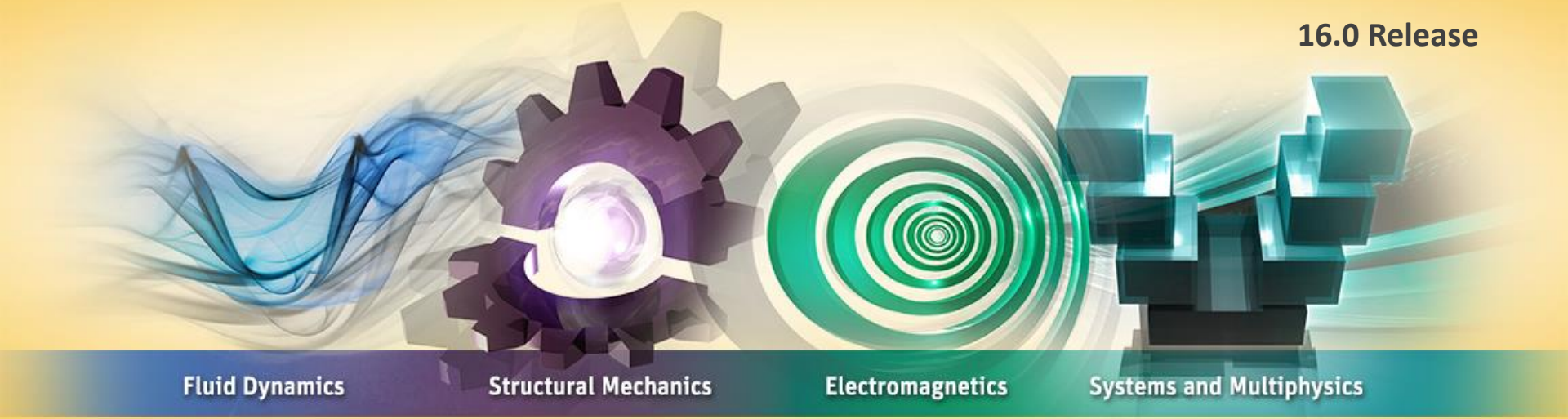
Workshop 3.1
2D Gear and Rack Analysis

16.0 Release



Introduction to ANSYS Mechanical

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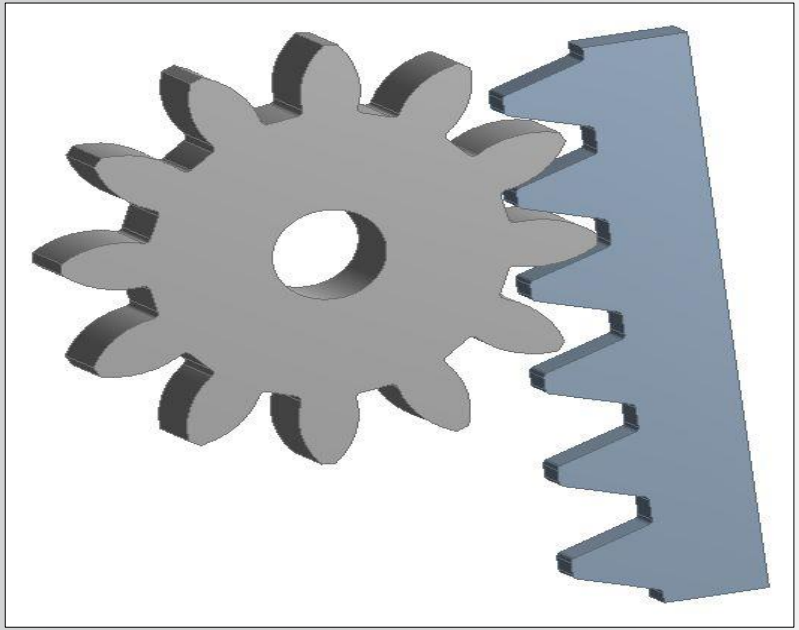
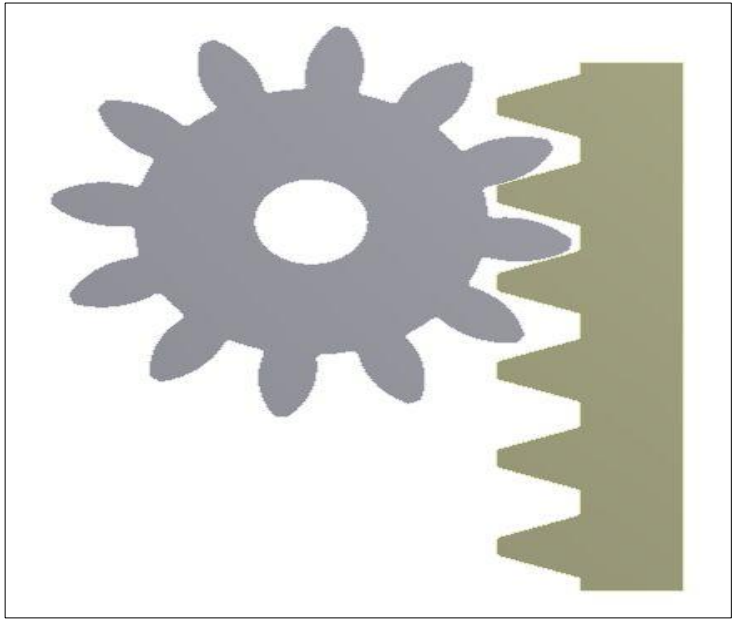
Assumptions

Workshop 3.1 consists of a 2 part assembly representing spur and rack gear components from a 2500 N hand press.

We will solve it as a 2D plane stress model (thickness = 12 mm).

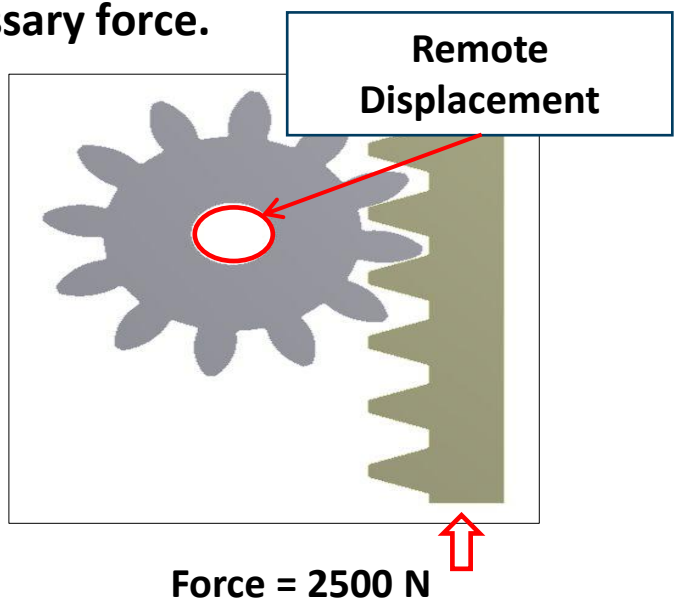




Goals

Analysis Goals:

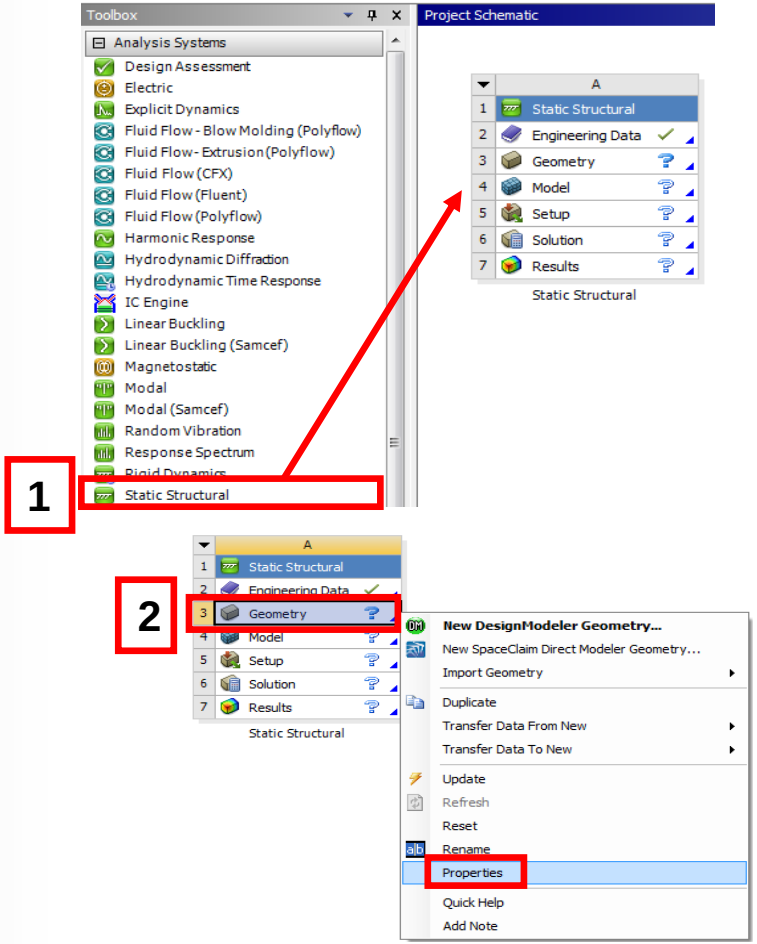
- We are designing a press that should be capable of delivering 2500 N of force in the rack.
- In order to design the mechanism for applying the load we need to know the required torque in the gear to produce the necessary force.
- We'll apply the desired force in the rack and extract the moment reaction at the gear.
- We will use a "Remote Displacement" to constrain the gear (instead of a fixed support) because this type of constraint provides rotational, as well as translational, constraints.



Project Schematic

1. Double click “Static Structural” analysis type to add a new system.

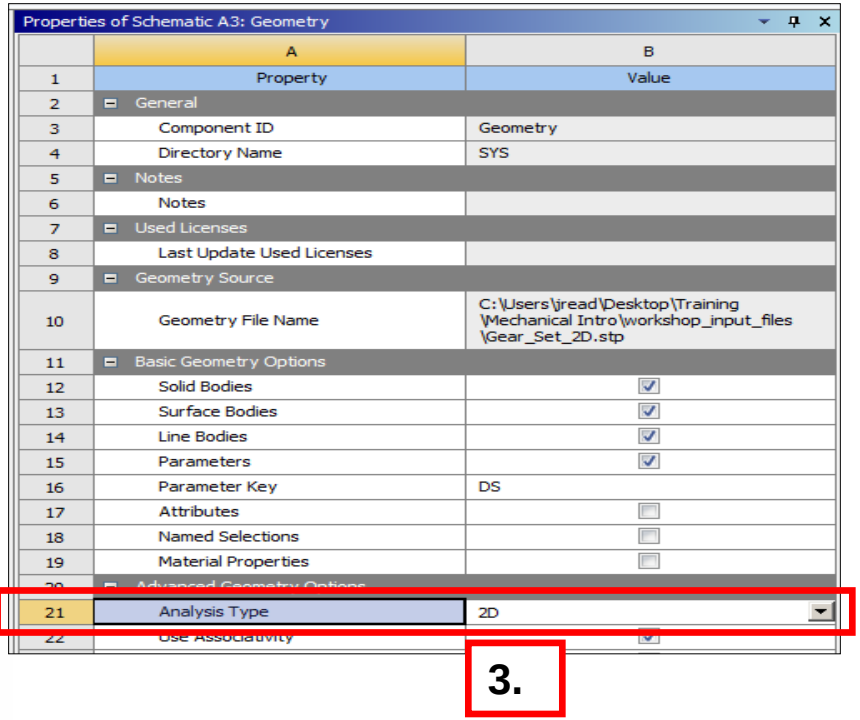
2. RMB the Geometry cell and request “Properties”.



. . . Project Schematic

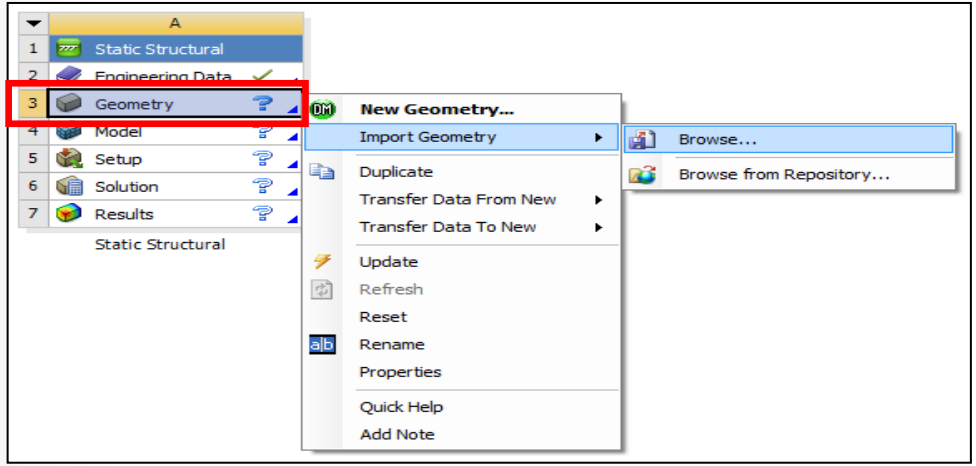
3. In the “Analysis Type” field specify “2D”.
   - Once this setting is made the properties window may be closed if desired.

Note this setting indicates the model to be analyzed is not a full 3D model but represents a symmetry section. It is important that this is set prior to importing geometry as this setting cannot be changed after the import.

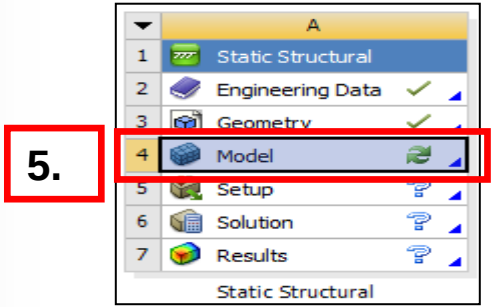


Geometry Setup

4. From the “Geometry” cell, RMB > “Import Geometry” and browse to: “Gear_Set_2D.stp”.

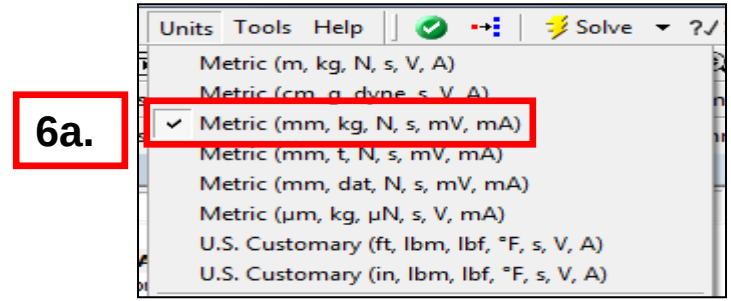


5. Double click the “Model” cell to start Mechanical.

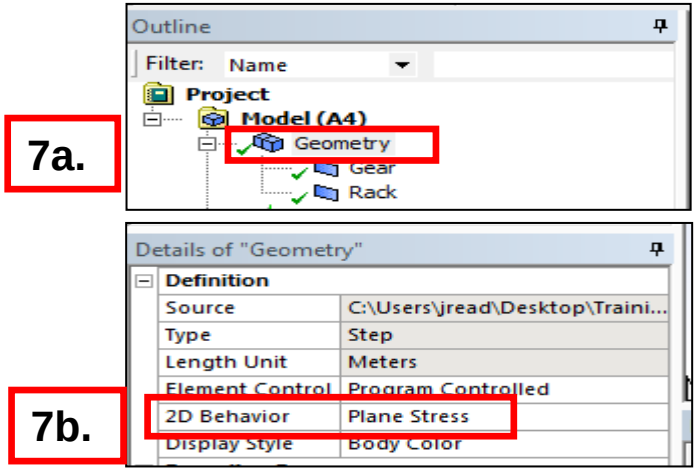


Preprocessing

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

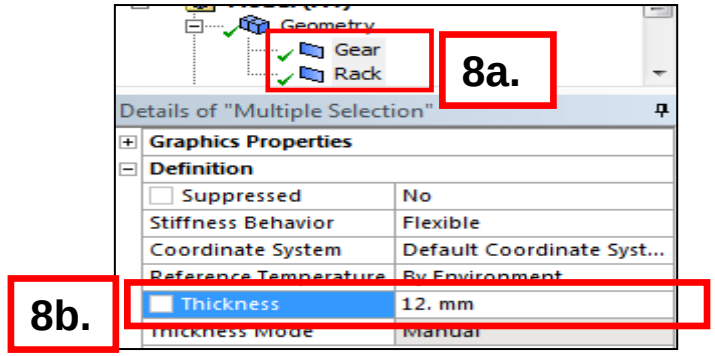


7. Set the Plane Stress options:
   a. Highlight the “Geometry” branch.
   b. Verify the “2D Behavior” to be “Plane Stress” (default).

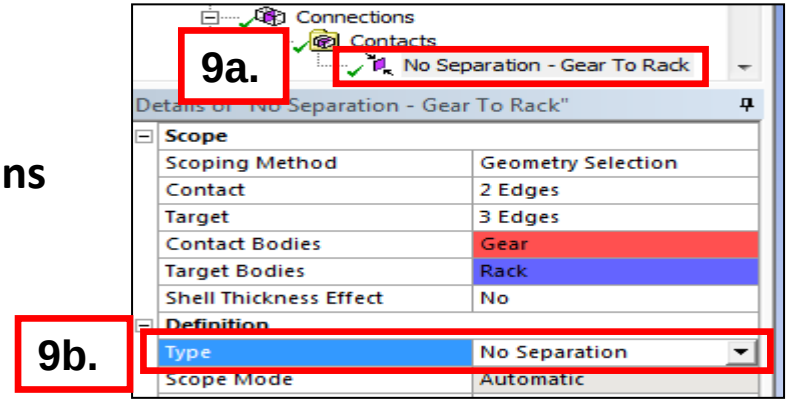


. . . Preprocessing

8. Set the geometry thickness:
   a. Highlight the Gear and Rack parts (use shift or control for multi-select).
   b. Set the thickness field to 12 mm.



9. Set the contact options:
   a. Highlight the contact branch under Connections
   b. Change the contact type to “No Separation”.

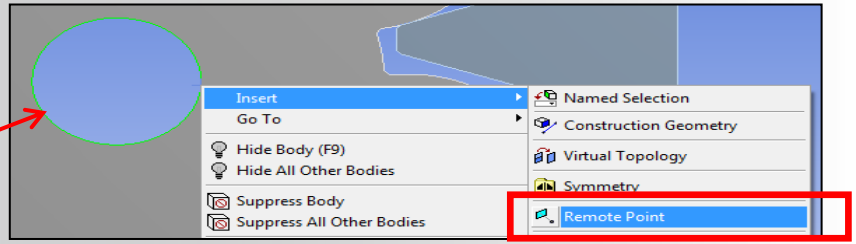


. . . Project Schematic

10. Create a remote point:
    a. Highlight the Model branch.
    b. Set the selection filter to “edge select”.
    c. Select the circular inner edge of the gear.
    d. RMB > Insert > Remote Point.

10a.

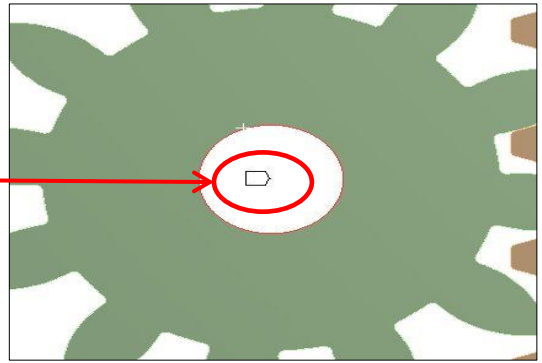
10b.



10c.

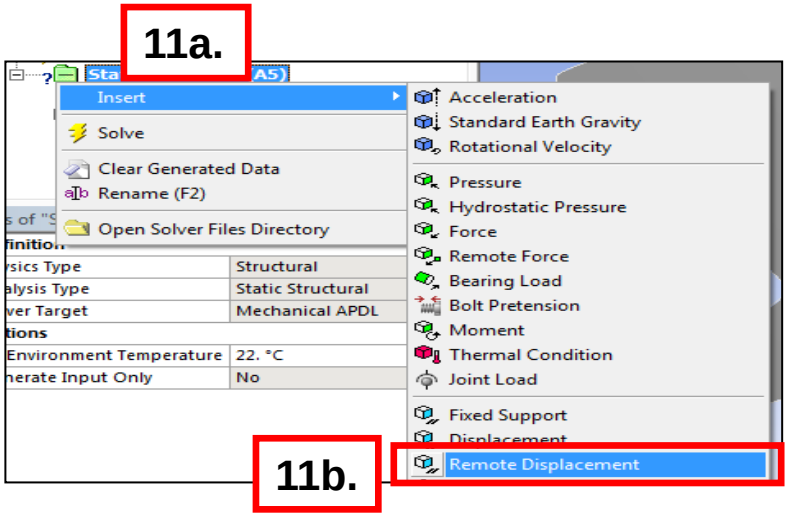
10d.

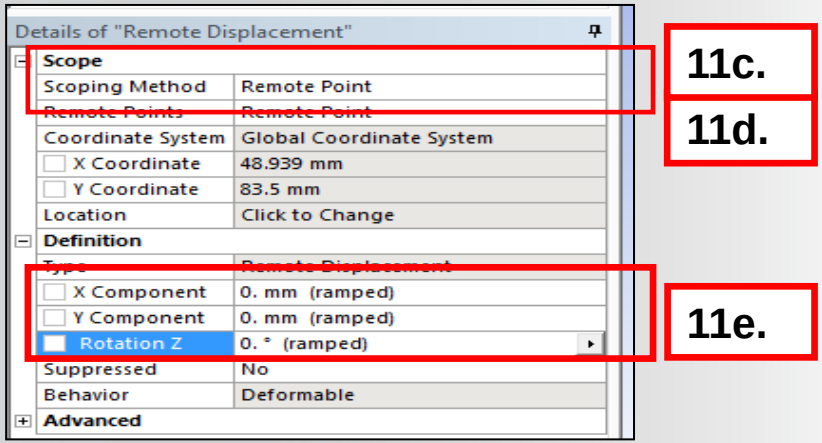
Note the annotation flag indicating the remote point location.



Environment

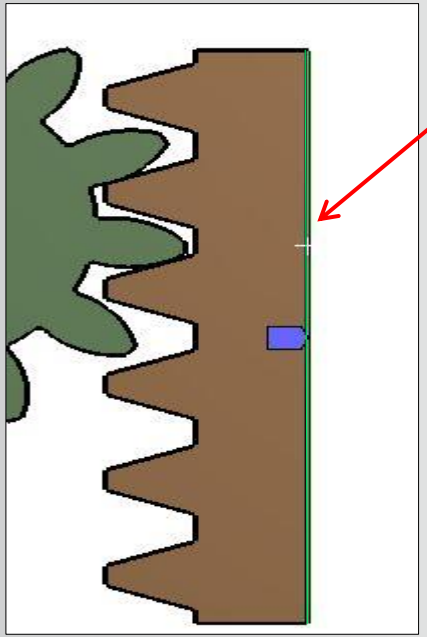
11. Apply remote displacement on the model:
    a. Highlight the Static Structural branch.
    b. "RMB > Insert > Remote Displacement".
    c. Change the scoping method to "Remote Point".
    d. Select "Remote Point" from the RP list
    e. Set X, Y and Rotation Z = 0.

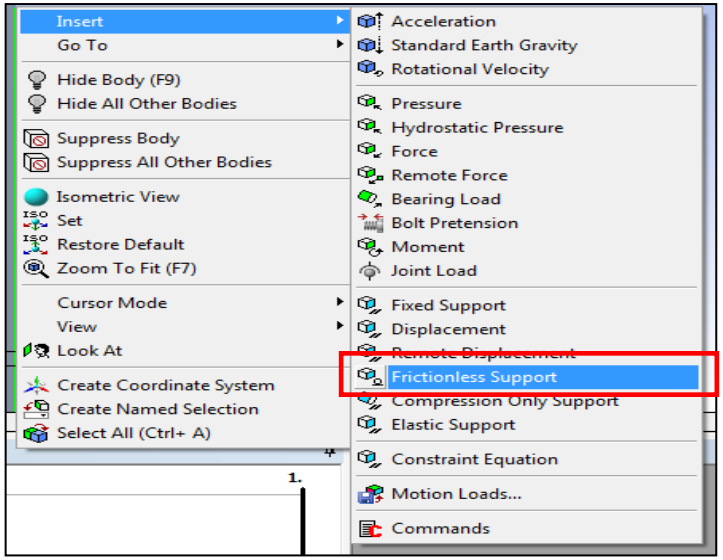




. . . Environment

12. Apply frictionless support to the model:
    a. Highlight the right edge of the rack.
    b. "RMB > Insert > Frictionless Support".

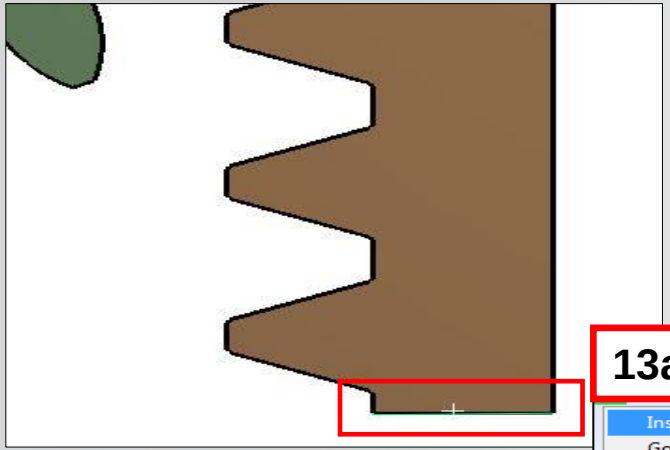




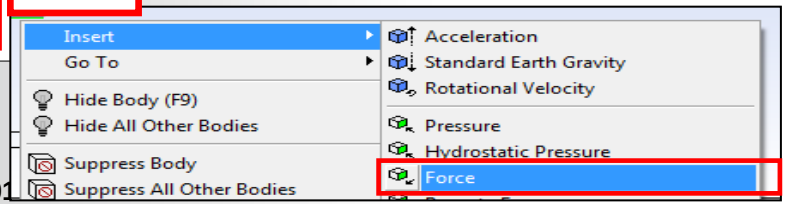
We use a frictionless support along the edge of the rack to simulate the guide the part rides in.

. . . Environment

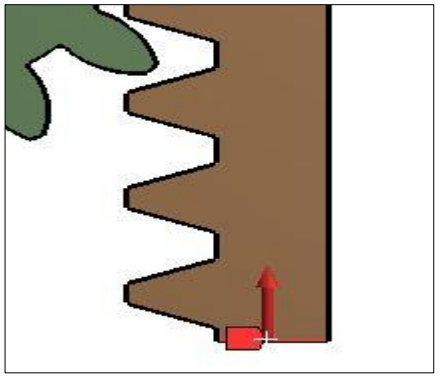
13. Apply a force to the model:
    a. Select the bottom edge of the Rack.
    b. "RMB > Insert > Force".
    c. Change to the component method.
    d. Input a Y component = 2500 N.



13a.

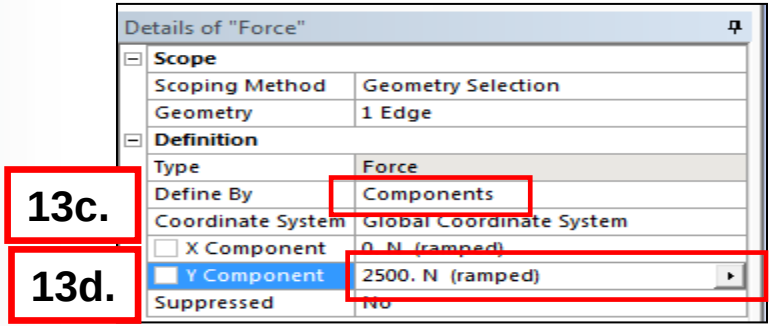


13b.



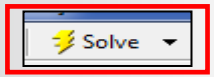
13c.

13d.



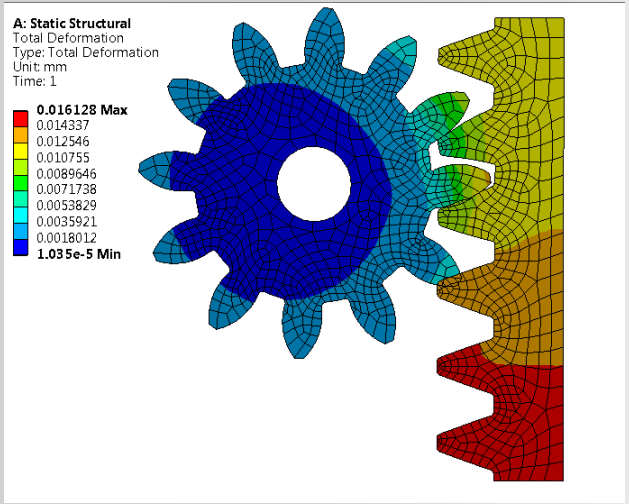
Solution

14. Solve the model.



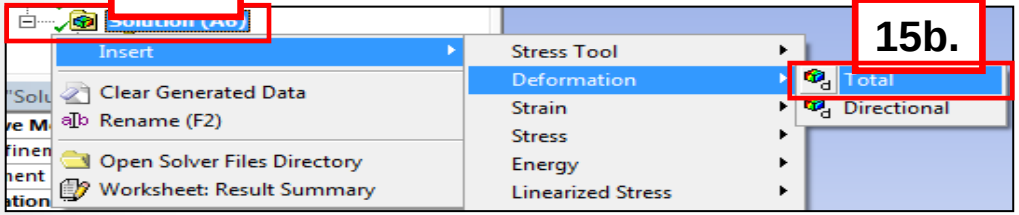
14.

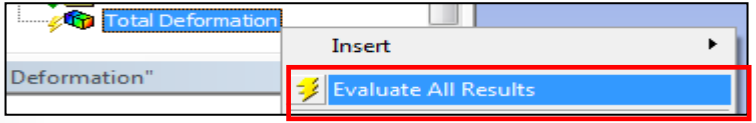
15. Insert a Total Deformation result:
    a. Highlight the Solution branch.
    b. RMB > Insert > Total Deformation.
    c. RMB > Evaluate All Results.



15a.

15b.

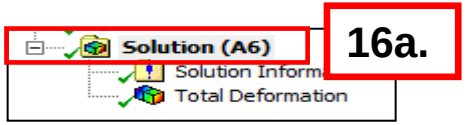




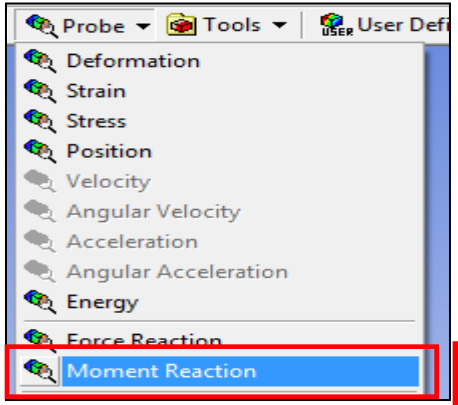
15c.

Postprocessing

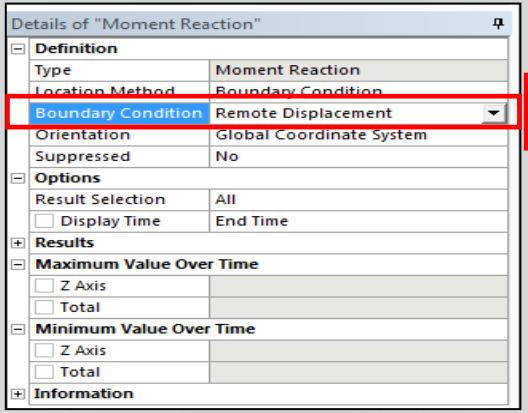
16. Extract the moment reaction in the gear:
    a. Highlight the Solution branch.
    b. From the context menu choose “Probe > Moment Reaction”.
    c. In the probe details choose “Remote Displacement” from the drop down list.
    d. RMB > Evaluate All Results.



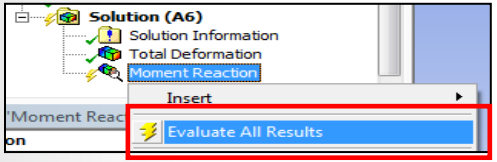
16a.



16b.



16c.



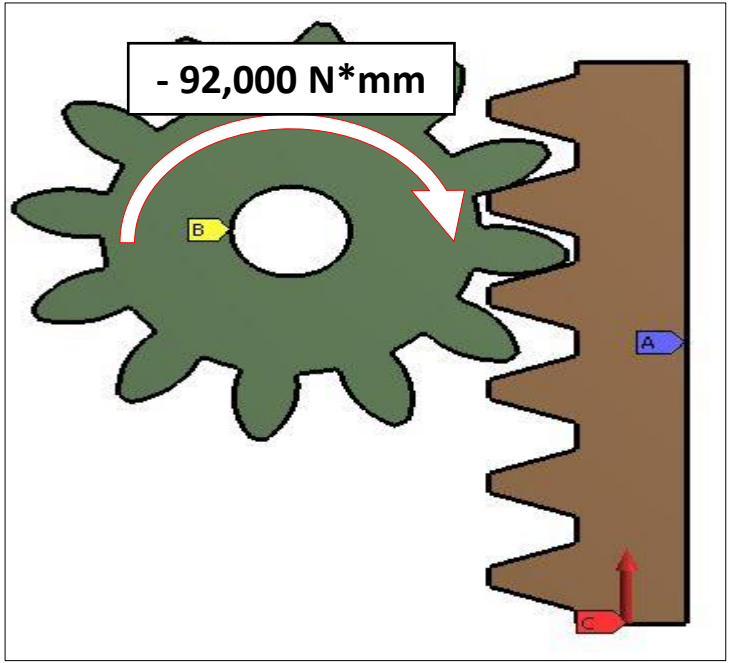
16d.

Moment reaction about Z axis

Conclusion

Our stated goal was to determine the required moment that must be applied to the gear in order to produce a 2500 N force in the rack. We conclude a torque of approximately 92,000 N*mm will be required.

Results	
Z Axis	-92229 N·mm
Total	92229 N·mm



Go further!

If you finish this workshop and find yourself with extra time, you could try the following steps

1. Go into the details box of the created “Remote Displacement”;
2. Change “Rotation Z” to free;
3. Insert “Moment” and scope it to the “Remote Point”;
4. Give it a value of -92,229 N*mm;
5. Delete “Force”;
6. In the bottom line of the “Rack” put in a “Frictionless Support”;
7. In the Results section put in a “Force Reaction” probe;
8. Observe the value for the “Force Reaction”.