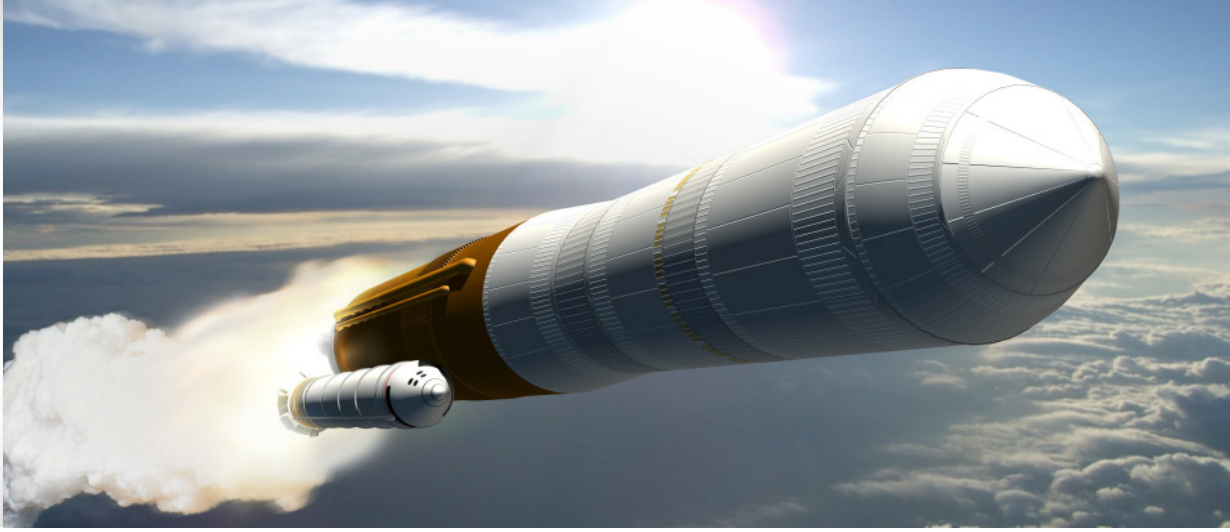
HyperSizer®

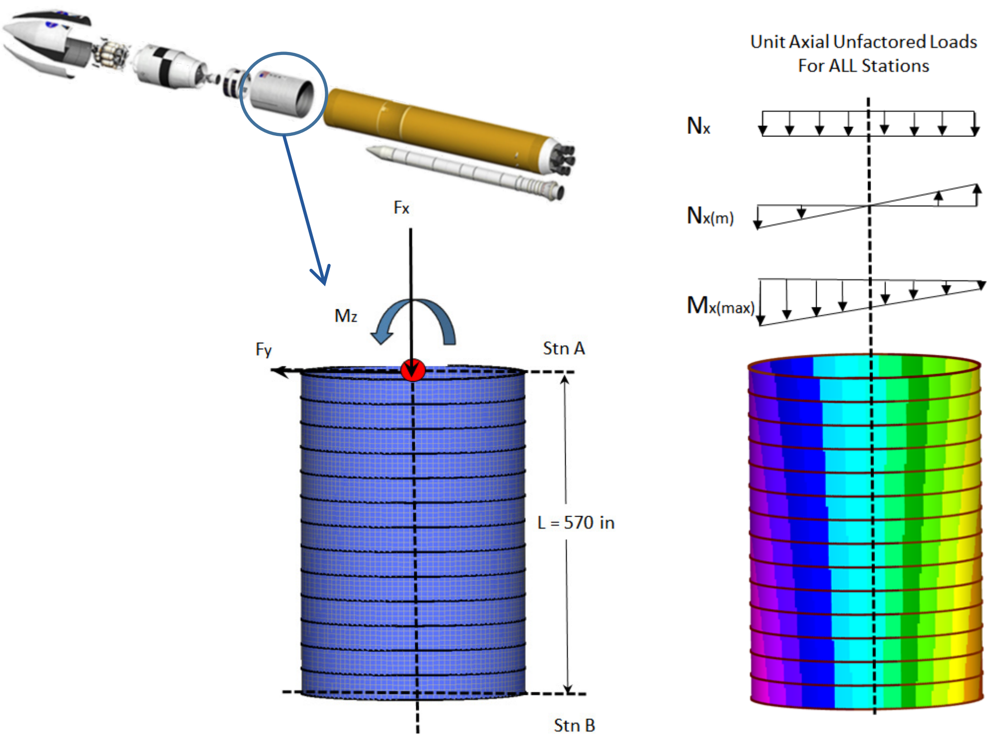
DESIGN | ANALYZE | OPTIMIZE



NASA Ares V Core Interstage

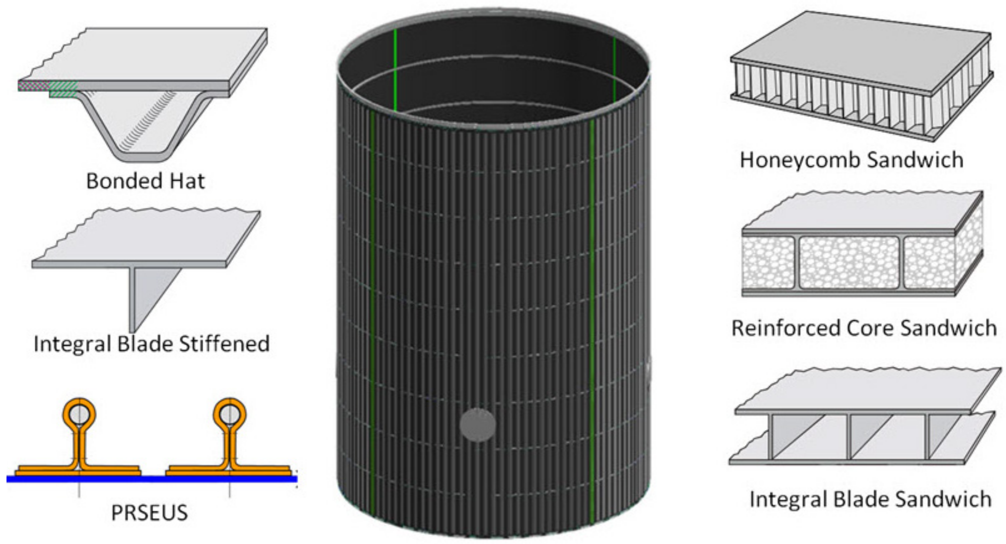
The Project

The Ares V Interstage is a 33 foot diameter, 48 foot tall cylindrical barrel that is axially compressed but must also withstand crushing and internal pressure causing compressive and tension hoop panel loads.



As for all launch vehicles, it is essential that it be designed to minimum weight. To establish minimum weight, trade studies were performed with HyperSizer to determine weight trends and the most efficient combination of architectural design, panel concept, cross sectional dimensions, material system, and layup sequence. Many panel concepts were considered and each concept was optimized to find the lightest weight panel designs based on ring frame spacing.

From the sandwich panel family, weights were reported for honeycomb sandwich, reinforced core sandwich, and integral blade sandwich. From the stiffened panel family bonded hat stiffened, integral blade stiffened, and Boeing's PRSEUS (Pultruded Rod Stitched Efficient Unitized Structure) stiffened panels were analyzed using HyperSizer.



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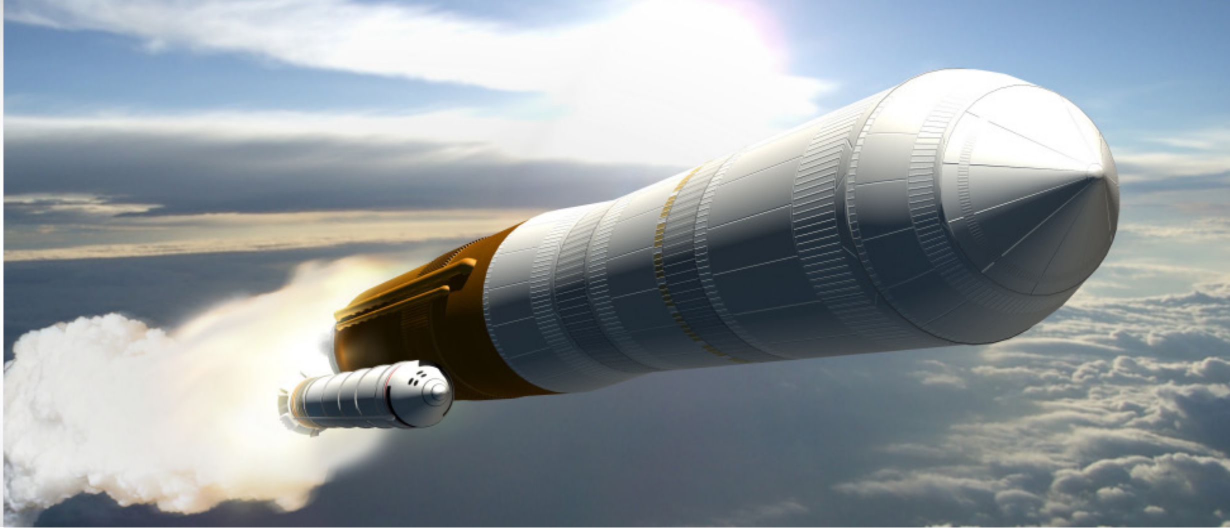
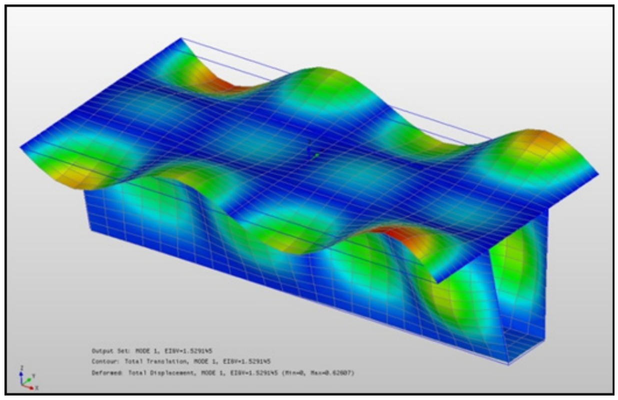
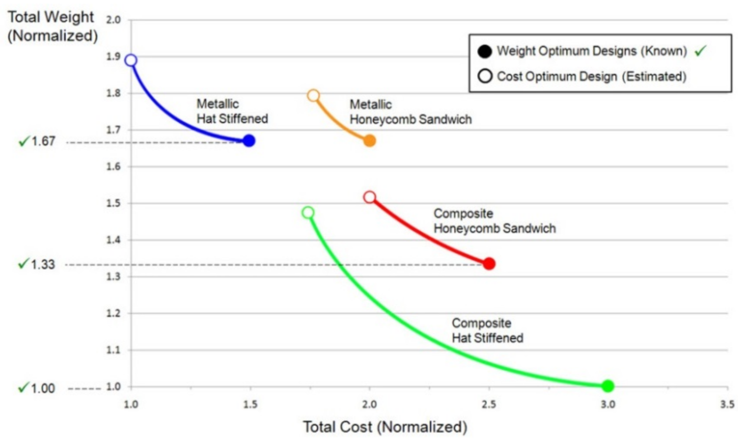


Postbuckling of Stiffened Panels



Weight savings is possible if stiffened panels are allowed to postbuckle. HyperSizer optimizations and analyses were performed for the hat panel, allowing the skin to initially buckle at limit load. The skin between the stiffeners (open span) buckles, and then the web may or may not buckle depending on the current design, but in either case, the additional load is accumulated in the corners of the cross section in the laminates effective widths.

Cost Reduction



Affordability is currently an important concern for NASA's heavy lift launch vehicles. With this in mind, a weight to cost metric was established. A metallic skin stringer design fabricated using friction stir welding (FSW) of the hat shaped stiffener onto the skin is relatively inexpensive. Any cross-sectional shape of aluminum can be extruded at a very low cost.

Ring Frame Optimization

All ring frames are sized to a required EI stiffness to prevent global buckling, material strength, local buckling of each beam object, and crippling.

Available Failure Analyses

Limit MS	Ultimate MS	γ	LS	Location - Analysis Description
0.001154 (0)			1	**C** Stiffness Requirement, Bending
	0.04588 (0)		4	**Web** Local Buckling, Longitudinal Direction
	1.458 (0)		4	**Flange Top, one sided** Local Buckling, Longitudinal Direction
	2.155 (0)		3	**Flange Top, one sided** Composite Strength, Max Strain 1 Direction
	2.155 (0)		3	**Flange Bottom, one sided** Composite Strength, Max Strain 1 Direction
	2.155 (0)		3	**Web** Composite Strength, Max Strain 1 Direction
	3.029 (0)		4	**Flange Bottom, one sided** Local Buckling, Longitudinal Direction
	3.691 (0)		4	**C** Crippling, Composite, method Mil-Hdbk-17-3E including Dij
	6.314 (0)		3	**Flange Top, one sided** Composite Strength, Max Strain 2 Direction
	6.314 (0)		3	**Flange Bottom, one sided** Composite Strength, Max Strain 2 Direction
	6.314 (0)		3	**Web** Composite Strength, Max Strain 2 Direction

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