Fosroc Solutions for
Concrete Repairs in Accordance with BS EN 1504

www.fosroc.com

FOSROC

constructive solutions

ABOUT
FOSROC INTERNATIONAL

Since the company's beginnings over 80 years ago, Fosroc has developed into an International leader in delivering Constructive Solutions for projects across a broad range of market segments including transport, utilities, industrial and general buildings.

Fosroc's commitment to customer service and technical support is second to none. We work closely with architects, structural engineers, contractors and owners to fully understand their requirements in order to develop bespoke solutions and add value to construction projects.

Fosroc has an extensive network of offices and manufacturing locations across Europe, the Middle East, India, North and South Asia, and is further represented in other regions across the world by distributor and licensee partners.

Selecting from the full portfolio of Fosroc products and services and integrating expert technical support, world class customer service and innovation, Fosroc goes beyond just product selling to ensure that we partner with our customers to deliver complete constructive solutions.

- Admixtures
- Protective Coatings
- Concrete Repairs
- Industrial Flooring
- Grouts & Anchors
- Joint Sealants
- Surface Treatments
- Waterproofing

FOSROC DELIVER SOLUTIONS NOT JUST PRODUCTS

CAD Details

A library of standard CAD details are available, bespoke CAD details can be created for your specific project

Project Specifications

Dedicated specification managers on hand to assist with correct system choices and tailored solutions

Site Support

Expert product and application support made available from our specialist teams

Seminar & Training

Comprehensive programme of seminars and training courses designed to expand and reinforce your knowledge

BUILDUK Leading the Construction Industry

CIHT Corporate Partner

CRA

CONCRETE SOCIETY

STRUCTURAL CONCRETE ALLIANCE

FeRFA

SCA

FOSROC HOLISTIC CONCRETE REPAIR SOLUTIONS

Fosroc are involved in concrete from the early stage process of cement grinding, through to concrete production, placement and finishing. Therefore we understand concrete in its deterioration phase and all the factors contributing to that deterioration. We have the solutions to repair and protect that concrete.

Our mission in concrete repair is to provide the most durable systems that will provide best life-cycle costs for the project. We aim to do this by providing a comprehensive range of repair, strengthening and protection systems that give us the right tools to manage the varying problems that occur.

The deterioration of concrete is a complex matter, influenced by numerous physical, chemical and environmental factors. This makes each concrete repair a little bit different from the last. It can be hard to gain an in depth understanding of concrete repair, as this is more often acquired through experience and little on this subject is taught in colleges and universities. As a result Fosroc have developed a CPD aimed at explaining the complexities of concrete repair and the solutions available.

Fosroc were among the pioneers of genuine concrete repair materials and we have been repairing concrete structures for over 50 years. Our involvement in thousands of concrete repair projects every year around the world builds daily on our years of experience. This experience filters into everything we do, from assistance with repair specifications, contractor training, know-how in application and our internal development of materials and systems.

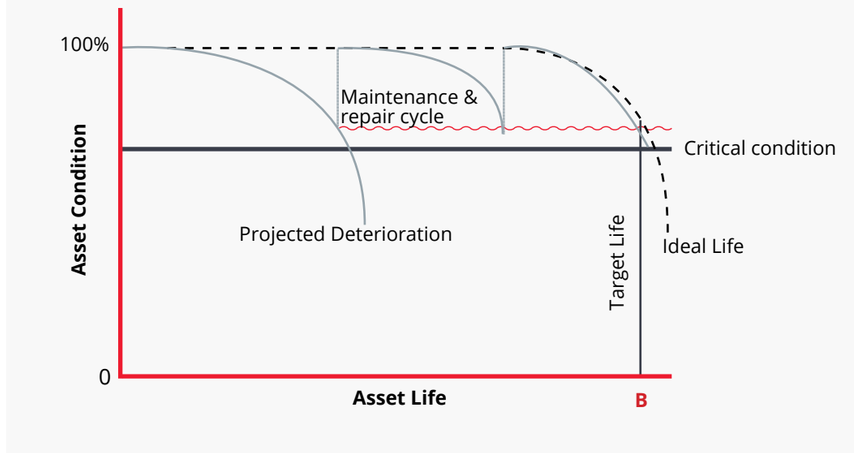
PROTECTING THE FUTURE

Billions are wasted every year demolishing and re-building structures that deteriorate or are deemed no longer fit for purpose. The energy and resources that are spent in waste management and re-construction have an immense impact on our planet.

Fosroc firmly believes that concrete should be built to last and that the application of our high-quality protective systems and repair materials can prolong the life of a structure well beyond its original design life. Lightweight modern strengthening systems mean that structures can be enhanced and changed to have an entirely new function. Protective systems can dramatically inhibit the impact of aggressive elements on the concrete. Our wide array of repair systems can make damaged concrete as good as new. Not only does this have a positive environmental impact, but structure owners see the benefits of improved management costs over the life of the structure.

Many Fosroc mortars are manufactured with the inclusion of recycled materials which have been designed to reduce the amount of cement included in the mortar. Far from reducing quality, the overall performance of the materials are enhanced with properties such as rapid strength gain and reduced alkalinity.

It is never too early to start enhancing. Every penny spent on improved concrete quality, protection and enhancement pays off in long term durability. Reducing the impact construction has on our environment makes a better future for all our sakes' choosing Fosroc materials enhances durability and makes that aim a reality.



INDUSTRY STANDARDS: BS EN 1504

In 2009 the harmonised standard of BS EN 1504 for the repair and protection of concrete structures came into force in all member states of the European Union. Outside of Europe the standard and CE marking that comes with it is not normally legally binding, however the standard is growing in significance globally and the principles of it are commonly regarded as good practice. One of the main reasons for this is that the standard moves beyond simple product testing and encompasses a holistic attitude towards the process of repair, monitoring and maintenance of concrete structures from start to finish.

It is important to note that following the standard requires more than simply requesting CE marked products; many products are CE marked, but this does not necessarily make them appropriate for the particular task in hand. A number of remedial solutions offered in the standard do not have CE marking available to them. Where they have been tested in accordance with BS EN 1504 requirements, Fosroc products go above and beyond the minimum requirements of the standard. Fosroc's CPD 'Making Good – Concrete Repairs in Accordance with BS EN 1504' explains the principles of the standard and their application.

Of course there are many other standards both national and industry specific. Local Fosroc companies look to comply with those standards where appropriate and meet the requirements of our customer base.

A number of our repair and protection systems have been tested to ensure they are safe for contact with drinking water by bodies such as the DWI and WRAS. Some of our products are included in London Underground's 'Deemed to Comply' register for fire safety. Esteemed bodies such a Taywood Engineering and Bureau Veritas test and certify Fosroc's manufacturing processes and products.

CE
0370

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Fosroc® Renderoc HB45

BS EN 1504-3 :
Structural and non structural repair methods 3 and 4

Compressive strength	Class R4 (>45 MPa)
Chloride ion content	<0.05%
Adhesion strength by pull-off test	≥ 2.0MPa
Thermal compatibility: freeze thaw cycling with immersion	≥ 2.0MPa
Carbonation resistance	Pass
Capillary absorption	0.5 kg / $m^{-2}.h^{-0.5}$
Elastic modulus	≥ 20 GPa
Reaction to fire	A2 s1 d0
Dangerous substances	Complies wtih 5.4

WRAS APPROVED MATERIAL

CE

bsi. ISO 9001 Quality Management ISO 14001 Environmental Management
FM 610 EMS61113

Within BS EN 1504 is a 6-step process that requires specifier, manufacturer and applicator to work together to produce the most appropriate solution. BS EN 1504-9 clearly lays out the process that each project team should adopt to ensure an effective repair and protective solution is adopted.

PROJECT PHASES

INFORMATION ABOUT THE STRUCTURE	PROCESS OF ASSESSMENT	MANAGEMENT STRATEGY	DESIGN OF REPAIR WORK	REPAIR WORK	ACCEPTANCE OF REPAIR WORK

BASIC CONSIDERATIONS & ACTIONS

> Condition & history of structure > Documentation > Previous repair & maintenance	> Defects, their classification & causes > Safety/structural appraisal after protection & repair	> Options > Principles > Methods > Safety/structural appraisal after protection & repair	> Intended use of product > Requirement substrate products work > Specification > Drawings > Safety/structural appraisal after protection & repair > Time scales for work	> Choice & use of products, systems, methods & equipment to be used > Tests of quality control > Health & safety > Fast return to service products	> Acceptance testing > Remedial works > Documentation

RELEVANT CLAUSES IN THE EUROPEAN STANDARD & OTHER PARTS OF THE EN 1504 SERIES

> Clause 4 of BS EN 1504-9	> Clause 4 of BS EN 1504-9	> Clauses 5 & 6 of BS EN 1504-9	> BS EN 1504-2 to BS EN 1504-7 > Clauses 6, 7 & 9 of BS EN 1504-9	> Clauses 6, 7, 9 & 10 of BS EN 1504-9 > BS EN 1504-10	> Clause 8 of BS EN 1504-9 > BS EN 1504-10

AVOID REPAIR FAILURE

For a number of reasons, concrete repairs do on occasion fail prematurely. The subsequent remedial work can be costly with the re-application of failed repairs adding further expense, in addition to being time consuming and disruptive.

Some of the most common causes of premature repair failure are:

- Incorrect root cause diagnosis
- Incorrect selection of repair strategy
- Selection of inappropriate repair materials
- Inadequate protection from further deterioration
- Poor surface preparation
- Incorrect product application
- Incorrect for design life of building

By using this guide and working with Fosroc we hope you will be able to avoid these problems and achieve effective and durable repair and protection for your project.

STRUCTURE INFORMATION

Before a full condition survey is undertaken it is important to understand the structure, its history, use, intended working life and any future plans that the client may have for it. Identify any obvious defects from reports or visual surveys. Identify unseen issues from concrete tests such as chloride and carbonation reports.

If the structure is in a poor condition it is important that efforts are made immediately to ensure that it is safe for the users and nearby people.

PROCESS OF ASSESSMENT

After specific areas of concern are identified it is important that full diagnostic testing of the concrete is undertaken. This is critical in terms of fully understanding the root causes of any defects. Unless this is undertaken, repairs have a high possibility of failure as they are likely to be treating symptoms instead of causes.

Qualified assessors are able to undertake a full condition assessment incorporating some or all of the following testing:

- Location of defects
- Covermeter survey
- Carbonation depth testing
- Half-cell potential
- Hammer testing
- Petrographic analysis
- Chloride penetration depth testing

The amount of testing will be proportionate to the level of importance, age and condition of the structure. As with all diagnostic work, more information will yield a better understanding of existing issues affecting the concrete and the likely future condition of the structure. An experienced professional will be able to diagnose the root causes of the problems and begin to determine the most appropriate remedial strategy once the survey results are completed.

COMMON PROBLEMS IN REINFORCED CONCRETE

As defined in BS EN 1504-9 there are 8 generic defect types, which are sub-divided into defects concerning the concrete and defects concerning the reinforcement. It is very common that these defects combine to create a larger scale problem, or that one issue leads to another causing the rate of deterioration to increase if not addressed.

CONCRETE DAMAGE

Mechanical

Overloading or movement of the structure causes cracking.

Physical impact cases or loss of concrete section.

Vibration or earthquakes.

Chemical

Contaminants from the soil such as sulphates can weaken and crack the cement matrix.

Aggressive chemicals from a variety of sources may contaminate the concrete and weaken the cement matrix.

Alkali Aggregate Reaction.

Physical

Breakage by impact.

Water in the capillaries of the concrete may freeze and expand causing sections of the concrete to spall.

Abrasion and wear from traffic or other moving elements.

Thermal movement.

Fire

Extremes of heat may cause loss of section, concrete embrittlement and weakening of the steel.

REINFORCEMENT CORROSION

Concrete Reinforcement Cover

Low cover caused by poor placement or slipping of formwork.

Damage to the covercrete.

Porous concrete due to poor quality concrete or bad workmanship.

Loss of Concrete Alkalinity

The ingress of carbon dioxide as a naturally occurring acidic gas, combined with moisture present in the concrete, serves to reduce the concrete pH. The loss of concrete alkalinity provides the steel reinforcement with an environment in which it may corrode.

Contamination of Concrete

Chlorides can be cast into concrete during construction. Chlorides may penetrate the structure in a salt rich environment.

In high concentrations the chlorides break down the passivating layer and initiate the corrosion cycle. Chloride induced corrosion can result in pitting of the steel, resulting in a drastic loss of steel cross-section.

Stray Current

Stray electrical currents from wiring of poorly installed cathodic protection systems may induce corrosion.

Metals with different electrochemical potential will induce the onset of corrosion if they are connected.

REINFORCEMENT CORROSION

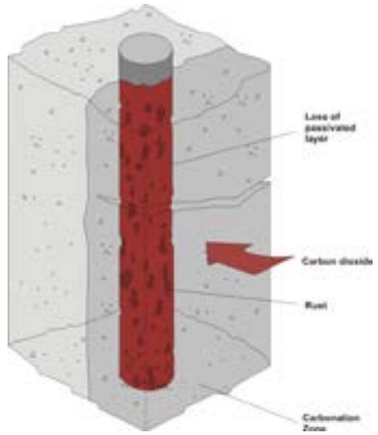
The corrosion of reinforcement is a common problem around the world. The most common causes of corrosion are carbonation and chloride ingress. Contaminants penetrate the concrete and gradually change the chemical composition of it until they reach the depth of the reinforcement. The length of time this takes is very dependent upon the quality of the concrete, the depth of reinforcement and the exposure levels.

Once the carbonation or chlorides reach the reinforcement they attack the passivating layer surrounding the steel. When this passivating layer is lost, the corrosion process can begin. The presence of moisture and oxygen are essential for the corrosion process to start, and will determine the corrosion rate.

Corrosion creates an electrical cell with anodic and cathodic sites. Corrosion occurs on the anodic sites and expands the steel molecules by up to 10 times their original size. This places stress on the concrete causing cracking.

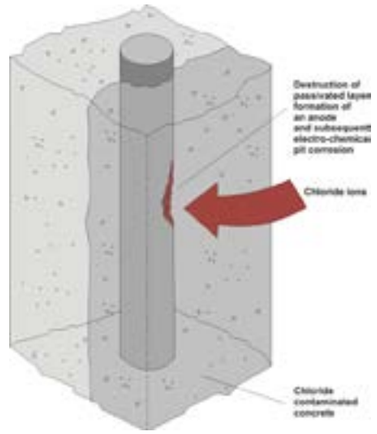
Cracking allows moisture and oxygen a direct passage to the steel which further accelerates the corrosion. After a period of time the concrete spalls away in sections, sometimes with devastating consequences. As the steel is more exposed, the rate of corrosion accelerates and eventually leads to partial or total collapse of the structure.

CORROSION PROCESS



Carbon dioxide is a naturally occurring gas and enters concrete of all quality levels through its pore structure, especially in mid-range humidity. The slightly acidic nature of the carbon dioxide, in combination with moisture, reduces the protective alkalinity of the concrete and slowly permeates to the level of the steel. Once at the steel, it changes the naturally protective environment into one that is conducive to eroding the passivating film on the steel. In this environment the presence of moisture and oxygen begin the corrosion process.

A covermeter survey combined with phenolphthalein testing is a good way to check for the progress of carbonation.



Chlorides can enter concrete for a variety of different reasons, the most common being the marine environment or the use of de-icing salts. Chlorides may also be bound into the concrete during its initial casting, by use of accelerators or unwashed sands and aggregates.

The aggressive nature of chlorides means that in high concentrations they can create an acid erosion of the steel that creates pits, rather than expansion, resulting in a significant loss of steel cross-section.

This is hard to detect unless proper testing is undertaken, using concrete sample analysis and a covermeter survey initially, moving on to more in depth testing as required thereafter.

THE BASIC CORROSION STEEL IN CONCRETE RELIES UPON THE FOLLOWING:

MANAGEMENT STRATEGY

Once the underlying causes of deterioration have been diagnosed, these are combined with the structural information, health and safety issues and the client's intended use of the structure both during the repair and in the future. A strategy can then be devised to assess what can be done to the structure. The options range from 'do nothing', all the way through to partial or complete demolition. If the decision to repair, or repair and improve is made, the management strategy should look at the options for repair and protection.

BS EN 1504-9 Provides 11 Principles for Repair and further protection of concrete. Single solutions occur in numerous management strategies, however some of the principles have overlapping strategies. It is frequently the case that a number of these repair principles are selected to create a complete system solution.

Sections 1 to 6 deal broadly with the repair and improvement of concrete and Sections 8 to 11 focus upon protection of reinforcement from corrosion. Sections 7-11 are to be considered carefully if instances of Chloride ingress or Carbonation are affecting the concrete. Failure to manage them will mean that further deterioration of the reinforcement and concrete is inevitable.

PRINCIPLES AND METHODS CONCERNING CONCRETE DEFECTS

The principles for controlling reinforcement corrosion rely upon reducing or eliminating the effects of the contributing input and output of the corrosion process.

1

Protection against Ingress

The basic principle is to keep the concrete dry by reducing its permeability by closing up pores and cracks.

2

Moisture Control

The principle of controlling moisture to acceptable levels using coatings and membranes.

3

Concrete Restoration

Repairing or replacing concrete using a variety of mortars.

4

Structural Strengthening

Replacing lost strength or increasing strength by adding steel, additional reinforced concrete or Fibre Reinforced materials.

5

Increasing Physical Resistance

Replacing lost concrete or providing additional cover and protection.

6

Increasing Resistance to Chemicals

Application of surface protection to improve resistance to chemical attack

7

Preserving / Restoring Passivity

Using mortars or concrete to replace contaminated concrete. Also techniques for re-alkalisation and chloride extraction.

8

Increasing Resistivity

Using coatings and protective systems to reduce the level of moisture in the concrete thereby increasing the electrical resistivity of the concrete and reducing the potential for corrosion.

9

Cathodic Control

Restricting the access of Oxygen to the cathodic site by coating the steel.

10

Cathodic Protection

Cathodic protection manages the output of current through the steel to channel currents to specific anodic sites. This may be done using external currents or sacrificial anodes.

11

Control of Anodic Areas

Corrosion of the reinforcement is controlled by a complete film formation, using coatings or corrosion inhibitors.

FOSROC PRODUCTS

Fosroc's outstanding range of products meets all of the major repair management options and nearly all of the more specialist applications. This means that once you have selected the strategy, Fosroc is an ideal partner to look at the more specific issues of the repair design. The product selector below highlights the range of options available and the product type. The direct application should be validated with your local Fosroc technical team to ensure the product is correct for the application conditions and specific material that is available in your country.

(Products mentioned in this table may or may not be CE marked depending upon a variety of factors, including country of origin, availability of test criteria and other factors. Always consult your local Fosroc office before selecting products and refer to the technical data sheet.)

Principals	Protection Against Ingress								Moisture Control					Concrete Restoration				Structural Strengthening							Physical Resistance			Chemical Resistance			Preserving or Restoring Passivity				Increasing Resistivity			Cathodic Control	Cathodic Protection	Control of Anodic Areas		
Repair Method Description	Hydrophobic Impregnation	Impregnation	Coating	Surface Bandaging of Cracks	Filling of Cracks	Transferring Cracks into Joints	Erecting External Panels	Applying Membranes	Hydrophobic Impregnation	Impregnation	Coating	Erecting External Panels	Electrochemical Treatment	Hand Applied Mortar	Recasting with Concrete or Mortar	Spraying with Concrete or Mortar	Replacing Elements	Adding or Replacing Reinforcement	Anchoring Reinforcement	Bonding Plate Reinforcement	Adding Mortar or Concrete	Injecting Cracks and Voids	Filling Cracks	Prestressing & Post Tensioning	Coating	Impregnation	Adding Mortar or Concrete	Coatings	Impregnation	Adding Mortar or Concrete	Increasing Concrete Cover	Replacing Contaminated Concrete	Electrochemical Realkalisation	Realkalisation by Diffusion	Chloride Extraction	Hydrophobic Impregnation	Impregnation	Coating	Limiting Oxygen at Steel	Cathodic Protection	Active Reinforcement Coating	Barrier Reinforcement Coating	Corrosion Inhibitors
Fosroc Products																																											
Repair Method Number	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2.1	2.2	2.3	2.4	2.5	3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4	4.5	4.6	4.7	5.1	5.2	5.3	6.1	6.2	6.3	7.1	7.2	7.3	7.4	7.5	8.1	8.2	8.3	9.1	10.1	11.1	11.2	11.3
Nitocote SN511, SN502	■								■																											■							
Dekguard A Plus, CP , Elastic, E2000, S,			■								■														■			■									■						
Nitoflor Systems			■								■														■			■									■						
Expoband H45				■																																							
Nitofill LV, TH					■																	■	■																				
Nitoseal, Thioflex & Colpor Sealants						■																																					
Nitofill UR63					■																																						
Polyurea WPE								■			■																	■									■						
Nitodek Car Park System								■			■																	■									■						
Nitodek FS Balcony Waterproofing								■			■																	■									■						
Renderoc & Patchroc mortars														■		■												■			■	■	■										
Renderoc LA,LA55, LA60															■						■							■			■	■	■										
Renderoc DS , DSR																■					■							■			■	■	■										
Nitobond EP																	■				■							■			■	■										■	
Auracast & Auramix Admixtures																	■				■							■			■	■											
Lokfix S25 / Lokfix E Range																		■	■		■																						
Nitoprime Zincrich Plus																																									■		
Protectosil® CIT	■								■																											■			■				■

APPLICATION OF REPAIR WORK: REPAIR MORTARS

Principles 3, 4 and 7 all utilise the application of repair mortars, either to replace concrete or to provide additional protection. Repair mortars come in 3 main application types, hand- applied, sprayed and cast.

BS EN 1504-3 categorises the types of repair mortar into 4 main classes. These classes are predominantly defined by their strength and adhesion characteristics. Stronger concrete requires a stronger repair mortar as typically the repair should exhibit a similar modulus to ensure compatibility. However, it is important to note that unless the load is transferred during the repair and curing process the patch repair may not be taking much structural load.

BS EN 1504 states that repair works should be undertaken by experienced and qualified contractors. Experience has proven that correct preparation, priming, application and curing is every bit as critical as obtaining high quality repair materials when it comes to getting maximum performance of the system.

Fosroc works closely with specialist applicators to develop an understanding of the challenges that they face on site. Products are adapted to suit local markets and local conditions. This means that the materials we make are site friendly, helping to create the highest quality finish on site.

Fosroc's range of Renderoc repair materials are world renowned for their consistency, high quality and usability. The products are designed with dimensional stability in mind, meaning that factors like adhesion, shrinkage and durability are considered.

Classification	Compressive Strength	Adhesion	Grade
Non-Structural	≥10 MPa	≥0.8 MPa	R1
	≥15 MPa	≥0.8 MPa	R2
Structural	≥25 MPa	≥1.5 MPa	R3
	≥45MPa	≥2.0MPa	R4

HAND APPLIED REPAIR MATERIALS

Hand-placed repair materials are excellent for small patches and detailed work. While the applicator requires skill to obtain the correct bond and finish the material, the requirement for specialist equipment is minimal.

Hand-placed repair materials come in varying grades and strengths depending upon the requirement for which they are used. Generally, a lower strength material may be applied at greater depth than a higher strength material.

Selecting the right repair material for the project enables the engineer to ensure that the material is matched to the requirements of the parent concrete. Over-specifying strengths reduces the depth of repair which can be made in a single layer, slowing down the contract and making it more expensive. Therefore Fosroc offer a range of materials to suit the contract both technically and practically.

Steel Primer – Nitoprime Zincrich Plus

Nitoprime Zincrich Plus has an active zinc content making it an excellent primer for steel reinforcement in corrosive environments. The zinc content means that even if the primer has some small pin-holes in application, there will be no corrosion hot-spot on the affected area.

R2 grade repair material - Renderoc FC / FCR

Renderoc FC is a trowel applied re-profiling mortar for filling minor surface blemishes, obtaining a smooth and pinhole free surface for subsequent coatings. A fast setting version Renderoc FCR is also available.

R2 grade repair material - Renderoc HB

Renderoc HB is a repair material with exceptional build-up qualities and high workability. It is ideally suited for non-structural applications requiring deep section repairs, ease of workability and material detailing.

R3 & R4 grade repair materials – Renderoc HB30, HB45, Renderoc Patch

Fosroc supplies a variety of hand applied grades of repair materials with strengths to match the substrate. They are suitable for buildings and civil structures, exhibiting excellent workability, durability and resistance to shrinkage.

R4 grade protective coating - Renderoc ST 05

Renderoc is a unique mortar offering multi-faceted protection for concrete. It's tough, abrasion and chemical resistant nature makes it suitable for a variety of applications from fairfaced concrete to car park deck protection. It may be applied as a thin screed, levelling mortar or even with a roller. It has been formulated to enhance equivalent concrete cover for atmospheric gas ingress resistance and can be tinted to match existing finishes or create new patterns.

R4 grade pavement repair materials - Patchroc 250, Patchroc GP, Paveroc

Patchroc and Paveroc products are designed for deck repairs where rapid reinstatement is required. The rapid strength gain of Patchroc GP and 250 means patch repairs can be trafficable within 2 hours, while larger areas can be reinstated using Paveroc and can accept pedestrian traffic in 12 hours.

SPRAYED REPAIR MATERIALS

The application of sprayed repair materials can be done by two different processes: Dry Spray and Wet Spray. Both systems typically produce high strength, well compacted concrete repairs. As the systems are applied with spray equipment, they are excellent at building up material thickness and applying large volumes in a short time.

Dry spray materials are mixed with water at the nozzle and are generally regarded as more suitable for stop/start applications, such as patch repairs. Wet spray systems are mixed with water and then pumped, making them generally more suitable for more continuous applications, such as overlays or tunnel linings.

The expensive equipment for spray application and the longer set up times make the application of sprayed systems well suited to large repair projects.

Renderoc DS
A high-strength dry spray repair mortar, Renderoc DS is an excellent material for large patch repair applications. It has high bond to the concrete substrate and low rebound of material, making it very cost-effective to work with.

Renderoc DSR
A rapid setting version of Renderoc DS for faster turn around.

Renderoc HB, HB30 & HB45
In addition to their use as hand-applied mortars Renderoc HB, HB30 and HB45 are formulated to be applied by the wet spray process.

CAST REPAIR MATERIALS

For large section repairs where high strength is required, re-casting with a proprietary pourable repair material is the perfect solution.

Renderoc LA, LA55, LA60
The unique formulation of Fosroc's Renderoc LA range of materials produces a highly fluid material which casts easily but will not shrink or crack away from the host concrete.

The high strength of the products make them suitable for civil works and they are often used in areas of reduced access where congested reinforcement renders hand and spray applied systems unsuitable. Unlike standard concrete the product contains finer aggregates which do not require agitation or vibration to settle and form a strong bond.

SEALING & BONDING CRACKS

Cracks can be sealed and bonded in a number of ways. However, it is important to understand what has caused the cracks, as failure to address any underlying cause will normally lead to a later re-occurrence. Although this can be a detailed process it is often an effective method for fast repairs.

Injection materials come in many forms and selection depend upon the project requirements. Typically static cracks are bonded with cementitious or epoxy materials. These can be used to create structural repairs. Live cracks may sometimes be filled with a flexible material such as a polyurethane, alternatively they may be transformed into movement joints by bandaging or cutting and sealing with flexible sealants.

Bonding - Nitofill LV/TH

To inject and re-bond cracks epoxy resin is injected into the concrete using a variety of techniques.

Filling

Static cracks may be filled using epoxy pastes such as Nitomortar PE which are trowelled into the surface.

Water Stopping

Cracks subject to water ingress can be filled using polyurethane systems such as Nitofill UR63 that react in the presence of water to foam or to create a complete seal. These systems do not bond the concrete.

Jointing

Cracks subject to continual movement should be treated as joints unless the movement can be stopped. Fosroc has a range of joint sealants for standard and challenging applications that offer high flexibility and may also provide chemical or physical resistance if required.

BALCONY WATERPROOFING

Balconies, external floors and roof decks are exposed to aggressive environmental and weather conditions which can cause them to deteriorate over time, with water penetration being a major cause of damage to the concrete substrate through corrosion of the steel reinforcement. Should water penetrate through to any habitable spaces below, disruption can be significant. These areas require rapid reinstatement to minimise inconvenience to users of the affected areas, while at the same time ensuring the concrete structure will remain watertight and protected from future damage.

The Nitodek FS System is a high performance, multi-layer, trafficable, waterproofing system that provides a seamless, highly resistant, elastomeric, anti-slip finish.

Typically polyurethane technology has been used to provide durability and flexibility, however the slow speed of curing in UK climates can be restrictive in projects requiring fast turnaround.

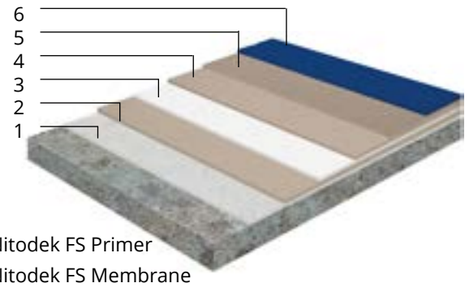
Fosroc's Nitodek FS system is a hybrid system that combines MMA Technology with polyurethanes, the benefits being that the product is fast curing (at approximately 60 minutes per layer) as well as hard wearing and flexible.

Bespoke Nitodek FS systems can be produced from the suite of system products to suit specific situations and performance requirements; from balconies and walkways, to roof decks, podium decks, car park decks, factory floors and airport hangars.

Nitodek FS forms part of Fosroc's comprehensive repair and protection offer, with the following advantages:

- Extremely short curing times
- Outstanding impact resistance
- Speed of application
- Crack bridging
- Easy to apply even at low temperatures down to 0°C
- Highly resistant to a wide range of chemicals
- Seamless finish resistant to mechanical stresses
- Anti-skid finish
- Easy care
- Fire resistant
- Attractive colour range
- Warranty up to 20 years*
- Waterproof

* Warranty details available upon request



1. Nitodek FS Primer
2. Nitodek FS Membrane
3. Nitodek FS Fleece
4. Nitodek FS Membrane
5. Nitodek FS Wearcoat (with Nitoflor Anti-Slip Grains)
6. Nitodek FS Topcoat

CORROSION INHIBITORS

The use of a surface applied corrosion inhibitor is a cost effective method of managing issues caused by reinforcement corrosion. Corrosion inhibitors can reduce the amount of repairs that are undertaken by managing contaminated but undamaged concrete. For such applications Fosroc offers Protectosil® CIT, a unique product, offering multi-functional steel protection and resistance against ingress. The product is based on silane technology which enables very deep concrete penetration and binding to steel and concrete. This means that the steel is protected by the formation of a bonded chemical barrier on its surface and the concrete is protected by the reduction of moisture uptake and chloride ingress.

Due to the strength of its chemical bond Protectosil® CIT can be used on wet substrates and is even effective in tidal zones. It can be used on any uncoated concrete surface and is highly effective at managing incipient anode formation and corrosion induced by chlorides and/or carbonation.

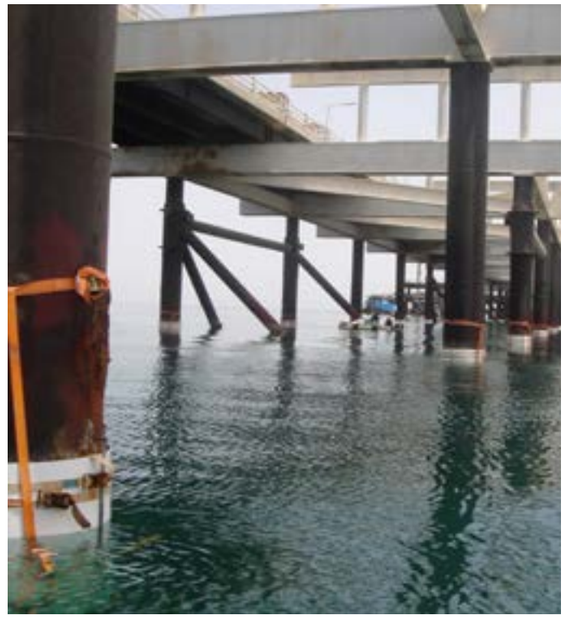
Fast and easy to apply, Protectosil® CIT is normally spray applied to the concrete surface and penetrates deeply to the reinforcement. It has negligible visual effect on the concrete because it is a clear liquid. It is possible to over-paint with Dekguard coatings if required by the project. The product can be monitored for effectiveness using Linear Polarisation methods.

CATHODIC PROTECTION

Fosroc Marine Jacket is a cathodic protection system provided specifically for marine piles. It is used on piers and jetties where the specific environment of high chlorides, moisture and oxygen combine adding erosion and mechanical abrasion into the mixture. This combination creates accelerated corrosion in the tidal and splash zones which is hard to combat using standard repairs and coatings.

Fosroc Marine Jacket uses self-regulating zinc mesh anodes to control corrosion; these anodes are protected by the strong GRP casing and grouted into place. This high quality solution is ideal to create a robust and durable repair and protection of these critical elements. Installation can be undertaken relatively easily and with minimum disruption to port activity.

Like all high quality jackets, Fosroc's is made to measure, allowing the zinc sections to fit into place perfectly before grouting. Once completed the sections are easily cleaned and maintain a good appearance. As with good cathodic protection systems, remote monitoring can also be employed on Fosroc Marine Jackets, ensuring the client is aware in advance of the need to make provision for new works, when the zinc anodes reach the end of their working life many years later.



CONCRETE PROTECTION SYSTEMS

One of the most effective and common techniques for protecting concrete is to protect the surface. This can be achieved using a wide variety of product types, applied in a number of ways. It is never too early to begin to protect the surface of the concrete and the most effective asset managers will apply systems to the surface of their structure as it is being built. This applies particularly to structures under aggressive attack from harsh environments such as chemical treatment works, marine areas and those subject to high abrasion. Protective coatings can also be very decorative and enhance a structure's appearance, functionality and safety.

Selecting the right protection requires a clear understanding of all the factors that will be important to the structure and those using it. Considerations may include:

- Carbonation resistance
- Slip resistance
- Aesthetic Appeal
- UV Stability
- Durability
- Resistance to chloride ions
- Chemical resistance
- Application Speed
- Waterproofing

Fosroc offer a comprehensive range of products for protecting concrete, utilising a variety of impregnations, coatings, coverings and membranes. Our technology types include polyurethanes, epoxies, acrylics, silanes, siloxanes, methacrylates.

Dekguard anti-carbonation coatings
Anti-carbonation coatings and anti-chloride coatings meet a prescribed set of properties defined in BS EN 1504 to ensure that the concrete receives an appropriate level of protection. They are applied in thicknesses of less than 1mm but provide protection equivalent to many metres of concrete. Fosroc's Dekguard systems provide protection far in excess of the Carbon Dioxide permeability stated as a requirement in BS EN 1504. This is because this layer of protection is often the most important part of the entire repair process when it comes to future durability.

Dekguard S and A Plus are rigid pigmented protective coatings while Dekguard CP provides a clear rigid finish. Dekguard Elastic and Dekguard E2000 have exceptional crack bridging capabilities, meaning that if fine cracks move below the surface of the protective film, they remain covered and protected. As a very visual part of the repair process Dekguard coatings come in a range of colours, meaning that the products are decorative as well as functional. They have exceptional UV stability and overall durability, with independently audited applications lasting well in excess of 15 years.

Nitocote chemical resistant coatings
Fosroc's Nitocote brand offers a wide variety of coatings that provide resistance to chemical attack and abrasion. This makes them ideal for situations where concrete is under attack from aggressive environments, such as chemical storage and bund areas, water treatment works, desalination plants, oil and gas processing sites. The specific coating requirement will be matched to the customer requirements by Fosroc's technical team.

Nitodek car park decking
Busy car park decks take an extraordinary amount of wear and attack. Clients require systems that provide protection from oil spills, de-icing salts, etc, while being able to withstand traffic and providing good anti-slip properties. The nature of the long span construction methods frequently means that decking systems should be flexible to bridge small cracks caused by flexure and thermal changes, keeping the decks watertight. Fosroc's Nitodek systems can achieve all of this while bringing an aesthetically pleasing, durable and maintainable finish to the car park, with coloured demarcation improving safety and in some cases providing improved brightness that can even reduce lighting costs.

ACCEPTANCE OF THE REPAIR WORK

Correct supervision of the contract ensures a successful outcome. Understanding the issues causing the damage to the structure and addressing any latent defects with high quality material will ensure that the repairs should last for many years.

Repairs should normally be undertaken by a suitably trained and experienced applicator. Fosroc has connections with these contractors and can make recommendations. This will ensure that the quality of the application will match the high quality of the material, providing maximum possible durability.

Wherever required Fosroc will attend site to assist the contractor and specifier in ensuring that the materials are applied in accordance with best practice. We also offer applicator training.

It is normally advisable that the structure is monitored regularly to ensure that there are no further issues. This should form part of the client handover document and the strategy for the continued management of the structure.

CASE STUDIES

Thackeray Building, London

The Thackeray Building is a 5-storey block of residential flats in Herbrand Street dating back to the early 1900's, constructed of concrete and brick. Over the years the concrete elements have suffered from water ingress which has resulted in spalling and also corrosion of steel 'H' sections above the windows. Fosroc were able to supply a total solution package.

A404M, Cannon Lane

Works included reconstruction of the joint edges and repairing defective concrete in the bridge deck with a clear objective to get the works completed quickly and reduce the closure of the very busy major route.
Patchroc 250 thick section repair mortar which exceeds the requirements of BS EN 1504, and Highways England was successfully installed minimising disruption and allowing a rapid return to service.

Victoria Hospital, Blackpool

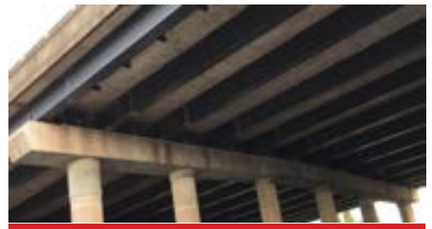
The Maternity Wing at Blackpool Victoria Hospital was constructed in the 1960's and over the years had been subjected to many environmental stresses, particularly due to its marine location. Fosroc provided a specification to repair the degraded concrete and bring a new lease of life to the structure using the Renderoc Repair System.

ICAIR, Sheffield

During construction the concrete to form the tanks had been poured to the wrong measurements and in order to correct the situation a product was required that could withstand the pressure and load from the stored water and gain a compressive strength similar to the parent concrete. Repairs were successfully carried out using Renderoc LA60.

Central Station, Glasgow

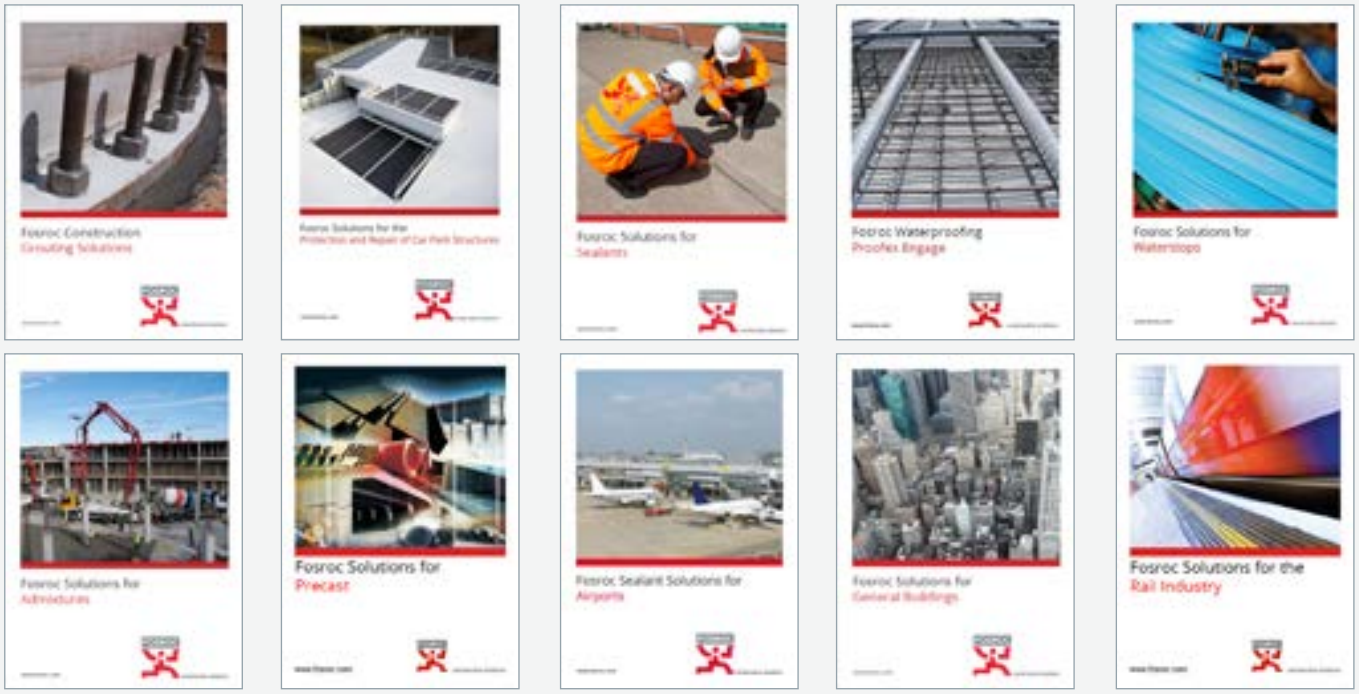
When platform repairs were required at Central Station, Glasgow Fosroc's Paveroc pavement reinstatement mortar was selected due to its rapid strength gain which means it can accept pedestrian traffic at 12 hours. In addition to providing a rapid return to service of the platforms Paveroc's high strength, abrasion and weather resistance ensures that it will provide a durable repair.



Oldbury Viaduct, M5 Midlands

Fosroc delivered a sustainable motorway repair solution using Renderoc LA60 meeting Highways England's quality standards. Fosroc successfully introduced innovations in product design, and in bulk supply, maintaining regular supply to site through a fully integrated supply chain and production process. This approach helped reduce costs, save time and enabled concrete repairs to be carried out effectively in a challenging environment.

Fosroc offers a full range of construction chemical solutions, helping to protect structures throughout the world. Please refer to our brochures, which include:



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