iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** V **Month of publication:** May 2022

DOI: https://doi.org/10.22214/ijraset.2022.43487

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue V May 2022- Available at www.ijraset.com

A Comparative Study of Cement-Treated Sub-Base and Granular Sub-Base

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Abstract: ***It's no secret that countries around the world are fast progressing, and the infrastructure sector plays a critical role in this process. The infrastructure sector is heavily dependent on transportation. Compared to rivers, trains, airlines, and other modes of transportation, the majority of countries rely on roads and highways for transportation of all types. Crushed rock and murrum are common subbase materials for road construction in underdeveloped nations. In many locations, these materials are scarce and difficult to obtain.***

Fast transportation and conveyance are a top priority for India's Ministry of Road Transport and Highways (MoRTH). As a result, there is an enormous demand for building materials. The expense of producing the base layer material used in pavements, including as drilling, blasting, crushing, and transporting, makes it an expensive choice. However, when subjected to high traffic and/or strong weather, this material does not hold up. In addition, it is difficult to find in urban regions. Among the topics covered in this research are, the strength parameters of the road, total cost of construction and the time required for its construction.

Comparative study of CTSB and GSB is explained in this paper. As a result, this material saves on construction costs by reducing the thickness of the crust. The Unconfined compressive strength, California bearing ratio of the cement-treated basis and sub-base is tested and results are obtained. It demonstrates that this material has superior strength and performance than that of typical materials when compared to those requirements. The CTSB methods saved the most money on construction costs of road, as evidenced by the findings. Using cement-treated foundation and sub-base instead of typical base material for road construction is shown in this paper.

Keywords: Cement Treated Sub base (CTSB), Granular Sub-Base (GSB), California Bearing Ratio, Unconfined compressive Strength, Performance Analysis.

I. INTRODUCTION

Today, India is the world's fastest-growing economy. The development of a country depends heavily on its ability to get people and goods around. To ensure speedier conveyance of all goods, materials, and cities, the interconnectedness of capital, ports, and industrial zones must be well-connected.

Motorways, railroads, and canals are all part of the transportation industry. Roads are essential for all modes of transportation in India. The material used for base layers in pavements is costly as it requires production cost i.e., drilling, blasting, crushing, transportation etc.

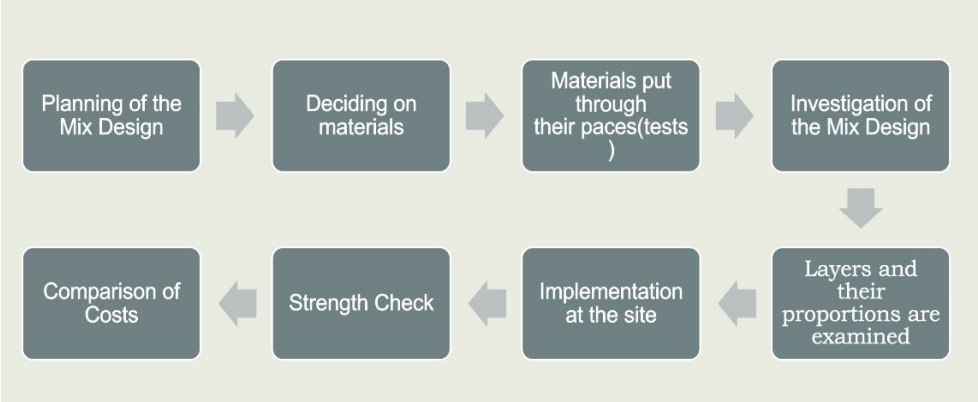
Cement-Treated Sub-bases are the non-conventional pavement layers used for improving the mechanical characteristics of base and sub-base courses. With the usual construction approach, GSB WMM as a base layer, the amount of material needed is also quite large, which raises both the material and overall cost of the project. Reduce the pavement's thickness by using an alternative base layer to save on both material and financial costs as well as increase efficiency.

II. OBJECTIVES OF STUDY

1) To see how CTSB technology affects the thickness of the flexible pavement.
2) To study the strength parameters and thickness parameters.
3) Compare the total cost analysis for CTSB method over conventional method.
4) Calculate speed of project completion with quality.

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III.METHODOLOGY ADOPTED

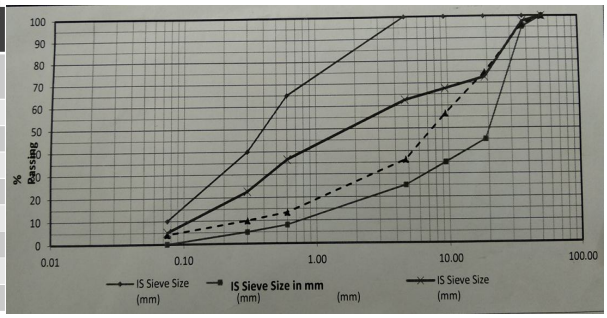


A. Test Conducted for Checking the Strength Parameters of Cement Treated sub base and Granular Sub-Base.

The OMC is calculated by the Procter Test after the Sub-Base material has been graded in accordance with MoRT&H guidelines. The granular material is then tested for CBR, and the CBR is then tested after the granular material has been treated with Cement of Proportion 2%, 3%, 4% and 5%, respectively. UCS Test is also conducted on CTSB for checking of strength parameter.

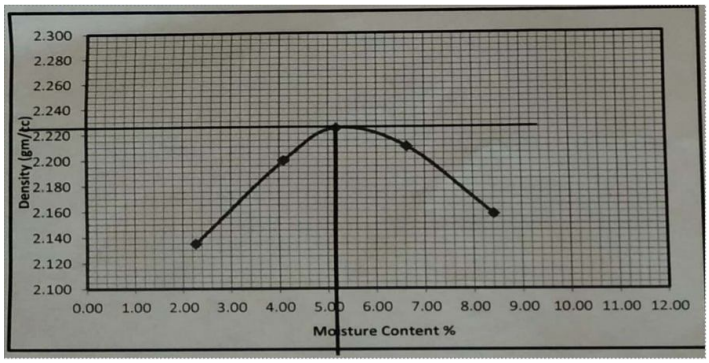
1) *Gradation Test:* For Gradation, the granular material is collected from the given site and gradation of those materials is conducted. % Retained over different sieves of the material is shown in the table and graph given below.

IS Sieve Size (mm)	Specification Limit as MORTH Table 400-4			% of passing
	Mid Value	Lower Value	Upper Value	
53.00	100.00	100.00	100	100
37.50	97.50	95	100	96.29
19.00	72.50	45	100	74.57
9.50	67.50	35	100	56.41
4.75	62.50	25	100	36.14
0.600	36.50	8	65	13.33
0.300	22.50	5	40	9.91
0.075	5.00	0	10	4.04



The sample is well-graded. Well graded means soil particles of sizes are present.

2) *Optimum Moisture Content:* Optimum Moisture Content for achieving maximum density of granular material is calculated by Modified Proctored Test. Water Content is added until maximum density is achieved. Curve for OMC is shown in the figure below.



MDD = 2.225 g/cc
OMC = 5.20 %

3) California Bearing Ratio Test: CBR test is conducted for both CTSB & GSB. The results for them are given in the table below.

Sample No.	Cement Treated	Cement Content	CBR Value %	
			2.5 mm	5.0 mm
1.	NA	0	37.44	44.87
2.	NA	0	30.04	42.88
3.	NA	0	32.84	42.09

Sample No.	Cement Treated	Cement Content	CBR Value %	
			2.5 mm	5.0 mm
1.	YES	2 %	106.23	125.70
2.	YES	3 %	147.63	150.50
3.	YES	4 %	168.50	178.49

4) Unconfined Compressive Strength Test: UCS test is conducted only on CTSB for checking the strength parameter. The results of it are given in the table below.

Sr.no.	Cube No.	Weight of the cube (g)	Density of Cube (g/cc)	Failure Load (kN)	Comp. Strength (N/mm^2)	Unconfined Compressive Strength	Average Value of (UCS) (N/mm^2)
1.	1.	8344	2.472	147	6.53	6.53	
2.	2.	8084	2.395	131	5.82	5.82	6.31
3.	3.	8199	2.429	148	6.58	6.58	

B. Cost Comparison.

Cost comparison is done of CTSB and GSB for 1 Km construction of road as per 2021 SSR rates.

TABLE I

SAVING IN COST

Sr. no.	Composition of Pavement	Cost per Km. (in Lakhs) (2 x 8.5 m)	% Reduction
1.	Conventional Method	476.61	31.15% saving on cost
2.	CTSB Method	328.13	

TABLE II

SAVING IN MATERIAL

Sr. no.	Composition of Pavement	Crust Thickness (in mm)	% Reduction
1.	Conventional Method	680	27.21 % saving in quantities
2.	CTSB Method	495	

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C. Time of Construction

Time of construction for GSB is:

1) Earthwork - Requires 3-4 days
2) Gradle – Requires 2-3 days
3) Modified penetration Macadam – 2-3days (Keep open for traffic for at least 7 days)
4) Bituminous Macadam – 2 days
5) Bituminous concrete – 2 days

So, in total of 25-30 days are required for the DBM road of 1 km using advanced machinery.

Time of construction of CTSB is:

a) Earthwork – Requires 1-2 days
b) Cement Spreading – 1/2 day
c) Mixing by CTSB machine – 1/2 day
d) Curing (sprinkling water) – 7 days
e) Laying with paver and compaction – 1 day
f) Rolling – 1-2 days

So, in total of 10-12 days are required for the construction of 1 km road by CTSB technology.

D. Figures



Fig. 1 Cement Spreading



Fig. 2 Mixing with CTSB machine



Fig. 3 Curing



Fig. 4 Paver



Fig. 5 Rolling



Fig. 6 CTSB road

IV. RESULTS

Sr. No.	Property	Granular Sub-Base	Cement Treated Sub-Base
1.	Crust Thickness	680	495
2.	CBR value for 5mm penetration (in %)	43.28	151.56
3.	UCS at 7 days for 150mm cube	4.20 MPa	6.31 MPa
4.	Cost of construction (per Km)	1,11,83,334.23	1,01,34,214.32
5.	Time of construction (per Km)	25-30 days	10-12 days

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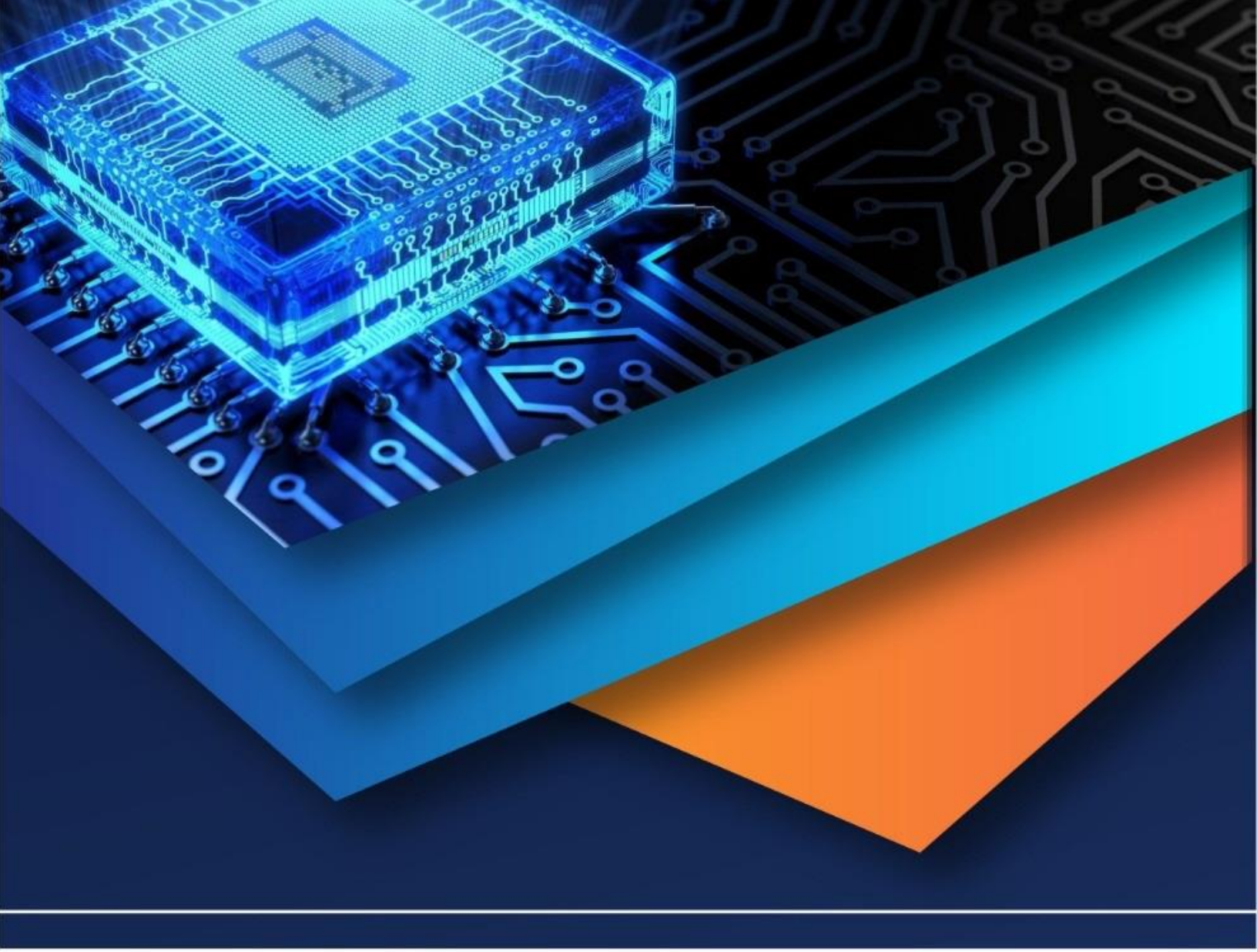
V. CONCLUSIONS

1) Project cost reduced by nearabout 30% using CTSB as compared to conventional method.
2) Accelerated speed of the project completion with 40% less time required.
3) Because CTSB has a higher bearing strength than unbound granular base, the base thickness is lowered by almost 400 mm.
4) Due to a robust Sub Base, bitumen use is reduced.

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