Establishing A Programmatic Workflow For Processing Tabular Datasets

AFGROW Workshop 2026

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Introduction

- Previously each tabular dataset has been handled individually and used slightly different methods
- Goal was to create new workflow that was repeatable, kept thorough records of what was done, and could be adapted faster for new datasets
- Want to share our process and reasoning behind decisions made

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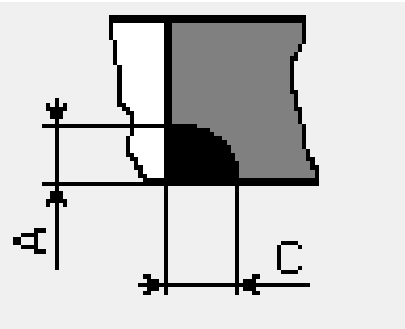
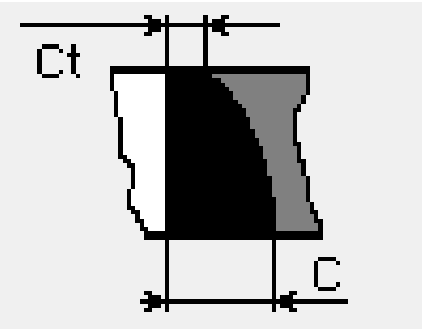
How do we use tabular data?

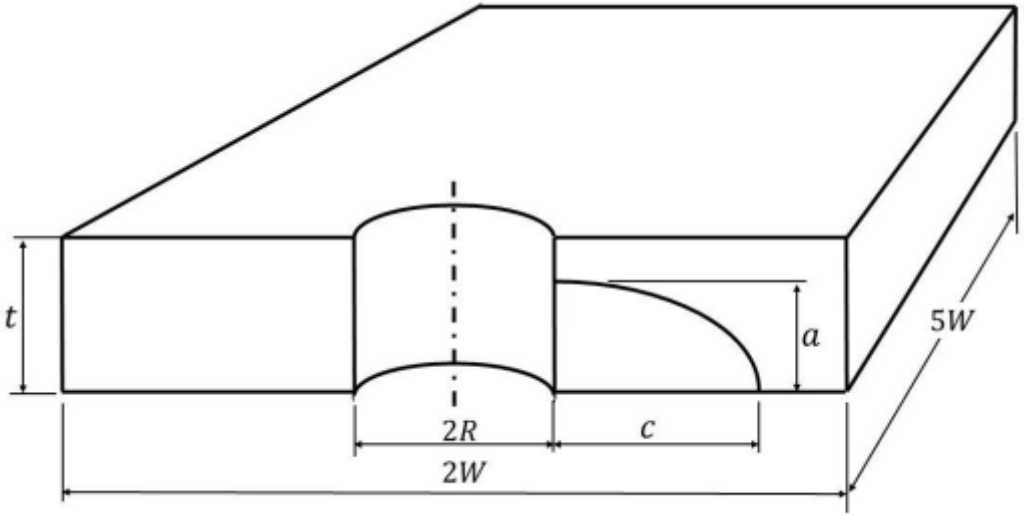
- Tabular datasets are used to supply AFGROW with information about a particular geometry.
- For dimensions we don’t have a datapoint for AFGROW interpolates between existing measurements, so it is important that the data is clean and continuous.
- Initial dataset was a Single Corner Oblique crack at hole from FEA models by Borje Andersson

Sample Model

- A/T, A/C, and R/T are ratios to normalize to geometry
- A vs C “direction”, but actually lots of Ct
- Initially used infinite, but are in process of adding finite plate with W/R parameter







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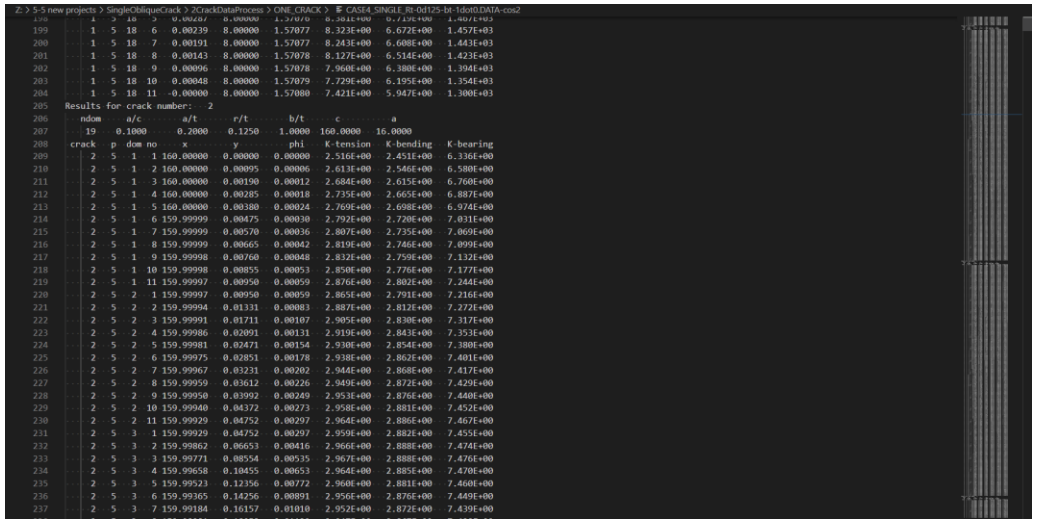
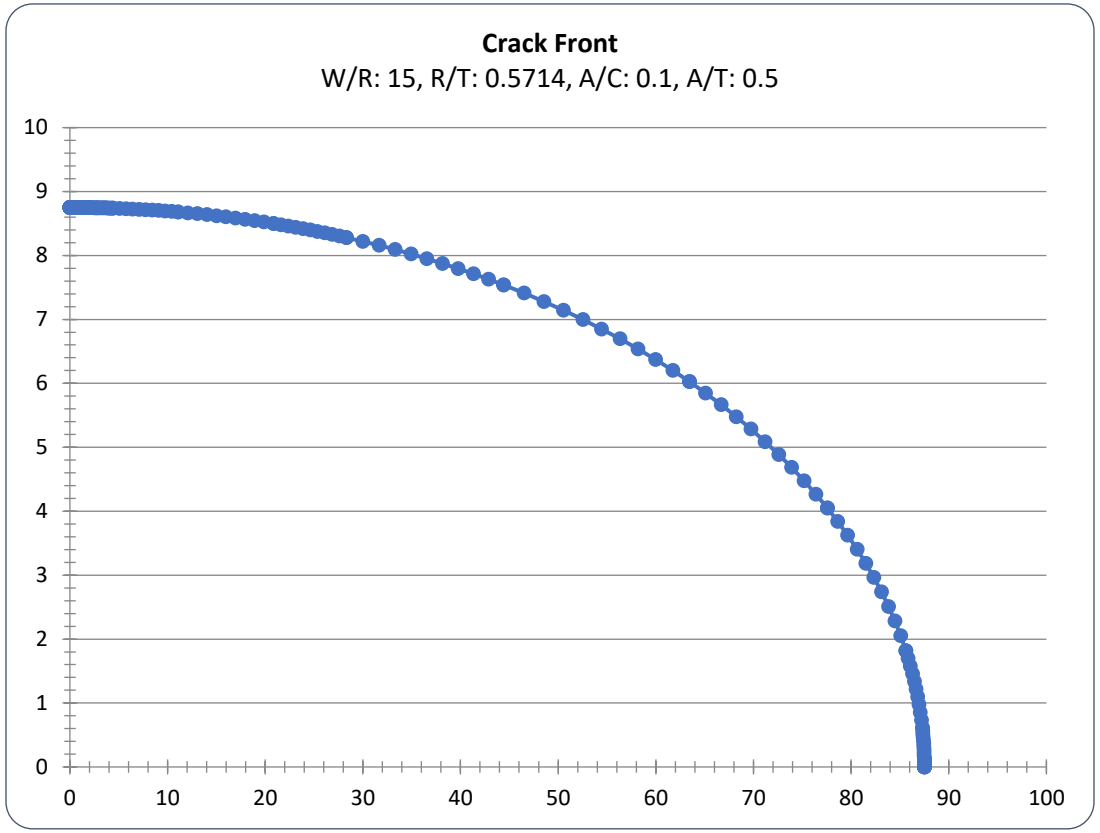
The Starting Point → The End Product

- Raw crack data along each individual crack front



Z: > S-S new projects > SingleObliqueCrack > 2CrackDataProcess > ONE_CRACK > CASE4_SINGLE_fit-0d125-bt-1dot0.DATA-cos2

```
    1   5  18   6   0.00239   8.00000   1.57077   8.323E+00   6.672E+00   1.457E+03
    1   5  18   7   0.00191   8.00000   1.57077   8.243E+00   6.608E+00   1.443E+03
    1   5  18   8   0.00143   8.00000   1.57078   8.127E+00   6.514E+00   1.423E+03
    1   5  18   9   0.00096   8.00000   1.57078   7.960E+00   6.380E+00   1.394E+03
    1   5  18  10   0.00048   8.00000   1.57079   7.729E+00   6.195E+00   1.354E+03
    1   5  18  11  -0.00000   8.00000   1.57080   7.421E+00   5.947E+00   1.300E+03
Results for crack number:   2
   ndom     a/c         a/t         r/t         b/t         c           a
     19    0.1000      0.2000      0.1250      1.0000   160.0000    16.0000
 crack    p  dom no      x           y           phi      K-tension   K-bending   K-bearing
    2   5   1   1 160.00000   0.00000   0.00000   2.516E+00   2.451E+00   6.336E+00
    2   5   1   2 160.00000   0.00095   0.00006   2.613E+00   2.546E+00   6.580E+00
    2   5   1   3 160.00000   0.00190   0.00012   2.684E+00   2.615E+00   6.760E+00
    2   5   1   4 160.00000   0.00285   0.00018   2.735E+00   2.665E+00   6.887E+00
    2   5   1   5 160.00000   0.00380   0.00024   2.769E+00   2.698E+00   6.974E+00
    2   5   1   6 159.99999   0.00475   0.00030   2.792E+00   2.720E+00   7.031E+00
    2   5   1   7 159.99999   0.00570   0.00036   2.807E+00   2.735E+00   7.069E+00
    2   5   1   8 159.99999   0.00665   0.00042   2.819E+00   2.746E+00   7.099E+00
    2   5   1   9 159.99998   0.00760   0.00048   2.832E+00   2.759E+00   7.132E+00
    2   5   1  10 159.99998   0.00855   0.00053   2.850E+00   2.776E+00   7.177E+00
    2   5   1  11 159.99997   0.00950   0.00059   2.876E+00   2.802E+00   7.244E+00
    2   5   2   1 159.99997   0.00950   0.00059   2.865E+00   2.791E+00   7.216E+00
    2   5   2   2 159.99994   0.01331   0.00083   2.887E+00   2.812E+00   7.272E+00
    2   5   2   3 159.99991   0.01711   0.00107   2.905E+00   2.830E+00   7.317E+00
    2   5   2   4 159.99986   0.02091   0.00131   2.919E+00   2.843E+00   7.353E+00
    2   5   2   5 159.99981   0.02471   0.00154   2.930E+00   2.854E+00   7.380E+00
    2   5   2   6 159.99975   0.02851   0.00178   2.938E+00   2.862E+00   7.401E+00
    2   5   2   7 159.99967   0.03231   0.00202   2.944E+00   2.868E+00   7.417E+00
    2   5   2   8 159.99959   0.03612   0.00226   2.949E+00   2.872E+00   7.429E+00
    2   5   2   9 159.99950   0.03992   0.00249   2.953E+00   2.876E+00   7.440E+00
    2   5   2  10 159.99940   0.04372   0.00273   2.958E+00   2.881E+00   7.452E+00
    2   5   2  11 159.99929   0.04752   0.00297   2.964E+00   2.886E+00   7.467E+00
    2   5   3   1 159.99929   0.04752   0.00297   2.959E+00   2.882E+00   7.455E+00
    2   5   3   2 159.99862   0.06653   0.00416   2.966E+00   2.888E+00   7.474E+00
    2   5   3   3 159.99771   0.08554   0.00535   2.967E+00   2.888E+00   7.476E+00
    2   5   3   4 159.99658   0.10455   0.00653   2.964E+00   2.885E+00   7.470E+00
    2   5   3   5 159.99523   0.12356   0.00772   2.960E+00   2.881E+00   7.460E+00
    2   5   3   6 159.99365   0.14256   0.00891   2.956E+00   2.876E+00   7.449E+00
    2   5   3   7 159.99184   0.16157   0.01010   2.952E+00   2.872E+00   7.439E+00
```



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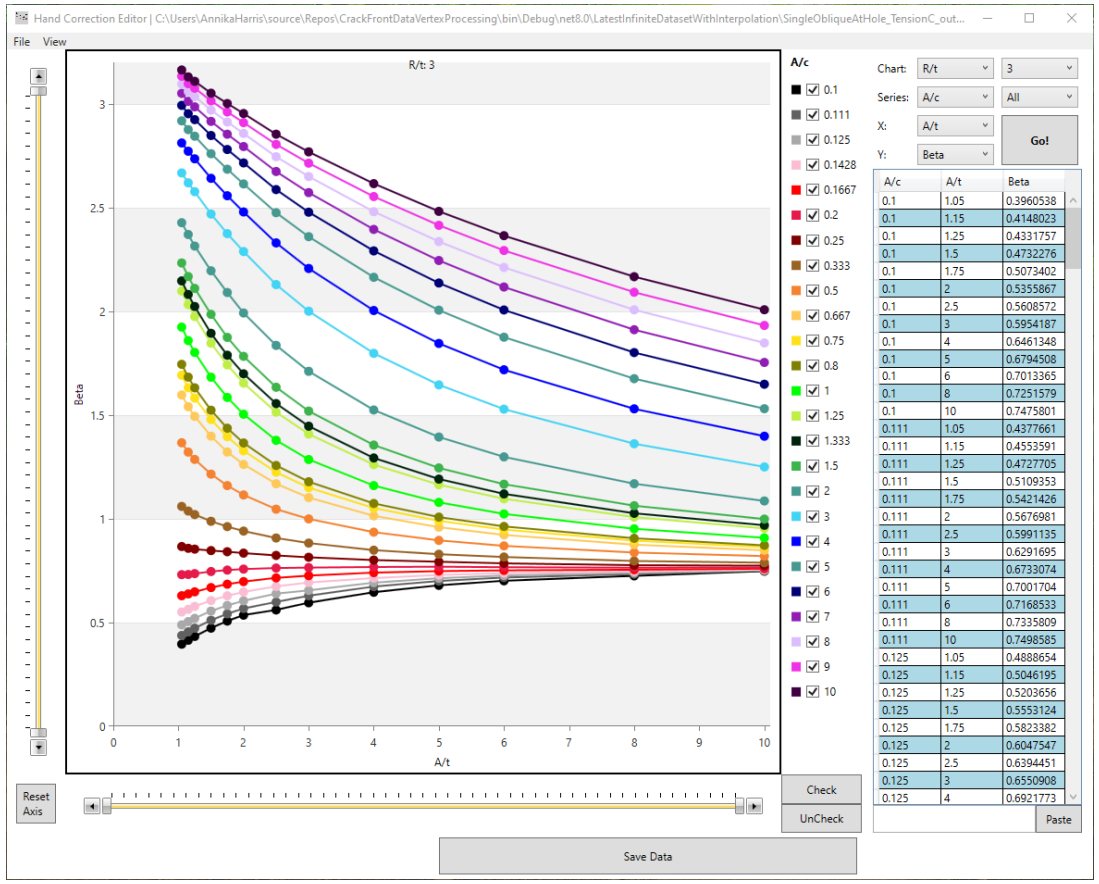
The Starting Point → The End Product

- Table of generalized condensed data that AFGROW can use easily

```
# Date Generated: 6/24/2026 12:28
# Borje Data Set: Z:\5-5 new projects\SingleObliqueCrack\2CrackDataProcess\ONE_CRACK
# Stresscheck Data Set: Z:\5-5 new projects\SingleObliqueCrack\VertexExtension\python\OutputFinalish\Combined-ProcessingFormat-rev
# Fits generated for Arc Length Vs K between 4% and 50% of arc length
# The original dataset may contain duplicate values from symetric crack fronts, if results are within 0.01% for both values the se
# Dataset was smoothed and filled in using iterative Alglib fits.
# Percent Method: Local max estimation between 0.125% and 3% of arc length
Dependent       Beta
R/t     A/c     A/t     Beta
0.1     0.1     1.05    0.0003606
0.1     0.1     1.15    0.0003492
0.1     0.1     1.25    0.0003541
0.1     0.1     1.5     0.0003445
0.1     0.1     1.75    0.000345
0.1     0.1     2       0.0003244
0.1     0.1     2.5     0.0003086
0.1     0.1     3       0.0002955
0.1     0.1     4       0.0002753
0.1     0.1     5       0.0002612
0.1     0.1     6       0.0002515
0.1     0.1     8       0.0002399
0.1     0.1     10      0.0002546
0.1     0.111   1.05    0.000425
0.1     0.111   1.15    0.0004082
0.1     0.111   1.25    0.0004015
0.1     0.111   1.5     0.0003917
0.1     0.111   1.75    0.0003856
0.1     0.111   2       0.0003816
0.1     0.111   2.5     0.0003558
0.1     0.111   3       0.000339
0.1     0.111   4       0.0003074
```



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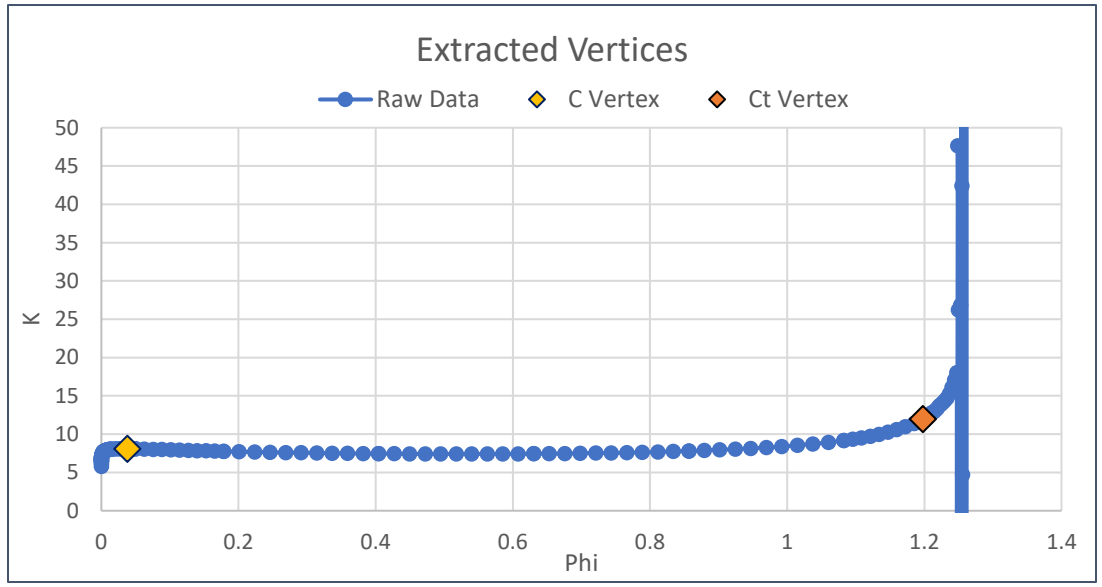
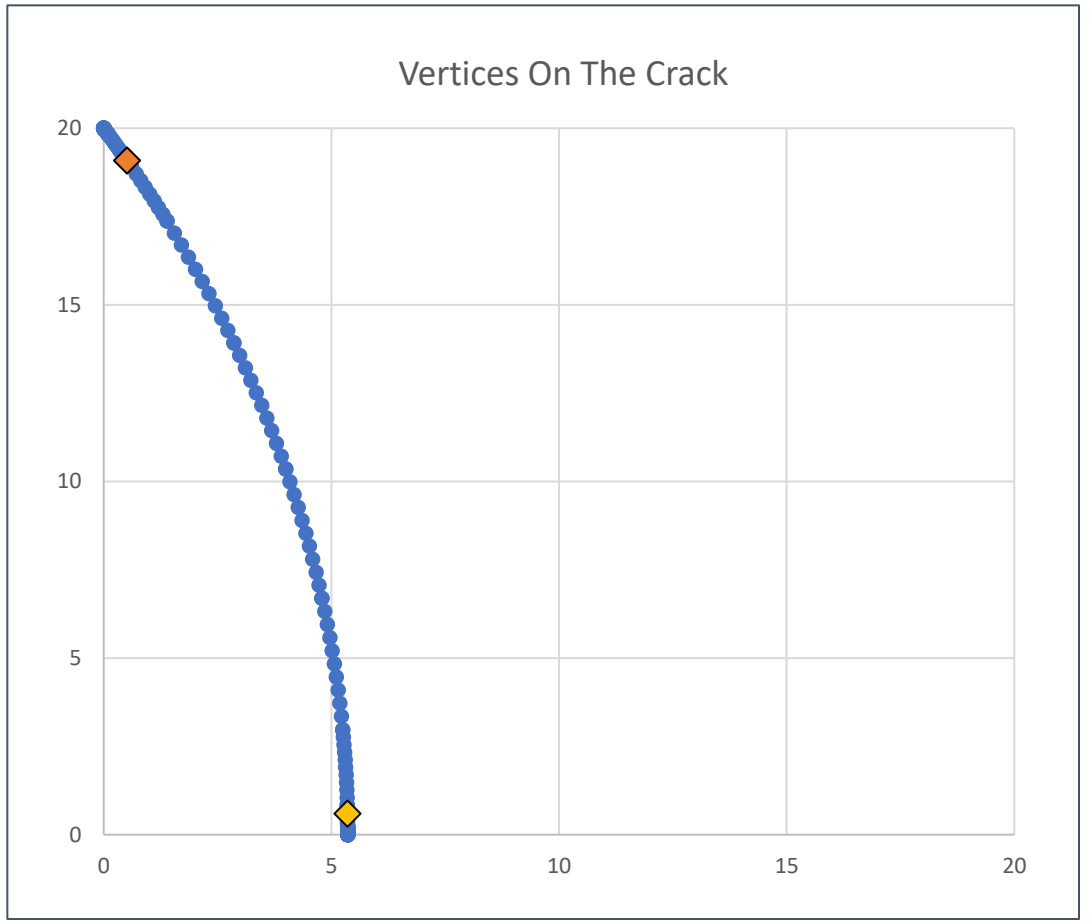
Extracting Vertices

- Infinite data fitting
- Local max (preferred)
- Average phi prediction
- Default phi percentage

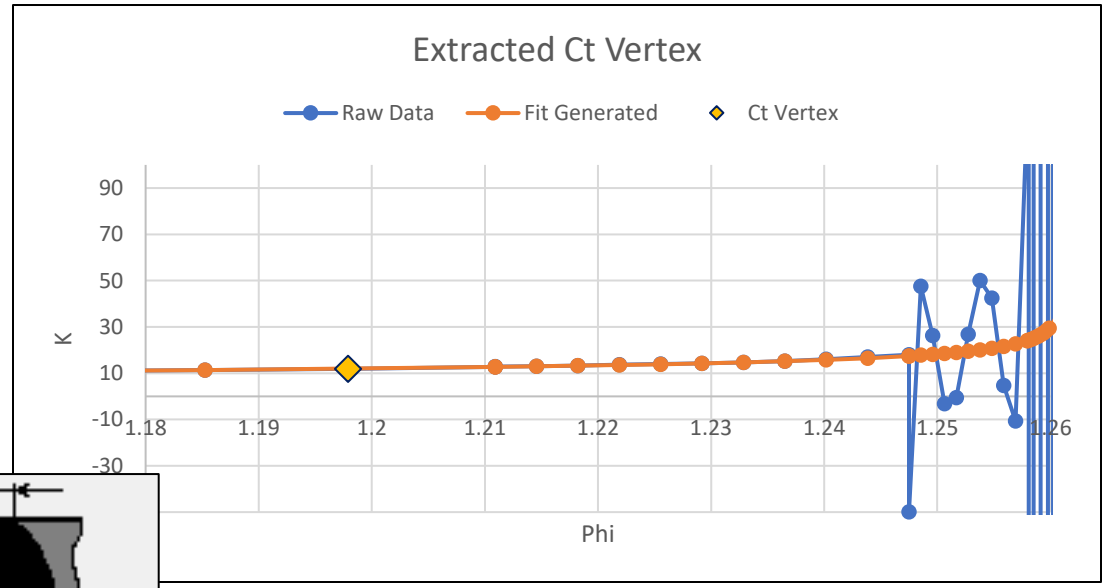


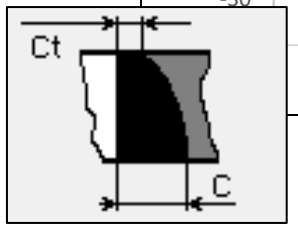


Extracting Vertices

Generating Fits

- Oblique crack fronts in particular become hard to model close to the edge
- We use the method developed by BARE to generate a stable fit for the data at small distances





$$K = C_1\Phi^{\lambda_a-\frac{I}{2}} + C_2\Phi^{\lambda_b-\frac{I}{2}} + C_3\Phi^{\lambda_a+1-\frac{I}{2}} + C_4\Phi^{\lambda_c-\frac{I}{2}}$$

Where each C is a constant coefficient and values for lambda are taken from a table generated with the BARE software STRIPE

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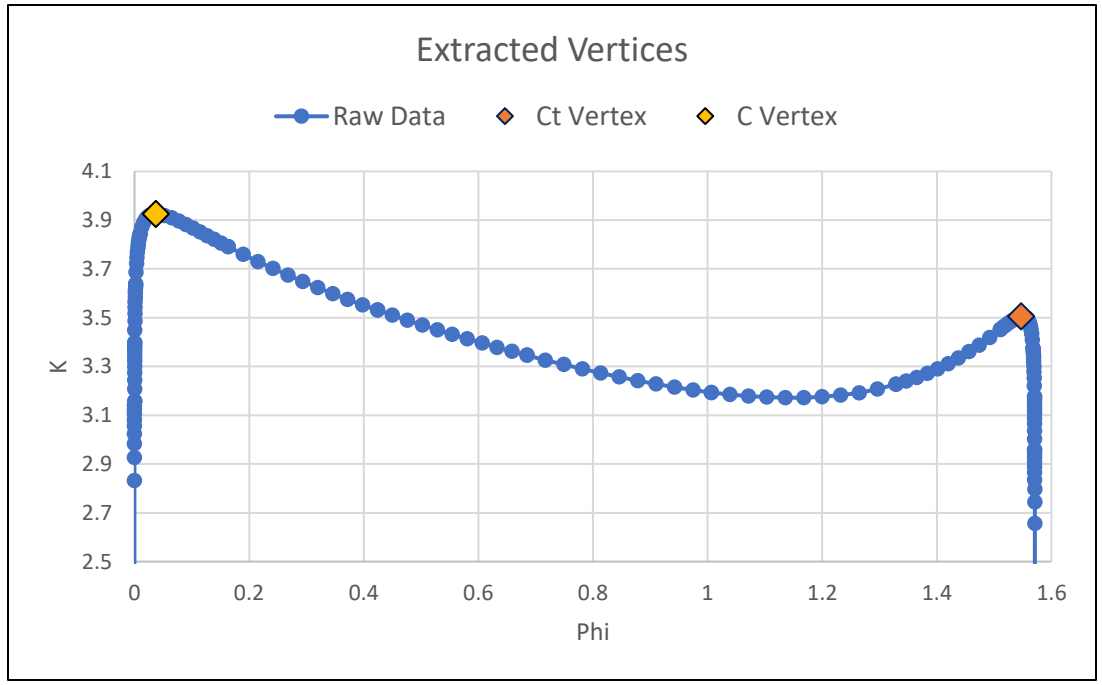
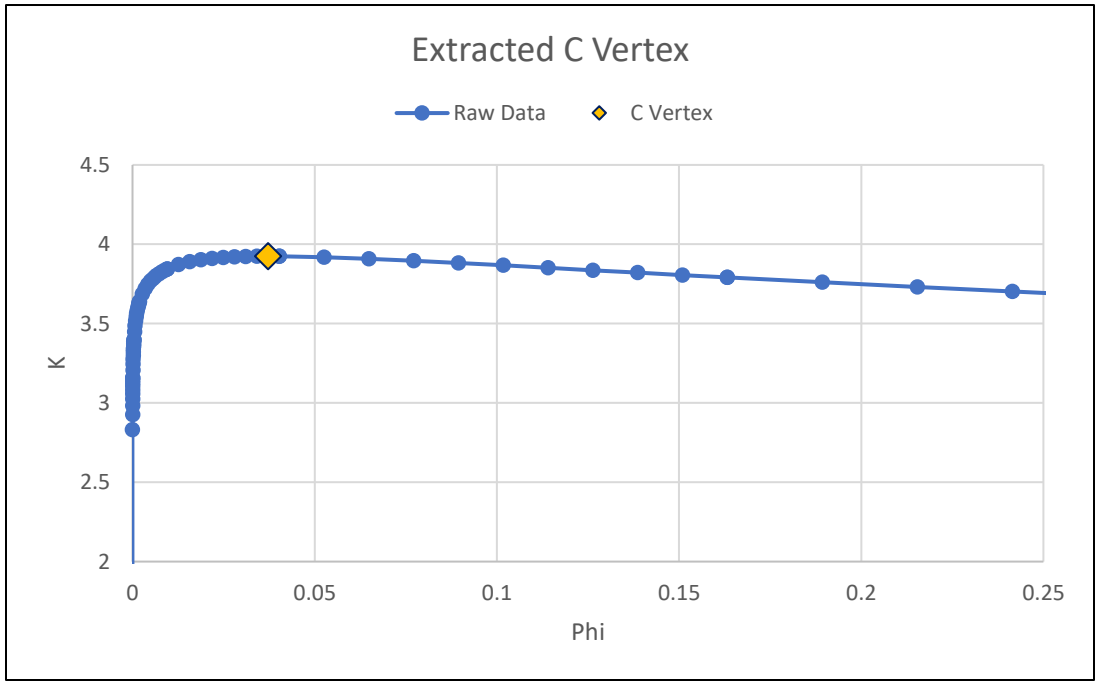
Extracting Vertices

Local Maximum

- Local maxima or minima location
- This is our “preferred” method, and we use it as much as possible

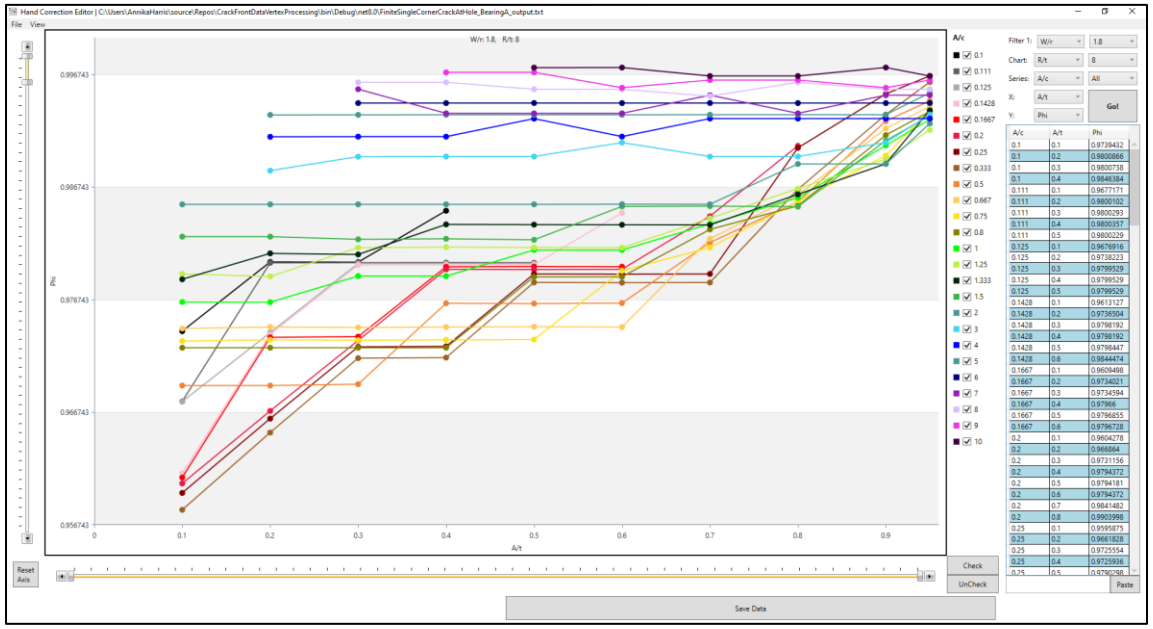


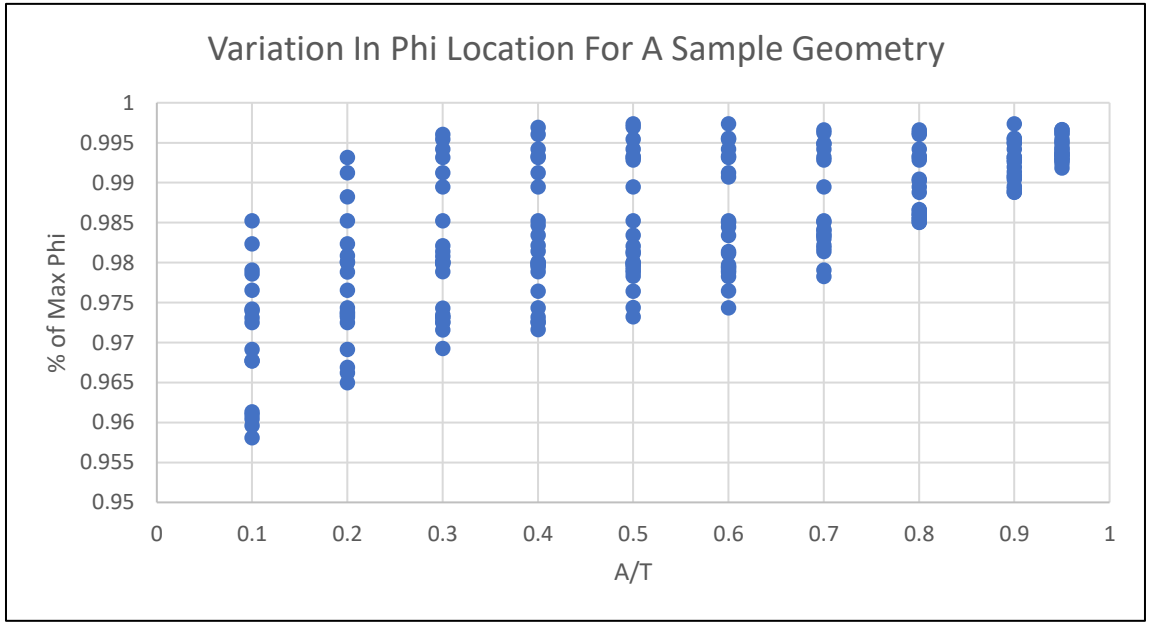


Extracting Vertices

Average Phi

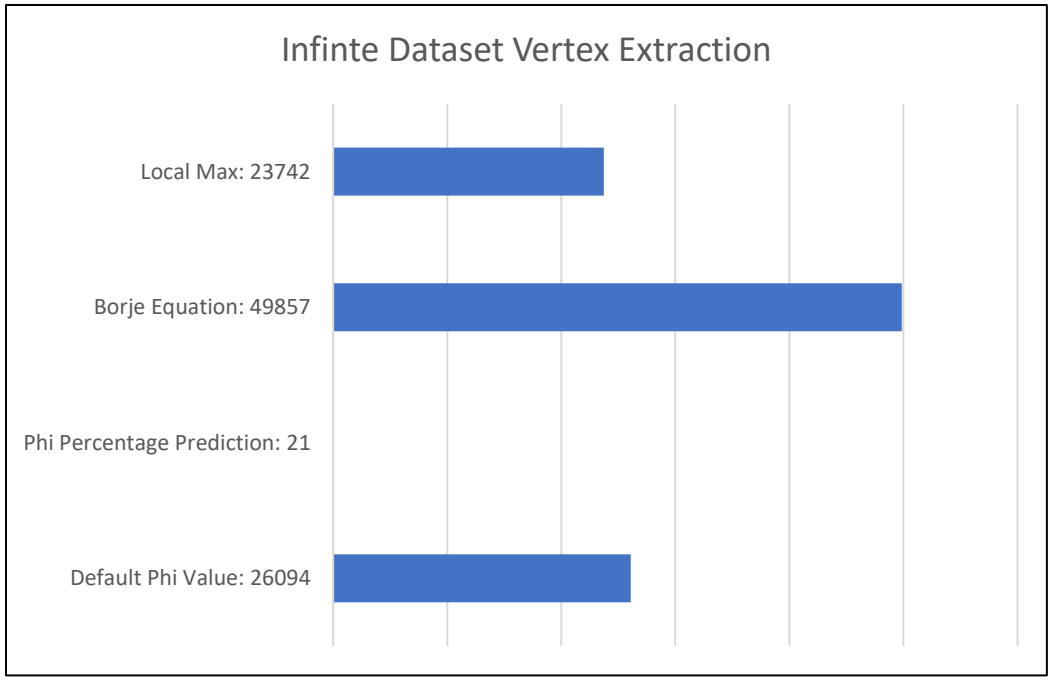
- For datasets with a large sample size (at least 3 points with matching R/T and A/C) the program will use the average location of nearby vertices to estimate the location of the next phi value with a fairly high degree of accuracy.

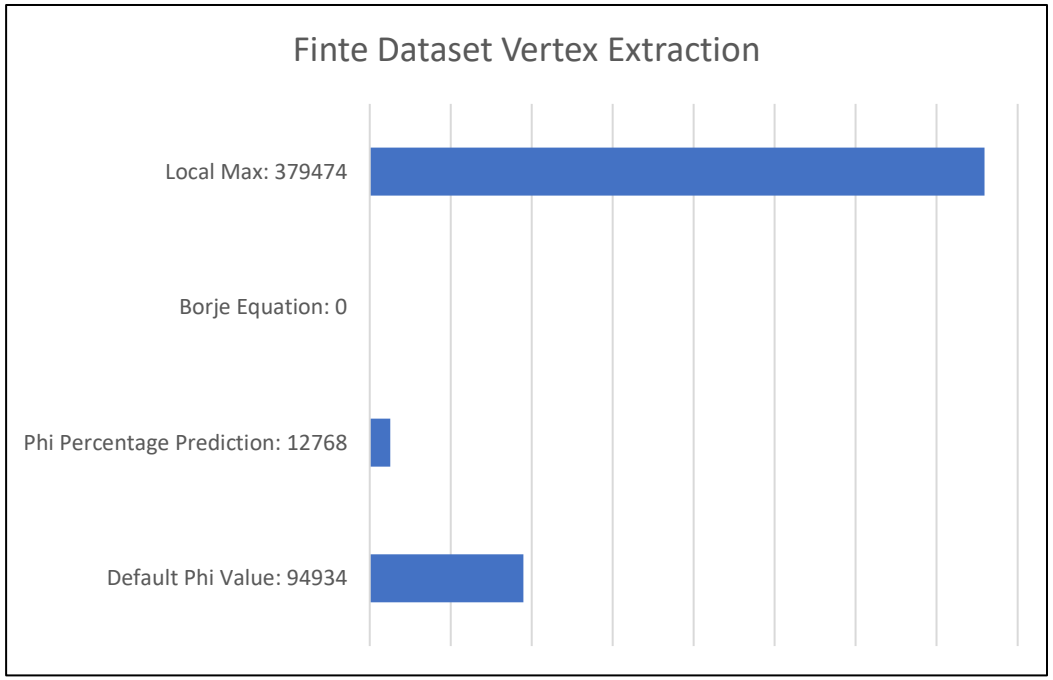




Extracting Vertices

Methods Used





This gives an idea of how much each method is used. Note there is a fairly large difference between our infinite and finite width data

* For more information on k extraction the paper *Experimental Verification Of Stress Intensity Factor Solutions For Corner Cracks At A Hole Subject To General Loading* by S. A. Fawaz, B. Andersson, and J. C. Newman Jr. is available on the AFGROW website

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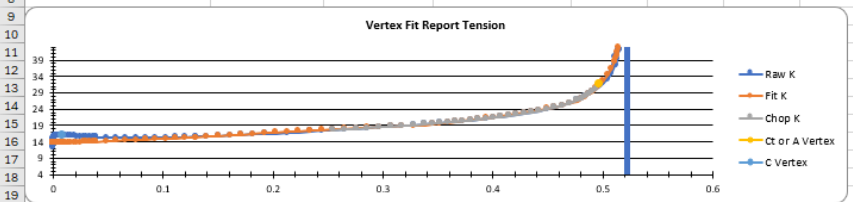
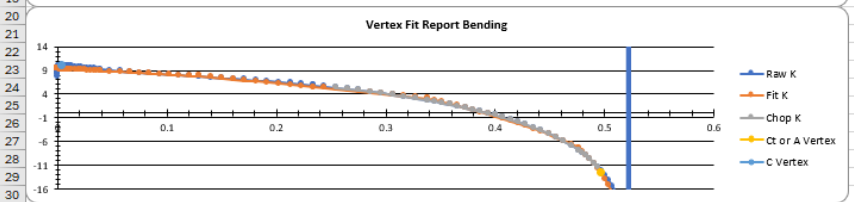
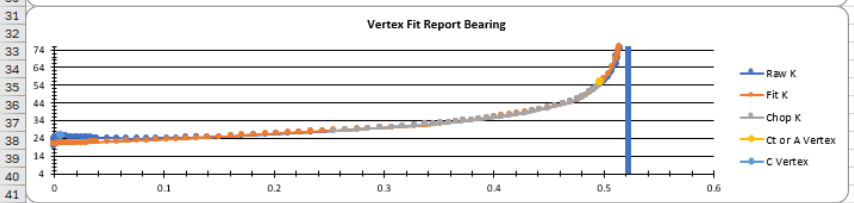
Verification Graphs

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	A/C: 0.1667, A/T: 2, R/T: 0.5	Vertex Phi Value:	Vertex K Value:	Vertex Method:	Lambda 1:	Lambda 2:	Lambda 3:		Raw Phi	Raw K	Fit Phi	Fit K	Chop Phi	Chop K		Raw K
2	Tension	0.49742	31.52020127	AlglibAndUserPercent	0.31978	1.0222	1.4309		0	12.28	0	13.53531826	0.25477	17.58		7.
3	Bending	0.49742	-12.69923845	AlglibAndUserPercent	0.31978	1.0222	1.4309		0.00001	12.76	0.00001	13.53544257	0.2652	17.79		8.
4	Bearing	0.49742	55.38491409	AlglibAndUserPercent	0.31978	1.0222	1.4309		0.00002	13.12	0.00002	13.53556781	0.27563	18		8.
5	Tension	0.00813	15.96	LocalMax					0.00003	13.37	0.00003	13.53569212	0.28606	18.22		8.
6	Bending	0.00483	9.924	LocalMax					0.00004	13.55	0.00004	13.53581736	0.2965	18.45		8.
7	Bearing	0.00648	25.07	LocalMax					0.00005	13.67	0.00005	13.53594488	0.30693	18.68		8.
8									0.00006	13.76	0.00006	13.53607012	0.31736	18.92		8.
9									0.00007	13.85	0.00007	13.53619442	0.32779	19.17		8.
10									0.00008	13.94	0.00008	13.53631966	0.33822	19.43		8.
11									0.00008	14.06	0.00008	13.53644397	0.33822	19.43		8
12									0.00009	14.22	0.00009	13.53657239	0.34515	19.61		8.
13									0.00009	14.12	0.00009	13.53657239	0.35209	19.8		8.
14									0.00013	14.29	0.00013	13.5370737	0.35903	19.99		8.
15									0.00017	14.44	0.00017	13.53757271	0.36596	20.2		9.
16									0.00021	14.56	0.00021	13.53807491	0.3729	20.41		9.
17									0.00025	14.66	0.00025	13.53857709	0.37983	20.63		9
18									0.00028	14.74	0.00028	13.53907925	0.38677	20.87		9.
19									0.00032	14.81	0.00032	13.53958049	0.3937	21.11		9.
20									0.00036	14.88	0.00036	13.54007943	0.40064	21.38		9.
21									0.0004	14.93	0.0004	13.54058156	0.40758	21.67		9.
22									0.00043	14.99	0.00043	13.54108367	0.40758	21.65		9.
23									0.00047	15.05	0.00047	13.54158576	0.41451	21.97		9.
24									0.00047	15.09	0.00047	13.54158576	0.42145	22.31		9.
25									0.00066	15.23	0.00066	13.5440919	0.42838	22.69		9.
26									0.00085	15.34	0.00085	13.54659769	0.43532	23.1		9.
27									0.00104	15.44	0.00104	13.54910311	0.44225	23.54		9
28									0.00123	15.52	0.00123	13.55160499	0.44919	24.02		9.
29									0.00141	15.58	0.00141	13.5541097	0.45613	24.55		9
30									0.0016	15.63	0.0016	13.55661498	0.46306	25.15		9.
31									0.00179	15.68	0.00179	13.55911578	0.47	25.86		9.
32									0.00198	15.72	0.00198	13.56161942	0.47693	26.76		9.
33									0.00217	15.76	0.00217	13.56411951	0.47693	26.67		9.
34									0.00236	15.79	0.00236	13.56661925	0.48032	27.16		9.
35									0.00236	15.8	0.00236	13.56661925	0.48371	27.85		9.
36									0.00318	15.86	0.00318	13.57758304	0.48711	28.64		9.
37									0.00401	15.91	0.00401	13.58853678	0.4905	29.46		9.
38									0.00483	15.94	0.00483	13.5994773	0.49389	30.26		9.
39									0.00565	15.96	0.00565	13.61040462	0.49728	31.07		9.
40									0.00648	15.96	0.00648	13.62132193				9.
41									0.0073	15.96	0.0073	13.63223016				
42									0.00813	15.96	0.00813	13.64312429				9.
43									0.00895	15.95	0.00895	13.65400936				9.
44									0.00978	15.94	0.00978	13.66488129				9
45									0.0106	15.94	0.0106	13.67574326				9.
46									0.0106	15.93	0.0106	13.67574326				9.
47									0.01346	15.88	0.01346	13.7140282				9
48									0.01631	15.82	0.01631	13.75217061				9.
49									0.01917	15.76	0.01917	13.79017637				9
50									0.02202	15.7	0.02202	13.8280406				9.
51									0.02488	15.64	0.02488	13.86576694				9.

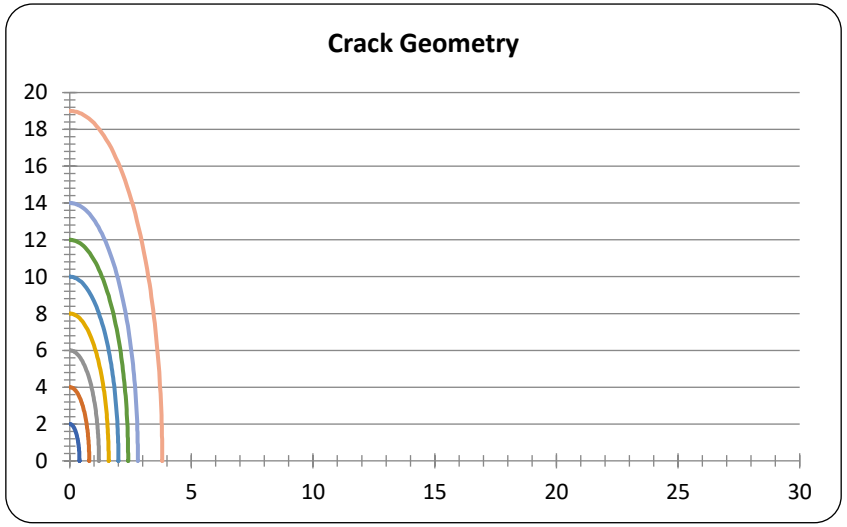






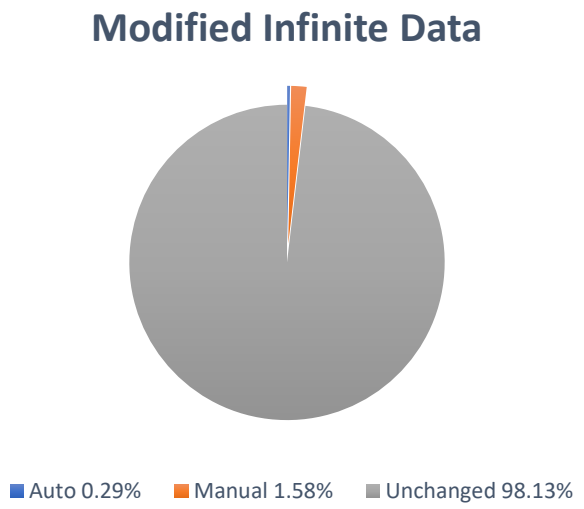
These auto generated graphs are for analyzing the data and double checking each step of our process

Left – vertex extraction
Below – crack fronts for each geometry



Validation and Cleanup

- “Manual” cleaning is performed by visually inspecting the set for outliers and recording them in a log
- Any symmetric cases (cracks with the same dimensions but on the opposite side of the hole) that have a difference in value of more than 0.1% are removed automatically
- The program also flags any duplicate values or gaps/holes in the data



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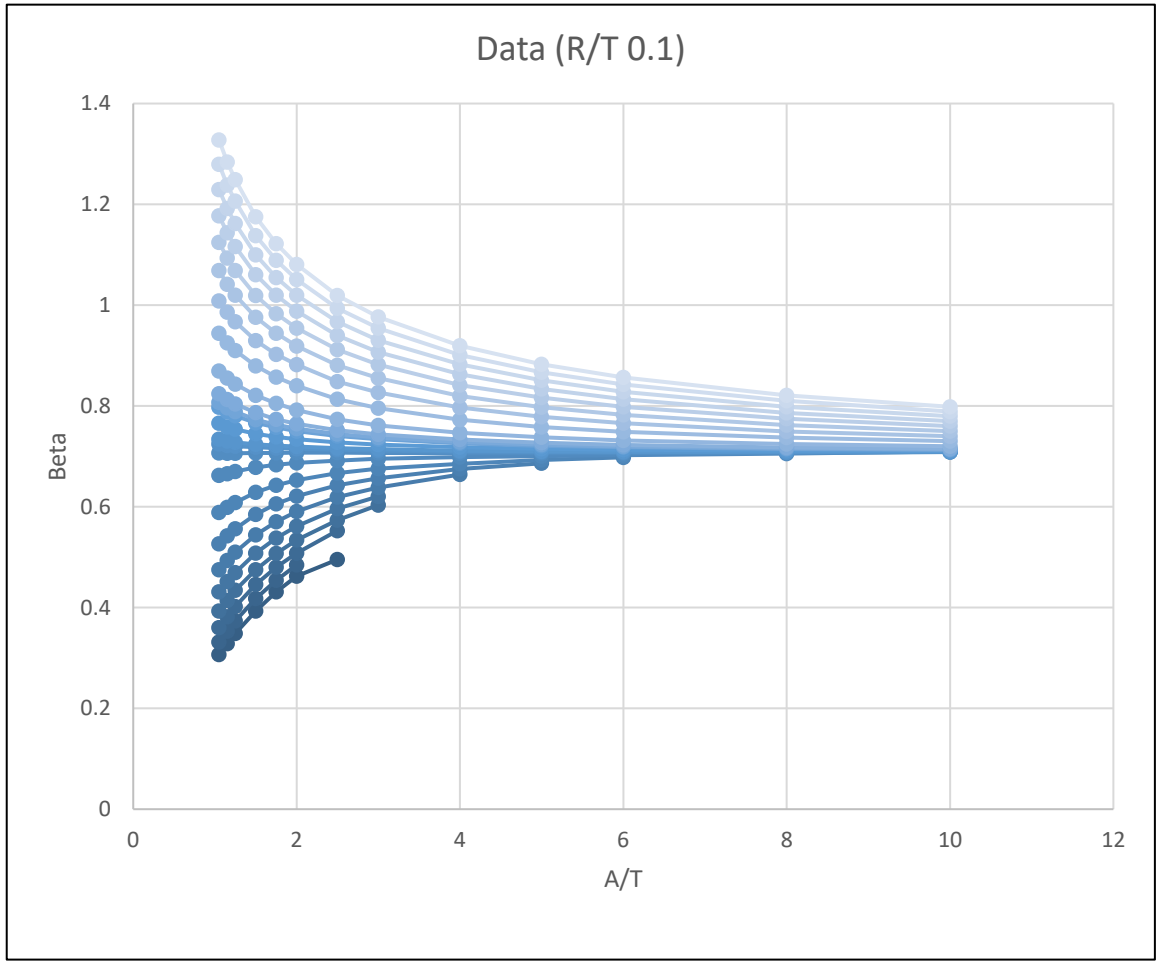
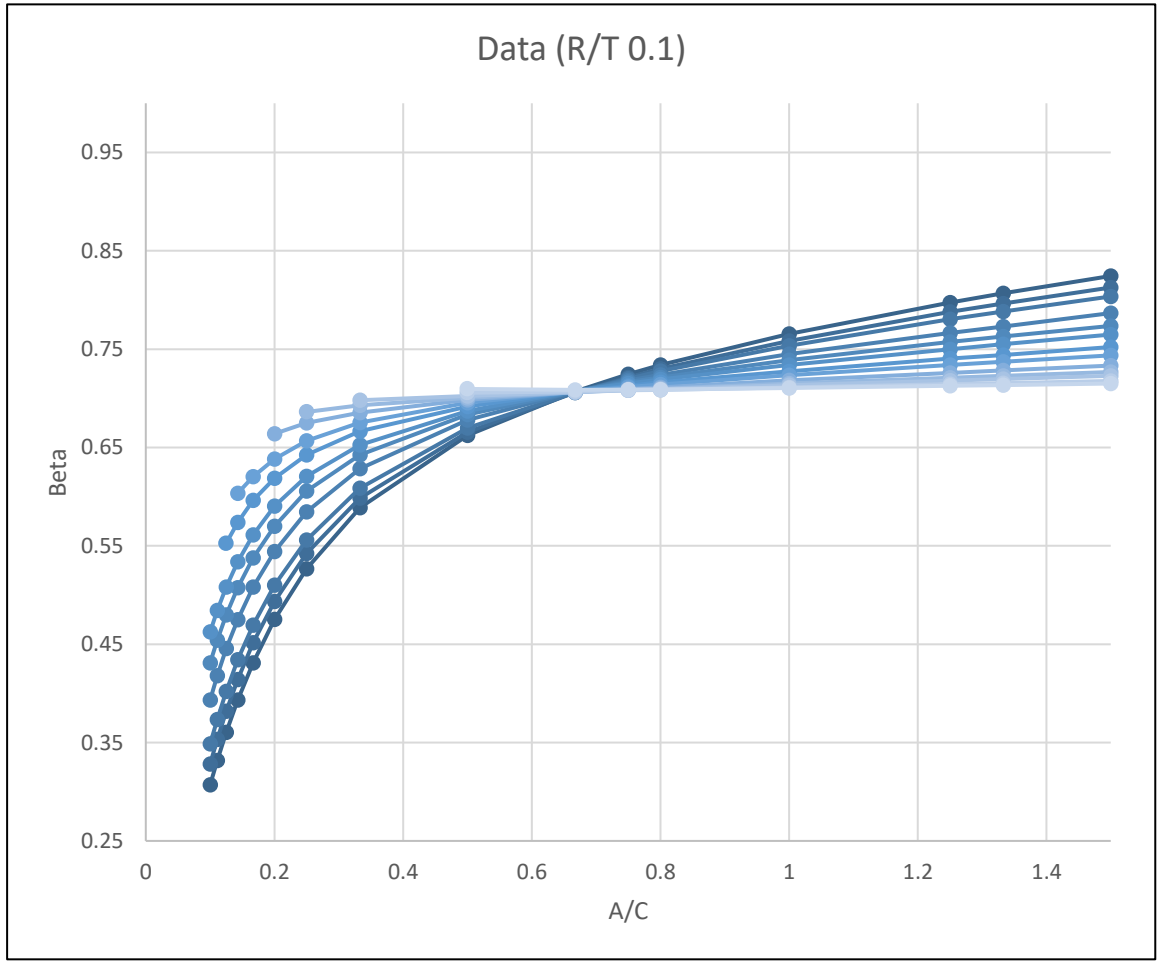
Example Case

Extracted Vertices





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Extending The Data

- We (usually) adjust the boundaries of the dataset to give it a neat limit and make the dataset square, since AFGROW performs interpolation
- Interpolation may become unstable near edges of set so extending the data slightly before we put it into AFGROW preserves the shape of the original data
- Sometimes includes areas that would be geometrically impossible, so that data isn’t used directly but makes interpolating/creating a solution based on it continuous

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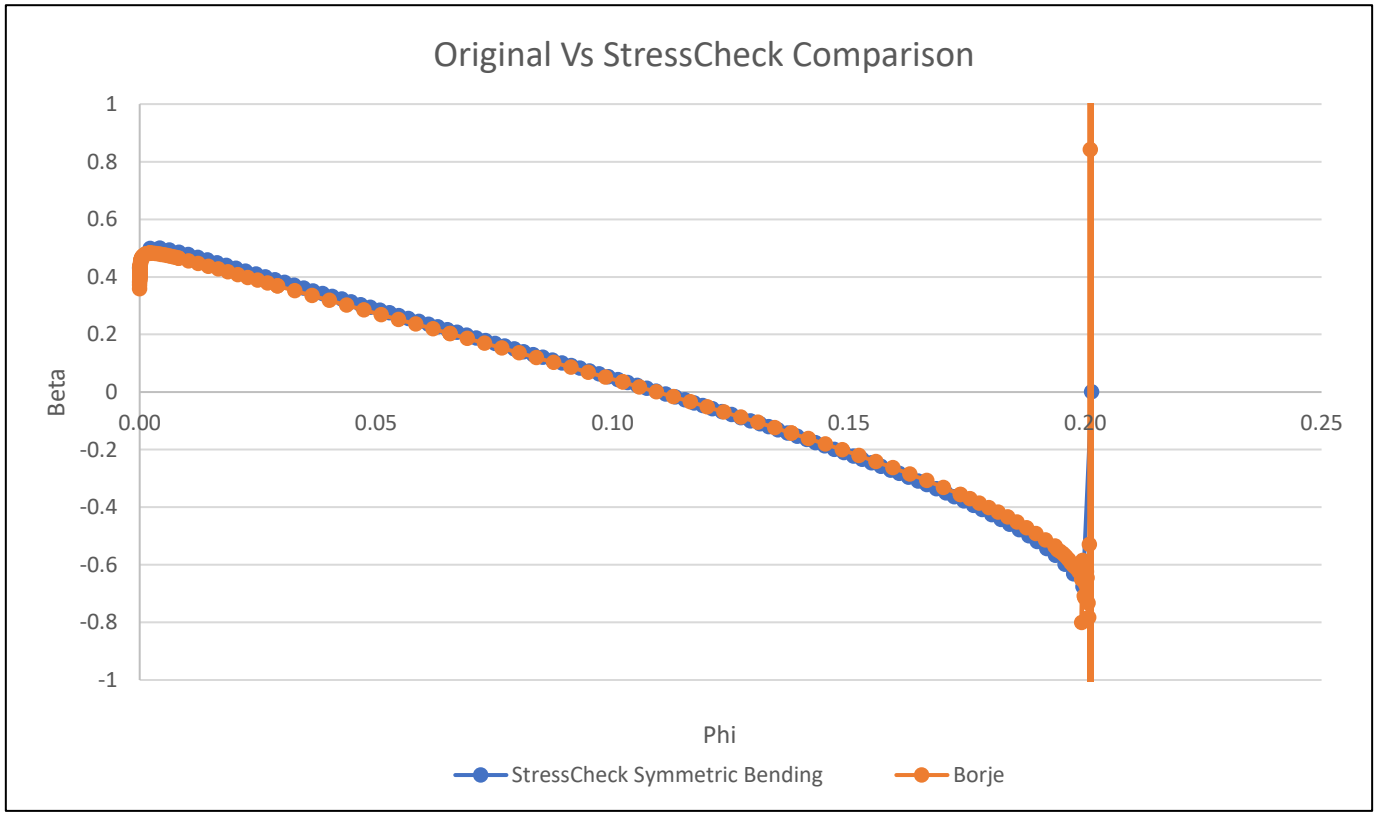
Initial Data VS In House StressCheck

- Our models are a less refined FEM than the initial data, but is a close enough match to seamlessly add points if needed.



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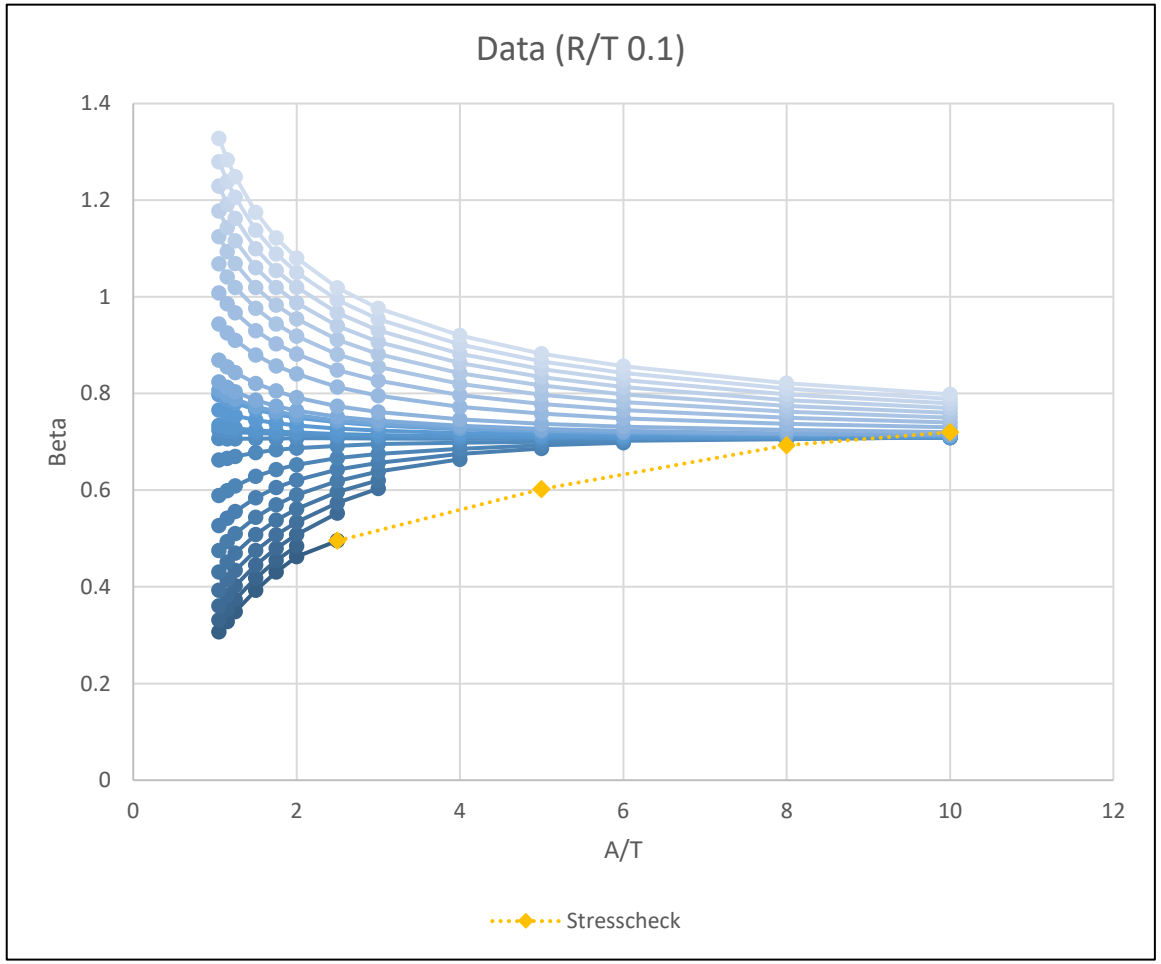
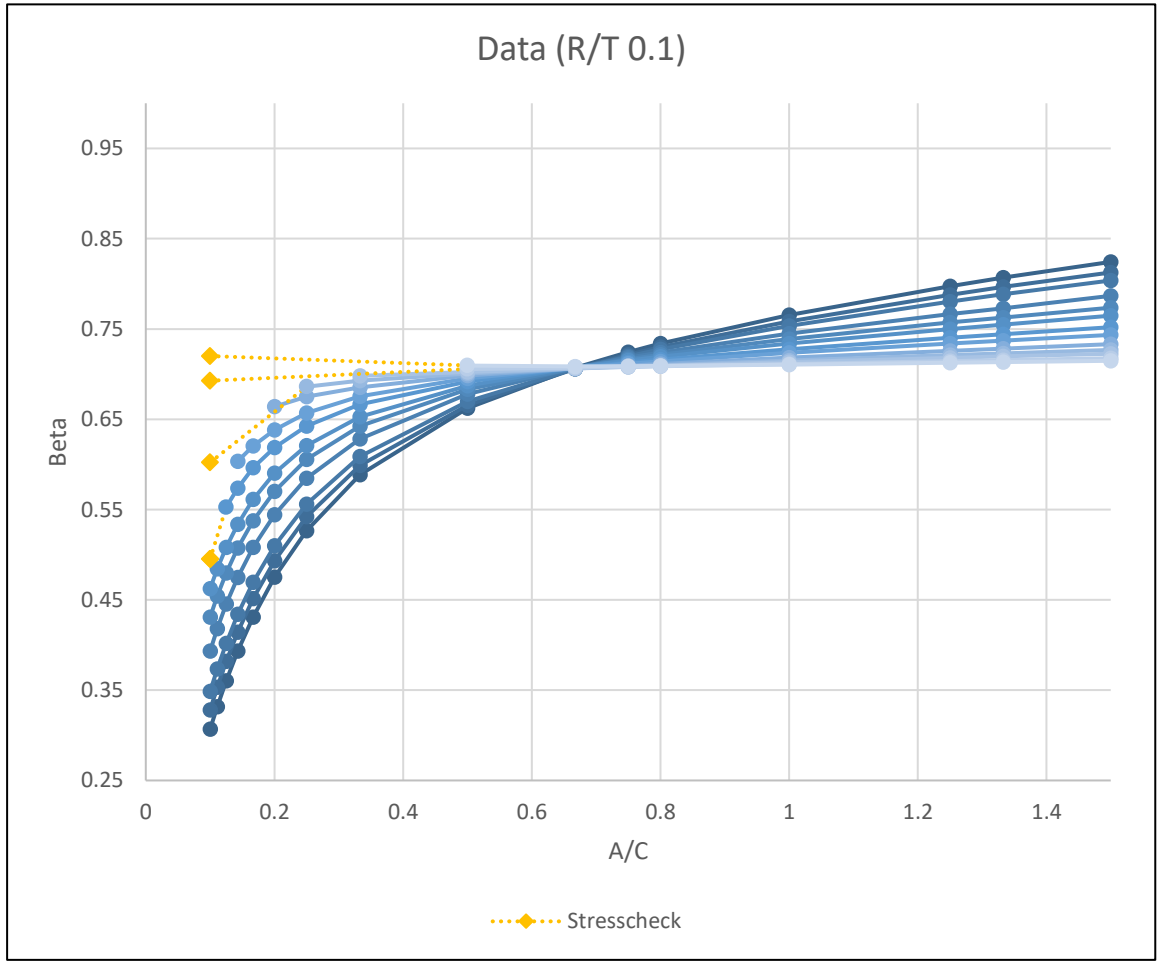
Example Case

Input Data





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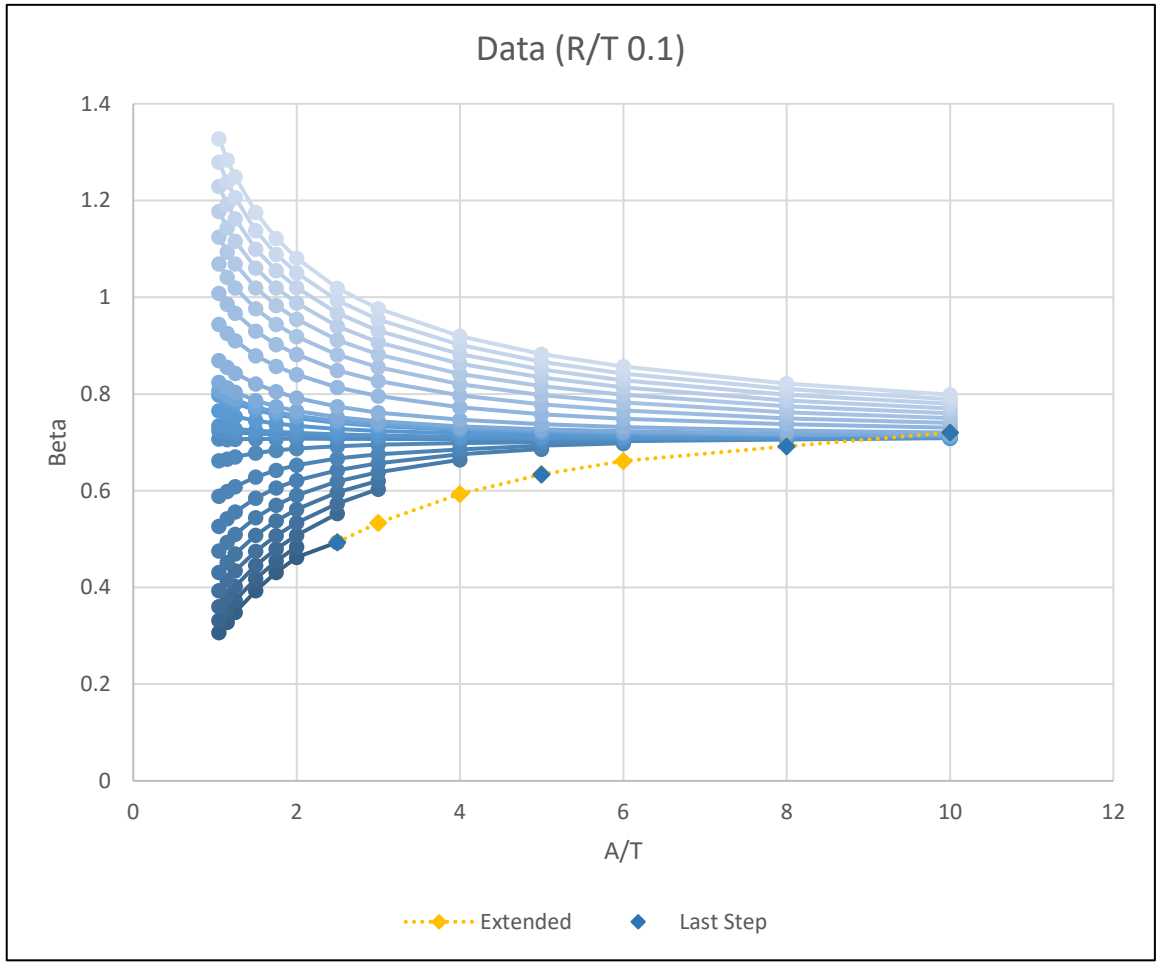
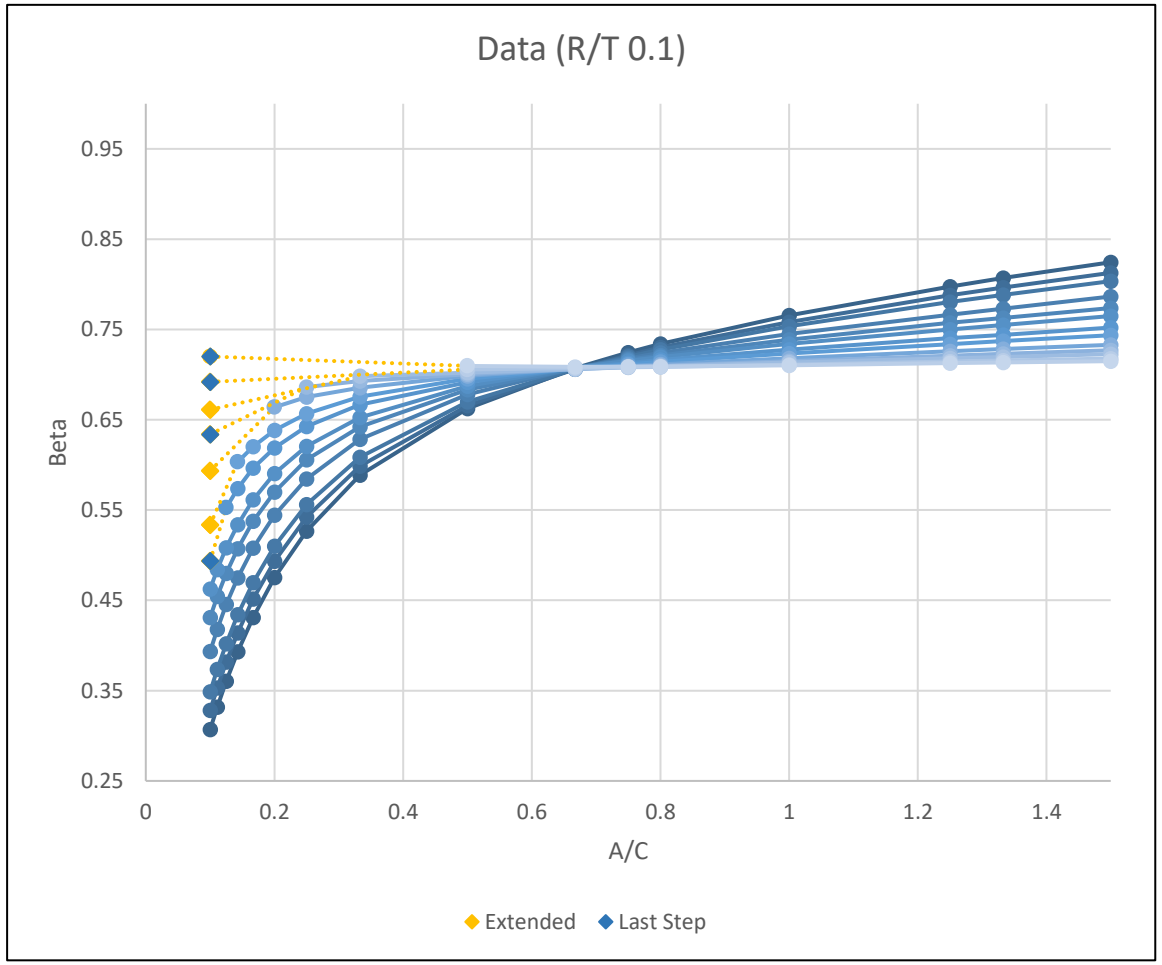
Example Case

Fit 1- Across A/c 0.1





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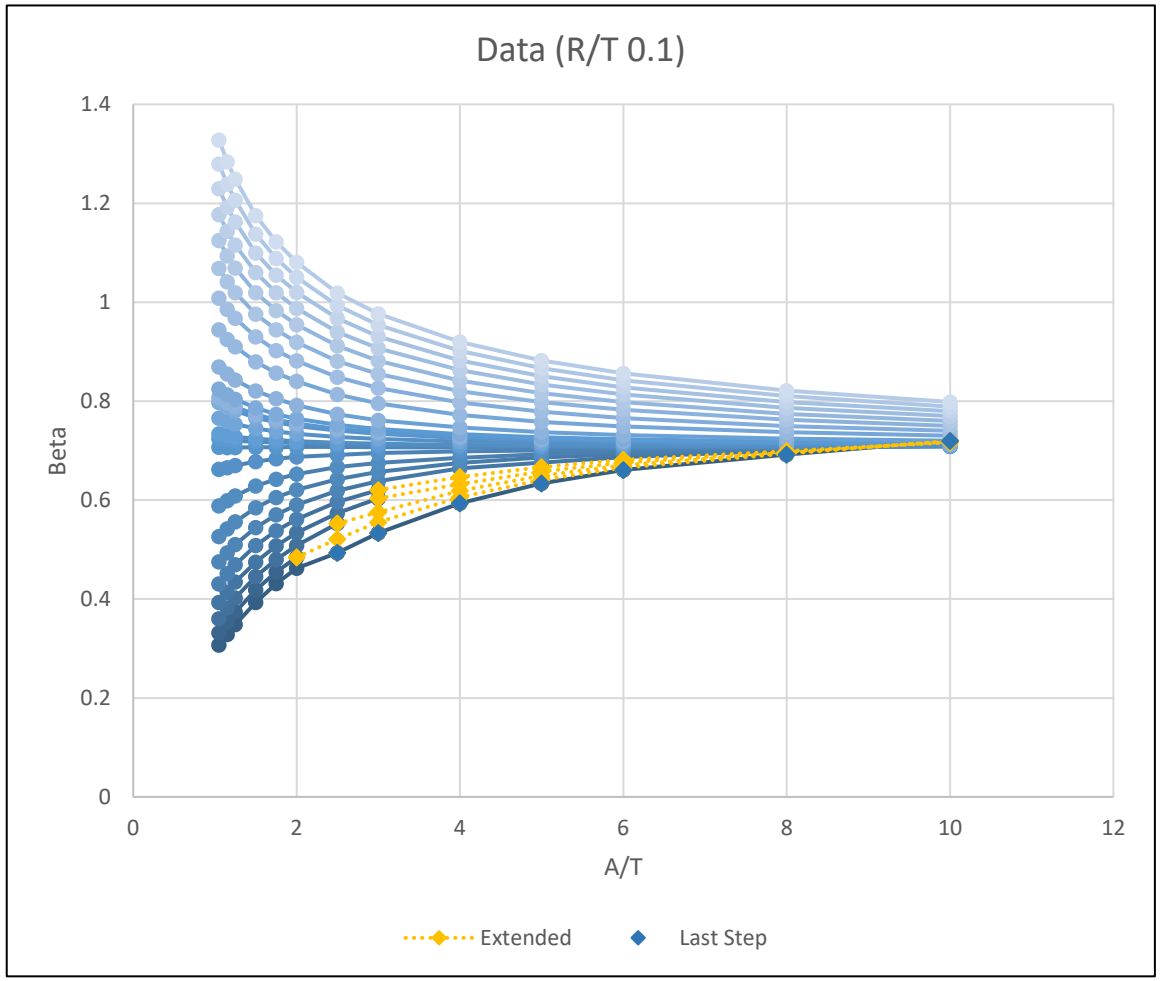
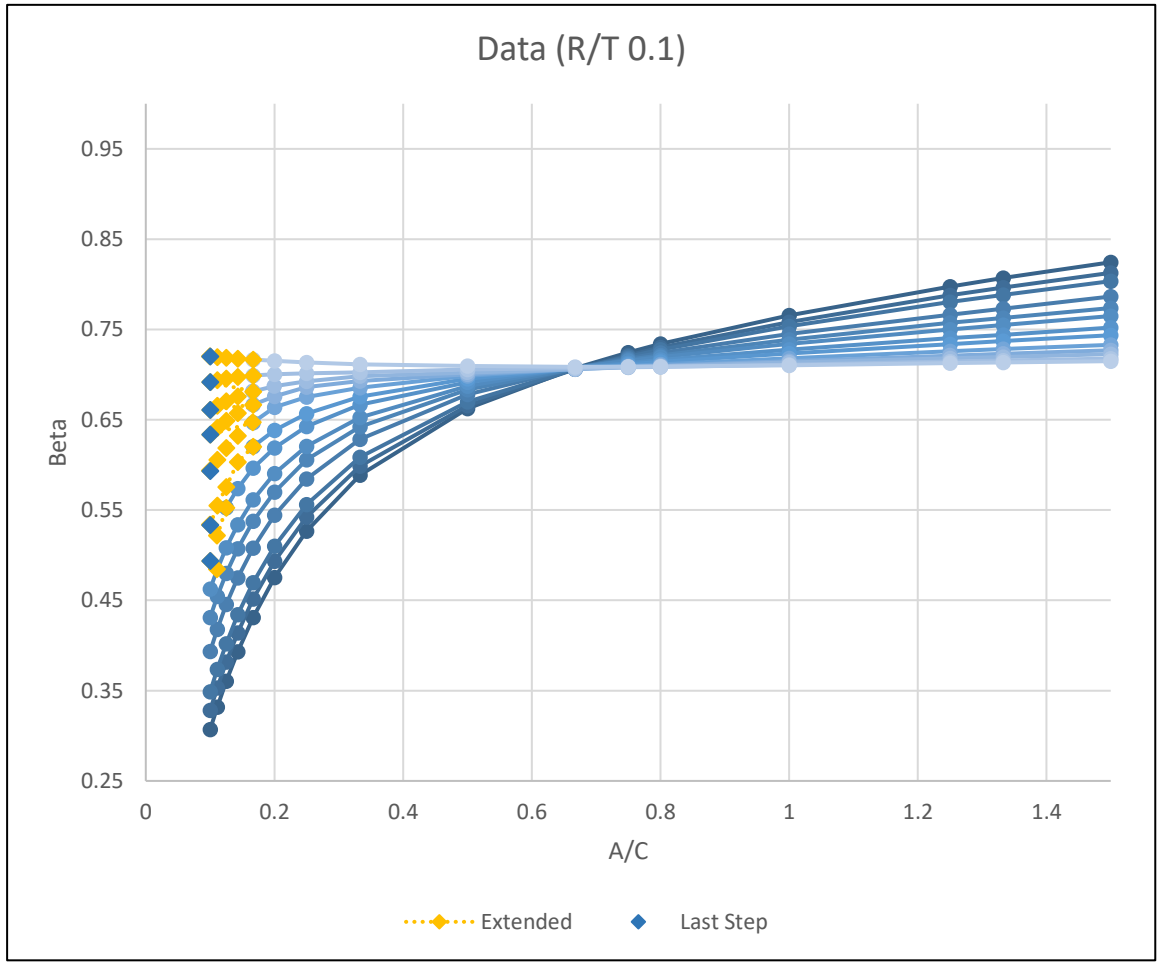
Example Case

Fit 2- On Each A/T





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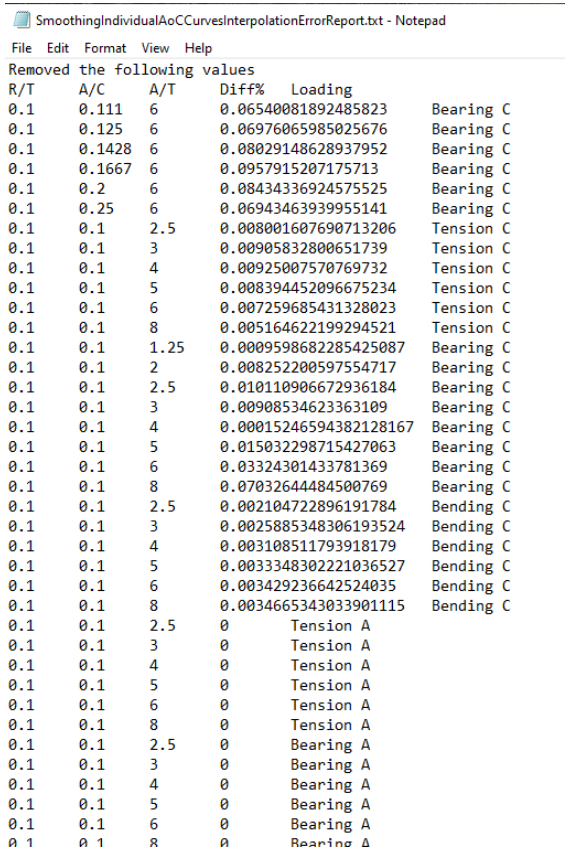
Smoothing The Data

- Layered fits each making subtle changes
- Record all changes to data based on this
- Only changing our own StressCheck and points that were generated by interpolation to refine our estimates
- Currently pretty specific to the corner crack datasets, but easy to modify and records what it's doing so it's easy to tweak the parameters and try again



SmoothingIndividualAoCCurvesInterpolationErrorReport.txt - Notepad

File Edit Format View Help

Removed the following values

R/T	A/C	A/T	Diff%	Loading
0.1	0.111	6	0.06540081892485823	Bearing C
0.1	0.125	6	0.06976065985025676	Bearing C
0.1	0.1428	6	0.08029148628937952	Bearing C
0.1	0.1667	6	0.0957915207175713	Bearing C
0.1	0.2	6	0.08434336924575525	Bearing C
0.1	0.25	6	0.06943463939955141	Bearing C
0.1	0.1	2.5	0.008001607690713206	Tension C
0.1	0.1	3	0.00905832800651739	Tension C
0.1	0.1	4	0.00925007570769732	Tension C
0.1	0.1	5	0.008394452096675234	Tension C
0.1	0.1	6	0.007259685431328023	Tension C
0.1	0.1	8	0.005164622199294521	Tension C
0.1	0.1	1.25	0.0009598682285425087	Bearing C
0.1	0.1	2	0.008252200597554717	Bearing C
0.1	0.1	2.5	0.010110906672936184	Bearing C
0.1	0.1	3	0.00908534623363109	Bearing C
0.1	0.1	4	0.00015246594382128167	Bearing C
0.1	0.1	5	0.015032298715427063	Bearing C
0.1	0.1	6	0.03324301433781369	Bearing C
0.1	0.1	8	0.07032644484500769	Bearing C
0.1	0.1	2.5	0.002104722896191784	Bending C
0.1	0.1	3	0.0025885348306193524	Bending C
0.1	0.1	4	0.003108511793918179	Bending C
0.1	0.1	5	0.0033348302221036527	Bending C
0.1	0.1	6	0.003429236642524035	Bending C
0.1	0.1	8	0.0034665343033901115	Bending C
0.1	0.1	2.5	0	Tension A
0.1	0.1	3	0	Tension A
0.1	0.1	4	0	Tension A
0.1	0.1	5	0	Tension A
0.1	0.1	6	0	Tension A
0.1	0.1	8	0	Tension A
0.1	0.1	2.5	0	Bearing A
0.1	0.1	3	0	Bearing A
0.1	0.1	4	0	Bearing A
0.1	0.1	5	0	Bearing A
0.1	0.1	6	0	Bearing A
0.1	0.1	8	0	Bearing A

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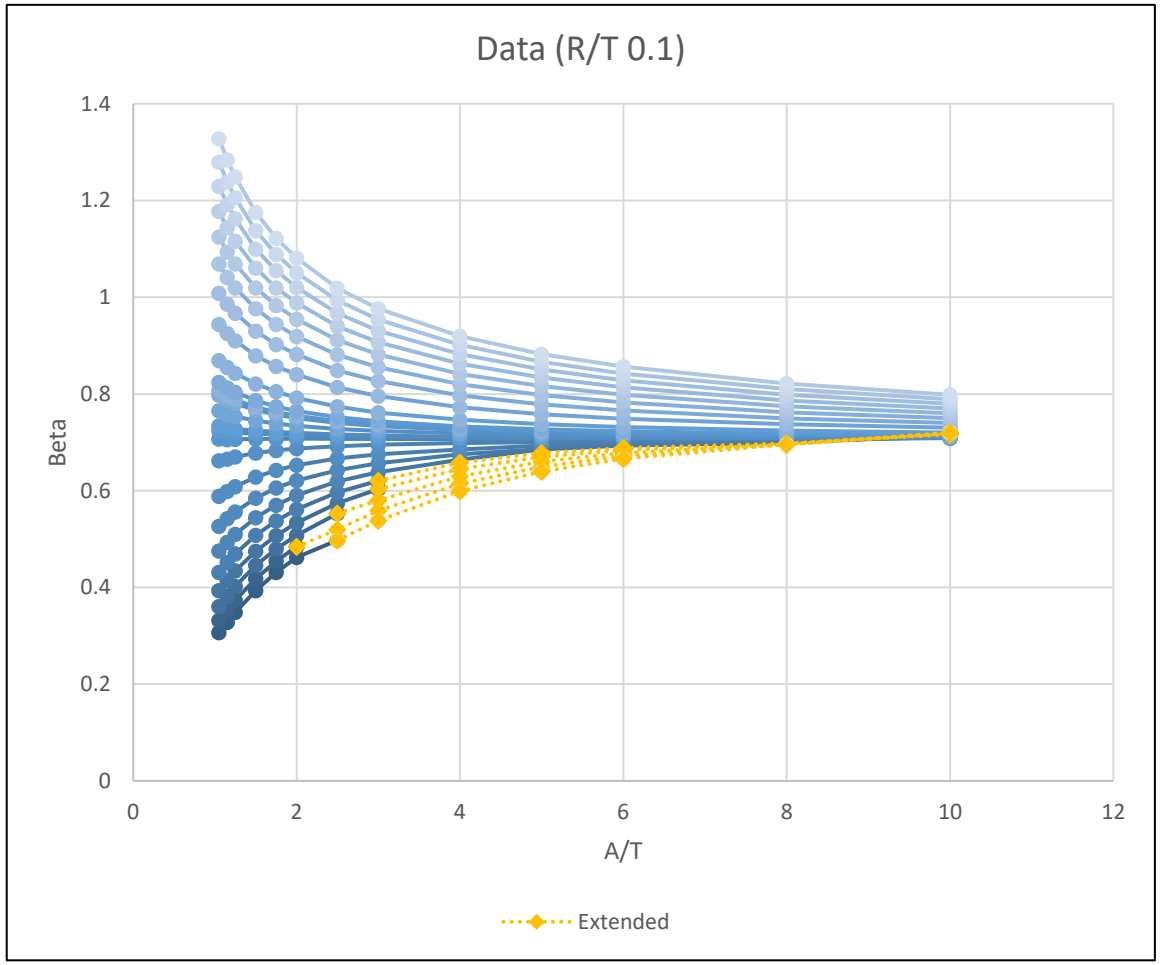
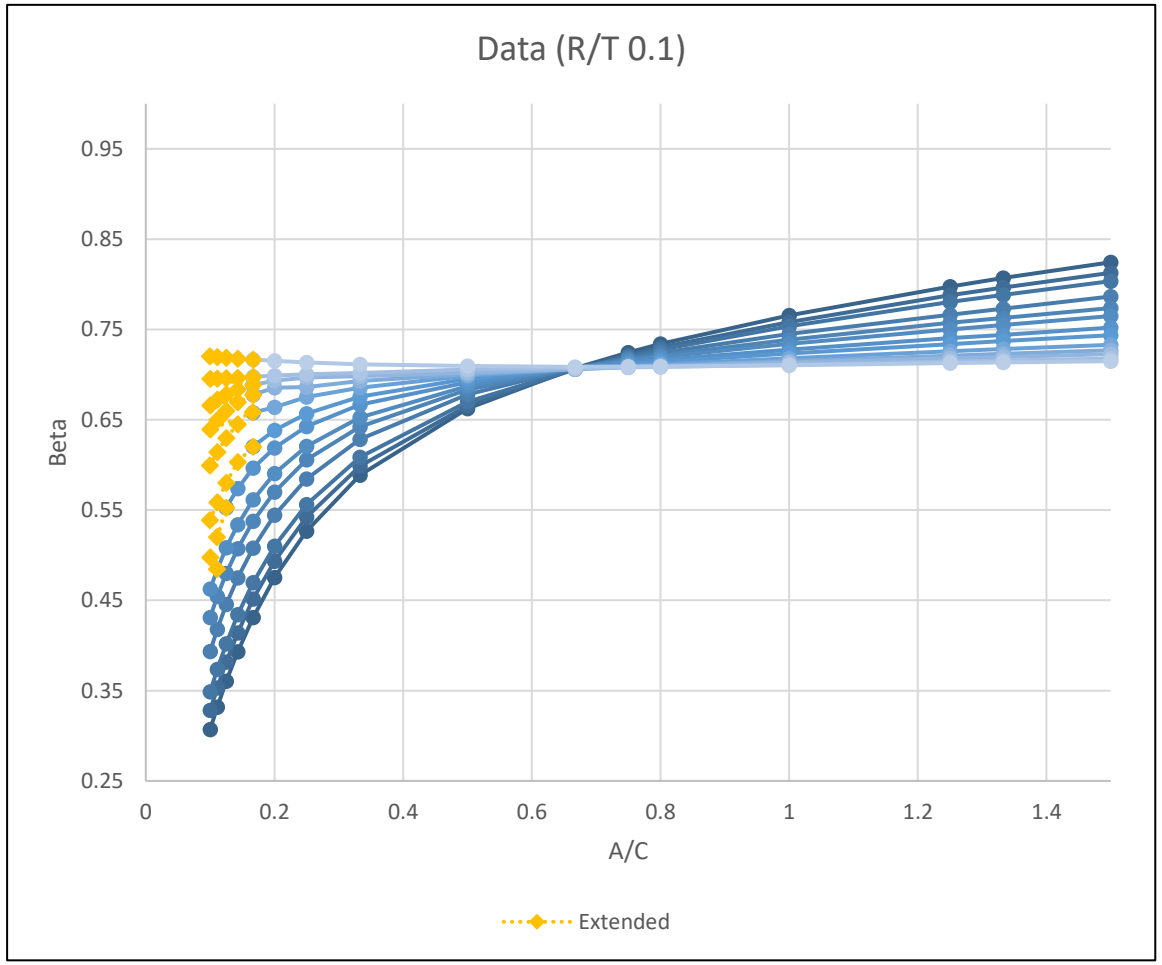
Example Case

Fit 3- Runs fit 1 again to smooth new data





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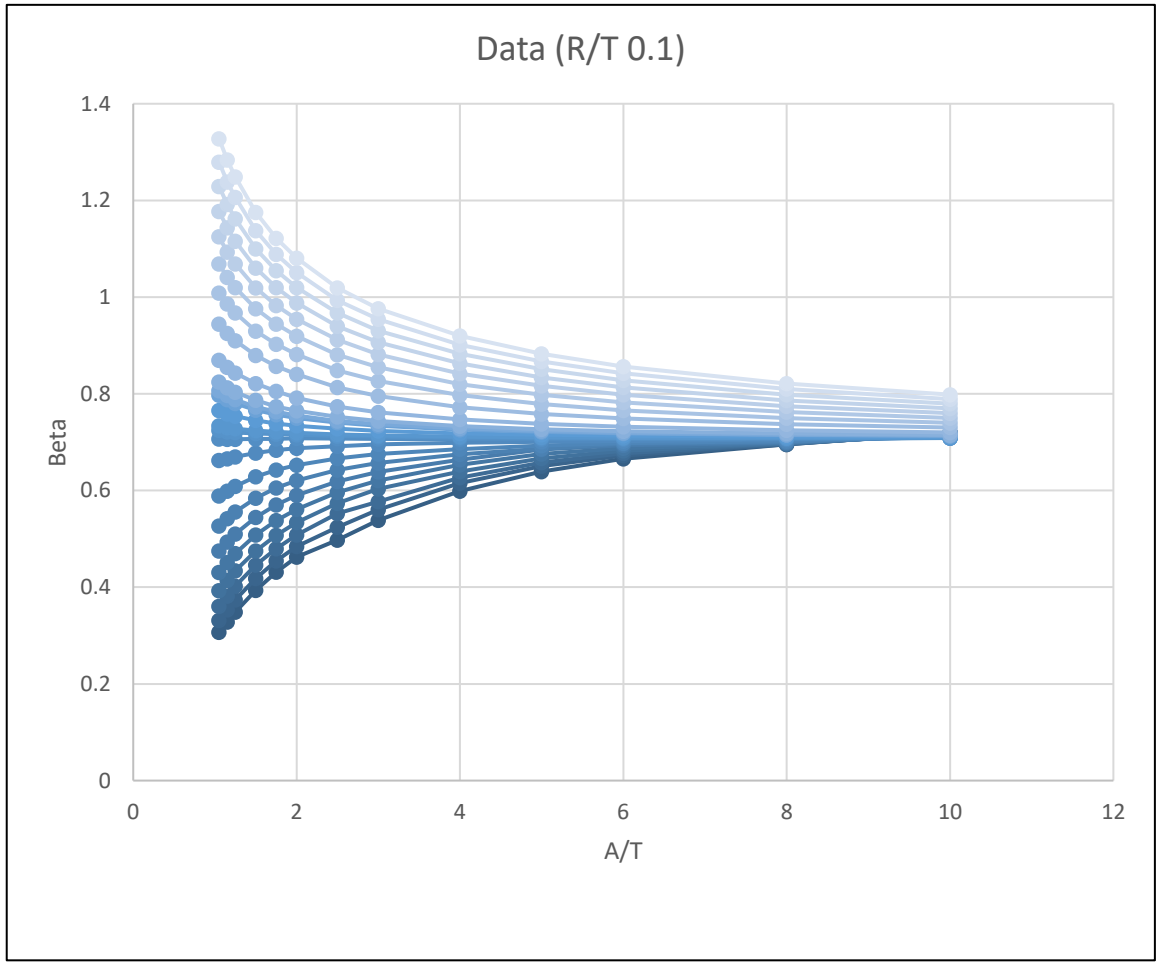
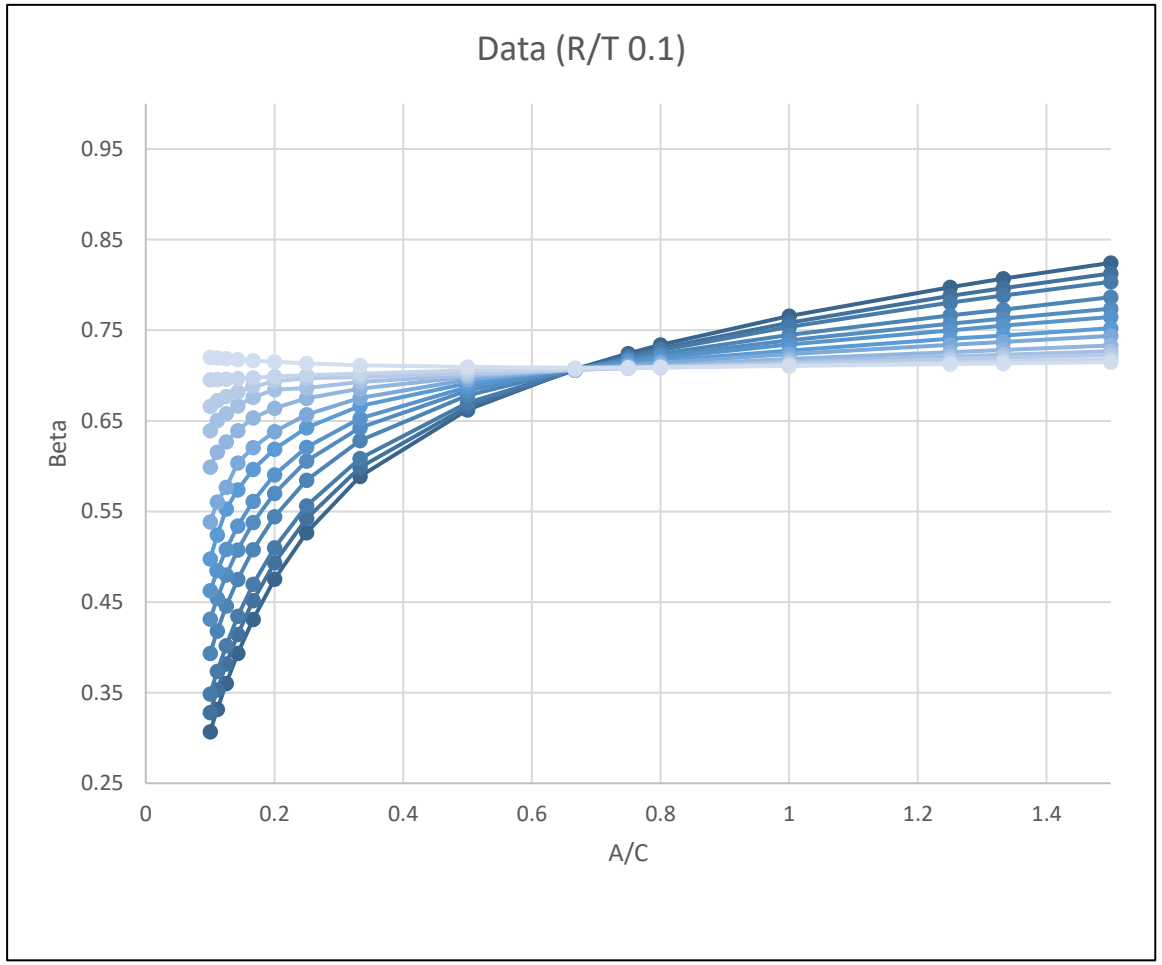
Example Case

Fit 4- 2D Fit





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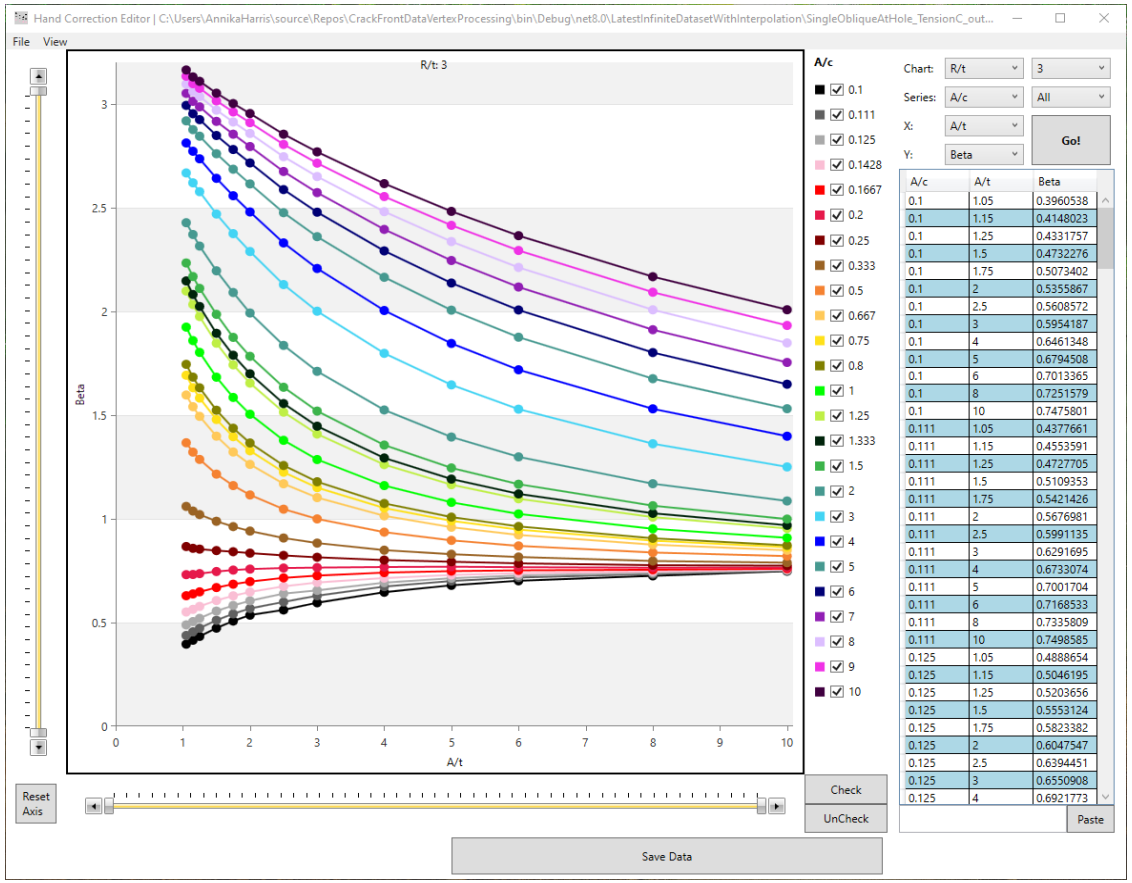
Final Result

TensionC_output.txt - Notepad

File Edit Format View Help

```
# Date Generated: 3/5/2026 01:36
# Data Set: Z:\5-5 new projects\SingleObliqueCrack\2CrackDataProcess\ONE_CRACK
# Fits generated for Arc Length Vs K between 4% and 50% of arc length
# The original dataset may contain duplicate values from symetric crack fronts, if res
# Percent Method: Local max estimation between 0.125% and 3% of arc length
Dependent       BetaTensionC
R/t     A/c     A/t     BetaTensionC
0.1     0.1     1.05    0.30696
0.1     0.1     1.15    0.32825
0.1     0.1     1.25    0.34868
0.1     0.1     1.5     0.39332
0.1     0.1     1.75    0.4297
0.1     0.1     2       0.46249
0.1     0.1     2.5     0.50568
0.1     0.1     3       0.53698
0.1     0.1     4       0.57307
0.1     0.1     5       0.58998
0.1     0.1     6       0.5979
0.1     0.1     8       0.60335
0.1     0.1     10      0.60662
0.1     0.111   1.05    0.33166
0.1     0.111   1.15    0.3532
0.1     0.111   1.25    0.37358
0.1     0.111   1.5     0.41807
0.1     0.111   1.75    0.45427
0.1     0.111   2       0.48434
```

Ln 1, Col 1 | 100% | Windows (CRLF) | UTF-8



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Conclusions

- Smooth dataset(s) with stable boundaries
- Repeatable process with detailed record of processing
- Implementing new datasets is now faster and a much less labor-intensive process

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Thank you!

Questions? Thoughts? Feedback?

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Any Questions?

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