22-206703-DFS-01-RS

DUMACK ENGINEERING ESTABLISHED IN 1004 A PROFESSIONAL CORPORATION	PROJECT Steel Spiral Stair	JOB NO 7883
	CLIENT Olivia Stravros-Tracy	DATE 3/17/2023
	LOCATION 6422 SE 58th Ave., Portland, OR 97206-6712	BY BLH
	TYPE *Steel*	SHEET NO 1 OF 7

Input Parameters

Diameter Stair (D_{stair}) :	6.0	ft	360^{O} Rotation
Tread Length (L_{tread}) :	34	in	PER PRODUCT INFORMATION
Tread Area (A_{tread}) :	408	in^2	PER PRODUCT INFORMATION
Tread Thickness (t_{tread}) :	0.1046	in	PER PRODUCT INFORMATION
Tread Attachment :	NON-STRUCTURAL SET SCREWS		
Height Column (H_{col}) :	9.50	ft	(Total height of stair)
Column Type :	Steel 3.5" OD-0.120		
Outside Column Diameter (D_{col}) :	3.50	in	PER PRODUCT INFORMATION
Nominal Column Thickness (t_{col}) :	0.120	in	PER PRODUCT INFORMATION
Number of Treads (N_{tread}) :	11		
Number of Platforms ($N_{platform}$) :	1		
Platform Area (P_{area}) :	9.51	ft^2	PER PRODUCT INFORMATION
Outside Sleeve Diameter (D_{sleeve}) :	4.00	in	PER PRODUCT INFORMATION
Tread Sleeve Thickness (t_{sleeve}) :	0.226	in	PER PRODUCT INFORMATION
Tread Sleeve Area (A_{sleeve}) :	2.21	in^2	PER PRODUCT INFORMATION
Sleeve Height (H_{sleeve}) :	4.88	in	PER PRODUCT INFORMATION
Baluster Width (D_{bal}) :	1.00	in	PER PRODUCT INFORMATION
Baluster Thickness (t_{bal}) :	0.083	in	PER PRODUCT INFORMATION
Baluster Spacing (s_{bal}) :	18.5	in	PER PRODUCT INFORMATION
Baluster Height (H_{bal}) :	42.00	in	PER BUILDING CODE
Baluster Attachment :	1/4" Carriage Bolts		
Tread Yield Stress ($F_{y\,tread}$) :	36000	psi	PER PRODUCT INFORMATION
Column Yield Stress ($F_{y\,col}$) :	42100	psi	PER PRODUCT INFORMATION
Sleeve Yield Stress ($F_{y\,sleeve}$) :	42100	psi	PER PRODUCT INFORMATION
Baluster Yield Stress ($F_{y\,bal}$) :	36000	psi	PER PRODUCT INFORMATION
Hand Railing Post Yield Stress ($F_{y\,post}$) :	36000	psi	PER PRODUCT INFORMATION
Base Plate Yield Stress ($F_{y\,bp}$) :	36000	psi	PER PRODUCT INFORMATION
Column Modulus of Elastisity (E_{steel}) :	29000000	psi	PER PRODUCT INFORMATION

REGISTERED PROFESSIONAL ENGINEER 76313PE OREGON MAY 10, 2005 HEATH A. DUMACK

EXPIRATION DATE 12/31/23

Code Material

Code:	2015	PER JOB SPECIFICATION
Building Type:	Residential	One or Two Story Dwelling
State Code:	2017 ORC, 2019OSSC	

Staircase Loads

Dead Load Total (DL_{total}) :	24.2	lb	PER PRODUCT INFORMATION
Live Load Uniform ($LL_{uniform}$) :	40.0	psf	PER BUILDING CODE
Total Uniform Live Load (LL_T) :	113.3	lb	$= LL_{uniform} \times A_{tread}$
Live Load Concentrated (LL_{conc}) :	300.0	lb	PER BUILDING CODE
Tread Critical Load (P) :	300.0	lb	Concentrated Load Governs
Dead Load of Platform ($DL_{platform}$) :	50.6	lb	PER PRODUCT INFORMATION
Live Load on Platform ($LL_{platform}$) :	380.3	lb	Based on 40 PSF Uniform Loading (Governs)

DATE	JOB NO.	PROJECT	SHEET NO.
3/17/2023	7883	Olivia Stravros-Tracy	2 OF 7

Tread Design			
Maximum Moment ($M_{max\ tread}$) :	7348	in - lb	= (P + DL_{total}) x (2/3) x L_{tread}
Effective Shear Cross-Section Area (A_{tread}) :	0.93	in^2	PER PRODUCT INFORMATION
Plastic Section Modulus (Z_{tread}) :	1.20	in^3	PER PRODUCT INFORMATION
Bending			
Allowable Bending Strength (M_n/Ω):	25842	in - lb	= ($F_{y\ tread}$ x Z_{tread}) / 1.67
Actual Moment ($M_{max\ tread}$):	7348	in - lb	= (P + DL_{total}) x (2/3) x L_{tread}
	0.28	OK	For Bending Moment
Shear			
Allowable Shear Strength ($V_{n\ tread}/\Omega$) :	12037	lb	= ($F_{y\ tread}$ x A_{tread} x C_v) / 1.67
Actual Shear Strength ($V_{max\ tread}$) :	324	lb	= P + Dl_{total}
	0.03	OK	For Shear
Unity for Combined Forces			
Unity :	0.31	OK	For Combine Forces
Weld Design			
Maximum Moment (M_{weld}) :	7348	in - lb	= (P + DL_{total}) x (2/3) x L_{tread}
Thickness of Weld (t_{weld}):	0.105	in	PER PRODUCT INFORMATION
Length of Weld (L_{weld}) :	11.67	in	PER PRODUCT INFORMATION
Area of Weld (A_{weld}) :	1.325	in	PER PRODUCT INFORMATION
Moment of Inertia (I_{weld}) :	2.985	in^4	PER PRODUCT INFORMATION
Top Center of Gravity (C_{weld}) :	1.106	in	PER PRODUCT INFORMATION
Bottom Section Modulus (S_{weld}) :	2.70	in^3	=I_{weld} / C_{weld}
Filler Metal (F_{EXX}):	70000	psi	AISC. Table J2.6
Allowable Yield Stress of Weld (R_n/Ω) :	21000	psi	= 0.6 x F_{EXX} / 2.00
Actual Stress on Weld (R) :	2734	psi	$= [((P+Dl_{total}) / A_{weld})^2 + (M_{weld} / S_{weld})^2\ ]^{1/2}$
	0.13	OK	For Weld Capacity
Sleeve Design			
Maximum Moment (M_{sleeve}) :	7996	in - lb	= (P + DL_{total}) x ((2/3) L_{tread}+D_{sleeve}/2)
Center of Gravity (C_{sleeve}) :	2.44	in.	= H_{sleeve} / 2
Moment of Inertia (I_{sleeve}) :	4.38	in^4	= 2 x (1/12) x t_{sleeve} x H_{sleeve}^3
Plastic Section Modulus (Z_{sleeve}):	2.69	in^3	= (1/2) A_{sleeve} (y_c + y_t)
Bending			
Allowable Bending Strength (M_n/Ω):	67840	in - lb	=($F_{y\ sleeve}$ x Z_{sleeve})/1.67
Actual Moment ($M_{max\ sleeve}$):	7996	in - lb	=$M_{max\ sleeve}$
	0.12	OK	For Bending Moment
Column Design			
Column Area (A_{col}) :	1.19	in^2	$= (¼\ \pi) \times [D_{col}^2 - (D_{col} - 2 \times 0.93\ t_{col})^2\ ]$
Column Dead Load (DL_{col}) :	4.04	plf	= 490pcf x A_{col} (1/144)
Maximum Unbraced Length of Column (L_{ub}):	9.50	ft	

DATE	JOB NO	PROJECT	SHEET NO
3/17/2023	7883	Olivia Stravros-Tracy	3 OF 7

Bending From Seismic Loading

Risk Category:	II	(ASCE 7-16, Table 1.5-1)	
Site Class:	D	(ASCE 7-16, § 11.4.2)	
Short Period Spectral Response (S_S):	0.890	(ASCE 7-16, § 22)	
1-Second Period Spectral Response (S_1):	0.388	(ASCE 7-16, § 22)	
Short Period Spectral Acceleration (S_{DS}):	0.712	(ASCE 7-16, Eq. 11.4-3)	
1-Sec. Period Spectral Acceleration (S_{D1}):	1	(ASCE 7-16, Eq. 11.4-4)	
Response Modification Factor (R_p):	1.25	(ASCE 7-16, §13.1.5 → Table 15.4-2)	
Component Amplification Factor (a_p):	1.0	(ASCE 7-16, Table 13.6-1[a])	
Seismic Importance Factor (I_p):	1.0	(ASCE 7-16, Table 1.5-2)	
Height Ratio of Structure (z/h):	1.0	(ASCE 7-16, §13.3.1)	
Effective Dead Load of Stair Structure (DL):	443.5	lb	$= 1.25\,[H_{col} \times DL_{col} + N_{TREAD}(DL_{TREAD}) + N_{PLAT}(DL_{PLAT})]$
25% Live Load of Stair Structure (LL):	825.0	lb	$= 0.25\,[N_{TREAD}(P)]$
Effective Seismic Weight (W_p):	1268.5	lb	$= DL + LL$
Seismic Design Force (F_p):	867.0	lb	$= [0.4a_pS_{DS}/(R_p/I_p)]\,[1+2(z/h)] \times W_p$
Effective Horizonal Seismic Force (E_h):	5.32	lb/in	$= 0.7 \times F_p / (H_{col} \times 12)$
Effective Concurrent Vert. Seismic Force (E_v):	126.4	lb	$= 0.7 \times (0.2S_{DS}W_p)$
Maximum Moment ($M_{seismic\,col}$) :	8649	in - lb	$= [E_h \times (L_{ub} \times 12)^2/8]$

Axial From Treads/Platform Loaded & Siesmic

Column Load from Treads (TL_{tread}) :	3566	lb	$= (P + DL_{total})\,N_{tread}$
Column Load from Platform(s) ($TL_{platform}$) :	431	lb	$= (DL_{platform} + LL_{platform})\,N_{platform}$
Radius of Gyration (r_{col}) :	1.20	in	$= [D_{col}^2 + (D_{col} - 2 \times t_{col})^2]^{1/2} / 4$
Buckling Stress (F_e) :	31642	psi	$= \pi^2E/(KL_{ub}/r)^2$ (K = 1.0) ← Top/Bottom Pinned
Flexural Buckling Stress (F_{cr}) :	24123	psi	$F_e \geq 0.44F_y,\ F_{cr} = [0.658\text{^}(F_y/F_e)]F_y$
			$F_e < 0.44F_y,\ F_{cr} = 0.877F_e$
Allowable Compressive Strength ($P_{n\,col}/\Omega$) :	17160	lb	$=(F_{cr} \times A_{col}) / 1.67$
Actual Compressive Force (P_{col}) :	4161	lb	$= H_{col} \times DL_{col} + TL_{tread} + TL_{platform} + E_v$
Compression Interaction :	0.24	OK	For Compressive Force

Biaxial Bending From 2 Treads Loaded

Total Inertial Loading ($F_{inertial}$):	2.938	lb/in	$= [(2.6\ ft/s^2)/g] \times P_{col} / H_{col}$
Maximum Moment X-Axis ($M_{biaxial\,x\,col}$) :	7996	in - lb	$= (P + DL_{total}) \times ((2/3)\,L_{tread} + D_{sleeve}/2)$
Maximum Moment Y-Axis ($M_{biaxial\,y\,col}$) :	7996	in - lb	$= (P + DL_{total}) \times ((2/3)\,L_{tread} + D_{sleeve}/2)$

Allowable Bending Moment of Column

Plastic Section Modulus X-Axis ($Z_{x\,col}$) :	1.28	in^3	$=[D_{col}^3 - (D_{col} - 2 \times 0.93t_{col})^3]/6$
Plastic Section Modulus Y-Axis ($Z_{y\,col}$) :	1.28	in^3	$=[D_{col}^3 - (D_{col} - 2 \times 0.93t_{col})^3]/6$
Allow. Bending Moment X-Axis ($M_{n\text{-}x}/\Omega$) :	32313	lb-in	$= (Z_{x\,col} \times F_{y\,col}) / 1.67$
Allow. Bending Moment Y-Axis ($M_{n\text{-}y}/\Omega$) :	32313	lb-in	$= (Z_{y\,col} \times F_{y\,col}) / 1.67$

Unity for Combined Forces

For $P_r/P_c \geq 0.2,\ \rightarrow\ P_r/P_c + 8/9[(M_{rx}/M_{cx}) + (M_{ry}/M_{cy})] \leq 1.0$

Eq. H1-1a, 13th Edition Steel Construction Manual

Unity : 0.92 OK For Combined Forces

$[P_{col}/(P_{n\,col}/\Omega)] + (8/9)[(M_{biaxial\,x\,col} + M_{seismic\,col})/(M_{nx\,col}/\Omega)) + ((M_{biaxial\,y\,col})/(M_{ny\,col}/\Omega))] \leq 1.0$

DATE	JOB NO.	PROJECT	SHEET NO.
3/17/2023	7883	Olivia Stravros-Tracy	4 OF 7

Railing Design

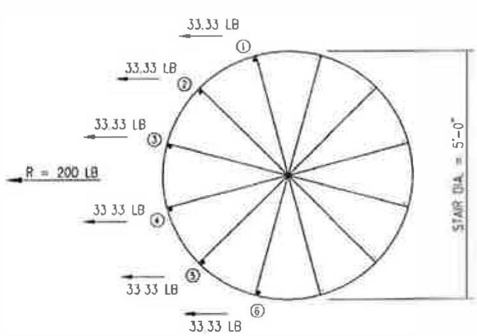
Handrail Material - Alum			
Handrail Live Load (LL_{hand}) :	50	plf	PER BUILDING CODE
Total Uniform Live Load ($LL_{T\,hand}$) :	77	lb	$= LL_{hand} \times s_{bal} / 12$
Handrail Live Load Concentrated ($LL_{conc\,hand}$) :	200	lb	PER BUILDING CODE
Critical Load (P_{hand}) :	200	lb	Concentrated Load Governs
Maximum Moment ($M_{max\,hand}$) :	925	in - lb	$= P_{hand} \times s_{bal} / 4$
Handrail Diameter (D_{hand}) :	1.50	in	PER PRODUCT INFORMATION
Handrail Thickness (t_{hand}) :	0.125	in	PER PRODUCT INFORMATION
Plastic Section Modulus (Z_{hand}) :	0.223	in^3	$= [D_{hand}^3 - (D_{hand} - 2 \times 0.93t_{hand})^3]/6$
Min. Handrail Yield Stress ($F_{y\,hand}$) :	13000	psi	PER PRODUCT INFORMATION
Allowable Bending Strength ($M_{n\,bal}/\Omega$) :	1737	in - lb	$= (F_{y\,hand} \times Z_{hand}) / 1.67$
Actual Moment (M_{bal}) :	925	in - lb	$= P_{hand} \times s_{bal} / 4$
		OK	For Bending Moment

Main Baluster Design

Pipe Size :	1" Outer Diameter x 14 Gage Steel Pipe		
Handrail Live Load (LL_{bal}) :	50	plf	PER BUILDING CODE
Total Uniform Live Load ($LL_{T\,bal}$) :	77	lb	$= LL_{bal} \times s_{bal} / 12$
Critical Load: (P_{bal}) :	77	lb	PER BUILDING CODE
Maximum Moment (M_{bal}) :	809	in - lb	$= (P_{bal} \times l_{bal})/4$
Plastic Section Modulus (Z_{bal}) :	0.066	in^3	$= [D_{bal}^3 - (D_{bal} - 2 \times 0.93t_{bal})^3]/6$
Allowable Bending Strength ($M_{n\,bal}/\Omega$) :	1420	in - lb	$= (F_{y\,bal} \times Z_{bal}) / 1.67$
Actual Moment (M_{bal}) :	809	in - lb	$= (P_{bal} \times l_{bal})/4$
		OK	For Bending Moment

Hand Railing Post Design

Pipe Size :	1" Outer Diameter x 14 Gage Steel Pipe		
Railing Post Outside Diameter (D_{post}):	1.00	in	PER PRODUCT INFORMATION
Post Height (H_{post}) :	42.00	in.	$= H_{bal}$
Railing Post Thickness (t_{post}):	0.0830	in	PER PRODUCT INFORMATION
Railing Post Plastic Section Modulus (Z_{post}):	0.070	in^3	$=(D_{post}^3/6) - ((D_{post} - (2 \times t_{post}))^3/6)$
Handrail Load Concentrated (LL_{hand}) :	200	lb.	PER BUILDING CODE
No. of Posts per Distributed Crit. Load (N_{post}) :	6	Posts	= 180°/30°
Allowable Bending Strength ($M_{n\,post}/\Omega$):	9052	lb-in	$=N_{post} (F_{y\,post} \times Z_{post}) / 1.67$
Actual Moment of Post Group (M_{post}):	8400	lb-in	$= P_{crit} \times H_{post}$
	0.93	**OK**	For Bending Moment



CONC. LOAD = 200 LB DISTRIBUTED TO 6 POSTS

Anchor Bolt Design:	**Per ACI 318-14 Chapter 17**		
Anchor Design Parameters			
Anchor Type:	3/8" Hilti KWIK Bolt TZ Steel Expansion Anchor, 3" embed.		
Anchor Bolt Diameter (d_o) :	3/8	in	
Number of Bolts (N_{bolt}) :	4	Bolts	
Concrete Compressive Strength (f'_c):	4000	psi	
Shear at Base of Column ($V_{u\ base}$) :	403	lb	$= [(M_{biaxial\ x\ col}{}^2 + M_{biaxial\ y\ col}{}^2)^{1/2} / (L_{ub} \times 12)] + ½L_{ub}E_h$
Tension at Base of Column ($T_{u\ base}$) :	0	lb	Base conn. does not experience tension/pullout
ASD Adjust Factor (α_v):	1.43	Per ACI 318-14, Chapt 17	
Seismic Strength Reduction Factor (ϕ_{seis})	0.75	Per ACI 318-14, Chapt 17	
Non-Ductile Reduction Factor (ϕ_{duct})	0.40	Per ACI 318-14, Chapt 17	
Steel Strength in Shear			
Effective Stress Area	0.0136	in2	$0.7854\ (D-(0.9743/n))^2$
Min Ult. Strength of Anchor	125000.00	psi	per Hilti
Steel Strength of Anchor in Shear (Vs)	3595.00	lb	$0.5A_{se}f_{uta}$
Seismic Steel Strength of Anchor in Shear (Veq)	2255.00		per Hilti
Steel Strength Reduction Factor (ϕ_{steel})	0.65		Per ACI 318-14, Chapt 17
Steel Shear Strength	1025.00	lb	
Actual Shear per Anchor	100.66	lb	
Shear Interaction	0.10		OK
Pryout Strength in Shear			
Cracked Concrete Factor	17.00		
Effective embedment depth	3.00	in	
Base Plate Diameter	8.00	in	
Bolt spacing in x-axis	4.25	in	
Bolt spacing in y-axis	4.25	in	
Area of failure per Single	81.00	in^2	$=9h_{eff}{}^2$
Area of Failure per Group	175.56	in^2	$=(1.5h_{eff} + s_x + 1.5h_{eff})(1.5h_{eff} + s_y + 1.5h_{eff})$
Concrete Breakout Strength	5586.77	lb/in	
Anchor Pryout Strength	12109	lb/in	
Pryout Reduction Factor	0.70		
Pryout Strength	1778.24	lb	
Actual Shear per Anchor Group	402.65	lb	
Shear Interaction	0.23		OK Pryout Strength of Anchor in Shear
Platform Lateral Loading			
Jnfactored Lateral Loading in Any Direction (F):	233	lb	$= E_h \times L_{ub} \times 12 / (2 \times 0.7)$
Dead Load			
Effective Dead Load of Stair Structure (DL):	508.3	lb	$= 1.25\ [H_{col} \times DL_{col} + N_{TREAD}(DL_{TREAD}) + N_{PLAT}(DL_{PLAT})]$
Effective Live Load			
25% Live Load of Stair Structure (LL):	825.0	lb	$= 0.25\ [N_{TREAD}(P)]$
Compressive Force at Base			
Actual Compressive Force (P_{col}) :	4161.5	lb	$= H_{col} \times DL_{col} + TL_{tread} + TL_{platform}$

***Supporting structure must be analyzed by professional engineer to resist the platform lateral loading specified, F, acting concurrently at each platform level in any horizontal direction**

PLATFORM RAILING PROPERTIES:

Railing and Post Geometry:

Posts:	Steel Type-1 - Stan HSS 1-1/2 X 1-1/2 X 0.095	
Post Spacing:	34.00	in
Post Height:	42	in
Section Area:	0.534	in^2
I_x =	0.176	in^4
S_x =	0.235	in^3
F_y =	45.7	ksi
E =	29000	ksi

Top Rail:	Steel Type-5 - Stan HSS 1X 1 X 0.083	
Railing Length:	36	
Section Area:	0.3044	in^2
I_y =	0.04302	in^4
S_y =	0.08603	in^3
F_y =	42	ksi
E =	29000	ksi

PLATFORM RAILING ANALYSIS:

Top Rail Loading:	50 plf x Post Spacing			
	141.66667 lb			
or	**200** lb		GOVERNS	
Shear:	w x L /2	or	P / 2	
V_r =	70.83	or	**100**	lbs
Moment:	w x L^2 / 8	or	P x L / 4	
M_r =	50.173611		**141.67**	ft-lbs

Post Loading:

P =	141.66667 lb			
or	200 lb x Proportion Distribution Factor (P_f) to adjacent posts			
Rail Stiffness (k_r) =	E x I_x / L			
Post Stiffness (k_p) =	E x I_y / H			
k_r =	34.655			
k_p =	121.52381			
Stiffness Ratio (k_r / k_p) =	0.285			
P_f =	0.65	(Conservative Based on Railing Load Distribution Chart, Sheet 8)		
Shear:	141.66667	or	200.0	
P_f x V_r =	92.08	or	**130**	lbs
Moment:	5950	or	8400	
P_f x M_r =	3867.5		**5460.0**	ft-lbs

DATE	JOB NO.	PROJECT	SHEET NO.
3/17/2023	7883	Olivia Stravros-Tracy	7 OF 7

RAILING ANALYSIS CONT.:

Allowable Top Rail Loading:

$V_n = A \times F_y$

12784.8 lbs

FOS: V_n / V_r = 127.8 | > 2.0 Therefore OK

$M_n = S_y \times F_y$

3613.26 in-lbs

FOS: M_n / M_r = 25.5 | > 1.67 Therefore OK

Allowable Post Loading:

$V_n = A \times F_y$

24403.8 lbs

FoS: V_n / V_p = 187.7 | > 2.0 Therefore OK

$M_n = S_y \times F_y$

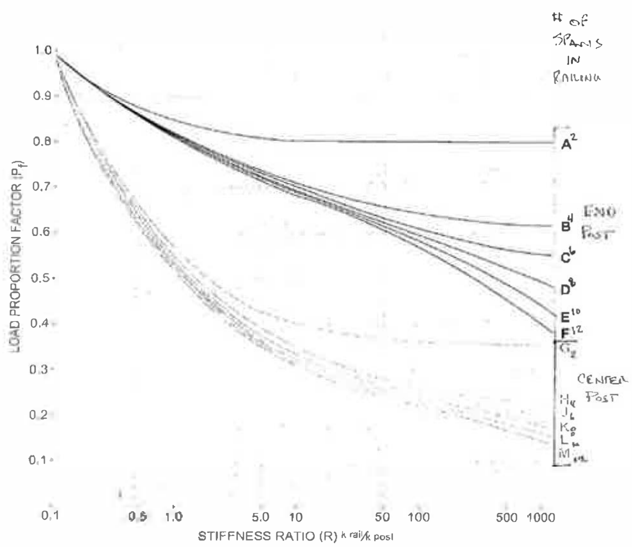
10739.5 in-lbs

FoS: M_n / M_p = 1.97 | > 1.67 Therefore OK

Railing Load Distribution Graph for P_f value

LOAD DISTRIBUTION CONSIDERATIONS

The graph below is used to determine railing load distribution. It has been determined by computer analysis and confirmed by laboratory test. The formula used in determining the graph assumes that all posts are of identical material and section.



The Stiffness (k) of a rail or post is: $k_r = \dfrac{E \times I}{L}$ for the rail

$k_p = \dfrac{E \times I}{h}$ for the post

March 17th, 2023

Olivia Stravos-Tracy
6422 SE 58th Ave.
Portland, OR 97206

RE: Spiral Stair Deferred Submittal
6422 SE 58th Ave.
Portland, Oregon 97206

Olivia,

This letter to verify that we have reviewed the deferred submittal for the Spiral Stair Structural Calculations from Dumack Engineering, dated 03/17/2023, and the Spiral Stair Shop Drawings, dated 03/15/2023.

We have attached our shop stamp to this letter pertaining to these two documents.

If you have any questions, please do not hesitate to call.

Sincerely,

Munzing Structural Engineering

Michael Munzing, P.E.
Principal

[X] Reviewed	[ ] Furnish As Corrected
[ ] Rejected	[ ] Revise and Resubmit
[ ] Submit Specific Item	

The review is only for general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. Corrections or comments made on the shop drawings during this review do not relieve contractor from compliance with the requirements of the plans and specifications. Approval of a specific item shall not include approval of an assembly of which the item is a component. Contractor is responsible for: dimensions to be confirmed and correlated at the jobsite: information that pertains solely to the fabrication processes or the means, methods, techniques, sequences and procedures of construction: coordination of the Work of all trades; and for performing all work in a safe and satisfactory manner.

MUNZING STRUCTURAL ENGINEERING, LLC

Date: 03/17/2023 By: Michael Munzing, PE