GNL-9

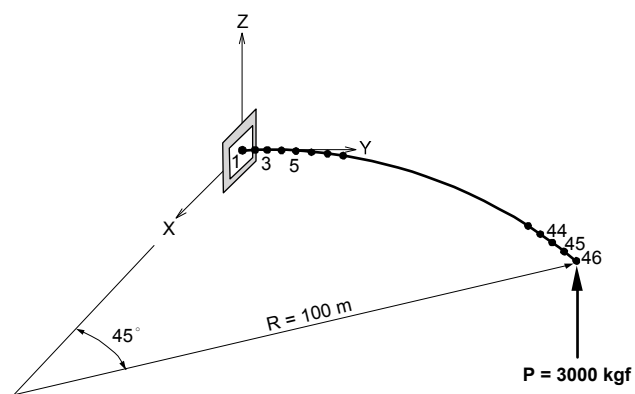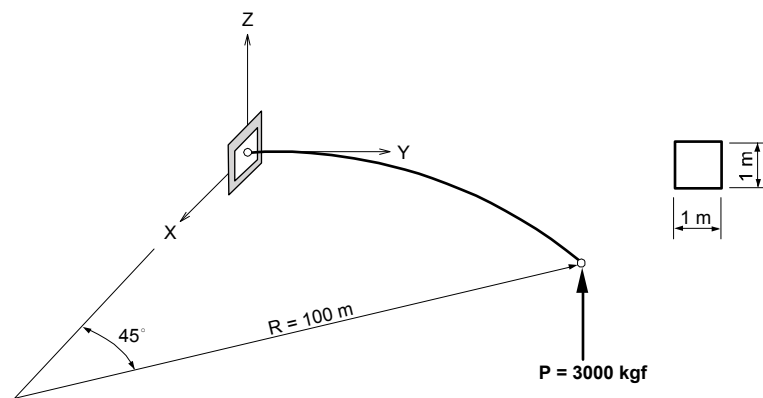## Title

Static large displacement analysis of a curved cantilever beam under free end load

Description

A curved cantilever beam spanning a 45° arc is bent by a shear load applied at the free end. Determine the large displacement response of the free end.

Structural geometry and analysis model

MODEL

Analysis Type

3-D static large displacement analysis

Unit System

m, kgf

Dimension

Radius 100 m

Element

Beam element

Material

Modulus of elasticity $E = 1.0 \times 10^7$ kgf/m^2
Poisson's ratio $\nu = 0.0$

Sectional Property

Rectangular cross section: b = 1 m,   h = 1 m

Boundary Condition

Node 1: Constrain all DOFs

Load Case

A concentrated load, P = 3000 kgf is applied to the node 46 in Z direction.

Results

	Node	Load	Step	DX (m)	DY (m)	DZ (m)	RX ([rad])	RY ([rad])	RZ ([rad])
	46	Top Loa	nl_001	−0,415	−0,559	9,404	0,154	−0,098	0,001
	46	Top Loa	nl_002	−1,539	−2,087	18,026	0,298	−0,189	0,005
	46	Top Loa	nl_003	−3,097	−4,247	25,424	0,425	−0,269	0,011
	46	Top Loa	nl_004	−4,829	−6,706	31,530	0,535	−0,337	0,017
	46	Top Loa	nl_005	−6,560	−9,226	36,491	0,628	−0,393	0,025
▶	46	Top Loa	nl_006	−8,200	−11,671	40,513	0,707	−0,440	0,032
	46	Top Loa	nl_007	−9,713	−13,975	43,795	0,774	−0,480	0,040
	46	Top Loa	nl_008	−11,091	−16,112	46,498	0,832	−0,514	0,047
	46	Top Loa	nl_009	−12,340	−18,078	48,750	0,881	−0,543	0,054
	46	Top Loa	nl_010	−13,473	−19,880	50,646	0,923	−0,568	0,061
	46	Top Loa	nl_011	−14,500	−21,530	52,261	0,960	−0,590	0,068
	46	Top Loa	nl_012	−15,436	−23,043	53,650	0,992	−0,610	0,074
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	46	Top Loa	nl_057	−30,922	−44,007	68,346	1,246	−0,938	0,226
	46	Top Loa	nl_058	−31,093	−44,148	68,445	1,246	−0,942	0,228
	46	Top Loa	nl_059	−31,261	−44,284	68,541	1,245	−0,946	0,230
	46	Top Loa	nl_060	−31,427	−44,417	68,634	1,244	−0,950	0,232

Large displacement response

Comparison of Results

Unit: m

	Static Large Displacement Response					
Applied load P	ABAQUS			MIDAS/Civil		
	X	Y	Z	X	Y	Z
300 kgf	-7.097	-12.130	40.430	-8.200	-11.671	40.513
450 kgf	-10.820	-18.700	48.670	-12.340	-18.078	48.750
600 kgf	-13.620	-23.780	53.580	-15.436	-23.043	53.650
3000 kgf	-24.990	-47.700	68.550	-31.427	-44.417	68.634

References

"*ABAQUS/Standard Example Problems, Verification*", Theory. (1996). Habbit, Karlsson & Sorensen, Inc., Pawtucket, RI.

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NAFEMS. (1995). "*A Review of Benchmark Problems for Geometric Non-linear Behavior of 3-D Beams and Shells (SUMMARY)*", Publication R0024, National Engineering Laboratory, E. Kilbride, Glasgow, UK.