# LAP

anaglyph

## Laminate Analysis Program

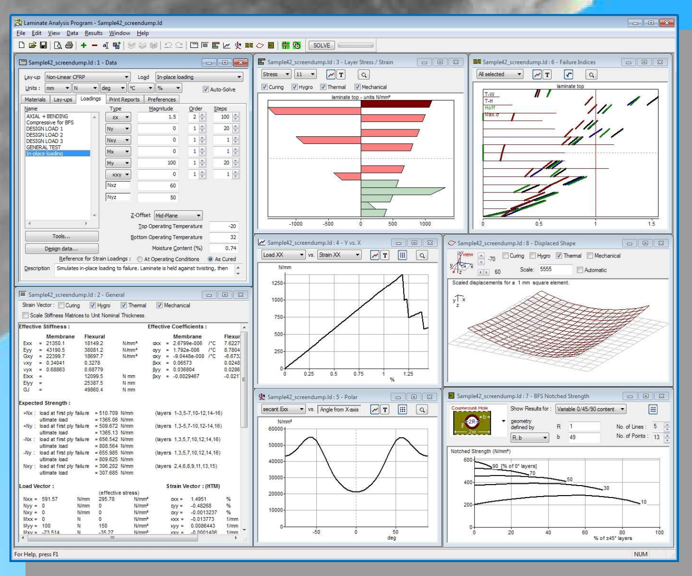
### *Rely on a proven track record*

**LAP is used by designers and researchers alike in over 25 countries across the world**

- **Analyse any type of composite laminate subjected to loads and moments.** The flat laminate has no fixed size apart from its thickness, so that the analysis can be applied to any composite component, at a location where loadings or deformations are known.

- Typically, LAP is used in **preliminary design for tailoring a stacking sequence**, then analysing the composite component with other methods such as finite elements, and finally optimising the design by **inspecting the laminate behaviour layer by layer.**

- LAP consists of **4 modules**. The Basic module includes the linear analysis functionality and constitutes the minimum configuration. The other three modules are optional. See details overleaf.



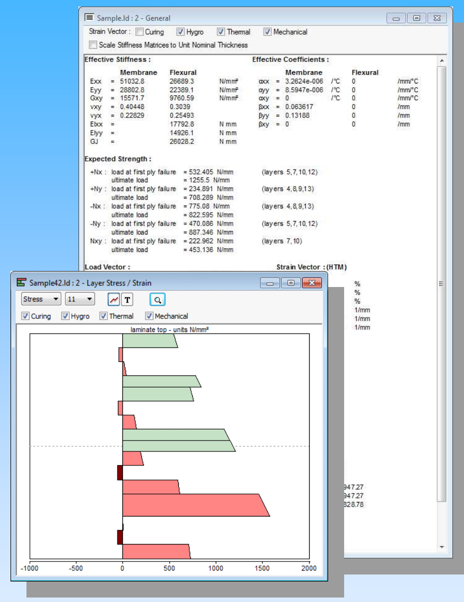
**Key Benefits:**

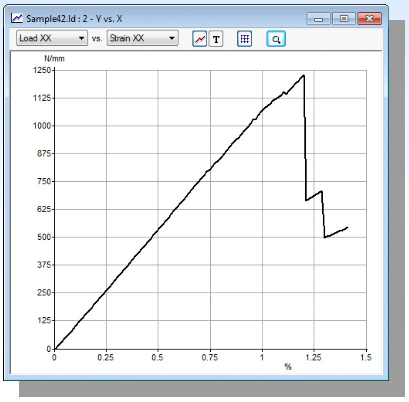
- ✓ The simplicity of the analysis ensures **universal applicability**,
- ✓ Maintains its emphasis on ease of use and fast, efficient, **robust** solvers.
- ✓ The program's powerful features make it an ideal tool for the demanding **expert**, yet a newcomer to composites can complete simple tasks within minutes.

## Basic module

The Basic module provides the linear analysis functionality:

- Curing, Hygroscopic, Thermal and Mechanical loadings are supported. Their effects can be viewed in isolation instantly.
- Mechanical loading can be defined by Load and/or Strain components, in an optional sequence of application.
- The effects of manufacturing deviations from the nominal fibre volume Fraction can be uniquely included.
- The main results include effective stiffness constants for the laminate, effective hygroscopic and thermal coefficients, solution matrices and vectors.
- The expected in plane laminate strength is computed, both initial and ultimate.
- Layer stress and strain can be examined in the global or fibre axis systems. Interlaminar shear stresses are supported.
- The built in failure criteria are TsaiWu, TsaiHill, Hoffman, maximum stress, and maximum strain.
- The laminate displaced shape can be seen in 3D, a useful tool in visualising the laminate behaviour under load.
- Polar plots of effective laminate stiffness and hygrothermal coefficients conveniently demonstrate off axis laminate behaviour.




## Non Linear module

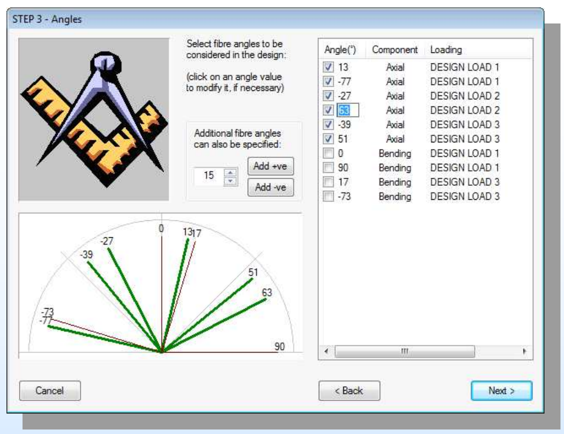
The optional Non Linear module extends the analysis functionality to include the effects
of non linear material stiffness properties:

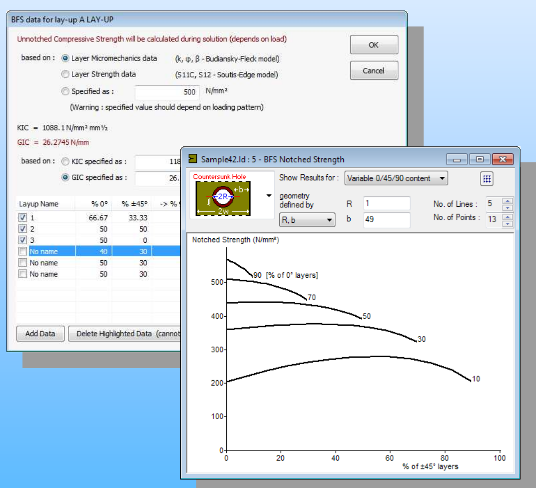
- Mechanical stiffness properties may be defined as piecewise functions of local stress or strain.
- The ability to set stiffness reduction factors upon layer failure is included.
- An accurate picture of nonlinear laminate stiffness response is given up to and beyond layer failure.
- This feature is very powerful, since it offers in depth understanding of what can happen to a composite component under high stress, thus increasing confidence in the design. Related effects, such as the shift in neutral axis under bending load, can also be monitored.

## Design module

The optional Design module introduces a new dimension to LAP, in two variants:

- The *Laminate Design* procedure consists of specifying a set of mechanical loadings, each with stiffness and strength constraints which must be satisfied by an optimum symmetric laminate to be designed. The materials and fibre angles to be considered by the software, as well as a number of other options, are specified by the user during the design process.
- LAP carries out a thorough investigation of the candidate stacking sequences and presents a finite set to the user, for further selection or optimisation. The method is unique in its conception and implementation.
- With *Batch Solution*, a number of laminates are examined to confirm that they indeed satisfy the stiffness and strength requirements set by the user. Typically, this is used to confirm compliance after changes have been introduced to the laminates suggested by the software.




## Additional Failure Criteria module

This optional module extends the LAP analysis functionality as follows:

- The BFS failure criterion (Budiansky-Fleck-Soutis) is used to calculate the unnotched as well as the notched longitudinal compressive strength for a laminate.
- The notch geometry can be one of: centre notch, edge notch, open hole, countersunk hole, or filled hole. Results also include carpet plots for a multitude of layup configurations.
- Through a user supplied function, a custom failure criterion can be defined for use with linear or nonlinear strength analysis, just as with the built in failure criteria.

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