Abstract

In real life many structures undergo large deformation, staying in linearly elastic regime. Objective of this work is to study the response of spatial beams under arbitrary loading without putting any prior assumption that deformation is to be small. Large local rotation is an essential assumption in the formulation. An exact transformation matrix has been employed in order to make the model more accurate. Orthogonal curvilinear coordinate system has been used in kinematical formulation. This formulation can be extended to analyze shell type structures too. Beam model has been chosen as first order shear deformable Timoshenko beam with shear correction factors and Euler-Bernoulli beam theory. Stretching of reference line and uniform torsional warping of the section have also been considered. In the present work different work-conjugate stress-strain pairs in the reference configuration have been introduced. Among them Jaumann stress and Jaumann strain have been employed in the formulation to circumvent the problem arising due to use of constant elastic modulus. In the constitutive relation isotropy as well as anisotropy have been considered. As the strain is infinitesimal, Kirchhoff material model is used in the formulation. A reduced stiffness matrix has been derived to relate the useful stresses and strains in anisotropic case. Nonlinear finite element method is used to find out solution of nonlinear ODE. Different numerical techniques to solve nonlinear system of equations have been talked about. To capture post-buckling behavior, a path following arc-length method has been used. At the end the formulation is validated with the existing results and other numerical experiments are carried out to demonstrate the workability of the formulation to capture the physics of the problem.