A PENALTY APPROACH TO OBTAIN LOWER BOUND BUCKLING LOADS OF IMPERFECTION-SENSITIVE SHELLS

LUIS A. GODOY[1], ROSSANA C. JACA[2], EDUARDO M. SOSA[3] AND FERNANDO G. FLORES[4]

[1] Institute for Advanced Studies in Engineering and Technology, CONICET-UNC, FCEFYN, Universidad Nacional de Córdoba, P. O. Box 916, Córdoba, Argentina
lgodoy@efn.uncor.edu

[2] Civil Engineering Department, Facultad de Ingeniería, Universidad Nacional del Comahue Buenos Aires 1400, Neuquén, Argentina
rossana.jaca@fain.uncoma.edu.ar

[3] Mechanical and Aerospace Engineering Department, West Virginia University Morgantown, WV 26506-6103, USA
eduardo.sosa@mail.wvu.edu

[4] Institute for Advanced Studies in Engineering and Technology, CONICET-UNC, and Departamento de Estructuras, FCEFYN, Universidad Nacional de Córdoba, P. O. Box 916, Cordoba, Argentina fflores@efn.uncor.edu

Key words: Buckling, Finite elements, Reduced Energy Method, Stability, Shells.

Abstract. A strategy, known as Reduced Stiffness (or Reduced Energy) Method, in which selected energy components are eliminated from the analysis to account for mode interaction and imperfection-sensitivity in a simplified way, has been developed by Croll and co-workers since the 1980s. This physical interpretation allows the formulation as an eigenvalue problem, in which the critical loads are lower bounds to experiments and to nonlinear incremental analysis. This paper considers the computational implementation of both reduced stiffness and reduced energy approaches to the buckling of shell structures. The structural configurations of interest in this work are cylindrical storage tanks with or without a roof. The reduced stiffness approach has been implemented in a special purpose finite element code for shells of revolution, while the reduced energy methodology was implemented in a general purpose code. The present results are compared with geometrically nonlinear analysis including shape imperfections. Links between this methodology and the Reduced Integration Technique employed in the analysis of plates/shells are discussed. Difficulties in extending the methodologies to complex problems in engineering practice are highlighted.