Client:
Regional Foundation & Crawlspace Repair

Structural Calculations

Cook Residence – Supplemental Floor Support
28 Port Tack
Sanford, NC 27332

Structural analysis and design for foundation repair and stabilization along with the addition of supplemental Smart Jack posts, new supplemental beam, and Smart Jack footings/bases.

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12/04/2023

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Design Criteria

Design Loads

Dead Loads:

Roof Dead Load =	15	psf
Attic Dead Load =	5	psf
Floor Dead Load =	15	psf
Exterior Wall Dead Load =	13	psf
Concrete Weight =	150	pcf
Masonry Weight =	78	psf
Chimney Weight =	45	psf
Deck Weight =	10	psf

Live Loads:

Roof (Snow) =	20	psf
Attic (Habitable w Sleeping Areas) =	30	psf
Attic (Uninhabitable w/ Storage) =	20	psf
Attic (Uninhabitable w/o Storage) =	10	psf
Floor =	40	psf
Deck =	40	psf

Report—Engineering Properties

Absence of an entry indicates that the data were not estimated. The asterisk '*' denotes the representative texture; other possible textures follow the dash. The criteria for determining the hydrologic soil group for individual soil components is found in the National Engineering Handbook, Chapter 7 issued May 2007(http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17757.wba). Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Engineering Properties–Harnett County, North Carolina

Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
GaB—Gilead loamy sand, 2 to 8 percent slopes														
Gilead	90	C	0-5	Sandy loam, loamy sand	SM, SC-SM	A-2-4	0- 0- 0	0- 3- 4	90-95-100	68-83-100	52-66-83	14-19-26	9-12 -14	NP
			5-8	Sandy loam, sandy clay loam	SC, SC-SM	A-2-4, A-4, A-6	0- 0- 0	0- 3- 4	95-96-100	66-80-100	47-62-96	23-33-60	20-30-40	4-10-16
			8-42	Sandy clay, clay loam, clay	CH, CL, MH, SC	A-5, A-6, A-7-5	0- 0- 0	0- 3- 5	95-96-100	80-89-100	60-76-95	38-51-67	40-55-70	9-23-37
			42-52	Sandy loam, sandy clay loam	CL, CL-ML, SC, SC-SM	A-2-4, A-4, A-6	0- 0- 0	0- 3- 4	95-96-100	81-89-100	60-77-99	29-43-61	20-30-40	4-10-16
			52-76	Sandy loam, sandy clay loam, clay	CL, SC-SM, MH	A-7-5, A-7-6	0- 0- 0	0- 3- 5	95-96-100	78-87-100	49-81-100	35-65-85	20-45-90	4-21-37
			76-80	Stratified gravelly loamy sand to extremely gravelly sandy clay loam, gravelly sand	SW-SM, SM	A-1-b, A-2-4	0- 0- 0	0- 5- 7	72-75-98	37-57-96	29-46-95	4- 8- 30	10-20-30	NP

Soil Properties:

Geotechnical Information: * Please note there is no geotechnical report for this project. The below values have been conservatively assumed based on soil type and typical values used around the area. These values are to be used for the Individual Bearing Method (Adams and klym, 1972; Hoyt and Clemence, 1089) in determining the ultimate pile capacity

Site Soil Properties: *(GM, SM, ML Classification - Loam, gravelly loam. Unweathered Bedrock)*

Vertical Foundation Pressure	1500	psf	*(per IBC Table 1806.2)*
Lateral Bearing Pressure	100	psf/ft	*(per IBC Table 1806.2)*
Active Pressure	60	psf/ft	

$Q_{ult} = A_h(cN_c + q'N_q + 0.5\gamma B N_\gamma)$

Where,

- A_h = Area of Plate
- c = Cohesion at Pier Depth
- N_c = Demensionless Bearing Capacity Factor
- q' = Effective Vertical Overburden Stress at Helix Depth (lb/ft^2)
- N_q = Demensionless Bearing Capacity Factor
- γ = Soil Unit Weight (lb/ft^3)
- B = Diameter of Helix Plate (ft)
- N_γ = Demensionless Bearing Capacity Factor

For Purely Cohesive Soils: (ϕ=0 and c=su and Qult=PTL)

$Q_{ult} = A_h(N_c c + q'N_q)$

$s_u = c$

c = 1500 psf

For Purely Granular (frictional) Soils: (c =0)

$Q_{ult} = A_h(q'N_q)$

Where,

ϕ = Friction Angle

$N_q = 1 + 0.56(12\phi)^{\phi/54}$

$N_c = (N_q - 1)\cot(\phi)$ > 9

Assumed Soil Profile:

Depth of Pier (ft)	Soil Type[c]	SPT "N" (blows/foot)	c[b] (psf)	γ eff. (pcf)	ϕ[a] (degrees)	Nc	q' (pcf)	Nq
0	SM, SC-SM	Unknown	0	120	29	23.41	0	13.98
4	CL, CL-ML, SC, SC-SM	Unknown	0	120	29	23.41	480	13.98
8	SW-SM, SM	Unknown	0	120	29	23.41	960	13.98
10	SW-SM, SM	Unknown	0	120	29	23.41	1200	13.98

a. The friction angle was conservatively assumed based off the soil type and typical values used around the area. In Appendix A. Typical relationship between the SPT Penetration, N-Value and friction angle. (Bowles, Foundation Analysis and Design)

b. There is not enough information to assume a suffcient cohesion for the varying soil types that can be encounted. A default of 0 has been used, this is an overall conservative approach.

c. Soil type has been determined per USDA, Natural Resource Conservative Service's Web Soil Survey. (https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx)

Soil Appendix A:

Soil type descriptions:

MAJOR DIVISIONS				SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTION
Coarse Grained Soils	More Than 50% Material Retained on No. 200 Sieve	Gravel and Gravelly Soils More Than 50% Coarse Fraction Retained on No. 4 Sieve	Clean Gravels (Little or No Fines)		GW	Well-graded Gravels, Gravel-Sand Mixtures, Little or No Fines
					GP	Poorly-graded Gravels, Gravel-Sand Mixtures, Little or No Fines
			Gravels with Fines (Significant Percentage of Fines)		GM	Silty Gravels, Gravel-Sand-Silt Mixtures
					GC	Clayey Gravels, Gravel-Sand-Clay Mixtures
		Sand and Sandy Soils More Than 50% Coarse Fraction Passing No. 4 Sieve	Clean Sands (Little or No Fines)		SW	Well-graded Sands, Gravelly Sands, Little or No Fines
					SP	Poorly-graded Sands, Gravelly Sands, Little or No Fines
			Sands with Fines (Significant Percentage of Fines)		SM	Silty Sands, Sand-Silt Mixtures
					SC	Clayey Sands, Sand-Clay Mixtures
Fine Grained Soils	More Than 50% Material Passing No. 200 Sieve	Silts and Clays	Liquid Limit Less than 50 percent		ML	Inorganic Silts and Very Fine Sands, Rock Flour, Silty-Clayey Fine Sands, Clayey Silts
					CL	Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays
					OL	Organic Silts and Organic Silty Clays of Low Plasticity
		Silts and Clays	Liquid Limit Greater than 50 percent		MH	Inorganic Silts Micaceous or Diatomaceous Fine Sand or Silty Soils
					CH	Inorganic Clays of High Plasticity, Fat Clays
					OH	Organic Clays of Medium to High Plasticity, Organic Silts
					PT	Peat, Humus, Swamp Soils
Topsoil						Humus and Duff Layer
Fill						Highly Variable Constituents

SPT Penetration, N-Value (blows/ft)	ϕ (degrees)
0	25-30
4	27-32
10	30-35
30	35-40
50	38-43

(Bowles, Foundation Analysis and Design)

Consistency of Fine-Grained Soils	
Relative Density	**N - Blows per Foot**
Very Soft	0 - 2
Soft	2 - 4
Medium Stiff	4 -8
Stiff	8 - 15
Very Stiff	15 - 30
Hard	30 - 50
Very Hard	50+

Relative Density of Coarse-Grained Soils	
Relative Density	**N - Blows per Foot**
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	50+

USCS Soil-class	Description	Cohesion (kPa)	Friction angle (°)
GW	well-graded gravel, fine to coarse gravel	0	40
GP	poorly graded gravel	0	38
GM	silty gravel	0	36
GC	clayey gravel	0	34
GM-GL	silty gravel	0	35
GC-CL	clayey gravel with many fines	3	29
SW	well-graded sand, fine to coarse sand	0	38
SP	poorly graded sand	0	36
SM	silty sand	0	34
SC	clayey sand	0	32
SM-SL	silty sand with many fines	0	34
SC-CL	clayey sand with many fines	5	28
ML	silt	0	33
CL	clay of low plasticity, lean clay	20	27
CH	clay of high plasticity, fat clay	25	22
OL	organic silt, organic clay	10	25
OH	organic clay, organic silt	10	22
MH	silt of high plasticity, elastic silt	5	24

Unified Soil Classification System (USCS)
http://en.wikipedia.org/wiki/Unified_Soil_Classification_System

Project Loading

Vertical Design Loads:

Tributary Widths:

Transverse Direction (Pier 1,2. Ref: Plan View on S0.1)

Roof	16	ft	240	plf
Ceiling	0	ft	0	plf
Third Floor	0	ft	0	plf
Second Floor	0	ft	0	plf
First Floor	5	ft	75	plf
Walls	9.00	ft	117	plf
Foundation (Footing)				
W =	1.33	ft		
T =	0.67	ft	133	plf
Foundation (Stemwall)				
H_s =	3.00	ft		
W_s =	0.67	ft	300	plf
Σ_{DL} =			865	plf

Live:				
Roof (Snow)	16	ft	400	plf
Third Floor	0	ft	0	plf
Second Floor	0	ft	0	plf
First Floor	5	ft	200	plf
Σ_{LL} =			600	plf

Max Pier Trib = 5 ft

Pier Working Loads:

P_{DL} =	4327	lbs
$0.75*P_{(LL+SL)}$ =	2250	lbs
P_{TL} =	6577	lbs

F_S = 2

P_{TL} = 13153 $= P_{TL}F_S$

Transverse Direction (Pier 3, 4. Ref: Plan View on S0.1)

Roof	4.5	ft	67.5	plf
Ceiling	0	ft	0	plf
Third Floor	0	ft	0	plf
Second Floor	0	ft	0	plf
First Floor	4	ft	60	plf
Walls	9.00	ft	117	plf
Foundation (Footing)				
W =	1.33	ft		
T =	0.67	ft	133	plf
Foundation (Stemwall)				
H_s =	3.00	ft		
W_s =	0.67	ft	300	plf
		Σ_{DL} =	678	plf
Live:				
Roof (Snow)	4.5	ft	112.5	plf
Third Floor	0	ft	0	plf
Second Floor	0	ft	0	plf
First Floor	4	ft	160	plf
		Σ_{LL} =	272.5	plf

Max Pier Trib = 5 ft

Pier Working Loads:

P_{DL} =	3389	lbs
$0.75*P_{(LL+SL)}$ =	1022	lbs
P_{TL} =	4411	lbs

F_S = 2

P_{TL} = 8822 $= P_{TL}F_S$

Push Pile Design

Design Working Load:

Q_{ult} = **13.15** kips

Q_{up} = 0

Pile Properties:

Pile Type	**PP288**	
Finishes	**Plain**	
Shaft Diameter	2.875	in
Batter Angle	**0**	°
Installation Depth L_p =	10	ft

Bracket Capacity :

Construction Type	**Retrofit**		
Bracket	**FS288BL2 (PP288)**		
Bracket Allowable Capacity	24	Kips	OK...
	(w/ 48" Sleeve)		

Installation Pressure, P:

Working Area of Hydraulic Ram

A_s = 9.62 in^2

$T_{herefore,\ Preq}$ = Q_{ult} / A_{cyl}

1367 psi

Project Loading (Supplemental - SJ288)

Vertical Design Loads:

Tributary Widths:

Transverse Direction (Smart Jacks 1-2. Ref: Plan View on S0.1)

Roof	0	ft	0	plf
Third Floor	0	ft	0	plf
Second Floor	0	ft	0	plf
First Floor	5	ft	100	plf
Ext. Walls	0.00	ft	0	plf
		Σ_{DL} =	100	plf

Live:

Roof (Snow)	0	ft	0	plf
Attic	0	ft	0	plf
Third Floor	0	ft	0	plf
Second Floor	0	ft	0	plf
First Floor	5	ft	200	plf
		Σ_{LL} =	200	plf

Max Trib = 7 ft

Smart Jack Working Loads:

P_{DL} = 700 lbs

P_{LL} = 1400 lbs

P_{TL} = 2100 lbs

ALLOWABLE COMPRESSION WITH SJQ350BP-C = 6.0K => OK

	Supplemental Beam Size	Supplemental Beam Allowable Load (plf)[1,2,3]				
SmartJack Post Spacing		4 ft	5 ft	6 ft	7 ft	8 ft
Sawn Lumber[4]	(3) - 2 x 8	1,170	750	520	380	290
	(3) - 2 x 10	1,760	1,120	780	570	440
	(3) - 2 x 12	2,360	1,510	1,050	770	590
	(1) - 4 x 6	850	550	380	280	210
	(1) - 6 x 6	1,030	660	460	330	250
Engineered Lumber[5]	3.5 x 5.5	1,250	740	420	270	180
Structural Steel[6]	S4 x 7.7 (PowerBrace™ Beam)	3,780	2,070	1,200	750	500
	W4 x 13	6,820	3,850	2,240	1,400	940
	HSS 4 x 4 x ¼	5,190	2,650	1,530	960	640
	HSS 4 x 2 x ¼ (Lying Flat in Plank Orientation)	990	500	290	180	120

1) This table makes no evaluation of the components of the existing structure.
2) Allowable loads in this table assume the supplemental beam is sufficiently restrained against lateral torsional buckling at an interval equal to or less than the SmartJack post spacing.
3) The new girder may be cantilevered over the end support by a distance of 30 inches or by a distance of approximately 50% of the adjacent SmartJack spacing, whichever is less. Each beam segment must be supported by at least two SmartJack posts.
4) Sawn lumber is assumed to be Douglas Fir Larch - No. 2 or better.
5) Engineered lumber is assumed to be iLevel 1.3E TimberStrand LSL or equivalent.
6) Structural steel is assumed to be ASTM A572 Grade 50 or equivalent for wide flange shapes, and ASTM A500 Grade B or equivalent for HSS tube shapes.