



The Chemical Company

MBrace® Composite Strengthening Systems



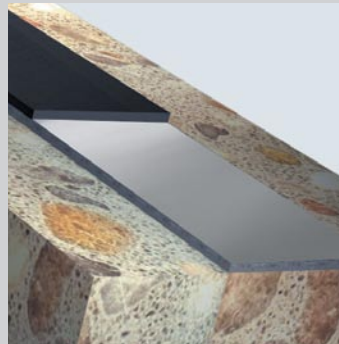
FABRICS
LAMINATES
RESINS
VAPOR PERMEABLE RESINS

MBrace®

MBrace® Composite Strengthening System

Fiber reinforced polymer (FRP) composites have been used for nearly 30 years in aerospace and manufacturing applications where low weight, high tensile strength, and noncorrosive structural properties are required. In civil engineering applications, FRP has proven itself for years in fabric roof structures, internal concrete reinforcement, deck gratings, and most of all as externally bonded reinforcement.

FRP materials are successful in all of these applications because they exhibit low creep, and compared with steel, are thinner, lighter, and have 10 times the tensile strength. The MBrace® Composite Strengthening System, an externally bonded FRP reinforcement system for concrete and masonry structures, has proven itself in the field by exhibiting all of these properties.



Fabrics

The MBrace® system is “cast-in-place” from its two primary components: fiber and polymer.

The fiber is delivered to the site in the form of dry, flexible fabrics which are formed around the structure and saturated with uncured epoxy, the polymer component.

As the epoxy cures, a rigid FRP composite is formed that shapes itself to the structure and monolithically bonds to the structure via the epoxy resin.

This technique, known as wet lay-up, provides flexibility, constructibility, and short installation times. The result: lower labor costs and less downtime.

Laminates

MBrace® S&P Laminates are pre-fabricated carbon fiber reinforced epoxy strips. The laminates are bonded to concrete using approved laminate epoxy adhesives. The 50/1.4 and 100/1.4 laminates are surface bonded to provide positive and negative bending (flexure) strength.

Near Surface

The MBrace® S&P 10/1.4 laminates are near surface mounted (NSM). NSM is a technique where the laminate is bonded into a shallow groove saw-cut into the concrete. NSM provides enhanced bond and protects the laminate from abrasion and wear.



MBrace® Typical Uses

Upgrade load bearing capacities of concrete and masonry structures

- Increase bending strength of concrete beams, slabs, and walls
- Increase shear strength of concrete beams and walls
- Improve the capacity of concrete silos, pipes, and tunnels

Restore capacity of concrete structures loss due to deterioration

- Replace reinforcing steel lost to corrosion
- Replace damaged post-tensioning tendons
- Provide confinement to concrete repairs

Correct design/construction errors

- Substitute missing reinforcing steel

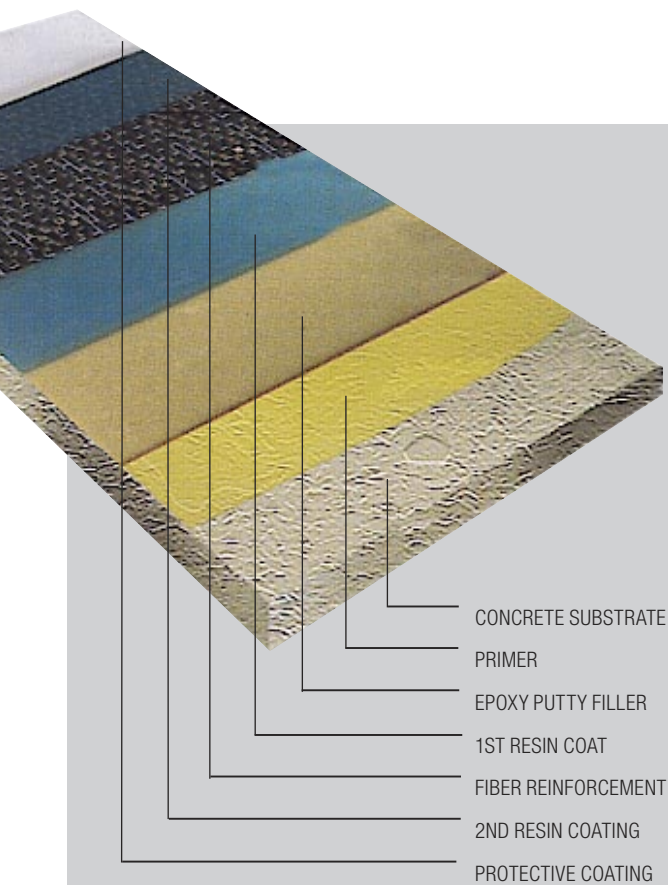
Seismic Retrofit

- Improve strength and ductility of concrete columns
- Provide additional confinement and strength to concrete connections
- Prevent brittle shear failures of concrete beams and walls

MBrace® Advantages

- High strength, high stiffness
- Lightweight
- Highly durable, non-corrosive
- Low installation time
- Can be installed in areas with limited access
- Easy to conceal
- Forms around complex surface shapes





MBrace® Fabric System Components

MBrace® Primer

Low viscosity to penetrate concrete pore structure

MBrace® Putty

High viscosity epoxy paste for surface leveling

MBrace® Saturant

Low sag epoxy for encapsulating the fibers

MBrace® Fiber Reinforcements

Carbon, E-Glass, and Aramid fiber fabrics

MBrace® Topcoats

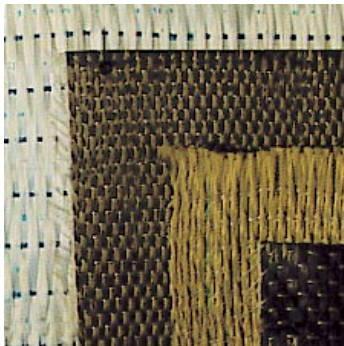
High viscosity epoxy paste for surface leveling

- **Topcoat ATX**

Latex topcoat with color/texture to match concrete

- **Topcoat FRL**

Fire-Resistant topcoat to improve burn characteristics



MBrace® AK 60 Aramid Fiber

- High strength
- Excellent chemical resistance
- Low conductivity and creep rupture
- Usable temperature range +/- 350° F
- Excellent impact resistance

MBrace® CF 130 & CF160

High Strength Carbon Fiber

- Very high strength and stiffness
- Excellent moisture and chemical resistance
- Highly resistant to fatigue and creep rupture

MBrace® CF 530 Carbon Fiber Fabric

- High strength, very high stiffness
- Excellent moisture and chemical resistance
- Highly resistant to fatigue and creep rupture

MBrace® EG 900 E-Glass Fiber

- High strength
- Relatively high elongation to failure
- Low conductivity

MBrace® Resicem

MBrace® Resicem components are vapor permeable. This allows total coverage or encapsulation while still allowing the concrete substrate to breathe.

- Vapor permeable
- VOC Compliant
- Patented technology (US patent #: 6,457 289 B1)
- New North American technology
- Cement modified epoxy matrix
- Application to substrates with up to 12% moisture-content
- Not to be used with E-Glass

MBrace® S&P Laminates

- Fast and easy installation
- Shipped in rolls or cut lengths
- Durable
- Light weight
- High-strength to weight ratio

MBrace® S&P Laminates	PRODUCT ARCHITECTURE	WIDTH	NOMINAL THICKNESS	ULTIMATE TENSILE STRENGTH	TENSILE MODULUS OF ELASTICITY	RUPTURE STRAIN
10/1.4	Pre-fabricated Carbon/Epoxy	3/8" (10mm)	0.055 in. (1.4 mm)	390 ksi (2690 MPa)	23,000 ksi (160 GPa)	1.67%
50/1.4	Pre-fabricated Carbon/Epoxy	2" (50mm)	0.055 in. (1.4 mm)	390 ksi (2690 MPa)	23,000 ksi (160 GPa)	1.67%
100/1.4	Pre-fabricated Carbon/Epoxy	4" (100mm)	0.055 in. (1.4 mm)	390 ksi (2690 MPa)	23,000 ksi (160 GPa)	1.67%

Ease of Installation

The MBrace® Composite Strengthening System is installed by trained, qualified applicators. Although the installation process will vary depending on the specifics of the project, there are a number of common steps that are followed.



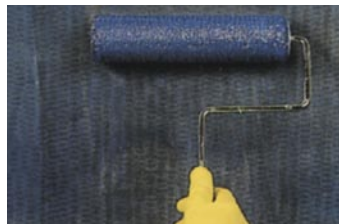
Repair any large areas of spalled, delaminated, or otherwise deteriorated areas of the concrete substrate and inject any existing cracks in the substrate. Profile the concrete surface by abrasive blasting, water blasting, or disc grinding.



1. Apply the surface primer using a medium nap roller.



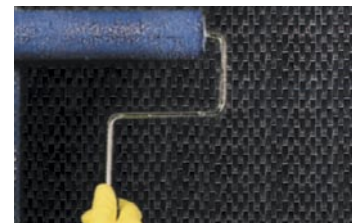
2. Apply the putty using a trowel to level uneven surfaces.



3. Apply a first layer of saturant (resin) using a medium nap roller.



4. Cut the dry fiber fabric into the proper width and length using shears or utility knife.



5. Set the dry fiber fabric into wet saturant and press to the surface using a rib (defoaming) roller. Apply a second layer of saturant to fully encapsulate fibers.



6. Repeat saturant/fiber/saturant layers as needed. Apply optional MBrace topcoat.

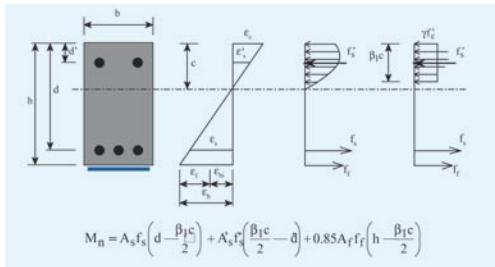
MBrace® Fiber Reinforcement	PRODUCT ARCHITECTURE	NOMINAL THICKNESS	ULTIMATE TENSILE STRENGTH	TENSILE MODULUS OF ELASTICITY	RUPTURE STRAIN
CF 130 High Strength Carbon Fiber	9 oz. Unidirectional fabric	0.0065 in/ply (0.165 mm/ply)	550 ksi (3800 MPa)	33,000 ksi (227 GPa)	1.67%
CF 160 High Strength Carbon Fiber	18 oz. Unidirectional fabric	0.0130 in/ply (0.330 mm/ply)	550 ksi (3800 MPa)	33,000 ksi (227 GPa)	1.67%
CF 530 High Modulus Carbon Fiber	9 oz. Unidirectional fabric	0.0065 in/ply (0.165 mm/ply)	510 ksi (3500 MPa)	54,000 ksi (373 GPa)	0.94%
EG900 E-glass Fiber	27 oz. Unidirectional fabric	0.0139 in/ply (0.353 mm/ply)	220 ksi (1520 MPa)	10,500 ksi (72.4 GPa)	2.10%
AK 60 Aramid Fiber	18 oz. Unidirectional fabric	0.0110 in/ply (0.279 mm/ply)	290 ksi (2000 MPa)	17,400 ksi (120 GPa)	1.67%

Once the resin cures, the final result is a solid fiber reinforced polymer (FRP) laminate that is bonded to the surface of the structure. The system generally achieves sufficient cure to receive load within 24 hours (depending on ambient temperatures).

American Concrete Institute (ACI) just recently published its first recommendations on the use of FRP systems for strengthening concrete. Based largely on the 1997 MBrace® Design Guide, ACI 440.2R-02 is a comprehensive document covering the design, construction and quality control aspects of using FRP systems.

Flexural Strengthening

MBrace® reinforcement may be used to supplement the bending strength of beams, slabs, walls, and other flexural elements. The bending capacity of reinforced, prestressed, and post-tensioned members can be increased by up to 70%. In these applications, the MBrace® system is installed along the length of the member similar to longitudinal steel reinforcement.



MBrace® can be applied to concrete and masonry walls to increase their resistance to out-of-plane loads. This includes loads due to wind, soil pressure, fluid pressure in tanks, and blast loading.

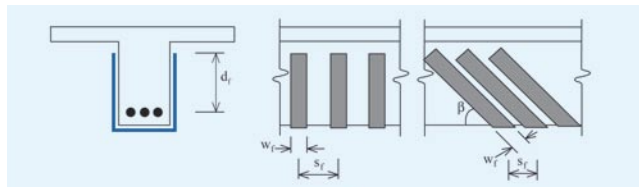
In negative moment regions, the reinforcement may be placed on the top of the member for increased capacity. The thin profile of the installed MBrace® system allows for carpet, tile, and other flooring finishes to be installed over the system without any significant change in floor elevation.

One of the distinct advantages of using MBrace® reinforcement on slabs is the ability to easily run reinforcement in two directions for two-way slabs. Due to the thin profile of the MBrace® fabrics, no special detailing is required at the intersection of two strips on reinforcement.

The lightweight, flexible nature of the MBrace® system allows overhead installations on beam and slab soffits to be simple, cost-effective, and much safer than using bonded steel plates.

Shear Strengthening

MBrace® reinforcement may be used to increase the shear capacity of concrete beams, columns, and other members. The shear capacity of members can be increased as much as 100% and more ductile behavior can be promoted by providing adequate shear reinforcement. In this application, the MBrace® reinforcement is oriented transversely similar to steel stirrups, ties, or hoops.

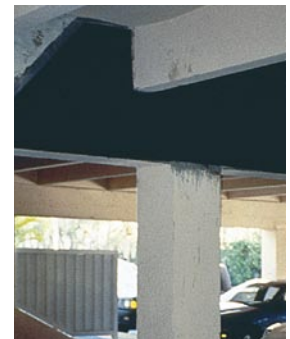


MBrace® shear reinforcement can be placed as individual strips of reinforcement. In some cases, this allows holes to be cut in the flange or slab so that the reinforcement can be wrapped around the section entirely.

MBrace® can also be wrapped around columns to provide additional shear capacity to resist seismic loads, wind loads, or movement of adjoining members (such as creep and shrinkage of adjoining beams).



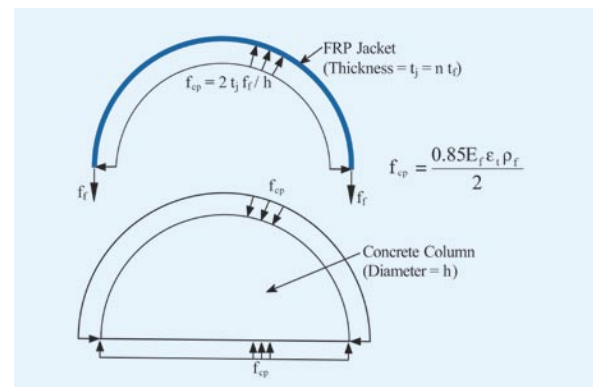
“U” wrapping — simply wrapping the sides and bottom of the section — can increase the shear strength of beams in high shear zones. An additional 1 to 2 kips (for every inch of beam depth) or 200 to 400 N (for every millimeter or beam depth) of shear capacity can be gained by “U” wrapping with MBrace® reinforcement.





Confinement

When confined with external FRP reinforcement, concrete's compressive behavior is dramatically improved. The compressive load carrying capacity of concrete can be nearly doubled using FRP confinement, and the deformation capacity can be increased ten fold. This allows concrete structures to be retrofitted for improved displacement ductility in seismic events. FRP confinement can also be used to clamp existing lap splices in columns — a common problem in seismic regions where tension splices are needed but only compression splices are provided.



Other Applications

MBrace® reinforcement is extremely versatile. Use it externally anywhere additional reinforcement is needed.

- Blast mitigation for concrete and masonry walls
- Strengthen for pressure in pipes, silos, and tanks
- Reinforce around slab and wall cutouts
- Strengthening domes, tunnels, and chimneys

MBrace Reinforcement Selection Guide

MBrace Reinforcement Selection Guide			APPLICATIONS									APPLICATION ENVIRONMENTS			
			Flexural Strengthening Concrete	Flexural Stiffening Concrete	Shear Strengthening Concrete	Confining Concrete for Axial Strengthening	Confining Concrete for Seismic Retrofit	Strengthening Masonry Walls	Strengthening Concrete Tanks, Pipes, Vessels	Strengthening Steel Tanks, Pipes, Vessels	Installing in Low Temperatures (32 - 50 F)	Installing in High Temperatures (120 - 160 F)	Allowing Moisture-Vapor Transmission through System	High Wear Abrasion	
FABRIC	REINFORCEMENT TYPE	RESIN SYSTEM													
	MBrace CF 130	Standard	•		•	•	•	•	•	•					
		Resicem	•		•	•	•	•	•				•		
		LTC	•		•	•	•	•	•	•					
	MBrace CF 160	Standard	•		•	•	•		•	•					
		Resicem	•		•	•	•		•				•		
		LTC	•		•	•	•		•	•	•				
	MBrace CF 530	Standard		•	•	•	•		•	•					
		Resicem		•	•	•	•		•				•		
		LTC		•	•	•	•		•	•	•				
	MBrace AK 60	Standard	•		•	•	•	•						•	
		Resicem	Resicem resins should not be used with AK 60 Reinforcement												
		LTC	•		•	•	•	•			•			•	
	MBrace EG 900	Standard					•	•							
		Resicem	Resicem resins should not be used with EG 900 Reinforcement												
	LTC					•	•			•					
LAMINATE	MBrace S&P 100/1.4	Not required	•	•					•	•		•			
	MBrace S&P 50/1.4	Not required	•	•					•	•		•			
	MBrace S&P 10/1.4	Not required	•		•			•	•					•	

MBrace Topcoat Selection Guide

	MATCHES CONCRETE COLOR	MATCHES CONCRETE TEXTURE	UV PROTECTION	OUTDOOR USE	HIGH CHEMICAL RESISTANCE	FIRE RETARDANT
MBrace Topcoat ATX	•	•	•	•		
MBrace Topcoat FRL			•			•
MBrace Topcoat	•		•	•	•	

Committed to Excellence

The MBrace® system comes with the industry's most complete support. Everything needed for a successful installation of MBrace® is here: specification and design support, contractor training, on-site testing and more. Through a dedicated staff of engineers and specific sales force, the MBrace® composite strengthening system is a comprehensive approach to bringing innovative strengthening technology to the construction industry.

Value

The MBrace® system offers an alternative to steel plate bonding, member enlargement with concrete or external post tensioning. MBrace® can meet complex repair challenges cost effectively, while delivering easy application, versatility and long-term performance.

Design Support

The MBrace® system includes engineering support for your project. A comprehensive Design Guide is available and includes design procedures, material characteristics, specification information, and standard details. Software for strengthening flexural members is also available.

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