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A THEORETICAL STUDY ON THE STRUCTURAL LOADS ON THE IGNITER HARDWARE OF LARGE SOLID BOOSTERS AND PROOF PRESSURE TESTING ADEQUACY

Abstract

ISRO's large Solid Rocket Motors (SRM) employ two stage (primary and secondary) pyrogenic Igniter for initiating the combustion of propellant. The secondary igniter initiates the primary or main igniter, which in turn ignites the SRM. Both these igniters are in fact, smaller rockets which operate for relatively shorter duration and are assembled together for serving the intended purpose of igniting the SRM. The connection between the secondary igniter to the primary igniter and similarly, between the primary igniter and the Motor are through flanged interface. Though, these igniters and SRM, ignite and operate in series, certain operational overlap is ensured between the secondary and primary igniter and similarly between primary igniter and SRM. This complex operation results in an intricate load distribution in the igniter hardware and its interface to the Motor case. Hence, unlike the SRM hardware one needs to consider several critical load cases to conservatively design analyse these hardware.

In this study, the various loads acting on the secondary and primary igniters are analysed through analytical and Finite Element Analysis (FEA) approaches. For analytical purpose, free body diagrams are used to work out the loads acting in the igniter hardware. The approach used being generic in nature can be used for any pyrogenic igniter for the SRMs. In fact this approach gives the most general methodology for estimating the loads in a Rocket Motor case. The axial loads in the igniter hardware as well as the interface are statically determinate (due to the fact that they are attached only at one axial section) and can be analytically evaluated through free body diagram and simple load-path analysis. However, the circumferential loads in the hardware and radial loads at the interface are structurally indeterminate and needs to be arrived at based on FEA. This need for numerical analysis is further supplemented by requirements such as fastener loads (non-linear problem), O-ring compression, thermo-structural response and global stress estimation. A comprehensive set of FEAs are carried out as part of this study using axisymmetric model (with interface bolt simulation) to address various load cases in the operation of the igniters. Accurate estimation of loads in the igniter hardware and at the interface is essential to devise the acceptance / qualification test scheme of this structure.