

Grain Silo Rupture Repair

by David Drake

Bartlett & Co. faced a huge cleanup job at its 6.9 million-bushel rail terminal in Wichita, Kansas in the fall of 1999. A grain silo 30 ft (9.1 m) in diameter and 130 ft (40 m) tall holding roughly 150,000 bushels (5300 m³) of high-protein wheat ruptured, creating a hole in the side measuring 35 ft wide by 65 ft high (11 m by 20 m). The result of the wheat running out of the silo created a vacuum inside the slipform concrete tank, sucking the roof down into the tank.

An investigation showed the cause of the rupture to be misplaced reinforcing bar, too few reinforcing bar laps, laps not staggered properly on each course, and reinforcing bar placed too close to the outer edge of the concrete, resulting in a "zipper effect" failure.

Repair Job

Bartlett brought in C-TEC, Inc. of York, Nebraska to handle the tank repair.

The first step in the repair process was to remove all of the damaged concrete and reinforcing bar. C-TEC workers on swing stage scaffolding and boom lifts used jackhammers and electric chipping hammers to complete removal of the damaged concrete down to the solid existing tank walls.

Before a new internal liner could be installed, repairs to the wall had to be completed. The repair was done in three sections to ensure safety and stability. Workers drilled and epoxied 4 ft (1.2 m)-long No. 5 reinforcing bar on 12 in. centers (300 mm) into the existing tank wall on each side and across the top and bottom of the hole. Then they installed vertical and horizontal reinforcing bars on 12 in. centers (300 mm) coinciding with the epoxied reinforcing bar.

Next workers tied forming to the backside of the reinforcing bar. They used a lightweight perforated metal form, rigid along its length but flexible across its width, allowing it to bend to fit the radius of the new tank wall. The big advantage of using this type of form is that it is left in place and shotcreted from the other side, eliminating the labor and time involved in stripping forms.

After workers completed the first section of reinforcing bar and forming, 3 in. (75 mm) of dry-mix shotcrete was applied to the outside of the form, covering the reinforcing bar. Once all three sections were finished, another inch of dry-mix shotcrete was applied and hand finished to a rubber float texture. This type of texture was desirable because the tank was to be painted after the shotcrete curing process was complete.

After the original tank wall was replaced, workers installed a complete steel reinforced shotcrete liner inside the original tank, working off of a swing-stage platform. They installed new vertical and horizontal reinforcing bar from the top of the hopper bottom to a height of 120 ft (36.5 m), near the top of the tank. They then applied 5 in. (125 mm) of shotcrete to cover the new reinforcing steel, leaving a natural gun finish.

Finally, the crew re-installed the roof by placing I-beams and metal decking on top of the tank wall. Workers used a concrete boom truck to place the reinforcing bar and concrete on the roof. Finally, the tank



Figure 1 (left): Ruptured grain silo after grain spill clean-up.

Figure 2 (below): Reconstruction of the silo wall.



was painted on the outside to match the rest of the facility. Greg Wurst, owner of the contractor company, commented "Shotcrete has always been used as a major part of repairing grain silos. It is the most cost effective method of achieving the needed strength."



David Drake is the Sales Director for C-TEC, Inc. of York, Nebraska. He has been involved in the concrete silo restoration business for over 24 years. He received Associate and Bachelor of Science degrees from North Dakota State University. Drake started in the silo re-

pair construction business in 1977 as a laborer and was promoted to foreman, then superintendent and then operations manager from 1990-1998. In 1998 he went to C-TEC, Inc. (www.cteconcrete.com) as the sales director. He has assisted in many new product developments throughout the years to meet the special construction needs in the grain industry.

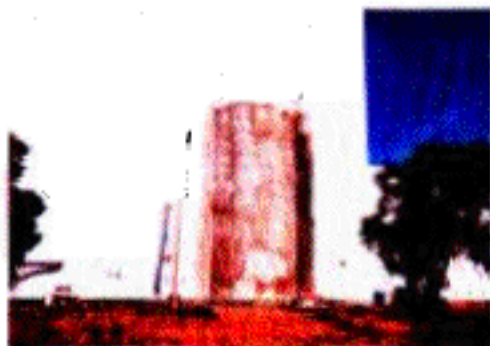


Figure 3 (above): Final repair work prior to painting

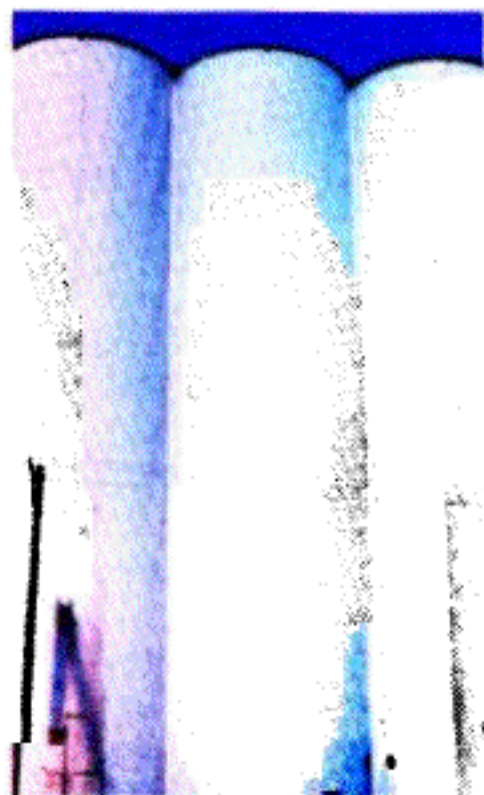


Figure 4 (right): Final result.