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NEW INFRASTRUCTURE REPAIR METHOD - FIBER REINFORCED PLASTICS

THE NEED

As the United States infrastructure gets older, the need for repair and rehabilitation increases. Most of the constructed facilities are deteriorating at a rate faster than they can be repaired. Nearly half of the nation's 575,600 highway bridges are structurally deficient or functionally obsolete (Engr. News Record, 11 Sept, 1995). Several studies have documented the three trillion dollar rehabilitation /retrofitting need of U.S. infrastructure. Through the development and use of composite materials, this tremendous problem could be solved. New materials need to be developed that can act as a permanent "Band-Aid" that would not require large amounts of demolition work to be done before repair begins. Also, simple retrofits to reinforce substandard structures have a huge potential place in the marketplace.

FIGURE 1 BEAM STRENGTHENED WITH FIBER REINFORCED PLASTIC

THE TECHNOLOGY

Thermal setting resins and fiber rods and sheets are being used to repair and upgrade structural systems. High-strength FRP fabric can be wrapped with relative ease around a bridge pier, a concrete column, or a concrete beams. They are primarily used to stiffen columns and beams and to repair deteriorated concrete components.

FIGURE 2 EXAMPLE FIBER REINFORCED PLASTIC

THE BENEFITS

Tests have established that wrapped structural elements, with confined concrete, can have an increase in strength and stiffness of 50% to 500% above that found with unwrapped elements. In addition, weak links in a structural system such as the lap-splice area near the column-footing interface can be strengthened to resist earthquake forces. Moreover, FRP plates and sheets are easier to install because they only need to be glued to the surface of a structure, which requires less on-site effort compared to steel plates.

STATUS

Research and development (R&D) concerning the strengthening and stiffening of reinforced concrete structural elements has been going on in Europe, Japan, and North America for nearly ten years. Much of the surface repair technology for defective bridge columns, smoke stacks and earthquake damaged buildings originated in Japan and consisted of either wrapping preformed composite sheets around structurally damaged column surfaces or jacketing smoke stacks with large-scale, on-location filament winding.

For example, the Constructed Facilities Center at West Virginia University has been working closely with several U.S. and Japanese industries to understand the behavior of concrete beams wrapped with CFRP fabrics through extensive testing. Two Japanese companies have promoted their products to the construction industry. One is the FITS method by Mistui Construction Co., which can improve existing RC columns' shearing strength and deformation properties by wrapping the surface of the columns with adhesive UD tape made of aramid fiber. The other is FTS system by Tonen Corporation, which is dry type sheet material alighted carbon or glass fiber unidirectionally on a thin back net with a layer of epoxy resin adhesive. Similarly in California, concrete bridge columns have been retrofitted to enhance their flexural and shear strength. For over ten years, Swiss Federal Laboratories for Material Testing and Research has been investigating static and fatigue resistance of CFRP sheets that reinforce concrete rectangular and T-beams on their tension side.

FYFE Co. LLC is one of the companies which offer a wide range of FRP product for use in various structural application, such as column, beam, slabs, wood piles, pipes, masonry walls and tanks.

BARRIERS

One barrier to the widespread use of these technologies using FRP materials for infrastructure repair is that they have not been broadly accepted by any building codes. Some concerns still remain about FRP's fire resistance, long-term creep characteristics, and aging due to ultraviolet rays or degradation of bond forces with time. Also, a full understanding of failure behavior and design models that would reflect the

improvements in strength and stiffness of rehabilitated or retrofitted concrete structural members still need to be developed.

To date, the cost of composite materials, along with design and manufacturing complexity, have restricted such materials to areas such as national defense or high-performance sporting goods.

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REVIEWERS

Peer reviewed as an emerging construction technology

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