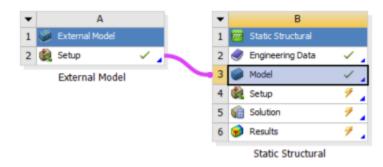
High Resolution FE Model of Bone - Physics Setup

Author: Rajesh Bhaskaran, Cornell University Problem Specification 1. Pre-Analysis & Start-Up 2. Geometry 3. Mesh 4. Physics Setup 5. Numerical Solution 6. Numerical Results 7. Verification & Validation Exercises Comments

Physics Setup

Create a material



We have not defined the material for this model so we will do that before we proceed. Double click on *Engineering Data*. Click on "click here to add a new material" to create a new material. Name the new material "Bone". Expand *Linear Elastic* and double click on *Isotropic Elasticity*.

B Physical Properties Linear Elastic Tisotropic Elasticity Orthotropic Elasticity Anisotropic Elasticity Hyperelastic Experimental Data Hyperelastic Chaboche Test Data Plasticity Creep Life Strength Gasket Viscoelastic Test Data Viscoelastic Shape Memory Alloy Geomechanical Damage Cohesive Zone Fracture Criteria Crateria Creiteria Context Context Context Context Context Context Context Context Context Context Context Context Context Context Context Context Context Context Context Context Context Context Context Context Context Context Context Context Context Context Con	Toolbox	٠	ņ	X
Isotropic Elasticity Orthotropic Elasticity Anisotropic Elasticity Hyperelastic Experimental Data Hyperelastic Experimental Data Hyperelastic Chaboche Test Data Plasticity Creep Life Strength Gasket Viscoelastic Test Data Viscoelastic Shape Memory Alloy Geomechanical Damage Cohesive Zone Fracture Criteria Crack Growth Laws	Physical Properties			
☑ Orthotropic Elasticity ☑ Anisotropic Elasticity ☑ Hyperelastic Experimental Data ☑ Hyperelastic Experimental Data ☑ Homelastic Experimental Data ☑ Homelastic Experimental Data ☑ Creep ☑ Life ☑ Strength ☑ Gasket ☑ Viscoelastic Test Data ☑ Viscoelastic ☑ Shape Memory Alloy ☑ Geomechanical ☑ Damage ☑ Cohesive Zone ☑ Fracture Criteria ☑ Crack Growth Laws	Linear Elastic			
Anisotropic Elasticity Hyperelastic Experimental Data Hyperelastic Experimental Data Hyperelastic Plasticity Creep Life Strength Gasket Viscoelastic Test Data Viscoelastic Shape Memory Alloy Geomechanical Damage E Cohesive Zone Fracture Criteria B Crack Growth Laws	🔀 Isotropic Elasticity			
Hyperelastic Experimental Data Hyperelastic Chaboche Test Data Plasticity Creep Life Strength Gasket Viscoelastic Test Data Viscoelastic Shape Memory Alloy Geomechanical Damage Cohesive Zone Fracture Criteria Crack Growth Laws				
B Hyperelastic Chaboche Test Data Strength Gasket Viscoelastic Test Data Viscoelastic Shape Memory Alloy Geomechanical Damage Cohesive Zone Fracture Criteria Crack Growth Laws	Anisotropic Elasticity			
B. Chaboche Test Data Plasticity Creep Life Strength Gasket Viscoelastic Test Data Viscoelastic Shape Memory Alloy Geomechanical Damage Cohesive Zone Fracture Criteria B. Crack Growth Laws	Hyperelastic Experimental Data			
	Hyperelastic			
B Creep Life Strength Gasket Viscoelastic Test Data Viscoelastic Shape Memory Alloy Geomechanical Damage Cohesive Zone Fracture Criteria D Crack Growth Laws	Chaboche Test Data			
B Life B Strength G Gasket Viscoelastic Test Data Viscoelastic Shape Memory Alloy G Geomechanical D Damage Cohesive Zone F Tracture Criteria D Crack Growth Laws	Plasticity			
■ Strength ■ Strength ■ Gasket ■ Viscoelastic Test Data ■ Viscoelastic ■ Shape Memory Alloy ■ Geomechanical ■ Damage ■ Cohesive Zone ■ Fracture Criteria ■ Crack Growth Laws	⊞ Creep			
B Gasket B Viscoelastic Test Data B Viscoelastic B Shape Memory Alloy B Geomechanical B Damage B Cohesive Zone B Fracture Criteria B Crack Growth Laws	🖽 Life			
Viscoelastic Test Data Viscoelastic Shape Memory Alloy Geomechanical Damage Cohesive Zone Fracture Criteria Crack Growth Laws	Strength			
Viscoelastic Shape Memory Alloy Geomechanical Damage Cohesive Zone Fracture Criteria Crack Growth Laws	Gasket			
B Shape Memory Alloy G Geomechanical Damage Cohesive Zone Fracture Criteria Crack Growth Laws	E Viscoelastic Test Data			
Geomechanical Damage Cohesive Zone Fracture Criteria Crack Growth Laws	Viscoelastic			
Damage Cohesive Zone Fracture Criteria Crack Growth Laws	Shape Memory Alloy			
Cohesive Zone Fracture Criteria Crack Growth Laws	Geomechanical			
Fracture Criteria Crack Growth Laws	Damage			
Crack Growth Laws	Cohesive Zone			
	Fracture Criteria			
Custom Material Models	Crack Growth Laws			
	Custom Material Models			

In the properties window, expand Isotropic Elasticity and enter 1e9 Pa for Young's Modulus and 0.3 for Poisson's Ratio.

	A	В	с		Е
1	Property	Value	Unit	8	φŢ
2	🔀 Material Field Variables	Table			
3	Isotropic Elasticity				
4	Derive from	Young's Modulus and Poisson's Ratio			
5	Young's Modulus	1E+09	Pa 💌		
6	Poisson's Ratio	0.3			
7	Bulk Modulus	8.3333E+08	Pa		
8	Shear Modulus	3.8462E+08	Pa		

Click on the Project tab, next to the Engineering Data tab, to return to the Project Schematic page.

Assign Material

The default material used for Mechanical is structural. We need to change it to the new material we defined earlier (Bone). In the outline window, right click on *Model*, and select *Refresh Materials*. Then, expand *Geometry* and highlight *Solid Body 1*. The bone model will now be highlighted in green, meaning it is being selected. Right below the outline window you will see "Details of Solid Body 1". Expand *Material*, and change the assignment to *Bone*. The material properties we defined for *Bone* will now be assigned to the bone model.



Named Selection

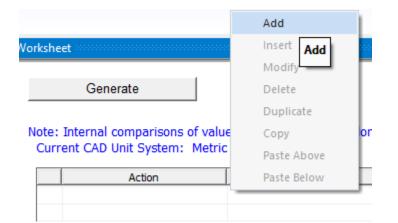
We will assign *deformation* to the *positive y* face and *roller support* to the *negative y face*. The geometry of the model makes it difficult to select all the faces in a given plane. However, we can easily assign the BC using name selection.

Click on the z axis in the coordinate axis viewer to view the XY plane. Use the vertex selection tool and select a point on the top edge. Right below the model you will see the coordinates of this point. The y position is 4.98 mm.

Right click on Named Selections and insert a new named selection. Change the Scoping Method to Worksheet.

-	Scope				
	Scoping Method	Geometry Selection	-		
	Geometry	Geometry Selection Worksheet			
-	Definition				
	Send to Solver	Yes			
	Visible	Yes			
	Program Controlled Inflation	Exclude			
Ξ	Statistics				
	Туре	Manual			
	Total Selection	No Selection			
	Suppressed	0			
	Used by Mesh Worksheet	No			

In the main window you will see an empty table. Right click on the empty table and click on Add.



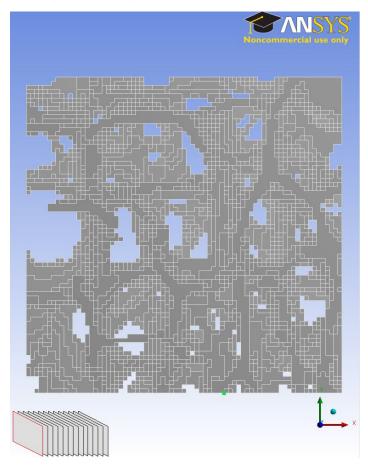
We will now enter the appropriate information that will help us create a named selection that includes all the faces in the top edge of the model viewed from the XY plane.

Select Face for Entity Type. Select Location y for Criterion. Select Equal for Operator. Enter 4.98 for Value.

Click on Generate to generate the named selection. Rename it top y.

	Generate								
	nternal comparisons of value nt CAD Unit System: Metric		in the CAD Unit System. See h	elp for more information.					
	Action	Entity Type	Criterion	Operator	Units	Value	Lower Bound	Upper Bound	Coordinate System
•	Add	Face	Location Y	Equal	mm	4.98	N/A	N/A	Global Coordinate System

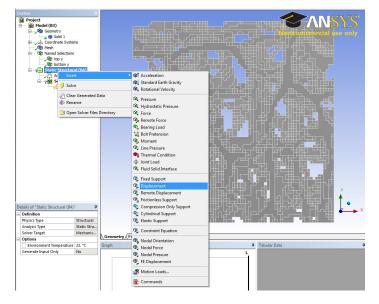
We will repeat the same steps to create a named selection for all the faces on the bottom edge of the model viewed from the XY plane.



The y coordinate for the bottom edge is 3.3e-2 mm. Rename the second named selection bottom y

Boundary Conditions

Right click on Static Structural (B4) and insert a displacement.



Change the Scoping Method to Named Selection and select top y. Enter -0.5 mm for the Y Component. This will assign a 0.5 mm displacement to the model in the -y direction on the faces selected for top y.

We can model the roller support as frictionless support in Mechanical. Right click on Static Structural (B4) and insert a frictionless support. Similarly, change the scoping method to Named selection but select bottom y.

De	etails of "Frictionle	ess Support" P	1			
Ξ	Scope					
	Scoping Method	Named Selection				
	Named Selection	bottom y 💌				
Ξ	Definition					
	Туре	Frictionless Support				
	Suppressed	No	-			

This will constraint the displacement in the y direction but the model is allowed to displace in the x direction. This is very similar to the conditions of a roller support.

The setup is finished. You may move on to setting up the solution.

Go to Step 5: Numerical Solution

r.

Go to all ANSYS Learning Modules