

RENEWWRAP[®]

Carbon Fiber Reinforced Polymer



STRUCTURAL STRENGTHENING

CASE STUDY:

Central, CA Grain Silo

OVERVIEW

A cluster of eight grain silos constructed in Central California in 2000 were recently strengthened with the RenewWrap™ carbon fiber strengthening system after one of the walls experienced a localized failure and a subsequent inspection revealed deficiencies in the quantity and detailing of the reinforcing steel.

Standing at approximately 150 feet tall and 44 feet in diameter, silo had 10-inch thick reinforced concrete walls. In 2014 a small section of one of the walls failed and collapsed into the interstice. The detailed inspection that followed found vertical cracking at various locations around the perimeter of the three silos and an as-built bar spacing that generally exceeded the original design spacing

SOLUTION

The owner was about to move forward with the same shotcrete solution used to repair on silo in 2005, when Ace Restoration & Waterproofing approached them with an alternate solution that involved using the RenewWrap™ fiber reinforced polymer (FRP) system. Ace assembled a design-build team to analyze and price various FRP strengthening scenarios and their disruption to the facility's operation. Finite element models were used to analyze multiple load cases including the impact of partially filling the interstices for stability in an attempt to optimize and reduce the cost of the repairs. After analyzing a number of approaches the designbuild team proposed installing the RenewWrap™ ESR CF600 carbon fiber strengthening system to the interior face of the silo wall.

Once the owner approved the proposal, scaffolding was quickly erected inside the silo to facilitate access to the entire wall surface area. The failed wall section was reconstructed using traditional cast-in-place techniques. The walls were then pressure washed to prepare the surface of the concrete to receive the RenewWrap™ FRP system. The cured FRP system was coated with an abrasion resistant coating to protect the FRP during normal filling/unfilling operations of the silo.

RESULTS

The silo was restored to its original design strength with practically no loss of storage capacity. The project was completed on time and on budget. The owner is now familiar with FRPs and is considering them for future projects.

PROJECT DETAILS

Location: Central, CA

Application: Grain Silo

Installation: March 2015

Contractor: Ace Restoration and Waterproofing

Owner's Engineer: Associated Design and Engineering, Inc.

FRP Engineer: KL Structures Group



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CASE STUDY:

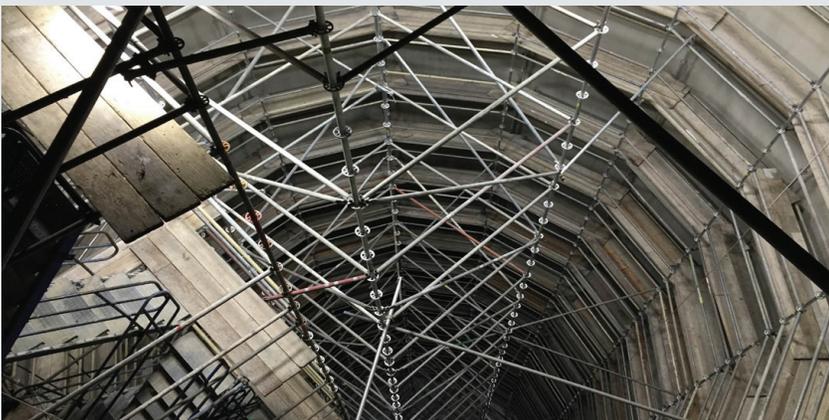
Central, CA Grain Silo



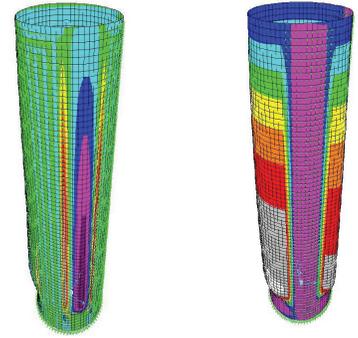
Failed wall section



Typical crack pattern in silo walls



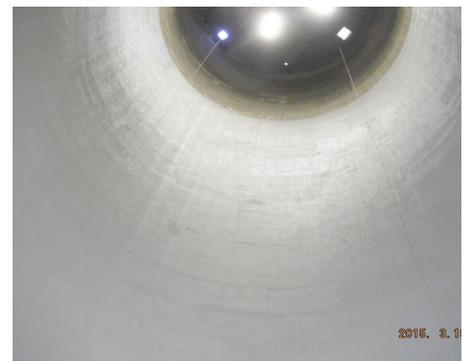
Scaffolding erected inside silo



Finite Element Analysis Output (ADD)



Hoop plies of RenewWrap ESR CF600



Completed silo



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