TECHNICAL MORTARS AND STRUCTURAL STRENGTHENING

July 2022

AGENDA

- About Weber
- Common causes of deterioration
- Relevance of cracks to corrosion
- Structural strengthening
- The repair strategy
- Case studies

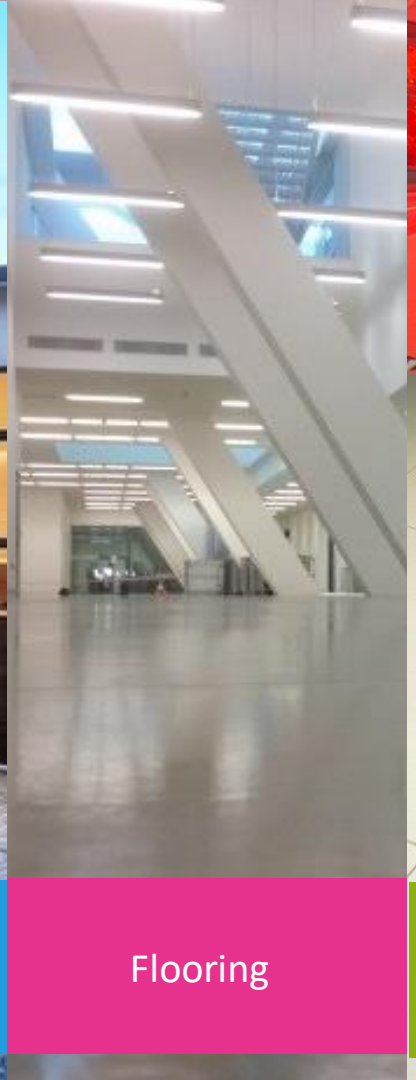
WEBER UK&I

SAINT-GOBAIN GROUP

weber
SAINT-GOBAIN

External Wall Insulation

Renders & Decorative Finishes



Flooring

Tile Fixing

Technical Mortars

INFRASTRUCTURE PRODUCTS

weber
SAINT-GOBAIN

COMMON CAUSES OF DETERIORATION

BS EN 1504 – 9


Common causes of deterioration
Concrete
Reinforcement corrosion
Mechanical
Chemical
Physical
Fire
Carbonation
Corrosive contaminants
Stray currents
Sulphate attack
Alkali aggregate reaction
Freeze/Thaw

SULPHATE ATTACK

- Physical

- Chemical

Na_2SO_4 + C_3A, CSH, monosulfate aluminate → Ettringite

K_2SO_4 + C_3A, CSH, monosulfate aluminate → Ettringite

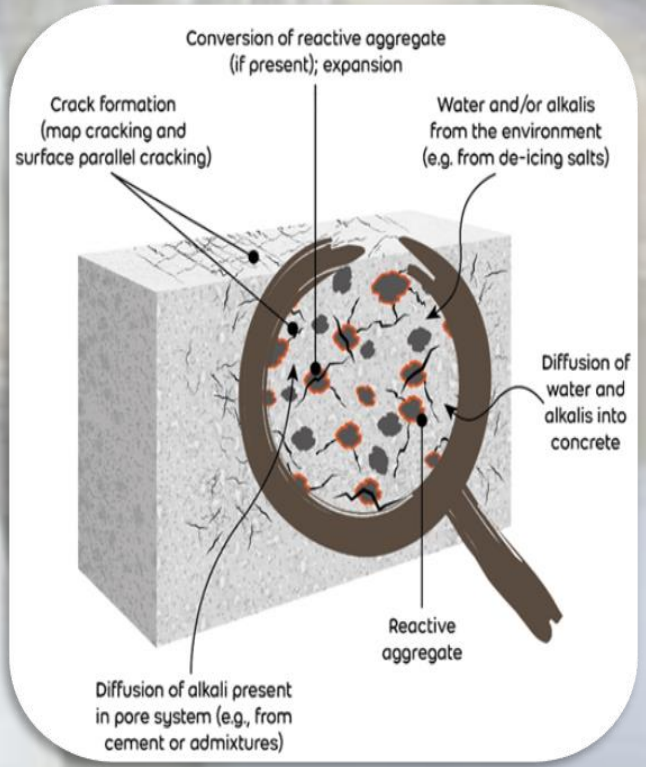
$CaSO_4$ + C_3A → Ettringite

$MgSO_4$ + CSH → $Mg(OH)_2$ Brucite → Dissolves forms more Mg and the process is repeated

weber
SAINT-GOBAIN

ALKALI AGGREGATE REACTION

- Alkali Silica Reaction (ASR)
- Alkali Carbonate Reaction (ACR)



BS EN 1504 – 9


Common causes of deterioration
Concrete
Reinforcement corrosion
Mechanical
Chemical
Physical
Fire
Carbonation
Corrosive contaminants
Stray currents
Sulphate attack
Alkali aggregate reaction
Freeze/Thaw

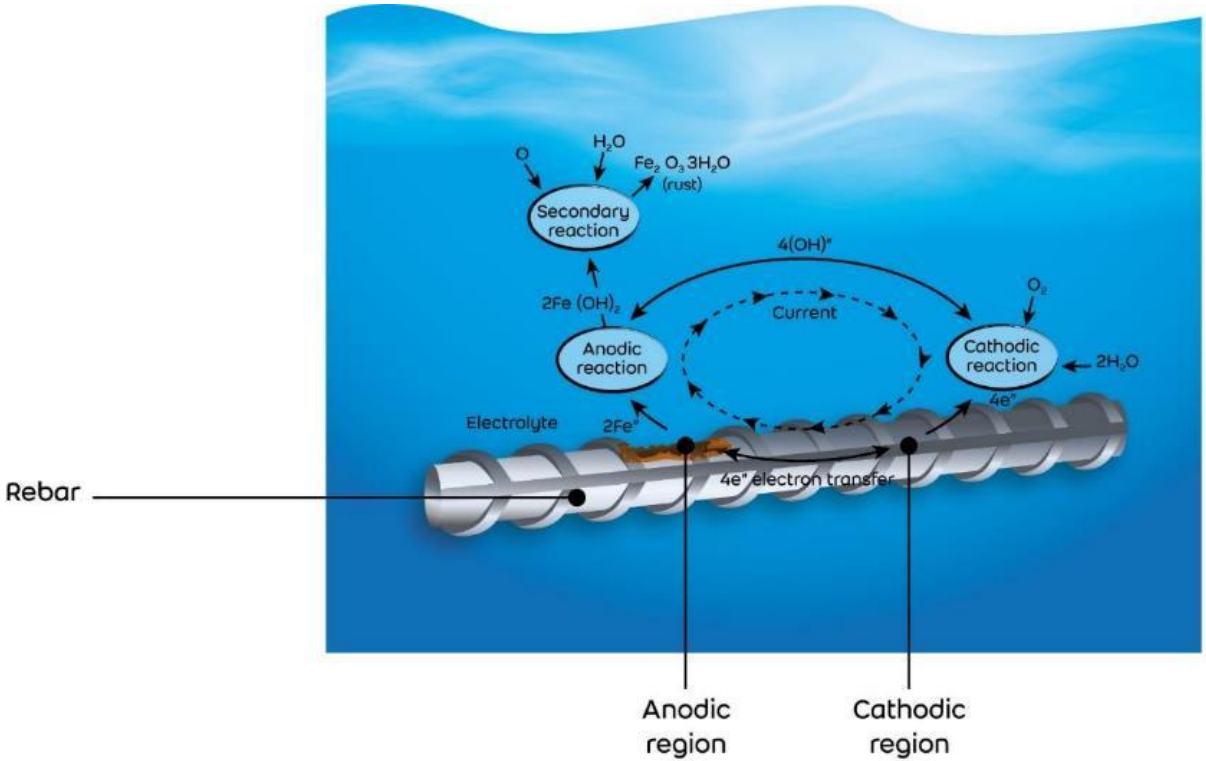
BS EN 1504 – 9


Common causes of deterioration
Concrete
Reinforcement corrosion
Mechanical
Chemical
Physical
Fire
Carbonation
Corrosive contaminants
Stray currents
Sulphate attack
Alkali aggregate reaction
Freeze/Thaw

CORROSION CELL

Main take away points

- Oxygen and water fuel the Cathodic reaction
- Oxygen is not required at the anode to initiate corrosion

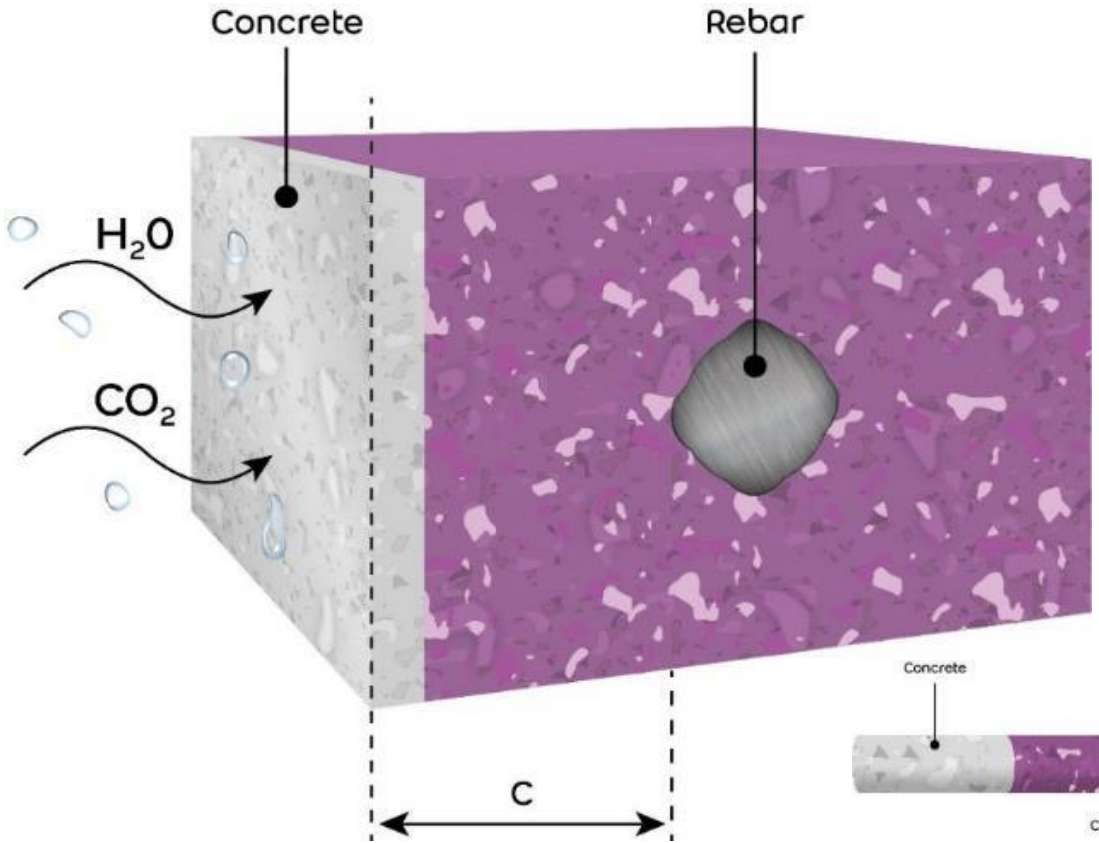


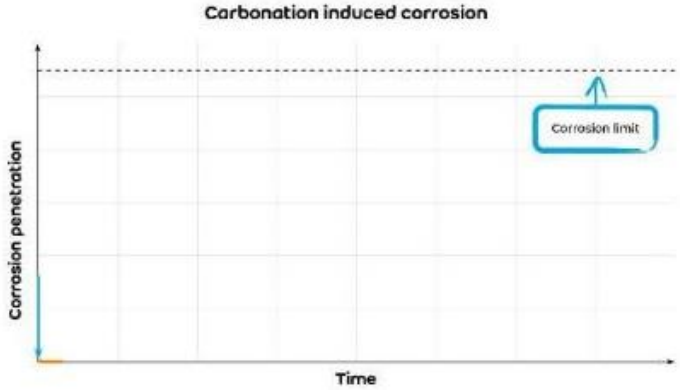
CARBONATION INDUCED CORROSION

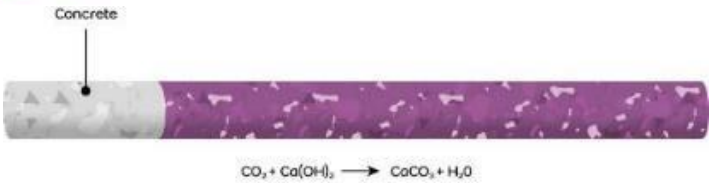
- Caused by the ingress of atmospheric gases
- $Ca(OH)_2 + CO_2 = CaCO_3 + H_2O$
- pH reduces from 13.0 to < 9.0
- Neutralizes protective alkalinity in concrete

weber
SAINT-GOBAIN

CARBONATION INDUCED CORROSION

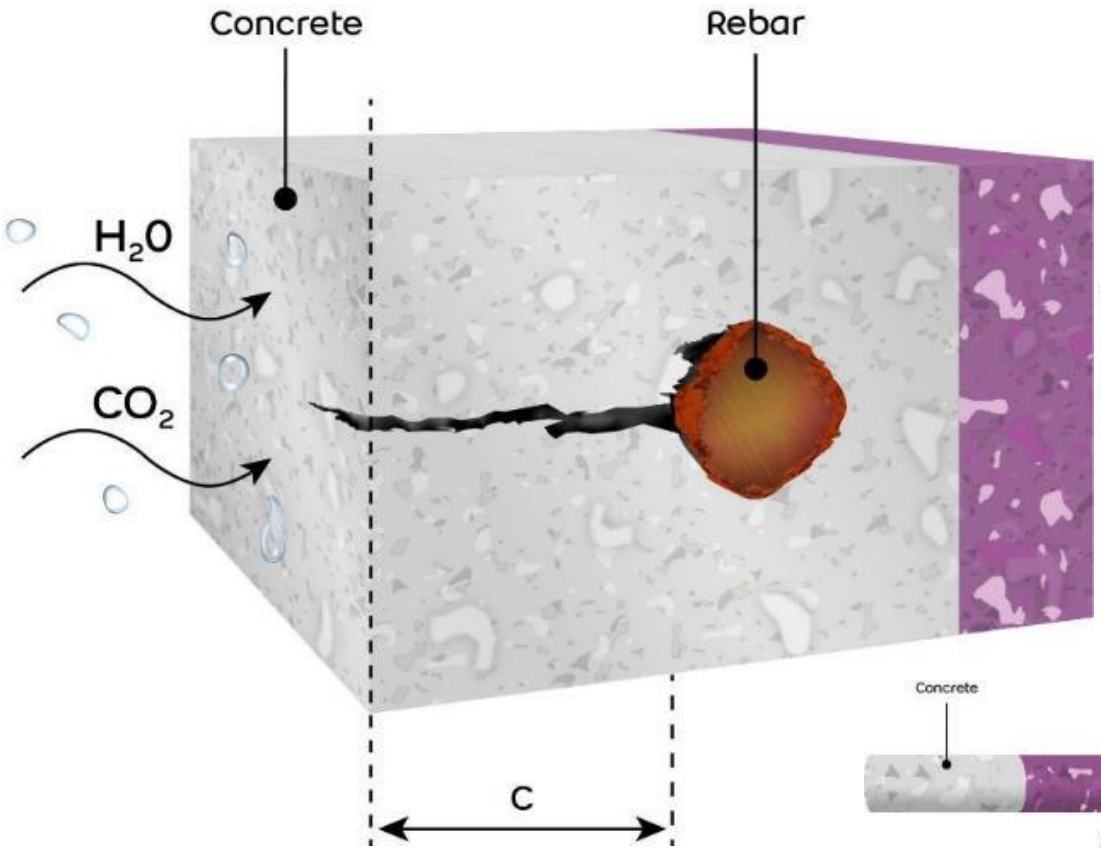


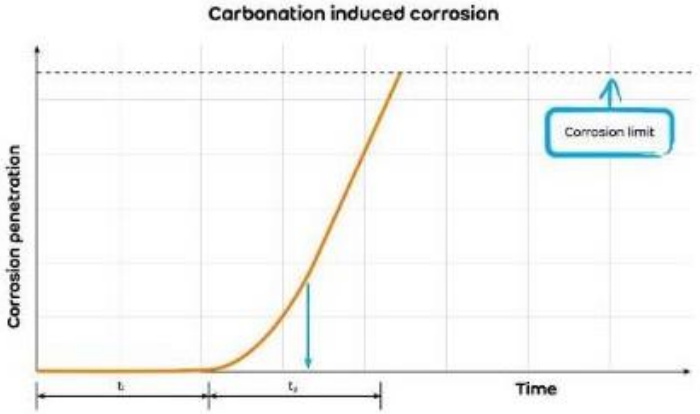


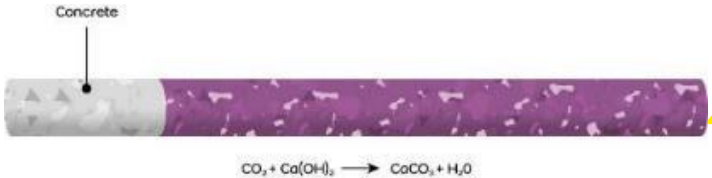


weber
SAINT-GOBAIN

CARBONATION INDUCED CORROSION







weber
SAINT-GOBAIN

BS EN 1504 – 9


Common causes of deterioration
Concrete
Reinforcement corrosion
Mechanical
Chemical
Physical
Fire
Carbonation
Corrosive contaminants
Stray currents
Sulphate attack
Alkali aggregate reaction
Freeze/Thaw

BS EN 1504 – 9


Common causes of deterioration
Concrete
Reinforcement corrosion
Mechanical
Chemical
Physical
Fire
Carbonation
Corrosive contaminants
Stray currents
Sulphate attack
Alkali aggregate reaction
Freeze/Thaw

CHLORIDES INDUCED CORROSION

- Where?
  - Marine Environment (salt water)
  - De-icing Salts
  - Cast in chlorides
  - Accelerators (Pre-1980's)
- Impact:
  - Attacks passive layer by changes in electro-potential

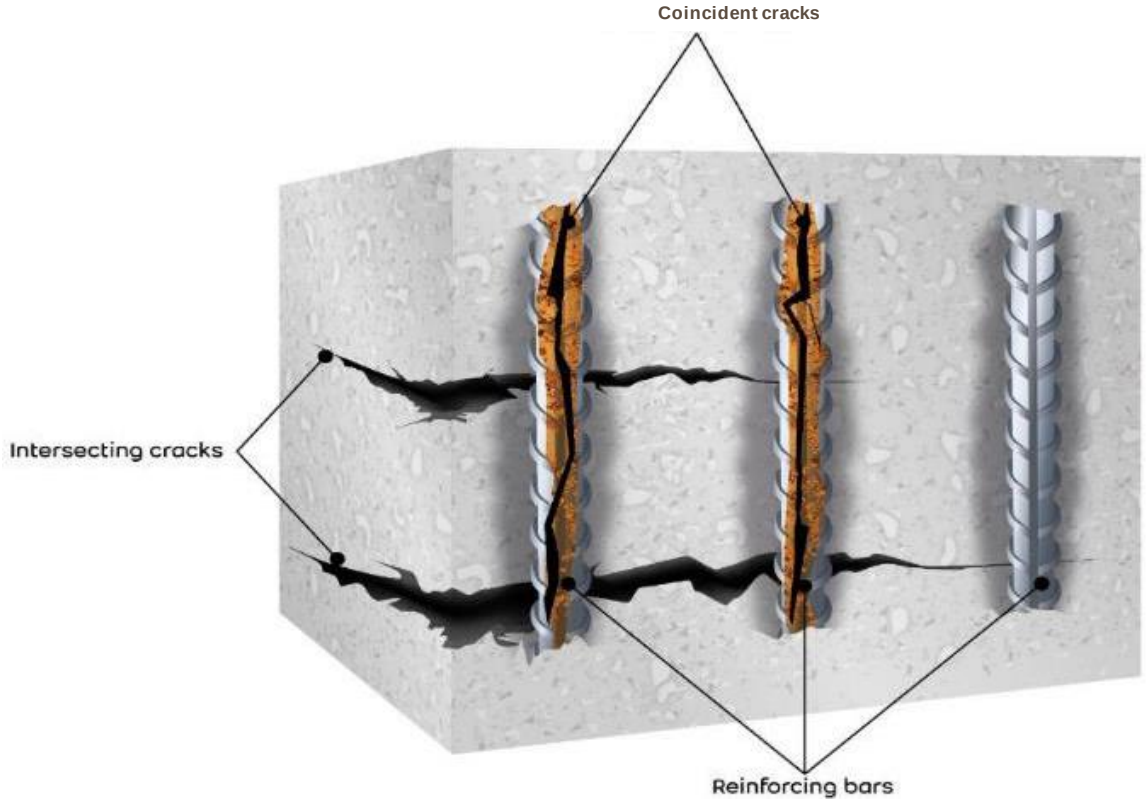
Without removal of all chlorides corrosion will continue at new sites!

weber SAINT-GOBAIN

RELEVANCE OF CRACKS TO REINFORCEMENT CORROSION

TYPES OF CRACKS

- Coincident cracks
  - Follow the line of reinforcement
- Intersecting cracks
  - Crossing the reinforcement



Change of the properties of crack with time (propagation status)

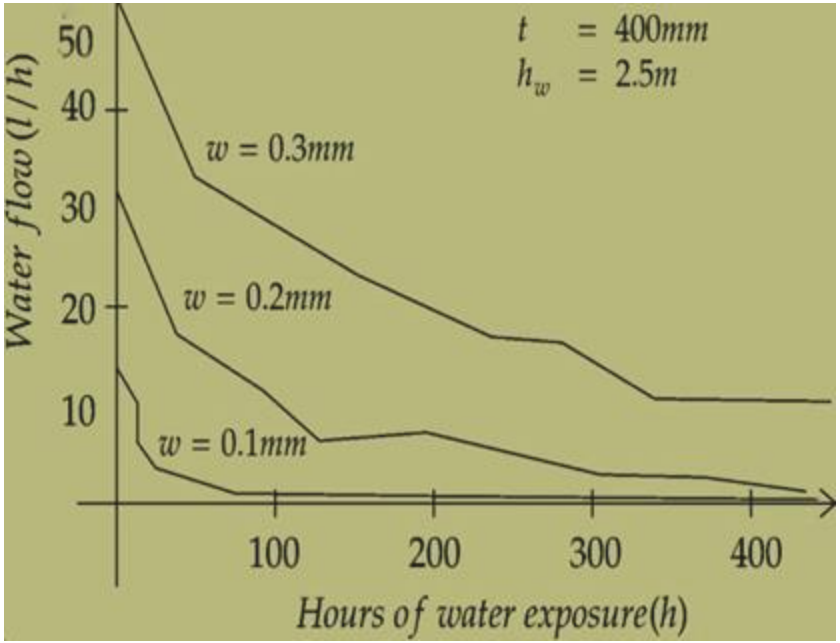
Type of crack	Dormant	Live
Plastic Shrinkage	✓	
Hydration temp difference	✓	
Shrinkage	✓	✓
Thermal expansion		✓
Pathological expansion (freeze-thaw, AAR)		✓
Settlement of foundations	✓	✓
Load	✓	✓

Crack Type (Nielsen, 1978). Adopted by The Concrete Society and published in TR 44

weber
SAINT-GOBAIN

SELF HEALING

- Main reason
  - Ongoing cement hydration
- Other factors
  - Crack width
  - Hydraulic gradient

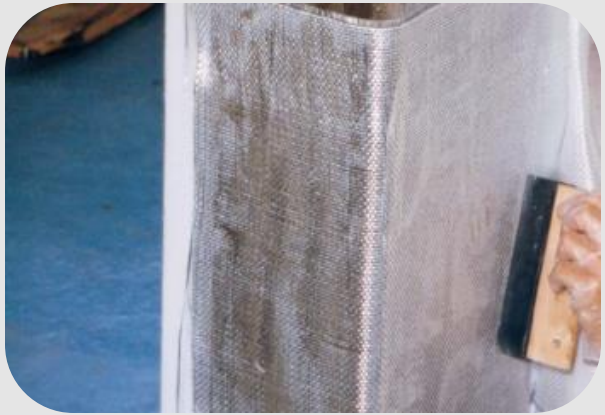


Concrete society, Technical report 44, page 11

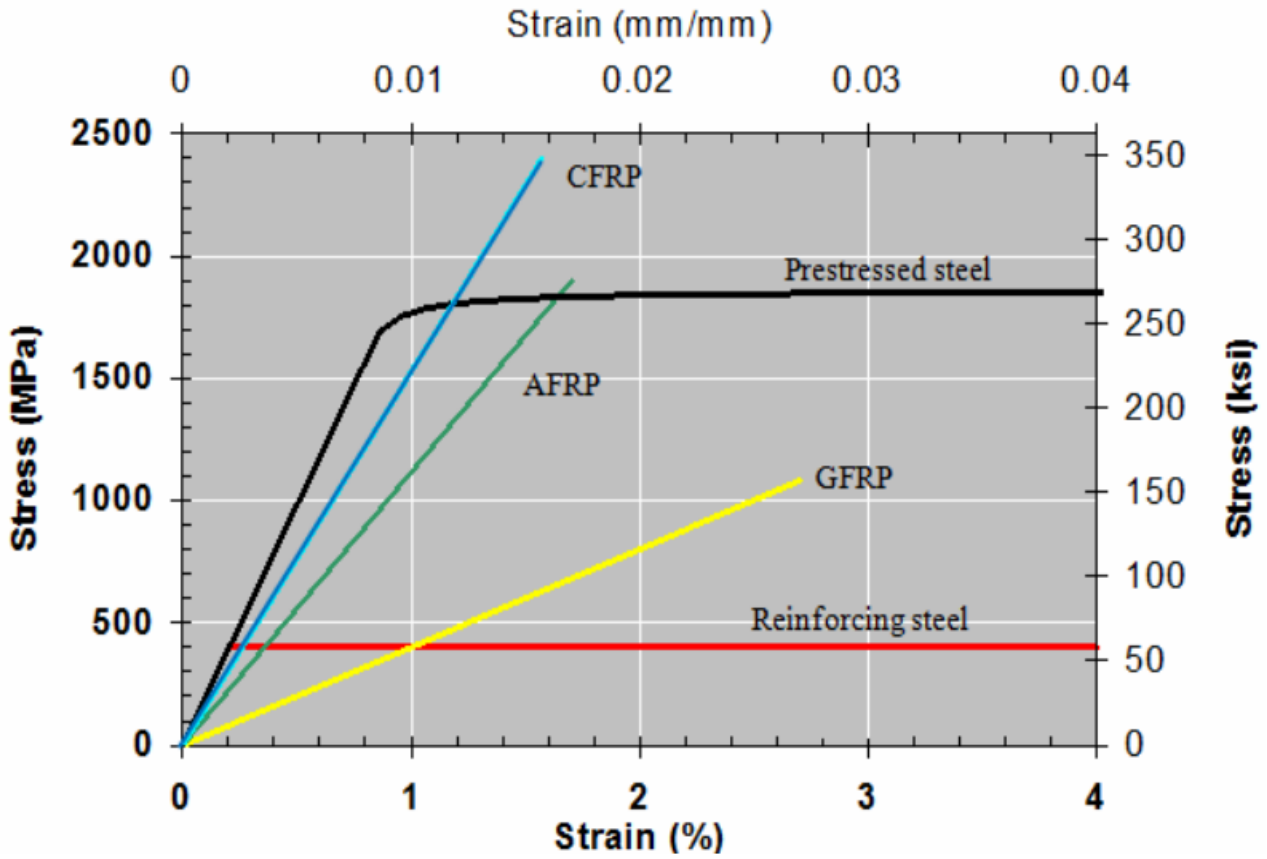
STRUCTURAL STRENGTHENING USING FRP

INTRODUCTION TO RESIN AND FIBRE TYPES

- What are fibre reinforced polymers?
  - **Fiber-reinforced polymer** (**FRP**) is a composite material made of a **polymer matrix reinforced with fibers**.



STRESS/STRAIN CURVE



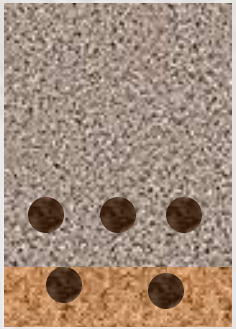
Source: ACI 440R2-96

FRP VS. CONVENTIONAL UPGRADE

SIMPLY SUPPORTED BEAM; 35% UPGRADE IN LIVE LOAD

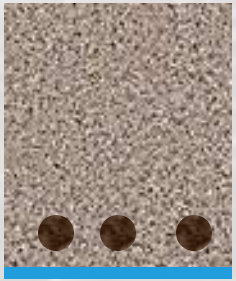
Bonded steel plate

- 6mm bolted plate
- 110 kg. dead load
- placed by lift truck



Member enlargement

- 2 Ø16mm rebar
- 100mm. concrete
- 1110 kg. dead load
- formed and cured



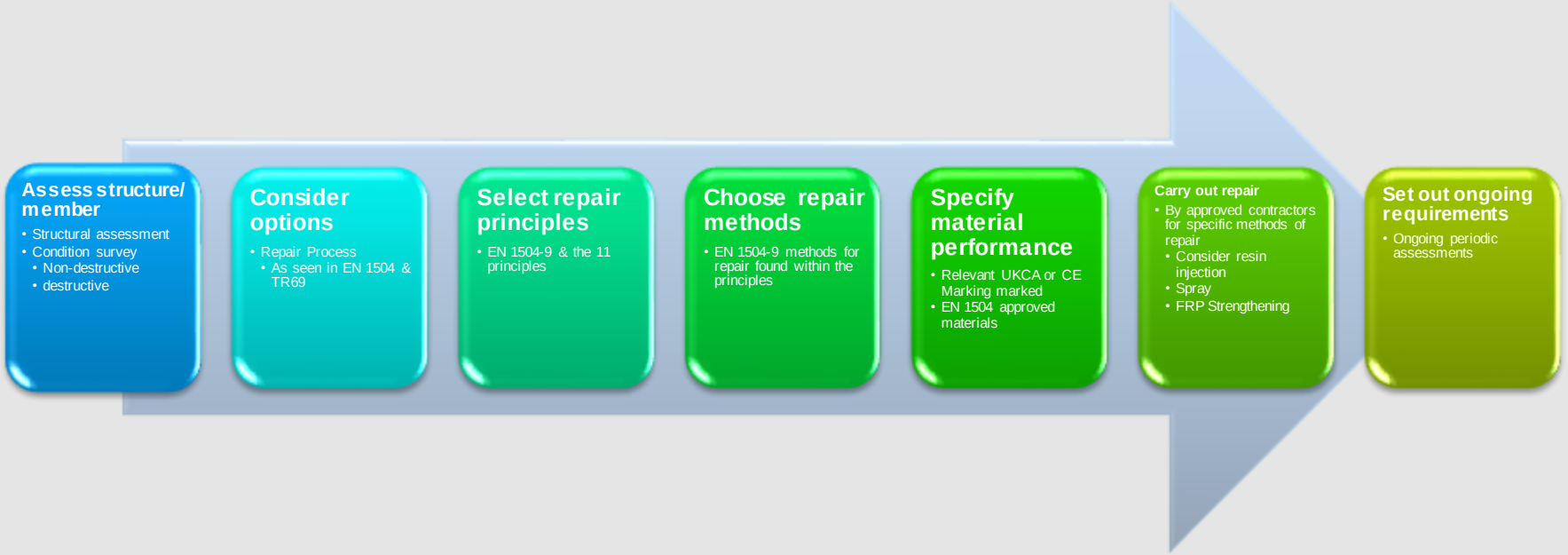
FRP sheet

- 1 layer resin bonded
- 1.5 kg. dead load
- placed by hand

weber
SAINT-GOBAIN

THE REPAIR PROCESS

REPAIR PROCESS/STRATEGY



CASE STUDIES

SPRAYED CONCRETE REPAIRS

- Large areas of structural concrete
- Highway structures
- Fire damaged concrete structures
- Rock and embankment stabilization

New Elvet Bridge, Durham

- M56 Wilmslow Bridge, Manchester
- M60 Junction 12 Bridge Refurbishment
- Deansbrook Viaduct - M1 Motorway
- Thelwall Viaduct M6
- A30 Shadftsbury Road Bridge Dorset
- Clyde Tunnel Approach Road
- Corkerhill Road Bridge, Paisley
- Blair's Bridge, Redding, Scotland
- A38/M6 Spaghetti junction
- Puntney Bridge
- Hammersmith Flyover
- M25 A12 Brentwood
- M25 Swanley Interchange
- Redbridge Flyover
- M1 Mil Hill Junc 2 & 3

weber
SAINT-GOBAIN

A90, GLENCARSE, PERTH

- Where a flowing, self-compacting repair concrete is required
- Where a structural (R4) repair concrete is required
- In areas of congested steel or difficult-to-access reinforcement

RECASTING CONCRETE

- Flowable & pumpable cementitious non shrink structural repair concrete ideal for deep section repairs and grouting
- webercem five star repair concrete CP (R4)
- R4 Hand Placed Mortars

- Moor Park Underground—Askew Road Bridge MR70A
- A71 Williamston Interchange Bridge, Scotland
- A52 Clifton Bridge Nottingham
- M5 Exminster Viaduct
- Bow Bridge, Wateringbury, Kent
- M8 Kingston Bridge, Glasgow
- Area 9 Midland Links M6, M5, M54
- Walton New Bridge, Warrington
- HS2 Bromford
- Coulsdon Town Centre Bypass/Regeneration (SP)

weber
SAINT-GOBAIN

CONCRETE PROTECTION

webertec aquapel crème

- Highly water repellent, but breathable
- Prevents chloride ingress, prevents carbonation
- Long-life (>25 years and counting)
- Not affected by mechanical impact & retains concrete appearance

---

- Brandy Bridge Merthyr Tydfil
- M2 Medway Bridge, Kent
- Needle Eye Bridge, M1, Yorkshire
- Stanley Bridge Lake District, Cumbria

weber
SAINT-GOBAIN

SUFFOLK STREET BRIDGE, BIRMINGHAM

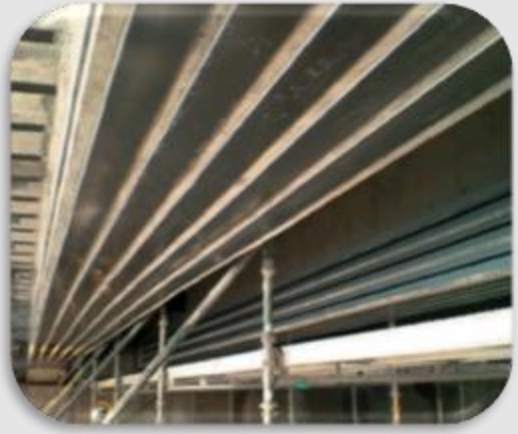
FRP STRENGTHENING & EPOXY RESINS.

- Structural strengthening of cast iron lamp stands for Tower Bridge, London
- Corkerhill Road Bridge, Paisley, Scotland
- A647 Henconner Lane Bridge, Stanningly Bypass, Leeds
- M6 Cumbria Bridges, J38—J40
- M2 Gillingham Bridge, Junction 4
- M62 Ashfield Bridge, Milnrow - J21
- Taney Bridge, Dundrum, Dublin
- Dockland Light Railway - London City Airport link
- Deansbrook Viaduct - M1 Motorway
- Pont Glanhros Wales Culvert

weber
SAINT-GOBAIN

BARNES BRIDGE, M60 MOTORWAY, CHEADLE IN CHESHIRE

- Client: Highways England
- Carbon Fibre strengthening
- Time saved (50% on programme) using FRP
- 5,500 metres of carbon fibre plate used



WEBER ANNUAL GOLF DAY

A chance for three winners

8th of September

Staverton Park Hotel & Golf Club

Daventry

Register your interest here:

https://bit.ly/3nVBrFY

OR

GET IN TOUCH WITH US

- Ahmed Sobhy
  - ahmed.sobhy@netweber.co.uk
  - 07542 861 250

- Paul Rigby
  - paul.rigby@netweber.co.uk
  - 07980 605 264