September 9, 2019
W.O. 7328-00(A)(Add.)

Mr. Conrad Higashionna
Engineering Concepts, Inc.
1150 South King Street, Suite 700
Honolulu, HI 96814

Subject: Addendum
Updated 50-foot Mast Arm Traffic Signal Pole Foundation Recommendations
Traffic Signal Modernization Project
Kahuapaani Street & Ulune Street Intersection
Halawa, Oahu, Hawaii

Reference: Report by Geolabs, Inc. dated August 6, 2019
entitled "Geotechnical Engineering Exploration,
Traffic Signal Modernization Project
Kahuapaani Street & Ulune Street Intersection
Halawa, Oahu, Hawaii"

Dear **Mr. Higashionna:**

This addendum to our report entitled "Geotechnical Engineering Exploration, Traffic Signal Modernization Project, Kahuapaani Street & Ulune Street Intersection, Halawa, Oahu, Hawaii," dated August 6, 2019, provides the results of our foundation analysis based on the updated structural loads provided by Nagamine Okawa Engineers Inc. for the 50-foot mast arm traffic signal pole structure.

The findings and recommendations presented herein are subject to the limitations noted at the end of this addendum report.

50-Foot Mast Arm Traffic Signal Pole Foundation

At the time of our initial Geotechnical Engineering Exploration report, structural loading information for the 50-foot mast arm traffic signal pole was not available. Therefore, in-house structural loading information from similar projects was used to develop preliminary foundation recommendations.

Updated structural loading information for the 50-foot mast arm traffic signal pole was transmitted to Geolabs on September 5, 2019 by Nagamine Okawa Engineers Inc.

The following Load and Resistance Factor Design (LRFD) values based on Extreme Limit State I were used for the design of the 50-foot mast arm traffic signal pole foundation.

50-FOOT MAST ARM TRAFFIC SIGNAL POLE UPDATED STRUCTURAL LOADS (EXTREME LIMIT STATE I)			
Axial Load (kips)	**Shear Force** (kips)	**Resultant Bending Moment** (kip-feet)	**Torsion** (kip-feet)
3.6	12	146	219

Based on the typical dimensions of the base plate and anchor bolts, we envision that a 36-inch diameter cast-in-place concrete drilled shaft would be required for the proposed 50-foot mast arm traffic signal pole. The cast-in-place concrete drilled shaft would derive vertical support principally from skin friction between the shaft and the surrounding soils. Our updated recommendations pertaining to the drilled shaft capacities are presented in the following table.

36-INCH DIAMETER DRILLED SHAFT FOUNDATION		
Shaft Length (feet)	**Allowable Compressive Load Capacity** (kips)	**Ultimate Uplift Load Capacity** (kips)
18	340	360

The allowable compressive load capacity for the drilled shaft is to support dead-plus-live loads and may be increased by up to one-third (⅓) when considering transient loads, such as wind or seismic forces.

Uplift loads may be resisted by a combination of the dead weight of the drilled shaft and shear along the shaft surface area and adjacent soils. The uplift load capacity provided in the table above should be used only for transient loading conditions. For sustained loading conditions, the uplift load capacity should be reduced further using a factor of safety of 2.0. The project structural engineer should check the capacity of the drilled shaft in tension.

The load-bearing capacities of the drilled shafts will depend largely on the consistency of the soils. Because local variations in the subsurface materials likely will occur, it is imperative that our representative is present during the shaft drilling operations to confirm the subsurface conditions encountered during the drilled shaft construction and to observe the installation of the drilled shafts. In addition, contract documents should include provisions (unit prices) for additional drilling and extension of the drilled shafts during construction to account for unforeseen subsurface conditions. The subsequent subsections address the design and construction of the drilled shaft foundations, which include the following:

- Lateral Load Resistance
- Foundation Settlements
- Drilled Shaft Construction Considerations

Lateral Load Resistance

The lateral load resistance of the drilled shaft is a function of the stiffness of the surrounding soil, the stiffness of the shaft, allowable deflection at the top of the shaft, and the induced moment in the shaft. The lateral load analyses were performed using the program LPILE 2018 for Windows, a microcomputer adaptation of a finite difference laterally loaded deep foundation program originally developed at the University of Texas at Austin. The program solves for deflection and bending moment along a deep foundation under lateral loads as a function of depth. The analysis was carried out with the use of non-linear “p-y” curves to represent soil moduli. The lateral deflection was then computed using the appropriate soil moduli at various depths.

Based on the provided structural loads, results of our lateral load analyses for the concrete drilled shaft foundation are presented in the following table. The top of the shaft was assumed to be free against rotation.

SUMMARY OF LATERAL LOAD ANALYSES				
Shaft Length (feet)	**Maximum Lateral Deflection** (inches)	**Maximum Shear** (kips)	**Maximum Induced Moment** (kip-feet)	**Depth to Maximum Moment** (feet)
18	0.08	28	193	5.3
NOTE: Analyses based on concrete compressive strength of 4,000 psi and a minimum of 1% longitudinal steel reinforcement.				

Foundation Settlements

Settlement of the drilled shaft foundation will result from elastic compression of the shaft and subgrade response of the foundation embedded in the subsurface soils. The total settlement of the drilled shaft is estimated to be on the order of less than 0.5 inches. We believe that a significant portion of the settlement is elastic and should occur as the loads are applied.

Drilled Shaft Construction Considerations

In general, the performance of the drilled shafts will depend significantly upon the contractor’s method of installation and construction procedures. The following conditions would have a significant effect on the effectiveness and cost of the drilled shaft foundations.

The load-bearing capacities of the drilled shaft depend, to a significant extent, on the frictional resistance between the shaft and the surrounding soils. Therefore, proper construction techniques, especially during the drilling operations, are important. The contractor should exercise care in drilling the shaft hole and in placing concrete into the drilled hole.

The subsurface materials generally consist of medium dense and stiff fill material overlying stiff residual soil, very dense saprolite, and basalt rock formation with depth. The residual and saprolitic soils encountered within the depth of the drilled shaft may contain cobbles and boulders. Therefore, some difficult drilling conditions may be encountered and should be expected in these soils. The drilled shaft contractor will need to have the appropriate equipment and tools to drill through the cobbles and boulders that may be encountered during drilled shaft installation operations.

Based on our field exploration and the estimated length of the drilled shaft, groundwater is generally not expected in the drilled hole during the shaft installation work. Due to the relatively short length of the drilled shaft, concrete placement using the free fall method should be acceptable. In the event of seasonal rainfall and/or perched groundwater, water may be encountered in the drilled hole and concrete placement by tremie method would be required.

A low-shrinkage concrete mix with a high slump (6 to 9-inch slump range) should be used to provide close contact between the drilled shaft and the surrounding soils. In addition, the concrete should be placed promptly after drilling (within 24 hours after drilling of the holes) to reduce the potential for softening of the sidewalls of the drilled hole.

It is imperative that a Geolabs representative is present at the project site to observe the drilling and installation of the drilled shafts during construction. Although the drilled shaft design is primarily based on skin friction, the bottom of the drilled hole should be relatively free of loose materials prior to placement of the concrete. Therefore, it is necessary for Geolabs to observe the drilled shaft installation operations to confirm the assumed subsurface conditions.

Limitations

This report has been prepared for the exclusive use of Engineering Concepts, Inc. and their consultants for specific application to the Kahuapaani Street and Ulune Street Intersection for the Traffic Signal Modernization project in accordance with generally accepted geotechnical engineering principles and practices. No warranty is expressed or implied.

This report has been prepared solely for the purpose of assisting the engineers in the project design. Therefore, this report may not contain sufficient data, or the proper information, to serve as a basis for construction cost estimates nor for bidding purposes.

A contractor wishing to bid on this project should retain a competent geotechnical engineer to assist in the interpretation of this report and/or in the performance of additional site-specific exploration for bid estimating purposes.

The owner/client should be aware that unanticipated soil conditions are commonly encountered. Unforeseen soil conditions, such as perched groundwater, soft deposits, hard layers, or cavities, may occur in localized areas and may require additional probing or corrections in the field (which may result in construction delays) to attain a properly constructed project. Therefore, a sufficient contingency fund is recommended to accommodate these possible extra costs.

Closure

We appreciate the opportunity to be of continued service to you on this project. If you have questions or need additional information, please contact our office.

Respectfully submitted,

GEOLABS, INC.

By

Gerald Y. Seki, P.E.
Vice President

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(2 Copies to Addressee)

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GERALD Y. SEKI
LICENSED PROFESSIONAL ENGINEER
No. 5635-C
HAWAII, U.S.A.

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION.

SIGNATURE

4-30-20
EXPIRATION DATE OF THE LICENSE