DESIGN AND ESTIMATION OF STILLING BASIN WITH DROPS AT MANIMUKTHA DAM

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ABSTRACT

Energy dissipation is the dissipation kinetic energy generated at base of a spillway. When the upstream water is directed to dam downstream, a hydraulic energy flow is created. High velocities occur in the hydraulic energy flow. These high velocities create high pressure and friction forces that cause erosion and scouring in the downstream. As a result, structures could collapse or serious damages could occur. Structures that dissipate the energy levels are high in especially spillways, planning energy dissipators requires great caution and knowledge. When hydraulic energy is dissipated, certain disruptions occur in the flow. The disruptions could cause resonance, erosion, wearing of the surfaces and cavitations. Because of these factors, energy dissipator structures are built. The horizontal apron type of stilling basin energy dissipators are adopted in this project. In order to prevent scouring that occurs when high velocity water enters the downstream of the dam. Manimuktha dam is a small village in Kallakurichi block in Villupuram district of TN, India. The dam is in Agrakottalam at Kallakurichi. The stilling basin is provided at the spillway of the dam. The stilling basins with the drops are given in this project. The project is about designing and estimation of stilling basin with drops at Manimuktha Dam. The Plan and Elevation is drawn by using AUTOCAD. The design of stilling basin is done by using IS4997:1968 and the estimation was given at this report.

INTRODUCTION

The water flowing in dam spillway has a high level of energy. Since this energy creates a high velocity flow in the downstream, it could cause damages such as cavitations and scouring in the riverbed. Thus, it should be dissipated between the spillway and downstream riverbed. Energy dissipation is usually ensured by stilling basins that dissipate energy with hydraulic jump, roller buckets, ejection and energy dissipator.

Dissipation of the kinetic energy formed at spillway bed is important for the stability of the river structure at the downstream. Energy dissipation structures are not significant only for prevention of erosion on the riverbed, but also for dam elements such as dam embankment, sluice outlet and spillway structure. The damage that could be caused by high velocity flow with turbulence is prevented by energy dissipating structures. The most important safety elements of the dams are spillways and energy dissipation structures.

The overflows that could happen at dam upstream are required to be channeled to the dam downstream safely before they could create any damage. To prevent the scouring that could occur in dam downstream due to created energy, the most adequate type should be selected. The types of energy dissipation structures depend on the velocity of the water at spillway toe, Froude number, type of the dam, type of the spillway and geological properties of the downstream. While the upstream water is directed to dam downstream, a hydraulic energy flow is created. High velocities occur in the hydraulic energy flow. These high velocities create high pressure and friction forces that cause erosion and scouring in the downstream. Structures that dissipate the energy levels are high in especially spillways, planning energy dissipator requires great caution and knowledge. When hydraulic energy is dissipated, certain disruptions occur in the flow. The disruptions could cause resonance, erosion, wearing of the surfaces and cavitations. Because of these factors, energy dissipator structures are built.

ENERGY DISSIPATORS

When spillway flows fall from reservoir pool level to downstream river level, a large part of static head is converted into kinetic energy. This energy manifests itself in the form of high velocities which if impeded, results in large pressures. On the other hand, if the high energy of flow is not dissipated, serious erosion to stream bed and damage to hydraulic structures may be caused. The device used to protect the river or tail channel and the hydraulic structures on downstream, is called as energy dissipator.

The function of energy dissipator is to absorb high energy of spillway flows and discharge these flows to the downstream water course, without causing serious scour or erosion of the toe of the dam or spillway or damage to adjacent structures. In hydraulic engineering numerous devices like stilling basins, baffled aprons & vortex shafts are known under the collective term of energy dissipator. Their purpose is to dissipate hydraulic energy. Dissipators are used to dissipate hydraulic energy which may cause damages like erosion of tail water channels, abrasion of hydraulic structures, generation of tail water waves, or scouring.

ENERGY DISSIPATORS TYPES

a) Hydraulic jump type stilling basins

1) Horizontal apron type
2) Sloping apron type

b) Jet diffusion and free jet stilling basins

1) Jet diffusion basins
2) Free jet stilling basins
3) Hump stilling basins
4) Impact stilling basins

c) Bucket type dissipator

1) Solid and slotted roller buckets
2) Trajectory buckets (ski jump, flip, etc)

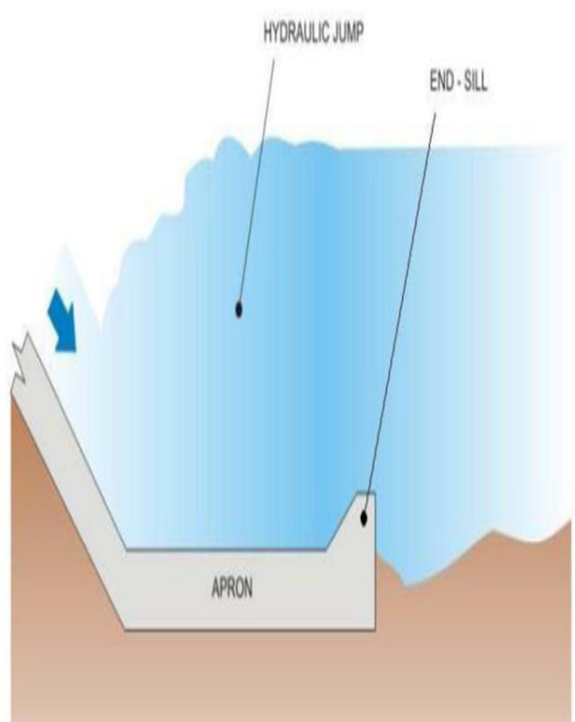
d) Interacting jets and other special type of stilling basins.

In India, hydraulic jump type stilling basins and bucket type energy dissipator are generally used for dissipation of energy depending on condition of downstream tail water.

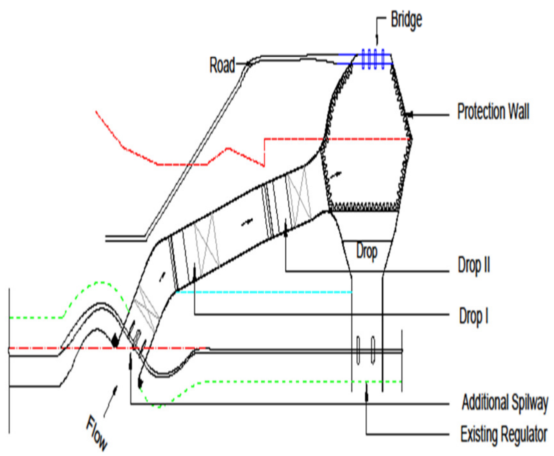
HYDRAULIC JUMP TYPE STILLING BASIN

Stilling basins are used to dissipate the energy of water exiting the spillway of a dam. Their purpose is to prevent scouring that occurs when high-velocity water enters the downstream reach of the dam. This scouring can damage the foundation of the dam, leading to overtopping, and also causes severe erosion downstream. The primary method of dissipating energy is to generate a hydraulic jump to transition flow from supercritical to subcritical.

HORIZONTAL APRON TYPE



PLAN FOR STILLING BASIN AND DROPS



LOCATION OF MANIMUKTHA DAM

Manimuktha dam comes under Madhavacherri Panchayath. It is located 71 KM towards west from District head quarters Villupuram. 236KM from state capital Chennai.

Manimuktha-dam is surrounded by Chinnasalem Block towards South, Thiyagadurugam Block towards East, Sangarapuram Block towards North and Rishivandhiam Block towards North.

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DETAILS OF MANIMUKTHA DAM

ATTRIBUTE	VALUE
Name of the Dam	Manimukthanadhi Dam
River	Manimuktha
Nearest city	Kallakurichi
District	Villupuram
Basin	East flowing rivers between penner and kanyakumari
Purpose of the Dam	Flood control, Irrigation
Year of Completion	1970
Type	Medium
Type of Dam	Earthen
Length of Dam	3618m
Max height above foundation	21m
Total volume content of Dam	497 TCM
Design Flood	926.06cumec
Culturable Command Area(CCA)	1.62 (th ha)
Additional spillway capacity	957 cumec
Existing spillway capacity	1220 cumec

DESIGN OF STILLING BASIN WITH DROPS

GIVEN DATA

Discharge	Q	=	957 m^3/s
Velocity	V	=	17 m/s
Breadth	b	=	50 m

SOLUTION

Discharge Intensity,q = Q/b

q = 19.14 m^2/s

Critical depth , y_c = 3.342m

STEP 1

Assume, D_0 = 2.5m

D_1 = 4.35m

Energy loss H_L = $(D_{1/}D_0)^3/4D_1D_0$

H_L = 0.14m

Froude no F_0 = $V_o/(\sqrt{gd})$

F_0 = 3.43

According to IS4997-1968,

Lj/D_1 = 5.2

Lj = 22.62m

STEP-2

D_1/D_0 = $\frac{1}{2}(\sqrt{(1+8F_0^2)}-1)$

= 4.37

From IS4997-1968 fig 4,K=1

From IS4997-1968 fig 5,

D_1'/D_0 = 2

D_1' = 5m

From IS4997-1968 fig 8A,

L_b/D_1 = 4

= 17.25m

h_s = $0.2xD_1$

hs = 0.9m

s = $0.15xD_1$

s = 0.65m

w = $0.35xD_1$

w = 1.5m

Provide 8 rows of concrete blocks of size1.5x1.5x0.9m with the spacing of 65mm.

CONCLUSION

- The stilling basin of the Manimuktha dam has designed and estimation are given in this report.
- The stilling basin is provided to avoid erosion of the structure.
- In order to control the high scouring velocity in a dam and to dissipate its energy the stilling basin with drops has been developed in the Manimuktha dam.
- The velocity from the stilling basin is greatly reduced.
- The drops are provided to dissipate the energy gradually.
- The horizontal stilling basin with the drops are provided to dissipate the energy from the toe of the spillway to avoid the damaging the overall structure.
- The planning, longitudinal cross section, elevation and half plan at top and bottom of Stilling basin, Drop-1 and Drop-2 are given in this report.

- The designing of the structures like Stilling basin, Drop-1 and Drop-2 are carried out by the references of IS4997-1968. In these designing Froude number, velocity of water, Energy loss, length of jump and length of basin are considered as most essential.
- Stilling basin is used to dissipate energy of water and velocity of water. Velocity of water is reduced in drop structures compared to stilling basin. So we had provided stilling basin with drops in the dam. Designing of concrete blocks are also carried out.
- The estimation of the structures like Stilling basin, Drop-1 and Drop-2 are given in this report. The total amount of the estimated quantity is Rs.42561927, adding 5% for extra contingencies and work charged is Rs.2128096. The total amount is Rs.44690023.

REFERENCES

- Garg, S.K. "Irrigation Engineering and Hydraulic Structures", Khana publishers, Delhi.
- IIT Kharagpur module of hydraulic structures for flow division and storage. The national programme on technology enhanced learning (NPTEL).
- IS4997:1968- Criteria for design of hydraulic jump type stilling basins with horizontal and sloping apron.
- IS7365:2010- Criteria for Hydraulic Design of Bucket Type Energy Dissipators.
- Overview of Energy Dissipators and Stilling Basins with Design Aspects of Hydraulic Jump by Sumanta das and Malini Roy Choudhury, Assistant professor of Gujarat Technological University.
- "Applied Hydraulics Engineering" by Dr.G.K.Vijayaragavan and N.Aravind.
- "Design of Reinforced Concrete Elements" by Dr.P.Purushothama Raj.
- "Standard schedule of rates" by Government of TamilNadu Public work department.