Structural Design and Analysis of a Student CubeSat 1U

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The CubeSat standard started in 1999, ideally to meet the need to have more frequent access to space by using small satellites to achieve the mission requirements of large satellites with similar or equal technology. The great advantage of CubeSat is that, unlike larger Satellites, the simplification of the satellite infrastructure makes it possible to design and produce functional satellites at a low cost, in addition to being able to launch several satellites and comply with different types of missions in a single launch.

During the design of a CubeSat, several system requirements must be met, as described in the document "CubeSat Design Specification" from California Polytechnic State University. These requirements include the mechanical requirements that are fundamental to ensure the integrity of the satellite and the launch vehicles in the most different environments. In this paper the structural metallic design and the mechanical analyses of the structural systems of the mission GamaSat-I, developed at the University of Brasilia, are presented following the requirements specified in the Cal Poly's CDS REV13, NASA's GSFC-STD-7000B and NASA-STD-6016 documents.

In the conceptual project phase, the structural design was developed with the compromise of ensuring the lowest cost both in the choice of materials and in the manufacturing of the prototype, always respecting the normative requirements, the design restrictions and structural resistance. Thus, it was selected the use of aluminum alloy 7075-t6 and the manufacture of the Z- and Z+ faces by subtractive manufacturing from a massive block of material in order to obtain a full structure and subtract the need for fasteners.

In the mechanical analysis, the global behavior of the structure was studied under the critical structural load environment listed in the previously mentioned standards, using computational analysis tools available on the ANSYS platform. The static analysis focused on the critical launch phase, using the high and low frequency static and vibro-acoustic load factors of the Space Launch Vehicle (SLV) Minotaur I, which was considered the worst loading environment of the launch vehicles researched. In addition, the dynamic analyses were supported by modal and harmonic response, random vibration and shock spectrum response analyses in accordance with the requirements of GSFC-STD-7000B standard.

The results showed positive safety factors (according to the von Misses yield criteria) for the studied static load environment, a natural primary frequency of 187.5 Hz and response to vibration spectra that satisfy the normative requirements. Finally, according to the proposal, it was obtained a metallic structure that meets the requirements and specifications raised allowing the integration with other subsystems and with total mass and inertia compatible with known commercial solutions but with lower cost.