Solutions Looking for Problems...

Carbon WRAP Solutions LLC

- beams
- columns
- blast
- walls
- slabs
- pipes
- protective coatings
- polymer concrete
carbonWrap™ Solutions, LLC is committed to providing turnkey innovative products and solutions for repair and retrofit of structures, using Fiber Reinforced Polymers (FRP). Our FRP line of products have been used in numerous concrete, masonry, steel, and wood structures around the world to increase their strength and ductility, and to make the structures last longer at a fraction of the cost and time of conventional materials and techniques.
A Brief History

In 1987, Dr. Hamid Saadatmanesh, Ph.D., P.E., professor of structural engineering at the University of Arizona, invented and pioneered the application of Fiber Reinforced Polymer (FRP) technology for upgrading of structures. He introduced this technology by publishing the first article of its kind in the American Concrete Institute (ACI) magazine in the late 1980’s. Since then, Dr. Saadatmanesh has developed many innovative applications of FRP for repair and retrofit of a variety of structures. He has published over 100 technical articles on this subject and has received numerous awards for his contributions to the understanding of FRP technology and its application in construction, such as the National Science Foundation Young Investigator Award.

Dr. Hamid Saadatmanesh, the President and CEO of CarbonWrap™ Solutions, LLC, has lead the commercial applications for FRP technology since 1994, including many of the first and pioneering projects. Since then, his companies have installed hundreds of thousands of square feet of FRP materials on a variety of structures, such as buildings, bridges, pipes, tanks etc. Because CarbonWrap™ Solutions, LLC is the originator of FRP technology in construction and focuses exclusively on FRPs, it is able to provide exceptional support for its clients throughout a project’s life from concept to design, materials supply, and installation (turnkey). CarbonWrap™ Solutions is committed to treating each client with integrity and respect, and to understanding the specific problems of each individual client so that it can customize a solution to meet each specific need.

For more information on our services, please visit www.CarbonWrapSolutions.com.
What is FRP?

The basic constituents of FRP are fibers such as carbon, aramid and/or glass, and a resin matrix. CarbonWrap™ Solutions, LLC supplies all types of fibers, as needed for specific projects.

The fibers come in the form of a flexible fabric that is saturated in the field and is bonded to substrate, using a specially formulated structural epoxy. The fiber/resin composite also comes in the form of pre-cured strips for application to surfaces that are smooth and can handle the relatively rigid strips.

ADVANTAGES INCLUDE:
- Corrosion proof
- Light-weight
- High strength
- Easy to install
- Flexible
- Low cost
- Costs less
- Requires less installation time
- Lasts longer
- Does not change original features of structure, i.e., (univasive)
- Requires minimal access for installation
- Adds only an eighth of an inch to the thickness of the original structure, preserving floor space
- Does not add to the weight of the structure
- Adds significant strength and ductility to the structures, without adding mass

The strength-to-weight ratio of FRP exceeds fifty-times that of steel.
Beams-Concrete
CarbonWrap™ can increase flexural and shear strength of concrete beams. For flexural strengthening, CarbonWrap™ is bonded to the tension face. For shear strengthening, CarbonWrap™ is bonded to the web of the beam.

Advantages
- Increases flexural strength
- Increases shear strength
- Does not reduce overhead clearance
- Light-weight and easy to install
- Costs less than alternatives

Beams-Steel
CarbonWrap™ is used to increase strength and to repair cracked steel girders. The full capacity of cracked girders can be restored by bonding CarbonWrap™ to the girder. Millions of fatigue cycles of the repaired girders showed no distress or delamination of the CarbonWrap™ from the steel.

Advantages
- Restores full capacity of cracked girders
- Increases flexural capacity
- Increases fatigue life
- Eliminates stress concentration and residual stresses due to welding
- Increases stiffness
- Costs less than alternatives

Test results show that the damaged and repaired girder is stronger than the original undamaged girder.
COLUMNS-CONCRETE
CarbonWrap™ is used to increase ductility and strength of concrete columns. Due to the beneficial effects of confinement, the column ductility is significantly increased. In addition, CarbonWrap™ helps to make up for inadequate amount, or improperly detailed lateral ties and increases the shear strength of the columns significantly.

ADVANTAGES
- Increases ductility
- Increases shear strength
- Increases axial load carrying capacity
- Light-weight and easy to install
- Can be wrapped along columns with varying cross section
- Costs less than alternatives such as steel jacketing

POLES/HOLLOW STEEL TUBES
Light Poles-Steel/Wood
Salt River Project (SRP), an Arizona utility company and the owner of thousands of light poles, has avoided replacing corroded and deteriorated light poles and has saved significant amount of time and money by relying on an innovative technique developed by Dr. Saadatmanesh, the President and CEO of CarbonWrap™ Solutions, LLC. The technique results in retrofitted poles that are stronger and last longer than new ones at a fraction of the time and cost of replacement. SRP has used this technique on thousands of its light poles.
Blast

A highly effective energy dissipating CarbonWrap™ system invented by Dr. Saadatmanesh, the President and CEO of CarbonWrap™ Solutions, LLC can provide remarkable strength to structures against explosions. The system dissipates the blast energy and reduces it significantly before it reaches the framing of the structure.

TEST SITE: BEFORE BLAST
Two identical concrete block walls were built. One was retrofitted with CarbonWrap™; the other was used as the control wall.

TEST SITE: DURING BLAST
Blast impact resulting from over 200 lbs of TNT hits the wall. Measured surface pressure was 185 psi.

A. Unretrofitted Masonry
B. Retrofitted Masonry

TEST SITE: AFTER BLAST
Unretrofitted wall: Destroyed
However, the retrofitted wall survived the blast completely protecting the inside.
Strengthening of Masonry and Brick Walls

CONCRETE MASONRY AND BRICK WALLS
CarbonWrap™ significantly increases the in-plane and out-of-plane strengths of un-reinforced masonry and brick buildings. It is very light-weight and is applied to this type of structure in a manner similar to wallpapering, but at the same time it provides significant strength as if shotcrete had been applied to the structure. The salient benefits of CarbonWrap™ for this application include:

ADVANTAGES
- Increases out-of-plane flexural strength
- Increases in-plane shear strength
- Adds insignificant weight to the existing structure
- Requires no foundation modification, since it does not add to the weight of the structure
- CarbonWrap™ is less than 1/8 inch thick and therefore, does not result in any loss of floor space
- CarbonWrap™ converts a brittle, unreinforced masonry structure into a reinforced and ductile structure by making all masonry units work together
- Fast and easy to install
- Costs less than alternatives such as shotcrete
Concrete Slabs

CONCRETE SLABS
CarbonWrap™ fabrics or strips are bonded to the bottom of slabs (positive moment regions) or to the top of the slab (negative moment regions) to increase flexural capacity.

ADVANTAGES
- Increases flexural strength
- Reduces deflections
- Light-weight and easy to apply
- Protects slab from further environmental damage
- Costs less than alternatives

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Concrete and Steel Pipes

CONCRETE PIPES
One of the most effective and economical applications of CarbonWrap™ is in strengthening of buried pipes. Concrete and steel pipes can be strengthened to take pressures even greater than that of their original design value at a fraction of the cost and time of alternatives. In the case of 3 foot and larger diameter pipes, simple access is made through the manholes and all operations are conducted internally. If the pipe can be accessed from the outside, the wrapping can be performed on the outside face of the pipe; resulting in the same benefits.

STEEL PIPES
Corroded or leaking steel pipes can be strengthened to make up for the lost thickness due to corrosion by using CarbonWrap™. This application also fully water proofs the pipe and prevents leaking. Steel pipes can be strengthened to take pressures higher than that of their original design value.

ADVANTAGES
- Requires no excavation
- Increases pipe strength to even higher than its original pressure rating
- Access is made only through manholes
- Creates a very smooth surface and improves pipe flow significantly
- CarbonWrap™ inside the pipe is about one-eighth of an inch thick, therefore, it does not reduce the inner diameter and flow volume of the pipe
- Light-weight: requires no heavy equipment for installation
- Costs far less than the alternatives and results in speedy construction

NSF 61 approved for potable water applications
CarbonWrap™ Solutions LLC, through its CarbonCoat™ line of products offers state-of-the-art systems for protection of steel and concrete structures in caustic environments. CarbonCoat™ systems effectively increases the life of structures by providing a complete protection against detrimental effects of some of the most caustic chemicals in industrial settings, such as petrochemical, mining, chemical processing, water and waste treatment facilities, etc. Thousands of square meters of structures have been coated with CarbonCoat™ systems, providing unsurpassed protection to structures.
Polycon™

High-Strength, Fast Cure Polymer Concrete

Polycon™ is a high-strength, fast cure polymer concrete specifically formulated to provide high compressive strength in less than six hours of ambient temperature cure (77 Degrees F). It is a waterless concrete made from a mixture of CarbonWrap™ Solutions resin and graded aggregates. When mixed, it becomes a low viscosity, highly flowable slurry that can easily flow through very tight rebar configurations and small cracks. It is primarily used for filling small cracks without the use of formwork and for repairing and filling large cracks and spalls, with the aid of formwork. Polycon™ bonded to existing concrete is extremely strong with complete failure of the host concrete when pull tested, according to the ASTM D4551 (No Cold Joint). The strong bond of POLYCON™ to the existing concrete eliminates the need for mechanical anchors, such as steel dowels.

**PROPERTIES**

**TABLE 1: TYPICAL COMPRRESSIVE STRENGTH OF POLYCON™**

<table>
<thead>
<tr>
<th>Material</th>
<th>Epoxy System</th>
<th>Aggregate to Epoxy Ratio by Volume</th>
<th>Compressive Strength in 24 hours at 77 Degree F</th>
</tr>
</thead>
<tbody>
<tr>
<td>POLYCON™</td>
<td>CarbonBond™ 300</td>
<td>2:1</td>
<td>&gt; 10,000 psi</td>
</tr>
</tbody>
</table>

Bridge deck retrofitting with Polycon™

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### CARBONWRAP™ SYSTEMS**

<table>
<thead>
<tr>
<th>Product</th>
<th>Design Tensile Strength, ksi (MPa)*</th>
<th>Design Modulus of Elasticity, ksi (MPa)*</th>
<th>Design Elongation, at Break %</th>
<th>Ply Thickness, inches (mm)</th>
<th>Available Width inches (cm)</th>
<th>Available Length yards (m)</th>
<th>ASTM Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFU10T</td>
<td>134 (920)</td>
<td>8,000 (55,265)</td>
<td>0.93</td>
<td>0.023 (0.58)</td>
<td>25 (63)</td>
<td>100 (91)</td>
<td>D3039</td>
</tr>
<tr>
<td>CFU20H</td>
<td>94 (650)</td>
<td>9,000 (62,000)</td>
<td>0.91</td>
<td>0.04 (1.02)</td>
<td>25 (63)</td>
<td>100 (91)</td>
<td>D3039</td>
</tr>
<tr>
<td>CFB20H</td>
<td>70 (490)</td>
<td>6,000 (42,000)</td>
<td>0.975</td>
<td>0.01 (0.241)</td>
<td>50 (126)</td>
<td>100 (91)</td>
<td>D638</td>
</tr>
</tbody>
</table>

*Design values are obtained from average values minus three standard deviations.

**The values reported here may differ somewhat from the actual properties of the materials shipped and need to be verified by the engineer of record for each project.

### GLASSWRAP™ SYSTEMS**

<table>
<thead>
<tr>
<th>Product</th>
<th>Design Tensile Strength, ksi (MPa)*</th>
<th>Design Modulus of Elasticity, ksi (MPa)*</th>
<th>Design Elongation, at Break %</th>
<th>Ply Thickness, inches (mm)</th>
<th>Available Width inches (cm)</th>
<th>Available Length yards (m)</th>
<th>ASTM Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>GFU13H</td>
<td>70 (480)</td>
<td>3,400 (23,600)</td>
<td>1.8</td>
<td>0.02 (0.51)</td>
<td>24 (60)</td>
<td>50 (45)</td>
<td>D3039</td>
</tr>
<tr>
<td>GFU27H</td>
<td>77 (530)</td>
<td>3,400 (23,600)</td>
<td>2.1</td>
<td>0.04 (1)</td>
<td>50 (126)</td>
<td>50 (45)</td>
<td>D3039</td>
</tr>
<tr>
<td>GFB10H</td>
<td>32 (225)</td>
<td>2,100 (15,000)</td>
<td>1.25</td>
<td>0.014 (0.356)</td>
<td>50 (126)</td>
<td>150 (135)</td>
<td>D638</td>
</tr>
</tbody>
</table>
CARBONWRAP™ STRIP SYSTEM**

<table>
<thead>
<tr>
<th>Product</th>
<th>Design Tensile Strength, ASTM D3039 ksi (MPa)</th>
<th>Design Modulus of Elasticity, ASTM D30309 ksi (MPa)*</th>
<th>Elongation at Break %</th>
<th>Ply Thickness, inches (mm)</th>
<th>Available Width inches (cm)</th>
<th>Available Length yards (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFUL50G</td>
<td>400 (2,750)</td>
<td>24,000 (165,500)</td>
<td>1.7</td>
<td>0.05 (1.25)</td>
<td>4 (100)</td>
<td>250 (227)</td>
</tr>
</tbody>
</table>

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INSTALLATION

FRPs can be bonded to concrete, masonry, steel and wood structures using a specially formulated structural epoxy to increase the load carrying capacity and ductility.

1. SURFACE PREPARATION
   - Repair Damage
   - Prepare Surface
   - Apply Primer

2. RESIN COAT
   - Apply Base Coat to Surface

3. CarbonWrap™ SHEET
   - Apply CarbonWrap™ Sheet
   - For Multiple-Layers (Repeat 2 & 3)

4. PROTECTIVE COAT
   - Apply Protective Coating
Testimonials

“The Gateway Company has found Hamid Saadatmanesh to be ingenious when it comes to technical knowledge of carbon fiber with an eagerness to demonstrate composite strengthening as a cost savings approach for all parties involved.”
Kelly Houston
President
The Gateway Company of Utah LLC
Salt Lake City, Utah

“CarbonWrap Solutions expertise and experience are superior to all others in this field.”
Jon Woods, Ph.D., P.E.
Project Manager
Grenier Engineering, Inc.
Tempe, Arizona

“Dr. Hamid Saadatmanesh provided engineering services and installation of a carbon fiber lining system on our Unit 3 and 4-10’ diameter PCCP circulating water lines. The reinforcing wires in the PCCP pipe had corroded to the point that the pipe needed replacement, or reinforcement. The decision was made to contact Dr. Saadatmanesh to install a carbon fiber lining system to reinforce the pressure capacity of the circulating water lines. The project was conducted on schedule and under budget. I was very satisfied with the professionalism and quality of work conducted by Dr. Saadatmanesh.”
Alan Benefiel
Maintenance and Engineering Manager
San Juan Generating Station
Farmington, New Mexico

“El Paso Water Utilities was extremely pleased with the results of the external carbon wrap repair you effected on our 48 inch steel cylinder concrete pipe segment. By targeting the repair to the joint we knew to have broken reinforcing wire, we were able to save a significant amount of money in comparison to replacement. By using the external wrap, we were also able to keep the line in service during the repair.”
John E. Balliew, P.E
Water System Division Manager
El Paso Water Utilities
El Paso, Texas

“Any company can put together carbon fiber with a polymer, slap it on a structure and call it a structural repair. Then hope it will stand the test of time. CarbonWrap Solutions’ products are engineered by highly experienced people who understand Fiber Reinforced Polymers from design through installation. There is no hoping only knowing with CarbonWrap Solutions’ FRP.”
John A. Charest
Vice President
Construction Solutions, Inc.