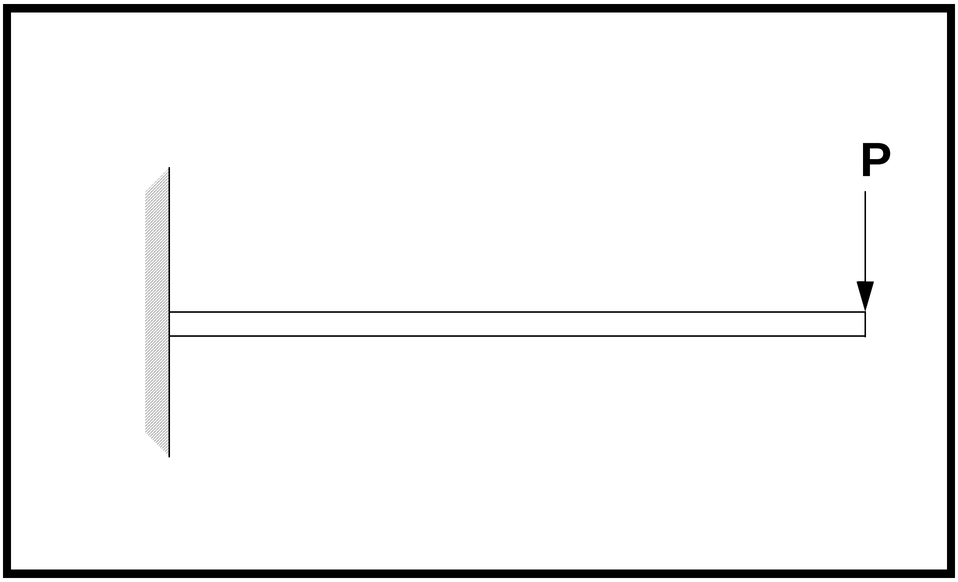
LESSON 10

Element Selection Study



Objectives:

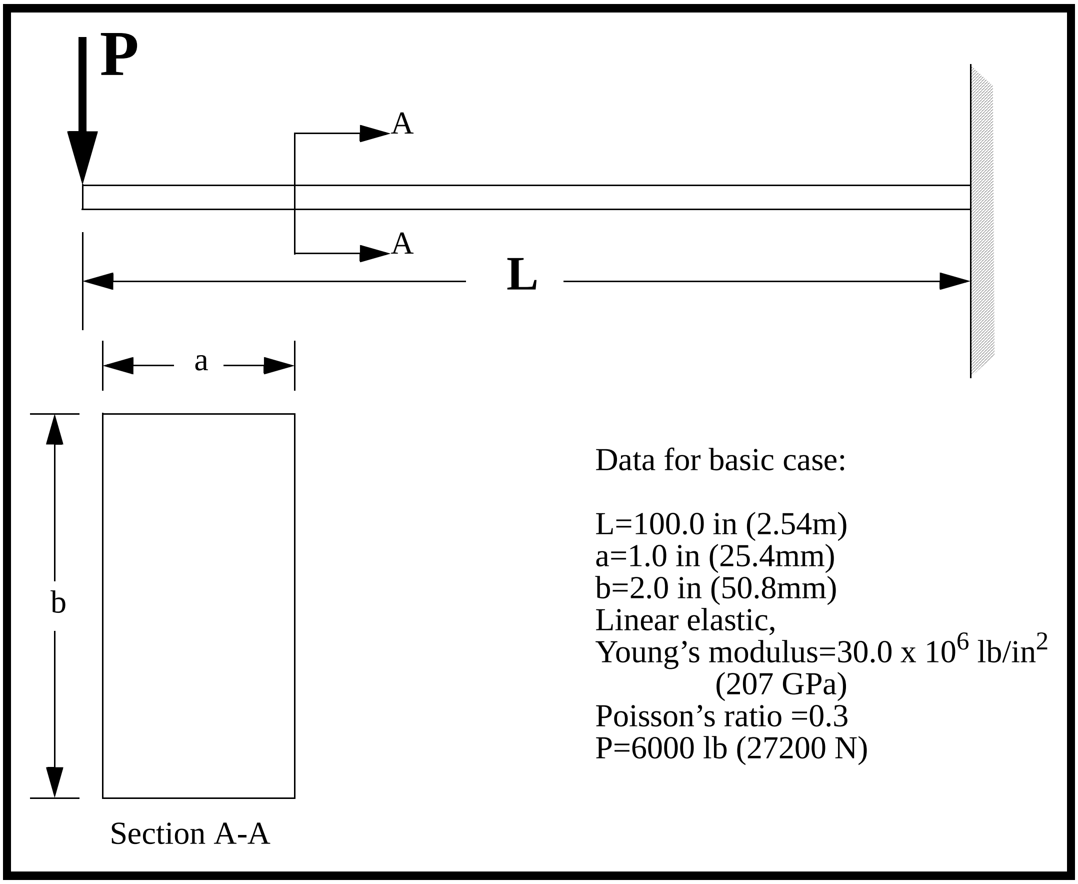
- Small/Large displacement analyses
- Compare performance of various element types
- Compare CPU time to solve the cantilever beam problem using a 1-D, 2-D and 3-D models

Model Description:

In this problem, you will re-run the cantilever beam you created in Lesson 1 with different Finite Elements. You will study the effectiveness of various1-D, 2-D and 3-D elements in linear as well as non-linear analysis.

Suggested Exercise Steps:

- Re-run the cantilever model creation in Lesson 1 with various elements.
- Use the mesh density suggested in Table 1.



Exercise Procedure:

1. Repeat creating the cantilever beam model from **Lesson 1**, and try different elements for Linear and Nonlinear analysis and use the elements suggested in the tables below.

Note: Use the following linear elastic material properties in all models:

E = 30.0E+06 psi
Poisson's Ratio = 0.3

Define the Tip_Load to sum to 6000 lbs in all cases.

2. Fill out the tables for deflection and total cpu time.

Note: 50x2 mesh means 50 elements long and 2 elements deep.

Note: CPU time for each run can be obtained from the end of the ".log" file.

3. There are questions at the end of this exercise. Read them over and be prepared to discuss them in class.

Table 1: Linear Analysis for Maximum Y-Displacement

	Finite Elements		Element Properties					
MSC.Marc ELEMENT	Element Type	Mesh	Dimension	Type	Option 1	Option 2	Tip Displacement	CPU Time
52	BAR2	5x1	1D	Elastic Beam	General Section	Euler-Bernoulli		
45	BAR3	5x1	1D	Planar Beam	Homoge-neous	Standard Formulation		
3	QUAD4	50x2	2D	2D Solid	Plane Stress	Standard Formulation		
3	QUAD4	50x4	2D	2D Solid	Plane Stress	Standard Formulation		
114	QUAD4	50x2	2D	2D Solid	Plane Stress	Reduced Integration		
114	QUAD4	50x4	2D	2D Solid	Plane Stress	Reduced Integration		
3	QUAD4	50x1	2D	2D Solid	Plane Stress	Assumed Strain		
53	QUAD8	50x1	2D	2D Solid	Plane Stress	Reduced Integration		
7	HEX8	50x2x1	3D	Solid	Standard Formulation	----------		
21	HEX20	50x1x1	3D	Solid	Standard Formulation	----------		
134	TET4	1.0	3D	Solid	Standard Formulation	----------		
127	TET10	1.0	3D	Solid	Standard Formulation.	----------		

Note: Mesh the models using Tet4 and Tet10 elements with the isomesher and a global edge length of 1.0.

Table 2: Nonlinear Analysis for Maximum Y-Displacement

	Finite Elements		Element Properties					
MSC.Marc ELEMENT	Element Type	Mesh	Dimension	Type	Option 1	Option 2	Tip Displacement	CPU Time
52	BAR2	5x1	1D	Elastic Beam	General Section	Euler-Bernoulli		
45	BAR3	5x1	1D	Planar Beam	Homoge-neous	Standard Formulation		
3	QUAD4	50x2	2D	2D Solid	Plane Stress	Standard Formulation		
3	QUAD4	50x4	2D	2D Solid	Plane Stress	Standard Formulation		
114	QUAD4	50x2	2D	2D Solid	Plane Stress	Reduced Integration		
114	QUAD4	50x4	2D	2D Solid	Plane Stress	Reduced Integration		
3	QUAD4	50x1	2D	2D Solid	Plane Stress	Assumed Strain		
53	QUAD8	50x1	2D	2D Solid	Plane Stress	Reduced Integration		
7	HEX8	50x2x1	3D	Solid	Standard Formulation	----------		
21	HEX20	50x1x1	3D	Solid	Standard Formulation	----------		
134	TET4	1.0	3D	Solid	Standard Formulation	----------		
127	TET10	1.0	3D	Solid	Standard Formulation	----------		

Note: Mesh the models using Tet4 and Tet10 elements with the isomesher and a global edge length of 1.0.

Table 3: Linear/Nonlinear Analysis for Maximum Y-Displacements (Answers)

		Linear Analysis		Nonlinear Analysis	
MSC.Marc ELEMENT	Mesh	Tip Displacement	CPU Time	Tip Displacement	CPU Time
52	5x1	-100	0.19	-65.7	0.31
45	5x1	-100	0.17	-65.5	0.33
3	50x2	-70.9	0.27	-53.8	1.50
3	50x4	-71.8	0.36	-54.2	2.77
114	50x2	-99.9	0.31	-65.3	0.78
114	50x4	-99.9	0.30	-65.2	1.41
3	50x1	-95.8	0.23	-63.8	0.97
53	50x1	-100	0.27	-65.2	1.19
7	50x2x1	-76.6	0.45	-56.2	6.31
21	50x1x1	-101	0.81	-64.9	27.78
134	1.0	-68.7	0.75	-52.6	7.78
127	1.0	-103	2.84	-65.0	47.75

Notes:

1. CPU Time is based on a Dell Precision 420- 800 MHz running v.r2a. CPU time will vary depending platform which analysis is performed on.

2. Tetrahedron Mesh Information:
   134 Mesh had 1000 elements, 606 nodes
   127 Mesh had 1000 elements, 2815 nodes

Figure 10.1: Deflection Results and Times for Linear Solution

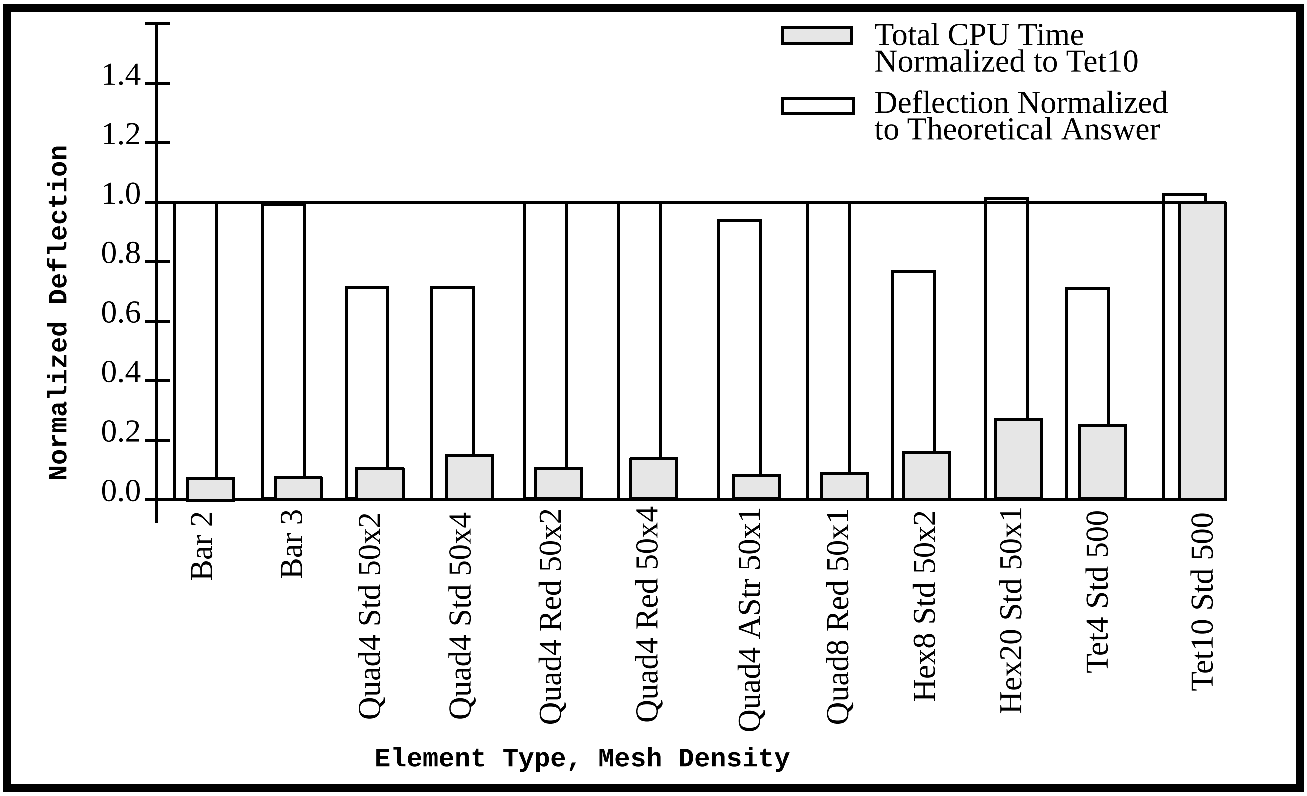
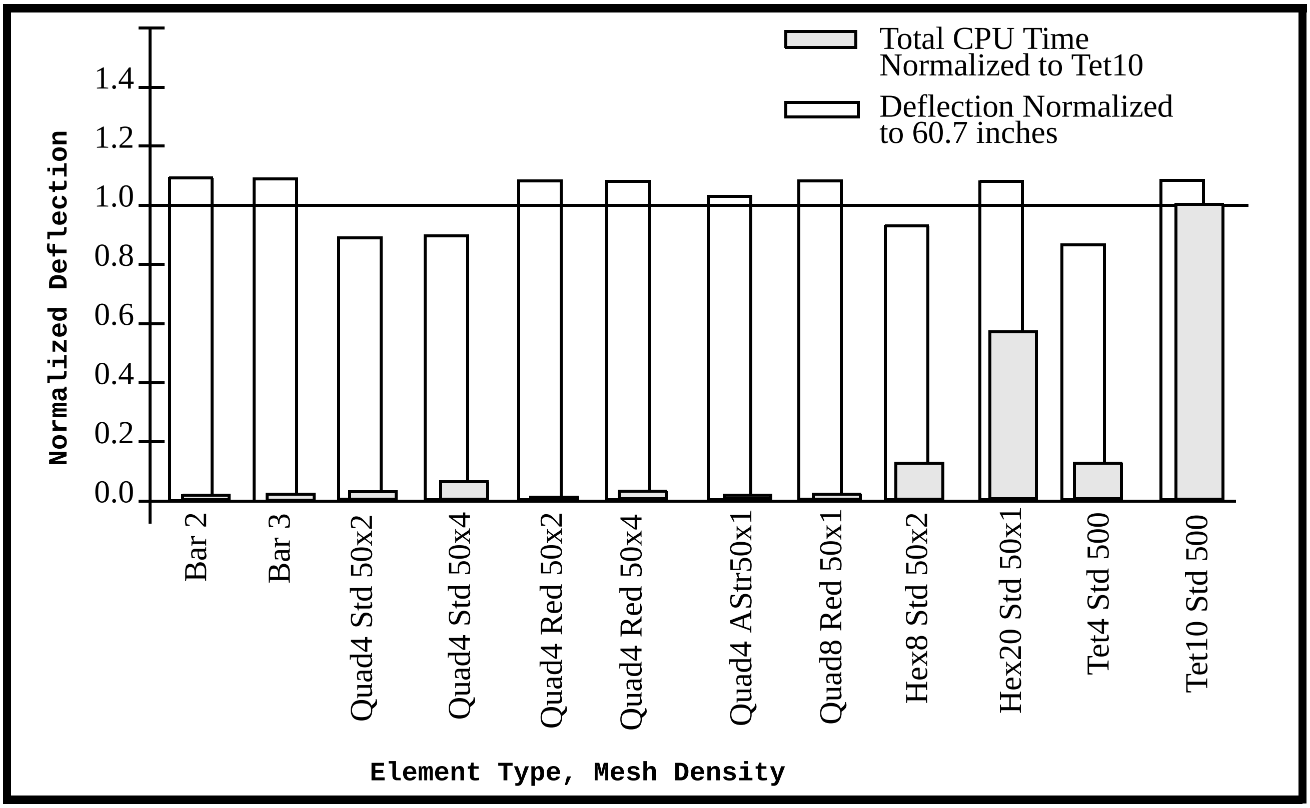


Figure 10.2: Deflection Results and Times for NonLinear Solution



Question: For Linear Elastic analysis using continuum elements, which one of the elements seem to be appropriate for bending application? Keep in mind that you may have distorted elements.

(class discussion)

Question: For non-linear analysis, which continuum element would you choose?

(class discussion)

Question: When is it appropriate to use 1-D, 2-D or 3-D elements?

(class discussion)