GEOTECHNICAL SITE CHARACTERIZATION AND ZONATION OF SOIL IN YANGON AREA

PhD DISSERTATION

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ABSTRACT

The study area is located in the North Latitude 16° 45' and 17° 04' and East Longitude 96° 00' and 96° 17'. It is bounded by Ngamoeyeik Creek in the east and Hlaing River in the south and west. The strong growth in population, development of infrastructures and industry, and the extension of new urban area have resulted in a variety of competing demands and substantial encroachments upon the environment. It is a reason why the research title "Geotechnical Characterization and Zonation of Soil in Yangon Area" is needed to perform. The research is prepared from various points of views such as geology, engineering geology and environmental geology. About one thousand boreholes are studied and evaluated for this research.

The topography of the studied area can be divided into five divisions such as hilly area, ridge areas, terraces, low lying flat plain, and tital flat and channel. The surface drainage pattern is dendritic pattern except Hlaing Tharyar. The climatic condition of Yangon area is a tropical monsoonal climate.

The study area is completely covered by Tertiary to Quanternary sediments, three Formations can be found such as Alluvium (Plistocene to Recent), Irrawaddy Formation (Upper Miocene to Pliocene), and Pegu Group (Lower Miocene to Middle Miocene). Pegu Group. includes Hlawga Shale, Thadugan Sandstone and Besapet Alternation.

Irrawaddy Formation consists of Arzarnigon Sandrock and Danyingone Clay. Arzarnigon Sandrock is mainly composed of blue and greenish gray clay and sandrocks. Danyingon Clays consist mainly of blue clays, yellowish clays and siltstones with interbedded sandrocks.

Alluvial deposits consist of recent alluvium and valley fill deposits. Valley fill deposits consist of a thick sequence of loose, highly pervious, interbedded sands and fine to very coarse gravels. Recent alluvium was deposited in recent time and consists essentially of yellowish grey silt and clay. As the study areas are located at the southern spur of the Pegu Yoma, geological structures such as fold, fault and joints are noted.

Field investigations are performed to evaluate the geotechnical characteristics and the foundation condition of soil. For this reasons Standard Penetration Test (SPT) is carried out and disturbed and undisturbed samples are collected systematically. Physical and mechanical tests are carried out to know the engineering properties of soils.

Generally, in Yangon, two water bearing horizons can be seen in the Irrawaddy Formation. The first layer is sand and clay interbedded and second layer is coarse-grained sandrock with some gravel.

Based on the result of mechanical analysis and index properties tests, the soils are classified into eight soil types SM, SW, SC, CL, CH, OH, ML and MH according to the Unified Soil Classification System. Distribution of soil in Yangon area at 3m, 5m, 10m and 20m are plotted on Yangon base map by Surfer 14 software. Geotechnical characteristics of individual townships are evaluated by graph in this research. In this research various pattern of graph show the nature and maturity of sediments. Most recent alluvial deposit show the complex distribution graph pattern. Most Irrawaddy Formation and Pegu Group show simple distribution graph pattern.

The uniaxial compressive strength and shear strength of various soil in Yangon area are evaluated to know the strength of various soil. The minimum uniaxial compressive strength is 5 kPa and maximum value is 635 kPa at 3m depth. The lowest and the highest uniaxial compressive strength at 5m depth are 5 kPa and 848kPa. The minimum and the maximum uniaxial compressive strength at 10m are 7 kPa and 800 kPa. The uniaxial compressive strength at 20m depth range from 19 kPa to 825 kPa. The calculated uniaxial compressive strength values of soil are plotted on Yangon base map by Surfer 14 software to produce the uniaxial compressive strength map.

The minimum shear strength is 5 kPa and maximum value is 85 kPa at 3m depth. The lowest and the highest shear strength at 5m depth are 5 kPa and 106kPa. The minimum and the maximum shear strength at 10m are 9 kPa and 179 kPa. The shear strength at 20m depth range from 10 kPa to 299 kPa. Shear strength values of soil are plotted on Yangon base map by Surfer 14 software to produce shear strength map.

Bearing capacity of shallow foundation at 3m and 5m are evaluated for the foundation condition of shallow soil by using Merhorf 's equation. Bearing capacity of shallow foundation at 3m depth ranges from 52 kPa to 8052 kPa. At 5m depth, bearing capacity is between 127 kPa and 9990 kPa. Bearing capacity values of soil are plotted on Yangon base map by Surfer 14 software to produce shallow foundation map.

Bored pile foundation calculation is done for the evaluation of deep foundation condition of soil at 10m and 20m. Bearing capacity of bored pile foundation at 10m depth ranges from 187 kPa to 36894 kPa. At 20m depth, bearing capacity is between 600 kPa and

98055 kPa. Bearing capacity values of deep soil are plotted on Yangon base map by Surfer 14 software to produce bore pile foundation map.

The soil in young alluvium is medium to high plasticity and compressible. It has very low bearing capacity and high swelling. Natural moisture content is high and soft. So, it is not suitable for heavy foundation especially N.Okkalarpa, Hlaing Tharyar, some part of Tharkata, and Botahtaung Township. Suitable ground improvement methods are needed for shallow and deep foundation.

In valley fill deposits, it contains fine loose sands and has medium compressibility. Moisture content is close to plastic limit. Maximum bearing capacity is approximately 100kPa.Therefore, it is suitable for shallow foundation and some ground improvement methods are required for deep foundation.

Danyingon Clays of Irrawaddy Formation contain low plasticity clay and silt. Swelling potential is medium to high. It is suitable for shallow foundation since it has good bearing capacity. But, settlement problems may occur. Some ground improvement methods are required for deep foundation. Danyingon Clays are poor foundation material for construction.

Arzarnigon Sandrocks of Irrawaddy Formation are slightly plastic. Low swelling potential and low compressibility. As they have high bearing capacity, good for shallow and deep foundation. Erosion protection should be considered in high land area. Arzarnigon Sandrocks are good foundation material for construction.

The soil in Pegu Group is low to high plastic clays and compressible. Loose to dense and fine to medium grain sand in Thardugan Sandstone. It is good for shallow and deep foundation. Hlawga Shale and Besapet Alternation are highly weathered. So, it cannot be tested the strength of rocks. Only Thadugan Sandstone is tested for the unconfined compressive strength of rock. According to the laboratory results, most of the Thadugan Sandstones are fine to medium grained and loose to dense. The unconfined compressive strength of Thadugan Sandstone is between 16 to 23 MPa.

Yangon area lies in fairly active zones. But the earthquake intensity is slight to moderate MM VII to MM VIII. Landslide features are usually noted at the ridge of Irrawaddian rocks. In Yangon area, frequent landslide hazards have been reported in raining season at ridge area such as Bahan Township but low-lying flat area of Hlaing Tharyar and Shwe Pyithar do not occur as hazards.

Flood occurred due to improper drainage systems, heavy rain and high tides. Wide spread flooded areas and isolated flooded areas are normally situated along the banks and close to Hlaing River and Ngamoeyeik creek. In new urban areas, Hlaing Tharyar and Shwe Pyithar, the land is flat thus it is more likely for flooding.

Since the most abundance of alluvial deposits in Yangon area, liquefaction may occur in some townships especially Kyee Myin Taing, Ahlon, Lanmataw, Latha, Pebedan, Kyauktada, Pazuntaung, Tharkata and Botahtaung Townships. So, liquefaction potential analysis should be performed before construction of high-rise building. According to the earthquake zonation map, Yangon is earthquake prone area. Some part of Yangon especially Hlaing Thar Yar, Dagon Myothit, Tharkata, N.Okkalarpa and downtown areas are necessary to consider for earthquake . Therefore, earthquake resistant design should be evaluated. Moreover, systematic drainage system and systematic ground improvement methods should be designed according to the design purposes.

CONTENTS