ABSTRACT

This Thesis deals with the finite element analysis of the effects of various geometrical parameters on the stress concentrations in three different types of adhesive bonded structural joints in isotropic and several FRP composite laminates and tubes. The three types of bonded joints in the purview of the present investigations are : single lap-joints, spar-wingskin joints and the tubular lap-joints, the applications of which of necessity, are found across wide spectrum of manufacturing industries. Scientifically generated higher order, finer and well graded isoparametric solid finite elements in plane strain and axisymmetric idealizations have been adopted after testing their validity for accuracy and convergence in analyses of the joints. A comprehensive parametric study of the single lap joints under uniform inplane tension with different combinations of composites has been conducted in plane strain finite element idealizations. Different concepts of spar-wingskin joints under out-of-plane loads have been studied for applications to aircraft structures. FRP composite tubular lap-joints under tension and torsion have been investigated with axisymmetric finite element formulations.

Various stress contours are presented to depict the overall stress fields in the joints. Important results include identification of localized peak stresses and their locations and hence the effects of geometrical parameters on stress concentrations are computed. Vital optimum design parameters have been established based on SCF. Results are presented in the form of nomographs and associated recommendations are provided for ready use by the designers.

Some experiments have been conducted on single lap-joints to establish the optimum overlap length based on ultimate load carrying capabilities. Results from straingage instrumentations on spar-wingskin joints are correlated with those obtained by finite element analyses.

KEY WORDS : adherend, adhesive, adhesive-core, bonded joints, composites, finite element, laminates, single lap-joints, spar-wingskin joints, spew-fillets, stress concentration factor, tubular lap-joints