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Demonstration of Low Earth Gravity Dams Stability Analysis using MATLAB Tool

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***Abstract:** The paper has demonstrated the application of the MATLAB tool in design and analysis steps for the stability analysis of the low earth gravity Dams. It is to make clear that paper just demonstrating the use of MATLAB tool rather emphasizing on efficient design. The Goal is just to take the random inputs to check the stability or instability of the dam. The three possible cases are considered for demonstration one is without water earth quack force acting down ward, Force acting upward, and the final case is analysis with water consideration. The matlab tool works efficiently and is good enough for the analysis. Careful parameter selection is required.*

Keywords: **Gravity Dam, Stability Analysis, Earth quack Force, Reservoirs, Water Analysis, share stress.**

I. INTRODUCTION

The analysis of the Dam during designs is a critical issue. As concrete dam must be designed for the expected worst case of the earth quack and must not fail. Thus the goal of the paper is to demonstrate the use of MATLAB TOOL for the stability analysis of low Gravity Dams. The Figure 1 represents the basic structure of the Gravity Dams.

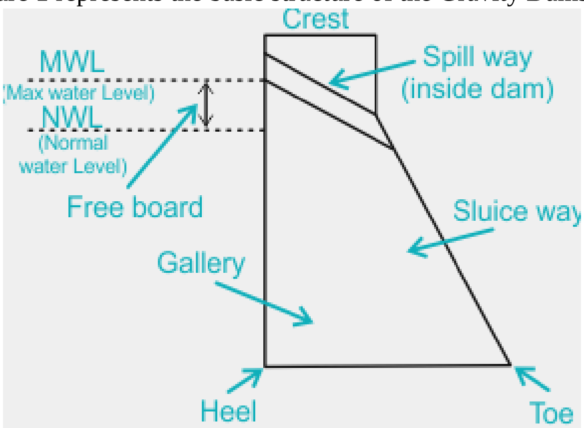

Fig.1.The structure of gravity Dam

A gravity dam is a construction that is made to withstand loads from its own weight as well as from its resistance to overturning and sliding off its foundation. These dams were largely constructed recently, and the majority of them are unsupported concrete monoliths with sealed fissures. The Figure 2 illustrated the basic design parameters to be considered for the Gravity Dam designs The weight of the dam is calculated using the defined heights parameters of the dam.

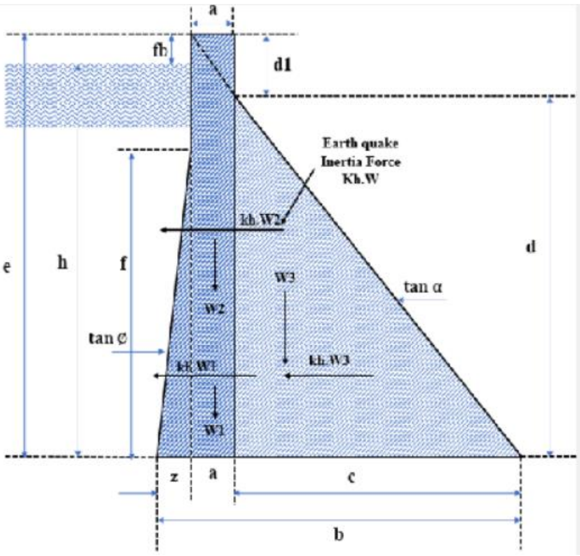

Fig.2. Layout of the Low Gravity Dams and design parameters.

The slope e is the ratio usually taken as 2/3 for the dam design. A gravity dam is a construction that has been built to withstand pressure through its own weight as well as durability against tipping upside down and sliding off its foundation. The vast majority of such dams, characterized by freestanding concrete monoliths with cemented fissures, were completed recently. Uses are given in Figure 3.

Fig.3.Most common uses of the Gravity Dams

II. LITERATURE REVIEW

Tekie, P. B. and others [1] proposed to evaluate concrete gravity dams' performance in the face of seismic threats, this research proposes a methodology for calculating their fragilities. The late 1930s-designed Bluestone Dam on the New River in West Virginia serves as an example of the methodology. According to the seismic fragility assessment, if the dam were to experience an earthquake with a magnitude equal to or greater than the maximum credible earthquake (MCE) established by the U.S. Army Corps of Engineers, sliding at the dam-foundation interface is likely to occur. Jianyun Chen et al [2] used heterogeneity of hard fill mass density, Young's modulus, and tensile strength are all taken into account utilizing the random finite element approach in this research using a 100 m high hard fill dam as an example. Discussions also cover the impact of the correlations between the tensile strength of hard fill and Young's modulus, the correlation between Young's modulus and mass density, the duration of the correlation, the dimension of the random field, and ground motions.

The research by Alban Kita et al. [3] includes numerical calculations using as a case study a sample concrete gravity dam situated in a strong seismic area of Italy. The adoption of a site-specific seismotectonic study and discussions of the variations from probabilistic code-based requirements follow. The impact of the vertical seismic component, which is frequently ignored in practical applications, is next investigated using streamlined studies.

M. A. Hariri-Ardebili et al. [4] updated 3D co-axial rotating smeared crack model with the capacity to update the variable shear transfer coefficient is employed in the current work. To evaluate the seismic cracking of three different types of concrete dams, namely gravity, buttress, and arch dams, the model is constructed in the finite element code.

K. Komal et al. [5] designed lower wardha dam, a concrete gravity dam located on the Wardha River at Varud (Baggaji) Dhanodi near Arvi in the Wardha District, is the subject of this paper's design and stability analysis. Throughout the challenging years, it has been noted that dam failures caused by a variety of factors are frequent. Therefore, it is crucial to analyses the dam in relation to all of its potential failure modes, forces acting on it, uncontrollable catastrophes like earthquakes, etc. For this, the preliminary information about the dam, including its dimensions, base and crest widths, etc., is needed for design.

Manoj Nallanathel and others [6] had main goal of project is to analyze the stability of a concrete gravity dam using both traditional and STAAD.pro methodologies. STAAD.pro is computer software that analyses a structure's stability and stress. Because the dam is such a large construction, evaluating it manually would take a very long time, so it is simple to assess the stability of the dam. STAAD pro

The paper by Azevedo et al. [7] is based on a network of seepage channels and a unidirectional discretization. The suggested model is calibrated so that the same water pressure and discharges are produced with both models, and the hydro-mechanical model applied in the computational module Parmac3D-Fflow are checked and confirmed using straightforward examples.

Maria Luisa Farinha and others [8] modeled the water flow is assumed to only occur along the channels that are at the margins of the triangular interface elements that represent the discontinuities. Using two alternative techniques and a variety of constitutive models at the dam/foundation interface, the model is utilized to perform coupled hydro-mechanical study of a large arch-gravity dam and to evaluate safety against dam base sliding.

J. Wang et al. [9] proposed a CAV site-effect evaluation for the Taipei areas is presented in this work. More than 1200 strong-motion data from 47 significant earthquakes that occurred near Taiwan formed the basis of the study. The findings demonstrate that the site impacts are stronger in places adjacent to the basin margins, where seismic waves might be more easily reflected, refracted, and overlaid, Naproposes, et al [10] research describes a method for determining the seismic risk of existing concrete gravity dams (CGDs) while taking the ageing effect into account.

The analysis has made use of the fragility function and cumulative absolute velocity (CAV) in combination, depending on two failure situations. It depicts the conditional change in structural vulnerability in the event of seismic excitation as well as the time-varying degradation of the concrete structure. There are other dam designs propped in [11 to 15] which are based on seismic or stability analysis of dams.

III. SIMULATION AND ANALYSIS

Paper has preseted the testing and demonstration of the random gravity dam design. the aim is to address the challenges of analysis and the parameter selection and there impacts. Identifications

The parameters are randomly selected for the simulation and demonstration of the MATLAB tool the most important parameters are height of dam and the base width. The weight of concrete is essential and is standard to be 24 rather taken as 10. The coefficient of earth quack force has to be tuned with base width and slope to clear the stability criterion.

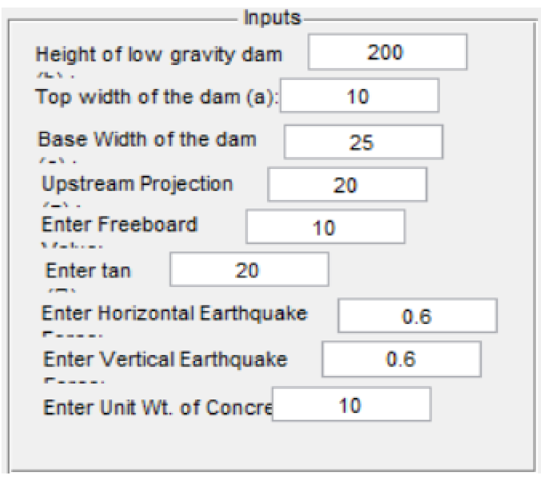

Fig.4. Input values to be assessed for the earth quacks

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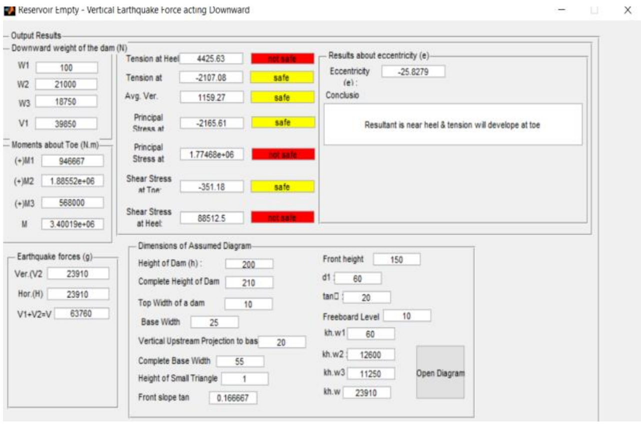

Fig.5. Results of the stability analysis of the Dam for the downward earthquake without Water case 1

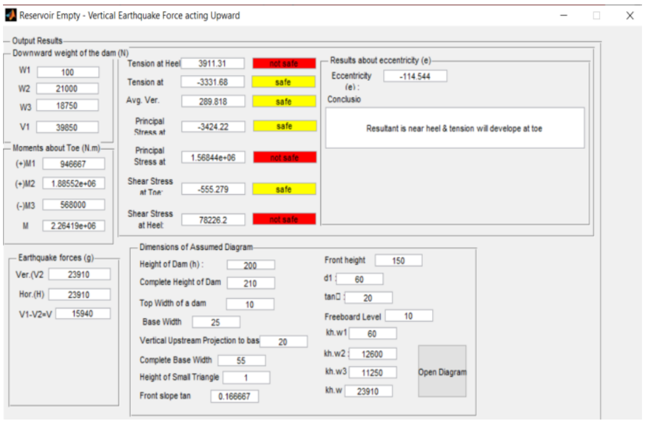

Fig.6. Results of the stability analysis of the Dam for the Up-ward earthquake without Water case 2

The MATLAB tool of Gravity dam stability analysis is tested for the random selected data parameters shown in Figure 4. The simulation is carried out using the Case 1 as earthquake acting downward. And case 2 as the earthquake acting upward. The result of stability analysis is shown in the Figure 5 and the Figure 6 respectively for two cases. It can be concluded as the concrete weight strength is taken low and the base width is not appropriate so the dam design fails for this case. The conclusions is that the proposer selection of dam height and width ratio is necessary to provide the right slop of the dam and the force coefficients are required to be satisfied properly according the units of forces. Thus still it is a challenging field of research but the Matlab tool is good enough to solve the critical problems.

IV. TESTING UNDER WATER CASE

As a specific case 3 the Water force analysis the most critical part of design is taken consideration the coefficient are selected as shown in the Figure 7

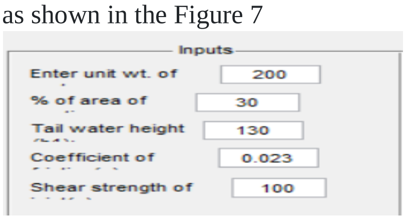

Fig.7.Random selected coefficients and inputs for the water analysis of Matlab tool for stability analysis.

The respective stability analysis results are shown in the Figure 9. The dam layout with water is shown in the Figure 8

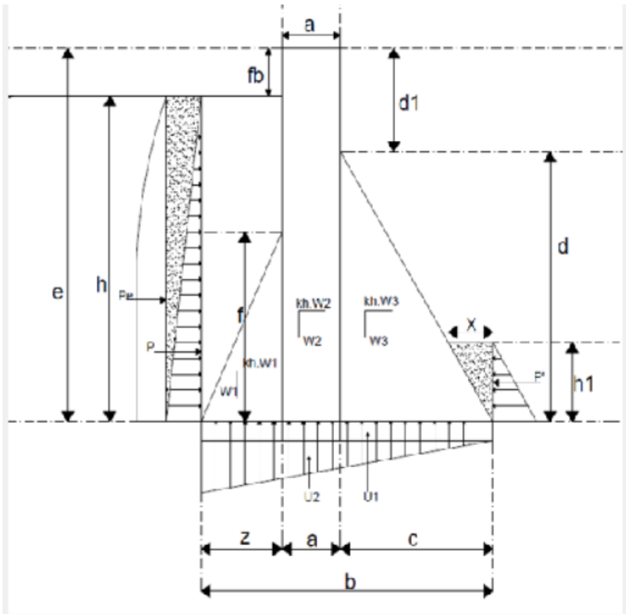

Fig.8.Water level geometry of analysis with water heights

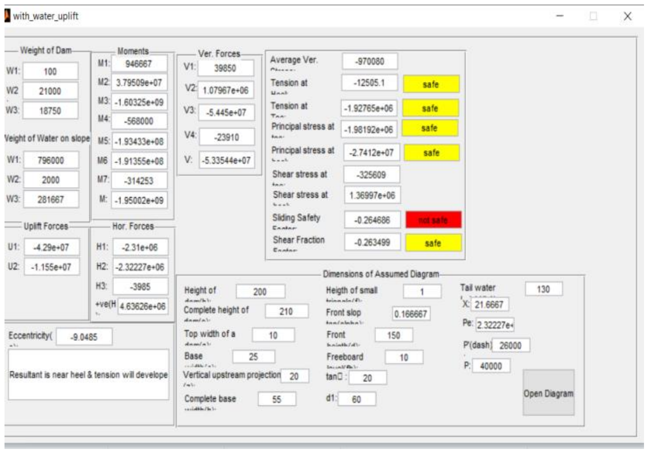

Fig.9. Results of the stability analysis of the Dam for the downward earthquake with Water level pressure case 3

It is again to e=mention that ultimately the design is failed due to wrong parameters. Thus, optimum parametric analysis is a critical design step. The aim of paper is to just distrait the validation of MATLAB tool.

V. CONCUSION

The study demonstrated the use of the MATLAB tool, as well as design and analysis stages, for the stability analysis of low earth gravity dams. It is important to note that the study is showcasing the usage of the MATLAB tool rather than emphasizing effective design. The goal is simply to use random inputs to determine the dam's stability or instability. For demonstration, three different instances are considered: one without water, one with earthquake force acting downward, one with force acting upward, and one with water consideration. The matlab tool works well and is adequate for the analysis. It is necessary to choose parameters with attention.

Although paper successfully validated and demonstrated the use of MATLAB Tool but still, random design is failure and the selection of the critical design parameters is essential for the future designs.

It is concluded that in future Tool can be used with optimal design to analyses the best possible dosing in short span of time.

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