UNIVERSITY OF NOTRE DAME
DEPARTMENT OF AEROSPACE AND MECHANICAL ENGINEERING
AME30362: Design Methodology, Fall 2009

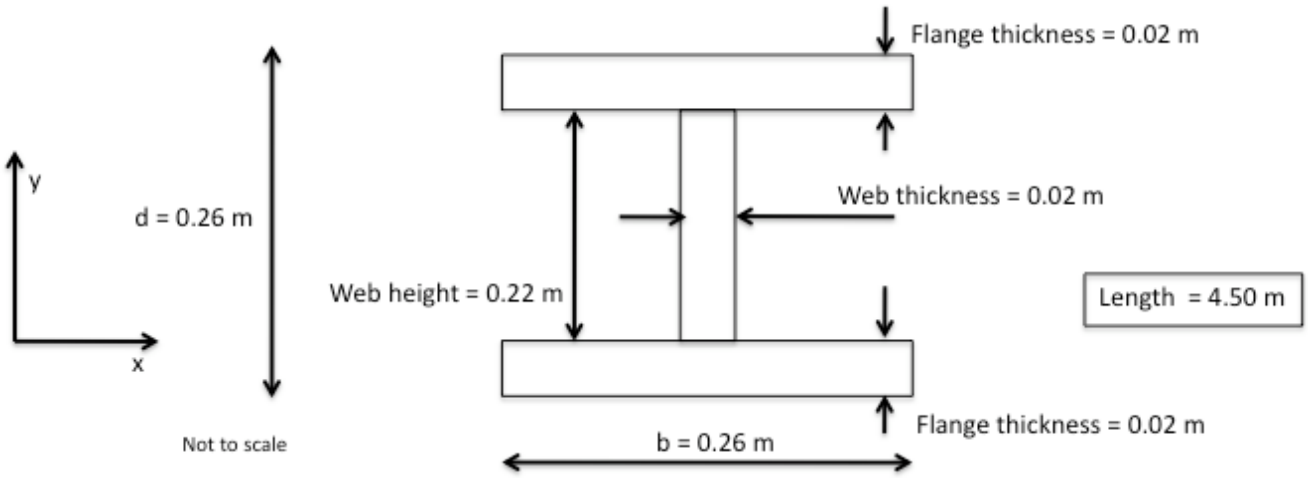
P6 – Computer Aided Engineering – Modeling and parametric trade study
Project Due Date: Thursday, December 3, 2009

This project provides the opportunity to develop some experience using the type of modeling and analysis software used in industry during the engineering design process. The project will involve modeling a simple component, verifying the information provided by the software by comparing results with an analytic prediction technique and then using the results to conduct a parametric trade study.

Project Description:

This project will involve using the Pro/E Mechanica finite element modeling and analysis software package to analyze and design a part. The part is a simple I-beam that could be found in many mechanical products or systems. There is no expectation that you become proficient in the use of Mechanica, nor do you need to refresh your Pro/E skills as you will use a detailed step-by-step tutorial to complete the project. Emphasis will be placed upon your interpretation of the results versus developing specific computer skills. In order to complete this individual project you will need to:

2. Create a Pro-E model of an "I"-beam. The beam's cross-section is sketched below.



2. Using Mechanica, fix one end of the beam and apply a distributed load at its free end with F = -5000 N (in the y-direction) and use AL6061 as the material (E = 68947.6 MPa, ρ = 2.7102e-6 kg/mm^3).

   a. Use Mechanica to perform a Sensitivity Design Study and determine how the tip deflection of the beam varies with beam length. Use 0.5 m as the starting length and 4.5 m as the ending length, with 3 steps (i.e. a total of 4 data points).

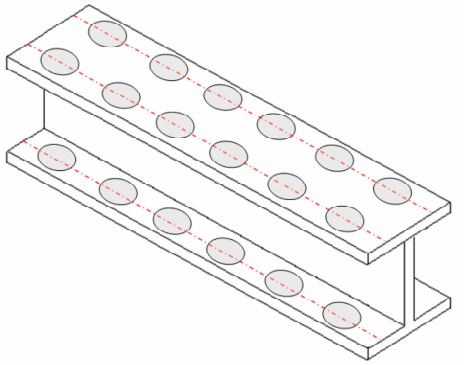
   b. Calculate the tip deflection vs. length using simple beam theory. *Some useful formulas:*

   Moment of inertia: $I = \dfrac{bd^3 - h^3(b-t)}{12}$ Tip Deflection: $\delta = \dfrac{Fl^3}{3EI}$

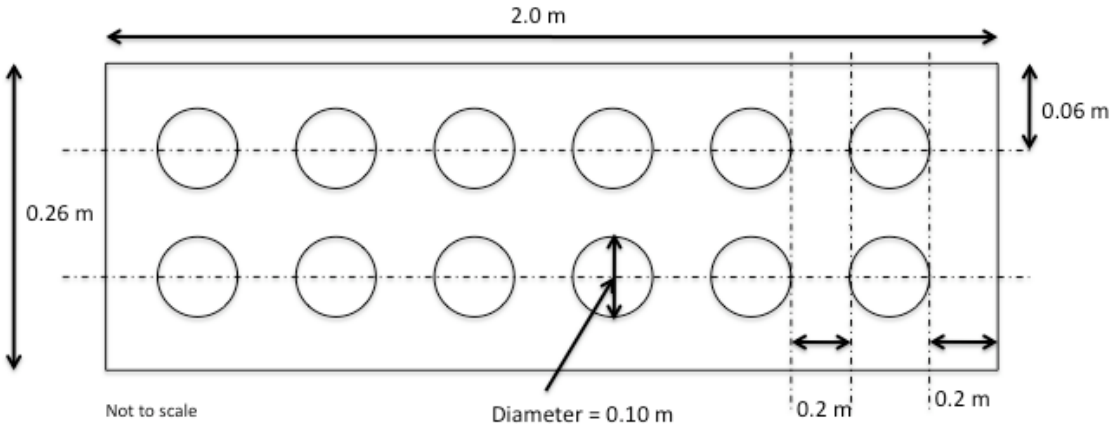
   c. Develop a plot of the tip deflection vs. length from part a. and part b. on the same axes. Compute and develop another plot of the <u>difference</u> between the two estimates of tip deflection and speculate on what may cause any observed differences.

3. It has been suggested that one could reduce the weight of the beam by putting holes in the web. Use the same cross section as before, except ***shorten the length of the beam to 2 m***. Place the following pattern of holes in the beam flanges:

Isometric view of the beam with holes:



Top view:



Note: Use a patterned extrusion, as mentioned in the tutorial, so that the diameter of the holes will all be controlled by the same parameter.

4. Using Mechanica, fix one end of the beam and apply a distributed load at its free end with F = -5000 N (in the y-direction) and use AL6061 as the material (E = 68947.6 MPa, ρ = 2.7102e-6 kg/mm^3). Then use Mechanica to perform a Sensitivity (Trade) Design Study to determine how the tip deflection of the beam varies with hole diameter. Use 0.025 m as the starting diameter and 0.10 m as the ending diameter, with 3 steps. Develop a plot of the tip deflection vs. hole diameter and beam weight vs. hole diameter. Comment on the percent changes in deflection vs. the percent changes in weight reduction achieved. Does this appear to be an effective way to decrease the weight of the beam and what other effects might result from this modification?

Project Requirements:
This is an individual project in which you will use Mechanica to perform the parametric study and document your results. You will document your study in a brief technical memo that will contain the four plots indicated above as well as your observations on the results and your comments in response to the questions regarding observed differences and using holes to reduce the weight of the beam

The format for the memorandum is at your discretion. The entire document, including figures MUST be no longer than 3 pages and any text elements should be 12-pt font, single-spaced. NO consideration will be given to any information on pages 4 or greater so concise and efficient presentation of your results and observations are critical. The memorandum should be submitted in hard-copy form in class and electronically in .pdf form.

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