

MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures - Dynamics and Microdynamics (3)

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THRUST DEGRADATION EFFECT RESEARCH ON NON-IDEAL CONFIGURATION OF SOLAR
SAIL BASED ON TIME-VARIANT SOLAR PRESSURE MODEL

Abstract

The thrust acceleration is the most important index in solar sail design, because it can finally determine the mission time, orbit period, attitude regulation and other system parameters. However, some design and analysis work on the sail regard it as an ideal configuration of plane or a curve surface with known curvature, especially neglecting the wrinkles existence. This ideal hypothesis can influence the sail wrong thrust thus guide to the error. Based on the transient dynamic and time-invariant solar pressure model, a precision sail model of dynamic which has considered this non-ideal sail configuration is constituted in this paper. Due to the concentrated load suspension sail system has been prone to the formation of structural wrinkles, this configuration of membrane can be obtained by buckling mode superposition method. According to the prestress in membrane and ahead buckling mode, the initial imperfection has been added in the sail model. Therefore the non-ideal configuration of wrinkles can be calculated. Furthermore, in order to get the acceleration more acute, the solar pressure in every sail membrane element and every transient calculated step has been updating by finite element method (FEM). Therefore, the pressure direction can be vertical to all the element all the time. In view of the above mentioned, the use of the method and is discussed and an example is given, which is applied to a 160 m quadrant based square architecture sail tensioned to 1 psi membrane stress. Moreover, the transient dynamic analysis to acceleration and other dynamic characteristics is also present. The result that the non-ideal surface with wrinkles has a remarkable effect on 0.1% order of degradation to ideal configuration has been calculated and shown. At last, the sensitivity of the thrust degradation effect has also been discussed by every non-ideal factor. It can be seen that the non-ideal configuration and dynamic analysis, neither of them can be neglected in solar sail design. This work concept of precision dynamic model can potentially extend solar sail mission applications.