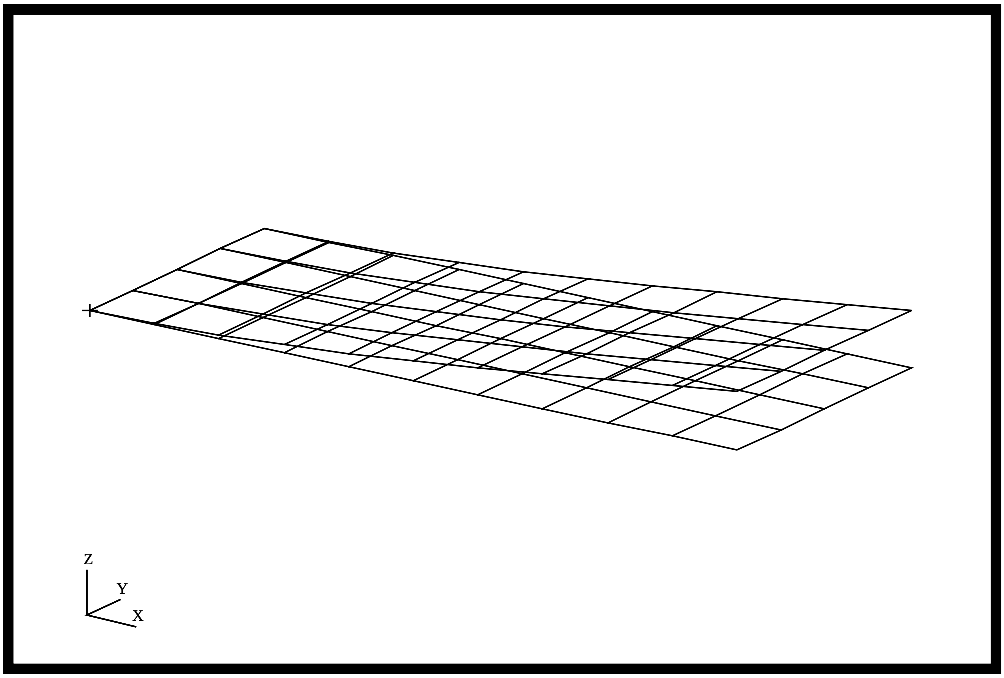
WORKSHOP PROBLEM 7

Direct Transient Response with Base Excitation



Objectives

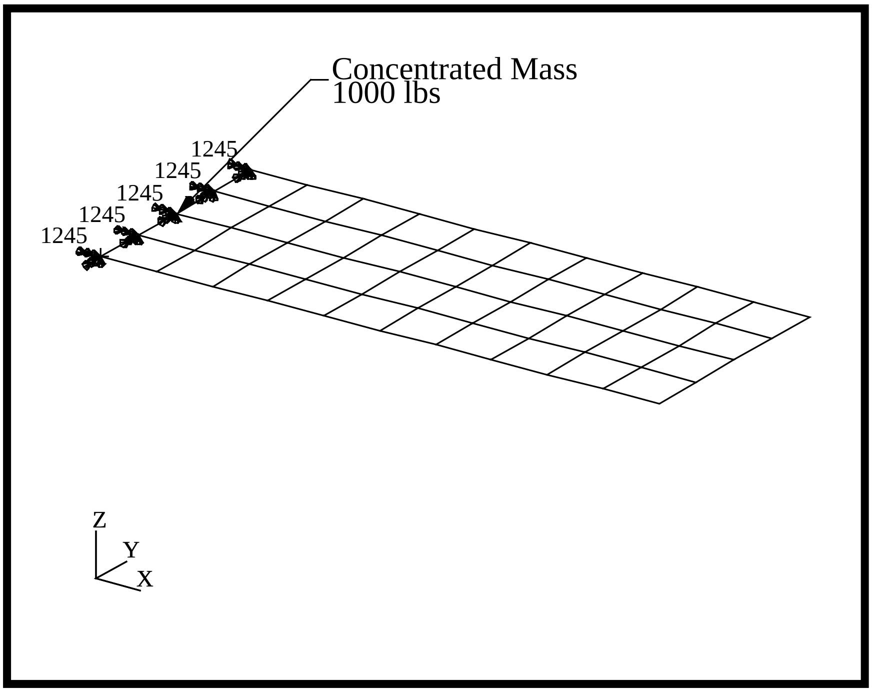
- Define a time-varying unit acceleration.
- Use the large mass method.
- Produce a MSC/NASTRAN input file from a dynamic math model, created in Workshop 1.
- Submit the file for analysis in MSC/NASTRAN.
- Compute nodal displacements for desired time domain.

Model Description:

Using the direct method, determine the transient response to a unit acceleration sine pulse of 250 Hz applied at the base in the z direction. A large mass of 1000 lb is applied to the base. Use a structural damping coefficient of g = 0.06 and convert this damping to equivalent viscous damping at 250 Hz.

Below is a finite element representation of the flat plate. It also contains the loads and boundary constraints.

Figure 7.1-Loads and Boundary Conditions



Suggested Exercise Steps

- Reference previously created dynamic math model, **plate.bdf**, by using the INCLUDE statement.
- Modify base constraints and release displacements in the Z-direction.
- Define the time-varying unit acceleration (TLOAD2 and DAREA).
- Create the large mass at the base (CMASS2 and RBE2).
- Specify the structural damping and convert this damping to equivalent viscous damping.
  - PARAM, G, 0.06
  - PARAM, W3, 1571
- Specify integration time steps (TSTEP).
- Prepare the model for a direct transient analysis (SOL 109).
- Request response in terms of nodal displacement, velocity and acceleration at Grids 11, 33 and 55.
- Generate an input file and submit it to the MSC/NASTRAN solver for normal modes analysis.
- Review the results, specifically the nodal displacements, velocities, and acceleration.

```
ID SEMINAR,PROB7
```

```
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 11, otherwise, proceed to step 2.

2. Create a new database and named **prob7.db**

File/New Database

New Database Name **prob7**

OK

In the ***New Model Preference*** form set the following:

Tolerance ◆ **Default**

Analysis code: **MSC/NASTRAN**

OK

3. Create the model by importing an existing MSC/NASTRAN input file, **(plate.bdf)**.

◆ **Analysis**

Action: **Read Input File**

Object: **Model Data**

Method: **Translate**

Select Input File

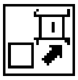
Select Input File **plate.bdf**

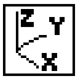
OK

Apply

OK

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


Show Labels



Iso 3 View

5. Create a time dependent load case for the transient response..

◆ **Load Cases**

Action:	**Create**
Load Case Name:	**transient_response**
Load Case Type:	**Time Dependent**
Assign/Prioritize loads/BCs *(Highlight the following:)*	**Displ_spc1.1**

OK

Apply

6. Place the large mass at the base. To do this, it will be necessary to create a point element at Node 23.

◆ **Finite Elements**

Action:	**Create**
Object:	**Element**
Method:	**Edit**
Shape:	**Point**
Node 1 =	**Node 23**

Apply

7. Next, define the scalar mass.

◆ **Properties**

Action:	**Create**
Dimension:	**0 D**
Type:	**Mass**
Property Set Name:	**scalar_mass**
Option(s)	**Grounded**

Input Properties...

Mass **1000**

DOF at Node 1 **UZ**

*(Select **String (UZ)** from the button on the right.)*

OK

Select Members: **Elm 41**

*(Change the select menu from **point** to **point element**, then select the point **element** which was previously created.)*

Point element

Add

Apply

8. Create the RBE Mass, which will be connected to the remaining base points.

◆ **Finite Elements**

Action: **Create**

Object: **MPC**

Type: **RBE2**

Define Terms ...

*(Turn off **Auto Execute**.)* ❒ **Auto Execute**

◆ **Create Independent**

Node List: **Node 23**

Apply

◆ **Create Dependent**

Node List: **Node 1, 12, 34, 45**

DOFs	**UZ**

Apply

Cancel

Apply

9. Create the time-dependent field for the unit acceleration.

◆ **Fields**

Action:	**Create**
Object:	**Non Spatial**
Method:	**Tabular Input**
Field Name:	**time_dependent_acceleration**

Options ...

Maximum Number of t:	**21**

OK

Input Data ...

Map Function to Table...

PCL Expression f'(t):	**sind(90000.*'t)**
Start time:	**0.0**
End time:	**0.004**
Number of Points:	**20**

Apply

Cancel

Go back to the ***Time/Frequency Scalar Table Data*** window. Add the following to row 21:

	Time(t)	**Value**
21	**0.04**	**0.0**

OK

Apply

9a. Now define the unit acceleration.

◆ **Loads/BCs**

Action:	**Create**
Object:	**Force**
New Set Name:	**unit_acceleration**

Input Data...

Spatial Dependence:	**<0, 0, 2.588>**
Time Dependence:	**f:time_dependent_acceleration**

OK

Select Application Region ...

◆ **FEM**

Node 23

Add

OK

Apply

9b. Finally, modify the existing constrants by releasing DOF3.

◆ **Load/BCs**

Action:	**Modify**
Object:	**Displacement**
Type:	**Nodal**
Select Set to Modify	**spc1.1**

Modify Data...

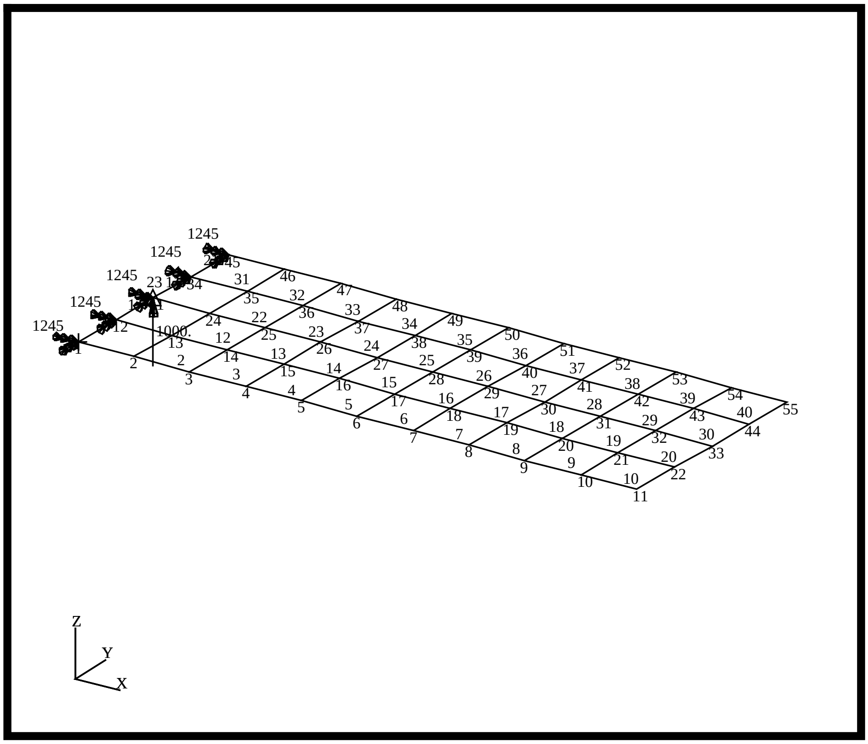
Translations < T1 T2 T3 >	**< 0, 0, >**
Rotations < R1 R2 R3 >	**< 0, 0, >**

OK

Apply

9c. The result should look like Figure 7.2

Figure 7.2



10. Generate the input file.

◆ **Analysis**

Action:	**Analyze**
Object:	**Entire Model**
Method:	**Analysis Deck**
Job Name:	**prob7**
Solution Type...	
Solution Type:	◆ **TRANSIENT RESPONSE**
Solution Parameters ...	
Formulation	**Direct**
Mass Calculation	**Coupled**
Wt.-Mass Conversion	**.00259**

Struct. Dampening Coeff. = **.06**

W3, Damping Factor = **1571**

OK

OK

Subcase Create ...

Available Subcases **transient_response**

Subcase Parameters...

Ending Time = **.04**

Number of Time Steps = **200**

OK

Output Request

under ***Select Result Type***, highlight: **Velocities** **Accelerations**

under ***Output Requests***, highlight:

SPCFORCES(SORT1,Real)=ALL FEM

Delete

OK

Apply

Cancel

Subcase Select ...

Subcases Selected: *(Click to deselect.)* **Default**

Subcases for Solution Sequence: 109 *(Click to select.)* **transient_response**

OK

Apply

An MSC/NASTRAN input file called **prob7.bdf** will be generated. This process of translating your model into an input file is called the Forward Translation. The Forward Translation is complete when the Heartbeat turns green. MSC/PATRAN Users should proceed to step 12.

Generating an input file for MSC/NASTRAN Users:

MSC/NASTRAN users can generate an input file using the data previously stated. The result should be similar to the output below.

11. MSC/NASTRAN Input File: **prob7.dat**

```
ID SEMINAR, PROB7
SOL 109
TIME 30
CEND
TITLE = TRANSIENT RESPONSE WITH BASE EXCITATION
SUBTITLE = USING DIRECT TRANSIENT METHOD, NO REDUCTION
ECHO = UNSORTED
SPC = 200
SET 111 = 23, 33
DISPLACEMENT (SORT2) = 111
VELOCITY (SORT2) = 111
ACCELERATION (SORT2) = 111
SUBCASE 1
DLOAD = 500
TSTEP = 100
$
OUTPUT (XYPLOT)
XGRID=YES
YGRID=YES
XTITLE= TIME (SEC)
YTITLE= BASE ACCELERATION
XYPLOT ACCELERATION RESPONSE / 23 (T3)
YTITLE= BASE DISPLACEMENT
XYPLOT DISP RESPONSE / 23 (T3)
YTITLE= TIP CENTER DISPLACEMENT RESPONSE
XYPLOT DISP RESPONSE / 33 (T3)
$
BEGIN BULK
$
$ PLATE MODEL DESCRIBED IN NORMAL MODES EXAMPLE
$
INCLUDE ’plate.bdf’
PARAM, COUPMASS, 1
PARAM, WTMASS, 0.00259
$
$ SPECIFY STRUCTURAL DAMPING
$
PARAM, G, 0.06
```

```
PARAM, W3, 1571.
$
$ APPLY EDGE CONSTRAINTS
$
SPC1, 200, 12456, 1, 12, 23, 34, 45
$
$ PLACE BIG FOUNDATION MASS (BFM) AT BASE
$
CMASS2, 100, 1000., 23, 3
$
$ RBE MASS TO REMAINING BASE POINTS
$
RBE2, 101, 23, 3, 1, 12, 34, 45
$
$ APPLY LOADING TO FOUNDATION MASS
$
TLOAD2, 500, 600, , 0, 0.0, 0.004, 250., -90.
$
DAREA, 600, 23, 3, 2.588
$
$ SPECIFY INTEGRATION TIME STEPS
$
TSTEP, 100, 200, 2.0E-4, 1
$
ENDDATA
```

Submitting the input file for analysis:

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

    12a. To submit the MSC/PATRAN **.bdf** file for analysis, find an available UNIX shell window. At the command prompt enter: **nastran prob7.bdf scr=yes**. Monitor the run using the UNIX **ps** command.

    12b. To submit the MSC/NASTRAN **.dat** file for analysis, find an available UNIX shell window. At the command prompt enter: **nastran prob7 scr=yes**. Monitor the run using the UNIX **ps** command.

13. When the run is completed, use **plotps** utility to create a postscript file, **prob7.ps**, from the binary plot file **prob7.plt**. The displacement, velocity, and acceleration response plots for Grids 11, 33 and 55 are shown in figures 7.3 to 7.8.

14. When the run is completed, edit the **prob7.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.

15. While still editing **prob7.f06**, search for the word:

    D I S P L (spaces are necessary)

    Displacement at Grid 23

    Time T3

    .0 = __________

    .02 = __________

    .04 = __________

    Displacement at Grid 33

    Time T3

    .0 = __________

    .02 = __________

    .04 = __________

    V E L O C (spaces are necessary)

    Velocity at Grid 23

    Time T3

    .0 = __________

    .02 = __________

    .04 = __________

    Velocity at Grid 33

    Time T3

    .0 = __________

    .02 = __________

    .04 = __________

A C C E L (spaces are necessary)

Acceleration at Grid 23

Time T3

.0 = __________

.02 = __________

.04 = __________

Acceleration at Grid 33

Time T3

.0 = __________

.02 = __________

.04 = __________

Comparison of Results

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

POINT-ID = 23

D I S P L A C E M E N T   V E C T O R

TIME	TYPE	T1	T2	T3	R1	R2	
.0	G	.0	.0	.0	.0	.0	.0
1.999998E-02	G	.0	.0	2.511800E-06	.0	.0	.0
3.999996E-02	G	.0	.0	2.523053E-06	.0	.0	.0

POINT-ID = 33

D I S P L A C E M E N T   V E C T O R

TIME	TYPE	T1	T2	T3	R1	R2	
.0	G	.0	.0	.0	.0	.0	.0
1.999998E-02	G	.0	.0	4.559710E-06	7.870200E-20	-5.699044E-07	.0
3.999996E-02	G	.0	.0	7.363514E-07	-8.475326E-19	4.972196E-07	.0

POINT-ID = 23

V E L O C I T Y   V E C T O R

TIME	TYPE	T1	T2	T3	R1	R2	
.0	G	.0	.0	1.029922E-05	.0	.0	.0
1.999998E-02	G	.0	.0	4.035838E-07	.0	.0	.0
3.999996E-02	G	.0	.0	4.712748E-07	.0	.0	.0

POINT-ID = 33

V E L O C I T Y   V E C T O R

TIME	TYPE	T1	T2	T3	R1	R2	
.0	G	.0	.0	-4.379307E-07	1.492096E-20	-1.481305E-07	.0
1.999998E-02	G	.0	.0	1.220225E-03	-2.594927E-15	-3.394969E-04	.0
3.999996E-02	G	.0	.0	6.578242E-04	3.797481E-15	-1.829342E-04	.0

POINT-ID = 23

A C C E L E R A T I O N   V E C T O R

TIME	TYPE	T1	T2	T3	R1	R2	
.0	G	.0	.0	1.029922E-01	.0	.0	.0
1.999998E-02	G	.0	.0	1.615566E-04	.0	.0	.0
3.999996E-02	G	.0	.0	-1.353748E-04	.0	.0	.0

POINT-ID = 33

A C C E L E R A T I O N   V E C T O R

TIME	TYPE	T1	T2	T3	R1	R2	
.0	G	.0	.0	-4.379307E-03	1.492096E-16	-1.481305E-03	.0
1.999998E-02	G	.0	.0	-1.464230E+00	-1.464654E-11	4.074106E-01	.0
3.999996E-02	G	.0	.0	1.231636E+00	1.381082E-11	-3.427888E-01	.0

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

18. Proceed with the Reverse Translation process, that is importing the **prob7.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	**prob7.op2**
OK	
Apply	

When the translation is complete bring up the form.

◆ **Results**

Form Type:	**Advanced**
Select Result Cases *(Highlight all cases.)*	
Get Results	
Select Result	**1.1 Displacements, Translational**
Plot Type	**XY Plot**
Plot Type Options ...	
Global Var...	
Global Variables:	**1. Time**
Apply	
Result (Y)...	
Results	**1.1 Displacements, Translational**
Vector Component	**❐X ❐Y ■Z**
OK	

Node IDs: **Node 23**

Apply...

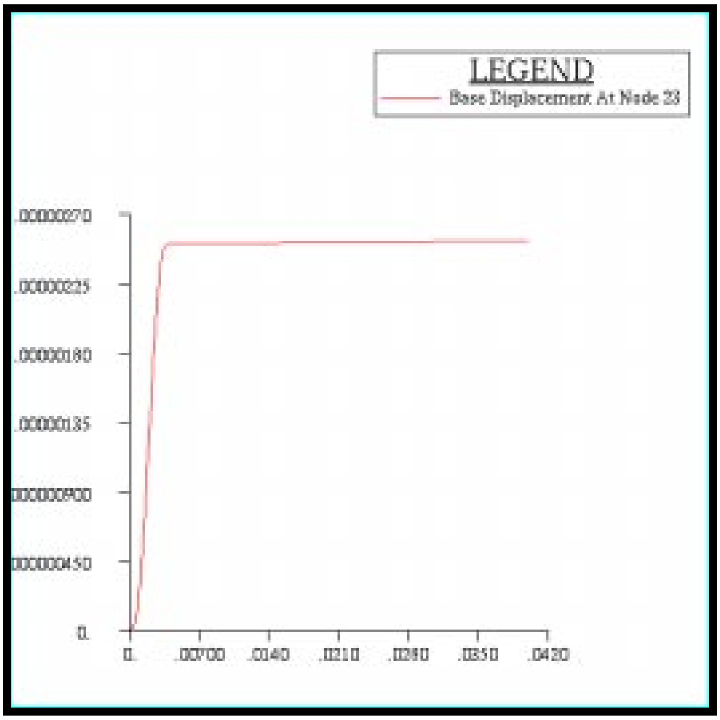
New Title or Title Filter: **Base Displacement At Node 23**

Rename

Apply

The output should look similar to Figure 7.3

Figure 7.3-Base Displacement at Node 23



19. Repeat the procedure to find the nodal displacement for Node 33.

◆ **Results**

Form Type: **Advanced**

Select Result Cases
(Highlight all cases.)

Get Results

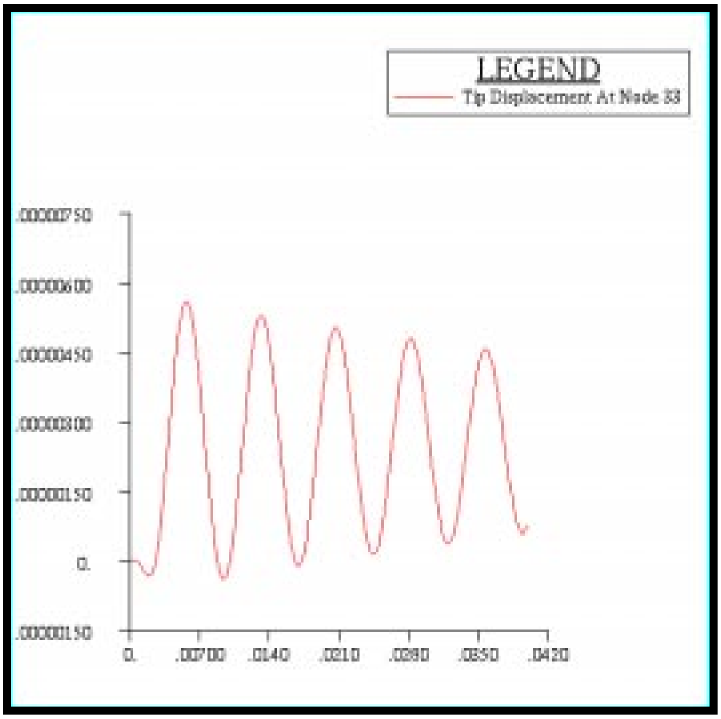
Select Result **1.1 Displacements, Translational**

Plot Type **XY Plot**

Plot Type Options ...	
Global Var...	
Global Variables:	**1. Time**
Apply	
Result (Y)...	
Results	**1.1 Displacements, Translational**
Vector Component	❐X ❐Y ■Z
OK	
Node IDs:	**Node 33**
Apply...	
Result XY Window Name:	**XYWindow2**
New Title or Title Filter:	**Tip Displacement at Node 33**
Rename	
Apply	

The output should look similar to Figure 7.4

Figure 7.4-Tip Displacement at Node 33



20. Repeat the procedure to find the nodal velocity for Node 23.

◆ **Results**

Form Type:	**Advanced**
Select Result Cases *(Highlight all cases.)*	
Get Results	
Select Result	**1.1 Velocity, Translational**
Plot Type	**XY Plot**
Plot Type Options ...	
Global Var...	
Global Variables:	**1. Time**
Apply	
Result (Y)...	
Results	**1.1 Velocity, Translational**
Vector Component	❐**X** ❐**Y** ■**Z**

OK

Node IDs: **Node 23**

Apply...

Result XY Window Name: **XYWindow3**

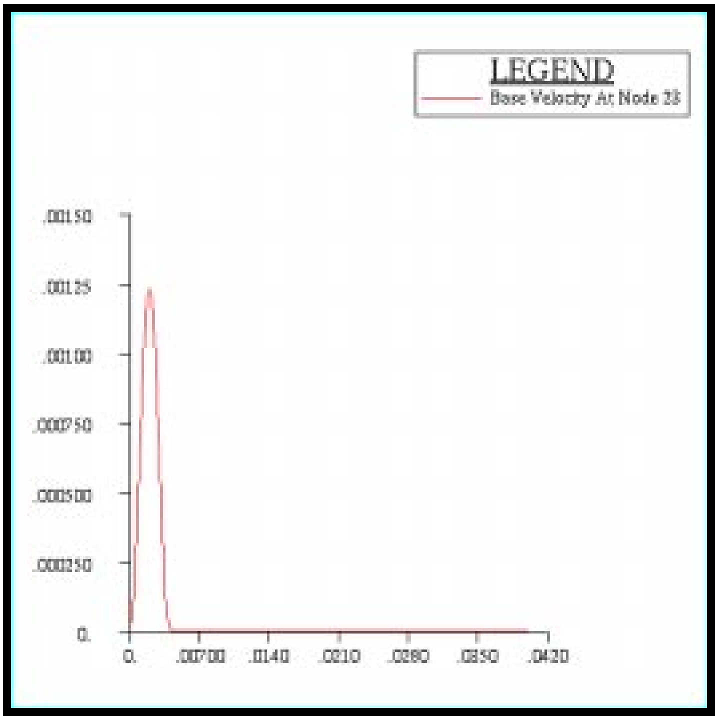
New Title or Title Filter: **Base Velocity at Node 23**

Rename

Apply

The output should look similar to Figure 7.5

Figure 7.5-Base Velocity at Node 23



21. Repeat the procedure to find the velocity at Node 33.

◆ **Results**

Form Type: **Advanced**

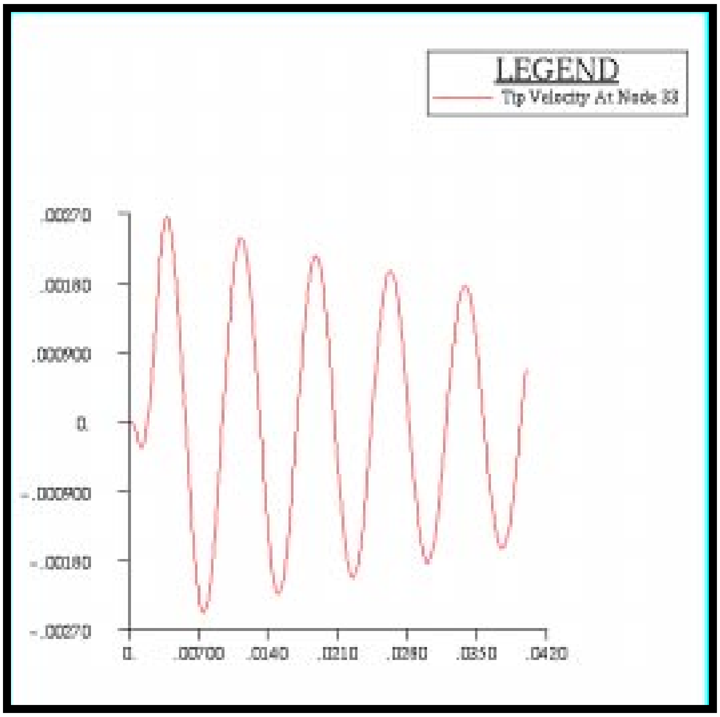
Select Result Cases
(Highlight all cases.)

Get Results

Select Result	**1.1 Velocity, Translational**
Plot Type	**XY Plot**
Plot Type Options ...	
Global Var...	
Global Variables:	**1. Time**
Apply	
Result (Y)...	
Results	**1.1 Velocity, Translational**
Vector Component	**❐X ❐Y ■Z**
OK	
Node IDs:	**Node 33**
Apply...	
Result XY Window Name:	**XYWindow4**
New Title or Title Filter:	**Tip Velocity at Node 33**
Rename	
Apply	

The output should look similar to Figure 7.6

Figure 7.6-Tip Velocity at Node 33



22. Repeat the procedure to find the nodal acceleration for Node 23.

◆ **Results**

Form Type:	**Advanced**
Select Result Cases (*Highlight all cases.*)	
Get Results	
Select Result	**1.1 Acceleration, Translational**
Plot Type	**XY Plot**
Plot Type Options ...	
Global Var...	
Global Variables:	**1. Time**
Apply...	
Result (Y)...	
Results	**1.1 Acceleration, Translational**
Vector Component	❐**X** ❐**Y** ■**Z**

OK

Node IDs: **Node 23**

Apply...

Result XY Window Name: **XYWindow5**

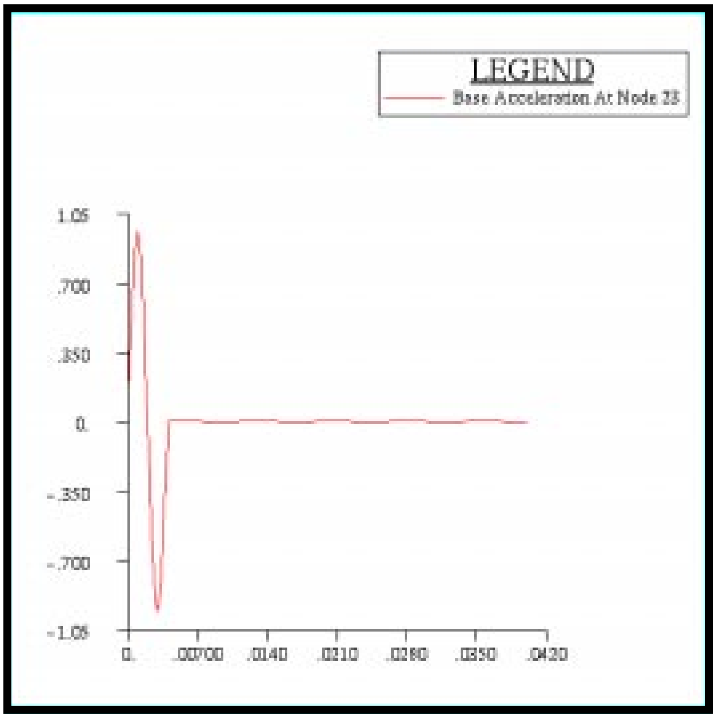
New Title or Title Filter: **Base Acceleration at Node 23**

Rename

Apply

The output should be similar to Figure 7.7

Figure 7.7-Base Acceleration at Node 23



23. Repeat the procedure to find the acceleration at Node 33.

◆ **Results**

Form Type: **Advanced**

Select Result Cases
(Highlight all cases.)

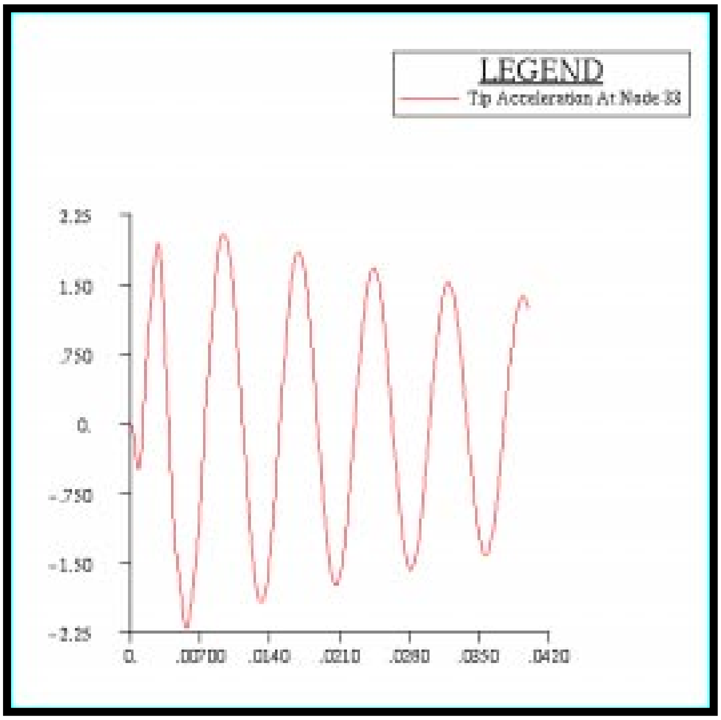
Get Results

Select Result **1.1 Acceleration, Translational**

Plot Type	**XY plot**
Plot Type Option ...	
Global Var...	
Global Variables:	**1. Time**
Apply	
Result (Y)...	
Results:	**1.1 Acceleration, Translational**
Vector Component	**❐X ❐Y ■Z**
OK	
Node IDs:	**Node 33**
Apply...	
Result XY Window Name:	**XYWindow6**
New Title or Title Filter:	**Tip Acceleration at Node 33**
Rename	
Apply	

The output should look similar to Figure 7.8

Figure 7.8-Tip Acceleration at Node 33



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