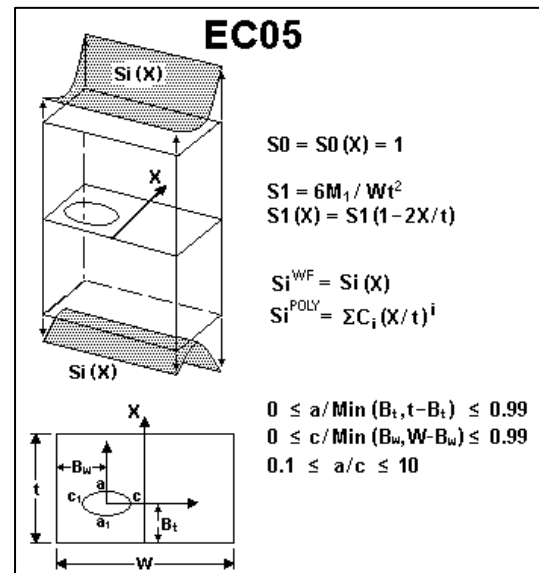
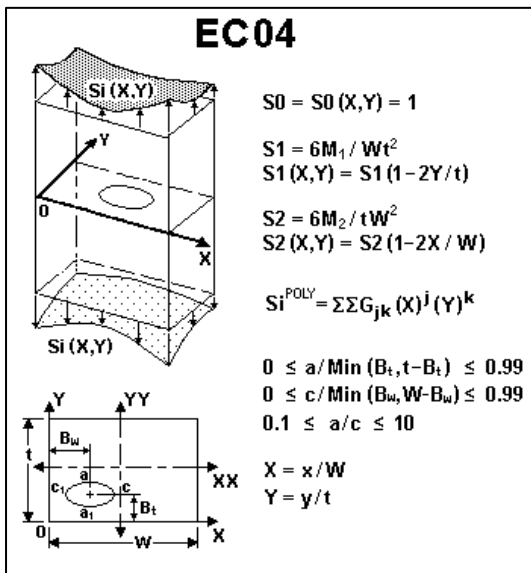
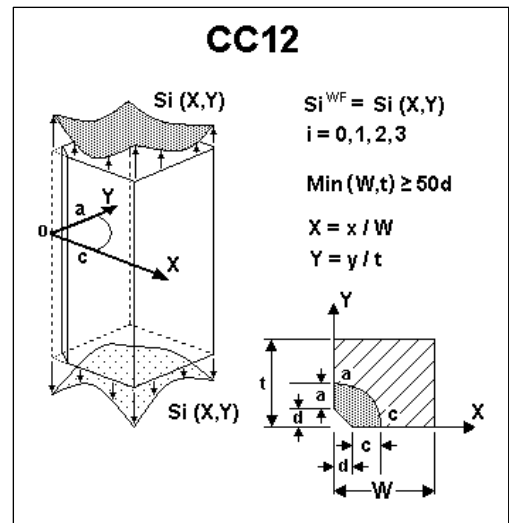


NASGRO v6.0 Release Notes

NASFLA Additions and Changes

New Stress Intensity Factor Models (also in NASSIF and NASCCS)

- CC12, corner crack spanning chamfer at edge of plate, bivariate weight function solution
- EC04, embedded crack in plate, bivariate weight function solution
- EC05, embedded crack in plate, univariate weight function solution using same reference solutions as EC04
- Net-section yield (NSY) expressions were added for these new stress intensity factor models



Improvements and Additions to Existing Stress Intensity Factor Models/Features (many also in NASSIF and NASCCS)

- For crack-at-hole univariate weight function solutions CC08, SC18, TC13, the option was added to specify two symmetric cracks at a centered hole under symmetric stressing. NSY expressions for this configuration were also added.
- For bivariate weight function solutions CC09, CC10, CC12, EC04, SC19, a new alternative 2D stress file input format which is more consistent with customary finite element stress output is now available.

- For all univariant weight function solutions (crack cases CC08, CC11, EC02, EC05, SC17, TC13), an alternative stress file input format that includes the full stress tensor was added. This alternative format is only available when shakedown is selected, since the additional stress terms only affect the shakedown calculation and not the stress intensity factor calculation (except as they change the post-shakedown stresses normal to the crack plane).
- For bivariant surface crack solution SC19, the coordinate system was redefined for consistency with crack cases CC09 and EC04.
- A new “Superseded Solutions” menu was added to the “Geometry Choices” on the Geometry Tab. Existing solutions CC05 and SC15 were removed from the regular menu of available solutions for corner cracks and surface cracks, respectively, and added to the new “Superseded Solutions” menu. CC05 and SC15 are first-generation bivariant solutions with known accuracy and performance limitations, and they have been superseded by CC09 and SC19, respectively. CC05 and SC15 are being retained in NASGRO at the present time for historical and comparative purposes only. Their use is not recommended.
- For crack cases TC01, TC02, TC03, TC05 and TC09, K solutions were changed to take into account more precisely the cycle-modifying effects of sign-independent stress quantities and their interplay with sign-dependent ones.
- Added crack transition feature to crack case CC12. The newly implemented feature transitions a CC12 crack to a through-thickness TC12 crack once the criterion for crack transition is met.
- Transition analysis from TC11 to TC12 was implemented.
- Implemented the effect of pin-load for TC03-to-TC02 transition, which was neglected after transition in previous versions, by converting pin-load of TC03 into additional remote tension and bending acting on TC02 after transition.
- NSY analysis for crack case CC09 was added to the polynomial stressing option.
- For crack cases TC12, CC09, CC11, and EC04 the residual stress effect was removed from the net section stress calculation.

NASFLA GUI Changes

- New GUI functionality was added to display the specific toughness values at each crack tip used by NASFLA for a given input file. The user is also now given the capability to override these default values and specify new critical toughness values on a tip-by-tip basis. In this case, the echo of material properties in the output will clearly indicate that these changes have been made.
- Optional user-supplied crack size limits were implemented as another condition to terminate a crack growth computation.
- Values and methods for the "NASA standard NDE" initial flaw sizes were changed to conform to NASA's new NDE requirements document (NASA-STD-5009), released in 2008.
- The Express Mode option was disabled on the Output Options tab whenever shakedown is selected for crack cases CC08, CC11, EC02, EC05, SC17, SC18, and TC13.
- The Express Mode option was disabled for crack case TC16.
- Crack case diagrams for SC03 and TC05 were amended with a note explaining the unique requirements for stress quantity S4 values in the NASGRO long block file format.

- Crack case diagrams for CC10, TC14, and TC15 were corrected to represent the solution more accurately.
- The polynomial expression is now properly displayed in the SC19 crack case diagram whenever the Crack Plane Stress Definition is set to Polynomial on the Geometry Tab.
- “Block” was added to all row labels in the parameter analyses scale factors grid.
- The GUI screens for NASFLA were enlarged to address previous overcrowding. The new GUI screens for the Geometry Tab were rearranged to display more lines of tabular stress input, and only one stress quantity is displayed at a time.
- Ramberg-Osgood material property input for shakedown analysis was moved from the Geometry Tab to the Material Tab.
- Updated the names of all the crack cases to a more unified and common format.
- For crack case DT03, data table plot legends now contain table column header values instead of numeric column numbers.
- Relocated the "Show list of frequently-used schedules" and "Add schedule to frequently-used list" buttons from the Load Blocks tab to the Build Schedule tab.
- Added message window whenever Residual Stress checkbox is checked stating that residual stresses are not used in the Net Section Stress (NSS) calculations for crack cases EC02, EC04, EC05, CC08-CC11, SC17-SC19, and TC11-TC13.
- Expanded spectrum file editing logic to include a check and correction for non-turning points in the spectrum file after “spectrum ordering” is used.
- For crack case SC19, pre-v6.0 input files will now be converted to follow the new coordinate system implemented for this crack case.

NASFLA Fixes

- The crack opening function (f) was set equal to the effective stress ratio (R) if $R > 0.99$.
- For BE02, a coding error resulting in zero crack growth rates during crack propagation was fixed, and the irrelevant accuracy check for crack aspect ratio c/c_1 was removed.
- For BE03, a coding error in the geometric check was fixed.
- Express mode calculations were corrected for the following crack cases: CC11, EC02, SC03, SC04-SC10, SC12-SC14, SC17-SC19, TC07, TC11, TC14, and TC15.
- Express mode has now been implemented for the following crack cases, which previously ran in regular mode (unknown to the user) when the express mode button was pressed: All BE solutions, all DT solutions, PS01, and all SS solutions.
- An error was fixed in TC03, so that life calculations are no longer invariant with the sense of the applied in-plane bending, S2.
- A problem was fixed with the EC02-SC17 transition.
- The code evaluating the beta (surface correction) factor, BT, when $R > 1$ (which arises when both $S(t_1)$ and $S(t_2)$ are negative), was modified, forcing BT in such cases to equal 1.
- A problem reported of non-zero crack growth even when $K_{max} = 0$ encountered while using the Walker-Chang material model was traced to a default setting for R of 0. This was fixed by changing the default setting in the K selector routine to a large value.
- A warning message indicating cycles with $R > 1.0$ was corrected to indicate that the triggering check was actually performed for $R \geq 1.0$.

- The procedure for selecting NASA standard NDE flaw sizes was corrected. Previously, when the user changed the "Initial flaw option" radiobox selection to "NASA Std NDE", no option to select the NDE type was presented, and the NDE rules were immediately applied to the entered thickness against the first allowed NDE type. Now, after "NASA Std NDE" is selected, the user may select the desired NDE type (method) before the NDE rules are applied to the entered thickness value.
- A problem found when crack transitions occurred during iterations when strip yield model was selected was corrected.
- A program crash caused by severe net section yield during shakedown computation was corrected.
- Computation speed for SC19 was improved by turning off the dynamic K interpolation.
- A problem isolated by the 2D Optimum Point Spacing routine when trying to interpolate univariant stress fields was corrected.
- An Optimum Point Spacing related problem for SC17 transitioning to TC11 was corrected.
- Erroneous output plotting behavior when choosing a/c or Klimit was corrected.
- An error in DT03 encountered when clicking the Plot Table Data button was corrected.
- A problem with residual strength calculation for CC01 was corrected.
- A problem was corrected with transposed file headers for plot text files.
- Overlap of some GUI screen controls was resolved for TC01 and TC02.
- A correction was made in the GUI, eliminating the checks comparing DK in the 2D Material crack growth table against (1-R) Kc and DK0. It was determined that the previous checks as formulated were inordinately stringent in certain cases, and redundant as well, since the checks were (and are) being performed correctly in the core DLL, and so can be removed from the GUI without loss of rigor.
- An errant error message received due to incorrect reading of compounding table during validation was corrected.
- The formula for calculation of Stress RMS value in the spectrum file statistical analysis function was corrected.
- Anomalies in the solution for TC05, in which K "oscillates" as a function of crack length for certain values of H/D have now been eliminated by using Hermite interpolation, whose dimensionality during the calculation phase has been reduced to one, making the process more efficient.
- An error in labeling of the NASBEM solution table when running BE03 has been corrected, clarifying what the numbers in the table actually represent. An incorrect tip value used in the proportioning arithmetic was corrected, as was a potential error when row and column numbers are unequal.
- Corrected a problem which prevented any input file containing a "Downing Algorithm I" cycle-counted spectrum file from running.
- Added a verification check when plotting stresses to confirm that all stresses chosen have been defined before plotting proceeds.
- Corrected spectrum file visualization logic for calculating R-values. Each cycle in the spectrum will now be examined for determining the proper method of calculating R-values (t1/t2 or t2/t1), whereas previously, only the first cycle in the spectrum determined the method for the entire spectrum.
- Fractional cycles are now recognized in the calculation of the overall spectrum statistics.

- The Material properties “a0” and “Kth(s)/Kth(l)” are now displayed on the Material Tab only for the Data Format selection of “NASGRO equation constants”.
- Corrected errors resulting from the function used to perform geometry checks on compounding tables that contained an incorrect index for retrieving the initial flaw size from the geometry table.
- When crack grows outside the bounds of compounding table, the computation is terminated and the out1 file is now properly saved.
- With compounding capabilities turned on, the fatigue life computed by the express mode no longer differs significantly from that calculated by the regular mode for crack cases TC01-TC04 and TC06-TC10.
- An additional check for crack size limits was added in the transition coding such that the computation is properly terminated before or after transition, as needed.
- For crack case TC15 additional validation checks were added to the thickness variation grid, checking values for ascending order, within the normalized range of 0.0 to 1.0.
- Corrected an error, shown as "inside-outside" coding error by OPS, which occurred when OPS tried to identify which iso-stress contour was inside and which was outside.
- For crack cases CC08, SC18, and TC13 when the checkbox "Two symmetric cracks at a centered hole under symmetric stressing" was checked, a verification on the geometry table was immediately performed to require that the hole center offset B is equal to half of the width W. The checkbox would automatically be unchecked if this test failed. This caused a problem if the geometry grid had not yet been filled in. Now, this verification check is performed only when the Run button is pressed, so the checkbox may now be checked independently of the geometry grid being completed.
- A number of fixes to crack case CC12 (corner crack at a chamfer) have been made:
 - Corrected error when checking geometry grid values for the requirement of c/W not to exceed 0.9.
 - Revised the crack case diagram to more clearly convey the proper definitions of crack tips 'a' and 'c', and the chamfer depth 'd'.
 - Corrected problems of no output for the user-specified stress distribution when OPS was used, and inconsistent FCG results between OPS and non-OPS results.
 - Corrected error in geometry check for the required condition $\text{Min}(W,t) \geq 50d$.
- When inserting rows, deleting rows, or deleting empty rows from the Residual Stress Grid, the blue background color was lost. This has been fixed.
- Corrected an error in the batch file for crack case TC01 with compounding tables enabling proper data table plotting and running.
- Crack case TC12: Corrected coding error preventing functionality of NASA std Flaw Sizes. This feature will now work correctly for this crack case.
- Crack case cc12: Non-OPS plotting of 2D stress files would not work if the user-supplied input stress file did not contain a space between the y-coordinate and the stress value.
- The bending stress was lost in the transition from SC02 to TC01 and is now correctly accounted for in the transition.
- The 2-D table selections for Data Format on the Materials tab when Data Source selection is 'NASGRO material file' have been removed since there are no 2-D tabular material data in this file.

- Screen controls for SIF Compounding were shown erroneously for elastic-plastic mode and have been removed.
- The "Fraction of crack size to be used for crack growth calculation increment" checkbox was shown erroneously on Output Options tab for elastic-plastic mode and has been removed.
- Crack case CC08: Residual stress data had no effect on calculations. Fixed.
- Crack case BE02: corrected batch file to properly output the crack size ratio $c/c1$.
- Spectrum files in Time-Mean-Range format were causing the GUI to crash. This has been corrected, and converted NASGRO-format files are now being properly created.
- If a spectrum file in "S(t1), S(t2), cycles" format did not contain a newline character after the last line, that line would not be processed. This has been corrected.
- For some pre-v5.0 input files, spectrum files in the "Time-Mean-Range" format could not be run. This has been corrected.
- Data table crack case DT04 has been deactivated pending further study.
- Expanded the size of "details to show" and "details to plot" list boxes and the output viewing window on the Computations tab to take advantage of the new larger GUI window size.

NASSIF Fixes

- Corrected batch file for CC12 crack case to contain value for chamfer depth "d".
- Corrected functionality when plotting stresses to skip those stress quantities not defined.

NASCCS Addition & Changes

- The ability to calculate the "threshold crack size," the largest crack size at which no crack tips will propagate under specified cyclic loading at a specified crack aspect ratio, was added. This new feature is limited to non-interaction mode (i.e., no load interaction models can be specified). Threshold properties can be entered in conventional NASGRO equation format or a simple tabular format.
- Added crack cases EC04, EC05, CC11, CC12, SC19, and TC15 to NASCCS.
- Enhanced crack cases CC08, SC18, and TC13 to handle two symmetric cracks.
- Modified code to allow a user to enter data points of 1-D threshold table in random order in threshold crack size determination.

NASMAT Additions, Changes, and Fixes

- The "Enter New Data" page was split into two pages: the "Enter da/dN Delta K" page and the "Enter a vs. N" page, facilitating the incorporation of new conversion capabilities.
- Two 2-dimensional standard specimen crack cases for semi-elliptical surface cracks in a plate under uniform remote tension loading, SS13 and SS14, were added to the library of solutions accessible to NASMAT. SS13 is based on SC01, and SS14 is based on SC17. Direct calls from the GUI to the solutions (in the NASFLA module) were implemented. K_{max} and ΔK calculations in the GUI were removed.

- The following modes of loading: (a) Constant R (with varying loads), (b) Constant Kmax, and (c) Varying R and Kmax, were added to the single loading type (constant loads) previously available for conversion, plotting, storage, and access by NASMAT.
- A problem with plotting toughness data was fixed, allowing plots to be made without crashing.
- Changes were made to the toughness file "naskcdta.dat" and the categories file "identify.dat" to eliminate inconsistencies between them.
- Enlarged the text box to display the entire value of R and Kmax in the "choose Plot/Fit Data" page.
- Raised the limit to 1000 on the number of data points in a single set of R-value data that can be curve fit (previously set at 500, in contrast to the 1000 of the GUI).
- Added a new Fortran driver running in tandem with the GUI to obtain K values for standard specimen geometries, overcoming the limits on the number of data points with the previous method.
- Restored and fixed the ability to input da/dN- Δ K data from multiple text files.
- Fixed NASMAT data limits for total number of da/dN points.
- Removed limit of 36 data points in 2-D a&c vs N input.
- Miscellaneous fixes/changes for specific material IDs:
 - Fixed a spurious data point in material ID P3ED11AB01G2 for R=0.3
 - Removed the M7QC21AB01C3 entry, with R=0.1
 - Removed the B5BFC2AB01B1 entry, with R=0.061
 - Removed the three repeated entries of S0BA16AB01Ax with R=0.7

NASFORM Changes & Fixes

- The NASFORM GUI was converted to use the 2.8.3 version of wxWidgets, the GUI and tools library. This change is transparent by-and-large to the user, except where it fixes certain crashes that occurred with the previous version of the GUI.
- For Stress-Life analyses, the "max, min, cycle" format should only be used only in tension.