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"EXPERIMENTAL AND ANALYTICAL INVESTIGATION OF FIBER REINFORCED POLYMER (FRP) BRIDGE DECK STRUCTURES": A GENERAL REVIEW

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Abstract – *FRP (Fiber Reinforced Polymer) bridge deck structure has more significance when they are compared with the conventional bridge structures. When these structures are compared with the conventional bridge structures it is found that FRP Structures perform better in various functions such as light weight, high durability, strength, high stiffness and can be easily install. As far as loading criteria is concerned, FRP bridge deck structures undergo two types of loading namely static and dynamic loading. The construction of FRP bridges are on large scale nowadays in various countries, therefore it is necessary to construct such bridges in India. Although the initial cost of FRP bridges is high but their technical parameters are more beneficial as compared to conventional bridges. This paper deals with the wide application of Fibre Reinforced Polymer (FRP) in construction of bridges.*

Key Words: - Fibre Reinforced Polymer (FRP), bridge deck panel, design considerations, advantages, applications.

1. INTRODUCTION

The application of fibre reinforced polymers in bridge construction has firstly started for strengthening of existing concrete bridges (carbon fibre reinforced polymer lamellas). Subsequently, FRP reinforcing bars were employed in production of 'steel free' concrete decks in order to avoid corrosion problems. The following move was to deliver connect decks made completely of fibre strengthened polymer composites. The essential reason of FRP materials being advantageous for use in pedestrian decks has the qualities of light weight and high strength to protect it from corrosion. A major number of walker spans have been worked as 'every composite' connect where all the bridge segments are made of FRP materials. While the in all likelihood utilization of FRP materials in street spans is FRP decks over for the most part steel braces. These days, various street spans are named fundamentally insufficient or practically out of date due to disintegrated basic parts or low load carrying capacity. Generally the fundamental load carrying capacity of individuals from these bridges is in great condition while the deck framework is deteriorated. Deterioration of bridges decks, which regularly are made of reinforced concrete, is for the most part brought about by corrosion of the support steel because of salts deposition. By and large, decay of concrete bridges happens before these bridges achieve their plan design service life.

2. RESEARCH AND EDUCATION OF FRP IN INDIA AND CHINA

India and its neighbour China are the two major rising and creating economies. While they began utilizing composites at the same time about over 30 years back, the advancement made by China is somewhat shocking. Fiber strengthened polymer (FRP) in India has come to progress in 1960s with a single resin manufacturer and a lone source of fibre glass. Throughout the years, the industry has developed consistently, yet at a slower pace. FRP materials were grown essentially for aviation and resistance enterprises during the 1940s and are broadly utilized in numerous ventures today, including aerodynamic, marine, car and electrical building. With the proceeding with cost decrease in superior FRP materials and the developing requirement for new materials to revamp common foundations, FRP materials are presently finding more extensive acknowledgment among structural engineers. Research on FRP in development in the territory of China might be followed back to the finish of 1950s when China was hard to find of steel. Development is a noteworthy piece of improvement plan of creating nations including India. To satisfy the vast need for foundation advancement, upkeep and life upgrade of existing structures are very important.

After numerous long stretches of utilization, a current structure frequently should be fixed or updated in comparison with a significant number of reasons like damage because of consumption or increased load demand and so on. There are a few techniques for retrofitting of structures like-guinting, post tensioning, externally bonded steel plates, steel or concrete jackets etc. Epoxy injection and recently created strategies like propelled systems for erosion influenced RCC and techniques for altering basic properties utilizing dynamic or uninvolved mass damper for tall structures are additionally there. The strategy of remotely holding FRP to reinforced concrete (RC) structures was brought into China in 1997.

In India, field utilization of FRP for basic strengthening could be followed as ahead of schedule as in 1999. Be that as it may, FRP is being utilized for new

development additionally in numerous nations; none could be followed in India. The material is as yet considered moderately new in this piece of the world. China is working away at utilization of FRP in new development in numerous headings like FRP spans, GFRP embankment, FRP space structure, concrete filled FRP tube sections. There exist numerous FRP footbridges in China.

3. FRP IN BRIDGE CONSTRUCTION

Generally, the recovery and development of ordinary short and medium range spans includes cast in place concrete. While this development system is reasonable for development of bridges in open development zones with no or extremely restricted traffic stream, they probably won't be a reasonable decision for development of bridges in urban zones. Cast in-situ concrete includes a gigantic utilization of labor and significant site exercises for development of formworks, position of support and casting of the concrete. These broad site exercises increment the danger of mishaps risking the wellbeing of specialists and street clients, impact the portability, increment air and other contamination and produce a great deal of waste nearby. Likewise, these exercises require a great deal of existence in the building site, causing consequently traffic aggravations, expanded traffic the board and street client costs and expanded green-house gas emission and energy use. To defeat these issues, modern ideas of quickened connect development that utilization pre-assembled connect components have begun to pull in expanding consideration both in research and in field application in the previous twenty years. The utilization of pre-assembled connect components for development of bridges offers a few advantages, for example,

1. Diminished construction time.
2. Improved constructability in obliged territories.
3. Diminished unfavorable social impact out on people and the encompassing network.
4. More secure workplace, improved user safety and reduce traffic accidents.
5. Diminished user delay costs.
6. Improved natural effects.

4. MATERIALS

Fibre reinforced polymer material is a combination of polymer resins, acting as a binder, with strong and stiff fibres which act as a reinforcement. Usually, fillers are also added to the resin to alter or enhance the material characteristics, such as to improve fire or ultraviolet (UV) resistance of the composite material. Typical fibre reinforcement materials used for civil engineering applications are glass, carbon, aramid or basalt fibres, while typical thermoset polymer resins are polyesters, vinyl esters and epoxies. The price of various materials usually increases with increased mechanical properties. Carbon fibres have the highest stiffness compared to all the other fibres, but the price of carbon fibres is more than 50 times compared with glass fibres. Regarding the resin types, epoxy resins exhibit better structural and environmental resistance and they are comparatively more expensive. As it can be noted the properties of the composite materials are in between the fibre and resin properties, where the fibres contribute most to the stiffness and the strength of the composite material in the direction of the fibres, while the resin is used to transfer the loads to the fibres and protect the fibres.

5. DESIGN CONSIDERATIONS

One of the troubles related with the structure of bridges with FRP decks is the absence of configuration codes. There exist structure rules for the plan of FRP passerby bridges and street spans ((AASHTO) 2008; Agency et al. 2005), however there is no all-around acknowledged standard code for FRP decks for use in street spans. Most current plans of street spans with FRP decks are done by following the details given by the FRP deck makers, which have been legitimized by verification tests. Nonetheless, standard examination and plan methodology for FRP connect decks are yet to be created.

FRP composite bridges decks should meet similar plan necessities as regular scaffold decks by following the contemporary methodologies of auxiliary structure of burden bearing frameworks which depend on the utmost state ideas. Generally speaking, basic investigation is portrayed to satisfy these points of confinement states for various burden cases characterized in the Euro codes. In the accompanying, the contemplations which have been taken in the plan of bridges with FRP decks are outlined.

6. APPLICATIONS OF FRP DECKS FOR BRIDGES.

Numerous pedestrian and road bridges have been build or rehabilitated with FRP decks up to now, mostly in the United States, Korea and Europe. The focus in this thesis is given to road bridges. FRP decks have been implemented in various bridge projects, where most of them have been deck replacement projects, and they can be distinguished as follows:

1. Deck replacement projects for deteriorated decks or bridges with traffic load restrictions, where the reduction in dead load could benefit an increase in live load ratings
2. Deck widening projects without imposing additional loads on the substructure.
3. Rehabilitation projects for historical bridges, avoiding the replacement of the bridge due to the cultural values.
4. Deck replacements for bascule bridges, benefiting from the lightweight of the deck to have simple mechanical systems for lifting or swinging and fast construction. One example in Europe is the Grasshopper bridge in Denmark, where the badly rotted timber deck whose

planking had to be replaced about every five years was replaced with an FRP deck in 2011.

5. Superstructure replacement projects due to deterioration (Turner et al. 2004). One example is West Mill bridge, which is the first all-composite road bridges in Europe, and it was installed in 2002, in England (Canning 2012).
6. New bridges where accelerated construction is needed to reduce the cost of maintenance and protection of traffic and reduce traffic congestions (Knippers et al. 2010; Lee et al. 2010).
7. FRP decks have been commonly used on steel structures with spacing between girders smaller than 3 meters. The spans of the superstructures have been relatively short (<14m), but in some projects FRP decks are applied for larger spans (Knippers et al. 2010).

7. CONCLUSION

The application of FRP in bridge construction had been reviewed. Experimental and analytical investigation has been carried out for finding out further behaviour of FRP panels with conventional panels but not discussed for the sake of brevity. Only little information about the FRP along with some literature has been discussed.

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