ENGINEERING SERVICES
EXAMINATION-2015

S(

A–GTD–O–DDAA

CIVIL ENGINEERING

Paper—I

(Conventional)

Time Allowed : Three Hours | *Maximum Marks : 200*

INSTRUCTIONS

Please read each of the following instructions carefully before attempting questions :

*Candidates should attempt **FIVE** questions in all.*

*Question no. **1** is compulsory.*

*Out of the remaining **SIX** questions attempt any **FOUR** questions.*

All questions carry equal marks. The number of marks carried by a part of a question is indicated against it.

*Answers must be written in **ENGLISH** only.*

Unless otherwise mentioned, symbols and notations have their usual standard meanings.

Assume suitable data, if necessary, and indicate the same clearly.

Neat sketches may be drawn, wherever required.

All parts and sub-parts of a question are to be attempted together in the answer book.

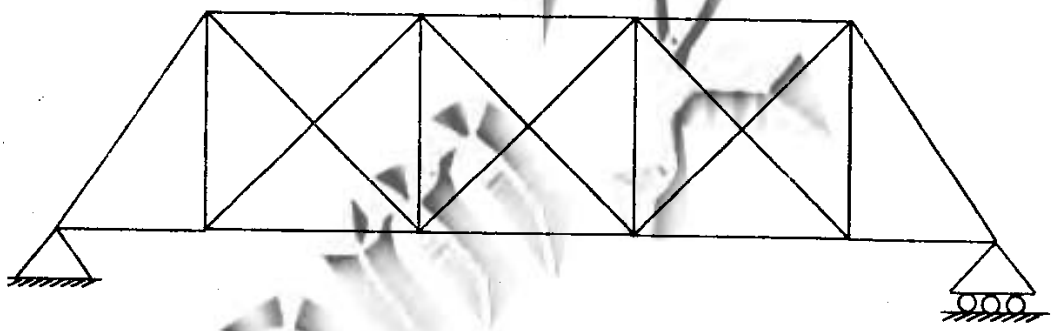
Attempts of questions shall be counted in chronological order.

Unless struck off, attempt of a question shall be counted even if attempted partly.

Any page or portion of the page left blank in the answer book must be clearly struck off.

1. (a) Give a detailed procedure for determining the compressive strength of bricks as per I.S. code. Also write about water absorption test. Mention the usual limit. 5

(b) Find the total degree of statical indeterminacy (both internal and external) for the bridge truss shown in the figure. 5



(c) A propped cantilever beam of length 4 m is subjected to UDL of 30 kN/m over the entire length of the span. If the flexural rigidity of the beam is 2×10^4 kN-m^2, what would be the rotation at the propped support of the beam ? Also determine the moment developed at the fixed support. 5

(Contd.)

(d) "In limit state method of design or working stress method of design, balanced neutral axis depth is not dependent on compressive strength of concrete." Justify the statement with the help of suitable formula. 5

(e) List types of losses of pre-stress in pre-tensioning and post-tensioning systems. 5

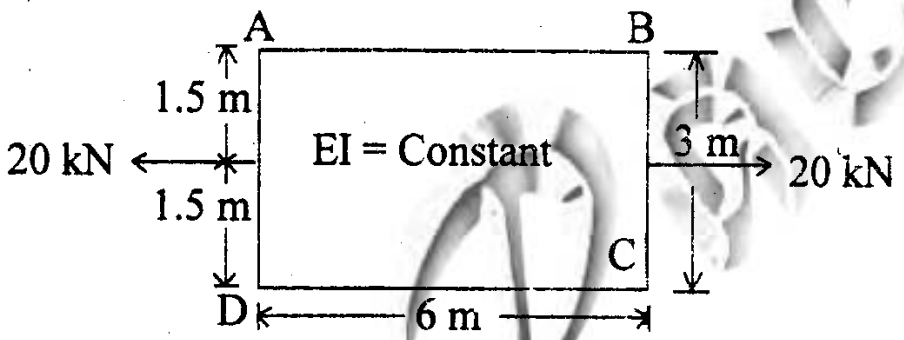
(f) A symmetrical three hinged parabolic arch has 40 m span and 5 m rise. A vertical downward load of 30 kN and a horizontal load of 20 kN (acting in the right hand side direction) act at one quarter span from left hand support. Determine reactions at the supports. 5

(g) What is the principle of design of splice in a steel member subjected to an axial force ? Explain with the help of neat sketches. 5

(h) Explain different types of vibrators and the application of each in construction works. 5

2. (a) Analyse the box-frame shown in the figure below by Moment Distribution Method.

Draw Bending Moment diagram with relevant values. 20



(b) A member in the plane truss is having the following data : L = length of the member; A = area of cross-section; E = Young's modulus of elasticity and α = angle in the first quadrant from x-axis in anticlockwise direction.

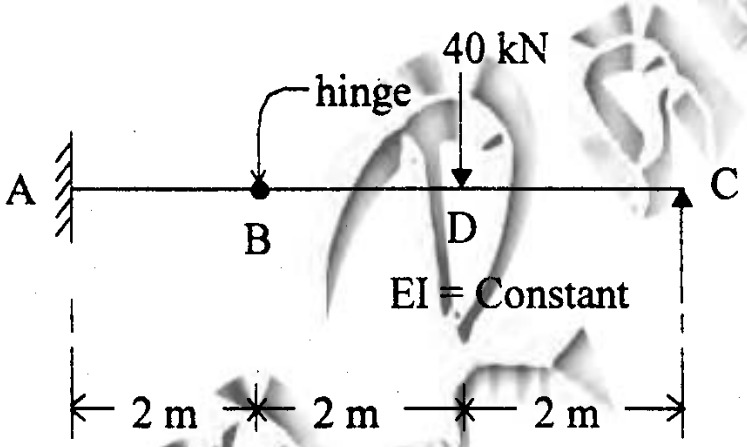
Derive the element stiffness matrix of the plane truss member in local and global coordinate system. 10

(Contd.)

(c) A beam fixed at one end and simply supported at the other end is having a hinge at B as shown in the figure.

Determine the deflections (a) under the load and (b) at the hinge B.

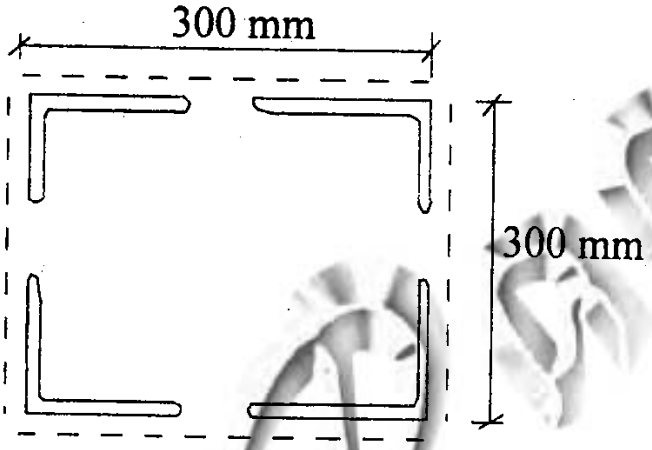
Use Moment Area Method. 10



3. (a) A column is made of 4 Nos. ISA 100 × 100 × 10 as shown. The effective length of column is 6 m. The lacing of column consists of 60 mm × 10 mm flat bars arranged in a single laced system by bolts and inclined at an angle of 45°. Determine the factored load on the column and check the local buckling of column angles. [ISA 100 × 100 × 10 :

(Contd.)

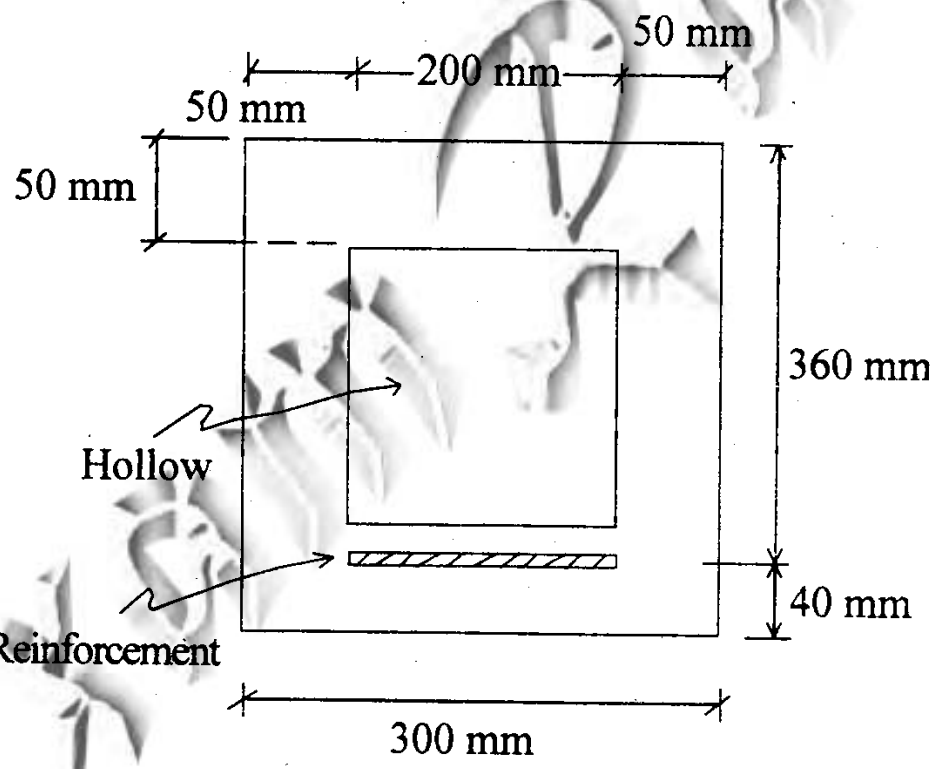
$A = 1903\ mm^2$, $I_{XX} = I_{YY} = 177 \times 10^4\ mm^4$, $C_{XX} = C_{YY} = 28.4$ mm]. Assume gauge length = 55 mm and $r_{vv} = 19.4$ mm. 20



KL/r	30	40	50	60	70	80	90
f_{cd} (MPa)	204	185	167	150	133	118	105

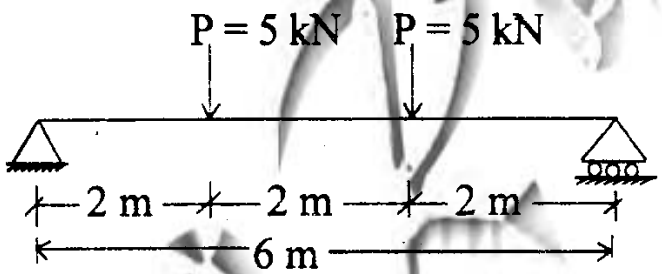
(b) A vertical cylindrical steel storage tank has 30 m diameter and the same is filled upto a depth of 15 m with the gasoline of relative density 0.74. If the yield stress for steel is 250 MPa, find the thickness required for the wall plate. Adopt a factor of safety of 2.5 and neglect localised bending effects, if any. 10

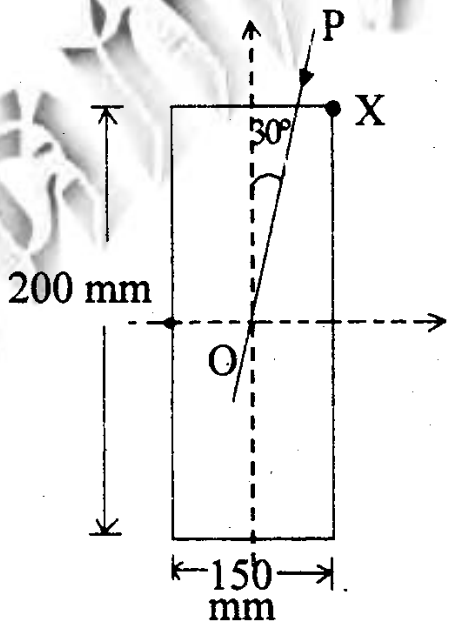
(c) Determine the reinforcement required to resist a factored bending moment of 40 kN-m acting on a beam of hollow cross section as shown, using M 25 grade of concrete and Fe 415 steel. Effective depth of the beam is 360 mm. Adopt Limit State method of Design. 10



4. (a) A rectangular beam 150 mm wide and 200 mm deep, is simply supported on a span of 6 m. Two

loads of 5 kN each are applied to the beam, each load being 2 m from the supports as shown in the Figures. The plane of loads make an angle of 30° with the vertical plane of symmetry. Find the direction of neutral axis and the bending stress at a point marked 'X'. 20





(Contd.)

(b) The vertical member of a triangular pratt truss is composed of 2 Nos. ISA 75 × 75 × 6 (connected back to back on each side of the gusset of 10 mm thickness). The factored forces in the member are :

107 kN (Compression)

79 kN (Tension)

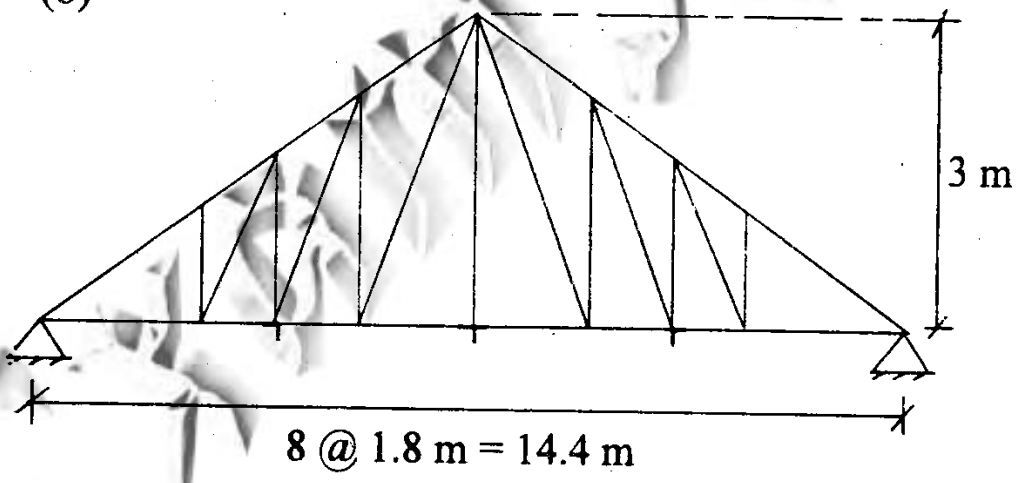
Design the fillet weld connection. Assume f_u = 410 MPa and γ_{mw} = 1.25. Welding shall be done along the length of the member. 10

(c) A PSC simply supported beam of length 4 m, width 200 mm and depth 200 mm is prestressed with a prestressing force of 200 kN. The beam is subjected to two concentrated loads of 10 kN each located 1 m from each support. Neglecting the dead weight of the beam, sketch the cable profile of the tendons for load balancing condition. Determine the maximum stress produced in the concrete. 10

5. (a) Two wheels, placed at a distance of 2.5 m apart, with a load of 200 kN on each of them, are moving on a simply supported girder (I-section) of span 6.0 m from left to right. The top and bottom flanges of the I-sections are 200 × 20 mm and the size of web plate is 800 × 6 mm.

If the allowable bending compressive, bending tensile and average shear stresses are 110 MPa, 165 MPa and 100 MPa respectively, check the adequacy of the section against bending and shear stresses. Self weight of the girder may be neglected. 20

(b)



The bottom chord of the truss is composed of 2 Nos. ISA 60 × 60 × 6 with gusset thickness of

(Contd.)

10 mm (back to back and both sides of the gusset). Calculate the factored load carrying capacity of the member under compression only.

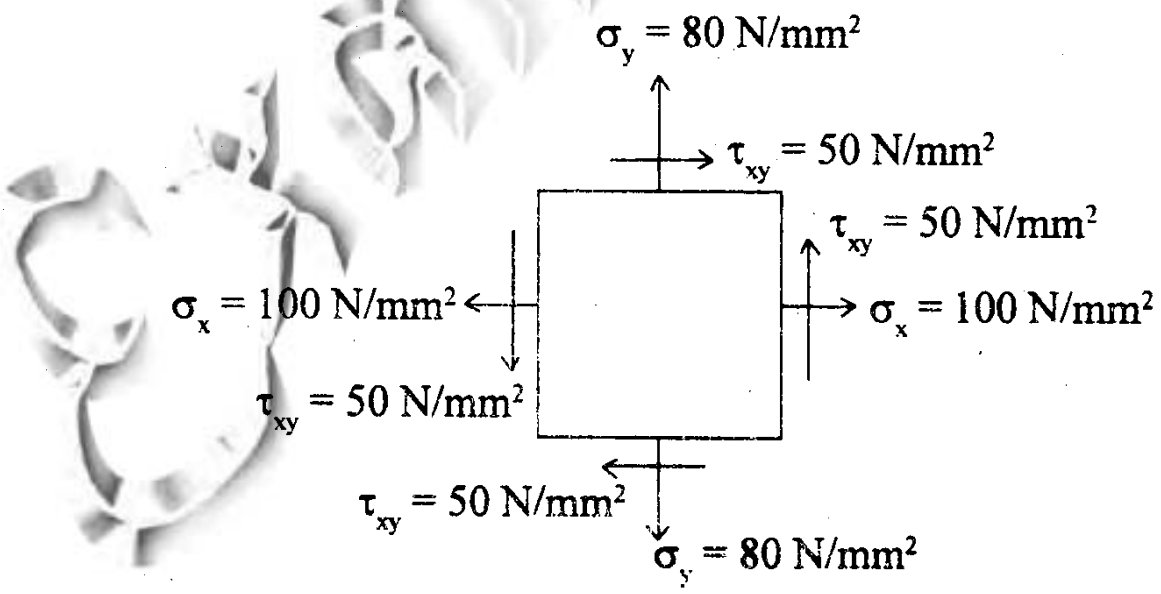
(ISA 60 × 60 × 6 : A = 684 mm^2, $I_{XX} = I_{YY}$ = 226000 mm^4, $C_{XX} = C_{YY}$ = 16.9 mm)

KL/r	80	90	100	110	120	130	140	150
f_{cd} (MPa)	118	105	92.6	82.1	73	65.2	58.4	52.6

Longitudinal ties are provided at alternate node of the bottom chord.

What are High Strength Friction Grip Bolts ? State their advantages. 15+5

6. (a) A plane element of a body is subjected to stresses as shown in the figure.



(Contd.)

Find the factor of safety as per the following theories, if the yield stress given for the material is 200 N/mm^2 and Poisson's ratio = 0.3 :

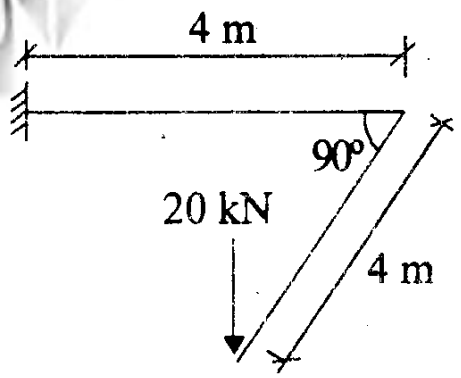
(i) Maximum principal stress theory

(ii) Maximum principal strain theory

(iii) Maximum shear stress theory

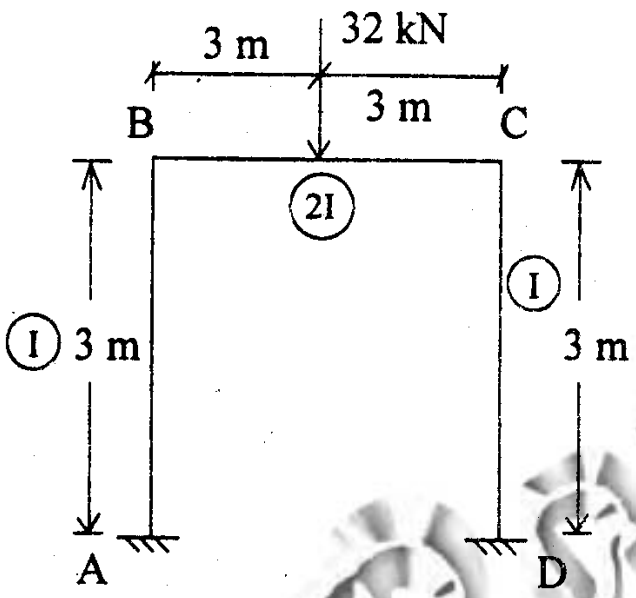
(iv) Maximum strain energy theory. 15

(b) Draw the bending moment and torsional moment diagram for the beam as shown. The load is perpendicular to the beam in plane. 5



(Contd.)

(c)

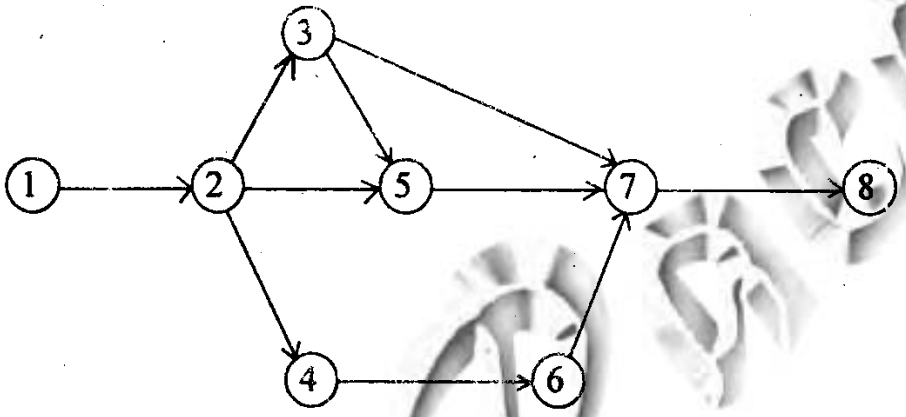


In the rigid frame shown in figure A central concentrated load is acting on "BC". Find slopes θ_A, θ_B, θ_C, θ_D. 10

(d) Discuss the stress-strain curve of steel of grade Fe 500 and its application under Plastic Analysis. 5+5

7. (a) For the network of a construction project with various activities shown below, determine the

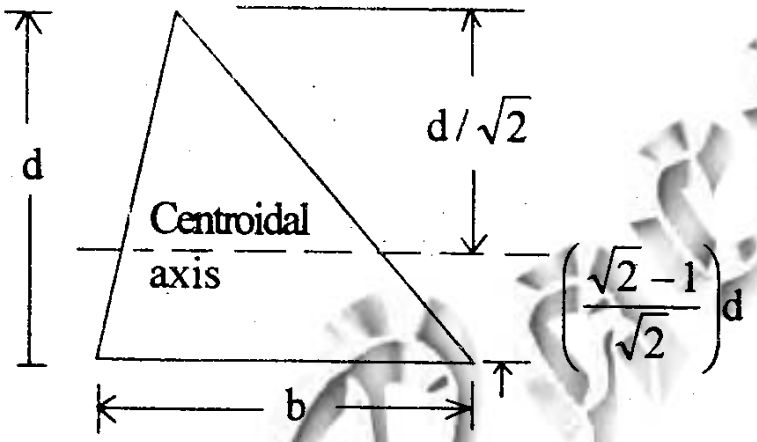
project completion time. Determine the total float of each activity. Mention the critical activities. 20



Activity	Duration (weeks)
1—2	16
2—3	24
2—4	36
2—5	8
3—5	12
4—6	40
3—7	32
5—7	8
6—7	16
7—8	12

(Contd.)

(b) Find the shape factor for a triangular section as shown in the figure. 10



(c) (i) Define critical path.

(ii) What is direct cost slope ?

(iii) Explain FLOAT and slack. 10

ENGINEERING SERVICES
EXAMINATION-2015

Sl. :

A–GTD–O–DDBB

CIVIL ENGINEERING

Paper—II

(Conventional)

Time Allowed : Three Hours	Maximum Marks : 200

INSTRUCTIONS

Please read each of the following instructions carefully before attempting questions.

Candidates should attempt FIVE questions in all.

Question No. 1 is compulsory.

Out of the remaining SIX questions, attempt any FOUR questions.

All questions carry equal marks. The number of marks carried by a part of a question is indicated against it.

Unless otherwise mentioned, symbols and notations have their usual standard meanings.

Assume suitable data, if necessary, and indicate the same clearly.

Neat sketches may be drawn, wherever required.

All parts and sub-parts of a question are to be attempted together in the answer-book.

Attempts of questions shall be counted in chronological order. Unless struck off, attempt of a question shall be counted even if attempted partly.

Any page or portion of the page left blank in the answer-book must be clearly struck off.

Answers must be written in ENGLISH only.

1. *(a)* A trapezoidal channel has a width of 10 m and a side slope of 1·5 horizontal to 1·0 vertical. A discharge of 100 m^3/sec is to be passed at a depth of 3 m. Design the slope of the channel. Assume uniform flow and Manning's n as 0·020. 4

(b) Define specific speed of a pump. Where is it useful? A centrifugal pump runs at a speed of 250 r.p.m. for 50 m^3/sec discharge at a head of 50 m. Find the specific speed. 4

(c) Determine the maximum base width of the elementary profile of a gravity dam with the following data : 4

Specific gravity of the dam material = 2·4

Uplift intensity factor = 1·0

Coefficient of static friction = 0·80

Height of the dam = 20·0 m

(d) There are four important theories with regard to formation of meanders— *(i)* disturbance theory, *(ii)* helicoidal flow theory, *(iii)* excess energy theory and *(iv)* instability theory. Friedkin and Werner subscribed to the idea of disturbance theory. In brief, explain their ideas. 4

(e) Give suitable reasons why the following are important parameters for drinking water quality : 8

(i) Nitrate

(ii) Fluoride

(iii) Total coliforms

(iv) Iron

(f) A proposed earthen dam will have a volume of 5000000 m^3 of compacted soil. The soil is to be taken from a borrow pit and will be compacted to a void ratio of 0·8. The void ratio of soil in the borrow pit is 1·15. Estimate the volume of soil that must be excavated from the borrow pit for the construction of the above dam. 4

(g) The soil at a site consists of two layers of thickness H each. The coefficient of permeability of the soil of 1st layer is K_1 in both horizontal and vertical directions, whereas for the 2nd layer, it is $K_1/2$. What will be the equivalent permeability of the two-layered soil in horizontal and vertical directions? 4

(h) Briefly explain how Global Positioning System (GPS) is useful in surveying work. 4

(i) Briefly explain *(i)* why AADT may be considered better parameter to ADT in representing average daily traffic and *(ii)* why thirtieth highest hourly volume may generally be considered as the hourly volume for design of traffic facilities. 4

2. (a) A 9 m deep tank contains 6 m of water and 3 m of oil of relative density 0·88. Determine the pressure at the bottom of the tank. What is the pressure at the bottom of the tank if the entire tank is filled with water? What is the water thrust in this case? Draw the pressure distribution diagram in both the cases. 8

(b) A guide bank is required for a bridge on a river. For a design flood discharge of 50000 m^3/sec, compute the following : 8

(i) Lacey waterway

(ii) Total length between banks

(iii) u/s length of guide bund and d/s length of guide bund

(iv) Radius of u/s curved head and d/s curved head with angles

(c) A town on the bank of river Ganga discharges 18000 $m^3 day^{-1}$ of treated wastewater into the river. The treated wastewater has a BOD_5 of 20 mg L^{-1} and a BOD decay constant of 0·12 day^{-1} at 20 °C. The river has a flow rate of 0·43 $m^3 sec^{-1}$ and an ultimate BOD of 5·0 mg L^{-1}. The DO of the river is 6·0 mg L^{-1} and the DO of the wastewater is 0·4 mg L^{-1}. Compute the DO and initial ultimate BOD in the river, immediately after mixing. 8

(d) A layer of sand 6·0 m thick lies above a layer of clay soil. The water table is at a depth of 2·0 m below the ground surface. The void ratio of the sand layer is 0·6 and the degree of saturation of the sand layer above the water table is 40%. The void ratio of the clay layer is 0·7. Determine the total stress, neutral stress and effective stress at a point 10 m below the ground surface. Assume specific gravity of the sand and clay soil respectively as 2·65 and 2·7. 8

(e) Four cars started from station O at the same time. After an hour, these cars reached at stations $S1$, $S2$, $S3$ and $S4$ respectively. Determine the correct interior angles in a closed compass traverse $O-S1-S2-S3-S4-O$ formed by these cars and original station O. The traversing was done in the clockwise direction. The following bearings were observed in the closed traverse : 8

Line	*FB*	*BB*
$O-S1$	S 42° 15′ E	N 42° 15′ W
$S1-S2$	S 48° 30′ W	N 49° 30′ E
$S2-S3$	N 76° 45′ W	S 75° 00′ E
$S3-S4$	N 15° 00′ E	S 16° 00′ W
$S4-O$	N 63° 45′ E	S 62° 30′ W

3. (a) A horizontal venturi meter which has an inlet diameter of 120 mm and throat diameter of 60 mm is connected to a pipeline. The coefficient of discharge is 0·95. The inlet pressure is 10 kPa (gauge) and local atmospheric pressure is 96 kPa (absolute). Determine the maximum discharge of water that can be allowed without causing cavitation. Assume vapour pressure of water as 4 kPa. 8

(b) Three distributaries are used for irrigation. The details are given below. Find which one is less efficient : 8

Discharge	15 m^3/sec	20 m^3/sec	25 m^3/sec
CCA	15000 ha	25000 ha	30000 ha
Intensity of irrigation	60%	80%	60%
Base period	200 days (cotton)	120 days (wheat)	360 days (sugarcane)

(c) Explain the significance of alkalinity in coagulation practice and in lime-soda softening. 8

(d) A sample of normally consolidated clay was subjected to a consolidated undrained triaxial compression test that was carried out until the specimen failed at a deviator stress of 50 kN/m^2. The pore water pressure at failure was recorded to be 20 kN/m^2 and confining pressure of 50 kN/m^2 was used in the test. Determine the consolidated undrained friction angle ϕ_{CU} and drained friction angle ϕ_{CD}. 8

(e) A road is to be constructed with a uniform rising gradient of 1 in 100. Determine the staff readings required for setting the tops of the two pegs on the given gradient at 30 metres interval from the last position of the instrument. The RL of the first peg is 384·500 m. A fly levelling was carried out from a BM of RL 387·000 m. The following observations (in m) were recorded : 8

Backsight : 1·625 2·345 2·045 2·955

Foresight : 1·315 3·560 2·355

4. *(a)* A hydraulic jump occurs in a horizontal rectangular channel. Froude number before the jump is 12 and energy loss is 4 m. Estimate sequent depths, discharge intensity and Froude number after the jump. 8

(b) Given below are the observed flows from a storm of 4 h duration on a stream with a drainage area of 2000 km^2. Derive 4 h unit hydrograph. Assume a constant base flow of 150 m^3/sec : 8

Time (day)	*Flow* (m^3/sec)	*Time* (day)	*Flow* (m^3/sec)
1	150	8	330
2	1050	9	268
3	880	10	230
4	680	11	205
5	570	12	180
6	470	13	160
7	400	14	150

(c) In a treatment plant, two banks of rapid sand filtration are proposed after sedimentation. Each filter bed has a surface area of 3 m × 2 m. The design flow rate to each bank of filters is 0·044 m^3/sec. The design loading rate to each bank of filters is 150 $m^3/day/m^2$. Determine the number of filter beds in each bank of filters. Determine the loading rate when one filter is out of service. The maximum acceptable loading rate is 235 $m^3/day/m^2$. 8

(d) A footing is to be constructed 1·8 m below the ground surface as shown in Fig. 4 *(d)*. The base of the footing is 2·7 m × 2·7 m and it carries a total load of 1800 kN which includes the column load and weight of the footing. Compute the total expected settlement of the footing (consider only consolidation settlement) : 8

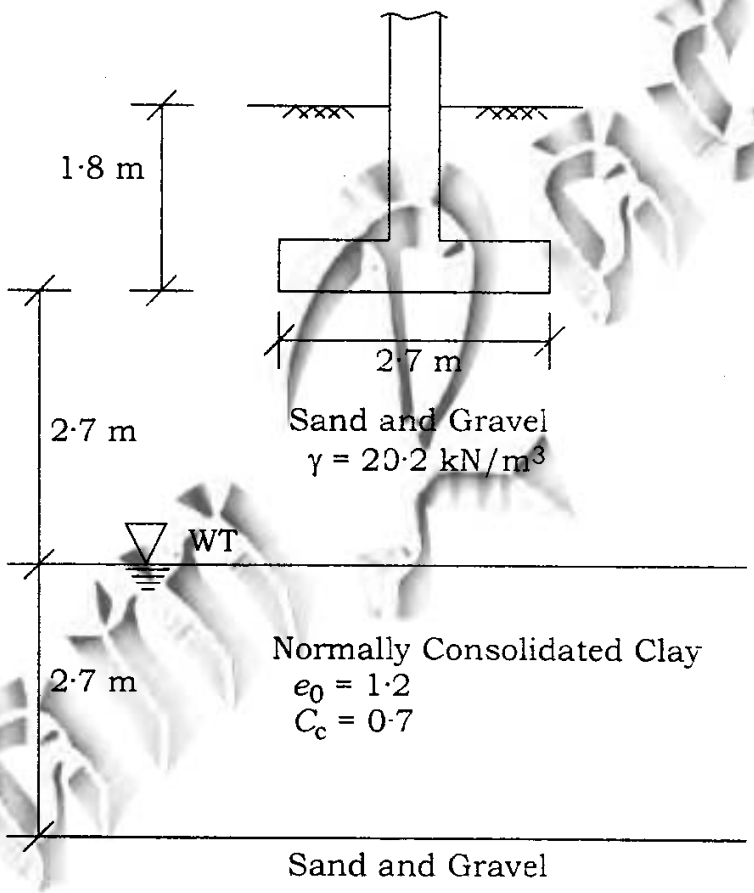


Fig. 4 *(d)*

(e) Differentiate between the following with reference to bituminous construction : 4+4=8

(i) Prime coat and Tack coat

(ii) Bituminous concrete and Bituminous macadam

5. *(a)* A discharge of 150 litres per second is to be measured by a V-notch of vertex angle 60°. What would be the head over the vertex? If the accuracy of the reading of the head is 1 mm, what error in discharge can be expected at this level? Assume $C_d = 0{\cdot}62$. 8

(b) Design a rigid boundary canal carrying 50 m^3/sec. Take Manning's $n = 0{\cdot}014$ and longitudinal slope of the canal as 12 per ten thousand. Channel is rectangular section. 8

(c) What is grit? Why should grit be removed from wastewater? What is the basic principle behind the design of grit chambers? What is the reason to have constant velocity of flow in grit chamber (conventional horizontal flow) and how is it achieved? 8

(d) A wall footing carrying a load of 150 kN/m length of the wall is to be constructed at a depth 1·2 m below the ground surface. Subsoil consists of uniform deposit of stiff clay with unit weight, $\gamma = 18{\cdot}8$ kN/m^3 and unconfined compressive strength = 160 kN/m^2. Determine the width of the footing using Terzaghi's theory. Use a factor of safety against bearing capacity failure = 3·0. 8

(e) *(i)* Briefly compare the construction of tunnels in rock strata and construction of tunnels in soft strata.

(ii) What are the uses of wet docks in harbours? 4+4=8

6. *(a)* An inward flow reaction turbine has an inlet and outlet diameter of 1·5 m and 0·75 m respectively. The breadth at the inlet is 0·30 m and at the outlet is 0·40 m. At a speed of rotation of 300 r.p.m., the relative velocity at the entrance is 5·25 m/sec and is radial. Calculate the—

(i) absolute velocity at entrance and inclination to the tangent of the runner;

(ii) discharge;

(iii) velocity of flow at the outlet. 8

(b) The surface runoff from a flood on a drainage basin amounted to 5·0 cm. The area of the basin is 250 km^2. The equivalent uniform depth of rainfall on the drainage basin was 15 cm and the time distribution of the rainfall is given as follows. Calculate the ϕ index : 8

Hour	08–09	09–10	10–11	11–12	12–13	13–14	*Total*
ppt (mm)	15	20	50	20	30	20	155

(c) A wastewater treatment plant operating primary settling tank gets an inflow of 12·96 million litres per day with influent suspended solids concentration of 280·0 mg/L. The primary settling tank has a removal efficiency of 59% with sludge concentration of 5%. If the volatile solids concentration in settled sludge is 60% and the specific gravity of volatile solids is 0·990; and the fixed solids concentration is 40% and the specific gravity of fixed solids is 2·65, determine the daily sludge production. 8

(d) A 400 mm diameter concrete pile is to be driven into a clay soil. Properties of the soil are : unconfined compressive strength = 200 kN/m^2, unit weight = 19·5 kN/m^3. The pile's design capacity is 1000 kN. Determine the length of the pile required for a factor of safety of 2. Assume adhesion factor, $\alpha = 0 \cdot 75$. 8

(e) (i) Differentiate between Loading gauge and Construction gauge.

(ii) A BG railway track is to be constructed in an area where ruling gradient permissible is 1 in 100. A curve of 3° is also required to be provided. Determine the gradient to be provided at this location so that the combined resistance due to gradient and curve should not exceed the resistance due to ruling gradient. 4+4=8

7. (a) Estimate for 1 : 20 model of a spillway (i) prototype velocity corresponding to a model velocity of 2 m/sec, (ii) prototype discharge per unit width corresponding to a model discharge per unit width of 0·3 m^3/sec/m, (iii) pressure head in the prototype corresponding to a model head of 5 cm of mercury at a point and (iv) the energy dissipated per second in the model corresponding to a prototype value of 1·5 kW. 8

(b) Using Lacey's theory, design an irrigation channel carrying 30 m^3/sec. Take silt factor as 1·0. 8

(c) A town of population of 50000 generates municipal solid waste of 500 g per person per day. How many trucks would be needed to collect the waste twice weekly? The trucks have a capacity of 4·5 t (metric tonnes) each and operate 5 days per week. Assume that the trucks average two loads per day at 75% capacity. If 20% of the waste generated is recycled, determine the weight of MSW that enters the landfill. If the density of the waste is 280 kg/m^3, what is the volume of MSW? 8

(d) A retaining wall with a smooth vertical back is 9 m high and retains a two-layer sand backfill with the following properties :

0–3 m depth : $c' = 0 \cdot 0$, $\phi' = 30°$, $\gamma = 18\ kN/m^3$

3–9 m depth : $c' = 0 \cdot 0$, $\phi' = 35°$, $\gamma = 20\ kN/m^3$

Show the active earth pressure distribution and determine the total active thrust on the wall. Assume that water table is well below the base of the wall. 8

(e) An airport is to be constructed at a site 190 m above mean sea level and on a level ground. The runway length required under standard atmospheric condition at sea level for landing is considered as 2100 m and for takeoff as 1600 m respectively. Determine the actual runway length to be provided at this airport site. Airport reference temperature may be considered as 21 °C. 8

★ ★ ★