

A SYSTEMATIC APPROACH FOR REPAIRS TO PARKING STRUCTURES



PATRICK DUFFY
APPLICATION FIELD MANAGER - REPAIR & PROTECTION
SIKA CANADA INC.

WHY CONCRETE REFURBISHMENT?



- Check the oil/fluids
- Check the tires
- Clean the car
- Service it regularly

If I don't look after my car?

WHY CONCRETE REFURBISHMENT?



IF WE DO NOT MAINTAIN CONCRETE STRUCTURES!



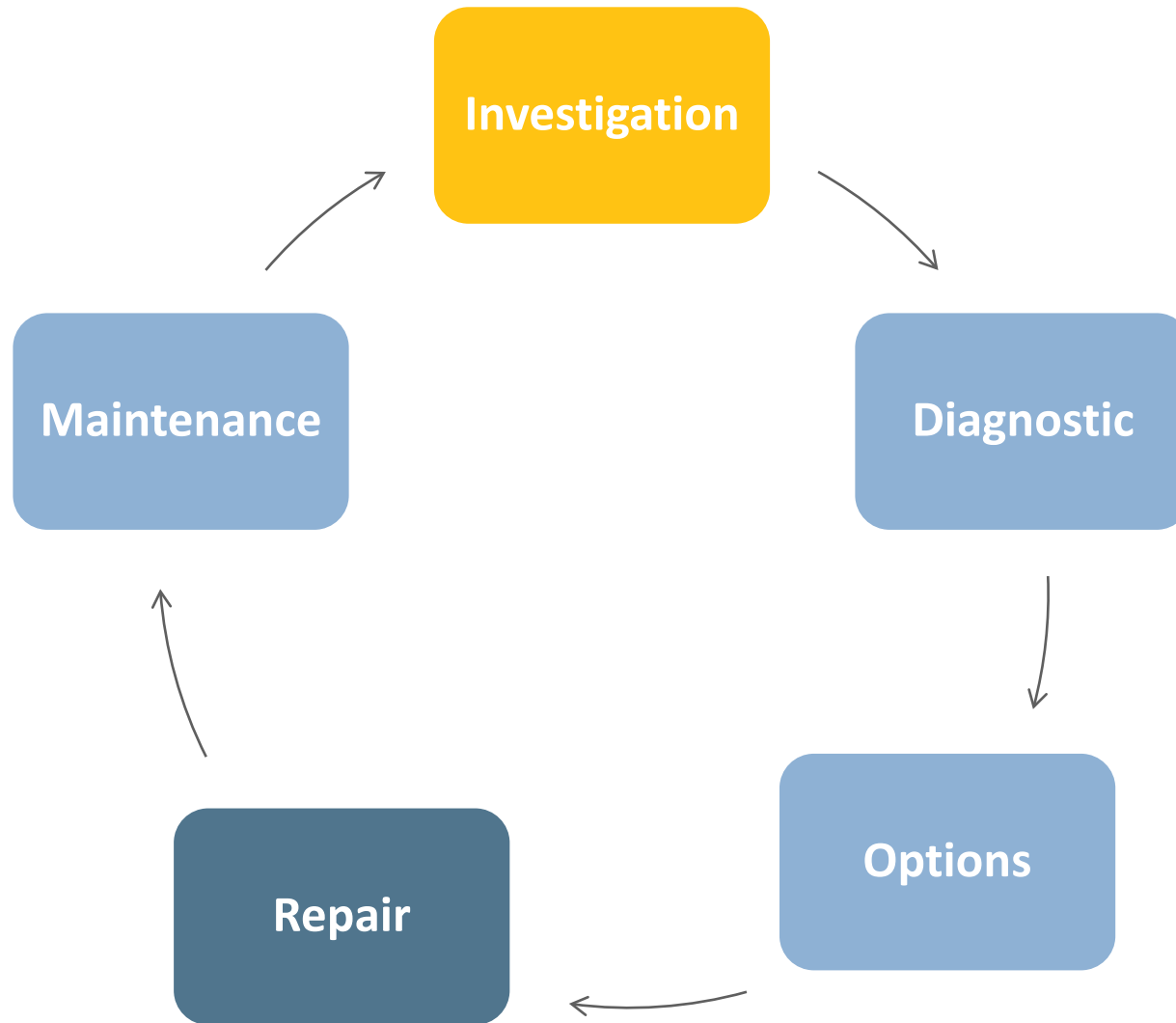


WHAT SHOULD WE DO TO THIS STRUCTURE?





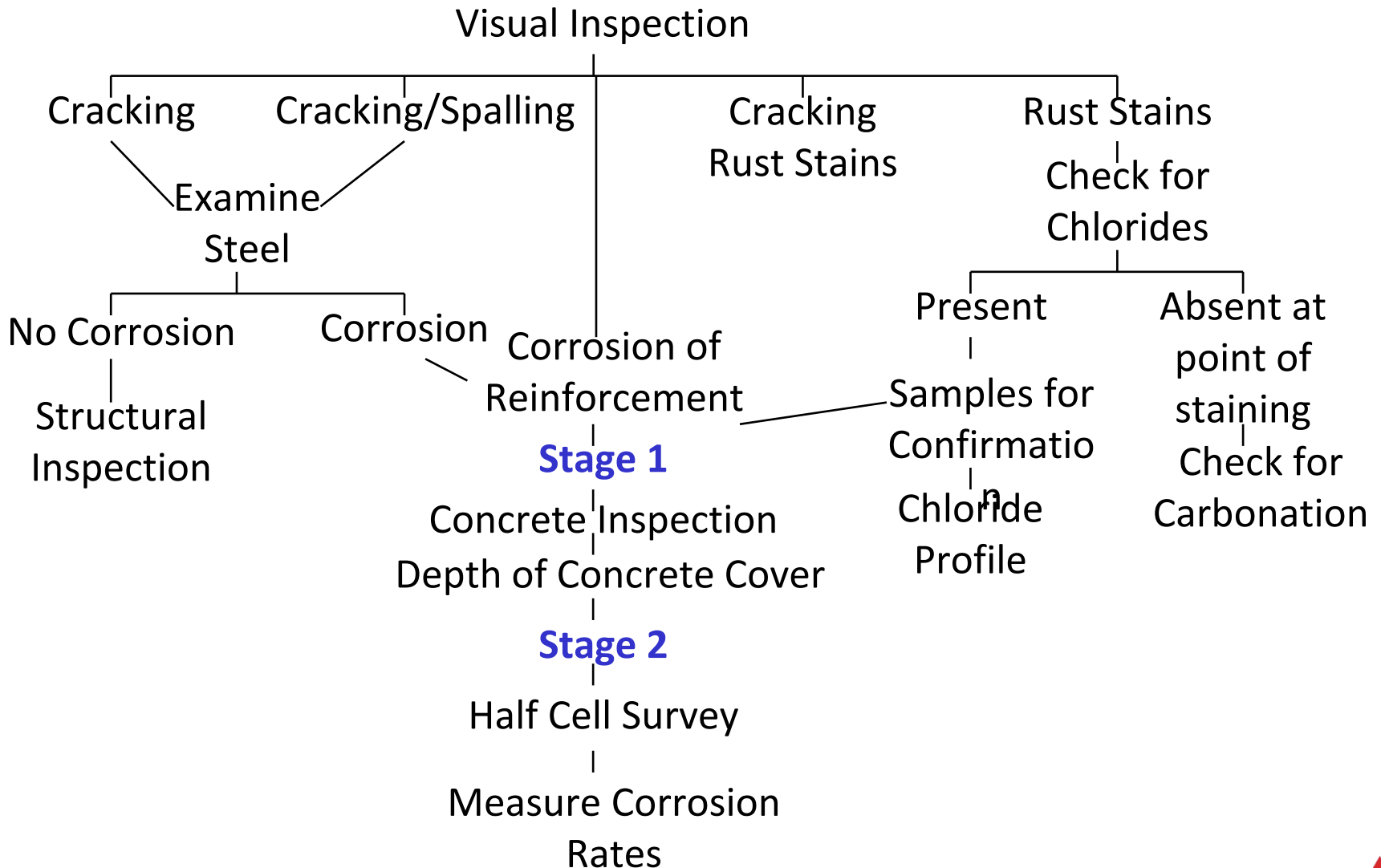
5 KEY STAGES IN CONCRETE REPAIR



Concrete Assessment



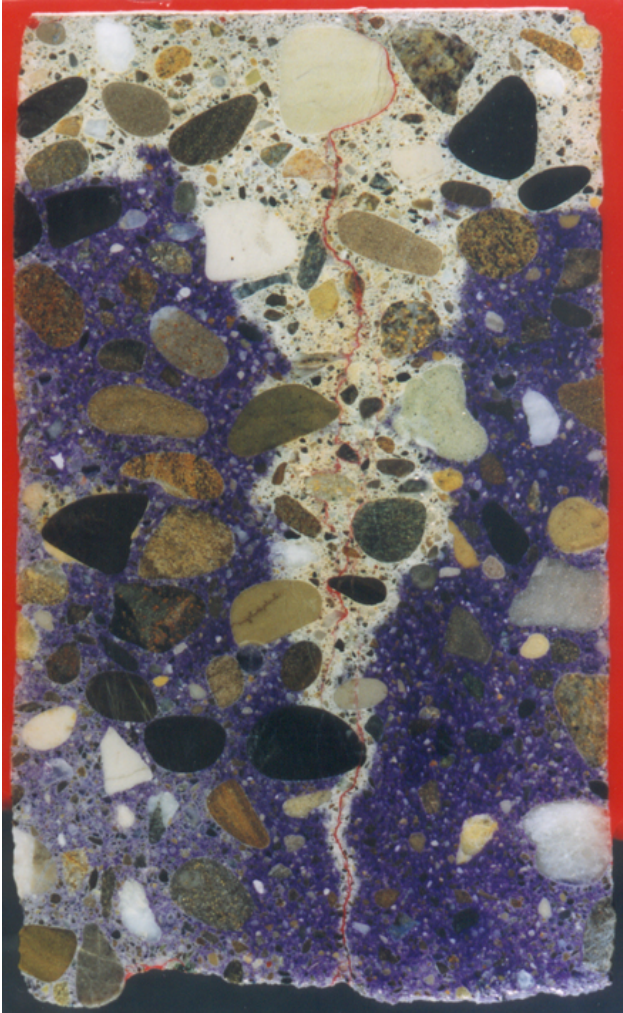
FLOWCHART FOR INSPECTION OF CORRODED STEEL IN CONCRETE



CHECKING FOR CARBONATION



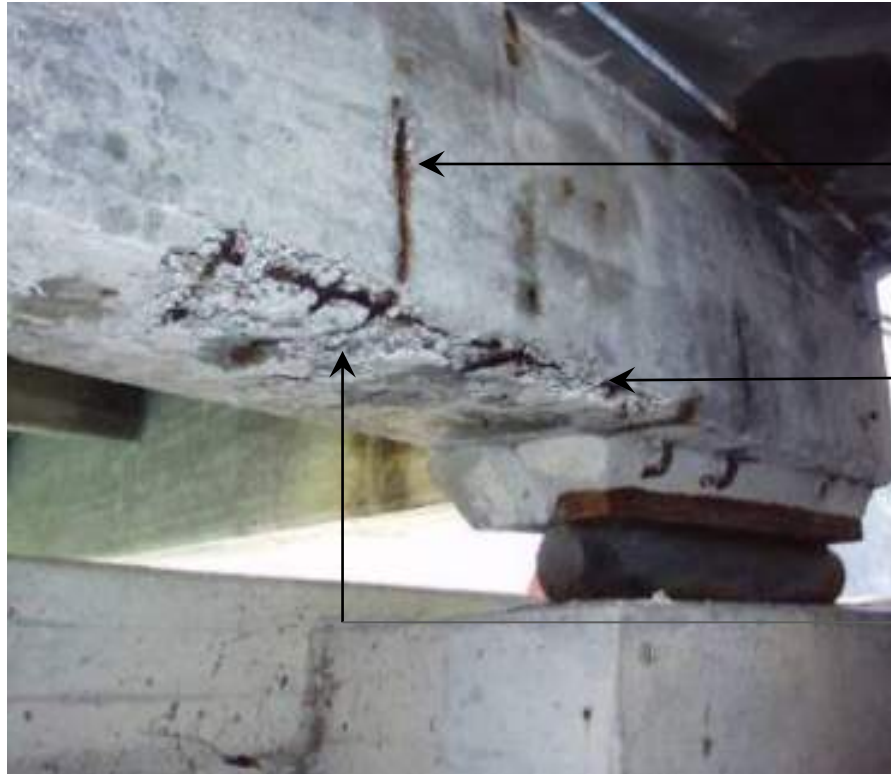
CARBONATION OF CONCRETE



- The core on the left has a crack which starts on the top and continues almost to the bottom of the core. Notice the pattern of the carbonated concrete.
- The block above was intentionally cast with low cover to demonstrate the effect of low cover and untreated cracks.



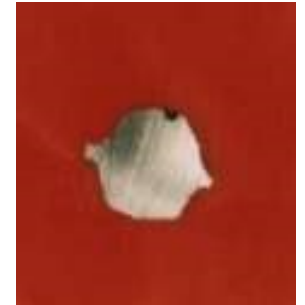
CORROSION DUE TO CARBONATION PROCESS



Concrete spalling

Corroded rebar

Low concrete cover



Reduction of rebar: approx. 0.02 to 0.2 mm per year





CHLORIDE ATTACK



- De-icing salt
- Sea water
- Industry salt (softening agent)
- Edible salt (cheese dairy, food production)
- Swimming pool (saline bath, water treatment, etc.)
- Magnetite floors ($MgCl_2$)
- Combustion of PVC



CORROSION OF REBARS DUE TO CHLORIDE



Reduction of rebar: approx. 1 to 10 mm per year!!

INVESTIGATION SUMMARY

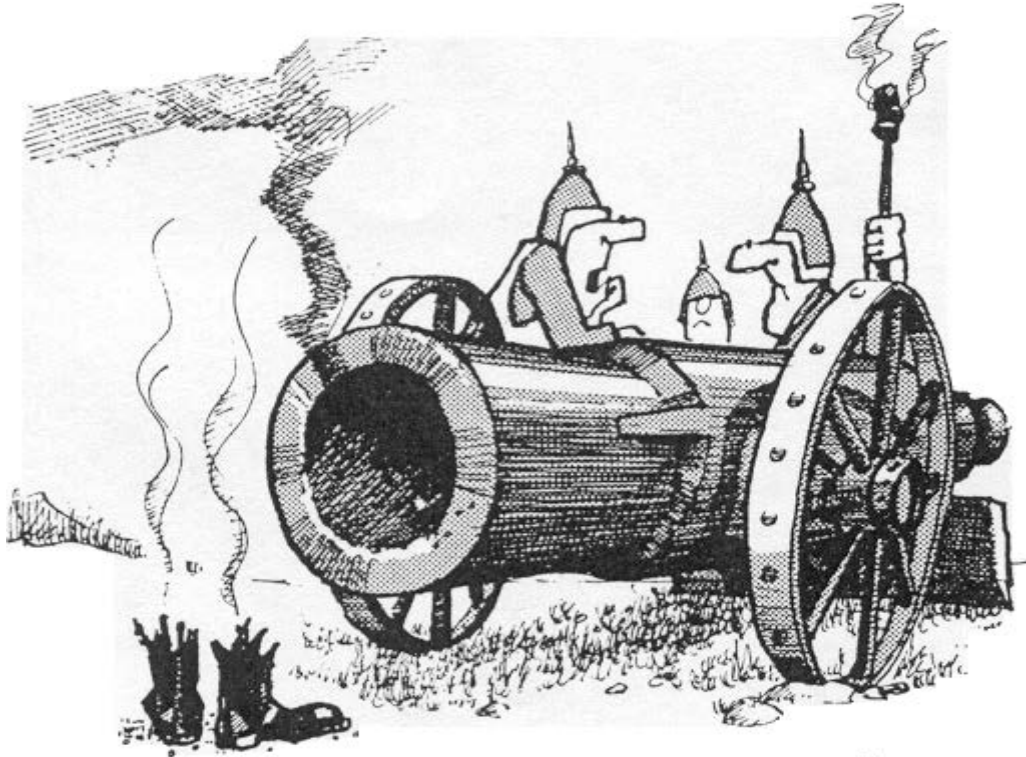
- Investigation should be the basis of all concrete repair work
- Cost of investigation is not proportional to value of the structure
- Investigations are mainly undertaken when damage is obvious
- Testing programs are not standardized
- Provide meaningful conclusions used to prepare specifications and a repair strategy



THE CONCRETE REPAIR PROCESS – WHAT'S REQUIRED?

- Accurate survey and investigation interpreted by an experienced engineer.
- Technically correct and practical specification.
- Good workmanship by an experienced repair contractor.
- On site supervision / control provided by a qualified engineer.

AS WITH ANYTHING, THE KEY IS GOOD PLANNING AND
GOOD PREPARATION...



Unger

“Herman ... two is load **THREE** is fire!”

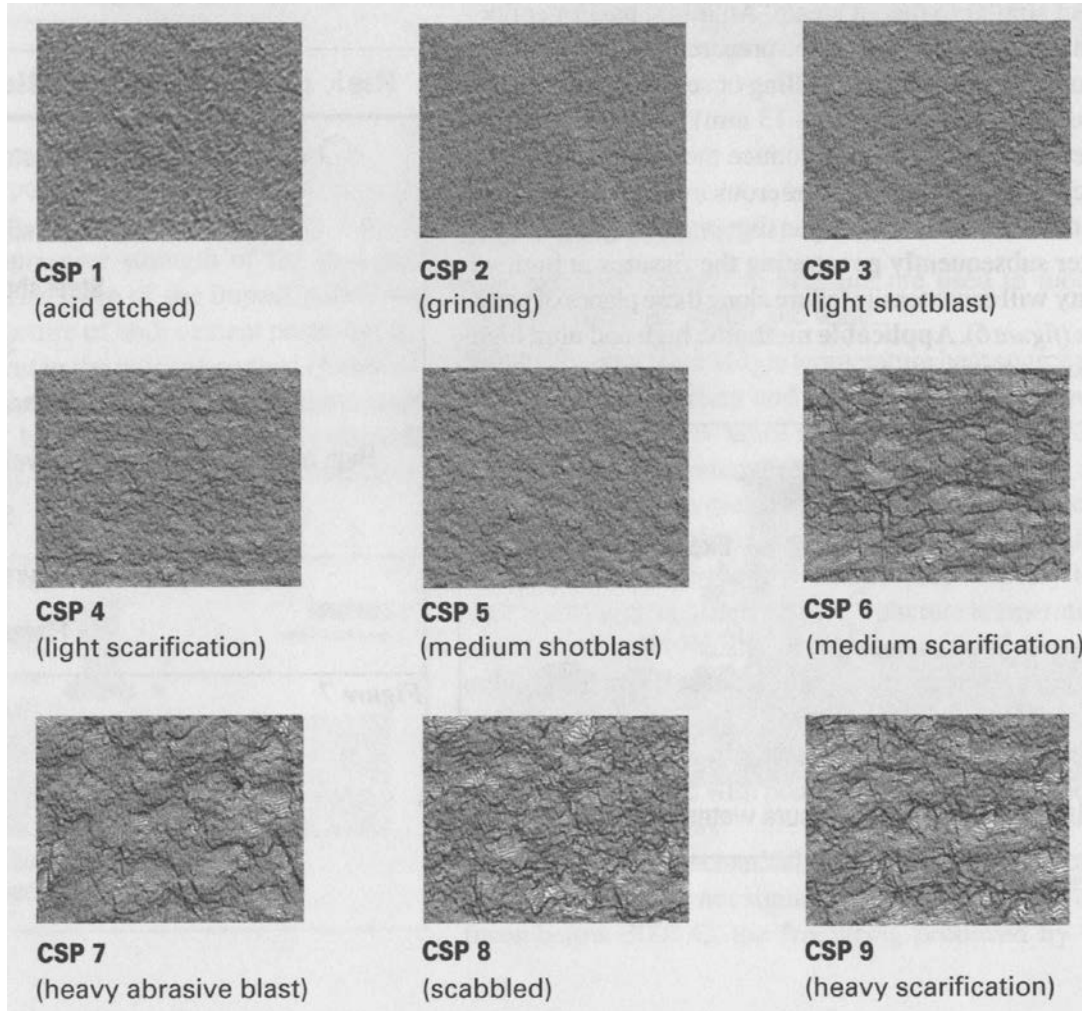
CONCRETE SURFACE PREPARATION

References:

ICRI Guideline 03730 “Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion”

ICRI Guideline 03732 “Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings and Polymer Overlays”

CONCRETE SURFACE PROFILES (CSP'S)



International Concrete Repair Institute (ICRI)

- Standardized Concrete Surface Profiles (CSP)
- Numbered 1 to 9 with increasing roughness as the numbers get higher
- Provides “standard” for surface profiles for all types of repairs

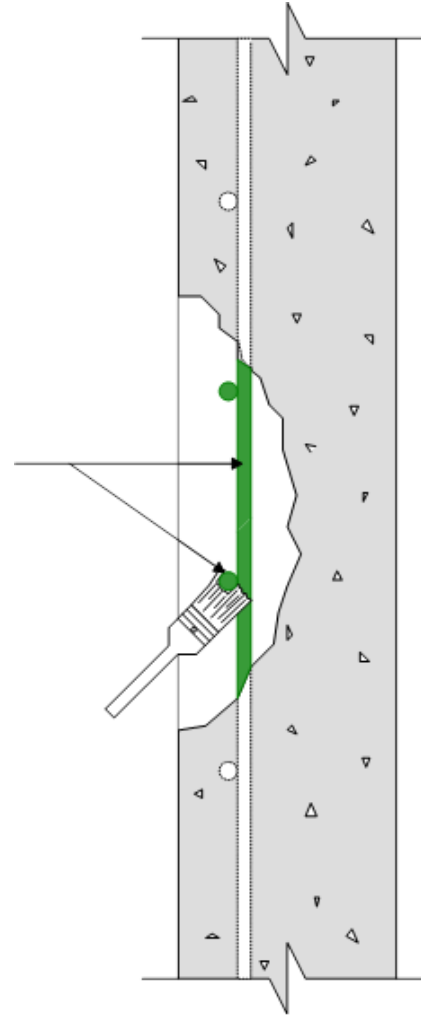


SURFACE PREPARATION

- Surface preparation is one of the most important parts of the repair process
- Good preparation is the key to getting the required surface profile
- Cutting back to trim costs in this area can be disastrous and costly.
- The most expensive jobs are the ones that have a lot of call backs as there is absolutely no profit to be made in this type of work

ANTI CORROSION COATING

SikaTop Armatec 110 EpoCem




SIKATOP ARMATEC 110 EPPOCEM



- Steel primer and bonding agent
- May be brush or spray applied
- Breathable for slab on grade applications
- Combines a water-based epoxy resin with a cement based binder for improved mechanical and chemical properties
- Ensures compatibility with cement based substrates

CORROSION MITIGATION SYSTEMS

Free Bulletins on Repair Application Procedures Page 1 sur 2



[Bookstore](#)
[Search](#)
[Feedback](#)
[RSS](#)
[Login](#)

[About ACI](#) • [Bookstore & Publications](#) • [Certification](#) • [Chapters](#) • [Committees](#) • [Conventions & Events](#) • [Education](#) • [International](#) • [Membership](#) • [Students](#) • [Technical](#)

ACI Press Release

Free Bulletins on Repair Application Procedures


These downloadable PDF's give you valuable how-to-do-it information on procedures used for five commonly used concrete repairs. Produced by ACI Committee E 706, Repair Application Procedures, the bulletins cover:

- Structural Crack Repair by Epoxy Injection (RAP-1)
- Crack Repair by Gravity Feed with Resin (RAP-2)
- Spall Repair by Low-Pressure Spraying (RAP-3)
- Surface Repair Using Form-and-Pour Techniques (RAP-4)
- Surface Repair Using Form-and-Pump Techniques (RAP-5)
- Vertical and Overhead Spall Repair by Hand Application (RAP-6)
- Spall Repair of Horizontal Concrete Surfaces (RAP-7)
- Installation of Embedded Galvanic Anodes (RAP-8)
- Spall Repair by the Preplaced Aggregate Method (RAP-9)

Each bulletin gives a concise description of the repair method including the purpose of the repair, when it should be used, needed surface preparation, material and equipment selection, and safety considerations. Step-by-step procedures that are also included will help repair technicians to do their jobs correctly. The bulletins are useful reference documents for facility owners, design professionals, and concrete repair contractors.


Users are encouraged to download these documents, make copies for distribution to their field personnel, and file them for future reference.

For other ACI documents dealing with concrete repair, [click here](#).

The reports are in pdf format - to read these you will need Adobe Acrobat Reader 

- [RAP-1](#)
- [RAP-2](#)
- [RAP-3](#)
- [RAP-4](#)
- [RAP-5](#)
- [RAP-6](#)
- [RAP-7](#)
- [RAP-8](#)
- [RAP-9](#)

<http://www.concrete.org/general/PressReleases/RepairApplicationProcedures.htm> 2009-04-25


 *ACI RAP Bulletin 8*

American Concrete Institute®
Advancing concrete knowledge

FIELD GUIDE TO CONCRETE REPAIR APPLICATION PROCEDURES

Installation of Embedded Galvanic Anodes

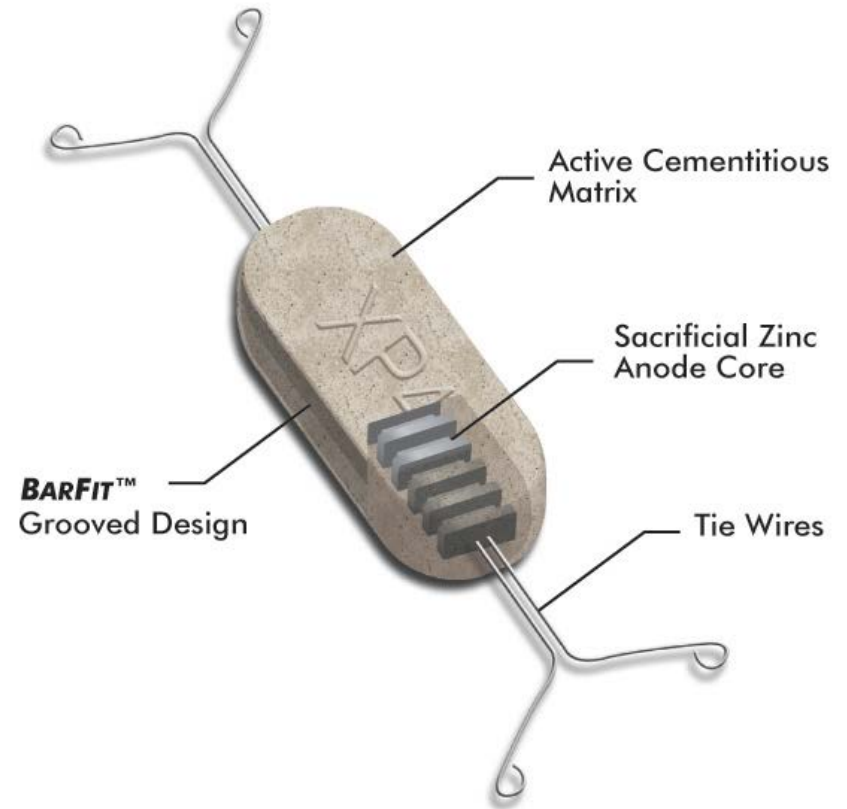
by David Whitmore



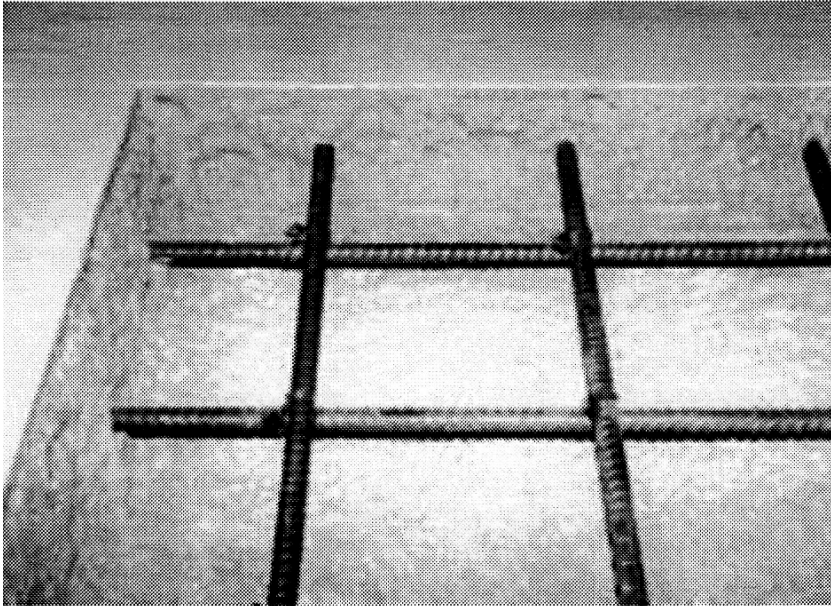
Installation of Embedded Galvanic Anodes (ACI RAP-8)

SIKA GALVASHIELD ANODES

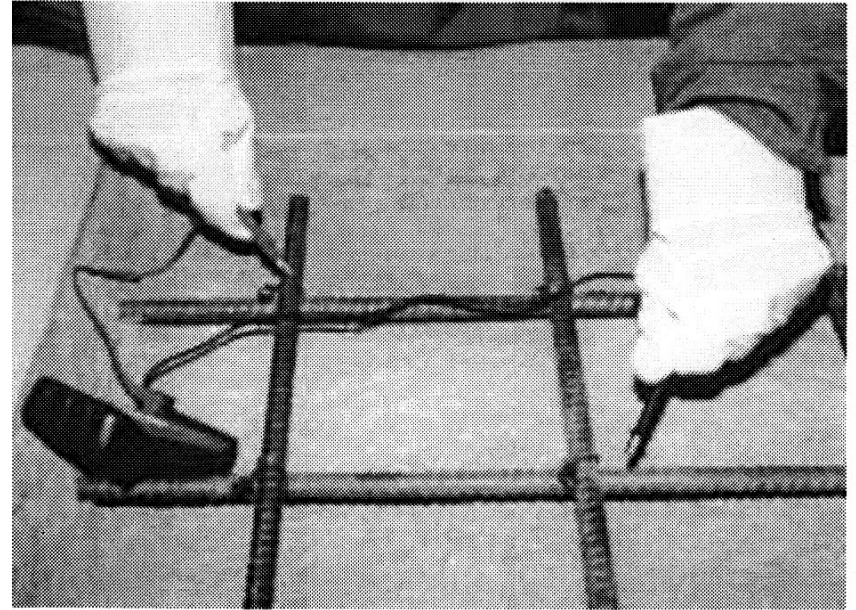
- Types of Galvanic anodes
 - Sika Galvahsiel XP
 - Sika Galvahsiel XPT
 - Sika Galvashield XP2
 - Sika Galvashield XP4
 - Sika Galvashield CC65



SIKA GALVASHIELD INSTALLATION

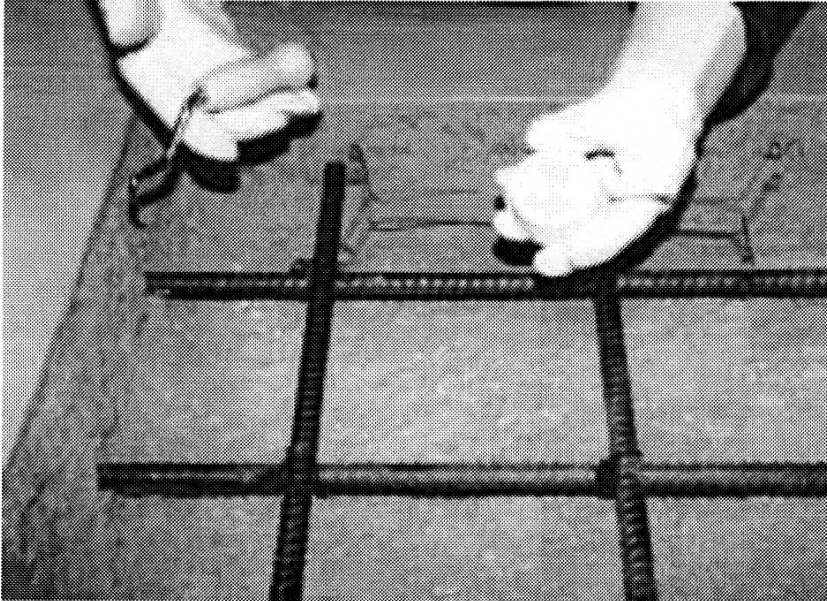


Sawcut & prepared patch

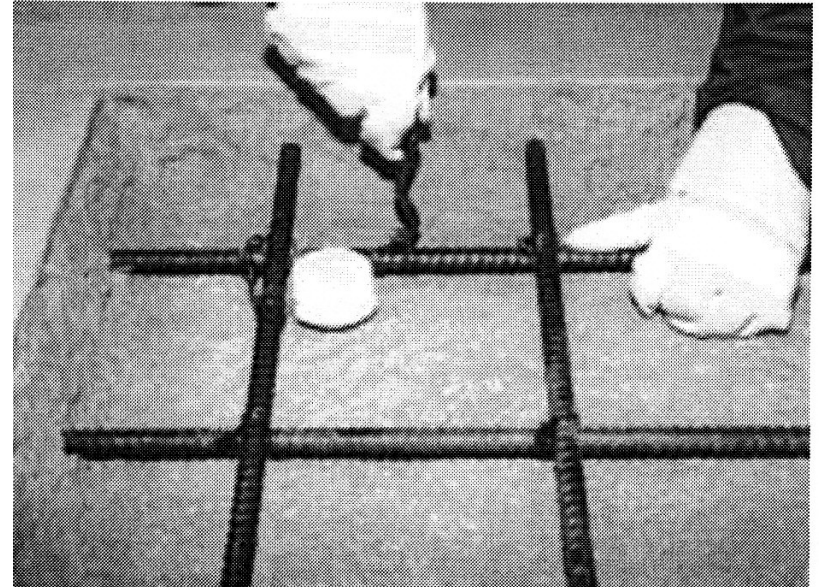


Check for continuity of the reinforcement.

SIKA GALVASHIELD INSTALLATION



Anode & installation tool



Securing anode to prepared reinforcement

INSTALLATION OD SIKA GALVASHIELD ANODES



SIKA GALVASHIELD XP2 ANODES FOR BEAM REPAIRS



SIKA GALVASHIELD ANODES FOR NEW TO OLD CONCRETE JUNCTIONS

- Anodes are installed along the edge of the existing concrete
- Anodes used to mitigate corrosion caused by the difference in electrical potential of the steel in the fresh concrete and existing concrete
- Anodes corrodes preferentially to the steel to provide protection



SIKA GALVASHIELD XP ANODE INSTALLATION WITH BEDDING MORTAR REQUIRED FOR HIGH RESISTIVITY REPAIR MORTARS OR CONCRETES

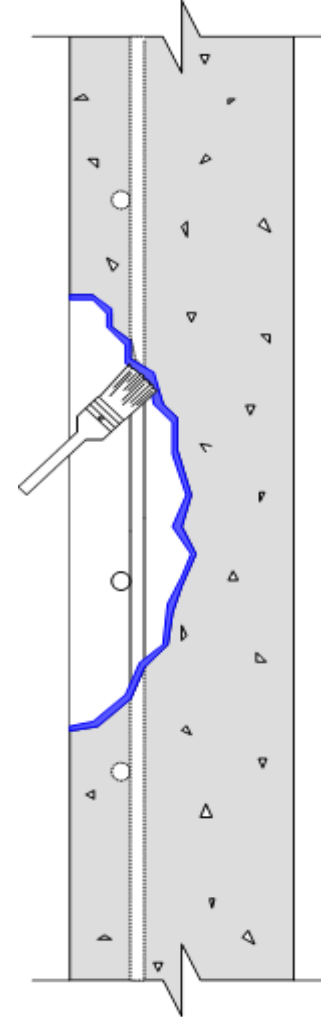


SIKA GALVASHIELD® CC ANODES



CONCRETE BONDING AGENTS

- SikaTop Armatec 110 EpoCem
- Sikadur 32 Hi-Mod
- Sikacem 810
- Sika Albitol Concentrate
- Sika Latex R



SIKATOP ARMATEC 110 EPOCEM

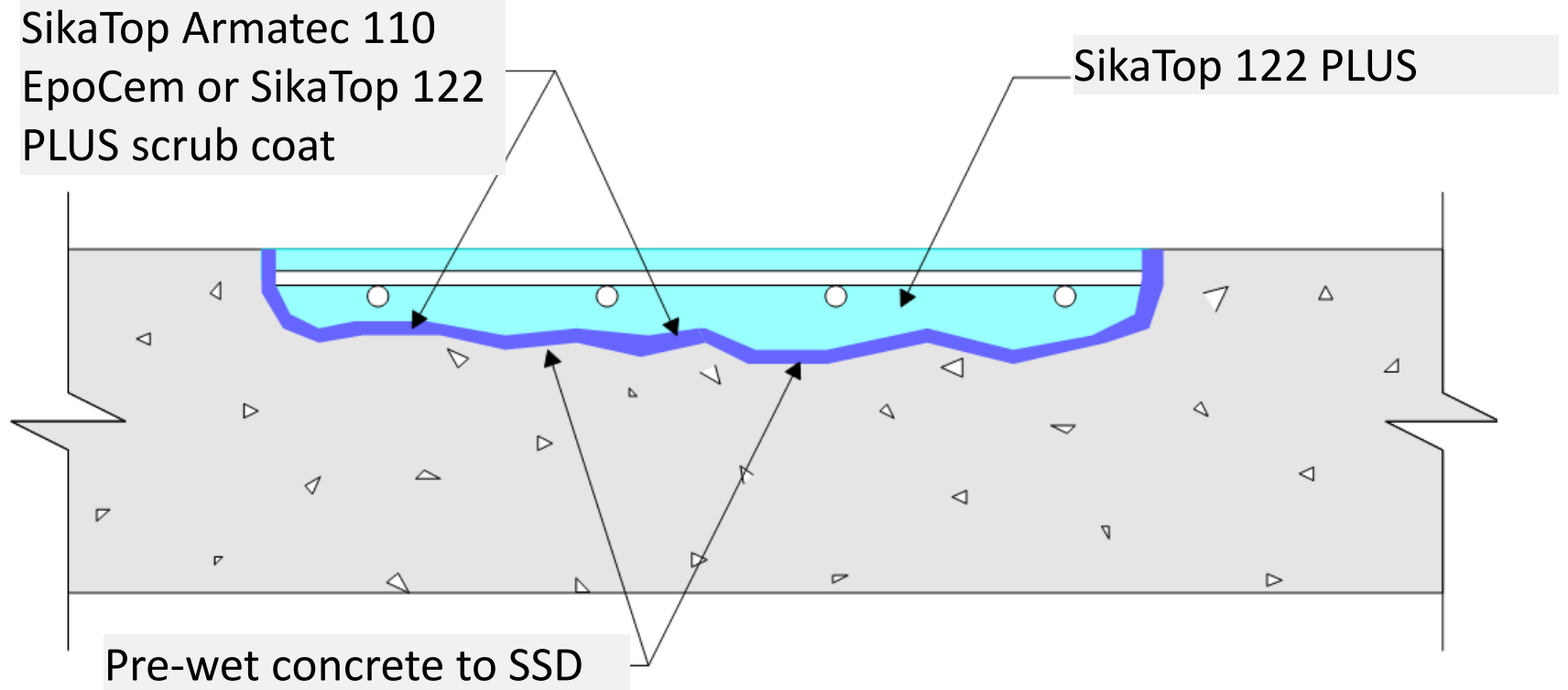


- Bonding agent for through slab repairs or bonded toppings
- Does not become a bond breaker if it dries as long as it is covered with concrete or a repair mortar within its open time
- Long open times (up to 12 hours at 20C)

SIKACEM 810 SAND/CEMENT SLURRY FOR BONDED TOPPINGS



HORIZONTAL REPAIR MORTAR



SIKATOP 122 PLUS REPAIR MORTAR FOR SLOPE CORRECTIONS



VERTICAL & OVERHEAD REPAIR MORTARS - HAND APPLIED

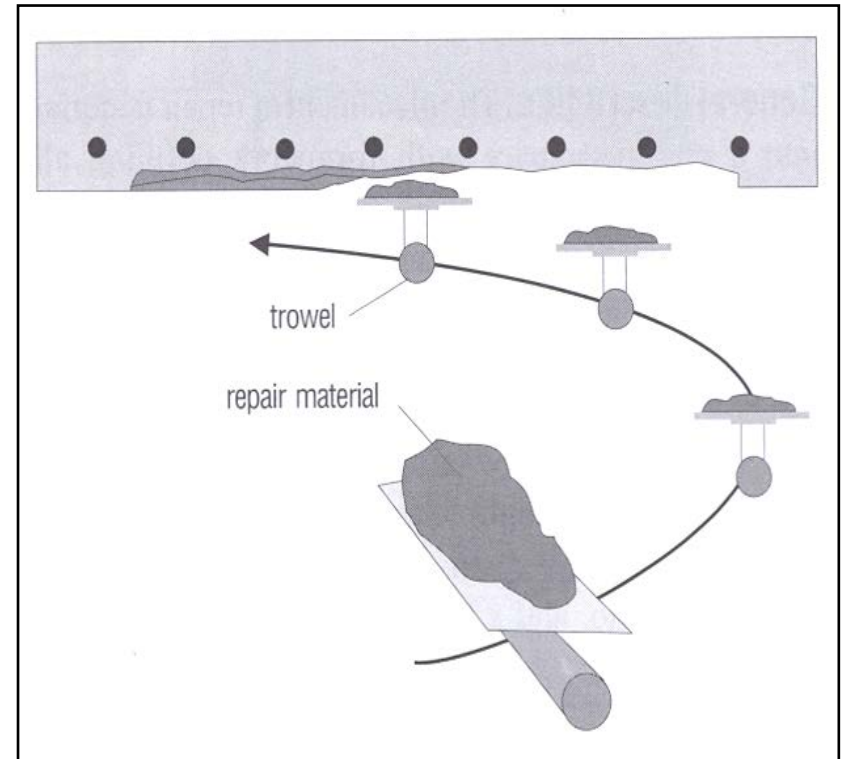
SikaTop 123 PLUS

SikaTop 123 PLUS Winter Grade

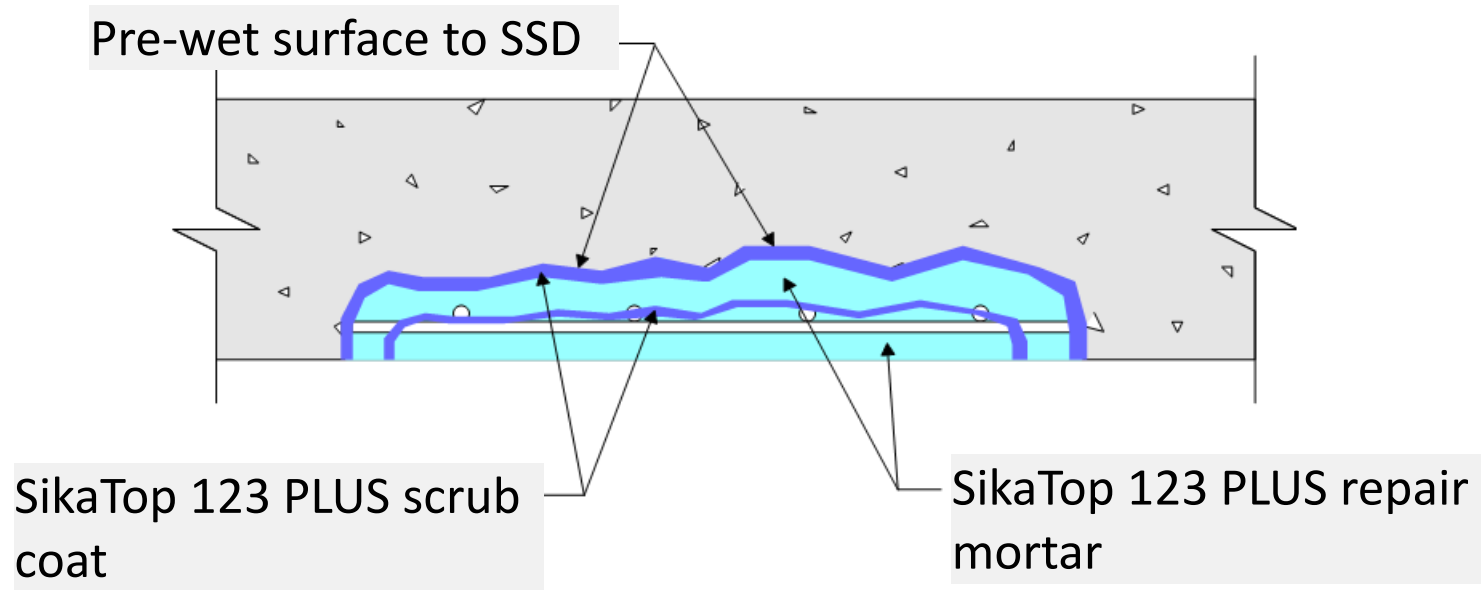
Sika MonoTop 623

SikaRepair 223 + Latex R

SikaRepair 223



VERTICAL & OVERHEAD REPAIR MORTAR

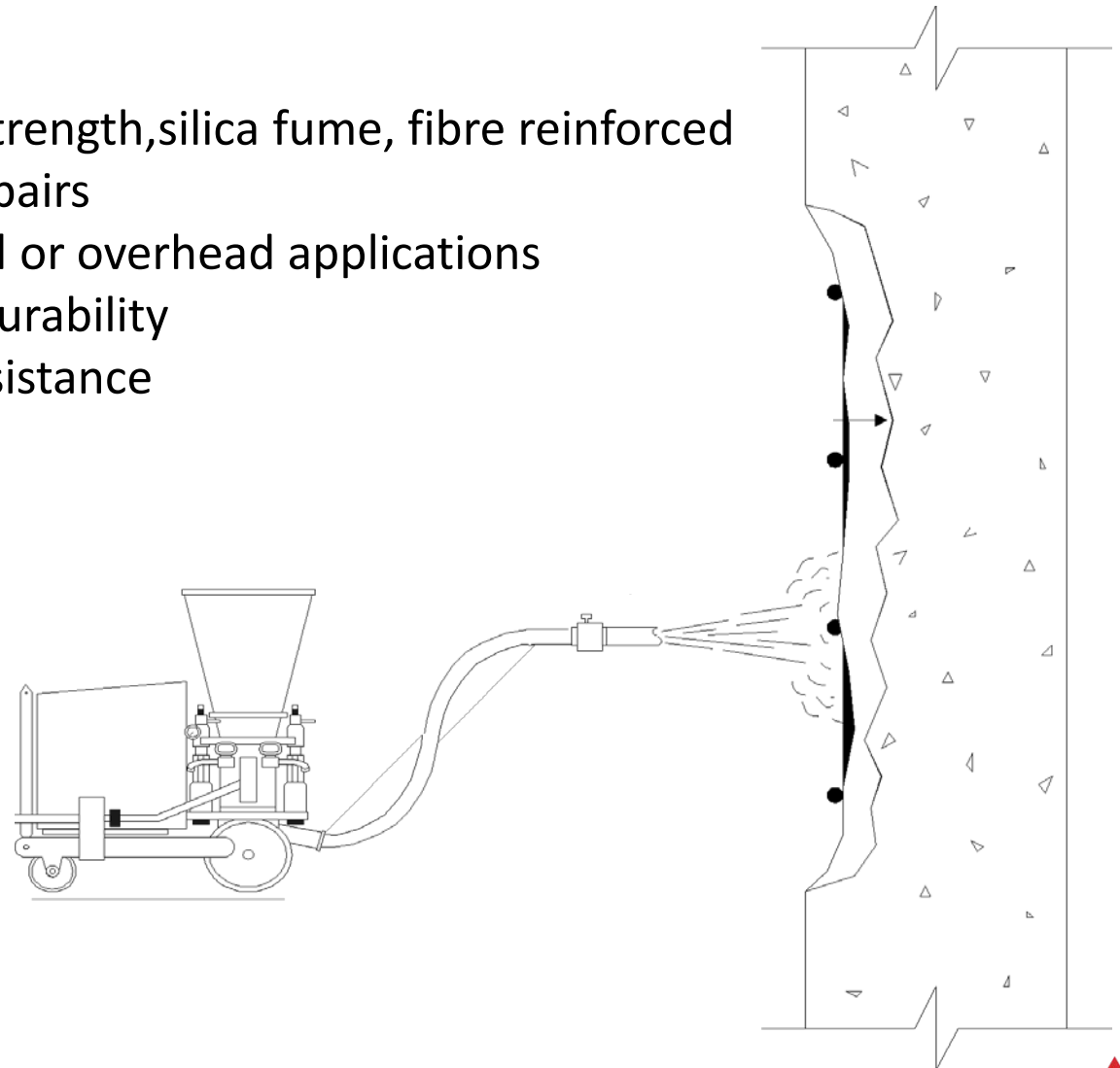


SIKATOP 123 PLUS VERTICAL & OVERHEAD REPAIR MORTAR



SIKAREPAIR 225 SPRAY APPLIED MORTAR

- One component, high strength, silica fume, fibre reinforced mortar for structural repairs
- May be used for vertical or overhead applications
- Excellent freeze/thaw durability
- Excellent salt scaling resistance



SIKAREPAIR 225 MACHINE APPLIED



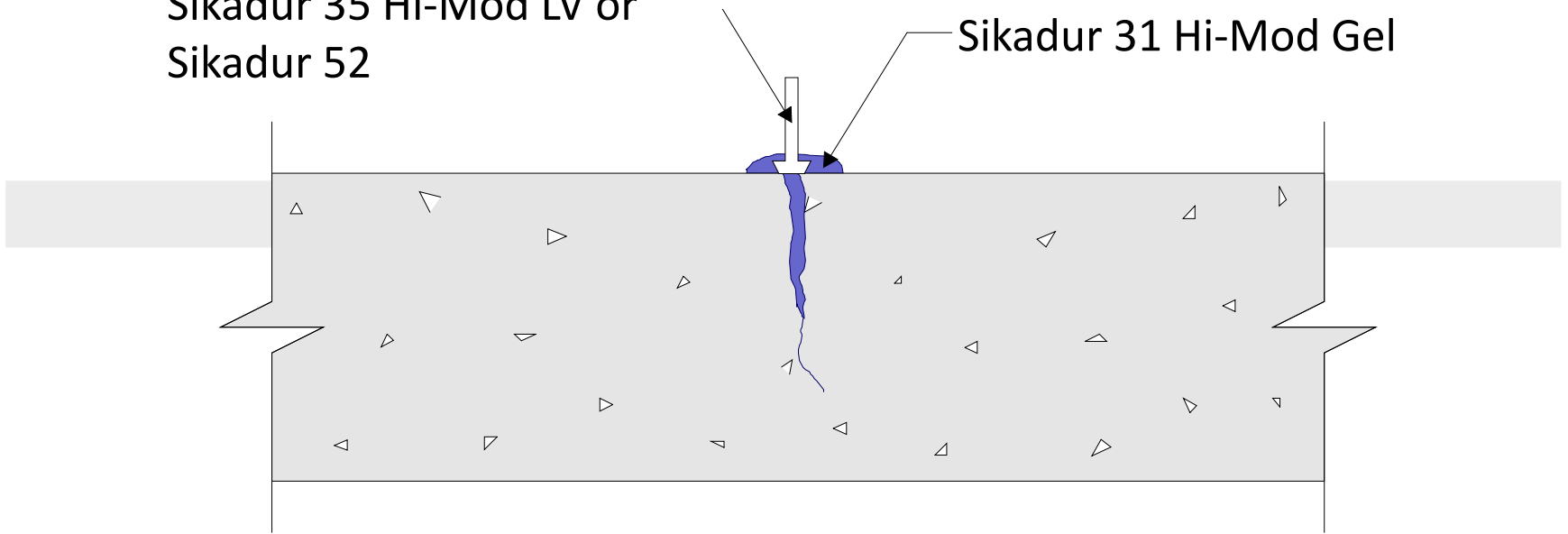
SIKACRETE-08 SCC FORM & PUMP APPLICATION



EPOXY INJECTION RESINS

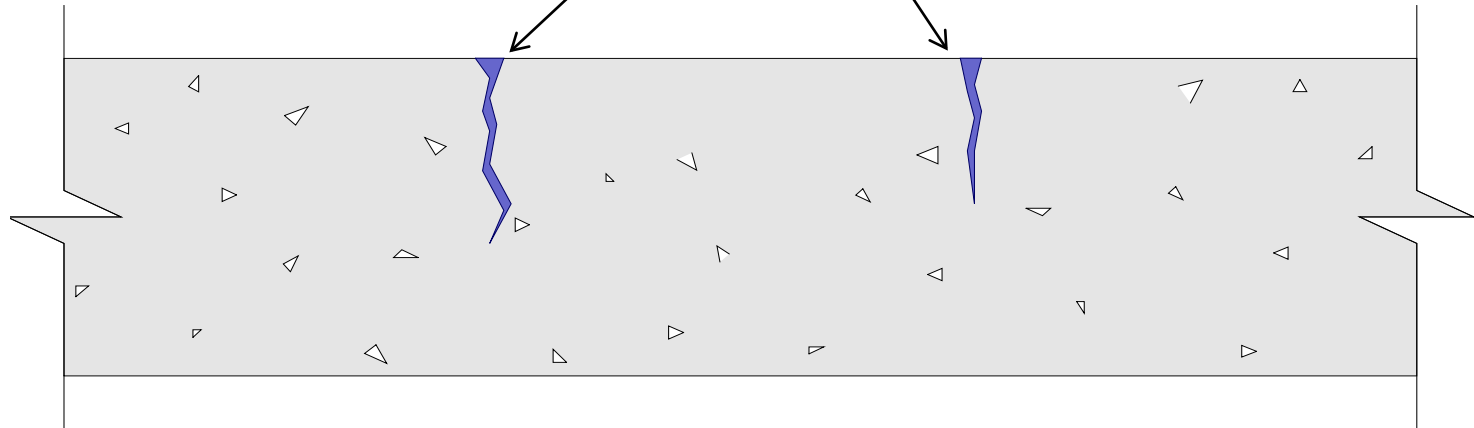
Sikadur 35 Hi-Mod LV or
Sikadur 52

Sikadur 31 Hi-Mod Gel



GRAVITY FEED CRACK TREATMENT RESINS

Sikadur 55 SLV or
Sikadur 35 H-Mod LV or
Sikadur 52



STRUCTURAL STRENGTHENING WITH STEEL BEAMS



- Structural adhesive to bond steel to hardened concrete
- Able to fill gaps up to 5 mm and to provide a flat, smooth surface to adhere to
- Sikadur 31 Hi-Mod Gel

STRUCTURAL STRENGTHENING USING FRP MATERIALS

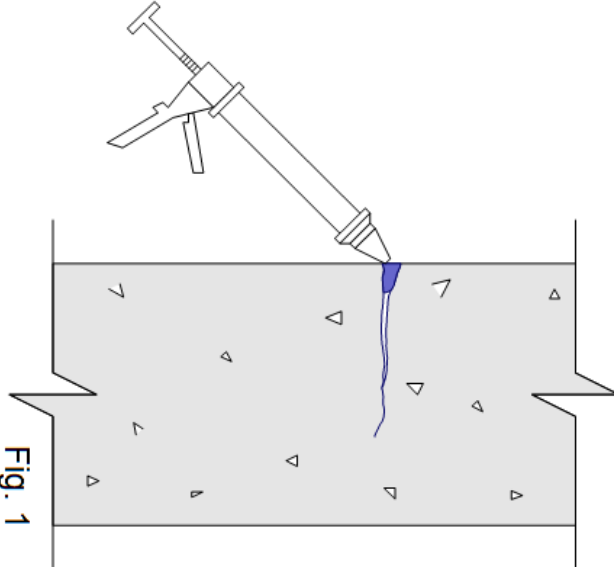


- Sika CarboDur FRP Plates
- Sika CarboShear Elements
- SikaWrap Carbon or Glass Fabrics
- Sika Carbodur Rods

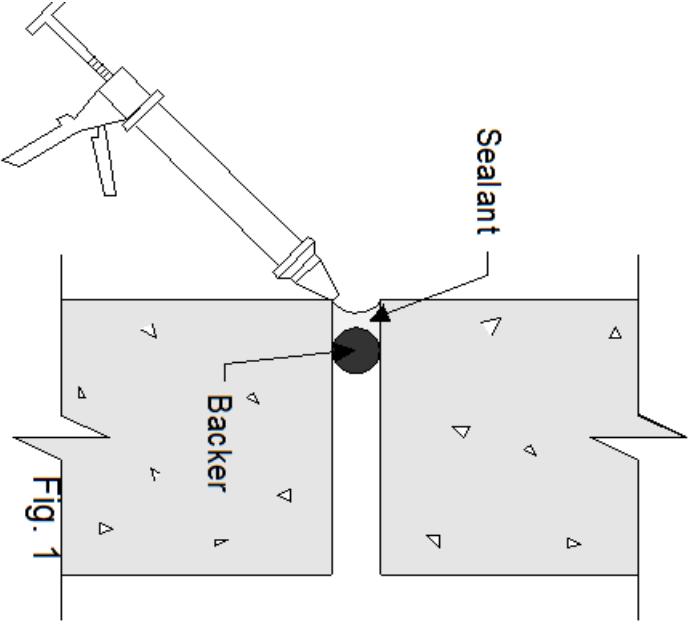
SIKA PDM SOLUTIONS



SIKAFLEX 2C NS E-Z MIX



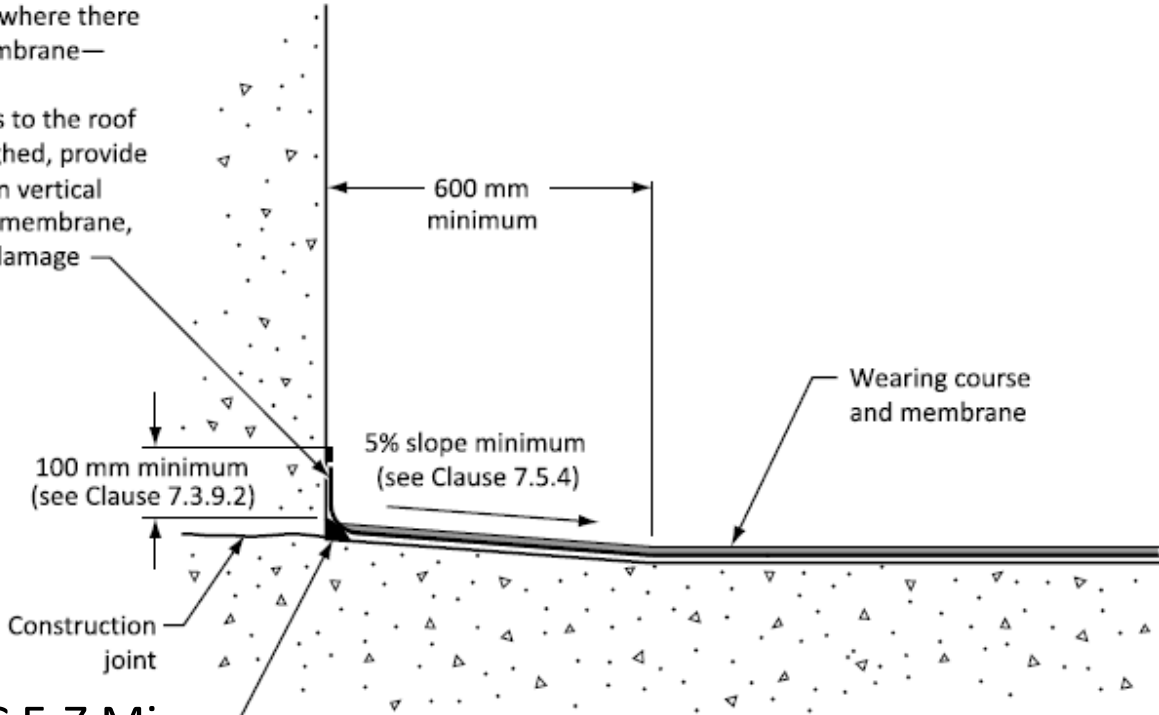
Crack Sealing



Expansion Joint

SLAB TO WALL TRANSITIONS

Sealer (mandatory where there is no upturned membrane—see Clause 7.3.10).
On roofs and ramps to the roof that are snowploughed, provide continuous chase in vertical surface and recess membrane, to protect against damage from plough blade.



100 mm minimum
(see Clause 7.3.9.2)

5% slope minimum
(see Clause 7.5.4)

600 mm
minimum

Wearing course
and membrane

Construction
joint

Sikaflex 2C E-Z Mix

STRIPE COATING OVER SEALED CRACKS

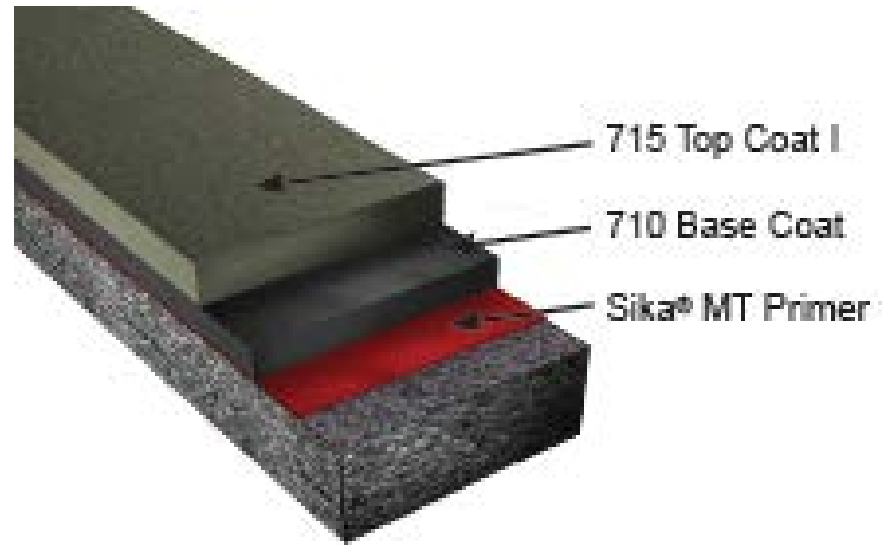


SIKALASTIC PARK DECK SYSTEMS

ONE COMPONENT PARK DECK MEMBRANES

■ Sikalastic 710/715 system

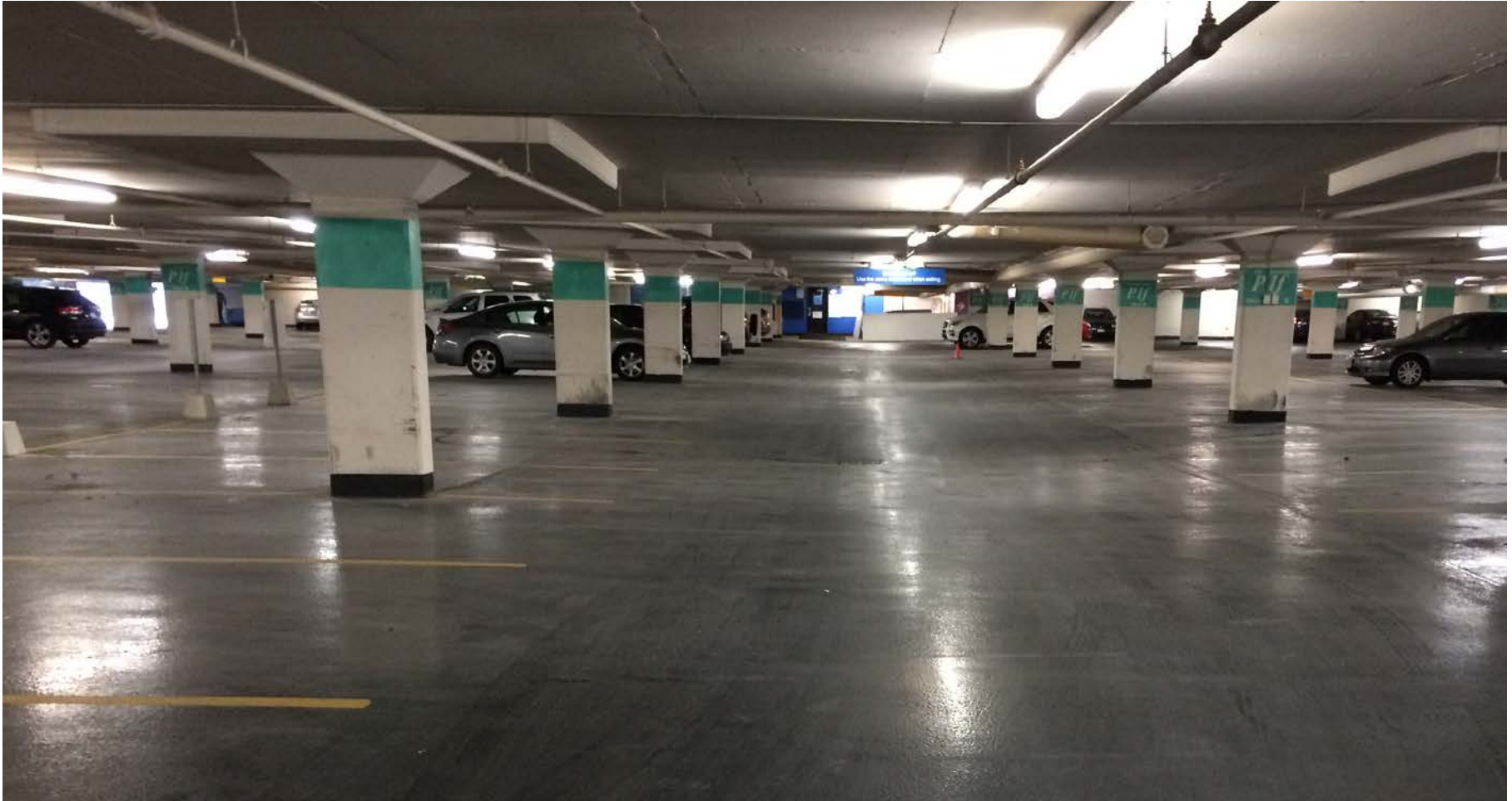
- One-component
- Pedestrian applications
- Vehicular Applications
- Solvent based
 - Meets new VOC criteria
- Standard detailing required
 - Wall-deck
 - Keys
 - Use of **Sikaflex 2C** recommended
- Standard aggregate recommendation of 16-30 mesh
- Curing accelerator available for colder weather installations



SIKALASTIC 710/715



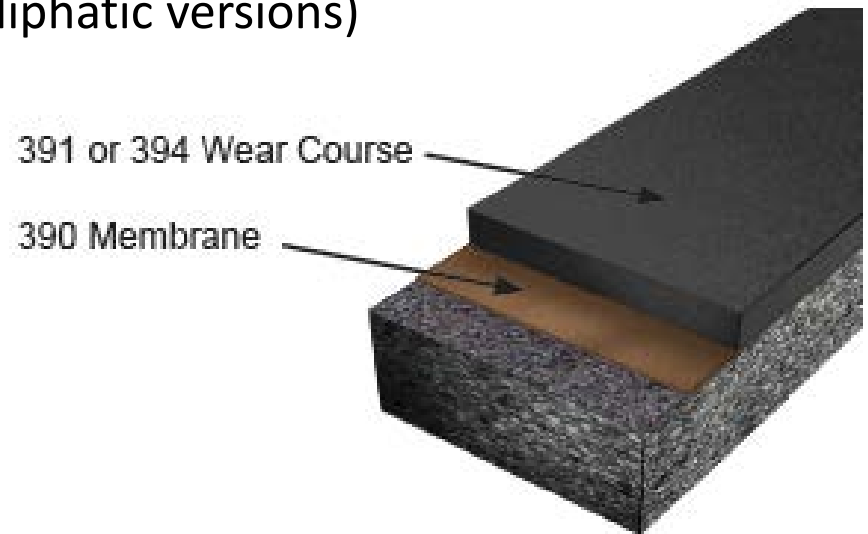
SIKALASTIC DUODECK 2 COMPONENT PU BASED TRAFFIC TOPPING



TWO COMPONENT TRAFFIC TOPPING

■ Sikalastic Duodeck Systems

- Sika MT Primer (same as for single component)
- Sika Duochem 390 (base coat)
- Sika Duochem 391 or Sika Duochem 391 SA (top coats)
- Sika Duochem 394 and 394 SA (aliphatic versions)
- Sika Duochem 8200



SIKALASTIC DUODECK 2 COMPONENT PU BASED TRAFFIC TOPPING

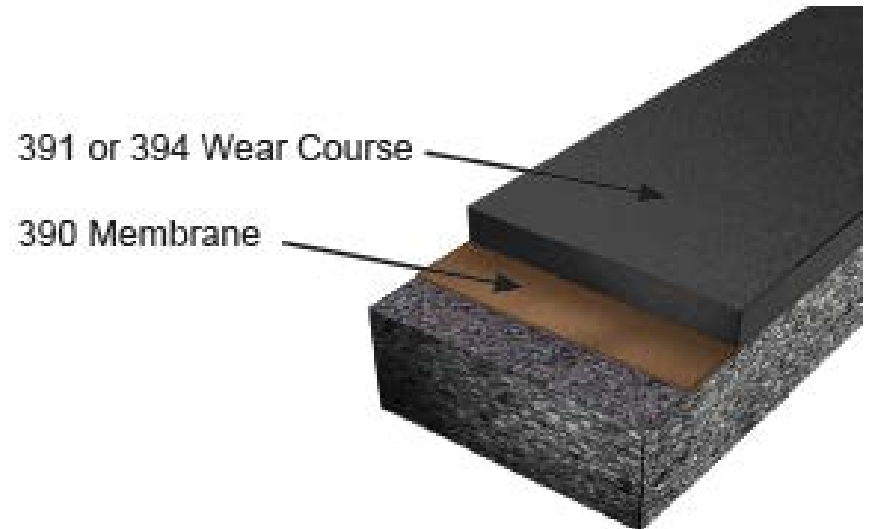


SIKALASTIC DUODECK 2 COMPONENT PU BASED TRAFFIC TOPPING



EXTRA HEAVY DUTY WEAR COURSE

- **Sikalastic Duodeck Systems**
 - Sika Duochem 8200
 - 2-Component
 - 100% solids
 - No odor
 - VOC compliant



SIKALASTIC DUODECK 2 COMPONENT PU BASED TRAFFIC TOPPING



SLABS ON GRADE



SPRAY APPLICATION OF SIKA FERROGARD 903+



- Application done by low pressure spray
- Application rate controlled on a volume per unit area (L/m^2) basis

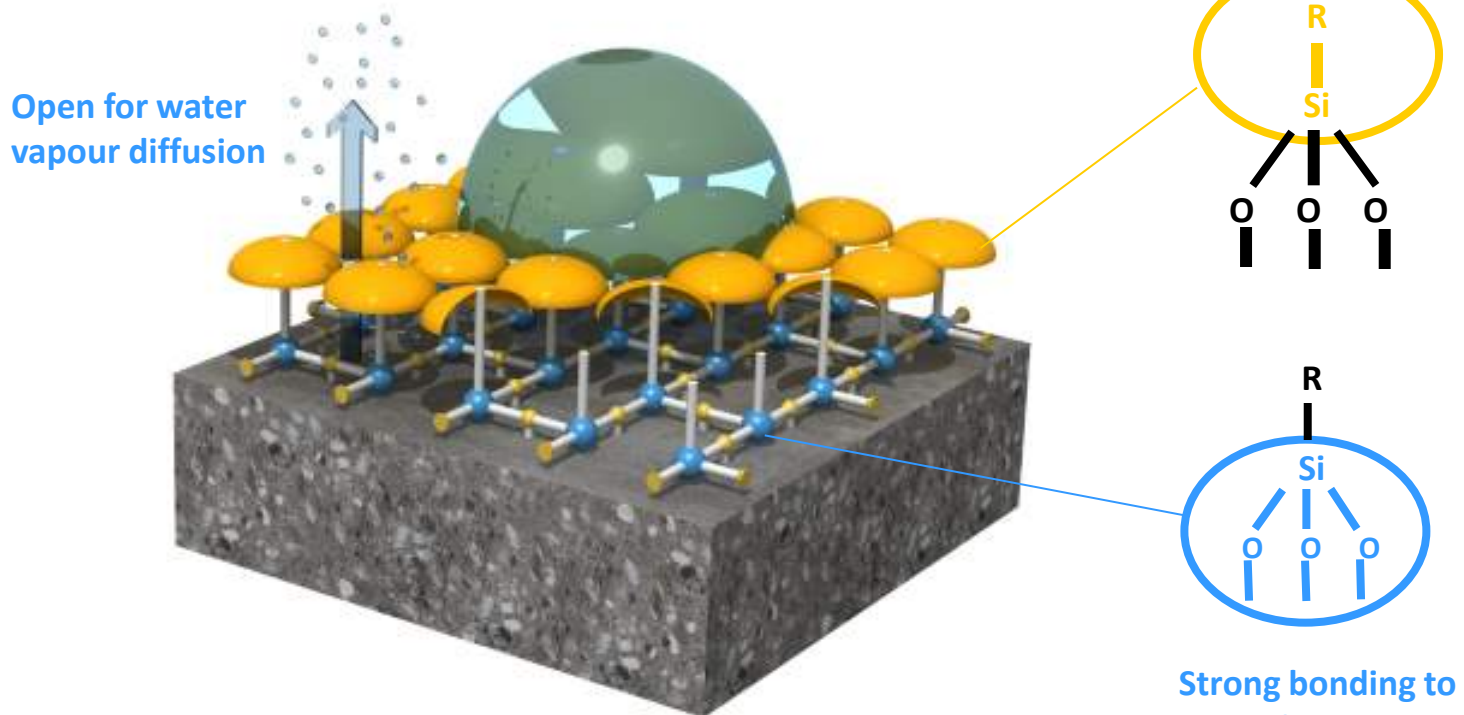


WHAT IS A HYDROPHOBIC IMPREGNATION?

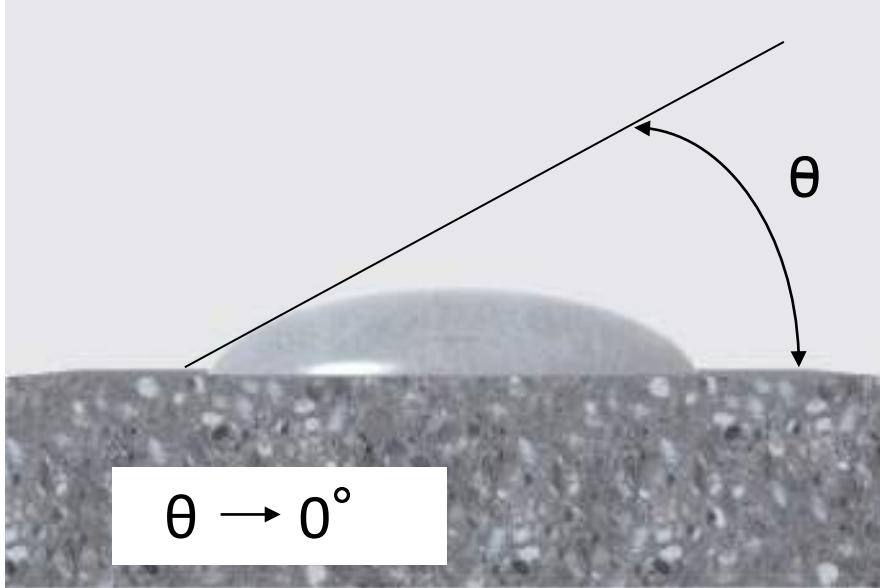
Silicone Resin Network

Hydrophobic impregnation treatments change the surface tension of mineral substrates including concrete, render and brickwork.

This produces a water repellent surface to keep water and aggressive water soluble salts out, such as chlorides and sulphates



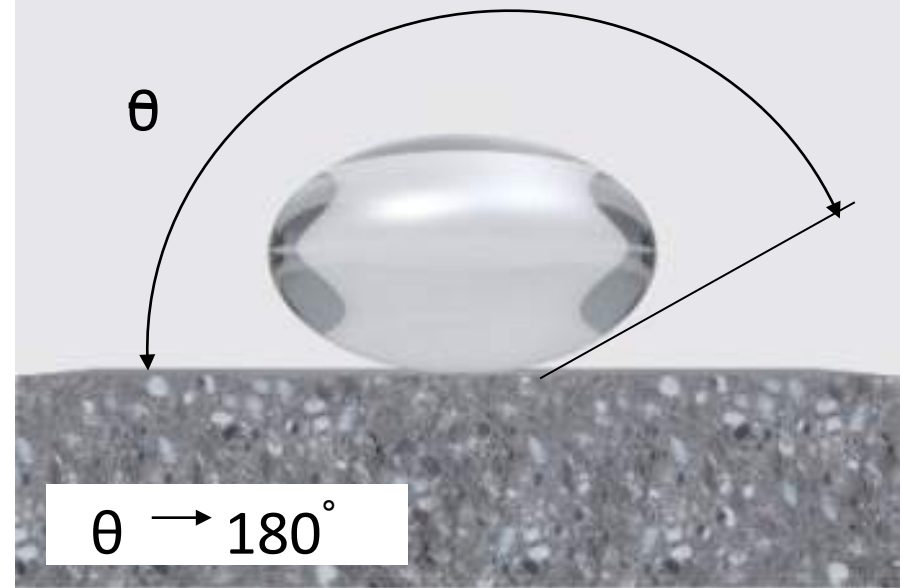
DIFFERENCE BETWEEN TREATED AND NON-TREATED SURFACE



Absorption of the water by the substrate!

Non-Treated Substrate

- The surface tension is higher than that of liquid water.
- The attraction from the substrate to the water is higher than the inter-attraction of the water molecules.



The surface repels the water!

Treated Substrate:

- Reduction of the surface tension by the hydrophobic impregnation
- The inter-molecular attraction of the water molecules is then much higher than the attraction of the water into the substrate.

SIKAGARD SN 100 SILANE SEALER FOR SLABS ON GRADE



BREATHABLE LIGHT REFLECTIVE COATINGS



- Sikagard 550W Elastic
- Elastomeric, crack bridging
- Anti-carbonation barrier
- Prevents water & chloride ingress



SIKA PDM SOLUTIONS



THANK YOU FOR YOUR TIME!

