بسم الله الرحمن الرحيم

MONA MAGHRABY

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

MONA MAGHRABY

شبكة المعلومات الجامعية

التوثيق الإلكتروني والميكروفيلم

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات

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تحفظ هذه الأقراص المدمجة بعيدا عن الغبار

MONA MAGHRABY

Ain Shams University
Faculty of Science
Geology Department

ENGINEERING GEOLOGICAL STUDIES OF THE AIN SUKHNA AREA, EASTERN DESERT, EGYPT

A Thesis
Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Sciences in Geology

By

Ahmed Mostafa Mohamed Abdel Kader

(B.Sc. in Geology, Ain Shams University)

Geology Department
Faculty of Science
Ain Shams University

2021

APPROVAL SHEET

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Supervisors	**Approved**
Prof. Dr. Samir Abdeltawab Mohamed Professor of Engineering Geology, Geology Department, Faculty of Science, Ain Shams University.	.....
Dr. Mohamed Yousef Rizk Associate Professor of Structural Geology, Geology Department, Faculty of Science, Ain Shams University.	.....
Dr. Waleed Abdelmoghny Metwally Ogila Lecturer of Engineering Geology, Geology Department, Faculty of Science, Ain Shams University.	.....

Dr. Karim W. Abdelmalik

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Associate Professor of Structural Geology, Geology Department,
Faculty of Science, Ain Shams University. .....

Dr. Waleed Abdelmoghny Metwally Ogila
Lecturer of Engineering Geology, Geology Department,
Faculty of Science, Ain Shams University. .....

Referees

Prof. Dr. Ahmed Mahmoud Saad Mahmoud
Professor of Engineering Geology, Geology Department,
Faculty of Science, Al-Azhar University. .....

Dr. Abdelaziz Fawzy Mahmoud El Shinawi
Associate Professor of Environmental and Engineering Geology, Geology Department, Faculty of Science, Zagazig University. .....

Prof. Dr. Samir Abdeltawab Mohamed
Professor of Engineering Geology, Geology Department,
Faculty of Science, Ain Shams University. .....

Dr. Mohamed Yousef Rizk
Associate Professor of Structural Geology, Geology Department,
Faculty of Science, Ain Shams University. .....

Dr. Karim W. Abdelmalik
.....
Head of Geology Department

NOTE

Name: Ahmed Mostafa Mohamed Abdel Kader

Degree: Master of Science in Geology

Department: Geology

Faculty: Science

University: Ain Shams

Graduated Year: 2009

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ENGINEERING GEOLOGICAL STUDIES OF THE AIN SUKHNA AREA, EASTERN DESERT, EGYPT

ABSTRACT

The present work deals with the study of the engineering geology at Ain Sukhna area along the eastern side of the Northern Galala Plateau that is currently subjected to intense constructions. The study area extends from Wadi Abu Darag in the northwestern side to Wadi Qiseib (Porto Sukhna area) in the southeastern side. The studies comprise the delineation of geomorphological, lithostratigraphical, structural, and geotechnical characteristics as well as the slope stability of the existing rock cut slopes. In addition to constructing the engineering geological map.

The high-land in the study area is the Northern Galala plateau, while the low-land area occupies the coastal plain along the Gulf of Suez. The intermediate area between high- and low-lands is a slope area represented by the eastern scarp of Northern Galala Plateau with several slope angles. The exposed rock units of the study area are dominated by the Upper Paleozoic, Mesozoic and Cenozoic outcrops. The Upper Paleozoic rocks are represented by the Aheimer Formation (sandstone, clay, shale and claystone intercalated by quartzite lenses) and the lower part of Qiseib Formation (sandstone, siltstone and claystone), while the upper part of this formation is possibly of Triassic age. The Mesozoic (Cretaceous) succession can be referred to as Aptian-Albian Malha sandstone, Cenomanian Galala (clay and marl), and Turonian Wata (dolomitic limestone). The Cenozoic succession is composed of the Thebes Formation (limestone with chert) and the Minia limestone of Early Eocene age. The stratigraphic succession are intruded by Oligo-Miocene basaltic dykes. The Quaternary sediments are the most recent deposits and composed of mixtures of sand, silt and clay sediments with gravels. These rock units are affected by three main normal fault sets striking northwest, northeast, and north-south.

The geotechnical parameters of the collected samples from the Paleozoic units (Aheirmer Formation) at the foundation bed were studied in detail. They comprise the determination of some physical and mechanical properties. The initial moisture content is variable ranging between 2.08% and 2.42% for clay and claystone samples, and from 0.2% to 0.9% for the sandstone samples. The average value of specific gravity and bulk density of these samples are 2.45 and 2.14 gm/cm^3, respectively. The Atterberg limits have relatively low liquid limits (average 28.28%), plastic limits (average 19.5%), and shrinkage limits (average 16.85%). Also, the free swell test results show that the samples have low to medium free swelling properties (average 33.11%). The Schmidt hammer (L-type) and point load test (PLT) were used to estimate the uniaxial compressive strength (UCS) for the collected Paleozoic samples. The higher value of UCS is recorded for quartzite samples ranging from 68 Mpa to 90 Mpa. Whereas, the lowest strength value of 12.5 Mpa is recorded for the semi-friable sandstone samples. The measured strength for massive sandstone samples range between 33.3 Mpa and 61.5 Mpa. The measured strength of claystone samples is 20.5 Mpa. In contrast, the highest value of PLT is recorded for quartzite samples which reachs up to 17.63 Mpa where the measured strength values for the massive sandstone samples range between 1.83 Mpa and 7.44 Mpa. Consequently, the massive sandstone layers represent good rock layers for foundation bed. While other rock layers including semi-friable sandstone, shale, clay and claystone bed rocks constitute a poor rock and cannot be used as foundation bedrock without treatment.

The different rock masses of the study area are categorized using Rock Mass Rating (RMR), Geological Strength Index (GSI) and Quality Index (Q-system) based on the numerical ratings. These classifications comprise the study of many parameters such as rock material origin, intact rock strength, rock quality designation (RQD), discontinuity properties, groundwater conditions, and weathering degree.

Assessment and slope stability analysis of the studied rock masses revealed that the planar, wedge, and toppling failures are dominant and controlled mainly by the discontinuities that affect these rock masses. Kinematic analysis of the studied discontinuities with the slope angles and orientations identify slope failures that occur through the steeper parts of each slope profile. The deterministic analysis and calculated factor of safety (FS) show that the most expected rock slope failures are stable in dry conditions and stability is significantly reduced in fully wet conditions (mostly become unstable) where the calculated FS is frequently less than unity in most studied slopes. Therefore, the planar, wedge and toppling failures are mostly rare in dry conditions with potential occurrence, while by increasing the urban development and human activities these failure types lead to predominant geohazard problems along the study slope profiles. Moreover, rockfall modeling is constructed along selected sections to assess the rockfall hazards related to the falling rock blocks and debris. The block trajectories, coverage distance, kinetic energy, and bounce profiles of the blocks are determined and considered as fair value to propose the appropriate method for mitigation measures. Based on the carried out slope stability analyses, the studied roads are classified into three mapped categories; low, moderate, and high risk zone of rockfall and rock failure hazards. The supporting measures are recommended according to the slope stability analyses, site inspection and encountered engineering geological conditions of different rock masses forming cut slopes. The recommended stability measures and slope protection can be used in the form of removal works, rock bolts, retaining and fence structures, shotcrete, wire mesh, and ditch structure.

Keywords: Northern Galala Plateau; Ain Sukhna-Zafarana road; Rock mass classifications; geotechnical parameters; slope stability analyses; factor of safety.

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