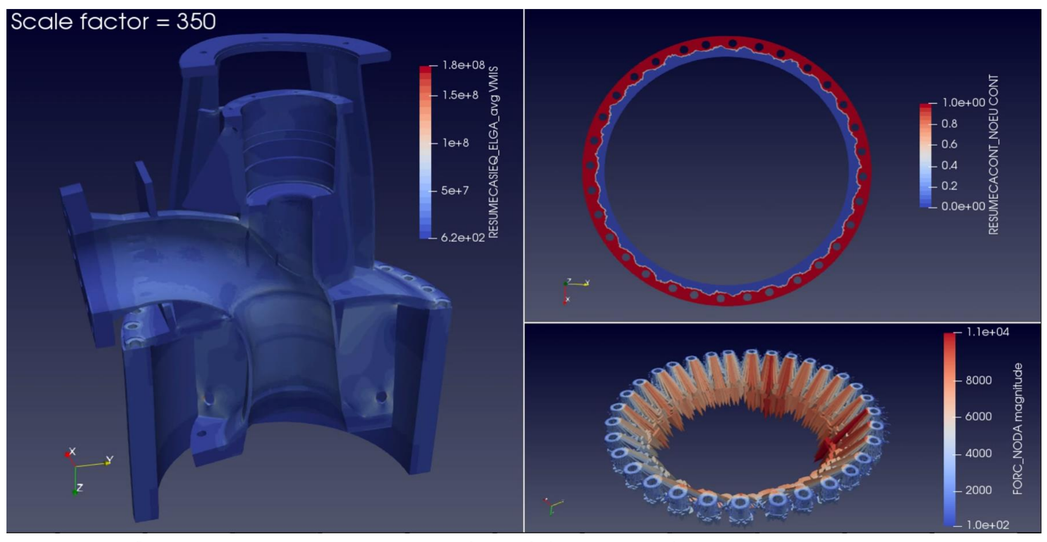
R&D in code_aster

Numerical modelling of contact and friction

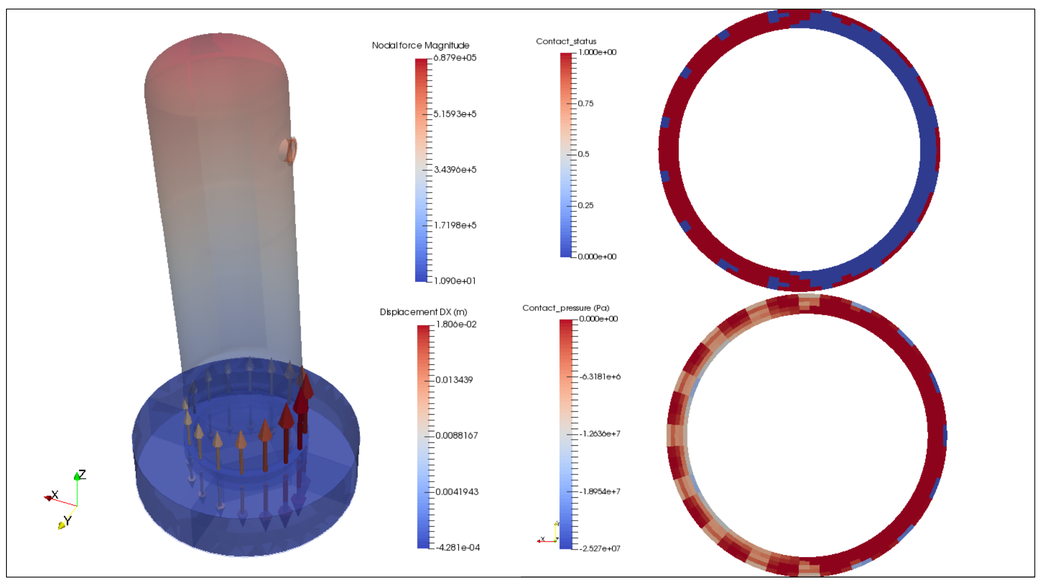
CONTEXT

One of the main non-linearities encountered in structural mechanics is that related to contact.

Many EDF studies introduce this non-linearity, very often coupled with material non-linearities (plasticity,...) and kinematics (large deformations)



Contact/friction on a ACO pump head (EDF/UTO)



Contact/friction on a tank (EDF/UTO)

USING IN CODE_ASTER

`DEFI_CONTACT, STAT_NON_LINE and DYNA_NON_LINE`

PhD THESIS

M. Zarroug – Éléments de contact frottant et applications – ECP – 2002

C. Zammali – Contribution à la modélisation mécanique et numérique des problèmes de contact-impact – ECP – 2005

M. Torkhani – Contribution au développement numérique d'éléments de contact et modélisation de l'usure des structures minces – ECP – 2008

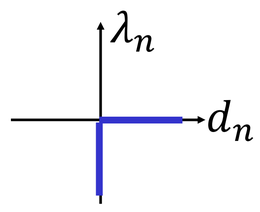
A. Kudawoo – Problèmes industriels de grande dimension en mécanique numérique du contact : performance, fiabilité et robustesse – Univ. Marseille – 2012

G. Drouet – Méthode locale de type mortar pour le contact dans le cas de maillages incompatibles de degré élevé – Univ. Toulouse – 2015

(now, employed at EDF)

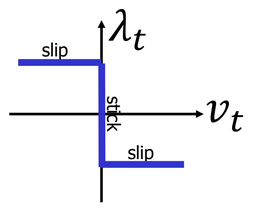
SCIENTIFIC CHALLENGES

The regularity of the solution u to the contact problem presents singularities whatever the Sobolev regularity of the data and generally the solution cannot be more regular than $H^{5/2}$



$$\begin{cases} \lambda_n \leq 0 \\ d_n \leq 0 \\ \lambda_n d_n = 0 \end{cases}$$

Contact condition of Signorini



$$\begin{cases} \text{If } \|\lambda_t\| < \mu|\lambda_n| \text{ then } v_t = 0 \\ \text{If } \|\lambda_t\| = \mu|\lambda_n| \text{ then } \dfrac{v_t}{\|v_t\|} = -\dfrac{\lambda_t}{\|\lambda_t\|} \\ v_t(\|\lambda_t\| - \mu|\lambda_n|) = 0 \end{cases}$$

Friction condition of coulomb

Other problems investigated:

- Contact problems between two or more bodies whose respective meshes may not coincide on the contact interface, the so called “nonmatching meshes” or “noncoinciding meshes
- Coupling contact with non-linear behaviours (plasticity, …) and large strains
- Huge problems and high-performance computing
- Contact problems in dynamic (impact)

SOME PUBLICATIONS

G. Dumont – *Algorithme de contraintes actives et contact unilatéral sans frottement* – Revue Européenne des Éléments finis, 4, pp. 55-73, 1995.

H. Ben Dhia, M.Zarroug – *Hybrid frictional contact particles-in elements* – Revue Européenne des Éléments finis, 11, pp. 417-430, 2002.

A.D. Kudawoo, M. Abbas, T. De Soza, F. Lebon, I. Rosu – *Computational Contact Problems: Investigations on the Robustness of Generalized Newton Method, Fixed-Point method and Partial Newton Method* – International Journal for Computational Methods in Engineering Science and Mechanics, 19, pp. 268-282, 2018.

G. Drouet, P. Hild – *Optimal convergence for discrete variational inequalities modelling Signorini contact in 2D and 3D without additional assumptions on the unknown contact set* – SIAM J. Numer. Anal., 53, pp. 1488-1507, 2015.

M. Abbas, G .Drouet, P. Hild – *The Local Average Contact (LAC) method* – Comput. Methods Appl. Mech. Engrg., 339, pp. 488-513, 2018.

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