TECHNO-GRAM
005-2018

DEPARTMENT OF PERMITTING, INSPECTIONS AND ENFORCEMENT

SUBJECT: Geotechnical Guidelines for Soil Investigations and Reports Required by Prince George's County Code, Subtitle 32 and Subtitle 24-131

PURPOSE: To Provide Guidance Regarding Geotechnical Investigations of Sites That Include or are Near Over-Consolidated (O/C) clay

SCOPE: Pertains to project sites that include or are in the vicinity of Over-Consolidated O/C clay such as Marlboro Clay and Christiana Clay

I. Definitions

1. **Over-Consolidated Clay** – In Prince George's County, O/C clay is fissured clay with residual effective angle of internal shear resistance ranging from 10° to 14°. It includes Marlboro Clay formations, Christiana Clay Complexes, and some Howell soil groups. It is typically classified as CH, MH, CL-CH or CL in the USCS classification system. In PGAtlas.com, the Marlboro clay layer is mapped on the environmental tab. When turned on, red and green bands appear. Red bands indicate where Marlboro Clay is present with accuracy that is intended for investigative purposes. Green bands indicate where its presence is likely, unless otherwise proven by detailed Geotechnical investigations.

2. **Critical slopes** – Slopes in or near O/C clays with one or more of the following features: a) 5H:1V and steeper (≥ 20%), b) greater than 20 feet in height, c) their failure may result in significant damage or costs, or d) deemed critical by the County.

II. Required Field Investigation

1. Engineer shall perform investigations that include standard penetration test (SPT) borings or an acceptable combination of SPT borings and one of the following methods: Cone Penetrometer Testing (CPT), Dilatometer Testing (DMT) or any other method justified by permittees and accepted by DPIE. Test frequency and locations shall be adequate to delineate the 3-dimensional presence of O/C clay that may impact proposed structures, roads, and utilities, and as necessary to address slope stability in the direction of critical slopes where O/C clay is present.

2. Engineer shall extend the soil test borings at least 10 feet below the O/C clay. Olive green sand of the Aquia Formation is typically found within such depths. The boring depth and location must be adequate to locate the O/C clay top and bottom surfaces by identifying at least 2 points on each surface. This is necessary to perform a slope stability analysis. Engineer shall survey the ground elevation at all locations of the test borings. If O/C clay is not encountered in the explored depths, at least one boring shall be drilled within the PG Atlas red band down to a depth of at least 30 feet depth to disprove the presence of the O/C clay on the site.

3. Engineer shall collect soil samples with split spoon (disturbed samples) and a thin-walled (undisturbed samples) shelby tube in accordance with the American Society for Testing and Measurement (ASTM) standards D 1586 and D 1587. Engineer shall determine the presence and depth of any fissures or slicken-sided joints in the soil samples. If DMT is used to confirm existing failure planes (KD≈2.0), it shall be performed in accordance with ASTM D 6635. Also, a DMT table shall be provided in the geotechnical report depicting at least the following: the gauge pressure, thrust, A-pressure, B-pressure, dilatometer modulus, dimensionless dilatometer index, dimensionless dilatometer horizontal stress in one dimensional compression, over-consolidation ratio, Ko, Phi, constrained modulus of soil compressibility, and the soil type based on USCS soil classification (per ASTM D-2487 and D-2488).

4. Engineer shall identify the locations of possible old slides, current suspected instable slopes, and slope movement signs evident on existing structures. This shall be based on site visits, a review of site plans, and a review of recent and old aerial photographs.

5. Engineer shall classify soil layers by geologic formation, where evident. At least Nanjemoy Formation, Marlboro Clay, and Aquia Formation shall be identified on the boring logs of the geotechnical report.

6. Engineer shall note groundwater presence and depth at the time of drilling completion, and at least **10** weeks later. If the groundwater is shallow, engineer shall investigate its seasonal fluctuations and identify seepage zones where evident.

III. Slope Stability Analysis of Critical Slopes

Engineer shall provide in the slope stability analyses:

1. Cross sections where slope stability is analyzed shall be adequate in number and location to address changes in stress due to the proposed grading and construction (removal of soil near slope toe, loads on the slope,…), and as necessary to accurately locate the 1.5 Factor of Safety (F.S.) line. Cross section lines and 1.5 F.S. lines shall be depicted on boring location plans and site grading plans. Grading plans shall show both, existing and proposed grades. Both grades shall be analyzed for slope stability.

2. Each cross section shall run through or tangent to at least 2 soil borings such that field verified soil data is used in the analysis. The lowest tested residual shear strength of a cross section shall be used in the stability analysis of that particular cross section.

3. Engineer shall use software that produces colored profiles with strength parameters of the soil layers tabulated on each profile. Only the "residual" friction angles obtained from laboratory testing of O/C clay shall be used, per item IV.1 of this document, to evaluate the long-term stability of slopes. Cohesion of O/C clays shall be assumed to have a value of **ZERO**.

4. Strength parameters of soils that are not highly plastic may be determined from correlations with adjusted SPT 'N' values, or comparisons with properties of similar soils published in electronically accessible literature. Exact methods of determining such parameters shall be explained in the geotechnical report. If the parameters are based on laboratory testing, test results shall be included in the report. DMT friction and shear angles may be used per standard output per the DMT Table (Item II.3).

5. Slope stability analyses shall result in delineating the 1.5 Factor of Safety (F.S.) line. The software output will be a 1.5 failure surface whose top intersects with the ground surface at a point. By connecting these points of intersection of all cross sections, a 1.5 F.S. line is identified. This line determined for pre-developed conditions shall be labeled "existing 1.5 F.S. Line". For post developed conditions, global stability shall be analyzed for slopes that will remain critical after proposed grading, and slopes that may become critical due to proposed grades and/or proposed structures. An additional 1.5 F.S. line shall be delineated for the proposed grades and structures. This line shall be labeled "proposed 1.5 F.S. Line".

6. Structures, houses, roads, and walls, shall not be planned on analyzed slopes at elevations lower than the 1.5 F.S. line. The building restriction line shall be at least 25 feet uphill from the 1.5 F.S. line for compliance with Prince George's County Code *Section 24-131 - Unsafe Land*. Once the layout of proposed structures is determined, their loads shall be considered in global stability analyses.

7. Engineer also shall identify onsite and offsite existing properties, structures, roads, ponds, and utilities that may be impacted by the proposed grading and/or loading of the O/C clay, and perform the necessary analyses to ensure their long-term slope stability.

IV. Laboratory Testing and Analysis

Tests shall be performed in accordance with applicable ASTM criteria and acceptable standards. Modifications to standard testing procedures will be considered by DPIE for acceptance if justified in the geotechnical report and noted on the print out of the stability analysis program.

1. For each cross section, engineer shall perform at least two 3-point drained shear tests on representative samples of O/C clays, to establish the residual shear-strength parameters. For the long-term stability, only slow strain rates shall be used on reconstituted or undisturbed shelby tube samples. The rates depend on the shearing procedure. For the required torsional ring shear test, the rate should be a maximum of 0.0008 in/min (ASTM D6467). Alternatively, the engineer may use a maximum rate of **0.00035** in/min (per the Army Corps of Engineers' procedure EM 1110-2-1906) for direct/residual shear (D/RS). Different rates of other procedures, such as that outlined in *Engineering Properties of Clay Shales* (Technical Report TR-S-71-6 by W. Haley and B.N. MacIver), shall be approved by DPIE first. Results of tests IV.2 thru IV.6 below shall be provided to DPIE for all applicable soil samples. Estimated parameters, undrained tests, unconfined tests, and simple direct shear (DS) tests are not accepted by DPIE for O/C clays.

2. Natural moisture content shall be provided for split spoon and thin-walled tube samples.

3. Atterberg limits shall be provided for cohesive soil samples and shear strength tests.

4. Hydrometer analysis shall be provided for cohesive samples, such as silt and clay.

5. Soil classification shall be provided per AASHTO and ASTM D 2487 and D 2488.

6. If structures are proposed on substantial fill, or soft O/C clay or cohesive soils, consolidation tests and relevant engineering recommendations shall be provided in the geotechnical report.

7. If roadways are proposed, proctor test results per American Association of State Highway and Transportation Official (AASHTO) standard T-180 shall be provided in the report for the two most predominant soil types below the road subbase stone. O/C clay shall be kept at least 2 feet away from subbase stone.

V. Conclusions and Information to be provided in the Geotechnical Report

Engineer shall analyze and provide the following in the geotechnical report at the concept stage of the project, and again at the permitting stage:

1. Engineer shall include locations of the 1.5 F.S. lines, cross sections analyzed for stability, and the areas of outcropping O/C clay delineated on site and adjacent to it. This information shall be provided on the boring location plans, concept plans, and grading plans. The delineated areas of O/C clay shall be lightly shaded. Shades and line patterns shall be identified in the plans legend.

2. The boring location plan shall be presented preferably on no more than 2 sheets. It shall be presented with a graphical scale and a north arrow on each sheet.

3. Colored profiles of the analyzed cross sections shall be provided in the report, along with print outs of all slope stability and global stability analyses.

4. If O/C clay is present on the site or adjacent to it, the report shall identify the ramifications and restrictions to the project due to presence of O/C clay and critical slopes.

5. Analysis of existing and proposed grades, evaluation of stability of slopes steeper than 5H:1V on the site and adjacent to it, and determination of the maximum allowable slopes, if applicable, shall be provided in the report.

6. Engineer shall include global stability analyses and mitigation or recommendations for the identified existing properties, structures, roads, ponds, and utilities that may be impacted by the proposed grading and/or loading of the delineated O/C clay. Engineer shall also recommend in the report further investigations, when needed.

7. Geotechnical design parameters and recommendations shall be provided for proposed mitigation, slope stabilization, pavement sections, foundation design, design of retaining and basement walls, especially if impacted by O/C clay. For structures to be founded in O/C clay areas, the geotechnical report shall identify the exact depths of footings and the uplift forces needed to identify any additional reinforcement of structures.

8. Geotechnical engineer shall review finalized permit plans and certify their conformance to the geotechnical report recommendations. Geotechnical engineer shall also ensure that the plans include this note: "*Design and construction shall be consistent with the recommendations of the geotechnical report of the permit referenced on the plans*".

9. If failure surfaces exist on site, or if water seepage from finished cut slopes is possible; locations of such surfaces shall be depicted on the boring location plans, and options to stabilize such condition shall be listed in the report.

10. The report shall offer recommendations for acceptable locations of proposed structures and stormwater management (SWM) devices. In general, SWM devices that allow infiltration into the site soil strata should be located below the O/C clay bottom. Generally, SWM devices in or above the O/C clay should be limited to rain barrels, vaults, or micro bioretention with impervious liners and underdrains that discharge into County approved storm drain pipes and eventually outfall at a lower elevation that the O/C clay bottom. The report shall include a table listing for each proposed SWM device, depths of the following: the device bottom, the O/C clay top surface, the O/C clay bottom surface, and the seasonal high groundwater level.

APPROVED BY:

Haitham A. Hijazi, Director

September 21, 2018
DATE