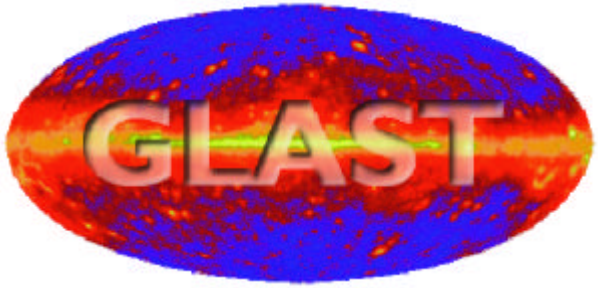
- Tracker Tower Analysis – Status Review

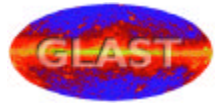


Erik Swensen

August 14, 2002

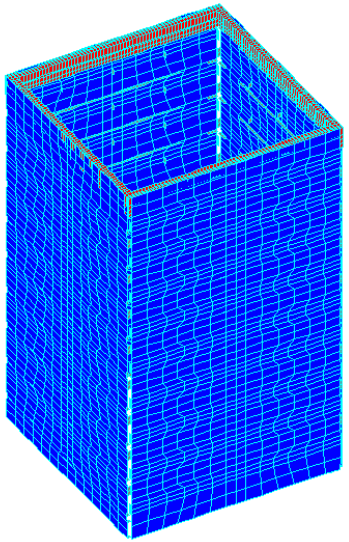
HYTEC INCORPORATED

Evolution of FE Model 2

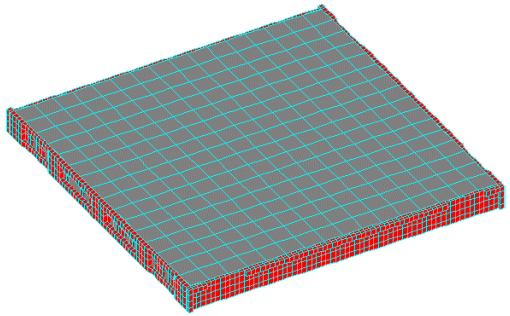


- Trays represented using solid elements for the closeouts, solid elements for the core, shell elements for the facesheets
- Sidewalls represented using shell elements
- Fixed base boundary conditions on the bottom tray
- Payload stiffness effects were studied and represented as layers on the facesheet; studied stiffness effects with and without payload
- Sidewalls were first attached all along the sides and modified to include specific fastener locations
- Modifications were made to include the individual attachment points of the sidewall
- Included flexures (1st concept) with fixed base boundary conditions at the bottom of the flexures
- Included Cho-Merics V-therm in the model and studied the stiffness effects of the gasket

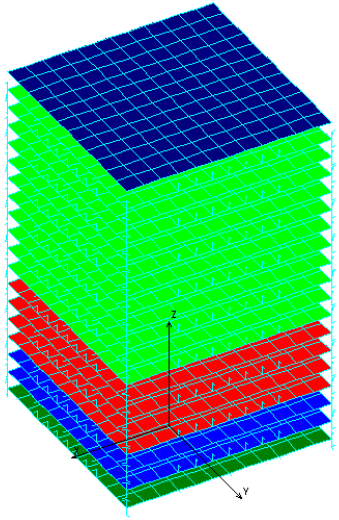
Model 2 FEM



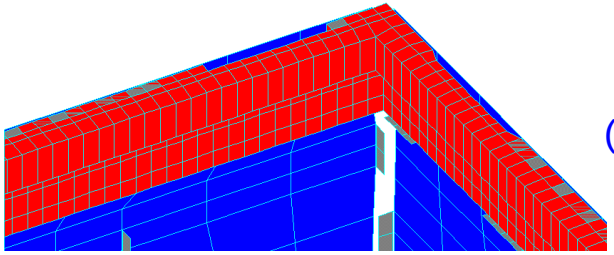
Tower FEM showing sidewalls and top try closeout



Typical Tray FEM



Schematic view of tray stack to illustrate tray sequence (trays shown as single layers)



Close-up view of top tray closeout & sidewall details

Model 2 Frequencies

Mode	Description	Frequencies (Hz)
1,2	Tower Bending	132, 137
3	Tower Plunging	315
4	Tower Torsion	358
5,6	Tower Rocking	426, 437
7-10	Thick Converter Trays	451 to 488
11	Top Tray	536
12-20	Standard Trays	557 to 559

- Results do NOT include thermal gasket material

Evolution of FE Model 3

- Began with Model 2 and included new flexure concept
- Top flexure bracket rigidly attached to the bottom tray
- Modified flexure attachment to the grid to include flanges
- Modified flexure attachment to include fasteners
- Refined joint modeling to represent joint compliance*

* currently in-progress

Model 3 Frequencies

Mode	Description	Frequencies (Hz)
1,2	Tower Bending	90, 93
3	Tower Plunging	235
4	Tower Torsion	259
5,6	Tower Rocking	322, 334
7-10	Thick Converter Trays	481 to 486
11	Top Tray	535
12-21	Standard Trays	555 to 557

- Results do NOT include thermal gasket material
- Results DO include grid attachment flange

Model 2 vs 3 Frequency Comparison

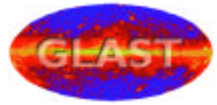
Mode	Description	Frequencies (Hz)	
		Model 2	Model 3
1,2	Tower Bending	148.8, 158.6	145.1, 151.0
3	Tower Plunging	352.5	348.8
4-7	Thick Converter Trays	450.5 to 450.7	450.5 to 450.7
8	Top Tray	519.8	529.4
9	Tower Torsion	534.3	534.3
10-19	Standard Trays	556.6 to 558.5	556.6 to 558.5
20	Tower Rocking	581.1	604.8

- Results are for comparison ONLY, frequencies do not match the current model configuration
  - Cho-merics V-therm gasket material is included in these models
  - Grid attachment (model 3) does NOT include attachment flanges

Model Correlation

- Model confidence must be gained through test results
  - Consider February test data
    - some confidence can be gained here
    - must consider which results we have the most confidence in (-6dB white noise)
  - Or, consider another modal test of the tower to identify frequencies without the thermal gasket material
    - this option will take some time to build and test the tower
    - need to consider what bottom tray to use

Model Correlation to Feb. Test Data



- Thrust Direction
  - FEA predicted 239 Hz
  - Test measured 248 Hz for the white noise check after the –6dB RV test (thermal gasket material was thoroughly compressed)
  - FEA predicted four tray modes above 550 Hz
  - Test measured these four modes with a maximum error of 11%
- Lateral direction
  - FEA predicted 90 Hz (1st mode) and 322 Hz (2nd mode)
    - Current model predictions were used
  - Test measured 88 Hz (1st mode) and 308 Hz (2nd mode) for the white noise check after the –6dB RV test

Design Allowables

- Carbon-Carbon Material Allowables
  - Tension is 8500 psi
  - Flexural is 7500 psi
  - Need better definition of shear and pullout allowables
- Allowables are calculated using 80%(1) of the average minimum test value for two test configurations
- Other industry criteria used to establish allowables
  - “A” & “B” Allowables
  - 3, 4, or 5 σ values

(1) Standard practice at Lockheed-Martin Commercial Satellites

Margin of Safety Calculations

- M.S. = [Allowable / (F.S. x Design Stress x S.C.F.)] – 1
  - F.S. = 1.4[1]
  - S.C.F. = 2.1[2]
  - Design Stress = P/A
    - Load = RMS value X 3σ
    - Area = thermal boss area

[1] NASA-STD-5001, "Structural Design and Test Factors of Safety for Spaceflight Hardware"

[2] R.E. Peterson, "Stress Concentration Design Factors"

Status

- The FEM is being modified to better represent the flexures & flexure attachment stiffness
- Analysis will proceed August 14th, which will include:
  - Load recovery of 1g static conditions in X, Y, & Z
  - Load recover of Liftoff & Transonic static loads
  - Load recover of MECO static loads
  - Load recovery of RV test conditions
  - Load recovery of RV test conditions with 1 & 2 fasteners removed from corner flexure
  - Investigate assembly stresses in fastener inserts
- We expect analysis results by the end of the week and will be tabulated/published early next week