ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Evaluation of the Pseudo static Analyses of Earth Dams Using Fe Simulation and Observed Earthquake-Induced Deformations

Mohammed Abdulraheem Jasim
Master of Civil Engineering (Structural Engineering),
Structural Design in Ministry of health Iraq-Thiqar.

ABSTRACT:

Assessment of the precision of the pseudostatic methodology is administered by the exactness with which the basic pseudostatic inertial powers speak to the unpredictable element inertial powers that really exist in a seismic tremor. In this study earth dams, which have been composed utilizing the pseudostatic approach for tremors, were examined and broke down. The limited component models of the dams were readied taking into account the itemized accessible information and aftereffects of in situ and research center material tests. Dynamic investigations were led to reenact the quake impelled disfigurements of the dams utilizing the PC program Plaxis code. At that point the pseudostatic seismic coefficient utilized as a part of the configuration and examinations of the dams were contrasted and the seismic coefficients got from element investigations of the mimicked model and additionally the other accessible proposed pseudostatic connections. In view of the examinations made, the precision and unwavering quality of the pseudostatic seismic coefficients are assessed and talked about.

Keywords:

Coefficients, Dynamic Analyses, Earthquakes, Pseudostatic Approach.

INTRODUCTION:

The seismic solidness of earth structures has been examined by pseudostatic methods for a long time in which the impacts of a quake are spoken to by consistent flat and/or vertical increasing speeds. Steadiness is communicated regarding a pseudostatic variable of wellbeing computed by utmost balance methods. Limit harmony investigations consider power and/or minute balance of a mass of soil over a potential disappointment surface [1]. The principal express utilization of the pseudostatic way to deal with the examination of seismic incline soundness has been credited to Terzaghi.

In their most basic structure, pseudostatic examinations speak to the impacts of tremor shaking by pseudostatic increasing speeds that create inertial strengths which act through the centroid of the disappointment mass. The consequences of pseudostatic investigations are fundamentally reliant on the estimation of the seismic coefficient. Choice of a proper pseudostatic coefficient (especially kh) is the most vital, and the most troublesome, part of a pseudostatic investigation. The seismic coefficient controls the pseudostatic power on the disappointment mass, so its worth ought to be identified with a few measures of the abundancy of the inertial power prompted in the conceivably shaky material. On the off chance that the incline material was unbending, the inertial power incited on a potential slide would be equivalent to the result of the genuine even speeding up and the mass of the flimsy material [1]. This inertial power would achieve its most extreme quality when the level increasing speed achieved its greatest worth.

In acknowledgment of the way that real inclines are not inflexible and that the crest speeding up exists for just a brief timeframe, the pseudostatic coefficients utilized as a part of practice by and large relate to increasing speed values well beneath the most extreme quality. Terzaghi initially recommended the utilization of kh = 0.1 for separate tremors (Rossi-Forel IX), kh = 0.2 for brutal and dangerous seismic tremors (Rossi-Forel X), and kh = 0.5 for cataclysmic quakes. Seed recorded pseudostatic plan criteria for 14 dams in 10 seismically dynamic nations and 12 required least variables of security of 1.0 to 1.5 with pseudostatic coefficients of 0.10 to 0.12. Marcuson proposed that suitable pseudostatic coefficients for dams ought to compare to 33% to one-portion of the most extreme quickening, including enhancement or deamplification impacts, to which the dam is subjected. Utilizing shear bars models, Seed and Martin and Dakoulas and Gazetas demonstrated that the inertial power on a possibly shaky slant in an earth dam relies on upon the reaction of the dam and that the normal seismic coefficient for a profound disappointment surface is generously littler than that of a disappointment surface that does not reach out

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

far underneath the peak. Seed additionally showed that misshapenings of earth dams built of flexible soils with peak increasing speeds under 0.75 g would be acceptably little for pseudostatic components of wellbeing of no less than 1.15 with kh = 0.1 (M = 6.5) to kh = 0.15 (M = 8.25) [2]. This criteria would permit the utilization of pseudostatic increasing speeds as little as 13 to 20 percent of the top peak quickening. Hynes-Griffin and Franklin connected the Newmark sliding square examination to more than 350 accelerograms and presumed that earth dams with pseudostatic variables of security more prominent than 1.0 utilizing kh = 0.5amax/g would not develop dangerously large deformations. As can be seen from above exchanges, there are no rigid tenets for choice of a pseudostatic coefficient for outline. Notwithstanding, it appears that the pseudostatic coefficient ought to be founded on the real foreseen level of speeding up in the disappointment mass and that it ought to relate to a few divisions of the expected top quickening, in spite of the fact that building judgment is required for all cases.

Representation of the mind boggling, transient, dynamic impacts of tremor shaking by a solitary consistent unidirectional pseudostatic increasing speed is clearly entirely unrefined [2]. Itemized investigations of authentic and late seismic tremor affected avalanches have outlined huge deficiencies of the pseudostatic approach. Aftereffects of pseudostatic investigations of some earth dams demonstrate that pseudostatic examinations created variable of security well above 1.0 for various dams that later fizzled amid tremors. Romo and Seed gathered a significant number of the destructed dams subsequent to 1900 to 1980 which had been planned utilizing pseudostatic strategy. These cases show the powerlessness of the pseudostatic technique to dependably assess the solidness of slants defenseless to debilitating shakiness. By the by, the pseudostatic methodology can give no less than a rough record of relative, if not supreme, strength.

In spite of the aforementioned restrictions, the pseudostatic approach has various alluring elements. The investigation is generally basic and direct. Without a doubt, its closeness to as far as possible balance investigations routinely led by geotechnical engineers makes its calculations straightforward and perform. It creates a scalar list of dependability (the component of wellbeing) that is similar to that delivered by static solidness investigations. It should dependably be perceived, in any case, that the precision of the pseudostatic methodology is administered by the exactness with which the basic pseudostatic inertial strengths speak to the unpredictable element inertial powers that really exist in a seismic tremor [3]. Trouble in the task of suitable pseudostatic coefficients and in understanding of pseudostatic elements of security, combined with the advancement of more practical strategies for investigation, has lessened the utilization of the pseudostatic approach for seismic slant soundness examinations. Techniques taking into account assessment of lasting incline twisting are being utilized progressively for seismic slant solidness investigation.

Methodology:

Most specialists consider the seismic coefficient as a method for assigning the size of a static power which is proportional in impacts (i.e., produces the same misshapenings of the earth dam) to the genuine element dormancy strengths affected by the quake. In any case, how might the seismic coefficient meaning this comparable static power be resolved? Doubtlessly the determination of a fitting quality would fundamentally include two stages [3]:

1.Determination and specification of deformations and degree of instability of dam induced by the earthquake;
2.Evaluation of equivalent static force with the capability to make the same displacements or instabilities.

Doubtlessly any endeavor to choose a last estimation of such a seismic coefficient without experiencing step (1) and without a huge accumulation of experience to manage the choice could have minimal solid premise.So as to decide accurate results for stage (1), it will be desirable over use dynamic examinations taking into account limited component technique, and consequently the Plaxis programming is by all accounts a suitable decision. High exactness of element examination puts it at high perspective. The outcomes got from two-dimensional element examinations of dams under relating tremor, for example, level and vertical removals, practically legitimize the watched relocations. At that point a proportional static power is resolved for every layer and seismic coefficient is acquired for those layers. Keeping in mind the end goal to achieve this point, the static strengths were actuated to every layer's gravity focus and removals and dam disfigurements were picked up. The significance of this study sparkles in assessing the fluctuating seismic coefficient for dams and that is pertinent to separation of every layer's coefficient of the dam [4]. Expecting a steady seismic coefficient would be appropriate for inflexible structures

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

and utilizing this present technique for earth dams which have not unbending body reaction is not objective. Pulverization of Lower San Fernando dam and Oshima Tailing dam affirms the invalidity of pseudostatic investigation with consistent coefficient, since them two had been planned utilizing pseudostatic examination having seismic coefficients of 0.15 and 0.2, individually. In this study, the identical seismic coefficients for various soil zones of Upper San Fernando and Earth dams have been resolved utilizing two-dimensional element investigations and vast excess, and after that the outcomes have been contrasted and the configuration seismic coefficient (0.15) of the dams [5].

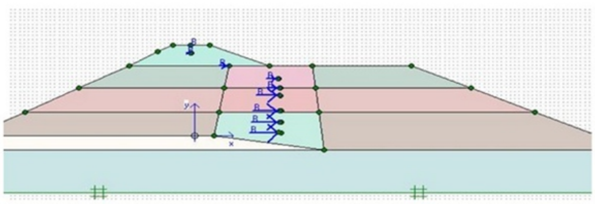

Figure 1: Equivalent static forces acting at layers gravity center.

DYNAMIC ANALYSES:

The greater part of the issues experienced in the zone of geotechnical designing, for example, holding dividers, burrows, earth dams, and banks are studied utilizing two-dimensional element examinations taking into account the limited component strategy (FEM) which is one of the accessible capable numerical strategies. The major stages required to make a FE model incorporate selecting a suitable component, isolating the model into components and gestures, augmenting mathematical statements of every component and deciding component's solidness framework, joining component's grid, and making a solitary network for model [4]. Components development mathematical statement is given by

$$[M]\{\ddot{U}\} + [C]\{\ddot{U}\} + [K]\{U\} = \{R(t)\} \qquad (3)$$

in which [M] is the whole mass matrix, [C] is the whole damping matrix, [U] is the model nods axial movement, and {R(t)} is the axial force of model points [4].One of the present techniques used to illuminate the development mathematical statement is the Newmark regulated strategy. Newmark gave this technique to element examination of seismic tremor stacking. In this strategy, relocation and speed are resolved utilizing the accompanying mathematical statements:

$$U_{t+\Delta t} = U_t + \dot{U}_t \Delta t + [\left(\frac{1}{2} - \alpha\right)\ddot{U} + \alpha U_t \ddot{+} \Delta t^2,$$

$$\dot{U}_{t+\Delta t} = \dot{U}_t + [(1-\beta)\ddot{U}_t + \beta U_{t+\ddot{\Delta} t}]\Delta t, \quad (4)$$

where Δt is time pace and α and β are controlling parameters for numerical integration accuracy, according to the implicit the Newmark scheme. In order to obtain a stable solution, these parameters have to satisfy the following condition [5]:

$$\beta \geq 0.5;\ \alpha \geq 0.25\,(0.5 + \beta)^2 \quad (5)$$

In the established Lagrange technique, β = 0.5 leads the estimations to judicious results. In spite of Newmark's damping technique, exploiting β = 0.6 and α = 0.3025 qualities, in this study, normal increasing speed strategy is being utilized to understand development mathematical statements, and also Newmark's strategy. Uncommon limit conditions must be characterized keeping in mind the end goal to maintain a strategic distance from the spurious impressions of the waves on the model limits [6]. These limits depend on the Lysmer-Kohlmeyer model. By model, the ordinary and shear stress parts consumed by a damper are resolved as follow:

$$\sigma_n = -C_1 \rho V_\rho \dot{u}_x, \qquad (6)$$

$$\tau = -C_2 \rho V_s \dot{u}_y,$$

where ρ is the mass density, VS is the shear wave velocity, VP are the longitudinal wave velocity, and = velocity of particle motion in the direction of x and y, respectively, and c1 and c2 are relaxation coefficients used to improve the wave absorption on the absorbent boundaries. c1 corrects the dissipation in the direction normal to the boundary and c2 in the tangential direction. The research and experience findings recommend to choose c1 = 1 and c2 = 0.25 for the best results [7].

DAM SIMULATION:

The process begins with specifying the clusters and defining the properties relevant to each cluster.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

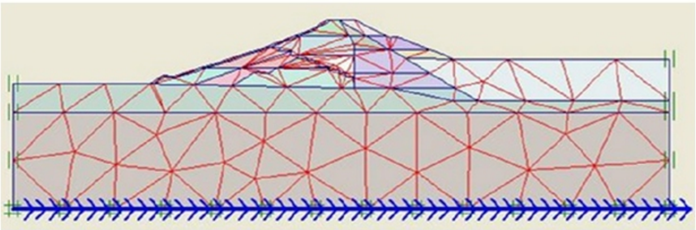

Figure 2: Section of generated mesh of earth dams.

The numerical counts utilizing Plaxis programming include 3 stages. To begin with stage is dam plastic investigation directed for the time when the development is over. Second stage incorporates dam plastic investigations under own body load lastly the last step comprises of element examination under tremor stacking. The third stage stacking is connected as a document (accelerogram) info to the system [6]. The entire misshapenings and level and vertical removals of the dams are gotten in the yield of the system, yet considering the significance of flat relocations, and for the purpose of space sparing, just the entire distortions and even dislodging [7].

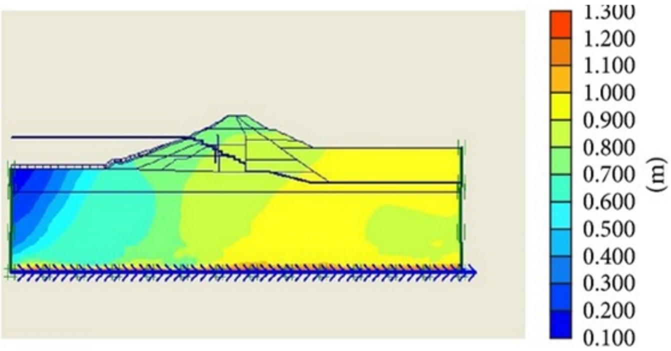

Figure 4: Whole deformations and horizontal displacements of earth dam.

STRESS-TIME ANALYSES:

Before beginning count step, stress focuses are picked on cross segment of the dam. These focuses are situated in the x course with three focuses at every level, one point upstream side (having image L), one point center part (with image M), and one point downstream side (with image R). 27 focuses constituting 9 lines and 30 focuses constituting 10 lines parallel to the x course are, separately, determined for (spoke to by K) earth dam. Stress (σxx)-time curves (27 curves for Upper San Fernando and 30 curves for Earth) can be obtained from CURVE step of the program. Owing to the generation of numerous curves and again for the sake of space saving, only some stress-time curves related to points at various levels of the sections are provided.Respectively, show these envisaged curves for Upper San Fernando and Earth dams [8].

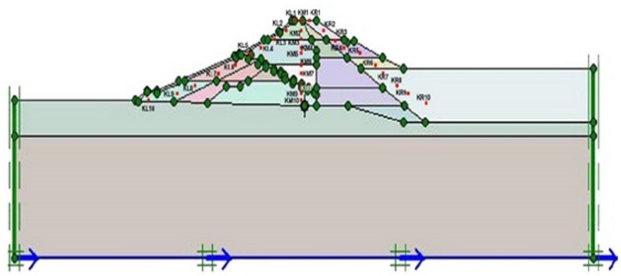

Figure 6: Location of stress points for Earth dam.

Determination of Equivalent Force:

For each curve, a maximum value is deliberated for a period and is considered due to its conservative value. Though the maximum value of each curve is multiplied by 0.7, the distribution of stress along the height of model is approximated to be linear for all points located in the upstream (US), downstream (DS), and middle (M) parts. Then each layer's equivalent force can be determined by employing the following equation:

$$F = \sum_{i=1}^{3} \frac{F_i L_i}{L}, (7)$$

in which Fi is force of the part (upstream, middle, and downstream), Li is the effective length of the part, and L is the layer's length. Finally seismic coefficient is calculated by dividing layer force to its weight [9].

Table 1: Seismic coefficients for Upper San Fernando and Earth dams under earthquake loading.

Layer number	Force (kN)	Height of layer (m)	Weight *W* (kN)	Seismic coefficient
Upper San Fernando dam				
1	74	0.8	247	0.311
2	319.2	2.8	1205.4	0.272
3	675.4	4	3023.2	0.254
4	780.5	2.9	3252	0.241
5	870	2.2	3766	0.236
6	1530	3.14	6486	0.235
7	1712.3	3.3	7354.8	0.232
8	1811.1	3.06	7879.2	0.229
9	1895.3	2.95	8739.5	0.216
Earth dam				
1	386	2.9	891.3	0.47
2	497	2.8	1420	0.35
3	877	3.5	3043.5	0.29
4	957	2.8	3385.2	0.27
5	1070	2.5	3742.5	0.27
6	1252	2.33	4891.7	0.25
7	1716	2.76	5765.6	0.25
8	1419	2.11	5234.8	0.26
9	2163	3.62	7846.6	0.23
10	681	0.78	3242.8	0.21

CONCLUSION:

The outcomes got from the examinations led for researching the Earth dams conduct, individually, tremor stacking demonstrate that the seismic coefficient increments with the expanding of the tallness. The proportion of seismic coefficient at the peak of the Upper San Fernando dam over seismic coefficient at the base of the dam is around 1.44 and this proportion for the Earth dam is around 2. For both dams the outline seismic coefficient was 0.15, however the base ascertained seismic coefficient for lower layers of the dams is 0.21.

In Upper San Fernando case, the peak of the dam settled to 0.76 m and moved 1.5 m downstream and the most extreme measure of flat relocations was around 2 m. In Earth case, the peak of the dam settled to 0.43 m and moved 0.72 m downstream and the maximum amount of horizontal displacements reached almost 0.98 m.

The outcomes show that the consistent seismic coefficients utilized as a part of outlining both dams were not appropriate and if there should arise an occurrence of utilizing steady seismic coefficient it must be between the base estimation of 0.21 and the most extreme estimation

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

of 0.311 for Upper San Fernando case and between the base estimation of 0.21 and the greatest estimation of 0.47 for Earth case. The comparing so as to accompany results are picked up the outline seismic coefficient to the figured seismic coefficients independently for both dams. At long last this study demonstrates that considering capricious seismic coefficient in earth dam configuration is more reasonable and balanced than considering a steady seismic coefficient. Besides the methodology utilized in this study can be used for assessment of outline seismic coefficient of developed earth dams composed utilizing pseudostatic investigations.

REFERENCE:

1.Terzaghi K. Mechanisms of Landslides. Engineering Geology (Berkley) Volume. New York, NY, USA: Geological Society of America; 1950.

2.Seed HB. Considerations in the earthquake-resistant design of earth and rockfill dams. Geotechnique. 1979;29(3):215–263.

3.Marcuson WF. Moderator's report for session on 'Earth dams and stability of slopes under dynamic loads'. Proceedings of the International Conference on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics; 1981; St. Louis, Mo, USA. p. p. 1175.

4.Seed HB, Martin GR. The seismic coefficient in earth dam design. Journal of the Soil Mechanics and Foundation Division. 1996;92(SM3):25–58.

5.Dakoulas P, Gazetas G. Seismic shear strains and seismic coefficients in dams and embankments. Soil Dynamics and Earthquake Engineering. 1986;5(2):75–83.

6.Hynes-Griffin ME, Franklin NG. Miscelaneous Paper. GL-84-13. Vicksburg, Miss, USA: US Army Corps of Engineers Waterways Experiment Station; 1984. Rationalizing the seismic coefficient method.

7.Romo MP, Seed HB. Computed and observed deformation of two embankment dams under seismic loading. Proceedings of the Conference on Design of Dams to Resist Earthquake; 1980; London, UK.

8.Seed HB, Lee KL, Idreiss IM, Makdisi R. Report. EERC 73-2. Berkeley, Calif, USA: Earthquake Engineering Research Center, University of California; 1973. Analysis of the slides in the San Fernando dams during the earthquake of Feb. 9, 1971.

9.Sawada S, Takahashi T. Study on the material properties and the earthquake behaviors of rock fill dams. Proceeding of 4th Japan Earthquake Engineering Symposium; 1975; Tokyo, Japan. pp. 695–702.