Storage Tank Solutions

Capabilities

- Hydro test exemptions for atmospheric storage tanks following shell and/or floor repairs per API 653
- Analysis of excessive floor settlement of above-ground storage tanks
- Fitness-for-service including remaining life predictions considering a wide range of damage mechanisms
- Fixed roof design validation
- Earthquake risk assessment
- Corrosion assessment
- Leak-before-break assessment
- Recommendations for maintenance and inspection

Benefits

- Identification of critical areas reduces inspection scope, thereby increasing time efficiency and minimizing downtime.
- Critical flaw sizes help categorize existing flaws as safe or requiring immediate action.
- Remaining life estimates provide reliable guidance for determining appropriate inspection plans.
- Hydro test exemptions can save water, disposal costs and weeks of downtime.

Applications

- Tank farms
- Refining and chemical
- Syngas; e.g. ammonia production facilities
- Distribution facilities
- Municipalities

Hydro Test Exemption

- Hydro tests are required following repairs to the tank bottoms or shells; however, API 653 allows for an exemption, provided the structural integrity of the repaired area can be validated. A hydro test exemption can improve time, resource and cost efficiency.

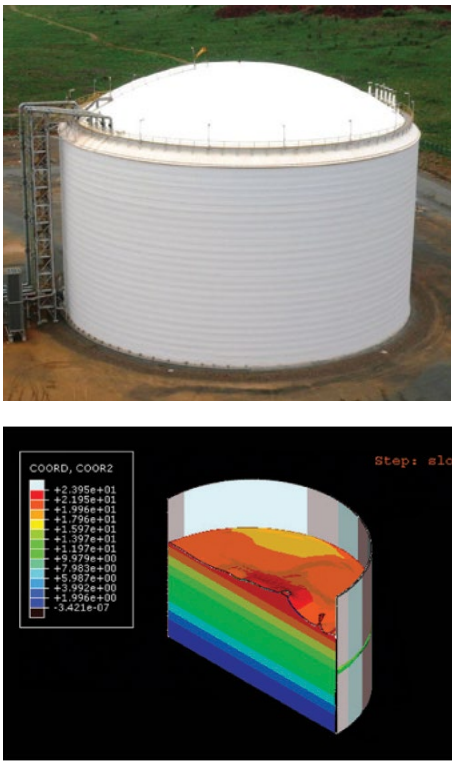

Figure 1. Dynamic analysis of tank subject to earthquake loads

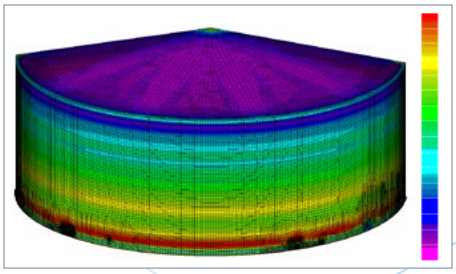

Figure 2. Hoop stress due to hydrostatic pressure

- API 653 Tank Inspection, Repair, Alteration and Reconstruction provides guidelines for the hydro test exemption procedure.
- We have completed a significant number of hydro test exemptions using this standard procedure.
- The assessment method employs finite element analysis (FEA) and measured fracture toughness values of welded samples.
- Comparing critical to maximum tolerable flaw sizes in the repaired area determines the acceptability.

Hydro test exemption is conducted given a history of safe tank operation and certain key quantitative operating values. The first is the determination of accurate stress values from the FEA. The second is the measure of material fracture toughness. A destructive test is performed using pieces of removed material from the repaired region, which are welded to the new plate material using the same welding procedure. The test provides fracture toughness results so that excessively conservative assumptions can be avoided.

Floor Settlement Analysis

The analysis can reliably predict the fitness-for-service and remaining life of the tank despite severe deformation, thereby avoiding unnecessary repairs and increasing operational and financial efficiency.

- Floor settlement measurements from internal inspections are used to create a highly detailed tank profile model for advanced stress analysis.
- The finite element analysis includes the properties from the underlying foundation; e.g. sand, concrete, structural fill, etc. The contact between the tank and the foundation is simulated using complex modeling techniques.
- The tank is analyzed through several fill cycles to ensure that future damage progression has ceased.
- Critical flaw sizes are computed at peak stress locations and compared with flaws easily detectable with UT, MT and PT inspections.

Fitness-for-Service Assessment

Confidently assess tanks for cracking, corrosion, deformation and remaining life to improve cost efficiency and save time.

- A fitness-for-service assessment typically includes a review of the operation, inspection and repair history to improve the overall understanding of the condition of the tank.
- Brittle fracture assessments are critical for atmospheric storage tanks operating at sub-zero temperatures.
- An assessment may include a leak-before-break evaluation. The leak-before-break evaluation follows guidelines in published fitness-for-service standards.
- Employing finite element and fracture mechanics analyses at the critical tank regions is central in determining appropriate future inspection plans and intervals.

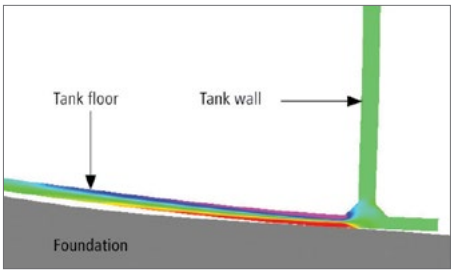

Figure 3. Floor settlement stress results on an axisymmetric model

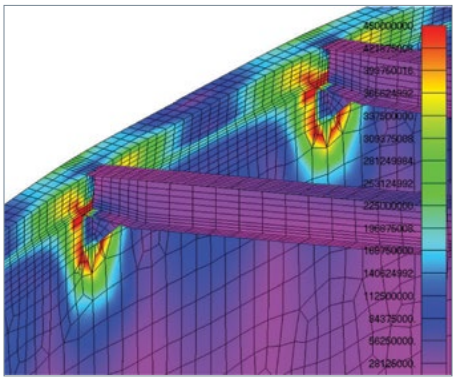

Figure 4. Stress analysis of a fixed roof connection

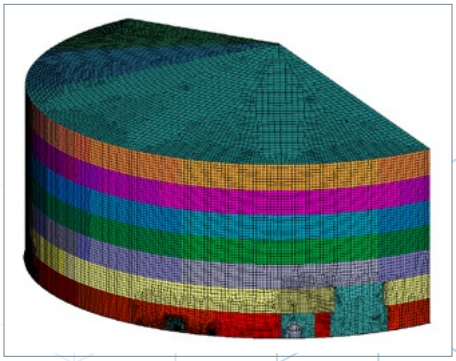

Figure 5. 1/2 symmetric model of storage tank with repairs