

SECTION - D

(17)

Spillway : \rightarrow Spillway is a waterway provided to dispose off surplus flood waters from a reservoir after it has been filled to its maximum capacity. Spillway acts as safety valve for a dam. The surplus flood water is taken to natural drain. A spillway may be located either within the body of dam or at one end of dam or entirely away from dam as an independent structure. It is necessary that spillway does not start discharging till the water reaches a predetermined level, called full reservoir level (F.R.L.).

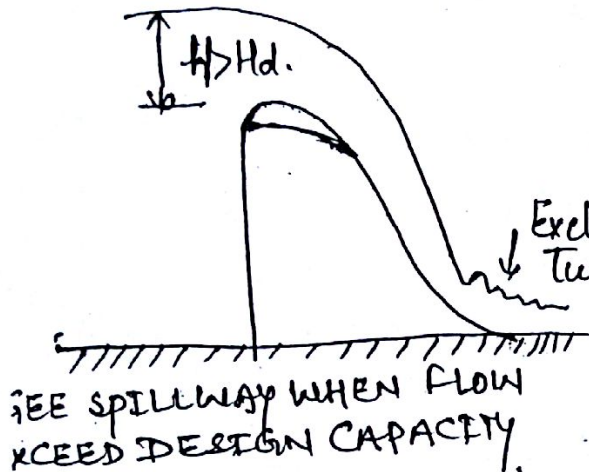
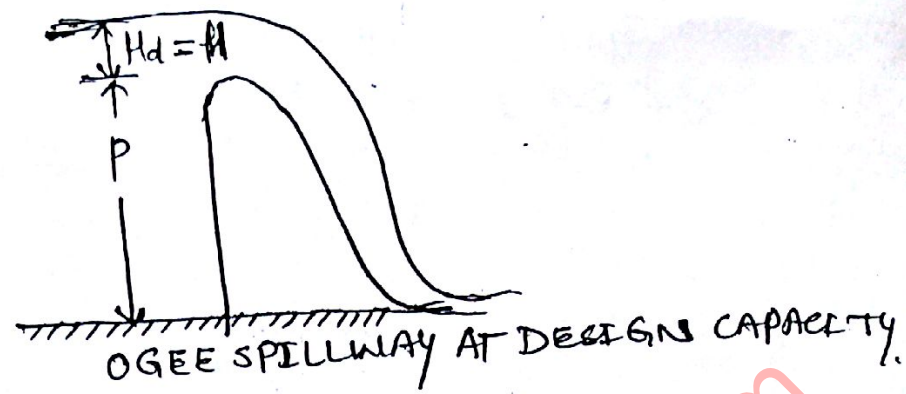
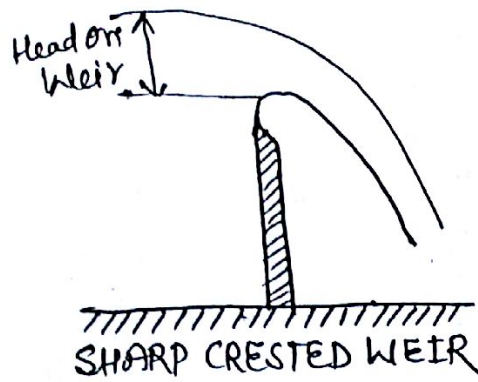
Component of Spillway : (A) Control Structure (B) Discharging Channel
(C) Energy Dissipator (D) Entrance and outlet Channel

Ogee Spillway : This is most common type of spillway provided usually on gravity dam, arch dam, buttress dam. The profile of spillway is ogee or 'S' shaped. In this spillway overflowing water is guided smoothly over the crest of spillway and is made to glide over the down face of spillway rather than straight drop spillway in which water flowing over crest drops as free jet away from the down face of spillway.

Crest Shapes for Ogee Spillway : The shape of the crest or upper curve of ogee spillway is ordinarily made to conform closely to the profile of lower surface of nappe (lower nappe) and discharging at a head equal to design head of spillway.

- 1) Nappe shaped profile for crest is ideal one, because discharge at design head the water flowing over the crest of spillway will remain in contact with surface of spillway as it glides over it and optimum discharge will occur [i.e. No pressure will be exerted on spillway] atmospheric pressure.
- 2) For discharge at head less than design head, the water flowing over the crest of spillway will remain in contact with surface of spillway. (i.e. Positive hydrostatic pressure will be exerted on spillway by flowing water)

For discharge at head greater than design head, the water flowing over the spillway tends to break contact with spillway surface and a zone of separation will be formed in which negative or suction pressure will be produced.



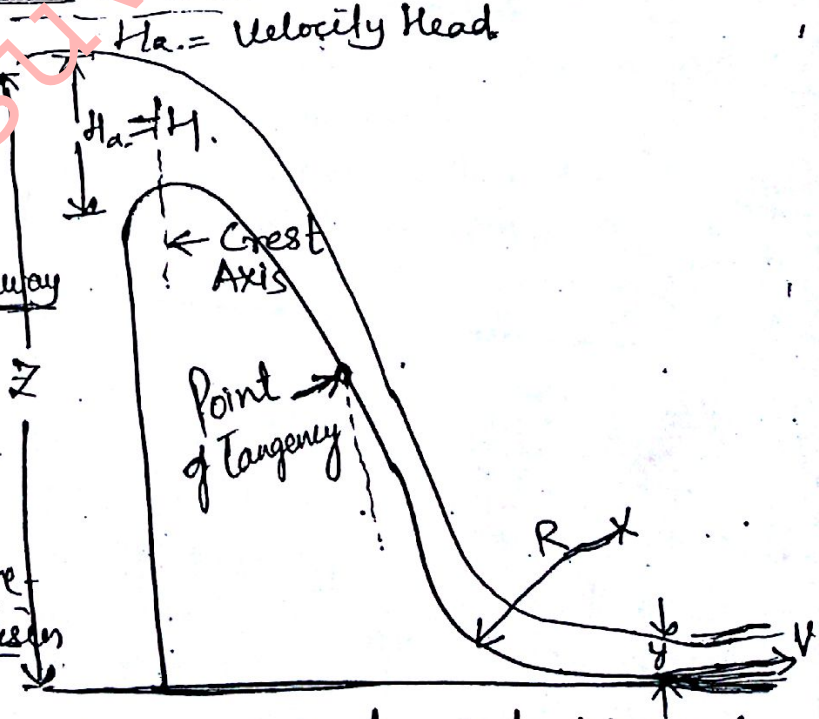
The shape of nappe shaped profile depends on.

- (i) Head
- (ii) Inclination of up face of spillway
- (iii) Height of spillway above streambed

DESIGN OF SPILLWAY CAPACITY

In ogee spillway the falling water is made to glide over the curved profile of spillway. A smooth gradual reverse curve on the up face of spillway is provided which turns flow from the approach stilling basin or in to spillway and on to the discharge channel.

The location of point of tangency depends on slope of straight portion of up face of spillway which in turn depends on stability requirements and on features of stilling basin at toe of spillway.



Z = Fall or vertical distance from up reservoir level to floor at the toe.

y = Depth of flow at toe, H = Head excluding head due to velocity approach.

H_a = Head due to velocity approach, V = Velocity of flow at toe of dam.

H_d = Design Head.

EP1 Head due to velocity approach (H_a)

$$H_a = \frac{V_a^2}{2g}$$

V_a = Velocity of Approach.
 g = Acceleration due to gravity

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EP2 Total Energy Head (H_e)

$$H_e = H + H_a.$$

H = Actual Head

H_a = Head due to velocity approach

EP3 Velocity of flow at Toe of spillway (V)

$$V = \sqrt{2g(Z + H_a - y)}$$

EP4 Radius of Bucket (R)

$$(V + 6.4H + 4.88) / 3.6H + 19.52$$

$$R = 10$$

EP5 Crest Profile for ~~Vertical~~ ^{Spillway} ups face

~~The ups profile should be tangential to vertical face and should have zero slope~~

Design Criteria for ^{Vertical} ups Crest Profile

The ups Profile should be tangential to the vertical face and should have zero slope at crest axis to ensure that there is no discontinuity.

$$y = \frac{0.724(x + 0.270H_d)^{1.85}}{H_d^{0.85}} + 0.126H_d - 0.4315H_d^{0.375}(x + 0.27H_d)^{0.61}$$

EP7 Crest Profile for inclined ups face

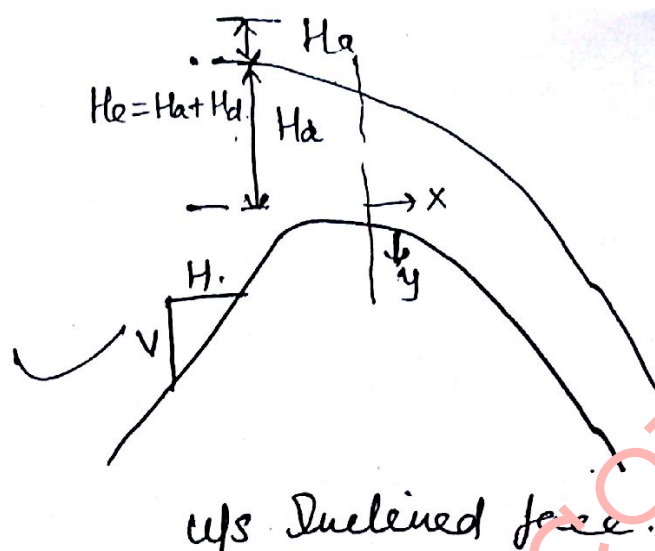
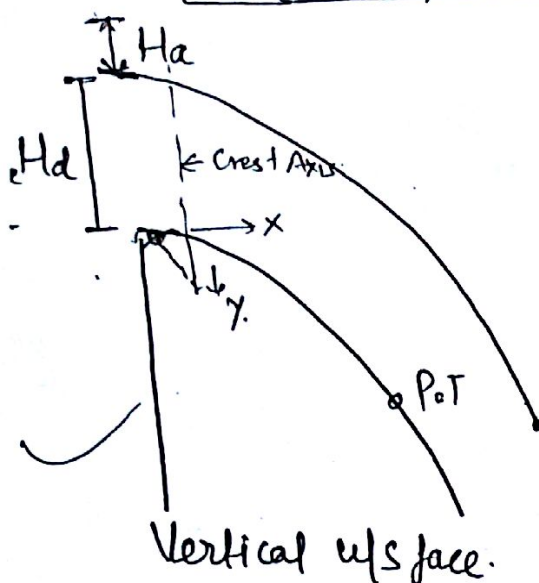
The shapes can be represented by

$$x^N = K H_d^{n-1} y$$

x, y = Co-ordinates of Crest profile measured from the apex of crest.

Slope	K	N
3V to 1H	2	1.850
3V to 2H	1.936	1.836
3V to 3H	1.852	1.780

$$X = 1.85 \sqrt{2 H_d} \quad \text{or} \quad 0.85 Y$$



STEP 6 DISCHARGE EQUATION:

(i) For Gated or Ungated Spillway at full gate opening

$$Q = C_d L_e H_e^{3/2}$$

L_e = Effective length of Crest

C_d = Cof of Discharge.

$$H_e = H + H_a$$

(ii) For Partial Gate Opening

$$Q = \frac{2}{3} C_d \sqrt{2g} L_e (H_1^{3/2} - H_2^{3/2})$$

g = Acceleration due to gravity

H_1, H_2 = Total Heads including head due to velocity approach

Coefficient of Discharge: It depend on following factors:

(a) Ratio of actual Head to design Head.

(b) Depth of Approach.

(c) Up face of Slope

(d) d/s approach interference

(e) d/s submergence.

STEP 7 EFFECTIVE LENGTH OF CREST OF OGEE SPILLWAY

$$L_e = L' - 2(NK_p + K_a) H_e$$

L' = Net length of Crest which is equal to sum of clear spans of gate bays b/w piers.

N = No. of piers.

K_a = Abutment Contraction Cof.

K_p = Pier Contraction Coefficient

or contraction coefficient (C_p). It depends on various factors.

- (i) Shape and location of pier nose.
- (ii) Thickness of pier
- (iii) Approach velocity
- (iv) Ratio of actual head to design head.

(3)

> STEP 8 Pressure On Ogee Spillway

- > When head of flow equal to design head, the pressure on spillway crest will equal to atmospheric pressure.
- 1) When head of flow is less than design head, then the pressure on crest will be above atmospheric pressure and will be positive hydrostatic pressure.
- > When head is more than design head, then pressure on crest will be less than atmospheric pressure which is negative or suction pressure.

DAMS

Dam \Rightarrow A dam is a barrier constructed across a river or natural stream to create a reservoir for impounding water from the river, or to retain debris flowing in the river along with water.

Classification of dams :

(1) Gravity Dam (2) Arch Dam (3) Buttress Dam.

Factor Governing Selection of Type of Dam \Rightarrow

- (1) Topography - Valley shape (2) Geology and Foundation Condition
- (i) Good Rocky foundation (ii) Gravel and coarse sand foundation
- (iii) Silt and fine sand foundation (iv) Clay foundation (v) Nonuniform foundation
- ✓ Spillway and size location.
- ✓ Environmental Consideration
- ✓ Earthquake Zone
- ✓ Cost
- ✓ General Consideration.

Selection of Site for a Dam \Rightarrow

Suitable foundation should be available at dam site. It is however possible to improve foundation condition by adopting appropriate foundation treatment.

For economy it is necessary that the length of dam should be small as possible and for a given height it should store large volume of water.

As far as possible the dam should be located on high ground as compared to river basin. This will reduce cost and facilitate drainage of dam.

A suitable site for the spillway should be available in the vicinity of dam.

From the stand point of economy the bulk of the material required for construction of a dam should be available near dam site.

Immediately on up side of dam site there should be a water-tight rim for the reservoirs formed by surrounding hill up to the proposed elevation of dam.

The value of property and land submerged in the reservoirs created by proposed dam should be as low as possible.

Dam site should be connected by rail, road so that it is easily accessible.

- In the near vicinity of dam there should be ample space with healthy environment must be available for establishing colonies for labour and other staff members associated with construction of dam.
- 1) The dam site should be such that it involves minimum overall cost of construction as well as minimum cost of maintenance.

Gravity Dam : A gravity dam is a solid masonry or concrete structure with its cross section approx. triangular in shape, so proportioned that the external force exerted on it are resisted by its own weight.

Since all the forces acting on a gravity dam including its self wt. are transmitted to the foundation, a sound rock foundation is essential requirement for the construction of gravity dam.

A gravity dam derives its stability from the force of gravity of the material in its section. The dead wt. of the body of the dam and manner of its distribution in the section is such so as to withstand the force of water impounded.

* Forces Acting on Dam :

- ① Water Pressure
- ② Wt. of Dam
- ③ Uplift Pressure
- ④ Seismic force
- ⑤ Self Pressure
- ⑥ Wave Pressure
- ⑦ Ice Pressure
- ⑧ Wind Pressure

