Tier 1 Supplier Composite Allowables Challenges

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Technology Standards and Certification (TSC)

Background

- Spirit AeroSystems was formed 5 years ago when it went through divestiture from a Big OEM (with head quarters in Chicago)
- As an OEM the former Boeing Wichita conducted numerous Allowables the Boeing Way
  - Data Reduction primarily done in Seattle
- Since Divestiture Spirit has generated Allowables on approximately 25 composite materials, adhesives, cores, processes and over 30 metallic materials.
- Comparing the process of developing allowables Spirit's lessons learned is:
  - Make the airplane out of metal!!

Composite vs. Metallic “Design Values”

- There are widely accepted industry metallic material specifications
  - Most composite specifications are company specific.
- Wide availability to industry of accepted metallic allowables
  - Most composite allowables are tailored for specific material and manufacturing process
  - Individual manufactures have unique analytical methods for design composite structures which require unique composite material allowables

Supplier Perspective of Allowable Development

- As a supplier who contracts with several Major Manufacturers there are several things noticed:
  - Each Manufacturer has their own unique approach to the design of composite structure.
  - As a supplier we do not have any direct contact with regulatory agencies.
  - There are limited industry wide standards for testing and analysis.

Allowables Issues

- The following are a sample of SOME of the issues pertaining to developing Allowables for Composites:
  - Data Reduction
  - Test Standards
  - Variability of data
  - Conditioning of Data
  - Acceptance of Data
  - Tribal Knowledge vs Industry Accepted Methods
- These slides do not offer suggestions on how to improve composite allowables/testing but just to bring to mind issues that makes getting allowables difficult and perhaps discourage the use of composites.

Data Reduction

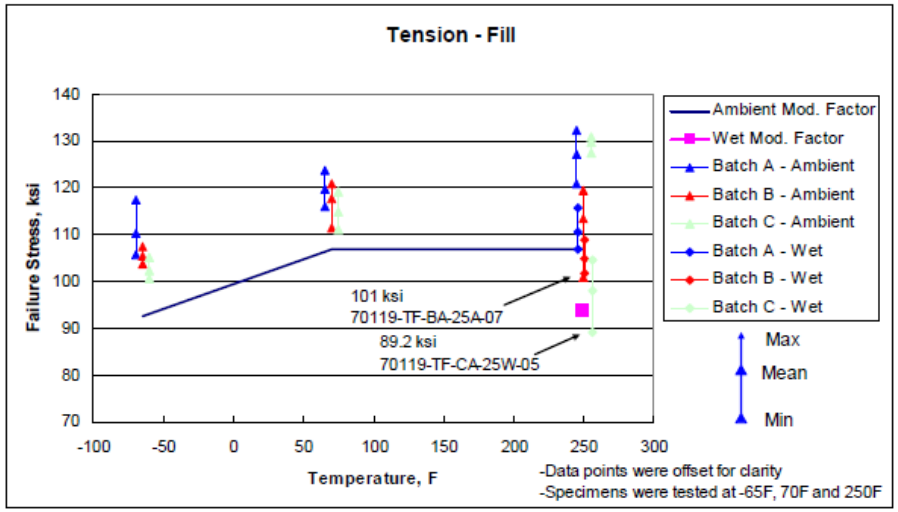
- Sources of Analysis Methods
  - Basic Allowables
    - CMH-17
      - STAT-17
      - AGATE
  - Indirect Properties
    - Average of Mean
    - STAT-17
    - Reduced Ratio's
- No consistent industry standards caused significant revisions and re-work
- Conservative data reduction eliminates benefits of composites.

Test Standards

- Test standards are still lacking as the requirements vary based on very subjective test “standards”
  - Examples
    - Tg
      - DMA ASTM D7028
      - TMA ASTM E831
      - DSC ASTM D3418
    - Compression Specimens
      - ASTM E641 - .5 inch wide by 5.5
        - Can get numbers lower than specimens with open hole
      - Modified ASTM D6484 -1.5 inch wide by 12 inches
    - Compression
      - Edge wise compression ASTM D7137 vs ASTM C364
      - Could Beam Flex replace these?

Variability of Data

- When testing composites a significant amount of scatter is observed
  - Within a panel typically scatter is minimal
  - Between panels (batches) significant variability can be observed.
  - Statistical factors can be severe trying to get A or B Basis Allowables



Specimen to Specimen Variability:

Sources: Different Failure Modes, Ply Splices, Panel Edges, Small Specimens, Secondary Bonds

Smaller un-notched specimens have higher variability.

Panel to Panel Variability:

Sources: Layups, Autoclave Cycles, Operators, Material Variability within Batch

Batch to Batch Variability:

Can hide Panel to Panel Variability

Sources: Resin Content, Density, Out Time

Examples of environment protection schemes

- Composites are much more susceptible to environmental conditions then equivalent metallic designs
  - Basic mechanical behavior of composites are directly affected by environmental conditions
  - The requirement to account for the effects of environment drive up testing costs of composites
  - Special protective measures must be taken with composite structures as compared to metallic ones

Conditioning of Specimens

- Every company and organization has different standards for saturation.
  - Different Temperatures and Tolerances
  - Different % Relative Humidity and Tolerances
  - Different Requirements to Prove Saturation
- Proving saturation can be difficult and time intensive. Moisture content increases at a diminishing rate so the majority of the moisture gain is done in the first few weeks, but specimens will remain in humidity chamber for additional weeks while the lab tries to prove saturation.
- After metal load blocks or facesheets are bonded to some specimens (lap shears, flatwise tension) many methods require moisture to travel through the load blocks or facesheets, or through the width of the specimen, which is not how moisture would travel into the part.
  - Bonding after saturation you lose moiture content and often get failures in bondline

Acceptance of Data

- Test Data generated for one OEM is not automatically accepted by other OEM
- Each company has own process specifications which often come from the same vendor processed the same way
- Test Methods can vary from company to company
  - i.e., saturation methods
- Even with FAA approval there is a reluctance to accept data
  - WACO approved data does not mean SACO approval to some OEM's.

Tribal Knowledge

- When running composite allowables programs the following phrases are often heard:
  - “Even though the Spec’s don’t allow it - that’s the way we always have done it”
  - “In my upper heft hand drawer I have a 1987 report that says that won’t work”
  - “But this is the way we do it here”
  - “I hate composites”
    - Mark Ofsthun’s often quoted saying this.

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