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Bearing, Stresses, Plate Girders & Ponding Considerations Formulas

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List of 22 Bearing, Stresses, Plate Girders & Ponding Considerations Formulas

Bearing, Stresses, Plate Girders & Ponding Considerations

Bearing on Milled Surfaces

1) Allowable Bearing Stress for Milled Surface Including Bearing Stiffeners

$$f_x \quad F_p = 0.9 \cdot F_y$$

[Open Calculator !\[\]\(de95854c7ee024cfadc48187bbb781b2_img.jpg\)](#)

$$ex \quad 225MPa = 0.9 \cdot 250MPa$$

2) Allowable Bearing Stress for Rollers and Rockers

$$f_x \quad F_p = \left(\frac{F_y - 13}{20} \right) \cdot (0.66 \cdot d_r)$$

[Open Calculator !\[\]\(6a9b39b98eb945faa14c645ec99e4eaa_img.jpg\)](#)

$$ex \quad 9.8999999MPa = \left(\frac{250MPa - 13}{20} \right) \cdot (0.66 \cdot 1200mm)$$



3) Diameter of Roller or Rocker given Allowable Bearing Stress

$$fx \quad d_r = \frac{F_p \cdot \left(\frac{20}{F_y - 13} \right)}{0.66}$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235_img.jpg\)](#)

$$ex \quad 1187.879\text{mm} = \frac{9.8\text{MPa} \cdot \left(\frac{20}{250\text{MPa} - 13} \right)}{0.66}$$

Plate Girders in Buildings

4) Allowable Bending Stress in Compression Flange

$$fx \quad F_{b'} = F_b \cdot R_{pg} \cdot R_e$$

[Open Calculator !\[\]\(5361750c22c4e047a52f4eac1ec2d4cc_img.jpg\)](#)

$$ex \quad 1.884096\text{MPa} = 3\text{MPa} \cdot 0.640 \cdot 0.9813$$

5) Depth to Thickness Ratio of Girder with Transverse Stiffeners

$$fx \quad ht = \frac{2000}{\sqrt{F_y}}$$

[Open Calculator !\[\]\(b792654f2cef9719eabeb6c5be00811e_img.jpg\)](#)

$$ex \quad 126.4911 = \frac{2000}{\sqrt{250\text{MPa}}}$$



6) Hybrid Girder Factor

[Open Calculator !\[\]\(dfbd6b3763a6d1d9afaa974f64e2e4b5_img.jpg\)](#)

$$fx \quad R_e = \frac{12 + \left(\beta \cdot \left(3 \cdot \alpha - \alpha^3 \right) \right)}{12 + 2 \cdot \beta}$$

$$ex \quad 0.981333 = \frac{12 + \left(3 \cdot \left(3 \cdot 0.8 - (0.8)^3 \right) \right)}{12 + 2 \cdot 3}$$

7) Maximum Depth to Thickness Ratio for Unstiffened Web

[Open Calculator !\[\]\(ec9132f1d27c8919987d92907322654d_img.jpg\)](#)

$$fx \quad ht = \frac{14000}{\sqrt{F_y \cdot (F_y + 16.5)}}$$

$$ex \quad 54.23872 = \frac{14000}{\sqrt{250MPa \cdot (250MPa + 16.5)}}$$

8) Plate Girder Stress Reduction Factor

[Open Calculator !\[\]\(758ebdf4629c903da74c2e079717ae32_img.jpg\)](#)

$$fx \quad R_{pg} = \left(1 - 0.0005 \cdot \left(\frac{A_{web}}{A_f} \right) \cdot \left(ht - \left(\frac{760}{\sqrt{F_b}} \right) \right) \right)$$

$$ex \quad 0.640295 = \left(1 - 0.0005 \cdot \left(\frac{80mm^2}{10mm^2} \right) \cdot \left(90.365 - \left(\frac{760}{\sqrt{3MPa}} \right) \right) \right)$$



Ponding Considerations in Buildings

9) Capacity Spectrum

$$fx \quad C_s = \frac{32 \cdot S \cdot L_s^4}{10^7 \cdot I_s}$$

[Open Calculator !\[\]\(74d4806277d7e73349d8e8c0897931e9_img.jpg\)](#)

$$ex \quad 5.555556 = \frac{32 \cdot 2.5m \cdot (0.5m)^4}{10^7 \cdot 90mm^4/mm}$$

10) Collapse Prevention Level

$$fx \quad C_p = \frac{32 \cdot L_p^4 \cdot L_s}{10^7 \cdot I_p}$$

[Open Calculator !\[\]\(8bba887393ca45b761e5cb49e755e762_img.jpg\)](#)

$$ex \quad 95.29412 = \frac{32 \cdot (1.5m)^4 \cdot 0.5m}{10^7 \cdot 85mm^4/mm}$$

11) Length of Primary Member using Collapse Prevention Level

$$fx \quad L_p = \left(\frac{C_p \cdot 10^7 \cdot I_p}{32 \cdot L_s} \right)^{\frac{1}{4}}$$

[Open Calculator !\[\]\(0fb13ad0bfa3d86868cdd3883e5665b3_img.jpg\)](#)

$$ex \quad 1.499984m = \left(\frac{95.29 \cdot 10^7 \cdot 85mm^4/mm}{32 \cdot 0.5m} \right)^{\frac{1}{4}}$$



12) Length of Secondary Member given Capacity Spectrum

$$\text{fx } L_s = \left(C_s \cdot 10^7 \cdot \frac{I_s}{32 \cdot S} \right)^{\frac{1}{4}}$$

[Open Calculator !\[\]\(d3fb9f94af8b26d1c844efa9a98805b0_img.jpg\)](#)

$$\text{ex } 0.499875\text{m} = \left(5.55 \cdot 10^7 \cdot \frac{90\text{mm}^4/\text{mm}}{32 \cdot 2.5\text{m}} \right)^{\frac{1}{4}}$$

13) Length of Secondary Member using Collapse Prevention Level

$$\text{fx } L_s = \frac{C_p \cdot 10^7 \cdot I_p}{32 \cdot L_p^4}$$

[Open Calculator !\[\]\(e1d6102fe77919492c04879c8450f1f5_img.jpg\)](#)

$$\text{ex } 0.499978\text{m} = \frac{95.29 \cdot 10^7 \cdot 85\text{mm}^4/\text{mm}}{32 \cdot (1.5\text{m})^4}$$

14) Moment of Inertia of Primary Member using Collapse Prevention Level

$$\text{fx } I_p = \frac{32 \cdot L_p^4 \cdot L_s}{10^7 \cdot C_p}$$

[Open Calculator !\[\]\(ab4e2b3fc7e7887b7a72f548aa6f5e60_img.jpg\)](#)

$$\text{ex } 85.00367\text{mm}^4/\text{mm} = \frac{32 \cdot (1.5\text{m})^4 \cdot 0.5\text{m}}{10^7 \cdot 95.29}$$



15) Moment of Inertia of Secondary Member given Capacity Spectrum

$$\text{fx } I_s = \frac{32 \cdot S \cdot L_s^4}{10^7 \cdot C_s}$$

[Open Calculator !\[\]\(9dfdaff1d86ba3c1f8353b4d1b61b8c5_img.jpg\)](#)

$$\text{ex } 90.09009\text{mm}^4/\text{mm} = \frac{32 \cdot 2.5\text{m} \cdot (0.5\text{m})^4}{10^7 \cdot 5.55}$$

Stresses in Thin Shells

16) Central Shear given Shearing Stress

$$\text{fx } T = \left(v_{xy} - \left(\frac{D \cdot z \cdot 12}{t^3} \right) \right) \cdot t$$

[Open Calculator !\[\]\(3cb60d42b10e53f9522bb0b392c1c4cd_img.jpg\)](#)

$$\text{ex } 50\text{kN}/\text{m} = \left(3.55\text{MPa} - \left(\frac{110\text{kN} \cdot \text{m} \cdot 0.02\text{m} \cdot 12}{(200\text{mm})^3} \right) \right) \cdot 200\text{mm}$$

17) Distance from Middle Surface given Normal Shearing Stress

$$\text{fx } z = \sqrt{\left(\frac{t^2}{4} \right) - \left(\frac{v_{xz} \cdot t^3}{6 \cdot V} \right)}$$

[Open Calculator !\[\]\(0d7ca0919e6c47bbd874bfa0189fe22e_img.jpg\)](#)

$$\text{ex } 0.02\text{m} = \sqrt{\left(\frac{(200\text{mm})^2}{4} \right) - \left(\frac{0.72\text{MPa} \cdot (200\text{mm})^3}{6 \cdot 100\text{kN}} \right)}$$



18) Distance from Middle Surface given Normal Stress in Thin Shells

$$f_x z = \left(\frac{t^2}{12 \cdot M_x} \right) \cdot ((f_x \cdot t) - (N_x))$$

[Open Calculator !\[\]\(6605b201d6f14d9b3bcb8ab5f274d107_img.jpg\)](#)

$$\text{ex } 0.019999\text{m} = \left(\frac{(200\text{mm})^2}{12 \cdot 90\text{kN}\cdot\text{m}} \right) \cdot ((2.7\text{MPa} \cdot 200\text{mm}) - (15\text{N}))$$

19) Normal Shearing Stresses

$$f_x v_{xz} = \left(\frac{6 \cdot V}{t^3} \right) \cdot \left(\left(\frac{t^2}{4} \right) - (z^2) \right)$$

[Open Calculator !\[\]\(e8fb589d58dad1692debababa5e928b6_img.jpg\)](#)

$$\text{ex } 0.72\text{MPa} = \left(\frac{6 \cdot 100\text{kN}}{(200\text{mm})^3} \right) \cdot \left(\left(\frac{(200\text{mm})^2}{4} \right) - ((0.02\text{m})^2) \right)$$

20) Normal Stress in Thin Shells

$$f_x f_x = \left(\frac{N_x}{t} \right) + \left(\frac{M_x \cdot z}{\frac{t^3}{12}} \right)$$

[Open Calculator !\[\]\(4688aadfd656ded00cd6bdfae55089a9_img.jpg\)](#)

$$\text{ex } 2.700075\text{MPa} = \left(\frac{15\text{N}}{200\text{mm}} \right) + \left(\frac{90\text{kN}\cdot\text{m} \cdot 0.02\text{m}}{\frac{(200\text{mm})^3}{12}} \right)$$



21) Shearing Stresses on Shells

$$f_x \quad v_{xy} = \left(\left(\frac{T}{t} \right) + \left(\frac{D \cdot z \cdot 12}{t^3} \right) \right)$$

[Open Calculator !\[\]\(c3d993ca47bfe2a953c700506ce31fa0_img.jpg\)](#)

$$ex \quad 3.55MPa = \left(\left(\frac{50kN/m}{200mm} \right) + \left(\frac{110kN \cdot m \cdot 0.02m \cdot 12}{(200mm)^3} \right) \right)$$

22) Twisting Moments given Shearing Stress

$$f_x \quad D = \frac{((v_{xy} \cdot t) - T) \cdot t^2}{12 \cdot z}$$

[Open Calculator !\[\]\(17413706fd4997a1a4bdf85c6864eee1_img.jpg\)](#)

$$ex \quad 110kN \cdot m = \frac{((3.55MPa \cdot 200mm) - 50kN/m) \cdot (200mm)^2}{12 \cdot 0.02m}$$



Variables Used









- **A_f** Area of Flange (Square Millimeter)
- **A_{web}** Web Area (Square Millimeter)
- **C_p** Collapse Prevention Level
- **C_s** Capacity Spectrum
- **D** Twisting Moments on Shells (Kilonewton Meter)
- **d_r** Diameter of Rollers and Rockers (Millimeter)
- **F_b** Allowable Bending Stress (Megapascal)
- **$F_{b'}$** Reduced Allowable Bending Stress (Megapascal)
- **F_p** Allowable Bearing Stress (Megapascal)
- **f_x** Normal Stress on Thin Shells (Megapascal)
- **F_y** Yield Stress of Steel (Megapascal)
- **ht** Depth to Thickness Ratio
- **I_p** Moment of Inertia of Primary Member (Millimeter⁴ per Millimeter)
- **I_s** Moment of Inertia of Secondary Member (Millimeter⁴ per Millimeter)
- **L_p** Length of Primary Member (Meter)
- **L_s** Length of Secondary Member (Meter)
- **M_x** Unit Bending Moment (Kilonewton Meter)
- **N_x** Unit Normal Force (Newton)
- **R_e** Hybrid Girder Factor
- **R_{pg}** Plate Girder Strength Reduction Factor
- **S** Spacing of Secondary Members (Meter)



- **t** Shell Thickness (Millimeter)
- **T** Central Shear (Kilonewton per Meter)
- **V** Unit Shear Force (Kilonewton)
- **v_{xy}** Shearing Stress on Shells (Megapascal)
- **v_{xz}** Normal Shearing Stress (Megapascal)
- **z** Distance from Middle Surface (Meter)
- **α** Ratio of Yield Stress
- **β** Ratio of Web Area to Flange Area




Constants, Functions, Measurements used

- **Function:** **sqrt**, $\text{sqrt}(\text{Number})$
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), Meter (m)
Length Unit Conversion 
- **Measurement:** **Area** in Square Millimeter (mm^2)
Area Unit Conversion 
- **Measurement:** **Pressure** in Megapascal (MPa)
Pressure Unit Conversion 
- **Measurement:** **Force** in Kilonewton (kN), Newton (N)
Force Unit Conversion 
- **Measurement:** **Surface Tension** in Kilonewton per Meter (kN/m)
Surface Tension Unit Conversion 
- **Measurement:** **Moment of Force** in Kilonewton Meter (kN*m)
Moment of Force Unit Conversion 
- **Measurement:** **Moment of Inertia per Unit Length** in Millimeter⁴ per Millimeter (mm^4/mm)
Moment of Inertia per Unit Length Unit Conversion 
- **Measurement:** **Stress** in Megapascal (MPa)
Stress Unit Conversion 



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