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# MBRACE®

## COMPOSITE (FRP) STRENGTHENING SYSTEMS

Systems to Extend the Life of Concrete, Masonry, Timber and Steel Structures Reinforced with FRP Based on Carbon and Aramid (KEVLAR®) Fibres.

### Description of Product

The MBRACE Composite Strengthening System is a comprehensive approach to bringing innovative strengthening techniques to the construction industry. The MBRACE Composite Strengthening System (FRP) is more than an economical, field-proven technology for supplemental structural reinforcing - it offers single source support from specification through completion.

The MBRACE Composite Strengthening System includes a high strength and high modulus unidirectional carbon fibre together with carbon fibre laminates.

The MBRACE System also includes a high strength aramid (KEVLAR®) fibre, giving in addition a superior impact resistance, and damage tolerance. Its non-conductive nature makes it free from electro-corrosion.

Both carbon and aramid fibres have been used extensively in the construction industry for a number of years for the strengthening of all types of structures including concrete, masonry, timber and steel.

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(FRP = Fibre Reinforced Polymer)

The MBRACE Composite Strengthening System consists of:

### MBRACE Primer

MBRACE Primer is the concrete bonding adhesive for use with the MBRACE Composite Strengthening System. It is a 100% solids low viscosity epoxy resin able to cure in the presence of moisture and at temperatures as low as 2°C. When applied to sound concrete MBRACE PRIMER gives a high tensile bond strength to the -MBRACE Composite Strengthening Systems

### MBRACE Putty

MBRACE Putty is the concrete smoothing material for use with the MBRACE Composite Strengthening System. It is a 100% solids, non-sag paste epoxy resin material. Recommended uses include sealing surfaces prior to epoxy injection, bonding of rigid materials, and levelling uneven surfaces prior to application of the MBRACE Composite Strengthening System.

### MBRACE Saturant

MBRACE Saturant resin is the easy-to-apply, 100% solids material that permits adhesion of a lightweight, Carbon Fibre or KEVLAR®, unidirectional (UD) fabrics, within the MBRACE® Composite Strengthening System. When cured with the tow sheet, MBRACE Saturant resin produces a high performance composite system for use in external structural repair or upgrade applications.

### MBRACE Fibre Reinforcement Systems

The backbone of the MBRACE Composite Strengthening System, MBRACE Fibre Reinforcement materials are enveloped MBRACE Saturant resin to yield a range of high performance features.

MBRACE Composite Materials include the MBRACE C1-30, C5-30 Carbon Fibre Systems as well as AK-60 and AK-40 KEVLAR® (aramid fibre).

Each fibre reinforced system within the finished MBRACE Composite Strengthening System provides high strength to cross section ratio, and structural integrity that is similar to bonding steel plate to structural surfaces.

**Topcoat**

Please contact BASF Construction Chemicals (UK) Technical Services Department for information on top-coats.

Technical Data/Typical Properties

<b>MBRACE Primer</b>	
Bonding to concrete, pr EN 1542 (direct)	$> \sigma_{tc}$ (c. failure)
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
<b>MBRACE Primer</b>	
Composition	Two Parts (A & B)
Type of resin (A)	Epoxy (Bisphenol-A)
Type of hardener (B)	Polyamine
Solids by volume	100%
Mixing ratio A:B	by weight 2:1
Specific gravity of components A and B	A: $1.135 \pm 0.024$ kg <sub>p</sub> /L B: $1.06 \pm 0.024$ kg <sub>p</sub> /L
Specific gravity	$1.10 \pm 0.024$ kg <sub>p</sub> /L
Colour	Transparent, Amber
Overall thickness	90 µm
Recommended layers	1
Theoretical consumption	0.2 L/m <sup>2</sup>
Theoretical coverage	5 m <sup>2</sup> /L
Pot life	-1°C; 8 hours 7°C; 2 hours 21°C; 45 min 32°C; 25 min
Tack-free	-1°C; 20 hours 7°C; 9 hours 21°C; 7 hours 32°C; 3 hours
Overcoating time	
▪ With MBRACE Putty	Fresh (30 min)
▪ With MBRACE Adhesive	
a) recommended	Tack free
b) max	48 hours
Optimal storage	18 - 24°C

<b>MBRACE Putty</b>	
Composition	Two parts (A & B)
Type of resin (A)	Epoxy (Bisphenol-A)
Type of hardener (B)	Polyamine
Solids by volume	100%
Mixing ratio A:B	by weight or volume 2:1
Specific weight of components	A: $1.6 \pm 0.024$ kg <sub>p</sub> /L B: $1.6 \pm 0.024$ kg <sub>p</sub> /L
Specific weight	$1.6 \pm 0.024$ kg <sub>p</sub> /L
Colour	Comp. A off white Comp. B black
Theoretical consumption	1.7 L/m <sup>2</sup> rough sup. 0.8 L/m <sup>2</sup> smooth sup.
Theoretical coverage	0.6 m <sup>2</sup> /L rough sup. 1.25 m <sup>2</sup> /L smooth sup.
Open time	20°C: 30 min.
Complete setting	48 hours at 20°C
Time for second coat	Immediate
<b>MBRACE Saturant</b>	
Composition	Two parts (A & B)
Type of resin (A)	Epoxy (Bisphenol-A)
Type of hardener (B)	Polyamine
Solids by volume, %	100
Mixing ratio A:B	by weight or volume 5:2
Specific gravity of components A and B	A: $1.0 \pm 0.024$ kg <sub>p</sub> /L B: $1.0 \pm 0.024$ kg <sub>p</sub> /L
Specific gravity	$1.0 \pm 0.024$ kg <sub>p</sub> /L
Colour	Translucent blue
Viscosity	3100 mPa.s
Workability time	20°C: 30 min
Complete setting	7 days at 20°C
Tack range	
▪ Recommended	Within 48 hours
▪ Max	7 days

MBRACE <sup>®</sup> Fibre Reinforcement Systems					
MBRACE <sup>®</sup> Fibre	C1-30	C5-30	AK-40	AK-60	AK-90
Type of fibre	High strength carbon	High modulus carbon	High strength aramid (Kevlar <sup>®</sup> )	High strength aramid (Kevlar <sup>®</sup> )	High strength aramid (Kevlar <sup>®</sup> )
Tow sheet shape	Unidirectional fabric	Unidirectional fabric	Unidirectional fabric	Unidirectional fabric	Unidirectional fabric
Packaging rolls: Width <b>W</b> (m), Length. <b>L</b> (m), Surface <b>S</b> (m <sup>2</sup> )	0.50/100/50	0.50/100/50	0.10/100/10 0.30/50/15 0.50/50/25	0.10/100/10 0.30/50/15 0.50/50/25	0.10/100/10 0.30/50/15 0.50/50/25
Superficial Density, <b>D<sub>s</sub></b> , Kg.m <sup>-2</sup>	0.300	0.300	0.320	0.450	0.650
Density of fibre, <b>ρ</b> , kg.m <sup>-3</sup> (g/cm <sup>3</sup> )	1820 (1.82)	1820 91.82)	1440 (1.44)	1440 (1.44)	1440 (1.44)
Effective thickness <b>s</b> , mm	0.165	0.165	0.193	0.286	0.430
Effective area per unit width, <b>A<sub>eff</sub></b> , mm <sup>2</sup> .cm <sup>-1</sup>	1.65	1.65	1.93	2.86	4.3
Tensile strength, <b>f<sub>tk</sub></b> , MPa (N/mm <sup>2</sup> )	4000	3000	2100	2100	2100
Tensile strength per N/mm unit width, <b>f<sub>tkl</sub></b> , N.mm <sup>-1</sup>	565	495	400	600	900
Tensile modulus of elasticity, <b>E<sub>tk</sub></b> , GPa	230	390	120	120	120
Tensile modulus per unit width KN/mm	38	64	23	34	52
Ultimate deformation, <b>ε<sub>ij</sub></b> ,	1.5	0.8	2.25	2.25	2.25
Coefficient of thermal expansion, <b>α</b> , K <sup>-1</sup>	-10 <sup>-7</sup>	-10 <sup>-7</sup>	0.2-10 <sup>-7</sup>	0.2-10 <sup>-7</sup>	0.2-10 <sup>-7</sup>
Thermal conductivity, <b>J.m<sup>-1</sup>.s<sup>-1</sup>.K<sup>-1</sup></b>	17	17	4	4	4
Electrical resistivity, Ω-m	2.6.10 <sup>-5</sup> Conductive	1.6.10 <sup>-5</sup> Conductive	Insulate	Insulate	Insulate
Bonding to concrete <sup>2</sup> a) pr EN 1542 (direct) b) pr EN 12615 (shear)	> ∫ <sub>c (c. failure)</sub> <sup>tc (c. failure)</sup> > ∫ <sub>c (c. failure)</sub>	> ∫ <sub>c (c. failure)</sub> <sup>tc (c. failure)</sup> > ∫ <sub>c (c. failure)</sub>	> ∫ <sub>c (c. failure)</sub> <sup>tc (c. failure)</sup> > ∫ <sub>c (c. failure)</sub>	> ∫ <sub>c (c. failure)</sub> <sup>tc (c. failure)</sup> > ∫ <sub>c (c. failure)</sub>	> ∫ <sub>c (c. failure)</sub> <sup>tc (c. failure)</sup> > ∫ <sub>c (c. failure)</sub>
Water vapour permeability coefficient <b>μ</b> , DIN 52615	<10 <sup>5</sup>	<10 <sup>5</sup>	<10 <sup>5</sup>	<10 <sup>5</sup>	<10 <sup>5</sup>

**Kevlar<sup>®</sup> is a Registered Trademark of DuPont.**

**Note**

Values above are typical mean values obtained from regular testing. Some variation may occur dependant on batch, size, and test method sensitivity. Allowance should be made for this in the design process.

The designer is advised to satisfy himself, by prior testing if necessary, that the grade chosen will conform to the performance criteria for his specific design.



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#### Features and Benefits

- Increased flexural strength
- Increased shear strength
- Confinement
- Blast resistance
- Fatigue enhancement
- Lightweight
- Durable
- Control of crack propagation
- Excellent strength to thickness ratio

#### Application Procedure

##### Preparation of Substrate

Concrete - shot blasting or abrasive blasting to remove laitance and surface contamination. The concrete must be thoroughly cured, free of oils, curing compounds or mould release agents and must be thoroughly dried and free of dust at time of application. The concrete substrate must be repaired using epoxy resin or polymer modified cementitious mortars with tensile strength equal to or greater than the original concrete.

Any cracks not

caused by steel corrosion should be repaired using epoxy resin crack injection. Surface defects in concrete should be made good using MBRACE Putty.

Differences in adjacent concrete surface levels must be no more than 1mm. Concrete surface protrusions such as small projections, grouting lines etc. must be ground flat using concrete planes, disc sanders etc.

Depressions in the concrete surface such as a concrete joint must be filled with MBT-MBRACE Putty. Sharp corners must be rounded with a radius of at least 10mm. The larger the radius the better the preparation. Internal concrete angles must be rounded using an MBRACE Putty.

##### Mixing

##### MBRACE Primer, MBRACE Putty and MBRACE Saturant

Mechanically premix the MBRACE Part A resin individually prior to adding Hardener. Mechanically mix Resin Part A and Hardener Part B for 3 minutes or until homogeneous.

#### Application

##### MBRACE PRIMER

Work site must be thoroughly ventilated. Do not apply MBRACE Primer if ambient temperature is less than 5°C. Only mix as much primer as can be applied within its pot life. Mixed primer should be applied with roller brush. If necessary a second coat can be applied if needed when surface is very porous. MBRACE Primer must be allowed to cure until tack-free (overnight curing is common practice).

##### MBRACE Putty

Only mix as much putty as can be applied within its pot life. Apply the MBRACE Putty Adhesive to the substrate using a steel trowel or other suitable implement in order to eliminate surface imperfections. Application thickness and coverage rates will be highly dependent on the condition and profile of the concrete substrate. Primed and smoothed surfaces should be top coated within two days to assure proper adhesion of the MBRACE Fibre Reinforcement System to the substrate.

##### MBRACE Saturant

The MBRACE Fibre Reinforcement System must be cut before application of MBRACE Saturant into prescribed sizes using scissors or cutters. The number of sheets cut shall be limited to those that can be used within a day. Size of any sheet length should be less than 2 metres in length to facilitate flat wrinkle-free application and ensure no air is entrapped under the fibre sheet. Apply fully mixed MBRACE Saturant resin first coat to the MBRACE Fibre Reinforcement surface with a roller brush.

Resin saturated C 1-30, C 5-30, AK-40 or AK-60 MBRACE Fibre Reinforcement Systems should be placed fibre side down onto the concrete surface onto which the MBRACE Primer has been applied.

The Fibre Reinforcement System should be strongly squeezed in the longitudinal direction of the fibres two or three times using a defoaming roller and rubber spatula in order to impregnate the resin into the fibres and to defoam the resin coat.

For joining strips of fibre sheet, a 20cm overlap length is required in the horizontal direction and 25cm overlap length in the vertical direction. Additional resin must be applied at the overlap location on top of the outer layer of fibre sheet to be overlapped. The adhered Fibre Reinforcement System should be allowed to stand for at least 30 minutes. Any lifting or dislocation that occurs during this period must be corrected using the roller and spatula.



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The second or overcoat of mixed MBRACE Saturant should then be applied onto the surface of the fibre sheet.

The coated surface should be strongly squeezed in the fibre longitudinal direction two or three times with the roller and spatula in order to impregnate the fibre sheet in the same manner as above.

In cases where more than one layer of fibre sheet is to be applied, the above application method MBRACE Saturant should be repeated.

The appearance of the MBRACE Saturant material should be translucent blue. The black tow sheet should be visible as should the aramid fibres. The colour of the application will be varied due to overlaps and slight thickness variations. Overlap areas should also be translucent.

#### Coverage

##### **MBRACE Putty**

Estimated coverage rates are as follows for 3 mm application thickness :

Smooth surfaces: 0.29 m<sup>2</sup>/litre  
Rough surfaces: 0.15 m<sup>2</sup>/litre

##### **MBRACE Primer**

First Coat: 3.9 to 5.25 m<sup>2</sup> /litre.  
Second Coat: (when required) 6.5 to 8.5 m<sup>2</sup> /litre.

##### **MBRACE Saturant**

Estimated coverage is 0.5 to 0.7 litre per m<sup>2</sup> based on pre-saturation of tow sheet and first and second coat of tow sheet installation; for carbon fibre.

Estimated coverage is 1.45 - 1.70 litre per m<sup>2</sup> based on pre-saturation of tow sheet and 1st & 2nd coat of tow sheet installation; for Kevlar<sup>®</sup>

Users should check actual coverage with the tow sheet used for accurate estimating of quantities.

#### **Topcoat**

Please contact BASFConstruction Chemicals (UK) Technical Services Department for information on top-coats.

#### Cleaning:

Use Feb Solvent No. 2, Methyl Ethyl Ketone or Acetone. Observe fire and health precautions with solvents.

#### Storage

Store in cool, dry area (10 to 32°C) away from direct sunlight, flame or other hazards. MBRACE fibre reinforcement materials contain carbon fibres. During application of MBRACE fibre materials, wear appropriate work clothing to minimize contact. Use caution when handling flammable liquids and eliminate all sources of ignition from work area. Product Material Safety Data Sheets (MSDS) are available and should be consulted and on hand during application and/or whenever handling these products. These products are for professional and industrial use only; application directions must be followed.

#### Shelf Life

##### **MBRACE Primer/Putty/Saturant**

Twenty four months when properly stored in unopened containers.

#### Packaging

MBRACE <sup>®</sup> Primer	2.5 litres
MBRACE <sup>®</sup> Putty	5 litres
MBRACE <sup>®</sup> Saturant	5 litres
MBRACE <sup>®</sup> Fibre Sheets	100m x 50mm 100m x 300mm

#### Watchpoints

MBRACE Primer/Putty/Saturant contain reactive resins and diluents. Observe the following health and physical precautionary measures before using this product:

Wear gloves, eye protection, and appropriate work clothing to avoid contact with components. Ventilation is required with special consideration for enclosed or confined areas. Air movement must be designed to ensure turnover at all locations in work adjacent areas to avoid buildup of heavy vapours.

Do not apply the MBRACE Fibre Reinforcement Systems when ambient temperature is less than 5°C.

#### Maintenance

Periodically inspect the applied material and repair localised areas needed. Consult BASFConstruction Chemicals (UK) Technical Services for additional information.

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#### **Health and Safety**

\*For full information on Health and Safety matters regarding this product the relevant Health and Safety Data Sheet should be consulted.

The following general comments apply to all products.

As with all chemical products, care should be taken during use and storage to avoid contact with eyes, mouth, skin and foodstuffs, (which may also be tainted with vapour until the product is fully cured and dried). Treat splashes to eyes and skin immediately. If accidentally ingested, seek medical attention. Keep away from children and animals. Reseal containers after use.

#### **Solvent Based Products**

Use in well ventilated areas; avoid inhaling. Suitable respiratory equipment may be needed, eg when spraying. Can cause skin, eye irritation. Wear protective eye shields and gloves during use. Do not smoke or allow sparks or naked lights when stored or in use.

#### **Powder Products**

Should be handled to minimise dust formation; use light mask if excessive dust unavoidable. Cement powders when wet or moistened can cause burns to skin and eyes which should be protected during use.

#### **Resin Products**

Can cause irritation, dermatitis or allergic reaction. Use protective equipment particularly for skin and eyes. Use only in well ventilated areas.

#### **Spillage**

Chemical products can cause damage; clean spillage immediately.

#### **Disclaimer:**

This information and all further technical advice is based on our present knowledge and experience. However, it implies no liability or other legal responsibility on our part, including with regard to existing third party intellectual property rights, especially patent rights. In particular, no warranty, whether express or implied, or guarantee of product properties in the legal sense is intended or implied. We reserve the right to make any changes according to technological progress or further developments. The customer is not released from the obligation to conduct careful inspection and testing of incoming goods. Performance of the product described herein should be verified by testing, which should be carried out only by qualified experts in the sole responsibility of a customer. Reference to trade names used by other companies is neither a recommendation, nor does it imply that similar products could not be used.