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17/ENG03/001

(1a)

Purpose of structural design

1. For safety
2. Economical purposes
3. Deformation of the structure must not infer with the integrity of the design.

(1b)

Elastic method

⟹ Elastic / Modular ratio design :- Deals with elasticity of concrete considering it to be perfectly elastic such that it continues to be elastic with time up to its elastic point overtime. It is permitted in CP114

⟹ Limit state design :- Considers all the disadvantages of elastic and load factor design and any other failure that can cause the structure to be structurally unfit of use.

(c)

$f_y = 410N/mm^2$, $f_{cu} = 25N/mm^2$, thread = 275mm

Rise = 150mm, slab thickness = 150mm,

Solution

Safety factor $SF = \frac{\sqrt{R^2 + T^2}}{T} = \frac{\sqrt{130^2 + 273^2}}{275}$

$= 1.14$

$F_y = 410\ N/mm^2$

$DL = 1.4G_K + 1.6Q_K$

loading =

Slab = 0.175 x 24 = 4.2

Partition = 1.0

Finishes = 1.2

6.4 kN/m²

$DL = 1.4(6.4) + 1.6(5) = 16.96 \approx 17\ kN/m$

Short Span

Mid span

$M = B x w l x^2 = 0.133 \times 17 \times 4^2$

$= 8.976\ kN/m^2$

$d = h - cover - 1/2\Phi = 175 - 25 - (1/2 \times 12) = 144$

$K = \frac{M}{bd^2 f_{cu}} = \frac{8.976 \times 10^6}{1000 \times 144^2 \times 25} = 0.0173$

$I_a = 0.5\sqrt{0.25 - \frac{K}{0.9}} = 0.98\ (\leq)\ 0.95$

$Z = I_a d = 0.95 \times 144 = 136.8\ mm$

$A_s = \frac{M}{0.95 f_y Z} = \frac{8.976 \times 10^6}{0.95 \times 410 \times 136.8} = 168.258\ mm^2$

Continuous edge

$M = B x w l x^2 = 0.044 \times 17 \times 4^2 = 11.968$

$K = \frac{M}{bd^2 f_{cu}} = \frac{11.968 \times 10^6}{1000 \times 144^2 \times 25} = 0.023$

$I_a = 0.5\sqrt{0.25 - \frac{K}{0.9}} = 0.97\ (\leq 0.95)$

$Z = I_a d = 0.95 \times 144 = 136.8$

$A_s = \frac{M}{0.95 f_y Z} = \frac{11.968 \times 10^6}{0.95 \times 410 \times 136.8}$

$= 224.61 mm$

Long span

Mid span

$d = 144 - 12 = 132 mm$

$M = 0.037 \times 17 \times 4^2 = 10.064$

$k = \frac{M}{bd^2 f_{cu}} = \frac{10.064 \times 10^6}{1000 \times 132^2 \times 25} = 0.0232$

$J_a = 0.5 + \sqrt{0.25 - \frac{k}{0.9}} = 0.97 \ (\le 0.95)$

$Z = J_a d = 0.95 \times 132 = 125.4$

$A_s = \frac{M}{0.95 f_y z} = \frac{10.064 \times 10^6}{0.95 \times 410 \times 125.4} = 206.05$

Provide Y12 @ 300 c/c

Deflection check.

$d_{req} = \frac{span}{M.F \times \text{effective depth ratio}}$

$M.F = 0.55 + \frac{477 - f_s}{120\left(0.9 + \frac{M}{bd^2}\right)} \le 2$

7,10t5152A $f_s = \frac{2}{3} \times \frac{1}{\beta} \times \frac{A_{req}}{A_{prov}} \times f_y$

$= \frac{2}{3} \times 1 \times \frac{224.67}{377} \times 250$

$= 98.33$

$= 0.55 + \frac{477 - 98.33}{120\left(0.9 + \frac{11.968 \times 10^6}{1000 \times 144^2}\right)}$ $= 6.02 \ r_2$

$$d_{req} = \frac{4 \times 1000}{.2 \times 26} = 76.92.$$