

VIRTUAL FRP TRAINING SCHOOL - QUESTIONS AND ANSWERS

What is the preferred FRP system when we need flexural strengthening on top (near supports - negative moment and additional top rebar requirement) ?

The preferred FRP system for negative moment (near support) strengthening depends on the amount of strengthening required but Sika CarboDur plates and Near Surface Mounted bars are a common strengthening method. Wet lay-up systems, such as SikaWrap Hex 103C, have also been successfully used for cases where flexural strengthening demand is more extensive.

Do girders or beams have to be wrapped, or can FRP be applied just to a side?

FRP may be used for both flexural and shear strengthening of beams/girders. For flexural strengthening FRPs are applied on the underside of the beam/girder. For shear strengthening, the FRPs are applied as U-wraps around the perimeter of the beam/girder.

Can CarboDur strips be painted or plastered, if so, how?

Yes, an epoxy coat, such as Sikadur 330 can be applied over the strips and broadcasted with sand to create a roughened surface. This will allow for the strips to be painted or plastered.

You mentioned that concrete needs to be 3 to 4 weeks old before applying FRP. Does it apply the same rule for the concrete repair?

FRP should not be applied to freshly formed or hand-applied concrete until the concrete has achieved the recommended compressive strength. Depending on the product used, this can vary from 7 days to 21 days.

Is there a cost to review a non-specified project?

No there is no cost to review a non-specified project as long as all the necessary information to quantify material amount is provided. Sika will be happy to evaluate a project and provide a cost estimate on products and support you with all the steps needed to specify an FRP product.

How can I design column beam etc. with FRP materials to get required strength?

Contact Sika's CFRP Specialist, Eri Vokshi, download our Sika CarboDur software, or follow ACI 440 design guide.

SIKA CORPORATION USA

201 Polito Avenue · Lyndhurst, NJ 07071 · USA

Phone: 800 933 SIKa · Fax: 201 933 6225 · www.sikausa.com

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ACI 440.2R requires the original structure without FRP reinforcement to be able to support 1.1DL+0.75LL, so if the original structure is significantly under-designed, can FRP reinforcing still be used?

No, it is not recommended that FRPs are used in structures where ACI 440's strengthening limits cannot be met. These limits are imposed to guard against collapse should an FRP failure occur due to loss of bond or FRP damage, which may occur due to vandalism, fire or other causes.

In addition, ACI 562-16 "Code Requirements for Evaluation, Repair, and Rehabilitation of Concrete Buildings" imposes very similar strengthening limitation for external reinforcing systems, such as FRPs. Because this is a code document, the language and requirements set forth are mandatory.

Is installation by a Certified Sika product contractor fully trained in the application of your products?

Yes, a contractor must be trained by a Sika representative prior to installing any of our FRP systems. In-field support by Sika team is also encouraged when a contractor installs the products for the first time.

Do you have a recommended cup grinder to get a csp3?

A double rounded diamond cup wheel will work well. The cup needs to be changed frequently to maintain the desired roughness of the concrete.

Is water blasting allowed for surface preparation?

Abrasive water blasting can be used to achieve the required CSP3 surface finish.

What is the fastest dolly adhesive Sika recommends for bonding Dollys for Adhesion Test?

Sika does not perform dolly testing in the field so it is best to consult with a testing company or the dolly manufacturer to determine best epoxy to bond dollies to the FRP substrate. With that being said, Sika Anchorfix products have been used successfully to adhere dollies for independent testing. The Sika Anchorfix 2 can provide bond in as little a 1 hour depending on temperature.

What if you are using an rh reader what is the moisture levels you can have?

If the Tramex meter reads under 4% at the time of install and there is no hydrostatic or osmotic pressure, the RH of the concrete is not as critical as long as the concrete can "breathe" and is not fully encapsulated in epoxy/FRP.

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Can you please share the ACI reference to min. tensile strength values for substrate and FRP?

Minimum concrete substrate strength requirements is given in ACI 440.2R-17, Section 1.2.1.4. Minimum FRP bond strength requirement is given in ACI 440.2R-17, section 7.2.5.

It seems like the surface prep could be fairly time intensive - especially for old structures requiring extra surface repair. Is all of the surface prep and repair included in the cost comparison for steel surface retrofit vs. FRP? (Ref Slide 17)

Yes, surface preparation was accounted for when comparing the steel vs. FRP composite repair solutions. Cost difference between the two systems will vary on a project to project basis.

How is the effect of UV on the epoxy that bonds the FRP to the concrete substrate? Will the bond-line degrade overtime due to UV exposure?

The epoxy bond-line between the FRP and the substrate degradation is much slower compared to the external FRP layers. Therefore, as long as a protective coating, such as Sikagard 670W, is used, UV degradation of the bond-line is minimal. Please note that UV degradation in FRPs occurs in very extreme UV exposure conditions and occurs over a prolonged period of time.

Is UV protection a design consideration required for design professional?

Yes. If a structure is externally exposed, a designer should consider specifying a top-coat compatible with the FRP system. Sika recommends specifying Sikagard 670W.

Is there a design life cycle for FRP composites? Such as, it needs maintenance after some x years etc. or needs replacement after so many years!

There are currently no recommendations in the design guides and codes on the frequency of inspection and assessment. While Sika can assist with such a plan, it is left up to the owner to determine the type and frequency of inspection.

Is FRP a permanent fix?

Like with all building materials, FRP's have a design life. This will depend on exposure conditions and maintenance. Historical data shows that externally applied FRP systems may last in excess to 30 years, when maintained and protected properly.

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Can you please discuss potential creep effect, debonding issues, exposure to heat, suggested ways of anchoring and fire resistance.

The above identified topics are well researched and addressed in the ACI 440 design guide via design limitations. Below is a very brief summary of each topic and how ACI 440 addresses them:

- Creep effect - Carbon fibers are highly resistive to creep rupture under sustained loading and fatigue failure under cyclic loading. Glass fiber systems are more sensitive to both loading conditions. Creep rupture is addressed in an FRP design by imposing stress limits on the FRP system for these conditions.
- Debonding – this is the most common controlling failure mode in FRP design. Limitations on the amount of strength the FRP can contribute to a repair depends on debondment limitations.
- Anchorage – the main advantage to using FRP anchorage systems is to enhance the bond strength between the FRP and substrate. There are currently no guidelines in ACI 440 to determine the amount of anchorage needed, however there is substantial research data that support the use of these systems. Anchorage design should be evaluated on a case-by-case basis.
- Fire resistance – FRPs are not designed to sustain loads during a fire event. Strengthening limitations are provided in ACI 440 and ACI 562 to prevent a collapse during a fire event. Sika has performed UL testing using our SikaWrap systems fire-proofed with Sikacrete 213F to show that fire-rating of a structure can be increased, as long as the strengthening limits highlighted in ACI 440 for fire conditions are met.

How fast does the system lose strength in a fire situation?

It depends if fire-proofing, such as Sikacrete 213F, is applied. FRP will lose its strength when the temperature exceeds the glass transition of the epoxy materials used.

Does the pre-cured FRP provide the same strain limit against debonding failure as wet lay-up? i.e., does wet lay-up provide a better bond strength or is it about the same?

Because the debondment strain is inversely proportional to the stiffness of the composite, an FRP system with a high Tensile Modulus, will debond sooner than a system with a low Tensile Modulus. Therefore, a wet lay-up system will have a higher debondment strain than the FRP plates. However, this does not mean that one system performs better than the other. It only means that the contribution of the FRP strength for the two systems will be different.

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Is FRP compatible to steel reinforcement in-regards to the member resistance?

If referring to equivalent area, FRP and steel will not provide the same amount of reinforcement. In other words, 0.1in² of FRP does not provide the same strength increase as 0.1in² steel.

Can confinement repairs tend to hide problems?

If the cause of damage in columns is not addressed, problems in FRP wrapped members can arise. Many times, this can occur due to presence of moisture entrapped in a member, which can exacerbate an unaddressed corrosion issue. As highlighted in ACI 440 and during our FRP training school, it is imperative that prior to application of FRP systems, all problems associated with the condition of the original concrete substrate are addressed. In addition, to promote vapor permeability in columns, many times designers specify a few inches of space between circumferentially applied FRP.

Do you require any minimum overlap of the seams?

For unidirectional FRP laminates, lap splices are required only in the direction of the fibers. For column applications, Sika recommends a minimum 6in overlap at the seam of the column wrap. Lap splices are not required in the direction transverse to the fibers.

Is there a specific mix ratio A&B for Sikadur 330 while preparing the epoxy?

There is, however we strongly discourage batching down any of our FRP epoxies.

Is this FRP method approved by NYC agencies. We usually follow the contract specs. for repair.

Yes, many NYC agencies have utilized FRP materials. Below is a list of them:

- MTA / New York City Transit / Metro-North / Staten Island Railroad / Long Island Railroad / Bridges and Tunnels
- New York City Housing Authority
- Department of Buildings
- New York City and State Department of Transportation
- Port Authority of NY/NJ
- New York City Department of Design and Construction
- New York City Parks Department
- New York State Thruway Authority
- New York State Dormitory Authority
- Department of Sanitation

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Post application QA/QC tests and their remedies? Are there special inspection guidelines/ requirements for FRP installation?

Sika provides QA/QC guidelines and field-test recommendations in the product Method Statements. Feel free to reach out to us to get a copy of this document, which also serves as an installation guide.

FRP main use appears to be as tension-reinforcement. What about use as compression? and use where there is surface abrasion or wear not advisable?

FRP materials are only designed to be used in tension. For cases where FRP is applied on top of a surface, such as negative moment reinforcement of slabs, it is recommended that the system is coated and sand is broadcasted to protect it from surface wear.

What is the effect of atmospheric moisture on epoxy part of FRP?

Moisture presence during curing of epoxies, which have not been designed to be applied in wet environments, will result in reduced material properties of both the epoxy and the FRP system.

Is there a minimum, maximum or ideal humidity level for the application of the wet layup presaturated FRP

More important than the humidity during the installation is the dew point at the time of installation. We want to maintain a temperature to humidity ratio that ensures we avoid the dew point which can cause issues in bond and cure of the epoxies.

Are FRP systems water vapor permeable?

FRP systems will cure to form a hard shell which does not promote water vapor permeability. Therefore, careful considerations should be made when considering the use of FRP in areas where full encapsulation of a member is required and where there is moisture presence.

Can presat be installed in a wet environment?

Yes, the Pre-saturated systems can be applied in wet environments. For these applications, the primer epoxy must be Sikadur 345, which is an epoxy primer specifically designed to be applied on wet substrates.

Can FRP strips be applied to chloride contaminated concrete?

No, chloride contaminated concrete will need to be replaced prior to FRP installation. Failure to do so will promote active corrosion of the reinforcing rebars, which can compromise the concrete substrate and the structural integrity of the externally applied FRP system.

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Can you solvent wipe concrete to clean it?

You can, but it is not necessary as long as all the proper surface preparation steps described in the presentation are completed. Xylene or other similar solvents can be used to help clean the substrate prior to installation and should be allowed to “flash” prior to epoxy installation.

Are FRP strips for beam strengthening (moment region) compatible with heavily map-cracked concrete (assuming cracks are < 10mm wide and no delaminations are noted).

A thorough assessment of the structure should be performed and the cause of the cracking should be identified, prior to FRP strengthening.

Does your SIKA bonding agent for new concrete to old develop the full strength of the concrete? In other words, can we assume composite action between the new and old concrete with SIKA bonding agent?

Bonding agent such as Sikadur 32 create a very strong bond between the existing and new concrete mortar for vertical and horizontal applications. Overhead applications should be evaluated on a case-by-case basis.

Better warranty with Pre-sat system versus wet layup?

No, Sikas standard warranty on the materials applies for all our SikaWrap product line.

Can multi-layer column wrap with pre-saturated system be installed in one continuous wrap?

Yes, however it is much more difficult to do. Experienced contractors have successfully used this technique in the past.

When applying is it better to start at the bottom? So the 6” lap will lay like a shingle

This is a based on contractor’s preference.