MODELLING OF CORRODED STEEL REINFORCEMENT BARS BASED ON 3D SCANN GEOMETRY

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ABSTRACT

Pitting on the steel surface due to steel corrosion produce different local effects in the bar, which take into non-uniform stress distribution throughout the cross-section, due to stress localization at the pit tip and centre of gravity displacement, for instance. Hence, what in first instance may be a uniaxial load, may turn into a multiaxial stress states in the surrounding of the pits. The study of corrosion in such a local ways could be interesting to go in depth in the corrosion phenomenon and its effects on the steel bar. Hence, the use of 3D scan technique open a broad range of possibilities; a statistical analysis of the pitting distribution, a 3D FEM model of the whole bar studying effects like stress concentration, multiaxial stress behaviour or non-homogeneous material distribution, or the analysis of the critical cross-section and the pitting geometry, for instance.

3D model development of scanned corroded specimens tested under tensile and cyclic loads were performed. The presented models describe the test conditions. A comparison between the experimental and the numerical data was performed. To pursue this goal, DIANA finite element software combined with the pre and post processor GiD were used. The direct tensile and cyclic load test were both reproduced with DIANA. Since DIANA only allows fatigue calculations in elastic analisys, a fatigue model to identify the damage level of each element after every cycle has been developed by means of an external subroutine. This subroutine made possible removing the elements from the model for the next steps whether they were broken and consider no-linear behaviour.

The presented model allows reproducing the fatigue life and tensile behaviour with a good agreement with respect to the experimental data. Fatigue life estimation require a high computational cost since in each load step the non-linear stress state has to be obtained. On the other hand, tensile test is low computational cost despite are needed many intermediate steps to describe the σ-ε behaviour until ultimate stress.

A multi-axial behaviour is described in the critical pitted cross-section. Simplest uniaxial models require an overestimation of the critical steel cross-section area to include these effects and get a good estimation of the yielding and ultimate stresses. The higher corrosion was the larger difference between the 3D model and the uniaxial calculation. As it was expected, since the multi-axial state in high-corroded cross-section is amplified.