Koneru Residence Stair

6610 E Mercer Way

Mercer Island, WA 98040

MALSAM TSANG
STRUCTURAL ENGINEERING

- ☐ REVIEWED AND NOTED FOR DESIGN INTENT ONLY
- ☑ REVIEWED FOR LOADS IMPOSED ON BASIC STRUCTURE ONLY
- ☑ NO EXCEPTION TAKEN
- ☐ NOTE MARKINGS
- ☐ SKETCHES ATTACHED
- ☐ REVISE AND RESUBMIT
- ☐ NOT REVIEWED

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JCM — REVIEWED BY

05/06/24 — DATE

Prepared for:	Dheeraj Koneru
Job #:	13221-2023-01
Date:	April 19, 2024

STRUCTURAL ENGINEERING
SEATTLE 2124 Third Ave, Suite 100, Seattle, WA 98121 O 206.443.6212
TACOMA 934 Broadway, Suite 100, Tacoma, WA 98402 O 253.284.9470
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KONERU RESIDENCE STAIR

SCOPE: DESIGN & DETAIL NEW FEATURE STAIR FOR A NEW RESIDENCE. STRUCTURAL DESIGN OF THE MAIN HOUSE STRUCTURE PER BUILDING EOR.

CRITERIA:

- CODE: 2018 IBC, AISC LRFD STEEL DESIGN

LOADING CRITERIA:

- DEAD - SELF-WEIGHT OF STRUCTURE
  - EXTERIOR GLASS STANCHION = 25 PLF
  - INTERIOR HANDRAIL = 5 PLF
  - 3 1/2" THICK WOOD TREAD = 10 PSF
  - MISC WEIGHT/FINISHES = 5 PSF
  - STEEL SELF WEIGHT - CALCULATED BY SOFTWARE
- LIVE = 40 PSF
- SEISMIC - LOADS PER ASCE 7 CH. 13
  - $S_s = 1.45$, $S_1 = 0.50$, SITE CLASS E
  - $S_{DS} = 1.17$, $S_{D1} = 0.67$, $I_p = 1.5$
  - $a_p = 1.0$ (STAIR STRUCTURE)
    $= 2.5$ (CONNECTIONS TO STRUCTURE)
  - $R_p = 2.5$, $z/h = 0.25$ (AVG RELATIVE ELEVATION)
  - $\Omega_0 = 2.5$ (POST-INSTALLED CONC ANCHORS)

SEISMIC LOAD CALCULATION

$$F_p = \frac{0.4 a_p S_{DS} W_p}{(R_p/I_p)}\left(1 + 2\frac{z}{h}\right) = \begin{cases} 0.281 & \text{FOR STAIR STRUCTURE} \\ 0.702 & \text{FOR CONNECTIONS} \end{cases} W_p$$

$$F_{p,min} = 0.3 S_{DS} I_p W_p = 0.351 W_p$$

$\therefore F_p = 0.351 W_p$ (FOR STAIR STRUCTURE)
$= 0.702 W_p$ (FOR CONNECTIONS)

Visual Analysis MODAL ANALYSIS

PRIMARY FREQUENCY = 9.93 Hz ≈ 10 Hz

- 10 Hz IS A STANDARD UPPER LIMIT WHERE A STEP FREQUENCY/ACCELERATION ANALYSIS SHOULD BE PERFORMED, THEREFORE, THIS STAIR IS RIGID ENOUGH TO OMIT THIS ANALYSIS.

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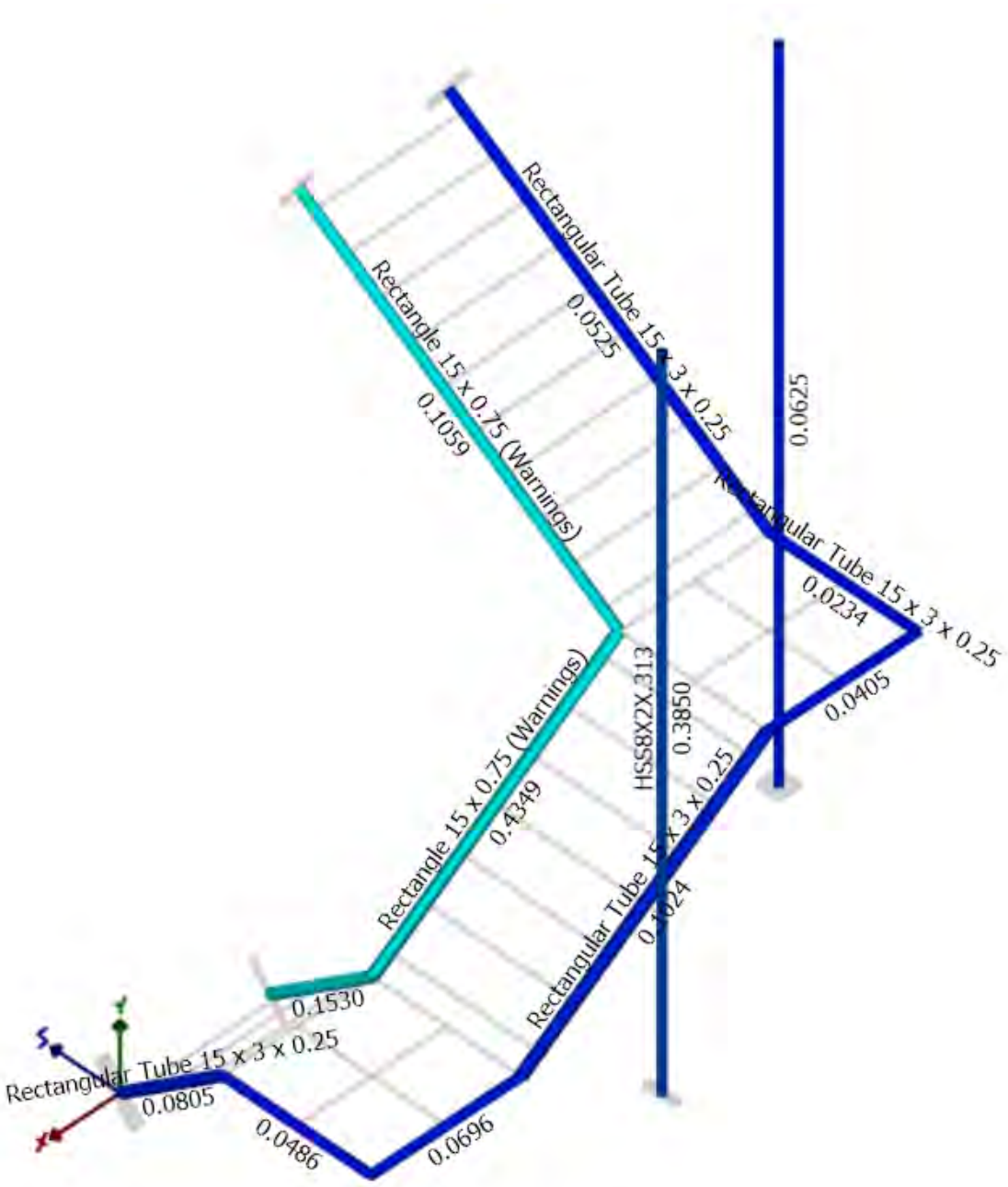
Visual Analysis Model Output

Member Demand/Capacity Ratios



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Koneru Residence Stair	4/19/2024
PROJECT	DATE
	13221-2023-01
	PROJ #
	SWJ
	DESIGN
	SHEET

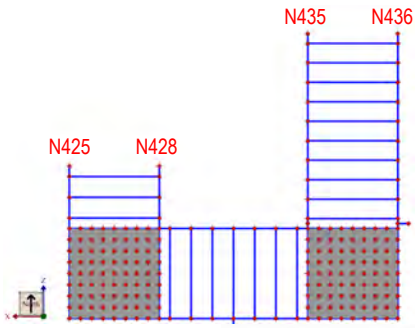
Max/Min Displacements (Dead + Live)

Displacements

DX	*-0.02318 -> 0.04347 in*
DY	*-0.15967 -> 0.01106 in*
DZ	*-0.0376 -> 0.05391 in*
RX	*-0.3832 -> 0.40505 deg*
RY	*-0.05851 -> 0.02008 deg*
RZ	*-0.39786 -> 0.29235 deg*

Stringer Loads Imposed On Structure

Node	Result Case	FX K	FY K	FZ K
N425	D	0.1494	-0.1584	-0.9386
N425	E+X	0.8704	-0.3717	0.652
N425	E+Z	0.2433	-0.1618	0.4731
N425	L	0.1601	-0.183	-0.8396
N428	D	0.0266	-1.6159	1.6438
N428	E+X	0.3228	0.0694	-0.406
N428	E+Z	0.0735	-0.2608	0.4346
N428	L	-0.0154	-1.3484	1.4407
N435	D	-0.1166	-1.2904	-0.9334
N435	E+X	0.3339	0.7396	1.2794
N435	E+Z	-0.0877	0.1726	0.5654
N435	L	-0.1467	-0.966	-0.6938
N436	D	0.0178	-0.2135	0.3191
N436	E+X	0.6469	-0.864	-1.4044
N436	E+Z	-0.093	0.6418	1.0782
N436	L	0.0787	-0.3496	0.1891



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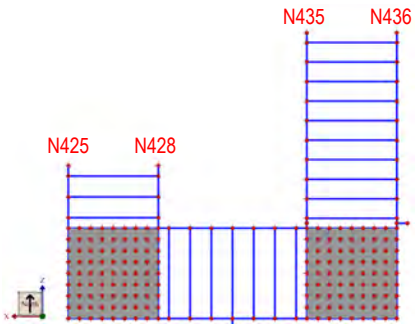
Stringer Base Imposed Loads - For Concrete Anchor Design

Stringer Combined Base Reactions

Node	Result Case	FX K	FY K	FZ K
N428	6. 1.2D+E+L+0.2S »+X:Ω	-0.6583	2.9869	-2.3449
N428	6. 1.2D+E+L+0.2S »+Z:Ω	-0.1525	3.5693	-4.05
N428	6. 1.2D+E+L+0.2S »-X:Ω	0.6133	3.1354	-4.0495
N428	6. 1.2D+E+L+0.2S »-Z:Ω	0.1075	2.553	-2.3444
N428	7. 0.9D+E »+X:Ω	-0.651	1.0295	-0.2897
N428	7. 0.9D+E »+Z:Ω	-0.1452	1.6119	-1.9948
N428	7. 0.9D+E »-X:Ω	0.6206	1.178	-1.9944
N428	7. 0.9D+E »-Z:Ω	0.1148	0.5956	-0.2892
N436	**Envelope**	**-0.6583**	**3.5693**	**-4.05**
N425	6. 1.2D+E+L+0.2S »+X:Ω	-2.2877	1.1794	0.4516
N425	6. 1.2D+E+L+0.2S »+Z:Ω	-0.8332	0.7861	0.7533
N425	6. 1.2D+E+L+0.2S »-X:Ω	1.694	-0.3646	3.3267
N425	6. 1.2D+E+L+0.2S »-Z:Ω	0.2395	0.0287	3.025
N425	7. 0.9D+E »+X:Ω	-2.0904	0.9191	-0.7652
N425	7. 0.9D+E »+Z:Ω	-0.6359	0.5258	-0.4635
N425	7. 0.9D+E »-X:Ω	1.8913	-0.6249	2.11
N425	7. 0.9D+E »-Z:Ω	0.4368	-0.2316	1.8082
N435	**Envelope**	**-2.2877**	**1.1794**	**3.3267**



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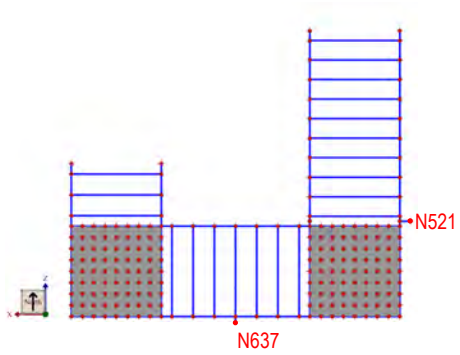
Unfactored Loads Imposed on Columns

Node	Result Case	Fx K	Fy K	Fz K	Mx K-ft	My K-ft	Mz K-ft
N521	D	-0.0821	-0.93	-0.0078	-0.0581	-0.181	0.8046
N521	E+X	0.3078	0.4698	0.0007	-0.0089	0.0563	-1.0989
N521	E+Z	-0.1383	-0.6678	-0.1528	0.0191	-0.0796	0.6526
N521	L	-0.0806	-0.8405	-0.0074	-0.0547	-0.1582	0.7678
N637	D	-0.0088	1.8284	-0.0842	-1.0296	0	-0.0103
N637	E+X	0.0146	-0.0374	-0.1322	-0.2337	0	0.3278
N637	E+Z	0.002	-0.2337	0.0512	0.1603	0	0.0013
N637	L	-0.0079	1.5645	-0.0788	-0.9141	0	-0.0044



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Company:		Date:	4/19/2024
Engineer:		Page:	1/5
Project:			
Address:			
Phone:			
E-mail:			

1.Project information

Customer company:
Customer contact name:
Customer e-mail:
Comment:

Project description:
Location:
Fastening description:

2. Input Data & Anchor Parameters

General
Design method:ACI 318-14
Units: Imperial units

Anchor Information:
Anchor type: Torque controlled expansion anchor
Material: Carbon Steel
Diameter (inch): 0.500
Nominal Embedment depth (inch): 3.750
Effective Embedment depth, h_{ef} (inch): 3.250
Code report: ICC-ES ESR-3037
Anchor category: 1
Anchor ductility: Yes
h_{min} (inch): 5.78
c_{ac} (inch): 7.33
C_{min} (inch): 12.00
S_{min} (inch): 2.75

Base Material
Concrete: Normal-weight
Concrete thickness, h (inch): 12.00
State: Cracked
Compressive strength, f'_c (psi): 3000
$\Psi_{c,V}$: 1.0
Reinforcement condition: B tension, B shear
Supplemental reinforcement: Not applicable
Reinforcement provided at corners: No
Ignore concrete breakout in tension: No
Ignore concrete breakout in shear: No
Ignore 6do requirement: Not applicable
Build-up grout pad: No

Base Plate
Length x Width x Thickness (inch): 6.50 x 24.00 x 0.25

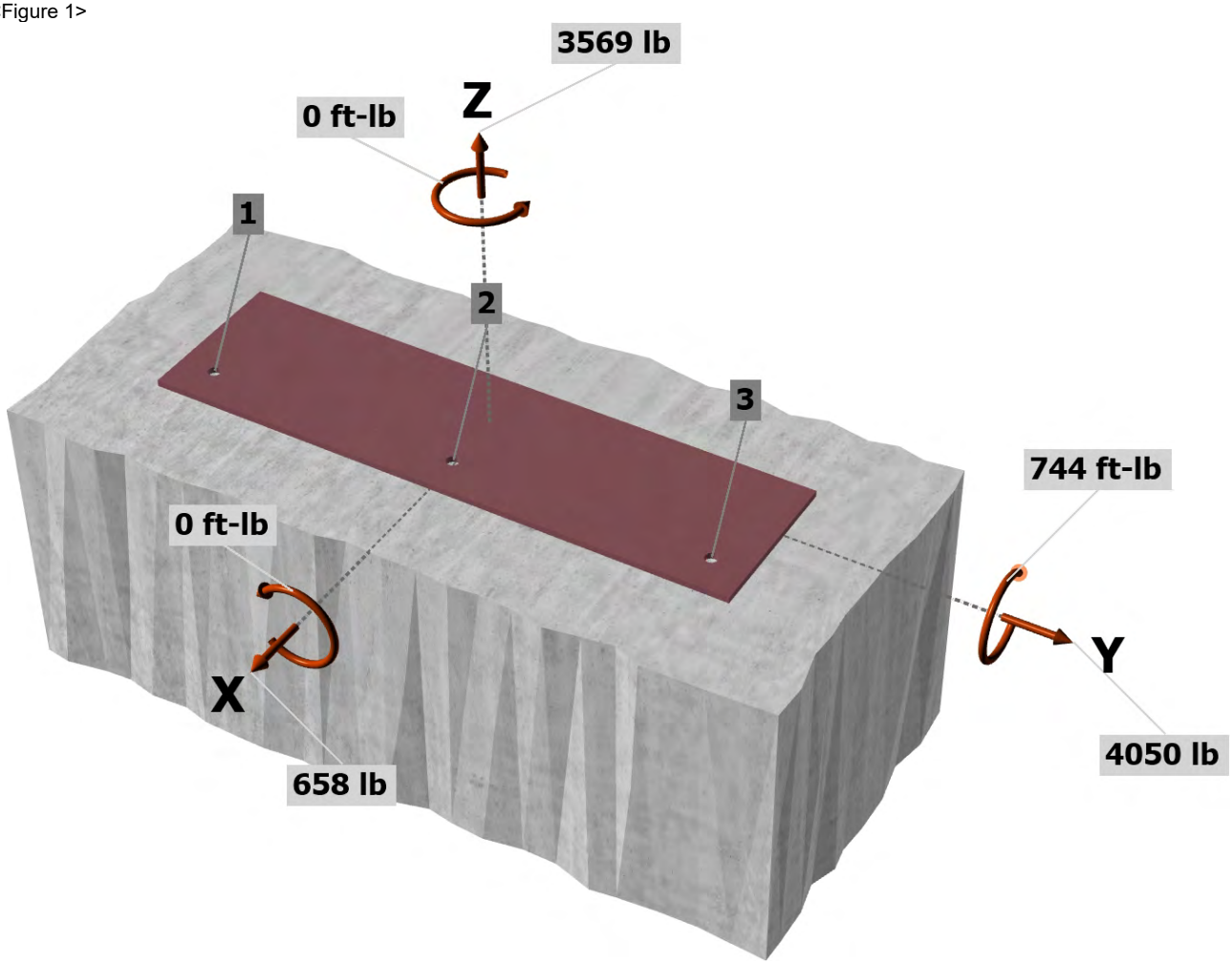
Recommended Anchor
Anchor Name: Strong-Bolt® 2 - 1/2"Ø CS Strong-Bolt 2, hnom:3.75" (95mm)
Code Report: ICC-ES ESR-3037

Load and Geometry
Load factor source: ACI 318 Section 5.3
Load combination: not set
Seismic design: No
Anchors subjected to sustained tension: Not applicable
Apply entire shear load at front row: No
Anchors only resisting wind and/or seismic loads: No

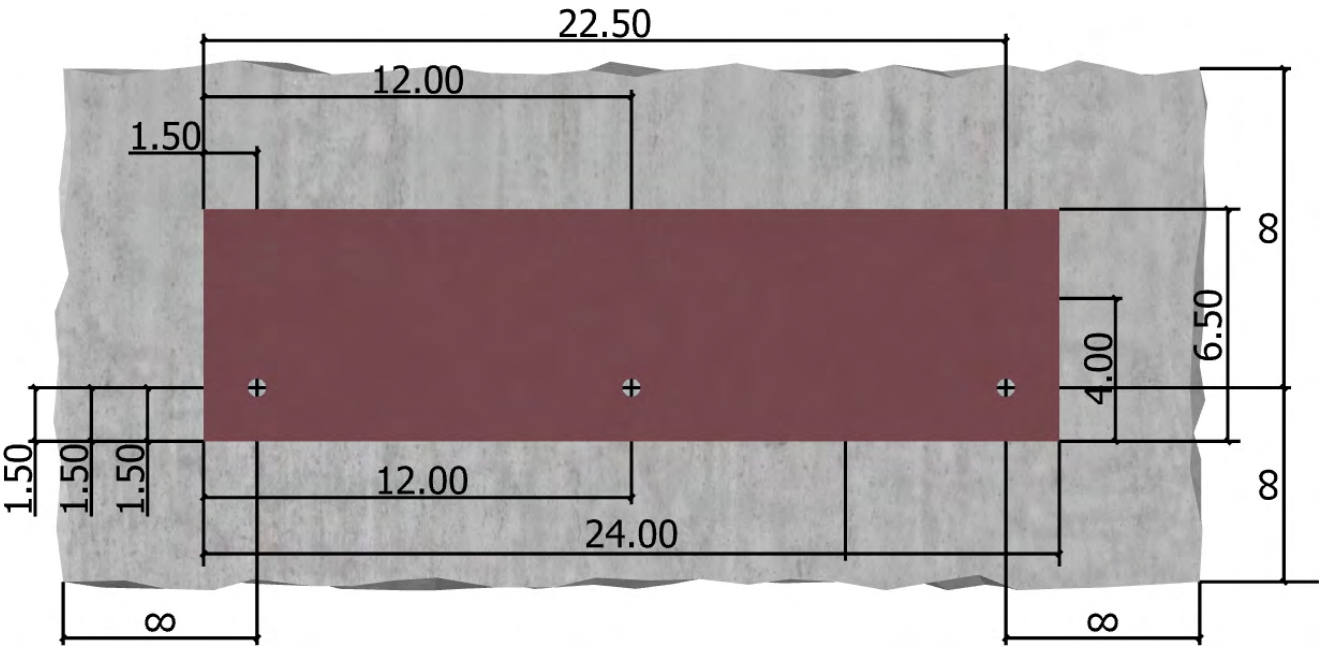
Strength level loads:

N_{ua} [lb]: 3569
V_{uax} [lb]: 658
V_{uay} [lb]: 4050
M_{ux} [ft-lb]: 0
M_{uy} [ft-lb]: -744
M_{uz} [ft-lb]: 0

<Figure 1>



<Figure 2>

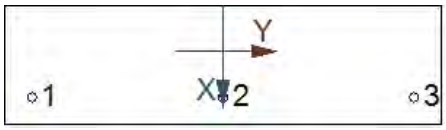


3. Resulting Anchor Forces

Anchor	Tension load, N_{ua} (lb)	Shear load x, V_{uax} (lb)	Shear load y, V_{uay} (lb)	Shear load combined, $\sqrt{(V_{uax})^2+(V_{uay})^2}$ (lb)
1	1189.7	-262.8	1350.0	1375.3
2	1189.7	219.3	1350.0	1367.7
3	1189.7	701.5	1350.0	1521.4
Sum	3569.0	658.0	4050.0	4264.4

Maximum concrete compression strain (‰): 0.00
Maximum concrete compression stress (psi): 0
Resultant tension force (lb): 3569
Resultant compression force (lb): 0
Eccentricity of resultant tension forces in x-axis, e'_{Nx} (inch): 0.00
Eccentricity of resultant tension forces in y-axis, e'_{Ny} (inch): 0.00
Eccentricity of resultant shear forces in x-axis, e'_{Vx} (inch): 0.00
Eccentricity of resultant shear forces in y-axis, e'_{Vy} (inch): 0.00

<Figure 3>



4. Steel Strength of Anchor in Tension (Sec. 17.4.1)

N_{sa} (lb)	ϕ	ϕN_{sa} (lb)
12100	0.75	9075

5. Concrete Breakout Strength of Anchor in Tension (Sec. 17.4.2)

$N_b = k_c \lambda_a \sqrt{f'_c} h_{ef}^{1.5}$ (Eq. 17.4.2.2a)

k_c	λ_a	f'_c (psi)	h_{ef} (in)	N_b (lb)
17.0	1.00	3000	3.250	5456

$\phi N_{cbg} = \phi \, (A_{Nc} / A_{Nco}) \, \Psi_{ec,N} \, \Psi_{ed,N} \, \Psi_{c,N} \, \Psi_{cp,N} N_b$ (Sec. 17.3.1 & Eq. 17.4.2.1b)

A_{Nc} (in^2)	A_{Nco} (in^2)	$c_{a,min}$ (in)	$\Psi_{ec,N}$	$\Psi_{ed,N}$	$\Psi_{c,N}$	$\Psi_{cp,N}$	N_b (lb)	ϕ	ϕN_{cbg} (lb)
285.19	95.06	-	1.000	1.000	1.00	1.000	5456	0.65	10638

6. Pullout Strength of Anchor in Tension (Sec. 17.4.3)

$\phi N_{pn} = \phi \Psi_{c,P} \lambda_a N_p (f'_c / 2{,}500)^n$ (Sec. 17.3.1, Eq. 17.4.3.1 & Code Report)

$\Psi_{c,P}$	λ_a	N_p (lb)	f'_c (psi)	n	ϕ	ϕN_{pn} (lb)
1.0	1.00	4750	3000	0.50	0.65	3382

8. Steel Strength of Anchor in Shear (Sec. 17.5.1)

V_{sa} (lb)	ϕ_{grout}	ϕ	$\phi_{grout}\phi V_{sa}$ (lb)
7235	1.0	0.65	4703

10. Concrete Pryout Strength of Anchor in Shear (Sec. 17.5.3)

$\phi V_{cp} = \phi k_{cp} N_{cb} = \phi k_{cp}(A_{Nc} / A_{Nco})\, \Psi_{ed,N}\, \Psi_{c,N}\, \Psi_{cp,N} N_b$ (Sec. 17.3.1 & Eq. 17.5.3.1a)

k_{cp}	A_{Nc} (in^2)	A_{Nco} (in^2)	$\Psi_{ed,N}$	$\Psi_{c,N}$	$\Psi_{cp,N}$	N_b (lb)	ϕ	ϕV_{cp} (lb)
2.0	95.06	95.06	1.000	1.000	1.000	5456	0.70	7638

11. Results

Interaction of Tensile and Shear Forces (Sec. 17.6.)

Tension	Factored Load, N_{ua} (lb)	Design Strength, øN_n (lb)	Ratio	Status
Steel	1190	9075	0.13	Pass
Concrete breakout	3569	10638	0.34	Pass
Pullout	**1190**	**3382**	**0.35**	**Pass (Governs)**

Shear	Factored Load, V_{ua} (lb)	Design Strength, øV_n (lb)	Ratio	Status
Steel	**1521**	**4703**	**0.32**	**Pass (Governs)**
Pryout	1521	7638	0.20	Pass

Interaction check	$N_{ua}/\phi N_n$	$V_{ua}/\phi V_n$	Combined Ratio	Permissible	Status
Sec. 17.6..1	0.35	0.00	35.2%	1.0	Pass

1/2"Ø CS Strong-Bolt 2, hnom:3.75" (95mm) meets the selected design criteria.

12. Warnings

- Designer must exercise own judgement to determine if this design is suitable.

- Refer to manufacturer's product literature for hole cleaning and installation instructions.