STRESS ENGINEERING SERVICES INC.

an employee-owned company

Tri-comb™ Structural Strength Testing

Bending Strength with Top Panel

Prepared for:

Warren L. Herron Intellectual Property Development & Management

Gulf Breeze, FL

September 18, 2017

SES Document No.: 2651051-TS-RP-04 (Rev 0)

Rev	Date	Description	Originator	Reviewer
0	18-Sept-2017	Issued for use	A Stoller	S Read

Tri-comb™ Structural Strength Testing

Bending Strength with Top Panel

SES Document No.: 2651051-TS-RP-04 (Rev 0)

September 18, 2017

Prepared for:

Warren L. Herron Intellectual Property Development & Management

Gulf Breeze, FL

Contact: Warren L. Herron III

Prepared by: _____

Alex Stoller

Associate II

Reviewed by: _____

Shannon Read

Sr. Staff Consultant

Stress Engineering Services, Inc.

7030 Stress Engineering Way

Mason, Ohio 45040-7386

Phone: 513-336-6701

Web: www.stress.com

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 bending strength of an example Tri-comb™ structure with a top panel.

The Tri-comb™ prototypes that were tested consist of repeating units of a 2" x 2" x 1" square cell core structure, as shown in Figure 1. A total of three (3) 8-cell specimens (8" x 4" x 1") were provided for testing in bending. In previous testing (SES test report 2651051-TS-RP-03), the Tri-comb™ structure had a nominal wall thickness of 0.125 inch. For the current bending test, the structure was modified for bending resistance with 0.25 inch wall thickness on the longitudinal vertical walls (Figure 2). In addition, the Tri-comb™ structure was tested with a 0.25 inch thick flat top panel, which was intended to distribute the locally applied bending loads to the underlying Tri-comb™ structure in a manner similar to potential usage in structural applications such as a bridge deck. All Tri-comb™ samples were manufactured from 6061-T651 aluminum alloy by the Client. The top panels were manufactured from 7075 aluminum alloy, also by the Client.

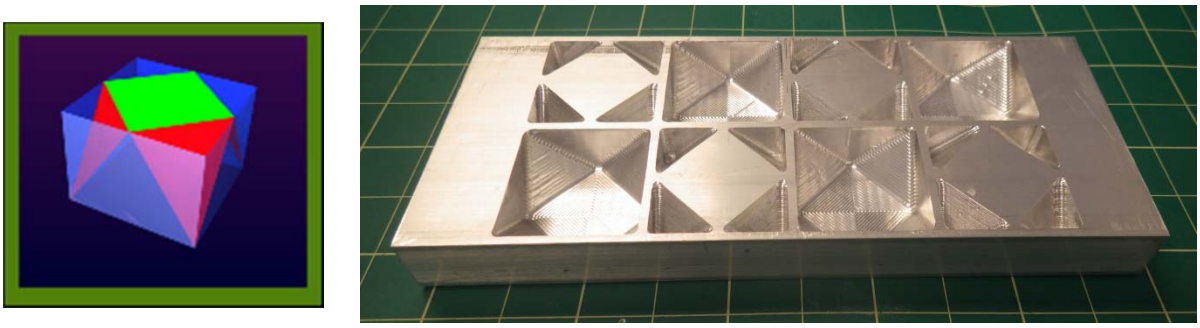

Figure 1. Example square cell core unit and 8-cell Tri-comb™ sample.

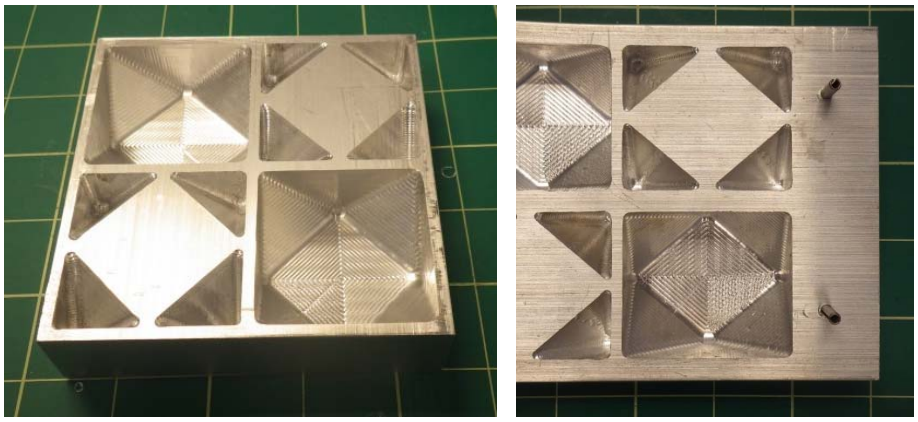

Figure 2. Tri-comb™ structure with 0.125" nominal wall thickness (left) and 0.25" longitudinal walls as manufactured for the bending test (right).

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 Bending

The bending test was performed with a 3-point beam bending setup as illustrated in Figure 3, using the fixtures previously designed and built to accommodate the Tri-comb™ sample geometry. Load was applied via steel rails, 1" diameter and 5" length, which were mounted on solid aluminum support rails. The lower supports had adjustable spacing, and a 9" support spacing was utilized for the test such that the lower supports were located on the solid ends of the 8 cell specimen. The upper steel rail was located at the centerline between the 2 lower supports, and was aligned at the center of the 8-cell Tri-comb™ structure. Load was applied along the centerline between the supports. The desired orientation of each specimen was marked by the Client, and this orientation was used by SES during the test setup. Slots in the top panel at each edge, along with spring pins inserted into the Tri-comb™ specimens, aided in alignment of the 2 pieces. Bending load was applied at a rate of 0.1 in/min until fracture or permanent deformation occurred, or a displacement of at least 1 inch was reached. Load vs. displacement was recorded, along with the bending strength and failure mode. Video recording of the test and failure of each specimen was performed.

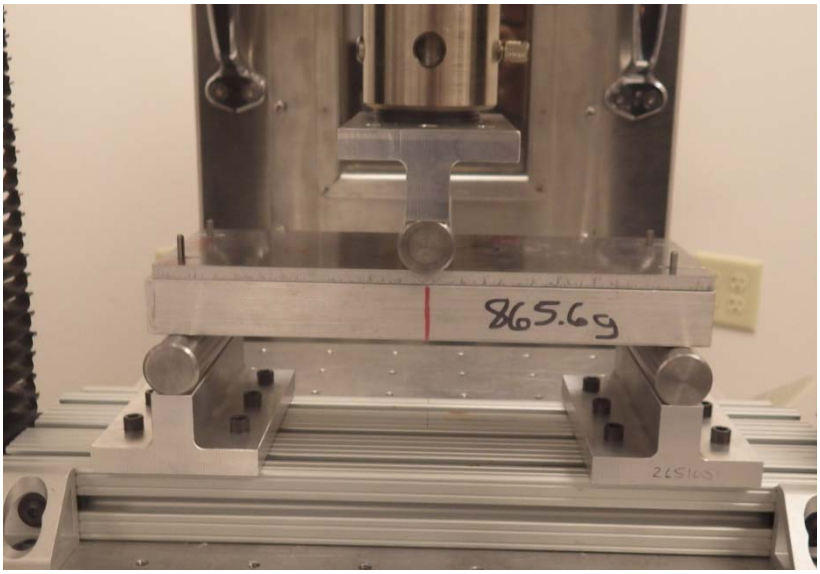

Figure 3. Bending test setup.

4. Results

4.1 Bending

Test results for the 3 bending samples are summarized in Table 1, with load-displacement curves provided in Figure 4. All samples were stopped upon reaching 1 inch displacement as planned per the test proposal. Videos of each test sample are available.[1]

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 2000 – 4000 lb) and offsetting the best fit line by 0.01 inches. The intersection of the offset fit line and the actual load-displacement curve was recorded as the yield load (see Figure 5 for example).

The yield strength averaged 4914 lb, which represents approximately 1706 times the average sample weight. The overall peak load averaged 9114 lb. Upon removal of the applied load, permanent deformation was observed in both the Tri-comb™ structure and the top panel; however curvature of the Tri-comb™ structure was greater (Figure 6). The deformed shape of the Tri-comb™ structure is illustrated in Figure 7.

Table 1. Summary of bending test results.

Part ID	Weight (lb)			Yield Load (lb)	Peak Load (lb)
	Tri-comb™	top panel	Total		
1	1.87	1.00	2.84	4876	9051
2	1.90	1.00	2.90	4945	9169
3	1.90	0.99	2.89	4920	9121

[1] https://webftp.stress.com/login Login and password information provided to client in a separate communication.

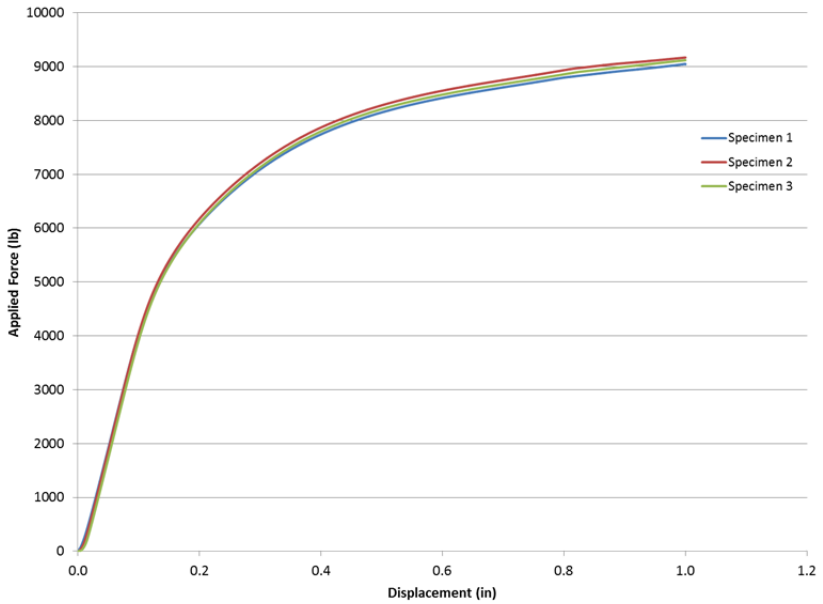

Figure 4. Load-displacement results for the bending test.

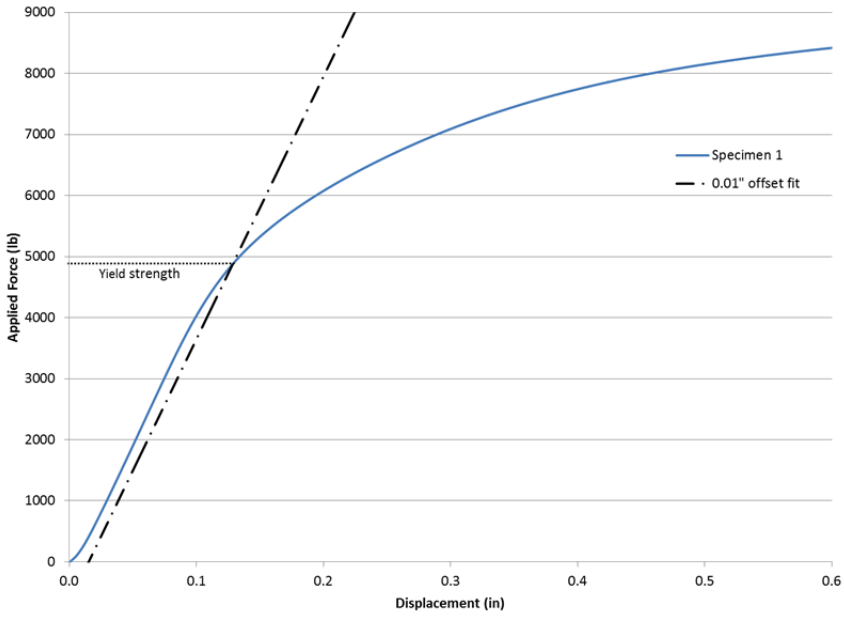

Figure 5. Example yield strength calculation.

Figure 6. Post-test photo of sample 1 showing permanent bending of the top panel and Tri-comb™ structure.

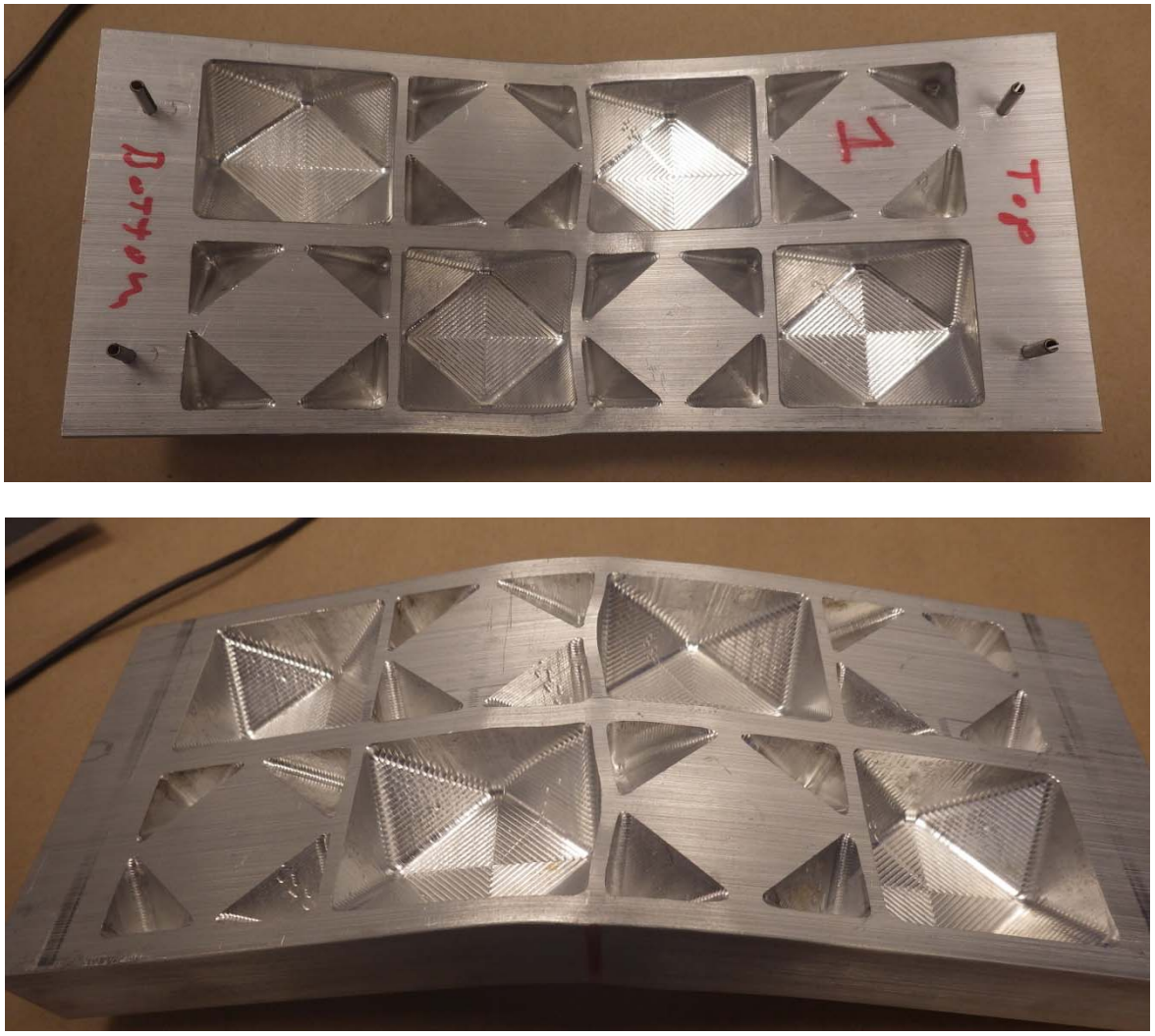

Figure 7. Buckled shape of the Tri-comb™ structure after the bending test.

5. Conclusions and Recommendations

The Tri-comb™ structure bending tests have been successfully completed. Bending yield strength averaged approximately 4900 lb or approximately 1700 times the sample weight.

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

It is Stress Engineering Services, Inc. (SES) policy to assign all intellectual property associated with product designs, functions, and processes to The Client. Stress Engineering Services, Inc. (SES) may generate designs and offer them to The Client as potential solutions without any specific knowledge regarding their patentability. If a particular design(s) emerges as a strong candidate, it is the responsibility of The Client to determine whether or not the concept infringes the patent of another entity. Stress Engineering Services, Inc. (SES) retains intellectual property rights for analysis and development methods that may occur in the course of a project.