Introduction

- Fiber-reinforced polymer (FRP) sandwich systems are primary load-bearing structures with relatively lower cost and high performance compared to solid laminate systems.
- FRP sandwich system consists of solid laminate facesheets on the outer surfaces with an aluminum honeycomb at the core of the sandwich structure.
- These FRP sandwich structures are deployed in manufacturing large structures where multiple sections of the core must be joined together to form the structure.
- This is where core splices happen and may result in gaps or discontinuities in the core structure that can result in premature failure in the composite structure.

Main Objective

To investigate the effect of the honeycomb core splice gaps on the performance of composite sandwich structures consisting of aluminum honeycomb core and carbon-fiber/epoxy facesheets.

Methods

- Specimens are prepared and cured in the press machine with heat and force.
- The specimens are exposed to bending and shear forces to understand how the core splice interacts with the overall structural response using four points bending test.
- The loading and displacements are recorded and further studied using ASTM Standards.

Results

- **Splice at High Shear Region**
  - Comparison of Performance Stress to Trial Type - Thick Core, 2 ply hessianat.
  - Comparison of Performance Stress to Trial Type - Thin Core, 2 ply hessianat.
  - Comparison of Performance Stress to Trial Type - Thick Core, 3 ply hessianat.
  - Comparison of Performance Stress to Trial Type - Thin Core, 3 ply hessianat.

- **Splice at High Moment Region**
  - Comparison of Performance Stress to Trial Type - Thick Core, 2 ply hessianat.
  - Comparison of Performance Stress to Trial Type - Thin Core, 2 ply hessianat.
  - Comparison of Performance Stress to Trial Type - Thick Core, 3 ply hessianat.
  - Comparison of Performance Stress to Trial Type - Thin Core, 3 ply hessianat.

Conclusions

- The core splices, regardless of their location or size, did affect the strength of the specimens. In some cases, the strength was reduced to 20% of the control specimen's strength value.
- In the 2 ply laminate the failure mainly occurred in the facesheets and not the core; this is because the facesheets are weaker than the core.
- When specimens that failed by a fracture in facsheets are repaired by core adhesive, an improvement in the strength properties is observed.
- The improvement by the repair mainly depends on the original failure mode.
- When there is a larger gap with no CA, especially in the shear region, delamination of face sheets happens as soon as loading starts. When CA is added, the failure mode switches either to fracture in the face sheet or shear failure in the CA material at the splice location followed by facesheet delamination.
- In the 2-ply facesheet specimens, the larger the gap the higher the improvement in strength when repaired with CA.
- In the 6-ply face sheets specimens, the larger the gap the lower the strength with or without CA, while in the 2-ply face sheets specimen this trend is not maintained.
- In the 6-ply face sheets with thin core specimens, a higher improvement in strength is achieved with the repair of the core splices with CA. This is mainly due to the original failure mode being a core-shear failure.

Future Work

- Use 3D Digital Image Correlation (DIC) to investigate the failure modes in the specimens by examining the full-field displacement and strain fields for core-spliced sections of the FRP sandwich structure under loading.
- Study the effect of non-visible impact of impacted FRP sandwich panels containing various core splice configurations with thru-transmission ultrasonic inspection to understand the extent of the non-visible damage inside the structure on its properties and strength.
- Develop a relationship to find the failure mode of FRP Sandwich structures with core splices.
- Use various types of core adhesives and study the extent of improvement happening when specimens are repaired with various types of core adhesives.

Literature cited


Acknowledgments

HEATCON Composites Systems for donating the core Adhesive material that was used in this research

For further information

Rawan Aqel: riaqel@uwm.edu
Rami Elhajjar: elhajjar@uwm.edu