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January 15, 2021

TO: Johnston Architects

SUBJECT: Design Submittal - Geopier Soil Reinforcement REVISED
Mercer Island Mixed-Use Development
Mercer Island, WA

This letter and the attached documents represent our design submittal for Geopier® soil reinforcement at the site of the Mercer Island Mixed-Use development located in Mercer Island, WA. The following paragraphs document our design of the Geopier-Rampact reinforcement system for support of the mat foundations. Based on the geotechnical report and project documents it is assumed that the ground improvement will only be required west of Gridline G and that east of Gridline G the mat foundation and spread footings will be founded on competent native soils.

Geopier Reinforcement Design

Subsurface information, as documented in the geotechnical report completed by Hart Crowser Inc., has been used as a basis for our design. Below are the simplified soil soil conditions:

- Loose to medium dense silty granular FILL, soft SILT and PEAT to variable depths between El.87ft and El.60ft.
- Underlain by interbedded layers of medium to hard SILT and silty CLAY and medium dense to dense SAND and silty SAND to the maximum exploration at about El.40ft.
- At about El.71.5 ft, where finished floor elevation (FFE) is defined, soils predominantly consist of very soft and soft SILT to about El. 60ft. In the southeast portion of building footprint, soils consist of very stiff to hard SILT and dense to very dense SAND.
- Groundwater was encountered at variable depths between 7.5 and 35 feet (assumed to be perched water).

In view of the loose/soft to medium dense/stiff sandy and silty soils, the Geopier-Rampact system or “displacement process” will be used to install the Geopier elements. The Geopier-Rampact system which we propose to utilize consists of a hollow mandrel with an internal compaction surface which is driven into the ground using a powerful static down force augmented by dynamic vertical impact energy. After driving to the design depth, the hollow mandrel serves as a conduit for aggregate placement. As the mandrel is raised and redriven downward thin lifts of compacted aggregate are formed and compacted both vertically and laterally. The process is repeated until the rammed aggregate pier is constructed. We anticipate installing Geopier elements from the approximate elevation between 68 and 69 ft. The mandrel will be driven to the dense to very dense soil conditions. Geopier elements will be installed to 15 feet or refusal below the planned FFE. Practical refusal is considered less than 1 foot of mandrel advancement in 30 seconds.

The Geopier reinforcement has been designed to support the structure based on the loading provided by the structural engineer plans with a maximum allowable bearing capacity of up to 4,000 psf which can be increased by 1/3 for short duration loading due to the ground improvement system but the ground improvement system has been designed for the actual pressures provided by the structural engineer. Actual loading of the mat provided by the structural engineer reveals an average bearing pressure of 1,500 psf. The design cell capacity

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(combination of the Geopier element and surrounding matrix soil) for each Geopier element supporting foundations is 60 kips.

Our Geopier elements will be installed directly beneath the mat foundations to provide adequate static support and beneath the mat foundation in a grid pattern with an approximate maximum spacing of 6 feet on-center.

Spread Foundation Settlement

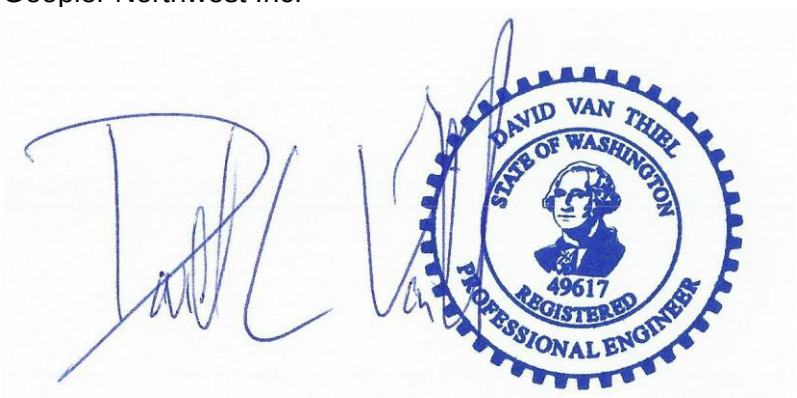
For our analysis, settlements are first calculated for a zone extending from the bottom of the footing to the depth of the reinforcement. Additional settlement may occur in the "lower zone" or in the unimproved soil beneath the reinforced zone. The lower zone settlement is calculated using an elastic or consolidation approach depending on the soil type. Please see our attached calculations for additional information.

Geopier Installation and Modulus Testing

The installation of the Geopier reinforcement, including a downward modulus test, will be completed in general accordance with the specifications. The installation and the modulus test will be conducted under the supervision of an experienced geotechnical engineer from Geopier Northwest. The modulus test will consist of loading the Geopier element in increments to 150% of the design load while measuring deflections to verify the design parameters. The modulus test will also incorporate a creep test at 115% of the design load.

We appreciate the opportunity to work with you on this project. If you have any questions or require further information, please call.

Sincerely,
Geopier Northwest Inc.



David Van Thiel, P.E., G.E.

Attachments: Geopier Foundation Plan and Construction Notes, and Geopier Capacity and Settlement Calculations

PROJECT:	Mecer Island Mixed Use	
NO:		
DATE:	12/9/2020	
ENGINEER:	DVT	

GEOPIER®

RAMMED AGGREGATE PIER ® DESIGN FOR MATS

Equivalent B = 185.7 ft.

Mat Width	115	ft
Mat Length	300	ft
Mat Area	34500	sq. ft.
Equiv Width, B	185.7	ft
Floor Pressure	1500	psf
Dgw	5	ft
γ soil	125	pcf
Hs	8	ft
Pier Diameter	24	inches

Rammed Aggregate Pier® Design:

								Center			Edge		
Spacing (feet o-c)	Layer Thickness	Ra	Em (ksf)	Eg (ksf)	Ecomp (ksf)	z (ft)	z/Beq	Influence Factor	ΔP (ksf)	S (inches)	Influence Factor	ΔP (ksf)	S (inches)
6.00	2	0.09	100	1400	213	1.0	0.01	1.00	1.50	0.2	1.00	1.50	0.2
6.00	2	0.09	100	1400	213	3.0	0.02	1.00	1.50	0.2	0.95	1.42	0.2
6.00	2	0.09	100	1400	213	5.0	0.03	1.00	1.50	0.2	0.87	1.31	0.1
6.00	2	0.09	100	1400	213	7.0	0.04	1.00	1.50	0.2	0.80	1.20	0.1
6.00	2	0.09	400	5000	801	9.0	0.05	1.00	1.50	0.0	0.75	1.13	0.0
	10												

Selected for Design:

6.00	0.09	0.7	0.6
Spacing (ft)	Ra	Ctr UZ (in)	Edge UZ (in)

Lower Zone:

											Center			Edge		
Layer	Soil Type		Esoil ksf	Cεr	Cεc	OCP ksf	Thickness ft	z ft	σ'v psf	z/Beq	Iσ Center	ΔP ksf	S (Center) in	Iσ Edge	ΔP ksf	S (Edge) in
UZ	GP-CL						10.0	5.0					0.7			0.6
1	ML			0.005		10000.00	10	15.00	1251	0.08	1.00	1.50	0.20	0.65	0.98	0.2
2	ML			0.005		10000.00	10	25.00	1877	0.13	0.99	1.48	0.15	0.59	0.89	0.1
							30.0						UZ (in) =	0.7		UZ (in) =	0.6
													LZ (in) =	0.4		LZ (in) =	0.3
													Total Center (in) =	1.1		Total Edge (in) =	0.9