Geometrically Exact Structural Analysis (GESA)

GESA is a total-Lagrangian displacement-based finite-element code for analyzing highly flexible structures. GESA is written in the MATLAB language and is based on newly developed theories for structures undergoing large displacements, large rotations, and finite strains. The structural theories fully account for geometric nonlinearities due to large rotations, large in-plane strains of two-dimensional structures, large axial strains of one-dimensional structures, initial curvatures, and transverse shear deformations by using Jaumann stress and strain measures, an exact coordinate transformation, and a new concept of orthogonal virtual rotations. The Jaumann strains are derived using a new concept of local displacements without performing polar decomposition and they are proved to be a corotated geometric objective measure. Because all possible initial curvatures are included in the strain-displacement equations, governing equations of plates and shells are unified and the strain-displacement relations can be used for most one- and two-dimensional structures. For two-dimensional structures, only global translational DOFs and their derivatives are used in the strain-displacement relations and no independent global rotational DOFs are used. A corotated point reference frame is defined using the symmetry of Jaumann strains. Moreover, there is no need for transformations before updating strains, stresses, and displacements. Fully nonlinear cable, truss, beam, membrane, plate, and shell elements of different shapes and different numbers of nodes have been developed, and both isotropic and anisotropic materials are considered. Available experimental and numerical results show that GESA is very accurate and efficient in computation.

![Finite Element Analysis Flow Chart](image-url)

Fig. 1: The finite element analysis flow chart.