Crack impinging a curved weak interface: Competition between deflection and penetration

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Weak interfaces are able to deviate and arrest the crack progression. Moreover, if the weak interface is not straigth but curve, the effect of crack arrest can be modulated and reinforced, see experiments by [1]. In fact, many natural systems are characterized by the presence of interfaces with non-planar profiles, including textured definitions or wavy patterns which can be accordingly engineered to achieve outstanding fracture response. Thus, curved weak interfaces present promising advantages to be implemented as crack arrestors in structures designed under the tolerant-design principles. Among other advantages, they neither add extra weight nor affect significantly to the global stiffness of the structural element, in contrast with other crack arrestors.

To be employed as crack arrestor, it is key that the interface can deviate the crack. If the crack penetrates across the interface, the effect of the weak interface as crack arrestor is canceled. In view of this, this work studies how to set the interface parameters to promote the crack deviation along the interface. In particular, following the dimensional analysis of the problem, the effect of three significant dimensionless parameters is studied: interface to bulk fracture toughness, interface to bulk tensile strength and the interface curvature radius normalized with the material characteristic length.

The study is carried out using the Coupled Criterion of the Finite Fracture Mechanics [3, 2]. This criterion is able to predict successfully the competition between crack deflection and competition at curved weak interfaces.

The results show that:

- The ratio of interface to bulk fracture toughness is the most relevant dimensionless parameter to switch from crack penetration to deflection.
- The dimensionless radius of the curved interface affects also significantly the failure mechanism governing the deflection/penetration competition.
- The other dimensionless parameters extracted from the dimensional analysis affects much less the competition.

References

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