11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20–25, 2014, Barcelona, Spain

CONTACT ENRICHMENT TECHNIQUE FOR SIMULATION OF WEAR AND COMPLEX INTERFACES

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Key words: *enriched contact, wear, roughness, complex contact interfaces*

Simulation of contact interaction between solids may require consideration of complex surface topographies and their evolutions under loading. At macroscopic scale it may be a structured surface of fiber-reinforced composite, at microscopic scale the most natural and industrial surfaces are rough. The topography of the surface may evolve under loading (dislocation escape, phase transformations, wear) or with time (corrosion, aging). We suggest an approximate enrichment technique, that enables to take these phenomena in consideration without excessive discretization and remeshing [1].

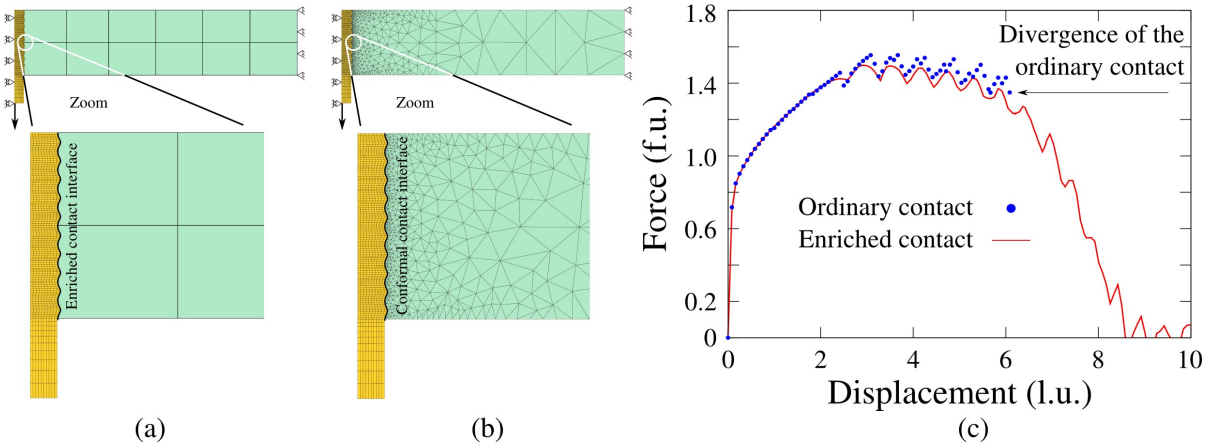

Figure 1: Simulation of a pull-out test for a beam with sinusoidal profile: (a) mesh used for the enriched contact, the two master elements (blue side) are enriched with five sine waves; (b) mesh used for ordinary contact treatment, matching interface; (c) reaction-displacement curves for two cases, the enriched contact provides quite an accurate solution and demonstrates a higher robustness than the ordinary contact.

The technique consists in enriching the surface geometry $s(t, \boldsymbol{\xi})$ of one of contacting

surfaces (master) by an arbitrary function h_e

$$\boldsymbol{s}_e(t, \boldsymbol{\xi}, \dots) = \boldsymbol{s}(t, \boldsymbol{\xi}) + h_e(t, \boldsymbol{\xi}, \dots)\boldsymbol{n}(\boldsymbol{\xi}),$$

where $\boldsymbol{n}$ is the unit normal and t is the time. The enriching function h_e may depend on the convective coordinate $\boldsymbol{\xi}$, time, stress-strain state or its history. Non-local effects may be also taken into account.

This rather simple approach requires only slight modifications in finite element procedures. One needs to alterate several terms entering the residual vector and the tangent matrix associated with contact elements, namely first and second variations of the normal gap and the convective slip coordinate. Also the associated detection technique has to consider the enriched master surface for proper local detection.

The method may be efficiently used to introduce on the sub-mesh level relevant details of the surface topography or its evolution. It can be employed for volume elements, shells and beams. For simulation of wear this method allows to avoid the expensive and difficult remeshing technique accompanied with non-trivial field transfer.

In this talk we will discuss details of implementation of enriched contact elements through some examples (see Fig. 1) and applications.

REFERENCES

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