KLEINFELDER
Bright People. Right Solutions.

March 2, 2018
File No: 20181569.002A

Mr. Ron Johnson
Contra Costa Community College District
2600 Mission Bell Drive
San Pablo, California 94806
Email: ronj@cslpm.com

SUBJECT: Response to Comments and Addendum Letter No. 1
Foundation Uplift Anchors
C-4016 New Allied Science Building
Contra Costa College
2600 Mission Bell Drive
San Pablo, California

Dear Mr. Johnson,

This addendum letter presents additional geotechnical recommendations pertaining to the C-4016 New Allied Science Building project located at Contra Costa College in San Pablo, California. This letter was prepared in response to comments received via email from Mr. Jeff Smith, structural engineer, of Rutherford + Chekene dated January 17, 2018 with regard to Kleinfelder's geotechnical report entitled "Geotechnical Engineering Investigation Report, C-4016 New Allied Science Building, Contra Costa College, 2600 Mission Bell Drive, San Pablo, California," dated October 17, 2017 (File No. 20181569.001A/PLE17R67485).

Recommendations provided herein address the construction of uplift anchors associated with the design of buckling-restrained braced frame (BRBF) seismic force-resisting system foundations. Our understanding of the proposed anchor design is based on telephone conversations with Mr. Smith and our review of project plans entitled "100 Percent Schematic Design, Phase 3 – DSA Increment 2," for Contra Costa College New Science Building, compiled by SmithGroupJJR, dated January 19, 2018. Recommendations for other elements needed for this project, including permanent soldier pile tie-back wall design, temporary shoring, and reuse of native soils for backfill are presently being considered and will be provided under separate cover. Recommendations provided in this report follow the 2016 California Building Code (CBC). The recommendations provided in the referenced geotechnical report should also be adhered to, as appropriate.

SITE SUBSURFACE CONDITIONS

The subsurface conditions at the project site are summarized in Table 1. This data is based on the soil borings included in the referenced geotechnical report (Kleinfelder, 2017).

Table 1 – Summary of Subsurface Conditions

Soil/Rock Description	Depth (ft)	Unit Weight, γ (pcf)	Assumed Friction Angle, ϕ (deg.)	Recommended Cohesion, c (psf)
Sandy CLAY	Varies 0 to 20	120	0	1,000
CLAYSTONE	20 to 40	130	0	4,000

FOUNDATION SOIL/ROCK ANCHOR DESIGN RECOMMENDATIONS

General

Based on the referenced design plans, we understand that uplift anchors are proposed to be constructed within isolated pad and strip footings throughout the building for the BRBF seismic force-resisting system.

Horizontal anchor spacing is presently proposed to be from 2 to 4 feet (center to center). The anchors are proposed to consist of an anchor bar/tendon in a grouted 6-inch minimum diameter hole with a minimum free stressing length of 10 feet and total anchor length of up to about 40 feet. Design loads on the order of 95 kips are anticipated for each individual anchor. Furthermore, we understand that these anchor elements will be used for uplift support only during potential seismic events.

Our geotechnical recommendations for the soil anchors with respect to Section 1811A of the 2016 CBC are provided below. The provided recommendations are based on guidelines presented in the Post-Tensioning Institute (PTI) "Recommendations for Prestressed Rock and Soil Anchors", Publication No. PTI DC35.1-14, dated 2014. We recommend soil anchor design and construction follow the PTI guidelines.

Minimum Diameter and Spacing

Uplift anchors should be at least 6 inches in diameter and sized to allow a minimum of 1 inch grout cover around the anchor tendon and its corrosion protection. Additionally, the hole diameter should be sized to allow for placement of a tremie grout tube alongside the tendon.

Upilft anchors should maintain a center to center spacing between bond zones of at least 5 feet. We are recommending this because deep, small diameter anchors can wander off a vertical in some cases. If that happens, the bond zones could end up being closer than anticipated. The minimum center to center spacing between installed bond zones must be greater than 3 anchor diameters. Staggering of the bond zone depths or varying the inclination of adjacent anchors should be adopted if closer spacing is necessary. Kleinfelder should evaluate that condition and its effect on anchor capacity on a case by case basis.

Grout to Ground Bond Stress

It should be noted that the exploratory borings drilled for this study extended to depths of about 40 feet and encountered claystone bedrock. At the time of the referenced geotechnical investigation, it was planned to support the building on spread footings. Therefore, deep borings and detailed characterization of the claystone bedrock were not performed.

For preliminary design of uplift anchors drilled in native claystone, the anchors should be designed for an ultimate grout to claystone bond stress of 2,000 psf, or 14 psi (taken as 50 percent of the estimated undrained shear strength for soil anchors). This is based on the recommendations contained in PTI (2014). Therefore, a maximum allowable bond stress of approximately 1,300 psf (9 psi) may be used for preliminary design. This value is derived using a factor of safety of 1.5 against pullout (for seismic events) and is based on the assumption that verification load testing will be performed on at least 3 sacrificial test anchors installed at locations selected by Kleinfelder and the project designer. Final design should be based on the results of pre-production verification testing performed by the Contractor prior to installation of the production anchors. Anchor load testing recommendations are provided in subsequent sections of this report.

Minimum Unbonded/Bonded Length of Tendon

Anchors should be designed with a minimum unbonded/free length of 10 feet for bar tendons. The bonded length should be a minimum of 15 feet in claystone. However, the minimum bonded length should be based on the required uplift capacity developed by skin friction of the grout to claystone bond. Based on a design load of 95 kips, a diameter of 6 inches, a factor of safety of 1.5 using a pressure grouted anchor, we estimate the minimum required bond length to be approximately 45.5 feet in claystone, which could extend over 25 feet below present boring depths.

Fractures and joints in the bedrock can cause excessive grout takes when using pressure-grouted anchors. The presence of fractures and joints is presently not well understood. For a gravity grouted anchor, the ultimate bond stress would be about half the value for a pressure grouted anchor, which would double the anchor bond length.

Geotechnical Considerations

Although it is likely in this geologic unit that other sedimentary rocks underlie the claystone unit encountered in the borings, their type and engineering properties have not been studied. Consideration could be given to increasing the anchor diameter to reduce the bond zone lengths in the claystone. If anchors must extend below depths of about 40 feet, we recommend performing at least 2 additional exploratory borings in the building pad area to depths of about 80 feet so that proper characterization of the bedrock unit can be performed. That will also enable us to further evaluate the appropriate anchor grouting method (i.e., gravity or pressure grouting).

Anchor Axial Tension Stiffness

Anchor axial tension stiffness should be provided by the structural engineer.

Grout Pressures

The recommended preliminary grout to ground bond stress provided above is based on pressure and/or post-grouted anchor types. Typical pressures vary from 50 to 400 psi for pressure grouting as the casing or auger is withdrawn from the hole and additional grout is pumped through the casing cap or grout swivel.

KLEINFELDER 2882 Prospect Park Dr., Suite 200, Rancho Cordova, CA 95670 p | 916.366-1701 f | 916.366-7013

Corrosion Protection

Based on the 2016 CBC Section 1811A, Class I corrosion protection is required at a minimum for permanent anchors. Analytical lab testing performed for the referenced geotechnical report resulted in the site soils having an extreme to high corrosion potential when compared to American Water Works Association (AWWA) standards. Additionally, the environment is considered 'aggressive' by PTI due to a low soil electrical resistivity (less than 2,000 ohm-cm). Reference should be made to the above referenced guidelines for specific recommendations on corrosion protection. Additionally, a qualified corrosion engineer may be retained to provide corrosion protection requirements for the anchors.

Verification Load Testing

Sacrificial load tests (often termed pre-production load tests or verification tests) should be performed to verify the design and installation procedure for the anchors prior to final design and construction of production anchors. These load tests are also needed to evaluate the anchor grout to ground bond stress for final design. The tests should be performed at three (3) locations to be determined by the Structural and Geotechnical engineers.

Each anchor should be load tested in tension to at least 150 percent of the design load, per ASTM D 3689. The central reinforcing bar should be designed such that the maximum tensile stress does not exceed 80 percent of the yield strength of the steel. The jack should be positioned at the beginning of the test such that unloading and repositioning of the jack during the test will not be required. Upon completion of the load testing, the geotechnical engineer should evaluate the data obtained and provide final recommendations for the production anchors.

During production anchor construction, proof-load testing should be performed on all production anchors up to 133 percent of the design load, per PTI guidelines.

Lock-off Loading

The magnitude of the lock-off load shall be specified by the structural engineer and shall not exceed 70 percent of the steel yield strength.

Drilling Methods

The anchor drilling method should be selected by the Contractor and should be appropriate for the encountered soil and rock conditions and proposed grouting method. Caving conditions are not anticipated within the clayey on-site soils and claystone. Additionally, groundwater was not encountered within the explored borings to depths of approximately 40 feet. However, groundwater has been encountered throughout borings and trenches performed throughout the college campus at depths ranging between 9 to 23 feet below the ground surface.

Construction Observation and Monitoring

We recommend that all anchor construction and testing be monitored by a representative of Kleinfelder, including drilling, grout placement, and all verification and proof-load testing in accordance with Chapter 17 of the CBC and PTI (2014). The purpose of these services would be to provide Kleinfelder the opportunity to observe the subsurface conditions encountered during construction, evaluate the applicability of the recommendations presented in this addendum letter

to the subsurface conditions encountered, and prepare recommendations for final anchor design and construction.

CLOSURE

Unless specifically superseded in this addendum, the recommendations presented in the above-referenced geotechnical report remain applicable. This document is intended to provide specific recommendations for preliminary design of uplift anchors for the subject project. Accordingly, it cannot be considered an independent document, as it does not contain adequate background information. This document is directed only to the personnel with detailed knowledge of the subject project. The conclusions and recommendations presented in this addendum were prepared under the conditions and limitations presented in our above-referenced October 2017 geotechnical investigation report.

We trust this information meets your current needs. We appreciate the opportunity to be of professional service to you on this project. If you have any questions, please do not hesitate to contact us at (916) 366-1701.

Respectfully submitted,

KLEINFELDER, **INC.**

Edgar A. Santos, EIT
Staff Engineer

Rebecca L. Money, PE, GE
Senior Geotechnical Engineer

Reviewed by:

Kenneth G. Sorensen, PE, GE
Principal Geotechnical Engineer

KLEINFELDER 2882 Prospect Park Dr., Suite 200, Rancho Cordova, CA 95670 p | 916.366-1701 f | 916.366-7013