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Design of Shafts Formulas

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List of 62 Design of Shafts Formulas

Design of Shafts

ASME Code for Shaft Desgin

1) Diameter of Shaft given Principle Shear Stress

Open Calculator

fx $$d_{ASME} = \left(\frac{16}{\pi \cdot \tau_{max\ ASME}} \cdot \sqrt{(Mt_{shaft} \cdot k_t)^2 + (k_b \cdot M_b)^2} \right)^{\frac{1}{3}}$$

ex $$59.75829mm = \left(\frac{16}{\pi \cdot 78N/mm^2} \cdot \sqrt{(3.3E5N{*}mm \cdot 1.3)^2 + (1.8 \cdot 1.8E6N{*}mm)^2} \right)^{\frac{1}{3}}$$

2) Equivalent Bending Moment when Shaft is Subjected to Fluctuating Loads

Open Calculator

fx $$Mb_{feq} = k_b \cdot M_b + \sqrt{(Mt_{shaft} \cdot k_t)^2 + (k_b \cdot M_b)^2}$$

ex $$6.5E\hat{}6N{*}mm = 1.8 \cdot 1.8E6N{*}mm + \sqrt{(3.3E5N{*}mm \cdot 1.3)^2 + (1.8 \cdot 1.8E6N{*}mm)^2}$$

3) Equivalent Torsional Moment when Shaft is Subjected to Fluctuating Loads

Open Calculator

fx $$Mt_{feq} = \sqrt{(Mt_{shaft} \cdot k_t)^2 + (k_b \cdot M_b)^2}$$

ex $$3.3E\hat{}6N{*}mm = \sqrt{(3.3E5N{*}mm \cdot 1.3)^2 + (1.8 \cdot 1.8E6N{*}mm)^2}$$

4) Principle Shear Stress Maximum Shear Stress Theory of Failure

Open Calculator

fx $$\tau_{max\ ASME} = \frac{16}{\pi \cdot d_{ASME}^3} \cdot \sqrt{(Mt_{shaft} \cdot k_t)^2 + (k_b \cdot M_b)^2}$$

ex $$150.51N/mm^2 = \frac{16}{\pi \cdot (48mm)^3} \cdot \sqrt{(3.3E5N{*}mm \cdot 1.3)^2 + (1.8 \cdot 1.8E6N{*}mm)^2}$$

Design of Hollow Shaft

5) Angle of Twist of Hollow Shaft on Basis of Torsional Rigidity

Open Calculator

fx $$\theta_{hollow} = 584 \cdot Mt_{hollowshaft} \cdot \frac{L_h}{G_h \cdot d_o^4 \cdot \left(1 - C^4\right)}$$

ex $$23.58565^\circ = 584 \cdot 3.2E5N*mm \cdot \frac{330mm}{70000N/mm^2 \cdot (46mm)^4 \cdot \left(1 - (0.85)^4\right)}$$

6) Axial Tensile Force given Tensile Stress in Hollow Shaft

Open Calculator

fx $$P_{ax\ hollow} = \sigma_{tp} \cdot \frac{\pi}{4} \cdot \left(d_o^2 - d_i^2\right)$$

ex $$25982.54N = 55.6N/mm^2 \cdot \frac{\pi}{4} \cdot \left((46mm)^2 - (39mm)^2\right)$$

7) Bending Moment given Bending Stress in Hollow Shaft

Open Calculator

fx $$M_{b\ h} = \sigma_{b\ h} \cdot \frac{\pi \cdot d_o^3 \cdot \left(1 - \left(C^4\right)\right)}{32}$$

ex $$549948.6N*mm = 120.4N/mm^2 \cdot \frac{\pi \cdot (46mm)^3 \cdot \left(1 - \left((0.85)^4\right)\right)}{32}$$

8) Bending Stress in Hollow Shaft

Open Calculator

fx $$\sigma_{b\ h} = 32 \cdot \frac{M_{b\ h}}{\pi \cdot d_o^3 \cdot \left(1 - C^4\right)}$$

ex $$120.4113N/mm^2 = 32 \cdot \frac{5.5E5N*mm}{\pi \cdot (46mm)^3 \cdot \left(1 - (0.85)^4\right)}$$

9) Inner Diameter of Hollow Shaft given Ratio of Diameters

Open Calculator

fx $$d_i = C \cdot d_o$$

ex $$39.1mm = 0.85 \cdot 46mm$$

10) Length of Shaft given Angle of Twist of Hollow Shaft on Basis of Torsional Rigidity

Open Calculator

fx $$L_h = \theta_{hollow} \cdot \frac{G_h \cdot d_o^4 \cdot (1 - C^4)}{584 \cdot Mt_{hollowshaft}}$$

ex $$329.921\text{mm} = 23.58^\circ \cdot \frac{70000\text{N/mm²} \cdot (46\text{mm})^4 \cdot \left(1 - (0.85)^4\right)}{584 \cdot 3.2\text{E5N*mm}}$$

11) Modulus of Rigidity given Angle of Twist of Hollow Shaft on basis of Torsional Rigidity

Open Calculator

fx $$G_h = 584 \cdot Mt_{hollowshaft} \cdot \frac{L_h}{\theta_{hollow} \cdot d_o^4 \cdot (1 - C^4)}$$

ex $$70016.77\text{N/mm²} = 584 \cdot 3.2\text{E5N*mm} \cdot \frac{330\text{mm}}{23.58^\circ \cdot (46\text{mm})^4 \cdot \left(1 - (0.85)^4\right)}$$

12) Outer Diameter given Ratio of Diameters

Open Calculator

fx $$d_o = \frac{d_i}{C}$$

ex $$45.88235\text{mm} = \frac{39\text{mm}}{0.85}$$

13) Outer Diameter of Hollow Shaft given Angle of Twist Torsional Rigidity

Open Calculator

fx $$d_o = \left(584 \cdot Mt_{hollowshaft} \cdot \frac{L_h}{G_h \cdot \theta_{hollow} \cdot (1 - C^4)}\right)^{\frac{1}{4}}$$

ex $$46.00275\text{mm} = \left(584 \cdot 3.2\text{E5N*mm} \cdot \frac{330\text{mm}}{70000\text{N/mm²} \cdot 23.58^\circ \cdot \left(1 - (0.85)^4\right)}\right)^{\frac{1}{4}}$$

14) Outer Diameter of Hollow Shaft given Bending Stress of Hollow Shaft

Open Calculator

fx $$d_o = \left(32 \cdot \frac{M_{b\,h}}{\pi \cdot \sigma_{b\,h} \cdot \left(1 - C^4\right)}\right)^{\frac{1}{3}}$$

ex $$46.00143\text{mm} = \left(32 \cdot \frac{5.5\text{E}5\text{N*mm}}{\pi \cdot 120.4\text{N/mm}^2 \cdot \left(1 - (0.85)^4\right)}\right)^{\frac{1}{3}}$$

15) Outer Diameter of Hollow Shaft given Principle Stress

Open Calculator

fx $$d_o = \left(16 \cdot \frac{M_{b\,h} + \sqrt{M_{b\,h}^2 + Mt_{hollowshaft}^2}}{\pi \cdot \tau \cdot \left(1 - C^4\right)}\right)^{\frac{1}{3}}$$

ex $$46.00708\text{mm} = \left(16 \cdot \frac{5.5\text{E}5\text{N*mm} + \sqrt{(5.5\text{E}5\text{N*mm})^2 + (3.2\text{E}5\text{N*mm})^2}}{\pi \cdot 129.8\text{N/mm}^2 \cdot \left(1 - (0.85)^4\right)}\right)^{\frac{1}{3}}$$

16) Outer Diameter of Shaft given Torsional Shear Stress

Open Calculator

fx $$d_o = \left(16 \cdot \frac{Mt_{hollowshaft}}{\pi \cdot \tau_h \cdot \left(1 - C^4\right)}\right)^{\frac{1}{3}}$$

ex $$45.96884\text{mm} = \left(16 \cdot \frac{3.2\text{E}5\text{N*mm}}{\pi \cdot 35.1\text{N/mm}^2 \cdot \left(1 - (0.85)^4\right)}\right)^{\frac{1}{3}}$$

17) Principle Stress Maximum Principle Stress Theory

Open Calculator

fx $$\tau = 16 \cdot \frac{M_{b\,h} + \sqrt{M_{b\,h}^2 + Mt_{hollowshaft}^2}}{\pi \cdot d_o^3 \cdot (1 - C^4)}$$

ex $$129.86\text{N/mm}^2 = 16 \cdot \frac{5.5\text{E}5\text{N*mm} + \sqrt{(5.5\text{E}5\text{N*mm})^2 + (3.2\text{E}5\text{N*mm})^2}}{\pi \cdot (46\text{mm})^3 \cdot \left(1 - (0.85)^4\right)}$$

18) Ratio of Diameter given Torsional Shear Stress in Hollow Shaft

Open Calculator

fx $$C = \left(1 - 16 \cdot \frac{Mt_{hollowshaft}}{\pi \cdot d_o^3 \cdot \tau_h}\right)^{\frac{1}{4}}$$

ex $$0.850395 = \left(1 - 16 \cdot \frac{3.2\text{E}5\text{N*mm}}{\pi \cdot (46\text{mm})^3 \cdot 35.1\text{N/mm}^2}\right)^{\frac{1}{4}}$$

19) Ratio of Diameters given Angle of Twist of Hollow Shaft and Torsional Rigidity

Open Calculator

fx $$C = \left(1 - 584 \cdot Mt_{hollowshaft} \cdot \frac{L_h}{G_h \cdot d_o^4 \cdot \theta_{hollow}}\right)^{\frac{1}{4}}$$

ex $$0.849953 = \left(1 - 584 \cdot 3.2\text{E}5\text{N*mm} \cdot \frac{330\text{mm}}{70000\text{N/mm}^2 \cdot (46\text{mm})^4 \cdot 23.58^\circ}\right)^{\frac{1}{4}}$$

20) Ratio of Diameters given Bending Stress of Hollow Shaft

Open Calculator

fx $$C = \left(1 - 32 \cdot \frac{M_{b\,h}}{\pi \cdot d_o^3 \cdot \sigma_{b\,h}}\right)^{\frac{1}{4}}$$

ex $$0.849982 = \left(1 - 32 \cdot \frac{5.5\text{E}5\text{N*mm}}{\pi \cdot (46\text{mm})^3 \cdot 120.4\text{N/mm}^2}\right)^{\frac{1}{4}}$$

21) Ratio of Diameters given Principle Stress

Open Calculator

fx $$C = \left(1 - 16 \cdot \frac{M_{b\,h} + \sqrt{M_{b\,h}^2 + Mt_{hollowshaft}^2}}{\pi \cdot d_o^3 \cdot \tau}\right)^{\frac{1}{4}}$$

ex $$0.84991 = \left(1 - 16 \cdot \frac{5.5E5N^*mm + \sqrt{(5.5E5N^*mm)^2 + (3.2E5N^*mm)^2}}{\pi \cdot (46mm)^3 \cdot 129.8N/mm^2}\right)^{\frac{1}{4}}$$

22) Ratio of Diameters given Tensile Stress in Hollow Shaft

Open Calculator

fx $$C = \sqrt{1 - \left(\frac{P_{ax\ hollow}}{\frac{\pi}{4} \cdot \sigma_{tp} \cdot d_o^2}\right)}$$

ex $$0.847842 = \sqrt{1 - \left(\frac{25980N}{\frac{\pi}{4} \cdot 55.6N/mm^2 \cdot (46mm)^2}\right)}$$

23) Ratio of Inner Diameter to Outer Diameter

Open Calculator

fx $$C = \frac{d_i}{d_o}$$

ex $$0.847826 = \frac{39mm}{46mm}$$

24) Tensile Stress in Hollow Shaft when Subjected to Axial Force

Open Calculator

fx $$\sigma_{tp} = \frac{P_{ax\ hollow}}{\frac{\pi}{4} \cdot (d_o^2 - d_i^2)}$$

ex $$55.59456N/mm^2 = \frac{25980N}{\frac{\pi}{4} \cdot \left((46mm)^2 - (39mm)^2\right)}$$

25) Torsional Moment given Angle of Twist on Basis of Torsional Rigidity

Open Calculator

$$Mt_{hollowshaft} = \theta_{hollow} \cdot \frac{G_h \cdot d_o^4 \cdot (1 - C^4)}{584 \cdot L_h}$$

$$319923.4 N^*mm = 23.58° \cdot \frac{70000 N/mm^2 \cdot (46mm)^4 \cdot \left(1 - (0.85)^4\right)}{584 \cdot 330mm}$$

26) Torsional Moment given Torsional Shear Stress in Hollow Shaft

Open Calculator

$$Mt_{hollowshaft} = \tau_h \cdot \frac{\pi \cdot d_o^3 \cdot (1 - C^4)}{16}$$

$$320651.1 N^*mm = 35.1 N/mm^2 \cdot \frac{\pi \cdot (46mm)^3 \cdot \left(1 - (0.85)^4\right)}{16}$$

27) Torsional Shear Stress when Shaft is Subjected to Pure Torsional Moment

Open Calculator

$$\tau_h = 16 \cdot \frac{Mt_{hollowshaft}}{\pi \cdot d_o^3 \cdot (1 - C^4)}$$

$$35.02873 N/mm^2 = 16 \cdot \frac{3.2E5 N^*mm}{\pi \cdot (46mm)^3 \cdot \left(1 - (0.85)^4\right)}$$

Maximum Shear Stress and Principal Stress Theory

28) Bending Moment given Maximum Shear Stress

Open Calculator

$$M_{b\,MSST} = \sqrt{\left(\frac{\tau_{max\,MSST}}{\frac{16}{\pi \cdot d_{MSST}^3}}\right)^2 - Mt_t^2}$$

$$980230 N^*mm = \sqrt{\left(\frac{58.9 N/mm^2}{\frac{16}{\pi \cdot (45mm)^3}}\right)^2 - (3.87E5 N^*mm)^2}$$

29) Diameter of Shaft given Permissible Value of Maximum Principle Stress

Open Calculator

fx $$d_{MPST} = \left(\frac{16}{\pi \cdot \sigma_1} \cdot \left(M_b + \sqrt{M_b^2 + Mt_{shaft}^2}\right)\right)^{\frac{1}{3}}$$

ex $$51.50622\text{mm} = \left(\frac{16}{\pi \cdot 135.3\text{N/mm}^2} \cdot \left(1.8\text{E6N*mm} + \sqrt{(1.8\text{E6N*mm})^2 + (3.3\text{E5N*mm})^2}\right)\right)^{\frac{1}{3}}$$

30) Diameter of Shaft given Principle Shear Stress Maximum Shear Stress Theory

Open Calculator

fx $$d_{MSST} = \left(\frac{16}{\pi \cdot \tau_{max\ MSST}} \cdot \sqrt{M_{b\ MSST}^2 + Mt_t^2}\right)^{\frac{1}{3}}$$

ex $$44.99695\text{mm} = \left(\frac{16}{\pi \cdot 58.9\text{N/mm}^2} \cdot \sqrt{(9.8\text{E5N*mm})^2 + (3.87\text{E5N*mm})^2}\right)^{\frac{1}{3}}$$

31) Equivalent Bending Moment given Torsional Moment

Open Calculator

fx $$Mb_{eq} = M_{b\ MSST} + \sqrt{M_{b\ MSST}^2 + Mt_t^2}$$

ex $$2\text{E\^{}6N*mm} = 9.8\text{E5N*mm} + \sqrt{(9.8\text{E5N*mm})^2 + (3.87\text{E5N*mm})^2}$$

32) Factor of Safety given Permissible Value of Maximum Principle Stress

Open Calculator

fx $$f_s = \frac{F_{ce}}{\sigma_1}$$

ex $$1.884701 = \frac{255\text{N/mm}^2}{135.3\text{N/mm}^2}$$

33) Factor of Safety given Permissible Value of Maximum Shear Stress

Open Calculator

fx $$f_s = 0.5 \cdot \frac{\sigma_{yt}}{\tau_{max\ MSST}}$$

ex $$1.88455 = 0.5 \cdot \frac{222\text{N/mm}^2}{58.9\text{N/mm}^2}$$

34) Maximum Shear Stress in Shafts

Open Calculator

fx $$\tau_{\max\ \mathrm{MSST}} = \frac{16}{\pi \cdot d_{\mathrm{MSST}}^3} \cdot \sqrt{M_{b\ \mathrm{MSST}}^2 + Mt_t^2}$$

ex $$58.88804\mathrm{N/mm^2} = \frac{16}{\pi \cdot (45\mathrm{mm})^3} \cdot \sqrt{(9.8E5\mathrm{N^*mm})^2 + (3.87E5\mathrm{N^*mm})^2}$$

35) Permissible Value of Maximum Principle Stress

Open Calculator

fx $$\sigma_1 = \frac{16}{\pi \cdot d_{\mathrm{MPST}}^3} \cdot \left(M_b + \sqrt{M_b^2 + Mt_{\mathrm{shaft}}^2}\right)$$

ex $$135.349\mathrm{N/mm^2} = \frac{16}{\pi \cdot (51.5\mathrm{mm})^3} \cdot \left(1.8E6\mathrm{N^*mm} + \sqrt{(1.8E6\mathrm{N^*mm})^2 + (3.3E5\mathrm{N^*mm})^2}\right)$$

36) Permissible Value of Maximum Principle Stress using Factor of Safety

Open Calculator

fx $$\sigma_1 = \frac{F_{ce}}{f_s}$$

ex $$135.6383\mathrm{N/mm^2} = \frac{255\mathrm{N/mm^2}}{1.88}$$

37) Permissible Value of Maximum Shear Stress

Open Calculator

fx $$\tau_{\max\ \mathrm{MSST}} = 0.5 \cdot \frac{\sigma_{yt}}{f_s}$$

ex $$59.04255\mathrm{N/mm^2} = 0.5 \cdot \frac{222\mathrm{N/mm^2}}{1.88}$$

38) Torsional Moment given Equivalent Bending Moment

Open Calculator

fx $$Mt_t = \sqrt{(Mb_{eq} - M_{b\ \mathrm{MSST}})^2 - M_{b\ \mathrm{MSST}}^2}$$

ex $$376961.5\mathrm{N^*mm} = \sqrt{(2.03E6\mathrm{N^*mm} - 9.8E5\mathrm{N^*mm})^2 - (9.8E5\mathrm{N^*mm})^2}$$

39) Torsional Moment given Maximum Shear Stress

Open Calculator

fx $$Mt_t = \sqrt{\left(\pi \cdot d_{MSST}^3 \cdot \frac{\tau_{max\ MSST}}{16}\right)^2 - M_{b\ MSST}^2}$$

ex $$387582.1N*mm = \sqrt{\left(\pi \cdot (45mm)^3 \cdot \frac{58.9N/mm^2}{16}\right)^2 - (9.8E5N*mm)^2}$$

40) Yield Strength in Shear Maximum Shear Stress Theory

Open Calculator

fx $$S_{sy} = 0.5 \cdot f_s \cdot \sigma_1$$

ex $$127.182N/mm^2 = 0.5 \cdot 1.88 \cdot 135.3N/mm^2$$

41) Yield Stress in Shear given Permissible Value of Maximum Principle Stress

Open Calculator

fx $$F_{ce} = \sigma_1 \cdot f_s$$

ex $$254.364N/mm^2 = 135.3N/mm^2 \cdot 1.88$$

Shaft Design on Strength Basis

42) Axial Force given Tensile Stress in Shaft

Open Calculator

fx $$P_{ax} = \sigma_t \cdot \pi \cdot \frac{d^2}{4}$$

ex $$125767.1N = 72.8N/mm^2 \cdot \pi \cdot \frac{(46.9mm)^2}{4}$$

43) Bending Moment given Bending Stress Pure Bending

Open Calculator

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

ex $$1.8E\hat{}6N*mm = \frac{177.8N/mm^2 \cdot \pi \cdot (46.9mm)^3}{32}$$

44) Bending Stress given Normal Stress

Open Calculator

fx $$\sigma_b = \sigma_x - \sigma_t$$

ex $$177.8\text{N/mm}^2 = 250.6\text{N/mm}^2 - 72.8\text{N/mm}^2$$

45) Bending Stress in Shaft Pure Bending Moment

Open Calculator

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

ex $$177.7273\text{N/mm}^2 = \frac{32 \cdot 1.8\text{E}6\text{N*mm}}{\pi \cdot (46.9\text{mm})^3}$$

46) Diameter of Shaft given Bending Stress Pure Bending

Open Calculator

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

ex $$46.8936\text{mm} = \left(\frac{32 \cdot 1.8\text{E}6\text{N*mm}}{\pi \cdot 177.8\text{N/mm}^2}\right)^{\frac{1}{3}}$$

47) Diameter of Shaft given Tensile Stress in Shaft

Open Calculator

fx $$d = \sqrt{4 \cdot \frac{P_{ax}}{\pi \cdot \sigma_t}}$$

ex $$46.94341\text{mm} = \sqrt{4 \cdot \frac{1.26\text{E}5\text{N}}{\pi \cdot 72.8\text{N/mm}^2}}$$

48) Diameter of Shaft given Torsional Shear Stress in Shaft Pure Torsion

Open Calculator

fx $$d = \left(16 \cdot \frac{Mt_{shaft}}{\pi \cdot \tau}\right)^{\frac{1}{3}}$$

ex $$46.9016\text{mm} = \left(16 \cdot \frac{3.3\text{E}5\text{N*mm}}{\pi \cdot 16.29\text{N/mm}^2}\right)^{\frac{1}{3}}$$

49) Maximum Shear Stress in Shaft Bending and Torsion

Open Calculator

fx $$\tau_{smax} = \sqrt{\left(\frac{\sigma_x}{2}\right)^2 + \tau^2}$$

ex $$126.3545\text{N/mm²} = \sqrt{\left(\frac{250.6\text{N/mm²}}{2}\right)^2 + (16.29\text{N/mm²})^2}$$

50) Normal Stress given Both Bending and Torsional act on Shaft

Open Calculator

fx $$\sigma_x = \sigma_b + \sigma_t$$

ex $$250.6\text{N/mm²} = 177.8\text{N/mm²} + 72.8\text{N/mm²}$$

51) Normal Stress given Principal Shear Stress in Shaft Bending and Torsion

Open Calculator

fx $$\sigma_x = 2 \cdot \sqrt{\tau_{max}^2 - \tau^2}$$

ex $$250.8935\text{N/mm²} = 2 \cdot \sqrt{(126.5\text{N/mm²})^2 - (16.29\text{N/mm²})^2}$$

52) Power transmitted by Shaft

Open Calculator

fx $$P = 2 \cdot \pi \cdot N \cdot M_t$$

ex $$8.834159\text{kW} = 2 \cdot \pi \cdot 1850\text{rev/min} \cdot 45600\text{N*mm}$$

53) Tensile Stress given Normal Stress

Open Calculator

fx $$\sigma_t = \sigma_x - \sigma_b$$

ex $$72.8\text{N/mm²} = 250.6\text{N/mm²} - 177.8\text{N/mm²}$$

54) Tensile Stress in Shaft when it is Subjected to Axial Tensile Force

Open Calculator

fx $$\sigma_t = 4 \cdot \frac{P_{ax}}{\pi \cdot d^2}$$

ex $$72.93483\text{N/mm²} = 4 \cdot \frac{1.26\text{E}5\text{N}}{\pi \cdot (46.9\text{mm})^2}$$

55) Torsional Moment given Torsional Shear Stress in Shaft Pure Torsion

Open Calculator

fx $$\mathrm{Mt_{shaft}} = \tau \cdot \pi \cdot \frac{\mathrm{d}^3}{16}$$

ex $$329966.2\mathrm{N*mm} = 16.29\mathrm{N/mm^2} \cdot \pi \cdot \frac{(46.9\mathrm{mm})^3}{16}$$

56) Torsional Shear Stress given Principal Shear Stress in Shaft

Open Calculator

fx $$\tau = \sqrt{\tau_{\mathrm{max}}^2 - \left(\frac{\sigma_{\mathrm{x}}}{2}\right)^2}$$

ex $$17.38275\mathrm{N/mm^2} = \sqrt{(126.5\mathrm{N/mm^2})^2 - \left(\frac{250.6\mathrm{N/mm^2}}{2}\right)^2}$$

57) Torsional Shear Stress in Shaft Pure Torsion

Open Calculator

fx $$\tau = 16 \cdot \frac{\mathrm{Mt_{shaft}}}{\pi \cdot \mathrm{d}^3}$$

ex $$16.29167\mathrm{N/mm^2} = 16 \cdot \frac{3.3\mathrm{E}5\mathrm{N*mm}}{\pi \cdot (46.9\mathrm{mm})^3}$$

Torsional Rigidity

58) Angle of Twist of Shaft

Open Calculator

fx $$\theta = 584 \cdot \mathrm{Mt_{shaft}} \cdot \frac{\mathrm{L}}{\mathrm{G} \cdot \mathrm{d_{torl}^4}}$$

ex $$15.41922^\circ = 584 \cdot 3.3\mathrm{E}5\mathrm{N*mm} \cdot \frac{450\mathrm{mm}}{90000\mathrm{N/mm^2} \cdot (43.5\mathrm{mm})^4}$$

59) Length of Shaft Subjected to Torsional Moment given Angle of Twist

Open Calculator

fx $$L = \theta \cdot \frac{G \cdot d_{torl}^4}{584 \cdot Mt_{shaft}}$$

ex $$450.0228\text{mm} = 15.42° \cdot \frac{90000\text{N/mm²} \cdot (43.5\text{mm})^4}{584 \cdot 3.3\text{E5N*mm}}$$

60) Modulus of Rigidity given Angle of Twist

Open Calculator

fx $$G = 584 \cdot Mt_{shaft} \cdot \frac{L}{\theta \cdot d_{torl}^4}$$

ex $$89995.45\text{N/mm²} = 584 \cdot 3.3\text{E5N*mm} \cdot \frac{450\text{mm}}{15.42° \cdot (43.5\text{mm})^4}$$

61) Shaft Diameter given Angle of Twist in Shaft

Open Calculator

fx $$d_{torl} = \left(584 \cdot Mt_{shaft} \cdot \frac{L}{G \cdot \theta}\right)^{\frac{1}{4}}$$

ex $$43.49945\text{mm} = \left(584 \cdot 3.3\text{E5N*mm} \cdot \frac{450\text{mm}}{90000\text{N/mm²} \cdot 15.42°}\right)^{\frac{1}{4}}$$

62) Torsional Moment given Angle of Twist in Shaft

Open Calculator

fx $$Mt_{shaft} = \theta \cdot \frac{G \cdot d_{torl}^4}{L \cdot 584}$$

ex $$330016.7\text{N*mm} = 15.42° \cdot \frac{90000\text{N/mm²} \cdot (43.5\text{mm})^4}{450\text{mm} \cdot 584}$$

Variables Used

- **C** Ratio of Inner to Outer Diameter of Hollow Shaft
- **d** Diameter of Shaft on Strength Basis *(Millimeter)*
- d_{ASME} Diameter of Shaft from ASME *(Millimeter)*
- d_i Inner Diameter of Hollow Shaft *(Millimeter)*
- d_{MPST} Diameter of Shaft from MPST *(Millimeter)*
- d_{MSST} Diameter of Shaft from MSST *(Millimeter)*
- d_o Outer Diameter of Hollow Shaft *(Millimeter)*
- d_{torl} Diameter of Shaft from Torsional Rigidity *(Millimeter)*
- F_{ce} Yield Strength in Shaft from MPST *(Newton per Square Millimeter)*
- f_s Factor of Safety of Shaft
- **G** Modulus of Rigidity of Shaft *(Newton per Square Millimeter)*
- G_h Modulus of Rigidity of Hollow Shaft *(Newton per Square Millimeter)*
- k_b Combined Shock Fatigue Factor of Bending Moment
- k_t Combined Shock Fatigue Factor of Torsion Moment
- **L** Length of Shaft from Torsional Rigidity *(Millimeter)*
- L_h Length of Hollow Shaft *(Millimeter)*
- $M_{b\ h}$ Bending Moment in Hollow Shaft *(Newton Millimeter)*
- $M_{b\ MSST}$ Bending Moment in Shaft for MSST *(Newton Millimeter)*
- M_b Bending Moment in Shaft *(Newton Millimeter)*
- M_t Torque transmitted by Shaft *(Newton Millimeter)*
- Mb_{eq} Equivalent Bending Moment from MSST *(Newton Millimeter)*
- Mb_{feq} Equivalent Bending Moment for Fluctuating Load *(Newton Millimeter)*
- Mt_{feq} Equivalent Torsion Moment for Fluctuating Load *(Newton Millimeter)*
- $Mt_{hollowshaft}$ Torsional Moment in Hollow Shaft *(Newton Millimeter)*
- Mt_{shaft} Torsional Moment in Shaft *(Newton Millimeter)*
- Mt_t Torsional Moment in Shaft for MSST *(Newton Millimeter)*
- **N** Speed of Shaft *(Revolution per Minute)*
- **P** Power Transmitted by Shaft *(Kilowatt)*
- $P_{ax\ hollow}$ Axial Force on Hollow Shaft *(Newton)*

- P_{ax} Axial Force on Shaft *(Newton)*
- S_{sy} Shear Yield Strength in Shaft from MSST *(Newton per Square Millimeter)*
- θ Angle of Twist in Shaft *(Degree)*
- θ_{hollow} Angle of Twist of Hollow Shaft *(Degree)*
- σ_1 Maximum Principle Stress in Shaft *(Newton per Square Millimeter)*
- $\sigma_{b\ h}$ Bending Stress in Hollow Shaft *(Newton per Square Millimeter)*
- σ_b Bending Stress in Shaft *(Newton per Square Millimeter)*
- σ_t Tensile Stress in Shaft *(Newton per Square Millimeter)*
- σ_{tp} Tensile Stress in Hollow Shaft *(Newton per Square Millimeter)*
- σ_x Normal Stress in Shaft *(Newton per Square Millimeter)*
- σ_{yt} Yield Strength in Shaft from MSST *(Newton per Square Millimeter)*
- τ Maximum Principle Stress in Hollow Shaft *(Newton per Square Millimeter)*
- τ_{max} Principal Shear Stress in Shaft *(Newton per Square Millimeter)*
- τ_{smax} Maximum Shear Stress in Shaft *(Newton per Square Millimeter)*
- τ Torsional Shear Stress in Shaft *(Newton per Square Millimeter)*
- τ_h Torsional Shear Stress in Hollow Shaft *(Newton per Square Millimeter)*
- $\tau_{max\ ASME}$ Maximum Shear Stress in Shaft from ASME *(Newton per Square Millimeter)*
- $\tau_{max\ MSST}$ Maximum Shear Stress in Shaft from MSST *(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: **Power** in Kilowatt (kW)
  Power Unit Conversion
- Measurement: **Force** in Newton (N)
  Force Unit Conversion
- Measurement: **Angle** in Degree (°)
  Angle Unit Conversion
- Measurement: **Frequency** in Revolution per Minute (rev/min)
  Frequency Unit Conversion
- Measurement: **Torque** in Newton Millimeter (N*mm)
  Torque Unit Conversion
- Measurement: **Stress** in Newton per Square Millimeter (N/mm²)
  Stress Unit Conversion

Check other formula lists

- Design against Fluctuating Load Formulas
- Design of Bevel Gear Formulas
- Design of Chain Drives Formulas
- Design of Cotter Joint Formulas
- Design of Coupling Formulas
- Design of Flywheel Formulas
- Design of Friction Clutches Formulas
- Design of Helical Gears Formulas
- Design of Keys Formulas
- Design of Knuckle Joint Formulas
- Design of Lever Formulas
- Design of Pressure Vessels Formulas
- Design of Shafts Formulas
- Design of Threaded Fasteners Formulas
- Power Screws Formulas
- Threaded Joints Formulas

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