B.F. Sisk Dam

General

B.F. Sisk Dam is a 300-foot-high zoned compacted earthfill embankment located on the west side of California's Central Valley approximately 12 miles west of Los Banos, California. The dam is over 3 ½ miles long and impounds San Luis Reservoir which has a total capacity of over 2 million acre-feet.

The dam was built between 1963 and 1967 to provide supplemental irrigation water storage for the Federal Central Valley Project and municipal and industrial water for the California State Water Project. Water is lifted into the reservoir for storage by the Gianelli Pumping – Generating Plant from the California Aqueduct and from the Delta-Mendota Canal via O'Neill Forebay. B.F. Sisk Dam (also known as San Luis Dam) is owned by the Bureau of Reclamation and operated by the California Department of Water Resources. Reservoir storage space is allotted 55 percent State and 45 percent Federal.

Geologic Investigations

The dam and reservoir are located in an area of high potential for severe earthquake forces from identified active faults, primarily the Ortigalita Fault that crosses the reservoir. The dam's foundation may be divided into two main areas, the abutments and the valley, each with different geology and separate issues. The

abutments are formed by soft sedimentary bedrock called the Panoche formation. However, most of the rock is covered by clayey material called "slopewash" which, as the name suggests, is formed by particles washed down the slope by precipitation. This material is much weaker than the bedrock, and it is of concern for deformation of the dam under earthquake loading. In the valley, the foundation is primarily sandy material deposited by flowing streams, referred to as "alluvium," with some clayey material deposited under still water in lakes or wetlands that existed in earlier geologic times. In much of the valley, the alluvium and lake deposits are several hundred feet thick.

In the early 1980s, Reclamation conducted an extensive investigation of the seismic safety of B.F. Sisk Dam. This included drilling holes to sample the soils and test their density in place, laboratory testing of the samples, and geophysical tests. The general conclusion of the analyses was that some of the less-dense soils could undergo liquefaction in a major earthquake. Liquefaction can occur in loose, saturated sand shaken by a major earthquake. It results in a major reduction in strength, and sometimes the sand can even flow like a liquid. However, a determination was made that liquefaction would not be sufficiently widespread to cause the slopes of the dam to be unstable. Using the simpler methods available at the time, the amount of predicted deformation that would occur under severe shaking would be small, and the conclusion was that the dam had no safety deficiencies.

By 2005, state of the art seismic analysis of dams had changed significantly and additional dam-safety investigations were performed. These included a reevaluation of the Ortigalita Fault, new understanding of the behavior of the soil materials including embankment fill under earthquake loading, and new computer-based analysis methods for predicting the behavior of the dam under various loadings. With the updated methods and earthquake loadings, the predicted settlement of the dam crest was almost as great as the minimum freeboard on the embankment for the most severe earthquake. Even now, state of the art analysis does not permit precise calculation of the amount of settlement that would occur and there is considerable uncertainty in the results. Although not likely, it is quite possible that the embankment deformation would exceed the available freeboard, resulting in reservoir overtopping the embankment and eroding a breach of the dam. Even without overtopping, it is possible that water flowing through cracks in the dam embankment could erode a breach as well.

Seismic Failure Modes

Seismic deformation and stability analyses were done for three typical sections of the dam: on the abutments where it bears on the clayey slopewash that covers bedrock, on the north side of the valley where it bears on sandy shallow alluvium, and the rest of the valley where it bears on deep clayey alluvium. For each section, there are two possible seismic failure modes: so much deformation of the embankment that the crest falls below the reservoir surface, with erosion of a breach by the overtopping flow, and enough cracking of the embankment that water flowing through the cracks can erode a breach.

Analysis of Risk

In an effort to balance public safety and costs for modifying dams, Reclamation uses a risk-based approach to making dam-safety decisions. The analysis of risk includes the probability of a severe earthquake in any particular year, the likelihood of dam failure if the earthquake were to occur, and the consequences of dam failure. The decisions are then based on Reclamation's Public Protection Guidelines. Reclamation and the California State Department of Water Resources recently completed a probabilistic risk analysis (PRA) that considers the earthquake deformation analysis and soil testing described above. A PRA consists of a detailed study of the chain of events that would have to occur and the likelihood of their occurrence in order for the dam to fail. Reclamation performs PRAs for all dams in the Reclamation dam safety inventory. For BF Sisk Dam, failure was determined to be very unlikely in any particular year; however, the consequences could be quite severe. As a result, the risk posed by the potential seismic failure modes does not meet the Public

Protection Guidelines, so there is justification to take corrective action. However, the risk is moderate and at present does not require a reservoir level restriction.

Corrective Action Study

Because of the risk being in excess of the Public Protection Guidelines, Reclamation determined that a Corrective Action Study (CAS) should be initiated. The corrective action study will include:

- additional detailed study of the potential extent of liquefaction in the foundation,
- additional geologic field investigation for assessing liquefaction susceptibility of the foundation soils and identifying borrow sources for construction,
- identifying a number of possible designs for modifying the embankment (or otherwise reducing the risk to the public),
- engineering and risk analysis of the proposed designs to verify that they would perform as needed, and
- selection of the preferred alternative, based on expected performance and cost

A cost sharing agreement between Reclamation and DWR was signed during September 2007. So far, work on the CAS has been limited to development of a Reclamation/DWR letter of agreement, project management planning, and preparations for corrective action alternative scoping activities. A detailed cost estimate for the CAS will be developed as the project progresses. Upon completion of the CAS, a modification report will be submitted to Congress for approval of the proposed corrective actions to reduce the risk.

An initial activity of the CAS will be to hold a Corrective Action Alternative Scoping Meeting. The Scoping Meeting is a brainstorming session to identify and screen possible corrective action alternatives. Participants at this meeting will include technical representatives from several water-user organizations, as well as representatives from Reclamation and DWR. The scoping meeting is tentatively planned for late 2007 or early 2008. This meeting will be held at B.F Sisk Dam. From that point, it is expected that the CAS would take 3-4 years to complete, ending with submittal of the Modification Report to Congress.

Final-design and construction phases will follow the CAS if a structural modification to the dam is selected as the preferred alternative. In accordance with public law, the construction contract can not be awarded until congressional approval of the Modification Report. However, final design and other activities are often started prior to that approval.

Funding and the Reclamation Safety of Dams Act

Reclamation will fund its portion of the project by means of the Reclamation Safety of Dams Act. The State of California will fund its portion of the project separately. Some of the provisions of the Reclamation Safety of Dams Act are as follows:

- The Secretary of the Interior is responsible for determining the need for risk reduction actions and selection of the actions to be implemented

- Any modifications performed may not provide new or additional benefits to the project

- Modifications are not to address reasonable and normal maintenance

- The cost of the modifications funded by the Act must be reimbursed. If the need for modification is due to a change in hydrologic, seismic, or the state-of-the-art conditions, the Act currently limits reimbursement to 15 percent of the total cost

- Reclamation must notify the project water beneficiaries of the need for risk reduction and explain the administrative and legal requirements

- Reclamation must provide opportunities for project beneficiaries to participate in development of plans for risk reduction actions

DWR Participation

Reclamation is taking the lead on the Corrective Action Study. However, DWR is an active participant and has participated in the Risk Analysis, has reviewed technical documents, and has participated in CAS formulation meetings. DWR and Reclamation have agreed to a 55 percent State/45 percent Federal cost share of the CAS. The cost sharing split is based on the cost-sharing agreement between DWR and Reclamation for the construction of the Joint Use Facilities.

Water Contractor Participation

During the process of developing and implementing a preferred risk-reduction action, water contractors are invited to participate in the process and to share thoughts and ideas for cost-effective means of achieving the required risk reduction. A program to involve water contractors is currently being developed. Initial elements of this program include issuance of notification letters, invitations to participate in the Scoping Meeting, and procedures to disseminate information and exchange ideas.

Contact Information

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