

# An enriched cohesive zone model for delamination in brittle interfaces

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# 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).

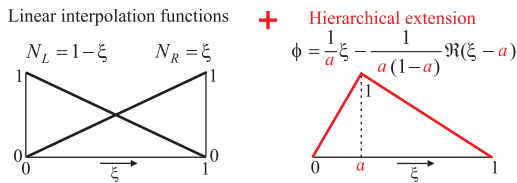


Fig. 1 Enrichment of interpolation functions.

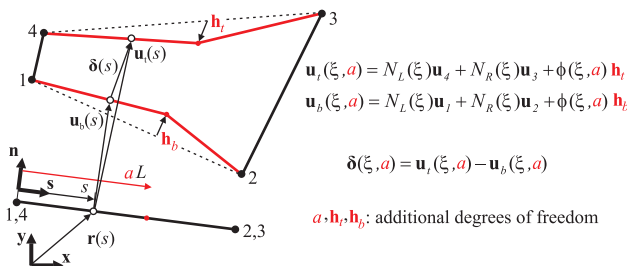


Fig. 2 Deformation of an enriched cohesive zone element.

## Peel-off test

An elastic bulk material characterized by  $C_{nm} = 45$  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).

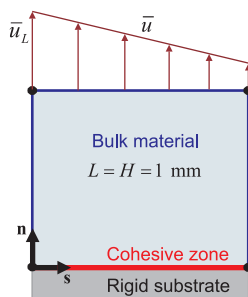


Fig. 3 Peel-off test.

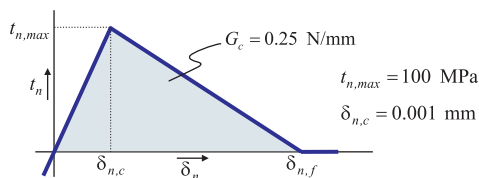


Fig. 4 Traction-separation law and parameters.

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.

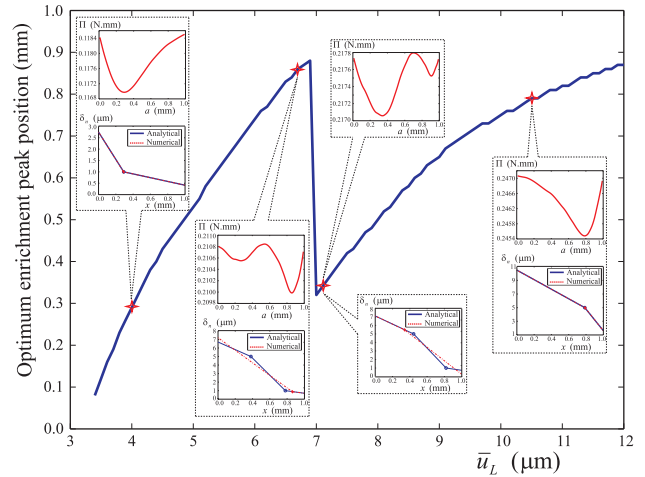


Fig. 5 Enrichment peak position variation through the deformation process.

## 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.

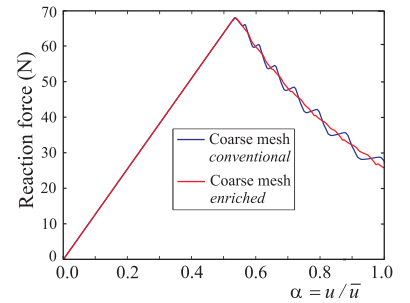


Fig. 6 Force displacement diagram of peel-off test.

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.

## 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.