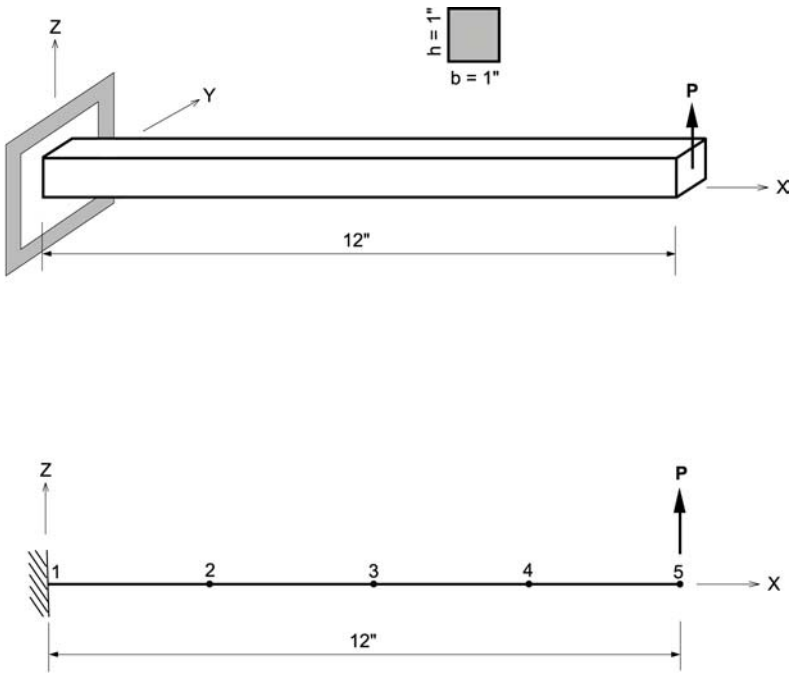
GNL-4

Title

Geometrical nonlinear analysis of a cantilever beam subjected to an end force

Description

A cantilever beam is subjected to a vertical load at the free end.
Determine the displacements due to the loading.



Structural geometry and analysis model

MODEL

Analysis Type

3-D geometrical nonlinear analysis

Unit System

in, lbf

Dimension

Length 12 in

Element

Beam element

Material

Modulus of elasticity $E = 3.0\times10^7$ psi
Poisson's ratio $\nu = 0.0$

Sectional Property

Rectangular cross-section: b = 1.0 in, h = 1.0 in

Boundary Condition

Node 1: Constrain all DOFs

Load Case

Load: $P = f \times n$

f = load factor ($f = 1, 2, 3, \ldots 10$)
$n = EI/L^2 = 17361.111$ lbf

Results

	Node	Load	Step	DX (in)	DY (in)	DZ (in)	RX ([rad])	RY ([rad])	RZ ([rad])
▶	5	ldc1	nl_001	-0,673531	0,000000	3,643869	0,000000	-0,462115	0,000000
	5	ldc1	nl_002	-1,926426	0,000000	5,979251	0,000000	-0,784850	0,000000
	5	ldc1	nl_003	-3,060529	0,000000	7,327887	0,000000	-0,991360	0,000000
	5	ldc1	nl_004	-3,964680	0,000000	8,153831	0,000000	-1,128228	0,000000
	5	ldc1	nl_005	-4,678190	0,000000	8,701316	0,000000	-1,223478	0,000000
	5	ldc1	nl_006	-5,250084	0,000000	9,089875	0,000000	-1,292542	0,000000
	5	ldc1	nl_007	-5,717711	0,000000	9,381184	0,000000	-1,344259	0,000000
	5	ldc1	nl_008	-6,107477	0,000000	9,609343	0,000000	-1,383983	0,000000
	5	ldc1	nl_009	-6,437904	0,000000	9,794385	0,000000	-1,415123	0,000000
	5	ldc1	nl_010	-6,722188	0,000000	9,948731	0,000000	-1,439940	0,000000
	5	ldc1	nl_max	-0,673531	0,000000	9,948731	0,000000	-0,462115	0,000000
	5	ldc1	nl_min	-6,722188	0,000000	3,643869	0,000000	-1,439940	0,000000
	14	ldc1	nl_001	-0,677869	0,000000	3,637031	0,000000	-0,461387	0,000000
	14	ldc1	nl_002	-1,930074	0,000000	5,952583	0,000000	-0,781879	0,000000
	14	ldc1	nl_003	-3,057268	0,000000	7,282908	0,000000	-0,986218	0,000000
	14	ldc1	nl_004	-3,953148	0,000000	8,094956	0,000000	-1,121477	0,000000
	14	ldc1	nl_005	-4,658782	0,000000	8,631658	0,000000	-1,215620	0,000000
	14	ldc1	nl_006	-5,223516	0,000000	9,011324	0,000000	-1,283951	0,000000
	14	ldc1	nl_007	-5,684653	0,000000	9,294894	0,000000	-1,335207	0,000000
	14	ldc1	nl_008	-6,068440	0,000000	9,516026	0,000000	-1,374669	0,000000
	14	ldc1	nl_009	-6,393272	0,000000	9,694508	0,000000	-1,405691	0,000000
	14	ldc1	nl_010	-6,672243	0,000000	9,842621	0,000000	-1,430500	0,000000
	14	ldc1	nl_max	-0,677869	0,000000	9,842621	0,000000	-0,461387	0,000000
	14	ldc1	nl_min	-6,672243	0,000000	3,637031	0,000000	-1,430500	0,000000

Displacements of the free end

Comparison of Results

Displacements/Beam length (δ_Z/L)			
Load Factor, f	Analytical solution (Ref.1)	MIDAS/Civil	
		4 elements	8 elements
1	0.302	0.304	0.303
2	0.493	0.498	0.496
3	0.603	0.611	0.607
4	0.670	0.680	0.675
5	0.714	0.725	0.719
6	0.745	0.758	0.751
7	0.767	0.782	0.775
8	0.785	0.801	0.793
9	0.799	0.816	0.808
10	0.811	0.829	0.820

References

Gere, J.M. and Timoshenko, S.P., "*Mechanics of materials*", a division of wadsworth, Inc., California, pp.414~418, 1984

Kim, Y.M., "*Geometrically nonlinear analysis of space frames including shear deformation effects*", KSCE Journal of Civil Engineering, Vol.13, No.4 pp.39~49, 1993