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Design of Beam and Slab Formulas

Calculators! Examples! Conversions!

List of 27 Design of Beam and Slab Formulas

Design of Beam and Slab

Curtailment of Flexural Tension Reinforcement

Development Length Requirements

1) Applied Shear at Section for Development Length of Simple Support

Open Calculator

fx $$V_u = \frac{M_n}{Ld - La}$$

ex $$33.4\mathrm{N/mm^2} = \frac{10.02\mathrm{MPa}}{400\mathrm{mm} - 100\mathrm{mm}}$$

2) Bar Steel Yield Strength given Basic Development Length

Open Calculator

fx $$f_y = \frac{Ld \cdot \sqrt{f_c}}{0.04 \cdot A_b}$$

ex $$249.8699\mathrm{MPa} = \frac{400\mathrm{mm} \cdot \sqrt{15\mathrm{MPa}}}{0.04 \cdot 155\mathrm{mm^2}}$$

3) Basic Development Length for 14mm Diameter Bars

Open Calculator

$$Ld = \frac{0.085 \cdot f_y}{\sqrt{f_c}}$$

$$5.486726\text{mm} = \frac{0.085 \cdot 250\text{MPa}}{\sqrt{15\text{MPa}}}$$

4) Basic Development Length for 18mm Diameter Bars

Open Calculator

$$Ld = \frac{0.125 \cdot f_y}{\sqrt{f_c}}$$

$$8.068715\text{mm} = \frac{0.125 \cdot 250\text{MPa}}{\sqrt{15\text{MPa}}}$$

5) Basic Development Length for Bars and Wire in Tension

Open Calculator

$$Ld = \frac{0.04 \cdot A_b \cdot f_y}{\sqrt{f_c}}$$

$$400.2083\text{mm} = \frac{0.04 \cdot 155\text{mm}^2 \cdot 250\text{MPa}}{\sqrt{15\text{MPa}}}$$

6) Computed Flexural Strength given Development Length for Simple Support

Open Calculator

$$M_n = (V_u) \cdot (Ld - La)$$

$$10.02\text{MPa} = (33.4\text{N/mm}^2) \cdot (400\text{mm} - 100\text{mm})$$

7) Development Length for simple Support

Open Calculator

$$Ld = \left(\frac{M_n}{V_u}\right) + (La)$$

$$100.3\text{mm} = \left(\frac{10.02\text{MPa}}{33.4\text{N/mm}^2}\right) + (100\text{mm})$$

Design of Continuous One-Way Slabs

Use of Moment Coefficients

8) Negative Moment at Exterior Face of First Interior Support for More than Two Spans

Open Calculator

$$M_t = \frac{W_{load} \cdot I_n^2}{10}$$

$$36.07204\text{N*m} = \frac{3.6\text{kN} \cdot (10.01\text{m})^2}{10}$$

9) Negative Moment at Exterior Face of First Interior Support for Two Spans

Open Calculator

$$M_t = \frac{W_{load} \cdot I_n^2}{9}$$

$$40.08004\text{N*m} = \frac{3.6\text{kN} \cdot (10.01\text{m})^2}{9}$$

10) Negative Moment at Interior Faces of Exterior Support where Support is Column

Open Calculator

fx $$M_t = \frac{W_{load} \cdot I_n^2}{12}$$

ex $$30.06003\text{N*m} = \frac{3.6\text{kN} \cdot (10.01\text{m})^2}{12}$$

11) Negative Moment at Interior Faces of Exterior Supports where Support is Spandrel Beam

Open Calculator

fx $$M_t = \frac{W_{load} \cdot I_n^2}{24}$$

ex $$15.03001\text{N*m} = \frac{3.6\text{kN} \cdot (10.01\text{m})^2}{24}$$

12) Negative Moment at Other Faces of Interior Supports

Open Calculator

fx $$M_t = \frac{W_{load} \cdot I_n^2}{11}$$

ex $$32.79276\text{N*m} = \frac{3.6\text{kN} \cdot (10.01\text{m})^2}{11}$$

13) Positive Moment for End Spans if Discontinuous End is Integral with Support

Open Calculator

fx $$M_t = \frac{W_{load} \cdot I_n^2}{14}$$

ex $$25.76574 N^*m = \frac{3.6kN \cdot (10.01m)^2}{14}$$

14) Positive Moment for End Spans if Discontinuous End is Unrestrained

Open Calculator

fx $$M_t = \frac{W_{load} \cdot I_n^2}{11}$$

ex $$32.79276 N^*m = \frac{3.6kN \cdot (10.01m)^2}{11}$$

15) Positive Moment for Interior Spans

Open Calculator

fx $$M_t = \frac{W_{load} \cdot I_n^2}{16}$$

ex $$22.54502 N^*m = \frac{3.6kN \cdot (10.01m)^2}{16}$$

16) Shear Force at All Other Supports

Open Calculator

fx $$M_t = \frac{W_{load} \cdot I_n^2}{2}$$

ex $$180.3602\text{N*m} = \frac{3.6\text{kN} \cdot (10.01\text{m})^2}{2}$$

17) Shear Force in End Members at First Interior Support

Open Calculator

fx $$M_t = 1.15 \cdot \frac{W_{load} \cdot I_n^2}{2}$$

ex $$207.4142\text{N*m} = 1.15 \cdot \frac{3.6\text{kN} \cdot (10.01\text{m})^2}{2}$$

Doubly Reinforced Rectangular Sections

18) Bending Moment given Total Cross-Sectional Area of Tensile Reinforcing

Open Calculator

fx $$Mb_R = A_{cs} \cdot 7 \cdot f_s \cdot \frac{D_B}{8}$$

ex $$52.21125\text{N*m} = 13\text{m}^2 \cdot 7 \cdot 1.7\text{Pa} \cdot \frac{2.7\text{m}}{8}$$

19) Cross-Sectional Area of Compressive Reinforcing

Open Calculator

fx $$A_{s'} = \frac{B_M - M'}{m \cdot f_{EC} \cdot d_{eff}}$$

ex $$20.61263\text{mm}^2 = \frac{49.5\text{kN*m} - 16.5\text{kN*m}}{8 \cdot 50.03\text{MPa} \cdot 4\text{m}}$$

20) Total Cross-Sectional Area of Tensile Reinforcing

Open Calculator

fx $$A_{cs} = 8 \cdot \frac{Mb_R}{7 \cdot f_s \cdot D_B}$$

ex $$13.19639\text{m}^2 = 8 \cdot \frac{53\text{N*m}}{7 \cdot 1.7\text{Pa} \cdot 2.7\text{m}}$$

Singly Reinforced Rectangular Sections

21) Area of Tension Reinforcement given Steel Ratio

Open Calculator

fx $$A = (\rho_{\text{steel ratio}} \cdot b \cdot d')$$

ex $$7.57998\text{m}^2 = (37.9 \cdot 26.5\text{mm} \cdot 7547.15\text{mm})$$

22) Beam Width given Steel Ratio

Open Calculator

fx $$b = \frac{A}{d' \cdot \rho_{\text{steel ratio}}}$$

ex $$34.96051\text{mm} = \frac{10\text{m}^2}{7547.15\text{mm} \cdot 37.9}$$

23) Distance from Extreme Compression to Centroid given Steel Ratio

Open Calculator

$$d' = \frac{A}{b \cdot \rho_{\text{steel ratio}}}$$

$$9956.688\text{mm} = \frac{10\text{m}^2}{26.5\text{mm} \cdot 37.9}$$

24) Lever Arm Depth Factor

Open Calculator

$$j = 1 - \left(\frac{k}{3}\right)$$

$$0.796667 = 1 - \left(\frac{0.61}{3}\right)$$

25) Modular Ratio

Open Calculator

$$m = \frac{E_s}{E_c}$$

$$43915.65 = \frac{1000\text{ksi}}{0.157\text{MPa}}$$

26) Steel Ratio

Open Calculator

$$\rho_{\text{steel ratio}} = \frac{A}{b \cdot d'}$$

$$50.00013 = \frac{10\text{m}^2}{26.5\text{mm} \cdot 7547.15\text{mm}}$$

27) Stress in Steel with Tension Reinforcement only

Open Calculator

fx $$f_{TS} = \frac{m \cdot f_{\text{comp stress}} \cdot (1 - k)}{k}$$

ex $$255.7377\text{kgf/m}^2 = \frac{8 \cdot 50\text{kgf/m}^2 \cdot (1 - 0.61)}{0.61}$$

Variables Used

- **A** Area of Tension Reinforcement *(Square Meter)*
- **A_b** Area of Bar *(Square Millimeter)*
- **A_{cs}** Cross-Sectional Area *(Square Meter)*
- **$A_{s'}$** Area of Compression Reinforcement *(Square Millimeter)*
- **b** Beam Width *(Millimeter)*
- **B_M** Bending Moment of Considered Section *(Kilonewton Meter)*
- **d'** Distance from Compression to Centroid Reinforcment *(Millimeter)*
- **D_B** Depth of Beam *(Meter)*
- **d_{eff}** Effective Depth of Beam *(Meter)*
- **E_c** Modulus of Elasticity of Concrete *(Megapascal)*
- **E_s** Modulus of Elasticity of Steel *(Kilopound Per Square Inch)*
- **f_c** 28 Day Compressive Strength of Concrete *(Megapascal)*
- **$f_{comp\ stress}$** Compressive Stress at Extreme Concrete Surface *(Kilogram-Force per Square Meter)*
- **f_{EC}** Extreme Compressive Stress of Concrete *(Megapascal)*
- **f_s** Reinforcement Stress *(Pascal)*
- **f_{TS}** Tensile Stress in Steel *(Kilogram-Force per Square Meter)*
- **f_y** Yield Strength of Steel *(Megapascal)*
- **l_n** Length of Span *(Meter)*
- **j** Constant j
- **k** Ratio of Depth
- **La** Additional Embedment Length *(Millimeter)*

- **Ld** Development Length *(Millimeter)*
- **m** Modular Ratio
- **M'** Bending Moment of Singly reinforced Beam *(Kilonewton Meter)*
- M_n Computed Flexural Strength *(Megapascal)*
- M_t Moment in Structures *(Newton Meter)*
- Mb_R Bending Moment *(Newton Meter)*
- V_u Applied Shear at Section *(Newton per Square Millimeter)*
- W_{load} Vertical Load *(Kilonewton)*
- $\rho_{steel\ ratio}$ Steel Ratio

Constants, Functions, Measurements used

- Function: **sqrt**, sqrt(Number)
  Square root function
- Measurement: **Length** in Millimeter (mm), Meter (m)
  Length Unit Conversion
- Measurement: **Area** in Square Millimeter (mm²), Square Meter (m²)
  Area Unit Conversion
- Measurement: **Pressure** in Newton per Square Millimeter (N/mm²), Megapascal (MPa), Pascal (Pa), Kilopound Per Square Inch (ksi), Kilogram-Force per Square Meter (kgf/m²)
  Pressure Unit Conversion
- Measurement: **Energy** in Newton Meter (N*m)
  Energy Unit Conversion
- Measurement: **Force** in Kilonewton (kN)
  Force Unit Conversion
- Measurement: **Moment of Force** in Newton Meter (N*m), Kilonewton Meter (kN*m)
  Moment of Force Unit Conversion
- Measurement: **Stress** in Megapascal (MPa)
  Stress Unit Conversion

Check other formula lists

- **Analysis Using Limit State Method Formulas**
- **Design of Beam and Slab Formulas**

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