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DATE: May 29, 2015
Report No: G15-113

Kuo & Associates, Inc.
10700 Richmond Avenue, Suite 113
Houston, Texas 77042

Attention: Mr. Shaheen Chowdhury, P.E.

Reference: Trench Safety Report
Water Line Replacement in Dodson Area
WBS NO. S-000035-0205-4
Houston, Texas

Dear Mr. Chowdhury:

Submitted herein are our recommendations for the trench safety for the open cut excavation/trenching/shoring involve in the proposed water line replacement. The project entails replacing approximately 40,960 linear feet of the existing water lines with new 4-, 6-, 8- and 12-inch diameter water lines, at depths ranging from about 7 to 17 feet below existing grade. Trenchless installation technique will mostly be employed. Open cut/trench excavation will be carried out at access pits (auger pits), and possibly in local areas where underground obstructions or site conditions warrant open cut/trenching.

OSHA Classification

Maintaining stability of sidewalls and base of a trench is necessary for the safety of the construction crew working in or near it and for mitigating risks of damages to adjacent structures/facilities due to lateral or vertical movements. At the federal level, Occupational Safety and Health Act (OSHA) requires protective systems for all trenches exceeding 5 feet in depth. Protective systems may be required for trenches shallower then 5 feet in depth if there are indications of potential ground movements. OSHA has developed a soil classification system to be used as a guideline in determining sloping and protective system requirements for trench excavations. This system has set forth a hierarchy of Stable Rock, Type A, Type B, and Type C, in decreasing degree of stability.

Based on the soil conditions from the borings, the water line construction excavation will likely be advanced mostly in firm to very stiff clay soils. However, silty and clayey sands sands (SM, SC-SM), sandy-silty clays (CL-ML) with slight plasticity and soft clay stratum will or may be encountered at the locations (but not limited to) identified in Table E and F in Section 5.2 of ATL Report No. G15-113, or at locations away from the locations investigated in this project.

Due to the shallow ground water depth, ATL recommends classifying all onsite soils as OSHA Soil Type "C", for the determination of allowable maximum slope or selection and design of the protective system. All submerged and/or saturated soils, fill soils, soft/loose soils, sands (SP, SM, SC), if encountered, shall be classified as OSHA Soil Type "C".

Excavations

The excavations can be made using open slopes, stepped back to stable slope, vertical cuts supported with shoring, sheet piles or other suitably designed retaining system. The excavation should be performed in accordance with the current OSHA 29 CFR Part 1926 of OSHA (Trench Safety System).

For short-term exposure during construction, open slopes in OSHA Type "C" soils should not be steeper than 1(V): 1.5(H). For long-term exposure (greater than 72 hours) during construction, open slopes in OSHA Type "C" soils should not be steeper than 1(V): 2(H). For OSHA Type "B" soils, open slopes is no steeper than 1(V): 1(H) is recommended. We do not recommend using unsupported vertical cuts.

Earth Pressures

For the trench support system, the lateral pressures exerted by surrounding soils are presented in the attached Figures 1 through 3. Temporary earth retaining walls are sometimes designed assuming an equivalent fluid pressure, in such cases, a lateral earth pressure equivalent imposed by a 84 PCF and 102 PCF fluid is recommended for cohesive soils below and above the water table, respectively; in sandy soils, a lateral earth pressure equivalent imposed by a 48 PCF and 85 PCF fluid is recommended for soils below and above the water table, respectively. In general, a surcharge magnitude of q psf will result in lateral earth pressure of 0.5q in cohesive soils and 0.4q in sandy soils. Timber shoring as outlined in 29 CFR Part 1926 of OSHA recommendation may be used in the construction of trench supporting system.

Due to the presence of the roadway adjacent to the proposed construction excavation along the project alignments, the effects of vehicular traffic should be considered in the design of the trench support systems. We recommend that a H20 vehicle loading be considered adjacent to the pit for design purposes, surcharge loading due to construction machinery should be considered. Boussinesq's equation should be used for computing both horizontal and vertical stresses imposed by a surface surcharge load. Stockpiling of excavated material may not be allowed near the excavation. Generally, a distance of one-half the excavation depth on both sides of the trench should be kept clear of any excavated material. If this is not possible due to space limitations then the retaining system design should take into account the surcharge loads.

Bottom Stability

Where granular soils are encountered at trench bottom, dewatering should be performed to lower the groundwater to a depth of at least 3-feet below the excavation bottom. In cohesive soils, the trench bottom stability can be evaluated using the procedure outlined in Section 5.2 of ATL Report No. G15-113.

Groundwater Control

Free water was encountered during drilling operation in most of the borings at depths ranging from about 2 to 22 feet below existing grade, and at depths of about 2 to 21.6 feet at end of drilling. Borings B-2, B-10, B-15, B-21A, B-25, B-32, B-38, B-42, B-48, B-53, B-63, B-71 and B-80 were converted into Piezometer PZ-1 through PZ-13, respectively, after completion of drilling and soil sampling. Water level in PZ-1 through PZ-13 was measured after 24 hours at depths between about 2.5 and 7 feet. Water level in PZ-1 through PZ-13 measured on 4/3/2015, 4/9/2015 and 4/27/2015 ranged between about 1.5 and 7 feet in depth.

Based on the proposed invert elevation and the groundwater information gathered during our field investigation, water line construction excavations as shallow as 1.5 feet may encounter groundwater, especially when the excavations stay open for 24 hours or more. It should be noted that groundwater level will fluctuate with the amount of precipitation and the prevailing environmental conditions prior to and during construction.

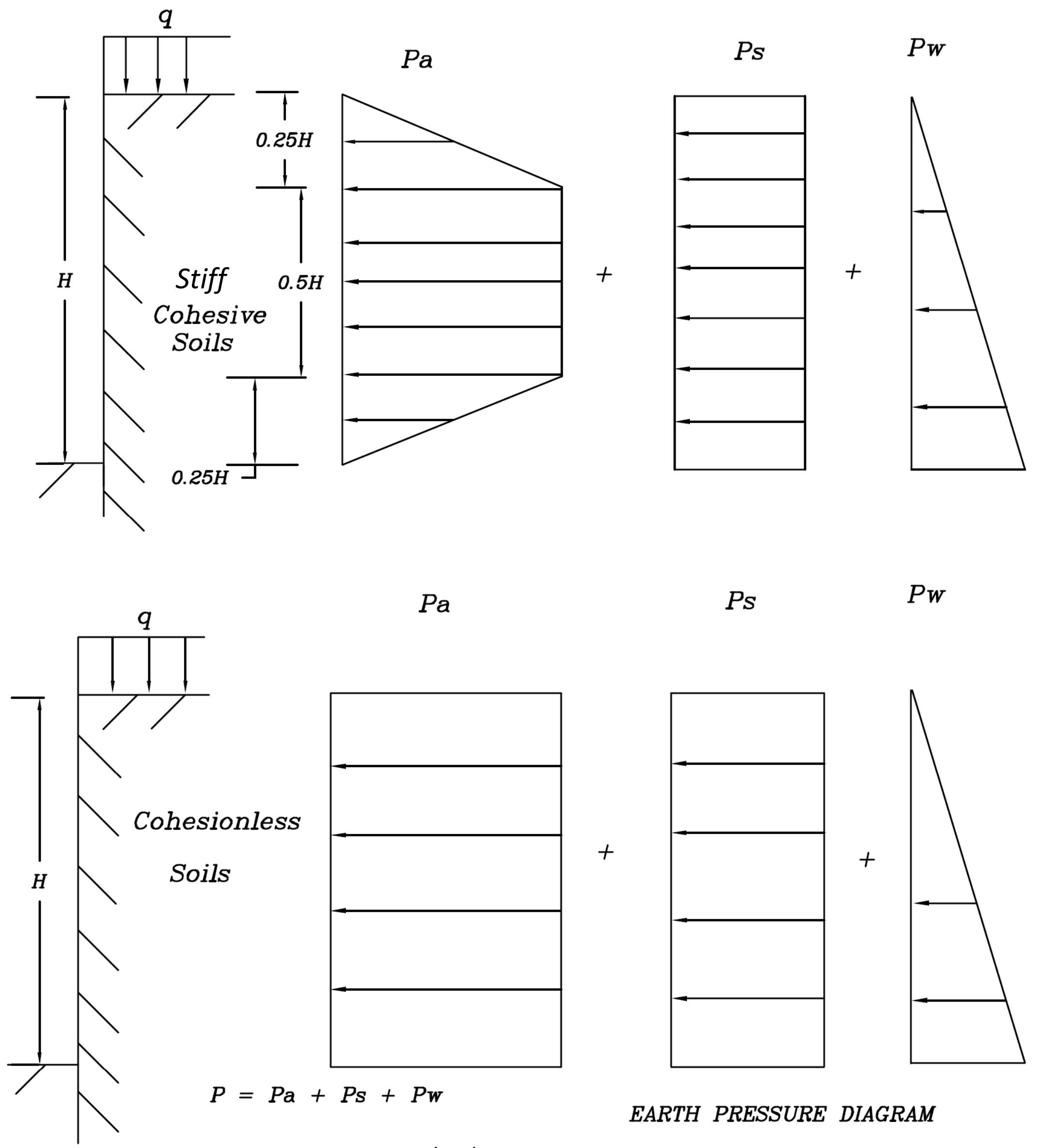
The flow of groundwater may vary depending upon depth of construction and weather conditions. A conventional sump and pump arrangement may be used for the trench excavations in cohesive soils to a depth of 15 feet. Below this depth, multi-staged pumps or well points will be required. Where non-cohesive soils are encountered or if the inflow is fast, then dewatering using well points may be necessary. Groundwater control should be in general accordance with the City of Houston Standard Specifications, Section 01578.

More detailed information regarding the soils and groundwater at individual locations can be obtained from our geotechnical report G15-113. We appreciate the opportunity to work with you on this project. Please call should you have any questions or need additional information.

Sincerely,

Peng Sia Tang, P.E.
Manager, Geotechnical Services

Enclosures: Figures 1 through 3 – Earth Pressure Diagrams



$P = Pa + Ps + Pw$

EARTH PRESSURE DIAGRAM

Where P = Total lateral pressure (psf)

Pa = Active earth pressure(psf) = $K_A \gamma H = 0.4 \gamma H$ for Stiff Clays
= $0.65\ K_A \gamma H = 0.25 \gamma H$ for cohesionless Sands ($0.33 \gamma H$ – for loose sand)

Ps = Lateral pressure due to surcharge load (psf) = 0.5q for Clays
= 0.4q for Sands
(0.5q for loose Sands)

Pw = Hydrostatic pressure (psf) = 62.4* water depth

H = Depth of braced excavation (ft)

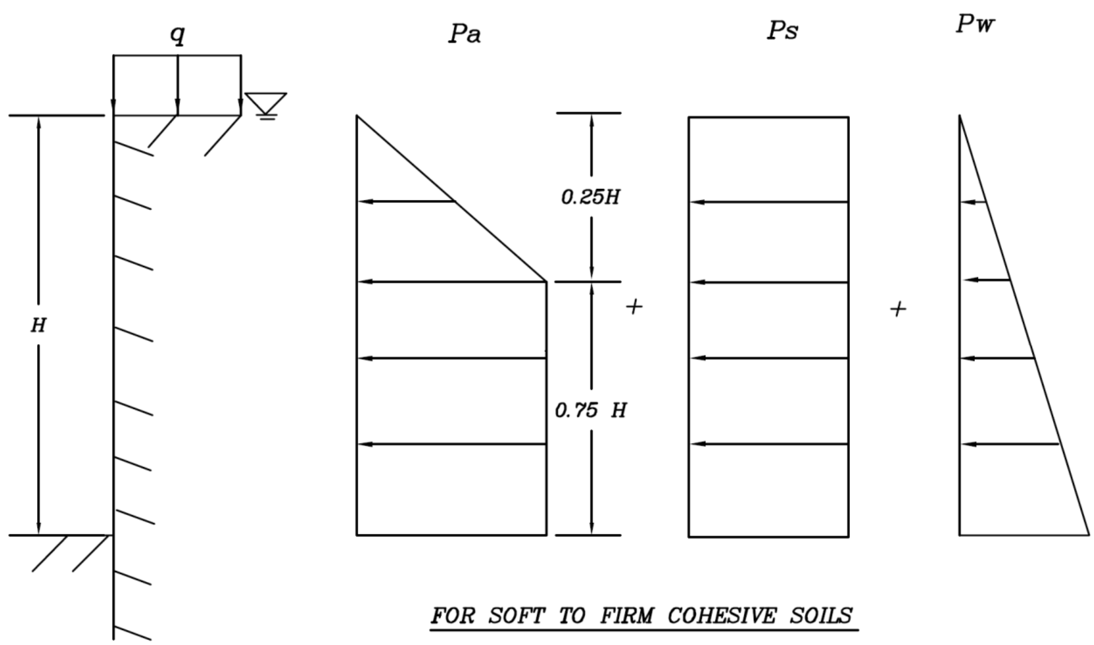
q = Surcharge load (psf) usually taken as 500 psf

γ = Submerged density of soils (pcf) = use 60 pcf (use 50 pcf for loose Sands)

Source: Peck, R.B. 1969. "Deep Excavations and Tunneling in Soft Ground".

EARTH PRESSURE DIAGRAM	ASSOCIATED TESTING LABAORATORIES, INC. 3143 YELLOWSTONE BLVD., HOUSTON, TEXAS TEL: (713) 748-3717 Fax: (713) 748-3748	
WATER LINE REPLACEMENT IN DODSON AREA	WBS NO. R-000035-0205-4	
	PROJECT NO. : G15-113	FIGURE 1

PST 8/28/12



FOR SOFT TO FIRM COHESIVE SOILS

Where P = Total lateral pressure (psf)

Pa = Active earth pressure(psf) = $1.0 K_a \gamma H$ for soft clays

K_a = Active Earth pressure coefficient

$= 1 - m \frac{2 q_u}{\gamma H} = 1 - m \frac{4C}{\gamma H}$ (taking $C = \frac{q_u}{2}$)

Here m=1 for N<4 and m=0.4 for N>5

N= Stability number $= \gamma H / C$

Ps = Lateral pressure due to surcharge load (psf) = K_a for clays

Pw = Hydrostatic pressure (psf) = 62.4* water depth

H = Depth of braced excavation (ft)

q = Surcharge load (psf) usually taken as 500 psf

γ = density of soils (pcf) = use 50 pcf below groundwater and 110 pcf above groundwater

q_u = Unconfined compressive strength, psf

C = Undrained shear strength, psf

Note: Neglect hydrostatic pressure above groundwater level

Source: Peck, R.B. 1969. "Deep Excavations and Tunneling in Soft Ground".

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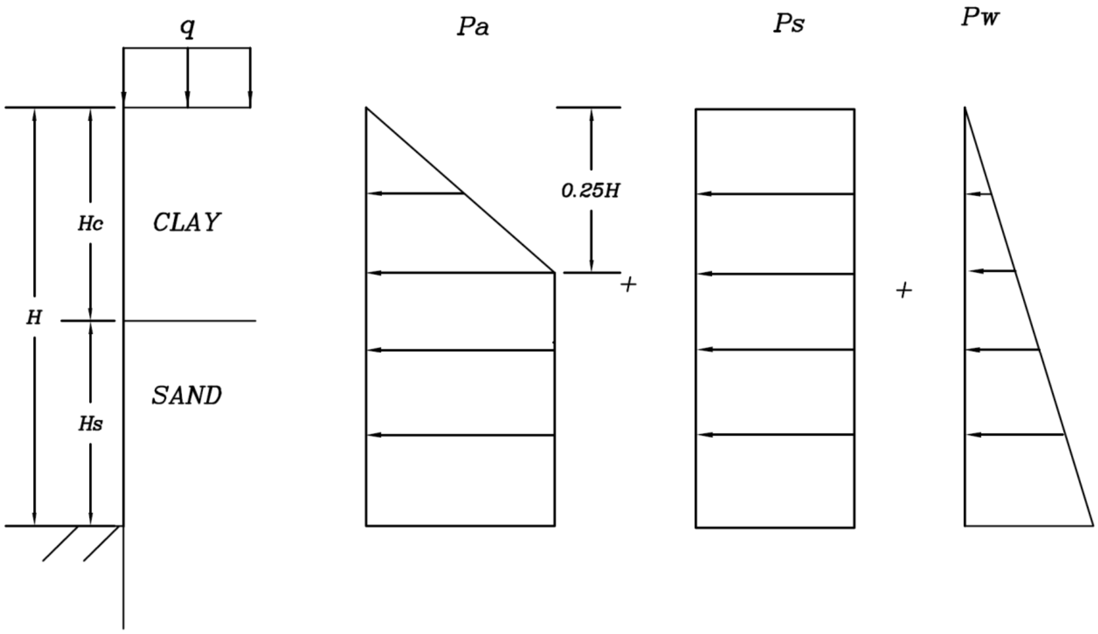
WATER LINE REPLACEMENT IN DODSON AREA	WBS No. S-000035-0205-4 PROJECT NO. : G15-113 — FIGURE 2



$P = Pa + Ps + Pw$

Where P = Total lateral pressure (psf)

Pa = Active earth pressure(psf) = $K_A \gamma H = 0.4 \gamma H$

Ps = Lateral pressure due to surcharge load (psf) = $0.5q$

Pw = Hydrostatic pressure (psf) = 62.4* water depth

H = Depth of braced excavation (ft)

q = Surcharge load (psf) usually taken as 500 psf

γ = Submerged density of soils (pcf) = use 60 pcf

Source: Peck, R.B. 1969. "Deep Excavations and Tunneling in Soft Ground".

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WATER LINE REPLACEMENT IN DODSON AREA	WBS NO. S-000035-0205-4	
	PROJECT NO. : G15-113	FIGURE 3

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