An enriched cohesive zone model for delamination in brittle interfaces

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Introduction

Application of conventional cohesive zone models (CZM) to simulate delamination in brittle interfaces may trigger non-smooth load displacement responses that lead to failure of iterative solution procedures. This non-smoothness is an artifact of the discretization and can be avoided by sufficiently refining the mesh.

Enriched cohesive zone model

Alternatively, an adaptive hierarchical extension is proposed to enrich the separation approximation in the process zone (see figures 1 and 2).

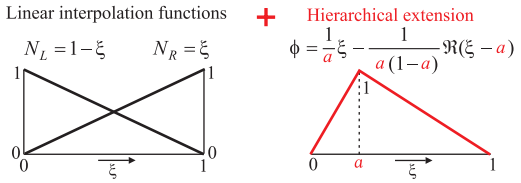

Fig. 1 *Enrichment of interpolation functions.*

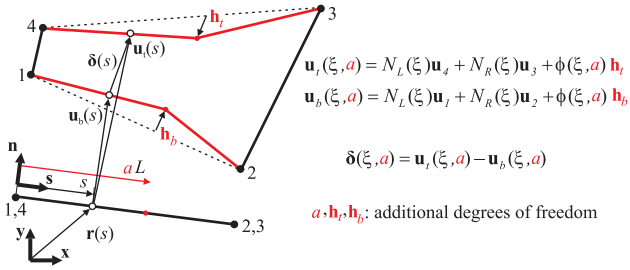

Fig. 2 *Deformation of an enriched cohesive zone element.*

Peel-off test

An elastic bulk material characterized by $C_{nn} = 45$ GPa and $C_{sn} = 0$ is pulled from a rigid substrate as shown in figure 3.
Interfacial behavior is described by a bi-linear traction-separation law (see figure 4).

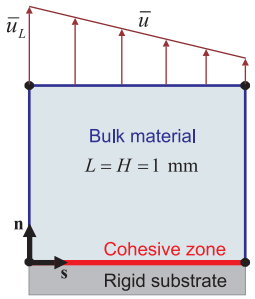

Fig. 3 *Peel-off test.*

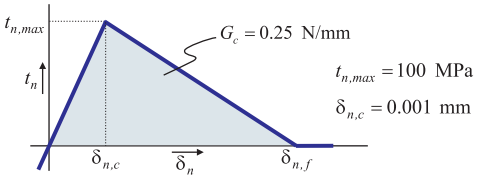

Fig. 4 *Traction-separation law and parameters.*

Using one bulk/cohesive zone element, the optimum position of a within the interface is obtained by minimization of the total work, as shown in figure 5.

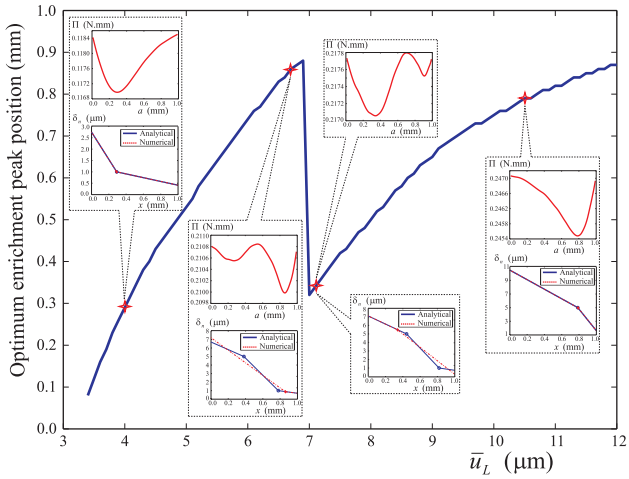

Fig. 5 *Enrichment peak position variation through the deformation process.*

Results: Mode I delamination

Peel-off test shown in figure 3 with a relatively brittle interfacial behavior ($C_{nn} = 27$ GPa) is analyzed by using a coarse mesh of 10 bulk/cohesive zone elements.

As depicted in figure 6, the new enrichment scheme improves the global load displacement response of the system discretized by a relatively coarse mesh without a need for further mesh refinement.

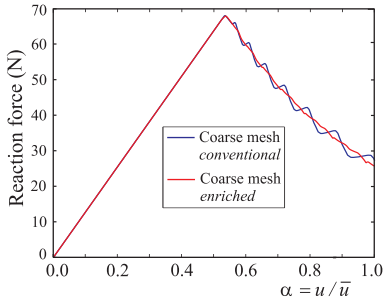

Fig. 6 *Force displacement diagram of peel-off test.*

Conclusions and remarks

- Mobile piece-wise linear enrichment improves the efficiency and robustness of a CZM.
- Extension of the proposed enrichment scheme to mixed mode delamination is in progress.

References:

[1] M. Samimi et al.,: *An enriched cohesive zone model for delamination in brittle interfaces* Int. J. Numer. Meth. Engng, 2009.