LexTech

AFGROW.NET

AFGROW European Workshop

AFGROW Release 5.4 Overview

Jun 23, 2022
ZHAW School of Engineering
Centre for Aviation

LexTech

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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

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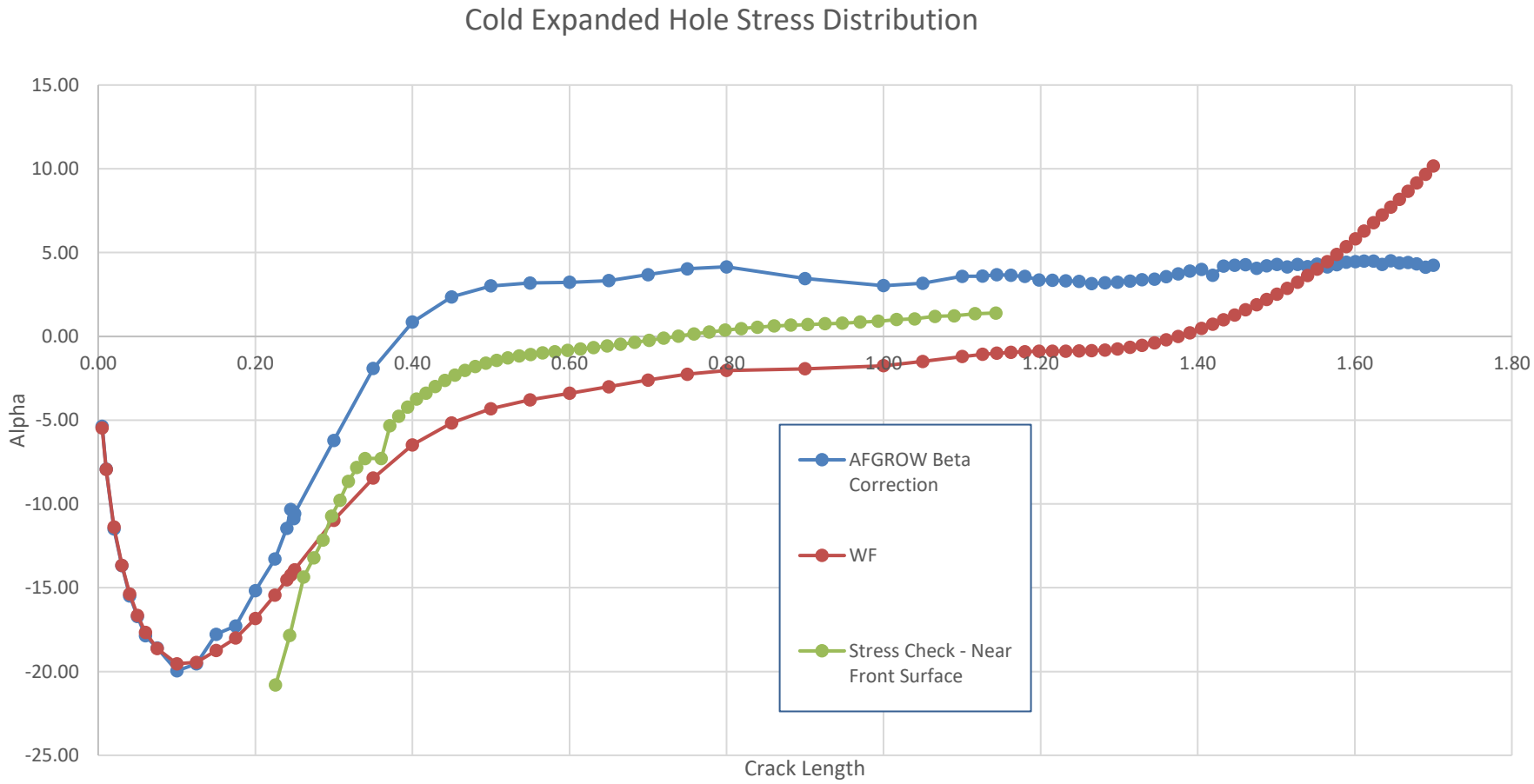
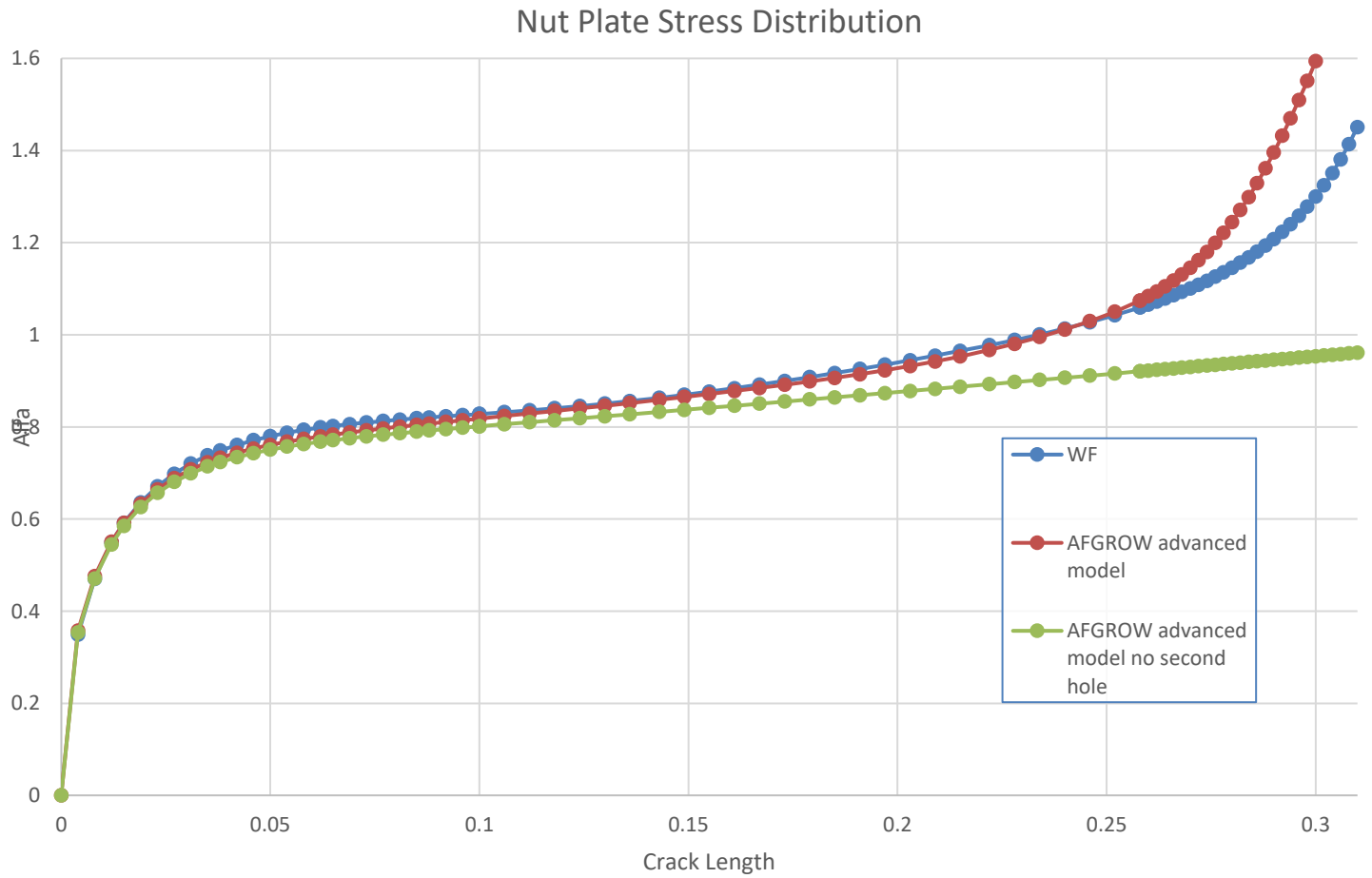
Single and Double Through Crack at Hole Weight function Solutions

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

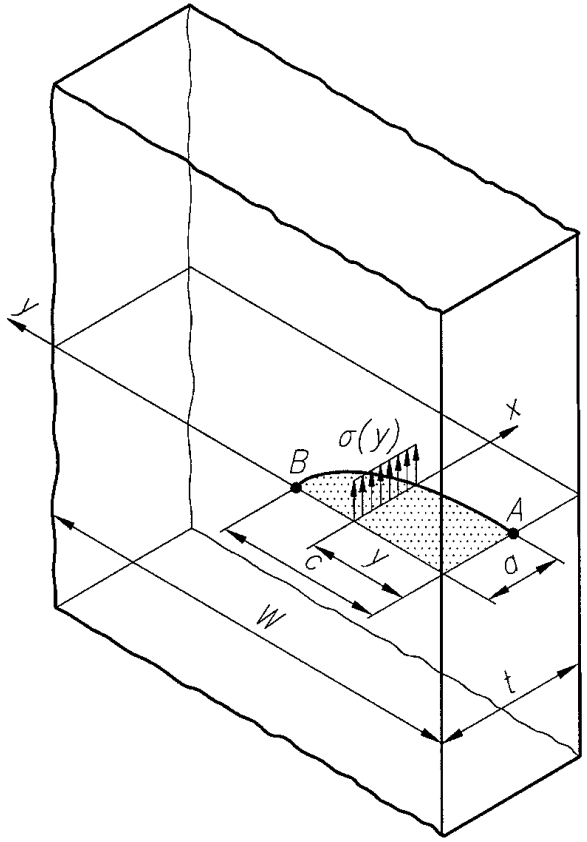
Single Through Crack at a Hole Weight Function Solution Verification - Case 1



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



Single Edge Corner Crack Weight Function Solution

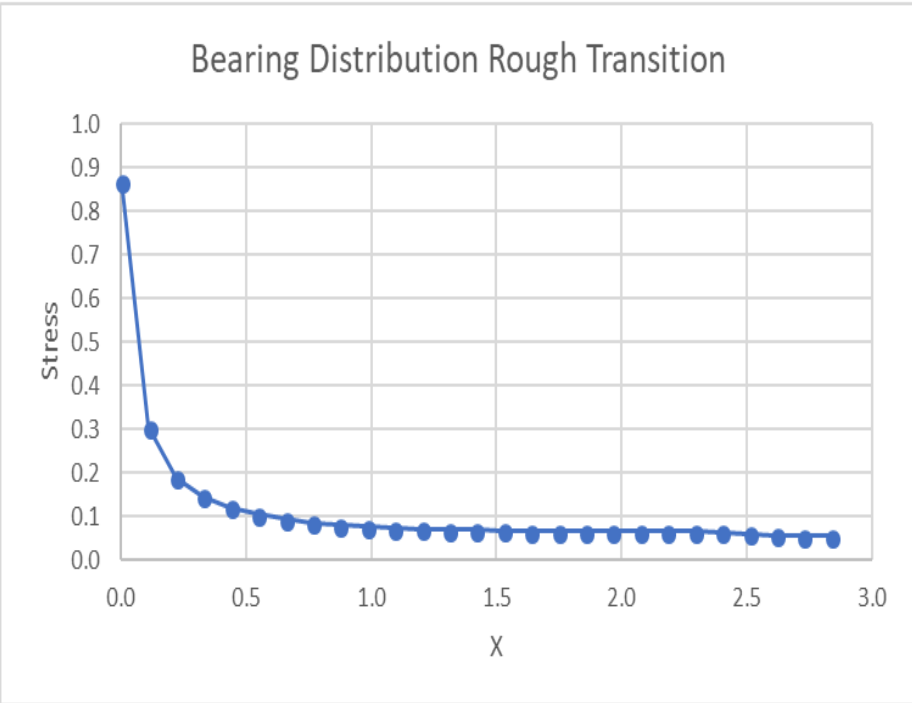


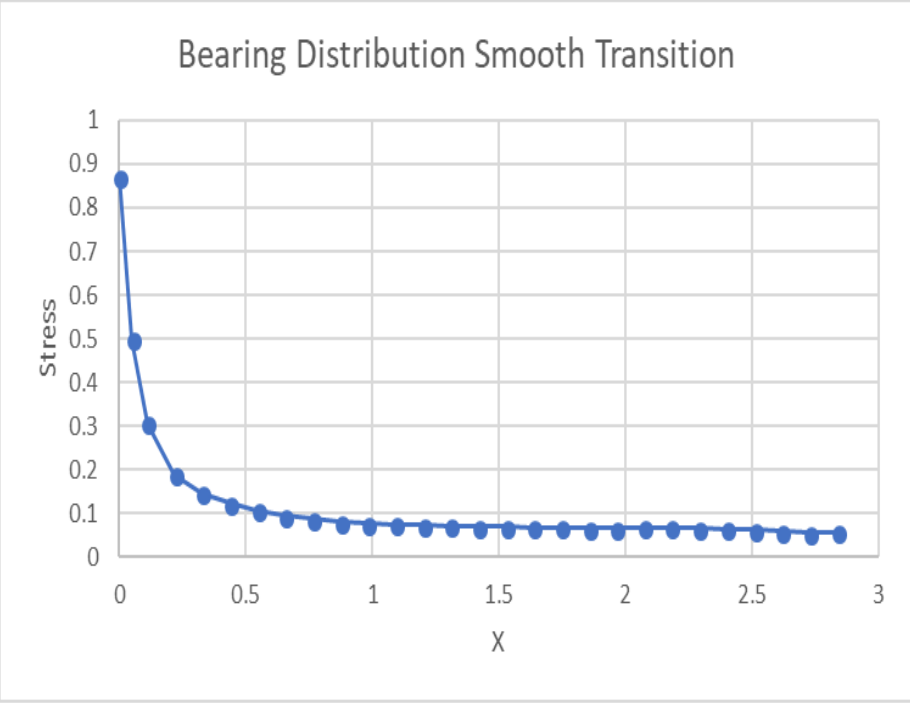
Based on Glinka, G., PhD, DSc., "*Quarter-elliptical corner crack in a finite thickness plate – in plane stress distribution*" delivered to LexTech, Inc. as part of the contract with SAFFD, Inc., Mannheim, Ontario, Canada

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

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

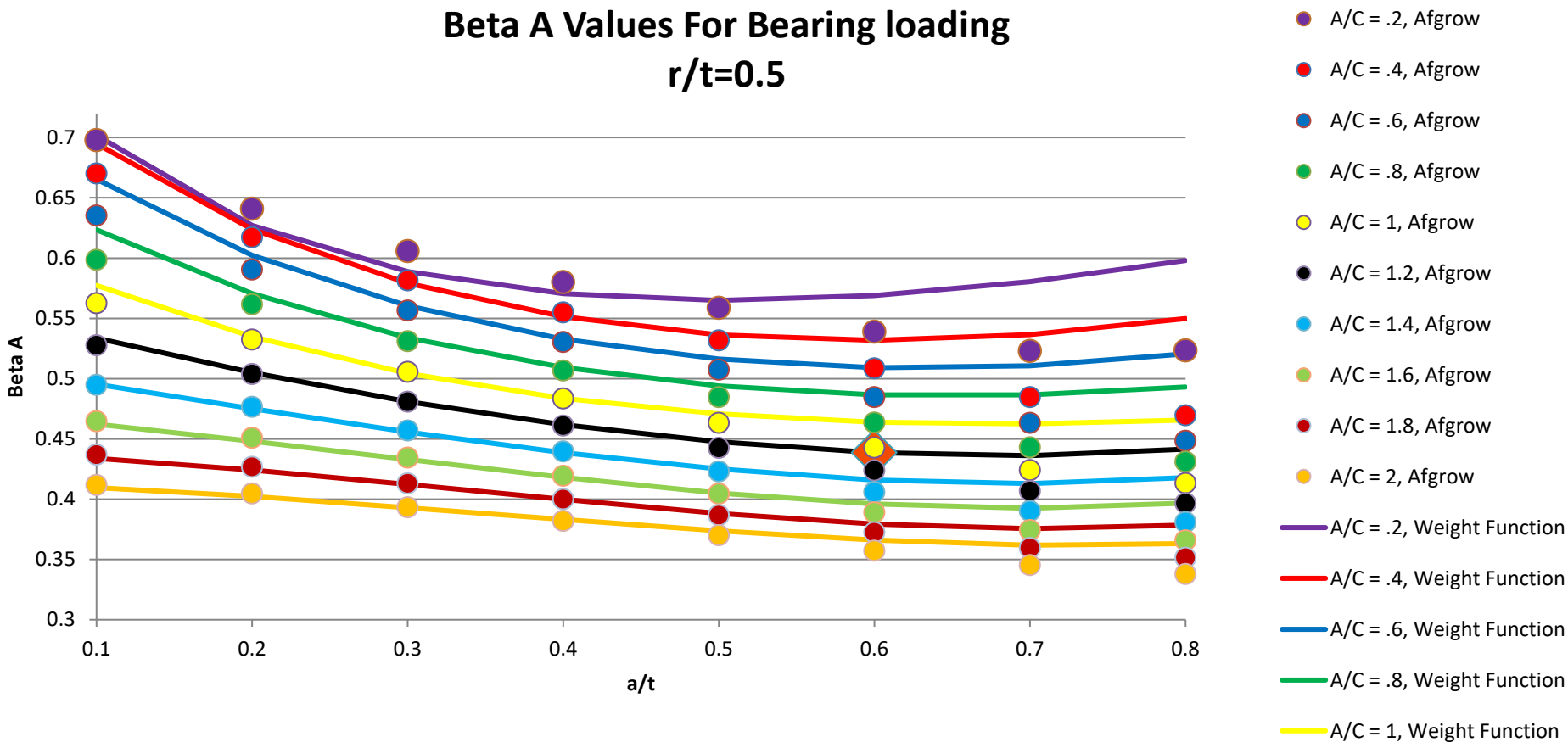
A plate with a centered hole, under bearing loading with a diameter equal to 0.629922 inches and a width of 6.299216 inches was used to produce the stress distribution. The generated betas were compared to advanced single corner crack at hole solution in AFGROW.





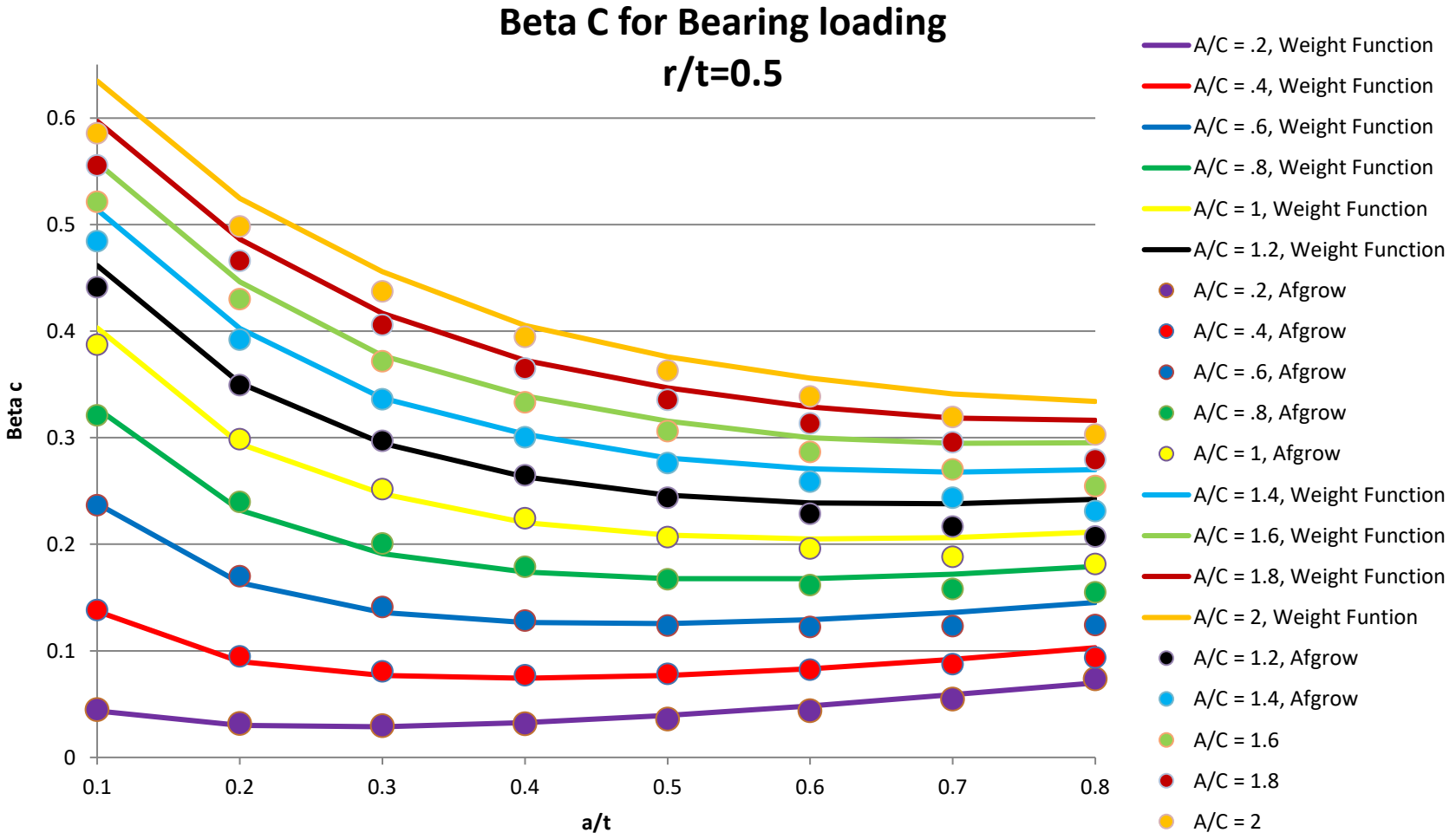
The stress distribution on the left was initially used to calculate the SIF and the results were not as expected.
An additional point was added to the beginning of the plot to smooth the transition. This change significantly improved the results.

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



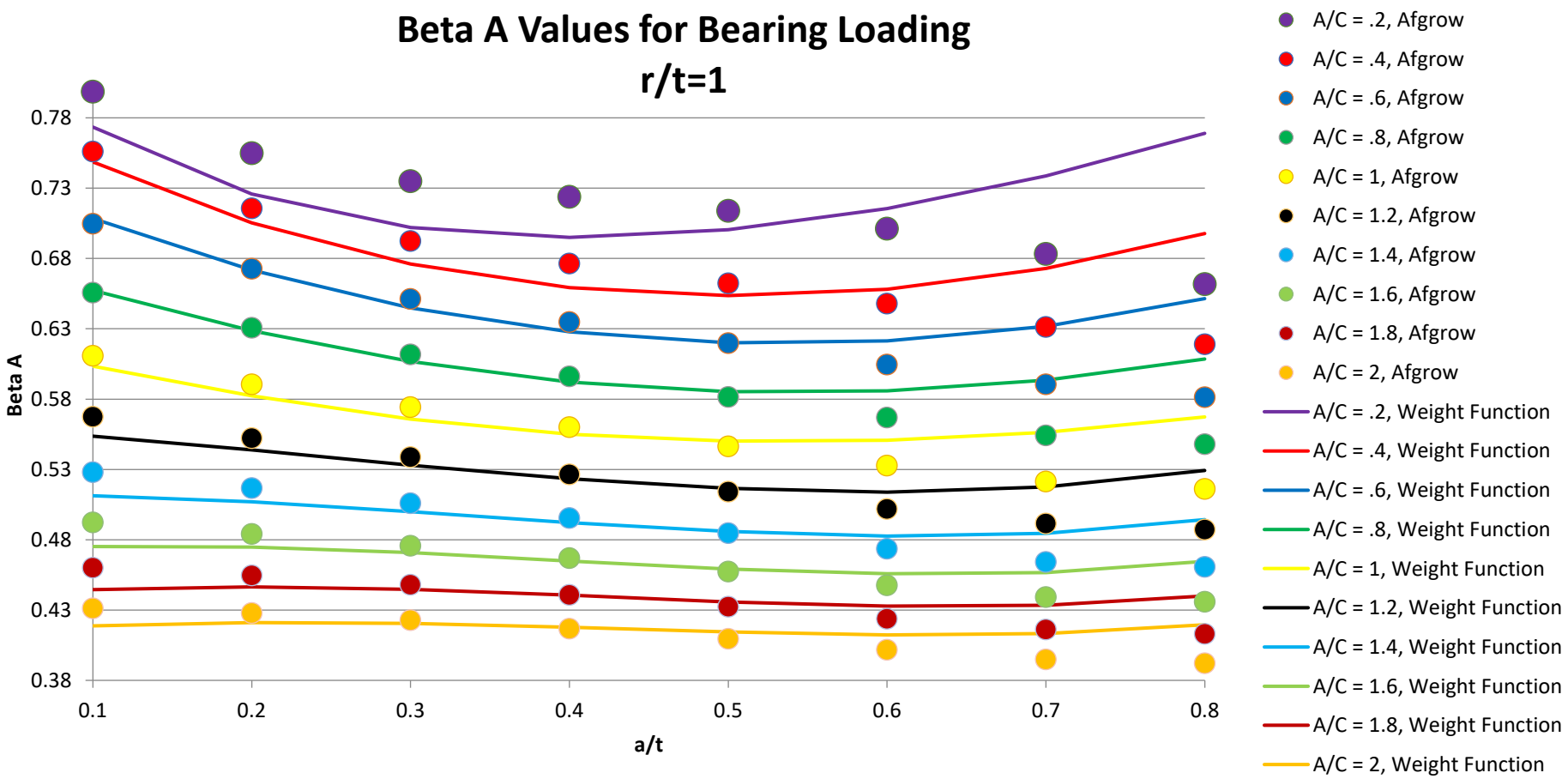
For the majority of the WF generated beta the error does not exceeds 2%. The error growth beyond 2% at a/t =0.7 and above.

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



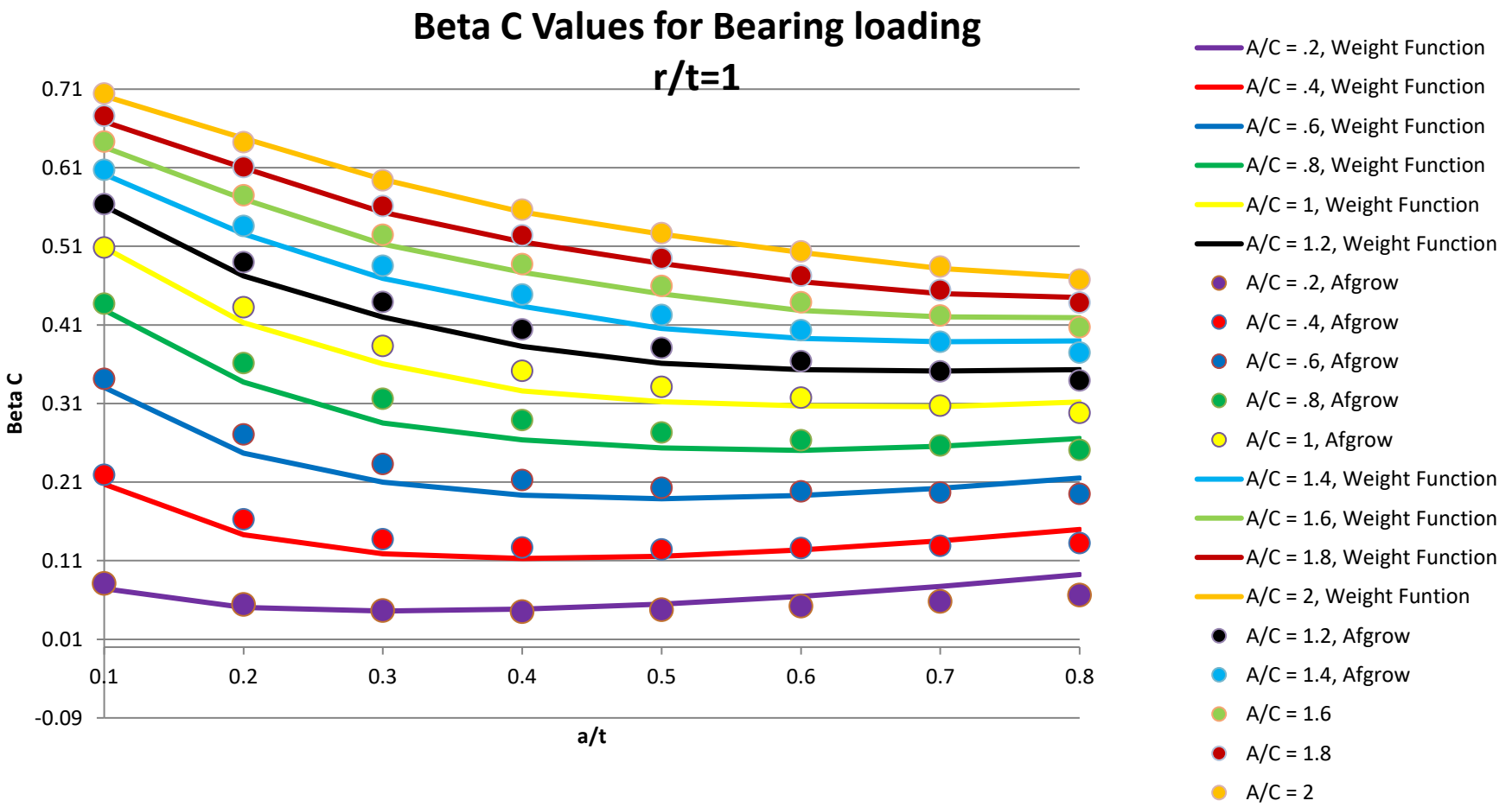
For the majority of the WF generated beta the error does not exceeds 5%. The error growth beyond 5% at a/t =0.7 and above.

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



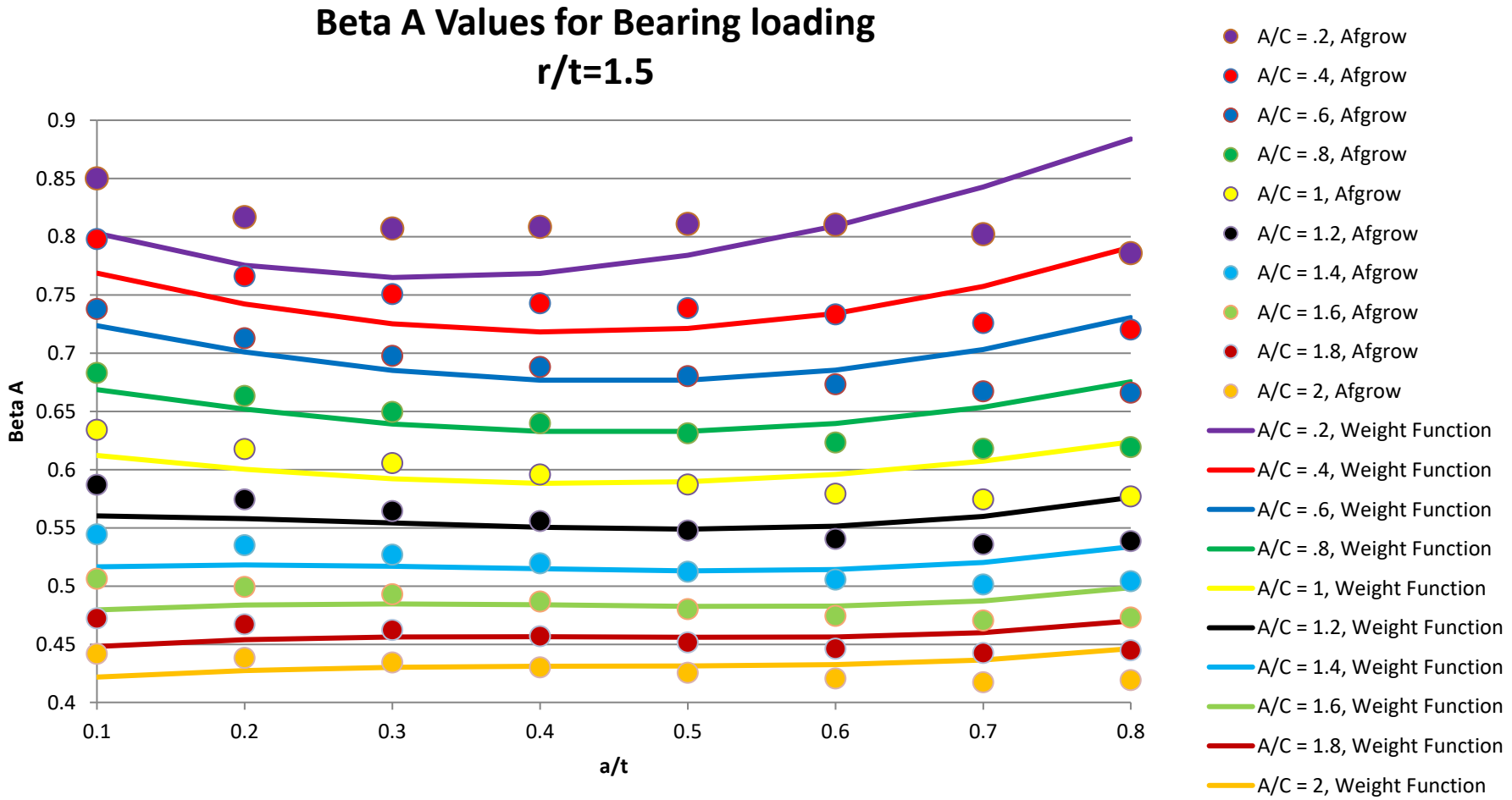
For the majority of the WF generated beta the error does not exceeds 8%. The error growth beyond 8% at a/t =0.7 and above.

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



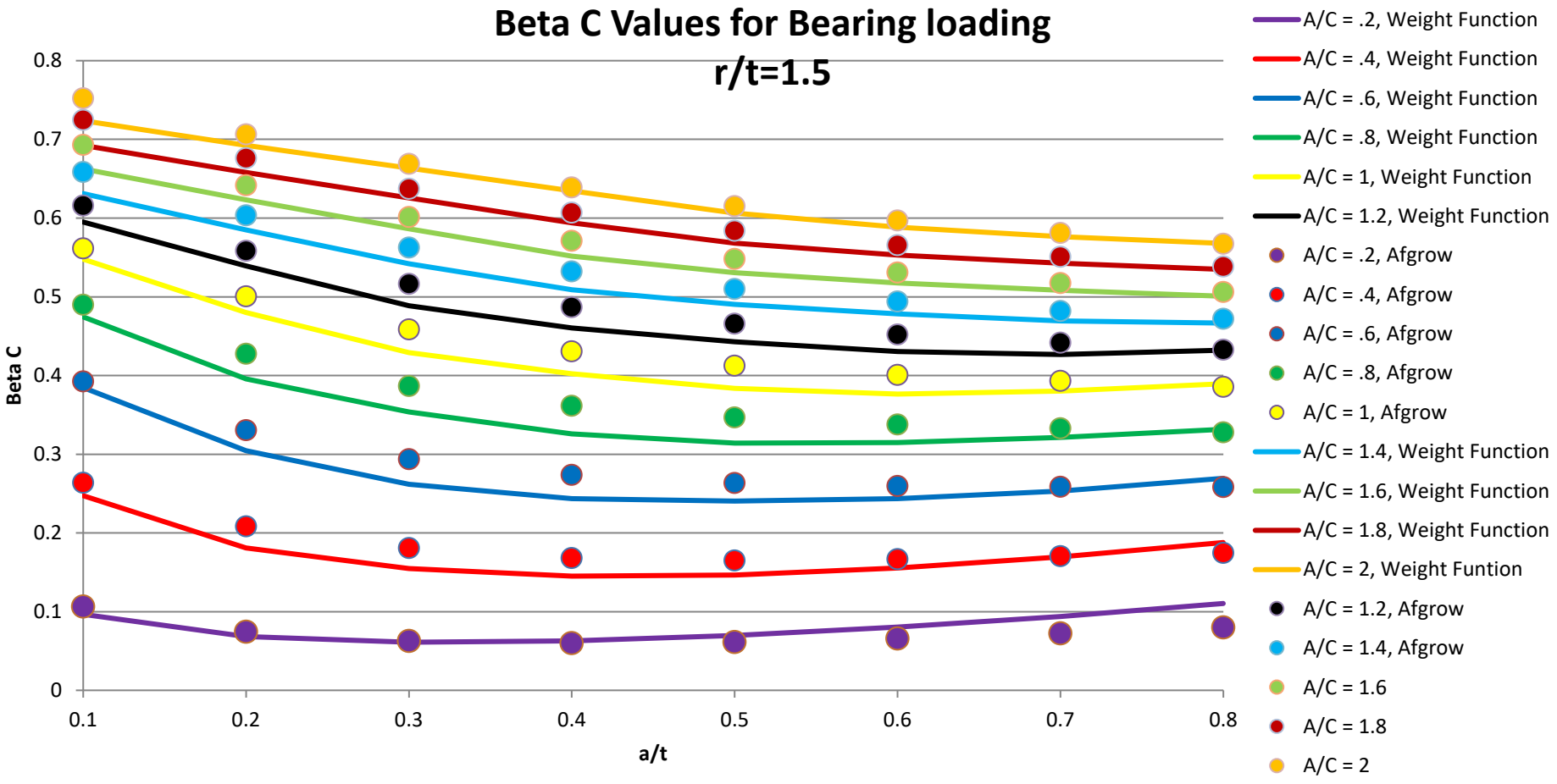
For the majority of the WF generated beta the error does not exceeds 3.7%. The error growth beyond 3.7% at a/t =0.7 and above.

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



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.

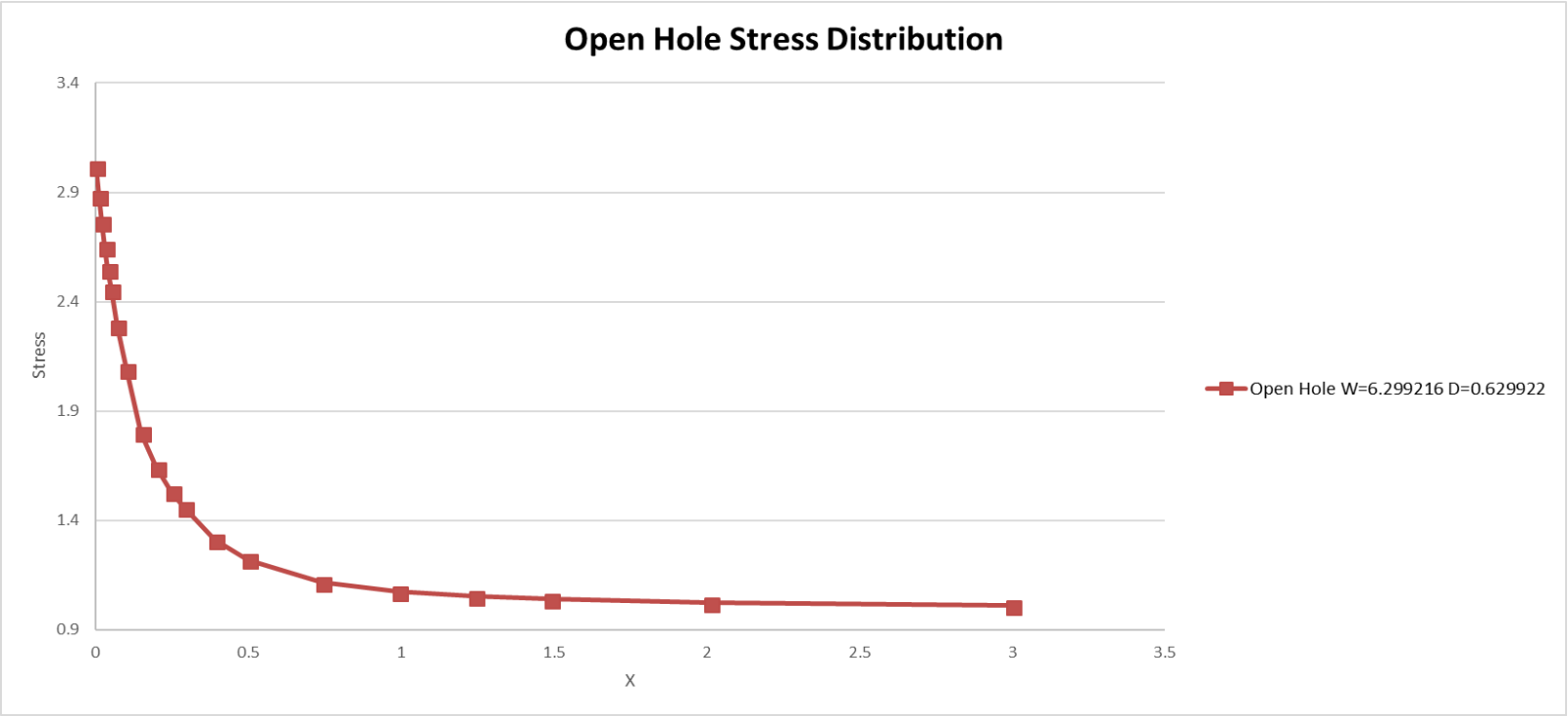
Single Edge Corner Crack Weight Function Solution Verification: Bearing Load Stress Distribution Results



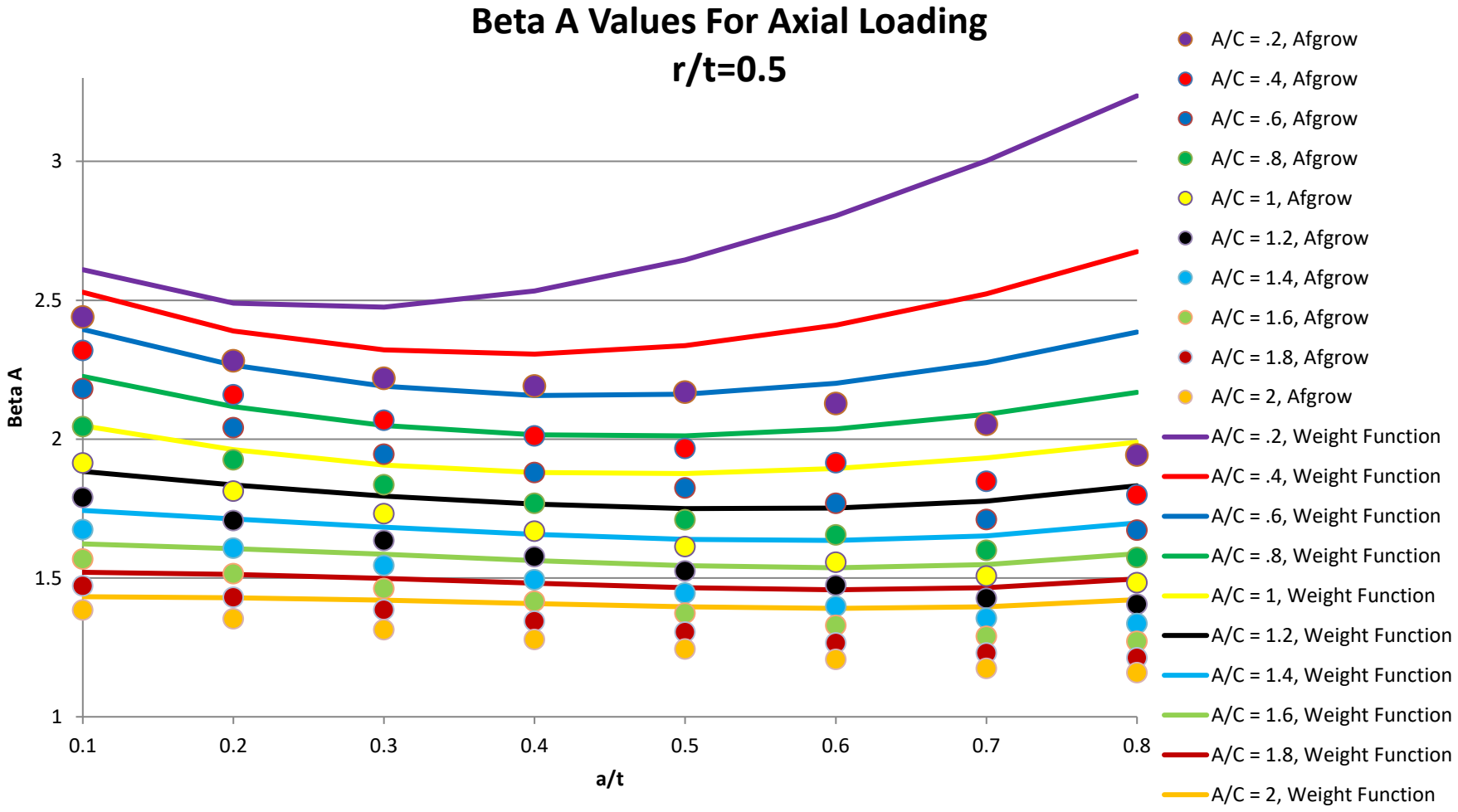
For the majority of the WF generated beta the error does not exceeds 5%. The error growth beyond 5% at a/t =0.7 and above.

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.

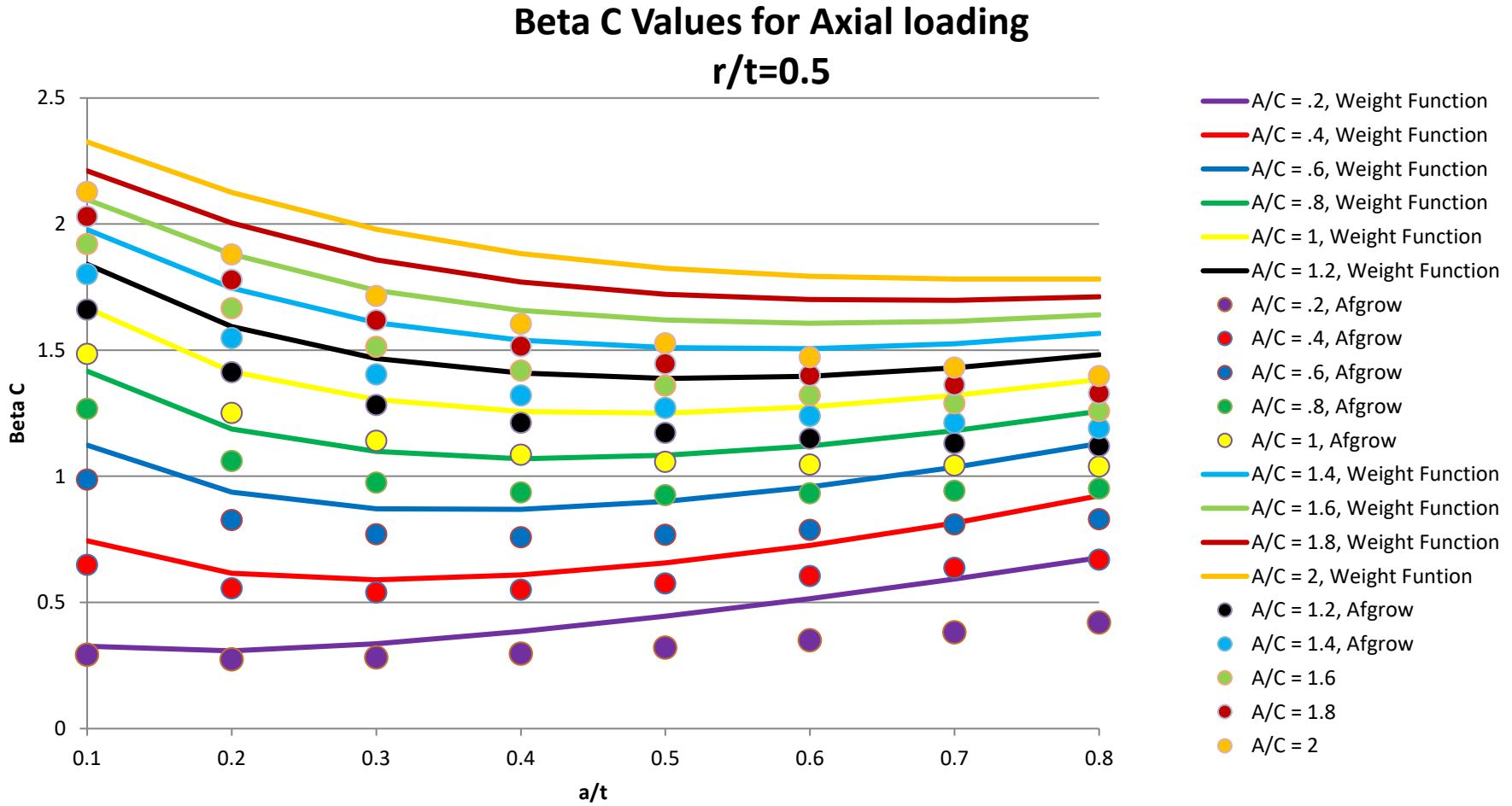


Single Edge Corner Crack Weight Function Solution Verification: Axial Load Stress Distribution Results



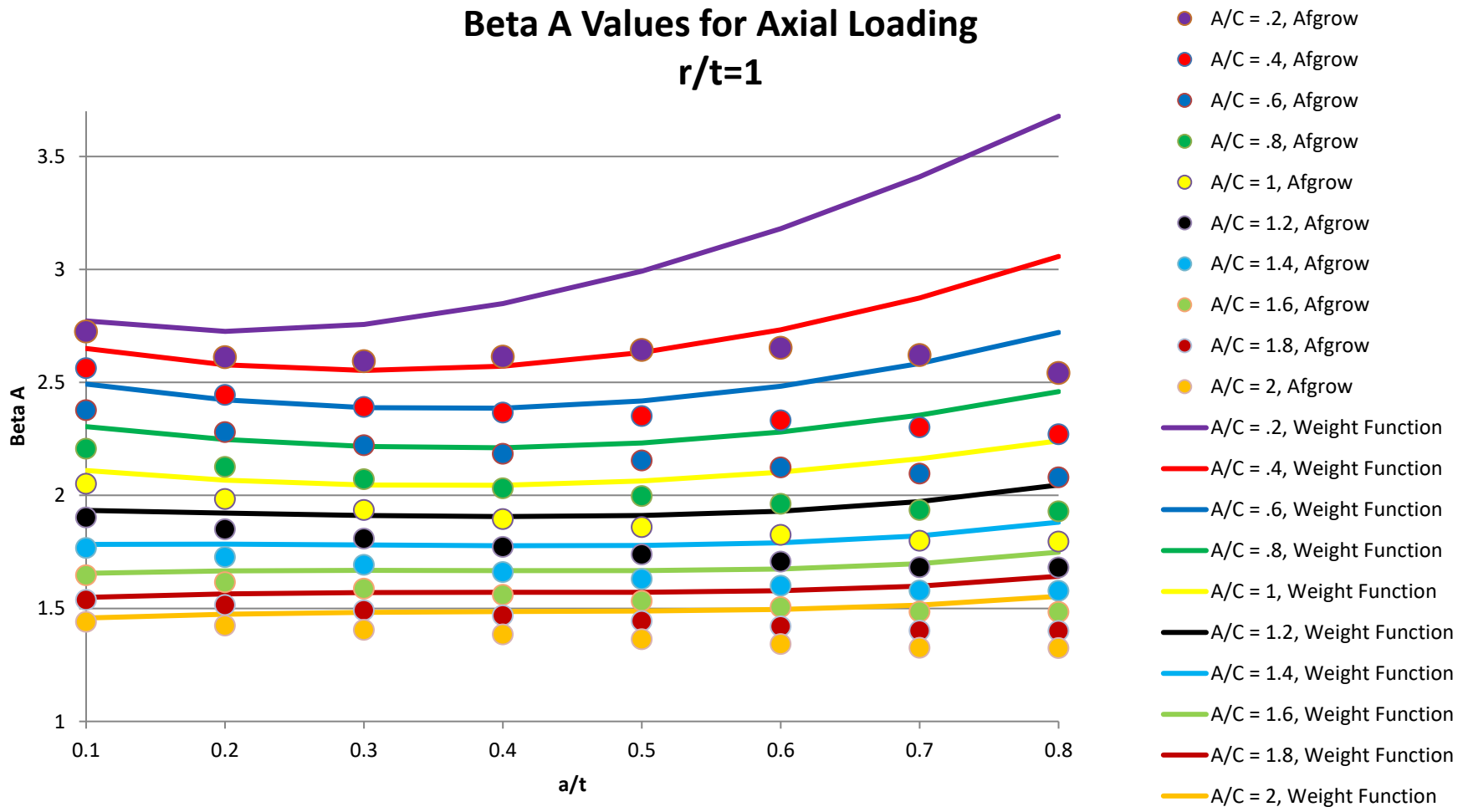
For the majority of the WF generated beta the error does not exceeds 15%. The error growth beyond 15% at a/t =0.5 and above.

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



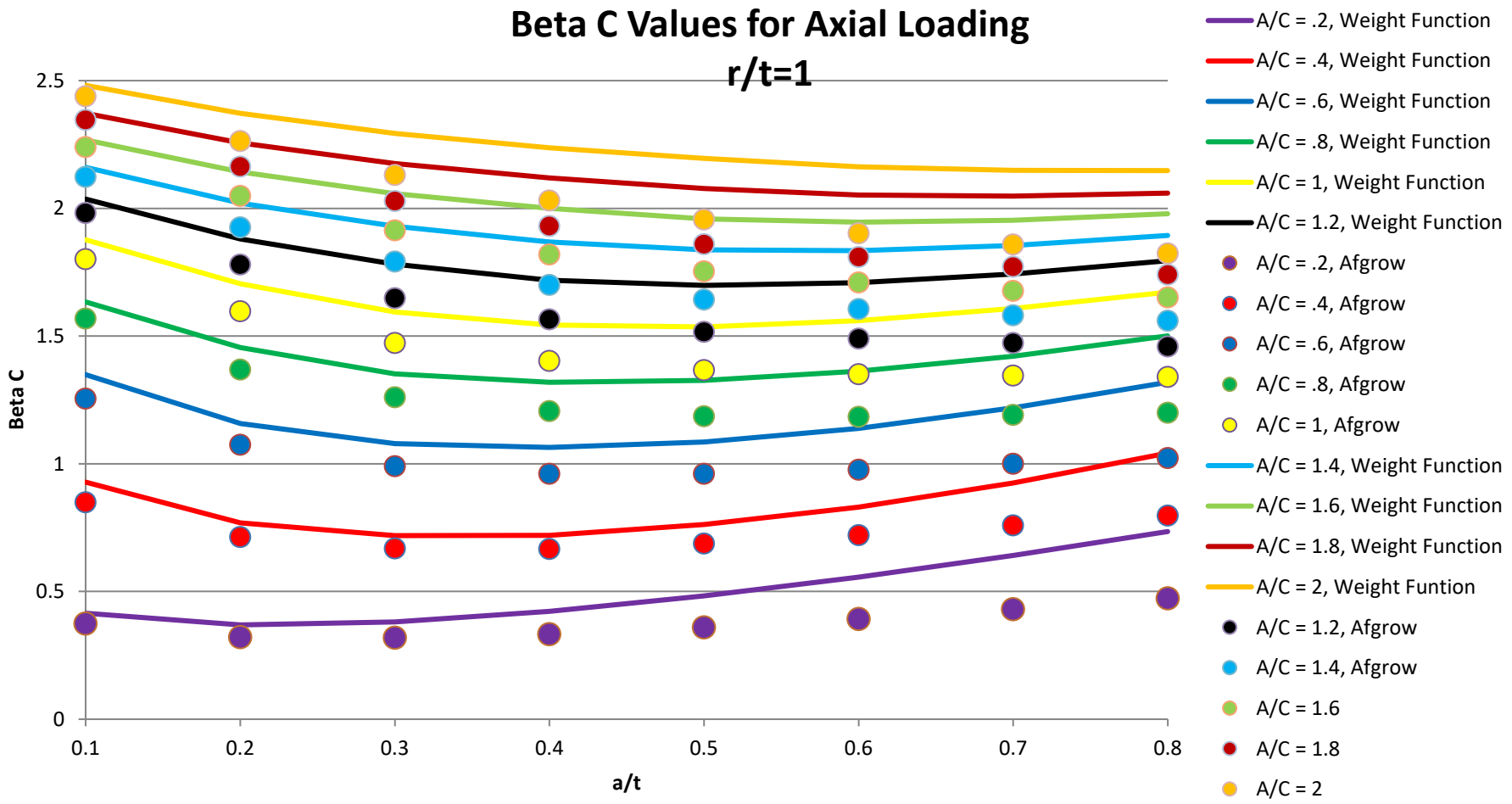
For the majority of the WF generated beta the error does not exceeds 11%. The error growth beyond 11% at a/t =0.5 and above.

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



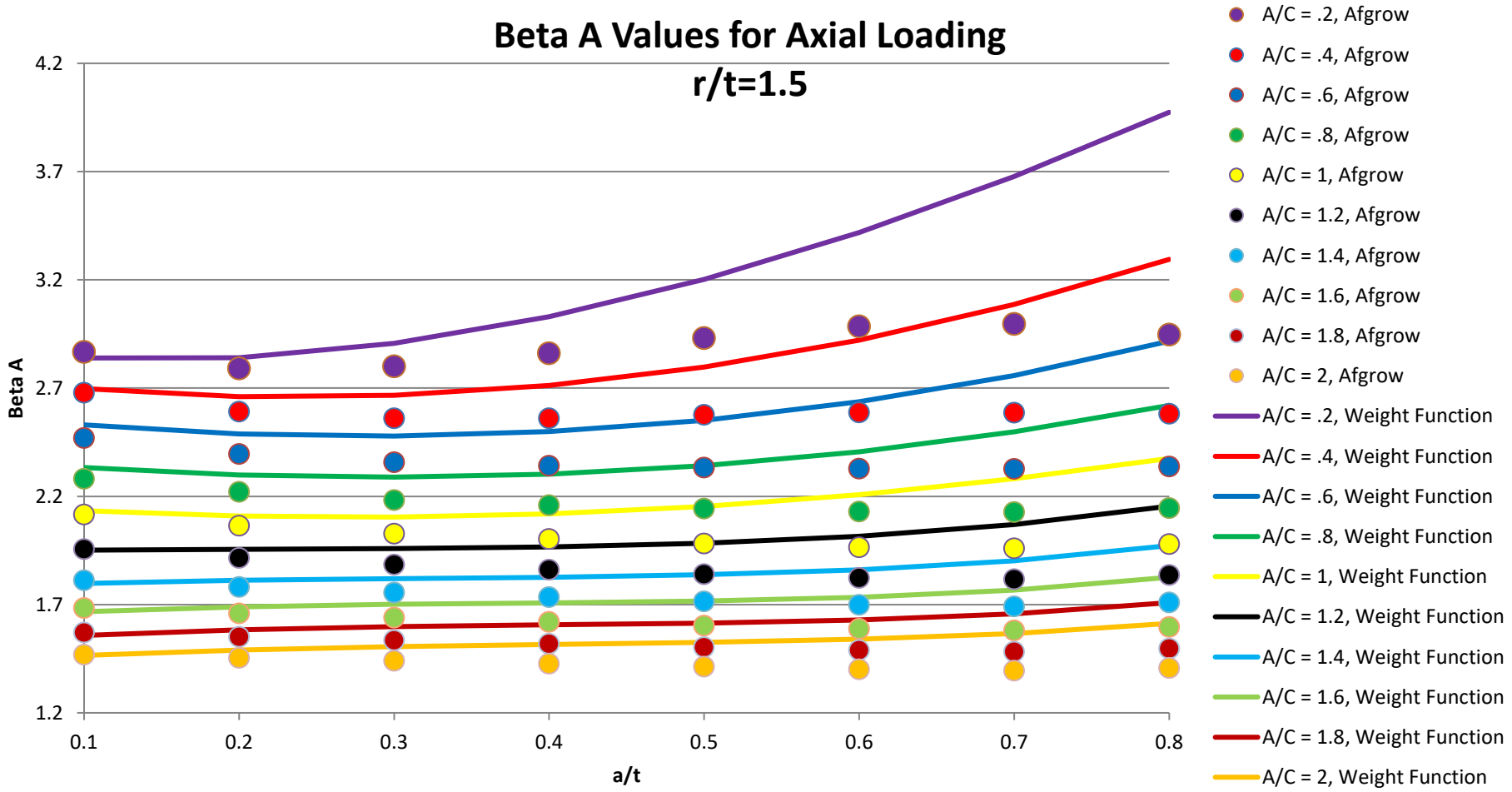
For the majority of the WF generated beta the error does not exceeds 10%. The error growth beyond 10% at a/t =0.6 and above.

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



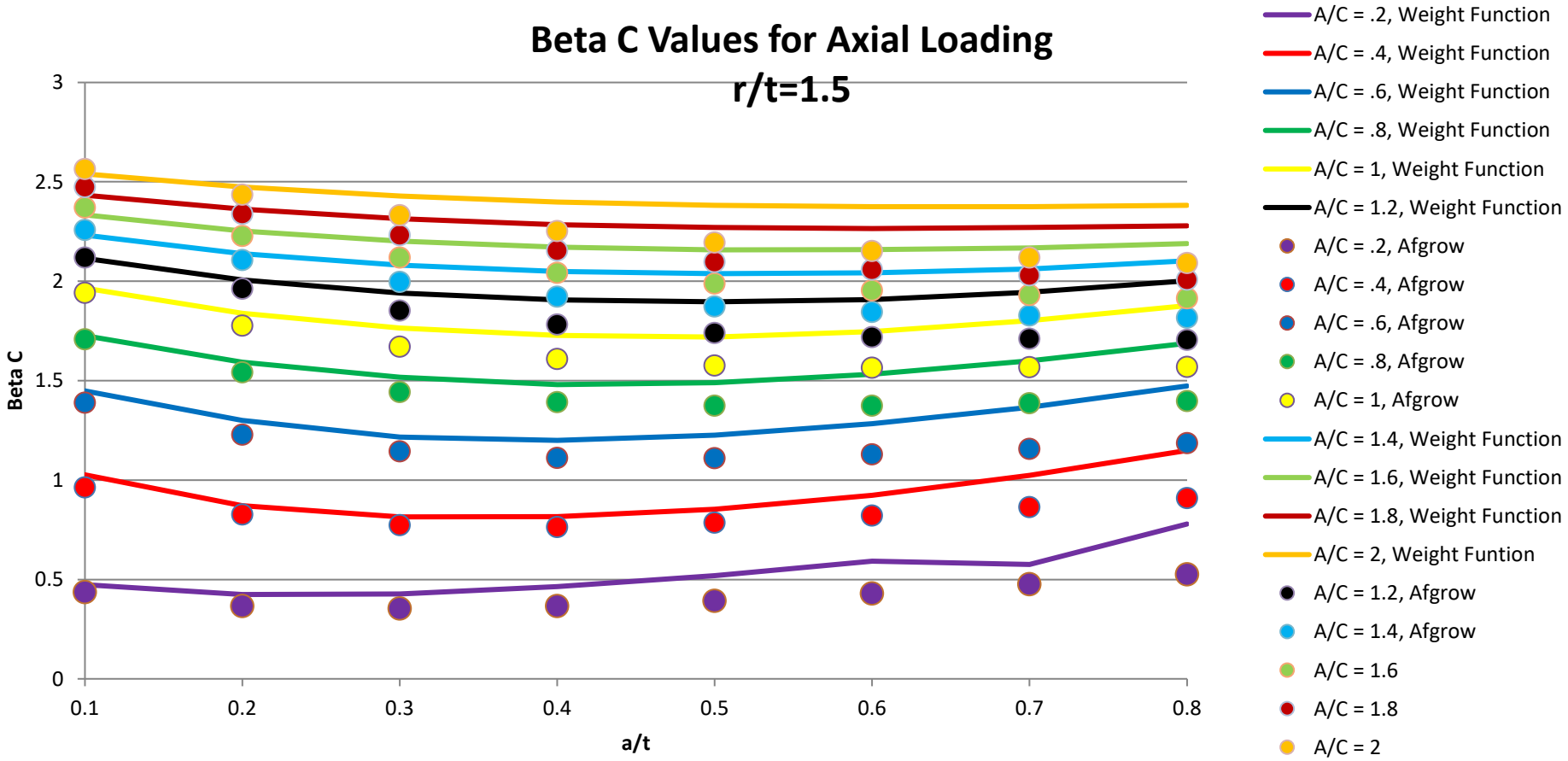
For the majority of the WF generated beta the error does not exceeds 10%. The error growth beyond 10% at a/t =0.6 and above.

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 exceeds 15%. The error growth beyond 15% at a/t =0.6 and above.

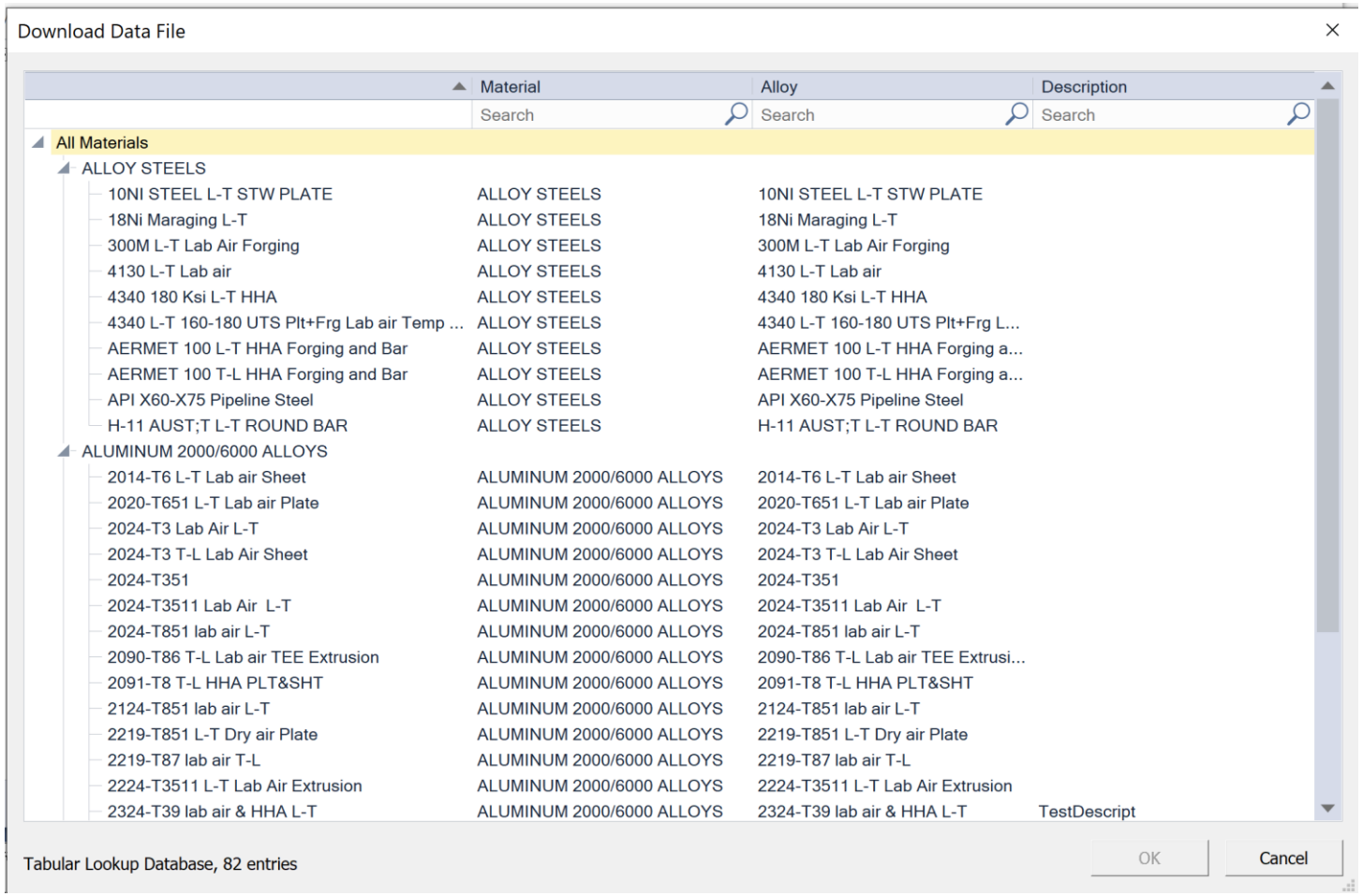
Single Edge Corner Crack Weight Function Solution Verification: Axial Load Stress Distribution Results



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.

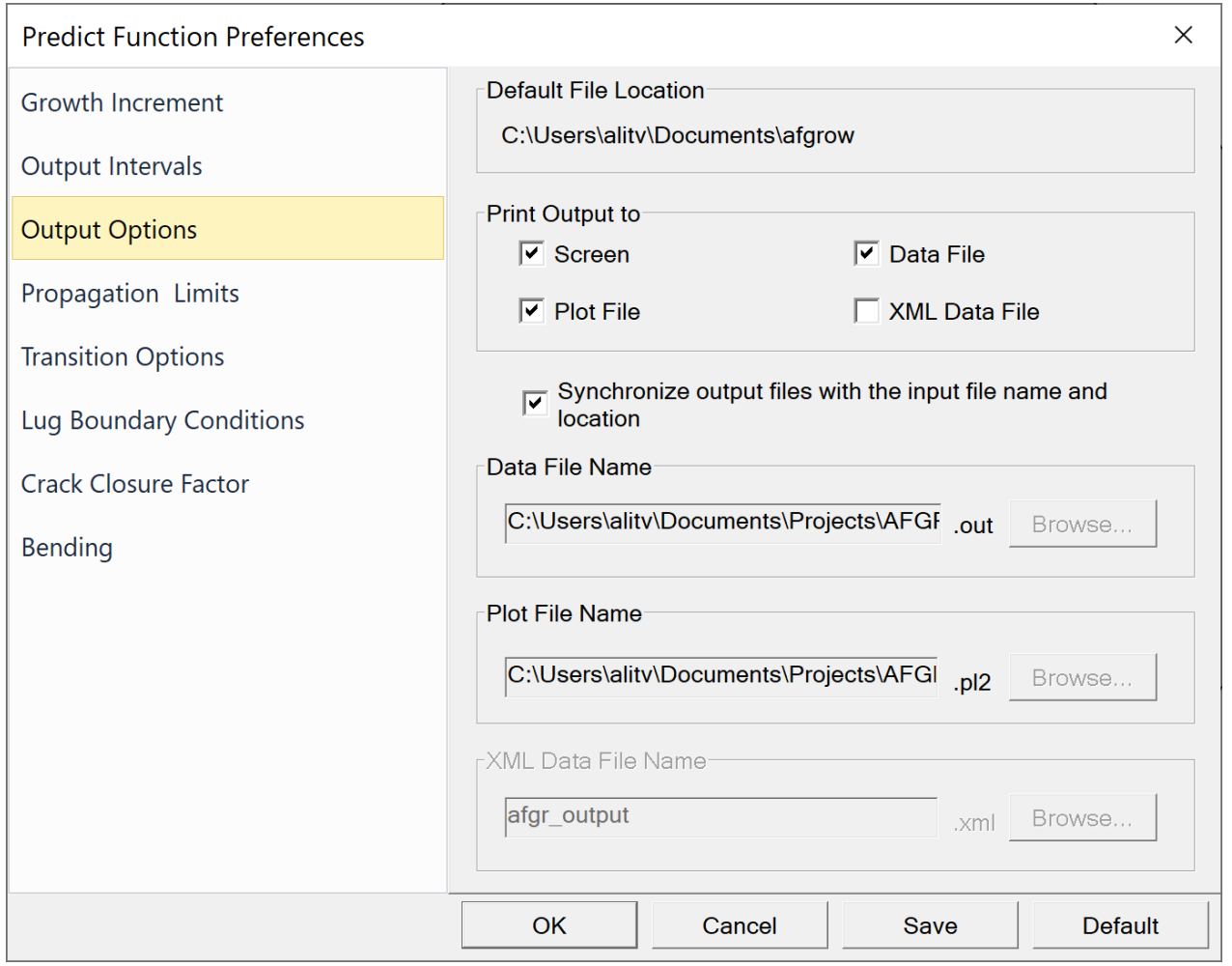
Local Material Database in the Tabular-Lookup format

- 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



Enhanced Output Preferences

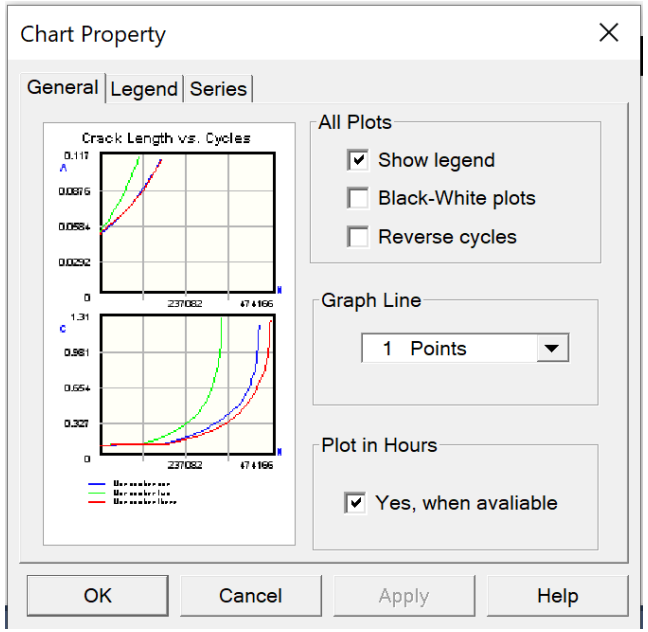
- Add a check box to put output file in the same folder as input file.
- Allow the for each output file type to have the same name as an input file.



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

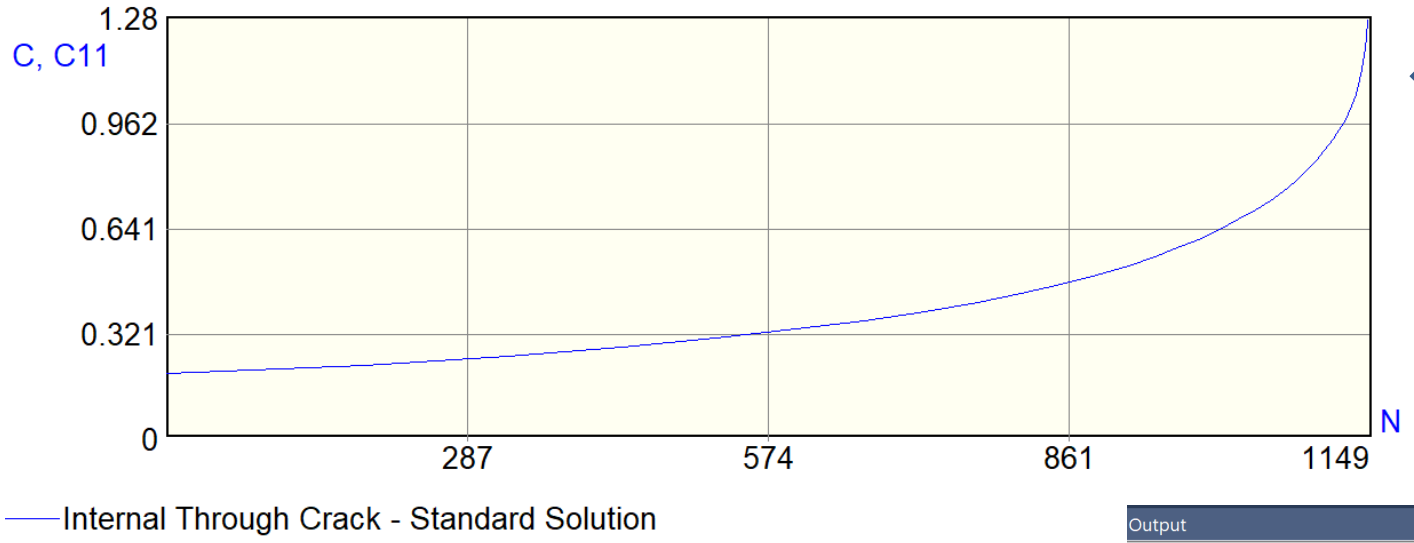
Print hours and cycles

```
C  Crack size=   1.089  Beta Tension= 1.2170 Beta Compression= 1.2170  R(k)= 0.0000 R(final)= 0.0000        Delta k=3.1513e+01  D()/DN=3.0626e-04
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        Delta k=3.2816e+01  D()/DN=4.4571e-04
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        Delta k=3.3463e+01  D()/DN=5.5443e-04
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        Delta k=3.6095e+01  D()/DN=2.1559e-03
Max stress =   14.000  r = 0.00     57400  Cycles  Subspectra:      0  Pass:  575   Hours: 1148
```



- 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

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          Delta k=3.1513e+01  D()/DN=3.0626e-04
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          Delta k=3.2816e+01  D()/DN=4.4571e-04
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          Delta k=3.3463e+01  D()/DN=5.5443e-04
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          Delta k=3.6095e+01  D()/DN=2.1559e-03
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          Delta k=3.8429e+01  D()/DN=1.0000e-02
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
```

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Questions