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A Review of Bond Strength of Gfrp Bars to Concrete

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Abstract: *This paper reviews works on to examine the suitability of GFRP (Glass Fiber Reinforced Polymer) bars as reinforcement in concrete structures. The problem of corrosion of ferrous steel rebars in concrete structures exposed to aggressive environments has been the main reason for looking at alternatives.*

In this investigation experimental studies will be conducted on flexure and shear critical beams reinforced with GFRP rebars having polyester and epoxy material. GFRP rebars have a smooth surface since they are pultruded, which affects its bond with the concrete. In this study its bond characteristics will be studied. Since the failure in tension of GFRP bars is brittle in nature, the beam section has to be designed to overcome the brittle failure of R.C. beams.

Keywords: *GFRP bars, Effective bond, Bond strength*

I. Introduction

The bond strength is the measure of the effectiveness of the grip between concrete and steel. Reinforced concrete in which reinforcement bars are embedded to create bond and thus to strengthen the concrete in tension. In fact, reinforcing bars made of Glass Fibre Reinforced Polymers (GFRPs) are currently employed as a feasible alternative to conventional steel bars for RC structures. However, the relatively low modulus of elasticity of GFRP bars, their brittle behavior, creep rupture and the lack of a complete understanding of their bond to cement based matrices are key aspects to be correctly addressed for a sound and reliable design of concrete structures reinforced with GFRP bars.

Development of FRP materials in various forms and configurations offers an alternative design approach for construction of new structures and rehabilitation of the existing civil infrastructure. The flexural behavior of concrete members reinforced with GFRP bars, mainly in terms of accomplishing the requirements for serviceability limit states (Gravina and Smith 2008[1]; Barris et al. 2009[2]). On the other hand, the bond performance of GFRP bars is inferior to steel bars (Choi et al. 2012[3]; Harajli and Abouniaj 2010 [4]). Hence, the serviceability limit states, such as controlling crack width and crack spacing, play a major role in designing GFRP RC structures. Many attempts have been made to evaluate the bond behavior between GFRP bars and concrete, considering different parameters, e.g., the concrete compressive strength, bar diameter, surface treatment of bar, bar position in cross-section of structural element, bond length, and temperature change (Pecce et al. 2001[5]; Tastani and Pantazopolou 2006[6]; Baena et al. 2009[7]; Among these, surface treatment of GFRP bar has been reported as one mostly affects the global bond behavior (He and Tian 2011[8]; Harajli and Abouniaj 2010[4]).

Therefore, various surface treatment techniques (e.g., sand-coated, indented, ribbed, helical, or wrapping) would provide different interfacial bond behavior. Moreover, several proposals for theoretical models addressing the issue of bond for FRP bars in concrete are currently available in the scientific literature (e.g., Eligehausen et al. [9], Cosenza et al. [10], Rossetti et al. [11], Tepfers and De Lorenzis [12], Malvar et al., [13], Sena and Barros [14], Bianco et al. [15])

Objective

The primary objective of this investigation is to examine the suitability of GFRP (Glass Fiber Reinforced Polymer) bars as reinforcement in concrete structures. The problem of corrosion of ferrous steel rebars in concrete structures exposed to aggressive environments has been the main reason for looking at alternatives.

Materials

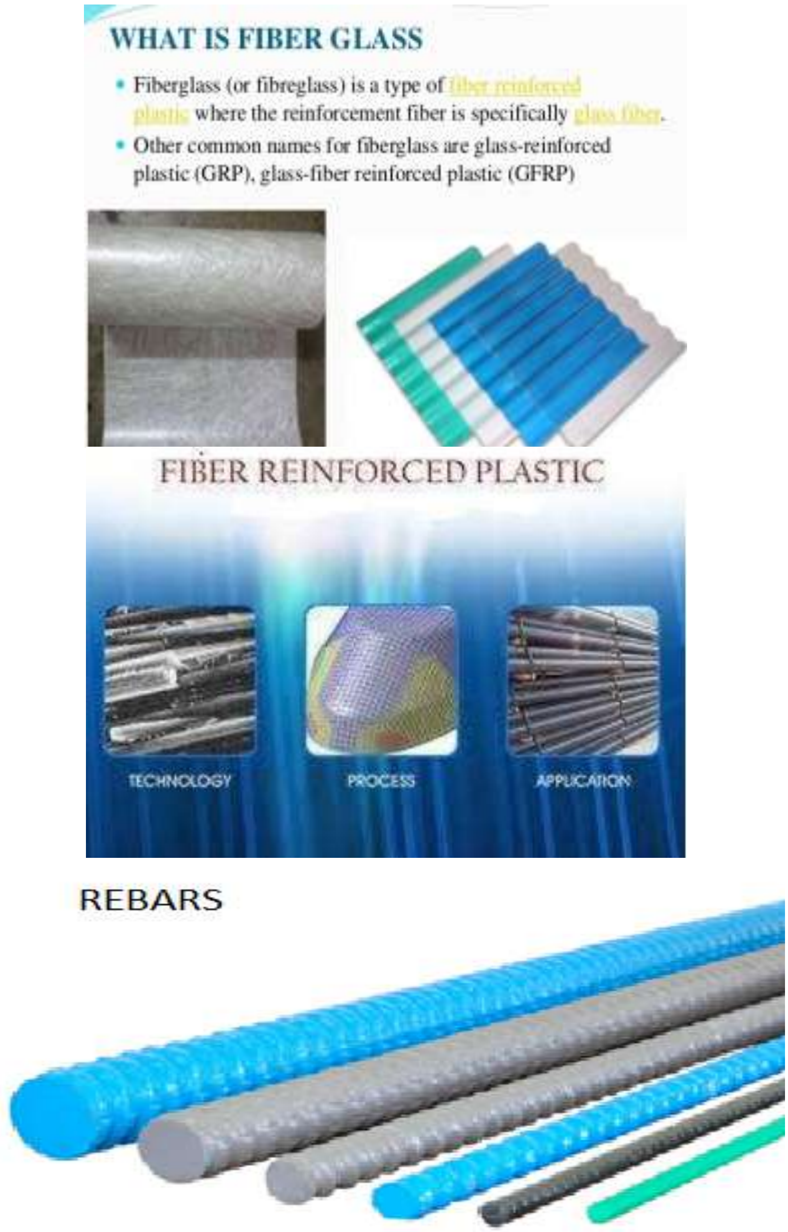

Fig. I FRP products for reinforced concrete construction

1. Polymeric fibres, including aramid fibres (i.e. Kevlar 29, Kevlar 49 and Kevlar 149 which is the highest tensile modulus aramid fibre)
2. Carbon fibres, including pan-based carbon and pitch-based carbon. Polyacrylonitrile (PAN) and cellulose are the common precursors from which pan-based carbon fibres are currently made. Petroleum and polyvinyl chloride are the common sources for the pitch used for carbon fibres. Pan-based carbon fibres have diameters of 5-711m while pitch-based carbon fibres have diameters of 10-12 Jim.
3. Inorganic fibres including E-glass, S-glass and boron fibres.

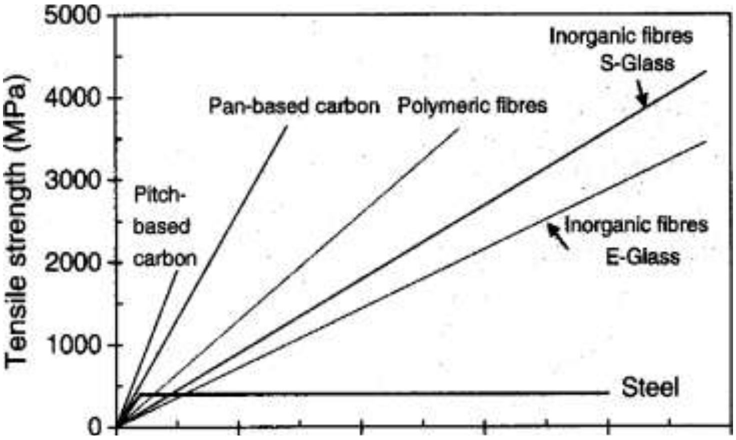

Fig. 2 Stress—strain relationship of FRP materials

Other specialty fibres such as optical fibres are currently being investigated for structural health monitoring applications[io,u]. Fig. 2 illustrates the strength and modulus of elasticity of various FRP materials.

Fig.3 Types of Rebars

a) GFRP rebar 12mm dia sand coated
b) GFRP rebar 12mm dia with ribs and grooves
c) GFRP rebar 8mm dia with ribs and grooves

II. Methodology

Pull-out tests will be performed on helically wrapped and sand coated GFRP rebars with a wide range of diameters. Nonlinear finite element simulations of the tests are allowed to determine the effective distribution of the bond stress in the development length and the debonding propagation. An analytical bond model will be developed to have an accurate prediction of the stress distribution at the interface and results will be assessed with the numerical ones.

Material Properties ⇒ **Mix Design** ⇒ **Sample preparation**
Sample Test ⇒ **Analyzing the Results** ⇒ **Bond model** ⇒ **Conclusions**

III. Conclusions

Although several proposals to predict the debonding level can be found in the literature, none of them is widely applicable. Hence through both experimental and numerical investigations a more accurate design model to control end debonding and an optimized anchorage solution are anticipated as the output of this research.
It's observed that the effect of spacing of projections on rebars is not completely studied
In my research paper two provisions are to be considered

1 Bond strength can be enhanced with more key space on GFRP rebar 2 Surface roughness of rebars to be improved

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