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Notch tip fields and material critical distance: what can we learn from concrete?

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The Theory of Critical Distances (TCD) [1] groups together a number of design methodologies that make use of specific material critical distances to assess the strength of cracked/notched engineering materials. According to the TCD's *modus operandi*, the critical distance is an intrinsic property which is related to the micro-/meso-/macro-structural features of the material being designed. Based on a comprehensive experimental work, it has been proven that the TCD is successful in predicting also the strength of cracked/notched unreinforced concrete subjected to Mode I [2] as well as to Mixed-Mode I-II [3] static/dynamic loading. This raises the obvious question of what the physical meaning of the critical distance is.

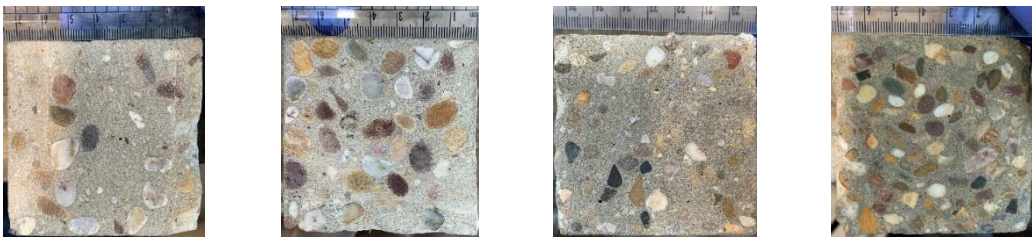

Fig. 1. Example of cut cross-sections taken to quantify the average spacing between aggregates.

Concrete is a quasi-linear heterogeneous material whose meso-structure is based on the following three key ingredients: cement paste, aggregates, and the transition regions at the interface between the two. Due to its specific characteristics, concrete is an engineering material that can be used to attempt to establish a direct link between material meso-structural features and critical distance. To this end, a number of experimental results were generated by testing specimens of unreinforced concrete under static and dynamic Mode I bending, with this experimental work involving not only plain samples, but also specimens containing crack-like saw-cut notches [4]. These specimens were fabricated by making use of different mixes so that the meso-structural features of the tested concrete could be controlled and then modelled in a very accurate way. The results from this systematic study strongly support the idea that the TCD critical length approaches the average distance between the crack-like saw-cut notch tip line and the first aggregates, with these aggregates acting as barriers slowing down/affecting the crack propagation process.

References

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