MURDOCH ENGINEERING
SIGN STRUCTURE PROFESSIONALS

STRUCTURAL DESIGN CALCULATIONS

Shake Shack, **Sign DTC.1 Qty. 2**
2051 NW Lowenstein Drive
Lee's Summit, MO 64081

DESIGN SPECIFICATIONS			
IBC	2018	with MO	amendments
ASCE	7-16	Minimum Design Loads for Buildings & Other Structures	
ACI	318-14	Building Code Requirements for Structural Concrete	
ANSI/AISC	360-16	Specification for Stuctural Steel Buildings	

DESIGN LOADS		
Wind	V =	115 mph
Exposure	C	
Risk Cat.	II	
Grnd. Snow	Pg =	20 psf

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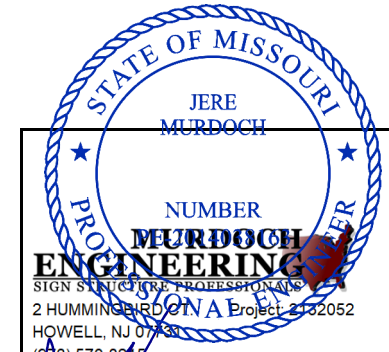

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2 HUMMINGBIRD CT Project: 2132052
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6/30/2021
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Exp. 12/31/2022

Rev. 7/20/2021
Rev. 8/6/2021
PN# 2132636

WIND LOADING & STEEL CALCULATIONS

Ultimate Wind Speed=	115	IBC-2018
Normal Wind Speed=	89.08	IBC-2018 Nominal
Exposure=	C	open terrain, scattered buildings <30Ft.
Cf=	1.70	ASCE 7-10 Force Coefficient
G=	0.85	Gust Factor
Kh=	0.85	Velocity pressure Coefficient @ height
Kzt=	1	Topographic factor
I=	1	Importance factor
Kd=	0.85	Wind directionality factor

STEEL COLUMN DESIGN

Areas Subject to Wind Forces

Description	(cF)	Height (ft)	Width (ft)	Area (sqft)	Centroid (ft)	Wind (psf)
Roof 21psf*1.2 = 25.2> (20psf sL)	1.70	6.00	9.00	54.00	10.0	25.2
Pole Cladding	1.67	11.00	1.76	19.36	5.5	21

Calculation of Design Forces at Critical Heights

y (ft)	M (#')	V (#)		y (ft)	M (#')	V (#)	M (#) Per/Colum	V (#) Per/Colu
@ grade	15,844	1,767		17.67			15,844	1,767
9.00	1,361	1,361		17.67			1,021	1,021
17.67				17.67				

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)
1	TS	5XX.25	9.00		9.00	N/A	6.41	29.7
2	TS	2XX.125	9.00	8.67	17.67	4.0	0.49	16.8

TS = Steel Tube 6x6x3/8" > 5"x5"x1/4" Min. = OK
TS = Steel Tube (Canopy Roof) = Proposed 3.5"x3.5" x 3/16" > 2"x2" x 1/8" Min. = OK

FOOTING CALCULATIONS

# Footings=	1		Moment/Per/Footing, M=	15844.08	lb-ft
Pass lat soil res, q=	150	psf	Composite Centroid, h=	8.81	ft
			Equiv Concentrated Load, P= M/h=	1,798	lb

Rectangular Pier

Width, W=	4.0	ft, parallel to sign face	
Length, L=	6.0	ft, perpendicular to sign face	
Depth, D= (A/2)(1+ SQR(1 + (4.36h)/A))=	4.4	ft	
	3.87	**Yards Conc**	
S1= (2)(q)(D/3)=	429	psf	Calc Depth
b= Sqrt(W^2 + L^2)=	7.2	ft	
A= (2.34)(P) / (S1)(b)=	1.4		

Augured (round footing)

Diameter, b=	3.00	ft, round augured hole	
Depth, D= (A/2)(1+ SQR(1 + (4.36h)/A))=	6.01	ft	
	1.57	**Yard Conc**	
S1= (q)(2)(D/3)=	607	psf	Calc Depth
A= (2.34 P) / (S1)(b)=	2.31		

Foundation Bearing Check

Allowable Soil Bearing Pressure= 1,500 psf, IBC 2018

	Square		*Round*	
Sign Wt=	1,166	lb	1,166	lb
Base Wt=	15,693	lb	6,368	lb
Area=	24.0	sq ft	7.1	sq ft
q max=	702	psf, soil	1,066	psf,soil
	OK, with depth increase		OK, with depth increase	

BASEPLATE CALCULATIONS

Plate Design

# of Base Plates=	1	
Maximum Column Dimension, OD=	6.00	in, perpendicular to sign face
Number of Bolts, n=	2	per line front and back
Compressive Strength of Concrete, f'c=	3,000	psi at 28 days
Moment / per/Base Plate, M=	15,844	lb-ft
Bolt Line Spacing, L=	9.04	in, from front to back
Base Plate Dimensions:	**N=** 12.50 in	**B=** 12.50 in
Tension per Bolt Line, T=	21,032	lb, = M/L (simple moment couple)
Maximum Moment on the Plate, Mpl=	31,969	lb-in, = (T)((L-OD)/2)
Plate Thickness w/o Gussets, t=	0.94	in, = Sqrt((6M)/(0.75Fy(4/3) Beff))
Plate Thickness w/ Gussets, t=	0.75	in, = Sqrt((6M)/(0.75Fy(4/3) Beff)*0.8)
Alum. PL Thickness w/o Gussets, t=	1.10	in, = Sqrt((6M)/(0.52Fy(4/3) Beff)
Alum. PL Thickness w/ Gussets, t=	0.88	

Anchor Bolt Design

(using A36 threaded rod with embedded end nut)

Tension per Anchor, Ta=	10,516	lb, = T/n
Req. Gross Area of Anchor Bolts, Ag=	0.41	sq in, = Ta\0.33Fu (1/3 inc)
Min. Diameter of Anchor Bolts, D=	0.73	in
Actual Bolt Diameter to be Used=	1.375	in
Req Proj Concrete Surface Area, Ap=	83	sq in, = Ta/(2 sqrt(f'c)) (1/3 inc)
Req Embeded Bolt Length, L=	27.50	in, = sqrt(Ap/3.14), min 20D
Min. Spacing to Edge of Concrete=	27.50	in
Min. Spacing Between Bolts in a Line,s=	13.75	in, = 2L
Actual Spacing Between Bolts in a Line, s=	9.04	in
# of Overlaps=	1	
Revised Ap Based on Overlap=	1380.60	in^2
Actual Shear Capacity of Concrete Cone=	201,145	lb. (1/3 inc)

Shear Engineering OK

Shear stress per bolt, fv=	298	psi, = Va/Ab
Allowed Tension Stress with Shear, Ft=	25,456	psi, = 0.43Fu - 1.8fv, max 0.33Fu (1/3 inc)
Actual Tension Stress per Bolt, ft=	7,082	psi, = Ta/Ab

Tension Engineering OK

Weld Design

(check connection of base column to plate, pipe and square tube only)

Shape of Column=	TS	**(P=round, TS=square)**
1/32" Less TS or P Thk. Fillet Weld Leg Size, a=	0.344	in, Max.
Section Modulus of Weld, Sw=	16.59	in3, = 1.34(b^2)(a)
Actual Weld Stress, fw=	11,457	psi, = M/Sw

Weld Engineering OK, <0.3Ft of E7018