

First Solar Series 7 (FS7) Module Rail

Valmont Solar | University of Colorado Boulder | Design Center Colorado

MISSION & BACKGROUND:

- In collaboration with Valmont Industries, our mission is to design a solar panel mounting bracket that securely attaches to Valmont's existing solar tracking system.
- Our goal is to create a cost-effective, manufacturable, and easy-to-assemble solution that reduces installation time.

REQUIREMENTS:

✓ Integration	Mounting rail must integrate with the FS7 module and rectangular torque tube
✓ Load	Withstand 1050 lbs. at 200mm mounting position and 1450 lbs. at 500mm mounting position
✓ Assembly Speed	Mounting time should be less than 2.4 minutes per module per person
✓ Manufacturability	Simple to produce with a maximum cost of \$4.15 for 200mm and \$7.00 for 500mm rails

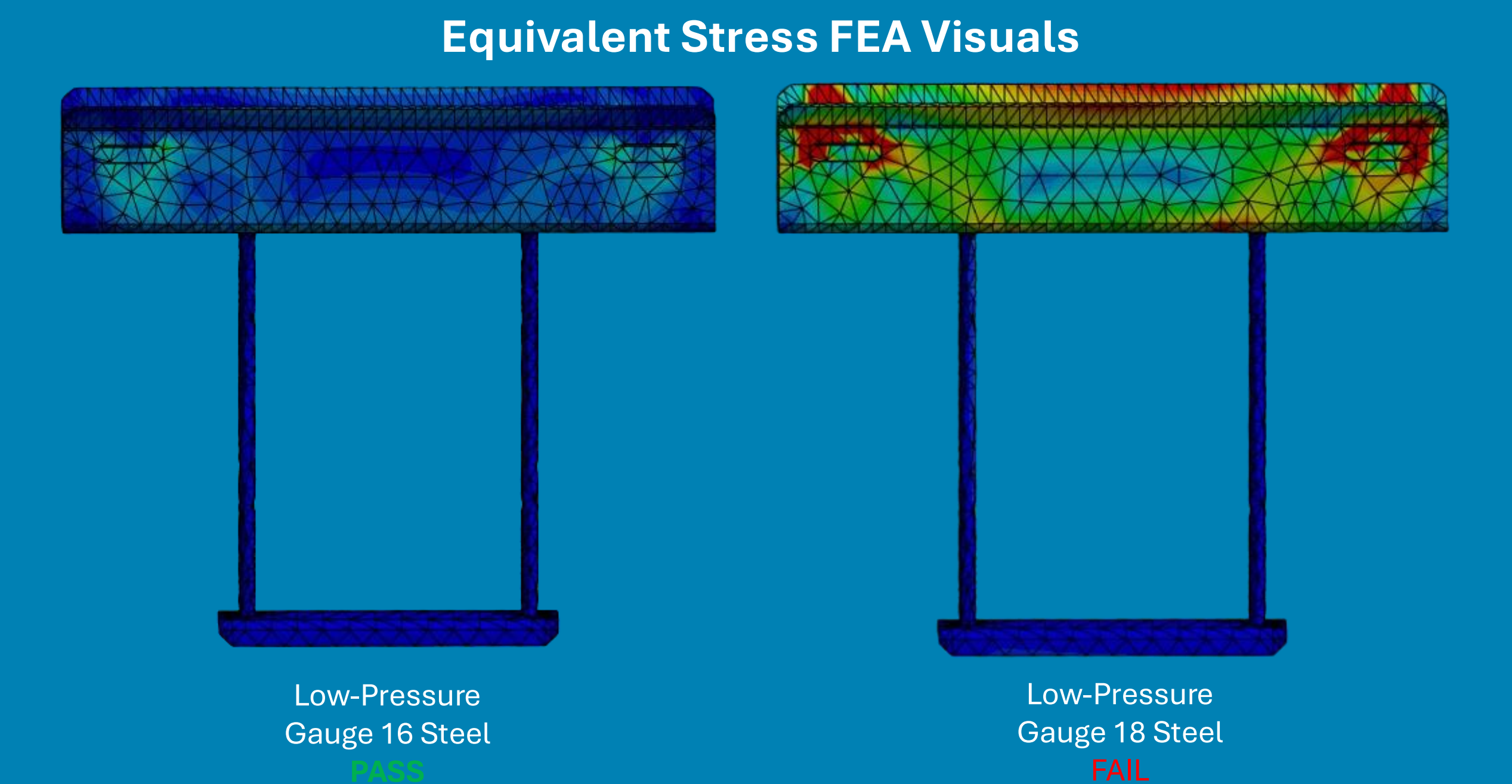
DESIGN PROCESS:

Initial Five Designs	✓ Pros	✗ Cons
Squeeze Clamp	Triangular geometry to minimize material	Difficult to manufacture
Hose Clamp	Minimizes cost with cheap fastener	Lack of structural integrity
U-Bolt & Hook	Simplifies assembly process by decreasing number of parts	
Channel	Optimizes industry standard by improving geometry and thus decreasing cost	

- We performed FEA in SolidWorks and ANSYS to assess the structural performance of both the hook and channel designs under required loads.
- The hook design required increased thickness at the bolt cutouts to avoid failure, which drove costs above acceptable limits.
- Due to high cost and failure risk, the hook design was eliminated, and the channel design was selected for testing.

FEA ANALYSIS:

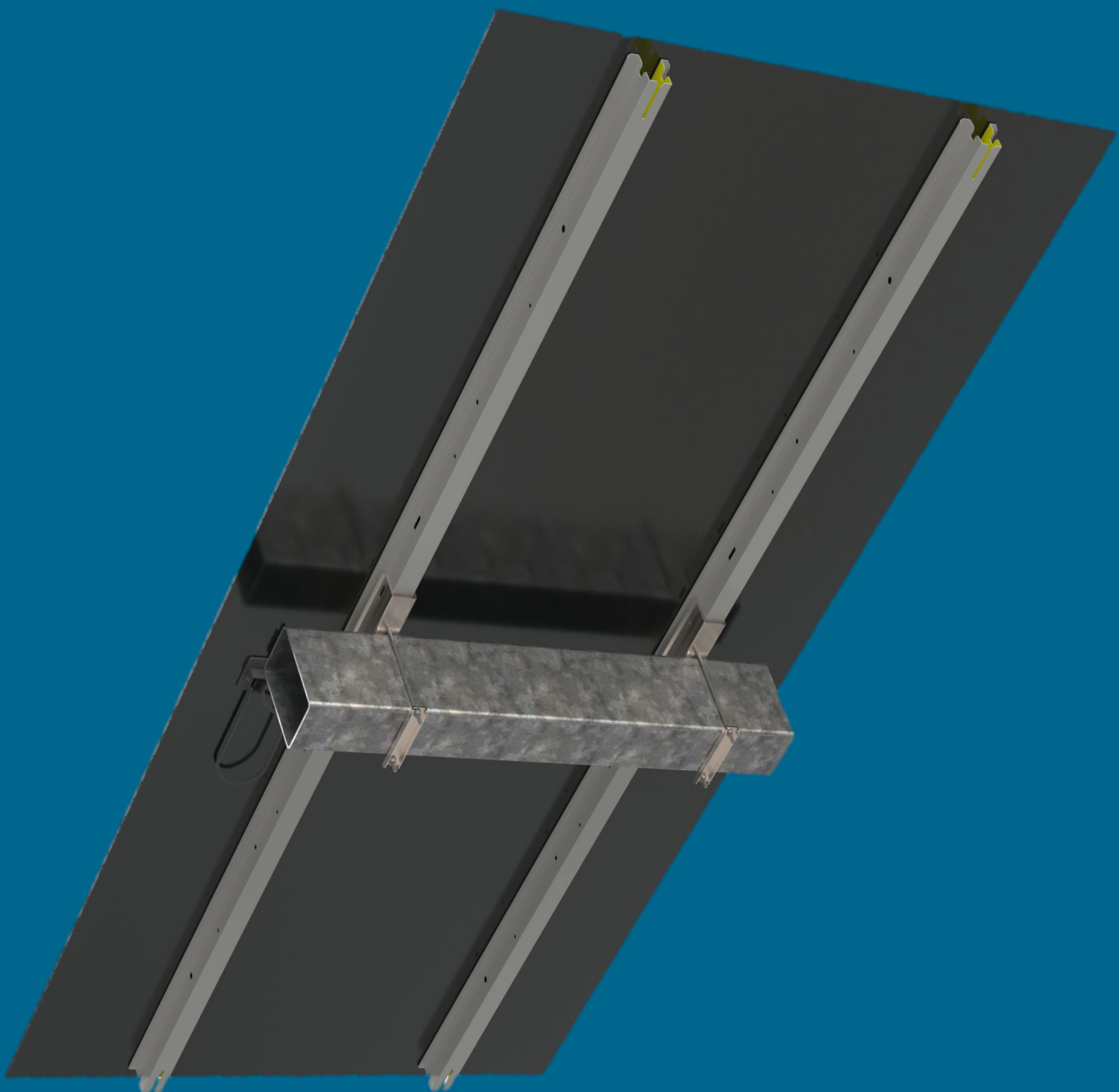
- Static structural analysis conducted with test loads using a full solar panel assembly and simplified constraints



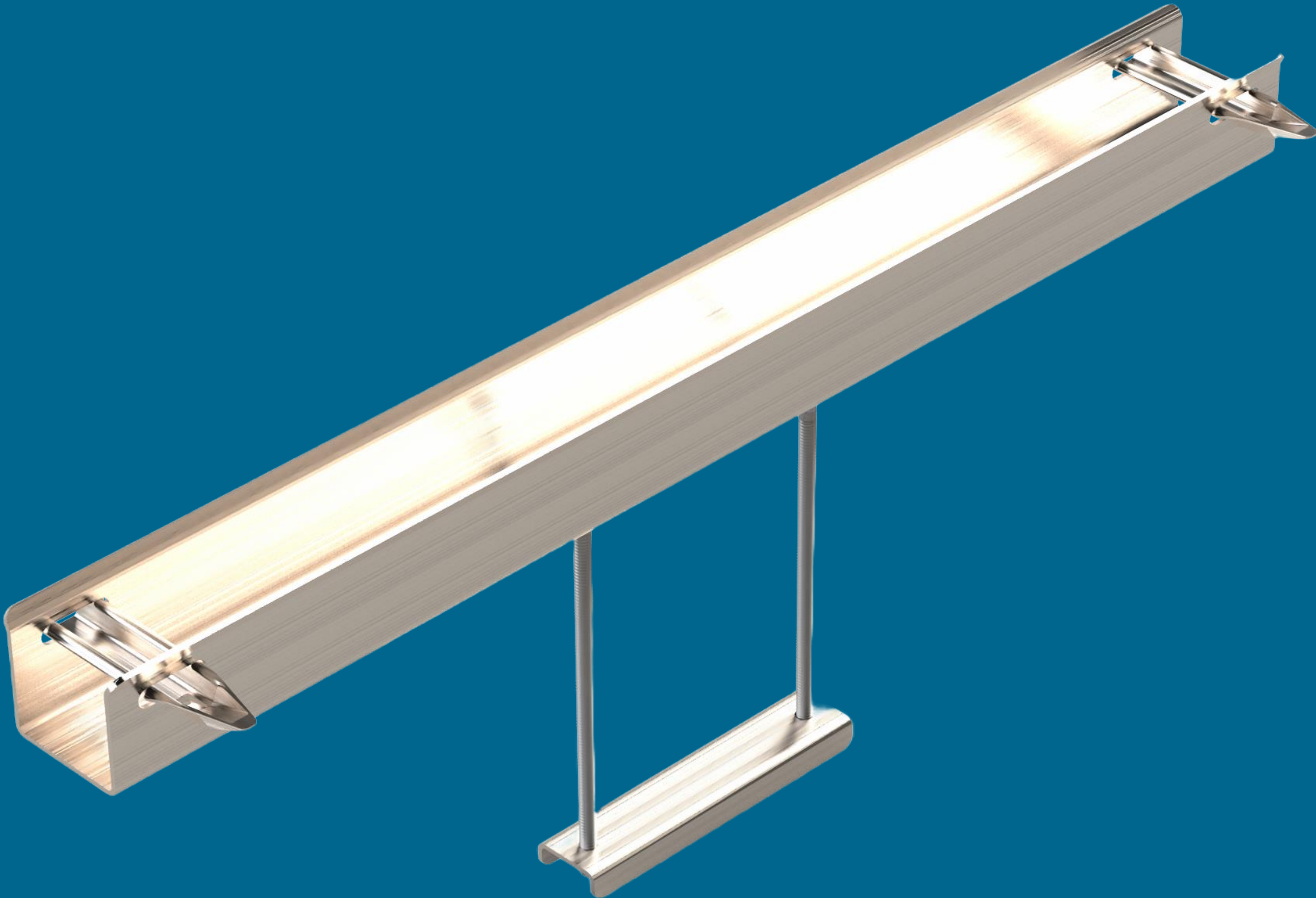
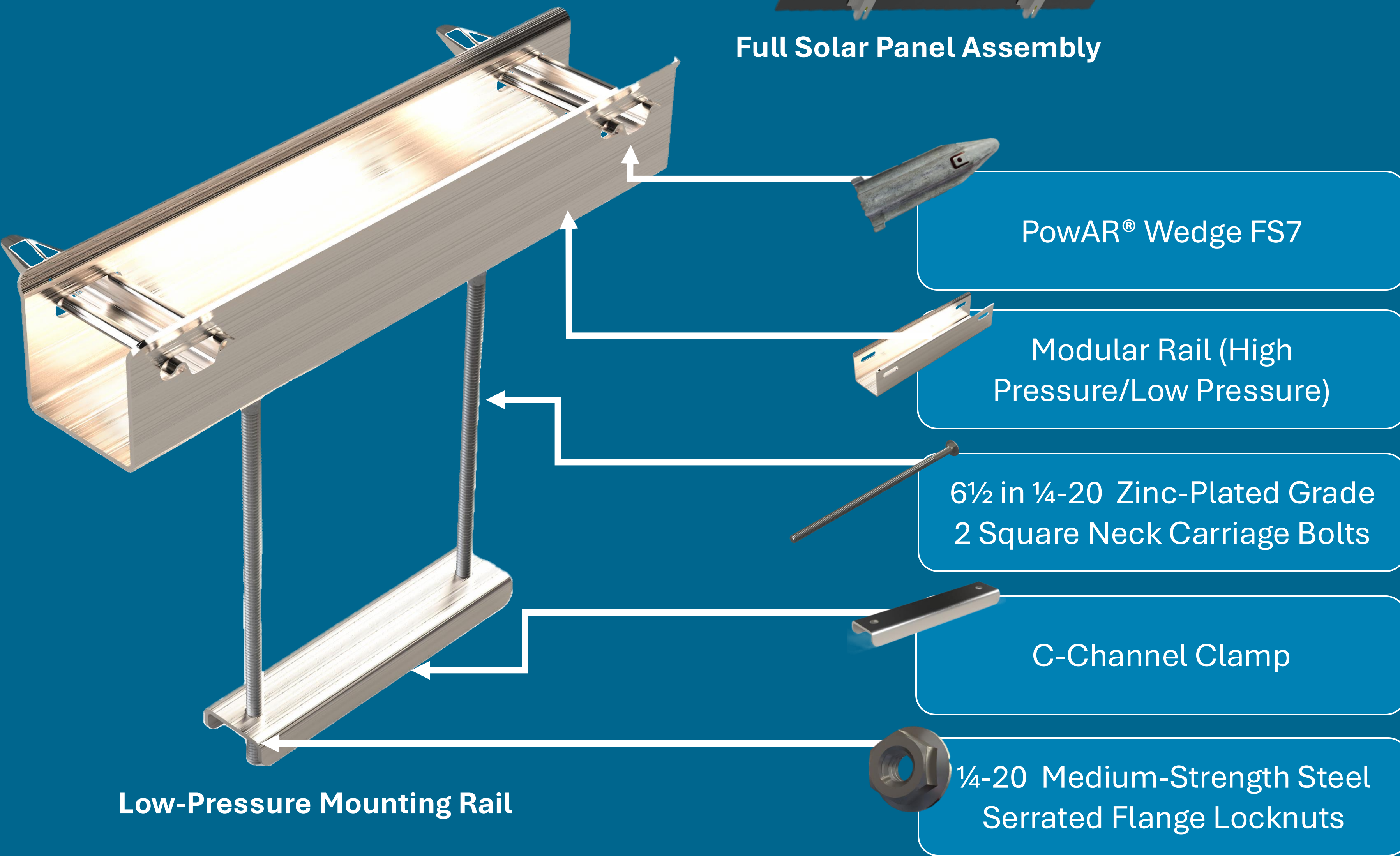
Channel Design Final Testing Data				
Force Configuration	Max Stress [psi]	Max Deformation [in]	Material Yield Strength [psi]	Safety Factor (Von Mises)
Low-Pressure	40611	.0185	76870	1.89
High Pressure	39740	.0138	76870	1.93



Solar Array



Full Solar Panel Assembly



High-Pressure Mounting Rail

MANUFACTURING PROCESS:

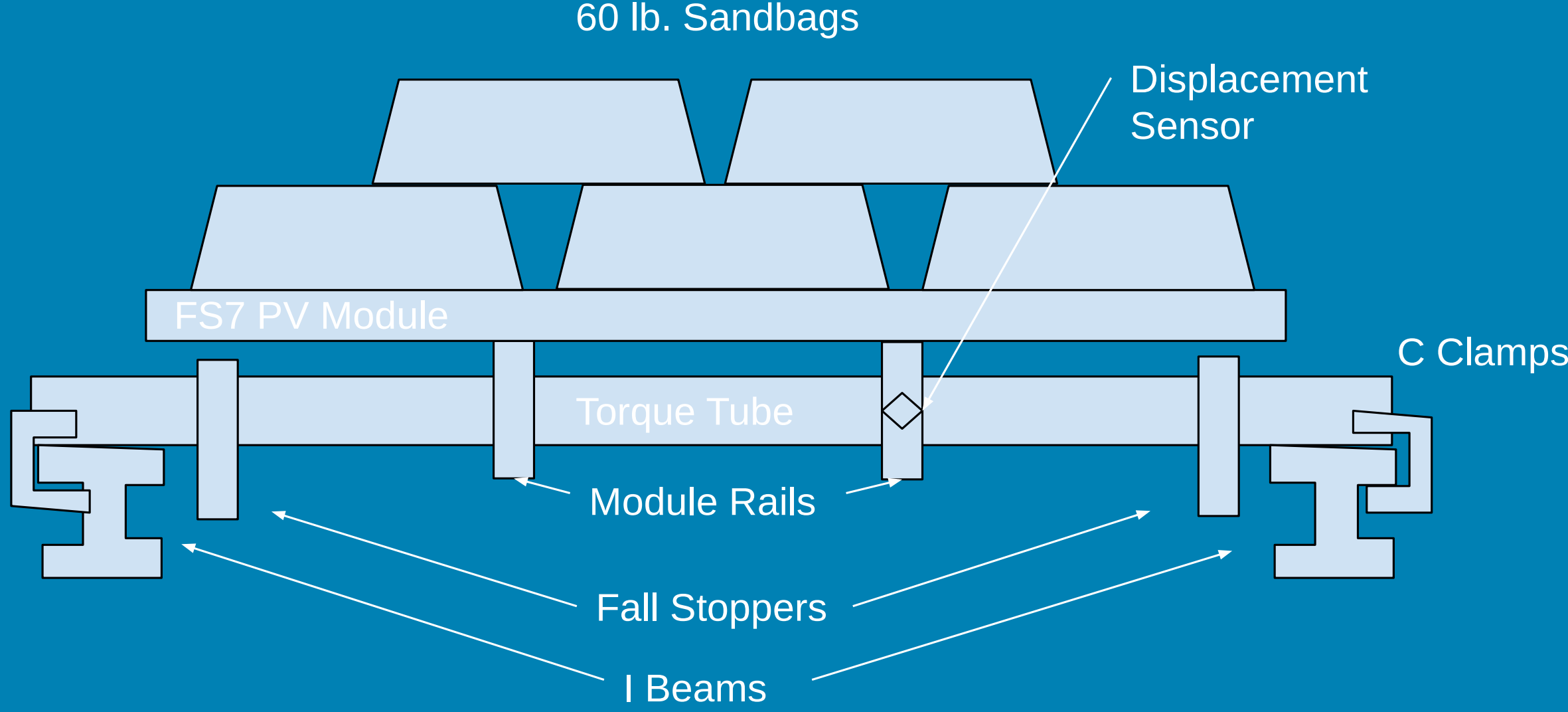
- Made from G90 Galvanized Sheet Steel
- Rolled formed and stamped for cost effective manufacturing at scale

FINAL COST BREAKDOWN:

Main Channel Type	Modular Rail Cost	1/4-20 Carriage Bolt	Serrated Flange Nut	C-Channel	Total Cost
200 mm (low pressure)	\$1.06	\$0.10	\$0.02	\$0.19	\$2.98
500 mm (high pressure)	\$2.36	\$0.10	\$0.02	\$0.19	\$5.58

LOAD TESTING:

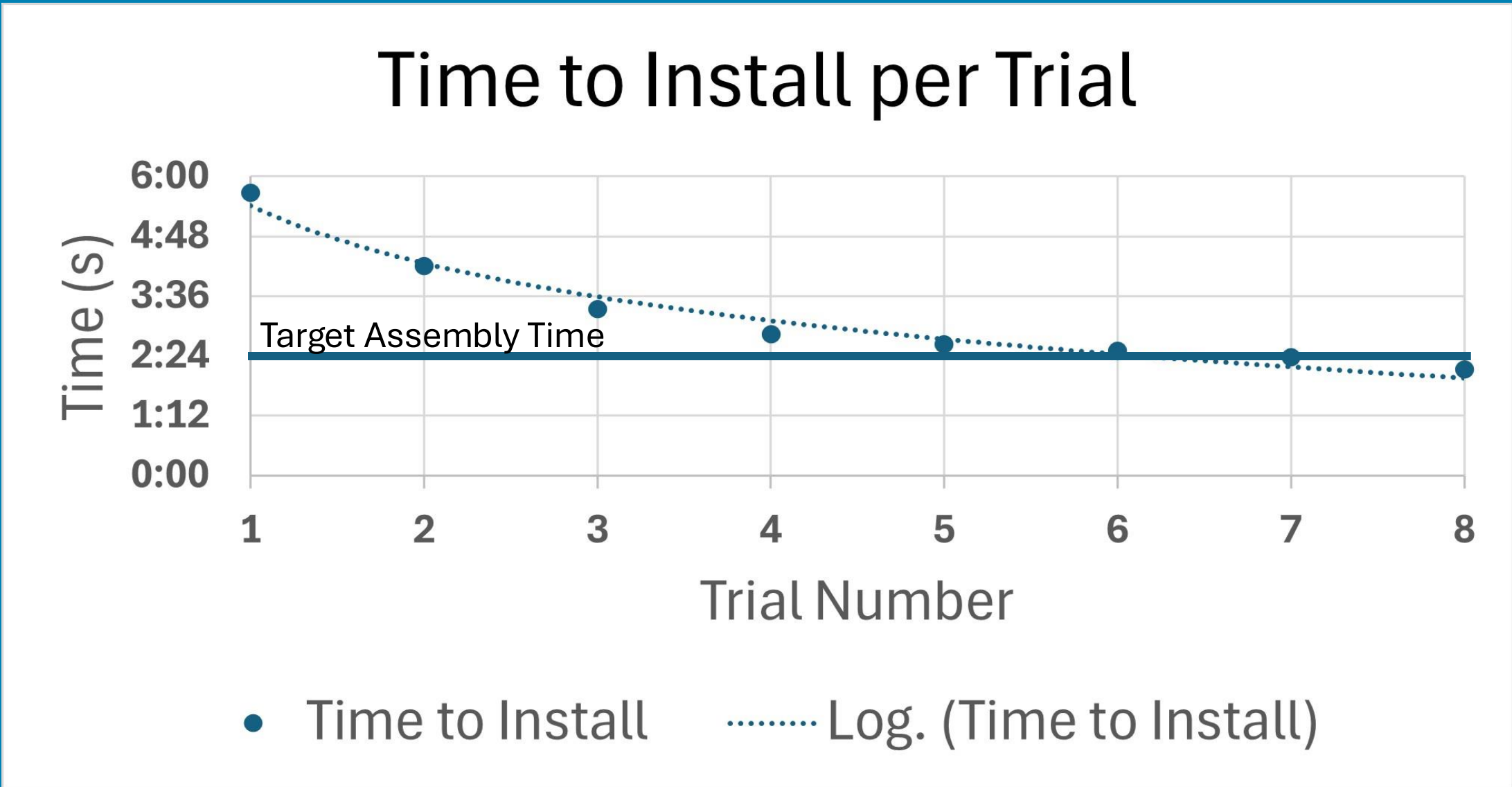
- Sandbags totaling 1050 lbs & 1450 lbs used to simulate weather forces for low-pressure and high-pressure scenarios respectively
- Applied load were tested on both front and back faces of the solar panel for 30 mins each
- Linear variable differential transformer(LVDT) used to track displacement at area of expected max displacement



Configurations	Gauge	Thickness (in)	Pass/Fail
200 mm (low pressure)	14	0.0747	Pass
500 mm (high pressure)	14	0.0747	Pass
200 mm (low pressure)	16	0.0598	Pass
500 mm (high pressure)	16	0.0598	Pass
200 mm (low pressure)	18	0.0478	Fail
500 mm (high pressure)	18	0.0478	Fail

ASSEMBLY TESTING:

- Two-person teams assembled modules under realistic conditions to assess ease and consistency of assembly.



CONCLUSION:

- Successfully designed and tested a solar panel mounting bracket that adheres to all compatibility, load, cost, and assembly speed requirements
- Our rail will be market ready for Valmont's implementation after First Solar has verified our findings through final testing