

# Changing the Face of Construction

**High strength composite technology protects masonry buildings.**

**C**an you envision a world where masonry buildings absorb the shock of bomb blasts without toppling? Where unreinforced masonry buildings maintain their structural integrity through hurricane-force winds and raging waters? Where, in less than a month, a 100-year-old brick building can be made new again – only stronger?

One scientist at the University of Arizona imagined just such a world, and the company he co-founded (HJ3 Composite Technologies, Tucson) transformed his research from a possibility to a reality.

Dr. Hamid Saadatmanesh is a leading researcher in the field of high strength composite systems designed to strengthen infrastructure. In 1994, he began developing carbon and glass composites that allowed masonry walls to survive earthquakes. Through a three-year research effort, Dr. Saadatmanesh proved that composite straps of carbon and glass fab-

rics could turn a weak and brittle masonry structure into a strong and ductile building. “The walls could cycle back and forth continuously under simulated seismic forces without any signs of structural failure,” said Dr. Saadatmanesh.

In 1997, Dr. Saadatmanesh was issued a patent for his method of strengthening concrete and masonry walls.

## What are high strength composites?

This technology combines the strength of materials such as carbon or fiberglass with the durability of high grade plastics. The carbon or glass fibers are woven into a fabric that is less than 1/32-inch thick. The fabrics are then saturated with a solvent free epoxy system that wets the fibers and provides adhesion of the fabric to the repair surface. Within 24 hours, the system cures and the adhesion transfers the strength of the fabric to the substrate.

The system is similar to external

reinforcement with steel. The live loads created from earthquakes, blasts, and hurricanes pass through the masonry substrate and into the adhered carbon or glass composite system. “However, the differences between high strength composites and steel are considerable,” said Dr. Saadatmanesh.

“We can achieve strength equal to that of 1/4-inch steel in a package that weighs less than 4 ounces per square foot and is less than 1/16-inch thick. In addition, the systems do not corrode and can withstand the most severe acidic or alkaline environments.”

These flexible materials are easy to install and can fit in hard to reach places without the removal of obstructions from the surface of the wall. The lightweight nature of the material eliminates the need for heavy equipment and because the materials are epoxy-bonded to the area of repair, coring, welding, and bolting are not necessary.

About 30,000 square feet of reinforced concrete tilt-up walls at a facility in Phoenix were repaired with a hybrid carbon/S-glass wrap to provide seismic protection and lateral shear reinforcement.



### How are they installed?

Proper surface preparation determines the success of high strength composite systems. All masonry surfaces must achieve a surface profile similar to 60-80 grit sandpaper and must be cleaned of all dirt and debris.

Once proper surface preparation is achieved, 20 mils of saturating resin are applied to the substrate, the carbon or glass reinforcing material is laid dry against the saturating resin, and an additional 20 mils of saturating resin are applied to fully wet the material and bond it to the substrate. Additional layers of reinforcing material can be applied to achieve higher levels of strengthening.

### Masonry applications

HJ3 focuses its research and development efforts on creating unique solutions for strengthening masonry. In 2005, the company introduced ArmorWall, which is designed to strengthen bowing and cracked foundation walls. The product is packaged

in kits that include rolls of 4-inch wide pre-cured carbon straps and a single component epoxy that bonds the carbon straps to foundation walls. Each strap is less than 1/8-inch thick, but delivers tensile strengths equivalent to a 3/8-inch steel plate.

Like steel I-beams bolted to basement walls, the carbon straps counteract external soil pressure that causes walls to crack and bow. Unlike steel I-beams, however, the carbon straps create minimal surface loss and easily blend into the wall surface,

## HJ3 Composite Technologies

The company was founded as a vehicle to catapult the science of high-strength composite materials out of the University of Arizona research laboratory and into the construction and defense industries. To date, the company has manufactured and supplied over 1,000,000 square feet of composite reinforcing materials.

Applications include strengthening traditional concrete and steel structures, such as beams, columns, walls, and slabs. The company also specializes in the repair of concrete, steel, and composite pipes.

To support its clients, HJ3 offers full turnkey design services. "We specialize in engineering solutions for our clients," said John Nighswander, co-founder of HJ3. "We have invested heavily in our engineering capabilities to support customers in each step of the process, from identifying the feasibility of composites for a particular project to preparing full calculations and CAD drawings."

Surveys performed by the company indicated that only a small percentage of engineers have ever used high strength composite materials. Therefore, HJ3 is releasing design software in 2006 to help consulting engineers incorporate high strength composite materials into their applications.

For more information, visit [www.hj3.com](http://www.hj3.com).

creating an aesthetically pleasing repair.

Another system – Blastek – is comprised of advanced carbon fiber composites specifically engineered for the mitigation and containment of blast energy. “The concept is similar to retrofitting walls for earthquakes,” said Dr. Saadatmanesh.

“Most walls are not designed for the live loads created by impact or blast waves. The inertia from these events causes the walls to cycle back and forth, weakening the mortar joints and crushing the masonry, which leads to collapse.”

In testing sponsored by the Department of Defense at the Energetic Material Testing and Research Lab in New Mexico, 212 pounds of TNT were detonated 33-ft. away from two unreinforced masonry walls – a control specimen and a wall retrofitted with Blastek. The explosion created a blast wave at the face of the unreinforced masonry walls that measured a peak load of 180 psi.

Upon impact, the control specimen was obliterated, but the wall retrofitted with Blastek remained completely intact. The system allowed only 1.4 of the 180-psi force to transfer to the other side. Following the explosion, vibration in the wall quickly attenuated and it came to rest in the original position.

The application of high strength composites to masonry in need of structural repair, retrofit, seismic upgrading, and blast protection represents the beginning of the transformation the materials could deliver to the construction industry. While the technology provides unprecedented benefits to standard masonry construction, it also offers solutions as the industry confronts new challenges, such as the damage caused by the earthquakes that sacked major cities in Iran, Pakistan, and Turkey and the hurricanes that ravaged the south last year.

*Jim Butler is president and co-founder of HJ3 Composite Technologies, Tucson, Ariz.*

*Mr. Butler has 10-years experience in business development for engineered systems within the industrial and construction markets, including high strength composites, corrosive resistant polymers, industrial automation, and robotics. He holds a Masters of Business Administration degree from the University of Arizona, Eller College of Business, with a focus in finance and entrepreneurship.*



In testing sponsored by the Department of Defense, two unreinforced concrete masonry walls were constructed within a larger containment structure, with each wall being 8-ft. wide x 11-ft. high. One wall served as the control specimen (below left), and the other was retrofitted with Blastek inside and outside (above and below right). A TNT explosive blast destroyed the control wall, while the protected one remained intact.

