# What's New in 4.2

Stress Intensity Factor (SIF) Library Improvements and Additions

New crack cases based on weight function solutions:

TC11: *Single through crack in center of a finite-width plate with an arbitrary nonlinear stress gradient along a line normal to crack plane and symmetric with the centerline of the plate.* TC11 is nominally the same geometry as TC01, but can accept as input the stress gradient in the corresponding uncracked body in tabular or polynomial (sixth-order) form.
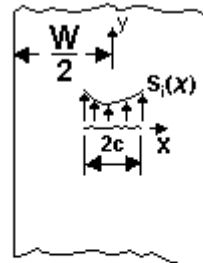
$$X = \frac{2x}{W}$$

$$i = 0, 1, 2, 3$$

TC12: *Single edge crack at in a finite-width plate with an arbitrary univariant stress gradient along a line normal to the crfack plane.* TC12 is nominally the same geometry as TC02, but can accept as input the stress gradient in the corresponding uncracked body in tabular or polynomial (sixth-order) form.
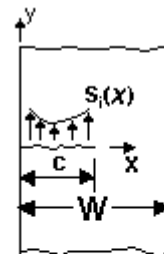
$$X = \frac{x}{W}$$

$$i = 0, 1, 2, 3$$

CC09: *Corner crack in a plate with an arbitrary <u>bivariant</u> stress gradient.* CC09 is nominally the same geometry as CC01 and CC05; however CC09 contains a new weight function solution defined in terms of general nonlinear bivariant stress distributions on the crack plane of the uncracked body. CC05 and CC09 have nominally the same capabilities, but CC05 was a first-generation bivariant solution with some accuracy limitations, and CC09 is a second-generation bivariant solution with improved accuracy covering a much broader range of *a*/*c* (0.025 to 40.0).
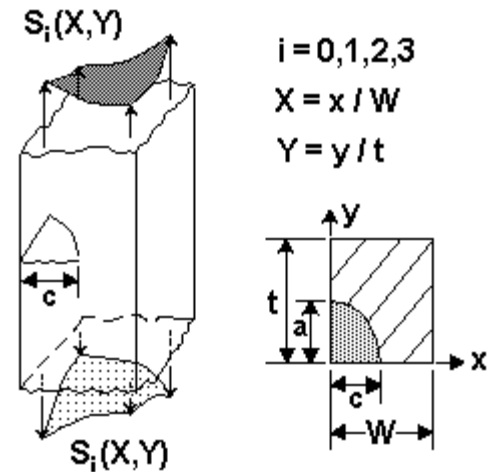
Note that the current TC01, TC02, CC01, and CC05 solutions are being retained in NASGRO for legacy purposes and because they have some functionality not available in the new weight function solutions.

Improvements to the existing SIF library:

- **TC13, CC08 and SC17:** the number of stress quantities was increased from one to four.

- **SC17:** capability to input stress distribution using a polynomial was added.

- **EC02:** additional weight function solutions were added providing improved accuracy and corrections for off-center cracks.

- **SC08:** bolt pre-load option was added.

Cyclic Shakedown Methodology

An option is now available to perform a cyclic shakedown analysis for the following fracture mechanics models: TC13, CC08, EC02, and SC17. The GUI provides the ability to input Ramberg-Osgood material property parameters for the shakedown analyses.

Temperature-Dependent Crack Growth

Spectrum input can now optionally include temperature as a parameter and temperature-dependent crack growth rate properties can now be input into NASGRO. A limited set of temperature-dependent crack growth property data are also supplied with the software.

There are three ways of inputting the operating temperature into NASGRO along with the fatigue load spectrum:

1. Manual input where an extra column is available for inputting the temperature for each load step.
2. Stored blocks (in the BLOCKT file, similar to the BLOCKS file) that have an extra column containing temperatures.
3. Standard NASGRO long block format with the temperatures input in an extra column just after the cycles column.

During the crack growth computations, for each step, the da/dN value for the operating temperature is computed, interpolating as needed between the input temperature-dependent crack growth property data.

Stress Spectrum Processing, Analysis and Visualization

New cycle counting options have been added for long blocks based on ASTM E1049-85 (1997) and are labeled "ASTM Rainflow" and "ASTM Range-Pair." The cycle counting options that existed in earlier versions of NASGRO had been modified from the ASTM counting methods in order to preserve the sequence of peaks. These earlier cycle counting options have been retained in v4.2 and have been renamed to "Modified Rainflow" and "Modified Range-Pair."

A number of options have been added to assist the user in analyzing and visualizing spectrum data. These include:
- Spectrum statistics (max, min, averages, etc.)
- Exceedance diagrams
- Stress level histograms
- R-value histograms

Residual Strength Diagrams

It is now possible, as an optional post-processing feature, to plot residual strength diagrams for the through crack (TC) fracture mechanics models based on fracture and/or net section yield. For all other cases, residual strength diagrams can be obtained based on fracture only.

Input, Output and other Operational Features

Context-sensitive help pages now include explanations for:
 - load block types
 - file formats for load blocks of type "long block" items available for display in output

GUI-based batch mode (running user-specified list of multiple input files sequentially within single session) now extended to NASSIF, NASCCS, and NASGLS modules.

The "Raw data dump to text file" plotting option now available as plot destination for all plots, with complete user discretion for file name and directory selection.

New user choices for block interval for printing detailed step output:
 - print every 2000th step in block (corresponds to v4.10 and prior, and v4.12)
 - print every step in block (corresponds to v4.11)

A new licensing scheme has been implemented such that every NASGRO distribution will require a license file, furnished by the NASGRO consortium manager, containing expiration date and feature restrictions, if any.