Idea for Term Project

Group Number 1

Group Members:

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Term Project Idea:

Studying of bending of beams involve developing a set of governing differential equations in terms of the transverse displacement and finding out the appropriate boundary conditions for the problem. While deriving the governing differential equation we come up with developing the displacement fields for the beam. Now, to obtain the displacement fields, we think of some *kinematical hypothesis*. We have already studied about one of the hypothesis in class. We generally call the theory as *Euler-Bernoulli Beam Theory* based on the pioneering work of Leonhard Euler and Jacob Bernoulli. Since this is a hypothesis, so we know it is based on some assumptions.

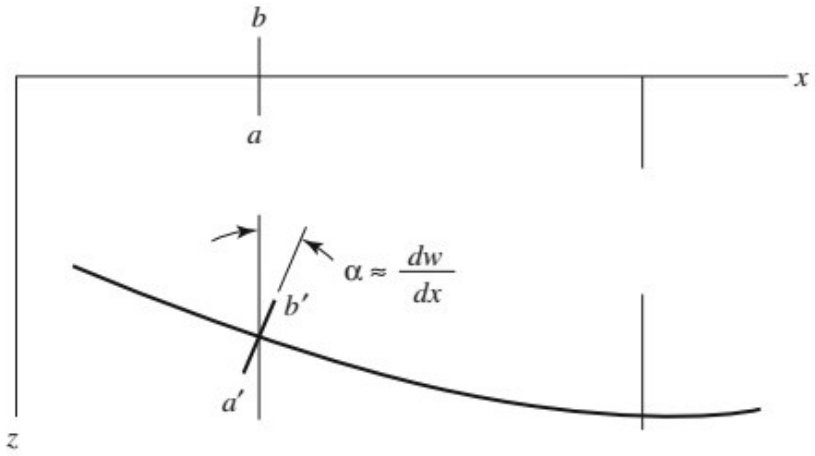

Figure 1: Section of a beam after bending [taken from *Solid Mechanics: A Variational Approach* by Dym and Shames]

The assumptions based on which Euler-Bernoulli beam theory is developed are-

1. As seen in figure (1), the plane section a-b after bending becomes a'-b'. The plane section remains plane after bending. Thus the shear stresses are assumed to be zero.
2. The transverse normal to the neutral axis remains normal to the vertical axis during and after deformation.

The hypothesis gives pretty good results for engineering problems. However we can assume the plane section to deflect by some angle after bending instead of remaining orthogonal. This theory was developed by Stephen Timoshenko in the early 20th century.

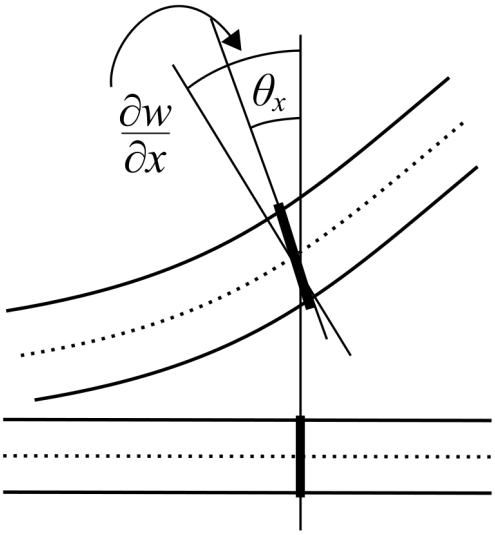

Figure 2: Deformation of a Timoshenko beam [taken from *Wikipedia*]

Till now, we have been studying static analysis of beams. We can include the time varying terms of transverse displacement to solve vibration of beams problems. We can study beam vibration using both Euler-Bernoulli beam theory and Timoshenko beam theory.

Finally we can develop a theory for beam buckling problems. We have already studied beam buckling using Euler-Bernoulli beam theory. However beam buckling being itself an instability kind of situation cannot be perfectly formulated using Euler-Bernoulli beam theory. Buckling can be formulated using Timoshenko beam theory which we hope can be an improvement over the previous theory.

Which platform will be used to implement the idea: MATLAB or Jupyter Notebook?

Our entire project would be coded in Jupyter Notebook. We will be using the libraries like SymPy and Matplotlib to accomplish the task. Very similar to last time, we will create a Github repository where all the codes will be uploaded and it can be used by both sides for improvement.

Tentative plan for implementing the idea:

The plan in which we will be carrying out the project are chronologically presented below.

1. The first task would be to briefly develop the Euler-Bernoulli beam theory as done in class. This will recapitulate the introduction to the theory and also help us to show how we can improve upon the results.

2. In the second step, we will work on Timoshenko beam theory and show how it is an improvement over Euler-Bernoulli beam theory.

3. Upon completing static analysis of beams, we will study on dynamic problems. We will discuss vibration of beams.

4. The concluding part of our study will be to present a theory for buckling of beams using Timoshenko beam theory and show it varies from Euler-Bernoulli beam theory.

Tentative distribution of work:

1. Team Member 1 i.e. *Neeruganti Ranjith Kumar* will be responsible to introduce the Timoshenko beam theory and show how it will improve upon the previous theory.

2. Team Member 3 i.e. *Sagar Das* will be working on the dynamic problem of a beam i.e. vibration of the beam.

3. Team Member 2 i.e. *Sayan Batabyal* will be working on beam buckling. Also the documentation will be prepared by him and the final code will be maintained by him.