وزارة التعليم العالي والبحث العلمي
جامعـة ديـالى
كليـة الهندسـة

سلوك الهطول – الحمل لثلاث أشكال من الأساسات المستندة على ترب جبسية مصنعة

رسالة مقدمـة إلى مجلس كليـة الهندسـة / جامعـة ديالى
وهي جزء من متطلبات نيل درجة الماجستير في علوم الهندسـة المدنيـة
(اختصاص ميكانيك التربة وهندسة الأساسات)

تقدم بها الطالب

حارث رسول مجبل

(بكالوريوس هندسة مدنية / ٢٠١٧)

بإشراف

أ.د. صفاء حسين عبد عون

أ.م. د. مصطفى احمد يوسف

آذار ٢٠٢٣ م.

شعبان ١٤٤٤ هـ.

Ministry of Higher Education and Scientific Research
University of Diyala
College of Engineering

Load-Settlement Behavior of Three Footing Shapes Resting on Densified Gypsified Soil

A Thesis
Submitted to the Council of College of Engineering, University of Diyala in Partial Fulfillment of the Requirements for the Degree of Master of Science in Civil Engineering (Geotechnical Engineering)

BY

Harith Rasul Mejbel
(B.Sc. Civil Engineering, 2017)

Supervised by

Prof.
Dr. Safa Hussain Abid Awn

Asst. Prof.
Dr. Mustafa Ahmed Yousif

March 2023 A.D. IRAQ Sha'aban 1444 A.H.

CHAPTER ONE
INTRODUCTION

CHAPTER ONE
INTRODUCTION

1.1 General

In geotechnical engineering, the term "soil" refers to any naturally formed mineral substance that is not rocky and ranges in size from clay and silt to sand, gravel, and boulders. Soil is distinguished from rock by its absence of a crystalline structure.

The features of these soils are well understood in both the dry and wet states; however, the presence of gypsum causes the soil properties to shift in a manner that is proportional to the amount of gypsum present.

According to **Smith & Robertson, (1962)**, the presence of gypsum materials in the soil at small levels (less than 10%) has no influence on the qualities of the soil, but when present in high amounts, it has a considerable impact on the various soil properties (engineering, chemical, and physical).

There are many regions and countries that are covered by gypseous soil. According to the **FAO (1998),** gypseous soil account for around 1.5% of the total area of the planet and this proportion reflects nearly 186 million hectares. Around a third of the area in Iraq is covered by gypseous soil, and experts estimate that these parts make up about a third of the country's total landmass. These areas are primarily located in the west desert, but they also extend to the south and southwest of the country. **Al Saoudi et. al. (2013).**

It is common practice to construct buildings and other structures on a variety of soils, each of which is unique in terms of the characteristics they present as well as the engineering challenges they present. In some cases, it is necessary to locate these facilities on problematic soils that present challenges.

Gypseous soil is the most common of these problematic soils and also the most hazardous. It may be found across Iraq. These soils frequently lead

to building issues in the foundations that are constructed on them, which ultimately leads to collapse due to excessive collapse when water penetrates the soil. There are a few potential causes of leakage, including precipitation, changes in groundwater levels, inadequate building services broken water pipelines, etc.

1.2 The Statement o□the Problem

In gypsum soils, To be more specific, it is almost impossible to obtain undistributed samples from the field and this fact is very necessary to consider because the use of a disturbed sample indicates that the gypsum soil has lost one of its sources of strength which is the soil structure that supports it and increase the particle size as a result of the bonds that link gypsum to the soil, which leads to a decrease in the accuracy of the results for laboratory tests and the behavior of gypsum soil. For this reason, manufactured soil samples are used in order to obtain results that are close to natural soil. In this study, the method of preparing the manufactured soil and verifying the similarity to be obtained and the method of conducting experiments on it will be addressed.

1.3 The Stud□s Aims and Ob□e□ti□es

there are methods to obtain undistributed samples at an extremely high cost, even if it is significantly higher than the cost of the actual work. Besides that, it is hard to find gypseous soil with similar characteristics with different percentages of gypsum content, The majority of the time, researchers rely on laboratory work, and present laboratory methods for preparing gypsum soil lack accuracy in work, in addition to other difficulties.

As a result, the purpose of this thesis is to investigate gypseous soil that with a limited sample disturbance thoroughly, the aim and objective are fulfilled through:

- Create a novel laboratory method that allows for as much as possible less disturbance for the sample while also addressing and overcoming the deficiencies of the existing approaches by preparing soil samples with four different proportions of gypsum using this new method, and verifying the properties of similarity between the natural and artificial gypsum soil by analyzing the chemical and physical composition as well as the engineering properties of both samples, in order to obtain results closer to reality.

- Investigate the behavior and properties of gypsum soil through conducting laboratory experiments for various values of applied stress in both dry and soaked conditions. Three different footing shapes were used (Strip, Rectangular and Square) to achieve the experiments.

1.□□imitations

The study is limited by some factors and effects:

- The influence of geological age on the properties of gypseous soil was not considered.
- It is specified that the percentages of gypsum with study equal or less than 40%.
- This study does not take into account the impact that the size of the gypsum particles has on the dissolving period, which can either increase or decrease (to overcome this issue, by making the particles small enough, which means that the increase in surface area leads to less time required to lose binder, which means that there is less time period for the structure to collapse).

1.□Thesis Stru□ture

This thesis is structured into five different chapters. The following offers an overview of each chapter, along with a brief explanation of its contents.

Cha□ter One□The introduction, which provides background information on gypsum soil; the purpose of this work; the limitations of this work; and the structuring of the thesis are all components of this section.

Cha□ter T□o: Includes a summary assessment of the relevant literature from earlier studies on general information regarding collapsible soil, including the numerous definitions of these soils, gypseous soil settlement, and collapse, as well as the impacts of leakage and water movement in the soil. in this study.

Cha□ter Three□This chapter contains the experimental work that was conducted, and it describes the process of preparing soil specimens by a novel method. It also includes descriptions of natural and artificial soil physical and chemical laboratory tests, as well as engineering tests, and manufacturing device that were used for this study.

Cha□ter Four□This chapter includes the presentation of test findings and discussions regarding those results, in addition to providing comparisons between natural and artificial gypseous soil.

Cha□ter Fi□e□This chapter presents a summary of the outcomes that were obtained in the search for the subject, as well as future recommendations for researchers pursuing a study on the issue that is the focus of this research.

□oad □Settlement o□ Three Footin□ Sha□es Restin□ on Densi□ied G□□si□ied Soil

By

Harith Rasul □ e□bel

Supervised by:

Pro□. Sa□a Hussain Abid A□n

Asst. Pro□. □ usta□a Ahmed □ousi□

A□STRACT

Gypseous soil is considered problematic due to its tendency to collapse, when water is allowed to flow through them, it experiences a huge rise in their compressibility and an extreme reduction in their strength. These soils present several challenges for construction.

Since the use of a disturbed sample leads to a decrease in the accuracy of the results for laboratory tests Besides that, it is not possible to obtain a sample with low disturb, that lead to the aim of the study which is achieve more precise results for both the settlement and collapse of gypseous soil, as well as other characteristics of gypsum soil. a unique new technique, known as the Elaborating Manufacture Artificial gypseous soil Similar to Natural gypseous soil (E.M.A.N) method, was developed to manufacture artificial samples of gypseous soil. Which it was successfully replicate the properties of natural gypseous soil and even shape of densified system as example specific gravity for both natural and manufactured soil was 2.534 and 2.549 respectively, and pH was 7.2 and 7.1 respectively.it was used standardize error to compare between natural and manufactured gypseous soil it was less than 13%

According (E.M.A.N) method, it was determined that 80 °C was the ideal temperature for drying out the gypseous soil sample instead of using 45°C This indicates that the gypseous soil needs to have its drying

process accelerated in order to be suitable for laboratory testing.

Four different percentages were taken to study (10%, 20%, 30%, 40%) of gypsum content to measure settlement using three different types of footings (strip, rectangular and square). The results show the strip footing has the worst settlement ratio compared to the rectangular and square footing.

According to last stage of increment stress (400 kN/m^2) assigned for soaked condition considering 20% gypsum content, the results revealed that for to the strip footing, the settlement ratio is 14%, for rectangular footing the ratio becomes 13.675%, whereas for square footing the the settlement ratio is 12.85%.

The conventional bearing capacity equations cannot be used for gypsum soil because the value of the angle of internal friction **(ϕ)** varies depending on the rate of reaction and the amount of dissolution of gypsum. As a result, these methods do not work with gypseous soil.

The chart of the stress-settlement curve followed in this study can be used as a design chart by knowing the maximum allowable settlement, it can determine the value of maximum stress (bearing capacity).