EFFECTS OF SEA WATER ON FIBERGLASS SANDWICH PANELS

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Introduction

Sea water environments are very harsh on the materials that are used in them, many problems are caused by corrosion and internal degradation to the materials. Composites are better suited for these environments because of their corrosion resistance and high strength to weight ratios.

This paper focuses on the study on sea water degradation over time in a controlled environment and in a raw sea water environment. Shear testing was performed on these panels, experimental results were then compared to panels which had not been placed in sea water, giving a base to compare the degradation of the panels once they have been immersed in filtered and raw sea water for a period of time.

Most naval composites consist of fiberglass laminates sandwiching a foam core; this study uses the same type of panel. Research has been done on the ingress of water into closed cell types of foam concluding that most water ingress occurs at the edges of the foam due to cellular breakage [1].

Experimental

Divinicell H-100 provided by Diab Inc. was used as the core material, four layers of Fiberglass were laid up on either side using the Vacuum Resin Infusion (VRI) technique seen in figure 1. This process is when vacuum is pulled on the sandwich panel and dry fiber and resin is then pulled across the part. The order of the layup was (from top to bottom) woven roving, chop strand mat, woven roving, chop strand mat, foam core, chop strand mat, woven roving, chop strand mat, ending with woven roving. The west systems 105 resin system was used with 206 hardener. These panels were then placed into filtered sea water, which filters out all large particles and organisms, and also into raw sea water. Samples was taken out each month and tested (longest duration not reached).

Fig.1 VRI process with resin flowing across a part

Fig. 2 Shear test setup

The parts where then tested using an Instron machine model 1331 and two steel jigs seen in figure 2.

Results and Discussion

The samples were all manufactured using the same methods and materials. A batch of the samples were then put into filtered sea water. After a period of one month 3 specimens were taken out weighted and tested for shear strength.

Filtered Sea Water Samples

The filtered water specimens showed a decrease in strength after 2 months but no notable loss after that. The following graph shows the relation between the conventional specimen and multiple sea water samples after their respective duration in the water.

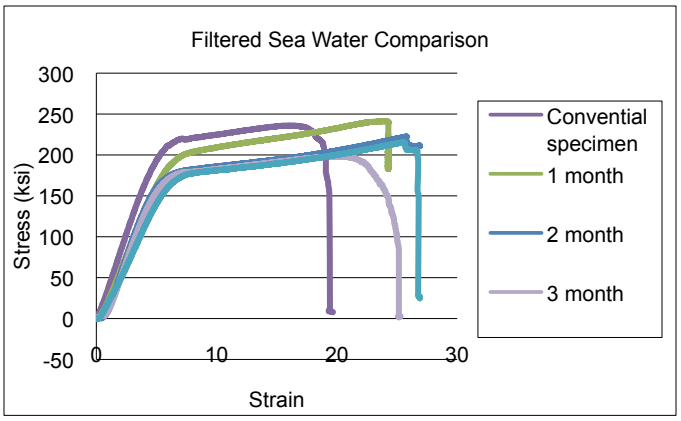

Fig. 3 Comparison graph of filtered sea water samples

It can be seen that the conventional specimen is stronger than all of the other test pieces but that it has a lower ultimate stress. This is partially due to the fact that the sea water makes the pieces more elastic and less brittle.
The failure that was seen in the conventional panels was a crack would form in the foam and the break causing a delamination along the skins for the final failure as seen in figure 4.

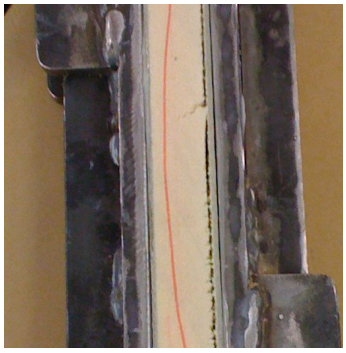
Fig. 4 Failure of conventional specimen

This type of failure was also commonly seen in the sea water pieces where they failed at the bond next to the foam, there was a mix of clean breaks along the interface and a crack forming in the foam before final failure. This is supported in other work which experience similar failure along the face-core bonding[2].
The 2 and 3 month specimens are much weaker than either the 1 month or conventional specimen in overall strength and in ultimate strength.

Raw Sea Water Samples

In figure 5 is a comparison between the conventional 1 month filtered specimen and 1 month raw sea water sample.

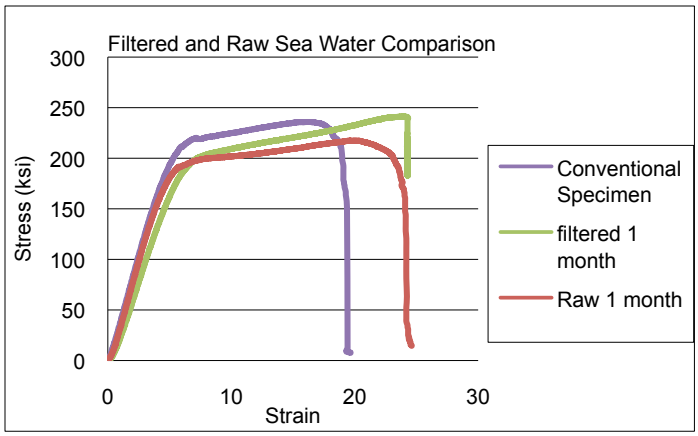

Fig. 5 Comparison of conventional, filtered, and raw sea water specimens

As expected the raw sea water specimen is weaker than both the convention and filtered specimens.

Conclusion

Foam sandwich panels decrease in strength when exposed to sea water and degrade more quickly when exposed to unfiltered sea water as it would be in normal use in the field. It was also observed that the weight gain in the specimens was not dramatic and was very reliant on the surface area exposed to the sea water environment.

References

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