A POSTERIORI ERROR ESTIMATION FOR hp-APPROXIMATION OF THE 3D-BASED FIRST ORDER SHELL MODEL PART 1. THEORETICAL ASPECTS

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Abstract

The paper presents theoretical aspects dealing with a posteriori error estimation for the finite element hp-approximation applied to the 3D-based first order shell model. The assignment of the presented error estimation is its application to hierarchical modelling and adaptive analysis of shell parts of complex structures consisting of thin-walled, thick-walled and solid parts. The main feature of the 3D-based formulation is that it is equipped with 3D degrees of freedom, while its mechanical model corresponds to the classical first order shell theory. The hp-approximation applied to the elaborated 3D-based model allows local p- and h-adaptivities, where h is the element size parameter while p is the transverse approximation order of the element.

The organization of the paper is the following. First we present the model shell problem through definition of the three-dimensional geometry of shell and introduction of the three-dimensional local and variational formulations of the Reissner-Mindlin theory. Next we apply the hp-approximation to the problem. The main body of the paper is devoted to a posteriori approximation error estimation for the elaborated model. Within this subject we present local and global characteristics of the error. The global characteristic is based on the difference of the potential energies corresponding to the exact and approximated solutions. It has been proved in the paper that the proposed error estimator is equivalent to the estimator based on the strain energy defined on the local error. We have also shown the upper bound property of the proposed global error estimate. Moreover, we have introduced the element approximation error indicators, the sum of which gives us the mentioned global estimate. The values of the local indicators can be obtained through solution of the element local problems. The practical method of obtaining these indicators is based on the finite element discretization of the local problems. The paper is completed with the conclusions.

The implementation details corresponding to the elaborated method of a posteriori approximation error estimation of the 3D-based first order shell model will be presented in the forthcoming paper [1].

Key words and phrases: A posteriori error estimation, Shell model, Finite

element method, Hierarchical modelling.
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