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Connectors and Stiffeners in Bridges Formulas

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List of 34 Connectors and Stiffeners in Bridges Formulas

Connectors and Stiffeners in Bridges

Number of Connectors in Bridges

1) 28-day Compressive Strength of Concrete given Force in Slab

Open Calculator

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

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

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

Open Calculator

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

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

3) Effective Concrete Area given Force in Slab

Open Calculator

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

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

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

Open Calculator

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

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

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

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

Open Calculator

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

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

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

Open Calculator

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

7) Force in Slab given Effective Concrete Area

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

Open Calculator

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

8) Force in Slab given Number of Connectors in Bridges

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

Open Calculator

ex $255\text{kN} = 15.0 \cdot 0.85 \cdot 20.0\text{kN}$

9) Force in Slab given Total Area of Steel Section

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

Open Calculator

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

10) Minimum Number of Connectors for Bridges

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

Open Calculator

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

11) Number of Connectors in Bridges

Open Calculator

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

ex $$14.41176 = \frac{245\text{kN}}{0.85 \cdot 20.0\text{kN}}$$

12) Reduction Factor given Minimum Number of Connectors in Bridges

Open Calculator

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

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

13) Reduction Factor given Number of Connectors in Bridges

Open Calculator

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

ex $$0.816667 = \frac{245\text{kN}}{15.0 \cdot 20.0\text{kN}}$$

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

Open Calculator

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

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

15) Steel Yield Strength given Total Area of Steel Section

Open Calculator

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

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

16) Total Area of Steel Section given Force in Slab

Open Calculator

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

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

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

Open Calculator

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

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

18) Ultimate Shear Connector Strength given Number of Connectors in Bridges

Open Calculator

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

ex $$19.21569\text{kN} = \frac{245\text{kN}}{15.0 \cdot 0.85}$$

Shear Strength Design for Bridges

19) Shear Capacity for Flexural Members

Open Calculator

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

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

20) Shear Capacity for Girders with Transverse Stiffeners

Open Calculator

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

ex $$8364.942\text{kN} = 0.58 \cdot 250\text{MPa} \cdot 200\text{mm} \cdot 300\text{mm} \cdot \left(0.90 + \left(\frac{1 - 0.90}{\left(1.15 \cdot \left(1 + \left(\frac{5000\text{mm}}{5000\text{mm}} \right)^2 \right)^{0.5} \right)} \right) \right)$$

Ultimate Shear Strength of Connectors in Bridges

21) 28-day Compressive Strength given Ultimate Shear Connector Strength for Welded Studs

Open Calculator

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

ex $$14.90116\text{MPa} = \frac{\left(\frac{20.0\text{kN}}{0.4 \cdot 64\text{mm} \cdot 64\text{mm}} \right)^2}{10.0\text{MPa}}$$

22) 28-day Compressive Strength of Concrete given Ultimate Shear Connector Strength for Channels

Open Calculator

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

ex $$14.97782\text{MPa} = \left(\frac{20.0\text{kN}}{17.4 \cdot 1500\text{mm} \cdot \left(188\text{mm} + \frac{20\text{mm}}{2} \right)} \right)^2$$

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

Open Calculator

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

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

24) Channel Length given Ultimate Shear Connector Strength for Channels

Open Calculator

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

$$1498.891\text{mm} = \frac{20.0\text{kN}}{17.4 \cdot \sqrt{15\text{MPa}} \cdot \left(188\text{mm} + \frac{20\text{mm}}{2} \right)}$$

25) Channel Web Thickness given Ultimate Shear Connector Strength for Channels

Open Calculator

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

$$19.70711\text{mm} = \left(\left(\frac{20.0\text{kN}}{17.4 \cdot 1500\text{mm} \cdot \sqrt{15\text{MPa}}} \right) - 188\text{mm} \right) \cdot 2$$

26) Diameter of Connector given Ultimate Shear Connector Strength for Welded Studs

Open Calculator

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

$$63.89431\text{mm} = \sqrt{\frac{20.0\text{kN}}{0.4 \cdot \sqrt{10.0\text{MPa} \cdot 15\text{MPa}}}}$$

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

Open Calculator

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

ex $$9.934107\text{MPa} = \left(\frac{\left(\frac{20.0\text{kN}}{0.4 \cdot 64\text{mm} \cdot 64\text{mm}} \right)^2}{15\text{MPa}} \right)$$

28) Ultimate Shear Connector Strength for Channels

Open Calculator

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

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

29) Ultimate Shear Strength for Welded Studs

Open Calculator

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

ex $$20.06622\text{kN} = 0.4 \cdot 64\text{mm} \cdot 64\text{mm} \cdot \sqrt{10.0\text{MPa} \cdot 15\text{MPa}}$$

Stiffeners on Bridge Girders

30) Actual Stiffener Spacing for Minimum Moment of Inertia of Transverse Stiffener

Open Calculator

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

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

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31) Minimum Moment of Inertia of Transverse Stiffener

Open Calculator

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

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

32) Web Thickness for Minimum Moment of Inertia of Transverse Stiffener

Open Calculator

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

ex $$21.44043\text{mm} = \left(\frac{12320\text{mm}^4}{50\text{mm} \cdot \left(\left(2.5 \cdot \frac{(45\text{mm})^2}{(50\text{mm})^2} \right) - 2 \right)} \right)^{\frac{1}{3}}$$

Longitudinal Stiffeners

33) Moment of Inertia of Longitudinal Stiffeners

Open Calculator

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

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

34) Web Thickness given Moment of Inertia of Longitudinal Stiffeners

Open Calculator

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

ex $$18.88223\text{mm} = \left(\frac{12320\text{mm}^4}{45\text{mm} \cdot \left(2.4 \cdot \left(\frac{(12\text{mm})^2}{(45\text{mm})^2} \right) - 0.13 \right)} \right)^{\frac{1}{3}}$$

Variables Used

- **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

- Function: **sqrt**, sqrt(Number)
  Square root function
- Measurement: **Length** in Millimeter (mm)
  Length Unit Conversion
- Measurement: **Area** in Square Millimeter (mm^2)
  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 $Millimeter^4$ (mm^4)
  Second Moment of Area Unit Conversion
- Measurement: **Stress** in Megapascal (MPa)
  Stress Unit Conversion

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- **Connectors and Stiffeners in Bridges Formulas**
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