

Eigen-8

Title

3-D single story frame structure

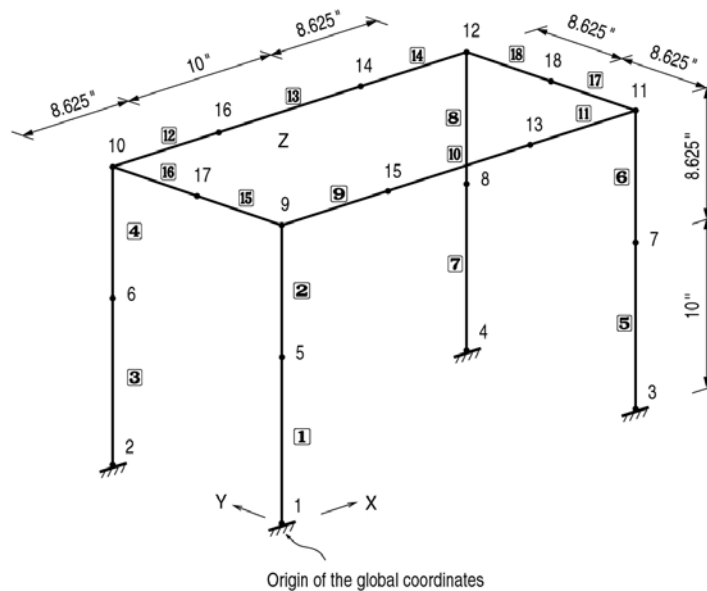
Description

Compute the natural frequencies of a 3-D single story frame structure.

· Nodal lumped masses

$M_5 \sim M_8, M_{13} \sim M_{18} = 8.94223 \times 10^{-3} \text{ lbf} \cdot \text{sec}^2/\text{in}$

$M_9 \sim M_{12} = 0.0253816 \text{ lbf} \cdot \text{sec}^2/\text{in}$



Structural geometry and analysis model

Model

Analysis Type

3-D eigenvalue analysis

Unit System

in, lbf

Dimension

Length 27.25 in Width 17.25 in Height 18.625 in
 Mass $M_5 \sim M_8, M_{13} \sim M_{18} = 8.94223 \times 10^{-3} \text{ lbf}\cdot\text{sec}^2/\text{in}$
 $M_9 \sim M_{12} = 0.0253816 \text{ lbf}\cdot\text{sec}^2/\text{in}$

Element

Beam element

Material

Modulus of elasticity $E = 27.9 \times 10^6 \text{ psi}$
 Poisson's ratio $\nu = 0.3$

Section Property

Area $A = 1.074531 \text{ in}^2$
 Shear Area $A_{sy} = 0.5372657 \text{ in}^2 (=A_{sz})$
 Torsional stiffness $I_{xx} = 1.331494 \text{ in}^4$
 Moment of inertia $I_{yy} = 0.665747 \text{ in}^4 (=I_{zz})$

Boundary Condition

Nodes 1 ~ 4 ; Constrain all DOFs.

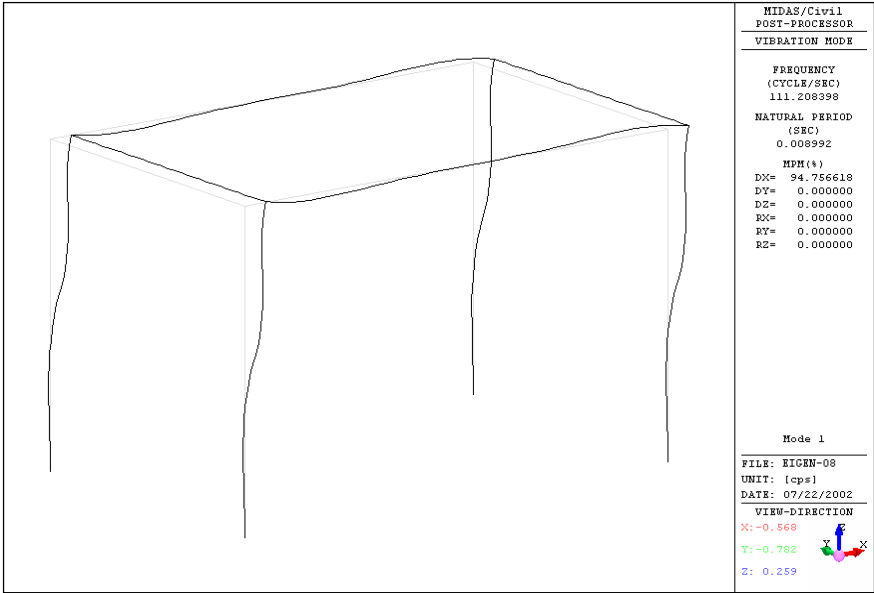
Analysis Case

Convert the self weight to nodal masses and input manually.
 Number of natural frequencies to be computed = 5

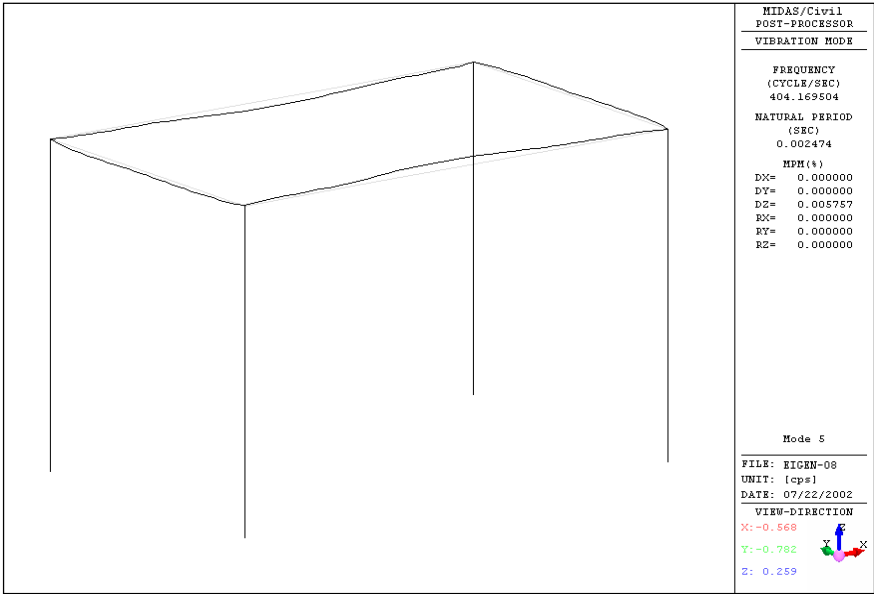
Results

Eigenvalue Analysis Results

EIGENVALUE ANALYSIS													
Mode No	Frequency				Period		Tolerance						
	(rad/sec)		(cycle/sec)		(sec)								
1	698,742970		111,208398		0,008992		3,7094e-012						
2	727,400973		115,769461		0,008638		7,4954e-012						
3	861,645970		137,135215		0,007292		2,3480e-011						
4	1355,576996		215,746780		0,004635		8,8263e-009						
5	2539,471891		404,169504		0,002474		8,8584e-007						
MODAL PARTICIPATION MASSES(%) PRINTOUT													
Mode No	TRAN-X		TRAN-Y		TRAN-Z		ROTN-X		ROTN-Y		ROTN-Z		
	MASS	SUM	MASS	SUM	MASS	SUM	MASS	SUM	MASS	SUM	MASS	SUM	
1	94,76	94,76	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
2	0,00	94,76	95,04	95,04	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
3	0,00	94,76	0,00	95,04	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
4	0,00	94,76	0,00	95,04	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
5	0,00	94,76	0,00	95,04	0,01	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00
EIGENVECTOR													



1st vibration mode of the structure



5th vibration mode of the structure

Comparison of Results

Natural frequency	Unit : Hz			
	ANSYS	SAP2000	NISA II	MIDAS/Civil
f_1	111.5	114.0	111.46	111.2
f_2	115.9	119.0	116.10	115.8
f_3	137.6	141.0	137.50	137.1
f_4	218.0	222.0	216.20	215.7
f_5	404.2	400.0	405.00	404.2

References

I.S. Tuba and W. B. Wright, ASME Pressure Vessel and Piping 1972, “*Computer Programs Verification*”, ASME Publication I-24, Problem 1

“*ANSYS, Engineering Analysis Verification Manual*”, Revision 4.4, SWANSON Analysis Systems, Inc., 1990

“*SAP90, A Series of Computer Programs for the Finite Element Analysis of Structures, Structural Analysis Verification Manual*”, Computers and structures, Inc., 1992, Example 4

“*NISA II, Verification Manual*”, Version 91.0, Engineering Mechanics Research Corporation, 1991