International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 08 | Aug 2021 www.irjet.net p-ISSN: 2395-0072

A Novel Technique for Seepage Control through the Permeable Foundation of Dharia Dam

Akash.V. Nimbalkar[1], Vivek.P. Kapadia [2], Mayur Baria[3]

[1]Deputy Executive Engineer(Civil), Water Resources Department ,Govt. of Gujarat, India
[2]Director (Civil Works), Sardar Sarovar Narmada Nigam Ltd, Govt. of Gujarat, India
[3]Assistant Engineer(Civil), Water Resources Department, Govt. of Gujarat, India

---***---

Abstract - *Steady state seepage has always been difficult to deal with especially for placing foundations.Also it has been observed that placing concrete underwater requires more stringent quality control as compared to conventional concrete placement .However; many techniques are available in the market such as anti-washout concrete, tremie concreting,concreting with viscosity modifier and ,grouting which can aid in controlling seepage and executing underwater constructions .But the cost economics of the project ,contractor's skills ,site situations are the major factors for applying any technique for seepage control. The objective of this paper is to provide a cost effective as well as contractor friendly solution by using rubbles, sand ,quarry spall and cement which were used in a predecided proportion to stop the seeping water and place foundation of the transition wall .After successful deployment of the solution not only the construction of the foundation was made feasible but also saved a huge amount .After adopting the solution on field, the seepage below the founding level was modelled using a finite element model in Plaxis which clearly suggested that an economical solution wa necessary for the situation.*

Key Words: Transition Wall, Steady State Seepage, Piezometric Head, Plain cement concrete ,Plaxis ,confined aquifer.

1.INTRODUCTION

Dharia Irrigation Scheme is situated about 28 Kilometers from Halol taluka of Panchmahals in Gujarat state of India.This scheme caters the needs of almost all tribal farmers in the area since 45 years The major components of the scheme includes a 2 Km long Earthen Embankment, 30 m wide ungated Spillway a transition wall separating the earthen levee and the spillway , a Head regulator with two vertical lift gates(auxillary and main) and a 6 km long main canal network. However, it was oserved that the transition wall which separated the spillway and the earthen embankment was showing the signs of severe distress and about 37 m part collasped completely . This warranted the construction of a new 37 m long portion of the transition wall using Plain cement concrete of M10 grade.

Figure 1 Spillway functioning in Monsoon

Figure 2 Collasped part of the Transition wall

1.1 Problem during Construction and the motivation for finding a viable solution

After the collapse of the transition wall , the estimates were prepared and duely submitted to the Government for the Administrative approval . Almost after a hefty period of about nine months since the wall shattered , the project was passed for the construction of 8.2 m high transition wall from the foundation level that was fixed at 1.5 m from the average ground level. M 10 grade equivalent to 1;3;6 proportions were planned without any basal or temperature steel.The main reason for not using any steel was the Gravity type design of the wall . The debris were removed surrounding the area to be excavated . After that the excavation was done up to 2 meters where the groundwater table was envisaged. Owning to the water table at such a shallow depth ,it was decided to do dewatering so as to make the area reasonably water tight . However, post dewatering it was observed that after complete removal of the water from the area under excavation was completely water logged within 15 minutes of dewatering .Although the seepage was not very high,but the pressure was responsible for such a abrupt rise in the water table . High pressure seepage , political intervention and the contractor's failure to complete the foundation work in time were the impetus for finding a viable technique

Figure 3 Knee height water after 15 minutes of dewatering

1.2 Solution Formulated

(a) 2 Layers of 15-30 cm thick Rubbles

(b) 2 Layers of 0.1 m thick 1;4:8 ordinary plain cement Concrete

(c) Quarry spall (fine graded) 15 tonnes to plug the voids.

After exavating 2 meters below the average ground level , muck that came along with the seepage was quickly removed after operating the pump so as to lower the water table .Keeping in mind the time lapse of 15 minutes ,rubbles in 2 layers were quickly dumped manually followed by removal of the muck coming. After placement of the rubbles quarry spall was dumped on the rubble layers so as to plug the voids between the rubbles. Finally 2 layers of a lean 1:4:8 ordinary concrete was done to make a levelled base for the construction of the transition wall.

Figure 4 Removal of the muck after initial dewatering

Figure 5 Dumping of rubbles manually

Figure 6 Quarry spall along with lean concreting layer

2. Finite Element Modelling Using Plaxis

A fifteen noded constant strain triangular element was used to model the soil beneath the permeable foundation .The problem was modelled based on certain assuptions. Based on the sub surface exploration carried on the site ,a 4.5 meter thick clayey sand exists below with was the rock mass up 10 meter.

Assumptions:

1. Soil is Homogeous and isotropic .
2. Existing soil is semi infinite elastic deformable medium.
3. Fow through the clayey sand is mdelled as "flow in a confined aquifer " sandwitched between the overburden of remaining portion of the transition wall and the rock layer existing beneath .
4. Footing is modelled as a Kirchoff thin plate.So all assumptions of Kirchoff plate holds true . The plate is subjected to a tranverse pressure arising from the self weight of the transition wall.
5. Mohr coulomb Model is considered for the clayey sand
6. Bernoulli theorem and continuity equation holds true for the flow

Input Parameters of **Clayey Sand** and **Footing**

γ_{unsat} [kN/m^3]: 15.79
γ_{sat} [kN/m^3]: 21.97
k_x [m/day]:0.475
k_y [m/day]:0.475
ν (poisson's ratio): 0.300
c_{ref} [kN/m^2]: 4.91
φ [°] : 17.00
Flexural Rigidity of the plate: 9.487E+04 KNm^2 /m
Equivalent thickness:0.759 m

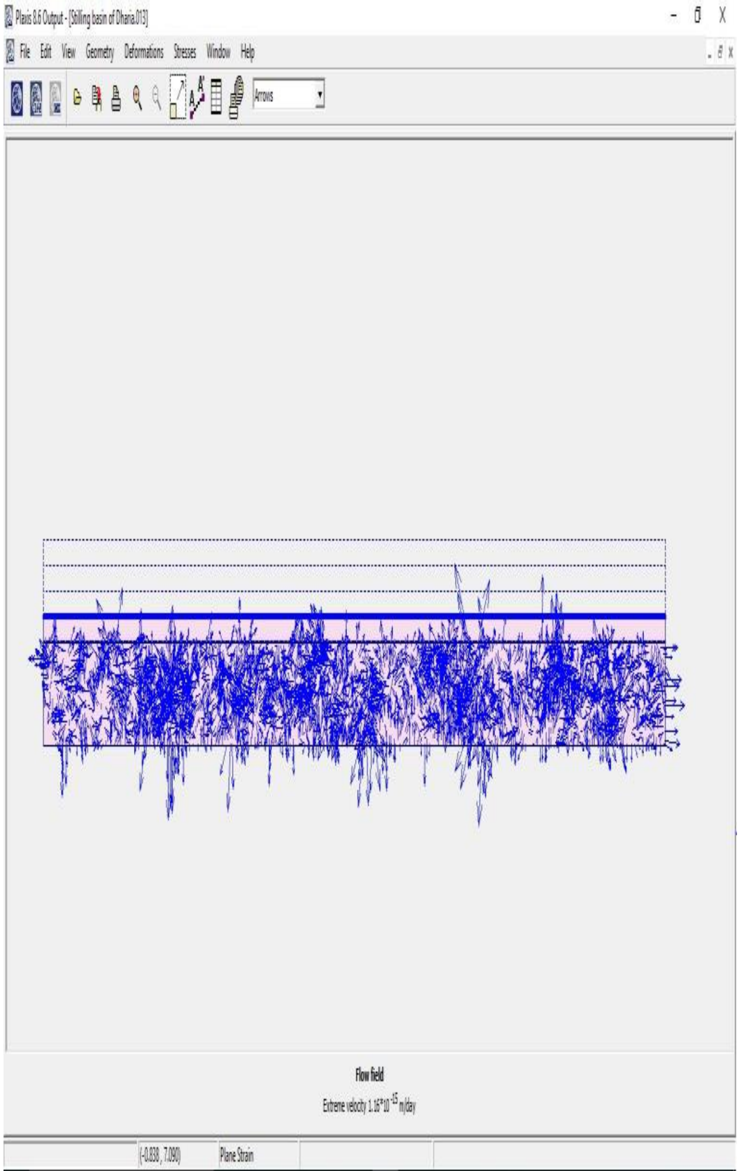

Figure 7 Model showing water rising upwards after excavation

2.1 Output Parameters and discussion on results:

Extreme effective stress after excavation	**895.59 KN/m^2**
Pore water Pressure	**19.79 KN/m^2**
Flow velocity	**1.16*10^{-15} m/day**

The FEM model clearly elicited the characteristics of confined aqufer and the associated steady state seepage near the excavation area. Initially before excavation the piezometric head was well below the foundaton level. Figure 7 gives the idea of the FEM model after reaching the final excavation depth .As the overburden on the confined aquifer was reduced by excavation which was related to puncturing of the aquifer made of permeable clayey sand ,there was a sudden increase in the piezometric head and perhaps the water rose to nearby foundation level . Though the seepage velocity being low ,but the pressure increased so as to maintain the Bernoulli Energy principle. Usage of 2 layers of 15 to 30 cm thick rubbles and 10 cm thick ,2 layers of plain cement concrete (1:4:8) on site helped in the counteracting the pressure of the seeping water. While the usage of the quarry spall resulted in pluging the voids between the rubbles

REFERENCES

[1] Soil Mechanics in Engineering Practise,3rd Edition by Karl Terzaghi,Ralph B Peck and Gholamreza Mesri , Wiley Publication,1996.

[2] Ground Water Hydrology by David Keith Todd,Larry W Mays ,Wiley Publication,August 2004

[3] Basic and applied soil mechanics by Gopal Ranjan and A.S.R Rao by New Age International Publishers ,2005

3. CONCLUSIONS

Working under waters have always been a challenge for civil Engineers . Detailed subsurface exploration needs to be carried out when works are to be carried out near Dam sites. Reservoirs are a potential source for recharge of underlying aquifers. Proper construction techniques should be planned while executing any construction activity within the confined aquifer zone. Slightest reduction in the confinement can cause a low velocity high pressure flow rising towards the foundating level. However; using locally available materials such as Rubbles, quarry spall and lean cement concrete can counteract the high pressure due to its own weight.