

Assessing the Accuracy of SEEP/W Simulations for Seepage Analysis in Earthen Dams

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ABSTRACT

The present research work is designed to compare the seepage of earthen dam using finite element based software GEOSTUDIO subproduct SEEP/W with field observed seepage through earthen dam. GEOSTUDIO software is capable to perform analysis such as, stress-strain, seepage, slope stability, dynamic analysis. SEEP/W, a subproduct of GEOSTUDIO is a finite element software which can simulate the movement and pore-water pressure distribution within porous materials like soil and rock. In present work the seepage of water through earthen portion of Ujjani dam, an earthfill cum masonry dam in Maharashtra is computed and phreatic line is simulated for single chainage. The observed actual field results of seepage are compared with results obtained by GEOSTUDIO software sub product SEEP/W.

KEYWORDS: *seepage, numerical simulation, Finite element Method, groundwater, SEEP/W, earthen dam*

INTRODUCTION

Any dam failure or accident to dam can cause potential hazard to property and lives of millions of people who dwell downstream of the dam. The life of a dam can be threatened by natural phenomena such as floods, rock slides, earthquake and deterioration of the foundation and construction materials. The records of failures of dams indicate that earth fill have involved in the largest number of failures followed by gravity dams, rock fills and multiple and single arches. Each type of dam has its own characteristic mode of failure. A gravity dam may collapse only in the section which is over stressed. A buttress dam may fail like a pack of cards through the successive collapse of its buttresses. The rupture of an arch may be sudden and complete. Failure of an embankment may be relatively slow with erosion progressing laterally and downward and accelerating as the flood tears through the breach. The dams are national property constructed for the development of national economy and in which large investments and other resources are deployed. The safety of the dams is very important aspect for safeguarding the national investment and the benefits derived by the nation from the project. In present study, seepage analysis of Ujjani dam, an earthfill cum masonry dam in Solapur district, Maharashtra has been performed using element based software "GEOSTUDIO". The sub product of GEOSTUDIO ie. SEEP/W has been used for seepage analysis through earthen dam portion of dam.

MATERIALS AND METHODS

Ujjani dam is built on the Bhima River. Bhima is a tributary of the Krishna River. It originates in Bhimashankar of the Western Ghats and forms the Bhima Valley with its tributary located near Ujjani village of Madha Taluka in Solapur district of the state of Maharashtra. Ujjani dam is an earthfill cum Masonry gravity dam. About twenty-two dams built on Bhima river of which the Ujjani Dam is the terminal dam on the river. It is the largest in the valley that intercepts a catchment area of 14,858 km² (which includes a free catchment of 9,766 km²). In present study earthen crosssection of dam at CH.1950 is selected for seepage modeling using SEEP/W.

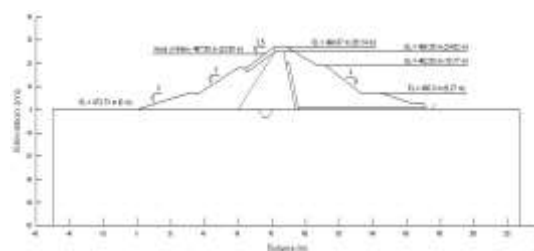


Fig 1 : Crosssection Of Ujjani Dam At CH :1950

SEEP/W Software

A numerical model is nothing but mathematical simulation of a real physical process. SEEP/W is a numerical model that can mathematically simulate the real physical process of water flowing through a particulate medium. SEEP/W is sub product of GEOSTUDIO software. It is finite element based software. finite element analysis consist of three main parts : 1) creating the numerical domain, including the selection of an appropriate geometry and creating the discretized mesh, 2) specification of material properties to the various sub-regions of the domain, 3) specification of the appropriate boundary conditions. 4) comparisons of field data and simulated seepage 5) model validation and calibration. In present research work a computer model has been developed for

Ujjani dam at different reservoir level ranging from FRL to LWL using above steps of SEEP/W modeling. The table I shows the actual field values of seepage and simulated one for different reservoir levels of dam.

RESULTS

Calibration of Material Properties

For calibration of material properties for the earthen section of the Ujjani dam, initially identical guess values were specified for all the sections. These guess values for different types of materials used in the dam are presented below in Table 1. Calibration of the material properties is made on the basis of minimization of error while comparing observed discharge with the simulated one.

Table 2. Material Properties

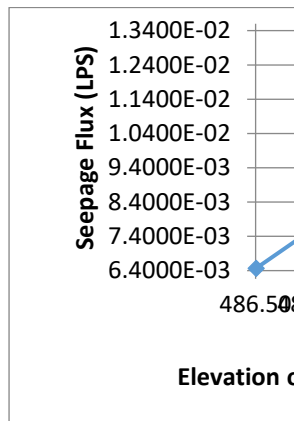
Sr. No	Material Type	Hydraulic Conductivity (m/Sec)
01	Foundation	10^{-4} to 10^{-6}
02	Shell	10^{-5} to 10^{-6}
03	Core	10^{-7} to 10^{-8}
04	Murum	$10^{-5} \times 10^{-6}$
05	Filter Blanket	10^{-2}

Source: Water Resources (Guess values)

Dept., Maharashtra

Table 2. Calibrated Values Of

Material Properties



Sr. No	Distance from U/S Ground Level to	Simulated Seepage Flux (m ³ /sec/m)	Actual observed Seepage Flux (m ³ /sec/m)
1	497.58	1.31570E-05	1.289E-05
01	496.92	1.27070E-05	9.189 x 10 ⁻⁶
2	495.78	1.20150E-05	1.258E-05
Q2	495.22	1.17090E-05	7.268 x 10 ⁻⁵
03	494.56	1.13050E-05	6.096 x 10 ⁻⁸
04	494.36	1.13050E-05	1.336E-05
04	494.36	1.13050E-05	9.572 x 10 ⁻⁵
05	491.56	1.03720E-05	4.475 x 10 ⁻²
7	492.94	1.03720E-05	1.027E-05
8	491.68	9.65740E-06	9.851E-06

Fig 2: Simulated Seepage Flux Vs. Surface Water Level For Selected Cross Section At CH:1950

Table 3. Computed Seepage Flux At Different Reservoir Levels

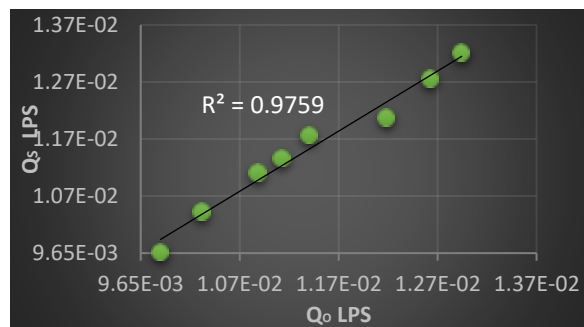


Fig 3 : Relationship Between Observed And Simulated Seepage Flux At Different Hydraulic Heads

CONCLUSION

- The seepage flux is maximum ($1.31 \times 10^{-5} \text{m}^3/\text{s}/\text{m}$) at MWL and it is minimum ($9.851 \times 10^{-6} \text{m}^3/\text{s}/\text{m}$) at almost LWL.
- There is insignificant maximum relative error between the observed and computed seepage discharges.
- Hence this implies that SEEP/W can be efficiently used for seepage modelling.

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