Modelling concrete fracture under dynamic loads using a lattice-based multi-scale framework

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ABSTRACT

An accurate manner of analysing concrete structures involves taking into account the heterogeneous nature of the microstructure of concrete and the dynamic character of the loads. To satisfy this need, we propose a two scale modelling framework which, at the macro scale, analyses the whole structure subjected to dynamic loads and, at the micro scale, takes into account the development of cracks in the microstructure of concrete using lattice models [1]. The heterogeneous nature of the microstructure is insured by adding randomness to the lattice structure [2] and by considering randomly placed and sized aggregates. The two scales are linked by assessing and re-evaluating the stiffness of the microscale as the cracks develop and adapting the stiffness of the macroscale accordingly. Linking is done on a macroscale element basis.

We investigate different ways of linking the two scales by using different boundary conditions at the microscale on several specimens with predetermined crack patterns. These configurations are compared to each other and to an equivalent model based on quadrilateral elements at several points during the evolution of the crack.

The results of the investigation show that the loss of stiffness due to cracking can be quantified, transmitted to the macro scale in an efficient manner and be taken into account during the dynamic analysis. This approach to performing dynamic analyses which takes into account material nonlinearities appears to be a viable solution, especially due to its time efficiency.

REFERENCES

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