Structures

Presented by

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Review of the Alpbach Structural Design

Structure of the Transfer and Science Vehicles

- Aluminium Truss Structure
- Structural mass: 40 kg

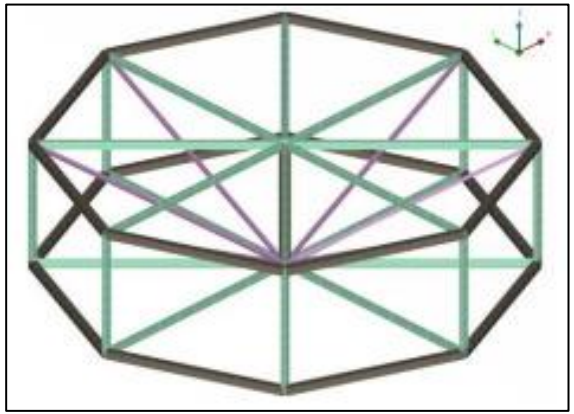


Fig.1 – Alpbach Structural Layout.

What's missing?

- Low stiffness/mass ratio;
- A lot of components, especially, on the transfer vehicle were not considered;
- The required propellant mass is significantly smaller than the current one;

- Hence, the structure was undersized for the expected mission and required mass propellant.

Functions and feared events

- **General Functions:**
  - High stiffness and high strength structure;
  - Accommodates the other subsystems;
  - The structure must be dimensionally stable.

- **Feared events**
  - It is mostly determined by the type of structure loads, namely:
    - Separation Loads;
    - Propulsion Loads;
    - Deployment Loads;
    - Inertia loads.

Material selection

- **Aluminum Honeycomb Structure and graphite epoxy facesheet material**
  - sandwich structure is designed to use a **thick** and **light core** to support the **thin, strong panels,** improving the **flexural performance** of the overall structure **without adding too much weight;**
  - high stiffness, high-temperature tolerance and low thermal expansion

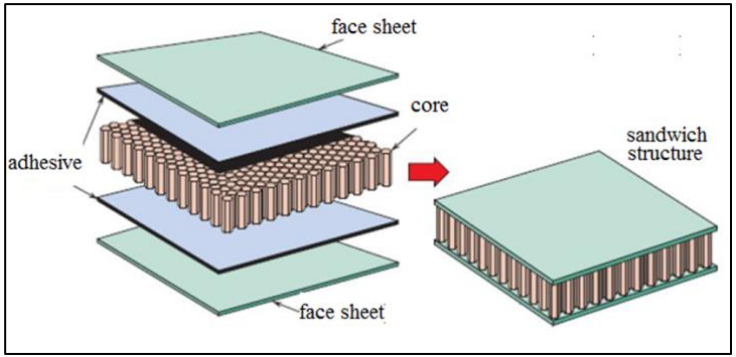


Fig.2 – Typical sandwich construction [1].

[1] Rajkumar, s & Murugan, Sivaraj & Rudrapati, Ramesh & Balasubramanian, Arulmurugan. (2018). Experimental and Finite-Element Analysis of Tee Joint's Stiffness Characteristics of A3003 Honeycomb Core Sandwich Panels.

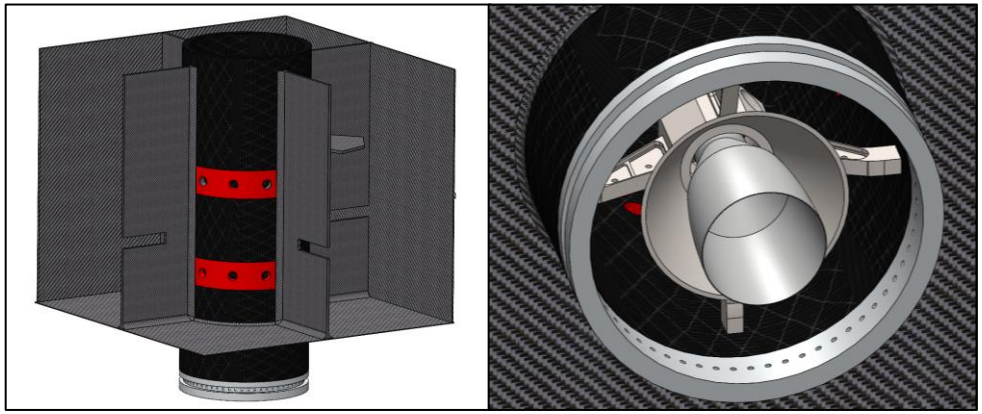
Post-Alpbach baseline design – Transfer V.

Primary Structure

- Central core of 0.9 m:
  - Main load carrying component;
- Exterior panels are attached to the central core;
- The panels sections are joined with bonded composite L-brackets;
- Material structure and structure layout have high TRL, and heritage from:
  - LISA
  - Dawn
  - MAVEN

Thruster truss supporting structure

- Connected directly to the central core, providing a smooth load transmission to the core.



(a) **(b)**

Fig.3 – (a) Primary structure of the T.V. **(b)** Thruster truss supporting structure

Post-Alpbach baseline design – Transfer V.

Primary Structure

Payload Adapter

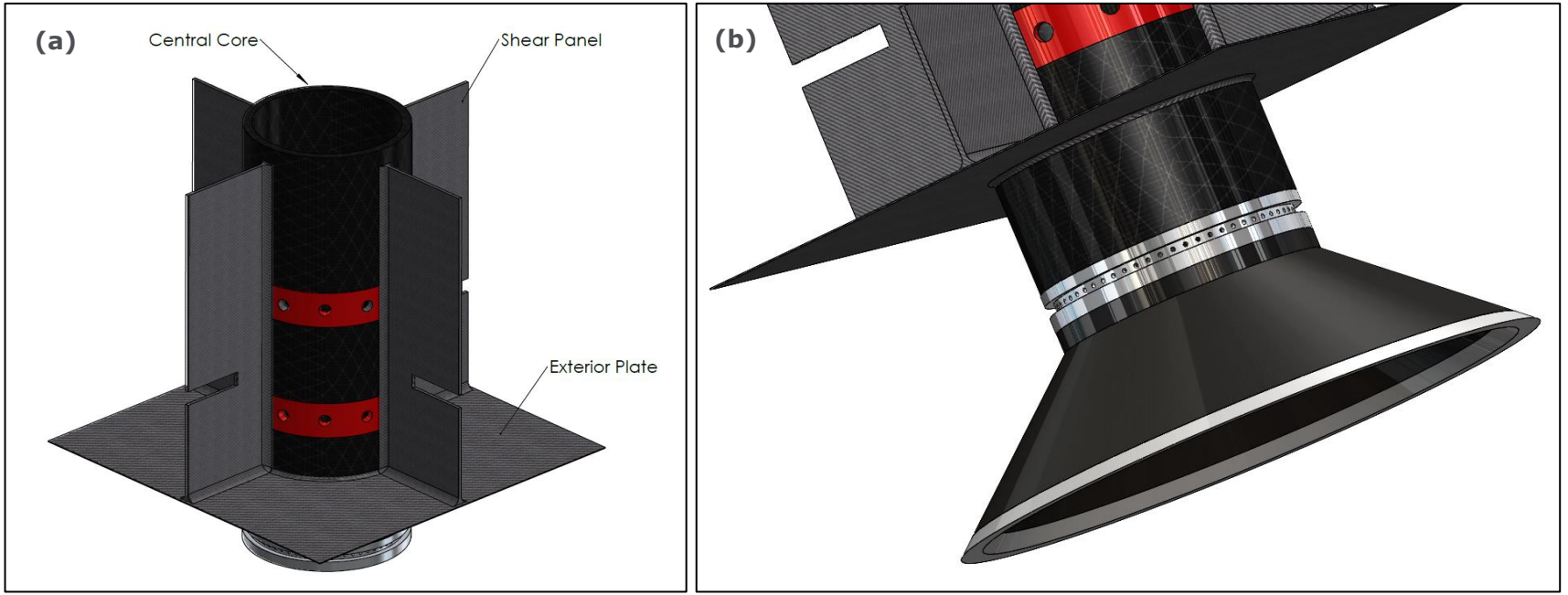


Fig.4 – (a) Primary structure components. **(b)** Payload Adaptor.

Post-Alpbach baseline design – Science V.

- Central core of 0.9 m:
  - Main load carrying component;
- Use of 8 panels aluminum honeycomb structure and graphite epoxy facesheet material instead of a truss structure;

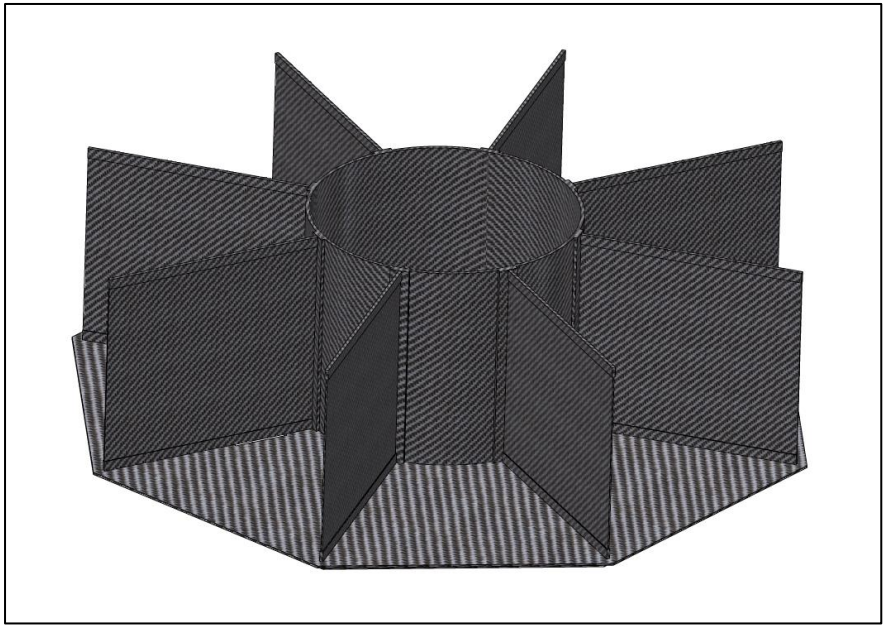


Fig.5 – Primary Structure of the science vehicle.

Post-Alpbach baseline design – Modal Analysis

Ariane requirements:

- Lateral Mode Frequency: **> 6 Hz**
- Axial Mode Frequency: **> 20 Hz**

Free vibration analysis results:

- Lateral Mode Frequency = 22.3 Hz
- Axial Mode Frequency = 80.1 Hz

Conclusion: According to the preliminary and very basic modal analysis, the resonance frequency of whole structure in the stacked configuration is much higher than the ones specified in the Ariane launch manual.

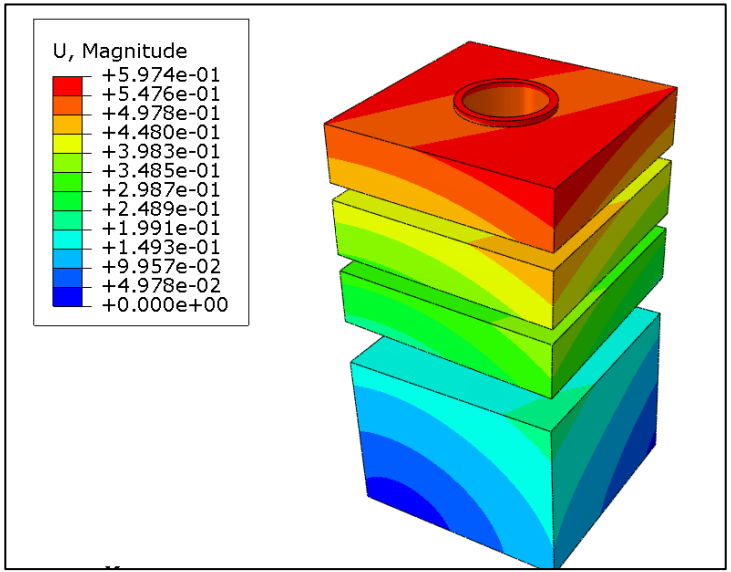
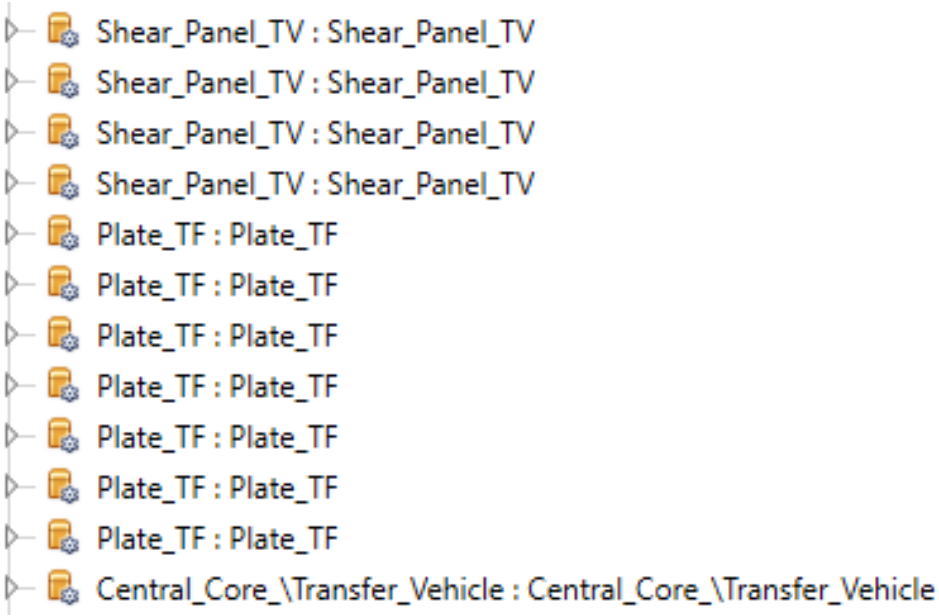


Fig.6 – Modal analysis of the whole structure (lateral mode).

Equipment

- Transfer Vehicle



- Science Vehicle