CRACKING BEHAVIOUR OF FRP REINFORCED CONCRETE TENSILE MEMBERS

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Summary. Cracking response of FRP reinforced concrete structures is affected by the mechanical properties of concrete and reinforcement, and the interaction between both materials. In this paper a general procedure derived from a cracking analysis based on slip and bond stresses is used to study the deformability of FRP reinforced concrete ties. Bond-slip law used in the study was derived in an experimental program of pull-out tests previously performed. The capability of the model to properly study the cracking phenomenon is confirmed through comparison with experimental reinforcement strain distribution along the bar. Moreover, predictions of the procedure on load-mean strain relationship are compared with those obtained with models used in the literature for the analysis of FRP reinforced concrete structures and available experimental results. The model reproduces adequately the general trends of the experimental results and predictions.

1 INTRODUCTION

The ability of concrete to carry stress in the tensile strain region between cracks is known as tension stiffening effect and is primarily a result of bond between concrete and reinforcement. Contrary to what happens with steel, commercially available FRP rebars present different geometrical and mechanical properties, with different interaction mechanism acting between the FRP reinforcement and the concrete. Therefore, different bond-slip laws can be found in the literature [1]. Existing models studying the cracking behaviour of reinforced concrete structures can be classified in three groups. The first group encloses the models that evaluate the deformability of the structure by an elastic analysis, where an effective cross-sectional area is determined as a combination of the gross area and the cracked area [2]. The second group includes models that modify the constitutive equation of either the reinforcing bar or the concrete [3,4]. The third group encompasses the models that take into account the behaviour of the materials (steel, FRP and concrete) and the interaction between them. Within this last approach the member deformability is evaluated by a non-linear analysis using a specific bond-slip law. The analysis can be conducted by either solving the system of differential equations [5] or by means of numerical procedure [6].
2 MODELLING FRP RC TIES

In this paper, a general procedure derived from a cracking analysis based on slip and bond stresses is presented. The model uses finite difference method to solve the system of differential equation with any “user-defined” bond-slip law. Pull-out tests on GFRP rebars that were nominally equal to those used in the RC ties were performed, and related bond-slip laws for the loaded and unloaded end were considered in the non-linear analysis (bond-slip laws named BSL1 and BSL2, respectively). The numerical approach is validated with experimental results obtained in RC tensile tests. To this end, a first validation through reinforcement strain distribution obtained from a specially strain gauged notched tie is presented in Figure 1a. Besides, numerical prediction on the tensile behaviour of RC ties is compared to experimental results and code predictions in Figure 1b. The model reproduces adequately the general trends of the experimental results and predictions.

![Figure 1: Comparison of numerical predictions with experimental results on a) reinforcement strain distribution and b) RC tie tensile behaviour (P-ε_m relationship)](image)

REFERENCES