

Boundary Condition Symmetry

I-DEAS™ Tutorials: Fundamental Skills

This tutorial shows the use of symmetry and anti-symmetry restraints. These methods will produce faster solve times and smaller file sizes.

Learn how to:

- use symmetry restraints
- use anti-symmetry restraints

Before you begin...

Prerequisite tutorials:

- Getting Started (I-DEAS™ Multimedia Training)

—or—

Quick Tips to Using I-DEAS

—and—

Creating Parts

- Managing Parts In Model Files
- Introduction to Simulation
- Free Meshing
- Boundary Condition Sets
- Boundary Condition Surface Loads



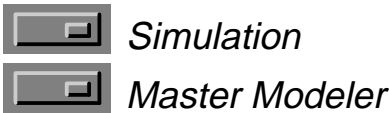
If you completed the tutorial “Boundary Condition Sets” and saved the part, you can continue to use that model file with the same part. Make sure you delete all FE models associated with the part, or you may not be able to modify the part later in this tutorial. **Skip to the page 5.**

Otherwise, open a new model file and give it a unique name.

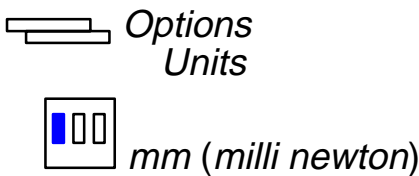
Hint



Make sure you’re in the following application and task:

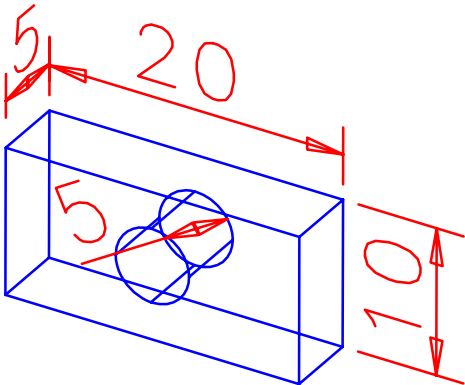
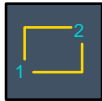


Set your units to mm.



What: Create the part shown.

Hint



What: Name the part.

Hint



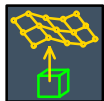
Name: Link Part

What: Create an FE model named “FEM4” associated with the part.

Hint

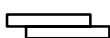


Boundary Conditions



FE Model Name: FEM4

Save your model file.



*File
Save*

Warning!

If you are prompted by I-DEAS to save your model file, respond:



No

Save only when the tutorial instructions tell you to—not when I-DEAS prompts for a save.

Why:

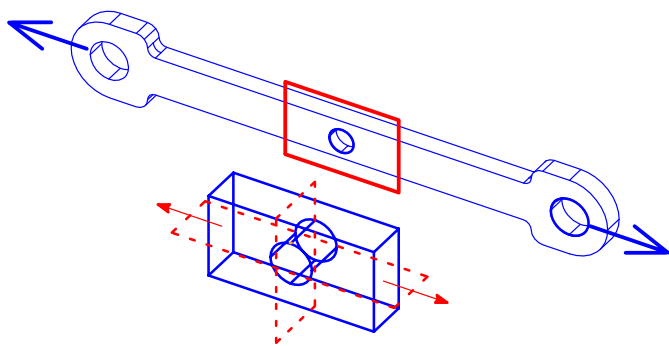
If you make a mistake at any time between saves and can’t recover, you can reopen your model file to the last save and start over from that point.

Hint

To reopen your model file to the previous save, press Control-Z.

If a part is symmetric and the loading is symmetric, you can analyze just one half of the part and get the same results as if you had analyzed the entire part. If there is more than one symmetry plane, you can even cut the model more than once.

This section shows you how to analyze the stress concentration on the pin hole in the center of a linkage, when the linkage is being pulled at both ends. This is an example of having symmetry on two planes.

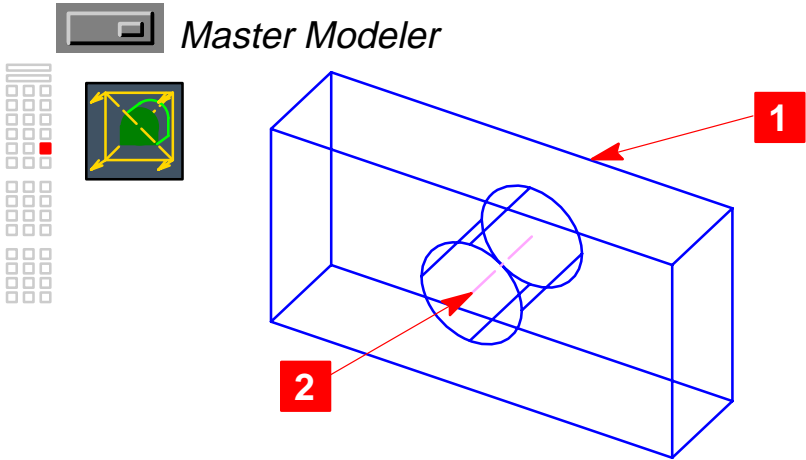


To use symmetry, you must provide the correct restraints. Along the plane of symmetry where the model is cut, nodes cannot move perpendicular to the plane or rotate in the plane.

For example, if the symmetry plane is the plane where X is a constant, all nodes on this plane must be restrained in X translation, Y rotation, and Z rotation.

What: Cut the part on the symmetry plane.

How:



1

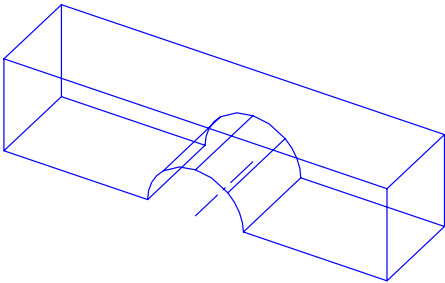
 *Axis Planes*

 *ZX Plane*

 *Pick point*

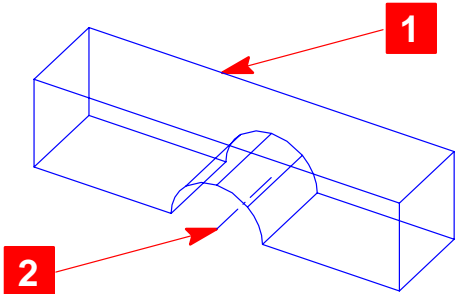
2 pick circle center point

 *Keep Positive Side*



What: Cut the part again on the other symmetry plane.

How:



1



Axis Planes



YZ Plane



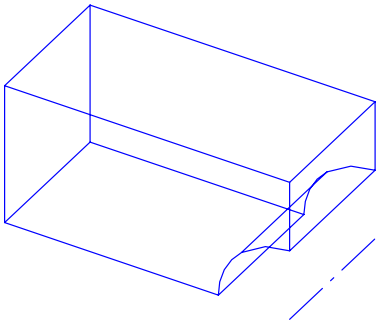
Pick point

2

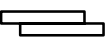
pick circle center point



Keep Negative Side



Recovery Point



*File
Save*

What: Create a new restraint set.

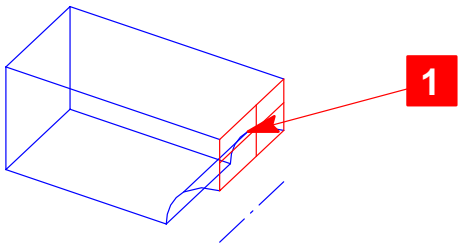
Hint



What: Restrain the cut faces to maintain symmetry.

Why: To properly represent the entire part, you must prevent movement along X for the vertical face and along Y for the horizontal face.

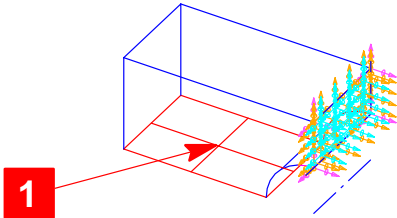
Hint



Continued on next page...

Displacement Restraint on Surface form

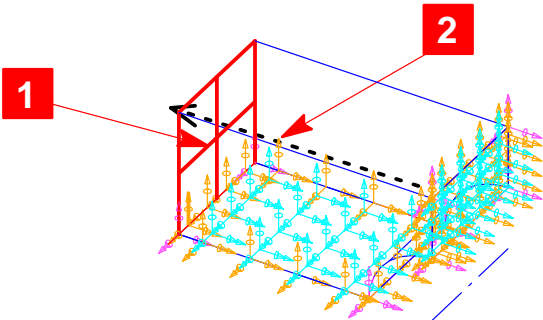
- ☐ X Translation: constant
- ☐ Y Translation: free
- ☐ Z Translation: free
- ☐ X Rotation: free
- ☐ Y Rotation: constant
- ☐ Z Rotation: constant
- ☐ OK



- ☐ X Translation: free
- ☐ Y Translation: constant
- ☐ Z Translation: free
- ☐ X Rotation: constant
- ☐ Y Rotation: free
- ☐ Z Rotation: constant
- ☐ OK

What: Apply a force to simulate pulling.

Hint



1 pick surface



Load Set: Symmetry Force



Vector



2 pick edge



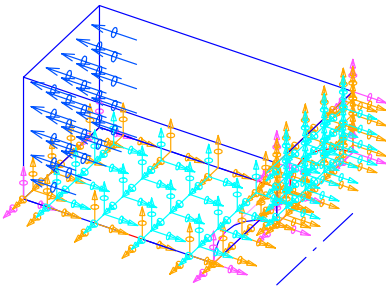
Yes (when arrow is as shown above)



Total Force



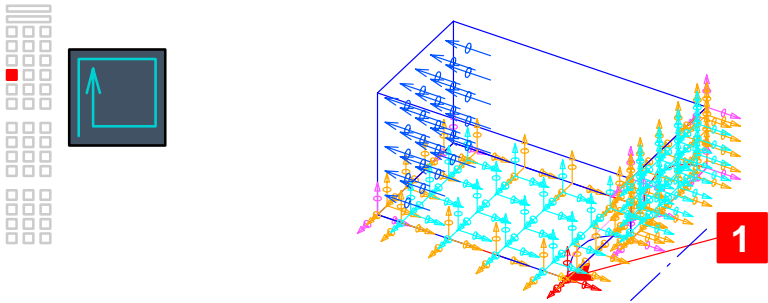
Traction: 500



What: Modify one restraint to restrict rigid body movement.

Why: Even though the model looks fully restrained, there is still a possibility of movement in the Z direction. The model may still solve correctly without the additional restraint, but you will get a warning in the *I-DEAS List* window.

How:



1 pick corner restraint




Displacement Restraint on ... form

 Specified

 Specify Restraint...

 Z Translation: constant

 OK (all forms)

Recovery Point

 File
Save

What: Create a boundary condition set.

Hint



Symmetry Pull



Restraint Set



Symmetry



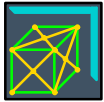
Load Sets: Symmetry Force

What: Create a solid mesh.

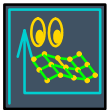
Hint



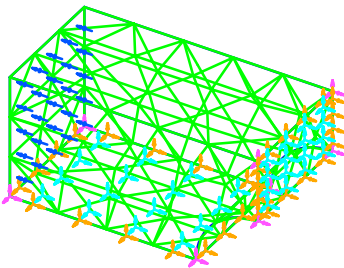
Meshing



Element Length: 2



Modify Mesh Preview form



Keep Mesh

What: Solve the model.

Hint



Model Solution



Create

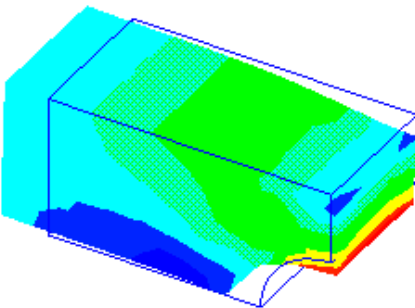


What: Display the results.

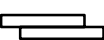
Hint



Post Processing



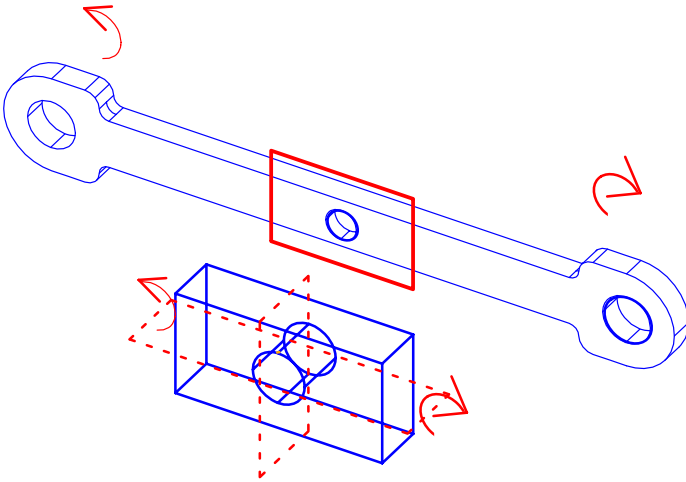
Recovery Point



*File
Save*

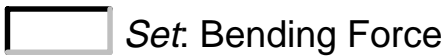
Another symmetry condition is anti-symmetry. This is where the part is symmetric, but the load is reversed across the plane of symmetry.

In the bending case shown below, the vertical cutting plane is symmetric, but the horizontal plane is anti-symmetric. On the horizontal plane, where Y is a constant, you'll restrain the X translation, Z translation, and Y rotation.



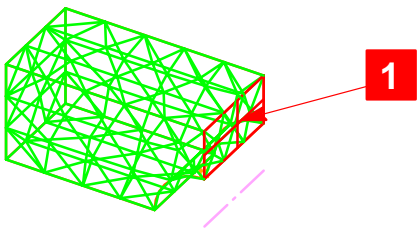
What: Create a new restraint set.

Hint



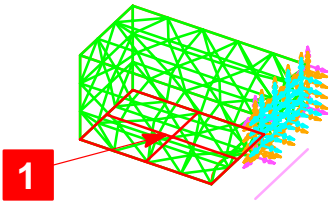
What: Restrain the cut faces.

Hint



Continued on next page...

- ☒ X Translation: constant
- ☐ Y Translation: free
- ☐ Z Translation: free
- ☐ X Rotation: free
- ☐ Y Rotation: constant
- ☐ Z Rotation: constant
- ☐ OK

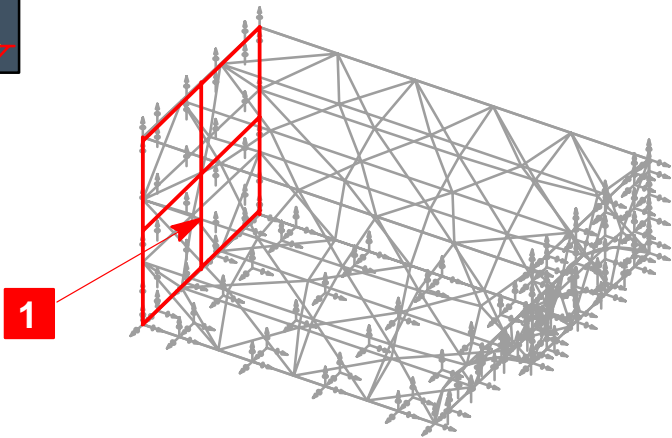


- ☒ X Translation: constant
- ☐ Y Translation: free
- ☒ Z Translation: constant
- ☐ X Rotation: free
- ☐ Y Rotation: constant
- ☐ Z Rotation: free
- ☐ OK

Why: The vertical face is symmetric, the same as the last case. The horizontal face is anti-symmetric; therefore, all the restraints switch the opposite way from the last case.

What: Restrain the left end in the Y direction.

Hint



1 pick surface



Y Translation: constant



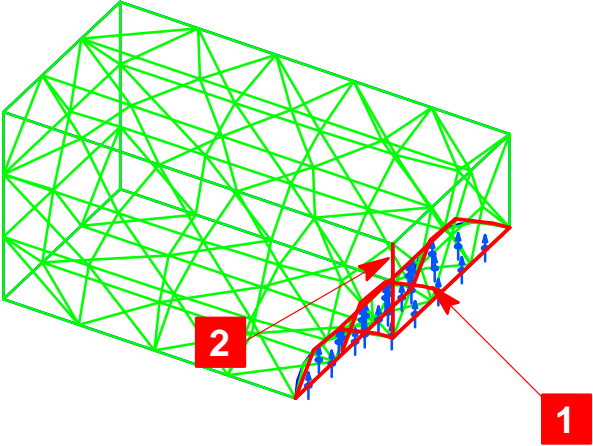
(all other directions): free



OK

What: Apply a Y force to the cylindrical surface.

Hint



1 pick cylindrical surface



 *Vector*



2 pick edge

 *Total Force*

 *Traction: 500*

 *OK*

Recovery Point

 *File*
 *Save*

What: Create a boundary condition set.

Hint



Bending



Restraint Set.



ANTI-SYMMETRY



Load Sets: Bending Force

What: Solve the model.

Hint



Model Solution



Create

Solution Set form



Boundary Condition Set: Bending

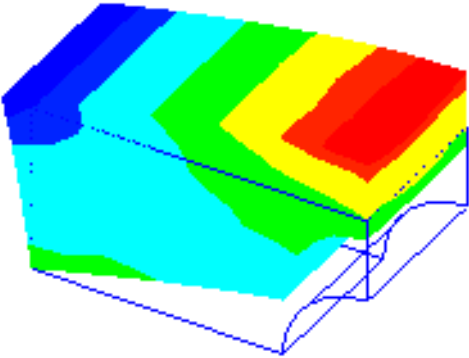


What: Select and display the bending stress and deflection.

Hint



Post Processing



You may want to turn off some of the boundary conditions to clarify the display.

Hint



FE Models...

Tutorial wrap-up

You have completed the Boundary Condition Symmetry tutorial.

What: Delete the FE model, then the part. This part is not used in any other tutorial.

Hint



See also...

For additional information on the concepts covered in this tutorial, see the following:

 *Help, Manuals, Table of Contents*

Simulation: Finite Element Modeling User's Guide
Simulation Techniques and Examples
Applying Boundary Conditions (symmetry)
Applying Boundary Conditions
Applying Restraints
Applying Structural Loads

What's next?

After completing the Fundamental Skills tutorials on boundary conditions, you should try the tutorials on displaying results.

To exit this tutorial, select:

 *File*
Exit

Warning!

Do not use the menu in the *I-DEAS Icons* window to exit. Use the menu in the Acrobat Reader window.

I-DEAS Master Series™ Online Tutorials

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