Important Bearing, Stresses, Plate Girders & Ponding Considerations Formulas PDF

Formulas
Examples
with Units

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

1) Bearing on Milled Surfaces Formulas

1.1) Allowable Bearing Stress for Milled Surface Including Bearing Stiffeners Formula

Evaluate Formula

Formula

$$F_p = 0.9 \cdot F_y$$

Example with Units

$$225\,\text{MPa} = 0.9 \cdot 250\,\text{MPa}$$

1.2) Allowable Bearing Stress for Rollers and Rockers Formula

Evaluate Formula

Formula

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

Example with Units

$$9.9\,\text{MPa} = \left(\frac{250\,\text{MPa} - 13}{20}\right) \cdot \left(0.66 \cdot 1200\,\text{mm}\right)$$

1.3) Diameter of Roller or Rocker given Allowable Bearing Stress Formula

Evaluate Formula

Formula

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

Example with Units

$$1187.8788\,\text{mm} = \frac{9.8\,\text{MPa} \cdot \left(\frac{20}{250\,\text{MPa} - 13}\right)}{0.66}$$

2) Plate Girders in Buildings Formulas

2.1) Allowable Bending Stress in Compression Flange Formula

Evaluate Formula

Formula

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

Example with Units

$$1.8841\,\text{MPa} = 3\,\text{MPa} \cdot 0.640 \cdot 0.9813$$

2.2) Depth to Thickness Ratio of Girder with Transverse Stiffeners Formula

Evaluate Formula

Formula

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

Example with Units

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

2.3) Hybrid Girder Factor Formula

Evaluate Formula

Formula

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

Example

$$0.9813 = \frac{12 + \left(3 \cdot \left(3 \cdot 0.8 - 0.8^3\right)\right)}{12 + 2 \cdot 3}$$

2.4) Maximum Depth to Thickness Ratio for Unstiffened Web Formula

Evaluate Formula

Formula

$$ht = \frac{14000}{\sqrt{F_y \cdot \left(F_y + 16.5\right)}}$$

Example with Units

$$54.2387 = \frac{14000}{\sqrt{250\,\text{MPa} \cdot \left(250\,\text{MPa} + 16.5\right)}}$$

2.5) Plate Girder Stress Reduction Factor Formula

Evaluate Formula

Formula

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

Example with Units

$$0.6403 = \left(1 - 0.0005 \cdot \left(\frac{80\,\text{mm}^2}{10\,\text{mm}^2}\right) \cdot \left(90.365 - \left(\frac{760}{\sqrt{3\,\text{MPa}}}\right)\right)\right)$$

3) Ponding Considerations in Buildings Formulas

3.1) Capacity Spectrum Formula

Evaluate Formula

Formula

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

Example with Units

$$5.5556 = \frac{32 \cdot 2.5\,\text{m} \cdot 0.5\,\text{m}^4}{10^7 \cdot 90\,\text{mm}^4/\text{mm}}$$

3.2) Collapse Prevention Level Formula

Evaluate Formula

Formula

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

Example with Units

$$95.2941 = \frac{32 \cdot 1.5\,\text{m}^4 \cdot 0.5\,\text{m}}{10^7 \cdot 85\,\text{mm}^4/\text{mm}}$$

3.3) Length of Primary Member using Collapse Prevention Level Formula

Evaluate Formula

Formula

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

Example with Units

$$1.5\,\text{m} = \left(\frac{95.29 \cdot 10^7 \cdot 85\,\text{mm}^4/\text{mm}}{32 \cdot 0.5\,\text{m}} \right)^{\frac{1}{4}}$$

3.4) Length of Secondary Member given Capacity Spectrum Formula

Evaluate Formula

Formula

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

Example with Units

$$0.4999\,\text{m} = \left(5.55 \cdot 10^7 \cdot \frac{90\,\text{mm}^4/\text{mm}}{32 \cdot 2.5\,\text{m}} \right)^{\frac{1}{4}}$$

3.5) Length of Secondary Member using Collapse Prevention Level Formula

Evaluate Formula

Formula

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

Example with Units

$$0.5\,\text{m} = \frac{95.29 \cdot 10^7 \cdot 85\,\text{mm}^4/\text{mm}}{32 \cdot 1.5\,\text{m}^{\,4}}$$

3.6) Moment of Inertia of Primary Member using Collapse Prevention Level Formula

Evaluate Formula

Formula

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

Example with Units

$$85.0037\,\text{mm}^4/\text{mm} = \frac{32 \cdot 1.5\,\text{m}^{\,4} \cdot 0.5\,\text{m}}{10^7 \cdot 95.29}$$

3.7) Moment of Inertia of Secondary Member given Capacity Spectrum Formula

Evaluate Formula

Formula

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

Example with Units

$$90.0901\,\text{mm}^4/\text{mm} = \frac{32 \cdot 2.5\,\text{m} \cdot 0.5\,\text{m}^{\,4}}{10^7 \cdot 5.55}$$

4) Stresses in Thin Shells Formulas

4.1) Central Shear given Shearing Stress Formula

Evaluate Formula

Formula

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

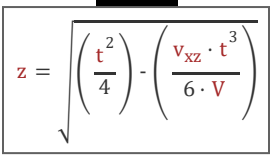
Example with Units

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

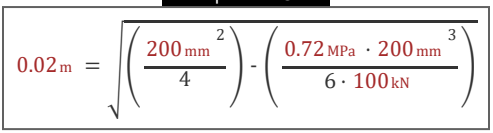
4.2) Distance from Middle Surface given Normal Shearing Stress Formula

Evaluate Formula

Formula



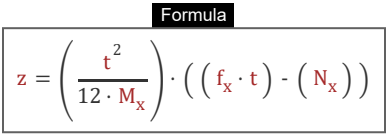
Example with Units



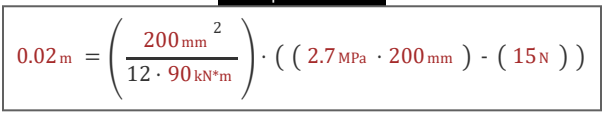
4.3) Distance from Middle Surface given Normal Stress in Thin Shells Formula

Evaluate Formula

Formula



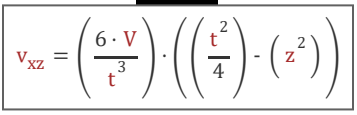
Example with Units



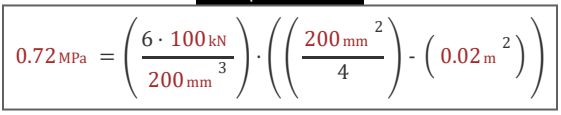
4.4) Normal Shearing Stresses Formula

Evaluate Formula

Formula



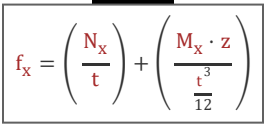
Example with Units



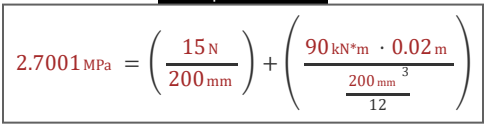
4.5) Normal Stress in Thin Shells Formula

Evaluate Formula

Formula



Example with Units



4.6) Shearing Stresses on Shells Formula

Evaluate Formula

Formula

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

Example with Units

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

4.7) Twisting Moments given Shearing Stress Formula

Evaluate Formula

Formula

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

Example with Units

$$110\,\text{kN*m} = \frac{\left(\left(3.55\,\text{MPa} \cdot 200\,\text{mm}\right) - 50\,\text{kN/m}\right) \cdot 200\,\text{mm}^2}{12 \cdot 0.02\,\text{m}}$$

Variables used in list of Bearing, Stresses, Plate Girders & Ponding Considerations Formulas above

- 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 in list of Bearing, Stresses, Plate Girders & Ponding Considerations Formulas above

- Functions: **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), Meter (m)
  Length Unit Conversion
- Measurement: **Area** in Square Millimeter (mm²)
  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 (mm⁴/mm)
  Moment of Inertia per Unit Length Unit Conversion
- Measurement: **Stress** in Megapascal (MPa)
  Stress Unit Conversion

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