

Durability of Bonded Aerospace Structures

Dr. Lloyd Smith
Harrison Scarborough

November 14th, 2013



Aims

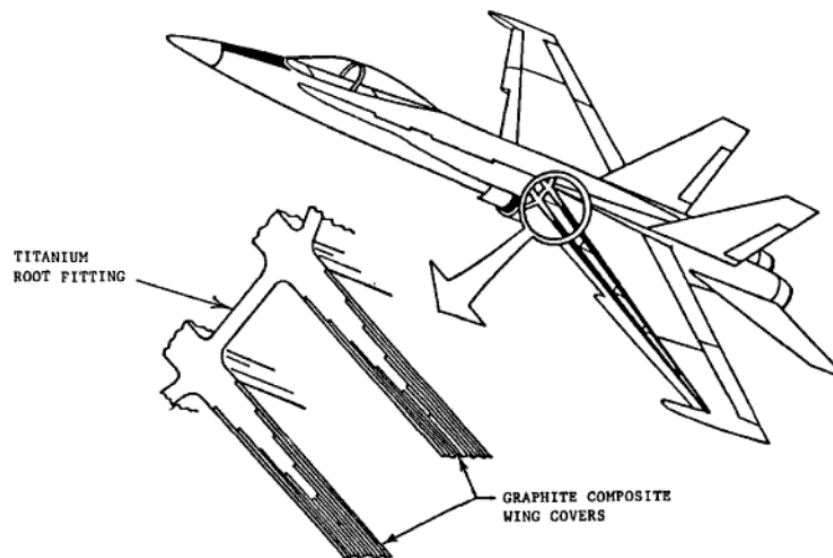
- Improve our understanding of bonded structure in fatigue
- Provide guidance to the FAA in certifying new aircraft

Adhesive Fatigue: Needs

- Reliable life prediction models
 - Largely empirical
 - Effect of environment, loading rate or different stress state often requires more testing
- Failure criteria
 - Plasticity and fracture models are most common
 - Their selection and application are not well defined
- Screening tests
 - Properties from quasi-static tests do not always correlate with fatigue life or strength

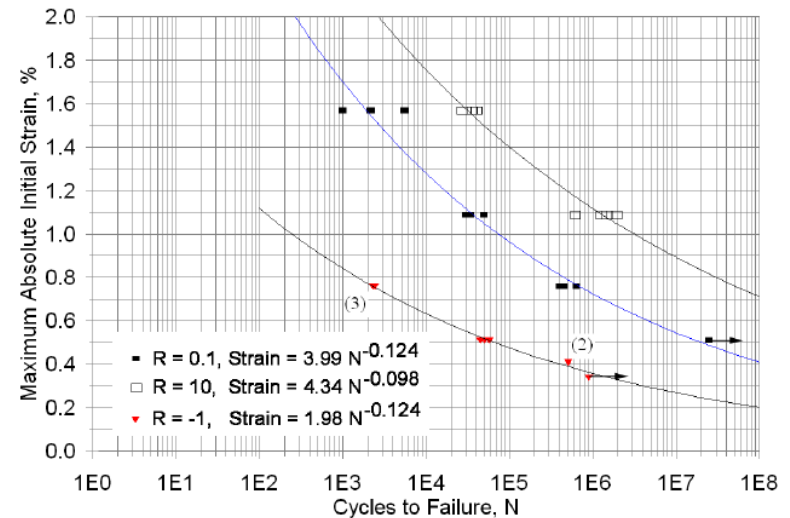
Example

- F-18 Bonded wing to fuselage
 - Stepped shear joint
 - Temperature requirements selected
 - FM 400, high strength and modulus
 - FM 300K, low strength, high elongation
 - FM 300K had twice the fatigue strength of FM 400



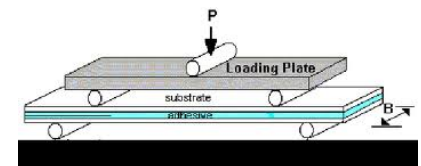
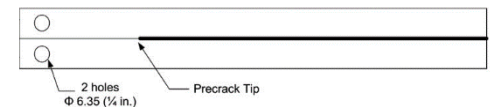
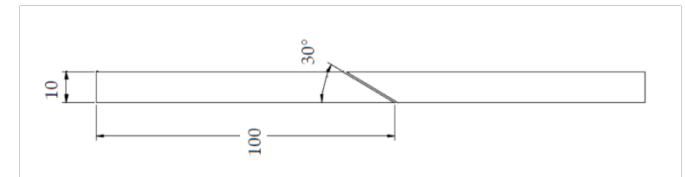
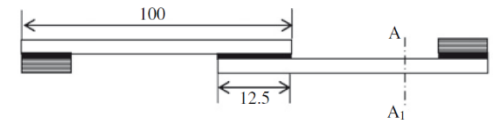
Factors Affecting Slope of Adhesive S-N Curve

- Strength
 - Modulus
 - Toughness
 - Stress state
 - Time dependence
-
- It is not clear how these (or other) properties combine to describe adhesive fatigue behavior



Approach

- Select 5 adhesives
 - Varying in strength and toughness
 - Cohesive failure
 - Constant surface preparation, adherends and adhesive thickness
- Quasi-static
 - Strength and toughness
 - Shear and scarf
 - Fracture mode I and II
- Fatigue
 - Shear and scarf
 - Crack initiation vs. propagation



Deliverables

- Year 1
 - Correlation between quasi-static behavior and fatigue response
- Year 2
 - Adhesive failure criteria