GEOTECHNICAL INVESTIGATION
HONOLUA STREAM BRIDGE
DESIGN CHANGE FROM RFP DECK TO CONCRETE DECK
HONOLUA, MAUI, HAWAII

INTRODUCTION

This report presents the results of our geotechnical investigation performed for the proposed design change of the Honolua Stream Bridge at Honolua, Maui, Hawaii. Our scope of services for this study included the following:

- A visual reconnaissance of the site and its vicinity to observe existing conditions which may affect the project. The general location of the project site is shown on the enclosed Location Map, Plate A1.1.
- A review of available in-house soils information pertinent to the site and the proposed project, including logs of our test borings drilled for the previously proposed replacement bridge alternative and the temporary ACROW bridge. The approximate locations of the previous borings are shown on Plate A1.2, and the boring logs are presented on Plates A2.1 through A2.10 in Appendix A.
- Preparation of this report presenting geotechnical recommendations for the design of foundations, including seismic considerations, resistance to lateral pressures, bridge approach slabs, and site grading.

PROJECT CONSIDERATIONS

Information regarding the proposed project was provided by your office.

The existing Honolua Stream bridge will be renovated. A new prefabricated fiber reinforced polymer (FRP) bridge deck was previously proposed to replace the existing concrete bridge deck. Since the weight of the proposed FRP deck would not exceed the weight of the existing concrete deck, the existing CRM abutments were planned to be reused, and a geotechnical investigation for the FRP bridge deck was not required. However, we understand that a concrete bridge deck is now planned in lieu of the initially proposed FRP deck. New bridge abutments, located behind the existing abutments, will therefore be required. The new bridge will be a single-span bridge with a length on the order of 50 feet, with the same single-lane configuration and alignment as the existing bridge.

SITE CONDITIONS

Honolua Bridge is located between mileposts 32.4 and 32.5 along Honoapiilani Highway (Route 30) on the northwestern coast of Maui, in the District of Lahaina. The existing bridge is a concrete structure, about 24 feet long and 18 feet wide, supported on grouted CRM abutments. The Honolua Stream is approximately 10 feet below the bridge and numerous cobbles and boulders were exposed at the streambed below the existing bridge.

ANTICIPATED SOIL CONDITIONS

Two test borings were drilled upstream of the existing bridge in 2009 for the previously proposed bridge replacement alternative. The borings encountered surface soil consisting of brown clayey silt. The soil was in a medium stiff to stiff condition and extended to depths of about 7 and 17 feet. Underlying the clayey silt were alluvium deposits consisting of gravel and cobbles with sand, clay, and occasional boulders. The alluvial material was in a dense condition. Dense to medium hard weathered basalt and hard basalt were encountered at depths of about 38 to 43 feet, extending down to the maximum depths drilled.

Groundwater was encountered in the test borings at depths of about 16.6 and 18.3 feet. It should be noted that the depths to groundwater can be expected to fluctuate with the water level in the stream, as well as with heavy rainfall.

Our 2021 test borings drilled for the temporary detour road ACROW bridge located downstream of the existing bridge encountered surface soil consisting of reddish brown clayey silt. The soil was in a medium stiff condition and ranged from about 3 to 4.5 feet in thickness. Underlying the surface clayey silt was dark brown to brown clayey silt extending down to the maximum depths drilled. The dark brown to brown clayey silt was in a firm to medium stiff condition and transitioned to a stiff condition at depths of about 9 and 6.5 feet. Below these depths, the clayey silt provided a matrix for the gravel, cobbles, and boulders. Neither groundwater nor seepage water was encountered in the borings.

Based on our previous borings drilled in the adjacent areas and our visual observation, we anticipate that the existing bridge site is underlain by alluvium consisting of gravel and cobbles in a dense condition. In our opinion, the depth to the gravel and cobbles stratum should be about 10 to 12 feet below the existing ground at locations behind the bridge abutments. Overlying the dense gravel and cobbles are existing abutment backfills consisting of the onsite soils. Based on our past experience, boulders may be presented in the backfills.

CONCLUSIONS AND RECOMMENDATIONS

Bridge Foundations

Conventional shallow foundations may be used to support the new concrete bridge deck. Since the footings will be located behind the existing CRM abutments, we recommend that the soils/existing bridge abutment backfills beneath the new footings be overexcavated down to the bottom of the existing CRM abutment footing elevation and replaced with CLSM (controlled low-strength material). The intent of this precautionary measure is to reduce the potential of imposing additional surcharge stresses on the existing CRM abutments which will remain in place.

The overexcavations should extend laterally a minimum 2 feet beyond the edge of the new footing. The CLSM should have a minimum compressive strength of 500 pounds per square inch. Prior to placement of the CLSM, the exposed subgrade at the bottom of the overexcavations should be thoroughly tamped and cleaned of all loose material. Soft or loose soils, indicated by pumping conditions, should be removed and replaced with CLSM.

Footings founded on the CLSM backfill may be designed for a bearing value of 3,750 pounds per square foot under strength limit states and 7,500 pounds per square foot under extreme limit states. A bearing value of 2,500 pounds per square foot may be used for service limit state. The footings should be a minimum 24 inches in width and embedded at least 24 inches below finish adjacent grade.

Seismic Design

Based on our previous borings drilled in the vicinity of the bridge site and our knowledge of the deep soil conditions in the area, we believe that the subsurface soils can be characterized as a stiff soil profile. Therefore, based on the 2020 AASHTO site classification criteria, a Seismic Site Class D is recommended for this site.

Lateral Design

Resistance to lateral loading may be provided by friction acting at the base of foundations, and by passive earth pressure acting on the buried portions of foundations. However, for new footings located immediately behind the existing CRM abutments, the passive earth pressure resistance between the new footings and the existing CRM abutment walls should be ignored.

Coefficients of friction of 0.5 and 0.58 may be used with the dead load forces for strength limit states and extreme event limit states, respectively. Passive earth pressure may be computed as an equivalent fluid having a density of 210 pounds per cubic foot for strength limit states and 425 pounds per cubic foot for extreme event limit states. Unless covered by pavement or concrete slabs, the upper 12 inches of soil should not be considered in computing lateral resistance.

For active earth pressure considerations, equivalent fluid pressures of 40 and 55 pounds per cubic foot may be used for freestanding and restrained conditions, respectively.

To prevent buildup of hydrostatic pressures, retaining walls should be well-drained. The standard of practice consists of placing a minimum 12-inch thick layer of free-draining gravel at the back of the wall. The gravel should extend from the base of the wall, around subdrains and/or weepholes, and up to within 12 inches of finish grade.

Alternatively, prefabricated drainage geocomposites, such as Miradrain or J-drain, may be used in lieu of the free-draining gravel. As with the free-draining gravel, the drainage geocomposites should be placed at the back of the wall, be connected with the weepholes and/or subdrains (in accordance with manufacturers specifications), and extend to within 12 inches of finish grade.

The drainage system should be covered by at least 12 inches of low permeability soil, such as the onsite clayey silt. If the drainage system is covered by concrete slabs or pavement, the unit drainage fill should extend to the bottom of slab cushion or base course elevation.

Foundation Settlement

Structural loads were not available at the time of this report. Due to the dense condition of the subsurface soils, excessive settlement is not anticipated.

Bridge Approach Slabs

Approach slabs behind the bridge abutments, if needed, should be underlain by at least 6 inches of aggregate base course. The base course should be compacted to a minimum 95 percent compaction as determined by ASTM D 1557. The subgrade should be compacted to a minimum of 90 percent compaction. A bearing value of 3,375 pounds per square foot at strength limit states may be used to design the footings supporting the slab.

Site Grading

Site Preparation - The project site should be cleared of all vegetation, AC pavements, and other deleterious material. Prior to fill placement, the existing ground should first be scarified to a depth of six inches, moisture conditioned to about 2 percent above optimum moisture content, and compacted to a minimum 90 percent compaction as determined by ASTM D 1557.

Structural Excavations - Based on our previous exploratory test borings, we believe that excavations into the surface clayey silt can be accomplished with conventional excavating equipment. We anticipate that the existing backfills behind the existing CRM abutments will consist of the onsite soils. Based on our past experience, boulders might be encountered in the abutment backfills for older bridges.

Temporary cuts should be stable at slope gradients of 1H:1V (horizontal to vertical) or flatter for temporary conditions. The contractor should be responsible for conforming to OSHA safety standards for all excavations.

Onsite Fill Material - The onsite clayey silt may be reused in compacted fills and backfills, provided all rock fragments larger than 3 inches in maximum dimension are removed. In addition, the moisture content of the clayey silt should be maintained at about 2 percent above the optimum moisture content during recompaction.

Imported Fill Material - Imported structural fill should be well-graded, non-expansive granular material. Specifications for imported granular structural fill should indicate a maximum particle size of 3 inches, and state that between 8 and 20 percent of soil by weight shall pass the #200 sieve. In addition, the plasticity index (P.I.) of that portion of the soil passing the #40 sieve shall not be greater than 10. Imported structural fill should have a CBR expansion value no greater than 1.0 percent and a minimum CBR value of 20 percent, when tested in accordance with ASTM D 1883.

Compaction - Fill and backfill consisting of cohesive soils, such as the onsite clayey silt, should be placed in horizontal lifts restricted to 8 inches in loose thickness, and compacted to a minimum 90 percent compaction as determined by ASTM D 1557.

Granular soils, such as the imported granular structural fill, should also be placed in 8-inch loose lifts, but compacted to at least 95 percent compaction as determined by ASTM D 1557.

Fill placed in areas which slope steeper than 5H:1V should be continually benched as the fill is brought up in lifts.

ADDITIONAL SERVICES

We recommend that we perform a general review of the final design plans and specifications. This will allow us to verify that the foundation design and earthwork recommendations have been properly interpreted and implemented in the design plans and construction specifications.

For continuity, we recommend that we be retained during construction to (1) observe footing excavations prior to placement of CLSM, reinforcing steel, and concrete, (2) review and/or perform laboratory testing on import borrow to determine its acceptability for use in compacted fills, (3) observe structural fill placement and perform compaction testing, and (4) provide geotechnical consultation as required.

Our services during construction will allow us to verify that our recommendations are properly interpreted and included in construction, and if necessary, to make modifications to those recommendations, thereby reducing construction delays in the event subsurface conditions differ from those anticipated.

LIMITATIONS

The boring logs indicate the approximate subsurface soil conditions encountered only at those times and locations where our previous borings were made, and may not represent conditions at other times and locations.

This report was prepared specifically for Austin, Tsutusmi & Associates, Inc., and their sub-consultants for design of the new concrete bridge deck for the Honolua Stream Bridge in Honolua, Maui, Hawaii. The referenced boring logs and recommendations presented in this report are for design purposes only, and are not intended for use in developing cost estimates by the contractor.

During construction, should subsurface conditions differ from those encountered in our previous borings, we should be advised immediately in order to re-evaluate our recommendations, and to revise or verify them in writing before proceeding with construction.

Our recommendations and conclusions are based upon the site materials observed, the preliminary design information made available, the data obtained from our previous test borings, our engineering analyses, and our experience and engineering judgment. The conclusions and recommendations in this report are professional opinions which we have strived to develop in a manner consistent with that level of are, skill, and competence ordinarily exercised by members of the profession in good standing, currently practicing under similar conditions in the same locality. We will be responsible for those recommendations and conclusions, but will not be responsible for the interpretation by others of the information-developed. No warranty is made regarding the services performed, either expressed or implied.

Respectfully submitted,

HIRATA & ASSOCIATES, INC.

Con Truong, Project Engineer

CON C. TRUONG
LICENSED PROFESSIONAL ENGINEER
No. 9019-C
HAWAII, U.S.A.

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