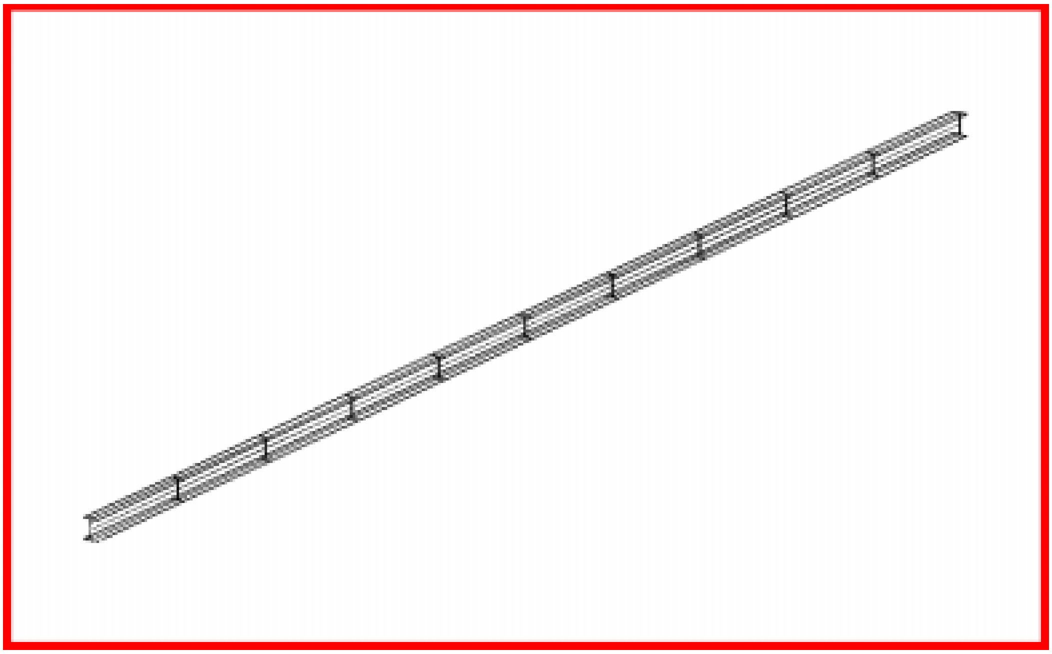
Appendix 1b

Normal Modes with Differential Stiffnes (SI Units)



Objectives

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

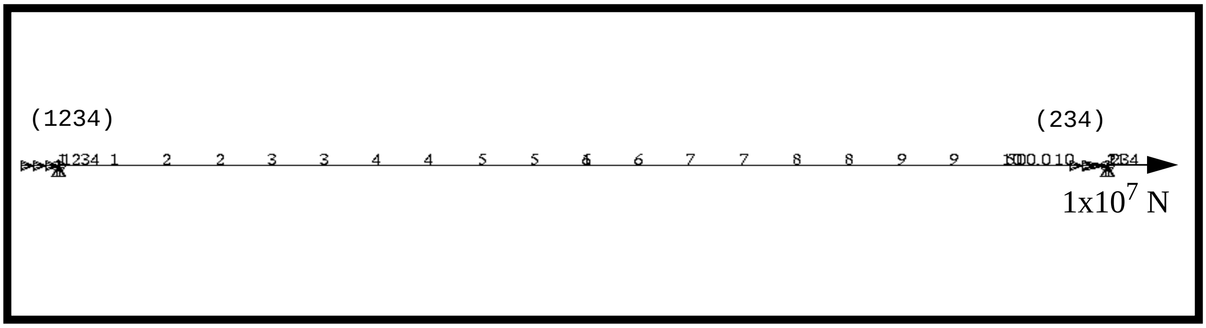
Model Description:

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

This is no longer a simple normal modes analysis. Instead we will be using a nonlinear static solution (SOL 106) with (PARAM, NMLOOP and METHOD and EIGRL).

Figure A-1b.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-1b.1-Grid Coordinates and Element Connectivities



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

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

$$f_n = 278.22Hz$$

For Static Load

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

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

$$\Delta = 9.67mm$$

Table A-1b.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**

Suggested Exercise Steps

- Open database created in Problem 1a in order to modify it, adding a load and reanalyze.
- Create $1x10^7$ N force applied at one end (FORCE).
- Make sure analysis is set to nonlinear static (SOL 106).
- Prepare nonlinear analysis to also analyze for normal mode (PARAM NMLOOP, EIGRL, PARAM LGDISP, NLPARM).
- Review the results, specifically the eigenvectors.

ID SEMINAR,PROB1

CEND

BEGIN BULK

1	2	3	4	5	6	7	8	9	10

1	2	3	4	5	6	7	8	9	10

ENDDATA

Exercise Procedure:

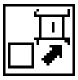
1. Users who are not utilizing MSC/PATRAN for generating an input file should go to Step 6, otherwise, proceed to step 2.

2. Open database created in Appendix Problem 1a named **probap1.db**.

   File/Open Database

Existing Database Name	**probap1**
OK	

3. Activate the entity labels by selecting the Show Labels icon on the tool-bar.

    **Show Labels**

4. Create force.

   ◆ **Loads/BCs**

Action:	**Create**
Object:	**Force**
Type:	**Nodal**
New Set Name	**pull**
Input Data...	
Force <F1 F2 F3>	**<1e7, , >**
OK	
Select Application Region...	
Select Geometry Entities	**Point 2**
Add	
OK	
Apply	

5. Now, you will generate the input file for analysis.

◆ **Analysis**

Action:	**Analyze**
Object:	**Entire Model**
Method	**Analysis Deck**
Job Name	**probap1b**
Solution Type...	
Solution Type:	◆ **NONLINEAR STATIC**
Solution Parameters ...	
<deselect Automatic Constraints>	❐ **Automatic Contraints**
Mass Calculation:	**Coupled**
Data Deck Echo:	**None**
OK	
OK	
Direct Text Input...	
◆ **Case Control Section**	**METHOD = 10**
◆ **Bulk Data Section**	**PARAM, NMLOOP, 5** **EIGRL, 10, , , 3**
OK	
Subcase Create...	
Available Subcases	**Default**
Subcase Parameters...	
Number of Load Increments =	**5**
OK	
Apply	
Cancel	
Apply	

An MSC/NASTRAN input file called **probap1b.bdf** will be generated. The process of translating your model into an input file is called Forward Translation. The Forward Translation is complete when the Heartbeat turns green. MSC/PATRAN Users should proceed to step 7.

Generating an input file for MSC/NASTRAN Users:

MSC/NASTRAN users can generate an input file using the data from Table A-1b.1. The result should be similar to the output below.

6. MSC/NASTRAN Input File: **probap1b.dat**

```
SOL 106
TIME 600
CEND
$
TITLT = NORMAL MODES WITH DIFFERENTIAL STIFFNESS
METHOD = 10
SUBCASE 1
   NLPARM = 1
   SPC = 1
   LOAD = 1
   DISPLACEMENT(SORT1,REAL)=ALL
$
BEGIN BULK
PARAM   COUPMASS 1
PARAM    LGDISP  1
NLPARM   1       5               AUTO    5       25      PW      NO      +       A
+       A        .001    1.-7
PARAM,NMLOOP,5
$
EIGRL,10,,,3
PBAR     1       1       5000.   1.04+6
CBAR     1       1       1       2       0.      1.      0.
CBAR     2       1       2       3       0.      1.      0.
CBAR     3       1       3       4       0.      1.      0.
CBAR     4       1       4       5       0.      1.      0.
CBAR     5       1       5       6       0.      1.      0.
CBAR     6       1       6       7       0.      1.      0.
CBAR     7       1       7       8       0.      1.      0.
CBAR     8       1       8       9       0.      1.      0.
CBAR     9       1       9       10      0.      1.      0.
CBAR     10      1       10      11      0.      1.      0.
$
MAT1     1       206840.         .32     7.83-9
GRID     1               0.      0.      0.              345
GRID     2               100.000 0.      0.              345
```

```
GRID    3               200.000 0.      0.              345
GRID    4               300.000 0.      0.              345
GRID    5               400.000 0.      0.              345
GRID    6               500.    0.      0.              345
GRID    7               600.000 0.      0.              345
GRID    8               700.000 0.      0.              345
GRID    9               800.000 0.      0.              345
GRID    10              900.000 0.      0.              345
GRID    11              1000.   0.      0.              345
SPC1    1       1234    1
SPC1    1       234     11
FORCE   1       11      0       1.+7    1.      0.      0.
ENDDATA
```

Submit the input file for analysis

7. Submit the input file to MSC/NASTRAN for analysis.

   7a. To submit the MSC/PATRAN **.bdf** file for analysis, find an available UNIX shell window. At the command prompt enter: **nastran probap1b.bdf scr=yes**. Monitor the run using the UNIX **ps** command.

   7b. To submit the MSC/NASTRAN **.dat** file for analysis, find an available UNIX shell window. At the command prompt enter: **nastran probap1b scr=yes**. Monitor the run using the UNIX **ps** command.

8. When the run is completed, edit the **probap1b.f06** file and search for the word **FATAL**. If no matches exist, search for the word **WARNING**. Determine whether existing WARNING messages indicate modeling errors.

9. While still editing **probap1b.f06**, search for the word:

E I G E N (spaces are necessary)

What are the first three natural frequencies?

1st = ___________Hz

2nd = ___________Hz

3rd = ___________Hz

Comparison of Results

10. Compare the results obtained in the **.f06** file with the results on the following page:

R E A L   E I G E N V A L U E S

MODE NO.	EXTRACTION ORDER	EIGENVALUE	RADIANS	CYCLES	GENERALIZED MASS	GENERALIZED STIFFNESS
1	1	3.056203E+06	1.748200E+03	2.782346E+02	1.000000E+00	3.056203E+06
2	2	1.864932E+07	4.318486E+03	6.873084E+02	1.000000E+00	1.864932E+07
3	3	6.517956E+07	8.073386E+03	1.284919E+03	1.000000E+00	6.517956E+07

11. MSC/NASTRAN Users have finished this exercise. MSC/PATRAN Users should proceed to the next step.

12. Proceed with the Reverse Translation process, that is importing the **probap1b.op2** results file into MSC/PATRAN. To do this, return to the Analysis form and proceed as follows:

◆ **Analysis**

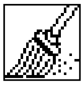
Action:	**Read Output2**
Object:	**Result Entities**
Method	**Translate**
Select Results File...	
Select Results File	**probap1b.op2**
OK	
Apply	

When the translation is complete bring up the ***Results*** form.

◆ **Results**

Form Type:	**Basic**
Select Results Cases	**1.1-Default, Mode 1:Freq=278.23**
Select Deformation Result	**1.1 Eigenvectors, Translational**
Apply	

To reset the graphics, click on this icon:



Reset Graphics

You can go back and select any *Results Case, Fringe Results or Deformation Results* you are interested in.

Quit MSC/PATRAN when you are finished with this exercise.