



## What's New in NASGRO<sup>®</sup> Version 4.1

### Stress Intensity Factor (SIF) Library Improvements and Additions

#### *New crack cases based on weight function solutions:*

**TC13:** *Single through crack at an off-center hole in a finite-width plate with an arbitrary univariant stress gradient along a line normal to the hole axis.* TC13 is nominally the same geometry as TC03, but can accept as input either the stress gradient in the corresponding uncracked body, or a uniform remote tension stress. The  $r/t$  range is from 0.25 to 2.0.

**CC08:** *Single corner crack at an off-center hole in a finite-width plate with an arbitrary univariant stress gradient along a line normal to the hole axis.* CC08 is nominally the same geometry as CC02, but can accept as input either the stress gradient in the corresponding uncracked body, or a uniform remote tension stress. The geometry ranges include  $r/t$  from 0.25 to 2.0,  $a/t$  from 0 to 1, and  $a/c$  from 0.5 to 10.

**SC17:** *Surface crack in a plate with an arbitrary univariant stress gradient.* SC17 is nominally the same crack case as SC02, but the SC17 solution provides improved accuracy, a broader range of  $a/c$  (0 to 4.0), and corrections for cracks that are off-center in the plate.

Note that the current TC03, CC02, and SC02 solutions are being retained in NASGRO for legacy purposes and because TC03 and CC02 have some functionality not available in TC13 and CC08.

#### *Improvements to the existing SIF library:*

In-plane bending (stress quantity S2) was added to crack case TC03, through crack at an offset hole in a plate.

SIF compounding tables were added for crack case TC03.

Simple 1-D SIF compounding tables were added for corner crack case CC02 to complement existing 2-D tables.

For TC05, through crack at a row of holes, specifying two cracks from each hole was made possible.

## **Material Modeling Improvements and Additions**

NASMAT, the materials properties database module in NASGRO, was extended to obtain Walker equation and spline fits, in addition to NASGRO equation fits, for crack growth rate data. The NASMAT GUI was rewritten using wxWindows 2.x, to create a “notebook” version of this module.

A multiplicative (scale) factor can now be applied as a material parameter in order to simulate an environmental effect on  $da/dN$  data.

The threshold coefficient  $C_{th}$  is now user-changeable.

Material property values were improved for a number of materials in the NASGRO database.

## **Input, Output and other Operational Features**

Substantial speed improvements (2x to 10x) have been implemented for some NASFLA applications, especially for cycle-by-cycle (long block) crack growth computations and complex SIF solutions:

- New option available to re-compute the geometry factor in SIF solution on every cycle (previous default) or less frequently (e.g., after 0.5% crack growth).
- Repetitive calculation of opening-stress function was replaced by a table.
- Bivariant weight function crack cases CC05 and SC15 have been speeded up.
- Repetitive spectrum diagnostic messages were consolidated to reduce I/O time.
- Output to GUI status bar was made more efficient.

Improved output file transfer provides 10-20x speed-ups in returning to the user control of the input interface after computations are complete. This is particularly noticeable for runs with very large output files, especially when NASGRO is installed in a server/client environment. Loading of detailed output into the display window has also been speeded-up by almost 10x.

It is now possible to install the NASGRO 4.1 software package on a server.

An option is now available to specify spectrum load blocks in terms of flights or flight hours, and to output crack length and other results as a function of flights or flight hours. Output as a function of cycles is now the default.

The max-min-cycle long block format now also accepts min-max-cycle format files.

It is now possible to visualize (plot) the contents of a spectrum file in addition to being able to view the actual data contained in the file. The scale (limits) of the plots can be adjusted to enable the user to zoom in on a particular portion of the spectrum file.

Geometry factors are now available in the output.

The user is now allowed to input ranges of crack size to calculate stress intensity factors or geometry factors in NASSIF, and have the code automatically fill in the resulting table.

The crack size increment for life computation is now selectable by the user, overriding the default.

For the strip yield model, additional output is provided for the new option of user-selected transition  $da/dN$  values.

Windows clipboard functionality now allows easy cutting and pasting of grid rows and columns to and from spreadsheet programs.

A large number of GUI improvements have been implemented.

### **NASFORM**

A Fatigue Crack Formation Analysis (Initiation) capability is now available within NASGRO as a separate module having its own GUI. NASFORM contains a stress-life model, four different strain-life equations and the ability to input tabular strain-life data. ESAFATIG and FORM98 were adapted and incorporated into NASGRO as the new NASFORM module.