

ADVANCED MODELS FOR THE NONLINEAR STATIC RESPONSE OF BIOLOGICAL STRUCTURES

D. Guarnera¹, E. Carrera^{1*}, I. Kaleel¹, A. Pagani¹ and M. Petrolo¹

¹ Mul 2 Team, Mechanical and Aerospace Engineering Department, Politecnico di Torino, Italy

* Corresponding author: erasmo.carrera@icmams.com

The results of an elastoplastic analysis of classical bio-structures via refined beam models are here presented.

In this work, an atherosclerotic plaque is taken into account as a typical bio-structure example with complex features and analyzed under both linear and non-linear assumptions, via one-dimensional kinematic models. Specific attention is paid to the evaluation of local effects and of the stress/strain distribution both in- and out-of-plane in the presence of different boundary conditions. The von Mises plasticity model is considered to account for the material nonlinearity, and the solution of the nonlinear algebraic equations is accomplished by the Newton-Raphson method.

This elastoplastic analysis is performed through the application of the Carrera Unified Formulation (CUF). The CUF is a higher-order one-dimensional theory in which the kinematics of the problem depends only on the expansion of the generalized unknown. Two kinds of cross-section expansion functions, Taylor's and Lagrange's polynomials, are adopted to model the structure, and finite element method (FEM) is used to formulate the governing equations. This technique allows reaching 3D-like results without any simplification of the geometry, avoiding the high computational effort, common in this kind of applications.