

Introduction to ANSYS Mechanical

Realize Your Product Promise®



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.



ANSYS 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..

ANSYS Project Schematic

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

 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.



ANSYS Preprocessing

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



ANSYS ... 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.

0					
]	Filter: Name	-		👌 🗻 -	}⊶ (<u>∓</u>
(Project				
E	🖻 🙆 Model (A4)				
	🗄 🖓 Geometr	v			
	E Coordina	, ate System	IS		
	E An Connect	ions	-		
		tacte			_
		Frictionlos	- Ebras To Mour	+	5a.
		Frictionies	s - Fiange To Mour	IL	Vui
	Mesn		· >		
	🗄 🌾 🔁 Static S	tructural	(A5)		
D	etails of "Frictionless	- Flange T	o Mount"		
	Scope				
	Scoping Method		Geometry Select	on	
	Contact		1 Face		
	Target		1 Face		
	Contact Bodies		Flange		
	Target Bodies		Mount		
Ξ	Definition			_	
	Туре		Frictionless		
	Scope Mode		Automatic		
	Behavior		Program Control	ed	
	Trim Contact		Program Control	ed	
	Trim Tolerance		0.39449 mm		
	Suppressed		No		
Ŧ	Advanced				
I FI	Geometric Modifi	cation			

5b



- 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.





ANSYS ... 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.



В	© 2015 ANSYS, Inc.	February 27, 2015
-	,	· · · · · · · · · · · · · · · · · · ·

	Outline		ņ
	Filter: Name 🔻	🛊 🛷 🕀 🖽	
	Project		•1
	Model (A4)	-	-
	Georgiante C	urtoma.	
		ystems	
	⊡ √@ Contacts	;	
	Frict	onless - Flange To Mount	_
	√ ਡ Circular -	Mount To Flange	•
	Details of "Circular - Mount	To Flange"	ņ
7	Graphics Properties		٦
1 d.	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	
7h	Scope	1 Face	
/ N.	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	_
	Benavior	Kigia	_
	Pinbali Kegion	All	_
		Coordinates - Colortina	_
	Applied By	Bemoto Attachmont	_
_	Applied By	1 Eco	_
7	Body	1 Face	
	Goordinate System	Flange	
	Mobile X Coordinate	-4 4318e-016 mm	-
	Mobile X Coordinate	40 mm	-
	Mobile 7 Coordinate	7 mm	-
	Mobile Location	Click to Change	-
	Behavior	Rigid	-
		1 Nigita	
	Coordinate System Mobile X Coordinate Mobile Y Coordinate Mobile Z Coordinate Mobile Location Behavior	Global Coordinate System 4.4318e-016 mm 40. mm 7. mm Click to Change Rigid	

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



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.

Repeat steps 6 through 8 for the remaining three holes.

	Details of "Circular - Mount	: To Flange"	д
ſ	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 Syste	em
	Reference X Coordinate	5.7954e-016 mm	
	Reference Y Coordinate	40. mm	
	Reference Z Coordinate	-9. mm	
0	Reference Location	Click to Change	
0d.	Behavior	Deformable	
	Pinball Region	All	
	Mobile		
	Scoping Method	Geometry Selection	
	Applied By	Remote Attachment	
	Scope	1 Face	
	Body	Flange	
	Coordinate System	Global Coordinate Syste	em
	Mobile X Coordinate	-4.4318e-016 mm	
	Mobile Y Coordinate	40. mm	
	Mobile Z Coordinate	7. mm	
Oh	Mobile Location	Click to Change	
	Behavior	Deformable	•
	Pinball Region	All	

ANSYS Environment

- 9. Add a remote force:
 - a. Highlight "Static Structural" in the tree.

9a.

- **b.** Select the flange face shown.
- **c.** RMB > Insert > Remote Force.

D	etails of "Remote For			
Ξ	Scope			
	Scoping Method	Geometry Selection	า	
	Geometry	1 Face		
	Coordinate System	Global Coordinate S	ystem	
	X Coordinate	0. mm	•	
	Y Coordinate	0. mm	90	
	Z Coordinate	100. mm		
	Location	Click to Change		
Ξ	Definition			
	ID (Beta)	42		
	Туре	Remote Force		
	Define By	Components		
	X Component	1000. N (ramped)		
	Y Component	0. N (ramped)		9e.
	Z Component	0. N (ramped)		
	Suppressed	No		_
	Behavior	Deformable		
+	Advanced			



- d. Set the location to 0, 0, 100 as shown.
- **e.** Switch to the component method and enter X component = 1000 N.

ANSYS ... 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.









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.

		utline		
	Ī	Model (A4)	y ate Systems ions	
11		Static S Static S Sale Fix Sale Sale Sale Sale Sale Sale Sale Sale	Tructural (A mote Force ed Support lution (A6)	5) ormation
	De	tails of "Analysis Settin	igs"	<u></u>
		Number Of Steps	1	
		Current Step Number	1.	
		Step End Time	1.s	
		Auto Time Stepping	Program Con	crolled
	E	Solver Controls		
		Solver Type	Program Con	crolled
		Weak Springs	Program Con	rolled 💌
		Large Denection	Program Con	rolled
		Inertia Relief	Off	
	1.1	Nonlineau Controle	Long Contraction of the long o	

12. Solve the model:

Choose solve from the tool bar or RMB in the tree and choose
 "Solve".
 File Edit View Units



- 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





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





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.

Result	1.4e+002 (Auto Scale) 💌
Outline	0.0 (Undeformed)
	1.0 (True Scale)
Pro Pro	68 (0.5x Auto)
Ð 5	1.4e+002 (Auto Scale)
+	2.7e+002 (2x Auto)
: [+	6.8e+002 (5x Auto)



- 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				
	Туре	Beam Probe			
	Boundary Condition	Circular - Flange To Mount			
	Suppressed	No			
-	Options				
	Result Selection	All			
	Display Time	End Time			
+	Results				
-	Maximum Value Or	ver 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 Ov	imum 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			
	C Moment At J	771, N·mm			
t	Information				





- **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.





etails of "Solution Information"		
Solution Information		
Solution Output	Solver Output	
Newton-Raphson Residuals	0	
Update Interval	2.5 s	
Display Points	All	
FE Connection Visibility		
Activate Visibility	Yes	
Display	All FE Connectors	
Draw Connections Attached To	All FE Connectors	
Line Color	CE Based Beam Based	
Visible on Results	Weak Springs	
Line Thickness	None	
Display Type	Lines	



- 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.



