Diploma in Civil Engineering

Term-End Examination

June, 2007

BCE-041 : THEORY OF STRUCTURES II

Time : 2 hours *Maximum Marks : 70*

Note : *Attempt Question. No. 1 which is* ***compulsory*** *and any other* ***four*** *questions. In all, solve* ***five*** *questions. All questions carry equal marks. Assume suitable data wherever necessary and mention it clearly. Use of calculator is permitted.*

1. Choose the most appropriate answer from the given alternatives : *7×2=14*

(i) In Limit State Method of design of flexural members, the neutral axis depth coefficient for a balanced section for steel of grade Fe 415 is

(a) 0·53

(b) 0·58

(c) 0·48

(d) 0·46

(ii) In Limit State Method of design for the flexural member the area of the stress block per unit width of the beam is

(a) $0{\cdot}36\ f_{ck}\ x_u$

(b) $0{\cdot}45\ f_{ck}\ x_u$

(c) $0{\cdot}42\ f_{ck}\ x_u$

(d) None of the above

(iii) In Limit State Method of design the vertical deflection limit is deemed to have been satisfied if the ratio of basic value K_B of the effective span to effective depth of the member in case of cantilever beam is

(a) 7

(b) 20

(c) 26

(d) 30

(iv) In Limit State Method of design of RCC flexural members the stress-strain relationship for concrete is assumed to be parabolic curve upto a certain strain. This strain is

(a) 0·20%

(b) 0·25%

(c) 0·30%

(d) 0·35%

(v) The maximum compressive strain in concrete in axial compression is taken as

(a) 0·35%

(b) 0·30%

(c) 0·25%

(d) 0·20%

(vi) The pitch of the helical ties in a circular column shall not be less than

(a) 50 mm

(b) 25 mm

(c) three times the diameter of the bar of helical tie

(d) Least of (b) and (c)

(vii) The minimum reinforcement in a slab is provided as a percentage of gross area of the section. This percentage for grade of steel Fe 415 is

(a) 0·15

(b) 0·12

(c) 0·20

(d) 0·25

2. Determine the moment of resistance M_u of a singly reinforced concrete T-section of flange width 2000 mm, depth of flange 110 mm, overall depth 350 mm, web or rib width 350 mm. The beam is reinforced with 5 bars of 25 mm diameter of grade Fe 415. Use an effective cover of 50 mm and grade of concrete M 20. *14*

3. Determine the moment of resistance and number of 16 mm diameter bars required for a reinforced rectangular beam of width 250 mm and overall depth of 550 mm. Use an effective cover of 50 mm, grade of steel Fe 415, grade of concrete M 25, permissible stress in steel σ_{st} = 230 N/mm^2 and of concrete σ_{cbc} = 8·5 N/mm^2. The modular ratio m can be taken as 11. *14*

4. Write short notes on any ***four*** of the following : $4\times3\frac{1}{2}=14$.

(a) Limit State of Serviceability

(b) Stress – Strain curve for steel

(c) Principles of slab design

(d) Types of slab

(e) Design steps of staircase

(f) Basic assumptions for design of sections

5. Design a simply supported beam of 4 metre clear span loaded with a UDL of 7·5 kN/m including its self weight. Assume support width of 250 mm, Grade of concrete M 20, Grade of steel Fe 415 for main reinforcement and Fe 250 for shear reinforcement. *14*

6. Design a roof slab simply supported on all its four edges of effective span 3 m × 7 m. The top of slab is covered with 100 mm thick lime terrace. Imposed load may be taken as 1·5 kN/m^2. Design parameters are f_{ck} = 20 N/mm^2 f_y = 415 N/mm^2 and nominal cover of 20 mm. *14*

7. Design a staircase having cantilever steps projecting from the wall of the stair hall of a residential house for the following data : width of steps 900 mm, riser 180 mm, tread 250 mm, concrete M 20 and steel Fe 415. *14*

8. Determine the areas of tensile as well as compression reinforcement for a doubly reinforced rectangular section of width 375 mm and depth 500 mm (overall). The beam is subjected to a factored moment M_u of 300 kNm. Use concrete M 25 and steel Fe 415 and an effective cover of 50 mm. *14*

design compressive stress f_{sc} = 351·8 N/mm^2 for comp. strain E_{sc} = 0·00276

design compressive stress f_{sc} = 342·8 N/mm^2 for comp. strain E_{sc} = 0·00241

***Note** : The following design data may be used wherever required.*

A. Design shear strength τ_c of concrete in N/mm^2 (Limit State Method).

100 A_{st} / bd	Concrete M20	Concrete M25
0·15	0·28	0·29
0·25	0·36	0·36
0·50	0·48	0·49
0·75	0·56	0·57
1·00	0·62	0·64
1·25	0·67	0·70
1·50	0·72	0·74
1·75	0·75	0·78
2·00	0·79	0·82
2·25	0·81	0·85
2·50	0·82	0·88
2·75	0·82	0·90

B. Design Bond stress τ_{bd} N/mm^2 (Limit State Method) for bars in tension.

	Steel Fe 250	Steel Fe 415
Concrete M20	1·20	1·92
Concrete M25	1·40	2·24

C. Design shear strength of concrete τ_c max. N/mm^2 (Limit State method)

Concrete M20 2·8

Concrete M25 3·1

D. For solid slabs, design shear strength of concrete shall be taken as $K \tau_c$. The values of K are as below :

Overall depth of slab (mm)	K
300 or more	1·00
275	1·105
250	1·10
225	1·15
200	1·20
175	1·25
150 or less	1·30

E. Modification factor K_2 for different percentages of tension reinforcement A_{st} in flexural RCC members for stress in steel at service loads, $f_s = 240$ N/mm^2, may be taken as below :

$100 A_{st} / bd$	K_2
0·2	1·7
0·4	1·32
0·6	1·15
0·8	1·05
1·0	1·0
1·2	0·95
1·4	0·90
1·6	0·88
1·8	0·86
2·0	0·84
2·2	0·82
2·4	0·80
2·6	0·79
2·8	0·78