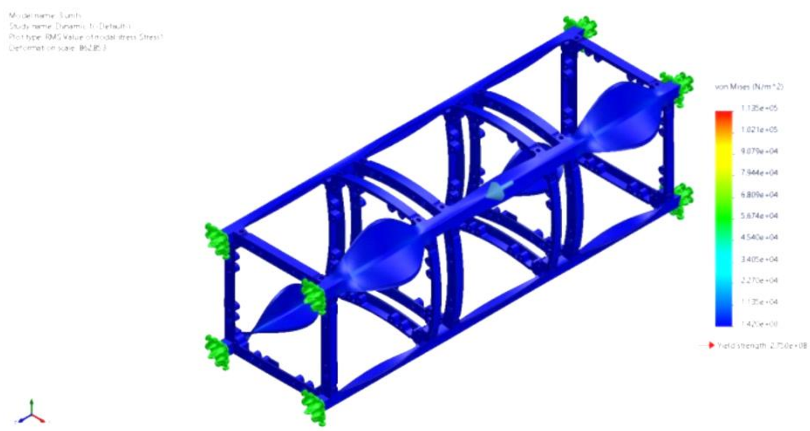
Comprehensive Simulation Report: CubeSat Structural and Thermal Evaluation



Executive Summary

- This report details a rigorous engineering assessment of small satellite structures, specifically focusing on various configurations of modular CubeSats. The primary objective was to determine how different materials—ranging from traditional aerospace-grade aluminum alloys to advanced polymers—respond to the physical and environmental stresses of spaceflight. The analysis confirms that the proposed designs are robust, maintaining structural integrity and thermal stability across all tested scenarios.

Structural Integrity and Dynamic Response

- The structural evaluation focused on random vibration analysis, which mimics the intense mechanical stress experienced during a rocket launch. By analyzing various mode shapes and frequency responses, the study determined the following:
- Material Performance: The aluminum structures exhibited exceptional stiffness, with total deformation remaining almost non-existent even under peak vibration loads. The polymer-based models, while more flexible, also remained well within their elastic limits, ensuring that no permanent warping or structural failure occurs during transit to orbit.

www.ksf.space
2525 Ponce De Leon Blvd #300, Coral Gables, FL 33134, USA
Tel: +1 305 200 8707 (USA Office)
USA Registration # 5605031

- Safety Margins: In every simulation, the internal stress levels recorded were a mere fraction of the material’s yield strength. This indicates a high factor of safety, suggesting the frames can support significantly heavier internal payloads than those currently modeled without risking a catastrophic collapse.
- Mass Efficiency: The report highlights a successful balance between weight and strength. The lighter polymer options provide a viable alternative for missions where mass savings are critical, without compromising the satellite's ability to protect its internal components.

Thermal Behavior and Environmental Stability

- The thermal analysis evaluated the satellites' ability to manage heat in the harsh vacuum of space, where temperature regulation depends entirely on radiation.
- Steady-State Equilibrium: When subjected to internal heat generation and the extreme cold of deep space, the structures reached a consistent temperature equilibrium. The materials used demonstrate effective thermal conductivity, preventing the formation of "hot spots" that could damage sensitive electronics.
- Radiative Cooling: The emissivity of the external surfaces was shown to be sufficient for shedding excess heat, ensuring the satellite maintains a stable operating environment despite the lack of atmospheric convection.

Technical Validation and Quality Assurance

- The reliability of these findings is underpinned by high-fidelity modeling techniques. The simulations utilized a sophisticated mesh with a massive number of calculation points to ensure precision. The quality of this mesh was verified through aspect ratio checks, confirming that the mathematical model accurately represents the physical geometry of the satellites.

Conclusion

- The results of this analysis provide a green light for the current CubeSat designs. Whether constructed from metal or high-performance polymers, the structures are capable of surviving launch vibrations and maintaining a stable thermal profile in orbit. These designs are validated as dependable platforms for future space missions.

2525 Ponce De Leon Blvd #300, Coral Gables, FL 33134, USA
Tel: +1 305 200 8707 (USA Office)
USA Registration # 5605031