Design Development and Structural Substantiation of Bonded Structure
- Breakout Session -

Moderators:
D. M. Hoyt, NSE Composites
Hyonny Kim, Purdue Univ.
Stephen Ward, SW Composites
Purpose of Breakout Session

• Reach agreement on “critical safety and certification issues”
• Focus on “what we need to worry about”
• Discuss “how-to’s” if time permits

• Initial design and repair development
  – Design
  – Data and analysis methods
  – Substantiation tests and analyses
Bonded Structure Design

• Design of part (and repair)
  – Design/size structure to fail outside bonded joint
  – Provide for redundant design features/load paths
  – Establish defect and damage sizes
    • Linked to inspection methods, policies (factory, in-service)
  – Consider tooling/manufacturing constraints
  – Consider maintenance (inspection) constraints
  – Establish sizing guidelines

• Design for repair
  – Include provisions in original design
  – Provide for repair access
  – Define max allowable repair size on primary structure
    • Structure w/ disbonded repair must sustain limit load
Bonded Structure Data and Analyses

• Data
  – Material properties and Statistical allowables
    • Stress-strain response as \( f(\text{env.}, \text{thickness}, \text{etc.}) \)
    • Fracture toughness for adherend and adhesive
    • Manufacturing variations (surface prep, curing, bondline thickness)
    • Manufacturing defects/anomalies
  – Strength with small damages, disbonds
  – Environmental durability
  – Point design data (lap shear, pull-off, etc.)

• Analysis Methods
  – Validated over range of design variables, environments
  – Predict static strength w/ and w/o defects
  – Predict durability: load cycling, env. exposure, long-term degradation
  – Predict damage tolerance w/ large disbond and/or damage

Appropriate scale for statistical assurance?
Bonded Structure Substantiation

• Static Strength
  – Validation of analysis methods
  – Validation of manufacturing process, including process “failures”
  – Validation of non-detectable defects, damages

• Durability
  – Demonstrate 2+ lifetimes load cycling + env. effects
  – Large scale tests at environment
  – Include non-detectable defects, damages
  – Demonstrate no-growth or validate growth predictions
  – Tests to protect on-going durability of the fleet

• Damage Tolerance
  – Demonstrate inspectability of potential damage
  – Demonstrate crack (disbond) arrestment ability
  – Test at worst realistic condition (cold?)

Appropriate scale for tests?
Engineering Practices to Address Key Issues
Industry Standards and/or Guidance Needs
Additional Research Needs