

Vehicle Architecture and Structural Design

Design objective

Stable, recoverable 25 in vehicle with a 4,000 ft simulated apogee target.

Structures Lead responsibilities

- Von Kármán nose and shoulder fit
- Fin-can and body integration
- Recovery attachment and load path
- PLA build and fit checks

Vehicle-level tradeoffs

- Nose mass changes CG and stability
- Retention must allow motor ejection
- Avionics and recovery share tube space

CAD assembly



CAD model

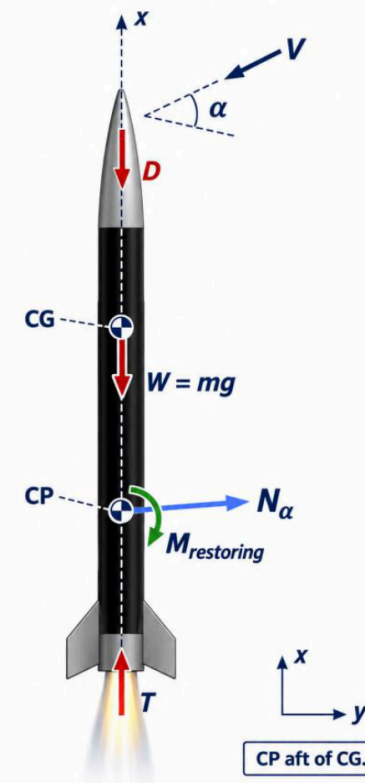
Built vehicle



Physical prototype

Forces and static stability

ROCKET FREE-BODY DIAGRAM



Static stability FBD

Nose Cone, Shoulder Fit, and Separation

Figure 1. Dimensioned Von Kármán nose and body joint

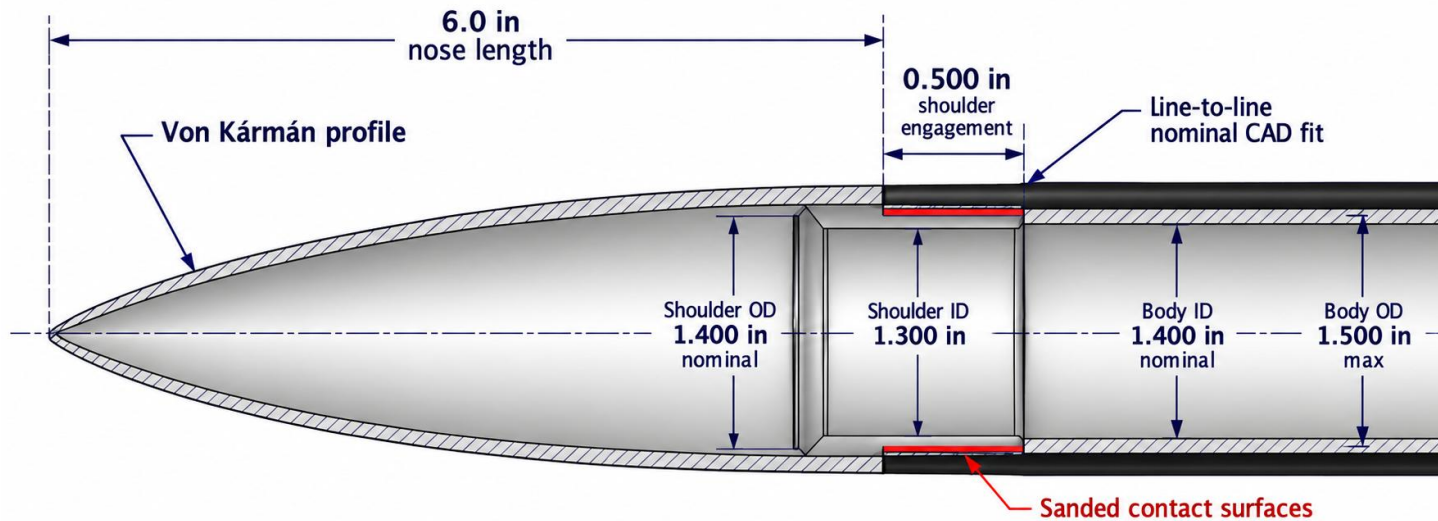
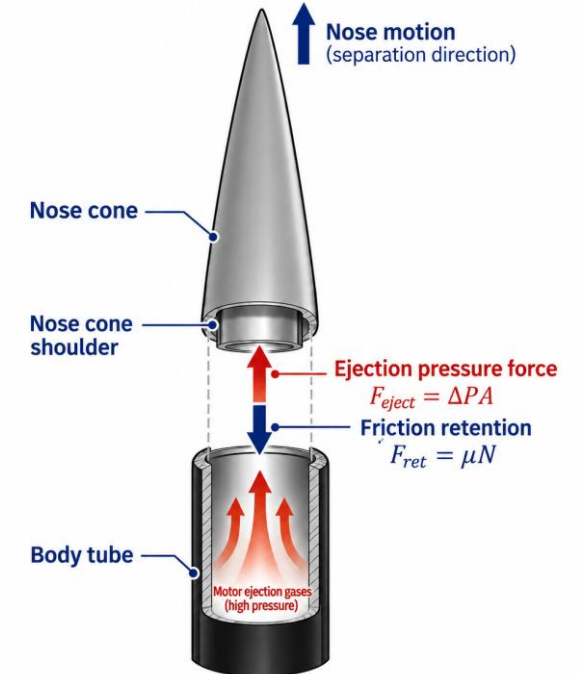


Figure 2. Idealized separation forces



Fit and pressure checks

Nominal clearance: $1.400 - 1.400 = 0.000$ in; radial wall: 0.050 in.

Recalled extraction force ≈ 19 N after sanding the printed shoulder.

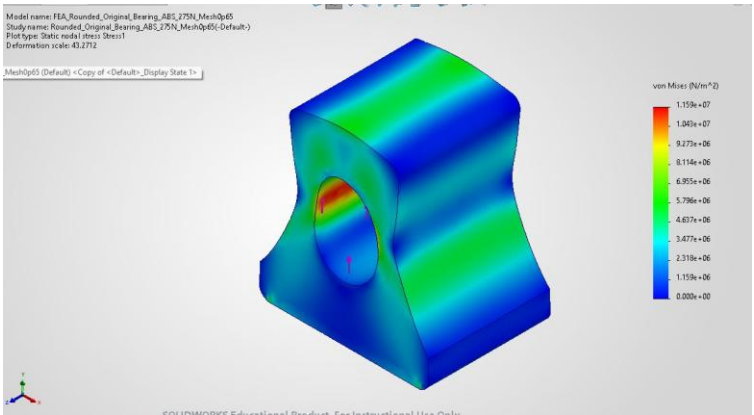
Ideal nose pressure: $19 \text{ N} / 9.931 \times 10^{-4} \text{ m}^2 = 19.1 \text{ kPa}$ (2.77 psi).

System constraint

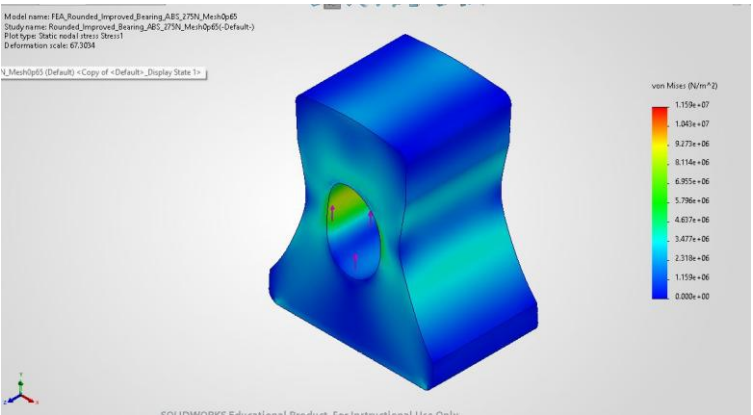
Pressure uses the exposed nose area. A sealed avionics bay needs a verified gas route to the recovery cavity; bypass losses require an ejection test.

Recovery Eyelet: Geometry and Structural Comparison

Original-style eyelet



Wider rounded profile



Applied load and fixed-root reaction

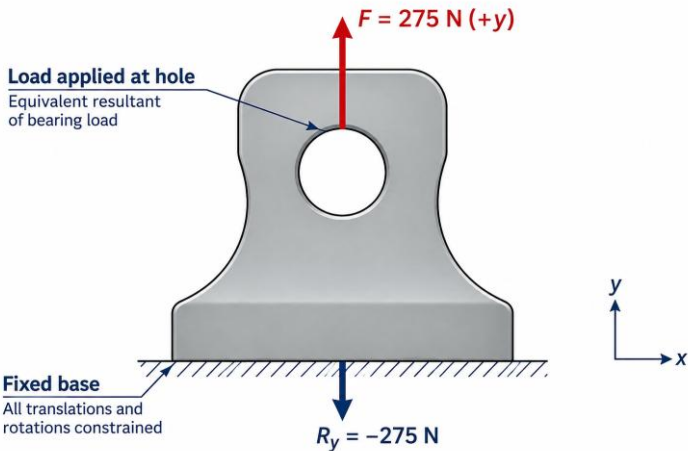
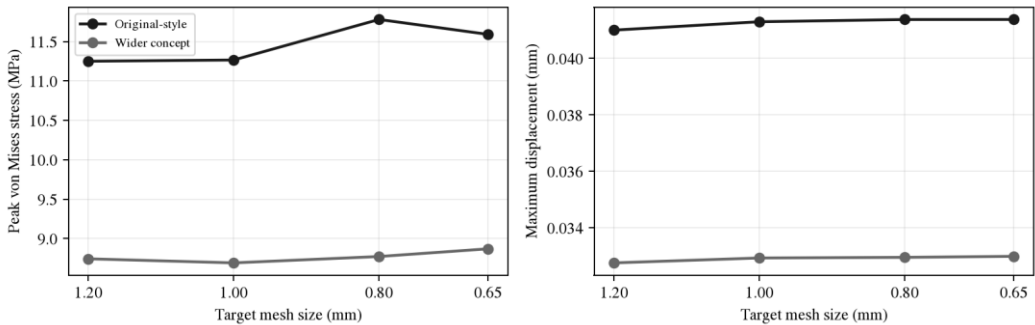


Figure 3. Common 0–11.591 MPa stress scale; saved SolidWorks results at 0.65 mm mesh target.

Figure 4. Equivalent 275 N hole load and root restraint.

Mesh refinement, both geometries



Four 275 N mesh sizes. From 0.80 to 0.65 mm: peak stress changed about 1.6%; displacement <0.2%.

Key findings and design lessons

- Peak stress: 11.591 to 8.869 MPa (23.5% lower)
- Displacement: 0.04138 to 0.03299 mm (20.3% lower)
- Wider, smoother profile reduced modeled peak stress.
- Recovery, structure and packaging change together.
- Printed PLA, pin contact and ejection need physical tests.

FEA comparison uses an idealized fixed root and assumed load.