

Project Name

Assistance with Safety Evaluation for Two Dams

Client

Richard Gillespie

Services Provided

- Geotechnical investigation, analysis and recommendations for the construction of the downstream dam to comply with the NJDEP requirements for Class III dams
- Design drawings and specifications for the refurbishment of a breached and partially constructed dam



Project Description

An existing farm pond on a 126-acre farm in central New Jersey had been breached in order to lower the water surface elevation so that the pond could be dredged. In addition, a large dam had been partially constructed downstream of the existing farm pond to form a second larger pond. Both projects were performed without design or the assistance of a professional engineer. The NJDEP performed a site visit and issued a written order to stop work. The NJDEP requested that a geotechnical evaluation be performed to assess the stability and safety of the dam, and that the owner comply with the Dam Safety regulations and permits.



Sadat Associates, Inc. (SAI) was retained by the owner to design a Class III dam to replace the partially constructed dam, to create a pond for fish breeding. The existing earth dam was constructed with residual clayey soils from the underlying shale bedrock formation.

Approach

SAI performed a site reconnaissance to develop recommendations to the client about the possibility of using the partially constructed dam to create the pond. The recommendations were formed by evaluating the dam's integrity and by proposing stabilization and rehabilitation measures to insure that the dam would perform its intended use safely. This approach would help the Client avoid the significant costs that would be required to remove the existing dam and construct a new one. The two main concerns regarding the evaluation of the performance of the earth dam were:

- a) Retaining the water in both ponds by minimizing the amount of seepage through the earth dam and percolation through the bottom of the pond; and
- b) Ensuring the stability of the earth dams of both ponds.



A geotechnical subsurface investigation was performed, which included eight Standard Penetration Test (SPT) borings. Six of the borings were drilled on top of the existing dam and two borings were drilled at the bottom of the pond. The six borings at the top of the dam extended to depths ranging from 14 to 22.5 feet below existing grades, and the two borings at the bottom of the pond were terminated 4 feet below grade due to refusal for further penetration. All recovered soil samples were delivered to the laboratory for examination and testing. Soil samples were classified and test boring logs were prepared.

In order to determine the soil physical characteristics, Atterberg Limits (ASTM D 4318) and Natural Moisture content (ASTM D 2216) tests were conducted. Shear strength of the natural soils was evaluated by performing Unconfined Compressive Strength Tests (ASTM D 2166) and Consolidated-Undrained Triaxial Tests (CU) (ASTM D 4765) on undisturbed Shelby Tube samples. In addition, soil permeability was evaluated by performing the Flexible Wall Permeameter Test (ASTM D 5084) on undisturbed Shelby Tube samples.

SAI examined several aspects of the earth dam to ensure the performance and stability of the structure. A seepage analysis was performed to determine the amount of water flowing through the dam. A flow net diagram was constructed for the existing dam. It was concluded that there was an excessive amount of seepage, and that remedial measures should be taken to reduce it. Accordingly, SAI recommended that the inside slopes of the dam be lined with a material of low permeability; specifically, a geosynthetic clay liner (GCL). In addition, the Factor of Safety against rapid draw down was calculated utilizing the Stability Charts developed by Spenser.

To insure the continued stability of the two dams, global slope stability and veneer stability of the GCL and the cover soil were performed. The slope stability analysis was performed using the computer program X-STABL. The program performs a two-dimensional limit equilibrium analysis to compute the Factor of Safety for a layered slope according to the general limit equilibrium method, Janbu's Generalized Procedure of Slices, Simplified Bishop, and Simplified Janbu. In addition, the veneer stability of each component of the linear system was evaluated, including the stability of the GCL itself, the GCL/subgrade soil interface and the GCL/cover soil interface. The stability of the GCL liner itself was calculated using the hydrated strength of the bentonite clay sandwiched between the two geotextiles. The stability of the GCL/subgrade interface and the GCL/cover soil interface were calculated utilizing the interfacial friction angle between the different surfaces.



Project Impacts

As a result of SAI's efforts, the Client avoided significant costs that would have been required to remove the partially constructed dam and to construct a new one. The new dam complies with NJDEP Class III Dam Safety Regulations. The constructed dam is performing its intended use safely and adequately.

SAI continues to inspect the dam periodically, to comply with NJDEP regulations and permit requirements.