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

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DESIGN APPROACH ADOPTED FOR ENSURING THE STRUCTURAL INTEGRITY OF A HYDRAULIC LINE ASSEMBLY ALONG THE SOLID ROCKET MOTOR FOR A REUSABLE LAUNCH VEHICLE TECHNOLOGY DEMONSTRATION MISSION

Abstract

ISRO is planning to demonstrate the reusable launch vehicle technology (RLV) through a Technology Demonstration Vehicle (TDV). A 9 ton Solid Rocket Motor is designed to function as the Booster Motor in this mission. This booster will carry the RLV-TD vehicle through the atmospheric regime. Electrical cables between the base shroud and the avionic packages mounted atop the Motor head end dome are routed along the 9m length of the Motor using the welded pads over the Motor case, which is a general practice followed in many other Motors. Similarly, a pair of hydraulic lines will be laid along the length of the Motor connecting the control fin actuation system in the base shroud and the oil reservoir positioned in the inter-stage. This system consists of a common hydraulic power plant that powers the actuators of both Solid Stage and TDV. The hydraulic fluid circulation to the Booster stage fin actuators is through two stainless steel tubes. These tubes are routed over the clamping system placed over the welded pads on the Motor. A cowling assembly protects this assembly from aerodynamic effects in flight. The entire assembly has to be properly integrated to the Motor to take care of the various loads occurring during the ascent phase. The thinner cylindrical shell of the Motor case posed a challenge for this objective. Hence, detailed checks based on analytical and numerical approaches were necessary for ensuring the required margins in various components/sub assembly. Detailed 3-D model of Motor case with segment joint, welded pads, detachable pads, Teflon bush, cowling, fasteners etc. was used for the numerical analysis. Axial dilation of the Motor due to aerodynamic heating, geometric and contact non-linearities etc. were considered in the analysis. Analytical approach was used for estimating the design margins in the welds connecting the welded pad to Motor case using the loads estimated from analysis. This paper describes on the details starting with the configuration design of welded pad, finite element modeling approach, various loads and the analytical/numerical results related to the hydraulic line cowling assembly to ensure the structural integrity of the system under the cumulative loading conditions.