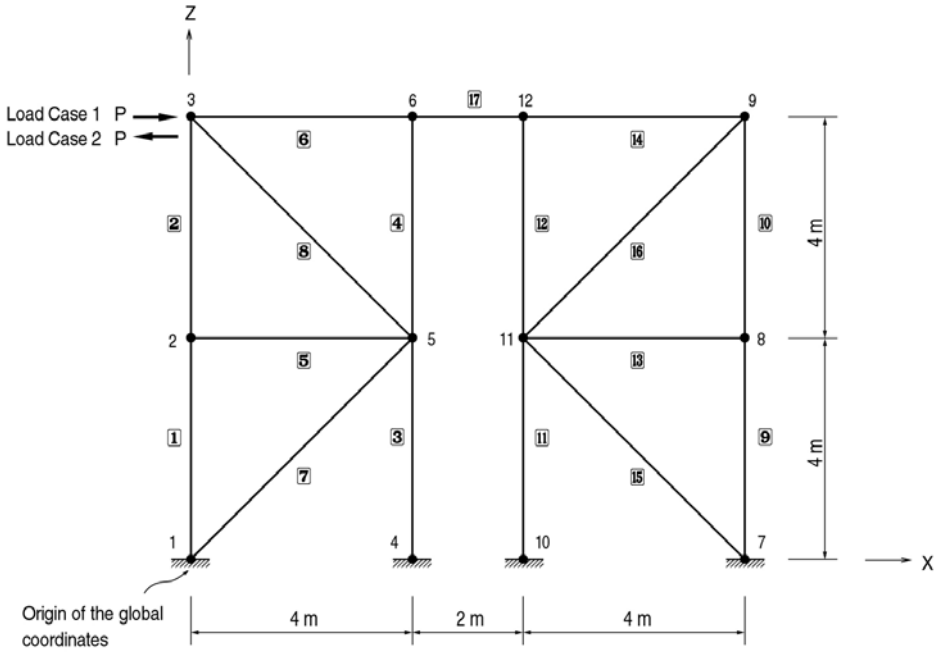
BNL-1

Title

Nonlinear analysis for a structure partially consisted of tension only elements

Description

Analyze a structure partially consisted of tension only elements



Structural geometry and analysis model

Model

Analysis Type

2-D nonlinear analysis (X-Z plane)

Unit System

mm, kgf

Element

Tension-only element and beam element

Material

Steel	Modulus of elasticity	$E = 2.1 \times 10^4$ kgf/mm2
	Poisson's ratio	$\nu = 0.3$

Section Property

Columns	1 ~ 4, 9 ~12	H 200 × 200 × 8/12 mm
Beams	5, 6, 13, 14 and 17	H 294 × 200 × 8/12 mm
Braces	7, 8, 15 and 16	L 100 × 100 × 7/7 mm

Tension-only elements are used for brace elements

Boundary Condition

Nodes 1, 4, 7 and 10 ; Constrain all DOFs.

Analysis Case

The number of iteration is 70 and the tolerance is 1×10^{-5} for the convergence.

Load Case

Loads are applied to the node 3 in the X direction.

Load Case 1, P = 2000 kgf

Load Case 2, P = -2000 kgf

Results

Displacements

	Node	Load	DX (mm)	DY (mm)	DZ (mm)	RX ([rad])	RY ([rad])	RZ ([rad])
▶	1	CASE1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	2	CASE1	0.451333	0.000000	0.023535	0.000000	0.000265	0.000000
	3	CASE1	4.282196	0.000000	0.034298	0.000000	0.000374	0.000000
	1	CASE2	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	2	CASE2	-3.682589	0.000000	-0.046298	0.000000	-0.000297	0.000000
	3	CASE2	-4.246805	0.000000	-0.078985	0.000000	-0.000059	0.000000

Member Forces

	Elem	Load	Force-I (kgf)	Force-J (kgf)
▶	7	CASE1	1403.8360	1403.8360
	8	CASE1	-0.946605	-0.946605
	15	CASE1	-0.919705	-0.919705
	16	CASE1	1512.9606	1512.9606
	7	CASE2	-0.914647	-0.914647
	8	CASE2	1540.6705	1540.6705
	15	CASE2	1385.2079	1385.2079
	16	CASE2	-0.941400	-0.941400

Results of MIDAS/Civil

Load Case 1

Unit : mm, kgf

Result		Tension-only elements incorporated	Braces under compression eliminated
Displacement	X displacement at the node 3	4.2822	4.2846
Member force	Axial force of the element 7	1403.8	1403.9
	Axial force of the element 16	1513.0	1513.1

Load Case 2

Unit : mm, kgf

Result		Tension-only elements incorporated	Braces under compression eliminated
Displacement	X displacement at the node 3	-4.2468	-4.2492
Member force	Axial force of the element 8	1540.7	1540.9
	Axial force of the element 15	1385.2	1385.3

※ A nonlinear analysis undergone through an iteration method can be reliable only when the results are fully converged.
The results of the nonlinear analysis containing tension and/or compression only elements should be checked first for convergence. The results can be relied upon only when a sufficient convergence is achieved.