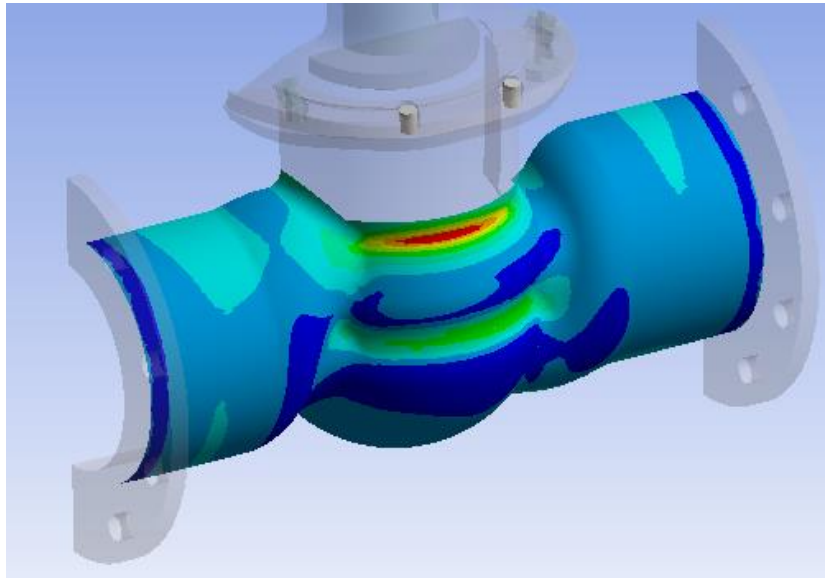
Ansys Mechanical Beyond the Basics

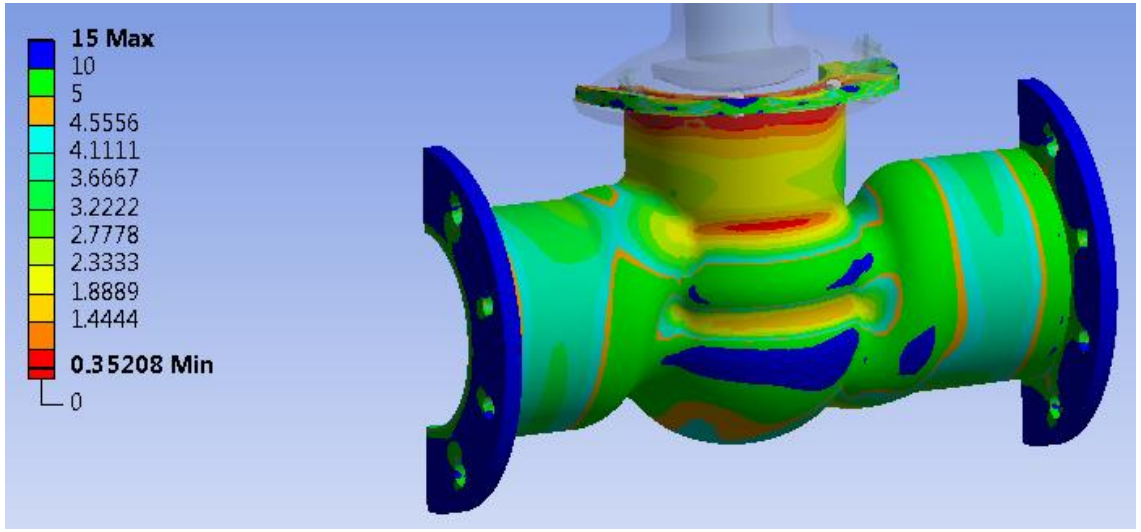
Module 06 Student Step-by-Step Guide: Expanded Results and Validation

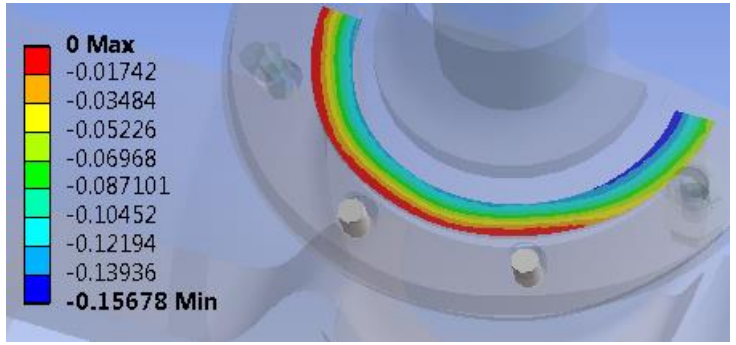
Release 2021 R2

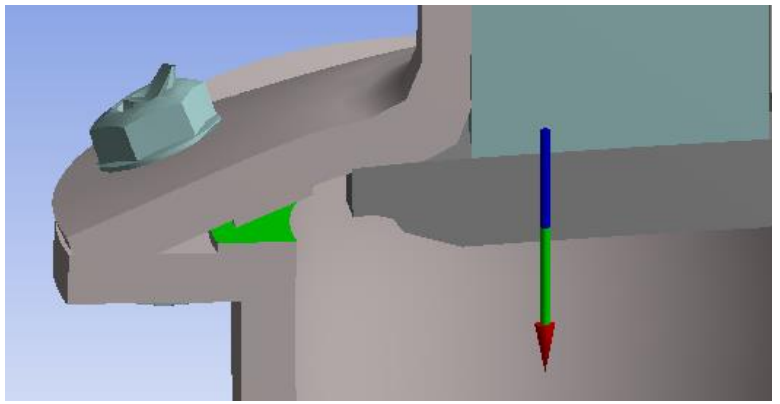
Step-by-Step Guide 06: Expanded Results and Validation

Use this guide to repeat the steps the instructor demonstrated within this module.



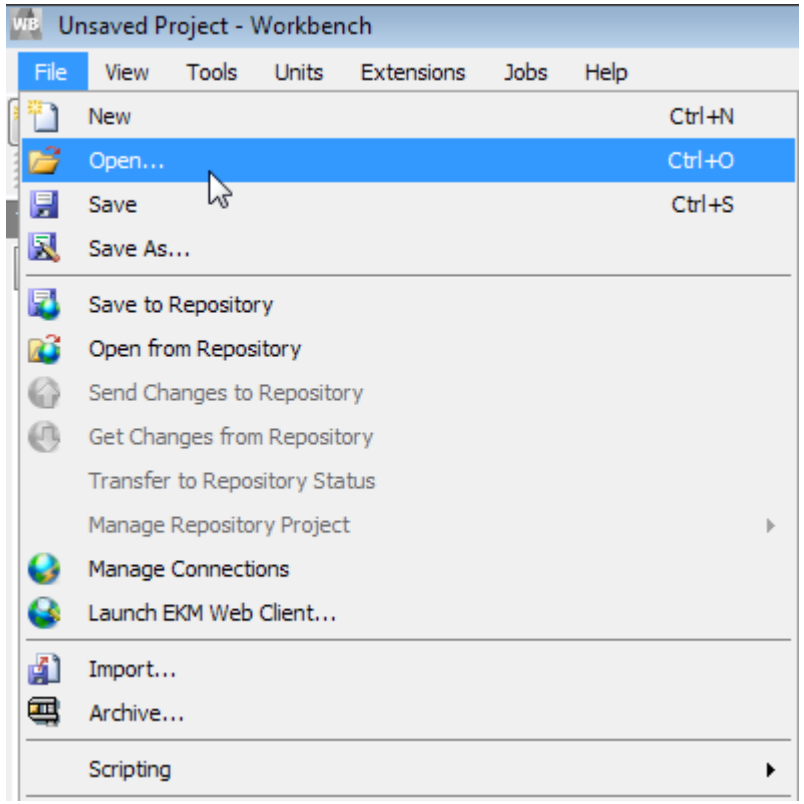


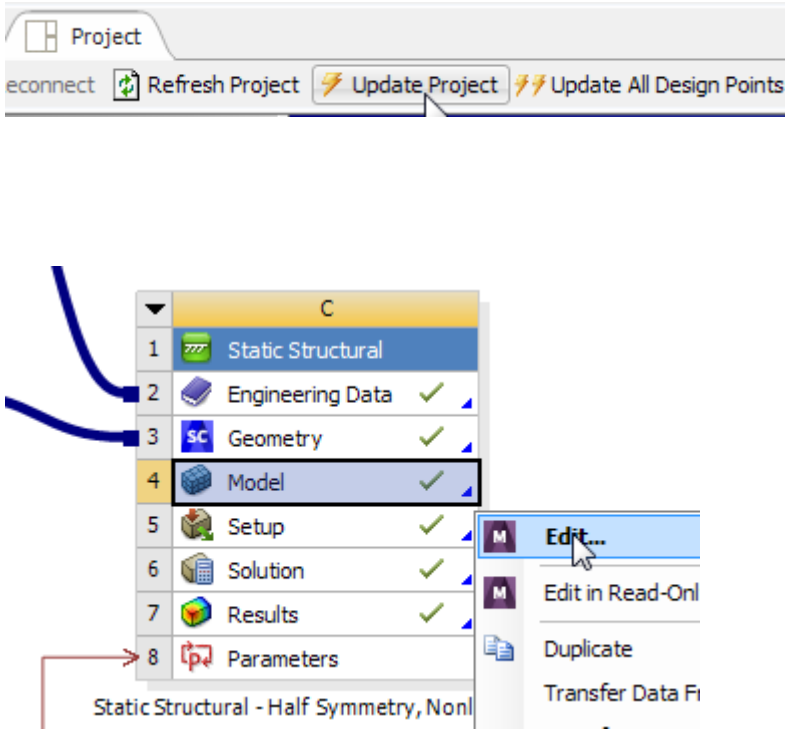




Step-by-Step Guide 06: Expanded Results and Validation

- **Open Archive:** “Globe_Valve_SS06_Start.wbpz”
- Update the Project to solve the model, then Open Mechanical





Step-by-Step Guide 06: Expanded Results and Validation

Review the **Solution Information** window:

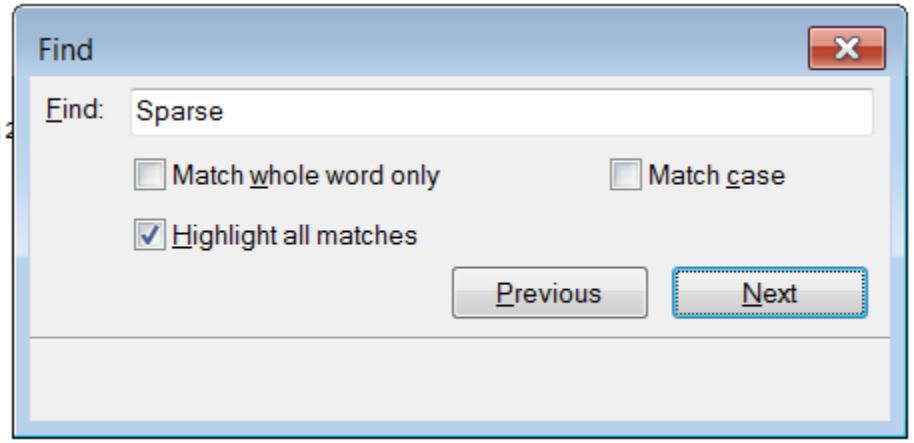
- Note the versioning information at the beginning
- Followed by the number of parallel processors requested
- Search within Solution Information for keywords such as “sparse”, “warning”, and “error”
  - **Ctrl-F → Sparse → Next**

```
DISTRIBUTED SPARSE MATRIX DIRECT SOLVER.
 Number of equations =      593554,    Maximum wavefront =    480

*** NOTE ***                            CP =      20.857   TIME= 16:2
The initial memory allocation (-m) has been exceeded.
 Supplemental memory allocations are being used.

 Local memory allocated for solver              =   2816.860 MB
 Local memory required for in-core solution     =   2468.077 MB
 Local memory required for out-of-core solution =    514.236 MB

 Total memory allocated for solver              =   5584.803 MB
 Total memory required for in-core solution     =   4893.627 MB
 Total memory required for out-of-core solution =   1012.653 MB
```



Step-by-Step Guide 06: Expanded Results and Validation

Review the **Solution Information** window:

- Compare the in-core solution statistics for this run against the out-of-core solution statistics for a different run using the **Image** inserted under **Solution Information;** this half symmetry model required much less computer resources

- **Solution Information**
  - **Example of Out-of-Core Solution**

DISTRIBUTED SPARSE MATRIX DIRECT SOLVER.
Number of equations = **3465736**, Maximum wavefront = 714

Local memory allocated for solver = 3149.457 MB
Local memory required for in-core solution = 16092.762 MB
Local memory required for out-of-core solution = 3061.049 MB

Total memory allocated for solver = **6246.819 MB**
Total memory required for in-core solution = **32711.935 MB**
Total memory required for out-of-core solution = 6071.417 MB

3,465,736 DOF → 10-20 GB RAM / 1 M DOF
Approx 34 GB RAM required

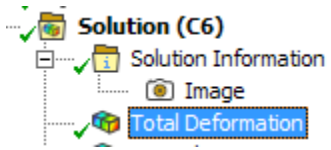
Solver only allocated 6 GB RAM

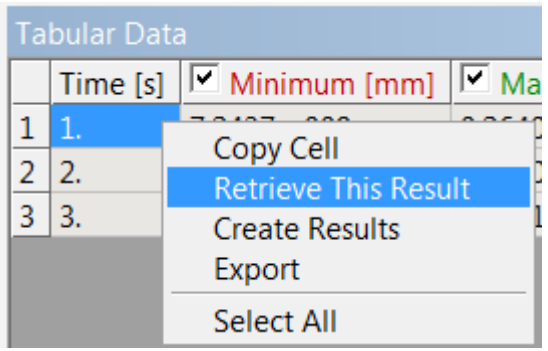
Solution requires 32 GB RAM

Step-by-Step Guide 06: Expanded Results and Validation

Use the **Tabular Data Window** below the Graphics window to retrieve and review results from each of the 3 steps of the solution:

- **Solution → Total Deformation**
- **Tabular Data → Time 1. → RMB – Retrieve This Result**
- Repeat for other results of interest
- Change Result Scaling as desired
- Alternatively, Set the **Display Time** in the Details of the result to the desired Time value → **RMB – Retrieve This Result**

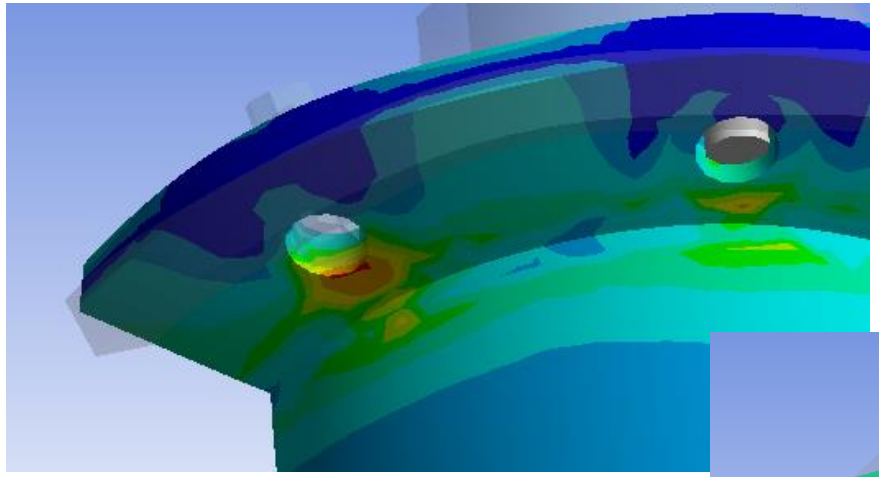


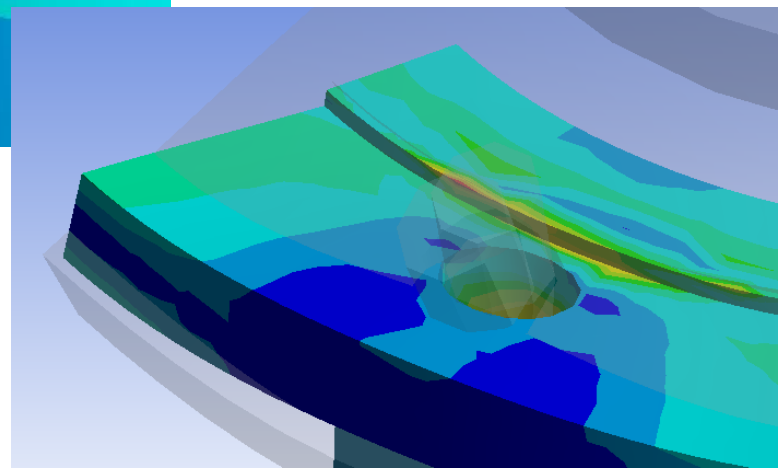


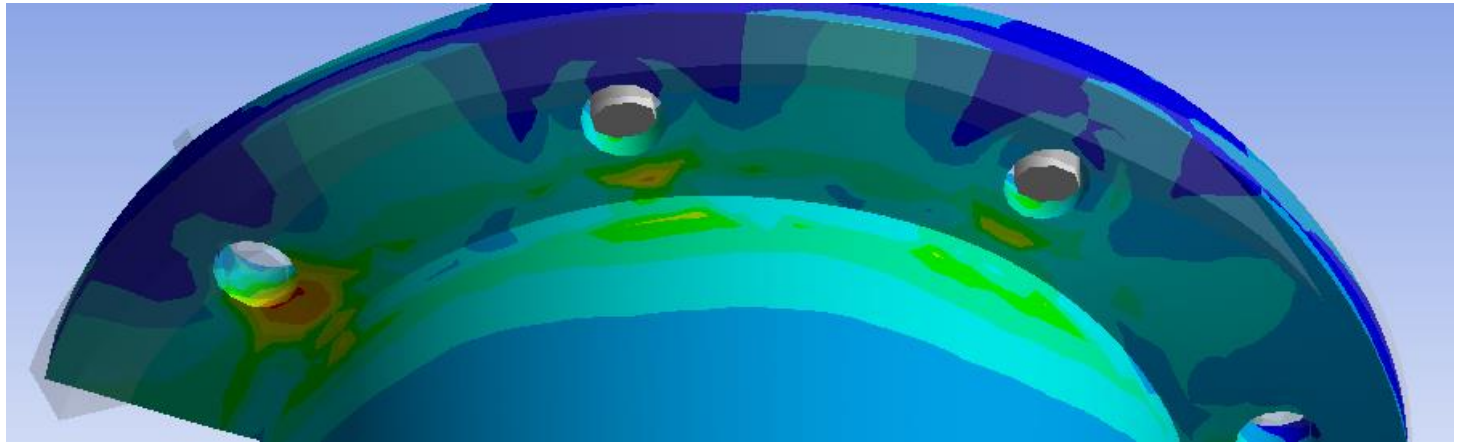
Step-by-Step Guide 06: Expanded Results and Validation

Review Stress in Valve Body and identify locations of stress singularity:

- **Solution → Equivalent Stress 2**



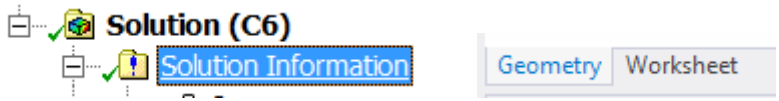


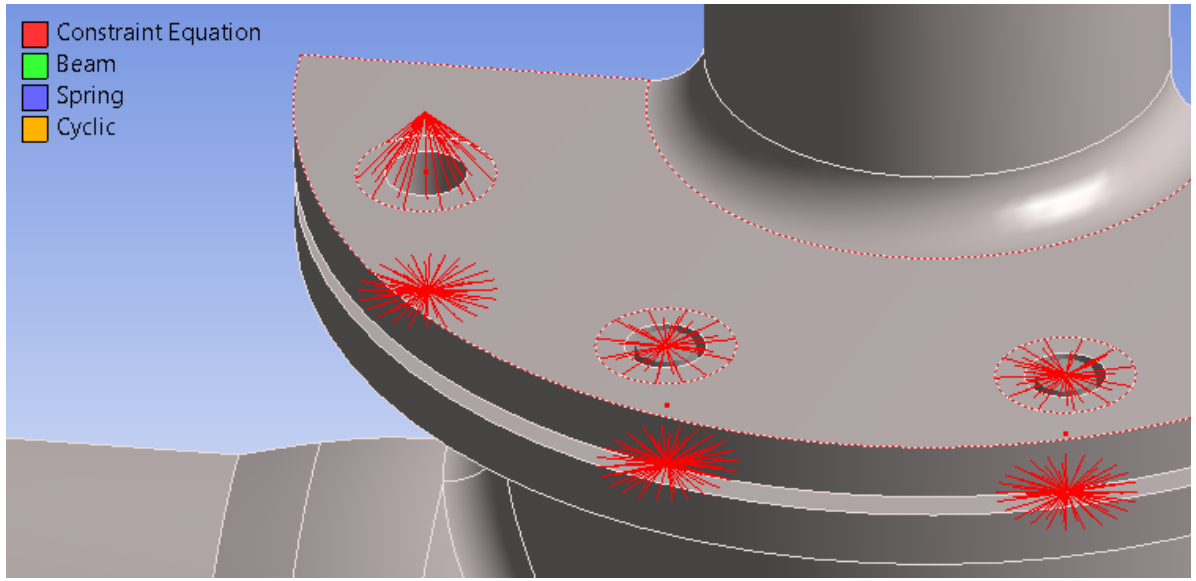


Step-by-Step Guide 06: Expanded Results and Validation

Use Solution Information to View **FE Connections**, identifying possible locations of stress singularity:

- **Solution Information → Graphics Tab**

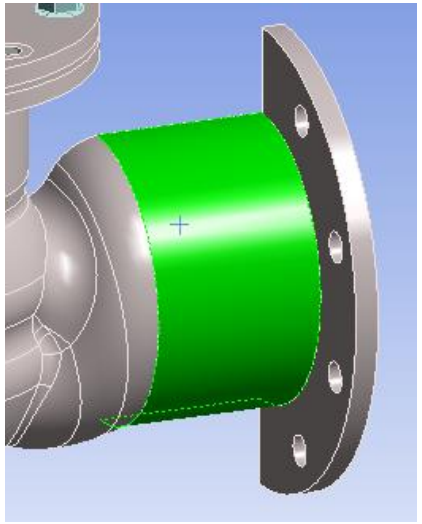


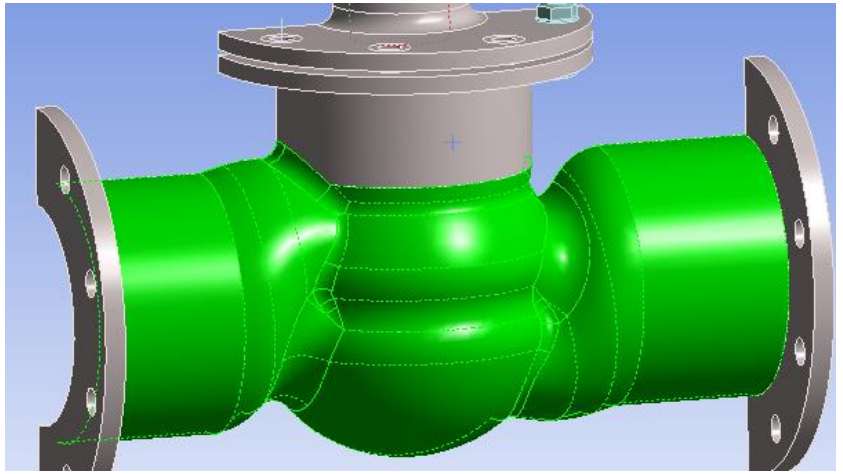


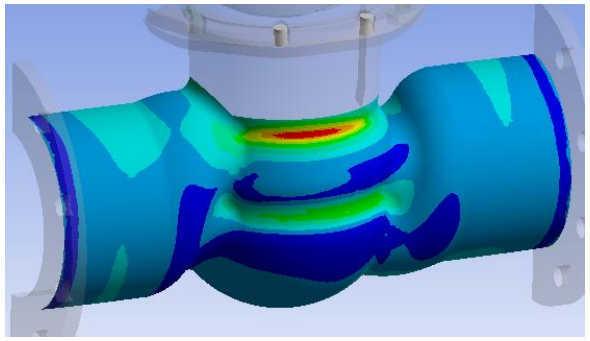
Step-by-Step Guide 06: Expanded Results and Validation

Add equivalent stress scoped to Valve Body; don't include regions of singular stress:

- **RMB – Solution → Insert → Stress → Equivalent (von-Mises)**
- Select cylindrical face of valve body → **Extend to Limits** → CTR—Select upper cylindrical surface (to un-select it)
- Geometry Scope → **All bodies → Apply**
- **RMB – Equivalent Stress 3 → Evaluate All Results**



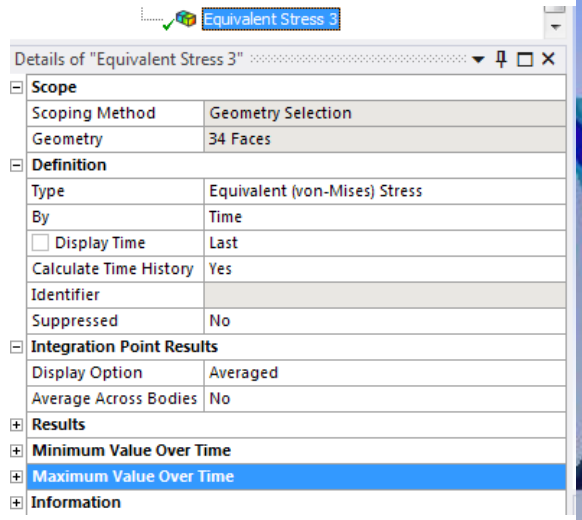


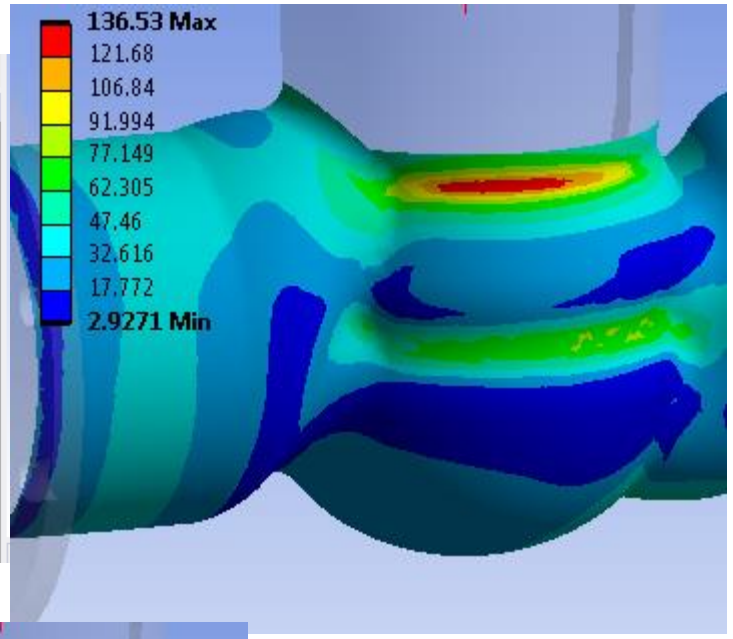


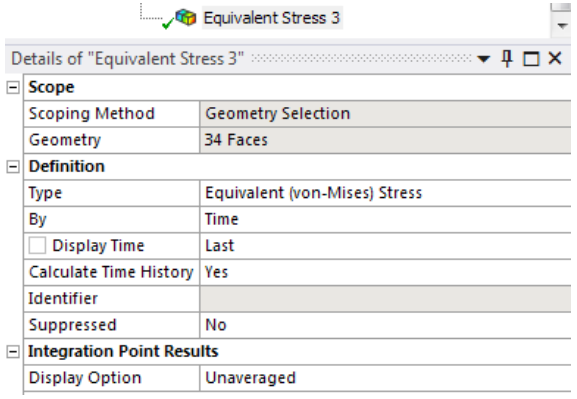
Step-by-Step Guide 06: Expanded Results and Validation

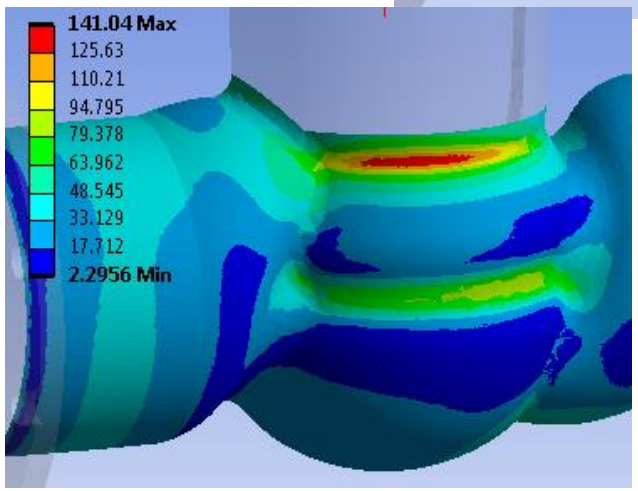
Compare Averaged and Unaveraged Results on Valve Body:

- Details of **Equivalent Stress 3 → Integration Point Results → Display Option → Averaged**
- Details of **Equivalent Stress 3 → Integration Point Results → Display Option → Unaveraged**
- **Evaluate All Results**





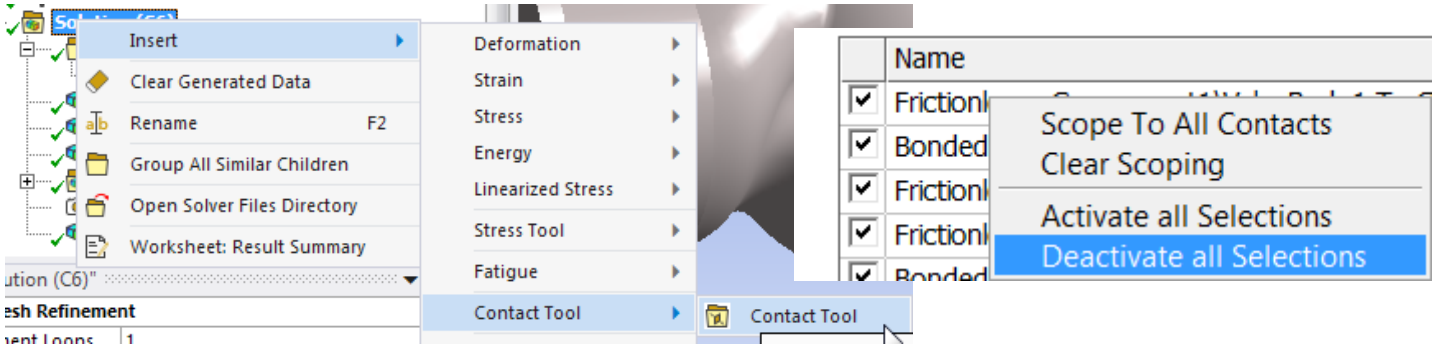


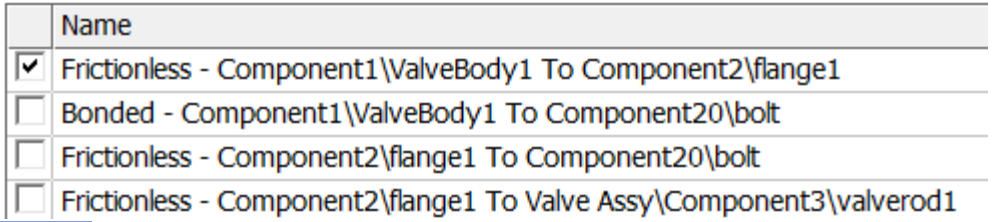


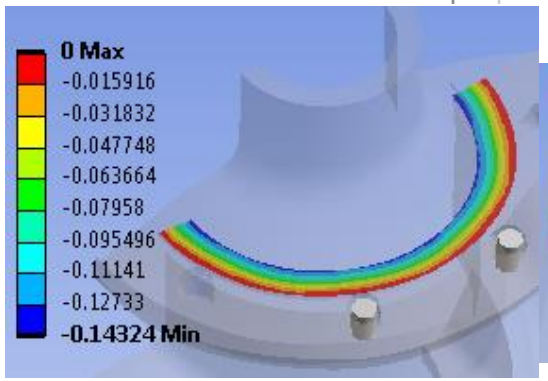
Step-by-Step Guide 06: Expanded Results and Validation

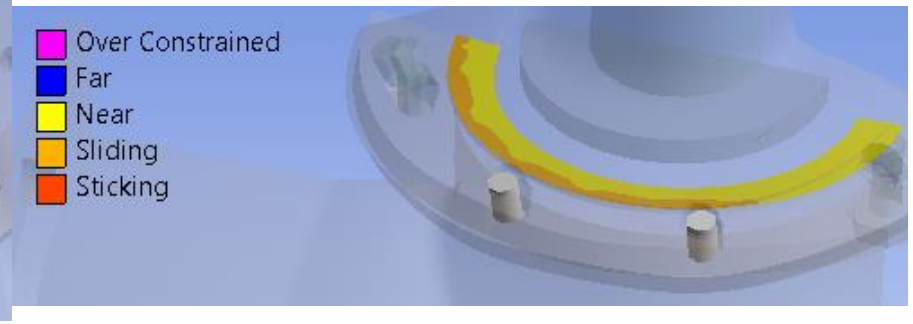
Use a Contact Tool to review Contact Status, Pressure, and Gap at the Valve Body to Flange Frictionless Contact Interface:

- **Solution → Insert Contact Tool**
- Deactivate All Selections
- Activate only the first Frictionless Contact Pair
- **RMB – Contact Tool → Insert → Pressure**
- **RMB – Contact Tool → Insert → Gap**
- **Evaluate All Results**





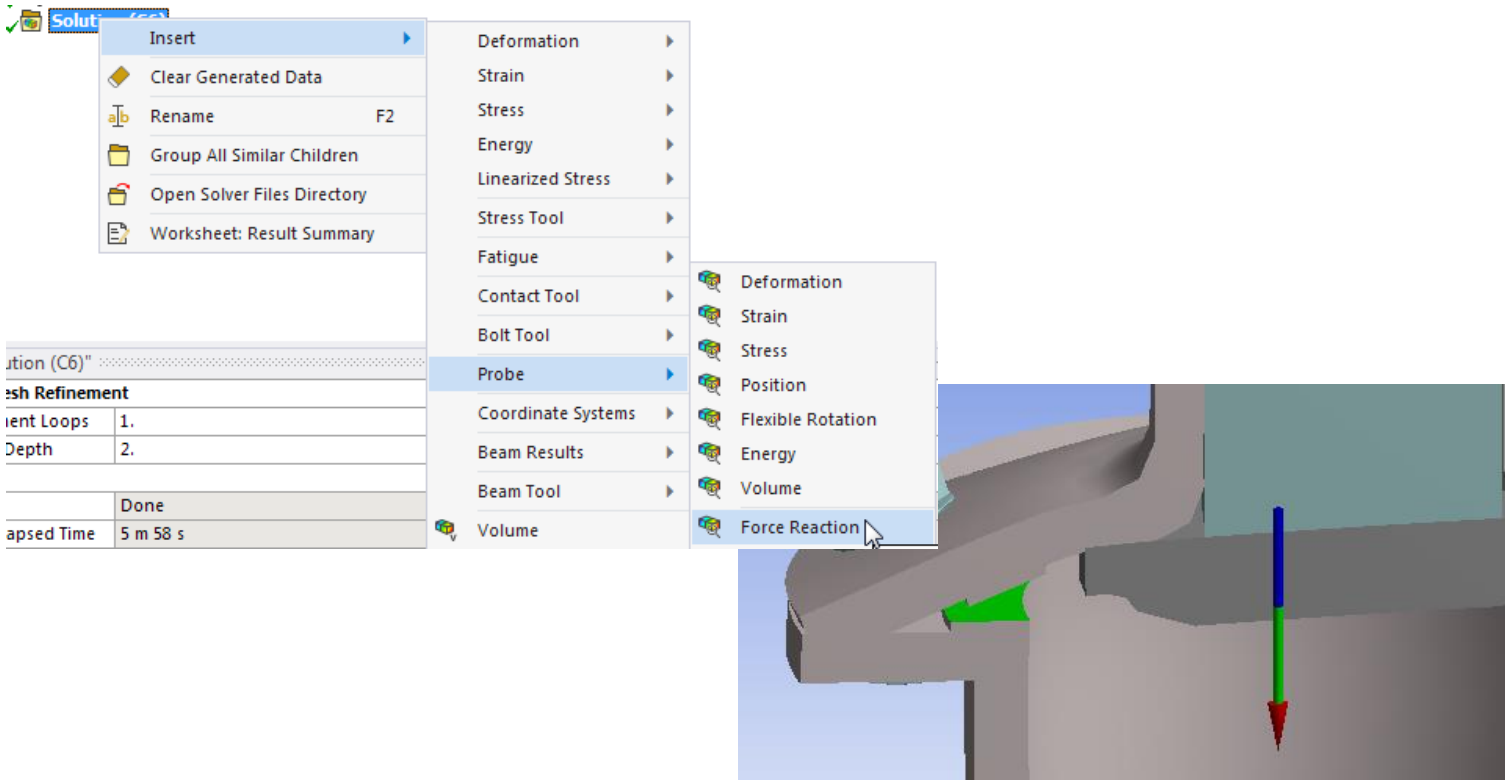




Step-by-Step Guide 06: Expanded Results and Validation

Review total clamping force between Valve Body and Flange using Force Reaction Probe:

- **Solution → Probe → Force Reaction**
- **Location Method → Contact Region**
- **Contact Region → Frictionless – Valve Body1 To Flange1**
- **Extraction → Contact (Contact Element)**
- **Evaluate All Results**



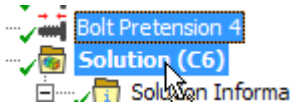
Tabular Data

	Time [s]	Force Reaction (X) [N]	Force Reaction (Y) [N]	Force Reaction (Z) [N]	Force Reaction (Total) [N]
1	1.	-5.4428e-011	-1.9142e-010	-41171	41171
2	2.	-5.4377e-011	-1.9122e-010	-41120	41120
3	3.	-3.6296e-011	-1.0835e-010	-23159	23159

Step-by-Step Guide 06: Expanded Results and Validation

Retrieve clamping force on a per-bolt basis using Force Reaction Probe on the Bolt Pretension Loads:

- Drag / Drop **Bolt Pretension 4** onto **Solution Folder**
- Repeat for **Bolt Pretension 3**
- **Evaluate All Results**



Tabular Data

	Time [s]	Bolt Pretension (Adjustment Reaction) [mm]	Bolt Pretension (Working Load) [N]
1	1.	0.19285	0.
2	2.	0.19285	10280
3	3.	0.19285	8302.5

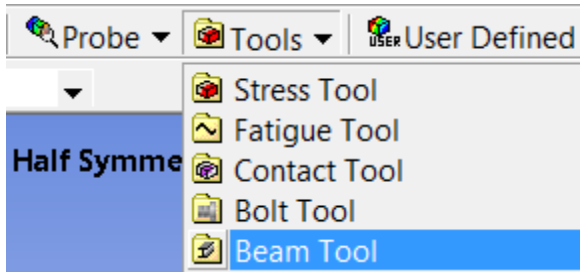
Tabular Data

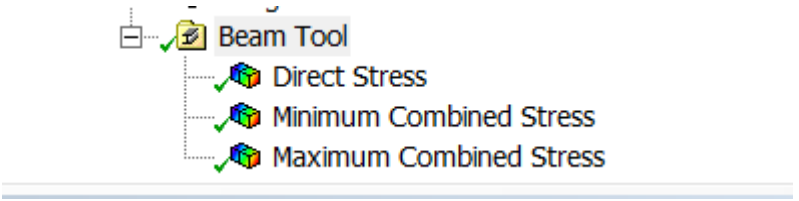
	Time [s]	Bolt Pretension 2 (Adjustment Reaction) [mm]	Bolt Pretension 2 (Working Load) [N]
1	1.	0.19278	0.
2	2.	0.19278	10280
3	3.	0.19278	8314.9

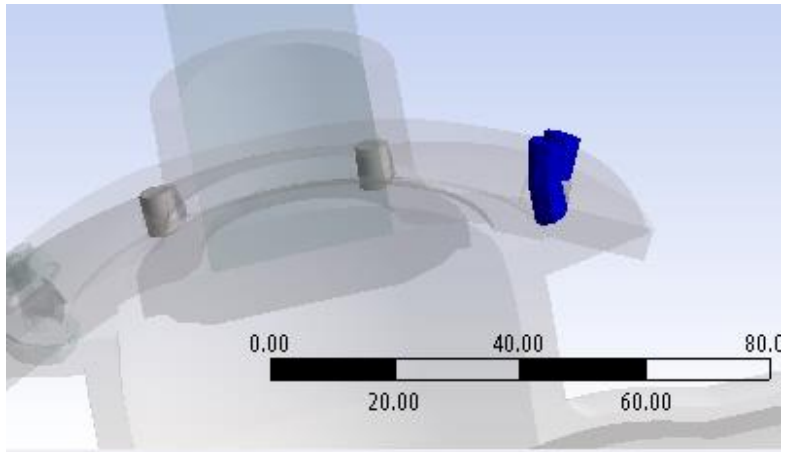
Step-by-Step Guide 06: Expanded Results and Validation

Review Stress (Direct, Min Combined, Max Combined) in line body beam using the Beam Tool:

- **Solution → Tools → Beam Tool**
- **Evaluate All Results**

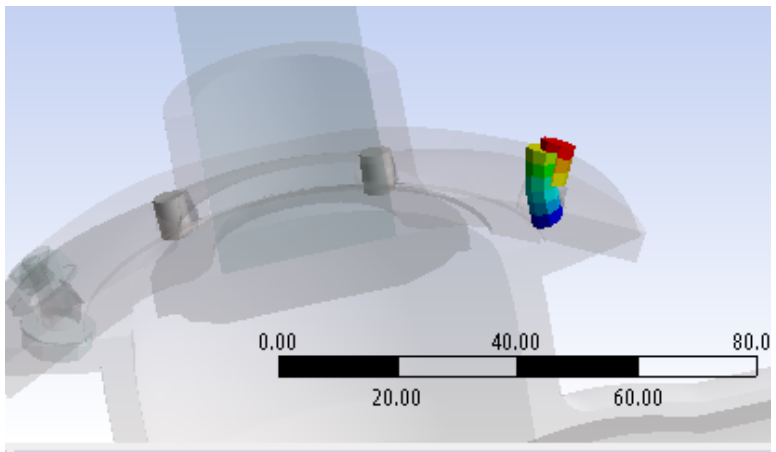






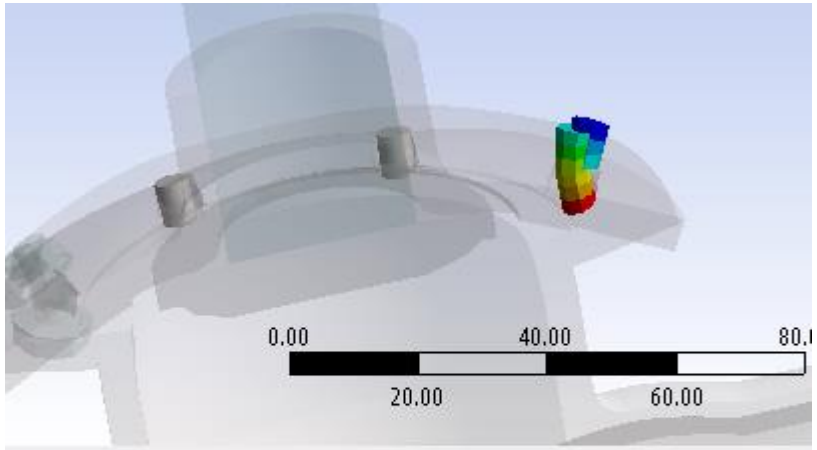
Tabular Data

	Time [s]	Minimum [MPa]	Maximum [MPa]	Average [MPa]
1	1.	449.26	449.26	449.26
2	2.	449.25	449.25	449.25
3	3.	381.82	381.82	381.82



Tabular Data

	Time [s]	Minimum [MPa]	Maximum [MPa]	Average [MPa]
1	1.	-707.51	113.69	-296.91
2	2.	-707.89	113.99	-296.95
3	3.	-786.55	-44.604	-415.58



Tabular Data

	Time [s]	Minimum [MPa]	Maximum [MPa]	Average [MPa]
1	1.	784.84	1606.	1195.4
2	2.	784.52	1606.4	1195.5
3	3.	808.24	1550.2	1179.2

Step-by-Step Guide 06: Expanded Results and Validation

Review forces and moments in the Body-to-Body Beam connections using the Beam Probe:

- **Solution → Probe → Beam**
- Boundary Condition → Circular – Flange1 To Valve Body1
- **Evaluate All Results**

Beam Probe

Details of " Beam Probe"

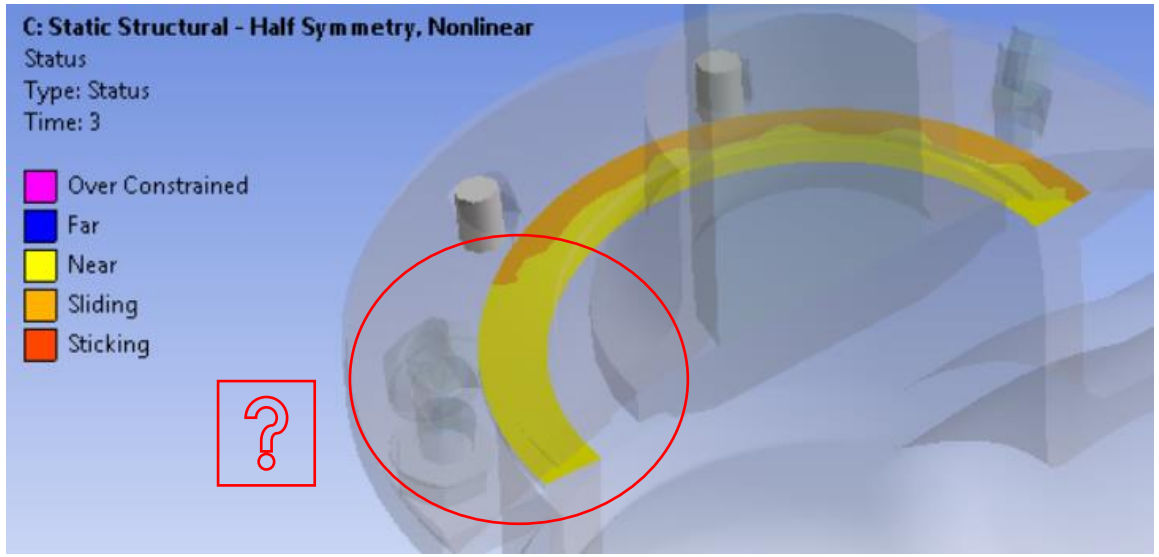
Definition	
Type	Beam Probe
Boundary Condition	Circular - Component2\flange1 To Component1\ValveBody1
Suppressed	No

Tabular Data

	Time [s]	Beam Probe (Axial Force) [N]	Beam Probe (Torque) [N·mm]	Beam Probe (Shear Force At I) [N]	Beam Probe (Shear Force At J) [N]	Beam Probe (Moment At I) [N·mm]	Beam Probe (Moment At J) [N·mm]
1	1.	10280	59.786	197.35	197.35	18297	17137
2	2.	10280	60.092	197.78	197.78	18301	17139
3	3.	8302.5	-8.5863	727.44	727.44	22951	18658

Step-by-Step Guide 06: Expanded Results and Validation

After reviewing the contact force and bolt pretension results at the bolted interface between the flange and the valve body, why does there appear to be no clamping force at the flange in the location of the 1 bolt modeled as a solid body? The contact status shows no contact in this region…

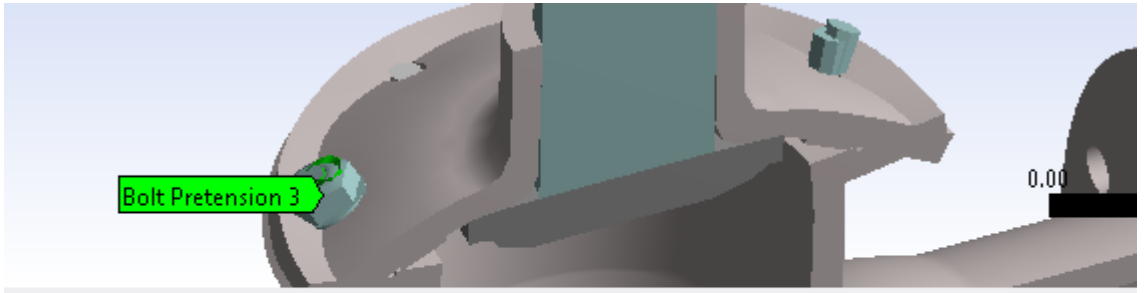


Step-by-Step Guide 06: Expanded Results and Validation

Review the clamping force in that solid body bolt:

- Drag the first **Bolt Pretension** load from the **Static Structural branch** to the **Solution** branch and **Evaluate All Results**

There is still a working load in the bolt. But it is now more than the original pretension force. It has taken on additional force, apparently due to separation of the joint. Why haven't the other bolts done the same thing?

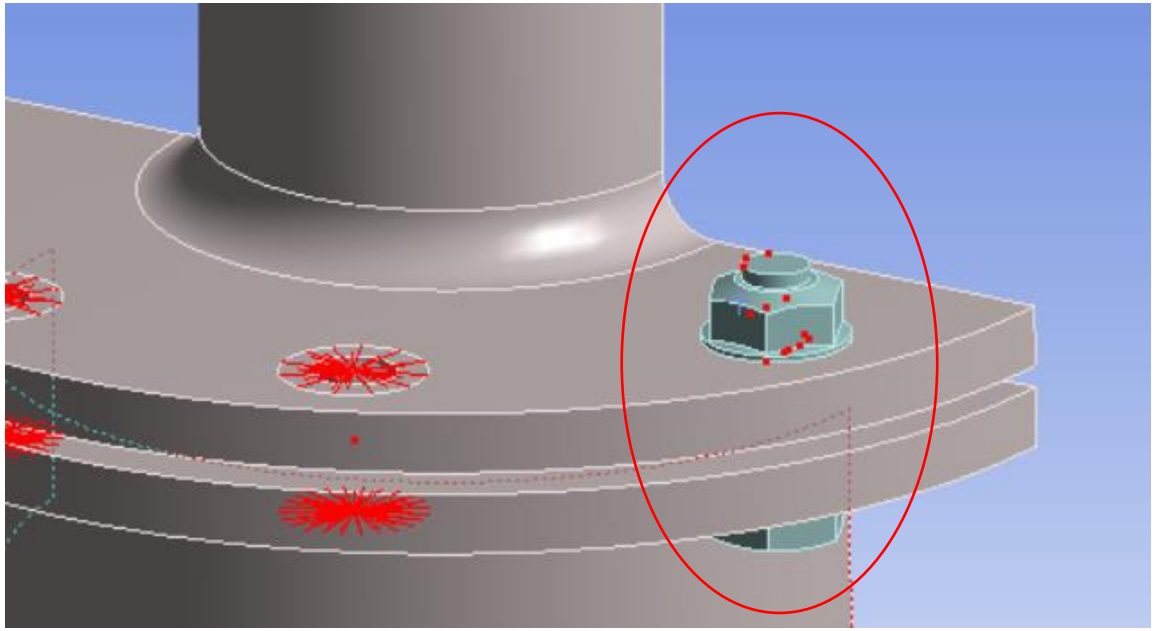


Tabular Data

	Time [s]	Bolt Pretension 3 (Adjustment Reaction) [mm]	Bolt Pretension 3 (Working Load) [N]
1	1.	0.2646	0.
2	2.	0.2646	10280
3	3.	0.2646	8905.

Step-by-Step Guide 06: Expanded Results and Validation

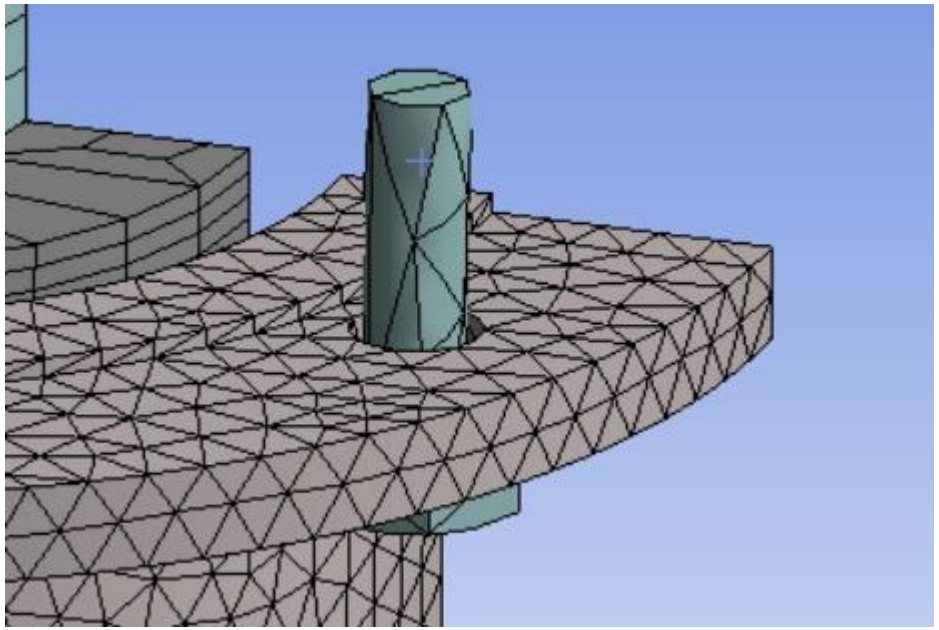
View the **FE Connections** once again by selecting **Solution Information** and the **Graphics** tab. Look at the FE Connections generated by the Bolt Pretension load. These connections represent the constraint equations used to “tie” the bolt body back together after it has been split by the bolt pretension load. It appears that the bolt body has been split outside of the joint. Ideally, the bolt would be split somewhere between the two flange surfaces.



Step-by-Step Guide 06: Expanded Results and Validation

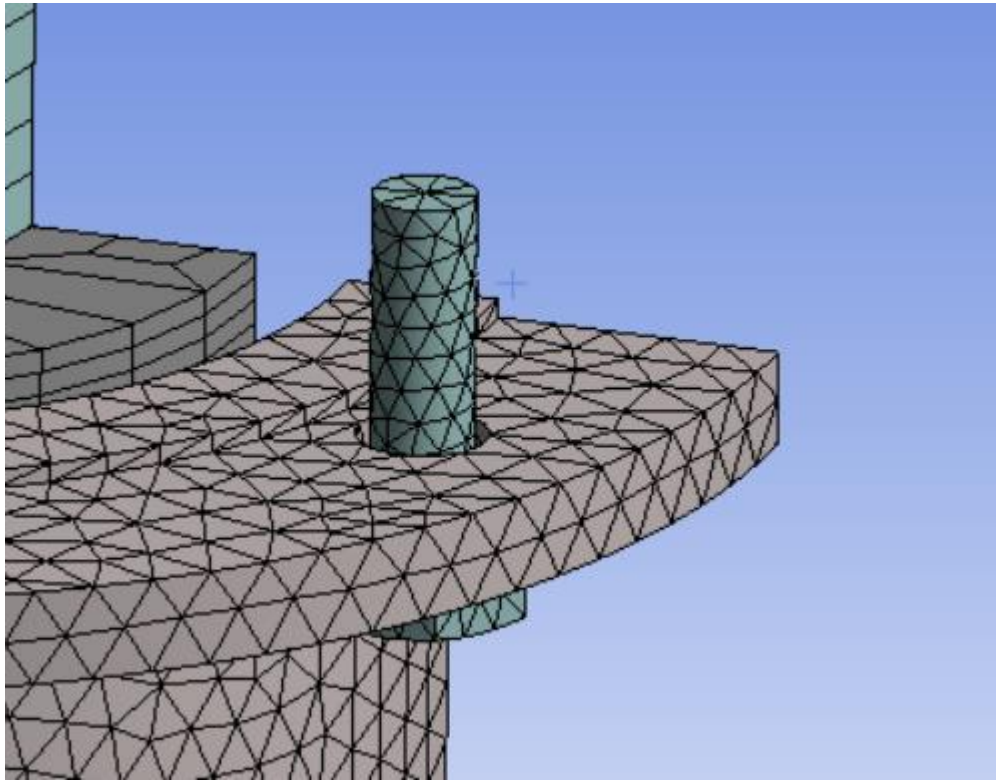
Check the mesh density on the solid body bolt. A mesh that is too coarse can be problematic for bolt pretension loads, as it does not provide a viable means of splitting the mesh.

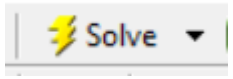
- Hide the remaining **nut** body along with the **flange1** body
- Select the Mesh branch to display the mesh on the bolt body
- Refine the mesh on the bolt body in order to supply more elements along the length of the bolt shaft.
- **Mesh → RMB → Insert → Sizing**
  - Select the bolt body
  - Element Size = **2.0 mm**
- **Generate Mesh**



Step-by-Step Guide 06: Expanded Results and Validation

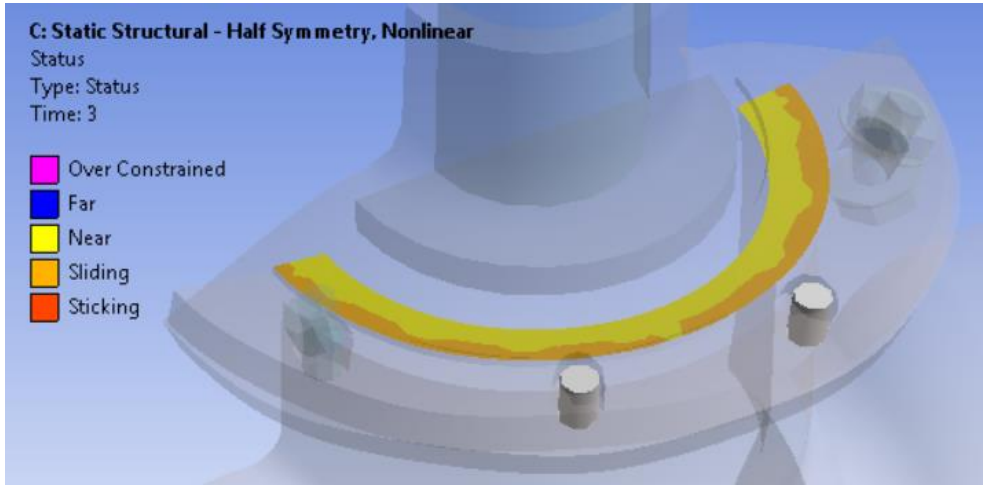
The bolt now has a more refined mesh. Re-solve the model and then review the **FE Connections, Contact Tool** and **Bolt Pretension** results once again.





Step-by-Step Guide 06: Expanded Results and Validation

These results look much more as expected now.

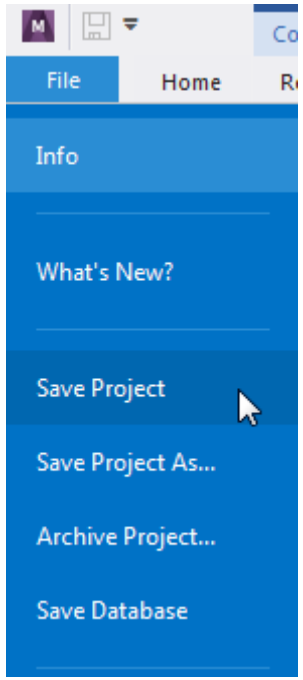


Tabular Data

	Time [s]	Bolt Pretension 3 (Adjustment Reaction) [mm]	Bolt Pretension 3 (Working Load) [N]
1	1.	0.25657	0.
2	2.	0.25657	10282
3	3.	0.25657	8910.4

Step-by-Step Guide 06: Expanded Results and Validation

- **Save Project** for use later if desired.

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