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Short Axially Loaded Columns with Helical Ties Formulas

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List of 21 Short Axially Loaded Columns with Helical Ties Formulas

Short Axially Loaded Columns with Helical Ties

1) Area of Concrete given Factored Axial Load

$$f_x \quad A_c = \frac{\left(\frac{P_f}{1.05}\right) - 0.67 \cdot f_y \cdot A_{st}}{0.4 \cdot f_{ck}}$$

[Open Calculator !\[\]\(a870788d6ed9b8fd294b7654a8c8526b_img.jpg\)](#)

$$ex \quad 52450.01\text{mm}^2 = \frac{\left(\frac{583672\text{kN}}{1.05}\right) - 0.67 \cdot 450\text{MPa} \cdot 452\text{mm}^2}{0.4 \cdot 20\text{MPa}}$$

2) Area of Cross-section of Spiral Reinforcement given Volume

$$f_x \quad A_{st} = \frac{V_h}{\pi \cdot (d_c - \Phi)}$$

[Open Calculator !\[\]\(c50c8b7b2cc2cf9ff925edec0ee94c0d_img.jpg\)](#)

$$ex \quad 452\text{mm}^2 = \frac{191700\text{m}^3}{\pi \cdot (150\text{mm} - 15\text{mm})}$$

3) Area of Longitudinal Reinforcement for Columns given Factored Axial Load in Spiral Columns

$$f_x \quad A_{st} = \frac{\left(\frac{P_f}{1.05}\right) - (0.4 \cdot f_{ck} \cdot A_c)}{0.67 \cdot f_y}$$

[Open Calculator !\[\]\(f60b7a900783ac3fd531bfd9c111be6d_img.jpg\)](#)

$$ex \quad 452.0003\text{mm}^2 = \frac{\left(\frac{583672\text{kN}}{1.05}\right) - (0.4 \cdot 20\text{MPa} \cdot 52450\text{mm}^2)}{0.67 \cdot 450\text{MPa}}$$



4) Characteristic Compressive Strength of Concrete given Factored Axial Load in Spiral Columns

$$fx \quad f_{ck} = \frac{\left(\frac{P_f}{1.05}\right) - 0.67 \cdot f_y \cdot A_{st}}{0.4 \cdot A_c}$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235_img.jpg\)](#)

$$ex \quad 20MPa = \frac{\left(\frac{583672kN}{1.05}\right) - 0.67 \cdot 450MPa \cdot 452mm^2}{0.4 \cdot 52450mm^2}$$

5) Characteristic Strength of Compression Reinforcement given Factored Load in Spiral Columns

$$fx \quad f_y = \frac{\left(\frac{P_f}{1.05}\right) - (0.4 \cdot f_{ck} \cdot A_c)}{0.67 \cdot A_{st}}$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0_img.jpg\)](#)

$$ex \quad 450.0003MPa = \frac{\left(\frac{583672kN}{1.05}\right) - (0.4 \cdot 20MPa \cdot 52450mm^2)}{0.67 \cdot 452mm^2}$$

6) Diameter of Core given Volume of Core

$$fx \quad d_c = \sqrt{4 \cdot \frac{V_c}{\pi \cdot P}}$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f_img.jpg\)](#)

$$ex \quad 150.0002mm = \sqrt{4 \cdot \frac{176715m^3}{\pi \cdot 10mm}}$$

7) Diameter of Core given Volume of Helical Reinforcement in One Loop

$$fx \quad d_c = \left(\frac{V_h}{\pi \cdot A_{st}}\right) + \Phi$$

[Open Calculator !\[\]\(b64b40baaee5acddc1eab8538ba84754_img.jpg\)](#)

$$ex \quad 150mm = \left(\frac{191700m^3}{\pi \cdot 452mm^2}\right) + 15mm$$



8) Diameter of Spiral Reinforcement given Volume of Helical Reinforcement in one Loop

$$f_x \Phi = d_c - \left(\frac{V_h}{\pi \cdot A_{st}} \right)$$

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95_img.jpg\)](#)

$$ex \ 14.99999mm = 150mm - \left(\frac{191700m^3}{\pi \cdot 452mm^2} \right)$$

9) Factored Axial Load on Member of Spiral Columns

$$f_x P_f = 1.05 \cdot (0.4 \cdot f_{ck} \cdot A_c + 0.67 \cdot f_y \cdot A_{st})$$

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2_img.jpg\)](#)

$$ex \ 583671.9kN = 1.05 \cdot (0.4 \cdot 20MPa \cdot 52450mm^2 + 0.67 \cdot 450MPa \cdot 452mm^2)$$

10) Pitch of Spiral Reinforcement given Volume of Core

$$f_x P = \frac{4 \cdot V_c}{\pi \cdot d_c^2}$$

[Open Calculator !\[\]\(fe3aebe81acea8d45108cd2768939da7_img.jpg\)](#)

$$ex \ 10.00002mm = \frac{4 \cdot 176715m^3}{\pi \cdot (150mm)^2}$$

11) Volume of Core in Short Axially Loaded Columns with Helical Ties

$$f_x V_c = \left(\frac{\pi}{4} \right) \cdot d_c^2 \cdot P$$

[Open Calculator !\[\]\(899d8b7697d64725bf017d3296cfcf1b_img.jpg\)](#)

$$ex \ 176714.6m^3 = \left(\frac{\pi}{4} \right) \cdot (150mm)^2 \cdot 10mm$$

12) Volume of Helical Reinforcement in One Loop

$$f_x V_h = \pi \cdot (d_c - \Phi) \cdot A_{st}$$

[Open Calculator !\[\]\(40770d9ed6ed4f1222ebf89a1396e8b2_img.jpg\)](#)

$$ex \ 191700m^3 = \pi \cdot (150mm - 15mm) \cdot 452mm^2$$



Short Axially Loaded Tied Columns

13) Area of Concrete given Factored Axial Load on Member

$$\text{fx } A_c = \frac{P_{fm} - 0.67 \cdot f_y \cdot A_{st}}{0.4 \cdot f_{ck}}$$

[Open Calculator !\[\]\(74d4806277d7e73349d8e8c0897931e9_img.jpg\)](#)

$$\text{ex } 52450\text{mm}^2 = \frac{555.878\text{kN} - 0.67 \cdot 450\text{MPa} \cdot 452\text{mm}^2}{0.4 \cdot 20\text{MPa}}$$

14) Area of Longitudinal Reinforcement for Columns given Factored Axial Load on Member

$$\text{fx } A_{st} = \frac{P_{fm} - 0.4 \cdot f_{ck} \cdot A_c}{0.67 \cdot f_y}$$

[Open Calculator !\[\]\(8bba887393ca45b761e5cb49e755e762_img.jpg\)](#)

$$\text{ex } -1389.864418\text{mm}^2 = \frac{555.878\text{kN} - 0.4 \cdot 20\text{MPa} \cdot 52450\text{mm}^2}{0.67 \cdot 450\text{MPa}}$$

15) Area of Longitudinal Reinforcement given Gross Area of Concrete

$$\text{fx } A_{sc} = p \cdot \frac{A_g}{100}$$

[Open Calculator !\[\]\(0fb13ad0bfa3d86868cdd3883e5665b3_img.jpg\)](#)

$$\text{ex } 30\text{mm}^2 = 2 \cdot \frac{1500\text{mm}^2}{100}$$

16) Factored Axial Load on Member

$$\text{fx } P_{fm} = (0.4 \cdot f_{ck} \cdot A_c) + (0.67 \cdot f_y \cdot A_{st})$$

[Open Calculator !\[\]\(e50091943b385fe16d3277389202856f_img.jpg\)](#)

$$\text{ex } 555.878\text{kN} = (0.4 \cdot 20\text{MPa} \cdot 52450\text{mm}^2) + (0.67 \cdot 450\text{MPa} \cdot 452\text{mm}^2)$$



17) Factored Axial Load on Member given Gross Area of Concrete 

$$fx \quad P_{fm} = \left(0.4 \cdot f_{ck} + \left(\frac{P}{100} \right) \cdot (0.67 \cdot f_y - 0.4 \cdot f_{ck}) \right) \cdot A_g$$

[Open Calculator !\[\]\(d3fb9f94af8b26d1c844efa9a98805b0_img.jpg\)](#)

ex

$$20.805kN = \left(0.4 \cdot 20MPa + \left(\frac{2}{100} \right) \cdot (0.67 \cdot 450MPa - 0.4 \cdot 20MPa) \right) \cdot 1500mm^2$$

18) Gross Area of Concrete given Area of Concrete 

$$fx \quad A_g = \frac{A_c}{1 - \left(\frac{P}{100} \right)}$$

[Open Calculator !\[\]\(73002692dd5e7a64e60946be3158e719_img.jpg\)](#)

ex

$$53520.41mm^2 = \frac{52450mm^2}{1 - \left(\frac{2}{100} \right)}$$

19) Gross Area of concrete given Area of Longitudinal Reinforcement 

$$fx \quad A_g = 100 \cdot \frac{A_{sc}}{p}$$

[Open Calculator !\[\]\(aab88c0d099e5d18d6533a97b13ec28d_img.jpg\)](#)

ex

$$1500mm^2 = 100 \cdot \frac{30mm^2}{2}$$

20) Gross Area of Concrete given Factored Axial Load on Member 

$$fx \quad A_g = \frac{P_{fm}}{0.4 \cdot f_{ck} + \left(\frac{P}{100} \right) \cdot (0.67 \cdot f_y - 0.4 \cdot f_{ck})}$$

[Open Calculator !\[\]\(f9f168a9979beed8b01f8750d577d508_img.jpg\)](#)

ex

$$40.07772mm^2 = \frac{555.878kN}{0.4 \cdot 20MPa + \left(\frac{2}{100} \right) \cdot (0.67 \cdot 450MPa - 0.4 \cdot 20MPa)}$$



21) Percentage of Compression Reinforcement given Area of Longitudinal Reinforcement

[Open Calculator !\[\]\(feabb98897b440bc8695a03336a6e2df_img.jpg\)](#)

$$\text{fx } p = \frac{A_{sc}}{\frac{A_g}{100}}$$

$$\text{ex } 2 = \frac{30\text{mm}^2}{\frac{1500\text{mm}^2}{100}}$$









Variables Used

- A_c Area of Concrete (Square Millimeter)
- A_g Gross Area of Concrete (Square Millimeter)
- A_{sc} Area of Steel Reinforcement in Compression (Square Millimeter)
- A_{st} Area of Steel Reinforcement (Square Millimeter)
- d_c Diameter of Core (Millimeter)
- f_{ck} Characteristic Compressive Strength (Megapascal)
- f_y Characteristic Strength of Steel Reinforcement (Megapascal)
- p Percentage of Compression Reinforcement
- P Pitch of Spiral Reinforcement (Millimeter)
- P_f Factored Load (Kilonewton)
- P_{fm} Factored Load on Member (Kilonewton)
- V_c Volume of Core (Cubic Meter)
- V_h Volume of Helical Reinforcement (Cubic Meter)
- Φ Diameter of Spiral Reinforcement (Millimeter)



Constants, Functions, Measurements used

- **Constant:** **pi**, 3.14159265358979323846264338327950288
Archimedes' constant
- **Function:** **sqrt**, sqrt(Number)
Square root function
- **Measurement:** **Length** in Millimeter (mm)
Length Unit Conversion 
- **Measurement:** **Volume** in Cubic Meter (m³)
Volume 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:** **Stress** in Megapascal (MPa)
Stress Unit Conversion 



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