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Research Article

Determination of Engineering Properties of Soil in Chitwan District

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Abstract: Soil testing is vital in agriculture, civil engineering, and environmental science to evaluate soil characteristics and engineering behavior. This study summarizes key laboratory tests including natural water content, specific gravity, sieve analysis, and the Proctor compaction test. Natural water content indicates the amount of moisture present in soil under natural conditions and affects soil fertility, stability, and hydrological processes. Specific gravity, defined as the ratio of soil solid density to water density, provides insight into soil composition and compaction characteristics. Sieve analysis determines particle size distribution and helps classify soils using coefficients of uniformity and curvature. The Proctor compaction test establishes the relationship between moisture content and dry density to identify optimum moisture content and maximum dry density, which are essential for construction activities.

Laboratory results from Kshetrapur, Padampur, and Parsa show variations in moisture content (8.33%, 4.76%, and 5%), specific gravity (2.46, 2.44, and 2.53), particle size distribution, and compaction properties, highlighting the importance of soil testing for safe and efficient engineering design.

Keywords: natural water content, specific gravity, sieve analysis, proctor compaction test.

1. Introduction

Geotechnical investigation is a systematic process used to evaluate the physical and engineering properties of soil to determine the suitability and safety of a site for construction. It typically involves drilling boreholes, collecting representative soil samples, and conducting laboratory tests to assess properties such as compaction, drainage, strength, and stability. In this study, a geotechnical investigation was carried out to support the design and construction of buildings at Kshetrapur, Padampur, and Parsa in Chitwan.

Specific gravity, defined as the ratio of the density of soil solids to the density of water, is a key parameter for assessing soil composition, compaction, and stability. It is determined in the laboratory by measuring the mass and volume of soil solids using methods such as the pycnometer, mercury displacement, and gas pycnometer techniques. Accurate determination of specific gravity contributes to better understanding of soil behavior under load.

Natural water content refers to the amount of moisture present in soil under undisturbed conditions and is commonly measured using

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gravimetric or volumetric methods. This property is influenced by climate, vegetation, soil texture, and topography. Knowledge of natural water content is essential for evaluating soil workability, fertility, and hydrological behavior, as well as for predicting settlement and strength characteristics.

Sieve analysis is a fundamental laboratory test used to determine soil particle size distribution. Soil samples are passed through a series of sieves with progressively smaller openings, and the mass retained on each sieve is recorded. The resulting particle size distribution curve is used to classify soils and evaluate gradation characteristics. Recent advancements, such as automated sieving and digital image analysis, have improved the accuracy and efficiency of this test.

The Proctor compaction test is widely used to determine the optimum moisture content and maximum dry density of soils, which are critical parameters for construction projects including roads, embankments, and building foundations. This test helps ensure that soils achieve adequate compaction and long-term performance in the field.

Overall, this review highlights the relationships between soil properties and engineering performance, compares soil characteristics from different locations in Chitwan, and discusses limitations of laboratory testing such as sample variability

4.

The methodology for this study involved several systematic steps. Sampling began with a survey to identify soil collection sites in Chitwan district, specifically at Kshetrapur, Padampur, and Parsa. Soil samples were collected using augers and shovels from depths below 1 meter from the ground surface. Sample preparation involved cleaning the collected soil to remove debris, followed by oven-drying for 24 hours to achieve consistent moisture content. Laboratory testing was then conducted, including natural water content

and testing conditions. It also identifies the need for further research into advanced testing techniques and long-term soil behavior to improve soil characterization and engineering design.

2. Literature Review

Geotechnical investigation is a primary requirement for any construction project, as the long-term performance of structures depends on the soil's ability to bear imposed loads throughout the structure's lifespan (Poudel & Neupane, 2008). Geotechnical engineering encompasses soil investigation, foundation design, and the study of soil behavior under various conditions. Although exact soil behavior cannot be determined with complete accuracy, laboratory and field tests provide reliable predictions based on established practices and experience (Gautam, 2019).

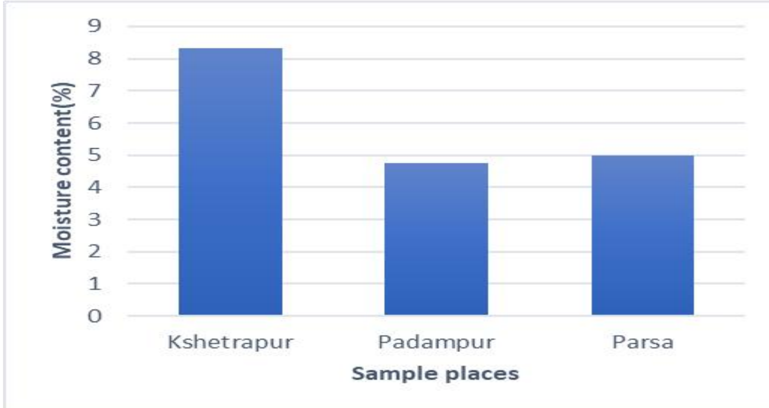
Key soil properties such as bearing capacity, moisture content, maximum dry density, specific gravity, particle size distribution, settlement, consolidation, and Atterberg limits provide essential data for safe and economical design (Rahman et al., 2019). Proper geotechnical investigation not only enhances structural safety but also helps optimize foundation design, leading to potential cost savings by avoiding overly conservative construction practices (Arora,2008).

3. Materials and Methods

determination, specific gravity measurement, sieve analysis, and the Proctor compaction test, to evaluate essential soil properties. For data analysis, results were interpreted using Microsoft Excel, enabling graph plotting and comparison of soil characteristics across the different sites. Ethical considerations were maintained by collecting samples solely from land owned by the researchers, ensuring compliance with proper sampling practices.

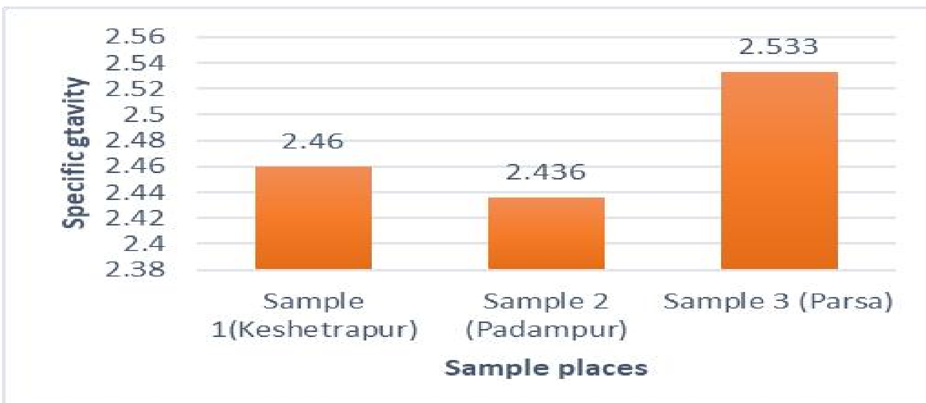
5. Results and Discussion

5.1. Comparison of natural water content of Soils



The above column chart represents the natural water content of the soils. In the column chart we compare the different collected soil sample from (Kshetrapur, Padampur and Parsa) in the laboratory of our college. After completing the test of different sample in lab, we found the sample from Kshetrapur shows the more natural water content than other two samples. But the water content in very sandy soil may vary from 3% to 10% from the driest (wilting point) condition to the wettest drained state (field capacity), and from 20% to 40% in a clay soil. So, all the three samples represent the sandy soils. The sandy soil is excellent for foundations and other engineering works due to their bearing capacity on loads, water management and stability.

4.2 Comparison of specific gravity of soils



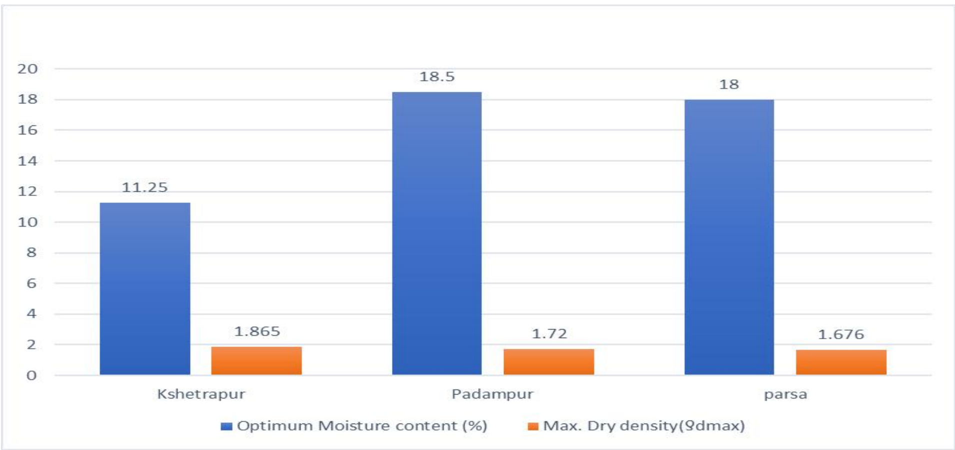
The above column chart represents the specific gravity of the soils of different sample places. In the column chart we compare the different collected soil sample from (Kshetrapur, Padampur and Parsa) in the laboratory of our college. After completing the test of different sample in lab, we found the sample from Parsa shows the more specific gravity than other two samples. So, soil sample from Parsa may contain heavy minerals and denser than others sample. Typically, the specific gravity of soils is in the range 2.60 to about 2.80. The specific gravity of GC (clayey gravel) samples used in geotechnical studies has been found to range from 1.96 to 2.54, with most values between 2.48 and 2.50. Generally, soils with higher specific gravity tend to be denser and have greater strength and stability. They also typically have higher bearing capacities, making them more suitable for supporting structures. On the other hand, soils with lower specific gravity may be more susceptible to settlement and erosion.

4.3 Comparison of sieve analysis data

Sample	D_{10}	D_{30}	D_{60}	Cu	Cc	Remarks
Kshetrapur	0.078	0.15	0.48	6.15	0.601	Poorly Graded Sand
Padampur	0.089	0.42	1.8	20.22	1.101	Well Graded Sand
Parsa	0.077	0.12	0.36	4.67	0.52	Poorly Graded Gravel

The above table represents the gradation of the soils. In the table we compare the different collected soil sample from (Kshetrapur, Padampur and Parsa) in the laboratory of our college. After completing the test of different sample in lab, we found the sample from Kshetrapur and Parsa are Poorly Graded Sand and Gravel respectively whereas the sample from the Padampur found to be Well Graded Sand. Poorly graded sand and gravel has limited range of particle sizes, lacking intermediate-sized particles which results in poor compaction and drainage characteristics so it may lead to issues such as erosion and settlement. Whereas well graded sand is balanced distribution of particle sizes can enhance properties such as compaction, drainage, and stability.so, it is good for construction of road bases, foundations, and drainage systems.

4.4Interpretation of compaction of soil samples



The above column chart represents the optimum moisture content and maximum dry density of the soils of different sample places. In the column chart we compare the different collected soil sample from (Kshetrapur, Padampur and Parsa) in the laboratory of our college. After completing the test of different sample in lab, we found the sample from Kshetrapur shows the less moisture content and more maximum dry density than other two samples. So, the soil sample with less moisture content and higher dry density typically indicates better compaction and stability, which could be desirable for construction purposes such as building foundations or road construction. Whereas soil sample with higher moisture content and lower dry density often indicates poor compaction and lower stability, which may not be ideal for construction projects. This could lead to issues like settlement or instability in structures built on such soil.

6. Conclusion

Based on the laboratory test results, **Kshetrapur's soil is most favorable for construction** due to its optimal engineering properties. It demonstrates higher natural water content, well-graded sand classification, and critically, the **highest**

maximum dry density (MDD) with the lowest optimum moisture content (OMC). This indicates it achieves superior compaction and stability under ideal moisture conditions, enhancing load-bearing capacity and reducing settlement risks. **Padampur's well-graded sand** offers good drainage and compaction potential, but its higher OMC and lower MDD suggest reduced compacted strength. **Parsa's soil**, while having higher specific gravity (suggesting denser mineral composition), is poorly graded gravel with the lowest MDD and highest OMC, making it prone to poor compaction and instability. Thus, for foundations and embankments, Kshetrapur's soil is the most suitable, followed by Padampur, with Parsa requiring significant geotechnical improvement before use in engineering works.

In conclusion, the results of these tests provide critical insights into the engineering properties of the soil, guiding decision-making in construction and civil engineering projects. Ensure that the soil meets the specified criteria to ensure structural integrity, stability, and long-term performance. Regular testing and monitoring are essential to ensure compliance with quality standards and project requirements

7. Conflicts of Interest

We declares that there is no conflict of interest regarding the publication of this paper.

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