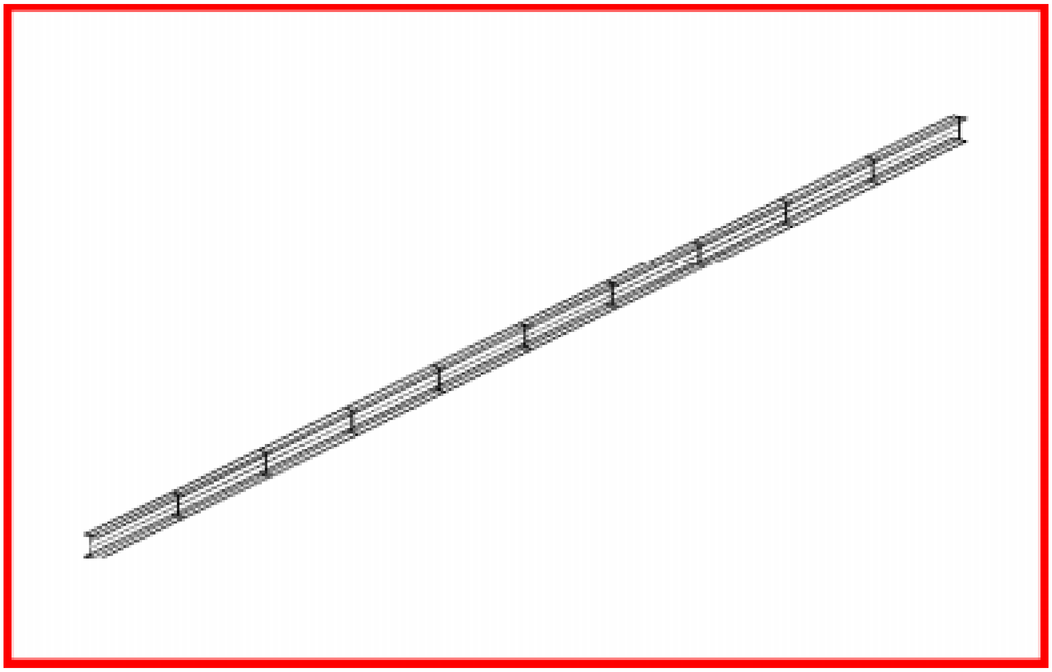
APPENDIX B

Normal Modes with Differential Stiffnes (SI Units)



Objectives

- Analyze a stiffened beam for normal modes.
- Produce NASTRAN input file that represent beam and load.
- Submit for analysis.
- Find normal modes (natural frequencies).

Model Description:

The goal of this example is to analyze a stiffened model. In this case, the beam from Appendix A. with a $1x10^7$ N force applied.

Figure A-b.1 below is a finite element representation of the beam. One end is pinned in 3 translations and one rotation. The other is pinned in 2 translations and one rotation with a $1x10^7$ N force applied.

Figure A-b.1

Grid Coordinates and Element Connectivities

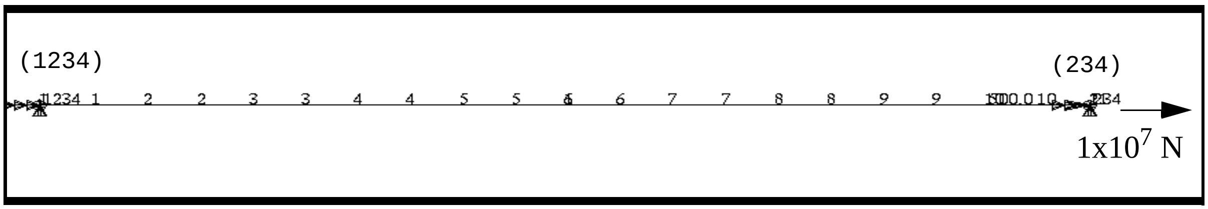


Table A-b.1

Length	**1.0×10^3 mm**
Elastic Modulus	**2.0684×10^5 MPa**
Density	**7.8334×10^{-9} N-sec^2/mm^4**
Poisson's Ratio	**0.32**
Area	**5×10^3 mm^2**
I_1	**1.0417×10^6 mm^4**
Force	**1×10^7 N**

Theoretical Solution

$$f_n = \frac{K_n}{2\pi}\left[\frac{EIg}{Wl^4}\left(1 + \frac{1}{Kr}\frac{Pl^2}{EI}\right)\right]^{1/2}$$

For Mode 1, Kr =9.87

$$fn = \frac{9.87}{2\pi}\left[\frac{(2.0684\times10^5)(1.0417\times10^6)}{(7.8334\times10^{-9})(5\times10^3)(1.0\times10^3)^4} x\left(1 + \frac{1}{9.87}\frac{(1\times10^7)(1\times10^3)^2}{(2.0684\times10^5)(1.0417\times10^6)}\right)\right]^{1/2}$$

$$f_n = 278.22Hz$$

For Static Load

$$\Delta = \frac{PL}{AE}$$

$$\Delta = \frac{(1\times10^7)(1\times10^3)}{(5\times10^3)(2.0684\times10^5)}$$

$$\Delta = 9.67mm$$

Exercise Procedure:

1. Start up MSC.Nastran for Windows 3.0 and begin to create a new model.

Double click on the icon labeled MSC.Nastran for Windows V3.0.

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

Open Model File: **New Model**

2. Import **prob1.DAT.**

File/Import/Analysis Model...

● **Nastran** **MSC/Nastran**

OK

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

File name: **appenA.DAT**

Open

To reset the display of the model do the following:

View/Redraw

View/Autoscale

OK

3. Create the load set.

Model/Load/Set...

Title: **pull**

OK

4. Define the options for a nonlinear analysis.

Model/Load/Nonlinear Analysis...

Solution Type: ● **Static**

Defaults...

Basic/Number of Increments: **5**

OK

5. Create the point loads.

Model/Load/Nodal...

Select **Node 11**.

OK

(highlight) **Force**

FX ☒ **1e7**

OK

Cancel

6. Submit the job for analysis.

File/Export/Analysis Model...

Analysis Type: **10..Nonlinear Static**

OK

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

File name: **appenB**

Write

☒ **Run Analysis**

Advanced...

Problem ID: **Normal Modes w/ Differential Stiffness**

OK

Under *Output Requests*, unselect everything except:

☒ **Displacement**

Also, change output to:

	2..Print and PostProcess
Type Input...	
Current Line:	**METHOD = 10**
OK	
OK	
Type Input...	
Current Line:	**PARAM, NMLOOP, 5**
More	
Current Line:	**EIGRL, 10, , , 3**
More	
Current Line:	**PARAM, COUPMASS, 1**
OK	
OK	

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

Yes	
File name:	**appenB**
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 smoothly, we will not bother with the details this time.

Continue

When asked if it is “OK to Begin Reading File C:\TEMP\appenB.xdb”, respond **Yes**.

Yes

7. Determine the results of the analysis.

To list the results, select the following:

List/Output/Query...

Under *the Output Set* pull down menu, what are the three modes?

Note: Check the second set of modes. The first set is the results from the previous exercise.

1st = __________Hz

2nd = __________Hz

3rd = __________Hz

Next, to list the displacement results, select the following:

Output Set:	**8..Case 1 Step 1.000000**
Category:	**1..Displacement**
Entity:	● **Node**
ID:	**11**

OK

What is the total displacement?

Displacement = __________

The answer is listed at the end of the exercise. Are the answers consistent with the theoretical solutions?

When finished, exit MSC.Nastran for Windows.

File/Exit

This concludes this exercise.

Mode 1	**278.22 Hz**
Mode 2	**687.43 Hz**
Mode 3	**1284.67 Hz**
Displacement	**9.67 mm**