Imotak Trex Bracket: Material Suitability Analysis

Introduction

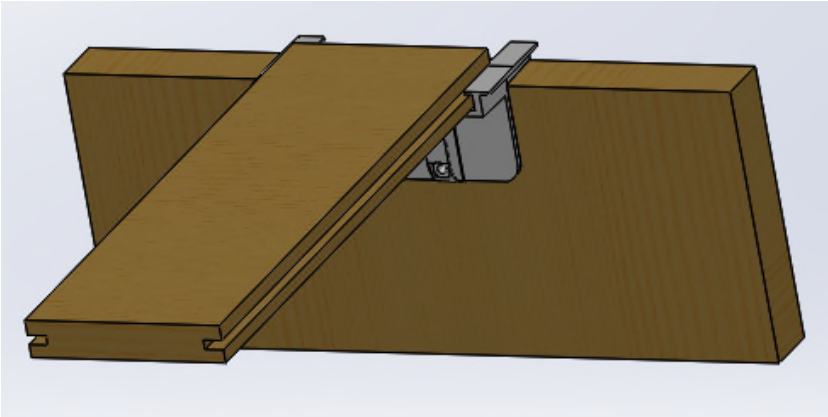
Objective and Summary

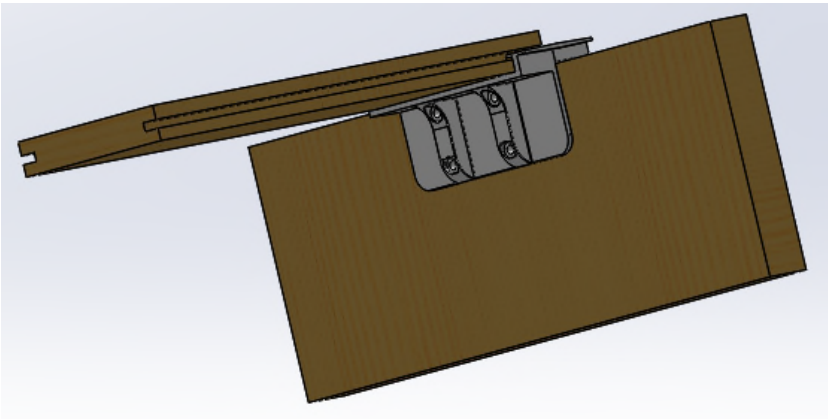
Alpine Engineering was commissioned to conduct a Finite Element Analysis (FEA) to evaluate suitable materials for a Trex bracket. The goal was to provide material recommendations based on strength, durability, and UV resistance.

Materials tested included ABS, HDPE, Nylon, and Vinyl. Although all tested plastics registered strengths "far within their yield strength," they have varied levels of UV resistance.

Three setups were used to evaluate possible loading conditions. Two setups are based on even pressure across the deck and the third is based on the concentrated load standard for stairs found in IRC R301.5.

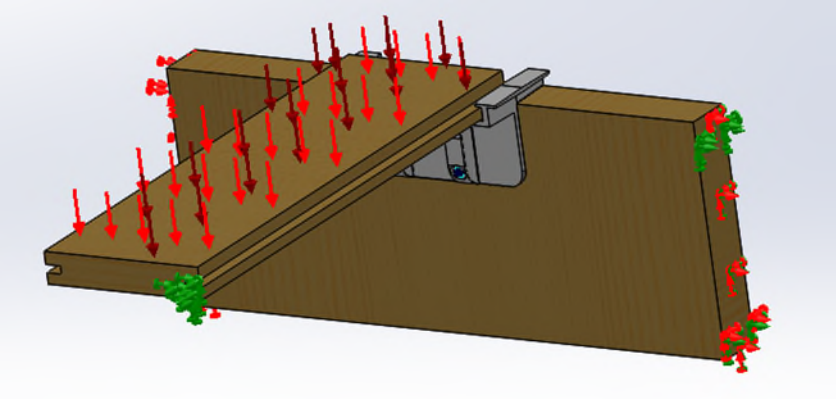
Setup 1





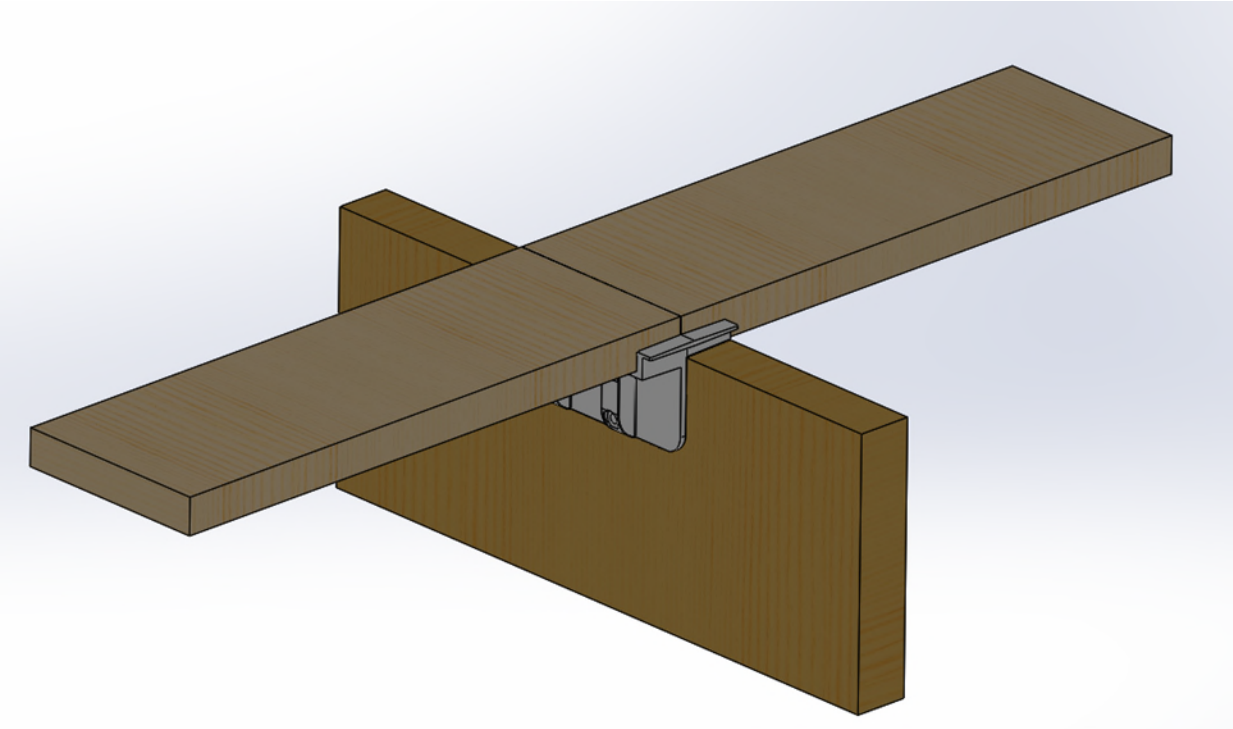
This configuration involved a joist and deck board (created with the same profile as a Trex board). A pressure of 144 psf was applied, significantly higher than the typical deck pressure of 40–50 psf.

For this first setup a 144 psf pressure was added. Typically, the deck sees a 40-50 psf. This increase in pressure reaffirms the brackets safety at 40-50 psf.



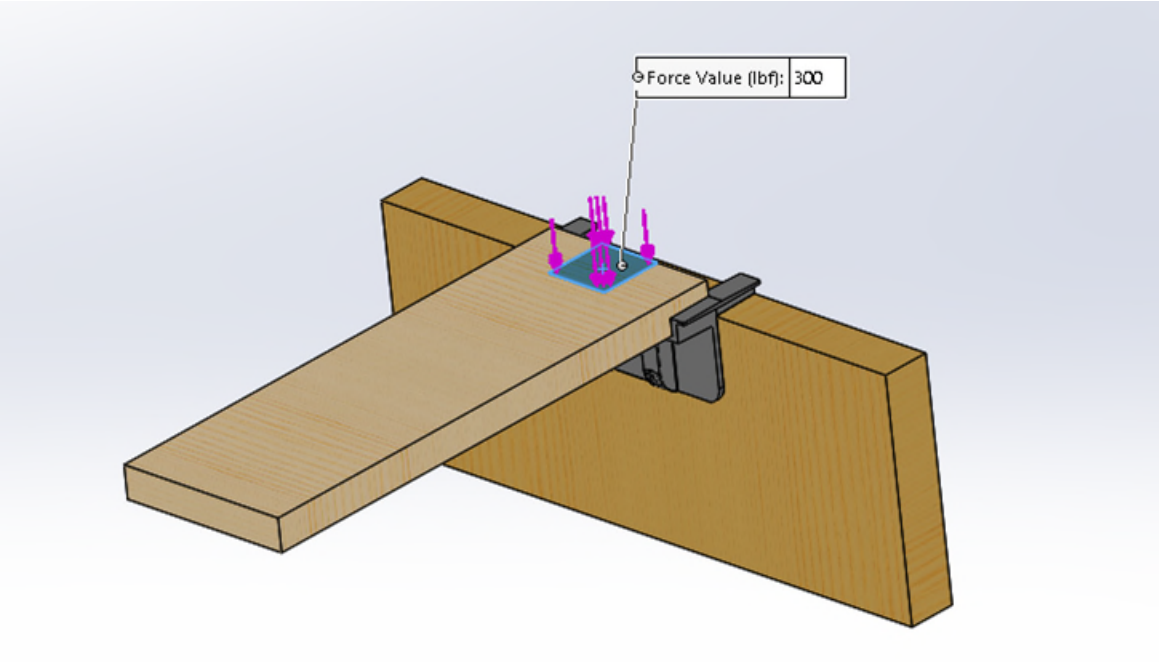
Setup 2

This setup utilized the same loading as Setup 1 with the higher distributed load. Both boards are loaded with 144 psf. This is a very likely loading scenario. It shifts the stress into the fins of the bracket which is a possible failure point.



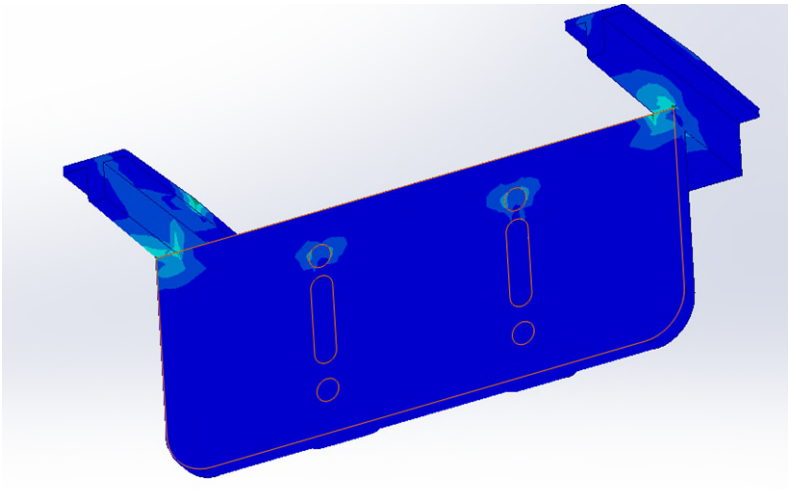
Setup 3

This test was based on the stair standard, applying a 300 lbs. load over a 2in-by-2in section.



Results

Backside view:

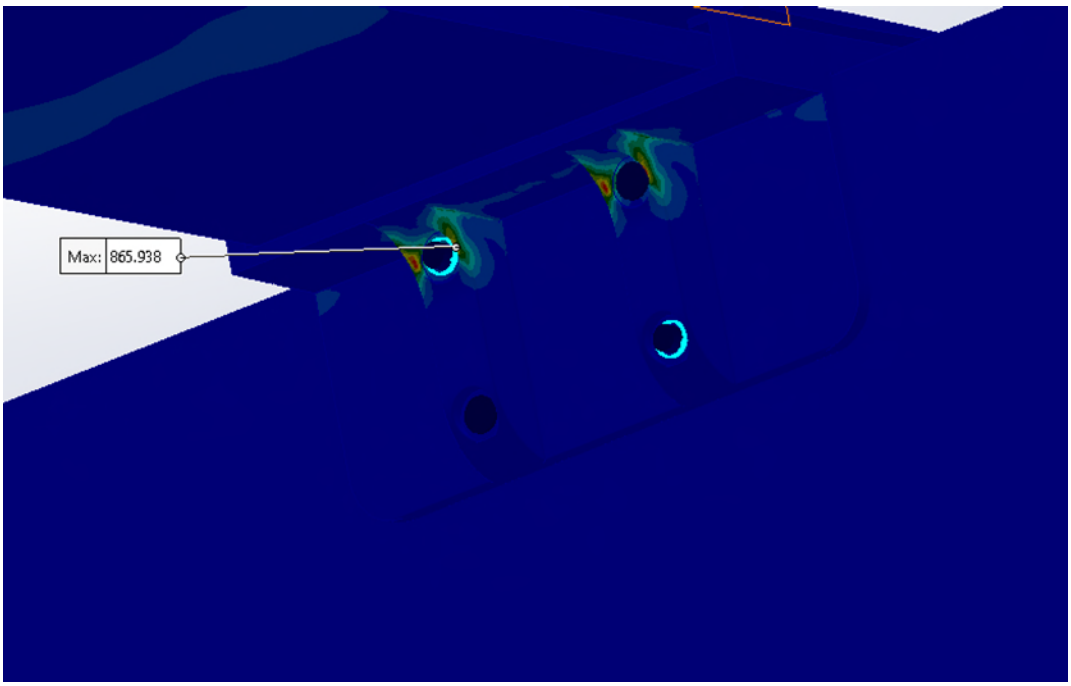


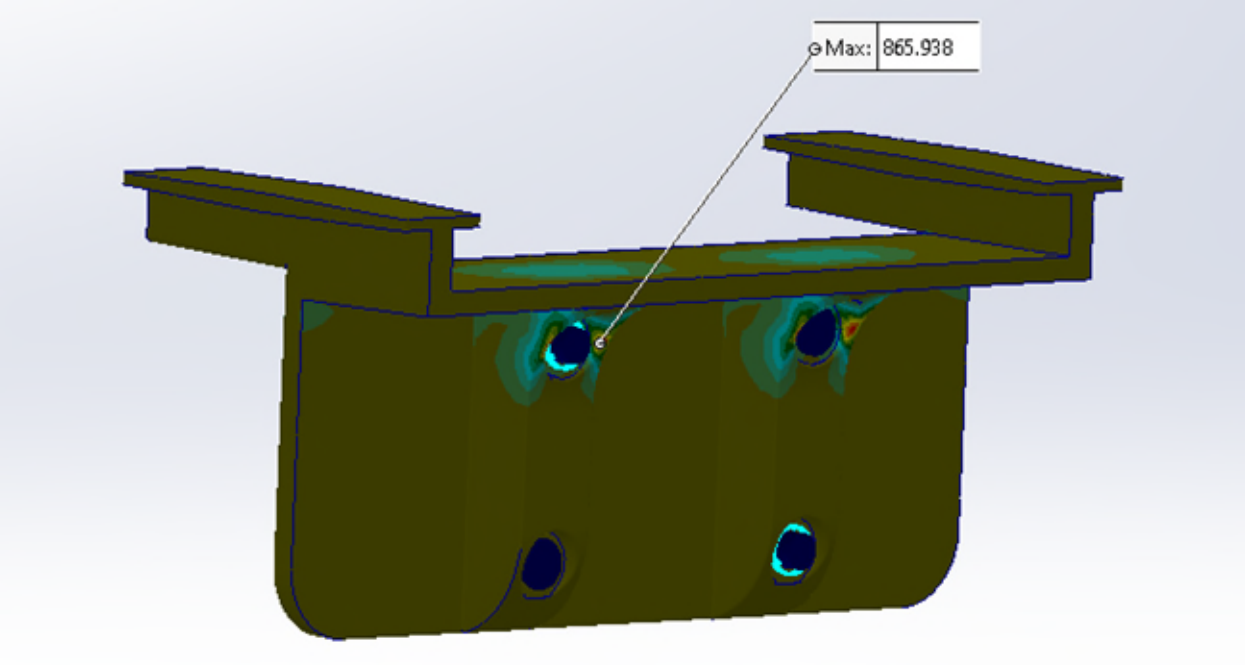
Most of the stress is concentrated around the bolt holes. To avoid redundancy the backside view has been left out.

Material	Yield strength (psi)	Max Stress (psi)	UV resistance	Cost (Ranked)	Notes
ABS	4,000-7,000	1) 870 2) 718 3) 1,580	Not Resistant (Stabilizer needed)	$$	The addition of fiber could double the strength of the ABS
HDPE	3,000-5,500	1) 592 2) 507 3) 1,280	Excellent	$	Most comprehensive of strength, durability, cost, and UV resistance
Nylon	7,000-15,000	1) 1,504 2) 1,590 3) 2,970	Not Resistant (Stabilizer needed)	$$$$	The strongest of these however it is the most expensive
PVC	7,500-9,000	1) 905 2) 773 3) 1715	Not Resistant (Chemically Resistant) (Stabilizer needed)	$$$	

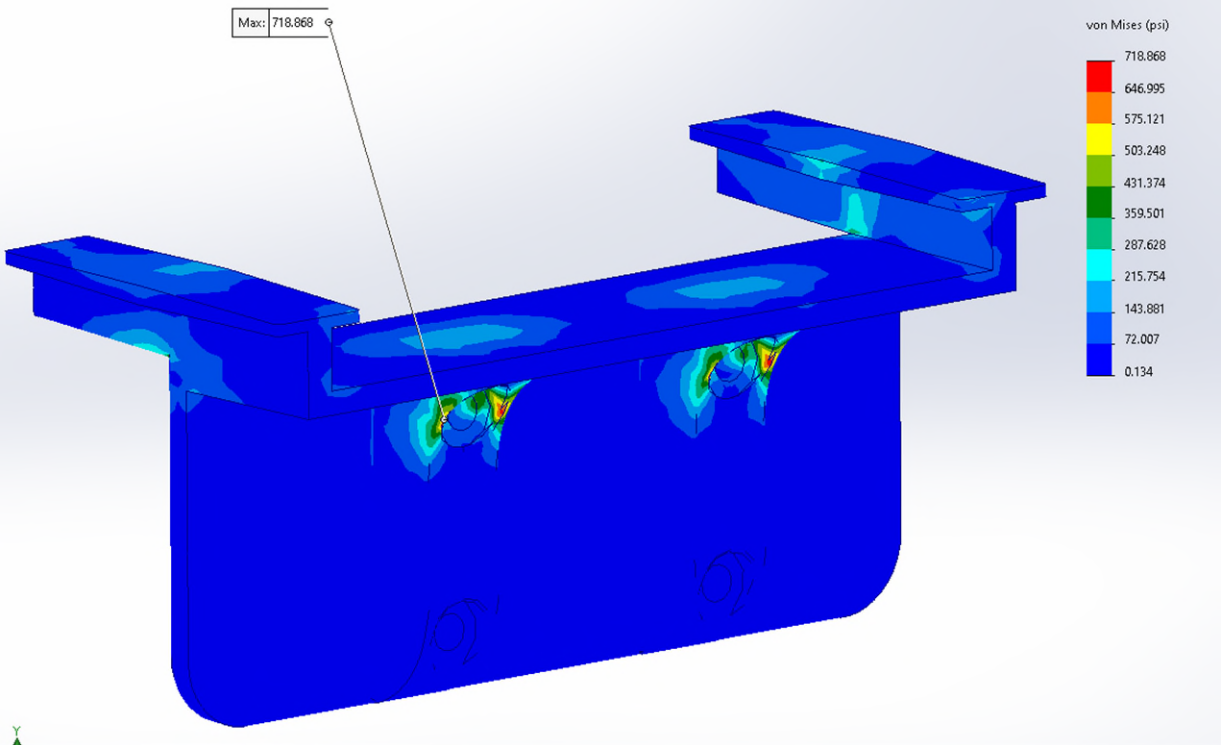
ABS

Result 1

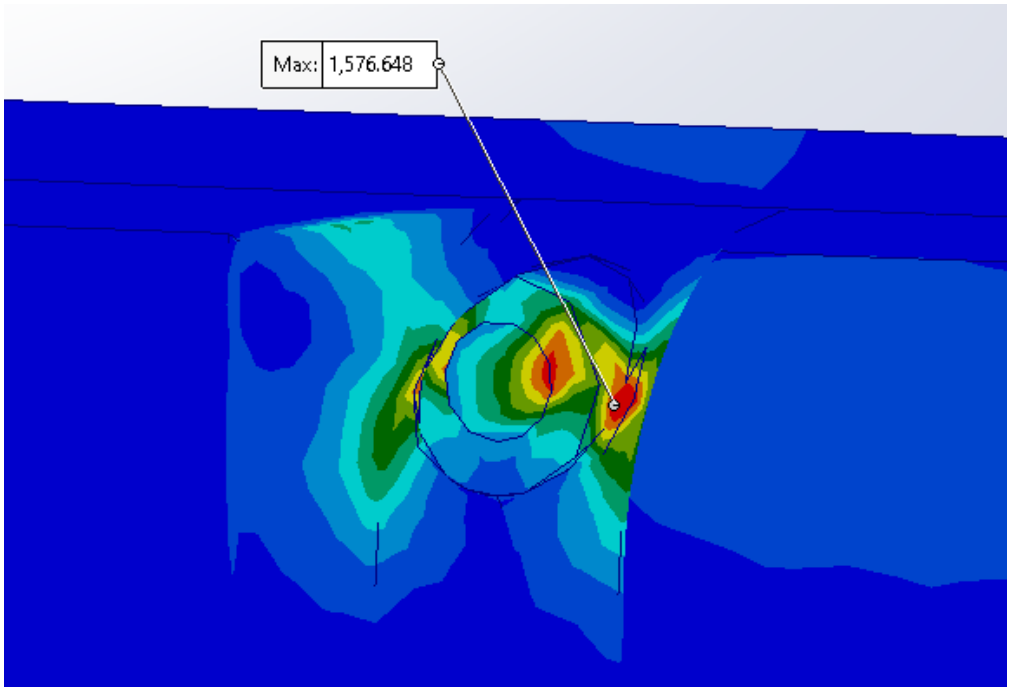



Max: 865.938

Result 2

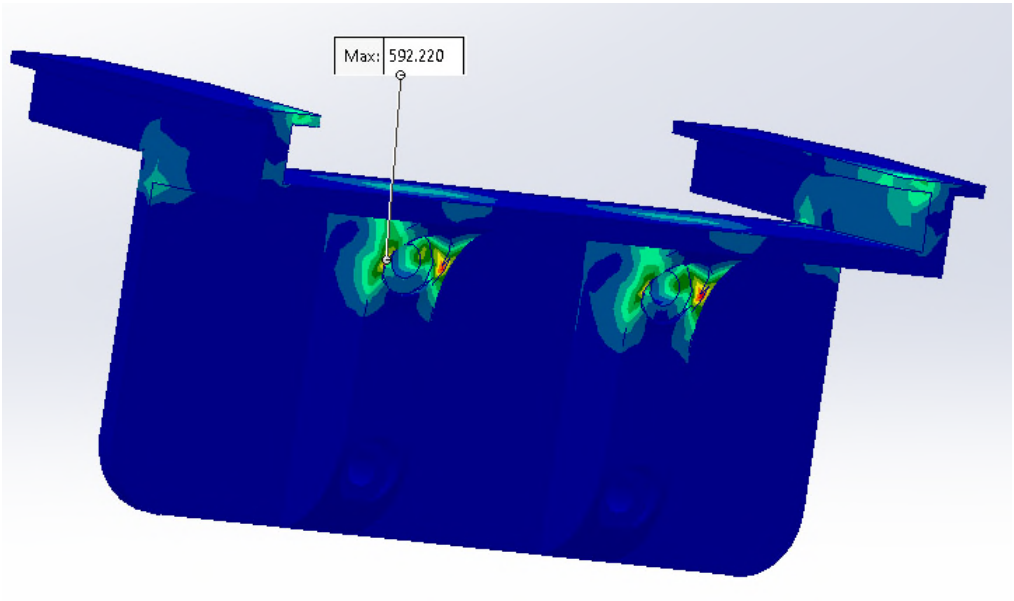

Max: 718.868
von Mises (psi)
718.868
646.995
575.121
503.248
431.374
359.501
287.628
215.754
143.881
72.007
0.134

Result 3



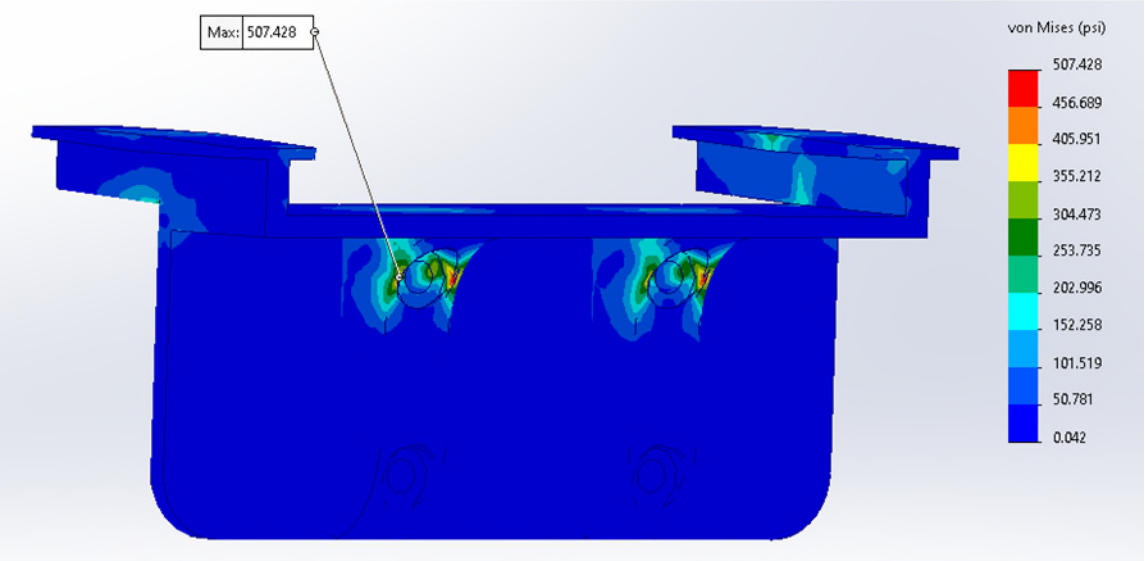
HDPE

Result 1

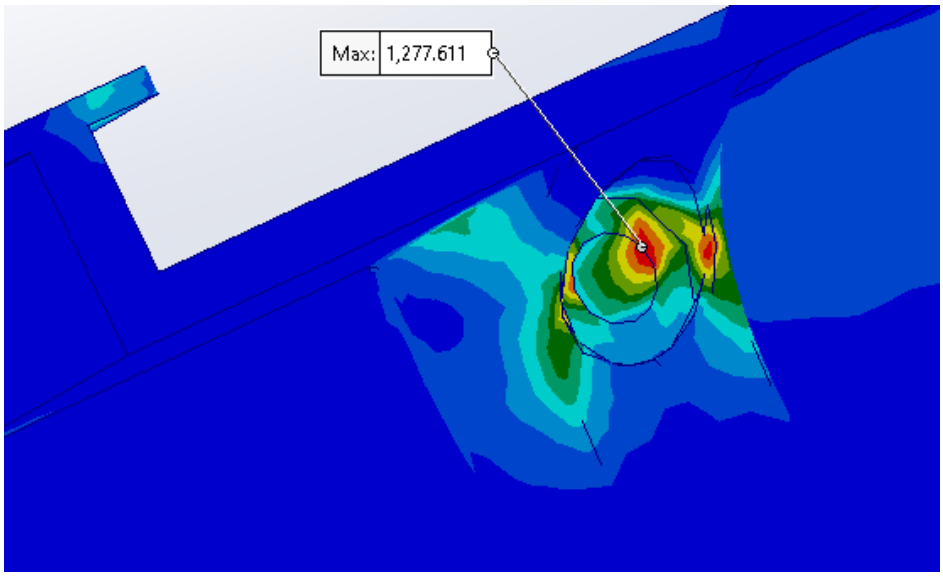


Result 2

Front view of HDPE:

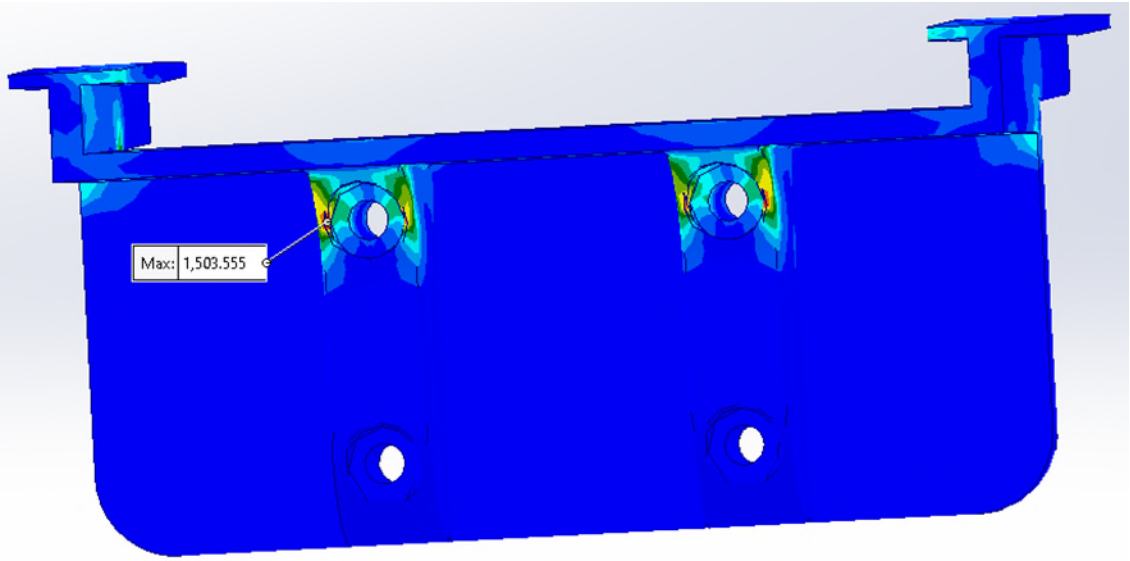


Result 3



Nylon

Result 1



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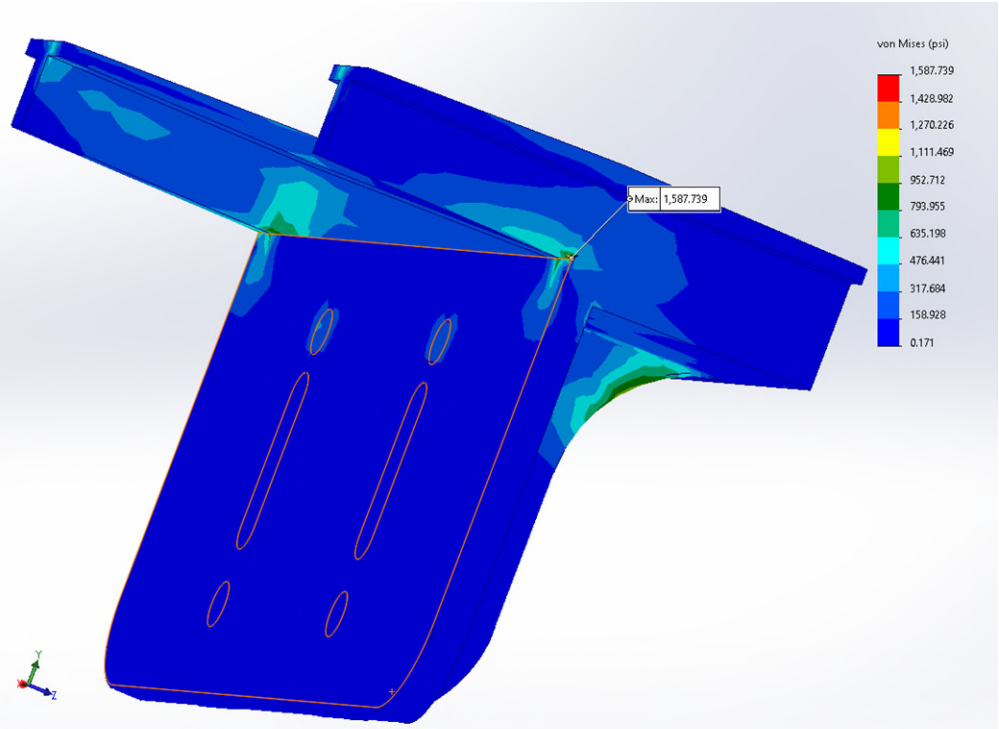
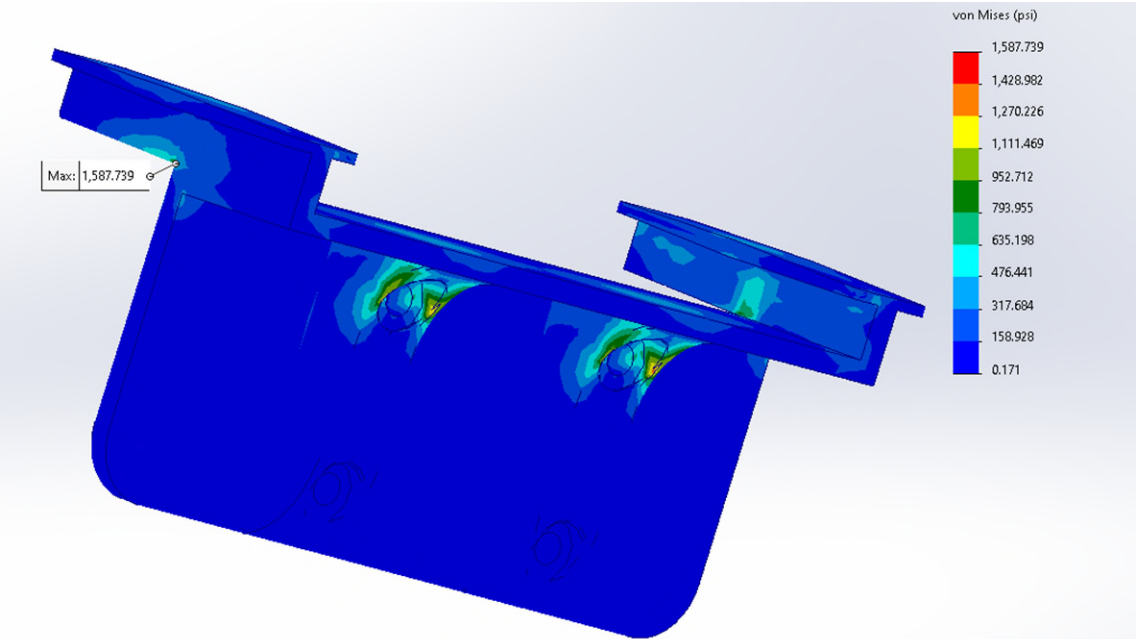
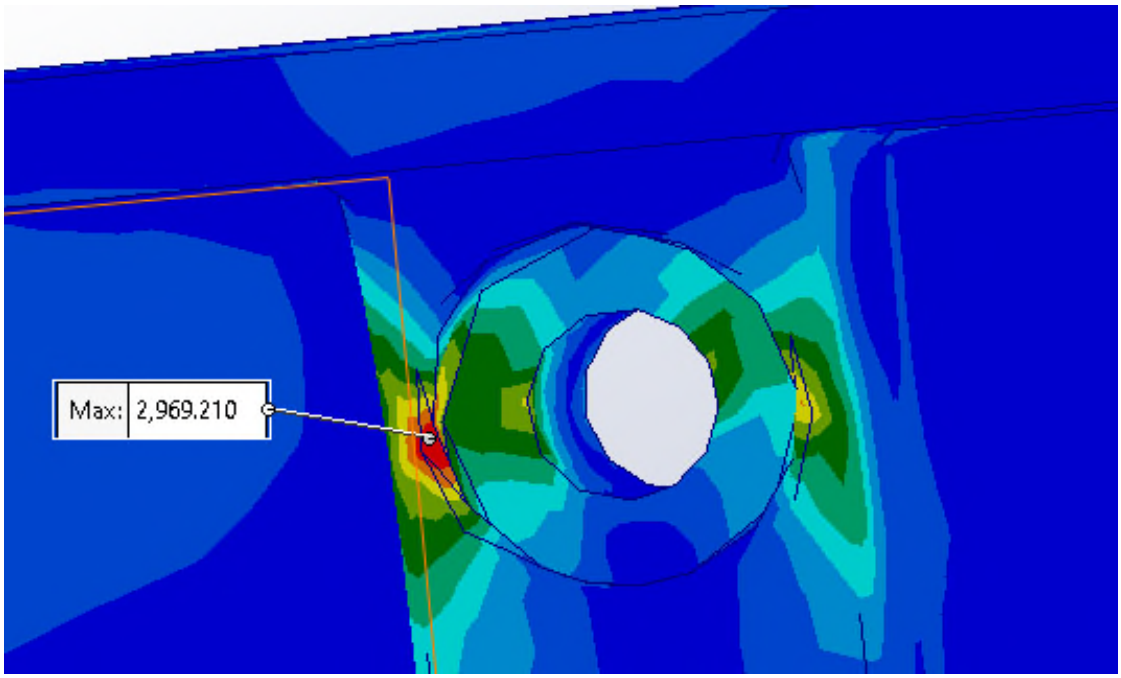


Nylon is a stronger material but is not inherently UV resistant.



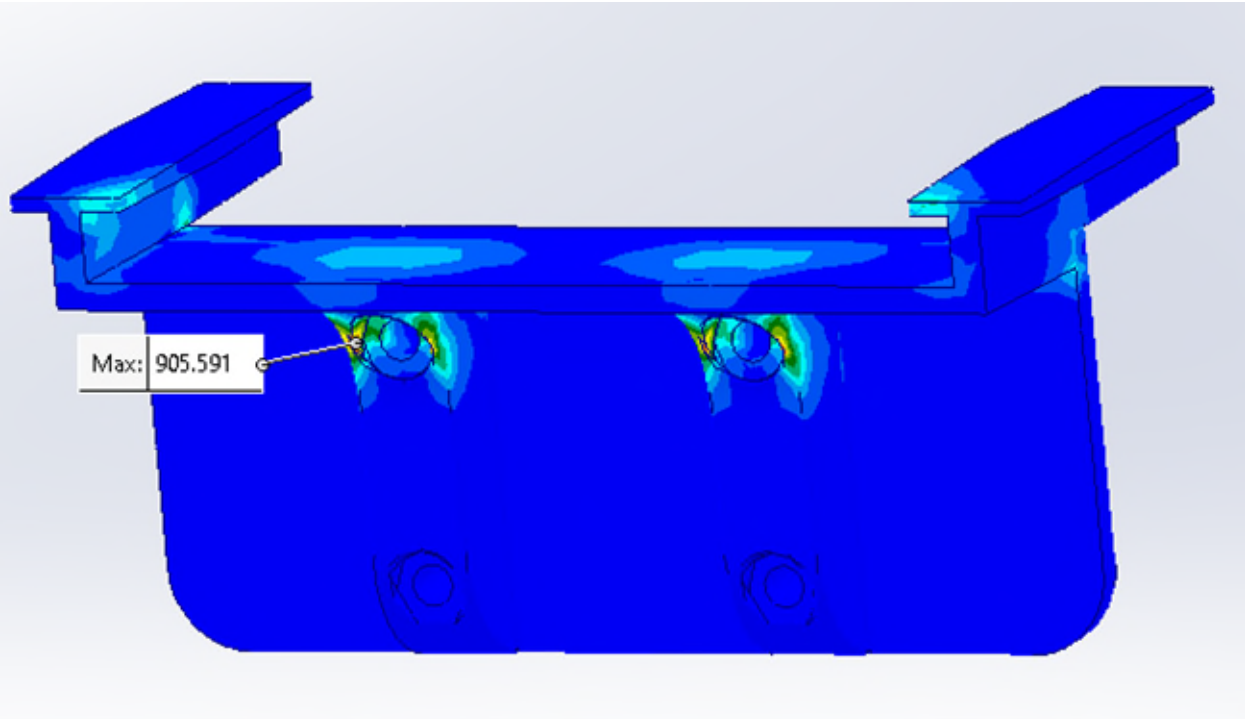
Result 3



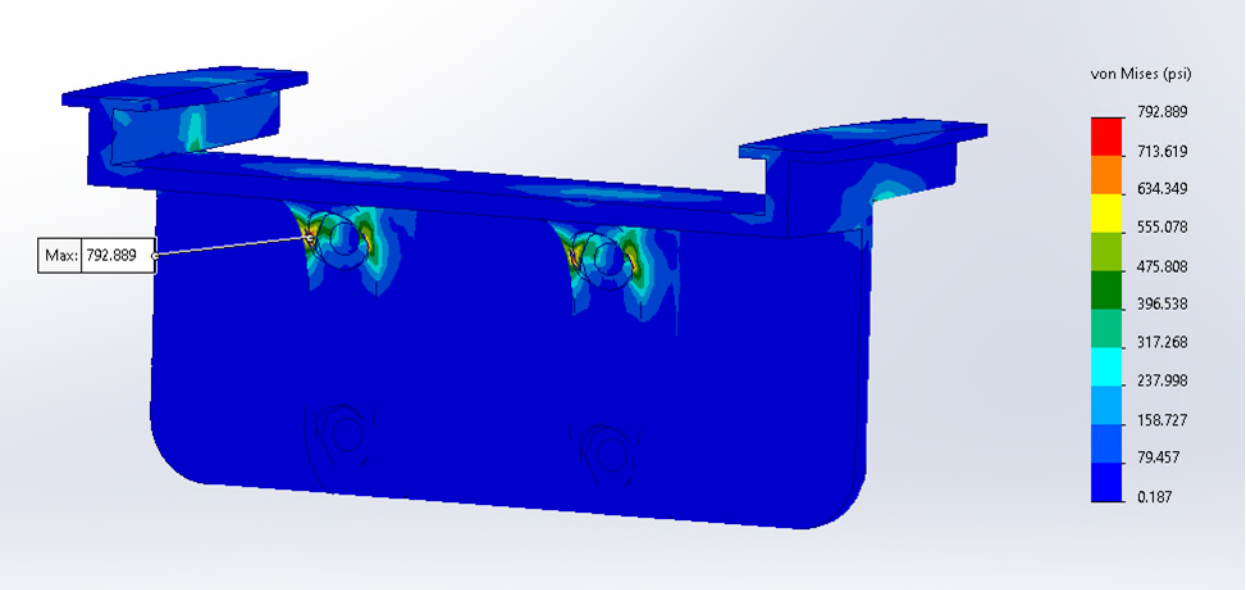
This is the greatest of the concentrated stresses. However, Nylon is the strongest of these materials.

PVC

Result 1

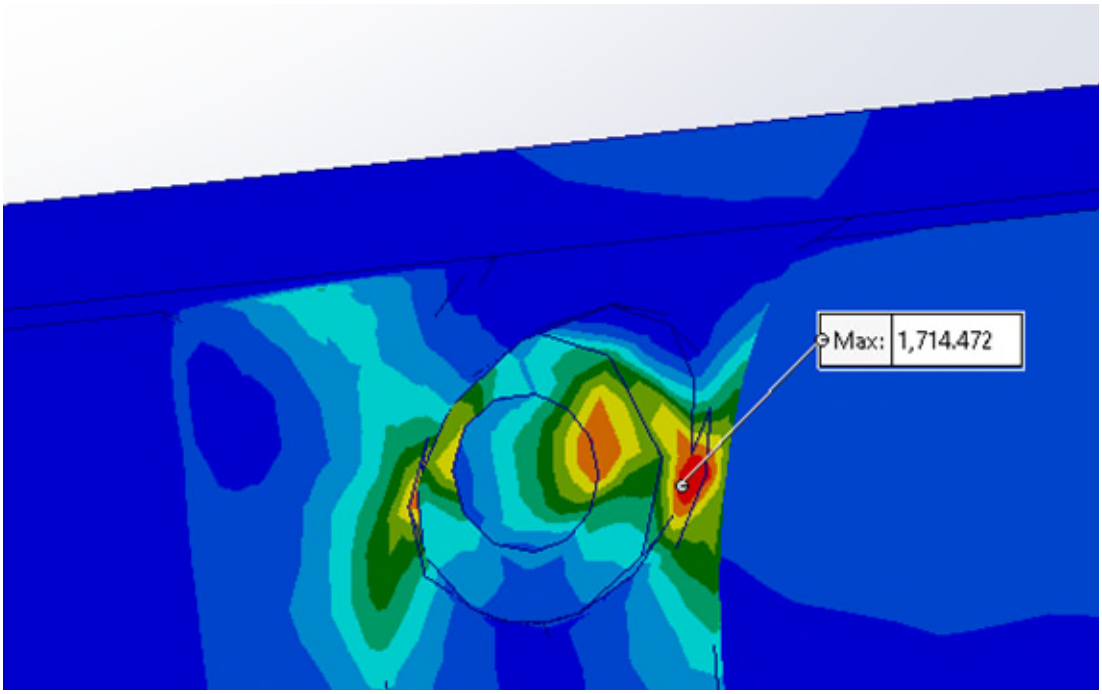


Result 2



PVC works well but is not inherently UV resistant.

Result 3



Conclusion

All materials analyzed present specific advantages and disadvantages concerning strength, durability, and weather resistance. For this specific application, HDPE stands out for its resistance to weathering, making it the recommended choice. However, any of the plastics analyzed have adequate strength and safety factors. Plastic manufacturing has a lot of variables, and a manufacturer should be consulted for finding the optimal balance of cost, formulation, and long-term reliability.

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