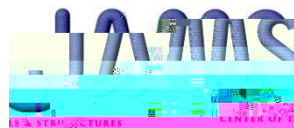


Effects of Moisture Diffusion in Sandwich Composites

2017 Technical Review

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Effects of Moisture Diffusion in Sandwich Composites

Motivation and Key Issues:

- Core-to-skin disbond initiation and growth are not completely understood, but are thought to occur due to combination of factors:

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....water ingress may occur due to:
 - Wicking of liquidous water through facesheet microcracks, along fiber/matrix interfaces, and/or through improper design of edge closeouts
 - Diffusion of water *molecules* through (otherwise undamaged) facesheets, resulting in increased core humidity levels



Effects of Moisture Diffusion in Sandwich Composites

Overall Program Objectives



Effects of Moisture Diffusion in Sandwich Composites

- Principal Investigator
 - Mark Tuttle
- Students
 -

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Outline of Presentation

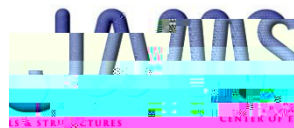
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 - Single-Cantilever Beam (SCB) test geometry/protocol under development by CMH-17 Task Group
 - Results obtained during 1st year of study (Sept '15-Sept '16)
 - Expanded test matrix for 2nd year of study (ongoing)
- Design and fabrication of GAG specimens and test set-up (ongoing)

} Presented at
Oct '16
AMTAS
meeting



SCB Tests Conducted During 1st Year of Study

- Cured facesheets and Nomex core were machined to size and stored for 2 months at 50°C (122°F) at 8% RH in a humidity chamber, to insure components were as “dry” as possible

SCB Tests Conducted During 1st Year of Study

- Six tests specimens were machined from the four “parent” panels (24 test specimens in total)
- Specimens produced from each panel were used for each Type, to avoid any potential manufacturing bias

Type	Specimen Number					
A (as-produced)	1-1	2-2	3-3	4-4	1-5	2-6
B (thermally cycled)	2-1	3-2	4-3	1-4	2-5	3-6
C (humid)	3-1	4-2	1-3	2-4	3-5	4-6
D (humid&thermally Cycled)	4-1	1-2	2-3	3-4	4-5	1-6

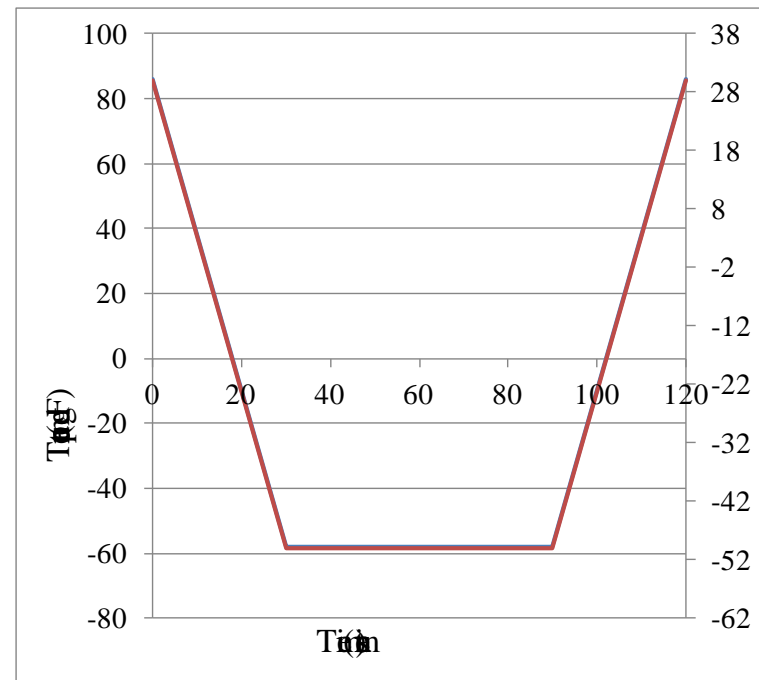
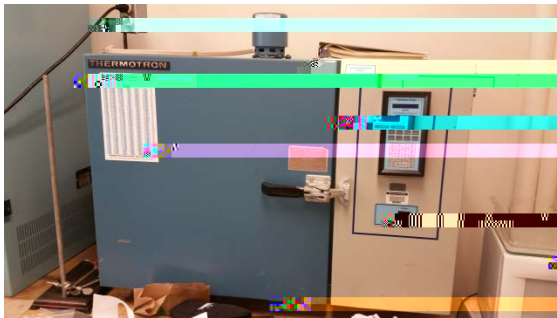
SCB Tests Conducted During 1



SCB Tests Conducted During 1st

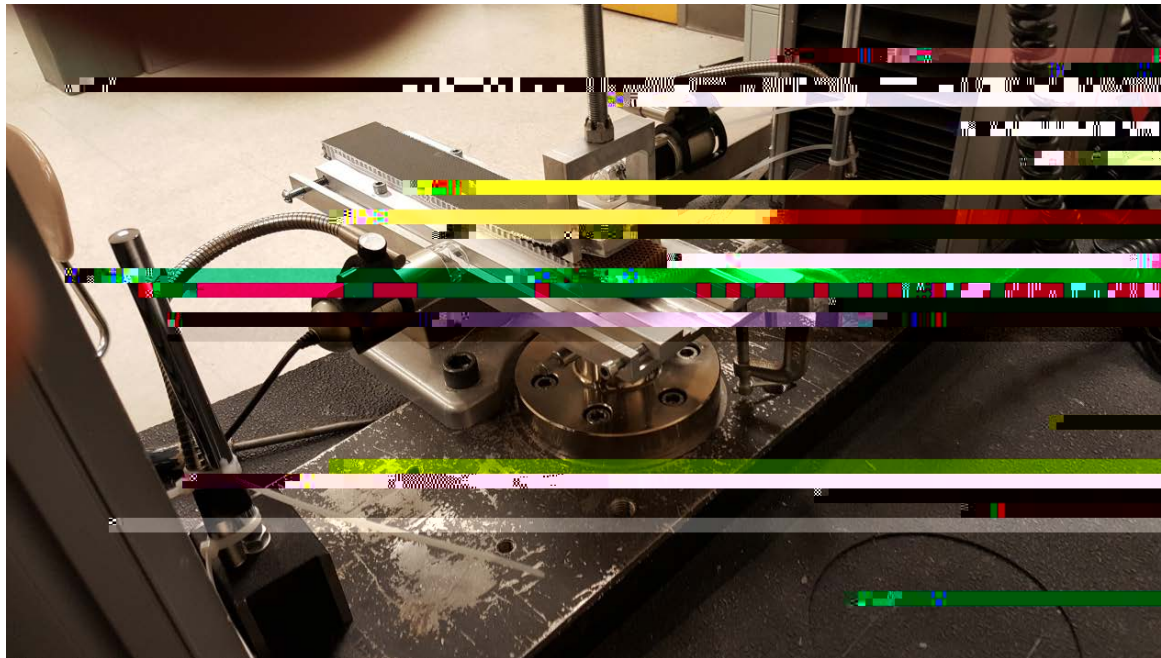
SCB Tests Conducted During 1st Year of Study

- All thermally-cycled specimens (Types B and D) were individually vacuum bagged (to insure constant moisture content in core volume) and subjected to 2-hr thermal cycles from 30° & <-50°C



SCB Tests Conducted During 1st Year of Study

- The interfacial fracture toughness, G_c , was measured in accordance with the single-cantilever-beam (SCB) test standard being developed by a CMH-17 working group



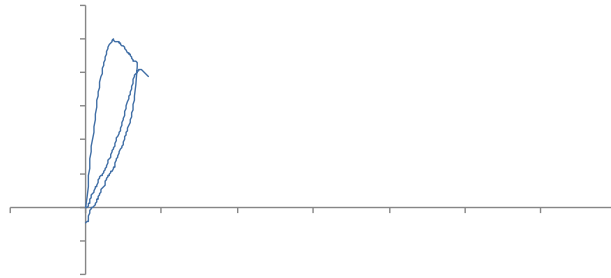
SCB Tests Conducted During 1st Year of Study



SCB Tests Conducted During 1st Year of Study

- A typical SCB test involves six load cycles
- Crack length is measured after each cycle

SCB Tests Conducted During 1st Year of Study





SCB Tests Conducted During 1st Year of Study

SCB Tests Conducted During 1st Year of Study

Condition	Ave G_c (J/m ²)	StdDev G_c (J/m ²)	Average G_c , Normalized to Type A
Type A	1508	213	1.00
Type B	1410	214	0.94
Type C	1440	142	0.95
Type D	1368	198	0.91

SCB Tests Conducted During 1st Year of Study

Preliminary Conclusions

- Although significant scatter was evident, it appears that environmental factors (i.e., thermal cycling and/or elevated humidity levels) have a modest but measureable impact on interfacial fracture toughness, G_c ,
- The most aggressive environmental conditions considered during this study (humid specimens exposed to 700 thermal cycles from RT to -50°C) resulted in about a 10% reduction in average G_c .

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SCB Tests Planned for 2nd Year of Study

Expanded Test Matrix:

Component	Description
Facesheet	Cytec T300/970 3k Plain Weave Fabric:
	[45/0/0/45] _T
	[0/90/90/0] _T
	[0/45/0] _T
	[0/45/90/45] _s
Core Materials	Hexcel HRH-10-1/8-3.0 (0.50 in thick)
	Hexcel HRH-10-1/8-3.0 (1.00 in thick)
	Hexcel HRH-10-1/8-8.0 (0.50 in thick)
	Hexcel HRH-36-1/8-3.0 (0.50 in thick)
Adhesive	3M Scotch-Weld Structural Film AF 163-2K

- Core materials recently received
- Test conditioning will be limited to “as produced” and “humid + thermally cycled”
- 18 “parent” panels being prepared (108 SCB specimens)

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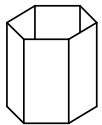
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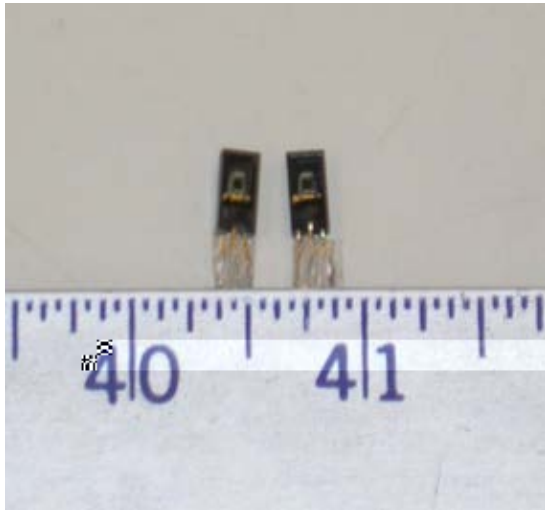
Design and Fabrication of GAG Specimen and Test Setup

GAG Specimen:

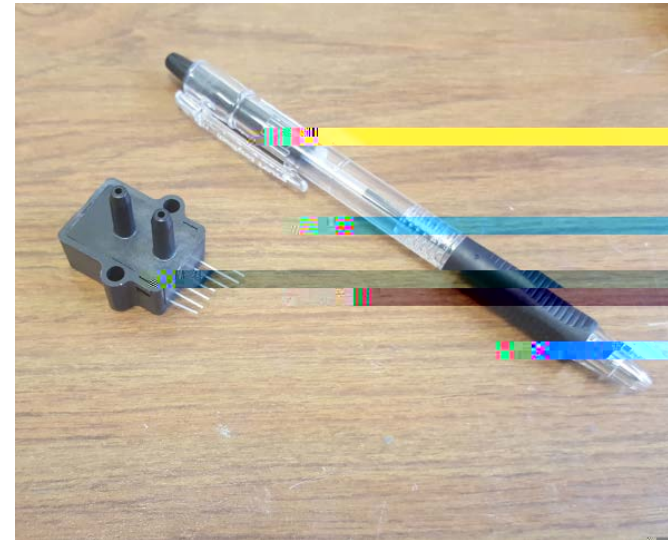


Design and Fabrication of GAG Specimen and Test Setup

GAG specimens must use 1-in core, due to size of commercially-available pressure sensors



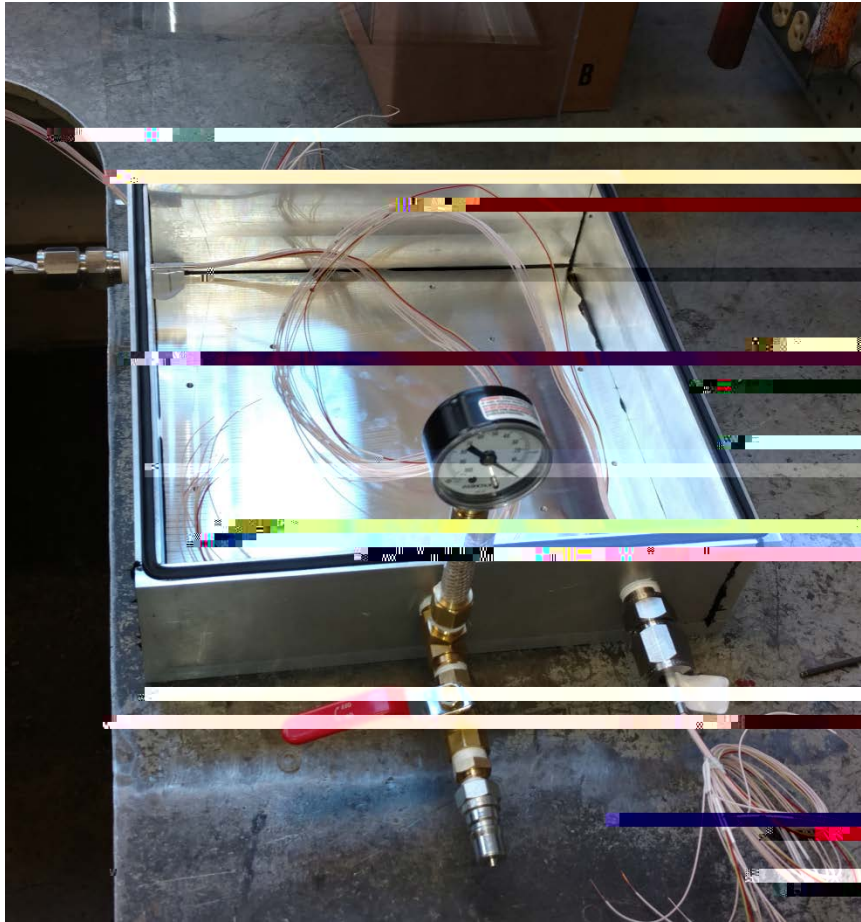
Om 1-MHC-
610
Rg = 5-95 %RH



AlS
MLV-015A-A6-AAF-N
0-15

Design and Fabrication of GAG Specimen and Test Setup

Design and Fabrication of GAG Specimen and Test Setup



Vacuum Box
Nearing Completion



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Thank You!

Questions, Comments, Suggestions?



End of Presentation.

Thank you.

