



This is a repository copy of *Notch tip fields and material critical distance : what can we learn from concrete?*.

White Rose Research Online URL for this paper:
<https://eprints.whiterose.ac.uk/186017/>

Version: Accepted Version

Proceedings Paper:

Alanazi, N. and Susmel, L. orcid.org/0000-0001-7753-9176 (2022) Notch tip fields and material critical distance : what can we learn from concrete? In: Sixth IJFatigue & FFEMS Joint Workshop : Characterisation of Crack/Notch Tip Fields under Static, Dynamic or Cyclic loading - Book of Abstracts. 6th IJFatigue & FFEMS Joint Workshop on Characterisation of Crack/Notch Tip Fields under Static, Dynamic or Cyclic loading, 11-13 Apr 2022, Dubrovnik, Croatia. University of Zagreb . ISBN 9789537738839

© 2022 The Author(s). For reuse permissions please contact the author(s).

Reuse

Items deposited in White Rose Research Online are protected by copyright, with all rights reserved unless indicated otherwise. They may be downloaded and/or printed for private study, or other acts as permitted by national copyright laws. The publisher or other rights holders may allow further reproduction and re-use of the full text version. This is indicated by the licence information on the White Rose Research Online record for the item.

Takedown

If you consider content in White Rose Research Online to be in breach of UK law, please notify us by emailing eprints@whiterose.ac.uk including the URL of the record and the reason for the withdrawal request.



eprints@whiterose.ac.uk
<https://eprints.whiterose.ac.uk/>

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

N. Alanazi^{1,2}, L. Susmel^{2,*}

¹Department of Civil Engineering, College of Engineering, University of Hail, Hail, 81411, Saudi Arabia

²Department of Civil and Structural Engineering, University of Sheffield, Mappin Street, Sheffield, S1 3JD, UK

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.

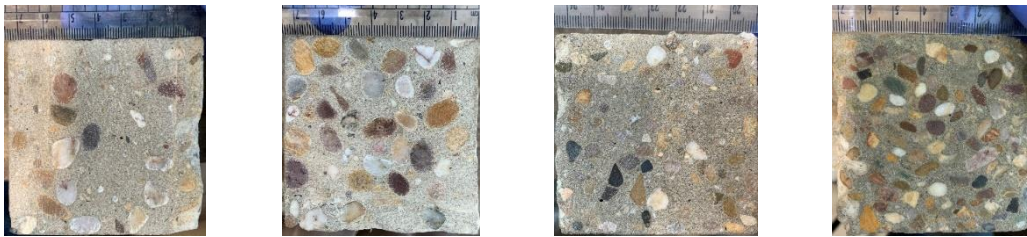


Fig. 1. Example of cut cross-sections taken to quantify the average spacing between aggregates.

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

- [1] Taylor D. The Theory of Critical Distances: a New Perspective in fracture mechanics, Elsevier, Oxford, UK, 2007.
- [2] Pelekis I., Susmel L. The Theory of Critical Distances to assess failure strength of notched plain concrete under static and dynamic loading. *Engineering Failure Analysis* 2017; 82: 378–389.
- [3] Alanazi N., Susmel L. Estimating static/dynamic strength of notched unreinforced concrete under mixed-mode I/II loading. *Engineering Fracture Mechanics* 2020; 240: 107329.
- [4] Alanazi N., Susmel L. Theory of Critical Distances and static/dynamic fracture behaviour of unreinforced concrete: length scale parameters vs. material meso-structural features. *Engineering Fracture Mechanics* 2022; 261: 108220.

* Corresponding author

E-mail address: l.susmel@sheffield.ac.uk (L. Susmel)