Important Railway Track and Track Stresses Formulas PDF

Formulas
Examples
with Units

List of 27
Important Railway Track and Track Stresses Formulas

1) Lap of Flange Formulas

1.1) Diameter of Wheel given Lap of Flange Formula

Evaluate Formula

Formula

$$D = \frac{\left(\frac{L}{2}\right)^2 - H^2}{H}$$

Example with Units

$$11.25\,\text{mm} = \frac{\left(\frac{50\,\text{mm}}{2}\right)^2 - 20\,\text{mm}^2}{20\,\text{mm}}$$

1.2) Extra Track Width in Curves Formula

Evaluate Formula

Formula

$$W_e = \left(W + L^2\right) \cdot \frac{125}{R}$$

Example with Units

$$2.1802\,\text{mm} = \left(3500\,\text{mm} + 50\,\text{mm}^2\right) \cdot \frac{125}{344\,\text{m}}$$

1.3) Lap of Flange given Diameter of Wheel Formula

Evaluate Formula

Formula

$$L = 2 \cdot \left(\left(D \cdot H\right) + H^2\right)^{0.5}$$

Example with Units

$$50\,\text{mm} = 2 \cdot \left(\left(11.25\,\text{mm} \cdot 20\,\text{mm}\right) + 20\,\text{mm}^2\right)^{0.5}$$

1.4) Lap of Flange given Extra Width of Track Formula

Evaluate Formula

Formula

$$L = \sqrt{\left(W_e \cdot \frac{R}{125}\right) - W}$$

Example with Units

$$49.9936\,\text{mm} = \sqrt{\left(2.18\,\text{mm} \cdot \frac{344\,\text{m}}{125}\right) - 3500\,\text{mm}}$$

1.5) Radius of Curve given Extra Width Formula

Evaluate Formula

Formula

$$R = \left(W + L^2\right) \cdot \frac{125}{W_e}$$

Example with Units

$$344.0367\,\text{m} = \left(3500\,\text{mm} + 50\,\text{mm}^2\right) \cdot \frac{125}{2.18\,\text{mm}}$$

1.6) Wheel Base given Extra Width Formula

Evaluate Formula

Formula

$$W = \left(W_e \cdot \frac{R}{125} \right) - L^2$$

Example with Units

$$3499.36\,\text{mm} = \left(2.18\,\text{mm} \cdot \frac{344\,\text{m}}{125} \right) - 50\,\text{mm}^2$$

2) Lateral Forces Formulas

2.1) Characteristic Length given Seat Load on Rail Formula

Evaluate Formula

Formula

$$I = W_L \cdot \frac{S}{z \cdot L_{max}}$$

Example with Units

$$15.997\,\text{m} = 43.47\,\text{kN} \cdot \frac{2.3\,\text{m}}{0.0125\,\text{m}^3 \cdot 500\,\text{kN}}$$

2.2) Maximum Contact Shear Stress Formula

Evaluate Formula

Formula

$$F_s = 4.13 \cdot \left(\frac{F_a}{R_w} \right)^{\frac{1}{2}}$$

Example with Units

$$9.1216\,\text{kgf/mm}^2 = 4.13 \cdot \left(\frac{200\,\text{tf}}{41\,\text{mm}} \right)^{\frac{1}{2}}$$

2.3) Maximum Load on Rail Seat Formula

Evaluate Formula

Formula

$$L_{max} = W_L \cdot \frac{S}{z \cdot I}$$

Example with Units

$$499.905\,\text{kN} = 43.47\,\text{kN} \cdot \frac{2.3\,\text{m}}{0.0125\,\text{m}^3 \cdot 16\,\text{m}}$$

2.4) Radius of Wheel given Shear Stress Formula

Evaluate Formula

Formula

$$R_w = \left(\frac{4.13}{F_s} \right)^2 \cdot F_a$$

Example with Units

$$40.3046\,\text{mm} = \left(\frac{4.13}{9.2\,\text{kgf/mm}^2} \right)^2 \cdot 200\,\text{tf}$$

2.5) Section Modulus of Rail given Seat Load Formula

Evaluate Formula

Formula

$$z = \frac{W_L \cdot S}{I \cdot L_{max}}$$

Example with Units

$$0.0125\,\text{m}^3 = \frac{43.47\,\text{kN} \cdot 2.3\,\text{m}}{16\,\text{m} \cdot 500\,\text{kN}}$$

2.6) Sleeper Spacing given Seat Load on Rail Formula

Evaluate Formula

Formula

$$S = z \cdot I \cdot \frac{L_{max}}{W_L}$$

Example with Units

$$2.3004\,\text{m} = 0.0125\,\text{m}^3 \cdot 16\,\text{m} \cdot \frac{500\,\text{kN}}{43.47\,\text{kN}}$$

2.7) Static Wheel Load given Shear Stress Formula

Evaluate Formula

Formula

$$F_a = \left(\frac{F_s}{4.13}\right)^2 \cdot R_w$$

Example with Units

$$203.4508\,\text{tf} = \left(\frac{9.2\,\text{kgf/mm}^2}{4.13}\right)^2 \cdot 41\,\text{mm}$$

2.8) Wheel Load given Seat Load Formula

Evaluate Formula

Formula

$$W_L = z \cdot I \cdot \frac{L_{max}}{S}$$

Example with Units

$$43.4783\,\text{kN} = 0.0125\,\text{m}^3 \cdot 16\,\text{m} \cdot \frac{500\,\text{kN}}{2.3\,\text{m}}$$

3) Vertical Loads Formulas

3.1) Bending Moment on Rail Formula

Evaluate Formula

Formula

$$M = 0.25 \cdot L_{Vertical} \cdot \exp\left(-\frac{x}{l}\right) \cdot \left(\sin\left(\frac{x}{l}\right) - \cos\left(\frac{x}{l}\right)\right)$$

Example with Units

$$1.5753\,\text{N*m} = 0.25 \cdot 49\,\text{kN} \cdot \exp\left(-\frac{2.2\,\text{m}}{2.1\,\text{m}}\right) \cdot \left(\sin\left(\frac{2.2\,\text{m}}{2.1\,\text{m}}\right) - \cos\left(\frac{2.2\,\text{m}}{2.1\,\text{m}}\right)\right)$$

3.2) Dynamic Overload at Joints Formula

Evaluate Formula

Formula

$$F = F_a + 0.1188 \cdot V_t \cdot \sqrt{w}$$

Example with Units

$$311.9522\,\text{tf} = 200\,\text{tf} + 0.1188 \cdot 149\,\text{km/h} \cdot \sqrt{40\,\text{tf}}$$

3.3) Isolated Vertical Load given Moment Formula

Evaluate Formula

Formula

$$L_{Vertical} = \frac{M}{0.25 \cdot \exp\left(-\frac{x}{l}\right) \cdot \left(\sin\left(\frac{x}{l}\right) - \cos\left(\frac{x}{l}\right)\right)}$$

Example with Units

$$42.926\,\text{kN} = \frac{1.38\,\text{N*m}}{0.25 \cdot \exp\left(-\frac{2.2\,\text{m}}{2.1\,\text{m}}\right) \cdot \left(\sin\left(\frac{2.2\,\text{m}}{2.1\,\text{m}}\right) - \cos\left(\frac{2.2\,\text{m}}{2.1\,\text{m}}\right)\right)}$$

3.4) Mass per Wheel given Dynamic Load Formula

Evaluate Formula

Formula

$$w = \left(\frac{F - F_a}{0.1188 \cdot V_t} \right)^2$$

Example with Units

$$39.3224\,\text{tf} = \left(\frac{311\,\text{tf} - 200\,\text{tf}}{0.1188 \cdot 149\,\text{km/h}} \right)^2$$

3.5) Static Wheel Load given Dynamic Load Formula

Evaluate Formula

Formula

$$F_a = F - 0.1188 \cdot V_t \cdot \sqrt{w}$$

Example with Units

$$199.0478\,\text{tf} = 311\,\text{tf} - 0.1188 \cdot 149\,\text{km/h} \cdot \sqrt{40\,\text{tf}}$$

3.6) Stress in Rail Foot Formula

Evaluate Formula

Formula

$$S_h = \frac{M}{Z_t}$$

Example with Units

$$27.0588\,\text{Pa} = \frac{1.38\,\text{N*m}}{51\,\text{m}^3}$$

3.7) Stress in Rail Head Formula

Evaluate Formula

Formula

$$S_h = \frac{M}{Z_c}$$

Example with Units

$$26.5385\,\text{Pa} = \frac{1.38\,\text{N*m}}{52\,\text{m}^3}$$

3.8) Speed Factor Formulas

3.8.1) Speed Factor Formula

Evaluate Formula

Formula

$$F_{sf} = \frac{V_t}{18.2 \cdot \sqrt{k}}$$

Example with Units

$$2.1138 = \frac{149\,\text{km/h}}{18.2 \cdot \sqrt{15\,\text{kgf/m}^2}}$$

3.8.2) Speed Factor according to German Formula Formula

Evaluate Formula

Formula

$$F_{sf} = \frac{V_t^2}{30000}$$

Example with Units

$$0.74 = \frac{149\,\text{km/h}^2}{30000}$$

3.8.3) Speed Factor using German Formula and Speed is above 100kmph Formula

Evaluate Formula

Formula

$$F_{sf} = \left(\frac{4.5 \cdot V_t^2}{10^5} \right) - \left(\frac{1.5 \cdot V_t^3}{10^7} \right)$$

Example with Units

$$0.5029 = \left(\frac{4.5 \cdot 149\,\text{km/h}^2}{10^5} \right) - \left(\frac{1.5 \cdot 149\,\text{km/h}^3}{10^7} \right)$$

3.8.4) Speed given Speed Factor Formula

Evaluate Formula

Formula

$$V_t = F_{sf} \cdot \left(18.2 \cdot \sqrt{k}\right)$$

Example with Units

$$140.9766\,\text{km/h} = 2 \cdot \left(18.2 \cdot \sqrt{15\,\text{kgf/m}^2}\right)$$

3.8.5) Speed using German Formula Formula

Evaluate Formula

Formula

$$V_t = \sqrt{F_{sf} \cdot 30000}$$

Example with Units

$$244.949\,\text{km/h} = \sqrt{2 \cdot 30000}$$

3.8.6) Track Modulus given Speed Factor Formula

Evaluate Formula

Formula

$$k = \left(\frac{V_t}{18.2 \cdot F_{sf}}\right)^2$$

Example with Units

$$16.756\,\text{kgf/m}^2 = \left(\frac{149\,\text{km/h}}{18.2 \cdot 2}\right)^2$$

Variables used in list of Railway Track and Track Stresses Formulas above

- **D** Diameter of Wheel *(Millimeter)*
- **F** Dynamic Overload *(Ton-Force (Metric))*
- F_a Static Load *(Ton-Force (Metric))*
- F_s Contact Shear Stress *(Kilogram-Force per Square Millimeter)*
- F_{sf} Speed Factor
- **H** Depth of Wheel Flange *(Millimeter)*
- **l** Characteristic Length of Rail *(Meter)*
- **k** Track Modulus *(Kilogram-Force per Square Meter)*
- **l** Characteristic Length *(Meter)*
- **L** Lap of Flange *(Millimeter)*
- L_{max} Seat Load *(Kilonewton)*
- $L_{Vertical}$ Vertical Load on Member *(Kilonewton)*
- **M** Bending Moment *(Newton Meter)*
- **R** Radius of Curve *(Meter)*
- R_w Radius of Wheel *(Millimeter)*
- **S** Sleeper Spacing *(Meter)*
- S_h Bending Stress *(Pascal)*
- V_t Speed of Train *(Kilometer per Hour)*
- **w** Unsuspended Mass *(Ton-Force (Metric))*
- **W** Wheelbase *(Millimeter)*
- W_e Extra Width *(Millimeter)*
- W_L Wheel Load *(Kilonewton)*
- **x** Distance from Load *(Meter)*
- **z** Section Modulus *(Cubic Meter)*
- Z_c Section Modulus in Compression *(Cubic Meter)*
- Z_t Section Modulus in Tension *(Cubic Meter)*

Constants, Functions, Measurements used in list of Railway Track and Track Stresses Formulas above

- Functions: **cos**, cos(Angle)
  Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.
- Functions: **exp**, exp(Number)
  n an exponential function, the value of the function changes by a constant factor for every unit change in the independent variable.
- Functions: **sin**, sin(Angle)
  Sine is a trigonometric function that describes the ratio of the length of the opposite side of a right triangle to the length of the hypotenuse.
- 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: **Volume** in Cubic Meter (m^3)
  Volume Unit Conversion
- Measurement: **Pressure** in Kilogram-Force per Square Millimeter (kgf/mm^2), Pascal (Pa), Kilogram-Force per Square Meter (kgf/m^2)
  Pressure Unit Conversion
- Measurement: **Speed** in Kilometer per Hour (km/h)
  Speed Unit Conversion
- Measurement: **Force** in Kilonewton (kN), Ton-Force (Metric) (tf)
  Force Unit Conversion
- Measurement: **Moment of Force** in Newton Meter (N*m)
  Moment of Force Unit Conversion

Download other Important Railway Engineering PDFs

- Important Geometric Design of Railway Track Formulas
- Important Materials Required per km of Railway Track Formulas
- Important Points and Crossings Formulas
- Important Railway Track and Track Stresses Formulas
- Important Traction and Tractive Resistances Formulas

Try our Unique Visual Calculators

- Percentage change
- LCM of two numbers
- Proper fraction

Please SHARE this PDF with someone who needs it!

This PDF can be downloaded in these languages

English Spanish French German Russian Italian Portuguese Polish Dutch

7/8/2024 | 9:12:42 AM UTC