

Utilization of COMSOL Multiphysics® Java API for the Integration of Composite Materials with a Customized User Interface

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Abstract

Usage of Composite Materials properties is rapidly gaining acceptance in various industries such as aircraft manufacturing, automotive, healthcare, etc. Its main strengths are light weight material, great strength and durability, strength related to weight, corrosion resistance and design flexibility. In the process of modeling and simulation, many a time a user wants to use Composite Materials properties in the analysis. While COMSOL Multiphysics® is capable of modeling and simulation of any physics-based system, adding a user-friendly interface to integrate Composite Material properties with it will further enhance its capabilities.

The Application Programming Interface (API) of COMSOL Multiphysics® is an interface based on Java and can be used to develop custom applications in the software. An initial GUI (Graphical User Interface) is built based on a model of a simple 'Rectangular Block', having a point force acting on the edge. And the final GUI is built based on a model of 'Mechanical Part', having a combination of forces and moments acting on it. Halpin-Tsai Model, a semi-empirical model chosen based on its accuracy and appropriateness, is used to develop algorithm to calculate the composite material properties.

The Composite Material Module is built as is shown in Figure 1. In addition, the GUI also includes certain Post-Processing features such as contour plot, line graph, surface plot and max/min line plot. Adding these Post-Processing features to the GUI will simplify their use by only allowing suitable settings to be viewed and changed. This will allow users who are not experienced in modeling to benefit from models created by others. The simulation of a 'Rectangular Block' is performed using Composite Materials in the initial GUI built as shown in Figure 2. Similarly, the simulation of a complex mechanical part is performed using Composite Materials in the final GUI.

Conclusion: The Composite Material properties were successfully integrated with COMSOL Multiphysics®. The GUI created is compatible to be used for any model for the purpose of performing simulation with Composite Material properties. Also, it can be used to perform some of the important Post-Processing which can be cumbersome to do in COMSOL Multiphysics® GUI for an inexperienced user.

Figures used in the abstract

Pre-Processing

Fiber Property:

% Fiber Content:

Matrix Property:

% Matrix Content:

E11:	<input type="text" value="396.15 MPa"/>
E22:	<input type="text" value="4287.22 MPa"/>
E33:	<input type="text" value="4287.22 MPa"/>
G12:	<input type="text" value="1494.97 MPa"/>
G23:	<input type="text" value="2143.61 MPa"/>
G31:	<input type="text" value="1494.97 MPa"/>
Nu12:	<input type="text" value="0.37"/>
Nu23:	<input type="text" value="0"/>
Nu31:	<input type="text" value="0"/>
Density:	<input type="text" value="1.32 g/cm<sup>3</sup>"/>

Figure 1: Composite Material Module.

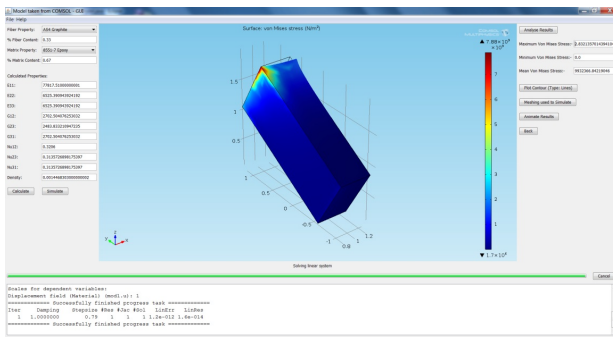


Figure 2: Simulation of a 'Rectangular Block' performed using Composite Materials.