mm - \frac{50000N}{40mm \cdot 45N/mm^2}$$

### 11) Diameter of Pin of Knuckle Joint given Tensile Stress in Fork

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

[Open Calculator !\[\]\(bd3b31712ad9bab5a241210fa6925cdd\_img.jpg\)](#)

$$ex \quad 43.71553mm = 80mm - \frac{50000N}{2 \cdot 26.5N/mm^2 \cdot 26mm}$$

### 12) Diameter of Pinhead of Knuckle Joint given Diameter of Pin

$$fx \quad d_1 = 1.5 \cdot d$$

[Open Calculator !\[\]\(7bc43b319a082987e20f7bf78f4bab80\_img.jpg\)](#)

$$ex \quad 55.5mm = 1.5 \cdot 37mm$$



### 13) Length of Pin of Knuckle Joint in Contact with Eye End

$$fx \quad l = \frac{L}{\sigma_c \cdot d}$$

[Open Calculator !\[\]\(d3fb9f94af8b26d1c844efa9a98805b0\_img.jpg\)](#)

$$ex \quad 45.04505mm = \frac{50000N}{30N/mm^2 \cdot 37mm}$$

### Diameter of Rod of Knuckle Joint

#### 14) Diameter of Rod of Knuckle Joint given its Enlarged Diameter near Joint

$$fx \quad d_{rk} = \frac{D_1}{1.1}$$

[Open Calculator !\[\]\(73002692dd5e7a64e60946be3158e719\_img.jpg\)](#)

$$ex \quad 35.45455mm = \frac{39mm}{1.1}$$

#### 15) Diameter of Rod of Knuckle Joint given Tensile Stress in Rod

$$fx \quad d_{rk} = \sqrt{\frac{4 \cdot L}{\pi \cdot (\sigma_t \text{rod})}}$$

[Open Calculator !\[\]\(104fbf564e2e5a8fbd84f31656d114c7\_img.jpg\)](#)

$$ex \quad 35.68248mm = \sqrt{\frac{4 \cdot 50000N}{\pi \cdot 50N/mm^2}}$$



## 16) Enlarged Diameter of Rod of Knuckle Joint near Joint

$$\text{fx } D_1 = 1.1 \cdot d_{rk}$$

[Open Calculator !\[\]\(9dfdaff1d86ba3c1f8353b4d1b61b8c5\_img.jpg\)](#)

$$\text{ex } 34.1\text{mm} = 1.1 \cdot 31\text{mm}$$

## 17) Rod Diameter of Knuckle Joint given Thickness of Eye

$$\text{fx } d_{rk} = \frac{b}{1.25}$$

[Open Calculator !\[\]\(2b376d1a92330ab09dad2665d2f89bf5\_img.jpg\)](#)

$$\text{ex } 32\text{mm} = \frac{40\text{mm}}{1.25}$$

## 18) Rod Diameter of Knuckle Joint given Thickness of Fork Eye

$$\text{fx } d_{rk} = \frac{a}{0.75}$$

[Open Calculator !\[\]\(c444627dab9fee9a1550c053ffaaaae2\_img.jpg\)](#)

$$\text{ex } 34.66667\text{mm} = \frac{26\text{mm}}{0.75}$$

## Outer Diameter of Eye of Knuckle Joint

### 19) Outer Diameter of Eye of Knuckle Joint given Diameter of Pin

$$\text{fx } d_o = 2 \cdot d$$

[Open Calculator !\[\]\(683dba75afe26e28cd4de5730b776760\_img.jpg\)](#)

$$\text{ex } 74\text{mm} = 2 \cdot 37\text{mm}$$



## 20) Outer Diameter of Eye of Knuckle Joint given Shear Stress in Eye

$$\text{fx } d_o = d + \frac{L}{b \cdot \tau_{\text{eye}}}$$

[Open Calculator !\[\]\(6605b201d6f14d9b3bcb8ab5f274d107\_img.jpg\)](#)

$$\text{ex } 89.08333\text{mm} = 37\text{mm} + \frac{50000\text{N}}{40\text{mm} \cdot 24\text{N/mm}^2}$$

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

$$\text{fx } d_o = \frac{L}{2 \cdot \tau_{\text{fork}} \cdot a} + d$$

[Open Calculator !\[\]\(e8fb589d58dad1692debababa5e928b6\_img.jpg\)](#)

$$\text{ex } 75.46154\text{mm} = \frac{50000\text{N}}{2 \cdot 25\text{N/mm}^2 \cdot 26\text{mm}} + 37\text{mm}$$

## 22) Outer Diameter of Eye of Knuckle Joint given Tensile Stress in Eye

$$\text{fx } d_o = d + \frac{L}{b \cdot (\sigma_{\text{t eye}})}$$

[Open Calculator !\[\]\(4688aadfd656ded00cd6bdfae55089a9\_img.jpg\)](#)

$$\text{ex } 64.77778\text{mm} = 37\text{mm} + \frac{50000\text{N}}{40\text{mm} \cdot 45\text{N/mm}^2}$$

## 23) Outer Diameter of Eye of Knuckle Joint given Tensile Stress in Fork

$$\text{fx } d_o = \frac{L}{2 \cdot (\sigma_{\text{t fork}}) \cdot a} + d$$

[Open Calculator !\[\]\(4146d17f71dced09c6ad789cacceaa6d\_img.jpg\)](#)

$$\text{ex } 73.28447\text{mm} = \frac{50000\text{N}}{2 \cdot 26.5\text{N/mm}^2 \cdot 26\text{mm}} + 37\text{mm}$$





## Stresses in Knuckle joint

### 24) Bending Stress in Knuckle Pin given Bending Moment in Pin

$$\text{fx } \sigma_b = \frac{32 \cdot M_b}{\pi \cdot d^3}$$

[Open Calculator !\[\]\(d66ff64371a51729ac8c1cdaa685ba6f\_img.jpg\)](#)

$$\text{ex } 90.49143\text{N/mm}^2 = \frac{32 \cdot 450000\text{N*mm}}{\pi \cdot (37\text{mm})^3}$$

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

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

[Open Calculator !\[\]\(faf942dc3e59ce8eb64b4ac481eca7e0\_img.jpg\)](#)

$$\text{ex } 93.84296\text{N/mm}^2 = \frac{32 \cdot \frac{50000\text{N}}{2} \cdot \left( \frac{40\text{mm}}{4} + \frac{26\text{mm}}{3} \right)}{\pi \cdot (37\text{mm})^3}$$

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

$$\text{fx } \sigma_c = \frac{L}{b \cdot d}$$

[Open Calculator !\[\]\(95b425611cbd2b8716a140cf67c81822\_img.jpg\)](#)

$$\text{ex } 33.78378\text{N/mm}^2 = \frac{50000\text{N}}{40\text{mm} \cdot 37\text{mm}}$$



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

$$\text{fx } \sigma_c = \frac{L}{2 \cdot a \cdot d}$$

[Open Calculator !\[\]\(0f848bbd71cef6b345273b16f905912a\_img.jpg\)](#)

$$\text{ex } 25.98753\text{N/mm}^2 = \frac{50000\text{N}}{2 \cdot 26\text{mm} \cdot 37\text{mm}}$$

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

$$\text{fx } M_b = \frac{L}{2} \cdot \left( \frac{b}{4} + \frac{a}{3} \right)$$

[Open Calculator !\[\]\(3211b5d1d968fc1665909b34f9f16010\_img.jpg\)](#)

$$\text{ex } 466666.7\text{N*mm} = \frac{50000\text{N}}{2} \cdot \left( \frac{40\text{mm}}{4} + \frac{26\text{mm}}{3} \right)$$

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

$$\text{fx } \tau_{\text{eye}} = \frac{L}{b \cdot (d_o - d)}$$

[Open Calculator !\[\]\(9c2e8d1b5bd77cb5c9f83b7a9cff79fd\_img.jpg\)](#)

$$\text{ex } 29.06977\text{N/mm}^2 = \frac{50000\text{N}}{40\text{mm} \cdot (80\text{mm} - 37\text{mm})}$$



### 30) Shear Stress in Fork of Knuckle Joint given Load, Outer Diameter of Eye and Pin Diameter

$$\text{fx } \tau_{\text{fork}} = \frac{L}{2 \cdot a \cdot (d_o - d)}$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235\_img.jpg\)](#)

$$\text{ex } 22.36136\text{N/mm}^2 = \frac{50000\text{N}}{2 \cdot 26\text{mm} \cdot (80\text{mm} - 37\text{mm})}$$

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

$$\text{fx } \tau_{\text{pin}} = \frac{2 \cdot L}{\pi \cdot d^2}$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0\_img.jpg\)](#)

$$\text{ex } 23.25127\text{N/mm}^2 = \frac{2 \cdot 50000\text{N}}{\pi \cdot (37\text{mm})^2}$$

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

$$\text{fx } (\sigma_{\text{t eye}}) = \frac{L}{b \cdot (d_o - d)}$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f\_img.jpg\)](#)

$$\text{ex } 29.06977\text{N/mm}^2 = \frac{50000\text{N}}{40\text{mm} \cdot (80\text{mm} - 37\text{mm})}$$



### 33) Tensile Stress in Fork of Knuckle Joint given Load, Outer Diameter of Eye and Pin Diameter

$$\text{fx } (\sigma_{\text{t fork}}) = \frac{L}{2 \cdot a \cdot (d_o - d)}$$

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95\_img.jpg\)](#)

$$\text{ex } 22.36136 \text{ N/mm}^2 = \frac{50000 \text{ N}}{2 \cdot 26 \text{ mm} \cdot (80 \text{ mm} - 37 \text{ mm})}$$

### 34) Tensile Stress in Rod of Knuckle Joint

$$\text{fx } (\sigma_{\text{t rod}}) = \frac{4 \cdot L}{\pi \cdot d_{\text{rk}}^2}$$

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2\_img.jpg\)](#)

$$\text{ex } 66.24555 \text{ N/mm}^2 = \frac{4 \cdot 50000 \text{ N}}{\pi \cdot (31 \text{ mm})^2}$$

## Thickness of Eye End of Knuckle Joint

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

$$\text{fx } b = 4 \cdot \left( 2 \cdot \frac{M_b}{L} - \frac{a}{3} \right)$$

[Open Calculator !\[\]\(626ce8ac21792b9405bfddfea8e0c96a\_img.jpg\)](#)

$$\text{ex } 37.33333 \text{ mm} = 4 \cdot \left( 2 \cdot \frac{450000 \text{ N*mm}}{50000 \text{ N}} - \frac{26 \text{ mm}}{3} \right)$$



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

$$fx \quad b = 4 \cdot \left( \frac{\pi \cdot d^3 \cdot \sigma_b}{16 \cdot L} - \frac{a}{3} \right)$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a\_img.jpg\)](#)

$$ex \quad 30.57708mm = 4 \cdot \left( \frac{\pi \cdot (37mm)^3 \cdot 82N/mm^2}{16 \cdot 50000N} - \frac{26mm}{3} \right)$$

### 37) Thickness of Eye End of Knuckle Joint given Shear Stress in Eye

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

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021\_img.jpg\)](#)

$$ex \quad 48.44961mm = \frac{50000N}{24N/mm^2 \cdot (80mm - 37mm)}$$

### 38) Thickness of Eye End of Knuckle Joint given Tensile Stress in Eye

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

[Open Calculator !\[\]\(bd3b31712ad9bab5a241210fa6925cdd\_img.jpg\)](#)

$$ex \quad 25.83979mm = \frac{50000N}{45N/mm^2 \cdot (80mm - 37mm)}$$

### 39) Thickness of Eye of Knuckle Joint given Rod Diameter

$$fx \quad b = 1.25 \cdot d_{rk}$$

[Open Calculator !\[\]\(7bc43b319a082987e20f7bf78f4bab80\_img.jpg\)](#)

$$ex \quad 38.75mm = 1.25 \cdot 31mm$$



## Thickness of Fork Eye of Knuckle Joint

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

$$\text{fx } a = 3 \cdot \left( 2 \cdot \frac{M_b}{L} - \frac{b}{4} \right)$$

[Open Calculator !\[\]\(950a62bbddad88d64435fd35607dfc42\_img.jpg\)](#)

$$\text{ex } 24\text{mm} = 3 \cdot \left( 2 \cdot \frac{450000\text{N} \cdot \text{mm}}{50000\text{N}} - \frac{40\text{mm}}{4} \right)$$

### 41) Thickness of Fork Eye of Knuckle Joint given Bending Stress in Pin

$$\text{fx } a = 3 \cdot \left( \frac{\pi \cdot d^3 \cdot \sigma_b}{16 \cdot L} - \frac{b}{4} \right)$$

[Open Calculator !\[\]\(73002692dd5e7a64e60946be3158e719\_img.jpg\)](#)

$$\text{ex } 18.93281\text{mm} = 3 \cdot \left( \frac{\pi \cdot (37\text{mm})^3 \cdot 82\text{N/mm}^2}{16 \cdot 50000\text{N}} - \frac{40\text{mm}}{4} \right)$$

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

$$\text{fx } a = \frac{L}{2 \cdot \sigma_c \cdot d}$$

[Open Calculator !\[\]\(104fbf564e2e5a8fbd84f31656d114c7\_img.jpg\)](#)

$$\text{ex } 22.52252\text{mm} = \frac{50000\text{N}}{2 \cdot 30\text{N/mm}^2 \cdot 37\text{mm}}$$



### 43) Thickness of Fork Eye of Knuckle Joint given Rod Diameter

$$\text{fx } a = 0.75 \cdot d_{rk}$$

[Open Calculator !\[\]\(9dfdaff1d86ba3c1f8353b4d1b61b8c5\_img.jpg\)](#)

$$\text{ex } 23.25\text{mm} = 0.75 \cdot 31\text{mm}$$

### 44) Thickness of Fork Eye of Knuckle Joint given Shear Stress in Fork

$$\text{fx } a = \frac{L}{2 \cdot \tau_{\text{fork}} \cdot (d_o - d)}$$

[Open Calculator !\[\]\(2b376d1a92330ab09dad2665d2f89bf5\_img.jpg\)](#)

$$\text{ex } 23.25581\text{mm} = \frac{50000\text{N}}{2 \cdot 25\text{N/mm}^2 \cdot (80\text{mm} - 37\text{mm})}$$

### 45) Thickness of Fork Eye of Knuckle Joint given Tensile Stress in Fork

$$\text{fx } a = \frac{L}{2 \cdot (\sigma_t \text{fork}) \cdot (d_o - d)}$$

[Open Calculator !\[\]\(c444627dab9fee9a1550c053ffaaaae2\_img.jpg\)](#)

$$\text{ex } 21.93945\text{mm} = \frac{50000\text{N}}{2 \cdot 26.5\text{N/mm}^2 \cdot (80\text{mm} - 37\text{mm})}$$







## Variables Used

- **a** Thickness of Fork Eye of Knuckle Joint (*Millimeter*)
- **b** Thickness 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>rk</sub>** Diameter of Rod of Knuckle Joint (*Millimeter*)
- **l** Length of Knuckle Pin in Eye End (*Millimeter*)
- **L** Load on Knuckle Joint (*Newton*)
- **M<sub>b</sub>** 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>eye** Tensile Stress in Eye of Knuckle Joint (*Newton per Square Millimeter*)
- **σ<sub>t</sub>fork** Tensile Stress in Fork of Knuckle Joint (*Newton per Square Millimeter*)
- **σ<sub>t</sub>rod** Tensile Stress in Knuckle Joint Rod (*Newton per Square Millimeter*)
- **T<sub>eye</sub>** Shear Stress in Eye of Knuckle Joint (*Newton per Square Millimeter*)
- **T<sub>fork</sub>** Shear Stress in Fork of Knuckle Joint (*Newton per Square Millimeter*)
- **T<sub>pin</sub>** Shear Stress in Knuckle Pin (*Newton per Square Millimeter*)







## Constants, Functions, Measurements used

- **Constant:** **pi**, 3.14159265358979323846264338327950288  
*Archimedes' constant*
- **Function:** **sqrt**, sqrt(Number)  
*Square root function*
- **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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