ADAPTIVE MESH PROCEDURE FOR COMPUTING VERY THIN SHELLS

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The relative thickness ε is a significant parameter in the shell theory and computation. For small ε (very thin shells), the solution u^ε often presents boundary layers which depends on the form and the boundary conditions of the shell.

The Kirchhoff-Love and Mindlin shell theories present elliptic systems equations for $\varepsilon > 0$ and their solution has traditional properties of regularity. However, the asymptotic behaviour for small ε is described by a system which is only elliptic when the principal curvatures of the surface are of the same sign. When this is not the case, the asymptotic behavior presents characteristic lines (asymptotic curves of the surface). In this case, singular data (on the boundary conditions or on the load) produce singularities which are propagated along the characteristic out of the area where they were originated.

When ε is small but not equal to zero, the solutions are smooth and present boundary layers where the deformation and energy concentrate. These layers are narrow areas (the thickness of which decreases with ε) where the solution or its derivative tends to infinite when ε tends to 0.

We present numerical solutions by finite elements concerning uniformly hyperbolic shells (which the middle surface has principal curvatures of opposite signs) and the boundary conditions ensure the geometrical rigidity. We focus our attention on the internal layers associated with propagation of singularities along the characteristics.

The finite element employed is the classical DKT, but to make accurate computations we need a refined mesh in the layers. To this end, we employ a mesh adaptation process which allows a high quality automatic iterative calculation. We employ the software BAMG (developed at INRIA by F Hecht) that produce locally anisotropic meshes (it automatically generate elements very stretched along the layers). Advantages of the calculations using adaptive meshes are shown in the results, allowing estimations of magnitude order of the boundary layers and of the normal displacement of the shell.

References

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