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CONFINED CYCLIC SHEAR BEHAVIOR OF CONCRETE STUDIED USING THE MICROPLANE MODEL MS1

M. Aguilar, A. Baktheer, H. Becks, M. Classen and R. Chudoba

Institute of Structural Concrete, RWTH Aachen University,
Mies-van-der-Rohe-Straße 1 , 52074 Aachen , Germany,

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Concrete exhibits a transition from isotropic to anisotropic behavior both under monotonic and cyclic loading caused by inelastic processes in the microstructure. The anisotropy emerges during the material degradation within a process zone, which gradually localizes into discrete cracks. For monotonic loading, microplane material models have been used with success to reproduce the evolving anisotropy in a clear and transparent manner. The microplane material model MS1, recently presented by the authors, introduces the cumulative inelastic shear strain rate as a damage driving variable with the aim to capture the fatigue degradation process at subcritical load levels.

The introduced dissipative hypothesis at the level of a microplane enables to reproduce the tri-axial stress redistribution within the fatigue process zone occurring at subcritical pulsating load levels. In order to isolate the aforementioned dissipative mechanism, test configurations with dominant shear stress are required for the model validation. In the present work, the punch-through shear test (PTST) is used to induce shear-dominated stress and strain along the test ligament of a specimen. Furthermore, the ability to control and measure the level of lateral confinement is utilized.

The PTST setup will be idealized using an axisymmetric finite element model, in which the material behavior will be represented by the MS1 microplane fatigue model. This material model uses a normal and tangential projection of the strain tensor onto the microplanes and a homogenization scheme based on the principle of energy equivalence with a direct tensorial representation of the effective elastic stiffness.

The particular question to be addressed is whether or not an analogy with a vertex effect observed for the monotonic shear loading under varied levels of confinement can be found also for fatigue loading. The chosen modeling concept allows us to study the retarding or accelerating effect on fatigue response under moderate or high levels of confinement, in correspondence to the vertex effect, respectively. The results of the simulations will be compared with the experimental results of an accompanying test series using the PTST setup.