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Reference: 016147.200

March 22, 2021

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1 Harpst Street
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Subject: Updated Geotechnical Recommendations, Jenkins Hall Renovation Project, Humboldt State University, Arcata, California

Dear Michael Fisher:

Introduction

This letter report presents our updated geotechnical recommendations in response to design review comments for the proposed project prepared by m6 Consulting, Inc., dated March 3, 2021. We previously performed a geotechnical investigation for the project in 2016 and presented the results of that investigation, including conclusions and recommendations, in our report dated August 23, 2016. The recommendations in that report were based on the 2016 California Building Code (CBC); seismic design parameters in that report were based on the January 8, 2016 version of the "CSU Seismic Requirements". We subsequently provided requested additional retaining wall recommendations to the structural engineer in an email dated October 29, 2020. It is our opinion that the project can be constructed as proposed, provided the recommendations in our August 23, 2016 report are followed. We believe the geotechnical recommendations in that report are current and applicable, except for the seismic design parameters and recommendations for the elevator which has been relocated to the interior of the building. The seismic design parameters based on the March 5, 2020 "CSU Seismic Requirements" are included below. In addition, the additional retaining wall recommendations previously provided to the structural engineer are also provided below, along with the updated recommendations for the elevator.

Seismic Design Parameters

The California State University (CSU) System uses seismic parameters for its different campuses as presented in its publication "CSU Seismic Requirements". The current edition is dated March 5, 2020. As recommended in our 2016 report a Site Class D (Stiff Soil Profile) is appropriate in accordance with the 2019 CBC and the American Society of Civil Engineers (ASCE) 7-16 Chapter 20. Seismic coefficients for the Humboldt State University campus can be obtained from the methods and data presented in Appendix B of the March 5, 2020 "CSU Seismic Requirements" using a Site Class D.

Retaining Walls

Retaining walls should be designed to resist static earth pressures, seismic earth pressures, and surcharge pressures. Retaining wall backfill should be placed and compacted according to the recommendations in Section 6.2, Site Preparation and Grading, of our August 23, 2016 report, and drainage should be provided behind walls according to the recommendations that follow. Retaining wall footings may be founded in the competent native soils at the site or engineered select fill. If footings are to be supported by engineered fill, the backfill should meet the material and placement recommendations in

Section 6.2, Site Preparation and Grading, of our August 23, 2016 report. All footings should be founded at least 18 inches below the lowest adjacent finished grade. Footings meeting the foregoing requirements may be designed for the following bearing pressures:

Dead plus long-term live load	2,500 psf
All loads, including wind and seismic	3,750 psf

Any new footing excavations or slab-on-ground subgrade should be maintained in a wetted condition prior to pouring concrete to avoid soil shrinkage.

Provided any new foundations are constructed in accordance with these recommendations, we estimate that total post-construction settlement will be 0.5 inch or less under static conditions; the differential settlement will be about half of the total settlement.

The resistance to lateral loadings may be calculated using a friction factor of 0.30 between the bottom of the footings and the native soil. Where the footings were poured neat and the adjacent ground surface paved or covered with concrete slabs, a passive resistance of 250 pound per cubic foot (pcf) equivalent fluid weight may be developed between the footings and the adjacent soil. Where the adjacent ground surface is not paved, the upper 1 foot should be neglected in determining the available passive resistance.

Active earth pressures may be used for design of unrestrained retaining walls where the top of the wall is free to translate or rotate. To develop active earth pressures, the walls should be capable of deflecting by at least 0.004H (where H is the height of the wall). At-rest earth pressures should be used for design of retaining walls where the wall top is restrained such that the deflections required to develop active soil pressures cannot occur or are undesirable. Cantilever walls retaining firm native soil or engineered fill may be designed for active or at-rest lateral earth pressures for various backfill slopes using the equivalent fluid unit weights presented in Table 1, Equivalent Fluid Unit Weight (pcf).

Table 1. Equivalent Fluid Unit Weight (pcf)

Backfill Slope	At-Rest Conditions	Active Conditions
Level	60	36
3H:1V	81	46
2H:1V	89	55

Lateral earth pressures for backfill slopes other than those given above can be estimated by interpolation. The lateral earth pressures should be applied to a plane extending vertically upward from the base of the heel of the retaining wall to the ground surface.

The lateral earth pressures given above apply where the wall backfill is fully drained, is not subject to traffic or other surcharge loads, and the backfill is not subject to heavy compaction equipment within a distance of one-third the height of the backfill. Lateral surcharge pressures are discussed later in this section.

If retaining wall backfill will be subject to passenger vehicle or light truck traffic loading within a distance of H/2 from the top of the wall (where H is the wall height), the wall should be designed to resist an additional uniform lateral pressure of 72 psf (equivalent to an additional 2 feet of backfill) applied to the back of yielding walls (active conditions), or 124 psf applied to the back of non-yielding walls (at-rest conditions). Surcharge loads imposed by greater loads or unusual loads within a distance of H of the back of the wall should be considered on a case-by-case basis.

Surcharge loads on retaining walls resulting from adjacent building foundations parallel to the retaining wall can be approximated by the following expression:

$\Delta p_h = (4p/\pi)(x^2z/R^4)$

Where:
Δp_h = the lateral stress on the wall at depth z
p = magnitude of the footing load (lbs/ft)
x = centerline distance from the footing load to the wall
z = depth below surface
$R^4 = x^4 + z^4$ = the radius from the location on the wall where Δp is measured to the footing load on the surface

Surcharge loads imposed by greater loads or unusual loads within a distance of H of the back of the wall should be considered on a case-by-case basis.
In addition to the active or at-rest lateral soil pressures, retaining walls should be designed to resist additional dynamic earth pressures during earthquake loading. The additional dynamic pressure increment may be calculated using an additional equivalent fluid pressure of 19 pcf for back slopes up to 3H:1V. The dynamic pressure increment should be applied to the wall as a triangular distribution so the resultant force acts at a distance of 0.33H above the base of the wall (where H is the height of the wall). Under the combined effects of static and dynamic loading, a safety factor of 1.1 against sliding or overturning is acceptable. The dynamic component of the lateral earth pressure was calculated using the Mononabe-Okabe equation and, therefore, assumes that sufficient deformation of the wall will occur during seismic loading to develop active soil conditions.

A drainage system should be constructed on the backside of all retaining walls. The drainage system for backfilled walls should consist of a 4-inch diameter perforated pipe surrounded by Class 2 Permeable Material complying with Section 68 of the Caltrans Standard Specifications, latest edition. Alternatively, the perforated pipe may be surrounded by clean coarse gravel or drain rock, provided the gravel or rock is completely separated from the surrounding soil by an engineering filter fabric such as Mirafi 140N or similar fabric. The section of permeable material should be at least 12 inches wide and should extend up the back of the wall to within about 18 inches of finished grade. The drainage material should be capped with compacted fine-grained soil, soil-cement, or other relatively impermeable material or barrier. The pipe should be PVC Schedule 40 or ABS with an SDR of 35 or better. Perforations in the drainpipe should be ¼ inch in diameter. The perforated pipe should be placed holes-down near the bottom of the section of permeable material and should discharge by gravity to a suitable outlet. Accessible subdrain cleanouts should be provided and maintained on a regular basis.

Proposed Elevator

We understand an interior elevator is proposed in the northeast portion of the Jenkins Hall Renovation, instead of the exterior elevator pit previously planned for the east side of the building. Footings for the perimeter walls and corner columns of the elevator pit should be sized, embedded, and reinforced to at least the minimums presented in the 2019 CBC. These footings should be designed according to the foundation recommendations above for retaining walls.

We understand that back-drainage will not be provided, in which case undrained at-rest earth pressures against the elevator pit perimeter walls can be calculated using an equivalent fluid pressure of 92 pcf to account for potential hydrostatic pressure build-up.

We anticipate that hand-excavated piers will be used to underpin the existing wall footing adjacent to the excavation for the elevator pit. The piers should be designed to gain support through end bearing in the firm native soil using a maximum allowable bearing pressure of 2,500 psf. The width and spacing should be determined by the underpinning designer based on the ability of the existing foundation to span an area of non-support. Underpinning piers should be embedded at least 24 inches below the planned excavation and should be designed for unbalanced horizontal loads resulting from the soil retained by the piers. The unbalanced load should be computed using an at-rest equivalent fluid weight of 60 pcf. Passive resistance at the toe of piers should be computed using an equivalent fluid weight of 250 pcf. Passive resistance from the top foot of soil should be ignored unless confined by a concrete slab or paving. The underpinning and/or shoring design should be performed by a licensed engineer and be in responsible charge of the temporary underpinning/shoring design. The contractor is responsible for means and methods of construction, as well as site safety.

Closure

As previously discussed, the remaining recommendations from our August 23, 2016 report remain applicable. During construction, we recommend that a representative of our firm confirm site conditions during soil-related work, including installation of foundations. If subsurface conditions differ significantly from those disclosed by our 2016 investigation, we should be given the opportunity to re-evaluate the applicability of our recommendations. Some alteration of recommendations may be appropriate.

We trust this provides the additional information you require at this time. If you have any comments or concerns, please call me at (707) 459-4518.

Sincerely,

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