

## DESIGN OF GRADE SLABS FOR DISTRIBUTED LOADS

### Input Data

Concrete cube compressive stress  $f_{cu} := 30 \text{ MPa}$

Concrete cylinder compressive stress  $f_{ck} := f_{cu} \cdot 0.8 = 24 \text{ MPa}$

Mean Axial Tensile Strength  $f_{ctm} := 0.3 \cdot \left( 0.8 \cdot \frac{f_{cu}}{\text{MPa}} \right)^{\frac{2}{3}} \text{ MPa} = 2.496 \text{ MPa}$

Characteristic Axial tensile strength  $f_{ctk0.05} := 0.7 \cdot f_{ctm} = 1.747 \text{ MPa}$

Mean value of concrete cylinder strength  $f_{cm} := f_{ck} + 8 \cdot \text{MPa} = 32 \text{ MPa}$

Secant Modulus of concrete  $E_{cm} := 22 \cdot \left( \frac{f_{cm}}{10 \text{ MPa}} \right)^{0.3} \cdot 1000 \text{ MPa} = 31186.574 \text{ MPa}$

Partial factor for concrete  $\gamma_C := 1.5$

Poissons Coefficient  $\mu := 0.20$

Coefficient of thermal expansion  $\alpha := \frac{1}{10^{-5} \text{ }^\circ\text{C}}$

### Steel fibre characteristics

Bekaert's Dramix 3D fibre has been used in the calculations

Fibre dosage  $D_f := 12 \frac{\text{kg}}{\text{m}^3}$

$R_{e3} := 0.3$

### Sub base characteristics

The sub base constant should be obtained from plate load test. In this case the

Modulus of subgrade  $k := 0.06 \frac{\text{N}}{\text{mm}^3}$

### Loading

Distributed load on the floor  $w := 100 \frac{\text{kN}}{\text{m}^2}$

### Load and material factors

Partial factor for variable action  $\gamma_Q := 1.2$

Partial factor for concrete  $\gamma_M := 1.5$

Partial factor for steel  $\gamma_S := 1.15$

### Geometry

Slab length  $L := 5000 \text{ mm}$

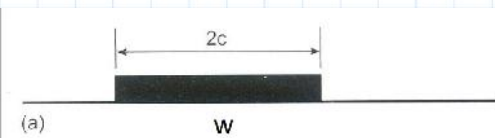
Slab width  $B := 5000 \text{ mm}$

Slab thickness  $h := 350 \text{ mm}$

### Design

#### Acting bending moments

Thickness checks are carried out as per Hetenyi's equation



$$\lambda := \sqrt[4]{\frac{3 \cdot k}{E_{cm} \cdot h^3}} \cdot \text{mm} = 6.057 \cdot 10^{-4}$$

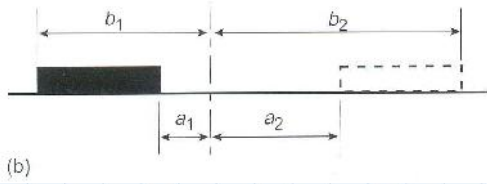
$$c := 0.5 \cdot L = 2.5 \text{ m}$$

$$\lambda \cdot \frac{\text{m}}{\text{m}} \cdot c = 0.002 \text{ m}$$

$$\text{Positive moment } M_p := \frac{w}{2 \cdot \lambda^2} \left( e^{-\lambda \cdot c} \cdot \sin(\lambda \cdot c \cdot \text{deg}) \right) \cdot \text{m} = ? \text{ kN} \cdot \text{m per unit width}$$

Check for maximum possible moment

$$M_{pmax} := \frac{0.161 \cdot w}{\lambda^2} \cdot \text{m} = (4.388 \cdot 10^7) \frac{1}{\text{m}^2} \cdot \text{kN} \cdot \text{m per unit width} \quad 2c = 5 \text{ m}$$



Calculation of Mean flexural tensile strength of concrete

$$f_{ctmfl1} := \left( 1.6 - \frac{h}{1000 \cdot mm} \right) \cdot f_{ctm} = 3.12 \text{ MPa}$$

$$f_{ctmfl2} := f_{ctm} = 2.496 \text{ MPa}$$

$$f_{ctmfl} := \max(f_{ctmfl1}, f_{ctmfl2}) = 3.12 \text{ MPa}$$

$$\text{Negative moment capacity } M_n := \frac{f_{ctmfl1}}{\gamma_C} \left( \frac{h^2}{6} \right) \cdot m = 42.468 \text{ kN}\cdot\text{m}$$

The maximum moment is negative and is induced by the arrangement of loading shown above. The equivalent distributed load for the moment capacity is

$$w_{cap} := \frac{1}{0.168 \cdot m} \cdot \lambda^2 \cdot M_n = (9.275 \cdot 10^{-5}) \text{ m}^2 \cdot \frac{\text{kN}}{\text{m}^2}$$

The capacity of the slab is greater than the applied load on the slab of 100 kN/sq.m. Hence the design is safe.