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To Check the Effectiveness of Cement Treated Base and Subbase of Flexible Pavement - A Case Study of Nandura Motala Road (Sh-272)

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ABSTRACT: The purpose of this research is to investigate the causes for the failure of flexible pavements, the materials utilised in conventional pavement construction, and the challenges related with these materials. For the cement treated sub-base and conventional material, the construction cost, amount of material, material transportation costs, machine need, and equipment fuel cost are studied and compared. This research demonstrates the advantages of using cement-treated base and sub-base to replace traditional base materials like GSB & WMM.

This project details the feasibility and issues that can arise while using the conventional method and the CTB/CTSB method in flexible pavement. It proceeds with failures which have occurred and remedies for all of those failures, following a brief analysis of different layers in terms of budget and quantity feasibility. The project's goal is to discover a related approach that could be used to profit and effectively replace the conventional flexible pavement method. To evaluate the layer's effectiveness in terms of environmental factors and cost of the project

KEYWORDS: CTB - Cement Treated Base, CTSB - Cement Treated Sub Base, GSB - Granular Sub Base, WMM - Wet Mix Macadam.

I. INTRODUCTION

Countries all around the world are fast developing, and the construction industry is essential to national growth. The transit sector is a major element of the construction sector. In comparison to waterway, railways, and airways, most people are dependent on highways and roads for all forms of transport. Crushed rock and murum are generally utilized as road pavement foundation materials in developing countries. Such materials are needed in huge numbers and are difficult to come by in many locations. For quick transportation and transmission, the Indian government is focusing on the development of National Highways and State Highways. As a result, the demand for construction materials is high.

Now a days, the improvement and new construction of huge number of highways are going on all over the country with different schemes and in the future that will increasing and its better for the development of country. Road pavement or materials construction accounts for nearly half of the total road construction cost. With these two huge, big projects, the material requirement for pavement construction has increased substantially. The cost of the essential materials should be affordable and widely available. If the material required is not available locally, it would have to be borrowed from some other location, which also will enhance the project's cost.



II. LITERATURE REVIEWS

Er. Ganesh D. Gavhane, Prof. Abhishek M. Loya (2020), have done study of “A Study on Performance Analysis of Cement Treated Base and Cement Treated Sub-Base in Flexible Pavement” and this research public in AEGAEUM Journal Volume-8, Issue-6-2020. It is found that the most of the causes of failures in pavement are due to heavy traffic, heavy rainfall and poor drainage capacity. Also for traditional method, the material using in sub-base & base course having a less durability & strength. The CTB and CTSB are having more strength & durability as compare to the traditional material. So the maintenance work required for CTB and CTSB is less. It is observed that the pavement with conventional crust fails for distresses condition such as cracking, and rutting But the CTB and CTSB better to resist in fatigue and rutting.

Er. Gregory E. Halsted, Er. David R. Luhr, Er. Wayne S. Adaska (2006), wrote a book of “Guide to Cement Treated Base (CTB)” with the help of Portland Cement Association. In this Guide of CTB they introduce the CTB Layer, How the CTB perform on site with their experiences. The material use for designing the Layer with the proper amount of material proportion with water i.e. mix design of Cement. The Requirement of Material, Material mix method, surfacing & laying of CTB layer on side i.e. Construction of CTB Layer. Suggested Construction Specification for Cement Treated Base.

Mr. Sanjay Singh, Er. Animikh banerjee, Er. Leevesh Kumar (2019), have study the “Design of CTSB & CTB Cubes and its Analysis” and this research was published in International Journal for Research in Applied Science & Engineering Technology (IJRASET) Volume 7 Issue V, May 2019, in studied in this research paper are the characteristics of Cement Treated Sub-Base/Base, the concept, mechanism and requirements of CTB/CTS, the mechanical properties and characteristics of this material. The experiments for the combinations of cementitious materials to be added in soil are performed and the result for unconfined compressive strength. In results they obtained the use of CTB/CTS saves the material required for the construction of flexible pavement. The transportation charge, fuel consumption, machineries required is less for CTB/CTS method than the traditional method. Hence the initial cost of construction is less for CTB/CTS method. The CTB/CTS is having more strength as compare to the traditional material. So the maintenance work required for CTB/CTS will be less.

Mr. Rahul Solanki, Mr. Shashikant B Dhobale have study the “A Performance Study of CTB & CTSB Method over Traditional Method (GSB, WMM) of Flexible Pavement” and this research was published in International Research Journal of Engineering and Technology (IRJET) Volume 8 Issue 6, June 2021, and studied in this research paper are the feasibility of a cement-treated bed have more strength than traditional methods and also for the basic stability of the road. Work is also underway to reduce road construction costs by reducing the thickness of the asphalt with primed concrete.

Er. V Swathi Padmaja, Er. A. Tejaswi (2019), have study the “Design and Comparison of Flexible and Rigid Pavements” and this research was published in International Research Journal of Engineering and Technology (IRJET) Volume 6 Issue 4, Apr 2019, and studied in this paper is with increase in the California bearing ratio of the soil the thickness of the pavement decreases. The life of rigid pavement is much more than the flexible pavement of about 30 years approx 2 times life of flexible pavement whose initial cost is much more than the flexible pavement but maintenance cost is very less. From the results they concluded the cost of rigid pavement is double that of flexible pavement. So flexible pavements are more economical when compared to the rigid pavement in terms of economy.

Indian Road Congress [IRC-37] (2012), publishes the “Tentative guidelines for the design of flexible pavements (IRC: 37-2012) and Code of practice for maintenance of bituminous surface of highways (IRC: 82-1982).” In the above said manual design criteria for flexible pavements, different layers and their requirements, material used for those layers, procedure of the works to be carried out etc. is explained in details. The second is code about the maintenance works to be carried out for flexible pavements in different types of failures. The general failure types and the preventive and curing measures to be taken for those is explained in details.



III.METHODOLOGY

Types of Failures in Flexible Pavements and their Repair Techniques

In general, the flexible pavement consists of the following component layers:

- Sub-grade
- Sub-base course
- Base Course
- Surface Course

Instability in any of the layers will result in the complete failure of the pavement system. This makes it necessary to construct each layer with utmost care and precision. There are different types of failures in flexible pavements. Determination of this failure and its reasons is necessary to facilitate correction in mix design and construction for future projects.

Types of Failures in Flexible Pavements due to Distress

The distress faced by the pavement can be of two types:

- a) Environmental distress, and
- b) Structural distress

Cement Treated Base (CTB)

Cement-Treated Base (CTB) is a type of Soil-Cement describing an intimate mixture of native soils and/or manufactured aggregates with measured amounts of portland cement and water that hardens after compaction and curing to form a strong, durable, frost-resistant paving material. CTB is versatile as it can be either mixed in place and compacted after blending, or mixed in a central plant where it is hauled to the placement area and spread on a prepared subgrade or subbase and compacted. A bituminous or portland cement concrete wearing course is placed on top of the cured CTB to complete the pavement structure. CTB is widely used as a pavement base for highways, roads, streets, parking areas, airports, and materials handling and storage areas.

Wet Mix Macadam (WMM)

This Layer is an improvement upon the conventional Wet Bound Macadam (WBM) and is intended to be as an alternative and more durable pavement layer in roads and highway works .

It generally consists of clean, crushed, graded aggregates premixed with other granular materials and water and rolled to a dense mass on a prepared surface.

Granular Sub Base (GSB)

Granular Sub-base (GSB) consists of laying and compacting well-graded material on prepared subgrade in accordance with the specifications. GSB layer is an intermediate layer in between Sub-grade and Wet mix macadam. GSB layer is laid in roads and highway works due to its properties.

We had take almost all test on field and in laboratory also for all materials listed above as per the MORTH and IRC-37-2012. The Material of cement is available at many locations easily so, we can take CTB and CTSB method for construction of Flexible Pavement. Due to this the load on the conventional metals or materials are decreases. Also when we use the CTB/CTSB method the thickness of layer also decreases. Because we considering the CTB/CTSB layer thickness for MSA-30 and for WMM and GSB layer thickness for MSA-10 for the quantity calculations and if we take for same MSA layer thickness the quantity is definitely decreases and the CTB/CTSB Method is around 15% to 20% cheaper than the Conventional Method of Flexible Pavement.

The machineries using while construction and maintenance of the Flexible Pavement by CTB/CTSB Method is not feasible for Small Scale Projects. Where the Right of Way has been available, water logging area has present and Large Scale Project at that location the CTB/CTSB method is feasible for construction of Flexible Pavement.

The Material designing, Environmental Factors, Amount available, Construction Period, Length of Road, Natural Conditions, Plants or Set up available, Technical Team available with there experiences and Construction methods are also effect on the Quality and Cost of the Project.



IV. EXPERIMENTAL RESULTS

Cost Analysis by CTB/CTSB Method and Conventional Method of Flexible Pavement

The total construction cost of flexible pavement with the CTSB/CTB method is lesser than the traditional Method, For Example, we consider a patch of 100 m length and 10 m width for CTB/CTSB & Traditional methods. The quantity and cost of materials required for the Main Carriageway are as follows:

Quantities for Pavement with CTB/CTSB Method				
Layer	Length (m)	Width (m)	Depth (m)	Quantity (m3)
BC	100	10	0.06	60
DBM	100	10	0.04	40
CTB	100	10.3	0.16	164.8
CTSB	100	10.5	0.2	210
SG	100	11	0.5	550
Total			1.00	

Table 1 : Required Quantities by CTB/ CTSB Method

Quantities for Pavement with Conventional Method				
Layer	Length (m)	Width (m)	Depth (m)	Quantity (m3)
BC	100	10	0.06	60
DBM	100	10	0.04	40
WMM	100	10.3	0.25	257.5
GSB	100	10.5	0.2	210
SG	100	11	0.5	550
Total			1.05	

Table 2 : Required Quantities by Conventional Method

From the above tables, it is seen that pavement with CTB/CTSB has a total crust thickness is 1000 mm whereas for the pavement with the conventional method the total thickness is 1050 mm. Hence by using the CTB/CTSB method the pavement thickness can be reduced up to 100 mm which results in the saving of the material required for pavement construction.

Total Cost of Construction as per Both Methods are Calculated Below:

Layers of Flexible Pavement	Rate (Rs)
Bituminous Concrete (BC)	8581
Dense Bituminous Macadam (DBM)	8077
Wet Mix Macadam (WMM)	1926
Cement Treated Base (CTB)	2486
Granular Sub Base (CTSB)	1976
Granular Sub Base (GSB)	1864
Sub-Grade (SG)	546

Table 3 : Basic Rate of Item SSR-2021-22

Construction Cost of CTB/CTSB Method			
Layer	Quantity (m3)	Rate (Rs)	Amount (Rs)
BC	60	8581	5,14,860.00
DBM	40	8077	3,23,080.00
CTB	164.8	2486	4,09,692.80
CTSB	210	1976	4,14,960.00
SG	550	546	3,00,300.00
Total Amount			19,62,892.80

Table 4 : Overall Cost by CTB/CTSB Method

Construction Cost of Conventional Method			
Layer	Quantity (m3)	Rate (Rs)	Amount (Rs)
BC	60	8581	5,14,860.00
DBM	40	8077	3,23,080.00
WMM	257.5	1926	4,95,945.00
GSB	210	1864	3,91,440.00
SG	550	546	3,00,300.00
Total Amount			20,25,625.00

Table 5 : Overall Cost by Conventional Method

From the above tables, it is seen that the construction cost for CTB/CTSB method for the 100 m is Rupees 19,62,892.80 /- and for the conventional method the construction cost for the 100 m is Rupees 20,25,625/- . So, the difference between Construction Cost is $20,25,625.00 - 19,62,892.80 = 62,732.20$ /-. So, Total Cost Saving per m. is 627.00 Rs by using the CTB/CTSB method, The Cost due to Conventional Method is increasing around 3.10% than CTB & CTSB Method.

The CTB/CTSB Method is not feasible for Small Scale projects, because at the time of maintenance of this road the material & machinery are not easily available. Generally, Road failures in CTB/CTSB Method are less due to uniform load transfer to Subgrade. This method is mainly used in the water logging area where the groundwater table is high.

V. CONCLUSION

• CONCLUSION

In the current project, we have study about the different layers in flexible pavement. The Flexible Pavement consists of conventional methods i.e., Earthwork, Subgrade, GSB, WMM, DBM & BC. Most of the Highway's are constructed the conventional method rather than the CTS & CTSB Method. Because the Construction Equipment and Material required for the Construction of CTB & CTSB are costly and for safe diversion provide to the traffic the extra land is also required, but in many places, there is a land issue. So, we conclude that for the Small-Scale Construction of roads the Conventional Method is better than CTB & CTSB methods. The Cost & Quantity of Material required for the Construction of the Conventional Method is greater than CTB/CTSB Method.

• SCOPE FOR FUTURE STUDY

First and foremost, the thing to study in this project is that the flexible pavement with layers of WMM & GSB are better for small-scale Project. The Machinery's required for the maintenance of the Road by CTB & CTSB methods are costly and machinery is not easily available. But by the Conventional method cost of construction is lesser than CTB & CTSB Method.



There are also various merits from CTB/CTSB Method in Flexible Pavement.

1. Longer Life of Pavements.
2. Fast Speed of Construction.
3. Material of Cement is easily available at any location.
4. Quantity required for Construction is less.
5. Uniformly Distribution of load to below layer.
6. Best option for Water logging area.

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