Total number of printed pages = 7

19/2nd Sem/PCEW 2124

2022

HYDRAULIC STRUCTURES

Full Marks – 100

Time – Three hours

The figures in the margin indicate full marks for the questions.

Answer any *five* questions.

1. (a) Suppose, you, as a member of a consultancy team, are tasked with the preparation of a pre-feasibility report of a hydroelectric power project requiring the construction of a dam for storing a river's flow at a site identified from study of GIS-derived contour maps. You visited the site with your team comprising a geologist, a hydrologist and a surveyor. After carrying out reconnaissance and preliminary studies of available data and information from secondary and/or tertiary sources, write

   (i) how would you select alternative locations of the dam for further study and final selection by optimization ?

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(ii) what are factors based on which you would decide the appropriate type(s) of dam at the selected locations ?

(iii) what are the aspects for which you would collect and compile data for analysing and ensuring safety of the types of dams that you might consider ? 3×4=12

(b) (i) What are the different types of river training works ?

(ii) What are the functions of Guide bunds and Spurs ? Show typical layouts of a guide bund and a spur. 2×4=8

2. (a) What combinations of forces acting on a gravity dam are to be considered for the design of the section of a such a dam. 6

(b) Investigate the stability against overturning of a concrete gravity dam having the shape of a right-angled triangle with the upstream face vertical. Other features of the dam are as below :

Height of the dam = 130m

Sloe of d/s face = 0.75H : 1V

Height of water retained = 130m

Free-board = 0

Height of tail water = 0

Unit weight of concrete = 24 kN/m^3

Uplift intensity factor = 0.6

Allowable coefficient of friction = 0.75

The earthquake forces may be taken as equivalent to 0.1g for horizontal forces and 0.05g for vertical forces. Neglect wave forces and its pressure. Assume any data if required. 14

3. Answer any *four* of the following questions : 5×4=20

(a) What are the different types of earthen dams ? Describe with sketches.

(b) State any eight important design criteria of an earthen embankment.

(c) Derive an expression for estimating seepage discharge through an embankment by considering the embankment as being made up of isotropic soil and by using a flow net.

(d) Derive an expression of Factor of Safety for assessing the stability of slopes of an earthen embankment starting with the Swedish slip circle method.

(e) Describe with a sketch the graphical solution of Casagrande for obtaining the phreatic surface within a homogeneous earthen dam provided with a horizontal filter on the downstream.

4. (a) What are the different causes of failure of an earthen dam ? 6

(b) On the basis of the investigation report of the failures of the Edenville and Sanford Dams in the USA in May, 2021 that you studied for your course assignment, state the phenomena by which these two dams failed ? 2

(c) Describe the major causes of failure of gravity dams together with the criteria for structural stability of such a dam. 6

(d) For investigating the failure potential of a weir founded on a permeable stratum, calculate the exit gradient when the elevations at the upstream pond level and the top of the downstream apron are 158.0m and 152.0m respectively. The downstream cut-off is 10.3m deep and the floor is 57.0m long. Comment on this exit gradient with reference to the safe exit gradient varying from 0.17 for fine sand to 0.25 for shingle. 6

5. (a) (i) On what basis is the profile of an ogee spillway determined ?

(ii) What are the design considerations for a spillway ? 3+3=6

(b) When is a hydraulic jump formed ? Derive the expression of sequent depths of a hydraulic jump. 2+4=6

(c) Briefly describe with suitable sketches the different types of energy dissipation arrangements that may be constructed for the following four settings of the sequent depth curve (y_2-curve) and the tail water curve (TWC) on the downstream of a dam spillway : 8

(i) the y_2-curve and the TWC coinciding at all spills

(ii) the TWC lying below the y_2-curve at all spills

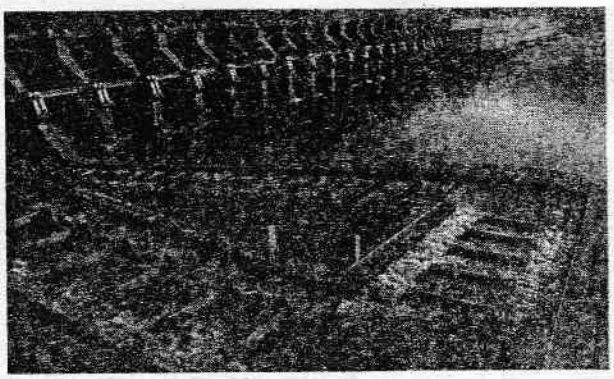
(iii) the y_2-curve lying below the TWC at all spills

(iv) the TWC lying above the y_2-curve at smaller spills and below the y_2-curve at larger spills.

6. (a) Why are canal falls necessary in an irrigation project ? What are the considerations made in deciding the locations of canal falls ? 4+4=8

(b) Describe the different categories of cross-drainage works for different settings of canals with reference to natural drainage by providing suitable sketches. 6

(c) Why are fish ladders provided in some dams ? What could be the criteria for designing the fish ladder shown on the downstream side of a dam in the following photograph ? 2+4=6



7. Write short notes on any *four* of the following : 5×4=20

(a) Factors on which the discharge of a spillway vary.

(b) Cavitation in a spillway.

(c) General formula for estimating the flow over a ogee spillway and the associated formula for calculating the effective length of the spillway crest.

(d) Different galleries constructed inside a large concrete gravity dam.

(e) Sealing of bocks of concrete gravity dam.

(f) The mathematical expression for deriving the requirement to ensuring that tension does not develop anywhere in a concrete gravity dam.