HyperSizer® Micromechanics

HyperSizer Micromechanics is an add-on module for the HyperSizer Structural Sizing Software, which was developed by integrating a powerful, university/NASA developed micromechanics analysis capability with HyperSizer.

This new add-on module combines the constitutive (fiber/matrix) buildup and non-linear analysis of MAC/GMC (Micromechanics Analysis Code with Generalized Method of Cells) with the data integrity and established laminate and material property editing interface of the HyperSizer product.

The interface to HyperSizer Micromechanics will be familiar to HyperSizer users. The normal HyperSizer database is opened and micromechanics is accessed via several different methods to perform a variety of analyses.

Two Modes of Operation

There are two modes of operation of HyperSizer Micromechanics. **First is the non-laminate micromechanics operation** *which analyzes a composite at the ply level to define and analyze heterogeneous, non-linear material systems (i.e. fiber–matrix combinations) and generate equivalent homogeneous properties. This mode of operation is accessible as a* **micromechanics workspace**. *In addition, the user can access HyperSizer Micromechanics while editing HyperSizer isotropic materials to tailor composite material properties by manipulating the constituent materials and packing arrangement.* **The second mode of operation is to analyze and optimize a laminate or a fully built up structure** *including the micro-mechanic definition of each ply. This capability will be easily performed by any user familiar with the HyperSizer Sizing form.*
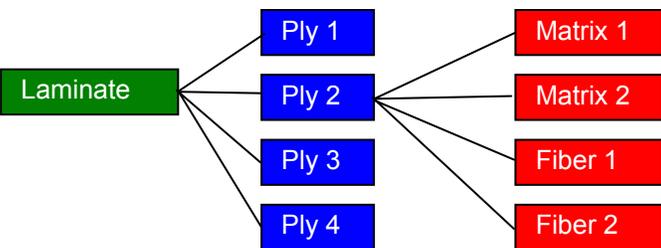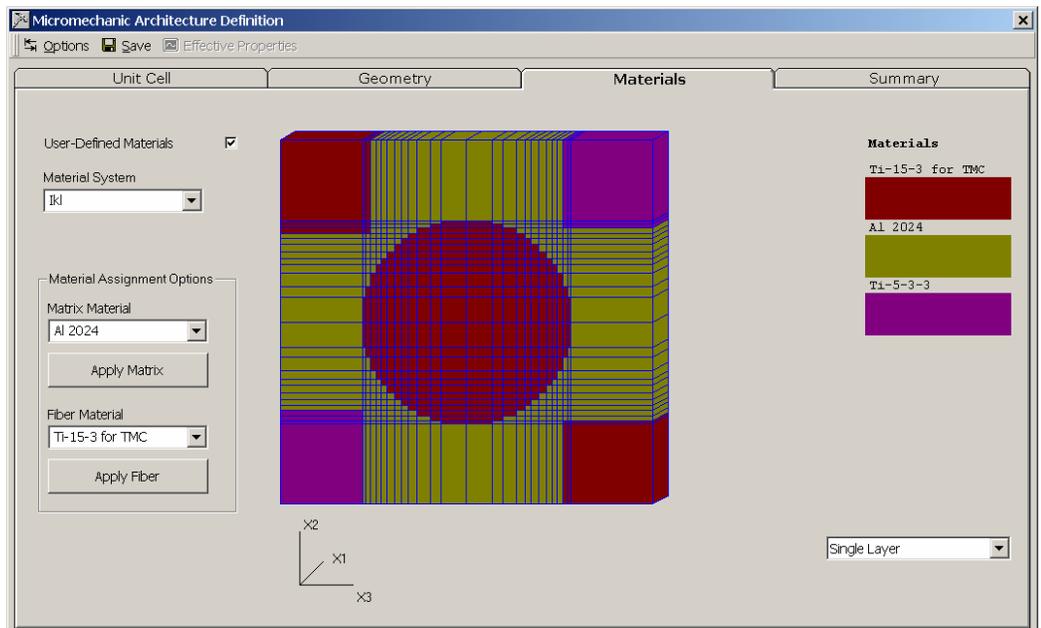

Figure 1: Material linking in HyperSizer

A New Material Hierarchy

The inclusion of micromechanics within HyperSizer creates a new distinction between material types: **heterogeneous** *and* **homogeneous**. *Homogeneous materials are materials for which there is no underlying micromechanics architecture and the material is analyzed using equivalent properties. The materials in HyperSizer's Material Manager, Basic and Pro products fall into the homogeneous category. Heterogeneous materials are those for which the micromechanic constituents of the model are specified and a micro-mechanics model is required for analysis.*

The Micromechanics Workspace

The HyperSizer Material Manager product allows entry and editing of linear elastic as well as non-linear constitutive properties needed for Micromechanics analysis. The standard HyperSizer database is the storage medium for micromechanic constitutive materials. After specifying constitutive materials with HyperSizer's material forms, The Micromechanics Definition form is used to build ply level data.

The database schema allows heterogeneous materials to link to other, homogeneous materials. HyperSizer Micromechanics allows a user to link together fiber and matrix constitutive materials to form new orthotropic materials in the same way that HyperSizer basic materials are linked together to form laminates through the laminate editor (See Figure 1).
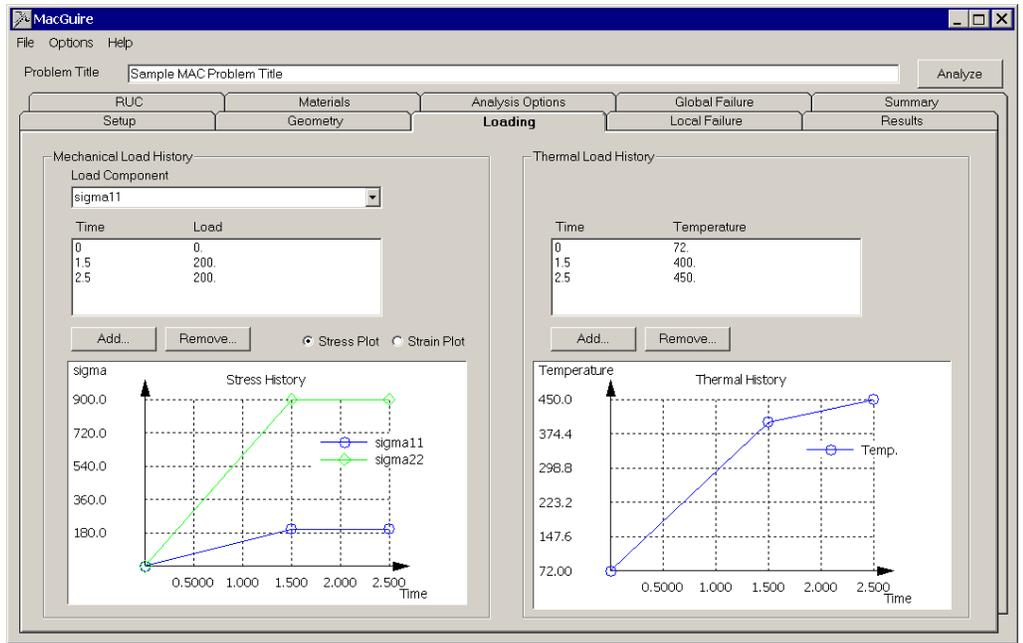
To analyze heterogeneous materials, the user opens a "micromechanics workspace", a new branch on the database explorer tree, parallel to HyperSizer Projects, and HyperSizer Structures Workspaces. This micromechanics workspace is linked to a heterogeneous material and allows input of time dependent loads, which are stored as part of the workspace. With the micromechanics definition and time dependent loading in place, a variety of non-linear analyses are possible including elastic, plastic, visco-elastic, visco-plastic, creep, etc.
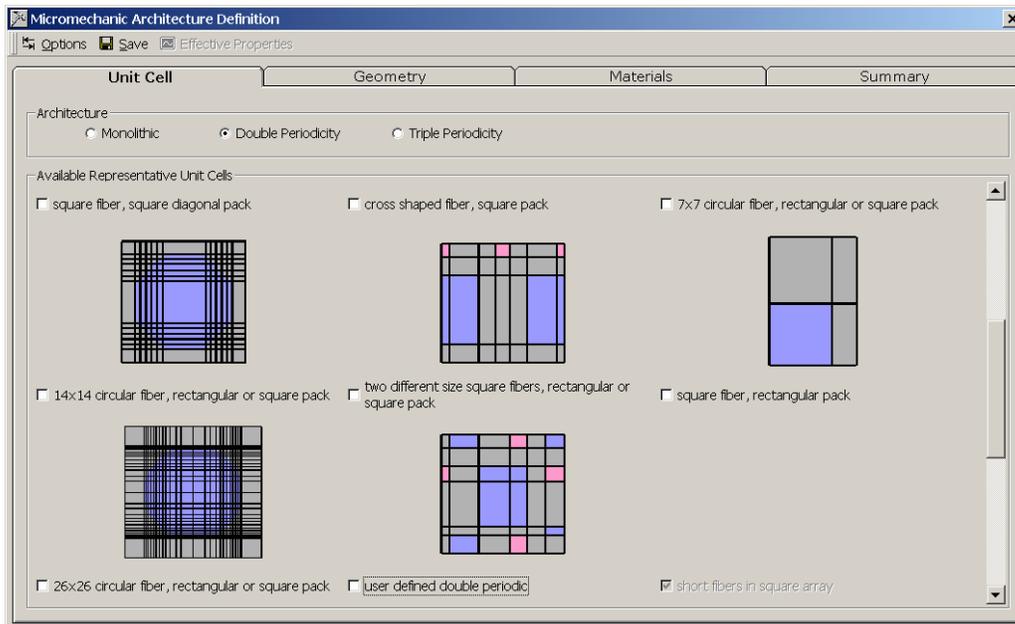
Micromechanic Structural Analysis

HyperSizer Micromechanics also goes to the core of the HyperSizer Structural analysis program by allowing non-linear or micromechanics driven problems to propagate to fully built up structures, such as hat-stiffened or honeycomb sandwich panels.

In the near future, this capability will also include advanced features, such as smart materials and structural electromagnetic capabilities. These revolutionary structural concepts that utilize piezo-electric or piezo-magneto materials will someday allow engineers to design "morphing" structures that are able to change their properties with the application of electric or magnetic fields. HyperSizer Micromechanics is the cutting edge technology that will make analyses of such concepts possible.

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