

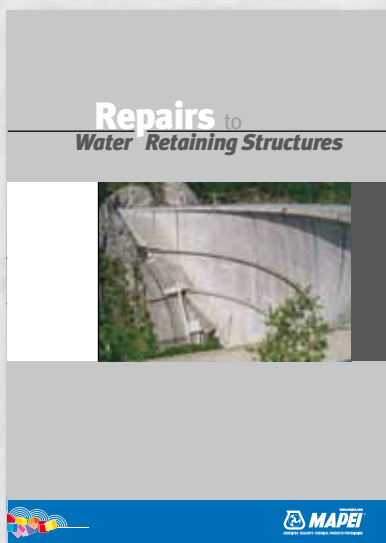
Repairs to *Water Retaining Structures*



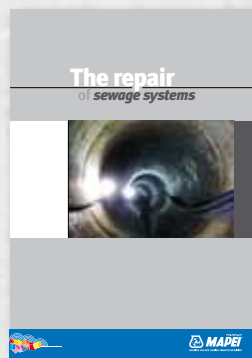
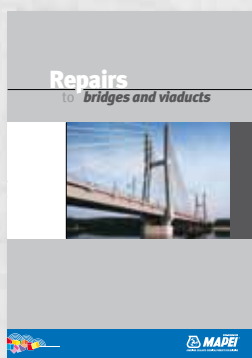
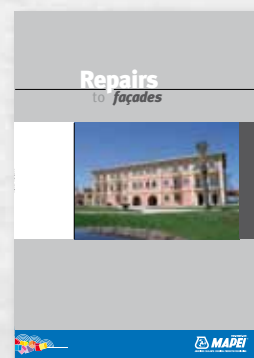
Mapei produces a series of technical manuals so that the subject of the deterioration of concrete may be analysed in depth, and to offer a professional approach to the problems regarding repair work.

The subject of this manual is:

Repairs to Water Retaining Structures



The other manuals available in the series are:



The manuals are available upon request.

Repairs to *Water Retaining Structures*

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► 1 | Introduction

In hydraulic structures, because of their sheer size, enormous volumes of concrete are required. The term “hydraulic structure” means various types of structures, such as channels, dams, drainage systems, etc. Each of these structures may be subject to different types of deterioration and, as a result, interventions carried out must take into consideration the various causes which have contributed in deteriorating the structure, and the most suitable materials to carry out repairs which are efficient and long-lasting must be chosen. Structures such as dams may have problems due to “fatigue” due to the loads the structure has to withstand, and will thus require products which guarantee excellent performance characteristics. Repairs to channels, which are subject to flowing water inducing high stresses on the walls and bed of the structure, have similar requirements. Other structures have different requirements, such as drainage systems where the structure’s problems are not related to its mechanical strength, but rather the nature of the water which flows through the system. The water may contain aggressive substances of various nature, for example from industrial waste, or sulphuric acid due to the presence of organic substances in refuse water.

And, as with interventions on large-scale infrastructures or civil works, MAPEI has developed a range of products for repairing concrete in hydraulic structures, which are employed according to the type of deterioration found on the structure.

Below is a list of methods for the repair of structures in contact with water:

- Preparing the substrate;
- Protecting reinforcement rods;
- Positioning new reinforcement;
- Repairing concrete using thixotropic mortar;
- Repairing concrete using castable mortar;
- Repairing concrete using cementitious binders;
- Waterproofing by injecting resin;
- Smoothing off concrete surfaces;
- Protecting and decorating concrete surfaces.

Every one of these items includes different types of products, which are all suitable for achieving the required scope. The choice of which one of these to use depends on the location, the thicknesses to be repaired, on-site organisation, etc.

► 2| Preparing the substrate

Preparation operations of concrete surfaces to make them suitable to be repaired or cladded, carried out so as to remove the parts which have swollen or which are detaching, and cleaning rust from the surface of exposed metal reinforcement without compromising the stability of the structure. Generally, every concrete surface which needs to be repaired requires preparation of the substrate. Which type of demolition technique to use will be evaluated according to the area and type of intervention; manually, if the repair work is small, mechanically, such as with a pneumatic hammer or grinder, or hydro-scarifying, if the area to be repaired is large and the substrate must be in perfect condition.

► 3| Protecting reinforcement rods

► 3.1| Protecting using MAPEFER

Description: *two-component, anti-corrosion cementitious mortar for protecting reinforcement rods.*

Apply MAPEFER on perfectly clean, rust-free reinforcement rods to bring the pH level back to more than 12, the minimum level required to guarantee passivation of the reinforcement rods. The mortar creates a protective, waterproof barrier and protection against aggressive agents present in the atmosphere. Apply MAPEFER by brush in two coats. The second coat may be applied 90-120 minutes after the first coat, and preferably within 24 hours. The total thickness of the two coats must be at least 1.5-2 mm. During this operation, it is inevitable that some of the concrete will also be coated with MAPEFER around the reinforcement rods. This will not create any kind of problem, since MAPEFER does not modify the adhesion of the repair mortar which, in normal environmental conditions, may be laid 4-5 hours after applying MAPEFER or even later, according to organisation of the site. The product meets the minimum requirements defined by EN 1504-07 regarding the protection against corrosion of reinforcement.

MAPEFER has the following performance characteristics:

Characteristics	Performance of product
Density (kg/m ³):	1,900
pH of mix:	> 12.6
Brookfield Viscosity:	20,000 mPa • s (6 rotor - 10 rpm)
Pot life:	approx. 1 hour (at 20°C)
Bond strength to concrete (MPa):	> 2.5
Bond strength to sand-blasted steel (MPa):	> 2.5
Consumption:	120 g/m (approx. 2 mm of product applied on Ø 8 mm rebar)

table 1

► 3.2| Protecting using MAPEFER 1K

Description: *single component, anti-corrosion cementitious mortar for protecting reinforcement rods.*

Apply MAPEFER 1K single component, anti-corrosion cementitious mortar on perfectly clean, rust-free reinforcement rods to bring the pH level back to more than 12, the minimum level required to guarantee passivation of the reinforcement rods. MAPEFER 1K creates a protective, waterproof barrier and protection against aggressive agents present in the atmosphere.

photo 1

Application of anti-corrosion mortar on reinforcement rods



After preparation, apply MAPEFER 1K by brush in two coats. We recommend completely covering the surface of the reinforcement with an even layer. The total thickness of the two coats must be at least 2 mm. During this operation, it is inevitable that some of the concrete will also be coated with MAPEFER 1K around the reinforcement rods. This will not create any kind of problem, since MAPEFER 1K does not modify the adhesion of the repair mortar which, in normal environmental conditions, may be laid 4-5 hours after applying MAPEFER 1K or even later, according to organisation of the site.

The product meets the minimum requirements for EN 1504-7 regarding the protection against corrosion of reinforcement.

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MAPEFER 1K has the following performance characteristics:

table 2

Characteristics	Test method	Minimum requirements according to EN 1504-7	Performance of product
Density of the mix (kg/m ³):	/	/	1,800
pH:	/	/	> 12.5
Pot life of mix:	/	/	approx. 1 hour (at 20°C)
Waiting time before applying repair mortar:	/	/	6-24 h (at +20°C)
Bond strength to substrate (MPa):	EN 1542	/	> 2.5 (after 28 gg)
Slip-resistance of reinforcement rods: - Load with reference to a movement of 0.1 mm:	EN 15184	Load equal to at least 80% of load on reinforcement with no coating	meets specifications
Resistance to corrosion: 10 condensation cycles in water; 10 cycles in sulphur dioxide according to EN ISO 6988; 5 days in saline mist according to EN 60068-2-11.	EN 15183	After the series of cycles, the protected rods must be corrosion-free. Penetration of rust at the ends of the steel rods with no protection must be < 1 mm.	meets specifications
Consumption (g/m):	/	/	100 (approx. 2 mm of product applied on a Ø 8 mm improved-adherence rebar)

► 4| **Positioning new reinforcement**

Diagnosis of the structure also includes the reinforcement rods, which are a fundamental part of a concrete structure. According to the results of the analysis, we can then decide which type of intervention must be carried out. A simple cleaning operation and application of a protective layer of a passivating product could be required. If the reinforcement is seriously compromised, on the other hand, with corrosion which has reduced its section by more than 30%, it will be necessary to place new reinforcement to strengthen the structure.

Where necessary, new reinforcement will be placed for the cast concrete to integrate the structure, and will become an integral part of the substrate by inserting a series of connectors. The dimensions and amount of reinforcement will result from the calculation of the reinforcement required for the structure.

photo 2
An example of new reinforcement applied on the surfaces to be repaired



Mapei mortars for repairing concrete

		WATER RETAINING STRUCTURES						
		Repairing walls	Repairing plateaus	Repairing joints	Repairing upstream facing walls	Repairing downstream facing walls	Repairing overflow channels	Fixing inspection shafts and manholes in place
Normal-setting thixotropic mortars	Mapegrout T60	•	•	•	•	•	•	
	Mapegrout FMR + Fibres FF	•	•	•	•	•	•	
	Mapegrout Easy Flow	•	•	•	•	•	•	
	Mapegrout Easy Flow GF	•	•	•	•	•	•	
	Mapegrout LM2K	•						
	Mapegrout BM	•	•	•	•	•	•	
Rapid-setting thixotropic mortars	Mapegrout SV T							•
Normal-setting castable mortars	Mapegrout Hi-Flow TI 20 + Fibres R60		•					•
	Mapegrout Hi-Flow GF		•					
Rapid-setting castable mortars	Mapegrout SV Fiber + Fibres R38		•					•
Cementitious binders	Stabilcem SCC	•			•	•		

► 5| **Repairing concrete using thixotropic mortar**

► 5.1| **Repairs using MAPEGROUT EASY FLOW**

Description: *single component, fibre-reinforced, compensated-shrinkage, sulphate-resistant thixotropic mortar, particularly suitable for repairing concrete structures with a rendering machine.*

Particularly suitable for: *repairing concrete structures by application with a rendering machine; particularly suitable when easy pumping over long distances and to elevated positions is required.*

photo 3

Mapegrout Easy Flow applied by spray

photo 4

A wall repaired using Mapegrout Easy Flow



Rebuilding of demolished parts by applying MAPEGROUT EASY FLOW on substrates saturated with water, but with a dry surface.

Thanks to its special composition, MAPEGROUT EASY FLOW is particularly suitable for repairing concrete structures when repair mortar is applied by spray, where the characteristics of the work (considerable height of the structure under repair, such as viaduct piles), the morphology of the site area (little space available to position mixing and pumping units next to the structure under repair) and for site organisation requirements, mortar which is easy to pump over long distances and up to considerable heights is required. To improve expansion in the open air during the first few days of curing, MAPEGROUT EASY FLOW must include 0.25% of MAPECURE SRA special liquid admix, which has the property of reducing hydraulic shrinkage and the formation of micro cracks. Layers of MAPEGROUT EASY FLOW thicker than 3 cm must only be applied after installing electro-welded metallic mesh of at least 10x10 cm and 5 mm diameter and after roughening the

Repairs to Water Retaining Structures

surface of the concrete, making sure that the concrete around the reinforcement is at least 2 cm thick. Thinner layers may be applied if there is no reinforcement, but the surface of the substrate must be well roughened before application to contrast expansion. The mortar may be applied by spray with a suitable worm-screw or piston-type rendering machine, such as a Turbosol or a Putzmeister.

The product meets the minimum requirements of EN 1504-3 Standards for R4-class structural mortar.

MAPEGROUT EASY FLOW has the following performance characteristics:

table 3

Characteristics	Test method	Minimum requirements according to EN 1504-3 for R4 class mortar	Performance of product
Density of the mix (kg/m ³):	/	/	2200
pH of mix:	/	/	> 12.5
Pot life of mix:	/	/	approx. 1 hour (at 20°C)
Mechanical characteristics using 17% of water:			
Compressive strength (MPa):	EN 12190	≥ 45 (after 28 days)	> 60 (after 28 days)
Flexural strength (MPa):	EN 196/1	/	> 8 (after 28 days)
Compressive modulus of elasticity (GPa):	EN 13412	≥ 20 (after 28 days)	27 (after 28 days)
Bond strength to substrate (MPa):	EN 1542	≥ 2 (after 28 days)	> 2 (after 28 days)
Crack resistance:	"O-Ring" Test	/	no cracks after 180 days
Resistance to accelerated carbonatation:	EN 13295	depth of carbonatation ≤ reference concrete (MC 0.45 type water/cement ratio = 0.45) according to UNI 1766	meets specifications
Impermeability to water: - penetration depth - (mm):	EN 12390/8	/	<5
Capillary absorption (kg/m ² • h ^{0.5}):	EN 13057	≤ 0.5	< 0.25
Slip-resistance of reinforcement rods: - bonding stress - (MPa):	EN 15184	/	≥ 25
Thermal compatibility to freeze-thaw cycles with deicing salts, measured as bonding according to EN 1542 (MPa):	EN 13687/1	≥ 2 (after 50 cycles)	> 2
Reaction to fire:	Euroclass	According to value declared by manufacturer	A1
Consumption (kg/m ²):	/	/	18.5 (per cm of thickness)

► **5.2| Repairs using MAPEGROUT EASY FLOW GF**

Description: *single component, shrinkage-compensated, sulphate-resistant, thixotropic, inorganic fibre-reinforced mortar for repairing concrete structures where higher ductility is required.*

Particularly suitable for: *repairing and/or enlarging sections of concrete structures using a rendering machine, applied at thicknesses of up to 5 cm without supporting reinforcement mesh. This product is particularly suitable when easy pumping over long distances and where elevated positions are required.*

Repairing deteriorated concrete structures and/or enlarging sections in concrete structures using MAPEGROUT EASY FLOW GF applied with a rendering machine. Thanks to its special composition, MAPEGROUT EASY FLOW GF is particularly suitable for repairing concrete structures when repair mortar is applied by spray, where the characteristics of the work (considerable height of the structure under repair, such as viaduct piles), the morphology of the site area (little space available to position mixing and pumping units in the vicinity of the structure under repair) and for site organisation requirements, mortar which is easy to

photo 5

Mapegrout Easy Flow GF
applied by spray



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pump over long distances and up to considerable heights is required. In fact, after mixing MAPEGROUT EASY FLOW GF with water, it forms a mortar with a thixotropic consistency which is very easy to apply, even on vertical surfaces, at thicknesses of between 1 and 5 cm without the need for dolly rods and formwork. To improve expansion in the open air during the first few days of the curing cycle, MAPEGROUT EASY FLOW GF must include 0.25% of MAPECURE SRA special liquid admix, which has the property of reducing hydraulic shrinkage and the formation of micro cracks. The mortar is usually applied using either a piston or worm-screw spray rendering machine, such as a Turbosol or a Putzmeister. The product meets the minimum requirements of EN 1504-3 Standards for R4-class structural mortar.

MAPEGROUT EASY FLOW GF has the following performance characteristics:

table 4

Characteristics	Test method	Minimum requirements according to EN 1504-3 for R4 class mortar	Performance of product
Density of the mix (kg/m ³):	/	/	2200
pH of mix:	/	/	> 12.5
Pot life of mix:	/	/	approx. 1 hour (at 20°C)
Mechanical characteristics using 16% of water:			
Compressive strength (MPa):	EN 12190	≥ 45 (after 28 days)	> 60 (after 28 days)
Flexural strength (MPa):	EN 196/1	/	> 11 (after 28 days)
Compressive modulus of elasticity (GPa):	EN 13412	≥ 20 (after 28 days)	27 (after 28 days)
Bond strength to substrate (MPa):	EN 1542	≥ 2 (after 28 days)	> 2 (after 28 days)
Crack resistance:	"O-Ring Test"	/	no cracks after 180 days
Resistance to accelerated carbonatation:	EN 13295	depth of carbonatation ≤ reference concrete (MC 0.45 type water/cement ratio = 0.45) according to UNI 1766	meets specifications
Impermeability to water: - penetration depth - (mm):	EN 12390/8	/	<5
Capillary absorption (kg/m ² • h ^{0.5}):	EN 13057	≤ 0.5	< 0.25
Slip-resistance of reinforcement rods: - bonding stress - (MPa):	EN 15184	/	≥ 25
Thermal compatibility to freeze-thaw cycles with deicing salts, measured as bonding according to EN 1542 (MPa):	EN 13687/1	≥ 2 (after 50 cycles)	> 2
Reaction to fire:	Euroclass	according to value declared by manufacturer	A1
Consumption (kg/m ²):	/	/	18.5 (per cm of thickness)

► **5.3| Repairs using MAPEGROUT T60**

Description: *fibre-reinforced, sulphate-resistant thixotropic mortar for repairing concrete.*

Particularly suitable for: *repairing deteriorated, normal concrete structures and reinforced cement structures subject to attack by sulphur. Hydraulic structures, repairs to concrete around reinforcement rods and applications on ceilings, such as the inside face of floor slabs.*

Repairing deteriorated, normal concrete structures and reinforced concrete structures subject to attack by sulphur using MAPEGROUT T60. Apply on substrates saturated with water, but with a dry surface. When this product is mixed with water, it forms a thixotropic mortar which is easy to apply, on vertical surfaces, even in high thicknesses, without formwork. To improve expansion in the open air during the first few days of the curing cycle, MAPEGROUT T60 may include 0.25%-0.5% of MAPECURE SRA special admix, which has the property of reducing plastic and hydraulic shrinkage and the

photo 6
Structure repaired
using Mapegrout T60



formation of micro cracks. If there is insufficient boundary support, filling layers of more than 20 mm must only be applied after inserting dolly rods and roughing the surface of the concrete. A layer of at least 20 mm thick must be applied over the rods. MAPEGROUT T60 may be applied by spray with a suitable worm-screw or piston-type spray rendering machine, such as a Turbosol or a Putzmeister.

The product meets the minimum requirements of EN 1504-3 Standards for R4-class structural mortar.

MAPEGROUT T60 has the following performance characteristics:

table 5

Characteristics	Test method	Minimum requirements according to EN 1504-3 for R4 class mortar	Performance of product
Density of the mix (kg/m ³):	/	/	2200
pH of mix:	/	/	> 12.5
Pot life of mix:	/	/	approx. 1 hour (at 20°C)
Mechanical characteristics using 17% of water:			
Compressive strength (MPa):	EN 12190	≥ 45 (after 28 days)	> 60 (after 28 days)
Flexural strength (MPa):	EN 196/1	/	> 8 (after 28 days)
Compressive modulus of elasticity (GPa):	EN 13412	≥ 20 (after 28 days)	27 (after 28 days)
Bond strength to substrate (MPa):	EN 1542	≥ 2 (after 28 days)	> 2 (after 28 days)
Crack resistance:	"O-Ring Test"	/	no cracks after 180 days
Resistance to accelerated carbonation:	EN 13295	depth of carbonation ≤ reference concrete (MC 0.45 type water/cement ratio = 0.45) according to UNI 1766	meets specifications
Impermeability to water: - penetration depth - (mm):	EN 12390/8	/	< 5
Capillary absorption (kg/m ² • h ^{0.5}):	EN 13057	≤ 0.5	< 0.25
Slip-resistance of reinforcement rods: - bonding stress - (MPa):	EN 15184	/	≥ 25
Thermal compatibility to freeze-thaw cycles with deicing salts, measured as bonding according to EN 1542 (MPa):	EN 13687/1	≥ 2 (after 50 cycles)	> 2
Reaction to fire:	Euroclass	According to value declared by manufacturer	A1
Consumption (kg/m ²):	/	/	18.5 (per cm of thickness)

► 5.4| Repairs using MAPEGROUT BM

Description: *two-component cementitious mortar with a low modulus of elasticity for restoration work to concrete.*

Particularly suitable for: *repairing deteriorated parts in concrete, the corners of beams and pillars and the front edges of balconies. Filling rigid joints, for example between footings and pillars.*

Repairing deteriorated cortex of concrete structures which are subject to small deformations under load, thermal cycles or which are exposed to particularly harsh climatic conditions using MAPEGROUT BM. Apply on substrates saturated with water, but with a dry surface. The maximum thickness to be applied for each layer is approximately 35 mm. For thicknesses of more than 30 mm, we recommend using electro-welded mesh embedded in the mortar. The product is applied by trowel or by spray without formwork, even on vertical surfaces or ceilings. The product meets the minimum requirements of EN 1504-3 Standards for R4-class structural mortar.

photo 7
Mapegrout BM
applied on a ceiling



MAPEGROUT BM has the following performance characteristics:

table 6

Characteristics	Test method	Minimum requirements according to EN 1504-3 for R4 class mortar	Performance of product
Density of the mix (kg/m ³):	/	/	2.100
pH of mix:	/	/	> 12.5
Pot life of mix:	/	/	approx. 1 hour (at 20°C)
Compressive strength (MPa):	EN 12190	≥ 45 (after 28 days)	> 47 (after 28 days)
Flexural strength (MPa):	EN 196/1	/	> 10 (after 28 days)
Compressive modulus of elasticity (GPa):	EN 13412	≥ 20 (after 28 days)	22 (after 28 days)
Bond strength to substrate (MPa):	EN 1542	≥ 2 (after 28 days)	> 2 (after 28 days)
Resistance to accelerated carbonatation:	EN 13295	depth of carbonatation ≤ reference concrete (MC 0.45 type water/cement ratio = 0.45) according to UNI 1766	meets specifications
Impermeability to water: - penetration depth - (mm):	EN 12390/8	/	<10
Capillary absorption (kg/m ² • h ^{0.5}):	EN 13057	≤ 0.5	< 0.25
Thermal compatibility measured as bonding according to EN 1542 (MPa):	EN 13687/1	≥ 2 (after 50 cycles)	> 2
Reaction to fire:	Euroclass	according to value declared by manufacturer	A1
Consumption (kg/m ²):	/	/	21 (per cm of thickness)

► **5.5| Repairs using MAPEGROUT FMR + FIBRES FF**

Description: *two-component, sulphate-resistant, shrinkage-compensated thixotropic mortar, reinforced using flexible, metal-alloy fibres, particularly suitable for repairing concrete structures where higher ductility is required.*

Particularly suitable for: *rebuilding the protective concrete layer in reinforced concrete structures. Repairing surfaces subject to high abrasion and impacts (channels, industrial floors, access ramps, etc.). Evening out diaphragm walls and tunnels.*

Repairing degraded vertical and horizontal surfaces and ceilings on concrete structures using MAPEGROUT FMR. This product meets the minimum requirements of the EN 1504-3 Standards for R4 class structural mortars. The mortar is characterised by better flexural and compressive strength and high resistance to impact. To guarantee that it expands in the open air during the first few days of the curing cycle, the product may also include

photo 8
Mapegrout FMR
applied by spray



MAPECURE SRA special liquid admix, which has the property of reducing hydraulic shrinkage and the formation of micro cracks. The product may be applied using traditional techniques, such as by trowel, or by spray using a piston-type rendering machine, at a maximum thickness of 50 mm per layer. The concrete surfaces to be rebuilt must be very rough because the mortar, due to its high adherence properties and high fibre content, generates an internal constraint comparable to that found in pre-compressed concrete. The product meets the minimum requirements of EN 1504-3 Standards for R4-class structural mortar.

MAPEGROUT FMR has the following performance characteristics:

table 7

Characteristics	Test method	Minimum requirements according to EN 1504-3 for R4 class mortar	Performance of product
Density of the mix (kg/m ³):	/	/	2200
pH of mix:	/	/	> 12.5
Pot life of mix:	/	/	approx. 1 hour (at 20°C)
Mechanical characteristics using 17.5% of water:			
Compressive strength (MPa):	EN 12190	≥ 45 (after 28 days)	> 64 (after 28 days)
Flexural strength (MPa):	EN 196/1	/	> 11 (after 28 days)
Compressive modulus of elasticity (GPa):	EN 13412	≥ 20 (after 28 days)	27 (after 28 days)
Bond strength to substrate (MPa):	EN 1542	≥ 2 (after 28 days)	> 2 (after 28 days)
Crack resistance:	"O-Ring Test"	/	no cracks after 180 days
Resistance to accelerated carbonatation:	EN 13295	depth of carbonatation ≤ reference concrete (MC 0.45 type water/cement ratio = 0.45) according to UNI 1766	meets specifications
Impermeability to water: - penetration depth - (mm):	EN 12390/8	/	< 5
Capillary absorption (kg/m ² • h ^{0.5}):	EN 13057	≤ 0.5	< 0.08
Slip-resistance of reinforcement rods: - bonding stress - (MPa):	EN 15184	/	≥ 25
Thermal compatibility to freeze-thaw cycles with deicing salts, measured as measured as bonding according to EN 1542 (MPa):	EN 13687/1	≥ 2 (after 50 cycles)	> 2
Reaction to fire:	Euroclass	according to value declared by manufacturer	A1
Consumption (kg/m ²):	/	/	19 (per cm of thickness)
CHARACTERISTICS OF THE FIBRES			
length/diameter ratio:	/	/	125
Length (mm):	/	/	30
Tensile strength (MPa):	/	/	> 1.900

► 5.6| Repairs using MAPEGROUT SV T

Description: *quick-setting and hardening, shrinkage-compensated thixotropic mortar for repairing concrete and fixing drains, manholes and urban fittings in place.*

Particularly suitable for: *repairing concrete elements, including those with a slope. Fixing inspection shafts and manholes in place, repairing pavements and fixing lamp-posts and fences in place. Anchoring protective barriers and crash barriers in place. Fixing grated covers for run-off channels in place.*

photo 9
Fixing a grated cover on a run-off channel in place using Mapegrout SV T



MAPEGROUT SV T is a single component, pre-blended, compensated-shrinkage thixotropic mortar in powder form, made from special hydraulic binders, high-strength cement, graded aggregates and special additives. MAPEGROUT SV T is suitable where large thicknesses need to be applied (up to 5 cm), in specially-prepared areas without the use of formwork. Thanks to its rapid hardening properties, it may be stepped on and opened to rubber-wheeled traffic after only 2 hours from application at a temperature of 23°C. Thanks to its special composition and the additives contained in the product, the mortar has high mechanical qualities even after a long period of time, is waterproof and is highly resistant to abrasion. Apply the product using a trowel in the pre-prepared area.

The product meets the minimum requirements of EN 1504-3 for R4-class structural mortar.

MAPEGROUT SV T has the following performance characteristics:

table 8

Characteristics	Test method	Minimum requirements according to EN 1504-3 for R4 class mortar	Performance of product
Density of the mix (kg/m ³):	/	/	2250
pH of mix:	/	/	> 12
Pot life of mix:	/	/	approx. 10 min. (at 20°C)
Mechanical characteristics using 13% of water at 20°C:			
Compressive strength (MPa):	EN 12190	≥ 45 (after 28 days)	> 45 (after 28 days)
Flexural strength (MPa):	EN 196/1	/	> 6 (after 28 days)
Compressive modulus of elasticity (GPa):	EN 13412	≥ 20 (after 28 days)	25 (after 28 days)
Bond strength to substrate (MPa):	EN 1542	≥ 2 (after 28 days)	> 2 (after 28 days)
Resistance to accelerated carbonatation:	EN 13295	depth of carbonatation ≤ reference concrete (MC 0.45 type water/cement ratio = 0.45) according to UNI 1766	meets specifications
Thermal compatibility to freeze/thaw cycles with de-icing salts, measured as adhesion according to EN 1542 (MPa):	EN 13687/1	≥ 2 (after 50 cycles)	> 2
Reaction to fire:	Euroclass	according to value declared by manufacturer	A1
Consumption (kg/m ²):	/	/	approx 20 (per cm of thickness)

► 5.7| Repairs using MAPEGROUT LM2K

Description: *two-component, thixotropic, fibre-reinforced, cementitious mortar with a low modulus of elasticity and added organic corrosion inhibitor for repairing concrete, applied in a single layer at a thickness of from 3 to 20 mm*

Particularly suitable for: *smoothing over surface defects in cast concrete, such as gravel clusters, spacer holes, construction joints, etc. Repairing deteriorated elements, such as beams, piles and pulvinoes.*

MAPEGROUT LM2K is a pre-blended thixotropic cementitious mortar with corrosion inhibitor made from two pre-closed components to be mixed together.

Component A (powder) is made from cement, selected, mixed aggregates, synthetic fibres and special additives which reduce both plastic shrinkage and final hygrometric shrinkage. Component B (liquid) is a solution of synthetic resin in water.

After hardening, MAPEGROUT LM2K has the following properties:

- Low modulus of elasticity;
- Excellent bond strength to old concrete (< 2 MPa) if dampened with water before application, and to reinforcement rods, especially if treated beforehand with MAPEFER or MAPEFER 1K;
- High dimensional stability and, therefore, low risk of cracking during the plastic phase and when hardened;
- Resistance to aggressive agents in the atmosphere (e.g. CO₂).

The product meets the minimum requirements of EN 1504-3 for R3-class structural mortar.



photo 10
Application of
MAPEGROUT LM2K

MAPEGROUT LM2K has the following performance characteristics:

Table 9

Characteristics	Test method	Minimum requirements according to EN 1504-3 for R3 class mortar	Performance of product
Density of mix (kg/m ³):	/	/	2080
Pot life of mix:	/	/	approx. 1 hour (at 20°C)
Compressive strength (Mpa):	EN 12190	≥ 25 (after 28 days)	≥ 38 (after 28 days)
Flexural strength (Mpa):	EN 196/1	/	≥ 7 (after 28 days)
Compressive modulus of elasticity (GPa):	EN 13412	≥ 15 (after 28 days)	17 (after 28 days)
Bond strength to substrate (Mpa):	EN 1542	≥ 1.5 (after 28 days)	≥ 2 (after 28 days)
Resistance to accelerated carbonatation:	EN 13295	Depth of carbonatation ≤ the reference concrete (MC 0.45 type water/cement ratio ≤ 0.45) according to UNI 1766	meets specifications
Thermal compatibility to freeze/thaw cycles with de-icing salts measured as bond strength EN 1542 (MPa):	EN 13687/1	≥ 1.5 (after 50 cycles)	≥ 2
Reaction to fire:	Euroclass	value declared by manufacturer	E
Consumption (kg/m ²):	/	/	approx. 21 (per cm of thickness)

► **5.8 | Summary of the main characteristics of thixotropic repair mortars**

Characteristics	THIXOTROPIC MORTARS						
	Mapegrout Easy Flow	Mapegrout Easy Flow GF	Mapegrout T60	Mapegrout BM	Mapegrout LM2K	Mapegrout FMR + Fibres FF	Mapegrout SV T
Standards class according to EN 1504-3	R4	R4	R4	R4	R3	R4	R4
Maximum size of aggregate	2.5 mm	2.5 mm	2.5 mm	2.5 mm	1.6 mm	2.5 mm	2.5 mm
Mixing ratio	16,5% - 17,5% of water	15,5% - 16,5% of water	16,5% - 17,5% of water	Comp. A : Comp. B 5,3 : 1	Comp. A : Comp. B 10 : 2,1	17% - 18% of water	12,5% - 13,5% of water
Density of mix	2200 kg/m ³	2200 kg/m ³	2200 kg/m ³	2100 kg/m ³	2080 kg/m ³	2200 kg/m ³	2250 kg/m ³
Application temperature range	from +5°C to +35°C	from +5°C to +35°C	from +5°C to +35°C	from +5°C to +35°C	from +5°C to +35°C	from +5°C to +35°C	from +5°C to +35°C
Pot life of mix	approx 1h	approx 1h	approx 1h	approx 1h	approx 1h	approx 1h	approx 10'
Compressive strength	> 60 MPa after 28 days	> 60 MPa after 28 days	> 60 MPa after 28 days	> 47 MPa after 28 days	≥ 38 MPa after 28 days	64 MPa after 28 days	45 MPa after 28 days
Flexural strength	> 8 MPa after 28 days	11 MPa after 28 days	> 8 MPa after 28 days	> 10 MPa after 28 days	> 7 MPa after 28 days	11 MPa after 28 days	> 6 MPa after 28 days
Compressive modulus of elasticity	27 GPa after 28 days	27 GPa after 28 days	27 GPa after 28 days	22 GPa after 28 days	17 GPa after 28 days	27 GPa after 28 days	25 GPa after 28 days
Bond strength on concrete according to EN 1766	> 2 MPa after 28 days	> 2 MPa after 28 days	> 2 MPa after 28 days	> 2 MPa after 28 days	> 2 MPa after 28 days	> 2 MPa after 28 days	> 2 MPa after 28 days
Thermal compatibility to freeze-thaw cycles with de-icing salts, measured as bond strength according to EN 1542	> 2 MPa	> 2 MPa	> 2 MPa	> 2 MPa	> 2 MPa	> 2 MPa	> 2 MPa
Maximum thickness applied by hand	35 mm	50 mm	40 mm	35 mm	20 mm	50 mm	50 mm
Consumption	18.5 kg/cm ² per cm of thickness	18.5 kg/cm ² per cm of thickness	18.5 kg/cm ² per cm of thickness	21 kg/cm ² per cm of thickness	21 kg/cm ² per cm of thickness	19 kg/cm ² per cm of thickness	20 kg/cm ² per cm of thickness

► 6 | Repairing concrete using castable mortar

► 6.1 | Repairs using MAPEGROUT HI-FLOW TI 20 + FIBRES R60

Description: *castable, shrinkage-compensated, fibre-reinforced, high-ductility cementitious mortar, used in combination with stiff steel fibres for repairing concrete.*

Particularly suitable for: *repairing concrete structures where high thicknesses are required, by casting into formwork at a thickness of up to 5 cm without the need for reinforcement mesh. Structural reintegration of pillars, beams, pulvinoes and reinforced concrete bearing elements, reintegration of floor slabs and repairs to concrete floors.*

Repairs where high thicknesses are required, or when repairs to complicated shapes require the use of a free-flowing mortar, using MAPEGROUT HI-FLOW TI 20 + FIBRES R60. Apply on substrates saturated with water but with a dry surface. When MAPEGROUT HI-FLOW TI 20 is mixed with water and 4.5% of FIBRES R60, it forms a highly-fluid mortar which is suitable for casting into formwork, without segregation, at a thickness of between 1 and 5 cm, and does not require electro-welded mesh as a support. To improve expansion in the open air during the first days of the curing cycle, MAPEGROUT HI-FLOW TI 20 must include 0.25 of MAPECURE SRA special liquid admix, which has the property of reducing hydraulic shrinkage and the formation of micro cracks. Pour MAPEGROUT HI-FLOW TI 20 into the formwork in a continuous flow from one side only, in order to help all air to be expelled.



photo 11

Filling a joint using
Mapegrout Colabile TI 20

The product meets the minimum requirements of EN 1504-3 Standards for R4-class structural mortar.

MAPEGROUT HI-FLOW TI 20 + FIBRES R60 has the following performance characteristics:

table 10

Characteristics	Test method	Minimum requirements according to EN 1504-3 for R4 class mortar	Performance of product
Density of mix (kg/m ³):	/	/	2300
pH of mix:	/	/	> 12.5
Pot life of mix:	/	/	approx. 1 hour (at 20°C)
Mechanical characteristics using 14% of water:			
Compressive strength (MPa):	EN 12190	≥ 45 (after 28 days)	> 70 (after 28 days)
Flexural strength (MPa):	EN 196/1	/	> 16 (after 28 days)
Compressive modulus of elasticity (GPa):	EN 13412	≥ 20 (after 28 days)	27 (after 28 days)
Bond strength to the substrate (MPa):	EN 1542	≥ 2 (after 28 days)	> 2 (after 28 days)
Impeded contraction in open air (µm/m):	UNI 8147 mod.	/	> 400 (after 1 day)
Crack resistance:	“O-Ring Test”	/	no cracks after 180 days
Resistance to accelerated carbonatation:	EN 13295	depth of carbonatation ≤ reference concrete (MC 0.45 type water/cement ratio = 0.45) according to UNI 1766	meets specifications
Impermeability to water: - penetration depth - (mm):	EN 12390/8	/	< 5
Capillary absorption (kg/m ² • h ^{0.5}):	EN 13057	≤ 0.5	< 0.3
Slip-resistance of reinforcement rods: - bonding stress - (MPa):	EN 15184	/	≥ 25
Thermal compatibility to freeze-thaw cycles with deicing salts, measured as measured as bonding according to EN 1542 (MPa):	EN 13687/1	≥ 2 (after 50 cycles)	> 2
Toughness: - load at first cracking: - toughness index:	ASTM C1018	none	> 20 kN I ₂₀ > 20
Fire resistance:	Euroclass	According to value declared by manufacturer	A1
Consumption (kg/m ²):	/	/	approx. 20 (per cm of thickness)
CHARACTERISTICS OF THE FIBRES			
Length (mm):	/	/	30
Diameter (mm):	/	/	0.6
Tensile strength (MPa):	/	/	> 1,200
Modulus of elasticity (GPa):	/	/	210

► 6.2| Repairs using MAPEGROUT SV FIBER + FIBRES R38

Description: *castable, shrinkage-compensated, quick-setting and hardening, high-ductility cementitious mortar applied at temperatures as low as -5°C, used in combination with stiff steel fibres for repairing concrete.*

Particularly suitable for: *repairing concrete structures where high thicknesses and special conformations of deterioration require the use of a free-flowing mortar, including at low temperatures. Repairing concrete floors. Repairing water retaining structures (breather channels, canals and forced run-off channels).*

Casting MAPEGROUT SV FIBER into leak-proof formwork, at a thickness of from 10 to 50 mm. MAPEGROUT SV FIBER must be mixed with rigid, stiff, hooked fibres in brass-plated steel called FIBRES R38 with the following characteristics:

- Length: 30 mm
- Diameter: 0.38 mm
- Tensile strength: > 2600 MPa

When MAPEGROUT SV FIBER is mixed with water and 2.5% of fibres, it forms a fluid mortar which is suitable for casting into formwork, without segregation, at a thickness of between 10 and 50 mm. If the thickness to be repaired is higher than 50 mm, suitably-sized gravel according to the thickness to be rebuilt must be added at a rate of 30% to 50% in weight of the mortar.



photo 12
Repairs to a floor using
Mapegrout SV Fiber

The cast mortar must be reinforced as required with metallic reinforcement inserted at approximately half the thickness of the mortar, and must be connected to the old reinforcement rods. Also, the surfaces of the element under repair must be saturated with water.

The product meets the minimum requirements of EN 1504-3 Standards for R4-class structural mortar.

MAPEGROUT SV FIBER has the following performance characteristics:

table 11

Characteristics	Test method	Minimum requirements according to EN 1504-3 for R4 class mortar	Performance of product
Density of mix (kg/m ³):	/	/	2400
pH of mix:	/	/	> 12.5
Pot life of mix:	/	/	approx. 20 min. (at 20°C)
Mechanical characteristics using 13.5% of water and 20°C:			
Compressive strength (MPa):	EN 12190	≥ 45 (after 28 days)	> 70 (after 28 days)
Flexural strength (MPa):	EN 196/1	/	> 20 (after 28 days)
Compressive modulus of elasticity (GPa):	EN 13412	≥ 20 (after 28 days)	29 (after 28 days)
Bond strength to the substrate (MPa):	EN 1542	≥ 2 (after 28 days)	> 2 (after 28 days)
Crack resistance:	“O-Ring Test”	/	no cracks after 180 days
Resistance to accelerated carbonatation:	EN 13295	depth of carbonatation ≤ reference concrete (MC 0.45 type water/cement ratio = 0.45) according to UNI 1766	meets specifications
Impermeability to water: - penetration depth - (mm):	EN 12390/8	/	< 5
Capillary absorption (kg/m ² • h ^{0.5}):	EN 13057	≤ 0.5	< 0.35
Slip-resistance of reinforcement rods: - bonding stress - (MPa):	EN 15184	/	≥ 25
Thermal compatibility to freeze-thaw cycles with deicing salts, measured as bonding according to EN 1542 (MPa):	EN 13687/1	≥ 2 (after 50 cycles)	> 2
Toughness: - load at first cracking: - toughness index:	ASTM C1018	none	> 20 kN I ₂₀ > 20
Fire resistance:	Euroclass	according to value declared by manufacturer	A1
Consumption (kg/m ²):	/	/	approx. 20 (per cm of thickness)
CHARACTERISTICS OF THE FIBRES			
Length (mm):	/	/	30
Diameter (mm):	/	/	0.38
Tensile strength (MPa):	/	/	> 2.600

► 6.3| Repairs using MAPEGROUT HI-FLOW GF

Description: *castable, compensated-shrinkage cementitious mortar reinforced with inorganic fibres, for repairing concrete structures where higher ductility is required.*

Particularly suitable for: *repairing motorway, road and railway viaduct piles. Repairing the lower spigots on pre-compressed beams for viaducts. Reintegrating floor slabs after removing deteriorated areas by scarifying. Repairs to concrete floors.*

MAPEGROUT HI-FLOW GF is a one-component pre-blended mortar made from high-strength cement, selected graded aggregates, special additives and synthetic and inorganic fibres.

When MAPEGROUT HI-FLOW GF is mixed with water, it forms a fluid mortar which is suitable for casting into formwork without segregating at a thickness of between 1 and 5 cm.

No electro-welded mesh is required as a support. MAPEGROUT HI-FLOW GF may also include 0.25% of MAPECURE SRA, a special admix with the property of reducing plastic and hydraulic shrinkage and the formation of micro cracks.

The product meets the minimum requirements of EN 1504-3 Standards for R4-class structural mortar.



photo 13
Application of
Mapegrout Hi-Flow GF

MAPEGROUT HI-FLOW GF has the following performance characteristics:

Table 12

Characteristics	Test method	Minimum requirements according to EN 1504-3 for R4 class mortar	Performance of product
Density of mix (kg/m ³):	/	/	2350
Pot life of mix:	/	/	approx. 1 hour (at 20°C)
pH of mix:	/	/	> 12.5
Compressive strength (Mpa):	EN 12190	≥ 45 (after 28 days)	≥ 65 (after 28 days)
Flexural strength (Mpa):	EN 196/1	/	10 (after 28 days)
Compressive modulus of elasticity (GPa):	EN 13412	≥ 20 (after 28 days)	27 (after 28 days)
Bond strength to substrate (Mpa):	EN 1542	≥ 2 (after 28 days)	> 2 (after 28 days)
Resistance to accelerated carbonatation:	EN 13295	Depth of carbonatation ≤ the reference concrete (MC 0.45 type water/cement ratio ≤ 0.45) according to UNI 1766	meets specifications
Thermal compatibility to freeze/thaw cycles with de-icing salts measured as bond strength EN 1542 (MPa):	EN 13687/1	≥ 2 (after 50 cycles)	> 2
Reaction to fire:	Euroclass	value declared by manufacturer	A1
Consumption (kg/m ²):	/	/	approx. 21 (per cm of thickness)

► **6.4 | Summary of the main characteristics of castable repair mortars**

Characteristics	CASTABLE MORTARS		
	Mapegrout Hi-Flow GF	Mapegrout Hi-Flow TI 20+ Fibre R60	Mapegrout SV Fiber+ Fibres R38
Standards class according to EN 1504-3	R4	R4	R4
Maximum size of aggregate	2.5 mm	2.5 mm	2.5 mm
Mixing ratio	14% - 16% of water	14% - 16% of water	13,5% - 14,5% of water
Density of mix	2.350 kg/m ³	2.300 kg/m ³	2.350 kg/m ³
Application temperature range	from +5°C to +35°C	from +5°C to +35°C	from +5°C to +35°C
Pot life of mix	approx 1h	approx 1h	from 15' to 1 h
Compressive strength	> 65 MPa after 28 days	> 70 MPa after 28 days	> 70 MPa after 28 days
Flexural strength	10 MPa after 28 days	> 16 MPa after 28 days	> 20 MPa after 28 days
Compressive modulus of elasticity	27 GPa after 28 days	27 GPa after 28 days	29 GPa after 28 days
Bond strength on concrete according to EN 1766	> 2 MPa after 28 days	> 2 MPa after 28 days	> 2 MPa after 28 days
Thermal compatibility to freeze-thaw cycles with de-icing salts, measured as bond strength according to EN 1542	> 2 MPa	> 2 MPa	> 2 MPa
Maximum thickness applied by hand	50 mm	50 mm	50 mm
Consumption	21 kg/cm ² per cm of thickness	20 kg/cm ² per cm of thickness	20 kg/cm ² per cm of thickness

► 7| **Repairing concrete using cementitious binders**

► 7.1| **Repairs using STABILCEM SCC**

Description: *Cementitious binder for mixing self-compacting, volumetrically-stable concrete, used for repairing concrete structures.*

Particularly suitable for: *preparing self-compacting, shrinkage-compensated, high-strength concrete, applied by pumping or casting, without the need to vibrate the cast concrete.*



photo 14
Super-fluid concrete
prepared using
Stabilcem SCC

Increasing the section of piles using self-compacting, high-strength, pozzolanic-reaction volumetrically-stable concrete without segregation.

Concrete applied using a concrete pump or by casting into formwork, without the need of vibrating the cast concrete.

STABILCEM SCC special binder is used to prepare the concrete, specially formulated to guarantee no shrinkage during the first few weeks of the curing cycle, including in open air.

According to the type of aggregate available and performance characteristics required, the dosage rate of the binder is between 550 and 600 kg/m³.

The concrete is prepared on site or in a cement-mixing plant, and must include from 25 to 35 kg/m³ of calcium oxide-based expanding agent, and 5 kg/m³ of MAPECURE SRA glycol-based curing admix, which has the property of containing shrinkage by reducing the surface tension of the capillary pores in the cementitious paste, and DYNAMON SP3 super-plasticiser or similar admix, according to the surrounding temperature, so that the formwork may be removed approximately 14 hours after casting.

The mix must contain inert materials with good grain-size distribution, with a maximum diameter of 15 mm, and a water/binder ratio of ≤ 0.35 .

Beton and concrete prepared using STABILCEM SCC has the following characteristics:

table 13

Characteristics	Performance of product
Density of the mix (kg/m ³):	2300
Slump flow (cm):	72
Compressive strength (EN 12390-3) (MPa): after 18 h at 10°C: after 18 h at 15°C: after 18 h at 20°C: after 1 day at 10°C: after 1 day at 15°C: after 1 day at 20°C: after 28 days at 10°C: after 28 days at 15°C: after 28 days at 20°C:	> 2 MPa > 10 MPa > 18 MPa > 8 MPa > 18 MPa > 24 MPa > 55 MPa > 55 MPa > 55 MPa
Bleeding:	none
Contrasted expansion (UNI 8148 mod.) (open-air curing at 20°C and 55% R.H.): after 24 hours: after 90 days:	300 µm/m < 100 µm/m
Impermeability according to EN 12390-8 penetration of water:	< 5 mm
Beton must be impermeable to water and conform to the exposition classes according to EN 206-1 Standards:	XC1-XC4, XS1-XS3, XD1-XD3, XF1-XF4, XA1-XA3
Dosage of binder: beton (kg/m ³): concrete (kg/m ³):	600 500-600

► 8 | Interrupting seeping water by injecting resin

► 8.1 | Injection with RESFOAM 1 KM

Description: *single component, ultra-fluid polyurethane resin applied by injection with variable reaction times, for waterproofing structures, ground and rocks subject to seeping water.*

Particularly suitable for: *waterproofing cracked concrete and masonry structures subject to seeping water, including water under pressure. For example, cracked galleries or in correspondence with construction joints between keystones.*

Repairing cracks in dams, canals and bulkheads, including those below the level of the water table.

RESFOAM 1 KM is a single component, halogen-free polyurethane resin made from a mixture of isocyanates, special additives and an accelerating agent. Before using RESFOAM 1 KM, it must be mixed with RESFOAM 1 KM AKS (accelerating agent) which, thanks to its special properties and according to the dosage used (from 5% to 20% in weight of the resin), regulates the reaction time of the system according to site requirements.

After mixing with the accelerating agent, and if there is no humidity, RESFOAM 1 KM remains workable for approximately one hour. During the period of its useful working life, RESFOAM 1 KM must be injected through packers into the structure to be waterproofed, using a piston or membrane-pump for single component products. When the resin comes into contact with water, it forms a semi-rigid, waterproof polyurethane foam. Thanks to its high fluidity, RESFOAM 1K is even able to penetrate through cracks which are only a few tenths of a millimetre wide, and to seal them even if water is seeping through. Once set, which takes place after 40-80 seconds according to the temperature and amount of accelerating agent used, RESFOAM 1 KM guarantees complete waterproofing of the area treated.

RESFOAM 1 KM has the following characteristics:

Characteristics	Performance of product			
Reactivity according to temperature with 10% of accelerator:				
- temperature:	5°C	10°C	15°C	23°C
- temperature at start of growth in seconds:	21	19	17	11
- temperature at end of growth in seconds:	80	76	68	62
Reactivity according to temperature with 15% of accelerator:				
- temperature:	5°C	10°C	15°C	23°C
- temperature at start of growth in seconds:	18	15	12	8
- temperature at end of growth in seconds:	62	50	48	41
Expansion ratio in open air:	40-60			
Dimensional stability:	yes			

table 14

► 8.2| Injection with FOAMJET F

Description: *two-component, extremely quick-setting, fluid polyurethane resin applied by injection, for consolidating and waterproofing structures subject to seeping water.*

Particularly suitable for: *repairing and waterproofing cracked concrete and masonry structures subject to seeping water, including when under pressure. For example, cracked galleries or in correspondence with construction joints between keystones. Repairing cracks in dams, channels and bulkheads, including those below the level of the water table.*

photo 15
Injection of Foamjet F



FOAMJET F is a two-component, halogen-free polyurethane resin composed of: FOAMJET F Comp A, a mixture of polyhydric alcohol, polyether and special additives, and FOAMJET Comp B, diphenylmethane di-isocyanate-based poly-isocyanates. After mixing the two components together at a ratio of 1:1 in volume with a special pump, FOAMJET F forms an extremely hard polyurethane foam. Thanks to its high fluidity, FOAMJET F is even able to penetrate through cracks which are only a few tenths of a millimetre wide, and to seal them even when there is water seeping through. After setting, which occurs after 45-70 seconds according to the surrounding temperature, FOAMJET F becomes completely waterproof and guarantees good consolidation of the treated structure.

FOAMJET F has the following characteristics:

table 15

Characteristics	Performance of product
Reactivity without presence of water: - start of reaction at 15°C: - start of reaction at 25°C: - end of reaction at 15°C: - end of reaction at 25°C: - hardening time at 15°C: - hardening time at 25°C: - foaming coefficient at 15°C: - foaming coefficient at 25°C:	1 min 10 sec ± 5 sec 45 sec ± 5 sec 1 min 11 sec ± 5 sec 46 sec ± 5 sec 15 min ± 60 sec 8 min ± 60 sec 1 1
(*) Reactivity with presence of water: - start of reaction at 15°C: - start of reaction at 25°C: - end of reaction at 15°C: - end of reaction at 25°C: - hardening time at 15°C: - hardening time at 25°C: - foaming coefficient at 15°C: - foaming coefficient at 25°C:	1 min 20 sec ± 10 sec 50 sec ± 10 sec 3 min 10 sec ± 10 sec 1 min 40 sec ± 10 sec 8 min ± 60 sec 5 min ± 60 sec approx. 3 approx. 3

(*) After mixing 50 dm³ of component A and 50 dm³ of component B for 10 seconds, 100 dm³ of water were added. The data above refers to laboratory trials, and may be subject to variation according to site conditions

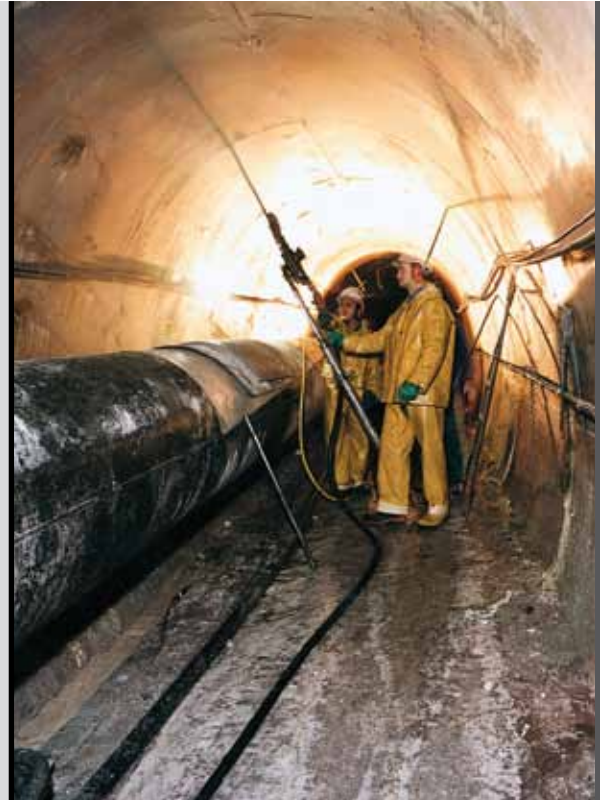
► 8.3| Injection with FOAMJET T

Description: *two-component, extremely quick-setting, high-viscosity polyurethane resin for injection purposes, for waterproofing structures with seeping water under high-pressure.*

Particularly suitable for: *waterproofing against strong flows of seeping water, for example through cracks into tunnels, or in correspondence with construction joints between keystones. Waterproofing wells or hydraulic structures with high leakages between working joints or cracks.*

FOAMJET T is a two-component, halogen-free polyurethane resin composed of: FOAMJET T Comp A, a mixture of polyhydric alcohol, polyether and special additives, and FOAMJET T Comp B, diphenylmethane di-isocyanate-based poly-isocyanates. After mixing the two components together at a ratio of 1:1 in volume with a special pump, FOAMJET T forms an extremely hard polyurethane foam. Thanks to its rheologic properties, FOAMJET T is even able to penetrate through cracks which are only a few tenths of a millimetre wide, and to seal them even if there is water seeping through. After setting, which occurs after 45-70 seconds according to the surrounding temperature, FOAMJET T becomes completely waterproof and guarantees good consolidation of the treated structure.

photo 16
Injection of Foamjet T



FOAMJET T has the following characteristics:

table 16

Characteristics	Performance of product
(*) Characteristics of the mix:	
- setting time at 15°C:	1 min 20 sec ± 15 sec
- setting time at 25°C:	45 sec ± 10 sec
- hardening time at 15°C:	15 min ± 60 sec
- hardening time at 25°C:	8 min ± 60 sec
- foaming coefficient at 15°C:	1.1 – 2.0
- foaming coefficient at 25°C:	1.1 – 2.0

(*) After mixing 50 dm³ of component A and 50 dm³ of component B for 10 seconds, 100 dm³ of water were added. The data above refers to laboratory trials, and may be subject to variation according to site conditions

Mapei mortars for smoothing, levelling, protecting and waterproofing concrete

	Product	Mapefinish	Mapelastic	Mapelastic Smart	Idrosilex Pronto
Type	Normal setting	•	•	•	•
	Rapid setting				
Application	Trowel/Flat trowel	•	•		•
	Roller/Brush			•	•
Where to use	Natural finish smoothing layer	•			
	Waterproofing		•	•	•
	Flexible finishing and smoothing layer		•	•	
	Smoothing out surface defects	•			
	Localised repairs				
	Abrasion resistance	•			
	Protecting against aggressive agents	•	•	•	

► **9| Smoothing, protecting and waterproofing concrete surfaces.**

► **9.1| Protection and waterproofing with MAPELASTIC**

Description: *two-component, flexible cementitious mortar for protecting and waterproofing concrete surfaces, balconies and swimming pools.*

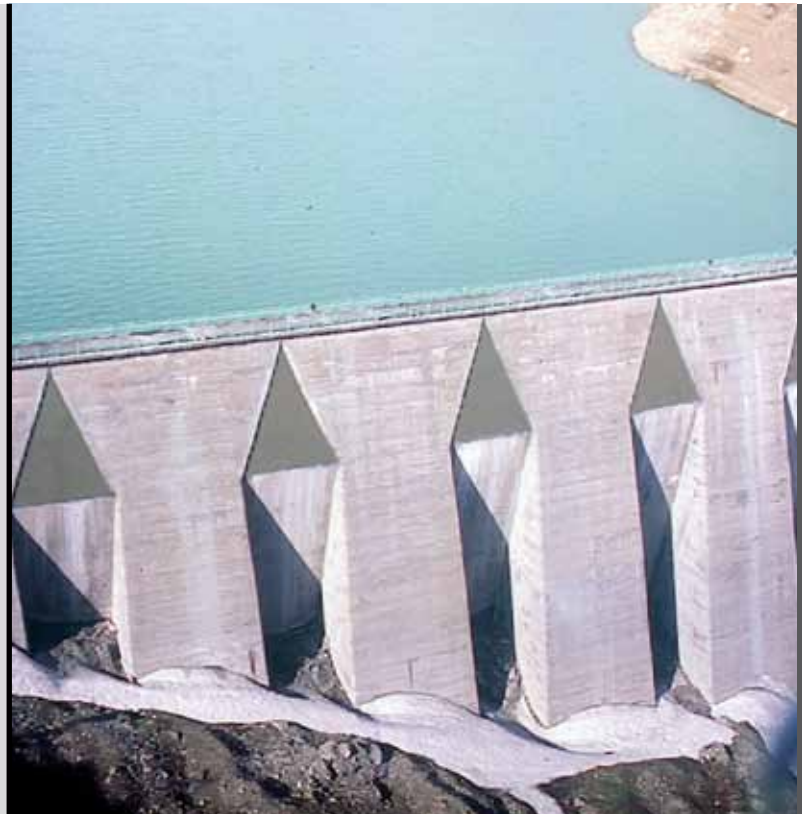
Particularly suitable for: *waterproofing and protecting concrete structure, including those subject to small deformations, render and cementitious screeds.*

Water tanks, bathrooms, showers, balconies and retaining walls.

Protecting against the penetration of water and aggressive atmospheric agents, seawater, de-icing salts and sulphate salts.

Waterproofing and protecting structures using MAPELASTIC. After mixing together the two components which make up MAPELASTIC to form a homogenous, lump-free product, apply according to the type of intervention to be carried out. The product may be applied manually using a smooth trowel or, in the case of large surface areas, as in this case, by spray using a rendering machine with a smoothing and levelling fitting. One of the following machines may be used to apply the product by spray:

photo 17
Structure waterproofed
using Mapelastic



1. Turbosol T6 or similar;
2. Agres Jolly;
3. Putzmeister S5 EV/TM/2.

Whatever type of the above equipment is used, a fitting for smoothing and levelling fitting must be used with a 10 mm diameter nozzle, with an air compressor with a capacity of 800 l/min.

Dampen the surface and apply a layer of at least 2 mm of MAPELASTIC by spraying within 60 minutes after mixing, and finish off with a flat trowel.

Thanks to the high content and quality of the synthetic resins, the hardened layer of the product remains highly flexible under all environmental conditions.

The product meets the minimum requirements of EN 1504-2 regarding protection systems for concrete surfaces.

MAPELASTIC has the following performance characteristics:

table 17

Characteristics	Performance of product
Mixing ratio:	component A . component B = 3 : 1
Density of mix (kg/m ³):	1,700
Pot life of mix:	1 hour (at 20°C)
Bond strength to concrete (MPa): - after 28 days at 20°C and 50% R.H.: - after 7 days at 20°C and 50% R.H. + 21 days in water:	1.1 0.6
Impermeability (EN12390/8 Mod) (1.5 atm for 7 days):	waterproof
Elongation according to DIN 53504 Mod.: - after 28 days at 20°C and 50% R.H. (%)	30
Vapour diffusion resistance coefficient (μ):	1,500
Resistance to freeze/thaw cycles of the treated concrete (UNI 7087):	more than 300 cycles
Resistance to calcium chloride (after 60 days in a 30% CaCl solution), measured by checking the loss in compressive strength of a concrete sample with a water/cement ratio of 0.4, protected with the cementitious waterproofing mortar:	no loss in performance
Resistance to sodium chloride (after 60 days in a 10% NaClP solution), measured by checking the Cl-ion penetration in a concrete sample with a water/cement ratio of 0.8, protected with the cementitious waterproofing mortar (mm):	≤ 2
Resistance to carbonatation (after 60 days in a 30% CO ₂ solution), measured by checking the carbonatation penetration in a concrete sample with a water/cement ratio of 0.8, protected with the cementitious waterproofing mortar (mm):	≤ 2
Fracture covering capacity Crack bridging at failure of the non-strengthened film layer: - after 28 days at 20°C and 50% R.H.: - after 7 days at 20°C and 50% R.H. + 21 days in water: - after 7 days at 20°C and 50% R.H. + 18 months in water:	width 0.8 mm width 0.6 mm width 0.5 mm
Crack-bridging at breakage of film reinforced with glass fibre mesh:	width 1.5 mm
Crack-bridging at breakage of film reinforced with non-woven fabric:	width > 3 mm
Consumption (kg/m ²): - manual application: - spray application using rendering machine:	approx. 1.7 (per mm of thickness) approx. 2.2 (per mm of thickness)

► 9.2| Protection and waterproofing with MAPELASTIC SMART

Description: *two-component, high-flexibility cementitious mortar, applied by brush or with a roller, for waterproofing concrete surfaces such as foundations, retaining walls, balconies, terraces, bathrooms and swimming pools, and for protecting against the penetration of aggressive agents.*

Particularly suitable for: *waterproofing and protecting concrete structures, may be applied by brush which makes it particularly suitable for waterproofing irregular-shaped surfaces. Waterproofing hydraulic structures and retaining walls. Protecting against the infiltration of water and aggressive atmospheric agents, seawater, de-icing salts and sulphate salts.*

Protecting new concrete structures, and concrete structures repaired using special mortar from the MAPEGROUT or PLANITOP ranges using MAPELASTIC SMART. When the two components are mixed together, a blend with a plastic consistency is obtained. It may be applied by brush or roller, or by spraying with a worm screw rendering machine with a smoothing and levelling fitting, on both horizontal and vertical surfaces at a thickness of approximately 2 mm per layer. Thanks to the high content and quality of the synthetic resins, the hardened layer of MAPELASTIC SMART remains constantly flexible under all environmental conditions. The product meets the minimum requirements of EN 1504-2 regarding protection systems for concrete surfaces.

MAPELASTIC SMART has the following performance characteristics:

table 18

Characteristics	Performance of product
Mixing ratio	component A : component B = 2 : 1
Density of mix (kg/m ³):	1600
Pot life of mix:	1 hour (at 20°C)
Bond strength to concrete (MPa): - after 28 days at 20°C and 50% R.H.: - after 7 days at 20°C and 50% R.H. + 21 days in water:	1.7 0.9
Impermeability (EN12390/8 Mod) (1.5 atm for 7 days):	waterproof
Elongation according to DIN 53504 Mod: - after 28 days at 20°C and 50% R.H.	130
Fracture covering capacity Crack-bridging at failure of the film layer without reinforcement: - after 28 days at 20°C and 50% R.H.: - after 7 days at 20°C and 50% R.H. + 21 days in water:	width 2.5 mm width 1.6 mm
Crack-bridging at failure of the film layer without reinforcement at -10°C - after 28 days at 20°C and 50% R.H.:	width 0.8 mm
Crack-bridging at breakage of film reinforced with non-woven fabric: - after 28 days at 20°C and 50% R.H.:	width > 3 mm
Crack-bridging at breakage of film reinforced with non-woven fabric at -10°C: - after 28 days at 20°C and 50% R.H.:	1.5 mm width
Consumption (kg/m ²): - application by brush or roller:	approx. 1.6 (per mm of thickness)

► 9.3| Protection with MAPEFINISH

Description: *two-component cementitious mortar for finishing off concrete.*

Particularly suitable for: *evening out surface defects in cast concrete before being painted over. Smoothing and levelling off concrete repaired using mortar from the MAPEGROUT range. Protecting concrete against weak aggressive agents from the surrounding environment.*

Protecting and evening out surfaces in MAPEFINISH two-component cementitious mortar for finishing off concrete. When the two components are mixed together, a free-flowing mix is obtained which may be easily applied, even on vertical surfaces, at a thickness of up to 2-3 mm in one single coat. Thanks to its high content of synthetic resin, MAPEFINISH has high bonding strength to all concrete surfaces and, once hardened, forms a tough, compact, layer which is impermeable to water and harmful gases present in the atmosphere (CO₂ - SO₂ - nitrous oxides) and is resistant to freeze-thaw cycles. The product meets the minimum requirements of EN 1504-3 regarding protection systems for concrete surfaces and EN 1504-2 regarding non-structural mortars of class R2.

MAPEFINISH has the following performance characteristics:

Characteristics	Performance of product
Density (kg/m ³):	1.900
pH of mix:	12.5
Pot life:	approx. 1 hour (at 20°C)
Brookfield viscosity (mPa • s):	80000
Bond strength to concrete (MPa):	> 2,5 (after 28 days)
Taber abrasion according to ASTM D 4060-84 Standards - after 200 cycles with 500 g weight (H22 disk) expressed as loss in weight (g):	1.6 (after 7 days)
Consumption (kg/m ²):	2 (per mm of thickness)

table 19

► **9.4| Protection and waterproofing with IDROSILEX PRONTO**

Description: *osmotic cementitious mortar suitable for surfaces in direct contact with drinking water, for waterproofing masonry and concrete structures.*

Particularly suitable for: *waterproofing water concrete and masonry tanks, containers and piping which contain drinking water, or storage tanks for refuse water. As extra waterproofing and smoothing layer of substrates on walls embedded in the ground before laying bitumen sheaths.*

IDROSILEX PRONTO is a pre-blended, cement-based powder composite with selected inert materials and special synthetic resin. When mixed with water, it forms a fluid mortar which may be applied by trowel or brush, characterised by its total impermeability, even if under slight counter-pressure, and excellent bond strength to the substrate. The product meets the minimum requirements of EN 1504-2 regarding protection systems for concrete surfaces.

IDROSILEX PRONTO has the following performance characteristics:

table 20

Characteristics	Performance of product
Density of the mix (kg/m ³):	approx. 1650
pH of mix:	approx. 12
Application temperature range:	from 5°C to 35°C
Pot life at 20°C:	2 hours
In-service temperature range:	from -30°C to 90°C
Bond strength to concrete after 28 days (N/mm ²):	> 1.5
Consumption (kg/m ²):	2 (per mm of thickness)

photo 18
Application of Idrosilex Pronto



► 9.5| Summary of the main characteristics of mortars for smoothing and levelling concrete

MORTAR FOR SMOOTHING AND LEVELLING CONCRETE		
Characteristics	Idrosilex Pronto	Mapefinish
Certification principles according to EN 1504-2	MC and IR	MC and IR
Maximum size of aggregate	0.4 mm	0.4 mm
Mixing ratio	22% - 24% of water	Comp. A : Comp.B 4 : 1
Density of mix	1750 kg/m ³	1900 kg/m ³
Application temperature range	from +5°C to +35°C	from +5°C to +35°C
Pot life of mix	approx 1 h	approx 1 h
Compressive strength	> 25 MPa after 28 days	> 35 MPa after 28 days
Flexural strength	> 6 MPa after 28 days	> 10 MPa after 28 days
Bond strength on concrete according to EN 1766	≥ 2 MPa after 28 days	≥ 2 MPa after 28 days
Thermal compatibility to freeze-thaw cycles with de-icing salts, measured as bond strength according to EN 1542		≥ 2 MPa
Thickness applied	from 2 to 3 mm	from 1 to 3 mm
Consumption	1.6 kg/m ² per mm of thickness	2 kg/m ² per mm of thickness

MORTAR FOR FLEXIBLE SMOOTHING AND LEVELLING LAYERS ON CONCRETE		
Characteristics	Mapelastic	Mapelastic Smart
Certification principles according to EN 1504-2	PI, MC and IR	PI, MC and IR
Mixing ratio	Comp. A : Comp.B 3 : 1	Comp. A : Comp.B 2 : 1
Density of mix	1700 kg/m ³	1600 kg/m ³
Density after application by spray	2200 kg/m ³	2200 kg/m ³
Application temperature range	from +5°C to +35°C	from +5°C to +40°C
Pot life of mix	1 h	1 h
Bond strength on concrete according to EN 1542	1 MPa	1.3 MPa
Thermal compatibility to freeze-thaw cycles with de-icing salts, measured as bond strength according to EN 1542	0.8 MPa	0.9 MPa
Static crack-bridging according to EN 1062-7 expressed as maximum width of crack	> 0.5 mm (-20°C)	> 2.5 mm (+20°C)
Dynamic crack-bridging according to EN 1062-7	No failure of test piece after 1,000 crack cycles with movement of crack from 0.1 to 0.3 mm (Mapelastic reinforced with Mapetex Sel at -20°C)	No failure of test piece after 20000 crack cycles with movement of crack from 0.2 to 0.5 mm (+20°C)
Permeability to water vapour according to EN ISO 7783-1	Sd: 2.4 µ: 1200	Sd: 3.6 µ: 1800
Impermeability to water expressed as capillary absorption according to EN 1062-3 (kg/m ² · h ^{0.5})	< 0.05	< 0.05
Permeability to carbon dioxide (CO ₂) according to EN 1062-6 - diffusion in equivalent air thickness Sdco2 (m)	> 50	> 50
Consumption	By hand: 1.7 kg/m ² per mm of thickness By spray: 2.2 kg/m ² per mm of thickness	By hand: 1.6 kg/m ² per mm of thickness By spray: 2.2 kg/m ² per mm of thickness

▶ 10| **Protecting and decorating concrete structures**

▶ 10.1| **ELASTOCOLOR PRIMER**

Description: *solvent-based, high-penetration reconsolidating primer for crumbly and dusty substrates, and curing agent for repair mortar.*

Particularly suitable for: *consolidating surface dust by impregnating absorbent surfaces. Suitable for promoting bonding before applying finishing products from the ELASTOCOLOR range of products.*

Fixing treatment for crumbly and dusty surfaces, such as cementitious render and concrete surfaces, using ELASTOCOLOR PRIMER. Thanks to its special properties, the product penetrates easily into absorbent substrates and guarantees excellent insulation and good bonding for successive coats of paint.

▶ 10.2| **Protecting and decorating using ELASTOCOLOR PAINT**

Description: *flexible acrylic resin-based paint in water dispersion for protecting and decorating concrete.*

Particularly suitable for: *application on cracked façades or concrete with deformation problems. Protects concrete structures against the phenomenon of carbonatation.*

photo 19
Application of Elastocolor Paint



Repairs to Water Retaining Structures

Painting surfaces by applying ELASTOCOLOR PAINT. Dilute ELASTOCOLOR PAINT with 10-15% of water and mix using a low-speed drill until it is completely blended. Once mixed as above, the product may be applied using traditional application techniques: by brush, roller or spray.

For effective, complete covering of the surface, apply at least two coats. Under normal humidity and temperature conditions, wait 24 hours between each coat.

ELASTOCOLOR PAINT is available in a wide range of colours, created using the COLORMAP® automatic colouring system.

The product meets the minimum requirements of EN 1504-2 regarding protection systems for concrete surfaces.

ELASTOCOLOR PAINT has the following performance characteristics:

Tabella 21

Characteristic	Performance of product
Density of mix (kg/m ³):	approx. 1400
Brookfield viscosity (mPa • s):	16,000 (rotor 6 – 20 revs)
Dry solids content (%):	approx. 65
Waiting time between each coat:	24 hours
Resistance to abrasion when damp (DIN 53778):	> 10000 cycles
Vapour diffusion resistance coefficient (DIN 52615) (μ): - after 7 days at 20°C and 50% R.H. + 21 days in water:	545
Resistance to passage of vapour of a 0.2 mm-thick layer in equivalent metres of air Sd (DIN 52615) (m):	0.109
Capillary action water absorption coefficient W (DIN 52617) (kg/m ² • h ^{0.5}):	0.1
Sd • W = 0.109 • 0.100 (kg/m • h ^{0.5}): The value of Sd • W must be less than 0.1 and respect KUenzle's theory (DIN 18550):	0.011
CO ₂ diffusion resistance factor (BASF test method) (μs):	1,320,594
Resistance to the passage of CO ₂ RG (BASF test method) (m):	462.21
Elongation at failure (%): - after 14 days at 23°C: - after 7 days at 23°C + 7 days at 60°C: - after 7 days at 23°C + 7 days in water: - after 7 days at 23°C + 7 days at -10°C: - after 7 days at 23°C + 7 days at 60°C + 7 days at -10°C: - after 7 days at 23°C + 7 days at 60°C in water + 7 days at -10°C: - after 7 days at 23°C + 7 days at 60°C + 7 days in water + 7 days at -10°C + 7 days at 23°C:	392 220 662 434 567 512 192
Crack-bridging ability at start cracking point for a 0.3 mm thick dry film (prEN 1062-7 mod.) (mm):	approx. 1.8
Resistance to accelerated aging (colour RAL 7032) after 1,000 hours exposure to a Weather-Ometer (ASTM G26/A):	Δ E < 2.5
Consumption (kg/m ²):	0.2 – 0.4 (per coat)

► **10.3| Protecting and decorating using ELASTOCOLOR WATERPROOF**

Description: flexible, acrylic resin-based paint in water dispersion for protecting structures waterproofed with MAPELASTIC or MAPELASTIC SMART and in direct, permanent contact with water.

Particularly suitable for: painting swimming pools and horizontal concrete surfaces which are not stepped on.

ELASTOCOLOR WATERPROOF increases chemical resistance to acid rain, and if adequately coloured, reduces the absorption of solar radiation and overheating of the surface.

The product meets the minimum requirements of EN 1504-2 regarding protection systems for concrete surfaces.

photo 20
Application of Elastocolor Waterproof



ELASTOCOLOR WATERPROOF has the following performance characteristics:

table 22

Characteristics	Performance of product
Density (g/m ³):	approx. 1.3
Dry solids content (%):	approx. 63
Resistance to abrasion when damp (DIN 53778):	>10,000 cycles
Vapour diffusion resistance coefficient (DIN 52615) (μ):	4,500
Capillary action water absorption coefficient W (DIN 52617) (kg/m ² • h ^{0.5}):	0.03
Elongation at breakage (%):	
- after 15 days at 23°C:	approx. 220
- after 60 days at 23°C:	approx. 200
- after 1,000 hours of accelerated aging to a Weather-Ometer according to ASTM G155 cycle 1:	approx. 21
Consumption:	0.5 - 0.7 kg/m ²

Repairs to *Water Retaining Structures*

Notes:

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