National Institute of Technology Rourkela

Synopsis Seminar

Seminar Title	: Theoretical and Experimental Analysis of Large Deformation Induced Damaged Composite Structure using Elastic/Elastoplastic properties under High Strain Loading Conditions
Speaker	: Vikash Kumar (Rollno : 519me1024)
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Venue	: Seminar Hall (Ground Floor, ME-001), Mechanical Engineering Science Building
Date and Time	: 08 Aug 2024 (16.00PM)

Abstract : The geometrically linear/nonlinear analysis of laminated plate/shell panels that are damaged under mechanical loading is being analyzed in this research. It has been performed computationally via a higher-order finite element (FE) formulation to predict the responses, i.e. static bending, free vibration, and transient deflection using elastic/elastoplastic properties, i.e., normal and high strain rate loading. The laminated shell physical model is formulated mathematically using an equivalent single-layer theory based on the third-order displacement variables. This, in turn, helps the model to maintain the necessary shear deformations, stress, and strain variation through the panel thickness. Additionally, the induced large deformation within the panel due to the geometrical distortion integrated mathematically through Green Lagrange nonlinear strain terms. The generalized nonlinear governing equation of the panel with and without damage has been derived using variational principle. The approximate nonlinear numerical solutions are calculated using the selective integration scheme (Gauss-Quadrature) associated with Picard's direct iterative method and the isoparametric FE steps. The finite element discretization of the shell panel is being done using a nine-noded (with ten nodal degrees of freedom) quadrilateral Lagrangian element. A generic computational algorithm has been prepared in MATLAB utilizing the current nonlinear mathematical formulation considering all of the nonlinear higher-order strains to maintain the necessary generality. In general, the consistency of the numerical FE solution is checked initially with adequate numbers of convergence tests. Similarly, the accuracy of the numerical solution is verified with the available published results (numerical and analytical). Further, to enhance confidence in the predicted numerical results, they are again compared with the various experimental data for the second stage at the parent institute by utilizing the available/fabricated lab-scale test rig. Similarly, the stress-strain values under different strain-rate loading are obtained numerically using Cowper&rsquos Simonds model of isotropic material (AISI304L-Stainlesss Steel) for comparison with experimental data. Moreover, a few composite property data are verified with the current prediction with published numerical results. Lastly, the effect of damages, including the various geometrical parameters, loading conditions, and edge-support conditions on the nonlinear structural responses, are studied for a clear insight into the damaged structural modelling. In addition, the effect of nonlinear strain terms on the final structural responses is presented. Based on the observation, the applicability of full geometrical (Green-Lagrange) strain-displacement relation is established.