

Example 1 – Investigation of a Slender Nonsway Column

Determine the adequacy of a 4" x 20" column¹ with 3-#11 bars on each 14" side in a nonsway frame with a clear height of 22'6". Use k=1.0.

The concrete used is 6000 psi and the reinforcing steel is 60,000 psi.

The factored load values for the column under consideration are as follows:

P (kip)115 kipsTop Muy (kip-ft)279 ft-kipsBottom Muy (kip-ft)-279 ft-kips

From the **File** menu, choose **New**. Any input data is cleared and the default values are restored.

- 1. From the **Input** menu, choose **General Information**.
 - Input the PROJECT header.
 - Select ENGLISH units and ACI 318-14 code.
 - Select Biaxial for run axis, Investigation for run option and Yes for Consider Slenderness?
 - Choose OK.

2. From the Input menu, choose Material Properties.

- Input 4.5 for the CONCRETE STRENGTH. Change the REINFORCING STEEL STRENGTH to 50. Other properties are computed and will be accepted.
- Choose Ok.

Material Properties	X
Concrete	Reinforcing Steel
Strength, flc: 4.5 ksi	Strength, fy: 50 ksi
🔽 Standard	🔽 Standard
Elasticity, Ec: 3823.68 ksi	Elasticity, Es: 29000 ksi
Max stress, fc: 3.825 ksi	
Beta(1): 0.825	Compression-controlled strain limit,
Ultimate strain: 0.003	Eps_yt: 0.00172414
<u>0</u> K	Cancel

From the Input menu, choose Section | Rectangular.

- Input 20 and 14 for the section width (along X) and depth (along Y).
- Choose OK.

General Information	1
Labels Project:	
spColumn Manual Example 2	
Column: Engineer:	
Wang 15.18.5 SP	
Design Code	-
ACI 318-14	
C English	
C Metric C Design	
C About X-Avia	
C About Y-Axis	
Consider slenderness? Yes No	
<u>D</u> K <u>C</u> ancel	

¹ Based on Example 15.8.5 from Reinforced Concrete Design by Chu-Kia Wang, Charles G. Salmon, and Jose A. Pincheira, Seventh Edition, 2007, John Wiley and Sons, Inc.





Sides Different							
	Top Bottom Left Right No. of bars: 2 2 1 1]					
Rectangular Section	Clear cover: 1.5 1.5 1.5 1.5 1.5	in					
Depth (along Y): 14 in	C Transverse bars © Longitudinal bars						
<u>DK</u> <u>Cancel</u>	<u>O</u> K <u>C</u> ancel						

- 3. From the Input menu, choose Reinforcement | Sides Different.
 - Input 2-#11 bars for TOP and BOTTOM and 1-#11 for LEFT and RIGHT. Input 1.5 in for the cover and select LONGITUDINAL BARS.
 - Choose OK.
- 4. From the Input menu, choose Slenderness | Design Column.
 - Input 22.5 for the column CLEAR HEIGHT.
 - Check NONSWAY FRAME and select INPUT 'K' FACTORS.
 - Choose OK.

Design Column	X
X-Axis	Y-Axis
Clear height: 22.5 ft	Clear height: 22.5 ft
Nonsway frame	Nonsway frame
C Sway frame	C Sway frame
Sway criteria	Sway criteria
(Sum Pc)/(Pc): 1	(Sum Pc)/(Pc): 1
(Sum Pu)/(Pu): 1	(Sum Pu)/(Pu): 1
☑ 2'nd order effects along length	☑ 2'nd order effects along length
Effective length factors	Effective length factors
C Compute 'k' factors	C Compute 'k' factors
Input 'k' factors:	Input 'k' factors:
k(ns): 1 k(s): 0	k(ns): 1 k(s): 0
Copy to Y-Axis	Copy to <u>X</u> -Axis
	Cancel

- 5. From the Input menu, choose Loads | Service.
 - Under LIVE, input 71.875 for the AXIAL LOAD, 0 for the X-MOMENTS @TOP, 0 for the X-MOMENTS @BOT, 174.375 for the Y-MOMENTS @TOP and -174.375 for the Y-MOMENTS @BOTTOM, respectively.
 - In column SUSTAINED LOAD keep default setting for dead load equal 100%.
 - Choose INSERT to add the entry to the list box.
 - Choose OK .





Service	Loads			X			
	-Axial Load (kip)-	-X-Moments (k-ft)	Y-Moments (k-ft)	Sustained Load (%)			
Dead: Live:	0 71.875		0 0 174.375 -174.375	0			
Wind: EQ:	0						
No. (P, 1	Insert Modify Delete						
	<u>D</u> K <u>C</u> ancel						

- 6. From the Input menu, choose Loads | Load Combinations.
 - If the list displays thirteen combinations, choose only the second load combination U2 and delete all the others by selecting them and using DELETE. Choose OK.

Load Comb	inations			
Dead 1.2 +	Live 1.6 +	Wind	EQ O	Snow + 0.5
Insert	Modify	D	elete	Defaults
Combo Dea	d Live	Wind	EQ	Snow
U1 1.2	1.6	0	0	0.5
		1		1
	OK		Cancel	

- 7. From the **Solve** menu, choose **Execute**.
 - The solver of the program is started and, upon completion, displays the interaction diagram of the section with the load point plotted within the diagram.
- 8. From the View menu, choose Results.





- Page through the results file.
- Choose FILE | EXIT to quit the spView program and get back to spColumn.

9. From the File menu, choose Print Results.

- Select the printer to send the text results to.
- Choose PRINT.
- 10. From the File menu, choose Print Screen.
 - Select the printer to send the graphical results to.
 - Choose PRINT.









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STRUCTUREPOINT - spColumn v5.50 (TM) Licensed to: StructurePoint. License ID: 00000-0000000-4-2A05D-2206F C:\Program Files (x86)\StructurePoint\spColumn\Examples\Examples-Manual\Example02.col General Information: File Name: C:\Program Files (x86)\StructurePoint\spColumn\Examples\Examples-Manual\Example02.col Project: spColumn Manual Example 2 Column: Wang 15.18.5 Code: ACI 318-14 Engineer: SP Units: English Run Option: Investigation Slenderness: Considered Run Axis: Biaxial Column Type: Structural Material Properties: Concrete: Standard Steel: Standard f'c = 4.5 ksi Ec = 3823.68 ksi fc = 3.825 ksi fy = 50 ksi Es = 29000 ksi Eps_yt = 0.00172414 in/in $Eps_u = 0.003 in/in$ Betal = 0.825 Section: Rectangular: Width = 20 in Depth = 14 in Gross section area, $Ag = 280 \text{ in}^2$ Ix = 4573.33 in⁴ rx = 4.04145 in Iy = 9333.33 in^4 ry = 5.7735 in Xo = 0 in $Y_0 = 0$ in Reinforcement: Bar Set: ASTM A615 Size Diam (in) Area (in^2) Size Diam (in) Area (in^2) Size Diam (in) Area (in^2) # 4 # 7 # 3 0.38 0.11 0.50 0.20 # 5 0.63 0.31 # 6 0.88 # 8 0.75 0.44 0.60 1.00 0.79 # 9 1.13 1.00 # 10 # 18 1.27 1.27 # 11 1.41 1.56 # 14 1.69 2.25 2.26 4.00 Confinement: Tied; #3 ties with #11 bars, #4 with larger bars. phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65Layout: Rectangular Pattern: Sides Different (Cover to longitudinal reinforcement) Total steel area: As = 9.36 in^2 at rho = 3.34% Minimum clear spacing = 3.39 in Тор Bottom Left Right 2 #11 2 #11 1 #11 1 #11 Bars Cover(in) 1.5 1.5 1.5 1.5 Service Loads: Mx @ Top Mx @ Bot Му @ Тор My @ Bot Load Axial Load No. Case kip k-ft k-ft k-ft k-ft 1 Dead 0.00 0.00 0.00 0.00 0.00 71.88 0.00 -174.38 Live 0.00 174.38 0.00 0.00 0.00 0.00 Wind EQ 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 Snow 0.00 0.00 Sustained Load Factors: Load Factor Case (8) 100 Dead Live 0 0 Wind 0 EQ Snow 0

Load Combinations:

U1 = 1.200*Dead + 1.600*Live + 0.000*Wind + 0.000*EarthQuake + 0.500*Snow

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Slenderness:



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Sway Cr:	iteri	a:											
X-axis: Y-axis:	Nons Nons	way column way column											
Column A	Axis	Height ft	Width in	Deptl i	h n	I in^4	1	f'c ksi	k	EC			
Design Above Below	X Y X Y X Y Y	22.5 22.5 (no column (no column (no column (no column	20 20 specified specified specified	14 14)))	 4 4	4573.33 9333.33	3	4.5 4.5	3823. 3823.	68 68			
X-Beams Location	n	Length ft	Width in	Deptl ii	h n	in^4	C 1	f'c ksi	k	Ec si			
Above Le Above R Below Le Below R	eft ight eft ight	(no beam s (no beam s (no beam s (no beam s	<pre>specified) specified) specified) specified)</pre>										
Y-Beams Location	n	Length ft	Width in	Deptl ii	h n	in^4	C 1	f'c ksi	k	EC			
Above Le Above R: Below Le Below R:	eft ight eft ight	(no beam s (no beam s (no beam s (no beam s	<pre>specified) specified) specified) specified)</pre>										
Effectiv	ve Le	ngth Facto	rs:										
Axis	Psi	(top) I	Psi(bot) k(1	Nonswa	y) 	k (Sway	()	klı	u/r 				
X Y		0.000 0.000	0.000	1.0	00 00	(N/2 (N/2	4) 4)	66 46	.81				
foment Ma	anifi	cation Fact	tore			25 - 52							
Stiffne Cracked 0.2*Ec* 0.2*Ec*	ss re -sect Ig + Ig +	duction fac ion coeffic Es*Ise (X-a Es*Ise (Y-a	ctor, phi(K) = cients: cI(bea axis) = 7.666 axis) = 2.366	= 0.75 ams) = e+006 1 e+007 1	0.35 kip-in kip-in	; cI(co] ^2 ^2	Lumns)	= 0.7					
X-axis			At Ends							Along Leng	th		
Ld/Comb	SumP	u(kip) I 	PC(Kip) SumPc	(K1p) (N/A)	(N/A)	Deltas		u(kip)	k'lu/r 	PC(K1p)	Betad		Delta 1 174
V-avis		(N/A)	(N/A)	(N/A)	(N/A)	(N/A)			(N/A/	Along Leng	th	1.000	1.1/4
Ld/Comb	SumP	u(kip) 1	Pc(kip) SumPc	(kip) 1	Betads	Deltas	P	u(kip)	k'lu/r	Pc(kip)	Betad	Cm	Delta
1 U1		(N/A)	(N/A)	(N/A)	(N/A)	(N/A)		115.00	(N/A)	3199.27	0.000	1.000	1.050
Factored 1	Momen	ts due to I	First-Order a	nd Sec	ond-Or	der Effe	ects:						
Minimum Minimum	ecce ecce	ntricity, I ntricity, I	Ex,min = 1.02 Ey,min = 1.2	in in									
NOTE: E F Se	acn ⊥ irst econd	oading com line - at line - at	column top column botto	udes ti m	ne Iol	lowing d	cases:						
X-axis Load		 Mns	1st Order Ms		Mu		Mmin		2nd	l Order Mi	 Mc	- Ratio	o - st
Combo		k-ft	k-ft		k-ft		k-ft		k-	ft	k-ft		
1 U1		0.00	(N/A) (N/A)		0.00		9.78 9.78	M1= M2=	0. -0.	00 00	11.47 11.47	1.1 1.1	L74 L74
Y-axis			1st Order						2nd	Order		- Ratio	- -
Load Combo		Mns k-ft	Ms k-ft		Mu k-ft		Mmin k-ft		k-	Mi ft	Mc k-ft	2nd/1s	st
1 U1		279.00 279.00	(N/A) (N/A)	2' 2'	79.00 79.00		11.50 11.50	M1= M2=	279. 279.	00 2 00 2	93.04 93.04	1.0)50)50



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Factored Loads and Moments with Corresponding Capacities:

NOTE: Each loading combination includes the following cases:

	First Secor	: line – at nd line – at	column top column bot	tom							
No.	Load Combo	Pu kip	Mux k-ft	Muy k-ft	PhiMnx k-ft	PhiMny k-ft	PhiMn/Mu	NA depth in	Dt depth in	eps_t	Phi
1	1 U1	115.00	11.47	293.04	13.83	353.32	1.206	5.19	18.77	0.00810	0.900
2		115.00	11.47	293.04	13.83	353.32	1.206	5.19	18.77	0.00810	0.900

*** End of output ***



Example 2 – Design of a Slender Column in a Sway Frame

Design a square column² with a clear height of 16 ft. The column is sway and subjected to dead, live and wind loads as shown below.

	<u>Dead</u>	<u>Live</u>	Wind
<i>P</i> (kip)	380	140	0
Top <i>M_x</i> (kip-ft)	32	20	50
Bottom <i>M</i> _x (kip- ft)	54	36	50

The column is to be checked for the following load combinations:

U1 = 1.2 D + 1.6 L

U2 = 1.2 D + 0.5 L + 1.6 W

The calculations in the reference are done based on the load combination U2.

In practice, the ratio $\Sigma P_c/P_c$ would have to be calculated before the problem can be attempted, using a trial value of $\Sigma P_c/P_c$. Here, the value of $\Sigma P_c/P_c$ used is 28.67 based on the reference value of P_c . There are 14 interior columns, 18 exterior columns and 4 corner columns. Therefore, the value of $\Sigma P_u/P_u = 14 + 18 * 2/3 + 4 * 1/3 = 27.33$ irrespective of the load combination being used.

- 1. From the **File** menu, choose **New**. Any input data is cleared and the default values are restored.
- 2. From the Input menu, choose General Information.
 - Input the PROJECT header.
 - Select English units and ACI 318-14 code.
 - Select About X-Axis for run axis, Design for run option and Yes for Consider slenderness?
 - Choose OK.
- 3. From the Input menu, pick Material Properties.
 - Input 5 for the concrete strength. Other properties are computed and will be accepted.
 - Choose OK.

General Information	×
-Labels Project:	
spColumn Manual Example 3	
Column: Engineer:	
Hassoun 12.4 SP	
Design Code]
ACI 318-14	
Units	
English O Investigation	
O Metric 💿 Design	
- Run Axis	
About X-Axis C Biaxial	
C About Y-Axis	
Consider slenderness? 💿 Yes 🔿 No	
<u>OK</u> <u>C</u> ancel	

² Based on Example 12.4, pp 409, from Structural Concrete: Theory and Design by M. Nadim Hassoun and Akthem Al-Manaseer, Fourth Edition, 2008, John Wiley and Sons, Inc.





Material Properties	X
Concrete	Reinforcing Steel
Strength, f'c: 5 ksi	Strength, fy: 60 ksi
✓ Standard	✓ Standard
Elasticity, Ec: 4030.51 ksi	Elasticity, Es: 29000 ksi
Max stress, fc: 4.25 ksi	
Beta(1): 0.8	Compression-controlled strain limit,
Ultimate strain: 0.003	Eps_yt: 0.00206897
<u>K</u>	Cancel

- 4. From the **Input** menu, pick **Section | Rectangular**.
 - Input 18 and 18 for the WIDTH (ALONG X) and DEPTH (ALONG Y) under both START and END options.
 - Choose OK.

Rectangular Section						
Start	End	Increment				
Width (along X): 1	18	0 in				
Depth (along Y): 18	18	0 in				
<u>D</u> K	<u>C</u> a	incel				

- 5. From the Input menu, choose Reinforcement | All Sides Equal
 - Input 4-#10 bars for Minimum, and 40-#10 bars for Maximum and 1.5 in for the cover, and select TRANSVERSE BARS and RECTANGULAR Bar Layout.
 - Choose OK.

All Sides Equal	
MinimumMaximumNo. of bars:40Bar size:#10 #10 #10 Clear cover:1.5	Cover to Transverse bars Longitudinal bars Bar Layout Rectangular Circular
<u>0</u> K	<u>C</u> ancel

- 6. From the Input menu, choose Slenderness | Design Column.
 - Input 16 for the column CLEAR HEIGHT.
 - Check SWAY FRAME
 - Under SWAY CRITERIA, input 28.67 and 27.33 for the Σ Pc/Pc and Σ Pu/Pu, respectively.
 - Leave 2ND ORDER EFFECT ALONG LENGTH option checked (default)
 - Select COMPUTE 'K' FACTORS.
 - Choose OK.





Design Column	X
-X-Axis	-Y-Axis
Clear height: 🕕 ft	Clear height: 16 ft
O Nonsway frame	C Nonsway frame
Sway frame	🖸 Sway frame
Sway criteria	Sway criteria
(Sum Pc)/(Pc): 28.67	(Sum Pc)/(Pc): 28.66
(Sum Pu)/(Pu): 27.33	(Sum Pu)/(Pu): 21.14
✓ 2'nd order effects along length	☑ 2'nd order effects along length
Effective length factors	Effective length factors
Compute 'k' factors	C Compute 'k' factors
C Input 'k' factors:	Input 'k' factors:
k(ns): 0.825 k(s): 1.406	k(ns): 0.8 k(s): 1.37
Copy to <u>Y</u> -Axis	Copy to ½-Axis
<u><u> </u></u>	Cancel

- 7. From the Input menu, choose Slenderness | Columns Above/Below.
 - Clear the NO COLUMN SPECIFIED option.
 - Input 11 for the column height (center-to-center) under HEIGHT (C/C) and leave the other data as is.
 - Choose Copy to Column Below.
 - Choose OK.

Columns Above and Below								
Column Above	Column Below							
No column specified	No column specified							
Height (c/c): 11 _{ft}	Height (c/c): 11 _{ft}							
Width (along X): 18 in	Width (along X): 18 in							
Depth (along Y): 18 in	Depth (along Y): 18 in							
Concrete, f'c: 5 ksi	Concrete, f'c: 5 ksi							
Ec: 4030. _{ksi}	Ec: 4030. ksi							
Copy to Column <u>B</u> elow	Copy to Column <u>A</u> bove							
<u>D</u> K <u>C</u> ancel								

- 8. From the Input menu, choose Slenderness | X-Beams.
 - Choose ABOVE LEFT.
 - Clear the NO BEAM SPECIFIED option.
 - Input 20 for the span (center-to-center) under SPAN(C/C).
 - Input 0.00 and 0.00 for the WIDTH and DEPTH, respectively.
 - Input 21436.6 for the moment of inertia under INERTIA.
 - Leave the other data as it is.
 - Choose ABOVE RIGHT and click on COPY FROM BEAM LEFT.
 - Choose BELOW LEFT and click on COPY FROM BEAM ABOVE.





- Choose BELOW RIGHT and click on COPY FROM BEAM ABOVE.
- Choose OK.

X-Beams (pe	erpend	icul	ar to X)	X
Beam Locatio	on:				
Above L	.eft	С	Above F	Right	
C Below L	eft	С	Below R	light	
Beam Above	Left				
🗌 No beam	specified	± _	Copy Fro	m Beam <u>F</u>	light
Span (c/c):	20	ft	f'c:	5	ksi
Width:	0	in	Ec:	4030.51	ksi
Depth:	0	in	Inertia:	21436.6	in^4
	<u>0</u> K			<u>C</u> ancel	

- 9. From the **Input** menu, choose **Loads | Service**.
 - Under DEAD, input 380, 32 and -54 for the AXIAL LOAD, X-MOMENTS and Y-MOMENTS respectively.
 - Under LIVE, input 140, 20 and -36 for the AXIAL LOAD, X-MOMENTS and Y-MOMENTS, respectively.
 - Under WIND, input 0, 50 and -50 for the AXIAL LOAD, X-MOMENTS and Y-MOMENTS, respectively.

Service	Loads			×					
[-Axial Load (kip)	-X-Moments (k-ft) @ Top @ Bot	Y-Moments (k-ft)	Sustained Load (%)					
Dead:	380	32 -54		100					
Live:	140	20 -36	0 0	0					
Wind:	0	50 -50	0 0	0					
EQ:	0	0 0	0	0					
Snow:	0	0 0	0 0	0					
No. [P, N 1 D [3	Snow: U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U U <thu< th=""> U <thu< th=""> <thu< th=""></thu<></thu<></thu<>								

- Under SUSTAINED LOAD keep the default settings of 100% for dead and 0% for all other load cases.
- Choose INSERT to add the entry to the list box.
- Choose OK.
- 10. From the Input menu, choose Loads | Load Combinations.



• If the list displays thirteen combinations, leave the first and second as they are. Delete the remaining combinations using DELETE.

11. From the **Solve** menu, choose **Execute**.

- The solver of the program is started and, upon completion, displays the interaction diagram of the section with the load points plotted within the diagram.
- 12. From the View menu, choose Results.
 - Page through the results file.
 - Choose Exit to quit the spView program and get back to spColumn.

13. From the File menu, choose Print Results.

- Select the printer to send the text results to.
- Choose PRINT.

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14. From the File menu, choose Print Screen.

- Select the printer to send the graphical results to.
- Choose PRINT.

Load Combinations								
Dead Liv 1.2 + 0.	/e 5 +	Wind 1.6 +	EQ O	Snow + 0.5				
Insert	Modify	De	elete	Defaults				
Combo Dead	Live	Wind	EQ	Snow				
U1 1.2	1.6 0.5	0	0	0.5				







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STRUCTUREPOINT - spColumn v5.50 (TM) Licensed to: StructurePoint. License ID: 00000-0000000-4-2A05D-2206F C:\Program Files (x86)\StructurePoint\spColumn\Examples\Examples-Manual\Example03.col General Information: File Name: C:\Program Files (x86)\StructurePoint\spColumn\Examples\Examples-Manual\Example03.col Project: spColumn Manual Example 3 Column: Hassoun 12.4 Engineer: SP Code: ACI 318-14 Units: English Run Option: Design Slenderness: Considered Run Axis: X-axis Column Type: Structural Material Properties: Concrete: Standard Steel: Standard f'c = 5 ksi Ec = 4030.51 ksi fc = 4.25 ksi fy = 60 ksi Es = 29000 ksi Eps_yt = 0.00206897 in/in $Eps_u = 0.003 in/in$ Betal = 0.8 Section: Rectangular: Width = 18 in Depth = 18 in Gross section area, $Ag = 324 \text{ in}^2$ Ix = 8748 in⁴ rx = 5.19615 in Iy = 8748 in^4 ry = 5.19615 in Xo = 0 in $Y_0 = 0$ in Reinforcement: Bar Set: ASTM A615 Size Diam (in) Area (in^2) Size Diam (in) Area (in^2) Size Diam (in) Area (in^2) # 4 # 7 # 5 # 8 # 3 0.38 0.11 0.50 0.20 0.63 0.31 # 6 0.88 0.75 0.44 0.60 1.00 0.79 9 1.13 1.00 # 10 # 18 1.27 1.27 # 11 1.41 1.56 # 14 1.69 2.25 2.26 4.00 Bar selection: Minimum number of bars Asmin = $0.01 * Ag = 3.24 in^2$, Asmax = $0.08 * Ag = 25.92 in^2$ Confinement: Tied; #3 ties with #10 bars, #4 with larger bars. phi(a) = 0.8, phi(b) = 0.9, phi(c) = 0.65Layout: Rectangular Pattern: All Sides Equal (Cover to transverse reinforcement) Total steel area: As = 15.24 in^2 at rho = 4.70% Minimum clear spacing = 3.06 in 12 #10 Cover = 1.5 in Service Loads: Му @ Тор My @ Bot Мх @ Тор Mx @ Bot Load Axial Load No. Case kip k-ft k-ft k-ft k-ft 1 Dead 380.00 32.00 -54.00 0.00 0.00 -36.00 -50.00 0.00 Live 140.00 20.00 0.00 50.00 0.00 Wind 0.00

Sustained Load Factors:

0.00

0.00

EO

Snow

Load	Factor
Case	(%)
Dead	100
Live	0
Wind	0
EQ	0
Snow	0

Load Combinations:

U1 = 1.200*Dead + 1.600*Live + 0.000*Wind + 0.000*EarthQuake + 0.500*Snow U2 = 1.200*Dead + 0.500*Live + 1.600*Wind + 0.000*EarthQuake + 0.500*Snow

0.00

0.00

0.00

0.00

0.00

0.00

0.00

0.00

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Slenderness:

Sway Criteria:

X-axis: Sway column. SumPc = 28.67 * Pc SumPu = 27.33 * Pu Second-order effects along length considered

		Height	Width	Depth	I	f'c	Ec	
Column	Axis	ft	in	in	in^4	ksi	ksi	
Design	x	16	18	18	8748	5	4030.51	
Above	x	11	18	18	8748	5	4030.51	
Below	х	11	18	18	8748	5	4030.51	
X-Beams		Length	Width	Depth	I	f'c	Ec	
Locati	on	ft	in	in	in^4	ksi	ksi	
Above	Left	20	0	0	21436.6	5	4030.51	
Above	Right	20	0.0001	0.0001	21436.6	5	4030.51	
Below	Left	20	0.0001	0.0001	21436.6	5	4030.51	
Below	Right	20	0.0001	0.0001	21436.6	5	4030.51	

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Effective Length Factors:

Axis	Psi(top)	Psi(bot)	k(Nonsway)	k(Sway)	klu/r
Х	1.252	1.252	0.802	1.390	51.36

Moment Magnification Factors:

Stiffness reduction factor, phi(K) = 0.75Cracked-section coefficients: cI(beams) = 0.35; cI(columns) = 0.7

0.2*Ec*Ig + Es*Ise (X-axis) = 2.02e+007 kip-in^2

X-axis	At Ends				Along Length						
Ld/Comb	SumPu(kip)	Pc(kip)	SumPc(kip)	Betads	Deltas	Pu(kip)	k'lu/r	Pc(kip)	Betad	Cm	Delta
1 U1	18584.40	2792.45	80059.54	0.000	1.448	680.00	(N/A)	5018.30	0.671	0.830	1.013
U2	14375.58	2792.45	80059.54	0.000	1.315	526.00	(N/A)	4490.56	0.867	0.927	1.098

Factored Moments due to First-Order and Second-Order Effects:

Minimum eccentricity, Ex,min = 1.14 in

NOTE: Each loading combination includes the following cases: First line - at column top Second line - at column bottom

X-axis		- 1st Order				2nd 01	der	- Ratio -
Load	Mns	Ms	Mu	Mmin		Mi	Mc	2nd/1st
Combo	k-ft	k-ft	k-ft	k-ft		k-ft	k-ft	
1 U1	70.40	0.00	70.40	64.60	M1=	70.40	71.32	1.013
	122.40	-0.00	122.40	64.60	M2=	122.40	124.00	1.013
1 U2	48.40	80.00	128.40	49.97	M1=	153.58	168.69	1.314
	82.80	80.00	162.80	49.97	M2=	187.98	206.47	1.268

Factored Loads and Moments with Corresponding Capacities:

Design/Required ratio PhiMn/Mu >= 1.00 NOTE: Each loading combination includes the following cases: First line - at column top Second line - at column bottom

No.	Lo	ad mbo	Pu kip	Mux k-ft	PhiMnx k-ft	Phi M n/Mu	NA depth in	Dt depth in	eps_t	Phi
1	1	U1	680.00	71.32	311.55	4.368	12.43	15.49	0.00074	0.650
2			680.00	124.00	311.55	2.512	12.43	15.49	0.00074	0.650
3	1	U2	526.00	168.69	344.47	2.042	10.76	15.49	0.00132	0.650
4			526.00	206.47	344.47	1.668	10.76	15.49	0.00132	0.650

*** End of output ***