

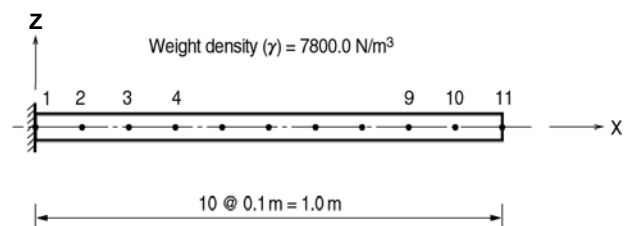
Eigen-5

Title

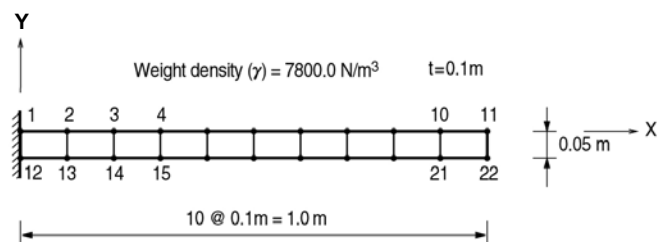
Eigenvalue analysis of the cantilever

Description

Compare the natural frequencies of a cantilever modeled with plate elements and beam elements separately.



(a) Structure modeled with beam elements (**Eigen-5-1**)



(b) Structure modeled with plate elements (**Eigen-5-2**)

MODEL

Analysis Type

3-D eigenvalue analysis

Unit System

m, N

Dimension

Length 1.0 m Depth 0.05 m Thickness 0.1 m

Gravitational acceleration $g = 1.0 \text{ m/sec}^2$

Element

Plate element (Thick type) and beam element

Material

Beam Elements

Modulus of elasticity $E = 2.0 \times 10^{11} \text{ N/m}^2$

Poisson's ratio $\nu = 0.3$

Weight density $\gamma = 7800.0 \text{ N/m}^3$

Plate Elements

Modulus of elasticity $E = 2.0 \times 10^{11} \text{ N/m}^2$

Poisson's ratio $\nu = 0.3$

Weight density $\gamma = 7800.0 \text{ N/m}^3$

Section Property

Beam Elements

Area $A = 0.005 \text{ m}^2$

Effective shear area $A_z = 4.1667 \times 10^{-3} \text{ m}^2$

Moment of inertia $I_{yy} = 4.166 \times 10^{-6} \text{ m}^4$

Plate Elements

Size $a \times b = 0.1 \text{ m} \times 0.05 \text{ m}$

Thickness $t = 0.1 \text{ m}$

Boundary Condition

Fixed end ; Constrain all DOFs
 The remaining nodes ; Constrain Dy and Rz

Analysis Case

Self weight is converted to nodal masses automatically.
 Number of natural frequencies to be computed = 5

Results**Eigenvalue Analysis Results (Beam elements)**

EIGENVALUE ANALYSIS													
Mode No	Frequency		Period		Tolerance								
	(rad/sec)	(cycle/sec)	(sec)	(sec)									
1	508,532908	80,935526	0,012356	3,3762e-016									
2	3046,021739	484,789417	0,002063	0,0000e+000									
3	7945,861496	1264,623134	0,000791	2,2120e-008									
4	8022,474963	1276,816546	0,000783	8,8812e-011									
5	14505,654309	2308,646586	0,000433	2,7614e-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	SUM
1	0,00	0,00	0,00	0,00	64,56	64,56	0,00	0,00	0,00	0,00	0,00	0,00	0,00
2	0,00	0,00	0,00	0,00	20,40	84,96	0,00	0,00	0,00	0,00	0,00	0,00	0,00
3	84,97	84,97	0,00	0,00	0,00	84,96	0,00	0,00	0,00	0,00	0,00	0,00	0,00
4	0,00	84,97	0,00	0,00	7,10	92,06	0,00	0,00	0,00	0,00	0,00	0,00	0,00
5	0,00	84,97	0,00	0,00	3,59	95,66	0,00	0,00	0,00	0,00	0,00	0,00	0,00
EIGENVECTOR													

Eigenvalue Analysis Results (Plate elements)

EIGENVALUE ANALYSIS													
Mode No	Frequency		Period		Tolerance								
	(rad/sec)	(cycle/sec)	(sec)	(sec)									
1	511,393	81,39	0,012	3,3386e-016									
2	3061,688	487,28	0,002	9,9352e-016									
3	5408,611	860,81	0,001	8,7615e-014									
4	8058,754	1282,59	0,001	2,7796e-010									
5	8329,526	1325,69	0,001	2,2424e-008									
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	SUM
1	0,00	0,00	0,00	0,00	64,39	64,39	0,00	0,00	0,00	0,00	0,00	0,00	0,00
2	0,00	0,00	0,00	0,00	20,38	84,77	0,00	0,00	0,00	0,00	0,00	0,00	0,00
3	0,00	0,00	0,00	0,00	0,00	84,77	0,00	0,00	0,00	0,00	0,00	0,00	0,00
4	0,00	0,00	0,00	0,00	7,14	91,90	0,00	0,00	0,00	0,00	0,00	0,00	0,00
5	84,97	84,97	0,00	0,00	0,00	91,90	0,00	0,00	0,00	0,00	0,00	0,00	0,00
EIGENVECTOR													

Comparison of Results

Frequency	Unit : Hz			
	Natural frequency of the first mode (f_1)			
	Theoretical	ADINA	NISA II	MIDAS/Civil
Plate elements	81.80	81.33	82.30	81.39
Beam elements	81.80	80.94	81.15	80.94

References

Blevins, R. D., “*Formulas for Natural Frequency and Mode Shape*”, Van Nostrand Reinhold Company, 1979.

“*ADINA, Verification Manual - Linear Problems*”, Version 6.1, ADINA R&D, Inc, 1992, Example A. 47 & A. 66.

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