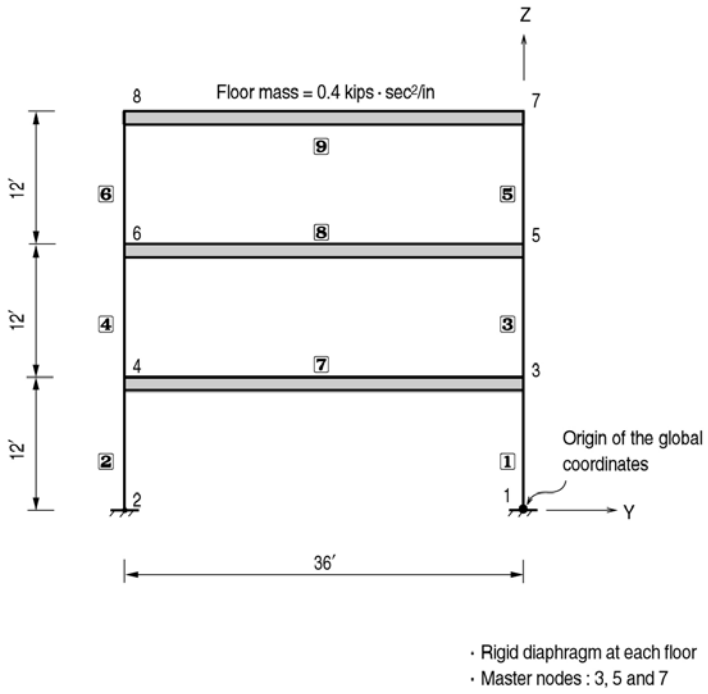
RS-1

Title

Dynamic response spectrum analysis of a 2-D, 3-story plane frame

Description

Assume that each floor is a rigid diaphragm.
Calculate the natural periods.
Perform a dynamic response spectrum analysis.
Determine the displacements at each floor and the reaction forces.



Structural geometry and analysis model

Model

Analysis Type

2-D response spectrum analysis

Unit System

in, kip

Dimension

Span 36 × 12 in	Height 36 × 12 in
Floor mass	M = 0.4 kips · sec^2/in
Damping ratio	ξ = 0.05 (5 %)
Gravitational acceleration	g = 386.4 in/sec^2
Response spectrum data	El Centro N-S component

Element

Beam element

Material

Modulus of elasticity E = 29500 ksi

Section Property

Columns	Area	A = 1.0×10^7 in^2
	Moment of inertia	I_{yy} = 999.0 in^4
Beams	Height	H = 24.0 in
	Moment of inertia	I_{yy} = 1.0×10^9 in^4

Boundary Condition

Nodes 1 and 2 ; Constrain Dy, Dz and Rx.

Nodes 3, 5 and 7 ; Constrain Dy of all nodes at each floor to these nodes. (Master nodes)

Analysis Case

Floor masses are assigned to the master nodes of each floor in the Y direction.

The response spectrum data of the EI Centro N-S component are imposed in the Y direction.

Number of natural frequencies to be computed = 3

Results

Eigenvalue Analysis Results

Node	Mode	UX		UY		UZ		RX		RY		RZ	
EIGENVALUE ANALYSIS													
	Mode No	Frequency (rad/sec)		Frequency (cycle/sec)		Period (sec)		Tolerance					
	1	10,829931		1,723637		0,580169		7,2698e-016					
	2	30,344815		4,829527		0,207060		3,5311e-014					
	3	43,849568		6,978875		0,143290		1,1731e-013					
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	0,00	0,00	91,41	91,41	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	2	0,00	0,00	7,49	98,90	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	3	0,00	0,00	1,10	100,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
EIGEN VECTOR													

Displacements

Node	Load	DX (in)	DY (in)	DZ (in)	RX ([rad])	RY ([rad])	RZ ([rad])
1	RY	0,0000000	0,0000000	0,0000000	0,0000000	0,0000000	0,0000000
2	RY	0,0000000	0,0000000	0,0000000	0,0000000	0,0000000	0,0000000
3	RY	0,0000000	1,5858575	1,0645275	5,9706375	0,0000000	0,0000000
4	RY	0,0000000	1,5858575	1,0645275	5,9706375	0,0000000	0,0000000
5	RY	0,0000000	2,8451981	1,5836307	4,1994856	0,0000000	0,0000000
6	RY	0,0000000	2,8451981	1,5836307	4,1994856	0,0000000	0,0000000
7	RY	0,0000000	3,5474620	1,7214968	1,5834502	0,0000000	0,0000000
8	RY	0,0000000	3,5474620	1,7214968	1,5834502	0,0000000	0,0000000

Reaction Forces

Node	Load	FX (kip)	FY (kip)	FZ (kip)	MX (kip-in)	MY (kip-in)	MZ (kip-in)
1	RY	0,000000	187,821111	218,080154	13523,132188	0,000000	0,000000
2	RY	0,000000	187,821111	218,080154	13523,132188	0,000000	0,000000
SUMMATION OF REACTION FORCES PRINTOUT							
	Load	FX (kip)	FY (kip)	FZ (kip)			
	RY	0,000000	375,642222	0,000000			

Comparison of Results

Natural periods

Unit : sec

Mode	Natural period	
	Theoretical	MIDAS/Civil
1st	0.5802	0.5802
2nd	0.2071	0.2071
3rd	0.1433	0.1433

Displacements and Reaction Forces

Unit : in, kip-in

Division		Theoretical	MIDAS/Civil
Displacement at each level	3rd	3.547	3.547
	2nd	2.845	2.845
	1st	1.586	1.586
Reaction moment	Node 1	13523.1	13523.1

References

Przemieniecki, J.S., "*Theory of Matrix Structural Analysis*", McGraw-Hill, 1968.

Paz, M., "*Structural Dynamics, Theory and Computations*", Van Nostrand Reinhold, 1985.

Wilson, E. L., Kiureghian, A. D., and Bayo, E. P., "*A Replacement for the SRSS Method in Seismic Analysis*", Earthquake Engineering and Structural Dynamics, Vol. 9, 1981.

Response Spectrum Data