Acrylic Strength Test Report

Varying fillet radius

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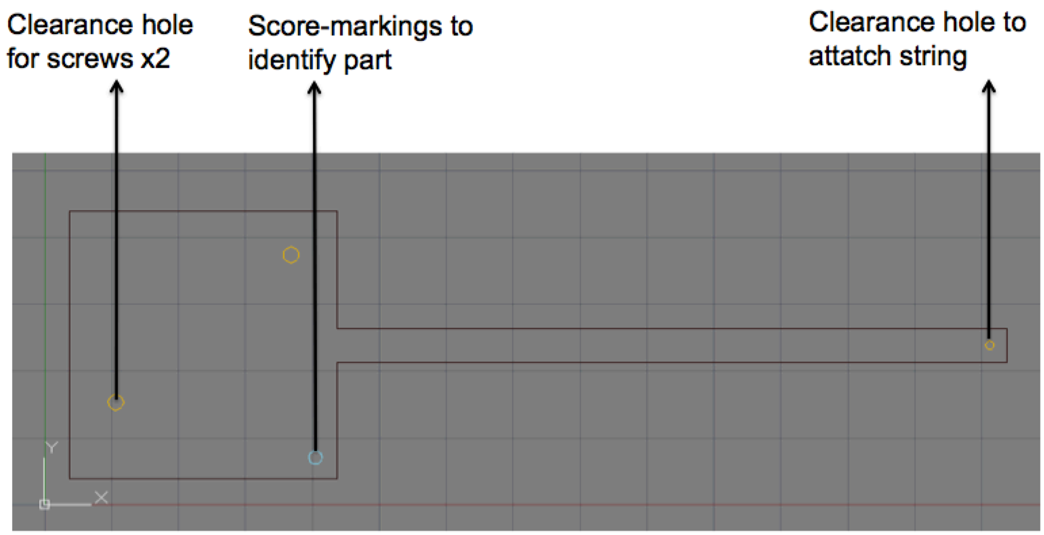
Objective of Test:

The objective of the test was to verify whether adding a fillet to the corners of acrylic parts cut by the Lasercamm would result in a noticeable increase in the strength of that corner.

We would also like to observe the general trend of the fillet strength versus the fillet radius. In particular, we are interested to know if a really small fillet radius (0.0015”) has comparable strength to that of a much larger radius (0.35”).

Description of Test Parts:

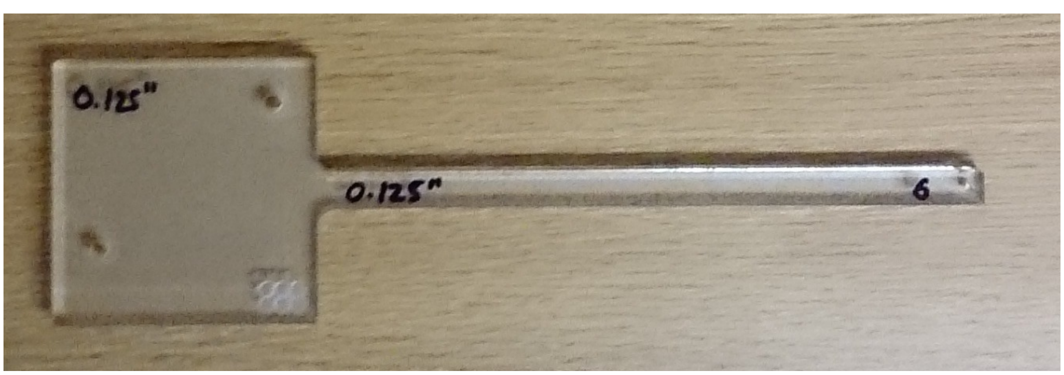
The parts were designed to resemble cantilever beams with the force applied at the end of each part. Seven parts were made with fillet radii varying from 0.0015” to 0.35” and a control part with no fillet.



CAD Figure of a test part

Two clearance holes were cut so that screws could be placed through them. This allowed the part to be clamped loosely so that minimal force would be applied onto the acrylic due to the clamp itself. The moment about the screws would then keep the acrylic in place.

Each part was scored with a different number of circle markings on the bottom to differentiate between them.

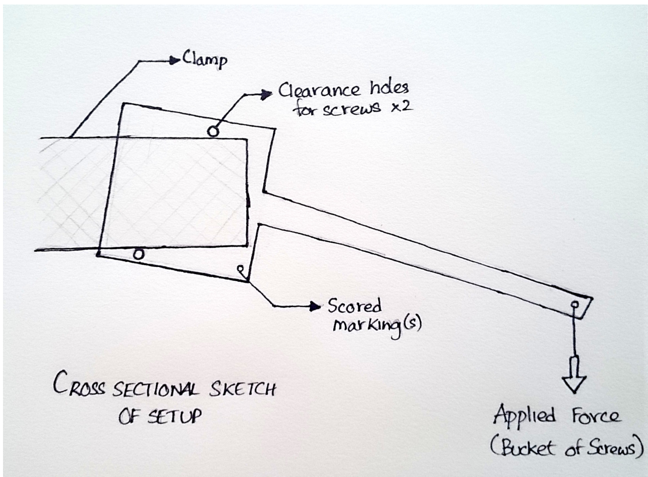


Actual part cut from Lasercamm

Description of Setup:

Two screws were inserted into the holes on the square portion of the part and then the part was clamped loosely, ensuring that the fillet was jutting out of the clamp.

A second part was also clamped at the other end of the clamp to ensure that uniform pressure was exerted on the parts during the test.

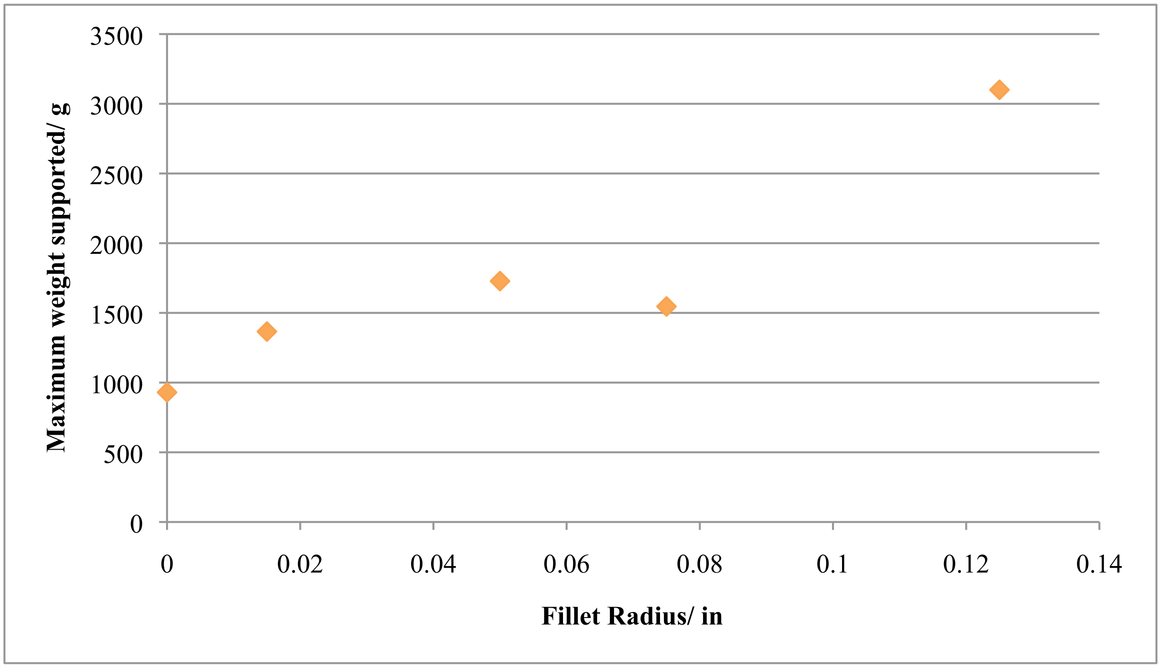


An empty bucket attatched to a string was tied to the hole at the end of the part and allowed to hang. Care was taken to ensure the bucket and thus the string underwent minimal rotation.

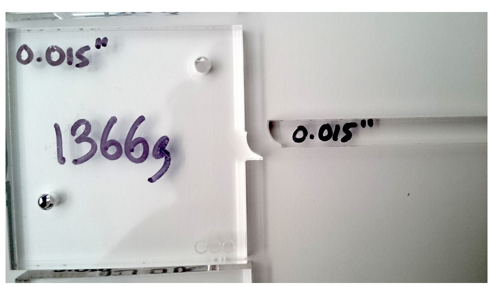
For each trial the bucket was slowly filled with screws until the part broke. Then, the weight of the bucket and screws in it were measured using a digital weighing scale or a spring balance (the maximum load of the digital scale was approx. 2kgs).

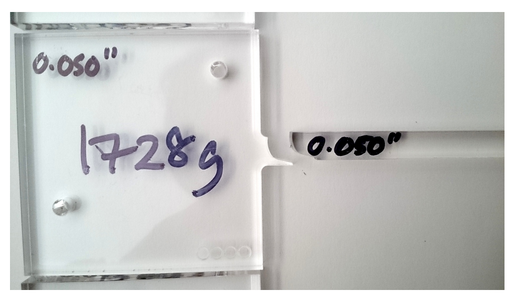
<u>Results:</u>

Fillet radius/ in	Maximum Weight Supported/ g
0	930
0.015	1366
0.050	1728
0.075	1546
0.125	3100



Note: The values for the 0.0015” and 0.35” radii fillet parts were omitted because of experimental errors (No steady loading and the string snapping before the maximum load, respectively).





Conclusion:

From the results and the graph, it is clear that adding a fillet does in fact significantly increase the load that the part can take before snapping.

There was approximately a 47% increase in maximum weight supported from a no fillet to a 0.015” fillet part.

There was approximately a 127% increase in maximum weight supported from a 0.015” fillet to a 0.125” fillet part.

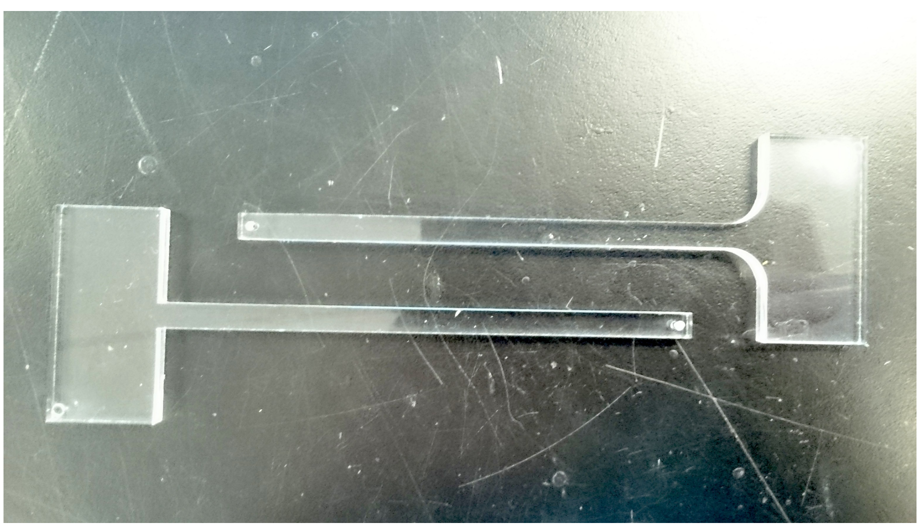
This suggests that adding a fillet with a larger radius should, in general allow the part to support more weight. However, even adding a small fillet radius is significantly better than no fillet.

Thus, it is desirable to use a small fillet (which does not affect the aesthetics of a part greatly) rather than not use one at all.

Evolution of Test parts:

Initially, the test parts were designed based off parts from my pendulum clock body. However, it turned out that much more force/weight would be required to break the parts than was available.

The second design was thus made intentionally weaker by making the parts resemble cantilever beams. However, while testing these parts, we realized that the parts with bigger fillet radii started slipping out of the clamp before breaking. To stop them from slipping, we tightened the clamp even more, but then realized that this would be putting external stress on the acrylic and hence would adversely affect the maximum weight the part could support.



Thus, for the third redesign the clearance holes for the screws were cut so that the screws could provide a counter moment to the weight applied and allow us to avoid over-tightening the clamp.

Acknowledgements:

There were a number of people who helped me carry out and plan this test successfully.

I would like to thank Professor Delson for encouraging me to carry out the experiment as well as helping me set up the theoretical analysis, Chris Cassidy for suggesting the cantilever beam design, Dane Sequeira for recommending the use of the screws to avoid over-tightening the clamp and Philip Dezonia for helping me record a video and take photos during the test.