

Failure of the Forestay Lower Toggle



The starboard toggle leg lower fracture surface shows some discoloration indicating fracture face has existed for some time. Also notice that the new metal part of the fracture face is to the port side. So failure progressed starboard to port including final failure.

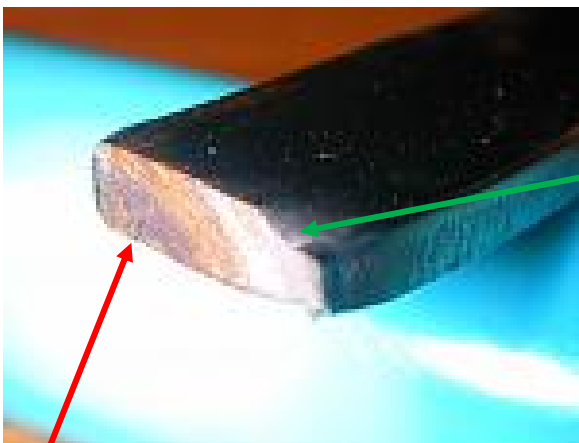


New toggle which tells me that the toggle above was mounted in the upset position or the legs of the "U" were pointed down.



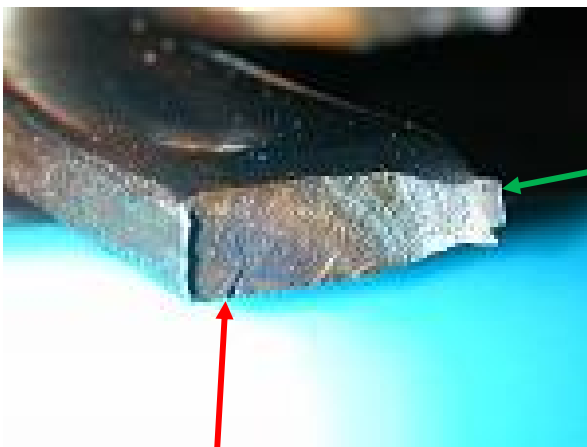
Port side fracture faces look new and not discolored meaning Port side leg fracture was secondary and not primary failure leg.

Starboard leg fracture face is discolored showing it is the primary failure leg.



Clean portion of fracture face plus sucking in of the metal in the through thickness direction indicates final fracture overload.

Discolored primary fracture face from Starboard leg showing cracking existed for some time before failure.



Again clean area with suck-in is indicative of overload final failure of the starboard leg.

Clam shell markings from lower left are indicative of fatigue. Stress corrosion cracking can create this appearance but usually not this definitive. The fracture surface ridge at the tip of the red arrow is usually indicative of boundary that separates two fracture origins. Both in the lower left area of the fracture surface.



Assuming I have the orientation right the red arrow points to the failure origin and green arrow points to the final fracture part of the starboard leg. That being the case it tells me that the crack started on the inside of the "U" and at a level adjacent to what appears to be a section of a bow roller. I would look for corrosion pits or wear (fretting) near or at the fracture face as the origin on the inside of the "U". In any case the presence of multiple fracture origins indicates a higher than planned load on this leg of the "U". Given that then it looks to me like the toggle is constrained from port to starboard and reverse movement by the side of the bow roller thus loading the starboard leg of the "U" in tension on a port tack.

What I am wondering at this point is that if the "U" legs had been pointing up and rotated 90 degrees. The base of the "U" would have been free to rotate port to starboard and reverse, and a pin at the legs of the "U" through an eye on the base of the turnbuckle would allow rotation fore and aft relieving all constraints on both tacks.

My interest in this failure is would it be easy to inspect without disassembling the toggle. Since I believe it started from the inside of the "U" it looks like I would have the disassembly the toggle to fully inspect it.