

Design
on the **Lighter Side**



HyperSizer[®]
Structural Sizing Software

Material Manager[™] Software Product Guide

HyperSizer® Material Manager

For over a decade, **HyperSizer** has significantly reduced weight on major aerospace programs with rapid analysis and composite optimization. Originally developed at NASA, it's now greatly enhanced and supported as a commercial product worldwide. **HyperSizer** is not CAD and is not finite element analysis (FEA).

HyperSizer is something different and is described next as three separate products that all share and build upon the same integrated and internal database. Starting with a user friendly software interface, it's both easy to use and powerful.

HyperSizer Material Manager™ is a highly integrated system for storing and managing temperature dependent properties for all material types. As a graphical composite laminate analysis tool, you can build composite laminates with any arbitrary stacking of material forms or types.

Based on customer demand for the composite laminate tools in our full range of HyperSizer products, Collier Research has made these features into a stand-alone software. You can now operate **HyperSizer Material Manager™** separately, and seamlessly migrate your data to **HyperSizer Basic™** or **Pro™** software packages.

The screenshot displays the HyperSizer Material Manager software interface. On the left, the 'Ply Angle Selector' shows a diagram of a ply with a +45° angle. Below it, the 'Ply Sequence' table lists 10 plies with their respective angles and materials. The main window is titled 'Laminate Analysis and Equivalent Orthotropic Properties' and contains several data tables and sections:

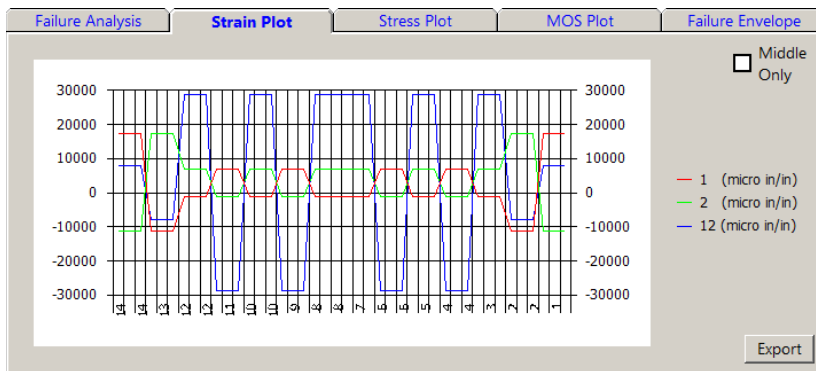
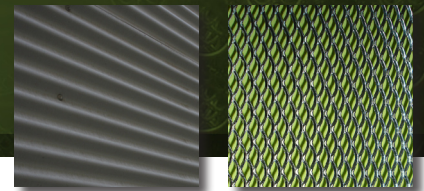
- Options:** Tension and Compression radio buttons.
- Reference Plane Location:** OML, Laminate Midplane, and -OML radio buttons.
- Reference Plane Offset:** A text input field set to 0.0.
- User Defined Load / Allowable Load:** A table with columns for Nx, Ny, Nxy, Mx, My, Mxy, and MOS, with values for each.
- Failure Theory:** A list of failure theories including Max Strain, Max Stress, Von Mises / Hoffman, Von Mises / Tsai-Hahn, Von Mises / Tsai-Hill, and Von Mises / Modified Tsai-Wu.
- Ref Temperature:** A text input field set to +72.
- Centroid Delta T:** A text input field set to 0.0.
- OML Delta T:** A text input field set to 0.0.
- Stiffness Terms:** A table with columns A, B, and D, and rows for various stiffness components.
- Effective Laminate Elastic Engineering Constants:** A table with columns E1, E2, v12, and G.
- Effective Laminate Flexural Elastic Engineering Constants:** A table with columns E11, E12, v12, and Gf.
- Effective Laminate Failure Allowables:** A table with columns Fu1, Fu2, Fsu12, eu1, eu2, and esu12.
- Thermal Bending / Coupling:** A table with columns for thermal bending and coupling coefficients.
- Neutral Axis:** A table with columns X and Y.
- Failure Envelope:** A graph showing stress/strain profiles for different shear levels (0%, 25%, 50% Shear).

"The best composite analysis software I have ever seen"

Patrick Hipp, Senior Mechanical Engineer, X-34, Orbital Sciences Corp.

- Use familiar cut, paste, and copy functions for quick ply insertions and lay up arrangements.
- Define and save stack templates and use other advanced layup tools.
- Graph failure envelopes and stress/strain profiles automatically.
- Choose from many popular composite failure theories, such as Tsai-Wu.
- Perform dynamic "what-if" design changes and see their effects real time.
- Generate laminate equivalent properties for export to FEA packages.
- Document designs and analyses automatically with Documenter.
- Maintain composite and metallic data with the tightly integrated relational database management system.

HyperSizer® Material Manager



Laminate Analysis Strain Plot

An Advanced Graphical User Interface

Designed specifically for Microsoft® Windows, users get the familiar functions for cutting, copying, and pasting plies into an intuitive tool for layup edits. The ply angle rotator, grouped ply movements and hybrid material selections are some of the other advanced layup arrangement tools provided in **Material Manager**. You can define stack templates and layup families based on your defined criteria, such as ply percentages. Laminates can be defined with any arbitrary stacking of material forms such as tape, fabric, metallic sheets, honeycomb, foam, and material systems such polymer (graphite/epoxy), ceramic, and metal matrix.

Conveniently select from the material database any of the 1800 layups which have been pre-defined based on aerospace industry best-design guidelines, such as pairing +45/-45 plies together and the 10% rule. Use the pre-defined library of layup families to effectively preclude industry proven poor designs from being considered and quickly focus on more manufacturable designs.

Analysis

Apply membrane forces and bending moments and compute fiber stresses and strains at the ply midplane and outer fibers. Choose any number of popular composite failure theories (max stress, max strain, Tsai-Hill, Tsai-Wu, Tsai-Hahn, & Hoffman) and plot their respective failure envelopes and ply-by-ply margins-of-safety.

Compute [A], [B], [D], temperature dependent stiffness matrices, and thermal expansion, bending, and

coupling coefficients.

Generate effective laminate elastic terms and stress/strain failure allowables and store automatically in the database as equivalent orthotropic ply materials. Export these properties in MSC/ NASTRAN, FEMAP, or I-DEAS FEM format.

Thermal effects

Apply temperature changes and through-the-thickness temperature gradients and compute thermal stresses and strains, including the effects of associated temperature dependent material properties. Compute 12 unique thermal coefficients for panels including specific coefficients for symmetric and unsymmetric membrane, bending, and membrane-bending coupling thermal responses.

Interactive Graphing

Material Manager provides interactive, dynamic modeling for real time "what-if" layup changes. Instantaneously see results to graphical failure envelopes and ply-by-ply stress and strain profiles.

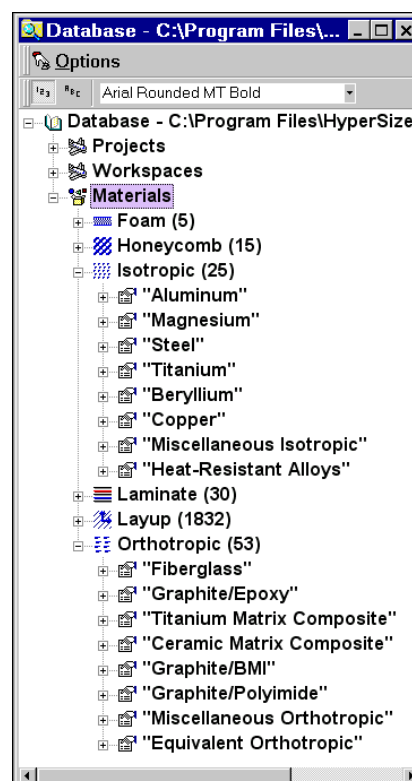
System for Storing and Managing Materials

The Microsoft Access® database management system forms the underlying software foundation for all HyperSizer products. The open structure of the material database schema allows developers to use it for their own tool development.

Integrated Material Database

Maintain metallic materials such as Mil Handbook 5 metals, Mil Handbook 17 polymer composites, and sandwich core honeycomb and foams. Create your own materials through the user interface and have their properties managed with the integrated database.

- **Metallics (isotropics)**
- **Polymer, ceramic, and metal matrix fiber reinforced composites (orthotropics/layups/laminates)**
- **Sandwich cores (honeycomb, foam, syntactic)**
- **Hybrid laminates with plies of tape, fabric, metallic sheet, and sandwich cores of all material types**



Material Database

The database schema (i.e. data tables and column layouts) is provided in an

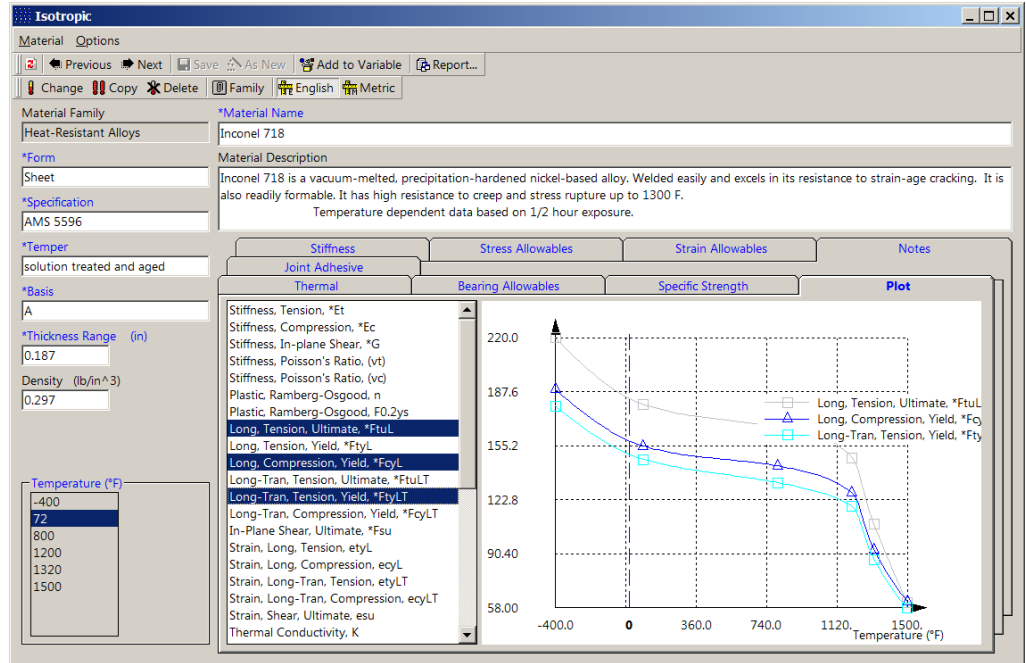
HyperSizer® Material Manager

open environment to permit developers direct access to load and retrieve data through user written programs using the widely accepted Standard Query Language (SQL).

Because **Material Manager** uses Access, a database program that is standard with most Microsoft® Office suites, it can be used with Visual Basic, C/C++, or any of the other Microsoft® Office products that use Visual Basic for Applications (VBA). Relational links defined in the database provide automatic cascading updates as data changes, relieving developers the burden of writing their own "triggers." This simplifies development and enhances productivity.

Mil Handbook 5 metallic and Mil Handbook 17 composite material family categories are in place already.

Most importantly, the Material Manager forms the kernel of the much larger **HyperSizer® Basic** and **Pro** database schemas, providing tight integration with the entire **HyperToolbox Suite**.



Data Display

Dynamically customize and plot your material property changes to quickly visualize their temperature-dependent behaviors.

Change between English or Metric units on the fly. Enter Metric properties from vendor data sheets and then display in English.

Documentation

Use the Material Documenter to run HTML and Word-based reports. Select your materials of interest and the desired format, and these files will be automatically generated.

These reports can be viewed by anyone who has an internet browser or Microsoft Word. HTML reports can be posted to your web site, and Word reports can be sent as an email attachment easily, providing a collaborative work environment for sharing and publishing material data.



For more information, visit us online at www.hypersizer.com or contact us directly at:

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Isotropic "Ti-6Al-4V, commonly used aerospace Titanium"

Material Summary	
Family	Titanium
*Form	Sheet Strip Plate
*Specification	AMS4911
*Temper	Solution Treated Aged
*Basis	A
*Thickness Range	0.125 (in)
Density	0.16 (lb/in ³)
Owner	CRD
Created	Saturday, January 10, 1998 at 3:34:54 PM
Last Modified	Friday, December 28, 2001 at 10:37:25 PM
Description	Ti-6Al-4V from MIL-HDBK-5F, Commonly used aerospace Titanium ALPHA-BETA_TITANIUM_ALLOY

Temperature Dependent Properties, Stress Allowables							
Temperature (°F)	FtuL (ksi)	FtyL (ksi)	FcyL (ksi)	FtuLT (ksi)	FtyLT (ksi)	FcyLT (ksi)	Fsu (ksi)
72	134	126	132	134	126	132	79
400	104.5	88.2	92.4	104.5	88.2	92.4	62
1000	67	55.4	58	67	55.4	58	40