VETERANS ADMINISTRATION MEDICAL CENTER BUILDING 1 SEISMIC CORRECTIONS

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Fig. 1: VAMC, San Diego, CA

The San Diego Veterans Administration (VA) Medical Center (VAMC) is located on La Jolla Village Drive in San Diego, CA (Fig. 1 and 2). It is run by the VA's Veterans Health Administration, the nation's largest healthcare system. They turned to composite strengthening for seismic upgrades for this project in 2006.

The San Diego VAMC is a five-story building that opened on the University of California, San Diego (UCSD) campus in La Jolla, CA, in 1972. Considering the current events in the Middle East, it has now become perhaps the most important hospital in the VA system for the following reasons:

1. As California Senator Diane Feinstein recently noted, "The San Diego region has the largest number of soldiers from Iraq and Afghanistan transitioning back to civilian life in the country. With 2.3 million veterans, California has the largest veteran population in the nation and there are about 274,000 veterans living in San Diego County, many of whom increasingly rely on VA healthcare."
2. The center provides medical, surgical, mental health, geriatric, spinal cord injury, and advanced rehabilitation services to veterans.
3. The center has 238 hospital beds, including skilled nursing beds, and operates several regional referral programs, including cardiovascular surgery and spinal cord injury.
4. Veterans from as far back as World War I and as recent as Iraq and Afghanistan come to the VAMC for their medical care.

Fig. 2: View of walkways

PROBLEMS THAT PROMPTED REPAIR

California Senate Bill 1953, enacted in 1994, required all hospitals in the state of California to meet stringent guidelines for seismic resistance by 2008. In part to satisfy this requirement and in part

Fig. 3: Concrete surface preparation on walkways

Fig. 4: Application of primer coat to walkways

to meet the growing demand on the VA medical system, the VAMC in San Diego initiated seismic corrections to Building 1 on the VAMC campus.

As part of the seismic corrections, the stair towers, which carry the majority of the lateral loads in a seismic event, were removed and replaced with stronger and stiffer braced steel frames. The stiffer frames and higher seismic forces demanded that the structural slabs carry additional shear diaphragm forces. In areas where the structural slab was penetrated by stairwells, elevator shafts, and so on, these diaphragm forces became too great for the slab to support. Thus, the floor slabs had to be reinforced in these areas.

Because the VAMC is a functioning hospital, it was critical to complete the reinforcement of the structural slab with minimal disruption to the operation of the hospital.

INSPECTION/EVALUATION

The building was analyzed using structural modeling to determine where the slab needed to be reinforced and the forces that the reinforcement would need to resist.

Direct tensile bond testing, in accordance with ACI 503R, was performed to determine the level of bond forces that the structural slab could withstand. These tests were used to determine whether an externally bonded reinforcement system would be appropriate.

REPAIR SYSTEM

The concrete was strengthened with an externally bonded fiber-reinforced polymer (FRP) reinforcement system. The system consists of a dry fabric constructed of very-high-strength, aerospace-grade carbon fibers encapsulated in high-performance polymer resin. These fabrics are applied to the surface of existing structural members in buildings, bridges, and other structures. The result is an externally bonded FRP reinforcement system that is engineered to increase the strength and structural performance of these members. Once installed, the system delivers externally bonded reinforcement with outstanding long-term physical and mechanical properties.

Fig. 5: Carbon-fiber fabric being applied to walkways

Fig. 6: Schematic of the completed layout of carbon-fiber fabric strengthening

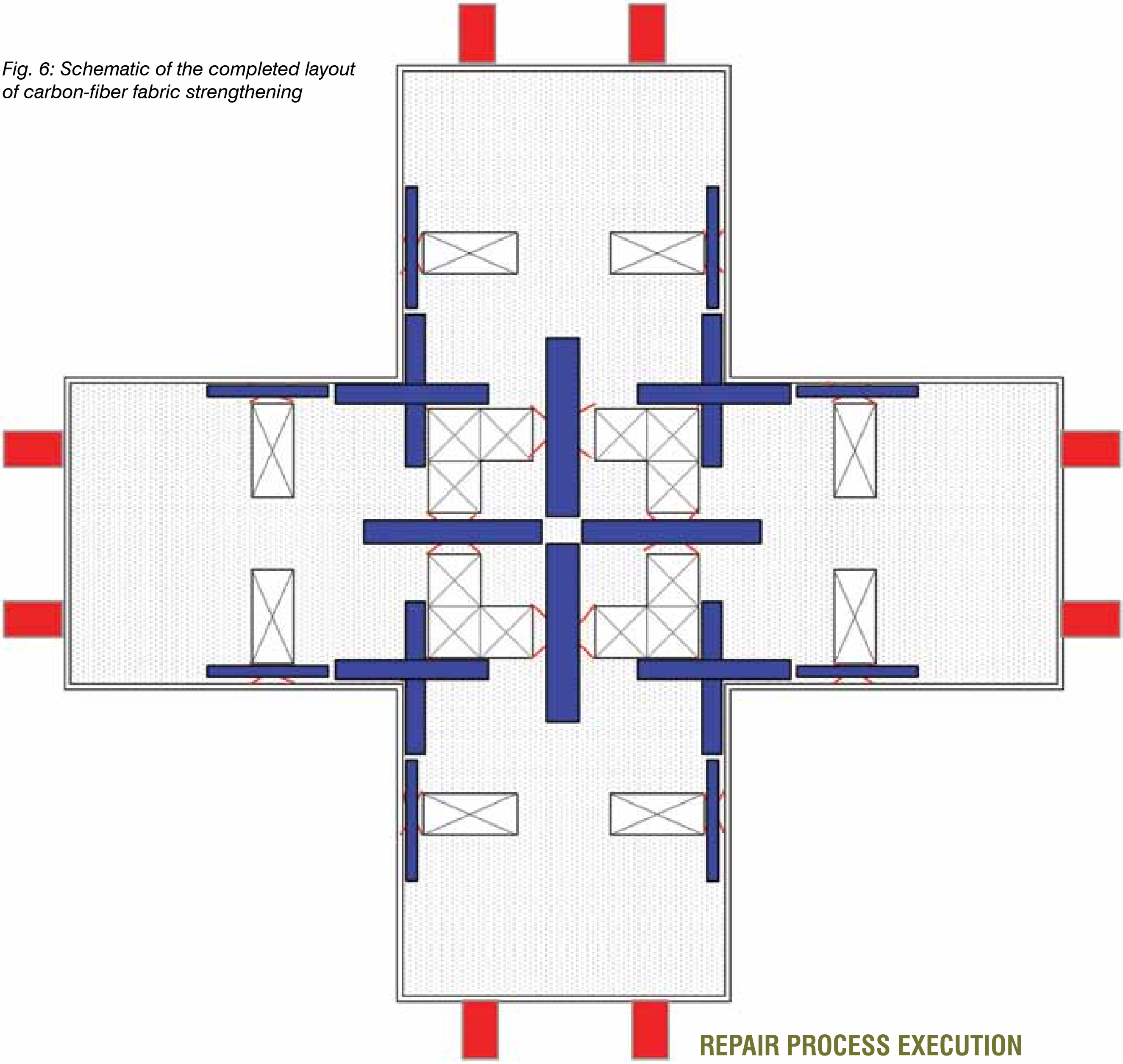

Fig. 7: Milled-down surface of walkways

REPAIR PROCESS EXECUTION

The following were the actual steps in the repair and strengthening process:

STEP 1—REMOVAL OF WALKWAY COVERINGS AND CONCRETE SURFACE PREPARATION

The concrete surfaces first had all the walkway coverings removed with mechanical scrapers (Fig. 3).

After the removal of the coatings, all the deteriorated and unsound concrete was removed. In accordance with ICRI Technical Guidelines, small-sized demolition hammers were used to avoid damaging the underlying concrete. After the removal of the unsound concrete, the surface was cleaned of all dust and other bond-inhibiting materials by abrasive blasting.

STEP 2—PRIMER APPLICATION

After the surface was cleaned, a low-viscosity, 100% solids, polyamine-cured epoxy primer was rolled onto the surface. This first-applied component of the system is used to penetrate the pore structure of cementitious substrates and to provide a high-bond base coat (Fig. 4).

STEP 3—EPOXY PUTTY

The next step was the application of a 100% solids, non-sag epoxy putty. This is used to level small surface defects and provide a smooth surface to which the system will be applied.

STEP 4—EPOXY SATURANT

The saturant is a 100% solids, low-viscosity epoxy material that is used to encapsulate carbon, glass, and aramid-fiber fabrics. When reinforced with fiber fabrics, the saturant cures to provide a high-performance FRP laminate. The resulting FRP laminate can provide additional strength to concrete, masonry, steel, and wood structural elements.

STEP 5—PLACEMENT OF CARBON-FIBER FABRIC AND ENCAPSULATION WITH SATURANT

The fabric is constructed of very-high-strength, aerospace-grade carbon fibers. These fabrics were applied to the surface of the existing structural member and then encapsulated with another layer of epoxy saturant (Fig. 5 and 6).

UNFORESEEN CONDITIONS FOUND

As the FRP system was being installed, other architectural changes were being incorporated into the building as well. Interior walls were being relocated and new roofing systems and new flooring were being installed. The design and installation of the FRP system in many areas had to be modified "on the fly" to adapt to the ever-changing obstacles to placement of the FRP material. In addition, several layers of the FRP system were required, in some areas, to meet the force demands. In areas where multiple layers were applied, the FRP system had to be installed beneath the surface of the slab to allow for placement of a vinyl composite tile floor. The surface of the concrete was milled down to the appropriate level in these areas (Fig. 7).

The project used over 36,000 ft^2 (3345 m^2) of carbon-fiber composite fabric and over 1000 gal. (3785 L) of epoxy primer, putty, and saturant combined. The project was completed on time with minimal disruption to hospital activities.