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Space Structures I - Development and Verification (Space Vehicles and Components) (1)

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STRUCTURAL INTEGRITY ASSESSMENT OF THE 3.2 M DIAMETER SOLID ROCKET MOTOR HARDWARE

Abstract

ISRO has realised a 3.2 m diameter Rocket Motor case out of 250 Grade Maraging steel through rolling and welding route. This three Segmented Motor case consists of a short Head End Segment (HES) having a length of 3m, a Middle Segment and Nozzle End Segment (NES) each with length of 8m approximately. The design of the cylindrical shell is based on fracture mechanics approach and tang and clevis joints are provided for the inter Segment connection. Flanged joints are on the Motor case for assembling the Igniter and Nozzle subsystems. The design of the flanged joint on Nozzle End Segment for attaching the Nozzle subsystem was a challenge on account of the higher opening diameter. The Segments are to be subjected to acceptance testing, called proof pressure test (PPT). The openings at the ends of the Segment are to be closed during the pressure testing. During the Motor functioning, the axial load on the Motor case is relieved on account of the thrust generation. To take advantage of this, the Motor to Nozzle joint is designed considering the reduced axial load during Motor firing condition. While pressure testing of this Segment along with bucket flange (bucket flange is the metallic hardware back up of submerged subassembly in Nozzle system), a floating piston assembly (FPA) is employed simulating the axial load reduction corresponding to proof pressure. Extensive analyses were carried out prior to finalizing the interface between Nozzle End Segment with bucket flange (stationary part) and floating piston assembly (moving part). Hydraulic oil is used as the pressurizing medium and various instrumentation techniques are employed to measure the strains, displacements, defect growth characteristics (acoustic emission sensors) etc. Measured strains were analysed based on the elastic plastic approach and were compared against the theoretical prediction based on finite element analysis. A close agreement was seen between the measured and predicted strains. The above design methodology has resulted in an optimized design of the Motor to Nozzle flanged interface. This paper outlines the salient aspects of the interface design, analysis and proof pressure testing of the ISRO's largest Solid Rocket Motor Segment hardware.