Repair specialists describe how to strengthen a shear wall, protect post-tensioning tendons, and color-match a patch

Concrete Repair Case Studies

Earthquake damage to historic courthouse

By Pete Barlow, Contech Services, Seattle

In July 1999, a magnitude 5.1 earthquake struck the Satsop/Montesano area of Washington about 70 miles southwest of Seattle. The three-story historic Gray's Harbor County Courthouse sustained significant seismic damage. By winter of 2000, my company was participating in the reconstruction of the courthouse by installing glass composite materials to strengthen the concrete shear walls.

General contractor Roglin's, Aberdeen, Wash., exposed the shear walls by mechanically removing all plaster. The walls had significant areas of rock pockets and poorly consolidated concrete. These areas required repair before the composite material could be installed.

Rock pocket repair consisted of chipping the unconsolidated concrete with pneumatic hammers. Workers first saw cut the area perimeter with dry diamond blades, then sandblasted and prewetted the wall surfaces to develop a surface-saturated dry condition. They then constructed plywood forms with bird's mouths at the top to facilitate concrete placement. A pre-bagged proprietary concrete mix was placed and consolidated. The mix was rapid-curing so that installation of the composite materials could proceed a few days later.

After the four wall surfaces were mechanically prepared and vacuumed, workers applied a saturated epoxy that was modified with inert fillers. This epoxy acted as a primer and smoothing compound. At the same time, we were saturating the glass-fiber composite with a neat epoxy saturating resin using an impregnator/saturating machine. Once the material was saturated, it was cut to appropriate lengths and transported to wall locations. A crew of three workers installed the composite the full height and width of each wall. Before the final set of the composite, they set fiber anchors along the perimeter of the fiber to anchor the edges and to transfer stresses back into the concrete elements.

In February 2001, this area suffered another earthquake with a 6.8 magnitude and an epicenter that was less than 30 miles away; an inspection showed that the courthouse and the composite-strengthened walls came through undamaged.

Glass-fiber composite fabric was used to repair shear walls in the earthquake-damaged Gray's Harbor County Courthouse.

CONTECH SERVICES

Protection of unbonded tendons

By Myles A. (Tony) Murray, Restruction Corp., Sedalia, Colo.

Increasingly, contractors face demands to repair parking garages and other structures that have unbonded post-tensioning tendons. These tendons must be protected from corrosion that could lead to failure of the tendon and eventually of the entire structure.

On one recent project, we found the unbonded tendons in the top deck of a two-story parking garage had been exposed to corrosion because de-icing salt and water had penetrated the protective sheathing through tears, punctures, and the unprotected ends of the tendons. The protective greases had deteriorated over time and allowed this water to fill the voids between the exterior wrap and the steel strands.

To protect the strands from corrosion, we injected specially formulated polyurethane into the strand sheaths

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This parking structure was repaired by encapsulating the unbonded tendons with polyurethane that was injected into the tendon sheathing.

using a patented system.* The strands are normally located by first finding the dead and live ends of the strands. A short piece of the prestressing strand, ½ inch to 1½ inches long, normally extends beyond the bulkhead of the live end. Although unbonded tendons are usually in a straight line, in this case we found them to be offset between the dead and live ends.

In this project, the tendons were installed straight for a distance of 192 feet. The structural engineer helped to estimate the high and low points of the strands, and we used a pachometer (metal detector) to confirm the locations. The high points were easily identified because they were partially exposed at the surface. We exposed the low points to monitor the flow of the polyurethane—this is when the water was found in the tendon sheathing.

Injection ports similar to those used for epoxy injection were mounted on the tendons to allow the transfer of the polyurethane into the sheathing to fill the void system around the tendon. Once the ports were installed, we forced compressed air into one end to determine if air could flow through the sheathed tendon system and if any free water was present. We then injected urethane at one high point and one low point. Injection ports were installed at the tendon ends to monitor the polyurethane flow. Once completely filled with polyurethane, we cut the sheathing at several points to verify curing and strand encapsulation. Finally, we sandblasted the ends to remove corrosion products and painted them with a zinc-rich paint.

*For information contact Jamor Engineering at 403-291-3925 or **circle 2** on the reader service card.

Improving the appearance of patch repairs

By Paul E. Gaudette and Deborah Slaton, Wiss, Janney, Elstner Associates, Northbrook, Ill.

Many patch repairs to existing concrete must match the adjacent concrete. Patches have often been installed, however, that do not properly match the color and finish of existing concrete.

We were asked to correct a poor match on patches that had been recently installed on a 1920s concrete structure. The localized cementitious patches were noticeably lighter in color than the adjacent concrete. But since the patches were structurally sound, well-bonded, and matched the texture and finish of the original concrete, the owner did not want to remove and replace them.

Changing the color of the original concrete rather than that of the patches was not an option because the original concrete was considered historic construction. Therefore, we needed repairs or coatings that could change the appearance of the patches without adversely affecting their performance. The problem was complicated by the fact that the original substrate was not coated, meaning that a pigmented coating could not be used to cover the patches and original concrete. The owner wanted good serviceability and low maintenance from any repairs, so the repair system selected had to have a good history of use in similar applications.

Materials that would change the appearance of the patches to more closely resemble the original concrete included abrasive surface treatments, chemical surface treatments, and non-film-forming stains. We found that abrasive surface treatments (power washing, sandblasting, or microabrasion) altered the surface texture but did not change the color. Chemical surface treatments (proprietary detergent or mild acid cleaners) changed the surface appearance by cleaning or bleaching the concrete, removing the paste, or etching the aggregate but also did not provide a color match.

The solution was non-film-forming pigmented stains, which we found effective in altering the color of the repair concrete to match the original material. A proprietary water-based resin-and-pigment coating, used on other projects as a stain for blending new concrete block with adjacent existing construction, had several advantages for this repair. The stain was effective in changing the patch color, was vapor-permeable, and did not add a visible surface film. A relatively transparent film-forming coating was also evaluated but was not as effective as the stain in achieving a color match. ■

A non-film-forming pigmented stain provided a good color match to the original concrete and lower maintenance for the owner of this historic structure. Upper right is the original repair, lower right is the modified repair, and the left side is the original concrete.

WISS, JANNEY, ELSTNER ASSOCIATES