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EXTENDED ABSTRACT

Investigating the Effect of Geometrical Changes of Earth Dam Dimensional Parameters on the Assessment of Piping Failure Discharge with Considering Uncertainty in the Mechanical Properties of Materials

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1. Introduction

The aim of this paper is to study the uncertainty in piping failure of the Teton earth Dam with considering geometrical parameters and material uncertainty using the BREACH-GUI model. Piping phenomenon in the body of the dam is one of the two common factors in the dam failure, which is a small intubation in the early hours with low diameter and low flow rate, due to erosion of the tunnel walls, the erosion of the tunnel walls increases the diameter of the tunnel and the flow of water passing through It will be tunnel that, if this amount of flow exceeds a limit, it will break the body of the dam and ultimately lead to the complete destruction of the body of the dam. Predicting the main breach characteristics (size, shape, time of formation) and the break outflow hydrograph with Monte Carlo uncertainty simulation are presented in this paper. The model is physically based on the principles of hydraulics, sediment transport, soil mechanics, geometric and material properties of the dam, and the reservoir properties (storage volume, spillway characteristics, and time-dependent reservoir inflow rate).Obtained results show that, the critical uncertainty parameters that produce the shortest time and maximum discharge flow arising from dam failure are φ (frictional angle) and D50 (efficient diameter of soil). Obtained results show that earth dams with smaller shape factor fails faster and also with increasing in the level of water in the reservoir earth dam piping failure of dam intensify and also with increasing height of dam with constant shape factor the possibility of piping failure of dam is increased.

2. Methodology

2.1. Breach Model

This paper presents a mathematical model (BREACH) for predicting the breach characteristics (size, shape, time of formation) and the break outflow hydrograph. The model is physically based on the principles of hydraulics, sediment transport, soil mechanics, geometric and material properties of the dam, and the reservoir properties (storage volume, spillway characteristics, and time-dependent reservoir inflow rate). The dam may be either man-made or naturally formed as a consequence of a landslide. In either, the mechanics of breach formation are very similar, the main difference being one of the scales.

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2.2. Monte Carlo Metod

Monte Carlo simulations are used to determine the equilibrium phase behavior of surfactant-inorganic oxide-solvent systems, in which the hydrophobic/hydrophilic nature of the inorganic precursor is modified to study how this change affects the final structure of the hybrid material. Lattice Monte Carlo simulations in the canonical ensemble are used to model the aggregation behavior of the hybrid materials and to obtain the ordered porous structure in a system where phase separation occurs. The model used depicts the general behavior of the system such as the self-assembly of surfactants in complex aggregates, phase separation and the formation of ordered lyotropic liquid crystal phases. Hexagonal, lamellar, and perforated lamellar liquid crystal phases are observed at high surfactant concentrations. Ternary phase diagrams for partial and complete miscibility between the inorganic precursor and the solvent are reported.

3. Results and discussion

3.1. Impact in terms of uncertainty

According to Table 1, the results indicate that the two parameters φ , D50 are considered as uncertainty parameters in two cases, taking into account the minimum failure time of the dam with a time 1.902 hour and the maximum discharge flow at the moment of dam failure With 82486.9 cubic meters per second, the most critical condition is created. As a continuation of this paper, all computations are considered taking into account the mechanical parameters of soil Ø, D50 as uncertainty parameters.

Table 1. Types of failure scenarios

ID	Tpmin hrs	QpCorresponding ($\boldsymbol{m^3}$/s)	QpMAX ($\boldsymbol{m^3}$/s)	Tp.Corresponding hrs
certain	2.207739	60585.65	60585.65	2.207739
C	2.191748	58110.73	61268.01	2.196458
Phi	2.18862	59088.41	79170.21	2.232687
Gama	2.196155	61162.02	61173.13	2.196155
D50	1.913725	62827.52	62827.52	1.913725
C,phi	2.187682	64135.3	79170.21	2.232687
C,gama	2.191746	58110.73	61351.73	2.192313
C,D50	1.911417	54294.16	63197.66	1.933407
Phi,gama	2.189802	63086.5	80731.91	2.237497
Phi,D50	1.902005	66710.57	82486.90	2.141016
Gama,D50	1.912905	63148.89	63148.89	1.912905
C,P,G	2.190925	63397.29	80731.91	2.337497
C,P,D50	1.911867	54484.41	81926.27	2.145301
C,G,D50	1.910693	62882.24	63204.59	1.938530
P,G,D50	1.902100	66704.17	81926.27	2.145301
C,P,G,D50	1.911867	54484.41	81926.27	2.145301

3.2. Parametric design equations

If the failure caused by the piping is simulated, the reservoir's water surface should be greater than the height of the center of the pipeline channel line, which will be rectangular. The tunnel volume will increase due to erosion and the tunnels will collapse and become trapezoidal. The flow of water flowing through the erosion tunnel will be calculated by the relationship 1:

$$Q_b = A\left[\frac{2g(H-Hp)}{1+\frac{fL}{D}}\right]^{0.5} \tag{1}$$

4. Conclusions

According to the research on changes in the dimensions of the body of the dam, changes in the surface water and changes in the height of the pipeline can be found in the dam, which is briefly summarized as below:

The uncertainty parameters that produce the shortest time and maximum critical flow are *Ø* and D50 simultaneously. With increasing *HU/B*, the amount of flow and the lowest critical time are increased and reduced, respectively, which create the most critical situation among the geometric changes of the body of the dam. With increasing HI, the amount of flow and the minimum critical time will increase and decrease respectively. With increasing HU, the amount of flow and the least critical time will increase. With increasing HPI, the amount of flow and the lowest critical time oscillate respectively increase and decrease. The core core thickness with ZC change will not have much effect on the flow rate and critical time.

5. References

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