

Modal Analysis of a Satellite - Physics Setup

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Physics Setup

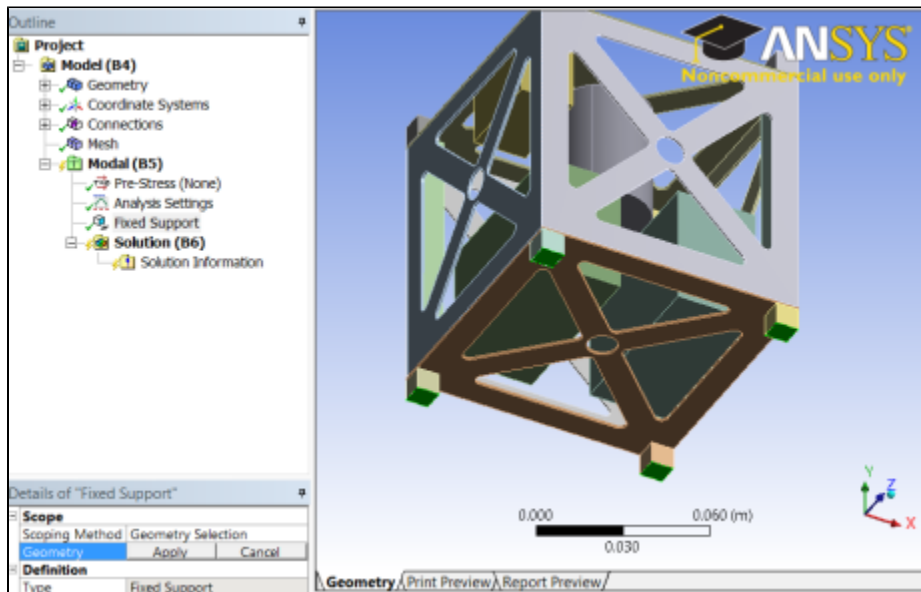
Boundary Conditions

The boundary conditions will differ depending on the launch configuration. For this model, I assumed the CubeSat was placed inside a PicoSatellite Orbital Deployer (P-POD) with the legs of the satellite aligned with the direction of the acceleration of the launch vehicle. In other words, the long rectangular P-POD is pointing up towards the sky.

1. Floor of P-POD Constraint

The side of the CubeSat that faces the ground should be fully constrained. This will simulate the floor of the P-POD during launch.

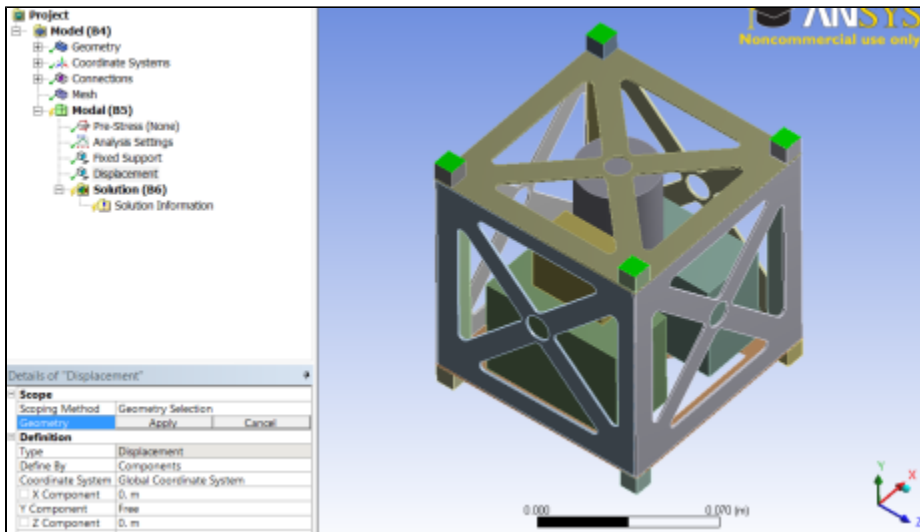
With the Design Modeler still open, right click **Modal** in the *Outline* window, then select **Insert>Fixed Support**. While holding down **Ctrl**, select the bottom face of all four -y-side legs. Select **Apply** next to the Geometry tab.



2. Top of P-POD Constraint

The P-POD is a spring-loaded deployment system, which can hold up to three 1U CubeSats. This spring-loaded design allows for a very small amount of vertical movement during launch, while the side rails keep the CubeSat rigidly fixed in two directions. Because of this, the side of the CubeSat facing the sky should be constrained in all directions other than the vertical direction (+y-direction for our model). This will allow the structure to warp slightly during takeoff, and will simulate the rigid sides of the P-POD.

With the Design Modeler still open, right click **Modal** in the *Outline* window, then select **Insert>Displacement**. While holding down **Ctrl**, select the top face of all four +y-side legs. Select **Apply** next to the Geometry tab.



To simulate the constraint of the side rails, set the X and Y components to **Constant** (0 m) and the Y component to **Free**.

Details of "Displacement"	
Scope	
Scoping Method	Geometry Selection
Geometry	4 Faces
Definition	
Type	Displacement
Define By	Components
Coordinate System	Global Coordinate System
☐ X Component	0. m
☒ Y Component	Free
☐ Z Component	0. m
Suppressed	No

Analysis Settings

As a CubeSat specification requirement, the satellite must have its 1st resonant frequency above 100 Hz. Most major forcing amplitudes in launch vehicles occur below 100Hz. The goal is to design a satellite which will not be destroyed by some forcing near or at a resonant frequency during the launch phase.

Under the **Modal** tab in the *Outline* window, left click **Analysis Settings**. Set the **Max Modes to Find** to 5. Select **Limit Search to Range** and click* Yes. Leave **Range Minimum** at 0 Hz and set **Range Maximum** to 1000 Hz. These settings allow us to reduce run time by using some foresight as to what modal frequencies we expect to see and care about.

Details of "Analysis Settings"	
Options	
Max Modes to Find	3
Limit Search to Range	Yes
Range Minimum	0. Hz
Range Maximum	1000. Hz
Solver Controls	
Solver Type	Program Controlled
Output Controls	
Analysis Data Management	

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