Load test to failure of VariEze N11EJ

Our thanks to Ernie Joiner, who donated his *Varieze* so that we might all benefit from a structural load test-to-failure of this 21-year-old airplane.

After removing the canopy and reserve fuel tank, we placed the *Varieze* upside down on a steel support structure, so that the two top longerons lay flat and level on top of two strips of PVC foam to spread the load. The wings and canard were installed, and we gathered together all of the 25 lb. shot-bags that we own. We marked the ¼ chord on the wing and canard lower surfaces, and laid out a series of butt lines 6 inches apart, full span. These markings were used to position the shot bags precisely at known butt line and fuselage station positions.

The canard shown here prior to adding another row on top of the first 8 stacks on each side. We missed getting a photo fully loaded due to an early failure! It failed at 8.3 'Gs'

We decided to load the canard first, but in order to do that we had to stack a bunch of shot bags on each wing root, to prevent the whole plane from nosing over! As you can see from the enclosed photos, we stacked 6 shot bags vertically starting at the side of the fuselage, and working outboard. We ended up with 8 vertical stacks of six 25 lb. shot bags, one stack of two shot-bags, and finally just one shot-bag at each canard tip. After a few seconds, the canard failed symmetrically starting at the right root, but both sides broke flush with the sides of the fuselage. Based on the maximum gross weight of a *VariEze* of 1050 lbs., this particular canard failed at an 8.3 'G' load factor.

This is lower than we expected. We have failed several canards over the years, none as old as this one, so age may be playing a part here, and we who fly these types of aircraft, should bear this fact in mind! The symmetrical failure and the failure mode were unusual though, and had not been seen before. The top spar cap, loaded in compression, popped loose from the 'C' shaped shear web lay-up beneath it, tearing the top skin loose, and then the shear web and lower spar cap failed catastrophically on both sides at almost the same instant. Typically we have seen one side of the canard fail all at once, at a load factor of 12 'G's, or more. We have never seen the top spar cap separate at the secondary bond line between the shear web and the top cap. This may have been due simply to the age of the materials and/or the hot/wet semi-marine type environment in which this aircraft spent most of its 21 years of life. It could also possibly be a workmanship issue, an incorrectly prepared shear web surface for example, or a combination of both.

We would very much like to test more canards, including if possible a *Long-EZ* Roncz canard. If there is anyone out there who has such items that they would be willing to donate, we would very much appreciate it, and so would all of the folk out there who are flying homebuilt EZs and perhaps even other glass and epoxy ships.

The left wing shown one instant before it failed catastrophically at 7 'Gs' Note the leading edge of the wing mismatched with the fuel strake as it fails!

The main wing was then carefully loaded, see photo. Because the normal failure of a *VariEze* wing would almost certainly be near the end of the wing spar box, around mid-span of the wing itself, we deliberately loaded this set of wings biased to the inboard to ensure a failure at or very near the wing fitting itself. In this we were successful. The failure occurred right at the wing attach fitting in the centersection spar. Just prior to this failure, the additional torsion that was applied, due to our desired load schedule, caused the centersection spar to tear away from the lower fuel tank skin, then the centersection spar box failed cleanly at the inboard edge of the wing fitting. The load factor at the moment of failure was 7 'G's. This failure also occurred at a lower load than expected. Some of this was due to our desire to fail the wing at the wing fitting. Some of it may be due to old age, and the hot/wet semi-marine environment in which it was stored. It is difficult to quantify exactly why the wings and the canard on this particular aircraft failed at a lower than expected 'G' load factor.

Prior to conducting this structural load test, we had done an informal load test to failure of the winglet to wing joint. We stood the left wing on its root end, and secured it to a structural steel post. We loaded this winglet such that the loads were bending the tip of the winglet inboard, because in normal flight, the lift generated by each winglet bends the winglet tip inboard, (toward the engine). In an extreme sideslip departure mode however, one winglet might see about one third of this load exerted bending the winglet tip outboard. For this reason we loaded the right wing/winglet so the winglet tip bent outboard.

The wingtip is supported at the winglet root, and the shot-bags shown here represent design limit load. The winglet failed right at ultimate load.

The steel support post & top of the wing can be seen. There are 42 shot-bags on the outboard side of the winglet, and a forklift with a pallet on its forks, is positioned just under, but not touching in case of a failure. It did NOT fail, although this load was more than two times the required strength!

The winglet tip-to-outboard test on the right wing resulted in a failure right at the prediction for such a failure. When we tested the left wing, we ultimately loaded 42 shot bags onto this winglet! This was all that it was possible to physically fit on to the winglet, however, we heard no noise, and could not fail this wing/winglet joint. Indeed, it way exceeded our expectations! Does this mean that age may not play much of a part? If so, maybe workmanship perhaps plays a much larger part?

All of the above testing was conducted on a *Varieze* with a design gross weight of 1050 lbs. The *Long-EZ* canard, at least the original GU canard, is essentially the same as the VariEze canard. However, the *Long-EZ* design gross weight is 1425 lbs, 36% heavier than the *VariEze.* While this comparison is not a perfectly linear function, the conclusion has to be that anyone flying a *Long-EZ* using the original GU canard may have less than the assumed normal safety factor of 1.5. The Roncz 1145MS canard is slightly different. It has a shorter span than the GU, and it also has thicker spar caps. We really do need to find a Roncz *Long-EZ* canard and perform a load test to failure on it, before we can come to any real understanding of this possible problem.

Conclusion: Based on just this one test-to-failure of what appears to be a well-built *VariEze*, we must insist that all *Varieze* flyers, as well as *Long-EZ* flyers with GU canards, should never exceed 3.5 ‘G’ in flight. If you do, particularly at heavier gross weights, you are possibly in danger of an in-flight structural failure! Do not take this lightly!

We are actively seeking a few more canards to test, and we would like these to be either *VariEze* or *Long-EZ* GU canards (the original plans built canards), and in addition, we would like to test at least one *Long-EZ* Roncz 1145MS canard. The older these canards are, the better. We do not really need to test a newly manufactured structure; we know how strong they are. We need to determine if age has any derogatory effect on structural integrity, and we will conduct structural testing to failure, and report back to this group with our findings. If you have or know someone who has one of these canards, please have him contact Mike Melvill at melvill@scaled.com