Parametric Studies on Design of Components for Retaining Wall for Irrigation Barrage

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Abstract

This paper provides a case study of various types of retaining structures behaviour under seismic condition and effect of earth pressure on their stability. In order to improve the stability of the structure it is necessary to study the effect of various loadings in details. Mostly the failure occurs during the application of loads like self weight, weight of backfill, earth pressure, and water pressure including hydrodynamic pressure .Due to this effects there is a need to understand the behaviour of retaining structures and check their stability as per IS 6512:1984.And hence the stability calculations by considering various parameters are carried out. The stresses at the foundation level are also checked as per IS 12720:2004.In this paper mainly the stability analysis of Divide wall and Guide wall are done.

Keywords: *Retaining structure, seismic effect, stability, earth pressure, Dividewall, Guide wall*

I. INTRODUCTION

The project Kanhan barrage is in progress and situated 8 km away from M.P. border near village Khapa. The storage capacity of reservoir is 76.06 thousand meter cube and command area is 3960 hectare. From this project thousand meter cube water is kept reserved for drinking water purpose for Nagpur city. Also it provides 1500 thousand meter cube water to Koradi thermal power station district Nagpur. Constructions of this barrage have been done up-to 60%.But the remaining construction has been stopped due to the soil problem. The wall on the right hand side is constructed because the favourable soil strata are obtained but on the left hand side the work has been stopped because of the soil strata. The soil condition is not favourable to sustain the pressure of the wall, therefore there is need to understand the load bearing capacity of soil and accordingly design the structure.

Retaining structures are very huge structures. And their construction cost is very large. Since it is high economy structure, it is necessary to construct such structures in proper manner. So As to improve their serviceability and stability to sustained the various pressures. To improve the stability of structures there is a need to understand the effect various forces on it. Forces due to earth pressure, water pressure, earthquake, uplift, backfill and self weight of the structure. The main aim of this project is to study the project in details soil condition and according to them design the guide wall for the Kochhi barrage and to understand the behaviour of retaining structures for the worst loading condition and according to that analyse and design the retaining structure.

A. Objective of this Paper:

1. To study the design methodology and parameters in design of divide wall and guide wall
2. To study the various standards and specifications in the design of divide wall and guide wall
3. To design divide wall and guide wall with alternative approach
4. To design the components and foundation with the reference to precaution for the settlement.

B. What is Divide Wall and Guide Wall:

This walls areconstructed usually at right angles to the axis of the barrage or weir generally extending beyond the main structure to separate the under sluices, river sluices and spillways into independent units for facilitating regulation. In order to prevent internal erosion at the junction of earth work and masonry structure, it is necessary to increase the length of contact between earth and masonry, such that there is sufficient head loss to reduce exit velocity and pressure, and to prevent movement of earth material at contact surface.

The stability analysis of divide wall and guide wall section at the deepest foundation level is to be carried out by using IS 6512:1984 and IS

12720:2002.seismic analysis is to be carried out as per IS 1894:1984.The controlled levels and various parameters for the design are mentioned below.

II. WORK CARRIED OUT

Table 1 Various Parameters Considered for the Analysis and Design:

Sr No.	Description	Divide wall	Guide wall
1	Deepest foundation level	R.L.288.00m	R.L.286.225m
2	Top level	R.L.322.50m	R.L.317.50m
3	Top width	1.5m	1.5m
4	Water side slope	Vertical	Vertical
5	Backfill side slope	1H:1V	075H:1V
6	Unit wt. of concrete	24 KN/m³	24 KN/m³
7	Unit wt. of water	10 KN/m³	10 KN/m³
8	Unit wt. of saturated soil	20 KN/m³	20 KN/m³
9	Uplift intensity	100%	100%
10	Angle of internal friction of earthwork	0.177 radians	0.177 radians
11	Seismic Zone	3	3
12	Average river bed level	R.L.300.50m	R.L.300.50m
13	Full reservoir level	R.L.316.00m	R.L.316.00m
14	Grade of concrete	M15	M15
15	Grade of steel	Fe415	Fe415

A. As per I S 6512:1984 following forces are considered for the stability analysis:

- Dead load
- Water pressure including hydrodynamic pressure
- Earthquake forces
- Uplift forces
- Earth pressure

1) ***Dead Load:***

The dead load consists of weight of concrete plus weight of the backfill. For the design the unit weight of concrete may be taken as 24 KN/m³. The unit weight of backfill is according with the type of backfill. In this case saturated backfill is provided and its unit weight is 20 KN/m³.and unit weight of water is taken as 10 KN/m³.

2) ***Water Pressure Including Hydrodynamic Force:***

The intensity of water pressure varies directly with the depth and this pressure calculated as $p = \gamma w\ h$

3) ***Hydrodynamic Effect:***

This effect occurs due to the horizontal acceleration of the foundation in the opposite direction of earthquake acceleration and calculated as per I S 1893:1984.

4) ***Earthquake Force :***

As the barrage lies in seismic zone 3.So as per I.S.1893:1984 basic seismic coefficient α0 for Zone 3 considered is 0.04-importance factor 1 is considered for the walls.

5) ***Uplift Pressure:***

Uplift pressure varies uniformly along the base and it act over the 100% of the base area. Here it is assumed that uplift pressure not be affected by an earthquake. Uplift pressure occurs as internal pressures in pores, cracks and seams within the body of the dam, at the contact between the wall and its foundation.

6) ***Earth Pressure:***

The lateral earth pressure exerted on the wall should be calculated considering their effect on wall that is whether it is active or passive as per I S 1893:1984.

B. Stability Criteria for Divide Wall and Guide Wall:

The divide wall should be designed to withstand the overturning moments for the following loading conditions:

Combination1: Dam completed but no water in reservoir and no tail water.

Combination 2:Reservoir at full reservoir level with 100% uplift.

Combination 3:Combination 1 with earthquake.

Combination 4: Combination 2 with earthquake.

It is observed that the loading combination 3 that is Self-weight plus Backfill is the worst combination for the structure. Stresses developed for this condition are maximum. The compressive as well as tensile stresses are developed at the foundation and this stresses are within the permissible limit.

Permissible limits for the stresses are calculated as per I.S.6512-1984.

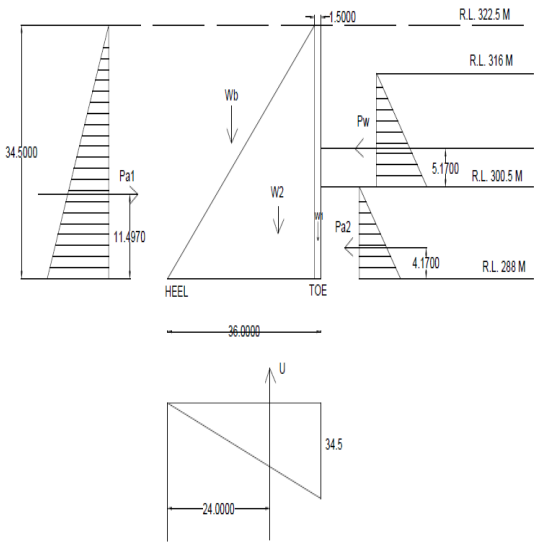
For the stability of the structure the wall must be safe against overturning moment and the factor of safety against overturning is calculated as the ratio of righting moment to the overturning moments and it should be less than 1.5. And it is also safe against sliding; generally the walls are failing in sliding at its base .and it is calculated as the ratio of actual coefficient of static friction μ on the horizontal joint to the sliding friction. And it should be greater than the values given in I.S.1893-1984.

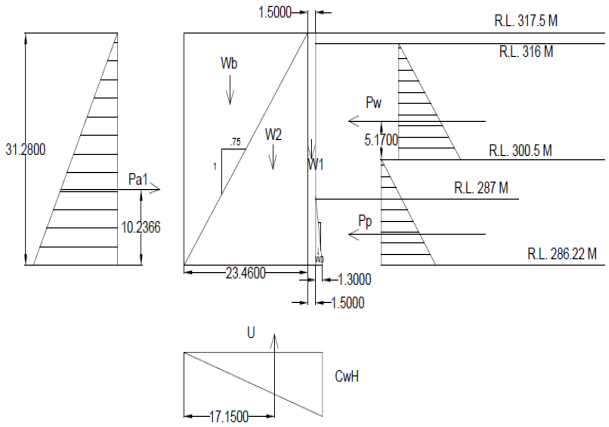
For an economical design the shear strength of joint should be considered. And the factor of safety in this condition known as shear friction factor and it is calculated as

S.F.F. = μΣV +(b.c)/ΣH

Table 2. Values for factor of safety:

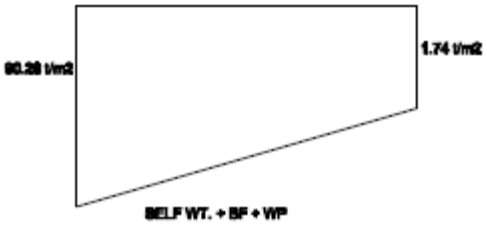
C. Pressure Distribution Diagram:

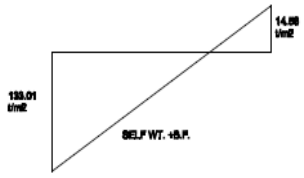




III. RESULTS

A. Nominal Stresses Developed at the Foundation for Various Loading Conditions are shown below Respectively:





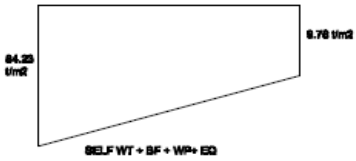


Table No.1 Values for Factor of Saftey:

Sr. No.	Load Combination	Factor of Saftey Against Sliding	Factor of Saftey Against Overturning	Shear Friction Factor
1	Self Weight +Backfill	2	1.5	4
2	Self Weight +Backfill +Earthquake	1.5	1.5	3
3	Self Weight +Backfill+ Water Pressure	2	1.5	4
4	Self Weight +Backfill+ Water Pressure+Earthquake	1.5	1.5	3

3.2 The divide walls are proposed in C.C. M-15 grade plume concrete. Temperature and surface reinforcement of steel 16ø at 240 mm c/c both ways on exposed faces is proposed. Stability analysis of divide wall section at the deepest foundation levels has been carried out as per IS 6512-1984. 3.3 The guide wall is proposed in C.C. M-15 concrete temperature and surface reinforcement of tor steel 16ø at 240 c/c both ways on exposed faces is proposed.

Table No.3 the Resulting Stresses at Foundation Level for Various Load Combinations:

Sr.No.	Load Combination	Actual Stresses At Foundation Level In T/M²	
		Heel	Toe
1	Self-Wt.+Backfill	141.02	5.149
2	Self-Wt.+Backfill+E.Q.	156.05	-28.38
3	Self-Wt. +Backfill+W.P.	96.090	22.087
4	Self Wt.+Backfill+W.P.+E.Q.	87.621	30.555

Table No.4 the Resulting Stresses at Foundation Level for Various Load Combinations:

Sr.No.	Load Combination	Actual Stresses At Foundation Level In T/M²	
		Heel	Toe
1	Self-Wt.+Backfill	133.01	-14.35
2	Self-Wt.+Backfill+E.Q.	139.92	-25.00
3	Self-Wt. +Backfill+W.P.	90.28	1.74
4	Self Wt.+Backfill+W.P. +E.Q.	82.23	9.78

Table no. 5 Permissible values of stresses:

Sr. No.	Load Combination	Permissible Stresses In T/M²	
		Tensile	Compressive
1	Self-Wt.+Backfill	0.00	300
2	Self-Wt.+Backfill+E.Q.	30.0	300
3	Self-Wt. +Backfill+W.P.	0.00	300
4	Self Wt.+Backfill+W.P.+ E.Q.	30.0	300

+Ve Sign Indicates Compression
-Ve Sign Indicates Tension

IV. OBSERVATIONS & CONCLUSIONS

- Divide wall and guide wall are safe against sliding on any plane or combination of planes with the walls at the foundation.
- Divide wall and guide wall are safe against overturning.
- The safe unit stresses in the concrete of the walls or in the foundation material not exceeded.
- The design is carried out as per provisions in relevant I.S. codes and is safe.
- Maximum pressure should not exceed the safe bearing capacity of the soil.

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