

# RESTORATION AND PROTECTION OF REINFORCED CONCRETE



# F specifications of RESTORATION AND PROTECTION OF REINFORCED CONCRETE

## **F.1 PRELIMINARY OPERATIONS**

### **F.1 LAVORAZIONI PRELIMINARI**

#### **F.1.1 PREPARATION OF SUBSTRATES**

##### **F.1.1.1 Idroscarifica**

#### **F.1.2 STEEL REINFORCEMENT**

#### **F.1.3 APPLICATION OF ELECTRO-WELDED MESH**

#### **F.1.4 FORMWORK**

## **F.2 PROTECTION OF STEEL REINFORCEMENT**

### **F.2.1 PROTECTION USING ANTI-CORROSION CEMENTITIOUS MORTAR**

Concrete structures deteriorated by carbonation and chlorides

### **F.2.2 INTERNAL GALVANIC CATHODIC PROTECTION**

Concrete structures exposed to chloride-rich environments

F.2.2.1 PROTECTION OF NEW STRUCTURES  
Procedure

F.2.2.2 PROTECTION OF STRUCTURES TO BE RESTORED (duration 10 years)  
Procedure

F.2.2.3 PROTECTION OF STRUCTURES TO BE RESTORED (duration 20 years)  
Procedure

### **F.2.3 EXTERNAL GALVANIC CATHODIC PROTECTION**

Concrete structures exposed to chloride-rich environments

## **F.3 RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES**

CIVIL, RESIDENTIAL, INDUSTRIAL AND INFRASTRUCTURAL WORKS WITHOUT DYNAMIC STRESS

### **F.3.1 RAPID-SETTING THIXOTROPIC MORTARS**

Procedure

### **F.3.2 NORMAL-SETTING THIXOTROPIC MORTARS**

Procedure

### **F.3.3 TWO-COMPONENT NORMAL-SETTING THIXOTROPIC MORTARS**

Procedure

## **F.4 STRUCTURAL RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES**

CIVIL, RESIDENTIAL, INDUSTRIAL AND INFRASTRUCTURAL WORKS WITHOUT DYNAMIC STRESS

### **F.4.1 NORMAL-SETTING THIXOTROPIC MORTARS**

Procedure



- F.4.2 **TWO-COMPONENT NORMAL-SETTING THIXOTROPIC MORTAR**  
Procedure
- F.4.3 **NORMAL-SETTING CASTABLE MORTAR**  
Procedure
- F.4.4 **CIVIL, RESIDENTIAL, INDUSTRIAL AND INFRASTRUCTURAL WORKS SUBJECTED TO DYNAMIC STRESS**  
**NORMAL-SETTING THIXOTROPIC MORTARS**  
Procedure
- F.4.5 **TWO-COMPONENT NORMAL-SETTING THIXOTROPIC MORTARS**  
Procedure
- F.4.6 **RAPID-SETTING CASTABLE MORTAR**  
Procedure
- F.4.7 **NORMAL-SETTING CASTABLE MORTAR**  
Procedure
- F.5 *STRUCTURAL RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES WITH LAYERS THICKER THAN AN AVERAGE OF 5 CM***
- F.5.1 **CONCRETE MADE WITH SPECIAL BINDERS**  
Procedure
- F.6 *SHRINKAGE REDUCER***
- F.6.1 **CURING ADMIX TO REDUCE HYDRAULIC SHRINKAGE AND THE FORMATION OF MICRO-CRACKS**
- F.7 *REPAIRS TO CRACKED CONCRETE BY INJECTION OR CASTING***
- F.7.1 **DRY OR SLIGHTLY-DAMP DIMENSIONALLY-STABLE CRACKS**
- F.8 *STRUCTURAL BONDING OF CONCRETE***
- F.8.1 **BONDING HARDENED CONCRETE TO HARDENED CONCRETE (E.G. PREFABRICATED UNITS)**
- F.8.2 **BONDING FRESH CONCRETE TO HARDENED CONCRETE (SECOND POURS)**
- F.8.3 **BONDING FLAT STEEL PLATES OR OTHER MATERIAL TO CONCRETE ELEMENTS**
- F.9 *SKIMMING THE SURFACE OF CONCRETE AND RENDER***
- F.9.1 **UNEVEN SURFACES WITH NO DYNAMIC STRESS**
- F.9.2 **UNEVEN SURFACES SUBJECTED TO DYNAMIC STRESS**
- F.10 *ANCHORING STEEL REINFORCEMENT, METAL STRUCTURES AND MACHINERY***
- F.10.1 **ANCHORING METAL REINFORCEMENT, STRUCTURES AND INDUSTRIAL MACHINERY**
- F.11 *RAPID FASTENING AND FILLING WORK***
- F.11.1 **FASTENING METAL BRACKETS, PIPEWORK, JUNCTION BOXES AND SHEATHS FOR ELECTRICAL INSTALLATIONS, BACKING FRAMES FOR WINDOW AND DOOR FITTINGS, ETC. ON CONCRETE AND MASONRY SUBSTRATES**
- F.11.2 **FIXING DRAIN SHAFTS, MAN-HOLES, URBAN FEATURES, ROAD SIGNS, ELECTRICITY**

AND TELEPHONE POLES, FENCES, ETC. IN PLACE

**F.12**     ***PROTECTION OF CONCRETE SURFACES***

F.12.1     HYDROPHOBIC IMPREGNATION

F.12.2     COATING RESISTANT TO THE PENETRATION OF AGGRESSIVE AGENTS

F.12.3     COATING RESISTANT TO CHEMICAL PRODUCTS

F.12.4     COATING FOR CONTACT WITH DRINKING WATER AND FOOD PRODUCTS

## F.1 PRELIMINARY OPERATIONS

### F.1.1.1 Hydro-scarifying

Hydro-scarification and removal of the cortex of deteriorated cementitious conglomerate, using hydro-scarifying equipment producing jets of water with a maximum pressure of 2,500 atm and a flow-rate of 250 litres of water per minute, to remove all deteriorated concrete and/or prepare the adhesion surface between old and new cast concrete without compromising either the integrity and anchorage of exposed steel reinforcement, or the structural integrity of concrete around the demolished areas.

Included and calculated in the price for work carried out according to specification:

- costs for taking precautions to prevent damage to structures and to protect service lines and units during execution of the work;
- suitable demolition tools and equipment;
- supply and feed of water;
- all costs for work carried out from mobile swing platforms;
- fine demolition work using manual lances in confined areas;
- use of hand chisels and/or mini demolition hammers, where required, to finish off unstable or deteriorated areas;
- removal of steel reinforcement detached from the concrete;
- arrangement of remaining steel reinforcement after demolishing and breaking up the agglomerate (repositioning steel reinforcement using new ties and packing);
- thorough cleaning of treated concrete surfaces with compressed air or high-pressure water;
- cleaning all walkways and removal and transport of all debris and waste material to an authorised waste disposal site.

a) for treated layers up to 5 cm thick

*per square metre*

..... (€/m<sup>2</sup>)

b) for treated layers more than 5 cm thick

*per square metre per cm of thickness*

..... (€/m<sup>2</sup>-cm)



## F.1 PRELIMINARY OPERATIONS

### F.1.1.2 Hand or power chiselling and cleaning steel reinforcement by brushing

Removal of the cortex of deteriorated cementitious conglomerate, using hand or power chisels, to remove all deteriorated concrete and/or prepare the adhesion surface between old and new cast concrete without compromising either the integrity and anchorage of exposed steel reinforcement, or the structural integrity of concrete around the demolished areas. Exposed steel reinforcement is then cleaned with a hand or power brush to remove oxidation, aggressive chemicals, loose surfaces and any traces of oil, grease, dirt and all other pollutants to leave a bare metal surface.

Included and calculated in the price for work carried out according to specification:

- costs for taking precautions to prevent damage to structures and to protect service lines and units during execution of the work;
- suitable demolition tools and equipment;
- all costs for work carried out from mobile swing platforms;
- arrangement of steel reinforcement after demolishing (repositioning steel reinforcement using new ties and packing);
- thorough cleaning of treated concrete surfaces with compressed air or high-pressure water;
- cleaning all walkways and removal and transport of all debris and waste material to an authorised waste disposal site.

for treated layers up to 2 cm thick

– per square metre

..... (€/m<sup>2</sup>)

## F.1 PRELIMINARY OPERATIONS

### F.1.1.3 Hydro-sandblasting

Cleaning of concrete surfaces and exposed steel reinforcement, where hydro-scarifying has not been carried out, by hydro-sandblasting with silica sand to remove oxidation, aggressive chemicals, loose surfaces and any traces of oil, grease, dirt and all other pollutants to leave a bare metal surface (grade SA 2½) (ISO 8501-1).

Hydro-sandblasting is not required if the surface has been prepared by hydro-scarifying. However, if the time between hydro-scarifying and treating the steel reinforcement is particularly long due to on-site logistics, hydro-sandblasting must be carried out.

Included and calculated in the price for work carried out according to specification:

– removal and transport of all debris and waste material to an authorised waste disposal site.

– per square metre

..... (€/m<sup>2</sup>)

## F.1 PRELIMINARY OPERATIONS

### F.1.1.4 Hydro-cleaning surfaces

Pressurised hydro-cleaning of concrete surfaces using hydro-cleaning equipment with more than 150 bar of pressure, to completely remove layers of micro-organisms, old, loose and crumbly portions, dust and traces of previous paint treatments. This operation is also required to saturate the substrate before applying cementitious mortar or concrete to improve its grip.

Included and calculated in the price for work carried out according to specification:

- supply and disposal of all water.
- all costs.

– *per square metre*

..... (€/m<sup>2</sup>)



## **F.1 PRELIMINARY OPERATIONS**

### **F.1.2 STEEL REINFORCEMENT**

#### **F.1.2.1 Replacement of damaged steel reinforcement and positioning new reinforcement**

Supply and installation of steel reinforcement in reinforced cement structures, after demolishing and breaking-up the cement to enable steel reinforcement to be arranged/replaced, before applying rheoplastic cementitious conglomerate, pre-mixed castable cementitious mortar and concrete.

Included and calculated in the price for work carried out according to specification:

- all costs to cut, straighten or bend new steel reinforcement according to design specifications;
- positioning, tying-in and packing new, supplementary reinforcement around existing, highly-oxidised steel reinforcement with a weak section, using Fe B 44k stainless steel rebar with a diameter sufficient to achieve the degree of strengthening calculated for the structure;
- wire and/or hooks to tie-in the reinforcement, and spot welds and spacers where required;
- clearing up cut and unused steel reinforcement;
- thorough cleaning with compressed air.

The price refers to the surface area of the concrete where the steel reinforcement is arranged/replaced.

- per square metre ..... (€/m<sup>2</sup>)

## F.1 PRELIMINARY OPERATIONS

### F.1.3 APPLICATION OF ELECTRO-WELDED MESH

#### F.1.3.1 Application of electro-welded mesh

Supply and application of electro-welded steel mesh dimensioned according to design specifications (for any diameter of steel wire and any size of mesh) with relative certificate of origin and quality, to reinforce cast concrete, pre-mixed thixotropic, castable cementitious mortar and concrete, suitable also for restoration work and cladding.

Included and calculated in the price for work carried out according to specification:

- cutting;
- all costs for cutting/bending to shape;
- wire to tie the mesh;
- spacers;
- waste material.

a) Mesh fastened to structure with metallic expansion plugs

- per kilo .....(€/kg)

b) Mesh fastened to the structure with ties

- per kilo .....(€/kg)

**F.1 PRELIMINARY OPERATIONS****F.1.4 FORMWORK****F.1.4.1 Positioning the formwork**

Supply and application of metallic formwork for cast concrete and pre-mixed, castable cementitious mortar for structural strengthening work.

Included and calculated in the price for work carried out according to specification:

- nails;
- stripping.

- *per square metre* ..... (€/m<sup>2</sup>)



## F.1 PRELIMINARY OPERATIONS

### F.1.4.2 Supports for overhanging formwork

Supply and application of supports for formwork fastened to structures, including overhanging formwork positioned at any height and using any system, to cast concrete and pre-mixed, castable cementitious mortar for modifying or restoring works of art.

Included and calculated in the price for work carried out according to specification:

- temporary supports;
- hire costs;
- fasteners and all other costs.

– *per square metre*

..... (€/m<sup>2</sup>)

## F.2 PROTECTION OF STEEL REINFORCEMENT

### F.2.1 PROTECTION USING ANTI-CORROSION CEMENTITIOUS MORTAR Concrete structures deteriorated by carbonation and chlorides

#### F.2.1.1 Application of one-component, anti-corrosion, re-alkalising cementitious mortar

Supply and application of a passivating treatment for steel reinforcement, by brush-applying two coats of one-component, anti-corrosion cementitious mortar made from cementitious binders, powdered polymers and corrosion inhibitors (such as **Mapefer 1K** produced by MAPEI S.p.A.). Apply the mortar after adequate preparation of the substrate (not included), by removing all deteriorated concrete to obtain a solid, sufficiently-rough substrate with no loose portions and removing all rust from steel reinforcement by hydro-sandblasting or power-brushing (not included), until a bare metal surface is obtained (grade SA 2½).

The product is suitable for providing steel reinforcement with a protective, re-alkalising treatment coating, and must have a pH value of at least 12, the minimum level to guarantee passivation of steel. Brush-apply the product in two even coats to form a layer at least 2 mm thick, making sure that the surface of all the steel is completely covered. Apply the first coat to form an even layer 1 mm thick to cover the surface of all the steel.

Apply the second coat after approximately 2 hours in normal conditions, or the following day within 24 hours, according to site logistics requirements.

Although some of the product will go on the concrete around the steel reinforcement, this will have no effect on the adherence of the restoration mortar applied later.

The product must comply with the minimum requirements of EN 1504-7 and have the following performance characteristics:

Adhesion to substrate (EN 1542) (MPa):	≥ 2
Slip-resistance of steel reinforcement rods (EN 15184):	meets specifications
Resistance to corrosion (EN 15183):	meets specifications
Waiting time before applying restoration mortar:	6-24 h (at +20°C)
Consumption (g/m):	100 (2 mm of product applied on 8 mm round bar)

Included and calculated in the price for work carried out according to specification:

– brush-application of two coats of product.

– per square metre

..... (€/m<sup>2</sup>)



## F.2 PROTECTION OF STEEL REINFORCEMENT

### F.2.1.2 Application of two-component, anti-corrosion, re-alkalising cementitious mortar

Supply and application of a passivating treatment for steel reinforcement by brush-applying two component anti-corrosion cementitious mortar made from cementitious binders, powdered polymers and corrosion inhibitors (Mapefer produced by MAPEI S.p.A.). Apply the mortar after adequate preparation of the substrate (not all deteriorated concrete to obtain a solid, sufficiently-rough substrate with no loose portions and remove reinforcement by hydro-sandblasting or power-brushing (not included), until a bare metal surface is obtained). The product is suitable for providing steel reinforcement with a protective, re-alkalising treatment with a pH value of at least 12, the minimum level to guarantee passivation of steel. Brush-apply the product to form a layer at least 2 mm thick, making sure that the surface of all the steel is completely covered. Apply the first coat to form an even layer 1 mm thick to cover the surface of all the steel. Apply approximately 2 hours in normal conditions, or the following day within 24 hours, according to site logs. Although some of the product will go on the concrete around the steel reinforcement, this will not affect the adherence of the restoration mortar applied later.

The product must comply with the minimum requirements of EN 1504-7 and have the following performance characteristics:

Mixing ratio:	comp A:comp B
Adhesion to substrate (EN 1542) (MPa):	≥ 2
Slip-resistance of steel reinforcement rods (EN 15184):	meets specific requirements
Resistance to corrosion (EN 15183):	meets specific requirements
Waiting time before applying restoration mortar:	6-24 h (at +20°C)
Consumption (g/m):	120 (2 mm of 10 mm round bar)

Included and calculated in the price for work carried out according to specification:

– brush-application of two coats of product.

– per square metre ..... (€/m<sup>2</sup>),





## F.2 PROTECTION OF STEEL REINFORCEMENT

### F.2.2 INTERNAL GALVANIC CATHODIC PROTECTION Concrete structures exposed to chloride-rich environments

#### F.2.2.1 PROTECTION OF NEW STRUCTURES Procedure

##### Protection of steel reinforcement

Protection of steel reinforcement using **Mapeshield I** 10/20 (see section **F.2.2.1.1**) or **Mapeshield I** 30/20 (see section **F.2.2.1.2**) pure zinc internal sacrificial anodes. The number of anodes connected to the steel reinforcement depends on the amount of steel contained in the first 20 cm of concrete, starting from the surface exposed to aggressive agents. For a steel/concrete surface area ratio of 1, use 2 **Mapeshield I** 10/20 anodes per square metre or 1.5 **Mapeshield I** 30/20 anodes per square metre.

Weld the connectors on the anodes to the steel reinforcement before casting the concrete. Do not apply **Mapefer**, **Mapefer 1K** or any other anti-rust treatment on the steel reinforcement. Make sure there is enough space between the anode and the steel reinforcement to allow the concrete to flow. Once installed, the continuity between the anodes and reinforcement rods must be checked with an ohmmeter. Resistance of up to 1 ohm is acceptable. Once the anodes have been installed, cast the concrete according to design specifications.

## F.2 PROTECTION OF STEEL REINFORCEMENT

### F.2.2.1.1 Application of pure zinc anodes (length 10 cm)

Supply and application of galvanic cathodic protection against corrosion (with no current applied) for steel reinforcement in reinforced concrete on new structures, by applying internal sacrificial anodes made from a pure zinc, multi-layered core coated with special conductive paste and a protective fabric dressing (such as **Mapeshield I** 10/20 produced by MAPEI S.p.A.), fastened directly to the steel reinforcement before casting the concrete.

Each anode must be delivered to site in vacuum-packed wrapping to protect against contamination. The galvanic anodes must comply with UNI EN 12696 European standards.

The product must have the following characteristics:

Total weight (g):	$320 \pm 10\%$
Zinc mass (g):	$245 \pm 2\%$
Length (mm):	$100 \pm 10\%$
Width (mm):	$50 \pm 10\%$
Thickness (mm):	$15 \pm 10\%$

Included and calculated in the price for work carried out according to specification:

– application of each anode, including welding to the steel reinforcement.

– per anode ..... (€/piece)



## F.2 PROTECTION OF STEEL REINFORCEMENT

### F.2.2.1.2 Application of pure zinc anodes (length 30 cm)

Supply and application of galvanic cathodic protection against corrosion (with no current applied) for steel reinforcement in reinforced concrete on new structures, by applying internal sacrificial anodes made from a pure zinc, multi-layered core coated with special conductive paste and a protective fabric dressing (such as **Mapeshield I 30/20** produced by MAPEI S.p.A.), fastened directly to the steel reinforcement before casting the concrete.

Each anode must be delivered to site in vacuum-packed wrapping to protect against contamination. The galvanic anodes must comply with UNI EN 12696 European standards.

The product must have the following characteristics:

Total weight (g):	570 ± 10%
Zinc mass (g):	450 ± 2%
Length (mm):	300 ± 5%
Width (mm):	50 ± 5%
Thickness (mm):	12 ± 10%

Included and calculated in the price for work carried out according to specification:

– application of each anode, including welding to the steel reinforcement.

– per anode ..... (€/piece)



**F.2.2.2 PROTECTION OF STRUCTURES TO BE RESTORED (duration 10 years)  
Procedure****Preparation of substrates**

Prepare all surfaces to be restored by completely removing all the deteriorated concrete with a power chisel (see section **F.1.1.2**) or with other suitable means, such as hydro-scarifying (see section **F.1.1.1**) to at least 2 cm below the steel reinforcement, to obtain a solid, sufficiently-rough substrate with no detached portions. If the deteriorated concrete has been removed with a power chisel, clean all exposed steel reinforcement with a brush (see section **F.1.1.2**) or by hydro-sandblasting (see section **F.1.1.3**) to remove all the rust.

Hydro-sandblasting is not required if the surface has been prepared by hydro-scarifying. However, if the time between hydro-scarifying and treating the steel reinforcement is particularly long due to on-site logistics, hydro-sandblasting must be carried out. Replace any steel reinforcement which has been cut or damaged, or which is highly corroded, with new reinforcement (see section **F.1.2.1**).

**Preparation of steel reinforcement**

After removing the rust, protect the steel reinforcement using **Mapeshield I** 10/10 (see section **F.2.2.2.1**) or **Mapeshield I** 30/10 (see section **F.2.2.2.2**) pure zinc internal sacrificial anodes. The number of anodes connected to the steel reinforcement depends on the amount of steel contained in the first 20 cm of concrete, starting from the surface exposed to aggressive agents. For a steel/concrete surface area ratio of 0.8, use 4 **Mapeshield I** 10/10 anodes per square metre, while for a steel/concrete surface area ratio of 1, use 2.5 **Mapeshield I** 30/10 anodes per square metre. Weld or tie the connectors on the anodes to the steel reinforcement before casting the concrete. Do not apply **Mapefer**, **Mapefer 1K** or any other anti-rust treatment on the steel reinforcement before casting the mortar. Enough space must be left under the anodes to allow the mortar to flow when it is applied. This space must never be less than 2-3 times the size of the largest aggregate in the restoration mortar. Once installed, the continuity between the anodes and reinforcement rods must be checked with an ohmmeter. Resistance of up to 1 ohm is acceptable.

**Restoration operations**

Clean all surfaces to be restored and saturate the substrate with water leaving a dry surface (s.s.d.) by hydro-cleaning (see section **F.1.1.4**).

The electrical resistivity of the restoration mortar must be in a range of between 50% and 200% of the original concrete, and up to a maximum of 100 kΩ, as prescribed by EN 12696 specifications.

We recommend using one of the following products:

- **Mapegrout 430** one-component, normal-setting, shrinkage-compensating, class R3 thixotropic mortar for layers from 0.5 to 3.5 cm thick (see section **F.3.2.1**);
- **Mapegrout T40** one-component, normal-setting, shrinkage-compensating, class R3 thixotropic mortar for layers from 1 to 3.5 cm thick (see section **F.3.2.2**);
- **Mapegrout Thixotropic** one-component, normal-setting, shrinkage-compensating, class R4 thixotropic mortar for layers from 1 to 3.5 cm thick (see section **F.4.1.1**);
- **Mapegrout T60** one-component, normal-setting, shrinkage-compensating, class R4 thixotropic mortar for layers from 1 to 4 cm thick (see section **F.4.1.2**);
- **Mapegrout Easy Flow** one-component, normal-setting, shrinkage-compensating, class R4 thixotropic mortar for high pumping heads, for layers from 1 to 3.5 cm thick (see section **F.4.4.2**);
- **Mapegrout Easy Flow GF** one-component, normal-setting, shrinkage-compensating, high-ductility, class R4 thixotropic mortar strengthened with inorganic fibres for medium-height pumping heads, for layers from 1 to 5 cm thick (see section **F.4.4.3**);
- **Stabilcem** expanding cementitious binder for pumped concrete (see section **F.5.1.1**);
- **Stabilcem SCC** expanding cementitious binder for pumped, self-compacting concrete (see section **F.5.1.2**).

If a finer finish is required, skim the restored surfaces once the mortar has cured with one of the

## F.2 PROTECTION OF STEEL REINFORCEMENT

### F.2.2.2.1 Application of pure zinc anodes (length 10 cm)

Supply and application of galvanic cathodic protection against corrosion (with no current applied) for steel reinforcement in reinforced concrete on structures under restoration, by applying internal sacrificial anodes made from a pure zinc, multi-layered core coated with special conductive paste and a protective fabric coating (such as **Mapeshield I 10/10** produced by MAPEI S.p.A.). Apply the anodes after adequate preparation of the substrate (not included), by removing all deteriorated concrete to obtain a solid, sufficiently-rough substrate with no loose portions and removing all rust from the steel reinforcement. After cleaning the substrate and saturating it with water, rebuild the areas where the concrete has been demolished using one of the restoration mortars recommended in the procedure (not included).

Apply the anodes after adequate preparation of the substrate (not included), by removing all deteriorated concrete to obtain a solid, sufficiently rough substrate with no loose portions and removing all rust from the steel reinforcement. After cleaning the substrate and saturating it with water, rebuild the areas where the concrete has been demolished using one of the restoration mortars recommended in the procedure (not included).

Each anode must be delivered to site in vacuum-packed wrapping to protect against contamination. The galvanic anodes must comply with UNI EN 12696 European standards.

The product must have the following characteristics:

Total weight (g):	230 ± 10%
Zinc mass (g):	168 ± 2%
Length (mm):	100 ± 10%
Width (mm):	50 ± 10%
Thickness (mm):	12 ± 10%

Included and calculated in the price for work carried out according to specification:

– application of each anode, including tying or welding to the steel reinforcement.

– *per anode* ..... (€/piece)



## F.2 PROTECTION OF STEEL REINFORCEMENT

### F.2.2.2.2 Application of pure zinc anodes (length 30 cm)

Supply and application of galvanic cathodic protection against corrosion (with no current applied) for steel reinforcement in reinforced concrete on structures under restoration, by applying internal sacrificial anodes made from a pure zinc, multi-layered core coated with special conductive paste and a protective fabric dressing (such as **Mapeshield I** 30/10 produced by MAPEI S.p.A.). Apply the anodes after adequate preparation of the substrate (not included), by removing all deteriorated concrete to obtain a solid, sufficiently-rough substrate with no loose portions and removing all rust from the steel reinforcement. After cleaning the substrate and saturating it with water, rebuild the areas where the concrete has been demolished using one of the restoration mortars recommended in the procedure (not included).

Each anode must be delivered to site in vacuum-packed wrapping to protect against contamination. The galvanic anodes must comply with UNI EN 12696 European standards.

The product must have the following characteristics:

Total weight (g):	450 ± 10%
Zinc mass (g):	340 ± 2%
Length (mm):	300 ± 5%
Width (mm):	50 ± 5%
Thickness (mm):	10 ± 10%

Included and calculated in the price for work carried out according to specification:

– application of each anode, including tying or welding to the steel reinforcement.

– per anode

..... (€/piece)



### F.2.2.3 PROTECTION OF STRUCTURES TO BE RESTORED (duration 20 years) Procedure

#### Preparation of substrates

Prepare all surfaces to be restored by completely removing all the deteriorated concrete with a power chisel (see section [F.1.1.2](#)) or with other suitable means, such as hydro-scarifying (see section [F.1.1.1](#)) to at least 2 cm below the steel reinforcement, to obtain a solid, sufficiently-rough substrate with no detached portions. If the deteriorated concrete has been removed with a power chisel, clean all exposed steel reinforcement with a brush (see section [F.1.1.2](#)) or by hydro-sandblasting (see section [F.1.1.3](#)) to remove all the rust.

Hydro-sandblasting is not required if the surface has been prepared by hydro-scarifying. However, if the time between hydro-scarifying and treating the steel reinforcement is particularly long due to on-site logistics, hydro-sandblasting must be carried out. Replace any steel reinforcement which has been cut or damaged, or which is highly corroded, with new reinforcement (see section [F.1.2.1](#)).

#### Preparation of steel reinforcement

After removing the rust, protect the steel reinforcement using **Mapeshield I** 10/20 (see section [F.2.2.3.1](#)) or **Mapeshield I** 30/20 (see section [F.2.2.3.2](#)) pure zinc internal sacrificial anodes. The number of anodes connected to the steel reinforcement depends on the amount of steel contained in the first 20 cm of concrete, starting from the surface exposed to aggressive agents. For a steel/concrete surface area ratio of 0.8, use 4 **Mapeshield I** 10/20 anodes per square metre, while for a steel/concrete surface area ratio of 1, use 2.5 **Mapeshield I** 30/20 anodes per square metre.

Weld or tie the connectors on the anodes to the steel reinforcement before casting the concrete. Do not apply **Mapefer**, **Mapefer 1K** or any other anti-rust treatment on the steel reinforcement before casting the concrete. Enough space must be left under the anodes to allow the mortar to flow when it is applied. This space must never be less than 2-3 times the size of the largest aggregate in the restoration mortar. Once installed, the continuity between the anodes and reinforcement rods must be checked with an ohmmeter. Resistance of up to 1 ohm is acceptable.

#### Restoration operations

Clean all surfaces to be restored and saturate the substrate with water leaving a dry surface (s.s.d.) by hydro-cleaning (see section [F.1.1.4](#)).

The electrical resistivity of the restoration mortar must be in a range of between 50% and 200% of the original concrete, and up to a maximum of 100 kΩ, as prescribed by EN 12696 specifications.

We recommend using one of the following products:

- **Mapegrout 430** one-component, normal-setting, shrinkage-compensating, class R3 thixotropic mortar for layers from 0.5 to 3.5 cm thick (see section [F.3.2.1](#));
- **Mapegrout T40** one-component, normal-setting, shrinkage-compensating, class R3 thixotropic mortar for layers from 1 to 3.5 cm thick (see section [F.3.2.2](#));
- **Mapegrout Thixotropic** one-component, normal-setting, shrinkage-compensating, class R4 thixotropic mortar for layers from 1 to 3.5 cm thick (see section [F.4.1.1](#));
- **Mapegrout T60** one-component, normal-setting, shrinkage-compensating, class R4 thixotropic mortar for layers from 1 to 4 cm thick (see section [F.4.1.2](#));
- **Mapegrout Easy Flow** one-component, normal-setting, shrinkage-compensating, class R4 thixotropic mortar for high pumping heads, for layers from 1 to 3.5 cm thick (see section [F.4.4.2](#));
- **Mapegrout Easy Flow GF** one-component, normal-setting, shrinkage-compensating, high-ductility, class R4 thixotropic mortar strengthened with inorganic fibres for medium-height pumping heads, for layers from 1 to 5 cm thick (see section [F.4.4.3](#));
- **Stabilcem** expanding cementitious binder for pumped concrete (see section [F.5.1.1](#));
- **Stabilcem SCC** expanding cementitious binder for pumped, self-compacting concrete (see section [F.5.1.2](#)).

If a finer finish is required, skim the restored surfaces once the mortar has cured with one of the

## F.2 PROTECTION OF STEEL REINFORCEMENT

### F.2.2.3.1 Application of pure zinc anodes (length 10 cm)

Supply and application of galvanic cathodic protection against corrosion (with no current applied) for steel reinforcement in reinforced concrete on structures under restoration, by applying internal sacrificial anodes made from a pure zinc, multi-layered core coated with special conductive paste and a protective fabric dressing (such as **Mapeshield I** 10/20 produced by MAPEI S.p.A.). Apply the anodes after adequate preparation of the substrate (not included), by removing all deteriorated concrete to obtain a solid, sufficiently-rough substrate with no loose portions and removing all rust from the steel reinforcement. After cleaning the substrate and saturating it with water, rebuild the areas where the concrete has been demolished using one of the restoration mortars recommended in the procedure (not included).

Each anode must be delivered to site in vacuum-packed wrapping to protect against contamination. The galvanic anodes must comply with UNI EN 12696 European standards.

The product must have the following characteristics:

Total weight (g):	320 ± 10%
Zinc mass (g):	245 ± 2%
Length (mm):	100 ± 10%
Width (mm):	50 ± 10%
Thickness (mm):	15 ± 10%

Included and calculated in the price for work carried out according to specification:

– application of each anode, including tying or welding to the steel reinforcement.

– per anode

..... (€/piece)





## F.2 PROTECTION OF STEEL REINFORCEMENT

### F.2.2.3.2 Application of pure zinc anodes (length 30 cm)

Supply and application of galvanic cathodic protection against corrosion (with no current applied) for steel reinforcement in reinforced concrete on structures under restoration, by applying internal sacrificial anodes made from a pure zinc, multi-layered core coated with special conductive paste and a protective fabric dressing (such as **Mapeshield I** 30/20 produced by MAPEI S.p.A.). Apply the anodes after adequate preparation of the substrate (not included), by removing all deteriorated concrete to obtain a solid, sufficiently-rough substrate with no loose portions and removing all rust from the steel reinforcement. After cleaning the substrate and saturating it with water, rebuild the areas where the concrete has been demolished using one of the restoration mortars recommended in the procedure (not included).

Each anode must be delivered to site in vacuum-packed wrapping to protect against contamination. The galvanic anodes must comply with UNI EN 12696 European standards.

The product must have the following characteristics:

Total weight (g):	570 ± 10%
Zinc mass (g):	450 ± 2%
Length (mm):	300 ± 5%
Width (mm):	50 ± 5%
Thickness (mm):	12 ± 10%

Included and calculated in the price for work carried out according to specification:

– application of each anode, including tying or welding to the steel reinforcement.

– per anode

..... (€/piece)



**F.2.3 EXTERNAL GALVANIC CATHODIC PROTECTION  
Concrete structures exposed to chloride-rich environments****Preparation of substrates**

Prepare all surfaces to be restored by completely removing all the deteriorated concrete with a power chisel (see section **F.1.1.2**) or with other suitable means, such as hydro-scarifying (see section **F.1.1.1**), to obtain a solid, sufficiently-rough substrate with no detached portions. If the deteriorated concrete has been removed with a power chisel, clean all exposed steel reinforcement with a brush (see section **F.1.1.2**) or by hydro-sandblasting (see section **F.1.1.3**) to remove all the rust. Hydro-sandblasting is not required if the surface has been prepared by hydro-scarifying. However, if the time between hydro-scarifying and treating the steel reinforcement is particularly long due to on-site logistics, hydro-sandblasting must be carried out. Replace any steel reinforcement which has been cut or damaged, or which is highly corroded, with new reinforcement (see section **F.1.2.1**). Remove all traces of concrete from the reinforcement and connect one or more pieces of electric wire, which will then be connected to the anodes when the restoration work has been completed. Each structural element (column, beam, etc.) must have at least one connection. The continuity of the reinforcement rods must be checked with an ohmmeter before installing the protection. Resistance of up to 1 ohm is acceptable.

**Restoration operations**

Clean all surfaces to be restored and saturate the substrate with water leaving a dry surface (s.s.d.) by hydro-cleaning (see section **F.1.1.4**). Do not apply **Mapefer**, **Mapefer 1K** or any other anti-rust treatment on the steel reinforcement before casting the concrete.

The electrical resistivity of the restoration mortar must be in a range of between 50% and 200% of the original concrete, and up to a maximum of 100 kΩ, as prescribed by EN 12696 specifications.

We recommend using one of the following products:

- **Planitop Smooth & Repair** one-component, rapid-setting, shrinkage-compensating, class R2 thixotropic mortar for layers from 0.3 to 4 cm thick (see section **F.3.1.1**).
- **Mapegrout 430** one-component, normal-setting, shrinkage-compensating, class R3 thixotropic mortar for layers from 0.5 to 3.5 cm thick (see section **F.3.2.1**);
- **Mapegrout T40** one-component, normal-setting, shrinkage-compensating, class R3 thixotropic mortar for layers from 1 to 3.5 cm thick (see section **F.3.2.2**);
- **Mapegrout Thixotropic** one-component, normal-setting, shrinkage-compensating, class R4 thixotropic mortar for layers from 1 to 3.5 cm thick (see section **F.4.1.1**);
- **Mapegrout T60** one-component, normal-setting, shrinkage-compensating, class R4 thixotropic mortar for layers from 1 to 4 cm thick (see section **F.4.1.2**);
- **Mapegrout Easy Flow** one-component, normal-setting, shrinkage-compensating, class R4 thixotropic mortar for high pumping heads, for layers from 1 to 3.5 cm thick (see section **F.4.4.2**);
- **Mapegrout Easy Flow GF** one-component, normal-setting, shrinkage-compensating, high-ductility, class R4 thixotropic mortar strengthened with inorganic fibres for medium-height pumping heads, for layers from 1 to 5 cm thick (see section **F.4.4.3**);
- **Stabilcem** expanding cementitious binder for pumped concrete (see section **F.5.1.1**);
- **Stabilcem SCC** expanding cementitious binder for pumped, self-compacting concrete (see section **F.5.1.2**).

When restoration work has been completed, the surface should be even and smooth and there should be no hollows.

**Application of plates**

The surface area to be covered with plates, when the restoration mortar has completely cured, must be directly proportional to the surface area of the steel in the first 20 cm of the concrete, starting from the surface exposed to aggressive agents.

Apply **Mapeshield E 25** (see section **F.2.3.1**) by removing the protective film from the conductive

## F.2 PROTECTION OF STEEL REINFORCEMENT

### F.2.3.1 Application of self-adhesive zinc plates

Supply and application of galvanic cathodic protection against corrosion (with no current applied) for steel reinforcement in reinforced concrete on structures under restoration, by applying external sacrificial anodes made from a 99.9% pure zinc plate coupled with high ion-conductive, adhesive electrolyte (such as **Mapeshield E 25** produced by MAPEI S.p.A.). Apply the anodes after adequate preparation of the substrate (not included), by removing all deteriorated concrete to obtain a solid, sufficiently-rough substrate with no loose portions and removing all rust from the steel reinforcement. After cleaning the substrate and saturating it with water, rebuild the areas where the concrete has been demolished using one of the restoration mortars recommended in the procedure (not included). Once the mortar has cured, apply the anodes and connect the electric wires attached to the steel reinforcement with mechanical fasteners.

Skim and even out the entire surface by applying two-component, elastic cementitious mortar with a brush or roller (such as **Mapelastic Smart** produced by MAPEI S.p.A.) (not included), after treating the edges and joints with one-component, solvent-free, polyurethane primer for non-absorbent surfaces (such as **Primer M** produced by MAPEI S.p.A.) and sealing them with one-component, paintable, thixotropic polyurethane sealant with a high modulus of elasticity (such as **Mapeflex PU45** produced by MAPEI S.p.A.).

Each anode must be delivered to site in protective polypropylene wrapping to prevent the ion-conductive, adhesive gel being contaminated.

The anodes must comply with UNI EN 12696 European standards.

The product must have the following characteristics:

Weight (g/m <sup>2</sup> ):	3.150 ± 5%
Length (mm):	250
Thickness (&mu;m):	250
Thickness of adhesive (&mu;m):	800 ± 200
Application temperature:	> 4°C
In service temperature range:	from -10°C to +60°C

Included and calculated in the price for work carried out according to specification:

– application per metre of plate, including installing and connecting electric wire:

– per metre of plate ..... (€/m)



### **F.3 RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES** CIVIL, RESIDENTIAL, INDUSTRIAL AND INFRASTRUCTURAL WORKS WITHOUT DYNAMIC STRESS

#### **F.3.1 RAPID-SETTING THIXOTROPIC MORTARS** **Procedure**

##### **Preparation of substrates**

Prepare all surfaces to be restored by completely removing all the deteriorated concrete with a hand or power chisel (see section [F.1.1.2](#)) or with other suitable means, such as hydro-scarifying (see section [F.1.1.1](#)), to obtain a solid, sufficiently-rough substrate with no detached portions. If the deteriorated concrete has been removed with a hand or power chisel, clean all exposed steel reinforcement with a brush (see section [F.1.1.2](#)) or by hydro-sandblasting (see section [F.1.1.3](#)) to remove the rust and bring the steel reinforcement back to a bare metal finish.

Hydro-sandblasting is not required if the surface has been prepared by hydro-scarifying. However, if the time between hydro-scarifying and treating the steel reinforcement is particularly long due to on-site logistics, hydro-sandblasting must be carried out.

Replace any steel reinforcement which has been cut or damaged, or which is highly corroded, with new reinforcement (see section [F.1.2.1](#)).

##### **Protection of steel reinforcement**

After removing all the rust, treat the steel reinforcement by brush-applying two coats of **Mapefer 1K** one-component, anti-corrosion cementitious mortar (see section [F.2.1.1](#)) or **Mapefer** two-component, anti-corrosion cementitious mortar (see section [F.2.1.2](#)). The specific function of both these products, made from cementitious binders, powdered polymers and corrosion inhibitors, is to prevent the formation of rust.

##### **Restoration operations**

Clean all surfaces to be restored and saturate the substrate leaving a dry surface (s.s.d.) by hydro-cleaning (see section [F.1.1.4](#)).

Restore the concrete using one of the following products:

- Planitop Smooth & Repair one-component, rapid-setting, shrinkage-compensating, class R2 thixotropic mortar for layers from 0.3 to 4 cm thick (see section [F.3.1.1](#)).
- **Mapegrout Fast-Set** one-component, rapid-setting, shrinkage-compensating, class R3 thixotropic mortar for layers from 0.5 to 2.5 cm thick (see section [F.3.1.2](#));

These cementitious mortars are supplied in pre-blended powder form, and must be mixed with the amount of water indicated in their relative Technical Data Sheet to form a well-blended, lump-free mix.

Apply the mortar with a trowel within the application temperature range indicated in the Technical Data Sheet.

If the thickness to be restored is more than the indicated values, apply the mortar in several coats and reinforce it by inserting electro-welded mesh (see section [F.1.3.1](#)) to compensate for hygrometric shrinkage and guarantee sufficient contrast to the expansive nature of the mortar. The size (diameter of wire and mesh size) must be according to design specifications.

Tamp the mortar. The waiting time depends on climatic conditions, and tamping should be carried out when a small imprint remains after touching the surface with a finger.

Since water content has an influence on the properties of the mortar, take special care to prevent it evaporating off too quickly while curing. In hot or windy weather, we recommend using the damp-curing technique or applying an anti-evaporation product to prevent rapid evaporation of the mixing water.

The anti-evaporation product must be compatible with the successive skimming or protective layer, and must be removed if necessary.

With Planitop Smooth & Repair, thanks to the maximum grain size of the aggregate in the mix (0.4 mm), the same product may be used for both restoration work and final skimming.

However, if **Mapegrout Fast-Set** is used and a finer finish is required, skim the restored surfaces once the mortar has cured with one of the following products:

### F.3 RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES CIVIL, RESIDENTIAL, INDUSTRIAL AND INFRASTRUCTURAL WORKS WITHOUT DYNAMIC STRESS

#### F.3.1.1 Application of one-component, rapid-setting, shrinkage-compensating, class R2 thixotropic mortar for layers from 0.3 to 4 cm thick

Supply and application of one-component, rapid-setting, shrinkage-compensating thixotropic mortar made from special hydraulic binders, selected fine-grained aggregates, synthetic polyacrylonitrile fibres, synthetic resins and special additives (such as **Planitop Smooth & Repair** produced by MAPEI S.p.A.), for reconstructing and skimming deteriorated concrete structures. Apply the mortar after adequate preparation of the substrate (not included), by removing all deteriorated concrete to form a sufficiently-rough, solid substrate with no detached portions. Clean the steel reinforcement down to bare metal (not included) and apply a passivating treatment by brush-applying two coats of one-component, anti-corrosion cementitious mortar (such as **Mapefer 1K** produced by MAPEI S.p.A.) (not included). Apply the product by trowel on a clean substrate saturated with water in layers from 0.3 to 4 cm thick.

The product must comply with the minimum requirements of EN 1504-3 for non-structural R2-class mortars and the requirements of EN 1504-2 coating (C) according to principles MC and IR for protecting concrete, and must have the following performance characteristics:

Setting time:

– start: approximately 30 min.  
– end: approximately 40 min.

Compressive strength (EN 12190) (MPa):  $\geq 18$  (after 28 days)

Flexural strength (EN 196/1) (MPa):  $\geq 4$  (after 28 days)

Compressive modulus of elasticity (EN 13412) (GPa): 13 (after 28 days)

Adhesion to substrate (EN 1542) (MPa):  $\geq 1.5$  (after 28 days)

Capillary absorption (EN 13057) ( $\text{kg/m}^2 \cdot \text{h}^{0.5}$ ):  $\leq 0.40$

Thermal compatibility to freeze/thaw cycles with de-icing salts (EN 13687/1) measured as adhesion according to EN 1542 (MPa):  $\geq 1.5$  (after 50 cycles)

Impermeability expressed as coefficient of permeability to free water (EN 1062-3) ( $\text{kg/m}^2 \cdot \text{h}^{0.5}$ ):  $W < 0.1$  Class III (low permeability to water) according to EN 1062-1

Permeability to water vapour

– equivalent air thickness  $S_D$  (EN ISO 7783-1) (m):  $S_D < 5$   
Class I (permeable to water vapour)

Reaction to fire (EN 13501-1) (Euroclass): A1

Consumption (per cm of thickness) ( $\text{kg/m}^2$ ): approximately 15

Included and calculated in the price for work carried out according to specification:

- hydro-cleaning of adhesion surfaces and saturation of substrate with water immediately before applying the mortar;
- application of the mortar by trowel around steel reinforcement;
- levelling off surfaces with a straight edge and final tamping;



### F.3 RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES CIVIL, RESIDENTIAL, INDUSTRIAL AND INFRASTRUCTURAL WORKS WITHOUT DYNAMIC STRESS

#### F.3.1.2 Application of one-component, rapid-setting, shrinkage-compensating, class R3 thixotropic mortar for layers from 0.5 to 2.5 cm thick

Supply and application of one-component, rapid-setting, shrinkage-compensating thixotropic mortar made from special hydraulic binders, selected aggregates, synthetic polyacrylonitrile fibres, synthetic resins and special additives (such as **Mapegrout Fast-Set** produced by MAPEI S.p.A.), for reconstructing deteriorated concrete structures. Apply the mortar after adequate preparation of the substrate (not included), by removing all deteriorated concrete to form a sufficiently-rough, solid substrate with no detached portions. Clean the steel reinforcement down to bare metal (not included) and apply a passivating treatment by brush-applying two coats of one-component, anti-corrosion cementitious mortar (such as **Mapefer 1K** produced by MAPEI S.p.A.) (not included). Apply the product by trowel on a clean substrate saturated with water in layers from 0.5 to 2.5 cm thick.

The product must comply with the minimum requirements of EN 1504-3 for structural R3-class structural mortars and have the following performance characteristics:

Setting time:	< 30 min.
Compressive strength (EN 12190) (MPa):	> 40 (after 28 days)
Flexural strength (EN 196/1) (MPa):	> 8 (after 28 days)
Compressive modulus of elasticity (EN 13412) (GPa):	24 (after 28 days)
Adhesion to substrate (EN 1542) (MPa):	> 1.5 (after 28 days)
Capillary absorption (EN 13057) (kg/m <sup>2</sup> ·h <sup>0.5</sup> ):	< 0.05
Thermal compatibility to freeze/thaw cycles with de-icing salts (EN 13687/1) measured as adhesion according to EN 1542 (MPa):	> 1.5 (after 50 cycles)
Reaction to fire (EN 13501-1) (Euroclass):	A1
Consumption (per cm of thickness) (kg/m <sup>2</sup> ):	18

Included and calculated in the price for work carried out according to specification:

- hydro-cleaning of adhesion surfaces and saturation of substrate with water immediately before applying the mortar;
- application of the mortar by trowel around steel reinforcement;
- levelling off surfaces with a straight edge and final tamping;
- careful curing of the mortar by spraying on water for at least 24 hours after application.

– per square metre per cm of thickness ..... (€/m<sup>2</sup>·cm)





### **F.3 RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES** CIVIL, RESIDENTIAL, INDUSTRIAL AND INFRASTRUCTURAL WORKS WITHOUT DYNAMIC STRESS

#### **F.3.2 NORMAL-SETTING THIXOTROPIC MORTARS** **Procedure**

##### **Preparation of substrates**

Prepare all surfaces to be treated by completely removing all the deteriorated concrete with a hand or power chisel (see section [F.1.1.2](#)) or with other suitable means, such as hydro-scarifying (see section [F.1.1.1](#)), to obtain a solid, sufficiently-rough substrate with no detached portions. If the deteriorated concrete has been removed with a hand or power chisel, clean all exposed steel reinforcement with a brush (see section [F.1.1.2](#)) or by hydro-sandblasting (see section [F.1.1.3](#)) to remove the rust and bring the steel reinforcement back to a bare metal finish.

Hydro-sandblasting is not required if the surface has been prepared by hydro-scarifying. However, if the time between hydro-scarifying and treating the steel reinforcement is particularly long due to on-site logistics, hydro-sandblasting must be carried out.

Replace any steel reinforcement which has been cut or damaged, or which is highly corroded, with new reinforcement (see section [F.1.2.1](#)).

##### **Protection of steel reinforcement**

After removing all the rust, treat the steel reinforcement by brush-applying two coats of **Mapefer 1K** one-component, anti-corrosion cementitious mortar (see section [F.2.1.1](#)) or **Mapefer** two-component, anti-corrosion cementitious mortar (see section [F.2.1.2](#)). The specific function of both these products, made from cementitious binders, powdered polymers and corrosion inhibitors, is to prevent the formation of rust.

##### **Restoration operations**

Clean all surfaces to be restored and saturate the substrate leaving a dry surface (s.s.d.) by hydro-cleaning (see section [F.1.1.4](#)).

Restore the concrete using one of the following products:

- **Mapegrout 430** one-component, normal-setting, shrinkage-compensating, class R3 thixotropic mortar for layers from 0.5 to 3.5 cm thick (see section [F.3.2.1](#));
- **Mapegrout T40** one-component, normal-setting, shrinkage-compensating, class R3 thixotropic mortar for layers from 1 to 3.5 cm thick (see section [F.3.2.2](#));

These cementitious mortars are supplied in pre-blended powder form, and must be mixed with the amount of water indicated in their relative Technical Data Sheet to form a well-blended, lump-free mix.

When preparing the mortar, add **Mapecure SRA** (see section [F.6.1.1](#)), a special shrinkage-reducing agent, at a dose of 0.25% in weight on the weight of the mortar.

Apply the mortar with a trowel or by spray within the application temperature range indicated in the Technical Data Sheet.

If the thickness to be restored is more than the indicated values, apply the mortar in several coats and reinforce it by inserting electro-welded mesh (see section [F.1.3.1](#)) to compensate for hygrometric shrinkage and guarantee sufficient contrast to the expansive nature of the mortar. The size (diameter of wire and mesh size) must be according to design specifications.

Tamp the mortar. The waiting time depends on climatic conditions, and tamping should be carried out when a small imprint remains after touching the surface with a finger.

Since water content has an influence on the properties of the mortar, take special care to prevent it evaporating off too quickly while curing. In hot or windy weather, we recommend using the damp-curing technique or applying an anti-evaporation product to prevent rapid evaporation of the mixing water. The anti-evaporation product must be compatible with the successive skimming or protective layer, and must be removed if necessary.

If a finer finish is required, skim the restored surfaces once the mortar has cured with one of the following products:

- **Monofinish** one-component, normal-setting cementitious mortar for skimming restored and

**F.3 RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES**  
 CIVIL, RESIDENTIAL, INDUSTRIAL AND INFRASTRUCTURAL WORKS WITHOUT DYNAMIC STRESS

**F.3.2.1 Application of one-component, normal-setting, shrinkage-compensating, class R3 thixotropic mortar for layers from 0.5 to 3.5 cm thick**

Supply and application of one-component, normal-setting, shrinkage-compensating thixotropic mortar made from cementitious binders, selected fine-grained aggregates, special additives and synthetic polyacrylonitrile fibres (such as **Mapegrout 430** produced by MAPEI S.p.A.), for reconstructing deteriorated concrete structures. Apply the mortar after adequate preparation of the substrate (not included), by removing all deteriorated concrete to form a sufficiently-rough, solid substrate with no detached portions. Clean the steel reinforcement down to bare metal (not included) and apply a passivating treatment by brush-applying two coats of one-component, anti-corrosion cementitious mortar (such as **Mapefer 1K** produced by MAPEI S.p.A.) (not included). Apply the product by trowel or spray with a continuous-feed rendering machine on a clean substrate saturated with water in layers from 0.5 to 3.5 cm thick. To improve expansion in the open air during the first few days of curing, add a special curing additive when mixing the mortar to reduce both plastic and hydraulic shrinkage (such as **Mapecure SRA** produced by MAPEI S.p.A.) at a dose of 0.25% in weight on the weight of the mortar.

The product must comply with the minimum requirements of EN 1504-3 for structural R3-class structural mortars and have the following performance characteristics:

Compressive strength (EN 12190) (MPa):	> 30 (after 28 days)
Flexural strength (EN 196/1) (MPa):	> 6 (after 28 days)
Compressive modulus of elasticity (EN 13412) (GPa):	23 (after 28 days)
Adhesion to substrate (EN 1542) (MPa):	> 2 (after 28 days)
Capillary absorption (EN 13057) (kg/m <sup>2</sup> ·h <sup>0.5</sup> ):	< 0.40
Resistance to accelerated carbonation (EN 13295):	less than reference concrete
Thermal compatibility measured as adhesion according to EN 1542 (MPa):	
– freeze-thaw cycles with de-icing salts (EN 13687/1):	> 1.5 (after 50 cycles)
– storm cycles (EN 13687/2):	> 1.5 (after 30 cycles)
– dry thermal cycles (EN 13687/4):	> 1.5 (after 30 cycles)
Reaction to fire (EN 13501-1) (Euroclass):	A1
Consumption (per cm of thickness) (kg/m <sup>2</sup> ):	17

Included and calculated in the price for work carried out according to specification:

- hydro-cleaning of adhesion surfaces and saturation of substrate with water immediately before applying the mortar;
- application of the mortar by trowel or spray around steel reinforcement;
- levelling off surfaces with a straight edge and final tamping;
- curing for at least 24 hours after application.

- a) A
- pe
- b) A
- pe



..... (€/m<sup>2</sup>·cm)

..... (€/m<sup>2</sup>·cm)





### F.3 RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES CIVIL, RESIDENTIAL, INDUSTRIAL AND INFRASTRUCTURAL WORKS WITHOUT DYNAMIC STRESS

#### F.3.2.2 Application of one-component, normal-setting, shrinkage-compensating, class R3 thixotropic mortar for layers from 1 to 3.5 cm thick

Supply and application of one-component, normal-setting, shrinkage-compensating thixotropic mortar made from cementitious binders, selected aggregates, special additives and synthetic polyacrylonitrile fibres (such as **Mapegrout T40** produced by MAPEI S.p.A.), for reconstructing deteriorated concrete structures. Apply the mortar after adequate preparation of the substrate (not included), by removing all deteriorated concrete to form a sufficiently-rough, solid substrate with no detached portions. Clean the steel reinforcement down to bare metal (not included) and apply a passivating treatment by brush-applying two coats of one-component, anti-corrosion cementitious mortar (such as **Mapefer 1K** produced by MAPEI S.p.A.) (not included). Apply the product by trowel or spray with a continuous-feed rendering machine on a clean substrate saturated with water in layers from 1 to 3.5 cm thick.




To improve expansion in the open air during the first few days of curing, add a special curing additive when mixing the mortar to reduce both plastic and hydraulic shrinkage (such as **Mapecure SRA** produced by MAPEI S.p.A.) at a dose of 0.25% in weight on the weight of the mortar.

The product must comply with the minimum requirements of EN 1504-3 for structural R3-class structural mortars and have the following performance characteristics:

Compressive strength (EN 12190) (MPa):	> 40 (after 28 days)
Flexural strength (EN 196/1) (MPa):	> 7 (after 28 days)
Compressive modulus of elasticity (EN 13412) (GPa):	25 (after 28 days)
Adhesion to substrate (EN 1542) (MPa):	> 2 (after 28 days)
Capillary absorption (EN 13057) ( $\text{kg/m}^2 \cdot \text{h}^{0.5}$ ):	< 0.20
Thermal compatibility measured as adhesion according to EN 1542 (MPa):	
– freeze-thaw cycles with de-icing salts (EN 13687/1):	> 1.5 (after 50 cycles)
– storm cycles (EN 13687/2):	> 1.5 (after 30 cycles)
– dry thermal cycles (EN 13687/4):	> 1.5 (after 30 cycles)
Reaction to fire (EN 13501-1) (Euroclass):	A1
Consumption (per cm of thickness) ( $\text{kg/m}^2$ ):	approximately 18.5

Included and calculated in the price for work carried out according to specification:

- hydro-cleaning of adhesion surfaces and saturation of substrate with water immediately before applying the mortar;
- application of the mortar by trowel or spray around steel reinforcement;
- levelling off surfaces with a straight edge and final tamping;
- careful curing of the mortar by spraying on water for at least 24 hours after application.

a) A				..... (€/m <sup>2</sup> ·cm)
– pe				
b) A				..... (€/m <sup>2</sup> ·cm)
– pe				



### F.3 RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES CIVIL, RESIDENTIAL, INDUSTRIAL AND INFRASTRUCTURAL WORKS WITHOUT DYNAMIC STRESS

#### F.3.3 TWO-COMPONENT NORMAL-SETTING THIXOTROPIC MORTARS Procedure

##### Preparation of substrates

Prepare all surfaces to be treated by completely removing all the deteriorated concrete with a hand or power chisel (see section [F.1.1.2](#)) or with other suitable means, such as hydro-scarifying (see section [F.1.1.1](#)), to obtain a solid, sufficiently-rough substrate with no detached portions. If the deteriorated concrete has been removed with a hand or power chisel, clean all exposed steel reinforcement with a brush (see section [F.1.1.2](#)) or by hydro-sandblasting (see section [F.1.1.3](#)) to remove the rust and bring the steel reinforcement back to a bare metal finish.

Hydro-sandblasting is not required if the surface has been prepared by hydro-scarifying. However, if the time between hydro-scarifying and treating the steel reinforcement is particularly long due to on-site logistics, hydro-sandblasting must be carried out.

Replace any steel reinforcement which has been cut or damaged, or which is highly corroded, with new reinforcement (see section [F.1.2.1](#)).

##### Protection of steel reinforcement

After removing all the rust, treat the steel reinforcement by brush-applying two coats of **Mapefer 1K** one-component, anti-corrosion cementitious mortar (see section [F.2.1.1](#)) or **Mapefer** two-component, anti-corrosion cementitious mortar (see section [F.2.1.2](#)). The specific function of both these products, made from cementitious binders, powdered polymers and corrosion inhibitors, is to prevent the formation of rust.

##### Restoration operations

Clean all surfaces to be restored and saturate the substrate leaving a dry surface (s.s.d.) by hydro-cleaning (see section [F.1.1.4](#)).

Restore the concrete using one of the following products:

- **Mapegrout BM** two-component, normal-setting, shrinkage-compensating, class R4 thixotropic mortar with a low modulus of elasticity (22 GPa) for layers from 1 to 3.5 cm thick (see section [F.3.3.1](#));
- **Mapegrout LM2K** two-component, normal-setting, shrinkage-compensating, class R3 thixotropic mortar with a low modulus of elasticity (17 GPa) with added organic corrosion inhibitor, for layers from 0.5 to 2 cm thick (see section [F.3.3.2](#));

The most suitable cementitious mortars for restoring deteriorated concrete structures, subjected to small deformations when under load, are made up of two pre-dosed components (A and B). Mix component A (powder) with component B (liquid) according to the mixing ratio indicated in the Technical Data Sheet, and without adding any other ingredient, to form a well-mixed, lump-free blend. If **Mapegrout LM2K** is chosen, add approximately 1% of water on the weight of the powder (0.25 kg every 25 kg sack of component A) if it is used at high temperatures.

When preparing the mortar, add **Mapecure SRA** (see section [F.6.1.1](#)), a special shrinkage-reducing agent, at a dose of 0.25% in weight on the weight of the mortar.

Apply the mortar with a trowel or by spray within the application temperature range indicated in the Technical Data Sheet.

If the thickness to be restored is more than the indicated values, apply the mortar in several coats and reinforce it by inserting electro-welded mesh (see section [F.1.3.1](#)) to compensate for hygrometric shrinkage and guarantee sufficient contrast to the expansive nature of the mortar. The size (diameter of wire and mesh size) must be according to design specifications.

Tamp the mortar. The waiting time depends on climatic conditions, and tamping should be carried out when a small imprint remains after touching the surface with a finger.

Since component B has an influence on the properties of the mortar, take special care to prevent it evaporating off too quickly while curing. In hot or windy weather, we recommend using the damp-curing technique or applying an anti-evaporation product to prevent rapid evaporation of the

**F.3 RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES**  
 CIVIL, RESIDENTIAL, INDUSTRIAL AND INFRASTRUCTURAL WORKS WITHOUT DYNAMIC STRESS

**F.3.3.1 Application of two-component, normal-setting, shrinkage-compensating, class R4 thixotropic mortar with a low modulus of elasticity (22 GPa) for layers from 1 to 3.5 cm thick**

Supply and application of two-component, normal-setting, shrinkage-compensating thixotropic mortar with a low modulus of elasticity (22 GPa) made from cementitious binders, selected aggregates, synthetic polyacrylonitrile fibres and polymer resins (such as **Mapegrout BM** produced by MAPEI S.p.A.), for reconstructing deteriorated concrete structures. Apply the mortar after adequate preparation of the substrate (not included), by removing all deteriorated concrete to form a sufficiently-rough, solid substrate with no detached portions. Clean the steel reinforcement down to bare metal (not included) and apply a passivating treatment by brush-applying two coats of one-component, anti-corrosion cementitious mortar (such as **Mapefer 1K** produced by MAPEI S.p.A.) (not included). Apply the product by trowel or spray with a rendering machine on a clean substrate saturated with water in layers from 1 to 3.5 cm thick. To improve expansion in the open air during the first few days of curing, add a special curing additive when mixing the mortar to reduce both plastic and hydraulic shrinkage (such as **Mapecure SRA** produced by MAPEI S.p.A.) at a dose of 0.25% in weight on the weight of the mortar.

The product must comply with the minimum requirements of EN 1504-3 for structural R4-class structural mortars and have the following performance characteristics:

Compressive strength (EN 12190) (MPa):	> 47 (after 28 days)
Flexural strength (EN 196/1) (MPa):	> 10 (after 28 days)
Compressive modulus of elasticity (EN 13412) (GPa):	22 (after 28 days)
Adhesion to substrate (EN 1542) (MPa):	> 2 (after 28 days)
Capillary absorption (EN 13057) (kg/m <sup>2</sup> ·h <sup>0.5</sup> ):	< 0.25
Impermeability to water:	
– penetration depth-(EN 12390/8) (mm):	< 10
Thermal compatibility measured as adhesion according to EN 1542 (MPa):	
– freeze-thaw cycles with de-icing salts (EN 13687/1):	> 2 (after 50 cycles)
– storm cycles (EN 13687/2):	> 2 (after 30 cycles)
– dry thermal cycles (EN 13687/4):	> 2 (after 30 cycles)
Reaction to fire (EN 13501-1) (Euroclass):	E
Consumption (per cm of thickness) (kg/m <sup>2</sup> ):	approximately 21

Included and calculated in the price for work carried out according to specification:  
 – hydro-cleaning of adhesion surfaces and saturation of substrate with water immediately before applying the mortar;

– application of the mortar;  
 – levelling of the mortar;  
 – curing of the mortar for at least 24 hours after application.

a) Application of the mortar and steel reinforcement;  
 – per square metre per cm of thickness ..... (€/m<sup>2</sup>·cm)  
 b) Application of the mortar;  
 – per square metre per cm of thickness ..... (€/m<sup>2</sup>·cm)




**F.3 RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES**  
 CIVIL, RESIDENTIAL, INDUSTRIAL AND INFRASTRUCTURAL WORKS WITHOUT DYNAMIC STRESS

**F.3.3.2 Application of two-component, normal-setting, shrinkage-compensating, class R3 thixotropic mortar with a low modulus of elasticity (17 GPa) with added organic corrosion inhibitor for layers from 0.5 to 2 cm thick**



Supply and application of two-component, normal-setting, shrinkage-compensating thixotropic mortar with a low modulus of elasticity (17 GPa) with added organic corrosion inhibitor, made from cementitious binders, selected aggregates, synthetic polyacrylonitrile fibres and polymer resins (such as **Mapegrount LM2K** produced by MAPEI S.p.A.), for reconstructing and skimming deteriorated concrete structures. Apply the mortar after adequate preparation of the substrate (not included), by removing all deteriorated concrete to form a sufficiently-rough, solid substrate with no detached portions. Clean the steel reinforcement down to bare metal (not included) and apply a passivating treatment by brush-applying two coats of one-component, anti-corrosion cementitious mortar (such as **Mapefer 1K** produced by MAPEI S.p.A.) (not included). Apply the product by trowel or spray with a continuous-feed rendering machine on a clean substrate saturated with water in layers from 0.5 to 2 cm thick. To improve the excellent inherent performance of the product, especially at high temperatures such as during the Summer, add a special internal curing additive when mixing the mortar to reduce surface tension in the capillary pores and improve, therefore, dimensional stability (such as **Mapecure SRA** produced by MAPEI S.p.A.) at a dose of 0.25% in weight on the weight of the mortar.

The product must comply with the minimum requirements of EN 1504-3 for structural R3-class structural mortars and have the following performance characteristics:

Compressive strength (EN 12190) (MPa):	≥ 38 (after 28 days)
Flexural strength (EN 196/1) (MPa):	≥ 7 (after 28 days)
Compressive modulus of elasticity (EN 13412) (GPa):	17 (after 28 days)
Adhesion to substrate (EN 1542) (MPa):	≥ 2 (after 28 days)
Bond strength to substrates determined by shear (EN 12615 mod.) (MPa):	≥ 5 (after 28 days)
Resistance to accelerated carbonation (EN 13295):	less than reference concrete
Thermal compatibility measured as adhesion according to EN 1542 (MPa):	
– freeze-thaw cycles with de-icing salts (EN 13687/1):	≥ 2 (after 50 cycles)
– storm cycles (EN 13687/2):	≥ 2 (after 30 cycles)
– dry thermal cycles (EN 13687/4):	≥ 2 (after 30 cycles)
Resistance to de-icing salts & Δm after 30 cycles (SIA 262/1) (mg/mm <sup>2</sup> ):	< 0.6
Capillary absorption (EN 13057) (ka/m <sup>2</sup> ·h <sup>0.5</sup> ):	< 0.5

Imp		< 15
– pe		E
Rea		approximately 21
Con		

Incl  
 – h  
 mortar,  
 ed out according to specification:  
 a damp substrate immediately before applying the

– ap		
– le		
– ca		
a) A		
– pe		
b) A		
– per square metre per cm of thickness		..... (cm <sup>3</sup> /cm)

## **F.4 STRUCTURAL RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES**

CIVIL, RESIDENTIAL, INDUSTRIAL AND INFRASTRUCTURAL WORKS WITHOUT DYNAMIC STRESS

### **F.4.1 NORMAL-SETTING THIXOTROPIC MORTARS Procedure**

#### **Preparation of substrates**

Prepare all surfaces to be treated by completely removing all the deteriorated concrete with a hand or power chisel (see section **F.1.1.2**) or with other suitable means, such as hydro-scarifying (see section **F.1.1.1**), to obtain a solid, sufficiently-rough substrate with no detached portions. If the deteriorated concrete has been removed with a hand or power chisel, clean all exposed steel reinforcement with a brush (see section **F.1.1.2**) or by hydro-sandblasting (see section **F.1.1.3**) to remove the rust and bring the steel reinforcement back to a bare metal finish.

Hydro-sandblasting is not required if the surface has been prepared by hydro-scarifying. However, if the time between hydro-scarifying and treating the steel reinforcement is particularly long due to on-site logistics, hydro-sandblasting must be carried out.

Replace any steel reinforcement which has been cut or damaged, or which is highly corroded, with new reinforcement (see section **F.1.2.1**).

#### **Protection of steel reinforcement**

After removing all the rust, treat the steel reinforcement by brush-applying two coats of **Mapefer 1K** one-component, anti-corrosion cementitious mortar (see section **F.2.1.1**) or **Mapefer** two-component, anti-corrosion cementitious mortar (see section **F.2.1.2**). The specific function of both these products, made from cementitious binders, powdered polymers and corrosion inhibitors, is to prevent the formation of rust.

#### **Restoration operations**

Clean all surfaces to be restored and saturate the substrate leaving a dry surface (s.s.d.) by hydro-cleaning (see section **F.1.1.4**).

Restore the concrete structure using one of the following products:

- **Mapegrout Thixotropic** one-component, normal-setting, shrinkage-compensating, class R4 thixotropic mortar for layers from 1 to 3.5 cm thick (see section **F.4.1.1**);
- **Mapegrout T60** one-component, normal-setting, shrinkage-compensating, class R4 thixotropic mortar made with cement with high resistance to sulphates, for layers from 1 to 4 cm thick (see section **F.4.1.2**);

These cementitious mortars are supplied in pre-blended powder form, and must be mixed with the amount of water indicated in their relative Technical Data Sheet to form a well-blended, lump-free mix.

When preparing the mortar, add **Mapecure SRA** (see section **F.6.1.1**), a special shrinkage-reducing agent, at a dose of 0.25% in weight on the weight of the mortar.

Apply the mortar with a trowel or by spray within the application temperature range indicated in the Technical Data Sheet.

If the thickness to be restored is more than the indicated values, apply the mortar in several coats and reinforce it by inserting electro-welded mesh (see section **F.1.3.1**) to compensate for hygrometric shrinkage and guarantee sufficient contrast to the expansive nature of the mortar. The size (diameter of wire and mesh size) must be according to design specifications.

Tamp the mortar. The waiting time depends on climatic conditions, and tamping should be carried out when a small imprint remains after touching the surface with a finger.

Since water content has an influence on the properties of the mortar, take special care to prevent it evaporating off too quickly while curing. In hot or windy weather, we recommend using the damp-curing technique or applying an anti-evaporation product to prevent rapid evaporation of the mixing water. The anti-evaporation product must be compatible with the successive skimming or protective layer, and must be removed if necessary.

If a finer finish is required, skim the restored surfaces once the mortar has cured with one of the



**F.4 STRUCTURAL RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES**

CIVIL, RESIDENTIAL, INDUSTRIAL AND INFRASTRUCTURAL WORKS WITHOUT DYNAMIC STRESS

**F.4.1.1 Application of one-component, normal-setting, shrinkage-compensating, class R4 thixotropic mortar for layers from 1 to 3.5 cm thick**

Supply and application of one-component, normal-setting, shrinkage-compensating thixotropic mortar made from high-strength cement, selected aggregates, special additives and synthetic polyacrylonitrile fibres (such as **Mapegrout Thixotropic** produced by MAPEI S.p.A.), for reconstructing deteriorated concrete structures. Apply the mortar after adequate preparation of the substrate (not included), by removing all deteriorated concrete to form a sufficiently-rough, solid substrate with no detached portions. Clean the steel reinforcement down to bare metal (not included) and apply a passivating treatment by brush-applying two coats of one-component, anti-corrosion cementitious mortar (such as **Mapefer 1K** produced by MAPEI S.p.A.) (not included). Apply the product by trowel or spray with a continuous-feed rendering machine on a clean substrate saturated with water in layers from 1 to 3.5 cm thick.

To improve expansion in the open air during the first few days of curing, add a special curing additive when mixing the mortar to reduce both plastic and hydraulic shrinkage (such as **Mapecure SRA** produced by MAPEI S.p.A.) at a dose of 0.25% in weight on the weight of the mortar.

The product must comply with the minimum requirements of EN 1504-3 for structural R4-class structural mortars and have the following performance characteristics:

Compressive strength (EN 12190) (MPa):	> 60 (after 28 days)
Flexural strength (EN 196/1) (MPa):	> 8.5 (after 28 days)
Compressive modulus of elasticity (EN 13412) (GPa):	26 (after 28 days)
Adhesion to substrate (EN 1542) (MPa):	> 2 (after 28 days)
Capillary absorption (EN 13057) (kg/m <sup>2</sup> ·h <sup>0.5</sup> ):	< 0.20
Thermal compatibility measured as adhesion according to EN 1542 (MPa):	
– freeze-thaw cycles with de-icing salts (EN 13687/1):	> 2 (after 50 cycles)
– storm cycles (EN 13687/2):	> 2 (after 30 cycles)
– dry thermal cycles (EN 13687/4):	> 2 (after 30 cycles)
Reaction to fire (EN 13501-1) (Euroclass):	A1
Consumption (per cm of thickness) (kg/m <sup>2</sup> ):	approximately 19

- Included and calculated in the price for work carried out according to specification:
- hydro-cleaning of adhesion surfaces and saturation of substrate with water immediately before applying the mortar;
  - application of the mortar by trowel or spray around steel reinforcement;
  - levelling off surfaces with a straight edge and final tamping;
  - curing for at least 24 hours after application.

a) A		..... (€/m <sup>2</sup> ·cm)
– pe		
b) A		..... (€/m <sup>2</sup> ·cm)
– pe		



## F.4 STRUCTURAL RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES

CIVIL, RESIDENTIAL, INDUSTRIAL AND INFRASTRUCTURAL WORKS WITHOUT DYNAMIC STRESS

### F.4.1.2 Application of one-component, normal-setting, shrinkage-compensating, class R4 thixotropic mortar made with cement with high resistance to sulphates, for layers from 1 to 4 cm thick

Supply and application of one-component, normal-setting, shrinkage-compensating thixotropic mortar made from cement with high resistance to sulphates, selected aggregates, synthetic polyacrylonitrile fibres, organic corrosion inhibitor and special water-retaining additives (such as **Mapegrout T60** produced by MAPEI S.p.A.), for reconstructing deteriorated concrete structures. Apply the mortar after adequate preparation of the substrate (not included), by removing all deteriorated concrete to form a sufficiently-rough, solid substrate with no detached portions. Clean the steel reinforcement down to bare metal (not included) and apply a passivating treatment by brush-applying two coats of one-component, anti-corrosion cementitious mortar (such as **Mapefer 1K** produced by MAPEI S.p.A.) (not included). Apply the product by trowel or spray with a continuous-feed rendering machine on a clean substrate saturated with water in layers from 1 to 4 cm thick. To improve expansion in the open air during the first few days of curing, add a special curing additive when mixing the mortar to reduce both plastic and hydraulic shrinkage (such as **Mapecure SRA** produced by MAPEI S.p.A.) at a dose of 0.25% in weight on the weight of the mortar.

The product must comply with the minimum requirements of EN 1504-3 for structural R4-class structural mortars and have the following performance characteristics:

Compressive strength (EN 12190) (MPa):	60 (after 28 days)
Flexural strength (EN 196/1) (MPa):	8 (after 28 days)
Compressive modulus of elasticity (EN 13412) (GPa):	27 (after 28 days)
Adhesion to substrate (EN 1542) (MPa):	> 2 (after 28 days)
Contrasted expansion (UNI 8147) (&mu;m/m):	> 400 (after 1 day)
Crack resistance ("O-Ring Test"):	no cracks after 180 days
Resistance to accelerated carbonation (EN 13295):	less than reference concrete
Impermeability to water	
– penetration depth – (EN 12390/8) (mm):	< 5
Capillary absorption (EN 13057) (kg/m <sup>2</sup> ·h <sup>0.5</sup> ):	< 0.25
Slip-resistance of reinforcement rods (EN 15184)	
– adhesion stress - (MPa):	≥ 25
Thermal compatibility measured as adhesion according to EN 1542 (MPa):	
– freeze-thaw cycles with de-icing salts (EN 13687/1):	> 2 (after 50 cycles)
– storm cycles (EN 13687/2):	> 2 (after 30 cycles)
– dry shrinkage (EN 12607):	> 2 (after 30 cycles)
Rea	A1
Con	approximately 18.5

Included out according to specification:  
 – preparation of substrate with water immediately before

– application on steel reinforcement;  
 – leveling on surfaces with a straight edge and final tamping;

- ca
- a) A
- pe
- b) A
- pe



## **F.4 STRUCTURAL RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES**

CIVIL, RESIDENTIAL, INDUSTRIAL AND INFRASTRUCTURAL WORKS WITHOUT DYNAMIC STRESS

### **F.4.2 TWO-COMPONENT NORMAL-SETTING THIXOTROPIC MORTAR Procedure**

#### **Preparation of substrates**

Prepare all surfaces to be treated by completely removing all the deteriorated concrete with a hand or power chisel (see section **F.1.1.2**) or with other suitable means, such as hydro-scarifying (see section **F.1.1.1**), to obtain a solid, sufficiently-rough substrate with no detached portions. If the deteriorated concrete has been removed with a hand or power chisel, clean all exposed steel reinforcement with a brush (see section **F.1.1.2**) or by hydro-sandblasting (see section **F.1.1.3**) to remove the rust and bring the steel reinforcement back to a bare metal finish.

Hydro-sandblasting is not required if the surface has been prepared by hydro-scarifying. However, if the time between hydro-scarifying and treating the steel reinforcement is particularly long due to on-site logistics, hydro-sandblasting must be carried out.

Replace any steel reinforcement which has been cut or damaged, or which is highly corroded, with new reinforcement (see section **F.1.2.1**).

#### **Protection of steel reinforcement**

After removing all the rust, treat the steel reinforcement by brush-applying two coats of **Mapefer 1K** one-component, anti-corrosion cementitious mortar (see section **F.2.1.1**) or **Mapefer** two-component, anti-corrosion cementitious mortar (see section **F.2.1.2**). The specific function of both these products, made from cementitious binders, powdered polymers and corrosion inhibitors, is to prevent the formation of rust.

#### **Restoration operations**

Clean all surfaces to be restored and saturate the substrate leaving a dry surface (s.s.d.) by hydro-cleaning (see section **F.1.1.4**).

Restore the concrete structure using:

- **Mapegrout BM** two-component, normal-setting, shrinkage-compensating, class R4 thixotropic mortar with a low modulus of elasticity (22 GPa) for layers from 1 to 3.5 cm thick (see section **F.4.2.1**);

The most suitable cementitious mortar for restoring deteriorated concrete structures, subjected to small deformations when under load, is made up of two pre-dosed components (A and B). Mix component A (powder) with component B (liquid) according to the mixing ratio indicated in the Technical Data Sheet, and without adding any other ingredient, to form a well-mixed, lump-free blend.

When preparing the mortar, add **Mapecure SRA** (see section **F.6.1.1**), a special shrinkage-reducing agent, at a dose of 0.25% in weight on the weight of the mortar.

Apply the mortar with a trowel or by spray within the application temperature range indicated in the Technical Data Sheet.

If the thickness to be restored is more than the indicated values, apply the mortar in several coats and reinforce it by inserting electro-welded mesh (see section **F.1.3.1**) to compensate for hygrometric shrinkage and guarantee sufficient contrast to the expansive nature of the mortar. The size (diameter of wire and mesh size) must be according to design specifications.

Tamp the mortar. The waiting time depends on climatic conditions, and tamping should be carried out when a small imprint remains after touching the surface with a finger.

Since component B has an influence on the properties of the mortar, take special care to prevent it evaporating off too quickly while curing. In hot or windy weather, we recommend using the damp-curing technique or applying an anti-evaporation product to prevent rapid evaporation of component B. The anti-evaporation product must be compatible with the successive skimming or protective layer, and must be removed if necessary.

If a finer finish is required, skim the restored surfaces once the mortar has cured with one of the



**F.4 STRUCTURAL RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES**

CIVIL, RESIDENTIAL, INDUSTRIAL AND INFRASTRUCTURAL WORKS WITHOUT DYNAMIC STRESS

**F.4.2.1 Application of two-component, normal-setting, shrinkage-compensating, class R4 thixotropic mortar with a low modulus of elasticity (22 GPa) for layers from 1 to 3.5 cm thick**

Supply and application of two-component, normal-setting, shrinkage-compensating thixotropic mortar with a low modulus of elasticity (22 GPa) made from cementitious binders, selected aggregates, synthetic polyacrylonitrile fibres and polymer resins (such as **Mapegrout BM** produced by MAPEI S.p.A.), for reconstructing deteriorated concrete structures. Apply the mortar after adequate preparation of the substrate (not included), by removing all deteriorated concrete to form a sufficiently-rough, solid substrate with no detached portions. Clean the steel reinforcement down to bare metal (not included) and apply a passivating treatment by brush-applying two coats of one-component, anti-corrosion cementitious mortar (such as **Mapefer 1K** produced by MAPEI S.p.A.) (not included). Apply the product by trowel or spray with a continuous-feed rendering machine on a clean substrate saturated with water in layers from 1 to 3.5 cm thick. To improve expansion in the open air during the first few days of curing, add a special curing additive when mixing the mortar to reduce both plastic and hydraulic shrinkage (such as **Mapecure SRA** produced by MAPEI S.p.A.) at a dose of 0.25% in weight on the weight of the mortar.

The product must comply with the minimum requirements of EN 1504-3 for structural R4-class structural mortars and have the following performance characteristics:

Compressive strength (EN 12190) (MPa):	> 47 (after 28 days)
Flexural strength (EN 196/1) (MPa):	> 10 (after 28 days)
Compressive modulus of elasticity (EN 13412) (GPa):	22 (after 28 days)
Adhesion to substrate (EN 1542) (MPa):	> 2 (after 28 days)
Capillary absorption (EN 13057) (kg/m <sup>2</sup> ·h <sup>0.5</sup> ):	< 0.25
Impermeability to water:	
– penetration depth – (EN 12390/8) (mm):	< 10
Thermal compatibility measured as adhesion according to EN 1542 (MPa):	
– freeze-thaw cycles with de-icing salts (EN 13687/1):	> 2 (after 50 cycles)
– storm cycles (EN 13687/2):	> 2 (after 30 cycles)
– dry thermal cycles (EN 13687/4):	> 2 (after 30 cycles)
Reaction to fire (EN 13501-1) (Euroclass):	E
Consumption (per cm of thickness) (kg/m <sup>2</sup> ):	approximately 21

Included and calculated in the price for work carried out according to specification:  
 – hydro-cleaning of adhesion surfaces and saturation of substrate with water immediately before applying the mortar:

– application of steel reinforcement;  
 – final tamping;  
 – curing for at least 24 hours after application.

a) A ..... (€/m<sup>2</sup>·cm)  
 b) A ..... (€/m<sup>2</sup>·cm)  
 – per square metre per cm of thickness



## **F.4 STRUCTURAL RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES**

CIVIL, RESIDENTIAL, INDUSTRIAL AND INFRASTRUCTURAL WORKS WITHOUT DYNAMIC STRESS

### **F.4.3 NORMAL-SETTING CASTABLE MORTAR Procedure**

#### **Preparation of substrates**

Prepare all surfaces to be treated by completely removing all the deteriorated concrete with a hand or power chisel (see section [F.1.1.2](#)) or with other suitable means, such as hydro-scarifying (see section [F.1.1.1](#)), to obtain a solid, sufficiently rough substrate with no detached portions. If the deteriorated concrete has been removed with a hand or power chisel, clean all exposed steel reinforcement with a brush (see section [F.1.1.2](#)) or by hydro-sandblasting (see section [F.1.1.3](#)) to remove the rust and bring the steel reinforcement back to a bare metal finish.

Hydro-sandblasting is not required if the surface has been prepared by hydro-scarifying. However, if the time between hydro-scarifying and treating the steel reinforcement is particularly long due to on-site logistics, hydro-sandblasting must be carried out.

Replace any steel reinforcement which has been cut or damaged, or which is highly corroded, with new reinforcement (see section [F.1.2.1](#)).

#### **Protection of steel reinforcement**

After removing all the rust, treat the steel reinforcement by brush-applying two coats of **Mapefer 1K** one-component, anti-corrosion cementitious mortar (see section [F.2.1.1](#)) or **Mapefer** two-component, anti-corrosion cementitious mortar (see section [F.2.1.2](#)). The specific function of both these products, made from cementitious binders, powdered polymers and corrosion inhibitors, is to prevent the formation of rust.

#### **Restoration operations**

Clean all surfaces to be restored and saturate the substrate leaving a dry surface (s.s.d.) by hydro-cleaning (see section [F.1.1.4](#)).

Restore the concrete structure using:

- **Mapegrout Hi-Flow** one-component, normal-setting, shrinkage-compensating, class R4 castable mortar for layers from 1 to 4 cm thick (see section [F.4.3.1](#));

This cementitious mortar is supplied in pre-blended powder form, and must be mixed with the amount of water indicated in the Technical Data Sheet to form a well-blended, lump-free mix.

When preparing the mortar, add **Mapecure SRA** (see section [F.6.1.1](#)), a special shrinkage-reducing agent, at a dose of 0.25% in weight on the weight of the mortar.

Cast the mortar within the application temperature range indicated on the Technical Data Sheet. Pour the mix in a continuous flow from one side only into the prepared area, making sure that all air is expelled. If applied into formwork, coat the formwork with a stripping compound before casting to prevent it drawing off any of the mixing water.

If the area to be restored is thicker than the values indicated, add dry, silica gravel at a ratio of 30 to 50% of the weight of the mortar. The grain size of the gravel must be suitable for the thickness to be reconstructed. Reinforce the reconstructed area by embedding electro-welded steel mesh in the mortar (see section [F.1.3.1](#)). The dimensions of the mesh (diameter of steel wire and mesh pitch) must be according to design specifications, and is used to compensate for hygrometric shrinkage and to guarantee sufficient contrast to the expansive action of the mortar. Embed the electro-welded mesh at around the mid-point of the layer of restoration mortar and connect it to the steel reinforcement.

Since water content has an influence on the properties of the mortar, take special care to prevent it evaporating off too quickly while curing. In hot or windy weather, we recommend using the damp-curing technique or applying an anti-evaporation product to prevent rapid evaporation of the mixing water. The anti-evaporation product must be compatible with the successive skimming or protective layer, and must be removed if necessary.

When the mortar has completely cured, and according to the quality of finish obtained which depends

**F.4 STRUCTURAL RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES**

CIVIL, RESIDENTIAL, INDUSTRIAL AND INFRASTRUCTURAL WORKS WITHOUT DYNAMIC STRESS

**F.4.3.1 Application of one-component, normal-setting, shrinkage-compensating, class R4 castable mortar for layers from 1 to 4 cm thick**

Supply and application of one-component, normal-setting, shrinkage-compensating castable mortar made from high-strength cement, selected aggregates, synthetic polyacrylonitrile fibres and special additives (such as **Mapegrout Hi-Flow** produced by MAPEI S.p.A.), for reconstructing deteriorated concrete structures. Apply the mortar after adequate preparation of the substrate (not included), by removing all deteriorated concrete to form a sufficiently-rough, solid substrate with no detached portions. Clean the steel reinforcement down to bare metal (not included) and apply a passivating treatment by brush-applying two coats of one-component, anti-corrosion cementitious mortar (such as **Mapefer 1K** produced by MAPEI S.p.A.) (not included). Apply the product by casting into the prepared area on a clean substrate saturated with water in layers from 1 to 4 cm thick. To improve expansion in the open air during the first few days of curing, add a special curing additive when mixing the mortar to reduce both plastic and hydraulic shrinkage (such as **Mapecure SRA** produced by MAPEI S.p.A.) at a dose of 0.25% in weight on the weight of the mortar.

The product must comply with the minimum requirements of EN 1504-3 for structural R4-class structural mortars and have the following performance characteristics:

Compressive strength (EN 12190) (MPa):	> 75 (after 28 days)
Flexural strength (EN 196/1) (MPa):	12 (after 28 days)
Compressive modulus of elasticity (EN 13412) (GPa):	27 (after 28 days)
Adhesion to substrate (EN 1542) (MPa):	> 2 (after 28 days)
Contrasted expansion (UNI 8147) (µm/m):	> 400 (after 1 day)
Crack resistance ("O-ring" test):	no cracks after 180 days
Resistance to accelerated carbonation (EN 13295):	less than reference concrete
Impermeability to water:	
– penetration depth – (EN 12390/8) (mm):	< 5
Capillary absorption (EN 13057) (kg/m <sup>2</sup> ·h <sup>0.5</sup> ):	< 0.08
Slip-resistance of reinforcement rods (EN 15184)	
– adhesion stress - (MPa):	≥ 25
Thermal compatibility measured as adhesion according to EN 1542 (MPa):	
– freeze-thaw cycles with de-icing salts (EN 13687/1):	> 2 (after 50 cycles)
– storm cycles (EN 13687/2):	> 2 (after 30 cycles)
– dry thermal cycles (EN 13687/4):	> 2 (after 30 cycles)
Reaction to fire (EN 13501-1) (Euroclass):	A1
Conductivity:	approximately 21

Included in the price of the product is the application of the product according to specification: preparation of substrate with water immediately before application.

– curing time for at least 24 hours after application.

– per square metre per cm of thickness ..... (€/m<sup>2</sup>·cm)



## **F.4 STRUCTURAL RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES**

CIVIL, RESIDENTIAL, INDUSTRIAL AND INFRASTRUCTURAL WORKS WITHOUT DYNAMIC STRESS

### **F.4.4 CIVIL, RESIDENTIAL, INDUSTRIAL AND INFRASTRUCTURAL WORKS SUBJECTED TO DYNAMIC STRESS NORMAL-SETTING THIXOTROPIC MORTARS Procedure**

#### **Preparation of substrates**

Prepare all surfaces to be treated by completely removing all the deteriorated concrete with a hand or power chisel (see section [F.1.1.2](#)) or with other suitable means, such as hydro-scarifying (see section [F.1.1.1](#)), to obtain a solid, sufficiently rough substrate with no detached portions. If the deteriorated concrete has been removed with a hand or power chisel, clean all exposed steel reinforcement with a brush (see section [F.1.1.2](#)) or by hydro-sandblasting (see section [F.1.1.3](#)) to remove the rust and bring the steel reinforcement back to a bare metal finish.

Hydro-sandblasting is not required if the surface has been prepared by hydro-scarifying. However, if the time between hydro-scarifying and treating the steel reinforcement is particularly long due to on-site logistics, hydro-sandblasting must be carried out.

Replace any steel reinforcement which has been cut or damaged, or which is highly corroded, with new reinforcement (see section [F.1.2.1](#)).

#### **Protection of steel reinforcement**

After removing all the rust, treat the steel reinforcement by brush-applying two coats of **Mapefer 1K** one-component, anti-corrosion cementitious mortar (see section [F.2.1.1](#)) or **Mapefer** two-component, anti-corrosion cementitious mortar (see section [F.2.1.2](#)). The specific function of both these products, made from cementitious binders, powdered polymers and corrosion inhibitors, is to prevent the formation of rust.

#### **Restoration operations**

Clean all surfaces to be restored and saturate the substrate leaving a dry surface (s.s.d.) by hydro-cleaning (see section [F.1.1.4](#)).

Restore the concrete structure using one of the following products:

- **Mapegrout T60** one-component, normal-setting, shrinkage-compensating, class R4 thixotropic mortar made with cement with high resistance to sulphates, for layers from 1 to 4 cm thick (see section [F.4.4.1](#));
- **Mapegrout Easy Flow** one-component, normal-setting, shrinkage-compensating, class R4 thixotropic mortar for high pumping heads, for layers from 1 to 3.5 cm thick (see section [F.4.4.2](#));
- **MapegroutEasyFlow GF** one-component, normal-setting, shrinkage-compensating, high-ductility, class R4 thixotropic mortar strengthened with inorganic fibres for medium-height pumping heads, for layers from 1 to 5 cm thick (see section [F.4.4.3](#));
- **Mapegrout FMR**, one-component, normal-setting, shrinkage-compensating, high-ductility, class R4 thixotropic mortar with flexible, rust-proof, metal-alloy fibres, for layers from 1 to 5 cm thick (see section [F.4.4.4](#));

These cementitious mortars are supplied in pre-blended powder form, and must be mixed with the amount of water indicated in their relative Technical Data Sheet to form a well-blended, lump-free mix.

When preparing the mortar, add **Mapecure SRA** (see section [F.6.1.1](#)), a special shrinkage-reducing agent, at a dose of 0.25% in weight on the weight of the mortar.

Apply the mortar with a trowel or by spray within the application temperature range indicated in the Technical Data Sheet.

If the thickness to be restored is more than the indicated values, apply the mortar in several coats and reinforce it by inserting electro-welded mesh (see section [F.1.3.1](#)) to compensate for hygrometric shrinkage and guarantee sufficient contrast to the expansive nature of the mortar. The size (diameter

## F.4 STRUCTURAL RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES

CIVIL, RESIDENTIAL, INDUSTRIAL AND INFRASTRUCTURAL WORKS WITHOUT DYNAMIC STRESS

### F.4.4.1 Application of one-component, normal-setting, shrinkage-compensating, class R4 thixotropic mortar made with cement with high resistance to sulphates, for layers from 1 to 4 cm thick

Supply and application of one-component, normal-setting, shrinkage-compensating thixotropic mortar made from cement with high resistance to sulphates, selected aggregates, synthetic polyacrylonitrile fibres, organic corrosion inhibitor and special water-retaining additives (such as **Mapegrout T60** produced by MAPEI S.p.A.), for reconstructing deteriorated concrete structures. Apply the mortar after adequate preparation of the substrate (not included), by removing all deteriorated concrete to form a sufficiently-rough, solid substrate with no detached portions. Clean the steel reinforcement down to bare metal (not included) and apply a passivating treatment by brush-applying two coats of one-component, anti-corrosion cementitious mortar (such as **Mapefer 1K** produced by MAPEI S.p.A.) (not included). Apply the product by trowel or spray with a continuous-feed rendering machine on a clean substrate saturated with water in layers from 1 to 4 cm thick. To improve expansion in the open air during the first few days of curing, add a special curing additive when mixing the mortar to reduce both plastic and hydraulic shrinkage (such as **Mapecure SRA** produced by MAPEI S.p.A.) at a dose of 0.25% in weight on the weight of the mortar.

The product must comply with the minimum requirements of EN 1504-3 for structural R4-class structural mortars and have the following performance characteristics:

Compressive strength (EN 12190) (MPa):	60 (after 28 days)
Flexural strength (EN 196/1) (MPa):	8 (after 28 days)
Compressive modulus of elasticity (EN 13412) (GPa):	27 (after 28 days)
Adhesion to substrate (EN 1542) (MPa):	> 2 (after 28 days)
Contrasted expansion (UNI 8147) ( $\mu\text{m}/\text{m}$ ):	> 400 (after 1 day)
Crack resistance ("O-Ring Test"):	no cracks after 180 days
Resistance to accelerated carbonation (EN 13295):	less than reference concrete
Impermeability to water:	
– penetration depth – (EN 12390/8) (mm):	< 5
Capillary absorption (EN 13057) ( $\text{kg}/\text{m}^2 \cdot \text{h}^{0.5}$ ):	< 0.25
Slip-resistance of reinforcement rods (EN 15184)	
– adhesion stress - (MPa):	$\geq 25$
Thermal compatibility measured as adhesion according to EN 1542 (MPa):	
– freeze-thaw cycles with de-icing salts (EN 13687/1):	> 2 (after 50 cycles)
– storm cycles (EN 13687/2):	> 2 (after 30 cycles)
– dry shrinkage (EN 12607):	> 2 (after 30 cycles)
Refractive index:	A1
Conductivity:	approximately 18.5

ed out according to specification:  
 ration of substrate with water immediately before

nd steel reinforcement;  
 – leveling on surfaces with a straight edge and final tamping;

– ca

a) A

– pe

b) A

– pe





**F.4 STRUCTURAL RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES**

CIVIL, RESIDENTIAL, INDUSTRIAL AND INFRASTRUCTURAL WORKS WITHOUT DYNAMIC STRESS

**F.4.4.2 Application of one-component, normal-setting, shrinkage-compensating, class R4 thixotropic mortar for pumping to high heads, for layers from 1 to 3.5 cm thick**

Supply and application of one-component, normal-setting, shrinkage-compensating thixotropic cementitious mortar for pumping to high heads and over long distances, made from sulphate-resistant hydraulic binders, selected aggregates, synthetic polyacrylonitrile fibres, organic corrosion inhibitor and special expansive and water-retaining additives (such as **Mapegrout Easy Flow** produced by MAPEI S.p.A.), for reconstructing deteriorated concrete structures. Apply the mortar after adequate preparation of the substrate (not included), by removing all deteriorated concrete to form a sufficiently-rough, solid substrate with no detached portions. Clean the steel reinforcement down to bare metal (not included) and apply a passivating treatment by brush-applying two coats of one-component, anti-corrosion cementitious mortar (such as **Mapefer 1K** produced by MAPEI S.p.A.) (not included). Apply the product by trowel or spray with a continuous-feed rendering machine on a clean substrate saturated with water in layers from 1 to 3.5 cm thick. To improve expansion in the open air during the first few days of curing, add a special curing additive when mixing the mortar to reduce both plastic and hydraulic shrinkage (such as **Mapecure SRA** produced by MAPEI S.p.A.) at a dose of 0.25% in weight on the weight of the mortar.

The product must comply with the minimum requirements of EN 1504-3 for structural R4-class structural mortars and have the following characteristics:

Compressive strength (EN 12190) (MPa):	> 60 (after 28 days)
Flexural strength (EN 196/1) (MPa):	> 8 (after 28 days)
Compressive modulus of elasticity (EN 13412) (GPa):	27 (after 28 days)
Adhesion to substrate (EN 1542) (MPa):	> 2 (after 28 days)
Contrasted expansion (UNI 8147) (µm/m):	> 400 (after 1 day)
Crack resistance ("O-Ring Test"):	no cracks after 180 days
Resistance to accelerated carbonation (EN 13295):	less than reference concrete
Impermeability to water	
– penetration depth – (EN 12390/8) (mm):	< 5
Capillary absorption (EN 13057) (kg/m <sup>2</sup> ·h <sup>0.5</sup> ):	< 0.25
Slip-resistance of reinforcement rods (EN 15184)	
– adhesion stress - (MPa):	≥ 25
Thermal compatibility measured as adhesion according to EN 1542 (MPa):	
– freeze-thaw cycles with de-icing salts (EN 13687/1):	> 2 (after 50 cycles)
– storm cycles (EN 13687/2):	> 2 (after 30 cycles)
– dry shrinkage (EN 12607):	> 2 (after 30 cycles)
Reactivity to chloride ions (EN 12607):	A1
Conductivity (EN 12607):	18.5

Included in the price: preparation and application of the mortar. Preparation of substrate with water immediately before application.

– application of the mortar by trowel or spray around steel reinforcement;



a) A

– pe

b) A

– pe

**F.4 STRUCTURAL RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES**

CIVIL, RESIDENTIAL, INDUSTRIAL AND INFRASTRUCTURAL WORKS WITHOUT DYNAMIC STRESS

**F.4.4.3 Application of one-component, normal-setting, shrinkage-compensating, high-ductility, class R4 thixotropic mortar strengthened with inorganic fibres for pumping to medium-height heads, for layers from 1 to 5 cm thick**

Supply and application of one-component, normal-setting, shrinkage-compensating thixotropic cementitious mortar for pumping to medium-height heads and over long distances, made from sulphate-resistant hydraulic binders, selected aggregates, synthetic polyacrylonitrile fibres, inorganic fibres, organic corrosion inhibitor and special additives (such as **Mapegrout Easy Flow GF** produced by MAPEI S.p.A.), for reconstructing deteriorated concrete structures.

The inorganic fibres contained in the mortar must have the following characteristics:


- length (mm): 12
- diameter (&mu;m): 14
- tensile strength (MPa): 1700
- modulus of elasticity (GPa): 72



Apply the mortar after adequate preparation of the substrate (not included), by removing all deteriorated concrete to form a sufficiently-rough, solid substrate with no detached portions. Clean the steel reinforcement down to bare metal (not included) and apply a passivating treatment by brush-applying two coats of one-component, anti-corrosion cementitious mortar (such as **Mapefer 1K** produced by MAPEI S.p.A.) (not included). Apply the product by trowel or spray with a continuous-feed rendering machine on a clean substrate saturated with water in layers from 1 to 5 cm thick, without using opposing reinforcement.

To improve expansion in the open air during the first few days of curing, add a special curing additive when mixing the mortar to reduce both plastic and hydraulic shrinkage (such as **Mapecure SRA** produced by MAPEI S.p.A.) at a dose of 0.25% in weight on the weight of the mortar.

The product must comply with the minimum requirements of EN 1504-3 for structural R4-class structural mortars and have the following performance characteristics:

- Compressive strength (EN 12190) (MPa): > 60 (after 28 days)
- Flexural strength (EN 196/1) (MPa): 11 (after 28 days)
- Compressive modulus of elasticity (EN 13412) (GPa): 27 (after 28 days)
- Adhesion to substrate (EN 1542) (MPa): ≥ 2 (after 28 days)
- Contrasted expansion (UNI 8147) (µm/m): > 400 (after 1 day)
- Crack resistance ("O-Ring Test"): no cracks after 180 days
- Resistance to accelerated carbonation (EN 13295): less than reference concrete

<p>Impermeability to water</p> <ul style="list-style-type: none"> <li>- permeability coefficient (EN 12067) (kg/m<sup>2</sup>h<sup>0.5</sup>): &lt; 5</li> <li>- capillary water absorption (EN 12067) (kg/m<sup>2</sup>): &lt; 0.25</li> <li>- absorption coefficient (EN 12067) (kg/m<sup>2</sup>h<sup>0.5</sup>): ≥ 25</li> </ul>		<p>Adhesion to substrate according to EN 1542 (MPa):</p> <ul style="list-style-type: none"> <li>- fresh mortar (EN 1542) (MPa): &gt; 2 (after 50 cycles)</li> <li>- stored mortar (EN 1542) (MPa): &gt; 2 (after 30 cycles)</li> <li>- dry thermal cycles (EN 13687/4): &gt; 2 (after 30 cycles)</li> </ul>
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<p>Reaction to fire</p> <ul style="list-style-type: none"> <li>- reaction to fire (EN 13501-2): Class B2</li> </ul>		<p>Application of curing additive</p> <ul style="list-style-type: none"> <li>- application of curing additive (EN 13295): as per manufacturer's instructions</li> </ul>	
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a) Application by trowel

## F.4 STRUCTURAL RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES

CIVIL, RESIDENTIAL, INDUSTRIAL AND INFRASTRUCTURAL WORKS WITHOUT DYNAMIC STRESS

### F.4.4.4 Application of one-component, normal-setting, shrinkage-compensating, high-ductility, class R4 thixotropic mortar strengthened with flexible, rust-proof, metal-alloy fibres, for layers from 1 to 5 cm thick

Supply and application of one-component, normal-setting, shrinkage-compensating, high-ductility thixotropic mortar made from cement with high resistance to sulphates, selected aggregates, flexible rust-proof, amorphous iron-chromium alloy fibres contained in the mortar must have the following characteristics:

– l/d ratio:	125
– length (mm):	30
– tensile strength (MPa):	> 1,900

And special admixtures (such as **Mapegrout FMR** produced by MAPEI S.p.A.), for reconstructing deteriorated concrete structures.

Apply the mortar after adequate preparation of the substrate (not included), by removing all deteriorated concrete to form a sufficiently-rough, solid substrate with no detached portions. Clean the steel reinforcement down to bare metal (not included) and apply a passivating treatment by brush-applying two coats of one-component, anti-corrosion cementitious mortar (such as **Mapefer 1K** produced by MAPEI S.p.A.) (not included). Apply the product by trowel or spray with a continuous-feed rendering machine on a clean substrate saturated with water in layers from 1 to 5 cm thick. To improve expansion in the open air during the first few days of curing, add a special curing additive when mixing the mortar to reduce plastic and hydraulic shrinkage (such as **Mapecure SRA** produced by MAPEI S.p.A.) at a dose of 0.25% in weight on the weight of the mortar.

The product must comply with the minimum requirements of EN 1504-3 for structural R4-class structural mortars and have the following performance characteristics:

Compressive strength (EN 12190) (MPa):	> 64 (after 28 days)
Flexural strength (EN 196/1) (MPa):	11 (after 28 days)
Compressive modulus of elasticity (EN 13412) (GPa):	27 (after 28 days)
Adhesion to substrate (EN 1542) (MPa):	> 2 (after 28 days)
Contrasted expansion (UNI 8147) (µm/m):	> 400 (after 1 day)
Crack resistance (“O-Ring Test”):	no cracks after 180 days
Resistance to accelerated carbonation (EN 13295):	less than reference concrete
Impermeability to water	
– penetration depth – (EN 12390/8) (mm):	< 5

Capillary absorption (EN 12390/8) (mm): < 0.08

Thixotropy (EN 12390/8) (mm): ≥ 25

Adhesion to substrate (EN 1542) (MPa):

– fresh (EN 1542) (MPa): > 2 (after 50 cycles)

– stored (EN 1542) (MPa): > 2 (after 30 cycles)

– dried (EN 1542) (MPa): > 2 (after 30 cycles)

Reaction to fire (EN 13501-1) (Euroclass): A1

Conductivity (EN 12390/8) (W/mK):

Characteristics of the mortar: EN 1504-3 (R4 class) and EN 1504-7 (Mapegrout FMR) EN 1504-7 (Mapefer 1K) EN 1504-7 (Mapecure SRA)

Included: – Hydro-cleaning of adhesion surfaces and saturation of substrate with water immediately before applying the mortar;





## **F.4 STRUCTURAL RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES**

CIVIL, RESIDENTIAL, INDUSTRIAL AND INFRASTRUCTURAL WORKS WITHOUT DYNAMIC STRESS

### **F.4.5 TWO-COMPONENT NORMAL-SETTING THIXOTROPIC MORTARS Procedure**

#### **Preparation of substrates**

Prepare all surfaces to be restored by completely removing all the deteriorated concrete with a hand or power chisel (see section **F.1.1.2**) or with other suitable means, such as hydro-scarifying (see section **F.1.1.1**), to obtain a solid, sufficiently-rough substrate with no detached portions. If the deteriorated concrete has been removed with a hand or power chisel, clean all exposed steel reinforcement with a brush (see section **F.1.1.2**) or by hydro-sandblasting (see section **F.1.1.3**) to remove the rust and bring the steel reinforcement back to a bare metal finish.

Hydro-sandblasting is not required if the surface has been prepared by hydro-scarifying. However, if the time between hydro-scarifying and treating the steel reinforcement is particularly long due to on-site logistics, hydro-sandblasting must be carried out.

Replace any steel reinforcement which has been cut or damaged, or which is highly corroded, with new reinforcement (see section **F.1.2.1**).

#### **Protection of steel reinforcement**

After removing all the rust, treat the steel reinforcement by brush-applying two coats of **Mapefer 1K** one-component, anti-corrosion cementitious mortar (see section **F.2.1.1**) or **Mapefer** two-component, anti-corrosion cementitious mortar (see section **F.2.1.2**). The specific function of both these products, made from cementitious binders, powdered polymers and corrosion inhibitors, is to prevent the formation of rust.

#### **Restoration operations**

Clean all surfaces to be restored and saturate the substrate with water leaving a dry surface (s.s.d.) by hydro-cleaning (see section **F.1.1.4**).

Restore the concrete using:

- **Mapegrout BM** two-component, normal-setting, shrinkage-compensating, class R4 thixotropic mortar with a low modulus of elasticity (22 GPa) for layers from 1 to 3.5 cm thick (see section **F.4.5.1**);

The most suitable cementitious mortar for restoring deteriorated concrete structures, subjected to small deformations when under load, is made up of two pre-dosed components (A and B). Mix component A (powder) with component B (liquid) according to the mixing ratio indicated in the Technical Data Sheet, and without adding any other ingredient, to form a well-mixed, lump-free blend.

When preparing the mortar, add **Mapecure SRA** (see section **F.6.1.1**), a special shrinkage-reducing agent, at a dose of 0.25% in weight on the weight of the mortar.

Apply the mortar with a trowel or by spray within the application temperature range indicated in the Technical Data Sheet.

If the thickness to be restored is more than the indicated values, apply the mortar in several coats and reinforce it by inserting electro-welded mesh (see section **F.1.3.1**) to compensate for hygrometric shrinkage and guarantee sufficient contrast to the expansive nature of the mortar. The size (diameter of wire and mesh size) must be according to design specifications.

Tamp the mortar. The waiting time depends on climatic conditions, and tamping should be carried out when a small imprint remains after touching the surface with a finger.

Since component B has an influence on the properties of the mortar, take special care to prevent it evaporating off too quickly while curing. In hot or windy weather, we recommend using the damp-curing technique or applying an anti-evaporation product to prevent rapid evaporation of component B. The anti-evaporation product must be compatible with the successive skimming or protective layer, and must be removed if necessary.

When the mortar has completely cured, skim the repaired surfaces with one of the following products:

**F.4 STRUCTURAL RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES**

CIVIL, RESIDENTIAL, INDUSTRIAL AND INFRASTRUCTURAL WORKS WITHOUT DYNAMIC STRESS

**F.4.5.1 Application of two-component, normal-setting, shrinkage-compensating, class R4 thixotropic mortar with a low modulus of elasticity (22 GPa) for layers from 1 to 3.5 cm thick**

Supply and application of two-component, normal-setting, shrinkage-compensating thixotropic mortar with a low modulus of elasticity (22 GPa) made from cementitious binders, selected aggregates, synthetic polyacrylonitrile fibres and polymer resins (such as **Mapegrout BM** produced by MAPEI S.p.A.), for reconstructing deteriorated concrete structures. Apply the mortar after adequate preparation of the substrate (not included), by removing all deteriorated concrete to form a sufficiently-rough, solid substrate with no detached portions. Clean the steel reinforcement down to bare metal (not included) and apply a passivating treatment by brush-applying two coats of one-component, anti-corrosion cementitious mortar (such as **Mapefer 1K** produced by MAPEI S.p.A.) (not included). Apply the product by trowel or spray with a continuous-feed rendering machine on a clean substrate saturated with water in layers from 1 to 3.5 cm thick. To improve expansion in the open air during the first few days of curing, add a special curing additive when mixing the mortar to reduce plastic and hydraulic shrinkage (such as **Mapecure SRA** produced by MAPEI S.p.A.) at a dose of 0.25% in weight on the weight of the mortar.

The product must comply with the minimum requirements of EN 1504-3 for structural R4-class structural mortars and have the following characteristics:

Compressive strength (EN 12190) (MPa):	> 47 (after 28 days)
Flexural strength (EN 196/1) (MPa):	> 10 (after 28 days)
Compressive modulus of elasticity (EN 13412) (GPa):	22 (after 28 days)
Adhesion to substrate (EN 1542) (MPa):	> 2 (after 28 days)
Capillary absorption (EN 13057) (kg/m <sup>2</sup> ·h <sup>0.5</sup> ):	< 0.25
Impermeability to water	
– penetration depth - (EN 12390/8) (mm):	< 10
Thermal compatibility measured as adhesion according to EN 1542 (MPa):	
– freeze-thaw cycles with de-icing salts (EN 13687/1):	> 2 (after 50 cycles)
– storm cycles (EN 13687/2):	> 2 (after 30 cycles)
– dry thermal cycles (EN 13687/4):	> 2 (after 30 cycles)
Reaction to fire (EN 13501-1) (Euroclass):	E
Consumption (per cm of thickness) (kg/m <sup>2</sup> ):	approximately 21

Included and calculated in the price for work carried out according to specification:

- hydro-cleaning of adhesion surfaces and saturation of substrate with water immediately before

app

– ap

– le

– ca

a) A

– pe

b) Application by spray with a rendering machine

– pe



nd steel reinforcement;  
nal tamping;  
r for at least 24 hours after application.

..... (€/m<sup>2</sup>·cm)



## **F.4 STRUCTURAL RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES**

CIVIL, RESIDENTIAL, INDUSTRIAL AND INFRASTRUCTURAL WORKS WITHOUT DYNAMIC STRESS

### **F.4.6 RAPID-SETTING CASTABLE MORTAR Procedure**

#### **Preparation of substrates**

Prepare all surfaces to be restored by completely removing all the deteriorated concrete with a hand or power chisel (see section [F.1.1.2](#)) or with other suitable means, such as hydro-scarifying (see section [F.1.1.1](#)), to obtain a solid, sufficiently-rough substrate with no detached portions. If the deteriorated concrete has been removed with a hand or power chisel, clean all exposed steel reinforcement with a brush (see section [F.1.1.2](#)) or by hydro-sandblasting (see section [F.1.1.3](#)) to remove the rust and bring the steel reinforcement back to a bare metal finish. Hydro-sandblasting is not required if the surface has been prepared by hydro-scarifying. However, if the time between hydro-scarifying and treating the steel reinforcement is particularly long due to on-site logistics, hydro-sandblasting must be carried out. Replace any steel reinforcement which has been cut or damaged, or which is highly corroded, with new reinforcement (see section [F.1.2.1](#)).

#### **Protection of steel reinforcement**

After removing all the rust, treat the steel reinforcement by brush-applying two coats of **Mapefer 1K** one-component, anti-corrosion cementitious mortar (see section [F.2.1.1](#)) or **Mapefer** two-component, anti-corrosion cementitious mortar (see section [F.2.1.2](#)). The specific function of both these products, made from cementitious binders, powdered polymers and corrosion inhibitors, is to prevent the formation of rust.

#### **Restoration operations**

Clean all surfaces to be restored and saturate the substrate with water leaving a dry surface (s.s.d.) by hydro-cleaning (see section [F.1.1.4](#)).

Restore the concrete structure using:

- **Mapegrout SV Fiber**, one-component, normal-setting, shrinkage-compensating, high-ductility, class R4 castable mortar strengthened with metal fibres, for layers from 1 to 5 cm thick (see section [F.4.6.1](#));

Mix the pre-blended powdered cementitious mortar with the amount of water indicated in the Technical Data Sheet to form a well-mixed, lump-free blend. Cast the mortar within the application temperature range indicated on the Technical Data Sheet (down to -5°C). Pour the mix in a continuous flow from one side only into the prepared area, making sure that all air is expelled. If applied into formwork, coat the formwork with a stripping compound before casting to prevent it drawing off any of the mixing water. If the area to be restored is thicker than the values indicated, add dry, silica gravel at a ratio of 30 to 50% of the weight of the mortar. The grain size of the gravel must be suitable for the thickness to be reconstructed. Reinforce the reconstructed area by embedding electro-welded steel mesh in the mortar (see section [F.1.3.1](#)). The dimensions of the mesh (diameter of steel wire and mesh pitch) must be according to design specifications, and is used to compensate for hygrometric shrinkage and to guarantee sufficient contrast to the expansive action of the mortar. Embed the electro-welded mesh at around the mid-point of the layer of restoration mortar and connect it to the steel reinforcement. Since water content has an influence on the properties of the mortar, take special care to prevent it evaporating off too quickly while curing. In hot or windy weather, we recommend using the damp-curing technique or applying an anti-evaporation product to prevent rapid evaporation of the mixing water.

**F.4 STRUCTURAL RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES**

CIVIL, RESIDENTIAL, INDUSTRIAL AND INFRASTRUCTURAL WORKS WITHOUT DYNAMIC STRESS

**F.4.6.1 Application of one-component, rapid-setting, shrinkage-compensating, high-ductility, class R4 castable mortar strengthened with metal fibres, for layers from 1 to 5 cm thick**

Supply and application of one-component, rapid-setting, shrinkage-compensating, high-ductility castable mortar made from specific hydraulic binders, high-strength cement, selected aggregates, rigid, brass-plated, hooked steel fibres and special admixtures (such as **Mapegrout SV Fiber** produced by MAPEI S.p.A.), for reconstructing deteriorated concrete structures at temperatures down to -5°C.

The rigid, brass-plated, hooked steel fibres contained in the mortar must have the following characteristics:

- length (mm): 30
- diameter (mm): 0.38
- tensile strength (MPa): > 2,600

Apply the mortar after adequate preparation of the substrate (not included), by removing all deteriorated concrete to form a sufficiently-rough, solid substrate with no detached portions. Clean the steel reinforcement down to bare metal (not included) and apply a passivating treatment by brush-applying two coats of one-component, anti-corrosion cementitious mortar (such as **Mapefer 1K** produced by MAPEI S.p.A.) (not included). Cast the mortar into the prepared area on a clean substrate saturated with water in layers from 1 to 5 cm thick, without using opposing reinforcement.

The product must comply with the minimum requirements of EN 1504-3 for structural R4-class structural mortars and have the following characteristics:

- Compressive strength (EN 12190) (MPa): > 70 (after 28 days)
- Flexural strength (EN 196/1) (MPa): > 20 (after 28 days)
- Compressive modulus of elasticity (EN 13412) (GPa): 29 (after 28 days)
- Adhesion to substrate (EN 1542) (MPa): > 2 (after 28 days)
- Crack resistance ("O-Ring Test"): no cracks after 180 days
- Resistance to accelerated carbonation (EN 13295): less than reference concrete
- Impermeability to water
  - penetration depth - (EN 12390/8) (mm): < 5
  - Capillary absorption (EN 13057) (kg/m<sup>2</sup>·h<sup>0.5</sup>): < 0.35
- Slip-resistance of reinforcement rods (EN 15184)
  - adhesion stress - (MPa): > 25
- Thermal compatibility measured as adhesion according to EN 1542 (MPa):
  - freeze-thaw cycles with de-icing salts (EN 13687/1): > 2 (after 50 cycles)
  - storm cycles (EN 13687/2): > 2 (after 30 cycles)
  - dry thermal cycles (EN 13687/4): > 2 (after 30 cycles)
- Toughness (ASTM C1018):
  - load at first cracking: > 20 kN
  - toughness index: I<sub>20</sub> > 20
- Reaction to fire (EN 13501-1) (Euroclass): A1
- Consumption (per cm of thickness) (kg/m<sup>2</sup>): approximately 20

<p>Incl</p> <p>- h</p> <p>app</p> <p>- Ca</p> <p>- Ca</p>		<p>ed</p> <p>ra</p> <p>r</p>		<p>fore</p>
<p>- per square metre per cm of thickness</p>		<p>..... (€/m<sup>2</sup>-cm)</p>		

## **F.4 STRUCTURAL RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES**

CIVIL, RESIDENTIAL, INDUSTRIAL AND INFRASTRUCTURAL WORKS WITHOUT DYNAMIC STRESS

### **F.4.7 NORMAL-SETTING CASTABLE MORTAR Procedure**

#### **Preparation of substrates**

Prepare all surfaces to be restored by completely removing all the deteriorated concrete with a hand or power chisel (see section **F.1.1.2**) or with other suitable means, such as hydro-scarifying (see section **F.1.1.1**), to obtain a solid, sufficiently rough substrate with no detached portions. If the deteriorated concrete has been removed with a hand or power chisel, clean all exposed steel reinforcement with a brush (see section **F.1.1.2**) or by hydro-sandblasting (see section **F.1.1.3**) to remove the rust and bring the steel reinforcement back to a bare metal finish.

Hydro-sandblasting is not required if the surface has been prepared by hydro-scarifying. However, if the time between hydro-scarifying and treating the steel reinforcement is particularly long due to on-site logistics, hydro-sandblasting must be carried out.

Replace any steel reinforcement which has been cut or damaged, or which is highly corroded, with new reinforcement (see section **F.1.2.1**).

#### **Protection of steel reinforcement**

After removing all the rust, treat the steel reinforcement by brush-applying two coats of **Mapefer 1K** one-component, anti-corrosion cementitious mortar (see section **F.2.1.1**) or **Mapefer** two-component, anti-corrosion cementitious mortar (see section **F.2.1.2**). The specific function of both these products, made from cementitious binders, powdered polymers and corrosion inhibitors, is to prevent the formation of rust.

#### **Restoration operations**

Clean all surfaces to be restored and saturate the substrate with water leaving a dry surface (s.s.d.) by hydro-cleaning (see section **F.1.1.4**).

Restore the concrete structure using one of the following products:

- **Mapegrout Hi-Flow GF** one-component, normal-setting, shrinkage-compensating, high-ductility, class R4 castable mortar strengthened with inorganic fibres, for layers from 1 to 5 cm thick (see section **F.4.7.1**);
- **Mapegrout Hi-Flow TI 20**, one-component, normal-setting, shrinkage-compensating, high-ductility, class R4 castable mortar strengthened with metal fibres, for layers from 1 to 5 cm thick (see section **F.4.7.2**);

These cementitious mortars are supplied in pre-blended powder form, and must be mixed with the amount of water indicated in their relative Technical Data Sheet to form a well-blended, lump-free mix.

When preparing the mortar, add **Mapecure SRA** (see section **F.6.1.1**), a special shrinkage-reducing agent, at a dose of 0.25% in weight on the weight of the mortar.

Cast the mortar within the application temperature range indicated on the Technical Data Sheet. Pour the mix in a continuous flow from one side only into the prepared area, making sure that all the air is expelled. If applied into formwork, coat the formwork with a stripping compound before casting to prevent it drawing off any of the mixing water.

If the area to be restored is thicker than the values indicated, add dry, silica gravel at a ratio of 30 to 50% of the weight of the mortar. The grain size of the gravel must be suitable for the thickness to be reconstructed. Reinforce the reconstructed area by embedding electro-welded steel mesh in the mortar (see section **F.1.3.1**). The dimensions of the mesh (diameter of steel wire and mesh pitch) must be according to design specifications, and is used to compensate for hygrometric shrinkage and to guarantee sufficient contrast to the expansive action of the mortar. Embed the electro-welded mesh at around the mid-point of the layer of restoration mortar and connect it to the steel reinforcement.



**F.4 STRUCTURAL RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES**

CIVIL, RESIDENTIAL, INDUSTRIAL AND INFRASTRUCTURAL WORKS WITHOUT DYNAMIC STRESS

**F.4.7.1 Application of one-component, normal-setting, shrinkage-compensating, high-ductility, class R4 castable mortar strengthened with inorganic fibres, for layers from 1 to 5 cm thick**

Supply and application of one-component, normal-setting, shrinkage-compensating, high-ductility castable mortar made from high-strength cement, selected aggregates, synthetic polyacrylonitrile fibres, inorganic fibres and special additives (such as **Mapegrout Hi-Flow GF** produced by MAPEI S.p.A.), for reconstructing deteriorated concrete structures.

The inorganic fibres contained in the mortar must have the following characteristics:

- length (mm): 6 and 12
- diameter (&mu;m): 14
- tensile strength (MPa): 1700
- modulus of elasticity (GPa): 72

Apply the mortar after adequate preparation of the substrate (not included), by removing all deteriorated concrete to form a sufficiently-rough, solid substrate with no detached portions. Clean the steel reinforcement down to bare metal (not included) and apply a passivating treatment by brush-applying two coats of one-component, anti-corrosion cementitious mortar (such as **Mapefer 1K** produced by MAPEI S.p.A.) (not included). Cast the mortar into the prepared area on a clean substrate saturated with water in layers from 1 to 5 cm thick, without using opposing reinforcement.




To improve expansion in the open air during the first few days of curing, add a special curing additive when mixing the mortar to reduce plastic and hydraulic shrinkage (such as **Mapecure SRA** produced by MAPEI S.p.A.) at a dose of 0.25% in weight on the weight of the mortar.

The product must comply with the minimum requirements of EN 1504-3 for structural R4-class structural mortars and have the following performance characteristics:

- Compressive strength (EN 12190) (MPa): > 65 (after 28 days)
- Flexural strength (EN 196/1) (MPa): 10 (after 28 days)
- Compressive modulus of elasticity (EN 13412) (GPa): 27 (after 28 days)
- Adhesion to substrate (EN 1542) (MPa): > 2 (after 28 days)
- Contrasted expansion (UNI 8147) (<math>\mu\text{m}/\text{m}</math>): > 400 (after 1 day)
- Crack resistance ("O-ring" test): no cracks after 180 days
- Resistance to accelerated carbonation (EN 13295): less than reference concrete
- Impermeability to water
  - penetration depth - (EN 12390/8) (mm): < 5
  - Capillary absorption (EN 13057) (<math>\text{kg}/\text{m}^2 \cdot \text{h}^{0.5}</math>): < 0.25
- Slip-resistance of reinforcement rods (EN 15184)
  - adhesion to reinforcement rods (EN 1542) (MPa): > 25

- adhesion to substrate (EN 1542) (MPa): > 2 (after 28 days)
- flexural strength (EN 196/1): > 2 (after 50 cycles)
- tensile strength (EN 196/1): > 2 (after 30 cycles)
- dynamic modulus of elasticity (EN 12518): > 2 (after 30 cycles)
- Reaction to fire (EN 13501-2): A1
- Compressive strength (EN 12190) (MPa): approximately 21

Included and calculated in the price for work carried out according to specification:

<ul style="list-style-type: none"> <li>- h</li> <li>app</li> <li>- ca</li> <li>- ca</li> <li>- pe</li> </ul>		<ul style="list-style-type: none"> <li>rding to EN 1542 (MPa):</li> </ul>	<ul style="list-style-type: none"> <li>for</li> </ul>
<ul style="list-style-type: none"> <li>- h</li> <li>app</li> <li>- ca</li> <li>- ca</li> <li>- pe</li> </ul>		<ul style="list-style-type: none"> <li>rding to EN 1542 (MPa):</li> </ul>	<ul style="list-style-type: none"> <li>for</li> </ul>
<ul style="list-style-type: none"> <li>- h</li> <li>app</li> <li>- ca</li> <li>- ca</li> <li>- pe</li> </ul>		<ul style="list-style-type: none"> <li>rding to EN 1542 (MPa):</li> </ul>	<ul style="list-style-type: none"> <li>for</li> </ul>

## F.4 STRUCTURAL RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES

CIVIL, RESIDENTIAL, INDUSTRIAL AND INFRASTRUCTURAL WORKS WITHOUT DYNAMIC STRESS

### F.4.7.2 Application of one-component, normal-setting, shrinkage-compensating, high-ductility, class R4 castable mortar strengthened with metal fibres, for layers from 1 to 5 cm thick

Supply and application of one-component, normal-setting, shrinkage-compensating, high-ductility castable mortar made from high-strength cement, selected aggregates, special admixtures, synthetic polyacrylonitrile fibres and rigid, brass-plated, hooked steel fibres (such as **Mapegrout Hi-Flow TI 20** produced by MAPEI S.p.A.), for reconstructing deteriorated concrete structures.

The rigid, brass-plated, hooked steel fibres contained in the mortar must have the following characteristics:

– length (mm):	30
– diameter (mm):	0.6
– tensile strength (MPa):	> 1,200
– modulus of elasticity (GPa):	210

Apply the mortar after adequate preparation of the substrate (not included), by removing all deteriorated concrete to form a sufficiently-rough, solid substrate with no detached portions. Clean the steel reinforcement down to bare metal (not included) and apply a passivating treatment by brush-applying two coats of one-component, anti-corrosion cementitious mortar (such as **Mapefer 1K** produced by MAPEI S.p.A.) (not included). Cast the mortar into the prepared area on a clean substrate saturated with water in layers from 1 to 5 cm thick, without using opposing reinforcement. To improve expansion in the open air during the first few days of curing, add a special curing additive when mixing the mortar to reduce plastic and hydraulic shrinkage (such as **Mapecure SRA** produced by MAPEI S.p.A.) at a dose of 0.25% in weight on the weight of the mortar.

The product must comply with the minimum requirements of EN 1504-3 for structural R4-class structural mortars and have the following characteristics:

Compressive strength (EN 12190) (MPa):	> 70 (after 28 days)
Flexural strength (EN 196/1) (MPa):	> 16 (after 28 days)
Compressive modulus of elasticity (EN 13412) (GPa):	27 (after 28 days)
Adhesion to substrate (EN 1542) (MPa):	≥ 2 (after 28 days)
Contrasted expansion (UNI 8147) (µm/m):	> 400 (after 1 day)
Crack resistance ("O-ring" test):	no cracks after 180 days
Resistance to accelerated carbonation (EN 13295):	less than reference concrete

Impermeability to water

– penetration depth - (EN 12390/8) (mm):	< 5
Capillary water absorption (EN 12607) (kg/m <sup>2</sup> ):	< 0.35

Slip resistance (EN 12518) (mm):

– according to EN 1542 (MPa):	≥ 25
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The mortar must comply with the minimum requirements of EN 1504-3 for structural R4-class structural mortars and have the following characteristics:	
– according to EN 1542 (MPa):	> 2 (after 50 cycles)
– according to EN 1542 (MPa):	> 2 (after 30 cycles)
– according to EN 1542 (MPa):	> 2 (after 30 cycles)

Toughness (ASTM C1016):

– according to EN 1504-7 (MPa):	> 2 (after 50 cycles)
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– according to EN 1504-7 (MPa):	> 2 (after 30 cycles)
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– according to EN 1504-7 (MPa):	> 2 (after 30 cycles)
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– according to EN 1504-7 (MPa):	> 2 (after 30 cycles)
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– according to EN 1504-7 (MPa):	> 2 (after 30 cycles)
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– according to EN 1504-7 (MPa):	> 2 (after 30 cycles)
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– according to EN 1504-7 (MPa):	> 2 (after 30 cycles)
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– according to EN 1504-7 (MPa):	> 2 (after 30 cycles)
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– according to EN 1504-7 (MPa):	> 2 (after 30 cycles)
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– according to EN 1504-7 (MPa):	> 2 (after 30 cycles)
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– according to EN 1504-7 (MPa):	> 2 (after 30 cycles)
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– careful curing of the mortar by spraying on water for at least 24 hours after application.



## **F.5 STRUCTURAL RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES WITH LAYERS THICKER THAN AN AVERAGE OF 5 CM**

### **F.5.1 CONCRETE MADE WITH SPECIAL BINDERS** **Procedure**

#### **Preparation of substrates**

Prepare all surfaces to be restored by completely removing all the deteriorated concrete with a hand or power chisel (see section [F.1.1.2](#)) or with other suitable means, such as hydro-scarifying (see section [F.1.1.1](#)), to obtain a solid, sufficiently rough substrate with no detached portions. If the deteriorated concrete has been removed with a hand or power chisel, clean all exposed steel reinforcement with a brush (see section [F.1.1.2](#)) or by hydro-sandblasting (see section [F.1.1.3](#)) to remove the rust and bring the steel reinforcement back to a bare metal finish.

Hydro-sandblasting is not required if the surface has been prepared by hydro-scarifying. However, if the time between hydro-scarifying and treating the steel reinforcement is particularly long due to on-site logistics, hydro-sandblasting must be carried out.

Replace any steel reinforcement which has been cut or damaged, or which is highly corroded, with new reinforcement (see section [F.1.2.1](#)).

#### **Protection of steel reinforcement**

After removing all the rust, treat the steel reinforcement by brush-applying two coats of **Mapefer 1K** one-component, anti-corrosion cementitious mortar (see section [F.2.1.1](#)) or **Mapefer** two-component, anti-corrosion cementitious mortar (see section [F.2.1.2](#)).

The specific function of both these products, made from cementitious binders, powdered polymers and corrosion inhibitors, is to prevent the formation of rust.

#### **Restoration operations**

Clean all surfaces to be restored and saturate the substrate with water leaving a dry surface (s.s.d.) by hydro-cleaning (see section [F.1.1.4](#)).

Restore the concrete structure using one of the following products:

- **Stabilcem** expanding cementitious binder for pumped concrete (see section [F.5.1.1](#));
- **Stabilcem SCC** expanding cementitious binder for pumped, self-compacting concrete (see section [F.5.1.2](#)).

Mix the concrete on site or in a concrete plant. It must be mixed with a low water/binder ratio and the materials which make up the cementitious conglomerate, the binder, aggregates in a granulometric curve, water and additives, must all comply with current legislation and be approved beforehand by the Works Director.

When preparing the mortar, add **Mapecure SRA** (see section [F.6.1.2](#)), a special shrinkage-reducing agent, at a dose of 5-8 l/m<sup>3</sup>.

Cast or pump the concrete in 5 cm thick layers into leak-proof formwork. We recommend coating the formwork with stripping compound to prevent it from drawing water off from the concrete.

Reinforce the concrete with electro-welded steel mesh (see section [F.1.3.1](#)). The dimensions of the mesh (diameter of steel wire and size of mesh) must be according to design specifications, and is used to compensate for hygrometric shrinkage and to guarantee sufficient contrast to the expansive action of the mortar. Embed the mesh at around the mid-point of the layer to be restored and connect it to the steel reinforcement.

Since water content has an influence on the properties of the concrete, take special care to prevent it evaporating off too quickly while curing. In hot or windy weather, we recommend using the damp-curing technique or applying an anti-evaporation product to prevent rapid evaporation of the mixing water. The anti-evaporation product must be compatible with the successive skimming or protective layer, and must be removed if necessary.

When the concrete has completely cured, and according to the quality of finish obtained which depends on the type of formwork used, remove all traces of stripping and/or anti-evaporation agent by hydro-sandblasting (see section [F.1.1.3](#)) and, if required, skim the repaired surfaces with one of the following products:

## F.5 STRUCTURAL RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES WITH LAYERS THICKER THAN AN AVERAGE OF 5 CM

### F.5.1.1 Application of expanding cementitious binder for pumped concrete

Supply and application of expanding cementitious binder to make shrinkage-compensating, pumped concrete (such as **Stabilcem** produced by MAPEI S.p.A.) for reconstructing deteriorated concrete structures.

The binder, used as a substitute for traditional cement, must be suitable for making high-quality, non-segregating, fluid concrete with a low water/cement ratio on site or in a concrete works. The concrete must also reach high levels of compressive strength, even after short curing times.

Apply the concrete after adequate preparation of the substrate (not included), by removing all deteriorated concrete to obtain a solid, sufficiently rough substrate with no loose portions and removing all rust from the steel reinforcement. Clean the steel reinforcement down to bare metal (not included) and apply a passivating treatment by brush-applying two coats of one-component, anti-corrosion cementitious mortar (such as **Mapofer 1K** produced by MAPEI S.p.A.) (not included). The performance characteristics of the concrete depend on the type and dimension of the aggregates and the amount of binder used, which must be between 300 and 550 kg/m<sup>3</sup>.

To improve expansion in the open air during the first few days of curing, add a special curing additive to the binder, water and aggregate mix to reduce both plastic and hydraulic shrinkage (such as **Mapecure SRA** produced by MAPEI S.p.A.) at a dose of 5-8 l/m<sup>3</sup>.

After approval by the Works Director, cast or pump the concrete in 5 cm thick layers into leak-proof formwork onto a clean substrate saturated with water. After stripping off the formwork, protect the concrete from rapid evaporation of the mixing water by treating the surface with a solvent-based anti-evaporation product (such as **Mapecure S** produced by MAPEI S.p.A.) (not included).

Included and calculated in the price for work carried out according to specification:

- hydro-cleaning of deteriorated surfaces and saturation of substrate with water immediately before applying the concrete;
- casting the concrete around steel reinforcement.

Typical concrete mix design

Stabilcem:	400 kg/m <sup>3</sup>
Aggregates (max diameter 15 mm):	1,700 kg/m <sup>3</sup>
Mapecure SRA:	5 l/m <sup>3</sup>
Water:	205 kg/m <sup>3</sup>
Water/binder ratio:	0.51
Slump flow:	> 21 cm
Compressive strength after 28 days:	≥ 50 N/mm <sup>2</sup>
- per cubic metre	..... (€/m <sup>3</sup> )



**F.5 STRUCTURAL RESTORATION OF CONCRETE DETERIORATED BY AGGRESSIVE AGENTS SUCH AS CARBONATION, CHLORIDES AND SULPHATES WITH LAYERS THICKER THAN AN AVERAGE OF 5 CM**

**F.5.1.2 Application of expanding cementitious binder for pumped, self-compacting concrete**

Supply and application of expanding cementitious binder to make volumetrically-stable, pumped, self-compacting concrete (such as **Stabilcem SCC** produced by MAPEI S.p.A.) for reconstructing deteriorated concrete structures. The binder, used as a substitute for traditional cement, must be suitable for making high-quality, non-segregating, fluid concrete with a low water/cement ratio on site or in a concrete works. The concrete must also reach high levels of compressive strength, even after short curing times, and must be able to flow into all the areas of the formwork without vibrating, even in the presence of dense steel reinforcement. Apply the concrete after adequate preparation of the substrate (not included), by removing all deteriorated concrete to obtain a solid, sufficiently rough substrate with no loose portions and removing all rust from the steel reinforcement. Clean the steel reinforcement down to bare metal (not included) and apply a passivating treatment by brush-applying two coats of one-component, anti-corrosion cementitious mortar (such as **Mapefer 1K** produced by MAPEI S.p.A.) (not included). The performance characteristics of the concrete depend on the type and dimension of the aggregates and the amount of binder used, which must be between 500 and 600 kg/m<sup>3</sup>.

To improve expansion in the open air during the first few days of curing, add a special curing additive to the binder, water and aggregate mix to reduce both plastic and hydraulic shrinkage (such as **Mapecure SRA** produced by MAPEI S.p.A.) at a dose of 5-8 l/m<sup>3</sup>.

After approval by the Works Director, cast or pump the concrete in 5 cm thick layers into leak-proof formwork onto a clean substrate saturated with water.

After stripping off the formwork, protect the concrete from rapid evaporation of the mixing water by treating the surface with a solvent-based anti-evaporation product (such as **Mapecure S** produced by MAPEI S.p.A.) (not included).

Included and calculated in the price for work carried out according to specification:

- hydro-cleaning of deteriorated surfaces and saturation of substrate with water immediately before applying the concrete;
- coating the concrete around steel reinforcement.

Typ

**Sta**

Agg

Map

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Slump flow:

Con

- pe



550 kg/m<sup>3</sup>  
 1,530 kg/m<sup>3</sup>  
 5 l/m<sup>3</sup>  
 215 kg/m<sup>3</sup>  
 0.39  
 74 cm



## F.6 SHRINKAGE REDUCER

### F.6.1 CURING ADMIX TO REDUCE HYDRAULIC SHRINKAGE AND THE FORMATION OF MICRO-CRACKS

#### F.6.1.1 For use when making mortar

Supply of chloride-free, liquid curing admix used when making shrinkage-compensating mortars from the Mapegrout range (such as **Mapecure SRA** produced by MAPEI S.p.A.). The admix reduces the formation of micro-cracking in the mortar when it expands in the open air during the first few days of curing, and considerably reduces hydraulic shrinkage.

The admix must have the following characteristics:

Consistency:	liquid
Colour:	transparent
Density (g/cm <sup>3</sup> ):	0.91
Consumption:	
– for mortar:	0.25% the weight of pre-blended product
– per 100 kg of mortar	..... (€)



## F.6 SHRINKAGE REDUCER

### F.6.1.2 For use when making concrete

Supply of chloride-free, liquid curing admix used when making traditional or self-compacting concrete (such as **Mapecure SRA** produced by MAPEI S.p.A.). The admix reduces the formation of cracking in the concrete when it expands in the open air during the first few days of curing, and considerably reduces hydraulic shrinkage. The admix must be compatible with the all traditional naphthalene-sulphonate super-plasticising admixes, the latest generation of acrylic admixes and with all the types of cement in UNI EN 197-1 standards.

The admix must have the following characteristics:

Consistency:	liquid
Colour:	transparent
Density (g/cm <sup>3</sup> ):	0.91
Consumption:	
– for concrete:	5-8 l/m <sup>3</sup>
– per m <sup>3</sup> of concrete	..... (€)



**F.7 REPAIRS TO CRACKED CONCRETE BY INJECTION OR CASTING**

**F.7.1 DRY OR SLIGHTLY-DAMP DIMENSIONALLY-STABLE CRACKS**

**F.7.1.1 Application of two-component, super-fluid epoxy resin**

Supply and application of two-component, solvent-free, super-fluid, low-viscosity epoxy resin (such as **Epojet** produced by MAPEI S.p.A.), applied by low-pressure injection or casting to carry out monolithic repairs and structural consolidation of cracked concrete. Apply the resin after adequate preparation of the substrate (not included) by removing all crumbling or detached areas and all traces of cement laitance and paint by sandblasting or brushing. For vertical cracks, drill a series of holes along the crack and carefully clean the area with compressed air to remove all traces of dust. Insert injector tubes into the holes and seal the elements to be repaired with two-component epoxy adhesive (such as **Adesilex PG1** or **Adesilex PG2** produced by MAPEI S.p.A.). Dust the surface with dry sand to improve the adhesion of any products applied later (not included). Wait until the adhesive hardens and inject compressed air to make sure the circuit is perfectly free. Mix the two pre-dosed components together (component A resin and component B catalyst), and inject the product into the lowest tube using a suitable low-pressure pump until it seeps out of the next tube. Seal the first tube and then inject the resin into the next one up, until the crack is completely filled. When the resin has hardened, remove the injector tubes. Repair horizontal cracks by casting the product directly into the cracks.

The product must comply with the minimum requirements of EN 1504-5 and have the following performance characteristics:

Workability time (EN ISO 9514):		40 min. (at +23°C)
Tensile adhesion force (cohesive failure of the substrate) (EN 12618-2):		meets specifications
Adhesion through inclined shear strength (monolithic failure) (EN 12618-3):		meets specifications
Shrinkage (EN 12617-2) (%):		1.9
Vitreous transition temperature (EN 12614):		≥ + 45°C
Injectability into a column of sand (EN 1771):	dry state	damp state
– injectability class (cracks from 0.2 to 0.3 mm):	4 mins 41 secs	4 mins 50 secs
– indirect traction (N/mm <sup>2</sup> ):	14	11
Durability (freeze/thaw and wet/dry cycles) (cohesive failure of the substrate) (EN 12618-2):		meets specifications
Development of tensile strength at 5°C after 72 h (EN 1543) (N/mm <sup>2</sup> ):		> 4.9
Tensile strength (EN ISO 527) (N/mm <sup>2</sup> ):		44
Tensile modulus of elasticity (EN ISO 527) (N/mm <sup>2</sup> ):		3,400
Deflection at maximum load (EN 12618-2):		1.0
Compressive strength (EN 12618-1):		95 (7 days)
Reactive modulus (EN 12618-2):		E
Conductivity (EN 12618-2):		1.1
Included in the following standards:		
– application of the product		..... (€/l)
– preparation of the substrate		



ed out according to specification:



## F.7 REPAIRS TO CRACKED CONCRETE BY INJECTION OR CASTING

### F.7.1.2 Application of two-component epoxy resin with very low viscosity

Supply and application of two-component, solvent-free, hyper-fluid, ultra low-viscosity epoxy resin (such as **Epojet LV** produced by MAPEI S.p.A.), applied by low-pressure injection or casting to carry out monolithic repairs and structural consolidation of micro-cracked concrete. Apply the resin after adequate preparation of the substrate (not included) by removing all crumbling or detached areas and all traces of cement laitance and paint by sandblasting or brushing. For vertical cracks, drill a series of holes along the crack and carefully clean the area with compressed air to remove all traces of dust. Insert injector tubes into the holes and seal the elements to be repaired with two-component epoxy adhesive (such as **Adesilex PG1** or **Adesilex PG2** produced by MAPEI S.p.A.). Dust the surface with dry sand to improve the adhesion of any products applied later (not included). Wait until the adhesive hardens and inject compressed air to make sure the circuit is perfectly free. Mix the two pre-dosed components together (component A resin and component B catalyst), and inject the product into the lowest tube using a suitable low-pressure pump until it seeps out of the next tube. Seal the first tube and then inject the resin into the next one up, until the crack is completely filled. When the resin has hardened, remove the injector tubes. Repair horizontal cracks by casting the product directly into the cracks.

The product must comply with the minimum requirements of EN 1504-5 and have the following performance characteristics:

Workability time (EN ISO 9514):		70 min. (at +23°C)
Tensile adhesion force (cohesive failure of the substrate) (EN 12618-2):		meets specifications
Adhesion through inclined shear strength (monolithic failure) (EN 12618-3):		meets specifications
Shrinkage (EN 12617-2) (%):		2.1
Vitreous transition temperature (EN 12614):		> +40°C
Injectability into a column of sand (EN 1771):	dry state	damp state
– injectability class (0.1 mm cracks):	1 min 10 secs	1 min 39 secs
– indirect traction (N/mm <sup>2</sup> ):	11	10
Durability (freeze/thaw and wet/dry cycles) (cohesive failure of the substrate) (EN 12618-2):		meets specifications
Development of tensile strength at +10°C after 72 h (EN 1543) (N/mm <sup>2</sup> ):		> 3
Tensile strength (EN ISO 527) (N/mm <sup>2</sup> ):		39
Tensile modulus of elasticity (EN ISO 527) (N/mm <sup>2</sup> ):		2,600
Deformation at failure (EN ISO 527) (%):		2.5
Con		70
Con		1.1
Incl		
– ap		
– pe		..... (€/l)



ed out according to specification:





## F.7 REPAIRS TO CRACKED CONCRETE BY INJECTION OR CASTING

### F.7.1.3 Application of two-component fluid adhesive

Supply and application of two-component, solvent-free, fluid, medium-viscosity epoxy adhesive (such as **Eporip** produced by MAPEI S.p.A.), applied by casting to carry out monolithic repairs and structural consolidation of cracked concrete. Apply the resin after adequate preparation of the substrate (not included) by removing all crumbly or detached areas and all traces of cement laitance, stripping oils and paint by sandblasting or brushing. Open cracks less than 0.5 mm wide and carefully clean with compressed air to remove all traces of dust (not included).

After mixing the two pre-dosed components together (component A resin and component B catalyst), cast the product directly into the cracks. Immediately after applying the resin, dust the surface with dry sand to improve the adhesion of any products applied later (not included).

The product must comply with the minimum requirements of EN 1504-4 and have the following performance characteristics:

Workability time (EN ISO 9514):	60' (at +23°C)
Linear shrinkage (EN 12617-1) (%):	0.02 (at +23°C) 0.10 (at +70°C)
Compressive modulus of elasticity (EN 13412) (N/mm <sup>2</sup> ):	3,000
Coefficient of thermal expansion (measured between -25°C and +60°C) (EN 1770):	97 x 10 <sup>-6</sup> K <sup>-1</sup>
Vitreous transition temperature (EN 12614):	> +40°C
Durability (freeze/thaw and hot damp cycles) (EN 13733):	
– compressive shear load > tensile strength of concrete:	meets specifications
Adhesion to concrete (failure of concrete) (EN 12636):	meets specifications
Sensitivity to water (failure of concrete) (EN 12636):	meets specifications
Shear strength (N/mm <sup>2</sup> ):	
– bonded mortar or concrete (fresh on fresh and hardened on hardened) (EN 12615):	> 9
Compressive strength (EN 12190) (N/mm <sup>2</sup> ):	> 70
Reaction to fire (EN 13501-1) (Euroclass):	C-s1, d0
Consumption (of cavities to be filled) (kg/l):	1.35
Included and calculated in the price for work carried out according to specification:	
– application by casting.	
– per litre of cavities to be filled	..... (€/l)



## F.7 REPAIRS TO CRACKED CONCRETE BY INJECTION OR CASTING

### F.7.1.4 Application of expanding cementitious binder for injection slurry

Supply and application of super-fluid, expanding cementitious binder for injection slurry made from powdered cementitious binder and special additives (such as **Stabilcem** produced by MAPEI S.p.A.), used as a substitute for normal cement to make high-quality, no-shrink slurry with no bleeding, applied by low-pressure injection or casting for consolidating and filling cracks in concrete.

Apply the slurry after adequate preparation of the substrate (not included) by removing all crumbly or detached areas to obtain a solid substrate. Remove all traces of dust or other elements which could prevent the product adhering correctly. For vertical cracks, drill a series of holes along the crack, and remove all traces of dust deposited in the internal porosity of the substrate by flushing it repeatedly with plenty of water under pressure. Start from the highest hole so that the dust and other loose particles flow out of the lower holes.

Insert injector tubes into the holes and seal the elements to be repaired with cementitious mortar (from the Mapegrout range produced by MAPEI S.p.A.) (not included). Wait until the mortar hardens and inject compressed air to make sure the circuit is perfectly free. After mixing the product, inject it into the lowest tube using a suitable low-pressure pump until it seeps out of the next tube. Seal the first tube and then inject the slurry into the next one up, until the crack is completely filled. When the slurry has hardened, remove the injector tubes. Repair horizontal cracks by casting the product directly into the cracks.

The product must have the following performance characteristics:

Flow-cone (EN 445):	20-30 s
Compressive strength (N/mm <sup>2</sup> ):	> 80 (after 28 days)
Flexural strength (N/mm <sup>2</sup> ):	> 8 (after 28 days)
Expansion during plastic phase (UNI 8996/89) (%):	≥ 0.3
Consumption (of cavities to be filled) (kg/l):	1.6

Included and calculated in the price for work carried out according to specification:

- cleaning of substrate immediately before applying the slurry;
- application by injecting or casting.

– per litre of cavities to be filled ..... (€/l)



## F.8 STRUCTURAL BONDING OF CONCRETE

### F.8.1 BONDING HARDENED CONCRETE TO HARDENED CONCRETE (E.G. PREFABRICATED UNITS)

#### F.8.1.1 Application of two-component, rapid-setting and hardening, thixotropic epoxy adhesive

Supply and application of two-component, rapid-setting and hardening, trowel-applied, thixotropic epoxy adhesive (such as **Adesilex PG1 Rapid** produced by MAPEI S.p.A.) for structurally bonding hardened concrete elements.

Apply the adhesive after adequate preparation of the substrate (not included) by removing all crumbling or detached areas and all traces of cement laitance, stripping oils and paint by sandblasting or brushing. Carefully clean the area with compressed air to remove all traces of dust deposits. After mixing the two pre-dosed components (component A resin and component B catalyst), spread the product on both the surfaces to be bonded, making sure it penetrates into particularly uneven areas. Press and hold the elements together until the adhesive has completely hardened.

The product must comply with the minimum requirements of EN 1504-4 and have the following performance characteristics:

Density of the mix (kg/l):	1.70
Workability time (at +23°C) (EN ISO 9514):	10'
Linear shrinkage (EN 12617-1) (%):	0 (at +23°C) 0 (at +70°C)
Compressive modulus of elasticity (EN 13412) (N/mm <sup>2</sup> ):	6,000
Coefficient of thermal expansion (measured between -25°C and +60°C) (EN 1770):	42 x 10 <sup>-6</sup> K <sup>-1</sup>
Vitreous transition temperature (EN 12614):	> +40°C
Durability (freeze/thaw and hot damp cycles) (EN 13733):	
– compressive shear load > tensile strength of concrete:	meets specifications
Adhesion to concrete (failure of concrete) (EN 12636):	meets specifications
Sensitivity to water (failure of concrete) (EN 12636):	meets specifications
Shear strength (N/mm <sup>2</sup> ):	
– bonded mortar or concrete (EN 12615):	> 10
Compressive strength (EN 12190) (N/mm <sup>2</sup> ):	> 70
Reaction to fire (EN 13501-1) (Euroclass):	C-s2, d0
Consumption (per mm of thickness) (kg/m <sup>2</sup> ):	1.65-1.75
Included and calculated in the price for work carried out according to specification:	
– application by spreading with a trowel.	
– per square metre per millimetre of thickness	..... (€/m <sup>2</sup> ·mm)



## F.8 STRUCTURAL BONDING OF CONCRETE

### F.8.1.2 Application of two-component, normal-setting, thixotropic epoxy adhesive

Supply and application of two-component, normal-setting, trowel-applied, thixotropic epoxy adhesive (such as **Adesilex PG1** produced by MAPEI S.p.A.) for structurally bonding hardened concrete elements. Apply the adhesive after adequate preparation of the substrate (not included) by removing all crumbling or detached areas and all traces of cement laitance, stripping oils and paint by sandblasting or brushing. Carefully clean the area with compressed air to remove all traces of dust deposits.

After mixing the two pre-dosed components (component A resin and component B catalyst), spread the product on both the surfaces to be bonded, making sure it penetrates into particularly uneven areas. Press and hold the elements together until the adhesive has completely hardened.

The product must comply with the minimum requirements of EN 1504-4 and have the following performance characteristics:

Density of the mix (kg/l):	1.70
Workability time (at 23°C) (EN ISO 9514):	35'
Linear shrinkage (EN 12617-1) (%):	0 (at +23°C) 0.05 (at +70°C)
Compressive modulus of elasticity (EN 13412) (N/mm <sup>2</sup> ):	6,000
Coefficient of thermal expansion (measured between -25°C and +60°C) (EN 1770):	43 x 10 <sup>-6</sup> K <sup>-1</sup>
Vitreous transition temperature (EN 12614):	> +40°C
Durability (freeze/thaw and hot damp cycles) (EN 13733):	
– compressive shear load > tensile strength of concrete:	meets specifications
Adhesion to concrete (failure of concrete) (EN 12636):	meets specifications
Sensitivity to water (failure of concrete) (EN 12636):	meets specifications
Shear strength (N/mm <sup>2</sup> ):	
– bonded mortar or concrete (EN 12615):	> 10
Compressive strength (EN 12190) (N/mm <sup>2</sup> ):	> 70
Reaction to fire (EN 13501-1) (Euroclass):	B-s1, d0
Consumption (per mm of thickness) (kg/m <sup>2</sup> ):	1.65-1.75
Included and calculated in the price for work carried out according to specification:	
– application by spreading with a trowel.	
– per square metre per millimetre of thickness	..... (€/m <sup>2</sup> ·mm)



## F.8 STRUCTURAL BONDING OF CONCRETE

### F.8.1.3 Two-component thixotropic epoxy adhesive with extended workability

Supply and application of two-component, trowel-applied, thixotropic epoxy adhesive with extended workability (such as **Adesilex PG2** produced by MAPEI S.p.A.) for structurally bonding hardened concrete elements.

Apply the adhesive after adequate preparation of the substrate (not included) by removing all crumbling or detached areas and all traces of cement laitance, stripping oils and paint by sandblasting or brushing. Carefully clean the area with compressed air to remove all traces of dust deposits.

After mixing the two pre-dosed components (component A resin and component B catalyst), spread the product on both the surfaces to be bonded, making sure it penetrates into particularly uneven areas. Press and hold the elements together until the adhesive has completely hardened.

The product must comply with the minimum requirements of EN 1504-4 and have the following performance characteristics:

Density of the mix (kg/l):	1.70
Workability time (at +23°C) (EN ISO 9514):	50'
Linear shrinkage (EN 12617-1) (%):	0 (at +23°C) 0.03 (at +70°C)
Compressive modulus of elasticity (EN 13412) (N/mm <sup>2</sup> ):	6,000
Coefficient of thermal expansion (measured between -25°C and +60°C) (EN 1770):	46 x 10 <sup>-6</sup> K <sup>-1</sup>
Vitreous transition temperature (EN 12614):	> +40°C
Durability (freeze/thaw and hot damp cycles) (EN 13733):	
– compressive shear load > tensile strength of concrete:	meets specifications
Adhesion to concrete (failure of concrete) (EN 12636):	meets specifications
Sensitivity to water (failure of concrete) (EN 12636):	meets specifications
Shear strength (N/mm <sup>2</sup> ):	
– bonded mortar or concrete (EN 12615):	> 10
Compressive strength (EN 12190) (N/mm <sup>2</sup> ):	> 70
Reaction to fire (EN 13501-1) (Euroclass):	C-s1, d0
Consumption (per mm of thickness) (kg/m <sup>2</sup> ):	1.65-1.75

Included and calculated in the price for work carried out according to specification:

- application by spreading with a trowel.
- per square metre per millimetre of thickness .....(€/m<sup>2</sup>-mm)



## F.8 STRUCTURAL BONDING OF CONCRETE

### F.8.2 BONDING FRESH CONCRETE TO HARDENED CONCRETE (SECOND POURS)

#### F.8.2.1 Application of two-component fluid adhesive

Supply and application of two-component, solvent-free, fluid, medium-viscosity, epoxy adhesive applied by brush, trowel or spray (such as **Eporip** produced by MAPEI S.p.A.) for second pours of fresh concrete onto hardened concrete. Apply the resin after adequate preparation of the substrate (not included) by removing all crumbling or detached areas and all traces of cement laitance, stripping oils and paint by sandblasting or brushing. After mixing the two pre-dosed components (component A resin and component B catalyst), apply the product on dry or slightly damp concrete, making sure it penetrates into particularly uneven, porous areas to ensure perfect adhesion to the entire surface to be bonded. Cast the second pour of fresh concrete onto the resin within the open time of the resin before it hardens.

The product must comply with the minimum requirements of EN 1504-4 and have the following performance characteristics:

Workability time (EN ISO 9514):	60' (at +23°C)
Open time:	3-4 h (at +23°C)
Linear shrinkage (EN 12617-1) (%):	0.02 (at +23°C) 0.10 (at +70°C)
Compressive modulus of elasticity (EN 13412) (N/mm <sup>2</sup> ):	3,000
Coefficient of thermal expansion (measured between -25°C and +60°C) (EN 1770):	97 x 10 <sup>-6</sup> K <sup>-1</sup>
Vitreous transition temperature (EN 12614):	> 40°C
Durability (freeze/thaw and hot damp cycles) (EN 13733):	
– compressive shear load > tensile strength of concrete:	meets specifications
Adhesion to concrete (failure of concrete) (EN 12636):	meets specifications
Sensitivity to water (failure of concrete) (EN 12636):	meets specifications
Shear strength (N/mm <sup>2</sup> ):	
– bonded mortar or concrete	
(fresh on hardened and hardened on hardened) (EN 12615):	> 9
Compressive strength (EN 12190) (N/mm <sup>2</sup> ):	> 70
Reaction to fire (EN 13501-1) (Euroclass):	C-s1, d0
Consumption (kg/m <sup>2</sup> ):	
– rough substrates:	0.5-0.7
– particularly uneven substrates:	1.0-2.0
Included and calculated in the price for work carried out according to specification:	
– application of product by brush, trowel or spray.	
– per square metre	..... (€/m <sup>2</sup> )



## F.8 STRUCTURAL BONDING OF CONCRETE

### F.8.3 BONDING FLAT STEEL PLATES OR OTHER MATERIAL TO CONCRETE ELEMENTS

#### F.8.3.1 Application of two-component, rapid-setting and hardening, thixotropic epoxy adhesive

Supply and application of two-component, rapid-setting and hardening, trowel-applied, thixotropic epoxy adhesive (such as **Adesilex PG1 Rapid** produced by MAPEI S.p.A.), to bond flat steel plates to concrete (béton plaqué) in structural strengthening work.

Apply the adhesive after adequate preparation of the concrete substrate (not included) by removing all crumbling or detached areas and all traces of cement laitance, stripping oils and paint by sandblasting or brushing. Carefully clean the area with compressed air to remove all traces of dust deposits. Remove all traces of rust, paint and oil from the surface of the steel by sandblasting (not included) to leave a bare metal finish (grade SA 2½). After mixing the two pre-dosed components (component A resin and component B catalyst), spread the product on both the surfaces to be bonded, making sure it penetrates into particularly uneven areas. Press and hold the elements together until the adhesive has completely hardened.

The product must comply with the minimum requirements of EN 1504-4 and have the following performance characteristics:

Density of the mix (kg/l):	1.70
Workability time (at +23°C) (EN ISO 9514):	10'
Linear shrinkage (EN 12617-1) (%):	0 (at +23°C) 0 (at +70°C)
Compressive modulus of elasticity (EN 13412) (N/mm <sup>2</sup> ):	6,000
Coefficient of thermal expansion (measured between -25°C and +60°C) (EN 1770):	42 x 10 <sup>-6</sup> K <sup>-1</sup>
Vitreous transition temperature (EN 12614):	> +40°C
Durability (freeze/thaw and hot damp cycles) (EN 13733):	
– compressive shear load > tensile strength of concrete:	meets specifications
– no failure of steel test sample:	meets specifications
Adhesion of concrete-steel (EN 1542) (N/mm <sup>2</sup> ):	> 3 (failure of concrete)
Adhesion of concrete- <b>Carboplate</b> (EN 1542) (N/mm <sup>2</sup> ):	> 3 (failure of concrete)
Adhesion to concrete (failure of concrete) (EN 12636):	meets specifications
Sensitivity to water (failure of concrete) (EN 12636):	meets specifications
Shear strength (N/mm <sup>2</sup> ):	
– strengthening using bonded plate (EN 12188):	50° > 39 60° > 34 70° > 31
Compressive strength (EN 12190) (N/mm <sup>2</sup> ):	> 70
Adherence (EN 12188) N/mm <sup>2</sup> ):	
– pull out:	> 18
– oblique shear strength:	50° > 80 60° > 80 70° > 98

Rea  
Con

Incl

– ap

– pe





## F.8 STRUCTURAL BONDING OF CONCRETE

### F.8.3.2 Application of two-component, normal-setting, thixotropic epoxy adhesive

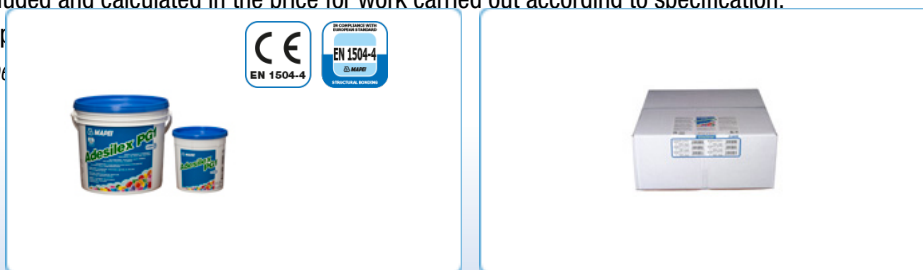
Supply and application of two-component, normal-setting, trowel-applied, thixotropic epoxy adhesive (such as **Adesilex PG1** produced by MAPEI S.p.A.), to bond flat steel plates to concrete (béton plaqué) in structural strengthening work. Apply the adhesive after adequate preparation of the concrete substrate (not included) by removing all crumbling or detached areas and all traces of cement laitance, stripping oils and paint by sandblasting or brushing. Carefully clean the area with compressed air to remove all traces of dust deposits. Remove all traces of rust, paint and oil from the surface of the steel by sandblasting (not included) to leave a bare metal finish (grade SA 2½). After mixing the two pre-dosed components (component A resin and component B catalyst), spread the product on both the surfaces to be bonded, making sure it penetrates into particularly uneven areas. Press and hold the elements together until the adhesive has completely hardened.

The product must comply with the minimum requirements of EN 1504-4 and have the following performance characteristics:

Density of the mix (kg/l):	1.70
Workability time (at +23°C) (EN ISO 9514):	35'
Linear shrinkage (EN 12617-1) (%):	0 (at +23°C) 0.05 (at +70°C)
Compressive modulus of elasticity (EN 13412) (N/mm <sup>2</sup> ):	6,000
Coefficient of thermal expansion (measured between -25°C and +60°C) (EN 1770):	43 x 10 <sup>-6</sup> K <sup>-1</sup>
Vitreous transition temperature (EN 12614):	+40°C
Durability (freeze/thaw and hot damp cycles) (EN 13733):	
– compressive shear load > tensile strength of concrete:	meets specifications
– no failure of steel test sample:	meets specifications
Adhesion of concrete-steel (EN 1542) (N/mm <sup>2</sup> ):	> 3 (failure of concrete)
Adhesion of concrete- <b>Carboplate</b> (EN 1542) (N/mm <sup>2</sup> ):	> 3 (failure of concrete)
Adhesion to concrete (failure of concrete) (EN 12636):	meets specifications
Sensitivity to water (failure of concrete) (EN 12636):	meets specifications
Shear strength (N/mm <sup>2</sup> ):	
– strengthening using bonded plate (EN 12188):	50° > 35 60° > 29 70° > 25
Compressive strength (EN 12190) (N/mm <sup>2</sup> ):	> 70
Adherence (EN 12188) N/mm <sup>2</sup> ):	
– pull out:	> 18
– oblique shear strength:	50° > 73 60° > 69 70° > 80
Reaction to fire (EN 13501-1) (Euroclass):	B-s1, d0
Consumption (per mm of thickness) (kg/m <sup>2</sup> ):	1.65-1.75

Included and calculated in the price for work carried out according to specification:

- ap
- ρ



## F.8 STRUCTURAL BONDING OF CONCRETE

### F.8.3.3 Two-component thixotropic epoxy adhesive with extended workability

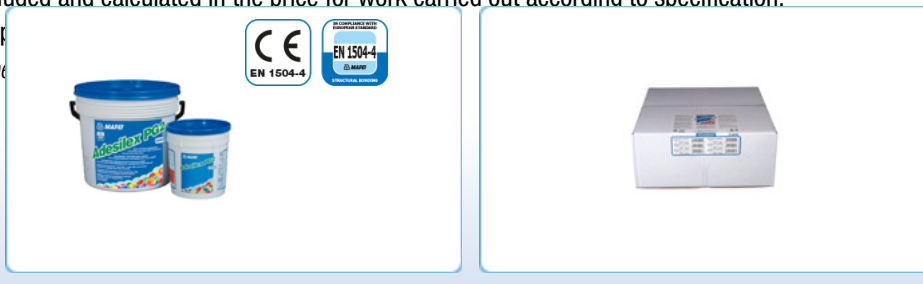
Supply and application of two-component, trowel-applied, thixotropic epoxy adhesive with extended workability (such as **Adesilex PG2** produced by MAPEI S.p.A.), to bond flat steel plates to concrete (béton plaqué) in structural strengthening work. Apply the adhesive after adequate preparation of the concrete substrate (not included) by removing all crumbling or detached areas and all traces of cement laitance, stripping oils and paint by sandblasting or brushing. Carefully clean the area with compressed air to remove all traces of dust deposits. Remove all traces of rust, paint and oil from the surface of the steel by sandblasting (not included) to leave a bare metal finish (grade SA 2½). After mixing the two pre-dosed components (component A resin and component B catalyst), spread the product on both the surfaces to be bonded, making sure it penetrates into particularly uneven areas. Press and hold the elements together until the adhesive has completely hardened.

The product must comply with the minimum requirements of EN 1504-4 and have the following performance characteristics:

Density of the mix (kg/l):	1.70
Workability time (at +23°C) (EN ISO 9514):	50'
Linear shrinkage (EN 12617-1) (%):	0 (at +23°C) 0.03 (at +70°C)
Compressive modulus of elasticity (EN 13412) (N/mm <sup>2</sup> ):	6,000
Coefficient of thermal expansion (measured between -25°C and +60°C) (EN 1770):	46 x 10 <sup>-6</sup> K <sup>-1</sup>
Vitreous transition temperature (EN 12614):	+40°C
Durability (freeze/thaw and hot damp cycles) (EN 13733):	
– compressive shear load > tensile strength of concrete:	meets specifications
– no failure of steel test sample:	meets specifications
Adhesion of concrete-steel (EN 1542) (N/mm <sup>2</sup> ):	> 3 (failure of concrete)
Adhesion of concrete- <b>Carboplate</b> (EN 1542) (N/mm <sup>2</sup> ):	> 3 (failure of concrete)
Adhesion to concrete (failure of concrete) (EN 12636):	meets specifications
Sensitivity to water (failure of concrete) (EN 12636):	meets specifications
Shear strength (N/mm <sup>2</sup> ):	
– strengthening using bonded plate (EN 12188):	50° > 28 60° > 25 70° > 22
Compressive strength (EN 12190) (N/mm <sup>2</sup> ):	> 70
Adherence (EN 12188) N/mm <sup>2</sup> ):	
– pull out:	> 18
– oblique shear strength:	50° > 58 60° > 60 70° > 70
Reaction to fire (EN 13501-1) (Euroclass):	C-s1, d0
Consumption (per mm of thickness) (kg/m <sup>2</sup> ):	1.65-1.75

Included and calculated in the price for work carried out according to specification:

- ap
- ρ



## F.9 SKIMMING THE SURFACE OF CONCRETE AND RENDER

### F.9.1 UNEVEN SURFACES WITH NO DYNAMIC STRESS

#### F.9.1.1 Application of one-component, fine-grained, rapid-setting and hardening cementitious mortar

Supply and application of one-component, fine-grained, rapid-setting and hardening, light grey cementitious mortar made from special cementitious binders, selected fine-grained aggregates, special additives and polymers (such as **Planitop 100** produced by MAPEI S.p.A.), for skimming and finishing off concrete substrates. Apply the mortar after adequate preparation of the substrate (not included) by removing all crumbly or detached areas to obtain a solid substrate. Remove all traces of dust or other elements which could prevent the product adhering correctly. Apply the product with a smooth metal trowel on a clean substrate saturated with water in layers from 1 to 3 mm thick.

The product must comply with the minimum requirements of EN 1504-2 coating (C) according to principles MC and IR for protecting concrete, and must have the following performance characteristics:

Setting time:	1 h - 1 h 30'
Compressive strength (EN 12190) (MPa):	> 15 (after 28 days)
Flexural strength (EN 196/1) (MPa):	> 4.0 (after 28 days)
Adhesion to substrate (EN 1542) (MPa):	> 2 (after 28 days)
Thermal compatibility measured as adhesion according to EN 1542 (MPa):	
– freeze-thaw cycles with de-icing salts (EN 13687/1):	≥ 2
– storm cycles (EN 13687/2):	≥ 2
Impermeability expressed as coefficient of permeability to free water (EN 1062-3) (kg/m <sup>2</sup> ·h <sup>0.5</sup> ):	W < 0.1 - Class III (low permeability to water) according to EN 1062-1
Permeability to water vapour	
– equivalent air thickness S <sub>D</sub> (EN ISO 7783-1) (m):	S <sub>D</sub> < 0.5 Class I (permeable to water vapour)
Reaction to fire (EN 13501-1) (Euroclass):	A1
Consumption (per mm of thickness) (kg/m <sup>2</sup> ):	1.3
Included and calculated in the price for work carried out according to specification:	
– hydro-cleaning of adhesion surfaces and saturation of substrate with water immediately before applying the mortar;	
– application of the mortar with a smooth, metal trowel;	
– finishing off the surface with a smooth, metal trowel or sponge float.	
Average thickness 2 mm	
– per square metre	..... (€/m <sup>2</sup> )



**F.9.1.2 Application of one-component, normal-setting cementitious mortar**

Supply and application of one-component, normal-setting, cementitious mortar made from high-strength cement, selected fine-grained aggregates, special additives and powdered synthetic polymers (such as **Monofinish** produced by MAPEI S.p.A.), for skimming and finishing off concrete substrates. Apply the mortar after adequate preparation of the substrate (not included) by removing all crumbling or detached areas to obtain a solid substrate. Remove all traces of dust or other elements which could prevent the product adhering correctly. Apply the product with a smooth metal trowel on a clean substrate saturated with water in layers from 1 to 3 mm thick.

The product must comply with the minimum requirements of EN 1504-3 for non-structural R2-class mortars and the requirements of EN 1504-2 coating (C) according to principles MC and IR for protecting concrete, and must have the following performance characteristics:

Compressive strength (EN 12190) (MPa):	> 25 (after 28 days)
Flexural strength (EN 196/1) (MPa):	> 6.5 (after 28 days)
Compressive modulus of elasticity (EN 13412) (GPa):	12 (after 28 days)
Adhesion to substrate (EN 1542) (MPa):	≥ 2 (after 28 days)
Capillary absorption (EN 13057) (kg/m <sup>2</sup> ·h <sup>0.5</sup> ):	< 0.30
Thermal compatibility measured as adhesion according to EN 1542 (MPa):	
– freeze-thaw cycles with de-icing salts (EN 13687/1):	≥ 2 (after 50 cycles)
– storm cycles (EN 13687/2):	≥ 2 (after 30 cycles)
– dry thermal cycles (EN 13687/4):	≥ 2 (after 30 cycles)

Impermeability expressed as coefficient of permeability to free water (EN 1062-3) (kg/m<sup>2</sup>·h<sup>0.5</sup>):

W < 0.05 - Class III (low permeability to water) according to EN 1062-1

Permeability to water vapour - equivalent air thickness S<sub>D</sub> (EN ISO 7783-1) (m):

S<sub>D</sub> < 0.5  
Class I (permeable to water vapour)

Resistance to accelerated carbonation (EN 13295):

depth of carbonation ≤ the reference concrete (MC 0.45 type water/cement ratio = 0.45) according to UNI 1766

Reaction to fire (EN 13501-1) (Euroclass):

E

Consumption (per mm of thickness) (kg/m<sup>2</sup>):

1.4

- Included and calculated in the price for work carried out according to specification:
- hydro-cleaning of adhesion surfaces and saturation of substrate with water immediately before applying the mortar;
  - application of the mortar with a smooth, metal trowel;
  - finishing off the surface with a smooth, metal trowel or sponge float.

Average thickness 2 mm

– per square metre ..... (€/m<sup>2</sup>)



## F.9 SKIMMING THE SURFACE OF CONCRETE AND RENDER

### F.9.1.3 Application of two-component cementitious mortar with good resistance to abrasion and high resistance to sulphates

Supply and application of two-component cementitious mortar with good resistance to abrasion and high resistance to sulphates, made from high-strength cement, selected fine-grained aggregates, special additives and synthetic polymers in water dispersion (such as **Mapefinish** produced by MAPEI S.p.A.), for skimming and finishing off concrete substrates. Apply the mortar after adequate preparation of the substrate (not included) by removing all crumbling or detached areas to obtain a solid substrate. Remove all traces of dust or other elements which could prevent the product adhering correctly.

Apply the product with a smooth metal trowel on a clean substrate saturated with water in layers from 1 to 3 mm thick.

The product must comply with the minimum requirements of EN 1504-3 for non-structural R2-class mortars and the requirements of EN 1504-2 coating (C) according to principles MC and IR for protecting concrete, and must have the following performance characteristics:

Compressive strength (EN 12190) (MPa): > 35 (after 28 days)

Flexural strength (EN 196/1) (MPa): > 10 (after 28 days)

Compressive modulus of elasticity (EN 13412) (GPa): 14 (after 28 days)

Adhesion to substrate (EN 1542) (MPa):  $\geq 2$  (after 28 days)

Thermal compatibility measured as adhesion according to EN 1542 (MPa):

– freeze-thaw cycles with de-icing salts (EN 13687/1):  $\geq 2$  (after 50 cycles)

– storm cycles (EN 13687/2):  $\geq 2$  (after 30 cycles)

– dry thermal cycles (EN 13687/4):  $\geq 2$  (after 30 cycles)

Capillary absorption (EN 13057) ( $\text{kg/m}^2 \cdot \text{h}^{0.5}$ ): < 0.30

Impermeability expressed as coefficient of permeability to free water (EN 1062-3) ( $\text{kg/m}^2 \cdot \text{h}^{0.5}$ ):  $W < 0.05$  Class III (low permeability to water) according to EN 1062-1

Permeability to water vapour - equivalent air thickness  $S_D$  (EN ISO 7783-1) (m):  $S_D < 0.5$

Class I (permeable to water vapour)

Resistance to accelerated carbonation (EN 13295): depth of carbonation  $\leq$  the reference concrete (MC 0.45 type water/cement ratio = 0.45) according to UNI 1766

Reaction to fire (EN 13501-1) (Euroclass): E

Consumption (per mm of thickness) ( $\text{kg/m}^2$ ): 2

Included and calculated in the price for work carried out according to specification:

- hydro-cleaning of adhesion surfaces and saturation of substrate with water immediately before applying the mortar;
- application of the mortar with a smooth, metal trowel;
- finishing off the surface with a smooth, metal trowel or sponge float.

Average thickness 2 mm

– per square meter ..... (€/m<sup>2</sup>)



## F.9 SKIMMING THE SURFACE OF CONCRETE AND RENDER

### F.9.1.4 Application of two-component, cementitious mortar with high resistance to abrasion and sulphates

Supply and application of two-component cementitious mortar with high resistance to abrasion and sulphates, made from high-strength cement, selected fine-grained aggregates, special additives and synthetic polymers in water dispersion (such as **Mapefinish HD** produced by MAPEI S.p.A.), for skimming and finishing off concrete substrates. Apply the mortar after adequate preparation of the substrate (not included) by removing all crumbling or detached areas to obtain a solid substrate. Remove all traces of dust or other elements which could prevent the product adhering correctly. Apply the product with a smooth metal trowel or by spray with a rendering machine on a clean substrate saturated with water in layers up to 2 mm thick.

The product must comply with the minimum requirements of EN 1504-2 coating (C) according to principles MC and IR for protecting concrete, and must have the following performance characteristics:

Compressive strength (EN 12190) (MPa):	> 50 (after 28 days)
Flexural strength (EN 196/1) (MPa):	> 8 (after 28 days)
Adhesion to substrate (EN 1542) (MPa):	≥ 2 (after 28 days)
Impermeability expressed as coefficient of permeability to free water (EN 1062-3) (kg/m <sup>2</sup> ·h <sup>0.5</sup> ):	W < 0.05 Class III (low permeability to water) according to EN 1062-1
Permeability to water vapour - equivalent air thickness S <sub>D</sub> (EN ISO 7783-1) (m):	S <sub>D</sub> < 0.5 Class I (permeable to water vapour)
Abrasion resistance	
– loss in weight (ISO 5470) (mg):	< 1000 (after 1000 cycles)
Böhme abrasion resistance (EN 13892-3):	Class A6
Reaction to fire (EN 13501-1) (Euroclass):	E
Consumption (per mm of thickness) (kg/m <sup>2</sup> ):	2.2
Included and calculated in the price for work carried out according to specification:	
– hydro-cleaning of adhesion surfaces and saturation of substrate with water immediately before applying the mortar;	
– application of the mortar with a smooth, metal trowel or by spray;	
– finishing off the surface with a smooth, metal trowel or sponge float.	
Average thickness 2 mm	
– per square metre	..... (€/m <sup>2</sup> )



**F.9.1.5 Application of water-repellent, cementitious skimming mortar with a fine-textured natural finish for concrete and plastic, glass and porcelain floor and wall coverings**

Supply and application of one-component, water-repellent cementitious skimming mortar with a fine-texture, high-adhesion, grey or white cementitious mortar, made from special high-strength binders, selected aggregates, special admixtures and powdered synthetic polymers (such as **Planitop 200** produced by MAPEI S.p.A.), for skimming and forming a natural finish on internal and external concrete, cementitious and lime-mortar render, old quartz paint and scratch-effect plastic coating, glass mosaic or porcelain coverings. Apply the mortar after adequate preparation of the substrate (not included) by removing all crumbling or detached areas to obtain a solid substrate. Remove all traces of dust or other elements which could prevent the product adhering correctly. If the substrate is painted, the paint must be even and must be well adhered to the substrate. Apply the product on clean, damp substrates if applied on absorbent surfaces (concrete and render), and on dry substrates if applied on old paintwork, glass mosaic or porcelain coverings, with a smooth, metal trowel in layers max. 3 mm thick, then finish off the surface with the same trowel or a sponge float.

Thicker layers, up to a maximum of 6 mm, must be applied in two layers. Place alkaline-resistant glass fibre mesh (compliant with ETAG 004 guidelines), with a mesh size of 4 x 4.5 mm and a weight of 150 g/m<sup>2</sup> (such as **Mapenet 150** produced by MAPEI S.p.A.), between the 1° and 2° layers. Overlap the edges of each strip of glass fibre mesh by at least 5 cm. The mesh must also be used if the surface to be skimmed is made up of substrates in different materials.

The product must comply with the minimum requirements of EN 1504-2 coating (C) according to principles MC and IR for protecting concrete, classified according to EN 998-1 standards as GP-type for skimming mortar, category CS IV, and must have the following performance characteristics:

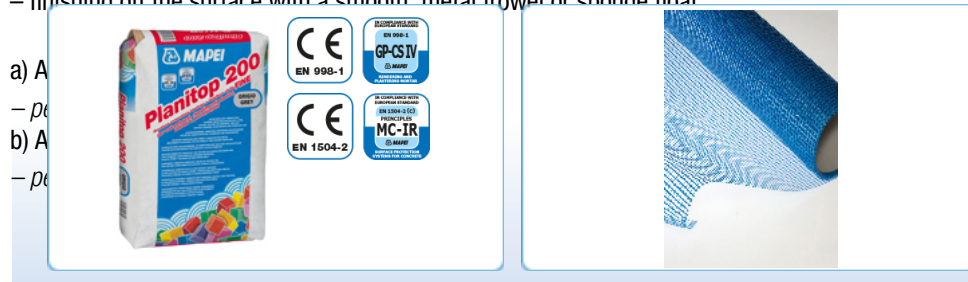
Compressive strength (EN 12190) (MPa):	> 20 (after 28 days)
Flexural strength (EN 196/1) (MPa):	> 5.0 (after 28 days)
Adhesion to substrate (concrete) (MPa):	≥ 2 (after 28 days)
– plastic covering:	≥ 1.5
– glass mosaic:	≥ 1.0
– porcelain tile:	≥ 0.8
Thermal compatibility measured as adhesion according to EN 1542 (MPa):	
– freeze-thaw cycles with de-icing salts (EN 13687/1):	≥ 1
– storm cycles (EN 13687/2):	≥ 1
Impermeability expressed as coefficient of permeability to free water (EN 1062-3) (kg/m <sup>2</sup> ·h <sup>0.5</sup> ):	W < 0.1 - Class III (low permeability to water) according to EN 1062-1

Permeability to water vapour	
– equivalent air thickness S <sub>D</sub> (EN ISO 7783-1) (m):	S <sub>D</sub> < 0.5 Class I (permeable to water vapour)

Reaction to fire (EN 13501-1) (Euroclass):	E
Consumption (per mm of thickness) (kg/m <sup>2</sup> ):	approximately 1.3

Included and calculated in the price for work carried out according to specification:

- hydro-cleaning of adhesion surfaces before applying the skimming;
- application of the skimming with a smooth, metal trowel;
- finishing off the surface with a smooth metal trowel or sponge float





**F.9.1.6 Application of one-component, coarse-grained, cementitious mortar for skimming and forming a natural finish on internal and external concrete, cementitious and lime-mortar render, old quartz paint and scratch-effect plastic coating**

Supply and application of one-component, water-repellent cementitious skimming mortar with a fine-texture, high-adhesion, grey or white cementitious mortar, made from special high-strength binders, selected aggregates, special admixtures and powdered synthetic polymers (such as **Planitop 207** produced by MAPEI S.p.A.), for skimming and finishing off internal and external concrete, cementitious and lime-mortar render, old quartz paint and scratch-effect plastic coating, glass mosaic or porcelain coverings. Apply the mortar after adequate preparation of the substrate (not included) by removing all crumbling or detached areas to obtain a solid substrate. Remove all traces of dust or other elements which could prevent the product adhering correctly. If the substrate is painted, the paint must be even and must be well adhered to the substrate. Apply the product on clean, damp substrates if applied on absorbent surfaces (concrete and render), and on dry substrates if applied on old paintwork, glass mosaic or porcelain coverings, with a smooth, metal trowel in layers from 1 to 3 mm thick, then finish off the surface with the same trowel or a sponge float.

Thicker layers, up to a maximum of 6 mm, must be applied in two layers. Place alkaline-resistant glass fibre mesh (compliant with ETAG 004 guidelines), with a mesh size of 4 x 4.5 mm and a weight of 150 g/m<sup>2</sup> (such as **Mapenet 150** produced by MAPEI S.p.A.), between the first and second layers. Overlap the edges of each strip of glass fibre mesh by at least 5 cm. The mesh must also be used if the surface to be skimmed is made up of substrates in different materials.

The product must comply with the minimum requirements of EN 1504-2 coating (C) according to principles MC and IR for protecting concrete, classified according to EN 998-1 standards as GP-type for skimming mortar, category CS IV, and must have the following performance characteristics:

Compressive strength (EN 12190) (MPa):	> 25 (after 28 days)
Adhesion to substrate (concrete) (MPa):	> 2 (after 28 days)
– plastic covering:	≥ 1.5
– glass mosaic:	≥ 1.0
– porcelain tile:	≥ 0.8

Impermeability expressed as coefficient of permeability to free water (EN 1062-3) (kg/m <sup>2</sup> ·h <sup>0.5</sup> ):	W < 0.1 - Class III (low permeability to water) according to EN 1062-1
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Permeability to water vapour	
– equivalent air thickness S <sub>D</sub> (EN ISO 7783-1) (m):	S <sub>D</sub> < 0.5 Class I (permeable to water vapour)

Reaction to fire (EN 13501-1) (Euroclass):	E
Consumption (per mm of thickness) (kg/m <sup>2</sup> ):	approximately 1.5

Included and calculated in the price for work carried out according to specification:

- hydro-cleaning of adhesion surfaces before applying the skimming;
- application of the skimming with a smooth, metal trowel;
- finishing off the surface with a smooth, metal trowel or sponge float.

a) Average thickness 2 mm

– pe

b) A

– pe



## F.9 SKIMMING THE SURFACE OF CONCRETE AND RENDER

### F.9.1.7 Application of water-repellent cementitious skimming mortar with a fine-textured, natural finish for concrete and plastic covering materials

Supply and application of one-component, water-repellent, fine-grained, high-adhesion, grey or white cementitious skimming mortar made from special high-strength binders, selected aggregates, special additives and powdered synthetic polymers (such as **Planitop 210** produced by MAPEI S.p.A.) for a fine-textured, natural-finish skimming layer on internal and external concrete substrates, cementitious and lime-mortar render, old quartz paint and scratch-effect plastics. Apply the mortar after adequate preparation of the substrate (not included) by removing all crumbly or detached areas to obtain a solid substrate. Remove all traces of dust or other elements which could prevent the product adhering correctly. If the substrate is painted, the paint must be even and must be well adhered to the substrate.

Apply the product on a clean, damp substrate if applied on absorbent surfaces (concrete and render), and on a dry substrate if applied on old paintwork or plastic covering materials with a smooth, metal trowel in layers up to 3 mm thick, then finish off the surface with the same trowel or a sponge float. Thicker layers, up to a maximum of 6 mm, must be applied in two steps. Place alkaline-resistant glass fibre mesh (compliant with ETAG 004 guidelines), with a mesh size of 4.5 x 4 mm and a weight of 150 g/m<sup>2</sup> (such as **Mapenet 150** produced by Mapei S.p.A.), between the 1° and 2° layers. Overlap the edges of each strip of glass fibre mesh by at least 5 cm. The mesh must also be used when the surface to be skimmed is made up of different types of material.

The product must comply with the minimum requirements of EN 1504-2 coating (C) according to principles MC and IR for protecting concrete, classified according to EN 998-1 standards as GP-type skimming mortar for render, category CS IV, and must have the following performance characteristics:

Compressive strength (EN 12190) (MPa):	> 16 (after 28 days)
Flexural strength (EN 196/1) (MPa):	> 4 (after 28 days)
Adhesion to substrate (concrete) (EN 1542) (MPa):	≥ 1 (after 28 days)
Adhesion to substrate (Mpa): plastic covering materials:	> 1
Thermal compatibility measured as adhesion according to EN 1542 (MPa):	≥ 1
freeze-thaw cycles with de-icing salts (EN 13687/1):	≥ 1
storm cycles (EN 13687/2):	≥ 1
Impermeability expressed as coefficient of permeability to free water (EN 1062-3) (kg/m <sup>2</sup> ·h <sup>0.5</sup> ):	W < 0.1 - Class III (low permeability to water) according to EN 1062-1
Permeability to water vapour equivalent air thickness S <sub>D</sub> (EN ISO 7783-1) (m):	S <sub>D</sub> < 0.5 Class I (permeable to water vapour)
Abrasion after 28 days (air) loss in weight (ISO 5470) (g):	< 50 (after 100 revs)
Reaction to fire (EN 13501-1) (Euroclass):	E
Consumption (per mm thickness) (kg/m <sup>2</sup> ):	approximately 1.3
Total price for application according to specification:	

– hydro-cleaning of adhesion surfaces before applying the skimming mortar:

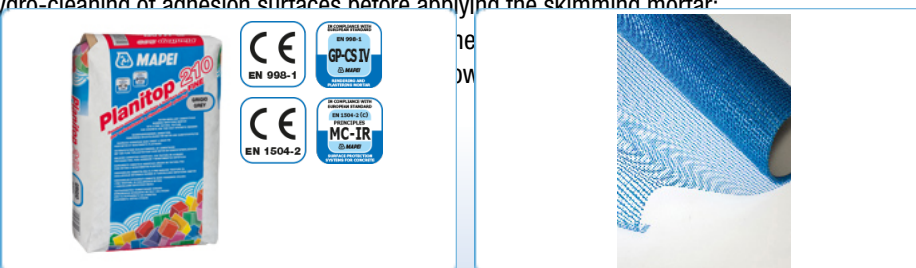
– ap  
– fir

a) A

– pe

b) A

– pe



## F.9 SKIMMING THE SURFACE OF CONCRETE AND RENDER

### F.9.1.8 Application of water-repellent cementitious skimming mortar with a coarse-textured, natural finish for concrete and plastic covering materials

Supply and application of one-component, water-repellent, coarse-grained, high-adhesion, grey or white cementitious skimming mortar made from special high-strength binders, selected aggregates, special additives and powdered synthetic polymers (such as **Planitop 217** produced by MAPEI S.p.A.) for a coarse-textured, natural-finish skimming layer on internal and external concrete substrates, cementitious and lime-mortar render, old quartz paint and scratch-effect plastics. Apply the mortar after adequate preparation of the substrate (not included) by removing all crumbly or detached areas to obtain a solid substrate. Remove all traces of dust or other elements which could prevent the product adhering correctly. If the substrate is painted, the paint must be even and must be well adhered to the substrate.

Apply the product on a clean, damp substrate if applied on absorbent surfaces (concrete and render), and on a dry substrate if applied on old paintwork or plastic coverings with a smooth, metal trowel in layers up to 3 mm thick, then finish off the surface with the same trowel or a sponge float.

Thicker layers, up to a maximum of 6 mm, must be applied in two steps. Place alkaline-resistant glass fibre mesh (compliant with ETAG 004 guidelines), with a mesh size of 4.5 x 4 mm and a weight of 150 g/m<sup>2</sup> (such as **Mapenet 150** produced by Mapei S.p.A.), between the 1° and 2° layers. Overlap the edges of each strip of glass fibre mesh by at least 5 cm. The mesh must also be used when the surface to be skimmed is made up of different types of material.

The product must comply with the minimum requirements of EN 1504-2 coating (C) according to principles MC and IR for protecting concrete, classified according to EN 998-1 standards as GP-type skimming mortar for render, category CS IV, and must have the following performance characteristics:

Compressive strength (EN 12190) (MPa):	> 16 (after 28 days)
Flexural strength (EN 196/1) (MPa):	> 4 (after 28 days)
Adhesion to substrate (concrete) (EN 1542) (MPa):	≥ 1 (after 28 days)
Adhesion to substrate (Mpa): plastic covering materials:	> 1
Thermal compatibility measured as adhesion according to EN 1542 (MPa):	
freeze-thaw cycles with de-icing salts (EN 13687/1):	≥ 1
storm cycles (EN 13687/2):	≥ 1
Impermeability expressed as coefficient of permeability to free water (EN 1062-3) (kg/m <sup>2</sup> ·h <sup>0.5</sup> ):	W < 0.1 - Class III (low permeability to water) according to EN 1062-1

Permeability to water vapour equivalent air thickness S <sub>D</sub> (EN ISO 7783-1) (m):	S <sub>D</sub> < 0.5 Class I (permeable to water vapour)
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Abrasion after 28 days (air) loss in weight (ISO 5470) (g):	< 80 (after 100 revs)
Reaction to fire (EN 13501-1) (Euroclass):	E
Consumption (per mm thickness) (kg/m <sup>2</sup> ):	approximately 1.3

Total price for application according to specification:

– hydro-cleaning of adhesion surfaces before applying the skimming mortar:

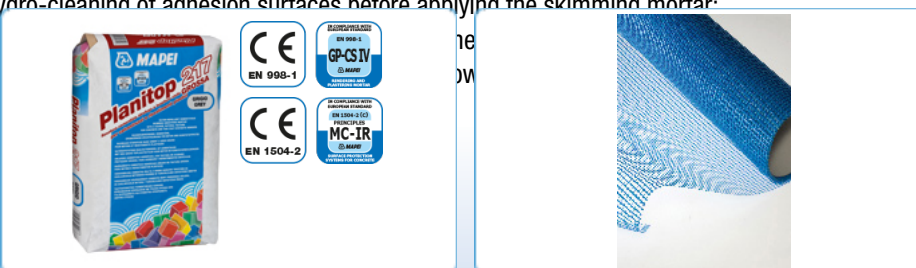
– ap  
– fir

a) A

– pe

b) A

– pe



## F.9 SKIMMING THE SURFACE OF CONCRETE AND RENDER

### F.9.1.9 Application of lime-cement skimming mortar with a fine-textured natural finish for render

Supply and application of fine-grained, natural-finish, grey or white, lime-cement based skimming mortar for internal and external traditional or pre-blended, “fresh” or “cured” rough render made from aerated and hydraulic binders, selected limestone and quartz sand and special powdered additives (such as **Planitop 510** produced by MAPEI S.p.A.) before decorating the surface with a thin layer of synthetic or mineral paint or coating.

Apply the mortar after adequate preparation of the substrate (not included) by removing all crumbly or detached areas to obtain a solid substrate. Remove all traces of dust or other elements which could prevent the product adhering correctly.

If the skimming mortar is applied on “cured” render, dampen the substrate beforehand.

Apply the product on a clean substrate with a smooth, metal trowel in layers up to 3 mm thick, then finish off the surface with the same trowel or a sponge float.

The product must be classified according to EN 998-1 standards as GP-type natural-finish skimming mortar, category CS II, and must have the following performance characteristics:

Compressive strength after 28 days (EN 1015-11) (N/mm <sup>2</sup> ):	Category CS II (from 1.5 to 5.0) ≥ 0.5 (Failure mode FP = B)
Adhesion to substrate (render) (1015-12) (N/mm <sup>2</sup> ):	
Capillary action water absorption (EN 1015-18) [kg/(m <sup>2</sup> ·min <sup>0.5</sup> )]:	Category W 0
Coefficient of permeability to water vapour (EN 1015-19) (m):	≤ 16
Thermal conductivity (EN 1745) (I <sub>10, dry</sub> ) (W/m · K):	0.41 (P = 50%)
Reaction to fire (EN 13501-1) (Euroclass):	A1
Consumption (per mm thickness) (kg/m <sup>2</sup> ):	approximately 1.3
Total price for application according to specification:	
– hydro-cleaning of adhesion surfaces to obtain a damp substrate before applying the skimming mortar;	
– application of the skimming mortar with a flat, metal trowel;	
– finishing off the surface with a smooth, metal trowel or sponge float.	

a) Average thickness 2 mm

– per square metre

..... (€/m<sup>2</sup>)



## F.9 SKIMMING THE SURFACE OF CONCRETE AND RENDER

### F.9.1.10 Application of lime-cement skimming mortar with a coarse-textured natural finish for render

Supply and application of coarse-grained, natural-finish, grey or white, lime-cement based skimming mortar for internal and external traditional or pre-blended, “fresh” or “cured” rough render made from aerated and hydraulic binders, selected limestone and quartz sand and special powdered additives (such as **Planitop 517** produced by MAPEI S.p.A.) before decorating the surface with a thin layer of synthetic or mineral paint or coating.

Apply the mortar after adequate preparation of the substrate (not included) by removing all crumbly or detached areas to obtain a solid substrate. Remove all traces of dust or other elements which could prevent the product adhering correctly.

If the skimming mortar is applied on “cured” render, dampen the substrate beforehand.

Apply the product on a clean substrate with a smooth, metal trowel in layers up to 3 mm thick, then finish off the surface with the same trowel or a sponge float.

The product must be classified according to EN 998-1 standards as GP-type natural-finish skimming mortar, category CS III, and must have the following performance characteristics:

Compressive strength after 28 days (EN 1015-11) (N/mm <sup>2</sup> ):	Category CS III (from 3.5 to 7.5) ≥ 0.5 (Failure mode FP = B)
Adhesion to substrate (render) (1015-12) (N/mm <sup>2</sup> ):	
Capillary action water absorption (EN 1015-18) [kg/(m <sup>2</sup> ·min <sup>0.5</sup> )]:	Category W 1
Coefficient of permeability to water vapour (EN 1015-19) (m):	≤ 16
Thermal conductivity (EN 1745) ( $I_{10, dry}$ ) (W/m · K):	0.57 (P = 50%)
Reaction to fire (EN 13501-1) (Euroclass):	A1
Consumption (per mm thickness) (kg/m <sup>2</sup> ):	approximately 1.3

Total price for application according to specification:

- hydro-cleaning of adhesion surfaces to obtain a damp substrate before applying the skimming mortar;
- application of the skimming mortar with a flat, metal trowel;
- finishing off the surface with a smooth, metal trowel or sponge float.

a) Average thickness 2 mm

– per square metre ..... (€/m<sup>2</sup>)



## F.9 SKIMMING THE SURFACE OF CONCRETE AND RENDER

### F.9.1.11 Application of lime-cement skimming mortar with a fine-textured natural finish for render and concrete

Supply and application of grey or white lime-cement-based skimming mortar with a fine-textured natural finish for “fresh” or “cured” internal and external traditional rough-finish render or pre-blended render, made from hydraulic and aerated binders, selected quartz aggregates and special powdered admixtures (such as **Planitop 530** produced by MAPEI S.p.A.), before decorating with thin coats of mineral or synthetic paint or coatings. Apply the mortar after adequate preparation of the substrate (not included) by removing all crumbling or detached areas to obtain a solid substrate. Remove all traces of dust or other elements which could prevent the product adhering correctly. If applied on “cured” render, dampen the substrate beforehand. Apply the product on the surface of clean substrates with a smooth, metal trowel in layers max. 3 mm thick, then finish off the surface with the same trowel or a sponge float.

The product must comply with the minimum requirements of EN 1504-2 coating (C) according to principles MC and IR for protecting concrete, classified according to EN 998-1 standards as GP-type skimming mortar for render, category CS IV, and have the following performance characteristics:

Compressive strength (EN 12190) (MPa):	> 6 (at 28 days)
Adhesion to substrate (EN 1542) (MPa):	> 1 (at 28 days)
Impermeability expressed as coefficient of permeability to free water (EN 1062-3) ( $\text{kg/m}^2 \cdot \text{h}^{0.5}$ ):	$W < 0.1$ - Class III (low permeability to water) according to EN 1062-1

Permeability to water vapour

– equivalent air thickness $S_D$ (EN ISO 7783-1) (m):	$S_D < 0.5$ Class I (permeable to water vapour)
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Reaction to fire (EN 13501-1) (Euroclass):

A1

Consumption (per mm of thickness) ( $\text{kg/m}^2$ ):

approximately 1.25

Included and calculated in the price for work carried out according to specification:

- hydro-cleaning of adhesion surfaces to obtain a damp substrate before applying the mortar;
- application of the mortar with a smooth, metal trowel;
- finishing off the surface with a smooth, metal trowel or sponge float.

Average thickness 2 mm

– per square metre

..... (€/m<sup>2</sup>)





## F.9 SKIMMING THE SURFACE OF CONCRETE AND RENDER

### F.9.1.12 Application of lime-cement skimming mortar with a fine-textured natural finish for render and concrete

Supply and application of natural-finish, grey or white, cementitious skimming mortar for “cured” internal and external concrete and render, made from cementitious binders, selected aggregates in a granulometric curve, special powdered additives and powdered synthetic polymers (such as **Planitop 540** produced by MAPEI S.p.A.), before decorating with thin coats of mineral or synthetic paint or coatings.

Apply the mortar after adequate preparation of the substrate (not included) by removing all crumbling or detached areas to obtain a solid substrate. Remove all traces of dust or other elements which could prevent the product adhering correctly.

Apply the product on the surface of clean, damp substrates with a smooth, metal trowel in layers max. 3 mm thick, then finish off the surface with the same trowel or a sponge float.

The product must comply with the minimum requirements of EN 1504-2 coating (C) according to principles MC and IR for protecting concrete, classified according to EN 998-1 standards as GP-type for skimming mortar, category CS IV, and must have the following performance characteristics:

Compressive strength (EN 12190) (MPa):	15 (after 28 days)
Adhesion to substrate (EN 1542) (MPa):	> 1 (after 28 days)
Impermeability expressed as coefficient of permeability to free water (EN 1062-3) (kg/m <sup>2</sup> ·h <sup>0.5</sup> ):	W < 0.1 - Class III (low permeability to water) according to EN 1062-1

Permeability to water vapour

– equivalent air thickness S <sub>D</sub> (EN ISO 7783-1) (m):	S <sub>D</sub> = 0.1 Class I (permeable to water vapour)
--	---

Reaction to fire (EN 13501-1) (Euroclass):

E

Consumption (per mm of thickness) (kg/m<sup>2</sup>):

approximately 1.2

Included and calculated in the price for work carried out according to specification:

- hydro-cleaning of adhesion surfaces to obtain a damp substrate before applying the mortar;
- application of the mortar with a smooth, metal trowel;
- finishing off the surface with a smooth, metal trowel or sponge float.

Average thickness 2 mm

– per square metre

..... (€/m<sup>2</sup>)





## F.9 SKIMMING THE SURFACE OF CONCRETE AND RENDER

### F.9.1.13 Application of lime-cement skimming mortar with an ultra fine-textured finish for render

Supply and application of fine-grained, white, lime-cement skimming mortar for “fresh” or “cured” external traditional rough-finish render or pre-blended render, made from hydraulic and aerated bituminous limestone sand, special admixtures and powdered synthetic polymers (such as **Planitop 560** prod S.p.A.), before decorating with thin coats of mineral or synthetic paint or coatings.

Apply the mortar after adequate preparation of the substrate (not included) by removing all crumbly areas to obtain a solid substrate. Remove all traces of dust or other elements which could prevent adhering correctly. If applied on “cured” render, dampen the substrate beforehand. Apply the product on clean substrates with a smooth, metal trowel in layers from 0 to 2 mm thick, then finish off the surface with the same trowel.

The product must be classified according to EN 998-1 standards as GP-type for skimming mortar, and must have the following performance characteristics:

Compressive strength after 28 days (EN 1015-11) (N/mm <sup>2</sup> ):	Category CS IV ( $\geq 6$ )
Adhesion to substrate (render) (EN 1015-12) (N/mm <sup>2</sup> ):	$\geq 0.4$ (Failure mode FP = I)
Capillary action water absorption (EN 1015-18) (kg/m <sup>2</sup> ·min <sup>0.5</sup> ):	Category W 0
Coefficient of permeability to water vapour (EN 1015-19) ( $\mu$ ):	$\leq 20$
Thermal conductivity (EN 1745) ( $\lambda_{10,dry}$ ) (W/m·K):	0.38 (P = 50%)
Reaction to fire (EN 13501-1) (Euroclass):	A1
Consumption (per mm of thickness) (kg/m <sup>2</sup> ):	approximately 1.1

Included and calculated in the price for work carried out according to specification:

- hydro-cleaning of adhesion surfaces to obtain a damp substrate before applying the mortar;
- application and finishing off the surface of the mortar with a smooth, metal trowel;

Average thickness 2 mm

– per square metre

..... (€/m<sup>2</sup>)



## F.9 SKIMMING THE SURFACE OF CONCRETE AND RENDER

### F.9.1.14 Lime-gypsum skimming mortar for internal render

Supply and application of fine-grained, white, lime and gypsum skimming mortar for “cured” or “dry” internal and external traditional rough-finish render or pre-blended gypsum, anhydrite or lime-cement render, made from hydrated lime, gypsum, ultra-fine marble powder, rheologic additives and powdered synthetic polymers (such as **Planitop 580** produced by MAPEI S.p.A.), before decorating with thin coats of mineral or synthetic paint or coatings.

Apply the mortar after adequate preparation of the substrate (not included) by removing all crumbling or detached areas to obtain a solid substrate. Remove all traces of dust or other elements which could prevent the product adhering correctly. Apply the product on dry surfaces with a smooth, metal trowel in layers max. 3 mm thick, then finish off the surface with the same trowel.

The product must have the following performance characteristics:

Compressive strength after 28 days (N/mm <sup>2</sup> ):	> 2
Flexural strength after 28 days (N/mm <sup>2</sup> ):	> 1.4
Adhesion to substrate after 28 days (N/mm <sup>2</sup> ):	≥ 0.5
Consumption (per mm of thickness) (kg/m <sup>2</sup> ):	approximately 0.8

Included and calculated in the price for work carried out according to specification:

– application and finishing off the surface of the mortar with a smooth, metal trowel;

Average thickness 2 mm

– per square metre ..... (€/m<sup>2</sup>)



## F.9 SKIMMING THE SURFACE OF CONCRETE AND RENDER

### F.9.2 UNEVEN SURFACES SUBJECTED TO DYNAMIC STRESS

#### F.9.2.1 Application of two-component, elastic cementitious mortar by trowel or spray

Supply and application of two-component, elastic cementitious mortar by trowel or spray with a rendering machine, made from cementitious binders, selected fine-grained aggregates, synthetic fibres, special additives and synthetic polymers in water dispersion (such as **Mapelastic** produced by MAPEI S.p.A.), for waterproofing and protecting concrete substrates against the penetration of chlorides and CO<sub>2</sub> (carbonation).

Apply the mortar after adequate preparation of the substrate (not included) by removing all crumbling or detached areas to obtain a solid substrate. Remove all traces of dust or other elements which could prevent the product adhering correctly.

Apply the product on the surface of clean, damp substrates with a smooth, metal trowel or by spray with a rendering machine, fitted with a spraying lance for skimming compound, to form a layer at least 2 mm thick, then finish off the surface with the same trowel.

In areas where there is the risk of crack-formation due to settling, or on structures particularly subjected to dynamic stress, the product must be applied in two layers, with alkaline-resistant glass fibre mesh (compliant with ETAG 004 guidelines), with a mesh size of 4 x 4.5 mm and a weight of 150 g/m<sup>2</sup> (such as **Mapenet 150** produced by MAPEI S.p.A.), placed between the first and second layers. Overlap the edges of each strip of glass fibre mesh by at least 5 cm.

The product must comply with the minimum requirements of EN 1504-2 coating (C) according to principles PI, MC and IR for protecting concrete, and must have the following performance characteristics:

Adhesion to concrete (EN 1542):

– after 28 days at +20°C and 50% R.H. (N/mm<sup>2</sup>): 1.0

Thermal compatibility to freeze/thaw cycles with de-icing salts, measured as adhesion (EN 1542) (N/mm<sup>2</sup>): 0.8

Adhesion to concrete (EN 1542):

– after 7 days at +20°C and 50% R.H. + 21 days in water (N/mm<sup>2</sup>): 0.6

Flexibility expressed as elongation (DIN 53504 mod.):

– after 28 days at +20°C and 50% R.H. (%): 30

Static crack-bridging at -20°C expressed as maximum width of the crack (EN 1062-7) (mm): class A3 (-20°C) (> 0.5 mm)

Permeability to water vapour (EN ISO 7783-1):

– equivalent thickness of air S<sub>D</sub> (m): S<sub>D</sub> = 2.4  
μ = 1,200

Impermeability to water, expressed as capillary absorption

(EN 1062-3) (kg/m<sup>2</sup>·h<sup>0.5</sup>): < 0.05

Permeability to carbon dioxide (CO<sub>2</sub>) (EN 1062-6)

– diffusion in equivalent thickness of air S<sub>DCO2</sub> (m): > 50

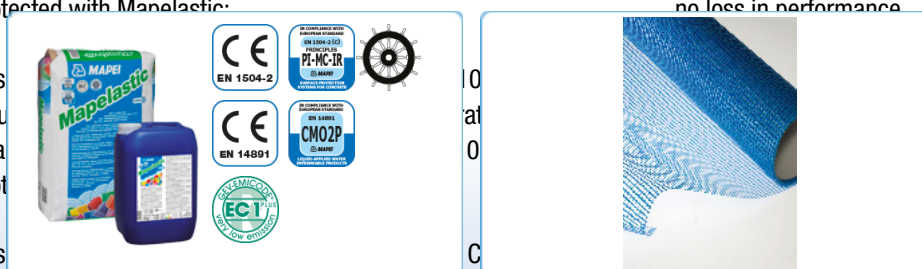
Reaction to fire (EN 13501-1) (Euroclass): C, s1-d0

Resistance to calcium chloride (after 60 days in a 30% CaCl<sub>2</sub> solution), measured by checking the loss in compressive strength of a concrete sample with a water/cement ratio of 0.4 protected with Mapelastic:

Res  
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Res

solution), measured by checking the carbonation penetration



## F.9 SKIMMING THE SURFACE OF CONCRETE AND RENDER

### F.9.2.2 Application of two-component, elastic cementitious mortar by brush or roller

Supply and application of two-component, elastic cementitious mortar by brush or roller, made from cementitious binders, selected fine-grained aggregates, synthetic fibres, special additives and synthetic polymers in water dispersion (such as **Mapelastico Smart** produced by MAPEI S.p.A.), for waterproofing and protecting concrete substrates against aggressive atmospheric agents.

Apply the mortar after adequate preparation of the substrate (not included) by removing all crumbling or detached areas to obtain a solid substrate. Remove all traces of dust or other elements which could prevent the product adhering correctly.

Apply the product on the surface of clean, damp substrates with a brush or roller, to form a layer at least 2 mm thick, then finish off the surface with a flat, metal trowel. In areas subjected to dynamic stress, to further improve the elongation and crack-bridging properties of the product, apply the product in two layers, with 0.6 mm-thick non-woven, macro-perforated, polypropylene fabric with a weight of 80 g/m<sup>2</sup> (such as **Mapetex Sel** produced by MAPEI S.p.A.), placed between the first and second layers.

Overlap the edges of each strip of non-woven fabric by at least 5 cm.

The product must comply with the minimum requirements of EN 1504-2 coating (C) according to principles PI, MC and IR for protecting concrete, and must have the following performance characteristics:

Adhesion to concrete (EN 1542):

– after 28 days at +20°C and 50% R.H. (N/mm<sup>2</sup>): 1.3

Thermal compatibility to freeze/thaw cycles with de-icing salts, measured as adhesion (EN 1542) (N/mm<sup>2</sup>):

0.9

Adhesion to concrete (EN 1542):

– after 7 days at +20°C and 50% R.H. + 21 days in water (N/mm<sup>2</sup>): 0.9

Flexibility expressed as elongation (DIN 53504 mod.):

– after 28 days at +20°C and 50% R.H.: 120

Static crack-bridging expressed as maximum width of the crack (EN 1062-7):

– after 28 days at +20°C and 50% R.H. (mm): class A5 (+20°C) (> 2.5 mm)

Dynamic crack-bridging expressed as resistance to cracking cycles (EN 1062-7):

class B4.2 (+20°C) after 20,000 cracking cycles

Permeability to water vapour (EN ISO 7783-1):

– equivalent thickness of air  $S_D$  (m):

$S_D = 3.6$

$\mu = 1,800$

Impermeability to water, expressed as capillary absorption (EN 1062-3) (kg/m<sup>2</sup>·h<sup>0.5</sup>):

< 0.05

Permeability to carbon dioxide (CO<sub>2</sub>) (EN 1062-6)

– diffusion in equivalent thickness of air  $S_{DCO_2}$  (m):

> 50

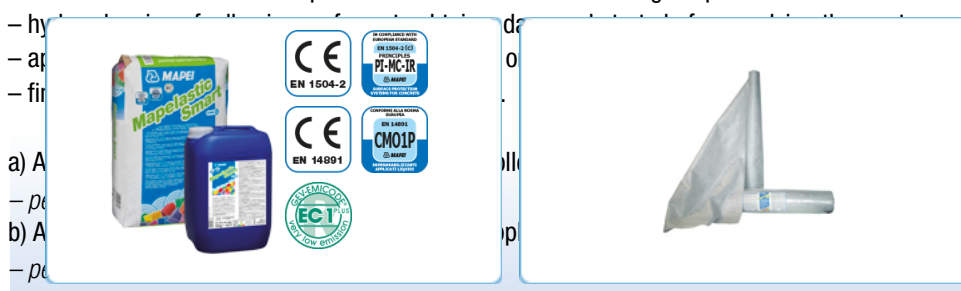
Reaction to fire (EN 13501-1) (Euroclass):

E

Consumption (per mm of thickness) (kg/m<sup>2</sup>):

approximately 1.6

Included and calculated in the price for work carried out according to specification:



## F.10 ANCHORING STEEL REINFORCEMENT, METAL STRUCTURES AND MACHINERY

### F.10.1 ANCHORING METAL REINFORCEMENT, STRUCTURES AND INDUSTRIAL MACHINERY

#### F.10.1.1 Application of expanding, rapid-setting cementitious mortar

Supply and application of expanding, rapid-setting, non-segregating, fluid cementitious mortar with the capacity to flow into intricate spaces and gaps, made from high-strength cement, selected aggregates and special additives, including an expanding agent (such as **Mapefill R** produced by MAPEI S.p.A.), for anchoring steel reinforcement and precision anchoring of machinery and metallic structures.

Apply the mortar after adequate preparation of the substrate (not included), by removing all deteriorated concrete to form a sufficiently-rough, solid substrate with no detached portions.

Cast the mortar onto clean substrates saturated with water leaving a dry surface (s.s.d.). Pour the mix in a continuous flow from one side only into the prepared area, making sure that all air is expelled.

The product must comply with the minimum requirements of EN 1504-6 and have the following performance characteristics:

Slump after mixing (EN 13395-2) (cm):	> 45
Compressive strength (EN 12190) (MPa):	62 (after 28 days)
Flexural strength (EN 196/1) (MPa):	8 (after 28 days)
Adhesion to substrate (EN 1542) (MPa):	≥ 2 (after 28 days)
Compressive modulus of elasticity (EN 13412) (GPa):	26 (after 28 days)
Free expansion during plastic phase (ASTM 827) (%):	≥ 0.3
Contrasted expansion after 24 hours (UNI 8147) (&mu;m/m):	> 400
Impermeability to water - penetration depth - (EN 12390/8) (mm):	< 5
Slip-resistance of reinforcement rods (EN 1881) (mm):	< 0.1
Reaction to fire (EN 13501-1) (Euroclass):	A1
Consumption (of cavities to be filled) (kg/dm <sup>3</sup> ):	1.95

Included and calculated in the price for work carried out according to specification:

- hydro-cleaning of adhesion surfaces and saturation of substrate with water immediately before applying the mortar;
  - pouring in the mortar around metallic elements;
  - careful curing of the mortar by spraying on water for at least 24 hours after application.
- per cubic decimetre ..... (€/dm<sup>3</sup>)



## F.10 ANCHORING STEEL REINFORCEMENT, METAL STRUCTURES AND MACHINERY

### F.10.1.2 Application of expanding, normal-setting cementitious mortar

Supply and application of expanding, normal-setting, non-segregating, fluid cementitious mortar with the capacity to flow into intricate spaces and gaps, made from high-strength cement, selected aggregates and special additives, including an expanding agent (such as **Mapefill** produced by MAPEI S.p.A.), for anchoring steel reinforcement and precision anchoring of machinery and metallic structures.

Apply the mortar after adequate preparation of the substrate (not included), by removing all deteriorated concrete to form a sufficiently-rough, solid substrate with no detached portions.

Cast the mortar onto clean substrates saturated with water leaving a dry surface (s.s.d.). Pour the mix in a continuous flow from one side only into the prepared area, making sure that all air is expelled.

The product must comply with the minimum requirements of EN 1504-6 and have the following performance characteristics:

Slump after mixing (EN 13395-2) (cm):	> 45
Compressive strength (EN 12190) (MPa):	70 (after 28 days)
Flexural strength (EN 196/1) (MPa):	9 (after 28 days)
Compressive modulus of elasticity (EN 13412) (GPa):	27 (after 28 days)
Adhesion to substrate (EN 1542) (MPa):	≥ 2 (after 28 days)
Free expansion during plastic phase (ASTM 827) (%):	≥ 0.3
Impermeability to water - penetration depth - (EN 12390/8) (mm):	< 5
Slip-resistance of reinforcement rods (EN 1881) (mm):	< 0.1
Reaction to fire (EN 13501-1) (Euroclass):	A1
Consumption (of cavities to be filled) (kg/dm <sup>3</sup> ):	1.95

Included and calculated in the price for work carried out according to specification:

- hydro-cleaning of adhesion surfaces and saturation of substrate with water immediately before applying the mortar;
  - pouring in the mortar around metallic elements;
  - careful curing of the mortar by spraying on water for at least 24 hours after application.
- per cubic decimetre ..... (€/dm<sup>3</sup>)



## F.10 ANCHORING STEEL REINFORCEMENT, METAL STRUCTURES AND MACHINERY

### F.10.1.3 Application of three-component epoxy mortar

Supply and application of three-component, fluid epoxy mortar, made from epoxy resin, selected aggregates in a granulometric curve and special additives (such as **Planigrout 300** produced by MAPEI S.p.A.), for anchoring steel reinforcement and precision anchoring of machinery and metallic structures.

Apply the epoxy mortar after adequate preparation of the concrete substrate (not included) by removing all crumbling or detached areas and all traces of cement laitance, stripping oils and paint by sandblasting or brushing.

Carefully clean the area with compressed air to remove all traces of dust deposits.

Remove all traces of rust, paint and oil from the surface of the steel by sandblasting (not included) to leave a bare metal finish (grade SA 2½).

After mixing the three components together (component A resin, component B catalyst and component C filler), pour the product in a continuous flow from one side only into the prepared area, making sure that all air is expelled.

The product must comply with the minimum requirements of EN 1504-6 and have the following performance characteristics:

Slump after mixing (EN 13395-2) (cm):	> 20
Final hardening time:	7 days
Vitreous transition temperature (EN 12614):	+50°C
Creep (EN 1544) (mm):	0.3
Compressive strength (EN 12190) (MPa):	95 (after 7 days)
Flexural strength (EN 196/1) (MPa):	40 (after 7 days)
Compressive modulus of elasticity (ASTM D695) (GPa):	2.4 (after 7 days)
Flexural modulus of elasticity (ISO 178) (GPa):	10 (after 7 days)
Adhesion to substrate (EN 1542) (MPa):	> 3 (failure of concrete)
Slip-resistance of reinforcement rods (EN 1881) (mm):	< 0.45
Reaction to fire (EN 13501-1) (Euroclass):	D-s2, d2
Consumption (of cavities to be filled) (kg/dm <sup>3</sup> ):	2.0
Included and calculated in the price for work carried out according to specification:	
– pouring in the mortar around metallic elements.	
– per cubic decimetre	.....(€/dm <sup>3</sup> )





## F.10 ANCHORING STEEL REINFORCEMENT, METAL STRUCTURES AND MACHINERY

### F.10.1.4 Application of two-component, super-fluid epoxy resin

Supply and application of two-component, solvent-free, super-fluid, low-viscosity epoxy resin (such as **Epojet** produced by MAPEI S.p.A.) for anchoring steel reinforcement and precision anchoring of machinery and metallic structures.

Apply the resin after adequate preparation of the substrate (not included) by removing all crumbly or detached areas and all traces of cement laitance, stripping oils and paint by sandblasting or brushing. Carefully clean the area with compressed air to remove all traces of dust deposits.

After mixing the two components together (component A resin and component B catalyser), pour the product in a continuous flow from one side only into the prepared area, making sure that all air is expelled.

The product must comply with the minimum requirements of EN 1504-6 and have the following performance characteristics:

Workability time (EN ISO 9514):		40 min. (at +23°C)
Tensile adhesion force (cohesive failure of the substrate) (EN 12618-2):		meets specifications
Adhesion through inclined shear strength (monolithic failure) (EN 12618-3):		meets specifications
Shrinkage (EN 12617-2) (%):		1.9
Glass transition temperature (EN 12614):		≥ +45°C
Injectability into a column of sand (EN 1771):	dry state	damp state
– injectability class (cracks from 0.2 to 0.3 mm):	4 mins 41 secs	4 mins 50 secs
– indirect traction (N/mm <sup>2</sup> ):	14	11
Durability (freeze/thaw and wet/dry cycles) (cohesive failure of the substrate) (EN 12618-2):		meets specifications
Development of tensile strength at +5°C after 72 h (EN 1543) (N/mm <sup>2</sup> ):		> 4.9
Creep (EN 1544) (mm):		0.46
Slip-resistance of reinforcement rods (EN 1881) (mm):		0.58
Tensile strength (EN ISO 527) (N/mm <sup>2</sup> ):		44
Tensile modulus of elasticity (EN ISO 527) (N/mm <sup>2</sup> ):		3,400
Deformation at failure (EN ISO 527) (%):		1.0
Compressive strength (EN 12190) (N/mm <sup>2</sup> ):		95 (after 7 days)
Consumption (of cavities to be filled) (kg/l):		1.1
Included and calculated in the price for work carried out according to specification:		
– pouring in the resin around metallic elements;		

– per cubic decimetre

..... (€/dm<sup>3</sup>)



## F.11 RAPID FASTENING AND FILLING WORK

### F.11.1 FASTENING METAL BRACKETS, PIPEWORK, JUNCTION BOXES AND SHEATHS FOR ELECTRICAL INSTALLATIONS, BACKING FRAMES FOR WINDOW AND DOOR FITTINGS, ETC. ON CONCRETE AND MASONRY SUBSTRATES

#### F.11.1.1 Application of rapid-setting and hardening, anti-shrinkage hydraulic binder

Supply and application of ready-to-use, rapid-setting and hardening, anti-shrinkage hydraulic binder made from high-strength cement and special additives (such as **Lampocem** produced by MAPEI S.p.A.) for fastening various types of construction elements in place.

Apply the mortar after adequate preparation of the substrate by removing all deteriorated or detached areas and all traces of dust. Roughen and wet the areas prepared for the fastening product and apply the mortar with a trowel.

The product must have the following performance characteristics:

Workability time:	approximately 1 min.
Time to completely set:	approximately 3 min.
Waiting time before putting into service:	1-2 h
Compressive strength (EN 196/1) (N/mm <sup>2</sup> ):	35 (after 28 days)
Flexural strength (EN196/1) (N/mm <sup>2</sup> ):	5 (after 28 days)
Consumption (of cavities to be filled) (kg/dm <sup>3</sup> ):	1.8

Included and calculated in the price for work carried out according to specification:

- saturation of substrate with water immediately before applying the mortar;
- application of the mortar with trowel.

– per cubic decimetre

..... (€/dm<sup>3</sup>)



## F.11 RAPID FASTENING AND FILLING WORK

### F.11.2 FIXING DRAIN SHAFTS, MAN-HOLES, URBAN FEATURES, ROAD SIGNS, ELECTRICITY AND TELEPHONE POLES, FENCES, ETC. IN PLACE

#### F.11.2.1 Application of rapid-setting and hardening castable mortar

Supply and application of grey or black one-component, rapid-setting and hardening, shrinkage-compensating, castable mortar, made from hydraulic binders, high-strength cement, selected aggregates and special additives (such as **Mapegrout SV** produced by MAPEI S.p.A.), for reconstructing deteriorated concrete structures and for fastening drain shafts, man-holes, urban features and fittings, road signs, electricity and telephones poles, fences, etc. in place. Apply the mortar after adequate preparation of the substrate (not included), by removing all deteriorated concrete to form a sufficiently-rough, solid substrate with no detached portions. Apply the product on a clean substrate saturated with water by pouring it into the prepared area in layers from 1 to 5 cm thick, making sure that all air is expelled. The product must set to pedestrian traffic and wheeled vehicles after approximately 2 hours (at +20°C). If thicker layers are required, add 40% of dry, silica stone aggregate in a granulometric curve of 6 to 10 mm (such as Gravel 6-10 produced by MAPEI S.p.A.) to the mortar (not included).

The product must comply with the minimum requirements of EN 1504-3 for R4-class structural mortars and have the following performance characteristics:

Application 5°C 10°C 20°C

temperature:

Pot life of 60' 20' 15'

mix:

Time for 100' 60' 35'

complete

setting:

Compressive

strength (EN

12190)

(MPa):

- 2 h: > 4 > 15 > 20

- 1 day: > 34 > 34 > 34

- 28 days: > 55 > 55 > 55

Flexural > 9 (after 28 days)

strength (EN

196/1)

(MPa):

Compressive 25 (after 28 days)

modulus of

elasticity (EN

13412)

(GPa):

Adhesion to > 2 (after 28 days)

substrate

(EN 1542)

(MPa):

Resistance

to

accelerated

carbonation

(EN 13055)

Capillary

absorption

(EN 13057)

(kg/m<sup>2</sup>·h<sup>0.5</sup>):



## F.11 RAPID FASTENING AND FILLING WORK

### F.11.2.2 Application of rapid-setting and hardening thixotropic mortar

Supply and application of black one-component, rapid-setting and hardening, shrinkage-compensating, thixotropic mortar, made from hydraulic binders, high-strength cement, selected aggregates and special additives (such as **Mapegrout SV T** produced by MAPEI S.p.A.), for reconstructing deteriorated concrete structures and for fastening drain shafts, man-holes, urban features and fittings, road signs, electricity and telephones poles, fencing, etc. in place. Apply the mortar after adequate preparation of the substrate (not included), by removing all deteriorated concrete to form a sufficiently-rough, solid substrate with no detached portions.

Apply the product on a clean substrate saturated with water by trowel in the prepared area in layers from 1 to 5 cm thick. The product must set to pedestrian traffic and wheeled vehicles after approximately 2 hours (at +20°C).

The product must comply with the minimum requirements of EN 1504-3 for R4-class structural mortars and have the following performance characteristics:

Application 5°C 10°C 20°C

temperature:

Pot life of 30' 15' 10'

mix:

Time for 100' 60' 35'

complete

setting:

Compressive  
strength (EN

12190)

(MPa):

– 2 h: 2 10 17

– 1 day: 20 22 25

– 28 days: 45 45 45

Flexural 6 (after 28  
strength (EN days)

196/1)

(MPa):

Compressive 25 (after 28  
modulus of days)

elasticity (EN

13412)

(GPa):

Adhesion to > 2 (after 28  
substrate days)

(EN 1542)

(MPa):

Resistance less than  
to reference

accelerated concrete  
carbonation

(EN 13295):

Capilla  
absorp

(EN 13

(kg/m<sup>2</sup>

Therm

compa

to

freeze/thaw



## F.12 PROTECTION OF CONCRETE SURFACES

### F.12.1 HYDROPHOBIC IMPREGNATION

#### F.12.1.1 Application of transparent, water-repellent, silane and siloxane impregnator in solvent

Supply and application of transparent, water-repellent, silane and siloxane impregnator in solvent (such as **Antipluviol S** produced by MAPEI S.p.A.). Apply several generous coats of the product.

The material must have the following special characteristics:

Colour:	transparent
Density (g/cm <sup>3</sup> ):	approx. 0.80
Active substance content (%):	9
Brookfield Viscosity (mPa s):	approx. 5 (rotor 1 - 50 revs)
Consumption (kg/m <sup>2</sup> ):	0.15-2 (according to the absorption of the substrate)
Penetration depth (mm):	4
Result/class:	I (< 10 mm)
Water absorption and absorption ratio UNI EN 13580	
Resistance to alkalis compared with untreated surface (%):	2.6
Result/class:	compliant (< 7.5%)
Absorption ratio compared with untreated surface after immersion in alkali (%):	6.6
Result/class:	compliant (< 10%)
Drying speed by hydrophobic impregnation drying speed coefficient UNI EN 13579 (%):	> 30
Result/class:	I (> 30%)
Loss in mass after freeze-thaw cycles with de-icing salts UNI EN 13581	
n° of cycles on treated surface:	> 50
n° of cycles on untreated surface:	9
&Delta; cycles (treated surface-untreated surface):	> 41
Result/class:	compliant (&Delta; cycles > 20)
Hazardous substances	
Result/class:	compliant
Included and calculated in the price for work carried out according to specification:	
– per square metre	..... (€/m <sup>2</sup> )



**F.12 PROTECTION OF CONCRETE SURFACES****F.12.2 COATING RESISTANT TO THE PENETRATION OF AGGRESSIVE AGENTS****F.12.2.1 ELASTIC CEMENTITIOUS COATINGS**

## F.12 PROTECTION OF CONCRETE SURFACES

### F.12.2.1.1 Application of two-component, elastic cementitious mortar by trowel or spray

Supply and application of two-component, elastic cementitious mortar by trowel or by spray with a rendering machine, made from cementitious binders, selected fine-grained aggregates, synthetic fibres, special additives and synthetic polymers in water dispersion (such as **Mapelastic** produced by MAPEI S.p.A.), for waterproofing and protecting concrete substrates against the penetration of chlorides and CO<sub>2</sub> (carbonation).

Apply the mortar after adequate preparation of the substrate (not included) by removing all crumbling or detached areas to obtain a solid substrate. Remove all traces of dust or other elements which could prevent the product adhering correctly.

Apply the product on the surface of clean, damp substrates with a smooth, metal trowel or by spray with a rendering machine, fitted with a spraying lance for skimming compound, to form a layer at least 2 mm thick, then finish off the surface with the same trowel.

In areas where there is the risk of crack-formation due to settling, or on structures particularly subjected to dynamic stress, the product must be applied in two layers, with alkaline-resistant glass fibre mesh (compliant with ETAG 004 guidelines), with a mesh size of 4 x 4.5 mm and a weight of 150 g/m<sup>2</sup> (such as **Mapenet 150** produced by MAPEI S.p.A.), placed between the first and second layers. Overlap the edges of each strip of glass fibre mesh by at least 5 cm.

The product must comply with the minimum requirements of EN 1504-2 coating (C) according to principles PI, MC and IR for protecting concrete, and must have the following performance characteristics:

Adhesion to concrete (EN 1542):

– after 28 days at +20°C and 50% R.H. (N/mm<sup>2</sup>): 1.0

Thermal compatibility to freeze/thaw cycles with de-icing salts, measured as adhesion (EN 1542) (N/mm<sup>2</sup>): 0.8

Adhesion to concrete (EN 1542):

– after 7 days at +20°C and 50% R.H. + 21 days in water (N/mm<sup>2</sup>): 0.6

Elasticity expressed as elongation (DIN 53504 mod.):

– after 28 days at +20°C and 50% R.H.(%): 30

Static crack-bridging at -20°C expressed as maximum width of the crack (EN 1062-7) (mm):

class A3 (-20°C)  
(> 0.5 mm)

Permeability to water vapour (EN ISO 7783-1):

– equivalent thickness of air S<sub>D</sub> (m):  
S<sub>D</sub> = 2.4  
μ = 1.200

Impermeability to water, expressed as capillary absorption (EN 1062-3) (kg/m<sup>2</sup>·h<sup>0.5</sup>):

< 0.05

Permeability to carbon dioxide (CO<sub>2</sub>) (EN 1062-6)

– diffusion in equivalent thickness of air S<sub>D CO2</sub> (m): > 50

Reaction to fire (EN 13501-1) (Euroclass):

C, s1-d0

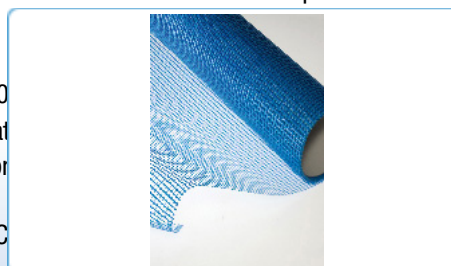
Resistance to calcium chloride (after 60 days in a 30% CaCl<sub>2</sub> solution), measured by checking the loss in compressive strength of a concrete sample with a water/cement ratio of 0.4 protected with Mapelastic:

no loss in performance

Res  
solu  
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at  
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C



solution), measured by checking the carbonation penetration in a concrete sample with a water/cement ratio of 0.8



## F.12 PROTECTION OF CONCRETE SURFACES

### F.12.2.1.2 Application of two-component, elastic cementitious mortar by brush or roller

Supply and application of two-component, elastic cementitious mortar by brush or roller, made from cementitious binders, selected fine-grained aggregates, synthetic fibres, special additives and synthetic polymers in water dispersion (such as **Mapelastico Smart** produced by MAPEI S.p.A.), for waterproofing and protecting concrete substrates against aggressive atmospheric agents.

Apply the mortar after adequate preparation of the substrate (not included) by removing all crumbling or detached areas to obtain a solid substrate. Remove all traces of dust or other elements which could prevent the product adhering correctly.

Apply the product on the surface of clean, damp substrates with a brush or roller to form a layer at least 2 mm thick, then finish off the surface with a flat, metal trowel. In areas subjected to dynamic stress, to further improve the elongation and crack-bridging properties of the product, apply the product in two layers, with 0.6 mm-thick non-woven, macro-perforated, polypropylene fabric with a weight of 80 g/m<sup>2</sup> (such as **Mapetex Sel** produced by Mapei S.p.A.), placed between the first and second layers. Overlap the edges of each strip of non-woven fabric by at least 5 cm.

The product must comply with the minimum requirements of EN 1504-2 coating (C) according to principles PI, MC and IR for protecting concrete, and must have the following performance characteristics:

Adhesion to concrete (EN 1542):

– after 28 days at +20°C and 50% R.H. (N/mm<sup>2</sup>): 1.3

Thermal compatibility to freeze/thaw cycles with de-icing salts, measured as adhesion (EN 1542) (N/mm<sup>2</sup>): 0.9

Adhesion to concrete (EN 1542):

– after 7 days at +20°C and 50% R.H. + 21 days in water (N/mm<sup>2</sup>): 0.9

Elasticity expressed as elongation (DIN 53504 mod.):

– after 28 days at +20°C and 50% R.H.(%): 120

Static crack-bridging expressed as maximum width of the crack (EN 1062-7):

– after 28 days at +20°C and 50% R.H. (mm): class A5 (+20°C)  
(> 2.5 mm)

Dynamic crack-bridging expressed as resistance to cracking cycles (EN 1062-7):

class B4.2 (+20°C) after  
20,000 cracking cycles

Permeability to water vapour (EN ISO 7783-1):

– equivalent thickness of air  $S_D$  (m):  $S_D = 3.6$   
 $\mu = 1.800$

Impermeability to water, expressed as capillary absorption (EN 1062-3) (kg/m<sup>2</sup>·h<sup>0.5</sup>):

< 0.05

Permeability to carbon dioxide (CO<sub>2</sub>) (EN 1062-6)

– diffusion in equivalent thickness of air  $S_{D, CO_2}$  (m): > 50

Reaction to fire (EN 13501-1) (Euroclass): E

Consumption (per mm of thickness) (kg/m<sup>2</sup>): approximately 1.6

Included and calculated in the price for work carried out according to specification:

– hydro-cleaning of adhesion surfaces to obtain a damp substrate before applying the mortar;

– application of the product in two layers;

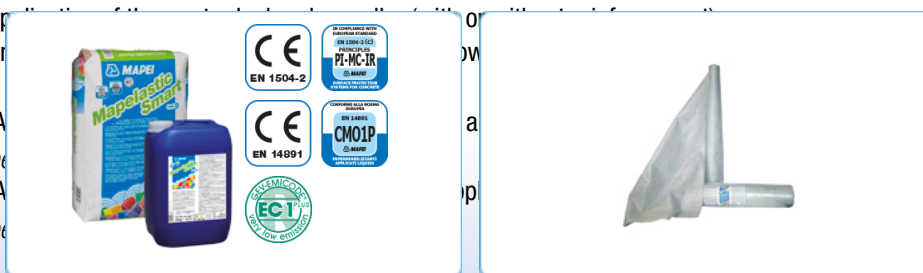
– finishing with a flat metal trowel.

a) A

– pe

b) A

– pe



**F.12 PROTECTION OF CONCRETE SURFACES**

**F.12.2.2 ELASTIC ACRYLIC COATINGS**

**F.12.2.2.1 Protective, elastomeric, crack-bridging paint**

Supply and application of elastic, acrylic resin paint in water dispersion (such as **Elastocolor Paint** produced by MAPEI S.p.A.). Apply two coats of the product with a brush, roller or by spray after applying a coat of suitable primer (such as **Malech**, **Elastocolor Primer** or **Quarzolite Base Coat** produced by MAPEI S.p.A.).

The finishing product must have the following characteristics:

Colour:	as specified by the Works Director or according to the manufacturer's colour chart	
Consistency:		thick liquid
Density (EN ISO 2811-1) (g/cm <sup>3</sup> ):		approx. 1.37
Dry solids content (EN ISO 3251) (%):		approx. 63
Consumption (kg/m <sup>2</sup> ):		0.2-0.4 (per coat)
Resistance to accelerated aging (colour RAL 7032) after 1,000 hours exposure to a Weather-Ometer (ASTM G 155 cycle 1):		&Delta;E < 2.5
Permeability to CO <sub>2</sub> (UNI EN 1062-6)	μ:	1,272,581
	S <sub>D</sub> for a 0.00025 m thick dry layer (m):	318
	result/class:	compliant (S <sub>D</sub> > 50 m)
Permeability to water vapour (UNI EN 7783-1,2)	(μ):	2193
	S <sub>D</sub> for a 0.00025 m thick 0.5 dry layer (m):	
	result/class:	I (S <sub>D</sub> < 5 m)
Permeability to water: (UNI EN 1062-3)	W <sub>24</sub> [(kg/(m <sup>2</sup> h <sup>0.5</sup> ))]	0.01
	result/class:	compliant (W <sub>24</sub> < 0.1)
Thermal compatibility: ageing 7 days at +70°C UNI EN 1062-11 4.1	result/class:	compliant: adherence ≥ 0.8 N/mm <sup>2</sup>
Thermal compatibility: freeze-thaw cycles with immersion in de-icing salts UNI EN 13687-1	result/class:	compliant: adherence ≥ 0.8 N/mm <sup>2</sup>
Thermal compatibility: storm cycles UNI EN 13687-2	result/class:	compliant: adherence ≥ 0.8 N/mm <sup>2</sup>
Thermal compatibility: thermal cycles without immersion in de-icing salts UNI EN 13687-3	result/class:	compliant: adherence ≥ 0.8 N/mm <sup>2</sup>

<p>Crack UNI Crack UNI Dire UNI</p>		<p>Crack UNI Dire UNI</p>	 <p>0.8 N/mm<sup>2</sup></p>
<p>Rea EN Exp UNI Diff All c</p>		<p>Rea EN Exp UNI Diff All c</p>	 <p>tion</p>

## F.12 PROTECTION OF CONCRETE SURFACES

### F.12.2.2 Fibre-reinforced elastomeric finishing product with good filling properties

Supply and application of ready-to-use, one-component, fibre-reinforced, elastomeric finish with good filling properties (such as **Elastocolor Rasante** produced by MAPEI S.p.A.). Apply the product by trowel or, if diluted with 5-10% of water, with a honeycomb or bristle roller, after applying a coat of suitable primer (such as **Malech**, **Elastocolor Primer** or **Quarzolite Base Coat** produced by MAPEI S.p.A.).

The product must have the following special characteristics:

Consistency:		thick liquid
Dry solids content (EN ISO 3251) (%):		approx. 67
Density (EN ISO 2811-1) (g/cm <sup>3</sup> ):		approx. 1.35
Consumption (kg/m <sup>2</sup> ):		0.4-0.7 (per coat)
Permeability to CO <sub>2</sub> (UNI EN 1062-6)	(μ):	611,487
	S <sub>D</sub> for a 0.00040 m thick dry layer (m):	245
	result/class:	compliant (S <sub>D</sub> > 50 m)
Permeability to water vapour: (UNI EN 7783-1,2)	(μ)	1417
	S <sub>D</sub> for a 0.00040 m thick dry layer (m):	6.6
	result/class:	I (S <sub>D</sub> < 5m)
Permeability to water: (UNI EN 1062-3)	W <sub>24</sub> [(kg/(m <sup>2</sup> h <sup>0.5</sup> ))]	0.02
	result/class:	compliant (W <sub>24</sub> < 0.1)
Thermal compatibility: UNI EN 1062-11 4.1	ageing 7 days at +70°C	
	result/class:	compliant: adherence ≥ 0.8 N/mm <sup>2</sup>
Thermal compatibility: freeze-thaw cycles with immersion in de-icing salts UNI EN 13687-1		
	result/class:	compliant: adherence ≥ 0.8 N/mm <sup>2</sup>
Thermal compatibility: storm cycles UNI EN 13687-2		
	result/class:	compliant: adherence ≥ 0.8 N/mm <sup>2</sup>
Thermal compatibility: thermal cycles without immersion in de-icing salts UNI EN 13687-3		
	result/class:	compliant: adherence ≥ 0.8 N/mm <sup>2</sup>

Crack resistance, static crack-bridging capacity

UNI EN 1062-7:	crack-bridging (μm)	1427
Crack resistance		
UNI EN 1062-8:		≥
Direct crack-bridging		
UNI EN 1062-9:		
Real crack-bridging		
Exposure to artificial atmospheric agents		
UNI EN 1062-10:		
Diffusion coefficient		
All other characteristics		tion

## F.12 PROTECTION OF CONCRETE SURFACES

### F.12.2.2.3 Fibre-reinforced elastomeric finishing product applied in thick coats

Supply and application of one-component, fibre-reinforced, elastomeric, acrylic resin coating with fine-grained quartz spheres in water dispersion with good filling properties (such as **Elastocolor Rasante SF** produced by MAPEI S.p.A.), after applying a coat of suitable primer (such as **Malech**, **Elastocolor Primer** or **Quarzolite Base Coat** produced by MAPEI S.p.A.).

The finishing product must also have the following characteristics:

Colour:	as specified by the Works Director or according to the manufacturer's colour chart	
Consistency:		thick liquid
Dry solids content (EN ISO 3251) (%):		approx. 77
Density (EN ISO 2811-1) (g/cm <sup>3</sup> ):		approx. 1.47
Consumption (kg/m <sup>2</sup> ):	trowel:	0.7-0.8 (per coat)
	brush or roller:	0.3-0.5 (per coat)
Permeability to CO <sub>2</sub> (μ):	130,569	
(UNI EN 1062-6)	S <sub>D</sub> for a 0.00060 m thick 78	
	dry layer (m):	
	result/class:	compliant (S <sub>D</sub> > 50 m)
Permeability to water vapour (μ):	1242	
(UNI EN 7783-1,2)	S <sub>D</sub> for a 0.00060 m thick 0.7	
	dry layer (m):	
	result/class:	I (S <sub>D</sub> < 5 m)
Permeability to water:	W <sub>24</sub> [(kg/(m <sup>2</sup> h <sup>0.5</sup> ))]	0.04
(UNI EN 1062-3)	result/class:	compliant (W <sub>24</sub> < 0.1)
Thermal compatibility:	ageing 7 days at +70°C	
UNI EN 1062-11 4.1	result/class:	compliant: adherence ≥ 0.8 N/mm <sup>2</sup>
Thermal compatibility: freeze-thaw cycles with immersion in de-icing salts		
UNI EN 13687-1	result/class:	compliant: adherence ≥ 0.8 N/mm <sup>2</sup>
Thermal compatibility: storm cycles		
UNI EN 13687-2	result/class:	compliant: adherence ≥ 0.8 N/mm <sup>2</sup>
Thermal compatibility: thermal cycles without immersion in de-icing salts		
UNI EN 13687-3	result/class:	compliant: adherence ≥ 0.8 N/mm <sup>2</sup>

Crack resistance - static crack-bridging capacity

UNI

Crack

UNI

Dire

UNI



Reaction to fire EN 13501-1

Euroclass: B s1 d0

Exp

UNI

Diff

All c



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**F.12 PROTECTION OF CONCRETE SURFACES**

**F.12.2.3 ACRYLIC COATINGS**

## F.12 PROTECTION OF CONCRETE SURFACES

### F.12.2.3.1 Semi-transparent acrylic paint

Supply and application of semi-transparent, pure acrylic resin paint in water dispersion with pigments and selected fillers (such as **Colorite Beton** produced by MAPEI S.p.A.). Apply at least two coats of the product using a brush, roller, spray or mixed air-airless spray after applying a suitable primer (such as **Malech** or **Elastocolor Primer** produced by MAPEI S.p.A.).

The finishing product must have the following characteristics:

Colour:	as specified by the Works Director or according to the manufacturer's colour chart
Consistency:	thick liquid
Dry solids content (EN ISO 3251) (%):	approx. 59
Density (EN ISO 2811-1) (g/cm <sup>3</sup> ):	approx. 1.27
Consumption (kg/m <sup>2</sup> ):	0.25-0.3 (in 2 coats)
Colour variation after 1,000 hours exposure to a Weather-Ometer (ASTM G 155 cycle 1) colour chart colours F.M. 4001, F.M. 4002, F.M. 4003 and F.M. 4004:	&Delta;E < 1
Permeability to CO <sub>2</sub> (UNI EN 1062-6)	(μ): 4,124,820 S <sub>D</sub> for a 0.00010 m thick dry layer (m): 412 Result/class: compliant (S <sub>D</sub> > 50 m)
Permeability to water vapour (μ): (UNI EN 7783-1,2)	3609 S <sub>D</sub> for a 0.00010 m thick dry layer (m): 0.4 result/class: I (S <sub>D</sub> < 5 m)
Permeability to water W <sub>24</sub> [(kg/(m <sup>2</sup> h <sup>0.5</sup> )): (UNI EN 1062-3)	0.02 result/class: compliant (W <sub>24</sub> < 0.1)
Thermal compatibility: UNI EN 1062-11 4.1	ageing 7 days at +70°C result/class: compliant: adherence ≥ 0.8 N/mm <sup>2</sup>
Thermal compatibility: freeze-thaw cycles with immersion in de-icing salts UNI EN 13687-1	result/class: compliant: adherence ≥ 0.8 N/mm <sup>2</sup>
Thermal compatibility: storm cycles UNI EN 13687-2	result/class: compliant: adherence ≥ 0.8 N/mm <sup>2</sup>
Thermal compatibility: thermal cycles without immersion in de-icing salts UNI EN 13687-3	result/class: compliant: adherence ≥ 0.8 N/mm <sup>2</sup>

Crack  
UNI



crack-bridging (μm): 1117  
result/class: A3 (> 0.5 mm)

Crack  
UNI  
Dire  
UNI EN 1542

result/class: B1

Rea  
Exp  
UNI  
Diff  
All c



result/class: compliant: adherence ≥

E  
r  
p  
p



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## F.12 PROTECTION OF CONCRETE SURFACES

### F.12.2.3.2 Protective acrylic paint for internal and external application

Supply and application of pure acrylic resin paint in water dispersion (such as **Colorite Performance** produced by MAPEI S.p.A.). Apply at least two coats of the product with a brush, roller or by spray after applying a suitable primer (such as **Malech**, **Elastocolor Primer** or **Quarzolite Base Coat** produced by MAPEI S.p.A.)

The finishing product must have the following characteristics:

Colour:	as specified by the Works Director or according to the manufacturer's colour chart
Consistency:	thick liquid
Dry solids content (EN ISO 3251) (%):	approx. 61
Density (EN ISO 2811-1) (g/cm <sup>3</sup> ):	approx. 1.35
Consumption (kg/m <sup>2</sup> ):	0.3-0.4 (in 2 coats)
Permeability to CO <sub>2</sub> (UNI EN 1062-6)	(μ): 1,363,475 S <sub>D</sub> for a 0.00015 m thick 205 dry layer (m): result/class: compliant (S <sub>D</sub> > 50 m)
Permeability to water vapour (μ): (UNI EN 7783-1,2)	2648 S <sub>D</sub> for a 0.00015 m thick 0.4 dry layer (m) result/class: I (S <sub>D</sub> < 5 m)
Permeability to water W <sub>24</sub> [(kg/(m <sup>2</sup> h <sup>0.5</sup> ))]: (UNI EN 1062-3)	0.01 result/class: compliant (W <sub>24</sub> < 0.1)
Thermal compatibility: UNI EN 1062-11 4.1	ageing 7 days at +70°C result/class: compliant: adherence ≥ 0.8 N/mm <sup>2</sup>
Thermal compatibility: freeze-thaw cycles with immersion in de-icing salts UNI EN 13687-1	result/class: compliant: adherence ≥ 0.8 N/mm <sup>2</sup>
Thermal compatibility: storm cycles UNI EN 13687-2	result/class: compliant: adherence ≥ 0.8 N/mm <sup>2</sup>
Thermal compatibility: thermal cycles without immersion in de-icing salts UNI EN 13687-3	result/class: compliant: adherence ≥ 0.8 N/mm <sup>2</sup>

Crack resistance, static crack-bridging capacity  
UNI EN 1062-7

crack-bridging (mm): 917

Crack  
UNI  
Dire  
UNI



Rea

Exposure to artificial atmospheric agents

UNI  
Diff  
All c



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tion

**F.12 PROTECTION OF CONCRETE SURFACES****F.12.3 COATING RESISTANT TO CHEMICAL PRODUCTS****F.12.3.1 SLIGHTLY AGGRESSIVE LIQUIDS**

## F.12 PROTECTION OF CONCRETE SURFACES

### F.12.3.1.1 Application of two-component epoxy paint in water dispersion

Supply and application of two-component, epoxy paint in water dispersion (such as **Mapecoat W** produced by MAPEI S.p.A.) for protective anti-corrosion treatments on concrete substrates in contact with slightly aggressive liquids.

Apply the epoxy paint after adequate preparation of the concrete substrate (not included) by removing all crumbling or detached areas and all traces of cement laitance, stripping oils and paint by sandblasting or brushing. Carefully clean the surfaces with compressed air to remove all dust deposits which could impede correct adhesion of the product.

Apply two coats of the product, with the first "key" coat slightly diluted with water. Apply the product with a brush, roller or by *airless* spray on well-cured, clean substrates with no damp from capillary infiltrations, to form a layer at least 250  $\mu\text{m}$  thick.

If surfaces are damp or slightly crumbly, apply a coat of suitable primer according to indications from the manufacturer of the paint beforehand.

The coating must have the following characteristics:

Components:	Part A	Part B
Colour:	transparent	white or grey
Consistency:	fluid	thick paste
Density:	1.1 kg/l	1.4 kg/l
Viscosity at 23°C:	700 MPa·s	300 MPa·s
Mixing ratio:	1	3
Inflammable:	no	no
Hazard classification according to EEC 88/379:	irritant	irritant
Mixed product		
Density A + B:	1.3 g/cm <sup>3</sup>	
Viscosity A + B (rotor S):	2600 MPa·s	
Colour A + B:	white, Manhattan grey	
Average consumption:	250-300 g/m <sup>2</sup> per coat	
Workability time at +23°C:	40-60 minutes	
Dust dry at +23°C:	1-2 hours	
Setting time of film applied at +23°C:	6-10 hours	
Waiting time between first and second coat:	6-24 hours	
Complete hardening time:	8-10 days	
Storage:	12 months in its original packaging	

Included and calculated in the price for work carried out according to specification:

– per square metre

..... (€/m<sup>2</sup>)



**F.12 PROTECTION OF CONCRETE SURFACES**

**F.12.3.2 AGGRESSIVE LIQUIDS**

## F.12 PROTECTION OF CONCRETE SURFACES

### F.12.3.2.1 Application of two-component epoxy resin paint modified with hydro-carbide resins

Supply and application of two-component, epoxy resin paint modified with hydro-carbide resins (such as **Duresil EB** produced by MAPEI S.p.A.) for anti-acid protection of concrete substrates.

Apply the epoxy paint after adequate preparation of the concrete substrate (not included) by removing all crumbling or detached areas and all traces of cement laitance, stripping oils and paint by sandblasting or brushing. Carefully clean the surfaces with compressed air to remove all dust deposits which could impede correct adhesion of the product. Apply two coats of the product with a brush, roller or by *airless* spray on solid, clean, dry substrates to form a layer at least 250  $\mu\text{m}$  thick.

The product must comply with the minimum requirements of EN 1504-2 coating (C) according to principles PI, MC, RC and IR for protecting concrete, and must have the following performance characteristics:

Dry solids content (%):	100
Final hardening time:	7 days (at +23°C)
Permeability to carbon dioxide (CO <sub>2</sub> ) (EN 1062-6) (m):	500
Permeability to water vapour (EN ISO 7783-1) (m):	S <sub>D</sub> < 50 Class II
Capillary absorption and permeability to water (EN 1062-3) (kg/m <sup>2</sup> ·h <sup>0.5</sup> ):	0.01
Resistance to thermal shock (EN 13687-5) (MPa):	3.5
Resistance to severe chemical attack (EN 13529) Class II: 28 days with no pressure:	no alteration. Opacification with a 10% acetic acid and 20% sulphuric acid solution
Direct tensile adherence test (EN 1542) (MPa):	3.5 (after 7 days)
Reaction to fire (EN 13501-1) (Euroclass):	E
Consumption (kg/m <sup>2</sup> ):	0.40-0.45 per coat
Included and calculated in the price for work carried out according to specification:	
– per square metre	..... (€/m <sup>2</sup> )



**F.12 PROTECTION OF CONCRETE SURFACES**

**F.12.3.3 HIGHLY AGGRESSIVE LIQUIDS**

## F.12 PROTECTION OF CONCRETE SURFACES

### F.12.3.3.1 Application of two-component epoxy resin containing pigments with high covering properties

Supply and application of two-component, epoxy paint containing pigments with high covering properties (such as **Mapecoat I 24** produced by MAPEI S.p.A.) for anti-corrosion coatings on concrete substrates in contact with highly aggressive liquids.

Apply the epoxy paint after adequate preparation of the concrete substrate (not included) by removing all crumbling

or detached areas and all traces of cement laitance, stripping oils and paint by sandblasting or brushing.

Carefully clean the surfaces with compressed air to remove all dust deposits which could impede correct adhesion of the product.

Apply two coats of the product with a brush, roller or by airless spray on sound, compact, crack-free substrates.

The product must comply with the minimum requirements of EN 1504-2 coating (C) according to principles PI, MC, PR, RC and IR for protecting concrete, and must have the following performance characteristics:

Mixing ratio:	comp A : comp B = 4 : 1
Density of mix (kg/m <sup>3</sup> ):	1,300
Viscosity of mix (mPa·s):	1,500 (rotor 7-20 revs)
Workability time at +23°C:	30'-40'
Setting time of film applied at +23°C:	4-5 hours
Final hardening time at 23°C:	3 days
Permeability to carbon dioxide (CO <sub>2</sub> ) (EN 1062-6) (m):	1255
Permeability to water vapour (EN ISO 7783-1-2) (m):	S <sub>D</sub> > 50 Class III
Capillary absorption and permeability to water (EN 1062-3) (kg/m <sup>2</sup> ·h <sup>0.5</sup> ):	< 0.1
Resistance to thermal shock (MPa):	≥ 2.0
Resistance to severe chemical attack:	Class I: 3 days with no pressure Class II: 28 days with no pressure Class III: 28 days with pressure
Impact strength:	Class I
Direct tensile adherence (N/mm <sup>2</sup> ):	≥ 1.5
Reaction to fire:	Efl
Consumption (kg/m <sup>2</sup> ):	0.40-0.45 per coat

Included and calculated in the price for work carried out according to specification:

– per square metre

..... (€/m<sup>2</sup>)





## F.12 PROTECTION OF CONCRETE SURFACES

### F.12.4 COATING FOR CONTACT WITH DRINKING WATER AND FOOD PRODUCTS

#### F.12.4.1 Application of two-component epoxy paint

Supply and application of two-component epoxy paint with pigments with good hiding power (such as **Mapecoat DW 25** produced by MAPEI S.p.A.) for coating concrete substrates suitable for contact with potable water and foodstuffs.

Apply the paint after adequate preparation of the substrate (not included) by removing all crumbly or detached areas to obtain a solid substrate. Remove all traces of dust or other elements which could prevent the product adhering correctly.

Apply two coats of the paint with a brush, roller or by airless spray.

The product must comply with the requirements of Ministerial Decree dated 06-04-2004 n° 174 Chap. 2 art. 5 for contact with potable water and must comply for contact with foodstuffs according to Regulation (EU) 10/2011.

The product must also comply with the minimum requirements of EN 1504-2 coating (C) according to principles PI, MC, PR, RC and IR for protecting concrete, and must have the following performance characteristics:

Mixing ratio:	comp. A : comp. B = 4 : 1
Density of mix (kg/cm <sup>3</sup> ):	1,300
Viscosity of mix (mPa·s):	1,500 (rotor 3 - 20 revs)
Workability time:	30'-40' (at +23°C)
Setting time of film:	4-5 h (at +23°C)
Complete hardening time:	7 days (at +23°C)
Permeability to carbon dioxide (CO <sub>2</sub> ) (EN 1062-6) (m):	> 900
Permeability to water vapour (EN ISO 7783-1-2) (m):	S <sub>D</sub> > 50 Class III
Capillary absorption and permeability to water (EN 1602-3) (kg/m <sup>2</sup> ·h <sup>0.5</sup> ):	< 0.01
Resistance to thermal shock (EN 13687-5) (MPa):	3.5
Resistance to severe chemical attack (EN 13529):	no alteration. Blisters with acetic acid after 28 days at 10%
Direct traction adherence test (EN 1542) (MPa):	3.5 (after 7 days)
Reaction to fire (EN 13501-1) (Euroclass):	B <sub>f1</sub> -s1
Consumption (kg/m <sup>2</sup> ):	0.40-0.60 (per coat)
Total price for application according to specification: – per square metre	.....(€/m <sup>2</sup> )

