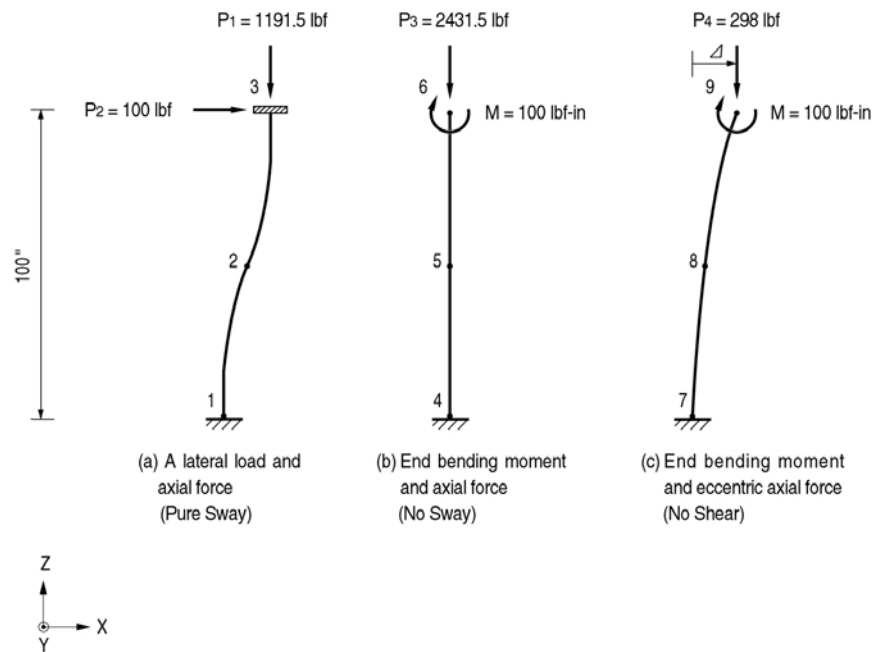# PDelta-2

Title

P-Delta effect analyses for three planar columns.

Description

Perform P-Delta effect analyses for 3 different columns cases (Pure Sway, No Sway and No Shear) .

Compute the maximum displacements, shear forces and internal moments for each case.

Structural geometry and analysis model

Model

Analysis Type
2-D, P-Delta effect analysis

Unit System
in, lbf

Dimension
Length   L = 100.0 in
Relative displacement tolerance   0.001

Element
Beam element

Material
Modulus of elasticity $E = 29.0 \times 10^6$ psi

Section Property
Area $A = 1.0$ in^2
Moment of inertia $I_{yy} = 1/12$ in^4

Boundary Condition
Nodes 1, 4 and 7   ; Constrain all DOFs.
Node 3   ; Constrain Ry.
Node 6   ; Constrain Dx.

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Analysis Case

Pure Sway ; An axial force, P_1 =1191.5 lbf is applied to the node 3 in the −Z
direction,and a lateral force, P_2 =100.0 lbf is applied to the node 3 in
the X direction.

No Sway ; An axial load, P_3=2431.5 lbf is applied to the node 6 in the -Z direction
and a bending moment about Y axis, 100.0 lbf-in is applied at the node 6.

No Shear ; An axial force, P_4 =298.0 lbf is applied at the node 9 in the -Z direction
and a bending moment about Y axis, 100.0 lbf-in is applied to the node 9.

Maximum number of iteration for the P-Delta effect analyses = 5

Results

Displacements

	Node	Load	DX (in)	DY (in)	DZ (in)	RX ([rad])	RY ([rad])	RZ ([rad])
▶	1	CASE1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	2	CASE1	3.409781	0.000000	-0.002054	0.000000	0.104485	0.000000
	3	CASE1	6.819561	0.000000	-0.004109	0.000000	0.000000	0.000000
	4	CASE1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	5	CASE1	-0.026859	0.000000	-0.004192	0.000000	-0.000477	0.000000
	6	CASE1	0.000000	0.000000	-0.008384	0.000000	0.001679	0.000000
	7	CASE1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	8	CASE1	0.113437	0.000000	-0.000514	0.000000	0.004420	0.000000
	9	CASE1	0.419673	0.000000	-0.001028	0.000000	0.007513	0.000000

Member Forces

	Elem	Load	Part	Axial (lbf)	Shear-y (lbf)	Shear-z (lbf)	Torsion (lbf·in)	Moment-y (lbf·in)	Moment-z (lbf·in)
▶	1	CASE1	i	-1191.50	0.00	100.00	0.00	9062.75	0.00
	1	CASE1	1/4	-1191.50	0.00	100.00	0.00	6797.07	0.00
	1	CASE1	2/4	-1191.50	0.00	100.00	0.00	4531.38	0.00
	1	CASE1	3/4	-1191.50	0.00	100.00	0.00	2265.69	0.00
	1	CASE1	j	-1191.50	0.00	100.00	0.00	0.00	0.00
	2	CASE1	i	-1191.50	0.00	100.00	0.00	0.00	0.00
	2	CASE1	1/4	-1191.50	0.00	100.00	0.00	-2265.69	0.00
	2	CASE1	2/4	-1191.50	0.00	100.00	0.00	-4531.38	0.00
	2	CASE1	3/4	-1191.50	0.00	100.00	0.00	-6797.07	0.00
	2	CASE1	j	-1191.50	0.00	100.00	0.00	-9062.75	0.00
	3	CASE1	i	-2431.50	0.00	-2.01	0.00	-101.18	0.00
	3	CASE1	1/4	-2431.50	0.00	-2.01	0.00	-59.71	0.00
	3	CASE1	2/4	-2431.50	0.00	-2.01	0.00	-18.23	0.00
	3	CASE1	3/4	-2431.50	0.00	-2.01	0.00	23.24	0.00
	3	CASE1	j	-2431.50	0.00	-2.01	0.00	64.72	0.00
	4	CASE1	i	-2431.50	0.00	-2.01	0.00	64.72	0.00
	4	CASE1	1/4	-2431.50	0.00	-2.01	0.00	73.54	0.00
	4	CASE1	2/4	-2431.50	0.00	-2.01	0.00	82.36	0.00
	4	CASE1	3/4	-2431.50	0.00	-2.01	0.00	91.18	0.00
	4	CASE1	j	-2431.50	0.00	-2.01	0.00	100.00	0.00
	5	CASE1	i	-298.00	0.00	0.00	0.00	225.06	0.00
	5	CASE1	1/4	-298.00	0.00	0.00	0.00	216.61	0.00
	5	CASE1	2/4	-298.00	0.00	0.00	0.00	208.16	0.00
	5	CASE1	3/4	-298.00	0.00	0.00	0.00	199.71	0.00
	5	CASE1	j	-298.00	0.00	0.00	0.00	191.26	0.00
	6	CASE1	i	-298.00	0.00	0.00	0.00	191.26	0.00
	6	CASE1	1/4	-298.00	0.00	0.00	0.00	168.44	0.00
	6	CASE1	2/4	-298.00	0.00	0.00	0.00	145.63	0.00
	6	CASE1	3/4	-298.00	0.00	0.00	0.00	122.81	0.00
	6	CASE1	j	-298.00	0.00	0.00	0.00	100.00	0.00

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Comparison of Results

Unit : in, lbf-in, rad

Case	Result	Theoretical	SAP2000	MIDAS/Civil
Pure Sway	Lateral displacement at the top	6.849	6.823	6.820
	End moment	9084.0	9064.9	9062.8
No Sway	Rotational displacement at the top	0.00170	0.00168	0.00168
	End moment	-102.0	-101.2	-101.2
	End shear	-2.02	-2.01	-2.01
No Shear	Lateral displacement at the top	0.420	0.420	0.420
	Rotational displacement at the top	0.00752	0.00751	0.00751
	End moment	225.2	225.0	225.1

References

Livesley, R. K., and Chandler, D. B., "*Stability Functions for Structural Frameworks*", Manchester University Press, UK, 1956.

"*SAP90, A Series of Computer Programs for the Finite Element Analysis of Structures, Structural Analysis Verification Manual*", Computer and Structures, Inc., 1992, Example 26.