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# MODAL SURVEY ON A FUSED DEPOSITION MODELLING CUBESAT PRIMARY STRUCTURE BY EXPERIMENTAL AND NUMERICAL MODAL ANALYSIS

**Abstract**

The use of plastic materials, thanks to the development of additive manufacturing, can be applied in space application, e.g. on the International Space Station with the installation of a 3D-printer. The main feature of 3D-printing is rapid prototyping of the desired model. However, it is well known that the mechanical properties of the extruded material are different between filament. They depend on setting parameters of the printer, thread process, and fiber orientation. It means that it is very difficult to characterize the material used for additive manufacturing. In addition, if it is used for space application, it is challenging to verify the environmental requirement related to the structure. The aim of this work is to study if a 6 Unit CubeSat primary structure, made by plastic material with an additive technology named Fused Deposition Modeling, is able to withstand to launch environment that is considered a worst case. For this reason, a low-cost experimentation as "hammer test" has been chosen. Test campaign was compared with 2D Finite Elements model. This model was created and examined in according to relevant features of the physical model, reducing time consuming of the SOL 103. Thanks to modularity and adaptability, typical of 4.0 industry, the dynamic property of elementary modules is compared with the one of similar continuous structures. The process provides the realization of several models: a continuous structure, the benchmark, and assembled one with elementary parts, from which to derive the dynamic properties as whole. For this purpose, Polylactide is an available and cheap material. The use of this material allowed a campaign of preliminary tests dedicated to specific samples. In this way mechanical properties of extruded plastic material have been identified, quickly and clearly. From methodological point of view, its use is considered as a starting point for more in-depth studies with "printable" space grade materials, despite it satisfies outgassing requirements. Assuming Soyuz as reference, the study confirms that all structures families satisfy the lateral and longitudinal natural frequency requirement allowing to accommodate payloads in modular and integrable as complex structure. It is clear the study offers a concrete support for the state-of-the-art related to the knowledge of plastic structures for space application. In addition, a dynamical numerical analysis and experimental verification methodology based on the knowledge of the sample genesis, is proposed.