Viscoelastic modelling of the pullout test of synthetic fibres treated with nano-silica

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Abstract

The present work is motivated mostly by needs in development of synthetic fiber reinforced concrete that attracted attention of researchers when it was shown that surface treatment of synthetic fibers may significantly increase the bond strength with the concrete matrix (Di Maida et al., 2015; Radi et al., 2015), thus enhancing the postcracking behavior of FRC. In the present work, an analytical model for the pullout process of viscoelastic fibres from a cement matrix is proposed in order to shed light on the postcracking behavior exhibited by fibre reinforced concrete. The viscoelastic behavior of the fibres is described by using fraction-exponential operators of Scott Blair-Rabotnov, which allow to obtain explicit closed form results. Indeed, the simplest viscoelastic models of Maxwell and Kelvin-Voigt are not sufficiently flexible to match experimental data for real materials. The alternative approach based on experimental observations proposed by Scott Blair and Coppen (1939, 1943) and by Rabotnov (1948, 1977) suggested to use fraction-exponential operators that, on one hand can describe experimental data of real materials with sufficient accuracy and, on the other hand, allow inverse Laplace transforms in explicit analytical form. Moreover, the proposed model can simulate the slip-hardening interface behavior exhibited by synthetic fibres treated with nanosilica, which display an increasing frictional bond strength as the slippage distance increases, as a consequence of the increasing abrasion of the fibre surface. Finally, the closed form results provided by the proposed model are compared with the results obtained from pullout tests performed on polymeric fibres embedded in a cement matrix. After conveniently setting the constitutive parameters, the model proves to be able to predict the experimental curves accurately.

References


