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Seismic Analysis of Concrete Gravity Dam

M. Madhu Mohan Reddy [1], DR. C.Rajaram[2]

[1]PG Student of Structural Engineering, Department Of Civil Engineering, Rgmcet Engg College, Nandyal, Andhra Pradesh, India

[2]Assisttant Professor, Department of Civil Engineering, Rgmcet Engg College, Nandyal, Andhra Pradesh, India

ABSTRACT

Concrete gravity dam are vital salvation structure as fine as symbolize the cologne of peoples usual of livelihood. These are very intricate structures and subjected to a variety types of forces both stagnant and vibrant in scenery. In the accessible study, a 125m height of non-overflow part is consider and a two dimensional (2D) and three-dimensional (3D) finite element model is shaped to simulate mutually of its body of dam foundation. All major loads are calculated and apply for the main load cases and load combination are generate for the most adverse load mixtures as per I.S 6512-1984. Dam and water interface is accorded by considering the instantaneous hydrodynamic forces during the seismic condition on u/s surface of dam interface is taken into consideration in the analysis of finite element modelling of the foundation and assigning their properties. So as to estimate response of dam for the duration of seismic activity. So as to applying the two ground motions for the following time history analysis of the dam and it can shows maximum and minimum principle stresses at toe and heel of the dam and it can evaluate natural time period and base shear of the dam can be resolute at the same way maximum displacement and various stresses of base of the dam

Key words: concrete gravity dam, finite element method, SAP2000, time history analysis, displacements, stresses contour, natural time period, base shear, and dam water interaction of forces

1. INTRODUCTION

The dams are imposing constructions in our earth as well as it is an attractive division of our narration to explore their source. The record shows to facilitate this construction are not innovation of now days, for the reason that the primary predecessor contains exist flush 5000 years before our recent times. All through the world, history of dams has been doing well in maintenance and attractive the excellence of living. At current, the oldest dams whispered to be known are very less. A dam is a barrier across a stream, river, or a stream for the reason of confine also domineering the run of water. It depends upon the needs constructions of a barrier it can be capable of diverge in amount and material as of small earthen embankment in the direction of huge concrete structure. The main use of dams being irrigation, hydroelectric power generation, and flood control, domestic and industrialized water provide etc. create these structures as one of the salvation structure. As such, dams are cornerstone in the water assets improvement of stream basins. In this document, a brief review had been made about a common methods related to the earthquake design of concrete gravity dam

2 Time history analysis

Time-history analyse are definite as the generally effectual method for the estimation of dynamic performance of structures, as they allow the solution of equations of motion in minor steps by direct Integration while they allow the solution of equations of motion in little time steps by direct evaluation. In the calculation method were the equilibrium of motion is satisfy at each step, the earthquake actions of the dam examine the total earthquake time and for that reason the time variations of the stresses and deformations may inspected. The main vital of the time history analysis is the solution ability for both linear and nonlinear system.

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3. Data for the gravity dam

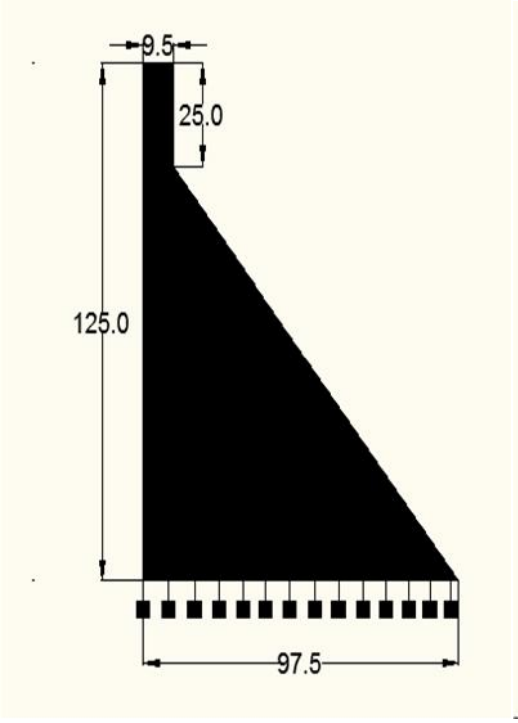

Fig1: Geometry variables of dam with fixed case

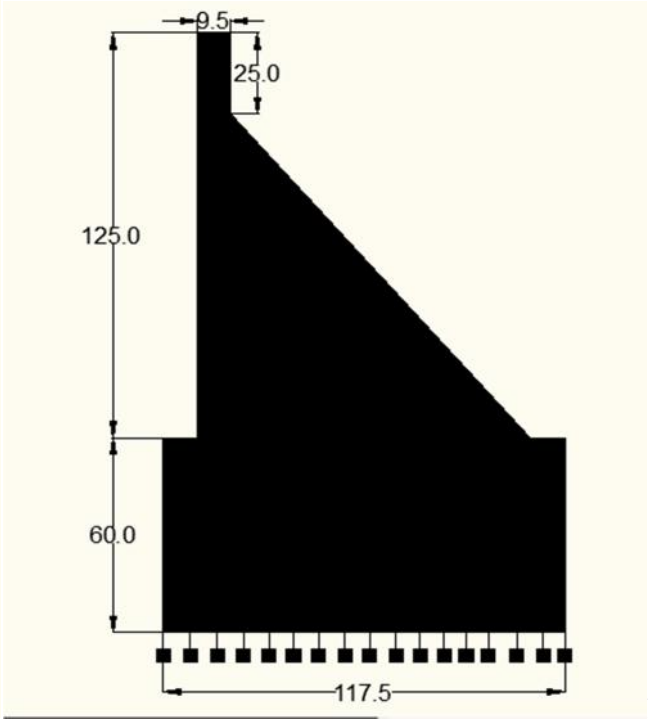

Fig2: Geometry variables of dam with foundation

Table1: Geometry parameters of Nagarjunasagar dam

Height of dam	125m
Base width of dam	97.5m
Top width of dam	9.5m
Foundation of dam	60m
Base width of dam	110m

Table2: Material properties of concrete gravity dam

Parameters	**Magnitudes**
Grade of concrete	M30
Specific Gravity of Concrete	2.4
Elasticity of modulus	30 GPa
Density of Concrete	26.5 kN/m^3

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4. Modelling of concrete gravity dam

This study includes modelling and analysis of the models using SAP 2000 software. Materials properties and section properties are defined and assigned Time history analysis is performed on models

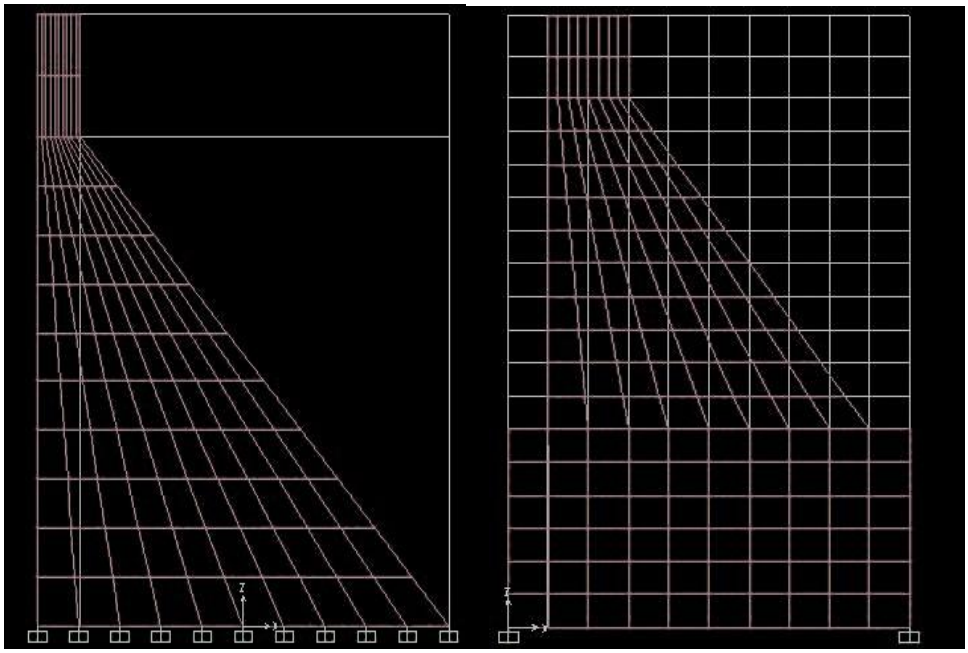

Fig2: Modelling of dam in sap for both cases

5. Selection of ground motion

The Ground motion parameter is vital for describing the involved characteristics of importance (i.e., amplitude, frequency content, and duration) of strong ground motions. In that Elcentro ground motion is taken

Table3: Seismic Ground Motion Parameters for Elcentro

Earthquake	Date	Station	M_w	Epicentre Distance	P_{ga}	Duration
ELCENTRO	18-5-1984	ELCENTRO	6.9	16.9	0.332g	2.42min

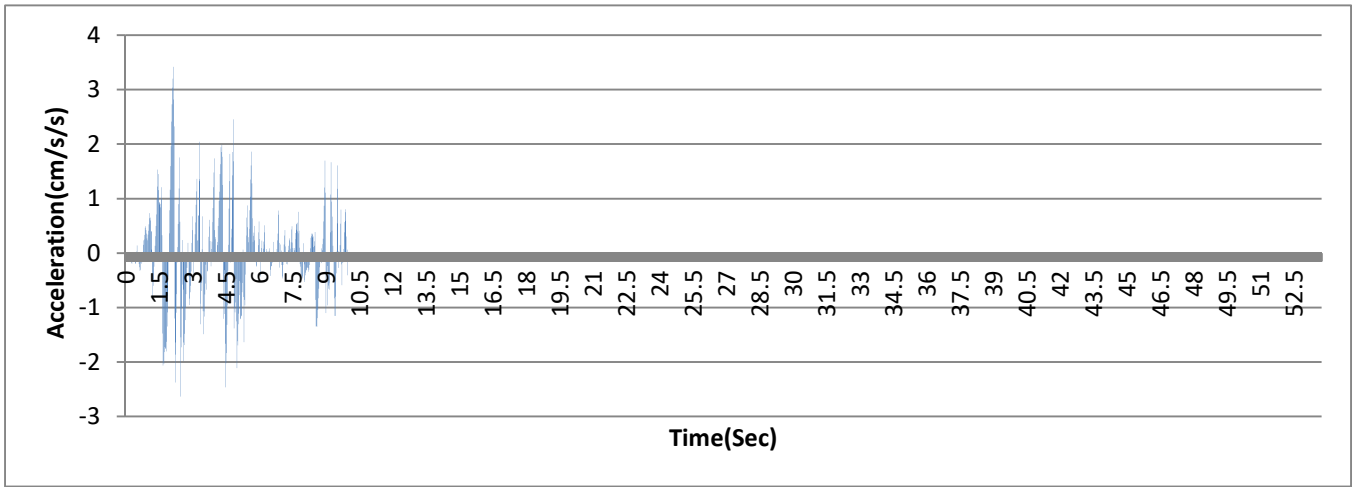

Fig3: Elcentro Seismic Ground Motion Record

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5.1 Timeperiod and base shear of dam

$$T = 5.5*\frac{H^2}{b} * \sqrt{\frac{W_m}{g*E_s}}$$

$$T = 5.5*\frac{1\ \ ^2}{9\ .5} * \sqrt{\frac{2\ .5X1\ ^3}{9.8\ \ X3\ \ .5X1\ ^9}}$$

$$= 0.25\text{sec}$$

Base Shear of Dam $V = A_u$ x w

$$\text{Were } A_u = \frac{\frac{Sa}{g}*Z*I}{2*R}$$

Z = seismic zone II = 0.10

I = Importance Factor = 1.5

(As per table 4 of IS 1893-1984)

R = Reduction factor = 4 (becoz concrete is brittle in nature) (As per table 5 of IS 1893-1984)

$$A_u = \frac{3.8\ *0.1\ *1.5}{2*4} = 0.0725$$

$$V = A_u*W$$

V= 0.0725x139184. = 10099.59 kN

6. Results and discussions:

1. Variation displacements of a dam according to height

Table 4: Variation displacements of a dam according to height

S.n.o	Height (m)	Displacement (m) for dam with foundation case	Displacement (m) for dam with fixed case
1	0	0	0
2	10	0.00159	0
3	20	0.00424	0
4	30	0.00766	0
5	40	0.0110	0
6	50	0.0146	0
7	60	0.00163	0
8	70	0.0171	0.000199
9	80	0.0202	0.000354
10	100	0.5095	0.000869
11	110	0.5948	0.00174
12	120	0.6880	0.00239
13	130	0.7901	0.00324
14	140	0.9020	0.00447
15	150	1.0250	0.00637
16	160	1.5800	0.0105
17	172.5	1.6080	0.0156
18	185	1.6390	0.000199

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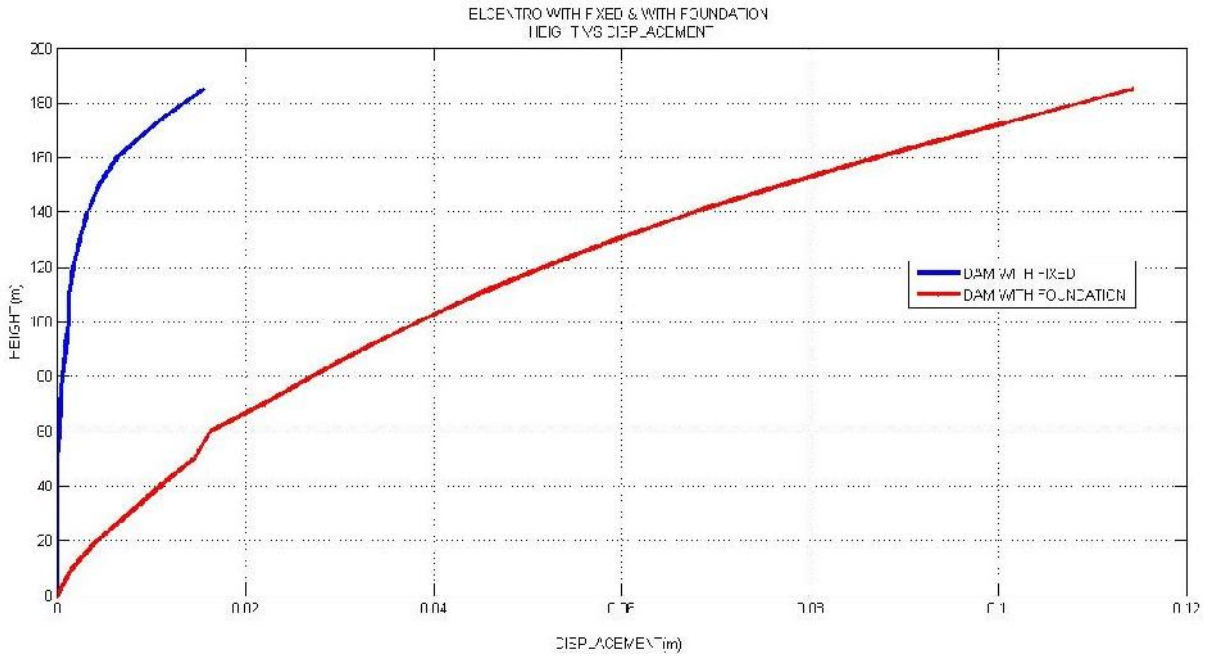
- From SAP2000 the displacement values obtained for the cases of dam with fixed case and dam with foundation system
- The maximum and minimum displacements occurred at a height of 185m and 0m in case of dam with foundation.
- The maximum and minimum displacements occurred at a height of 185m and 70m in case of dam with fixed case.



Elcentro ground motion dam with foundation & dam with fixed base height vs displacement

2. Stresses of a dam with fixed case due to hydrostatic pressure

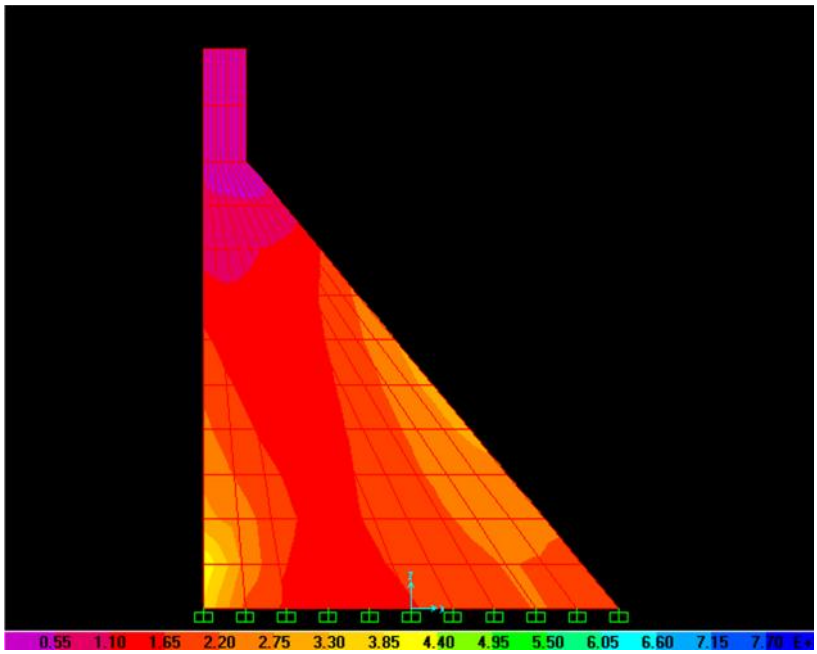


Fig 4: Stresses of a dam with fixed case due to hydrostatic pressure

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The Min stresses of a dam with fixed case due to hydrostatic pressure = 0.55 kN/m^2

The Max stresses of a dam with fixed case due to hydro static pressure = 4.90 kN/m^2

3. The modal periods of dam

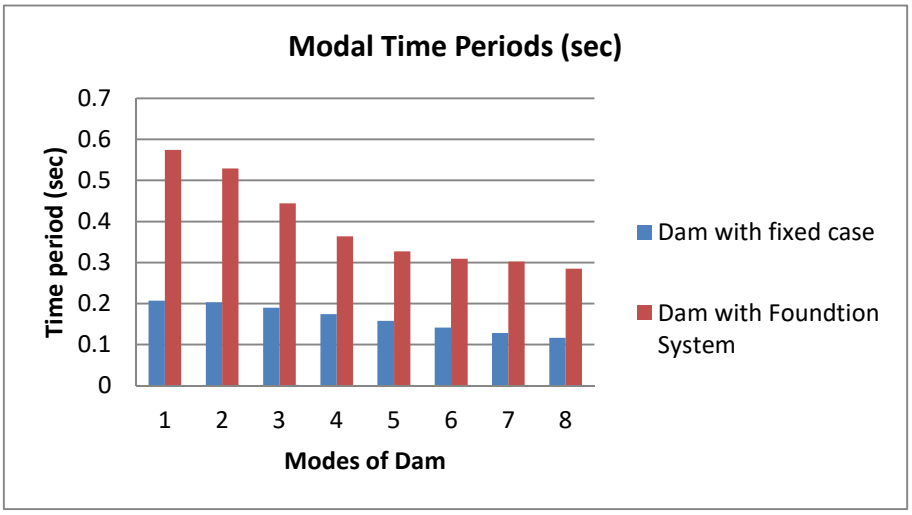

Fig5: Comparison of dam with fixed case and dam with foundation for modal time periods

Conclusion

The conclusion are tense as of on top of examine are as follows

The finite elements modelling of the dam plays a vital role in the design of concrete gravity dam and witness during the distribution of stresses to the foundations.

1. The displacement value is more in dam with foundation compare to fixed base of dam.
2. The stresses are increasing for a dam top to bottom.
3. The first mode of dam with foundation case (0.57sec) is greater than compare to dam with fixed base (0.25sec).

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