Design Development and Structural Substantiation of Bonded Structure
- Summary of Breakout Sessions -

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Bonded Structure Design

• Design/size structure to fail outside the adhesive
  – Know failure mode and location
  – In composite joints, failures typically occur outside adhesive but not outside joint area
• Redundant design features
  – Varied opinions on value vs. damage tolerance approach
  – Part 23 requirement
    • Not effective for global process failure
    • Not required for co-cured structure/sandwich
• Establish defect and damage sizes
  – Most agreed on value, need better linkage to analysis and test
• Define max allowable repair size on primary structure
  – Debate over max size limit for bonded repair.
  – Need for some load capability requirement in case of failed repair?
  – Bolted-bonded repairs?
Bonded Structure Data and Analyses

- **Material properties and Statistical allowables**
  - Data must align with criteria and analysis
  - Debate over value of thick-adherend adhesive data, develop statistics at this level? Appropriate level for allowables development?
  - Value of adhesive data, when composite joints often have other failure modes. Adherend data? Fracture toughness data?
  - Dealing with material and process changes, showing equivalency back to certification database.
  - Need to capture manufacturing variations
- **Environmental durability**
  - Not design data but process validation
  - Strength loss vs. time is not a design knockdown but a process problem
- **Environment “knockdowns”**
  - What to apply to full-scale RT test? From worst case coupon level effects?
- **Analysis Methods**
  - Should be linked to failure modes, drives data needs
Bonded Structure Substantiation

- **Static Strength**
  - Validation of analysis methods
    - Key is to verify failure mode at element and subcomponent level
  - Validation of manufacturing process
    - Need to play “what if” game? Look at all worst case scenarios? To what level to consider process failures?

- **Durability**
  - Capture environmental durability service experience and data and feed it back into the design and test loop
  - Large scale tests at environment
    - Test at highest scale feasible (usually not economic at full scale)
  - Test to demonstrate growth? Verifying “no growth” doesn’t tell you where threshold is.

- **Damage Tolerance**
  - What level to incorporate damage/flaw testing?
  - Demonstrate inspectability of potential damage
    - Structural health monitoring issues
Standards, Guidance, and R&D Needs

- Standards/Guidance
  - Durability test standards (environmental)
    - wedge test? DCB?
  - Equivalency guidance for adhesives and bonded processes
  - Building block guidance for bonded structure
  - Guidance on statistical allowables for bonded joints
  - Need fracture toughness test standards to support evolving methods
  - More usable data into Mil-17
    - adhesive data
    - preliminary design data ok
  - Bonded structures certification guidance (AC or policy memo)

- R&D Needs
  - Improved inspection methods
  - Effective Gc, R-curve effects for bonded joints