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RVE-based Homogenisation of Shell Structures using Scaled Boundary Isogeometric Analysis

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A first-order homogenisation approach based on the Hill-Mandel condition is used for the analysis of shell structures. The coupled two-scale model consisting of macroscopic shell elements and mesoscopic solid elements can be numerically solved using the so-called FE^2-approach presented in [1]. Assuming periodicity of the mesoscopic structure allows the definition of a representative volume element (RVE) which will be homogenised. The RVE is discretised with 3D solids in boundary representation, similar to the modelling technique in CAD. Isogeometric analysis is used for the solution of the boundary value problem on the mesoscale [2]. This is especially useful for complex mesostructures, as CAD models can be directly used for analysis.

Using periodic boundary conditions to apply the macroscopic shell strains to the RVE has proven to be beneficial as boundary effects can be reduced. Due to the moment and shear force interaction, the homogenised shear stiffness is dependent on the in-plane size of the RVE. By constraining the normal stresses this length dependency can be eliminated [3]. Benchmark results on linear elastic RVEs are in agreement with analytical solutions.

REFERENCES

[1] F. Gruttmann and W. Wagner. A coupled two-scale shell model with applications to layered structures. *Int. J. Numer. Meth. Engng.*, Vol. **94**, pp. 1233–1254, 2013.

[2] M. Chasapi, L. Mester, B. Simeon, and S. Klinkel. Isogeometric analysis of 3D solids in boundary representation for problems in nonlinear solid mechanics and structural dynamics. *Int. J. Numer. Meth. Engng.*, 2021.

[3] S. Klarmann, F. Gruttmann, and S. Klinkel. Homogenization assumptions for coupled multiscale analysis of structural elements: beam kinematics. *Comput. Mech.*, Vol. **65**, pp. 635–661, 2020.