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A Review of Flexible Pavement Using CBR Method

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Abstract- To insure the safety of people in public as well as domestic places, surveillance cameras are being installed everywhere such as in banks, malls, markets, academic institutions, parking and most importantly on the roads where the traffic, both pedestrians as well as on wheels, is present 24x7. Different situations are captured by surveillance cameras installed at different places, like accidents on the roads are handled by cameras installed on the roads or traffic lights and crimes are handled by cameras installed in the household or streets or colonies and especially illegal activities happening in hotels or public places. The Particle Filters are suitable for object tracking in non-Gaussian environments with dynamic background thereby outperforming the conventional Kalman Filters; the third approach proposes the novel Branching Particle Filters that removes the limitations of particle filters.

Keywords- Pavement,CBR,Aggregates

I. INTRODUCTION

Roads are critical for moving people and products and for the growth of the country's economy. The flexible pavement covers the majority of the country's highways. Flexible pavement is made up of sub-grade, sub-base, base course, and surface layer layers. The layer at the bottom is known as sub-grade. The most significant component in the design and functioning of a flexible pavement is the strength of the sub-grade material.

Finally, the weight transferred from the pavement surface to the sub-grade and sub-base. The sub-grade is designed such that the stress transferred does not exceed the limit of elasticity. As a result, before constructing a pavement, the appropriateness and stability of the sub-grade material are evaluated. The soaked California bearing ratio (CBR) value (%) is utilised as a strength metric in sub-grade design.

The CBR value is the main thickness that determines the thickness of the sub-grade. If the CBR value is higher, the sub-grade is designed to be thinner, and vice versa. The soaked CBR test takes a lot of time and a lot of soil samples. The soil is reshaped until it reaches its maximum dry density (MDD).

So, it's hard to finish the whole stretch of road in a short amount of time, which slows down the project and makes it more expensive. To solve this problem, you need a method that is easy and takes less time, like correlating the soaked CBR value with easy-to-find soil parameters.

Many highway projects require contractors to obtain aggregates from distant locations in order to meet the quality and quantity requirements for creating pavements. It is critical to hunt for materials in order to save natural materials and meet the growing demand for construction. In other circumstances, inferior materials may be utilized, but the layer may be made thicker so that the required axle load passes through before the rut depth and fatigue cracking.

The quantity of crushed aggregates for the granular base and sub base layers alone ranges from 75% to 88%, corresponding to 150 million standard axles (MSA) to 2 MSA of traffic, according to the Indian Road Congress guidelines on design of flexible pavement structure covering sub grade. It is critical to utilize fewer aggregates when constructing a flexible pavement base/sub base layer, especially for low-traffic pavements. Large-scale model experimental (LSME) studies are utilized to compare the performance of reinforced and unreinforced pavements. LSME is intended to model a pavement structure (or parts of it) at prototype scale as nearly as feasible to field circumstances.

II. LITERATURE REVIEW

Rakaraddi, P. G., &Gomarsi, V. (2015)The CBR value of the sub-grade is used as a strength metric since it is thought to be the best layer in flexible pavements for withstanding wheel load. The CBR test is not only time-consuming and expensive, but it also presents significant challenges when trying to achieve an in-situ density while molding the sample in the lab. Moreover, if the available soil is of low quality, suitable additives are combined with it, and the resulting strength of the soil is evaluated using a time-consuming metric called the CBR value.

In this investigation, we employ alternative techniques, such as regression-based models (both basic and multivariate). Soil from several locations in the Bagalkot district is analyzed to establish parameters for predicting the soaked CBR value, including the liquid limit, plastic limit, plasticity index, optimal moisture level, maximum dry density, and % fineness of the soil (passing a 75-micron sieve).

Gill, S., & Maharaj, D. K. (2015) Different approaches to creating design charts have been discussed. The Group Index Method measures the combined thickness of the pavement's surface, base, and sub base. The depth of the sub-base is measured as well. When it comes to flexible pavement design, the CBR method is by far the most used. Given that it takes the material's strength parameter into account, the CBR approach is more reasonable than the Group Index Method. The North Dakota Approach is comparable to the CBR strategy. Design curve between pavement thickness and cone bearing ratio is used to determine pavement thickness.

Burmister's Design Method is predicated on the idea of a two-layer system, with the top layer (which includes the road surface, base course, and sub-base) having a thickness of h and the bottom layer (the sub-grade) having an unlimited depth. Burmister suggests a pavement thickness of 5 mm deflection for this technique. Additionally, Burmister's two-layer hypothesis is the foundation for the U.S. Navy's plate bearing testing procedure. Base course and sub-grade modulus of elasticity are used in this technique.

Khatti, E. J., Jangid, E. A. K. et al, (2018) Flexible pavements are designed using the sub grade's California bearing ratio (CBR) value per IRC recommendation. The choice of pavement material could have an effect on the final design. Black cotton soil is an expansive soil; its expansion upon contact with water is a primary contributor to the collapse of black cotton soil layers. Material such as fiber, ash, lime, sludge, etc. can take advantage of the black cotton soil's engineering potential. The maximum dry density, optimum moisture content, shrinkage, swelling pressure, degree of expansiveness, and permeability, as well as the liquid limit (Wl) and plastic limit (Wp) of the soil or mix specimen, all influence the CBR value.

The University Teaching Department of Rajasthan Technical University in Kota is where these analyses are conducted. This study examines the feasibility of creating a flexible pavement out of a mixture of black cotton soil and Kota stone slurry in varying concentrations. Kota stone slurry concentrations ranging from 5% to 30% are used in conjunction with black cotton soil in this study. Tests are often used to establish engineering parameters.

Goud, G. N., Ramu, B. et al, (2022) One way to measure the worth of pavement reinforcement is through the Layer Coefficient Ratio (LCR). LCRs for unreinforced and geogrid-reinforced base layers on soft to stiff sub grades were determined by a series of Large-Scale Model Experiments (LSMEs) in this study. The LCR values for the reinforced foundation layers ranged from 1.01 to 1.33 as determined by careful LSME testing. As with conventional flexible pavements, geogrid-reinforced versions are developed with the use of LCR-based theory.

Saha, D. C., & Mandal, J. N. (2017) It is common practice to propose grade-separated structures such as flyovers, vehicular underpasses (VUPs), pedestrian underpasses (PUPs), and cattle underpasses (CUPs) at regular intervals when expanding the carrying capacity of an existing National Highway (NH) Project. As a result, the approaches to these constructions necessitate that the present road levels be increased, rendering the current pavement materials obsolete. Milling the pavement surface prior to placing an overlay for reinforcement is another way to get existing pavement materials. The purpose of this research is to evaluate the viability of Reclaimed Asphalt Pavement (RAP) as a subbase/base course material for flexible pavement. From a review of the relevant literature, it was determined that 100% recycled asphalt pavement (RAP) does not meet Indian Standards for use as a flexible pavement base with a California bearing ratio (CBR) of 3.5 or above (IRC). Accordingly, crushed stone aggregates, cement stabilization, and a mixture of the two were all tried to increase the CBR of RAP. CBR experiments were performed in the lab on recycled asphalt pavement (RAP).

Goud, G. N., &Umashankar, B. (2017) If they want to build roadway pavements to the appropriate quality and quantity, contractors often have to source aggregates from great distances. To both reduce waste and keep up with rising construction demands, it is necessary to find sustainable alternatives to the materials that are currently in high demand. If the layer is thick enough, it will be able to withstand the necessary axle load passes without reaching terminal rut depth and fatigue cracking, allowing for the use of lower quality materials.

According to the Indian Road Congress guidebook [16] on design of flexible pavement structure covering sub grade, the percentage of crushed aggregates for granular base and sub base layers alone varies from 75% to 88%, equal to 150 million standard axles (MSA) to 2 MSA of traffic, respectively. It is essential to utilize as little aggregates as possible when constructing a flexible pavement base/sub base layer and this is especially true for low-volume pavements.

Choudhary, D. K., & Joshi, Y. P. (2014) Design of flexible pavements is guided by the sub grade California Bearing Ratio (CBR) value, per IRC guidance. For the design of airfield runways and flexible pavements, the California Bearing Ratio (CBR) value is a crucial soil characteristic. Soil sub-reaction can be calculated with this method as well. When it comes to planning the foundation of highways, this engineering property of soil is crucial. Furthermore, the value is affected by whether the soil is wet or dry. This sort of testing can be simply carried out in a lab. If the CBR could be estimated using these tests, which take much less time and money to conduct, then it would be simple to gather data on the road network's sub grade strength. Because of this, many scholars in the past have studied the topic and built several kinds of pavements by determining the CBR value through the results of easy, cheap, and quick testing.

III. RESEARCH METHODOLOGY

1. California bearing ratio (CBR):

The California bearing ratio (CBR) is an empirical test used to design flexible pavement all over the world. The California Highway Department devised this method of operation in 1928 and 1929. During WWII, CBR test data were initially used to design roadways in the United States. They were then adopted as a standard design method in other regions of the world. However, because of how imperialistic this method is, some industrialised countries are now discouraging its usage (Brown, 1996). The California bearing ratio (CBR) test is frequently used to analyse granular materials in the base, subbase, and subgrade layers of road and airport pavements. The California State Highway Department was the first to incorporate the CBR test. It was then used by the Army Corps of Engineers to design flexible pavements. It has become so widespread around the world that it is included in several international standards, such as ASTM 2000.

The CBR test is significant for two reasons: almost all pavement design charts use unbound material CBR values when they are compacted in pavement layers, and the CBR value has been linked to some of the most important soil properties, such as plasticity indices, grain-size distribution, bearing capacity, modulus of subgrade reaction, modulus of resilience, shear strength, density, and moulding moistness. Doshi and Guirguis met in 1983. The CBR test is still widely used since these correlations are many and engineers who work with them on a daily basis have wide expertise with them.

IV. PAVEMENT ANALYSIS AND DESIGN

During 1920s, pavement sections were designed based on the sub grade shear strength. In 1929, California Highway Department proposed CBR (California Bearing Ratio) test that was related to the shear strength of the sub grade soil. Empirical pavement design methods based on CBR of sub grade were developed to provide the thickness of the pavement layer that can be safely supported by the sub grade with anticipated design traffic load throughout the life of the pavement. During 1950s, CBR method was the most popular and widely used method for the design of flexible pavements and later it was suggested with modifications by USACE (US Army Corps of Engineers), HRB (Highway Research Board), Asphalt Institute as well as several other agencies throughout the world.

In due course, with increased traffic loads and experience gained, performance parameters, such as, riding quality and distress analysis were given due consideration in pavement analysis and design to check the deterioration rate of pavement. On these lines of thoughts, AASHTO (during 1960s) proposed empirical design guidelines based on serviceability index, and, later, published Interim Guide for the design of pavement structures.

With extensive research, experimentation and consideration of new factors and variables affecting the design of pavements, AASHTO, 1993 expanded the existing guidelines that take into consideration the reliability aspect, resilient modulus of soil support & flexible pavement layer coefficients, drainage, environment consideration, tied concrete shoulders or widened lane, sub-base erosion, life cycle cost consideration, rehabilitation etc. AASHTO (1993) is now one of the most widely accepted empirical design procedure for pavements.

V. CONCLUSION

The national and regional road networks in Greece are primarily made up of flexible pavements. Rigid pavements are rarely utilized. They are only used on pavements and at a few toll points along the national highway system. According to the World Road Association, just 200 kilometers of rigid pavements have been discovered on Greece's national road network.

Greece's present rules and recommendations for roadwork design do not specify how to select the best or most recommended design method, nor do they specify how much the pavement should cost as a result. The study reported in this paper sought to determine how different approaches to developing flexible pavements affect the cost of construction. The purpose of this paper is to give recommendations for cost-effective approaches to design flexible roadworks.

This will help to address a void in Greece's pavement regulatory and standardization framework.

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