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DETERMINATION OF STRESSED-STRAINED CONDITIOS FOR STRUCTURE OF SPACE STAGE OF LIQUID LAUNCH VEHICLE UNDER LONGITUDINAL OSCILLATION

Longitudinal oscillation of liquid launch vehicle due to the longitudinal instability result in additional loads of structural elements. Those dynamic loads must be considered for the strength computations of structural elements of the space stage during the design. The technique of determination of the stressed-strained state of the propellant compartment of the space stage with a complex spatial configuration under longitudinal oscillation of the launch vehicle on the active portion of the flight in operation of the cruise propulsion system of the first stage is proposed. The technique is developed by the finite element method and means of mechanical design computations (CAE Systems) and takes into account the propellant component mobility, energy dissipation of structural vibrations and liquid filling, variances in the tank wall thickness. Based on the proposed technique, the stressed-strained state of the structure of the spheroconical liquid-filled suspended propellant compartment of the space stage on the active portion of the flight of the three-stage launch vehicle is determined. It is shown that the maximum stress intensities of the space stage propellant compartment structure are demonstrated near points of attachment to the launcher vehicle under longitudinal oscillations of the launcher vehicle. It is found that, when the frequency of the longitudinal harmonic disturbance affecting the space stage structure is close to the frequency of the first mode of its natural longitudinal oscillation, the values of amplitudes of structural vibrations of the propellant compartment can be 10 times more than amplitudes of oscillations in points of attachment of the space stage of the launch vehicle. The proposed technique can be in progress for strength computations of space stages with complex 3D configurations under 3D oscillation of the launch vehicle.

Keywords: longitudinal oscillation, longitudinal stability of liquid launch vehicles, dynamic loads, stressed-strained conditions, finite- element method.

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