

1/10

Structural Engineering Calculations for:

ARCO-AM/PM & other signs.

Donco & sons
Perris, CA
80' OAH Double pole sign

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COUNTY OF RIVERSIDE
DEPARTMENT OF
BUILDING AND SAFETY
APPROVED

REVIEWED BY tkw DATE 1/12/09

Approval of these plans shall not be construed to be a permit for, or an approval of, any violations of any of the provisions of the state or county laws. This set of plans must be kept on the job until completion.

KUMAR ENGINEERING

Consulting Engineers
6871 East Kentucky Ave
Anaheim, CA 92807



SPECIFICATIONS

Project: *ARCO-AM/PM & other signs.*
Descript: *80' OAH Double pole sign* Perris, CA

Steel...

Design and fabrication according to AISC-ASD, **13th edition.**

Plate, angle, channel, tee and wide flange: ASTM A36.

Round pipe: ASTM A53 Grade B or equivalent.

Square and rectangular tube: ASTM A500 Grade B.

High strength bolts: ASTM A325, bearing type connections (snug tight).

Machine bolts: ASTM A307.

Anchor bolts or threaded rod: ASTM A36.

Steel for reinforced concrete: Grade 60.

Welding...

Design and fabrication according to AWS D1.1.

AWS certification required for all structural welders.

Welding to be done by city Certified Welder.

E70XX electrodes for SMAW processes.

F7X-EXXX electrodes for SAW processes.

Sign Fabrication to be done by City approved fabrication shop.

Concrete...

Design and construction according to **ACI 318-05,**

Compressive strength at 28 days, $f'c = 2,500$ psi minimum.

Concrete poured into constrained earth excavations must cure under proper conditions for 4 days prior to sign box installation. (Exception: if the overall height of the sign is less than 20 feet and the sign pole is adequately braced against wind loads for a minimum of 4 days, the box may be installed the same day as the footing is poured.)

For pier and caisson footings, concrete must be poured against undisturbed earth.

Maintain a minimum 3" concrete cover over all embedded steel.

Inspection...

Foundation to be inspected and certified by soils engineer prior to placement of concrete.

3/10

Project: ARCO-AM/PM & other signs.
 Descript: Perris, CA 2007 CBC

Check for Wind load and Seismic Load based on 2007 CBC

Wind Pressure $p = q_h G C_f A_f$ for main frame and sign or fixture

where $q_h = 0.00256 K_z K_{zt} K_d V^2 I$
 $q_h =$ Velocity Pressure
 $V =$ Basic Wind Speed=
 $K_z =$ Velocity Pressure Coeff.
 $K_{zt} =$ 1 Flat Terrain
 $K_d =$ 0.85 Wind Directional Factor Table 6-4
 $I =$ Important Factor Category Table 6-1

Calculation of Design Velocity Pressures q_h

Height (ft.)	K_z	q_h (psf)
Y		
0-15	0.85	13.36
20	0.90	14.15
25	0.94	14.78
30	0.98	15.41
40	1.04	16.35
50	1.09	17.14
60	1.13	17.77
70	1.17	18.39
80	1.21	19.02
100	1.26	19.81

Design Wind Pressure = $q_h G C_f A_f$ for main frame and sign or fixture

$q_h =$ Design Velocity Pressure as defined above
 $G =$ Gust Effect Factor = 0.85 (Section 6.5.8.1)
 $C_f =$ Force Coeff. Fig 6-19 & 6-20
 $A_f =$ Wind Surface Area (Fig 6-11 to 6-14)

	Case I	80 ft OAH	Case II	100 ft OAH
$B =$ width of sign =		24		24
$s =$ ht. Of sign =		35 ft		35
$h =$ ht above ground		80 ft		100
$s/h =$		0.44		0.35
$B/s =$		0.69		0.69
From fig.6-20 method 2				
$C_f =$		1.75		1.75

For Vertical Pole

$D =$ Dimension of pole Shroud = 2 ft
 $h =$ ht above ground 45 ft
 $h/D =$ 22.50

for Rectangle Section
From fig.6-21 method 2
Cf=

2,0

Net Wind Pressure

	Height (ft):	qh(psf)	G	Cf	wind pressure	
	Y					
Sign	0-15	13.36	0.85	1.1	12.49 PSF	
	25	14.78	0.85	1.8	22.61	
	80	17.77	0.85	1.75	26.43	Use 26 PSF as Design load for Sign
Poles	45	17.74	0.85	2	30.16	Use 30 PSF as Design load for Shroud.

Seismic =

Fundamental Frequency:

Sec12.8.2 $T_a = 0.02 \times (25)^{.75}$
 0.223607 Say 0.22

Wind Load

Use R = 3

Perris, CA , Zip = 92570

V = $C_s W$ where W= 10 PSF for Sign Structures

$C_s = S_{ds} / (R/I)$ where $S_{ds} = .67 \times F_a \times S_s$ Fa= 1, Ss = 1.53

$C_s = .67 \times 1 \times 1.53 / 3 = 0.34$

V = $0.34 \times 10 = 3.4$ PSF

Dead Load LED Module = 10 PSF

Reference : Engineering Sign Structures, By Benjamin Jones PE

Wind Governs

STEEL COLUMN DESIGN

Descript: 80' OAH Double pole sign Perris, CA
 Ref: Manual of Steel Construction, AISC 13th Edition

Areas Subject to Wind Forces

Description	Height (ft)	Width (ft)	Area (sqft)	Centroid (ft)	Wind (psf)
1) Top Sign	35.00	24.00	840.00	62.0	26.0
2) Shrouds	45.00	6.00	270.00	22.0	30.0

2 poles x 3 ft wide shroud
= 6 ft.

Calculation of Design Forces at Critical Heights

y (ft)	M (#)	V (#)	y (ft)	M (#)	V (#)
@grade	1,532,280	29,940	20.00	933,480	29,940
			45.00	371,280	21,840
			60.00	68,400	21,840

Column Support Design Table

# of Cols	Column Type (P, TS)	Column Size	Length (ft)	Start Elev (ft)	End Elev (ft)	Sleeve Depth (in)	S act (in ³)	fb (ksi)
2	P	36" Diam. .375	37.00	-12.00	25.00	0.00	370.00	24.8
2	P	30" Diam. .375	28.00	25.00	50.00	4.0	255.00	22.0
2	P	20" diam x .375	28.00	50.00	75.00	3.0	111.00	20.1

Allowable = $0.66 \times 35 \times 1.3 = 30.72$ ksi
 Say 30 ksi

All Poles are ok.

Allowable Bending Stresses

Column Type	Column Size	Criteria	Stress increase factor =	1.33
P	36" Diam. .375	d/t < 3300/Fy	so... Fb = 0.66Fy =	30.7 ksi
P	30" Diam. .375			

LATERAL BEARING PIER AND CAISSON FOOTINGS

Project: ARCO-AM/PM & other signs.
 Descript: 80' OAH Double pole sign
 Ref: Uniform Building Code

Perris, CA

# Footings=	2	Moment/Footing, M=	766,140	lb-ft
Pass lat soil res, q=	200 psf	Composite Centroid, h=	52.27	ft
150*133 =200 psf		Equiv Concentrated Load, P= M/h=	14,657	lb

Rectangular Pier

Width, W=	0.0	ft, parallel to sign face
Length, L=	0.0	ft, perpendicular to sign face
Depth, D= (A/2)(1+ SQR(1 + (4.36h)/A))=	0.0	ft
S1= (2)(q)(D/3)=		psf
b= Sqrt(W^2 + L^2)=		ft
A= (2.34)(P) / (S1)(b)=		

Round Caisson

Diameter, b=	4.00	ft, round augered hole
Depth, D= (A/2)(1+ SQR(1 + (4.36h)/A))=	20.36	ft
48"dia x 20.0 ft deep foundation		
S1= (q)(2)(D/3)=	1,600	psf
A= (2.34 P) / (S1)(b)=	5.36	

Foundation Bearing Check

Allowable Bearing Pressure=	1,333	psf, 1997 UBC table 18-1-A, at grade
<i>Square</i>		<i>Round</i>
Sign Wt=	lb	Sign Wt= 2,000 lb / Pole
Base Wt= 0 lb		Base Wt= 38,373 lb
Area= 0.0 sq ft		Area= 12.6 sq ft
q max= psf, soil		q max= 3,213 psf, soil
		OK, with depth increase

Concrete Volume

Outside Width of Column=	48	in
Depth of Column in Footing=	20	ft
Volume of Concrete per Footing=	9.3	
Total Order Volume of Concrete=	20	Cu Yds

Project: ARCO-AM/PM & other signs.
Descript: Perris, CA 2007 CBC

B. Shroud Attachment to pole Details

Shear per pole = Wind Load x pole area.
Wind Load = 23 psf at 25 ft .
Shear per pole = 23x 3 69 lbs per ft.

Capacity 1/2" Molly Bolt = Area x 10 ksi = 1.96 kips Say 2 kips

Number of Bolts per column = 4 bolts per side

Capacity 2x4x1.96 15.68 kips.

Use 1/2" diam Molly bolts to attach shrouds to the pole.

C Sign framing by Sign Manufacturer.

D Pole Shroud Fastener: By Shroud Manufacturer.

E Sign attachment to the pole: :Use2- 3/4" thru bolt per sign module.

Use Sign 'D' as the design sign for bolts:

Shear per pole = 30 psf (wind load) x 24x11 (sign area)
7920 lbs Or 3960 lbs per pole.

Capacity two 3/4 inch thru bolts = 10.6 kips x 2 = 21.2 kips.

Use 3/4 " thru bolt to attach each Sign Module to poles.

(Page 7-22, AISC 13th Edition.)

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Project: ARCO-AM/PM & other signs.
Descript: Perris, CA 2007 CBC

Sleeve Detail at 60 ft from Top:

M = 933,480 ft lbs Shear 29,940 k
or 933 kft

Length sleeve = 2d 60" or 5 ft
for 30 " Polle

C = T = 93,348.00 per pole
93,000 lbs say =93 k per pole

Capacity : Section Modulus 1/4" weld, 30 " Diam = (3.14) x 30 x .25
23.55

Stress = 93 / 23.55 3.9 due to moment

Stress (shear) Shear/ Throat area

29.9/2 (per pole)/ 0.7x0.25x3.14x30

= 0.53 ksi

Total Stress = =4.43 ksi < 21 ksi allowable. OK

Sleeve Detail at 35 ft from top

Similar Calcs as above: Length = 2d = 40" minimum or 3.3 ft minimum

M / pole = 185,640 say 186 kft per pole

T = C = m/L = 186/3.3 56 kip

SM 1/4" weld = (3.14)x 20x.25 12.56

C = T = 56/12.56 4.5

Stress (bending) = 4.5 ksi

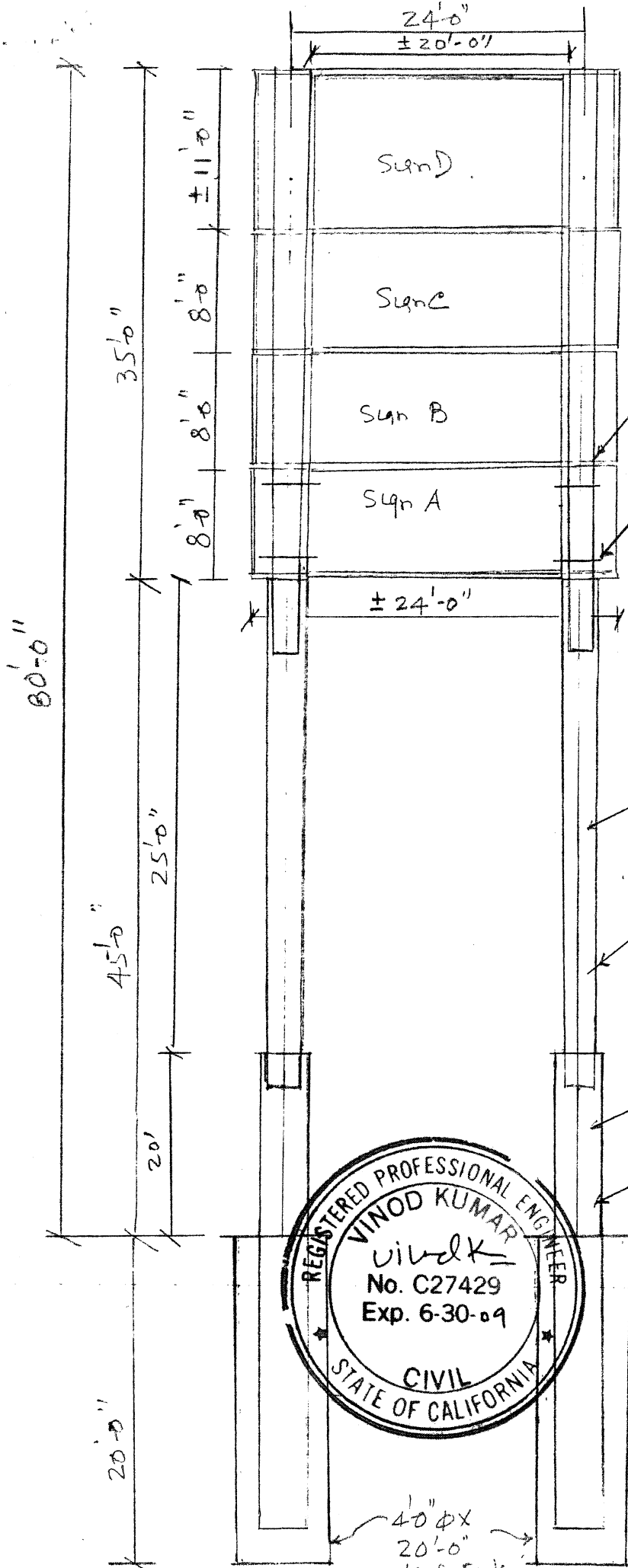
Stress Shear= shear / throat area Shear 21,840 lbs

Throat area = .7 x .25 x 3.14 x 20 =11 sq inch

Stress (shear) = 4.5 / 11 0.4 ksi

Total = 4.9 ksi < 21 ksi allowable OK.

Both Sleeve Details are OK.



20" x 0.375" ±

3/4" thru bolts - 4 Per Sign Panel to attach sign Modules to EACH Pole

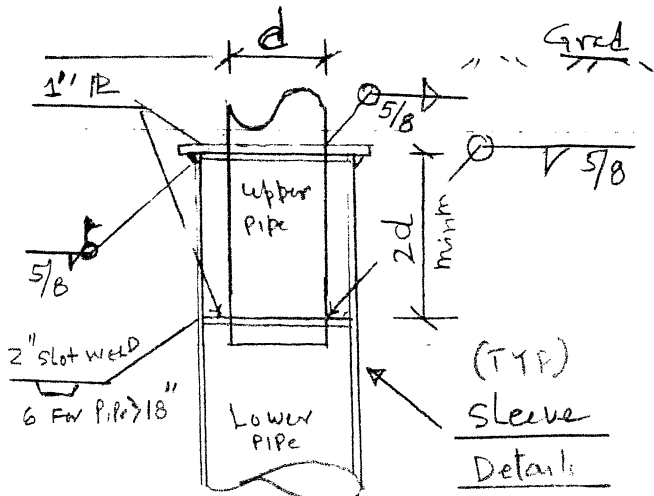
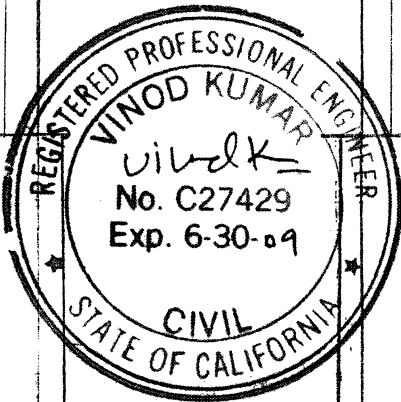
30" φ x 0.375" ±

3'-0" strong ALL ROUND EACH COLUMN.

(Note: Use 1/2" dia bolts 2 EACH TOP & BOTTOM FOR attachment to pole)

36" φ x 0.375" ±

40" STRONG EACH SIDE



40" φ x 20'-0"

ARCO
High-rise Sign Structure

23261 Cajalco Road
Perris, California

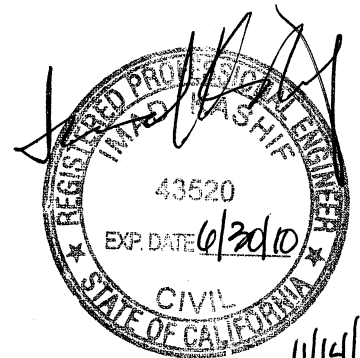
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November 14, 2008

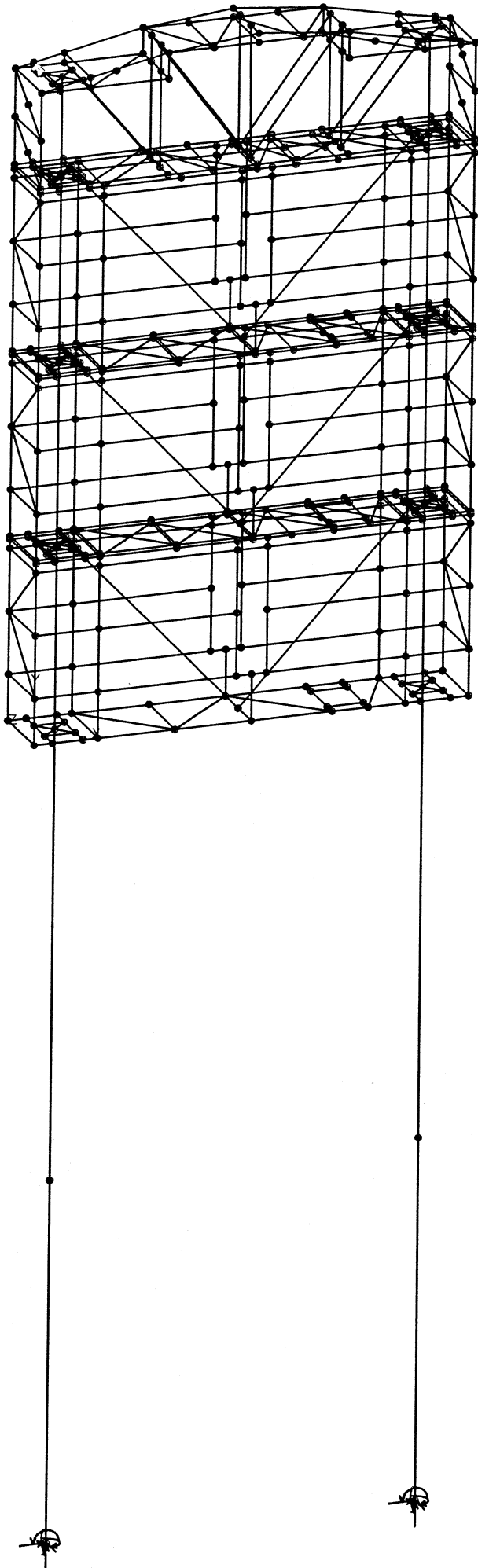


General Notes:

- This sign is designed in accordance with the provisions of the California Building Code 2007, for 85 – 3- second gust MPH wind speed - exposure C.
- Qualified individuals, able to verify the design intent and site compliance prior to construction, shall perform this installation.
- In the event that the stated minimum requirements are not met or conditions appear deleterious, consult a qualified professional engineer or the appropriate building official.
- Design height provided by the client is less than 80'-0" above grade.
- Design Pressure used in this design is 28.5 psf.

Material Specifications and Construction Guidelines:

- The Sign shall be constructed of incombustible materials or other UL approved application for the sign type construction.
- Structural steel shall conform to ASTM A36
- Steel pipe shall conform to ASTM A53 grade B or API 5L-B
- Steel tubing shall conform to ASTM A500 grade B
- All connection bolts shall be zinc coated ASTM A325 (SAE Grade 5) unless otherwise noted on drawings.
- Extruded aluminum shall be 6063-T6 unless specified otherwise on construction drawings.
- Aluminum sheet shall be 3003-H14
- Galvanized hot roll sheet used as cabinet filler material shall be A653 CS 18 Ga. With an average yield strength of 38 ksi.
- Welding of structural steel members shall conform to recommendations published by the American Welding Society (AWS). Welding shall only be performed by workmen who have been recently certified by a qualified testing laboratory. E70XX electrodes shall be used.
- Concrete shall be mixed to attain a minimum compressive strength of 3000 psi in 28 days.
- Steel reinforcement bars shall conform to ASTM 615 grade 60 with deformations in accordance with ASTM A-305. Welding of bars is prohibited.



Company:

File: S:\Engineering\2008\08-0751-08-1500\08-1229 III.vap

Member Min/Max Stresses

Extreme Item Member	Load Case	Offset		fa		fby(+z)		fby(-z)		fbz(+y)		fbz(-y)		fc(+z+y)		fc(-z-y)		fc(-z-y)	
		in	psi	psi	psi	psi	psi	psi	psi	psi	psi	psi	psi	psi	psi	psi	psi	psi	psi
Max fby(+z)	PP146	14.1421	-9.3593	13895.5	-13895	244.262	-244.262	14130.48	13641.95	-13660.6	-14149.1								
Max fby(-z)	COL6	0.0000	-4.0305	-18172	18172.4	-41.210	41.2109	-18217.7	-18135.3	18127.25	18209.67								
Max fbz(+y)	M20-2	23.8800	-33.791	-19.432	19.4325	15237.7	-15237	15184.50	-15290.9	15223.36	-15252.0								
Max fbz(-y)	PP148	16.9734	74.6524	10294.7	-10294	-14271	14271.4	-3902.05	24640.80	-24491.4	4051.356								
Max fc(+y+z)	PP112	14.1421	60.1073	8231.50	-8231.5	8880.07	-8880.0	17171.68	-588.459	708.6740	-17051.4								
Max fc(+y-z)	PP84	0.0000	-51.779	-10309	10309.7	14364.7	-14364	4003.248	-24726.2	24622.69	-4106.80								
Max fc(-y+z)	PP148	16.9734	74.6524	10294.7	-10294	-14271	14271.4	-3902.05	24640.80	-24491.4	4051.356								
Max fc(-y-z)	M7-16	0.0000	1860.44	-6881.8	6881.89	-11898	11898.7	-16920.1	6877.297	-3156.41	20641.08								
Max fx	Diag9-1	0.0000	4448.36	131.292	-312.51	929.663	-390.56	5509.316	4189.084	5065.511	3745.279								
Min fby(+z)	COL6	0.0000	-4.0305	-18172	18172.4	-41.210	41.2109	-18217.7	-18135.3	18127.25	18209.67								
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Min fc(-y-z)	PP112	14.1421	60.1073	8231.50	-8231.5	8880.07	-8880.0	17171.68	-588.459	708.6740	-17051.4								
Min fx	Diagl	0.0000	-4173.4	307.892	-732.87	453.754	-190.63	-3411.84	-4056.23	-4452.61	-5096.99								

Nodal Reactions

Node	Load Case	FX		FY		FZ		MX		MY		MZ	
		lb	lb	lb	lb	lb	lb	lb	lb	lb	lb	lb	lb
N376	Dead	24.1990	24163.2	0.2043	15.0183	-2.3596	-440.98						
"	Wind	15.4723	-20.585	-13529	-761086	62288.5	-564.92						
N377	Dead	-24.199	24354.4	-0.2043	42.7337	-1.7909	421.127						
"	Wind	-15.472	20.5856	-17011	-952864	58462.6	146.758						

PROJECT #	08-1229	OWNER:	ARCO
November 12, 2008			23261 CAJALCO ROAD
DRAWING #	B171480		PERRIS, CA 92570
WIND LOAD	28.490	PSF	
WIND SPEED	85.000	MPH	CLIENT: SIGNRESOURCE
# COLUMNS	2.000	CBC 2007	6135 DISTRICT BLVD
ENGINEER	IK		MAYWOOD, CA

ITEM	HEIGHT	WIDTH	SHAPE FACTOR	CENTROID HEIGHT	FACTORED AREA	TOTAL FORCE	MOMENT
SIGN	35.000	24.000	0.979	17.140	822.192	23.424	401.492
COLUMN	25.000	6.000	0.700	12.500	105.000	26.416	1024.491
COLUMN	20.000	7.000	0.700	10.000	98.000	29.208	1580.725
EMEB	7.417			3.708	0.000	29.208	1797.349
OAH	87.417						

COLUMN STRESSES (CODES P=PIPE;O=OTHER;T=TUBE)

ITEM	MOMENT	Sxx REQ'D	COLUMN DEPTH	COLUMN WALL	Ixx COLUMN	Sxx COLUMN	ACTUAL STRESS	ALLOWABLE STRESS	OBLIQUE LOAD STRESS	COLUMN CENTER DISTANCE	OBLIQUE LOAD FACTOR
P SIGN	401.492	109.498	24.000	0.375	1942.3	161.86	14.883	23.100	18.992	20.000	1.276
P COLUMN	1024.491	279.407	36.000	0.500	8786.2	488.12	12.593	23.100	16.070		
P COLUMN	1580.725	431.107	42.000	0.500	14035.8	668.37	14.190	23.100	18.108		
P EMEB	1797.349	490.186	42.000	0.500	14035.8	668.37	16.135	23.100	20.590		

CAISSON
MOMENT 1008.582 FT-KIP
FORCE 18.636 KIP
REFERENCE IBC 1805.7.2 & TABLE 1804.2
ASSUME SOIL CLASS #4 SW, SP, SM, SC, GM & GC
LATERAL BEARING PRESSURE - PSF/FT OF DEPTH S1 150.0 PSF/FT
DEPTH 1200.0 FT.
DIAMETER 22.250 FT.
6.000 FT.
54.120 FT.
6.057 FT.
CALCULATED DEPTH 22.172 FT.
MINIMUM THICKNESS WITHOUT REINFORCEMENT 105.680 IN.
ACTUAL DIAMETER 72.000 IN.
CONCRETE 23.300 CU. YD.

SPLICES BEGINNING AT TOP

SPLICE #1

CAP PLATE

weight above 11000 lb
 upper pipe d1 24.00 in
 wall tk 0.38 in
 lower pipe d2 36.00 in
 wall tk 0.50 in

c' 75.398224
 b 0.2094395
 p 30.555556
 d 6

calc'd tk 0.4678013 in

min tk 0.9356026 in

RINGS

dist. between 39 in
 moment @ splice 256171.74 ft-lb
 force to ring 78822.075 lb
 ring depth 5.5 in
 ring width (30 deg) 6.2831853 in

treat as column
 trial P/A<= 21600 psi
 calc'd thickness 0.5808 in
 trial thickness 0.6171
 A = 3.8774
 I = 0.1994
 r = 0.2268
 kl/r = 24.2536
 Cc = 126
 Fa = 20.330214
 P/A<= 20330.214 psi
 calc'd thickness 0.6171 in
 min. thickness 1.2341

use 1 1/4 R

SPLICE #2

CAP PLATE

weight above 14200 lb
 upper pipe d1 36.00 in
 wall tk 0.50 in
 lower pipe d2 42.00 in
 wall tk 0.50 in

c' 113.09734
 b 0.3141593
 p 39.444444
 d 3

calc'd tk 0.3068659 in

min tk 0.6137318 in

RINGS

dist. between 54 in
 moment @ splice 653676.5 ft-lb
 force to ring 145261.44 lb
 ring depth 2.5 in
 ring width (30 deg) 9.424778 in

treat as column
 trial P/A<= 21600 psi
 calc'd thickness 0.7136 in
 trial thickness 0.7288
 A = 6.8688
 I = 0.4172
 r = 0.2464
 kl/r = 10.1444
 Cc = 126
 Fa = 21.14773
 P/A<= 21147.73 psi
 calc'd thickness 0.7288 in
 min. thickness 1.4576

use 1 1/2 R