Case Study: Big Bay Dam Failure

CEEn 544 – Seepage and Slope Stability

Dillon Bliler, Matthew Bayles

Background

The Big Bay Dam was constructed in 1991 and failed on March 12, 2004. It was built to be a dam holding back a recreational reservoir in Lamar County, Mississippi. The design for the dam was prepared by an amateur engineer whose focus was not in dam design. No software or prediction model was used to foresee seepage and stability. It was constructed with highly erodible materials and with several design flaws. The dam had no seepage filter and drain around the conduit, where the dam failed. The dam had no monitoring systems to look out for piping. Evaluation of the dam post-incident showed that the core was not made of a material with a sufficiently low coefficient of permeability despite being mixed with bentonite clay. The construction of the dam in 1991 also proved to be done by an amateur construction company and little inspection and quality assurance testing was performed on the materials used in construction. Inspectors of the dam identified seepage and wet spots on the downstream side of the dam as early as 1993 and later observed sinkholes and leakage including sediment into the culvert below the dam. After the dam failed, 104 structures were damaged and lawsuits ensued and a settlement of $1.1 million dollars was reached with further lawsuits continued for personal property damages.

Analysis

Alvi Associates out of Towson, Maryland performed a study and analysis of the Big Bay Dam Failure in 2015 which inspected the original designs, soil index properties and emergency action plans put in place prior to construction. Permeability values for the core of the dam were in the range of 10^-4 to 10^-7 cm/sec, far higher than typical allowable permeability values for similar dams. Alvi Associates found that the clay cutoff core of the dam was not deep enough to prevent high hydraulic gradient around the toe of the core. This high hydraulic gradient combined with the high permeability of the soils used in construction led to seepage and eventual piping. This slow percolation and movement of sediment occurred over 12 years but eventually led to failure. The ultimate failure of the dam originated out of the conduit which did not feature a seepage filter to prevent loss of sediment from the inside of the dam. An analysis has been performed by Alvi Associates and Matthew Bayles investigating hydraulic gradient if the clay core of the dam had been deeper. With a deeper core, less critical gradient may have led to less percolation and at a minimum a longer life of the dam and could have potentially avoided its failure.

Conclusion

The Big Bay Dam failure is an excellent case study including the topics of seepage and slope stability. It also illustrates the necessity for adequate professional geotechnical engineer review and later inspection of compliance with design in construction. By analysis, we learn the detrimental effects of non-compliance with safe dam design and quality assurance. If this dam had been constructed with respect for an analysis of seepage, piping and slope stability, the people of Lamar County, Mississippi may not have lost their homes and property.

References

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