SUNAIR AWNINGS & SCREENS

OPERA PERGOLA UNITS

Engineering Report published revision 02/19/18

CALCULATIONS ENGINEERED BY

Sullaway Engineering

Pergola Engineering Request

Determine what you need from Sunair

Options available:

- You may use the enclosed documents in conjunction with you existing or future efforts to obtain your permit.

- You may have the enclosed document stamped, with your state and project referenced, for a flat fee of $340.00 which you will pay directly to Sullaway Engineering to the contact below. *(price may change, contact Sullaway Eng. directly for costing)*

- If you need a full site specific engineering package done for your project you will need to contact Sullaway Engineering and reference project ID #16017. They will then price your job and you will work directly with them.

    - Sullaway Engineering : Attn Pruthvi (Raji) Chauhan 10815 Rancho Bernardo Rd, Ste 260 San Diego, CA 92198 phone: 858-312-5150

These signed engineering calculations may be utilized by your engineer to certify your Sunair/Pratic Pergola Awning system project. In order to secure your permit this engineering report may also require alterations or recalculations by a local engineer in your state. Any such alterations and costs is the responsibility of the customer. Neither Sunair Awnings or Pratic will be liable for the use of these calculations to certify and secure permits for your project. Sunair or Pratic will not be liable for the performance of subject Pergola structures in the field using any calculations we provide. It is up to each customer to do site specific engineering calculations for each project signed by a local engineer licensed in the state in which the project resides. Sunair is not responsible for any lack of or unsuitability of structure to properly fasten the Pergola to the customer's existing structure, walls, decking, floors or footers. Sunair's current Pergola warranty and current "Sales Terms" also applies to all projects and these engineering calculations. The most recent revisions of engineered drawings apply.

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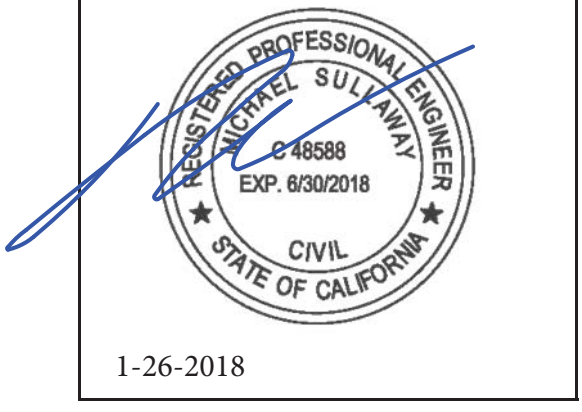
STRUCTURAL CALCULATIONS

for

Pratic OPERA Pergola Awning

PROJECT: 16589B

DATE: 1/25/2018



1-26-2018

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STRUCTURAL CALCULATIONS

for

Pratic OPERA Pergola Awning

This structural calculation package addresses the maximum allowable windspeeds for the Pratic OPERA pergola awning distributed by Sunair Awnings and Solar Screens. The evaluation is solely base on the ASCE 7-10 Minimum Design Loads for Buildings and Other Structures as referenced in the 2015 International Building Code.

This report establishes the maximum allowable windspeeds derived from ultimate windspeeds under exposure C conditions for various dimensional configurations of the OPERA model pergola awning based on the above mentioned references. The intent of this report is to allow an end-user, supplier, or designer to make an educated decision in selecting dimensions for planning purposes. All factors affecting wind speed and structural performance are site-specific and cannot be captured in a report of this nature as to completely assess structural adequacy.

As such, this report is not intended to substitute site specific engineering documentation. Such engineering services to check connections of members to each other, connections to existing structure, and anchorage to the ground is highly recommended. Additionally, certain topographical features may contribute to a higher wind pressure and lower the structural performance contained herein. Under no circumstance shall Sullaway Engineering, Sunair, or Pratic be held liable for the performance of any connections or any loading conditions not specified in this report.

1. The maximum allowable and ultimate wind speeds for various configurations are presented on pages 4 and 5.
2. Reaction outputs are available on pages 6 and 7 for use by a designer for site-specific anchorage.
3. Frames should be anchored to the ground to prevent uplift as listed on pages 6 and 7.
4. Unit is assumed to be a fully open structure for wind analysis.
5. Unit is analyzed with a ground snow load of 30 psf in the retracted position. Snow load was not applied to the expanded position.
6. Aluminum should be 6061-T6.

These signed engineering calculations may be utilized by your engineer to certify your Sunair/Pratic Pergola Awning system project. In order to secure your permit this engineering report may also require alterations or recalculations by a local engineer in your state. Any such alterations and costs is the responsibility of the customer. Neither Sunair Awnings or Pratic will be liable for the use of these calculations to certify and secure permits for your project. Sunair or Pratic will not be liable for the performance of subject Pergola structures in the field using any calculations we provide. It is up to each customer to do site specific engineering calculations for each project signed by a local engineer licensed in the state in which the project resides. Sunair is not responsible for any lack of or unsuitability of structure to properly fasten the Pergola to the customer's existing structure, walls, decking, floors or footers. Sunair's current Pergola warranty and current "Sales Terms" also applies to all projects and these engineering calculations.

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TYPICAL INSTALLATIONS

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SINGLE-BAY MAXIMUM ALLOWABLE WINDSPEEDS

FABRIC FULLY EXPANDED

Projection, P (ft) \ Bay Length, L	8	10	12	14	15	
8	139	139	139	139	139	
10	139	139	139	139	139	
12	139	139	139	139	139	
14	139	139	139	139	139	
16	139	139	139	139	139	
18	139	139	139	139	139	
20	139	139	139	132	128	

FABRIC FULLY RETRACTED

Projection, P (ft) \ Bay Length, L	8	10	12	14	15	
8	139	139	139	139	139	
10	139	139	139	139	139	
12	139	139	139	139	139	
14	139	139	139	139	139	
16	139	139	139	139	139	
18	139	139	139	139	139	
20	139	139	139	139	139	

SINGLE-BAY ASCE 7-10 ULTIMATE WINDSPEEDS

FABRIC FULLY EXPANDED

Projection, P (ft) \ Bay Length, L	8	10	12	14	15	
8	180	180	180	180	180	
10	180	180	180	180	180	
12	180	180	180	180	180	
14	180	180	180	180	180	
16	180	180	180	180	180	
18	180	180	180	180	180	
20	180	180	180	170	165	

FABRIC FULLY RETRACTED

Projection, P (ft) \ Bay Length, L	8	10	12	14	15	
8	180	180	180	180	180	
10	180	180	180	180	180	
12	180	180	180	180	180	
14	180	180	180	180	180	
16	180	180	180	180	180	
18	180	180	180	180	180	
20	180	180	180	180	180	

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MULTI-BAY MAXIMUM ALLOWABLE WINDSPEEDS

FABRIC FULLY EXPANDED

Projection, P (ft) \ Bay Length, L	8	10	12	14	15	
8	139	139	139	139	139	
10	139	139	139	139	139	
12	139	139	139	139	139	
14	139	139	139	136	128	
16	139	139	124	112	108	
18	139	120	105	93	89	
20	120	105	89	77	74	

FABRIC FULLY RETRACTED

Projection, P (ft) \ Bay Length, L	8	10	12	14	15	
8	139	139	139	139	139	
10	139	139	139	139	139	
12	139	139	139	139	139	
14	139	139	139	139	139	
16	139	139	139	139	139	
18	139	139	139	139	139	
20	139	139	139	139	139	

MULTI-BAY ASCE 7-10 ULTIMATE WINDSPEEDS

FABRIC FULLY EXPANDED

Projection, P (ft) \ Bay Length, L	8	10	12	14	15	
8	180	180	180	180	180	
10	180	180	180	180	180	
12	180	180	180	180	180	
14	180	180	180	175	165	
16	180	180	160	145	140	
18	180	155	135	120	115	
20	155	135	115	100	95	

FABRIC FULLY RETRACTED

Projection, P (ft) \ Bay Length, L	8	10	12	14	15	
8	180	180	180	180	180	
10	180	180	180	180	180	
12	180	180	180	180	180	
14	180	180	180	180	180	
16	180	180	180	180	180	
18	180	180	180	180	180	
20	180	180	180	180	180	

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SINGLE-BAY SERVICE REACTIONS

VERTICAL WALL LOAD PER GUIDE (lb)

Projection, P (ft) \ Bay Length, L	8	10	12	14	15
8	449	561	673	785	841
10	561	701	841	981	1051
12	673	841	1009	1177	1262
14	785	981	1177	1374	1472
16	897	1121	1346	1570	1682
18	1009	1262	1514	1766	1892
20	1121	1402	1682	1871	1958

ORTHO. WALL LOAD PER GUIDE (lb)

Projection, P (ft) \ Bay Length, L	8	10	12	14	15
8	193	222	252	281	296
10	193	222	252	281	296
12	193	222	252	281	296
14	193	222	252	281	296
16	193	222	252	281	296
18	193	222	252	281	296
20	193	222	252	251	249

DOWNWARD FOOTING LOAD PER COL (lb)

Projection, P (ft) \ Bay Length, L	8	10	12	14	15
8	614	767	920	1074	1150
10	767	959	1150	1342	1438
12	920	1150	1381	1611	1726
14	1074	1342	1611	1879	2013
16	1227	1534	1841	2148	2301
18	1381	1726	2071	2416	2589
20	1534	1917	2301	2515	2608

UPLIFT FOOTING LOAD PER COL (lb)

Projection, P (ft) \ Bay Length, L	8	10	12	14	15
8	56	70	84	98	105
10	70	87	105	122	131
12	84	105	125	146	157
14	98	122	146	171	183
16	111	139	167	195	209
18	125	157	188	219	235
20	139	174	209	97	28

SINGLE-BAY FACTORED REACTIONS

VERTICAL WALL LOAD PER GUIDE (lb)

Projection, P (ft) \ Bay Length, L	8	10	12	14	15
8	831	1039	1247	1455	1559
10	1039	1299	1559	1818	1948
12	1247	1559	1870	2182	2338
14	1455	1818	2182	2546	2727
16	1662	2078	2494	2909	3117
18	1870	2338	2805	3273	3507
20	2078	2598	3117	3328	3408

ORTHO. WALL LOAD PER GUIDE (lb)

Projection, P (ft) \ Bay Length, L	8	10	12	14	15
8	193	222	252	281	296
10	193	222	252	281	296
12	193	222	252	281	296
14	193	222	252	281	296
16	193	222	252	281	296
18	193	222	252	281	296
20	193	222	252	251	249

DOWNWARD FOOTING LOAD PER COL (lb)

Projection, P (ft) \ Bay Length, L	8	10	12	14	15
8	974	1217	1461	1704	1826
10	1217	1522	1826	2130	2282
12	1461	1826	2191	2556	2739
14	1704	2130	2556	2982	3195
16	1948	2435	2931	3408	3652
18	2191	2739	3287	3834	4108
20	2435	3043	3652	3885	3970

UPLIFT FOOTING LOAD PER GUIDE (lb)

Projection, P (ft) \ Bay Length, L	8	10	12	14	15
8	514	642	770	899	963
10	642	802	963	1123	1204
12	770	963	1156	1348	1444
14	899	1123	1348	1573	1685
16	1027	1284	1541	1797	1926
18	1156	1444	1733	2022	2167
20	1284	1605	1926	1919	1889

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MULTI-BAY SERVICE REACTIONS

VERTICAL WALL LOAD PER GUIDE (lb)

Projection, P (ft) \ Bay Length, L	8	10	12	14	15
8	897	1121	1346	1570	1682
10	1121	1402	1682	1962	2103
12	1346	1682	2018	2355	2523
14	1570	1962	2355	2683	2742
16	1794	2243	2449	2667	2794
18	2018	2243	2459	2690	2823
20	1994	2277	2509	2760	2903

ORTHO. WALL LOAD PER GUIDE (lb)

Projection, P (ft) \ Bay Length, L	8	10	12	14	15
8	193	222	252	281	296
10	193	222	252	281	296
12	193	222	252	281	296
14	193	222	252	266	249
16	193	222	199	182	179
18	193	165	142	125	121
20	143	125	103	87	82

DOWNWARD FOOTING LOAD PER COL (lb)

Projection, P (ft) \ Bay Length, L	8	10	12	14	15
8	1227	1534	1841	2148	2301
10	1534	1917	2301	2684	2876
12	1841	2301	2761	3221	3451
14	2148	2684	3221	3638	3652
16	2454	3068	3231	3416	3542
18	2761	2931	3086	3268	3392
20	2606	2857	3015	3206	3334

UPLIFT FOOTING LOAD PER COL (lb)

Projection, P (ft) \ Bay Length, L	8	10	12	14	15
8	111	139	167	195	209
10	139	174	209	244	261
12	167	209	251	293	314
14	195	244	293	237	39
16	223	279	0	0	0
18	251	0	0	0	0
20	0	0	0	0	0

MULTI-BAY FACTORED REACTIONS

VERTICAL WALL LOAD PER GUIDE (lb)

Projection, P (ft) \ Bay Length, L	8	10	12	14	15
8	1662	2078	2494	2909	3117
10	2078	2598	3117	3637	3896
12	2494	3117	3740	4364	4676
14	2909	3637	4364	4872	4771
16	3325	4156	4166	4216	4302
18	3740	3728	3685	3693	3758
20	3313	3412	3340	3329	3383

ORTHO. WALL LOAD PER GUIDE (lb)

Projection, P (ft) \ Bay Length, L	8	10	12	14	15
8	193	222	252	281	296
10	193	222	252	281	296
12	193	222	252	281	296
14	193	222	252	266	249
16	193	222	199	182	179
18	193	165	142	125	121
20	143	125	103	87	82

DOWNWARD FOOTING LOAD PER COL (lb)

Projection, P (ft) \ Bay Length, L	8	10	12	14	15
8	1948	2435	2921	3408	3652
10	2435	3043	3652	4261	4565
12	2921	3652	4382	5113	5478
14	3408	4261	5113	5698	5558
16	3895	4869	4842	4864	4949
18	4382	4322	4227	4192	4249
20	3842	3914	3777	3714	3755

UPLIFT FOOTING LOAD PER GUIDE (lb)

Projection, P (ft) \ Bay Length, L	8	10	12	14	15
8	1027	1284	1541	1797	1926
10	1284	1605	1926	2247	2407
12	1541	1926	2311	2696	2889
14	1797	2247	2696	2913	2644
16	2054	2568	2209	1892	1799
18	2311	1881	1421	1013	874
20	1672	1315	777	303	129

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MEMBER PROFILE INFORMATION

OPERA GUIDE

y	220 mm	=	8.661422 in	c_x	4.331 in	A	1889 mm^2	=	2.928 in^2		
x	150 mm	=	5.905515 in	c_y	2.953 in						
I_x	8021969 mm^4	=	19.27 in^4	S_x	4.45 in^3					r_x	2.566 in
I_y	3627715 mm^4	=	8.71564 in^4	S_y	2.952 in^3					r_y	1.725 in
J	12292952 mm^4	=	29.534 in^4								

OPERA COLUMN

y	150 mm	=	5.905515 in	c_x	2.953 in	A	2479 mm^2	=	3.842 in^2		
x	150 mm	=	5.905515 in	c_y	2.953 in						
I_x	8256765 mm^4	=	19.837 in^4	S_x	6.718 in^3					r_x	2.272 in
I_y	5939193 mm^4	=	14.269 in^4	S_y	4.832 in^3					r_y	1.927 in
J	10020750 mm^4	=	24.075 in^4								

OPERA GUTTER

y	220 mm	=	8.661422 in	c_x	4.331 in	A	3552 mm^2	=	5.506 in^2		
x	150 mm	=	5.905515 in	c_y	2.953 in						
I_x	19191973 mm^4	=	46.109 in^4	S_x	10.65 in^3					r_x	2.894 in
I_y	5827227 mm^4	=	14 in^4	S_y	4.741 in^3					r_y	1.595 in
J	12292952 mm^4	=	29.534 in^4								

6061-T6 ALUMINUM PROPERTIES AND CONSTANTS

MATERIAL PROPERTIES

F_{tu}	42 ksi	E	10100 ksi
F_{ty}	35 ksi	G	3787.5 ksi
F_{cy}	35 ksi		
F_{su}	24 ksi		

BUCKLING CONSTANTS

B_c	39.37	k_1	0.35
D_c	0.246	k_2	2.27
C_c	65.67	k_t	1
C_b	1		

REDUCTION FACTORS

ϕ_y	0.9
ϕ_b	0.9

LOAD VALUES AND REFERENCES

K_d	0.85	Table 26.6-1
K_z	0.85	Table 27.3-1
K_{zt}	1	26.8.2
G	0.85	

Roof Live Load	20	psf
Dead Load	1	psf
Ground Snow Load	30	psf

		C_{NW}	C_{NL}
0	A	1.2	0.3
	B	-1.1	-0.1
7.5	A	0.9	1.5
	B	1.6	0.3

WIDTHS (FT):	8	10	12	14	15		
PROJECTIONS (FT):	8	10	12	14	16	18	20
EAVE HEIGHT (FT):		10					
ROOF HEIGHT DELTA (FT):		0					
MEAN ROOF HEIGHT (FT):		10					

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SAMPLE CALCULATION ALGORITHM FOR FABRIC FULLY EXPANDED

L	15	ft
P	20	ft
V	95	mph
Multi-Bay	Yes	
L'	30	ft

θ	0	deg
l	20	ft
h	10	
q	16.7	psf

GUIDE BENDING STRENGTH

Sx	4.45	in^3
ϕMn	210.3	k-in

GUIDE COMP STRENGTH

λ	2.607	
D^*_c	13.12	
S^*_1	0.333	
S^*_2	1.231	
ϕ_{cc}	0.945	
ϕF_c	4.867	ksi

POST STRONG BENDING

S	44.77	-
S1	123.2	-
S2	1685	-
ϕF_b	31.5	ksi

POST COMP STRENGTH

λ	1.167	
D^*_c	13.12	
S^*_1	0.333	
S^*_2	1.231	
ϕ_{cc}	0.755	
ϕF_c	18.17	ksi

POST WEAK BENDING

S	62.57	-
S1	123.2	-
S2	1685	-
ϕF_b	31.5	ksi

GUTTER WEAK BENDING

S	83.94	-
S1	123.2	-
S2	1685	-
ϕF_b	31.5	ksi

POST STRONG AXIS WIND

C_p	0.8		
p	11.35	psf	
=	5.586	lb/ft	
R_1	20.95	lb	(top)
R_2	34.91	lb	(btm)
M_{max}	69.83	lb-ft	(btm)
=	0.838	kip-in	
f_b	0.125	ksi	
D/C	0.004	OK	

POST WEAK AXIS WIND

C_p	0.8		
p	11.35	psf	
=	5.586	lb/ft	
R_1	20.95	lb	(top)
R_2	34.91	lb	(btm)
M_{max}	69.83	lb-ft	(btm)
=	0.838	kip-in	
f_b	0.173	ksi	
D/C	0.006	OK	

GUTTER

C_p	0.8	
p	11.35	psf
=	8.193	lb/ft
R_1	61.45	lb
R_2	61.45	lb
M_{max}	230.4	lb-ft
=	2.765	kip-in
f_b	0.583	ksi
D/C	0.019	OK

180° CASE A

(btm)	$C_{NW, A}$	1.2	-
(top)	$C_{NL, A}$	0.3	-
(btm)	$p_{NW, A}$	17.03	psf
(top)	$p_{NL, A}$	4.257	psf
(btm)	$p_{NW, A}$	28.23	psf
(top)	$p_{NL, A}$	15.46	psf
(btm)	w_1	423.4	lb/ft
(top)	w_2	231.8	lb/ft
(btm)	R_1	3755	lb
(top)	R_2	2797	lb
	M_{max}	16652	lb-ft
	=	199.8	kip-in
	D/C	0.95	OK

180° CASE B

$C_{NW, B}$	-1.1	-	
$C_{NL, B}$	-0.1	-	
$p_{NW, B}$	-15.61	psf	
$p_{NL, B}$	-1.419	psf	
$p_{NW, B}$	-4.408	psf	
$p_{NL, B}$	9.781	psf	
w_1	-66.11	lb/ft	
w_2	146.7	lb/ft	
R_1	-129.1	lb	
R_2	935.1	lb	
M_{max}	2980	lb-ft	
=	35.76	kip-in	
D/C	0.17	OK	

90° CASE A & B

$C_{N, A}$	-0.8	-
$C_{N, B}$	0.8	-
p_A	-11.35	psf
p_B	11.35	psf
p_A	-0.151	psf
p_B	22.55	psf
w	338.3	lb/ft
R_1	3383	lb
R_2	3383	lb
M_{max}	16913	lb-ft
=	203	kip-in
D/C	0.965	OK

COLUMN COMPRESSION

P_u	3755	lb
=	3.76	kip
f_c	0.98	ksi
D/C	0.05	OK

FOOTING REACTION (FACTORED)

P_y	3.755	kip	Compression
	-0.129	kip	Uplift

WALL REACTION (FACTORED)

R_y	3383	lb
R_x	82	lb

SERVICE LOADS FOR FOOTING BEARING CALCULATIONS

(btm)	$p_{NW, A}$	23.7	psf
(top)	$p_{NL, A}$	17.92	psf
(btm)	w_1	355	lb/ft
(top)	w_2	269	lb/ft
(btm)	R_1	3334	lb
(top)	R_2	2903	lb

$p_{NW, B}$	9.0	psf	
$p_{NL, B}$	15.36	psf	
w_1	135	lb/ft	
w_2	230	lb/ft	
R_1	1586	lb	
R_2	2065	lb	

p_A	10.9	psf	
p_B	21.11	psf	
w_1	163	lb/ft	
w_2	317	lb/ft	
R_1	2017	lb	
R_2	2783	lb	

FOOTING REACTION (SERVICE)

P_y	3.334	kip	Compression
	0.000	kip	Uplift

WALL REACTION (SERVICE)

R_y	2903	lb
R_x	82	lb

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SAMPLE CALCULATION ALGORITHM FOR FABRIC FULLY RETRACTED

Hood (H) 30 in = 2.5 ft

p_g	30	psf	Ground Snow Load
C_e	1		Exposure Factor (Table 7-2)
C_t	1.2		Thermal Factor (Table 7-3)
I_s	1		Importance Factor (Table 1.5-1)
p_f	25.2	psf	Flat Roof Snow Load
θ	0	deg	Roof Section Slope
Cs	1		Slope Factor (Figure 7-2 per 7.4.3)
ps	25.2	psf	Sloped Roof Snow Load

180° CASE A		180° CASE B		90° CASE A & B	
$p_{NL, A}$	4.257 psf	$p_{NL, A}$	-1.419 psf	$p_{NL, A}$	11.35 psf
LC #3 w/ Lr	35.33 psf	LC #3 w/ Lr	32.49 psf	LC #3 w/ Lr	38.88 psf
LC #3 w/ S	43.65 psf	LC #3 w/ S	40.81 psf	LC #3 w/ S	47.2 psf
LC #4 w/ Lr	15.46 psf	LC #4 w/ Lr	9.781 psf	LC #4 w/ Lr	22.55 psf
LC #4 w/ S	18.06 psf	LC #4 w/ S	12.38 psf	LC #4 w/ S	25.15 psf
MAX	43.65 psf	MAX	40.81 psf	MAX	47.2 psf
w_H	654.7 lb/ft	w_H	612.2 lb/ft	w_H	707.9 lb/ft
(top) R_1	1535 lb	R_1	1435 lb	R_1	1659 lb
(btm) R_2	102.3 lb	R_2	95.65 lb	R_2	110.6 lb
M_{max}	1798 lb-ft	M_{max}	1681 lb-ft	M_{max}	1944 lb-ft
=	21.58 kip-in	=	20.18 kip-in	=	23.33 kip-in
D/C	0.103 OK	D/C	0.096 OK	D/C	0.111 OK

COLUMN COMPRESSION

P_u	110.6	lb
=	0.111	kip
f_c	0.029	ksi
D/C	0.002	OK

FOOTING REACTION (FACTORED)

P_y	111	lb	Compression
	0	lb	Uplift

WALL REACTION (FACTORED)

R_y	1659	lb
R_x	82.4	lb