

Nitro ZV Boat Trailer Winch Mount Analysis

KTO Solutions

20220416

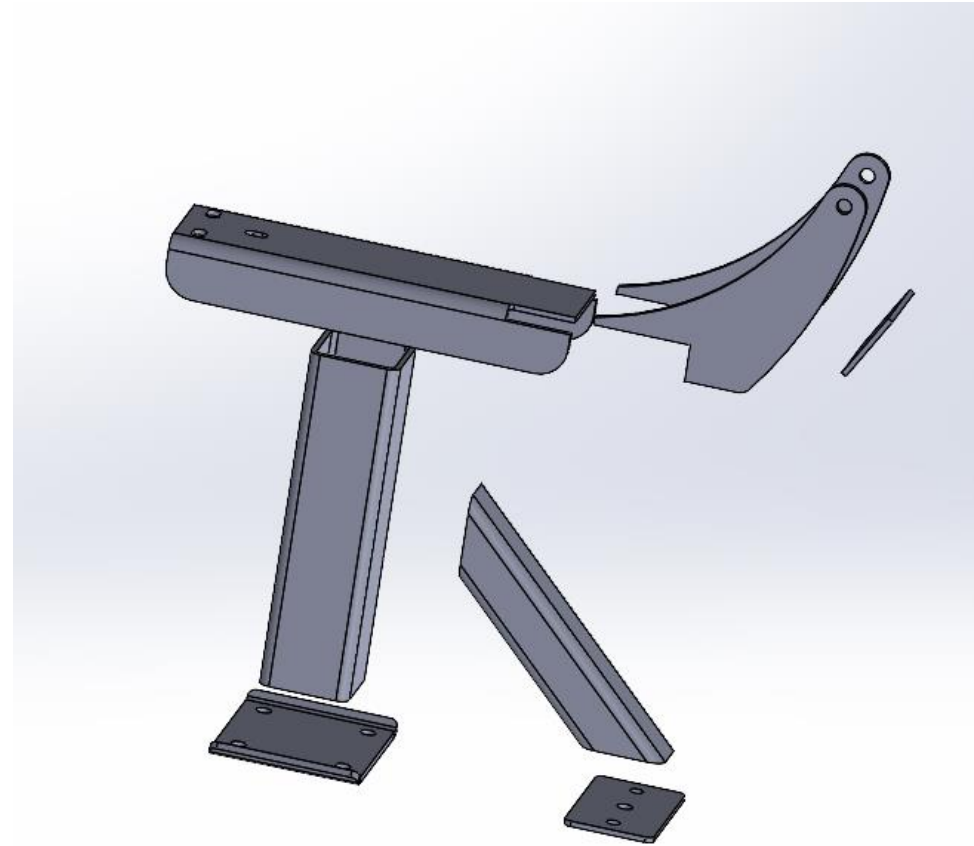
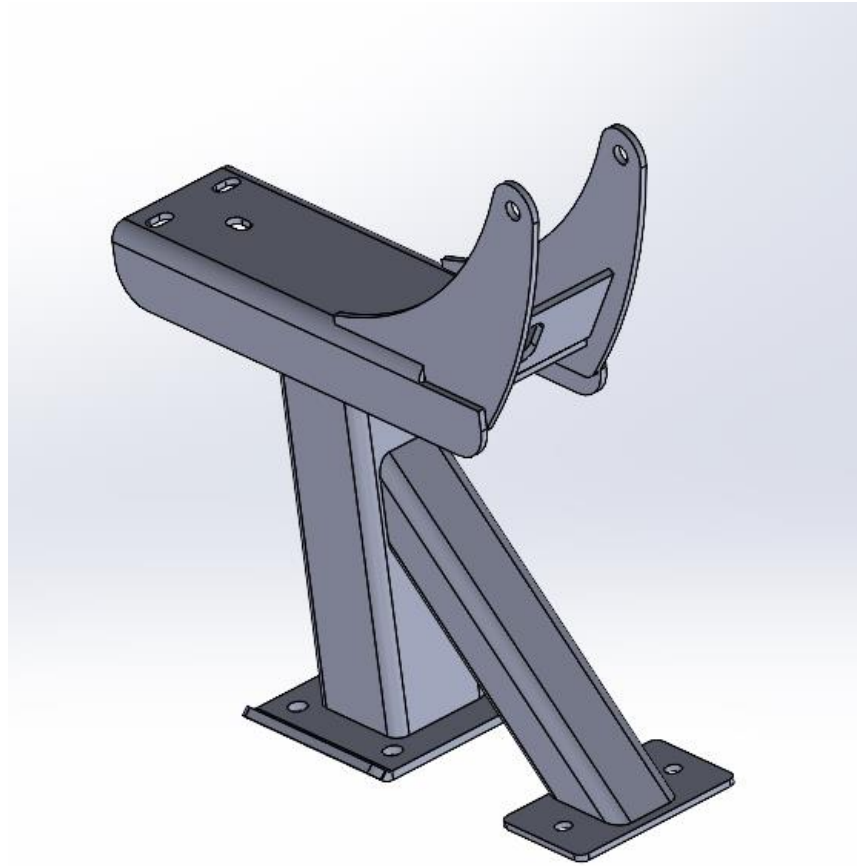
Summary

- There are several instances of winch mount failures on NITRO ZV21 boat trailers in recent history. This is exacerbated by the use of the popular Drotto Latch system.
- The root cause of the failures is due to the minimal weld installed to attach the winch mount c-channel to the 3x3 upright tube. Any excess push by the boat puts the weld in tension and it fails on each end of the weld that is nearest the boat.
- The material thickness is also “just good enough” for winch use without a Drotto and is easily overstressed with just a 500lb force into the Drotto Latch attach bolt.
- The easiest fix is to weld on a gusset that connects the C-channel to the upright tube and downward to the 45 degree brace tube. The assembly stress drops from an initial 358MPa (52ksi) down to 222MPa (32ksi) which is a 39% reduction.
- More reduction in stress can be had by increasing the wall thickness in all the parts to ¼” and applying the same gusset, 3x3 full perimeter weld and filling in the slots where the uprights are fitted.

Problem Definition

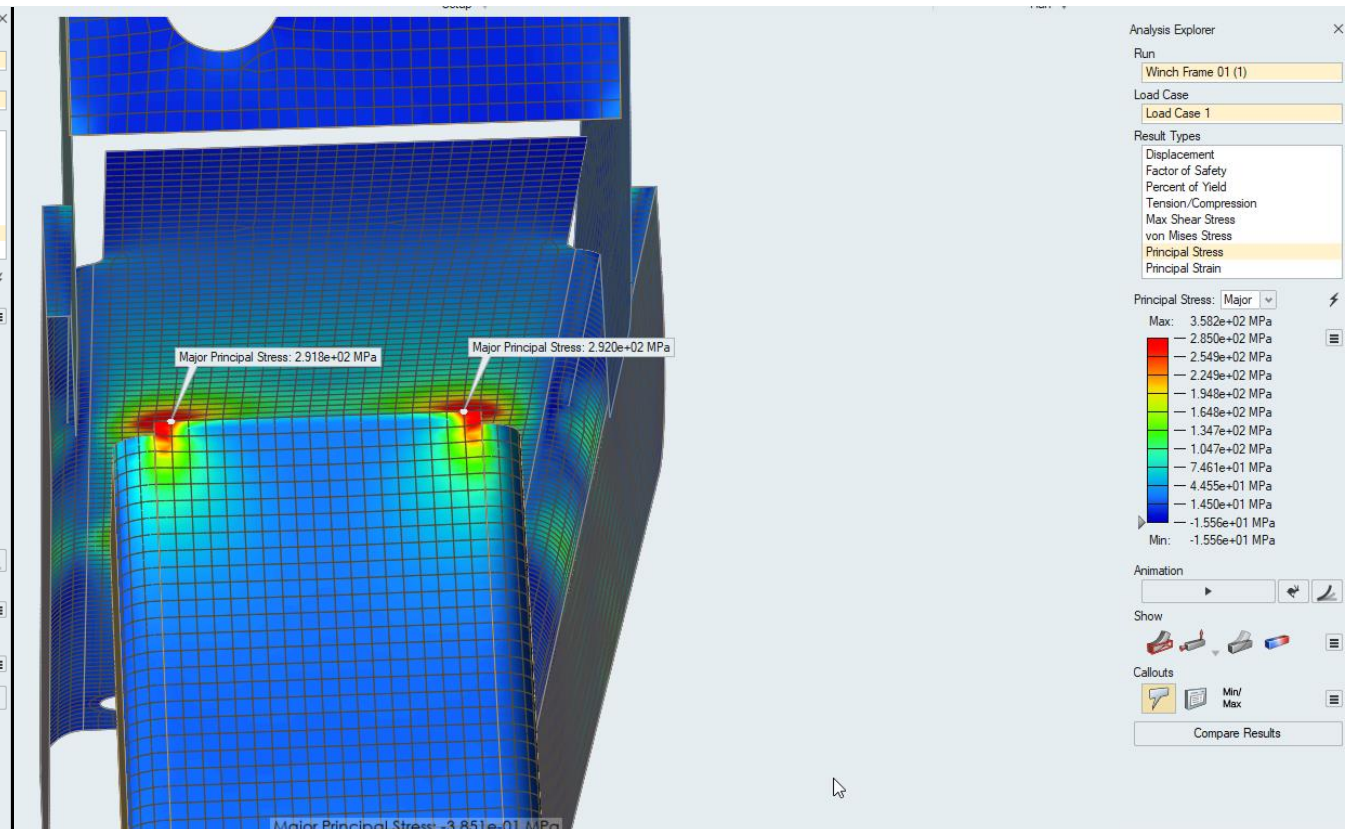
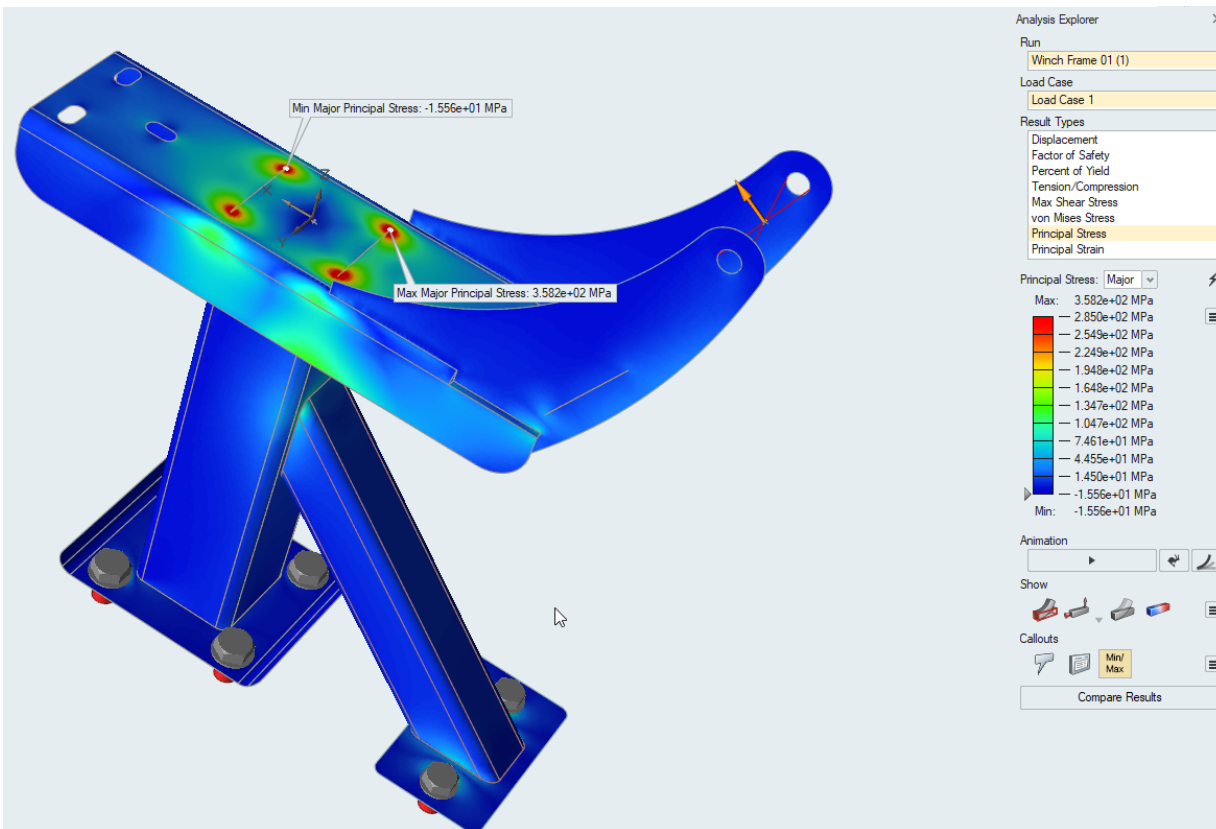
- The Drotto Attach bolt “receives” the light latching load in an upward vector. This upward vector overstresses the weld that attaches the winch mount c-channel to the 3x3 tube. You can probably inspect your winch mount today and see rust on each end of that weld. The rust signifies that the weld is already starting to break.
- A secondary issue is the 3/16” mild steel used all the winch mount components except for the mounting feet. When applying “fixes” to the c-channel, the parent material is easily overstressed. This condition requires careful application of measures to guide the load through the winch mount to minimize promoting downstream failures.

Winch Mount CAD model



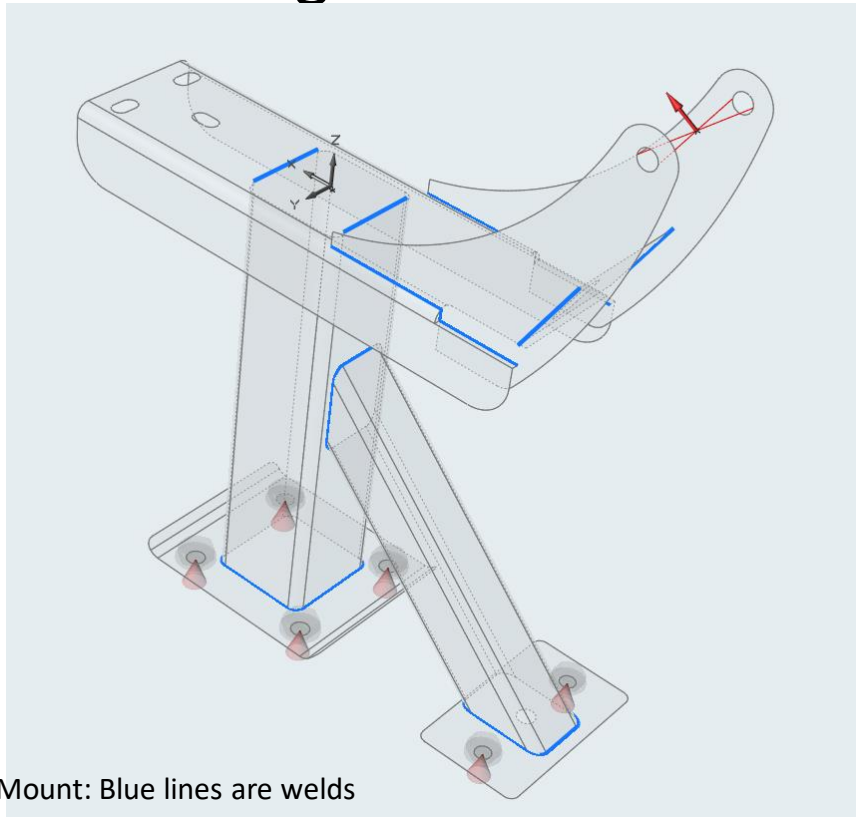
Initial FEA Result – all 4 weld corners light up

the applied load is 500lbf up 30° from horizontal (it's a 2 ton boat being pushed with a nudge from 300-400hp)



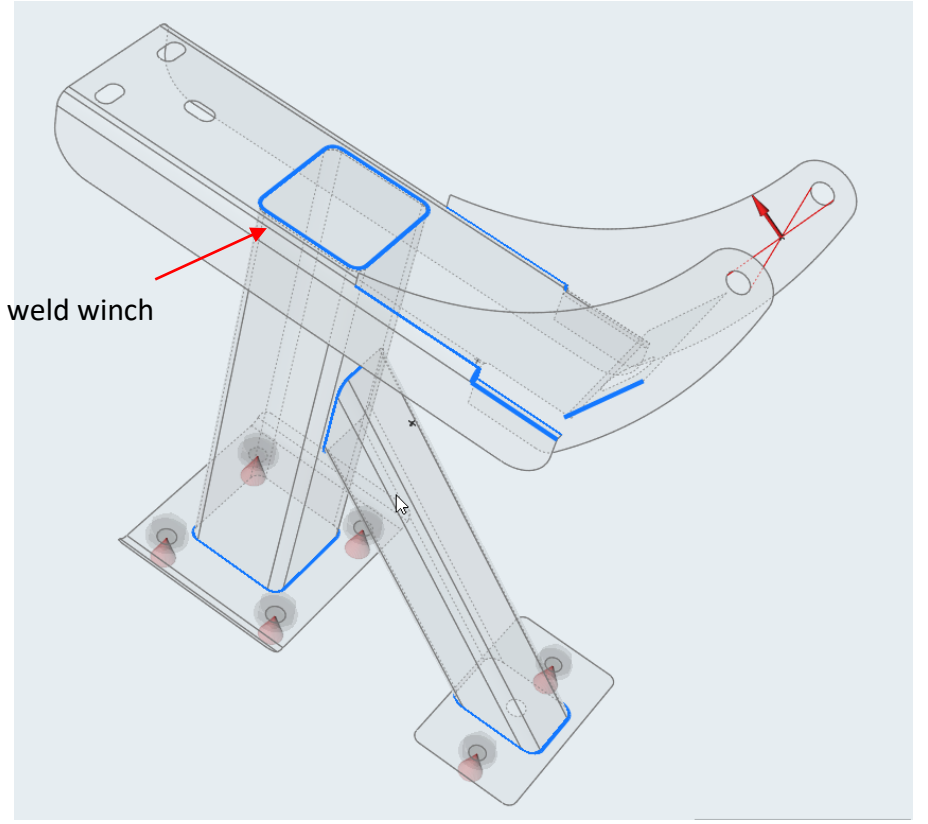
Create a Solution that doesn't cause more stress

- The first obvious fix is to complete the welding of the 3x3 tube to the winch base. This is done by using a cutoff wheel from the top and finishing with a Dremel. Then plug welds are installed.

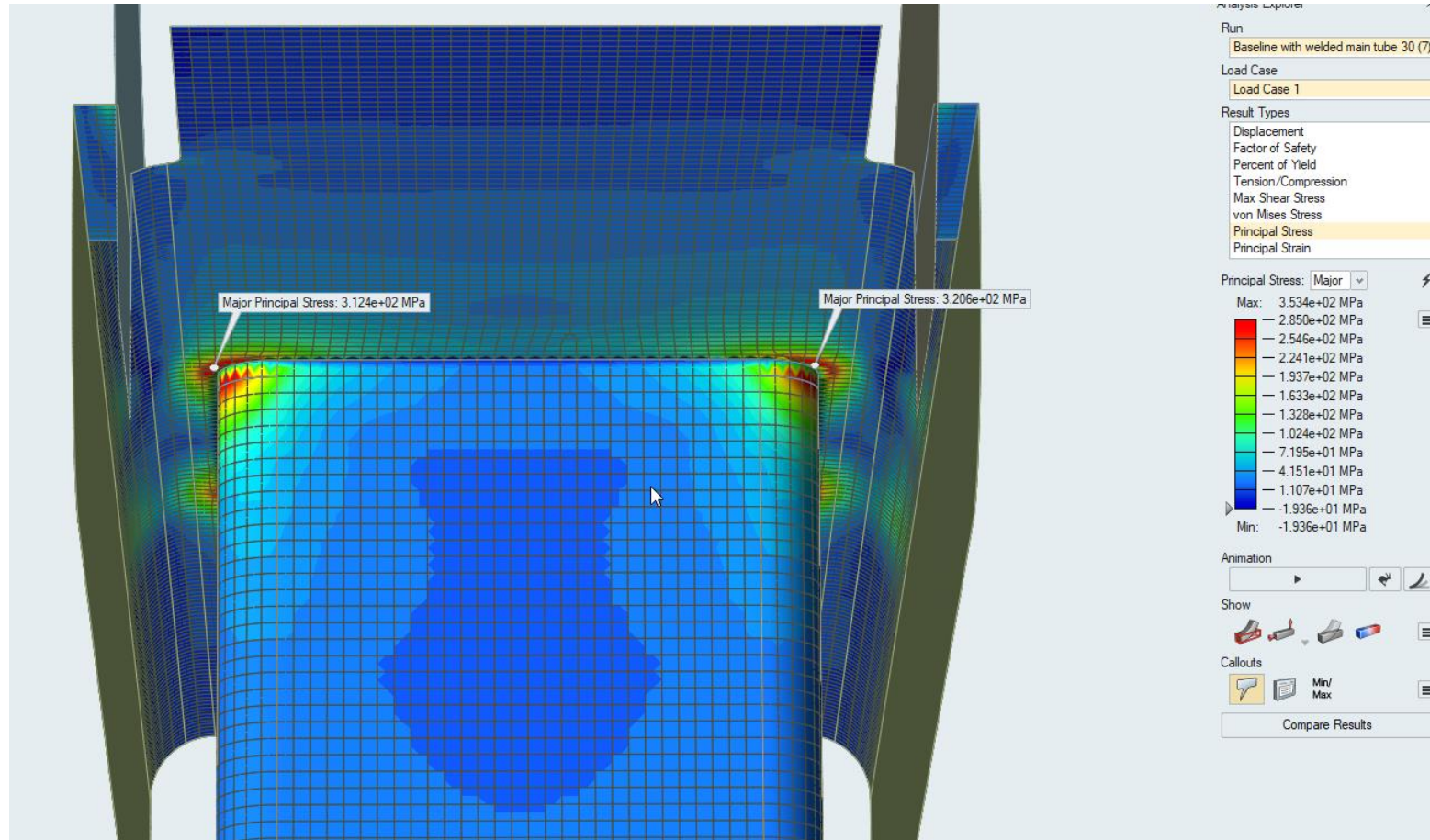


Original Mount: Blue lines are welds

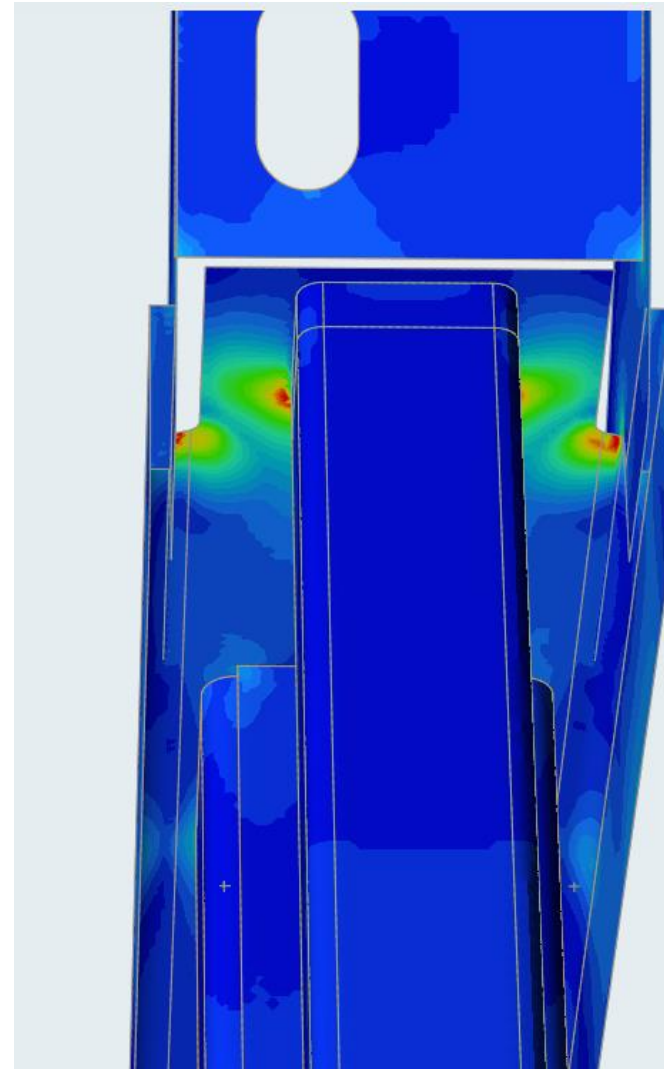
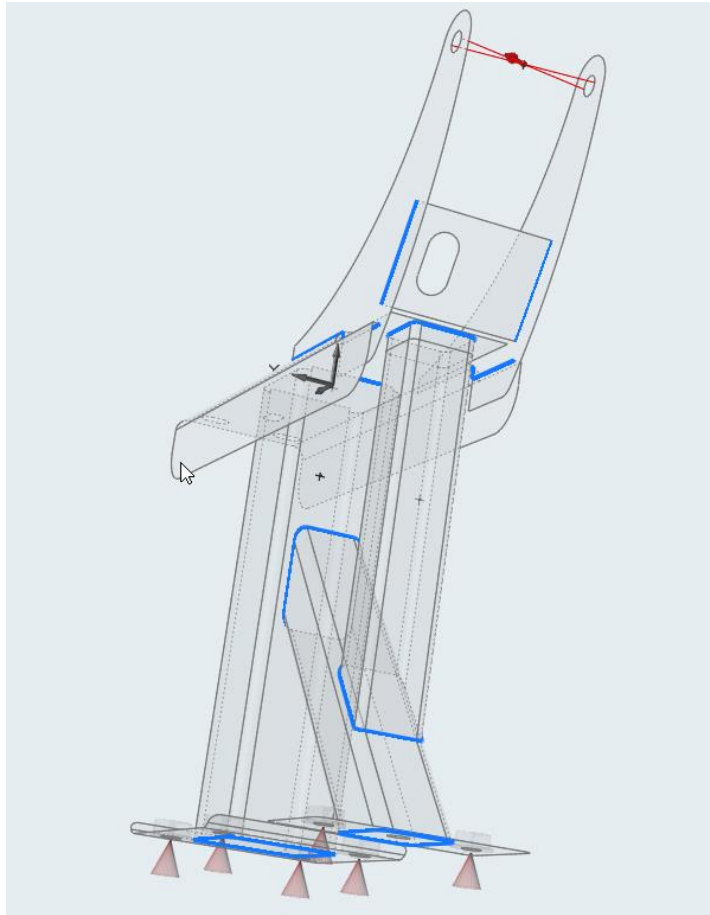
Mod #1: full perimeter weld winch base to 3x3 tube



Mod #1 Results: Stress transfers to the thin Winch Base material, a better fix is needed.



Mod #2: Add a vertical brace tube, remove extra 3x3 tube welds (one change at a time)



Stress transfers into the winch base material and now the slots light up. The slots can be fixed but overstressing the winch base thickness is not acceptable.

Analysis Explorer

Run

Winch Frame newbrace tube 06 (6)

Load Case

Load Case 1

Result Types

Displacement
Factor of Safety
Percent of Yield
Tension/Compression
Max Shear Stress
von Mises Stress
Principal Stress
Principal Strain

Principal Stress: Major

Max: 3.383e+02 MPa
2.850e+02 MPa
2.551e+02 MPa
2.252e+02 MPa
1.953e+02 MPa
1.654e+02 MPa
1.356e+02 MPa
1.057e+02 MPa
7.578e+01 MPa
4.589e+01 MPa
1.600e+01 MPa
Min: -1.389e+01 MPa

Animation

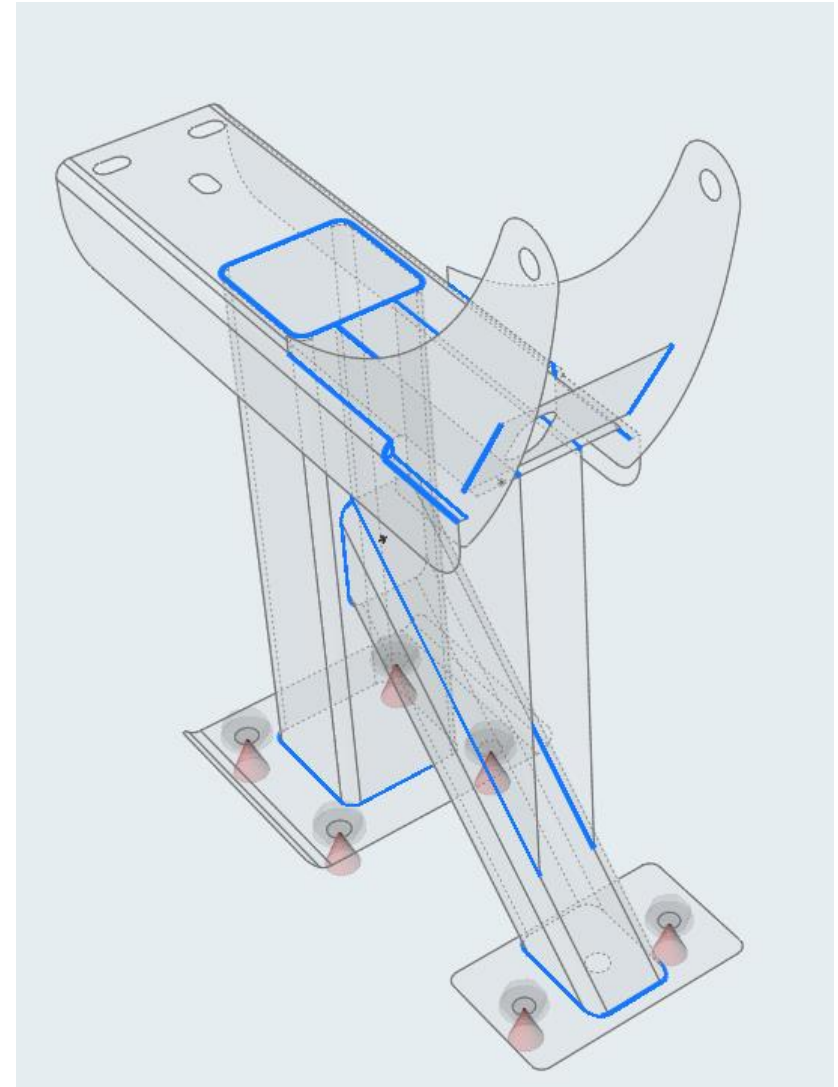
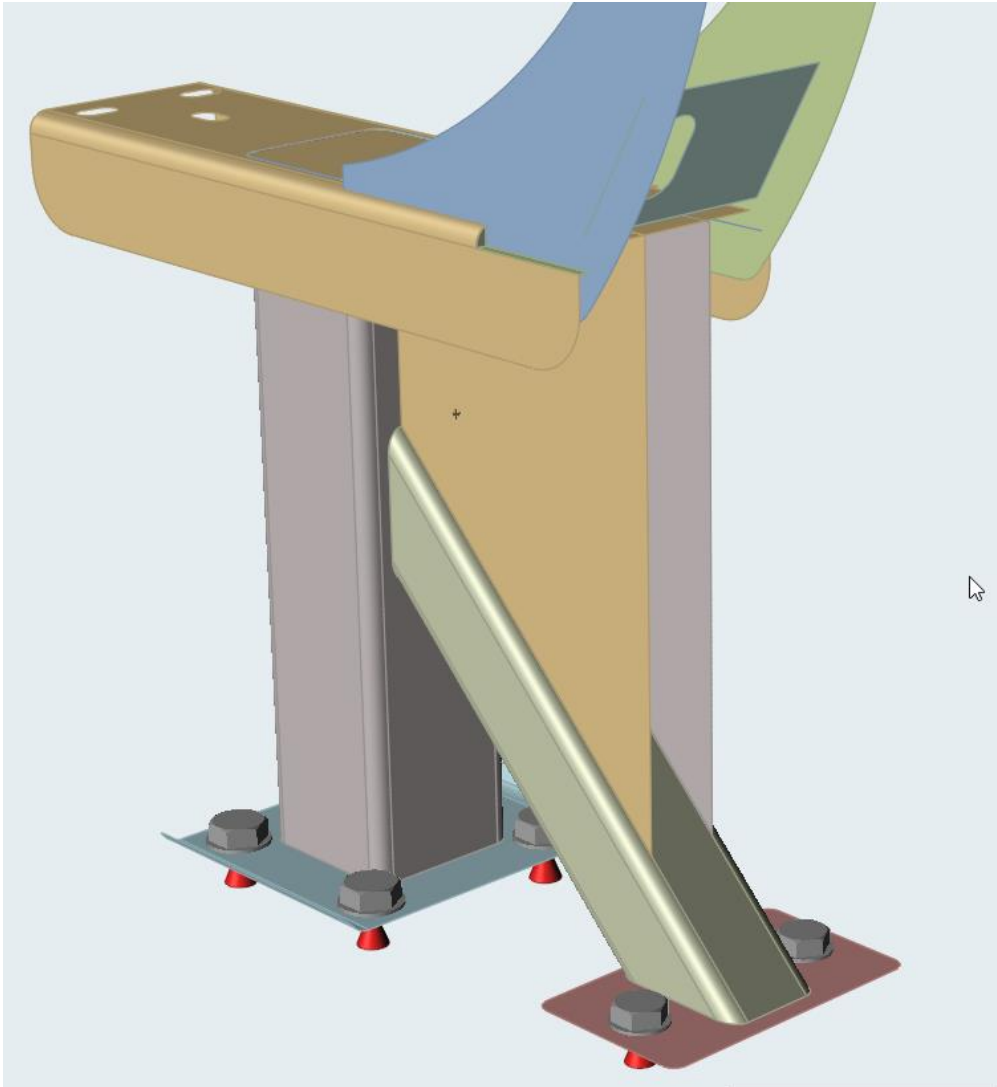
Show

Callouts

Min/Max

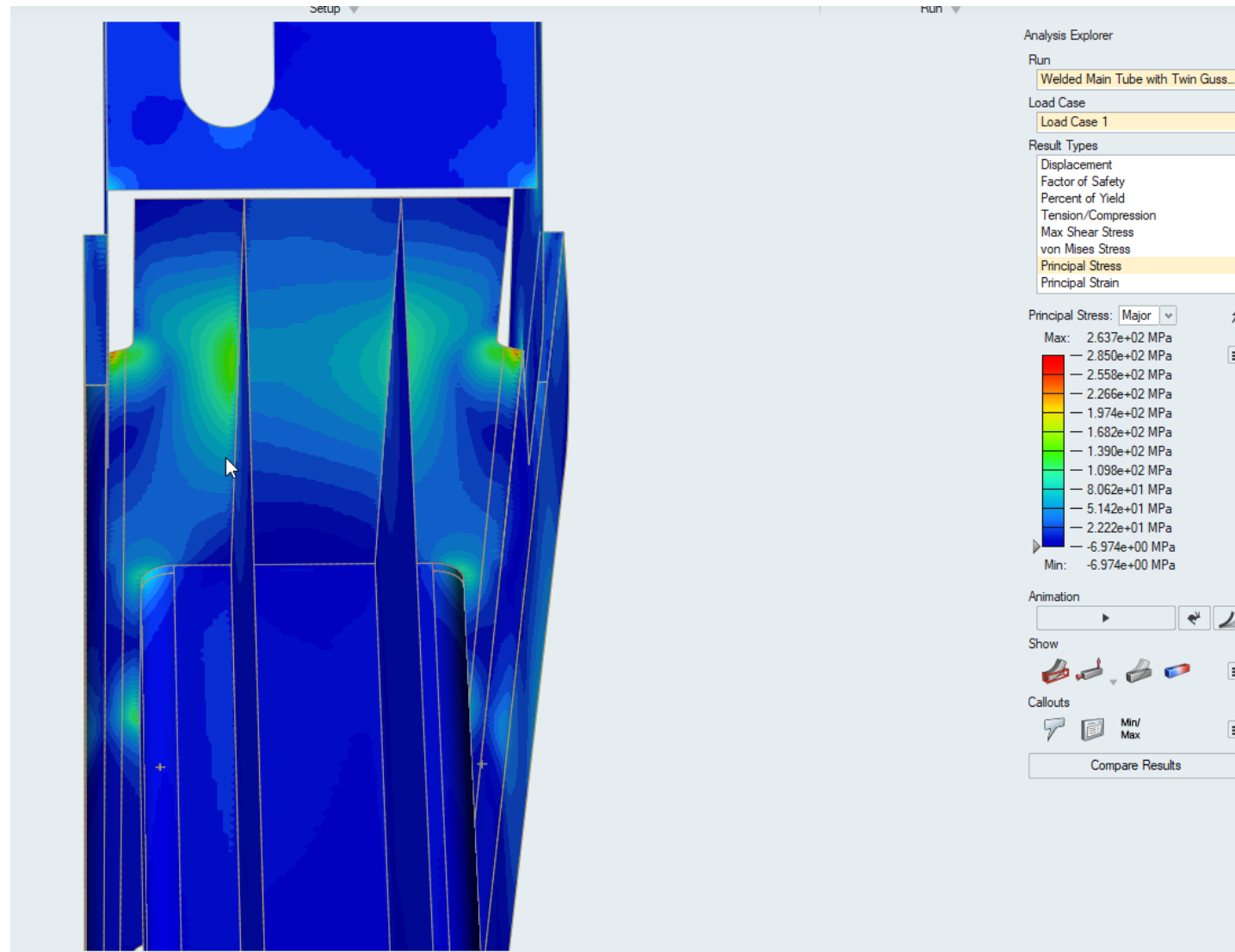
Compare Results

Mod #4 (Mod #3 was a bust): Twin $\frac{1}{4}$ " thick gussets with full 3x3 tube weld



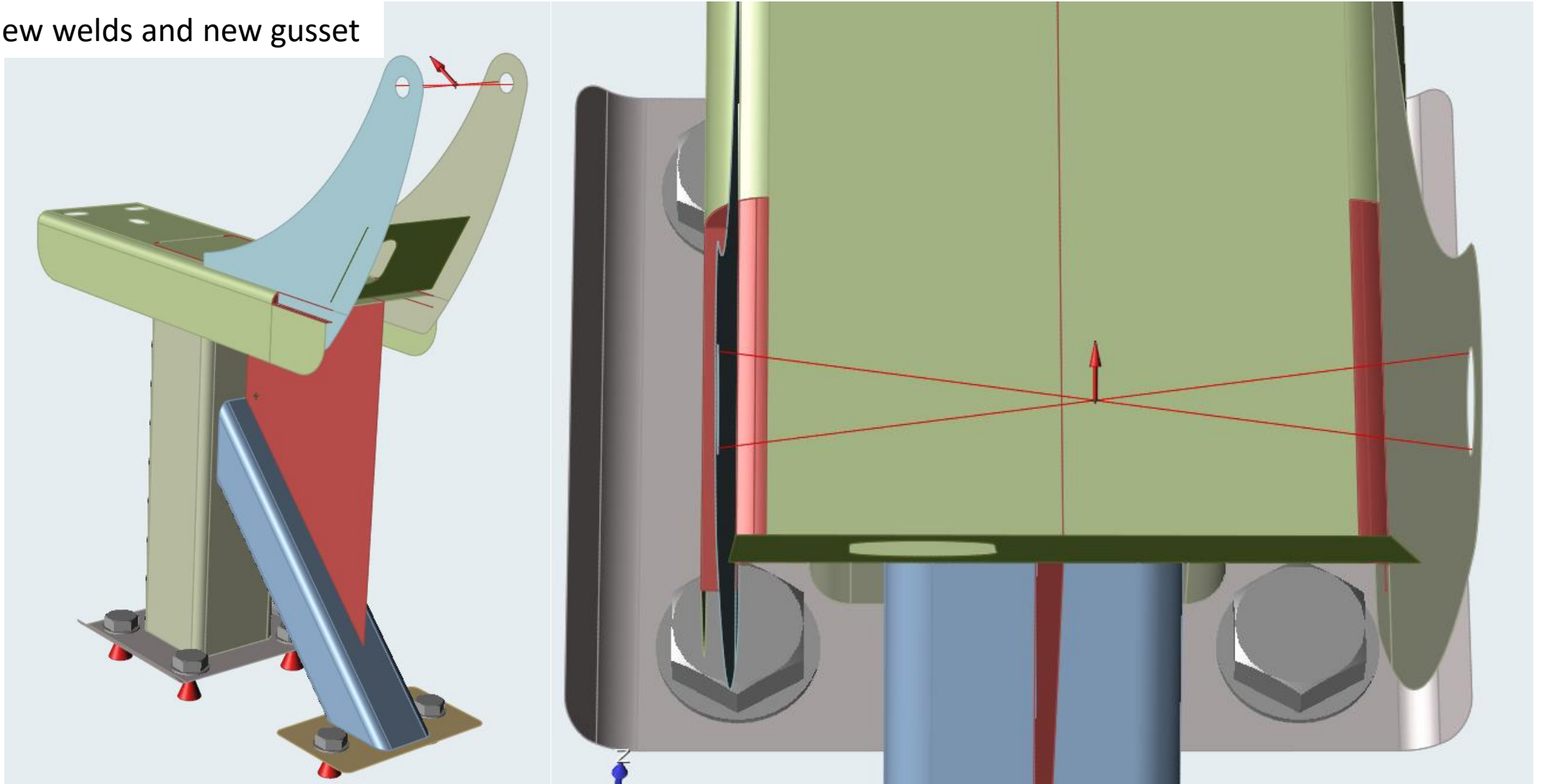
Mod #4 Results: Stress is lowered and slots don't light up as much

Now it looks like we can manage the stress but a MIG tip is not going to fit to full weld the gussets.



Mod #5: Single $\frac{1}{4}$ " thick gusset, full 3x3 tube weld and filled in slots

Oxide color are new welds and new gusset



Mod #5 Results: Lowest stress and all areas are below yield stress

That little bit of orange in the slot welds can be eliminated by tailing off the weld upwards or downwards into the uprights. I don't believe this material is AISI 1015, my sense tells me it is closer to A36 since it is cheaper.

We started at 358MPa on the OEM winch stand and ended up at 222MPa which is a significant reduction in stress. Afterwards, I had to retighten the u-bolts as the winch stand would move forward when latching the Drotto. I put my Drotto in the lower hole and now I back in and fully submerge the bunks and I just idle in and bump the throttle – no more drama, just click, and then wifey pulls me out of the water.

