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Literature Review on Effects of Saturation on Soil Subgrade Strength

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ABSTRACT- The remainder of the pavement system is supported by the subgrade, the soil layer on top of which the subbase or pavement is constructed. The California Bearing Ratio (CBR) value of a subgrade must be at least 10. This is essential for highway engineers. Numerous studies demonstrate that if a subgrade has If the subbase material has a CBR value < 10, it will deflect under traffic loads in a similar way to the subgrade and harm the pavement. Pavement drainage and stability are provided by the subbase, a layer of aggregate material immediately beneath the pavement. The inferior, that Undrained water can freeze and expand in the layers supporting the pavement, placing intense internal strain on the pavement structure. Additionally, running water can transport debris from the subbase or subgrade and, in conjunction with traffic, pump it out of the drains. Highway engineers must consequently provide a solid, permeable subbase with longitudinal sub-drains. The effects of saturation on the stability of the soil subgrade are reviewed in this essay.

KEYWORDS- sub grade, CBR test, highway planning, and Pavement design.

I. INTRODUCTION

The subgrade and subbase quality affects the performance of pavements. A long-lasting pavement is facilitated by a stable subgrade and a subbase that drains effectively. For the pavement system to function well, a subgrade and subbase must have a high degree of spatial homogeneity in terms of important engineering factors including shear strength, stiffness, volumetric stability, and permeability. These geotechnical qualities are impacted both immediately and over time by a multitude of environmental factors, including temperature and moisture. The subgrade and subbase serve as the framework for the top pavement layers and are essential for mitigating the negative effects of the environment as well as the static and dynamic pressures brought on by traffic. The design and construction of homogeneous and stable subgrades and subbases have been the subject of much research on stabilization/treatment procedures, including the use of recycled materials, geotextiles, and polymer grids.

The water table can suddenly rise or fall, capillary action, flooding, or precipitation can all cause changes in the saturation level of the subgrade. Subgrade strength changes as a result of changes in moisture content. Additionally, it becomes crucial for an engineer to comprehend the precise nature of the subgrade strength's dependence on moisture fluctuation. A greater understanding of the relationship between local soil water content and CBR strength would result in better design and maintenance procedures. CBR testing is often a quick and widely used technique used to assess the subgrade's strength using soil samples. The subgrade strength is, however, also evaluated using a variety of different methods. The level of saturation, or the amount of water exposed to the soil, can have a significant impact on the strength of subgrade soil. In order to examine the engineering features of soils, including CBR at varying saturation levels, it has been attempted to modify the degree of soaking and, consequently, the saturation level in various types of soils.

However, the interaction between stabilization/treatment procedures and geotechnical characteristics is complicated. Due to this, there is a discrepancy between current design and construction methods for subgrades and subbases and the geotechnical qualities of subgrades and subbases as determined by research findings. This manual's goal is to compile findings from both past and present research conducted in Iowa and other states.

II. LITERATURE REVIEW

However, Alayaki and Bajomo (2011) evaluated the interaction of geotechnical parameters and moisture change on the strength properties of laterite soil in Abeokuta, Ogun State, Nigeria. The results demonstrated that the CBR of the soil decreased with an increase in the soaking time of the compacted soil sample from 1 to 5 days. He noticed that the CBR value of the soaking soil is higher on its top face than it is on its bottom face [3].

Jaleel (2011) investigated how soaking affected a sub-base material's top and bottom CBR values. At modified AASHTO compaction of 95% relative, he created 14 CBR samples. The findings demonstrated that the soaking caused a sizable decrease in the CBR for top and bottom. For the top and bottom CBRs, respectively, the majority of the drop in soaking CBR value was noticeable in the first days. He came to the conclusion that the load applied to the subbase layer reduces with increasing soaking time [4] based on the findings of tests on the impact of soaking period on top and bottom subbase for highway purposes.

Ampadu (2006) investigated the impact of water content on the CBR of a subgrade soil. Soil samples from a study site were created by laboratory compaction at various levels of water content to produce samples at various densities. The CBR value was then calculated after the remoulded samples underwent varying degrees of wetting in a water tank and drying in the laboratory. The rate of change in CBR per percentage change in water content during drying from the OMC was 3 to 7 times bigger than during wetting from the OMC [5], according to the laboratory CBR test findings on a subgrade material at varied water contents for three distinct dry densities.

For calculating soaking and unsoaking California Bearing Ratio (CBR) values for fine-grained subgrade soils, Singh et al. (2011) developed regression-based models. Five soils that were readily available locally were gathered from various West Bengali regions. The samples were compacted at four distinct levels (50, 56, 65, and 75 blows) and five different levels (2% OMC, 1% OMC, and OMC) of moisture content on the dry and wet sides of an OMC of a soil. The degree of soil compaction, moisture content, and many independent characteristics were taken into consideration when developing regression models. One finding was that the CBR valueThus, changes in moisture content and compaction effort had a considerable impact on both soaking and unsoaking [2].

The link between index characteristics and CBR testing of soils in Pekanbaru, Indonesia, both with and without soaking, was examined by Ningsih et al. in 2012. This study seeks to compare CBR soaking test results for CBR un-soaking in varying clay contents and to make straightforward comparisons between CBR soaking for CBR unsoaking by taking the characteristics of the soil into account. The findings demonstrated a linear relationship between CBR soaking and CBR unsoaking, which was also influenced by the type of the index (soil qualities) [11].

Rahman (2010) investigated the relationship between CBR findings and soil physical characteristics. Based on the gathered soil data and outcomes from laboratory 7 works, correlation had been proposed in the study to forecast the CBR values at top face of the soil sample for Malaysia's type of soil. These correlations were created using the Maximum Dry Density (MDD), the Optimal Moisture Content (OMC), and the number of blows (in the CBR test) [12]. CBR value and Undrained Shear Strength from Vane Shear Test were connected by Hussain (2008). To get the information needed to establish the correlation, several soil samples with various Plasticity Indexes and moisture contents were compacted and evaluated using the CBR test and Vane Shear test. He discovered that as the plastic index rises, the CBR value and undrained shear strength do as well. Inverse relationships exist between moisture content and the CBR value and Undrained shear strength of soil samples tested using the Vane shear method [7].

Cokca et al. (2003) investigated how the moisture content of the compaction affected the shear strength of an unsaturated clay. In this work, the effects of soaking and compaction moisture content on the clay's unsaturated shear strength characteristics were examined. The samples used in the experiments were compacted at the ideal moisture content, on the dry side of the ideal, and on the wet side of the ideal. He discovered that the cohesiveness component of shear strength reaches its maximal value around the ideal moisture content, and angle of friction rapidly declines with increasing moisture contents. Moisture content first rises, then falls. [8]

The impact of submergence on subgrade strength was researched by Yasin et al. His research sought to ascertain the effects of submergence depth and time on the subgrade strength of soil samples taken from the Dhaka-Aricha highway. After a brief period of typical soaking as well as after prolonged soaking, CBR experiments were conducted at various depths of submergence. There was no effect of submergence on the sub-grade CBR strength for any of the three types of soils evaluated for the examined depth and period of submergence [10].

A gypsiferous subgrade soil's strength and deformation characteristics were evaluated by Razouki et al. in 2003. California Bearing Ratio (CBR), resilient modulus, and deformation of compacted Iraqi gypsiferous soil containing around 34% gypsum were examined during long-term soaking. In order to prepare the 16 (CBR) samples, the modified AASHTO compaction test was compacted at 95% of the maximum dry density and at the ideal moisture content. The study shows that soaking gypsiferous soils for four days can produce findings that are dangerous and misleading in terms of strength, stiffness, and deformation.

III. EFFECT OF MOISTURE VARIATIONS

- Kim (2011) investigated how the amount of water in weathered granite soil affected its shear strength. By using a direct shear test, this study examines the impacts of initial water content and disturbance on the strength reduction for both disturbed and undisturbed samples of aged granite soil in Korea. On undisturbed or disturbed samples with varied water contents under normal stress ranging from 30 KPa to 140 KPa, several series of direct hear tests were conducted. He discovered that when the degree of saturation increases, the cohesiveness and friction angle of weathered granite soils linearly decrease [14].
- In connection to the tensile strength, Blazejczak et al. (1995) examined the impact of soil water conditions and compaction on the age hardening process of loamy sand and silty loamy sand. At water concentrations of 10%, 15%, and 20%, soil samples were compressed to a density of 1.35, 1.45, and 1.53 g/cm3. The indirect tension test was used to assess the tensile strengths of the damp samples at various points after moulding. At same bulk density, soil's tensile strength was negatively impacted by high water content. However, with same water content, high bulk density improved tensile strength [15].

Desirable properties of a subgrade soil

The desirable properties of sub grade soil are:

- Stability
- Incompressibility
- Good drainage
- Ease of compaction
- Permanency of strength
- Minimum changes in volume and stability under adverse conditions of weather and ground water

A. Soil Types

The enormous variety of soil types that are accessible as building materials has made it necessary for the highway engineer to recognized categories various soils. India has a wide variety of soil types, gravel, moorum, and naturally

existing soft aggregates that can be utilised in road construction, according to an assessment of locally accessible materials and soil types.
Broadly, the soil types can be categorized as:

- Laterite soil,
- Alluvial soil
- Moorum / red soil,
- Desert sands,
- Clay including Black cotton soil.

IV. CONCLUSION

The strength of the subgrade soil over which the various pavement layers are to be built is a key factor that the author has examined in this article. CBR is the most common unit of expression for subgrade strength (California Bearing Ratio). Stronger sub grade works better with thinner pavement layers, whilst weaker sub grade basically calls for thicker layers. The water table can suddenly rise or fall, capillary action, flooding, or precipitation can all cause changes in the saturation level of the subgrade. Subgrade strength changes as a result of changes in moisture content. The precise nature of the reliance of subgrade strength on moisture fluctuation becomes crucial for an engineer. A greater understanding of the relationship between local soil water content and CBR strength would result in better design and maintenance procedures.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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