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AFGROW.NET

AFGROW Workshop 2012

AFGROW Release 5.2

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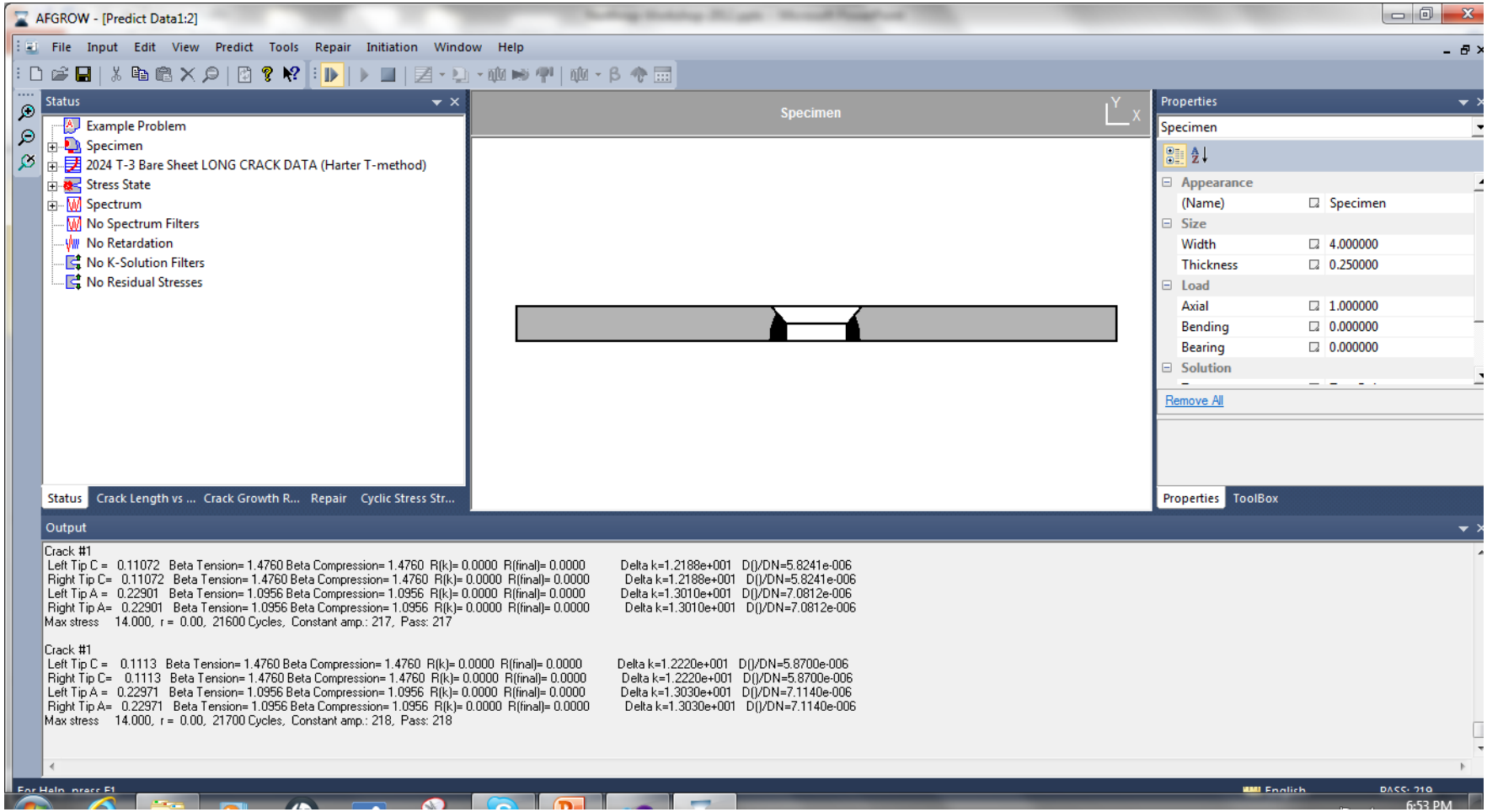
LexTech, Inc

New Release

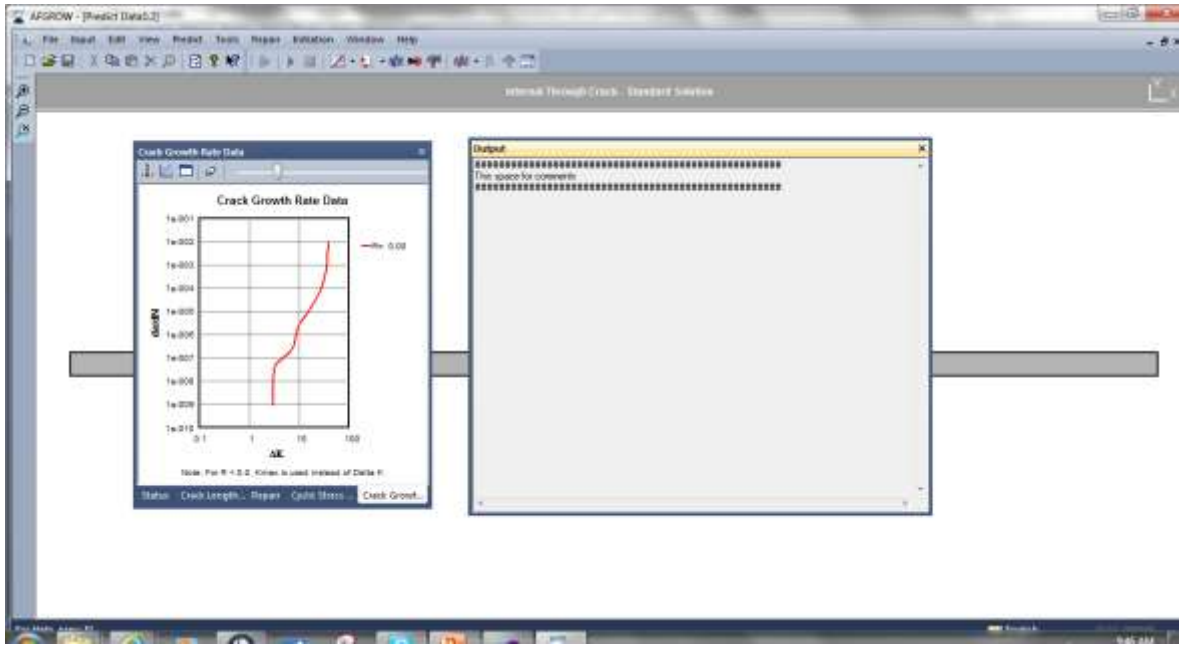
- Extended Advanced Model Solution for Corner Cracks at a Hole to Handle Small Cracks – 100%
- Updated Solution for a Single Through Crack at a Hole Under Bearing Load – 100%
- Improved Offset Correction for Cracks at Holes Under Bearing Load – 100%
- Multi-Channel Spectrum Format – 75%
- Spectrum Tool – 90%
- Warning Messages When K-Solution Limits are Exceeded – 50%
- ~~Ability to Replicate Results From Previous Versions (back to Version 5.01)~~
- Expanded Input Table Size (virtually unlimited) – 75%
- ~~Option to Save Input File With Retardation State Data for Later Restart~~
- Improved COM and Plug-In Interface – 75%
- New GUI – 95%
- Corner Crack at a Countersunk Hole Solution – 90%
- Beta Sub-R – 100%
- Complete Beta Correction Capability for Advanced Models – 60%
- Fix known bugs – 80%
- Create new AFGROW installation

NEW GUI

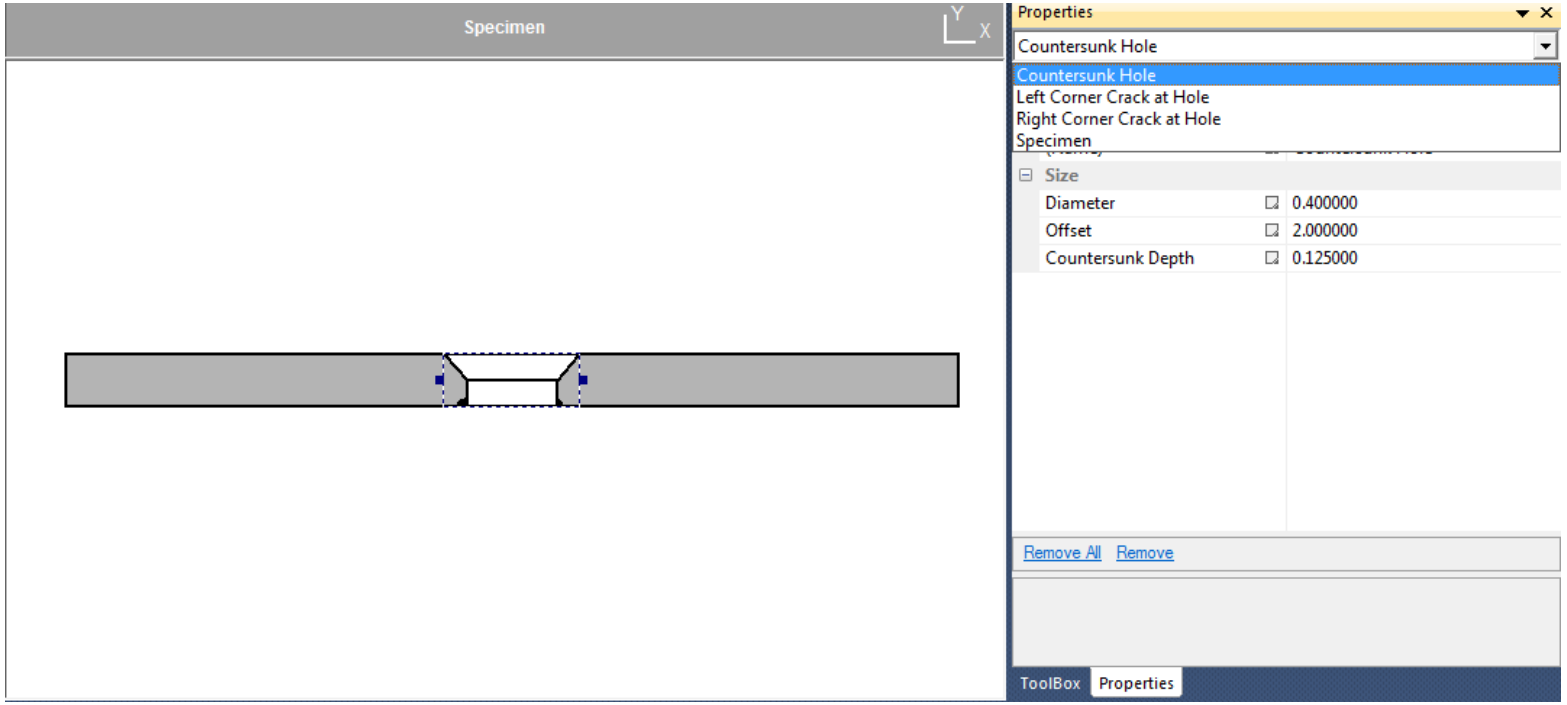

AFGROW - [Predict Data1:2]
File Input Edit View Predict Tools Repair Initiation Window Help
Status
Example Problem
Specimen
2024 T-3 Bare Sheet LONG CRACK DATA (Harter T-method)
Stress State
Spectrum
No Spectrum Filters
No Retardation
No K-Solution Filters
No Residual Stresses
Status Crack Length vs ... Crack Growth R... Repair Cyclic Stress Str...
Specimen
Properties
Specimen
Appearance
(Name) Specimen
Size
Width 4.000000
Thickness 0.250000
Load
Axial 1.000000
Bending 0.000000
Bearing 0.000000
Solution
Remove All
Properties ToolBox
Output
Crack #1
Left Tip C = 0.11072 Beta Tension= 1.4760 Beta Compression= 1.4760 R(k)= 0.0000 R(final)= 0.0000 Delta k=1.2188e+001 D()/DN=5.8241e-006
Right Tip C= 0.11072 Beta Tension= 1.4760 Beta Compression= 1.4760 R(k)= 0.0000 R(final)= 0.0000 Delta k=1.2188e+001 D()/DN=5.8241e-006
Left Tip A = 0.22901 Beta Tension= 1.0956 Beta Compression= 1.0956 R(k)= 0.0000 R(final)= 0.0000 Delta k=1.3010e+001 D()/DN=7.0812e-006
Right Tip A= 0.22901 Beta Tension= 1.0956 Beta Compression= 1.0956 R(k)= 0.0000 R(final)= 0.0000 Delta k=1.3010e+001 D()/DN=7.0812e-006
Max stress 14.000, r = 0.00, 21600 Cycles, Constant amp.: 217, Pass: 217
Crack #1
Left Tip C = 0.1113 Beta Tension= 1.4760 Beta Compression= 1.4760 R(k)= 0.0000 R(final)= 0.0000 Delta k=1.2220e+001 D()/DN=5.8700e-006
Right Tip C= 0.1113 Beta Tension= 1.4760 Beta Compression= 1.4760 R(k)= 0.0000 R(final)= 0.0000 Delta k=1.2220e+001 D()/DN=5.8700e-006
Left Tip A = 0.22971 Beta Tension= 1.0956 Beta Compression= 1.0956 R(k)= 0.0000 R(final)= 0.0000 Delta k=1.3030e+001 D()/DN=7.1140e-006
Right Tip A= 0.22971 Beta Tension= 1.0956 Beta Compression= 1.0956 R(k)= 0.0000 R(final)= 0.0000 Delta k=1.3030e+001 D()/DN=7.1140e-006
Max stress 14.000, r = 0.00, 21700 Cycles, Constant amp.: 218, Pass: 218

Output Frame – Copy and Paste

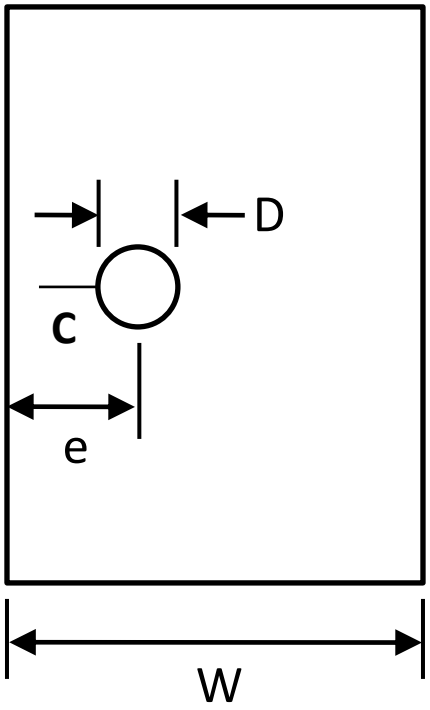
Floating Dockable Views

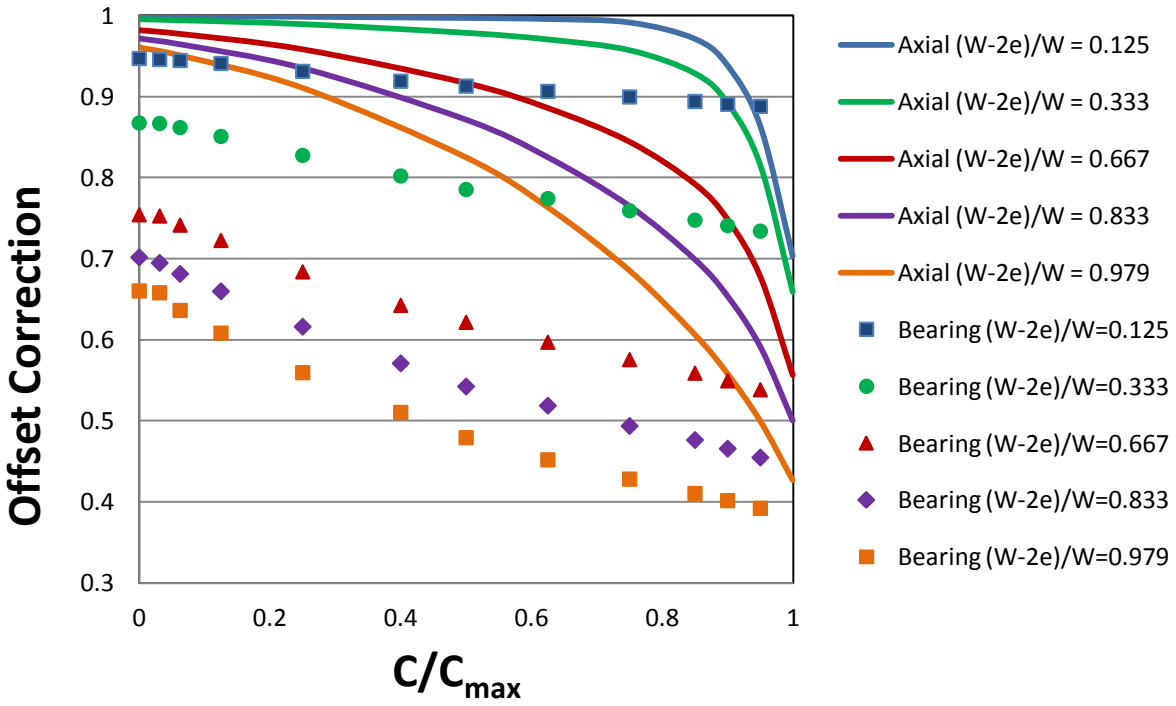


Advanced Model – Switch Objects



New Offset Hole Solution
Bearing Load Case





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Solution Matrix

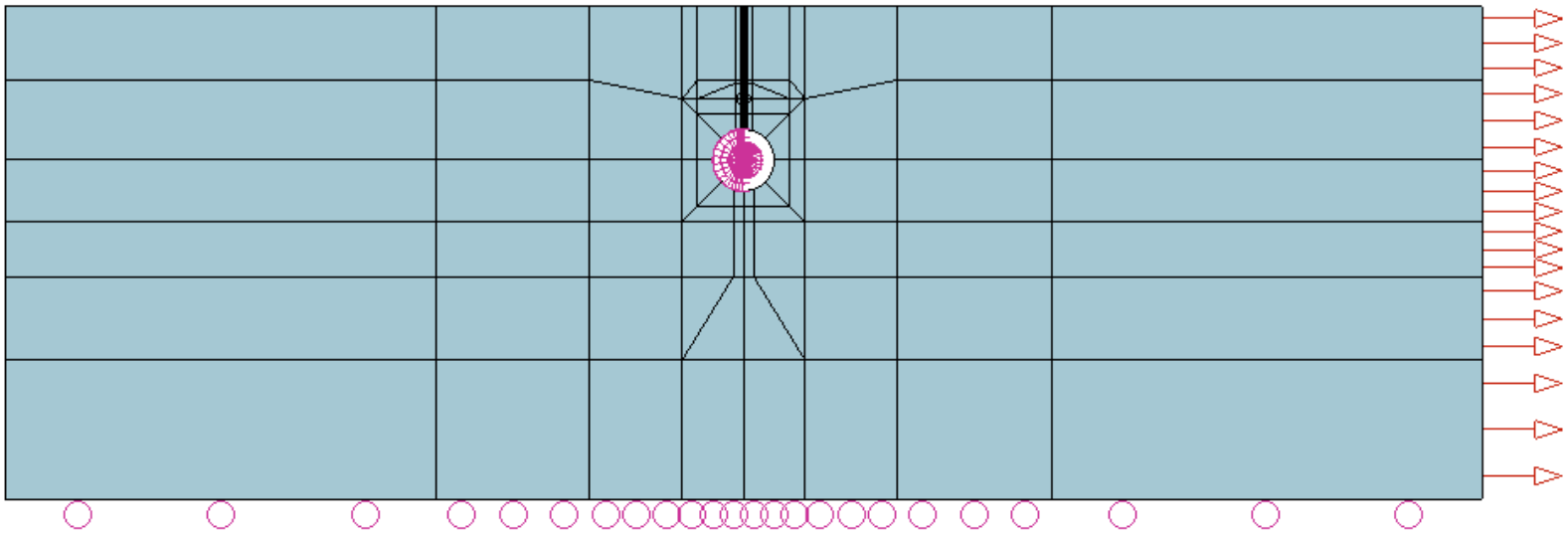
e/D: 0.75, 1, 2, 4, 8, 16

(W-2e)/W: 0.125, 0.25. 0.333, 0.667, 0.833, 0.918, 0.958, 0.979

C/C_{max}: 0 to 0.95

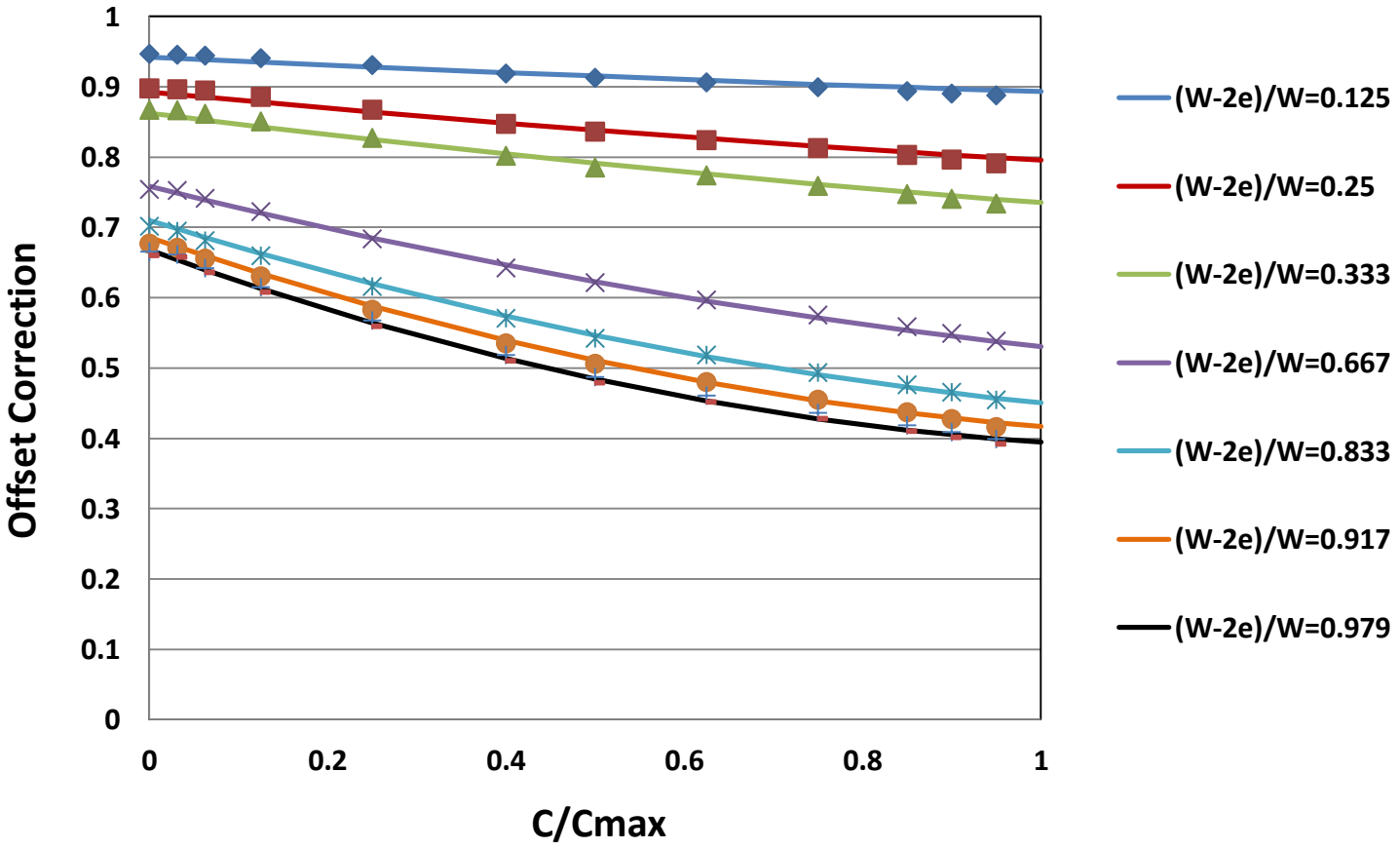
Note: The zero crack length correction was determined by the ratio of the local K_T values

FEM* Boundary Conditions

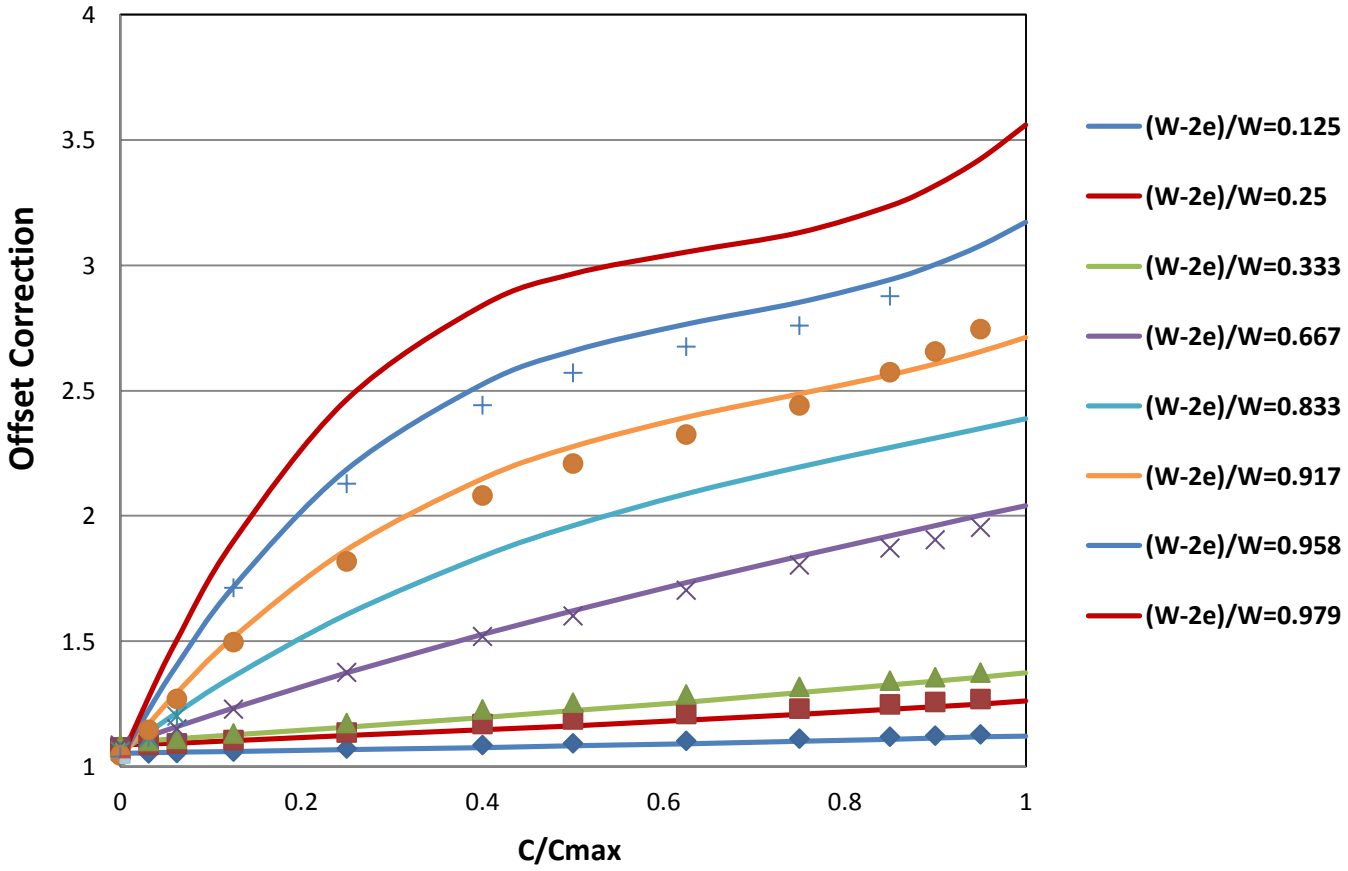


Model Thickness = 1.0
Loading to produce a unit resultant force at the hole (1/W)
Spring (E_{Spring} = 3X E_{Plate}) B.C. along ½ hole

Near Edge Offset Correction
e/D = 2



Far Edge Offset Correction
e/D = 2



Advanced Model Solution Approach for Small Cracks (a/t < 0.1)

 - Single Corner at a Hole

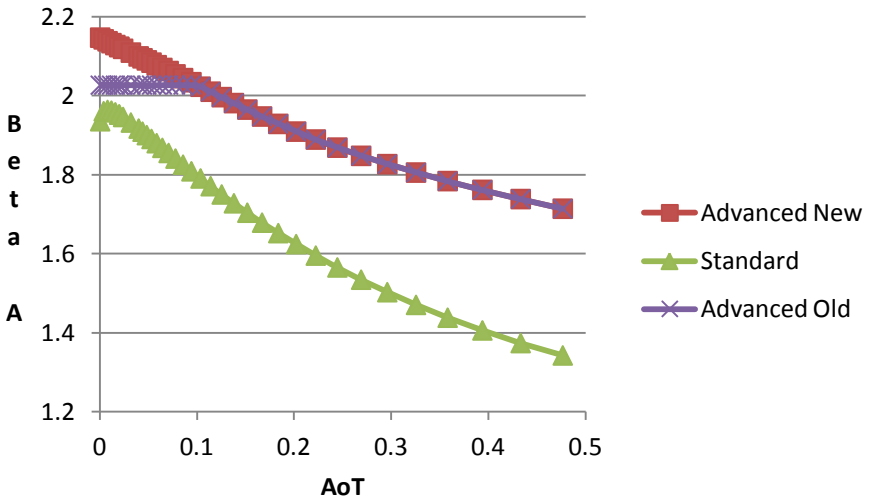
 - Double Corner at a Hole

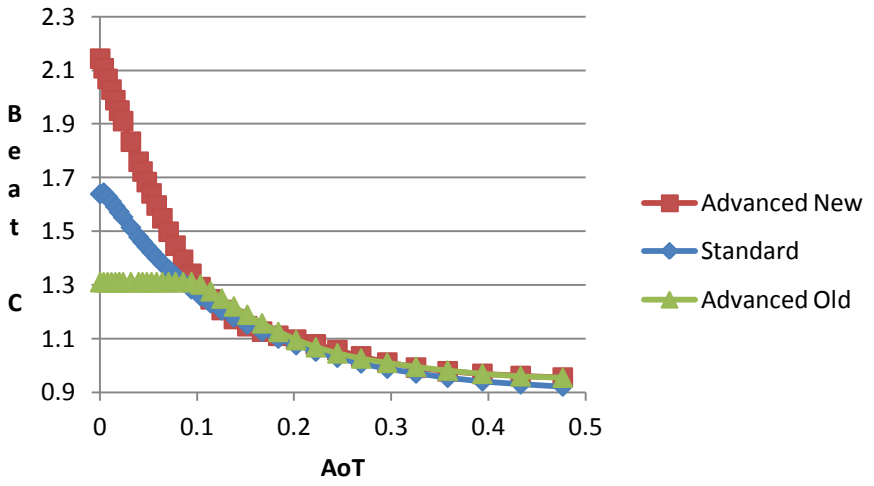
As the crack length goes to zero, the beta for both crack growth directions converge to :

$$\beta = 1.122\ K_t \frac{2}{\pi}$$

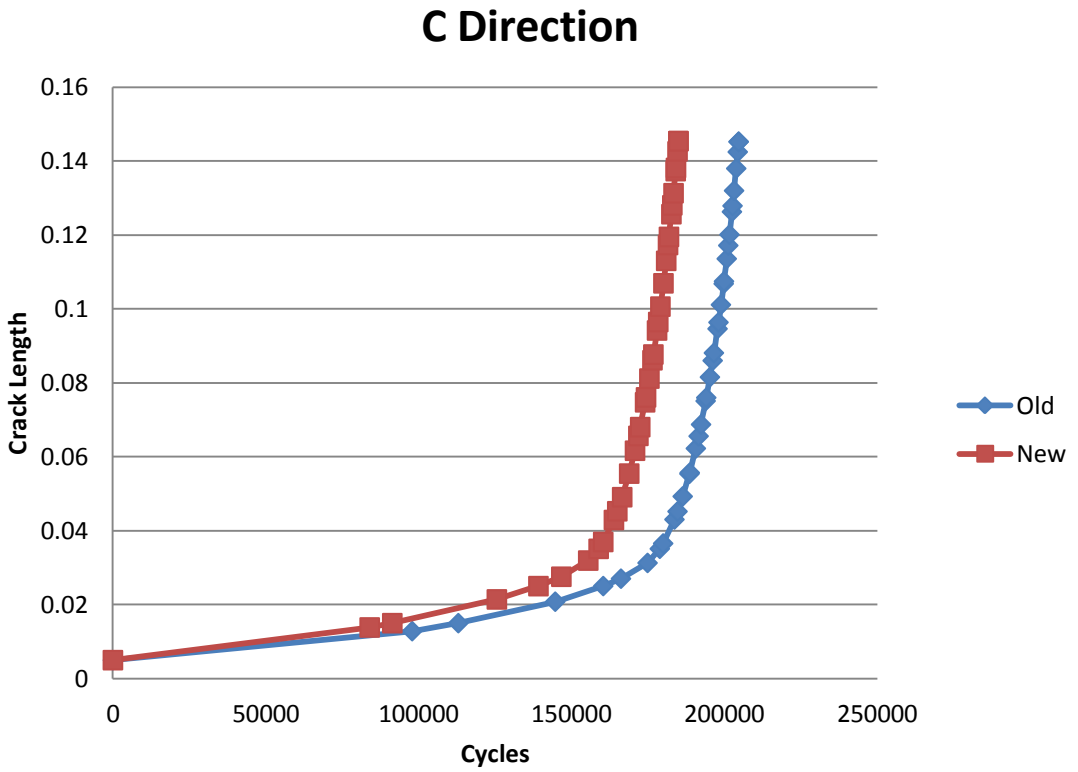
Tension and Bending = 2.142, Bearing = 0.625 (W/D = 100, same as Fawaz/Andersen)

Advanced Corner Cracked Hole Model (Small Crack Beta Values)





Advanced Corner Cracked Hole Model (Small Crack Life Comparison)

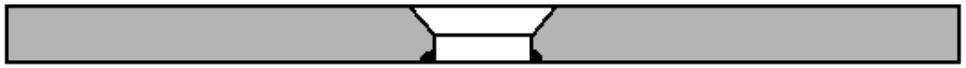


Countersunk Hole Solution

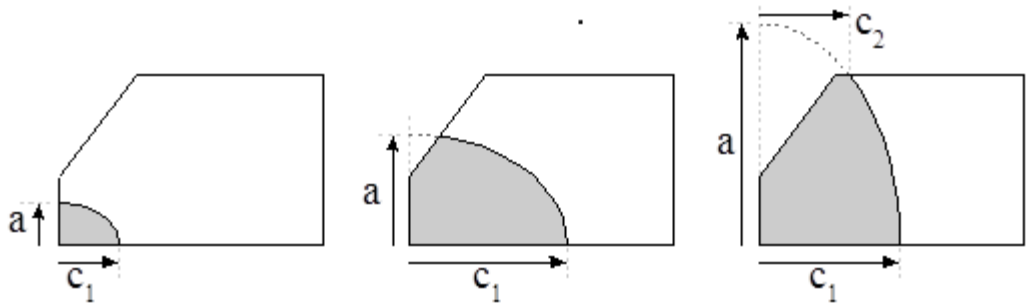
- Base on PHD thesis of the Reinier de Rijck
- Bending, Tension ad Bearing Solutions for the symmetric corner crack

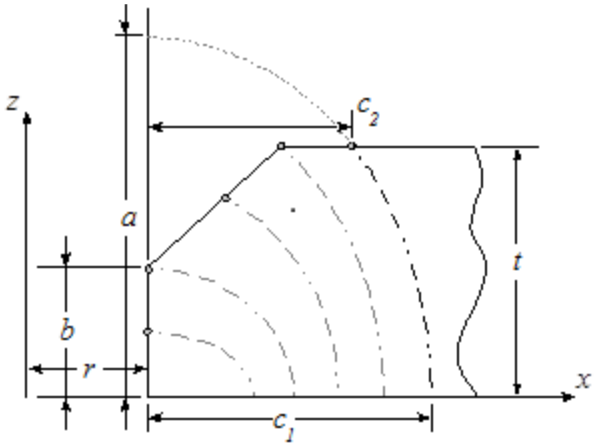
- Centered or offset hole with single corner crack

- Centered hole with symmetric double corner crack



Countersink Dimensions





Countersunk Solution Workspace

Countersink Angle – 100 Degrees

Depth to Thickness Ratios (B/T)
0.05, 0.25, 0.5

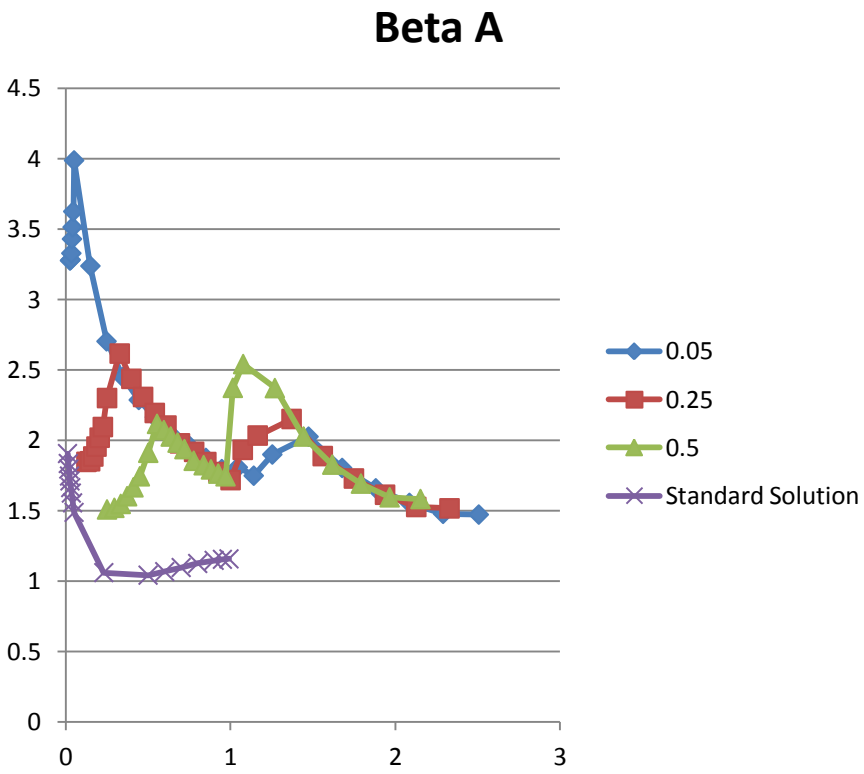
Virtual Crack Depth to Thickness Ratios (A/T)
0.025, 0.0294467, 0.0333167, 0.0371867, 0.0410568, 0.0449268, 0.05, 0.149025, 0.24687, 0.344714, 0.442559, 0.540403, 0.646563, 0.752822, 0.849658, 0.946494, 1.04333, 1.14017, 1.25287, 1.47261, 1.6767, 1.8808, 2.0849, 2.28899, 2.50574

Crack Depth to Crack Length Ratios (A/C)
0.5, 0.67, 0.75, 1., 1.5, 2., 5.

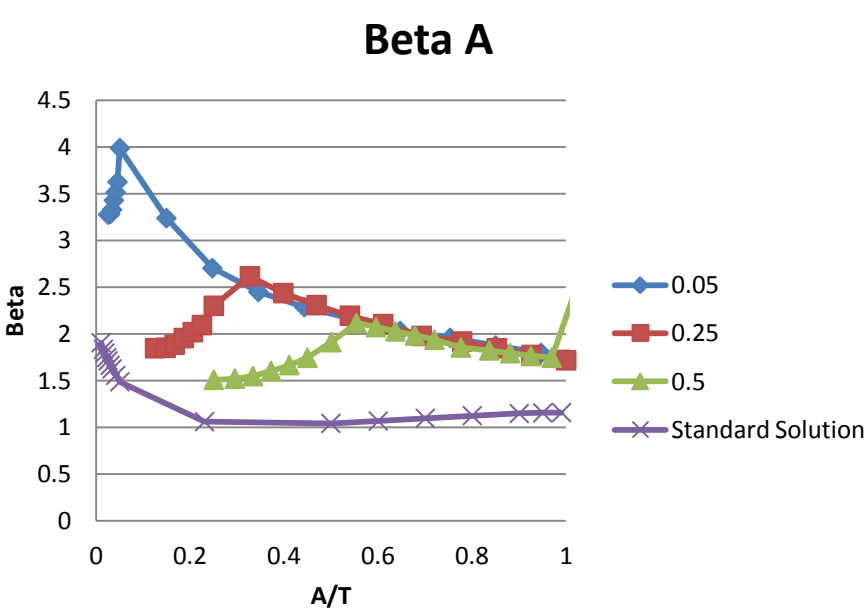
Hole Radius to Thickness Ratios (R/T)
0.1, 0.25, 0.5,0.67, 1.0, 1.2, 1.5, 2.0, 2.4

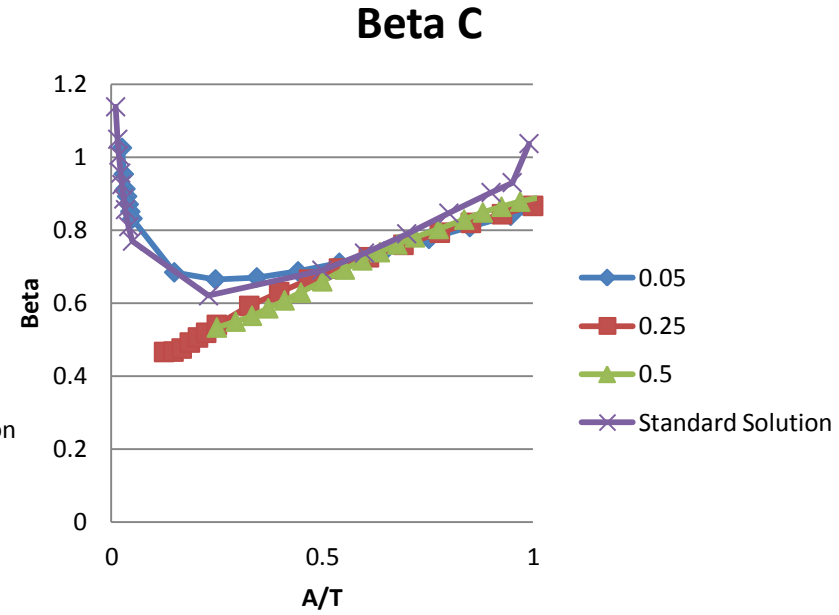
Countersunk Hole Transitions

- Through the knuckle
- To an oblique crack
- To a through crack



Countersunk Solution Betas





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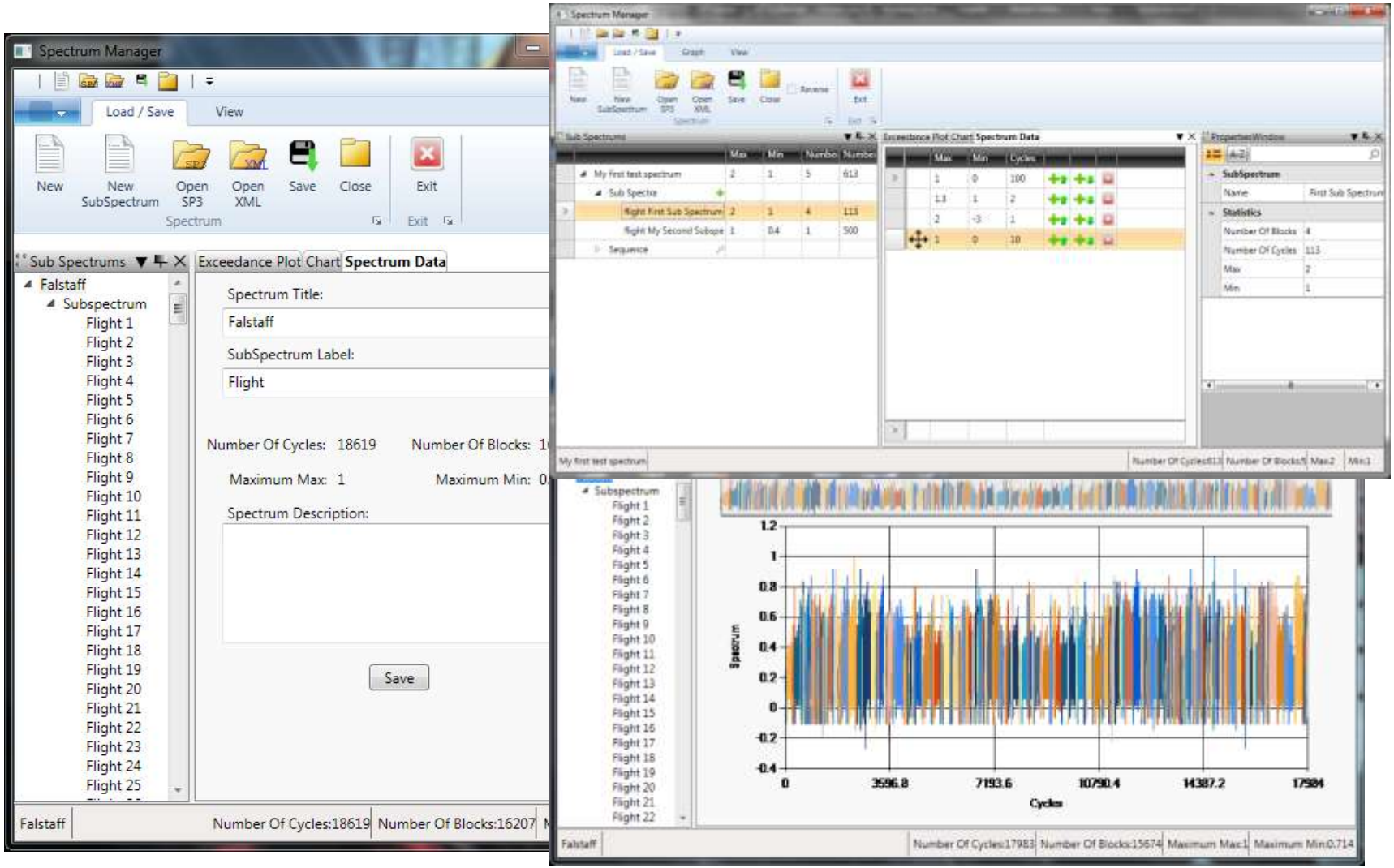
Spectrum Tool



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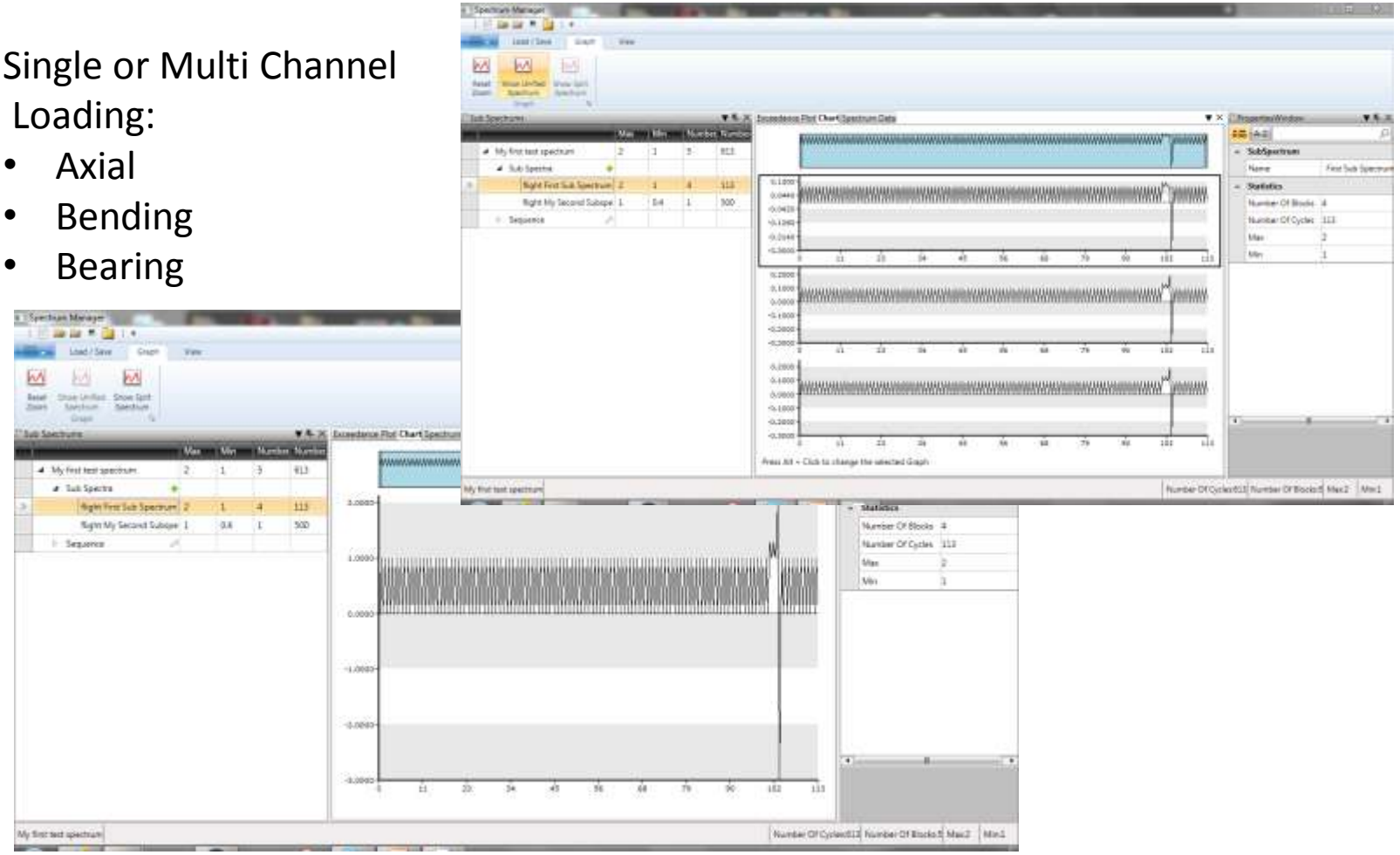
Spectrum Tool

Single or Multi Channel Loading:

- Axial
- Bending
- Bearing



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Spectrum Tool

- Visual spectrum design
- Spectrum Statistics at a glance
- Clipping
- Truncation
- Spectrum reversal (flip Min with Max, requested by Northrop)
- Spectrum level reordering
- Copy-Paste from Excel
- Sub spectra re-ordering
- Plug-able architecture – will help handling /convert different spectrum formats

Crack Closure Factor

- Why do we have it?
- Applied only on a crack at the open edge surface
- Added to standard, user defined, advanced and plug-in k solutions

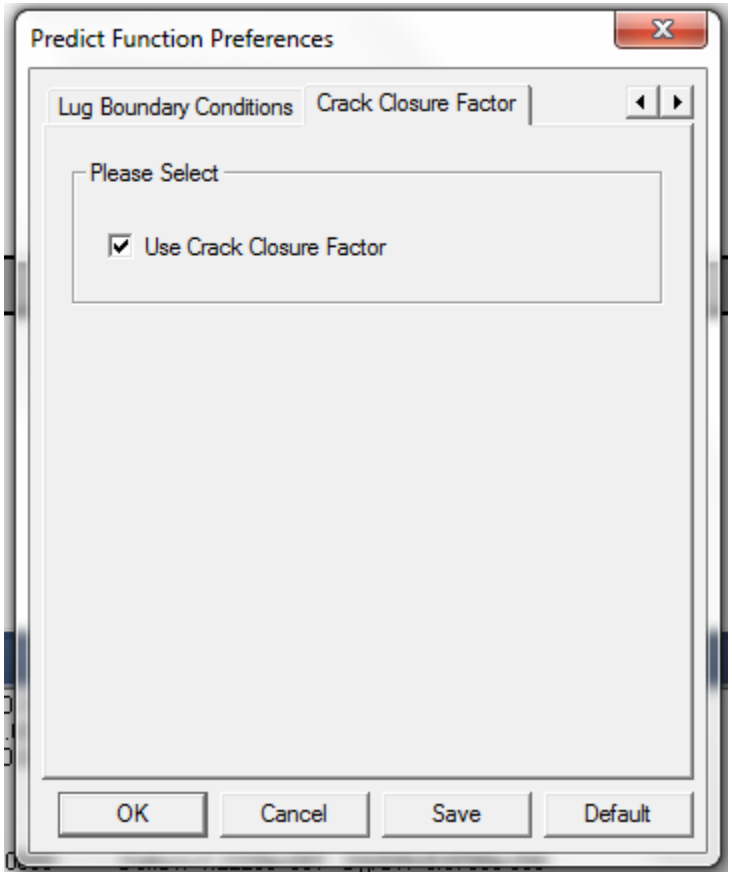
$$K = \beta_r * \sigma\sqrt{Length * \pi} * \beta$$

if $R = 0$
then

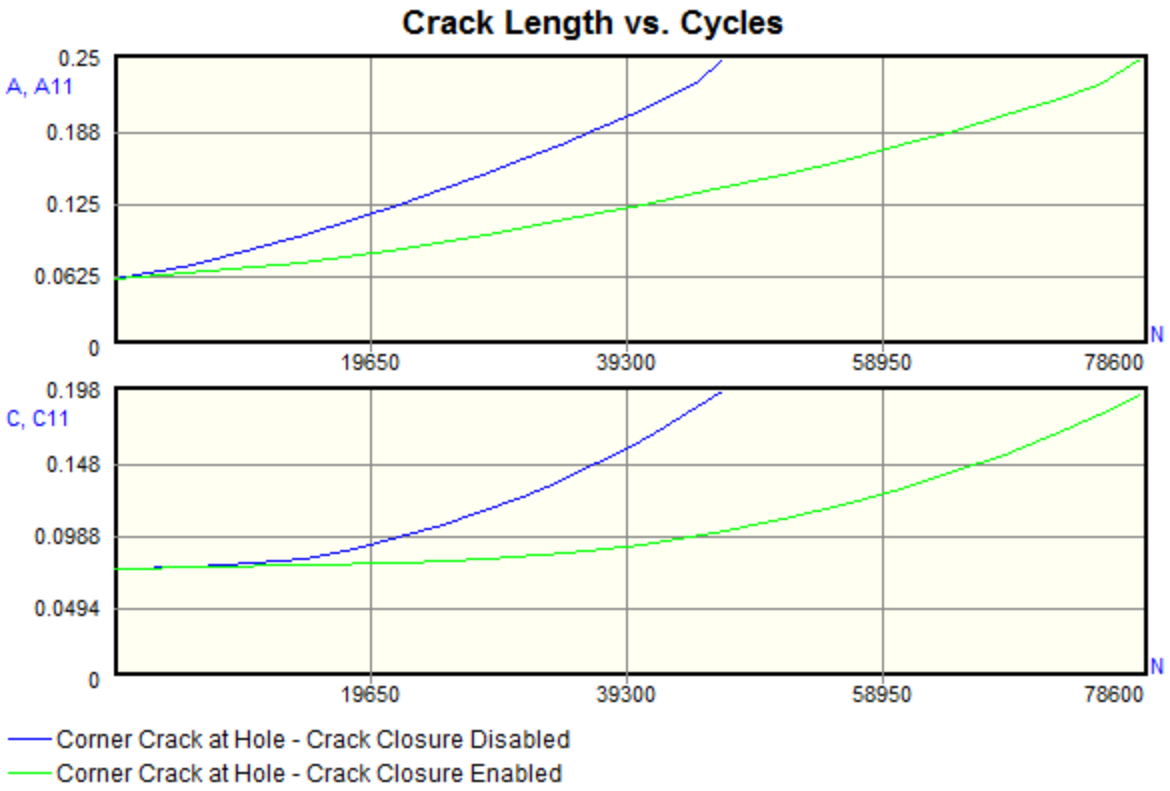
$$\beta_r = 0.9$$

else

$$\beta_r = 0.9 + 0.2 * R^2 - 0.1 R^4$$



Crack Closure Factor



COM and Plug-in API changes

- Add FileName Property to the plug-in API
- Add option to get access to the COM Automation API from plugin API
- Add ability to set NASGRO model parameters through the COM API
- Add ability to display a bitmap in the AFROW plot window using plugin API
- Add ability to do not place exclusive lock on the data data files

Customers

Advanced Technologies Incorporated
Air Force Research Laboratory
Air Spray Aviation Services
Airwork
Airworks
Altep
Australian Aerospace
Australian Department of Defense
Bell Helicopter
Caterpillar Inc.
Cessna
Circor Aerospace
Creare
DART Aerospace
Delta Engineering
European Science Foundation
Honda Aerospace
Gulfstream
Italian Air Force
Instytut Techniczny Wojsk Lotniczych /ITWL
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Institute for Materials Applications in Mechanical Engineering
Japan Aerospace Exploration Agency
Kalitta Air, LLC
L-3
Live TV
Lockheed Martin
Marshall Aerospace
Micro Craft, Inc.
MIT
Mitre
NASA
Naval Academy
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P.B. Engineering Inc.
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Precision Engineering LLC
Raytheon
SAFE, Inc.
SwRI
TanBeräkning AB
Tenaris
Tcagi
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The University of Utah
Virginia Tech
VZLU - Aeronautical Research & Test Institute
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Questions