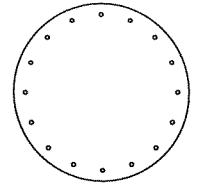
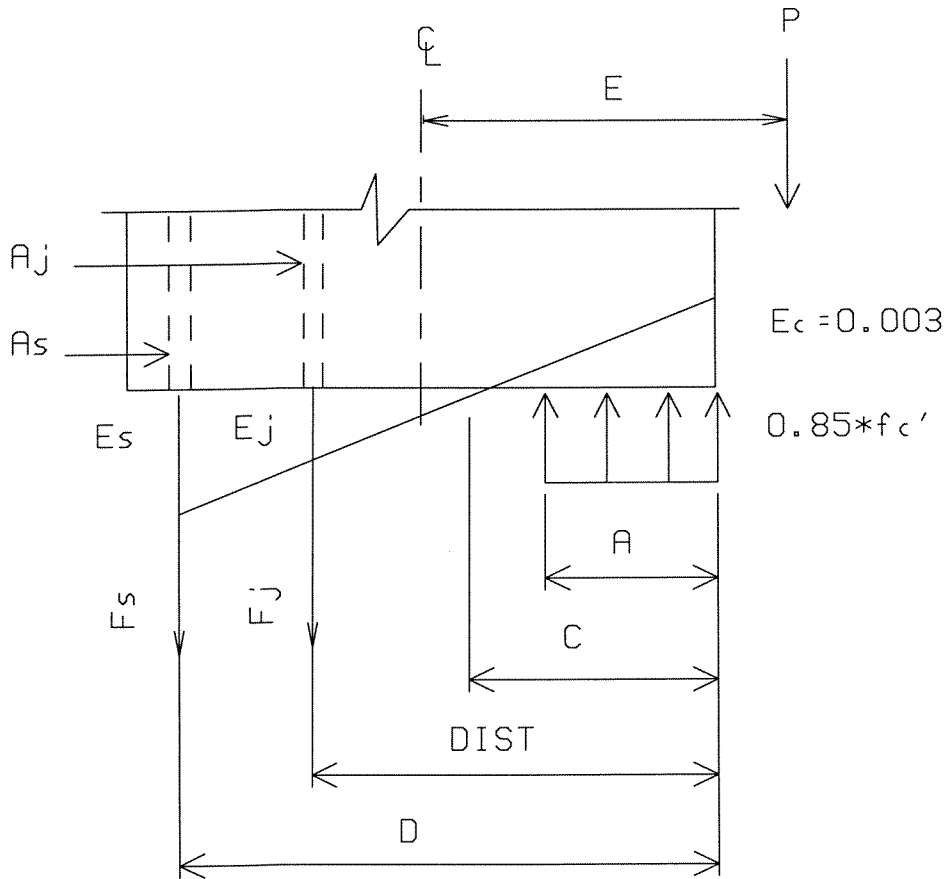


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COLUMN DESIGN:

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48.00" DIA.  
 16 -# 10  
 # 4 SPIRAL  
 2.00" CL

COLUMN DESIGN EQUATIONS:

-----

By similar triangles,  $c/e_c = d/(e_c - e_s)$ , where  $e_s$  is negative (tension)  
 Therefore,  $c = d * e_c / (e_c - e_s) = d * 0.003 / (0.003 - e_s)$

Compression block depth,  $a = \beta * c = .85 * c$  (ACI 318 sec. 10.2.7)

Force in compression block =  $0.85 * f_{c'} * \text{Area of compression block}$

Moment of compression block about centerline,

Moment = Force \* Arm of compression block

Strain at any line of reinforcing,

$$e_j = (.003 - e_s) * (d - \text{dist}) / d + e_s$$

Stress in reinforcing,  $F_s = e_j * 29000$ , not to exceed  $F_y$

(where reinforcing falls within compression block, deduct  $0.85 f_{c'}$  from stress.)

Force in reinforcing,  $F_j = F_s * A_j$

Moment of force in reinforcing about centerline of section =  $F_j * (\text{Radius} - \text{dist})$

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COLUMN DESIGN - CIRCULAR COLUMN:

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COMPUTE ZERO ECCENTRICITY LOAD:

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$$A_g = 3.14159 * (48.00 \text{ in})^2 / 4 = 1809.55 \text{ in}^2$$

$$P_0 = 0.8 * .75 * [0.85 f_c' * (A_g - A_s) + A_s * F_y]$$

$$= 0.8 * .75 * [0.85 * 3.50 * (1809.55 - 19.63) + 19.63 * 60.00]$$

$$= 3901 \text{ k}$$

COMPUTE 0% TENSION POINT (es= 0.00000):

-----

$$c = 44.87 * (0.003 / (0.003 + 0.00000)) = 44.87 \text{ in}$$

Compression block depth, a = .85 \* 44.87 = 38.14 in

Concrete Force = 0.85 \* 3.50 ksi \* 1541.99 sq. in. = 4587 k

Concrete Moment = 4587 k \* 3.15 in = 14455 k\*in

Dist. from face (in)	Strain	Stress (ksi)	Area (in <sup>2</sup> )	Force (k)	arm (in)	Moment (k*in)
44.87	0.00000	0.00	1.22	0	-20.87	0
43.28	0.00010	3.08	1.22	3	-19.28	-72
38.76	0.00040	11.85	1.22	14	-14.76	-214
31.98	0.00086	22.00	1.22	27	-7.98	-215
24.00	0.00139	37.49	1.22	46	-0.00	-0
16.01	0.00192	52.98	1.22	65	7.98	519
9.23	0.00238	57.02	1.22	69	14.76	1032
4.71	0.00268	57.02	1.22	69	19.28	1349
3.12	0.00279	57.02	1.22	69	20.87	1460
4.71	0.00268	57.02	1.22	69	19.28	1349
9.23	0.00238	57.02	1.22	69	14.76	1032
16.01	0.00192	52.98	1.22	65	7.98	519
23.99	0.00139	37.49	1.22	46	0.00	0
31.98	0.00086	22.00	1.22	27	-7.98	-215
38.76	0.00040	11.85	1.22	14	-14.76	-214
43.28	0.00010	3.08	1.22	3	-19.28	-72
Concrete				4587		14455
SUMS =				5250		20713

Strength reduction factor= .75

$$P_u = .75 * 5250 \text{ k} = 3937 \text{ k}$$

$$M_{uy} = .75 * 20713 \text{ k*in} / 12 = 1294 \text{ k*ft}$$

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COLUMN DESIGN

-----

COMPUTE 25% TENSION POINT (es= -0.00051):

-----

c= 44.87 \* (0.003/ (0.003 + 0.00051))=38.27 in  
 Compression block depth, a = .85 \* 38.27 = 32.53 in  
 Concrete Force=0.85\* 3.50 ksi \* 1305.59 sq. in.= 3884 k  
 Concrete Moment= 3884 k \* 5.76 in = 22383 k\*in

Dist. from face (in)	Strain	Stress (ksi)	Area (in <sup>2</sup> )	Force (k)	arm (in)	Moment (k*in)
44.87	-0.00051	-15.00	1.22	-18	-20.87	384
43.28	-0.00039	-11.38	1.22	-13	-19.28	269
38.76	-0.00003	-1.10	1.22	-1	-14.76	19
31.98	0.00049	11.31	1.22	13	-7.98	-110
24.00	0.00111	29.47	1.22	36	-0.00	-0
16.01	0.00174	47.63	1.22	58	7.98	466
9.23	0.00227	57.02	1.22	69	14.76	1032
4.71	0.00263	57.02	1.22	69	19.28	1349
3.12	0.00275	57.02	1.22	69	20.87	1460
4.71	0.00263	57.02	1.22	69	19.28	1349
9.23	0.00227	57.02	1.22	69	14.76	1032
16.01	0.00174	47.63	1.22	58	7.98	466
23.99	0.00111	29.47	1.22	36	0.00	0
31.98	0.00049	11.31	1.22	13	-7.98	-110
38.76	-0.00003	-1.10	1.22	-1	-14.76	19
43.28	-0.00039	-11.38	1.22	-13	-19.28	269
Concrete				3884		22383

-----

SUMS = 4401 30284

Strength reduction factor= .75  
 Pu= .75 \* 4401 k = 3301 k  
 Muy= .75 \* 30284 k\*in/12 = 1892 k\*ft

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COLUMN DESIGN

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COMPUTE 50% TENSION POINT (es= -0.00103):

-----

c= 44.87 \* (0.003/ (0.003 + 0.00103))=33.36 in  
 Compression block depth, a = .85 \* 33.36 = 28.36 in  
 Concrete Force=0.85\* 3.50 ksi \* 1113.02 sq. in.= 3311 k  
 Concrete Moment= 3311 k \* 7.87 in = 26067 k\*in

Dist. from face (in)	Strain	Stress (ksi)	Area (in <sup>2</sup> )	Force (k)	arm (in)	Moment (k*in)
44.87	-0.00103	-30.00	1.22	-36	-20.87	768
43.28	-0.00089	-25.85	1.22	-31	-19.28	611
38.76	-0.00048	-14.05	1.22	-17	-14.76	254
31.98	0.00012	3.59	1.22	4	-7.98	-35
24.00	0.00084	21.45	1.22	26	-0.00	-0
16.01	0.00156	42.27	1.22	51	7.98	414
9.23	0.00216	57.02	1.22	69	14.76	1032
4.71	0.00257	57.02	1.22	69	19.28	1349
3.12	0.00271	57.02	1.22	69	20.87	1460
4.71	0.00257	57.02	1.22	69	19.28	1349
9.23	0.00216	57.02	1.22	69	14.76	1032
16.01	0.00156	42.27	1.22	51	7.98	414
23.99	0.00084	21.45	1.22	26	0.00	0
31.98	0.00012	3.59	1.22	4	-7.98	-35
38.76	-0.00048	-14.05	1.22	-17	-14.76	254
43.28	-0.00089	-25.85	1.22	-31	-19.28	611
Concrete				3311		26067
SUMS =				3691		35553

Strength reduction factor= .75  
 Pu= .75 \* 3691 k = 2768 k  
 Muy= .75 \* 35553 k\*in/12 = 2222 k\*ft

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COLUMN DESIGN

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COMPUTE 100% TENSION POINT (es= -0.00206):

-----

c= 44.87 \* (0.003/ (0.003 + 0.00206))=26.55 in  
 Compression block depth, a = .85 \* 26.55 = 22.57 in  
 Concrete Force=0.85\* 3.50 ksi \* 836.38 sq. in.= 2488 k  
 Concrete Moment= 2488 k \* 10.95 in = 27270 k\*in

Dist. from face (in)	Strain	Stress (ksi)	Area (in <sup>2</sup> )	Force (k)	arm (in)	Moment (k*in)
44.87	-0.00206	-60.00	1.22	-73	-20.87	1537
43.28	-0.00188	-54.79	1.22	-67	-19.28	1296
38.76	-0.00137	-39.97	1.22	-49	-14.76	724
31.98	-0.00061	-17.78	1.22	-21	-7.98	174
24.00	0.00028	8.38	1.22	10	-0.00	-0
16.01	0.00119	31.57	1.22	38	7.98	309
9.23	0.00195	53.75	1.22	65	14.76	973
4.71	0.00246	57.02	1.22	69	19.28	1349
3.12	0.00264	57.02	1.22	69	20.87	1460
4.71	0.00246	57.02	1.22	69	19.28	1349
9.23	0.00195	53.75	1.22	65	14.76	973
16.01	0.00119	31.57	1.22	38	7.98	309
23.99	0.00028	8.38	1.22	10	0.00	0
31.98	-0.00061	-17.78	1.22	-21	-7.98	174
38.76	-0.00137	-39.97	1.22	-49	-14.76	724
43.28	-0.00188	-54.79	1.22	-67	-19.28	1296
Concrete				2488		27270
SUMS =				2578		39925

Strength reduction factor= .75  
 Pu= .75 \* 2578 k = 1933 k  
 Muy= .75 \* 39925 k\*in/12 = 2495 k\*ft

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COLUMN DESIGN

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COMPUTE PURE MOMENT POINT:

-----

By trial and error,  $es = -0.01086$   
 $c = 44.87 * (0.003 / (0.003 + 0.01086)) = 9.71$  in  
 Compression block depth,  $a = .85 * 9.71 = 8.25$  in  
 Concrete Force =  $0.85 * 3.50$  ksi \*  $207.38$  sq. in. = 616 k  
 Concrete Moment =  $616$  k \*  $19.10$  in = 11784 k\*in

Dist. from face (in)	Strain	Stress (ksi)	Area (in <sup>2</sup> )	Force (k)	arm (in)	Moment (k*in)
44.87	-0.01086	-60.00	1.22	-73	-20.87	1537
43.28	-0.01037	-60.00	1.22	-73	-19.28	1420
38.76	-0.00897	-60.00	1.22	-73	-14.76	1086
31.98	-0.00688	-60.00	1.22	-73	-7.98	588
24.00	-0.00441	-60.00	1.22	-73	-0.00	0
16.01	-0.00194	-56.43	1.22	-69	7.98	-553
9.23	0.00014	4.23	1.22	5	14.76	76
4.71	0.00154	41.79	1.22	51	19.28	989
3.12	0.00203	56.03	1.22	68	20.87	1435
4.71	0.00154	41.79	1.22	51	19.28	989
9.23	0.00014	4.23	1.22	5	14.76	76
16.01	-0.00194	-56.43	1.22	-69	7.98	-553
23.99	-0.00441	-60.00	1.22	-73	0.00	-0
31.98	-0.00688	-60.00	1.22	-73	-7.98	588
38.76	-0.00897	-60.00	1.22	-73	-14.76	1086
43.28	-0.01037	-60.00	1.22	-73	-19.28	1420
Concrete				616		11784
SUMS =				-2		21972

Strength reduction factor = .89  
 $P_u = .89 * -2$  k = -2 k  
 $M_{uy} = .89 * 21972$  k\*in/12 = 1647 k\*ft

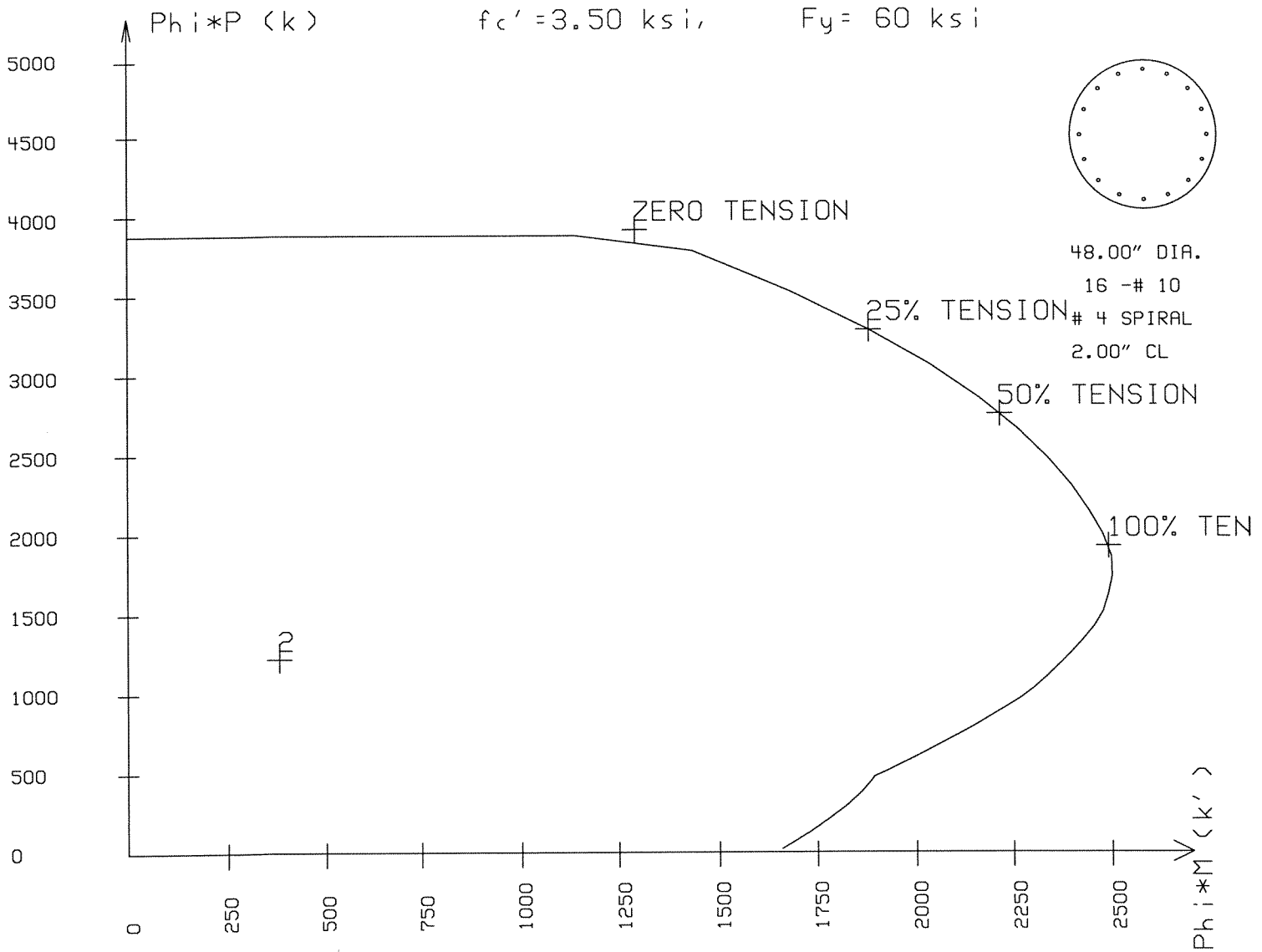
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 TITLE:Example COLUMN calculation

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COLUMN DESIGN:  
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INTERACTION DIAGRAM

MOMENT MAGNIFICATION DATA:

KLx= 40.29 ft,  $C_{mx}=1.000$ ,  $B_dX= 0.000$  (per AASHTO 8.16.5.2.7)  
 KLy= 40.29 ft,  $C_{my}=1.000$ ,  $B_dY= 0.000$

LOADING CHECK:

$$M_r = [M_x^2 + M_y^2]^{.5}$$

Check  $P_u < P_n$  and  $M_u < M_n$ , where  $P_n$  &  $M_n$  are the reduced strengths on the interaction curve, having the same eccentricity as  $P_u$  &  $M_r$ .

Load	$P_u$ (k)	$M_x$ (k')	$M_y$ (k')	$M_r$ (k')	$P_n$ (k)	$M_n$ (k')	Check	
1	1435	1.14x	0	1.14x 153	176	3901	479	OK