HILL ENGINEERING
Predict. Test. Perform.

Relifing ain’t all its cracked up to be

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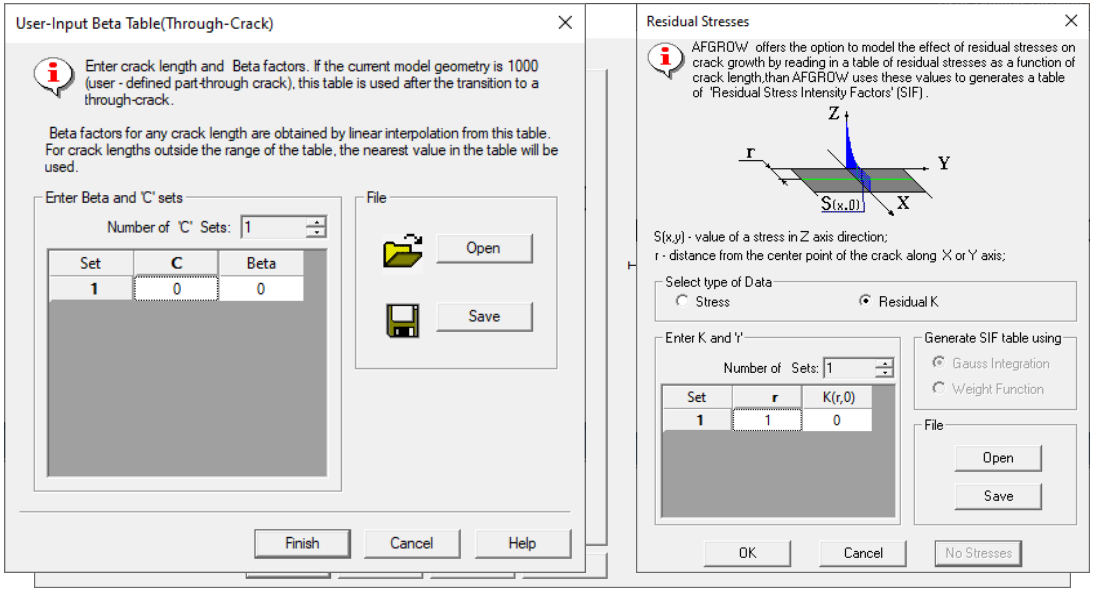
Relifing in BAMF/AFGROW

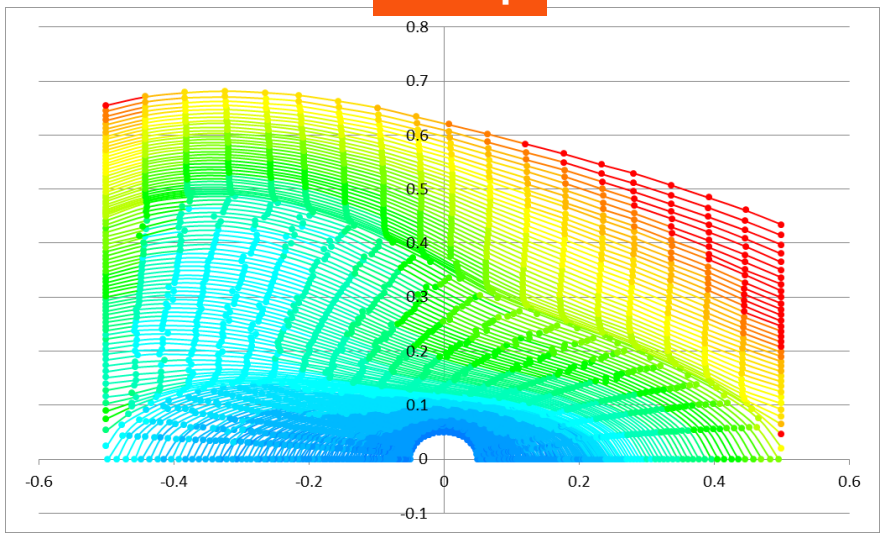
- Extract K_{rs} and β_{app} from a BAMF run
- Input into a user defined through crack model
  - Analysis should be iterated to find the “closest matching life”
  - Typically c-direction is most appropriate
- Relifing assumes no change in crack shape



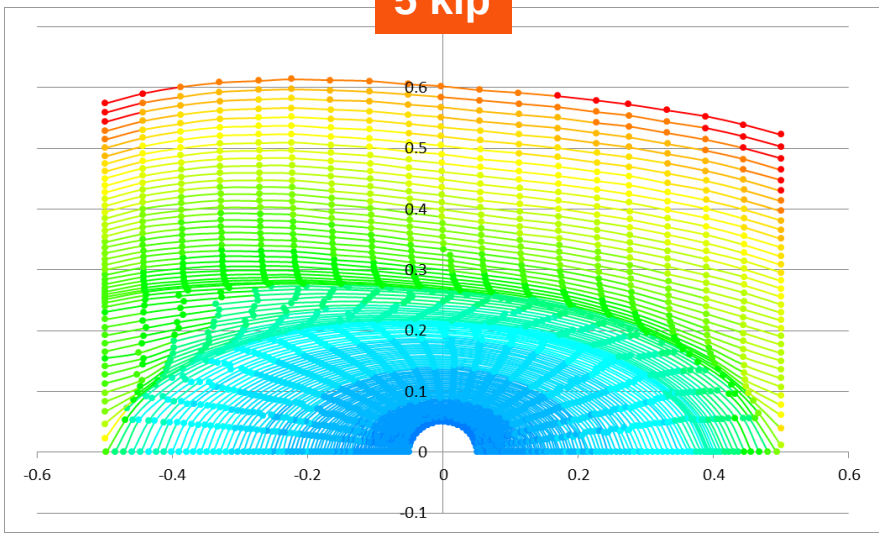
Crack Shape Differences

- Crack shape differences will change stress intensities
- Large differences have been observed in crack shape for different max applied stresses

3.5 kip

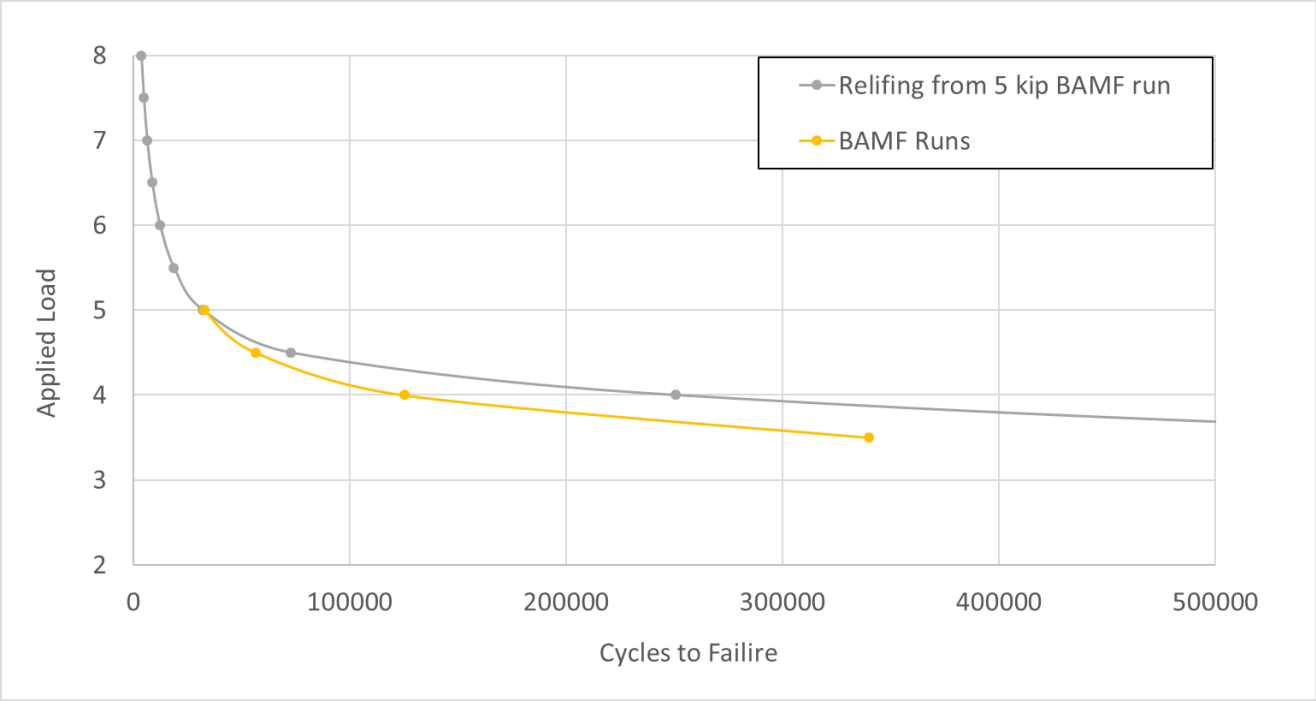


5 kip



Crack Shape Differences

- Stress intensity differences can have a drastic effect on fatigue life
- What about retardation correlation?



CX SOLR Correlation

- **Correlation was performed using K_{rs} and β_{app} from BAMF solution using:**
  - Manage-To RS
  - ERSI coupon RS (Applied Expansion 3.7% LHS only)
- **Initial flaw 0.05”x0.05”**
  - Closely resembles averages from test
- **After correlation, analyses was also performed in BAMF to investigate the appropriateness of the user defined beta solution**

Retardation with Residual Stress

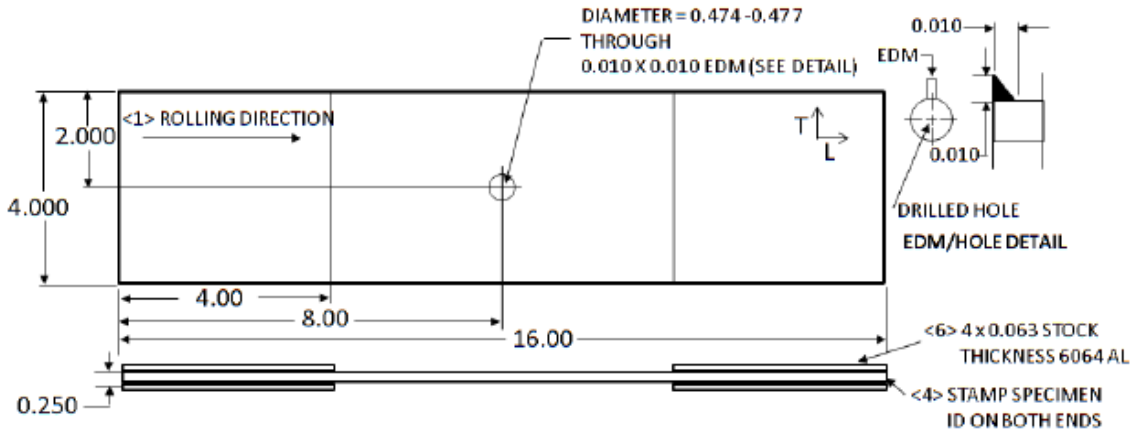
- **Utilizing Jake Warner's thesis data, determine appropriate SOLR for "Manage-To" residual stress and measured residual stress**
- **CP 7 spectrum tests, 2024-T351 aluminum, various stress levels**
- **Initial SOLR correlation with baseline coupons and new material file**
- **BAMF analysis with no retardation**
  - User defined beta analysis to determine retardation values correlated to test
  - Final BAMF analysis to verify user defined beta approach is appropriate for SOLR correlation

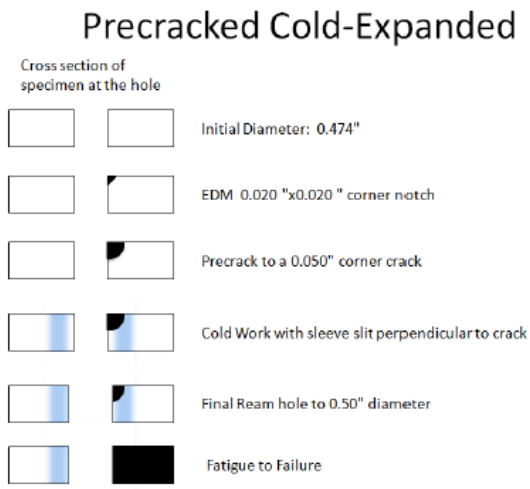
Specimen Details

Table 1 Final Test Matrix

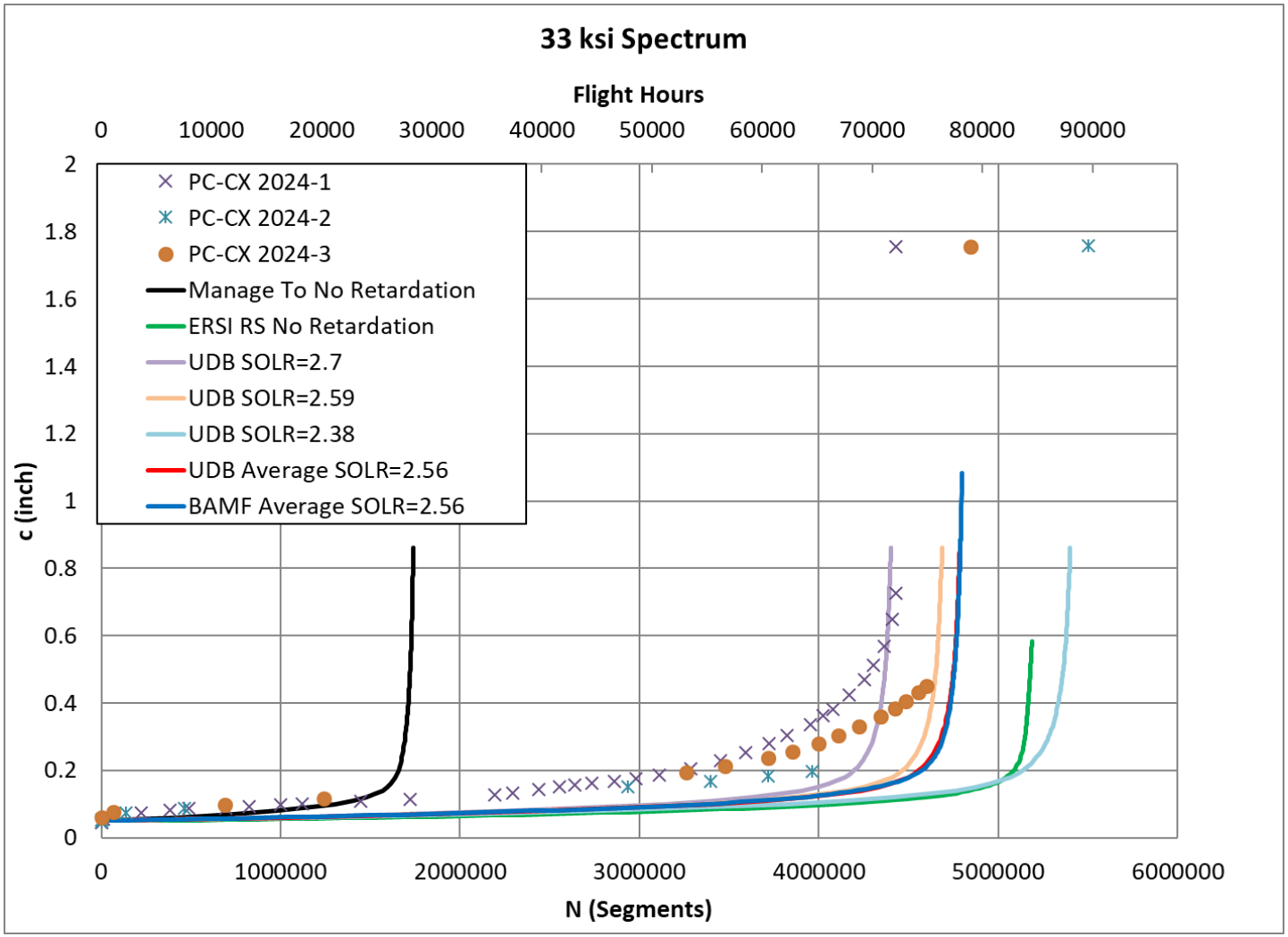
CX/NON-CX	CA or Spectrum	Peak Stress (ksi)	Specimens Tested	Specimen ID's
NON-CX	CA (ASTM E647)	11.25	2	2024-1;-2
NON-CX	Spectrum	25.00	3	NCX 2024-1 thru -3
		33.00	3	NCX 2024-4 thru -6
		43.25	1	NCX 2024-7
CX	CA	20.00	4	PC-CX 2024-9;-10;-11
		25.00	3	PC-CX 2024-15;-16;-17
	Spectrum	25.00	1	PC-CX 2024-5
		30.00	3	PC-CX 2024-4;-12;-13
		33.00	3	PC-CX 2024-1 thru -3
		43.25	3	PC-CX 2024-6 thru -8

Specimen ID's	Post Pre-Crack Diameter (inches)	Applied Percent Cold Expansion
PC-CX 2024-1	0.476945	3.47%
PC-CX 2024-2	0.476695	3.53%
PC-CX 2024-3	0.476595	3.55%





CX SOLR Correlation



Retardation Correlation Conclusions

- **Retardation values of Non-CX and CX are not interchangeable**
  - Makes sense based on relative differences in overload behavior
- **“Manage-To” RS correlates to final life using “typical” aluminum SOLR values**
  - SOLR=2.6, 33 ksi
  - SOLR=3.8, 43 ksi
- **User defined beta approach works in this case for SOLR re-correlation**
- **User defined beta approach does not produce similar results when going from a constant amplitude analysis to a spectrum analysis**
  - Makes sense based on difference of crack opening, crack pinning (or lack of), and crack shape evolution
- **ANYTHING THAT COULD IMPACT CRACK SHAPE PROGRESSION SHOULD NOT UTILIZE RELIFING**