DSA FOR ELASTIC-PLASTIC SHELLS AND EXPLICIT DYNAMICS

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Algorithmic aspects of computation of design derivatives for explicit dynamics w.r.t. constitutive parameters are considered, see [1], [2]. The explicit dynamics algorithm is formulated for finite-rotation shells, and the Huber-Mises deviatoric plasticity with non-linear isotropic/kinematic hardening is a constitutive model. A description of the DSA algorithm includes the following parts:

- Update of design derivatives of the constitutive state variables $\mathbf{s} = \{\boldsymbol{\Sigma}, \bar{e}^p, \boldsymbol{\alpha}_R^p, \boldsymbol{\varepsilon}^p, \varepsilon_{33}, \boldsymbol{\psi}_R\}$, where $\boldsymbol{\Sigma}$ is the back-rotated Kirchhoff stress, and $\boldsymbol{\psi}_R$ are rotational parameters for shell laminas.
- Design derivative of stress update algorithm for finite rotation shells. Constitutive equations are written for the back-rotated Kirchhoff stress $\boldsymbol{\Sigma}$, and the plane stress constraints are directly incorporated. The yield surface is ellipsoidal, and a Newton loop is used on the constitutive level.
- Design derivative of explicit dynamics algorithm, which is complicated due to the rotational inertia term and a parametrization of rotations.

Several examples are presented, in which the design derivatives are computed analytically and by the Finite Difference method. They show that despite a great complexity of the solution algorithm for the finite-rotation elastic-plastic shells, it is feasible to compute analytical design derivative of this algorithm, and the yielded sensitivities are of very good accuracy, see Fig.1.

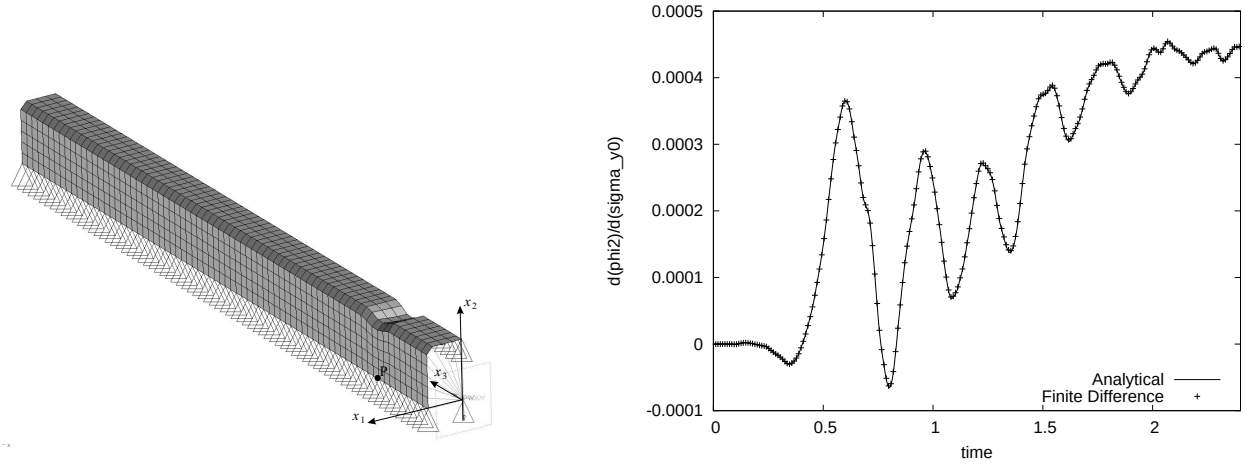

Figure 1: Elastic-plastic dynamic compression of rail. Derivative of rotation at P w.r.t. yield stress.

References

[1] K. Wisniewski, P. Kowalczyk, E. Turska, "On computation of design derivatives for Huber-Mises plasticity with non-linear hardening", *International Journal for Numerical Methods in Engineering*, Vol.57, pp.271-300, 2003.
[2] K. Wisniewski, P. Kowalczyk, E. Turska, "Analytical DSA for explicit dynamics of elastic-plastic shells", in preparation, 2005.

Acknowledgement. This research was partially supported by: EC Growth Project G3RD-CT-2000-00276, and the Polish Committee for Scientific Research (KBN) Grant 7T11F01921.