

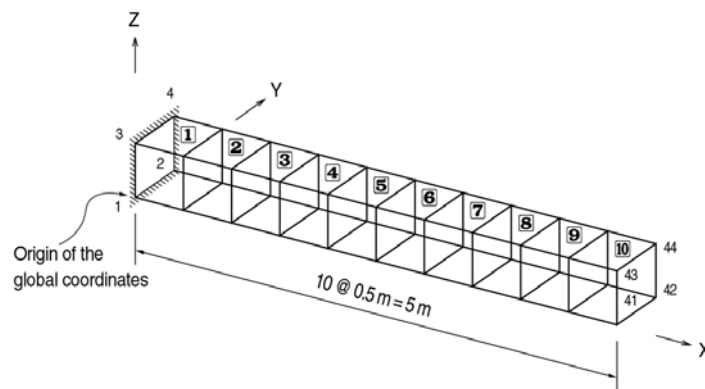
Eigen-7

Title

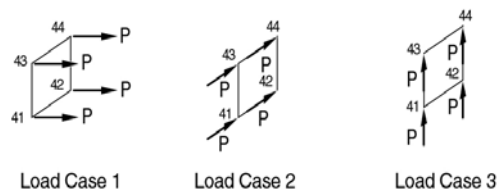
Behaviors of a cantilever beam under concentrated loads at the free end

Description

Examine the static & dynamic behaviors of a cantilever beam.



(a) Structural analysis model



Load Case 1

Load Case 2

Load Case 3

(b) Load cases

Structural analysis model and load cases

Model

Analysis Type

3-D eigenvalue analysis

Unit System

m, tonf

Dimension

Length 5 m

Element

Solid element

Material

Concrete	Modulus of elasticity	E	=	2.1×10^6 tonf/m ²
	Poisson's ratio	ν	=	0.167
	Weight density	γ	=	2.4 tonf/m ³

Boundary Condition

Nodes 1, 2, 3 and 4 ; Constrain all DOFs.

Load Case

A concentrated load, 1 tonf is applied to each of the nodes 41, 42, 43 and 44 at the free end. The load cases 1,2 and 3 represent the loads acting in the directions of X, Y and Z respectively.

Analysis Case

Self weight is converted to nodal masses automatically.

Number of natural frequencies to be computed = 10

Results

Displacements (Solid element)

	Node	Load	DX (m)	DY (m)	DZ (m)	RX (rad)	RY (rad)	RZ (rad)
▶	41	CASE1	9.5054e-006	7.9524e-008	7.9524e-008	0.0000e+000	0.0000e+000	0.0000e+000
	42	CASE1	9.5054e-006	-7.9524e-008	7.9524e-008	0.0000e+000	0.0000e+000	0.0000e+000
	43	CASE1	9.5054e-006	7.9524e-008	-7.9524e-008	0.0000e+000	0.0000e+000	0.0000e+000
	44	CASE1	9.5054e-006	-7.9524e-008	-7.9524e-008	0.0000e+000	0.0000e+000	0.0000e+000
	41	CASE2	2.8510e-004	3.8100e-003	1.9129e-007	0.0000e+000	0.0000e+000	0.0000e+000
	42	CASE2	-2.8510e-004	3.8100e-003	-1.9129e-007	0.0000e+000	0.0000e+000	0.0000e+000
	43	CASE2	2.8510e-004	3.8100e-003	-1.9129e-007	0.0000e+000	0.0000e+000	0.0000e+000
	44	CASE2	-2.8510e-004	3.8100e-003	1.9129e-007	0.0000e+000	0.0000e+000	0.0000e+000
	41	CASE3	2.8510e-004	1.9129e-007	3.8100e-003	0.0000e+000	0.0000e+000	0.0000e+000
	42	CASE3	2.8510e-004	-1.9129e-007	3.8100e-003	0.0000e+000	0.0000e+000	0.0000e+000
	43	CASE3	-2.8510e-004	-1.9129e-007	3.8100e-003	0.0000e+000	0.0000e+000	0.0000e+000
	44	CASE3	-2.8510e-004	1.9129e-007	3.8100e-003	0.0000e+000	0.0000e+000	0.0000e+000

Eigenvalue Analysis Results (Solid element)

EIGENVALUE ANALYSIS													
Mode No	Frequency				Period		Tolerance						
	(rad/sec)		(cycle/sec)		(sec)								
1	58,826542		9,362535		0,106809		7,8845e-016						
2	58,826542		9,362535		0,106809		2,6282e-016						
3	347,409943		55,292010		0,018086		0,0000e+000						
4	348,283594		55,431056		0,018040		4,7986e-016						
5	348,283594		55,431056		0,018040		3,5989e-016						
6	907,298137		144,400983		0,006925		5,2410e-012						
7	907,298137		144,400983		0,006925		1,5643e-010						
8	920,975281		146,577768		0,006822		1,2526e-010						
9	1033,675445		164,514557		0,006078		1,7240e-008						
10	1631,288670		259,627655		0,003852		5,4685e-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	26,52	26,52	37,07	37,07	0,00	0,00	0,00	0,00	0,00	0,00	0,00
2	0,00	0,00	37,07	63,59	26,52	63,59	0,00	0,00	0,00	0,00	0,00	0,00	0,00
3	0,00	0,00	0,00	63,59	0,00	63,59	0,00	0,00	0,00	0,00	0,00	0,00	0,00
4	0,00	0,00	10,43	74,02	9,33	72,92	0,00	0,00	0,00	0,00	0,00	0,00	0,00
5	0,00	0,00	9,33	83,35	10,43	83,35	0,00	0,00	0,00	0,00	0,00	0,00	0,00
6	0,00	0,00	4,99	88,34	1,65	85,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
7	0,00	0,00	1,65	89,99	4,99	89,99	0,00	0,00	0,00	0,00	0,00	0,00	0,00
8	84,80	84,80	0,00	89,99	0,00	89,99	0,00	0,00	0,00	0,00	0,00	0,00	0,00
9	0,00	84,80	0,00	89,99	0,00	89,99	0,00	0,00	0,00	0,00	0,00	0,00	0,00
10	0,00	84,80	1,36	91,35	2,00	91,99	0,00	0,00	0,00	0,00	0,00	0,00	0,00
EIGENVECTOR													

Comparison of Results

Displacements

Load Case	Unit : m		
	NISA II (Solid elements)	MIDAS/Civil (Beam elements)	MIDAS/Civil (Solid elements)
LDC 1 (X direction)	9.505E-06	9.524E-06	9.505E-06
LDC 2 (Y direction)	0.003810	0.003836	0.003810
LDC 3 (Z direction)	0.003810	0.003836	0.003810

Natural Periods

Natural Period	Unit : sec		
	NISA II (Solid elements)	MIDAS/Civil (Beam elements)	MIDAS/Civil (Solid elements)
1 st mode	0.1068087	0.1067212	0.1068097
4 th mode	0.0180404	0.0177576	0.0180404
6 th mode	0.0069252	0.0067133	0.0069252
8 th mode	0.0068223	0.0068348	0.0068223

Reference

Tomas J.R. Hughes, “*The Finite Element Method*”, Chapter 3