e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:03/Issue:09/September-2021 Impact Factor- 6.752 www.irjmets.com

FINANCIAL REVIEW OF FLEXIBLE BITUMEN ROAD PAVEMENT MIXED WITH CEMENT FOR SURFACE BASE AND SUB BASE

Pankaj Dubey*1, Mukesh Kumar*2

*1PG Student, Department Of Civil At Jagannat University, Jaipur, India.

*2Assistant Professor, Department Of Civil At Jagannat University, Jaipur, India.

ABSTRACT

The countries of the world are developing rapidly and the infrastructure sector plays an important role in national development. Transportation is an important part of the infrastructure sector. Compared to waterways, railways and aviation, most countries rely on roads and highways for various modes of transport. In many developing countries, crushed stone and crushed stone are used as raw materials for paving work. These materials are in high demand and are not available in many areas. The Indian government is focusing on improving national roads and highways for fast transportation and transportation. Although this argument failed due to heavy traffic and pouring rain. This is also not true for urban areas. The amount of cementitious material added for the stabilization process. This report also discusses the need for buffers in concrete processing. This shows that this material can offer better durability and performance than traditional materials depending on the needs. Construction costs, material consumption, material transport costs, machine requirements and fuel costs are analyzed and compared on the basis of conventional concrete and material processing. The results show that CTB and CTSB methods can save additional construction costs. This report demonstrates the benefits of using concrete substrates and substrates over traditional substrates used in road construction.

Keywords: Cement Treated Sub-Base (CTSB); (CTB) Cement Treated Base; Flexible Pavement.

I. INTRODUCTION

As we know, India is a developing country and infrastructure is crucial for the success of developed countries. In India, both rural and urban areas are engaged in many infrastructural development activities, which has led to a shortage of building materials. The highway / road sector itself makes a significant contribution to the infrastructure. The flooring industry is looking for easily accessible and economically viable alternatives for road construction. A large number of roads on the road consume the mountains every day. To address this issue, the aim of this study is to design actual floor coverings and treatment layers and economically analyze their impact on the project. The cement and subcutaneous treatment area consists of a mixture of basic / whole (whole) materials and a certain amount of Portland cement. Not only is the use of concrete on the road surface economical, but it also helps to extend the lifespan of road projects. The use of cement in a bitumen layer becomes stronger and stronger than an unstable particle layer.

II. NEED OF STUDY

As we see significant general use in the road industry, the use of cement-treated concrete can have significant environmental benefits. It can reduce the total cost of the highway by reducing the thickness of the pavement. Even in view of the current state of road maintenance, unsustainable due to inflexible modules, the use of small concrete maintenance structures and small structures on motorways will be beneficial in the long run. Cemented panels also withstand more traffic than granular coatings. Cement-treated coatings can also prevent water leaks due to their good drainage properties. It can also withstand cold circuits, rain and weather damage on asphalt.

The actual road does not last long due to the low flex module, so it can be improved by using a smaller concrete structure and a smaller structure. Granular buses can carry less payload, but they can carry more. As the tonnage of the facility increases, the possible cost for small particles increases, but not for concrete-treated parts. If traffic is diverted from motorways to service roads due to maintenance work, the concrete subgrade can withstand greater traffic loads than small granular sections. CTB can handle water leaks from other sources due to its good drainage properties. Improved cracking and fatigue compared to the unsterilized granular base with cemented base. It is resistant to circuit screens, rain and weather than a gravel foundation for a busy road. Compared to the layers of untreated granulate, the cementitious concrete supports acquire resistance and increase with age, even with the passage.

III. OBJECTIVE OF STUDY

A comparative study of the rough granular layer and the layered flexible asphalt concrete was carried out. India is known as a developing country, due to its large infrastructure, ongoing construction activities lead to shortage of building materials. Using asphalt-concrete layers can be a cost-effective alternative for asphalt strength, increased strength, and total reduction. This not only saves money, but also increases the resistance of the road. A small amount of cement is added evenly to the particle layer in the flexible asphalt.

IV. METHODOLOGY

Pavement Composition of Flexible Pavement

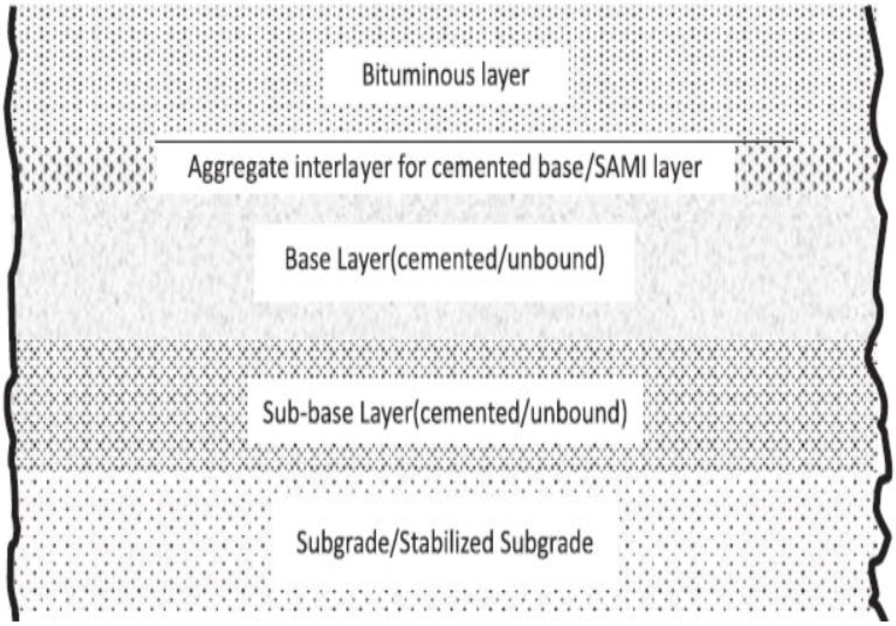


Fig 1: Layers of Flexible Pavement

The variation in the CBR values shall be considered in designing aspects. If the variation is found frequent along the road, the pavement shall be designed for lowest CBR value or different pavement layers shall be used as per design and CBR of the particular stretch.

Table 1: Permissible Variation in CBR Value

CBR (percent)	Maximum variation in CBR value
5	-1
05-Oct	-2
Nov-30	-3
>30	-5

- Effective CBR - When along the Highway there is large difference between the CBRs of the embankment soils & selected sub-grade (Borrow area), the design CBR shall be taken as effective CBR.

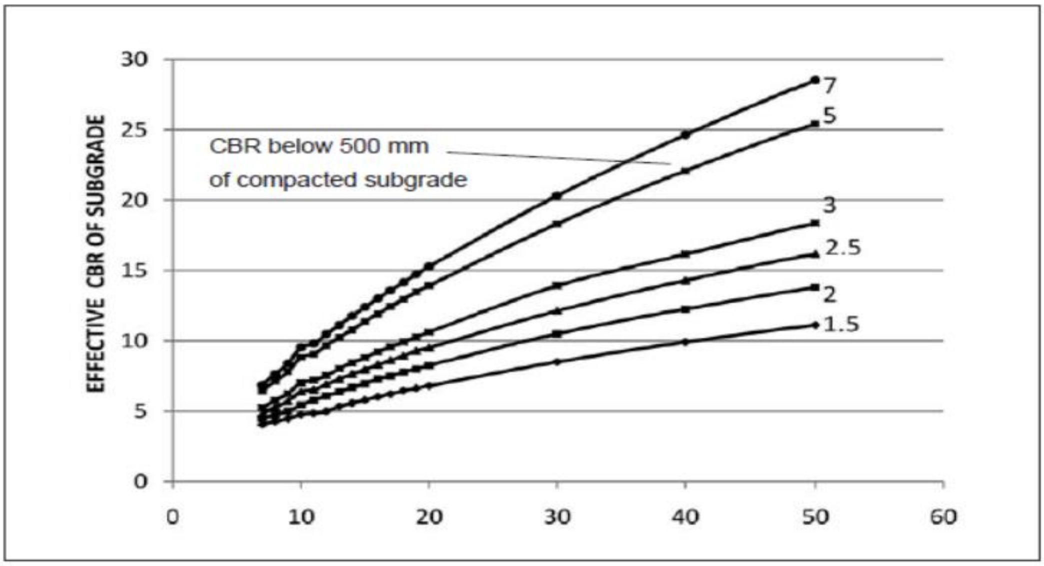


Fig 2: CBR of Compacted Borrow Material 500mm thick

The recommended resilient modulus values of the bituminous materials with different binders are given in Table below.

Table 2: Resilient Modulus of Bituminous Mixes, MPa

Mix Type	Temperature °C				
	20	25	30	35	40
BC & DBM for VG 10	2300	2000	1450	1000	800
BC & DBM for VG 30	3500	3000	2500	1700	1250
BC & DBM for VG 40	6000	5000	4000	3000	2000

Fig 3: Sieves for Gradation of Aggregates

Fig 4: Procter Test of Aggregates

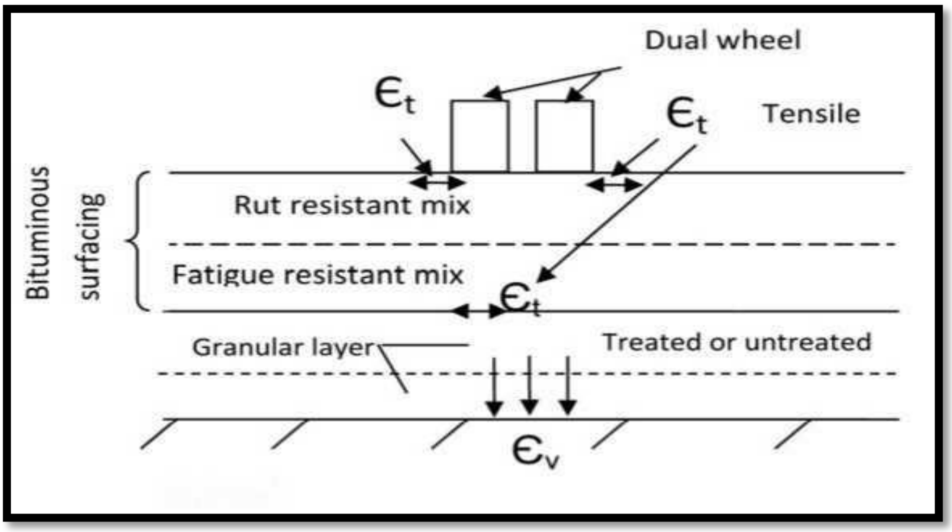


Fig 5: Stress & Strain over layers of Flexible Pavement

Table 3: Design Life as per Type of Road

S. No.	Type of Road	Minimum Design Life
1	National Highways & State highways	15 Years
2	Expressways and Urban Roads	20 Years
3	MDR, VR& other category roads	10-15 Years

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:03/Issue:09/September-2021 Impact Factor- 6.752 www.irjmets.com

Table 4: Lane Distribution Factor for various type of Roads

Type of Road	Number of Vehicle to be Designed
Single Lane Roads	100 %
Two Lane Single Carriageway	50 % of both the directions (If VDF is higher in one direction, higher VDF is considered)
Four Lane Single Carriageway	40 % of total commercial vehicles in both directions
Dual two lane Carriageway	75 % of total commercial vehicles in each directions
Dual three lanesCarriageway	60 % of total commercial vehicles in each directions
Dual four lane Carriageway	45 % of total commercial vehicles in each directions

Table 5: Vehicle Type-Axle Configurations

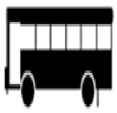
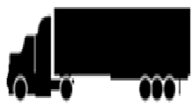
Class	Vehicle Type	Axle Configuration	Class	Vehicle Type	Axle Configuration
	LCV	1.1/1.2		4 Axle	1.1.22
	2 Axle	1.2		4 Axle	1.2.22
	3 Axle	1.22		4 Axle	1.222
	Bus	1.2/1.22		5 Axle	1.2.222
	5 Axle	1.22.22		6 Axle	1.22.222

Table 6: Sample Size for Axle Load Survey

Total number of Commercial Vehicles per day
< 3000
3000 to 6000
>6000

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:03/Issue:09/September-2021 Impact Factor- 6.752 www.irjmets.com

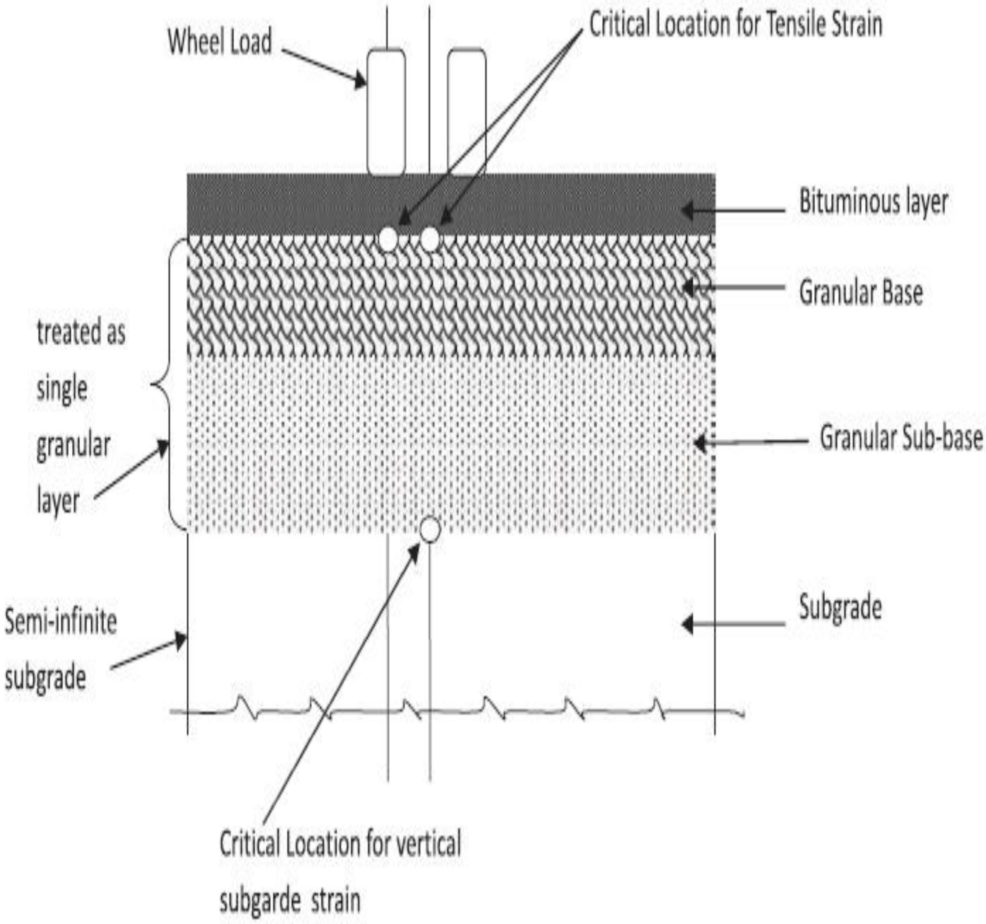


Fig 6: Three Elastic Layer of Bitumen Pavement & their Critical Locations for Strains

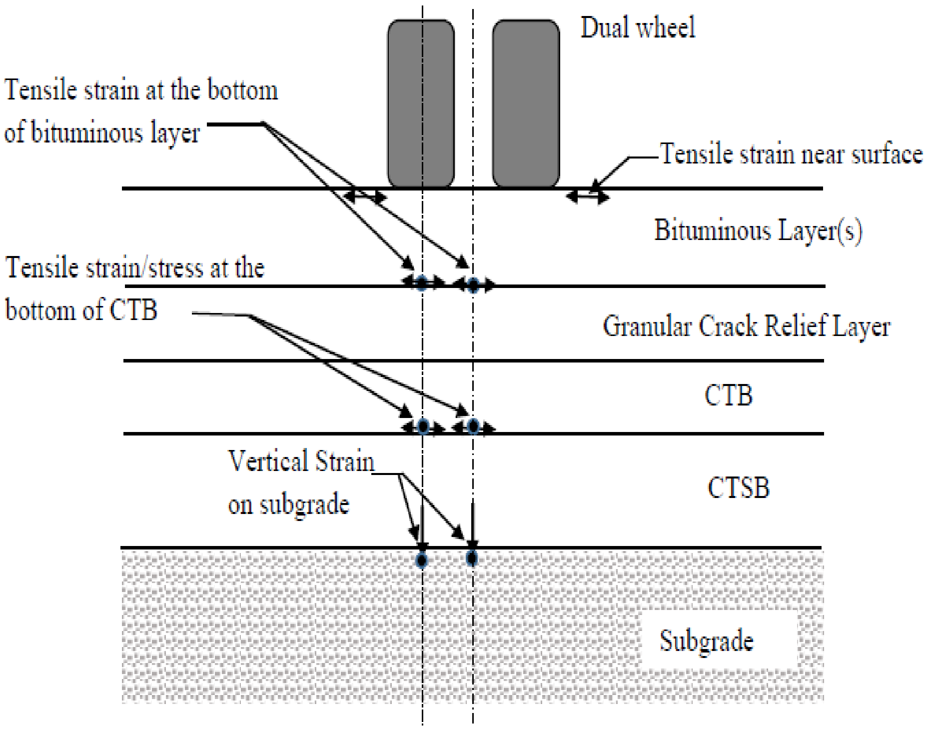


Fig 7: Five Layer of Cement Treated Granular Bitumen Pavement & their Critical Locations for Strains

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:03/Issue:09/September-2021 Impact Factor- 6.752 www.irjmets.com

V. RESULT

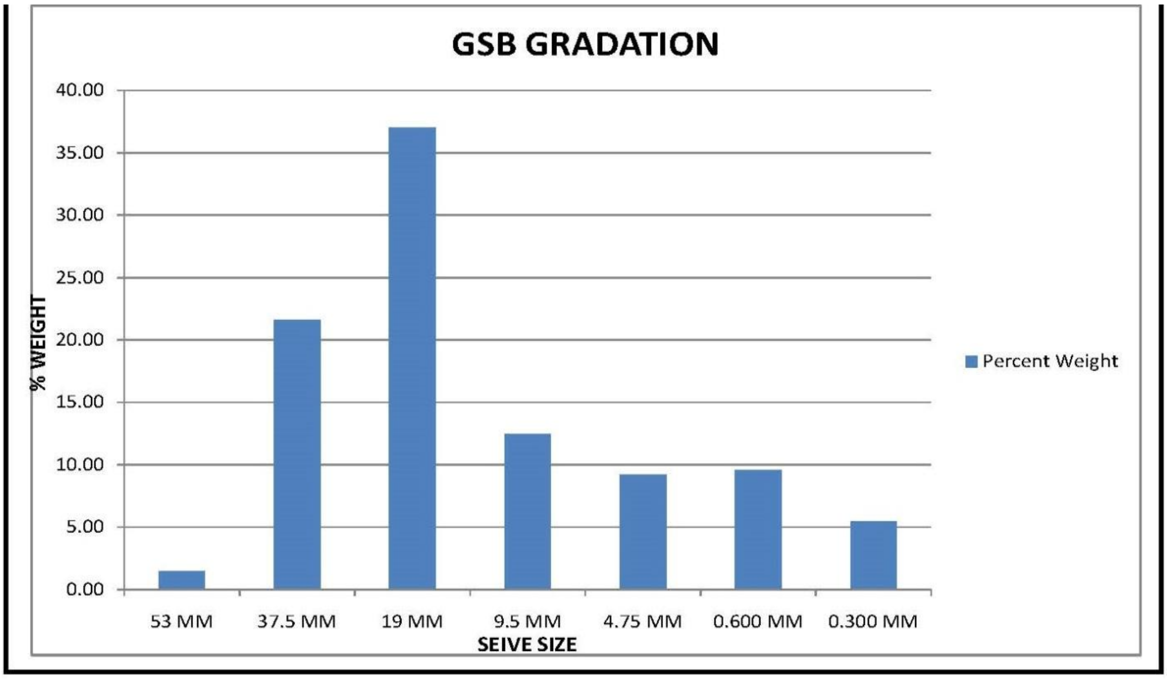


Fig 8: Tests For Granular Layer Materials

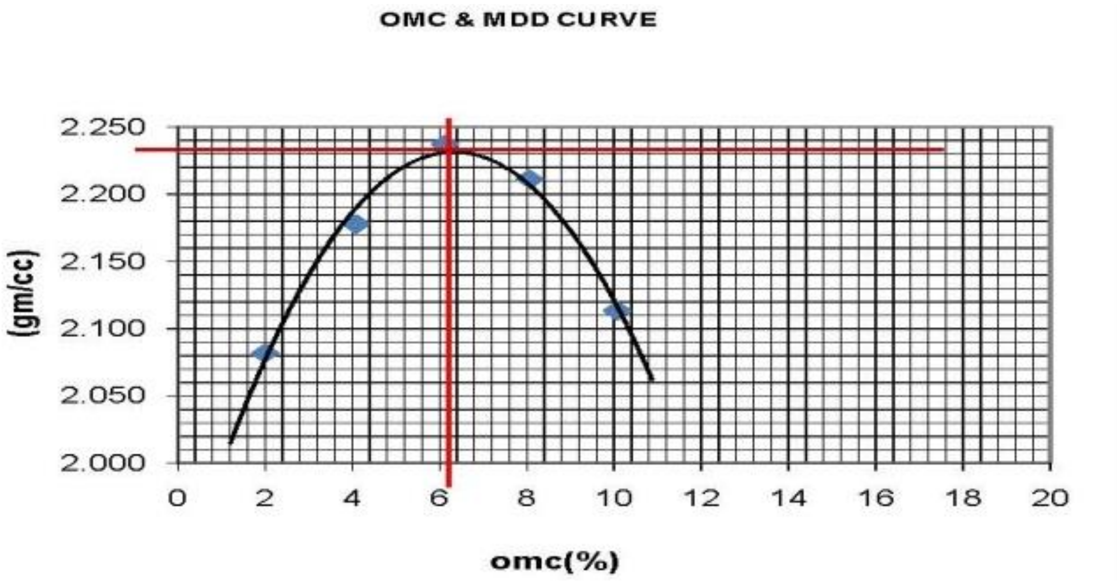


Fig 9: Maximum Dry Density Test by Modified Procter Test

Table 7: CBR Test Results of Untreated & Treated GSB Material

Sample No	Cement Treated	Cement Content	CBR VALUE %	
			2.5 mm	5.0 mm
1	NA	0	43.38	50.5
2	NA	0	38.17	51.09
3	NA	0	41.07	50.25
4	YES	1 %	87.44	105.18
5	YES	2 %	112.23	129.39
6	YES	3 %	152.49	157.18
7	YES	4 %	173.18	178.62
8	YES	5 %	173.18	200.4
9	YES	6 %	183.31	223.23

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:03/Issue:09/September-2021 Impact Factor- 6.752 www.irjmets.com

Table 8: VDF of Vehicles

SWAIMADHOPUR TO SYOPUR							
All Vehicle				Excluding Empty Vehicle			
Vehicle Type	No. of Vehicles	Total ESAL	VDF	Vehicle Type	No. of Vehicles	Total ESAL	VDF
2A	11	6.42	0.583636	2A	5	5.87	1.174
3A	65	1647.61	25.34785	3A	34	1668.12	49.06235
4A	9	119.5	13.27778	4A	6	108.59	18.09833
4LCV	2	0.08	0.04	4LCV	1	0.007	0.007
5A	5	89.76	17.952	5A	4	88.51	22.1275
6A	7	372.29	53.18429	6A	5	360.85	72.17
6LCV	6	0.68	0.113333	6LCV	4	0.58	0.145
BUS	23	38.13	1.657826	BUS	23	39.13	1.701304
SYOPUR TO SWAIMADHOPUR							
Vehicle Type	No. of Vehicles	Total ESAL	VDF	Vehicle Type	No. of Vehicles	Total ESAL	VDF
2A	14	38.89	2.777857	2A	5	31.39	6.278
3A	48	192.95	4.019792	3A	13	184.6	14.2
4A	14	370.1	26.43571	4A	10	365.11	36.511
4LCV	3	0.2047	0.068233	4LCV	0	0	0
5A	6	153.57	25.595	5A	6	151.93	25.32167
6A	4	1.60	0.4	6A	0	0	0
6LCV	14	7.87	0.562143	6LCV	6	6.99	1.165
BUS	16	30.14	1.88375	BUS	16	28.87	1.804375

COST ANALYSIS

Comparative Rate Analysis of Untreated & Cement Treated Granular Layer

Table 9: Comparative analyses for Untreated & Cement Treated Layer Cost

		Summary		% Cost Profit
CBR	10	Type of Pavement	Cost per KM	
MSA	30	Cement Treated Flexible Pavement	1,01,97,600	10.11%
		Flexible Pavement VG-40	1,13,45,350	

Trial 2					Cement Treated Aggregate Interlayer			
Sl. No.	Item	Unit	Length (m)	Width (m)	Depth (m)	Quantity	*Rate (INR)	Cost (INR)
1	CT Sub Base	cum	1000	10	0.2	2,000	1189	2378000
2	CT Base	cum	1000	10	0.07	700	1603	1122100
3	Primer Coat	sqm	1000	10		10,000	17	170000
4	Tack Coat	sqm	1000	10		20,000	9	180000
5	Aggregate Layer	cum	1000	10	0.1	1,000	1100	1100000
6	DBM	cum	1000	10	0.05	500	5291	2645500

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:03/Issue:09/September-2021 Impact Factor- 6.752 www.irjmets.com

7	BC	cum	1000	10	0.04	400	6505	2602000
							Total	₹ 1,01,97,600

Trial 3					Typical Granular Pavement			
					Depth (m)	Quantity	*Rate (INR)	Cost (INR)
1	GSB	Cum	1000	10	0.2	2,000	603	1206000
2	WMM	Cum	1000	10	0.25	2,500	1076	2690000
3	Primer Coat	Sqm	1000	10		10,000	17	170000
4	Tack Coat	Sqm	1000	10		20,000	9	180000
5	DBM	Cum	1000	10	0.085	850	5291	4497350
6	BC	Cum	1000	10	0.04	400	6505	2602000
						Total	₹ 1,13,45,350	

Cost analysis for the project NH-552 using Cement Treated Base & Sub Base

Table 10: Comparative Analyses for Untreated & Cement Treated Project Cost

Description	Percentage	**Actual Amount**	**After using Cement Treated Layer @ 9% saving**
Road works	40.61%	₹ 53,54,83,460.00	₹ 48,13,46,082.19
Minor Bridge	2.43%	₹ 3,20,41,980.00	₹ 2,88,02,535.82
Major Bridge	41.40%	₹ 54,59,00,400.00	₹ 49,07,09,869.56
Other Works	15.56%	₹ 20,51,74,160.00	₹ 18,44,31,052.42
Total	100.00%	₹ 1,31,86,00,000.00	₹ 1,18,52,89,540.00
Total Saving in Cr		₹ 13,33,10,460.00	
Total Saving in %		10.11%	

VI. CONCLUSION

Reduced Project Cost: Reduction in Pavement thickness of Pavement Layers ultimately reduces the project cost. In lonfg stretches of Roads, reduction in thickness of the pavement affect diversely the whole project cost.

Reduced thickness of pavement: Thickness of pavement of Cement Treated Layer in Pavement 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.

Longer Life of pavements: A small content of cement in pavement layers can reduce sub-grade stresses more than a thicker layer of untreated aggregate base. Sub-grade failures, potholes, and road roughness are thus reduced. Cement Treated Layers provides a durable, long-lasting base in all types of climates. In view of future aspect from point of view of engineering, it is designed to resist damage caused by cycles of wetting and drying and freezing and thawing.

Speed of the Project Completion is accelerated: As the thickness of the pavement is reduced, quantity of aggregates which will be required will reduce which will ultimately accelerate the progress of the project.

Reduced Use of Aggregates: Reduction in pavement thickness will reduce the quantity of Aggregate.

Transportation/haulage is reduced: Transportation cost of the project affect the overall cost of the project. Reduction in quantum of aggregate will also reduce the transportation cost.

Reduction of bitumen consumption due to strong Sub-Base: As seen from the pavement design using cement Treated Base & Sub-Base, also reduces the thickness of Bitumen Layer. The strong uniform supported Cement Treated Base& Cement Treated Sub-Base reduces the thickness of Bitumen Layer.

Uniform distribution of Load in CTS road as compared to conventional road: Cement Treated Layers's slab-like characteristics and beam strength are unmatched by granular bases that can fail when interlock is lost of completed Cement Treated Layers showing the tightly bound soil/aggregate.

Resistance against rutting and fatigue cracking: Rutting is reduced in a Cement Treated Layers pavement. Generally Heavy & continuous Loads from channelized traffic will displace unbound granular material beneath flexible surface pavements making a rutted surface.

Best option in low lying water clogged area: Moisture intrusion can destroy unstabilized pavement bases, but not when cement is used to bind the base. CTB pavements form a moisture-resistant base that keeps water out and maintains higher levels of strength, even when saturated, thus reducing the potential for pumping of sub-grade soils.

VII. REFERENCES

[1] Aher D.D, Sangale Y.B., Pagar S.R., Yadnesh Patil, Rahul Rayate,"Cement Treated Sub-Base For Bituminous Pavement", Published at 6th International Conference on Recent Trends in Engineering & Technology 2018 (ICRTET- 0171).Pg 875-880.D. Kornack and P. Rakic, "Cell Proliferation without Neurogenesis in Adult Primate Neocortex," Science, vol. 294, Dec. 2001, pp. 2127- 2130, doi:10.1126/science.1065467.

[2] Portland Cement Association, Cement Treated Base.

[3] A.S. Balsubramaniam, G.W.K. Chai, E.Y.N. Oh, "In-situ stabilization of Road base using Cement- Case study in Malaysia", School of Engineering, Griffith University Gold Coast). Campus, Gold Coast, Queensland 9726, Australia

[4] Indian Road Congress, 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).

[5] Maricopa Association of Government Uniform Standard Specification, (2014) "Placement & Construction of Cement Treated Sub-grade", Section 311-2014 Revision of the 2012 Edition.

[6] Jaritngam, Somchainuek and P. Taneerananon, (2014), "Feasibility of Lateritecement mixture as pavement base course aggregate", IJST, Transaction of Civil Engineering, Vol. 38, C1, pp. 275-284.

[7] Ministry of Rural Development, Quality Assurance Hand book for Rural Roads, Construction of Cement Stabilized Sub-Base/Base.

[8] Ministry of Roads, Highways and Transport, 5th revision, Government of India.

[9] Udhara Ashani Dewalegama, Shivani Sharma, S.N.Sachdeva (2018) "Thickness Reduction in Flexible Pavement Using Cement Treated Base and Sub-Base" International Journal of Research and scientific Innovation (IJRSI) ,Volume V, Issue III, Pg 183-186.

[10] Sovina Sood, Shikha Bansal, "Evaluation of Construction Materials for Soil Stabilization in Road Making Industry- A Techno Economic Study", International Journal of Engineering Research & Technology (IJERT),Volume 4 ,Issue 05, May 2015,Pg.404-410.

[11] Paul A. Dixon, W Guthrie, Dennis L. Eggett, (2012), "Factors affecting the strength of Road Base Stabilized with Cement Slurry or Dry Cement in Conjunction with Full Depth Reclamation", TRB Annual Meeting, Paper No. 12-2216.

[12] M. Jayakumar and Lau Chee Sing, "Experimental Studies on Treated Sub-Base Soil with Fly Ash and Cement for Sustainable Design recommendations", International Scholarly and Scientific Research & Innovation(2012), Volume-6,No- 8, Pg 611-614.