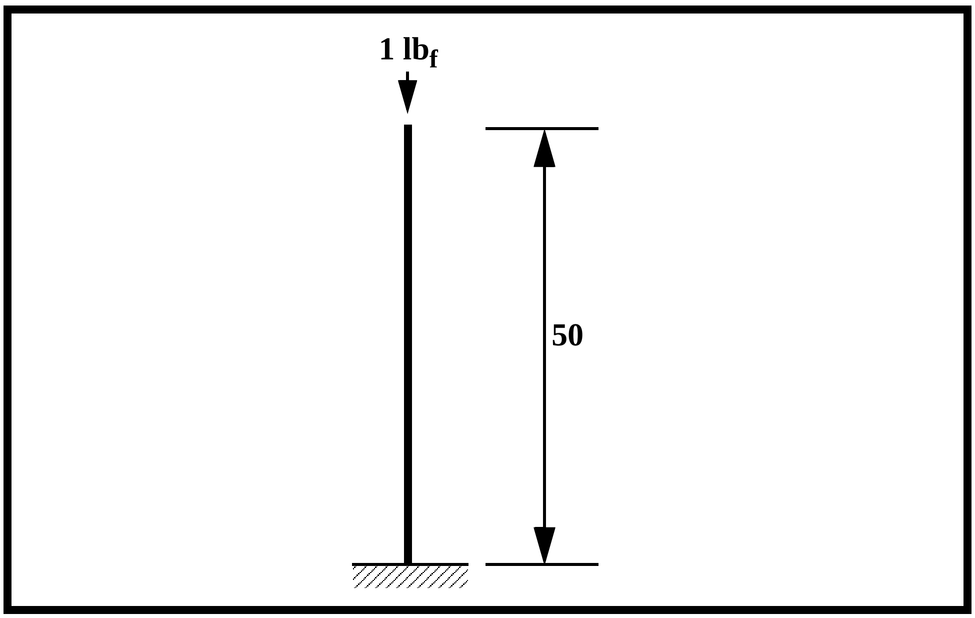
WORKSHOP 24

Buckling Analysis of a Euler Column



Objectives:

- Create the geometry for a cantilever beam.
- Load the beam axially.
- Set up and run a buckling analysis of the beam.

Model Description:

Below is a finite element representation of the axially loaded beam shown on the title page. The material and beam properties are listed below.

Figure 24.1 - Load Conditions

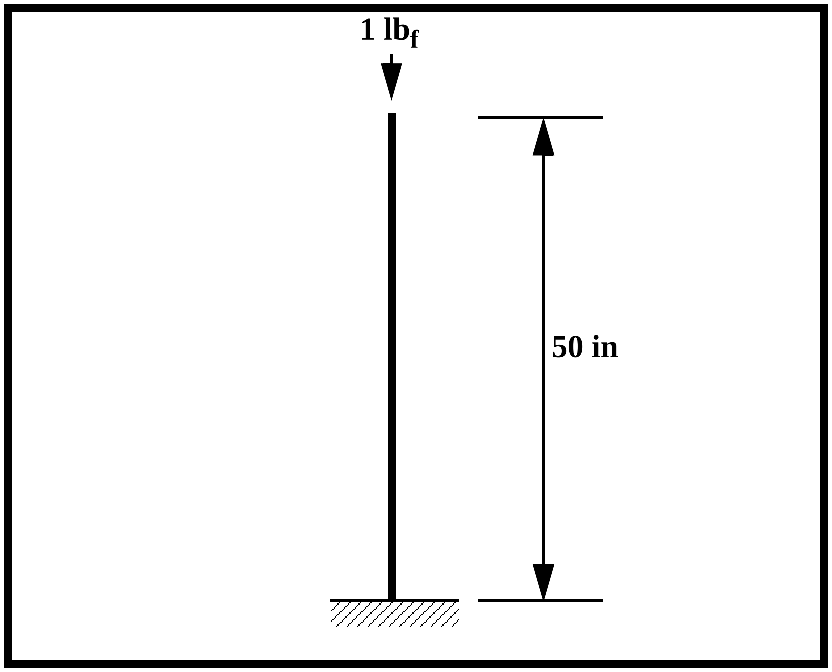


Table 24.1 - Material Properties

Youngs Modulus:	**10E+06 psi**
Poisson's Ratio:	**0.3**
Density:	**0.101 lb/in^3**
Plate Thickness:	**0.1 in**
Bar Cross-Sectional Area:	**1.525 in^2**
I_{aa}:	**4.0568 in^4**
I_{bb}:	**0.3343 in^4**
J:	**0.0251 in^4**

Exercise Procedure:

1. Start up MSC.Nastran or Windows V4.0 and begin to create a new model.

   Double click on the icon labeled **MSC.Nastran for Windows V4.0**.

   On the *Open Model File* form, select **New Model.**

Open Model File:	**New Model**

2. Create a material called **mat_1**.

   From the pulldown menu, select **Model/Material.**

   Model/Material...

Title:	**mat_1**
Youngs Modulus:	**10E6**
Poisson's Ratio:	**0.3**
Mass Density:	**0.101**

   OK

   Cancel

3. Create a property called **prop_1** to apply to the members of the beam.

   From the pulldown menu, select **Model/Property**.

   Model/Property...

Title:	**prop_1**
Material:	**1..mat_1**

   Elem/Property Type...

   Change the property type from plate elements (default) to bar elements.

Line Elements:	● **Bar**

   OK

A:	**1.525**

I1:	**4.0568**
I2:	**0.3343**
J:	**0.0251**

OK

Cancel

4. Create the Nastran geometry for the beam.

Mesh/Between...

Property:	**1..prop_1**
Mesh Size/ #Nodes/ Dir 1:	**11**

OK

	X:	*Y:*	*Z:*
Corner 1:	**0**	**0**	**0**

OK

	X:	*Y:*	*Z:*
Corner 2:	**0**	**50**	**0**

OK

Now, specify the orientation vector for the bar elements.

	X:	*Y:*	*Z:*
Base:	**0**	**0**	**0**
Tip:	**1**	**0**	**0**

OK

To fit the display onto the screen, use the **Autoscale** feature.

View/Autoscale <Ctrl+A>

Rotate to an isometric view.

View/Rotate... <F8>

Isometric

OK

Turn off the workplane.

Tools/Workplane... <F2>

☐ **Draw Workplane**

Done

View/Regenerate... <Ctrl+G>

5. Create the model constraints.

   Before creating the appropriate constraints, a constraint set needs to be created. Do so by performing the following:

Model/Constraint/Set...

Title: **constraint_1**

OK

Now define the relevant constraint for the model.

Model/Constraint/Nodal...

<Select **Node 1**>

OK

On the *DOF* box, select all 6 boxes.

☒ **TX** ☒ **TY** ☒ **TZ**

☒ **RX** ☒ **RY** ☒ **RZ**

OK

Cancel

6. Create the model loading.

Like the constraints, a load set must first be created before creating the appropriate model loading.

Model/Load/Set...

Title: **load_1**

OK

Now, define the 1 lb_f axial force.

Model/Load/Nodal...

<Select **Node 11**>

OK

Highlight **Force.**

Force

FY ☒ **-1**

OK

Cancel

7. Run the analysis

File/Export/Analysis Model...

Analysis Format/Type: **7..Buckling**

OK

Change the directory to **C:\Temp**.

File Name: **buckling**

Write

Additional Info: ☒ **Run Analysis**

OK

When asked if you wish to save the model, respond **Yes**.

Yes

File Name: **buckling**

Save

When the MSC.Nastran manager is through running, MSC.Nastran will be restored on your screen, and the *Message Review* form will appear. To read the messages, you could select **Show Details**. Since the analysis ran successfully, we will not bother with the details this time.

Continue

8. Look at the results to determine the first three eigenvalues.

Answer the following questions:

What are the first eigenvalue?
Eigenvalue 1 = _______

HINT: Use **View/Select**, **Deformed and Contour Data**, **Output Set** or **List/Output/Query...,Output to List/Output Set**.

$$P_{cr} = P_{applied} * \text{Eigenvalue 1}$$

$$= 1.0 \times 3299.412 = 3299.4 \text{ lb}$$

9. Theory.

Classic Euler:

$$P_{cr} = \frac{TL^2 EA}{\left(\frac{L'}{\rho}\right)^2}$$

$$L' = \frac{L}{\sqrt{C}} = \frac{50}{\sqrt{.25}} = 100$$

$$\rho = \sqrt{\frac{I}{A}} = \sqrt{\frac{0.3343}{1.525}} = 0.468$$

Thus,

$$P_{cr} = \frac{TL^2(10e6)(1.525)}{\left(\frac{100}{0.468}\right)^2}$$

= 3299.4 lb

This concludes the exercise.

File/Save

File/Exit

Eigenvalue 1	**3299.412**
Eigenvalue 2	**29696.69**
Eigenvalue 3	**33527.16**