Behavior of Sandwich Core Under Extreme Temperature Conditions

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Abstract and Objectives

- Composite Structure: A structure that is made up of more than one material
- Composite structures are used in marine, aerospace and wind industries.
- These materials are exposed to extreme temperature changes when used in industry.

Methodology Used

- The experiment run to gather data for the strength of the material was a three point bend test using an Instron 5582 test machine. One experiment was run at room temperature and another was run at -70°C after the specimens were conditioned at -22°C. An equation from ASTM standard D790 was then used to determine the value of the strength.

\[ \sigma_f = \frac{3PL}{2bd^2} \]

\( \sigma_f \) = flexural stress
\( P \) = load
\( L \) = support span
\( b \) = beam width
\( d \) = beam depth

ASTM Standard D790 was used to calculate bending strength.

Results and Discussion

\[ \sigma_f = \frac{3PL}{2bd^2} \]

Post-mortem photos of foam specimens (a) F type; (b) H type; (c) PN type after three-point bend test at room temperature

As predicted, some foams acted brittle in the three point bend test and others were more flexible and only deformed, but did not break. More specimens fully fractured at low temperature compared to room temperature.

\[ \sigma_f = \frac{3PL}{2bd^2} \]

Bending stress vs. strain graphs for foam specimens at (a) room temperature 23°C; (b) low temperature -70°C

This graph shows a positive correlation between density and strength as well as a negative correlation between temperature and strength.

Conclusions

- Foam strength increases as the temperature decreases. The lower temperatures cause the foam to become more brittle and break more than at room temperature.
- Density and strength have a positive correlation, which is expected because the higher the density, the more material is used in the foam. The more material would correlate to more strength.
- There is also a positive correlation between density and energy.

Status

- 3D microscope images are being taken (see above) to see cell shape and size
- Cell wall thickness calculations and predictions

Flexural energy follows the same trends as strength for the F group foams, but in H and PN groups, the room temperature have larger energies. In the PN group, the difference between room and low temperature is substantial. All groups of foams have a positive correlation between energy and density.

Specific flexural energy for foam specimens at room temperature (23°C) and low temperature (-70°C)

Micro computed tomography (µCT) images for (a) F type; (b) H type; (c) PN type foam specimens

Micro computed tomography images show cell size and shape and aid in determining cell wall thickness. These scans support the positive correlation between density and strength because it is visible that the larger density foams have more material which attest to higher strength.