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BENDING MODE PROPAGATION IN SHOCK ANALYSIS USING AXIS SYMMETRICAL SHELL ELEMENTS TIME EXPLICIT SOLUTION AND SPECTRAL ELEMENTS

Abstract

This paper shall focus on the lessons learned resulting from an adequate formulation for dynamic analyses, which is used for modeling the launcher upper stage of Ariane V. This formulation includes axis symmetrical shell elements of the type C0 in a time explicit solution. The dynamic analyses in this paper are dedicated to the higher frequent transient response taking into account the wave propagation, sometimes also referred as shock. Since structural tests on large launchers or stages in the range of high frequency dynamics usually show uncertainties, the verification and further improvements of existing analysis codes versus analytical available solutions are necessary. Simplified analytical methods based on the Timoshenko beam have been developed in terms of the spectral method. Whereat, the spectral methods result from the introduction of plane wave modes into the elemental formulation. The Timoshenko beam is a representative model for a reduced shell formulation, retaining transversal shear and bending stiffness in a plane model configuration. In comparison, the Mindlin-Reissner type shell formulation exhibits a degenerated in-plane shear and longitudinal wave coupling, degenerated bending and twisting wave coupling and a transversal shear wave of different wave propagation velocity. Whereas, the Timoshenko beam provides the representative wave modes of first order wave effects of the transversal bending shear waves on a selected wave front. Thus, the Timoshenko beam is an adequate formulation to represent the wave propagation in shell structures. Within these restrictions, examples for typical space parts and structures are investigated in terms of a pyroshock event.