Aalto University
School of Engineering

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Interesting title

Title of the dissertation	Effect of the surface roughness of fibres on the bonding capacity of the interfacial zone between the fibres and cementitious matrix
Contents of the dissertation	As fibre-reinforced cementitious composites (FRCC) are multi-scale materials, their structural performance depends on the micro-scale properties of the fibre-matrix bond. However, the development and utilisation of FRCC are restricted due to the limited knowledge of the micro-scale phenomena that influence the bond between the fibres and the cementitious matrix and its response to loading. The focus of this research was the definition of the properties of the fibre surface and the cement paste surrounding it, also called the interfacial transition zone (ITZ), which affect the formation and performance of the fibre-matrix bond. These micro-scale properties were explored by employing a different approach to applying the existing experimental techniques. The utilisation of scanning electron microscopy (SEM) indicated the changes in the distribution of calcium hydroxide and calcium silicate hydrate, and the application of phase-contrast micro-computed tomography revealed the changes in the three-dimensional distribution of pores and unhydrated cement grains within the ITZ. The importance of the steel fibre surface for the formation of the fibre-matrix bond was examined by evaluating its average surface roughness using SEM image analysis as an indirect measuring technique and an atomic force microscope and stylus profilometer as direct ones. The increase in fibre surface roughness decreased the mobility of the water along the fibres, which was measured with contact angle goniometry. This change in fiber wettability facilitated the reduction in the porosity near these fibres, which was confirmed using SEM. As a result, the maximum capacity of the bond between the cement paste and fibres with different surface roughness, which was examined under direct tension cycles with gradually increasing amplitudes, increased with the increase of fibre surface roughness. The deterioration of the fibre-matrix bond was observed as the constant development of the residual deformation from the beginning of loading in the deceleration, steady and acceleration stages. This study points out that the properties of the fibre surface and the cement paste surrounding it clearly affect the performance of the fibre-matrix bond by introducing novel insights about the fibre-matrix interaction that advance the development and modelling of FRCC.
Field of the dissertation	Civil engineering
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