Cantilever Beam Modal Analysis - Pre-Analysis & Start-Up

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Pre-Analysis & Start-Up

Pre-Analysis

The following equations give the frequencies of the modes and the mode shapes and are derived from Euler-Bernoulli Beam Theory.

$$w_n = \alpha_n^2 \sqrt{\frac{EI}{ml^3}}$$
$$n = 1, 2, 3, \ldots$$
$$\alpha_n = 1.875, 4.694, 7.855, \ldots$$
$$m = \rho V = \rho \cdot l \cdot h \cdot w$$
$$I = \frac{w \cdot h^3}{12}$$
$$w_1 = 1.875^2 \sqrt{\frac{70\ E9\ \frac{kg}{m \cdot s^2} \cdot \frac{0.346m \cdot (0.346m)^3}{12}}{2.7\ E3\ \frac{kg}{m^3} \cdot 4m \cdot 0.346m \cdot 0.346m \cdot (4m)^3}} = 111.7\ \frac{rad}{s} = 17.8\ Hz$$
$$w_2 = 4.694^2 \sqrt{\frac{70\ E9\ \frac{kg}{m \cdot s^2} \cdot \frac{0.346m \cdot (0.346m)^3}{12}}{2.7\ E3\ \frac{kg}{m^3} \cdot 4m \cdot 0.346m \cdot 0.346m \cdot (4m)^3}} = 700.4\ \frac{rad}{s} = 111.5\ Hz$$
$$w_3 = 7.855^2 \sqrt{\frac{70\ E9\ \frac{kg}{m \cdot s^2} \cdot \frac{0.346m \cdot (0.346m)^3}{12}}{2.7\ E3\ \frac{kg}{m^3} \cdot 4m \cdot 0.346m \cdot 0.346m \cdot (4m)^3}} = 1961.2\ \frac{rad}{s} = 312.1\ Hz$$

$$y_i(x) = cosh(\frac{\alpha_i x}{L}) - cos(\frac{\alpha_i x}{L}) - \sigma_i(sinh(\frac{\alpha_i x}{L}) - sin(\frac{\alpha_i x}{L}))$$
$$\alpha_i = 1.875, 4.694, 7.855, \ldots$$
$$\sigma_i = 0.73409,\ 1.018647,\ 0.9992245,\ \ldots$$

Start ANSYS Workbench & Load Files

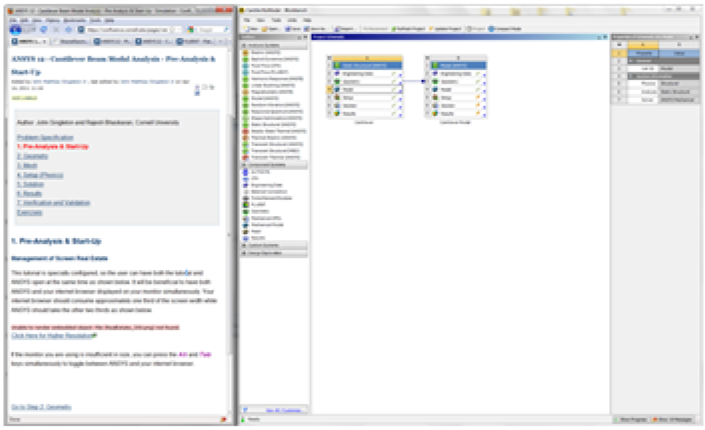
In this section we will launch ANSYS Workbench and then load the project file, "cantilever.wbpj" that was created in the "Cantilever Beam" tutorial.

Start > All Programs > ANSYS 12.1 > Workbench

File > Open
Then choose the "cantilever.wbpj" file that you created in the "Cantilever Beam" tutorial.

Management of Screen Real Estate

This tutorial is specially configured, so the user can have both the tutorial and ANSYS open at the same time as shown below. It will be beneficial to have both ANSYS and your internet browser displayed on your monitor simultaneously. Your internet browser should consume approximately one third of the screen width while ANSYS should take the other two thirds as shown below.



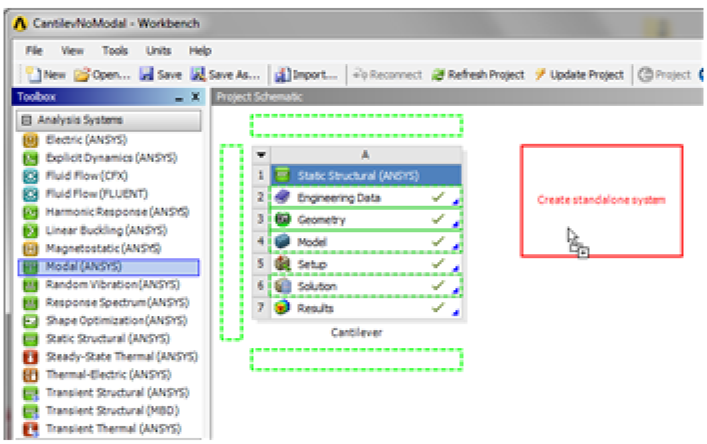
Click Here for Higher Resolution

If the monitor you are using is insufficient in size, you can press the ***Alt*** and ***Tab*** keys simultaneously to toggle between ANSYS and your internet browser.

Modal (ANSYS) Project Selection

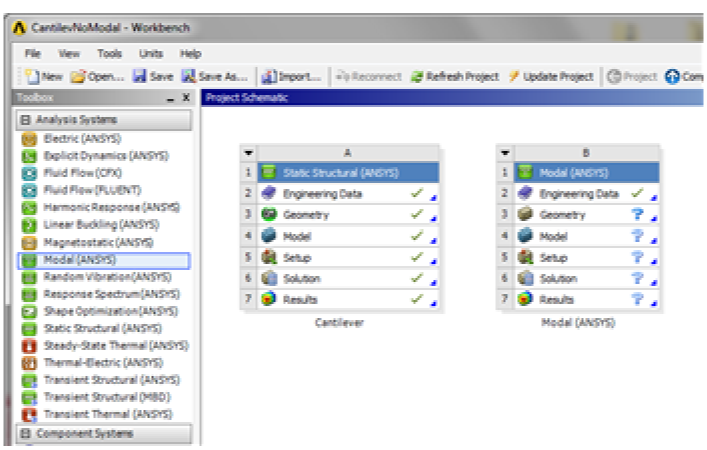
Left, click on ***Modal ANSYS***, 

, and drag it to the right of the "Cantilever" project. You should then see a red box to the right of the "Cantilever" project that says "Create standalone system" as shown below.



Higher Resolution Image

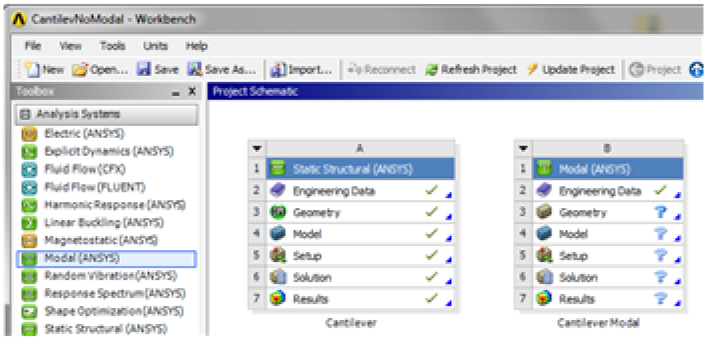
Now, release the left mouse button. Your ***Project Schematic*** window should now look comparable to the image below.



Higher Resolution Image

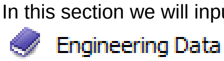
Rename Modal (ANSYS)

Double click on Modal (ANSYS) and rename it to "Cantilever Modal".

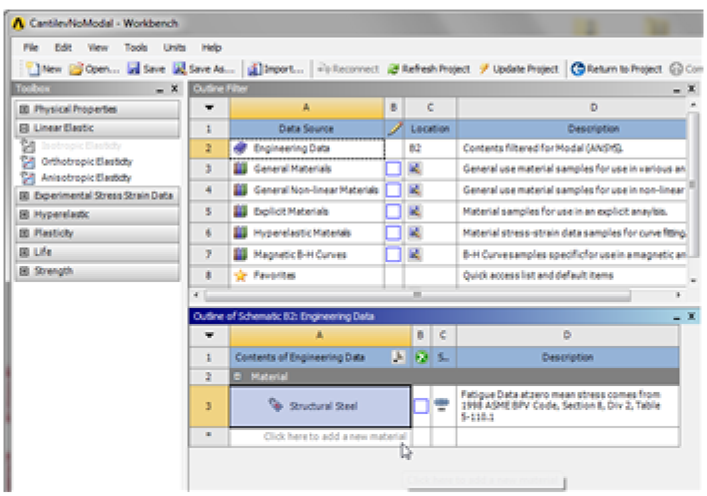


Higher Resolution Image

Engineering Data

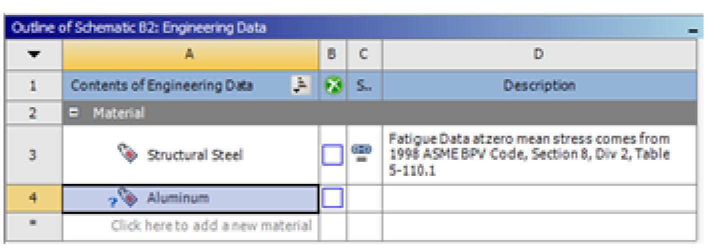
In this section we will input the properties of aluminum (as defined in the the Problem Specification) in to ANSYS. First, double click ***Engineering Data***, 

, in the "Cantilever Modal" Project. Next, click where it says "Click here to add a new material" as shown in the image below.



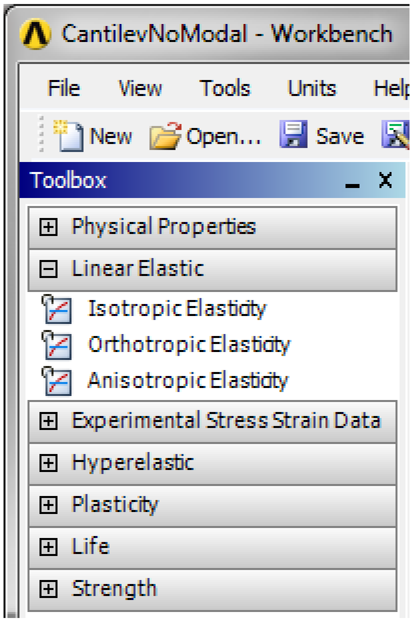
Higher Resolution Image

Next, enter "Aluminum" and press **enter**. You should now have Aluminum listed as one of the materials in table called "Outline of Schematic B2: Engineering Data", as shown below.

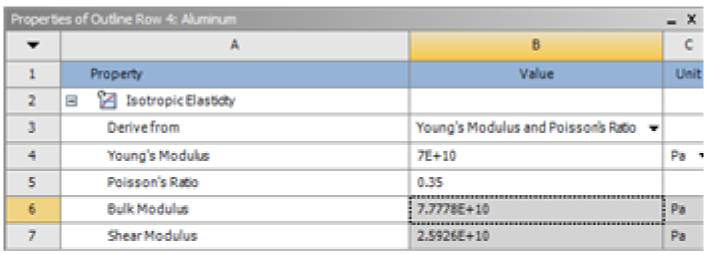


Higher Resolution Image

Then, ***(expand) Linear Elastic***, as shown below.



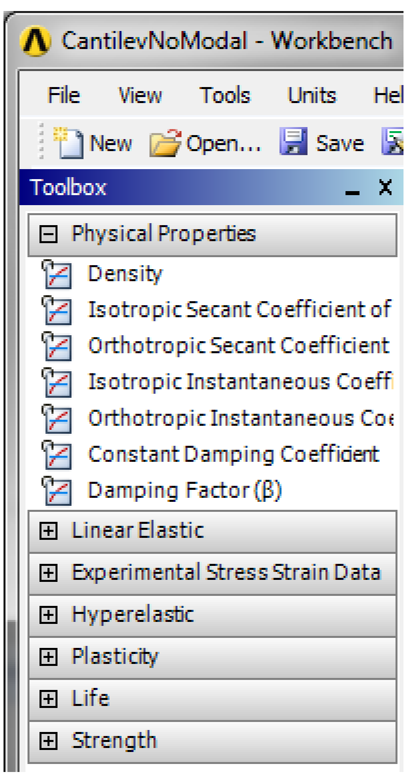
Now, ***(Double Click) Isotropic Elasticity***. Then set ***Young's Modulus*** to 70e9 Pa and set ***Poisson's Ratio*** to 0.35 , as shown below.


Properties of Outline Row 4: Aluminum

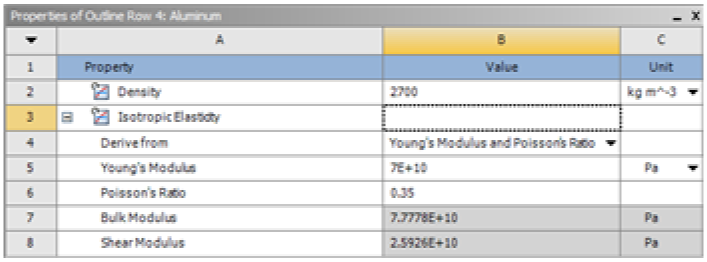
	A	B	C
1	Property	Value	Unit
2	Isotropic Elasticity		
3	Derive from	Young's Modulus and Poisson's Ratio	
4	Young's Modulus	7E+10	Pa
5	Poisson's Ratio	0.35	
6	Bulk Modulus	7.7778E+10	Pa
7	Shear Modulus	2.5926E+10	Pa

Higher Resolution Image

Next, ***(expand) Physical Properties***, as shown below.



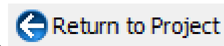
Now, ***(Double Click) Density***. Then, set ***Density*** to 2,700 kg / m^3 , as shown below.



Properties of Outline Row 4: Aluminum

	A	B	C
1	Property	Value	Unit
2	Density	2700	kg m^-3
3	Isotropic Elasticity		
4	Derive from	Young's Modulus and Poisson's Ratio	
5	Young's Modulus	7E+10	Pa
6	Poisson's Ratio	0.35	
7	Bulk Modulus	7.7778E+10	Pa
8	Shear Modulus	2.5926E+10	Pa

Higher Resolution Image

Now, the material properties for Aluminum have been specified. Lastly, ***(Click) Return To Project***, 

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Save

Save your project now and periodically, as you work. ANSYS does not have an auto-save feature.

Go to Step 2: Geometry

Go to all ANSYS Learning Modules