



# NASGRO<sup>®</sup>

## Fracture Mechanics & Fatigue Crack Growth Analysis Software

NASGRO is a suite of programs used to analyze fracture and fatigue crack growth (FCG) in structures and mechanical components. The software is developed jointly by Southwest Research Institute<sup>®</sup> (SwRI<sup>®</sup>) and NASA under a Space Act Agreement, with additional support from the NASGRO Consortium and the Federal Aviation Administration.

NASGRO consists of integrated modules with user-friendly graphical interfaces that:

- Calculate stress intensity factors ( $K$ ), FCG life, and critical crack size
- Store, retrieve, and curve-fit FCG and fracture toughness data

NASGRO is the most widely used fracture mechanics and FCG software in the world today.

### Recent Enhancements

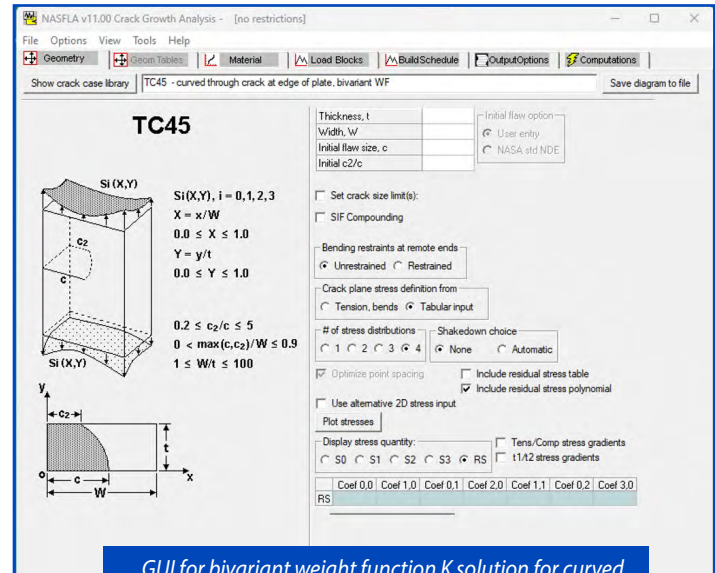
Recent enhancements in the current version 11.1 include:

- New  $K$  solution for a through crack in the web of a T-section
- New  $K$  solution for a surface crack at the fillet of an L-section
- New  $K$  solution for a corner crack at an L-section
- New  $K$  solution for an edge crack growing toward a hole
- Expansion of  $K$  solution for one curved through crack at one hole in a row of holes
- Addition of newer weight function (WF)  $K$  solutions to the elastic-plastic fracture mechanics (EPFM) module
- Capability to use API 579 & ASME Paris Equations (1-D and 2-D)
- Access to material database from the critical crack size module (NASCCS)
- Expanded availability of  $K$  solutions in the NASGLS module
- Improved crack transition features

### Future Development

Major new features planned for version 11.2 include:

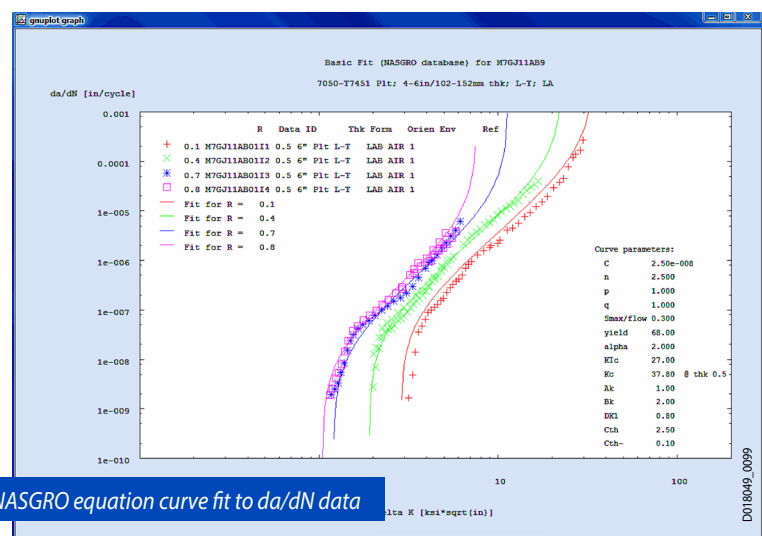
- Superposition methods for time-dependent crack growth
- Advanced methods for thermomechanical fatigue crack growth
- Expansion of countersunk hole  $K$  solution to include corner crack at faying surface
- Addition of optional constraint conditions for corner crack  $K$  solution in L-section
- Addition of out-of-plane bending to 2-D WF  $K$  solution for a corner crack at a hole
- Addition of pin load (bearing stress) to through crack and corner crack at offset hole with broken ligament  $K$  solutions
- New  $K$  solution for an embedded crack in a round bar



GUI for bivariant weight function  $K$  solution for curved through crack at edge of plate

$$\frac{da}{dN} = C \left[ \left( \frac{1-f}{1-R} \right) \Delta K \right]^n \frac{\left( 1 - \frac{\Delta K_{th}}{\Delta K} \right)^p}{\left( 1 - \frac{K_{max}}{K_c} \right)^q}$$

NASGRO fatigue crack growth equation



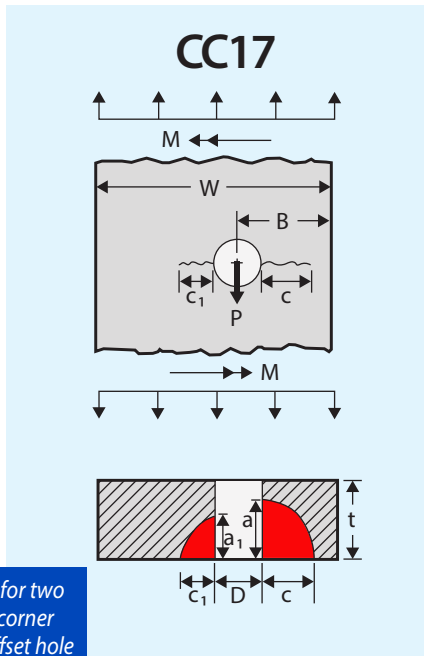
NASGRO equation curve fit to  $da/dN$  data

## Plans for future versions include:

- Improve NASGRO installation process
- Add through-wall crack transition  $K$  solutions for surface cracks in a cylinder and a sphere
- Add failure assessment diagram (FAD) capability for univariant WF solutions for curved through-thickness cracks
- Approximate (compounding) method for multi-site damage
- Ability to call NASGRO directly from another user program
- More improvements to EPFM module and documentation
- Additional  $K$  solutions for other unique geometries

## Crack Growth Module

- Over 110 different  $K$  solutions
  - Uniform tension/bend/pressure/pin load
  - Univariant/bivariant weight function models
  - User-defined tables
  - Generalized compounding
- Multiple crack growth rate models
  - NASGRO, Walker
  - Tabular  $da/dN$  vs.  $\Delta K$  data
  - Temperature effects
- Multiple load interaction models
- Multiple load history input formats
- Load spectrum visualization, editing, cycle counting
- Multiple analysis options
  - Calculate  $K$ , life,  $da/dN$
  - Critical initial, final, or threshold crack size
- Account for residual stresses
- Cyclic shakedown for local plasticity
- Elastic-plastic crack growth analysis
- Failure assessment diagrams
- Interactive and batch modes

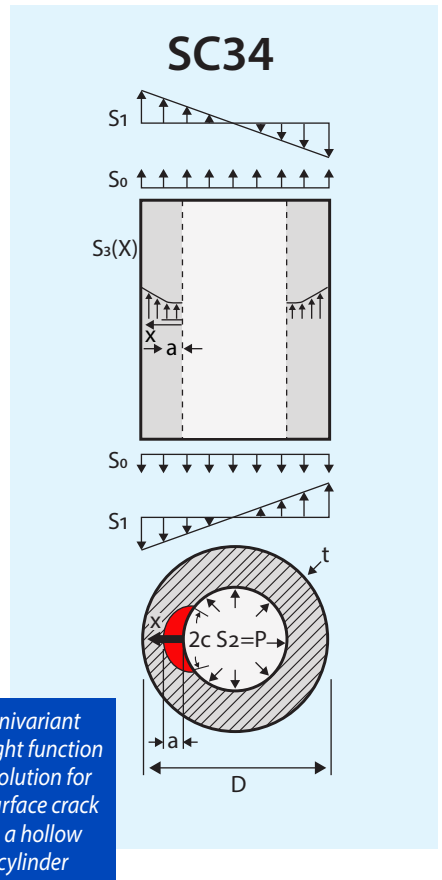


*K solution for two unequal corner cracks at offset hole in a plate.*

## Material Property Module

- Search, retrieve, plot, and curve fit data
- Import user data
- English or metric units
- Over 500 metallic materials
- 3,600 sets of FCG data
- 6,500 fracture toughness points

The NASGRO software runs on all Windows platforms. User support and training courses are available. A perpetual license for a single copy of version 11.1 is \$4,900. Organizations with multiple users should consider a site license or participation in the NASGRO Consortium. Special prices may apply for non-US companies, especially in China and India. Please contact SwRI for a specific quote.



*Univariant weight function K solution for a surface crack in a hollow cylinder*

## NASGRO Consortium Participants

The Aerospace Corporation  
 Airbus  
 Airbus Canada  
 BAE Systems  
 Blue Origin  
 The Boeing Company  
 Bombardier  
 Embraer  
 GKN Aerospace Sweden  
 Honda Aero  
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Mechanical Engineering Division

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