GX508

OLLSCOIL NA hÉIREANN, GAILLIMH

THE NATIONAL UNIVERSITY OF IRELAND, GALWAY

SUMMER EXAMINATIONS, 2001

B.E. DEGREE EXAMINATION

ADVANCED CONCRETE DESIGN

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Time allowed: ***Two*** hours

Answer ***Question 1 and two other questions***

Notes:

- All dimensions are in mm. unless noted otherwise;
- Some expressions relating to Question 3 appear at the end of the paper.

1. The rectangular slab shown in fig. Q1 is fully fixed along edge AB and simply supported on the other edges. The isotropic bottom reinforcement provides an ultimate moment of resistance ***m*** of 24kNm, and the ultimate resistance at the fixed edge is similar. Select a realistic yield-line pattern, and determine the uniformly distributed load, ***q*** kN/m^2, which the slab can support.

Comment on any assumptions made.

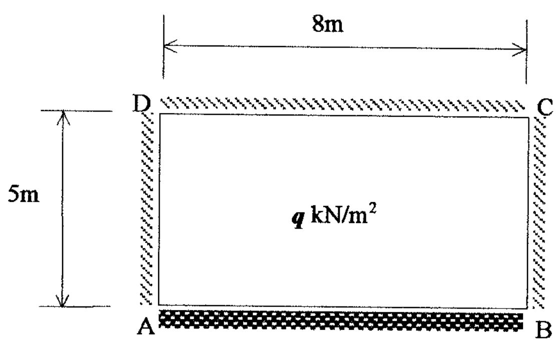
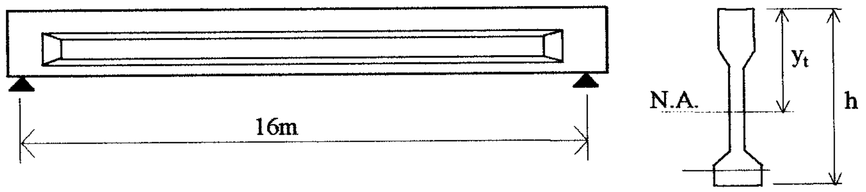


Fig. Q1

2. Determine the limits of cable zone, at supports and at midspan, for the post-tensioned beam shown in Fig. Q2, if the initial prestress at the anchorage is 3000kN.

Select suitable eccentricities and calculate top and bottom stresses at these locations.



Material properties

Concrete:

f_{cu} = 50 N/mm^2

f_{c14} = 40 N/mm^2

(transfer at 14 days)

Allowable stresses in concrete

at transfer:

$f'_{max} = 0.5\ f_{c14}$

f'_{min} = -1 N/mm^2

in service:

$f_{max} = 0.33\ f_{cu}$

f_{min} = 0 N/mm^2

Assume total prestress losses at midspan, after transfer, to be 25%

Section properties

Concrete:

A = 2.90 x 10^5 mm^2

I = 2.73 x 10^{10} mm^4

y_t = 552 mm

h = 950 mm

Loading

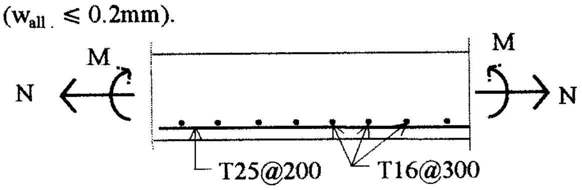
Q_k = 24 kN/m

Span

L = 16m

Fig. Q2

3. Fig. Q3 shows, in plan view, a section of reservoir wall. The 450 thick wall is reinforced with T25@200 horizontally and T16@300 vertically. Under service conditions, the wall is subjected, per metre height, to a bending moment, *M*, of 160kNm combined with an axial tensile force, *N*, of 100kN. Determine if the section satisfies BS8007 criteria for crack width ($w_{all.} \leq$ 0.2mm).



f_{cu} = 35 N/mm^2

f_y = 460 N/mm^2

cover = 40mm

$\alpha_e = E_s/E_c = 15$

Fig. Q3

4. (a) Determine losses due to friction for the continuous post-tensioned beam shown in fig. Q4a, assuming tendons to be stressed from both ends. The beam is symmetrical about the interior support. Sketch also the effect of jacking from one end only.

Assume the values of friction coefficients to be: $\mu = 0.3$ (/rad.); $k = 0.003$ (/m)

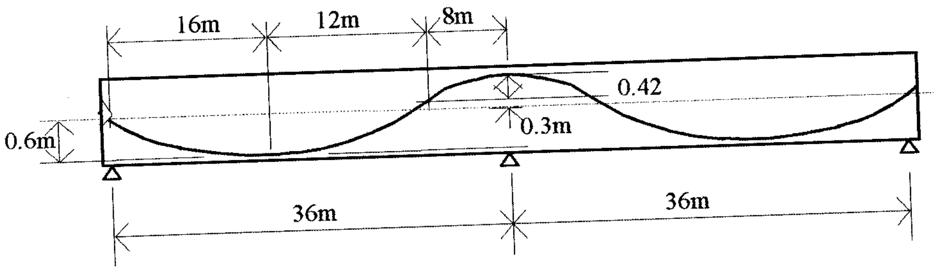


Fig.

(b) The beam in fig. Q4b is stressed with 6 tendons, each of which has an initial prestressing force of 550kN. The eccentricity of the centroid of the group of tendons with respect to the neutral axis is 450mm at midspan and 0mm at supports. Assuming tendons to be stressed sequentially, from both ends, determine the prestress loss due to elastic shortening of the beam. Express the loss as a percentage of initial prestress, if the initial tendon stress is 1120 N/mm^2. Assume 10% friction losses between support and midspan.

Section properties (concrete)

$A = 3.64 \times 10^5$ mm^2
$I = 3.78 \times 10^{10}$ mm^4

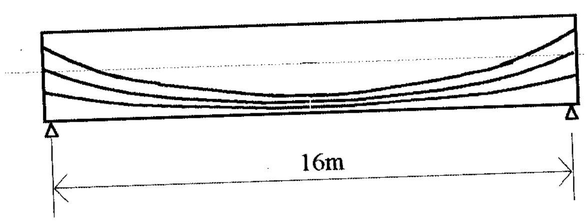


Fig. Q4b

Expressions relating to Question 3:

Reinforced concrete sections in bending and direct tension

(i) with bending predominant:

$$\left(\frac{100A_s}{bd}\right)_{\text{effective}} = \left(\frac{100A_s}{bd}\right)\left(\frac{e+\frac{h}{2}-d}{e+\frac{h}{2}-\frac{x}{3}}\right)$$

with:

A_s area of steel adjacent to tensile face

b breadth of section

h overall depth of section

d depth to centroid of steel area A_s

x depth to neutral axis

e is the eccentricity M/N where N is the axial force and M is the initial bending moment (referred to the centroidal axis)

(ii) with direct tension predominant:

$$f_{s1} = \frac{1}{2A_{s1}}\left(N+\frac{M}{d-\frac{h}{2}}\right) \quad \text{and} \quad f_{s2} = \frac{1}{2A_{s2}}\left(N-\frac{M}{d-\frac{h}{2}}\right)$$

additional terms in the above are:

A_{s1} area of steel at face which is ***most*** heavily stressed in tension

f_{s1} stress in steel area A_{s1}

d depth to centroid of steel area A_{s1}

A_{s2} area of steel at face which is *least* heavily stressed in tension

f_{s2} stress in steel area A_{s2}

d' depth to centroid of steel area A_{s2} (take $d' = h-d$)