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Seismic Performance Study on Earthen-Dams Using Geo Studio

[1]Vedavathi R P, [2]Dr. V. Ramesh

[1]M.Tech CCT, EPCET, [2]Department of Civil Engineering, EPCET

Abstract: **An earthquake is a vibration of the earth produced by a rapid release of energy. An earthquake only occurs for a few brief moments; the aftershocks can continue for weeks; the damage can continue for years. The present work deals with an important and complex issue in geotechnical and earthquake engineering, which concerns the influence of both elasticity and pore water pressure on the seismic response of earthen dams to artificial earthquake records using the finite element program GEOSTUDIO QUAKE/ W.**

The study includes observation during earthquake loading, the different methods of seismic analysis of earth dams. The study presents numerical analyses of the seismic behaviour of homogeneous and cored earthen dams. The analysis is first conducted for a simple case which concerns the elastic response of the earthen dam. This analysis provides some indications about the response of the dam, mainly the dynamic amplification and pore water generation. For the elastic analyses, a parametric study is conducted for the investigation of the influence of major parameters such as the mechanical properties of the earth material density and soil stiffness.

Keywords: **Seismic Performance, Earthen-Dams Using Geostudio, Earthquake Loading.**

1. INTRODUCTION

Damage to infrastructural facilities during natural and man made disasters is continuously increasing at an alarming rate. The explosion of population, unscientific growth of infrastructure and lack of knowledge and awareness about the effects of such disasters increases the vulnerability and damaging effects. Earthquakes are the most dangerous natural disasters that have caused severe damage to mankind in terms of both loss of life and economic loss. Fig 1 and Fig 2 present the damaging effects of earthquake from the data collected over one decade by an N.G.O organization.

Like most of engineering structures, earth dams may fail due to faulty design, improper construction and poor maintenance practices, etc. The various causes of failure may be hydraulic failure, seepage failure, piping through dam body, structural failure and due to earthquake. An earthquake is a vibration of the earth produced by a rapid release of energy.

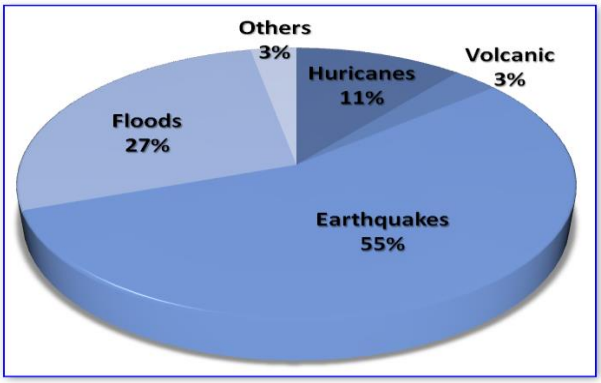


Fig. 1 : Percentage of Loss of Life in different Natural disasters

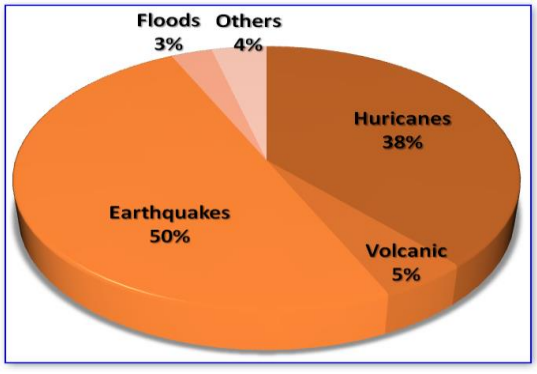


Fig. 2 : Percentage of economic loss to Built Environment in different Natural disasters

2. OBJECTIVES OF THE STUDY

The main objective of this investigation is to study the seismic behaviour of homogenous and core earthen dam by using a finite element software QUAKE/W. QUAKE/W is a geotechnical finite element software product used for the dynamic analysis of earth structures subjected to earthquake shaking and other sudden impact loading such as dynamiting or pile driving. The study includes the analysis to investigate the response of the ground and the structure when it is subjected to an earthquake, and to examine the possibility that there may be some generation of excess pore-pressures, which in turn could lead to some liquefaction.

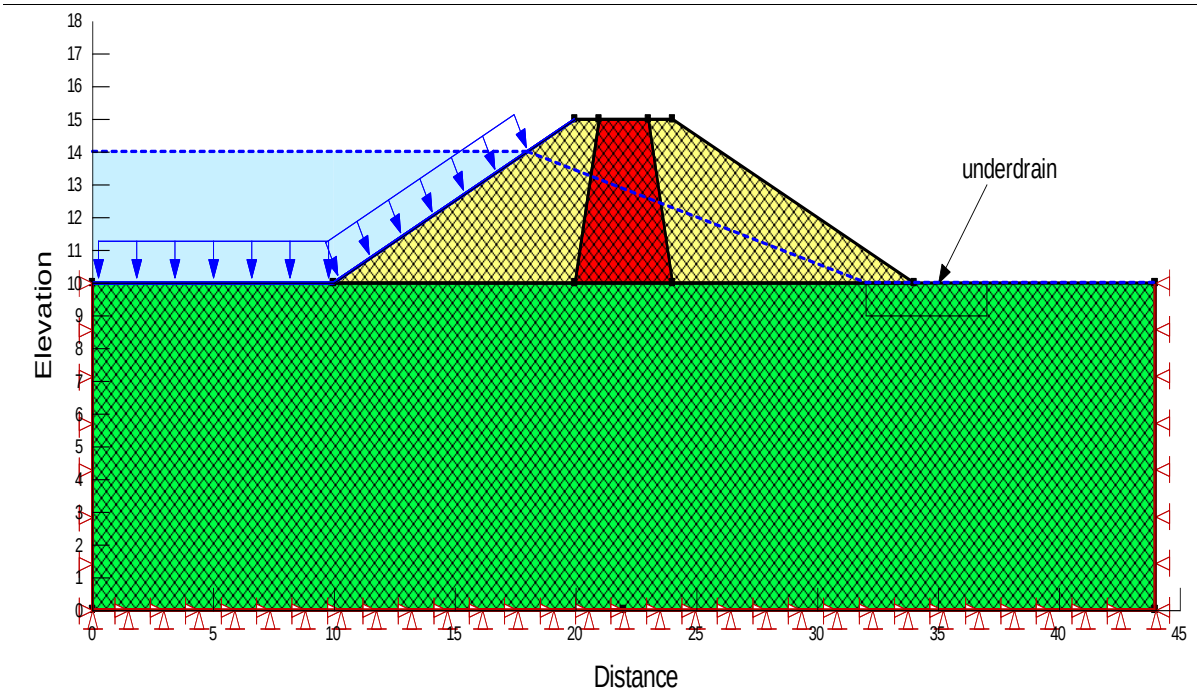
3. METHODOLOGY

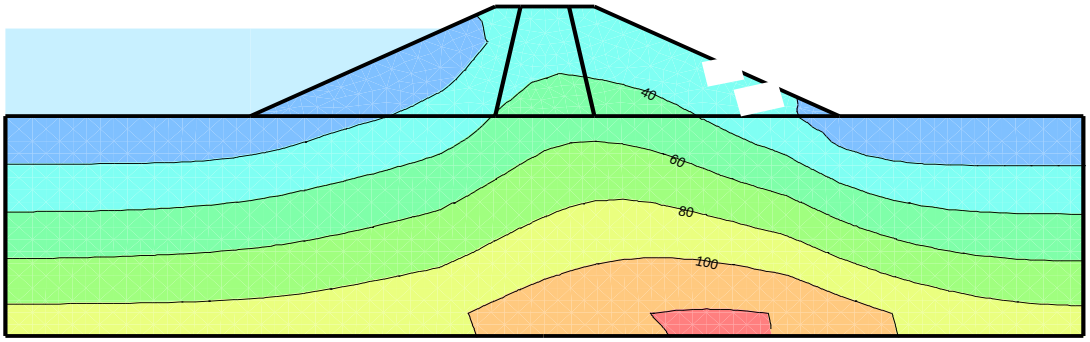
- Arriving at Design method
- Analytical Modelling
- Application of Seismic Loading
- Analysis of results

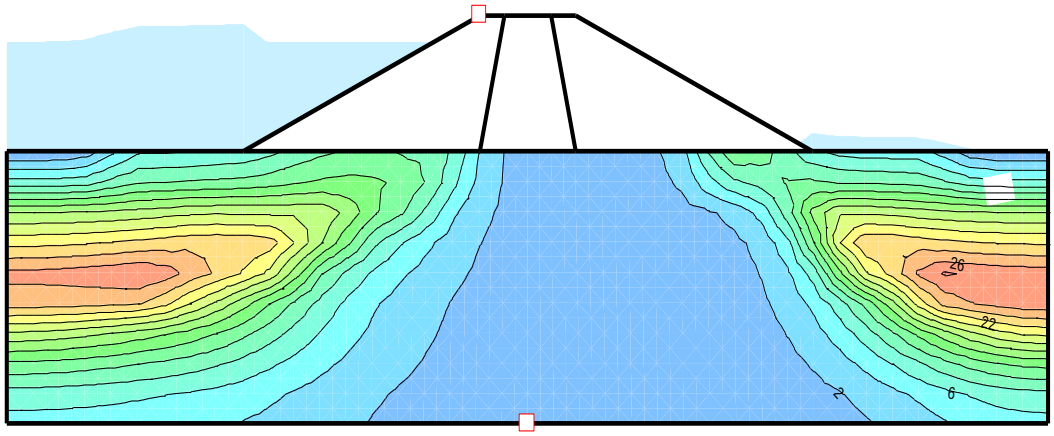
Solution for a Typical Problem:

Problem Configuration: Figure 1 shows the problem configuration of a homogeneous and a core earth dam with mesh. Basically it is an earth dam founded on an 8-metre stratum of gravel soil. The embankment is 5-m high with 2H : 1V side slopes. The dam retains a reservoir with a full supply level (FSL) at an elevation of 12 m with a water head of 4 meters. The properties of the materials considered for the study is shown in Table 1.

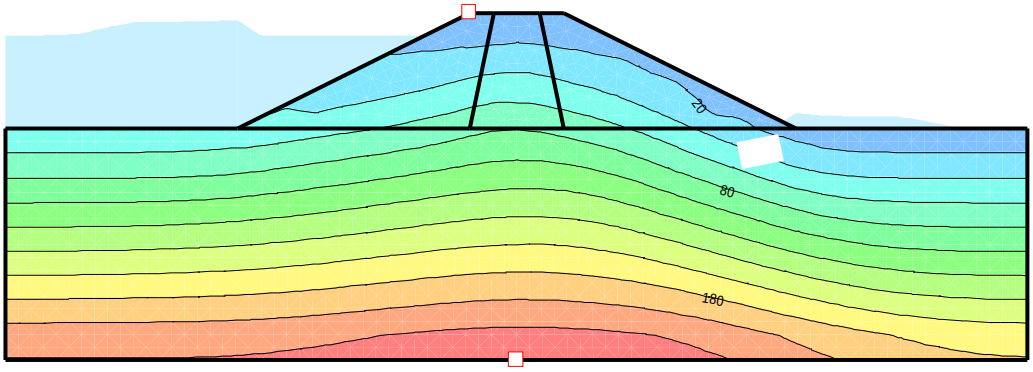
Parameter	Unit	Shell material	Core material	Foundation
Unit Weight (γ)	kN/m3	16	18	19
Poisson's Ratio (ν)		0.3	0.3	0.3
Damping Ratio (ξ)		0.1	0.1	0.1
Shear Modulus (Gmax)	MPa	5000	5000	5000



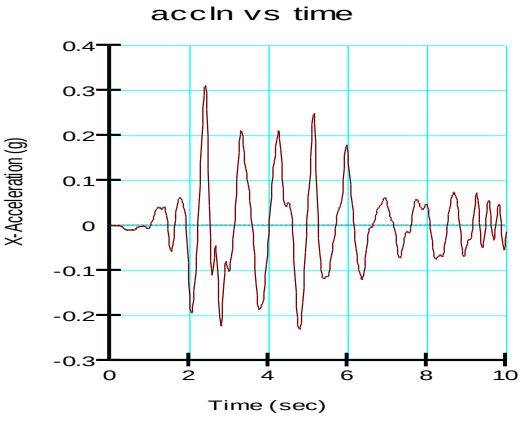


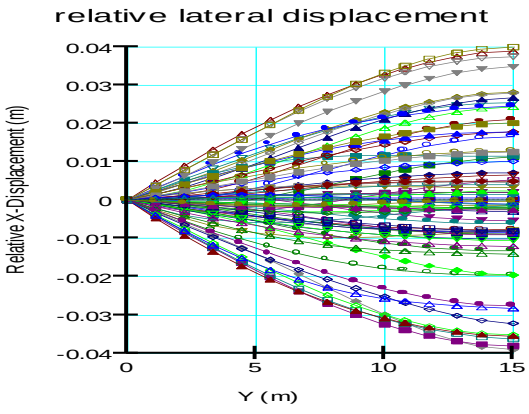


Excess Pore Water Pressure:



Total Stress:





COMPARISION OF RESULTS OBTAINED FOR DIFFERENT CASES:

HOMOGENOUS TYPE			**CORE TYPE**	
1.ACCELERATION-0.12 & DURATION 10SECS				
AT CREST	0.31		AT CREST	0.3
AT BASE	0.18		AT BASE	0.17
DISPLACEMENT	0.04		DISPLACEMENT	0.03
2.ACCELERATION-0.12 & DURATION 12SECS				
AT CREST	0.35		AT CREST	0.31
AT BASE	0.19		AT BASE	0.17
DISPLACEMENT	0.05		DISPLACEMENT	0.04
3.ACCELERATION-0.12 & DURATION 15SECS				
AT CREST	0.33		AT CREST	0.3
AT BASE	0.18		AT BASE	0.16
DISPLACEMENT	0.06		DISPLACEMENT	0.05
4.ACCELERATION-0.15 & DURATION 10SECS				
AT CREST	0.4		AT CREST	0.31
AT BASE	0.15		AT BASE	0.18
DISPLACEMENT	0.04		DISPLACEMENT	0.04
5.ACCELERATION-0.15 & DURATION 12 SECS				
AT CREST	0.45		AT CREST	0.4
AT BASE	0.16		AT BASE	0.15
DISPLACEMENT	0.06		DISPLACEMENT	0.05
6.ACCELERATION-0.15 & DURATION 15SECS				
AT CREST	0.4		AT CREST	0.34
AT BASE	0.15		AT BASE	0.14
DISPLACEMENT	0.06		DISPLACEMENT	0.05

4. CONCLUDING REMARKS

Many of the material properties used in this analysis are simple estimates. They are, however, adequate for understanding the key issues and mechanisms. The response of the homogeneous dam under earthquake loading with comparing to core dam was investigated and evaluated. Concentration of stress in core model is less than homogeneous model. Therefore, it can be concluded that the core dam section has better static behaviour compare to simple homogeneous dam. Displacement, acceleration, and spectral response in homogeneous dam are similar to those in core dam. Therefore, it seems that natural frequency of homogeneous dam is close to that of core dam to the frequency of earthquake. Changing material in core zone does not have enough effect on response of dam. Therefore, core model has shown more safety against failure from tensile stresses under pore water pressure.

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