

# Femap assembly modeling

Enabling product teams to quickly and easily model the interaction between components in a complex assembly

## Technical Brief

Siemens PLM Software provides automatic assembly detection functionality through its Femap™ application, including capabilities to support linear contact, glued connection, spot welds and fasteners, and bolted connections. Femap includes a transparent highlighter to let you visualize all contact instances either by contact-face-to-contact-face or part-to-part representations.

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## Assembly modeling challenges

Increased demands on simulation to accurately represent more complex systems and assemblies drive the need for a fast and robust capability that correctly models the interaction between components in an assembly.

Within an assembly, there are various ways that components can interact with each other, from simple contact to contact with friction. In addition, various methods are available to enable you to assemble these components together, including using fasteners such as spot welds, gluing or bonding, and bolted joints.

One key factor of the assembly process is model setup – the ability to quickly and easily identify all components that come into contact and accurately define the contact conditions that exist between any given two components.

## Femap automatic assembly detection

Automatic assembly detection, which is supported through preprocessor and postprocessor applications such as Siemens PLM Software's Femap application, enables product teams to determine which components come into contact. Femap provides a transparent highlighter to let you visualize all contact instances either by contact-face-to-contact-face or part-to-part representations.

Representation of the connection behaviors can be set up to show simple or glued contact by referencing an appropriate property definition either automatically when contact

detection is being performed or later when existing definitions can easily be edited and changed. New contact segments can be defined manually from scratch as well, and the contact conditions can be applied either to the geometry model prior to meshing – or to the finite element faces (of solid or shell elements) themselves.

Often simply viewing the contacting components can be a problem. However, features like Femap transparent highlighter make the task of visualizing the model contact segments much easier, thereby enabling product teams to understand how more complex assembly models fit together and how their various components interact.

## How can Siemens PLM Software help?

Siemens PLM Software provides automatic assembly detection functionality through its Femap application, including capabilities to support:

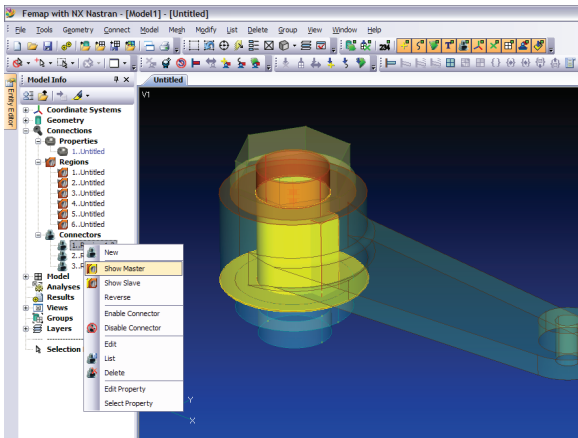
- Linear contact
- Glued connection
- Spot welds and fasteners
- Bolted connections

## Linear contact

A rigorous solution to contact problems typically has required a nonlinear approach to account for contact and other potentially nonlinear behaviors, such as large deformations and material nonlinear properties.

However, if it is possible to stay within certain limitations – such as small deflections and linear material behavior – then an easier solution can be found with linear contact that does not compromise accuracy.

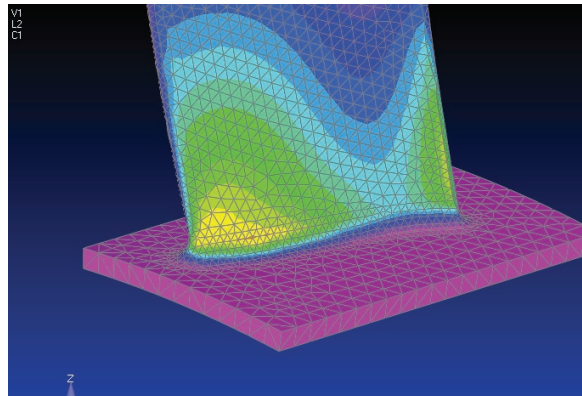
The surface-to-surface linear contact capability in Siemens PLM Software’s NX™ Nastran® system runs in a linear static analysis solution, and uses an iterative approach to search and detect contact between element faces that might come into contact under certain applied loading conditions. Finite sliding with optional friction can also be simulated.



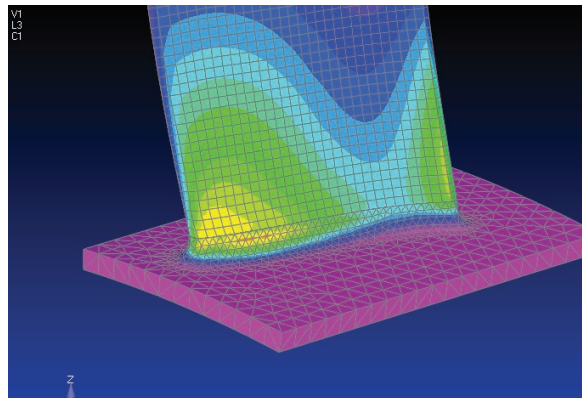
## Glued connection

Glued connection can be used to glue or bond components of an assembly together, as well as to allow parts that comprise differing or non-contiguous meshes to be joined as long as they both share the same connecting surface. The glued connection capability in NX Nastran uses an innovative approach to refine the meshes of the joined surfaces so that the load transfer across the interface is distributed as accurately as possible.

Results obtained from this methodology are much improved and yield smoother contours across the joining interface than can be obtained using the more traditional approaches to non-contiguous mesh connection (such as rigid body elements or multi-point constraints). This allows glued connections to exist in areas of the model where high accuracy is desired. As a result, the requirement of keeping this kind of connection away from areas of interest and regions of high stress change is eliminated.



Contiguous mesh model (all tet-element model).



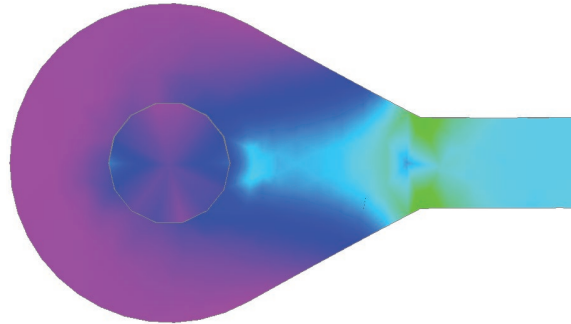
Glued connection model (hex-mesh blade, tet-mesh base).

## Choosing linear or glued contact

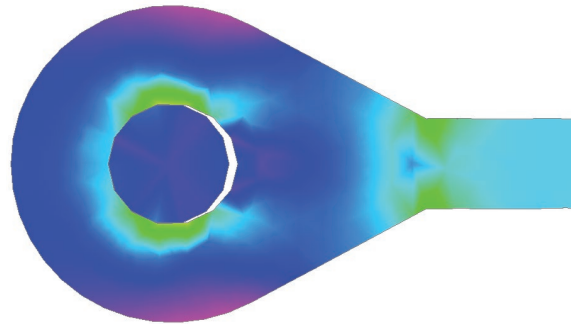
Clearly an engineering decision needs to be made about selecting the appropriate contact condition for an assembly model. The issue here is how to correctly represent the real-life situation since selecting glued over linear contact will completely change the model behavior, affect load paths, and hence the results within the model.

For example, a simple lug and pin might be modeled (as in the accompanying models) using linear contact and glued connection. The pin is fixed, and a load applied to the lug toward the right hand side. The load transfer between the pin and the lug for the linear contact example takes place only at the bearing surface (on the left of the pin) and a gap opens up on the opposite side. In contrast, with the glued model, the pin can both pull and push against the lug, giving a completely different result and stress distribution.

In addition to different contact modeling methodologies, there are methods of connecting components of an assembly together using connection elements such as fasteners, spot welds, or bolted joints (which are discussed in the following subsections).



*Glued Contact (?max = 50,500 lbf/in<sup>2</sup>).*



*Linear Contact (?max = 78,800 lbf/in<sup>2</sup>).*

## Spot welds and fasteners

Spot welds and fasteners used to connect assemblies together are typically modeled with a connector element that connects two surface patches, elements or points. In this case, the meshes being connected are not required to be coincident, which allows much more freedom when assembling the various components. Typically, the connector element stiffness is determined from the weld diameter, length (if not a spot weld) and material property.

## Bolted connections

When components of an assembly are bolted together, the torque with which the bolts are tightened translates into an axial bolt preload. Usually, it is desirable to analyze bolted structures with the preload already set and in effect. However, you may also want to obtain stresses caused by the preloading condition in isolation.

Traditionally in finite element analysis, bolt preloads are modeled with equivalent thermal loading. However, this method is approximate and models that contain multiple bolts require many solution iterations. The methodology employed by NX Nastran automates and simplifies this multi-solution process. The bolts themselves are represented as beam elements with bolt preloads applied at the ends.

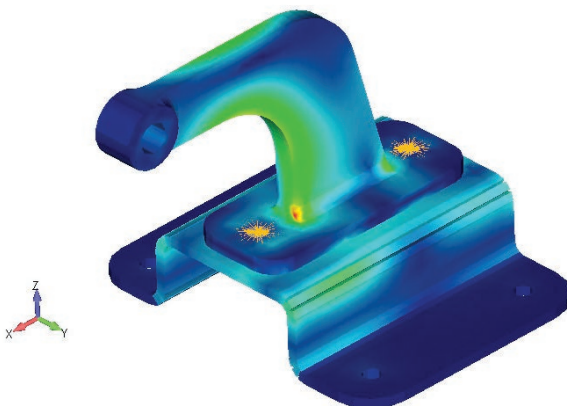
Linear and glued contact, spot welds and preloaded bolt capabilities are provided by the base Femap with NX Nastran module.

## How do I get started?

For more information about Femap, NX Nastran and Femap with NX Nastran, visit our website at:

[www.siemens.com/plm/femap](http://www.siemens.com/plm/femap)

In addition, you can contact your Siemens PLM Software representative today and let us work with you to determine the best way to get started.



*Bolt preload assembly model.*

## Siemens PLM Software

### Headquarters

Granite Park One  
5800 Granite Parkway  
Suite 600  
Plano, TX 75024  
USA  
+1 972 987 3000

### Americas

Granite Park One  
5800 Granite Parkway  
Suite 600  
Plano, TX 75024  
USA  
+1 314 264 8287

### Europe

Stephenson House  
Sir William Siemens Square  
Frimley, Camberley  
Surrey, GU16 8QD  
+44 (0) 1276 413200

### Asia-Pacific

Suites 4301-4302, 43/F  
AIA Kowloon Tower, Landmark East  
100 How Ming Street  
Kwun Tong, Kowloon  
Hong Kong  
+852 2230 3308

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