Important Composite Construction in Highway Bridges Formulas PDF

Formulas
Examples
with Units

List of 22
Important Composite Construction in Highway Bridges Formulas

1) Bending Stresses Formulas

1.1) Dead Load Moment given Stress in Steel for Shored Members Formula

Evaluate Formula

Formula

$$M_{D(shored)} = \left(S_{tr} \cdot f_{steel\ stress} \right) - M_L$$

Example with Units

$$14885\,\text{N*mm} = \left(250\,\text{mm}^3 \cdot 60\,\text{N/mm}^2 \right) - 115\,\text{N*mm}$$

1.2) Dead Load Moment given Stress in Steel for Unshored Members Formula

Evaluate Formula

Formula

$$M_{D(unshored)} = S_s \cdot \left(f_{steel\ stress} - \left(\frac{M_L}{S_{tr}} \right) \right)$$

Example with Units

$$8931\,\text{N*mm} = 150\,\text{mm}^3 \cdot \left(60\,\text{N/mm}^2 - \left(\frac{115\,\text{N*mm}}{250\,\text{mm}^3} \right) \right)$$

1.3) Live Load Moment given Stress in Steel for Shored Members Formula

Evaluate Formula

Formula

$$M_L = S_{tr} \cdot f_{steel\ stress} - M_{D(shored)}$$

Example with Units

$$115\,\text{N*mm} = 250\,\text{mm}^3 \cdot 60\,\text{N/mm}^2 - 14885\,\text{N*mm}$$

1.4) Live Load Moment given Stress in Steel for Unshored Members Formula

Evaluate Formula

Formula

$$M_L = S_{tr} \cdot \left(f_{steel\ stress} - \frac{M_{D(unshored)}}{S_s} \right)$$

Example with Units

$$115\,\text{N*mm} = 250\,\text{mm}^3 \cdot \left(60\,\text{N/mm}^2 - \frac{8931\,\text{N*mm}}{150\,\text{mm}^3} \right)$$

1.5) Multiplier for Allowable Stress when Flange Bending Stress is lesser than Allowable Stress Formula

Evaluate Formula

Formula

$$R = 1 - \frac{(1 - \alpha)^2 \cdot (\beta \cdot \psi) \cdot (3 - \psi + \psi \cdot \alpha)}{6 + \beta \cdot \psi \cdot (3 - \psi)}$$

Example

$$0.5 = 1 - \frac{(1 - 1.5)^2 \cdot (3 \cdot 2.0) \cdot (3 - 2.0 + 2.0 \cdot 1.5)}{6 + 3 \cdot 2.0 \cdot (3 - 2.0)}$$

1.6) Section Modulus of Steel Beam given Stress in Steel for Unshored Members Formula

Evaluate Formula

Formula

$$S_s = \frac{M_{D(unshored)}}{f_{steel\ stress} - \left(\frac{M_L}{S_{tr}}\right)}$$

Example with Units

$$150\,mm^3 = \frac{8931\,N*mm}{60\,N/mm^2 - \left(\frac{115\,N*mm}{250\,mm^3}\right)}$$

1.7) Section Modulus of Transformed Composite Section given Stress in Steel for Shored Members Formula

Evaluate Formula

Formula

$$S_{tr} = \frac{M_{D(shored)} + M_L}{f_{steel\ stress}}$$

Example with Units

$$250\,mm^3 = \frac{14885\,N*mm + 115\,N*mm}{60\,N/mm^2}$$

1.8) Section Modulus of Transformed Composite Section given Stress in Steel for Unshored Members Formula

Evaluate Formula

Formula

$$S_{tr} = \frac{M_L}{f_{steel\ stress} - \left(\frac{M_{D(unshored)}}{S_s}\right)}$$

Example with Units

$$250\,mm^3 = \frac{115\,N*mm}{60\,N/mm^2 - \left(\frac{8931\,N*mm}{150\,mm^3}\right)}$$

1.9) Stress in Steel for Shored Members Formula

Evaluate Formula

Formula

$$f_{steel\ stress} = \frac{M_{D(shored)} + M_L}{S_{tr}}$$

Example with Units

$$60\,N/mm^2 = \frac{14885\,N*mm + 115\,N*mm}{250\,mm^3}$$

1.10) Stress in Steel for Unshored Members Formula

Evaluate Formula

Formula

$$f_{steel\ stress} = \left(\frac{M_{D(unshored)}}{S_s}\right) + \left(\frac{M_L}{S_{tr}}\right)$$

Example with Units

$$60\,N/mm^2 = \left(\frac{8931\,N*mm}{150\,mm^3}\right) + \left(\frac{115\,N*mm}{250\,mm^3}\right)$$

2) Shear Range Formulas

2.1) Allowable Horizontal Shear for Individual Connector for 100,000 Cycles Formula

Evaluate Formula

Formula	Example with Units
$Z_r = 4 \cdot w$	$832\,\text{kN} = 4 \cdot 208\,\text{mm}$

2.2) Allowable Horizontal Shear for Individual Connector for 2 Million Cycles Formula

Evaluate Formula

Formula	Example with Units
$Z_r = 2.4 \cdot w$	$499.2\,\text{kN} = 2.4 \cdot 208\,\text{mm}$

2.3) Allowable Horizontal Shear for Individual Connector for 500,000 Cycles Formula

Evaluate Formula

Formula	Example with Units
$Z_r = 3 \cdot w$	$624\,\text{kN} = 3 \cdot 208\,\text{mm}$

2.4) Allowable Horizontal Shear for Individual Connector for over 2 Million Cycles Formula

Evaluate Formula

Formula	Example with Units
$Z_r = 2.1 \cdot w$	$436.8\,\text{kN} = 2.1 \cdot 208\,\text{mm}$

2.5) Allowable Horizontal Shear for Welded Studs for 100,000 Cycles Formula

Evaluate Formula

Formula	Example with Units
$Z_r = 13.0 \cdot \left(d^2\right)$	$832\,\text{kN} = 13.0 \cdot \left(8\,\text{mm}^2\right)$

2.6) Allowable Horizontal Shear for Welded Studs for 2 Million Cycles Formula

Evaluate Formula

Formula	Example with Units
$Z_r = 7.85 \cdot \left(d^2\right)$	$502.4\,\text{kN} = 7.85 \cdot \left(8\,\text{mm}^2\right)$

2.7) Allowable Horizontal Shear for Welded Studs for 500,000 Cycles Formula

Evaluate Formula

Formula	Example with Units
$Z_r = 10.6 \cdot \left(d^2\right)$	$678.4\,\text{kN} = 10.6 \cdot \left(8\,\text{mm}^2\right)$

2.8) Allowable Horizontal Shear for Welded Studs for over 2 Million Cycles Formula

Evaluate Formula

Formula	Example with Units
$Z_r = 5.5 \cdot \left(d^2\right)$	$352\,\text{kN} = 5.5 \cdot \left(8\,\text{mm}^2\right)$

2.9) Horizontal Shear Range at Juncture of Slab and Beam Formula

Evaluate Formula

Formula

$$S_r = \frac{V_r \cdot Q}{I_h}$$

Example with Units

$$6.4\,\text{kN/mm} = \frac{80\,\text{kN} \cdot 10\,\text{mm}^3}{125\,\text{mm}^4}$$

2.10) Moment of Inertia of Transformed Section given Horizontal Shear Range Formula

Evaluate Formula

Formula

$$I_h = \frac{Q \cdot V_r}{S_r}$$

Example with Units

$$125\,\text{mm}^4 = \frac{10\,\text{mm}^3 \cdot 80\,\text{kN}}{6.4\,\text{kN/mm}}$$

2.11) Shear Range due to Live and Impact Load given Horizontal Shear Range Formula

Evaluate Formula

Formula

$$V_r = \frac{S_r \cdot I_h}{Q}$$

Example with Units

$$80\,\text{kN} = \frac{6.4\,\text{kN/mm} \cdot 125\,\text{mm}^4}{10\,\text{mm}^3}$$

2.12) Static Moment of Transformed Section given Horizontal Shear Range Formula

Evaluate Formula

Formula

$$Q = \frac{S_r \cdot I_h}{V_r}$$

Example with Units

$$10\,\text{mm}^3 = \frac{6.4\,\text{kN/mm} \cdot 125\,\text{mm}^4}{80\,\text{kN}}$$

Variables used in list of Composite Construction in Highway Bridges Formulas above

- **d** Stud Diameter *(Millimeter)*
- $f_{steel\ stress}$ Tensile Steel Stress *(Newton per Square Millimeter)*
- I_h Moment of Inertia of Transformed Section *(Millimeter⁴)*
- $M_{D(shored)}$ Dead Load Moment for Shored Member *(Newton Millimeter)*
- $M_{D(unshored)}$ Dead Load Moment for Unshored Member *(Newton Millimeter)*
- M_L Live Load Moment *(Newton Millimeter)*
- **Q** Static Moment *(Cubic Millimeter)*
- **R** Allowable Stress Multiplier
- S_r Horizontal Shear Range *(Kilonewton per Millimeter)*
- S_s Section Modulus of Steel Beam *(Cubic Millimeter)*
- S_{tr} Section Modulus of Transformed Composite Section *(Cubic Millimeter)*
- V_r Shear Range *(Kilonewton)*
- **w** Length of Channel *(Millimeter)*
- Z_r Allowable Range of Horizontal Shear *(Kilonewton)*
- **α** Ratio of Web to Flange Yield Strength
- **β** Ratio of Web to Flange Area
- **ψ** Distance Ratio of Flange to Depth

Constants, Functions, Measurements used in list of Composite Construction in Highway Bridges Formulas above

- Measurement: **Length** in Millimeter (mm)
  Length Unit Conversion
- Measurement: **Volume** in Cubic Millimeter (mm^3)
  Volume Unit Conversion
- Measurement: **Pressure** in Newton per Square Millimeter (N/mm^2)
  Pressure Unit Conversion
- Measurement: **Force** in Kilonewton (kN)
  Force Unit Conversion
- Measurement: **Torque** in Newton Millimeter (N*mm)
  Torque Unit Conversion
- Measurement: **Second Moment of Area** in Millimeter⁴ (mm^4)
  Second Moment of Area Unit Conversion
- Measurement: **Shear Range** in Kilonewton per Millimeter (kN/mm)
  Shear Range Unit Conversion

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