MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures I - Development and Verification (Space Vehicles and Components) (1)

Author: Mr. Rajesh Mathew
ISRO, India, rrroniemathew@gmail.com

Mr. Yezhil Arasu
Vikram Sarabhai Space Centre (VSSC), India, yezhil_arasu@yahoo.com
Mr. Thomas Kurian
Indian Space Research Organization (ISRO), India, thomas_kurian@vssc.gov.in
Mr. Jayaprakash J
Vikram Sarabhai Space Centre (VSSC), India, j_jayaprakash@vssc.gov.in
Mr. Sri S. Somanath
Vikram Sarabhai Space Centre (VSSC), India, s_somanath@vssc.gov.in

EQUIVALENT STIFFNESS APPROACH (ESAF) FOR TWO DIMENSIONAL ANALYSIS OF FLANGED JOINTS OF SOLID ROCKET MOTORS

Abstract

Flange joints are used extensively to form leak tight joints for igniter and nozzle interfaces of Solid Rocket Motors. Their design and analysis becomes very important to ensure high reliability of the solid rocket motor which is subjected to high pressure loads in operation. The design process involves design iterations through analysis. The flange joints on the rocket motor case posses cyclic symmetry, thus a 3D half pitch model completely defines the problem. However such 3D models are not convenient to be used in the preliminary design stage when many numbers of design iterations are needed to be carried out due to their high computation time, resources and modeling efforts involved. It is also observed that the entire stress field is not required for design purposes, for fasteners especially axial force, shear force and bending moment is sufficient. Thus a 2D analysis technique is required for the designer. 2D axisymmetric analysis techniques (such as bolt cylinder Approach/technique) exist but are shown to be inaccurate, especially when the joints are unsymmetrical as in case of solid rocket motors. In this work, an approach to carry out a 2D axisymmetric analysis is developed and validated. First a hypothesis and theoretical frame work based on simulation of stiffness of individual component is formulated to convert the cyclically symmetric 3D problem to a 2D problem. Secondly, to execute this approach in finite element analysis, a methodology is developed, various 2D elements are chosen and the dimensions or material properties are varied to equate the stiffness of the individual components along with a way to post process the results. Thirdly, this approach (ESAF) and the existing bolt cylinder technique is compared with 3D model for a symmetrical and unsymmetrical joint. A good match in results is obtained for ESAF while bolt cylinder is shown to be inaccurate especially in the case of unsymmetrical joints. The causes of the errors, advantages and limitations, and the theoretical and practical improvements to this approach and methodology are also discussed.