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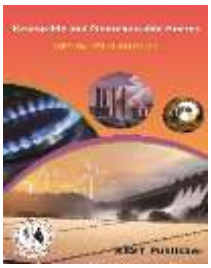

Structural Analysis and Development of a Nano Satellite Framework

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Abstract: *Objectives of the proposal are to analyze and design a Pico satellite; the one reason for miniaturizing satellites is to reduce the cost: heavier satellites require larger rockets with greater thrust which also has greater cost to finance. In retrospect, smaller and lighter satellites require smaller and cheaper launch vehicles and can sometimes be launched in multiples. They can also be launched 'piggyback', using excess capacity on larger launch vehicles. Miniaturized satellites allow for cheaper designs as well as ease of mass production, although few satellites of any size other than 'communications constellations' where dozens of satellites are used to cover the globe have been mass-produced in practice.*

Keywords: *Nano Satellite structure, Catia, Ansys, Prototype model.*

1. INTRODUCTION

This Report aims at designing & development of a Nano Satellite. In this, it is responsible for designing the Nano Satellite, selecting its mission, integrating the components, testing, preparing for launch and then analyzing the data. By analyzing the data recorded by the Nano Satellite, and investigate the reasons of its success and/or failure. A Nano Satellite is a simulation of a real satellite, integrated within the volume and shape of a regular soft drink can. It is small, non-orbiting and with limited complexity, but it is still like a "satellite" in terms of many of the challenges real satellites faces. No Nano Satellite has ever left the atmosphere or even orbited the earth. In November 1998 at the University Space Systems Symposium (USSS) held in Hawaii, Prof. Bob Twiggs, (Stanford University Space Development Laboratory) suggested the so-called "Nano Satellite" concept, whereby the entire satellite would adopt the size of a 350-ml can. All of the components, such as sensors, actuators, and GPS, are housed inside a 350-ml can. Nano Satellite provides an affordable opportunity for educators and students to acquire basic knowledge of space engineering and to experience engineering challenges in building a satellite. We are able to design and build a small electronic payload that can fit inside a standard drink can (350 ml). The Nano Satellites will be launched by a rocket or balloon and released in the air. Using a parachute, the Nano Satellite will slowly descend back to the ground as it performs its designated mission (i.e., taking pictures and transmitting telemetry). By analyzing the data recorded by the Nano Satellite, participants will investigate the reasons of its success and/or failure.

2. METHODOLOGY

To Design and Develop the Nano Satellite structure, we need:

- Month 1 – Material Acquisition
- Month 2-4 –CAD modelling / Analysis
- Month 5 – Module Integration,
- Month 6 – System Testing

Procedure: Three concepts were evaluated in preparation for the Nano Satellite structure: a parachute control system, a parachute control system and a glider approach. Given the lack of availability of appropriate skills required developing a glider, and because

Acrylics material is chosen for the on-board system Key mechanical components were identified as:

The main parts of the on-board computer are:

- Predrilled Main board for mounting circuit boards.
- Angle bracket for attaching a parachute.
- Computer board with processor and connectors for sensors and communications.
- Programmable processor that can be programmed in BASIC Software.
- Serial interface connector for host PC communications.
- Sensor board with a pressure and temperature sensor.
- a parachute is far less susceptible to interference from the wind when compared to a parachute – the parachute approach was chosen.

As construction of parachute requires a person who is skilled at sewing, it was decided that one should be purchased. A strong on-board construction was considered vital to successful recover of the Small Satellite, as even with a parachute it would descend at a high speed. The Small Satellite was thus built around a Perspex chassis (providing support for circuits, sensors, the battery) housing made out of acrylics providing protection on impact. Out of Four Designs made, best suitable design is selected for On-board Computer as shown below.

3. INTRODUCTION TO CATIA

CATIA (Computer Aided Three-dimensional Interactive Application) is a multi-platform CAD/CAM/CAE commercial software suite developed by the French company DassaultSystemes. Written in the C++ programming language, CATIA is the cornerstone of the DassaultSystemes product lifecycle management software suite.

***Final cattie model for Nano satellite*:**

With the help of Katia software 2D representation of Existing component will takes place. In Katia, sketcher is the main tool used to represent 2D models. A sketcher is a 2D section of the feature being created. It is a basic 2D shape, and is created on a planar reference. Almost all the models designed in Katia, consist of Datum's, sketched features, and placed features.

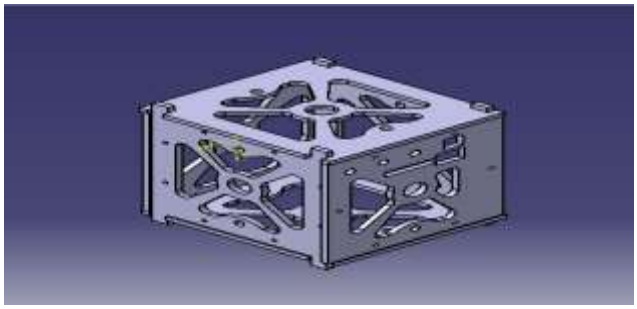

FIGURE 1. Final Nano Satellite Design

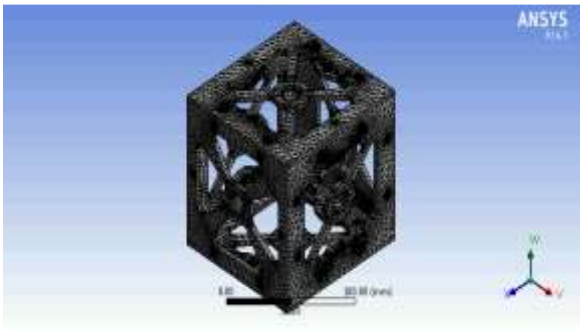

FIGURE 2.

4. ANALYSIS OF NANO SATELLITE STRUCTURE

Importing the Model: In this step the CATIA V5 model is to be imported into ANSYS workbench as follows:

In utility menu file option and selecting import external geometry and open file and click on generate. To enter into simulation module, click on project tab and click on new simulation

***Defining Material Properties*:** To define material properties for the analysis, following steps are used **The** main menu is chosen select model and click on corresponding bodies in tree and then create new material enter the values again select simulation tab and select material

Defining Element Type: To define type of element for the analysis, these steps are to be followed:

Chose the main menu select type of contacts and then click on mesh-right click-insert method

- Method - Tetrahedrons
- Algorithm - Patch Conforming
- Element Mid Side Nodes – Kept

Meshing the model: To perform the meshing of the model these steps are to be followed: Chose the main menu click on mesh-right click- insert sizing and then select geometry enter element size and click on edge behavior curvy proximity refinement and then right click generate mesh.

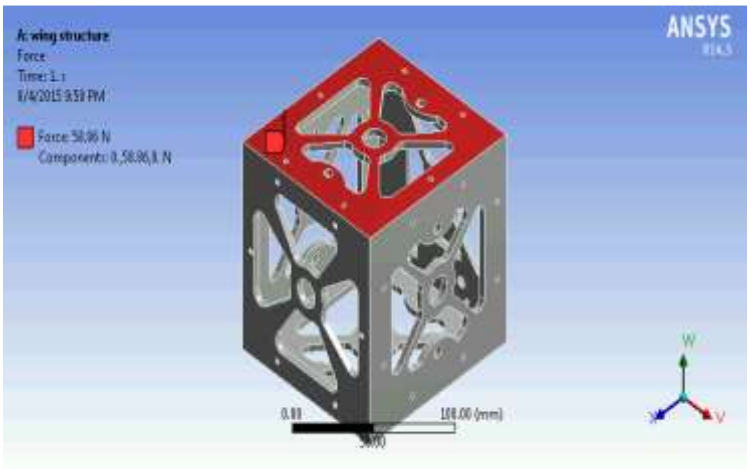

FIGURE 3. Mesh Generation on Nano Satellite Structure

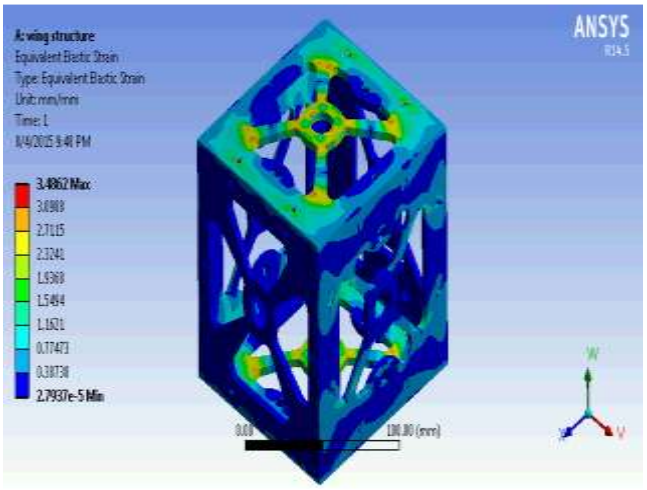

FIGURE 4. Fixed support and force application on Nano Satellite Structure

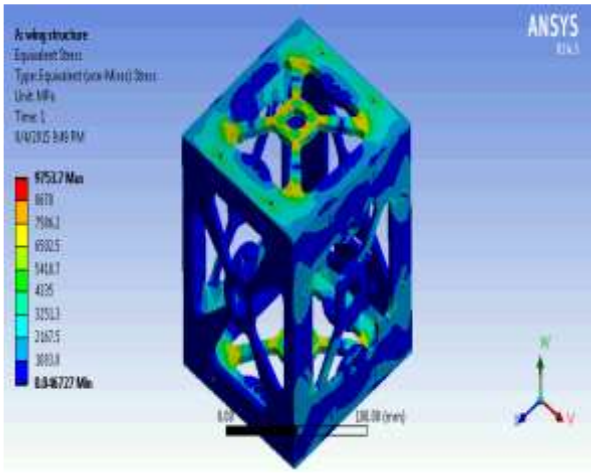

FIGURE 5. Equivalent Elastic Strain for the Applied Load

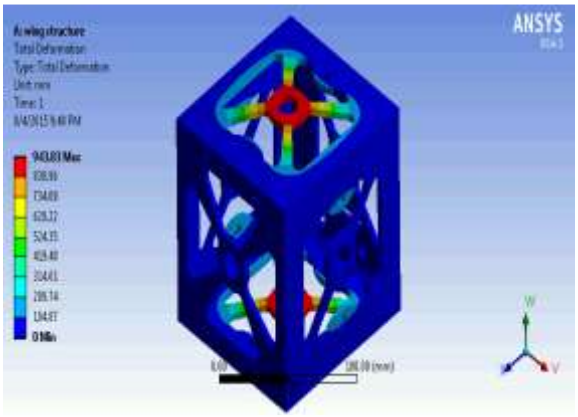

FIGURE 6. Von-misses Stress for the applied Load

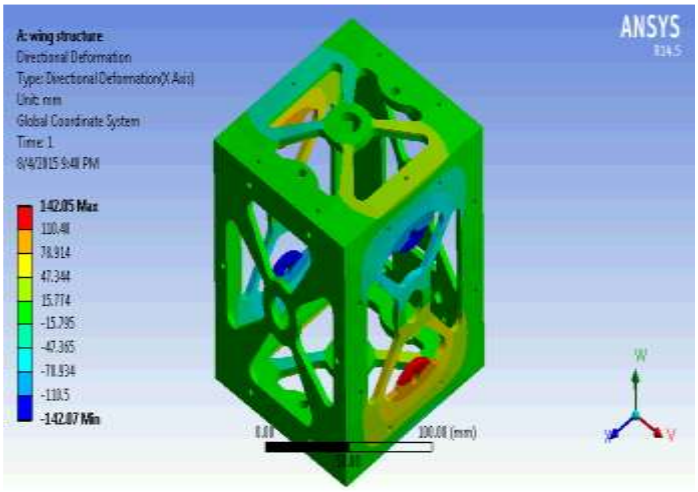

FIGURE 7. Total deformation for Nano Satellite Structure

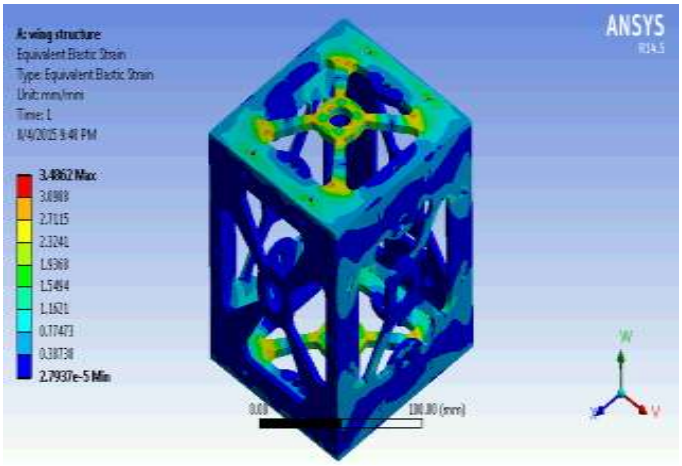

FIGURE 8. Total Directional Deformation for the applied Load

FIGURE 9. Total Equivalent Elastic Strain for the applied Load

5. RESULTS AND CONCLUSION

TABLE 1. Analysis results for Nano Satellite structure

S.No	Object Name	Maximum Value	Minimum Value
1	Total Deformation	943.83mm	1 mm
2	Directional Deformation	-142.07 mm	142.05 mm
3	Equivalent Elastic Strain	2.7937e-005 mm/mm	3.4862 mm/mm
4	Equivalent(Von-Mises) Stress	9753.7 MPa	4.6727e-002 MPa

The development of the Nano Satellite includes 3 vital steps:

- Design a CAD model for the external body of the satellite and perform design iterations of the CAD model, conduct the stress analysis for the body made and make respective corrections.
- Fabricating the sensors, GPS, radio transceiver along with the Arduino board, programming and compiling the on-board computer.
- Develop an algorithm for the Graphical User Interface which is to be developed and interfacing the on board computer with GUI.

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