



# Fosroc Solutions to Concrete Repairs, Retrofitting & Surface Protection

*"The greatest constructions require solid foundations, the best being built on ROCK. Here is the foundation that supports FOSROC"*

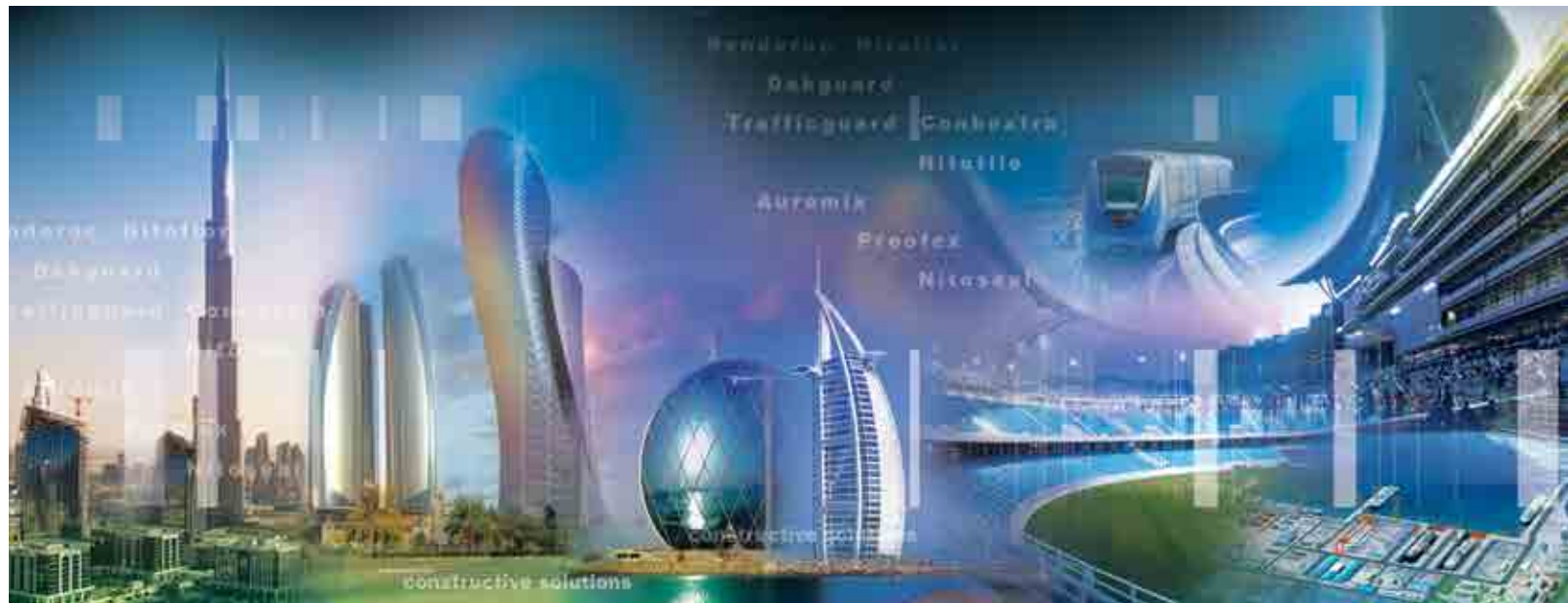
**Dr. James Hay**, Chairman – JMH Group

Our Profile

Fosroc commenced its Indian operations in 1981 and established a 100% subsidiary in 1999.

Fosroc has four state-of-the-art manufacturing facilities at Bengaluru, Karnataka; Ankleshwar, Gujarat; Kolkata, West Bengal and Keshwana, Rajasthan.

Fosroc Chemicals (India) Pvt. Ltd. works closely with its customers, including distribution and Applicator associates, through its well-equipped technical service department, a network of sales engineers, customer service professionals, Concrete technologist, Specification team etc. Fosroc India prides itself for the level of technical and customer support that it gives to its valued customers.



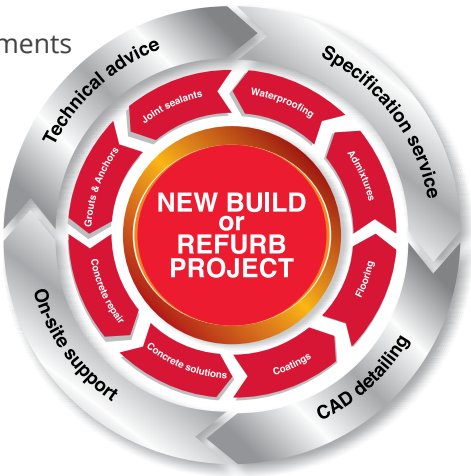
International leverage gives Fosroc the opportunity to offer tried and tested solutions from one geographical region to another with great confidence.

Fosroc Chemicals (India) Pvt. Ltd. provides time-tested solutions that include services such as:

- Diagnosis and Specification Support
- Application Support
- Distribution Support
- After-Sales Service
- Mix design support

Fosroc Chemicals (India) Pvt. Ltd. remains focused on the Industry, Infrastructure and Building Segment with a wide range of quality products.

- Admixtures and Surface Treatments
- Grouts and Anchors
- Industrial Flooring
- Concrete Repair
- Protective Coatings
- Joint Sealants and Adhesives
- Waterproofing
- Cement Additives



Fosroc is working with customers to meet the high requirements set out in BS EN 1504- supplying products to meet the standards the construction industry demands.

Fosroc offers a comprehensive range of concrete repair and remediation products tested to European standard methods including our internationally proven specialist Renderoc repair mortars and Dekguard anti-carbonation coatings.

Whatever the structures-from bridges to car parks and commercial buildings to jetties, Fosroc's technical expertise in concrete repair, protection and retrofitting technology can help guide you through the application of BS EN 1504 and ACI 440.2R-02 design and specification standards enabling you to develop cost effective and highly beneficial solutions for distress in your concrete structures.

Fosroc provides tailored constructive solutions combining - High quality products, Innovation, Expert tech support, Onsite customer service and Design & Specification support.

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# What is BS EN 1504?

European standard BS EN 1504: products and systems for the protection and repair of concrete structures replaces existing individual national standards, providing an integrated framework for the concrete repair industry throughout Europe.

The standard covers all stages of the concrete repair process from assessing the initial problem to methods of remediation, recommended site practice and specifications for products to ensure the future integrity of the structure.

Fosroc experts can help specifiers, clients and contractors apply BS EN 1504, developing appropriate solutions as well as specifying and applying the best materials to ensure optimum concrete repair and protection.

## EN 1504 - 1

General scope and definitions

## EN 1504 - 2

Surface protection systems for concrete

## EN 1504 - 3

Structural and non-structural repair

## EN 1504 - 4

Structural bonding

## EN 1504 - 5

Concrete injection

Using the definitions set out in BS EN 1504-1, parts 2- 7 focus on product specifications, classifying materials by their properties and relevant test methods. These sections not only provide the principles

## EN 1504 - 6

Anchoring of reinforcing steel bar

## EN 1504 - 7

Reinforcement corrosion protection

## EN 1504 - 8

Quality control and evaluation of conformity

## EN 1504 - 9

Principles for the use of product and systems

## EN 1504 - 10

Site application of products and systems and quality control of the works

for manufacturers designing products, but also provide specifiers and designers with an exact profile of properties for comparing and selecting products.

Part 8 describes how manufacturers must operate a permanent factory production control system which is subject to an annual audit in order to maintain quality and evaluate conformity.

Part 9 establishes general principles for the systems of concrete repair ( see opposite)and part 10 details site procedures for carrying out a repair programme. Fosroc's team of experts are always available to provide support and advise on any technical problems arising during a repair project.

# Design Philosophy – Specifying to BS EN 1504

Part 9 of BS EN 1504 outlines a structured approach to the investigation of the causes of defects in concrete and explains the 11 principles of remedial action which clients and designers/specifiers should use to prepare their specification. The system of options, principles and methods is the basis for the selection of products and Fosroc can help designers make optimal use of the repair principles to find the most appropriate action taking into account health and safety, structural and environmental factors.

1

### Assess structure

- Present condition
- Original design approach
- Environment and contamination
- Conditions during construction
- Conditions of use
- History of structures
- Future use

2

### Consider options

- Do nothing for a certain time
- Downgrade function (eg. reduce maximum loads)
- Preservation of current state
- Improve, strengthen or refurbish part or all of structure
- Reconstruction of part or all of structure
- Demolition of all or part of the structure

### Other factors to be considered, for example:

- Likely long term performance of repair system
- The number and cost of repair cycles
- Methods of preparation and appearance of repair
- Intended use, design life and service life
- Opportunities for additional protection and monitoring
- Acceptable number and cost of future repair cycles
- Appearance of protected or repaired structures

3

### Select repair principle/s

- Protection against ingress
- Moisture control
- Concrete restoration
- Structural strengthening
- Physical resistance
- Resistance to Chemicals
- Preserving or restoring passivity
- Increasing resistivity
- Cathodic control
- Cathodic protection
- Control of anodic areas

4

### Choose remedial method/s

- Appropriate to type and cause
- Appropriate to future service conditions
- Appropriate to protection or repair option chosen
- Compliance with the principle chosen
- Availability of products/ systems complying with BS EN 1504

5

### Specify material performance

Minimum performance characteristics for all intended uses/certain intended uses/ specific applications

6

### Set out ongoing requirements

Record of the protection or repair works that have been carried out and instructions on future inspections and maintenance

### EN 1504-1 Definitions

EN 1504-9 principles for the use of products and systems

EN 1504-10 Site application quality control of the works

Parts 2-7: Products  
2 Surface protection  
3 Mortars  
4 Bonding  
5 Injections  
6 Anchoring  
7 Corrosion protection

### Tests/ standards/ methods

62 testing standards  
Eg: EN 12190  
Compressive strength  
EN ISO 6572-1 Impact  
resistance

### Part 8: Quality control of the products



# The 11 principles for Concrete repair & rehabilitation (BS EN 1504-9)

## Defects in concrete

Principles 1-6 cover defects to concrete or the structure caused by :

Mechanical actions; eg: impact

Chemical and biological actions from environments  
Physical actions eg: freeze thaw, thermal cracking.

## Reinforcement Corrosion

Principles 7-11 cover reinforcement corrosion caused by: Physical loss of concrete cover

Chemical loss of alkalinity in the protective concrete contamination of the protective concrete cover with corrosive agents eg: Chloride ions

Stray electrical currents conducted or induced in the reinforcement from neighbouring electrical installations.

Principle no.	Principle	EN 1504 part	Methods for protecting or repairing structure	Fosroc products
<b>Principle 1 (P)</b>	Protect against ingress	2 2 2 5	1.1 Hydrophobic impregnation 1.2 Impregnation 1.3 Coating 1.4 Surface bandaging of cracks 1.5 Filling of cracks 1.6 Transferring cracks into joints 1.7 Erecting external panels 1.8 Applying membranes	Dekguard range / Nitocote range Nitocote range Dekguard range Expoband one Conbextra EP10/EP10 (M) Nitofill WS60 & UR 63 Polyurea WPE
<b>Principle 2 (MC)</b>	Moisture control	2 2 2	2.1 Hydrophobic impregnation 2.2 Impregnation 2.3 Coating 2.4 Erecting external panels 2.5 Electrochemical treatment	Nitocote / Dekguard Range Nitocote range Dekguard range
<b>Principle 3 (CR)</b>	Concrete restoration	3 3 3	3.1 Hand applied mortar 3.2 Recasting with concrete or mortar 3.3 Spraying concrete or mortar 3.4 Replacing elements	Renderoc HB2/HS Xtra Renderoc RG/RGSPL/LA Xtra/LA 80 Sprayset HBL/HS Xtra/Renderoc DS/SC
<b>Principle 4 (SS)</b>	Structural Strengthening	6 4 3,4 5 5	4.1 Adding or replacing embedded or external reinforcing bars 4.2 Adding reinforcement anchored in pre-formed or drilled holes 4.3 Bonding plate reinforcement 4.4 Adding mortar or concrete 4.5 Injecting cracks, voids, or interstices 4.6 Filling cracks, voids or interstices 4.7 Pre-stressing - (post tensioning)	Renderoc HB2/HS Xtra Renderoc RG/RGSPL/LA Xtra/LA 80 Sprayset HBL/HS Xtra/Renderoc DS/SC
<b>Principle 5 (PR)</b>	Increasing physical resistance	2 2 3	5.1 Coating 5.2 Impregnation 5.3 Adding mortar or concrete	Dekguard Range Nitocote Range Renderoc S2/HS Xtra/RG/RGSPL/LA Xtra/80
<b>Principle 6 (RC)</b>	Resistance to chemicals	2 2 3	6.1 Coating 6.2 Impregnation 6.3 Adding mortar or concrete	Dekguard Range Nitocote Range Renderoc S2/HS Xtra/RG/RGSPL/LA Xtra/80
<b>Principle 7 (RP)</b>	Resistance to chemicals	3 3	7.1 Increasing cover with additional mortar or concrete 7.2 Replacing contaminated or carbonated concrete 7.3 Electrochemical realkalisation of carbonated concrete 7.4 Realkalisation of carbonated concrete by diffusion 7.5 Electrochemical chloride extraction	Renderoc S2/HS Xtra/RG/RGSPL/LA Xtra/80
<b>Principle 8 (IR)</b>	Increasing resistivity	2 2 2	8.1 Hydrophobic impregnation 8.2 Impregnation 8.3 Coating	Nitocote / Dekguard range Nitocote range Dekguard range
<b>Principle 9 (CC)</b>	Cathodic control		9.1 Limiting oxygen content (at the cathode) by saturation or surface coating	Nitocote / Dekguard range
<b>Principle 10 (CP)</b>	Cathodic protection		10.1 Applying an electrical potential	
<b>Principle 11 (CA)</b>	Control of anodic areas	7 7	11.1 Active coating of the reinforcement 11.2 Barrier coating of the reinforcement 11.3 Applying corrosion inhibitors in or to the concrete	Nitozinc primer / Nitozinc primer std Nitobond EP/EP std Conplast CN

# Case Study of Repair and Restoration of Kandla Port Jetty, Gujarat, damaged by earthquake

In the year 2001 a high intensity earthquake attacked this state of Gujarat in India damaging several structures out of which the Kandla port Jetty was one.

Due to the impact of this earthquake, all the 1600 RC piles of the Jetty were damaged with structural cracks and loss of strength and dimensional stability.

Fosroc was called for the repair and restoration of the jetty as per the design given by IIT Madras, the structural consultant and to work under the civil contractor Indiana Build Pvt Ltd., Mumbai

Fosroc Constructive Solutions of Concrete Repair and Restoration as per principle no.3 of BS EN 1504

- Sealing of cracks in the piles with Conbextra EUW, under water, high strength, epoxy repair grout
- Structural strengthening and reinstatement of the damaged RC piles with Renderoc UW, under water, high strength, cementitious, repair micro concrete encasement.
- The above repair and restoration work was carried out between the low and high tides successfully to the satisfaction of the customer and is still intact even after a decade.



Cracks in the Jetty piles

Piles repaired and restored with Conbextra EUW and Renderoc UW



## Quality (BS EN 1504-8)

BS EN 1504 as a product standard leads to CE marking of concrete repair products across Europe ensuring the use of products and systems to meet minimum performance requirements for a range of repair applications.

In line with part 8 of BS EN 1504 - Quality control and evaluation of conformity, Fosroc's range of concrete repair products are manufactured to satisfy the repair principles and perform according to specification.



# Structural and Non - Structural repair - BS EN 1504-3

Fosroc world- renowned range of Renderoc mortars has been developed to provide appropriate solutions to the wide variety of problems resulting in defective concrete. These pre-bagged single component products are available in 4 different classes specified in BS EN 1504 for structural and non structural concrete repair products:

## Non Structural products

- ▶ Class R1> 10Mpa
- ▶ Class R2> 15Mpa

## Structural products

- ▶ Class R3> 25Mpa
- ▶ Class R4> 45Mpa

This basic classification is by compressive strength, however additional test data is required for

each product depending on the application for which it is being used. The BS EN 1504 Principles and Methods which apply to structural and non structural repairs are:

### Principle 3 (CR) Concrete restoration

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

### Principle 4(SS) Structural Strengthening

- 4.4 Adding mortar or concrete

### Principle 7(RP) Preserving or restoring passivity

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

# Product Selector





## Non - structural repair products

R1

### Renderoc Plug (method 3.1)

- Rapid setting cement based, waterstopping mortars
- Emergency waterstopping capability
- Single component – pre-bagged to overcome variations in site batching
- Excellent bond to substrate
- Low exotherm minimizes thermal cracking
- Chloride free

R2

### Renderoc FC (Method 3.1, 7.1, 7.2)

- Polymer modified fairing coat
- Designed for application in thin layers to produce a fair-faced appearance to concrete or masonry surfaces in readiness to receive a protective coating
- BBA approved

### Renderoc HB2 (Method 3.1, 3.3, 7.1, 7.2)

- High performance lightweight concrete reinstatement mortar used for vertical and overhead high build applications



## Structural repair products

R3

### Nitomortar 30 (Method 3.1, 3.3, 4.4, 7.1, 7.2)

Structural grade epoxy resin based repair mortar for small repairs.

### Renderoc SP40/ Renderoc DS40

Polymer modified, cementitious, trowelable repair mortars for reinstatement of large areas of concrete.

R4

### Renderoc HS Xtra/ Nitomortar S/ PE (Method 3.1, 3.3, 4.4, 7.1, 7.2)

Structural grade polymer modified, cementitious & epoxy resin based, thixotropic & trowel applied concrete reinstatement mortars for reinstatement of damaged/ distressed concrete cover.

### Patchroc/ Superpatch (Method 3.3, 4.4, 7.1, 7.2)

- Fast setting, high strength, structural grade, cementitious & epoxy resin based, patch repair mortars used for emergency reinstatement of concrete pavements, airport aprons, access ramps, roadways and warehouse floors.
- Rapid strength gain. Will accept traffic in just 2 hours.

- High strength, abrasion and weather resistance.

### Renderoc RG/ RG Spl/ LA Range-LA Xtra (3.2, 4.4, 7.1, 7.2)

- Free-flowing, Non-Shrink, high strength, structural grade, low alkali micro-concretes.
- Ideal for reinstatement of large structural sections of concrete.

- Excellent resistance to chloride ion and carbon dioxide diffusion.
- Can be used for repairs to reinforced concrete structures affected by chloride and carbonation corrosion, alkali silica reaction & sulphate attack.
- Can be pumped or poured.
- Self compacting – expels air without vibration.





# Surface protection systems **BS EN 1504-2**

Once damaged concrete has been repaired, consideration should be given to the protection of the structure against future attack from the surrounding environment.

Fosroc's range of protective and decorative Dekguard anti-carbonation, anti chloride high performance coatings offer protection in the line with BS EN 1504-2 and are compatible with Fosroc's range of Renderoc mortars, providing an effective and attractive repair and protection system.

## 1. Dekguard Range of Anti carbonation coatings

Dekguard S/Std/S 300/ WB 300/ E2000/WB Elastic

- Anti-carboation, anti-chloride higher performance coatings
- For use on atmospherically exposed concrete
- High UV resistant
- Flexible, crack bridging systems
- Wide colour range

## 2. Anticorrosion Coatings

Chemical resistant cementitious and resin based coatings for use in aggressive environments or below ground.

- Nitozinc primer – two component zinc rich epoxy primer for structural and fabrication steel
- Nitocote BCS 300-CECRI technology epoxy PU multi layer anti corrosion coating systems
- Nitocote EM 300-CECRI technology moisture compatible epoxy Mio based, anti corrosion coating system for cooling towers

## Nitocote range of Chemical and abrasion resistant coatings

Chemical resistant cementitious and resin based coatings for use

in aggressive environments or below ground.

Potable grade/Food grade Epoxy resin coating for water retaining structures tested at CECRI

## Nitocote EP 410/EP 140/EP 135

Highly chemical resistant two pack epoxy based system based on CECRI technology.

## Food grade potable coatings:

- Nitocote EP405:- Solvent free, epoxy resin based, CFTRI tested coating system for concrete and steel surfaces.
- Nitocote CM 210:Polymer modified cementitious based, WARS approved coating system for concrete.

# Additional Concrete repair products

## Resins

### Nitomortar Range

Range of epoxy reinstatement mortars, with high resistance to a wide range of chemicals, suitable for emergency repairs where fast strength gain is important.

### Nitomortar S

Ideally suited for acid tanks, sea walls, industrial floors and as a bedding mortar

### Nitomortar PE

Used for repairing and re-profiling of precast concrete units, damaged treads



## Crack Injection Resins

### Conbextra EP10/M

Pre-packaged low viscosity or thixotropic epoxy resin injection grout.

- Achieve high strength bond to dry or wet concrete
- Material designed for low creep
- Non Shrink- no loss of bond or surface contact
- High Compressive, tensile and flexural strengths
- Excellent chemical resistance

## Floor Coatings

### Nitoflor Range

High performance epoxy resin floor coatings

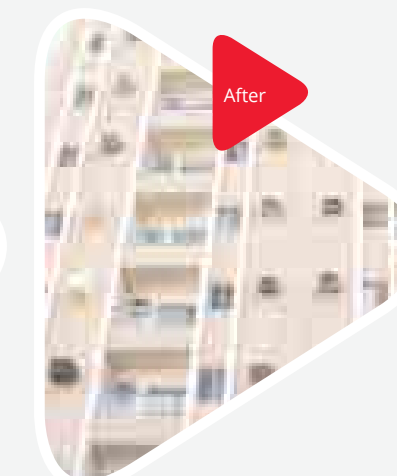
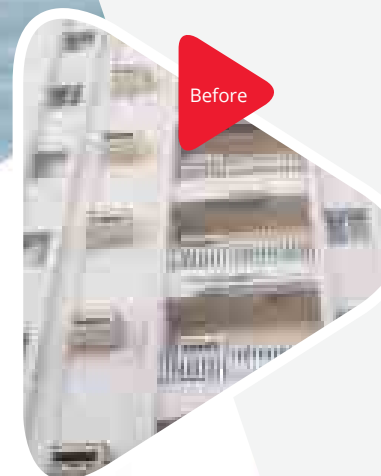
- Hard wearing- durable, low maintenance costs
- High chemical resistance
- Hygienic – impervious finish provides easily cleaned surface

## Protective coatings

### Fosroc Polyurea WPE/FLM

Anti-corrosion , waterproof and protective coating for concrete and steel in a wide range of environmental conditions

- Fast setting,seamless coating
- Very long lifecycles and high durability



# Fosroc Solutions for Structural strengthening with FRP Composite Technology

## Introduction

FRP Composite technology for retrofitting of concrete structures is a boon to civil engineering since it has provided a cost effective, easier, faster, economical and durable solutions to address the requirement of enhancement of strength of existing reinforced and prestressed concrete structural members for the following retrofitting applications.

- Enhancement of Axial load carrying capacity of columns.
- Enhancement of Flexural strength of beams and slabs.
- Enhancement of stiffness of beams and slabs.
- Enhancement of shear strength of beams and shear walls.
- Enhancement of ductility of structural members to impact earthquake resistance.

## Types of FRP Composite Retrofitting Fibres

There are 4 types of non metallic fibres used for FRP

applications as mentioned below:

- Carbon fibers
- Carbon fiber Pultruded Plates or laminates
- Glass fibers (E Glass)
- Aramid fibers
- Basalt fibers

# Advantages of FRP composite Retrofitting Materials and Systems

- Very high strength to thickness or weight ratio, appreciable increase in strength and load carrying capacity without significant increase in dead load
- Enhanced stiffness, shear and tensile capacities increased load carrying capacity and better resistance to seismic forces and deflection
- Chemical resistant-Excellent resistance to acids and alkalis
- Flexible- can be applied on any shape or contour or substrate
- Thin sections-can be effectively used in space constrained areas.

- Creep and Fatigue resistance-ideal for conditions of sustained loading and repeated loading.
- Economical-Easy to install, time and labour saving.

## Typical application areas of FRP Retrofitting Systems

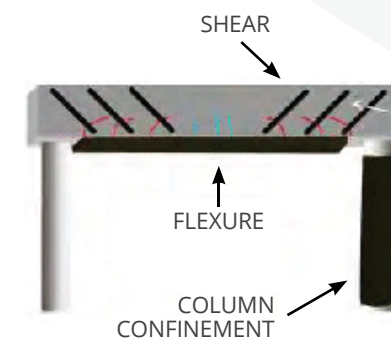
FRP retrofitting systems are used for enhancement of strength, stiffness and ductility for the following structural members in the form of carbon fibres & laminates and glass fibers:

- Piers
- Columns

- Shear walls
- Beams
- RT and PT slabs
- Retaining walls
- Masonry bridges
- Pipes
- Chimneys
- Tunnels



Nitowrap FRP Fabric and laminates used for strengthening of RC structural members and masonry walls



Structural strengthening functions of Nitowrap FRP Composites



# Durable and sustainable retrofitting solutions **Fosroc Nitowrap FRP Composites**

## Nitowrap product range

Fosroc's FRP retrofitting systems and solutions constitute the following:

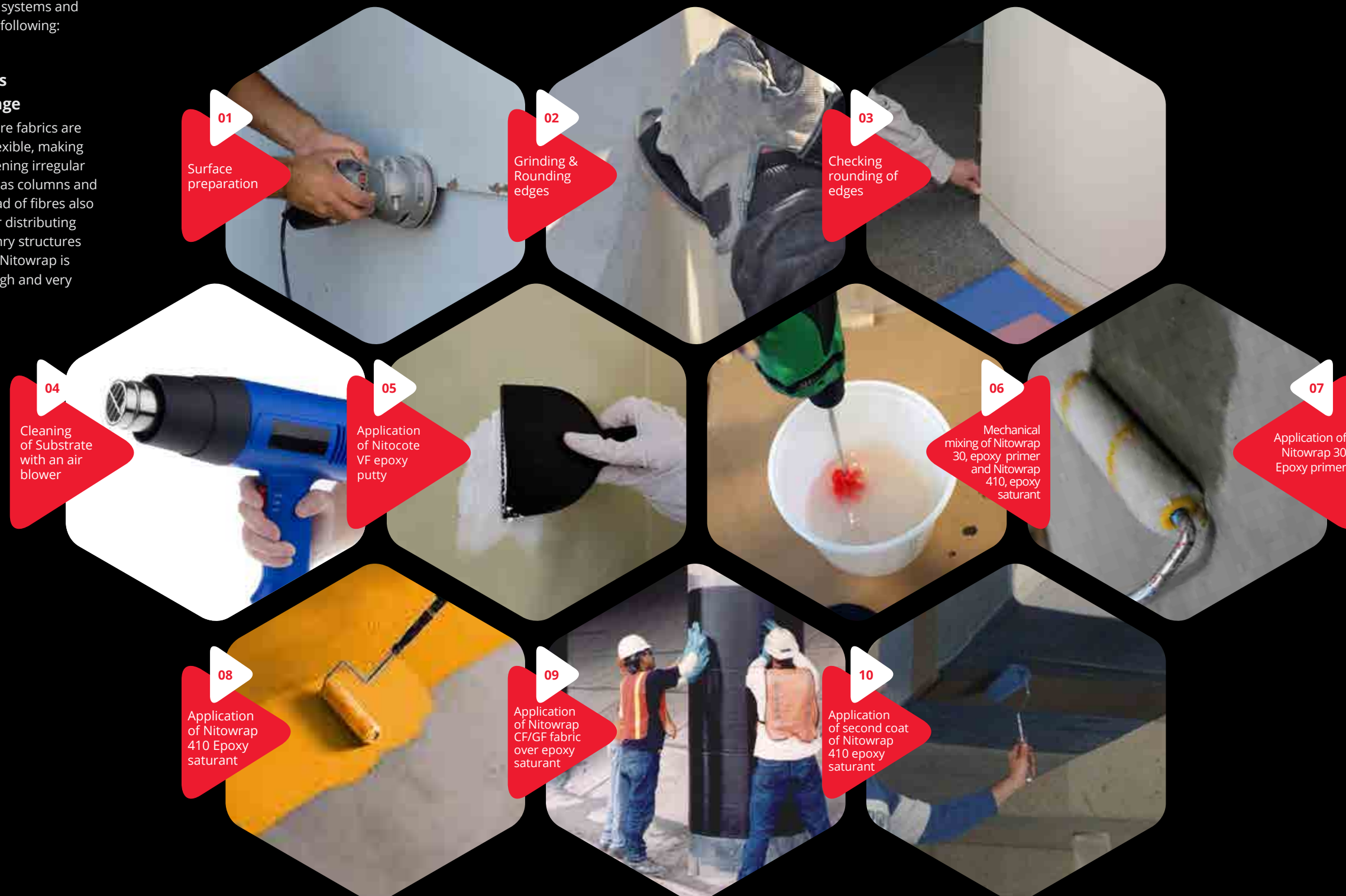
### Nitowrap CW (Formerly Known as Nitowrap EPCF) range

Nitowrap CW-carbon fibre fabrics are ultra-light weight and flexible, making them ideal for strengthening irregular or curved sections such as columns and beams. Their wide spread of fibres also makes them suitable for distributing loads, such as on masonry structures or in seismic situations. Nitowrap is available in standard, high and very high e-modulus grades..

### Nitowrap GW (Formerly Known as Nitowrap EPGF) range

Nitowrap GW is a 0° unidirectional glass fibre sheet with good strength and elastic modulus. It is used with specially developed resins 'Nitowrap 30 Primer' and 'Nitowrap 410 saturant Resin' and externally

applied to concrete or masonry. When correctly designed and applied, the Nitowrap system may improve structural load carrying capacity, flexural strength, shear strength and provide resistance to deformation.



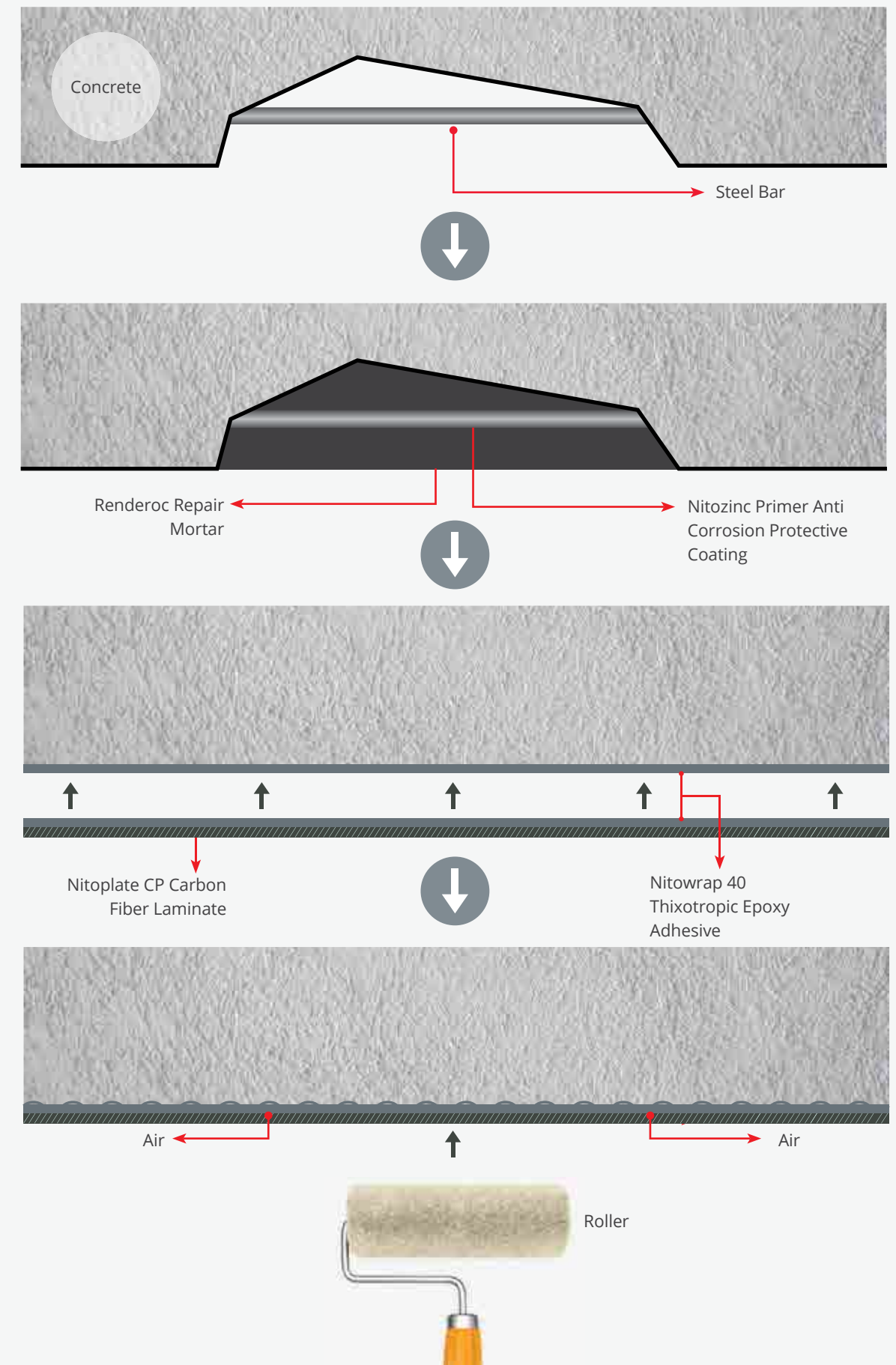
# Durable and Sustainable retrofitting Solutions

## Fosroc Nitowrap FRP Composites

### Nitowrap Product range

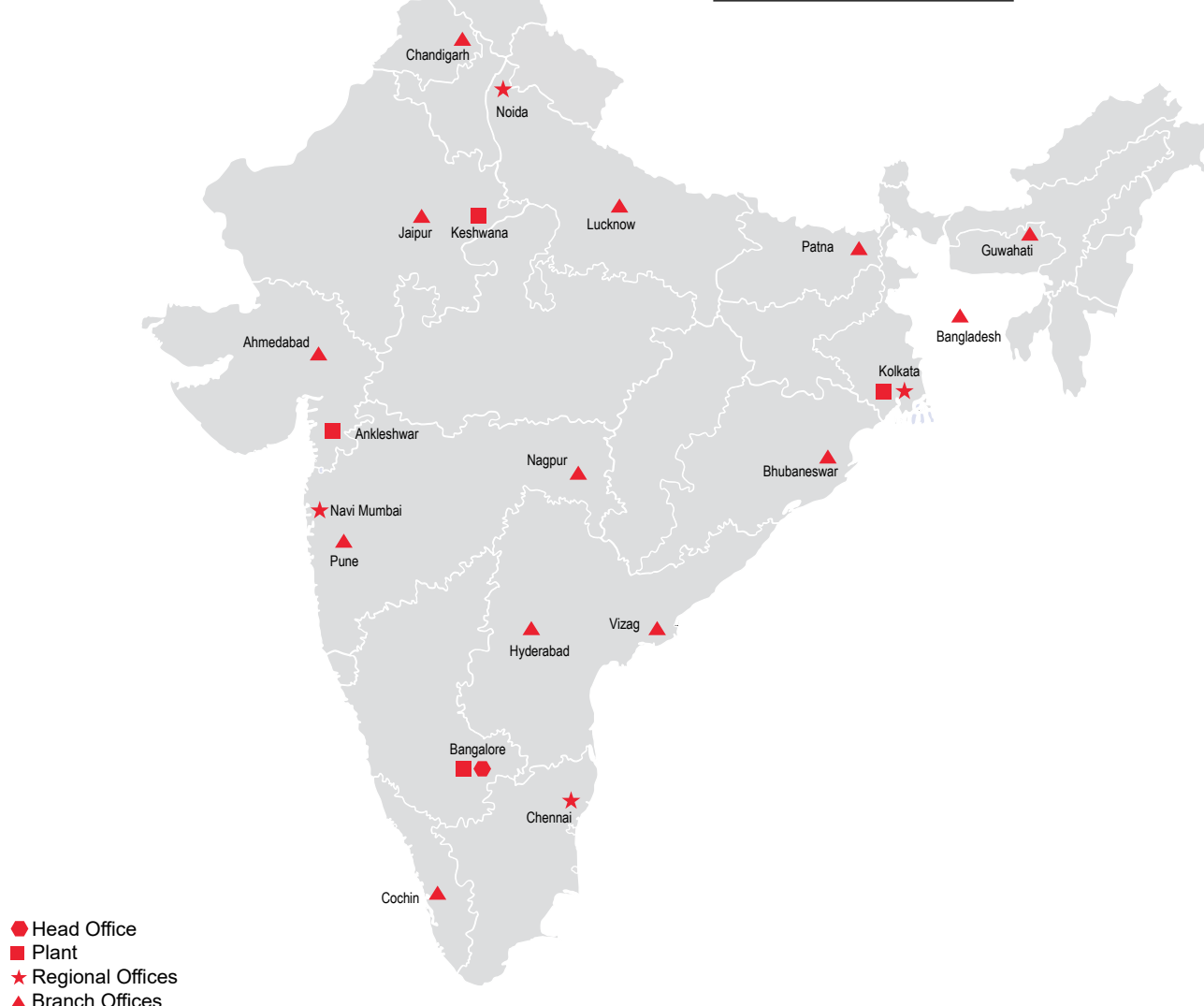
#### Nitoplate CP (Formerly Known as Nitowrap CFP) Range

Nitoplate CP are pultruded and resin bound strips, packed densely together for manoeuvrability. This makes them especially suited to strengthening overhead and on narrow sections such as beams. They are available in standard, medium and high tensile modulus grades in varying thicknesses and widths.





## FOSROC OPERATIONS



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#### Important Note

Fosroc products are guaranteed against defective materials and manufacture and are sold subject to its standard terms and conditions of sale, copies of which may be obtained on request. Whilst Fosroc endeavours to ensure that any advice, recommendation, specification or information it may give is accurate and correct, it cannot, because it has no direct or continuous control over where or how its products are applied, accept any liability either directly or indirectly arising from the use of its products, whether or not in accordance with any advice, specification, recommendation or information given by it.



*constructive solutions*

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