



T-38 EN Analysis Section



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Continuing Damage Testing & Analysis

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U.S. AIR FORCE



Continuing Damage Overview



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- **Assumes diametrically opposed corner cracks in a hole**
- **Primary flaw usually has the larger initial flaw size of 0.05” and is located on the side of the hole with a shorter ligament**
- **Secondary flaw has an initial flaw size of 0.005”**
- **Total life is the sum of the life of the primary flaw and secondary flaw, post-ligament failure**

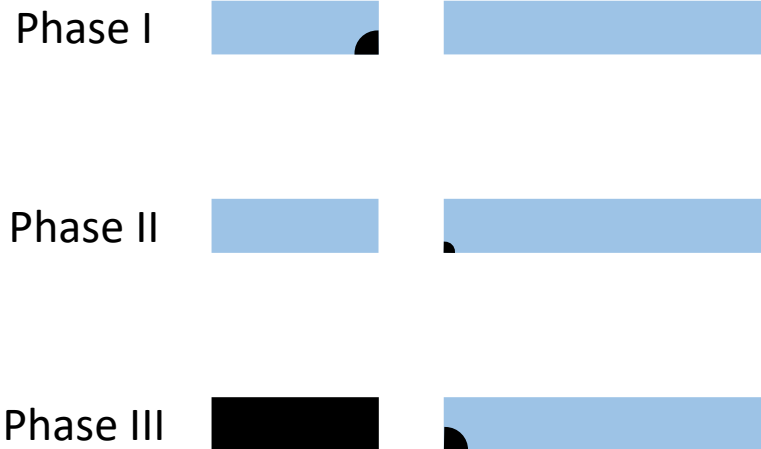


Modeling Approaches



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Phased Crack Growth



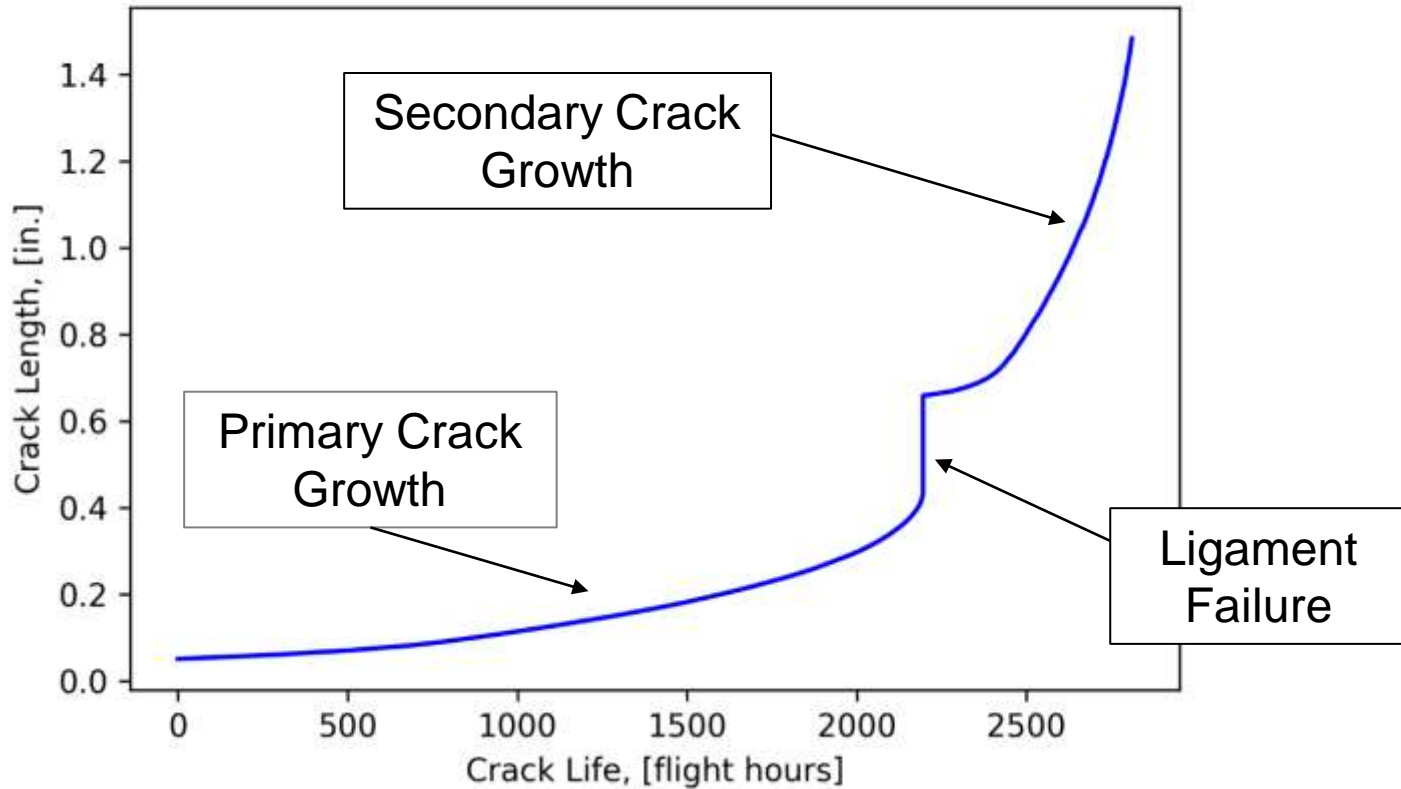
Simultaneous Crack Growth





Phased Continuing Damage Curve

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A-10 ASIP Continuing Damage Test Program



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- **45 coupons**
 - **Test methods consistent with ASTM E647**
 - **Constant amplitude loading**
 - **R = 0.1**
 - **Variable amplitude loading using A-10 CP7 spectrum**
 - **A-10 control point spectrum**
 - **New manufacture coupons:**
 - **e/D: 1.2 – 1.5**
 - **Primary and secondary flaw sizes intended to match JSSG-2006 standards**
 - **No cold-expansion**
 - **Failed ligament coupons:**
 - **Identical in geometry, but have been previously tested until the ligament failed**
 - **No continuing flaw size present**
 - **Includes cold-expanded holes**



A-10 ASIP Continuing Damage Test Program



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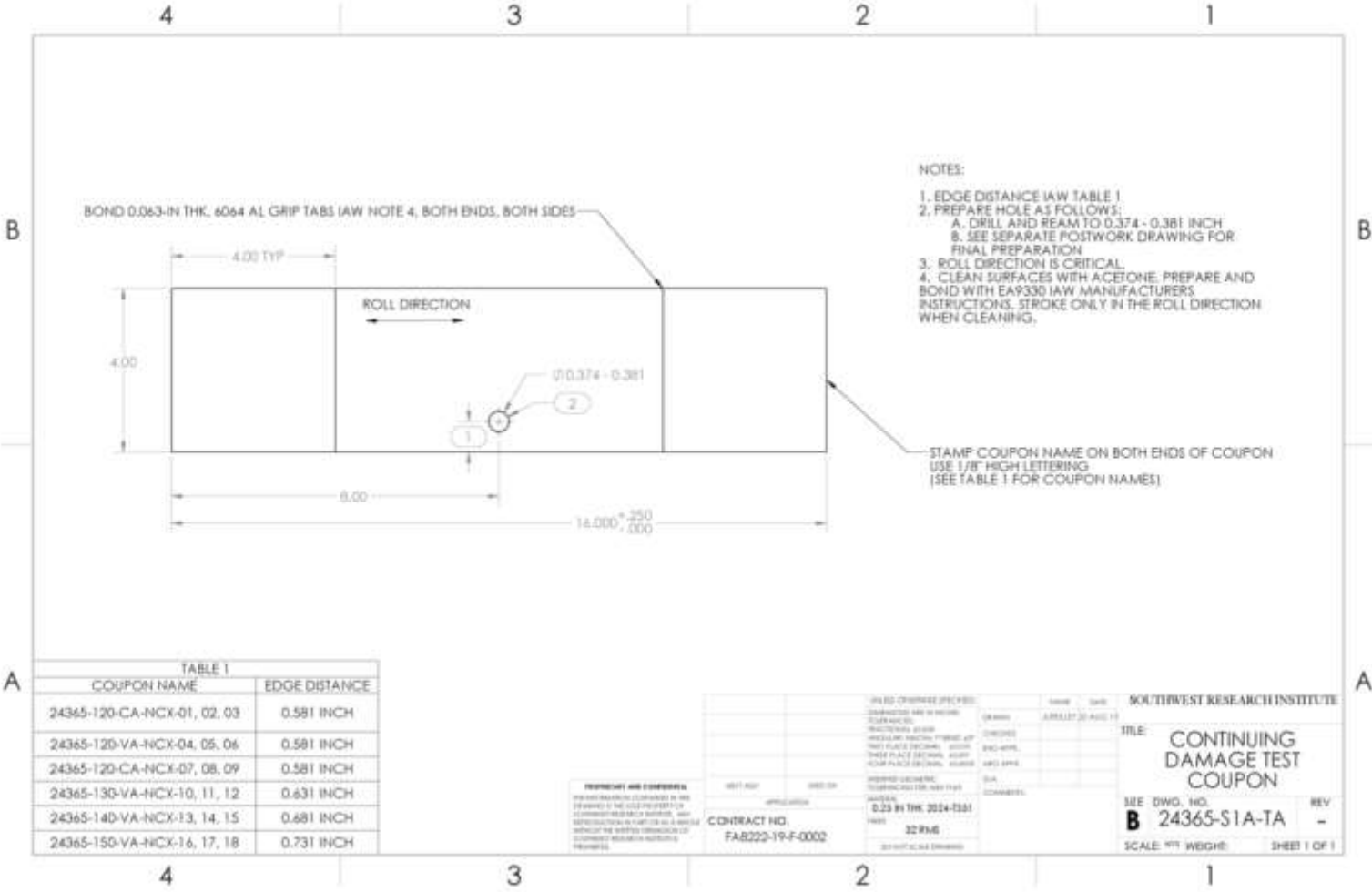
- **Objectives:**

- Provide validation for 0.005” continuing damage flaw size
- Compare pre-cracked specimens to those without pre-cracks
- Collect data on secondary damage characteristics from specimens with previously failed ligaments
- Compare crack size and shape between specimens with induced secondary cracks and those with naturally occurring secondary
- Collect data on the effects of edge distance on continuing damage crack lives
- Determine in-plane bending affect on continuing damage crack



Coupon Geometry

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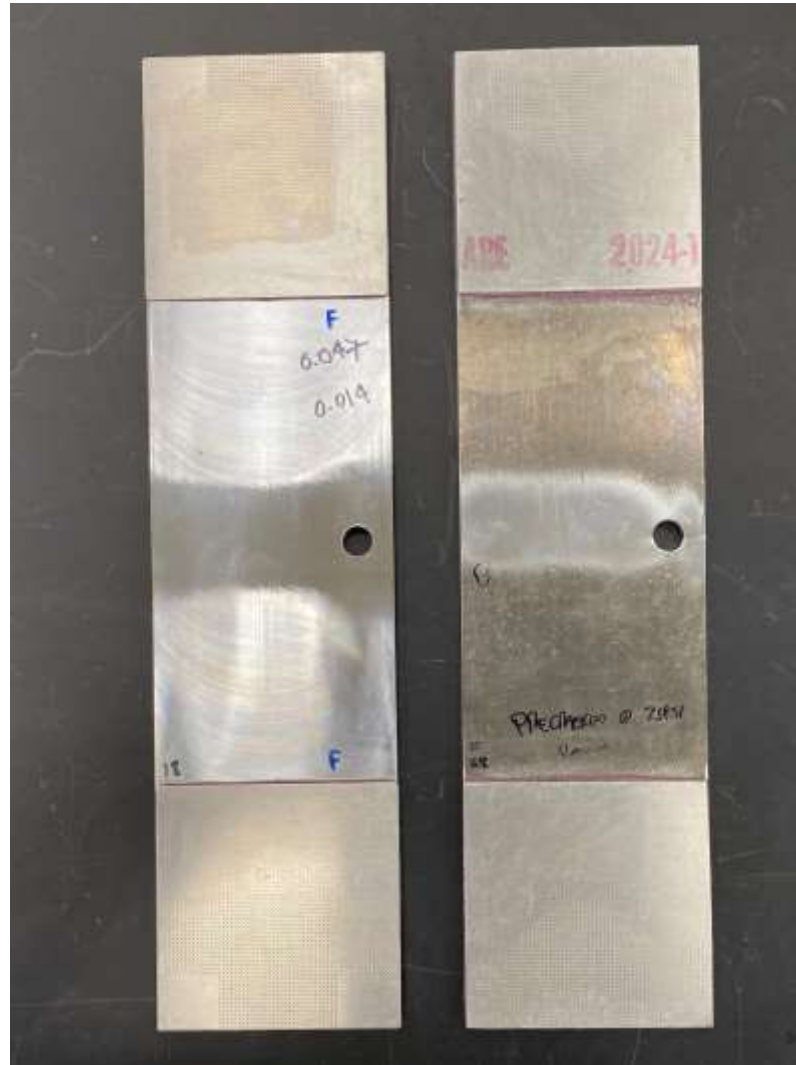




Coupon Geometry



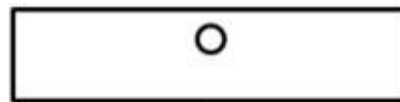
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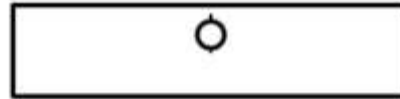


Pre-cracking Approach

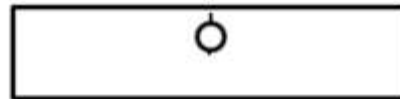
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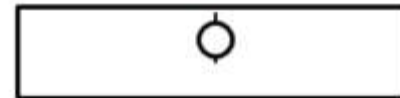
Drill Starter Hole



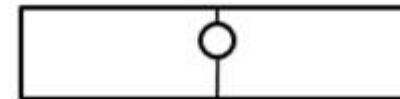
EDM Notch to 0.030"



Pre-Crack to 0.555 Total Length



Ream to Final Diameter



Test to Failure



Test Setup



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Work in Progress



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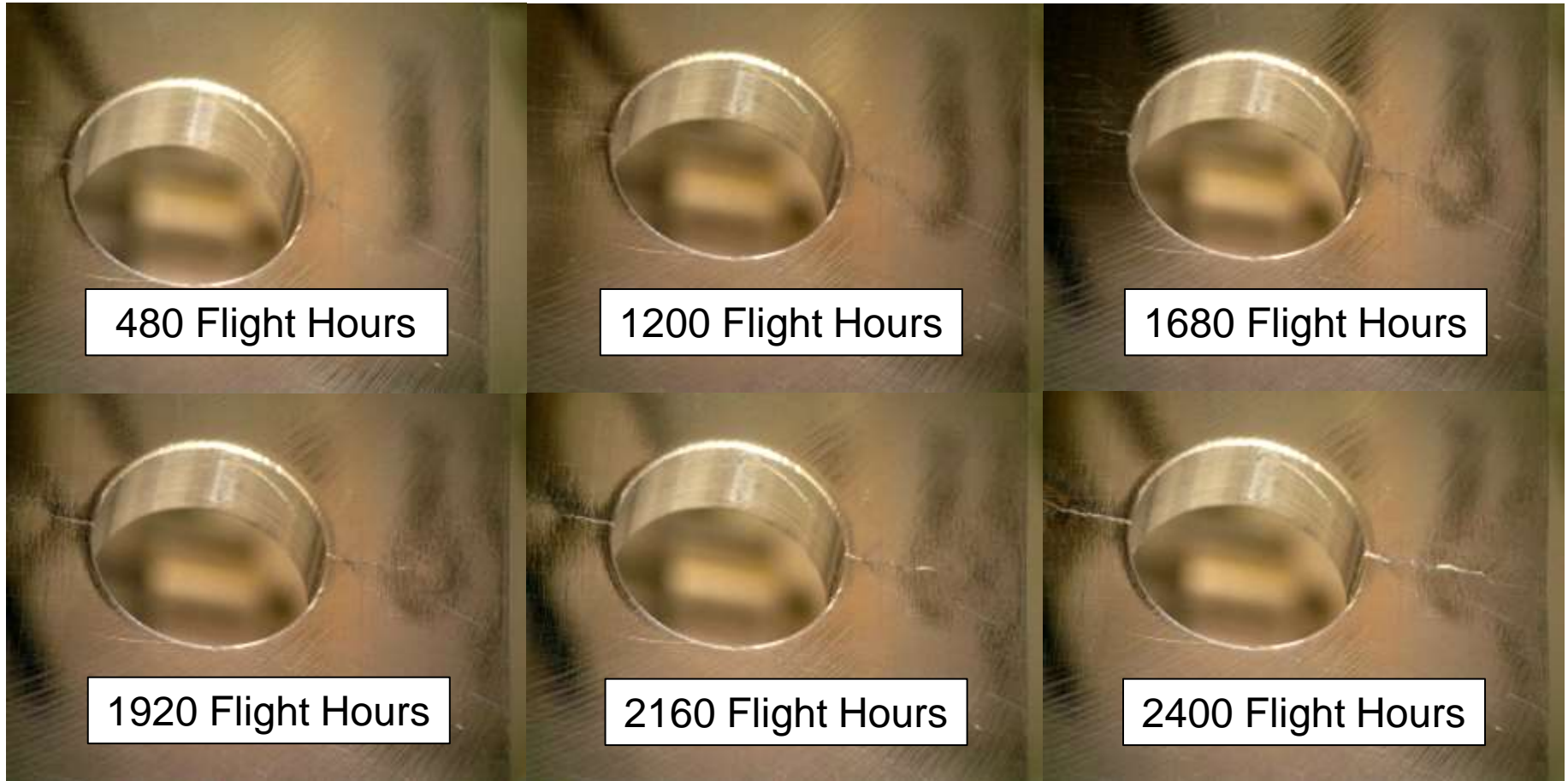
- **Sample testing**
 - Tested 12 samples so far
 - 1 continuing damage sample
 - 11 failed ligament samples
- **AFGROW modeling of samples**
- **StressCheck modeling of in-plane bending effects on continuing damage stress intensity factors**



Continuing Damage Sample Testing



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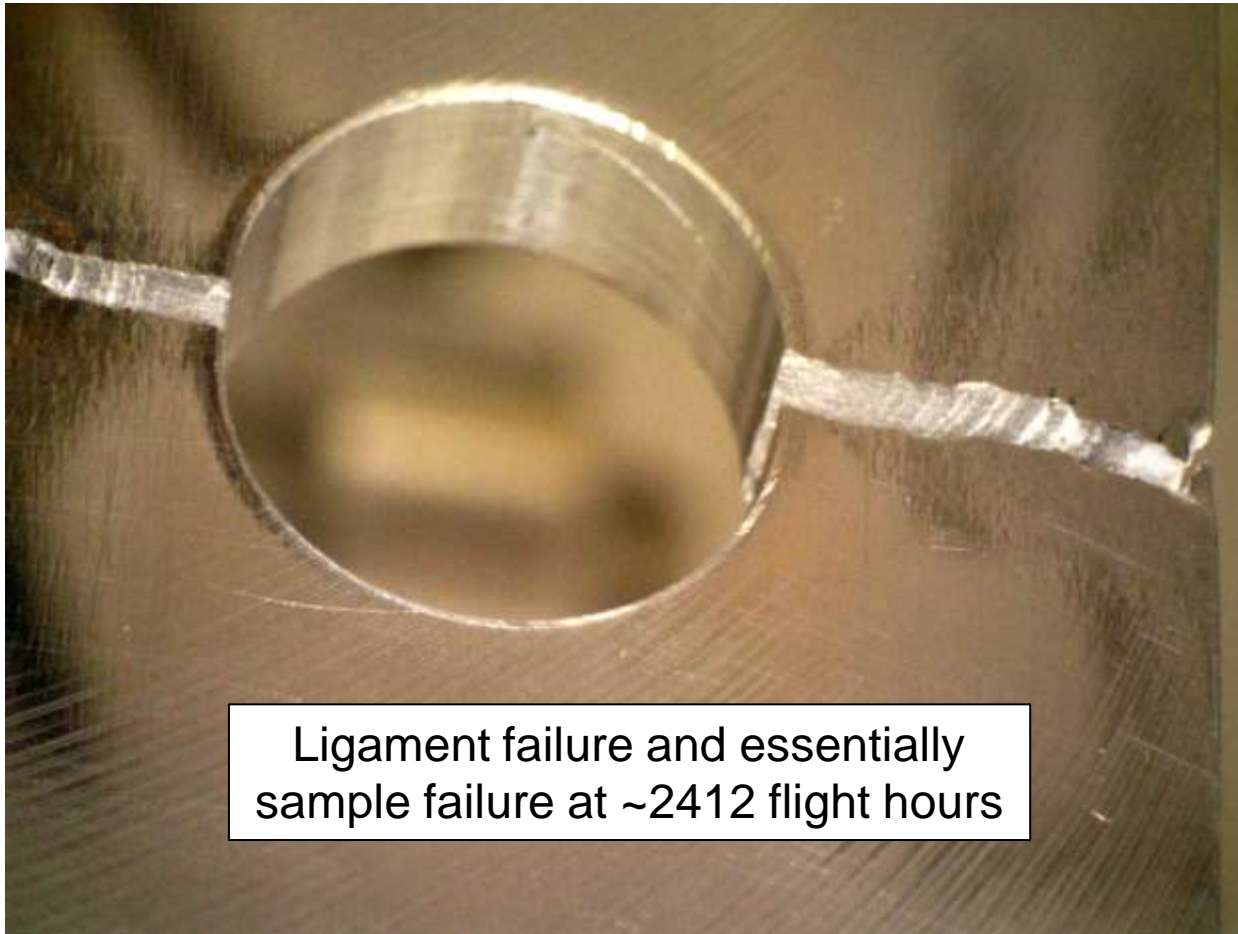




Continuing Damage Sample Testing



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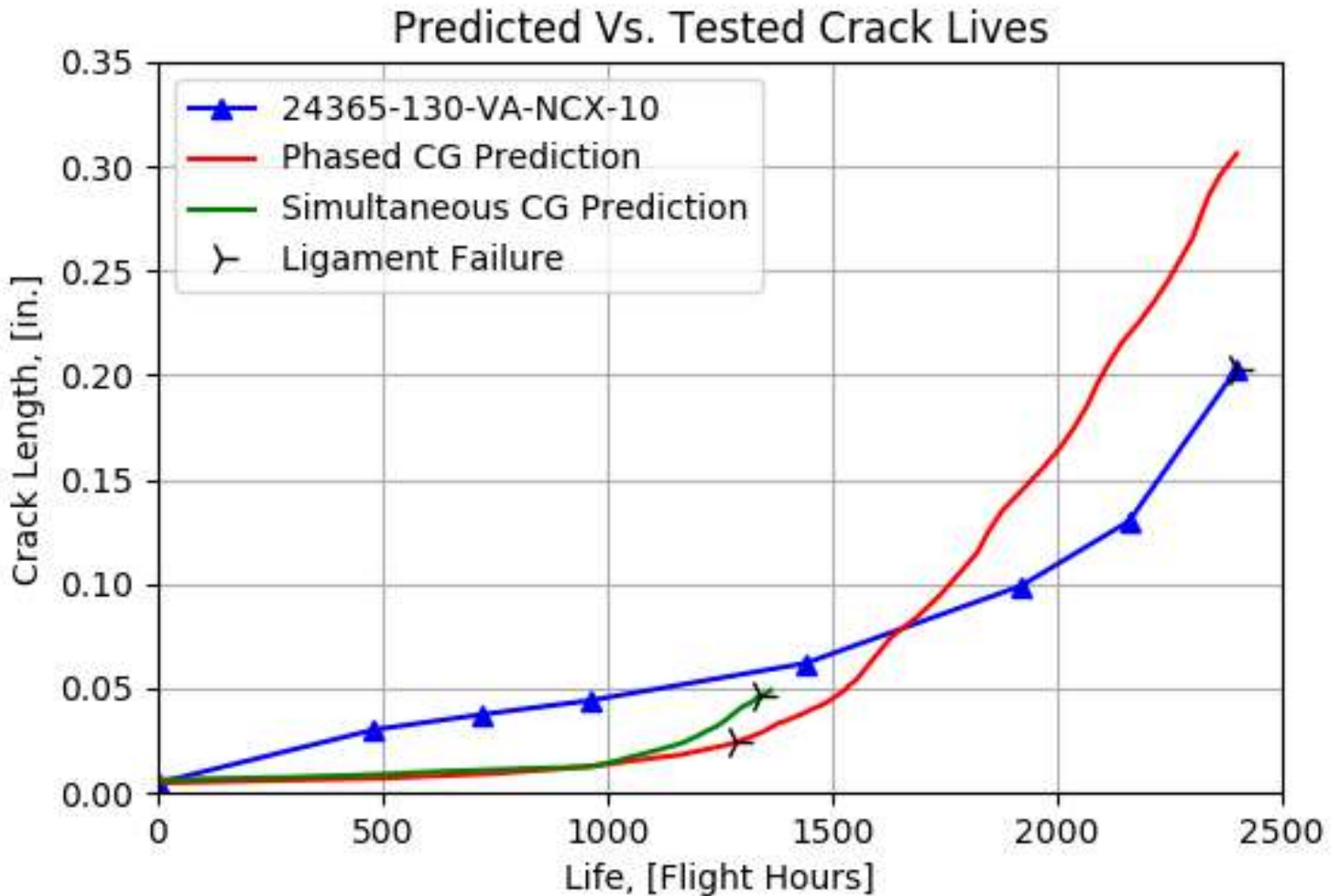




AFGROW Modeling, CD



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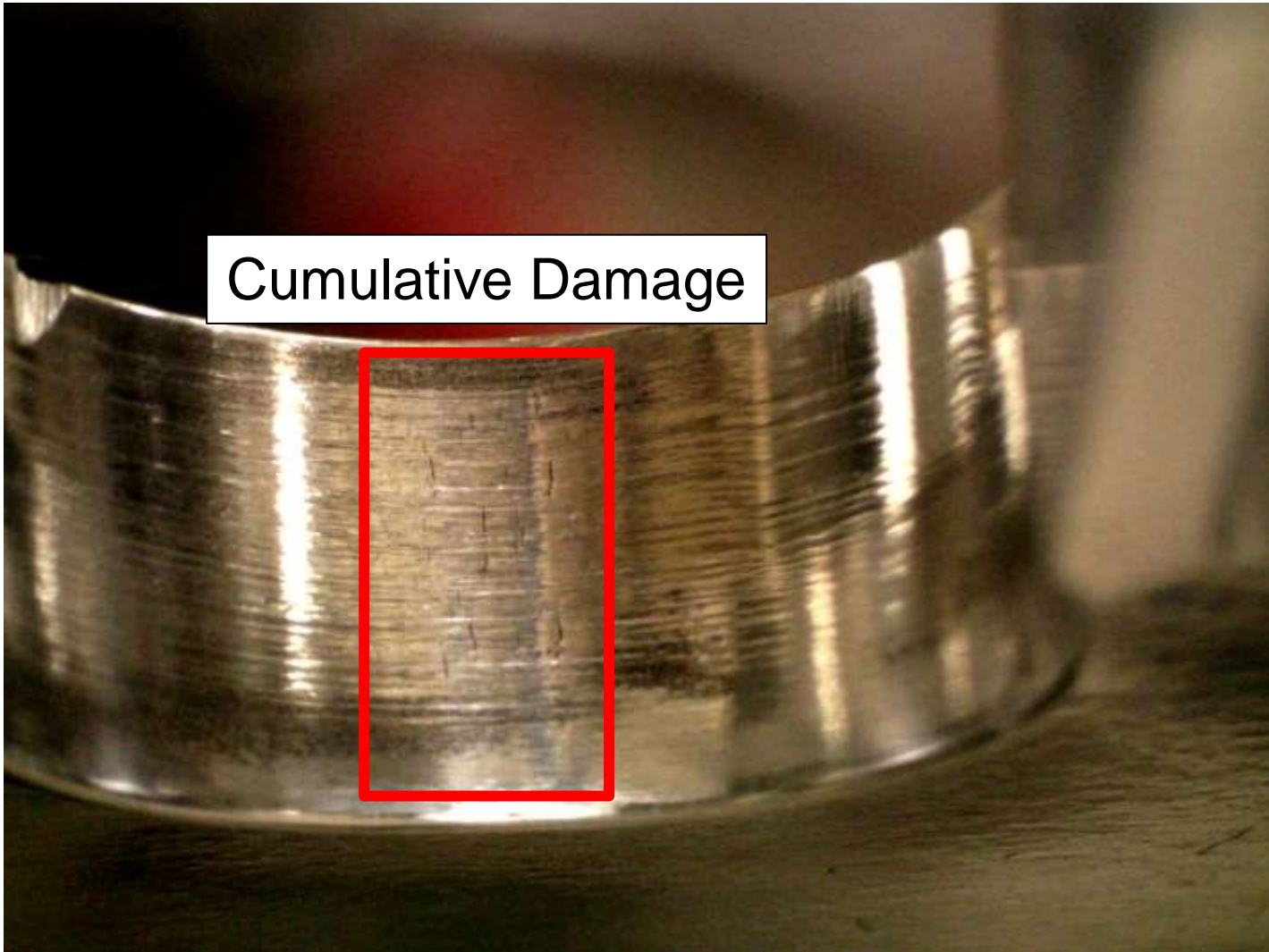




Failed Ligament Sample Testing



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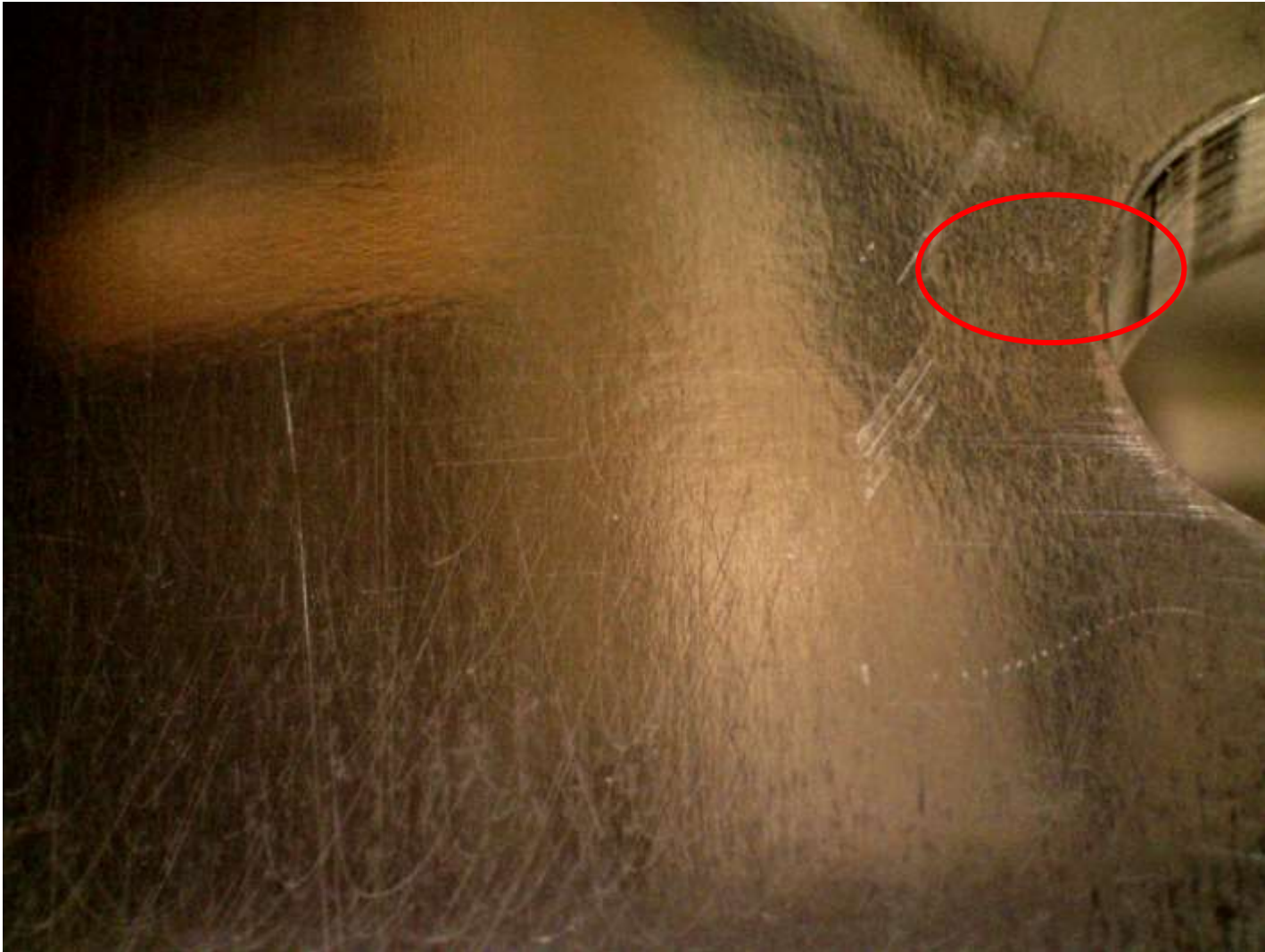




Failed Ligament Sample Testing



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Failed Ligament Sample Testing



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Failed Ligament Sample Testing



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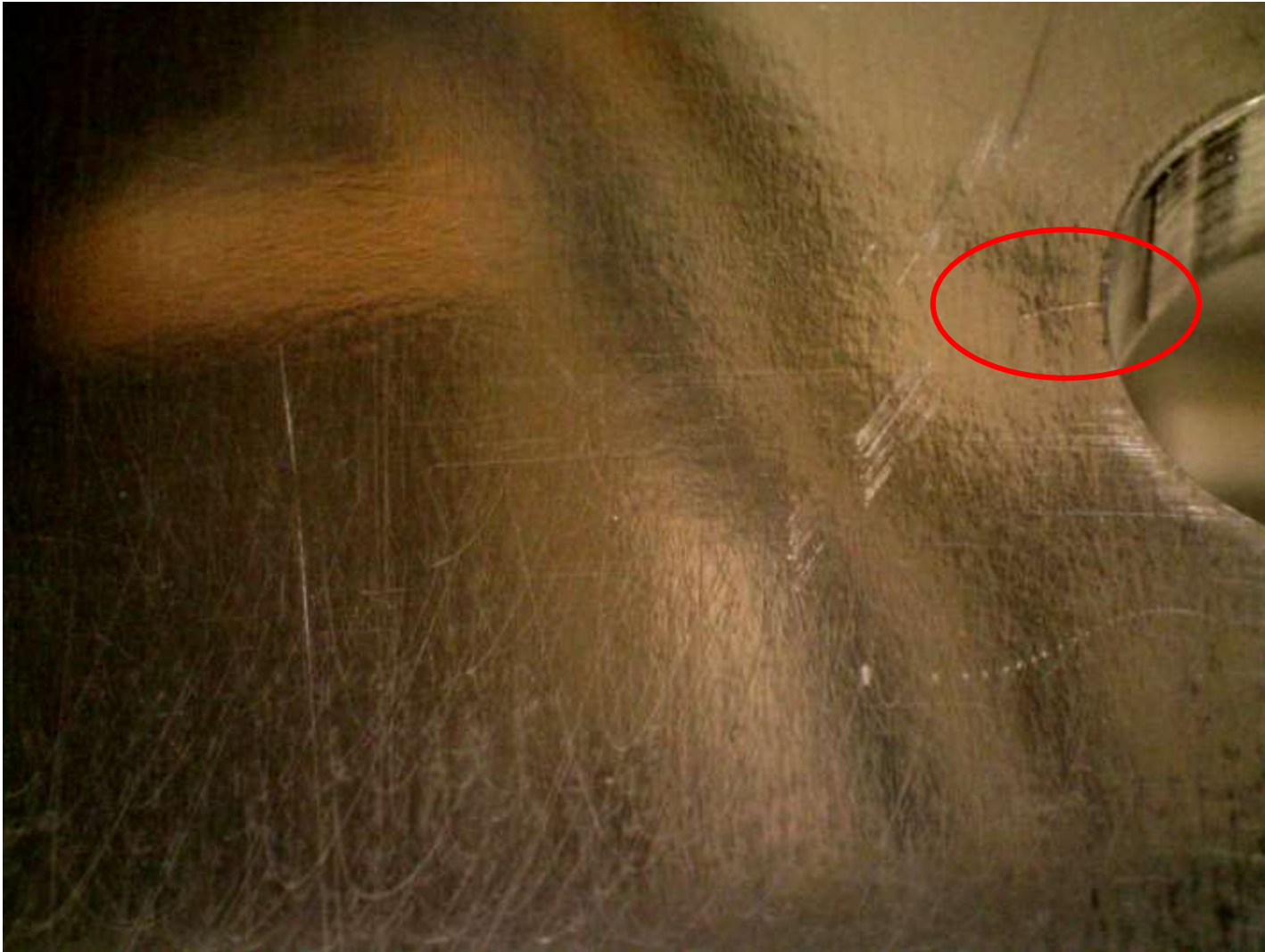




Failed Ligament Sample Testing



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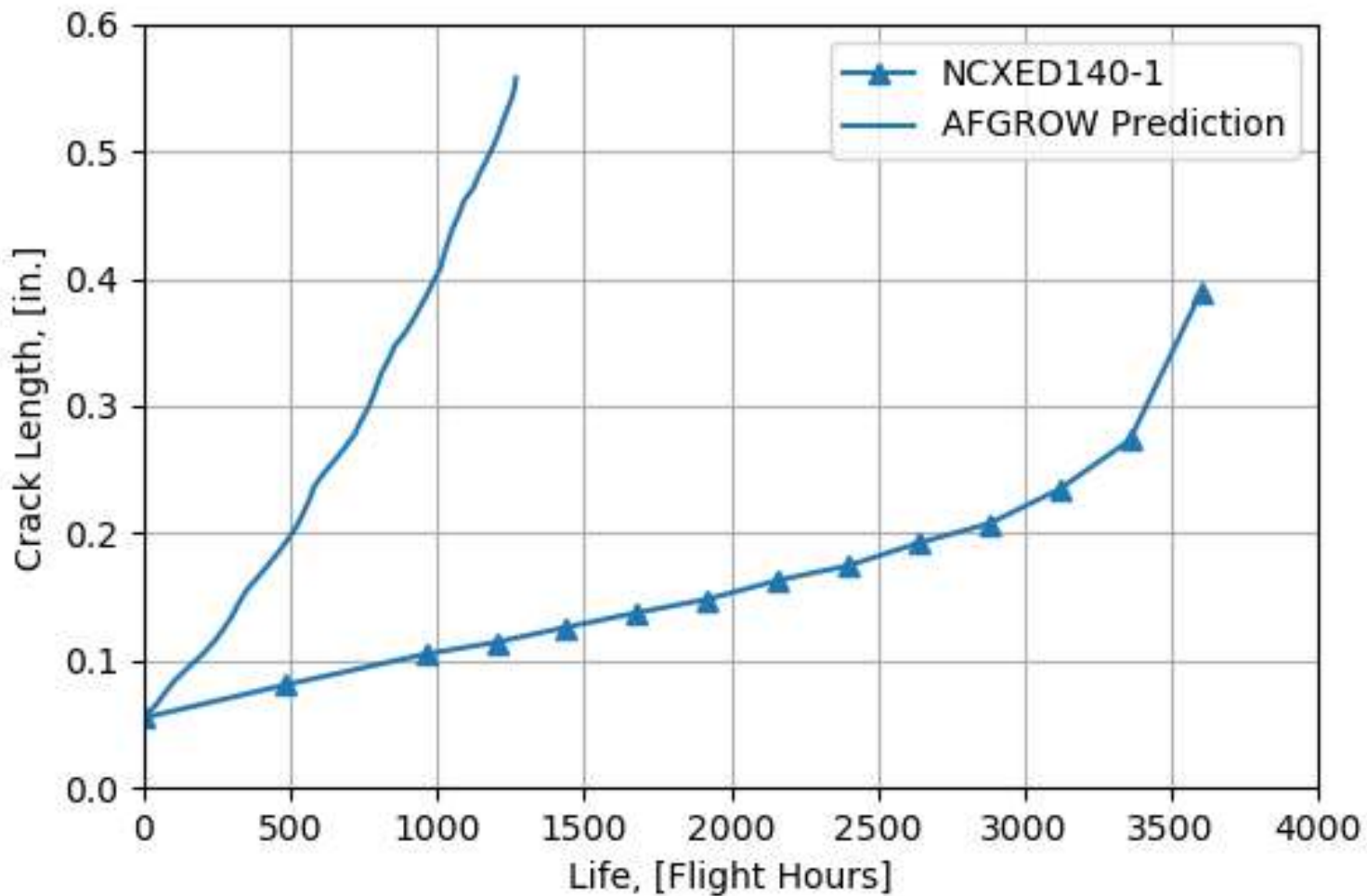




AFGROW Modeling, FL



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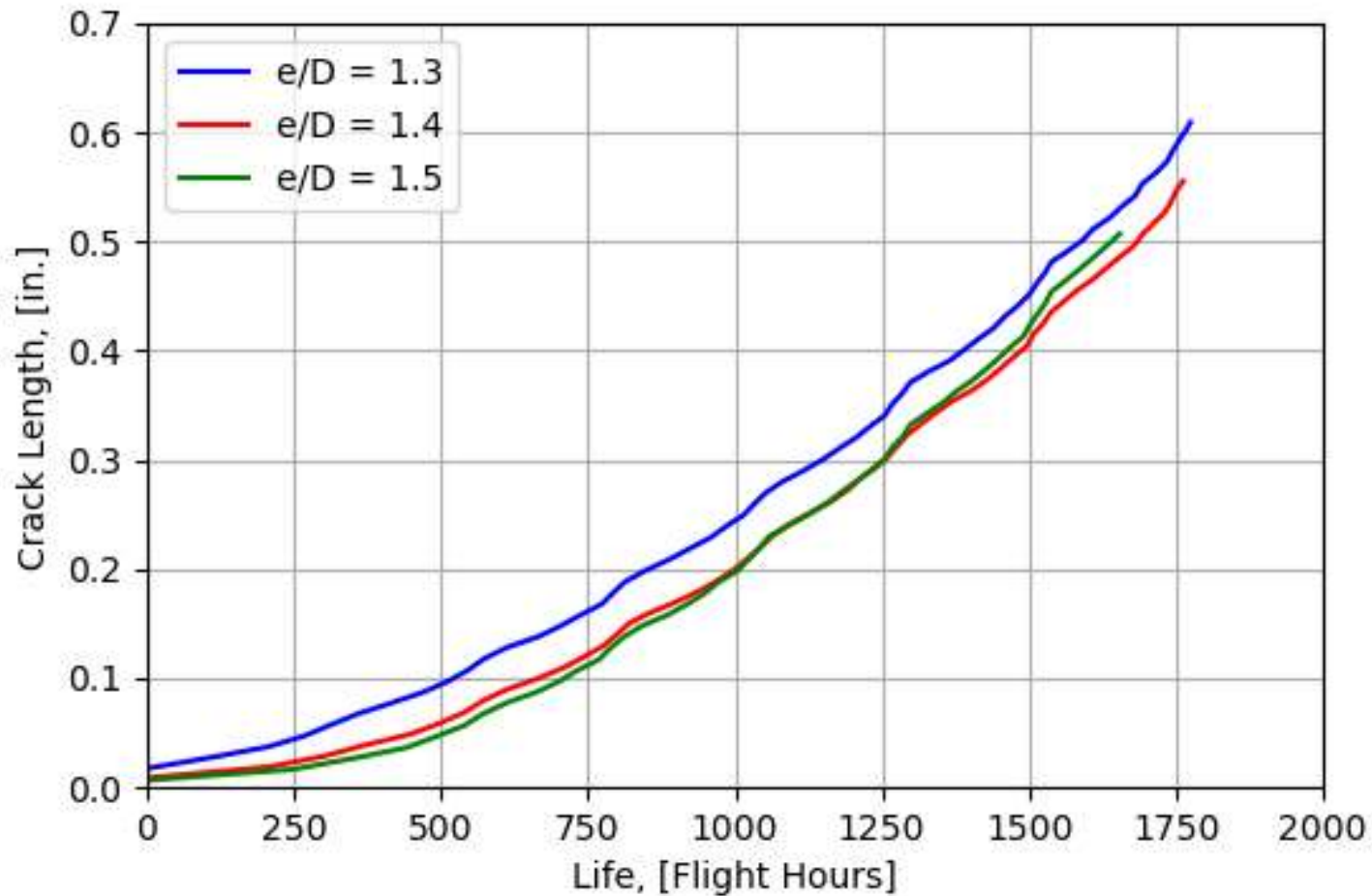




AFGROW Modeling, FL



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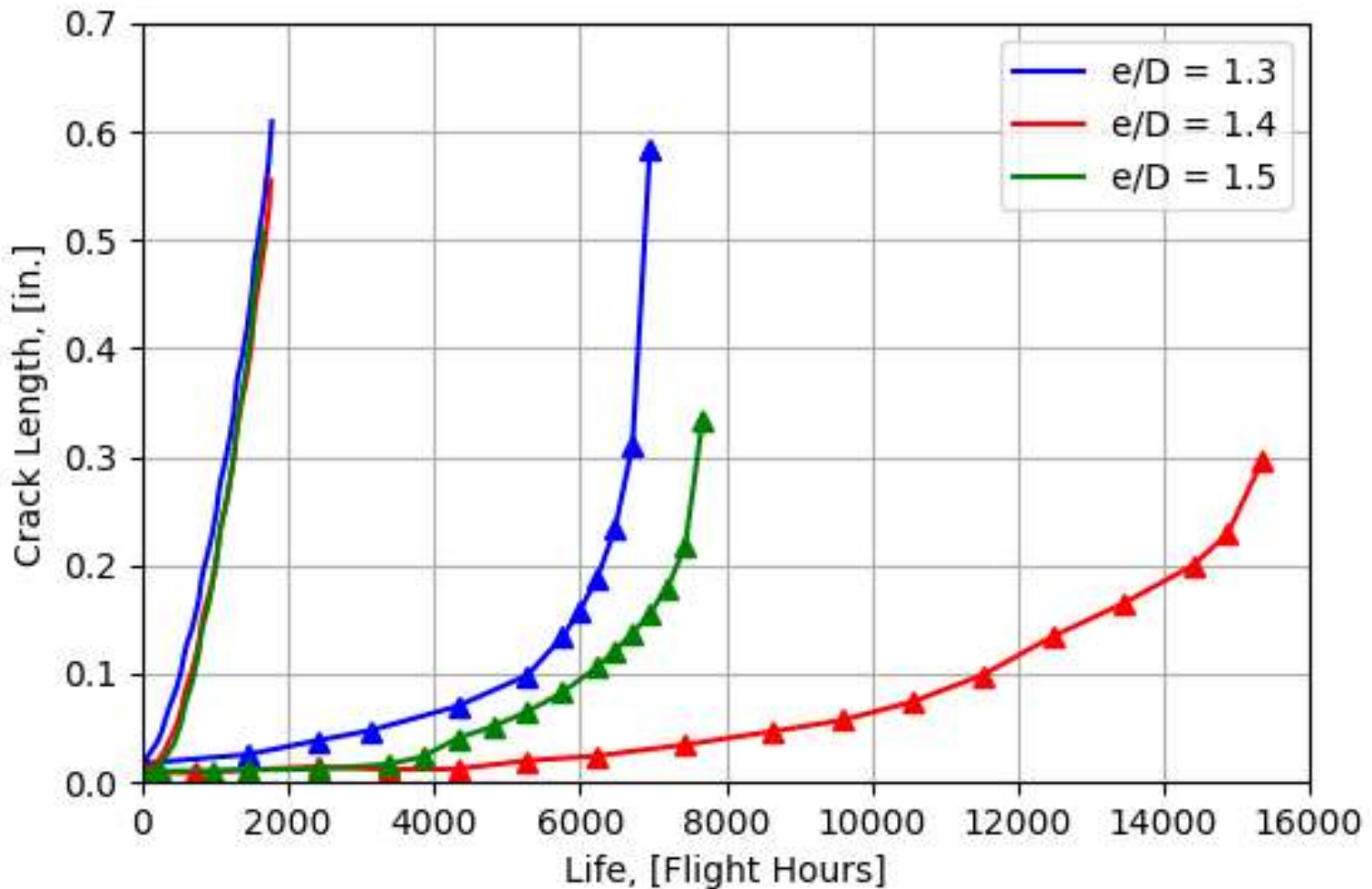




AFGROW Modeling, FL



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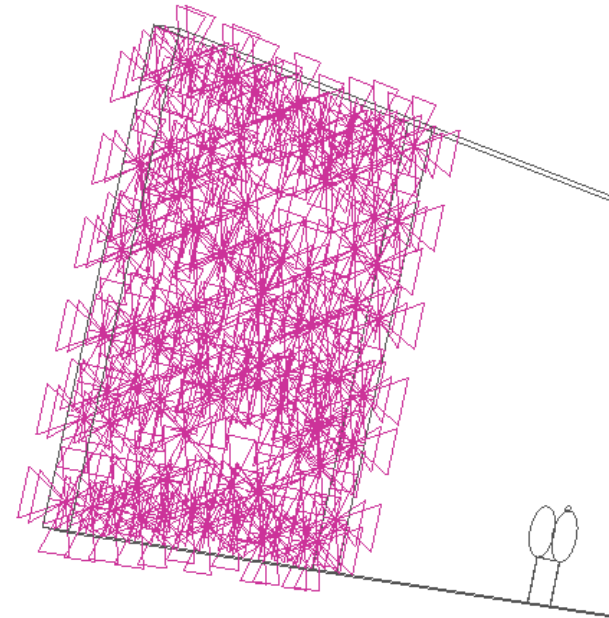
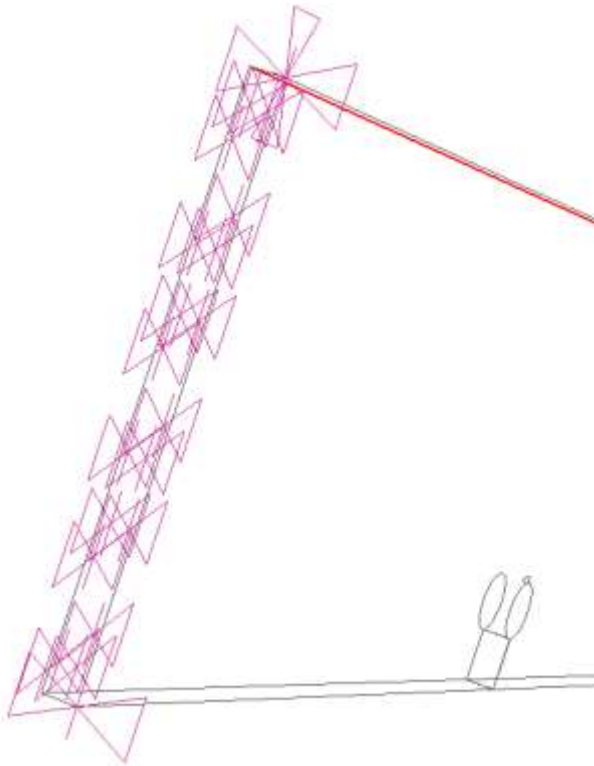




In-plane Bending Modeling



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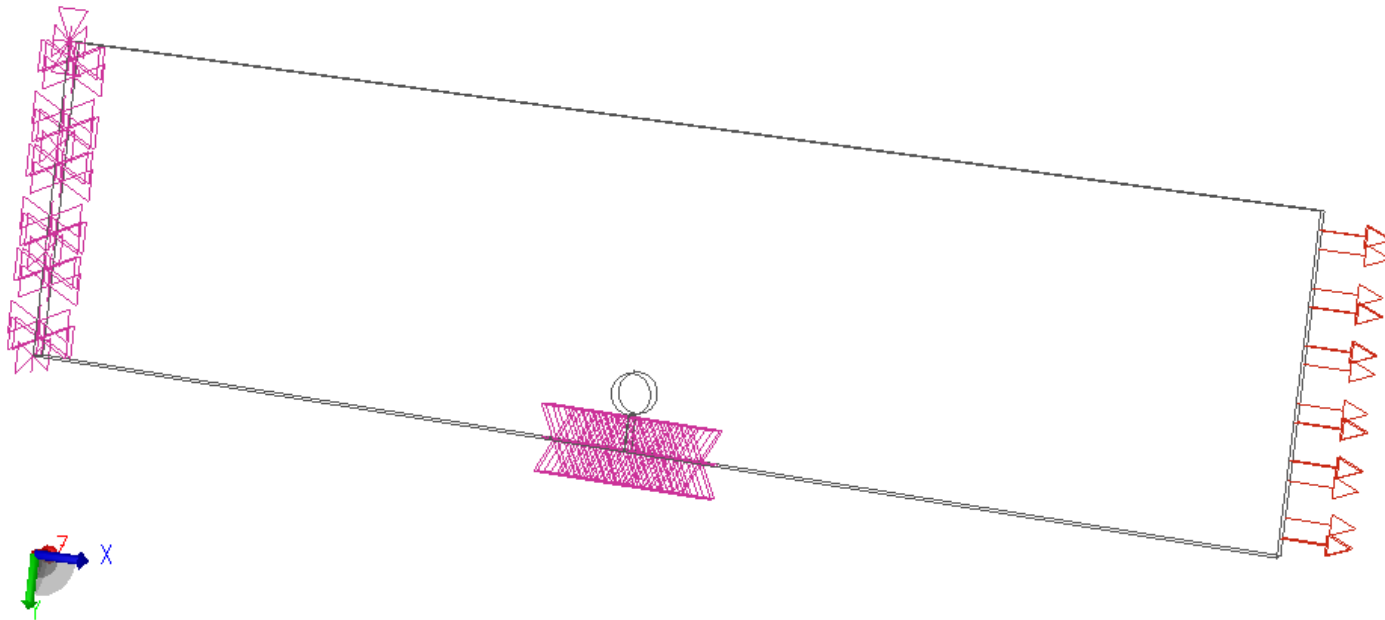




In-plane Bending Modeling



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Acknowledgments



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Questions?



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