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Purdue ECT Team
Purdue University, ectinfo@ecn.purdue.edu

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CARBON FRP GRID STRUCTURES FOR USE IN REINFORCING CONCRETE

THE NEED

Concrete is inherently strong in compression and weak in tension. To address this concrete often reinforced with steel in the form of rebar, welded wire mesh or stressing strands (Prestressed or post-tensioned). In theory, the concrete has to crack when loaded in tension for the steel to begin to share the load in the steel reinforced concrete composite. The concrete helps protect the steel by providing a high pH alkaline environment to retard corrosion of the steel. To properly protect the steel the concrete needs to cover the steel by a minimum thickness, not have large cracks and not have its chemistry altered by environmental factors like deicing salts, carbonation, etc.. ACI codes specify minimum cover thicknesses depending on the application of the structure. In practice, steel often corrodes due to poor design, workmanship, environmental effects such as deicing salts or coastal environments and a myriad of other causes. Due to the inherent properties of steel reinforced concrete, many structures are expensive, heavy and costly to maintain. The repair of these structures is a multi-billion dollar business worldwide according to industry sources (ICRI).

FIGURE 1 C-GRID BEING USED TO RECONSTRUCT NAUMBURG BANDSHELL,
NEWYORK CENTRAL PARK

**FIGURE 2 C-GRID BEING USED AT CHS TERMINAL BRIDGE,
MISSISSIPPI RIVER**

THE TECHNOLOGY

Carbon FRP Grids are structural reinforcement materials that improve the performance of concrete structures such as insulated wall panels, architectural panels, double tee parking garage tee beams, concrete countertops and other products. The carbon grids can be used in place of welded wire mesh in most structures and is imbedded the same way as a welded wire mesh. The inherent properties of carbon fiber: high strength, high modulus and excellent resistance to creep and fatigue allow the carbon grid to perform well in this application.

THE BENEFITS

Carbon grids provide a corrosion resistant reinforcement that has a higher modulus of elasticity than steel that is imbedded inside concrete (similar to conventional steel mesh). This allows for designs that don't require as much concrete cover, so concrete structures can be lighter and much more durable than before. For instance, using carbon fiber grid in insulated wall panels can provide a stronger, lighter, more thermally efficient panel than is practical with conventional designs. FRP fabrics that are used as external reinforcements are impregnated with polymer on the jobsite and have to be bonded to a surface of a concrete structure. In contrast, carbon grids provide an internal reinforcement and have fibers that are impregnated with a polymer (typically epoxy) in a factory rather than on the job site, saving time and insuring consistent quality. Also, the open spaces of the grid provide a mechanical bond to transfer load within the concrete structure. Additional benefits of the carbon grid structure are that it is light, easy to

handle, non-magnetic and easier to cut than steel. These properties allow for use where steel is impractical or cumbersome.

STATUS

Carbon grids have been manufactured by Chomarat North America (formerly TechFab LLC) since 2003 and have found commercial uses in concrete countertops, shotcrete, ornamental concrete, caststone products, precast insulated wall panels, double tee beams and a myriad of other concrete products. These materials have also been used in a number of 21+ repair projects including the Naumburg Band shell in New York City cited on the website www.carbongrid.com. A variety of product strengths and apertures are offered depending on the application.

BARRIERS

The main drawback of the carbon grid is the additional cost of carbon as compared to mild carbon steel. In addition, since carbon is a linear elastic material (without a yield point), reinforced concrete structures have to be designed to account for this. Carbon fiber grids can be used in design using ACI 440 methodology similar to FRP rebar. Typically, the structure will also use steel in an appropriate location or be over designed so that the structure fails by crushing the concrete in tension providing ductility.

REFERENCES

1. www.carbongrid.com

REVIEWERS

Peer reviewed as an emerging construction technology

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PUBLISHER

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