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ON THE NONLINEAR ANALYSIS OF THIN SHELLS BY THE GENERALIZED MOVING-LEAST SQUARES APPROXIMATION

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ABSTRACT

In the present contribution a geometrically exact thin shells formulation is presented. An analysis procedure based on a meshfree approximation is outlined.

As no restrictions are imposed on the rotational fields, the present formulation falls on the category of the geometrically exact structural theories. The derivation is made by imposing the kinematic hypothesis on the three-dimensional continuum. Contrary to previously presented works [1,2], where shear deformation was accounted, here only the bending deformation is included. We define energetically conjugated cross sectional stresses and strains based on the first Piola-Kirchhoff stress tensor and the deformation gradient, respectively.

The complete linearization of the weak form is presented. For hyperelastic materials and conservative loadings the tangent bilinear form, *i. e.*, the generalized stiffness matrix, is always symmetric even in points far from the generalized equilibrium positions.

Initially curved shells are regarded as a stress-free deformed state from a chosen plane reference configuration [3]. The mapping between both configurations allows the exact consideration of the initial configuration.

As the variational basis of the formulation requires the use of C^1 approximations, the generation of compatible of finite elements is not trivial in the present case. In order to circumvent this inconvenience, meshless approximations are used. The first-order Generalized Moving-Least Squares Approximation has been successfully used in the solution of thin plate bending problems [4,5,6]. Although it increases the number of degrees-of-freedom per node, its performance is clearly superior to the conventional Moving-Least Squares Approximation in this specific class of problems.

As the approximation does not possess the Kronecker-delta property, the imposition of the essential boundary conditions is not immediate. These are enforced using a hybrid-displacement version of the shell formulation. To this end, the steps indicated in [7] are followed.

This thin shell formulation has the basic advantage over their shear-deformable counterpart: no special devices have to be taking into account in order to avoid shear-locking.

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