KINGKRETE®
We Create Future

ACADEMY

CPD SEMINAR CPD-CR-IN-01

Crack Injection: Diagnosing and Sealing Cracks in Concrete

Reading cracks, choosing resins and grouts, and specifying injection that lasts

0.75 LEU	AIA LU|HSW	45 MIN	PRACTITIONER

RIBA core curriculum · Design, construction and technology



BEFORE WE START

Continuing education credit

AIA CES provider logo

KingKrete Academy is a Registered Provider with The American Institute of Architects Continuing Education Systems (AIA/CES). Credit earned on completion of this program will be reported to AIA/CES for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request. This program is registered with AIA/CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product.

RIBA CPD provider logo

This seminar has been reviewed under the RIBA CPD Providers Network and is mapped to the RIBA core curriculum topic: Design, construction and technology. It counts towards the CPD hours RIBA members record each year.

Questions about specific materials, methods and services will be addressed at the end of this presentation.

Copyright and course conduct



Copyright

This presentation is protected by international copyright laws. Reproduction, distribution, display or use of it without written permission of KingKrete Academy is prohibited. © KingKrete Academy 2026.



No product promotion

This course is educational. It covers generic technologies, standards and good practice. It does not name, endorse or compare proprietary products.



Product questions

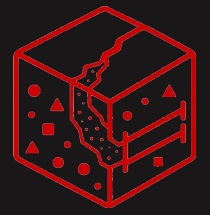
Questions about specific products or services are answered after the course, outside the time that earns credit.

Why this matters

Crack injection works well when the crack is understood, and fails quickly when the material, method or diagnosis is wrong.

This seminar builds on concrete repair principles. It shows how to read and monitor cracks, how to choose between epoxy, polyurethane, acrylic and microfine cement by purpose, how to specify packers, pressure and sequence, and how to verify the result or recognise when injection is the wrong repair.

FOR Structural engineers, repair contractors, asset owners and specifiers



CREDIT

0.75 LEU · AIA LU|HSW

RIBA TOPIC

Design, construction and technology

LEVEL

Practitioner

FORMAT

Live, in-office or self-paced

ASSESSMENT

10 questions, 80% to pass

PREREQUISITE

CPD-CR-RP-01

LEARNING OBJECTIVES

By the end of this course you will be able to

01

Diagnose

crack types and causes, and decide whether a crack is live or dormant, structural or non-structural

HSW

02

Compare

epoxy, polyurethane, acrylic and microfine cement injection materials by purpose: to bond, to seal or to stop water

03

Specify

injection methods, packer spacing, pressure and sequence for structural bonding and for water stopping

HSW

04

Verify

injection quality with cores, testing and inspection, and recognise when injection is the wrong repair

HSW

AGENDA

How the next 45 minutes run

01	Reading the crack	LO1	8 min
02	Live or dormant?	LO1	8 min
03	Choosing the injection material	LO2	8 min
04	Specifying the injection	LO3	8 min
05	Verification and limits	LO4	8 min
Q	Knowledge check and summary	LO1–LO4	5 min

01

MODULE 01 · 8 MIN · LO1

Reading the crack

Crack types, causes and timing, following ACI 224.1R

What a crack can tell you, and cost you

A crack is evidence. Before deciding how to fill it, decide what it is telling you.

01

A path for water

Cracks let water, chlorides and carbon dioxide reach the steel far faster than sound cover

02

Leakage

Through-cracks in basements, tanks and tunnels leak, especially under water pressure

03

A structural signal

Some cracks reveal overload, settlement or inadequate reinforcement or detailing

04

An active mechanism

Corrosion, ASR or restraint cracks can show a process that is still going on

05

Appearance and confidence

Even harmless cracks worry owners and users and can damage applied finishes

Cracks that form while concrete is young

Crack type	Cause and pattern	Typical time of appearance
Plastic settlement	Concrete settles over bars or at depth changes; cracks follow top bars	Ten minutes to three hours after placing
Plastic shrinkage	Rapid surface drying; diagonal or random cracks on slabs	Thirty minutes to six hours after placing
Early thermal	Restrained cooling after hydration heat; regular through-cracks	One day to two or three weeks
Crazing	Fine surface network from rich, overworked or poorly cured finishes	One to seven days, sometimes later

Timings are typical ranges from established guidance on non-structural cracks. Site and pour records help confirm them.

Cracks in mature concrete and their causes

01 Drying shrinkage

Restrained long-term moisture loss; weeks to months, often at re-entrant corners and long bays

02 Flexure and shear

Flexural cracks start at the tension face; shear cracks run inclined near supports

03 Reinforcement corrosion

Cracks along bar lines with rust staining, usually years after construction

04 Alkali-silica reaction

Map cracking in damp areas, tending to align with main bars or restraint in members



What to record at every crack

01

Location and orientation

Element, face, position relative to supports, bars, joints and openings

02

Width and length

Width at several points along the crack, and its full length and ends

03

Depth

Surface only, partial depth or through the section, from cores or ultrasonic tests

04

Moisture

Dry, damp, seeping or flowing, and whether this changes with season or tide

05

Deposits and staining

Rust, efflorescence, gel or old repair material in or around the crack

06

History

When it was first seen, whether it has grown, and any change in use or loading

Structural or non-structural crack?

Likely structural

- Follows the bending or shear pattern for the loading
- Width relates to load, span or support movement
- Accompanied by deflection, spalling or distress
- Located in tension or shear zones of main members
- Needs engineering assessment before repair

Likely non-structural

- Caused by plastic, thermal or shrinkage effects
- Pattern set by restraint, geometry or finishing
- Often stable once the driving effect has passed
- Main concerns are leakage, durability or appearance
- Can often be treated as a maintenance repair

Non-structural does not mean harmless: a through-crack can still leak and let chlorides reach the steel.

Fine diagonal cracks appeared on a slab surface two hours after a pour on a hot, windy day. What is the most likely cause?

A Early thermal contraction under restraint

B Long-term drying shrinkage of the slab

C Plastic shrinkage from rapid surface drying

D Alkali-silica reaction in the aggregate

QUICK CHECK · LO1 · ANSWER

Fine diagonal cracks appeared on a slab surface two hours after a pour on a hot, windy day. What is the most likely cause?

A Early thermal contraction under restraint

B Long-term drying shrinkage of the slab

C Plastic shrinkage from rapid surface drying

D Alkali-silica reaction in the aggregate

WHY Plastic shrinkage cracks form within hours of placing when surface water evaporates faster than bleed water rises, typically on hot, windy days.

02

MODULE 02 · 8 MIN · LO1

Live or dormant?

Measuring and monitoring cracks before choosing a repair

Tools for measuring width and depth

01	**Crack comparator card**	Printed lines of known width matched by eye; quick, cheap and good for surveys
02	**Crack width microscope**	Hand-held, illuminated, with a graduated scale; typically reads to about 0.02 mm
03	**Ultrasonic pulse tests**	Transit times across the crack can estimate its depth in accessible members
04	**Cores across the crack**	Show true depth, width inside the section and any deposits or old fillers
05	**Photographs with scale**	Dated images with a scale bar build a record that others can check later

Monitoring long enough to see the cycle

12 mo

Typical monitoring period to capture a full seasonal temperature cycle

0.1 mm

Typical reading precision of a simple grid tell-tale

Daily

Thermal movement can open and close cracks within a single day

---

A crack measured once tells you its width, not its behaviour. Repeated readings show whether it is moving, how much, and what drives it.

Ways to monitor crack movement

01

Brittle tell-tales

Glass or mortar strip bonded across the crack; breakage shows movement but not its size

02

Grid tell-tales

Two overlapping plates with a scale; read opening and sliding movement directly

03

Demec studs

Studs fixed either side and read with a demountable gauge for precise width change

04

Electronic gauges

Displacement transducers with data loggers record daily and seasonal cycles

05

Record conditions

Log time, temperature and moisture with every reading to explain the movement

THE KEY DISTINCTION

Dormant cracks versus live cracks

Dormant	Live
Width stable over a full monitoring period	Opens and closes with temperature or load
Cause has run its course, such as early shrinkage	Or keeps widening as the cause continues
Can be bonded with a rigid resin if needed	A rigid repair will crack again alongside
Re-cracking beside the repair is unlikely	Needs a flexible seal, a joint or cause removal

A live crack that is only cycling can be sealed; one that keeps widening needs its cause found and treated.

DIAGNOSIS WORKFLOW

From observation to a crack decision

01	02	03	04	05
Record	**Find the cause**	**Monitor**	**Classify**	**Set the aim**
Map location, pattern, width, length, depth, moisture and staining	Compare pattern and timing with known mechanisms; test where needed	Measure movement over a period that captures load and temperature cycles	Live or dormant; structural or non-structural; dry, damp or leaking	Bond, seal, stop water, or treat the cause first, possibly with no injection

ACI 224.1R follows the same logic: determine the cause before selecting a repair method.

Grid tell-tales show a wall crack opening about 0.3 mm each winter and closing each summer. How should it be classed?

A Live, because it moves with the seasonal cycle

B Dormant, because it returns to its first width

C Structural, because it is wider than 0.2 mm

D Non-structural, so it needs no further action

Grid tell-tales show a wall crack opening about 0.3 mm each winter and closing each summer. How should it be classed?

A **Live, because it moves with the seasonal cycle**

B Dormant, because it returns to its first width

C Structural, because it is wider than 0.2 mm

D Non-structural, so it needs no further action

WHY The crack moves with temperature, so it is live. A rigid bond would crack again beside the repair; a flexible seal suits a cycling crack.

03

MODULE 03 · 8 MIN · LO2

Choosing the injection material

EN 1504-5 intended uses and materials matched to bond, seal or stop water

Three intended uses for injection products

Category	Purpose	Typical materials
F – force transmitting	Bond the crack faces so the section acts as one and carries load	Low-viscosity epoxy; some cementitious grouts
D – ductile	Seal a crack that may still move a little, keeping it watertight	Flexible polyurethane and some other elastic resins
S – swelling	Fill a crack with a product that swells when it takes up water	Acrylic or acrylate gels and some polyurethanes

Products are declared for an intended use. A D product will not restore strength; an F product will not follow movement.

Epoxy: the material to bond

01

Low viscosity

Enters fine cracks, typically down to about 0.05 mm, under modest pressure

02

Structural bond

Bond and tensile strength exceed the concrete, so failure moves into the substrate

03

Dry or damp faces

Moisture-tolerant grades bond to damp cracks; flowing water prevents a sound bond

04

Rigid once cured

Low elongation means a moving crack will reopen beside or through the repair

05

ASTM C881

Classifies epoxy bonding systems by type, grade and class for use and temperature

Polyurethane foams, elastic resins and gels

Polyurethane foam

- Water-reactive; foams and expands on contact
- Stops active leaks fast, even under flow
- Cellular structure; often a first stage only
- Usually followed by a sealing resin

Polyurethane resin

- Cures to a flexible, elastomeric solid
- Seals cracks with some ongoing movement
- Many grades tolerate wet crack faces
- Not a force-transmitting repair

Acrylic gel

- Very low viscosity, close to water
- Penetrates fine cracks, soil and fill
- Used for curtain injection behind walls
- Must stay damp; shrinks if it dries out

Microfine cement for wide cracks and voids

01	**Very fine particles**	Ground far finer than ordinary cement, so the grout enters narrower gaps
02	**Best for wide openings**	Suits wide cracks, honeycombing and voids where resin volumes would be large
03	**Mineral and alkaline**	Similar in nature to concrete, non-combustible and supportive of steel passivity
04	**Know the limits**	Cannot enter hairline cracks; bleed and water content must be tightly controlled

VISCOSITY AND CRACK WIDTH

Thinner materials reach finer cracks

< 10 mPa·s

Typical viscosity of acrylic injection gels, close to water

100–500 mPa·s

Typical range for low-viscosity epoxy injection resins

0.05 mm

Approximate finest crack width low-viscosity epoxy can enter

Viscosity, crack width, depth and moisture together decide how far and how easily a material will travel. Always check the product data against the crack.



SELECTING BY PURPOSE

Bond, seal or stop water

01

To bond

Dormant crack, dry or damp: low-viscosity epoxy declared for force transmission

02

To seal

Damp or slightly moving crack: flexible polyurethane resin declared as ductile

03

To stop flowing water

Water-reactive PU foam first, then a flexible resin for the durable seal

04

To seal from behind

Acrylic gel curtain injection into the ground behind leaking walls

05

To fill wide gaps

Microfine cement grout for wide cracks, honeycombing and voids

A basement wall crack is actively leaking under groundwater pressure. Which first-stage injection material suits best?

A Low-viscosity epoxy resin

B Microfine cement grout

C Moisture-tolerant epoxy paste

D Water-reactive polyurethane foam

QUICK CHECK · LO2 · ANSWER

A basement wall crack is actively leaking under groundwater pressure. Which first-stage injection material suits best?

A Low-viscosity epoxy resin

B Microfine cement grout

C Moisture-tolerant epoxy paste

D Water-reactive polyurethane foam

WHY Flowing water stops epoxy bonding and washes out cement grout. Water-reactive PU foam reacts with the water and stops the flow, ready for a sealing resin.

04

MODULE 04 · 8 MIN · LO3

Specifying the injection

Packers, spacing, pressure and sequence for bonding and water stopping

Surface ports or drilled packers

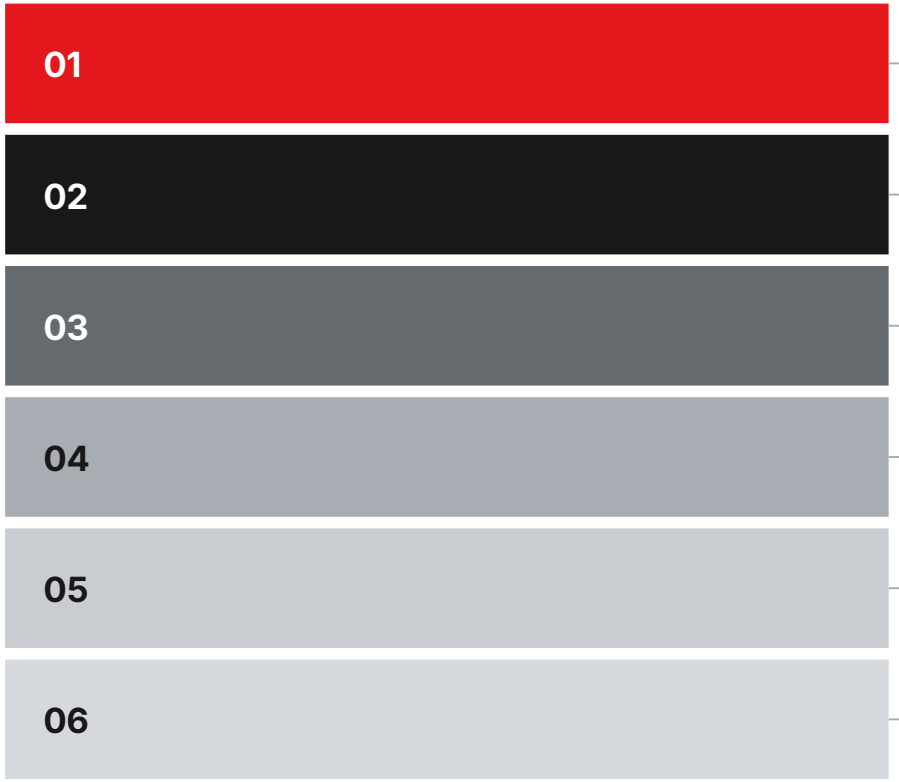
Surface ports

- Bonded to the surface directly over the crack
- Used with a full surface seal or cap
- Common for epoxy bonding of dormant cracks
- No drilling, so no risk of cutting bars
- Suited to low or moderate pressures

Drilled packers

- Holes drilled at about 45° to cross the crack
- Mechanical packer grips and seals the hole
- Common for polyurethane and water stopping
- Allow higher pressure and deeper reach
- Locate reinforcement before drilling

Section through a drilled injection packer



Injection nipple
Non-return valve or grease nipple connects the pump and holds pressure

Mechanical packer
Rubber sleeve expands as the packer is tightened, sealing the drill hole

Surface seal, where used
Paste or fast-setting mortar over the crack face stops material escaping

Drill hole at about 45°
Started offset from the crack so that it crosses it near mid-depth

Crack plane
Material travels from the intersection along and through the crack

Sound concrete
Member thickness and bar positions set hole depth, offset and angle

A hole that misses the crack takes no resin. Check the first holes by flushing with water or air.

Typical packer spacing and set-up

Item	Surface ports	Drilled packers
Spacing along crack	Typically about equal to member thickness; closer for fine cracks	Typically about half the member thickness
Arrangement	In line along the crack, both faces where accessible	Staggered on alternate sides of the crack
Drill offset	Not applicable	Typically about half the thickness, so holes cross near mid-depth
Preparation	Clean crack line; seal full length and let the seal cure	Flush holes to remove dust; check they connect to the crack
Pressure	Low, raised gradually within the system limits	Higher possible; limit it to avoid spalling or widening

These are starting points. Trial injection and the product data set the final spacing and pressure.

Injecting a vertical crack, step by step

01

Prepare and seal

Clean the crack, fix ports or packers, and let the surface seal cure

02

Start at the bottom

Begin at the lowest port; on a horizontal crack, start at one end

03

Low pressure first

Raise pressure slowly so material flows rather than forcing the crack

04

Watch the next port

When material appears at the next port, close the current one

05

Move on and repeat

Connect to the next port and continue along the full length

06

Cure and finish

After cure, remove ports and seal, then make the surface good

Record pressure, volume and travel at each port. A port that takes far more than expected may indicate a void or leak.

Temperature, moisture and water limits

01

Cold substrates

Most resins have a minimum temperature, typically around 5 °C; cold slows flow and cure

02

Hot conditions

Heat shortens pot life; mix small batches and inject in the cooler hours

03

Moisture in the crack

Epoxy needs dry or damp faces; choose a moisture-tolerant grade where needed

04

Flowing water

Stop the flow first with water-reactive foam, then seal with a flexible resin

05

Blocked cracks

Dirt, efflorescence and old repairs block material; flush where the system allows

06

Records

Log temperatures, pressures, volumes and port-to-port travel for every crack

TWO SPECIFICATIONS

Structural bonding versus water stopping

Structural bonding

- Aim: restore monolithic action (category F)
- Dormant cracks, dry or damp
- Low-viscosity epoxy via ports or packers
- Full-depth fill verified by cores

Water stopping

- Aim: a watertight seal (category D or S)
- Leaking cracks, which may still move
- PU foam then flexible resin, or acrylic gel
- Verified by dry faces under water pressure

During epoxy injection of a vertical crack, resin appears at the port above the one being injected. What should happen next?

A Raise the pressure to drive resin further up

B Close the current port and move to the next one

C Stop and let the resin cure before continuing

D Move to the top port and inject downwards

During epoxy injection of a vertical crack, resin appears at the port above the one being injected. What should happen next?

A Raise the pressure to drive resin further up

B Close the current port and move to the next one

C Stop and let the resin cure before continuing

D Move to the top port and inject downwards

WHY Resin at the next port shows the crack is filled up to that point. Close the current port and continue from the next one, working upwards.

05

MODULE 05 · 8 MIN · LO4

Verification and limits

Proving the fill, and recognising when injection is the wrong repair

VERIFICATION

How to check that injection worked

01	**Injection records**	Volumes, pressures and travel between ports for every crack, checked daily
02	**Cores across the crack**	Show penetration depth and continuity of fill through the section
03	**Ultrasonic pulse velocity**	Shorter transit times across the crack after injection indicate filling
04	**Visual and water checks**	Dry faces under water pressure; no weeping, staining or new leaks
05	**Bond or load tests**	Where specified, tests on cores or elements confirm structural bond

Typical acceptance criteria for cores

≥ 90%

Typical specified proportion of crack depth filled, as seen in cores

Concrete

Split or loaded cores should fail in the concrete, not at the crack

Criteria are project-specific. Set them in the specification, take cores at agreed locations, and re-inject or core again where results fall short.

KNOW THE LIMITS

Injection fills a crack, not its cause

If the cause is still active, injection only moves the problem. Corrosion, continuing structural movement and ASR need the cause treated first, or new cracks will form beside the repair.



When injection is the wrong answer

01

Corrosion cracks

Rust keeps expanding; break out, treat the steel and restore the cover instead

02

Live structural cracks

Overload or settlement needs assessment and, often, strengthening first

03

ASR cracking

Expansion continues while moisture is present; control the moisture first

04

Cracks acting as joints

Rout and seal as a joint, or form a proper movement joint

05

Unsound concrete

Honeycombed, delaminated or weak concrete may need replacing, not injecting

CASE BRIEF

Leaking cracks in a basement retaining wall

THE BRIEF

Structure

Reinforced concrete basement wall, 300 mm thick, three years old

Symptoms

Vertical cracks at roughly 5 m centres; two seeping water

Monitoring

Grid tell-tales show small seasonal movement, under 0.1 mm

Aim

Dry wall for a plant room; engineer finds no structural concern

01 **Diagnose**

Restrained thermal and shrinkage cracks: live but small, non-structural

02 **Stop the water**

Drilled packers at 45°, about 150 mm apart, staggered; water-reactive PU foam

03 **Seal durably**

Re-inject with flexible polyurethane resin to give an elastic, watertight seal

04 **Verify**

Inspect through the wet season; record and re-inject any remaining weeps

A beam soffit shows cracks along the bars with rust staining. Why is epoxy injection unsuitable as the main repair?

A Epoxy cannot bond to concrete on soffits

B Corrosion continues, so the cover will crack again

C The cracks are too wide for any resin to fill

D Rust staining shows that the crack is dormant

A beam soffit shows cracks along the bars with rust staining. Why is epoxy injection unsuitable as the main repair?

A Epoxy cannot bond to concrete on soffits

B Corrosion continues, so the cover will crack again

C The cracks are too wide for any resin to fill

D Rust staining shows that the crack is dormant

WHY Cracks along bars with rust staining point to reinforcement corrosion. Injection leaves the corrosion active, so the cover keeps cracking and spalling.

SUMMARY

Four things to take away

LO1 Read pattern, timing and movement to find the cause; classify cracks as live or dormant, structural or not

LO2 Choose by purpose: use epoxy to bond, flexible PU or gel to seal, foam to stop flow, microfine cement for gaps

LO3 Specify packers, spacing, low-to-high pressure and bottom-up sequence, with limits on temperature and moisture

LO4 Prove the result with records, cores, UPV and water checks, and never inject over an active cause

EARN YOUR CREDIT

Complete the online assessment

10

questions drawn at random from the four objectives

80%

to pass; two attempts, reshuffled each time

0.75

LEU and AIA LU|HSW on your certificate

specify.kingkrete.com
Knowledge › CPD-CR-IN-01

Sign in to SpecWorld, open the course and take the assessment. Your certificate is issued on passing and kept in your Workdesk under CPD & Certificates.

Standards and references

ACI 224.1R

Causes, Evaluation, and Repair of Cracks in Concrete Structures

ACI RAP-1

Structural Crack Repair by Epoxy Injection

EN 1504-5

Products and systems for the protection and repair of concrete structures – Concrete injection

EN 1504-9

General principles for the use of products and systems for repair and protection of concrete

EN 1504-10

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

ASTM C881

Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete

EN 12504-4

Testing concrete in structures – Determination of ultrasonic pulse velocity

Concrete Society TR22

Non-structural cracks in concrete

KINGKRETE®
We Create Future
ACADEMY

THANK YOU FOR ATTENDING

Questions?

Kashif Aijaz
KingKrete Academy · www.kingkrete.com

This concludes The American Institute of Architects Continuing Education Systems course.

