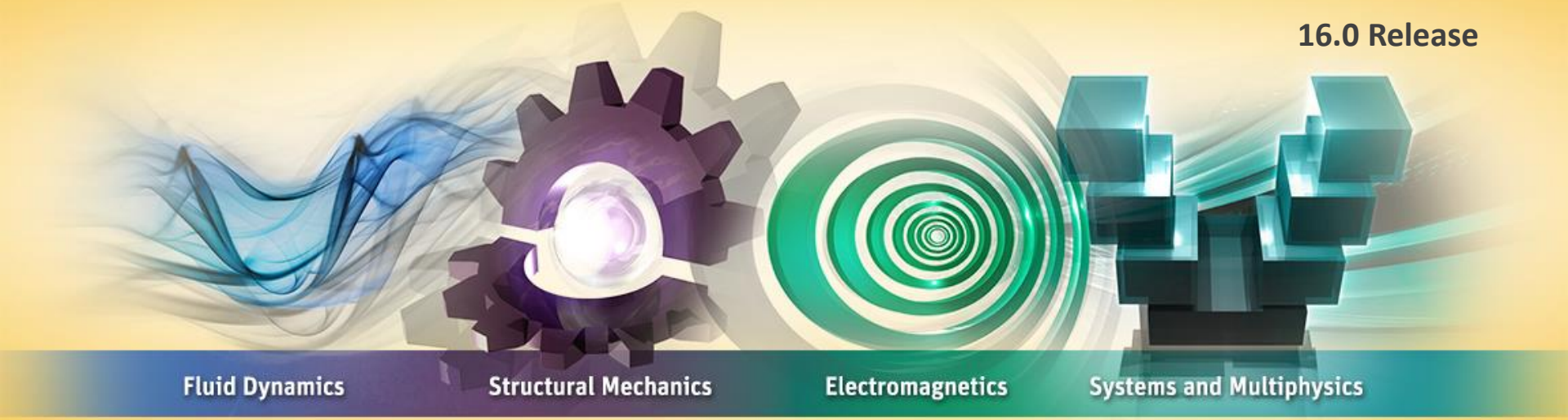
Workshop 7.2
Beam Connections

16.0 Release



Introduction to ANSYS Mechanical

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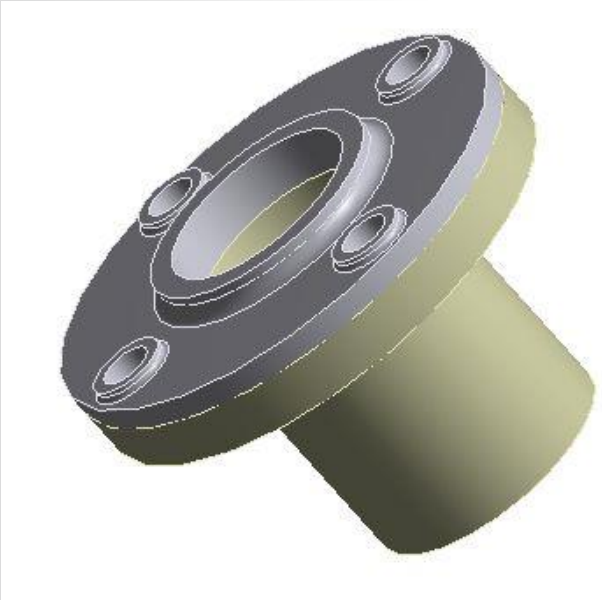
Goals

Workshop 7.2 consists of a flange containing 2 parts. The fasteners holding the flange together are not modeled. Instead we'll use Mechanical's beam feature to simulate them. We'll then use a remote force to represent a structural load whose line of action is located some distance from the flange.



Assumptions

We'll assume the mount is fixed to some larger assembly.

As noted, we'll use the Body to Body bolt feature to simulate the fasteners.

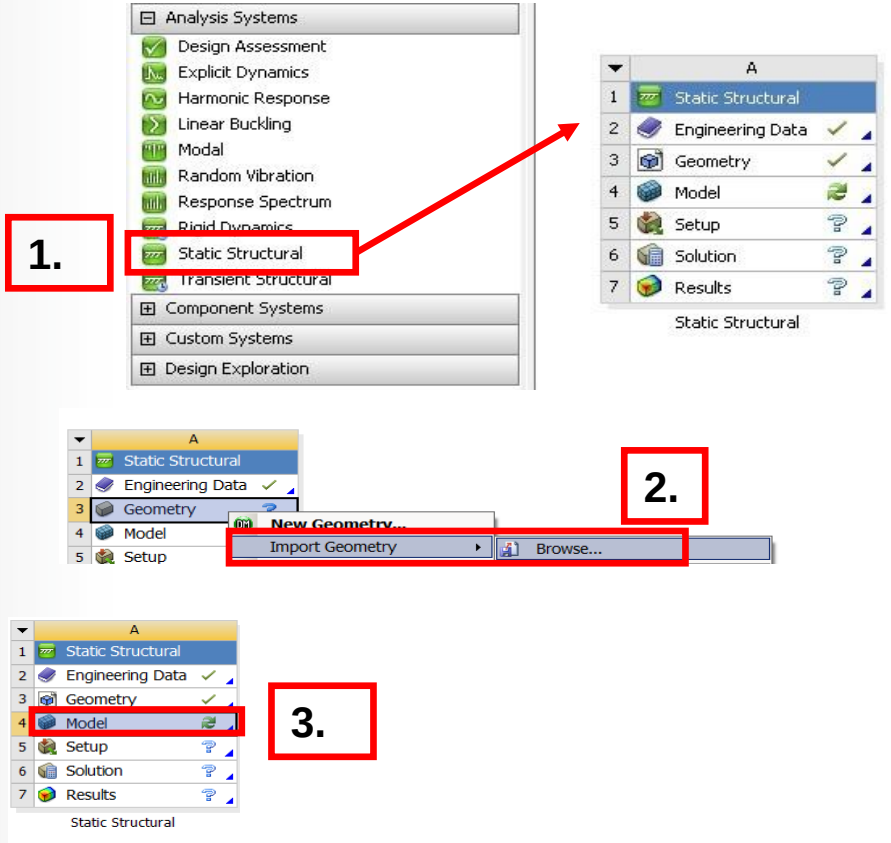
Finally, a remote load (X = 1000 N) scoped to the flange face and located at Z = 100 mm..

Project Schematic

1. From the Toolbox insert a “Static Structural” system into the Project Schematic.

2. From the Geometry cell, RMB and “Import Geometry > Browse”. Import the file “Flange Mount.stp”.

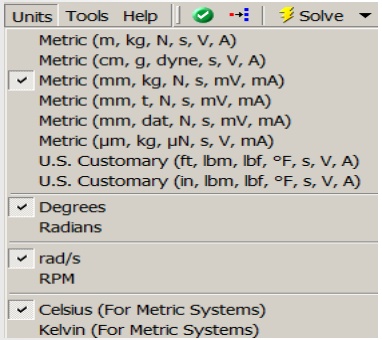
3. Double click the “Model” cell to start the Mechanical application.



Preprocessing

4. **Set the working unit system:**
   - **“Units > Metric (mm, kg, N, s, mV, mA)”.**

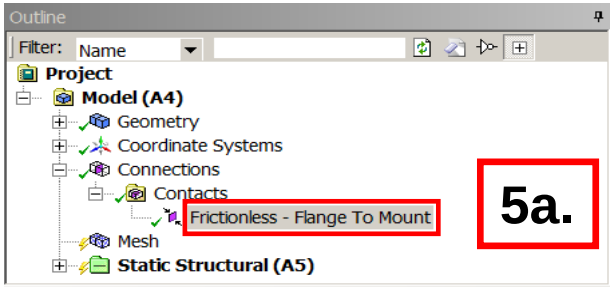
4.

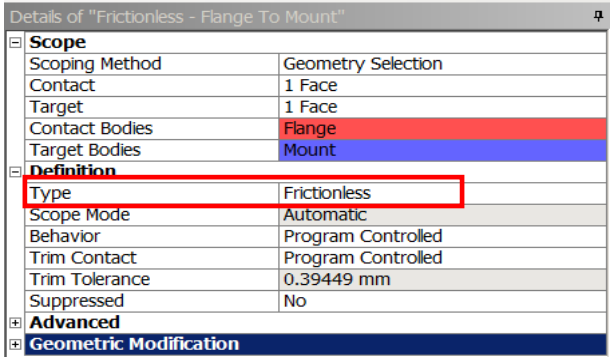


. . . Preprocessing

5. Change the contact region behavior:
   a. Highlight the contact branches.
   b. From the detail window change the contact type to "frictionless".

Note: frictionless contact is nonlinear. We are using frictionless contact because this behavior allows separation.

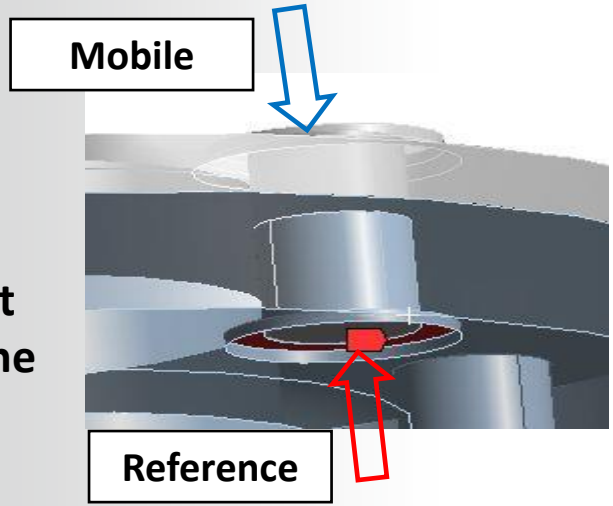


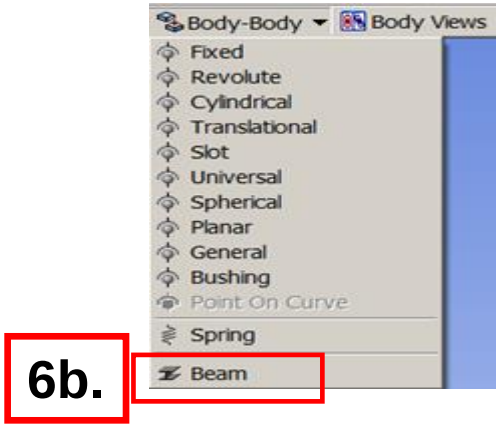


. . . Preprocessing

6. Add beams to model fasteners:
   a. Highlight the connections branches.
   b. From the connections context menu choose “Body-Body > Beam”.

The scope of the bolted connections is shown here for clarity. The next several slides describe the procedure.





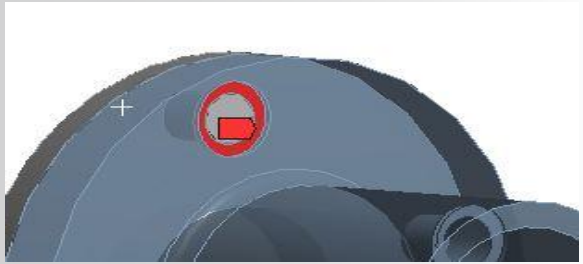
. . . Preprocessing

7. Add beam details:

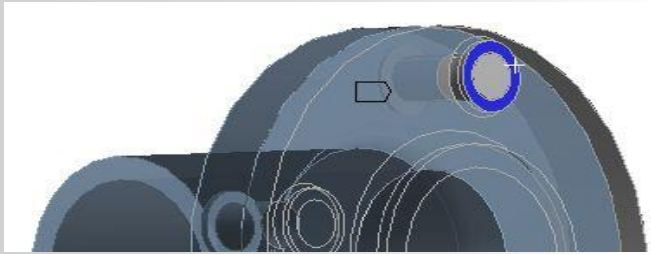
   a. Enter “5” mm for beam radius.

      – Note, structural steel is the assumed material

   b. Scope the Reference side of the beam as shown.



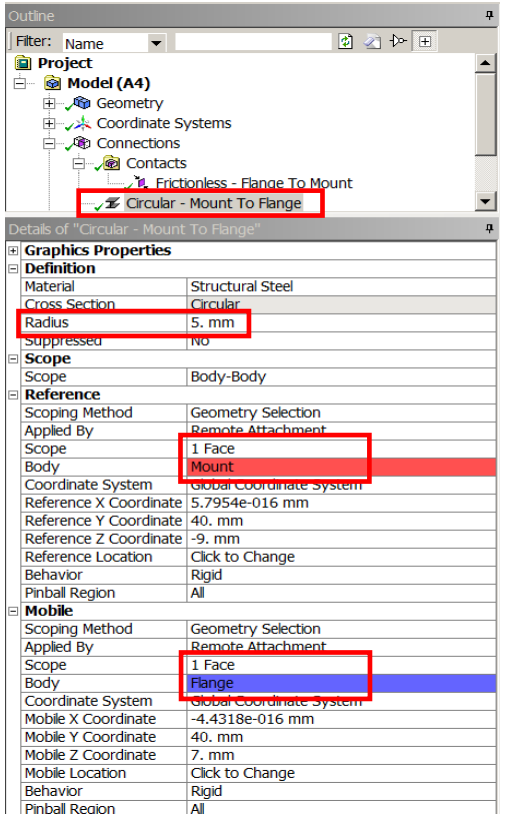
   c. Scope the Mobile side of the beam as shown.



7a.

7b.

7c.



Note: the designation of which face is to be reference or mobile is arbitrary in this case.

. . . Preprocessing

8. Change beam behavior:

a. Change the reference behavior to “Deformable”.

b. Change the mobile behavior to “Deformable”.

- Alternatively, the user may wish to select the reference face and the mobile face prior to creating the beam. In cases where the reference and mobile entities are inter-changeable this could offer time savings.

<u>Repeat steps 6 through 8 for the remaining three holes.</u>

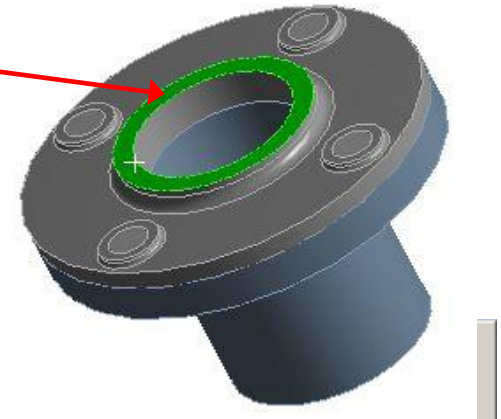
8a.

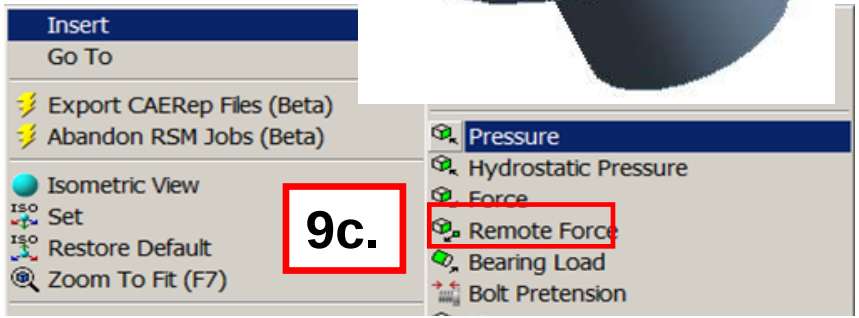
8b.

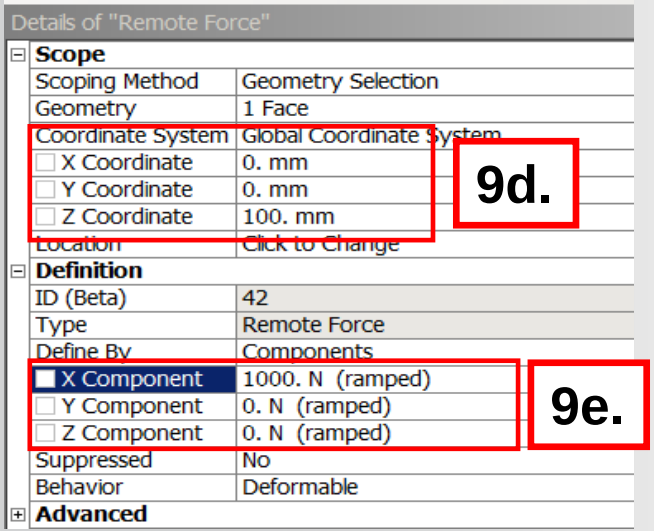
Details of "Circular - Mount To Flange"	
Graphics Properties	
Definition	
Material	Structural Steel
Cross Section	Circular
Radius	5. mm
Suppressed	No
Scope	
Scope	Body-Body
Reference	
Scoping Method	Geometry Selection
Applied By	Remote Attachment
Scope	1 Face
Body	Mount
Coordinate System	Global Coordinate System
Reference X Coordinate	5.7954e-016 mm
Reference Y Coordinate	40. mm
Reference Z Coordinate	-9. mm
Reference Location	Click to Change
Behavior	Deformable
Pinball Region	All
Mobile	
Scoping Method	Geometry Selection
Applied By	Remote Attachment
Scope	1 Face
Body	Flange
Coordinate System	Global Coordinate System
Mobile X Coordinate	-4.4318e-016 mm
Mobile Y Coordinate	40. mm
Mobile Z Coordinate	7. mm
Mobile Location	Click to Change
Behavior	Deformable
Pinball Region	All

Environment

9. Add a remote force:
   a. Highlight “Static Structural” in the tree.
   b. Select the flange face shown.
   c. RMB > Insert > Remote Force.





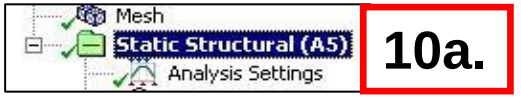


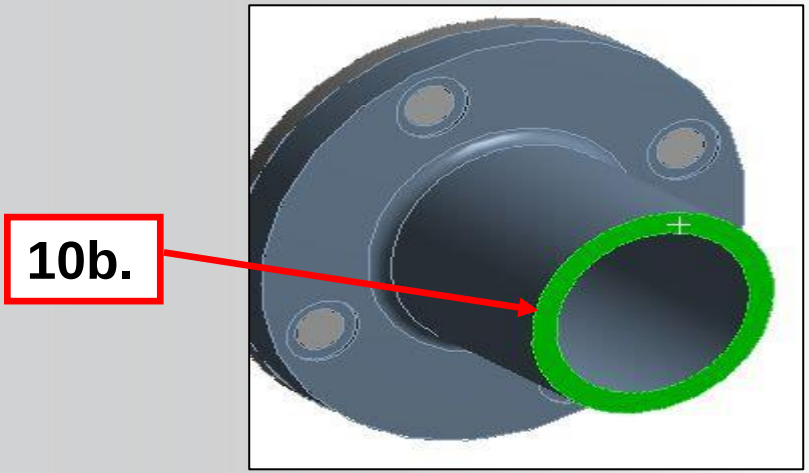
d. Set the location to 0, 0, 100 as shown.

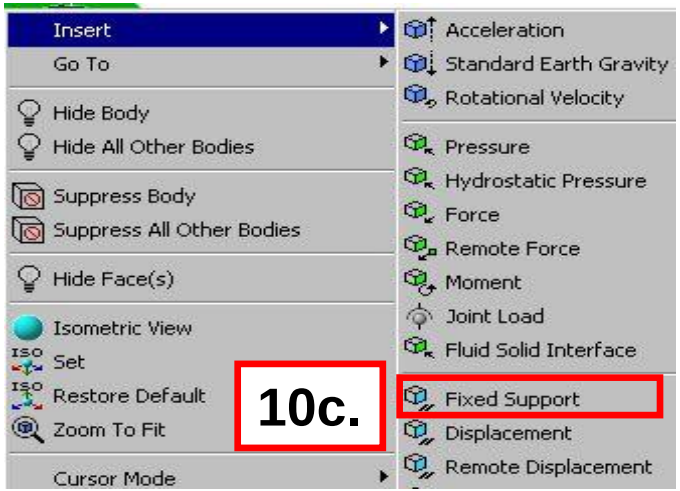
e. Switch to the component method and enter X component = 1000 N.

. . . Environment

10. **Apply the fixed support to the mount:**
    a. **Highlight the "Static Structural" branch.**
    b. **Highlight the mount surface shown.**
    c. **RMB > Insert > Fixed Support.**

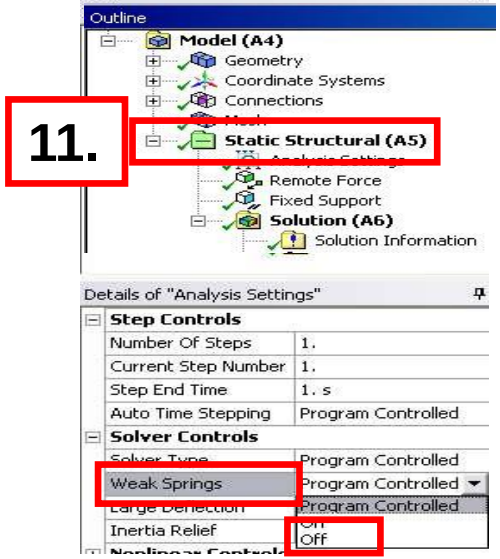






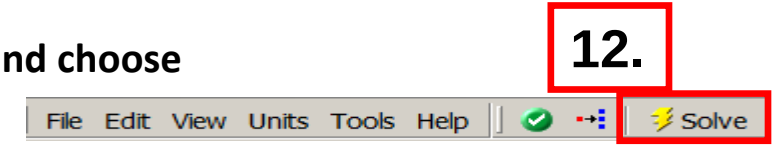
Solution

11. Highlight the “Analysis Settings” and from the details window change “Weak Springs” from “Program Controlled” to “Off”.



Note : Because of the presence of frictionless contact Workbench-Mechanical will trigger the use of weak springs during the solution. If we know the model is fully constrained we can turn off this function.

12. Solve the model:
    - Choose solve from the tool bar or RMB in the tree and choose “Solve”.

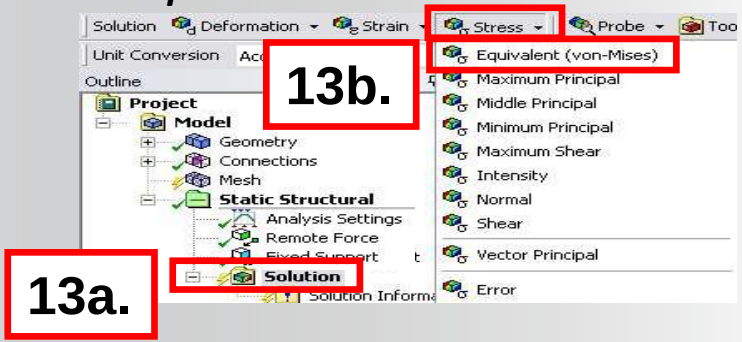


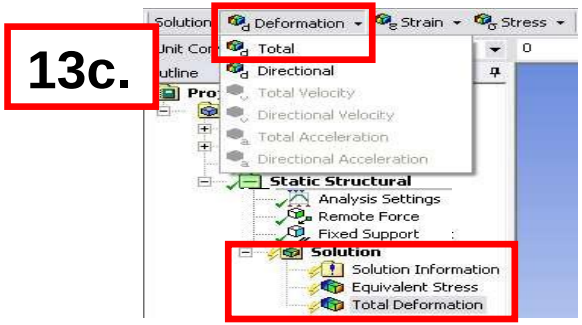
Postprocessing

13. Add results to solution:
    a. Highlight the solution branch:
    b. From the context menu, choose Stresses > Equivalent (von-Mises) or RMB > Insert > Stress > Equivalent (von-Mises)
    c. Repeat the step above, choose Deformation > “Total Deformation”

14. Solve again.

- *Note: adding results and re-solving the model will not cause a complete solution to take place. Requesting new results requires only a re-read of the results file.*
- *Alternatively, the requested results can be process by RMB on Solutions and pick Evaluate All Results options*

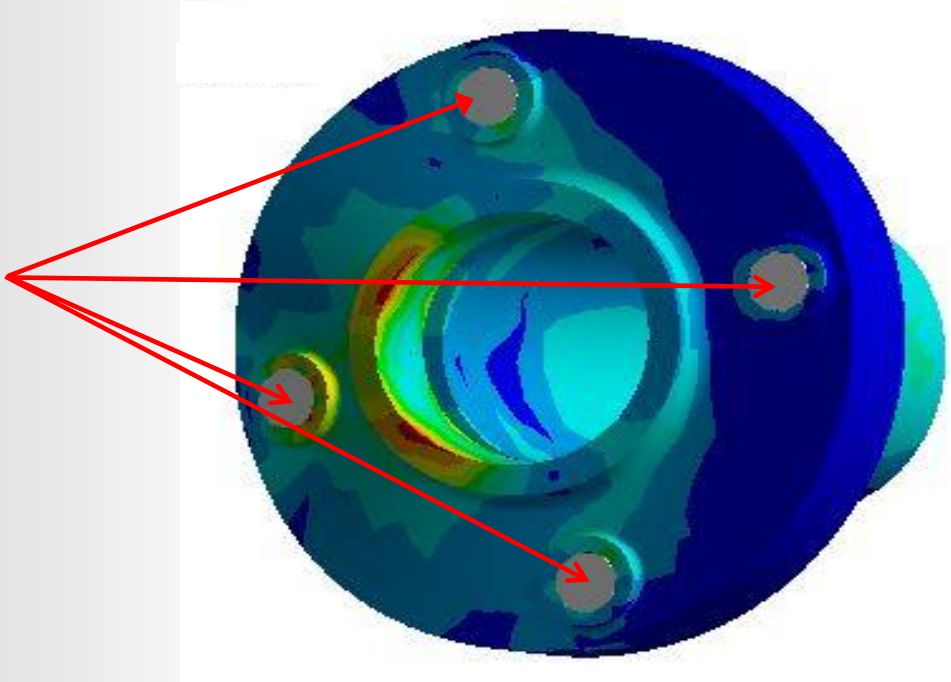




. . . Postprocessing

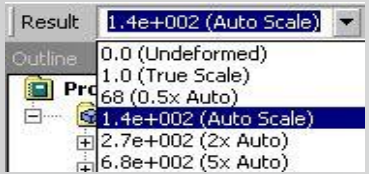
For beam connections, no contours are displayed however results can be obtained using a Beam Probe (see step 15).

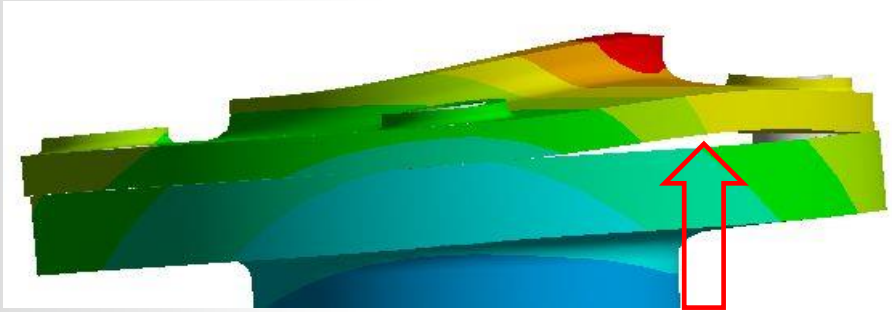
Beam Connections



. . . Postprocessing

By turning on Auto Scale from the context menu (magnifying displacements) you can see the tendency for the flange to separate due to the remote force.



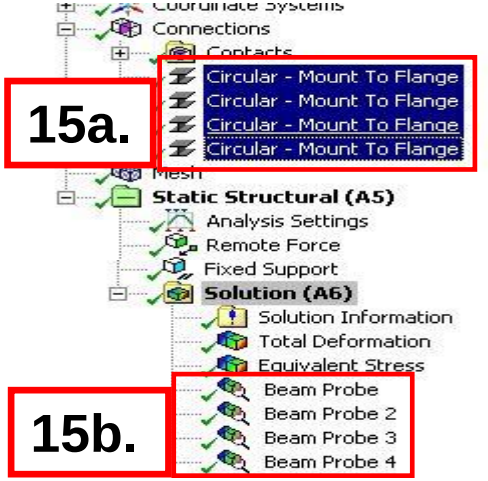


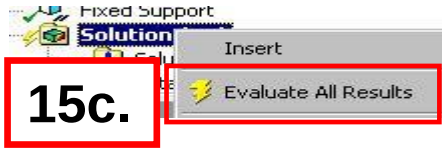
. . . Postprocessing

15. Retrieve results for beams:
    a. Highlight the 4 branches representing the circular beams.
    b. Drag and drop the beams on to the Solution branch.
    c. RMB > Evaluate All Results.

A sample of one of the details windows for the beam sections shown here displays the various results available

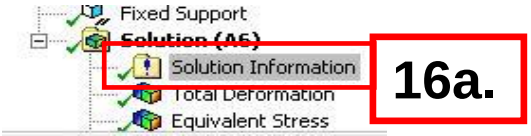
Definition	
Type	Beam Probe
Boundary Condition	Circular - Flange To Mount
Suppressed	No
Options	
Result Selection	All
Display Time	End Time
Results	
Maximum Value Over Time	
Axial Force	2037,6 N
Torque	1,7833 N·mm
Shear Force At I	360,49 N
Shear Force At J	360,49 N
Moment At I	6537,7 N·mm
Moment At J	771, N·mm
Minimum Value Over Time	
Axial Force	2037,6 N
Torque	1,7833 N·mm
Shear Force At I	360,49 N
Shear Force At J	360,49 N
Moment At I	6537,7 N·mm
Moment At J	771, N·mm
Information	

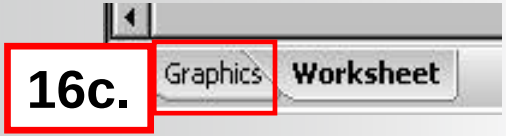


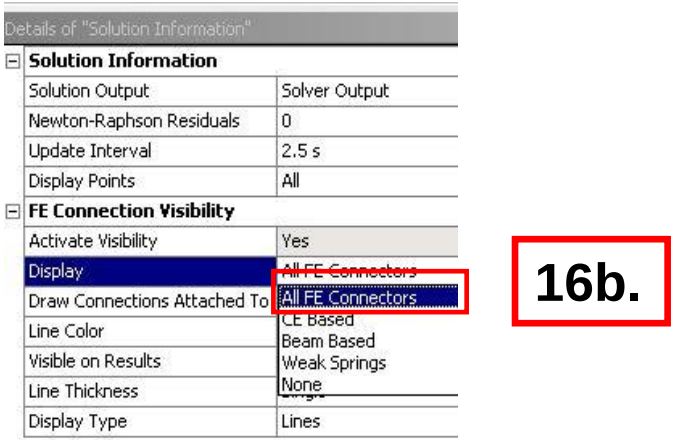


. . . Postprocessing

16. Review FE Connections:
    a. Highlight the Solution Information Branch.
    b. In the “FE Connection Visibility” section set “Display” to “All FE Connectors”.
    c. At the bottom of the graphics window change to the Graphics tab.







. . . Postprocessing

- The figure on the left shows all constraint equations written as a result of the remote force and the beam connections.
- On the right the beam connections are shown.