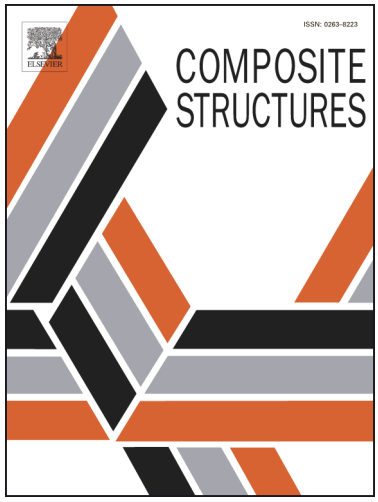

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Nonlinear indirect identification method for cement composite-to-concrete bond

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Abstract:

In the application of cement composites as Externally Bonded Reinforcement (EBR) for concrete structures, debonding is reported to be a common and undesired failure mode. This paper presents an indirect bond identification method that incorporates the nonlinear material behaviour of cement composites. The extended nonlinear indirect method is compared with a linear method by means of virtual and laboratory experiments. The virtual experiments allow omitting measurement scatter and hence quantify the error inherent to the theoretical assumptions. The laboratory experiments validate the use of the indirect method on real slip measurements. The results show that incorporating the cement composite's nonlinear secant modulus as a function of the occurring strain is essential to accurately determine the cement composite - concrete bond from experiments.

Keywords: bond; cement composites; concrete; finite element model; FRP; TRC.

1. Introduction

Recent studies have shown that high performance fibres, made of carbon or glass, are promising for the construction industry. The two most common material systems incorporating the high tensile strength and stiffness of these fibres are Fibre-Reinforced Polymers (FRP) and strain hardening cement composites (amongst which Textile Reinforced Concrete or Mortar (TRC/TRM)). While FRP use an organic matrix (usually an epoxy resin), cement composites use an inorganic, cement-based matrix to impregnate the fibres. As a consequence, cement composites have a better fire resistance [1], higher permeability [2] and better thermal compatibility with concrete [3]. On the other hand, due to their high granularity, the maximum amount of fibres that can be achieved in cement composites is low and consequently they have a lower stiffness and strength compared to FRP.

The use of composite materials as an external reinforcement for existing and newly built concrete structures is intensively researched and recently even applied in practice. In the first case of the existing structures, the composites are used for strengthening and retrofitting of deteriorated concrete elements [2,4,5]. In the second case of new structures, the materials are studied for their use as a structural Stay-in-Place (SiP) formwork [6–8], which is permanent and contributes to the load-bearing capacity of the final structure.

Research concerning Externally Bonded Reinforcement (EBR) has shown the great importance of the bond between reinforcement and concrete, as debonding represents a major failure mode for both FRP and cement composite [9–11] strengthened concrete structures. As a result, bond tests are frequently performed in an attempt to describe the bond behaviour [12–14]. Nevertheless, these results of the bond tests are scattered and

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