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SOLID ROCKET BOOSTER SEGMENT JOINT - A PARAMETRIC STUDY

Abstract

Solid rocket boosters are normally manufactured in segments that are independently propellant cast and later assembled for the launch. The joint between the segments is generally a tang and clevis (tongue and groove) type joint with shear pins having minimum clearance fit to ease the assembly. As an assembly feature, three numbers of the holes drilled in the tongue ring are slit open to ensure circumferential alignment, and hence no load is transferred at these locations. Due to this provision, the shear pins adjacent to slit holes are the most critical ones in sharing the load. However, since these pins are in shear mode, even a small difference in the clearance in this critical pin-hole interface, can cause a different kind of load distribution. Considering the fact that the pin and hole has a clearance fit, the load in each pin becomes indeterminate due to the various possible pin and hole combinations. To address this issue, the worst possible combination is considered for estimating the load in critical pin locations based on a 3D finite element model of the joint. During the developmental stage of the segment hardware many cases of deviations are reported in the pin hole dimensions which resulted in higher variability in the load shared among the pins. This observation called for a parametric 3D finite element model capable of simulating any possible combination of tolerances in the pin and hole. Apart from the pin and hole tolerance, the 3D model can also incorporate the possible fit between the various mating diameters of the tongue and groove ring. The effect of friction in sharing the axial load is also estimated from this model. Application of experimental techniques such as strain gauging or photoelasticity to estimate the pin loads is found not feasible in these intrinsic geometry. Hence, these finite element models were extremely useful in assessing the criticality of the observed deviation in pin holes, since no other experimental technique could be successfully used for this purpose. This method has not only avoided unnecessary rejections but also is helpful in proposing salvaging plans, resulting in saving of equivalent amount of monetary as well as time resources.