



Nonlinear Structural Materials Module

User's Guide

Nonlinear Structural Materials Module User's Guide

© 1998–2018 COMSOL

Protected by patents listed on www.comsol.com/patents, and U.S. Patents 7,519,518; 7,596,474; 7,623,991; 8,457,932; 8,954,302; 9,098,106; 9,146,652; 9,323,503; 9,372,673; and 9,454,625. Patents pending.

This Documentation and the Programs described herein are furnished under the COMSOL Software License Agreement (www.comsol.com/comsol-license-agreement) and may be used or copied only under the terms of the license agreement.

COMSOL, the COMSOL logo, COMSOL Multiphysics, COMSOL Desktop, COMSOL Server, and LiveLink are either registered trademarks or trademarks of COMSOL AB. All other trademarks are the property of their respective owners, and COMSOL AB and its subsidiaries and products are not affiliated with, endorsed by, sponsored by, or supported by those trademark owners. For a list of such trademark owners, see www.comsol.com/trademarks.

Version: COMSOL 5.4

Contact Information

Visit the Contact COMSOL page at www.comsol.com/contact to submit general inquiries, contact Technical Support, or search for an address and phone number. You can also visit the Worldwide Sales Offices page at www.comsol.com/contact/offices for address and contact information.

If you need to contact Support, an online request form is located at the COMSOL Access page at www.comsol.com/support/case. Other useful links include:

- Support Center: www.comsol.com/support
- Product Download: www.comsol.com/product-download
- Product Updates: www.comsol.com/support/updates
- COMSOL Blog: www.comsol.com/blogs
- Discussion Forum: www.comsol.com/community
- Events: www.comsol.com/events
- COMSOL Video Gallery: www.comsol.com/video
- Support Knowledge Base: www.comsol.com/support/knowledgebase

Part number: CM022901

The Nonlinear Structural Materials Module

The Nonlinear Structural Materials Module is an optional add-on package for COMSOL Multiphysics® designed to assist you to model structural behavior that includes nonlinear materials. The module is an add-on to the Structural Mechanics Module or the MEMS Module and extends it with support for modeling nonlinear materials, including hyperelasticity, creep, plasticity, and viscoplasticity. The module is designed for researchers, engineers, developers, teachers, and students who want to simulate nonlinear structural materials, including a full range of possible multiphysics couplings.

The module provides an extensive set of nonlinear structural material models, including:

- Predefined and user-defined hyperelastic materials: neo-Hookean, Mooney-Rivlin, Saint-Venant Kirchhoff, Arruda-Boyce, Ogden, and others.
- Small-strain and large-strain plasticity models using different types of hardening.
- User-defined plasticity, flow rule and hardening models.
- Porous plasticity models, used for example for powder compaction simulation.
- Predefined and user-defined nonlinear elastic materials: Ramberg-Osgood, Power law, and others.
- Shape memory alloys.
- Predefined and user-defined creep and viscoplastic material models: Norton, Garofalo, Anand, potential, volumetric, deviatoric, and others.
- Models for damage in brittle materials.

ACCESSING THE NONLINEAR STRUCTURAL MATERIALS DOCUMENTATION

This is an add-on module requiring either the Structural Mechanics Module or the MEMS Module. The feature information, including theory and modeling details, is included in the *Structural Mechanics Module User's Guide*.

When you install COMSOL Multiphysics, the documentation sets are installed in several locations, both on your computer and most easily accessible while you are working in COMSOL Multiphysics. The next section details where to access it.

ACCESSING COMSOL DOCUMENTATION AND APPLICATION LIBRARIES

A number of internet resources have more information about COMSOL, including licensing and technical information. The electronic documentation, topic-based (or context-based) help, and the application libraries are all accessed through the COMSOL Desktop.



If you are reading the documentation as a PDF file on your computer, the [blue links](#) do not work to open an application or content referenced in a different guide. However, if you are using the Help system in COMSOL Multiphysics, these links work to open other modules, application examples, and documentation sets.

THE DOCUMENTATION AND ONLINE HELP

The *COMSOL Multiphysics Reference Manual* describes the core physics interfaces and functionality included with the COMSOL Multiphysics license. This book also has instructions about how to use COMSOL Multiphysics and how to access the electronic Documentation and Help content.

Opening Topic-Based Help

The Help window is useful as it is connected to the features in the COMSOL Desktop. To learn more about a node in the Model Builder, or a window on the Desktop, click to highlight a node or window, then press F1 to open the Help window, which then displays information about that feature (or click a node in the Model Builder followed by the **Help** button (). This is called *topic-based* (or *context*) help.

To open the **Help** window:

- In the **Model Builder**, **Application Builder**, or **Physics Builder** click a node or window and then press F1.
- On any toolbar (for example, **Home**, **Definitions**, or **Geometry**), hover the mouse over a button (for example, **Add Physics** or **Build All**) and then press F1.
- From the **File** menu, click **Help** ().
- In the upper-right corner of the COMSOL Desktop, click the **Help** () button.

 Win

	To open the Help window:
 Mac	<ul style="list-style-type: none">In the Model Builder or Physics Builder click a node or window and then press F1.
 Linux	<ul style="list-style-type: none">On the main toolbar, click the Help () button.From the main menu, select Help>Help.

Opening the Documentation Window

	To open the Documentation window:
 Win	<ul style="list-style-type: none">Press Ctrl+F1.From the File menu select Help>Documentation ().
 Mac	To open the Documentation window:

 Linux	<ul style="list-style-type: none">Press Ctrl+F1.On the main toolbar, click the Documentation () button.From the main menu, select Help>Documentation.
---	---

THE APPLICATION LIBRARIES WINDOW

Each model or application includes documentation with the theoretical background and step-by-step instructions to create a model or app. The models and applications are available in COMSOL Multiphysics as MPH files that you can open for further investigation. You can use the step-by-step instructions and the actual models as templates for your own modeling. In most models, SI units are used to describe the relevant properties, parameters, and dimensions, but other unit systems are available.

Once the Application Libraries window is opened, you can search by name or browse under a module folder name. Click to view a summary of the model or application and its properties, including options to open it or its associated PDF document.

	The Application Libraries Window in the <i>COMSOL Multiphysics Reference Manual</i>.
---	--

Opening the Application Libraries Window

To open the **Application Libraries** window ():

- From the **Home** toolbar, **Windows** menu, click () **Applications Libraries**.

 Win

- From the **File** menu select **Application Libraries**.

To include the latest versions of model examples, from the **File>Help** menu, select () **Update COMSOL Application Library**.

 Mac Select **Application Libraries** from the main **File>** or **Windows>** menus.

 Linux To include the latest versions of model examples, from the **Help** menu select () **Update COMSOL Application Library**.

CONTACTING COMSOL BY EMAIL

For general product information, contact COMSOL at info@comsol.com.

COMSOL ACCESS AND TECHNICAL SUPPORT

To receive technical support from COMSOL for the COMSOL products, please contact your local COMSOL representative or send your questions to support@comsol.com. An automatic notification and a case number are sent to you by email. You can also access technical support, software updates, license information, and other resources by registering for a COMSOL Access account.

COMSOL ONLINE RESOURCES

COMSOL website	www.comsol.com
Contact COMSOL	www.comsol.com/contact
COMSOL Access	www.comsol.com/access
Support Center	www.comsol.com/support
Product Download	www.comsol.com/product-download
Product Updates	www.comsol.com/support/updates
COMSOL Blog	www.comsol.com/blogs
Discussion Forum	www.comsol.com/community
Events	www.comsol.com/events

COMSOL Video Gallery	www.comsol.com/video
Support Knowledge Base	www.comsol.com/support/knowledgebase
