Important Connectors and Stiffeners in Bridges Formulas PDF

Formulas
Examples
with Units

List of 34
Important Connectors and Stiffeners in Bridges Formulas

1) Number of Connectors in Bridges Formulas

1.1) 28-day Compressive Strength of Concrete given Force in Slab Formula

Evaluate Formula

Formula

$$f_c = \frac{P_{on\ slab}}{0.85 \cdot A_{concrete}}$$

Example with Units

$$15\,\text{MPa} = \frac{245\,\text{kN}}{0.85 \cdot 19215.69\,\text{mm}^2}$$

1.2) Area of Longitudinal Reinforcing given Force in Slab at Maximum Negative Moments Formula

Evaluate Formula

Formula

$$A_{st} = \frac{P_{on\ slab}}{f_y}$$

Example with Units

$$980\,\text{mm}^2 = \frac{245\,\text{kN}}{250\,\text{MPa}}$$

1.3) Effective Concrete Area given Force in Slab Formula

Evaluate Formula

Formula

$$A_{concrete} = \frac{P_{on\ slab}}{0.85 \cdot f_c}$$

Example with Units

$$19215.6863\,\text{mm}^2 = \frac{245\,\text{kN}}{0.85 \cdot 15\,\text{MPa}}$$

1.4) Force in Slab at Maximum Negative Moments given Minimum Number of Connectors for Bridges Formula

Evaluate Formula

Formula

$$P_3 = N \cdot \Phi \cdot S_{ultimate} - P_{on\ slab}$$

Example with Units

$$10\,\text{kN} = 15.0 \cdot 0.85 \cdot 20.0\,\text{kN} - 245\,\text{kN}$$

1.5) Force in Slab at Maximum Negative Moments given Reinforcing Steel Yield Strength Formula

Evaluate Formula

Formula

$$P_{on\ slab} = A_{st} \cdot f_y$$

Example with Units

$$245\,\text{kN} = 980\,\text{mm}^2 \cdot 250\,\text{MPa}$$

1.6) Force in Slab at Maximum Positive Moments given Minimum Number of Connectors for Bridges Formula

Evaluate Formula

Formula

$$P_{on\ slab} = N \cdot \Phi \cdot S_{ultimate} - P_3$$

Example with Units

$$245\,kN = 15.0 \cdot 0.85 \cdot 20.0\,kN - 10\,kN$$

1.7) Force in Slab given Effective Concrete Area Formula

Evaluate Formula

Formula

$$P_{on\ slab} = 0.85 \cdot A_{concrete} \cdot f_c$$

Example with Units

$$245\,kN = 0.85 \cdot 19215.69\,mm^2 \cdot 15\,MPa$$

1.8) Force in Slab given Number of Connectors in Bridges Formula

Evaluate Formula

Formula

$$P_{on\ slab} = N \cdot \Phi \cdot S_{ultimate}$$

Example with Units

$$255\,kN = 15.0 \cdot 0.85 \cdot 20.0\,kN$$

1.9) Force in Slab given Total Area of Steel Section Formula

Evaluate Formula

Formula

$$P_{on\ slab} = A_{st} \cdot f_y$$

Example with Units

$$245\,kN = 980\,mm^2 \cdot 250\,MPa$$

1.10) Minimum Number of Connectors for Bridges Formula

Evaluate Formula

Formula

$$N = \frac{P_{on\ slab} + P_3}{\Phi \cdot S_{ultimate}}$$

Example with Units

$$15 = \frac{245\,kN + 10\,kN}{0.85 \cdot 20.0\,kN}$$

1.11) Number of Connectors in Bridges Formula

Evaluate Formula

Formula

$$N = \frac{P_{on\ slab}}{\Phi \cdot S_{ultimate}}$$

Example with Units

$$14.4118 = \frac{245\,kN}{0.85 \cdot 20.0\,kN}$$

1.12) Reduction Factor given Minimum Number of Connectors in Bridges Formula

Evaluate Formula

Formula

$$\Phi = \frac{P_{on\ slab} + P_3}{S_{ultimate} \cdot N}$$

Example with Units

$$0.85 = \frac{245\,kN + 10\,kN}{20.0\,kN \cdot 15.0}$$

1.13) Reduction Factor given Number of Connectors in Bridges Formula

Evaluate Formula

Formula

$$\Phi = \frac{P_{on\ slab}}{N \cdot S_{ultimate}}$$

Example with Units

$$0.8167 = \frac{245\,kN}{15.0 \cdot 20.0\,kN}$$

1.14) Reinforcing Steel Yield Strength given Force in Slab at Maximum Negative Moments Formula

Evaluate Formula

Formula

$$f_y = \frac{P_{on\ slab}}{A_{st}}$$

Example with Units

$$250\,\text{MPa} = \frac{245\,\text{kN}}{980\,\text{mm}^2}$$

1.15) Steel Yield Strength given Total Area of Steel Section Formula

Evaluate Formula

Formula

$$f_y = \frac{P_{on\ slab}}{A_{st}}$$

Example with Units

$$250\,\text{MPa} = \frac{245\,\text{kN}}{980\,\text{mm}^2}$$

1.16) Total Area of Steel Section given Force in Slab Formula

Evaluate Formula

Formula

$$A_{st} = \frac{P_{on\ slab}}{f_y}$$

Example with Units

$$980\,\text{mm}^2 = \frac{245\,\text{kN}}{250\,\text{MPa}}$$

1.17) Ultimate Shear Connector Strength given Minimum Number of Connectors in Bridges Formula

Evaluate Formula

Formula

$$S_{ultimate} = \frac{P_{on\ slab} + P_3}{\Phi \cdot N}$$

Example with Units

$$20\,\text{kN} = \frac{245\,\text{kN} + 10\,\text{kN}}{0.85 \cdot 15.0}$$

1.18) Ultimate Shear Connector Strength given Number of Connectors in Bridges Formula

Evaluate Formula

Formula

$$S_{ultimate} = \frac{P_{on\ slab}}{N \cdot \Phi}$$

Example with Units

$$19.2157\,\text{kN} = \frac{245\,\text{kN}}{15.0 \cdot 0.85}$$

1.19) Ultimate Shear Strength of Connectors in Bridges Formulas

1.19.1) 28-day Compressive Strength given Ultimate Shear Connector Strength for Welded Studs Formula

Evaluate Formula

Formula

$$f_c = \frac{\left(\frac{S_{ultimate}}{0.4 \cdot d_{stud} \cdot d_{stud}}\right)^2}{E}$$

Example with Units

$$14.9012\,\text{MPa} = \frac{\left(\frac{20.0\,\text{kN}}{0.4 \cdot 64\,\text{mm} \cdot 64\,\text{mm}}\right)^2}{10.0\,\text{MPa}}$$

1.19.2) 28-day Compressive Strength of Concrete given Ultimate Shear Connector Strength for Channels Formula

Evaluate Formula

Formula

$$f_c = \left(\frac{S_{ultimate}}{17.4 \cdot w \cdot \left(h + \frac{t}{2} \right)} \right)^2$$

Example with Units

$$14.9778\,\text{MPa} = \left(\frac{20.0\,\text{kN}}{17.4 \cdot 1500\,\text{mm} \cdot \left(188\,\text{mm} + \frac{20\,\text{mm}}{2} \right)} \right)^2$$

1.19.3) Average Channel Flange Thickness given Ultimate Shear Connector Strength for Channels Formula

Evaluate Formula

Formula

$$h = \frac{S_{ultimate}}{17.4 \cdot w \cdot \left(\left(f_c \right)^{0.5} \right)} - \frac{t}{2}$$

Example with Units

$$187.8536\,\text{mm} = \frac{20.0\,\text{kN}}{17.4 \cdot 1500\,\text{mm} \cdot \left(\left(15\,\text{MPa} \right)^{0.5} \right)} - \frac{20\,\text{mm}}{2}$$

1.19.4) Channel Length given Ultimate Shear Connector Strength for Channels Formula

Evaluate Formula

Formula

$$w = \frac{S_{ultimate}}{17.4 \cdot \sqrt{f_c} \cdot \left(h + \frac{t}{2} \right)}$$

Example with Units

$$1498.8906\,\text{mm} = \frac{20.0\,\text{kN}}{17.4 \cdot \sqrt{15\,\text{MPa}} \cdot \left(188\,\text{mm} + \frac{20\,\text{mm}}{2} \right)}$$

1.19.5) Channel Web Thickness given Ultimate Shear Connector Strength for Channels Formula

Evaluate Formula

Formula

$$t = \left(\left(\frac{S_{ultimate}}{17.4 \cdot w \cdot \sqrt{f_c}} \right) - h \right) \cdot 2$$

Example with Units

$$19.7071\,\text{mm} = \left(\left(\frac{20.0\,\text{kN}}{17.4 \cdot 1500\,\text{mm} \cdot \sqrt{15\,\text{MPa}}} \right) - 188\,\text{mm} \right) \cdot 2$$

1.19.6) Diameter of Connector given Ultimate Shear Connector Strength for Welded Studs Formula

Evaluate Formula

Formula

$$d_{stud} = \sqrt{\frac{S_{ultimate}}{0.4 \cdot \sqrt{E \cdot f_c}}}$$

Example with Units

$$63.8943\,\text{mm} = \sqrt{\frac{20.0\,\text{kN}}{0.4 \cdot \sqrt{10.0\,\text{MPa} \cdot 15\,\text{MPa}}}}$$

1.19.7) Elastic Modulus of Concrete given Ultimate Shear Connector Strength for Welded Studs Formula

Evaluate Formula

Formula

$$E = \left(\frac{\left(\frac{S_{ultimate}}{0.4 \cdot d_{stud} \cdot d_{stud}} \right)^2}{f_c} \right)$$

Example with Units

$$9.9341\,\text{MPa} = \left(\frac{\left(\frac{20.0\,\text{kN}}{0.4 \cdot 64\,\text{mm} \cdot 64\,\text{mm}} \right)^2}{15\,\text{MPa}} \right)$$

1.19.8) Shear Capacity for Flexural Members Formula

Evaluate Formula

Formula

$$V_u = 0.58 \cdot f_y \cdot d \cdot bw \cdot C$$

Example with Units

$$7830\,\text{kN} = 0.58 \cdot 250\,\text{MPa} \cdot 200\,\text{mm} \cdot 300\,\text{mm} \cdot 0.90$$

1.19.9) Shear Capacity for Girders with Transverse Stiffeners Formula

Evaluate Formula

Formula

$$V_u = 0.58 \cdot f_y \cdot d \cdot bw \cdot \left(C + \left(\frac{1 - C}{\left(1.15 \cdot \left(1 + \left(\frac{a}{H} \right)^2 \right)^{0.5} \right)} \right) \right)$$

Example with Units

$$8364.9417\,\text{kN} = 0.58 \cdot 250\,\text{MPa} \cdot 200\,\text{mm} \cdot 300\,\text{mm} \cdot \left(0.90 + \left(\frac{1 - 0.90}{\left(1.15 \cdot \left(1 + \left(\frac{5000\,\text{mm}}{5000\,\text{mm}} \right)^2 \right)^{0.5} \right)} \right) \right)$$

1.19.10) Ultimate Shear Connector Strength for Channels Formula

Evaluate Formula

Formula

$$S_{ultimate} = 17.4 \cdot w \cdot \left(\left(f_c \right)^{0.5} \right) \cdot \left(h + \frac{t}{2} \right)$$

Example with Units

$$20.0148\,\text{kN} = 17.4 \cdot 1500\,\text{mm} \cdot \left(\left(15\,\text{MPa} \right)^{0.5} \right) \cdot \left(188\,\text{mm} + \frac{20\,\text{mm}}{2} \right)$$

1.19.11) Ultimate Shear Strength for Welded Studs Formula

Evaluate Formula

Formula

$$S_{ultimate} = 0.4 \cdot d_{stud} \cdot d_{stud} \cdot \sqrt{E \cdot f_c}$$

Example with Units

$$20.0662\,\text{kN} = 0.4 \cdot 64\,\text{mm} \cdot 64\,\text{mm} \cdot \sqrt{10.0\,\text{MPa} \cdot 15\,\text{MPa}}$$

2) Stiffeners on Bridge Girders Formulas

2.1) Actual Stiffener Spacing for Minimum Moment of Inertia of Transverse Stiffener Formula

Evaluate Formula

Formula

$$a_o = \frac{I}{t^3 \cdot J}$$

Example with Units

$$61.6\,\text{mm} = \frac{12320\,\text{mm}^4}{20\,\text{mm}^3 \cdot 0.025}$$

2.2) Minimum Moment of Inertia of Transverse Stiffener Formula

Evaluate Formula

Formula

$$I = a_o \cdot t^3 \cdot \left(2.5 \cdot \left(\frac{D^2}{a_o^2} \right) - 2 \right)$$

Example with Units

$$10000\,\text{mm}^4 = 50\,\text{mm} \cdot 20\,\text{mm}^3 \cdot \left(2.5 \cdot \left(\frac{45\,\text{mm}^2}{50\,\text{mm}^2} \right) - 2 \right)$$

2.3) Web Thickness for Minimum Moment of Inertia of Transverse Stiffener Formula

Evaluate Formula

Formula

$$t = \left(\frac{I}{a_o \cdot \left(\left(2.5 \cdot \frac{D^2}{a_o^2} \right) - 2 \right)} \right)^{\frac{1}{3}}$$

Example with Units

$$21.4404\,\text{mm} = \left(\frac{12320\,\text{mm}^4}{50\,\text{mm} \cdot \left(\left(2.5 \cdot \frac{45\,\text{mm}^2}{50\,\text{mm}^2} \right) - 2 \right)} \right)^{\frac{1}{3}}$$

2.4) Longitudinal Stiffeners Formulas

2.4.1) Moment of Inertia of Longitudinal Stiffeners Formula

Evaluate Formula

Formula

$$I = D \cdot t^3 \cdot \left(2.4 \cdot \left(\frac{A_o^2}{D^2} \right) - 0.13 \right)$$

Example with Units

$$14640\,\text{mm}^4 = 45\,\text{mm} \cdot 20\,\text{mm}^3 \cdot \left(2.4 \cdot \left(\frac{12\,\text{mm}^2}{45\,\text{mm}^2} \right) - 0.13 \right)$$

2.4.2) Web Thickness given Moment of Inertia of Longitudinal Stiffeners Formula

Evaluate Formula

Formula

$$t = \left(\frac{I}{D \cdot \left(2.4 \cdot \left(\frac{A_o^2}{D^2} \right) - 0.13 \right)} \right)^{\frac{1}{3}}$$

Example with Units

$$18.8822\,\text{mm} = \left(\frac{12320\,\text{mm}^4}{45\,\text{mm} \cdot \left(2.4 \cdot \left(\frac{12\,\text{mm}^2}{45\,\text{mm}^2} \right) - 0.13 \right)} \right)^{\frac{1}{3}}$$

Variables used in list of Connectors and Stiffeners in Bridges Formulas above

- **a** Clear Distance between Transverse Stiffeners *(Millimeter)*
- $A_{concrete}$ Effective Concrete Area *(Square Millimeter)*
- a_o Actual Stiffener Spacing *(Millimeter)*
- A_o Actual Distance between Transverse Stiffeners *(Millimeter)*
- A_{st} Area of Steel Reinforcement *(Square Millimeter)*
- **bw** Breadth of Web *(Millimeter)*
- **C** Shear Buckling Coefficient C
- **d** Depth of Cross Section *(Millimeter)*
- **D** Clear Distance between Flanges *(Millimeter)*
- d_{stud} Stud Diameter *(Millimeter)*
- **E** Modulus Elasticity of Concrete *(Megapascal)*
- f_c 28 Day Compressive Strength of Concrete *(Megapascal)*
- f_y Yield Strength of Steel *(Megapascal)*
- **h** Average Flange Thickness *(Millimeter)*
- **H** Cross Section's Height *(Millimeter)*
- **I** Moment of Inertia *(Millimeter⁴)*
- **J** Constant
- **N** No of Connector in Bridge
- P_3 Force in Slab at Negative Moment Point *(Kilonewton)*
- $P_{on\ slab}$ Slab Force *(Kilonewton)*
- $S_{ultimate}$ Ultimate Shear Connector Stress *(Kilonewton)*
- **t** Web Thickness *(Millimeter)*
- V_u Shear Capacity *(Kilonewton)*
- **w** Channel Length *(Millimeter)*
- **Φ** Reduction Factor

Constants, Functions, Measurements used in list of Connectors and Stiffeners in Bridges 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)
  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)
  Force Unit Conversion
- Measurement: **Second Moment of Area** in Millimeter⁴ (mm⁴)
  Second Moment of Area Unit Conversion
- Measurement: **Stress** in Megapascal (MPa)
  Stress Unit Conversion

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