PART A

General Engineering

(CIVIL AND STRUCTURAL)

1. (a) Write a short note on Night Irrigation.

(b) Give a brief account of the drawbacks in Kennedy's theory.

(c) For a Highway project, a straight tunnel is to be run between two points P and Q whose co-ordinates are given below :

Point	Co-ordinates	
	N	E
	0	0
	4020	800
R	2110	1900

It is desired to sink a shaft at S, the mid-point of PQ. S is to be fixed from R, the third known point. Calculate

(i) The co-ordinates of S

(ii) The length of RS

(iii) The bearing of RS *15*

(d) Find out the time required for 50% consolidation in a soil having thickness of 800 cm and pervious strata at top and bottom. What will be the value of coefficient of consolidation if coefficient of permeability = 0·0000001 cm/sec ? *15*

Void ratio = 1·8 = m_v = 0·0003 cm^2/gm

Time factor (T_v) = 0·3

γ_w = 1 gm/cc

2. (a) Calculate the ultimate bearing capacity per unit area of :

(i) A strip footing 1 m wide

(ii) A square footing 3 m x 3 m

(iii) A circular footing of diameter 3 m

Given :

Unit weight of the soil 1·8 t/m^3, cohesion = 2 t/m^2 and φ = 20 degree. N_c = 17·5, N_q = 7·5 and N_γ = 5. *15*

(b) Calculate the discharge through a pipe of dia. 200 mm when the difference of pressure head between two ends of a pipe 500 m apart is 4 m of water. Take the value of f = 0·009 in the formula $h_f = \frac{4 . f . L . V^2}{d . 2g}$. 15

(c) Compare and contrast Flexible and Rigid pavements. 15

(d) Discuss the impact of Urbanisation and Industrialisation in water resource (in terms of both quantity and quality). 15

3. (a) The annual sinking fund of a machine costing ₹ 50,000 is ₹ 150 and its salvage value is estimated to be ₹ 5,000. Assuming interest rate as 4%, determine the life of the machine. 20

(b) Describe the factors affecting the rate analysis. 10

(c) Write a short note on the classification of bricks. 15

(d) Discuss the constituent parts of paint and their functions. 15

4. (a) List the physical tests that are generally used on cement. Describe any three of them. 15

(b) Discuss the relation between water-cement ratio and strength. 15

(c) Design a cantilever beam which projects beyond the fixed end by 3 m. The superimposed load on it is 10 kN/m. Use M 20 grade (σ_{cbc} = 7 N/mm^2) of concrete and Fe 415 steel (σ_{st} = 230 N/mm^2). Assume moderate exposure conditions. 30

5. A simply supported 13 m effective span RCC rectangular beam of 500 mm × 1500 mm (overall depth) section is reinforced throughout with 21 nos. 25 mm diameter bars in three layers of 7 bars each at a clear cover of 37·5 mm on tensile face. The reinforcement on the compression face is 4 – 25 mm + 1 – 20 mm diameter bars in one layer at an effective cover of 50 mm. The clear cover between the different layers on tension face is 25 mm. M 25 grade concrete and Fe 415 grade steel bars are used in the beam throughout. The beam is laterally restrained throughout the span.

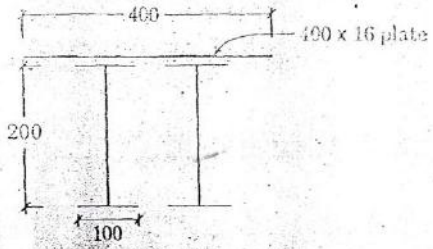
(a) What shall be the superimposed uniformly distributed load w, that the beam can carry at working conditions ? 15

(b) Design the shear reinforcement at support if design shear strength of concrete τ_c is given as follows for different values of p = 100 A_s / bd. 15

p	1·25	1·5	1·75
τ_c (MPa)	0·70	0·74	0·78

(c) Calculate the moment of resistance of the compound steel section shown in the figure. The compound section consists of two steel sections ISMB 200 @ 25·4 kg/m (I_{XX} = 2235·4 cm^4, A_{XX} = 32·33 cm^2) with a single cover plate, 40 cm wide and 16 mm thick connected to the top flange.

Assume bending stress = 150 MPa. *15*



Dimensions in mm

(d) A mild steel T section has the following cross-sectional dimensions :

Total depth = 200 mm

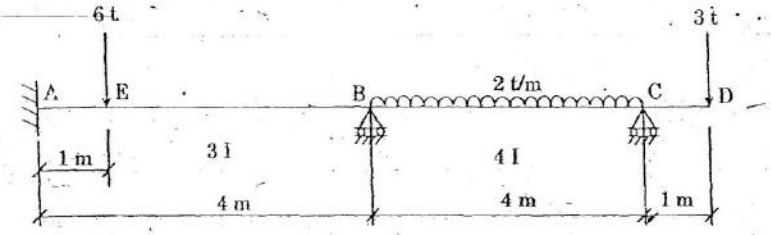
Width of flange = 120 mm

Thickness of flange = 20 mm

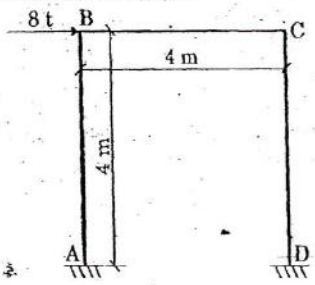
Thickness of web = 20 mm

If the yield stress, σ_y = 250 MPa, determine the plastic moment capacity of the section. Also calculate the shape factor for the section. *15*

6. (a) Analyze the beam shown in figure and determine the end moments. Plot the B.M.D. on the tension side. *30*



(b) Analyze the portal frame shown in the figure. Also sketch the deflected shape of the frame. The end A is fixed and the end D is hinged. Also, the value of EI is constant throughout. *30*



26.2.1.1 Design bond stress in limit state method for plain bars in tension shall be as below :

Grade of concrete	M 20	M 25	M 30	M 35	M 40 and above
Design bond stress, τ_{bd}, N/mm^2	1·2	1·4	1·5	1·7	1·9

Table 16 : Nominal Cover to Meet Durability Requirements

(Clause 26.4.2)

Exposure	*Nominal Concrete Cover in mm Not Less Than*
Mild	20
Moderate	30
Severe	45
Very severe	50
Extreme	75

Notes :

1. For main reinforcement up to 12 mm diameter bar for mild exposure the nominal cover may be reduced by 5 mm.
2. Unless specified otherwise, actual concrete cover should not deviate from the required nominal cover by $^{+10}_{0}$ mm.
3. For exposure condition 'severe' and 'very severe', reduction of 5 mm may be made, where concrete grade is M 35 and above.

Table 19 : Design Shear Strength of Concrete, τ_c, N/mm^2

(Clauses 40.2.1, 40.2.2, 40.3, 40.4, 40.5.3, 41.3.2, 41.3.3 and 41.4.3)

$100\frac{A_s}{bd}$	Concrete Grade					
	M 15	M 20	M 25	M 30	M 35	M 40 and above
(1)	(2)	(3)	(4)	(5)	(6)	(7)
≤ 0·15	0·28	0·28	0·29	0·29	0·29	0·30
0·25	0·35	0·36	0·36	0·37	0·37	0·38
0·50	0·46	0·48	0·49	0·50	0·50	0·51
0·75	0·54	0·56	0·57	0·59	0·59	0·60
1·00	0·60	0·62	0·64	0·66	0·67	0·68
1·25	0·64	0·67	0·70	0·71	0·73	0·74
1·50	0·68	0·72	0·74	0·76	0·78	0·79
1·75	0·71	0·75	0·78	0·80	0·82	0·84
2·00	0·71	0·79	0·82	0·84	0·86	0·88
2·25	0·71	0·81	0·85	0·88	0·90	0·92
2·50	0·71	0·82	0·88	0·91	0·93	0·95
2·75	0·71	0·82	0·90	0·94	0·96	0·98
3·00 and above	0·71	0·82	0·92	0·96	0·99	1·01

Note : The term A_s is the area of longitudinal tension reinforcement which continues at least one effective depth beyond the section being considered except at support where the full area of tension reinforcement may be used provided the detailing conforms to 26.2.2 and 26.2.3.

Table 20 : Maximum Shear Stress, $\tau_{c\,max}$, N/mm^2

(Clauses 40.2.3, 40.2.3.1, 40.5.1 and 41.3.1)

Concrete Grade	M 20	M 25	M 30	M 35	M 40 and above
$\tau_{c\,max}$, N/mm^2	2·8	3·1	3·5	3·7	4·0

Table 21 : Permissible Stresses in Concrete

(Clauses B-1.3, B-2.1, B-2.1.2, B-2.3 and B-4.2)

All values in N/mm^2

Grade of Concrete	*Permissible Stress in Compression*		*Permissible Stress in Bond (Average) for Plain Bars in Tension*
	Bending	*Direct*	
(1)	(2)	(3)	(4)
	σ_{cbc}	σ_{cc}	τ_{bd}
M 10	3·0	2·5	–
M 15	5·0	4·0	0·6
M 20	7·0	5·0	0·8
M 25	8·5	6·0	0·9
M 30	10·0	8·0	1·0
M 35	11·5	9·0	1·1
M 40	13·0	10·0	1·2
M 45	14·5	11·0	1·3
M 50	16·0	12·0	1·4

Notes :

1. The values of permissible shear stress in concrete are given in Table 23.
2. The bond stress given in col. 4 shall be increased by 25 percent for bars in compression.

Table 23 : Permissible Shear Stress in Concrete

(Clauses B-2.1, B-2.3, B-4.2, B-5.2.1, B-5.2.2, B-5.3, B-5.4, B-5.5.1, B-5.5.3, B-6.3.2, B-6.3.3 and B-6.4.3 and Table 21)

$100 \frac{A_s}{bd}$	Permissible Shear Stress in Concrete, τ_c, N/mm^2 Grade of Concrete					
	M 15	M 20	M 25	M 30	M 35	M 40 and above
(1)	(2)	(3)	(4)	(5)	(6)	(7)
≤ 0·15	0·18	0·18	0·19	0·20	0·20	0·20
0·25	0·22	0·22	0·23	0·23	0·23	0·23
0·50	0·29	0·30	0·31	0·31	0·31	0·32
0·75	0·34	0·35	0·36	0·37	0·37	0·38
1·00	0·37	0·39	0·40	0·41	0·42	0·42
1·25	0·40	0·42	0·44	0·45	0·45	0·46
1·50	0·42	0·45	0·46	0·48	0·49	0·49
1·75	0·44	0·47	0·49	0·50	0·52	0·52
2·00	0·44	0·49	0·51	0·53	0·54	0·55
2·25	0·44	0·51	0·53	0·55	0·56	0·57
2·50	0·44	0·51	0·55	0·57	0·58	0·60
2·75	0·44	0·51	0·56	0·58	0·60	0·62
3·00 and above	0·44	0·51	0·57	0·60	0·62	0·63

Note : A_s is the area of longitudinal tension reinforcement which continues at least one effective depth beyond the section being considered except at support where the full area of tension reinforcement may be used provided the detailing conforms to 26.2.2 and 26.2.3.

Table 24 : Maximum Shear Stress, $\tau_{c\,max}$, N/mm^2

(Clauses B-5.2.3, B-5.2.3.1, B-5.5.1 and B-6.3.1)

Concrete Grade	M 15	M 20	M 25	M 30	M 35	M 40 and above
$\tau_{c\,max}$, N/mm^2	1·6	1·8	1·9	2·2	2·3	2·5

PART-A

GENERAL ENGINEERING (Civil and Structural)

1. (a) What are the chief chemical ingredients and their percentage used in the manufacturing of Portland cement ? Also briefly explain the Bogue components and their properties in the cement. 20

(b) Explain *any four* of the following thermal insulation : 5x4=20

(i) Slab or block insulation

(ii) Blanket insulation

(iii) Bat insulating materials

(iv) Insulating boards

(c) Explain Whole Circle Bearing system. The following bearings were observed with a compass. Calculate the interior angles. 20

LINE	FORE BEARINGS
AB	60° 30′
BC	122° 00′
CD	46° 00′
DE	205° 30′
EA	300° 00′

2. (a) What is superelevation ? Derive the relation between superelevation and speed of vehicle on horizontal curve. Design the rate of superelevation for a horizontal curve of a radius 500 m and speed 100 km/hr. 5+15

(b) Describe the terms - True and Magnetic bearings ; local attraction ; back bearings and magnetic declination. 20

(c) Explain the term Base period and Crop period. After how many days will you order irrigation in order to ensure healthy growth of crops if : 20

(i) Field capacity of soil = 29%

(ii) Permanent wilting point = 11%

(iii) Density of soil = 1300 kg/m^3

(iv) Effective depth of root zone = 700 mm

(v) Daily consumptive use of water of the given crop = 12 mm

Consider moisture content must not be less than 25% of the water holding capacity between the field capacity and permanent wilting point.

3. (a) What do you mean by "Viscosity" ? Velocity distribution of a fluid of dynamic viscosity is 8.63 poise is $U = 2/3y - y^2$ in which U is the velocity in m/sec at a distance y meter above the plate, determine the shear stress at $y = 0$ and $y = 0.15$. Take dynamic viscosity of fluid is 8.63 poise. 20

(b) Define air pollution. Enlist natural and man made air pollution. What are the effects of air pollution on human, plants and materials ? 5+5+10=20

(c) Define the term BOD, COD and TDS. The 5 days 30°C BOD of sewage sample is 110 mg/l. Calculate its 5 days 20°C BOD. Assume the deoxygenation constant at 20°C k_{20} as 0.1 ? 3x3+11=20

4. (a) Two plates 6 mm thick are joined by 14 mm diameter rivets in a triple staggered riveted lap joint as shown in fig 1. In what way will the joint fail if allowable tensile stress for plate = 150 MPa ; allowable shear stresses for rivets = 90 MPa and allowable bearing stress for rivets = 270 MPa. Also find the efficiency of the joint. 20

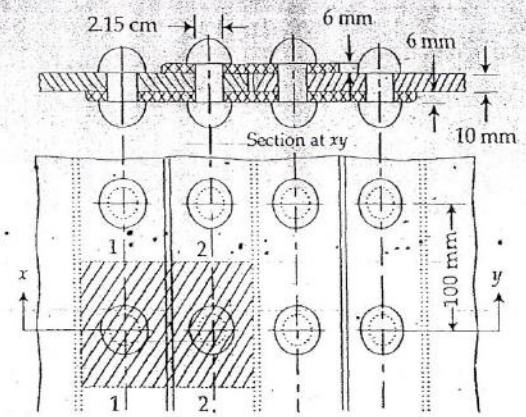


Fig. 1

(b) A sand deposit is 10 m thick and overlies a bed of soft clay. The ground water table is 3 m below the surface. If the sand above the ground water table has a degree of saturation of 45%, plot the diagram showing the variation of the total stress, pore water pressure and the effective stress. The void of the sand is 0.70. Take G = 2.65. 20

(c) Draw the shear force and bending moment diagrams for the beam shown in fig : 2. 20

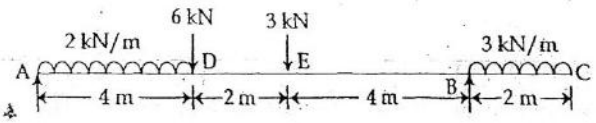


Fig. 2

5. (a) The cross - section of a joist is a T-section, 120 mm × 200 mm × 12 mm, with 120 mm side horizontal. Sketch the shear stress distribution and hence find the maximum shear stress if it has to resist a shear force of 200 kN. 25 5

(b) For the I section shown in fig : 3 determine the position of centroid and moment of inertia about the base flange (I_{KL}). 10+10=20

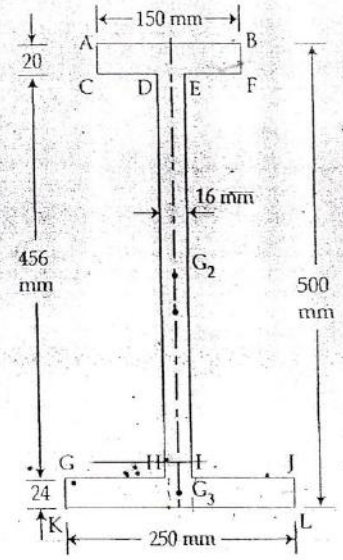


Fig. 3

(c) (i) What is bond ? Explain flexural and anchorage bond. 6

(ii) What is development length ? Write its significance in RCC design. 4+5=9

6. (a) A singly reinforced beam having a width of 250 mm is reinforced with 3 bars of 16 mm diameter at an effective depth of 400 mm. If M20 grade concrete and Fe415 HYSD bars are used, compute for the section. 15+15

(i) Working moment of resistance

(ii) Ultimate moment of resistance.

(b) Design a square column section subjected to concentrated load of 1000 kN at service. Consider concrete grade of M25 and steel grade Fe 415. 10

(c) Design a built - up column composed of two channel sections placed back to back, carrying an axial load of 1345 kN. Effective length of column is 4.95 m. Take $f_y = 250$ kN/mm^2. 20

26.2.1.1 Design bond stress in limit state method for plain bars in tension shall be as below :

Grade of concrete	M 20	M 25	M 30	M 35	M 40 and above
Design bond stress, τ_{bd}, N/mm^2	1.2	1.4	1.5	1.7	1.9

Table 16 : Nominal Cover to Meet Durability Requirements

(Clause 26.4.2)

Exposure	*Nominal Concrete Cover in mm Not Less Than*
Mild	20
Moderate	30
Severe	45
Very severe	50
Extreme	75

Notes :

1. For main reinforcement upto 12 mm diameter bar for mild exposure the nominal cover may be reduced by 5 mm.

2. Unless specified otherwise, actual concrete cover should not deviate from the required nominal cover by $^{+10}_{0}$ mm.

3. For exposure condition 'severe' and 'very severe', reduction of 5 mm may be made, where concrete grade is M 35 and above.

Table 19 : Design Shear Strength of Concrete, τ_c N/mm^2

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$100\frac{A_s}{bd}$	Concrete Grade					
	M 15	M 20	M 25	M 30	M 35	M 40 and above
(1)	(2)	(3)	(4)	(5)	(6)	(7)
≤0.15	0.28	0.28	0.29	0.29	0.29	0.30
0.25	0.35	0.36	0.36	0.37	0.37	0.38
0.50	0.46	0.48	0.49	0.50	0.50	0.51
0.75	0.54	0.56	0.57	0.59	0.59	0.60
1.00	0.60	0.62	0.64	0.66	0.67	0.68
1.25	0.64	0.67	0.70	0.71	0.73	0.74
1.50	0.68	0.72	0.74	0.76	0.78	0.79
1.75	0.71	0.75	0.78	0.80	0.82	0.84
2.00	0.71	0.79	0.82	0.84	0.86	0.88
2.25	0.71	0.81	0.85	0.88	0.90	0.92
2.50	0.71	0.82	0.88	0.91	0.93	0.95
2.75	0.71	0.82	0.90	0.94	0.96	0.98
3.00 and above	0.71	0.82	0.92	0.96	0.99	1.01

Note : The term A_s is the area of longitudinal tension reinforcement which continues at least one effective depth beyond the section being considered except at support where the full area of tension reinforcement may be used provided the detailing conforms to 26.2.2 and 26.2.3.

Table 20 : Maximum Shear Stress, $\tau_{c\,max}$, N/mm^2

(Clauses 40.2.3, 40.2.3.1, 40.5.1 and 41.3.1)

Concrete Grade	M 20	M 25	M 30	M 35	M 40 and above
$\tau_{c\,max}$, *N/mm*^{2}	2.8	3.1	3.5	3.7	4.0

Table 21 : Permissible Stresses in Concrete

(Clauses B-1.3, B-2.1, B-2.1.2, B-2.3 and B-4.2)

All values in N/mm^2

Grade of Concrete	Permissible Stress in Compression		Permissible Stress in Bond (Average) for Plain Bars in Tension
	Bending	Direct	
(1)	(2)	(3)	(4)
	σ_{cbc}	σ_{cc}	τ_{bd}
M 10	3.0	2.5	-
M 15	5.0	4.0	0.6
M 20	7.0	5.0	0.8
M 25	8.5	6.0	0.9
M 30	10.0	8.0	1.0
M 35	11.5	9.0	1.1
M 40	13.0	10.0	1.2
M 45	14.5	11.0	1.3
M 50	16.0	12.0	1.4

Notes :

1. The values of permissible shear stress in concrete are given in Table 23.

2. The bond stress given in col. 4 shall be increased by 25 percent for bars in compression.

Table 23 : Permissible Shear Stress in Concrete

(Clauses B-2.1, B-2.3, B-4.2, B-5.2.1, B-5.2.2, B-5.3, B-5.4, B-5.5.1, B-5.5.3, B-6.3.2, B-6.3.3 and B-6.4.3 and Table 21)

$100\frac{A_s}{bd}$	Permissible Shear Stress in Concrete τ_c, N/mm^2 Grade of Concrete					
	M 15	M 20	M 25	M 30	M 35	M 40 and above
(1)	(2)	(3)	(4)	(5)	(6)	(7)
≤0.15	0.18	0.18	0.19	0.20	0.20	0.20
0.25	0.22	0.22	0.23	0.23	0.23	0.23
0.50	0.29	0.30	0.31	0.31	0.31	0.32
0.75	0.34	0.35	0.36	0.37	0.37	0.38
1.00	0.37	0.39	0.40	0.41	0.42	0.42
1.25	0.40	0.42	0.44	0.45	0.45	0.46
1.50	0.42	0.45	0.46	0.48	0.49	0.49
1.75	0.44	0.47	0.49	0.50	0.52	0.52
2.00	0.44	0.49	0.51	0.53	0.54	0.55
2.25	0.44	0.51	0.53	0.55	0.56	0.57
2.50	0.44	0.51	0.55	0.57	0.58	0.60
2.75	0.44	0.51	0.56	0.58	0.60	0.62
3.00 and above	0.44	0.51	0.57	0.60	0.62	0.63

Note : A_s is the area of longitudinal tension reinforcement which continues at least one effective depth beyond the section being considered except at support where the full area of tension reinforcement may be used provided the detailing conforms to 26.2.2 and 26.2.3.

Table 24 : Maximum Shear Stress, $\tau_{c\,max}$, N/mm^2

(Clauses B-5.2.3, B-5.2.3.1, B-5.5.1 and B-6.3.1)

Concrete Grade	M 15	M 20	M 25	M 30	M 35	M 40 and above
$\tau_{c\,max}$, N/mm^2	1.6	1.8	1.9	2.2	2.3	2.5

No. JK- 203936

AT-2011

GENERAL ENGINEERING / सामान्य इंजीनियरी

PAPER II / प्रश्न-पत्र-II

Time Allowed : Two Hours | *Maximum Marks : 300*
निर्धारित समय : दो घण्टे | *अधिकतम अंक : 300*

Attention :

1. *Paper consists of Part A (Civil and Structural) and Part B (Electrical and Mechanical) and only one Part is to be attempted as per option given in the Application Form. Both Parts A and B consist of 2 Sections each and candidates should attempt 10 questions in all taking 5 questions from each Section, i.e., Section I and Section II of either Part A or Part B. All questions carry equal marks.*
2. *Each candidate will be given 2 (two) Answer Books. Candidates attempting Part A (Civil and Structural) should attempt Section I (Civil) and Section II (Structural) in separate Answer Books. Similarly, candidates attempting Part B (Electrical and Mechanical) should attempt Section I (Electrical) and Section II (Mechanical) in separate Answer Books.*
3. *Answers to all questions must be written in one language, i.e., either in English or in Hindi according to the option given by the candidate in his/her Application Form. Candidates are not allowed to write the answers partly in English and partly in Hindi.*
4. *Candidates must write their Name, Roll No., Ticket No., Name of the Examination and Subject, at the prescribed place, on the cover page of the Answer Book correctly. Candidates must also put their signature on the cover page at the prescribed place. The above instructions must be fully complied with failing which the Answer Book will not be evaluated and zero mark will be awarded.*
5. *No credit will be given for answers written in a language other than the one opted by the candidate.*
6. *Necessary tables of IS 456 : 2000 Code of Practice are given at the end of Part A for use of candidates attempting Civil and Structural part.*

ध्यान दीजिए :

1. *प्रश्न-पत्र में भाग क (सिविल एवं संरचनात्मक) और भाग ख (वैद्युत एवं यांत्रिक) हैं और आवेदन-पत्र में दिए गए विकल्प के अनुसार केवल एक भाग का ही उत्तर दिया जाना है । दोनों भागों, क एवं ख, में 2 खण्ड हैं और अभ्यर्थियों को प्रत्येक खण्ड अर्थात् भाग क या भाग ख के खण्ड I तथा खण्ड II में प्रत्येक से 5 प्रश्न लेते हुए कुल 10 प्रश्न करने होंगे । सभी प्रश्नों के अंक बराबर हैं ।*
2. *प्रत्येक अभ्यर्थी को 2 (दो) उत्तर-पुस्तिकाएँ दी जाएँगी । भाग क (सिविल एवं संरचनात्मक) को हल करने वाले अभ्यर्थियों को खण्ड I (सिविल) तथा खण्ड II (संरचनात्मक) को अलग-अलग उत्तर-पुस्तिकाओं में हल करना चाहिए । इसी प्रकार, भाग ख (वैद्युत एवं यांत्रिक) को हल करने वाले अभ्यर्थियों को खण्ड I (वैद्युत) तथा खण्ड II (यांत्रिक) को अलग-अलग उत्तर-पुस्तिकाओं में हल करना चाहिए ।*
3. *सभी प्रश्नों के उत्तर अभ्यर्थी द्वारा अपने आवेदन-पत्र में दिए गए विकल्प के अनुसार किसी एक भाषा में अर्थात् अंग्रेजी या हिन्दी में, दिए जाने चाहिए । अभ्यर्थियों को कुछ उत्तर अंग्रेजी में और कुछ उत्तर हिन्दी में लिखने की अनुमति नहीं है ।*
4. *अभ्यर्थी उत्तर-पुस्तिका के आवरण पृष्ठ पर निर्धारित स्थान में अपना नाम, रोल नंबर, टिकट नंबर, परीक्षा का नाम तथा विषय सही-सही अवश्य लिखें । अभ्यर्थी आवरण पृष्ठ पर निर्धारित स्थान में अपने हस्ताक्षर भी अवश्य करें । उपर्युक्त अनुदेशों का पूरी तरह अनुपालन किया जाए, अन्यथा उत्तर-पुस्तिका की नहीं जाँचा जाएगा और शून्य अंक दे दिया जाएगा ।*
5. *अभ्यर्थी द्वारा दिए गए विकल्प की भाषा के अतिरिक्त किसी अन्य भाषा में दिए गए उत्तरों के लिए कोई अंक नहीं दिए जाएँगे ।*
6. *सिविल एवं संरचनात्मक भाग की परीक्षा देने वाले अभ्यर्थियों के प्रयोग के लिए आई.एस. 456 : 2000 प्रैक्टिस कोड की आवश्यक सारणियाँ भाग क के अन्त में दी गई हैं ।*

PART A

(Civil and Structural)

SECTION I

(Civil)

1. (a) Write a short note on Consumptive use of water. 15

(b) Advantages and disadvantages of concrete sleeper. 15

2. (a) To determine the mean elevation of a station O interpolated in a triangulation system, the following observations were made :

Station	Height of Inst.	Station observed	Distance in m	Height of signal	Vertical angle	Remarks
O	1.53	D	3684	5.58	+1° 1' 20"	R sin 1° = 30.88 m
	1.53	E	4698	4.11	− 0° 52' 50"	m = 0.07
	1.53	F	5028.6	4.9	− 0° 34' 10"	log sin 1° = 6.685575

Find the mean elevation of station O, given that the elevations of D, E and F are 293.58, 157.725 and 179.355 respectively. 15

(b) In a consolidation test on a soil, the void ratio of the sample decreases from 1.24 to 1.12 when the pressure is increased from 20 to 40 tonnes/sq.m. Calculate the co-efficient of consolidation in m^2/year, given that the co-efficient of permeability of the soil during this pressure increment is 8.5×10^{-3} cm/sec. 15

3. (a) In a plate bearing test on pure clayey soil failure occurred at a load of 12.2 tonnes. The size of the plate was 45 cm × 45 cm and the test was done at the depth of 1.0 m below ground level. Find out the ultimate bearing capacity for a 1.5 m wide continuous wall footing with its base at a depth of 2 m below the ground level. The unit weight of clay may be taken as 1.9 gm/cc and Nc = 5.7 and Nq = 1 and Nr = 0. 20

(b) Write a short note on the significant properties of soil. 10

4. (a) A rectangular channel 2.0 m wide has a discharge of 250 lit/sec which is measured by a right angled V-notch weir. Find the position of the apex of the notch from the bed of the channel if the maximum depth of the water is not to exceed 1.3 m. Take $C_d = 0.62$. 18

(b) List down the modes of water penetration into road structure with a neat sketch. 12

5. (a) Measures to control water pollution. 10

(b) A room 600 cm long and 500 cm wide has a flat roof. There is one T-beam in the centre (cross section below the slab 30 cm × 50 cm) and the slab is 15 cm thick. Estimate the quantity of iron bars required for reinforcement (for the T beam only) from the data given below :

Main bars – 3 nos. of 25 mm dia. in 2 rows of 4 each (all 4 in the bottom being straight and others being bent)

Stirrups – 10 mm dia. and 15 cm centre to centre throughout

Anchor bars – 2 nos. of 16 mm dia. 20

6. (a) What is analysis of rates ? And explain its purpose. 15

(b) Explain the manufacturing of cement by wet process. 15

SECTION II

(Structural)

7. (a) Discuss the significance of cold weather concreting with special emphasis on problems faced by concrete in freezing conditions. 15

(b) Define workability of concrete and explain briefly the factors affecting workability. 15

8. Design a cantilever beam with a clear span of 3 m which carries a superimposed load of 15 kN/m. Its depth varies from 500 mm at the fixed end to 150 mm at the free end. Show reinforcement with a neat sketch. 30

9. A simply supported beam of 4.5 m effective span is carrying a live load of 25 kN/m. The size of the beam has to be restricted to 250 mm × 380 mm depth. Design the beam for bending using limit state method. The design coefficients are $K = 0.138$, $\tau = 0.80$, $K_u = 0.479$. Use M20 grade concrete and Fe 415 steel. 30

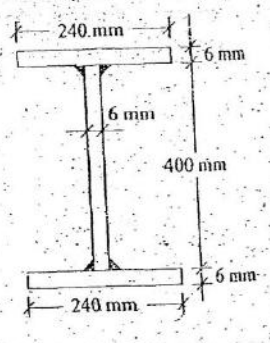
10. Design a beam of 4.8 m span carrying a total load of 15 kN/m inclusive of self weight. The beam is laterally supported throughout. 30

11. (a) Compute the allowable compressive load on an axially loaded steel column having a cross section as shown in the figure and an effective length of 3.5 m.

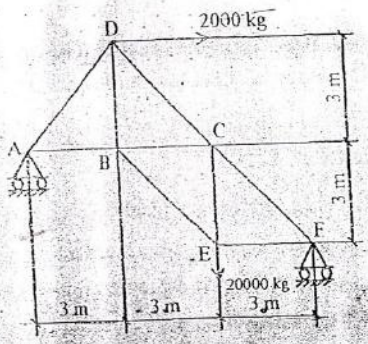
For the purpose of computing the cross sectional area, the moment of inertia and the radius of gyrations, the maximum width of the outstand should be taken out not more than 16 times the thickness of the flange. Also, the maximum depth of web should be taken not more than 50 times its thickness. 15

Use the following data :

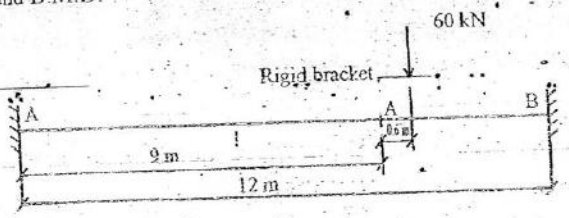
l/r	Allowable stress in axial compression (kg/cm^2)
60	1130
70	1075
80	1007
90	928
100	840



(b) Determine the forces in the members of the truss shown in the figure below : 15



12. A fixed beam of constant section carries a load transferred from a rigid bracket as shown in figure. Find the bending moment and reactions at the fixed ends and plot S.F.D. and B.M.D. 30



26.2.1.1 Design bond stress in limit state method for plain bars in tension shall be as below

Grade of concrete	M 20	M 25	M 30	M 35	M 40 and above
Design bond stress, τ_{bd}, *N/mm*^{2}	1·2	1·4	1·5	1·7	1·9

Table 16 : Nominal Cover to Meet Durability Requirements

(Clause 26.4.2)

Exposure	*Nominal Concrete Cover in mm Not Less Than*
Mild	20
Moderate	30
Severe	45
Very severe	50
Extreme	75

Notes :

1. For main reinforcement up to 12 mm diameter bar for mild exposure the nominal cover may be reduced by 5 mm.
2. Unless specified otherwise, actual concrete cover should not deviate from the required nominal cover by $^{+10}_{0}$ mm.
3. For exposure condition 'severe' and 'very severe', reduction of 5 mm may be made, where concrete grade is M 35 and above.

Table 19 : Design Shear Strength of Concrete, τ_c, N/mm^2

(Clauses 40.2.1, 40.2.2, 40.3, 40.4, 40.5.3, 41.3.2, 41.3.3 and 41.4.3)

$100\frac{A_s}{bd}$	Concrete Grade					
	M 15	M 20	M 25	M 30	M 35	M 40 and above
(1)	(2)	(3)	(4)	(5)	(6)	(7)
≤ 0·15	0·28	0·28	0·29	0·29	0·29	0·30
0·25	0·35	0·36	0·36	0·37	0·37	0·38
0·50	0·46	0·48	0·49	0·50	0·50	0·51
0·75	0·54	0·56	0·57	0·59	0·59	0·60
1·00	0·60	0·62	0·64	0·66	0·67	0·68
1·25	0·64	0·67	0·70	0·71	0·73	0·74
1·50	0·68	0·72	0·74	0·76	0·78	0·79
1·75	0·71	0·75	0·78	0·80	0·82	0·84
2·00	0·71	0·79	0·82	0·84	0·86	0·88
2·25	0·71	0·81	0·85	0·88	0·90	0·92
2·50	0·71	0·82	0·88	0·91	0·93	0·95
2·75	0·71	0·82	0·90	0·94	0·96	0·98
3·00 and above	0·71	0·82	0·92	0·96	0·99	1·01

Note : The term A_s is the area of longitudinal tension reinforcement which continues at least one effective depth beyond the section being considered except at support where the full area of tension reinforcement may be used provided the detailing conforms to 26.2.2 and 26.2.3.

Table 20 : Maximum Shear Stress, $\tau_{c\,max}$, N/mm^2

(Clauses 40.2.3, 40.2.3.1, 40.5.1 and 41.3.1.)

Concrete Grade	M 20	M 25	M 30	M 35	M 40 and above
$\tau_{c\,max}$, N/mm^2	2.8	3.1	3.5	3.7	4.0

Table 21 : Permissible Stresses in Concrete

(Clauses B-1.3, B-2.1, B-2.1.2, B-2.3 and B-4.2)

All values in N/mm^2

Grade of Concrete	*Permissible Stress in Compression*		*Permissible Stress in Bond (Average) for Plain Bars in Tension*
	Bending	*Direct*	
(1)	(2)	(3)	(4)
	σ_{cbc}	σ_{cc}	τ_{bd}
M 10	3·0	2·5	—
M 15	5·0	4·0	0·6
M 20	7·0	5·0	0·8
M 25	8·5	6·0	0·9
M 30	10·0	8·0	1·0
M 35	11·5	9·0	1·1
M 40	13·0	10·0	1·2
M 45	14·5	11·0	1·3
M 50	16·0	12·0	1·4

Notes :

1. The values of permissible shear stress in concrete are given in Table 23.
2. The bond stress given in col. 4 shall be increased by 25 percent for bars in compression.

Table 23 : Permissible Shear Stress in Concrete

(Clauses B-2.1, B-2.3, B-4.2, B-5.2.1, B-5.2.2, B-5.3, B-5.4, B-5.5.1, B-5.5.3, B-6.3.2, B-6.3.3 and B-6.4.3 and Table 21)

$100\frac{A_s}{bd}$	Permissible Shear Stress in Concrete, τ_c, N/mm^2 Grade of Concrete					
	M 15	M 20	M 25	M 30	M 35	M 40 and above
(1)	(2)	(3)	(4)	(5)	(6)	(7)
≤ 0·15	0·18	0·18	0·19	0·20	0·20	0·20
0·25	0·22	0·22	0·23	0·23	0·23	0·23
0·50	0·29	0·30	0·31	0·31	0·31	0·32
0·75	0·34	0·35	0·36	0·37	0·37	0·38
1·00	0·37	0·39	0·40	0·41	0·42	0·42
1·25	0·40	0·42	0·44	0·45	0·45	0·46
1·50	0·42	0·45	0·46	0·48	0·49	0·49
1·75	0·44	0·47	0·49	0·50	0·52	0·52
2·00	0·44	0·49	0·51	0·53	0·54	0·55
2·25	0·44	0·51	0·53	0·55	0·56	0·57
2·50	0·44	0·51	0·55	0·57	0·58	0·60
2·75	0·44	0·51	0·56	0·58	0·60	0·62
3·00 and above	0·44	0·51	0·57	0·60	0·62	0·63

Note : A_s is the area of longitudinal tension reinforcement which continues at least one effective depth beyond the section being considered except at support where the full area of tension reinforcement may be used provided the detailing conforms to 26.2.2 and 26.2.3.

Table 24 : Maximum Shear Stress, $\tau_{c\,max}$, N/mm^2

(Clauses B-5.2.3, B-5.2.3.1, B-5.5.1 and B-6.3.1.)

Concrete Grade	M 15	M 20	M 25	M 30	M 35	M 40 and above
$\tau_{c\,max}$, N/mm^2	1.6	1.8	1.9	2.2	2.3	2.5

LN No. 370388

AB 2010 II

GENERAL ENGINEERING / सामान्य इंजीनियरी

PAPER II / प्रश्न-पत्र II

Time Allowed : Three Hours
निर्धारित समय : तीन घण्टे

Maximum Marks : 300
अधिकतम अंक : 300

Attention :

1. Paper consists of Part A (Civil and Structural) and Part B (Electrical and Mechanical) and only one Part is to be attempted as per option given in the Application Form. Both Parts A and B consist of 2 Sections each and candidates should **attempt 10 questions** in all taking **5 questions from each Section**, i.e., Section I and Section II of **either** Part A or Part B. All questions carry equal marks.
2. Each candidate will be given 2 (two) Answer Books. Candidates attempting Part A (Civil and Structural) should attempt Section I (Civil) and Section II (Structural) in **separate** Answer Books. Similarly, candidates attempting Part B (Electrical and Mechanical) should attempt Section I (Electrical) and Section II (Mechanical) in **separate** Answer Books.
3. Answers to all questions must be written in one language, i.e., either in English or in Hindi, according to the option given by the candidate in his/her Application Form. Candidates are not allowed to write the answers partly in English and partly in Hindi.
4. Candidates must write their Name, Roll No., Choice No., Name of the Examination and Subject, at the prescribed place, on the cover page of the Answer Book correctly. Candidates must also put their signature on the cover page at the prescribed place. The above instructions must be fully complied with failing which the Answer Book will not be evaluated and zero mark will be awarded.
5. No credit will be given for answers written in a language other than the one opted by the candidate.
6. Necessary tables of IS 456 : 2000 Code of Practice are given at the end of Part A for use of candidates attempting Civil and Structural part.

ध्यान दीजिए :

1. प्रश्न-पत्र में भाग क (सिविल एवं संरचनात्मक) और भाग ख (वैद्युत एवं यांत्रिक) है और आवेदन-पत्र में दिए गए विकल्प के अनुसार केवल एक भाग का ही उत्तर दिया जाना है। दोनों भागों, क एवं ख, में 2 खण्ड हैं और अभ्यर्थियों को प्रत्येक खण्ड, अर्थात् भाग क या भाग ख के खण्ड I तथा खण्ड II में प्रत्येक से 5 प्रश्न लेते हुए कुल 10 प्रश्न करने होंगे। सभी प्रश्नों के अंक बराबर हैं।
2. प्रत्येक अभ्यर्थी को 2 (दो) उत्तर-पुस्तिकाएँ दी जाएँगी। भाग क (सिविल एवं संरचनात्मक) को हल करने वाले अभ्यर्थियों को खण्ड I (सिविल) तथा खण्ड II (संरचनात्मक) को अलग-अलग उत्तर-पुस्तिकाओं में हल करना चाहिए। इसी प्रकार, भाग ख (वैद्युत एवं यांत्रिक) को हल करने वाले अभ्यर्थियों को खण्ड I (वैद्युत) तथा खण्ड II (यांत्रिक) को अलग-अलग उत्तर-पुस्तिकाओं में हल करना चाहिए।
3. प्रश्न-पत्र के उत्तर अभ्यर्थी द्वारा अपने आवेदन-पत्र में दिए गए विकल्प के अनुसार किसी एक भाषा में अर्थात् अंग्रेजी या हिन्दी में दिए जाने चाहिए। अभ्यर्थियों को कुछ उत्तर अंग्रेजी में और कुछ उत्तर हिन्दी में लिखने की अनुमति नहीं है।
4. अभ्यर्थी उत्तर पुस्तिका के आवरण पृष्ठ पर निर्धारित स्थान में अपना नाम, सेल नंबर, टिकट नंबर, परीक्षा का नाम तथा विषय आदि के अवश्य लिखें। अभ्यर्थी आवरण पृष्ठ पर निर्धारित स्थान में अपने हस्ताक्षर भी अवश्य करें। उपर्युक्त अनुदेशों का सही तरह अनुपालन किया जाए, अन्यथा उत्तर-पुस्तिका को नहीं जाँचा जाएगा और शून्य अंक दे दिया जाएगा।
5. अभ्यर्थी द्वारा दिए गए विकल्प की भाषा के अतिरिक्त किसी अन्य भाषा में दिए गए उत्तरों के लिए कोई अंक नहीं दिए जाएँगे।
6. सिविल एवं संरचनात्मक भाग की परीक्षा देने वाले अभ्यर्थियों के प्रयोग के लिए आई.एस. 456 : 2000 प्रैक्टिस कोड की आवश्यक सारणियाँ भाग क के अन्त में दी गई है।

PART A

(Civil and Structural)

SECTION I

(Civil)

1. (a) Describe the classification of rocks. 10

(b) What are the ingredients of a varnish ? Describe the various types of varnishes. 10

(c) Discuss the manufacture of cement. 10

2. (a) A steel tape is 30 m long at a temperature of 15° C and a pull of 50 N when laid on the flat. The tape weighs 18 N. It is stretched between end supports only allowing it to sag. Find the correct length of the tape at a field temperature of 25° C at a pull of 115 N. If in the above condition a base line is measured and the recorded length of the line is 600 m, find the correct length of the base line. 14

Take $\alpha = 12 \times 10^{-6}$ per °C and $E = 2 \times 10^5$ N/mm²

Sectional area of the tape = 7·50 mm²

(b) Write brief notes on the following : 16

(i) Prismatic compass

(ii) Plane table and its accessories

3. (a) The following properties of the soil were determined by performing tests on clay sample :

Natural moisture content = 25%

Liquid limit = 32%

Plastic limit = 24%

Diameter of 60% size = 0·006 mm

Diameter of 10% size = 0·006 mm

Calculate the liquidity coefficient, uniformity coefficient and relative consistency. 15

(b) A sample of soil 10 cm diameter, 15 cm length was tested in a variable head permeameter. The initial head of water in the burette was found to be 45 cm and it was observed to drop to 30 cm in 195 seconds. The diameter of the burette was 1·9 cm. Calculate the coefficients of permeability in metre/day. 15

4. (a) Explain standard penetration test for measuring the penetration resistance of the soil. 12

(b) An earthen embankment is compacted to a dry density of 1·82 gm/cc at a moisture content of 12%. The bulk density and moisture content are 1·72 gm/cc and 6% at the site from where the soil is borrowed and transported at the site of construction. How much excavation should be carried out in the pit of borrowed area for each cu·m of the embankment. 18

5. (a) An oil of viscosity 1·0 poise and relative density 1·05 is flowing through a circular pipe of diameter 5 cm and of length 200 m. The rate of flow is 3·52 *l*/sec. Find the shear stress at the pipe wall. 12

(b) Lubricating oil of specific gravity 0·85 and dynamic viscosity 0·01 kgf·s/m^2 is pumped through a 3 cm diameter pipe. If pressure drop per metre length of the pipe is 0·15 kgf/cm^2, determine the mass flow rate in kg/min, the shear stress at the pipe wall, the Reynolds number of flow and the power required per 40 m length of pipe to maintain the flow. 18

6. (a) Discuss in detail the physical and chemical characteristics of sewage. 18

(b) Design a rapid sand filter system for a water supply of 9 m.l.d. to a township. All the principal components shall be designed. Enumerate your assumptions during the design steps. 12

SECTION II
(Structural)

7. (a) Draw S.F. and B.M. diagrams for the beam shown in Fig. 1. 10

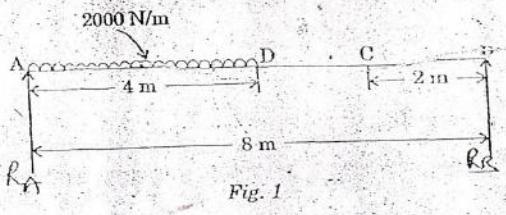


Fig. 1

(b) Find the moment of inertia of the triangular section shown in Fig. 2. 10

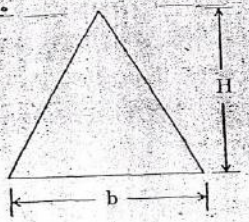


Fig. 2

(c) A straight circular bar of steel 1 cm in diameter and 120 cm long is mounted in testing machine and loaded axially in compression till it buckles. Assuming the Euler formula for pinned ends to apply, estimate the maximum central deflection before the material reaches its yield stress of 350 N/mm^2. E = 0·21 × 10^5 N/mm^2. 10

8. (a) For the beam shown in Fig. 3, find deflection at the free end and middle of span. 15

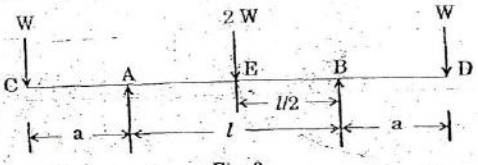
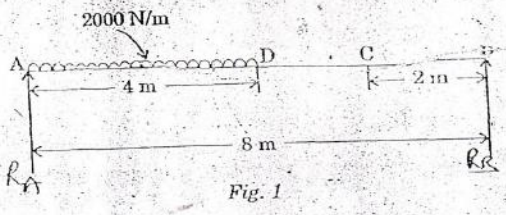


Fig. 3

(b) Describe the properties of water which are necessary to be used to get good concrete. What do you understand by the term 'water cement ratio' ? 15

SECTION II
(Structural)

7. (a) Draw S.F. and B.M. diagrams for the beam shown in Fig. 1. 10



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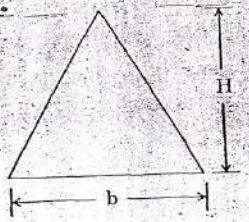

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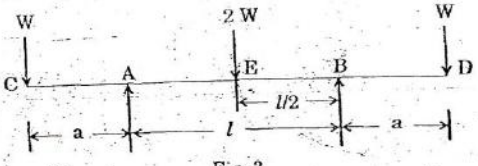

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(b) Describe the properties of water which are necessary to be used to get good concrete. What do you understand by the term 'water cement ratio' ? 15

26.2.1.1 Design bond stress in limit state method for plain bars in tension shall be as below :

Grade of concrete	M 20	M 25	M 30	M 35	M 40 and above
Design bond stress, τ_{bd} *N/mm*^{2}	1·2	1·4	1·5	1·7	1·9

Table 16 : Nominal Cover to Meet Durability Requirements

(Clause 26.4.2)

Exposure	*Nominal Concrete Cover in mm Not Less Than*
Mild	20
Moderate	30
Severe	45
Very severe	50
Extreme	75

Notes :

1. For main reinforcement up to 12 mm diameter bar for mild exposure the nominal cover may be reduced by 5 mm.

2. Unless specified otherwise, actual concrete cover should not deviate from the required nominal cover by $^{+10}_{0}$ mm.

3. For exposure condition 'severe' and 'very severe', reduction of 5 mm may be made, where concrete grade is M 35 and above.

N No 381559

JE(C+E)-2009/II

GENERAL ENGINEERING / सामान्य इंजीनियरी

PAPER II / प्रश्न-पत्र II

Allowed : Three Hours
रत समय : तीन घण्टे

Maximum Marks : 300
अधिकतम अंक : 300

ntion :

Paper consists of Part A (Civil and Structural) and Part B (Electrical and Mechanical) and only one Part is to be attempted as per option given in the Application Form. Both Parts A and B consist of 2 Sections each and candidates should attempt 10 questions in all taking 5 questions from each Section, i.e., Section I and Section II of either Part A or Part B. All questions carry equal marks.

Each candidate will be given 2 (two) Answer Books. Candidates attempting Part A (Civil and Structural) should attempt Section I (Civil) and Section II (Structural) in separate Answer Books. Similarly, candidates attempting Part B (Electrical and Mechanical) should attempt Section I (Electrical) and Section II (Mechanical) in separate Answer Books.

Answers to all questions must be written in one language, i.e., either in English or in Hindi according to the option given by the candidate in his/her Application Form. Candidates are not allowed to write the answers partly in English and partly in Hindi.

Candidates must write their Name, Roll No., Ticket No., Name of the Examination and Subject, at the prescribed place, on the cover page of the Answer Book correctly. Candidates must also put their signature on the cover page at the prescribed place. The above instructions must be fully complied with failing which the Answer Book will not be evaluated and zero mark will be awarded.

No credit will be given for answers written in a language other than the one opted by the candidate.

Necessary tables of IS 456 : 2000 Code of Practice are given at the end of Part A for use of candidates attempting Civil and Structural part.

न दीजिए :

प्रश्न-पत्र में भाग क (सिविल एवं संरचनात्मक) और भाग ख (वैद्युत एवं यांत्रिक) हैं और आवेदन-पत्र में दिए गए विकल्प के अनुसार केवल एक भाग का ही उत्तर दिया जाना है। दोनों भागों, क एवं ख, में 2 खण्ड हैं और अभ्यर्थियों को प्रत्येक खण्ड अर्थात् भाग क या भाग ख के खण्ड I तथा खण्ड II में प्रत्येक से 5 प्रश्न लेते हुए कुल 10 प्रश्न करने होंगे। सभी प्रश्नों के अंक बराबर हैं।

प्रत्येक अभ्यर्थी को 2 (दो) उत्तर-पुस्तिकाएँ दी जाएँगी। भाग क (सिविल एवं संरचनात्मक) को हल करने वाले अभ्यर्थियों को खण्ड I (सिविल) तथा खण्ड II (संरचनात्मक) को अलग-अलग उत्तर-पुस्तिकाओं में हल करना चाहिए। इसी प्रकार, भाग ख (वैद्युत एवं यांत्रिक) को हल करने वाले अभ्यर्थियों को खण्ड I (वैद्युत) तथा खण्ड II (यांत्रिक) को अलग-अलग उत्तर-पुस्तिकाओं में हल करना चाहिए।

सभी प्रश्नों के उत्तर अभ्यर्थी द्वारा अपने आवेदन-पत्र में दिए गए विकल्प के अनुसार किसी एक भाषा में अर्थात् अंग्रेजी या हिन्दी में, दिए जाने चाहिए। अभ्यर्थियों को कुछ उत्तर अंग्रेजी में और कुछ उत्तर हिन्दी में लिखने की अनुमति नहीं है।

अभ्यर्थी उत्तर-पुस्तिका के आवरण पृष्ठ पर निर्धारित स्थान में अपना नाम, रोल नंबर, टिकट नंबर, परीक्षा का नाम तथा विषय सही-सही अवश्य लिखें। अभ्यर्थी आवरण पृष्ठ पर निर्धारित स्थान में अपने हस्ताक्षर भी अवश्य करें। उपर्युक्त अनुदेशों का पूरे तरह अनुपालन किया जाए, अन्यथा उत्तर-पुस्तिका को नहीं जाँचा जाएगा और शून्य अंक दे दिया जाएगा।

अभ्यर्थी द्वारा दिए गए विकल्प की भाषा के अतिरिक्त किसी अन्य भाषा में दिए गए उत्तरों के लिए कोई अंक नहीं दिए जाएँगे।

सिविल एवं संरचनात्मक भाग की परीक्षा देने वाले अभ्यर्थियों के प्रयोग के लिए आई.एस. 456 : 2000 प्रेक्टिस कोड की आवश्यक सामग्रियाँ भाग क के अन्त में दी गई हैं।

PART A –
(Civil and Structural)
SECTION I
(Civil)

2. (a) Describe briefly the characteristics of good stones. 10

(b) What do you mean by Seasoning of Timber ? Describe the methods of seasoning timber. 10

(c) Describe the various ingredients of a paint. 10

3. (a) Discuss in detail the methods of plane table surveying. 15

(b) The true bearing of a tower T as observed from a station A was 357°, the magnetic bearing of the same was 9°. The back bearings of the lines AB, AC and AD were found to be 286°, 337° and 30° respectively when measured with a prismatic compass. Find the true bearings of the lines AB, AC and AD respectively. 15

4. (a) A sample of soil has a porosity of 35 percent and specific gravity of solids is 2·67. Calculate void ratio, dry density and unit weight if

(i) the soil is 50% saturated,

(ii) the soil is 100% saturated. 15

(b) A sample of soil is 5 cm high and 8 cm in diameter. It was tested in a constant head permeameter. Water percolates through the soil under a constant head of 45 cm for 8 m. The water was collected and weighed. Its weight was recorded as 500 gm. On oven drying the sample of soil, the weight was recorded as 450 gm. If G is 2·65 calculate

(i) coefficient of permeability,

(ii) seepage velocity of water when the water was under operation. 15

5. (a) An embankment was compacted at a moisture content of 15%. Its density was determined with the help of a core cutter and the following data was collected :

empty weight of the cutter = 1200 gm

weight of cutter when it is full of soil = 3200 gm

volume of the cutter = 1000 cc

Calculate bulk density and saturation percentage of the embankment. If the embankment becomes fully saturated due to rains, then, determine its moisture content and saturated density. Take G = 2·70. 20

(b) Explain the factors which affect the bearing capacity of soils. 10

SECTION II
(Structural)

7. (a) A bar 40 mm in diameter is subjected to a tensile force of 40,000 kg. The extension of bar measured over a gauge length of 200 mm was 0·348 mm. The decrease in diameter was found to be 0·02 mm. Calculate values of Young's modulus of elasticity and modulus of rigidity of the material. *10*

(b) Draw S.F. and B.M. diagrams for beam loaded with varying load as shown in Fig. 1. *10*

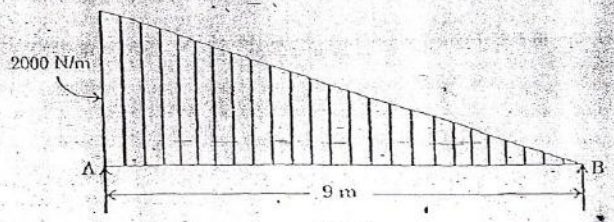

Fig. 1

(c) An R.S.J. 55 cm deep and 19 cm wide having flange and web thicknesses of 1·5 cm and 0·99 cm respectively is used as a beam. Calculate the moment of resistance at a section where maximum stress is 100 N/mm^2. *10*

8. (a) A cantilever of length 'l' and depth 'd' tapers in plan in such a way that the breadth 'b' at the fixed end, decreases to zero at the free end. Determine the deflection at the free end due to load 'W' acting at the free end (Fig. 2). *12*

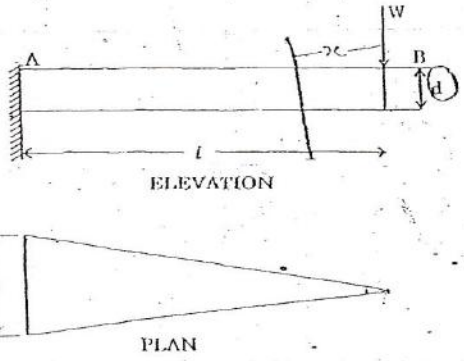

Fig. 2

5. (a) The space between two parallel plates 4 mm apart is filled with an oil of specific gravity 0·85. The upper plate of area 800 cm^2 is dragged with constant velocity of 0·75 m/s by applying a force of 0·2 kgf to it. Assume straight line velocity distribution and calculate velocity gradient, dynamic viscosity of oil in poise and kinematic viscosity of oil in stokes. 15

(b) A bend in pipeline conveying water gradually reduces from 60 cm to 30 cm diameter and deflects the flow through an angle of 60°. At the larger end the gauge pressure is 1·75 kg/cm^2. Determine the magnitude and direction of the force exerted on the bend

(i) when there is no flow, 15

(ii) when the flow is 876 lit/sec

6. (a) Describe in detail the methods employed to purify water, before supplying to the consumers. 18

(b) Design a septic tank for a small colony of 300 persons with average daily sewage flow of 85 litres per head. Detention period is 30 hours. Clearing interval is 6 months. 12

Constant head permeability...

$Q = \frac{R}{t} = KiA = K \times \frac{h}{L} \times A$

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3. For exposure condition 'severe' and 'very severe', reduction of 5 mm may be made, where concrete grade is M 35 and above.

(b) Write short notes on :

(i) Workability of concrete

(ii) Slump test

9. (a) What do you understand by the term 'curing' ? Why is it essential to cure concrete ? What are the various methods commonly adopted in curing ? 15

(b) Discuss in detail "placing of concrete in cold and hot weather". 15

10. (a) A reinforced concrete beam 400 mm × 650 mm (effective) in section is reinforced with 3 bars of 28 mm φ. If the effective span is 5 m, find the concentrated load the beam can support at the centre. Assume M 20 concrete and Fe 250 steel (n = 13·33). 15

(b) Design a column to carry a load of 590 kN. Height of the column is 3·5 m effective, one side of the column is restricted to 250 mm. Use $\sigma_{cc} = 5$ N/mm^2, $\sigma_{sc} = 190$ N/mm^2 and 10 mm φ lateral lies. 15

11. Design a cantilever slab to carry a superimposed load of 4188 N/m^2. The overhang of the slab is 1·2 m. Adopt M 20 concrete and Fe 415 steel. 30

12. (a) What are the advantages and disadvantages of welded joints ? 12

(b) Determine the maximum load in the rivets of the eccentric connection shown in Fig. 3. 18

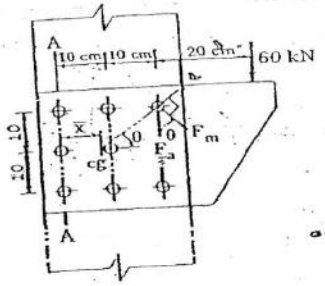

Fig. 3

JE-2005

(सिविल एवं संरचनात्मक)

खण्ड I
(सिविल)

1. (a) उत्तम इमारती पत्थर के मुख्य अभिलक्षण क्या हैं ? विशिष्ट प्रयोगों के लिए विभिन्न प्रकार के पत्थरों की उपयुक्तता का वर्णन करें । 8+7

(b) भारतीय मानक ब्यूरो (BIS) के अनुसार ईंटों का वर्गीकरण करें । ईंटों की गुणता सुनिश्चित करने के लिए उन पर कौनसे परीक्षण किए जाते हैं ? 4+6

(c) आधुनिक भवनों में प्रयोग होने वाले पेंटों तथा पॉलिशों के प्रकारों पर एक टिप्पणी लिखें । 5

2. (a) एक तलेक्षण गज को टैकोमीटर के अक्ष के 100 मीटर तथा 300 मीटर की दूरी पर ऊर्ध्वाधर पकड़ा गया है और क्षैतिज दृष्टियों के लिए गज के अंतःखण्ड क्रमशः 0.99 मी. तथा 3.00 मी. है । उपकरण के खिलक शर्त करें । उपकरण को स्टेशन A पर स्थापित किया गया और गज को स्थल B पर ऊर्ध्वाधर पकड़ा गया है । क्षैतिज से 10° अवनमन कोण पर नत दूरदर्शी से गज पर पाठ्यांक 2.670, 1.835, 1.0 मी. हैं । 'B' के RL को ज्ञात और A से इसकी क्षैतिज दूरी की गणना करें । बताया जाता है कि HI = 1.42 मी. और A का RL = 450.5 मी । 10

(b) स्टेशन A से प्रेक्षित एक टी.वी. टावर (T) का वास्तविक दिक्मान 358° 00′ था और उसका चुंबकीय दिक्मान 8° 00′ था । त्रिज्यीय क्रम से मापने पर रेखाओं AB, AC तथा AD के अग्र दिक्मान क्रमशः 290° 00′, 340° 00′ और 30° 00′ पाए गए । रेखाओं AB, AC तथा AD के वास्तविक अग्र दिक्मान ज्ञात करें । 10

3. (a) एक संगुनित अपरिहित त्रि-अक्षीय परीक्षण में मृदा का एक नमूना 60 kN/m² के कोशिका दाब पर विफल रहा । प्रभावी अपरूपण सामर्थ्य पैरामीटर $c' = 15$ kN/m² और $\phi' = 20°$ है । संपीडन सामर्थ्य ज्ञात करें । 15

(b) एक क्षैतिज स्तरित मृदा निक्षेप में तीन परतें हैं और प्रत्येक परत अपने में एकसमान है । परतों की पारगम्यता क्रमशः 8×10^{-4}, 50×10^{-4} और 15×10^{-6} सेमी/सेकण्ड है और मोटाई क्रमशः 6, 3, 12 मी. है । क्षैतिज तथा ऊर्ध्वाधर दिशाओं में निक्षेप की प्रभावी औसत पारगम्यता ज्ञात करें । 15

4. (a) 20 मिमी व्यास के तार के एक पतले वलय को पानी की सतह से उठाने के लिए अपेक्षित बल की गणना करें । वलय के वक्र को उपेक्षा कर दें । 15

(b) 1.5 मी. व्यास का एक गोलीय पिंड एक जलाशय में पूरी तरह निमज्जित है और तले में जंजीर से बाँध दिया गया है । यदि जंजीर का तनाव 5.30 kN हो तो ज्ञात करें कि पिंड को जलाशय से बाहर वायु में निकालने पर उसका वजन कुछ होगा । 15

K-/2005/II

3

5. (a) A combined sewer of a circular section is to be laid to serve a particular area. Calculate the size of the sewer.

Area = 100 hectare, Population = 1 lakh, Rate of water supply = 135 *l*pcd

Time of entry = 3 min, Time of flow = 15 min

Average impermeability factor = 0·5

Maximum permissible velocity = 2 m/s

Intensity of rainfall in mm/hr = $\frac{25{\cdot}4 \times 30}{t + 10}$ 20

(b) Compute the dimensions of a continuous flow rectangular settling tank treating average of 24×10^5 litres/day. Take detention period for raw water sedimentation to be 6 hours. 10

6. (a) State the three point problem. Explain how it is soived. 10

(b) What is the main difference between compaction and consolidation ? 10

(c) What is the mechanism involved in treatment of waste water (sewage) by septic tank ? 10

KJ/2005/II

SECTION II

(Structural)

7. (a) Draw the shear force and bending moment diagrams for the beam carrying loads as shown in Figure 2·1, and locate the point of contraflexure. 15

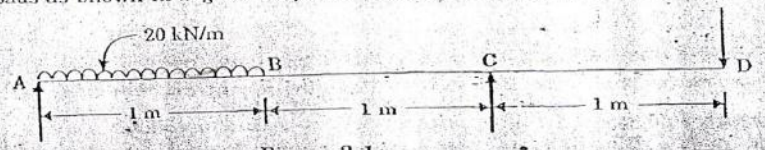

Figure 2·1

(b) Determine the slope and deflection at the free end of the cantilever loaded as shown in Figure 2·2. Take I = 10,000 cm^4 and E = 2·1 × 10^6 kg/cm^2. 15

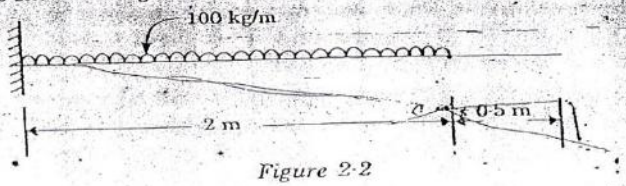

Figure 2·2

8. (a) A square hole is punched out of a circular laminate, as shown in Figure 2·3. Find the moment of inertia about Y – Y axis through c.g. 15

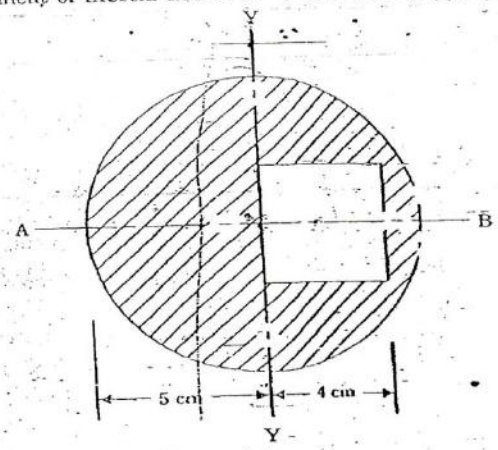

Figure 2·3

(b) A steel rod 5 m long and of 3 cm diameter is used as a column, with both ends fixed. Determine the crippling load by writing the differential equation. Take E = 2 × 10^6 kg/cm^2. 15

9. (a) Explain the steps which can be taken to prevent/reduce the ill-effects of concreting in hot weather. 10

(b) What is compaction ? Why is it needed ? List the different methods of compaction. 3+4+3

(c) Explain the need for curing of concrete. List the different methods that can be used for wet curing of concrete. For how long should curing be done ? 3+4+3

Note : Attempt Q. 10(a), 10(b) and 11(a) using either working stress method or limit state method. It is not necessary to use the same method in all the three problems. The candidate must specify, at the start of each problem, the method to be used by him.

10. (a) Design a rectangular beam section, of width 300 mm, for a total service bending moment 200 kNm. Use M 20 concrete and bars Fe 415 grade. Assume the exposure as mild. Design for flexure only. 12

(b) Design a suitable square footing for a column of size 350 × 350 mm². The column transfers a service load of 1800 kN. Use M 20 concrete and Fe 415 grade bars. Safe bearing capacity of soil is 200 kN/m². Check for flexure and two way shear only. 18

11. (a) A rectangular RCC beam with b = 300 mm, and d = 550 mm, has a service shear force of 100 kN at a section near the support. Four bars of 20 mm (= 1257 mm²) are provided as tensile reinforcement at the section, which are continued to the support. For M 20 concrete and Fe 415 grade bars, design vertical stirrups for the section. 15

(b) A member of a truss ISA 125 × 95 is used to carry a tensile load 180 kN. The angle section is connected to a 10 mm thick gusset plate, through the longer leg, by five power driven shop rivets, as shown in Figure 2-4. Select a suitable angle thickness and rivet diameter. 15

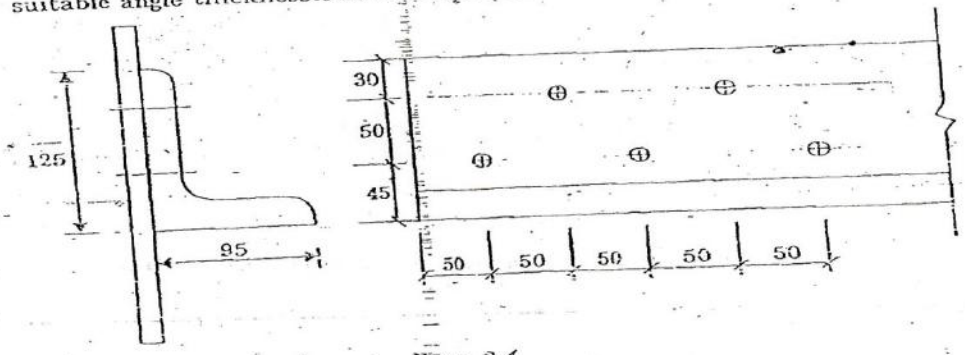

Figure 2-4

JE-2005

12. (a) A tension member in a truss consists of a pair of angles ISA 100 × 65 × 10 mm welded on either side of a 12 mm thick gusset plate, using a 7 mm weld. Design the welded joint, shown in Figure 2·5. 12

Properties of ISA 100 × 65 × 10

Area = 15·51 cm^2

C_x = 3·37 cm

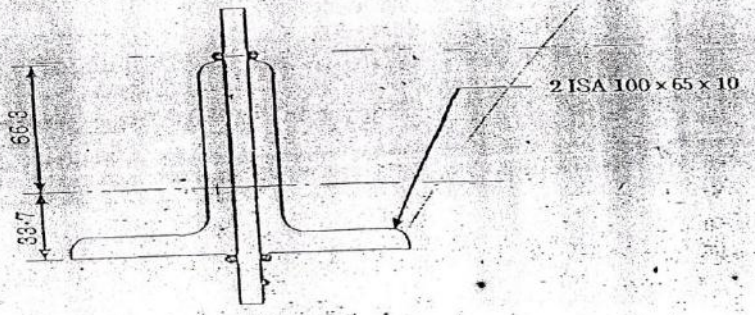

Figure 2·5

(b) Find the maximum load P that can be carried by the bracket connection shown in Figure 2·6, if 5 – 20 mm dia power driven shop rivets are used. 18

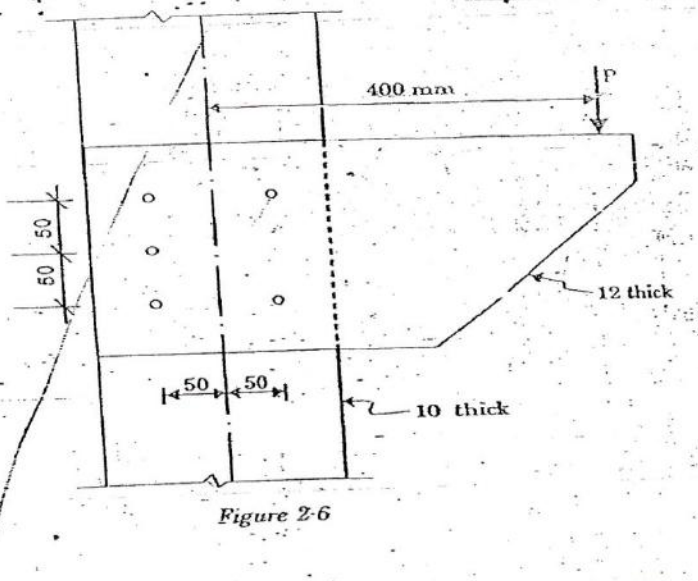

Figure 2·6

9. (a) Explain briefly the importance of different concretes in construction. 10

(b) List the properties of cement concrete in plastic and hardened stage. 5

(c) Explain briefly the terms batching, mixing, transporting, compacting and curing. 15

10. (a) A reinforced concrete beam 30 cm × 60 cm in section is reinforced with 4 bars 16 ϕ at top and 5 bars 22 ϕ at bottom with an effective cover of 4 cm. Assume safe compressive strength of concrete = 50 kg/cm^2; σ_{se} = 1400 kg/cm^2; m = 19. Find moment of resistance (WSM) 15

(b) Design a reinforced concrete beam with balanced section for flexure by working stress method for the data given below (WSM) 15

Effective span (simply supported) = 8 m

Live load = 12 kN/m

Breadth of the beam = 300 mm

Concrete grade = M 20

Reinforcement steel grade = Fe 415

11. Design a circular tank of 13·75 m diameter and 3·0 m height of wall. Free board = 0·3 m. The tank rests on a firm ground. The walls are fixed at base and free at top. (LSM) 30

12. (a) The bracket shown in Fig. 4 consists of pair of mild steel plates riveted to the flanges of 305 mm × 152 mm I-column. If the resultant force on the critical rivet is limited to 45 kN, determine the load P, the bracket can support. 15

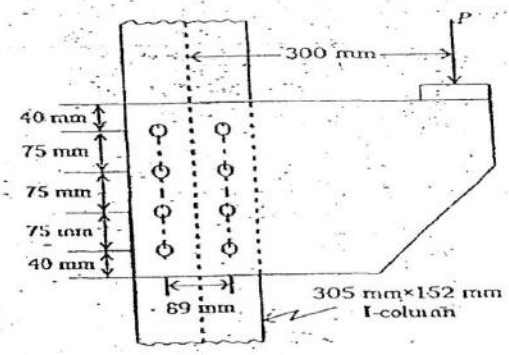

Fig. 4

(b) Calculate the size of the weld required for the welded bracket loaded as shown in Fig. 5. 15

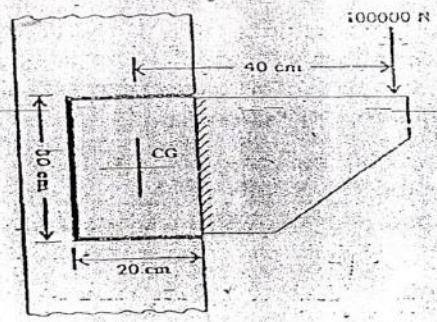

Fig. 5

JE- 2007

5. (a) Calculate the diameter and discharge of a circular sewer laid at a slope of 1 in 400, running half-full and with velocity 1·9 m/s. ($n = 0·012$) 15

(b) The 5-day BOD of a waste is 280 mg/l. The ultimate BOD is reported to be 410 mg/l. At what rate the waste is being oxidised? 15

6. (a) What are the various methods of doing theodolite traversing? Describe the deflection angle method in detail. 10

(b) What soil investigations are required for constructing (i) an embankment and (ii) a building? Give details. 10

(c) Write a note on flow measurement methods employed for pipe flow and open channels [with specific reference to drains]. 10

SECTION—II

(Structural)

7. (a) Draw SF and BM diagrams for the beam with applied moment as shown in Fig. 1. 15

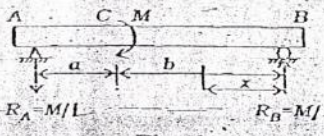

Fig. 1

(b) A bar 40 mm in diameter is subjected to a tensile force of 40000 kg. The extension of bar measured over a gauge length of 200 mm was 0·318 mm. The decrease in diameter was found to be 0·02 mm. Calculate the values of Young's modulus of elasticity and modulus of rigidity of the material. 15

8. (a) Find the slope and deflection at the free end of a cantilever shown in Fig. 2. Moment of inertia of AC is twice the moment of inertia of BC. 15

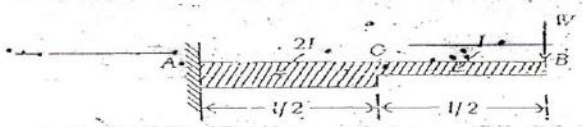

Fig. 2

(b) The I-beam shown in Fig. 3 is simply supported at its ends over a 4 m span and carries central load of 50000 N which acts through the centroid, the line of action being as shown in Fig. 3. Calculate the maximum stress. 15

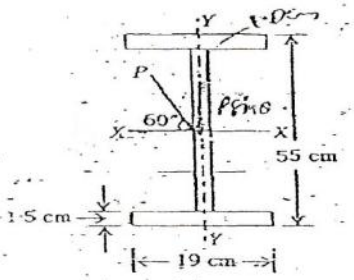

Fig. 3

PART—A

(Civil and Structural)

SECTION—I

(Civil)

1. Differentiate between the following materials, giving specific uses in the building industry : 6+8+8+8

(a) Igneous, sedimentary and metamorphic rocks

(b) Bitumen, coal tar and asphalt

(c) Common burnt clay bricks, firebricks and flyash bricks

(d) Paints and varnish

2. (a) A river is flowing from West to East. For determining the width of the river, two points *A* and *B* are selected on the Southern bank such that the distance *AB* = 75 m. Point *A* is Westward. The bearings of a tree *C* on the Northern bank are observed to be 38° and 338°, respectively, from *A* and *B*. Calculate the width of the river. 20

(b) What are contour gradients? Explain their importance in the location of a hill road. 10

3. (a) A 10 m thick bed of sand is underlain by a layer of clay 6 m thick. The water table that was originally at ground level is lowered by drainage to a depth 4 m, whereupon the degree of saturation above lowered water table reduces to 20%. Determine the increase in the effective pressure at mid of clay layer due to water table lowering. Given saturated densities of sand and clay as 2·1 g/cm^3 and 1·8 g/cm^3, and the dry density of sand = 1·7 g/cm^3

Note g/cm^3 = 10^3 kg/m^3 × 9·8 m/s^2 = 9·81 kN/m^2] 20

(b) An earth embankment is compacted at water content of 17% to a bulk density of 1·9 g/cc. If the sp. gr. of soil grains is 2·65, calculate the void ratio of the compacted embankment. 10

4. (a) The space between two parallel horizontal plates is kept 5 mm apart. This is filled with crude oil of dynamic viscosity 2·5 kg/m-s. If the lower plate is stationary and the upper plate is pulled with velocity of 1·75 m/s, determine the shear stress on the lower plate. 15

(b) An open tank 5 m long, 2 m deep and 3 m wide contains oil of relative density 0·9 to a depth of 0·9 m. If the tank is accelerated along its length on a horizontal track at a constant value of 3 m/s^2, determine the new position of oil surface. 15

4. (a) A direct shear box test performed on a remoulded sand sample yielded the following observations at the time of failure :

Normal load = 0·36 kN
Shear load = 0·18 kN
The sample area was 36 cm^2.

Determine :

(i) the angle of internal friction,

(ii) the magnitude and direction of the principal stresses in the zone of failure, and

(iii) the magnitude of maximum deviator stress if a sample of the same sand with the same void ratio were tested in a triaxial test with an all-round pressure of 60 kN/m^2. Assume c = 0. 18

(b) A 2·2 m square footing is located at a depth of 4·4 m in a stiff clay of saturated unit weight 21 kN/m^3. The undrained strength of clay at a depth of 4·4 m is given by parameters $w = 120\ kN/m^2$ and $\varphi_u = 0$. For a factor of safety 3, with respect to shear failure, compute (i) the net value of bearing capacity, and (ii) the value of maximum load that could be carried by the footing. 12

5. (a) The space between two square flat parallel plates is filled with oil. Each side of the plate is 60 cm. The thickness of the oil film is 12·5 mm. The upper plate, which moves at 2·5 m per sec requires a force of 98·1 N to maintain the speed. Determine :

(i) the dynamic viscosity of the oil, in poise, and

(ii) the kinematic viscosity of the oil, in stokes, if the specific gravity of the oil is 0·95. 15

(b) A pelton wheel is to be designed for the following specifications :

Shaft power = 11,772 kW; Head = 380 m;

Speed = 750 r.p.m.; Overall efficiency = 86%;

Diameter is not to exceed one-sixth of the wheel diameter.

Determine :

(i) the wheel diameter,

(ii) the number of jets required, and

(iii) diameter of the jet.

Take coefficient of velocity = 0·985 and speed ratio = 0·46. 15

6. Write short notes on the following :

(i) Sewer — Underground pipes to carry sewage

(ii) Sewage — waste water

(iii) Sewerage system — System of collecting, treating and di

(iv) Drain and trench drain — Drain — Sections to carry storm water
Trench Drain — Effluent from septic tank is disp
th in dispersion trenches

Design a 15×10^6 g.p.d. water treatment plant with rapid gravity sand filter. Assume suitable design parameters. 18

PART—A

(Civil and Structural)

SECTION—I

(Civil)

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(b) What are contour gradients? Explain their importance in the location of a hill road. 10

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Note: g/cm^3 = 10^3 kg/m^3 × 9·8 m/s^2 = 9·81 kN/m^3 20

(b) An earth embankment is compacted at water content of 17% to a bulk density of 1·9 g/cc. If the sp. gr. of soil grains is 2·65, calculate the void ratio of the compacted embankment. 10

4. (a) The space between two parallel horizontal plates is kept 5 mm apart. This is filled with crude oil of dynamic viscosity 2·5 kg/m-s. If the lower plate is stationary and the upper plate is pulled with velocity of 1·75 m/s, determine the shear stress on the lower plate. 15

(b) An open tank 5 m long, 2 m deep and 3 m wide contains oil of relative density 0·9 to a depth of 0·9 m. If the tank is accelerated along its length on a horizontal track at a constant value of 3 m/s^2, determine the new position of oil surface. 15

SECTION II

(Structural)

7. (a) When a bar of certain material 40 cm square is subjected to an axial pull of 1,600,000 N the extension on a gauge length of 200 mm is 0·1 mm and the decrease in each side of the square is 0·005 mm. Calculate Young's modulus, Poisson's ratio, shear modulus and bulk modulus for this material. 10

(b) Draw S.F. and B.M. diagrams for the beam having overhangs on both sides and loaded as shown in Fig. 1. 20

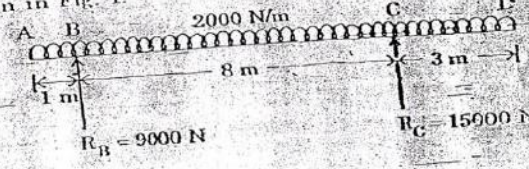

Fig. 1

8. (a) Find the deflections at points D and C of the beam loaded as shown in Fig. 2. 15

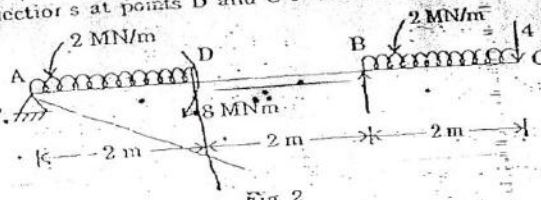

Fig. 2

A solid steel column and a hollow steel column, both have the same length and same cross-section area, and are fixed at the ends. If the internal diameter of hollow column is 2/3 of its external diameter, find the ratio of buckling strengths of solid steel column to that of hollow steel column. 15

9. (a) Explain the important properties of cement concrete both in plastic and hardened stage. 15

(b) Describe the sequence of concreting operations. 15

10. (a) A particular sand sample of 250 grams, when sieved successively through the following sieves, left retentions on the sieves as follows :

IS sieve	10 mm	480	240	120	60	30	15
Retention grams	NIL	10	15	50	50	75	50

What is its fineness modulus ? What sand is it – fine, medium or coarse ? 10

(b) Design a simply supported R.C.C. slab for an office floor having clear dimensions of 4 m by 10 m with 230 mm walls all-around. Adopt M-20 grade concrete and Fe-415 grade HYSD bars. 20

11. Design a cantilever retaining wall to retain an earth embankment 4 m high above ground level. The density of earth is 18 kN/m^3 and its angle of repose is 30°. The embankment is horizontal at top. The safe bearing capacity of the soil may be taken as 200 kN/m^2 and the coefficient of friction between soil and concrete is 0·5. Adopt M-20 grade concrete and Fe-415 HYSD bars. 30

12. (a) Find the suitable pitch for single riveted lap joint for plates 1 cm thick, if $\sigma_t = 150$ N/mm^2, $\sigma_s = 100$ N/mm^2 and $\sigma_b = 300$ N/mm^2. 12

(b) Calculate the maximum load that the bracket shown in Fig. 3 can carry if the size of the weld on flange is 8 mm and that on the web is 5 mm. The allowable shear stress is 102·5 N/mm^2. 18

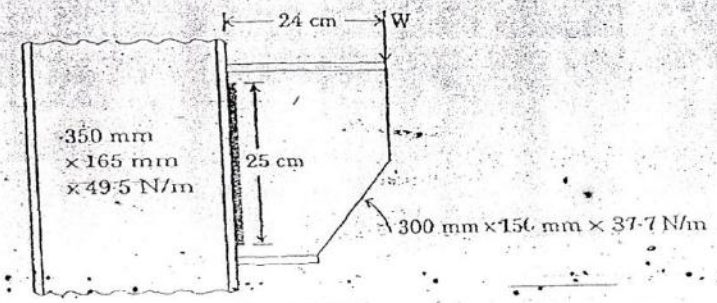

Fig. 3

CIVIL END

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