Partially Buried Reinforced Concrete Reservoir

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Project Description

The purpose of the project is to design a partially buried rectangular cast-in-place reinforced concrete reservoir with a 1.3 MG capacity. The reservoir will supply water to a residential area in Orange, CA. The design of the reservoir will consider loading based on California Building Code, ACI 350, and ASCE 7-16 with hydrodynamic loading due to seismic forces. Additionally, design software such as CAD and RISA-3D will be implemented. The design process consists of various structural elements such as the flat slab, roof, columns, walls, and footings. The roof will be partially covered with solar panels to implement a environmentally-friendly structure and will generate electricity for site security.

Design Criteria and Considerations

Design Criteria:

- Hydraulic considerations include demand and proper amount of water head pressure
- Environmental Considerations which includes California Environmental Quality Act (CEQA)
- ACI-350, ACI-350.3
- ASCE 7-16

Design Considerations:

- Volume of Tank
- Partially-buried
- Loading Conditions - Hydrostatic, Hydrodynamic (impulsive and convective)
- Operational, fire and emergency needs

Reservoir Location:
El Modena Open Space
Orange, CA 92869

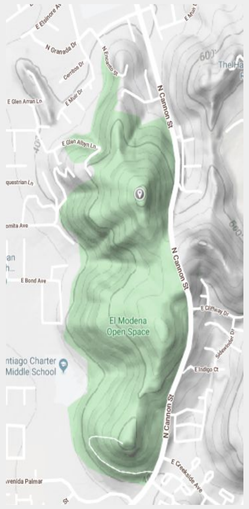


Figure 1: Topographic Map of the Site.

Loading

The loads that were considered to properly analyze the structure includes the **self-weight of the reservoir, roof live load, solar panels and lateral earth pressure** caused by the soil. Additionally, the stored water will impose **hydrostatic pressure** against the walls of the reservoir, and **hydrodynamic forces** during a seismic event.

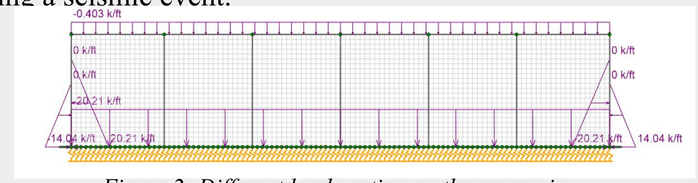


Figure 2: Different loads acting on the reservoir.

Structural Analysis

The structural analysis has been performed using an FEM software (RISA 3D), in order to determine the structural demands imposed by the loading mentioned above. The maximum ultimate (LRFD level) shear and flexural demands have been determined for an envelope solution that includes all load combinations, and will be used during the concrete design phase to establish the required concrete thickness and reinforcing size and spacing throughout all structural elements of the reservoir. Service level load combinations have been also introduced with the intent of determining ASD level flexural demands to be used in determining the environmental durability factor (Sd), as uniquely required by ACI 350 for environmental structures.

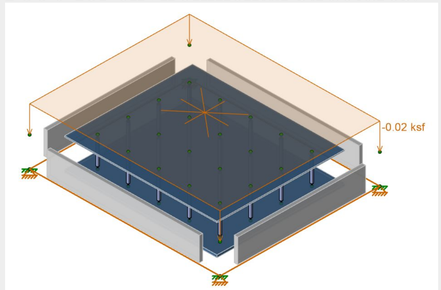
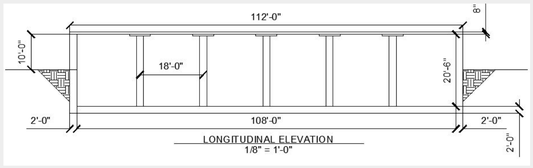


Figure 3: Preliminary RISA-3D Model.

Structural Design

The design of the reservoir follows an iterative process of determining the slabs, walls, columns and reinforcement detailing. The behavior of the mentioned forces on the structure are taken into consideration during the design process, which is based on the structural analysis results obtained from the RISA-3D model. The reservoir meets the ACI 350-06, ASCE 7-16 and California Building Code requirements.



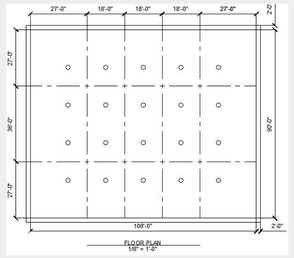


Figure 4: Profile and Plan view of the reservoir.

In order to assess the demand and capacity of the partially buried reservoir, design strips were created to design the two way slabs of the reservoir in the transverse and longitudinal directions. With the design strips and the appropriate load combinations applied to them as specified in *ASCE 7-16* modeled, the loading demand on the structure can be found as the beginning part of the analysis. The 3D rendered model, deflected shape, and moment diagram of each design strip are displayed below in Figures 5.1, 5.2 and 5.3 respectively.

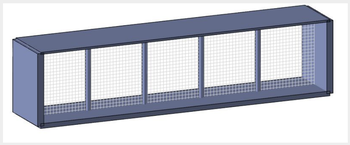


Figure 5.1: 3D Rendered model of the transverse design strip

Figure 5.1: Deflected Shape.

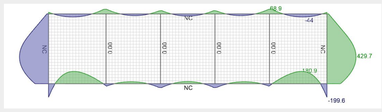


Figure 5.1: Moment Diagram.