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Jehanne Simon-Gillo
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Dear Jehanne:

At the request of P-25 personnel, I modeled the Rohacell foam C-cell module with all six silicon panels attached. It had been found in previous testing that the distance between the circular holes, measured laterally, increased when the ambient humidity was increased. It was desired to see if this behavior could be duplicated using finite element analysis.

The previously used model included a total of four silicon panels. All three inner silicon panels were used. One outer silicon panel was located to the side of the center.

The previous model was modified by adding two additional silicon panels to the outer positions, one in the center and one on the opposite side, for a total of six panels. To be consistent with previous runs, a $\Delta\%RH$ (% Relative Humidity) of +50% was used for this run, with the previously used value of [0.0001789 (mm/mm) /%RH] used for the hygroscopic expansion coefficient. This value is regarded as being representative, although variations could certainly be postulated.

The restraints were changed from the previous models. The model was restrained about the Z and X axes of symmetry. This allows the model to be less artificially restrained. Using this system, it would have been possible to model only a quarter section of the C-cell module, however the entire module was modeled for clarity, in order to more easily interpret the output plots.

The results are shown on the following attached pages. The distance between the inside edges of the holes was originally 5.231 in (132.9 mm). With a $\Delta\%RH$ of +50% from initial conditions, the distance increased by **0.0282 in (0.716 mm)**. This change is in all likelihood due to the differential expansion due to humidity between the foam and silicon. It is postulated that the inner panels act to "close up" the C-cell module, while the outer panels act to "open up" the module. Because the outer panels are somewhat longer, their effect predominates, resulting in a net effect of "opening up" the module. Concave dishing of the panels (relative to the silicon side) is also noticeable, particularly near the corners of the panels.

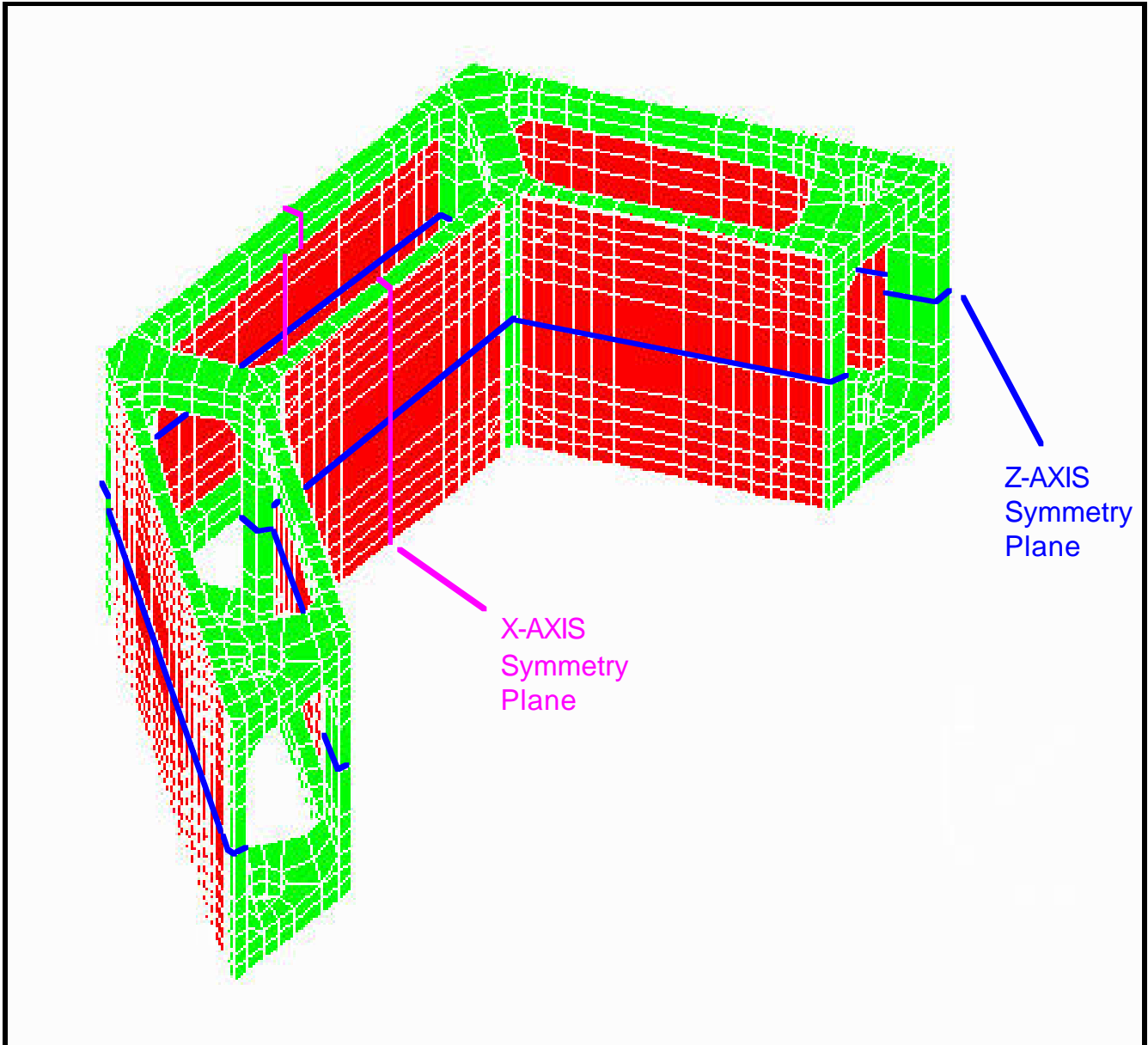
Please contact me if you should have anymore questions. Thank you for this opportunity to help you.

Sincerely,

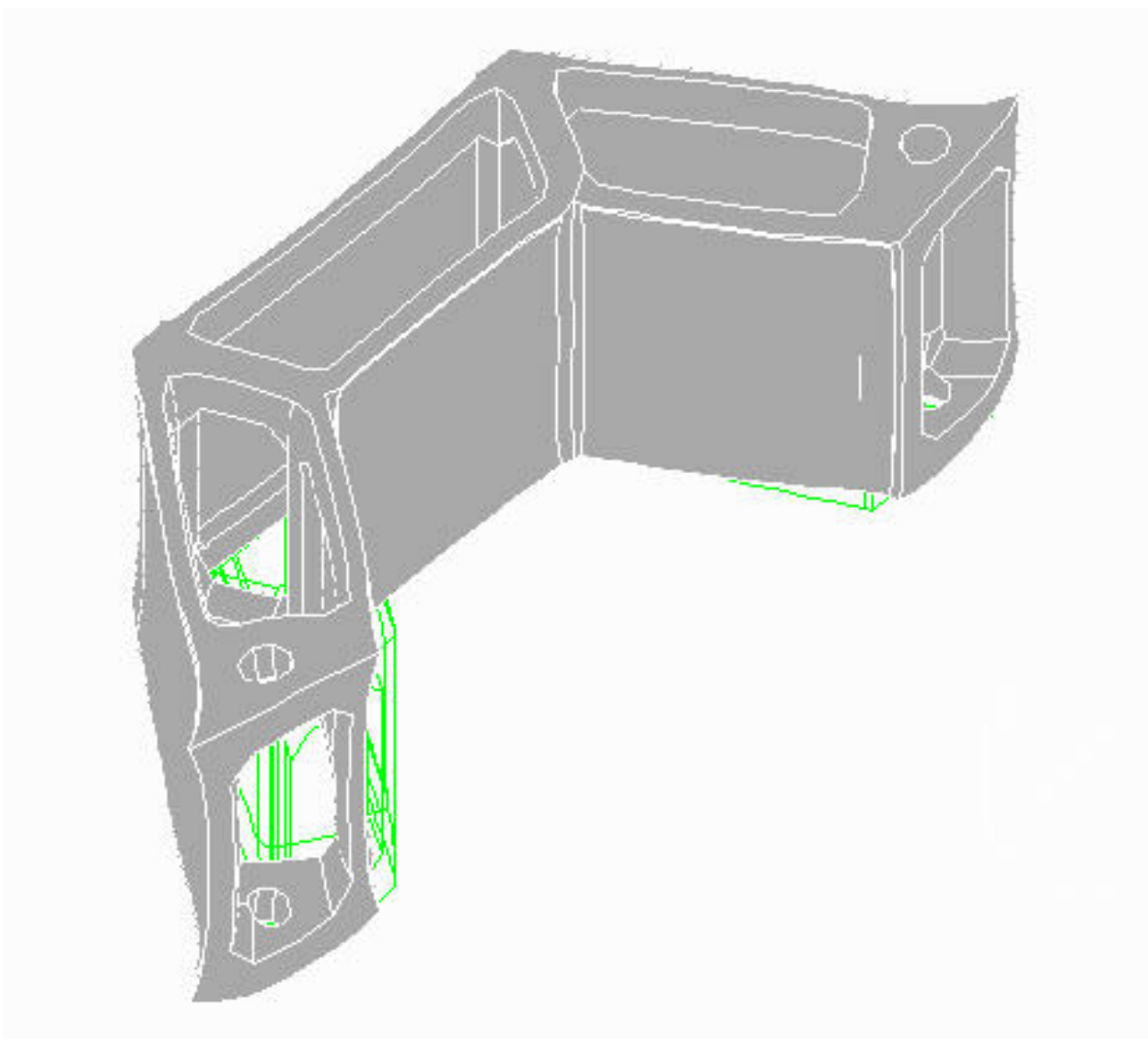
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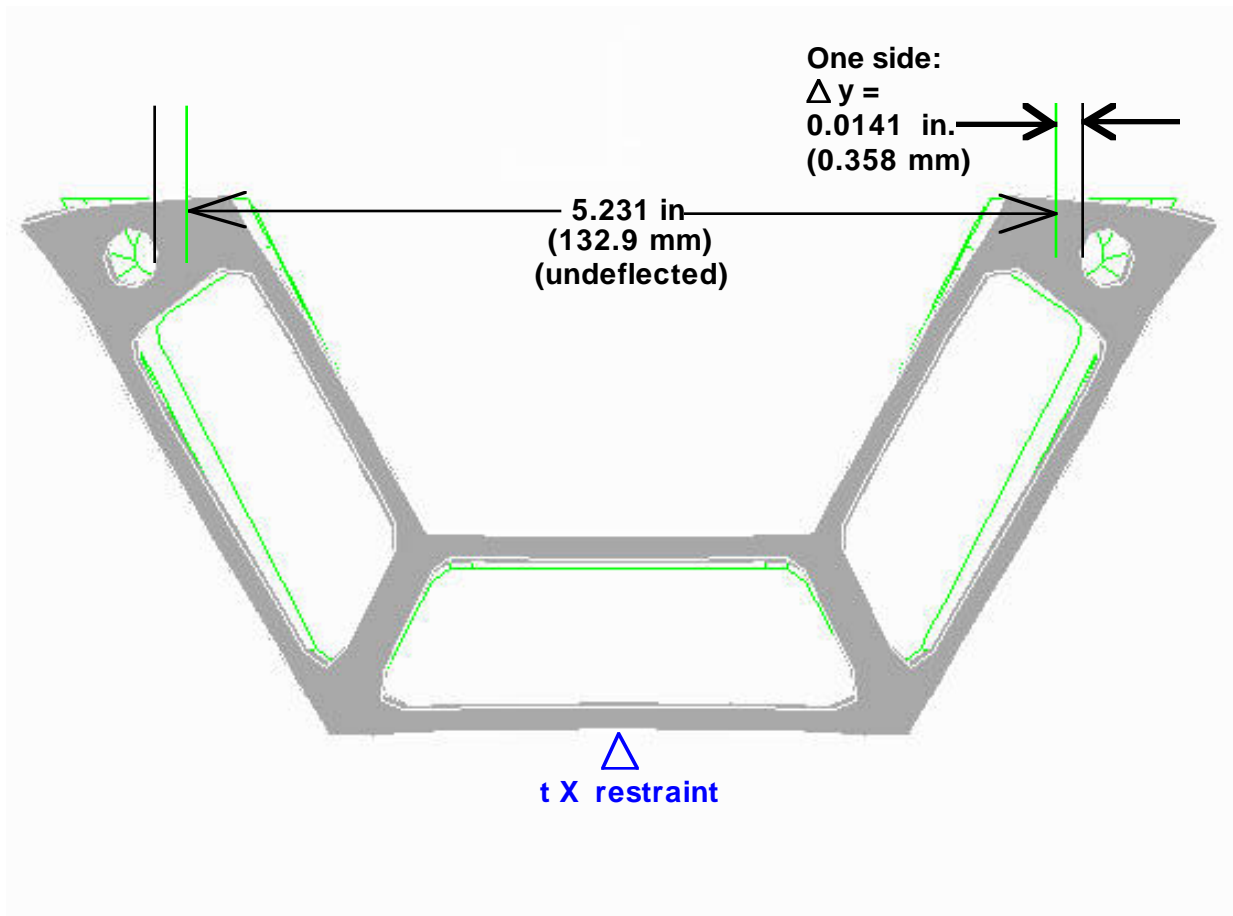
GRID USED TO MODEL C-CELL MODULE. The grid is derived from the one used in previous models. The *Rohacell* material is shown in green, and the silicon panels are shown in red. The main difference from the previous models is that the silicon panels cover all six surfaces. The symmetry axes split the model into four equal sections. The plane of symmetry about the Z Axis is shown in blue, and the plane of symmetry about the Y Axis is shown in magenta. It would have been possible to model only a quarter-section of the module, but the entire module was modeled for more clarity.



DISPLACED C-CELL MODULE. The undisplaced shape, partially hidden, is shown in green. A 50% Relative humidity increase from conditions at initial assembly was used. The displacement is plotted magnified 20 times. The cell ends are moving away from each other. (The C-module is “opening up”, or the holes are getting further apart.)

The apparent mechanism that causes this is the foam expanding while silicon remains stationary. This causes a bending of the inside and outside silicone-foam interfaces away from each other. Because the outside interfaces are somewhat longer than the inside interfaces, the effect of the outside interfaces predominates, and the net effect is for the cell to “open up”.

Also note that the outside ends of the modules show a pronounced concave bending. This is also probably due to the expansion difference of the silicon-foam interface.



END VIEW OF C-CELL MODULE DISPLACEMENTS. Displacements for a single *Rohacell* foam cage viewed looking straight down the lengthwise axis. The undisplaced shape can be seen as green lines underneath the displaced shape. The displacements are magnified 10 times. The displacement is measured from the inside of the opposing holes across the longer lateral axis of the assembly, across a distance of 5.231 inches (132.9 mm). (This may vary slightly from the actual dimension because the holes are approximated by multi-sided figures.) The displacement is 0.0141 inch on one side, for a total displacement of **0.0282 inch** (0.716 mm). The two holes are getting farther apart, or the assembly is “opening up,” as the foam expands.