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Dynamic crack propagation and crack tip shielding in porous materials analyzed by the phase field method for fracture

Jenny Carlsson[1,*], **Per Isaksson**[2]

[1] Uppsala University, Box 534, SE-75121, Uppsala, jenny.carlsson@angstrom.uu.se
[2] Uppsala University, Box 534, SE-75121, Uppsala, per.isaksson@angstrom.uu.se

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Many naturally occurring materials with intricate micro-structures also show high density to toughness ratios; in fact the cellular micro-structure of wood is assumed to be one key to the fracture behaviour of wood [1]. In this study, the influence of material heterogeneity and especially porosity on dynamic crack propagation is investigated. A dynamic phase field finite element model (cf. [2]) is used to study the effects of material heterogeneity (in terms of variations in stiffness and density) on crack path and crack propagation velocity in a strip specimen geometry with circular inclusions.

The study shows that the effect of inclusions of a deviating stiffness dominates over the effect of inclusions of a deviating density. Moreover, holes and inclusions of lower stiffness act as attractors for the crack, and this attraction is stronger when there is more energy available for crack growth. The attraction has an interesting effect on the apparent toughness of porous materials. When the crack propagates through a series of holes, the apparent toughness is lowered compared to the reference material. If, on the other hand, the crack does not propagate directly though the series of holes but in the proximity of the holes the apparent toughness is increased compared to the reference material. It is further noticed that large inclusions produce a greater disturbance of the strain energy density field, and are more likely to lead to crack tip shielding, which further increases the apparent toughness and may result in crack arrest.

REFERENCES

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