STRESS ENGINEERING SERVICES INC.

an employee-owned company

Tri-comb™ Structural Compressive Strength Testing

Final Report

Prepared for:

Warren L. Herron Intellectual Property Development & Management

Gulf Breeze, FL

August 4, 2017

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1. Introduction and Scope

Warren L. Herron Intellectual Property Development and Management (herein, the "Client") has patented a panel structure known as Tri-comb™ technology that may offer improved performance vs. other engineered structural materials. Per request, Stress Engineering Services (SES) has performed mechanical testing on prototype Tri-comb™ samples to measure compressive strength.

The Tri-comb™ prototypes to be tested consist of repeating units of a 2" x 2" x 1" square cell core structure, as shown in Figure 1. A total of six (6) 4-cell specimens (4" x 4" x 1") were provided for testing in compression (3 each in face and edge-loaded orientations). The desired orientation of each specimen was marked by the Client, and this orientation was used by SES during the test setup. All samples were manufactured from 6061-T651 aluminum alloy by the Client.

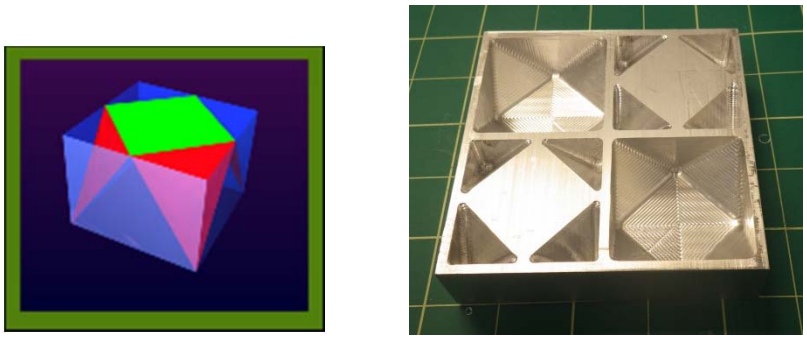

Figure 1. Example square cell core unit and 4-cell Tri-comb™ samples provided for testing.

2. Assumptions and Restrictions

The components tested for this report represent prototypes of one possible Tri-comb™ structure; they were not optimized models and were not produced using the expected production processes. Test results may not be representative of optimized structures and/or those produced via mass production processes.

3. Methods

3.1 Side Compression

For the edge-loaded compression test, a uniformly distributed load was applied on the 4" x 1" edge of the 4-cell specimen, while supporting the opposite edge (Figure 2). The sample was loaded and supported by steel compression platens. Each sample was compressed at a rate of 0.1 in/min until buckling or other failure mode occurred, or until the height of the sample was compressed by 1 inch (reduced to 75% of the original nominal thickness). Load vs. displacement was recorded, along with the

compressive yield strength and failure mode. Video recording of the test and failure of each specimen was performed.

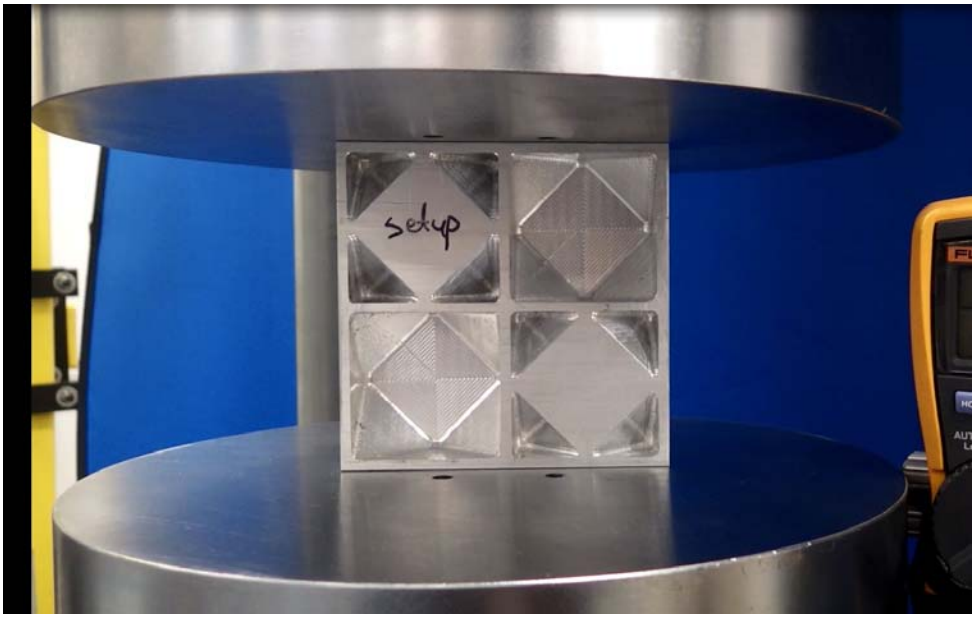

Figure 2. Side compression test setup.

3.2 Top Compression

For the face-loaded compression test, a uniformly distributed load was applied on the 4” x 4” face of the 4-cell specimen, while supporting the opposite face (Figure 3). The sample was loaded and supported by steel compression platens. Each sample was compressed until buckling or other failure mode occurred. The test was stopped when a displacement of 0.4 inches was reached, i.e. compression of the test sample to 60% of its original thickness. Load vs. displacement were recorded, along with the compressive yield strength and failure mode.

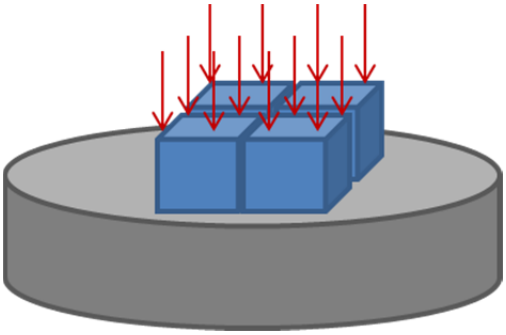

Figure 3. Schematic drawing of the top compression test setup.

4. Results

4.1 Side Compression

Test results for the 3 side compression samples are summarized in Table 2, with load-displacement curves provided in Figure 5. All samples were stopped upon reaching 1 inch displacement, as significant buckling and visible cracks were visible at that point. Videos of each test sample are available.

Yield strength was calculated for each specimen as the load when the displacement curve began to deviate from the initial linear portion of the curve (an indication that buckling has occurred). This was accomplished by fitting a line to the linear portion of the data (applied loads of 5000 – 15000 lb) and offsetting the best fit line by 0.01 inches. An example of yield strength determination is shown in Figure 6.

The observed initial buckling mode and more severely deformed shape of the Tri-comb™ structure during the side compression test are shown in Figure 7.

Table 2. Summary of side compression test results.

Part ID	Weight (lb)	Yield Load (lb)	Peak Load (lb)
2/19	0.49	25,060	27,566
3/11	0.48	23,293	25,508
3/15	0.48	22,884	25,368

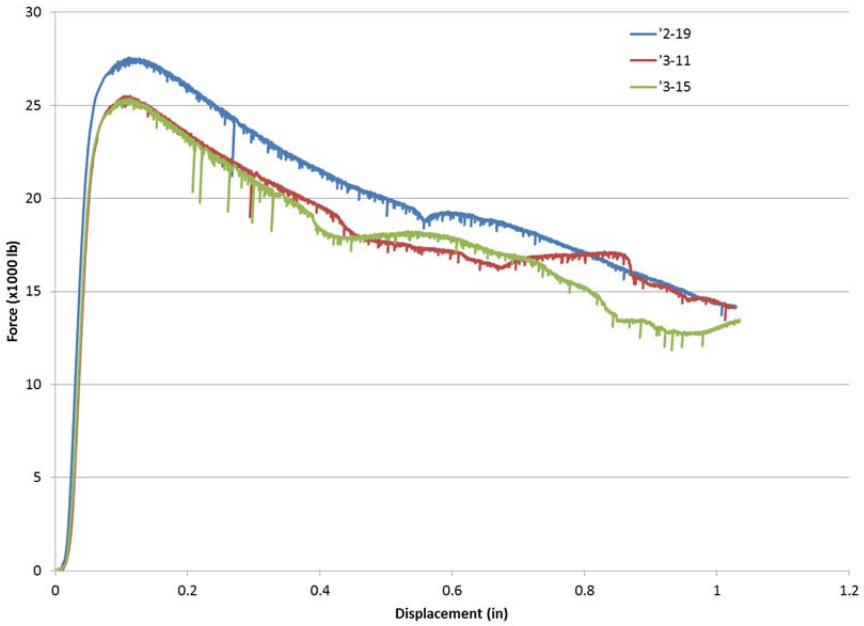

Figure 5. Load-displacement results for the side compression test.

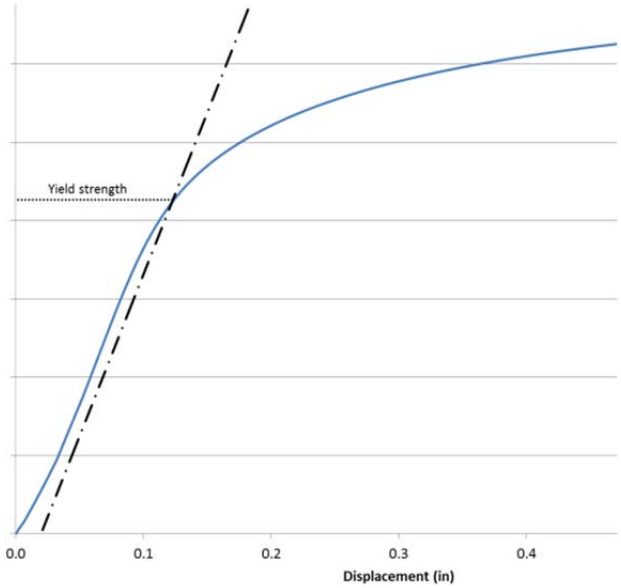

Figure 6. Example yield strength calculation.

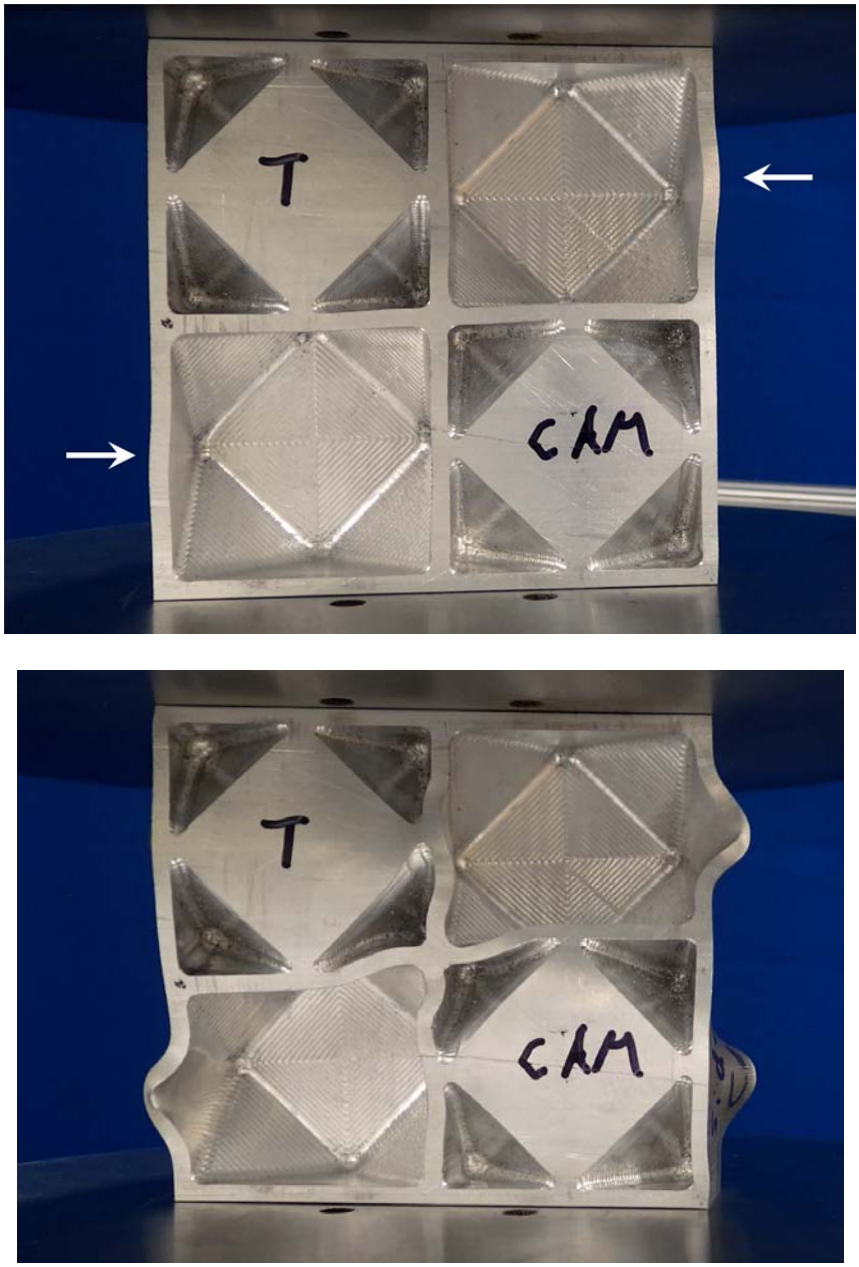

Figure 7. Initial buckling mode (top) and more extensively deformed shape later during the test (bottom) of the 2/19 test sample.

4.2 Top Compression

Test results for the 3 top compression samples are summarized in Table 3, with load-displacement curves provided in Figure 8. All samples were stopped upon reaching 0.4 inch displacement.

Yield strength was calculated for each specimen as the load when the displacement curve began to deviate from the initial linear portion of the curve (an indication that buckling has occurred). This was

accomplished by fitting a line to the linear portion of the data (applied loads of 50,000 – 150,000 lb) and offsetting the best fit line by 0.01 inches.

The post-test deformed shape of the Tri-comb™ structure during the top compression test is shown in Figure 9.

Table 3. Summary of top compression test results.

Part ID	Weight (lb)	Yield Load (lb)	Peak Load (lb)
2/12	0.50	175,380	250,810
2/16	0.50	177,780	251,050
2/17	0.50	180,150	250,900

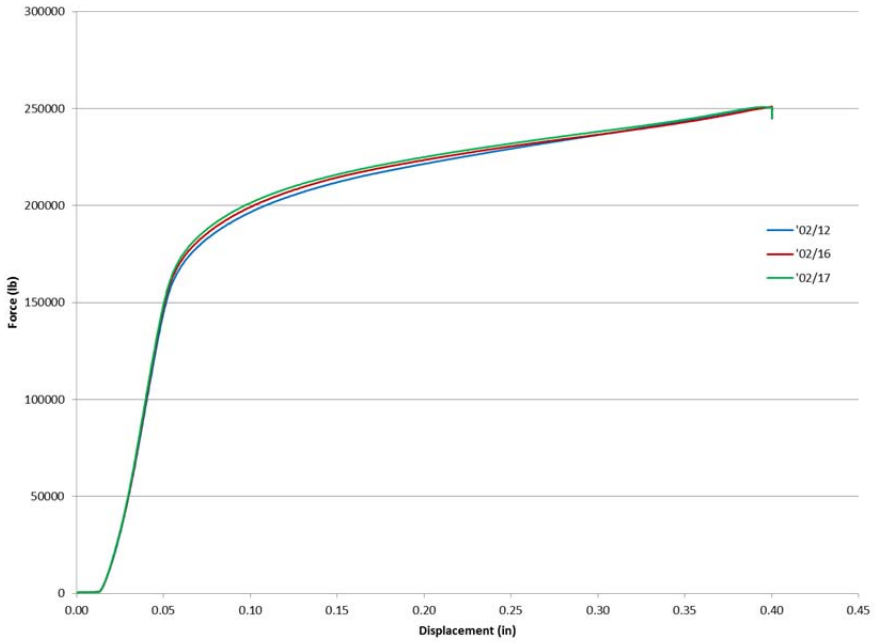

Figure 8. Load-displacement results for the top compression test.

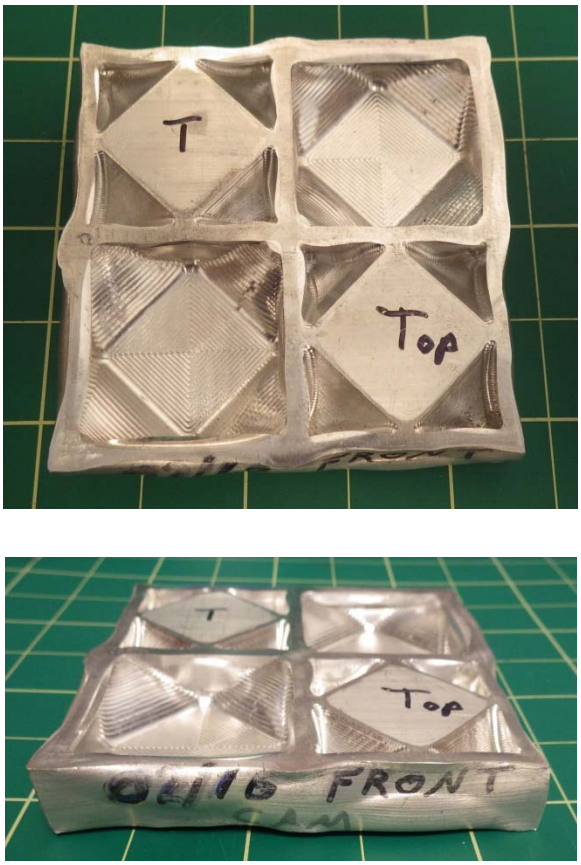

Figure 9. Deformed shape after top compression testing of the 2/16 test sample.

5. Conclusions and Recommendations

The Tri-comb™ structure side compression and top compression tests have been successfully completed. Buckling loads during the side compression test averaged 23,750 lb, and top compression buckling loads averaged 177,800 lb. These buckling loads represent nearly 50,000 times the sample weight for side compression, and over 350,000 times the sample weight in the top-loaded compression test.

Limitations of This Report

This report is prepared for the sole benefit of the Client, and the scope is limited to matters expressly covered within the text. In preparing this report, SES has relied on information provided by the Client and, if requested by the Client, third parties. SES may not have made an independent investigation as to the accuracy or completeness of such information unless specifically requested by the Client or otherwise required. Any inaccuracy, omission, or change in the information or circumstances on which this report is based may affect the recommendations, findings, and conclusions expressed in this report. SES has prepared this report in accordance with the standard of care appropriate for competent professionals in the relevant discipline and the generally applicable industry standards. However, SES is not able to direct or control operation or maintenance of the Client's equipment or processes.

Intellectual Property

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