

# MBrace™

## Composite Strengthening System

Carbon, Aramid and Glass Composite Reinforcement to  
Extend the Life of Concrete and Masonry Structures



 **BASF**

The Chemical Company



# MBrace™ Composite Strengthening System

Fibre Reinforced Polymer (FRP) composites have been used for nearly 30 years in aerospace and manufacturing applications where low weight, high tensile strength, and non-corrosive 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 masonry and steel structures has proven itself in the field by exhibiting all of these properties.

The **MBrace™ System** forms part of our integrated repair regime for concrete and steel structures. Our Emaco Nanocrete R3 and R4 are ideally suited to structural reinstatement prior to the application of our laminate or fabric **MBrace™** products. Additionally where structural bonding or crack injection forms part of the repair solution our range of Concrete resin products complement the **MBrace™** strengthening system.



The **MBrace™** Composite Strengthening System uses aerospace-grade **carbon, glass** and **aramid fibres** combined with epoxy resins formulated for substrate adhesion, durability, and constructability. But the **MBrace™** System is more than just materials. BASF Construction Chemicals and its applicators have developed a strategic partnership to provide the most comprehensive system support possible, including:

- materials testing, quality control and R&D
- engineering design and specification support
- installation support and contractor training
- on-site testing and inspection

This combined technical and field expertise is unmatched in the industry.

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

**MBrace™** Composite Strengthening System has received Worldwide approvals and awards. For details please contact your local BASF Construction Chemicals representative.



# MBrace™ Systems and Components

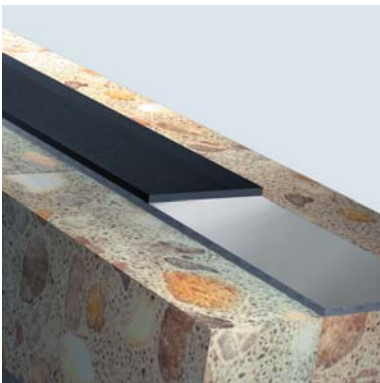
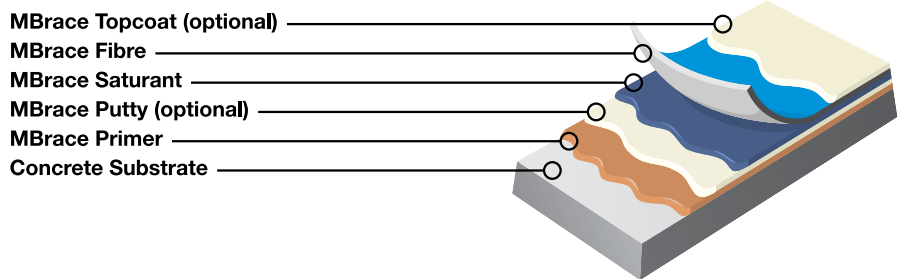
The MBrace™ Composite Strengthening System is 'cast-in-place' from its two primary components: fibre and polymer.

BASF Construction Chemicals specifically formulates all components of the MBrace™ System to work together. The system and system components undergo rigorous testing to ensure structural properties, material capability, bond characteristics and durability. Additionally, all materials must undergo a series of field trials to assure ease of installation and use.



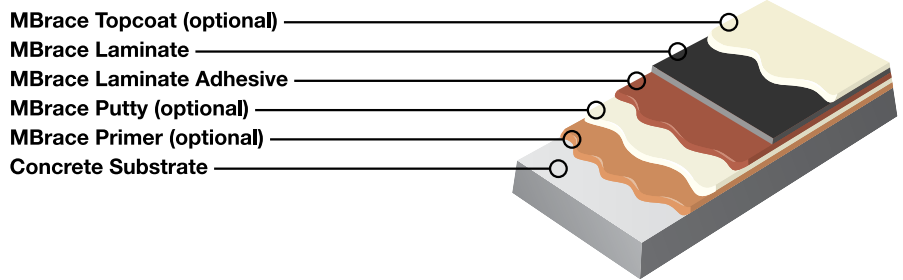
## Sheet System

In the Sheet System, the fibre is delivered to the site in the form of dry, flexible unidirectional 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 following the shape of the structure and monolithically bonds to it via the epoxy primer.



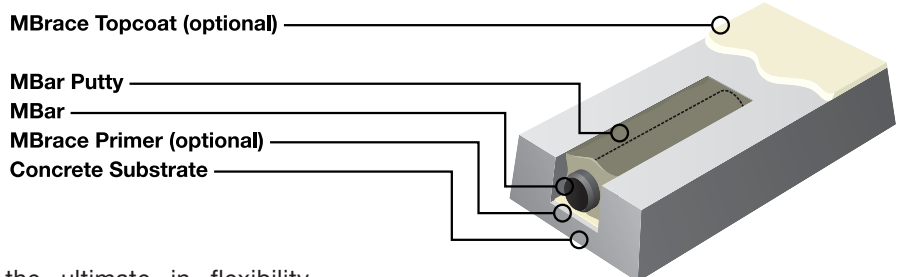
## Laminate System

The Laminate System consists of a prefabricated unidirectional carbon fibre plate which is adhered to the structure using an epoxy adhesive. The unidirectional carbon plate is made using the pultrusion system which creates a carbon fibre/epoxy composite referred to as a Laminate.



## Bar System

The Bar System, uses an FRP material also obtained by a pultrusion production process based on linearly oriented fibres to form round bars. After being measured on site, the bars are simply placed into a groove cut into the substrate and bonded with an epoxy paste adhesive.



These three techniques provide the ultimate in flexibility, constructability and short installation time. The results: lower labour costs, less downtime and a more economical project cost.



# Carbon Fibre

## Sheet

### Typical Applications

#### MBrace™CF

MBrace™ CF sheets provide a strength increase in:

- Flexure – Beams slabs and walls
- Shear – Beams and walls
- Axial confinement and crack control – columns, silos, pipes
- Seismic (Earthquake) – columns and walls
- Impact Resistance – columns and walls
- An increase in axial load-bearing capacity – columns
- Trimming around penetrations - slabs and walls
- Reduced deflection from dead loads
- Increase in structural fatigue strength



### Features and Benefits

#### MBrace™CF

- Very high strength and stiffness (5-10 times that of steel)
- Excellent moisture and chemical resistance
- Highly resistant to fatigue and creep rupture
- Control of crack propagation
- Unidirectional and can be used in multiple layers and directions



### Carbon Fibre

Fibre Reinforcement CF 120/130/140	Carbon - High Tensile
Fibre Density	1.76 g/cm <sup>3</sup>
Fibre Modulus	230 GPa
Fibre Weight (CF)	
CF 120	200 g/m <sup>2</sup>
CF 130	300 g/m <sup>2</sup>
CF 140	400 g/m <sup>2</sup>
Tensile Strength, Ultimate	4,900 MPa
Tensile Elongation, Ultimate	1.55%
Design tensile force @ 0.6% strain/m width	149, 222, 298 kN
Fibre Reinforcement CF 530	Carbon - High Modulus
Fibre Density	2.1 g/cm <sup>3</sup>
Fibre Modulus	640 GPa
Fibre Weight (CF)	400 g/m <sup>2</sup>
Thickness	0.19mm
Tensile Strength	2,650 MPa
Tensile Elongation, Ultimate	0.4%
Design tensile force @ 0.2% strain/m width	200 kN
Roll Length	50m
Sheet Width	300mm

### MBrace primer

Bonding to concrete, pr EN 1542 (direct)	> 3.5 MPa (concrete failure)
Ultimate elongation, ASTM D638	3%
Tensile strength:	
• direct, ASTM D638	> 12 MPa
• by flexing, ASTM D790	> 24 MPa
Modulus of elasticity:	
• tensile, ASTM D638	> 700 MPa
• flexural, ASTM D790	> 580 MPa

### MBrace saturant

Bonding to concrete, (direct traction) pr EN 1542	> 3.5 MPa (concrete failure)
Tensile strength:	
• direct, ASTM D638	> 50 MPa
• by flexing, ASTM D790	> 120 MPa
Modulus of elasticity:	
• tensile, ASTM D638	> 3000 MPa
• flexural, ASTM D790	> 3500 MPa
Ultimate elongation, ASTM D638	2.5%
Compressive strength ASTM D695	> 80 MPa

# Carbon Fibre

## Laminate

### Typical Applications

#### MBrace™ Laminates

- Flexure – Beams slabs and walls
- Can be used on concrete, timber, masonry and steel
- Trimming around penetrations- slabs and walls
- Lateral load resistance of poles and chimneys
- Reduced deflection from dead loads
- Increase in structural fatigue strength

### Features and Benefits

#### MBrace™ Laminates

- Peel- ply to protect both surfaces from contamination and creates an excellent bonding surface
- Fast and easy installation - no solvent wipe required
- Shipped in rolls or cut lengths
- Durable
- Light weight
- High-strength to weight ratio
- Special profiles can be manufactured to order



MBrace Laminate			
	165/2500	170/3100	210/3300
Typical tensile strength	2500 MPa	3100 MPa	3300 MPa
Typical tensile modulus	165 GPa	170 GPa	210 GPa
Width	100mm/120mm	150mm	150mm
Thickness	1.3mm	1.4mm	1.4mm
Ultimate deformation	1.3%	1.6%	1.4%
Fibre content %	70	70	70
Density g/cm <sup>3</sup>	1.6	1.61	1.6
Inter laminar shear strength	80 MPa	80 MPa	80 MPa
Thermal expansion m/m/°C	0.6 x 10 <sup>-6</sup>	0.6 x 10 <sup>-6</sup>	0.6 x 10 <sup>-6</sup>

MBrace Laminate adhesive	
Compressive strength	> 60 MPa
Flexural strength	> 30 MPa
Bonding, ASTM D 4541	
• Concrete	> 3.5 MPa (concrete failure)
• Steel	> 5 MPa
Electrical resistivity	10 <sup>14</sup> Ω m



Laminate 460/1500	
Typical tensile strength	1500 MPa
Typical tensile modulus	460 GPa
Elongation at break %	0.3-0.4
Fibre content %	71
Density g/cm <sup>3</sup>	1.82
Inter Laminate Shear Strength	50 MPa
Thermal Expansion m/m/°C	0.4 x 10 <sup>-6</sup>





# Carbon Fibre

## Bar

### Typical Applications

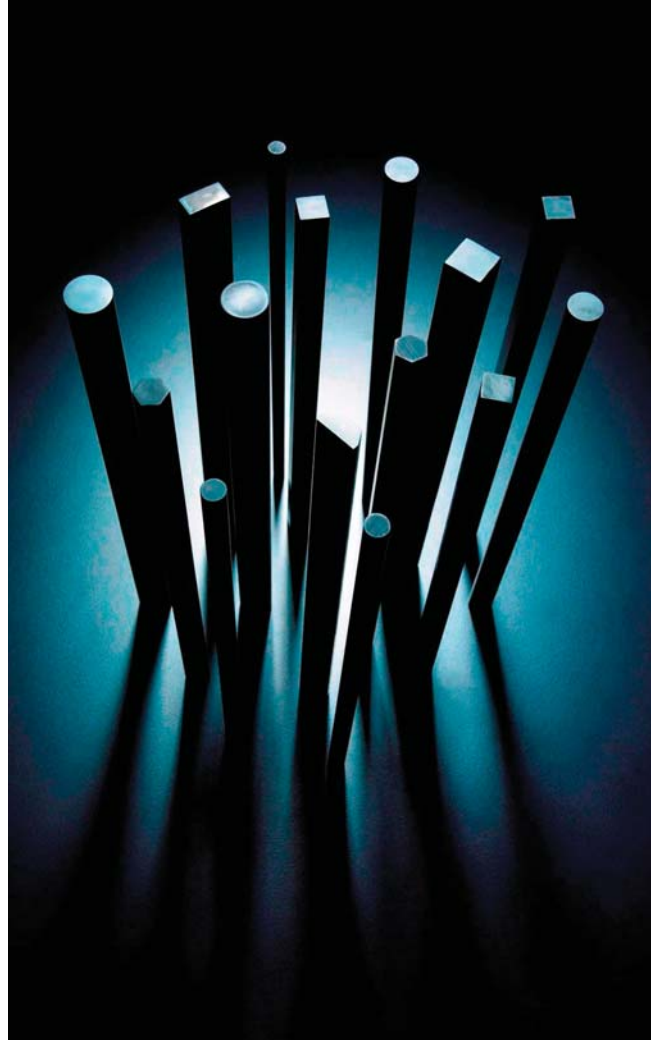
#### MBar™

- Flexure – Beams slabs and walls
- Can be used on concrete, timber and masonry
- Trimming around penetrations- slabs and walls
- Poles and chimneys for lateral load resistance
- Historic masonry structures to supplement inherent low strength materials

### Features and Benefits

#### MBar™

- Available in carbon (also with Peel-Ply) and glass fibre
- Profiles normally round (square available)
- Can be used to create stabilization (soft nailing) for tunneling or ground stabilization
- “Cut-in” type applications where cover to reinforcement is low



### MBrace Laminate adhesive

Compressive strength	> 60 MPa
Flexural strength	> 30 MPa
Bonding, ASTM D 4541	
• Concrete	> 3.5 MPa (concrete failure)
• Steel	> 5 MPa
Electrical resistivity	$10^{14} \text{ } \Omega \cdot \text{m}$

### MBar

	MBar 8	MBar 12	MBar 16
Typical tensile strength	2500 MPa	2500 MPa	2500 MPa
Typical tensile modulus	165 GPa	165 GPa	165 GPa
Diameter mm	8	12	16
Section area mm <sup>2</sup>	46.6	107.5	193.6
Ultimate deformation	1.5%	1.5%	1.5%
Fibre content %	65	65	65
Density g/cm <sup>3</sup>	1.61	1.61	1.61
Inter laminar shear strength	77 MPa	77 MPa	77 MPa
Thermal expansion m/m/°C	$0.6 \times 10^{-6}$	$0.6 \times 10^{-6}$	$0.6 \times 10^{-6}$



# Aramid Fibre

## Typical Applications

- Blast mitigation for walls and columns
- Impact resistance in columns and walls

## Features and Benefits

- High impact resistance
- Can be used in conjunction with carbon fibre for protection especially columns in car parks etc
- Unidirectional

### MBrace AF129 - Aramid Fibre (AF) Reinforcement System

Fibre Reinforcement	Aramid
Fibre Density	1.45 g/cm <sup>3</sup>
Fibre Modulus	120 GPa
Fibre Weight	290 g/m <sup>2</sup>
Thickness	0.200 mm
Tensile Strength <sup>1</sup>	2,900 MPa
Tensile Elongation, Ultimate	2.5%
Tensile force	AF 129: 446 kN
@ ult. strain /m width (in kN)	AF 142: 647 kN
Roll Length	150 m
Sheet Width	300 mm



# Glass Fibre

## Typical Applications

- Seismic retro fit
- Masonry and other low strength materials

## Features and Benefits

- Bi-directional for two way strengthening
- Binds together low strength materials
- Excellent for controlling seismic activities in new and old buildings due to low E modulus

### MBrace EG - E-Glass (EG) Reinforcement

Fibre Reinforcement	E-Glass
Fibre Density	2.6 (2.68) g/cm <sup>3</sup>
Fibre Modulus	73 (65) GPa
Fibre Weight - EG & ARG 50/50	(both directions) 175 g/m <sup>2</sup>
Thickness - EG & ARG 50/50	0.067 (0.065) mm
Tensile Strength Fibre	3,400 (3,000) MPa
Tensile Strength Impregnated Fibre	2,400 (1,700) MPa
Tensile Elongation, Ultimate Tensile force	4.5(4.3)%
@ ult. strain /m width (in kN) - EG & ARG 50/50	(both directions) 115 (79)
Roll Length	50 m
Sheet Width	670 mm





# Methods of Installation

The easy to use **MBrace™** components ensure fast, user friendly installation. The complete system is installed by trained, qualified applicators in easy to follow steps, starting with properly prepared surfaces under appropriate working conditions.

## Sheet System



**1** Apply MBrace Primer onto prepared concrete substrate (optional)



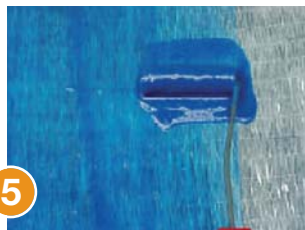
**2** Level prepared concrete substrate with MBrace Putty / Levelling Mortar (optional)



**3** Apply first coat of MBrace Saturant



**4** Apply MBrace Fibre Reinforcement



**5** Apply second coat of MBrace Saturant



**6** Apply MBrace Topcoat (optional)

## Laminate System



**1** Apply MBrace Primer onto prepared concrete substrate (optional)



**2** Level prepared concrete substrate with MBrace Putty / Levelling Mortar (optional)



**3** Apply MBrace Laminate Adhesive to substrate



**4** Remove Peel-Ply from Laminate. The easiest way to take off the peel-ply is with a cutter/Stanley knife. Start to lift the peel-ply with the knife (start from the corner as it will be the easiest spot) and move the knife across the sheet. Once the peel-ply has started to lift, pull back by hand the required length of the Laminate.



**5** Apply MBrace Laminate Adhesive to Laminate



**6** Position MBrace Laminate and apply to substrate



**7** Roll MBrace Laminate to secure onto substrate and clean up excess



**8** Apply MBrace Topcoat (optional)



## Bar System



1 Grooving the surface of the concrete



2 Apply MBrace Primer (optional) followed by MBrace Laminate Adhesive onto groove



3 Placing Mbar



4 Levelling of surface with MBrace Laminate Adhesive



5 Apply MBrace Topcoat (optional)

## Contractor Training

The **MBrace™** System is installed exclusively within an international network of trained and experienced contractors. Each **MBrace™** System installation site requires the presence

of trained contractors who are experienced in repair and strengthening strategies, product information, installation methods and QC testing to ensure successful projects.

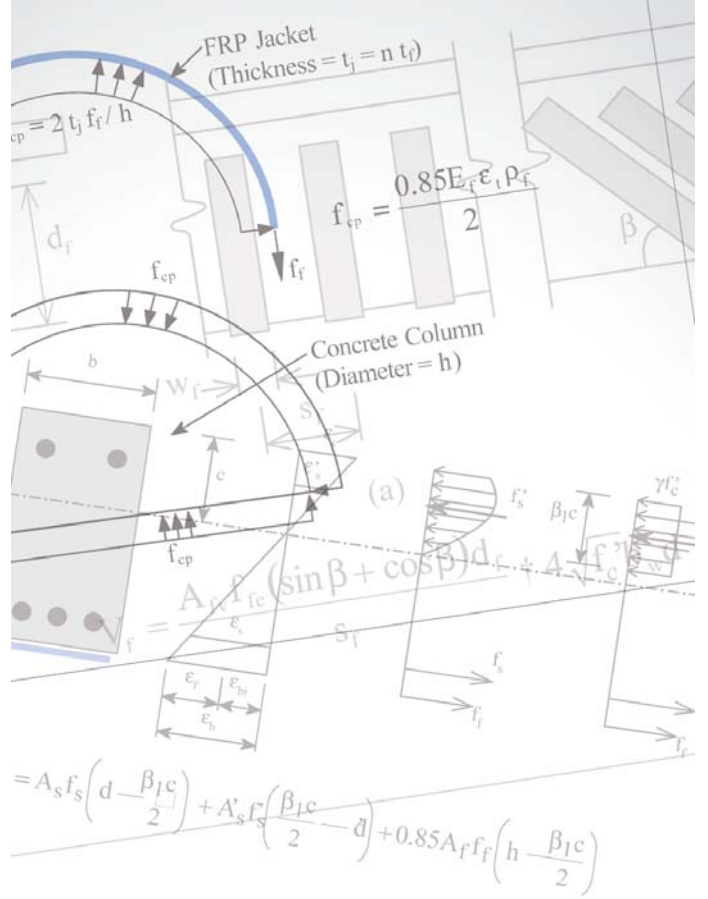


# Design Support

The **MBrace™** System includes state-of-the-art tools for engineering support for your project. A comprehensive design guide is available, and includes:

- Design procedures
- Material characteristics
- Specification information
- Standard details
- Application Guidelines

BASF Construction Chemicals and its selected **MBrace™** System contractors work together to see that all proper procedures are followed. This streamlines the project and ensures a quality installation.



# Selection of Completed Projects

Six Banyan Temple  
Hong Kong

Majestic Theatre  
Singapore

Wan Kai New Town  
China

Thachompoo Bridge  
Thailand

Raffles City Shopping  
Centre  
Singapore

Royal Melbourne Institute  
of Technology (RMIT)  
Melbourne

Flinders Street Railway  
Station  
Melbourne

Ouse River Bridge  
Tasmania

Evangel Family Church  
Singapore

Liang Court  
Singapore

Jurong Island Tunnel  
Singapore

Little River Bridge  
Victoria





# 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	Allowing Moisture-Vapour Transmission Through System	High Impact Resistance	
FABRIC	REINFORCEMENT TYPE	RESIN SYSTEM										
	MBrace CF 130	Standard	●			●		●	●	●		
		Resicem	●			●		●	●		●	
	MBrace CF 140	Standard	●			●		●	●	●		
		Resicem	●			●		●	●		●	
	MBrace CF 530	Standard		●	●				●	●		
		Resicem		●	●				●		●	
	MBrace AF 129	Standard	●		●	●	●	●	●		●	
	MBrace EG	Standard					●	●				
LAMINATE	MBrace Laminate 165/2500		●	●				●	●			
	MBrace Laminate 170/3100		●	●	●			●	●		●	
	MBrace Laminate 210/3300		●	●	●			●	●		●	
BAR	MBar 6mm		●		●			●	●			
	MBar 8mm		●		●			●	●			
	MBar 12mm		●		●			●	●			

# Intelligent Solutions from BASF Construction Chemicals

**Concresive®** - Resin Based Mortars, Adhesives and Injection Systems

**Conibridge®** - PU Based Membranes to Protect Bridge Decks

**Conideck®** - Hand and Spray Applied Waterproof Membrane Systems

**Coniroof®** - PU Based Roofing Systems

**Emaco®** - Concrete Repair Systems

**Finestone®** - Exterior Insulation and Finishing Systems (EIFS)

**Glenium®** - For Hyperplasticized Concrete

**Masterflex®** - Joint Sealants

**Masterflow®** - Precision and Structural Grouts

**Masterpren®** - Preformed Membrane Waterproofing Sheets

**Masterseal®** - Coatings and Waterproofing

**Mastertop®** - Decorative and Industrial Flooring Solutions

**MBrace™** - Composite Strengthening Systems

**Meyco®** - For Shotcrete and Spraying Equipment

**PCI®** - Tile Fixing and Cement Underlays

**Pozzolith®** - For Water-reduced Concrete

**Rheobuild®** - For Superplasticized Concrete

**Rheomix®** - For Improved Block Mortars

**Rheoplus®** - Cost-effective Products for Hyperplasticized Concrete

**Ucrete®** - Flooring Solutions for Harsh Environments

**WABO®** - Expansion Control Systems

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*As a reliable partner, BASF helps its customers in virtually all industries to be more successful. With its high-value products and intelligent solutions, BASF plays an important role in finding answers to global challenges such as climate protection, energy efficiency, nutrition and mobility.*

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