Eigen-4

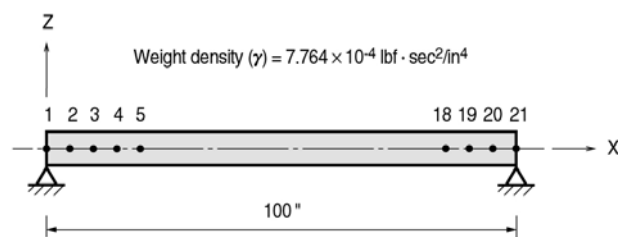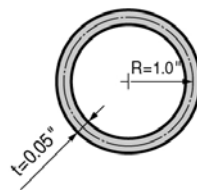## Title

Eigenvalue analysis of a simply supported shaft

Description

Calculate the natural frequencies of a simply supported shaft.

(a) Simply supported shaft

(b) Cross section of the shaft

Structural geometry and analysis model

MODEL

Analysis Type
   2-D eigenvalue analysis (X-Y plane)

Unit System
   in, lbf

Dimension
   Length   L   = 100 in
   Weight density γ = 7.764×10^{-4} lbf/in^3
   Gravitational acceleration   g   = 1.0 in/sec^2

Element
   Beam element

Material
   Modulus of elasticity   E   = 30×10^6 psi

Section Property
   Area   A = 0.31416 in^2
   Moment of inertia I_{yy} = 0.15708 in^4
   Radius   R = 1.00 in
   Thickness   t   = 0.05 in

Boundary Condition
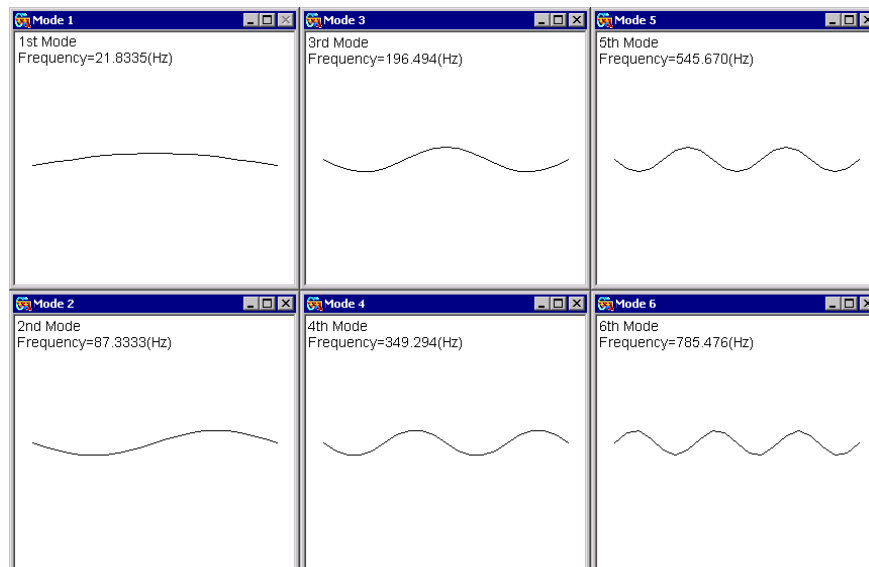   Nodes 1 and 21 ; Constrain Dx and Dz.

Analysis Case
   Self weight is converted to nodal masses automatically.
   Number of natural frequencies to be computed = 6

Results

Eigenvalue Analysis Results

EIGENVALUE ANALYSIS									
Mode No	Frequency		Period (sec)		Tolerance				
	(rad/sec)	(cycle/sec)							
1	137,183673	21,833460	0,045801		0,0000e+000				
2	548,731126	87,333271	0,011450		1,9331e-016				
3	1234,609024	196,494129	0,005089		1,2755e-013				
4	2194,679065	349,294022	0,002863		8,2755e-012				
5	3428,546973	545,670198	0,001833		6,2645e-009				
6	4935,292411	785,476183	0,001273		1,5356e-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	0,00	0,00	0,00	0,00	84,97	84,97	0,00	0,00	0,00	0,00	0,00	0,00
2	0,00	0,00	0,00	0,00	0,00	84,97	0,00	0,00	0,00	0,00	0,00	0,00
3	0,00	0,00	0,00	0,00	9,13	94,10	0,00	0,00	0,00	0,00	0,00	0,00
4	0,00	0,00	0,00	0,00	0,00	94,10	0,00	0,00	0,00	0,00	0,00	0,00
5	0,00	0,00	0,00	0,00	3,07	97,17	0,00	0,00	0,00	0,00	0,00	0,00
6	0,00	0,00	0,00	0,00	0,00	97,17	0,00	0,00	0,00	0,00	0,00	0,00
EIGENVECTOR									

Mode 1 — 1st Mode — Frequency=21.8335(Hz)

Mode 3 — 3rd Mode — Frequency=196.494(Hz)

Mode 5 — 5th Mode — Frequency=545.670(Hz)

Mode 2 — 2nd Mode — Frequency=87.3333(Hz)

Mode 4 — 4th Mode — Frequency=349.294(Hz)

Mode 6 — 6th Mode — Frequency=785.476(Hz)

Eigenvalue Analysis Results

Comparison of Results

Unit : Hz

Natural frequency	Ref. 1	MSC/NASTRAN	MIDAS/Civil
f_1	21.8335	21.8335	21.8335
f_2	87.3339	87.3333	87.3333
f_3	196.501	196.494	196.494
f_4	349.335	349.294	349.294
f_5	545.837	545.670	545.670
f_6	786.005	785.476	785.476

References

J. P. Den Hartog, "*Mechanical Vibrations*", 4th Edition, McGraw-Hill, New York, 1956, p. 432.

"*MSC/NASTRAN, Verification Problem Manual*", V.64, The MacNeal-Schwendler Corporation, 1986, Problem No. V0306.