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AFGROW.NET

Northrop – Grumman Workshop 2012

AFGROW

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Overview

- About AGROW
- New features in the upcoming AFGROW release 5.2
- New features in release 5.3
- Q&A

About AFGROW

AFGROW is a Damage Tolerance Analysis (DTA) framework that allows users to analyze crack initiation, fatigue crack growth, and fracture to predict the life of metallic structures.

http://www.afgrow.net http://www.facebook.com/afgrow

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Customers

Advanced Technologies Incorporated
Air Force Research Laboratory
Air Spray Aviation Services
Altep
Australian Aerospace
Australian Department of Defense
Bell Helicopter
Caterpillar Inc.
Cessna
Circor Aerospace
Creare
DART Aerospace
Delta Engineering
European Science Foundation
Gulfstream
Italian Air Force
Instytut Techniczny Wojsk Lotniczych /ITWL
ITT
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
Northrop Grumman
NRC Institute for Aerospace Research
NTSB
Ogden Air Logistics Center
PACS Engineering
P.B. Engineering Inc.
Pilatus Aircraft Ltd
Precision Engineering LLC
Raytheon
TanBeräkning AB
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Tcagi
Textron India
Triumph Group, Inc
TUI Airlines
United States Air Force Academy
University of Ulsan
The University of Utah
Virginia Tech
VZLU - Aeronautical Research & Test Institute
Western Avionics
Wyle

New Release

- Extended Advanced Model Solution for Corner Cracks at a Hole to Handle Small Cracks
- Updated Solution for a Single Through Crack at a Hole Under Bearing Load
- Improved Offset Correction for Cracks at Holes Under Bearing Load
- Multi-Channel Spectrum Format
- Spectrum Tool
- Warning Messages When K-Solution Limits are Exceeded
- ~~Ability to Replicate Results From Previous Versions (back to Version 5.01)~~
- Expanded Input Table Size (virtually unlimited)
- ~~Option to Save Input File With Retardation State Data for Later Restart~~
- Improved COM and Plug-In Interface
- New GUI
- Corner Crack at a Countersunk Hole Solution
- Beta Sub-R

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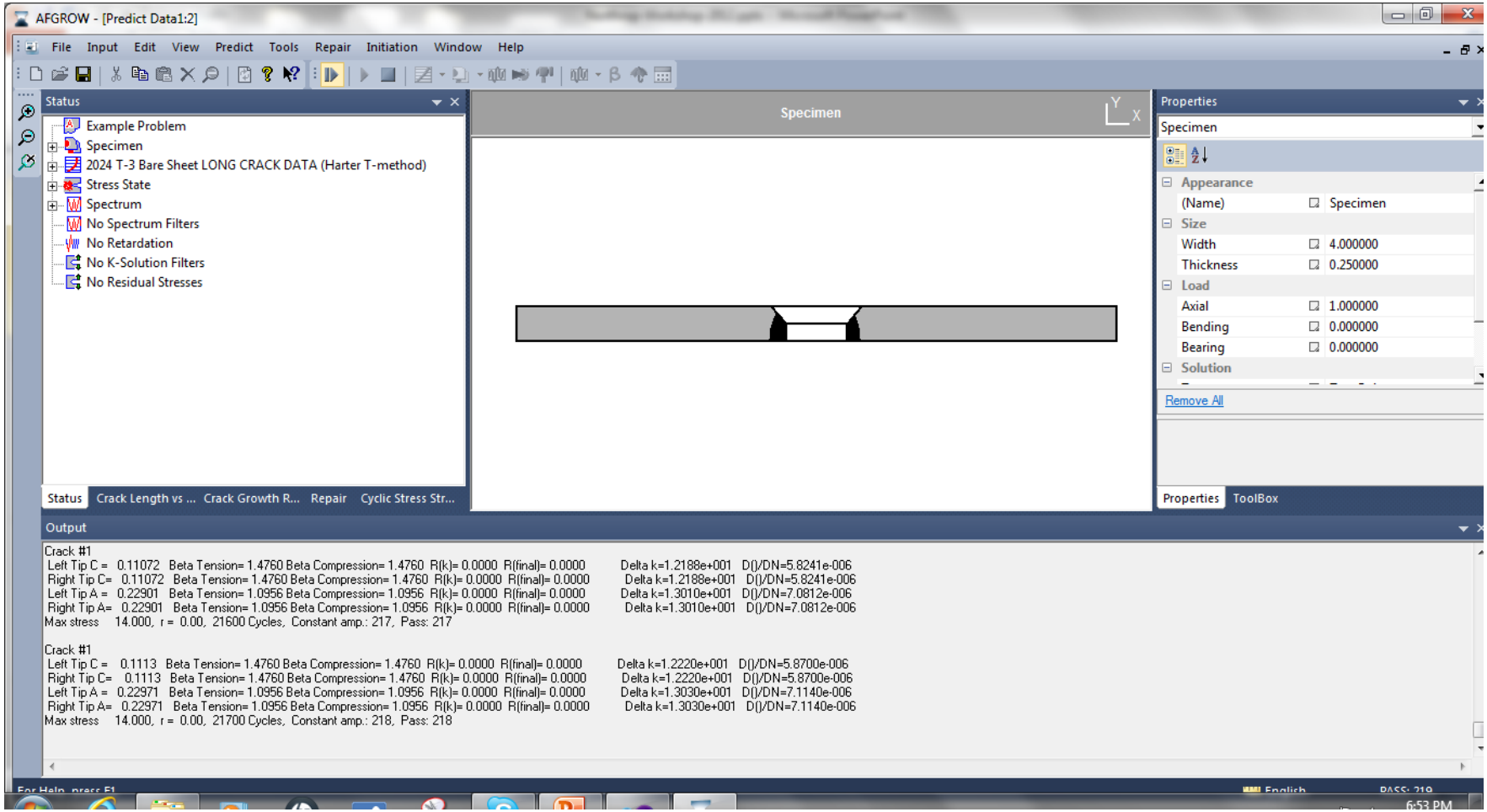
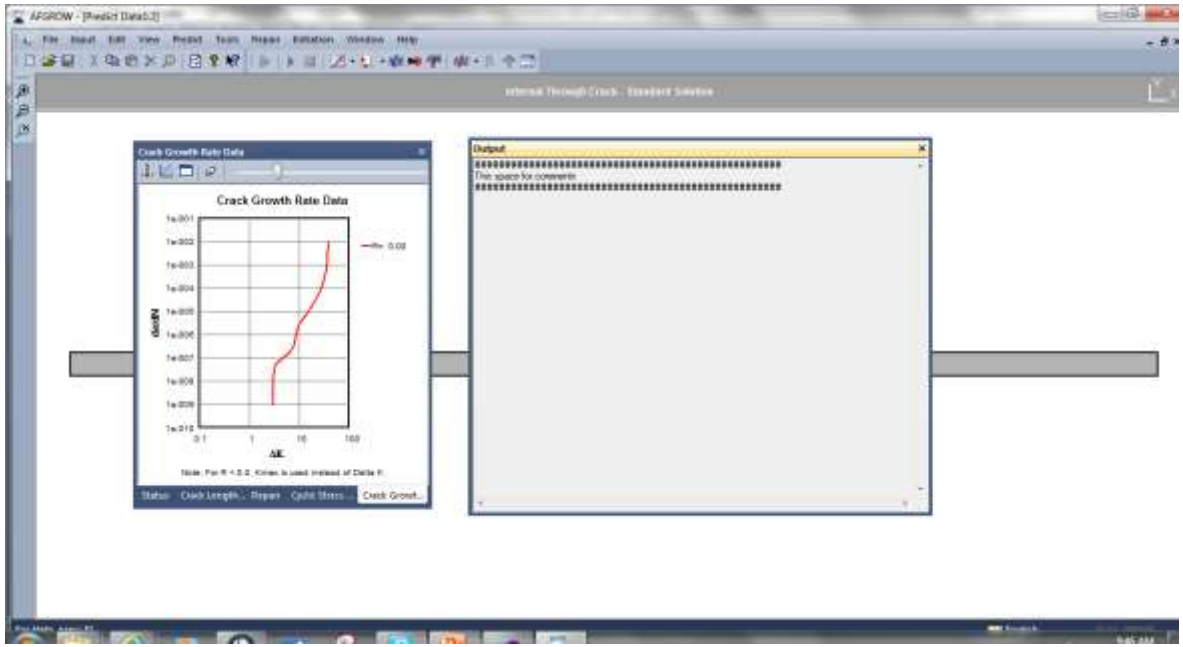
NEW GUI

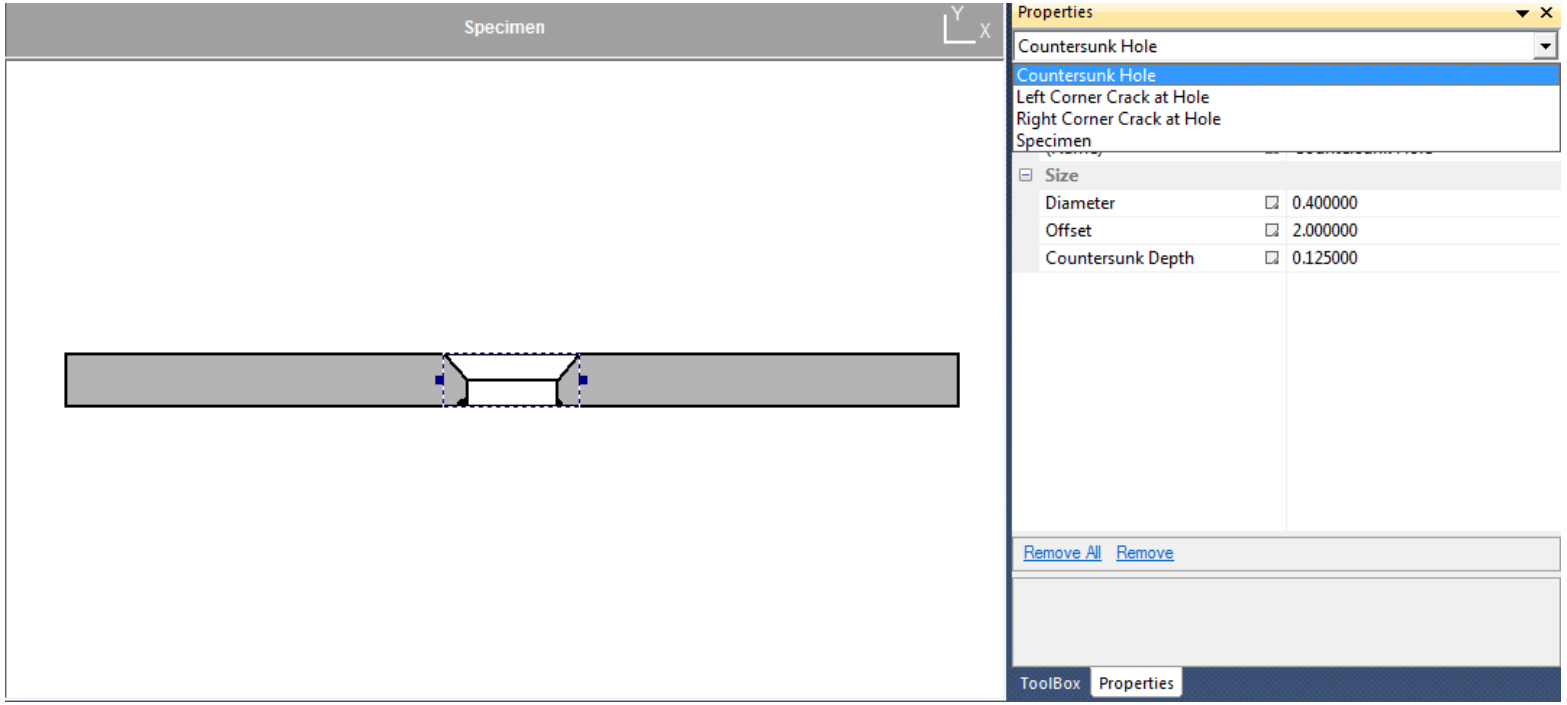


Output Frame – Copy and Paste

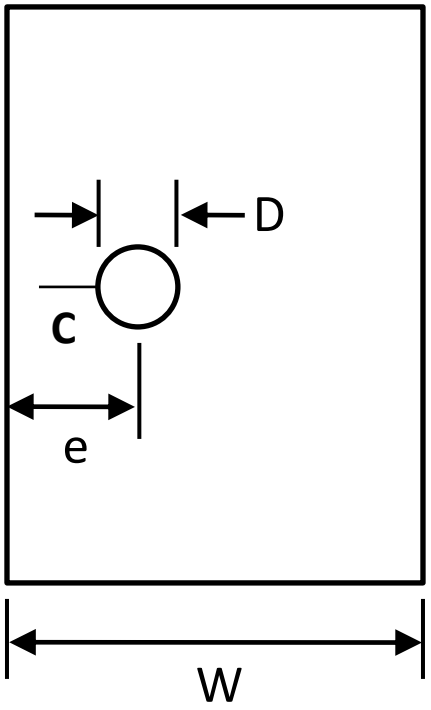
Floating Dockable Views

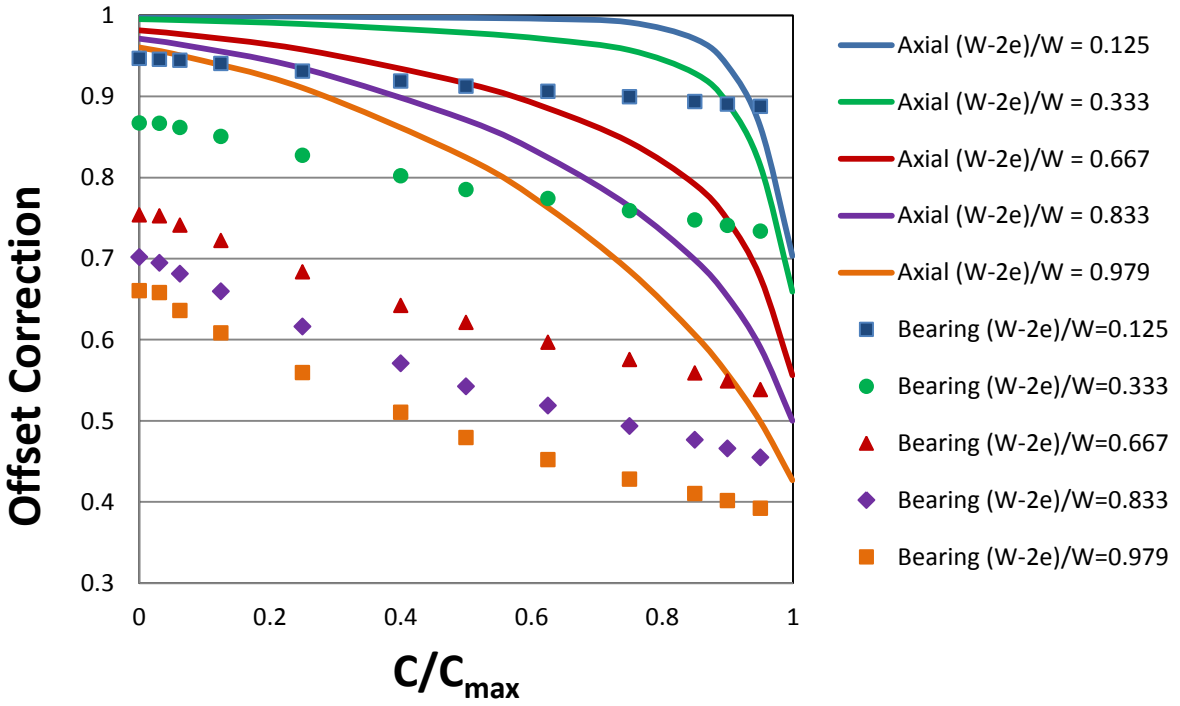


Advanced Model – Switch Objects



New Offset Hole Solution
Bearing Load Case





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Solution Matrix

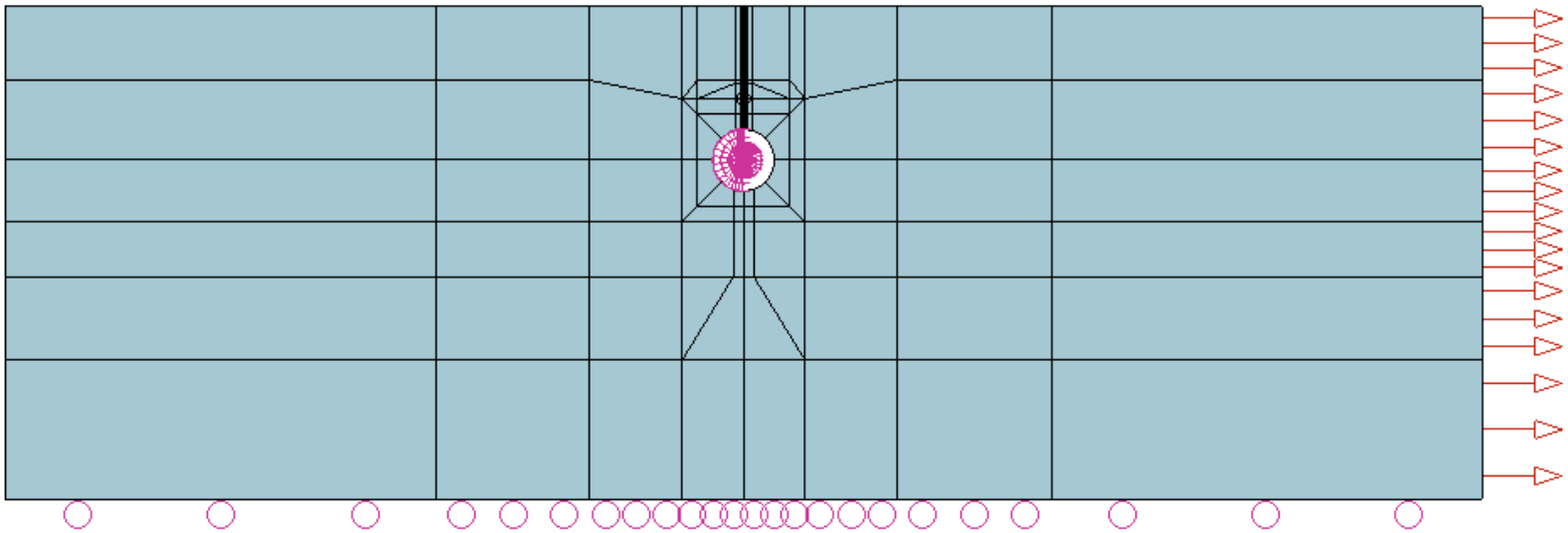
e/D: 0.75, 1, 2, 4, 8, 16

(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

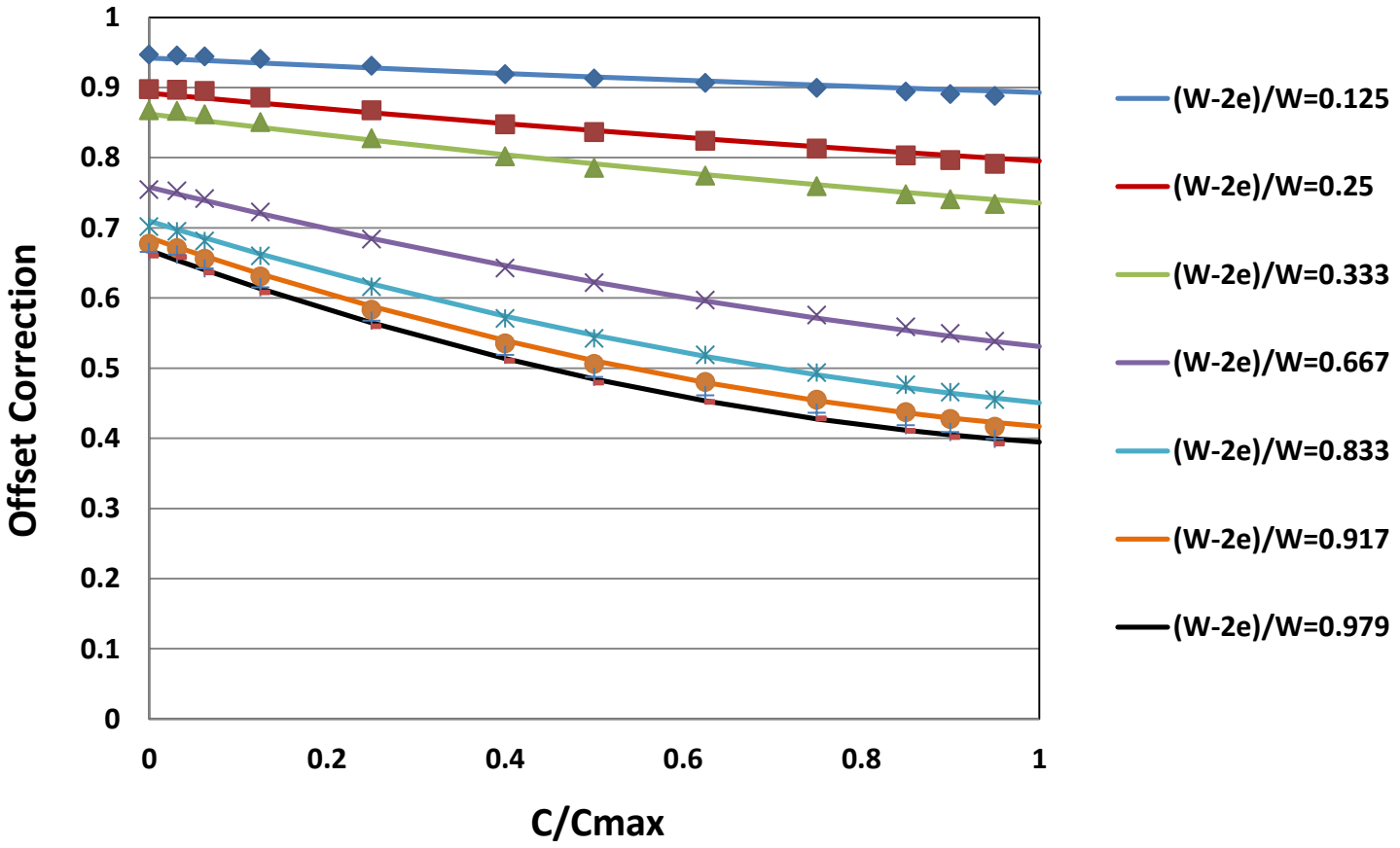
Note: The zero crack length correction was determined by the ratio of the local K_T values

FEM* Boundary Conditions

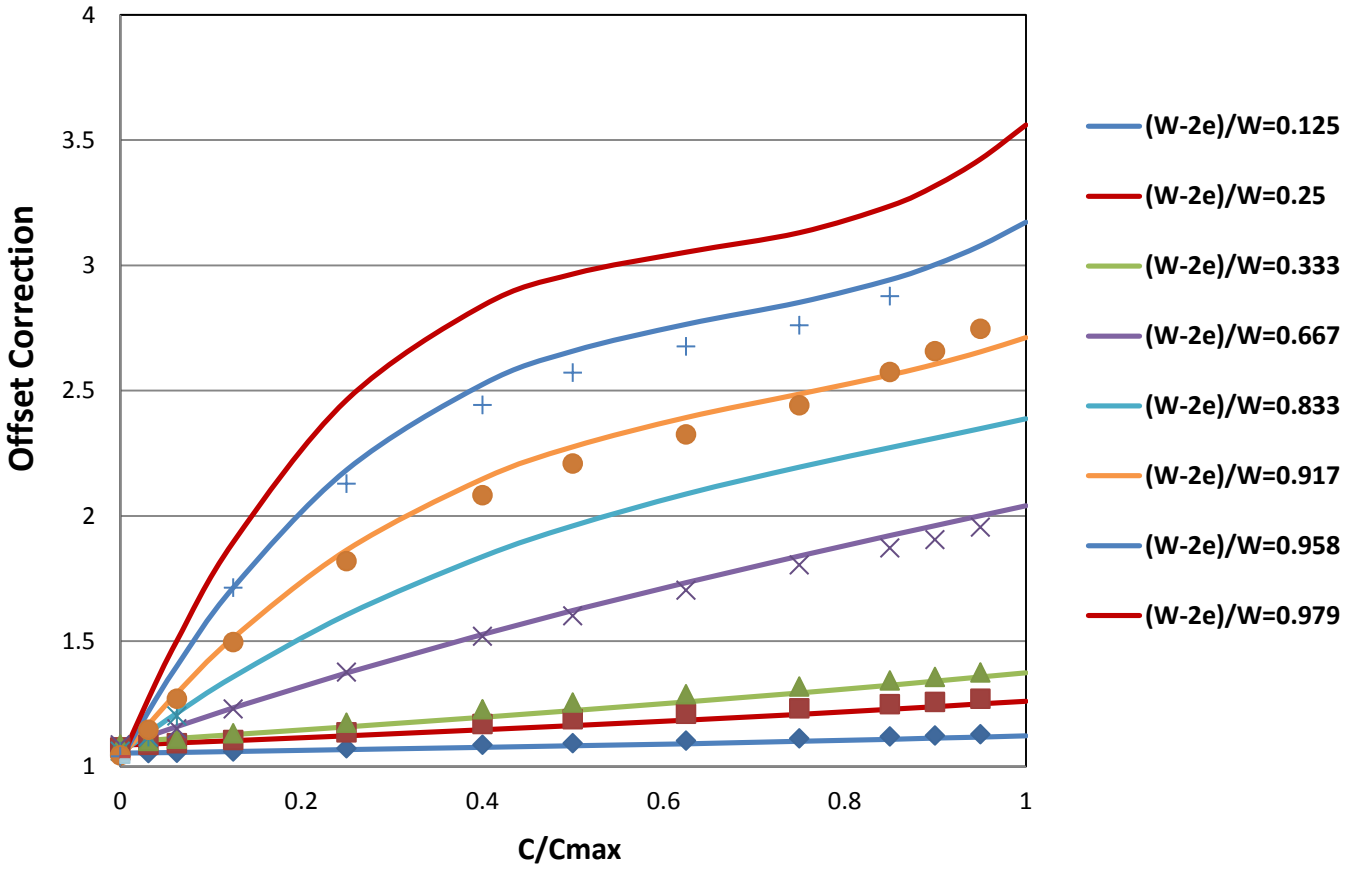


Model Thickness = 1.0
Loading to produce a unit resultant force at the hole (1/W)
Spring (E_{Spring} = 3X E_{Plate}) B.C. along ½ hole

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

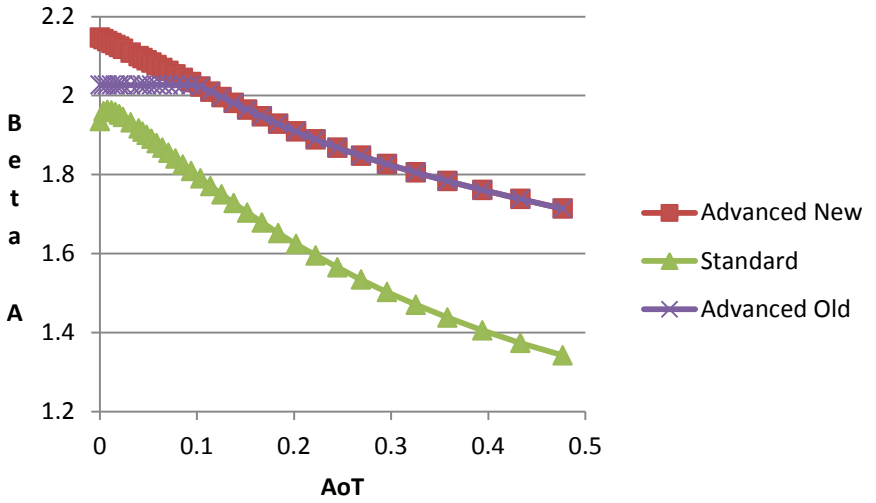
 - Double Corner at a Hole

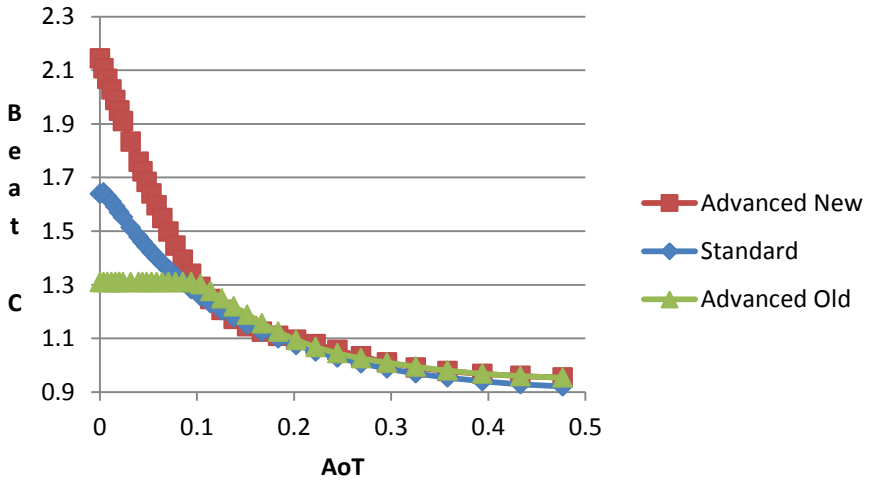
As the crack length goes to zero, the beta for both crack growth directions converge to :

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

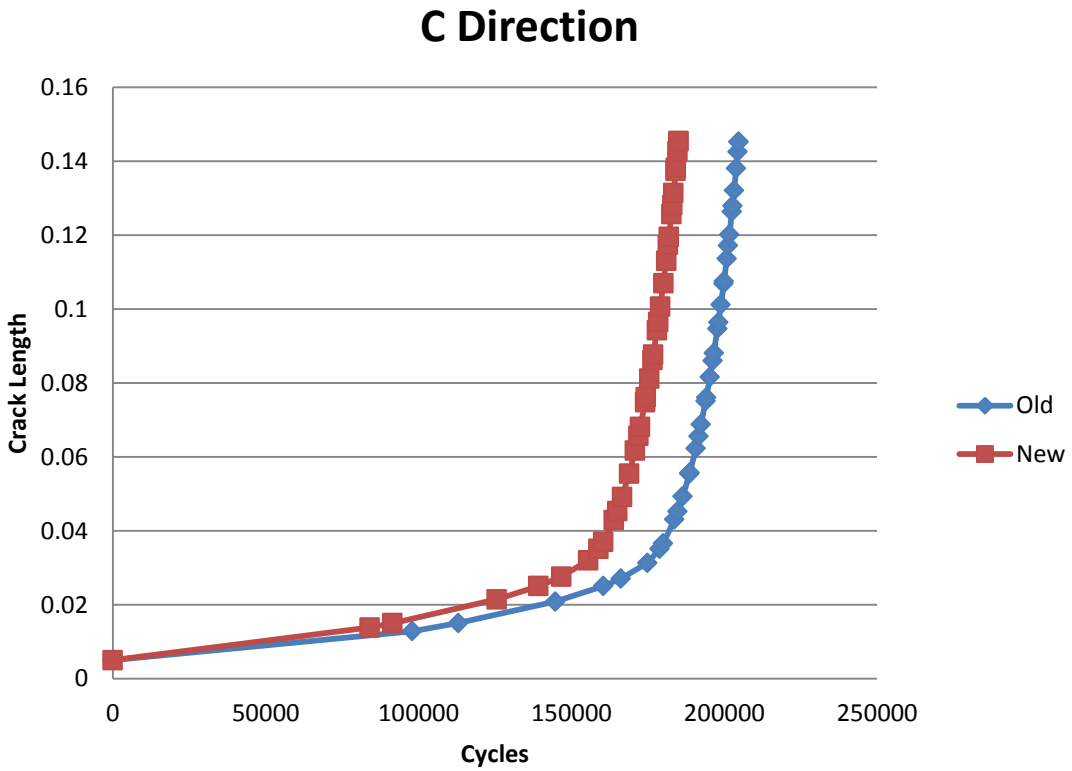
Tension and Bending = 2.142, Bearing = 0.625 (W/D = 100, same as Fawaz/Andersen)

Advanced Corner Cracked Hole Model (Small Crack Beta Values)





Advanced Corner Cracked Hole Model (Small Crack Life Comparison)

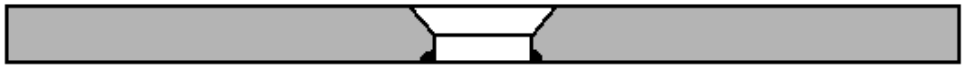


Countersunk Hole Solution

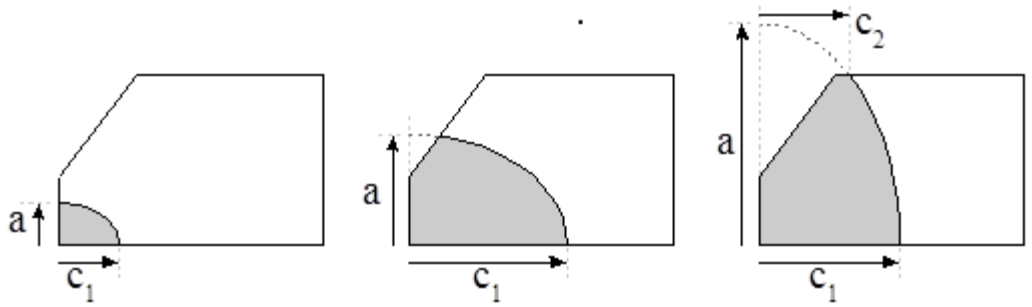
- Base on PHD thesis of the Reinier de Rijck
- Bending, Tension ad Bearing Solutions for the symmetric corner crack

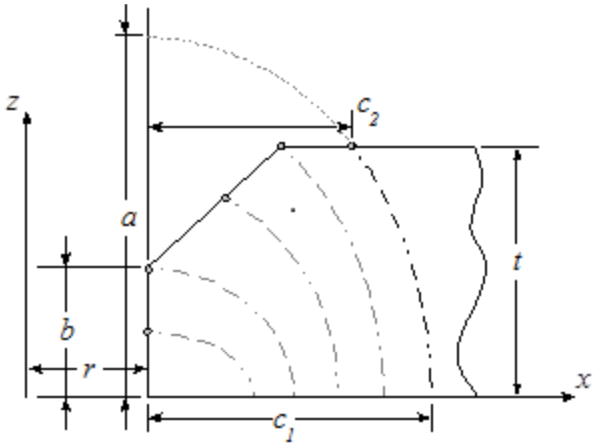
- Centered or offset hole with single corner crack

- 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

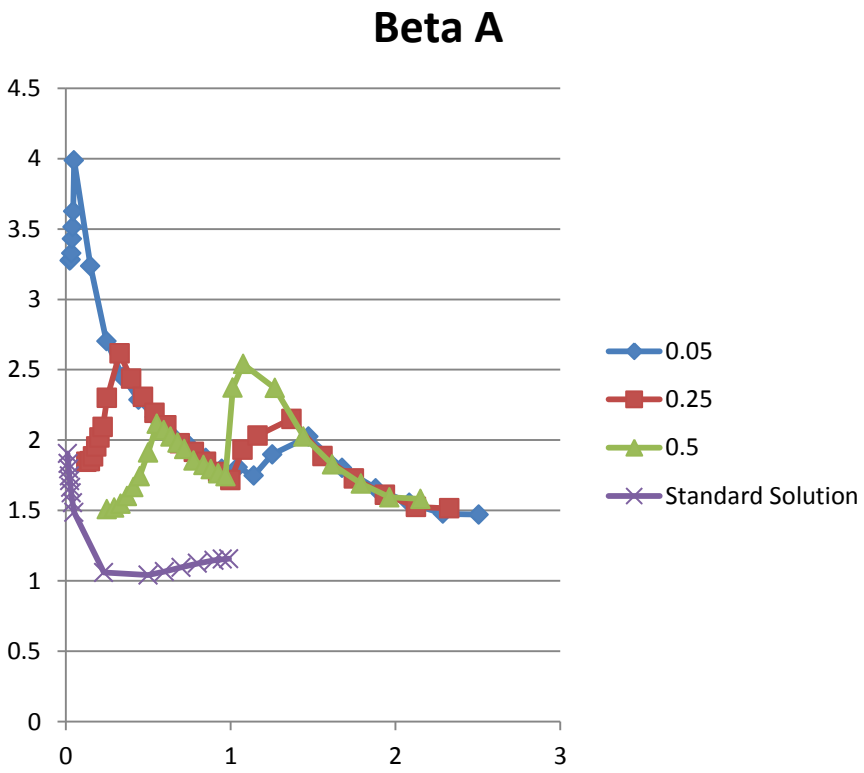
Virtual Crack Depth to Thickness Ratios (A/T)
0.025, 0.0294467, 0.0333167, 0.0371867, 0.0410568, 0.0449268, 0.05, 0.149025, 0.24687, 0.344714, 0.442559, 0.540403, 0.646563, 0.752822, 0.849658, 0.946494, 1.04333, 1.14017, 1.25287, 1.47261, 1.6767, 1.8808, 2.0849, 2.28899, 2.50574

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

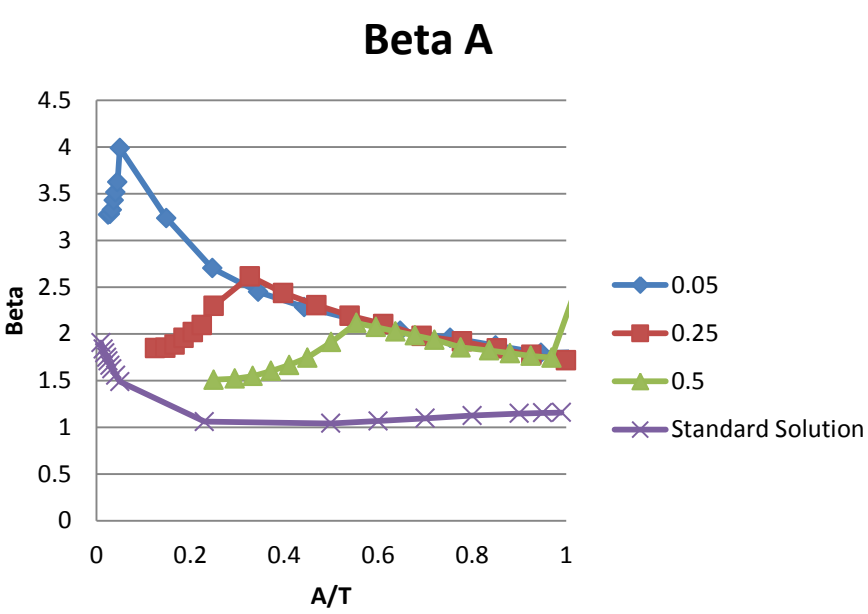
Hole Radius to Thickness Ratios (R/T)
0.1, 0.25, 0.5,0.67, 1.0, 1.2, 1.5, 2.0, 2.4

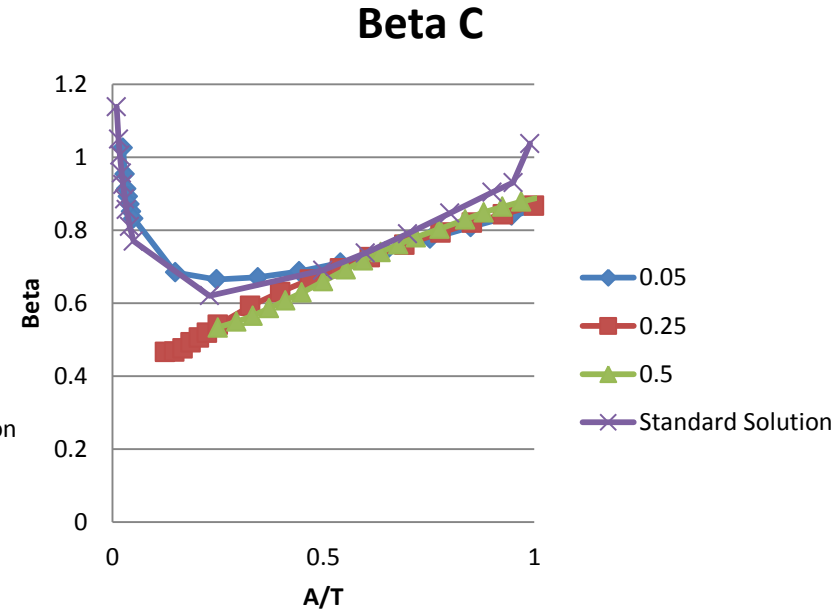
Countersunk Hole Transitions

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



Countersunk Solution Betas





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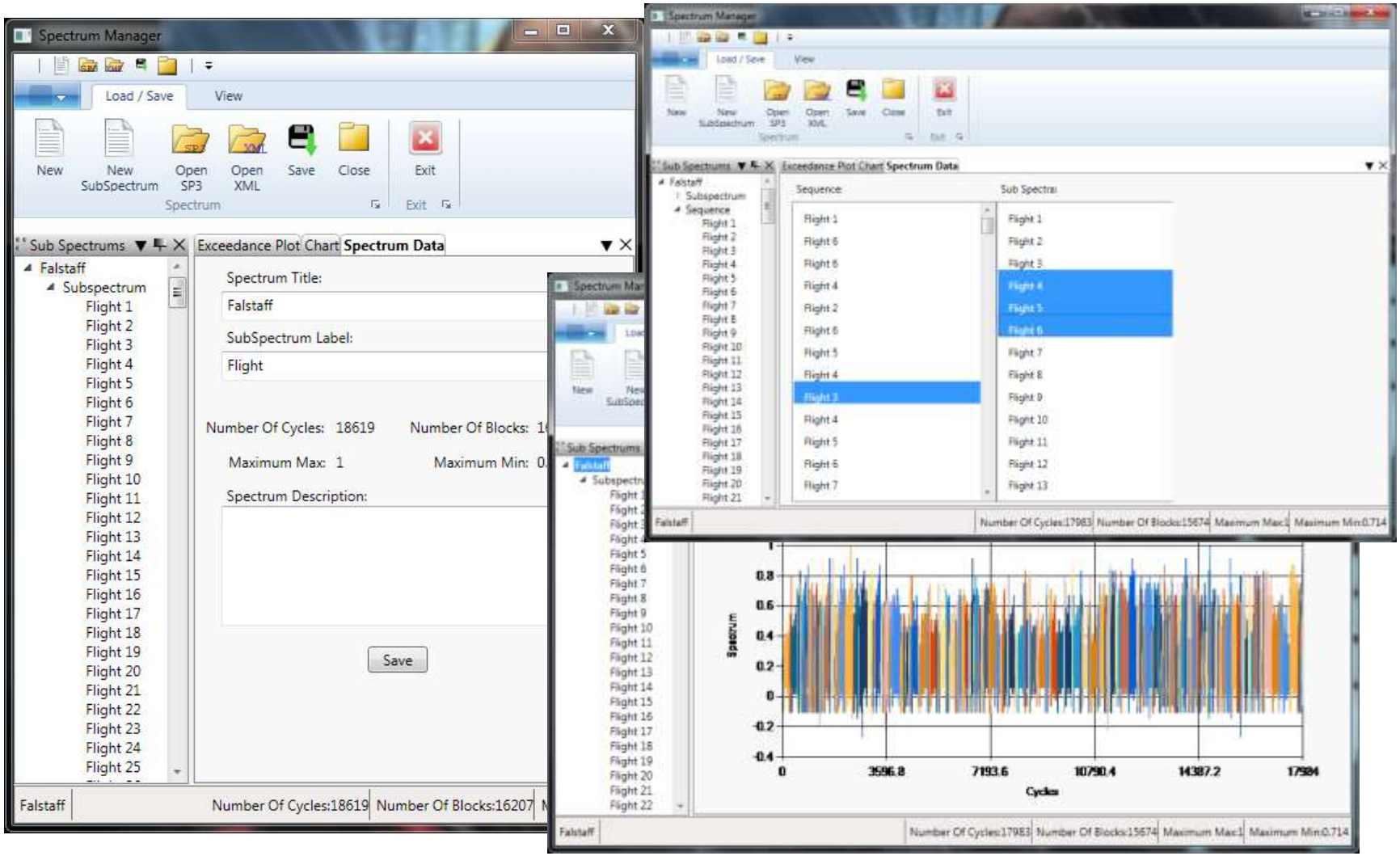
Spectrum Tool



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

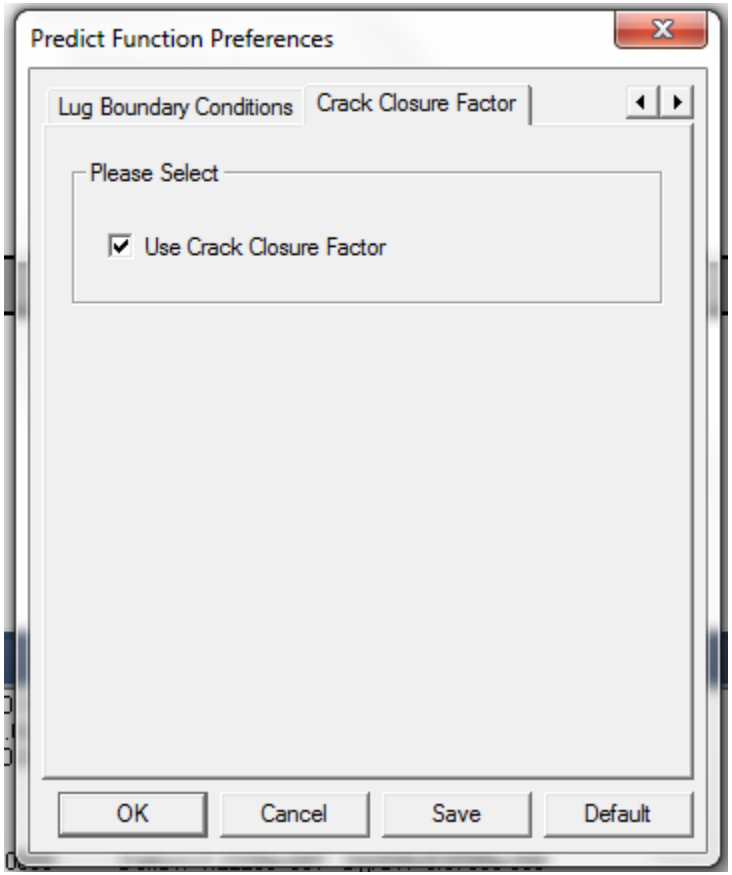
$$K = \beta_r * \sigma\sqrt{Length * \pi} * \beta$$

if $R = 0$
then

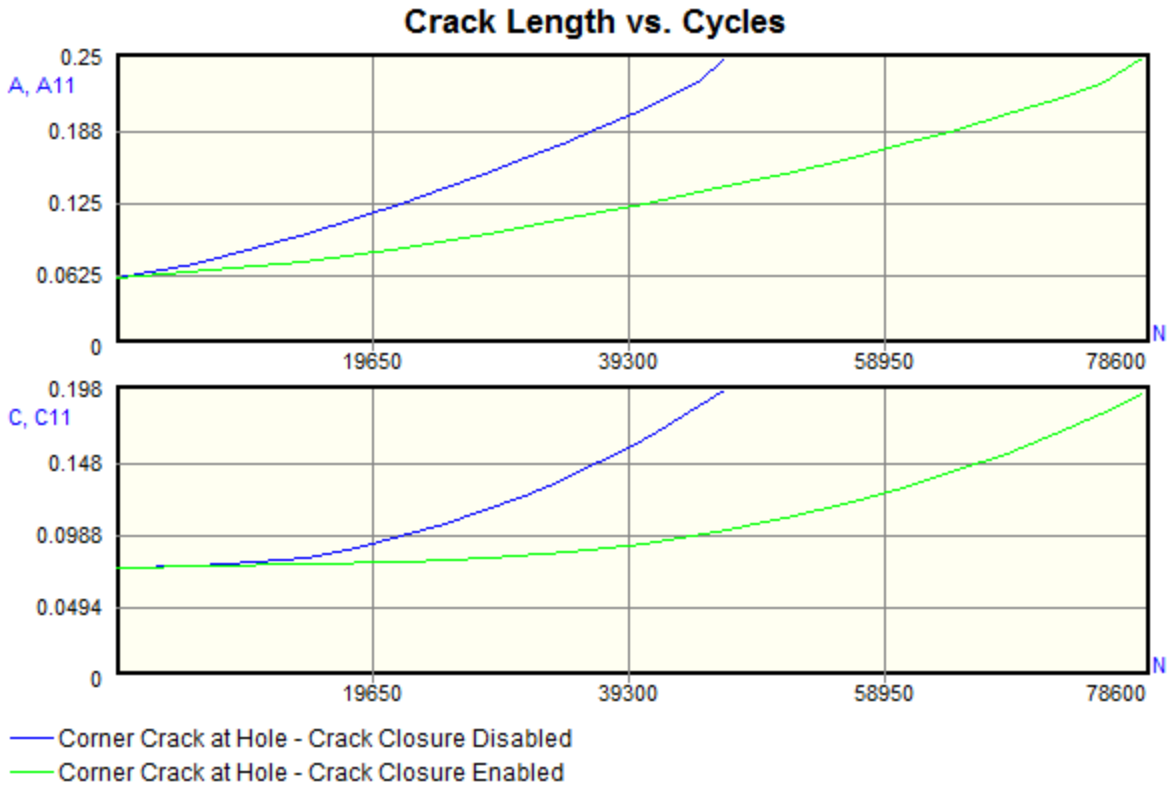
$$\beta_r = 0.9$$

else

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



Crack Closure Factor Effect



Release 5.3

- New weight functions solutions (crack at hole, stress distribution in C-direction for part through cracks)
- Using different material data as a function of spectrum
- Applying different material data to the different crack directions
- Ability to Replicate Results From Previous Versions (back to Version 5.01)
- Option to Save Input File With Retardation State Data for Later Restart
- Undo-Redo
- New solution for a corner crack at the countersink knuckle

AFGROW Users Workshop 2012

The Annual AFGROW Users Workshop will be held at the Davis Conference Center in Layton, UT on September 8-10, 2012.

Who should attend: Engineers, researchers, technologists, and managers who are users of AFGROW and/or have an interest in Crack Growth Analysis tools.

The purpose of the workshop is to provide a forum for users to share ideas, demonstrate how AFGROW is being used for practical cases, and discuss future development. We will also provide information on the latest development efforts.

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Questions