Anchoring products

according to ***EN 1504-6 European standards and ETA*** (European Technical Approval)

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MAPEI®

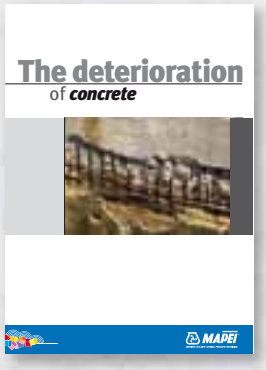
ADHESIVES · SEALANTS · CHEMICAL PRODUCTS FOR BUILDING

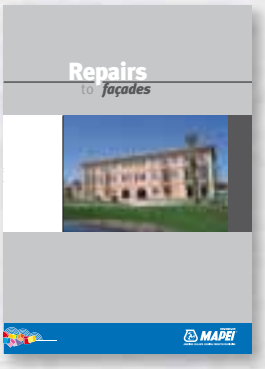
Mapei has issued this manual, dedicated to anchoring products in compliance with EN 1504 standards, as part of a series of technical manuals about the deterioration of concrete.

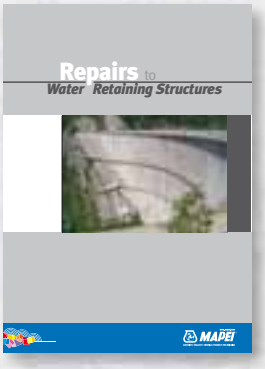
The subject of this manual is:

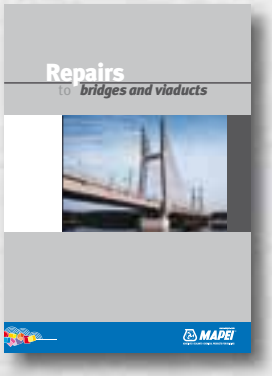
Anchoring products according to EN 1504-6
European standards and ETA (European Technical Approval)

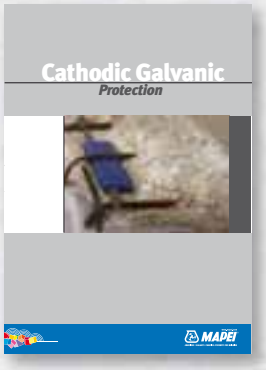
The other manuals available in the series are:

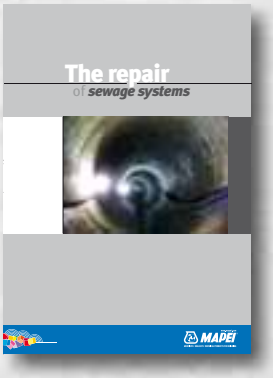












The manuals are available upon request.

Anchoring products

according to ***EN 1504-6 European standards and ETA*** (European Technical Approval)

Index

1| Introduction

1.1| Certification

Since the 1st of January 2009, all products used in the repair and conservation of concrete must comply with the prescriptions of European standard EN 1504 “Products and systems for the protection and repair of concrete structures – Definitions, requirements, quality control and evaluation of conformity”. The EN 1504 standard is comprised of 10 sections, with each section covering a different area of use. The section regarding this technical manual is EN 1504 part 6, which specifies the minimum requirements of anchoring products to qualify for CE marking, an essential requisite for marketing and using a product in member states of the European Union. The standard covers both hydraulic binder-based and synthetic resin-based products with a fluid or thixotropic consistency.

In the mechanical engineering and construction industries, strong, durable anchors often need to be executed to connect machinery or structural elements to foundations, normally made from concrete. These connections may be made between any of the following: concrete to concrete (e.g. prefabricated columns anchored in an encapsulated foundation plinth), steel to concrete (anchoring foundation beds for machinery, metal bars and rods, guide rails for cranes, etc.) or steel to solid or perforated masonry (e.g. reinforcing rods, brackets and metal supports).

photo 1
Anchorage of a turbine in a power station

To prevent the onset of problems, apart from using certified products, it is indispensible that every aspect of the anchoring system is carefully analysed, that is:

- substrate characteristics;
- entity of loads transmitted;
- minimum requirements of the product.

The results of this analysis are then used to select the most appropriate anchoring system.
The first aspect to take into consideration is the condition of the substrate: an even, compact concrete base without cracks or signs of deterioration and with a sufficiently rough surface makes an ideal substrate, and is able to fully exploit the characteristics of the anchoring product. If, however, the substrate is not up to standard, it will have to be prepared accordingly to ensure that its physical-mechanical properties are sufficient to carry out the intervention.

photo 2
Guide rails of an overhead crane

The second aspect to be taken into consideration is the entity of the loads transmitted to the foundations or substrate. Every type of structure (such as cranes, piping, metal elements, etc.) is connected to suitable foundations, and these foundations are subjected to considerable stress. The direction of the loads transmitted determines whether they are axial, shear, oblique or flexural. Also, depending on their variation over time, they are considered static if they remain constant (such as due to their own weight or if a load is permanent), or dynamic if the load varies over time (such as with vibrations or impact). All the forces involved, of whatever nature, must be transmitted to the foundations as uniformly as possible.

The third aspect to take into consideration regards the minimum requirements of EN 1504-6. To form a durable, safe connection, therefore, only products carrying the EC symbol must be used to guarantee specific performance characteristics: high dimensional stability, mechanical strength adequate for the type of intervention to be carried out, pull-out resistance and perfect adhesion to both the element to be anchored and the substrate.

For anchoring products, the requirements of EOTA (European Organisation for Technical Approval) must also be taken into consideration which, through the ETA (European Technical Approval) product certification system, guarantees that a given product is suitable for intended final use.

The problems most frequently encountered when anchoring elements are:

- failure of the substrate or foundations;
- failure of the anchoring product;
- movement in the anchoring product.

As far as the first point is concerned, as mentioned previously, the mechanical characteristics of the substrate and foundations must be assessed to verify their suitability. If they are not suitable, they must be prepared accordingly. As far as failure and/or movement in the anchoring product are concerned, the factors which have the most effect are the mechanical characteristics of the product and the size and depth of the anchoring void, which must be calculated according to the intervention to be carried out.
To help with this particular aspect, Mapei has a wide range of products available for design engineers and sector professionals.

2| Characteristics of an anchoring mortar

2.1| Durability

Durability means the capacity of a material to maintain its physical and mechanical characteristics over a period of time when subjected to mechanical stresses, and to chemical-physical stresses if exposed to particularly aggressive environments. An anchor must remain strong and durable over time and, if this were not the case, the onset of problems would have a negative impact on the efficiency, functionality and safety of the anchored structure. For example, if an anchor point for machinery deteriorates or fails, the performance of the machinery would be affected resulting in a loss in efficiency, and, therefore, a stoppage for maintenance.
To make a durable anchor suitable for any situation, including for structures or elements with a particularly complex shape, products with adequate characteristics at both the fresh and hardened state must be used.

2.2| Characteristics of fresh mortar

The characteristics of fresh mortar, such as fluidity, maintenance of workability, shrinkage during the plastic phase, bleeding and segregation, are of considerable importance because they have a direct influence on the final performance characteristics of the product.

- **Fluidity:** anchoring products must have the capacity to flow into tight areas and complex shapes, and/or where there is a dense network of reinforcing steel, so that all the areas are filled evenly and porosity and the formation of voids are limited as much as possible without forming defects and irregular areas.

- **Maintenance of workability:** workability must be sufficient for the type of intervention to be carried out. For example, for simple, quick anchors, a rapid-setting product would be the most suitable, while for larger, more complex anchors, a product with a longer setting time sufficient to allow the anchor point to be completed must be used. One of the factors which has the greatest influence on the workability of a product is temperature, in that it may slow down (at low temperatures) or accelerate (at high temperatures) setting times. For this reason, before making an anchor, this parameter must be thoroughly analysed.

- **Expansion during the plastic phase:** this characteristic is obtained by adding special expansive agents which increases the volume of the mix without forming hydrogen. To prevent rapid evaporation of the mixing water, which would lead to an interruption of the expansive reaction, surfaces directly exposed to the surrounding air may be protected using damp sheets.

- **Bleeding:** this occurs in cementitious-based mortars and results in part of the mixing water rising to the surface. If bleeding occurs, when the water evaporates, voids and detached portions are formed which then compromise perfect contact between the substrate and the anchoring product and, therefore, a reduction in its mechanical characteristics due to a higher water/cement ratio at the surface of the mortar. To prevent bleeding, the guidelines and instructions on the Technical Data Sheet of the product must be strictly adhered to.

- **Segregation:** segregation takes place in both cementitious and resin-based mortar, and consists in the separation of the various components of the mix due to gravity. Larger-sized aggregates tend to deposit at the bottom, while cement or resin tends to rise towards the surface. Segregation, therefore, generates areas with different mechanical strength, a different modulus of elasticity and a difference in shrinkage between the upper layer, rich in finer components, and the lower layer, with a higher concentration of large components. To prevent segregation, the product must be mixed with the correct amount of water when a cementitious product is used, and with the correct amount of inerts where required (for three-component products) when a resin-based product is used.

Whether a cementitious or resin-based product is used, the guidelines and instructions on the Technical Data Sheet of the product must be strictly adhered to.

2.3| Characteristics of hardened mortar

To guarantee their durability, anchoring products must have specific characteristics when hardened. The following is a brief description of the most important characteristics.

- **Compressive and flexural strength:** these characteristics are fundamental to guarantee sufficient mechanical resistance of the mortar to static and dynamic forces. The most suitable anchoring mortar must be chosen according to the loads the anchored element must transmit to the foundations and substrate.

- **Modulus of elasticity:** this is a fundamentally important parameter to guarantee excellent compatibility in terms of deformation between the mortar and the concrete used for the substrate.

- **Pull-out resistance of steel rods:** this indicates the resistance offered by the malt to a steel rod anchored in the mortar being pulled out and is directly proportional to the adherence stress. High adherence of the anchoring mortar to the element to be anchored (steel or concrete) and to the substrate (usually concrete) is an indispensible characteristic to obtain a durable anchor point and limit the risk of failure.

- **Expansion during the hardened phase:** this characteristic is obtained by adding special expansive agents which react with the mixing water, and restrain the reduction in volume caused by partial evaporation of the water. Reduction in volume may be prevented by keeping to a low water/cement ratio when preparing the mortar (only use the amount of water indicated on the Technical Data Sheet) and by covering surfaces exposed to the air with damp sheets. Excessive evaporation of the mixing water may generate such a high rate of reduction in volume that cracks may form or portions between the mortar and the anchored element become detached.

- **High impermeability to water:** anchoring mortar must be compact with low porosity. These characteristics are required to guarantee sufficient impermeability to both water and any aggressive agents dissolved in the water which could provoke premature deterioration of the reinforcing steel.

- **Excellent resistance to freeze-thaw cycles:** this is the capacity of the mortar to maintain its characteristics (compressive and flexural strength and modulus of elasticity) even after numerous thermal cycles. This characteristic is particularly important if the anchor is formed outside in areas subject to particularly high variations in temperature.

- **Excellent resistance to chemicals:** the capacity of the anchoring product to maintain its physical and mechanical characteristics if it comes into contact with various chemical substances (e.g. oil, lubricants, diesel fuel, acids, etc.).

2.4| Determining the characteristics of fresh and hardened mortar

Tests compliant to current norms and standards must be carried out to determine the characteristics of anchoring mortar. The following is a brief description of some of the tests carried out.

EN 13395-2 Determination of consistency - flow test

This test, carried out on cementitious-based mortar only, measures the flow of 1 litre of mortar along a channel in 30 seconds. The distance the mortar flows in the prescribed time represents its flow value.

photo 3 - photo 4
Equipment used
to carry out a flow test

UNI 8996 Determination of free expansion in the plastic phase

Free expansion of expansive cementitious mortar in the plastic phase consists in determining the change in volume of the mortar in the first 24 hours of hydration. Expansion or contraction is determined by measuring the change in volume of settled mortar in a suitable container. The reading is made using two calibrated screws. An alternative method is to measure the variations with a laser detector and a data acquisition system which records the amount of expansion and contraction for 24 hours.

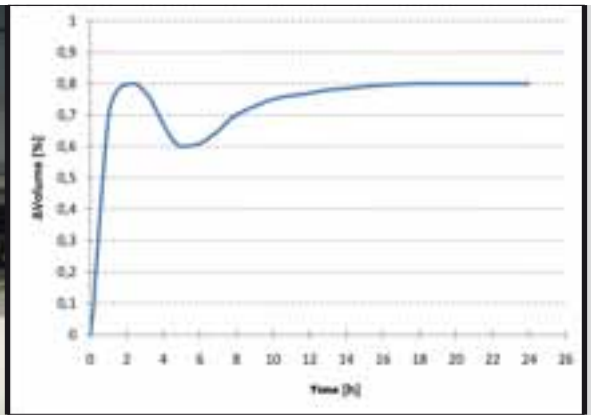
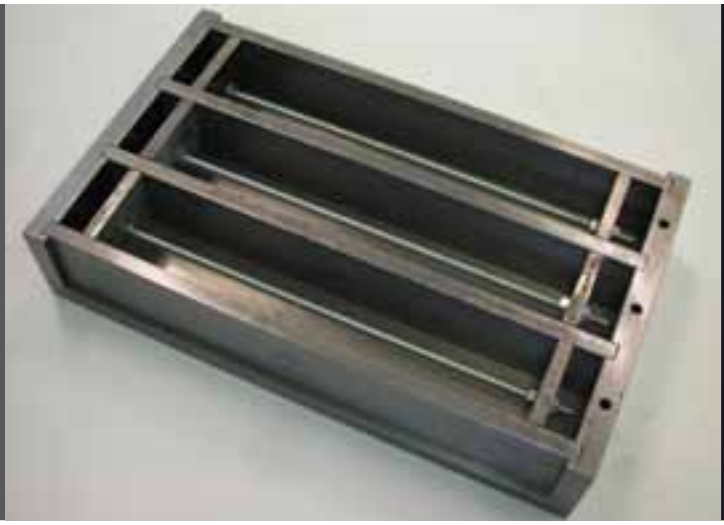


photo 5
Equipment used for the test to determine free expansion in the plastic phase

photo 6
Graph of the results obtained during the test

UNI 8147 Determination of restrained expansion

This test consists in measuring the expansion of mortar, using a threaded carbon steel rod, embedded in a 250 x 50 x 50 mm prismatic test sample. After preparing the test samples, they are cured at approximately 20°C and relative humidity of at least 90%. After 8 hours, the samples are stripped from their moulds and the initial length of the rod is measured. The samples are then cured in still water saturated with lime at approximately 20°C. The length is then measured after 7 days and 28 days of curing.



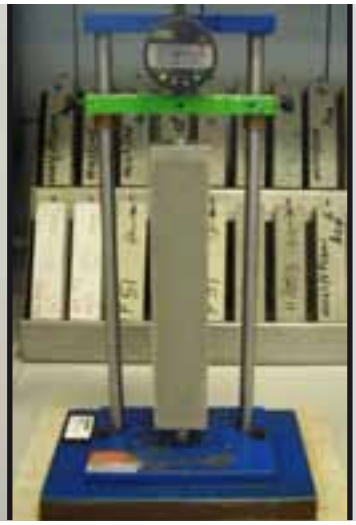


photo 7 - photo 8
Equipment used in the test to determine restrained expansion

EN 12390-8 Water permeability test

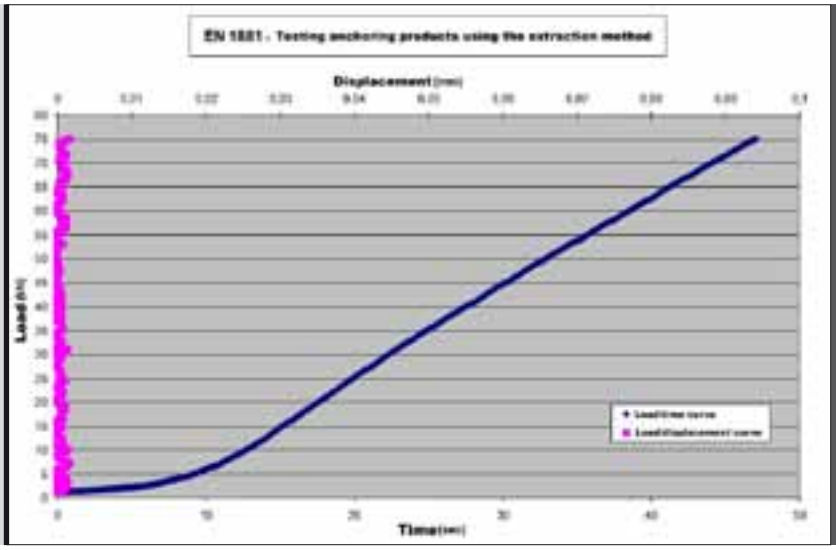
This test determines the penetration depth of water under pressure into mortar cured for 28 days. The test sample of mortar is placed in a suitable chamber containing water at a pressure of 5 bar for 3 days. After three days, the sample is cut into two pieces and the penetration depth of the water is measured.

photo 9
Equipment used to carry out the water permeability test

EN 1881 Pull-out resistance of steel rods - extraction method

This test comprises in applying a tensile force at the free end of a reinforcing rod anchored with the anchoring mortar in a concrete sample with a specified composition. The load and movement of the rod are measured using a data acquisition system. The mortar passes the test if the movement under a load of 75 kN is ≤ 0.6 mm.

photo 10
A graph illustrating load/movement and load/time results of a pull-out resistance test



Anchoring test of a foundation plate

This test is not covered by current standards. It is carried out under laboratory conditions, and simulates the anchoring of a foundation plate to verify the speed and distance covered by the mortar and the surface porosity of the mortar. In fact, once hardened, it is possible to assess the quality of the surface according to the presence of micro and macro voids.

photo 11
Formwork for the foundation plate anchoring test

photo 12
Contrast analysis to determine the surface porosity of anchoring mortar. It is carried out by colouring the surface and applying filler to fill the voids. After eliminating the excess filler, an image analysis programme is used to measure the ratio between the pores and the total surface area

3| Preparing the substrate and forming the anchor point

3.1| Preparing the substrate

To guarantee a durable anchor point, optimum preparation of the substrate is absolutely essential.

The substrate in which the anchor point is to be formed must be solid and compact, and any loose or detached portions must be completely removed. A key factor in obtaining sufficient adhesion between the anchoring mortar and the foundations is to provide a substrate which, apart from being clean and free of all traces of dust, is also sufficiently rough so that the mortar creates a solid grip.

Before applying the cementitious mortar, the substrate must be saturated with a dry surface (s.s.d. state). Compressed air may be used to help eliminate any free-standing water.

Unlike cementitious products, when resin-based products are applied, the substrate must be dry to guarantee correct hardening of the mortar.

3.2| Forming the anchor point

After preparing the substrate, the element to be anchored is placed in position and firmly held while the mortar is cast. The mix must be prepared according to whether a cementitious-based or a resin-based product is used.

3.3| Cement-based mortars

Cement-based mortars may be mixed using a low-speed drill with a mixing attachment or with a cement mixer, depending on the amount of product required. Pour in the specified amount of water (as indicated on the Technical Data Sheet for each product) and then gradually add the powdered mortar and mix for a few minutes until a fluid, even blend is obtained.

Then pour the mix in a continuous flow into the cavities to be filled, making sure that all air is expelled.

When filling large cavities, cementitious anchoring mortar must be mixed with 6 to 10 mm gravel at a ratio of 30% of the weight of product.

Anchoring mortars do not need to be vibrated. However, when casting into particularly complex areas and cavities, metal rods may be used to help expel the air contained in them.

3.4| Resins

Epoxy-based anchoring products are either two-component or three-component.

The mix is prepared by mixing all the components with a low-speed drill until an even blend is obtained. If the product also contains fillers (component C), this component is then added and then mixed again to obtain an even blend.

The product may be applied by casting or by pressure injection, according to the viscosity of the product.

4| Anchoring with Mapei products certified according to EN 1504-6 standards

Mapefill Anchoring product	
Mapefill R Anchoring product	
Mapefill F Anchoring product	
Mapefill MF Anchoring product	
Mapefill MF 610 Anchoring product	1,000 kg bags
Planigrout 300 Anchoring product	
Epojet Anchoring product	

4.1| MAPEFILL

Description: *fluid expansive anchoring mortar.*

Particularly suitable for: *precision anchoring of machine tools and metallic structures. Filling rigid joints between concrete and pre-cast concrete elements; underpinning walls.*

When mixed with water, MAPEFILL forms a fluid mortar which does not segregate with the capacity to flow into tight and complex spaces. Thanks to a special expansive agent, MAPEFILL is characterised by its total lack of shrinkage during both the plastic and hardened phases, and develops very high flexural and compressive strength after short curing times. Pour MAPEFILL from one side only in a continuous flow, making sure that any air in the cavity to be filled is completely expelled. The cavity to be filled must be at least twice the diameter of the rod to be anchored. If cavities larger than the recommended maximum size need to be

photo 13
Anchoring a metal footing plate with MAPEFILL

filled, add GRAVEL 6-10 at a rate of 30% of the weight of the MAPEFILL.

The product meets the minimum requirements of EN 1504-6 regarding the anchoring of steel reinforcing rods.

MAPEFILL has the following performance characteristics:

table 1

Characteristics	Test method	Minimum requirements according to EN 1504-6	Performance of product
Density of mix (kg/m^3):	/	/	2,250
pH of mix:	/	/	> 12.5
Flow after mixing (EN 13395-2) (cm):	/	/	> 45
Maximum size of aggregate (mm):	/	/	2.5
Pot life of mix:	/	/	approximately 1 hour (at 20°C)
Mechanical characteristics using 14.5% water:			
Compressive strength (MPa):	EN 12190	> 80% of value declared by manufacturer	30 (after 1 day) 55 (after 7 days) 70 (after 28 days)
Flexural strength (MPa):	EN 196/1	/	5 (after 1 day) 8 (after 7 days) 9 (after 28 days)
Compressive modulus of elasticity (GPa):	EN 13412	/	27 (after 28 days)
Adhesion to concrete (substrate in MC 0.40 – water/cement ratio = 0.40) according to EN 1766 (MPa):	EN 1542		≥ 2 (after 28 days)
Impermeability to water - penetration depth - (mm):	EN 12390/8	/	< 5
Free expansion during plastic phase (%):	ASTM 827	/	≥ 0.3
Pull-out resistance of steel rods - movement under a load of 75 kN (mm):	EN 1881	< 0.6	< 0.1
Adherence stress of rod anchored with Mapefill (MPa) for a 75 kN load (mm):	EN 1881 (*)	/	> 25
Reaction to fire:	Euroclass	Value declared by manufacturer	A1

(*) Test sample made according to EN 1881 standards considering uniform stress distribution between the rod and MAPEFILL.

4.2| MAPEFILL R

Description: *rapid-hardening, fluid, expansive anchoring mortar*

Particularly suitable for: *precision anchoring of machine tools and metallic structures. Filling rigid joints between concrete and pre-cast concrete elements; underpinning walls.*

MAPEFILL R is a pre-blended powdered mortar made from high-strength cement, selected aggregates and special admixtures. When mixed with water, it forms a fluid mortar which does not segregate with the capacity to flow into tight and complex spaces. Thanks to a special expansive agent, MAPEFILL R is characterised by its total lack of shrinkage during both the plastic and hardened phases, and develops very high flexural and compressive strength after short curing times. Pour MAPEFILL R from one side only in a continuous flow, making sure that any air in the cavity to be filled is completely expelled. The cavity to be filled must be at least twice the diameter of the rod to be anchored. If cavities larger than the recommended maximum size need to be filled, add GRAVEL 6-10 at a rate of 30% of the weight of the MAPEFILL R. The product meets the minimum requirements of EN 1504-6 regarding the anchoring of steel reinforcing rods.

photo 14
Anchoring under a foundation plate with MAPEFILL R (rapid-hardening mortar)

MAPEFILL R has the following performance characteristics:

table 2

Characteristics	Test method	Minimum requirements according to EN 1504-6	Performance of product
Density of mix (kg/m^3):	/	/	2,250
pH of mix:	/	/	> 12.5
Flow after mixing (EN 13395-2) (cm):	/	/	> 45
Maximum size of aggregate (mm):	/	/	2.5
Pot life of mix:	/	/	approximately 45 mins (at 20°C)
Mechanical characteristics using 17.5% water:			
Compressive strength (MPa):	EN 12190	> 80% of value declared by manufacturer	32 (after 1 day) 50 (after 7 days) 62 (after 28 days)
Flexural strength (MPa):	EN 196/1	/	5 (after 1 day) 7 (after 7 days) 8 (after 28 days)
Compressive modulus of elasticity (GPa):	EN 13412	/	26 (after 28 days)
Adhesion to concrete (substrate in MC 0.4 – water/cement ratio = 0.40) according to EN 1766 (MPa):	EN 1542	/	≥ 2 (after 28 days)
Impermeability to water - penetration depth - (mm):	EN 12390/8	/	< 5
Free expansion during plastic phase (%):	ASTM 827	/	≥ 0.3
Pull-out resistance of steel rods - movement under a load of 75 kN (mm):	EN 1881	< 0.6	< 0.1
Adherence stress of rod anchored with Mapefill R (MPa):	EN 1881 (*)	/	> 25
Reaction to fire:	Euroclass	Value declared by manufacturer	A1

(*) Test sample made according to EN 1881 standards considering uniform stress distribution between the rod and MAPEFILL R.

4.3| MAPEFILL F

Description: *high-performance anchoring and sealing mortar.*

Particularly suitable for: *precision anchoring and sealing of machinery and metallic structures. Filling joints between concrete and pre-cast concrete elements.*

When mixed with 18-20% of water, MAPEFILL F forms a fluid mortar which does not segregate with the capacity to flow into tight and complex spaces. Apply on substrates saturated with water with a dry surface (s.s.d. state). MAPEFILL F adheres exceptionally well to steel and concrete and has excellent resistance to sulphates. Pour MAPEFILL F from one side only in a continuous flow, making sure that any air in the cavity to be filled is completely expelled. The cavity to be filled must be at least twice the diameter of the rod to be anchored. If cavities larger than the recommended maximum size need to be filled, add GRAVEL 6-10 at a rate of 30% of the weight of the MAPEFILL F. The product meets the minimum requirements of EN 1504-6 regarding the anchoring of steel reinforcing rods.

photo 15
Rebar anchored in concrete with MAPEFILL F

MAPEFILL F has the following performance characteristics:

table 3

Characteristics	Test method	Minimum requirements according to EN 1504-6	Performance of product	
Density of mix (kg/m^3):	/	/	2,200	
pH of mix:	/	/	> 13	
Flow after mixing (EN 13395-2) (cm):	/	/	> 45 (20% water)	
Maximum size of aggregate (mm):	/	/	1.0	
Pot life of mix (at 20°C):	/	/	approximately 1 h (12.5% water) approximately 1 h 30 mins (20% water)	
Mechanical characteristics:				
Compressive strength (MPa):	EN 12190	> 80% of value declared by manufacturer	12.5% water	20% water
			60 (after 1 day) 83 (after 7 days) 100 (after 28 days)	32 (after 1 day) 54 (after 7 days) 77 (after 28 days)
Flexural strength (MPa):	EN 196/1	/	12.5% water	20% water
			9 (after 1 day) 13 (after 7 days) 15 (after 28 days)	5.5 (after 1 day) 7.0 (after 7 days) 10.0 (after 28 days)
Adhesion to concrete (substrate in MC 0.4 – water/cement ratio = 0.40) according to EN 1766 (MPa):	EN 196/1	/	≥ 2 (after 28 days)	
Pull-out resistance of steel rods - movement under a load of 75 kN (mm):	EN 1881	< 0.6	< 0.2	
Adherence stress of rod anchored with Mapefill F (MPa):	EN 1881 (*)	/	> 25	
Reaction to fire:	EN 13501-1	Euroclass	A1	

(*) Adhesion stress calculated on a test sample made according to EN 1881 standards, considering uniform stress distribution between the rod and MAPEFILL F.

4.4| MAPEFILL MF

Description: *fluid, expansive anchoring mortar.*

Particularly suitable for: *anchoring machine tools by casting under foundation plates. Anchoring metallic structures and sealing rigid joints.*

MAPEFILL MF is a pre-blended, fibre-reinforced, shrinkage-compensating powdered mortar made from high-strength cement, graded aggregates, special additives and polyacrylonitrile fibres. When mixed with 14-16% of water, MAPEFILL MF forms a fluid mortar which does not segregate with the capacity to flow into tight and complex spaces. Thanks to a special expansive agent, MAPEFILL MF is characterised by its total lack of shrinkage during the plastic phase, and hygrometric shrinkage is drastically reduced thanks to its combined action with MAPECURE SRA added to the mix, thus reducing the onset of cracking. Also, thanks to the inclusion of synthetic fibres, MAPEFILL MF offers excellent resistance to mechanical stress, including dynamic stress. If cavities larger than the recommended maximum size need to be filled, add GRAVEL 6-10 at a rate of 30% of the weight of the MAPEFILL MF. The product meets the minimum requirements of EN 1504-6 regarding the anchoring of steel reinforcing rods.

MAPEFILL MF has the following performance characteristics:

table 4

Characteristics	Test method	Minimum requirements according to EN 1504-6	Performance of product
Density of mix (kg/m^3):	/	/	2,250
pH of mix:	/	/	> 12.5
Flow after mixing (EN 13395-2) (cm):	/	/	> 45
Maximum size of aggregate (mm):	/	/	2.5
Pot life of mix:	/	/	approximately 45 mins. (at 20°C)
Mechanical characteristics using 16% water and 0.25% Mapecure SRA:			
Compressive strength (MPa):	EN 12190	> 80% of value declared by manufacturer	> 28 (after 1 day) > 52 (after 7 days) > 65 (after 28 days)
Flexural strength (MPa):	EN 196/1	/	> 5 (after 1 day) > 7 (after 7 days) > 8 (after 28 days)
Compressive modulus of elasticity (GPa):	EN 13412	/	28 (after 28 days)
Adhesion to concrete (substrate in MC 0.4 – water/cement ratio = 0.40) according to EN 1766 (MPa):	EN 1542	/	≥ 2 (after 28 days)
Impermeability to water - penetration depth - (mm):	EN 12390/8	/	< 5
Free expansion during plastic phase (%):	ASTM C827	/	≥ 0.3
Restrained expansion (μm/m):	UNI 8147	/	> 400 (after 1 day)
Pull-out resistance of steel rods - movement under a load of 75 kN (mm):	EN 1881	< 0.6	< 0.1
Reaction to fire:	EN 13501-1	Euroclass	A1

4.5| MAPEFILL MF 610

Description: *pre-blended expansive mortar applied in thick layers for precision anchoring.*

Particularly suitable for: *anchoring machine tools by casting layers thicker than 5 cm under foundation plates. Anchoring steel and concrete pillars and turbines. Sealing rigid joints.*

MAPEFILL MF 610 is a pre-blended, fibre-reinforced, powdered mortar made from high-strength cement, selected aggregates, special admixtures and polyacrylonitrile fibres. When mixed with 9.5-10.5% of water, it forms a fluid mortar which does not segregate with the capacity to flow into tight and complex spaces.

MAPEFILL MF 610 adheres exceptionally well to steel and concrete and has high resistance to mechanical stress, including dynamic stress. Also, thanks to the addition of MAPECURE SRA, a special admixture which reduces shrinkage and improves air curing, it is highly resistant to cracking. MAPEFILL MF 610 may be cast either by gravity or with a suitable pump. Pour the mortar from one side only in a continuous flow, making sure that any air in the area to be filled is completely expelled. Use flexible metal rods during casting to help expel air.

The product meets the minimum requirements of EN 1504-6 regarding the anchoring of steel reinforcing rods.

photo 16

Testing the connection between two concrete caissons for the Moses tidal defence system in Venice. This project, backed by the Ministry of Infrastructure and Transport and the Waters Magistrate, is being constructed by the Venezia Nuova Consortium and is at an advanced stage of execution.
MAPEFILL MF 610 was used for this test

MAPEFILL MF 610 has the following performance characteristics:

table 5

Characteristics	Test method	Requirements according to EN 1504-6	Performance of product
Density of mix (kg/cm^3):	/	/	2,330
pH of mix:	/	/	> 12.5
Maximum size of aggregate (mm):	/	/	≤ 10
Mechanical characteristics using 10% water and 0.16% Mapecure SRA:			
Compressive strength (MPa):	EN 12190-3	> 80% of value declared by manufacturer	25 (after 1 day) 60 (after 7 days) 70 (after 28 days)
Flexural strength (MPa):	EN 12390-5	/	3 (after 1 day) 6 (after 7 days) 7 (after 28 days)
Compressive modulus of elasticity (GPa):	EN 13412	/	29 (after 28 days)
Adhesion to concrete (substrate in MC 0.4 – water/cement ratio = 0.40) according to EN 1766 (MPa):	EN 1542	/	≥ 3 (after 28 days)
Adhesion to concrete (shear) (MPa):	EN 12615	/	> 6
Free expansion during plastic phase (%):	ASTM C827	/	≥ 0.3
Capillary absorption (kg/m^2 • h$^{0.5}$):	EN 13057	/	< 0.08
Bleeding:	UNI 8998	/	absent
Restrained expansion (%)	UNI 8148	/	> 0.03 (after 1 day)*
Thermal compatibility measured as adhesion according to EN 1542 (freeze-thaw cycles with de-icing salts) (MPa):	EN 13687-1	/	≥ 3 (after 28 days)
Determination of slump flow (mm):	EN 11041	/	> 600
Crack resistance:	"O-Ring" test	/	no cracks after 180 days (*)
Impermeability to water – penetration depth - (mm):	EN 12390/8	/	< 5
Pull-out resistance of steel rods - movement under a load of 75kN-(mm):	EN 1881	< 0.6	< 0.1
Pull-out resistance of steel rods (MPa):	RILEM-CEB-FIP RC6-78	/	> 30
Exposure class:	/	/	XS2 / XS3
Reaction to fire:	EN 13501-1	Euroclass	A1

(*) Performance achievable by adding 0.16% MAPECURE SRA.

4.6| PLANIGROUT 300

Description: *three-component fluid epoxy mortar for repairing deteriorated concrete elements and precision anchoring.*

Particularly suitable for: *repairs and structural strengthening of beams, pillars, guide rails for cranes and gantry cranes and crumbling joints in industrial flooring. Repairing deep voids in concrete floors and floor slabs, levelling the surface of concrete bearing points and anchoring tie-rods.*

photo 17
Anchoring a guide rail for a gantry crane with PLANIGROUT 300

PLANIGROUT 300 is a three-component product made from epoxy resin, selected aggregates and special admixtures. After mixing PLANIGROUT 300 component A with its relative catalyser (component B) and fillers (component C), it forms a castable mortar (also for use in sealed formwork) which is easy to apply in layers up to 5 cm thick.

PLANIGROUT 300 hardens after 8 hours without shrinking and forms a strong, composite product with exceptional adhesion and chemical resistance, which maintains its characteristics for a very long period of time. It may be used both internally and externally.

Treat the surfaces to be repaired with PRIMER MF to guarantee good adhesion.

The product meets the minimum requirements of EN 1504-6 regarding the anchoring of steel reinforcing rods.

PLANIGROUT 300 has the following performance characteristics:

table 6

Characteristics	Test method	Minimum requirements according to EN 1504-6	Performance of product
Density of mix (kg/m^3):	/	/	2,000
Brookfield viscosity (mPa · s):	/	/	35,000
Flow after mixing (EN 13395-2) (cm):	/	/	> 20
Maximum size of aggregate (mm):	/	/	2.0
Pot life of mix:	/	/	1 h (at 23°C)
Setting time:	/	/	6-8 h
Complete hardening time:	/	/	7 days
Mechanical characteristics:			
Compressive strength (MPa):	EN 12190	> 80% of value declared by manufacturer after 7 days	55 (after 1 day) 80 (after 3 days) 95 (after 7 days)
Flexural strength (MPa):	EN 196-1	/	25 (after 1 day) 35 (after 3 days) 40 (after 7 days)
Compressive modulus of elasticity (MPa):	ASTM D695	/	2,400
Modulus of flexural elasticity (MPa):	ISO 178	/	10,000
Adhesion to concrete (substrate in MC 0.4 – water/ cement ratio = 0.40) according to EN 1766 (MPa):	EN 1542	/	> 3 (failure of concrete)
Creep - movement with a load of 50 kN for 3 months - (mm):	EN 1544	≤ 0.6	0.3
Pull-out resistance of steel rods - movement under a load of 75 kN - (mm):	EN 1881	≤ 0.6	< 0.45
Glass transition temperature:	EN 12614	≥ 45°C	50°C
Reaction to fire:	EN 13501-1	Euroclass	D-s2, d2

4.7| EPOJET

Description: *two-component, super-fluid, injectable epoxy resin.*

Particularly suitable for: *cast anchor points for threaded bars. Monolithic repairs to cracked load-bearing structures, such as beams, pillars and floor slabs, elements for façades, coatings and detached architectural features. Restoring the waterproofing capacity of cracked basins, storage tanks and water channels.*

EPOJET is a solvent-free epoxy adhesive made up of two pre-dosed components mixed together prior to use. When mixed, EPOJET forms a low-viscosity liquid particularly suitable for injecting and pouring into suitably prepared voids-to form anchor points.

EPOJET has excellent dielectric properties and high mechanical strength. It also adheres perfectly to concrete and steel. It hardens without shrinking and, once hardened, becomes waterproof.

Thanks to the lack of fillers and high fluidity, EPOJET may be used for anchoring metal rods and threaded bar, after drilling a void in the substrate at least 2 mm larger than the rod or bar to be anchored. The product is poured in the hole until it is completely filled. The product meets the minimum requirements of EN 1504-6 regarding the anchoring of steel reinforcing rods.

EPOJET has the following performance characteristics:

table 7

Characteristics	Test method	Minimum requirements according to EN 1504-6	Performance of product	
Density of the mix (kg/l):	/	/	1.14	
Brookfield viscosity (mPa · s):	/	/	380 (rotor 2 – 5 rpm)	
Setting time (h): – at 23°C: – at 30°C:	/	/	 4 h 3 h	
Complete hardening time:	/	/	7 days	
Mechanical characteristics: (7 days - 23°C – 50 R.H.)				
Tensile strength (MPa):	EN ISO 527	/	44	
Compressive strength (MPa):	ASTM D695	> 80% of value declared by manufacturer	95	
Tensile modulus of elasticity (MPa):	EN ISO 527	/	3,400	
Deformation at failure (%):	EN ISO 527	/	1.0	
Tensile adhesion force:	EN 12618-2	cohesive failure of the substrate	meets specifications	
Inclined shear adhesion:	EN 12618-3	monolithic failure	meets specifications	
Volumetric shrinkage (%):	EN 12617-2	/	1.9	
Glass transition temperature:	EN 12614	≥ 45°C	> 45°C	
Sand column injectability (dry state and damp state):	EN 1771	injectability class: /	dry	damp
			4 mins 41 secs	4 mins 50 secs
		indirect tension: /	14 MPa	11 MPa
Durability (freeze/thaw and wet/dry cycles):	EN 12618-2	cohesive failure of the substrate	meets specifications	
Development of tensile strength at 5°C (MPa):	EN 1543	/	> 4.9	
Pull-out resistance of steel rods - movement under a load of 75 kN - (mm):	EN 1881	< 0.6	0.58	

photo 18
Anchor points made using EPOJET

4.8| Summary of the main characteristics of anchoring products

table 8

	Compressive strength after 1 day (MPa) EN 12190	Compressive strength after 28 days (MPa) EN 12190	Flexural strength after 1 day (MPa) EN 196/1	Flexural strength after 28 day s (MPa) EN 196/1	Maximum size of aggregate (mm):	Adhesion on concrete (MPa) EN 1542	Compressive modulus of elasticity (GPa) EN 13412	Pot life of mix
MAPEFILL	30	70	5	9	2,5	≥ 2	27	1 h
MAPEFILL R	32	62	5	8	2,5	≥ 2	26	45 mins
MAPEFILL F	60	100	5,5	15	1,0	≥ 2	27	1 h
MAPEFILL MF	28	65	5	8	2,5	≥ 2	28	45 mins
MAPEFILL MF 610	25	70	3 (EN 12390-5)	7 (EN 12390-5)	10,0	≥ 3	29	2 h
PLANIGROUT 300	55	95	25	40 (7gg)	2,0	≥ 3	2,4 (ASTM D695)	1 h
EPOJET	95 (7 gg) (ASTM D695)		/		/	/	3,4 (EN ISO 527)	40 mins

table 9

	Cementitious	Resin	Minimun size of cavity to be filled (mm)			Setting time	
			< 10	10-30	> 30	Rapid	Normal
MAPEFILL	●			●			●
MAPEFILL R	●			●		●	
MAPEFILL F	●			●			●
MAPEFILL MF	●			●		●	
MAPEFILL MF 610	●				●		●
PLANIGROUT 300		●	●				●
EPOJET		●	●			●	

5| Examples of anchors in concrete structures

5.1| Anchoring pillars in encapsulated pile foundations

photo 19
The foundation seating is cleaned, all mud, debris and any other loose material is removed and the pre-fabricated elements are placed in position

photo 20
The pillars to be anchored to the encapsulated pile foundations are positioned

photo 21
MAPEFILL fluid, expansive anchoring mortar is poured in the pile housing. The product meets the minimum requirements of EN 1504-6 European standards

5.2| Repairing the guide rails of a gantry crane

photo 22

The substrate is prepared by eliminating all uneven and detached areas. All traces of dust are then removed from the substrate with compressed air or an industrial-grade vacuum cleaner. All traces of rust, paint and oil must also be removed from metal surfaces, preferably by sandblasting

photo 23

The metal elements are positioned on the substrate after suitable preparation

photo 24

PLANIGROUT 300 three-component, fluid, epoxy-cementitious mortar is then poured in the cavities. The product meets the minimum requirements of EN 1504-6 European standards

5.3| Anchoring steel reinforcing rods in concrete for installing soundproofing barriers

photo 25
The voids for the reinforcing rods are prepared

photo 26
The voids are cleaned with compressed air to remove all traces of dust and other debris

photo 27
The reinforcing rods are anchored with PLANIGROUT 300 three-component, fluid, epoxy-cementitious mortar. The product meets the minimum requirements of EN 1504-6 European standards

5.4| Clamping dowels for reinforcing rods in an upgraded foundation slab

photo 28

The substrate is drilled and then cleaned

photo 29

MAPEFILL fluid, expansive anchoring mortar is poured in the anchor points. The product meets the minimum requirements of EN 1504-6 European standards

photo 30

The rods used to hold the new reinforcing steel is anchored in place

5.5| Sealing rigid joints in reinforced concrete caissons

photo 31
Reinforced concrete caissons for the Moses tidal defence system in Venice with rigid joints sealed with MAPEFILL MF 610

photo 32
The formwork is prepared and positioned around the reinforced concrete caissons

photo 33
MAPEFILL MF 610 is pumped into the formwork

6| Characteristics of a resin used for chemical anchors

The most important performance characteristics of chemical anchors are their high mechanical strength and their capacity to harden very rapidly. To make it easier to set chemical anchors, they are supplied in ready-to-use cartridges containing two pre-dosed components in separate chambers. The two components are mixed together and extruded through a nozzle with a static mixer screwed to the end of the cartridge, thus eliminating complicated preparation procedures and preventing the risk of mixing errors.
There are various types of resin available on the market to make chemical anchors: polyester, vinylester, methacrylate, epoxy-acrylate, hybrids, epoxy-cementitious, epoxy, etc.

To simplify their use, the various types of chemical anchors may be classified according to the physical-mechanical performance characteristics an anchoring product guarantees:

- resins for light loads;
- resins for heavy loads;
- resins for structural loads.

For each of the aforementioned anchoring categories, Mapei has a specific solution which meets the performance requirements for each type of application:

- MAPEFIX PE SF styrene-free polyester resin for light loads and perforated substrates;
- MAPEFIX VE SF styrene-free hybrid resin for heavy loads;
- MAPEFIX EP pure epoxy resin for structural loads.

Chemical anchors are certified according to norms issued by a specific European body, the EOTA (European Organisation for Technical Approval). This organisation awards a product ETA (European Technical Approval), guaranteeing to designers and installers that the product has undergone trials according to specific test procedures, rather than the parameters of the manufacturer, and is therefore suitable for the intended use.
Anchoring systems are evaluated according to these norms by accredited institutes and awarded a Certificate of Conformity and, therefore, the EC mark.

7| Preparing the substrate and forming the chemical anchor

The size of the void in the substrate, the anchoring depth, the diameter of the element to be anchored and the maximum permitted loads must be calculated by a qualified design engineer. Based on our experience of on-site and laboratory testing, Mapei has devised a series of practical tables to help select the right size of anchor according to the design loads.

Once the size of the anchor has been selected, the procedure to execute a chemical anchor is the same for all types considered.

7.1| Preparing the substrate

- Make voids in the substrate with a drill or a hammer drill, according to the type of material to be drilled;
- remove all traces of dust and loose material from inside the voids with compressed air;
- clean the surfaces inside the voids with a long-bristled bottle-brush to remove any loose parts which are still sticking to the sides of the void;
- clean the void again with compressed air;
- on uneven or perforated substrates, place a mesh sleeve in the void with a diameter and length suitable for the size of the void .

7.2| Preparing and forming the chemical anchor

- Screw the static mixer to the end of the cartridge;
- insert the cartridge in an extrusion gun;
- discard the first 3 shots of resin, for at least the first 2/3 of the volume;
- starting from the bottom of the void, extrude the product into the void until it is full;
- clean and de-grease the deformed or threaded bar to be anchored in the void;
- insert the bar in the void while turning it slightly to expel any air;
- make sure the excess resin comes out of the void.

8| Chemical anchors using Mapei products

8.1| MAPEFIX PE SF

Styrene-free, polyester resin-based chemical anchor for light loads and perforated substrates. Suitable for anchoring lightweight elements on brickwork and solid or perforated masonry.

PRODUCT DETAILS

Appearance: thixotropic paste
Colour: light grey
Density (g/cm³): 1.74
Storage: 12 or 18 months in its original sealed packaging, depending on the size of cartridge
Certification available: ETA option 7 (anchors in compression zones)

APPLICATION DATA (at 23°C and 50% R.H.)

Application temperature range: from -5°C to 35°C
Start setting time T_{gel}: see table 10
Final hardening time T_{cure}: see table 10

table 10

Reaction time of product			
Substrate temperature (°C)	Start setting time T_{gel}	Final hardening time $T_{cure:}$	
		dry substrate	damp substrate
-5	90’	6 h	12 h
0	45’	3 h	6 h
5	25’	2 h	4 h
10	15’	80’	3 h
20	6’	45’	90’
30	4’	25’	50’
35	2’	20’	40’

MAPEFIX PE SF has the following performance characteristics:

table 11

Characteristics	Performance of product
Compressive strength:	75 N/mm^2
Flexural strength:	30 N/mm^2
Dynamic modulus of elasticity:	4000 N/mm^2
In-service temperature range:	from -40°C to 80°C
Design parameters for concrete:	see table 12
Design parameters for masonry:	see table 13
Recommended loads for concrete	see table 14

table 12

Design parameters for anchors with threaded bar in concrete						
threaded bar	M8	M10	M12	M16	M20	M24
recommended distance from edge (mm)	80	90	110	125	170	210
minimum distance from edge (mm)	40	50	60	80	100	120
recommended pitch between anchors (mm)	160	180	220	250	340	420
minimum pitch between anchors (mm)	40	50	60	80	100	120
depth of threaded bar (mm)	80	90	110	125	170	210
depth of anchor void (mm)	110	120	140	161	218	258
diameter of threaded bar (mm)	8	10	12	16	20	24
diameter of anchor void (mm)	10	12	14	18	24	28
tightening torque (Nm)	10	20	40	60	120	150

table 13

Design parameters for anchors with threaded bar in masonry				
threaded bar	M6	M8	M10	M12
recommended distance from edge (mm)	250	250	250	250
recommended pitch between anchors (mm)	250	250	250	250
depth of threaded bar (mm)	60	80	90	110
depth of anchor void (mm)	65	85	95	115
diameter of threaded bar (mm)	6	8	10	12
diameter of anchor void (mm)	7	9	12	14
tightening torque (Nm)	3	8	8	8

table 14

Design guide for anchoring threaded bar in concrete						
threaded bar	**M8**	**M10**	**M12**	**M16**	**M20**	**M24**
distance from edge (mm)	80	90	110	125	170	210
pitch between anchors (mm)	160	180	220	250	340	420
diameter of anchor void (mm)	10	12	14	18	24	28
depth of anchor void (mm)	110	120	140	161	218	258
diameter of threaded bar (mm)	8	10	12	16	20	24
depth of threaded bar (mm)	80	90	110	125	170	210
tightening torque (Nm)	10	20	40	60	120	150
recommended load (kN) temperature 50°C/80°C	5.7	8.6	11.9	13.3	22.4	34.3
maximum recommended load (kN) temperature 24°C/40°C	8.6	13.8	16.7	24.0	35.7	52.2
recommended shear load (kN) without bending moment	5.1	8.6	12	22.3	34.9	50.3

table 15

Design guide for anchoring threaded bar in masonry				
threaded bar	**M6**	**M8**	**M10**	**M12**
recommended distance from edge (mm)	250	250	250	250
recommended pitch between anchors (mm)	250	250	250	250
depth of threaded bar (mm)	60	80	90	110
depth of anchor void (mm)	65	85	95	115
diameter of threaded bar (mm)	6	8	10	12
diameter of anchor void (mm)	7	9	12	14
tightening torque (Nm)	3	8	8	8
maximum recommended load on perforated bricks (kN)	0.3	0.3	0.3	0.3
maximum recommended load on perforated calcium silicate blocks (kN)	0.3	0.3	0.3	0.3
maximum recommended load on solid calcium silicate blocks (kN)	0.5	1.7	1.7	1.7
maximum recommended load on solid bricks (kN)	0.5	1.7	1.7	1.7
maximum recommended load on perforated lightweight concrete blocks (kN)	0.3	0.3	0.3	0.3
maximum recommended load on solid concrete blocks (kN)	0.5	0.6	0.6	0.6

8.2| MAPEFIX VE SF

Styrene-free, hybrid vinylester resin-based chemical anchor for heavy loads on all types of solid and perforated substrate. Also suitable for anchors in damp substrates.

PRODUCT DETAILS

Appearance: thixotropic paste

Colour: light grey

Density (g/cm³): 1.65

Storage: 12 or 18 months in its original sealed packaging, depending on the size of cartridge

Certification available: ETA option 7 (anchors in compression zones), ETA option REBAR (anchoring additional reinforcing steel in concrete), fire resistant for 120 mins.

APPLICATION DATA (at 23°C and 50% R.H.)

Application temperature range: from -10°C to 35°C

Start setting time T_{gel}: see table 16

Final hardening time T_{cure}: see table 16

table 16

Reaction time of product			
Temperature (°C)	Start setting time T_{gel}	Final hardening time T_{cure}	
		dry substrate	damp substrate
- 10 *	90’	24 h	48 h
- 5	90’	14 h	28 h
0	45’	7 h	14 h
5	25’	2 h	4 h
10	15’	80’	3 h
20	6’	45’	90’
30	4’	25’	50’
35	2’	20’	40’

** temperature of product 15°C*

MAPEFIX VE SF has the following performance characteristics:

table 17

Characteristics	Performance of product
Compressive strength:	80 N/mm^2
Flexural strength:	17 N/mm^2
Dynamic modulus of elasticity:	4000 N/mm^2
In-service temperature range:	from -40°C to 120°C
Design parameters for concrete:	see tables 17 and 18
Recommended loads for concrete:	see tables 19 and 20

table 18

Design parameters for anchors with threaded bar in concrete								
threaded bar	M8	M10	M12	M16	M20	M24	M27	M30
recommended distance from edge (mm)	92	126	152	188	253	291	312	329
minimum distance from edge (mm)	40	50	60	80	100	120	135	150
recommended pitch between anchors (mm)	184	252	304	376	506	582	624	658
minimum pitch between anchors (mm)	40	50	60	80	100	120	135	150
depth of anchor (mm)	80	90	110	125	170	210	250	280
depth of anchor void (mm)	110	120	140	161	218	266	314	350
diameter of anchor (mm)	8	10	12	16	20	24	27	30
diameter of anchor void (mm)	10	12	14	18	24	28	32	35
tightening torque (Nm)	10	20	40	60	120	150	200	250

table 19

Design parameters for anchors with deformed bar in concrete								
deformed bar	ø8	ø10	ø12	ø16	ø20	ø25	ø28	ø32
recommended distance from edge (mm)	85	115	139	185	231	274	289	309
minimum distance from edge (mm)	40	50	60	80	100	125	140	160
recommended pitch between anchors (mm)	170	230	278	370	462	548	578	618
minimum pitch between anchors (mm)	40	50	60	80	100	125	140	160
depth of anchor (mm)	80	90	110	125	170	210	250	280
depth of anchor void (mm)	110	120	140	165	218	274	320	360
diameter of anchor (mm)	8	10	12	16	20	25	28	32
diameter of anchor void (mm)	12	14	16	20	24	32	35	40

table 20

Design guide for anchoring threaded bar								
threaded bar	**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
maximum recommended load (kN) temperature 24°C/40°C	8.6	13.5	19.7	28	44.4	61	79.2	93.9
maximum recommended load (kN) temperature 50°C/80°C	7.2	10.1	14.8	22.4	38.1	53.4	63.1	68.1
maximum recommended load (kN) temperature 72°C/120°C	5.0	7.0	10.2	15.5	26.4	35.8	43.6	48.9
maximum recommended shear load (kN) temperature 50°C/80°C	5.1	8.6	12	22.3	34.9	51.3	59.3	66.1
anchor depth (mm)	80	90	110	125	170	210	250	280
distance from edge (mm)	92	126	152	188	253	291	312	329
pitch (mm)	184	252	304	376	506	582	624	658

table 21

Design guide for anchoring deformed bar								
deformed bar	**ø8**	**ø10**	**ø12**	**ø16**	**ø20**	**ø25**	**ø28**	**ø32**
maximum recommended load (kN) temperature 24°C/40°C	8.1	11.2	16.5	24.9	42.4	58.9	69.8	78.2
maximum recommended load (kN) temperature 50°C/80°C	5.7	8.4	12.3	18.7	31.8	45.8	52.4	55.9
maximum recommended load (kN) temperature 72°C/120°C	4.2	5.8	8.5	12.9	22.0	30.5	36.2	40.5
maximum recommended shear load (kN) temperature 50°C/80°C	6.7	10.5	14.8	23.0	35.5	47.8	54.2	61.8
anchor depth (mm)	80	90	110	125	170	210	250	280
distance from edge (mm)	85	115	139	185	231	274	289	309
pitch (mm)	170	230	278	370	462	548	578	618

8.3| MAPEFIX EP

Pure epoxy resin-based chemical anchor for structural loads on all types of solid and perforated substrate. Suitable for anchoring all loads in any type of solid or perforated substrate, in smooth voids and in damp substrates.

PRODUCT DETAILS

Appearance: thixotropic paste

Colour: light grey

Density (g/cm³): 1.41

Storage: 24 months in its original sealed packaging

Certification available: ETA option 1 (anchors in tension zones), ETA option 7 (anchors in compression zones), fire resistant for 120 mins.

APPLICATION DATA (at 23°C and 50% R.H.)

Application temperature range: from 5°C to 40°C

Start setting time T_{gel}: see table 22

Final hardening time T_{cure}: see table 22

table 22

Reaction time of product			
Substrate temperature (°C)	Start setting time T_{gel}	Final hardening time T_{cure}	
		dry substrate	damp substrate
5	2 h	2 days	4 days
10	90’	30 h	2.5 days
20	30’	10 h	20 h
30	20’	6 h	12 h
40	12’	4 h	8 h

MAPEFIX EP has the following performance characteristics:

table 23

Characteristics	Performance of product
Compressive strength:	137 N/mm^2
Flexural strength:	47 N/mm^2
Dynamic modulus of elasticity:	3240 N/mm^2
In-service temperature range:	from -40°C to 72°C
Design parameters for concrete:	see tables 23 and 24
Recommended loads for concrete:	see tables 25 and 26

table 24

Design parameters for anchors with threaded bar											
threaded bar	M8	M10	M12	M16	M20	M24	M27	M30	M33	M36	M39
recommended distance from edge (mm)	113	135	165	188	255	304	342	379	400	436	472
minimum distance from edge (mm)	40	50	60	80	100	120	135	150	165	180	195
recommended pitch between anchors (mm)	226	270	330	375	510	607	683	759	799	872	945
minimum pitch between anchors (mm)	40	50	60	80	100	120	135	150	165	180	195
depth of threaded bar (mm)	80	90	110	125	170	210	250	280	320	350	380
depth of anchor void (mm)	110	120	140	161	214	266	314	350	394	432	472
diameter of threaded bar (mm)	8	10	12	16	20	24	27	30	33	36	39
diameter of anchor void (mm)	10	12	14	18	24	28	32	35	37	42	46
tightening torque (Nm)	10	20	40	60	120	150	200	250	350	500	700

table 25

Design parameters for anchors with deformed bar											
deformed bar	**ø8**	**ø10**	**ø12**	**ø14**	**ø16**	**ø20**	**ø25**	**ø28**	**ø32**	**ø36**	**ø40**
recommended distance from edge (mm)	97	121	139	170	180	219	274	298	330	372	413
minimum distance from edge (mm)	40	50	60	70	80	100	125	140	160	180	200
recommended pitch between anchors (mm)	194	242	277	339	360	438	548	596	661	744	826
minimum pitch between anchors (mm)	40	50	60	70	80	100	125	140	160	180	200
depth of deformed bar (mm)	80	90	110	115	125	170	210	250	280	340	360
depth of anchoring void (mm)	110	120	142	151	165	214	274	320	360	432	460
diameter of deformed bar (mm)	8	10	12	14	16	20	25	28	32	36	40
diameter of anchor void (mm)	12	14	16	18	20	24	32	35	40	46	50

table 26

Recommended loads												
Recommended loads on concrete with threaded bar according to EOTA Technical Report 029, Method A												
	threaded bar		**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**	**M33**	**M36**	**M39**
Tensile load	24°C/40°C	non-cracked concrete (kN)	8.6	13.8	20.0	28.0	38.1	52.3	67.9	80.5	98.3	113	127
		cracked concrete (kN)	6.0	8.3	12.0	17.0	24.3	34.5	46.2	57.4	70.1	80.2	90.7
	43°C/60°C	non-cracked concrete (kN)	7.6	10.7	14.8	21.2	29.1	40.4	54.1	67.3	79.0	94.2	111
		cracked concrete (kN)	3.6	5.0	7.3	10.3	14.8	20.9	28.0	36.5	47.2	56.4	65.3
	43°C/72°C	non-cracked concrete (kN)	6.8	9.5	13.2	18.7	25.4	37.7	46.9	58.3	67.7	80.8	95.0
		cracked concrete (kN)	3.3	4.5	6.6	9.3	13.3	18.8	25.2	32.8	42.5	50.7	58.8
Shear load *	non-cracked concrete (kN)		5.1	8.3	12	22.6	35.1	50.3	65.7	78.8	88.6	102	117
	cracked concrete (kN)		5.1	8.3	12	16.5	27.0	37.0	46.7	55.8	62.8	72.5	82.8
depth of threaded bar (mm)			80	90	110	125	170	210	250	280	320	350	380
distance from edge (mm)			113	135	165	188	255	304	342	379	400	436	472
pitch (mm)			226	270	330	396	510	608	684	758	800	872	944

** with no bending moment*

table 27

Recommended loads

Recommended loads on concrete with deformed bars according to EOTA Technical Report 029, Method A

	deformed bar		ø8	ø10	ø12	ø14	ø16	ø20	ø25	ø28	ø32	ø36	ø40
Tensile load	24°C/40°C	non-cracked concrete (kN)	8.8	12.3	16.5	20.1	23.7	32.7	50.5	63.6	76.6	105	117
		cracked concrete (kN)	6.0	8.3	12.0	13.6	16.7	23.3	35.9	48.4	57.4	76.8	83.6
	43°C/60°C	non-cracked concrete (kN)	5.2	7.3	10.7	13.0	15.0	20.0	30.9	37.4	43.1	58.9	69.2
		cracked concrete (kN)	3.6	5.0	7.3	8.3	10.1	14.1	21.8	30.4	40.1	54.8	63.5
	43°C/72°C	non-cracked concrete (kN)	4.8	6.7	9.1	11.0	13.7	20.0	28.0	33.7	38.3	52.3	61.5
		cracked concrete (kN)	3.3	4.5	6.6	7.5	9.1	12.7	19.6	27.4	36.1	49.3	57.1
Shear load *	non-cracked concrete (kN)		6.7	10.2	14.8	19.1	22.5	33.2	47.8	56.3	67.2	83.2	97.9
	cracked concrete (kN)		6.1	8.6	11.0	13.9	16.6	23.5	33.9	39.9	47.6	58.9	69.4
depth of deformed bar (mm)			80	90	110	125	170	210	250	280	320	350	380
distance from edge (mm)			97	121	139	170	180	219	274	298	330	372	413
pitch (mm)			194	242	278	340	360	438	548	596	660	744	826

** with no bending moment*

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