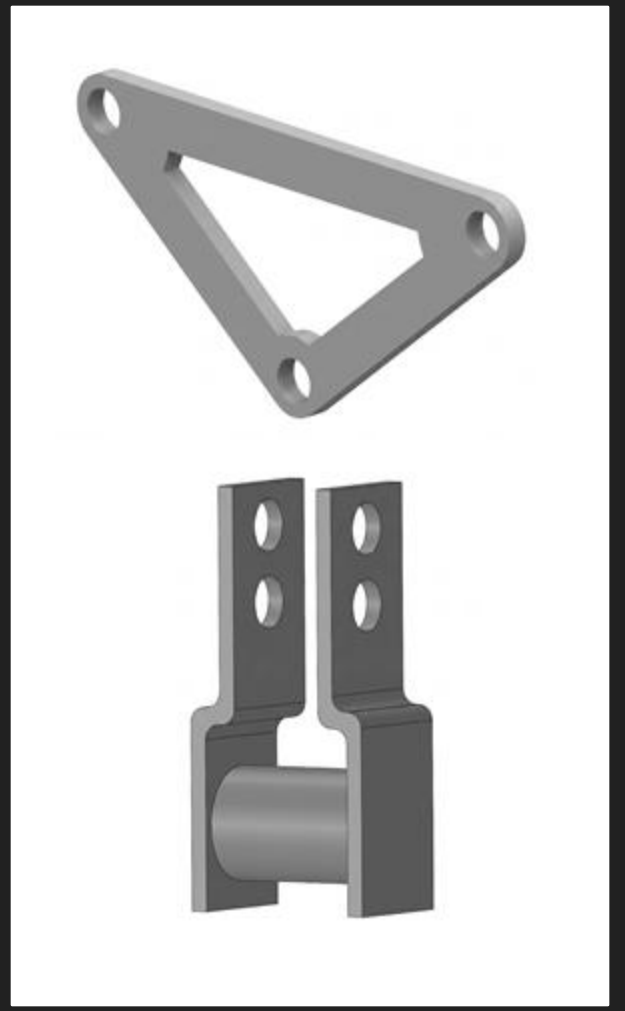
Car 5 Body Latch System

Mechanical Design Review

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Outline

1. Abstract
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3. Dual Rotary Latch
4. Operation
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14. Connections
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Sections 9 to 16 are completed from the Ansys study

Abstract

Location

Along the seam between the top body (solar collector shell) and the bottom body. Each latch sits on the top edge of a bottom body bulkhead. Each striker hangs from the matching top body rib.

Purpose

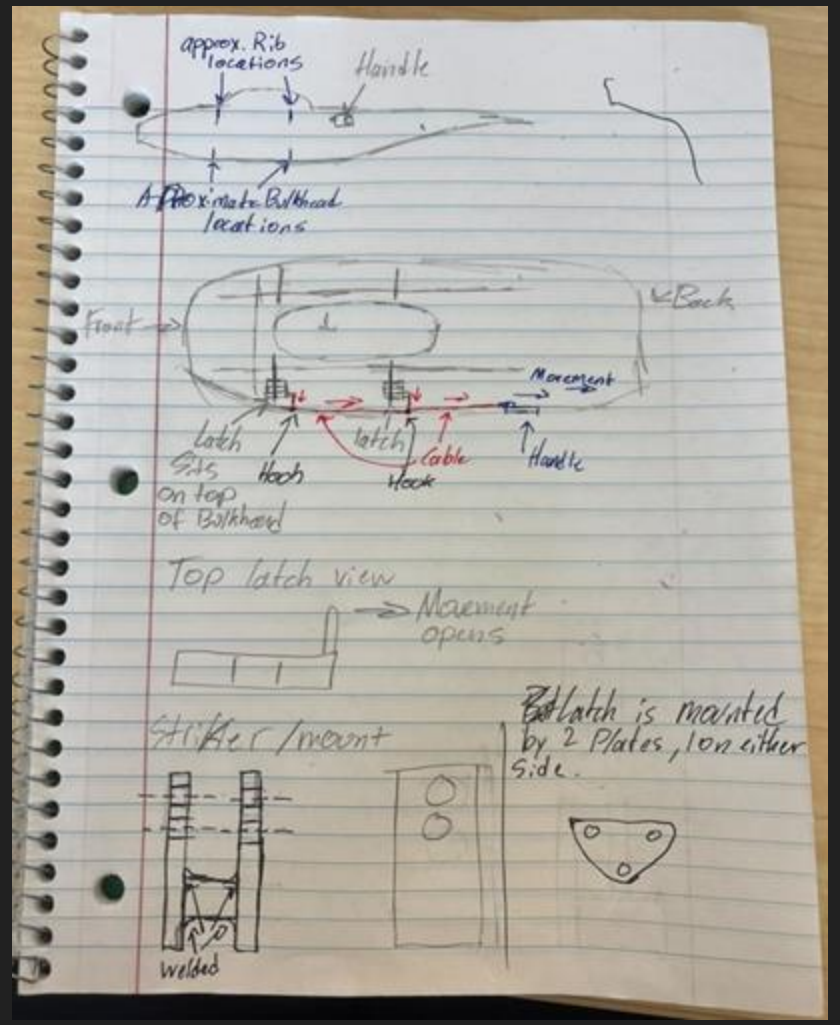
Positively hold the top body closed while driving and release both latches at once from one exterior flush latch at the front or rear of the car, operated by one person.

Restrictions

ASC 2026 Rev C Regs 10.1, 10.1.C, 10.4, and 9.8.B if the top body is the egress path. Loads go into composite sandwich panels.

Improves on

Car 4 double rotary latches at the wheel wells, which need two people reaching through the wheel wells to open.



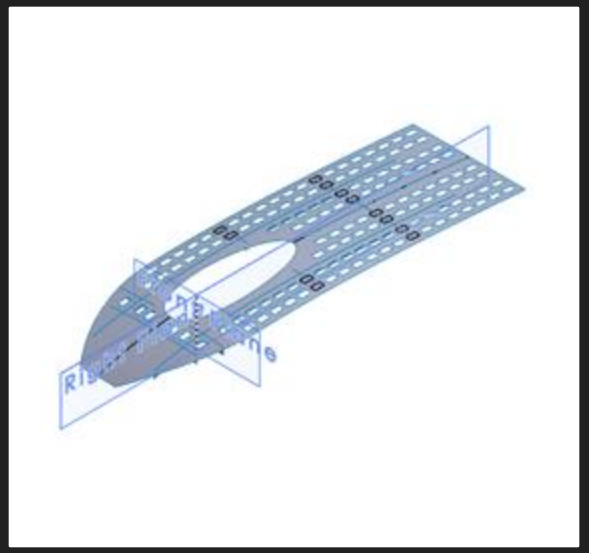
Concept sketch, M. Sabag and J. Bethke

System Overview



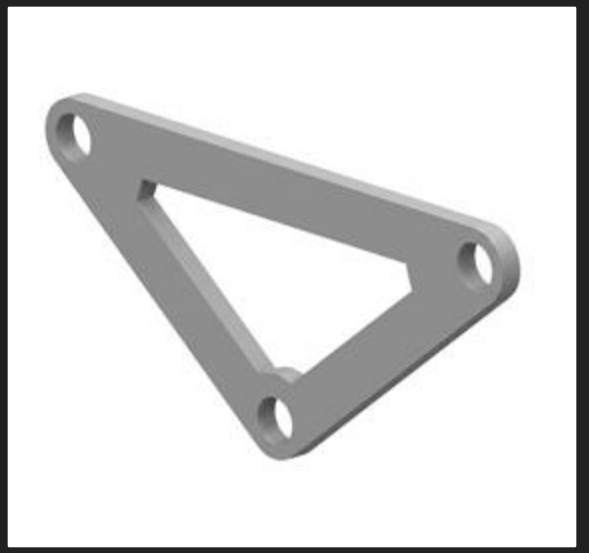
Bottom body

Carries the bulkheads. Latches mount to the bulkhead top edges.



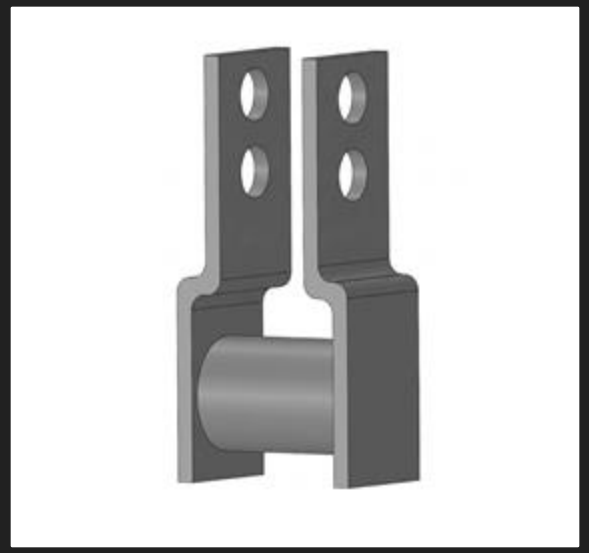
Top body

Solar collector shell. Ribs carry the striker brackets.



Bulkhead attachment

Triangular plate, two per latch, one each side. Two holes to the latch, one through hole into the bulkhead panel.



Bent rib attachment

Striker mount. Bent bracket with two through holes into the rib. Carries the striker pin.

Load path

Top body rib ▶ Bent rib attachment ▶ Rotary latch ▶ Attachment plates ▶ Bulkhead

Dual Rotary Latch OTS Component



Rotary Latch

TriMark two rotor rotary latch, the off the shelf mechanism securing the top aeroshell to the bottom body. One latch mounts to each bottom body bulkhead through a pair of triangular brackets and captures a striker pin on the matching top body rib. Both latches release simultaneously through a stainless wire rope run to a single exterior flush handle.

Operation

1

Close

Top body lowers. Each striker pin enters its rotary latch and the two rotors close around the pin.

2

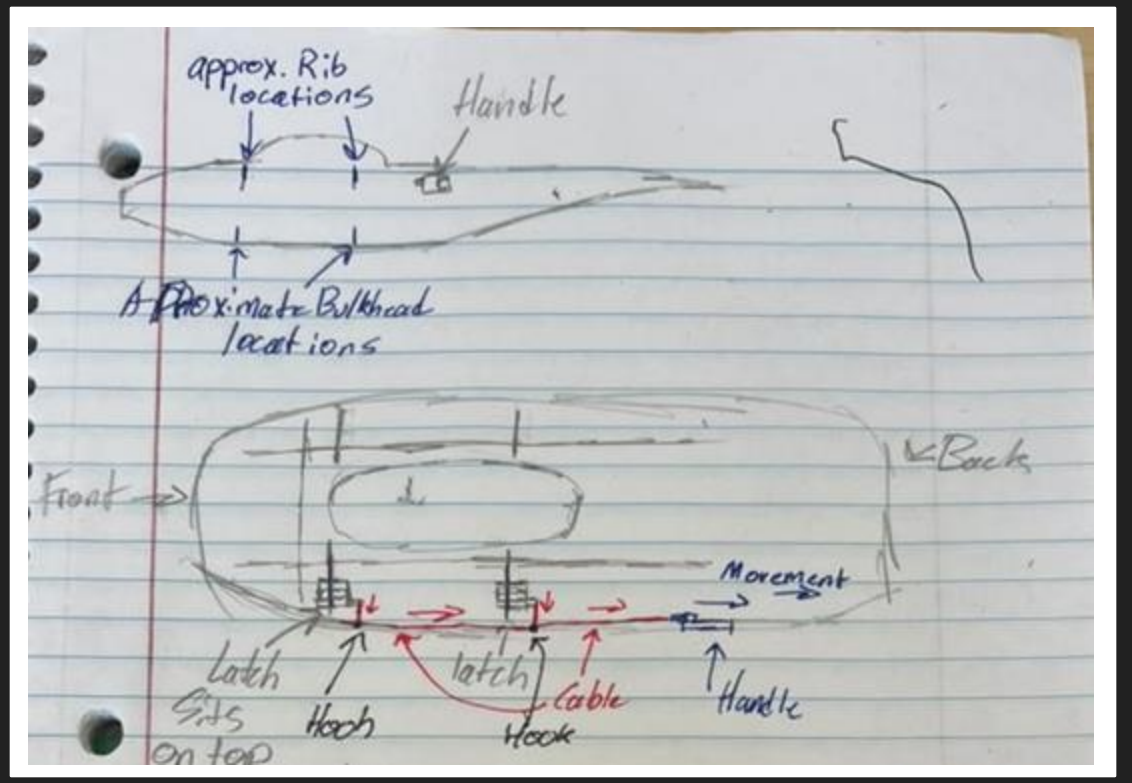
Drive

Latches hold the strikers. Lift and bump loads pass from the rib, through the latch, into the bulkhead, and vice versa.

3

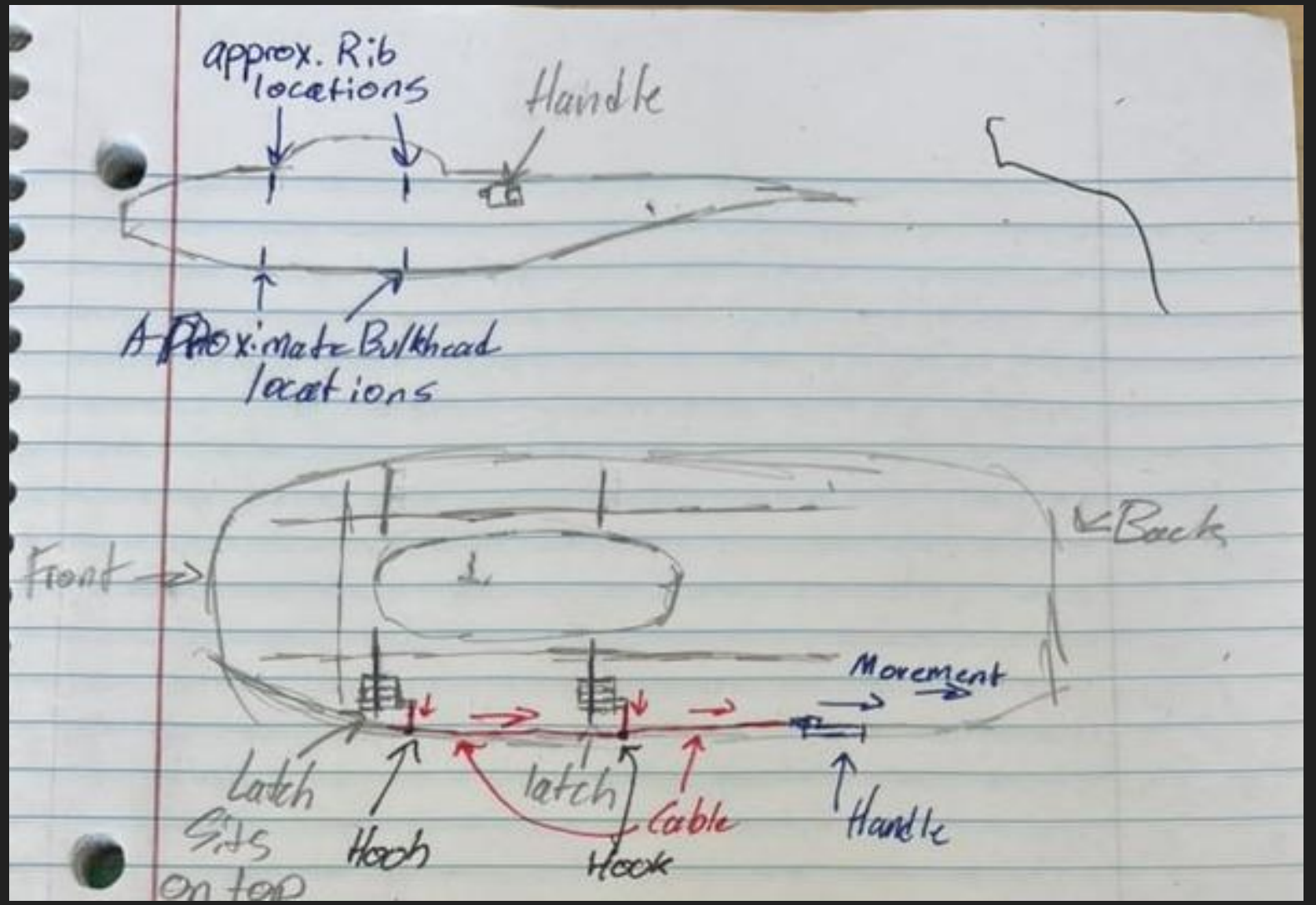
Open

Pulling the exterior flush latch at the front or rear tensions a stainless wire rope to each rotary latch. Each wire loops around a hook beside its bracket, so both latches release at the same time.



Side and plan views from the concept sketch. Red arrows show wire travel toward the release. Flush latch goes at the front or rear of the car.

System Closeup



Regulations

Reg 10.1, ASC 2026 Rev C
"All moving or removable body panels and the solar collector must be securely fastened to prevent unintended movement."

Reg 10.1.C, ASC 2026 Rev C
"Teams shall provide two independent and different means of securing the solar collector (top shell of the car) to the chassis." If lanyards are used, lanyards and hardpoints hold 900 N, allow no more than 600 mm of upward travel, forward hardpoint within 300 mm of the seam front, second hardpoint behind the driver on the opposite side of centerline. Zip ties and tape are not allowed.

Reg 9.8.B.2, 9.8.B.3, 9.8.B.5, ASC 2026 Rev C (applies if the top body is an egress opening)
Egress openings must be secured and released from both inside and outside, must be "positively latched closed," and the external release must be within 300 mm of the edge of the opening.

Reg 10.4 and 10.4.B, ASC 2026 Rev C
Fasteners must suit the application. Structural and critical fasteners need a reusable locking method such as flex loc nuts, castle nuts with cotter pins, or safety wire. Nylon lock nuts, Loctite, and lock washers are not accepted.

Appendix E.3.2, ASC 2026 Rev C
The Mechanical VDR must include an isometric drawing of the body and solar collector and show the egress opening latch design.

Design Trade Offs

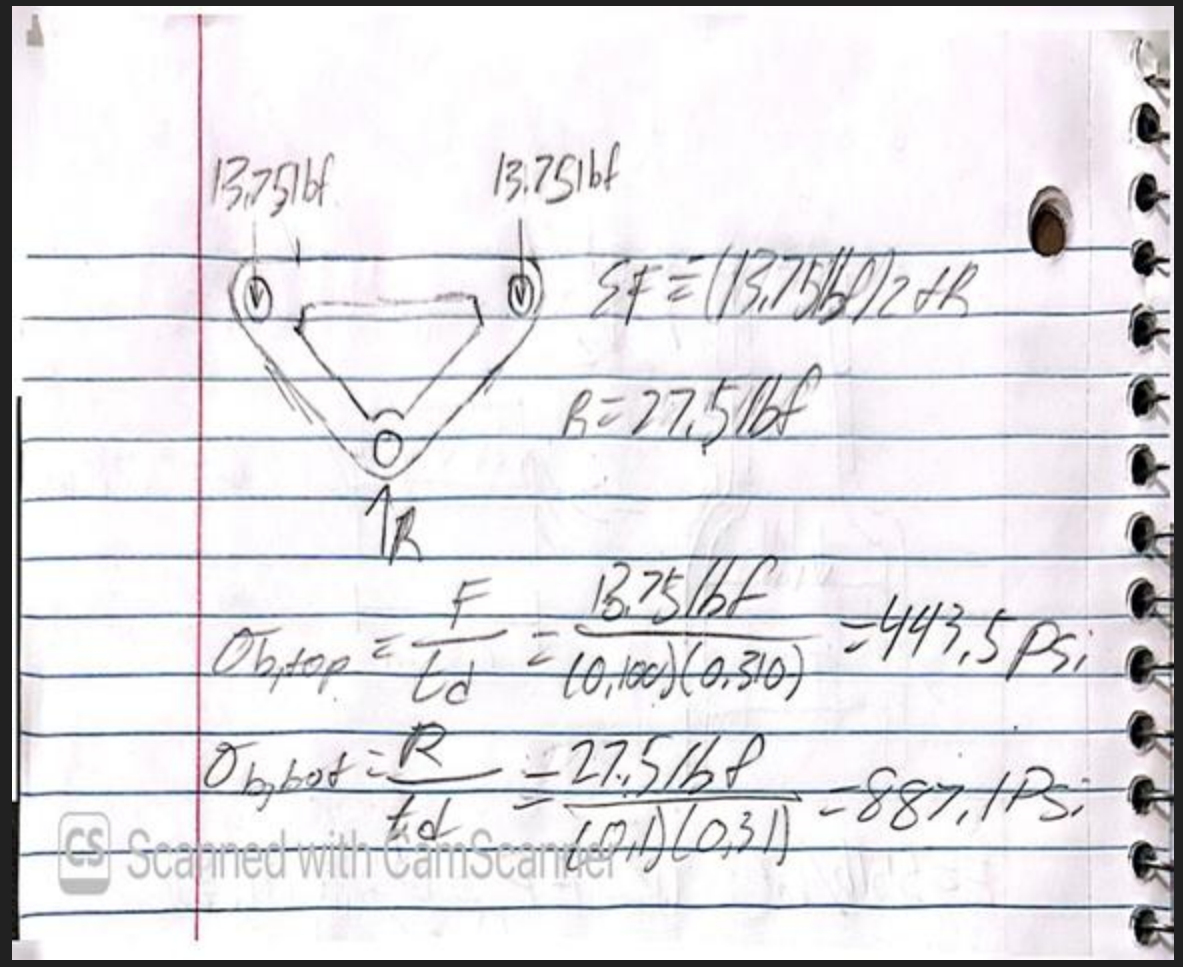
Criteria	A. Car 4 rotary latches at wheel wells	B. Cockpit actuator and lanyard	C. Bulkhead rotary latches, flush latch release (selected)
People to open	Two	One, from inside	One, from outside
Access	Reach through wheel wells	Cockpit only	One flush latch, front or rear
Load path	Inner body walls	Same as A	Bulkheads and ribs
Checkpoint repair	OTS parts	OTS parts, never implemented on Car 4	OTS TriMark latches, spare on hand
Reg exposure	Same latch used twice for 10.1.C	External release needed for 9.8.B.2	Requires use of lanyards as second method

Decision and justification

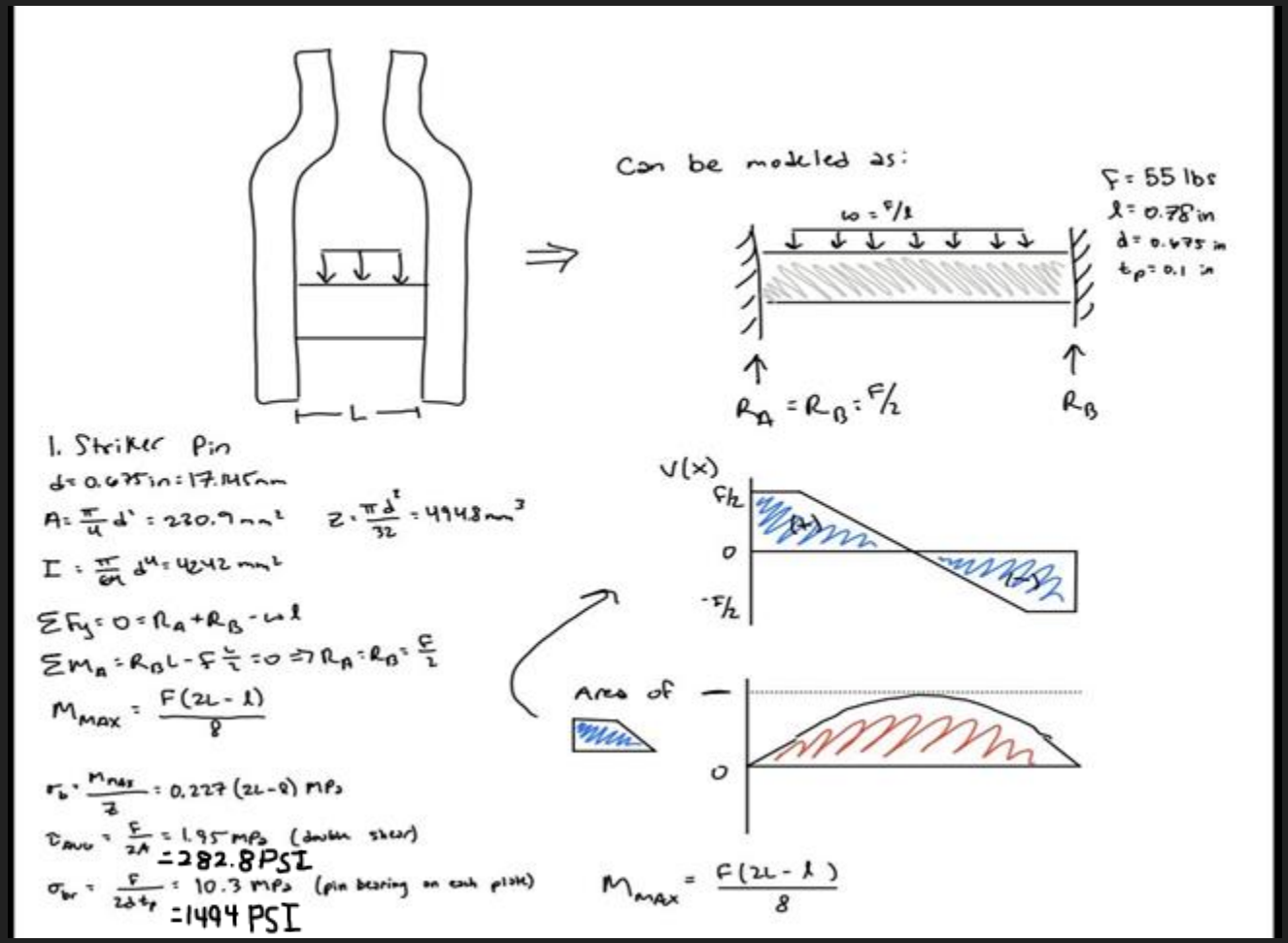
Option C puts creates the most seamless and intuitive solution while complying with regulations. It focuses on intuitive ease of use while maintaining a clean footprint and not taking too much space.

FBD and Analytical Justification

Bulkhead Attachment



Rib Attachment



Methodology

1

Methods

Static structural analysis was performed across several loading cases.

2

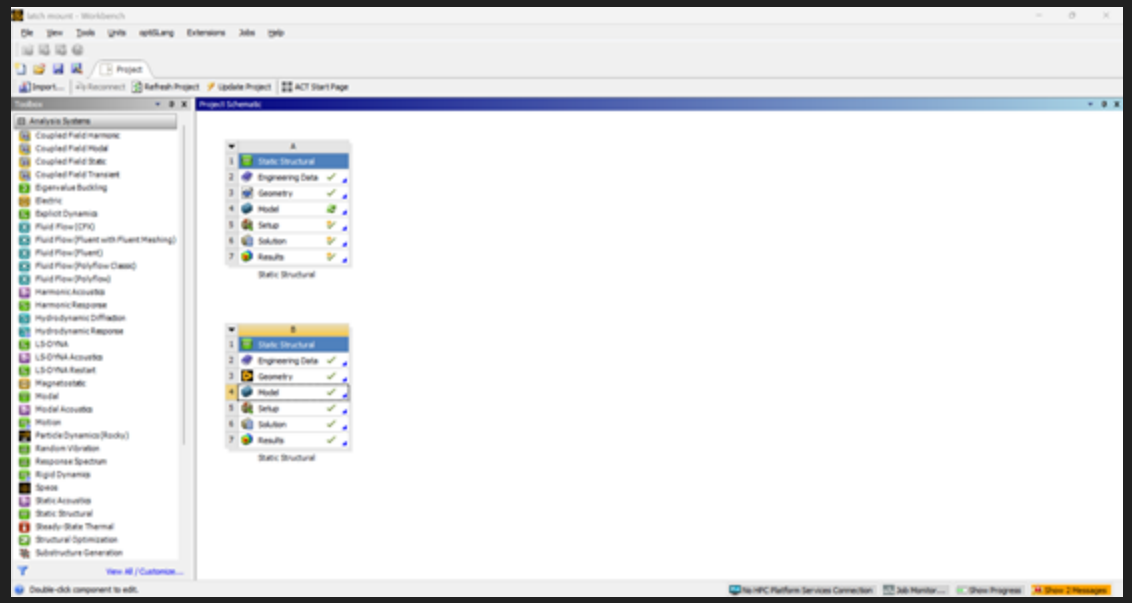
Goal

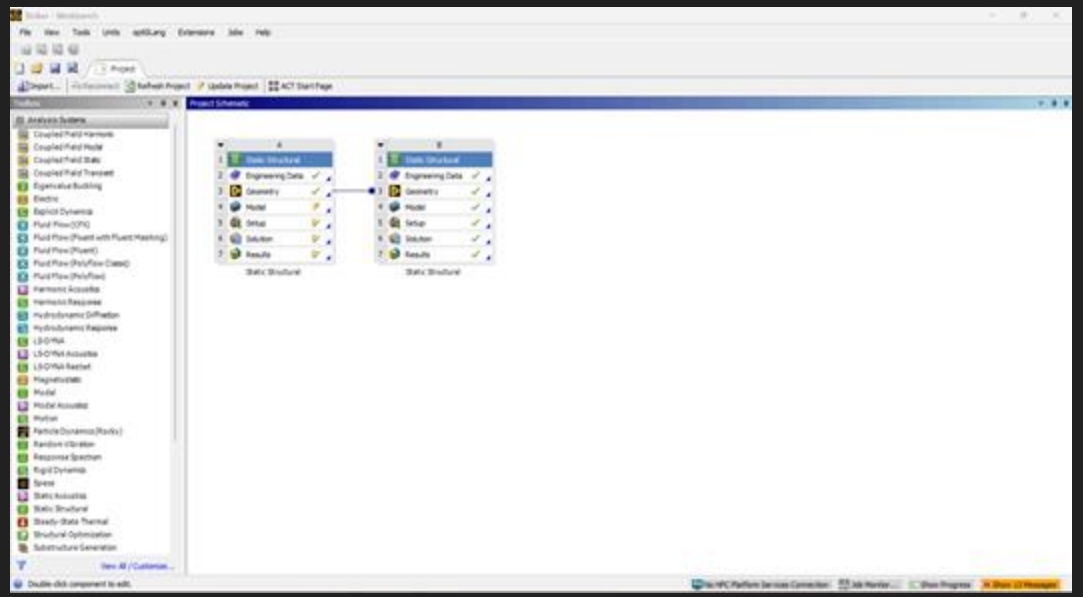
Estimate the maximum equivalent stress and calculate the factor of safety for each part. Identify locations of high stress concentration for concern of failure.

3

Approach

Prioritize increasing element quality to an acceptable number (above 0.5), and reducing low element quality especially around high stress areas.





Assumptions

#	Assumption	Effect if wrong
A1	Load splits evenly between the two latches and the two hinges	One latch sees more than F_s
A2	The entire load of the top body on the bottom body is negligible	The latches and hinges experience less force.
A3	Loads are quasi static. No fatigue or slam loads	Fatigue at bend and pin not covered
A4	Sandwich panels act as rigid supports in FEA	Panel crush and insert pull out checked separately
A5	Material properties do not change with environmental conditions	May skew stress and deformation data.
A6	Latch release force will not introduce significant stress	May introduce stress concentrations or fatigue.
A7	Cylindrical supports are assumed to fix all three DOF	Latch support may rotate.
A8	Supports are not subjected to forces due to lateral movement	May introduce stress concentrations or fatigue.

Geometry

Part	Qty	Envelope (in^3)	Mass Per Unit (lb)	Density (lb/in^3)	Material
Bulkhead attachment plate	4	2.301	0.04	0.0975	Aluminum 6061-T6
Bent rib attachment	2	0.656	0.21	0.28	Steel 1020 (CR)
Rotary latch, TriMark TM 11645-16 LH	2	6.919	0.8	Not listed	Steel, zinc plated
Flush handle, Cables, and Accessories	1	N/A	1.2	N/A	Misc.
Total assembly	N/A	≈10	3.38	N/A	Misc.

Material Properties

Properties of Outline Row 3: Structural Steel

	A	B	C	D	E
1	Property	Value	Unit		
2	Material Field Variables	Table			
3	Density	0.2836	lb in^-3		
4	Isotropic Secant Coefficient of Thermal Expansion				
5	Coefficient of Thermal Expansion	1.2E-05	C^-1		
6	Isotropic Elasticity				
7	Derive from	Young's Modulus a...			
8	Young's Modulus	2.9008E+07	psi		
9	Poisson's Ratio	0.3			
10	Bulk Modulus	1.6667E+11	Pa		
11	Shear Modulus	7.6923E+10	Pa		
12	Strain-Life Parameters				
20	S-N Curve	Tabular			
24	Tensile Yield Strength	36259	psi		
25	Compressive Yield Strength	36259	psi		
26	Tensile Ultimate Strength	66717	psi		
27	Compressive Ultimate Strength	0	psi		

Properties of Outline Row 3: Aluminum Alloy

	A	B	C	D	E
1	Property	Value	Unit		
2	Material Field Variables	Table			
3	Density	0.10007	lb in^-3		
4	Isotropic Secant Coefficient of Thermal Expansion				
5	Coefficient of Thermal Expansion	2.3E-05	C^-1		
6	Isotropic Elasticity				
7	Derive from	Young's Modulus a...			
8	Young's Modulus	1.0298E+07	psi		
9	Poisson's Ratio	0.33			
10	Bulk Modulus	6.9608E+10	Pa		
11	Shear Modulus	2.6692E+10	Pa		
12	S-N Curve	Tabular			
16	Tensile Yield Strength	40611	psi		
17	Compressive Yield Strength	40611	psi		
18	Tensile Ultimate Strength	44962	psi		
19	Compressive Ultimate Strength	0	psi		

Load Cases (Proposed)

Case	Description	Total load on top body	Per latch F_s	Source and status
LC1	Static, top body weight at 1G	W_{top} = 110 lbf	27.5 lbf	Top body weight confirmed as 110 lbf distributed across the entire area. Distributed across 4 supports (2 latches and 2 hinges).
LC2	2G vertical bump	2 W_{top} = 220 lbf	55 lbf	Load factor borrowed from Appendix E.2 suspension case. Used to approximate maximum compression force.
LC3	Proof load	202 lbf	50.5 lbf	Reg 10.1.C lanyard hardpoint value used as a conservative bound.

Why these cases

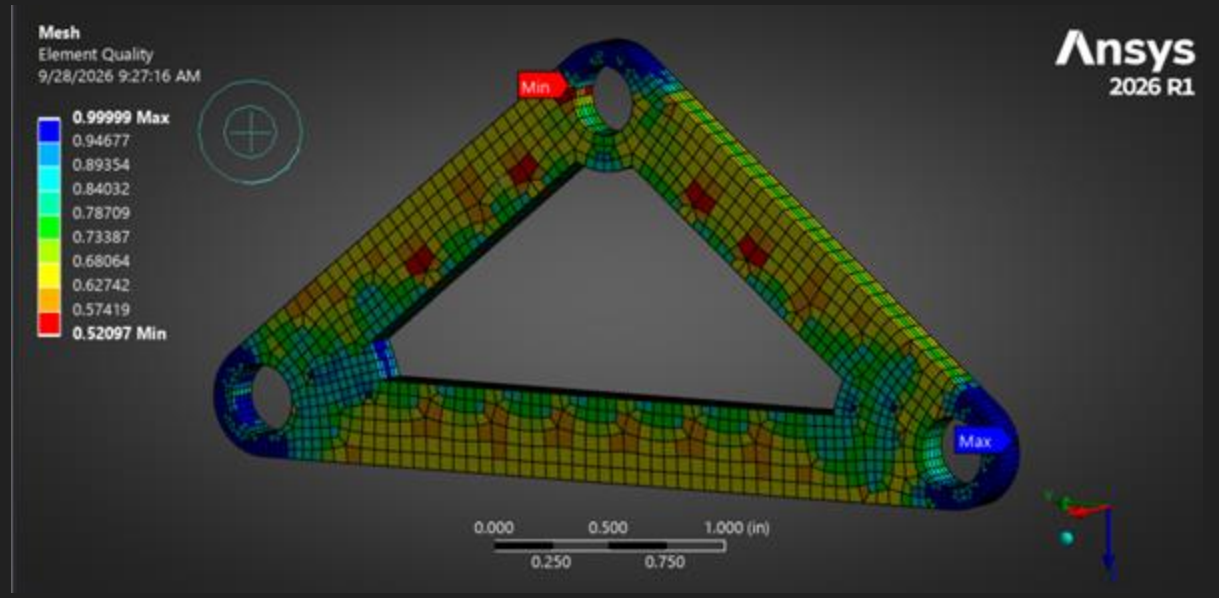
The regulations give no load for body latches. These cases bound what the latch actually sees on the road and give Ansys a defined input. Even load shared between latches is an assumption, since the hinge side also reacts load.

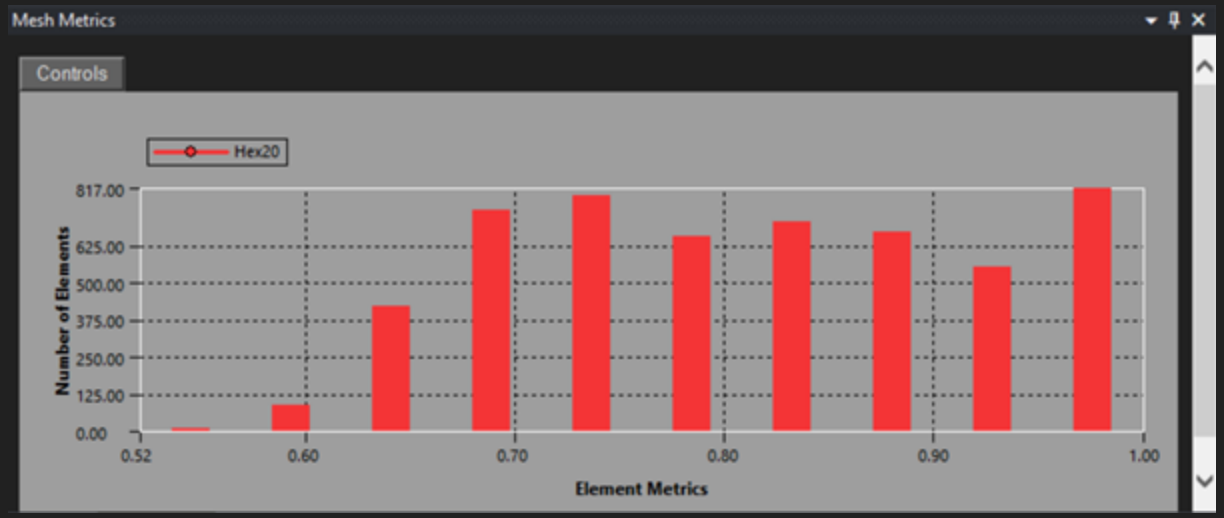
Bulkhead Support Mesh

Item	Bulkhead attachment
Refinements added	See note below.
Nodes	28358
Elements	5455
Elements through thickness (Y/N)	Yes
Element quality, avg and min	Avg: 0.81, Min: 0.52

Mesh refinement methods:

- Using Multizone, hexa swept type and a hex dominant free mesh type.
- Reducing element size to 0.07 in.
- Increasing the curvature normal angle to 45°.
- Reducing the growth rate to 1.2.



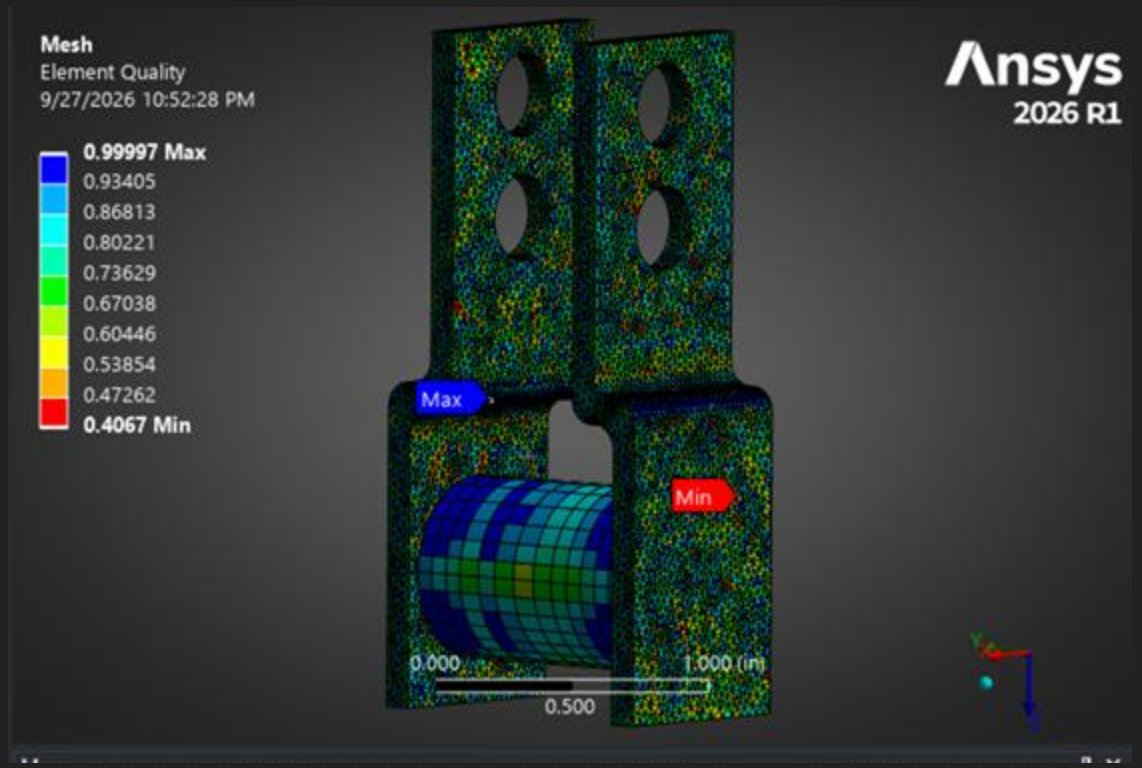


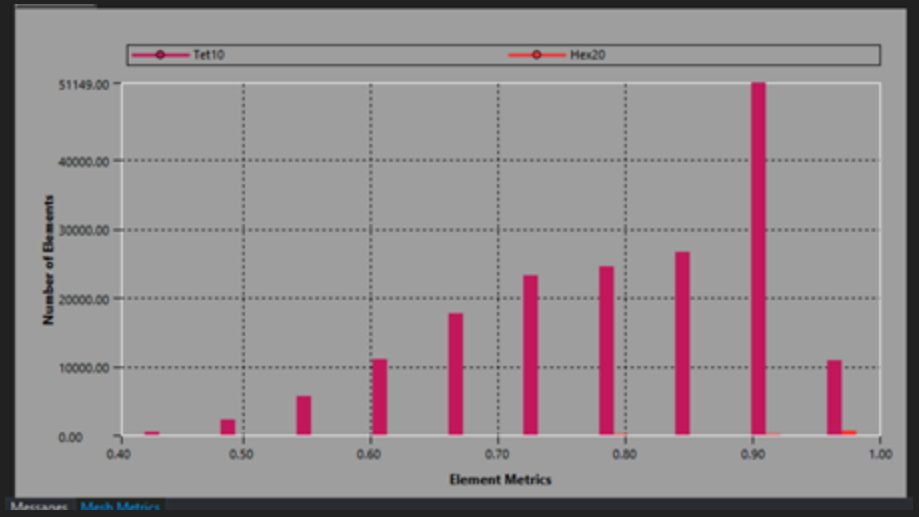
Rib Attachment Mesh

Item	Rib Attachment
Refinements added	See note below.
Nodes	262038
Elements	174730
Elements through thickness (Y/N)	Yes
Element quality, avg and min	0.806, 0.4067

Mesh refinement methods:

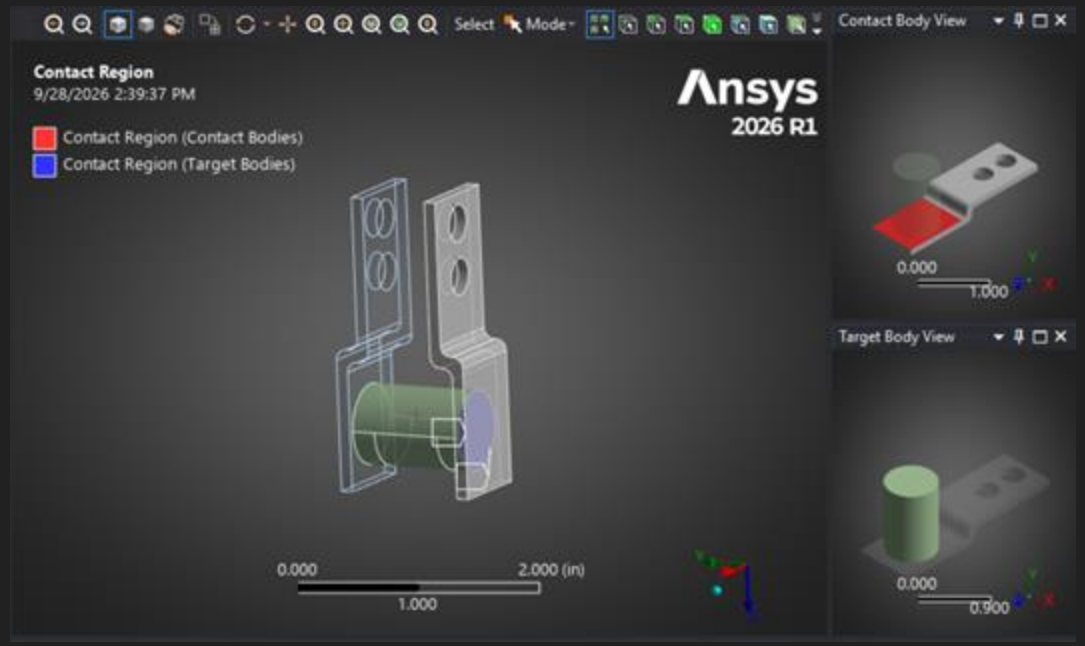
- Reduced the max element size on the side panels to 0.07 in.
- Used a patch independent tetrahedral mesh for the side panels.
- Increased the curvature normal angle to 45°.
- Used a swept mesh method for the cylindrical geometry.
- Merged filleted geometry to reduce boundary inconsistencies.

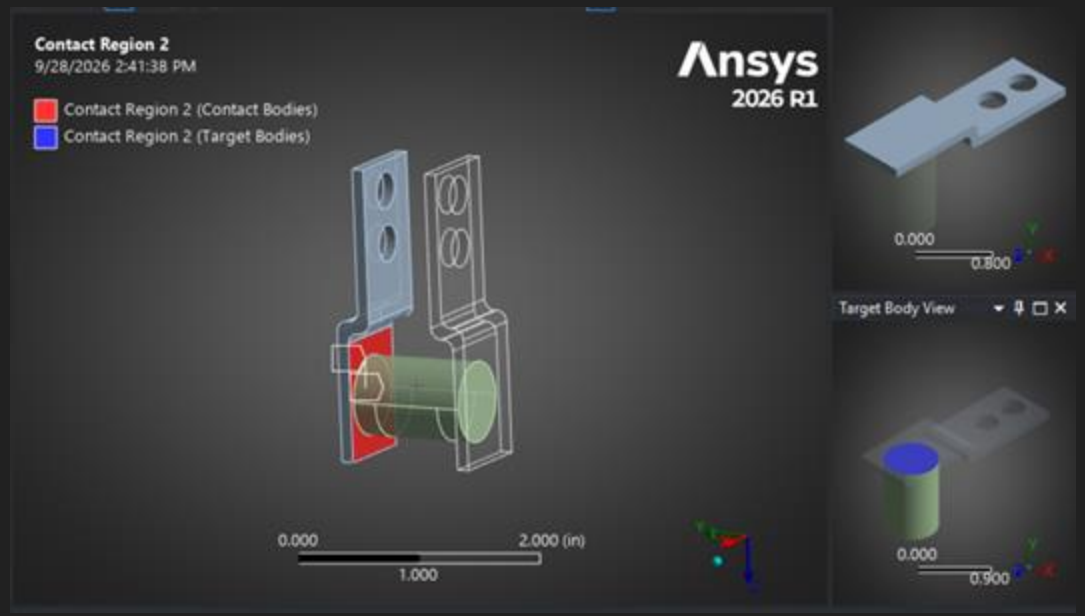




Connections

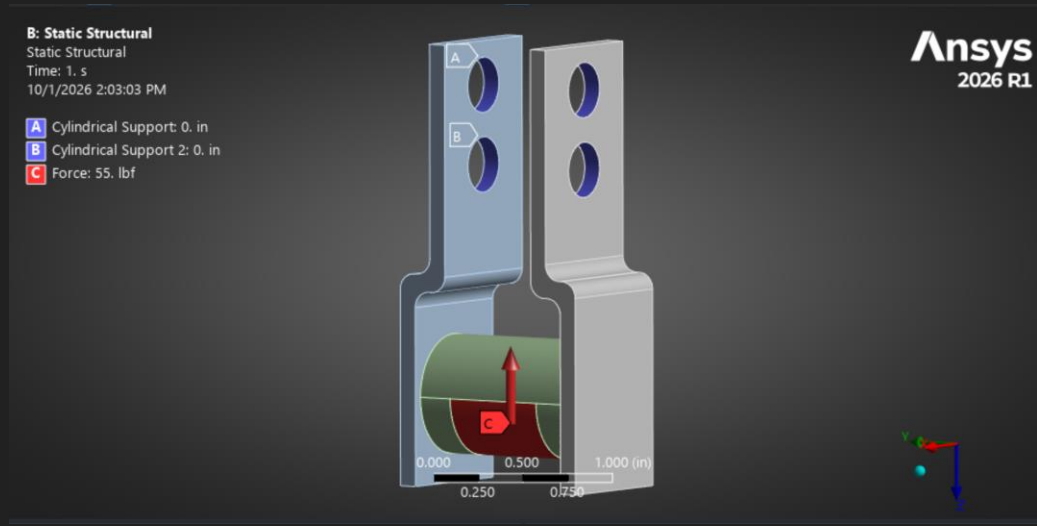
Part	Contact Surface	Target Surface	Type
Rib Attachment	Side body face	Striker face	Bonded
Rib Attachment	Side body face	Striker face	Bonded

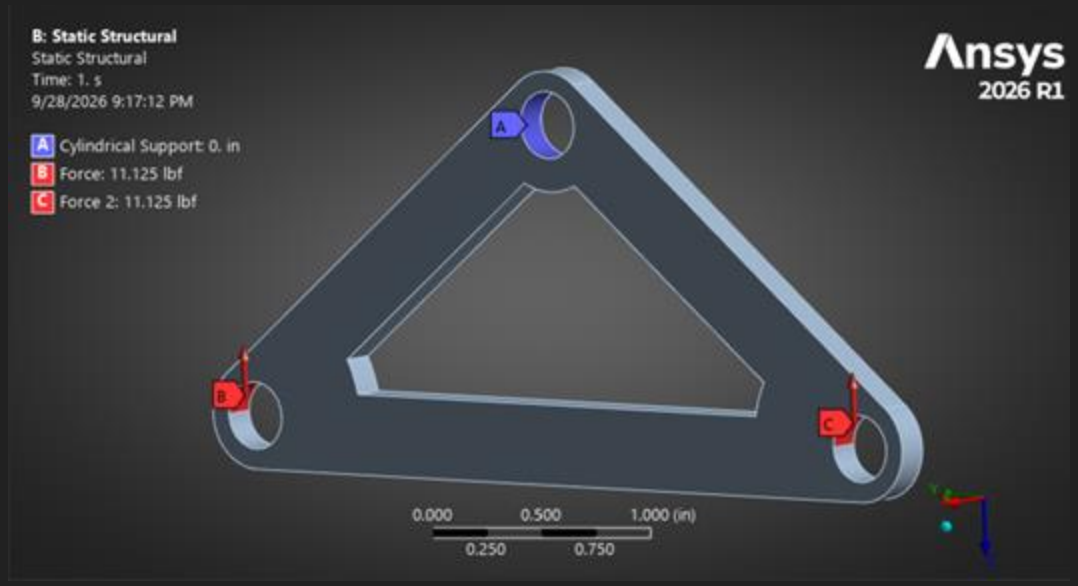




Boundary & Loading Conditions

Item	Part	Applied to	Type	Why
Support	Bulkhead	Support holes	Cylindrical supports	Acts as a bolt support
Supports	Rib	Pair of bolt holes	Cylindrical supports	Acts as bolt supports
Loads	Bulkhead	Pair of loading bolt holes	Force	Distributed across area of hole in compression
Load	Rib	Striker pin	Force	Distributed force across pin area





Checks

- [x] **Mesh goes through the thickness**

  Peak stress is real, not a surface artifact

- [x] **Mass matches SolidWorks**

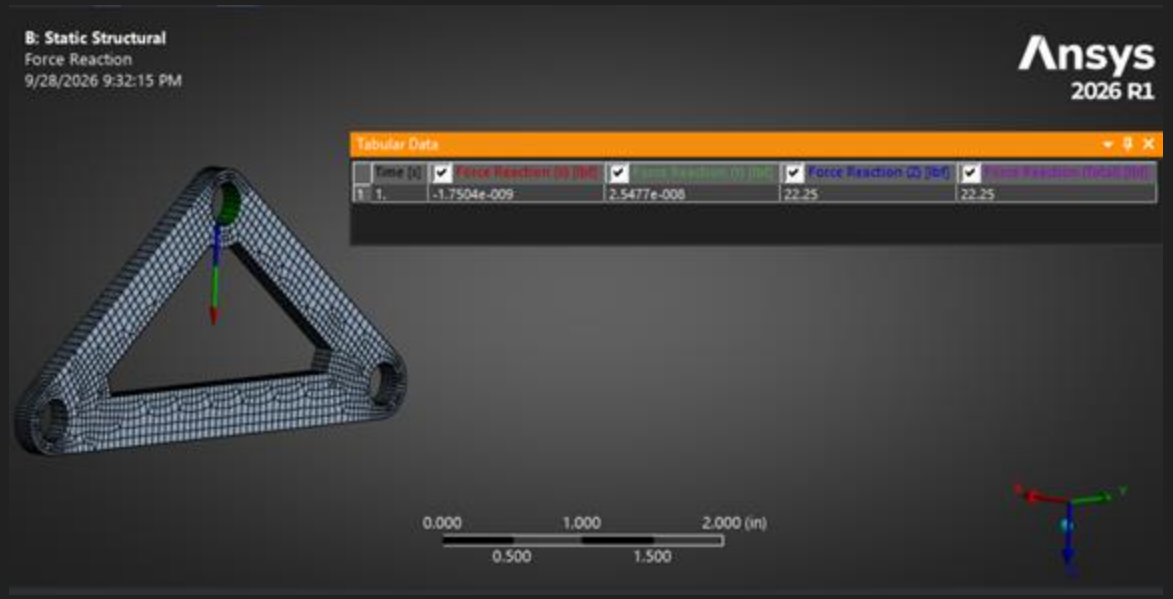
  Ansys mass vs SolidWorks Mass Properties

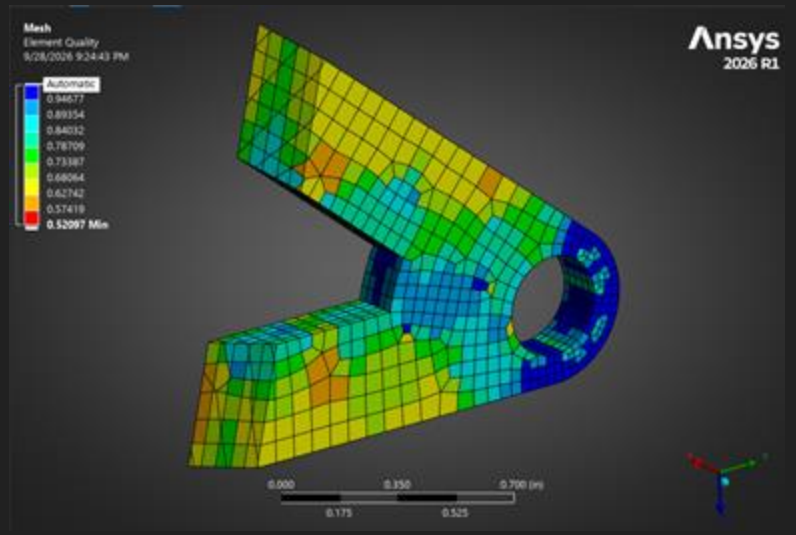
- [x] **Reaction force equals applied load**

  Sum of support reactions vs F_s

- [x] **Hand calc agrees with FEA**

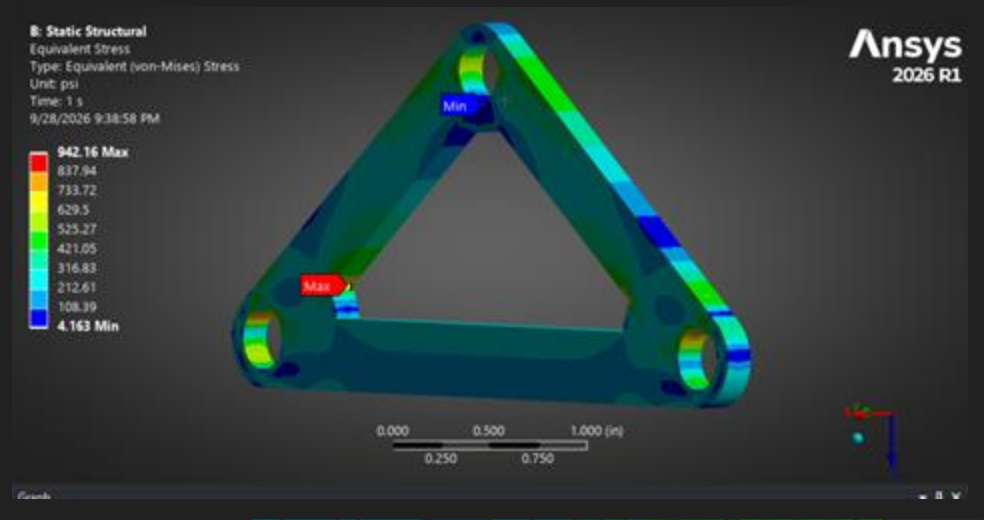
  Bending stress at the bend within [x]%

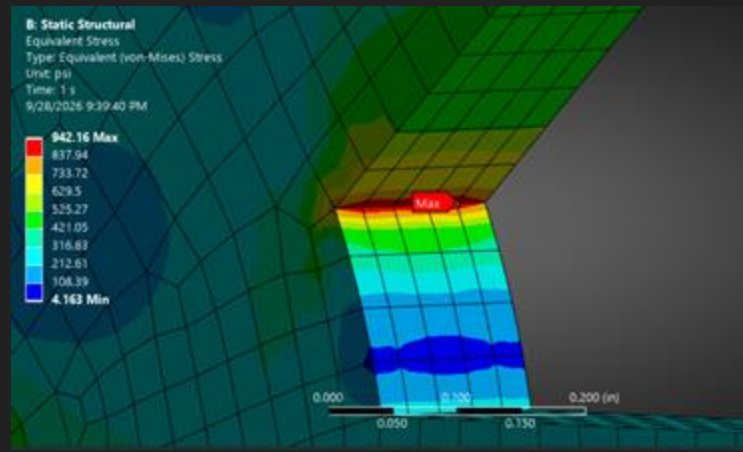


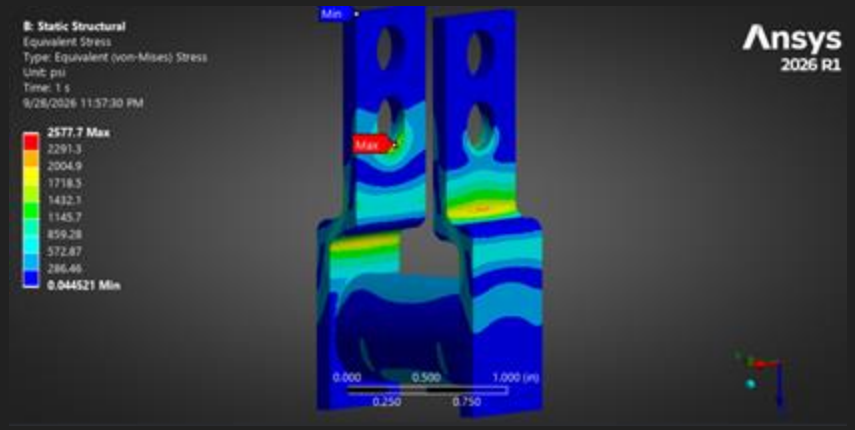


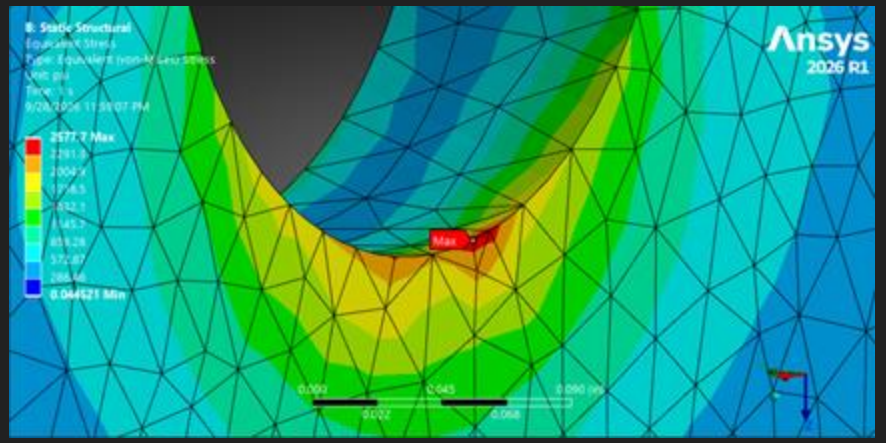
Results

Part	Max von Mises (PSI)	Max deformation (in)	FOS (n_{mss})
Bulkhead Attachment	942.16	0.00016	43
Rib Attachment	2577.7	0.000049	14.07









Suggestions

Experience and Next steps

WOULD'VE DONE DIFFERENTLY

- Settle the egress path and the Reg 10.1.C second securing method before starting CAD
- Choose the latch and get its datasheet first, then design the mounts around it
- Agree on load cases with the lead before starting FEA

NEXT STEPS

- Finalize the bulkhead to rib dimensions, and complete in CAD with assigned materials
- Add a wire rope adjuster and confirm the terminations hold the release pull
- Add bonded inserts to the sandwich panels and pull test them

References

[1] Innovators Educational Foundation, "American Solar Challenge 2026 Regulations," Revision C, May 25, 2026.

[2] Solar Gators, "Mechanical Design Review, Cockpit," University of Florida, September 15, 2025.

[3] A. P. Reichl, "Updates and Design Review Expectations," Solar Gators, University of Florida, September 10, 2026.

[4] Solar Gators, Car 5 CAD models, "Final Topbody" and "Geom1" part files, University of Florida, 2025.

[5] Austin Hardware and Supply, "TriMark TM 11645-16 LH Two Rotor Latch," https://www.austinhardware.com/rotary-2-pt-w-tapped-mtg-holes-9061.html, accessed September 2026.

[6] Unicorn Stainless, "Stainless Cross Wire Clamp, Standard, S0721-0003," https://unicornstainless.com/products/stainless-cross-wire-clamp-standard/, accessed September 2026.

[7] Lowe's, "1/4 in Weldless Galvanized Steel Cable, By the Foot," https://www.lowes.com/pd/Blue-Hawk-1-Ft-1-4-in-Weldless-Galvanized-Steel-Cable-By-the-Foot/1000829994, accessed September 2026.

[8] Ace Hardware, "Koch Industries Zinc Plated Forged Steel Wire Rope Clip, Item 5059470," https://www.acehardware.com/departments/hardware/chain-and-rope/rope-and-chain-accessories/5059470, accessed September 2026.

[9] Amazon, "[Product Name]," https://www.amazon.com/dp/B0F27ZPWLQ, accessed September 2026.

[10] Amazon, "[Product Name]," https://www.amazon.com/dp/B0GJSWLTT4, accessed September 2026.

Questions?