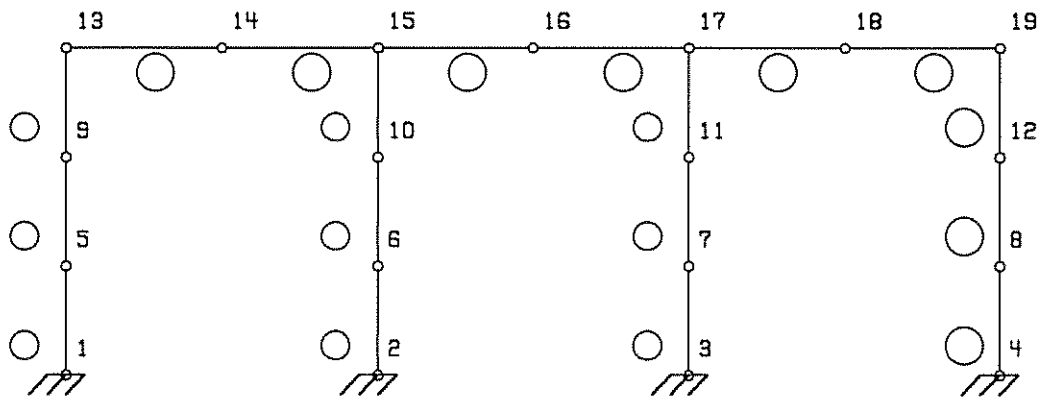


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NONLINEAR PLANE FRAME ANALYSIS



PLANE FRAME MODEL

DESIGN DATA:

Type of Frame: PLANE FRAME
Number of Joints = 19
Number of Members = 18
Number of Supports= 4
Number of Loadings= 1
Number of Load Combinations= 0
Default Length Unit: FEET
Default Force Unit: KIPS
Material 1:STEEL
Modulus of Elasticity=29000 ksi
Coefficient of Thermal Expansion=0.0000064/F
Poisson's Ratio = .30
Unit weight = .490 kcf
Material 2:CONCRETE (DEFAULT)
Modulus of Elasticity= 4030 ksi
Coefficient of Thermal Expansion=0.0000060/F
Poisson's Ratio = .20
Unit weight = .150 kcf

Theory:

This program performs an non-linear frame structural analysis using the "Newton-Raphson Method" (refer to "Stability Design of Steel Frames by Chen and Lui", p. 187). A load case is applied incrementally to the structure. The finite element model is revised for each iteration based on the current geometry. Plastic moment hinges are introduced at ends of members once moments reach plastic moment capacity.

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MADE BY:KJH DATE:11-05-2014
TITLE: Example UNLINEAR calculation

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NONLINEAR PLANE FRAME ANALYSIS

JOINT COORDINATES

Joint No.	X (ft)	Y (ft)	Z (ft)	Support Fixity					
				x	y	z	mx	my	mz
1	0.00	0.00	0.00	Y	Y				Y
2	10.00	0.00	0.00	Y	Y				Y
3	20.00	0.00	0.00	Y	Y				Y
4	30.00	0.00	0.00	Y	Y				Y
5	0.00	3.33	0.00						
6	10.00	3.33	0.00						
7	20.00	3.33	0.00						
8	30.00	3.33	0.00						
9	0.00	6.66	0.00						
10	10.00	6.66	0.00						
11	20.00	6.66	0.00						
12	30.00	6.66	0.00						
13	0.00	10.00	0.00						
14	5.00	10.00	0.00						
15	10.00	10.00	0.00						
16	15.00	10.00	0.00						
17	20.00	10.00	0.00						
18	25.00	10.00	0.00						
19	30.00	10.00	0.00						

FIRM:DesignCalcs, Inc.
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TITLE: Example UNLINEAR calculation

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NONLINEAR PLANE FRAME ANALYSIS

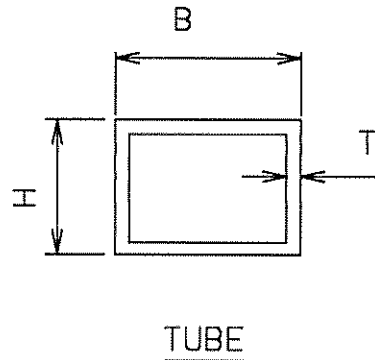
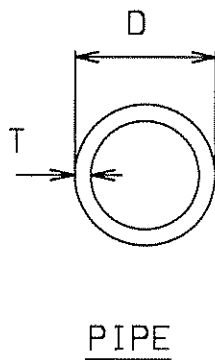
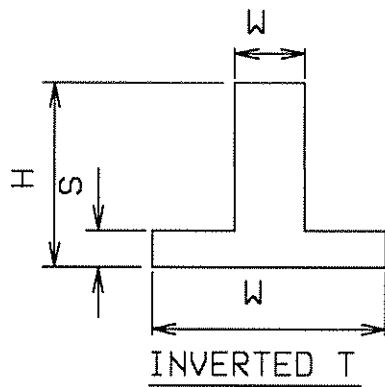
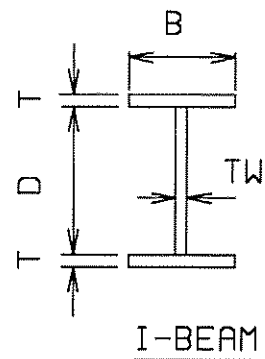
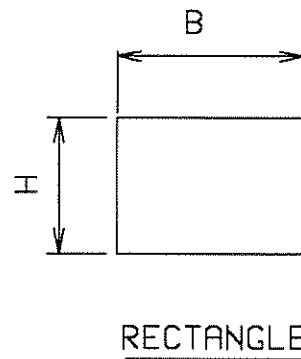
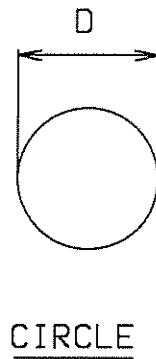
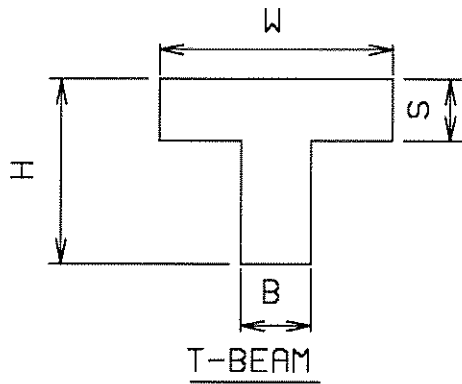
MEMBER INCIDENCES:

Member No.	Begin Jt.	End Jt.	Hinge At begin?	Hinge At end?	Ratio of Gross Properties
1	1	5			1.000
2	5	9			1.000
3	9	13			1.000
4	2	6			1.000
5	6	10			1.000
6	10	15			1.000
7	3	7			1.000
8	7	11			1.000
9	11	17			1.000
10	4	8			1.000
11	8	12			1.000
12	12	19			1.000
13	13	14			1.000
14	14	15			1.000
15	15	16			1.000
16	16	17			1.000
17	17	18			1.000
18	18	19			1.000

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NONLINEAR PLANE FRAME ANALYSIS

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MEMBER PROPERTIES:

- 1 Rectangle:B=1ft, H=1ft,STEEL,Beta=0.00 deg.
- 2 Clone Member:1
- 3 Clone Member:1
- 4 Clone Member:1
- 5 Clone Member:1
- 6 Clone Member:1
- 7 Clone Member:1
- 8 Clone Member:1
- 9 Clone Member:1
- 10 Clone Member:1
- 11 Clone Member:1
- 12 Clone Member:1
- 13 Clone Member:1
- 14 Clone Member:1
- 15 Clone Member:1
- 16 Clone Member:1
- 17 Clone Member:1
- 18 Clone Member:1

FIRM:DesignCalcs, Inc.
MADE BY:KJH DATE:11-05-2014
TITLE: Example UNLINEAR calculation

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NONLINEAR PLANE FRAME ANALYSIS

MEMBER PLASTIC MOMENT CAPACITIES AT ENDS:

Member No.	Begin Jt.	MpZ at Begin Jt. (K*Ft)	End Jt.	MpZ at End Jt (K*Ft)
1	1	20.00	5	20.00
2	5	20.00	9	20.00
3	9	20.00	13	20.00
4	2	20.00	6	20.00
5	6	20.00	10	20.00
6	10	20.00	15	20.00
7	3	20.00	7	20.00
8	7	20.00	11	20.00
9	11	20.00	17	20.00
10	4	20.00	8	20.00
11	8	20.00	12	20.00
12	12	20.00	19	20.00
13	13	20.00	14	20.00
14	14	20.00	15	20.00
15	15	20.00	16	20.00
16	16	20.00	17	20.00
17	17	20.00	18	20.00
18	18	20.00	19	20.00

FIRM:DesignCalcs, Inc.
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TITLE: Example UNLINEAR calculation

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NONLINEAR PLANE FRAME ANALYSIS

LOADINGS:

LOAD 1-50 k horizontal load at top
JOINT LOADS
JT 13 FX=50

FIRM:DesignCalcs, Inc.
MADE BY:KJH DATE:11-05-2014
TITLE: Example UNLINEAR calculation

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NONLINEAR PLANE FRAME ANALYSIS

PLASTIC HINGE FORMATION HISTORY:

Member No.	Plastic Hinge At Joint No.	Formed at Load	
4	2	.300 x LOAD	1
7	3	.334 x LOAD	1
1	1	.338 x LOAD	1
10	4	.355 x LOAD	1
6	15	.360 x LOAD	1
9	17	.367 x LOAD	1
13	13	.368 x LOAD	1
18	19	.386 x LOAD	1

FIRM:DesignCalcs, Inc.
MADE BY:KJH DATE:11-05-2014
TITLE: Example UNLINEAR calculation

JOB NO.123
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NONLINEAR PLANE FRAME ANALYSIS

JOINT NO. 19 DISPLACEMENT HISTORY DUE TO LOAD 1						
Load Ratio	X-Trans (in)	Y-Trans (in)	Z-Trans (in)	X-Rotan (rad)	Y-Rotan (rad)	Z-Rotan (rad)
0.050	0.01695	-0.00008	0.00000	0.00000	0.00000	-0.00009
.100	0.03391	-0.00017	0.00000	0.00000	0.00000	-0.00018
.150	0.05087	-0.00026	0.00000	0.00000	0.00000	-0.00028
.200	0.06783	-0.00035	0.00000	0.00000	0.00000	-0.00037
.250	0.08479	-0.00044	0.00000	0.00000	0.00000	-0.00047
.284	0.09638	-0.00051	0.00000	0.00000	0.00000	-0.00053
.288	.09793	-0.00052	0.00000	0.00000	0.00000	-0.00054
.305	.10794	-0.00057	0.00000	0.00000	0.00000	-0.00060
.310	.11255	-0.00059	0.00000	0.00000	0.00000	-0.00063
.317	.12238	-0.00063	0.00000	0.00000	0.00000	-0.00066
.318	.12441	-0.00064	0.00000	0.00000	0.00000	-0.00067
.336	.19500	-0.00083	0.00000	0.00000	0.00000	-0.00094
.337	.20011	-0.00085	0.00000	0.00000	0.00000	-0.00096

FIRM:DesignCalcs, Inc.
MADE BY:KJH DATE:11-05-2014
TITLE: Example UNLINEAR calculation

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DATE:

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NONLINEAR PLANE FRAME ANALYSIS

STRUCTURE BECOMES A MECHANISM AT .337 x LOAD 1

JOINT DISPLACEMENTS DUE TO .337 x LOAD 1

Joint	X-Trans (in)	Y-Trans (in)	Z-Trans (in)	X-Rotan (rad)	Y-Rotan (rad)	Z-Rotan (rad)
1	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
2	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
3	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
4	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
5	0.06154	0.00020	0.00000	0.00000	0.00000	-0.00194
6	0.06110	-0.00017	0.00000	0.00000	0.00000	-0.00193
7	0.06052	0.00009	0.00000	0.00000	0.00000	-0.00191
8	0.05979	-0.00027	0.00000	0.00000	0.00000	-0.00190
9	.14272	0.00037	0.00000	0.00000	0.00000	-0.00195
10	.14159	-0.00037	0.00000	0.00000	0.00000	-0.00193
11	.14044	0.00016	0.00000	0.00000	0.00000	-0.00191
12	.13923	-0.00057	0.00000	0.00000	0.00000	-0.00191
13	.20534	0.00056	0.00000	0.00000	0.00000	-0.00100
14	.20403	-0.01071	0.00000	0.00000	0.00000	0.00028
15	.20272	-0.00055	0.00000	0.00000	0.00000	-0.00024
16	.20185	-0.00014	0.00000	0.00000	0.00000	0.00013
17	.20097	0.00026	0.00000	0.00000	0.00000	-0.00024
18	.20054	0.01042	0.00000	0.00000	0.00000	0.00028
19	.20011	-0.00085	0.00000	0.00000	0.00000	-0.00096

FIRM:DesignCalcs, Inc.
 MADE BY:KJH DATE:11-05-2014
 TITLE: Example UNLINEAR calculation

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NONLINEAR PLANE FRAME ANALYSIS

MEMBER END FORCES DUE TO .337 x LOAD 1							
Member	Jt	Axial (k)	Shear-Y (k)	Shear-Z (k)	Torsion (k*ft)	Mom-Y (k*ft)	Mom-Z (k*ft)
1	1	-3.46	3.51	0.00	0.00	0.00	20.00
	1	5.00	3.46	3.51	0.00	0.00	0.00
2	5	-3.46	3.44	0.00	0.00	0.00	5.90
	1	9.00	3.46	3.44	0.00	0.00	0.00
3	9	-3.46	3.44	0.00	0.00	0.00	-8.03
	1	13.00	3.46	3.44	0.00	0.00	0.00
4	2	1.98	3.52	0.00	0.00	0.00	20.00
	1	6.00	-1.98	3.52	0.00	0.00	0.00
5	6	1.98	3.49	0.00	0.00	0.00	5.79
	1	10.00	-1.98	3.49	0.00	0.00	0.00
6	10	1.98	3.49	0.00	0.00	0.00	-8.34
	1	15.00	-1.98	3.49	0.00	0.00	0.00
7	3	-1.98	3.52	0.00	0.00	0.00	20.00
	1	7.00	1.98	3.52	0.00	0.00	0.00
8	7	-1.98	3.49	0.00	0.00	0.00	5.79
	1	11.00	1.98	3.49	0.00	0.00	0.00
9	11	-1.98	3.49	0.00	0.00	0.00	-8.34
	1	17.00	1.98	3.49	0.00	0.00	0.00
10	4	3.46	3.51	0.00	0.00	0.00	20.00
	1	8.00	-3.46	3.51	0.00	0.00	0.00
11	8	3.46	3.44	0.00	0.00	0.00	5.90
	1	12.00	-3.46	3.44	0.00	0.00	0.00
12	12	3.46	3.44	0.00	0.00	0.00	-8.02
	1	19.00	-3.46	3.44	0.00	0.00	0.00
13	13	12.67	-3.16	0.00	0.00	0.00	-20.00
	1	14.00	-12.67	-3.16	0.00	0.00	0.00
14	14	12.67	-3.16	0.00	0.00	0.00	-2.70
	1	15.00	-12.67	-3.16	0.00	0.00	0.00
15	15	8.43	-1.35	0.00	0.00	0.00	-7.08
	1	16.00	-8.43	-1.35	0.00	0.00	0.00

FIRM:DesignCalcs, Inc.
 MADE BY:KJH DATE:11-05-2014
 TITLE: Example UNLINEAR calculation

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NONLINEAR PLANE FRAME ANALYSIS

MEMBER END FORCES DUE TO .337 x LOAD 1

Member	Jt	Axial (k)	Shear-Y (k)	Shear-Z (k)	Torsion (k*ft)	Mom-Y (k*ft)	Mom-Z (k*ft)
16	16	8.43	-1.35	0.00	0.00	0.00	.32
	1	17.00	-8.43	-1.35	0.00	0.00	0.00
17	17	4.18	-3.16	0.00	0.00	0.00	-13.09
	1	18.00	-4.18	-3.16	0.00	0.00	0.00
18	18	4.18	-3.16	0.00	0.00	0.00	4.21
	1	19.00	-4.18	-3.16	0.00	0.00	0.00

SUPPORT REACTIONS DUE TO .337 x LOAD 1

Joint	Force-X (k)	Force-Y (k)	Force-Z (k)	Mom-X (k*ft)	Mom-Y (k*ft)	Mom-Z (k*ft)
1	-3.52	-3.46	0.00	0.00	0.00	20.00
2	-3.52	1.98	0.00	0.00	0.00	20.00
3	-3.53	-1.98	0.00	0.00	0.00	20.00
4	-3.51	3.46	0.00	0.00	0.00	20.00