A STUDY ON PERFORMANCE ANALYSIS OF CEMENT TREATED BASE AND CEMENT TREATED SUB-BASE IN FLEXIBLE PAVEMENT

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Abstract: *Countries around the world are developing rapidly and the infrastructure sector plays a vital role in the development of nations. Transport is the main component of the infrastructure sector. Most countries depend on roads and highways for transport of all types, compared to waterways, railways, airways, etc. In many developing countries, crushed rock and murrum are used as a basic material for road paving. These materials are needed in large quantities and are not readily available in many regions. The Indian government is focusing on the development of national and state roads for rapid transport and transport. Therefore, the requirement of building materials is very large. The material used for the base layers on the sidewalks is expensive, as it requires a production cost, i.e. drilling, blasting, crushing, transport, etc. Although this material fails under a heavy traffic load as well as heavy rains. In addition, it is not readily available in areas of the city. This report is a study of the reasons for the failure of flexible sidewalks, the materials used for the construction of the pavement in the traditional method, the problems associated with these materials. This study explains the basic mechanism treated with cement and subbase. The amount of cement to be added to the stabilization process. This report also examines the requirements of the cement treated base/subbase. The construction process is explained in detail. This material is useful because it minimizes the thickness of the bark or crust and then saves the material needed for construction. The concrete-treated base and sub-base are tested for non-confined compression resistance and results are obtained. It shows that, this material gives greater strength based on needs and performance even better than traditional materials. The construction cost, the quantity of material, the transport costs for the material, the requirement of the machine, the fuel cost of the machinery are analyzed and compared with the subbase treated with cement and the traditional material. The result shows that the construction cost savings for the CTB and CTSB method are greater. This report shows how advantageous of using the cement treated base and subbase to replace the traditional basic material used for road construction. And after study the behavior of the both method after pavement is opening to the traffic.*

Keywords: **Cement Treated Sub base (CTSB), Cement Treated Base (CTB), Flexible pavement, Performance Analysis.**

1. INTRODUCTION

Now a days, India is the fastest growing country in the world. Transport plays a very important role in the development of the country. The interconnectivity of capital, ports, industrial zones, etc. must be well connected to ensure faster transport of all goods, materials and cities. The transport sector includes motorways, railways, waterways, etc. In India, roads play a vital role for all types of transport.

Today, many major road projects are underway across the country and will increase in the future. The Indian government has planned the rs. 5.35 Lakh Crore road projects under Bharatmala Pariyojna to meet the target of the construction of 83,677 km of roads in 2017-2022. This bharatmala will significantly increase road infrastructure. Bringing 6 NC corridors to 50 corridors, from 40% to 80% on national roads, also elevates district connectivity from 300 district to 550 connected district from a minimum of 4 lanes. The Maharashtra government has also planned the most prestigious road project, namely the Samruddhi Highway, which will connect 700 km in length across ten districts with a huge budget of 48,000 hubs. This sector contributes 6% of total GDP, 70% of which comes from the road sector. Construction of the road pavement costs about 50% of the total cost of road construction. Now, with these two large ambitious projects, the material

requirement for the construction of the flooring is very high. The cost of the requested material must be within the budget and must be readily available. If the requested material is not available locally, then it must be borrowed from the other site will affect the cost of the project.
The material requirement for the construction of the pavement using the conventional method, namely GSB WMM as a base layer, is also very high and also increases the material as well as the total cost of the project. To reduce the thickness of the pavement you need to use the alternative base layer to minimize material consumption and save money. To obtain this cement treated base and subbase is used as an alternative to flexible pavement without compromising the strength.

1.1 NEED OF STUDY

For high-traffic road constructions and the area of high rainfall, the pavement should be well needed to carry the heavy load and to increase the strength of the pavement it is necessary to increase the thickness of the bark. If we increase the thickness, then the material requires even more. It also increases the burden on the contractor and affects the total cost of the project. Flexible sidewalks in regions of heavy rain have reached many problems such as surface cracking, rutting, potholes, undulations, etc. Therefore, to achieve the desired strength of the flooring with limited resources, the floor design must be redesigned. When we consider the current growth in traffic volume, the availability of materials, resources and economy, better and sustainable road design is needed and to achieve such pavement design, I would like to present the cement treated base & subbase as a solution to the problem mentioned above.

1.2 OBJECTIVES OF THE STUDY

A. To study the effect of CTB & CTSB method on Crust thickness of Flexible Pavement.

B. To Study the Concept of Cement Treated Base and Cement treated Sub-base in flexible pavement.

C. To Study the Causes of failure in flexible

D. To compare the Total cost analysis for CTB and CTSB method with conventional method.

2. FAILURE OF FLEXIBLE PAVEMENT

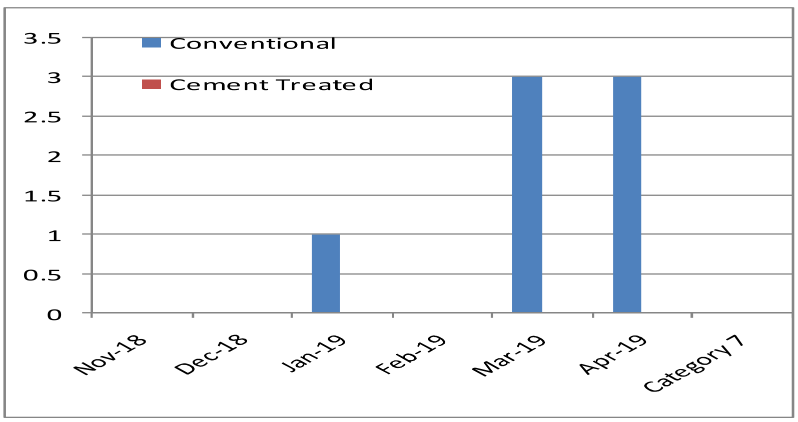
The main failures of flexible pavements are fatigue cracking, rutting cracking and thermal cracking. The fatigue cracking of flexible pavements is due to the horizontal tensile stress at the bottom of the bituminous concrete. The failure criterion relates the number of load repetitions authorized with the tensile stress and this relationship can be determined in the laboratory fatigue test on bituminous concrete samples. rutting occurs only on flexible pavements, as indicated by permanent deformation or the depth of the path along the wheel load path. Two design methods were used to control the formation of grooves: one to limit the vertical compressive stress at the top of the basement and the other to limit the tolerable quantity (normally 12 mm). Thermal cracks which have two types such as low temperature cracks and thermal fatigue cracks.These failure patterns are due to the weakness of the sub-layers and the poor drainage of water through the sub-bases.

3. PERFORMANCE ANALYSIS OF PAVEMENT

The Analysis of pavement performance using CTB & CTSB was performed with traditional method. The study of pavement conditions was carried out as follows with the guidelines of IRC-37-2012. The pavement evaluation and data collection for both types of Pavement was carried out in the JNPT NH-4B project. For the pavement evaluation of the CTB and CTSB method, the length of 1 km is taken for the D-E section of the project and for the conventional method, the length of 1km is taken for D to G section.

In that, the section is divided into 10 parts. Each part 100 m long and 9 m wide. This section measures the condition of the pavement for different types of distress such as cracking, rubbing, delirium, potholes and patches. To this end, detailed observation and registration were maintained for six months from the day of traffic diverted on the said stretches. The observations made of the pavements for both types at the regular interval of the 15 days for the six months. The following figure shows the comparison between the pavement with CTB and CTSB with the conventional one & Shows the percentage of distress observed in the Pavement when pavement is opening to the traffic.

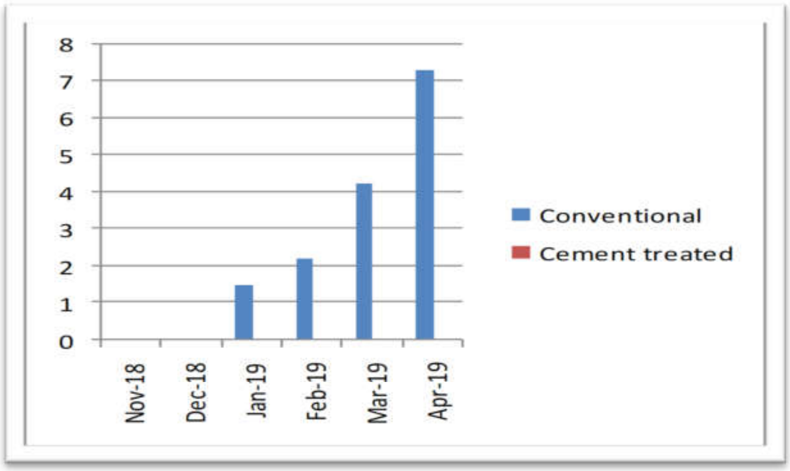
A. **Cracking :-** In this graph on the X-axis the period is plotted and on the y-axis the percentage of cracking is plotted. From this it is clearly seen that the cracking are observed in the conventional pavement and no cracking in the CTB and CTSB pavement.



Graph 1 - Comparison between Conventional Vs CTB/CTSB Method

Fig. 1 Cracking along the road in traditional method

B. Rutting :- The rutting graph also plotted for both the pavements. In this graph also on X-axis the period is plotted and on the y-axis the rutting observed in mm is plotted. From this it is clearly seen that the rutting are observed in the conventional pavement and no rutting in the CTB and CTSB pavement.



Graph 2 - Comparison between Conventional Vs CTB/CTSB Method

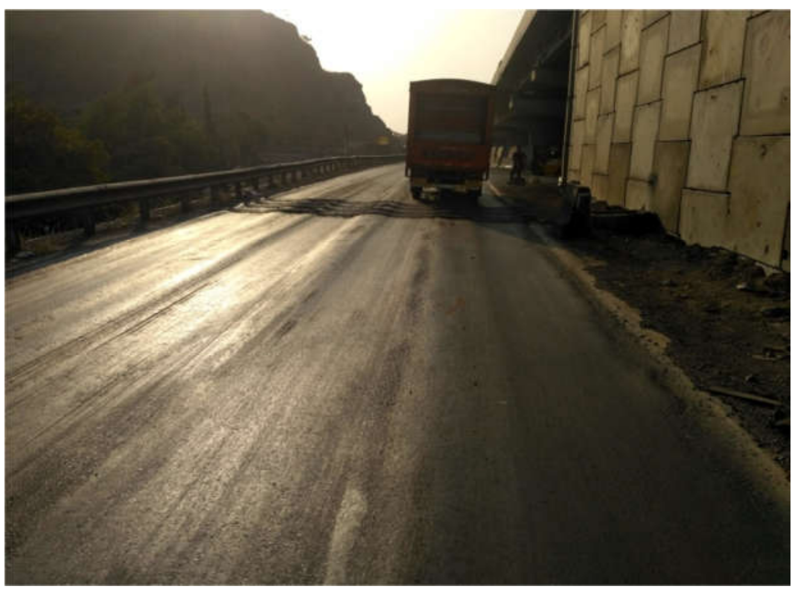


Fig. 2 - Rutting along the road in traditional method

4. OVERALL COST ANALYSIS OF PAVEMENT

The Total construction cost of flexible pavement with CTSB/CTB method is less than the traditional Method, because of saving in material transportation charges, required machineries, fuel consumption etc.

For Example, we consider a patch of 1 Km length and 9 m width for CTB/CTSB & Traditional methods. The quantity and cost of materials required for Main Carriageway as follows:

Table 4.1 : Required Quantities of Material for CTB/CTSB Method

Quantities for Pavement with CTB/CTSB Material				
Layer	**Length (m)**	**Width (m)**	**Depth (m)**	**Quantity (m3)**
BC	1000	9	0.05	450
DBM	1000	9	0.05	450
WMM	1000	9	0.100	900
CTB	1000	9	0.110	990
CTSB	1000	9	0.250	2250
SG	1000	9	0.05	4500
Total			**1060**	

Table 4.2 : Required Quantities of Material for Conventional Method

Quantities for Pavement with Conventional Material				
Layer	**Length (m)**	**Width (m)**	**Depth (m)**	**Quantity (m3)**
BC	1000	9	0.05	450
DBM	1000	9	0.120	1080
WMM	1000	9	0.250	2250
GSB	1000	9	0.200	1800
SG	1000	9	0.500	4500
Total			**1120**	

From above tables, it is seen that pavement with CTB/CTSB has total crust thickness is 1060 mm where as the pavement with conventional method the total thickness is 1160 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.

Table 4.3 : BOQ of Material for CTB/CTSB Method

Layers	Rate (Rs)
Bituminous Course (BC)	8084
Dense Bituminous Macadam (DBM)	7702
Wet Mix Macadam (WMM)	1542
Cement Treated Base (CTB)	1667
Cement Treated Sub Base (CTSB)	1291
Granular Sub Base (GSB)	1046
Sub-Grade (SG)	527

Total construction cost for the both type of the pavement for the 1 km is calculated is shown below : -

Table 4.4 : Overall Cost of Material for CTB/CTSB Method

Construction Cost for CTB/CTSB Method			
Layers	**Quantity (m3)**	**Rate (Rs)**	**Amount (Rs)**
BC	450	8084	3637800
DBM	450	7702	3465900
WMM	900	1542	1387800
CTB	990	1667	1650330
CTSB	2250	1291	2904750
SG	4500	527	2371500
TOTAL AMOUNT			**1,54,18,080/-**

Table 4.5 : Overall Cost of Material for Conventional Method

Construction Cost for Conventional Method			
Layers	**Quantity (m3)**	**Rate (Rs)**	**Amount (Rs)**
BC	450	8084	3637800
DBM	1080	7702	8318160
WMM	2250	1542	3469500
GSB	1800	1046	1882800
SG	4500	527	2371500
TOTAL AMOUNT			**1,96,79,760/-**

Table 4.6 : Transportation Charges for CTB/CTSB Method

Transportation Charges for CTB/CTSB Method					
Layers	**Length (km)**	**Charges per km**	**Quantity for 1 km**	**Unit**	**Amount (Rs)**
Murrrum for SG	10	10	8100	Cum	81000
GSB for CTSB	10	8	5012	Mt	40096
GSB for CTB	10	8	2233.44	Mt	17867.52
Cement for CTB/CTSB	18	12.5	150.33	Mt	1906.92
Flyash for CTB/CTSB	22	12.5	150.53	Mt	1879.125
WMM	10	8	2133	Mt	17064
DBM	10	8	1102.5	Mt	8820
BC	10	8	1125	Mt	9000
TOTAL AMOUNT					**1,77,633/-**

Table 4.7 : Transportation Charges for Conventional Method

Transportation Charges for Conventional Method					
Layers	**Length (km)**	**Charges per km**	**Quantity for 1 km**	**Unit**	**Amount (Rs)**
Murrrum for SG	10	10	8100	Cum	81000
GSB for GSB	10	8	4008.6	Mt	32068.8
WMM	10	8	5332.5	Mt	42660
DBM	10	8	2646	Mt	21168
BC	10	8	1125	Mt	9000
TOTAL AMOUNT					**1,85,896/-**

From the above tables it is seen that the construction cost for CTB/CTSB method for the 1 km is 1,54,18,080/- and for the conventional method the construction cost for the 1 km is 1,96,79,760/-.So the difference between Construction Cost is 1,96,79,760-1,54,18,080 = 42,61,680/-. And difference between Transportation Cost is 1,85,896 – 1,77,633 = 8263 Rs . So The Total Cost Saving for per km. is (Saving in Construction Cost + Saving in Transportation Cost) 42,61,680 + 8263 = 42,69,943 Rs by using the CTB/CTSB method.

5. CONCLUSON :-

1. 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 coarse having a less durability & strength.
2. The CTB and CTSB is having more strength & durability as compare to the traditional material. So the maintenance work required for CTB and CTSB is less.
3. The overall charges of transportation of material is less for CTB and CTSB method than the traditional method. As well as Rs. 8263.53/- can be saved per Km for the transportation of material required for CTB and CTSB method.
4. The Construction cost of the materials is calculated and compared & total cost for CTB/CTSB method is Rs. 1,54,18,080/- whereas for traditional method it is about Rs. 1,96,79,760/- it means CTB/CTSB method saves about Rs. 42,61,680/- per Km.
5. So that total cost saving is (saving in Material's transportation cost + saving in Construction cost) = (8263+42,61,680) = 42,69,943 per km.
6. The CTB and CTSB is having more strength as compare to the traditional material. So the maintenance work required for CTB and CTSB are be less which affect on the life cycle cost of the project.
7. 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.

8. Also by using CTB/CTSB there is reduction in the bitumen consumption and The pavement thickness is reduced up to 100 mm.
9. The life of the pavements is longer than conventional pavement.

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