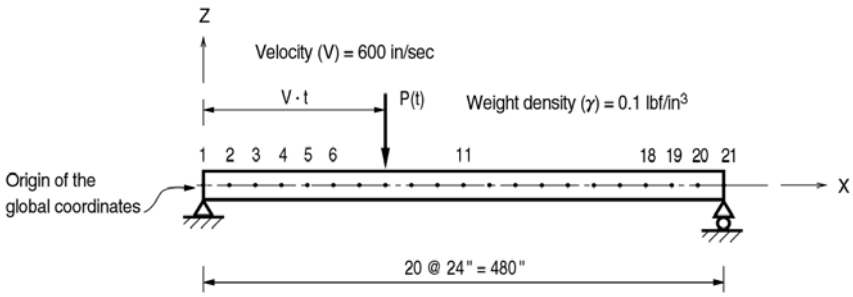
# TH-3

## Title

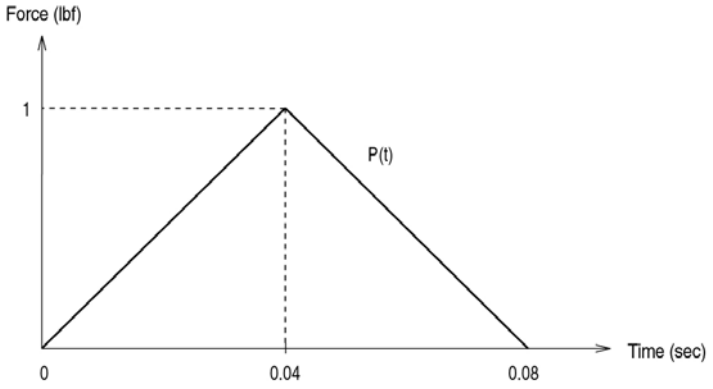
Simply supported beam subjected to a traveling dynamic load

## Description

A simply supported beam is subjected to a dynamic force traveling along the span at a constant velocity.
Perform a time history analysis and determine the displacements, velocities and accelerations at the mid-span of the beam with a time history.




(a) Simply supported beam subjected to a travelling dynamic load




(b) Force P(t)

*Structural geometry and analysis model*

# Model

***Analysis Type***

2-D time history analysis (X-Z plane)

***Unit System***

in, lbf

***Dimension***

| | | |
|---|---|---|
| Length | L | = 480 in |
| Analysis time | t | = 0.8 sec |
| Time step | $\Delta t$ | = 0.001 sec |
| Gravitational acceleration | g | = 1.0 in/sec$^2$ |

***Element***

Beam Element

***Material***

| | | |
|---|---|---|
| Modulus of elasticity | E | = $2.4 \times 10^{11}$ psi |
| Weight density | $\gamma$ | = 0.1 lbf/in$^3$ |

***Section Property***

| | | |
|---|---|---|
| Area | A | = 1.0 in$^2$ |
| Moment of inertia | $I_{yy}$ | = 0.083333 in$^4$ |

***Boundary Condition***

Node 1 ; Constrain Dx and Dz. (Hinge support)

Node 21 ; Constrain Dz. (Roller support)

***Analysis Case***

A concentrated load which varies with time travels at a 600 in/sec velocity and acts in the –Z direction.

That is, it takes 0.04 sec for a load to move between two adjacent nodes.

| Time (sec) | Unit load (lbf) |
|---|---|
| 0.00 | 0 |
| 0.04 | 1.0 |
| 0.08 | 0 |

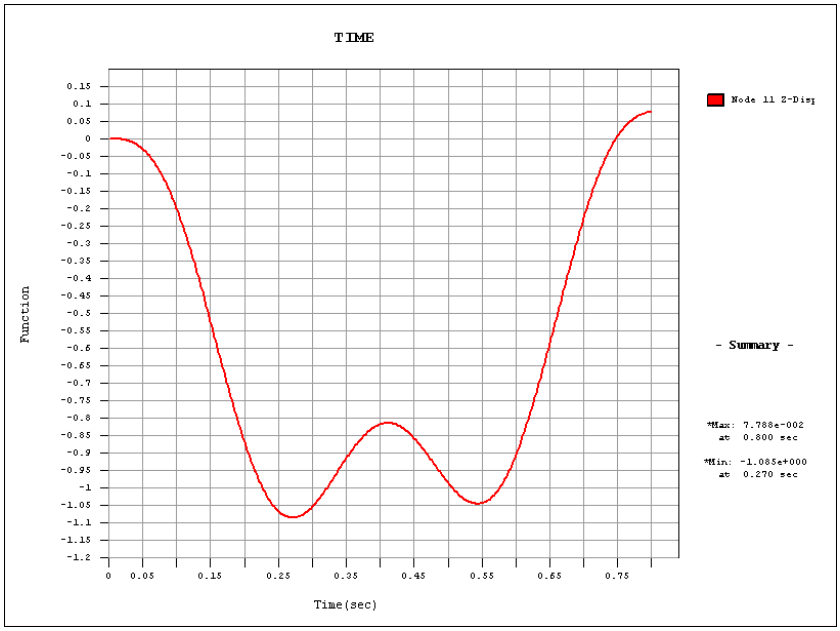
Force applied to a node = Multiplier for the time history data × Unit load

Now, the multiplier for the time history data is defined as the load under which the maximum deflection becomes a unit displacement when a concentrated load is applied to the mid-span of the beam.

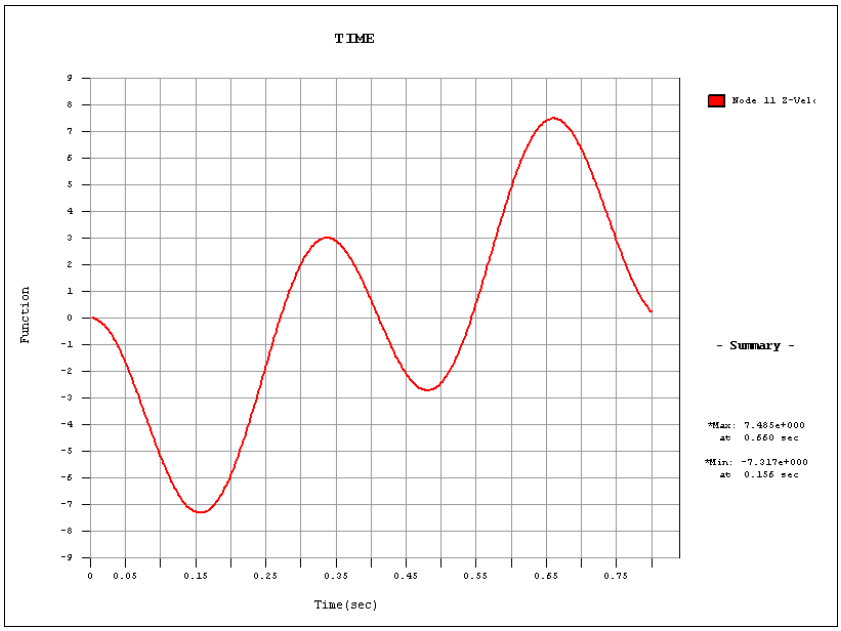
Thus,the maximum deflection, $\delta_{max}=PL^3/(48EI)=1$ occurs with the load 8680.6 lbf.

# Results

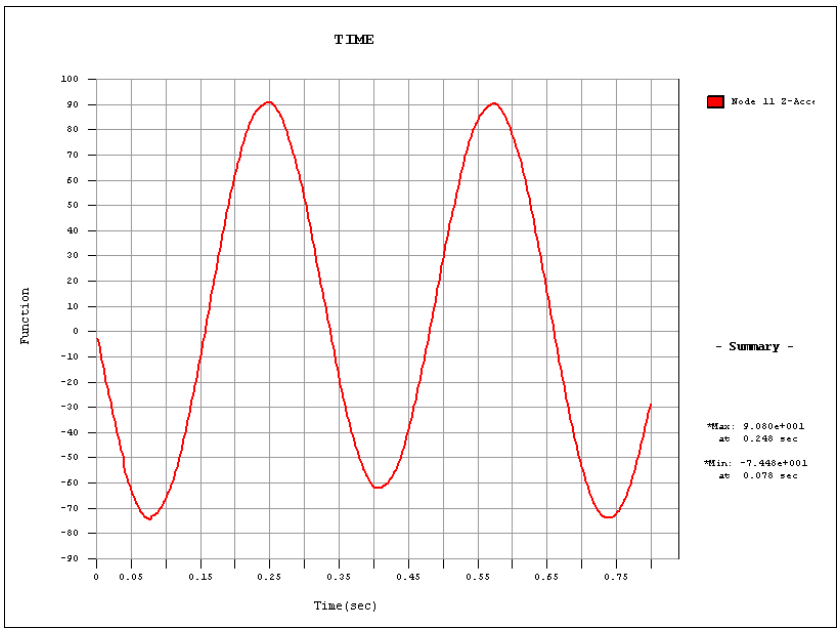
***Time History Analysis Results***




*Z- displacements at the node 11*




*Z-velocities at the node 11*




*Z-accelerations at the node 11*

## Comparison of Results

Unit : in

| Time | Z-displacement at the node 11 ($\delta_Z$) | | |
|---|---|---|---|
| | Theoretical | ADINA | MIDAS/Civil |
| $t_1$ = 0.04 sec | -0.0152 | -0.0160 | -0.0147 |
| $t_2$ = 0.08 sec | -0.1080 | -0.1071 | -0.1091 |
| $t_3$ = 0.12 sec | -0.3103 | -0.3053 | -0.3152 |

## References

Biggs, J. M., "*Introduction to Structural Dynamics*", McGraw-Hill, New York, 1964, pp. 315～318.

"*ADINA, Verification Manual - Linear Problems*", Version 6.1, ADINA R&D, Inc., 1992, Example A. 58.

***Time History Loading Data***