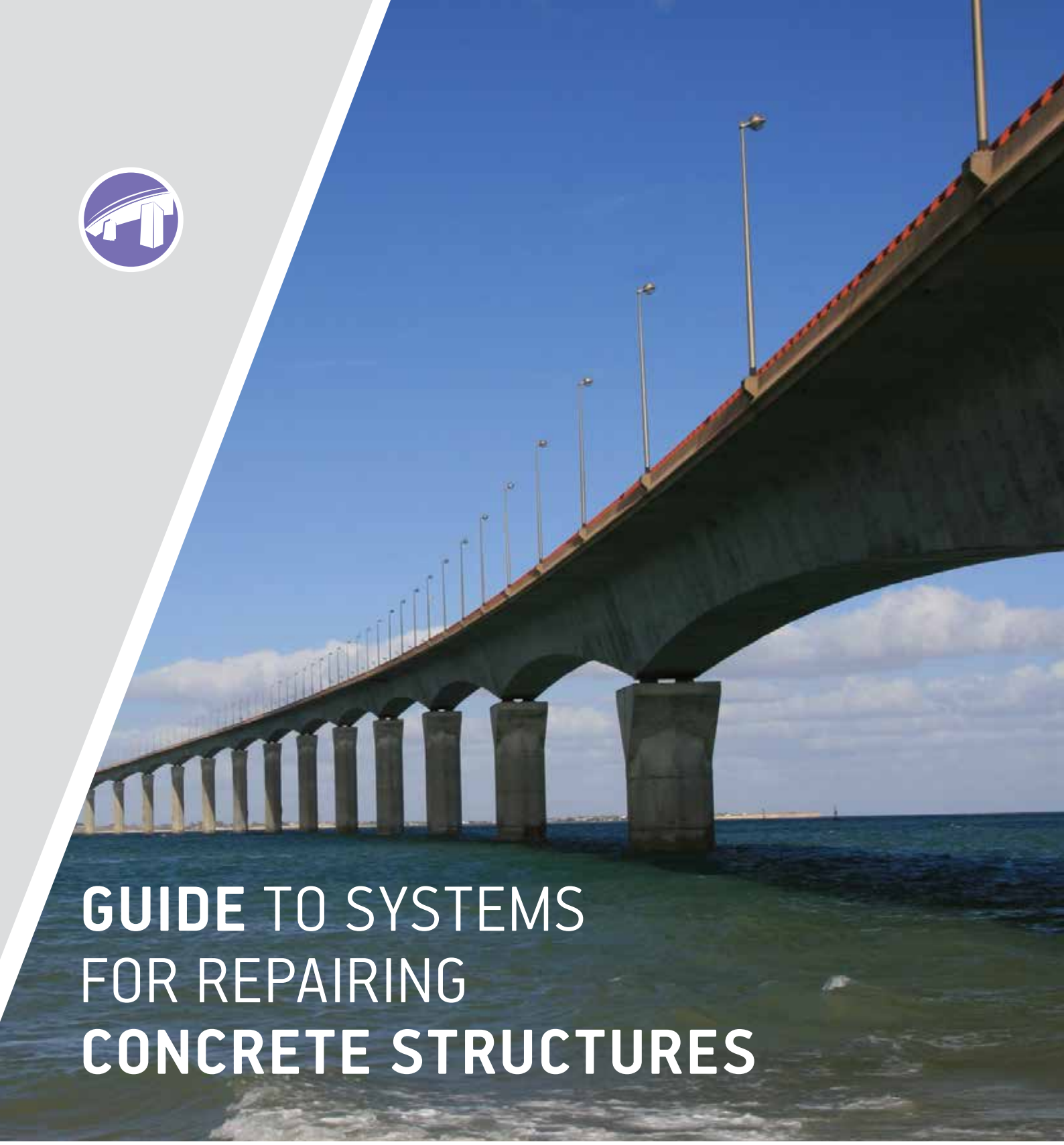


GUIDE TO SYSTEMS FOR REPAIRING **CONCRETE STRUCTURES**

TECHNICAL MANUAL OF PRESCRIPTIVE REQUIREMENTS FOR REPAIR AND MAINTENANCE OF LARGE REINFORCED AND PRESTRESSED CONCRETE STRUCTURES

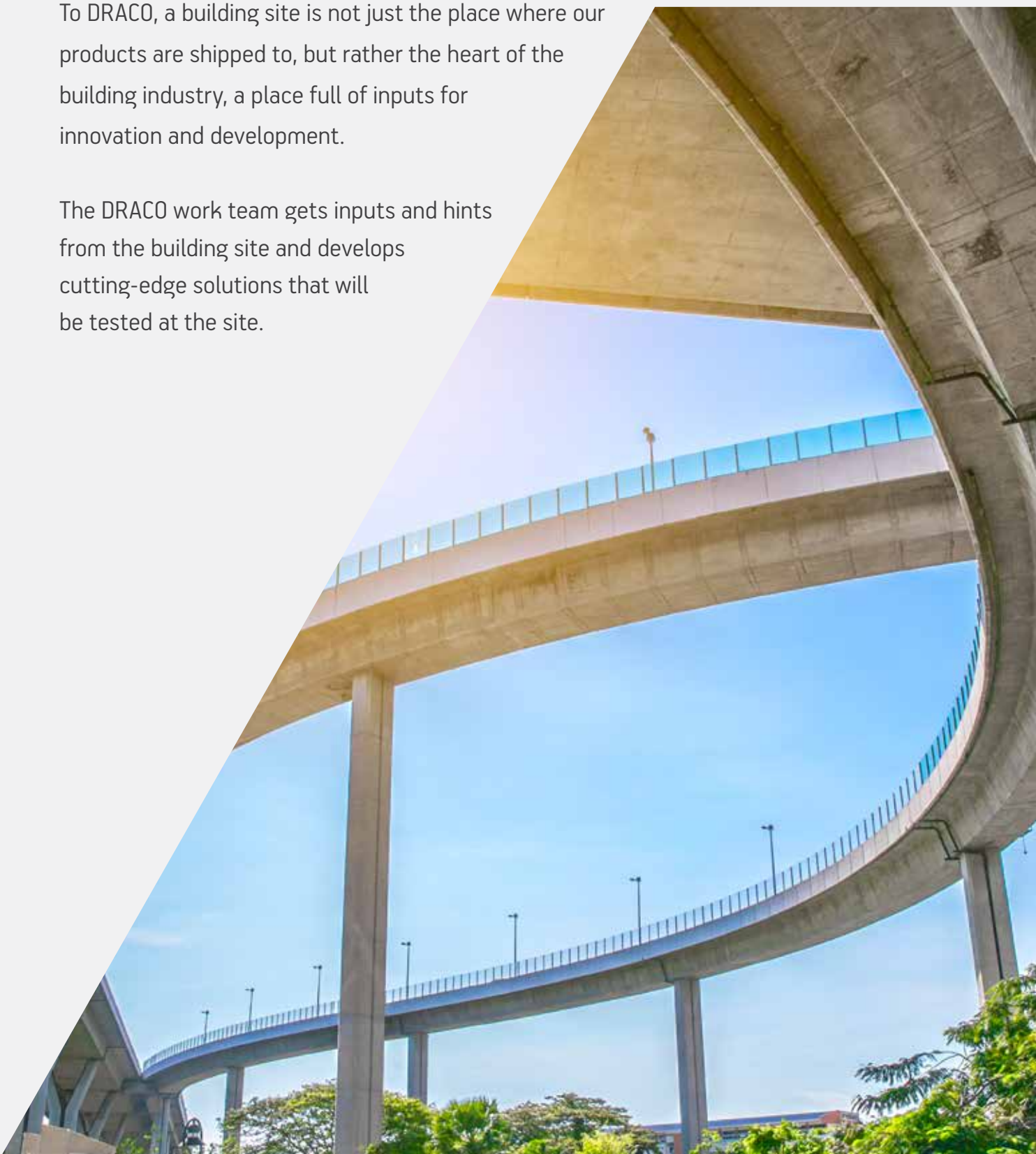
draco-edilizia.com

DRACO
QUALITY YOU CAN BUILD ON

THE BUILDING SITE IS THE CORNERSTONE OF OUR WORK

To DRACO, a building site is not just the place where our products are shipped to, but rather the heart of the building industry, a place full of inputs for innovation and development.

The DRACO work team gets inputs and hints from the building site and develops cutting-edge solutions that will be tested at the site.



THE COMPANY

A TRADITION OF EXCELLENCE AND EXPERIENCE

Our history dates back to the beginning of the 1980s, when DRACO started to work in the mortar and concrete admixtures industry. Since then, the business has been growing rapidly along with our product differentiation, while always ensuring high specialisation and presence onsite, in order to offer global solutions to the whole construction industry.

Today DRACO provides technical support and advice, from design to execution, thanks to a team of professionals working at the R&D department and assisting our customers at the construction site.

Our constant research for performances, different technologies and cutting-edge systems resulted in a wide range of products for repairing concrete structures featuring any level of deterioration, and for restoring the performances of structures treated with DRACO systems much beyond the required standards.

DRACO: quality products for Italian infrastructure.

40 ANNIVERSARY 1982 - 2022

QUALITY YOU CAN BUILD ON

DRACO: QUALITY AND INNOVATION FOR THE CONSTRUCTION INDUSTRY

DRACO HAS BEEN DEVELOPING AND PRODUCING TECHNICAL SOLUTIONS FOR THE MODERN CONSTRUCTION INDUSTRY SINCE 1982

At DRACO, the product development process is aimed at achieving top quality and real innovation for designers, businesses, floor layers and construction firms. We design products that must perform well on-site and last longer. DRACO provides assistance and advice from design to installation. We can make a difference and we will be always by the customer's side.

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CONTENTS

GUIDE TO PRESCRIPTIVE SPECIFICATIONS OF CONCRETE REPAIR SYSTEMS

» DESIGN LIFE, DURABILITY AND DETERIORATION OF REINFORCED CONCRETE AND PRESTRESSED CONCRETE STRUCTURES

At the beginning of the 20th century, reinforced concrete structures were considered indestructible, almost everlasting. Today, though, if we look at our cities, it is pretty clear that this is not case. A very high number of concrete, reinforced concrete and prestressed concrete structures undergo degradation and deterioration processes.

Pursuant to the Italian **Ministerial Decree of 17.01.2018 «Technical Standards for Construction»**, *the **design service life** V_N of a structure is conventionally defined as the number of years during which the structure is expected to maintain specific levels of performance, provided that the necessary maintenance interventions are carried out*, while the **durability** of a structure is *the capability of a structure to maintain, throughout its design life, the levels of performance for which it was designed, taking into account the characteristics of the environment in which it is located and the foreseen maintenance level*. The definition of the concept of **durability** encompasses all the variables it depends on, i.e. design in relation to the environment where the structure is in service, quality of the materials used, installation (as well as curing, for reinforced concrete works), controls during execution, the environment in which the structure is built, monitoring and resulting continuous and constant maintenance. Should one of the aforesaid variables be neglected, the **durability** of a structure cannot be guaranteed, unless major and costly repairs are carried out. This is confirmed in **chapter 2 par. 2.2.4. Durability** of the Italian Ministerial Decree of 17.01.2018, in which the following is established: *an adequate level of durability can be guaranteed by designing the structure, and maintenance to the same, in such a way that the deterioration which may occur during the design life, does not lower the performance of the structure below the expected level*. Therefore, in addition to design, construction, curing and control, two other very important and strictly related phases must be taken into account: (continuous and constant) **monitoring** and **maintenance**, and as a result the **maintenance plan of the structure** becomes an integral part of the project.

Defining the **design service life** V_N of a structure means ensuring that performance and safety level are maintained throughout its lifespan. The **design service life** must be considered to all intents and purposes, as structural performance; it must be properly analysed and studied during the design phase and must be guaranteed through proper sizing of the structures, the right choice of materials and constant and continuous maintenance interventions, to ensure resistance and functionality over time.

Deterioration caused by lack of maintenance, bad environmental and/or exposure conditions, incorrect design, incorrect concrete placing, lack of and/or wrong compaction and lack of and/or improper moist curing of freshly cast concrete, leads to a reduction in the functional capacity of the structures, well before reaching the **design service life** estimated in the design phase. According to the Italian Ministerial Decree of 17.01.2018, the designer must declare in the project the design life of the structure, based on construction type: from 10 years minimum for temporary and provisional structures, to 50 years for those with ordinary performance levels and 100 years for high performance structures. The decree also classifies structures into classes the designer must comply with, with respect to the consequences of an interruption in operation or failure, from class 1 to class 4 (par. 2.4.2 - Ministerial Decree of 17.01.2018).

Direct and indirect costs, malfunctions and/or inconveniences for users and the community, associated with the occurrence of the abovementioned problems are very expensive, and the longer the time of deterioration, the higher the cost. Chapter 11 of the abovementioned Ministerial Decree illustrates the **process that guarantees the durability** of reinforced concrete structures, which is given below. To guarantee the durability of ordinary reinforced concrete or prestressed concrete structures, exposed to environmental attack, measures must be taken to limit the effects of deterioration induced by chemical and physical attack, corrosion of reinforcement and freeze-thaw cycles. For this purpose, the environmental conditions of the site where the structure will be built or in use must be properly assessed pursuant to the indications given in ***Table 4.1.III*** of the said decree; then during the design phase, it is necessary to indicate the characteristics of concrete in compliance with the Guidelines on structural concrete issued by the Central Technical Service of the Superior Council of Public Works, also by making reference to standards UNI EN 206 and UNI 11104, if no specific assessments are carried out.

Moreover, it is necessary to respect the values for nominal concrete cover given in point 4.1.6.1.3, as well as the method and period of moist curing in compliance with standard **UNI EN 13670**, the Guidelines for placing structural concrete and the Guidelines for evaluating the characteristics of placed concrete issued by the Central Technical Service of the Superior Council of Public Works. For the purpose of assessing durability, tests aimed at measuring resistance to the penetration of aggressive agents like carbon dioxide and chlorides, may also be required by prescriptive specifications. The impermeability of concrete can also be taken into account by calculating the depth of penetration of water under pressure. The test aimed at determining the depth of penetration of water under pressure in hardened concrete is described by standard **UNI EN 12390-8**. These indications can also be used as a guide to the phases that characterize the structure and related actions. Concerning actions, paragraph **2.5.1. Classification of actions** *defines an action as every cause or set of causes capable of inducing limit states in a structure*, while paragraph **2.5.1.1. Classification of actions based on how they occur** differentiates between *direct* actions, caused by concentrated forces and distributed loads - either fixed or mobile -, *indirect* actions caused by transmitted displacements, temperature and humidity changes, shrinkage, prestressing, constraint failures etc, and *deterioration* actions, defined as endogenous in case of natural alteration of the material the structural work is made of, or exogenous in case of alteration of the characteristics of the materials the structural work is made of, as a result of external agents. Protective measures against excessive deterioration must be defined with respect to the expected environmental conditions; protection must be achieved by properly choosing details, materials, structural dimensions, even through the application of protective substances or coatings, as well as by adopting other active or passive protective measures.

Pursuant to paragraph **4.1.2.2.4.2 Environmental conditions** of the Ministerial Decree of 17.01.2018, *to protect steel reinforcements against corrosion and concrete against deterioration, environmental conditions can be divided into ordinary, aggressive and very aggressive in relation to the indications provided in* ***Table 4.1.III*** *with respect to the exposure classes established by the Guidelines on structural concrete issued by the Central Technical Service of the Superior Council of Public Works, as well as by standard UNI EN 206:2016.*

Exposure classes related to rebar corrosion are **XC1 - XC2 - XC3 - XC4, XD1 - XD2 - XD3** and **XS1 - XS2 - XS3**; exposure classes **XF1 - XF2 - XF3 - XF4, XA1 - XA2 - XA3** refer to concrete deterioration only.

ENVIRONMENTAL CONDITIONS	EXPOSURE CLASS
ORDINARY	**X1 - XC1 - XC2 - XC3 -** XF1
AGGRESSIVE	**XC4 - XD1 - XS1 -** XA1 - XA2 - XF2 - XF3
VERY AGGRESSIVE	**XD2 - XD3 - XS2 - XS3** - XA3 - XF4

Table 4.1.III D.M. 17.01.2018 - Description of environmental conditions

To ensure the durability of reinforced concrete structures, rebars must be protected by an adequate concrete layer (concrete cover) which *which must be sized depending on more or less aggressive environmental conditions and susceptibility of rebars to corrosion, by also taking into account rebar installation tolerances; for this purpose, reference can be made to standard* **UNI EN 1992-1-1** (paragraph **4.1.6.1.3 Concrete cover and spacing between rebars** - Ministerial Decree of 17.01.2018).

For a rational approach to durability, the definition of environmental exposure of structures and an in-depth analysis of concrete deterioration, please refer to the related chapter on page 49 of this guide. Assessing the environment and related attacks to structures, in general, and to reinforced concrete structures in particular, is crucial to achieve the expected service life. In conclusion, as already mentioned several times, this goal can be achieved through a "process" that leads to durability starting from design, and going through proper execution, curing, strict and tight controls by the Works Management, consistent frequency of monitoring of the structures, or elements of the same, and preventive maintenance. Therefore, in the "magic chain of durability", no one is excluded: designer, manufacturer of materials, contractor, works management, tester and, once the structure is in service, the client who is responsible for constant and continuous monitoring and maintenance actions.

This guide is intended as a technical manual of prescriptive requirements for repair and maintenance of large reinforced and prestressed concrete structures to help all professionals involved in the construction of concrete structures.

» REPAIR OF REINFORCED CONCRETE AND PRESTRESSED CONCRETE STRUCTURES

The ultimate goals of repairing a reinforced concrete structure are restoring safety and function, as well as enhancing the appearance of the structure. Today, large reinforced concrete works are not only exposed to the environment in which they were built, but, once in service, they must also face new conditions compared to the time when they were conceived and designed, such as a significant increase in traffic affecting most of Italian infrastructure. As a result, maintenance works must be performed in the framework of either one of the following categories of specific goals: solving structural criticalities caused by ongoing deterioration of materials and protecting the structure against future deterioration for its entire lifespan.

This short overview clearly explains that proper design of maintenance work to reinforced concrete firstly requires to identify the types and levels of alteration, the causes of deterioration and whether the problem affects single structural elements or rather the whole structure.

In large reinforced concrete works, the prescription and execution of ordinary and extraordinary maintenance work must be entrusted exclusively to competent professionals and experts, qualified workers and products certified according to the applicable regulations.

In particular, **UNI EN 1504** ***Products and systems for the protection and repair of concrete structures*** is the reference standard for the materials used in repair cycles, and also provides essential technical information for designers, applicators and works managers, by defining the principles of intervention and offering a guide to choosing the most appropriate systems for the intended use.

DETERIORATION ASSESSMENT

» ASSESSING THE TYPE OF INTERVENTION ACCORDING TO DETERIORATION LEVEL

Ordinary and/or aggressive environmental conditions, both in terms of air, climate and weather, such as the presence of CO_2, water and humidity, the presence of chlorides in the air, repeated increasingly severe temperature changes and the destructive action of freeze-thaw cycles, especially in winter, expose structures to various types of hazardous conditions, including those that can affect their safety in operation, both locally and globally. These adverse conditions often occur together and have negative effects that significantly reduce the durability of a work.

In the following table and chapters we illustrate some techniques for the assessment of the most suitable materials for volume reconstruction with cementitious products - both thixotropic and pourable –, and for protective treatments. All products are manufactured in compliance with the aforementioned standard **UNI EN 1504**.

LEVEL OF DETERIORATION	Intervention technology	Anas code
NO VISIBLE SURFACE DETERIORATION	PROTECTION WITH FILM-FORMING RESIN SYSTEMS	B.09.105.1.a
		B.09.105.1.b
		B.09.105.2
		B.09.115
SLIGHTLY DETERIORATED	SMOOTHING WITH ANTI-CARBONATION CEMENTITIOUS SKIM COATS	B.09.215.a
		B.09.215.b
		B.09.215.c
MODERATELY DETERIORATED	REPAIR WITH THIXOTROPIC OR POURABLE CEMENT MORTARS - THICKNESS UP TO 5 cm	B.09.220.1.a
		B.09.220.2.a
		B.09.220.3
		B.09.220.4
HIGHLY DETERIORATED	REPAIR WITH THIXOTROPIC OR POURABLE CEMENT MORTARS AND GROUTS - THICKNESS UP TO 10 cm	B.09.230.a
		B.09.230.b
SEVERELY DETERIORATED	REPAIR WITH GROUTS OR FLUID CONCRETE - THICKNESS ABOVE 10 cm	B.09.260.a
		B.09.260.b
		B.09.260.c
RAPID AND LOW TEMPERATURE INTERVENTIONS	FAST-SETTING PRE-BLENDED POURABLE MORTARS WITH STEEL FIBRES	B.09.305.a
		B.09.305.b

Materials should be chosen based on the assessment of deterioration thickness. This geometric parameter, however, is not exhaustive for the evaluation of the problem, and other diagnostic levels (analytical, chemical and morphological) must be foreseen, which all together can provide a picture in line with the level of knowledge expected and the type of intervention to be carried out, according to the executive project.

Deterioration assessment	Type of repair	RECOMMENDED PRODUCTS
Structure protection - concrete painting	Concrete protection based on elastomeric polyurethane resin	**PRIMER ES40 + POLIFLEX PP**
Structure protection - concrete painting	One-component concrete protection based on elastomeric acrylic resin	**ACRIFLEX + ACRIPRIMER**
Structure protection - concrete painting	Concrete protection with rigid one-component coat of methacrylic resin	**DRACOLOR**
Structure protection - concrete painting	Reinforced concrete water-repellent treatment	**IDROSILOXAN**
Mild deterioration - surface repair - 2-10mm thickness	Two-component mortar mixed with polymers - 2 mm thickness minimum	**MAGIFLEX CLE**
Mild deterioration - surface repair - 2-10mm thickness	Two-component mortar mixed with polymers -3-6 mm thickness	**FLUECO 45 T2 BM**
Mild deterioration - surface repair - 2-10mm thickness	Two-component mortar mixed with polymers -7-10 mm thickness	**FLUECO 45 T2 BM**
Moderate deterioration - repair - 10-50mm thickness	TWO-COMPONENT thixotropic mortar with polymers (LOW MODULUS)	**FLUECO 80T2**
Moderate deterioration - repair - 10-50mm thickness	Thixotropic mortar REINFORCED with synthetic polyacrylonitrile fibres	**FLUECO 80T FIBER**
Moderate deterioration - repair - 10-50mm thickness	POURABLE mortar reinforced with synthetic STEEL fibres	**FLUECO 80C SFR**
Moderate deterioration - repair - 10-50mm thickness	POURABLE mortar reinforced with synthetic STEEL fibres	**FLUECO 80C SFR**
Deep deterioration - repair - 60-100mm thickness	CE-marked pre-dosed expansive cement concrete with polyacrylonitrile fibres	**FLUECO 60**
Deep deterioration - repair - 60-100mm thickness	CE-marked pre-dosed expansive cement concrete with steel fibres	**FLUECO 80C SFR**
Very deep deterioration - repair - > 100 mm thickness	Rck > 45 MPa	**DRACOFLOW or DRACOFLOW LS**
Very deep deterioration - repair - > 100 mm thickness	Rck > 65 MPa + synthetic fibres	**DRACOFLOW + FIBERBETON**
Very deep deterioration - repair - > 100 mm thickness	Rck > 65 MPa + steel fibres	**DRACOFLOW LF**
Rapid and low temperature interventions	Pre-blended POURABLE mortar with steel fibres with rapid development of mechanical strength	**FLUECO 80 C QUICK**
Rapid and low temperature interventions	CE-marked pre-dosed concrete (mortar +35% gravel)	**FLUECO 80C SFR + GRAVEL**

REFERENCE PROJECT FOR MAINTENANCE TO REINFORCED CONCRETE WORKS

After the catastrophic events of the last few years, the Italian infrastructure sector is facing a difficult time, which urges all players in the sector – inspectors, managing and control bodies, designers, companies, works managers and manufacturers – to be more and more committed and professional. In this respect, the expertise of **DRACO** S.p.A. in certified products is made available for the prescription of the products, which is indeed one of the most important

LEVEL OF DETERIORATION	Definition of intervention cycle	Thickness	Distinctive characteristic
	STRUCTURE PROTECTION concrete painting	*microns*	**PROTECTIVE TREATMENT OF REINFORCED CONCRETE STRUCTURES**
MILD	**REPAIR** **Surface** **Surface**	*2 mm* *3 - 10 mm*	**SMOOTHING OF REINFORCED CONCRETE STRUCTURES WITH READY MIX MORTARS WITH POLYMER ADMIXTURES**
MODERATE	**REPAIR** **Moderate** **Moderate** **Moderate**	*10 - 50 mm* *10 - 50 mm* *10 - 50 mm*	**TWO-COMPONENT AND ONE-COMPONENT PRE-BLENDED MORTARS**
DEEP	**REPAIR** **Deep** **Deep**	*60 - 100 mm* *60 - 100 mm*	**CE-MARKED PRE-DOSED CONCRETE**
VERY DEEP	**REPAIR** **Very deep** **Very deep** **Very deep**	*> 100 mm* *> 100 mm* *> 100 mm*	**SHRINKAGE-COMPENSATING CONCRETE**

factors for the success of the interventions. **DRACO** S.p.A has prepared 10 graphs for extraordinary maintenance to infrastructure, based on one of the reference documents for the industry: Anas extraordinary maintenance pricelist for major work repairs - **CHAPTER B.09.**

Anas code	Product	GRAPH
B.09.105.1.a	PRIMER ES 40 + POLIFLEX PP	TAV 01
B.09.105.2	DRACOLOR PRIMER + DRACOLOR	
B.09.115	IDROSILOXAN	
B.09.215.a	MAGIFLEX CLE	TAV 02
B.09.215.b	FLUECO 45 T2 BM	TAV 03
B.09.215.c	FLUECO 45 T2 BM	TAV 03
B.09.220.1	FLUECO 80 T2	TAV 04
B.09.220.2	FLUECO 80 T FIBER	TAV 05
B.09.220.3	FLUECO 80 C FLOWFIBER	TAV 06
B.09.220.4	FLUECO 80 C SFR	TAV 06
B.09.230.a	FLUECO 60	TAV 07
B.09.230.b	FLUECO 80 C SFR	TAV 08
B.09.260.a	DRACOFLOW o DRACOFLOW LS	TAV 09
B.09.260.b	DRACOFLOW + FIBERBETON + FIBERFLEX S	TAV 09
B.09.260.c	DRACOFLOW LF	TAV 09

PRODUCTS FOR REINFORCED CONCRETE MAINTENANCE

The following table contains a **list of over 30 products** that can be taken into account for many types of interventions, depending on deterioration levels, for ordinary and extraordinary maintenance to large reinforced concrete structures.

LEVEL OF DETERIORATION	INTERVENTION	RECOMMENDED PRODUCTS
No visible surface deterioration	**Protection with film-forming resin systems**	▸ ACRIFLEX ▸ ACRIPAINT ▸ DRACOLOR ▸ EPOWALL ALM ▸ POLIFLEX PP
Slightly deteriorated	**Smoothing with anti-carbonation cementitious skim coats**	▸ CONCRETE FINISHER ▸ CONCRETE FINISHER 2 ▸ MAGIFLEX CLE ▸ MAGIFLEX BRAVO ▸ EPOMALT
Moderately deteriorated	**Manual or spray restoration with thixotropic or pourable cement mortars**	▸ FLUECO 35 ▸ FLUECO 75 ▸ FLUECO 55 T ▸ FLUECO 80 T2 ▸ FLUECO 40 T ▸ FLUECO 80 C ▸ FLUECO 80 C FLOWFIBER ▸ FLUECO 80 C QUICK ▸ FLUECO 175 T CR FR ▸ FLUECO 175 C CR FR ▸ FLUECO BLITZ ▸ FLUECO BLITZ R4 ▸ FLUECO 45 T2 BM ▸ FLUECO 100 C SFR ▸ FLUECO 80 C SFR ▸ FLUECO 80 T FIBER
Severely deteriorated	**Lining or repair with pourable thixotropic grouts or fluid concrete**	▸ FLUECO 60 ▸ FLUECO 60 QUICK ▸ FLUECO 80 T GG ▸ DRACOFLOW ▸ DRACOFLOW LF ▸ DRACOFLOW LS ▸ PRESIDIO SRA ▸ DRACOSTEEL ▸ DRACOSTEEL MONO ▸ TIME EXTENDER

CLE TECHNOLOGY

Large infrastructure like bridges were designed and built with the ambition of maintaining mechanical and functional performance for a long time. However, the life cycle of many of these structures is reaching the final phase.

This is why there is a need for identifying, developing and producing technological solutions for existing large works, capable of extending durability.

DRACO CLE ***"Concrete Life Extender"*** is a newborn family of innovative, highly technological products with certified performance, supported by precise standardised testing campaigns. Protection-wise they rank at the top of the product category they belong to, in accordance with coating and impregnation principles, and with the methods related to concrete defects, as contained in **UNI EN 1504-9**.

CLE CONCRETE LIFE EXTENDER

MAGIFLEX CLE

Two-component elastic cementitious mortar for coating and protecting large concrete works subjected to high stresses; it has high crack-bridging capacity and resistance to penetration of aggressive and deteriorating agents such as CO_2 and chlorides, corresponding to a big sacrificial C32/40 concrete layer, which is equivalent to 120 mm.

SUPERGARD CLE

Innovative liquid product having a twofold function - mass admixture for new mixes or impregnating agent with migration capacity on existing concrete - **and threefold performance** - 50% reduction in expansion caused by alkali-aggregate reaction (AAR); inhibition of corrosion in rebars with indicative reduction above 50% and increase in concrete water-repellent property with 33% reduction in water absorption.

APPLICATION CYCLES FOR REPAIRING REINFORCED CONCRETE

Inspecting, controlling and monitoring the conditions of bridge structures means assessing the mechanical, physical and chemical actions that affect durability, as well as choosing suitable materials for maintenance work.

In the next pages, we describe some recurrent situations for which a given product family can be used for repair and protection cycle, in compliance with the requirements of standard **UNI EN 1504**. However, we definitely intend to rule out any simplified approach, especially when it comes to structural rehabilitation cycles, as we strongly reiterate how important it is to preliminarily perform an analytical and diagnostic assessment of the conditions as they are.

- SMOOTHING OF REINFORCED CONCRETE STRUCTURES
- REPAIR OF BRIDGE AND VIADUCT PIERS
- REPAIR OF BRIDGE AND VIADUCT BEAMS
- REPAIR OF SLABS AND KERBS OF BRIDGES AND VIADUCTS
- REPAIR OF DOSSERETS AND SUPPORTS
- RECONSTRUCTION OF STRUCTURAL JOINTS

TECHNICAL ADVICE – LARGE INFRASTRUCTURE

"AT THE SERVICE OF ITALIAN INFRASTRUCTURE HERITAGE"

DRACO S.p.A. has since ever placed great emphasis on correct prescriptive specifications and technical assistance at the construction site, for proper work execution. As a result, in addition to constant R&D activity for the development of new solutions, such as the recently created **CLE *"Concrete Life Extender"* technologies**, a **pool of** experienced **professionals** has been set up for the large infrastructure industry. To make sure your project is correct right from preliminary design, and in compliance with the applicable regulations and all requirements established by the same, you can request **BESPOKE SPECIALIST ADVICE**, to get additional documents and services during project development and work management:

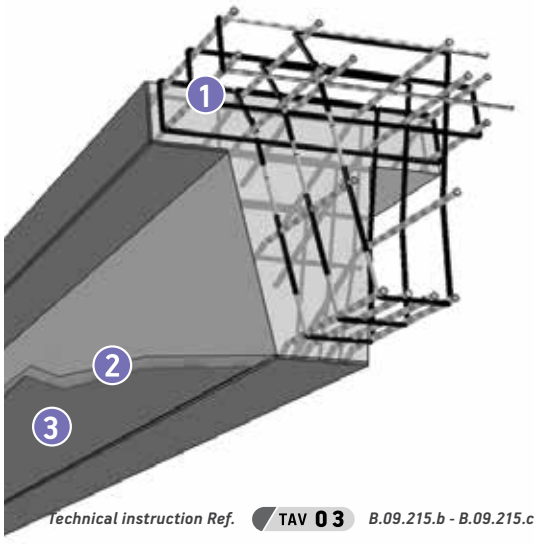
- **Price analysis and definition of specifications for works, even related to Anas reference maintenance projects.**
- **Exclusive reports for technical improvements in bids, based on the most economically advantageous tender criterion.**
- **Lab certificates and test reports in compliance with the applicable regulations.**
- **Assistance to preliminary, final and executive design.**
- **Assistance to businesses at the construction site to ensure proper application of the materials.**
- **Assistance to works management for physical check of the work.**
- **Assistance to testers during the checks of the documents of the products used.**

MAIN APPLICATION CYCLES

SMOOTHING OF REINFORCED CONCRETE STRUCTURES

» SURFACE REPAIR WITH TWO-COMPONENT MORTAR WITH POLYMER ADMIXTURES.
Thickness between 3 and 10 mm

DETERIORATION TYPE



Technical instruction Ref. TAV 03 *B.09.215.b - B.09.215.c*

PRODUCTS USED

» DRACOSTEEL MONO

Protective re-alkalisation treatment of rebars against corrosion.

» FLUECO 45 T2 BM

Two-component, fibre-reinforced thixotropic mortar with low modulus of elasticity for surface restoration of reinforced concrete structures in aggressive environments.

» ACRIFLEX

Flexible waterproof resin protecting against carbonation for concrete structures.

» SPECIFICATIONS ITEMS

» **FLUECO 45 T2 BM:** repair, volume reconstruction and coating in very aggressive environments by application of a two-component fibre-reinforced thixotropic cement-based mortar with low modulus of elasticity of the type of **FLUECO 45 T2 BM** by Draco Italiana S.p.A. to be applied in layers up to 20 mm thick. The product must be characterised by high adhesion to the substrate, impermeability and development of high initial and final mechanical strength and must comply with the requirements of standard EN 1504-3 for structural repair mortars of class R4. All instructions and precautions followed must comply with the recommendations given by the manufacturer DRACO Italiana S.p.A.

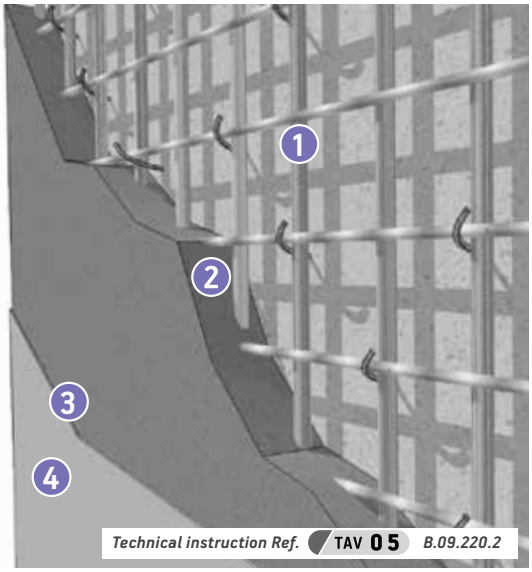
» **ACRIFLEX:** concrete protective coating made with flexible, waterproof acrylic resin in aqueous solution, with anti-carbonation properties and resistant to weathering and UV of the type of **ACRIFLEX** by DRACO Italiana S.p.A. ACRIFLEX shall be applied manually by brush or roller or sprayed using a low pressure machine, with several coats crossed in the opposite direction. The product must satisfy the minimum requirements pursuant to EN 1504-2 coating (C) according to principles PI (method 1.3) and MC (method 2.2) for concrete structure protection.

For comprehensive information on installation and performances, refer to the technical data sheets and specifications that can be downloaded from our website **draco-edilizia.it**

REPAIR OF BRIDGE AND VIADUCT PIERS

» REPAIR WITH THIXOTROPIC STRUCTURAL MORTAR AND SMOOTHING WITH TWO-COMPONENT POLYMER MORTAR. Thickness between 10 and 50 mm

DETERIORATION TYPE



Technical instruction Ref. TAV 05 B.09.220.2

PRODUCTS USED

» DRACOSTEEL MONO

Protective re-alkalisation treatment of rebars against corrosion.

» FLUECO 80T FIBER

Fibre-reinforced, thixotropic structural mortar with shrinkage compensation for structural repair in aggressive environments.

» MAGIFLEX CLE

Two-component cementitious mortar for coating and protecting large concrete works exposed to high stresses.

» ACRIFLEX

Flexible waterproof resin protecting against carbonation for concrete structures.

» SPECIFICATIONS ITEM

» **FLUECO 80 T FIBER:** structural repair, volume reconstruction made with structural shrinkage-compensating, sulphate-resistant, fibre-reinforced thixotropic mortar of the type of **FLUECO 80 T FIBER** by DRACO Italiana S.p.A. to be applied in layers up to 5 cm thick with no electro-welded mesh. The product must be characterised by high adhesion to the substrate, impermeability and development of high initial and final mechanical strength and must comply with the requirements of standard EN 1504-3 for structural repair mortars of class R4. All instructions and precautions followed must comply with the recommendations given by the manufacturer DRACO Italiana S.p.A.

» **MAGIFLEX CLE:** protection and elastic smoothing of concrete surfaces by application by spatula or spraying of two-component mortar based on cementitious binders, fine-grained aggregates, synthetic fibres and special acrylic resins in aqueous solution for a final thickness of 2 mm minimum, of the type of **MAGIFLEX CLE** by DRACO Italiana S.p.A. The product must meet the requirements set by EN 1504-2 coating (C), according to principles PI, MC and IR for concrete protection. If microcracks by settlement are expected on the cementitious substrate, the alkali-resistant 8x8mm mesh **MAGINET** should be installed between the first and second layer of the product.

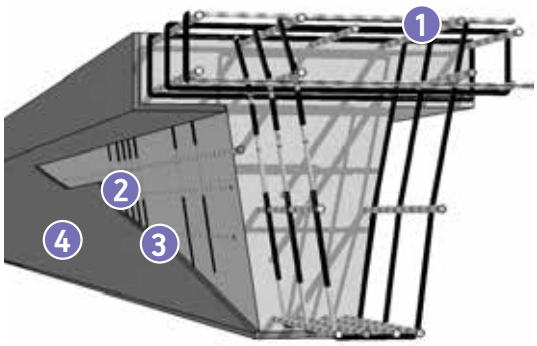
For comprehensive information on installation and performances, refer to the technical data sheets and specifications that can be downloaded from our website **draco-edilizia.it**

MAIN APPLICATION CYCLES

REPAIR OF BRIDGE AND VIADUCT BEAMS

» REPAIR WITH TWO-COMPONENT THIXOTROPIC STRUCTURAL MORTAR AND SMOOTHING WITH TWO-COMPONENT POLYMER MORTAR. Thickness between 10 and 50 mm

DETERIORATION TYPE



Technical instruction Ref. TAV 04 *B.09.220.1*

PRODUCTS USED

» DRACOSTEEL MONO

Protective re-alkalisation treatment of rebars against corrosion.

» FLUECO 80 T2

Two-component, fibre-reinforced and polymer-modified thixotropic structural mortar for structural restoration in aggressive environments.

» MAGIFLEX CLE

Two-component cementitious mortar for coating and protecting large concrete works exposed to high stresses.

» ACRIFLEX

Flexible waterproof resin protecting against carbonation for concrete structures.

» SPECIFICATIONS ITEM

» **FLUECO 80 T2:** structural repair, volume reconstruction and thick layer coating in highly aggressive environments by application of a two-component, thixotropic mortar of the type of **FLUECO 80 T2** by DRACO Italiana S.p.A. to be applied in layers up to 5 cm thick. The product must be characterised by high adhesion to the substrate, impermeability and development of high initial and final mechanical strength and must comply with the requirements of standard EN 1504-3 for structural repair mortars of class R4. All instructions and precautions followed must comply with the recommendations given by the manufacturer DRACO Italiana S.p.A.

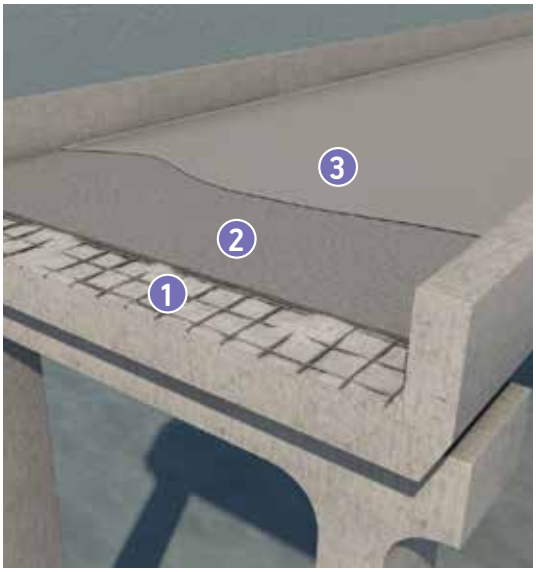
» **MAGIFLEX CLE:** protection and elastic smoothing of concrete surfaces by application by spatula or spraying of a two-component mortar based on cementitious binders, fine-grained aggregates, synthetic fibres and special acrylic resins in aqueous solution for a final thickness of 2 mm minimum, of the type of **MAGIFLEX CLE** by Draco Italiana S.p.A. The product must meet the requirements set by EN 1504-2 coating (C), according to principles PI, MC and IR for concrete protection. If microcracks by settlement are expected on the cementitious substrate, the alkali-resistant 8x8mm mesh **MAGINET** should be installed between the first and second layer of the product.

For comprehensive information on installation and performances, refer to the technical data sheets and specifications that can be downloaded from our website **draco-edilizia.it**

REPAIR OF SLABS AND KERBS OF BRIDGES AND VIADUCTS

» REPAIR WITH POURABLE STRUCTURAL MORTAR AND WATERPROOFING WITH TWO-COMPONENT EPOXY-BITUMINOUS ELASTIC COATING. Thickness between 30 and 100 mm

DETERIORATION TYPE



PRODUCTS USED

» DRACOSTEEL MONO

Protective re-alkalisation treatment of rebars against corrosion.

» FLUECO 80C SFR

Pre-blended pourable cement-based mortar, with restrained expansion in the air and superior ductility containing synthetic fibres and reinforced with rigid steel fibres.

» ELASTOPROOF

Two-component flexible waterproof coating based on epoxy-polyurethane resins modified with non-toxic coal-tar.

» FLUECO 80C FLOWFIBER

Super fluid pre-blended fibre-reinforced mortar with shrinkage compensation in the air for structural repair of concrete by pouring.

» FLUECO 80 C SFR: structural repair and restoration of concrete structures by pouring a fibre-reinforced, shrinkage-compensating, sulphate-resistant cementitious mortar of the type of **FLUECO 80 C SFR** by DRACO Italiana S.p.A. The product must be characterised by high adhesion to the substrate, impermeability and development of high initial and final mechanical strength and must comply with the requirements of standard EN 1504-3 for structural repair mortars of class R4. All instructions and precautions followed must comply with the recommendations given by the manufacturer Draco ITALIAna S.p.A.

» FLUECO 80C FLOWFIBER: structural repair, volume reconstruction and thick layer coating in highly aggressive environments by application of a pourable, fibre-reinforced sulphate-resistant mortar with shrinkage compensation and air curing of the type of **FLUECO 80 C FLOWFIBER** by Draco Italiana S.p.A. to be applied in layers up to 5 cm thick with no electro-welded mesh. The product must exhibit high adhesion to the substrate, impermeability and development of high initial and final mechanical strength and must comply with the requirements of standard EN 1504-3 for structural repair mortars of class R4. All instructions and precautions followed must comply with the recommendations given by the manufacturer Draco Italiana S.p.A.

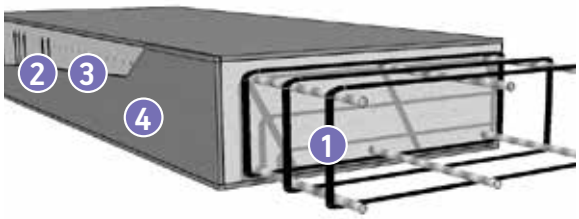
» SPECIFICATIONS ITEM

For comprehensive information on installation and performances, refer to the technical data sheets and specifications that can be downloaded from our website **draco-edilizia.it**

REPAIR OF DOSSERETS AND SUPPORTS

» REPAIR WITH THIXOTROPIC STRUCTURAL MORTAR OR POURABLE SHRINKAGE-COMPENSATING GROUT. Thickness between 50 and 100 mm

DETERIORATION TYPE



Technical instruction Ref. TAV 05 B.09.220.2

Technical instruction Ref. TAV 07 B.09.230.a

PRODUCTS USED

» DRACOSTEEL

Protective re-alkalisation treatment of rebars against corrosion.

» FLUECO 80T FIBER

Fibre-reinforced, thixotropic structural mortar with shrinkage compensation for structural repair in aggressive environments.

» MAGIFLEX CLE

Two-component cementitious mortar for coating and protecting large concrete works exposed to high stresses.

» ACRIFLEX

Flexible waterproof resin protecting against carbonation for concrete structures.

» FLUECO 60

Shrinkage compensated pourable grout with synthetic fibres for structural thickness repair.

» DRACOFIX HP

Universal thixotropic epoxy adhesive in cartridge for anchoring and structural bonding applications.

» SPECIFICATIONS ITEM

» FLUECO 80 T FIBER: structural repair and volume reconstruction with structural shrinkage-compensating, sulphate-resistant, fibre-reinforced thixotropic mortar of the type of **FLUECO 80 T FIBER** by DRACO Italiana S.p.A. to be applied in layers up to 5 cm thick with no electro-welded mesh. The product must exhibit high adhesion to the substrate, impermeability and development of high initial and final mechanical strength and must comply with the requirements of standard EN 1504-3 for structural repair mortars of class R4. All instructions and precautions followed must comply with the recommendations given by the manufacturer DRACO Italiana S.p.A.

» FLUECO 60: structural repair and restoration of concrete structures by pouring, also into a formwork, of shrinkage-compensating, sulphate-resistant, fibre-reinforced cementitious grout of the type of **FLUECO 60** by Draco Italiana S.p.A. to be applied in 3 to 10cm-thick coats. The product must be characterised by high adhesion to the substrate, impermeability and development of high initial and final mechanical strength and must comply with the requirements of standard EN 1504-3 for structural repair mortars of class R4. All instructions and precautions followed must comply with the recommendations given by the manufacturer Draco Italiana S.p.A.

For comprehensive information on installation and performances, refer to the technical data sheets and specifications that can be downloaded from our website **draco-edilizia.it**

RECONSTRUCTION OF STRUCTURAL JOINTS

» JOINT REPAIR.

DETERIORATION TYPE

PRODUCTS USED

1

» DRACOFIX EP

Anchoring of rebars of edge beams with thixotropic epoxy adhesive in cartridge for structural bonding.

/ DRACOFIX PE

Anchoring of rebars of edge beams with two-component pourable rapid-setting polyester mortar for anchoring and grouting.

/ DRACOFIX PS

Anchoring of rebars of edge beams with two-component styrene-free polyester resin-based chemical anchor.

/ DRACOFIX HP

Universal thixotropic epoxy adhesive in cartridge for anchoring and structural bonding applications.

2

» FLUECO 100 C SFR

Rapid-setting pre-blended pourable cementitious mortar containing synthetic fibres and reinforced with rigid steel fibres for casting adjacent edge beams and backing rods.

» MAGIJOINT

3

+ EP FIX HP

Waterproofing of intrados with joint tape and two-component epoxy adhesive in paste for structural bonding ensuring enhanced adhesion.

4

» EPOBETON C

Two-component pourable epoxy-based mortar for repair of concrete floors, filling of sections, anchoring and grouting.

5

» DRACOFLEX TR

Filling of extrados holes of the joint with two-component polyurethane fluid mortar for fixing and anchoring.

TECHNICAL ADVICE SERVICE:

For information about the application cycle, contact DRACO Infrastructure Technical Support team.

For comprehensive information on installation and performances, refer to the technical data sheets and specifications that can be downloaded from our website **draco-edilizia.it**

REINFORCED CONCRETE MAINTENANCE PRODUCTS

In the following pages you will find a list of **over 30 products** that can be taken into account for many types of interventions, depending on deterioration levels, for ordinary and extraordinary maintenance to large reinforced concrete structures.

» CEMENTITIOUS SYSTEMS FOR VOLUMETRIC RECONSTRUCTION AND VERTICAL/OVERHEAD REPAIR

- Repair with thixotropic structural mortars
- Repair with two-component thixotropic mortars
- Repair with thixotropic grouts
- Overview of thixotropic repair mortars

» POURABLE AND INJECTABLE CEMENTITIOUS SYSTEMS FOR VOLUMETRIC RECONSTRUCTION AND RESTORATION

- Repair with pourable cementitious grouts
- Repair with pourable mortars
- Repair with pourable mortars containing steel fibres
- Overview of pourable repair mortars

» SOLUTIONS FOR INJECTION AND CONSOLIDATION

- Binders for concrete, cement grouts and injectable mortars

» POURABLE FLUID EXPANSIVE CEMENTITIOUS SYSTEMS FOR ANCHORING AND GROUTING OF STRUCTURES AND MACHINERY

- Mortars for fixing, anchoring and grouting

» CEMENTITIOUS SYSTEMS FOR VERY THIN SMOOTHING, LOW THICKNESS REPAIR AND PROTECTION OF SURFACES

- Concrete smoothing and protection

» COATING AND PROTECTIVE POLYMER SYSTEMS

- Protective concrete coating
- Table of concrete paints and protective resins

» MORTAR ADMIXTURES

» STEEL REINFORCEMENT PASSIVATING PROTECTION

- Anti-corrosion treatment

OVERVIEW OF MORTARS AND GROUTS FOR CONCRETE REPAIR

REPAIR WITH THIXOTROPIC STRUCTURAL MORTARS

» CEMENTITIOUS SYSTEMS FOR VOLUMETRIC RECONSTRUCTION AND VERTICAL/OVERHEAD REPAIR

FLUECO 40 T

SHRINKAGE-COMPENSATED, HIGH STRENGTH, FIBRE-REINFORCED THIXOTROPIC NANO POLYMER MORTAR FOR STRUCTURAL RESTORATION

Easy to use for layers up to 5 cm thick without electro-welded mesh.

FLUECO 40 T is suitable for the repair and maintenance of exposed reinforced concrete structures subjected to high chemical, physical and environmental attack. Ideal for restoration and thick repair of exposed concrete structures, pillars, slabs, reinforced concrete walls and support walls. Due to high bond strength and resistance to chemical attack, it can be sprayed or applied by trowel on surfaces which have been previously sandblasted. Ideal also for repairing concrete affected by carbonation with no need for passivation treatment.

CONSUMPTION: approx. 17.4 kg/m² per cm of thickness

FLUECO 55 T

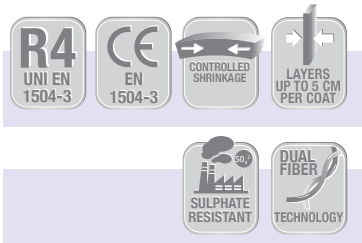
RESTRAINED EXPANSION, FIBRE-REINFORCED THIXOTROPIC MORTAR

Ideal for structural repair in highly aggressive environments. Thickness up to 50 mm.
For overlays of more than 30 mm an electro-welded mesh must be used.

FLUECO 55 T is suitable for structural repair, maintenance and restoration of reinforced concrete structures subjected to the attack of aggressive substances causing deterioration over time. Ideal for restoration and thick repair of hydraulic works, viaducts, pillars and ducting structures, it can be sprayed or applied by trowel.

CONSUMPTION: approx. 19 kg/m² per cm of thickness

FLUECO 80 T FIBER



FIBRE-REINFORCED THIXOTROPIC MORTAR WITH SHRINKAGE COMPENSATION

Ideal for structural repair in highly aggressive environments.
Thickness up to 5 cm per layer with no electro-welded mesh.

FLUECO 80 T FIBER is a one-component cementitious mortar reinforced with polymeric fibres with a microstructural reinforcing action and containing inorganic alkali-resistant rust-proof flexible fibres to be mixed with water to obtain a thixotropic mix with shrinkage compensation in the air. **FLUECO 80 T FIBER** develops high initial and final mechanical strength, it is waterproof and impermeable to carbon dioxide, durable even in aggressive environments, and provides excellent adhesion to steel and concrete.

CONSUMPTION: approx. 19 kg/m² per cm of thickness

REPAIR WITH THIXOTROPIC STRUCTURAL MORTARS

» CEMENTITIOUS SYSTEMS FOR VOLUMETRIC RECONSTRUCTION AND VERTICAL/OVERHEAD REPAIR

FLUECO 175 T CR FR

HIGHLY DUCTILE TWO-COMPONENT THIXOTROPIC MORTAR, RESISTANT TO AGGRESSIVE ENVIRONMENTS, REINFORCED WITH FLEXIBLE CHROME FIBRES

Ideal for structural repair works where higher ductility is required.

FLUECO 175 T CR FR properties make it possible to structurally repair works subjected to high chemical, physical and environmental attack, with thickness up to 4 cm with no electro-welded mesh. **FLUECO 175 T CR FR** can be sprayed or applied by spatula, both horizontally and vertically, even with high thickness and exhibits excellent adhesion to steel and concrete. It contains fibres that increase resistance to bending and impact. Ideal for repairing prefabricated structures, beams, pillars, slabs and reinforced concrete walls, hydraulic works, viaducts and tunnels, and concrete structures in general, even in contact with seawater or aggressive substances.

CONSUMPTION: approx. 19 kg/m² per cm of thickness

FLUECO BLITZ

FAST-SETTING, THIXOTROPIC CEMENT-BASED STRUCTURAL MORTAR WITH NATURAL FINISH FOR CONCRETE REPAIR

Ideal for repair and reprofiling with thicknesses from 5 to 40 mm.

FLUECO BLITZ is a fast-setting, ready-to-use cement mortar suitable for spot repairs and for finishing damaged concrete and RC and can be used both vertically and horizontally. **FLUECO BLITZ** develops high initial and final mechanical strength; it is waterproof and long-lasting even in aggressive environments and provides strong bonding to steel and concrete. Thanks to its special additives and structural fibres, with **FLUECO BLITZ** it is easy to create layer thickness from 5 mm to 4 cm guaranteeing strong bonding and protection against carbonatation. **FLUECO BLITZ** does not contain any metal parts or chlorides, is resistant to chemical and environmental attacks and is suitable for all the exposure classes defined in UNI 11104.

CONSUMPTION: approx. 18 kg/m² per cm of thickness

FLUECO BLITZ R4

FAST-SETTING, FIBRE-REINFORCED, THIXOTROPIC STRUCTURAL MORTAR WITH NATURAL FINISH FOR CONCRETE REPAIR

Ideal for repair and reprofiling with thickness from 1 to 40 mm in one coat.

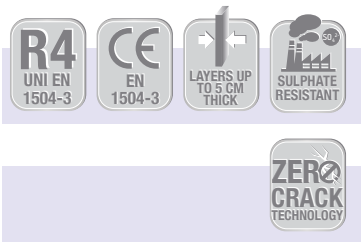
FLUECO BLITZ R4 is a ready-to-use thixotropic cementitious mortar. Rapid setting, microfibres, medium modulus of elasticity combined with the shrinkage compensation technology turn this mortar into a multipurpose product for repair and levelling of concrete surfaces, which are usually hard to achieve with one product alone. **FLUECO BLITZ R4** is suitable for rapid structural repair and smoothing of vertical and horizontal concrete surfaces and reinforced concrete structures. **FLUECO BLITZ R4** increases initial and ultimate mechanical strength; it is waterproof, long-lasting - even in aggressive environments - and also ideal for repairing structures exposed to the atmosphere or in contact with water. Applied in layers from 5 to 40 mm thick, **FLUECO BLITZ R4** provides strong bonding to steel and concrete and protection against carbonation. **FLUECO BLITZ R4** is resistant to chemical and environmental attacks and is suitable for all exposure classes defined by UNI 11104.

CONSUMPTION: approx. 18-18,5 kg/m² per cm of thickness

REPAIR WITH TWO-COMPONENT THIXOTROPIC MORTARS

» CEMENTITIOUS SYSTEMS FOR VOLUMETRIC RECONSTRUCTION AND VERTICAL/OVERHEAD REPAIR

FLUECO 80 T2



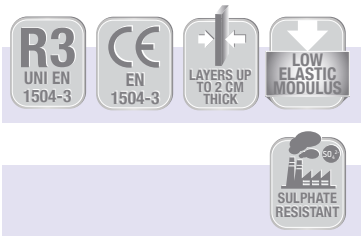
TWO-COMPONENT FIBRE-REINFORCED POLYMER-MODIFIED THIXOTROPIC MORTAR

Ideal for structural restoration in aggressive environments and in the presence of load deformation; for layer thickness up to 5 cm.

FLUECO 80 T2 properties make it possible to structurally repair works subjected to high chemical, physical and environmental attack. It is ideal for repairing structures, including prefabricated works, subjected to repeated stresses or deformations, reinforced concrete beams, pillars, slabs and walls, hydraulic works, infrastructure, viaducts and tunnels, even in contact with seawater.

CONSUMPTION: approx. 21 kg/m² per cm of thickness

FLUECO 45 T2 BM



TWO-COMPONENT, FIBRE-REINFORCED THIXOTROPIC MORTAR WITH LOW MODULUS OF ELASTICITY

Ideal for surface restoration of reinforced concrete structures in aggressive environments - layer thickness from 5 to 20 mm.

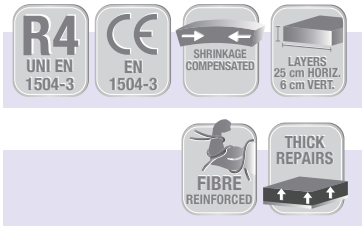
FLUECO 45 T2 BM is a two-component, fibre-reinforced mortar made of a cement-based premix to be hydrated with a specific synthetic latex to obtain shrinkage compensated thixotropic mixes. **FLUECO 45 T2 BM** develops good initial and final mechanical strength and has a low modulus of elasticity. It is waterproof and durable, even in aggressive environments, and provides excellent adhesion to steel and concrete. **FLUECO 45 T2 BM** contains an organic corrosion inhibitor and is resistant to chemical and environmental attack.

CONSUMPTION: approx. 20 kg/m² per cm of thickness

REPAIR WITH THIXOTROPIC GROUTS

» CEMENTITIOUS SYSTEMS FOR VOLUMETRIC RECONSTRUCTION AND VERTICAL/OVERHEAD REPAIR

FLUECO 80 T GG



SHRINKAGE-COMPENSATED THIXOTROPIC GROUT FOR STRUCTURAL REPAIR
High thickness.

FLUECO 80 T GG is a ready-to-use, fibre-reinforced, coarse grain cement-based grout to be mixed with water to obtain shrinkage compensated thixotropic mixes.
FLUECO 80 T GG develops high initial and final mechanical strength, it is waterproof, durable, even in aggressive environments, and provides excellent adhesion to steel and concrete. **FLUECO 80 T GG** can be sprayed or applied by trowel or spatula, both vertically and horizontally in thick layers.

CONSUMPTION: approx. 19 kg/m² per cm of thickness

OVERVIEW OF THIXOTROPIC REPAIR MORTARS

» CEMENTITIOUS SYSTEMS FOR VOLUMETRIC RECONSTRUCTION AND VERTICAL/OVERHEAD REPAIR



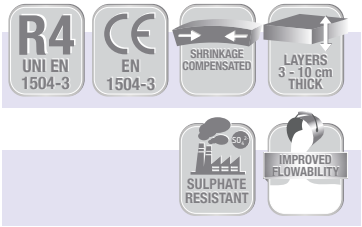

PERFORMANCES OF THIXOTROPIC MORTARS UNI EN 1504	**FLUECO 55 T**	**FLUECO 80 T FIBER**	**FLUECO 40 T**	**FLUECO BLITZ**
CLASSES PURSUANT TO EN 1504-3	R4	R4	R4	R3
MAXIMUM AGGREGATE DIAMETER (mm)	2.5	2.5	2.5	0.5
BULK DENSITY - EN 12190 (kg/m^3)	2180	2200	2070	2030
MIXING WATER (%)	15-18	15-17	18-20	20-22
APPLICATION TEMPERATURE (°C)	+5 to +35	+5 to +35	+5 to +35	+5 to +35
POT LIFE (20°C - RH 50%)	approx. 50 min.	approx. 60 min.	approx. 80 min.	approx. 20 min.
COMPRESSIVE STRENGTH after 28 days (MPa)	60	70	50	30
FLEXURAL STRENGTH after 28 days (MPa)	8	10	6.5	7
MODULUS OF ELASTICITY IN COMPRESSION after 28 days (GPa) [± 2]	28	28	22	22
ADHESION TO CONCRETE - EN 1766 (MPa)	> 2	> 2	> 2	> 2
THERMAL COMPATIBILITY WITH FREEZE-THAW CYCLES WITH DE-ICING SALTS, MEASURED AS ADHESION PURSUANT TO EN 1542 - TEST METHOD PURSUANT TO UNI EN 13687-1 (MPa)	> 2	> 2	> 2	> 2
MAX THICKNESS PER COAT (cm)	5 cm 2 cm in overhead applications	5 cm 2 cm in overhead applications	5 cm 2 cm in overhead applications	4 cm 2 cm in overhead applications
CONSUMPTION (approx. kg/m^2 per cm of thickness)	19	19	17.4	18

				
FLUECO BLITZ R4	**FLUECO 80 T GG**	**FLUECO 175 T CR FR**	**FLUECO 80 T2**	**FLUECO 45 T2 BM**
R4	R4	R4	R4	R3
1	5	2.5	2.5	1.2
2160	2160	2170	2130	2050
17-20	11-13	16-18	No	-
+5 to +35	+5 to +35	+5 to +35	+5 to +35	+5 to +35
approx. 20 min.	approx. 60 min.	approx. 60 min.	approx. 30 min.	approx. 30 min.
50	70	65	55	38
9	8	14	10	7.5
22	30	30	25	17.5
> 2	> 2	> 2	> 2	> 2
> 2	> 2	> 2	> 2	> 2
4 cm 2 cm in overhead applications	6 cm in vertical applications 25 cm in horizontal applications	4 cm 2 cm in overhead applications	5 cm	2 cm
18-18.5	19	19	21	20

REPAIR WITH POURABLE CEMENTITIOUS GROUTS

» POURABLE AND INJECTABLE CEMENTITIOUS SYSTEMS FOR VOLUMETRIC RECONSTRUCTION AND RESTORATION

FLUECO 60



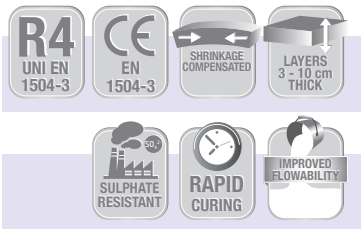
SHRINKAGE-COMPENSATING RHEODYNAMIC POURABLE CEMENTITIOUS GROUT REINFORCED WITH SYNTHETIC FIBRES, FOR THICK STRUCTURAL REPAIRS WITH SUPERIOR DURABILITY

Thickness from 3 to 10 cm.

FLUECO 60 is a super fluid, polymer-modified, fibre-reinforced "coarse grain" cement-based grout. Its special formula ensures superior water tightness and durability even in aggressive environments. **FLUECO 60** is particularly suitable for restoring reinforced concrete by form-and-pump technique for standard and highly reinforced structures.

CONSUMPTION: approx. 21 kg/m² per cm of thickness

FLUECO 60 QUICK



SHRINKAGE-COMPENSATING POURABLE CEMENTITIOUS GROUT FOR REPAIRS BY POURING

Rapid setting.

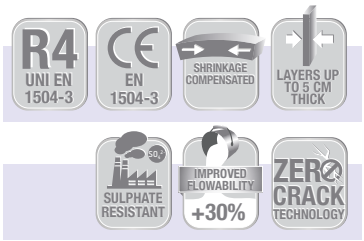
The characteristics of **FLUECO 60 QUICK** ensure rapid structural repair and refurbishment of concrete works and structures in general.
It is applied by pouring, also into formworks, and even on highly reinforced structures with thickness of 3 to 10 cm. Ideal for maintenance and strengthening of pillars, viaducts, slabs, decks and quays also in aggressive environments.

CONSUMPTION: approx. 21 kg/m² per cm of thickness

REPAIR
WITH POURABLE MORTARS

» POURABLE AND INJECTABLE CEMENTITIOUS SYSTEMS FOR VOLUMETRIC RECONSTRUCTION AND RESTORATION

FLUECO 80 C



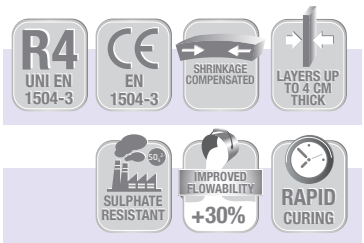
POURABLE FIBRE-REINFORCED MORTAR WITH SUPERIOR DURABILITY AND SHRINKAGE COMPENSATION

Ideal for structural repair in highly aggressive environments

FLUECO 80 C is a pourable, rheoplastic, cement-based mortar that is ready for use and fibre-reinforced with polymeric fibres for pouring. **FLUECO 80 C** is used for maintenance, structural repairs and restoration in industrial and urban areas with high concentrations of aggressive agents. **FLUECO 80 C** develops high initial and final mechanical strength, both compressive and tensile. It is waterproof and durable even in very aggressive environments. It provides strong bonding to steel and concrete. **FLUECO 80 C** is resistant to chemical and environmental attacks and is suitable for all the classes of exposure required by UNI 11104.

CONSUMPTION: approx. 20.2 kg/m² per cm of thickness

FLUECO 80 C QUICK



FAST-HARDENING POURABLE, FIBRE-REINFORCED MORTAR WITH SHRINKAGE COMPENSATION AND SUPERIOR DURABILITY

Ideal for structural repair in highly aggressive environments

FLUECO 80 C QUICK is a fast-setting, pourable, rheoplastic mortar that is shrinkage-compensated. It contains hydraulic binders, selected aggregates and water-soluble polymers and is suitable for casting. **FLUECO 80 C QUICK** has high adhesion to steel and concrete, superior ductility and is waterproof and long-lasting even in highly aggressive environments. **FLUECO 80 C QUICK** is used for maintenance, structural repairs and restoration in industrial and urban areas with high concentrations of aggressive agents. When carrying out structural repairs adequate reinforcement is necessary; this reinforcement must be placed so that at least 1 cm of rebar cover is left.

CONSUMPTION: approx. 19.5 kg/m² per cm of thickness

FLUECO 80 C FLOWFIBER

SUPER FLUID PRE-BLENDED FIBRE-REINFORCED MORTAR WITH SHRINKAGE COMPENSATION AND AIR CURING

Ideal for structural restorations of concrete by form-and-pump technique Layer thickness up to 5 cm without electro-welded mesh

FLUECO 80 C FLOWFIBER is a ready-to-use, pre-mixed, pourable cement-based mortar reinforced with polymer fibres and synthetic, rustproof, flexible alkali-resistant fibres, with high fracture toughness and resistance to cyclic loading. **FLUECO 80 C FLOWFIBER** develops high initial and final mechanical strength, both compressive and tensile. It is waterproof and durable even in very aggressive environments and it provides strong bonding to steel and concrete. **FLUECO 80 C FLOWFIBER** is resistant to chemical and environmental attacks and is suitable for all the classes of exposure required by UNI 11104.

CONSUMPTION: approx. 20 kg/m² per cm of thickness

REPAIR WITH POURABLE MORTARS CONTAINING METAL FIBRES

» POURABLE AND INJECTABLE CEMENTITIOUS SYSTEMS FOR VOLUMETRIC RECONSTRUCTION AND RESTORATION

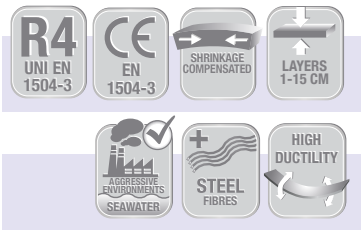
FLUECO 80 C SFR

HIGHLY DUCTILE PRE-BLENDED POURABLE CEMENT-BASED MORTAR CONTAINING SYNTHETIC FIBRES AND REINFORCED WITH RIGID STEEL FIBRES WITH RESTRAINED EXPANSION IN AIR

Ideal for structural repair in aggressive environments and areas subjected to high dynamic loads.
FLUECO 80 C SFR is a high-performance one-component pre-blended pourable cementitious mortar, reinforced with rust-resistant stiff metal fibres, specially designed for precision anchoring. **FLUECO 80 C SFR** develops high initial and final mechanical strength even at low temperatures; it is waterproof, durable, even in aggressive environments, and highly resistant to impact and dynamic loads. **FLUECO 80 C SFR** is resistant to chemical and environmental attack and is suitable for all exposure classes defined by standard UNI 11104.

CONSUMPTION: approx. 20.5 kg/m² per cm of thickness

FLUECO 100 C SFR

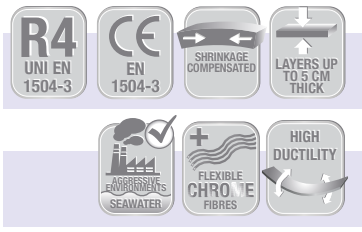


RAPID-SETTING PRE-BLENDED POURABLE CEMENT-BASED MORTAR REINFORCED WITH RIGID STEEL FIBRES FOR PRECISION ANCHORING AND STRUCTURAL REPAIR IN AGGRESSIVE ENVIRONMENTS AND AREAS SUBJECTED TO DYNAMIC LOADS

FLUECO 100 C SFR is a one-component pre-blended pourable cementitious mortar reinforced with stiff steel fibres offering top performance levels, specially designed for precision anchoring. **FLUECO 100 C SFR** develops high initial and final mechanical strength, even at low temperatures (-5°C); it is waterproof, durable, even in aggressive environments, and highly resistant to impact and dynamic loads. **FLUECO 100 C SFR** is resistant to chemical and environmental attack and is suitable for all exposure classes defined by standard UNI 11104.

CONSUMPTION: approx. 20 kg/m² per cm of thickness

FLUECO 175 C CR FR



HIGHLY DUCTILE POURABLE MORTAR RESISTANT TO AGGRESSIVE ENVIRONMENTS, REINFORCED WITH FLEXIBLE CHROME FIBRES

Layer thickness up to 5 cm with no electro-welded mesh

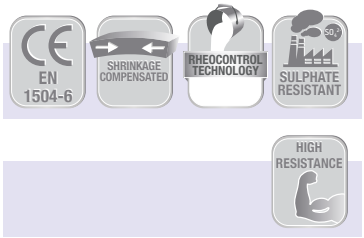
FLUECO 175 C CR FR is a pre-blended, pourable, shrinkage-compensating cementitious mortar reinforced with synthetic fibres and flexible rust-resistant chrome steel fibres, specially designed for structural repair of reinforced and prestressed concrete pillars, beams and slabs subjected to sulphate attack or in contact with seawater. **FLUECO 175 C CR FR** develops high initial and final mechanical strength; it is waterproof, durable, even in aggressive environments, and provides excellent adhesion to steel and concrete. **FLUECO 175 C CR FR** is sold together with chrome steel fibres.

CONSUMPTION: approx. 20 kg/m² per cm of thickness

BINDERS FOR CONCRETE, CEMENT GROUTS AND INJECTABLE MORTARS

» SOLUTIONS FOR INJECTION AND CONSOLIDATION

DRACOFLOW

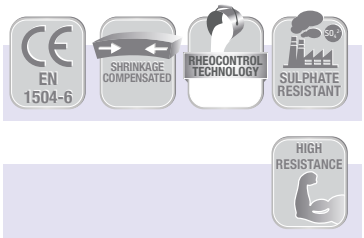


BINDER FOR THE PREPARATION OF INJECTABLE SUPER FLUID SHRINKAGE-COMPENSATED GROUTS AND MORTARS

DRACOFLOW is a pre-blended hydraulic binder specially designed for the preparation of injectable grouts, mortars and superfluid concrete; it is non-segregating, pumpable, shrinkage-compensating, with high mechanical strength, and resistant to sulphates, chlorides, carbon dioxide etc. It is suitable for filling cavities and cracks and for masonry consolidation. **DRACOFLOW** does not require other admixtures.

CONSUMPTION: see technical data sheet

DRACOFLOW LF

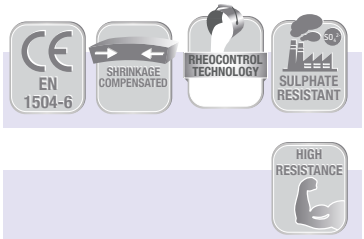


EXPANSIVE BINDER REINFORCED WITH RIGID METAL FIBRES FOR THE PREPARATION OF DUCTILE AND RHEOPLASTIC CONCRETE
Thickness above 80 mm.

DRACOFLOW LF is a specially designed expansive binder based on cements and polymers, reinforced with high performance steel fibres treated with anti-corrosion galvanic treatment, for the preparation of ductile, rheoplastic, non-segregating, self-compacting concrete (SCC), which is shrinkage-compensating and high performing. Its formula provides superior pumpability, cohesion and no bleeding. The resulting mixes have high mechanical strength even in case of fast curing, high chemical resistance and extended durability.

CONSUMPTION: see technical data sheet

DRACOFLOW LS



EXPANSIVE BINDER FOR THE PREPARATION OF SELF-COMPACTING CONCRETE (SCC) WITH NO BLEEDING, LOW W/C RATIO AND SUPERIOR MECHANICAL STRENGTH

DRACOFLOW LS is an expansive binder based on cements and water-soluble polymers specially designed for the preparation of grouts and rheoplastic and rheodynamic self-compacting concrete (SCC), which is shrinkage-compensating and high performing. Its formula provides superior pumpability, cohesion and no bleeding. The resulting mixes have high mechanical strength even in case of fast curing, high chemical resistance and extended durability. **DRACOFLOW LS** does not require other admixtures.

CONSUMPTION: see technical data sheet

OVERVIEW OF POURABLE REPAIR MORTARS

» POURABLE AND INJECTABLE CEMENTITIOUS SYSTEMS FOR VOLUMETRIC RECONSTRUCTION AND RESTORATION



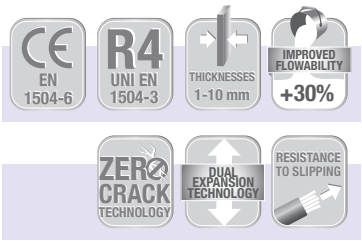

PERFORMANCES OF POURABLE MORTARS AND GROUTS UNI EN 1504	**FLUECO 60**	**FLUECO 60 QUICK**	**FLUECO 80 C**	**FLUECO 80 C QUICK**
CLASSES PURSUANT TO 1504-3	R4	R4	R4	R4
MAXIMUM AGGREGATE DIAMETER (mm)	6	6	2.5	2.5
BULK DENSITY - EN 12190 (kg/m^3)	2320	2250	2210	2270
MIXING WATER (%)	11-13	14	13.2-15.2	16-18
APPLICATION TEMPERATURE (°C)	+5 to +35	+5 to +35	+5 to +35	+5 to +35
POT LIFE (20°C - RH 50%)	60 min.	30 min.	60 min.	30 min.
COMPRESSIVE STRENGTH after 28 days (MPa)	70	50	70	50
FLEXURAL STRENGTH after 28 days (MPa)	7	8	7	7
MODULUS OF ELASTICITY IN COMPRESSION after 28 days (GPa) [± 2]	30	29	28	29
ADHESION TO CONCRETE PURSUANT TO EN 1766 (MPa)	> 2	> 2	> 2	> 2
THERMAL COMPATIBILITY WITH FREEZE-THAW CYCLES WITH DE-ICING SALTS, MEASURED AS ADHESION PURSUANT TO EN 1542 - TEST METHOD PURSUANT TO UNI EN 13687-1 (MPa)	> 2	> 2	> 2	> 2
MAX THICKNESS PER COAT (cm)	10	10	5	4
CONSUMPTION (approx. kg/m^2 per cm of thickness)	21	21	20.2	19.5

 FLUECO 80 C FLOWFIBER	 FLUECO 80 C SFR	 FLUECO 100 C SFR	 FLUECO 175C CR FR
R4	R4	R4	R4
2.5	2.5	2.5	2.5
2280	2280	2400	2170
13.2-15.2	12-13	11-12	15-17
+5 to +35	+5 to +35	da -5 a +35	+5 to +35
60 min.	60 min.	15-30 min.	60 min.
70	70	85	70
10	16	24	11
28	27	30	27
> 2	> 2	> 2	> 2
> 2	> 2	> 2	> 2
5	10	15	5
20	20.5	20	20

MORTARS FOR FIXING, ANCHORING AND GROUTING

» POURABLE FLUID EXPANSIVE CEMENTITIOUS SYSTEMS FOR GROUTING AND ANCHORING OF STRUCTURES AND MACHINERY

FLUECO 75



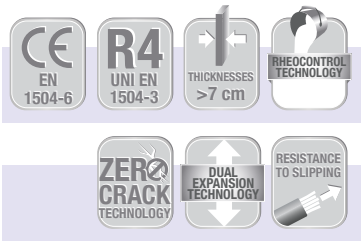
EXPANSIVE FLUID MORTAR FOR PRECISION ANCHORING OF MACHINERY AND STRUCTURES

Thickness between 1 and 10 cm.

FLUECO 75 is a pre-blended cementitious mortar for anchoring structural elements and machinery that may be subject to vibration, rotation and thermal stress. Simply mix **FLUECO 75** with water to form a fluid, non segregatable mix with high adhesion to rebars and durability.

CONSUMPTION: approx. 1950 kg/m³

FLUECO 35



SHRINKAGE-COMPENSATED EXPANSIVE GROUT FOR PRECISION ANCHORING APPLICATIONS

Sections above 7 cm.

FLUECO 35 is a pre-blended cementitious mortar for anchoring of structures and machinery that may be subject to vibration and / or thermal stress. Simply mix **FLUECO 35** with water to form a fluid, non segregatable, bleed-free mix. This grout adheres exceptionally well to rebars and is long-lasting. Its extended workability time (60 minutes at 20° C) facilitates instalment and it is totally waterproof to guarantee no infiltration of water, oil or steam which may contain sulphates, sulphides and chlorides.

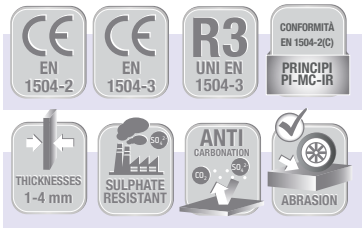
CONSUMPTION: approx. 2100 kg/m³

PERFORMANCES OF EXPANSIVE MORTARS AND GROUTS FOR ANCHORING - UNI EN 1504-6	**FLUECO 75**	**FLUECO 35**
Class - EN 1504-3	R4	R4
Maximum aggregate diameter (mm)	2.5	5
Bulk density - EN 12190 (kg/m³)	2250	2300
Mixing water (%)	16-17.2	13 - 15
Application temperature (°C)	+5 to +35	+5 to +35
Pot life (20°C - RH 50%)	approx. 60 min.	approx. 60 min.
Compressive strength after 28 days (MPa)	> 80	> 70
Adhesion to concrete - EN 1766 (MPa)	> 2	> 2
Pull-out resistance - EN 1881 (mm)	> 0.6 mm	≤ 0.6 mm
Maximum thickness per layer (cm)	10	20 (confined)
Consumption (approx. kg/m³)	1950	2100

CONCRETE SMOOTHING AND PROTECTION

» CEMENTITIOUS SYSTEMS FOR VERY THIN SMOOTHING, LOW-THICKNESS REPAIR AND PROTECTION OF SURFACES

CONCRETE FINISHER



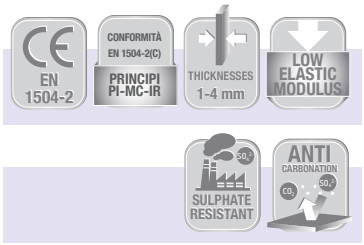
ONE-COMPONENT POLYMER-MODIFIED CEMENTITIOUS SKIM MORTAR FOR SMOOTHING AND LOW-THICKNESS REPAIRS (1 ÷ 4 mm)

High protection against carbonation.

CONCRETE FINISHER is a pre-blended carbonation resistant cementitious mortar based on specific fine-grained aggregates, synthetic polymers and special admixtures to be mixed with water. **CONCRETE FINISHER** is formulated for the restoration and the smoothing out of concrete structures in thickness up to 1-4 mm in a single coat. **CONCRETE FINISHER** is easy to use and simply mixed with water forms a soft paste easy to apply even on vertical surfaces that smooth out and protects concrete against carbonation and aggressive environments. It is ideal as a smoothing cementious top layer for concrete repair system with FLUECO mortars.

CONSUMPTION: approx. 1.8 kg/m² per mm of thickness

CONCRETE FINISHER 2



TWO-COMPONENT CEMENTITIOUS SKIM MORTAR WITH LOW MODULUS OF ELASTICITY FOR SMOOTHING AND LOW-THICKNESS REPAIRS (1 ÷ 4 mm)

High resistance to aggressive environments and carbonation.

CONCRETE FINISHER 2 is a two-component premixed cement mortar based on specially selected fine aggregates, synthetic polymers and special admixtures to be mixed with micronized synthetic latex for increased bond. **CONCRETE FINISHER 2** is very compact and resistant to freeze-thaw cycles and chemical attack. Its high bond strength and low permeability to carbon dioxide and water make **CONCRETE FINISHER 2** ideal for smoothing and protecting concrete structures and finishing any repair cycles using FLUECO mortars.

CONSUMPTION: approx. 2 kg/m² per mm of thickness

MAGIFLEX CLE

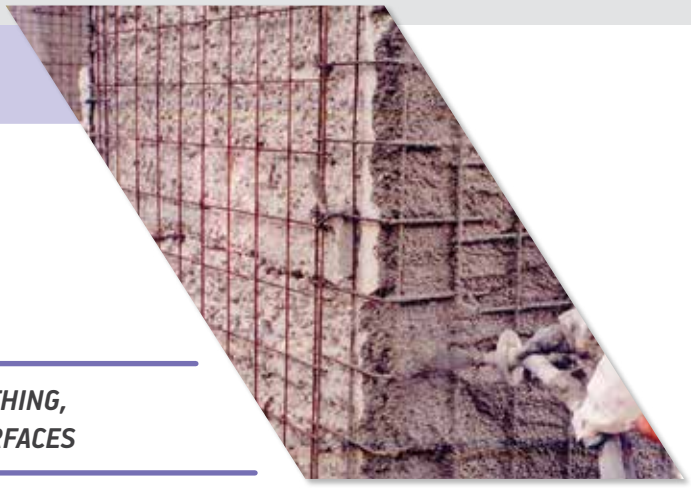
CLE CONCRETE LIFE EXTENDER

ELASTIC TWO-COMPONENT CEMENTITIOUS MORTAR FOR COATING AND PROTECTING LARGE CONCRETE WORKS EXPOSED TO HIGH STRESSES

MAGIFLEX CLE is a two-component elastic cementitious mortar based on specially selected fine-grained aggregates, hydraulic binders, admixtures and polymers (component A) to be mixed with micronized synthetic latex (component B). Fast and easy to apply, **MAGIFLEX CLE** features high flexibility, tensile strength and bonding strength to the substrate. **MAGIFLEX CLE** allows to realise 2mm-thick coatings, including vertical ones, on surfaces exposed to high stresses. Waterproof, impermeable to chloride ions and carbon dioxide, it maintains its elasticity, even when exposed to harsh environments.

CONSUMPTION: approx. 1.5 kg/m² per mm of thickness
Sprayed by plastering machine: approx. 1.9 kg/m² per mm of thickness

CONCRETE SMOOTHING AND PROTECTION



» CEMENTITIOUS SYSTEMS FOR VERY THIN SMOOTHING, LOW THICKNESS REPAIR AND PROTECTION OF SURFACES

MAGIFLEX BRAVO

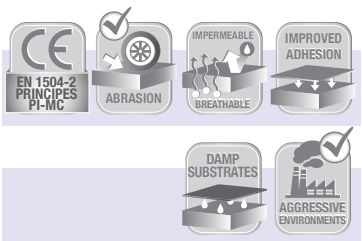
FLEXIBLE, WATERPROOF, BREATHABLE, TWO-COMPONENT CEMENT-BASED COATING FOR FOUNDATIONS AND RETAINING STRUCTURES

Suitable for negative side waterproofing and resistant to chemical attack.

MAGIFLEX BRAVO is a flexible two-component brushable waterproof coating based on selected aggregates, hydraulic binders, additives and polymers. **MAGIFLEX BRAVO** can be used for 1.5-3 mm thick waterproof coatings on most surfaces even those subject to micro-cracking (determination of "static crack bridging" properties according to UNI EN 1062-7 - cert. ELLETIPI 46759/17 of 19/12/17 and "dynamic crack bridging" according to UNI EN 1062-7 - cert. ELLETIPI 48191/18 of 21/02/18). Resistant to negative pressure, **MAGIFLEX BRAVO** is quick and practical to apply and has high flexibility, tensile strength and adhesion to the substrate.

CONSUMPTION: approx. 1.7 kg/m² per mm of thickness (by brush or roller)
approx. 2 kg/m² per mm of thickness (spray application)

EPOMALT



TWO-COMPONENT EPOXY-CEMENT RESIN FOR REPAIRING AND PROTECTING CONCRETE FLOORING

Maximum adhesion even on damp substrates.

EPOMALT is a two-component epoxy-cement based high-performance skimming mortar for levelling and smoothing concrete structures and industrial flooring. It provides excellent resistance to abrasion and chemical attack and is waterproof even against negative water pressure. The epoxy-cement formula makes it also suitable for applications in very hot weather and windy conditions.

CONSUMPTION: approx. 1.6 kg/m² per mm of thickness

TABLE OF CONCRETE SKIM COATS AND PROTECTIVE PRODUCTS		CONCRETE FINISHER	CONCRETE FINISHER 2	MAGIFLEX CLE	MAGIFLEX BRAVO	EPOMALT
Classification according to EN1504-3		EN 1504-2 PI-MC-IR, EN 1504-3, R3	EN 1504-2 PI-MC-IR	EN 1504-2 PI-MC-IR	EN 1504-2 PI-MC	EN 1504-2 PI-MC
APPLICATION METHOD	Spatula/Trowel	●	●	●		●
	Roller/Brush				●	
	Rapid setting					
USES AND CHARACTERISTICS	Flexible			●	●	
	Repair					
	Natural finish	●	●			●
	Resistant to abrasion		●	●	●	●
	Anti-carbonation protection	●	●	●	●	●
	Resistant to aggressive agents	●	●	●	●	●
	Suitable for ceramic installation					●

PROTECTION AND COATING OF CONCRETE

» COATING AND PROTECTIVE POLYMER SYSTEMS

ACRIPAINT

BREATHABLE ACRYLIC RESIN PROTECTING AGAINST CARBONATION FOR CONCRETE STRUCTURES

ACRIPAINT is a one-component synthetic paint based on acrylic resins in aqueous emulsion. **ACRIPAINT** is specially formulated to decorate concrete, reinforced concrete and pre-stressed concrete while providing protection from carbonation. Once cured, the coating is waterproof but permeable to water vapour, and exhibits excellent adhesion and resistance to yellowing and mould growth.

CONSUMPTION: 1.48 kg/m² approx. per mm of thickness
180 ÷ 250 g/m² per coat
minimum recommended: 400 ÷ 500 g/m²

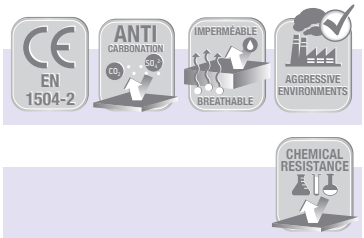
ACRIFLEX

FLEXIBLE WATERPROOF RESIN PROTECTING AGAINST CARBONATION FOR CONCRETE STRUCTURES

ACRIFLEX is a one-component solvent-free elastic coating based on acrylic resins. It is practical and easy to apply. **ACRIFLEX** provides a highly attractive finish even on surfaces that are cracked and subjected to deformation, and is ideal in the presence of aggressive atmospheres and structures exposed to UV.

CONSUMPTION: 1.3 kg/m² per mm of thickness
300 ÷ 400 g/m² per coat
minimum recommended: 600 ÷ 800 g/m²

DRACOLOR



DECORATIVE, PROTECTIVE, BREATHABLE COATING FOR CONCRETE SURFACES BASED ON METHACRYLIC RESINS IN SOLVENT

DRACOLOR is a one-component solvent containing paint based on methacrylic resins and selected pigments with superior coverage rates. **DRACOLOR** is specially formulated to protect against carbonation, whilst at the same time decorating concrete surfaces. **DRACOLOR** is used on concrete surfaces of bridges, viaducts and flyovers, amongst others, to provide a coating that resists to water ingress and aggressive atmospheric agents, whilst maintaining excellent water vapour breathability properties.

CONSUMPTION: 1.6 kg/m² approx. per mm of thickness
200 ÷ 250 g/m² per coat
minimum recommended: 400 ÷ 500 g/m²

PROTECTION AND COATING OF CONCRETE

» COATING AND PROTECTIVE POLYMER SYSTEMS

POLIFLEX PP

FLEXIBLE, PROTECTIVE, TWO-COMPONENT POLYURETHANE COATING IN SOLVENT PHASE

Ideal as film-forming coating for reinforced concrete protection

POLIFLEX PP is a two-component, elastic, aliphatic polyurethane resin in solvent, with excellent chemical resistance and flexibility, ideal as protective finish coat for reinforced concrete structures, either new or repaired with mortars of the FLUECO line. Applied by roller or (airless) sprayer **POLIFLEX PP** forms a protective film with high crack-bridging ability.

CONSUMPTION: 80 ÷ 300 g/m² per coat
minimum recommended: 300 g/m²

EPOWALL ALM

NON-TOXIC TWO-COMPONENT EPOXY COATING FOR FOOD CONTAINERS

EPOWALL ALM is a two-component coating with excellent mechanical strength; it has been specially designed for chemical attack-resistant coating of food containers for the food industry, processing rooms, pharmaceutical companies, testing labs etc. **EPOWALL ALM** is certified for contact with foodstuffs according to the requirements of Ministerial Decree of 21/03/73 and subsequent amendments.

CONSUMPTION: 200 ÷ 300 g/m² per coat depending on substrate porosity
minimum recommended: 500 ÷ 600 g/m² in 2 coats

TABLE OF CONCRETE PAINTS AND PROTECTIVE RESINS

» COATING AND PROTECTIVE POLYMER SYSTEMS

		 ACRIPAINT	 ACRIFLEX	 DRACOLOR	 POLIFLEX PP	 EPOWALL ALM
Classification according to UNI EN 1504-2		coating (C) principles PI - MC	coating (C) principles PI - MC	coating (C) principles PI - MC	coating (C) principles PI - MC	coating (C) principles PI - MC
CHARACTERISTICS	**Flexibility**	-	+++	-	++	-
	Breathability	+++	+++	+	+	+
	Impermeability	+	+++	+++	+++	+++
	Anti-carbonation protection	++	+++	+++	+++	+++
	Resistance to environmental attack	+	++	+++	+++	+++
	Resistance to freeze-thaw cycles	++	+++	++	++	++
	Chemical resistance to contact with acids	+	+	++	+	+++
	Suitability for contact with food	-	-	-	-	YES

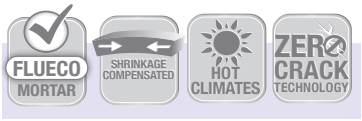
LEGEND

EXCELLENT	+++
GOOD	++
MODERATE	+
ND	-

MORTAR ADMIXTURES

» CURING AND RETARDING ADMIXTURES FOR GROUTS AND MORTARS

PRESIDIO SRA



INTERNAL CURING ADMIXTURE FOR THE REDUCTION OF DRYING SHRINKAGE AND THE CONTROL OF MICRO-CRACKING

Specific for use with FLUECO shrinkage compensated mortars

PRESIDIO SRA is a liquid curing additive that reduces drying shrinkage of mortars and grouts and regulates moisture loss from the mixing water from the inside (internal curing), thus controlling cracking and curling. When used in combination with the grouts and mortars of the FLUECO line **PRESIDIO SRA** allows to obtain shrinkage compensated mortars with curing in the air.

CONSUMPTION: 1% by weight of mortar

TIME EXTENDER

RETARDING ADMIXTURE FOR FAST-SETTING CEMENT MORTARS

Specific for use with FLUECO BLITZ and FLUECO BLITZ R4 mortars

TIME EXTENDER is a liquid chloride-free retarding admixture in aqueous solution specifically formulated to increase workability of fast-setting cement mortars and to be used with FLUECO BLITZ and FLUECO BLITZ R4 mortars. **TIME EXTENDER** delays cement hydration and hence increases the workability time of fast-setting cement mortars.

CONSUMPTION: 1-2% by weight of mortar

ANTI-CORROSION TREATMENT

» STEEL REINFORCEMENT PASSIVATING PROTECTION

DRACOSTEEL

PROTECTIVE RE-ALKALISATION TREATMENT OF REBARS AGAINST CORROSION

DRACOSTEEL is a two-component cementitious mortar based on water-dispersed polymers, cementitious binders and corrosion inhibitors that can be applied by brush to create a protective passivation layer on steel reinforcement. **DRACOSTEEL** is applied on reinforced concrete rebars to protect them from anodic and cathodic corrosion. **DRACOSTEEL** is ideal as protective re-alkalisation treatment of rebars when repairing concrete, reinforced concrete and prestressed concrete structures. It is also suitable as bonding bridge on concrete.

CONSUMPTION: 110 g/m on 8mm bars (2 mm thickness)

DRACOSTEEL MONO

ONE-COMPONENT PROTECTIVE RE-ALKALISATION TREATMENT OF REBARS AGAINST CORROSION

DRACOSTEEL MONO is a one-component cementitious mortar based on water-dispersed polymers, cementitious binders and corrosion inhibitors that can be applied by brush to create a protective passivation layer on steel reinforcement. **DRACOSTEEL MONO** is applied on reinforced concrete rebars to protect them from anodic and cathodic corrosion.
DRACOSTEEL MONO is ideal as protective re-alkalisation treatment of rebars when repairing concrete, reinforced concrete and prestressed concrete structures.

CONSUMPTION: 100 g/m on 8mm bars (2 mm thickness).

OVERVIEW OF MORTARS AND GROUTS FOR CONCRETE REPAIR

		 FLUECO 55T	 FLUECO 80T FIBER	 FLUECO 80 T2	 FLUECO 80 C	 FLUECO 80 C QUICK	 FLUECO 80 C FLOWFIBER	 FLUECO 60
REPAIR TYPE	Concrete cover reconstruction	●	●	●	●	●	●	●
	Structural repair	●	●	●	●	●	●	●
	pursuant to EN1504-3	R4	R4	R4	R4	R4	R4	R4
APPLICATION METHOD	Spatula/Trowel	●	●	●	-	-	-	-
	Plastering machine with continuous mixer	-	-	-	-	-	-	-
	Plastering machine with premixer	●	●	-	-	-	-	-
	Pouring	-	-	-	●	●	●	-
INFRASTRUCTURE	Repair of piers	●	●	●	-	-	-	-
	Restoration of beams	●	●	●	-	-	-	-
	Repair of foundation intrados	●	●	●	-	-	-	-
	Repair of foundation extrados	●	●	●	●	●	●	●
	Repair of dosserets	●	●	●	●	●	●	●
	Repair of supports	●	●	●	●	●	●	●
	Filling of rigid joints	-	-	-	●	●	●	●
HYDRAULIC WORKS	Repair of walls	●	●	●	-	-	-	-
	Repair of slabs	●	●	●	●	●	●	●
	Repair of exterior walls	●	●	●	-	-	-	-
	Repair of spillways	●	●	●	-	-	-	-
CIVIL APPLICATIONS	Repair of parapets	●	●	●	-	-	-	-
	Overhead repairs	●	●	●	-	-	-	-
	Restoration of apron linings, balconies	●	●	●	-	-	-	-
	Reconstruction of edges of beams and pillars	●	●	●	-	-	-	-
INDUSTRIAL APPLICATIONS	Grouting of pillars	-	-	-	-	-	-	-
	Repair of prefabricated panels	●	●	●	-	-	-	-
	Repair of concrete flooring	-	-	-	●	●	●	●
	Restoration of beams and pillars	●	●	●	-	-	-	-
	Anchoring of machinery	-	-	-	-	-	-	-
	Section enlargement of pillars up to 4 cm	-	-	-	●	●	●	-
	Section enlargement of pillars above 4 cm	-	-	-	-	-	-	●

 FLUECO 60 QUICK	 FLUECO 40 T	 FLUECO BLITZ	 FLUECO 75	 FLUECO 35	 FLUECO 175 C CR FR	 FLUECO 175 T CR FR	 FLUECO 80 T GG	 FLUECO 45 T2 BM	 DRACO-FLOW
●	●	●	●	●	●	●	●	●	●
●	●	-	●	●	●	●	●	●	●
R4	R4	R3	R4	R4	R4	R4	R4	R3	-
-	●	●	-	-	●	●	●	●	-
-	-	-	-	-	-	-	-	-	-
●	●	-	-	-	●	●	-	-	-
-	-	-	●	●	●	-	-	-	●
-	-	-	-	-	●	●	-	●	-
-	-	-	-	-	●	●	-	●	●
-	-	-	-	-	●	●	-	-	
●	-	-	-	-	●	●	●	-	●
-	-	-	-	-	●	●	●	●	●
●	-	-	-	-	●	●	●	●	●
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-	-	-	-	-	-	-	-	-	-
●	-	-	-	-	-	-	●	-	-

APPROACH TO DURABILITY AND DETERIORATION PHENOMENA

To prevent the degradation of reinforced concrete structures, an *engineering-based* approach to durability must be adopted. As such, it must take into account not only material deterioration, but also the resulting construction type-related structural consequences, any deviations between theoretical models and real behaviours of the structures, errors due to the difficulty in building construction elements and distortions caused by temperature and humidity variations. Structures have often microcracks and/or cracks that can alter degradation if compared to allegedly intact concrete elements. Indeed, initial microcracks can progress to major lesions due to stresses caused by changes in temperature and humidity – heating/cooling, humidity-induced shrinkage – and restrained by more or less rigid connections between structural elements; furthermore, the aggressive agents in the environment where the structure is located can penetrate through these preferential paths and worsen deterioration.

For instance, corrosion induced by chloride or carbon dioxide reduces the cross-section of rebars and the steel-to-concrete adhesion and causes loss of concrete cover portions; as a result, it also reduces the overall stiffness of the structural elements, thus leading to deformation and affecting the functionality of the whole structure.

Accordingly, the engineering-based approach to durability must take into account not only the deterioration of materials, but also the multiple factors that contribute to the degradation of real structures. Therefore, the concrete deterioration mechanisms described in this document, one by one, should be considered as *one of the factors* inducing degradation; the assessments given herein must be coupled with structural calculation, cracking assessment, construction site conditions at the time the structure is built, curing methods and times, inevitable deviations between construction and design, monitoring and maintenance plans.

» DEFINITION OF ENVIRONMENTAL EXPOSURE OF THE STRUCTURES

Based on the information given in the previous paragraph, it is clear that in order to guarantee the durability of reinforced concrete structures exposed to degradation, it is necessary to adopt more or less strict measures, depending on the risk they are exposed to. Standards UNI EN 206 and UNI 11104 define the environments where the structure is in service, as well as environmental exposure classes and the corresponding deterioration mechanisms (Table 1).

		MAIN DETERIORATION MECHANISMS
EXPOSURE CLASSES	X0	Non-reinforced structures with no risk of deterioration
	XC	Reinforced concrete structures subject to corrosion of the reinforcement induced by carbonation
	XD	Reinforced concrete structures subject to corrosion induced by chlorides other than from seawater
	XS	Reinforced concrete structures in marine environment subject to corrosion induced by chlorides from seawater
	XF	Concrete structures exposed to freeze-thaw attack with or without de-icing agents
	XA	Concrete structures exposed to chemical attack from soil and water

Table 1 - Classes of environmental exposure pursuant to UNI EN 206 and UNI 11104.

» STRUCTURES EXPOSED TO CARBONATION - EXPOSURE CLASS **XC**

As previously stated, **carbonation** is a process through which carbon dioxide, which is one of main components of air, penetrates the concrete cover and reacts with calcium hydroxide contained in the hydrated cement paste, thus lowering concrete pH to around 9. As a result, the rebar that is normally in a condition of higher pH, loses its *passive film* - at values below 11 already - and protection drops.

When the film is no longer waterproof, metals are exposed to the environment: oxygen and water penetrate a generally porous concrete and trigger a chemical process of oxide-reduction with the rebar (cathode) followed by formation of rust, which results in volume increase as high as seven times the initial volume of the rebar.

Rust causes internal compressive stresses in concrete, as well as surface tensile stresses, resulting in surface cracks parallel to the rebars; cracks progress gradually causing spalling of concrete cover at the edges or cover delamination on flat and vertical surfaces.

For corrosion to occur – after the front of carbonation has reached the rebars and destroyed its natural protection – both water and oxygen must be present.

» STRUCTURES EXPOSED TO CHLORIDE ATTACK - EXPOSURE CLASSES **XD** AND **XS**

Corrosion induced by chlorides is one of the most important and most common causes of degradation in reinforced concrete, as chloride ions are contained in de-icing salts, brines used in industrial processing and seawater. When chlorides are present, localized corrosion occurs in the reinforcement steel creating pits of a variable size from 1 to 10 mm. The higher the amount of oxygen that reaches the rebars, the more severe the chloride-induced corrosion will be. Aerial structures are mostly exposed to deterioration induced by chlorides, rather than submerged or underground structures where huge amounts of chlorides are unlikely to reach the rebars during the service life of the structure. Hence, chloride-induced corrosion is not significant in submerged or underground concrete from an engineering perspective. In this case, for gradual damage to rebars to occur, both oxygen and a high amount of chloride must be present at the same time.

The mechanism of corrosion is such that the localised attack is stabilised, since there is a concentration of chloride and pH drops within the corroded area, while the passive film around it gets more stable. This is why chlorides cause localised corrosion in the form of local pits. Indeed, the aforesaid localised corrosion is known as pitting, and can develop quite fast: in wet concrete with high chloride content near the rebars, a penetration rate of 1÷1.5 mm/year can be achieved.

Corrosion induced by chlorides is the same, regardless of chloride type; however, standards **UNI EN 206** and **UNI 11104** classify the **attack by chlorides** into two classes: **XS** for chlorides from seawater and **XD** for chlorides other than from seawater, such as industrial processing tanks, swimming-pools, road infrastructure exposed to de-icing salts.

The reason is that the marine environment has specific features. The time needed by chloride, close to the rebars, to reach a critical concentration and induce corrosion depends on the porosity of the cement matrix and the thickness of the concrete cover: concrete with relatively low w/c ratio and thick concrete cover has excellent durability against aggressive chloride ions. Moreover, chloride ingress in concrete can be slowed down by using pozzolanic cement and blast-furnace cement, in which hydration materials can partially absorb chloride so that chloride will need more time to reach the threshold limit.

» STRUCTURES EXPOSED TO FREEZE-THAW CYCLES - EXPOSURE CLASS **XF**

Temperature changes cause deterioration in concrete: when temperature goes up, the element dilates, while it shrinks when temperature goes down. The structural elements of a building are usually hyper-static and not free to shrink; this generates tensile stresses much higher than the tensile strength of concrete, resulting in cracking.

Degradation of structures in service can also be enhanced by cyclical temperature fluctuations around 0°C, due to an increase in water pressure inside concrete capillary pores, which can generate destructive stresses to the cement matrix and aggregates.

It is known that when temperature falls below 0°C, liquid water turns into ice and volume increases by approx. 9%.

The freezing point of liquid water drops as surface attractive forces increase, and thus capillary pore dimensions decrease. Attractive forces are determined by absorption, which is due to solid-vapour interaction in water inside capillary pores (Van der Waals forces).

At a given temperature and cooling rate, which characterize the place where the structure is located, the pressure inside the cement matrix caused by temperature falling below 0°C, strictly depends on concrete saturation level and porosity (total volume and pore distribution).

If concrete saturation is above 91.7% (critical saturation), the increase in water volume caused by freezing cannot be contained inside the pores that are not saturated with water yet. These conditions generate inner pressures that can progressively destroy concrete, especially in case of repeated freeze-thaw cycles, because of fatigue failure. Deterioration occurs in the form of cracking, spalling and scaling. If concrete saturation is below 91.7%, and in case of complete freezing of liquid water inside the pores, the increased volume of ice cannot fill them completely; as a result, no excess water is pushed out.

Nonetheless, if concrete saturation is below 85%, pressures generated by freeze-thaw cycles cannot overcome the resistance of the material and thus engineering-wise, no significant deterioration occurs.

In cold weather areas, concrete deterioration is enhanced by de-icing salts and occurs following a number of chemical, physical and electrochemical events which happen simultaneously in real structures, depending on the type of salt used. De-icing salts commonly used to remove ice or prevent ice formation on roads and motorways and external pavements are usually made of calcium chloride or a mix of calcium chloride and sodium chloride, which may be also mixed with stone chippings to increase tyre grip.

They severely deteriorate concrete because of higher saturation resulting from ice melting, plus thermal and osmotic effects.

» STRUCTURES EXPOSED TO CHEMICAL ATTACK - EXPOSURE CLASS **XA**

Natural (not industrially produced) chemical agents promoting concrete deterioration can be found both in soil and water. Therefore, when designing an underground or hydraulic structure, it is crucial to perform a chemical analysis in order to check for any concrete aggressive substances in water and soil; as a matter of fact, this type of degradation is more common than expected and affects structures in contact with water or soil containing chemical substances that can react with the components of the hydrated cement paste.

Numberless chemical substances promote concrete degradation and are mainly found in acid environments. Magnesium (Mg++) and ammonium (NH_4^+) can be found in the most common fertilizers used in agriculture; they react with the calcium ion contained in cement hydration products and generate soluble calcium salts that are easily washed out by water. Magnesium, in particular, replaces the compounds ensuring mechanical strength and generates a hydrated silicate responsible for the partial loss of mechanical performance in concrete.

Free carbon dioxide – not bound in carbonates or bicarbonate – is present in water as carbonic acid (H_2CO_3): at first, it reacts with the lime contained in cement paste and forms calcium carbonate, which can further react with surrounding carbonic acid to form calcium bicarbonate. The latter being highly soluble, it is washed out by the cement paste. Water contains a (theoretical) amount of free CO_2 that guarantees balance and prevents the formation of calcium bicarbonate. "Aggressive" carbon dioxide is the excess free carbon dioxide in water with respect to the value of balance; the resulting bicarbonate is easily washed out by water in contact with the structure. Essentially, the mass loss in the cement matrix increases porosity and reduces mechanical performances.

The most common and hazardous deterioration effect in exposure class **XA** is undoubtedly represented by the sulphates in soil and water that are in contact with concrete structures. Sulphate can come from industrial (artificial) wastewater or (natural) organic decomposition of organic substances that contain sulphur, as it happens in plants or manure. Alluvial and cohesive soils can also contain pyrite (iron sulphide) that in some cases can lead to massive formation of gypsum ($CaSO_4$).

Finally, sewage systems, purification tanks and manure collection tanks contain huge amounts of sulphates; in this case, it is possible to get the chemical analyses that are regularly conducted by the managing companies and identify the class.

Deterioration induced by sulphates appears as expansion or misalignment in the structures, which cause cracking and expulsion of portions of the element; under extreme conditions, the binding matrix disintegrates and looks like non-cohesive soil.

» OTHER TYPES OF DETERIORATION - ALKALI-AGGREGATE REACTION (AAR)

This type of concrete deterioration is caused by some *reactive aggregates* containing a special type of silica that reacts with the alkalis (Na^+ and K^+ ions) contained in cement, in the presence of moisture. The said reaction produces low crystallised sodium or potassium silicates that, by absorbing water, have an expansive effect which can damage concrete with microcracks or pop-out of small cones on the concrete surface.

CONCRETE:
DURABILITY AND SERVICE LIFE

» DURABILITY OF REINFORCED CONCRETE STRUCTURES

Pursuant to the New Technical Standards for Construction (NTC) – Ministerial Decree of 14 January 2018 – the client and designer must declare the service life of a structure in the project, according to the categories given in the following table.

SERVICE LIFE OF STRUCTURES BY CONSTRUCTION TYPE

	CONSTRUCTION TYPE	Minimum values of V_N (years)
1	TEMPORARY AND PROVISIONAL STRUCTURES	10
2	ORDINARY PERFORMANCE STRUCTURES	50
3	HIGH PERFORMANCE STRUCTURES	100

The classes of use of structures pursuant the New Technical Standards for Construction (NTC) - Ministerial Decree of 14 January 2018, are given below:

CLASSES OF USE

» CLASS I

Structures with occasional presence of people, agricultural buildings.

» CLASS II

Structures in which crowding is foreseen in normal use, with no hazards for the environment and no essential public and social functions. Factories performing activities which are not hazardous to the environment. Bridges, infrastructure, road networks not belonging to Class 3 or Class 4, rail networks the interruption of which does not generate emergency situations. Dams, the collapse of which does not have major effects.

» CLASS III

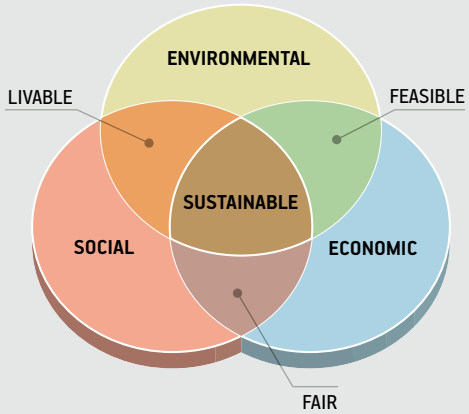
Structures in which significant crowding is foreseen in normal use. Factories performing activities which are hazardous to the environment. Suburban road networks not belonging to Class 4. Bridges and rail networks the interruption of which does generate emergency situations. Dams, the collapse of which has major effects.

» CLASS IV

Structures with important public or strategic functions, also with respect to the management of Civil Defence in case of natural disasters. Factories performing activities which are very hazardous to the environment. Road networks of type A or B, as per Ministerial Decree no. 6792 of 5 November 2001, "Functional and geometric rules for road construction", and of type C when belonging to routes connecting capital cities which are not linked by roads of type A or B. Bridges and rail networks which are critical to maintaining means of communication, in particular in the aftermath of an earthquake. Dams used for the operation of aqueducts and power plants.

» SUSTAINABLE DEVELOPMENT AND DURABILITY

Sustainability does not only refer to the protection of heritage and natural resources, but also to the economic, social and environmental components that are interconnected and responsible for development. Today, externalities associated with maintenance and indirect costs for disruptions are increasing in the economic and social context of our communities. Therefore designing must be based on conscious choices, an accurate selection of materials and execution methods aimed at refurbishing existing buildings.



Restoring the operation and service life of the structures is paramount also in terms of sustainable development.

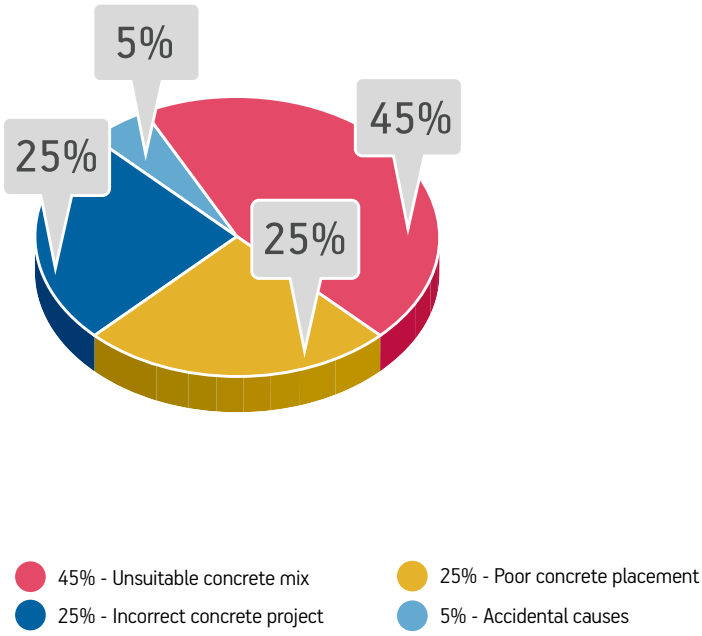
DEGRADATION
OF CONCRETE STRUCTURES

» *MAIN CAUSES OF DEGRADATION*

MAIN CAUSES OF DEGRADATION OF REINFORCED CONCRETE STRUCTURES FOLLOWING EXPOSURE AND ENVIRONMENTAL ATTACK

	CHEMICAL CAUSES	PHYSICAL CAUSES
REBARS	Corrosion induced by carbonation (CO_2) Corrosion induced by chlorides	Stray currents
CEMENT PASTE AND AGGREGATES	Washout Acid attack Attack by sulphates - alkali-aggregate reaction	Freeze-thaw cycles Shrinkage and cracking High temperatures/fire
	Mosses/Lichens Algae Fungi Contact with water	Abrasion Erosion Impact Vibrations Overload

» *MAIN CAUSES OF CONCRETE DETERIORATION*

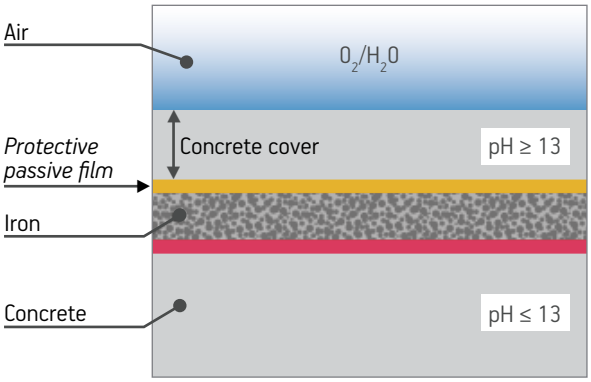


DETERIORATION OF REBARS

» CHEMICAL CAUSES: CORROSION

Rebars are mostly affected by electrochemical corrosion, which is caused by the **alteration of the basic protective film around them**. **Carbonation** and **chloride attack** are the main causes of such alteration. Corrosion affects not only the functional aspects or appearance of the structures, but also **structural** and **safety**-related elements. The main structural effects of corrosion are illustrated in the scheme at the bottom of the page.

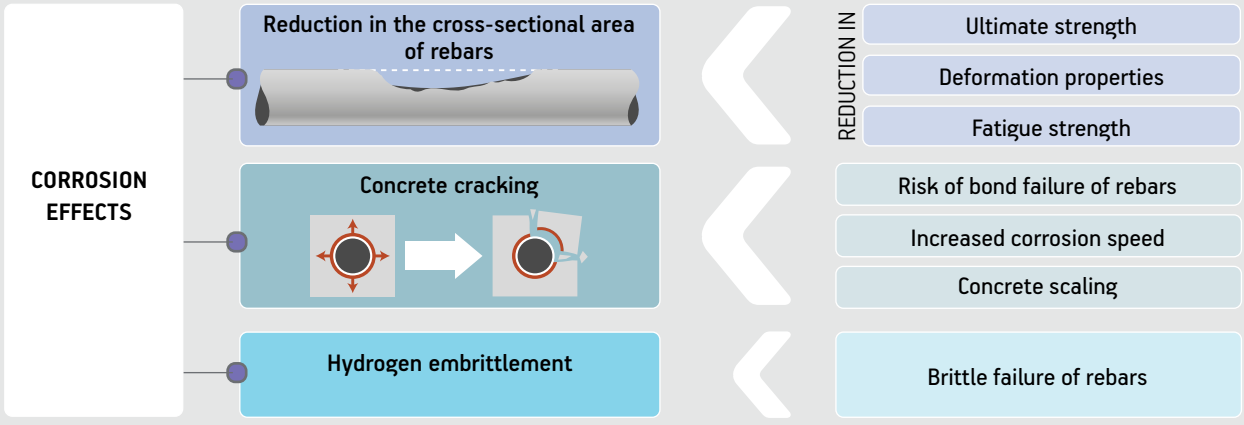
Rebar corrosion and detachment of concrete cover



PASSIVE FILM FORMATION *- Hardened cement paste has a pH between about 12.5 (solution saturated with lime) and 13.5 (cement containing alkaline substances); under normal conditions a thin protective oxide layer (the passive film) is formed.*

In case of localised attack, the **reduction of the resistant cross-section** in rebars can affect the **capacity of bearing static and dynamic loads.** The expansive action induced by corrosion to the rebar-concrete interface can cause **cracks in the concrete cover**, quick falling off or complete delamination of the same, poor rebar adhesion, which can have serious structural effects. In exceptional cases and only with high yield strength steel, sudden structural failures caused by stress corrosion may occur.

» STRUCTURAL EFFECTS OF REBAR CORROSION



» CHEMICAL CAUSES: CORROSION INDUCED BY CHLORIDES

The presence of chloride ions in concrete may be the result of concrete mix preparation – ions contained in the mix water, aggregates etc. – or may come from the environment – seawater, marine environment, de-icing salts, marine works, roads, motorways etc. Chlorides penetrate the protective oxide film and generate a corrosive cathodic current that lowers pH by hydrolysis, down to values below 5.

» CHEMICAL REACTION CAUSED BY CHLORIDE ATTACK

The protective oxide film on the surface of rebars guarantees zero corrosion speed, from an engineering point of view. Nonetheless its stability can be affected by critical amounts of chloride that reach the rebars and trigger corrosion.

The weakening of the rebar passivation film produces a chemical reaction that, however, needs to be fuelled by **oxygen** and **water**.

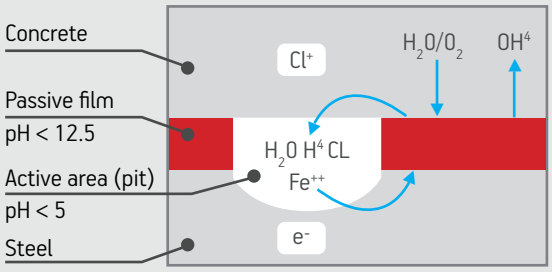
$$4\,Fe + 3\,O_2 + 2H_2O \rightarrow 4\,Fe(OOH)$$

Rebars are attacked due to the loss of the passivation film caused by chloride ion

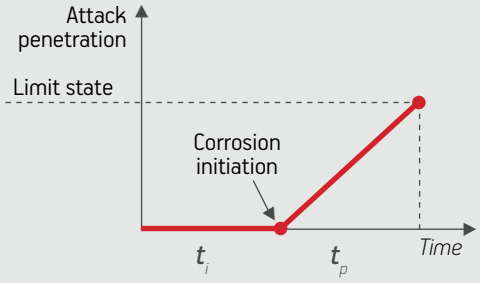
Humid air

Iron hydroxide

» REBAR CORROSION INDUCED BY CHLORIDES



WEAKENING OF PASSIVE FILM - Chlorides penetrate and destroy the passive film causing localised corrosion.



SERVICE LIFE - Initiation + Propagation
Prevention and maintenance interventions are key to prevent chloride-induced corrosion over time.

DETERIORATION
OF REBARS

» CHEMICAL CAUSES: CORROSION

» ELEMENTS TRIGGERING CORROSION:

» OXYGEN AND WATER

Rebars are attacked by chlorides in the presence of humid air, which carries water and oxygen that are responsible for oxidation.

Where can be found:
- **areas bathed by seawater;**
- **air, especially in the presence of humidity.**

Concrete deterioration in structures in contact with seawater and exposed to chloride attack.

» CHLORIDES

Chlorides weaken the rebar protective film and lead to the formation of pits, which is where corrosion initiates.

Where can be found:
- **areas bathed by seawater;**
- **de-icing salts;**
- **chlorides contained by mistake in concrete ingredients.**

» STRUCTURES AT RISK

STRUCTURES TREATED WITH DE-ICING SALTS
Concrete bridges, viaducts, pavements, service areas, roads.

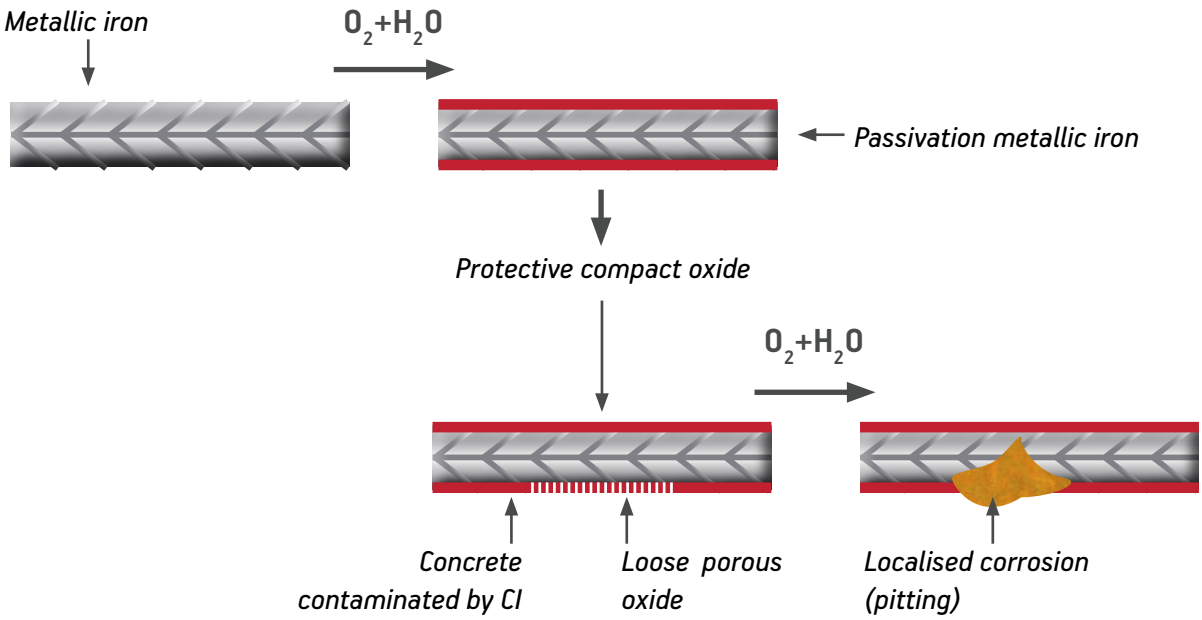
AREAS INDIRECTLY EXPOSED TO DE-ICING SALTS
Concrete bridges, viaducts, pavements, service areas, roads.

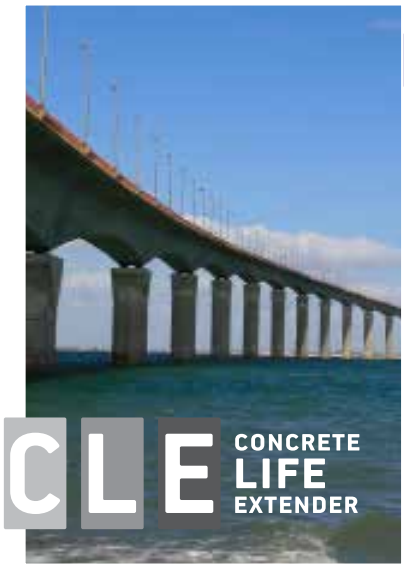
STRUCTURES IN CONTACT WITH CHLORIDE-CONTAINING SOLUTIONS
Tanks for industrial processing with brines, fish farming tanks, cooling towers using seawater.

MARINE STRUCTURES
Buildings and infrastructure up to 2-3 km away from the shore, quays, piers, careening basins, offshore structures.

» CHEMICAL CAUSES: CORROSION INDUCED BY CHLORIDES

Chlorides induce the de-passivation of steel reinforcement and leads to a corrosion initiation.





SUPERGARD CLE

LIQUID INHIBITOR OF ALKALI-AGGREGATE REACTION, WITH PASSIVATION, ANTI-CARBONATION AND WATER-REPELLENT EFFECT

SUPERGARD CLE ***is an innovative ready-to-use liquid inhibitor with a combined effect.***
One product with a threefold action: **inhibition of alkali-aggregate reaction** (ASTM C1260-14), **inhibition of rebar corrosion** (ASTM C876), **water-repellent effect** (ASTM C642-13).

SUPERGARD CLE is a low viscosity liquid inhibitor that can be used for reinforced concrete impregnation in existing structures, as well as admixture in mass concrete to be added to new mixes.

SUPERGARD CLE penetrates concrete and forms an integrated molecular layer that improves waterproofing and resistance to chemical attack and consolidates the surface. It is a preventive measure to eliminate the risk of ASR (Alkali-Silica Reaction) that affects durability of concrete. Testing conducted by the Department of Materials, Environmental Sciences and Urban Planning of the Marche Polytechnic University.

DETERIORATION
OF REBARS

» CHEMICAL CAUSES: CORROSION INDUCED BY CARBONATION

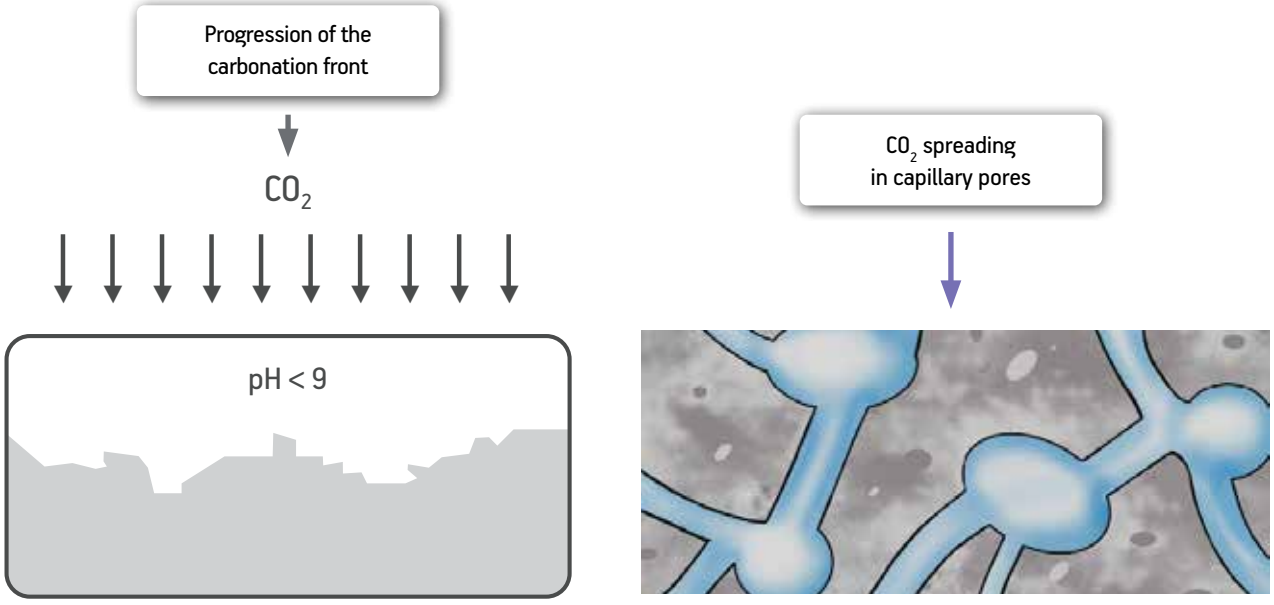
CO_2 in the air (which increases with pollution) reacts with the soluble alkaline components of concrete and neutralises them with the following reaction:

$$Ca(OH)_2 + CO_2 = CaCO_3$$

This lowers the pH of the aqueous solution contained in the pores of the cement matrix down to values far below the minimum threshold of 11.5, which guarantees passivation of rebars.

» CHEMICAL REACTION OF CORROSION INDUCED BY CARBONATION

Penetration of CO_2 » $Ca(OH)_2 + CO_2 = CaCO_3$ » Loss of passive film » Corrosion initiation



» ENVIRONMENTAL FACTORS AFFECTING CORROSION INDUCED BY CARBONATION

RELATIVE HUMIDITY

Carbon dioxide penetrates easily in the pores filled with water, but hardily in the ones with aqueous solution and does not penetrate at all in case of permanent submersion. Indeed carbonation can only happen in the presence of water (RH > 40%) and carbon dioxide (air). For these two reasons, the most dangerous relative humidity range for carbonation is, in contrast, 50 to 80%.

CONCRETE ALKALINITY

Concrete alkalinity is proportional to the amount of cement used and is also influenced by the cement type (Portland > pozzolanic > blast-furnace).

CONCRETE POROSITY

In low porosity concrete the carbonation front progresses more slowly. Thus lower w/c ratio and proper curing improve durability.

» CONCRETE-RELATED FACTORS

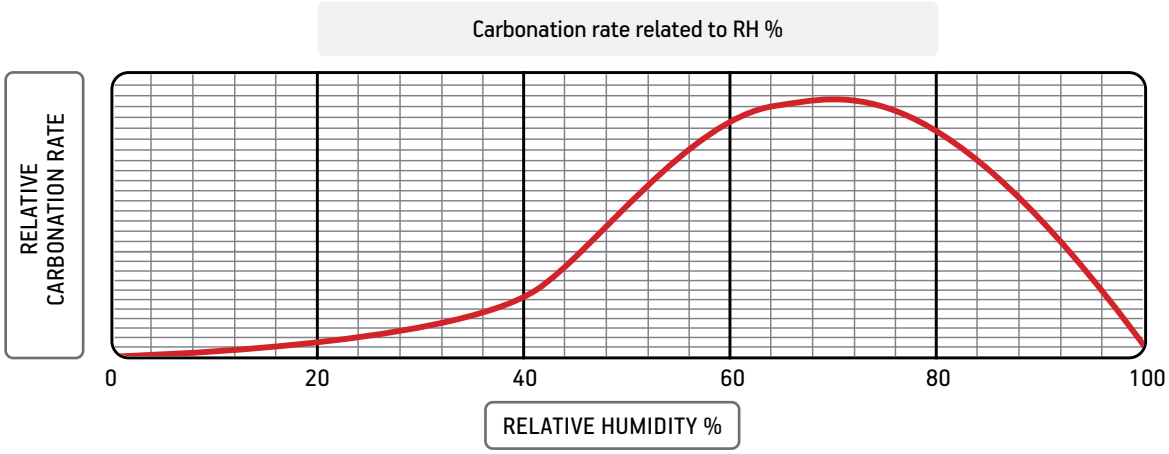
CARBON DIOXIDE CONCENTRATION

As carbon dioxide concentration increases in the air, the carbonation front progresses faster.

TEMPERATURE

Given the same conditions and same humidity, which is usually the most important parameter, when temperature goes up, the penetration speed goes up as well.

» REBAR CORROSION: BETTER SAFE THAN SORRY



CEMENT MATRIX **DETERIORATION**

» *CHEMICAL CAUSES: SULPHATE ATTACK*

Sulphate attack occurs when the sulphate ion SO_4^{2-} reacts with aluminates, free lime and hydrosilicates contained in the cement matrix. The consequence is the formation of expansive products like ettringite and thaumasite (in cold weather), that can cause swelling, delamination and disintegration of concrete.

Swelling and concrete outer layer detachment caused by ettringite formation.

Where does sulphate ion come from?

- **Soil, especially if manured**
- **Impurities of aggregates, like gypsum or anhydrite**
- **Environment**

» *DETERIORATION INDUCED BY SULPHATE ATTACK*

Sulphate attack causes **excessive swelling due to the formation of expansive products**; swelling mostly occurs on concrete surface which is exposed to the environment and is more easily attacked by sulphates.

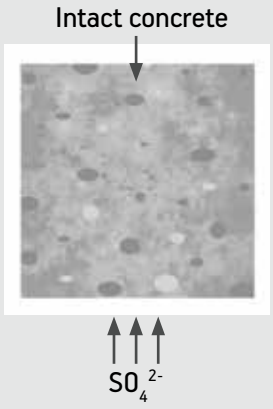
The presence of sulphates leads to three destructive reactions in concrete. The reaction products are:

» **GYPSUM DIHYDRATE** ($CaSO_4 \cdot 2H_2O$) due to the transformation of calcium hydroxide in concrete;

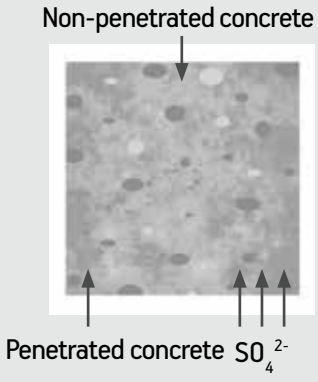
» **ETTRINGITE** ($3CaO \cdot Al_2O_3 \cdot 3CaSO_4 \cdot 32H_2O$) due to the transformation of hydrated aluminates in concrete;

» **THAUMASITE** ($CaCO_3 \cdot CaSO_4 \cdot CaSiO_3 \cdot 15H_2O$) due to the reaction of gypsum with lime, carbon dioxide and calcium silicate – mostly present in cold humid weather, with high carbon dioxide concentration.

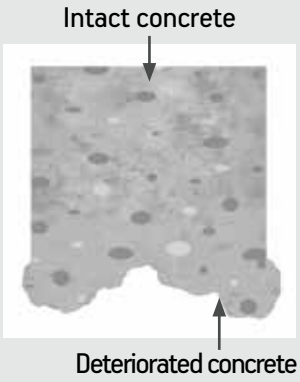
A **Contact between concrete and sulphate environment**



B **Sulphate penetration in concrete**



C **Formation of gypsum, ettringite and thaumasite in the area of penetration**



» CHEMICAL CAUSES: WASHOUT (ACID ATTACK)

It is a chemical-physical attack that can remove water soluble compounds from the cement paste. The presence of any acids increases the washout effect. Pure water with aggressive CO_2 - like water from ice melt - can form carbonic acid, in which free lime has a carbonation reaction that leads to the formation of calcium bicarbonate. Calcium chloride used as deicer can contribute to washout as it forms very soluble calcium oxychloride. Moreover, all aggressive inorganic acids like HCl, HNO_3 and H_2SO_4 have a destructive action on the cement matrix because they react with the hydrosilicates.

Environments at risk:

- **pure meltwater;**
- **water containing aggressive organic acids;**
- **magnesium rich water.**

Washout effect on concrete surface.

» ALKALI-AGGREGATE REACTION (AAR)

AAR is a material degradation phenomenon that occurs in concrete. It is a chemical reaction occurring between reactive silica components present in the aggregates that react with the alkalis (Na+ and K+ ions) present in cement. The reaction products are low crystallized sodium or potassium silicates that absorb water causing expansion and microcracking or the formation of pop-outs, small conical fragments which detach from the surface, that damage concrete.

Deterioration caused by alkali-aggregate reaction.

Pop-out on a concrete surface.

CONCRETE **DETERIORATION**

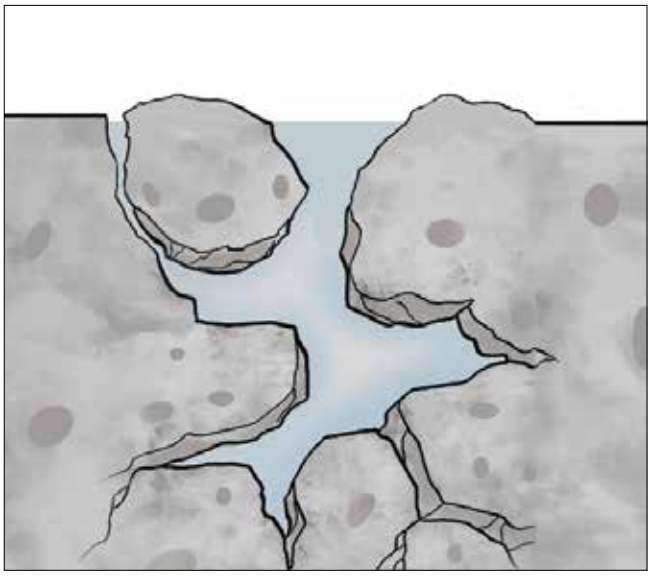
» *PHYSICAL CAUSES: DEGRADATION INDUCED BY FREEZE-THAW CYCLES*

Ice can damage concrete only if there is liquid water in concrete. Although concrete can be not perfectly dry, moisture must not exceed a given threshold value of "critical saturation". Water in concrete pores must not exceed critical saturation, so that when it freezes and increases in volume, it remains inside the pores and does not cause stresses.

When water freezes into a solid state, its molecules form a crystalline structure and this change is accompanied by an expansion of 9% in volume.

The resulting damage is proportional to:

- **Porosity level**
- **Moisture saturation level**
- **Number of cycles**
- **Entrapped air**



Spalling due to water volume increase caused by freeze-thaw cycles.

» *HIGH TEMPERATURE*

In structures exposed to high temperature, the concrete cover is extremely important as it slows down temperature propagation. The thicker the concrete cover, the longer the time needed by rebars to reach the temperature of failure. The concrete cover is key in case of fire.

- **Limit temperature of concrete: 650°C**
- **Temperature of failure of rebars: 500°C**

» CHEMICAL CAUSES: SHRINKAGE AND CRACKING

Shrinkage is a change in volume that occurs in concrete during setting and hardening, caused by gradual removal of water inside the cement paste. The faster water is eliminated from concrete mass, the more serious the phenomenon will be.

Shrinkage leads to cracking and to a decrease of structural durability of concrete.

Plastic shrinkage

0 ÷ 12 hours

- Reduction in volume between water + cement and cement gel
- Expansion caused by hydration heat
- Water loss by evaporation and absorption
- Segregation and bleeding

Hydraulic shrinkage

0 ÷ 12 hours

- Caused by slow progression of hydration reaction
- Higher in structures with large section and built with slow setting concrete (dams)

FACTORS AFFECTING HYDRAULIC SHRINKAGE

COMPOSITION-RELATED →	▸ VOLUME OF CEMENT PASTE ▸ STIFFNESS OF AGGREGATES
STRUCTURAL →	▸ GEOMETRY OF STRUCTURE (ratio between surface exposed to evaporation and concrete volume) ▸ PERCENTAGE OF REINFORCEMENT IN THE SECTION
EXTERNAL →	▸ AMBIENT RELATIVE HUMIDITY
TIME-RELATED →	▸ TIME PASSED FROM EXPOSURE TO UNSATURATED VAPOUR ENVIRONMENT

Hygrometric shrinkage

12 hours ÷ 28 years (80% within 6 months, 85% within 12 months)

- Water loss by evaporation
- Proportional to temperature
- Inversely proportional to relative humidity rate

Autogenous shrinkage (between initial and final setting time)

- Induced by self-drying of pores caused by hydration reaction of cement paste
- Higher in concrete with low w/c ratio

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