

Demonstration of Normalized Stress Correction Factor to Compute the Stress Intensity Factors

Scott Prost-Domasky, PE, D.Sc.

APES, Inc.

St. Louis, MO

Agenda

- Why? AFGROW versatile, but can't cover every possible crack scenario
- Steps to stress correction process
- Process and results demonstrated on “elliptic surface crack in a stepped flat tension bar”
- Conclusions

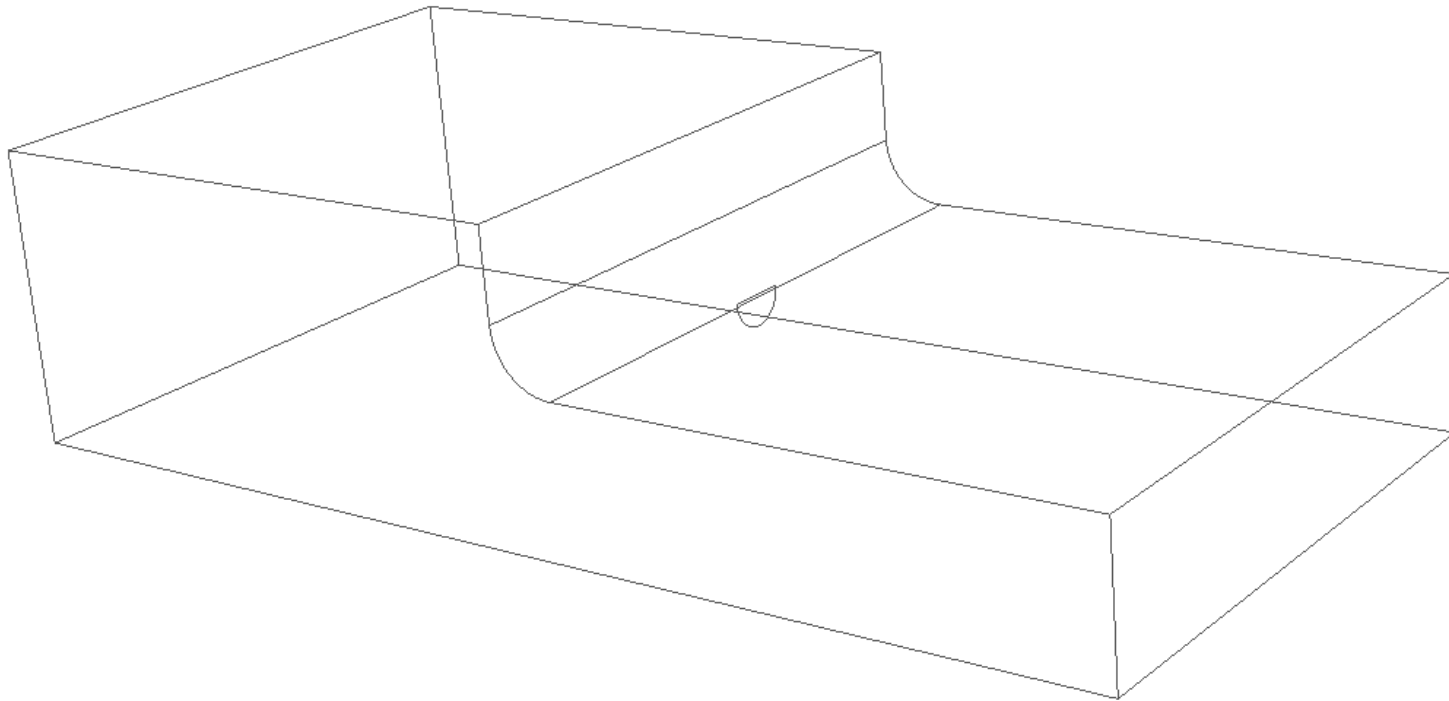
Steps for Using Stress Correction in AFGROW

- Pick reference crack scenario—as close as possible to ***YOUR*** crack scenario. With the reference crack scenario comes a reference uncracked stress state *at the plane where crack will be located*
- Compute stress for your geometry (no crack)
- Shift coordinate system of your stresses to reference crack origin
- Ratio your uncracked stress to reference uncracked stress

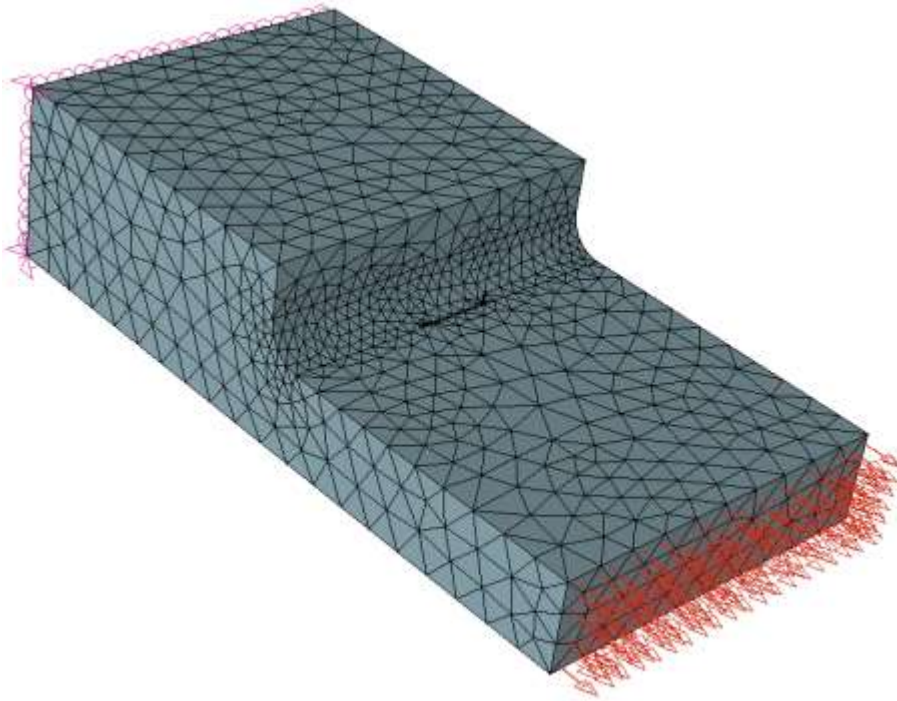
Steps for Using Stress Correction in AFGROW (continued)

- Normalize the ratioed stresses to the stress at the ‘First Point’—keep this value handy, you’re going to need it later
- Create .sd2 file with the normalized stresses
- Read into AFGROW with reference crack scenario model
- Multiply SMF by this “First Point” value

Crack Scenario in Stepped Flat Tension Bar



Stepped Flat Tension Bar Mesh



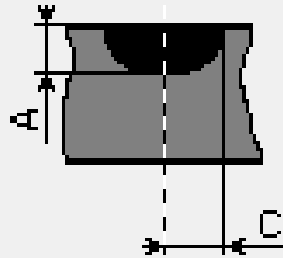
- Stepped flat tension bar in 3D
- Dimensions: $W=2$ in., $h_1=0.5$ in., $h_2=1.0$ in., fillet= 0.2 in.
- Constant tension on one face; symmetry on opposite face

Reference Crack Scenario is Center Semi-elliptic Surface Flaw

Center Semi-elliptic Surface Flaw - Standard Solution



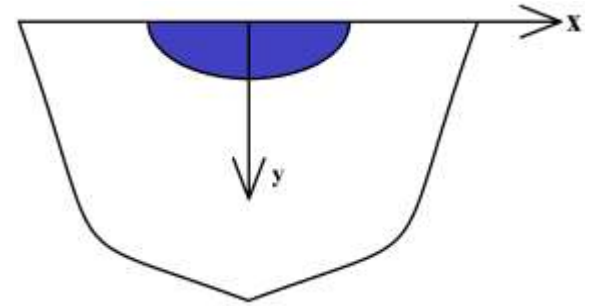
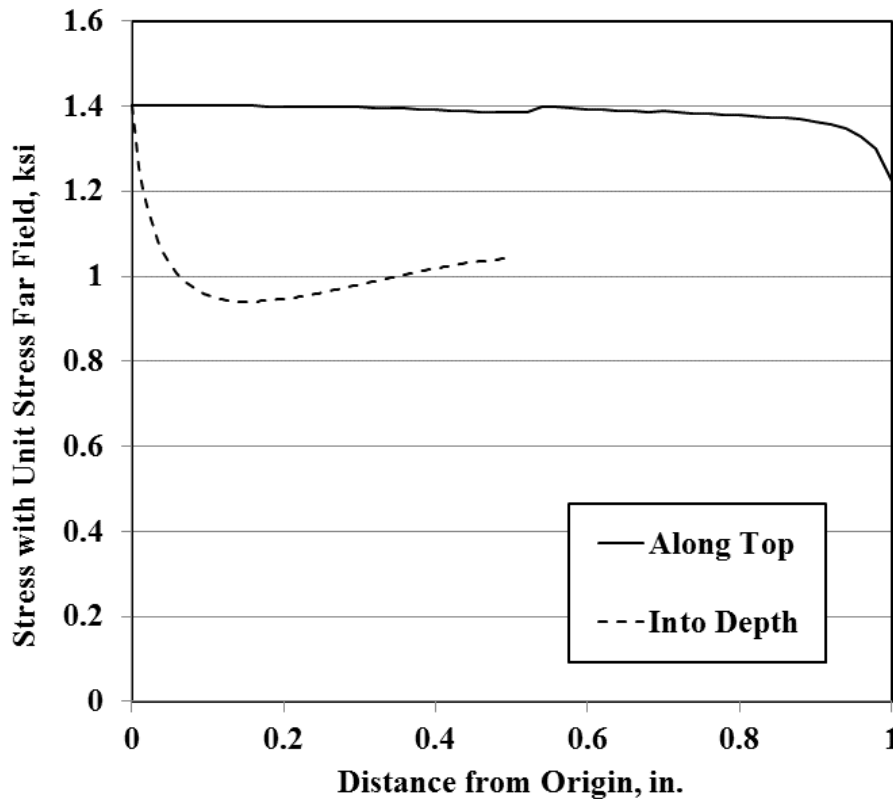
Enter crack dimensions



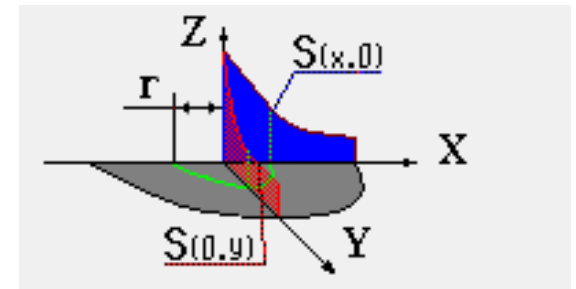
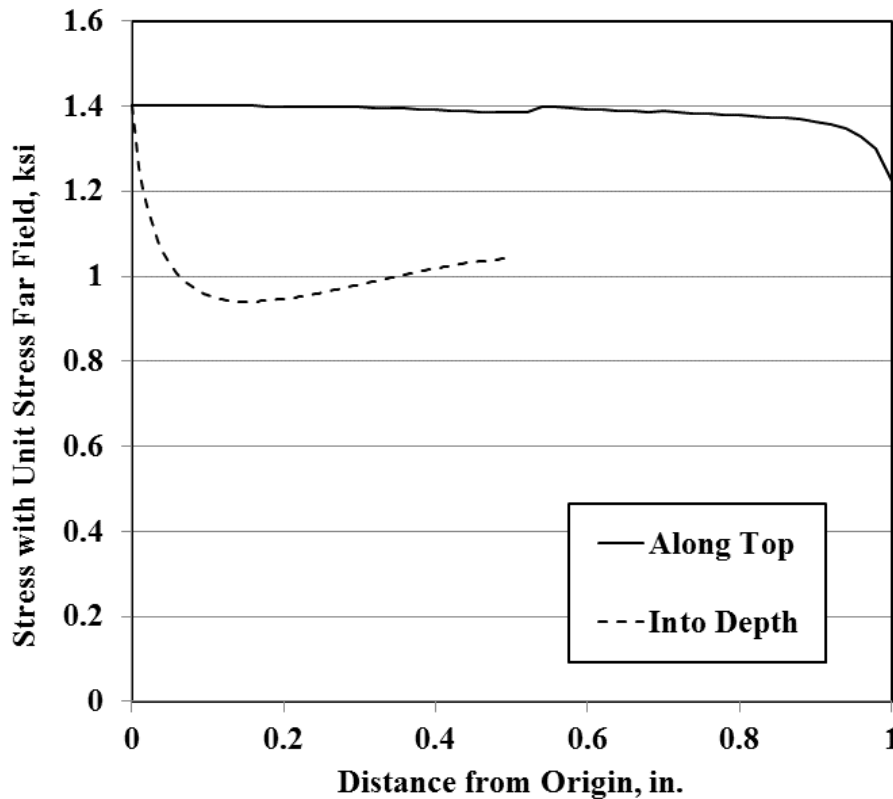
Crack Length '-C' Direction:

Crack Length '-A' Direction:

Uncracked Stress in Stepped Flat Tension Bar

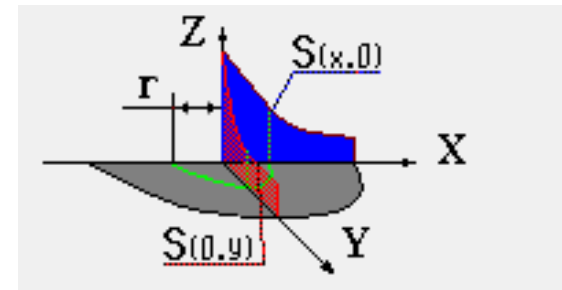
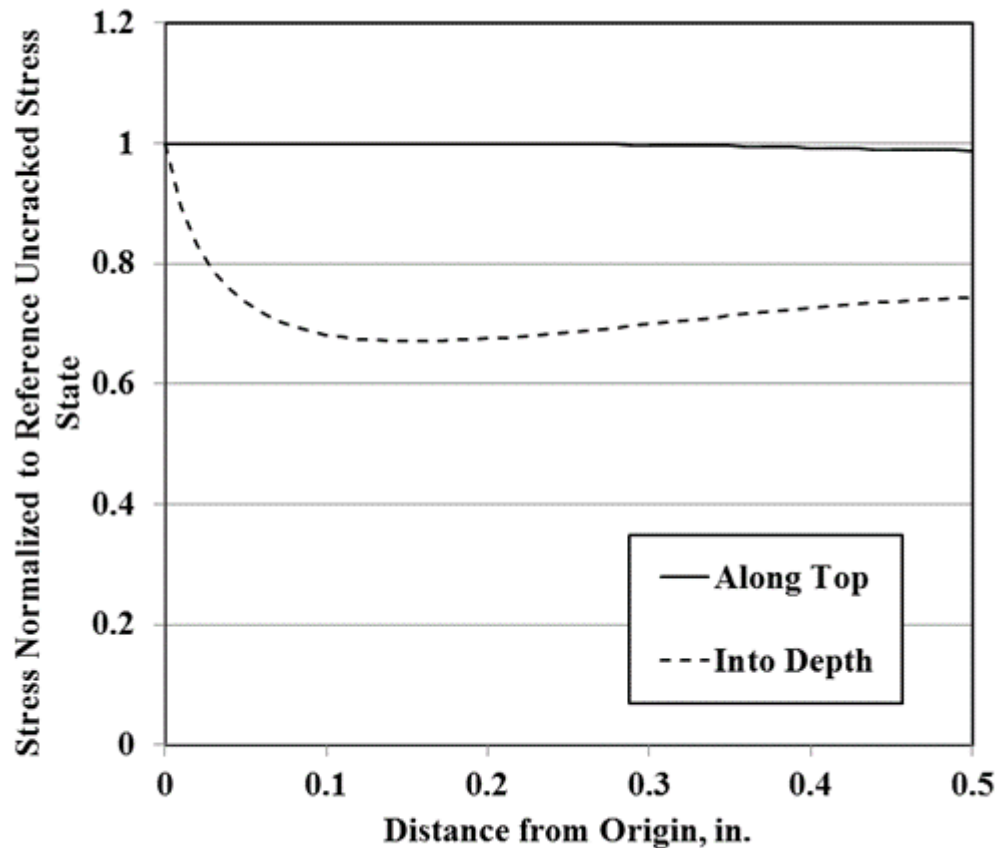


Normalized to Reference Stress State



**Reference
Uncracked
Stress is 1 ksi**

Normalized to “First Point”

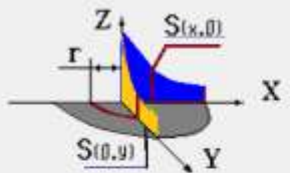


*SAVE “1.402”
for SMF later*

AFGROW Stress Correction

Beta Correction Factors

AFGROW allows the stress intensity factor solutions to be modified by using multiplication (Beta Correction) factors.



$S(x,y)$ - value of a stress in Z axis direction, normalized to the stress at the crack origin;
 r - distance from the center point of the crack along X or Y axis;

Select type of Data

Normalized Stress Beta Correction Factors

Enter Beta and 'r' sets

Number of Sets: 37

Set	r	S(r,0)	S(0,r)
0	0	1	1
1	0.01	0.9	0.98
2	0.1	0.85	0.95
3	0.2	0.82	0.95
4	0.25	0.8	0.95
5	0.26	0.79	1

OK
Cancel
File
Save
Open

For this study...

$$S(x,0)=S(r,0)$$

$$S(0,y)=S(0,r)$$

50		
0.01	1.000004811	0.894619325
0.02	1.000002504	0.831424341
0.03	0.999986126	0.788611297
0.04	0.999949392	0.75789559
0.05	0.999889946	0.735283373
0.06	0.999820494	0.718071035
0.07	0.999760346	0.705059486
0.08	0.999740164	0.695194296
0.09	0.999771885	0.687978784
0.1	0.999781213	0.681464713
0.11	0.9996999	0.677623746

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Note: Because you have normalized all stresses to the $r=0$ (origin) AFGROW assumes $S(r=0,0)$ and $S(0,r=0)$ are 1.0; thus no need to put the $r=0$ data.

Adjust the SMF

Multiply SMF by “1.402”

Center Semi-elliptic Surface Flaw - Standard Solution

Item
elliptic Surface Flaw - Standard Solution
Sheet LO

Filters
on
n Filters
stresses
on Factors

Length...

its
#####

Spectrum

i Stress Multiplication Factor [SMF] multiplies the stress or load levels found in spectrum files. This allows normalized spectra to be used. If actual stress levels are used in the spectrum files, SMF should be set to 1.

Residual Strength Requirement [Pxx] is the value of stress (or load for models using load input) which must be carried at all crack sizes. It is used to determine the critical crack size - if a non-zero value is entered.

Stress Preload [SPL] is used to account for pre-existing stresses. This value is added to the max and min spectrum stresses after they have been multiplied by SMF.

Enter

Stress Multiplication Factor(SMF): 1.402

Residual Strength Requirement (Pxx): 0

Stress Preload (SPL): 0

Select

Create new spectrum file

Open spectrum file

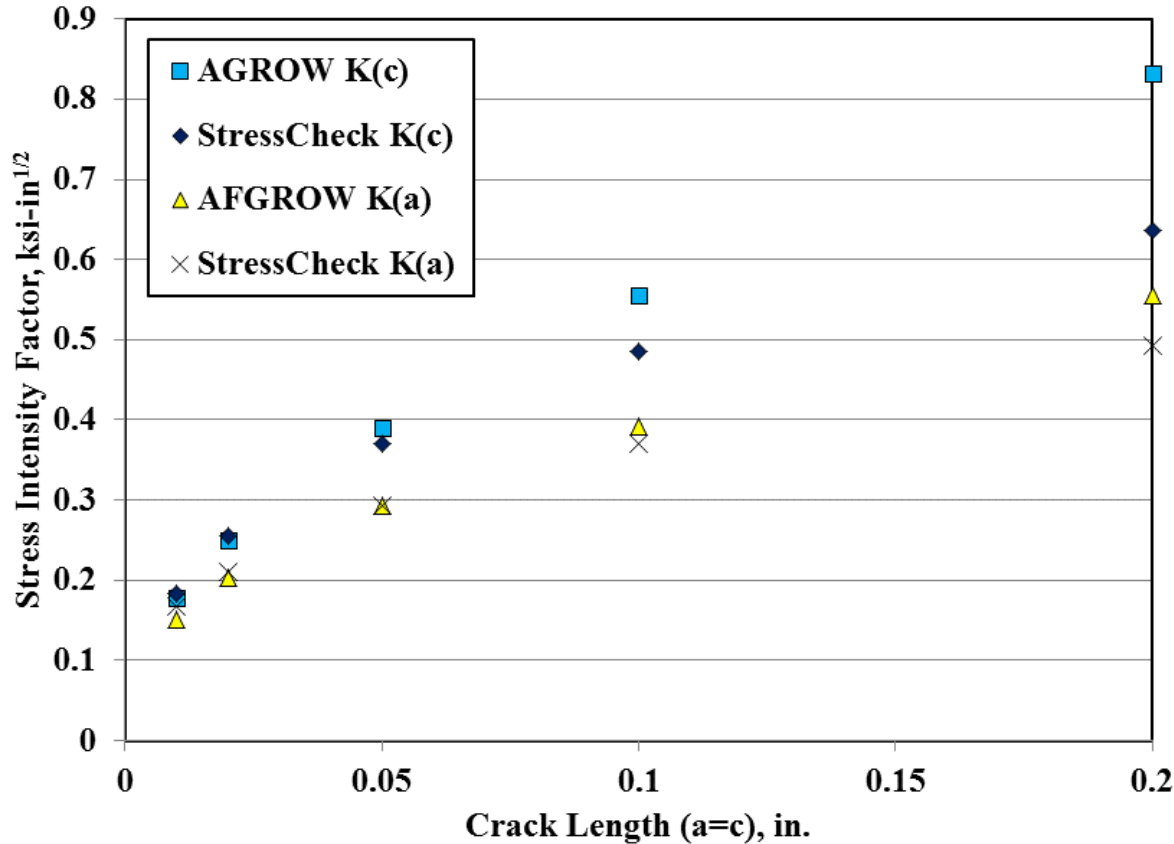
Constant amplitude loading

OK

Cancel

Note: My, original non stress corrected SMF was “1.0”.

Difference is Larger as Crack Dimensions Increase



Conclusions

- AFGROW's stress correction allows you to greatly increase the crack scenarios you can analyze
- Stress correction method may not be as accurate as you need

