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Short Communication

Development of Advanced Finite Element Methods for Different Applications

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DESCRIPTION

The structural components of a launch vehicle can be broadly classified into primary structures like motor-cases, inter-stages, propellant tanks, thrust frame/structure, nose fairings, etc., which are intended to provide a load transfer path during the actual service and secondary/appendage structures like solar panel backup deck plates/antenna dishes, cover panels, etc., which are primarily functional designs which need to bear self-weight and operational loads. These are further classified into pressurized and non-pressurized structures and depending on service environment, these could be either hot or cold structures. Structural components at critical areas needing detailed investigation are: Pressure vessels, segmented joints in solid propellant rocket motors. Junctions of cylindrical shell and ends, solid propellant rocket motor grain configurations, rocket motor nozzles, inter-stage structures: truncated conical shell cylindrical shell, heat-shield structures, final stage motor casings & satellite interface and satellite structures [1].

The performance of a space-vehicle structure depends upon its strength, stiffness and compatibility with propulsion and guidance. Probability of a successful space flight is increased by simplicity of design and analysis, avoidance of discontinuities and high thermal gradients, minimization of dynamic effects and use of stable materials and structural configurations. A higher local safety factor greatly improves the reliability of connections, attachments, fittings and other load-concentration areas, with only a very small over-all weight increase. A smooth flow of stress is important. Therefore machine-welded, milled, forged, extruded or east parts with continuous contours and gradual cross-sectional changes are preferable to built-up hand-welded, spot-welded, bolted or riveted parts [2].

The causes of failures in structural components may be generally classified into three groups faulty design, including improper selection of materials, faulty manufacturing and deterioration with time in service conditions may deviate from the designer's expectations. The generally identified modes of structural failure are brittle fracture, fatigue, yielding due to overload of the cross-section, leakage of containment vessels, corrosion, erosion, corrosion fatigue and stress corrosion, instability (buckling) and creep or creep-fatigue interaction. Two types of failure criteria recognized by rocket industry are yielding and fracture. Failure due to yielding is applied to a criterion in which some functional of the stress or strain is exceeded and fracture is applied to a criterion in which an already existing crack extends according to energy balance hypothesis [3].

Experimentation with a variety of materials would show that the theory works well for certain materials but not very well for others. Designer has to use/establish a suitable failure theory for the intended materials. Structural analysis and testing are being employed to assess the adequacy of the design. The derivation of classical (analytical) solutions to obtain design formulae for complex structural configurations involves considerable mathematical difficulties [4].

CONCLUSION

The finite element method has become one of the most popular and general numerical methods of structural analysis. Applications of finite element method to other areas of engineering include, Fluid flows, Heat transfer, electromagnetism, etc.,. Brief historical reviews of the finite element method are given in two articles. The finite element method has the capability to deal with complex loading conditions, material behavior and practical geometries. The finite element methods for analyzing the stress and displacement distributions of an elastic continuum have long been interpreted as approximate methods associated with different variational principles in elasticity. These displacement and for stress fields are then assumed in each element and the resulting equations from the application of the variational principles are simultaneous algebraic equations, which may have generalized displacements, generalized internal forces or stresses or both displacements and forces at the nodal points as unknowns to be evaluated.

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