

TH-2

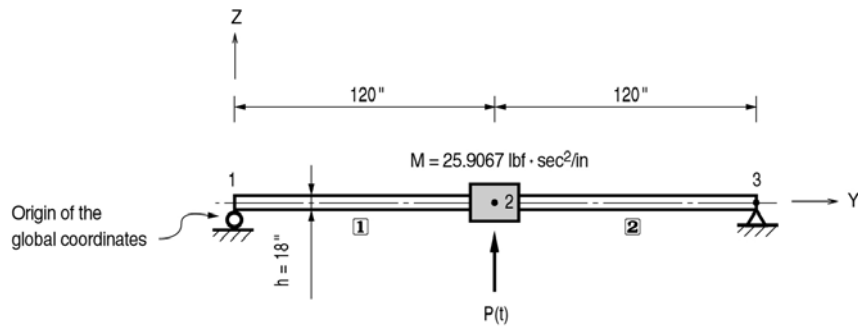
Title

Simply supported beam subjected to dynamic loads

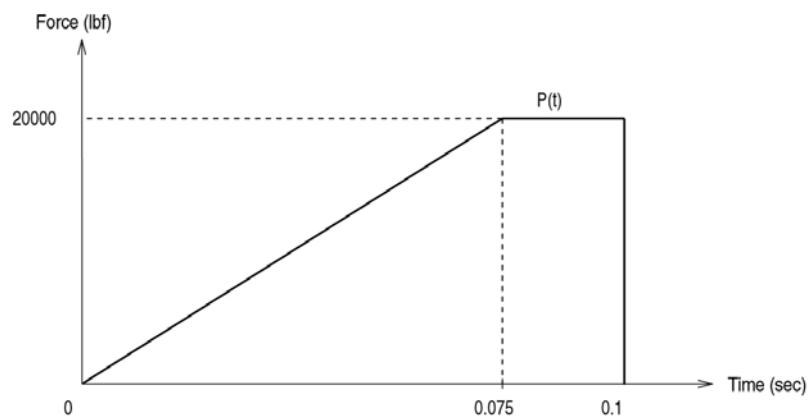
Description

A steel beam is subjected to dynamic loads.

Assume that the weight of the beam is negligible. Determine the time at which the maximum deflection occurs and the corresponding bending stresses.



(a) Simply supported beam with a lumped mass at the mid-span



(b) Force $P(t)$

Structural geometry and analysis model

Model

Analysis Type

2-D time history analysis

Unit System

in, lbf

Dimension

Length $L = 240$ in
 Mass $M = 25.9067 \text{ lbf} \cdot \text{sec}^2/\text{in}$ (in the Z direction)
 Analysis time $t = 0.1$ sec
 Time step $\Delta t = 0.001$ sec

Element

Beam element

Material

Modulus of elasticity $E = 30 \times 10^6$ psi

Section Property

Depth $H = 18.00$ in
 Moment of inertia $I_{yy} = 800.6 \text{ in}^4$

Boundary Condition

Node 1 ; Constrain Dz. (Roller support)
 Node 3 ; Constrain Dy and Dz. (Hinge support)

Analysis Case

Time step force acts in the Z direction.
 The time step force data are as follows :

Time (sec)	Force (lbf)
0.000	0
0.075	20000
0.100	20000

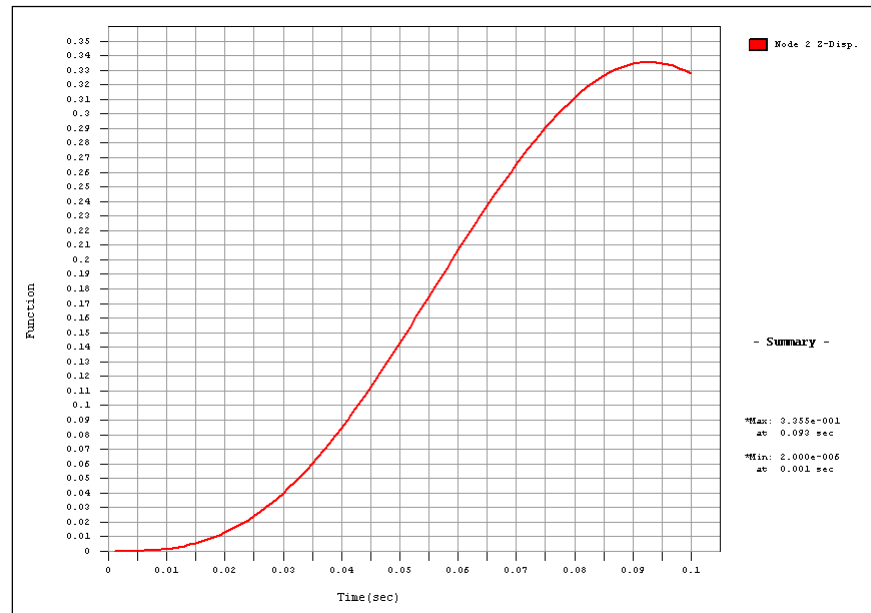
Results

Displacements

	Node	Load	DX (in)	DY (in)	DZ (in)	RX ([rad])	RY ([rad])	RZ ([rad])
▶	1	LCOMB1(max)	0.000000	0.000000	0.000000	0.004194	0.000000	0.000000
	2	LCOMB1(max)	0.000000	0.000000	0.335506	0.000000	0.000000	0.000000
	3	LCOMB1(max)	0.000000	0.000000	0.000000	-0.000000	0.000000	0.000000
	1	LCOMB1(min)	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	2	LCOMB1(min)	0.000000	0.000000	0.000002	0.000000	0.000000	0.000000
	3	LCOMB1(min)	0.000000	0.000000	0.000000	-0.004194	0.000000	0.000000
	1	LCOMB1(all)	0.000000	0.000000	0.000000	0.004194	0.000000	0.000000
	2	LCOMB1(all)	0.000000	0.000000	0.335506	0.000000	0.000000	0.000000
	3	LCOMB1(all)	0.000000	0.000000	0.000000	0.004194	0.000000	0.000000

Stresses

	Elem	Load	Part	Axial (lbf/in ²)	Shear-y (lbf/in ²)	Shear-z (lbf/in ²)	Bend(-y) (lbf/in ²)	Bend(y) (lbf/in ²)	Bend(-z) (lbf/in ²)	Bend(z) (lbf/in ²)	Cb(min/max) (lbf/in ²)	Cb1(-y+z) (lbf/in ²)	Cb2(-y-z) (lbf/in ²)	Cb3(-y-z) (lbf/in ²)	Cb4(-y-z) (lbf/in ²)
▶	1	LCOMB1(max)	i	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	4.72e+003	0.00e+000	4.72e+003	0.00e+000	0.00e+000
	1	LCOMB1(max)	1/4	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	-2.41e-002	4.72e+003	4.72e+003	-2.41e-002	-4.82e-002	4.72e+003	4.72e+003
	1	LCOMB1(max)	2/4	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	-4.82e-002	9.44e+003	9.44e+003	-4.82e-002	-7.24e-002	9.44e+003	9.44e+003
	1	LCOMB1(max)	3/4	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	-7.24e-002	1.42e+004	1.42e+004	-7.24e-002	-9.65e-002	1.42e+004	1.42e+004
	1	LCOMB1(max)	j	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	-9.65e-002	1.89e+004	1.89e+004	-9.65e-002	0.00e+000	1.89e+004	1.89e+004
	2	LCOMB1(max)	i	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	1.89e+004	-9.65e-002	1.89e+004	1.89e+004	1.42e+004	-9.65e-00	-9.65e-002
	2	LCOMB1(max)	1/4	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	-7.24e-002	1.42e+004	1.42e+004	-7.24e-002	-4.82e-002	1.42e+004	1.42e+004
	2	LCOMB1(max)	2/4	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	-4.82e-002	9.44e+003	9.44e+003	-4.82e-002	-2.41e-002	9.44e+003	9.44e+003
	2	LCOMB1(max)	3/4	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	-2.41e-002	4.72e+003	4.72e+003	-2.41e-002	0.00e+000	4.72e+003	4.72e+003
	2	LCOMB1(max)	j	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000
	1	LCOMB1(min)	i	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	2.41e-002	0.00e+000	2.41e-002	0.00e+000	0.00e+000
	1	LCOMB1(min)	1/4	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	-4.72e+003	2.41e-002	-9.44e+003	-4.72e+003	-9.44e+003	2.41e-002	2.41e-002
	1	LCOMB1(min)	2/4	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	-9.44e+003	4.82e-002	-1.42e+004	-9.44e+003	-1.42e+004	4.82e-002	4.82e-002
	1	LCOMB1(min)	3/4	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	-1.42e+004	7.24e-002	-1.89e+004	-1.42e+004	-1.89e+004	7.24e-002	7.24e-002
	1	LCOMB1(min)	j	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	-1.89e+004	9.65e-002	-1.89e+004	-1.89e+004	0.00e+000	9.65e-002	9.65e-002
	2	LCOMB1(min)	i	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	9.65e-002	-1.89e+004	-1.89e+004	9.65e-002	7.24e-002	-1.89e+00	-1.89e+004
	2	LCOMB1(min)	1/4	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	-1.42e+004	7.24e-002	-1.42e+004	-1.42e+004	-9.44e+003	7.24e-002	7.24e-002
	2	LCOMB1(min)	2/4	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	-9.44e+003	4.82e-002	-9.44e+003	-9.44e+003	-4.72e+003	4.82e-002	4.82e-002
	2	LCOMB1(min)	3/4	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	-4.72e+003	2.41e-002	-4.72e+003	-4.72e+003	0.00e+000	2.41e-002	2.41e-002
	2	LCOMB1(min)	j	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000
	1	LCOMB1(all)	i	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	4.72e+003	0.00e+000	4.72e+003	0.00e+000	0.00e+000
	1	LCOMB1(all)	1/4	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	-2.41e-002	4.72e+003	4.72e+003	-2.41e-002	-4.82e-002	4.72e+003	4.72e+003
	1	LCOMB1(all)	2/4	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	-4.82e-002	9.44e+003	9.44e+003	-4.82e-002	-7.24e-002	9.44e+003	9.44e+003
	1	LCOMB1(all)	3/4	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	-7.24e-002	1.42e+004	1.42e+004	-7.24e-002	-9.65e-002	1.42e+004	1.42e+004
	1	LCOMB1(all)	j	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	-9.65e-002	1.89e+004	1.89e+004	-9.65e-002	0.00e+000	1.89e+004	1.89e+004
	2	LCOMB1(all)	i	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	1.89e+004	-9.65e-002	-1.89e+004	1.89e+004	1.42e+004	-9.65e-002	-9.65e-002
	2	LCOMB1(all)	1/4	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	-7.24e-002	1.42e+004	1.42e+004	-7.24e-002	-4.82e-002	1.42e+004	1.42e+004
	2	LCOMB1(all)	2/4	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	-4.82e-002	9.44e+003	9.44e+003	-4.82e-002	-2.41e-002	9.44e+003	9.44e+003
	2	LCOMB1(all)	3/4	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	-2.41e-002	4.72e+003	4.72e+003	-2.41e-002	0.00e+000	4.72e+003	4.72e+003
	2	LCOMB1(all)	j	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000	0.00e+000



Z-displacements at the node 2

Comparison of Results

Result	Theoretical	Unit : sec, in, psi
		MIDAS/Civil
Time at which the maximum displacement occurs (t)	0.092	0.093
Maximum displacement ($\delta_{z,max}$)	0.331	0.336
Maximum bending stress (σ_{max})	18.6×10^3	18.87×10^3

References

Biggs, J. M., "Introduction to Structural Dynamics", McGraw-Hill Book Co., New York, 1964, p. 50, Example E.

Time History Loading Data

