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Executive Summary: Teton Dam Failure Case Study

Background

The Teton Dam was built in Eastern Idaho by the Bureau of Reclamation between 1972 and 1976. Lack of irrigation water and continuous flooding caused by spring runoff brought about the need for a dam to be built along the Teton River. The earthen dam stood 305 feet tall and had a capacity of just under 290,000 acre-feet. On the morning of June 5, 1976, workers found multiple flows of water on the rock in the right embankment ranging between 1 and 25 cfs. Later that morning, a wet spot appeared on the downstream side of the dam about 20 feet from the right abutment. The seepage soon turned into seepage flow which lead to piping and washing out the embankment material. Although workers tried to fix the problem by using bulldozers, they were forced to alert officials, have the downstream area evacuate, and prepare for flooding. Just before noon, the piping caused slope failure, allowing the water to rush downstream. Damage from the flood ranged as high as 2 billion dollars, with the majority of the desolation occurring in the cities of Wilford, Sugar City, and Rexburg. The flooding caused 11 human deaths, and killed over 13,000 cattle. At the time, the Teton Dam failure was known as one of the most expensive disasters in the nation.

Analysis

Based on the construction plans that we were able to obtain and our UTEXAS analysis, the dam had an adequate slope-failure factor of safety of 1.7 on the upstream side and 1.2 on the downstream side. After the dam failed and the core was inspected, inspectors found that the core was coarser than the design permitted, and it acted more as a sand than an impermeable clay layer. To represent this, we also analyzed the dam using a coarser material for the core which resulted in factors of safety of 0.67 upstream and 0.94 downstream. The failure circles were much deeper than before.

We also did a seepage analysis for this dam and concluded that seepage had the largest impact on the dam failure. The surrounding material of the dam was rhyolite with large fissures big enough for people to walk in and explore. The construction company decided to fill the fissures with grout, but they were not as extensive as they should have been. All the fissures were not completely filled. This caused seepage through the fissures under the dam and leading to water flowing at the toe of the dam. Seepage also occurred near the right abutment of the dam where the failure occurred. Based on this information and our analysis in SEEP2D for the designed dam, there was a flow of 0.01 cfs/ft with all the flow going through the rhyolite foundation. We then changed the core of the dam to be a weaker and coarser material resembling a fine sand. The flow increased slightly to 0.015 cfs/ft, but about 30-40% of the flow went through the core. Other documents about the dam failure stated that the core would lose much of its strength and structure as water was introduced to the system. Seepage was the beginning of the dam failure which then triggered a slope failure, and it ended in a catastrophe.

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Conclusion

Our analysis shows that if the dam had been built with a more cohesive core and sufficient grouting of the rhyolite foundation, failure may have been avoided. Flow would have been constricted to around the dam through the permeable rock and not through the embankment. The flow through the core weakened the dam, and made the dam more susceptible to slope failure. The dam eventually failed due to seepage and slope failures which caused significant damage downstream.

References

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