National Institute of Technology Rourkela

Progress Seminar

Seminar Title	: Multiscale Fracture Analysis of Concrete
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Venue	: Seminar Hall, Department of Civil Engineering
Date and Time	: 16 May 2024 (10 AM)
Abstract	: Fracture and fatigue studies in concrete play a crucial role in determining the service life of structures. Concrete being a quasi-brittle material, exhibits non-linear softening in post-peak regions of stress-strain curve. This non-linear response of concrete is attributed to the energy dissipation in formation of an inelastic zone of microcracking called Fracture Process Zone (FPZ). Various toughening mechanisms occur inside the FPZ, that impart a resistance to failure of material. Thus, a precise estimation of FPZ size is necessary. In this study, an attempt has been made to estimate the width of FPZ using DIC analysis. Additionally, a closed form mathematical formulation has been developed based on boundary effect model to estimate the width of FPZ. The proposed methodology has been compared to existing strain-based and DIC- based methodologies. The proposed methodology gives closer results to analytical formulation than other two methodologies. The strain-based methodology overestimates the FPZ width. While the DIC-based methodology underestimates the width of FPZ. The work has been extended to model the fracture processes at nanoscale. Nanoscale modelling has been performed on Calcium Silicate Hydrate (C-S-H) gel, one of the major hydration product of cement. The Molecular Dynamics (MD) simulations have been performed on C-S-H gel to study the fracture mechanisms. Initially, uniaxial tension load has been applied on z- and x- direction. Damage in x-direction occurs when calcium and silicate chains break while in z-direction, damage is due to interlayer deformation of water. The study is extended to edge-notched C-S-H gel under uniaxial tension load in z-direction. Due to the presence of notch, the crack initiates from notch only. On further application of load, phenomenon of crack bridging is observed due to calcium and hydrogen bonds. The molecular dynamics study provides insights on the mechanism of crack propagation at nanoscale.