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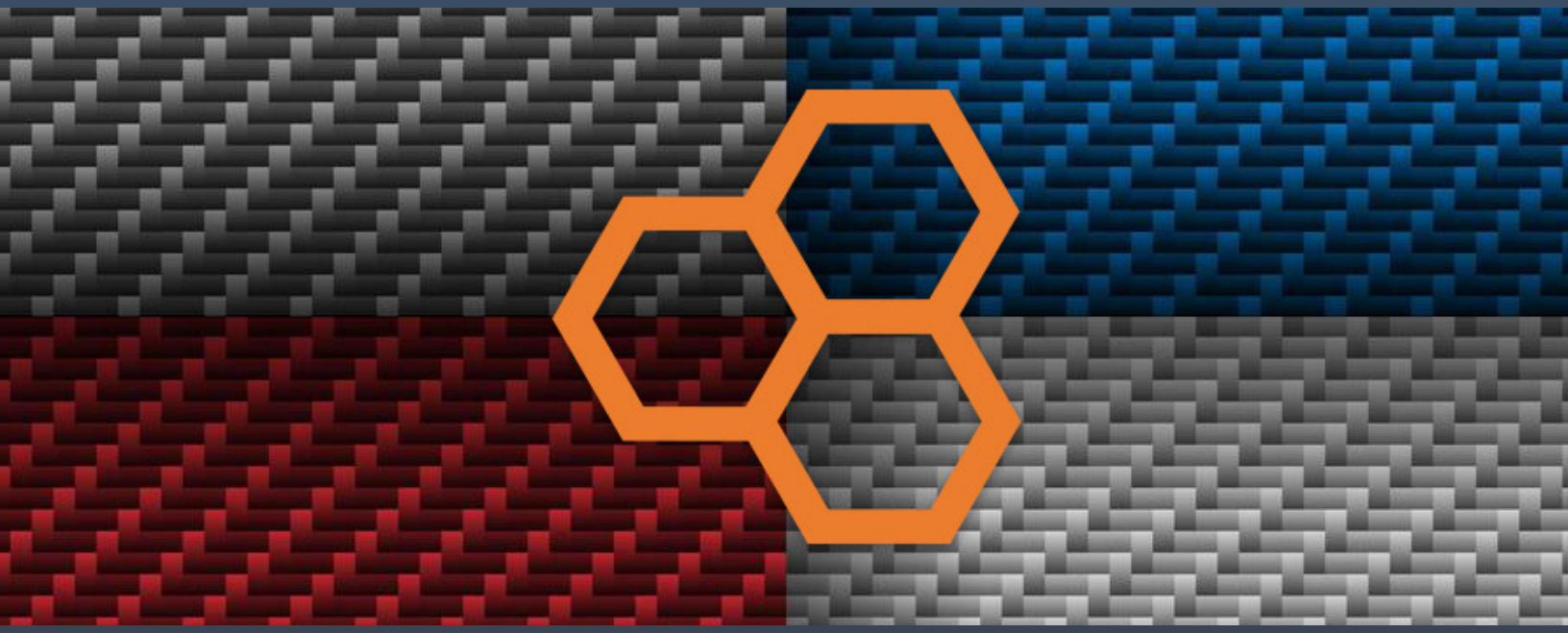

CARBON FIBER & CONCRETE REPAIR - AN UNLIKELY BUT VERY COMPATIBLE DUO

COMPOSITE ENVISIONS

CARBON FIBER & CONCRETE REPAIR

INTRODUCTION

Think Carbon Fiber is just for lightweight applications reserved for aerospace, auto racing, and small projects? You may think differently after reading this. Carbon Fiber is being recognized and used in a different perspective, expanding its use in the concrete repair in the construction industry. Heavy Duty applications with concrete, wall support, bridge pillars, and home foundations have been reinforced or repaired using carbon fiber and epoxy mixtures, changing the way the world thinks about Carbon Fiber and its versatile properties.

The first question many have may be how and why? We'd like to take some time to explain a little about Carbon's properties and why this application is growing all over the world. We will also dive into some DIY instructions and best practices of applying this method to your next home project.

REINFORCEMENT

Carbon Fiber is renowned for its strength characteristics. But CF's high modulus paired with its strength that sets CF apart from any other material on this earth. Simply, Carbon Fiber is stiff AND strong, making it an ideal material for construction uses where one might not want any bending or movement. Pairing CF with a top performing epoxy resin system makes for a highly rigid material suitable for secondary bonding on construction applications. Carbon Fiber's applicable advantage over other methods is having a very low profile when layered on top of an existing structure. Basically, it is no burden on a building's existing design requirements / constraints all while providing reinforcement that is invisible after being worked and painted over.

Repairs may be applied as a traditional type layup or with pre-made plates. In addition, CF paired in with an engineered epoxy system formulated to be highly chemical resistant, adding a layer of protection against elements that would otherwise continue to degrade a building's structure. Using CF Fabrics with epoxy is very easy to work with and is also easy to work with, making it a more viable solution than traditional means of concrete and structural repair.

Cost is (obviously) a major factor in any industry. While slapping Carbon Fiber fabrics on a large structure may not be the cheapest solution on the surface, rebuilding an entire structure isn't exactly a cheap option either. There are many reasons why a building structure can deteriorate. It is easy to point to design errors, but environmental factors are a leading cause in building structure degradation. Seemingly the earth is always changing and buildings simply age. Often buildings are used differently than they were initially intended when built.

For that reason, Carbon Fiber & Epoxy systems offer a cost-effective solution like no other.

Its versatility in application is seemingly endless and most of the repairs completed are done in a fraction of the time in which (older) traditional repair methods could be used. This is because the need for large tools or equipment are not needed. Most of these types of repairs can be completed with simple hand tools. Although, some applications may require a scissor lift or other man lifting device for certain applications as means of getting to the repair area. Are we saying that new construction practices are making complete housing structures from carbon fiber or that we might soon see a CF skyscraper? Probably Not. However, CF and epoxy resin systems have been proven to provide additional strength to construction applications and provide a means to repair structural damage in slabs, wall strengthening, columns, and beams. Uses are not limited to just basements & buildings, it extends into the Oil & Gas industry, water systems & infrastructure, and even into transportation.

STRUCTURAL FOUNDATION REPAIRS

Wrapping bridges, foundations, sea walls

Carbon Fiber and structural epoxy is often used for wrapping structures such as bridge pylons, foundations, and even sea walls. If a crack is present or the support structure has become weakened, the crack itself may be filled by a resin alone or with an added CF mixture. Then the structure itself is laid over by wrapping unidirectional or woven carbon fiber and epoxy matrix over the existing surfaces as designed. This effectively strengthens the overall construction and reduces stress on that existing structure. When this type of repair is carried out, it is commonly practiced using an epoxy resin formulated for higher chemical resistance and even water-proof epoxies for prolonged exposure to elements. These types of repairs can vary greatly in their design and practice. While it may seem like a cure all, there is a lot at stake when structures such as bridges or structurally loaded buildings are repaired. There are years behind the experience and materials knowledge it takes to make the critical decisions and designs on these repairs.

Bowed Interior walls

Interior walls of basements have a history of being troublesome in regard to bowing due to the pressure placed by the soil. This inward pressure will in time cause the concrete foundation walls to bow inward. To combat additional deterioration, concrete walls can be reinforced by carbon fiber straps. These straps are applied vertically along the wall. Carbon Fiber and Epoxy can be used effectively because it will conform to the slightly bowed walls and stabilize the interior wall from bowing more. This type of repair is done by placing the straps perpendicular to the bowing surface. The bow being inward, the repair will go up and down the wall. The repair may apply differently if the wall had a vertical crack in it from another cause. In this case, the carbon straps may be applied from side to side, combating future movement of the wall. The concept being, always applying the reinforcement perpendicular to the discrepant area. In these types of repairs, unidirectional CFs are used more effectively.

GENERAL PRACTICES FOR REPAIR

Carbon fiber and epoxy systems on construction applications with concrete follow the same guidelines as that of bonding to other composite substrates. The area in which is being bonded must be clean and free of any FOD (Foreign object debris). With most concrete repairs in construction, a clean room like atmosphere is nearly impossible. This can be a challenge as there is usually an amass of dirt and grime accumulated on most construction surfaces whether they are indoors or out. One of the best methods of cleaning these construction substrates involves use of different tools and cleaning methods.
Achieve an even bonding substrate. With concrete, it will need to be as even as possible, removing any high spots and sharp edges. Any sharp edges of walls should be sanded down to get a smooth enough surface to lay the CF fabric over smoothly. On sharp edges, the radius should be more than 20-30 mm. This may be achieved by grinding, grit blasting, sand blasting, sanding and / or pressure washing.

SURFACE PREP FOR BONDING

An etching chemical such as Muriatic Acid may help even the dirtiest surfaces of concrete become clean enough for composite for bonding. It is highly important to note that special PPE (Personal Protective Equipment) is required for use. Chemical resistant gloves, sleeves, googles, and a respirator would be required for safe effective use of this product. It is also important that the acid does not reach any metals as it can deteriorate and etch metal surfaces. It can be mixed 50/50 or less and poured onto the concrete surfaces, it will begin to bubble and work through everything it contacts. After it sets for (~5) minutes, it can be removed by pouring water over it to neutralize the acid. It is important to read the Safety Data Sheet associated with any chemical before using it, especially with Muriatic Acid.
Soap and water may also be used to clean concrete or other construction substrates for bonding. This may be the cheapest and safest option, requiring the lowest amount of PPE.
Whether chemicals are used or not, a vacuum cleaner or shop vac should be used to rid any remaining debris from the proposed bonding area. When an effective prep is complete, and the concrete surface(s) is FULLY DRY the real fun can begin.

MIXING

Most concrete specific epoxies have special additives that make them more suitable for various applications. Depending on the repair strength needed, temperature conditions, or type of repair, or differing chemical exposures, special types or formulated construction epoxies are made. Regardless, most epoxy construction adhesives come as a (2) part system that will need to be mixed according to the adhesive's technical data sheet (TDS). If the adhesive was not shipped with one, a TDS can usually be found by a quick online search. Some formulations may require a low-speed mixer to be most effective, but some may be

completed by hand depending on the amount. Construction epoxies vary heavily in their physical, working, and cure characteristics; so be sure to study the adhesive well before buying a specific construction adhesive. When mixing is complete, be sure to clean all mixing tools for future use.

INITIAL DIY REPAIR (CRACKED CONCRETE)

One easier project one may consider in their own home as a test would be a slightly cracked floor repair, maybe outside on the porch or in a shop type of environment. Failure isn't going to mean catastrophic consequences of an entire building. As one becomes more comfortable with the idea, structural repairs may be within reach.

For repairing a cracked floor, use the above concepts and follow below as a guide to complete a staple repair for cracked concrete.

Clean the immediate area and drape a cloth around the areas needed that will mitigate later clean up.

Using an angle grinder with a bit made for cutting or grinding concrete will suffice. Grind away rigid hard edges of the cracks, smoothing all surfaces on the concrete substrate. Acquire carbon staple assembly and place it as close to the beginning of the crack as possible. Center the staple perpendicular to the crack. Draw the outline of the staple(s) with a sharpie or other marking material. Follow the crack another 8-12" and repeat the outline perpendicular to the crack. Do this for the entire length of the crack.

Using a grinder or other means of cutting away concrete in a straight manner, cut the traced marking to the depth of the carbon fiber staple. Ensure this is done to its full extent for the staples to go in completely and there is not a raise in the floor afterwards. Once the lines are cut, drill a hole to the size of each staple end, (2) per staple. It is highly encouraged to use masonry bits as if you do not, this will be an endless job. The staple will need to fit completely inside the cut away concrete.

Once complete vacuum the entire area, ensuring there is no dust or FOD present within the immediate area. Remember, cleanliness in the next steps is critical to achieving a good bond between the epoxy, the staples, and the concrete.

After ensuring the staples will fit into the holes adequately, fill each cut and drilled hole(s) with an epoxy paste. As they are filled, apply the carbon staples. Once all holes are filled with staples, apply another layer of paste over each staple until it is even with the existing concrete surface. Using a scraper removes any excess epoxy, any excess could be used for the next hole.

Once the epoxy has fully cured, any excess may be removed by grinding. As an option, one

may choose to paint over this repaired area. We are unsure why one would hide such a masterful piece of repair art, but it is not our repair either, we're just here to help.

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