

Isogeometric Analysis of Shells in LS-DYNA

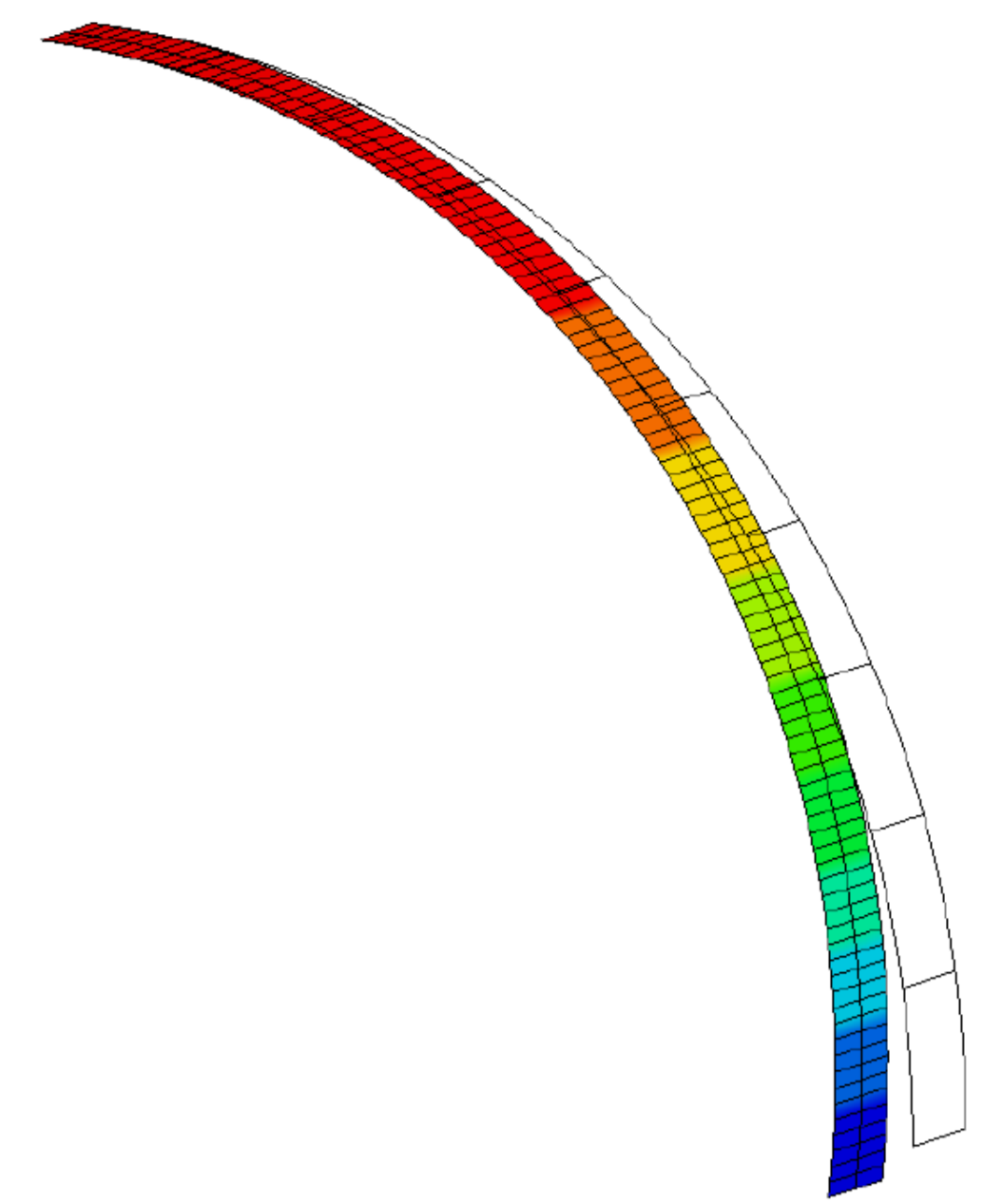
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Abstract

- Simple benchmark tests to analyze different locking-phenomena (transverse shear locking and membrane locking) in shells.
- Analyze the influence of various model and discretization parameters like geometry, slenderness, shell theory type and mesh density.
- Compare results of FEM and IGA for an industrial problem.

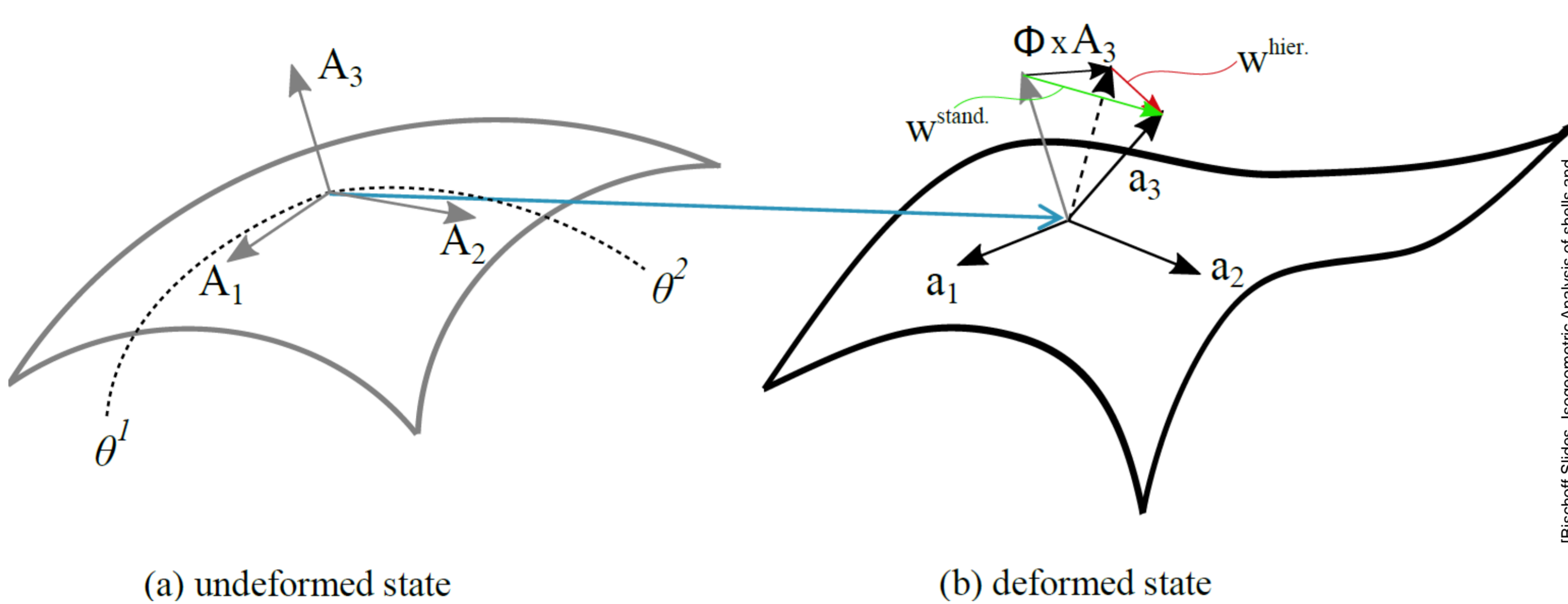


Lotus Temple, Delhi, India



Cylindrical Shell Strip under radial load

Solution



Hierarchical Formulation in a Reissner-Mindlin shell

- Hierarchic formulations from IBB completely alleviate transverse shear locking.
- Reduced integrations schemes in LS-Dyna help alleviate locking.
- Membrane locking effects can be completely alleviated by using a hierarchic DSG formulation with a modification in the membrane part.
- Higher polynomial orders also reduce locking tendencies in IGA using LS-Dyna.

Hierarchic Parameterization:

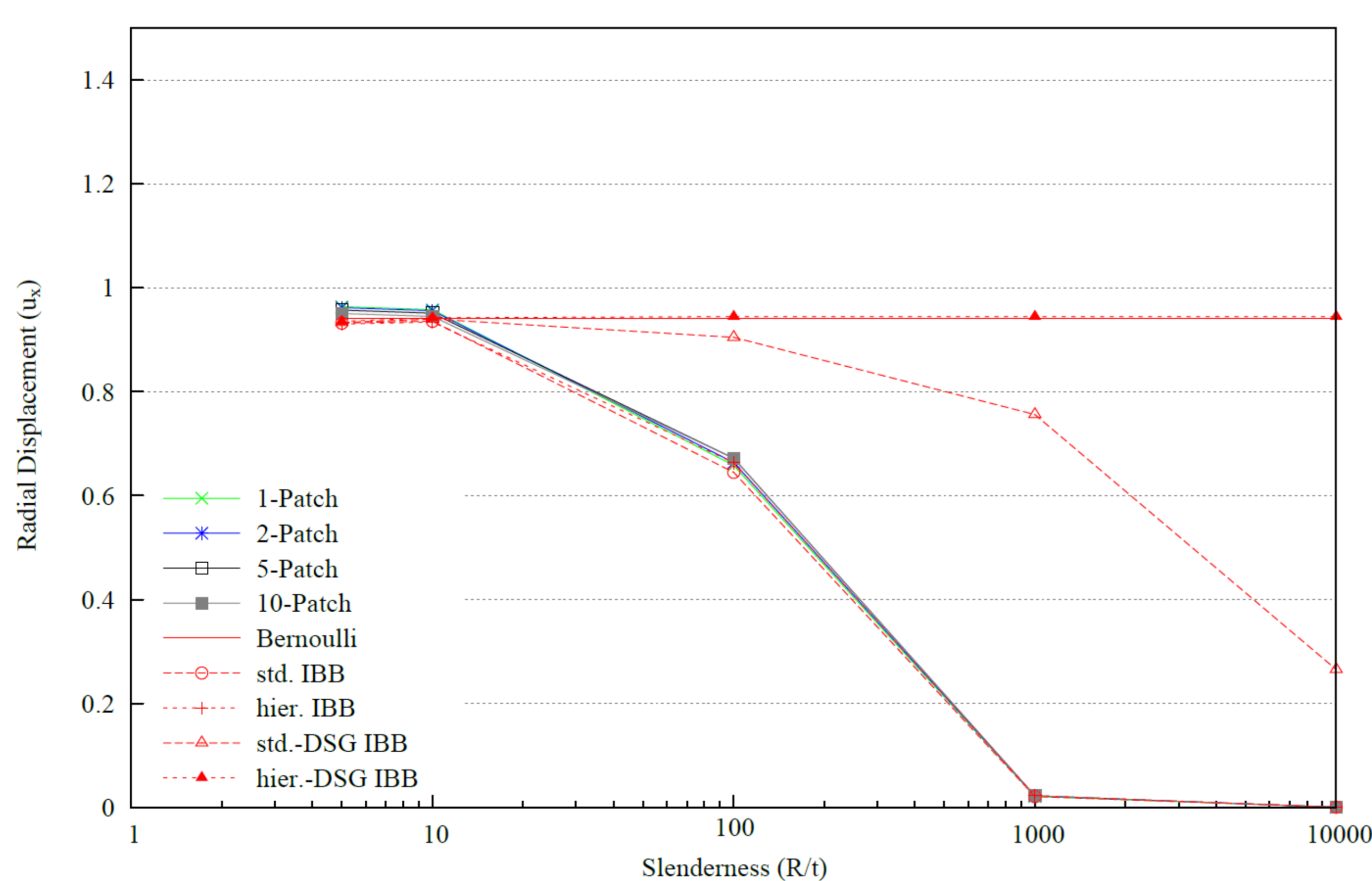
$$\mathbf{a}_3 = \underbrace{\mathbf{A}_3 + \Phi \times \mathbf{A}_3}_{\text{Kirchhoff-Love}} + \mathbf{w}^{hier.}$$

where

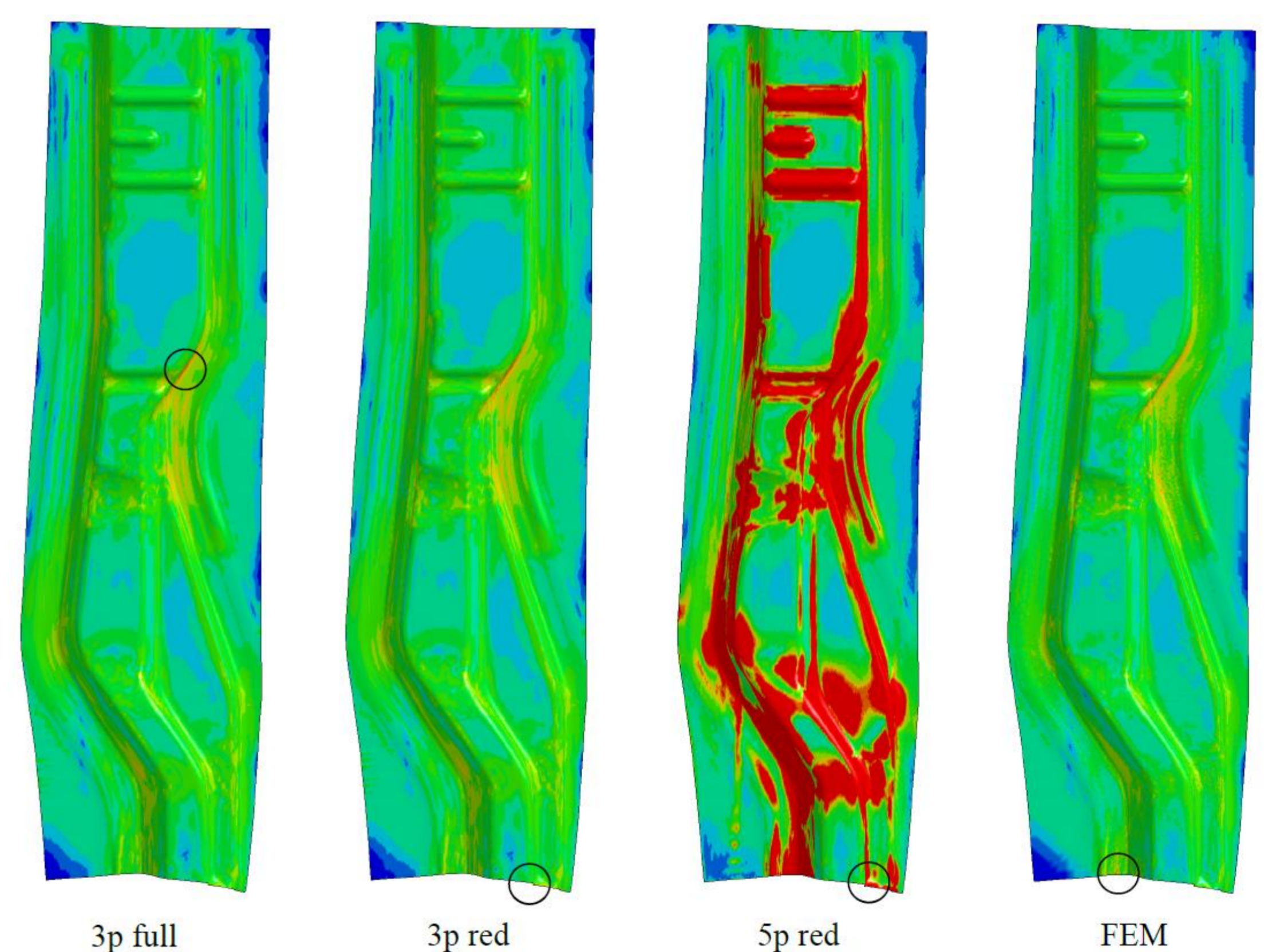
$$\mathbf{w} = w^1 \mathbf{A}_1 + w^2 \mathbf{A}_2$$

$$\Phi = \varphi_1 \mathbf{A}_1 + \varphi_2 \mathbf{A}_2$$

More Results



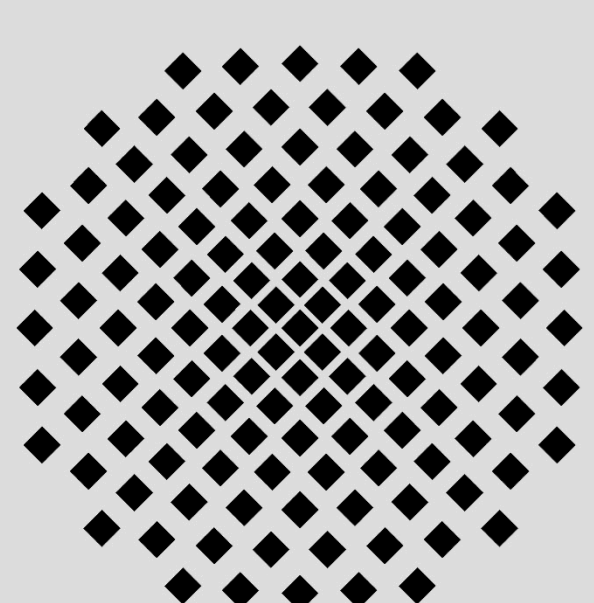
Multi Patch Tests - simply supported plate 5p shell - full integration



Von-Mises stress plot in the stamping of a front side member of car – IGA and FEM

Literatur:

- R. Echter, B. Oesterle, M. Bischoff: A hierarchic family of isogeometric shell finite elements, *Computer Methods in Applied Mechanics and Engineering*, 2013
- R. Echter, M. Bischoff: Numerical efficiency, locking and unlocking of NURBS finite elements, *Computer Methods in Applied Mechanics and Engineering*, 199, 2010, pp. 374-382



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