WASHINGTON STATE UNIVERSITY

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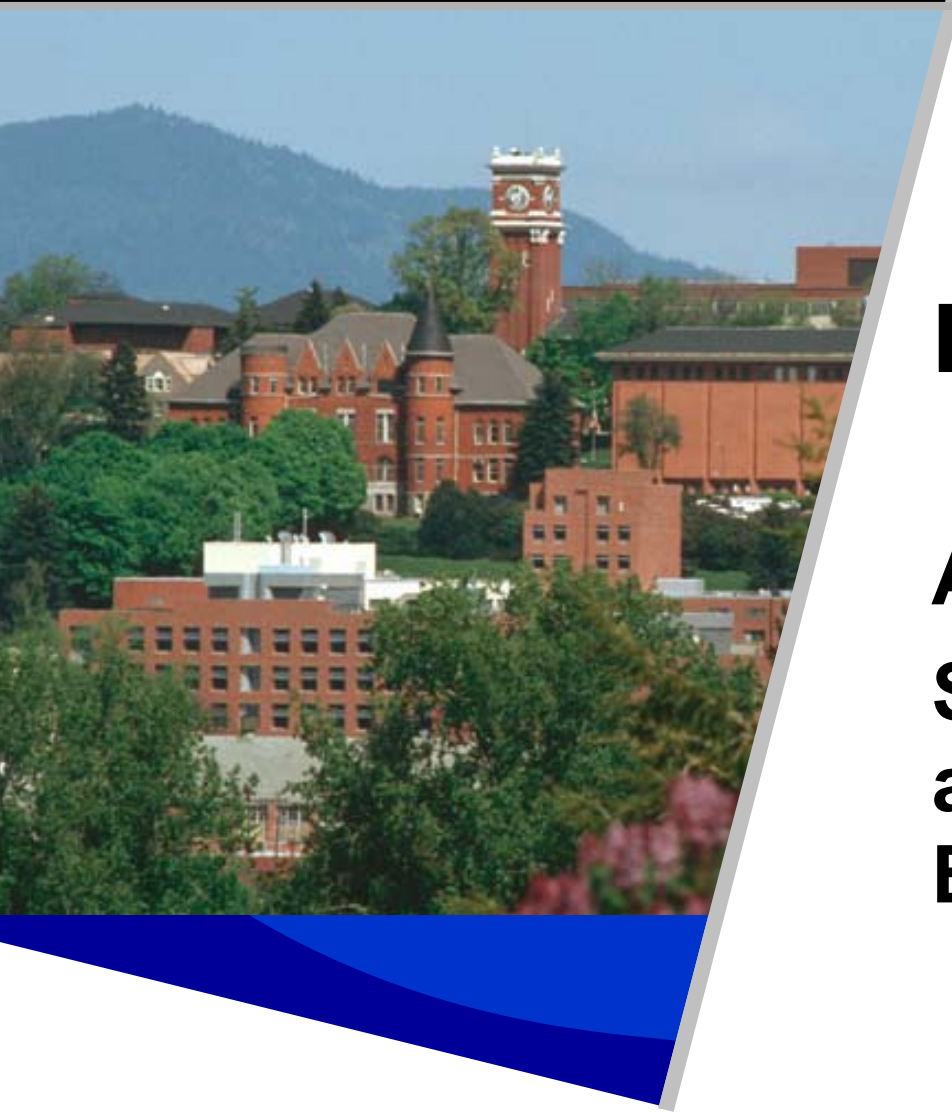

Lloyd Smith

Associate Professor

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First Year Project

- The Effect of Surface Treatment on the Degradation of Composite Adhesives
  - Surface treatment
    - Strength
    - Fracture toughness
    - Durability
  - Accelerated test methods
    - Wedge crack

Coupons

- Double cantilever beam
  - Mode I fracture toughness
- Wide area lap shear
  - Static load (s)
  - Low frequency (0.01 hz) cyclic load
- Wedge crack coupons
  - Compliant adherends

Materials

- Low cost prepreg adherends
  - 777 or 7e7
- Co-bonded adhesive films
  - Metal bond 1515-3 or AF555
- Surface treatments
  - No prep (6001 peel ply)
  - Grit blast
  - Plasma etch

Simulated Environmental Exposure

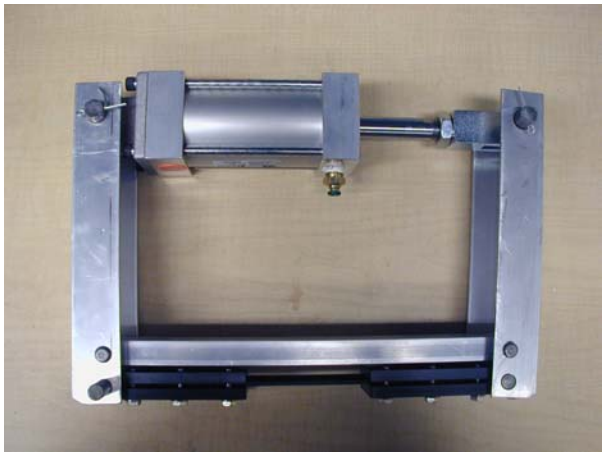
- 140F water immersion
- Up to 10k hour durations

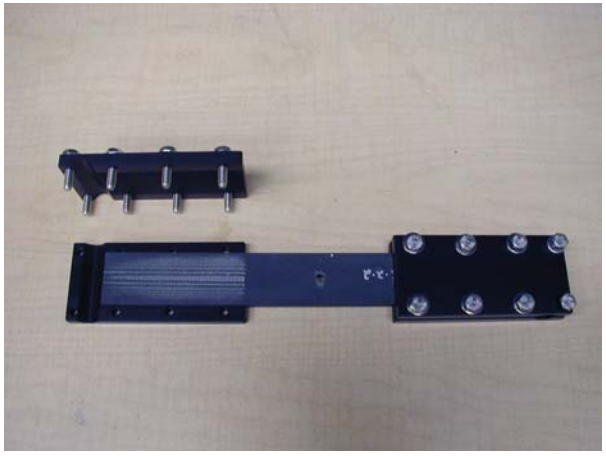
- Post mortem surface characterization to be performed at University of Washington

Environmental Exposure Facility

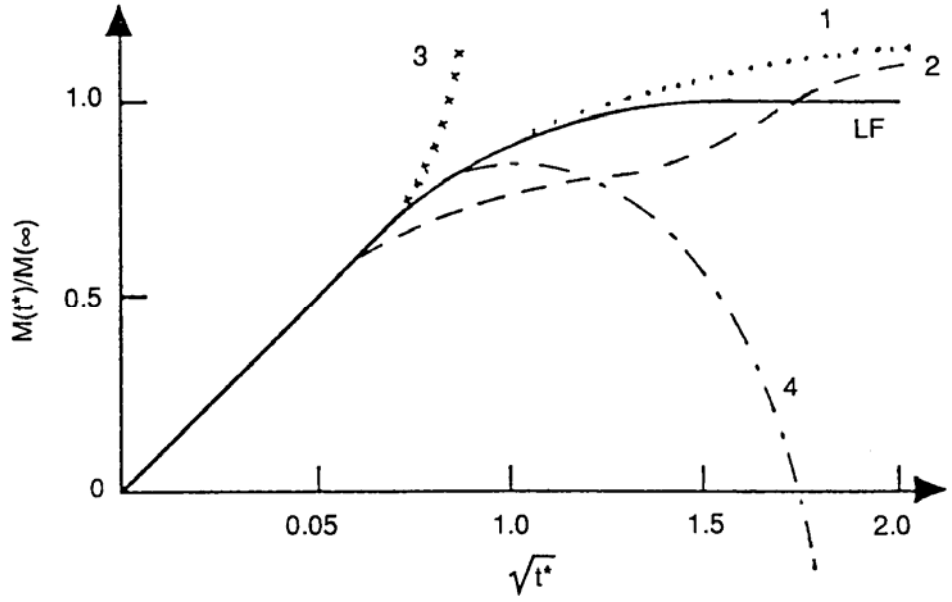
- Aggressive environments
- Temperature
- Stress
- Time

Environmental Exposure Facility





Fickian and Non-Fickian Weight Change



Modeling Degradation

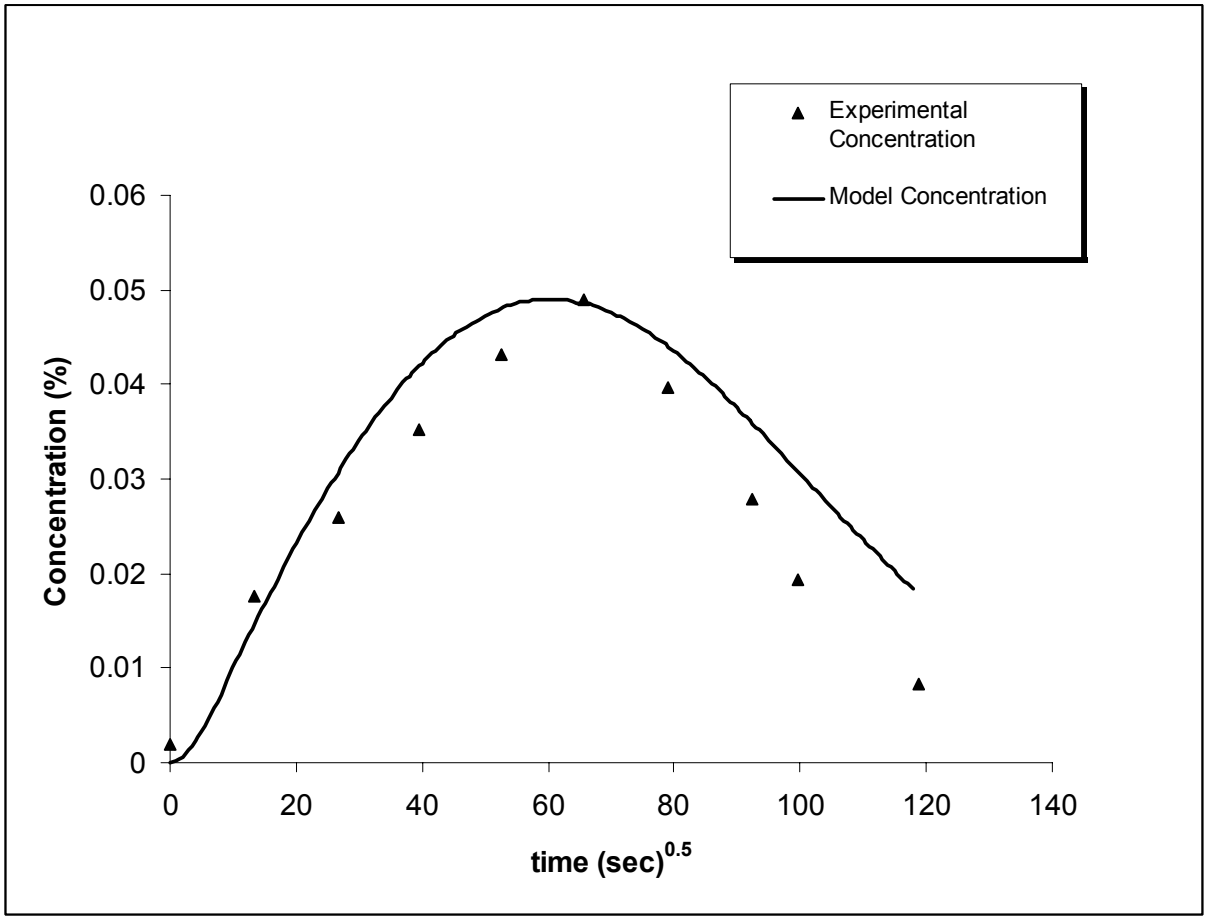
$$\frac{\partial c}{\partial t} = D \cdot \frac{\partial^2 c}{\partial z^2}$$

$$-\frac{d[C]}{dt} = k[C]$$

$$C(t,z) = \int_0^t \exp\left(-k(t-\tau)\right) \cdot \left[\frac{dC_o}{d\tau}\right] \cdot d\tau$$

$$\overline{C}(t) = \frac{1}{h}\int_0^h C(t,z) \cdot dz$$

Comparison of predicted and measured moisture concentration



Proposed First Year Project

- Long term durability
  - Select a “young” composite material with multiple cure schedules
  - Load matrix (lap shear or +/- 45 degree coupons) at service temperature in aviation environments
  - Compare weight gain, strength and modulus retention as a function of time for disparate cure schedules

Proposed First Year Project

- Modeling degradation
  - Expose material to aggressive solvent with measurable weight change (gain or loss)
  - Characterize fundamental degradation parameters (D, c_m, k)
  - Consider temperature and geometry effects