

NASGRO v8.2 Release Notes

Stress Intensity Factor Models:

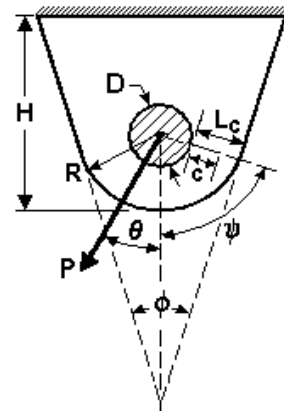
- **New Lug Solutions:**

- **TC30 - Through Crack at Hole in Obliquely Loaded and Tapered Lug**
- **CC23 - Corner Crack at Hole in Obliquely Loaded and Tapered Lug**

Two completely new lug solutions are now available that model a through-thickness (TC30) or a corner crack (CC23) at the hole of a symmetric tapered lug under oblique pin loading. These are new univariant weight function (WF) solutions that utilize nonlinear stress distributions obtained from a large matrix of finite element analyses (FEA). They are distinct and separate from earlier lug solutions that assumed straight, short lugs under vertical loading.

These models consider a neat-fit pin/hole condition, and the FEAs employ state-of-the-art contact algorithms to include the friction and contact between the pin and the lug. Cracks initiate at the location of maximum opening stress that maintains the minimum crack growth ligament. These WF models can also accommodate residual stresses. Additional detail on the development and verification of these new lug models is contained in Appendix C of the User's Manual.

TC30



$$S_3 = P/Dt$$

t = thickness

$$1.25 \leq 2R/D \leq 10$$

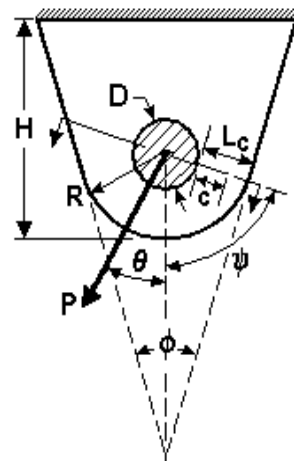
$$1 \leq H/2R \leq 2$$

$$0^\circ \leq \phi \leq 90^\circ$$

$$0^\circ \leq \theta \leq 90^\circ$$

$$0 \leq c/L_c \leq 0.999$$

CC23



$$S_3 = P/Dt$$

$$0.1 \leq D/2t \leq 10$$

$$1.25 \leq 2R/D \leq 10$$

$$1 \leq H/2R \leq 2$$

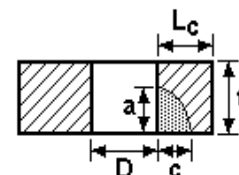
$$0^\circ \leq \phi \leq 90^\circ$$

$$0^\circ \leq \theta \leq 90^\circ$$

$$a/c \geq 0.1$$

$$0 \leq a/t \leq 0.9$$

$$0 \leq c/L_c \leq 0.9$$



- **Revisions to CC16 & CC17 Finite Width Correction Factors for Pin Loading**

The stress intensity factor solution CC16 combines solutions from the Fawaz-Anderson database of wide-plate solutions with finite-width and offset correction factors to compute K-values. These solutions apply to elliptical corner cracks at offset holes in finite-width plates under tension, out-of-plane bend, and pin loading. CC16 was first implemented in NASGRO version 7.1. It was discovered during the v8.0 development cycle that CC16 results for pin-loaded holes (and only pin-loaded holes) in narrow plates could be excessively non-conservative. Therefore, a modified finite-width correction factor for pin-loaded CC16 was developed based on the CC08 solution, which had been modified to accommodate pin-loading and to widen the geometry range significantly. Further study of this revised solution indicated that, while accurate for narrow plates with centered holes, these values could be over-conservative for narrow plates with holes highly offset from the centerline. Therefore, a second CC16 revision focusing on the hole-offset correction factor was developed, verified, and implemented in v8.1a. Once again, the revised CC16 solution only changed K-values under pin-loading – solutions for tension and out-of-plane bending have been unaffected. These solutions were applied to CC17 starting in 8.01 and 8.1f.

Even further study revealed non-physical oscillations – “peaks” and “troughs” – in the solution introduced by the interpolation process. These “peaks” and “troughs” only influenced relatively small cracks ($a/t \leq 0.2$) at small holes ($D/\min(2B, 2 \times (W - B)) \leq 0.5$). The oscillations themselves tend to reduce the overall effect on fatigue lives. Some portions of the fatigue crack growth curve will give crack growth rates that are too low due to low stress intensity factor values. Other portions of the fatigue crack growth curve will give rates that are too high due to high stress intensity factor values. It is unclear exactly how these changes will impact fatigue crack growth lives overall, but the errors may effectively cancel out in some cases.

Several attempts were made to eliminate the non-physical oscillations in the solution. Adding more points to the solution matrix shifted the oscillations to other parts of the solution space, even if the solution matrix tripled in size. NASGRO 8.2b changed the solution space in only the small crack regime and left the remainder of the solution space untouched. Unfortunately, this modification introduced a discontinuity in the stress intensity factor solution at the boundary ($a/t = 0.2$). This discontinuity was triggered by fundamental differences in the two interpolation schemes. This approach has been abandoned.

NASGRO 8.2f takes the radical step of changing the entire parameterization for pin-loaded CC16 to eliminate the non-physical oscillations. This approach eliminates the non-physical oscillations and improves the solution quantity. It does not introduce any discontinuities into the solution. The new parameterization scheme interpolates over the relative hole size rather than over the relative crack depth. Consequently, stress intensity factors in NASGRO 8.2f will differ from stress intensity factors in earlier versions of NASGRO. These changes only affect cracks under pin-loading. Again, it is unclear exactly how these changes will impact fatigue crack growth lives overall, but the

differences may effectively cancel out in some cases. Preliminary investigations with these new pin-loaded geometry correction factors have revealed lower lives for: 1) cracks on the long ligament side of highly offset holes as $0.5 \times D/(W - B) > 0.5$ and 2) cracks in very thick plates where $D/2t \rightarrow 0.1$. In this second case, additional studies suggest that both the old and new geometry correction factors are systematically conservative.

The new correction factor routines are based on a look-up table of nearly 53,000 solutions at various non-dimensional ratios, again based on the current CC08 solution. The look-up table was derived by comparing CC08 solutions for wide plates with CC08 solutions for narrow plates with offset holes. For a given geometry, the routines determine the appropriate correction factor by interpolating over the relevant solution space that includes both finite-width and hole-offset effects. These new correction factors provide improved CC16 solutions for pin-loading that are usually within 10% of benchmark stress intensity factor solutions, as evaluated by a matrix of 162 benchmark K-solutions from 3D finite element models with explicitly meshed crack fronts.

CC17 uses the same pin-loaded geometry correction factors as CC16. Consequently, these modifications to the geometry correction factors propagate to the pin-loaded solutions of CC17 as well. Stress intensity factors computed in NASGRO 8.2f show similar agreement to benchmark values as the stress intensity factors in NASGRO 8.1f.

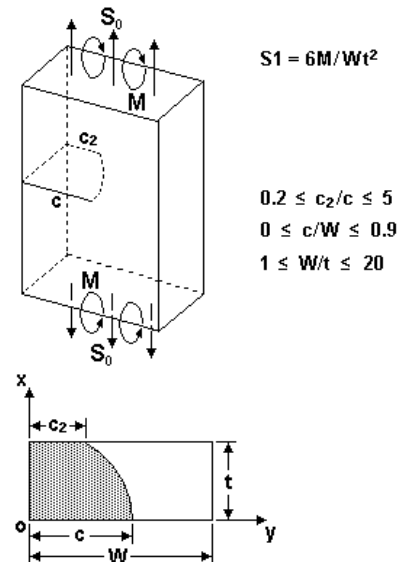
Additional details on the development and verification of the CC16/CC17 finite width correction factor for pin loading are provided in Appendix C of the User's Manual.

- **New Curved Through Crack at Edge of Plate (TC28):**

TC28

This new univariant weight function (WF) solution models a through crack with a *curved* crack front at the edge of a plate. The two crack tips, respectively denoted by c -tip at the front surface and c_2 -tip at the back surface, are assumed to be located along a curved crack tip perimeter described by an ellipse centered at the bottom-left corner of the rectangular cross section.

TC28 can accept remote tension and linear out-of-plane bending stress loadings (S_0 and S_1) or it can accept a univariant stress gradient in the thickness direction $S(X)$. Additional detail on the formulation of this model is contained in Appendix C of the User's Manual.



- **New Through Crack in L-section under Remote Loading (TC31 & TC32):**

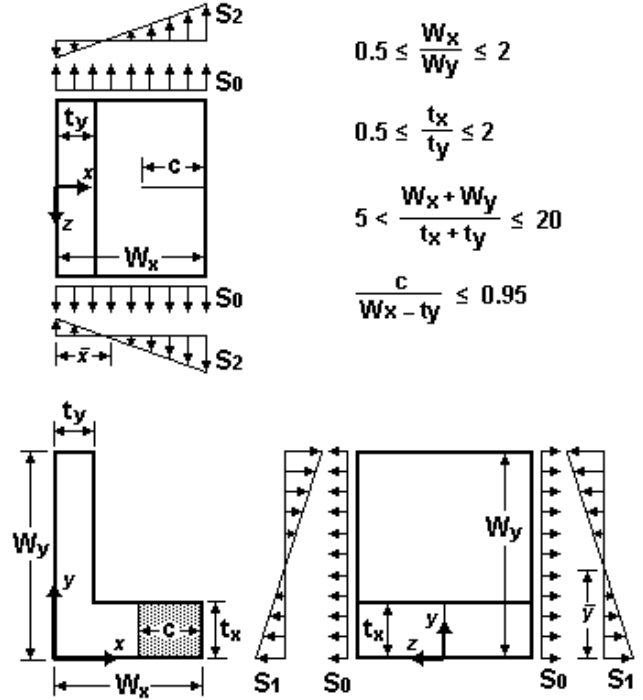
The TC31 solution features a through crack in *one* leg of an L-section under remote stresses. TC31 places the through crack on the cross-section and normal to the axial length of the structural member. TC31 restricts the through crack to be straight and normal to free surfaces. TC31 contains stress intensity factor (SIF) solutions for cracks under remotely applied uniform stresses and univariant stress gradients. TC31 limits the crack to one leg of the L-section, i.e., it does not turn the corner of the section. At this time, TC31 does not restrain bending.

The TC32 solution features a through crack in *two* legs of an L-section under remote stresses. TC32 places the through crack on the cross-section and normal to the axial length of the structural member. TC32 restricts the through crack to be straight and normal to free surfaces. TC32 contains SIF solutions for cracks under remotely applied uniform stresses and univariant stress gradients. TC32 considers the crack to be in two legs of the L-section, i.e., it has turned the corner of the section. At this time, TC32 does not restrain bending.

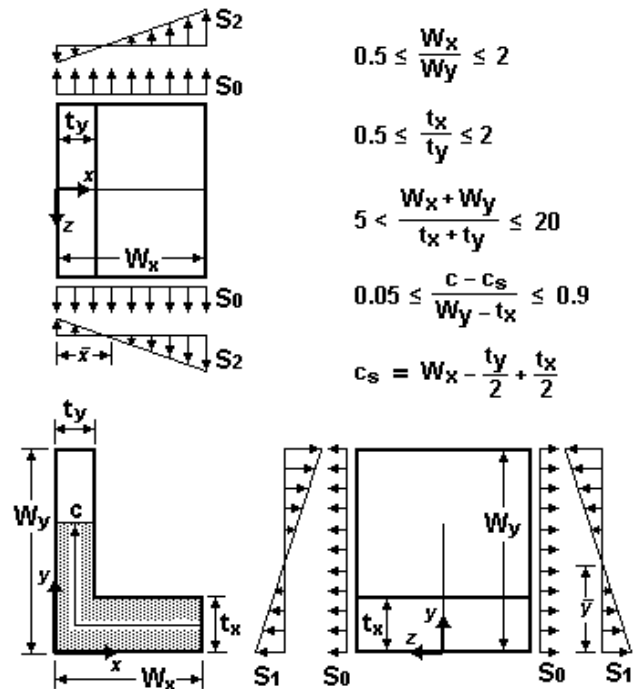
TC31 will transition to TC32 with no life (zero cycles) being expended as the crack grows around the corner. This is a simplifying, but conservative, assumption.

Additional detail on the development and verification of these new models for through cracks in an L-section is contained in Appendix C of the User's Manual.

TC31

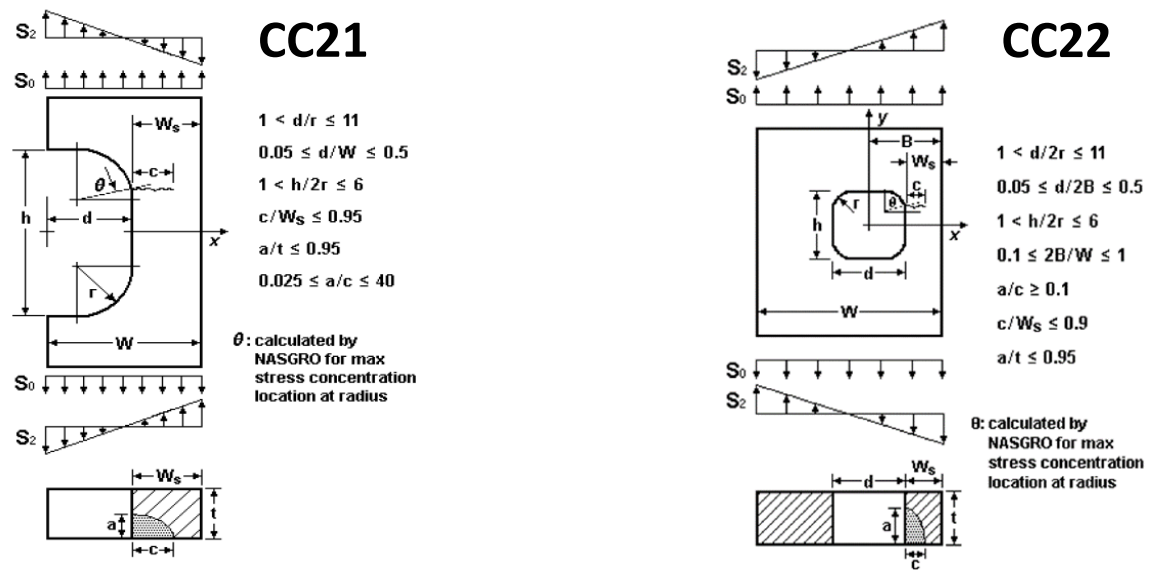


TC32



- **New Corner Crack at Rectangular Cutout with Rounded Corners (CC21 & CC22):**

The crack configurations for CC21 and CC22 are very similar to TC25 and TC26, respectively. Both models represent cracks at the rounded corner of a rectangular cutout in a plate. CC21 models a corner crack at a rectangular cutout at the edge of a plate, whereas CC22 models a corner crack at an internal (offset) rectangular cutout in a plate. The initiation site of the corner crack, the highest stress concentration location, designated by the angle θ , is numerically determined in accordance with the approach used for TC25 and TC26. These corner crack models utilize the crack opening stress extracted along the crack plane and compute the stress intensity factors at both surface tips using the weight function formulation, as described in Appendix C of the User's Manual.



- **Extension of K Solutions for Arbitrary Internal Notches to Thin Sheets**

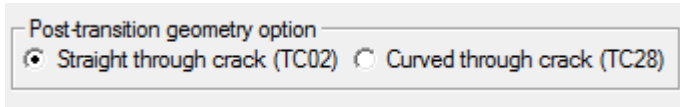
The geometry limits of the following internal notch (slot or elliptical hole) models were extended to better handle thin sheets: CC14, TC18, and TC26. The new limits are shown in the GUI for each crack case as well as in Appendix C.

- **Tension/Bend Option Added to CC11, TC11, and TC12**

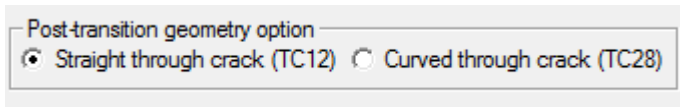
These three univariant weight function models previously only permitted input of stresses on the crack plane (in tabular or polynomial formats). The capability was added to enable users to now provide tension and bending remote loadings.

- **Optional Transitions from Corner Crack in Plate to Curved Through Crack**

With the implementation of the new through crack with a *curved* crack front at the edge of a plate model (TC28, discussed above) the user now has the ability to optionally select TC28 as the post-transition geometry for the following corner crack in a plate models: CC01, CC09, and CC11. The default remains a transition to a *straight* crack front model. On the geometry page, the GUI provides radio buttons for the user to optionally select the curved through crack (TC28) as the post-transition option:



CC01



CC09 & CC11

- **Superseded Models:**

The following crack cases have been moved to the “superseded solutions” group:

- CC03 – (use CC19 instead)
- SC12 – (use SC32 instead)
- EC02 – (use EC05 instead)
- BE02 – (use TC23 instead)
- BE03 – (use HC01 instead)

These models may still be used but are no longer recommended. They are being retained in the “superseded solutions” group for historical and comparative purposes. Note that the “Boundary Element Solutions” category has also been removed from the menu of crack case categories, since both BE solutions have been moved to the “superseded” category.

- **Revised Geometry Limits & Transition Criteria for WF Solutions**

- A comprehensive review of geometry limits and related transition criteria for “newer” WF solutions led to some minor adjustments for consistency between solutions
- Newer limits are less restrictive and may lead to slight increases in calculated lifetimes, although differences may be very small in some cases
- Notable changes:
 - SC30 & SC31: limits on crack center offset removed entirely
 - SC30 & SC31: limits on $c/\min(B, W-B)$ now consistently 0.95 (some previously 0.9 or 1.0)
 - SC18: limits on crack center offset (T/t) removed entirely
 - CC09 and CC11: a/t and c/W limits now consistently 0.95 (some previously 0.9)

NASGLS Upgrades & Additions:

- The NASGLS computing engine has been upgraded and is now able to handle 3-dof and 4-dof crack cases.
- The following crack cases have been added to the NASGLS module:
 - CC11, SC30, SC31, EC04, EC05

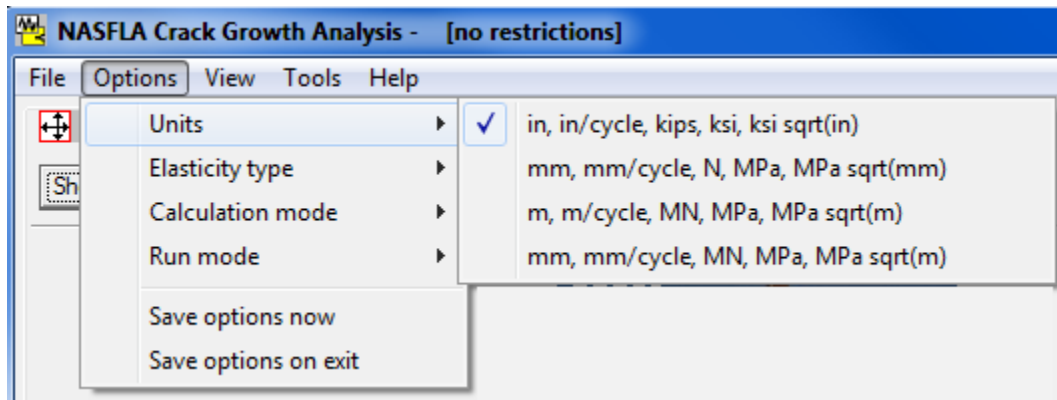
New Sets of Metric Units

Two new sets of Metric units have been added to NASFLA, NASSIF, and NASCCS. These are:

m, m/cycle, MN, MPA, MPA sqrt(m)

mm, mm/cycle, MN, MPA, MPA sqrt(m)

The user can now choose between four sets of units as shown below by clicking on Options/Units from the main menu bar in NASFLA, NASSIF, and NASCCS as shown below.

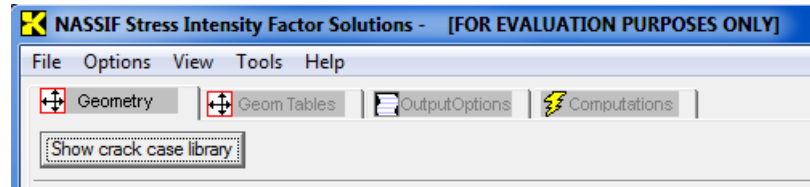


Additional points to note about these two new units systems:

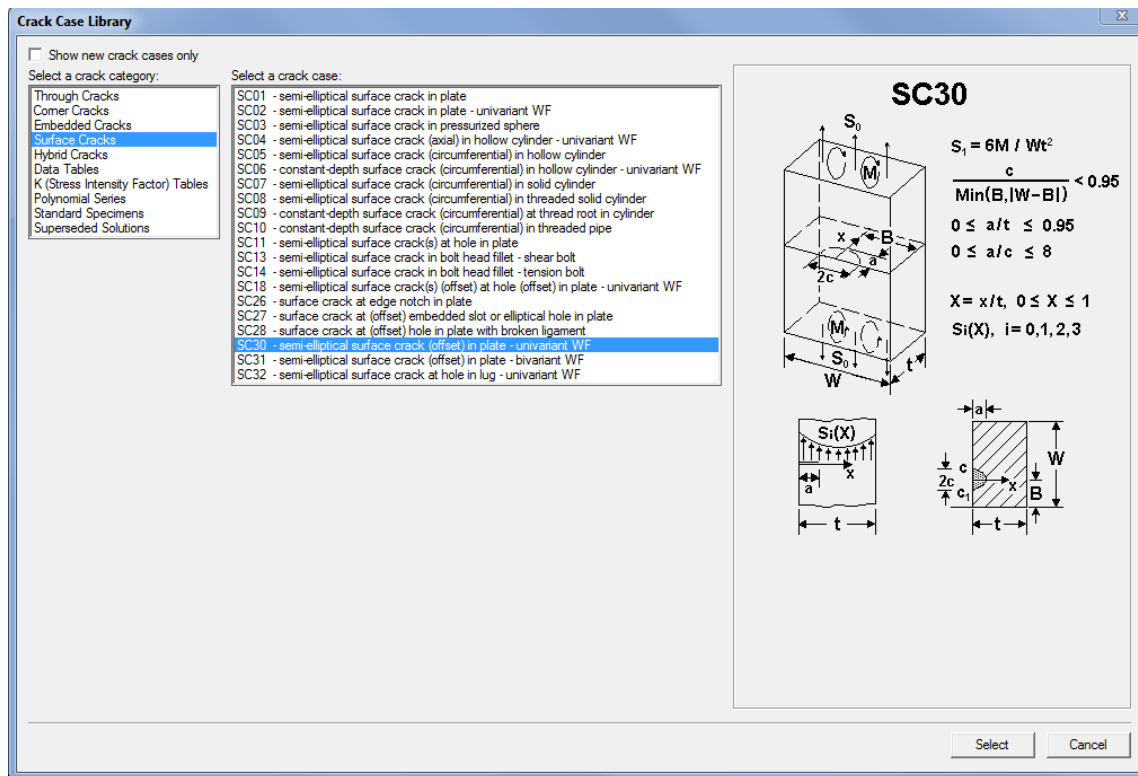
- These two new systems are not available in NASGLS, NASBEM or NASFORM.
- These two new systems are not available for the “Constant Closure” or “Strip Yield” load interaction models.
- The {m, m/cycle, MN, MPA, MPA sqrt(m)} units system previously existed in NASMAT. Now, NASMAT fits performed in this set of units can be saved to the NASFLA materials file.
- The {mm, mm/cycle, MN, MPA, MPA sqrt(mm)} units set is not be supported in NASMAT at this time.

New GUI for Crack Case Selection

The graphical user interface (GUI) used to choose and select the NASGRO crack cases (stress intensity factor solutions) has been re-designed for all modules (NASFLA, NASSIF, NASCCS, and NASGLS). When any of these modules are first opened a button named “Show crack case library” appears as shown below:

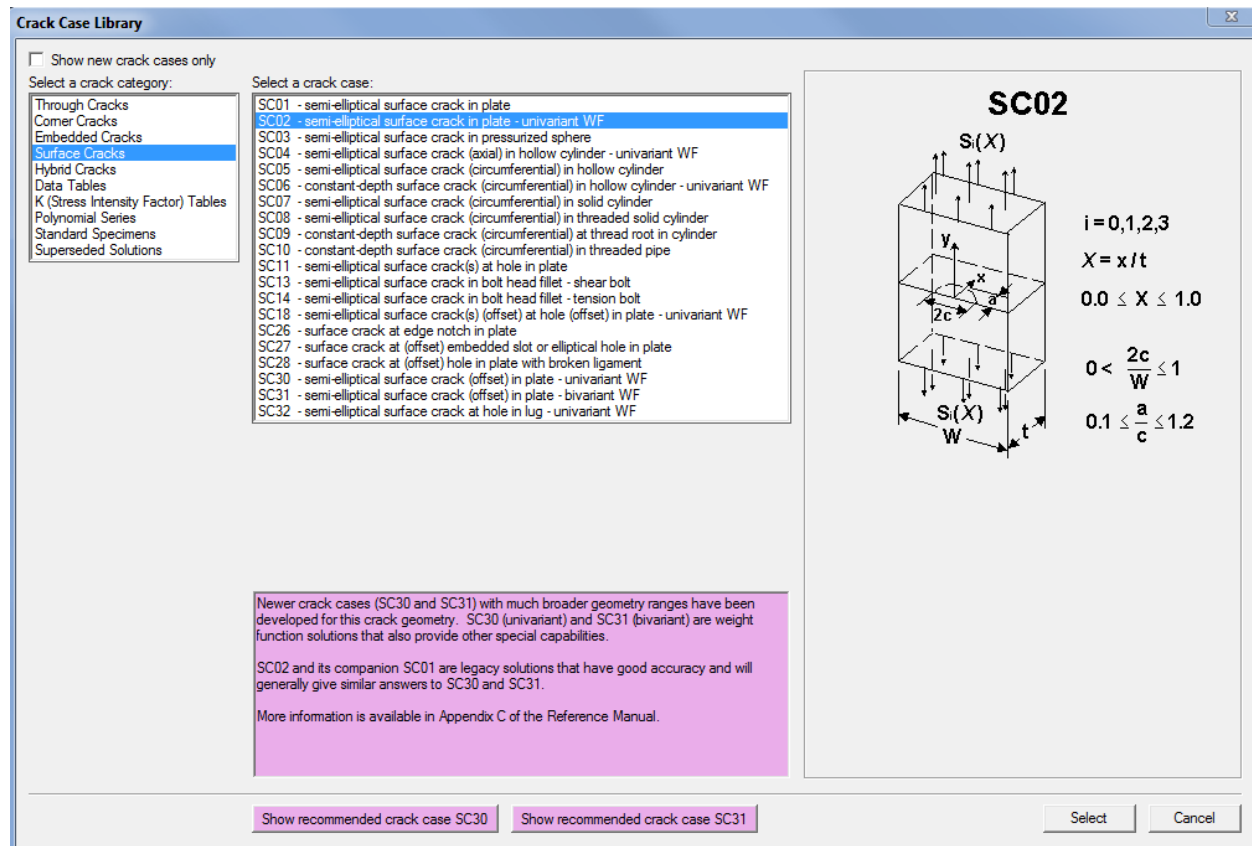


Clicking on the “Show crack case library” opens up the Crack Case Library screen which enables the user to first choose the crack category and then the crack case (and the drawing of the model and limits are automatically displayed). Note that the previously used pull-down menus have been removed. An example is shown below using SC30.

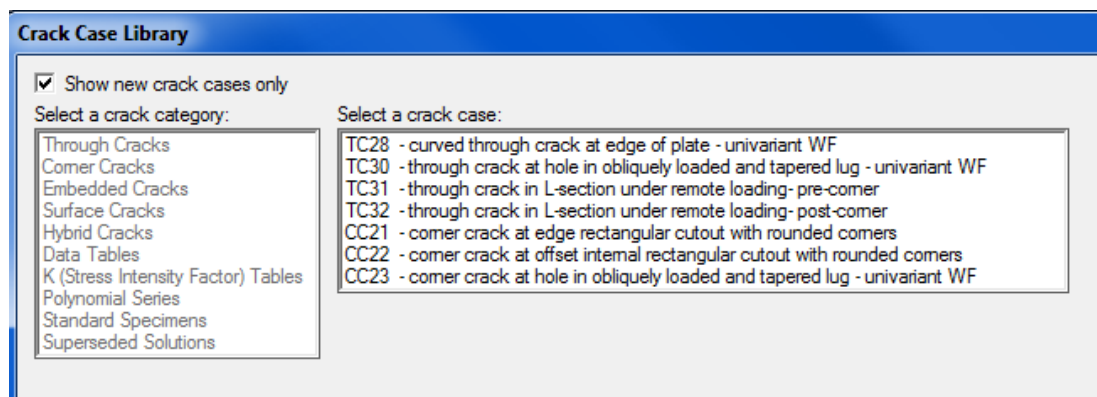


A key feature of this new GUI for displaying and choosing crack cases is that the user can easily view different crack cases (within a chosen crack category) and have the drawing displayed automatically for easy review and deciding on which model to use in the analysis. Once that decision is made, then the user would click on the “Select” button to proceed with specifying the geometry details and continue setting up the analysis for that module.

Previous versions of NASGRO displayed pop-up notes or warnings for a number of crack cases that provided guidance to the user regarding the limitations of some of the legacy models and recommendations for using newer crack cases instead. These pop-ups have now been replaced by text boxes displayed directly in the GUI as shown below using SC02 as an example. Note that below the text box are buttons that allow the user to show the recommended model choices before making the final model selection for use in the analysis.



There is also a checkbox at the top of the Crack Case Library screen that allows the user to display the new crack cases first introduced in this version, as shown below. The user can now easily explore the features of the new crack cases without having to search through the entire lists of different crack categories and cases.



Saving User Changes to 1D and 2D Tabular Material Data to User File

After loading 1D or 2D tabular user material data from file into the NASFLA GUI, any manual changes made to that data on-screen can now be immediately saved to the user file, using the new button “Save Data To User File”. Previously available only for the “NASGRO equation” data format, this feature is now also available for both “1D tabular” and “2D tabular” user data formats. Changes made to existing user tabular data, as well as “New (tabular) Data” that is entered, may be saved to the user tabular material file. The changed data can be saved to file under the same ID, or as an entirely new material ID, to the same user file from which the original data was read. “New Data” entered will always be saved as a new material ID to the tabular material file that is specified by the user. If a new material ID is created from changes to existing file data, that material ID will also be loaded automatically into the NASFLA GUI’s Material tab after it has been added to the file.

Configuration Control Improvements:

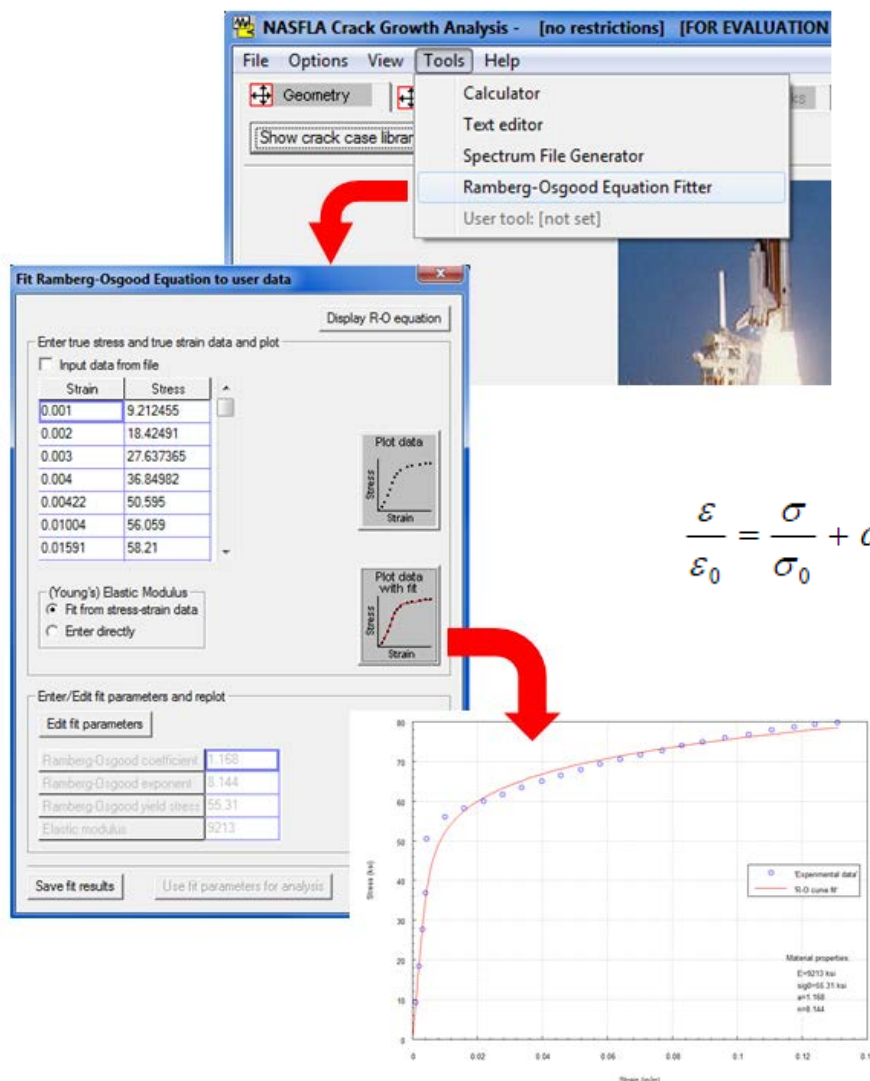
Profile files have been updated to allow compatibility between versions. Any profile generated by version 8.2b or later will now be compatible with future versions of the Configuration Control GUI. Previously, profiles were not designed to be compatible between versions.

Menu items have been added to duplicate the existing functionality of the following buttons: “Add/Edit Manager’s Notes”, “Remove All Restrictions”, and “Create Control File” located at the bottom of the Configuration Control GUI. This is to accommodate some laptop users whose displays and screen resolutions were not capable of displaying the full height of the GUI, preventing the display of those buttons.

Ramberg-Osgood Stress-Strain Curve Fitting Tool:

An analysis tool to curve-fit tabular true stress-strain data to the Ramberg-Osgood equation was developed and is accessible via the “Tools” menu at the top of the NASFLA GUI. The units used will be those in effect by default or as changed using Options/Units.

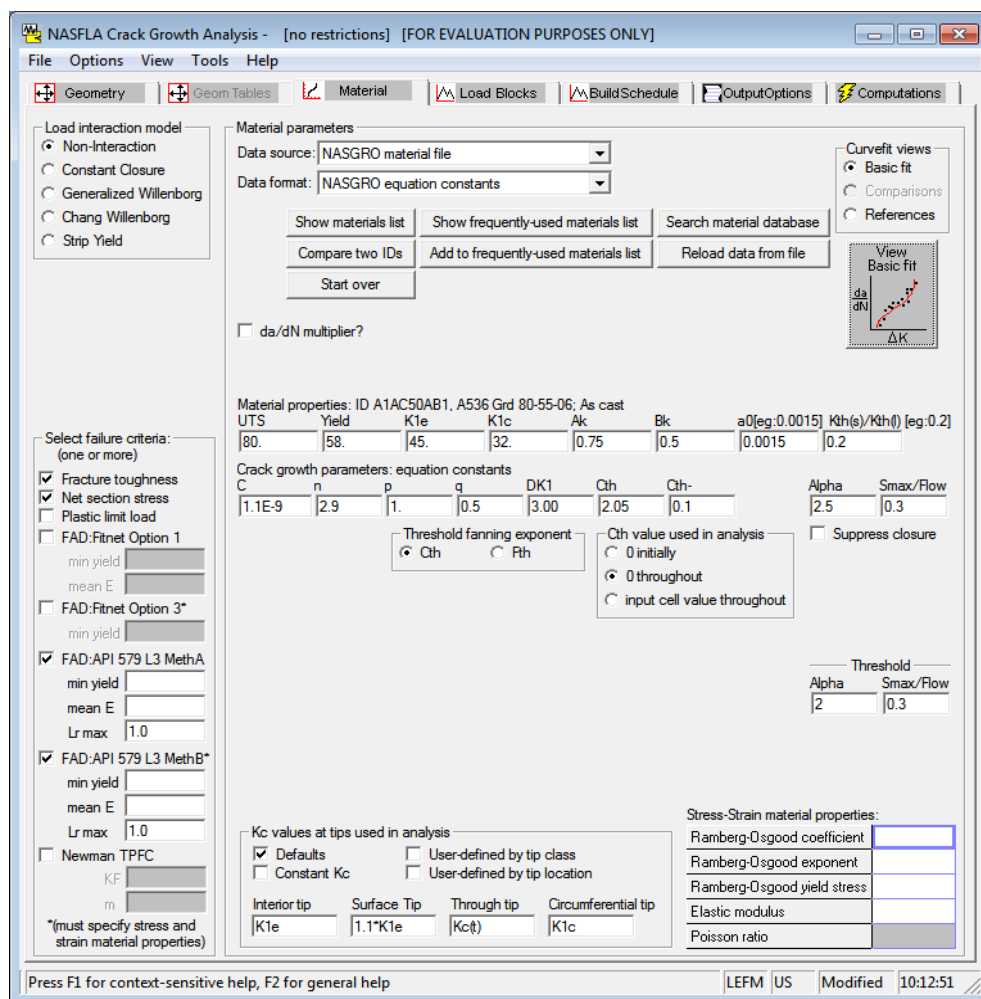
This tool reads true stress-strain data from a text file (or accepts manual input) and enables users to easily generate the parameters of the Ramberg-Osgood equation for use in the Failure Assessment Diagram (FAD) analysis approaches that require it (FITNET Option 3 and API/ASME Method B) as well as for other NASGRO analysis options such as shakedown). It has the capability to graphically display and output the original data alone as well as a combined plot of the fit and the original data. The figure below shows an example of the GUI displays and resulting fit for the Ramberg-Osgood fitting tool using a “notional” material.



Example of the Ramberg-Osgood fitting tool GUI and resulting fit for a “notional” material

New ASME FFS/API-579 FAD Approach:

NASGRO has the capability of using a Failure Assessment Diagram (FAD) as one of the “Alternate Failure Criteria” described in Appendix X of the NASGRO User’s Manual. Previously, there were two FAD options available in NASGRO as outlined by the FITNET¹ procedures. Now, in NASGRO v8.2, the ASME FFS/API-579² failure assessment diagram methods have been incorporated into NASGRO. The “Select failure criteria” box on the material page has been expanded and slightly rearranged to accommodate the new ASME FFS/API-579 FAD options as shown below. The new GUI arrangement will allow the user to select *either* the FITNET FAD approach *or* the API/ASME FAD approach *but not both*. Complete details of the implementation of all the alternative failure criteria in NASGRO are provided in Appendix X of the NASGRO User’s Manual.



Example of the NASFLA material screen showing the addition of the ASME API 579 FAD options in the “Select failure criteria” box

¹ *FITNET Fitness-For-Service (FFS) Procedure*, M. Koçak, S. Webster, J. J. Janosch, R.A. Ainsworth, and R. Koers, Editors, 2008.

² *Fitness-For-Service, API-579-1/ASME FFS-1*, June 5, 2007.

Application of Surface Crack Closure Correction Factor to SIF Models

Updates and fixes have been made regarding the application of the surface crack closure correction factor as shown in the table below. This revised table is also included in Section C14 of Appendix C. Table entries in **bold red font** indicate fixes and changes made in v8.2f.

Surface crack models										
Crack case	Crack closure factor (β_R) used				Crack case	Crack closure factor (β_R) used				
	a-tip	c-tip	a1-tip	c1-tip		a-tip	c-tip	a1-tip	c1-tip	
SC01	No	Yes	N.A.		SC13	No	N.A.			
SC02	No	Yes			SC14	No				
SC03	No	Yes			SC17	No	Yes	N.A.	Yes	
SC04	No	Yes			SC18	Yes	No	Yes	N.A.	
SC05	No	Yes			SC19	No	Yes	N.A.	Yes	
SC06	No	N.A.			SC26	Yes	No	Yes	N.A.	
SC07	No				SC27	Yes	No	Yes		
SC08	No				SC28	Yes	No	Yes		
SC09	No				SC30	No	Yes	N.A.	Yes	
SC10	No					SC31	No	Yes	N.A.	Yes
SC11	Yes	No	N.A.		SC32	Yes	No	Yes	N.A.	
SC12	Yes	No								
Corner crack models										
Crack case	Crack closure factor (β_R) used				Crack case	Crack closure factor (β_R) used				
	a-tip	c-tip	a1-tip	c1-tip		a-tip	c-tip	a1-tip	c1-tip	
CC01	Yes	Yes	N.A.		CC13	No	No	N.A.		
CC02	Yes	Yes			CC14	Yes	Yes			
CC03	Yes	Yes			CC15	No	No			
CC04	Yes	Yes			CC16	Yes	Yes			
CC07	Yes	Yes			CC17	Yes	Yes	Yes	Yes	
CC08	Yes	Yes			CC19	Yes	Yes	N.A.		
CC09	No	No			CC20	Yes	Yes			
CC10	Yes	Yes			CC21	Yes	Yes			
CC11	No	No			CC22	Yes	Yes			
CC12	No	No			CC23	Yes	Yes			
Standard specimens										
Crack case	Crack closure factor (β_R) used				Crack case	Crack closure factor (β_R) used				
	a-tip	c-tip	a1-tip	c1-tip		a-tip	c-tip	a1-tip	c1-tip	
SS08	Yes	No	N.A.		SS11	Yes	Yes	N.A.		
SS09	Yes	Yes								
Boundary element solutions and Hybrid crack model										
Crack case	Crack closure factor (β_R) used									
	a-tip	c-tip	a1-tip	c1-tip						
BE03	Yes	Yes	N.A.							
HC01	Yes	Yes	N.A.							
Color-coded solution type:										
	Uni-variant weight function solution									
	Bi-variant weight function solution									
	Displacement-controlled crack model									

New Items, Changes, and Fixes by NASGRO Module for v8.2 Alpha

July 25, 2016

Category	Applicable NASGRO Module										Description
	NASGRO Main	Config Control	NASFLA	NASSIF	NASCCS	NASGLS	NASMAT	NASBEM	NASFORM	Users Manual	
New			X	X	X					X	Implemented net section yield (NSY) analysis for TC28, TC30, TC31, TC32 and CC23, and documented the NSY analysis for these crack cases in Appendix B.
New			X								Parameter studies are now enabled for inverse calculation modes.
Change										X	Updated text and bitmaps in main manual (and Appendices B, C & D, as appropriate) for (a) New crack cases: CC21, CC22, CC23, TC28, TC30, TC31, and TC32 (b) Tension/bend option addition to crack cases CC11, TC11, and TC12
Fix			X								Newman's TPFC failure criterion with all secondary stresses resulting in NaN (not-a-number error). The pitfall was due to no secondary stress formulation in TPFC failure criterion. It is decided when TPFC is invoked, all secondary stresses will be used as primary stresses.
Fix			X								Crack case HC01: On the material tab, the controls for "Kc values at tips used in analysis" were missing for the options "User-defined by tip class" and "User-defined by tip location".
Fix			X								Crack cases TC25, TC26: If selecting "Do parameter analysis by varying geometry and loading?" on the Computations tab, some column header names, which should correspond exactly to the parameters represented in the geometry grid on the Geometry tab, were incorerct or missing.
Fix				X							No result from CC09 NASSIF analysis when the crack depth ratio a/t was exactly at 0.95, the solution limit. A very small tolerance was included to circumvent this numerical issue when geometric checks were performed.
Fix				X							No result from TC18 NASSIF analysis where e1/B was exactly at the lower bound of solution limits. A tolerance was included for the geometric checks and the API stress module for the determination of crack opening stress to resolve this numerical issue.
Fix			X								An incorrect program check of the value for the material parameter "Smax/Flow" disallowed the correct value of 1.0, and caused an error message, preventing the analysis from running.
Fix						X					Crack case SC30 was not available in NASGLS.
Fix			X								The material parameter "C" was not being handled correctly by the code that compares material parameter values in the GUI input file with the corresponding values in the material database. This code compares the two values, and generates a list of differences, so the user may see exactly which input file parameters differ from the database, and can choose which set to use for the analysis. In this instance, the values of "C" were not being compared properly, so actual differences were not being listed for the user.
Fix										X	Appendix C: Added supplementary description for TC02 when subjected to bending constraint
Fix										X	Appendix C: Added description for crack cases TC25 and TC26
Fix			X								Fixed the overflow problem of the number of cycles displayed in NASFLA status bar.
Fix				X							Removing interrupting message in CC09 SIF table output in SCREEN.OUT files. The removal was to facilitate the NASGRO verification procedure where tabulated results were extracted for comparison.
Fix			X								On the Material tab, with the data source "New data" selected and the format "1-D table: da/dN vs dK", changing units would clear the 1D table of values rather than convert them.
Fix				X	X						Crack case CC11 was performing an invalid geometry check that would block computation.
Fix			X								When "New Data" was selected as the "Data source" on the Material tab (and any "Data format"), if "Through crack at toughness computed from" is set to "Kc vs. thickness table", the displayed grid was overlapped by the "description" text field above it. This grid was also not being properly cleared from the screen if the "Data format" was then changed.
Fix			X								A batchfile format error prevented the analysis from running when the "Generalized Willenborg" load interaction was selected using a multiple temperature material ID.
Fix				X							Crack case CC13 was not calculating the maximum value of c correctly, leading to erroneous error messages claiming the "c" value was out of geometric bounds.
Fix			X								Inverse computation for initial crack size for TC17 with cyclic shakedown not working. The problem was identified that several flags and array deallocation were not handled correctly during inverse computation when cyclic shakedown was invoked.
Fix			X								Crack case CC02, in inverse calculation mode, was performing geometry checks on the values of "a", "c" and "a/c" that did not apply in inverse calculation mode, blocking computation.
Fix			X								Inverse computation for initial crack size using FAD for CC11 encountered problem during iteration. The error indicated the backup file for shakedown could not be located. The problem was found that the the flags which controlled the computation and output were mistakenly overwritten during iteration in inverse computation.
Fix			X								Two continuous SC30 NASFLA analyses invoking inverse computation crashed the program. The standalone NASGRO was used to produce such an erroneous scenario. The cause was identified because of an overwritten internal flag for OPS by previous iteratios.
Fix			X								Fth values of "0" were triggering erroneous error messages on the Material tab, claiming that Fth had to be greater than zero.
Fix					X						Crack case TC02: a batchfile format error prevented the analysis from running.

New Items, Changes, and Fixes by NASGRO Module for v8.2 Alpha

July 25, 2016

Category	Applicable NASGRO Module										Description
	NASGRO Main	Config Control	NASFLA	NASSIF	NASCCS	NASGLS	NASMAT	NASBEM	NASFORM	Users Manual	
Fix			X								Crack case CC16 in inverse calculation mode was not properly updating the geometry grid on the Geometry tab when selecting or deselecting the "two symmetric cracks" checkbox.
Fix				X							When generating run-time error checks, NASSIF did not always transition to the tab that generated the error message.
Fix				X							NASSIF plotting for correction factors not working. The "View plot" button in Computation GUI tab produced no plots. The problem was found due to incorrect PLT file being generated by NASGRO DLL. Once the PLT format issue was resolved, the plotting works fine.
Fix			X								TC15 with Newman's TPFC producing NaN in final failure report. The problem was due to no stress and moment being computed when no other failure criteria except TPFC was selected. This error has been corrected.
Fix			X								SC32 NASFLA analysis with display cycles incomplete with error in SCREEN.OUT. Invalid crack tip mapping was found in the program that lead to terminating the computation. Revision providing the correct mapping for crack size used for displaying cycles resolves this error.
Fix				X							Incorrect calls to NSY routine for CC11 from CC13 and CC15 identified during v8.2a release testing. The flag was incorrectly assigned to assume uniform tension and bend instead of utilizing the concentrated stress gradients interpolated from FEA-determined stress database.
Fix						X					Un-defined variable in CC02 fracture mechanics module causing program to crash when NASGLS was invoked. The scenario was re-produced in debug mode under software development environment. It was caused by a variable used in all analysis modes; i.e., NASFLA, NASCCS,etc., except NASGLS, resulting in error from un-initialized variable.
Fix			X	X							Post-processing plotting of SIF compounding data would not plot the following data, due to typos in the function that identifies the column headers for this data: cf41(c1), cf42(c1), cf43(c1), cf44(c1), f4(c1).

Additional Changes, Fixes and New Items by NASGRO Module for v8.2 Beta

October 24, 2016

Category	Applicable NASGRO Module										Description
	NASGRO Main	Config Control	NASFLA	NASSIF	NASCCS	NASGLS	NASMAT	NASBEM	NASFORM	Users Manual	
Change					X						CC21 and CC22 have been added to NASCCS
Change										X	Amended Appendix B: re-generated most of the formulas using the upgraded Microsoft Equation Editor and edited many of the figures.
Change										X	Revised Appendix D for crack cases SC30, SC31, EC02, EC04, and EC05.
Fix			X								SC03 direct NASFLA analysis resulting in run-time error when surface defect was placed at external surface. The problem was resolved after the root cause was identified from inconsistent definition on the number of stress quantities specified internally inside the program.
Fix			X								Crack case SC03: Computation was blocked when changing from 'internal' to 'external' cracks.
Fix			X								The data lines in SC28 FLABAT files to specify B - the offset of the hole, and D - the hole diameter, were found mistakenly switched in accordance with the input requirement of NASGRO DLL. As a result, the computation, though completed, gave incorrect result from such inconsistency.
Fix			X								On the Geometry tab with "SIF Compounding" enabled, attempting to select "Specify secondary cyclic stresses in FAD analysis" would properly convey the warning that SIF Compounding was not compatible with secondary stresses, and would block the selection until SIF Compounding was unselected. However, the secondary stresses information would still be shown in the Load Blocks tab.
Fix			X								Problems encountered when running SC19 with 8 blocks but using 6 blocks worked. The root cause was identified due to incorrect usage of TC01 as one of the transtion crack models resulting from too large crack depth in the thickness direction.
Fix		X									When selecting "new profile" or "remove all restrictions" the unavailable lists for the KT and HC crack cases, as well as the "manager's notes" fields were not being properly cleared.
Fix			X	X	X	X					Crack case SC08, DT/KT tables: In SC08 when switching between units, the bolt selection information and the "perform bolted joint analysis fields" were not being properly converted. In the DT/KT tables when changing units the "User Dimension D" field on the "Geom Tables" tab was not being properly converted. For all cases, changing units now updates the thickness label when viewing basic fits on the "Materials" tab.
Fix			X								Fixed a data overwriting problem in the SIF compounding calculation, which can result in abnormal termination of computation or generate incorrect computational results. The problem comes up in NASFLA inverse calculation of initial flaw size or stress scale factor multiplier if transition occurs during fatigue life calculation.
Fix			X								Crack case SC07: In inverse calculation mode, NASFLA was not writing the crack size limit correctly, resulting in incorrect results.
Fix					X						Crack case SC04: With "S0 from unit internal press." selected on the "Geometry" tab, the stress values on the Load Blocks tab would not correctly load from input files.
Fix					X						Crack case SC30: The residual stress options on the "Geometry tab" were not correctly displaying.
Fix			X	X							Fixed a problem in the 2-D SIF compounding, which can result in program freezing up if any of the 2-D compounding tables contains more than ten columns of compounding factors. Improved the output formats of the 2-D SIF compounding tables.
Fix						X					NASGLS was not filling the 'Superseded' crack case list properly, listing no crack cases.
Fix			X								Crack case TC28: The "Output Options", when selecting "Frequency of writing data to output files" as "crack growth intervals" there was no "c2" or "c" options available. Under pure bending cases, this caused an "c2/c out of range" error because the "c2" tip does not grow.
Fix			X								Missing term in routine for transformation of 2D stress polynomial function. The erroneous scenario occurred when the polynomial stress option was selected to describe stress variations for SC19 or SC31 crack model of which location was close to the very bottom right corner of the rectangular section. The transition into CC09 reproduced this bug from incorrect polynomial transformation.
Fix			X								Crack case TC28: The status bar displays negative crack growth due to not being able to parse the "c2" values correctly.
Fix			X								TC31 NASFLA computation with no output in OUT1 files. The out-of-bound scenario was detected in the SIF routine and computation was terminated immediately with no proper handling of error. The applied fix would issue the error description in OUT1 file and provide a more proper exit.
Fix			X								TC32 NASFLA analysis generating inconsistent output crack size at the first line of OUT2 files. The crack length shown at the first line was not the real crack length; instead, it's in reference to the 90-degree corner of the L-section. Such an error has been corrected.
Fix			X	X							Crack case CC22: The geometry checks for "2B/W" and "n/2r" were not being processed correctly. The "2B/W" check generated an error message erroneously stating the "n/2r" value was out of range, and the "n/2r" check allowed ratios as high as 11 rather than the 6 specified in the geometric limits.

Additional Changes, Fixes and New Items by NASGRO Module for v8.2 Beta

October 24, 2016

Category	Applicable NASGRO Module										Description
	NASGRO Main	Config Control	NASFLA	NASSIF	NASCCS	NASGLS	NASMAT	NASBEM	NASFORM	Users Manual	
Fix			X								The load interaction model utilizing the strip yield model with K-analogy was not working and the SCREEN.OUT file showed NaN (not a number) in final result. The root cause was from non-initialized variable, which was not identified by previous version of the compiler used to generate NASGRO DLL.
Fix			X								The "Visualize Current block" plotting feature would not plot when specifying either "Number of bins" or "Size of bins" when plotting histograms.
Fix			X	X	X	X					When changing units, the "Stress scale factors" on the "Load Blocks" tab would correctly alter on screen, but would write incorrect values for the currently displayed block when saving the input file or starting computation.
Fix			X								Crack case CC17: NASFLA was not disabling the "0 Initially" option on the Materials tab.
Fix			X								Changed the clip level labels under the "Available standard long blocks" title to make the displayed numbers conform to the contents of the long blocks "TWIST" and "MINI-TWIST". The new label has $S_{min< t >}$ as the fundamental normalizer and not S_{mean} as was shown earlier.
Fix							X				When plotting NASMAT fits, the y-max value would default to "0" instead of "0.0010" preventing the plots from being shown.
Fix			X								When changing units with a 1-D table selected on the Material tab, NASFLA was using the wrong conversion factors for dK values.
Fix			X								On the Materials tab, the values for "Cth", "Cthm" and "DK1" were being replaced with the material file values when selecting an 7.10a or earlier input file.
Fix			X								In the NASFLA material file, "Pyrowear 53" was incorrectly labelled as "Pyrowear 52".
Fix							X				In the NASMAT material file, "Pyrowear 53" was incorrectly labelled as "Pyrowear 52".

Additional Changes, Fixes and New Items by NASGRO Module for v8.2 Final

February 2, 2017

Category	Applicable NASGRO Module										Description
	NASGRO Main	Config Control	NASFLA	NASSIF	NASCCS	NASGLS	NASMAT	NASBEM	NASFORM	Users Manual	
Change										X	Updated Appendix B to document net section stress calculation for crack cases TC25, TC26, TC27, CC19, CC20, and SC32
Change										X	Updated Appendix C for CC16's pin-load solution
Change										X	Updated the β_R factor table in Appendix C, i.e. the table of surface crack closure correction factors
Change										X	Updated Appendix D to document transitions for crack case SC32
Change										X	Updated Appendix U to document the default setting of fracture toughness for crack cases TC24, TC25, TC26, TC27, TC28, TC30, TC31, TC32, CC19, CC20, CC21, CC22, CC23, SC30, SC31, and SC32
Change										X	Updated Appendix V to document the default setting of plastic zone constraint coefficients for crack cases TC24, TC25, TC26, TC27, TC28, TC30, TC31, TC32, CC19, CC20, CC21, CC22, CC23, and SC32
Change			X	X	X	X					The nasfla.ini, nassif.ini, nasccs.ini, and nasgls.ini files have been moved from the Program Files directory to the AppData directory to allow users without the proper administrative privileges to save their user options.
Fix			X								Crack Case TC02: NASFLA was erroneously enforcing a geometric limit of "Flaw size must be less than Width/2" instead of the correct "Flaw size must be less than Width".
Fix			X								When plotting basic material data fits, the thickness value in the plot legend for "Kc @ thk" was incorrectly being rounded to zero, due to small values and a formatting error, when using the new SI units option "m, m/cycle, MN, Mpa, Mpa sqrt(m)".
Change					X						Crack case TC02: Added the feature "Bending constraints at remote ends" to the NASCCS GUI, which was previously available only for NASFLA and NASSIF.
Fix			X								On the Materials tab, when using a User material file in a directory other than the datafiles directory, attempting to compare two user IDs for a second time generated a GUI crash.
Fix			X								Crack Case SC08: On the Geometry tab, with "Perform bolted joint analysis" selected, changing the selected units did not convert the values of the "Bolt preload value, P" field correctly.
Fix			X								TC28 NASFLA analysis with a strong out-of-plane bending loading resulted in a very large DKth/DK ratio in OUT2. The problem was caused by an erroneous definition of stress ratio when Kmax is exactly zero; for instance, the c2-tip in this case was subjected to compressive bending. Revising the definition of stress ratio when Kmax=0 resolved the issue.
Fix			X								Crack Case SC07: The user chosen values in the "Set crack size limit(s)" fields was being duplicated in the output file passed to the DLL, potentially generating incorrect results.
Fix			X								Crack Case SC15: When saving changes to the input file, the SIF Compounding box was removed from the GUI display and the contents of the checkbox was not written to the batchfile. This caused a run-time error when attempting to compute.
Fix			X								SC15 NASFLA analysis completed with error message in SCREEN.OUT after transition. The error was from un-defined length parameters for the transitioned TC11 and not including SC15 in crack mapping.
Fix			X								SC18 NASFLA with SIF compounding gave incorret column output in OUT3 files when transition was involved. The inconsistency was from incorrect index to provide the number of SIF compounding tables in the routine for post-transition.
Fix			X								DK values in HCFOUT files for all SS crack models (from SS01 to SS12) were incorrectly computed. The fix is only applied to v8.2.
Fix			X								Increased the width of the plot legend for FAD plotting, due to possible long plot legend titles.
Fix			X								Plotting the user supplied t1/t21 and/or tension/compression stresses on the Geometry tab with "Input stresses from file" selected erroneously generated the error message "Some filename(s) not yet selected" instead of plotting.
Fix			X								Crack Case TC05: When switching to TC05 from TC13, NASFLA would not properly clear the stress components from the Geometry tab.
Fix			X								Consecutive computation of SC04 and SC17 resulted in error indicating allocated memory was not cleared in SC02 before invoking SC17. The bug fix resolved two issues. One was the memory leak where allocated memory for SC04 TPFC FAD was not deallocated before new analysis was invoked, and the second was the removal of the lingering file fort.12.
Fix			X								After loading an input file containing a "non-interaction" load model, switching to "Generalized Willenborg" and reselecting a material caused the "Shutoff Overload Ratio" text-labels to be misaligned.
Fix			X								Material parameter values for "Cth" and "Fth" for the parameter set NOT on-screen will now be properly calculated/converted from the new on-screen values of the constituent material parameters which affect their values, when those parameter values are changed.
Fix			X								On the materials tab, when changing units, the values in the Ramberg-Osgood stress-strain grid were not being converted.
Fix			X								Two consecutive NASFLA computations for initial crack size resulted in a memory leak error. The pitfall was from un-allocated memory for load spectrum used by the first analysis. The bug fix resolved two issues: the first toward the memory leak and the second toward the open status of IOU3 files after the analysis was completed.

Additional Changes, Fixes and New Items by NASGRO Module for v8.2 Final

February 2, 2017

Category	Applicable NASGRO Module										Description
	NASGRO Main	Config Control	NASFLA	NASSIF	NASCCS	NASGLS	NASMAT	NASBEM	NASFORM	Users Manual	
Fix			X								For multi-temperature plotting, the values of the plot coordinates saved to text file were incorrect, due to an unnecessary antilog conversion being performed.
Fix				X							CC08 NASSIF analysis using D/B ratios at solution limits caused a run-time error. There were two issues involved. One was the solution limits posted in GUI bitmap for D/B were incorrect. The second was that the error caught by DLL did not terminate the computation right away and thus crashed the GUI.
Fix			X	X	X	X					Crack Case CC08: The geometry limits for D/B have been updated from "0.1 <= D/B <= 1.9" to "0.02 <= D/B <= 1.8"
Fix			X								The beta-correction factors for surface crack tips for CC20 and CC21 crack models were missing. This has been fixed and the surface beta-correction table in Appendix C was also updated.
Fix			X								When changing units, the user-entered values for "Kc values at tips used in analysis" options was not being properly converted.
Fix					X						Disabled the irrelevant check (the NSY check) in calculation of threshold crack size calculation
Fix			X								When reading 2D tabular material data from file, records containing more than nine R-values will not be read (since the table in the GUI that displays this data holds a maximum of nine R-values). An error message will be issued stating the record selected exceeds the maximum number (9) of allowed R-values. The user will then be required to edit that record for it to be read successfully by the GUI.
Fix			X								Some 2D tabular material data could not be loaded into the NASFLA GUI, due to the user data exceeding the current table capacity, which has since been increased.
Fix			X								CC01 NASFLA analysis with HCF threshold check resulting in slightly longer life when compared with the result from v8.1f. The discrepancy was found from incorrect initialization of HCF parameters that overwrote the input value. The update should give the same result as those from v8.1f.
Bug fix			X								On the Build Schedule tab, when choosing to load schedules from file, schedules would not load stress scale factors or file names on the Load Blocks tab.
Known Issue & Workaround			X								When plotting multitemperature material IDs in the NASFLA GUI, saved PNG files are missing text from the plot legends and axes labels. The current workaround for this issue is to copy the plot "to screen" image, which is correct, to the clipboard (make that plot image window active by clicking on the title bar, then press Ctrl+C), from which it can then be pasted (press Ctrl+V) into an MS Word document and saved, or into MS Paint and saved as either a .PNG or .JPG file.