



MasterBrace[®]

Composite Strengthening
Systems Solutions



MasterBrace® Composite Strengthening Systems

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 over 20 years in fabric roof structures, internal concrete reinforcement, deck gratings, and most of all as externally bonded reinforcement.

FRP Materials

FRP Materials have proven successful in many civil engineering applications because of their light weight, high tensile strength, and low creep. Despite being much thinner than steel, FRP materials can have as much as 10 times the tensile strength of steel. The MasterBrace Composite Strengthening System, an externally bonded FRP reinforcement system used primarily for concrete and masonry structures, utilizes these material properties to provide superior solutions to a wide variety of structural applications.

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 lost due to deterioration

- Replace reinforcing steel lost to corrosion
- Replace damaged post-tensioning tendons
- Provide confinement to concrete columns and piers

Correct design/construction errors

- Replace missing reinforcing steel

Seismic Retrofit

- Improve strength and ductility of concrete columns
- Prevent brittle shear failures of concrete beams and walls

Fabrics

The MasterBrace fabric 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 substrate 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

MasterBrace Laminates are prefabricated carbon fiber reinforced epoxy strips. The laminates are bonded to the substrate using approved Master Builders Solutions epoxy adhesives. The MasterBrace LAM 50/1.4CFS and MasterBrace LAM 100/1.4CFS laminates are surface bonded to provide positive and negative bending (flexural) strength as well as shear strengthening applications.

- Fast and easy installation
- Durable
- Light weight
- High-strength to weight ratio
- NSM Information

MasterBrace advantages include high strength with high stiffness, lightweight, highly durable, non-corrosive and low-install times





Advantages and Installation

The MasterBrace 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.

MasterBrace FIB 300/50CFS and 600/50CFS

High Strength Carbon Fiber

Dry fabrics constructed of very high strength, aerospace grade carbon fibers. These fabrics are applied onto the surface of existing structural members in buildings, bridges, and other structures using the MasterBrace family of performance polymers.

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

MasterBrace FIB 900/50FG E-Glass Fiber

These fabrics are applied onto the surface of existing structural members in buildings, bridges, and other structures using the MasterBrace family of performance polymers. The result is an externally bonded FRP (fiber reinforced polymer) reinforcement system that is engineered to increase the structural performance of these members.

- High strength
- Relatively high elongation to failure
- Non conductive

MasterBrace Laminates

	Product Architecture	Width	Diameter	Nominal Thickness	Ultimate Tensile Strength	Tensile Modulus of Elasticity	Rupture Strain
MasterBrace BAR 1000CFS	Pre-fabricated Carbon/Epoxy		3/8" (10 mm)		320 ksi (2200 MPa)	23,000 ksi (158 GPa)	1.40%
MasterBrace LAM 50/1.4CFS	Pre-fabricated Carbon/Epoxy	2" (50 mm)		0.055 in. (1.4 mm)	390 ksi (2690 MPa)	23,000 ksi (160 GPa)	1.67%
MasterBrace LAM 100/1.4CFS	Pre-fabricated Carbon/Epoxy	4" (100 mm)		0.055 in. (1.4 mm)	390 ksi (2690 MPa)	23,000 ksi (160 GPa)	1.67%

MasterBrace Fiber Reinforcement

	Product Architecture	Nominal Thickness	*Ultimate Tensile Strength	*Tensile Modulus of Elasticity	*Rupture Strain
MasterBrace FIB 300/50 CFS 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%
MasterBrace FIB 600/50 CFS 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%
MasterBrace FIB 900/50 FG 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%

*Per ASTM D-3039

MasterBrace Fabric System Components

MasterBrace P3500 (Primer)

Low viscosity to penetrate concrete pore structure

MasterBrace F2000 (Putty)

High viscosity epoxy paste for surface leveling

MasterBrace SAT 4500 (Saturant)

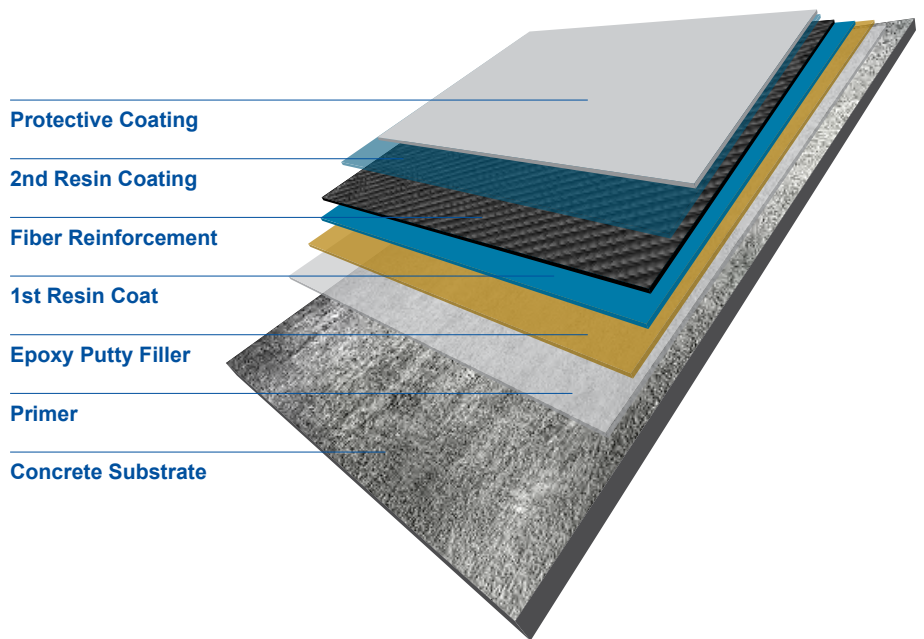
Low sag epoxy for encapsulating the fibers

MasterBrace Fiber Reinforcements

Carbon, E-Glass, and Aramid fiber fabrics

MasterBrace SAT 4700 (Saturant)

Low temperature, has accelerator for applications down to 35°F



Installation

Repair any large areas of spalled, delaminated, or otherwise deteriorated areas of the concrete substrate and inject any existing cracks in the substrate greater than 10 mils. Profile the concrete surface by abrasive blasting, water blasting, or disc grinding.

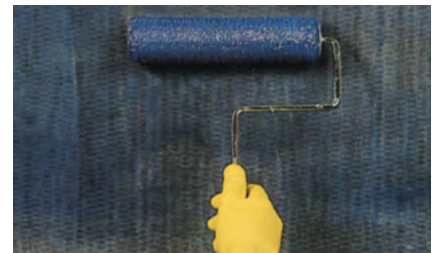
Once the resin cures, the final result is a solid fiber reinforced polymer (FRP) laminate that is bonded to the surface of the structure. The system generally achieves initial cure within 12 hours (depending on ambient temperatures).



1. Apply MasterBrace P3500 using a 3/8" nap roller.



2. Apply MasterBrace F2000 using a trowel or putty knife to level uneven surfaces.



3. Apply a first layer of MasterBrace SAT 4500 or 4700 using a 3/8" nap roller.



4. Cut the dry fiber fabric into the proper width and length using shears or a 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. Repeat saturant/fiber/saturant layers as needed.

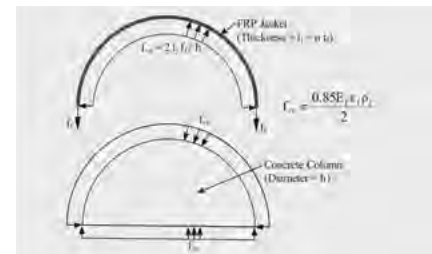
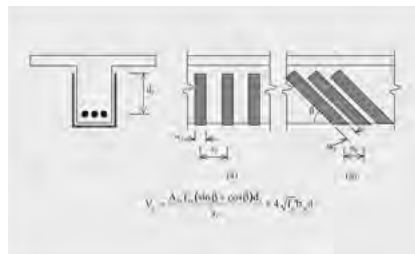
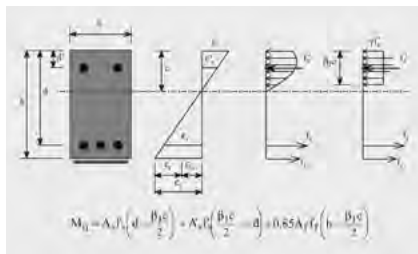


6. Apply topcoat if required.



Applications

American Concrete Institute (ACI) recommends the use of FRP systems for strengthening concrete. ACI 440.2R-08 is a comprehensive document which provides guidelines for the design, construction and quality control aspects of using FRP systems.



Flexural Strengthening

MasterBrace 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 MasterBrace system is installed along the length of the member similar to longitudinal steel reinforcement.

MasterBrace 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 MasterBrace 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 MasterBrace reinforcement on slabs is the ability to easily run reinforcement in multiple directions for two-way slabs. Due to the thin profile of the MasterBrace fabrics, no special detailing is required at the intersection of two strips of reinforcement. The lightweight, flexible nature of the MasterBrace system allows overhead installations on beam and slab soffits to be simple, cost-effective, and much safer than using traditional strengthening techniques.

Shear Strengthening

MasterBrace 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 two kips per inch of beam depth and significant increases in ductility can be achieved. In this application, the MasterBrace reinforcement is oriented transversely, similar to steel stirrups, ties or hoops.

MasterBrace shear strengthening can be applied to beams, walls, slabs and columns exposed to shear loading. It may be installed in discrete strips or as a continuous plate. When moisture in the concrete is a concern or possibility, discretely spaced strips should be used to avoid moisture entrapment.

Completely wrapping a member provides the greatest gains in shear strength, however the presence of slabs, walls or other obstructions may make this not feasible. In these cases, the MasterBrace is installed in a "U-Wrap" configuration, wrapping only the sides and bottom. Though not as efficient as completely wrapping a member, an additional 2 kips per inch of beam depth can be expected.

Confinement

When confined with external FRP reinforcement, ductility of concrete columns and piers is dramatically improved. Moderate increases in the compressive load carrying capacity can be realized using FRP confinement, but more notably the ductility index can be increased 3 – 4 times. 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

MasterBrace reinforcement is extremely versatile and can be used as external strengthening nearly anywhere additional reinforcement is required.

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

MasterBrace Reinforcement Selection Guide

		APPLICATIONS						
		Flexural Strengthening Concrete	Shear Strengthening Concrete	Confining Concrete for Axial Strengthening	Confining Concrete for Seismic Retrofit	Strengthening Masonry Walls	Strengthening Concrete Tanks, Pipes and Vessels	Strengthening Steel Tanks, Pipes and Vessels
FABRIC	REINFORCEMENT TYPE	RESIN TYPE						
		MasterBrace FIB 300/50 CFS	SAT 4500	✓	✓	✓	✓	✓
SAT 4700			✓	✓	✓	✓	✓	✓
MasterBrace FIB 600/50 CFS		SAT 4500	✓	✓	✓	✓	✓	✓
		SAT 4700	✓	✓	✓	✓	✓	✓
MasterBrace FIB 900/50 FG	SAT 4500	✓	✓	✓	✓	✓	✓	
	SAT 4700	✓	✓	✓	✓	✓	✓	
LAMINATE	MasterBrace LAM 100/1.4CFS	NOT REQUIRED	✓	✓		✓		
	MasterBrace LAM 50/1.4CFS	NOT REQUIRED	✓	✓		✓		
	MasterBrace BAR 1000CFS	NOT REQUIRED	✓			✓		



Committed to Excellence

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

Value and Design Support

The MasterBrace system offers an alternative to steel plate bonding, section enlargement with concrete or external post tensioning. MasterBrace can meet complex repair challenges cost effectively, while delivering easy application, versatility and long-term performance. Software for strengthening shear and flexural members is also available.



Master Builders Solutions

The Master Builders Solutions brand brings all of MBCC Groups expertise together to create chemical solutions for new construction, maintenance, repair and renovation of structures. Master Builders Solutions is built on the experience gained from more than a century in the construction industry.

The know-how and experience of a global community of MBCC Group construction experts form the core of Master Builders Solutions. We combine the right elements from our portfolio to solve your specific construction challenges. We collaborate across areas

of expertise and regions and draw on the experience gained from countless construction projects worldwide. We leverage global MBCC Group technologies, as well as our in-depth knowledge of local building needs, to develop innovations that help make you more successful and drive sustainable construction. The comprehensive portfolio under the Master Builders Solutions brand encompasses concrete admixtures, cement additives, chemical solutions for underground construction, waterproofing solutions, sealants, concrete repair and protection solutions, performance grouts and performance flooring solutions.

Master Builders Solutions products for the Construction Industry:

MasterAir®

Solutions for air-entrained concrete

MasterBrace®

Solutions for concrete strengthening

MasterCast®

Solutions for manufactured concrete product industry

MasterCem®

Solutions for cement manufacture

MasterEmaco®

Solutions for concrete repair

MasterFinish®

Solutions for formwork treatment

MasterFlow®

Solutions for precision grouting

MasterFiber®

Comprehensive solutions for fiber reinforced concrete

MasterGlenium®

Solutions for high-performance concrete

MasterInject®

Solutions for concrete injection

MasterKure®

Solutions for concrete curing

MasterLife®

Solutions for enhanced durability

MasterMatrix®

Advanced rheology control solutions for self-consolidating concrete

MasterPel®

Solutions for water tight concrete

MasterPolyheed®

Solutions for high-performance concrete

MasterPozzolith®

Solutions for water-reduced concrete

MasterProtect®

Solutions for concrete protection

MasterRheobuild®

Solutions for super-plasticized concrete

MasterRoc®

Solutions for underground construction

MasterSeal®

Solutions for waterproofing and sealing

MasterSet®

Solutions for retardation control

MasterSure®

Solutions for workability control

MasterTop®

Solutions for industrial and commercial floors

Ucrete®

Flooring solutions for harsh environments

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 889 Valley Park Drive
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