Four-Point Bending of Thermoplastic Sandwich Panels

Preliminary Report

Prepared for:

Innovative Composite Products Inc.

By:

Concordia Center for Composites

Concordia University

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Introduction:

As a part of a joint project between Concordia Center for Composites CONCOM and Innovative Composite Products ICP, a series of mechanical tests will be performed for process optimization and material characterizations. This report covers the preliminary results related to the flexural behavior of sandwich panels. Two types of panels provided by ICP were investigated.

1. The first panel is made of woven fabric Glass/Polypropylene as facesheets and honeycomb polypropylene as core. The facesheets contains %60 of glass fiber by weight and the honeycomb core has the average cell size of 8 mm and density of 80 kg/m^3.
2. Facesheets of the second panel are made of Glass/Polypropylene with %40 of glass fiber by weight and polyethylene terephthalate PET recycled foam as core with density of 100 kg/m^3.

The four-point bending test based on the ASTM C393 were performed [1].

Test Method and results:

Composite sandwich panels were cut with the total length of 23" and width of 3". Other dimensions are presented in the table 1.

Table 1: Dimensions of two sandwich panels

Sample type	Total length	Span length	Load nose length	Average width	Average thickness	Facesheet thickness	Nominal core thickness	Actual core thickness
Foam core sandwich panel	23"	20"	10"	76.77 mm	51.82 mm	0.7 mm [40%glass]	2" (50.8mm)	50.42 mm
Honeycomb sandwich panel	23"	20"	10"	74.57 mm	50.17 mm	1 mm [60%glass]	2" (50.8mm)	48.17 mm

The four-point bending fixture with Instron universal testing machine were used to perform the tests. The samples were installed inside the fixture and loaded under displacement control with the rate of 2 mm/min. The fixture setup was based on the quarter-point loading. Load displacement diagram of the test is presented in Figure 1. It can be seen that the composite sandwich panel with honeycomb core can bear higher load (52% more than foam core maximum load). Honeycomb sandwich panel fails at 7.58 mm loading head displacement while foam core sandwich panel failed at 5.72 mm. Since both panels failed because of compression failure of top facesheet, in addition to core material, the different facesheet thickness and fiber volume fraction plays an important role in the failure load and displacement.

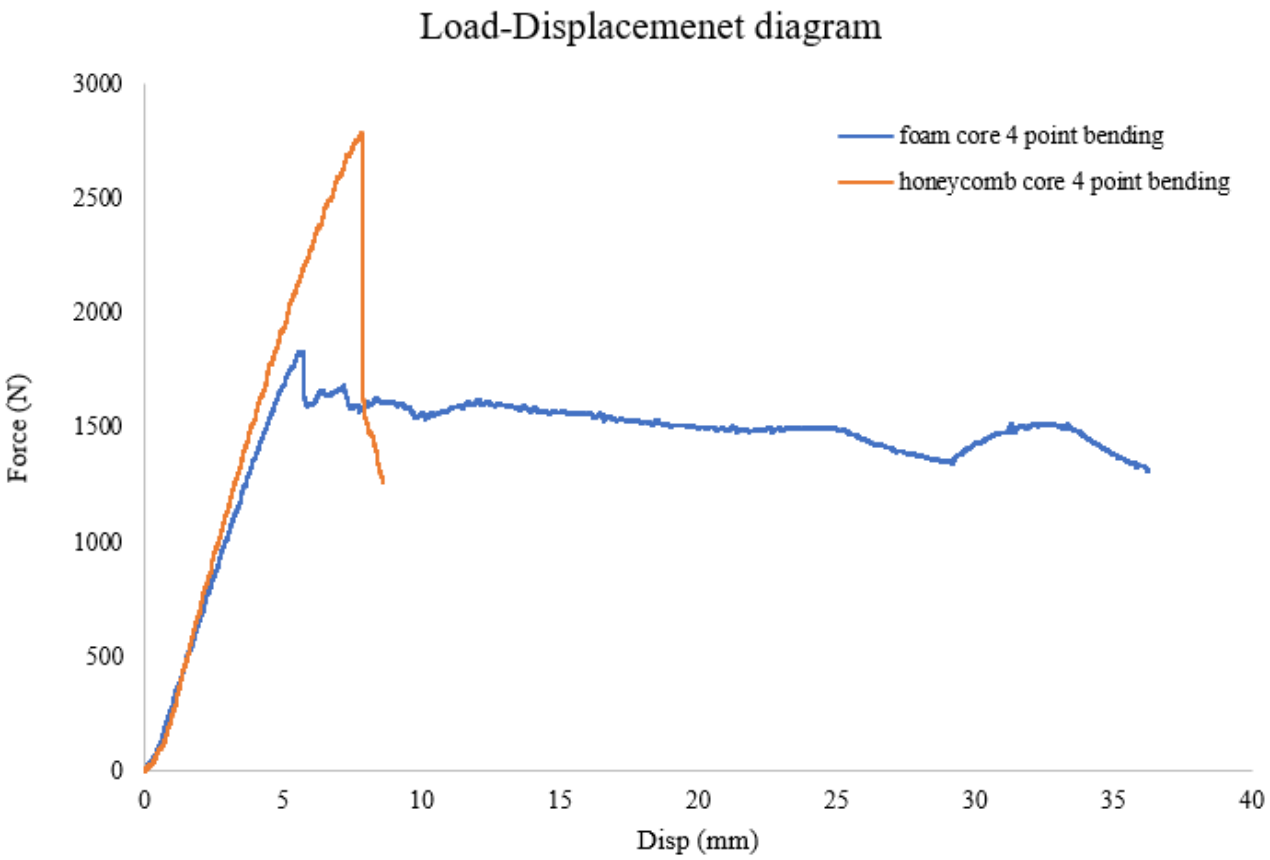

Figure 1: Load-displacement diagram for two different panels

One of the major differences between the foam core and honeycomb material was after failure behavior of these two panels. After failure of the compression side, a drastic sudden drop load was seen where the test is stopped. However, the load did not decrease so much after the initial failure of foam core sandwich panel. For this sample the test was continued while other failures were also seen at the panel surface. In addition to the mentioned compression failure of facesheet, core compression failure happened at the loading nose (Figure 2). None of the samples failed because of core shear failure; therefore, more tests are needed to proof the accomplished results while determining the core shear failure

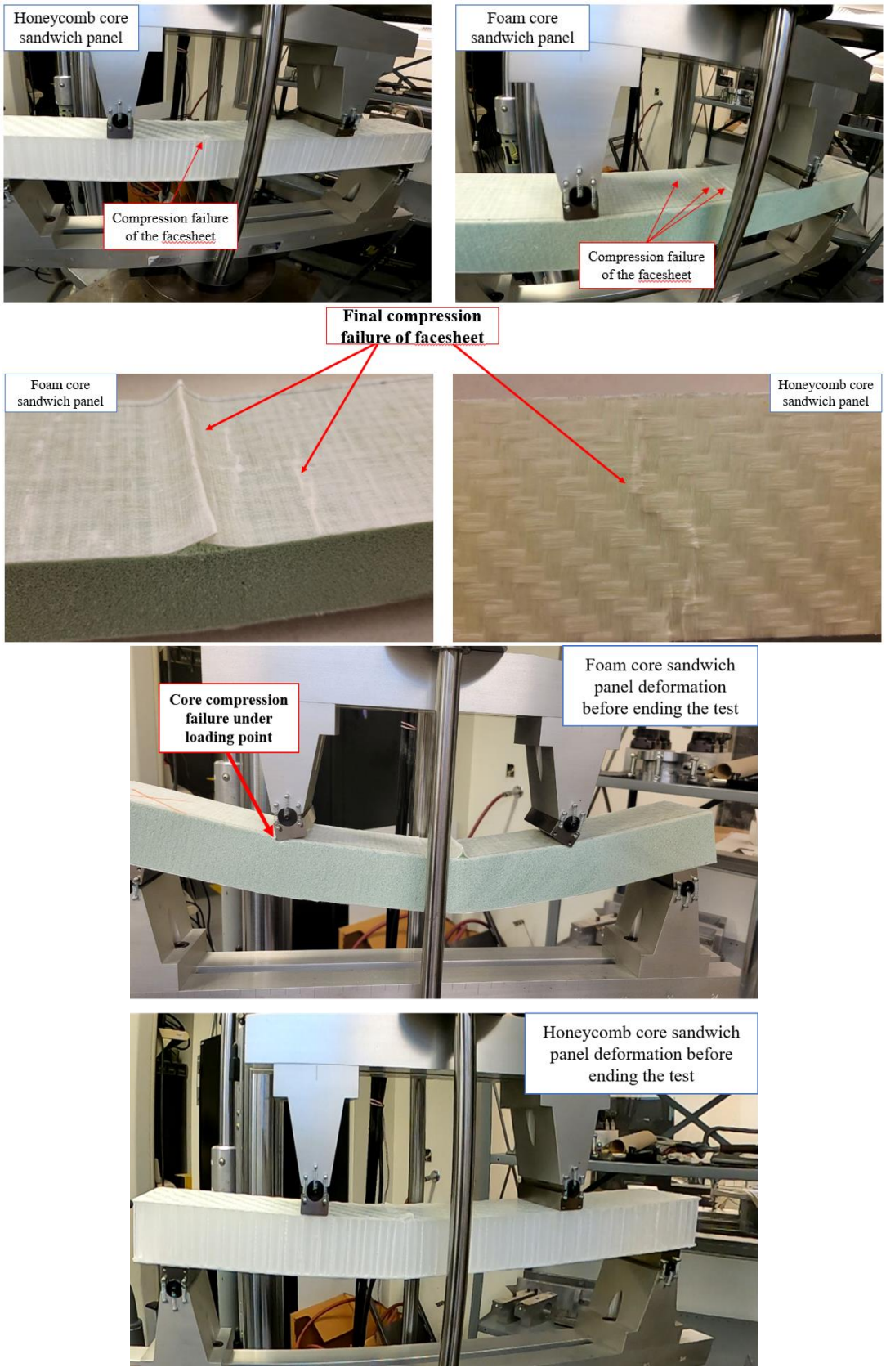

Figure 2: Two panels under the test

Since the loading is continued for foam core sandwich panels, a permanent deformation is depicted in the sample (Figure 3). It is worth of mentioning that both tests were stopped and final fracture of the samples are not reached.

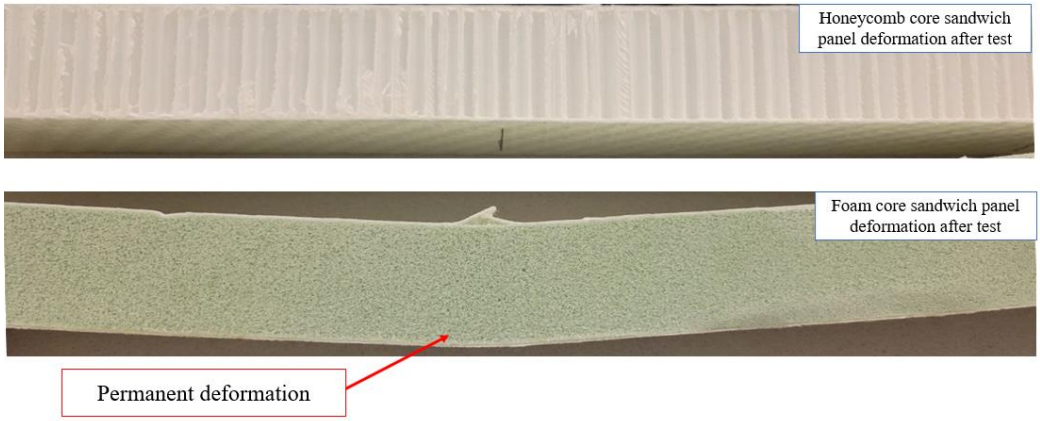

Figure 3: Samples cross-sections after the test

Figure 4 represent the calculated facesheet normal stress and core shear stress during the test. The stress components were calculated using Equations 1 and 2 as follows [1]:

$$\sigma = \frac{PL}{4t(d+c)b} \tag{1}$$

$$\tau = \frac{P}{(d+c)b} \tag{2}$$

where σ and τ are the facecsheet normal stress, and core shear stress, respectively. P represents the load, d is sandwich thickness, c is core thickness, b is the sandwich panel width and finally, t represents the facesheet thickness.

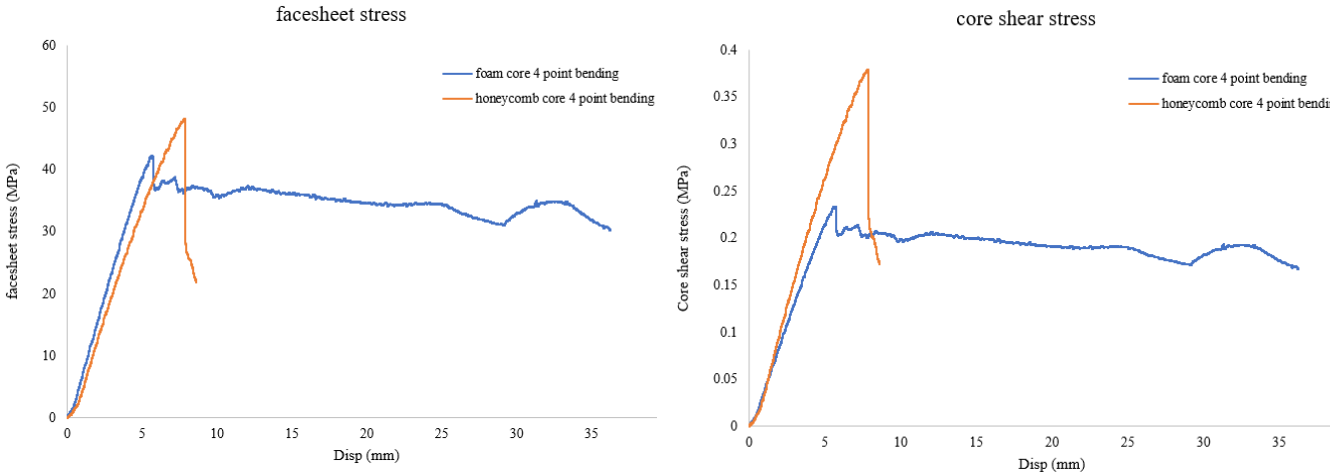

Figure 4: Facesheets normal stresses and core shear stresses for two different samples

Conclusions:

Two thermoplastic sandwich panels were tested using four-point bending fixtures. The sandwich panel with honeycomb core was able to hold more load before failure. There are many ways to improve the performance of both panels. It is required to do more test and generate more data.

References:

[1] ASTM C393 - Standard Test Method for Flexural Properties of Sandwich Constructions 2017. https://doi.org/10.1520/C0393-00.