

ARMOSHIELD®

Technology for structural reinforcement: plating or wrapping of composite systems in carbon fibre

OVERVIEW

The term 'composite system in carbon fibre' refers to materials composed of high-resistance, continuous-fibre fabrics immersed in a polymer matrix. Since the nineteen-fifties, these materials have been used on a large scale in aeronautical and mechanical engineering because of their very high level of mechanical performance. More recently, they have been used in other industrial sectors, and especially in the field of structural reinforcement in buildings.

The principle characteristics of the composite system are high resistance to tensile stress, very good resistance to corrosion, high flexibility and very limited weight.

DESCRIPTION

The ARMOSHIELD system is formed by high-density carbon-fibre strips attached to supports with special resinous binders with superior mechanical characteristics. With both the plating and the wrapping methods of application, the system fortifies structures where it is necessary to improve or restore static conditions, by increasing their resistance, load-bearing qualities and ductility, but without overloading the structure.

USES

The main applications of the ARMOSHIELD system are in the following areas:

- Reinforcement of deflected structures:

Reduction of loaded deflection, increase of load-bearing capacity, and the regeneration of transmission of tension interrupted by cracking, in flooring, beams, interlocked elements etc.

- Reinforcement of compressed structures:

Increase of compressive strength and ductility, for example in pillars, columns, chimney stacks etc. This type of intervention is particularly suitable for the improvement of structures in seismic zones without increasing weight.

- Reinforcement of weakened structures:

Important applications are the restoration of vaults and arches in masonry, cupolas, deflected masonry etc.

In general, the ARMOSHIELD technique can be applied in historic buildings and monuments, structures in reinforced concrete such as viaducts, car-parks, civil and industrial buildings and wooden structures.

ADVANTAGES

High level of mechanical characteristics and performance

High chemical resistance to corrosion

Increase of resistance to stress

Reliability and long-life of the system

Excellent applicability in humid environments (water absorption $\leq 0.1\%$)

Excellent level of wettability of fabric

High tear resistance also on irregular, uneven substrates

Very low system weight

Reinforcement thickness of 1-2 mm

The ARMOSHIELD fabric can be easily draped over structures and adapted to complex forms and uneven surfaces

The system can be easily applied without complicated on-site management

Structures where the system is applied can be kept open during intervention; less inconvenience

Limited reduction of permeability in frescoed vaults

Zero or very limited time prior to re-use

Project and application experience

Reduced time and costs for application.

TECHNICAL DATA

The ARMOSHIELD system consists of fibre reinforcement in carbon with resins for smoothing, adhesion and protection.

TYPES OF ARMOSHIELD FIBRE REINFORCEMENT IN CARBON

Type (sp.gr.1.8 g/cm ³)	Uni-directional U		Balanced B		Bi-axial± 45° T	
Weight of the fabric g/m ²	330	500	320	600	450	600
Thickness mm	0,18	0,28	Warp 0,11 Weft 0,07	Warp 0,21 Weft 0,13	0,12	0,16 direction
Standard heights	5-10-20-50-100 cm		5-10-20-50-100		on request	
Distribution of weight	100% Warp		60% Warp - 40% trama		50% per direzione	
Length of strips	50 - 100 m, depending on type					

TECHNICAL CHARACTERISTICS OF ARMOSHIELD FIBRE REINFORCEMENTS IN CARBON

Resistance to tensile stress 3,530 MPa

Elasticity modulus for tensile stress 235,000 MPa (up to 500,000 on request)

Ultimate elongation 1.5 %

TYPES AND TECHNICAL CHARACTERISTICS OF THE POLYMER MATRIX IN THE ARMOSHIELD SYSTEM

The application system varies in accordance with the type of substrate and the conditions of the same.

In general, the application cycle requires a primer, a smoothing coat, an adhesive coat and saturation.

In some cases a final protective coating may be required.

PRIMER - ARMOPRIMER 200 ⁽¹⁾

Structure type:	porous
Specific gravity:	1 g/cm ³
Dry residual matter:	40 %
Workability:	480 min
Touch dry at:20°C	18 h
Min application temperature:	10 °C

ARMOPRIMER 200

SMOOTHING COATS AND ADHESION WITH ARMOFIX T ⁽¹⁾

Smoothing with special ARMOFIX T epoxy filler as required when the surface is irregular or when the substrate needs adequate reinforcing for the transmission of forces and tension. ARMOFIX T is used in many cases as a binder for the ARMOSHIELD fibre reinforcement as a replacement for the MT and MTX binders.

Specific gravity	1.60 g/cm ³
Workability at 20°C:	30 min
Touch dry at 20°C	8 h
Min application temperature	5°C
Elasticity modulus	3500 MPa
Compressive strength	65 MPa
Resistance to tensile stress	24 MPa
Flexural strength	35 MPa

ARMOFIX T

ADHESION - ARMOFIX MT - MTX ⁽¹⁾

The adhesive system features high performance epoxy adhesives

Specific gravity	1.1 g/cm ³
Workability at 20°C:	30 min
Touch dry at 20°C	16 h
Min application temperature	10°
Adhesion to concrete with broken substrate	> 3.5 MPa
Resistance to tensile stress	30 MPa
Flexural strength	50 MPa
Compressive strength	95 MPa
Elasticity modulus	2200 MPa

ARMOFIX MT - MTX

FINISHING - ARMOLAST

In cases where a final protection is required for the ARMOSHIELD fibre reinforcement, it is advisable to use the ARMOLAST special finishing product, which offers the properties of elasticity and protection against U.V. rays.

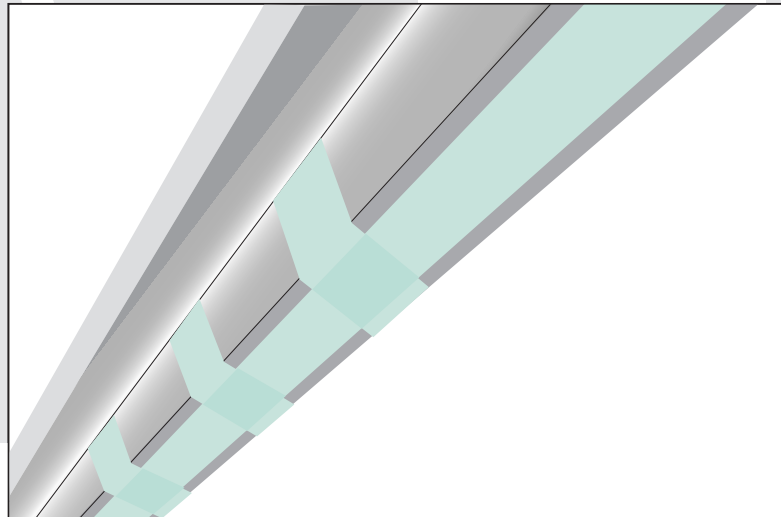
ARMOLAST is available in different colours.

Specific gravity	1.5 g/cm ³
Workability at 20°C	40 min
Touch dry at 20°C	24 h
Min application temperature	10°
Resistance to tensile stress	8 MPa
Hardness	74
Ultimate elongation	100%

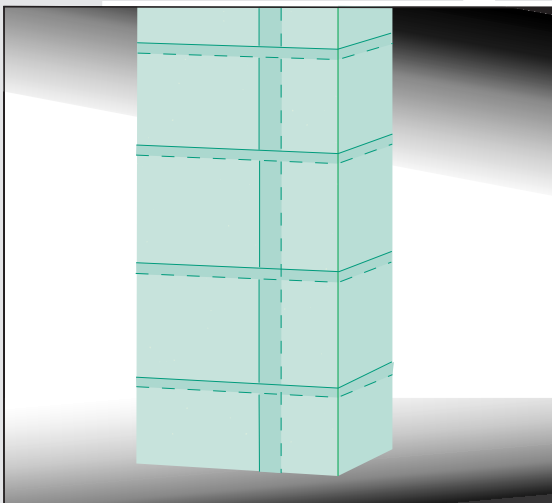
The mixing ratios for the various types of resin are indicated on the packaging

INSTRUCTIONS FOR USE

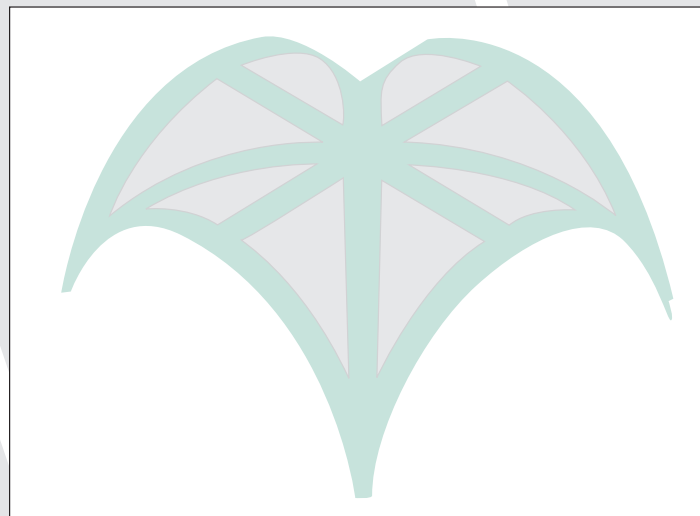
Application of ARMOSHIELD structural reinforcement requires careful and precise preparation of the surface to be treated. For intervention and operation on masonry and vaults, it is important to remove any loose or crumbling parts first. The surface must then be brushed and all dust removed. Remove all traces of grease or oil. Any cracks must be saturated with ARMOLINE or with lime-base slurries. The substrate must then be primed, using a brush or roller, and applying quantities of primer suitable for the absorption capacity of the surface. After the touch-dry period has elapsed and in any case within the first 24 hours following application of the primer, the smoothing coat is applied if required by means of a spatula or plasterer's float or trowel. Then apply the adhesive resin with a brush or roller after the smoothing coat has become touch dry and in any case within 24 hours. Lay the carbon reinforcement in accordance with the restoration plans or particular requirements and exercise constant pressure with a roller or manually until the fibres are fully impregnated. After about one hour apply a second coat of adhesive. Repeat the procedure if more than one reinforcement layer is needed. Quartz sand may be applied 'fresh-on-fresh' over the final coat of adhesive if it is necessary to produce subsequent plaster coating layers or adherent coverings. When required, the final protection coating is applied when the adhesive is dry. For work on concrete the substrate must be prepared by means of sanding, following a check of the state of deterioration of the surface to be treated. If the surface is deteriorated, remove the weakened layer by scraping, hydro-demolition or using other methods, and then restore the metal reinforcement rods and concrete with a restoration cycle, using ARMOCRETE fibro-reinforced mortars. Before application of the ARMOSHIELD reinforcement system, remove all traces of oil, grease and dust. The cycle must be carried out according to the instructions given above. Care must be taken to avoid sharp, protruding or jagged points, which may impede the normal performance of the reinforcement. If there are any such structural areas, smoothing coats should be applied or the protruding points should be reduced or eliminated by flexible or other means. It is normally convenient and advantageous to let the fibre reinforcement fabric overlap by 15 - 20 cm in the longitudinal direction of the fibres and by 2 cm in the transverse direction. In certain cases the smoothing coating itself may be used as an adhesive for the carbon fibres.



Application of **ARMOSHIELD** for beams.



Wrapping of **ARMOSHIELD** for pillars.



Application of **ARMOSHIELD** for vaults.

GENERAL RULES FOR APPLICATION

The final resulting performance of the structural ARMOSHIELD reinforcement system strictly depends on the care with which the phases of the application cycle are carried out. In particular, care must be taken with the following factors:

- Carefully observe application times and requirements of the project;
- Prepare the substrates adequately;
- Visually check for perfect impregnation of the reinforcement system over the entire area treated, in which there should be no areas left out and not wetted by the resin and no air pockets;
- The fabric must be flattened, well-anchored and laid out properly so as to properly transmit forces and tension;
- Do not allow the fabric to rise or become loosened in peripheral areas or around edges, which may initiate progressive peeling. If this happens, apply resin or specific covering;
- Round off or reduce any sharp points.

YIELD

Consumption of the material is closely linked to project requirements. Generally speaking, for 1 sq. m of the ARMOSHIELD U330 type structural reinforcement, about 3 kg of resin and primer will be required, excluding preparation of the substrate.

PACKING

ARMOSHIELD carbon fibre reinforcement fabric: 50 - 100 m rolls.

ARMOSHIELD resin: drums. For quantities, see the packaging.

CAUTION

Use gloves during application, and do not allow the resin to come into contact with the skin or delicate parts of the body or eyes. In the event of contact, wash with abundant quantities of water and neutral soap. Use protective glasses or lenses when working with these materials.

STORAGE

ARMOSHIELD fabric can be stored for an unlimited period of time when fully protected. The resins can be stored for at least 12 months when kept in their original sealed packaging in a warm environment. The resins must be protected against freezing.

ABSTRACT

Type of operation

Structural reinforcement with carbon fibre fabric of beams, flooring, trusses and tie-beams, pillars, floor or wall joists, concrete vaults and masonry, without overloading of the structure and reduced on-site requirements.

Technical specification

Supply and assembly of reinforcement armature in carbon fibre. The method adopted is the ARMOSHIELD system. Compatibility must be ensured for individual phases and operations. Operations include:

- Installation: supply and removal of machinery required for reinforcement work;
- Scaffolding: supply and assembly / disassembly of scaffolding and all materials used for protection against dust during reinforcement and restoration work;
- Rounding off of any rough edges to a minimum radius of 1 cm;
- Preparation of substrates: elimination of the superficial concrete slurry and all weakened parts, including final cleaning with metal brushes and/or vacuum cleaning equipment;
- Laying of surface mortar: elimination of protruding profiles and filling of cavities in the adhesive area;
- Application of primer of the ARMOPRIMER type;
- Application of a smoothing coat and adhesive resin of the ARMOFIX T - MT types and fabric in carbon fibre of the ARMOSHIELD type.

Application and laying of surface layers with an adhesive system featuring high resistance to shearing stress. The fabric must be easily draped and impregnated over the entire section to be covered. One or more layers may be laid, one above the other, depending on the characteristics of the project.

Weight of the carbon fibre: uni-directional type, balanced type, bi-axial type, and heights varying from 5 to 100 cm.

Overlay in the direction of the fibre	15-20 cm
Overlay in the transversal direction	2 cm
Elasticity modulus	235000 MPa
Resistance to tensile stress	3530 MPa
Ultimate elongation	1,5%

- Application of a protective covering of the ARMOLAST type (with a high level of vapour transfer and elasticity) over the reinforced areas or spreading of quartz prior to final plaster coating if required.