HPSC AE
Civil (Mains)

Previous Year Paper
(Irrigation & WRD)
30 Sept, 2024

Civil Engineering/31 E
2024

Time: 3 hours
समय: 3 घंटे

Maximum Marks: 150
अधिकतम अंक: 150

Question paper specific instructions

प्रश्न प्रत्र के लिए विशिष्ट अनुदेश

(Please read following instructions carefully before attempting questions)

(कृपया प्रश्नों का उत्तर देने से पहले निम्नलिखित निर्देशों को ध्यान से पढ़ें)

1. There are eighteen (18) questions in all.

   कुल अठारह (18) प्रश्न हैं।

2. Candidate has to attempt any fifteen (15) questions in all.

   अभ्यर्थी को कुल मिलाकर किन्हीं पंद्रह (15) प्रश्नों का उत्तर देना होगा।

3. No extra/additional sheet will be provided.

   कोई अतिरिक्त/अतिरिक्त शीट प्रदान नहीं की जाएगी।

4. Answer must be written in the authorized medium. No marks will be given for answers written in a medium other than the authorized one.

   उत्तर अधिकृत माध्यम में ही लिखना होगा। अधिकृत माध्यम के अलावा किसी अन्य माध्यम में लिखे गए उत्तरों के लिए कोई अंक नहीं दिए जाएंगे।

5. All questions carry equal marks i.e 10 each.

   सभी प्रश्न समान अंक वाले हैं, अर्थात प्रत्येक 10 अंक का है।

Q. 1. A two hinged parabolic arch of span 20 m and central rise 5 m carries a uniformly distributed load of 30 kN/m horizontal run over the left half span. Determine the horizontal thrust at supports.

[10]

Q.2 A). A mass of 15 kg has been attached at the free end of a cantilever mild steel rod of 16 mm diameter and 1 m length. It is displaced through 30 mm and released to vibrate. Determine system's undamped natural frequency. Take Modulus of elasticity of the rod as 200 GPa.

[5]

Q. 2 B). A propped cantilever beam of span 7 m carries one point load of 60 kN at 2 m from fixed support and another point load of 90 kN at 4 m from fixed support. Determine design plastic moment capacity of the beam using kinematic method.

[5]

Q. 3. A simply supported concrete beam with span 8 m is having a cross section 300 mm x 450 mm. It has been prestressed by means of 14 straight wires of 6 mm diameter located at 70 mm from the bottom of the beam and 6 straight wires of 6 mm diameter located at 60 mm from top of the beam.Assuming the prestress in the wires as 900 N/mm², calculate the resultant stresses at the extreme fibres of the mid-span section. Consider uniformly distributed load of 5 kN/m is acting on the entire span as a live load. Take density of concrete as 24 kN/m³.

[10]

Q 4 A) A national highway passing through rolling terrain in heavy rainfall area has a horizontal curve of radius 500 m. Design the length of transition curve based on following data:

Ruling design speed (V) = 80 kmph

Normal pavement width , W = 7.0 m.
Rate of introduction of super elevation , 1 in N = 1 in 150

Wheel base of vehicle , l = 6.0 m   [5]

Q.4 B) What are the requirements for mix in which Viscosity Grade bitumen used, to construct the Dense Graded Bituminous Macadam layer. The conformity with grading and quality requirements for individual materials have been done and their requirements are not to be listed.   [5]

5 A) Which are the steps followed in traffic accidents studies ? What are the data collected in the studies of accidents?   [5]

Q.5 (B) The initial traffic after completion of a four-lane divided highway is estimated to be 3500 CV per day. Design the flexible pavement (FP) for a life of 15 years using data given below:

Design CBR = 8%, Growth rate of CV = 6.5% p.a., VDF = 4.0, Lane distribution factor = 0.75. For pavement composition use table below: (5)

Draw cross-section.

CBR , %	CSA, msa	Total Thickness of FP, mm	GSB, mm	GB, mm	DBM, mm	BC, mm
	30	590			100	40
	50	610			120	40
8	100	640	200	250	140	50
	150	610			160	50

6 A) Calculate the superelevation and maximum permissible speed for a 2° BG transitioned curve on a high-speed route with a maximum sanctioned speed of 110 kmph. The speed for calculating the equilibrium superelevation as decided by the Chief Engineer is 80 kmph and the booked speed of goods trains is 50 kmph. [6]

Q6 B) Write briefly the ICAO and FAA recommendations for the corrections required for the actual runway length at site. [4]

Q.7. A) A theodolite traverse survey by Loose-needle method was conducted round a forest and the following whole-circle bearings were observed. Determine which of the stations suffer from local attraction and compute the values of the corrected bearings. Compute Consecutive coordinates of all lines and adjust it by Bowditch rule. If Independent coordinates of A is (100, 100) find out Independent coordinates of B, C and D. (7)

Line	Length	Fore Bearing	Back Bearing
AB	30	74° 20' 20"	256° 00' 20"
BC	40	107° 20' 20"	286° 20' 20"
CD	50	224° 50' 20"	44° 50' 20"
DA	60	306° 40' 20"	126° 00' 20"

Q.7 B) How Level loop can be carried out for above traverse? Explain adjustment of Level loop. (3)

Q.8. A) Write note about contour gradient. Explain the methods of locating contour gradient on a map and on the ground. (5)

Q.8 B) The area enclosed by contours on the upstream face of a dam in a proposed hydro-electric project, are tabulated below.

Contour Value (m)	Area enclosed (sq. m.)
1000	314100
990	267400
980	248900
970	222300
960	193700
950	177400
940	129100
930	53500

$\frac{h}{2}(A_1+A_2) + A_2 + A_3$

Considering the lowest draw down level to be 933 m, compute the total volume at 1000 m. (5)

Q.9 A) Explain Fly levelling and Balancing of BS's FS distances? How it is advantageous to carry out Fly levelling with Balancing of BS' FS distances? (3)

Q.9 B) The following readings were obtained in running fly levels from a bench mark of R.L. =310.000 m.

1.285, (1.120, 2.100), (3.545, 1.890), (2.300, 2.635)

From the last setting of the instrument, five pegs at 20 m intervals are to be set out on a uniform rising gradient of 1 in 50. The R.L. of the first peg is 307.225 m. Work out the staff readings required for setting the tops of pegs on the required gradient. Enter all readings in page of level field book. (7)

Geotechnical engineering

10. (A) (i) A saturated clayey soil specimen was subjected to an effective vertical stress of 100 kPa in a consolidometer. After 24 hours, the height of the specimen decreased from 20 mm to 19 mm. If dry unit weight of the soil specimen is 1.6 g/cc and specific gravity of soil solid as 2.67, calculate the final void ratio.

(3)

(ii) An earthen dam is to be constructed at a pervious ground (sand) having porosity of 50 % and G = 2.62. Calculate the critical hydraulic gradient and also find the permissible upward hydraulic gradient with a factor of safety of 3 against quick sand.

(2)

10. B) (i) A foundation trench is to be excavated in a clay stratum of 8 m thick underlain by sand. If the GWT (ground water table) is at 2.0 m depth from GL (ground level), calculate the depth of excavation at which the bottom of the excavated bed becomes unstable due to artesian pressure. The specific gravity and void ratio of the clay soil are 2.7 and 0.7 respectively. If excavation is to be carried out upto 7.0 m depth, how much water table be lowered in the vicinity of the trench? Take Y_w = 10 kN/m³ (3)

(ii) In an unconfined aquifer, the sand layer is underlain by a clay stratum at a depth of 16 m from GL. The GWT is at a depth of 2.0 m from GL. A test well and two observation wells are sunk into the ground at a distance of 20 m and 40 m from the test well. The water was pumped out from the test well at the rate of 1000 litres per minute and in steady state, the drawdown in observation wells are found to be 1.5 m and 3.0 m respectively. Calculate the permeability of the sandy strata. (2)

Q11. (A) At a site, the vane shear test was performed on a soft saturated clay bed and the torque applied to shear the soil mass was found to be 40 N-m.

Calculate the undrained shear strength of the soil bed. The vane was then rotated fast to cause remoulding of the soil. The torque. required for shearing the soil was 10 N-m. Find the sensitivity of the soil. The diameter and the height of the vane was 50 mm and 100 mm respectively. (5)

Q 11 (B) Stability analysis by Swedish method of slices for a 8.0 m high embankment made of cohesive soil (c = 20 kPa, φ = 50) has the following data: (5)

i. Length of the arc = 18 m

ii. Total shearing force mobilized along the arc = 400 kN

iii. Total normal force = 1800 kN

iv. Total pore water pressure = 200 kN

Calculate the factor of safety of this slope.

Q 12 (A) A square footing of size 2 m x 2 m is supported on a soil with its base at a depth of 1.5 m from GL. The properties of the soil are:

C' = 24 kPa, ϕ' = 250, Y = 18 kN/m3 above the GWT and 20 kN/m3 below GWT.

Nc' = 14.8, Nq' = 5.6, NY' = 3.2. Calculate the ultimate and net safe bearing capacity of the soil if GWT is 0.5 m below the base of the footing using Terzaghi's bearing capacity equations. Take FOS = 2.5. (5)

Q 12 (B) Calculate the ultimate load carrying capacity of a single under-reamed pile of length 10 m and shaft diameter 0.4 m embedded in cohesive bed (cu = 50 kPa, ϕu = 0, α=0.7). The diameter of the under-ream is 2.5 times the shaft diameter. (5)

Q.13 (A) A two-hour rain fell in a catchment area of 1000 hectares. The rate of rainfall is tabulated below. If the value of average infiltration rate ϕ- index = 3.0 cm/hour, calculate (i) Total rainfall and (ii) net run-off. [5]

Time duration (minutes)	0 - 40	40-60	60-80	80-100	100-120
Rainfall intensity (cm/hour)	2	2.5	6.5	12	4

Q. 13 (B) An unconfined aquifer has a saturated depth of 30 m. A fully penetrating 20 cm diameter well in this aquifer is pumped at a rate of 32 litres per second. The drawdown measured in two observation wells located at distance of 15 m and 110 m from the well are 7.5 m and 0.5 m. Determine the average hydraulic conductivity of the aquifer. At what distance from the well the drawdown is insignificant? [5]

Q. 14 (A) Determine the hydraulic gradient in a 90 cm diameter old iron pipe carrying a discharge of 0.75 cumec by using (a) Manning formula (b) Darcy- Weisbach formula and (c) Hazen-William formula.

Take:

Manning roughness coefficient = 0.014

Darcy friction factor f = 0.015 and

Hazen-Williams roughness coefficient C = 120 (6)

Q. 14 (B) A sluice gate discharges water into a horizontal rectangular channel with velocity of 7.5 m/s and depth of water is 0.5m. The width of channel is 5 m. Determine whether a hydraulic jump will occur, and if so, find its height and corresponding loss of energy. [4]

Q. 15 (A) Oil of specific gravity 0.8 flows at a rate of 720 liters per minute through a 60 mm diameter horizontal pipe. Find the viscosity of the oil, if pressure drop is 500 Pa for 100 mm length of pipe. Also check that the flow is laminar or not. [5]

Q. 15 (B) Given below the data for a broad crested weir:

(a) Discharge per unit width = 1.54 cumec/m

(b) Weir coefficient = 0.33

Calculate (i) head over crest (ii) critical depth of flow and (iii) critical velocity [5]

Q:16 (A) Students in graduate level environmental engineering laboratory took samples of the influent (raw sewage) and effluent (treated sewage) of a municipal wastewater treatment plant. They used these samples to determine the BOD rate constant (k). would you expect the rate constants to be same or different? If different which would be higher and why? [05]

Q 16 B) If it were your job to set standards for a water body and you had a choice of either BOD 5 or ultimate BOD, which would you choose & why? [05]

Q:17 (A) Cement dust is characterized by very fine particulates. The exhaust gas temperatures from a cement kiln are very hot. Which of the following air pollution control devices would appear to be appropriate? Explain the reasoning for your selection.

(a) Venturi Scrubber

(b) Baghouse

(c) Electrostatic Precipitator [05]

Q.17 (B) Photochemical oxidants are not directly attributable to eighter people or natural sources. Why then are automobiles singled out as the major cause of the formation of ozone? [05]

Q:18 (A) A Waste to Energy Plant (WTE) is being proposed as part of an Integrated Waste Management System (ISWM) plan. The proponents of the WTE argue that recycling is not necessary and will have no effect on the performance of the plant. Do you agree or disagree explain. [05]

Q 18 (B) Although the market value of the compost is negligible, many communities have implemented yard waste composting system. Explain why. [05]