KINGKRETE® We Create Future ACADEMY

CPD SEMINAR CPD-CR-FR-01

Strengthening Concrete with Bonded FRP: Design Principles and Installation

When to use externally bonded FRP, how it is designed and how to install it so it performs

1.0 LEU | AIA LU|HSW | 60 MIN | ADVANCED

RIBA core curriculum · Design, construction and technology · Health, safety and wellbeing



BEFORE WE START

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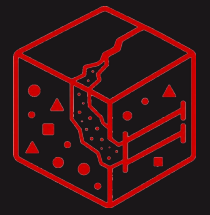
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Why this matters

Bonded FRP can add capacity to concrete quickly and with little added weight, but only when the existing member, the bond and the environment allow it.

This seminar explains when externally bonded FRP is appropriate, compares fibres, laminates, fabrics and adhesives, walks through flexural, shear and confinement design to current ACI and fib guidance, and sets out the substrate preparation, testing and quality control that make a design work on site.

FOR Structural engineers, specialist contractors and specifiers (prerequisite: concrete repair course)



CREDIT

1.0 LEU · AIA LU|HSW

RIBA TOPIC

Design, construction and technology; Health, safety and wellbeing

LEVEL

Advanced

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

Explain

when externally bonded FRP is an appropriate way to strengthen a concrete member and the limits set by the existing structure, fire and environment

HSW

02

Compare

carbon, glass and aramid fibres, pre-cured laminates and wet lay-up fabrics, and the role of the epoxy adhesive or saturant

03

Describe

the flexural, shear and confinement design approach in current ACI and fib guidance, including debonding, strain limits and the unstrengthened-capacity check

HSW

04

Specify

substrate preparation, pull-off testing, installation, protection and quality control for an FRP strengthening system

HSW

AGENDA

How the next 60 minutes run

01	When FRP strengthening fits	LO1	11 min
02	FRP materials and adhesives	LO2, LO1	11 min
03	Flexural design principles	LO3, LO1	11 min
04	Shear, confinement and detailing	LO3, LO4	11 min
05	Installation and quality control	LO4	11 min
Q	Knowledge check and summary	LO1–LO4	5 min

01

MODULE 01 · 11 MIN · LO1

When FRP strengthening fits

Reasons to strengthen, the alternatives and the limits of the existing member

Common reasons a concrete member needs more capacity

Strengthening raises capacity above the original design. Repair only restores what was lost.

01

Change of use

Office floors becoming storage, plant rooms or archives carry far heavier imposed loads than designed

02

Added load

New equipment, roof plant, green roofs or extra storeys put more demand on existing members

03

Code upgrade

Revised loading, seismic or robustness requirements can leave older members under strength

04

Design or site error

Missing bars, short laps, low concrete strength or misplaced steel found during or after construction

05

Openings

New service penetrations cut through slabs or walls remove reinforcement that must be compensated

06

Deterioration

Corrosion section loss reduces capacity, but the cause must be repaired before strengthening

REPAIR FIRST

Repair the concrete before you strengthen it

FRP bonded to contaminated, cracked or corroding concrete will fail with it. Stop the cause of deterioration, repair defects and restore the substrate first. The bond can only be as good as the concrete it sits on.



Bonded FRP against the main alternatives

Method	Main strengths	Main limitations
Bonded FRP	Light, thin, fast to fit, corrosion resistant, little headroom loss	Bond-dependent, lost in fire, capped by existing member capacity
Section enlargement	Robust, fire resistant, adds stiffness and compression capacity	Adds dead load, loses space, needs formwork and curing time
Steel plate bonding	Well-established, stiff, ductile steel	Heavy plates, corrosion risk, needs propping and bolting
External post-tensioning	Active load relief, reduces deflection and cracking	Anchorage and deviator details, access, tendon corrosion protection

Choose on structural need, fire, durability, access and programme, not on habit.

Bond-critical and contact-critical applications

Bond-critical

- Flexural strengthening of beams and slabs
- Shear strengthening by side bonding or U-wraps
- Load reaches the FRP only through the adhesive bond
- Substrate tensile strength governs performance
- Needs pull-off testing and careful surface preparation

Contact-critical

- Confinement of columns by full wrapping
- FRP is engaged by the concrete pressing against it
- Intimate contact matters more than adhesive bond
- Corner rounding and fit-up are critical
- Still needs a sound, clean, dry surface

The distinction decides how demanding the substrate checks need to be.

Limits set by the member you are strengthening

01	**Concrete quality**	Weak or contaminated cover cannot carry bond stress; test strength and pull-off first
02	**Existing steel**	Flexural FRP relies on the steel yielding first; section loss and laps must be known
03	**Compression zone**	FRP adds tension capacity only; crushing of the compression zone can still govern
04	**Unstrengthened reserve**	The member without FRP must still carry a reduced load set, so gains are capped
05	**Load path**	Supports, connections and foundations must carry the higher loads too

Fire, heat and exposure limit what FRP can do

01

Fire

Epoxy softens at modest temperatures, so FRP is generally assumed lost in a fire

02

Service temperature

Keep service temperature well below the adhesive glass transition temperature, Tg

03

Hot, sunny exposure

Roofs, soffits near plant and sun-facing faces in hot regions can approach adhesive Tg

04

Moisture and alkalinity

Wet, alkaline or chemical exposure reduces long-term properties, especially for glass

05

Vandalism and impact

Exposed FRP at low level can be cut or struck; protect it or place it out of reach

DECISION ROUTE

From problem to a strengthening decision



Define the demand

New loads, code requirements and the target capacity for each member

Assess the member

As-built survey, materials testing, defects, corrosion and existing strain

Repair first

Remove the cause of deterioration and restore sound, clean concrete

Screen the options

Compare FRP with enlargement, steel plates and post-tensioning

Check FRP limits

Unstrengthened reserve, fire, service temperature, exposure and access

Design and specify

Design to current guidance and specify preparation, testing and QC

If the unstrengthened or fire check fails, FRP alone is not the answer.

A corroding car park beam needs extra flexural capacity. What should happen before the FRP is designed and installed?

A Wrap the beam fully so the FRP seals out chlorides

B Repair the corrosion damage and its cause, then strengthen

C Increase the FRP area to allow for future section loss

D Apply FRP first and repair the concrete afterwards

QUICK CHECK · LO1 · ANSWER

A corroding car park beam needs extra flexural capacity. What should happen before the FRP is designed and installed?

A — Wrap the beam fully so the FRP seals out chlorides

B — Repair the corrosion damage and its cause, then strengthen

C — Increase the FRP area to allow for future section loss

D — Apply FRP first and repair the concrete afterwards

WHY FRP bonded to deteriorating concrete fails with it. The cause of corrosion must be addressed and the substrate repaired before strengthening.

02

MODULE 02 · 11 MIN · LO2, LO1

FRP materials and adhesives

Fibres, product forms, epoxy resins and long-term durability

Carbon, glass and aramid fibres compared

Property	Carbon (CFRP)	Glass (GFRP)	Aramid (AFRP)
Stiffness	High; standard to high-modulus grades	Low, around a third of carbon or less	Moderate, between glass and carbon
Tensile strength	Very high	Moderate to high	High
Creep-rupture	Excellent resistance	Poor; low sustained stress limit	Moderate
Durability	Inert in alkali and moisture	Sensitive to alkali and moisture	Sensitive to moisture and UV
Other points	Conductive; isolate from steel	Low cost; non-conductive	Tough; good impact resistance
Typical uses	Flexure, shear and stiffness-critical work	Confinement, seismic wraps, low-cost jackets	Impact and blast protection

Values vary widely by product; always design from the supplier's tested design data.

Pre-cured laminates, wet lay-up fabrics and NSM

Pre-cured laminates

- Factory-made strips of fibre and resin
- Bonded with a thixotropic epoxy adhesive
- Consistent quality and thickness
- Best on flat soffits and faces
- Cannot follow curves or wrap corners

Wet lay-up fabrics

- Dry sheets saturated with epoxy on site
- Wrap columns, beams and curved shapes
- Several plies can be built up
- Quality depends on site workmanship
- Design on net fibre area or tested laminate

Near-surface mounted

- Bars or strips set in grooves cut in cover
- Bonded on more faces, so better bond
- Better protected from impact and fire
- Needs adequate cover depth
- Suits slab tops and negative moment zones

What the epoxy adhesive or saturant does

01

Primer

Penetrates and seals the prepared surface so the next layer bonds to sound concrete

02

Putty or filler

Fills small voids and smooths minor irregularities so the FRP lies flat

03

Saturant

Wets out dry fabric fully and forms the matrix that binds the fibres together

04

Laminate adhesive

Non-sag paste that transfers shear from concrete to a pre-cured strip

05

Load transfer

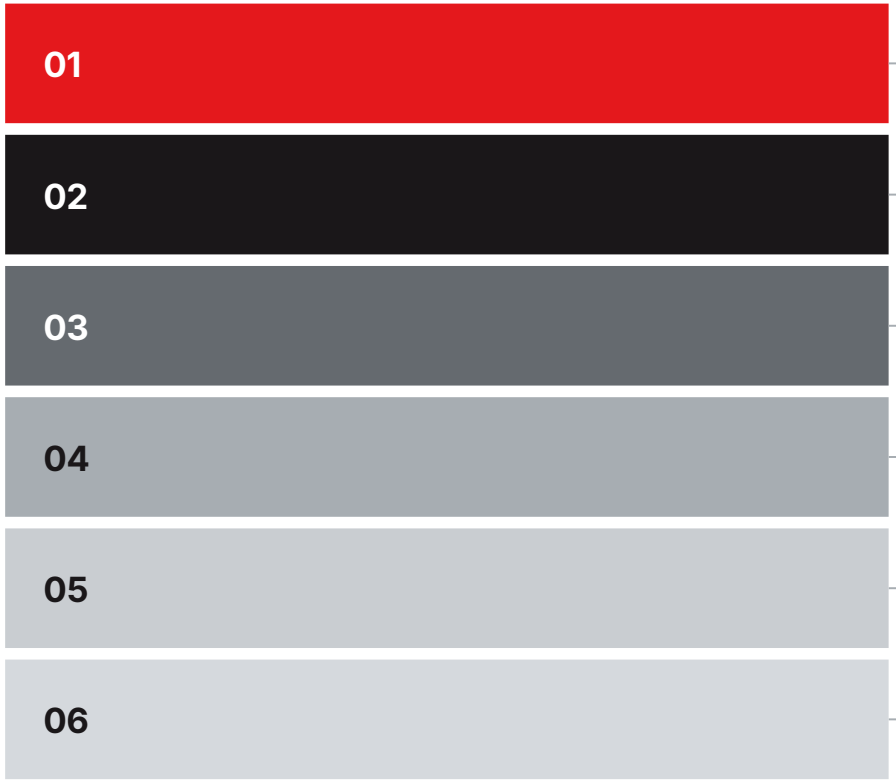
Every newton in the FRP passes through the resin and the concrete surface

06

One tested system

Primer, putty, resin and fibre are qualified together; do not mix suppliers

Typical wet lay-up system on a concrete soffit



Protective coating
UV-resistant, fire-protective or decorative finish compatible with the epoxy

Saturated fabric plies
Fabric wetted out in saturant; further plies laid wet-on-wet with overlaps

Saturant undercoat
First coat of saturant applied to the primed surface

Putty
Fills voids and smooths small irregularities to give a flat bed

Primer
Penetrating epoxy that seals and consolidates the surface

Prepared concrete
Sound, repaired, profiled to at least CSP 3, clean and dry

Pre-cured systems replace the saturant and fabric with a paste adhesive and laminate.

Keep service temperature well below the adhesive Tg

Tg − 15 °C

ACI upper limit on service temperature for the resin system

0.55

ACI sustained stress limit for CFRP, as a fraction of design strength

0.20

ACI sustained stress limit for GFRP, reflecting creep-rupture risk

Tg falls if the resin is poorly cured or wet. In hot regions, measure real surface temperatures and look for a larger margin than the minimum.

How design allows for environment and ageing

01	**Environmental factor CE**	Reduces design strength by exposure class and fibre type; glass reduced most
02	**Guaranteed properties**	ACI uses mean strength minus three standard deviations from tests
03	**Moisture and alkali**	Glass needs protection in wet or alkaline exposure; carbon is largely unaffected
04	**Galvanic isolation**	Separate carbon from steel anchors and plates to avoid corrosion of the steel
05	**UV and abrasion**	Epoxy chalks in sunlight; a compatible protective coating is usually needed

What to ask for before accepting a system

01

Tensile test data

Strength, modulus and rupture strain from standard tests such as ASTM D3039 or D7565

02

Basis of values

Whether properties are per net fibre area or per gross laminate thickness

03

Resin Tg

Measured glass transition temperature, test method and cure conditions

04

Durability evidence

Results after moisture, alkali and temperature conditioning

05

Installation limits

Temperature, humidity, pot life, recoat windows and cure times

Which combination best suits wrapping an irregular column in a wet, alkaline environment where cost is not the governing factor?

A Pre-cured glass laminates bonded with a paste adhesive

B Wet lay-up aramid fabric left uncoated

C Wet lay-up carbon fabric with a compatible protective coating

D Pre-cured carbon strips bonded to each face separately

QUICK CHECK · LO2 · ANSWER

Which combination best suits wrapping an irregular column in a wet, alkaline environment where cost is not the governing factor?

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B Wet lay-up aramid fabric left uncoated

C Wet lay-up carbon fabric with a compatible protective coating

D Pre-cured carbon strips bonded to each face separately

WHY Wet lay-up fabric follows the shape and gives a continuous wrap; carbon resists moisture and alkali, and the coating protects the resin.

03

MODULE 03 · 11 MIN · LO3, LO1

Flexural design principles

Guidance, strengthening limits, failure modes, debonding and fire

The current design documents

01

ACI PRC-440.2-23

Current ACI guide for externally bonded FRP; formerly published as ACI 440.2R-17

02

fib Bulletin 90

fib guidance (2019) on externally applied FRP reinforcement for concrete

03

fib Bulletin 14

Earlier fib guidance from 2001; now superseded by Bulletin 90

04

Local requirements

Regional codes and annexes may add rules; check what the authority accepts

05

Consistent basis

Use one document's factors throughout; do not mix ACI and fib values

Information the flexural design depends on

01	**Material properties**	Concrete strength, steel grade, bar areas and depths from survey and testing
02	**Existing strain**	Strain on the soffit at installation from loads already acting on the member
03	**Load cases**	New factored loads, service loads and the reduced unstrengthened combination
04	**Exposure class**	Interior, exterior or aggressive, which sets the environmental factor
05	**System data**	Design strength, modulus and thickness of the proposed FRP system

STRENGTHENING LIMIT

The unstrengthened member must still stand up

1.1 DL

Dead load factor in the ACI strengthening-limit combination

0.75 LL

Live load factor in the same reduced combination, using new loads

Under ACI, the existing member's design strength without FRP should resist 1.1 times dead load plus 0.75 times the new live load. fib applies a similar principle.

FAILURE MODES

How FRP-strengthened members fail

Mode	What happens	How design controls it
Concrete crushing	Compression zone fails before or after steel yields	Strain compatibility; limit FRP so steel yields first
FRP rupture	Fibres reach their rupture strain	Design rupture strain reduced by CE
Intermediate crack debonding	FRP peels from a flexural crack towards the end	Limit FRP strain to a debonding strain
End or cover debonding	FRP end or concrete cover rips off at the plate end	Terminate near supports; end anchorage or U-wraps
Shear failure	Member fails in shear before flexure develops	Check shear for the new demand; add shear FRP

In practice debonding, not FRP rupture, governs most flexural designs.

Flexural design sequence

01 — Check the limit

Confirm the unstrengthened member resists the reduced load combination

02 — Design properties

Apply CE to guaranteed strength and strain; find the debonding strain

03 — Existing strain

Calculate the soffit strain at installation from loads already acting

04 — Strain compatibility

Iterate the neutral axis; FRP strain limited to the governing value

05 — Strength check

Apply strength and FRP reduction factors; check ductility of the section

06 — Service checks

Limit steel stress, concrete stress and FRP sustained stress at service

ACI expresses the debonding strain as a function of concrete strength and FRP stiffness, Ef·tf.

Service limits that often govern

01

Steel stress

ACI limits service stress in existing steel to about 80% of yield to avoid yielding

02

Concrete stress

Service compressive stress limited to about 45% of concrete strength

03

Sustained FRP stress

Creep-rupture limits by fibre type, much lower for glass than carbon

04

Deflection and cracking

FRP adds little stiffness; deflection may still need checking or another fix

Assume the FRP is lost in a fire

Check that the unstrengthened member, at elevated temperature, still carries the service loads required for the fire rating. Fire protection rarely keeps the adhesive below Tg for long.

In most externally bonded flexural designs, which failure mode typically limits the usable strain in the FRP?

A Rupture of the fibres at their full tensile strain

B Creep of the steel reinforcement at service load

C Debonding of the FRP from the concrete surface

D Compression failure of the FRP laminate

QUICK CHECK · LO3 · ANSWER

In most externally bonded flexural designs, which failure mode typically limits the usable strain in the FRP?

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B Creep of the steel reinforcement at service load

C Debonding of the FRP from the concrete surface

D Compression failure of the FRP laminate

WHY Debonding typically occurs well before fibre rupture, so guidance limits FRP strain to a debonding strain related to concrete strength and FRP stiffness.

04

MODULE 04 · 11 MIN · LO3, LO4

Shear, confinement and detailing

Wrapping schemes, column confinement, anchorage and a worked example

Shear wrapping schemes

Full wrap

- FRP passes right round the section
- Most effective and reliable scheme
- Highest reduction factor, least bond reliance
- Needs access to all four faces
- Often impossible where a slab sits on top

U-wrap

- Covers the soffit and both sides
- Common for T-beams under slabs
- Ends can debond at the top of the web
- Effectiveness reduced by bond length
- Can be improved with end anchors

Side bonding

- FRP on the two sides only
- Used where soffit access is restricted
- Least effective; bond-governed
- Lower reduction factor applies
- Anchorage strongly recommended

Strips with gaps or continuous sheets both work; the strip spacing is limited by guidance.

Key points in FRP shear design

01

Effective strain

Full wraps are limited to a low effective strain, 0.004 in ACI, to keep aggregate interlock

02

Bond reduction

U-wraps and side bonding use a bond-dependent factor that lowers usable strain

03

Spacing of strips

Limit clear gaps between strips so every potential shear crack is crossed

04

Total shear limit

Combined steel and FRP shear is capped to prevent web crushing

05

Fibre direction

Fibres at right angles to the axis are normal; check orientation on drawings

Confining columns with FRP jackets

01	**Circular is best**	Uniform hoop pressure confines the whole section efficiently
02	**Rectangular is weaker**	Only the arching core is effectively confined; corners concentrate stress
03	**Round the corners**	ACI minimum radius 13 mm; many specifications call for 20 to 25 mm
04	**Limit aspect ratio**	ACI does not recommend confinement for sides over 900 mm or ratio above 2
05	**Limit strain**	Hoop strain reduced by an efficiency factor; axial strain also capped

Confinement numbers worth remembering

0.55

ACI strain efficiency factor applied to FRP rupture strain in jackets

13 mm

ACI minimum corner radius for wrapped rectangular sections

0.08

ACI minimum confinement ratio, confining pressure to concrete strength

Below the minimum confinement ratio, the jacket gives too little restraint to change the stress-strain behaviour reliably.

Anchoring FRP to delay debonding

01

Extend past need

Run flexural FRP beyond the point where it is no longer required, towards supports

02

End U-wraps

Transverse wraps at plate ends restrain peeling and cover delamination

03

FRP spike anchors

Fibre bundles bonded into drilled holes and fanned onto the sheet

04

Mechanical anchors

Plates and bolts; isolate steel from carbon and check edge distances

05

Test-based design

Anchor capacity is system-specific; rely on tested details and guidance

WORKED EXAMPLE

Strengthening a slab for a change of use

THE BRIEF

Structure

One-way reinforced concrete slab, interior, originally designed for offices

New use

Archive storage with much higher imposed load than the original design

Survey

Sound concrete, no corrosion, good cover; bar sizes confirmed by scanning

Constraints

Unpropped installation, fire rating required, ceiling services below

01 **Screen the member**

Check unstrengthened capacity against 1.1 DL plus 0.75 LL and the fire case

02 **Check shear and supports**

Confirm slab shear and supporting beams carry the new load without FRP

03 **Design soffit strips**

Allow for existing strain; size laminates with FRP strain at the debonding limit

04 **Check service**

Steel stress, concrete stress, sustained FRP stress and deflection

05 **Detail and specify**

Strip spacing, terminations, avoidance of services, preparation and testing

What the strengthening drawings must show

01	**System and properties**	Required design strength, modulus, thickness and number of plies or strips
02	**Layout and orientation**	Location, width, spacing, fibre direction, laps and termination points
03	**Anchorage details**	End wraps, spike anchors or mechanical anchors with their exact positions
04	**Substrate criteria**	Corner radius, flatness, surface profile and minimum pull-off strength
05	**Testing and protection**	Witness panels, pull-off tests, inspection and protective coatings

A rectangular column is to be confined with FRP. Which detail most directly improves the effectiveness of the jacket?

A Leaving the corners sharp so the fabric grips the edges

B Bonding separate vertical strips to each face

C Rounding the corners to a suitable radius before wrapping

D Using pre-cured laminates instead of fabric

QUICK CHECK · LO3 · ANSWER

A rectangular column is to be confined with FRP. Which detail most directly improves the effectiveness of the jacket?

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B Bonding separate vertical strips to each face

C Rounding the corners to a suitable radius before wrapping

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WHY Rounded corners reduce stress concentration and fibre damage, increasing the effective confining pressure. Sharp corners cause early jacket rupture.

05

MODULE 05 · 11 MIN · LO4

Installation and quality control

Substrate preparation, site conditions, testing, inspection and protection

Preparing the concrete for bonded FRP

01	02	03	04	05	06
Investigate	**Repair**	**Inject cracks**	**Profile**	**Shape and flatten**	**Clean and dry**
Map delamination, cracks, corrosion and contamination across the area	Break out unsound concrete and repair with compatible repair materials	Inject cracks wider than about 0.25 mm with epoxy before bonding	Abrasive blast or grind to remove laitance; at least ICRI CSP 3	Round corners, grind fins and steps, fill voids to tolerance	Remove dust and oil; confirm moisture is within system limits

ICRI surface profile chips CSP 1 to 10 give a visual reference for the required texture.

Minimum targets for the prepared surface

1.4 MPa

ACI minimum pull-off strength (200 psi) for bond-critical work

1.5 MPa

Typical minimum pull-off strength in fib-based specifications

CSP 3

Minimum ICRI concrete surface profile for bonded systems

Test on the prepared surface, spread across the area, and investigate any failure at the surface layer before proceeding.

Ambient conditions during application

01

Dew point

Surface typically at least 3 °C above dew point to avoid condensation

02

Substrate moisture

Within the system limit; damp concrete weakens the primer bond

03

Temperature range

Within the supplier's limits; heat shortens pot life in hot weather

04

Shade and timing

In hot climates, work in shade or cooler hours and store resins cool

05

Record keeping

Log air and surface temperature, humidity and dew point every shift

Installing the FRP system

01	**Mix accurately**	Full units or weighed batches, mechanical mixing, within pot life
02	**Prime and fill**	Primer and putty within the recoat window to the prepared surface
03	**Apply FRP**	Saturate fabric or butter laminate; press and roll out air and excess resin
04	**Laps and orientation**	Check fibre direction, ply count and lap lengths against drawings
05	**Cure and protect**	Protect from rain, dust, impact and loading until the system is cured

Tests and inspections for FRP strengthening

Check	Purpose	Typical method
Witness panels	Confirm laminate properties and cure on site	Panels made alongside the work, tested in tension
Bond pull-off	Confirm bond of FRP to concrete	ASTM D7522 on the installed system or test areas
Delamination survey	Find voids and unbonded areas	Tap testing or thermography across the surface
Cure and Tg	Confirm hardness and degree of cure	Hardness checks; Tg by DMA on site samples
Records	Prove materials and conditions	Batch numbers, mixing log, ambient readings

Repair delaminations by injection or cut-out and patch, as the specification sets out.

Protecting the finished system

01

UV protection

Compatible coating over exposed epoxy to prevent chalking and degradation

02

Fire protection

Where required, a tested insulating system; it supports, not replaces, the fire check

03

Impact and vandalism

Protective boarding or barriers at low level and in vehicle areas

04

Finishes

Paints and renders confirmed compatible; no solvents that attack the epoxy

05

Inspection plan

Record locations so owners inspect and avoid drilling through the FRP

SPECIFICATION

Specify the whole process, not just the material

An FRP system performs only when design, materials, preparation, installation and testing all meet the specification. Name the acceptance criteria, the tests and who signs each stage off.



Pull-off tests on a prepared soffit for flexural FRP give 1.0 MPa, failing in the top skin of the concrete. What is the right next step?

A Proceed, since the FRP adhesive is stronger than the concrete

B Add an extra ply of FRP to compensate for weak bond

C Proceed but reduce the design load by a third

D Stop, investigate the weak layer and re-prepare or repair before retesting

Pull-off tests on a prepared soffit for flexural FRP give 1.0 MPa, failing in the top skin of the concrete. What is the right next step?

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B Add an extra ply of FRP to compensate for weak bond

C Proceed but reduce the design load by a third

D **Stop, investigate the weak layer and re-prepare or repair before retesting**

WHY The result is below the ACI minimum of 1.4 MPa for bond-critical work. The weak surface must be removed or repaired and retested before bonding.

SUMMARY

Four things to take away

LO1 Use FRP only after repair, and only where the unstrengthened member, fire and exposure limits allow it

LO2 Choose fibre and product form to suit the job; the tested epoxy system carries every newton of load

LO3 Design to one guide consistently; debonding, strain limits and the unstrengthened check usually govern

LO4 Specify preparation, pull-off acceptance, site conditions, testing, protection and sign-off at each stage

EARN YOUR CREDIT

Complete the online assessment

10

questions drawn at random from the four objectives

80%

to pass; two attempts, reshuffled each time

1.0

LEU and AIA LU|HSW on your certificate

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.

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Knowledge › CPD-CR-FR-01

Standards and references

ACI PRC-440.2-23

Design and Construction of Externally Bonded FRP Systems for Strengthening Concrete Structures — Guide

fib Bulletin 90

Externally applied FRP reinforcement for concrete structures (supersedes fib Bulletin 14)

ASTM D7522/D7522M

Standard Test Method for Pull-Off Strength for FRP Laminate Systems Bonded to Concrete Substrate

ASTM C1583/C1583M

Tensile Strength of Concrete Surfaces and Bond Strength of Repair and Overlay Materials by Direct Tension

ASTM D3039/D3039M

Standard Test Method for Tensile Properties of Polymer Matrix Composite Materials

ASTM D7565/D7565M

Determining Tensile Properties of Fiber Reinforced Polymer Matrix Composites Used for Strengthening

ICRI 310.2R

Selecting and specifying concrete surface preparation for sealers, coatings, overlays and repair

EN 1504-9

Products and systems for the protection and repair of concrete structures — General principles

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THANK YOU FOR ATTENDING

Questions?

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

