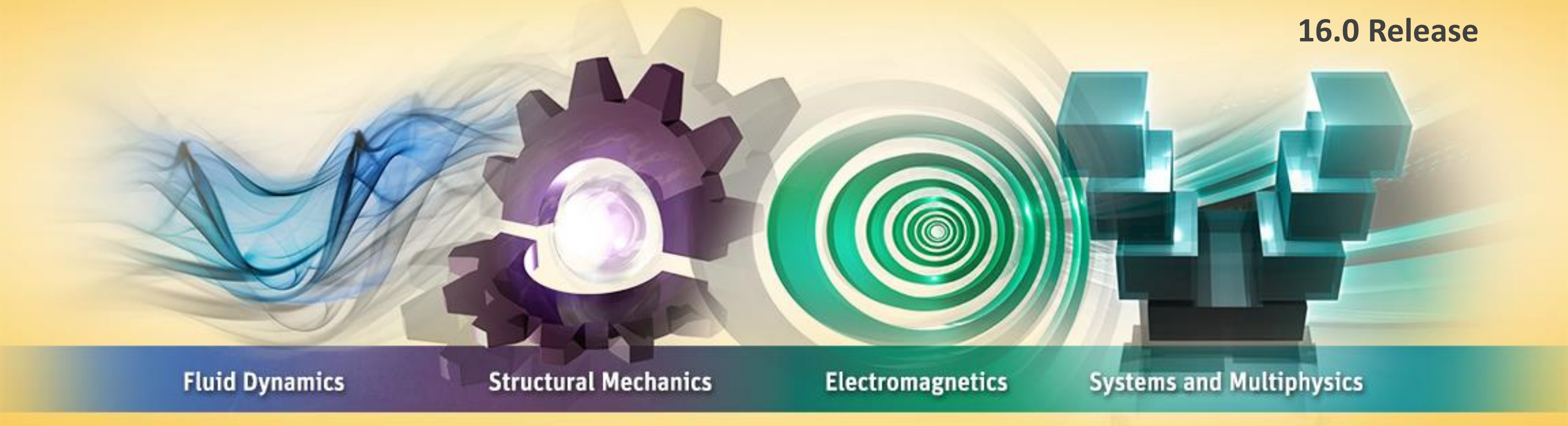
Workshop 6.2
Constraint Equations

16.0 Release



Introduction to ANSYS Mechanical

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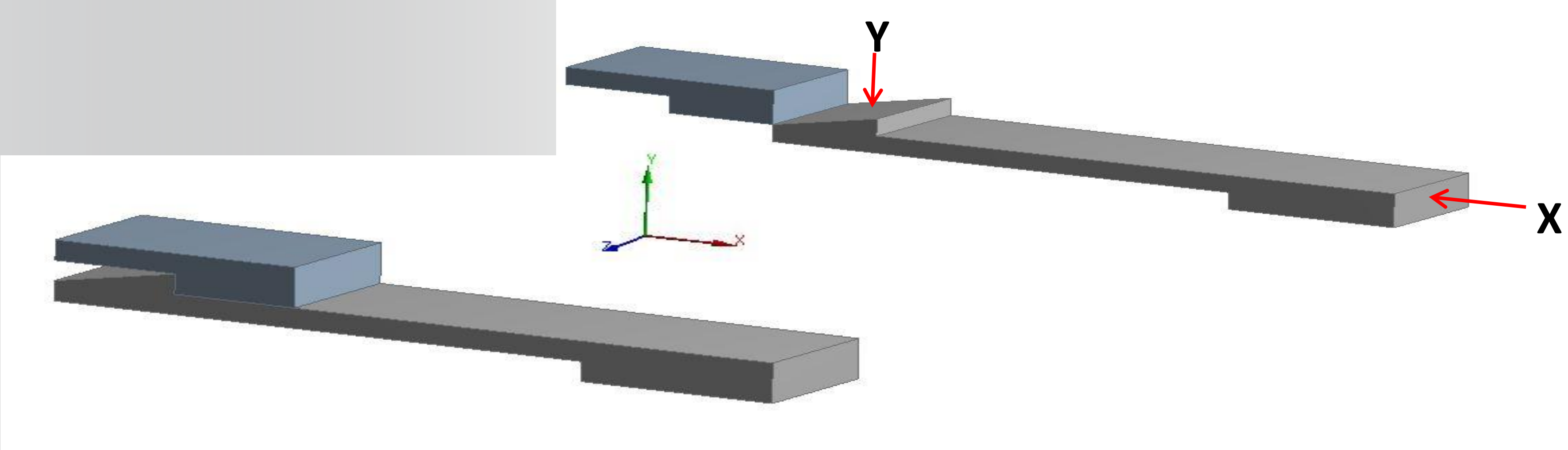
Goals

The model shown represents a hook fastener often used to snap components together in an assembly. The goal of this workshop is construct a constraint equation that will simulate the Y displacements in the hook's tip as it is pressed into place in the X direction. Only the hook section is modeled.

Note, although there are a number of ways this simulation could be set up, the purpose of this workshop is to gain practice with constraint equations.



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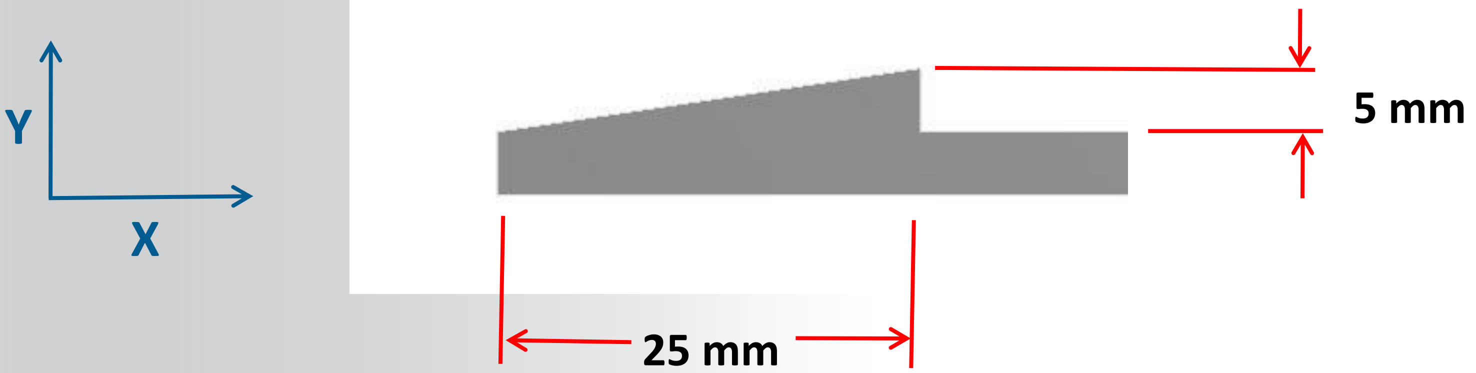
Background

Using the dimensions shown here we can readily see that a simple relationship exists between the X and Y directions. Specifically, the –Y displacements will be 1/5 of the – X displacements. In other words, when the part has displaced 25 mm in the X direction it will have displaced 5 mm in the Y. Thus:

$$(1/5)*UX = (UY) \Rightarrow UX = 5*(UY) \Rightarrow 0 = 5*(UY) - UX$$



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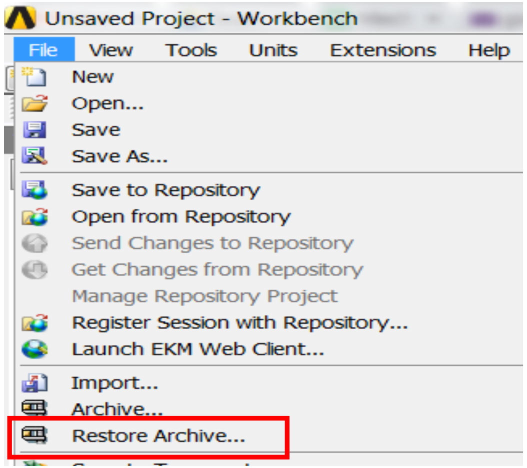
Project Schematic

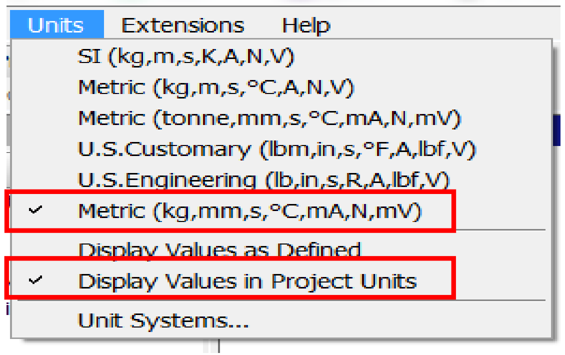
Begin a new Workbench session and, from the Project page, choose “Restore Archive . . . “ and browse to the file “ConstEqn.wbpz” and Open (location provided by instructor).



When prompted, “Save” using the default name in the same location as the archive file.

From the “Units” menu verify:

- **Project units are set to “Metric (kg, mm, s, ºC, mA, N, mV).**
- **“Display Values in Project Units” is checked (on).**



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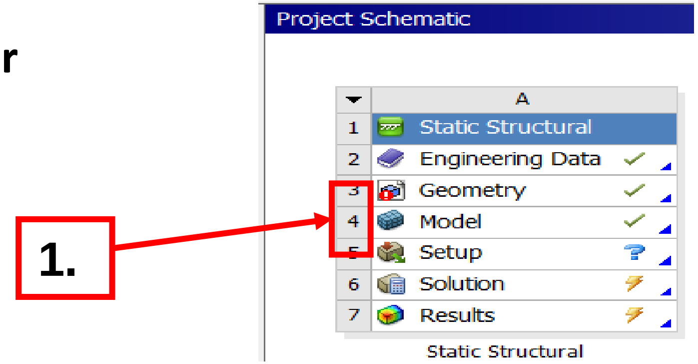
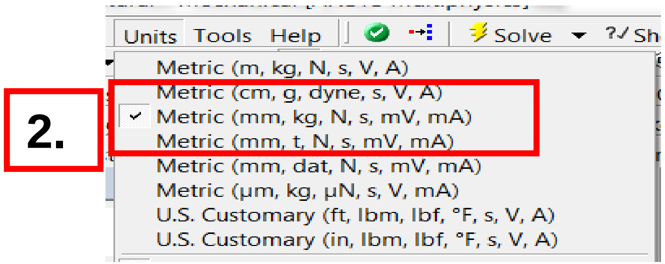
. . . Project Schematic

1. From the Static Structural system double click (or RMB > Edit) the “Model” cell.



2. When Mechanical opens, verify the units are set to “Metric (mm, kg, s, mV, mA)”.



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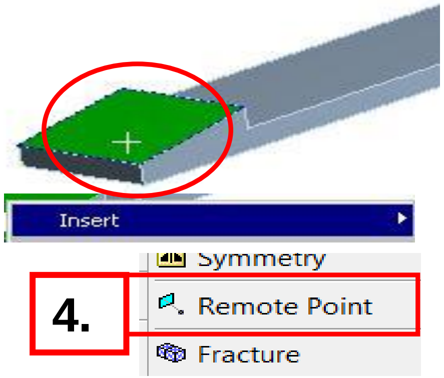
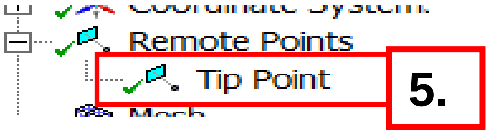
Preprocessing

Constraint equations are written in terms of remote points. Before we can write the necessary expression we first need to create the remote points.

3. Highlight the Model branch in the tree.



4. Highlight the top face of the hook tip (shown here), RMB > Insert > Remote Point.



5. Right click the new remote point and rename “Tip Point”.

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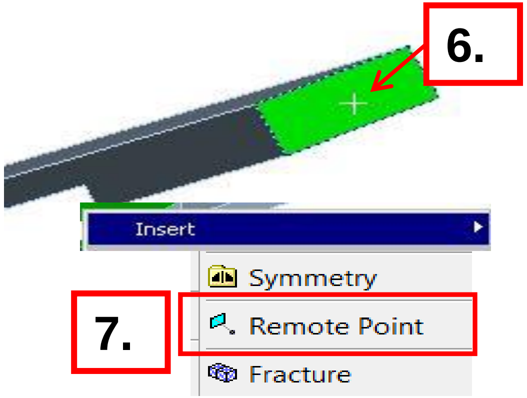
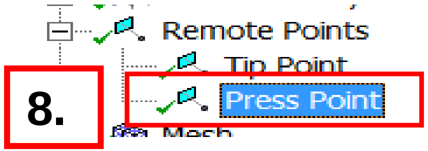
6. Highlight the rectangular end of the hook.

7. RMB > Insert > Remote Point.



8. Right click the new remote point and rename “Press Point”.



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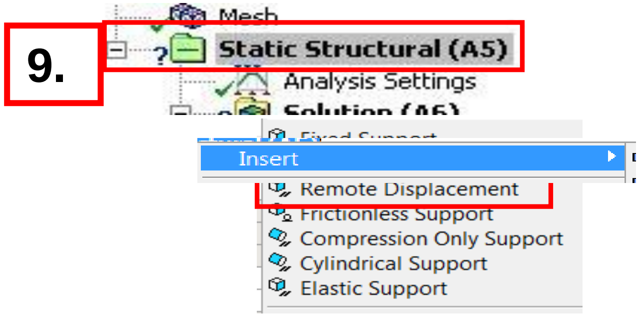
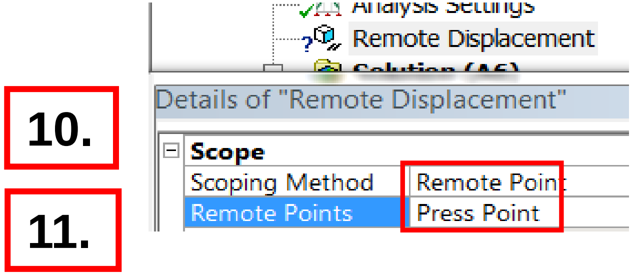
9. Highlight the Static Structural branch, RMB > Insert > Remote Displacement.



10. In the details for the remote displacement change the scope method to “Remote Point”.

11. In the “Remote Points” field choose the point “Press Point”.



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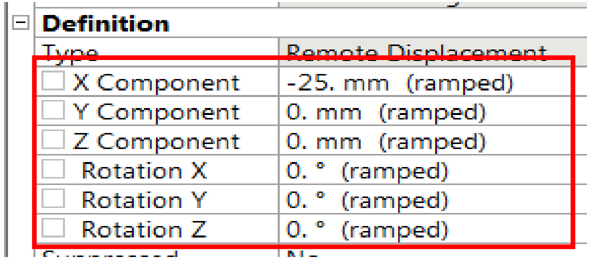
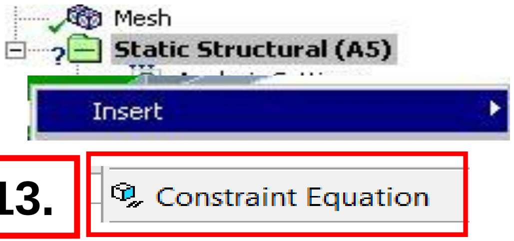
12. In the “Definition” section of the remote point details enter a value of -25 for the X component. In all other fields enter 0.

12.



13. From the Static Structural branch RMB > Insert > Constraint Equation.

13.



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14. In the constraint equation worksheet "RMB > Add" to insert the first row.

15. Referring to the expression from page 5:
    - Coefficient = 5
    - Remote Point = "Tip Point"
    - DOF Selection = Y Displacement

14.

Constraint Equation

0 =

Coefficient	Units	Remote Point	DOF Selection

Add

Modify

15.

0 = 5 (1/mm) * Tip Point(Y Displacement)

Coefficient	Units	Remote Point	DOF Selection
5	1/mm	Tip Point	Y Displacement

16. Add a second row and configure as shown below (coefficient = -1, remote point = "Press Point" and DOF = X displacement).

16.

0 = 5 (1/mm) * Tip Point(Y Displacement) + -1 (1/mm) * Press Point(X Displacement)

Coefficient	Units	Remote Point	DOF Selection
5	1/mm	Tip Point	Y Displacement
-1	1/mm	Press Point	X Displacement

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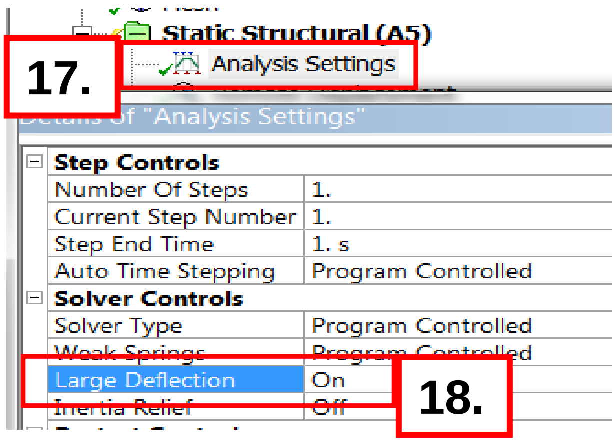
Solution

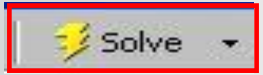
17. Highlight the “Analysis Settings” branch.

18. In the details change “Large Deflection” to “On”.



Since we are applying a displacement of 25 mm on the model it means the geometry will change location significantly. The large deflection option instructs the solver to track the change in location of each node. While beyond the scope of this course, the subject is covered in detail in the ANSYS Mechanical Structural Nonlinearities course.

19. Solve.



19.

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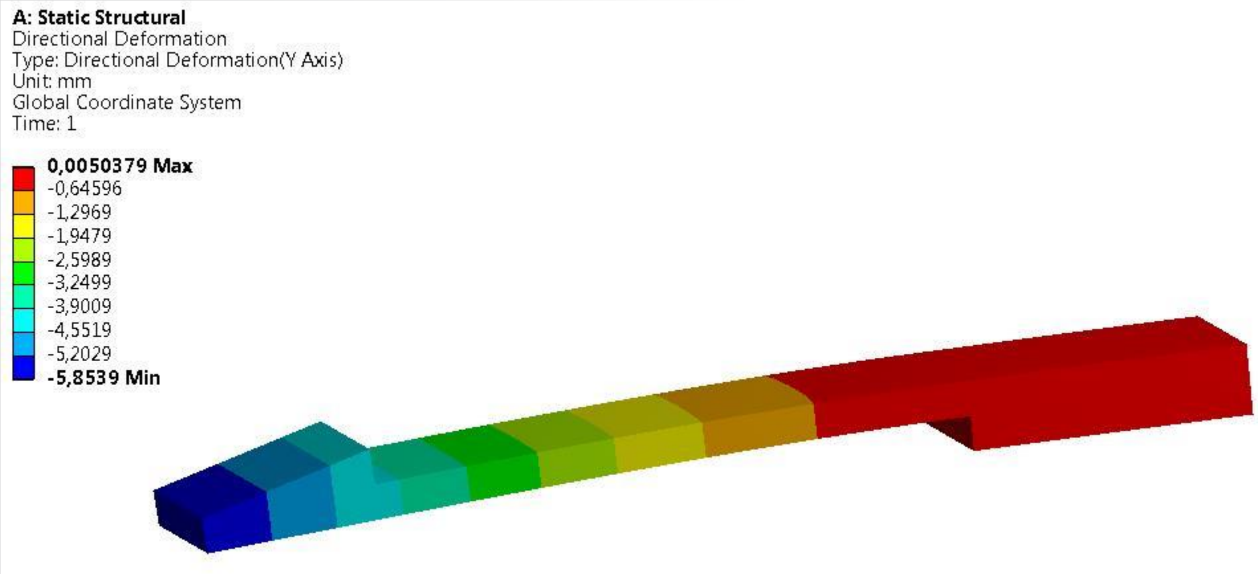
Postprocessing

Viewing deformation in the Y direction can confirm the desired behavior is being simulated. Animation can also provide insight into how the constraint equation is performing.



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Solution Note

In the workshop we created 2 remote points as a part of the exercise however only one was really necessary. The upper figure shows our original expression. The lower figure is equivalent.

$$0 = 5*(UY)_{tippoint} - (UX)_{prespoint}$$

This is equivalent in this case

$$0 = 5*(UY)_{tippoint} - (UX)_{tippoint}$$

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