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Economic Analysis of use of Cement Treated Base & Sub-Base in Flexible Pavement

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***Abstract*: As we know India is a developing Nation and Infrastructure is a key for the successful developed Nation. In India the massive infrastructure development activities are going in both rural & urban areas which have caused scarcity of construction material. Highway/Road sector itself contributes majorly to the Infrastructure. Pavement Industry looks for alternative materials that are readily available & economically viable for use of Roadway construction. Use of massive amount of aggregates in Roads is depleting mountains day by day. To overcome this problem, the objective of this study is to design the pavement using cement treated layers & economically analyzing its impact on the project. Cement Treated Base & Sub-Base is a mixture of Base/Sub-Base material (aggregate material) with some amount of Portland cement. Use of cement in layers of Pavement will not only economically beneficial but also help to increase the design life cycle of road. Use of cement in pavement layers will be much stronger & more rigid than unstabilized granular layer.**

Keywords: Flexible Pavement; Cement Treated Base & Sub-Base, Economic Pavement.

I. INTRODUCTION

In today's world, considering the rate of construction activities especially in highways sectors there is going to be scarcity of Highways materials. Looking to the future demand, cement treated granular layer in flexible pavement could be a better option. In this study tests are performed on Treated & Untreated Granular Materials of flexible pavement. It is found that the use of small amount of cement content in granular layers can surprisingly increase the strength of the granular layers & ultimately decrease the thickness of the pavement. CBR value of the granular material increase by 100% after adding small amount of cement content. Cement Treated granular layers act like a slab structure and load is uniformly divided making a strong layer in comparison to untreated layers. By the help of software IIT Pave, stresses at critical locations could be calculated & cement treated layers of the flexible pavement have given a very economical result. Resilient modulus of the cement treated granular layer is higher as compared to the untreated granular layer which gives stronger support.

Fig. 1 – Rolling of Cement Treated Granular Layer

Use of Cement in granular layer decreases the thickness of the pavement; also the thickness of bitumen layers is decreased. Cement treated granular layers are also comparative good and less affected under contact with water as it gains more strength as increase in water content. So ultimately less amount of usage of aggregates will not only decrease the overall project cost as well as it will help us to sustain our environment by saving the amount of aggregates needed for the project.

II. NEED OF STUDY

As we can see the massive use of aggregates in Highway sector, use of Cement Treated Base & Sub-Base could be very useful for the environment. It could reduce the overall cost of highways by decreasing the thickness of the layers. Also looking to the present scenario of service of roads that are less durable due to less elasticity modulus, the use of cement treated Base & Sub-Base in highways will be beneficial in long run. Cement treated pavement also withstand more traffic as compared to granular layers. Cement Treated layers may also handle leakage of water due to its property of good drainage. It could also resist cyclic freezing, rain & multi weather damage to the pavement of road.

Present roads are less durable due to its less elasticity modulus, so by use of cement treated base &sub Base it can be increased. Granular bases can carry less tonnage of loads but can withstand more tonnage of loads. As Design tonnage increases cost increases in Granular bases but not in the case of cement treated bases. When traffic is diverted from main

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Carriageway to Service road due to maintenance, cement treated bases can withstand more traffic load as compared to granular bases. CTB can handle leakage of water from other sources due to its good drainage properties. Improved Performance in Rutting and Fatigue Cracking compared to unsterilized granular base to cement treated base. It resists cyclic freezing, rain, and spring-weather damage, when compared with granular base of service road. As compared to untreated granular layer, Cement-treated base continues to gain strength with age even under traffic.Maintaining the Integrity of the Specifications

III. SCOPE OF THE STUDY

A comparative study has been made between untreated & cement treated granular layers in the flexible pavement. As we know India is a developing Nation & due to massive infrastructure, construction activities are taking place which has caused scarcity of construction materials. Use of cement treated layers of pavement could be a good option for durability of pavement, increase in strength and found economic as reduction in quantity of aggregates. It will not only save money but also increase the durability of the Road. A small amount of cement is uniformly added in the granular layer of flexible pavements.

IV. OBJECTIVE OF THE STUDY

- Economization of Pavement cost by lowering the thickness using cement treated granular layers.
- Lowering quantity of aggregate needed in construction of pavement layers of Highways.
- Durable Pavement Layer as compared to ethnic Untreated granular layers.

V. METHODOLOGY ADOPTED

- *TESTS OF RELIABILITY & STRENGTH OF CEMENT TREATED SUB-BASE & BASE MATERIAL.*

CBR is tested for both i.e. Untreated Granular Sub-Base material & Cement Treated Granular Sub-Base Material. After gradation for Sub-Base material as per MoRT&H provisions, Optical Moisture Content (OMC) is calculated by Procter Test. Then CBR is tested for the granular material & thereafter the CBR is tested after treatment of Granular Material with Cement of propotion 1%, 2%, 3% & 4% respectively.

- *DESIGN OF FLEXIBLE PAVEMENT*

Pavement is designed considering the Detailed Calculations given in IRC:37-2012 (Guidelines for Design of Flexible Pavements) for both untreated & cement treated granular layer. Stresses over critical points specified in IRC:37-2012 are calculated by IIT-Pave software. Pavement Layer thickness is calculated thereafter as per codal provisions.

- *COST COMPARIZON*

Costs of the Pavement layers are calculated per metre for Ethnic untreated Granular Layer type flexible Pavement & Cement Treated Flexible Pavement.

VI. RESULTS

- *GRADATION TEST RESULTS*

Granular Material is taken from the site & gradation is done of the material. Percentage retained over different seives of the material is as shown in Fig.1.

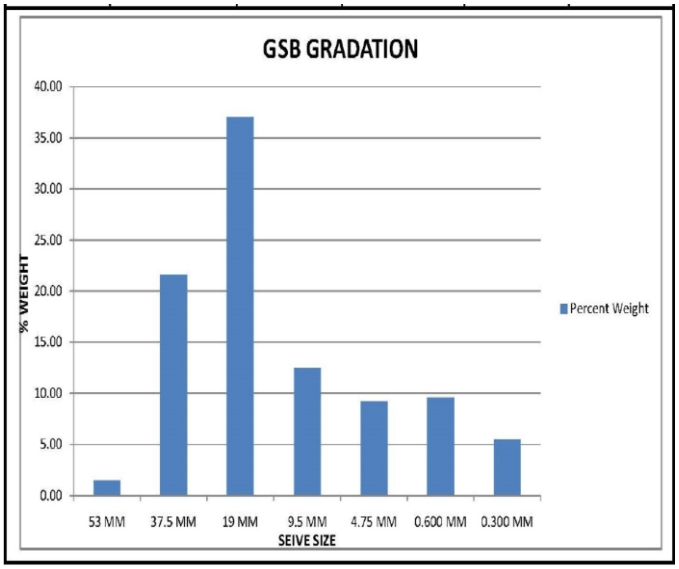

Fig.2 – Gradation of GSB Material

- *OPTIMUM MOISTURE CONTENT*

Optimum Moisture Content for achiving maximum densidty of granular material is calculated by Modified Procter Test. Water content is added untill maximum density is achieved i.e.6.3%. Curve for OMC is shown in Fig.2.

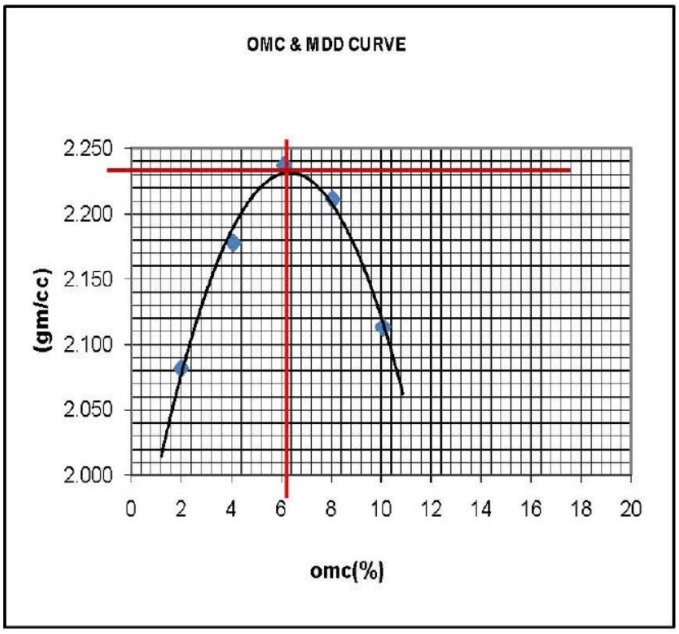

Fig. 3 – Optimum Moisture Content Curve

- *CALIFORNIA BEARING RATIO TEST*

CBR is calculated for Both Untreated & cement treated granular material. Results are as given below in Table-01.

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Sample No	Cement Treated	Cement Content	CBR VALUE %	
			2.5 mm	5.0 mm
1	NA	0	36.25	43.37
2	NA	0	31.04	43.96
3	NA	0	33.94	43.12
4	YES	1 %	80.31	98.05
5	YES	2 %	105.10	122.26
6	YES	3 %	145.36	150.05
7	YES	4 %	166.05	171.49
8	YES	5 %	166.05	193.27
9	YES	6 %	176.18	216.10

Table 1 CBR Test results

As we can see after treatment of granular material with cement, CBR value of granular layer increases which will ultimately increase the strength of the pavement layers which results reduction in layer thickness of flexible pavement.

➢ *PAVEMENT DESIGN OF UNTREATED & CEMENT TREATED FLEXIBLE PAVEMENT*

Comparizon of Design of Untreated & Cement Treated Flexible Pavement		Granular Pavement Design as per Plate 6 IRC:37-2018	Cement Treated Pavement Design as per Plate 14 of IRC:37-2018	Cement Treated Pavement Design	Cement Treated Pavement Design
		Trial 1	Trial 2	Trial 3	Trial 4
Design Traffic in MSA:		30	30	30	30
Effective CBR of Subgrade		10	10	10	10
Layer	Resilient Modulus, Mpa	Pavement composition (mm)	Pavement composition (mm)	Pavement composition (mm)	Pavement composition (mm)
Resilient modulus of subgrade	77				
Bituminous Layer (mm)	3000	125	100	90	50
Aggregate Inter Layer(mm)	450	0	100	100	100
Granular Base (mm)	167	250			
Cement Treated Base (mm)	5000		100	70	70
Granular Subbase (mm)	184	200			
Cement Treated Subbase (mm)	600		200	200	200
Total Thickness		**575**	**500**	**460**	**420**
Allowable Tensile Strain at the Bottom of Bituminous Layer (εt) =		2.316E-04	2.316E-04	2.316E-04	2.316E-04
Allowable Vertical Strain at the Top of the Subgrade (εz) =		4.160E-04	4.160E-04	4.160E-04	4.160E-04
Allowable Tensile Strain in Cementious layer (εz) =			7.407E-05	7.407E-05	7.407E-05
IIT Pave Horizontal Strain at the bottom of BT layer (εt) =		2.01E-04	1.32E-04	1.420E-04	1.43E-04
IIT Pave Vertical Strain at top the Subgrade (εz) =		2.914E-04	2.518E-04	3.065E-04	3.669E-04
IIT Pave Horizontal Strain on cemented Layer (εz) =			5.792E-05	6.444E-05	8.073E-05
RESULT		DESIGN IS SAFE	DESIGN IS SAFE	DESIGN IS SAFE	DESIGN IS NOT SAFE

➢ *COST COMPARISON*

Cost is calculated for both Untreated & Cement Treated Flexible Pavement and comparison of per metre cost is as under in Table-2 & summary of cost comparison in Table-3.

Cement Treated Flexible Pavement				
Sl. No.	**Item**	**Thickness (m)**	***Rate (INR)**	**Cost (INR)**
1	CT Sub Base	0.2	1200	2400000
2	CT Base	0.07	1500	1050000
3	Primer Coat		19	190000
4	Tack Coat		7	140000
5	Aggregate Layer	0.1	1029	1029000
6	DBM	0.05	5308	2654000
7	BC	0.04	6,678	2671214.324
		Total		**₹ 1,01,34,214.32**

Untreated Flexible Pavement				
Sl. No.	**Item**	**Thickness (m)**	***Rate (INR)**	**Cost (INR)**
1	GSB	0.2	549	1098000
2	WMM	0.25	1029	2572500
3	Primer Coat		19	190000
4	Tack Coat		7	140000
5	DBM	0.085	5,308	4511619.91
6	BC	0.04	6,678	2671214.324
		Total		**₹ 1,11,83,334.23**

Table.2- Cost Comparison of per meter Untreated & Treated Flexible Pavement

Type of Pavement	Cost per KM	% Difference
Cement Treated Flexible Pavement	Rs. 1,01,34,214.32	9%
Untreated Flexible Pavement	Rs. 1,11,83,334.23	

Table.3- Summary of Cost Comparison of per meter Untreated & Treated Flexible Pavement

VII. CONCLUSIONS

From above study it is seen that Cement treated flexible pavement layers thicknesses are less than those required for granular bases carrying the same traffic because the loads are distributed over a large area. The strong uniform support provided by cement treated layers results in reduced stresses applied to the sub-grade. CBR value of the cement treated layers are increased as we increase the % of cement content i.e. 0%, 1%, 2%, 3%, 4%, 5% & 6% the CBR values are 43.12, 98.05, 122.26, 150.05, 171.49, 193.27 & 216.10 respectively. As an engineered material (Cement Treated Granular Layer) it is designed to resist damage caused by cycles of wetting and drying and freezing and thawing. As the thickness of the pavement is reduced, quantity of aggregates which will be required will reduce which will ultimately reduces the project cost. The overall saving in pavement layers is upto 9% by using optimum amount of cement content in granular layers of flexible pavement layers.

VIII. REFERENCE

[1] Rasha. Abd Al-RedhaGhani, Dr. Mohammed A. Al-Jummaily and Dr. Ahlam K. R. Al-Zerjawi, Study of Cement Treated Base Aggregate Properties for Pavement Structures, 2017
[2] M. Shabbir Hossain, Harikishnan Nair & H. Celik Ozyilidirim, Determination of Mechanical Properties for Cement Treated Aggregate Base, June 2016
[3] Saket Prasad, Feasibility Study on Cement Treated Base and Sub Base layers of Service Roads, 2016
[4] Korakod Nusit, Peerapong Jitsangiam, Damage Behavior of Cement-Treated Base Material, 2016
[5] Deren Yuan, Evaluation and Mix Design of Cement-Treated Base Materials with High RAP Content, 2011
[6] Gregory E. Halsted, David R. Luhr & Wayne S. Adaska, Guide to Cement-Treated Base (CTB), 2006
[7] Guidelines for the Design of Flexible Pavements IRC:37-2012 (Third Revision)
[8] Guidelines for the Design of Flexible Pavements IRC:37-2018 (Fouth Revision)
[9] Guidelines for the Manual of Specifications and Standard for Two Laning of Highways with Paved Shoulder IRC:SP:73-2015 (First Revision)
[10] Guidelines for the Manual of Specifications and Standard for Two Laning of Highways with Paved Shoulder IRC:SP:73-2018 (Second Revision)