Fracture Mechanics and Fatigue Crack Growth Analysis Software

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Fracture is the primary threat to the integrity, safety, and performance of nearly all highly stressed mechanical structures; e.g., spacecraft, military/civilian aircraft and rotorcraft, gas turbine and rocket engines, ground vehicles, pipelines and pressure vessels, offshore structures, and ship structures. Failures due to fracture can have major negative consequences, including serious injury or loss of life, severe environmental damage, and substantial economic loss.

Two design methodologies used to reduce the risk of such failure are (1) fracture control, which is the application of engineering, manufacturing, and operations technology dealing with the analysis and prevention of crack propagation leading to catastrophic failure; and (2) damage tolerance, which is the assessment of the remaining life of components or systems in service and conditions leading to failure, as well as providing a basis for setting inspection intervals.

The NASGRO fracture mechanics analysis computer program is NASA's standard software package used by all NASA Centers and many NASA contractors for fracture control analysis of space hardware and safety-critical ground systems. The importance to NASA of this program is the ready availability of an accepted, accurate, reliable, and state-of-the-art code with unmatched analytic capabilities for performing crack propagation analysis on fracture-critical space structures and hardware. NASGRO is also widely used for damage-tolerance assessments in resolving crack-like flaw anomalies in structural components or hardware equipment that can possibly cause a catastrophic accident.

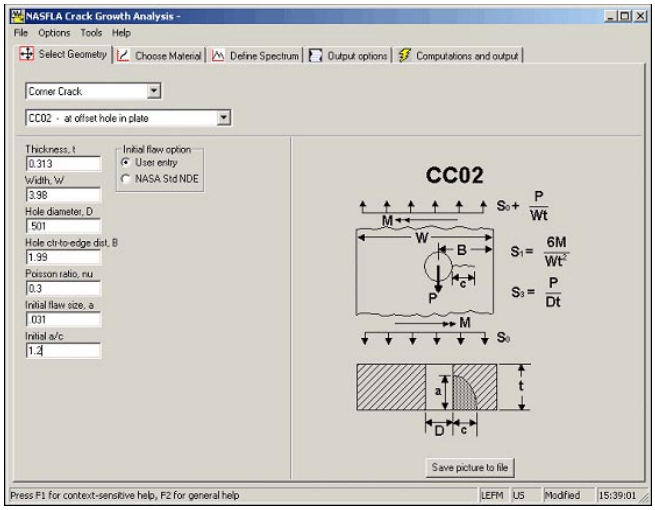
Originally developed for fracture control on NASA hardware, developments in recent years have made NASGRO so powerful and versatile that it is now widely used outside of NASA in the aircraft, railroad, and shipbuilding industries. Structural integrity analysis of aging aircraft is a critical necessity in view of the increasing numbers of such aircraft in general aviation, the airlines, and the military.

Features that make NASGRO unique among fracture mechanics analysis tools include:

- A large library of more than 50 crack geometries and solutions, and an integrated Boundary Element module that calculates accurate new solutions for any user-defined crack and component geometry with any user-defined loads
- A massive material property database featuring 476 different metallic materials, 3,000 sets of fatigue crack growth data, 6,000 fracture toughness data points, and original test data and reference citations so that users can evaluate fits of crack growth equation parameters and generate new parameter fits as needed
- Its unique crack growth equation, simultaneously accounting for onset of growth, which is important because the bulk of a component's useful life is spent in the near-threshold region; small-crack behavior, which is important in small components such as jet-engine blades and discs; crack closure effects, which is important in modeling the beneficial and

detrimental effects of the overloads and underloads in variable amplitude load spectra; and crack instability

- Its capability to model severe elastic-plastic loading; e.g., rocket engines
- Its capability to perform sustained crack growth analysis to determine the time at which a constant load can be sustained before a glass or glass-like material fails
- Its capability to compute the critical initial crack size that will grow to failure for a given load history
- A user-friendly graphical user interface to make data input, analysis, and post-processing easy for the nonexpert
- Its receipt of NASA's "Software Of The Year" Award in 2003
- Its receipt of R&D Magazine's "R&D100" Award as one of the 100 most technologically significant products of 2003



Major ongoing developments include:

- Modules to calculate crack initiation life
- More than 10 additional crack cases for complex stresses
- Effects of time, temperature, and environment on crack growth
- Analysis of cracks in complex, built-up airframe structures
- Modules with which to analyze proof tests of pressurized systems
- Probabilistic analysis modules
- Residual stress fields