Tom Boynton
ETM 467
March 10, 2009
HW#4

Homework 4: Beam Analysis

Problem Description:

In this homework, a stress analysis was performed on two beams with ten elements each as shown in the model descriptions. First these beams were analyzed using hand calculations with the superposition method for deflection and the $\frac{Mc}{I}$ formula for stress. Results were obtained and verified using the Algor FEA FemPro Software. The hand calculations and the software analysis determined the location and magnitude of the maximum deflection and stress in these beams. The software and the hand calculations agreed with each other.

Results: Beam 1

The first beam was shown to have the maximum deflection at the center point between the two supports because of the symmetric loading and boundary conditions. It had a value of -0.6348 inches in the Y direction (figure 2). The maximum stress was also at this point (60 inches from each end) with a value of 8438 psi (figure 3).

Model Description, Beam 1 (Figure 1):

- **Geometry:** The first beam is a 2 inch wide by 4 inch rectangular beam shown in Figure 1 that is 120 inches long; consequentially its cross-sectional area is 8 in^2.
- **Loads:** The beam is loaded with a distributed load of 25 lb/in along its whole length.
- **Boundary Conditions:** This beam is pin supported at point A; free to move only in the Z rotational direction. It is roller supported at point B; free to move in the x translational and z rotational direction.
- **Material Properties:** This beam is made of 6061-T6 Aluminum with a Poisson's ratio of 0.33 and a Modulus of Elasticity of 9993200 lbf/in^2. These properties are quoted by the program as coming from Matweb.
- **Initial Conditions:** There are no additional initial conditions

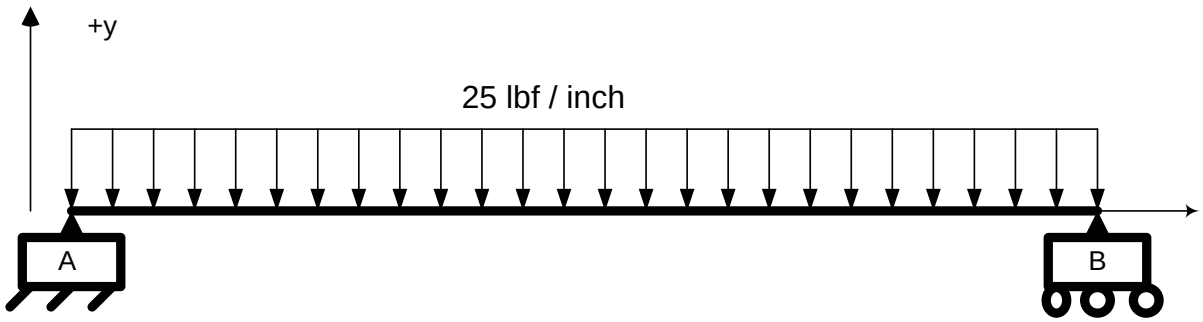

Figure 1: Beam 1 with distributed load, simply supported

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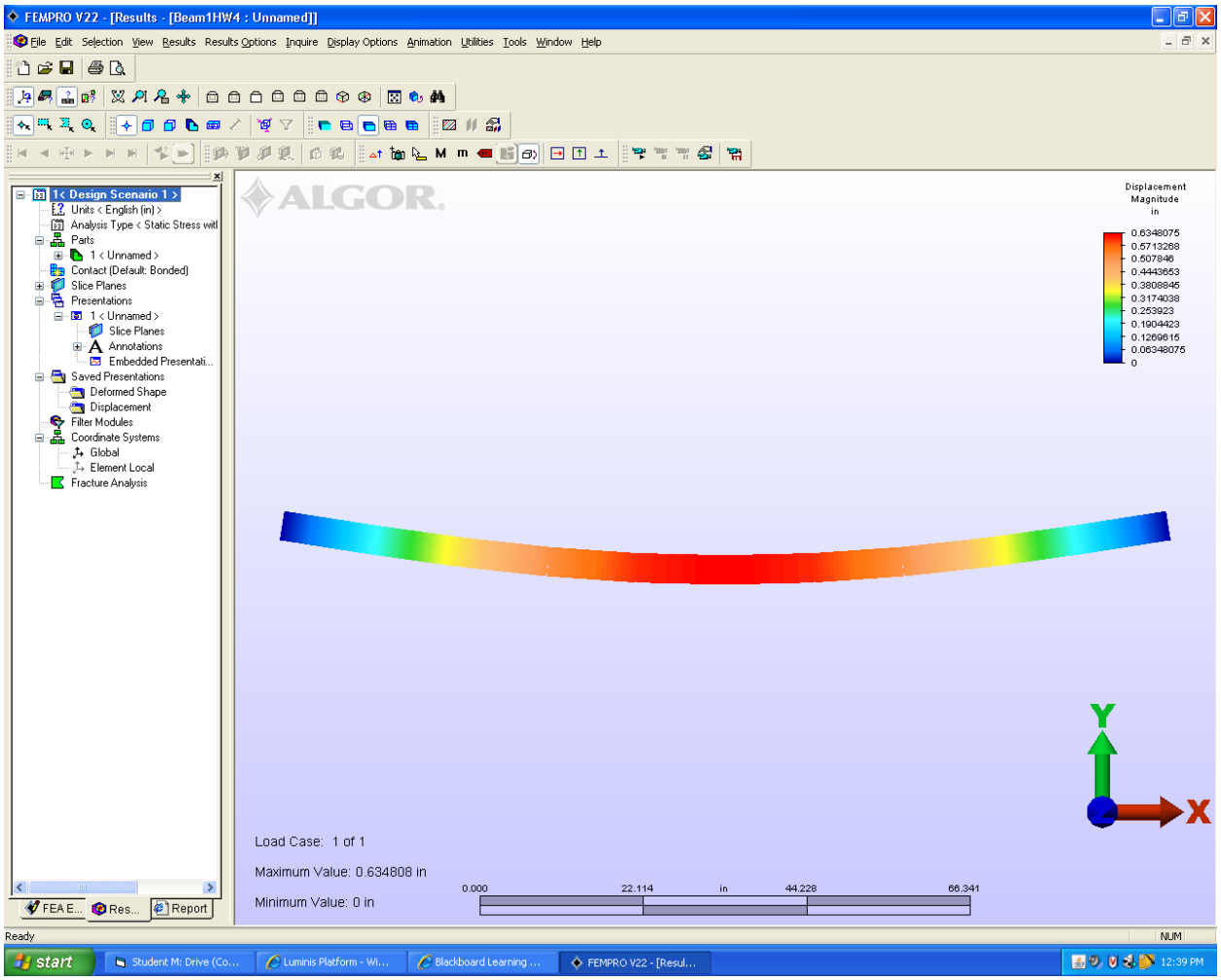

Figure 2: Beam 1 Deflection

Beam 1: Results

Beam 1	Hand Calculated Stress	Algor Calculated Stress	Hand Calculated deflection	Algor Calculated Deflection
	8437.24 psi	8438.027 psi	0.63324 in.	0.634808 in

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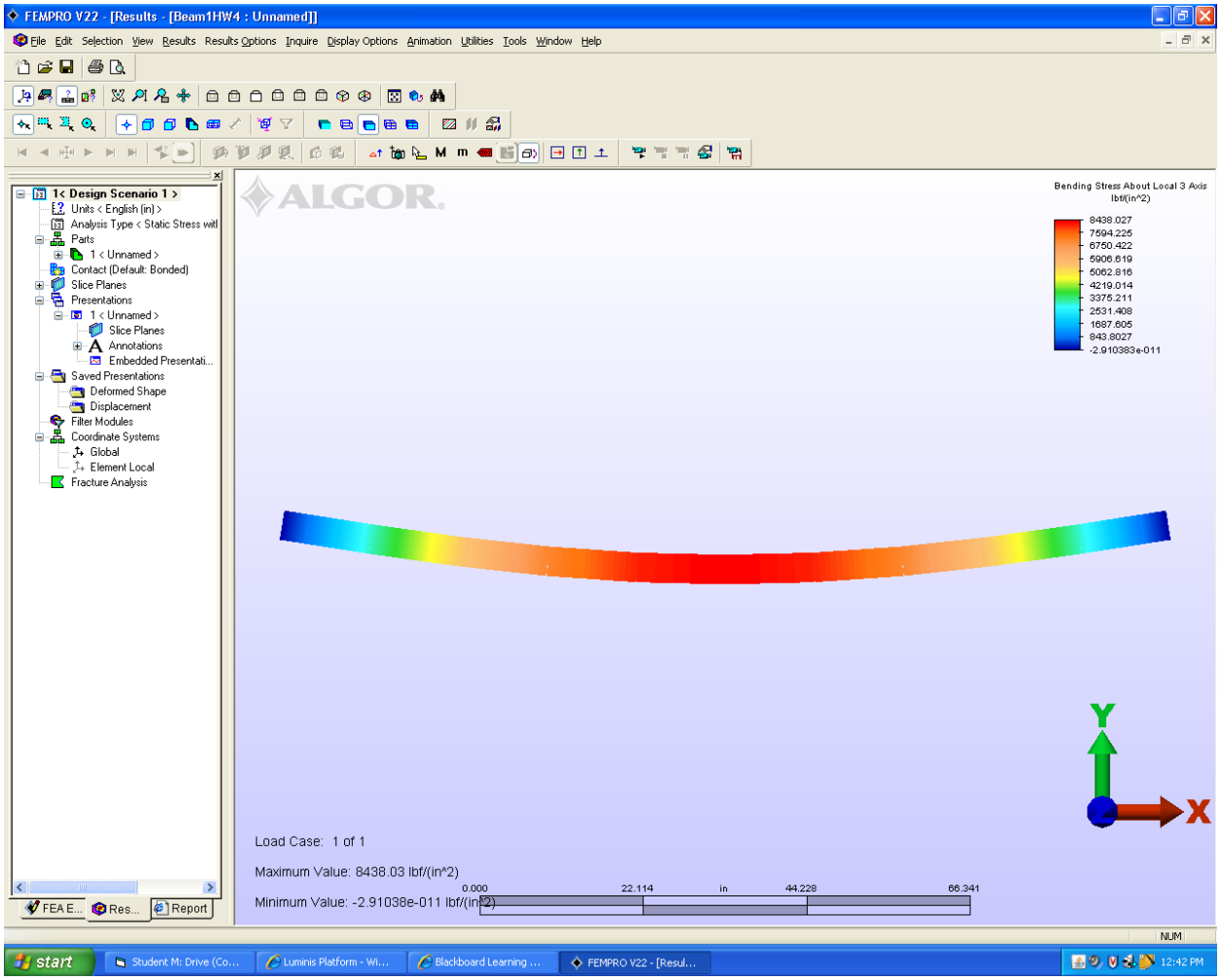

Figure 3: Beam 1 Maximum Stress

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Results: Beam 2

The second beam was shown to have the maximum deflection at the free end due to the cantilevered design with no boundaries and the full moment at the free end. This was -2.27 inches in the Y direction (figure 5). The maximum stress was at the bounded end with a value of -9167 psi in the Z direction (figure 6). This was expected as it only has one bounded point and a force at the free end.

Model Description, Beam 2 (Figure 4):

- **Geometry:** The second beam is a round beam, 120 inches long and 2 inches in diameter as shown in Figure 4.
- **Loads:** The beam is loaded at the free end B with a negative moment of 7200 lb/in.
- **Boundary Conditions:** This beam is cantilevered; fixed in all degrees of freedom at point A and free at point B in all six degrees of freedom.
- **Material Properties:** This beam is made of ASTM A36 rectangular steel with a Modulus of Elasticity of 29 MPa and a poisons ratio of 0.29 with values obtained from the Algor Software and Matweb.
- **Initial Conditions:** There are no additional initial conditions

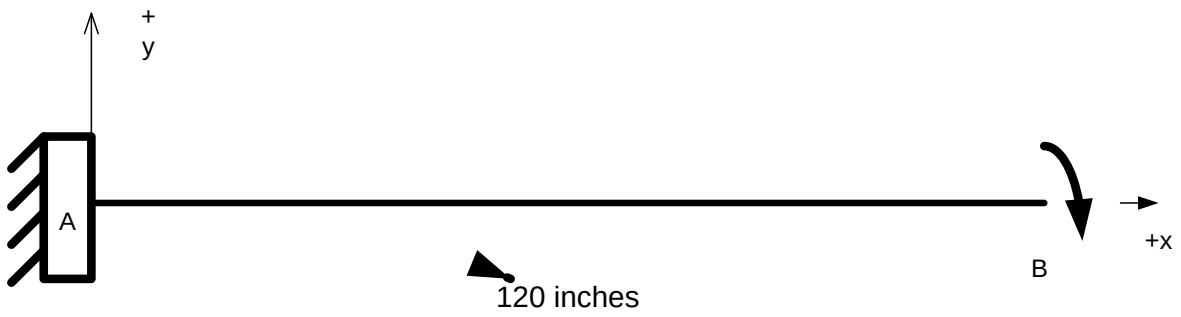

Figure 4: Beam 2 Cantilevered Geometry

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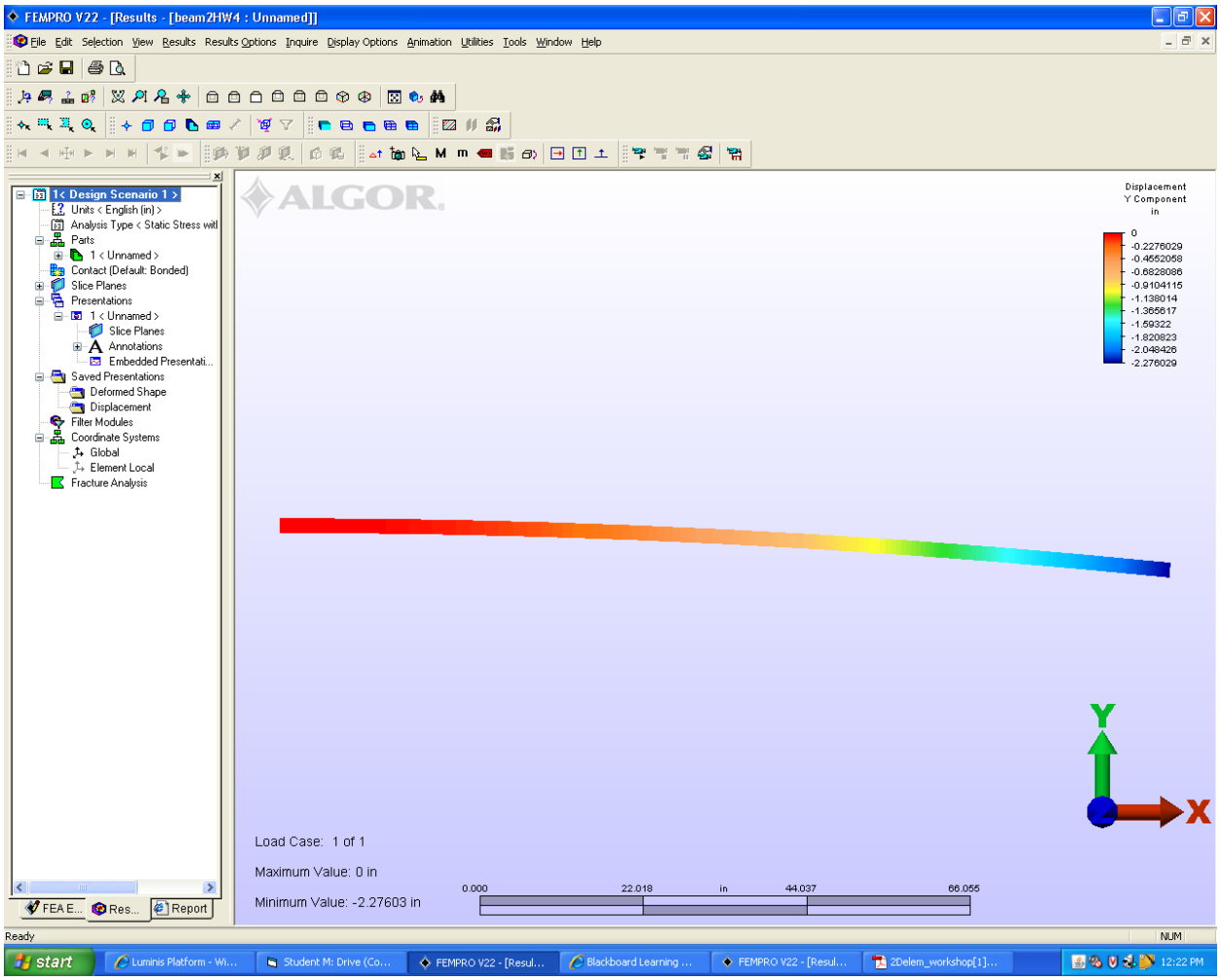

Figure 5: Deflection of Beam 2

Results: Beam 2

Beam 2	Hand Calculated Stress	Algor Calculated Stress	Hand Calculated deflection	Algor Calculated Deflection
	-9171.97 psi	-9167.338 psi	-2.277 in	-2.2760 in.

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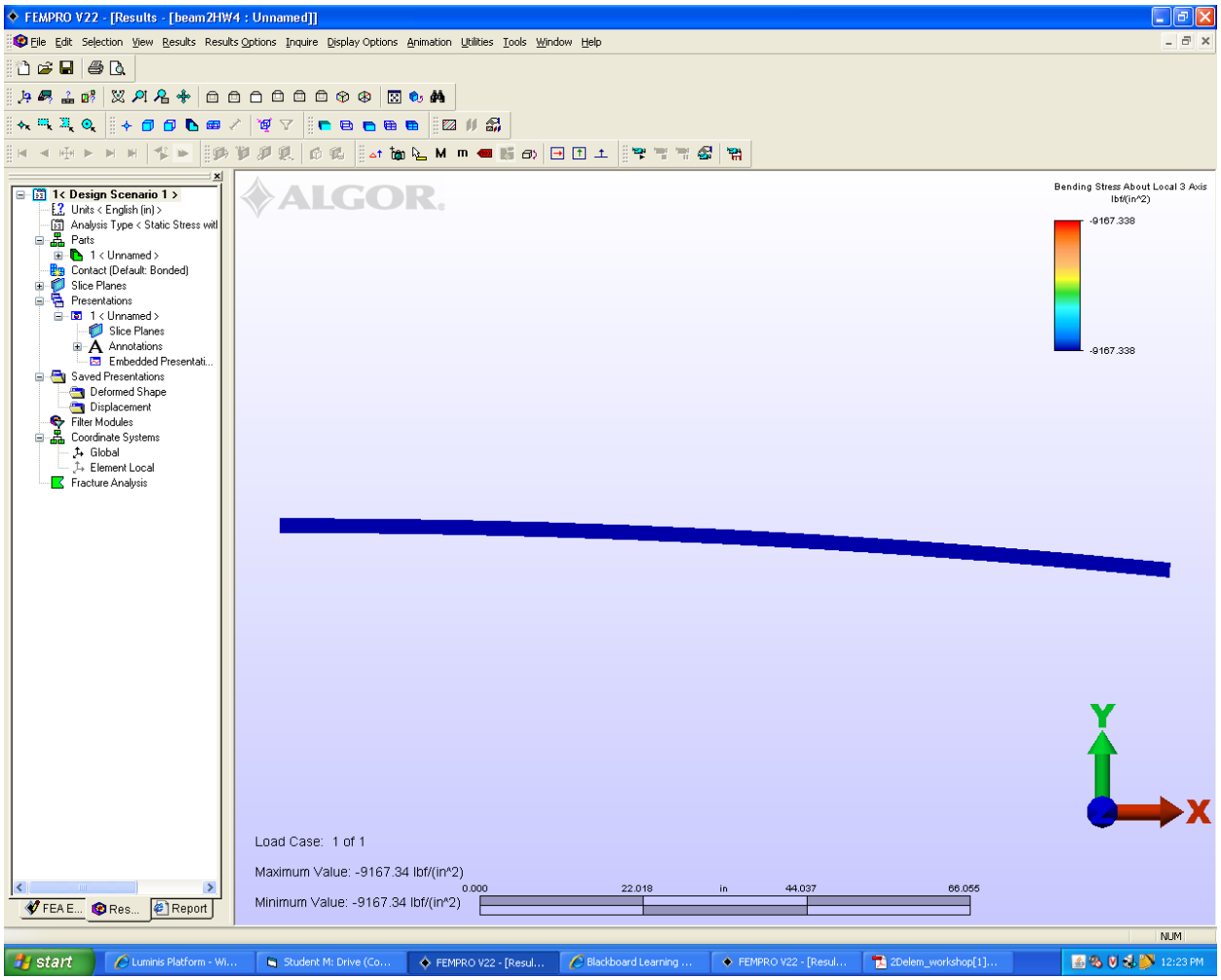

Figure 6: Beam 2 Maximum Stress

Attached Documents:

Algor screen shots (4 pages)
Hand calculations (2 pages)