Important Stress Concentration Factors in Design Formulas PDF

Formulas
Examples
with Units

List of 26
Important Stress Concentration Factors in Design Formulas

1) Rectangular Plate against Fluctuating Loads Formulas

1.1) Diameter of Transverse Hole of Rectangular Plate with Stress Concentration given Nominal Stress Formula

Evaluate Formula

Formula

$$d_h = w - \frac{P}{t \cdot \sigma_o}$$

Example with Units

$$35\,\text{mm} = 70\,\text{mm} - \frac{8750\,\text{N}}{10\,\text{mm} \cdot 25\,\text{N/mm}^2}$$

1.2) Highest Value of Actual Stress near Discontinuity Formula

Evaluate Formula

Formula

$$\sigma a_{max} = k_f \cdot \sigma_o$$

Example with Units

$$53.75\,\text{N/mm}^2 = 2.15 \cdot 25\,\text{N/mm}^2$$

1.3) Load on Rectangular Plate with Transverse Hole given Nominal Stress Formula

Evaluate Formula

Formula

$$P = \sigma_o \cdot \left(w - d_h\right) \cdot t$$

Example with Units

$$8747.5\,\text{N} = 25\,\text{N/mm}^2 \cdot \left(70\,\text{mm} - 35.01\,\text{mm}\right) \cdot 10\,\text{mm}$$

1.4) Nominal Tensile Stress in Rectangular Plate with Transverse Hole Formula

Evaluate Formula

Formula

$$\sigma_o = \frac{P}{\left(w - d_h\right) \cdot t}$$

Example with Units

$$25.0071\,\text{N/mm}^2 = \frac{8750\,\text{N}}{\left(70\,\text{mm} - 35.01\,\text{mm}\right) \cdot 10\,\text{mm}}$$

1.5) Thickness of Rectangular Plate with Transverse Hole given Nominal Stress Formula

Evaluate Formula

Formula

$$t = \frac{P}{\left(w - d_h\right) \cdot \sigma_o}$$

Example with Units

$$10.0029\,\text{mm} = \frac{8750\,\text{N}}{\left(70\,\text{mm} - 35.01\,\text{mm}\right) \cdot 25\,\text{N/mm}^2}$$

1.6) Width of Rectangular Plate with Transverse Hole given Nominal Stress Formula

Evaluate Formula

Formula

$$w = \frac{P}{t \cdot \sigma_o} + d_h$$

Example with Units

$$70.01\,\text{mm} = \frac{8750\,\text{N}}{10\,\text{mm} \cdot 25\,\text{N/mm}^2} + 35.01\,\text{mm}$$

2) Round Shaft against Fluctuating Loads Formulas

2.1) Bending Moment in Round Shaft with Shoulder Fillet given Nominal Stress Formula

Evaluate Formula

Formula

$$M_b = \frac{\sigma_o \cdot \pi \cdot d_{small}^3}{32}$$

Example with Units

$$23089.1036\,\text{N*mm} = \frac{25\,\text{N/mm}^2 \cdot 3.1416 \cdot 21.11004\,\text{mm}^3}{32}$$

2.2) Diameter of Shaft given Ratio of Torsional Strength of Shaft with Keyway to without Keyway Formula

Evaluate Formula

Formula

$$d = \frac{0.2 \cdot b_k + 1.1 \cdot h}{1 - C}$$

Example with Units

$$45\,\text{mm} = \frac{0.2 \cdot 5\,\text{mm} + 1.1 \cdot 4\,\text{mm}}{1 - 0.88}$$

2.3) Height of Shaft Keyway given Ratio of Torsional Strength of Shaft with Keyway to without Keyway Formula

Evaluate Formula

Formula

$$h = \frac{d}{1.1} \cdot \left(1 - C - 0.2 \cdot \frac{b_k}{d} \right)$$

Example with Units

$$4\,\text{mm} = \frac{45\,\text{mm}}{1.1} \cdot \left(1 - 0.88 - 0.2 \cdot \frac{5\,\text{mm}}{45\,\text{mm}} \right)$$

2.4) Nominal Bending Stress in Round Shaft with Shoulder Fillet Formula

Evaluate Formula

Formula

$$\sigma_o = \frac{32 \cdot M_b}{\pi \cdot d_{small}^3}$$

Example with Units

$$25\,\text{N/mm}^2 = \frac{32 \cdot 23089.1\,\text{N*mm}}{3.1416 \cdot 21.11004\,\text{mm}^3}$$

2.5) Nominal Tensile Stress in Round Shaft with Shoulder Fillet Formula

Evaluate Formula

Formula

$$\sigma_o = \frac{4 \cdot P}{\pi \cdot d_{small}^2}$$

Example with Units

$$25\,\text{N/mm}^2 = \frac{4 \cdot 8750\,\text{N}}{3.1416 \cdot 21.11004\,\text{mm}^2}$$

2.6) Nominal Torsional Stress in Round Shaft with Shoulder Fillet Formula

Evaluate Formula

Formula

$$\sigma_o = \frac{16 \cdot M_t}{\pi \cdot d_{small}^3}$$

Example with Units

$$20\,\text{N/mm}^2 = \frac{16 \cdot 36942.57\,\text{N*mm}}{3.1416 \cdot 21.11004\,\text{mm}^3}$$

2.7) Ratio of Torsional Strength of Shaft with Keyway to without Keyway Formula

Evaluate Formula

Formula

$$C = 1 - 0.2 \cdot \frac{b_k}{d} - 1.1 \cdot \frac{h}{d}$$

Example with Units

$$0.88 = 1 - 0.2 \cdot \frac{5\,\text{mm}}{45\,\text{mm}} - 1.1 \cdot \frac{4\,\text{mm}}{45\,\text{mm}}$$

2.8) Smaller Diameter of Round Shaft with Shoulder Fillet in Tension or Compression Formula

Evaluate Formula

Formula

$$d_{small} = \sqrt{\frac{4 \cdot P}{\pi \cdot \sigma_o}}$$

Example with Units

$$21.11\,\text{mm} = \sqrt{\frac{4 \cdot 8750\,\text{N}}{3.1416 \cdot 25\,\text{N/mm}^2}}$$

2.9) Tensile Force in Round Shaft with Shoulder Fillet given Nominal Stress Formula

Evaluate Formula

Formula

$$P = \frac{\sigma_o \cdot \pi \cdot d_{small}^2}{4}$$

Example with Units

$$8749.999\,\text{N} = \frac{25\,\text{N/mm}^2 \cdot 3.1416 \cdot 21.11004\,\text{mm}^2}{4}$$

2.10) Torsional Moment in Round Shaft with Shoulder Fillet given Nominal Stress Formula

Evaluate Formula

Formula

$$M_t = \frac{\tau_o \cdot \pi \cdot d_{small}^3}{16}$$

Example with Units

$$36942.5657\,\text{N*mm} = \frac{20\,\text{N/mm}^2 \cdot 3.1416 \cdot 21.11004\,\text{mm}^3}{16}$$

2.11) Width of Shaft Keyway given Ratio of Torsional Strength of Shaft with Keyway to without Keyway Formula

Evaluate Formula

Formula

$$b_k = 5 \cdot d \cdot \left(1 - C - 1.1 \cdot \frac{h}{d}\right)$$

Example with Units

$$5\,\text{mm} = 5 \cdot 45\,\text{mm} \cdot \left(1 - 0.88 - 1.1 \cdot \frac{4\,\text{mm}}{45\,\text{mm}}\right)$$

3) Flat Plate against Fluctuating Loads Formulas

3.1) Load on Flat Plate with Shoulder Fillet given Nominal Stress Formula

Evaluate Formula

Formula

$$P = \sigma_o \cdot d_o \cdot t$$

Example with Units

$$8750\,\text{N} = 25\,\text{N/mm}^2 \cdot 35\,\text{mm} \cdot 10\,\text{mm}$$

3.2) Major Axis of Elliptical Crack Hole in Flat Plate given Theoretical Stress Concentration Factor Formula

Evaluate Formula

Formula

$$a_e = b_e \cdot \left(k_t - 1\right)$$

Example with Units

$$30\,\text{mm} = 15\,\text{mm} \cdot \left(3 - 1\right)$$

3.3) Mean Stress for Fluctuating Load Formula

Evaluate Formula

Formula

$$\sigma_m = \frac{\sigma_{max} + \sigma_{min}}{2}$$

Example with Units

$$110\,\mathrm{N/mm^2} = \frac{180\,\mathrm{N/mm^2} + 40\,\mathrm{N/mm^2}}{2}$$

3.4) Minor Axis of Elliptical Crack Hole in Flat Plate given Theoretical Stress Concentration Factor Formula

Evaluate Formula

Formula

$$b_e = \frac{a_e}{k_t - 1}$$

Example with Units

$$15\,\mathrm{mm} = \frac{30\,\mathrm{mm}}{3 - 1}$$

3.5) Nominal Tensile Stress in Flat Plate with Shoulder Fillet Formula

Evaluate Formula

Formula

$$\sigma_o = \frac{P}{d_o \cdot t}$$

Example with Units

$$25\,\mathrm{N/mm^2} = \frac{8750\,\mathrm{N}}{35\,\mathrm{mm} \cdot 10\,\mathrm{mm}}$$

3.6) Smaller Width of Flat Plate with Shoulder Fillet given Nominal stress Formula

Evaluate Formula

Formula

$$d_o = \frac{P}{\sigma_o \cdot t}$$

Example with Units

$$35\,\mathrm{mm} = \frac{8750\,\mathrm{N}}{25\,\mathrm{N/mm^2} \cdot 10\,\mathrm{mm}}$$

3.7) Theoretical Stress Concentration Factor Formula

Evaluate Formula

Formula

$$k_t = \frac{\sigma a_{max}}{\sigma_o}$$

Example with Units

$$2.15 = \frac{53.75\,\mathrm{N/mm^2}}{25\,\mathrm{N/mm^2}}$$

3.8) Theoretical Stress Concentration Factor for Elliptical Crack Formula

Evaluate Formula

Formula

$$k_t = 1 + \frac{a_e}{b_e}$$

Example with Units

$$3 = 1 + \frac{30\,\mathrm{mm}}{15\,\mathrm{mm}}$$

3.9) Thickness of Flat Plate with Shoulder Fillet given Nominal Stress Formula

Evaluate Formula

Formula

$$t = \frac{P}{\sigma_o \cdot d_o}$$

Example with Units

$$10\,\mathrm{mm} = \frac{8750\,\mathrm{N}}{25\,\mathrm{N/mm^2} \cdot 35\,\mathrm{mm}}$$

Variables used in list of Stress Concentration Factors in Design Formulas above

- **a_e** Major Axis of Elliptical Crack *(Millimeter)*
- **b_e** Minor Axis of Elliptical Crack *(Millimeter)*
- **b_k** Width of Key in Round Shaft *(Millimeter)*
- **C** Ratio of Shaft Strength
- **d** Diameter of Shaft with Keyway *(Millimeter)*
- **d_h** Diameter of Transverse Hole in Plate *(Millimeter)*
- **d_o** Smaller Width of Plate *(Millimeter)*
- **d_{small}** Smaller Diameter of Shaft with Fillet *(Millimeter)*
- **h** Height of Shaft Keyway *(Millimeter)*
- **k_f** Fatigue Stress Concentration Factor
- **k_t** Theoretical Stress Concentration Factor
- **M_b** Bending Moment on Round Shaft *(Newton Millimeter)*
- **M_t** Torsional Moment on Round Shaft *(Newton Millimeter)*
- **P** Load on Flat Plate *(Newton)*
- **t** Thickness of Plate *(Millimeter)*
- **w** Width of Plate *(Millimeter)*
- **$σ_m$** Mean Stress for Fluctuating Load *(Newton per Square Millimeter)*
- **$σ_{max}$** Maximum Stress at Crack Tip *(Newton per Square Millimeter)*
- **$σ_{min}$** Minimum Stress at Crack Tip *(Newton per Square Millimeter)*
- **$σ_o$** Nominal Stress *(Newton per Square Millimeter)*
- **$σa_{max}$** Highest Value of Actual Stress near Discontinuity *(Newton per Square Millimeter)*
- **$τ_o$** Nominal Torsional Stress for Fluctuating Load *(Newton per Square Millimeter)*

Constants, Functions, Measurements used in list of Stress Concentration Factors in Design Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- 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)
  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/mm²)
  Stress Unit Conversion

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