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Name- Infrastructure Cost Management with comparative material.

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Abstract

Cement-Treated Sub-bases the unconventional pavement layers known as sub-bases are utilized to enhance the mechanical properties of base and sub-base courses. The typical Constructing method, which uses GSB, WMM as a base layer, also requires a significant amount of material, which drives up the project's material and overall costs. Utilizing a different foundation layer will reduce the thickness of the pavement, saving money and materials while also improving efficiency. The entire surface is disturbed if the bottom coating is wavy, yet the structure varies under load. The road surface has a significant compressive stress due to the transfer of weight from the grain to the tip of the grain, necessitating the removal of a solid layer . . A flexible layer has four layers; Wear a layer, a base coat, a base coat and a subgrade The base that has been treated consists of a complete granular mixture that has been blended with enough water and an appropriate amount of Portland cement to achieve a high concentration. Enough moisture, proper concrete content, thorough mixing, adequate density, and adequate hardness are the fundamental variables that govern the quality of the CTSB. Because of this, this substance thins the crust, saving money on construction. In comparison to those specifications, it shows that this material performs and is stronger than conventional materials. The results show that the CTSB methods saved the greatest money on road construction expenditures. using sub-base and foundation treated with cement rather than the usual base material for Constructing roads.

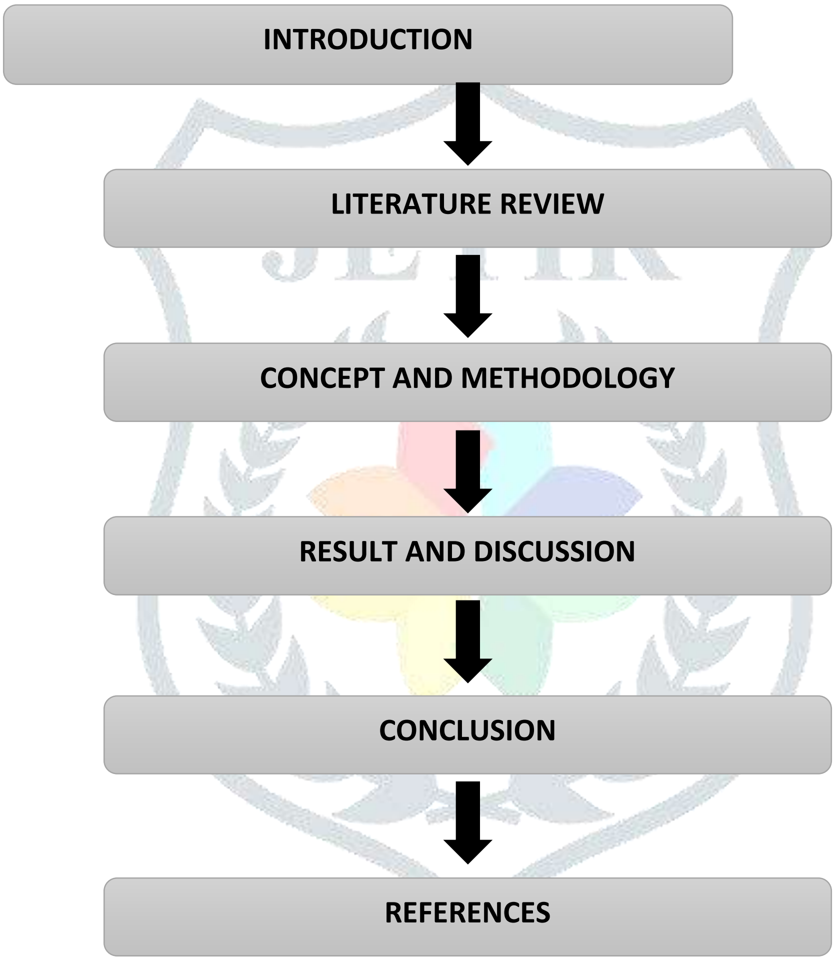
Index terms- CTSB,GSB

1.Introduction

The Study include Comparison between CTSB and GSB for determine the financial impact on Highway Projects. The Comparative cost Statement cover the determination of the rate analysis based on different economical factors. For the determination of work shall be consist of laying and compacting well-graded material on prepared subgrade in accordance with the requirements of these Specifications. To identify the best suited material for highway construction as a subbase in reference of speed of construction, ecomical, Environment friendly, etc. To compare the two material with different design parameters.

The term "cement-treated base" (CTB) refers to a specific mixture of manufactured aggregates and/or native soils that has been mixed with water and Portland cement in regulated amounts. After compaction and curing, the mixture hardens to form a robust, long-lasting, frost-resistant paving material. Other terms that are occasionally used include cement-stabilized base, cement-treated aggregate base, soil-cement base, and cement-stabilized roadbed. CTB can be mixed either on-site using materials available or in a central plant with specific materials, usually produced aggregates. After blending, CTB mixed in a central plant is compacted, and graders, pavers, or Jersey-style spreaders are used to lay the material on the road. Dump trucks transport the CTB mixed in a central plant to the placement area. Portland cement concrete or a bituminous wearing course are used on on top of the CTB to complete the pavement

Flow Chart-



Objective of Project:

1. To understand the concept of CTSB.
2. Assessment of financial impact in highway construction.
3. Comparison of GSB and CTSB for financial implication.
4. Discussion and Suggestion for CTSB layer.

2.LITERATURE REVIEW

Saket Prasad (2016): "Feasibility study on Cement Treated Base and Sub Base Layers of Service Road- A case study on Khed Sinnar NH 50 Project." And this research paper published in International Research Journal of Engineering and Technology (IRJET), Volume 03, Issue09. It is found that from cost comparison for convention and CTB/CTSB method the CTB/CTSB method is more economical from conventional one and the material consumption also less than conventional one. The author concluded the following things: 1. Reduction of the bitumen consumption due to strong sub base. 2. Less local traffic due to fast construction of the road. 3. Uniform distribution of load in cement treated service road as compared to conventional road. 4. Best for laying in the most Water logged area.[1]

Pranshul Sahu, Ritesh Kamble (2017): Design of flexible pavement using CBR method'' and this research was published in the International Journal of Mechanical and Production Engineering Volume- 5, Issue-11, Nov.- 2017. It is the purpose of this paper to point out the problems associated with flexible pavements, to summarize the research that the Joint Highway Research Project has done in this field, and to outline present endeavours. In so doing, it must be recognized, first of all that flexible- pavement research, or the general problem of flexible-pavement design, consists of two parts. One of these is the material design of competent layers of the flexible pavement, such as the sub base, base, or surface course. In addition to the strength characteristics of such layers, factors of durability also must be recognized in establishing their design. The second part of the problem is concerned with the thickness design of the component layers, wherein it is required that sufficient strength be built up to carry the imposed loads. In this connection the problem must be viewed as one in which the subgrade soil is required to carry the load, but that in order to do so it must be reinforced to the extent that stress applied to it will be so distributed as not to cause failure.[2]

Harshavardhan N. Shinde (2018): "Minimal Cost Approach for Selecting the Flexible Pavement Type to Minimize the Construction Cost of Road" and this research published in the International Journal of Latest Technology in Engineering, Management & Applied Science (IJLTEMAS) Volume VII, Issue VI, June 2018 in this study the included some alternate material crusts for the road construction of having traffic more than 2 msa. The following alternate methods are used a. Granular Base and Granular Subbase. (GB and GSB) b. Cementitious Base and Cementitious Subbase of aggregate interlayer for crack relief. (CB and CSB) c. cementitious base and subbase with SAMI at the interface of base and the bituminous layer. (CB and CSB with

SAMI) d. Foamed bitumen/bitumen emulsion treated RAP or fresh aggregates over 250 mm cementitious subbase. (RAP) e. Cementitious base and granular subbase with crack relief layer of aggregate layer above the cementitious base (CB) and GSB with crack relief layer) For this above methods the authors has done direct cost analysis for the all methods and the strength of the sub grade for various crust material for various CBR was done. [3]

Indian Road Congress (2012): "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.[4]

Ministry of Roads, Highways and Transport, 5th revision (2013): published by the "Government of India." This is the guide manual for all the works to be carried out in the highway project. The section wise manual is available for all types of pavements, their requirements, materials and their requirements, procedure to be followed for different works, their measurements etc. is included in this manual. For the study of CTSB/CTB the clause no. 403 is useful. Also for the maintenance work for flexible pavements the clause no. 3000 is helpful.[5]

3. **CONCEPT AND METHODOLOGY**

Construction methodology & Material and grading Composition of GSB Bed-

The sub-base material specified in the Contract shall be mixed with water using a mechanical mixer equipped with controlled water addition and mechanical mixing to ensure a uniform mix. The water content required will be determined as per IS: 2720 (Part 8). The mixture will then be spread on the prepared subgrade using a motor grader with hydraulic controls on the blade for slope and grade adjustments, or other approved means by the Engineer. Moisture content will be checked according to IS: 2720 (Part 2) and adjusted to be 1 to 2 percent below the optimum moisture content during compaction. Upon completion of spreading the mix, an approved roller must be used for rolling. If the compacted layer is less than 100 mm thick, a smooth wheeled roller weighing between 80 to 100 KN can be utilized. For a single layer up to 200 mm thick, compaction should be carried out using a vibratory roller with a minimum static weight of 80 to 100 KN, capable of achieving the required compaction. Rolling should start from the lower edge and progress longitudinally towards the upper edge for sections with unidirectional cross fall or super elevation. In the case of carriageways with cross fall on both sides, rolling should begin at the edges and move towards the crown. Each pass of the roller should overlap at least one-third of the track made in the previous pass. Throughout the rolling process, the grade and cross fall (camber) should be monitored, and any high spots or depressions should be rectified by adding or removing fresh material. The speed of the roller should not exceed 5 km per hour. Rolling must continue until the achieved density is at least 98 percent of the maximum dry density for the material as per IS: 2720 (Part 8). The surface of each compacted layer should be smooth, free from movement under compaction equipment, and without any compaction planes, ridges, cracks, or loose material. Any loose, segregated, or defective areas should be repaired to the full thickness of the layer and re-compacted.

IS Sieve Designation	Percent by Weight Passing the IS Sieve					
	Grading I	Grading II	Grading III	Grading IV	Grading V	Grading VI
75.0 mm	100	-	-	-	100	-
53.0 mm	80-100	100	100	100	80-100	100
26.5 mm	55 –90	70-100	55-75	50-80	55-90	75-100
9.50 mm	35-65	50-80	–	–	35-65	55-75
4.75 mm	25 – 55	40-65	10-30	15-35	25-50	30-55
2.36 mm	20- 40	30-50	–	–	10-20	10-25
0.85 mm	–	–	–	–	2-10	–
0.425 mm	10-15	10- 15	–	–	0-5	0-8
0.075 mm	<5	< 5	< 5	< 5	–	0-3

Grading for Granular Sub Base

Aggregate Impact Value (AIV)	IS:2386 (Part 4) or IS:5640	40 maximum
Liquid Limit	IS:2720 (Part 5)	Maximum 25
Plasticity Index	IS:2720 (Part 5)	Maximum 6
CBR at 98% dry density (at IS:2720-Part 8)	IS:2720 (Part 5)	Minimum 30 unless otherwise specified in the Contract

Physical Requirements for materials for Granular sub base

Construction methodology & Material and grading Composition of CTSB Bed-

The stabilizing agent can be spread at the necessary dosage rate either manually or by machine. When using manual methods, bags of stabilizer are placed at specific intervals, opened, and then raked across the surface evenly. Precautions must be taken when spreading quicklime to protect the operators, especially when done manually. Lime, having a lower bulk density than cement, allows for a more uniform distribution when spread manually. The consistency of the stabilizer layer spread before mixing determines the uniformity of the final mixed material. Mechanical spreaders automatically control the amount of stabilizer spread, resulting in a more consistent distribution compared to manual spreading. It is essential to calibrate the equipment before use and regularly check to maintain the correct spread rate within specified limits.

Property	7-Day values
Compressive strength	300 – 800 psi (2.1 – 5.5 MPa)
Modulus of rupture	100 – 200 psi (0.7 – 1.4 MPa)
Modulus of elasticity	600,000 – 1,000,000 psi (4,100 - 6,900 MPa)
Poisson's ratio	0.15

Properties of CTSB

IS sieve size	Percentage by mass passing Sub-Base/Base within the range
53.00 mm	100
37.5 mm	95 – 100
19.0 mm	45 – 100
9.5 mm	35 – 100
4.75 mm	25 – 100
600 micron	8 – 65
300 micron	5 – 40
75 micron	0 – 10

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Gradation of CTSB

Figure CTSB Laying

Figure Spreading Cement For CTSB

Figure CTSB Laying

4.RESULTS AND DISCUSSION

The Pavement Compositions for New road Construction (Option-1) is shown in Table

Table Pavement Compositions for New Construction (Option-1)

Pavement Composition for New Construction							
Homogeneous Sections	**Design Traffic For 15 Years (MSA)**	**Design CBR (%)**	**Design Thickness (mm)**				
			BC	DBM	WMM	GSB	Subgrade
Option-1 BC+DBM+WMM+GSB	75	9	50	105	250	200	500

The Abstract Using GSB is showing in Table

Table Cost Abstract Using GSB

Sr. No.	**Description of Items**	**BOQ (Using GSB)**			
		Unit	**Rate (Rs)**	**Quantity**	**Amount (Rs)**
1	Construction of sub-grade and earthen shoulders with approved material obtained from borrow pits with all lifts & leads, transporting to site, spreading, grading to required slope and compacted to meet requirement of table No. 300-2	Cum	446	14210	**6337660**
2	Construction of granular sub-base by providing close graded Material, mixing in a mechanical mix plant at OMC, carriage of mixed Material to work site, spreading in uniform layers with motor grader on prepared surface and compacting with vibratory power roller to achieve the desired density, complete as per clause 401	Cum	1806	5524	**9976344**
3	Providing, laying, spreading and compacting graded stone aggregate to wet mix macadam specification including premixing the Material with water at OMC in mechanical mix plant carriage of mixed Material by tipper to site, laying in uniform layers with paver in sub- base / base course on well prepared surface and	Cum	2168	4717.5	**10227540**

	compacting with vibratory roller to achieve the desired density.				
4	Providing and applying primer coat with bitumen emulsion on prepared surface of granular Base including clearing of road surface and spraying primer at the rate of 0.60 kg/sqm using mechanical means.	Sq.m	22	18000	**396000**
5	Providing and applying tack coat with bitumen emulsion using emulsion pressure distributor at the rate of 0.20 kg per sqm on the prepared bituminous/granular surface cleaned with mechanical broom.	Sq.m	9	36000	**324000**
6	Providing and laying dense graded bituminous macadam with 100-120 TPH batch type HMP producing an average output of 75 tonnes per hour using crushed aggregates of specified grading, premixed with bituminous binder @ 4.0 to 4.5 per cent by weight of total mix and filler, transporting the hot mix to work site, laying with a hydrostatic paver finisher with sensor control to the required grade, level and alignment, rolling with smooth wheeled, vibratory and tandem rollers to achieve the desired compaction as per MORTH specification clause No. 507 complete in all respects.	Cum	6821	1890	**12891690**
7	Providing and laying bituminous concrete with 100-120 TPH batch type hot mix plant producing an average output of 75 tonnes per hour using crushed aggregates of specified grading, premixed with bituminous binder @ 5.4 to 5.6 per cent of mix and filler, transporting the hot mix to work site, laying with a hydrostatic paver finisher with sensor control to the required grade, level and alignment, rolling with smooth wheeled, vibratory and tandem rollers to achieve the desired compaction as per MORTH specification clause No. 509 complete in all respects	Cum	7629	900	**6866100**
	Total Amount				**47019334**

The Pavement Compositions for New road Construction (Option-2) is shown in Table

Table- Pavement Compositions for New road Construction (Option-2)

Pavement Design Options	Design Lane traffic Loading (msa)	Effective subgrade CBR for Design	Thickness (mm) as per IRC:37-2018			
			Designation of the Pavement Layer			
			Bituminous concrete (BC) with VG-40	Dense Bituminous Macadam (DBM) with VG-40	Wet Mix Macadam (WMM)	CTSB Layer Grading IV of Table 400-1
Option-2 BC+DBM+WMM+CTSB	75	9	50	75	150	200

The Abstract Using CTSB is showing in Table

Table 4.5.Cost Abstract Using CTSB

Sr. No.	Description of Items	BOQ Using CTSB			
		Unit	Rate (Rs)	Quantity	Amount (Rs)
1	Construction of sub-grade and earthen shoulders with approved material obtained from borrow pits with all lifts & leads, transporting to site, spreading, grading to required slope and compacted to meet requirement of table No. 300-2	Cum	446	13950	**6221700**
2	Construction of granular sub-base by providing close graded Material, mixing in a mechanical mix plant at OMC, carriage of mixed Material to work site, spreading in uniform layers with motor grader on prepared surface and compacting with vibratory power roller to achieve the desired density, complete as per clause 401	Cum	2391.01	5420	**12959274.2**
3	Providing, laying, spreading and compacting graded stone aggregate to wet mix macadam specification including premixing the Material with water at OMC in mechanical mix plant carriage of mixed	Cum	2168	2775	**6016200**

	Material by tipper to site, laying in uniform layers with paver in sub-base / base course on well prepared surface and compacting with vibratory roller to achieve the desired density.				
4	Providing and applying primer coat with bitumen emulsion on prepared surface of granular Base including clearing of road surface and spraying primer at the rate of 0.60 kg/sqm using mechanical means.	Sq.m	22	18000	**396000**
5	Providing and applying tack coat with bitumen emulsion using emulsion pressure distributor at the rate of 0.20 kg per sqm on the prepared bituminous/granular surface cleaned with mechanical broom.	Sq.m	9	36000	**324000**
6	Providing and laying dense graded bituminous macadam with 100-120 TPH batch type HMP producing an average output of 75 tonnes per hour using crushed aggregates of specified grading, premixed with bituminous binder @ 4.0 to 4.5 per cent by weight of total mix and filler, transporting the hot mix to work site, laying with a hydrostatic paver finisher with sensor control to the required grade, level and alignment, rolling with smooth wheeled, vibratory and tandem rollers to achieve the desired compaction as per MORTH specification clause No. 507 complete in all respects.	Cum	6821	1350	**9208350**
7	Providing and laying bituminous concrete with 100-120 TPH batch type hot mix plant producing an average output of 75 tonnes per hour using crushed aggregates of specified grading, premixed with bituminous binder @ 5.4 to 5.6 per cent of mix and filler, transporting the hot mix to work site, laying with a hydrostatic paver finisher with sensor control to the required grade, level and alignment, rolling with smooth wheeled, vibratory and tandem rollers to achieve the desired compaction as per MORTH	Cum	7629	900	**6866100**

The Comparative Cost Statement of CTSB and GSB is showing in Table

	specification clause No. 509 complete in all respects					
	Total Amount					**41991624.2**

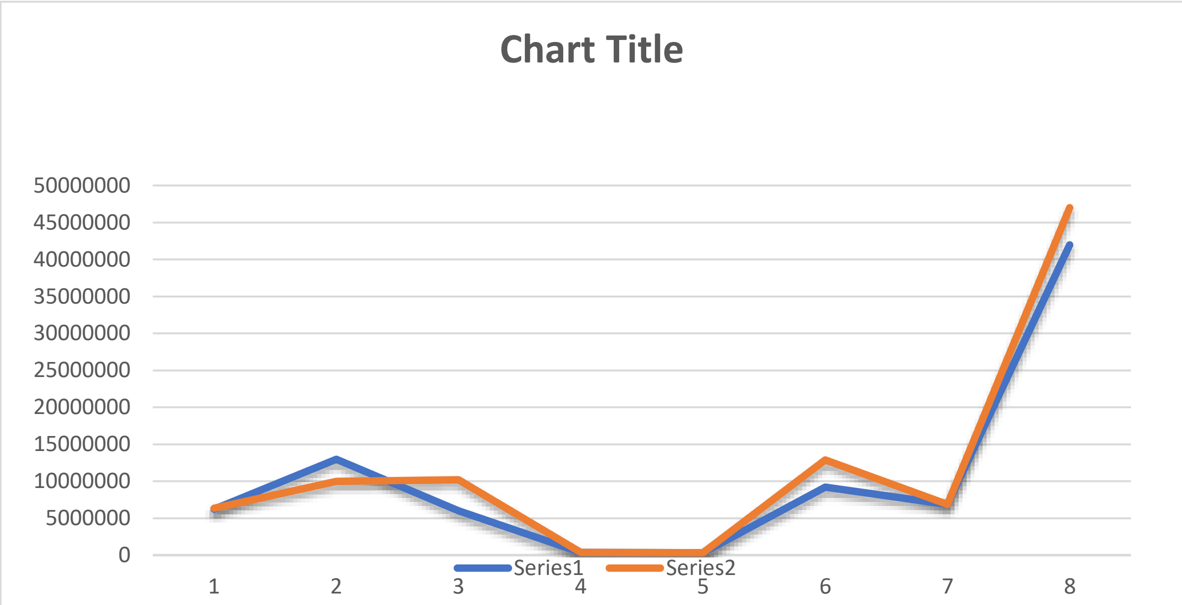
Table-

Comparative Cost Statement of CTSB and GSB

Sr. No.	Description of Items	Comparative Cost Statement				
		Unit	Rate (Rs)	Rate (Rs)	Amount (Rs) Using CTSB	Amount (Rs) Using GSB
1	Construction of sub-grade and earthen shoulders with approved material obtained from borrow pits with all lifts & leads, transporting to site, spreading, grading to required slope and compacted to meet requirement of table No. 300-2	Cum	446	446	**6221700**	**6337660**
2	Construction of granular sub-base by providing close graded Material, mixing in a mechanical mix plant at OMC, carriage of mixed Material to work site, spreading in uniform layers with motor grader on prepared surface and compacting with vibratory power roller to achieve the desired density, complete as per clause 401 (CTSB)	Cum	**2391.01**	**1806**	**12959274.2**	**9976344**
3	Providing, laying, spreading and compacting graded stone aggregate to wet mix macadam specification including premixing the Material with water at OMC in mechanical mix plant carriage of mixed Material by tipper to site, laying in uniform layers with paver in sub- base / base course on well prepared surface and compacting with vibratory roller to achieve the desired density.	Cum	2168	2168	**6016200**	**10227540**
4	Providing and applying primer coat with bitumen emulsion on prepared surface of granular Base including clearing of road surface and spraying primer at the rate of 0.60 kg/sqm using mechanical means.	Sq.m	22	22	**396000**	**396000**

5	Providing and applying tack coat with bitumen emulsion using emulsion pressure distributor at the rate of 0.20 kg per sqm on the prepared bituminous/granular surface cleaned with mechanical broom.	Sq.m	9	9	**324000**	**324000**
6	Providing and laying dense graded bituminous macadam with 100-120 TPH batch type HMP producing an average output of 75 tonnes per hour using crushed aggregates of specified grading, premixed with bituminous binder @ 4.0 to 4.5 per cent by weight of total mix and filler, transporting the hot mix to work site, laying with a hydrostatic paver finisher with sensor control to the required grade, level and alignment, rolling with smooth wheeled, vibratory and tandem rollers to achieve the desired compaction as per MORTH specification clause No. 507 complete in all respects.	Cum	6821	6821	**9208350**	**12891690**
7	Providing and laying bituminous concrete with 100-120 TPH batch type hot mix plant producing an average output of 75 tonnes per hour using crushed aggregates of specified grading, premixed with bituminous binder @ 5.4 to 5.6 per cent of mix and filler, transporting the hot mix to work site, laying with a hydrostatic paver finisher with sensor control to the required grade, level and alignment, rolling with smooth wheeled, vibratory and tandem rollers to achieve the desired compaction as per MORTH specification clause No. 509 complete in all respects	Cum	7629	7629	**6866100**	**6866100**
	Total Amount				**41991624.2**	**47019334**
			Difference Between Cost		**5027709.8**	
			difference in percentage		**10.693**	

Graphical representation of difference between CTSB and GSB Cost.



CONCLUSIONS

The following conclusions can be drawn from our study:

- Longer Life of pavements.
- Speed of the Project Completion is accelerated.
- Reduced Use of Aggregates.
- Less local construction traffic due to fast construction.
- Transportation/haulage is reduced.
- Reduced Project Cost (approx.10.67% Cost per KM)
- Reduced thickness of pavement.
- Reduction of bitumen consumption due to strong Sub Base.
- Aggregate consumption is less for the case of stabilized base compared to that of the conventional method.
- Uniform distribution of Load in Cement treated service road as compared to conventional road.
- Resistance against cracking and fatigue cracking.
- Best option in low lying water clogged area

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