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A TRADE-OFF STUDY ON THE MECHANICAL SUPPORT STRUCTURE OF THE MASCOT-2 SMALL BODY LANDER PACKAGE

Abstract

The Mobile Asteroid surface SCOuT (MASCOT) is a 11 kg small body lander package developed under DLR lead for the Japanese space probe Hayabusa2. Its structure consists of two main components, the actual landing module (LM) and a mechanical support structure (MESS), supporting the lander on the space probe. Based on MASCOT-1 a modified MASCOT-2 lander package was studied for the AIM (Asteroid Impact Mission) mission proposal targeting the binary asteroid system 65803 Didymos.
The objective of the study was to develop a lander package, which maximizes heritage and reuse from the MASCOT-1 predecessor. Thus the landing module's framework structure retained the MASCOT-1 design concept, being up-scaled by approx. 20% (MASCOT-2: 330mm x 300mm x 210mm, 13 kg). In contrast, the interface structure experienced a more significant re-design, due to the need of interface simplification and the peculiarities of the lander deployment for AIM mission and the Didymos system.

This paper introduces four possible design concepts for the mechanical support structure, which were later narrowed down to two and are presented in greater detail: a CFRP-honeycomb sandwich plate with additional unidirectional stiffening plies and an X-shaped solid CFRP hat beam structure. Both are much simplified compared to the MASCOT-1 support structure, but retain the overall mounting concept. Hence, the fundamental positions of the mounting points between the landing module and the mechanical support structure as well as between the support structure and the carrier S/C (AIM) are predefined. Especially the second interface towards the carrier S/C requires additional insert and bearing solutions. These vary due to the two quite different structural concepts and are introduced and discussed briefly.

The conceptual discussion is followed by a detailed structural analysis of both mechanical support structures. Provided by a set of mechanical loads and stiffness requirements, the sandwich and beam interface structures are separately simulated in a finite element model, consisting of shell and beam elements, respectively. The attached landing module is modelled with both, shell and beam elements, allowing a coupled structural analysis of the system. By varying geometrical and material parameters in the structural models, a trade-off between the resulting minimal masses, the stiffness and the strength requirements is performed. Specifically considering also development risks it is concluded that the sandwich design concept shows an overall better performance.