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A REVIEW STUDY ON FLEXIBLE PAVEMENT USING CBR METHOD AND THEIR IMPORTANCE

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Abstract- ***In the recent year researcher are more focusing and working on flexible pavement by using CBR (California Bearing Ratio) Methods. Flexible pavements are constructed of several thicknesses of asphalt or bituminous concrete layers overlying a base of granular material on a prepared subgrade. Periodic evaluation of low-volume urban roads is expected in a developing country like India to prioritise the order of maintenance and reconstruction of the road network. The construction of highways and pavements is crucial in DPR projects. Pavement design is an essential component of the comprehensive engineering analysis. The majority of Indian roads are currently flexible pavements with bituminous layers. Due to a lack of cement in the past, India opted for lightweight pavements with bituminous toppings. The California Bearing Ratio (CBR) test is a penetration test used to evaluate the subgrade strength of roads and pavements. This is the most commonly used approach for flexible pavement design. The CBR value determines the thickness of the various elements that make up a pavement. The present paper is focusing on review study of flexible pavement using CBR methods. It has been observed by the author that CBR is play very important role to design the flexible pavement and also CBR values for the design purpose of flexible pavement as per guidelines of IRC: SP: 37-2001 is taken by many researchers. Author also find that this penetration test that is CBR has been applied on the different structure design. which have diverse properties. The details literature review has been provided by the authors in the present paper.***

Keywords - Flexible pavement, California Bearing Ratio, CBR value, IRC: SP: 37-2001

I. INTRODUCTION

Pavement is a long-lasting surface material that is laid down on a road or walkway to support vehicular or pedestrian traffic. Cobblestones and granite sets were common in the past, but asphalt and concrete have largely replaced these surfaces.[1]. The pavement system should be able to provide an acceptable riding surface with sufficient skid resistance, good light reflecting properties, and low noise pollution. The ultimate goal is to ensure that the transmitted stresses caused by wheel load are minimised to the point that they do not surpass the subgrade's bearing power. Pavements are divided into two categories:

(i) Flexible pavement
(ii) Rigid pavement

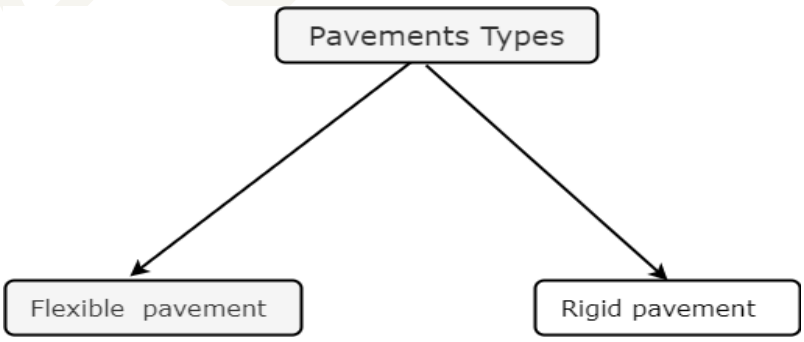

Fig1. Types of Pavements

Flexible pavements are those, which on the whole have low flexural strength and are rather flexible in their structural action under the loads. The flexible pavement layers reflect the deformation of the lower layers on to the surface of the layer.[1]. A typical Flexible pavement consists of four components:

I. Surface course
II. Base course
III. Sub base course
IV. Soil sub grade

Flexible pavement design by CBR method is used to determine the total thickness of pavement. Generally there are two methods to design the pavement from CBR (California bearing ratio) value. They are 1. CBR method recommended by California state of highways 2. CBR method recommended by IRC [2]. The California bearing ratio (CBR) is an empirical measure that is commonly used in flexible pavement design around the world. The CBR is a penetration test used for determining the subgrade strength value of pavements and roads. These results of tests are used with help of curves to determine the pavement thickness and various subgrade layers.[3] The majority of India's highway system is made up of flexible pavement, which can be built in a variety of ways.

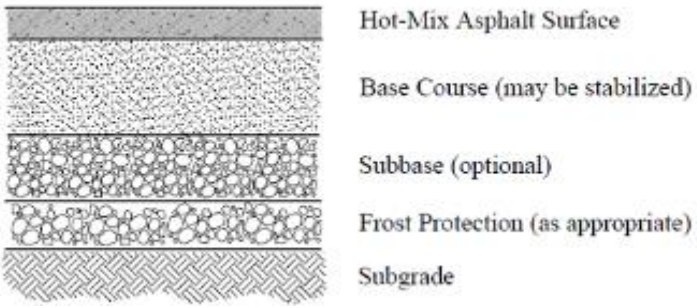

Fig.2 Structure of pavement design [4]

The California Bearing Ratio (CBR) test is a flexible pavement design empirical procedure. [5]. It's a load test that's applied to the surface and used in soil investigations to help with pavement design.The design for new construction should be based on the strength of the samples prepared at optimum moisture content (OMC) corresponding to the Proctor Compaction and soaked in water for a period of four days before testing. In case of existing road requiring strengthening, the soil should be moulded at the field moisture content and soaked for four days before testing. [5].

TYPICAL LAYERS OF A FLEXIBLE PAVEMENT Typical layers of a conventional flexible pavement includes seal coat, surface course, tack coat, binder course, prime coat, base course, sub-base course, compacted sub-grade, and natural sub-grade

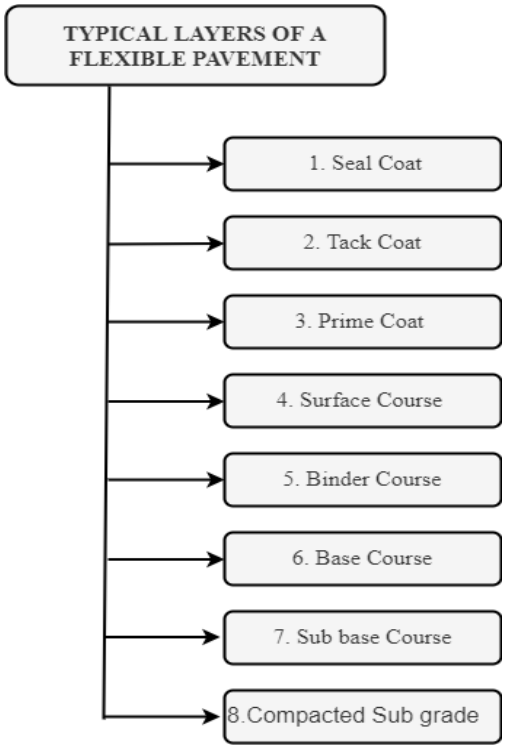

Fig 3. Typical Layers of a Flexible Pavement

1. Seal Coat 2. Tack Coat 3. Prime Coat 4. Surface Course 5. Binder Course 6. Base Course 7. Sub base Course

8. Compacted Sub grade

THE CALIFORNIA SATE OF HIGHWAYS RECOMMENDS THE CBR METHOD:

As per the recomandation the date required by the flexible pavement design is sated as follow a. CBR value of soil subgrade b. CBR value of sub base course c. CBR value of base course d. Wheel load in KG or KN Wheel load is classified into three groups based on traffic conditions.[2]

- Light traffic(3175 KG)
- Medium traffic(4082 KG)
- Heavy traffic (5443 KG)

Flexible Pavement Design Procedure

Calculation of total thickness (T): From the below chart for given CBR value of soil subgrade and Wheel load value select appropriate thick curve value of "combined thickness of surface, base and sub-base line" which will give the total thickness of pavement.[2]

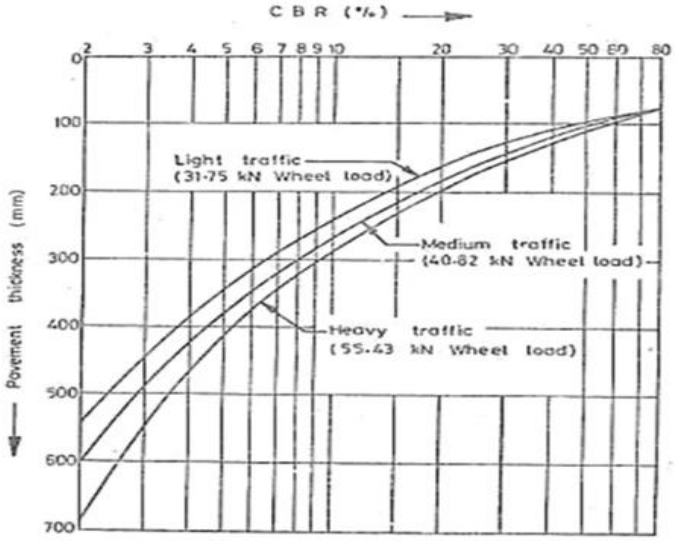

Fig 4. Flexible Pavement Design Procedure [2]

Calculation of sub base course thickness (t_{sb}): By using the above chart, for give CBR value of sub base course material and for wheel load read the thickness of pavement which is above the soil sub base. It is denoted as (Tsb). Which is highlighted by circle in the below fig. but here we have to find t_{sb}. Therefore, thickness of sub base course $t_{sb} = T - Tsb$ [2]

Calculation of base course thickness (t_b): Similar to the above procedure, from the CBR value of base course and wheel load read the value of thickness of pavement which is above the base course (t_s). From this we can find out the value of t_b. $t_b = T_{sb} - t_s$ Therefore all the values of pavement are known and cross section of pavement is as[2]

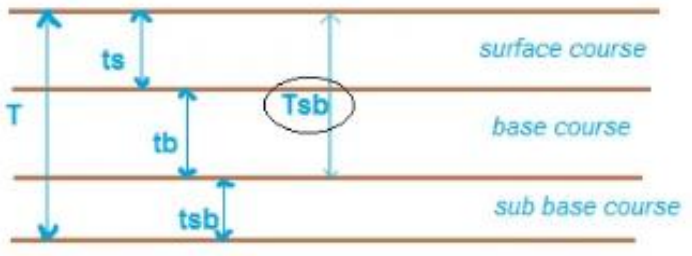

Fig.5 Calculation of base course thickness [2]

CBR method recommended by IRC (Indian road congress):

In this method, the chart contains several curves (A, B, C, D, E, F, and G) which represents the different levels of traffic intensities. Based on this we will find out the layer's thicknesses.

Data required for design:

A. CBR value of soil subgrade
B. CBR value of sub base course
C. CBR value of base course
D. Traffic intensity

1) Flexible Pavement Design Procedure:

Calculation of total thickness (T): In this step, firstly for the given value of traffic intensity select appropriate curve from classification table which is shown in the below chart. Now, from the given CBR value of subgrade soil read the total thickness (T) with respect to selected curve.[2]

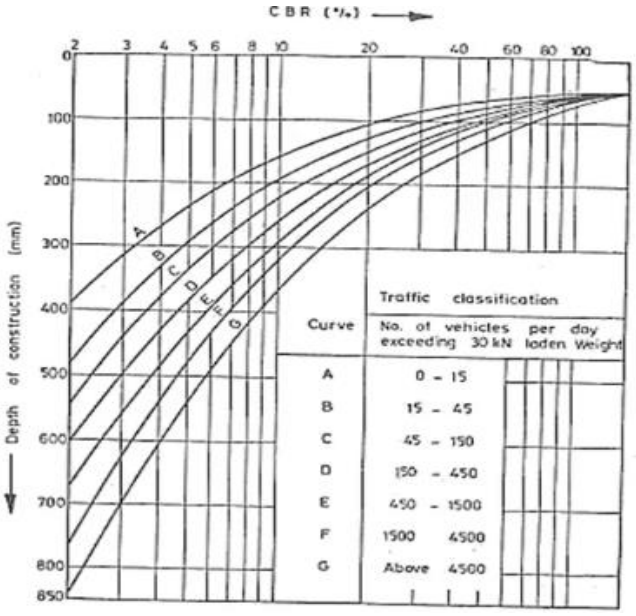

Fig .6 Calculation of total thickness (T) [2]

Calculation of sub base course thickness (t_{sb}): By using the above chart, for give CBR value of sub base course material and for traffic intensity value read the thickness of pavement which is above the soil sub base. It is denoted as (Tsb). Which is highlighted by circle in the below fig. but here we have to find t_{sb}. Therefore, thickness of sub base course t_{sb} **=T – Tsb** [2]

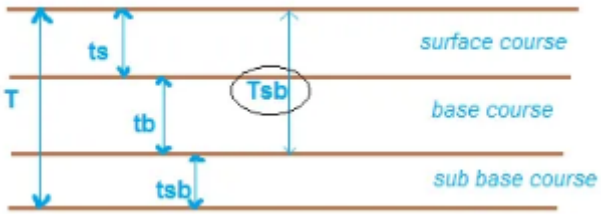

Fig .7 **Calculation of sub base course thickness (t_{sb})** [2]

Calculation of base course thickness (t_b): Repeat the above procedure again, from the CBR value of base course and from traffic intensity value read the value of thickness of pavement which is above the base course (t_s). From this we can find out the value of t_b. $\mathbf{t_b = T_{sb} - t_s}$ Therefore all the values of pavement are known and cross section of pavement is as follows. [2]

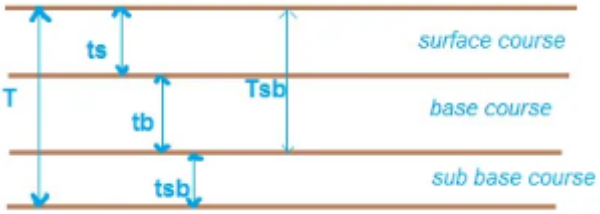

Fig .8 Calculation of base course thickness (t_b)[2]

LITERATURE REVIEW

Patel, M A ,Patel, H S(2012) suggest that Using the linear regression method, empirical correlations between test results have been developed. Other collections of test data are used to verify the formulations. Using a simple and quick DCP test, the established empirical correlations could be used to estimate time-consuming strength parameters as well as physical properties at multiple locations within the study region. [6]

Ramasubbarao, G V &Siva Sankar, G (2013) observed that In terms of gran size measurement, LL, PL, MDD, and OMC, the current study aims to establish regression-based models for predicting soaked CBR value for fine-grained subgrade soils.. [7]

Salahudeen, A B ,Eberemu, A O,Osinubi, K J (2014) Results obtained show that the index properties of the soil improved with CKD treatment. Peak unconfined compressive strength of 357.07 kN/m2 and California bearing ratio (CBR) of 7 % as well as resistance to loss in strength of 44 % were recorded at 10 % CKD treatment. [8]

Jiang, R,Zhu, B,Tian, M,Cao, Y (2015) suggest that the old cement pavement damage status directly affect the design of the paving renovation. Based on the state of the old road investigation, combined with the research data at home and abroad, use the control index that average deflection, deflection value and CBR value to determine the reasonable time to overlay. [9]

Janjua, Z S,Chand, J (2016) The California bearing ratio (CBR) test is used to assess the stiffness modulus and shear strength of subgrade, which is used in the construction of flexible pavement for airport runways, village roads, and highways, among other applications. The subgrade serves as a base for the pavement material and should be compacted thoroughly to fully utilise its strength. The CBR value of the soil is related to the subgrade intensity. The static penetration test protocol is used to conduct the CBR test according to IS: 2720. [10]

Sahu, Pranshul (2017) suggest that Flexible pavements consists of following layers :- a)Asphalt layer b)Base layer C)Sub Base layer d)Subgrade layer. For estimating the design traffic, the following information is needed: 1. Initial traffic after construction (CVPD) 2. Traffic growth rate during design life Flexible pavements will transmit wheel load stresses to the lower layers by grain to grain transfer through the points of contact in the granular structure. The following common factors influencing the performance of pavement are :-a)Traffic b)moisture c)Subgrade d)construction quality e)maintenance.[4]

Nutrition, Naturopathic (2018) suggest that several investigators have previously conducted research in this field and constructed various pavements based on the results of low-cost, low-time-consuming, and simple-to-perform studies. The aim of this study was to find the CBR values of different soil samples and compare them for the purpose of designing versatile pavements according to IRC: SP: 37-2001 guidelines.[11]

Raghava Rao, E V,Satyanarayana Reddy, C N V(2020) observed that In comparison to non linear regression analysis, the study found that multiple variable linear regression equations with the highest degree generated better equations. The research also discovered that as the degree of correlation equation increased, the accuracy of the CBR value increased**.** [10]

Mora L., Otto ,Murillo A., Michel,Rosania A., Tiana,Castañeda A., Abraham,Pinto C., Rosa,Padilla M., Andrea (2020) suggest that the Design Percentiles of the CBR design unit were expanded for the Asphalt Institute method, thus, allowing the approach of more reliable and safe designs, considering that this method limits the selection percentiles to three traffic levels. [12]

Kamala Raju, Y,Vivek Kumar, C (2020) In this present study, the flexible pavement thickness is designed for both sub grade soils as per IRC:37-2001 code and its pavement thickness is calculated by California Bearing Ratio (CBR)method.

CONCLUSION

A CBR test is used to determine the California Bearing Ratio (CBR) of a material that will be used as the subgrade for flexible pavements. However, Resilient Modulus is the actual quantity that concerns the subgrade material's resilience. CBR is distinct from it, but it is heavily correlated. There are also curves plotted for the CBR against projected traffic (million axles per year) for each subgrade thickness in the literature. The author collects the data from the different sources and it has been concluded CBR method is one the best technique which use to design and test the flexible pavement. The critical operation of performing the California bearing ratio test is the same of variations of different soil conditions and construction types. The pavement is designed as a flexible pavement upon a black cotton soil sub grade, the CBR method as per IRC 37-2001 is most appropriate method than available methods

FUTURE SCOPE

In the future study we will present the experimental study of CBR method for flexible pavement. Other relevant factor will be consider to test the pavement.

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