

AFGROW

European Workshop

AFGROW Release 5.4 Overview

Jun 23, 2022
ZHAW School of Engineering
Centre for Aviation

Outline

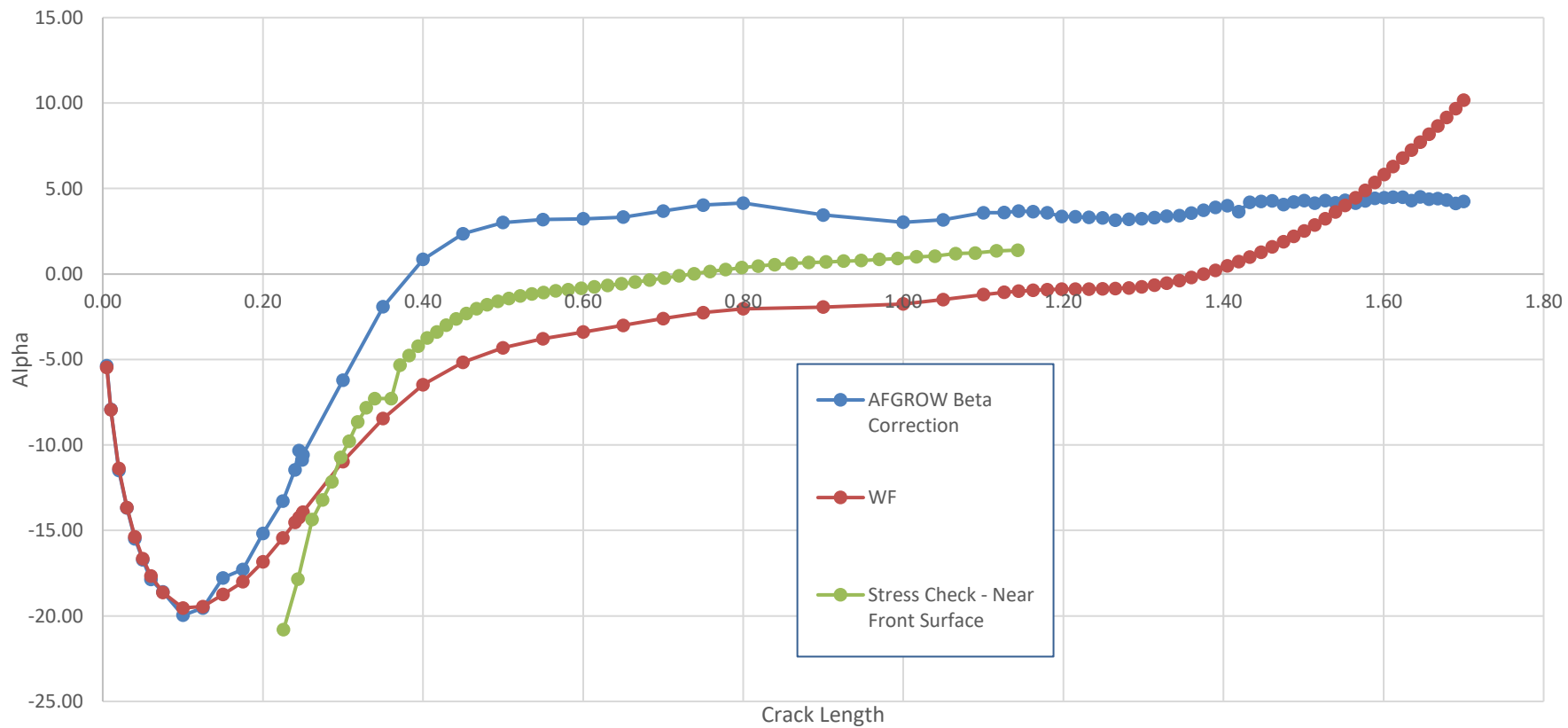
- New weight function solutions for a single and double symmetric crack at hole and single edge corner crack
- Local material database in the tabular-lookup format
- Enhanced output preferences
- Enhanced life in hours output

Single and Double Through Crack at Hole Weight function Solutions

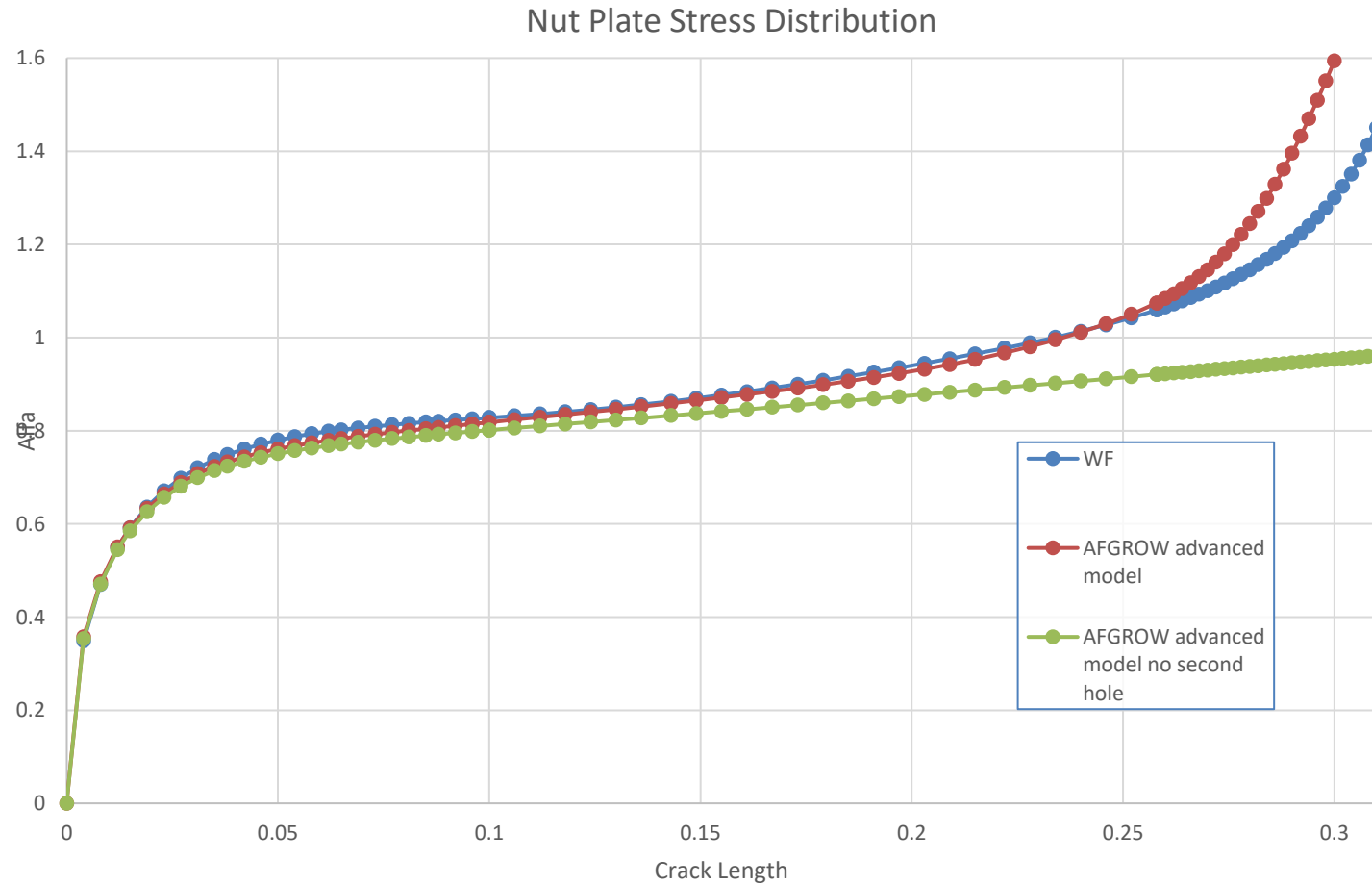
Based on Jihwi Kim, Michael R. Hill (*Department of Mechanical and Aerospace Engineering, University of California*) paper: “*Weight functions for a finite width plate with single or double radial cracks at a circular hole*” that was published in *Engineering Fracture Mechanics* and also presented at AFGROW Workshop 2016

Single Through Crack at a Hole Weight Function Solution Verification - Case 1

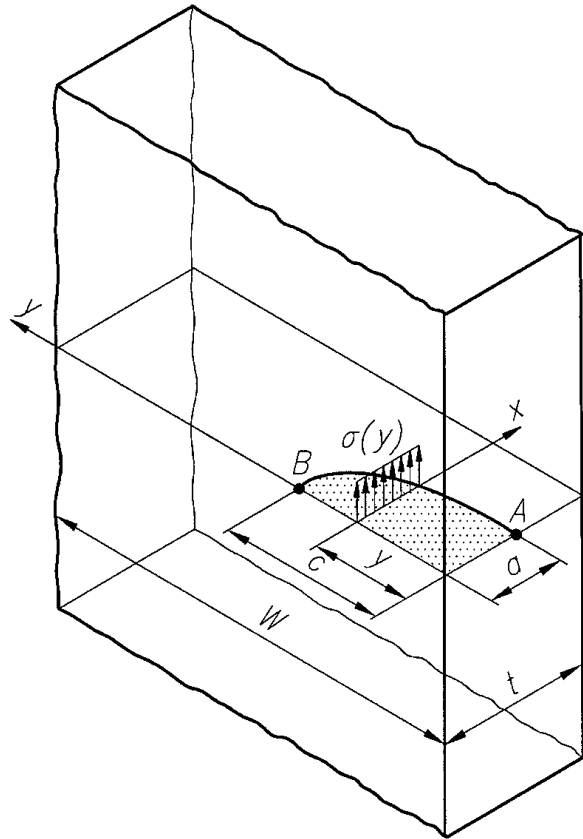
Cold Expanded Hole Stress Distribution



Single Through Crack at Hole Weight Function Solution Verification - Case 2



Single Edge Corner Crack Weight Function Solution

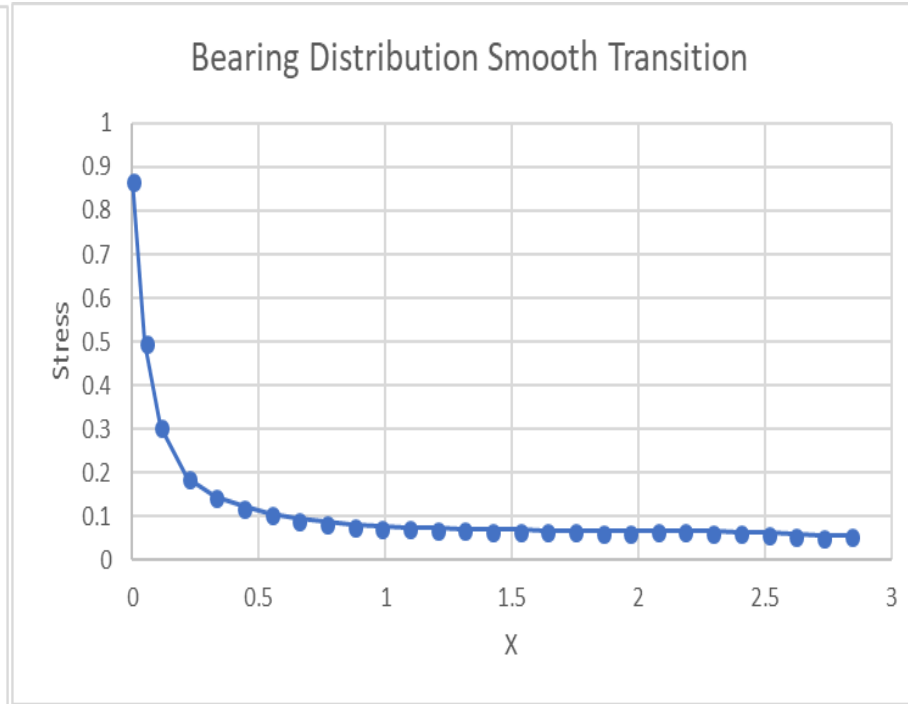
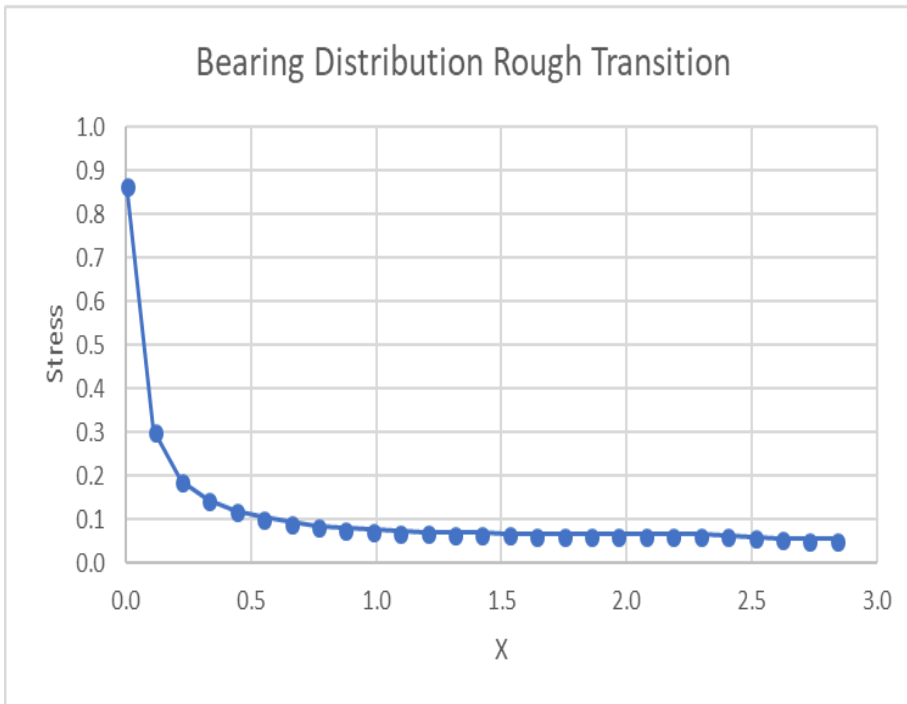


Based on Glinka, G., PhD, DSc., “*Quarter-elliptical corner crack in a finite thickness plate – in plane stress distribution*” delivered to LexTech, Inc. as part of the contract with SAFFD, Inc., Mannheim, Ontario, Canada

Can be used to model the single edge corner cracks or single corner cracks

Single Edge Corner Crack Weight Function Solution Validation: Bearing Load Stress Distribution

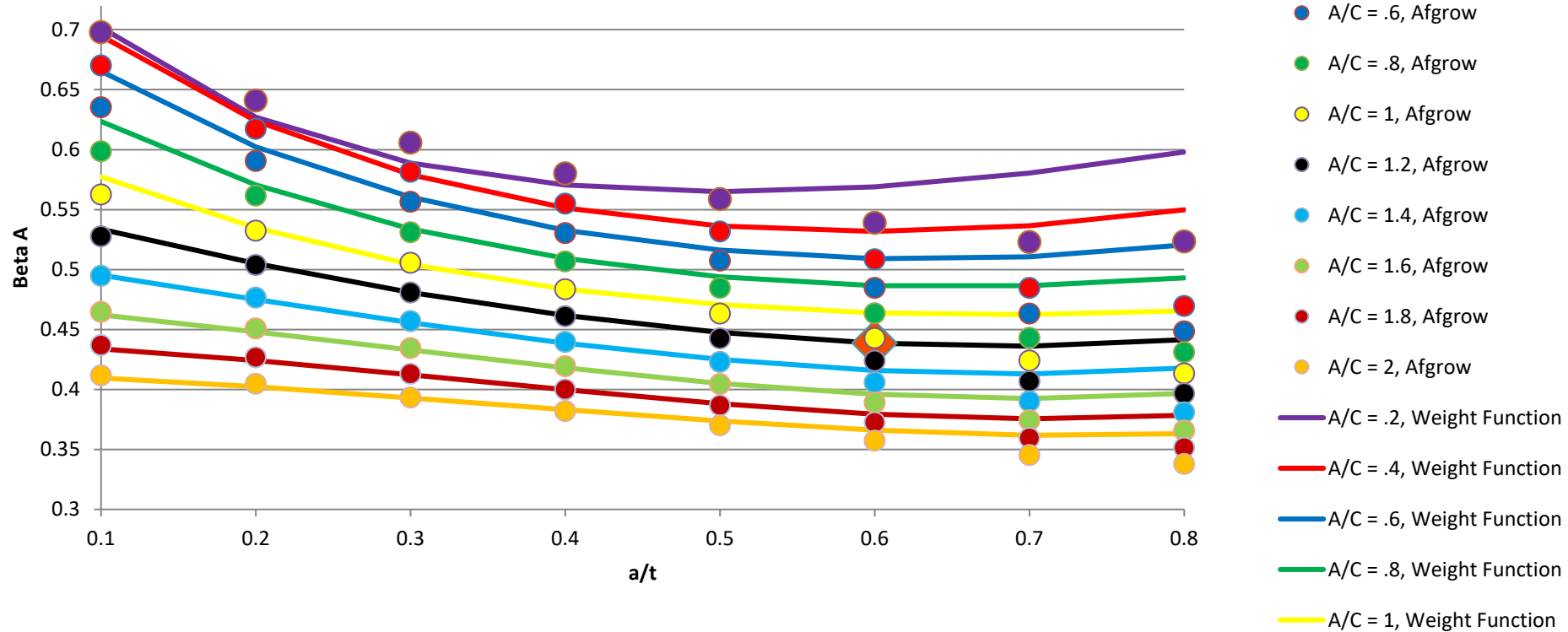
A plate with a centered hole, under bearing loading with a diameter equal to 0.629922 inches and a width of 6.299216 inches was used to produce the stress distribution. The generated betas were compared to advanced single corner crack at hole solution in AFGROW.



The stress distribution on the left was initially used to calculate the SIF and the results were not as expected. An additional point was added to the beginning of the plot to smooth the transition. This change significantly improved the results.

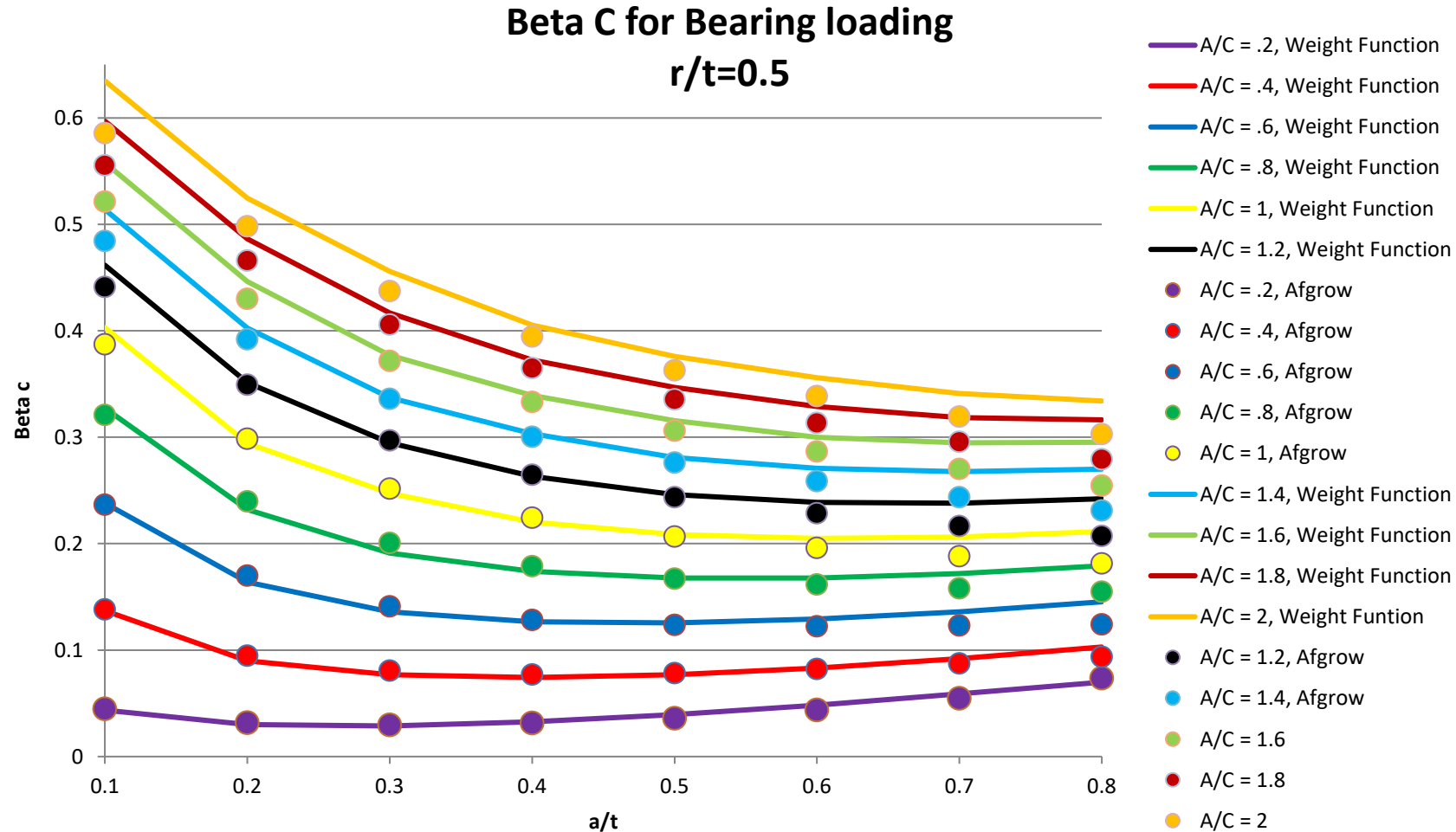
Single Edge Corner Crack Weight Function Solution Verification: Bearing Load Stress Distribution Results

Beta A Values For Bearing loading
r/t=0.5



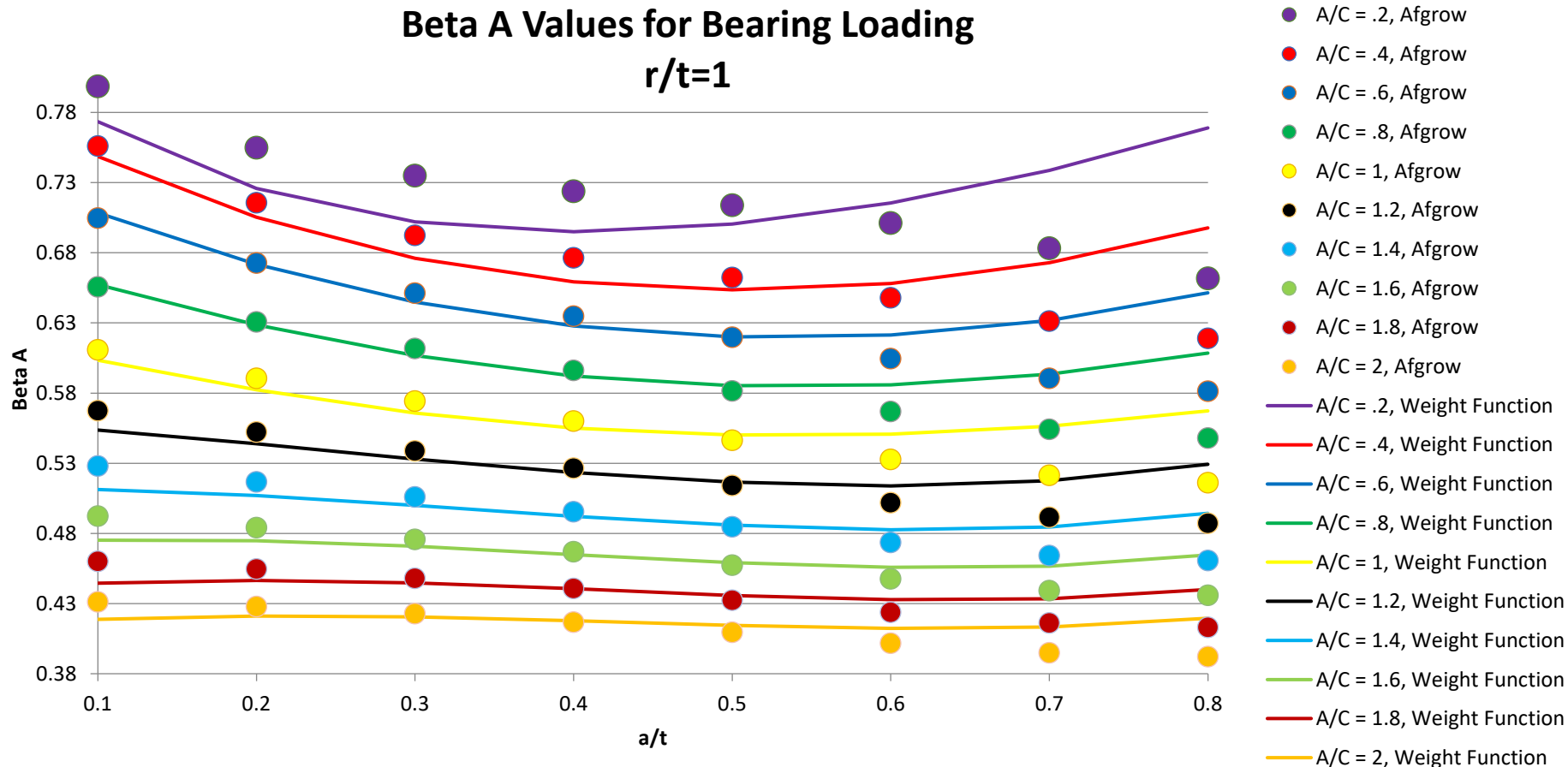
For the majority of the WF generated beta the error does not exceeds 2%. The error growth beyond 2% at a/t =0.7 and above.

Single Edge Corner Crack Weight Function Solution Verification: Bearing Load Stress Distribution Results



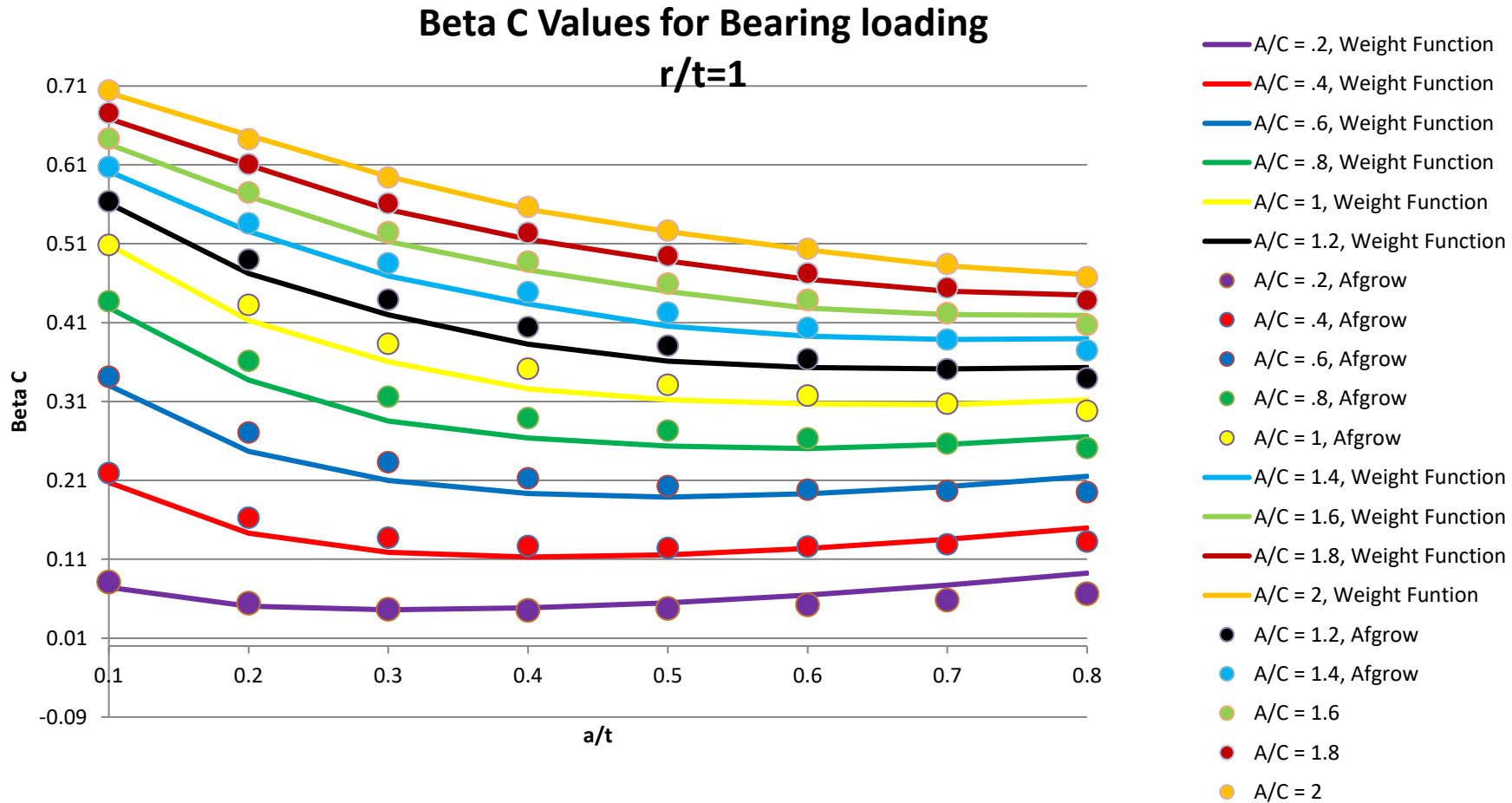
For the majority of the WF generated beta the error does not exceeds 5%. The error growth beyond 5% at a/t =0.7 and above.

Single Edge Corner Crack Weight Function Solution Verification: Bearing Load Stress Distribution Results



For the majority of the WF generated beta the error does not exceeds 8%. The error growth beyond 8% at a/t =0.7 and above.

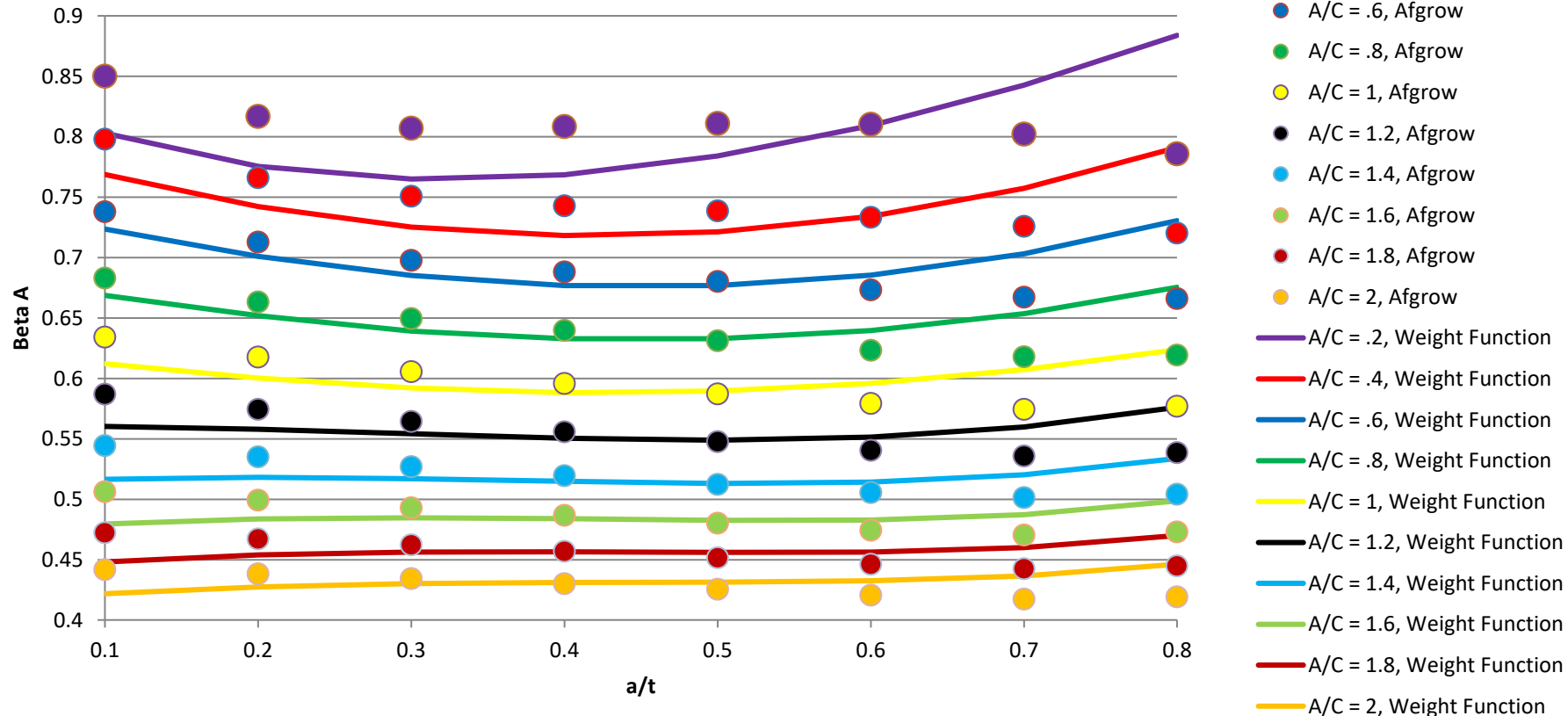
Single Edge Corner Crack Weight Function Solution Verification: Bearing Load Stress Distribution Results



For the majority of the WF generated beta the error does not exceed 3.7%. The error growth beyond 3.7% at a/t = 0.7 and above.

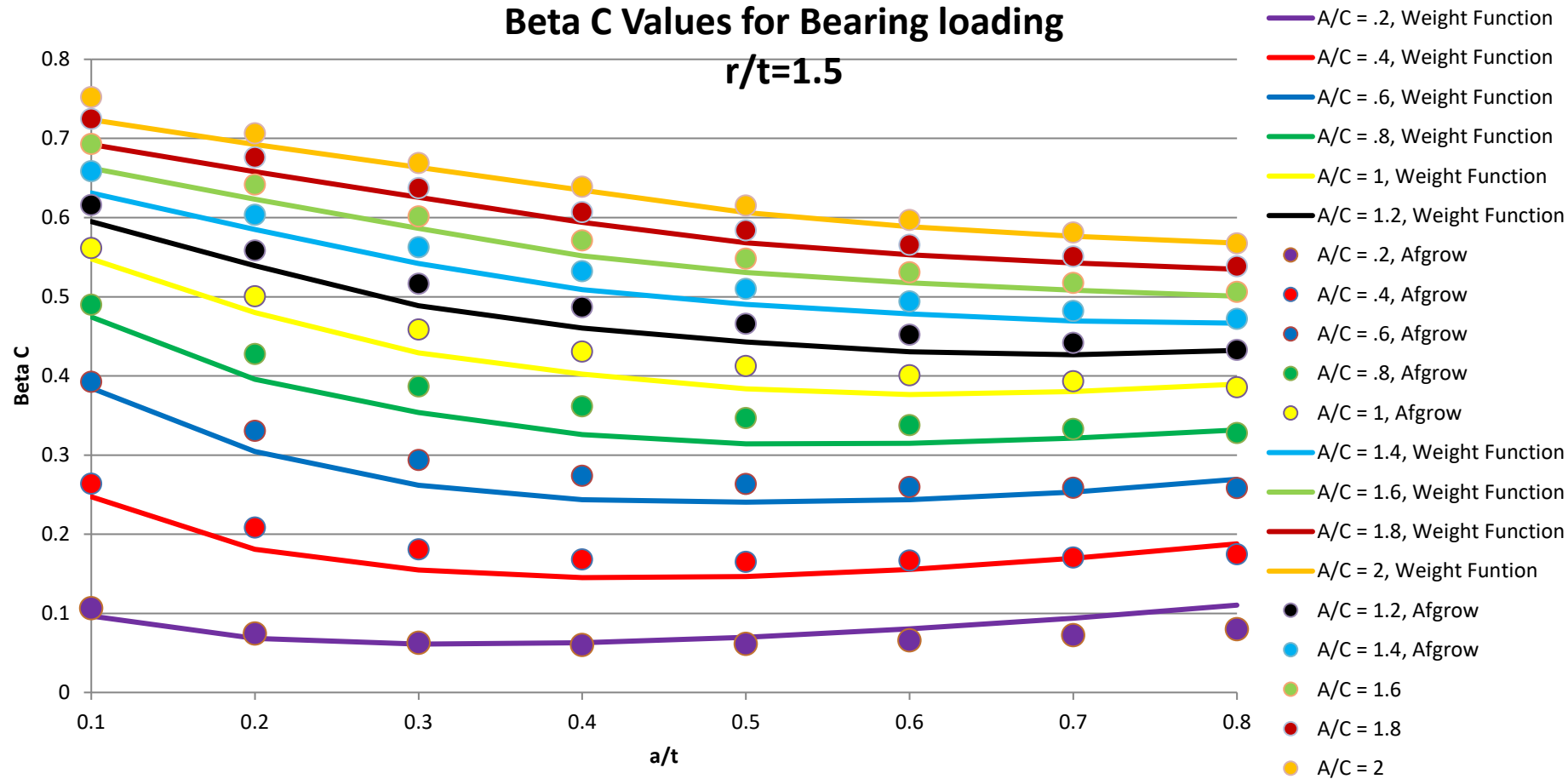
Single Edge Corner Crack Weight Function Solution Verification: Bearing Load Stress Distribution Results

Beta A Values for Bearing loading
r/t=1.5



For the majority of the WF generated beta the error does not exceeds 6%. The error growth beyond 6% at a/t =0.7 and above.

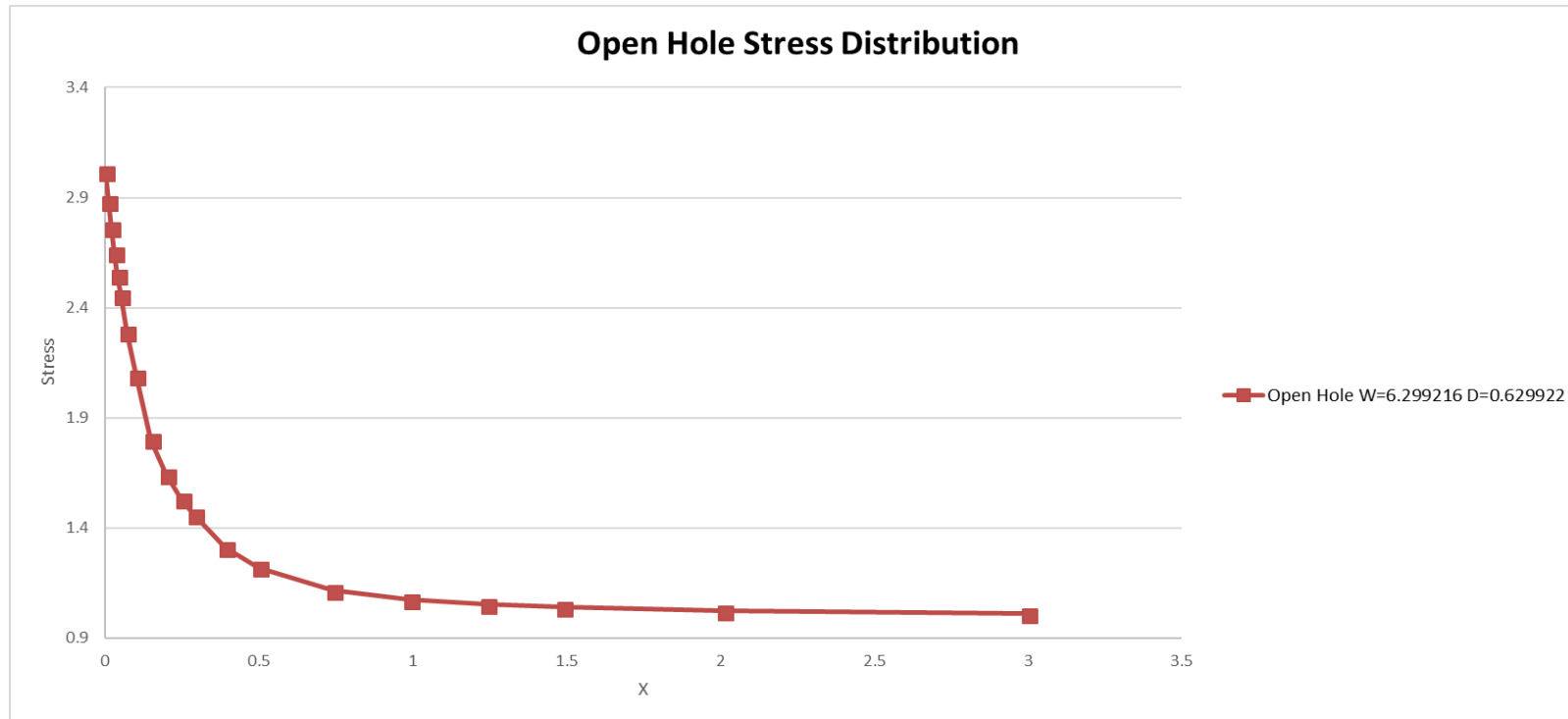
Single Edge Corner Crack Weight Function Solution Verification: Bearing Load Stress Distribution Results



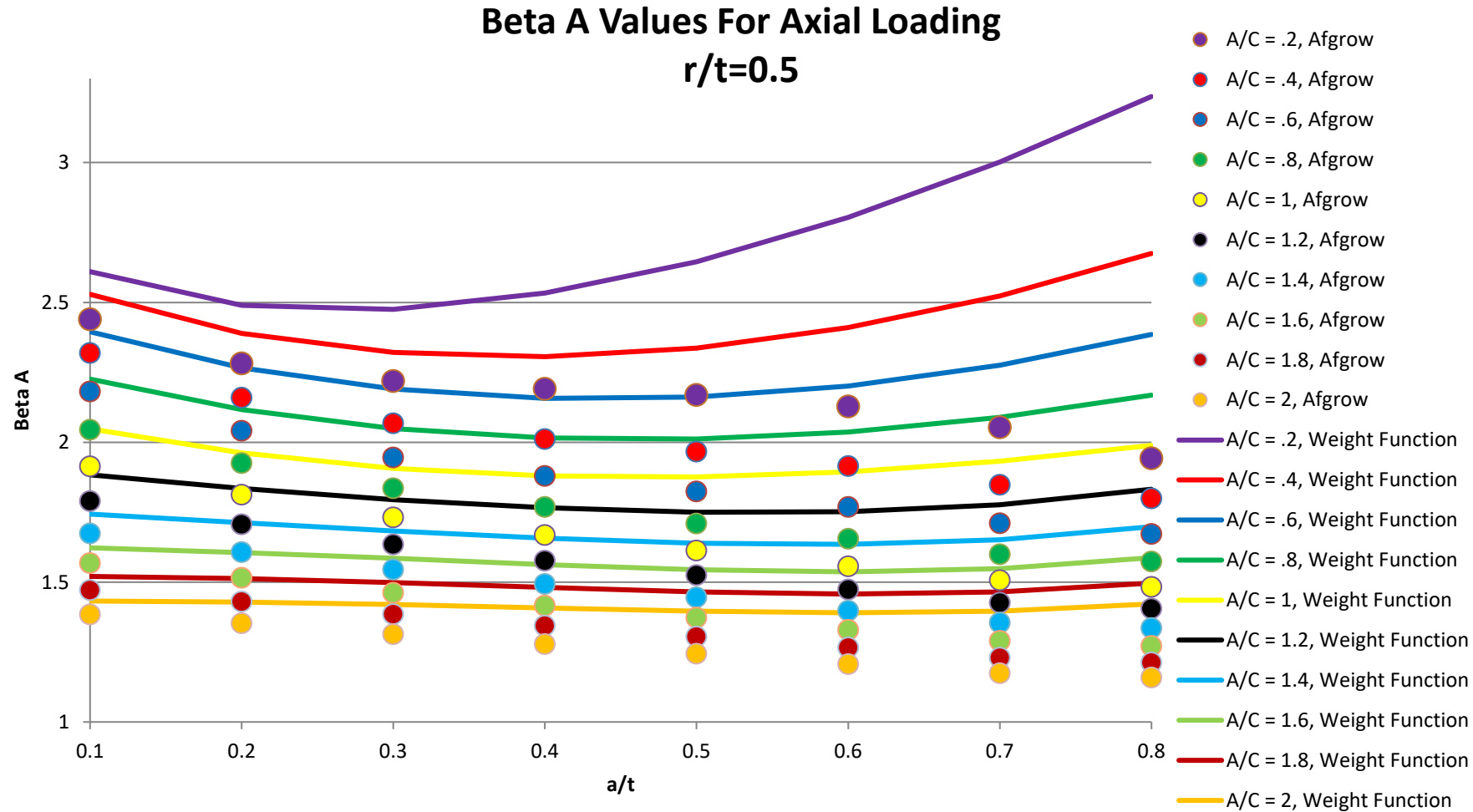
For the majority of the WF generated beta the error does not exceeds 5%. The error growth beyond 5% at $a/t = 0.7$ and above.

Single Edge Corner Crack Weight Function Solution Validation: Axial Load Stress Distribution

A plate with a centered hole, under bearing loading with a diameter equal to 0.629922 inches and a width of 6.299216 inches was used to produce the stress distribution. The generated betas were compared to advanced single corner crack at hole solution in AFGROW.



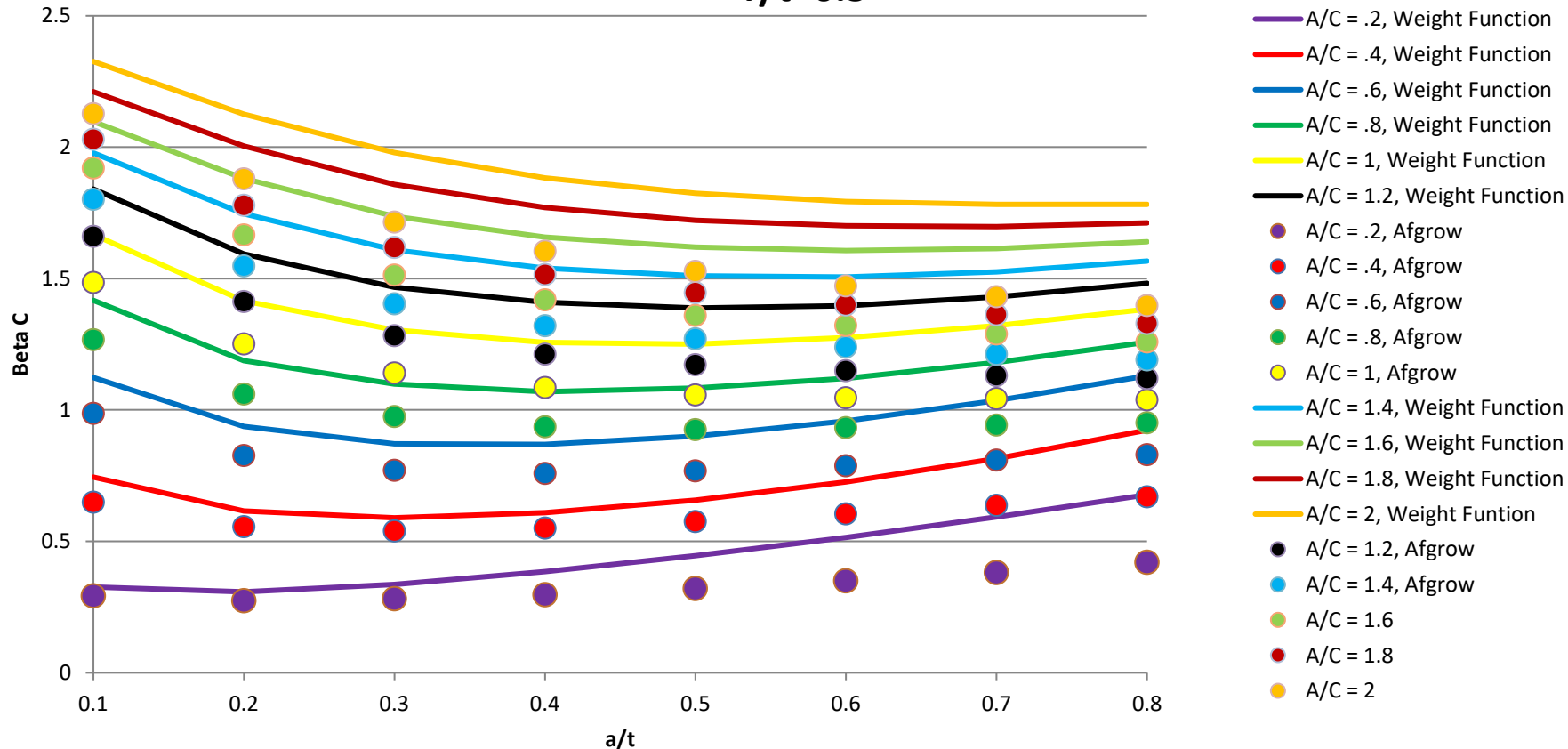
Single Edge Corner Crack Weight Function Solution Verification: Axial Load Stress Distribution Results



For the majority of the WF generated beta the error does not exceed 15%. The error growth beyond 15% at a/t = 0.5 and above.

Single Edge Corner Crack Weight Function Solution Verification: Axial Load Stress Distribution Results

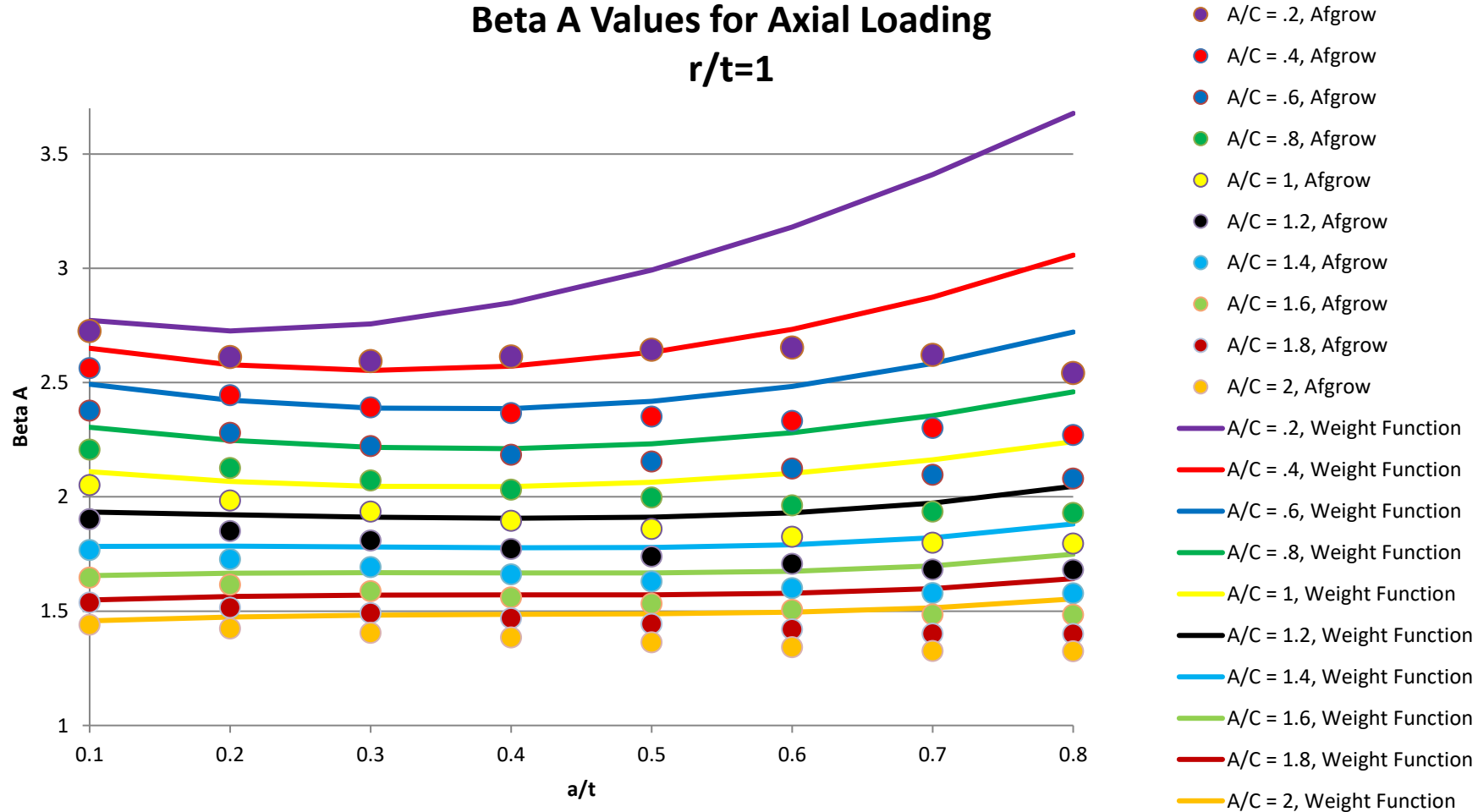
Beta C Values for Axial loading
r/t=0.5



For the majority of the WF generated beta the error does not exceeds 11%. The error growth beyond 11% at a/t =0.5 and above.

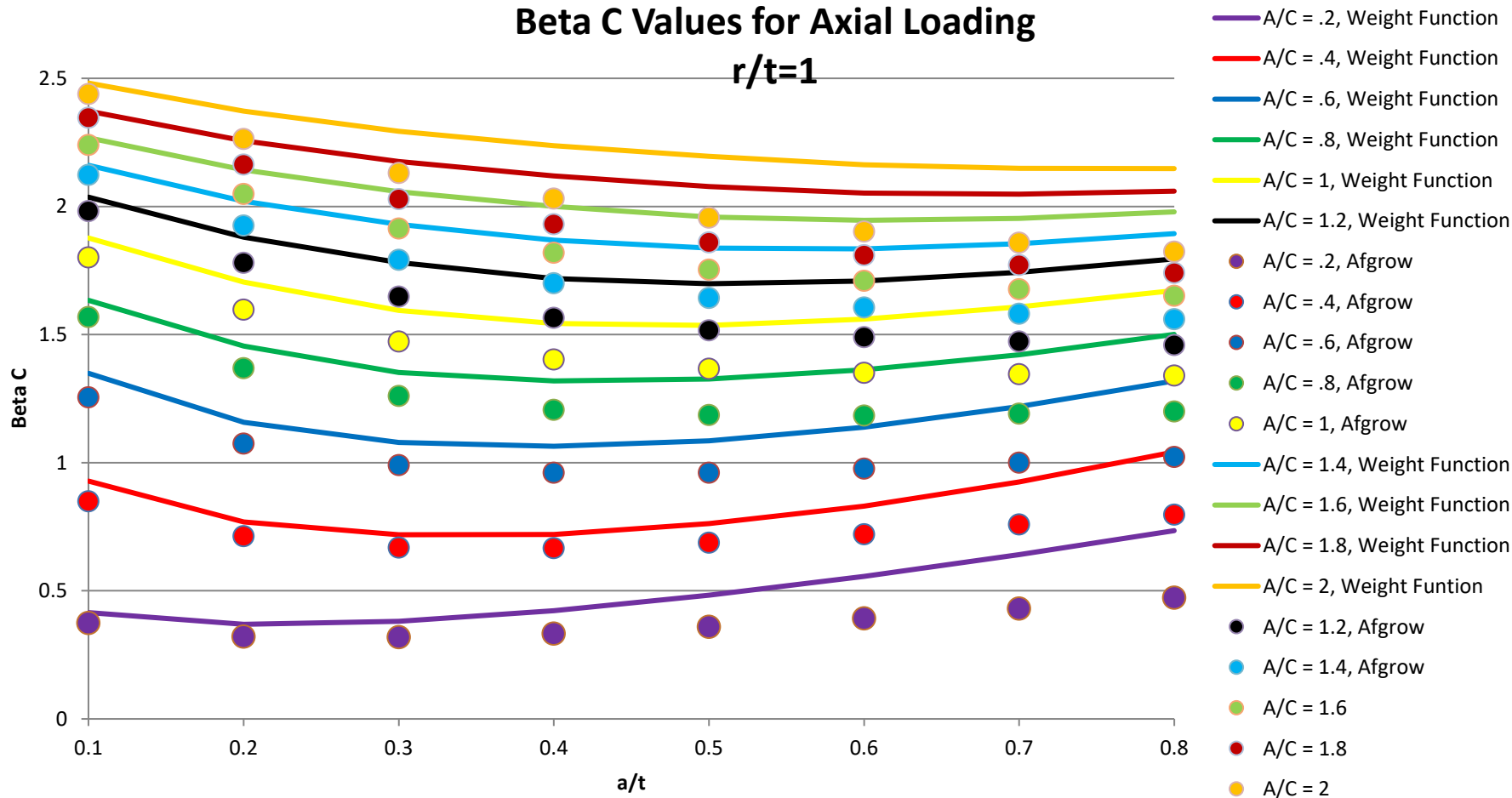
Single Edge Corner Crack Weight Function Solution Verification: Axial Load Stress Distribution Results

Beta A Values for Axial Loading
r/t=1



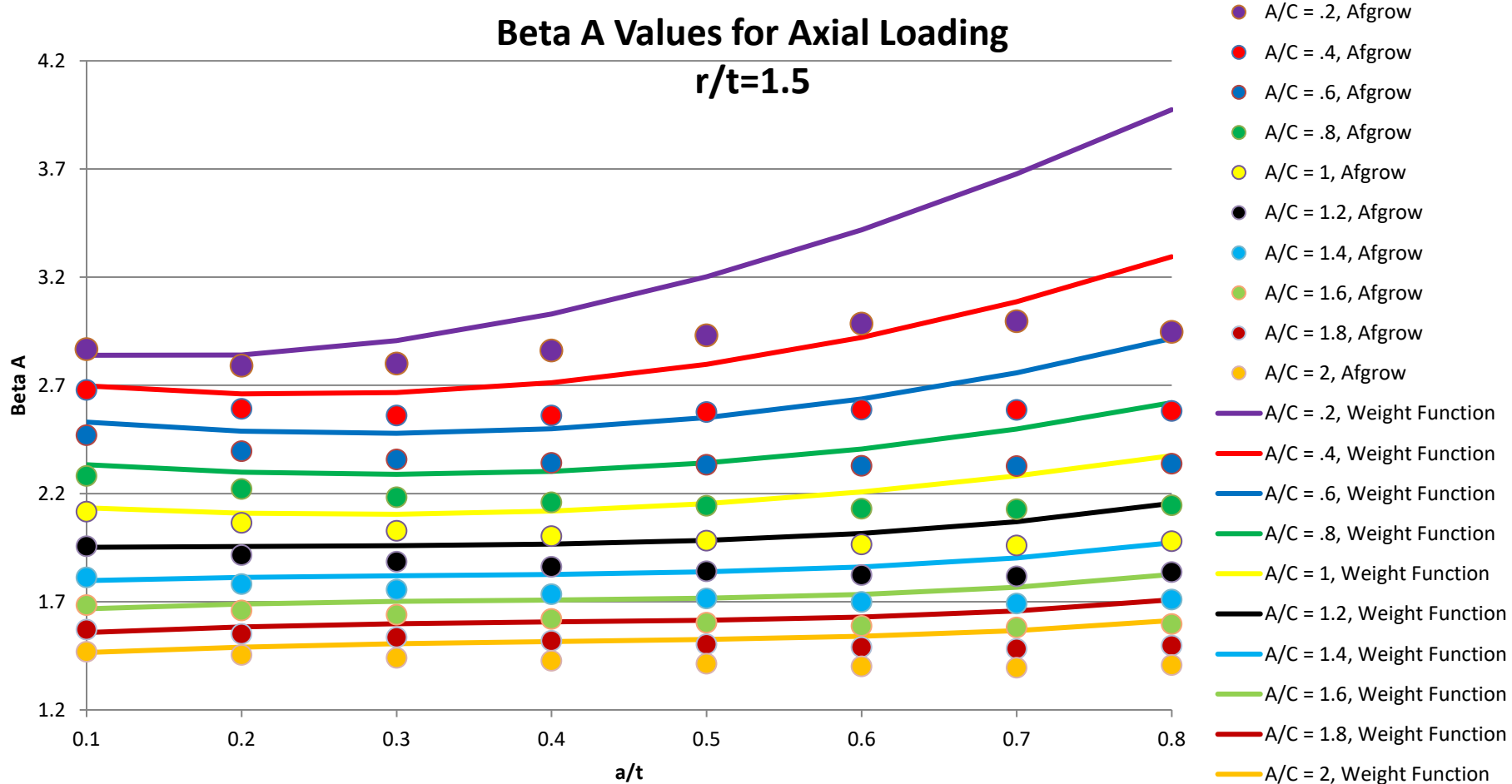
For the majority of the WF generated beta the error does not exceeds 10%. The error growth beyond 10% at a/t =0.6 and above.

Single Edge Corner Crack Weight Function Solution Verification: Axial Load Stress Distribution Results



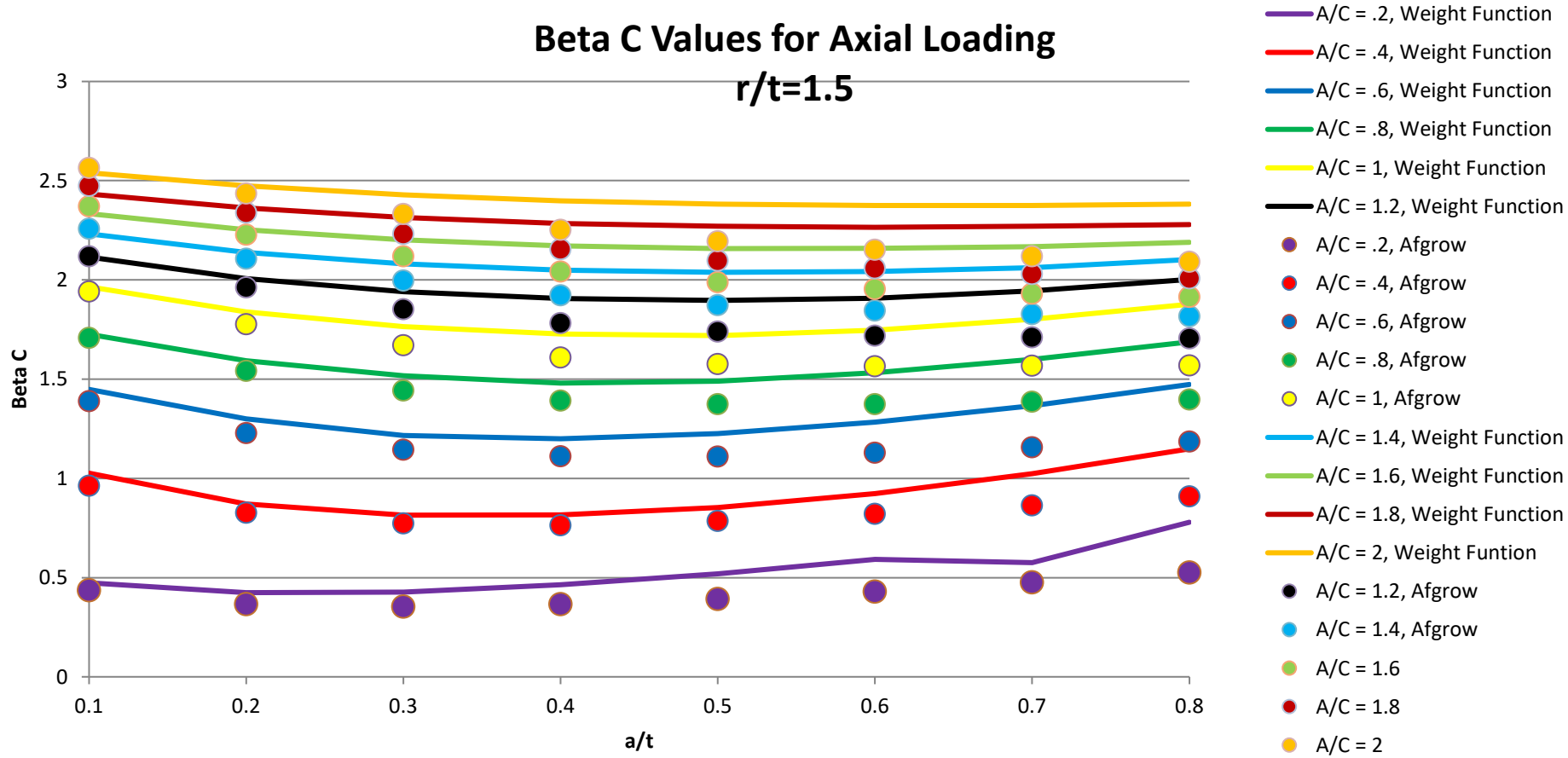
For the majority of the WF generated beta the error does not exceed 10%. The error growth beyond 10% at $a/t = 0.6$ and above.

Single Edge Corner Crack Weight Function Solution Verification: Axial Load Stress Distribution Results



For the majority of the WF generated beta the error does not exceed 15%. The error growth beyond 15% at a/t = 0.6 and above.

Single Edge Corner Crack Weight Function Solution Verification: Axial Load Stress Distribution Results



For the majority of the WF generated beta the error does not exceeds 6%. The error growth beyond 7% at $a/t = 0.6$ and above.

Local Material Database in the Tabular-Lookup format

- Based on AFMAT Data
- Searchable by material name and material type
- Data can not be modified
- AFGROW can be configured to be used the database on local computer, network server or company intranet

Download Data File

Material	Alloy	Description
All Materials		
ALLOY STEELS		
10NI STEEL L-T STW PLATE	ALLOY STEELS	10NI STEEL L-T STW PLATE
18Ni Maraging L-T	ALLOY STEELS	18Ni Maraging L-T
300M L-T Lab Air Forging	ALLOY STEELS	300M L-T Lab Air Forging
4130 L-T Lab air	ALLOY STEELS	4130 L-T Lab air
4340 180 Ksi L-T HHA	ALLOY STEELS	4340 180 Ksi L-T HHA
4340 L-T 160-180 UTS Plt+Frg Lab air Temp ...	ALLOY STEELS	4340 L-T 160-180 UTS Plt+Frg L...
AERMET 100 L-T HHA Forging and Bar	ALLOY STEELS	AERMET 100 L-T HHA Forging a...
AERMET 100 T-L HHA Forging and Bar	ALLOY STEELS	AERMET 100 T-L HHA Forging a...
API X60-X75 Pipeline Steel	ALLOY STEELS	API X60-X75 Pipeline Steel
H-11 AUST;T L-T ROUND BAR	ALLOY STEELS	H-11 AUST;T L-T ROUND BAR
ALUMINUM 2000/6000 ALLOYS		
2014-T6 L-T Lab air Sheet	ALUMINUM 2000/6000 ALLOYS	2014-T6 L-T Lab air Sheet
2020-T651 L-T Lab air Plate	ALUMINUM 2000/6000 ALLOYS	2020-T651 L-T Lab air Plate
2024-T3 Lab Air L-T	ALUMINUM 2000/6000 ALLOYS	2024-T3 Lab Air L-T
2024-T3 T-L Lab Air Sheet	ALUMINUM 2000/6000 ALLOYS	2024-T3 T-L Lab Air Sheet
2024-T351	ALUMINUM 2000/6000 ALLOYS	2024-T351
2024-T3511 Lab Air L-T	ALUMINUM 2000/6000 ALLOYS	2024-T3511 Lab Air L-T
2024-T851 lab air L-T	ALUMINUM 2000/6000 ALLOYS	2024-T851 lab air L-T
2090-T86 T-L Lab air TEE Extrusion	ALUMINUM 2000/6000 ALLOYS	2090-T86 T-L Lab air TEE Extrusi...
2091-T8 T-L HHA PLT&SHT	ALUMINUM 2000/6000 ALLOYS	2091-T8 T-L HHA PLT&SHT
2124-T851 lab air L-T	ALUMINUM 2000/6000 ALLOYS	2124-T851 lab air L-T
2219-T851 L-T Dry air Plate	ALUMINUM 2000/6000 ALLOYS	2219-T851 L-T Dry air Plate
2219-T87 lab air T-L	ALUMINUM 2000/6000 ALLOYS	2219-T87 lab air T-L
2224-T3511 L-T Lab Air Extrusion	ALUMINUM 2000/6000 ALLOYS	2224-T3511 L-T Lab Air Extrusion
2324-T39 lab air & HHA L-T	ALUMINUM 2000/6000 ALLOYS	2324-T39 lab air & HHA L-T
		TestDescript

Tabular Lookup Database, 82 entries

OK Cancel

Enhanced Output Preferences

- Add a check box to put output file in the same folder as input file.
- Allow the for each output file type to have the same name as an input file.

Predict Function Preferences

Growth Increment

Output Intervals

Output Options

Propagation Limits

Transition Options

Lug Boundary Conditions

Crack Closure Factor

Bending

Default File Location
C:\Users\alitiv\Documents\afgrow

Print Output to

Screen Data File

Plot File XML Data File

Synchronize output files with the input file name and location

Data File Name
C:\Users\alitiv\Documents\Projects\AFGF .out Browse...

Plot File Name
C:\Users\alitiv\Documents\Projects\AFGI .pl2 Browse...

XML Data File Name
afgr_output .xml Browse...

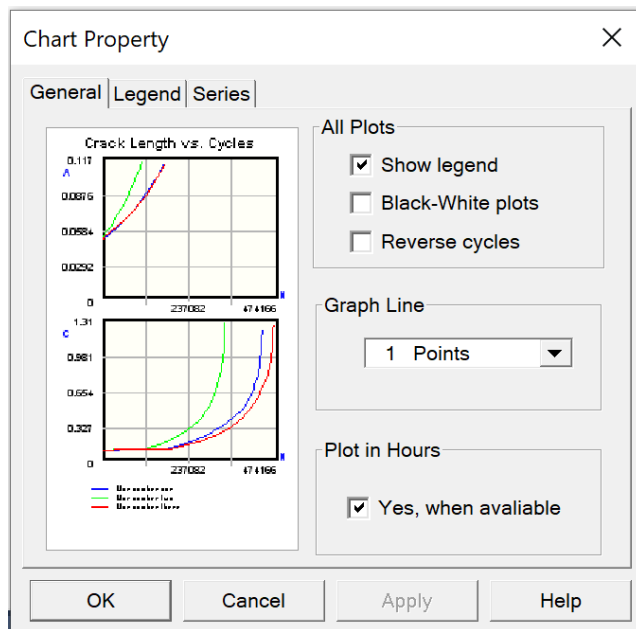
OK Cancel Save Default

Life in Hours Output – What Do We Do with a Time Dependent Spectrum?

Print hours and cycles

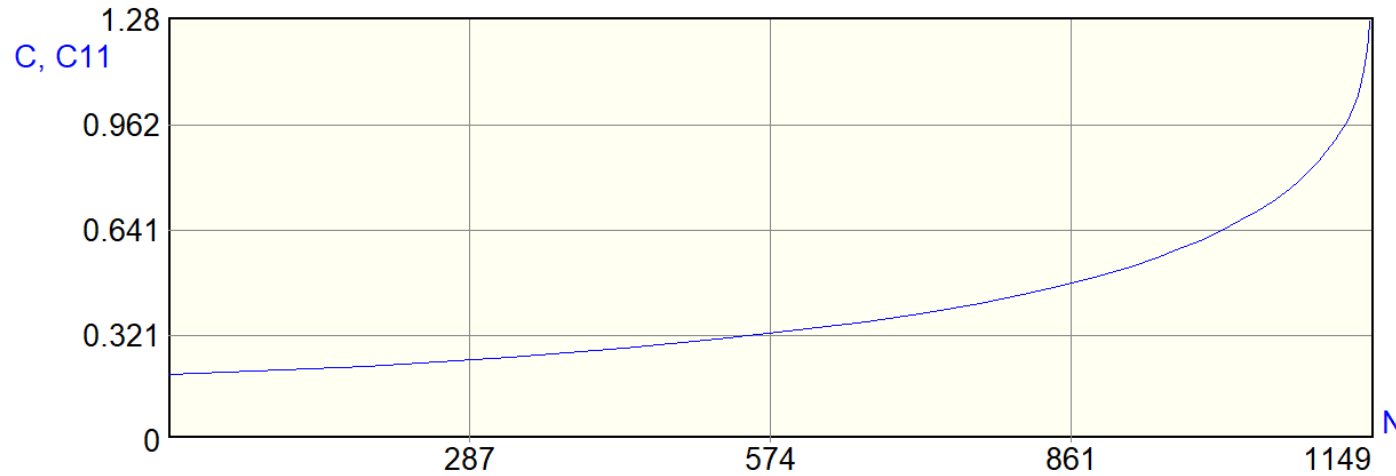


C Crack size= 1.089 Beta Tension= 1.2170 Beta Compression= 1.2170 R(k)= 0.0000 R(final)= 0.0000 Max stress = 14.000 r = 0.00 57100 Cycles Subspectra: 0 Pass: 572 Hours: 1142	Delta k=3.1513e+01 D()/DN=3.0626e-04
C Crack size= 1.1196 Beta Tension= 1.2498 Beta Compression= 1.2498 R(k)= 0.0000 R(final)= 0.0000 Max stress = 14.000 r = 0.00 57200 Cycles Subspectra: 0 Pass: 573 Hours: 1144	Delta k=3.2816e+01 D()/DN=4.4571e-04
C Crack size= 1.1642 Beta Tension= 1.2498 Beta Compression= 1.2498 R(k)= 0.0000 R(final)= 0.0000 Max stress = 14.000 r = 0.00 57300 Cycles Subspectra: 0 Pass: 574 Hours: 1146	Delta k=3.3463e+01 D()/DN=5.5443e-04
C Crack size= 1.2196 Beta Tension= 1.3171 Beta Compression= 1.3171 R(k)= 0.0000 R(final)= 0.0000 Max stress = 14.000 r = 0.00 57400 Cycles Subspectra: 0 Pass: 575 Hours: 1148	Delta k=3.6095e+01 D()/DN=2.1559e-03



- Let user decide what to see in the plot view.
- “Crack Length vs. Cycles” graph will be in hours only if “Yes” button is checked in and plots are covetable to hours

New Life in Hours Output Options



← The crack length plots converted to hours if the option to display life in hours is selected

— Internal Through Crack - Standard Solution

Output intervals printed in "hours" if the option to display life in hours is selected



Output			
Max stress =	14.000	r = 0.00	57000 Cycles Subspectra: 0 Pass: 571 Hours: 1140
C Crack size=	1.089	Beta Tension= 1.2170	Beta Compression= 1.2170 R(k)= 0.0000 R(final)= 0.0000
Max stress =	14.000	r = 0.00	57100 Cycles Subspectra: 0 Pass: 572 Hours: 1142
C Crack size=	1.1196	Beta Tension= 1.2498	Beta Compression= 1.2498 R(k)= 0.0000 R(final)= 0.0000
Max stress =	14.000	r = 0.00	57200 Cycles Subspectra: 0 Pass: 573 Hours: 1144
C Crack size=	1.1642	Beta Tension= 1.2498	Beta Compression= 1.2498 R(k)= 0.0000 R(final)= 0.0000
Max stress =	14.000	r = 0.00	57300 Cycles Subspectra: 0 Pass: 574 Hours: 1146
C Crack size=	1.2196	Beta Tension= 1.3171	Beta Compression= 1.3171 R(k)= 0.0000 R(final)= 0.0000
Max stress =	14.000	r = 0.00	57400 Cycles Subspectra: 0 Pass: 575 Hours: 1148
*****Fracture based on 'Kmax' Criteria (current maximum stress)			
C Crack size=	1.2821	Beta Tension= 1.3677	Beta Compression= 1.3677 R(k)= 0.0000 R(final)= 0.0000
Max stress =	14.000	r = 0.00	57429 Cycles Subspectra: 0 Pass: 575 Hours: 1148.58
Stress State in the 'C' direction (PSC): 2			
Fracture has occurred- run time: 0 hour(s) 0 minute(s) 1 second(s)			
1148.5800 hours have passed			

Questions