9 CHAPTER

Dams, Spillways, Energy Dissipation and Spillway Gates

Q.1 The base width of a solid gravity dam is 25 m. The material of the dam has a specific gravity of 2.56 and the dam is designed as an elementary profile ignoring uplift. What is the approximate allowable height of the dam?
(a) 64 m (b) 40 m
(c) 164 m (d) 80 m

Q.2 Earthen dams are
(a) rigid dams (b) non-rigid dams
(c) overflow dams (d) diversion dams

Q.3 The only arch dam of India is in
(a) Tamil Nadu
(b) Jammu & Kashmir
(c) Himachal Pradesh
(d) Kerala

Q.4 A dam reservoir without any gate controls on its spillway is called
(a) Detention basin
(b) Storage reservoir
(c) Retarding basin
(d) All of these

Q.5 The vertical stress distribution at the base of a gravity dam when the reservoir is empty, is
(i) 2 *W/b* at the heel
(ii) 0 at the toe
(iii) *W/b* at the heel
The correct answer is
(a) both (i) and (ii)
(b) both (i) and (iii)
(c) both (ii) and (iii)
(d) none of the above

Q.6 Hydraulic failures of an earthen dam may be due to
(i) overtopping.
(ii) erosion of upstream face.
(iii) erosion of down stream face by gully formation.
(iv) cracking due to frost action.
The correct answer is
(a) both (i) and (ii) (b) (i), (iii) and (iv)
(c) (ii), (iii) and (iv) (d) (i), (ii), (iii) and (iv)

Q.7 Seepage failures of an earthen dam may be due to
(i) piping through foundations.
(ii) piping through dam body.
(iii) sloughing of down stream toe.
The correct answer is
(a) only (i) (b) only (ii)
(c) both (ii) and (iii) (d) (i), (ii) and (iii)

Q.8 Study the following statements with reference to horizontal filter in earthen dams:
(i) Horizontal filter helps in bringing down the phreatic line in the body of the dam.
(ii) Horizontal filter provides the drainage of the foundation and helps in rapid consolidation.
(iii) Horizontal filter tries to make soil more pervious in the horizontal direction and causes stratification.
(iv) The length of the horizontal filter should be equal to the three times the height of the dam.
The correct statements are
(a) both (i) and (ii) (b) both (i) and (iii)
(c) both (i) and (iv) (d) (i), (ii), (iii) and (iv)

Q.9 An earthquake acceleration of 0.1 g acting vertically downward causes in a gravity dam

(a) an increase in the weight of dam by 10%.
(b) a reduction in the unit weight of concrete only by 10%.
(c) a decrease in the unit weight of concrete and water by 10%.
(d) a decrease in the unit weight of water by 10%.

Q.10 'Bank Storage' in a dam reservoir
(a) increases computed reservoir capacity.
(b) decreases computed reservoir capacity.
(c) sometimes increases, sometimes decreases reservoir capacity.
(d) has no effect on reservoir capacity.

Q.11 For a flood control reservoir, the effective storage is equal to
(a) useful storage + valley storage.
(b) useful storage + surcharge storage – valley storage.
(c) useful storage + surcharge storage + valley storage.
(d) useful storage – valley storage.

Q.12 Average yield of a storage reservoir is the arithmetic average of its
(a) firm yields over a long period.
(b) secondary yields over a long period.
(c) firm and secondary yields over a long period.
(d) None of the above.

Q.13 With the reduction in reservoir capacity over the passage of time, the trap efficiency
(a) increases.
(b) decreases.
(c) remain unaffected.
(d) may increase or decrease, depending upon the reservoir characteristics.

Q.14 The centre of pressure of wave pressure due to wave of height h_w acting on a gravity dam will be at a height above the maximum still water level of
(a) $h_w/2$ (b) $3h_w/8$
(c) $h_w/3$ (d) $2h_w/3$

Q.15 The axis of a dam is the
(a) line joining the mid-point of the base.
(b) centre line of the top width of the dam.
(c) line of the crown of the dam on the downstream side.
(d) line of the crown of the dam on the upstream side.

Q.16 If the uplift pressure is neglected, the base width of an elementary profile of a gravity dam of height H, having relative density of the dam material as G, and coefficient of friction as μ is
(a) $H/(G+1)$
(b) $H/(G-1)$
(c) larger of $H/\sqrt{G}$ and $H/\mu G$
(d) smaller of $H/\mu\sqrt{G}$ and H/G

Q.17 If full uplift pressure is considered, the base width of an elementary profile of a gravity dam of height H with relative density of dam material as G and coefficient of friction as μ is
(a) larger of $H/\sqrt{G-1}$ and $H/\mu(G-1)$
(b) larger of $H/\sqrt{G}$ and $H/\sqrt{\mu-1}$
(c) smaller of $H/\sqrt{G}$ and $H/\mu G$
(d) $H/(G-1)^{1/2}$

Q.18 The limiting height of a low gravity dam of elementary profile having full uplift condition is
(a) $f_c/(\gamma G)$ (b) $f_c/(\gamma\sqrt{G})$
(c) $f_c/[(G-1)\gamma]$ (d) $f_c/[\gamma\sqrt{G-1}]$

Q.19 Which of the following comparative statements, relating to gravity and buttress dams, is not correct?
(a) Buttress dams required only 30% to 50% of the concrete required by gravity dams.
(b) Buttress dams can be built on foundations that are too weak to support gravity dams.
(c) Buttress dams are 30% less expensive than gravity dams.
(d) The height of a buttress dam can be increased relatively more easily than that of gravity dams.

Q.20 Design yield of a storage reservoir is kept
(a) higher than its firm or safe yield.
(b) lower than its firm or safe yield.
(c) equal to its firm or safe yield.
(d) higher or lower than the firm yield, depending upon the designer's intuition.

Q.21 As the height of a proposed dam is increased, the cost per unit of storage
(a) increases.
(b) decreases.
(c) initially increases and then decreases.
(d) initially decreases and then increases.

Q.22 "Economical height of a dam" is that height, for which the
(a) cost per unit of storage is minimum.
(b) benefit cost ratio is maximum and net benefits are maximum.
(c) net benefits are maximum.
(d) None of the above.

Q.23 The most preferred soil for the central impervious core of a zoned embankment type of an earthen dam, is
(a) highly impervious clay
(b) highly pervious gravel
(c) coarse sand
(d) clay mixed with fine sand

Q.24 A gravity dam is subjected to hydro dynamic pressure, caused by
(a) the rising waters of the reservoir when a flood wave enters into it.
(b) the rising waves in the reservoir due to high winds.
(c) the increase in water pressure, momentarily caused by the horizontal earthquake, acting towards the reservoir.
(d) the increase in water pressure, momentarily caused by the horizontal earthquake, acting towards the dam.

Q.25 If 20% of the reservoir capacity is earmarked for dead storage in a storage reservoir of 30 M cum; and the average annual silt deposition in the reservoir is 0.1 M cum, then the useful life of the reservoir will start reducing after
(a) 60 years (b) 120 years
(c) 240 years (d) 300 years

Q.26 In order to have economy on the provided section of a concrete gravity dam, attempts are made to reduce the uplift by
(a) providing drainage gallery to collect seepage water.
(b) constructing cut-off under upstream face.
(c) pressure grouting in dam foundation.
(d) All of the above method.

Q.27 In modern practice the free board normally provided for gravity dam is
(a) 3 to 4% of dam height
(b) 2 h_w (h_w = height of wave)
(c) 2 to 3% of dam height
(d) 3 h_w

Q.28 When a reservoir is full, the maximum compressive stress in gravity-dam occurs
(a) at the heel.
(b) at the toe.
(c) within the middle third of the base.
(d) at the midpoint of the base.

Q.29 What is the height of wave likely to be generated by a wind of 90 kmph having a reservoir fetch of 60 km?
(a) 2.3 m (b) 2.0 m
(c) 2.6 m (d) 1.8 m

Q.30 Which one of the following spillway is least suited to earthen dams?
(a) Ogee spillway
(b) Side channel spillway
(c) Chute spillway
(d) Shaft spillway

Q.31 The portion of a chute spillway, which is known as its control structure, is
(a) low ogee weir.
(b) chute channel.
(c) approach channel leading the water from the reservoir to the ogee weir.
(d) stilling basin at its bottom.

Q.32 For a saddle siphon, the maximum operative head is 6.25 m. The width and height of the throat of the siphon are 4 m and 2 m respectively. The coefficient of discharge is 0.90. How many units are required to pass a flood of 300 cumec? (Take $g = 10\ m/s^2$)
(a) One (b) Two
(c) Three (d) Four

Q.33 The coefficient of discharge of an ogee spillway is 2.0 and the length of spillway is 20 m and water is flowing at a head of 2.0 m above top of spillway. Then the discharge through the spillway will be
(a) 400 cumec (b) 556 cumec
(c) 800 cumec (d) 600 cumec

Q.34 A siphon spilway has a cross-section of 2m-high and 2 m wide. The tail water elevation at design flow is 4 m below the summit of the siphon and the headwater elevation is 4.0m below the summit of the siphon and the head water elevation is 4.0 m above the summit. If the coefficient of discharge will be 0.6. The discharge capacity of the siphon spillway will be
(a) 20 cumec (b) 30 cumec
(c) 40 cumec (d) 3 cumec

Q.35 Match List-I (Main provision) with List-II (Surplussing arrangement) and select the correct answer using the codes given below the lists:

List-I
A. Minor irrigation work
B. Medium irrigation project
C. Earth dam across main river
D. Masonry dam

List-II
1. Saddle spillway
2. Syphon spillway
3. Ogee spillway
4. Surplus weir on good rock

Codes:

	A	B	C	D
(a)	4	2	1	3
(b)	4	2	3	1
(c)	2	4	3	1
(d)	2	4	1	3

Q.36 Match List-I (Characteristic of the spillway) with List-II (Name of spillway) and select the correct answer using the codes given below the lists:

List-I
A. Discharge characteristic is $Q = K_1 H_1^{1/2}$ where H_1 is operating head.
B. Discharge characteristic is $Q = K_1 H_2^{3/2}$ where H_2 is operating.
C. Hazard of clogging with debris and also unsuitable discharge characteristics at high heads over the crest.
D. Combination of Ogee crest and a long steep channel.

List-II
1. Ogee spillway
2. Siphon spillway
3. Chute spillway
4. Shaft spillway

Codes:

	A	B	C	D
(a)	2	1	4	3
(b)	2	1	3	4
(c)	1	2	4	3
(d)	2	4	1	3

Q.37 Match List-I (Nature of jump rating curve) with List-II (Suitable type of energy dissipater) and select the correct answer using the codes given below the lists:

List-I
Jump rating curve is
A. slightly above tailwater rating curve
B. slightly below tailwater using rating curve
C. very much above tailwater rating curve
D. considerably below tailwater rating curve and stiff rock in the river bed

List-II
1. Ski jump bucket
2. Roller bucket
3. Jump on a sloping floor
4. Jump in a depressed apron

Codes:

	A	B	C	D
(a)	4	3	1	2
(b)	3	4	2	1
(c)	4	3	2	1
(d)	4	2	3	1

Q.38 In a saddle-siphon spillway, an air vent is provided at the level of the full reservoir surface
(a) to break the siphonic action at that level
(b) to initiate the siphonic action at that level
(c) to prevent cavitation
(d) to maintain ventilation inside the siphon

Q.39 A trash rack is not needed at entrance to a
(a) morning glory spillway
(b) siphon spillway
(c) high head-gate installation
(d) drum gate installation

Q.40 According to Von-karman, the hydrodynamic force on a dam is equal to
(a) $0.555\ K_h WH^3$ (b) $0.555\ K_h WH^2$
(c) $0.055\ K_h W.H^3$ (d) $0.055\ K_h W.H^2$
Where K_h is the coefficient of hydrodynamic pressure
W is the specific weight of water and
H is the height of the dam

Q.41 Hydrodynamic pressure due to earthquake acts at a height of
(a) $4H/3\pi$ from the base.
(b) $3H/2\pi$ from the base.
(c) $3H/4\pi$ from the base.
(d) $3H/4\pi$ below the water surface.

Q.42 The wave force on a gravity dam acts at a height of
(a) 3/8 h_w above the reservoir surface.
(b) 5/8 h_w above the reservoir surface.
(c) 3/4 h_w above the reservoir surface.
(d) 5/9 h_w above the reservoir surface.
(h_w is the height of wave)

Q.43 A coffer dam is
(a) a kind of gravity dam.
(b) an earthen dam of small height built to protect important areas like townships from floods.
(c) a temporary structure constructed to exclude water from the work area during construction.
(d) an embankment built along a river to regulate the river for navigation purposes.

Q.44 In a ski-jump bucket, the lip angle is 30° and the actual velocity of the flow entering the bucket is 30 m/s. The vertical distance of throw of the jet above the lip (in m) is
(a) 45.87 (b) 34.40
(c) 22.94 (d) 11.47

Q.45 Currently, the most commonly used form of vertical lift gates on a spillway crest is
(a) stoney gate.
(b) sliding gate.
(c) fixed wheel gate.
(d) tainter gate.

Q.46 The construction of step after the crest in case of Siphon spillways is done to achieve
(a) higher energy dissipation.
(b) better stability for the body of spillway.
(c) support for the main hood over the siphon.
(d) better priming of siphon.

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Answers Dams, Spillways, Energy Dissipation and Spillway Gates

1. (b)	2. (b)	3. (d)	4. (c)	5. (a)	6. (d)	7. (d)	8. (d)	9. (c)	10. (a)
11. (b)	12. (c)	13. (b)	14. (b)	15. (d)	16. (c)	17. (a)	18. (a)	19. (c)	20. (b)
21. (d)	22. (a)	23. (d)	24. (c)	25. (a)	26. (d)	27. (a)	28. (b)	29. (a)	30. (a)
31. (a)	32. (a)	33. (b)	34. (b)	35. (a)	36. (a)	37. (a)	38. (a)	39. (d)	40. (b)
41. (a)	42. (a)	43. (c)	44. (d)	45. (c)	46. (a)				

Explanations Dams, Spillways, Energy Dissipation and Spillway Gates

3. (d)
Idukki dam, height 169 m.

9. (c)
Effective unit weight is given by

$$w_e = \left(1 \pm \frac{\alpha_v}{g}\right)$$

so when $\alpha_v = 0.1\,g$ (downward)
effective unit weight

$$= w_e\left(1 - \frac{0.1g}{g}\right) = 0.9w_e$$

Net effective weight of Dam

$$= W - \frac{W}{g} \times \alpha_v$$

(at $\alpha_v = 0.1g$)

$$= W - 0.1\,W = 0.9\,W$$

15. (d)
Axis of dam is the line of crown on the upstream face of dam.

16. (c)
When uplift pressure is neglected, base width 'B' is given by larger of $\frac{H}{\sqrt{G}}$ and $\frac{H}{\mu G}$. When uplift pressure is considered base, width 'B' is given by larger of $\frac{H}{\sqrt{G-1}}$ and $\frac{H}{\mu(G-1)}$.

18. (a)
Limiting height of gravity dam is given by

$$H = \frac{f_c}{\gamma(G - C + 1)}$$

At full uplift condition, $C = 1$

$$\therefore \quad H = \frac{f_c}{\gamma(G - 1 + 1)} = \frac{f_c}{\gamma G}$$

22. (a)
The economical height of a dam is that height of dam, corresponding to which, the cost of the dam per unit of storage is the minimum.

23. (d)
Zoned embankments are usually provided with a central impervious core, covered by a comparatively pervious transition zone, which is finally surrounded by a much more pervious outer zone. Clay inspite of it being highly impervious, may not make the best case, if it shrinks and swells too much. Due to this reason, clay is mixed with fine sand or fine gravel so as to use it as the most suitable material for the central impervious core.

29. (a)

$$F > 32 \text{ km}$$

$$h_s = 0.032\sqrt{VF}$$

$$= 2.35 \text{ m}$$

38. (a)
In a saddle-siphon spillway, air vent pipe is provided to break the siphonic action at the level of full reservoir surface.

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