Club des Utilisateurs du code Z-set

6 février 2018
Centre des Matériaux, Pierre-Marie Fourt - MINES ParisTech

Outils numériques pour la modélisation mécanique de l'écaillage et l'usure des surfaces

9h30 Accueil autour d'un café

10h00 **Fissuration et écaillage des revêtements céramiques épais, un remix**
Vincent Maurel, Vincent Guipont, Alain Köster, Hélène Sapardanis
Centre des Matériaux - Mines ParisTech

10h45 **Modélisation par éléments finis de l'usure sous chargement de fretting**
Stéphanie Basseville[a, b], Henry Proudhon[b], Eva Heripre[c], Jarmila Savkova[d], Georges Cailletaud[b]
(a) Laboratoire d'Ingénierie des Systèmes de Versailles, Université de Versailles Saint-Quentin, (b) Centre des Matériaux - Mines ParisTech, (c) Laboratoire MSS-Mat - CentraleSupelec , (d) Université of West Bohemia Pilzen, Republique Thecque

11h30 **Frictional contact and wear along virtual interfaces: couplling the X-FEM with surface-to-surface contact discretizations**
Basava Raju Akula[a], Julien Vignollet[b], Vladislav A. Yastrebov[a]
(a) Centre des Matériaux - Mines ParisTech, (b) Safran Tech

12h15 Déjeuner

Nouvelles fonctionnalités dans le code Z-set

13h45 **Préconditionnement des solveurs itératifs par résolution d'un problème sur grille grossière**
Stéphane Quilici, Basile Marchand
Centre des Matériaux - Mines ParisTech

Mon plus beau calcul avec le code Z-set

14h15 **Analyse de l'usure multi-échelle des outils de forage en carbure de tungsten cimenté**
Vladislav Yastrebov, Centre des Matériaux - Mines ParisTech

14h30 **Modélisation d'un élastomère chargé**
Christophe Bovet, Onera site de Châtillon

14h45 **Quelques applications du modèle GTN**
Jacques Besson, Centre des Matériaux - Mines ParisTech

15h00 **Fissuration d'une éprouvette en croix à partir d'un modèle d'endommagement ductile**
Sylvia Feld-Payet, Onera site de Châtillon

15h15 **Data pruning of tomographic data for the calibration of constitutive models: application to a resin-bonded sand**
William Hilth, Centre des Matériaux - Mines ParisTech

15h30 **Simulation aéro-thermo-mécanique d'une interaction flamme-paroi**
Jean-Didier Garaud, Onera site de Châtillon

15h45 Discussion autour d'un café

RÉSUMÉS

Frictional contact and wear along virtual interfaces: couplling the X-FEM with surface-to-surface contact discretizations

Basava Raju Akula[a], Julien Vignollet[b], Vladislav A. Yastrebov[a]

(a) Centre des Matériaux - Mines ParisTech, (b) Safran Tech

" Interaction between solids involving contact, friction, adhesion and wear are complex both with regard to their mathematical description and numerical treatment. The interfacial nature of these phenomena lays a strong emphasis on the interface discretization scheme. Stability and appropriate patch-test performance of these schemes are necessary ingredients to ensure the overall accuracy and robustness of the contact treatment.

A relative motion between contacting bodies can lead to material removal (wear) of rubbing solids. The change of geometry change the contact pressures, and thus leads to alteration of the system's global response and affects the further evolution of wear. Numerical simulation of wear usually involve (1) constitutive local wear laws determining the wear depth evolution at every effective cycle, (2) remeshing procedures to capture the shape changes at the interface, and (3) field remapping in case of material behavior involving internal variables. In this presentation we will suggest a novel method enabling to simplify the treatment of wear problems and ensuring optimal convergence as well as accurate representation of surface tractions, which is essential for wear simulation.

Face-to-face discretization techniques combined with penalty-based or Lagrange-multiplier based treatment of contact/friction constraints form the state of the art methods enabling to handle contact interaction along non-conformal interfaces in a robust way and ensure the accuracy of surface tractions [1]. The extended finite element method (X-FEM) presents a different technique to handle intra-mesh discontinuities: shock waves, oxidation fronts, composite materials, voids and cracks [2]. Combining the face-to-face contact formulation with the X-FEM method presents an attractive option to treat contact problems along virtual surfaces/interfaces with incompatible meshes: the face-to-face discretization ensures an accurate treatment of contact and the X-FEM ensures independence of interfaces of the finite element mesh [3]. The virtual contact surface embedded in the volumetric mesh can incorporate geometrical aspects, such as roughness, and can evolve in time due to wear and/or third body accumulation. The main emphasis will be put on wear simulation of elasto-plastic materials within this computational scheme.

1 Gitterle, Popp, Gee, Wall (2010). Finite deformation frictional mortar contact using a semi-smooth newton method with consistent linearization. Int J Num Methods Eng 84(5):543-571.

2 Sukumar, Chopp, Moës, Belytschko (2001). Modeling holes and inclusions by level sets in the extended finite-element method. Comp. Methods Appl Mech Eng 190(46):6183-6200.

3 Sanders, Laursen, Puso (2012). A Nitsche embedded mesh method. Comp Mech 49(2):243-257.

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Préconditionnement des solveurs itératifs par résolution d'un problème sur grille grossière

Stéphane Quilici, Basile Marchand

Centre des Matériaux - Mines ParisTech

” Afin de permettre l'emploi des solveurs itératifs pour les problèmes fortement non-linéaires un nouveau préconditionneur a été implémenté dans le code Z-set. Ce préconditionneur est basé sur la factorisation de la matrice de rigidité du problème formulé sur un maillage grossier. La matrice factorisée ainsi calculée, à faible coût, est utilisée pour préconditionner le système du problème de référence. L'emploi de ce préconditionneur permet de fortement améliorer la convergence des solveurs itératifs et de réaliser ainsi pour des coûts, de calcul et d'occupation mémoire, réduits des calculs de structures à comportements mécaniques complexes. ”

Quelques applications du modèle GTN

Jacques Besson

Centre des Matériaux - Mines ParisTech

” Les deux points suivants seront traités :

· pilotage avec une décharge partielle

· post processing d'avancée de fissure

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Data pruning of tomographic data for the calibration of constitutive models: application to a resin-bonded sand

William Hilth[a], David Ryckelynck[a], Adrien Laforêt[b]

(a) Centre des Matériaux - Mines ParisTech, (b) Montupet

" With the development and the generalization of digital image correlation (DIC) and digital volume correlation (DVC) techniques, the volume of data acquired has drastically increased. This raises new challenges, such as data storage, data mining or the development of relevant experiments-simulations dialog methods such as model validation and model calibration. Data pruning of the experimental results is a relevant solution, focusing on meaningful data while saving time and storage. We developed an objective method to reduce drastically the amount of data thanks to model reduction techniques. From experimental snapshots, containing the values of a given field (displacement, strain, 2D temperature,...) in all the sample at all time steps, and image correlation error maps, we can extract reduced basis and coordinates of the full experiment. These basis are used to build an experimental Reduced Domain (RD) where the data is actually needed or relevant with a modified hyper-reduction method. This RD can be completed with a chosen Zone Of Interest (ZOI), enabling to decide to keep the data where it seems worthwhile. The RID can only be 10% or 25% of the complete sample. Then, in order to simplify data exploitation and storage, we can only focus on the RD and the projection of the reduced basis on this new geometry, reducing drastically the amount of data stored. Moreover, keeping only the pruned experimental data still enables model calibration. They can be directly imposed as Dirichlet boundary conditions, with the use of an hybrid FEM/hyper-reduction method. The hybrid method calculations are 10 to 70 times quicker than full field FEM calculations. The method is applied for a model validation and calibration of a polyurethane resin-bonded sand sample studied in in situ X-Ray CT. The experimental RD was determined thanks to computed displacement field and and its uncertainty. Two elastoplastic constitutive models of gradual complexity were assessed. The procedure showed that the simpler approach failed to model correctly the complex behavior of the bonded sand and motivated the development of more sophisticated constitutive equations. This new model was successfully validated and calibrated. "

Les sessions se déroulent au Centre des Matériaux de Mines ParisTech
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