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Author: Dr. CHU Fuyun  
LandSpace Technology Corporation Ltd., China, chu\_fuyun@163.com

LONGITUDINAL-LATERAL-TORSIONAL-SLOSH INTEGRATED MODELING TECHNIQUE FOR  
LIQUID-PROPELLANT LAUNCH VEHICLE

**Abstract**

Abstract: A new Longitudinal-Lateral-Torsional-Slosh integrated modeling technique is proposed for the first Chinese liquid Oxygen-Methane (LOX/LCH<sub>4</sub>) commercial launcher named “ZQ-2”, and the sloshing of free surface and liquid structure coupling can be considered by the Acoustical-Structure Interaction Model. In order to solve the problem that the restoring force of every node is not equal caused by the irregular meshing, a method of modifying the restoring force according to the actual coverage area of the node is proposed. The sloshing frequencies and shapes can be obtained accurately based on the proposed method. The modeling method is applied to the liquid propellant tank and a medium/large scale liquid-propellant launch vehicle as the first Chinese LOX/LCH<sub>4</sub> commercial launcher ZQ-2. By comparing with the analytical solution and test results, it is proved that the sloshing frequency, lateral frequency, longitudinal frequency and torsional frequency from this model have high precision. Therefore, the proposed method can be used in the elastic and sloshing design of liquid-propellant launch vehicle.

Key words: Liquid Oxygen-Methane propellant launch vehicle; Commercial Launch Vehicle; First Chinese Private Liquid Launcher; Longitudinal-lateral-torsional-slosh; Structural dynamic; Liquid structure coupling