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Faculdade de Ciências e Tecnologia
Universidade Nova de Lisboa
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palestras de ENGENHARIA CIVIL na NOVA

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Part 3. A large rotation finite element analysis of flexible bodies by incremental rotation vector and exact strain measure

Different strategies based on the rotation vector and exact strain measure have been proposed over the years for analyzing flexible bodies undergoing arbitrary large rotations.

To avoid the singularity of the vector-like parametrization, the interpolation of the incremental rotation vector is the most popular approach in this context, even if this leads to path dependence and numerical instability, i.e. error accumulation. It is also non-objective, although both objectivity and path independence are recovered with *h* and *p* refinement. Co-rotational approaches do not have these drawbacks, even though the geometrically exact model is achieved by mesh refinement. This lecture presents a novel strategy which uses the incremental nodal rotation vectors to define co-rotational nodal rotations, which are then interpolated for the evaluation of the nonlinear strains. This choice makes the approach singularity-free, allows for additive updates within each increment and preserves all the features of the theoretical problem for any mesh and interpolation: rotational variables, objectivity, exact strain measure, path independence and symmetric stiffness matrix for conservative loads. This last property is a consequence of the direct differentiation of the relation between local and global rotations, whose compact form also makes a simple and general definition of the internal forces and the tangent stiffness for any order of interpolation possible. In addition, it will be shown how the common approach of interpolating incremental vectors can be made stable by a simple updating procedure based on local rotations carried out at the end of each increment in order to avoid cumulative errors. Geometrically exact 3D beams are considered as a demonstrative example.

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