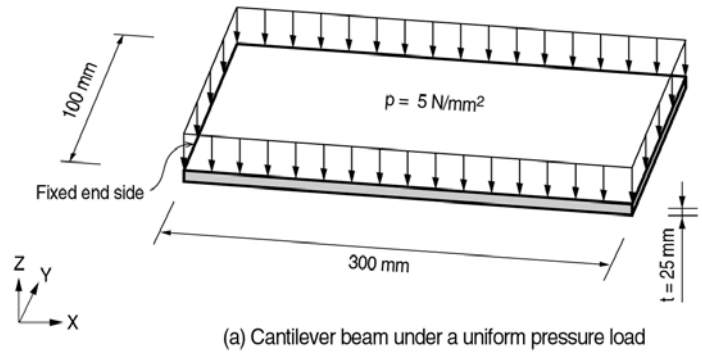
Static-13

Title

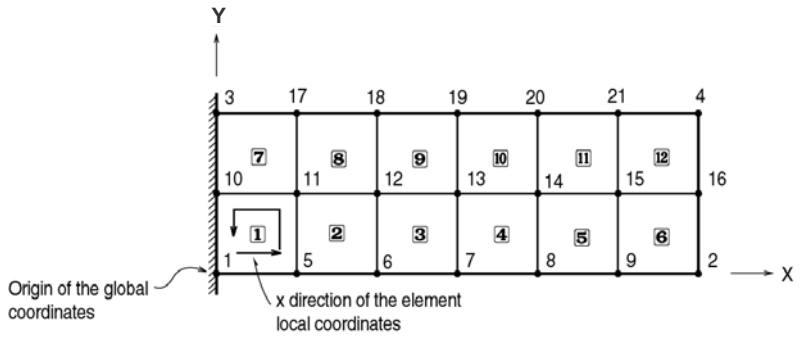
Cantilever plate subjected to a uniform pressure load

Description

Determine the deflections and the bending moments of the structure.



(a) Cantilever beam under a uniform pressure load



(b) Finite element model

Structural geometry and analysis model

Model

Analysis Type

3-D static analysis

Unit System

mm, N

Dimension

Length 300 mm Width 100 mm Thickness 25 mm

Element

Plate element (Thick type)

Material

Modulus of elasticity $E = 2.1 \times 10^5$ N/mm^2

Element Property

Size $a \times b = 50$ mm $\times$ 50 mm

Thickness $t = 25$ mm

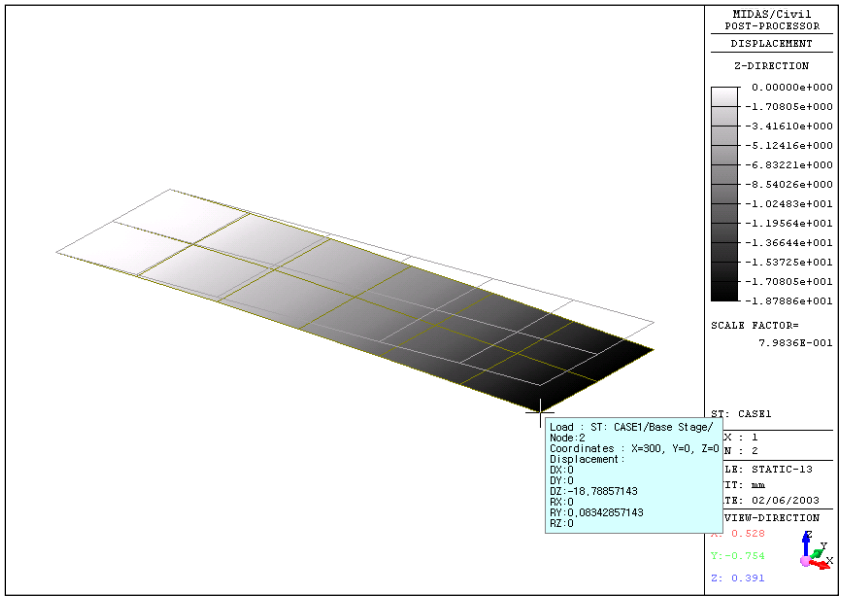
Boundary Condition

Nodes 1, 3 and 10 ; Constrain all DOFs.

Load Case

A uniform pressure load, 5 N/mm^{2}is distributed over the entire cantilever plate in the -Z direction.

Results



Z-displacements shape of the structure (Node 2)

Element Forces

	Elem	Load	Node	FX (N)	FY (N)	FZ (N)	MX (N·mm)	MY (N·mm)	MZ (N·mm)
	1	CASE1	1	0,00	0,00	37500,00	0,00	-5625000,0	0,00
	1	CASE1	5	0,00	0,00	-31250,00	0,00	3906250,00	0,00
	1	CASE1	11	0,00	0,00	-31250,00	0,00	3906250,00	0,00
	1	CASE1	10	0,00	0,00	37500,00	0,00	-5625000,0	0,00
	7	CASE1	10	0,00	0,00	37500,00	0,00	-5625000,0	0,00
	7	CASE1	11	0,00	0,00	-31250,00	0,00	3906250,00	0,00
	7	CASE1	17	0,00	0,00	-31250,00	0,00	3906250,00	0,00
	7	CASE1	3	0,00	0,00	37500,00	0,00	-5625000,0	0,00

Comparison of Results

Theoretical calculation of the maximum deflection and bending moment

Maximum deflection (δ_{max})

$$= \frac{\omega L^2}{8El} + \frac{\omega L^2}{2GAs} \text{ (at the free end)}$$

$$= \frac{(5\times100)(300)^4}{8\times(210\times10^3)(100\times25^3/12)} + \frac{6/5\times(5\times100)(300)^2}{2\times105\times5/6(100\times25)}$$

$$= 8.51 \text{ mm}$$

Maximum bending moment (M_{max}) = $\omega L^2/2$ (at the fixed end)

$$= (5 \times 100)\,(300)^2 / 2$$

$$= 22.5 \times 10^6 \text{ N·mm}$$

FEM analysis of the maximum deflection and bending moment

Maximum deflection (δ_{max}) = 18.62 mm (nodes 2, 16 and 4 at the free end)

Maximum bending moment (M_{max}) = Number of nodes pertaining to the fixed end elements × the bending moment at one node (nodes 1&10 of the element 1and nodes 3 &10 of the element 7)

$= 4 \times 5625000$ N·mm

$= 22.5 \times 10^6$ N·mm

Unit : mm, KNm

Result	Theoretical	SAP2000	MIDAS/Civil
Maximum deflection (δ_{max})	18.617	18.788	18.789
Maximum bending moment (M_{max})	22.50×10^6	22.50×10^6	22.5×10^6

Reference

Gere & Timoshenko,*"Mechanics of Material",*1984