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MAPEI®

Protection and Repair of *concrete*

in compliance with European Standard UNI EN 1504

Protection and Repair of *concrete in compliance with European Standard UNI EN 1504*

MAPEI

www.mapei.com

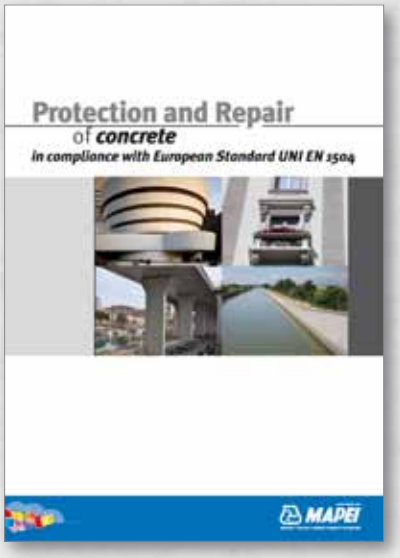
MAPEI®

ADHESIVES · SEALANTS · CHEMICAL PRODUCTS FOR BUILDING

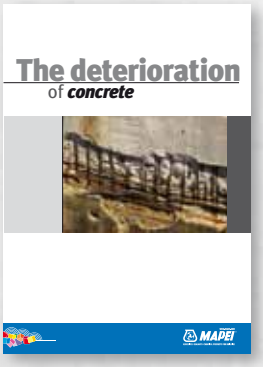
Mapei produces a series of technical manuals which offer an in-depth analysis of the deterioration of concrete in order to offer a professional approach to the problems regarding repair work.

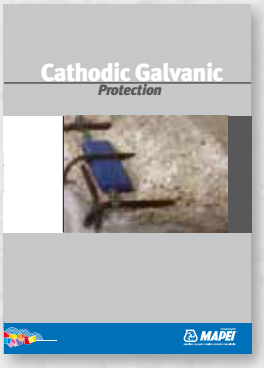
The subject of this manual is:

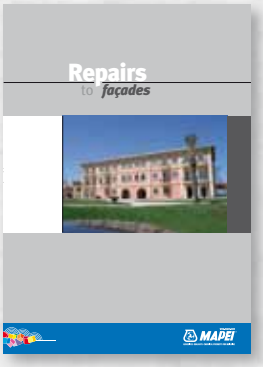
Protection and repair of concrete in compliance with European Standard UNI EN 1504

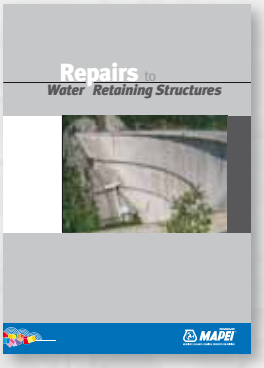


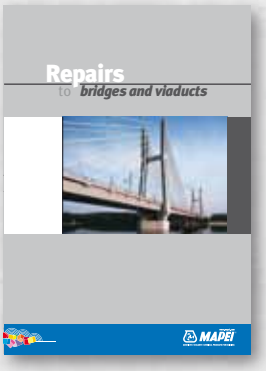
The other manuals available in the series are:

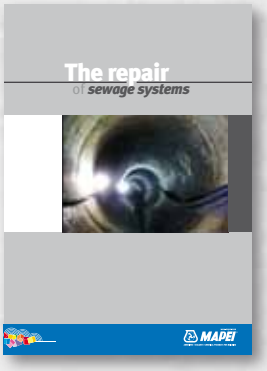












The manuals are available upon request.

Protection and Repair of *concrete*

in compliance with European Standard UNI EN 1504

Index

1| European Standard UNI EN 1504

Repairing a concrete structure compromised by one of many possible causes is an activity which requires qualified, competent personnel. Apart from this aspect, there must also be standard procedures available which define the operations so they may be correctly implemented.
The European Standard EN 1504 “Products and systems for the repair and protection of concrete structures – definitions, requirements, quality control and evaluation of conformity” defines the procedures and characteristics of products used to repair, maintain and protect concrete structures.

The UNI EN 1504 standard is divided into 10 parts:

UNI EN 1504-1:2005:	Definitions
UNI EN 1504-2:2005:	Surface protection systems for concrete
UNI EN 1504-3:2006:	Structural and non-structural repair
UNI EN 1504-4:2005:	Structural bonding
UNI EN 1504-5:2005:	Concrete injection
UNI EN 1504-6:2007:	Anchoring of reinforcing steel bar
UNI EN 1504-7:2007:	Reinforcement corrosion protection
UNI EN 1504-8:2005:	Quality control and certification of conformity
UNI EN 1504-9:2008:	General principles for the use of products and systems
UNI EN 1504-10:2005:	Site application of products and quality control of the works

The main aim of the standard is to supply a valid instrument to optimise repair operations, to help overcome an all too common simplistic approach based on the false belief that, if deteriorated material is eliminated and replaced with any type of repair mortar, then the problem has been solved.

Over the following pages, all the sections enclosed in the UNI EN 1504 standard will be described in detail, and each part will describe the aim and area of application and the definitions and performance characteristics of products according to their specified use, as declared in the original document.

2| UNI EN 1504-part 1

Products and systems for protecting and repairing concrete structures.
Definitions, requirements, quality control and conformity assessment.
Part 1:
Definitions

The first part of the standard contains a definition of the most significant terms used in the other sections regarding repair, maintenance, protection, renovation and consolidation of concrete structures.

2.1| Terms and definitions

Batch: a quantity of material produced in one single operation or, in continuous cycle production processes, a defined quantity (in tonnes), whose composition conformity must be demonstrated by the manufacturer and whose quantity must not exceed the daily production rate.

Declared value: a declared value with documented proof by the manufacturer which attests the identification or performance requirements.

Identification test: a test carried out to check a declared value of the composition or property of the product or system in terms of production uniformity.

Note: this permits the correspondence between the product or system to be tested and the product or system subjected to trial tests to be guaranteed within the permitted tolerances.

Performance: the capacity of a product or system to offer efficient, durable repairs or protection without procuring damage to the original structure, other structures, those who will operate in the area, users of the product or system, to third parties or the environment.

Performance requirements: mechanical, physical and chemical properties required for products and systems to guarantee durability and stability from both the repaired concrete and the structure.

Performance test: test carried out to verify the value of a property required from a product or system in terms of its specified performance during its application and use.

Note: this permits the conformity of a product or system's respective specified performance characteristics to be guaranteed.

Product: constituents formulated to repair or protect concrete structures.

Systems: two or more products which are used either together or consecutively to repair or protect concrete structures.

Technology: application of a product or system using a specified instrument or method (for example injection in cracks).

2.2| Main categories of products and systems

Anchoring products and systems which:

- fix steel reinforcement in place in concrete to give sufficient structural behaviour;
- fill cavities to ensure continuity between steel and concrete elements.

Products and systems for injection: products and systems which, when injected into a concrete structure, restore the integrity and/or durability of the structure.

Products and systems for non-structural repairs: products and systems which, when applied on concrete surfaces, restore the geometric and aesthetic appearance of the structure.

Products and systems for protecting reinforcement: products and systems applied on unprotected reinforcement to increase its protection from corrosion.

Products and systems for structural gripping: products and systems applied on concrete to guarantee a durable structural bond with other materials applied.

Products and systems for structural repairs: products and systems applied on concrete structures to replace damaged concrete and restore its structural integrity and durability.

Products and systems for surface protection: products and systems which, when applied, increase the durability of concrete and reinforced concrete structures.

2.3| Main chemical types and constituents for protection and repair products and systems

Additives: finely divided inorganic materials which may be added to repair products to improve certain properties or to give a product special properties.

There are two types of additives:

- additives which are practically inert (type I);
- pozzolanic additives or additives with latent hydraulicity (type II).

Additives for hydraulic binders: products added to hydraulic binders to give them specific properties and which are not included in admixes and additives.

Additives for reactive polymers: products different from admixes and additives which give specific properties to repair products.

Note: typical admixes are, for example:

- *plasticisers*
- *flexibility enhancers*
- *accelerators*
- *retardants*
- *materials to regulate rheology*
- *pigments*
- *fillers*

Additives: added during the concrete mixing process at up to 5% of the mass of cement in the concrete to modify the properties of fresh and/or hardened concrete.

Coating: treatment applied to form a continuous protective layer on the surface of concrete.

Note 1: its thickness is generally between 0.1 mm and 5.0 mm. Special applications may require a thickness of more than 5 mm.
Note 2: examples of binders include organic polymers, organic polymers with cement filler or hydraulic cement modified with polymeric latex.

Hydraulic binders (H): inorganic material which reacts with water and undergoes a hydration process to produce a solid material.
Note: this generally includes cement which conforms to EN 197-1 or EN 413-1 Standards or construction lime which conforms to EN 459-1 Standards or combined with other cements.

Hydraulic mortar and hydraulic concrete (CC): mortar or concrete with a hydraulic binder base mixed with a suitable blend of aggregates which may also contain admixes and additives which, when mixed with mortar, set through a hydration reaction.

Hydrophobic impregnation: treatment for concrete to obtain a water-repellent surface. It forms a hydrophobic coat on the internal walls of pores and capillaries without filling them. It does not form a film on the surface of the concrete so its appearance is unaltered or only slightly modified.
Note: active composites include silanes and siloxanes, for example.

Impregnation: treatment of concrete to reduce surface porosity and strengthen the surface. The pores and capillaries are partially or completely filled.
Note 1: this treatment generally forms a thin, discontinuous film on the surface of concrete.
Note 2: binders include organic polymers, for example.

Cementitious mortar and hydraulic polymer concrete (PCC): hydraulic mortar and concrete modified by adding sufficient quantities of polymeric admixes to obtain specific properties.
Note: Polymers generally used include:
- *acrylics, metacrylates or modified acrylic resin in dispersible powder form or in water dispersion;*
- *vinylic monopolymers, copolymers and terpolymers in dispersible powder form or in water dispersion;*
- *styrene-butadiene copolymers, generally used in water dispersion;*
- *natural latex rubber;*
- *epoxy resin.*

Polymeric mortar and polymeric concrete (PC): mixtures of polymeric binders and calibrated aggregates which set through polymerisation.

Reactive polymeric binders (P): binders generally formed from two components, a reactive base polymer and a catalyser, which polymerise at ambient temperature. Admixes may also be added.
Note 1: in certain systems, water vapour at ambient temperature may act as a catalyser.
Note 2: typical binders include:
- *epoxy resin;*
- *unsaturated polyester;*
- *reticulating acrylic;*
- *mono or bi-component polyurethane.*

▸ 3| UNI EN 1504-part 9

Products and systems for protecting and repairing concrete structures.
Definitions, requirements, quality control and conformity assessment.

Part 9:

General principles for the use of products and systems

Part 9 of UNI EN 1504 defines the principles and methods for protecting and repairing concrete structures which have suffered damage or which may suffer damage or deterioration, and offers a guide on choosing products and systems suitable for their intended use. This is why this part of the Standard must be taken into consideration before the other parts.

The fundamental points in UNI EN 1504-9 are the following:

- Minimum requirements for protection and repairs;
- Aims of protection and repairs;
- Base concepts when selecting products and systems.

Minimum requirements for protection and repairs

This part of the Standard defines:

- Basic principles to assess the conditions of structures;
- Safety aspects, regarding the assessment of health risks due to falling rubble or the mechanical instability of structures;
- Defect assessment and their causes.

Photo 1
Example of concrete deteriorated by sulphur aggression

The most common causes of deterioration to concrete and steel reinforcement are the following:

- Abrasion
- Fatigue
- Impact
- Over-loading
- Movement
- Explosion
- Vibration

Mechanical

Fire

Causes of defects in concrete

Chemical

- Biological activity
- Aggressive agents (e.g. Sulphates)
- Alkali reaction of aggregates

Physical

- Freeze/thaw cycles
- Thermal cycles
- Crystallisation of salts
- Shrinkage
- Erosion
- Wear

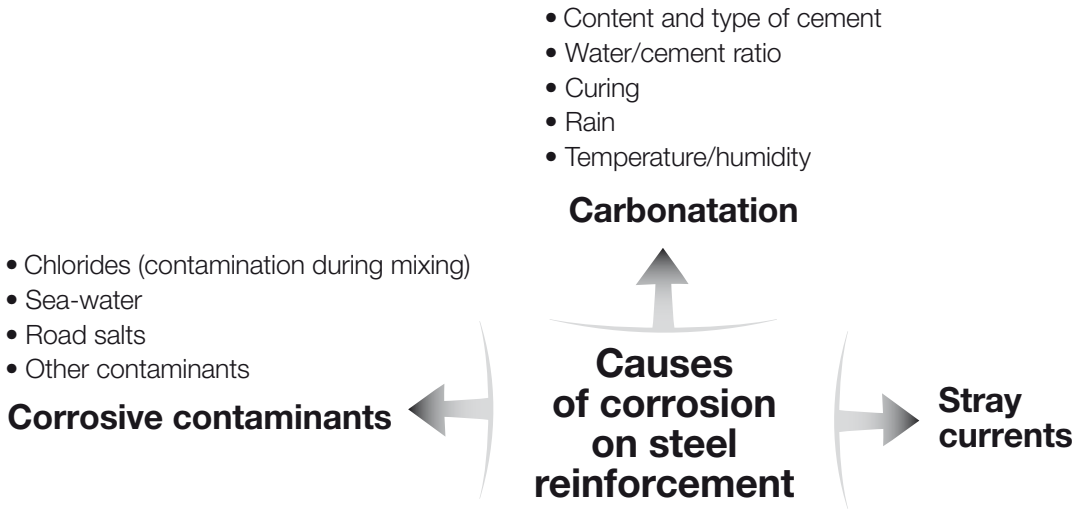


Photo 2
Example of deterioration on concrete reinforcement due to corrosion

3.1| Aims of protection and repair

In this paragraph, the Standard specifies various factors to define the correct type of intervention required. The first considerations to be made are the various options available before carrying out any kind of work. When deciding which option to be taken into consideration, the following must be identified:

- general factors (e.g. intended use, service life, performance requirements, etc.);
- health and safety (e.g. the consequences of collapse, impact on occupants of the structure);
- structural aspects (e.g. variations in dynamic aspects during and after the operations);
- environmental aspects (e.g. the environment where the structure is located).

Once all the above aspects have been analysed the most appropriate type of intervention may be selected, taking into consideration the cause or combination of causes which provoked deterioration and the conditions to which the structure will be exposed.

3.2| Base concepts when selecting products and systems

When choosing a suitable product for repair or protection work on a structure, the choice must be based on an analysis of the principles and methods which best satisfy them. Principles 1 to 6 and their correlated methods are aimed at defects in concrete, while principles 7 to 11 are connected to defects due to corrosion of the reinforcement.

Principle	Method	Contained in UNI EN 1504 part
Principles and methods related to defects in concrete		
1) Protection against ingress (PI)	1.1 Hydrophobic impregnation	2
	1.2 Impregnation	2
	1.3 Surface coating	2
	1.4 Surface binding of cracks	
	1.5 Filling cracks	5
	1.6 Transforming cracks into joints	
	1.7 Erecting external panels	
	1.8 Application of membranes	
2) Moisture control (MC)	2.1 Hydrophobic impregnation	2
	2.2 Impregnation	2
	2.3 Surface coating	2
	2.4 Erecting external panels	
	2.5 Eletcrochemical treatment	
3) Concrete restoration (CR)	3.1 Applying mortar by hand	3
	3.2 Recasting with concrete or mortar	3
	3.3 Spraying concrete or mortar	3
	3.4 Replacing elements	
4) Structural strengthening (SS)	4.1 Adding or replacing embedded or external reinforcing steel bars	
	4.2 Installing bonded rebars in preformed or drilled holes in the concrete	6
	4.3 Plate bonding	4
	4.4 Adding mortar or concrete	3, 4
	4.5 Injecting in cracks, voids or interstices	5
	4.6 Filling cracks, voids or interstices	5
	4.7 Pre-compression (post-tensioning)	
5) Increase in physical resistance (PR)	5.1 Overlays or coatings	2
	5.2 Impregnation	2
	5.3 Adding mortar or concrete	3
6) Resistence to chemicals (RC)	6.1 Overlays or coatings	2
	6.2 Impregnation	2
	6.3 Adding mortar or concrete	3
Principles related to reinforcement corrosion		
7) Preserving or restoring passivity (RP)	7.1 Increasing cover to reinforcement with additional concrete or mortar	3
	7.2 Replacing contaminated or carbonatated concrete	3
	7.3 Electrochemical realkalisation of carbonatated concrete	
	7.4 Electrochemical realkalisation of carbonatated concrete by diffusion	
	7.5 Electrochemical chloride extraction	
8) Increasing resistivity (IR)	8.1 Hydrophobic impregnation	2
	8.2 Impregnation	2
	8.3 Overlays or coatings	2
9) Cathodic control (CC)	9.1 Limiting oxygen content (at the cathode) by saturation or surface coating	
10) Cathodic protection (CP)	10.1 Applying electrical potential	
11) Control of the anodic areas (CA)	11.1 Active coating of steel reinforcement	7
	11.2 Painting reinforcement with barrier coatings	7
	11.3 Applying corrosion inhibitors on concrete	

4| UNI EN 1504-part 2

Products and systems for protecting and repairing concrete structures.
Definitions, requirements, quality control and conformity assessment.

Part 2:

Surface protection systems for concrete.

Part 2 of the UNI EN 1504 Standard considers 5 of the 11 principles described in UNI EN 1504-9:

(PI) Principle 1 - Protection against ingress:

1.1 hydrophobic impregnation
1.2 impregnation
1.3 overlays or coatings

(MC) Principle 2 - Moisture control:

2.1 hydrophobic impregnation
2.3 overlays or coatings

(PR) Principle 5 - Increase in physical resistance:

5.1 overlays or coatings
5.2 impregnation

(RC) Principle 6 - Resistance to chemicals:

6.1 overlays or coatings

(IR) Principle 8 - Increasing resistivity

8.1 hydrophobic impregnation
8.3 overlays or coatings

Photo 3
Protection of the concrete structure on a bridge

Photo 4
Protection of the concrete façade on a residential building

All 5 principles are satisfied with the use of three different surface protection methods:

- **hydrophobic impregnation:** treatment of the concrete to obtain a water-repellent surface. The pores and capillaries are coated internally without filling them. No skin on the surface of the concrete with little or no change to its appearance.

Performance characteristics of hydrophobic impregnation according to the principles defined in UNI EN 1504-9 (tables 1 and 3 of UNI EN 1504-2).

Performance characteristics	Principle 1 Protection against ingress	Principle 2 Moisture control	Principle 8 Increasing resistivity	Test method	Minimum requirements (table 3 UNI EN 1504, part 2)
Resistance to freeze/ thaw cycles (determining loss in volume)	●			EN 13581	Retarded loss in volume with a minimum of cycles compared with un-treated sample
Penetration depth	Δ	Δ	Δ	(*)	Class 1: < 10 mm Class 2: ≥ 10 mm
Water absorption and resistance to alkali test	Δ	Δ	Δ	EN 13580	Water absorption < 7,5% Resistance to alkalis < 10%
Drying speed	Δ	Δ	Δ	EN 13579	Class 1:> 30% Class 2:> 10%
Diffusion of chloride ions				National standards and regulations	Subject to national standards and regulations

(*) Penetration depth measured within an accuracy of 0.5 mm by breaking open the treated test sample and spraying the surface of the fracture with water according to prEN 14630. The depth of the dry area is considered the effective depth of the hydrophobic impregnation.

● for all intended uses Δ for certain intended uses

- **Impregnation:** treatment of concrete to reduce surface porosity and strengthen the surface. The pores and capillaries are partially or completely filled;

Performance characteristics of impregnation according to the principles defined in UNI EN 1504-9 (tables 1 and 4 of UNI EN 1504-2)

Performance characteristics	Principle 1 Protection against ingress	Principle 5 Increase in physical resistance	Test method	Minimum requirements (table 4 UNI EN 1504, part 2)
Abrasion resistance		●	EN ISO 5470	Improvement of at least 30% compared with an untreated sample
Permeability to water vapour	Δ		EN ISO 7783-1 EN ISO 7783-2	Class I: $S_d < 5$ m Class II: 5 m ≤ S_d ≤ 50 m Class III: $S_d > 50$ m
Capillary absorption and permeability to water	●	●	EN 1062-3	W < 0,1 kg/m^2 x h^{0,5}
Freeze-thaw cycles with immersion in de-icing salts	Δ	Δ	EN 13687 – 1	After thermal/ageing cycles: • No blisters, fracture or delamination • • Adhesion strength by pull-off test: - vertical: ≥ 0,8 N/mm^2 - horizontal with no mechanical load: ≥ 1,0 N/mm^2 - horizontal with mechanical load: ≥ N/mm^2
Cyclic loads (thermal shock):	Δ	Δ		
Thermal cycles without impact of de-icing salts	Δ	Δ	EN 13687 – 2	
Clause 4.1: curing: 7 days at 70°C	Δ	Δ	EN 13687 – 3 EN 1062 – 11	
Chemical resistance	Δ		EN ISO 2812 – 1	No visible variation after exposure for 30 days
Impact strength		●	EN ISO 6272 – 1	No cracks or delamination after loading
Direct traction adherence test	Δ	●	EN 1542	- vertical: ≥ 0,8 N/mm^2 - horizontal with no mechanical load: ≥ 1,0 N/mm^2 - horizontal with mechanical load: ≥ 1,5 N/mm^2
Fire resistance test	Δ	Δ	EN 13501 – 1	Euro classes

Performance characteristics	Principle 1 Protection against ingress	Principle 5 Increase in physical resistance	Test method	Minimum requirements (table 4 UNI EN 1504, part 2)
Slip/streak resistance	Δ	Δ	EN 13036 – 4	Class I: > 40 tested in damp state (damp internal surface) Class II: > 40 tested in dry state (dry internal surface) Class III: > 55 tested in damp state (external) or according to national regulations
Penetration depth	●	●	(*)	≥ 5 mm
Diffusion of chloride ions	Δ		National standards and regulations	Subject to national standards and regulations

(*) Penetration depth measured within an accuracy of 0.5 mm by breaking open the treated test sample and spraying the surface of the fracture with water according to prEN 14630. The depth of the dry area is considered the effective depth of the hydrophobic impregnation.

● for all intended uses Δ for certain intended uses

• **Coating:** treatment applied to form a continuous protective layer on the surface of concrete.

Performance characteristics of coatings according to the principles defined in UNI EN 1504-9 (tables 1 and 5 of UNI EN 1504-2)

Performance characteristics	Principle 1 Protection against ingress	Principle 2 Moisture control	Principle 5 Increase in physical resistance	Principle 6 Chemical resistance	Principle 8 Increase of resistivity	Test method	Minimum requirements (table 5 UNI EN 1504, part 2)
Linear shrinkage	Δ	Δ	Δ	Δ	Δ	EN 12617 – 1	≤ 0,3% (suitable only for rigid systems with coating thickness ≥ 3 mm)
Compressive strength			Δ	Δ		EN 12190	Class I: ≥ 35 N/mm^2 (polyamide wheels) Class II: ≥ 50 N/mm^2 (steel wheels)
Thermal expansion coefficient	Δ	Δ	Δ	Δ	Δ	EN 1770	Rigid systems for external applications: $\alpha_T \leq 30.10^{-6}K^{-1}$ (only for coats with thickness ≥ 1 mm)
Abrasion resistance			●			EN ISO 5470 - 1	Loss in weight less than 3000 mg H22 wheels/1000 cycles/ load 1000 g
Oblique shear test	Δ	Δ	Δ	Δ	Δ	EN ISO 2409	Shear value: ≤ GT2
Permeability to CO_2	●					EN 1062 – 6	S_d > 50 m
Permeability to water vapour	●	●			●	EN ISO 7783 – 1 EN ISO 7783 – 2	Class I: S_d < 5 m Class II: 5 m ≤ S_d ≤ 50 m Class III: S_d > 50 m
Capillary absorption and permeability to water	●	●	●	Δ	●	EN 1062 – 3	W < 0,1 kg/m^2 x h$^{0.5}$

Performance characteristics	Principle 1 Protection against ingress	Principle 2 Moisture control	Principle 5 Increase in physical resistance	Principle 6 Chemical resistance	Principle 8 Increase of resistivity	Test method	Minimum requirements (table 5 UNI EN 1504, part 2)
Freeze-thaw cycles with immersion in de-icing salts	Δ	Δ	Δ	Δ	Δ	EN 13687 – 1	After thermal/ageing cycle: • no swelling or blistering/no fracture or delamination • adhesion strength by pull-off test
Cyclic loads (thermal shock):	Δ	Δ	Δ	Δ	Δ	EN 13687 – 2	
Thermal cycles without impact of de-icing salts	Δ	Δ	Δ	Δ	Δ	EN 13687 – 3	
Clause 4.1: curing: 7 days at 70°C	Δ	Δ	Δ	Δ	Δ	EN 1062 – 11	
Resistance to thermal shock	Δ		Δ	Δ		EN 13687	
Chemical resistance	Δ					EN ISO 2812 – 1	No visible variation after exposure for 30 days
Resistance to severe chemical attack				●		EN 13529	Loss in hardness (Buchholz or Shore): < 50% Class I: 3 days with no pressure Class II: 28 days with no pressure Class III: 28 days with pressure
Crack bridging	Δ	Δ	Δ	Δ	Δ	EN 1062 – 7	Depends on the classes and test conditions (e.g. climate, size of cracks and dynamic movements)
Impact strength			●			EN ISO 6272 – 1	No cracks or delamination after loading Class I: ≥ 4 Nm Class II: ≥ 10 Nm Class III: ≥ 20 Nm
Adhesion strength by pull-out test	●	●	●	●	●	EN 1542	Crack bridging Rigid or flexible systems No traffic ≥ 0,8 N/mm^2 ≥ 1,0 N/mm^2 Traffic ≥ 1,5 N/mm^2 ≥ 2,1 N/mm^2
Reaction to fire resistance test	Δ	Δ	Δ	Δ	Δ	EN 13501 – 1	Euro Class

Performance characteristics	Principle 1 Protection against ingress	Principle 2 Moisture control	Principle 5 Increase in physical resistance	Principle 6 Chemical resistance	Principle 8 Increase of resistivity	Test method	Minimum requirements (table 5 UNI EN 1504, part 2)
Slip/streak resistance	Δ	Δ	Δ	Δ	Δ	EN 13036 – 4	Class I: > 40 tested in damp state (damp internal surface) Class II: > 40 tested in dry state (dry internal surface) Class III: > 55 tested in damp state (external) or according to national regulations
Class 4.2: behaviour after artificial atmospheric agents	Δ	Δ	Δ	Δ	Δ	EN 1062 – 11	After test cycle of 2,000 hours: no swelling or blistering/no fracture or delamination
Anti-static behaviour	Δ	Δ	Δ	Δ	Δ	EN 1081	Class I: > 104 e <106 Ω (explosives) Class II: > 106 e < 108 Ω (substance at risk of explosion)
Bond strength to damp concrete	Δ	Δ	Δ	Δ		EN 13578	After load: no swelling or blistering/no fracture or delamination. Bond strength ≥ 1,5 N/mm^2 with type of damage for more than 50% of concrete
Diffusion of chloride ions	Δ					National standards and regulations	Subject to national standards and regulations

4.1| Reaction to fire

For all products used to protect the surface of concrete on elements subject to fire-resistance requirements, the manufacturer must declare the fire reaction class of the product. Products with up to 1% in mass or volume (the highest of the two values) of evenly distributed organic materials may be declared as fire-reaction Class A1 without testing the said product. Hardener products with more than 1% in mass or volume (the highest of the two values) of evenly distributed organic materials must be classified according to EN 13501-1 Standards and the appropriate fire-reaction class must be declared.

4.2| MAPEI products certified in compliance with UNI EN 1504-2

IN COMPLIANCE WITH EUROPEAN STANDARD
EN 1504-2
MAPEI
SURFACE PROTECTION SYSTEMS FOR CONCRETE

Antipluviol S
Hydrophobic impregnator certified according to PI, MC and IR principles

Colorite Beton
Coating certified according to PI, MC and IR principles

Colorite Performance
Coating certified according to PI, MC and IR principles

Duresil EB
Coating certified according to PI, MC, RC and IR principles

Elastocolor Paint
Coating certified according to PI, MC and IR principles

Elastocolor Rasante
Coating certified according to PI, MC and IR principles

Elastocolor Rasante SF
Coating certified according to PI, MC and IR principles

Elastocolor Waterproof
Coating certified according to PI, MC and IR principles

Idrosilex Pronto
Coating certified according to MC and IR principles

Idrosilex Pronto RPF
Coating certified according to MC and IR principles

Mapecoat I 24
Coating certified according to PI, MC, IR, PR and RC principles

Mapefinish
Coating certified according to MC and IR principles

IN COMPLIANCE WITH EUROPEAN STANDARD
EN 1504-2
MAPEI
SURFACE PROTECTION SYSTEMS FOR CONCRETE

Mapefloor Finish 50
Coating certified according to MC and IR principles

Mapefloor Finish 52 W
Coating certified according to MC and IR principles

Mapelastic
Coating certified according to PI, MC and IR principles

Mapelastic Foundation
Coating certified according to PI, MC and IR principles

Mapelastic Smart
Coating certified according to PI, MC and IR principles

Monofinish
Coating certified according to MC and IR principles

Planitop 100
Coating certified according to MC and IR principles

Planitop 200
Coating certified according to MC and IR principles

Planitop 207
Coating certified according to MC and IR principles

Planitop 540
Coating certified according to MC and IR principles

Planitop Fast 330
Coating certified according to MC and IR principles

Planitop HDM
Coating certified according to MC and IR principles

Planitop Smooth & Repair
Coating certified according to MC and IR principles

5| UNI EN 1504-part 3

Products and systems for the repair and protection of concrete structures – definitions, requirements, quality control and evaluation of conformity

Part 3:

Structural and non-structural repair

Part 3 of UNI EN 1504 considers not only mortar and concrete used together with other products and systems to repair and/or replace deteriorated concrete, but also the protection of reinforcement steel to extend the service life of structures with signs of deterioration.
This part considers 3 of the 11 principles described in UNI EN 1504-9:

(CR) Principle 3 – Concrete repair

3.1 Applying mortar by hand
3.2 Recasting with concrete or mortar
3.3 Spraying concrete or mortar

(SS) Principle 4 – Structural strengthening

4.4 Adding mortar or concrete

(RP) Principle 7 – Preserving and restoring passivity

7.1 Increasing cover to reinforcement with additional concrete or mortar
7.2 Replacing contaminated or carbonatated concrete

Various assessment parameters regarding the principle and repair method are taken into consideration to classify restoration mortar:

Performance characteristics	Test method	Repair principle			
		3	3	4	7
		Repair method			
		3.1; 3.2	3.3	4.4	7.1; 7,2
Compressive strength	EN 12190	●	●	●	●
Chloride ion content	EN 1015 – 17	●	●	●	●
Loss in adherence	EN 1542	●	●	●	●
Contrasted expansion/shrinkage	EN 12617 – 4	●	●	●	●
Durability - resistance to carbonatation	EN 13295	●	●	●	●
Durability Thermal compatibility Freeze/thaw cycles; storm conditions; dry cycles	EN 13687-1-2-4	Δ	Δ	Δ	Δ
Modulus of elasticity	EN 13412	Δ	Δ	●	Δ
Slip resistance	EN 13036 – 4	Δ	Δ	Δ	Δ
Thermal expansion coefficient	EN 1770	Δ	Δ	Δ	Δ
Capillary absorption (permeability to water)	EN 13057	Δ	Δ	Δ	Δ

● for all intended uses Δ for certain intended uses

The Standard defines 4 mortar classes: R1 and R2 for non-structural mortar and R3 and R4 for structural mortar.

Non-structural mortar → R1 – R2

Structural mortar → R3 – R4

Performance characteristics according to the various tests carried out identify the class of restoration mortar. This means that all types of mortar used for structural and non-structural restoration work must satisfy the minimum requirements according to the Standard.

Class R1 non-structural restoration mortar

Test N°	Performance characteristics	Test method	Requirement
			Non-structural
			Class R1
1	Compressive strength	EN 12190	≥ 10 MPa
2	Chloride ion content	EN 1015 – 17	≤ 0,05%
3	Adherence bond	EN 1542	≥ 0,8 MPa
4	Contrasted expansion/shrinkage	EN 12617 – 4	No requirement
5	Durability – resistance to carbonatation	EN 13295	No requirement
6	Modulus of elasticity	EN 13412	No requirement
7	Thermal compatibility Freezing-Thawing	EN 13687-1	Visual inspection after 50 cycles
8	Thermal compatibility Storms	EN 13687-2	Visual inspection after 30 cycles
9	Thermal compatibility Dry cycles	EN 13687-4	Visual inspection after 30 cycles
10	Slip resistance	EN 13036 – 4	Classe I: > 40 units with damp test; Classe II: > 40 units with dry test; Classe III: > 55 units with damp test.
11	Thermal expansion coefficient	EN 1770	Not required if tests 7,8 or 9 are carried out, otherwise declared value
12	Capillary absorption (permeability to water)	EN 13057	No requirement

Class R2 non-structural repair mortar

Test N°	Performance characteristics	Test method	Requirement
			Non-structural
			Class R2
1	Compressive strength	EN 12190	≥ 15 MPa
2	Chloride ion content	EN 1015 – 17	≤ 0,05%
3	Adherence bond	EN 1542	≥ 0,8 MPa
4	Contrasted expansion/shrinkage	EN 12617 – 4	Bond strength after test ≥ 0,8 MPa
5	Durability – resistance to carbonatation	EN 13295	No requirement
6	Modulus of elasticity	EN 13412	No requirement
7	Thermal compatibility Freezing-Thawing	EN 13687-1	Bond strength after 50 cycles ≥ 0,8 MPa
8	Thermal compatibility Storms	EN 13687-2	Bond strength after 30 cycles ≥ 0,8 MPa
9	Thermal compatibility Dry cycles	EN 13687-4	Bond strength after 30 cycles ≥ 0,8 MPa
10	Slip resistance	EN 13036 – 4	Class I: > 40 units with damp test; Class II: > 40 units with dry test; Class III: > 55 units with damp test.
11	Thermal expansion coefficient	EN 1770	Not required if tests 7,8 or 9 are carried out, otherwise declared value
12	Capillary absorption (permeability to water)	EN 13057	≤ 0,5 $kg \cdot m^{-2} \cdot h^{-0,5}$

Photo 5
Strengthening of a concrete structure with **PLANITOP HDM** + **MAPEGRID G220**, non-structural class R2 mortar

Class R3 structural repair mortar

Test N°	Performance characteristics	Test method	Requirement
			Structural
			Class R3
1	Compressive strength	EN 12190	≥ 25 MPa
2	Chloride ion content	EN 1015 – 17	≤ 0,05%
3	Adherence bond	EN 1542	≥ 1,5 MPa
4	Contrasted expansion/shrinkage	EN 12617 – 4	Bond strength after test ≥ 1,5 MPa
5	Durability - resistance to carbonatation	EN 13295	d_k ≤ control concrete
6	Modulus of elasticity	EN 13412	≥ 15 GPa
7	Thermal compatibility Freezing-Thawing	EN 13687-1	Bond strength after 50 cycles ≥ 1,5 MPa
8	Thermal compatibility Storms	EN 13687-2	Bond strength after 30 cycles ≥ 1,5 MPa
9	Thermal compatibility Dry cycles	EN 13687-4	Bond strength after 30 cycles ≥ 1,5 MPa
10	Slip resistance	EN 13036 – 4	Class I: > 40 units with damp test; Class II: > 40 units with dry test; Class III: > 55 units with damp test.
11	Thermal expansion coefficient	EN 1770	Not required if tests 7,8 or 9 are carried out, otherwise declared value
12	Capillary absorption (permeability to water)	EN 13057	≤ 0,5 $kg \cdot m^{-2} \cdot h^{-0,5}$

Photo 6
Application by spray of **MAPEGROUT 430**, class R3 structural mortar on a concrete structure

Class R4 structural repair mortar

Test N°	Performance characteristics	Test method	Requirement
			Structural
			Class R4
1	Compressive strength	EN 12190	≥ 45 MPa
2	Chloride ion content	EN 1015 – 17	≤ 0,05%
3	Adherence bond	EN 1542	≥ 2,0 MPa
4	Contrasted expansion/shrinkage	EN 12617 – 4	Bond strength after test – ≥ 2,0 MPa
5	Durability – resistance to carbonatation	EN 13295	$d_k \leq$ control concrete
6	Modulus of elasticity	EN 13412	≥ 20 GPa
7	Thermal compatibility Freezing-Thawing	EN 13687-1	Bond strength after 50 cycles – ≥ 2,0 MPa
8	Thermal compatibility Storms	EN 13687-2	Bond strength after 30 cycles ≥ 2,0 MPa
9	Thermal compatibility Dry cycles	EN 13687-4	Bond strength after 30 cycles ≥ 2,0 MPa
10	Slip resistance	EN 13036 – 4	Class I: > 40 units with damp test; Class II: > 40 units with dry test; Class III: > 55 units with damp test.
11	Thermal expansion coefficient	EN 1770	Not required if tests 7,8 or 9 are carried out, otherwise declared value
12	Capillary absorption (permeability to water)	EN 13057	≤ 0,5 $kg \cdot m^{-2} \cdot h^{-0,5}$

Photo 7
Large-scale concrete structure repaired with **MAPEGROUT T60**, class R4 structural mortar

5.1| Reaction to fire

For all products used to repair concrete elements subject to fire-resistance requirements, the manufacturer must declare the fire reaction class of the repair product.

Products with up to 1% in mass or volume (the highest of the two values) of evenly distributed organic materials may be declared as fire-reaction Class A1 without testing the said product.

Hardened repair products with more than 1% in mass or volume (the highest of the two values) of evenly distributed organic materials must be classified according to EN 13501-1 Standards and the appropriate fire-reaction class must be declared.

5.2| MAPEI products certified in compliance with UNI EN 1504-3

IN COMPLIANCE WITH EUROPEAN STANDARD
EN 1504-3
MAPEI
REPAIR MORTAR

Product	Class - Type	
Idrosilex Pronto RPF	R2 – PCC	
Mapefinish	R2 – PCC	
Monofinish	R2 – PCC	
Planitop HDM	R2 – PCC	
Planitop HDM Maxi	R2 – PCC	
Planitop Smooth & Repair	R2 – PCC	

Product	Class - Type	
Idrosilex Pronto RPG	R3 – PCC	
Mapegrout 430 (once Planitop 430)	R3 – CC	
Mapegrout LM2K	R3 – PCC	
Mapegrout Fast-Set	R3 – PCC	
Mapegrout T40	R3 – PCC	
Planitop 400	R3 – CC	
Mapegrout BM	R4 – PCC	
Mapegrout Hi-Flow	R4 – CC	
Mapegrout Hi-Flow GF	R4 – CC	

IN COMPLIANCE WITH EUROPEAN STANDARD
EN 1504-3
MAPEI
REPAIR MORTAR

Product	Class - Type	
Mapegrout Hi-Flow TI 20 + Fibres R60	R4 – CC	
Mapegrout Easy Flow	R4 – CC	
Mapegrout Easy Flow GF	R4 – CC	
Mapegrout FMR + Fibres FF	R4 – CC	
Mapegrout Gunite	R4 – CC	
Mapegrout SV	R4 – CC	
Mapegrout SV Fiber + Fibres R38	R4 – CC	
Mapegrout SV T	R4 – CC	
Mapegrout T60	R4 – CC	
Mapegrout Thixotropic	R4 – PCC	

6| UNI EN 1504-part 4

Products and systems for protecting and repairing concrete structures.
Definitions, requirements, quality control and conformity assessment
Part 4:
Structural bonding

Part 4 of UNI EN 1504 specifies the performance (including durability) and identification and safety requirements of products and systems used for structural bonding of strengthening materials to old concrete structures, including:

- Bonding plates of steel or other suitable materials (for example fibre-reinforced composites) to the external surface of concrete structures for strengthening purposes;
- Bonding hardened concrete on hardened concrete, generally associated with the use of pre-fabricated elements for repair and strengthening;
- Pouring fresh concrete on hardened concrete using a bonded flexible joint, forming an integral part of a new structure composed of the three elements.

Part 4 of UNI EN 1504 only considers principle 4 described in UNI EN 1504-9:
(SS) Principle 4 – Structural strengthening
4.3 Reinforcing plate bonding
4.4 Adding mortar or concrete

Photos 8 e 9
Structural bonding of hardened concrete on hardened concrete using **ADESILEX PG1**, structural adhesive certified according to UNI EN 1504-4

Photos 10
Structural bonding of fresh concrete on hardened concrete using **EPORIP**, structural adhesive certified according to UNI EN 1504-4

Performance characteristics of products/methods for structural bonding

Characteristics	Principle 4 – Structural consolidation					
	Method 4.3			Method 4.4		
	Uses	Test method	Performance requirements	Uses	Test method	Requisiti
Suitability for application: - on vertical and internal surfaces; - on horizontal and external surfaces; - by injection.	 Δ Δ Δ	 EN 1799 EN 1799 EN 12618-2	 (1*) (2*) (3*)	 Δ Δ Δ	 EN 1799 EN 1799 EN 12618-2	 (1*) (2*) (3*)
Suitability for application and curing in the following particular environmental conditions: - Low or high temperatures; - Damp substrate.	 Δ -	EN 12188	(4*)	 Δ ●	EN 12636 o EN 12615	(9*)
Bond strength: - Plate on plate - Plate on concrete - Steel with anti-corrosion protection on steel with anti-corrosion protection - Steel with anti-corrosion protection on concrete - Hardened concrete on hardened concrete - Fresh concrete on fresh concrete	 ● ● Δ Δ - -	EN 12188	(5*)	 - - - - ● ●	EN 12636 o EN 12615	(9*)
Durability of composite system: - Thermal cycles - Damp cycles	 ● ●	EN 13733	(6*)	 ● ●	EN 13733	(10*)
Characteristics of the material for designers: - Open time - Workability time - Compressive modulus of elasticity - Modulus of flexural elasticity - Compressive strength - Shear strength - Glass transition temperature - Thermal expansion coefficient - Shrinkage	 ● ● ● Δ - ● ● ● ●	 EN 12189 EN ISO 9514 EN 13412 EN ISO 178 - EN 12188 EN 12614 EN 1770 EN 12617-1 o EN 12617-3	 (7*) (8*) ≥ 2000 N/mm² ≥ 2000 N/mm² - ≥ 12 N/mm² ≥ 40°C ≤ 100x10-6 per °C ≤ 0,1%	 ● ● ● ● ● ● ● ● ●	 EN 12189 EN ISO 9514 EN 13412 EN ISO 178 EN 12190 EN 12615 EN 12614 EN 1770 EN 12617-1 o EN 12617-3	 (7*) (8*) ≥ 2000 N/mm² ≥ 2000 N/mm² ≥ 30 N/mm² ≥ 6 N/mm² ≥ 40°C ≤100x10-6 per °C ≤ 0,1%

● for all intended uses Δ for certain intended uses

(1*) *The material must not drop more than 1 mm when applied at a thickness of less than 3 mm;*

(2*) *The surface area of the adhesive agent after the crush test must not be less than 3000 mm^2 (60 mm diameter);*

(3*) *With the dry test, fracture must occur in the concrete;*

(4*) *Compressive shear strength of prisms bonded obliquely at various angles θ must not be lower than the following σ_0 N/mm^2 values:*

θ	σ_0
50°	50
60°	60
70°	70

(5*) *Tensile stress created by the bonded joint in a direct tensile test must not be lower than 14 N/mm^2. Shear compressive strength of the prisms bonded obliquely at various angles θ must not be lower than the following σ_0 N/mm^2 values:*

θ	σ_0
50°	50
60°	60
70°	70

(6*) *The shear-compressive load at failure of the hardened concrete samples after exposure to thermal cycles or hot-damp environments must not be lower than the tensile strength of the concrete. The steel to steel samples must not break after being exposed to thermal cycles or hot-damp environments.*

(7*) *Declared value ± 20%*

(8* *Declared value*

(9*) *According to EN 12636 for hardened concrete on hardened concrete, the flexural strength test must provoke failure of the concrete. For fresh concrete on hardened concrete, the direct tensile strength test must provoke failure of the concrete. According to EN 12615 the compressive shear test must provoke failure of the concrete.*

(10*) *The shear-compression load at failure of the hardened concrete on hardened concrete or fresh concrete on hardened concrete samples after exposure to thermal cycles or hot-damp environments must not be lower than the lowest tensile strength of the bonded or original concrete.*

6.1| Reaction to fire

For all products for structural bonding used on elements subject to fire-resistance requirements, the manufacturer must declare the fire reaction class of the product.

Products with up to 1% in mass or volume (the highest of the two values) of evenly distributed organic materials may be declared as fire-reaction Class A1 without testing the said product.

Hardened products with more than 1% in mass or volume (the highest of the two values) of evenly distributed organic materials must be classified according to EN 13501-1 Standards and the appropriate fire-reaction class must be declared.

6.2| MAPEI products certified in compliance with UNI EN 1504-4

IN COMPLIANCE WITH EUROPEAN STANDARD
EN 1504-4
MAPEI
STRUCTURAL BONDING

Adesilex PG1
Structural adhesive (concrete/plate and concrete/concrete)

Adesilex PG1 Rapido
Structural adhesive (concrete/plate and concrete/concrete)

Adesilex PG2
Structural adhesive (concrete/plate and concrete/concrete)

Adesilex PG4
Structural adhesive (concrete/plate and concrete/concrete)

Eporip
Structural adhesive (concrete/plate and concrete/concrete)

7| UNI EN 1504-part 5

Products and systems for protecting and repairing concrete structures.
Definitions, requirements, quality control and conformity assessment.
Part 5:
Concrete injection.

Part 5 of UNI EN 1504 regards products used for injection, repair and protection of concrete structures, used for:

- filling cracks, voids and interstices in concrete in order to transmit forces (category F);
- ductile filling of cracks, voids and interstices in concrete (category D);
- expansive filling of cracks, voids and interstices in concrete (category S).

This part considers 2 of the 11 principles described in UNI EN 1504-9:

(PI) principle 1 - Protection against the risk of penetration:

1.5 Filling cracks

(SS) Principle 4 – Structural strengthening

4.5 Injecting in cracks, voids or interstices
4.6 Filling cracks, voids or interstices

Photo 11
Injecting EPOJET in a cracked concrete slab

Injection products for filling cracks, voids and interstices in concrete with transmission of forces (F):

• products capable of binding to the surface of concrete and to allow the transmission of forces through them.

Characteristics and performance requirements of injection products for force transmission filling of cracks:

	Performance characteristics	Test method	Repair principle			Requirement
			1	4	4	
			Repair method			
			1.5	4.5	4.6	
BASIC CHARACTERISTICS	Adhesion by tensile bond (H, P)	EN 12618-2	●	●	●	- > 2 N/mm² (H) - > 0,6 N/mm2 (for injection products for filling voids and interstices only) - Cohesive failure in the substrate (P)
	Adhesion by inclined shear strength (HP)	EN 12618-3	Δ	Δ	Δ	Monolitic failure
	Volumetric shrinkage (P)	EN 12617-2	●	●	●	< 3%
	Bleeding (H)	EN 445/3.3	●	●	●	Bleeding < 1% of the initial volume after 3 hours
	Variation in volume (H)	EN 445/3.4	●	●	●	- 1% < variation in volume < 5% of the initial volume
	Glass transition temperature (P)	EN 12614	Δ	Δ	Δ	> 40 °C
	Chloride content (H)	EN 196-21	Δ	Δ	Δ	< 0,2%
REACTIVITY CHARACTERISTICS	Injectability into dry medium (H, P)*	EN 1771 EN 12618-2	●	●	●	Injectability class: - high: < 4 minutes for 0.1 mm cracks - minimum: < 8 minutes for 0.2 and 0.3 mm cracks Degree of crack filling > 90% Indirect tension: > 7 N/mm² (P) – > 3 N/mm² (H)
	Viscosity (P)	EN ISO 3219	●	●	●	Declared value
	Time to efflux (H)	EN 14117	●	●	●	Declared value

REACTIVITY CHARACTERISTICS	Workability time (H, P)	EN ISO 9514	●	●	●	Declared value
	Tensile strength development of polymers (P)	EN 1543	●	●	●	Tensile strength > 3 N/mm2 within 72 hours at the minimum application temperature or within 10 hours at the minimum application temperature for daily movements of more than 10% for the larger cracks or 0.03 mm (the lowest value)
	Setting time (H)	EN 196-3	●	●	●	Declared value
DURABILITY	Adhesion by tensile bond strength after thermal and wet drying cycles (H, P)	EN 12618-2	●	●	●	Reduction of tensile strength less than 30% of initial values (H) Cohesive failure in the substrate (P)
	Compatibility with concrete (H, P)	EN 12618-2	●	●	●	Reduction of tensile strength less than 30% of initial values (H) Cohesive failure in the substrate (P)

● for all intended uses Δ for certain intended uses

(H) Hydraulic binders (P) Reactive polymeric binders

** Width of the cracks: 0.1 mm – 0.2 mm - 0.3 mm: determining injectability and direct tensile test (EN 1771);*
Width of cracks: 0.5 mm - 0.8 mm or if EN 1771 is not suitable: treated as adhesion through tensile bond strength (EN 12618-2)

Injection products for ductile filling of cracks, voids and interstices in concrete (D): flexible products capable of supporting successive movements.

Characteristics and performance requirements of injection products for ductile filling of cracks, voids and interstices in concrete:

	Performance characteristics	Test method	Repair principle 1 Repair method 1.5	Requirement
BASIC CHARACTERISTICS	Adherence and elongation capacity of products for ductile injection (P)	EN 12618-1	●	- > 2 N/mm^2 (H) - > 0,6 N/mm^2 (for injection products for filling voids and interstices only) - Cohesive failure in the substrate (P)
	Water-tightness (P)	EN 14068	Δ	Monolithic failure
	Glass transition temperature (P)	EN 12614	Δ	< 3%
WORKABILITY CHARACTERISTICS	Injectability into dry medium (P)*	EN 1771 EN 12618-2	●	Injectability class: - high: < 4 minutes for 0.1 mm cracks - minimum: < 8 minutes for 0.2 and 0.3 mm cracks Degree of crack filling > 90%
	Injection into non-dry medium (P)*	EN 1771 EN 12618-2	●	Injectability class: - high: < 4 minutes for 0.1 mm cracks - minimum: < 8 minutes for 0.2 and 0.3 mm cracks Degree of crack filling > 90%
	Viscosity (P)	EN ISO 3219	●	Declared value
	Expansion ratio development (P)		Δ	Declared value
REACTIVITY CHARACTERISTICS	Workability time (P)	EN ISO 9514	●	Declared value
DURABILITY	Compatibility with concrete (P)	EN 12618-2	●	No failure during compression tests Lost deformation work < 20%

● for all intended uses Δ for certain intended uses
(P) Reactive polymeric binders

** Width of the cracks: 0.1 mm – 0.2 mm – 0.3 mm: determining injectability (P);*
Width of cracks: 0.5 mm – 0.8 mm or if EN 1771 is not suitable: injection between concrete slabs (P).

Injection products for expansive filling of cracks, voids and interstices in concrete (S): products at the reactive state with the capacity of expanding repeatedly by the absorption of water so that the water molecules bond to the molecules of the injection product.

Characteristics and performance requirements of injection products for expansive filling of cracks, voids and interstices in concrete.

	Performance characteristics	Test method	Repair principle 1 Repair method 1.5	Requirement
BASIC HARACTERISTICS	Water-tightness (P)	EN 14068	●	Water-tight at 2 x 10^5 Pa for special applications: water-tight at 7 x 10^5 Pa
	Behaviour with corrosion (P)	EN 12614	Δ	Must not contain substances at levels which could cause corrosion of the reinforcement
WORKABILITY CHARACTERISTICS	Viscosity (P)	EN ISO 3219	●	≤ 60 mPa·s Degree of crack filling > 95%
	Expansion ratio development (P)	EN 14498	●	Declared value
REACTIVITY CHARACTERISTICS	Workability time (P)	EN ISO 9514	●	Declared value
DURABILITY	Sensitivity to water: expansion ratio caused by water conditioning (P)	EN 14498 (A water conditioning)	●	The expansion rate must be constant when immersed in water
	Sensitivity to wet-dry cycles (P)	EN 14498 (B water conditioning)	●	There must be no variation in the expansion ratio after immersion in water following the damp-dry cycles
	Compatibility with concrete (P)	EN 12637-1	●	The strength properties compared with the water-immersed test samples shall not differ more than 20%

● for all intended uses Δ for certain intended uses
(P) Reactive polymeric binders

7.1 MAPEI products certified in compliance with UNI EN 1504-5

IN COMPLIANCE WITH EUROPEAN STANDARD
EN 1504-5
MAPEI
CONCRETE INJECTION

Epojet
Formulate with reactive polymer binder U(F1)W(2)(1)(5/30)(0)

Epojet LV
Formulate with reactive polymer binder U(F1)W(1)(1/2)(10/35)(0)

Key: U: intended use **W:** workability

F: Injection product for force transmission filling of cracks:
F1: Bond by tensile strength > 2 N/mm^2 (by injecting into cracks, voids and interstices);
F2: Bond by tensile strength > 0.6 N/mm^2 (by injecting into cracks, voids and interstices);

The letter W is followed by 4 groups of numbers:

First group:
- (1, 2, 3, 5 and8) is the minimum thickness guaranteed by the crack measured in tenths of a millimetre;

Second group:
- moisture level of the crack
(1 for dry, 2 for damp, 3 for wet and 4 for running water);

Third group:
- minimum and maximum application temperature;

Fourth group:
- (0) used for cracks without regular daily movements or with movements less than 10% or 0.03 mm during curing.
- (1) used for cracks with regular daily movements of more than 10% or 0.03 mm during curing.

For example: **EPOJET: U(F1)W(2)(1)(5/30)(0)**

Injection product for filling force transmission cracks with bonding by tensile strength > 2 N/mm^2. Injectable in dry cracks > 0.2 mm. Suitable for use from 5°C to 30°C. Used for cracks without regular daily movements or with movements less than 10% or 0.03 mm during curing.

8| UNI EN 1504-part 6

Products and systems for protecting and repairing concrete structures.
Definitions, requirements, quality control and conformity assessment.
Part 6:
Anchoring reinforcing steel bars.

Part 6 of UNI EN 1504 Standards regards hydraulic or synthetic resin binders (or a mixture of both) with a fluid or thixotropic consistency used for cementing steel reinforcement bars in concrete structures.

Part 6 of UNI EN 1504 only considers principle 4 described in UNI EN 1504-9:
(SS) Principle 4 – Structural strengthening
4.2 Installing bonded rebars in preformed or drilled holes in the concrete

Photo 12
Anchoring steel bars in concrete using **PLANIGROUT 300**

Performance characteristics	Repair principle 4	Repair method	Requirement
	Test method		
Pull-out	●	prEN 1881	Displacement ≤ 0,6 mm with a load of 75 KN
Chloride ion content	●	EN 1015-17	≤ 0,05%
Glass transition temperature*	●	EN 12614	≥ 45°C o 20°C above the maximum ambient temperature of the structure in service, whichever is the highest
Tensile deformation*	●	prEN 1544	Displacement ≤ 0,6 mm after a continuous load of 50 KN for 3 months

● for all intended uses - * for polymers only (PC products)

8.1| Reaction to fire

For all products used to repair concrete elements subject to fire-resistance requirements, the manufacturer must declare the fire reaction class of the repair product.
Products with up to 1% in mass or volume (the highest of the two values) of evenly distributed organic materials may be declared as fire-reaction Class A1 without testing the said product.
Hardened repair products with more than 1% in mass or volume (the highest of the two values) of evenly distributed organic materials must be classified according to EN 13501-1 Standards and the appropriate fire-reaction class must be declared.

8.2| MAPEI products certified in compliance with UNI EN 1504-6

IN COMPLIANCE WITH EUROPEAN STANDARD
EN 1504-6
MAPEI
ANCHORING MORTAR

Mapefill
Anchoring product

Mapefill F
Anchoring product

Mapefill R
Anchoring product

Planigrout 300
Anchoring product

9| UNI EN 1504- part 7

Products and systems for protecting and repairing concrete structures.
Definitions, requirements, quality control and conformity assessment.
Part 7:
Reinforcement corrosion protection

In order to create conditions in which it is impossible for potentially anodic areas of the reinforcement steel to form part of the corrosion process, two different types of coating may be defined:

- Active coatings: coatings which contain electrochemically active pigments which may function as inhibitors or which may provide localised cathodic protection.*
- Barrier coatings: coatings which isolate the reinforcement steel from pore water in the surrounding cementitious matrix.

* Cement is considered to be an active pigment due to its high alkalinity.

Part 7 of the UNI EN 1504 Standards considers only principle 11 describedin UNI EN 1504-9:

Photo 13
Steel reinforcement bars on bridge beams treated with **MAPEFER 1K,** anti-corrosion protective coating.

(CA) Principle 11 - Control of anodic areas

11.1 Active coating of steel reinforcement

11.2 Painting reinforcement with barrier coatings

Performance characteristics	Repair principle 11		Test method	Requirement
	Repair method			
	11.1	11.2		
Protection from corrosion	●	●	EN 15183	The test may be considered successful if the coated areas of the steel are free from corrosion and if the corrosion cracks around the base of the pillar are smaller than 1 mm
Glass transition temperature	Δ	Δ	EN 12614	Minimum 10 °K above the maximum service temperature
Cohesion with the matrix (coated steel in the concrete)	Δ	Δ	EN 15184	This is assessed by considering the bond stress with displacement of Δ= 0,1 mm. The test may be considered successful if the bond stress of the coated bars is at least 80% of the reference bond stress for uncoated bars.

● for all intended uses Δ for certain intended uses

9.1| MAPEI products certified according to EN 1504-7

IN COMPLIANCE WITH EUROPEAN STANDARD
EN 1504-7
MAPEI
REINFORCEMENT CORROSION PROTECTION

Mapefer
Reinforcement corrosion protection

Mapefer 1K
Reinforcement corrosion protection

Photo 14
Reinforcement bars on a cooling tower treated with **MAPEFER 1K**

10| UNI EN 1504-part 8

Products and systems for protecting and repairing concrete structures.
Definitions, requirements, quality control and conformity assessment.

Part 8:

Quality control and conformity assessment

Part 8 of the Standard specifies procedures for quality control, evaluation of conformity and marking and labelling of the products and systems for protecting and repairing concrete according to UNI EN 1504, parts 2 to 7. It is specially addressed to manufacturers and certification institutes.
The following subjects are covered in the Standard:

Sampling:

- description and registration;
- sampling frequency.

Conformity assessment:

- description and initial test types;
- identification tests;
- performance tests;
- factory production control.

Marking and labelling

Assessment, surveillance and certification of factory production control

Tasks of inspection body:

- initial assessment of factory production control;
- constant surveillance of factory production control.

Tasks of certification institute:

- certification of factory production control;
- corrective actions to be implemented in case of non-conformity.


ICMQ

CERTIFICATE OF
FACTORY PRODUCTION CONTROL

1305-CPD-0616

Products and systems for the protection and repair of concrete structures

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EN 1504-2:2004, EN 1504-3:2005, EN 1504-4:2004 and EN 1504-5:2004

CE

MAPEI S.p.A

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1305-CPD-0616 Plant in Robbiano di Mediglia
1305-CPD-0615 Plant in Latina
1305-CPD-0852 Plant in Sassuolo

The date of production is printed on the package

EN 1504-2

Surface protection product – Coating
for intended use in protection against ingress;
moisture control and increasing resistivity

Permeability to CO_2:	s_D > 50 m
Water vapour permeability:	Class I
Capillary absorption and permeability to water:	< 0.1 $kg*m^{-2}*h^{-0.5}$
Thermal compatibility:	
- Freeze-Thaw cycling:	≥ 0.8 N/mm^2
- Thunder Shower:	≥ 0.8 N/mm^2
Adhesion strength by pull-off test:	≥ 0.8 N/mm^2
Reaction to fire:	C-s1,d0
Dangerous substances:	comply with 5.3

11| UNI EN 1504-part 10

Products and systems for protecting and repairing concrete structures.
Definitions, requirements, quality control and conformity assessment.
Part 10:
Site application of products and quality control of the works

Part of the UNI EN 1504 Standard contains the requirements for the conditions of the substrate before and after application, including structural stability, storage, preparation and application of products and systems for protecting and repairing concrete structures, including quality control, maintenance, health and safety and the environment.
All repair and protection projects are characterised by 5 fundamental points:
1) Analysis and diagnosis of the causes of deterioration;
2) The correct choice of methods and systems to restore the structure to its original efficiency;
3) Careful preparation of both the concrete and reinforcement steel;
4) The correct choice of products/systems according to the Standard and application methods by trained, experienced operators;
5) Respect for the health and safety of operators and the environment before and during application.

11.1| Diagnosing the causes of deterioration

There are a multitude of diagnostic testing techniques which may be summarised into three main groups:

- Non-destructive physical testing, such as visual inspection to find cracks and stains, localisation of voids, measurement of the concrete around the reinforcement, potential mapping to determine the condition of reinforcement steel and measuring the size of cracks;
- Chemical tests such as the use of phenolphthalein to measure the depth of carbonatated concrete, chloride ion content, microscopic analysis, etc.;
- Destructive physical testing such as the analysis of core samples to determine the mechanical characteristics of the concrete.

11.2| Selecting the correct method and preparation of substrates

The first part of UNI EN 1504-10 regards all the phases to prepare the substrate and is divided into preparation of the concrete and preparation of the reinforcement steel.

Preparation of the concrete

The substrate must be prepared correctly to remove all the deteriorated and detached concrete until a solid, strong substrate with a rough surface is obtained. Any areas previously repaired and which are not perfectly bonded must also be removed.
Preparation may be carried out by hydro-blasting, roughing the surface or by removing the concrete.

Preparation of the steel reinforcement

Both old and any new steel reinforcement must be prepared correctly and be free of all the contaminated concrete before applying any type of protection or repair system.
The steel reinforcement may be prepared by sand-blasting the surface.

11.3| Application of products and systems

Apart from being suitable for the substrate and structure under repair, all products and systems used to repair concrete must respect the intrinsic characteristics of the material itself and the environmental conditions in which it will be used.

- Storage of goods;
- Protection before, during and after application;
- Temperature, humidity and dew point;
- Curing times and methods, etc.
- Apart from the above, it is fundamental that trained professional operators and companies are employed to carry out the work.

Various points are defined and taken into consideration in the Standard, divided according to whether the work is carried out due to defects in the concrete and/or structural strengthening or defects provoked by corrosion of the steel reinforcement.

Defects in the concrete and structural strengthening

- Adherence
- Mortar or concrete applied by hand
- Shotcrete or mortar
- Cast mortar or concrete
- Curing
- Cracks and joints
- Surface coatings and other treatments
- Anchorage
- Plate bonding

Defects provoked by corrosion of the reinforcement steel

- Coating reinforcement steel
- Removal
- Replacement

11.4| Quality control, health and safety

During the entire life of a project, on-site inspections must be carried out to guarantee the control of materials, their application and health and safety measures before, during and after all work carried out to restore a structure in line with the needs of the owner.

Repair examples of concrete structures

Repairs on a viaduct

Photo 15
Preparation of the substrate by hydroscarifying and hydrodemolition until a solid, compact surface with no loose parts is obtained

Photo 16
Passivation of the reinforcement steel using mono-component, anti-corrosion cementitious mortar (such as **MAPEFER 1K**), which complies with the minimum requirements of EN 1504-7).

Photo 17
Reconstruction of the removed concrete layer with R4 class structural mortar (such as **MAPEGROUT EASY FLOW**, **MAPEGROUT EASY FLOW GF** or **MAPEGROUT BM**), which comply with the minimum requirements of EN 1504-3.

Photo 18
Protection and waterproofing with two-component flexible cementitious mortar (such as **MAPELASTIC**), which complies with the minimum requirements of EN 1504-2. An alternative is to smooth and level off using mono-component, cementitious mortar with high bond strength (such as **PLANITOP 200 or MONOFINISH**), which comply with the minimum requirements of EN 1504-2. Painting with flexible, protective and decorative synthetic resin-based paint in water dispersion for concrete (such as **ELASTOCOLOR PAINT**), which complies with the minimum requirements for EN 1504-2.

Repair examples of concrete structures

Increasing the section and strengthening a floor slab on a pier

Photo 19
Preparation of the substrate by grinding or bush-hammering to leave a solid, compact surface and removal of all loose parts

Photo 20
Positioning new strengthening reinforcement where required

Photo 21
Application of an even layer of two-component, solvent-free epoxy adhesive for construction joints (such as **EPORIP**), which complies with the minimum requirements of EN 1504-4

Photo 22
Fresh-on-fresh application of a cementitious screed at the required thickness, but never less than 4-5 cm

Repair examples of concrete structures

Sealing cracked concrete on a dam

Photos 23 e 24
Opening the crack followed by blowing and vacuuming off the dust. Positioning the special injection tubes

Photo 25
Surface sealing of the crack with bi-component thixotropic epoxy adhesive for structural bonds (such as **ADESILEX PG1** or **ADESILEX PG2),** which comply with the minimum requirements of **EN 1504-4**

Photo 26
Injection with super-fluid epoxy resin (such as **EPOJET or EPOJET LV**), which comply with the minimum requirements of EN 1504-5, until the crack is completely filled. Once the injection phase is complete cut the tubes

Repair examples of concrete structures

Grouting a pillar in an encapsulated pile foundation


Photo 27


Photo 28


Photo 29

Photos 27 e 28
Cleaning the seat of the foundations, removal of mud and other debris and loose material and positioning the pre-fabricated element

Photo 29
Casting into the foundation seat until full using fluid, expansive mortar for anchoring (such as **MAPEFILL** or **MAPEFILL R**), which meet the minimum requirements of EN 1504-6

The examples illustrated on the previous pages represent only a few of the products certified according to UNI EN 1504 European Standards. The MAPEI range includes a number of products which comply with the requirements of the Standard and which guarantee a solution for a wide array of applications and needs.

▸ 12| MAPEI products certified in compliance with UNI EN 1504

Products and systems for the protection and repair of concrete structures -									
		Adesilex PG1	Adesilex PG1 Rapido	Adesilex PG2	Adesilex PG4	Antipluviol S	Colorite Beton	Colorite Performance	Duresil EB
EN 1504-2	Surface protection systems for concrete					•	•	•	•
EN 1504-3	Structural and non-structural repair								
EN 1504-4	Structural bonding	•	•	•	•				
EN 1504-5	Concrete injection								
EN 1504-6	Anchoring of reinforcing steel bar								
EN 1504-7	Reinforcement corrosion protection								
		Mapecoat I 24	Mapefer	Mapefer 1K	Mapefill	Mapefill F	Mapefill R	Mapefinish	Mapegrout 430
EN 1504-2	Surface protection systems for concrete	•						•	
EN 1504-3	Structural and non-structural repair							• (R2)	• (R3)
EN 1504-4	Structural bonding								
EN 1504-5	Concrete injection								
EN 1504-6	Anchoring of reinforcing steel bar				•	•	•		
EN 1504-7	Reinforcement corrosion protection		•	•					
		Mapegrout SV Fiber	Mapegrout SV T	Mapegrout T40	Mapegrout T60	Mapegrout Thixotropic	Mapelastic	Mapelastic Foundation	Mapelastic Smart
EN 1504-2	Surface protection systems for concrete						•	•	•
EN 1504-3	Structural and non-structural repair	• (R4)	• (R4)	• (R3)	• (R4)	• (R4)			
EN 1504-4	Structural bonding								
EN 1504-5	Concrete injection								
EN 1504-6	Anchoring of reinforcing steel bar								
EN 1504-7	Reinforcement corrosion protection								

Definitions, requirements, quality control and evaluation of conformity										
Elastocolor Paint	Elastocolor Rasante	Elastocolor Rasante SF	Elastocolor Waterproof	Epojet	Epojet LV	Eporip	Idrosilex Pronto	Idrosilex Pronto RPG	Idrosilex Pronto RPF	
•	•	•	•				•		•	
								• (R3)	• (R2)	
						•				
				•	•					
Mapegrout BM	Mapegrout Hi-Flow	Mapegrout Hi-Flow GF	Mapegrout Hi-Flow TI 20	Mapegrout Easy Flow	Mapegrout Easy Flow GF	Mapegrout FMR	Mapegrout Gunite	Mapegrout LM2K	Mapegrout Fast-Set	Mapegrout SV
• (R4)	• (R4)	• (R4)	• (R4)	• (R4)	• (R4)	• (R4)	• (R4)	• (R3)	• (R3)	• (R4)
Monofinish	Planigrout 300	Planitop 100	Planitop 200	Planitop 207	Planitop 400	Planitop 540	Planitop Fast 330	Planitop HDM	Planitop HDM Maxi	Planitop Smooth & Repair
•		•	•	•		•	•	•		•
• (R2)					• (R3)			• (R2)	• (R2)	• (R2)
	•									