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VIRTUAL MODELING OF MEMBRANE FRACTURE

Abstract

In rocket engine design, it is very important to know the state and operating conditions of rocket engine components. Nozzle membranes are used in solid rocket motors (SRM) to ensure the SRM tightness and maintain the combustion chamber pressure at the level required for starting the motor. The limits of SRM membrane op-erational loads are very strict. The objective of this paper is to solve the problem of determining the SRM membrane loads and reaction time. To determine the SRM membrane stress-strain behavior and fracture pattern, a virtual actual-size 3D model of the manufactured and studied membrane was built us-ing the program module [1] that the author of this paper has developed before. The 3D model was built in accordance with the membrane geometry scanned using a man-ual micrometer. The stress-strain behavior of an actual membrane was investigated using the halogen method [2]. The LS-DYNA finite element analysis software was used for the virtual modelling of membrane fracture. The following membranes were used as design models: - Membrane built in accordance with design documents; - Membrane with a groove, built in accordance with design documents; - Scanned model of an actual membrane; - Scanned model of an actual membrane with a groove; - Scanned model of an actual membrane with a groove and thickening along the groove edges. The paper describes the following data: - Membrane fracture under operational loads; - Distribution of stresses in the membrane; - Differences in the stress-strain behavior and the fracture pattern of a mem-brane built in accordance with design drawings and a 3D membrane model being a virtual actual-size copy of the manufactured and investigated mem-brane. The results of the work demonstrate a significant difference in both the fracture geometry and the reaction time of the studied membranes. The obtained results allow determining the membrane reaction time with a higher accuracy and protecting the SRM from the effect of the membrane after the latter has operated. The conducted study enables the wider use of finite element modeling in designing, thereby reducing the cost of the full-scale tests.