

AFGROW Workshop 2018

AFGROW Release 5.3

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AFGROW Release 5.3

The screenshot displays the AFGROW software interface. The main window shows a specimen model with a crack. A 'Crack Growth Rate Data' plot is visible on the left, showing da/dN on a logarithmic scale versus ΔK on a logarithmic scale. The plot includes a red curve and the text $R= 0.00$. A 'Predict Function Preferences' dialog box is open in the foreground, with the 'Bending' option selected. The dialog contains the following information:

- Information:** The out-of-plane (transverse) bending solution for internal and edge through cracks is approximated using the axial load solution multiplied by a bending correction factor. The default correction factor is two-thirds.
- Select:**
 - Use default correction factor
 - Correction factor:
- Warning:** User defined correction factor value must range between 1/3 and 2/3.

The dialog box has buttons for 'OK', 'Cancel', 'Save', and 'Default'. The background interface includes a menu bar (FILE, INPUT, EDIT, VIEW, PREDICT, TOOLS, REPAIR, INITIATION, WINDOW, HELP), a toolbar, a 'Properties' panel on the right showing specimen details (Name: Specimen, Width: 4.000000), and a 'ToolBox' panel with various crack types (Hole, Countersunk Hole, Through Crack, Part-Through Crack, Slot). The status bar at the bottom indicates 'English' and 'PASS: 999999'.

AFGROW Release 5.3 – Highlights

- Release Date - **December 6, 2017**
- 64 bit version
- Multilingual support
- Material Database redesign and outgoing data update –1296 new da/dN material tests are loaded. A-10, T-38, NRC and additional Air Force provided data.
- New 53 downloadable material data in tabular lookup format are available online
- Spectrum Manager to create, edit and transform spectra included in the release

AFGROW Release 5.3 – New Functionality

- Numerous K-solution changes/enhancements
- Ability to use different material data as a function of spectrum level
- Ability to apply different material data to different crack directions
- Corrosion Effects
 - Exfoliation
 - Intergranular
 - Pitting
- Added a new spectrum format that supports above changes and future enhancements
- Ability to open read only material data from the network or online folder. System administrator managed feature.

AFGROW Release 5.3 – New K-Solution Functionality

- Option to control the % of the axial load solution that is used to approximate the out-of-plane bending solution for straight through-the-thickness cracks:
 - Classic edge crack
 - Classic double edge crack
 - Classic through crack
 - All advanced cracks where bending was not available with the exception of crack at slot
- New solution for a corner crack at the countersink knuckle
- Bearing solution for advanced through crack(s) at a hole
- Capability to use the current 2-D User-Defined Beta Model for 2, inter-dependent through cracks that can be assigned different plate thickness values = 100%
- Single edge crack model with the finite height – provided by SAFE
- Added global “Constrained” property for advanced model in-plane bending - only applicable for notch solutions.

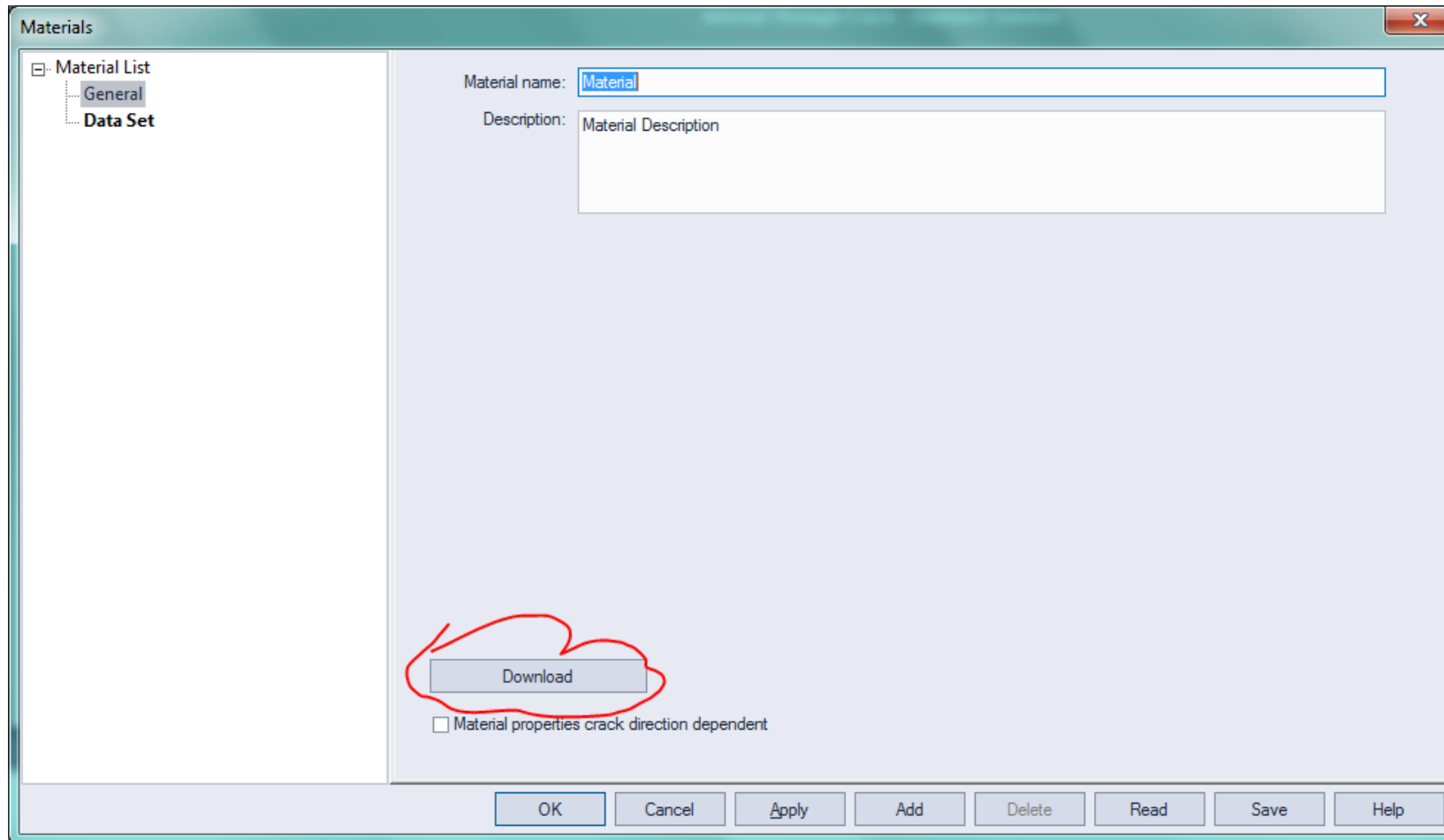
Network or Online Access to Material Data

- Only tabular lookup format right now
- Require modification to the AFGROW configuration file and can be done only by administrator
- Require a data configuration file that points to all material data files
- Material files need to be in the lkpx (XML based format)

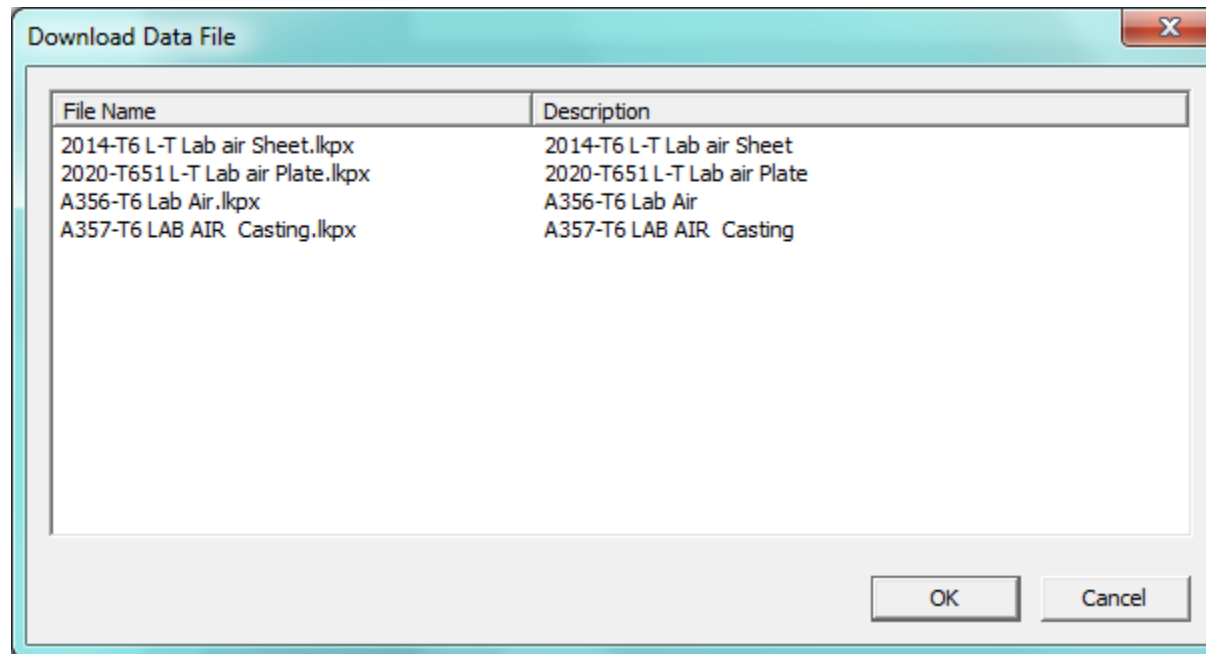
Network or Online Access to Material Data - Advantages

- Provides the same set of material data for all users
- Can not be modified by users
- Easy to implement and manage
- User access can be modified per file or per group of files

Network or Online Access to Material Data



Network or Online Access to Material Data – Download Data Dialog



AFGROW Configuration File

```
<?xml version="1.0" encoding="utf-8" ?>
<configuration>
  <appSettings>
    <add key="MaterialLookupListUr!"
value="http://www.afgrow.net/mate value = "Z:\ServerFolders\Material-Data_load\MaterialLookupList.xml" />
  </appSettings>
  <custom.settings>
    <plugins>
      <plugin> Counter_Sunk_Hole_In_Plate.Counter_Sunk_Hole_In_Plate_Plugin</plugin>
      <plugin>VZLUPlugin.VZLUPluginClass</plugin>
    </plugins>
  </custom.settings>
</configuration>
```

Material Configuration File

```
<?xml version="1.0"?>
```

```
-<MaterialFileList>
```

```
    <MaterialFile location="http://www.afgrow.net/material/" name="2020-T651 L-T Lab air  
Plate.lkpx">2020-T651 L-T Lab air Plate</MaterialFile>
```

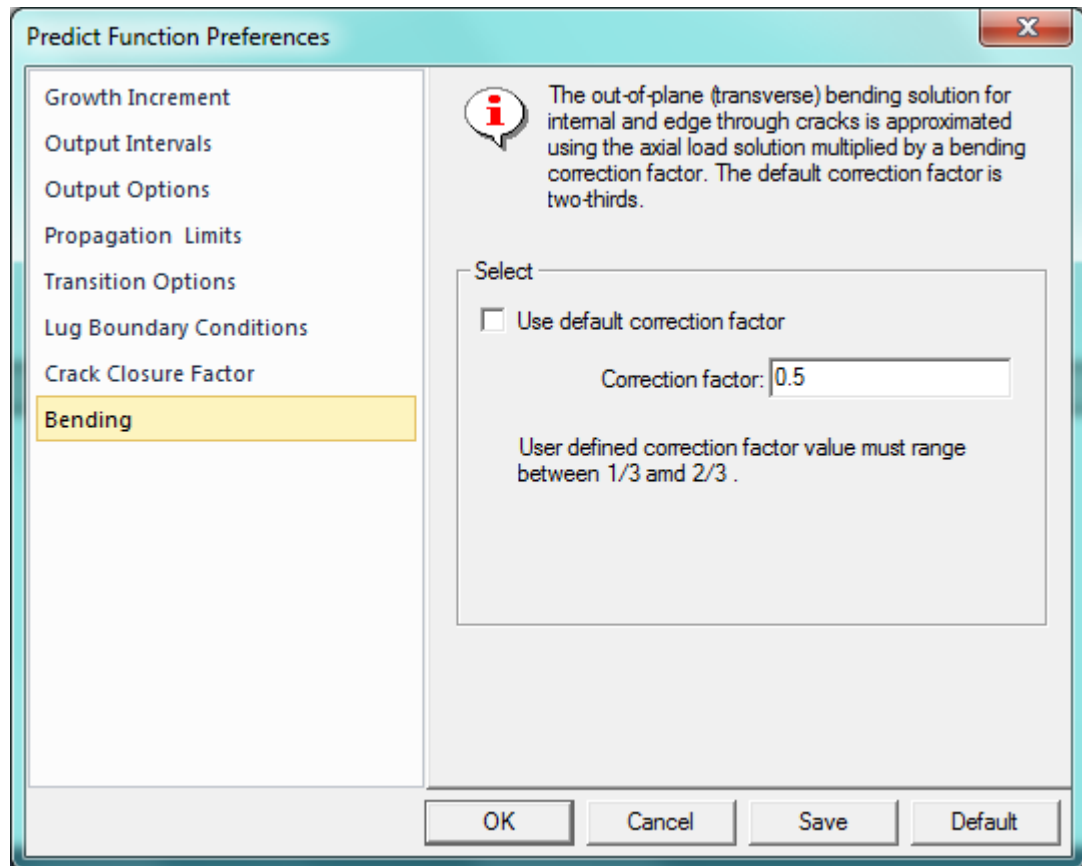
```
    <MaterialFile location="http://www.afgrow.net/material/" name="A356-T6 Lab Air.lkpx">A356-T6 Lab  
Air</MaterialFile>
```

```
    <MaterialFile location="http://www.afgrow.net/material/" name="A357-T6 LAB AIR Casting.lkpx">A357-  
T6 LAB AIR Casting</MaterialFile>
```

```
    <MaterialFile location="http://www.afgrow.net/material/" name="2014-T6 L-T Lab air Sheet.lkpx">2014-  
T6 L-T Lab air Sheet</MaterialFile>
```

```
</MaterialFileList>
```

Option to Approximate the Thru-Crack Out-of-Plane Bending Solution



- Classic edge crack
- Classic double edge crack
- Classic through crack
- All advance cracks where bending was not available with the exception of crack at slot

Using different material data as a function of spectrum level

- Material data will consist of different material “sets”
- One material “set” is always default
- Material sets can be tagged for different conditions
- Only the Environment “tag” can be used right now
- Applicable only for tabular lookup data, but code infrastructure has been changed to handle any AFGROW material model if necessary, and requires only GUI changes
- Spectrum with Environment “tags” applied to a level
- Must be used with the new XML spectrum format
- New XML tabular lookup data file format
- Ability to use old tabular lookup data files for either growth direction
- The resulting DAX input file is backward and upward compatible

Applying different material data to different crack directions

- Works only with A and C directions (Ct and C direction use the same material data)
- Applicable only for tabular lookup data, but code infrastructure has been changed to handle any AFGROW material model if necessary, and requires only GUI changes
- C direction is always the default direction
- Will not work with the Advanced multipoint corner crack(s) at a hole model
- Can be used in conjunction with the “Using different material data as a function of spectrum” option
- DAX input file is backward and upward compatible
- Plugin model changed to handle different material data for different crack directions

53 Material Data from AFMAT Converted to Tabular Lookup Format in AFGROW

- Will be distributed through AFMAT
- Material data will be in new tabular-Lookup format that is going to be introduced in AFGROW 5.3

AFGROW | AFMAT
Crack Growth Database

Home Product Reference Specimen Test Profile










[AF Mat](#) > Home

Online Crack Growth Database

	Id	Data Source	Condition Heat Treatment	Property Type	Alloy	Environment
Alloy Steels	20240	Purdue Aging Aircraft Data		Fatigue Life (a vs N)	7075-T6	Unknown
Aluminum	1222	AIR FORCE	AS RECD	Plane Strain Fracture Toughness (K1C)	TI-6AL-4V	Unknown
Beryllium/Beryllium Alloys	1223	Additional NASA Data	AS RECD	Plane Strain Fracture Toughness (K1C)	TI-6AL-4V	Unknown
Brass	1224	Additional NASA Data	AS RECD	Plane Strain Fracture Toughness (K1C)	TI-6AL-4V	Unknown
Bronze	1225	Additional NASA Data	AS RECD	Plane Strain Fracture Toughness (K1C)	TI-6AL-4V	Unknown
Copper/Copper Alloys	1226	Additional NASA Data	AS RECD	Plane Strain Fracture Toughness (K1C)	TI-6AL-4V	Unknown
Iron Alloys	1227	Additional NASA Data	AS RECD	Fatigue Crack Growth Rate (da/dN vs delta K)	C11000(ETP BUS BAR)	LAB AIR
Magnesium Alloys	1228	Additional NASA Data	AS RECD	Fatigue Crack Growth Rate (da/dN vs delta K)	C11000(ETP BUS BAR)	LAB AIR
Molybdenum/Molybdenum Alloys	1229	AIR FORCE	AS RECD;PROBABLY MA	K1 Environmentally Assisted Cracking	TI-6AL-4V	3.5PCT NAACL
Nickel Based Super Alloys	1230	NASA	AS ROLL	Fatigue Crack Growth Rate (da/dN vs delta K)	304	LAB AIR
Niobium/Niobium Alloys						
Solders						
Stainless Steels						
Titanium Alloys						

New Classic Models

- Single corner crack model with finite height
- 2 inter-dependent through cracks that can be assigned different plate thickness values

Model	Description of the Configurations	Beta Solution
<input type="checkbox"/>	 Part Through Crack in Pipe	Application Defined
<input type="checkbox"/>	 Through Crack	User Defined
<input type="checkbox"/>	 Interdependent Through Cracks	User Defined
<input checked="" type="checkbox"/>	 Internal Through Crack	Application Defined
<input type="checkbox"/>	 Single Through Crack at Hole	Application Defined
<input type="checkbox"/>	 Double Through Crack at Hole	Application Defined
<input type="checkbox"/>	 Single Through Crack at a Semi-circular Notch	Application Defined
<input type="checkbox"/>	 Single Edge Through Crack	Application Defined
<input type="checkbox"/>	 Single Edge Through Crack in a Finite Height ...	Application Defined

Corrosion Effects

- $d(\text{geometry})/d(\text{time})$ models: intergranular corrosion model or exfoliation corrosion modeling.
- Requires the time dependent spectrum in the old .st3 or new .spx format
- Only one of two can be used at the same time
- Initial crack size (pitting model): Pitting model is not time dependent, it calculates maximum possible pit size for a given environment/specified material
- Developed under contract with SAFE

Spectrum Manager

Spectrum Manager - C:\Users\alex\Documents\Visual Studio 2010\Projects\AfgrowDevelopment\Targets\dfstaf.sp3

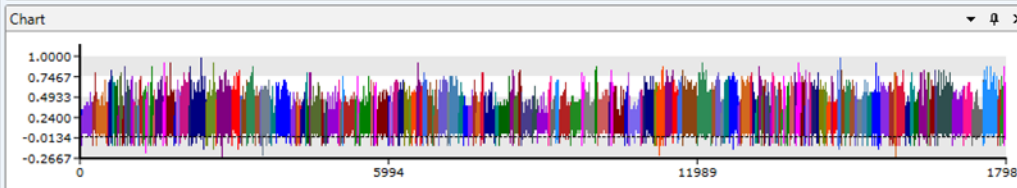
Edit Preview Spectrum View



Sub Spectrums

- Falstaff
 - Sub Spectra +
 - Flight 1
 - Flight 2
 - Flight 3
 - Flight 4
 - Flight 5
 - Flight 6
 - Flight 7
 - Flight 8
 - Flight 9
 - Flight 10
 - Flight 11
 - Flight 12
 - Flight 13
 - Flight 14
 - Flight 15
 - Flight 16
 - Flight 17
 - Flight 18
 - Flight 19

#	cycle	Max	Min	Cycles	Sub Spectrum Name
14	22	0.3462	0.1828	1	Flight 1
15	23	0.3054	0.1828	1	Flight 1
16	24	0.3462	0.1011	1	Flight 1
17	25	0.2236	0.1011	2	Flight 1
18	27	0.2645	0.1011	1	Flight 1
19	28	0.2236	0.1011	1	Flight 1
20	29	0.3462	0.1419	1	Flight 1
21	30	0.2645	0.1419	1	Flight 1
22	31	0.2645	0.1011	1	Flight 1
23	32	0.2236	0.1011	2	Flight 1
24	34	0.2645	-0.0624	1	Flight 1
25	35	0.0193	-0.0624	1	Flight 1



PropertiesWindow

A-Z

Spectrum

Title	Falstaff
SubSpectrum Label	Flight
Description	
Hours Per Pass	1

Statistics

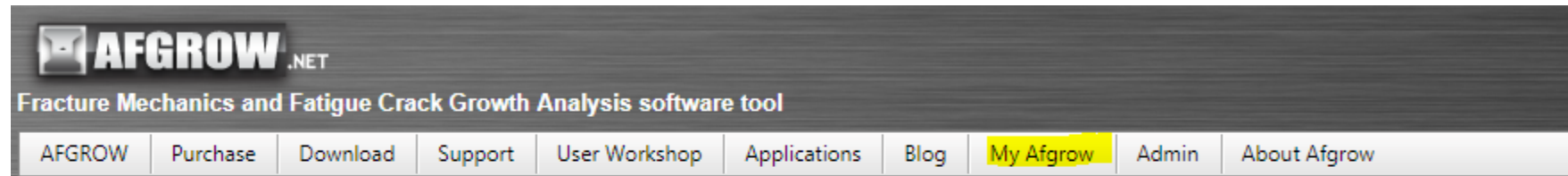
Number Of Levels	15674
Number Of Cycles	17983
Max	1
Min	-0.2667

Properties Errors

Minor Release 5.03.02.22-March 4, 2018


- Fixed Bug: The “Constrained” option for a classic edge crack could not be set using COM
- Fixed Bug: Under certain conditions, a corner crack at the base of a C/S (knee) model could go into an endless loop
- Fixed Bug: Spectrum title was missing in the *.pl2 file
- Fixed Bug: The H/W value was not being calculated/reported correctly in the Notification frame for a "single edge crack in a finite height plate" model

Publication -Using MATLAB to Perform a Life Prediction in AFGROW




My AFGROW


Documents


Download [Fracture Mechanics Database Manual](#)  (Updated 12/15/2017).

Publications

[Download Using MATLAB to Perform a Life Prediction in AFGROW](#) , James Lambert, Cordell Smith, LexTech, Inc. (New 7/18/2018)

Download [Modeling Bearing Load in Wide Panels Using AFGROW](#) , James A. Harter, Consultant, for LexTech, Inc. (Updated 11/2/2017)

Download [Stress Intensity Factor Solution for Two, Independent Through-the-Thickness Cracks at an Offset Pin Loaded Hole](#) , Cordell E. Smith, LexTech, Inc., James A. Harter, Consultant, for LexTech, Inc.

Download [Internal Through Cracks in a Row of Fastener Holes](#) , James A. Harter, Consultant, for LexTech, Inc.

Download [Finding Equivalent Crack Growth Rate Data for Similar Steel Alloys](#) , James A. Harter, Consultant, for LexTech, Inc.

Download [How to Open an AFGROW XML Output File in Excel](#) , Alex Dunbar, LexTech, Inc., James A. Harter, Consultant.

Download [Using Beta Correction for Unusual Geometries](#) , James A. Harter, Consultant., Cordell Smith, LexTech, Inc.

Minor Release 5.03.03.23-September 17, 2018 (Estimated)

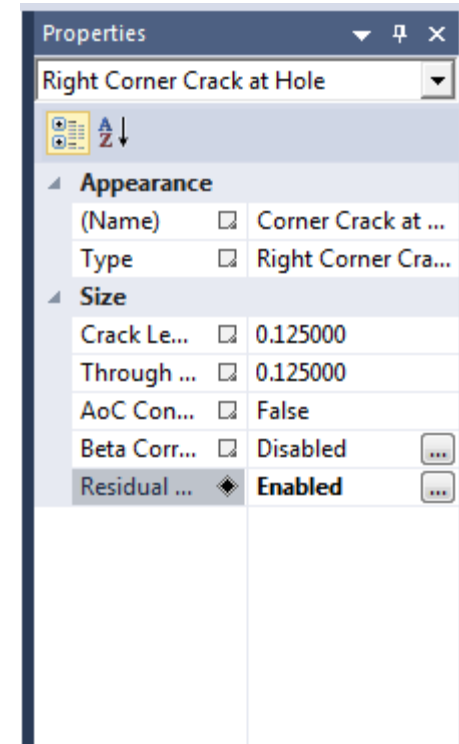
- Enhancement - Add ability to use residual stresses for advanced model with crack(s) at hole
- Enhancement - Improved residual stress calculation routine
- Enhancement – Made AFGROW to providing COM interface information at runtime.
- Bug fixed - Initiation issue for high cycle fatigue (interpolation error)
- Bug fixed - Impossible to set Ultimate Strength value for Tabular Lookup model through COM interface
- Bug fixed - AFGROW will sometimes use the wrong NASGRO K* value for Advanced and Plugin models
- Bug fixed - Add block size variable to ConstAmplitudeSpectrum COM method
- Bug fixed - Two parameters delta K threshold and Yield Strength in the tabular lookup material model not echoed in the Tree Status view
- Bug fixed - NASGRO Material K* was not recalculated when any not plate with hole models were selected through COM interface
- Bug fixed - AFGROW does not correctly paint sub-spectra in the spectrum view
- Bug fixed - AFGROW does not output the spectrum pass count on the status bar
- Bug fixed - Not able to read in a Forman material file

Improvements to Residual Stresses calculation routine

- The Gaussian integration routine did not include a part-through correction to the handbook solution for a point load on a through crack.
- The integration is now performed twice – part-through case, and through crack case. This solves the crack transition issue with the slope change limitation.
- Improved the interpolation method in the routine.

Ability to Use Residual Stresses for Advanced Models with Crack(s) at Hole

- The Advanced Solution is more accurate than the Classic Solution
- Residual stresses are applied to the one or both cracks independently
- Results look much better based on the ERSI RR test results



AFGROW modified to provide COM Interface Information at Runtime (Late binding)

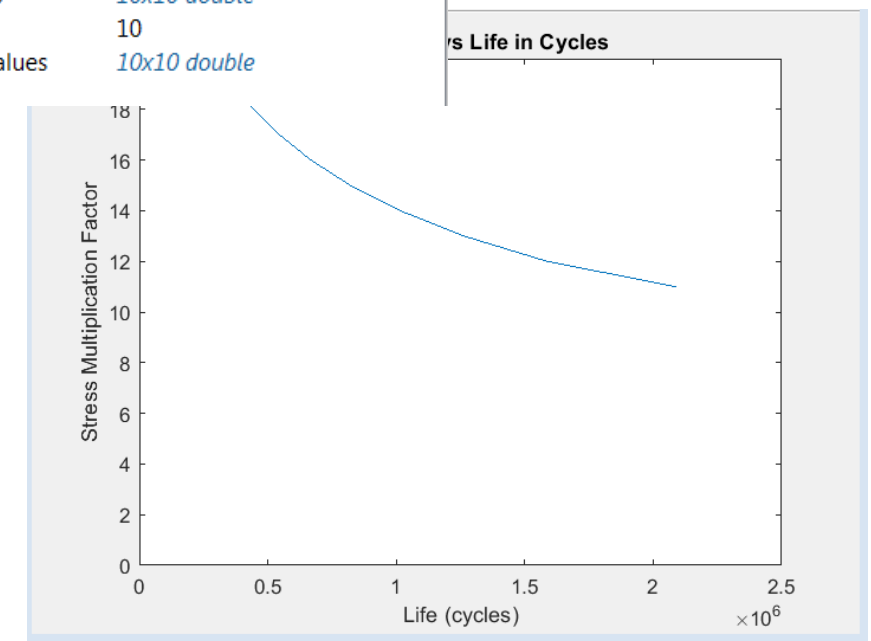
- Binding is a process of matching function calls to the actual code that implements the function.
- Late-binding, where the target method is looked up at run time, mostly by function name
- Late binding is exclusively used by Matlab.

```

1 - clear;
2 - afgrow = actxserver('Afgrow.Application');
3 - afgrow.Model = 'aSingleEdgeCorner';
4 - afgrow.SpecimenWidth = 6;
5 - afgrow.SpecimenThickness = 1;
6 - afgrow.CrackLengthA = .05;
7 - afgrow.CrackLengthC = .05;
8 - afgrow.ConstAmplitudeSpectrum(0.0);
9
10 - count = 10;
11
12 - cycles = zeros(count);
13 - smfValues = zeros(count);
14 - for i = 1:count
15 -     afgrow.SMF = 10 + i;
16 -     [~, cycles(i), ~, ~, ~, ~, ~, ~] = afgrow.RunFrozPredict();
17 -     smfValues(i) = afgrow.SMF;
18 - end
19
20 - plot(cycles, smfValues);
21 - title('SMF Values vs Life in Cycles');
22 - xlabel('Life (cycles)');
23 - ylabel('Stress Multiplication Factor');
24

```

Name ^	Value
afgrow	1x1 Afgrow_Application
ans	1
count	10
cycles	10x10 double
i	10
smfValues	10x10 double



Upcoming short term changes

- Output intervals printed in "hours" if the option to display life in hours is selected in the Output Intervals tab, the crack length plots also will be converted to hours
- Add ability to open AFGROW input dialogs by clicking on items in the status tree view
- Access to plugin models through COM
- Longitudinal through crack in a pipe under internal pressure
- Weight functions for edge corner crack and edge through crack, fixed original Glinka's corner crack at the edge solution
- Bending loading solution for corner crack at the edge
- Bearing loading solution for corner/through crack at hole with the slot on another side

Acknowledgements

- A-10 and T-38 Structural Integrity and Analysis Group
- SAFE Inc.
- NRC (compounding solution for two cracks under bearing load)
- ASIMIS
- AFGROW Customers and Consortium Members

Questions