iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 7 Issue: V Month of publication: May 2019

DOI: https://doi.org/10.22214/ijraset.2019.5328

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 7 Issue V, May 2019- Available at www.ijraset.com

Design of CTSB & CTB Cubes and its Analysis

Sanjay Singh[1], Animikh banerjee[2], Leevesh Kumar[3]
[1, 2]B. Tech, [3]Assitant Professor, Civil Engineering, 4thYear, Career Point University, Kota, Rajasthan, India.

Abstract: Present service roads are less durable due to its less elasticity modulus, so by use of cement treated base or 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 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 unstabilized granular base to cement treated base. It resists cyclic freezing, rain, and spring-weather damage, when compared with granular base of service road. Cement-treated base continues to gain strength with age even under traffic, when compared.

It is necessary to study the characteristics of properties of the material, testing its feasibility, the test on various parameters of material, strength etc. It will help to design the cement treated base and sub base layers for service road, to improve the strength properties of layers with addition of cement. The objective of the present study is to develop Comprehensive guidelines for pavement design for rural roads using CTB/CTSB.

Keywords: Cement Treated Sub-Base (CTSB), Cement Treated Base (CTB), Flexible Pavement, Stabilization Performance Analysis, Thickness.

I. INTRODUCTION

In India, due to massive infrastructure construction activities are taking place both in rural and urban area have caused scarcity of construction materials.

The pavement industry looks for ways of improving lower quality materials that are readily available for use in road way construction. Cement /lime treatment has become an accepted method for increasing the strength and durability of soils and marginal aggregates, reducing quantity of aggregates. Indian roads congress (IRC) developed a special publication for mix design of base/ subgrade.

No pavement design guideline is presently available cement treated sub base. To overcome this problem, the objective of present research work is to develop a pavement design chart using cement and lime stabilized sub base for rural and urban roads with light and medium traffic (up to 50 MSA). It not only saves money but also helps to increase life cycle of roads.

This report consists of the study of reasons of failure of the flexible pavements. The materials used for the pavement construction in traditional method.

The problems associated with these materials. This study explains the mechanism of Cement Treated Base/Sub-base. The quantity of the cementatious material required to be added for stabilization process.

II. RESEARCH METHODOLOGY

This report consists of study of the reasons of failure of flexible pavements in India. Also the conventional materials used for the construction of layers in flexible pavements. The cement treated bases and sub-bases is studied. The unconfined compressive strength for the various combinations of cementatious materials to be added in GSB material is checked and its performance is compared with the traditional method of construction of flexible pavements. Comparison is done on the basis of following factors:

A. Quantity of materials required: The quantity of materials required for construction of 1 Km long and 7.5 m wide highway with CTB/CTSB method and traditional method is compared.

B. This chapter briefly summarizes the findings of studies performed at the Center for Highway Research and by other investigators in two major areas pertaining to cement-treated materials: factors affecting the tensile strength of cement-treated soil and shrinkage characteristics of cement-treated base materials. In addition, two mix design procedures are reviewed. The findings concerning tensile strengths are evaluated in more details.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 7 Issue V, May 2019- Available at www.ijraset.com

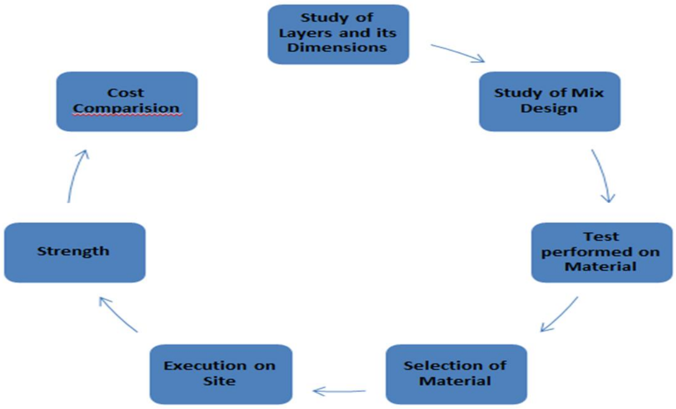

Fig.1 Methodology

A. Mix Design

1) Mix Design Of Cement Treated Base (CTB)

a) Physical and chemical testing of aggregate, cement, water.
b) Selection of Proportion of Material like 20mm, 10mm, dust and cement (% weight) to form CTB is done with the help of MORTH table 400-4.
c) Sieve Analysis of final CTB is done and compared with MORTH table 400-4.
d) Then, Modified Proctor test is done to determine Max. Dry Density (MDD) and Optimum Moisture Content with min cement percentage of CTB according to IS 2720 (Part 8).
e) Find Liquid Limit, Plastic Limit and Plasticity Index according to IS 2720 (part 5).
f) Plasticity Modulus and Product are determined according to IS 2720 (part 5).
g) Find Uniformity Coefficient as specified.
h) Water absorption of 20mm,10mm and dust is find out according to IS 2386 (part 3).
i) Then cubes are casted with the help of Vibro Hammer.
j) It is cured for 7 days and its strength is measured with the help of Compressive Testing Machine.
k) If all Results are found within limits as specified, then Design of CTB material is finalized.

2) Mix Design Of Cement Treated Sub Base (CTSB)

a) Physical and chemical testing of aggregate, cement, water.
b) Selection of Proportion of Material like GSB, dust and cement (% weight) to form CTSB is done with the help of MORTH table 400-4.
c) Sieve Analysis of final CTSB is done and compared with MORTH table 400-4.
d) Then, Modified Proctor test is done to determine Max. Dry Density (MDD) and Optimum Moisture Content of CTSB with min. cement content according to IS 2720 (Part 8).
e) Find Liquid Limit, Plastic Limit and Plasticity Index according to IS 2720 (part 5).
f) Plasticity Modulus and Product are determined according to IS 2720 (part 5).
g) Find Uniformity Coefficient as specified.
h) 10% Fines value is determined according to IS 2386 (Part 4)
i) Water absorption of material larger and less than 10mm in size is found out according to IS 2386 (part 3).
j) Then cubes are casted with the help of Vibro Hammer.
k) Cubes are cured for 7 days and its 7 days Unconfined Compressive Strength (UCS) is measured with the help of Compressive Testing Machine.
l) Two extra cubes are casted for Soundness Test. It is subjected to 12 cycles of wetting and drying consisting of immersion in water for 5 hours followed by drying at 71degree Celsius. After each cycle specimens are brushed with scratch wire brush (18-20 strokes on the sides and 4 strokes at each end). The loss in weight of brushed specimen is determined. Parallel test of volume and moisture changes of specimens after each cycle is recorded.
m) If all Results are found within limits as specified, then Design of CTSB material is finalized.

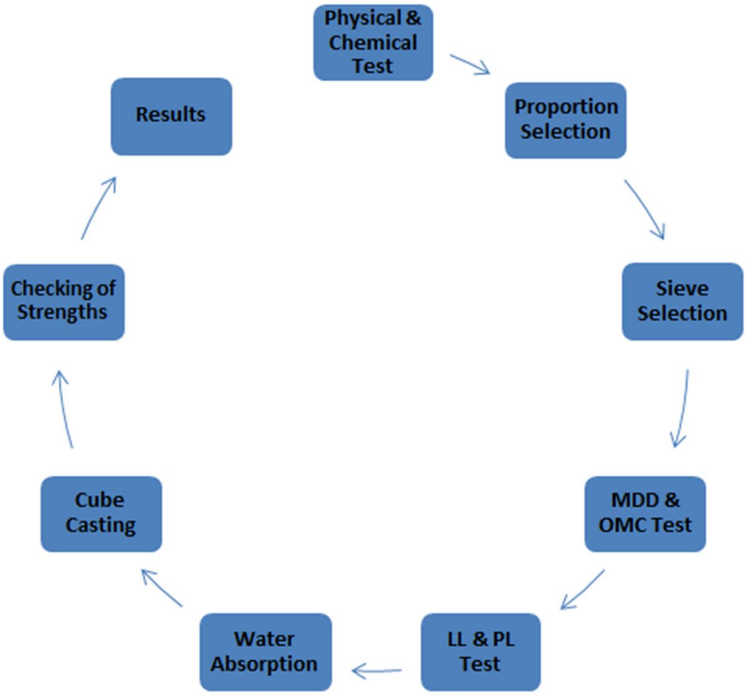

Fig.2 Process Cycle of CTB and CTSB

III. DATA AND ITS ANALYSIS

A. *Unconfined Compressive Strength Tests (CTB)*

As per the Clause 403.2.6 of MoRTH the quantity of cement added shall not be less than 2% by weight of the dry soil. The design mix shall be done on the basis of 7 day unconfined compressive strength (UCS) and/or durability test under 12 cycles of wet-dry conditions. The laboratory strength values shall be at least 1.5 times the minimum field UCS value. The mix design shall be done to achieve strength of 1.75 MPa when tested on cylindrical specimens compacted to the density at optimum moisture content, tested in accordance with IS: 2720 after 7 days moist curing.

Table1. Material Composition in CTB

Material	All-in-Aggregate	Stone Dust
Proportions	90%	10%

1) *Sieve Analysis*

Table2. Material Composition in CTB

IS Sieve Size in mm	53.00	37.50	19.00	9.50	4.75	0.60	0.300	0.075
Average % of Passing	100.00	98.98	80.82	55.28	44.68	14.94	10.58	5.11
Specification Limits	100	95-100	45-100	35-100	25-100	08.-65	05.-40	0-10

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 7 Issue V, May 2019- Available at www.ijraset.com

2) Physical Properties

Table3. Physical Properties of CTB Material

TEST		ACHIEVED	SPECIFIED
i) Modified Proctor (With Cement 4.00% by wt. of Mix)			
Maximum dry density (MDD)		2.480 gm/cc	-
Optimum Moisture content (OMC)		6.45%	-
ii) Plastic Index		Non Plastic	Max. 6 %
iii) Plasticity Product		Non Plastic	Max. 60
iv) Uniformity Coefficient		44.00	>10
v) Water absorption			
All-in-Aggregate above 9.50		1.16%	Max. 2 %
All-in-Aggregate below 9.50		1.72%	Max. 2 %
vi) Aggregate Impact Value		10.00%	Max. 40 %
vii) 7 Days Unconfined Compressive Strength (UCS) as per IRC 37, IRC:SP 89 & MORT&H	Cylindrical Cube	5.149 N/mm2	1.75 N/mm2 as Per MORT&H Clauses 403.2.6
	150MM Cube	7.36 N/mm2	4.5 to 7.0 N/mm2

B. Unconfined Compressive Strength Tests (CTSB)

Table4. Material Composition in CTSB

Material	40MM	20MM	10MM	Dust
Proportions	25%	16%	24%	35%

1) Sieve Analysis

Table5. Material Composition in CTSB

IS Sieve Size in mm	53.00	37.50	19.00	9.50	4.75	0.60	0.300	0.075
Average % of Passing	100.00	96.86	74.75	56.68	39.91	13.85	8.85	5.62
Specification Limits	100	95-100	45-100	35-100	25-100	08.-65	05.-40	0-10

2) Physical Properties

Table6. Physical Properties of CTSB Material

TEST		ACHIEVED	SPECIFIED
i) Modified Proctor (With Cement 2.410% by wt. of Mix)			
Maximum dry density (MDD)		2.410 gm/cc	-
Optimum Moisture content (OMC)		6.10%	-
ii) Plastic Index		Non Plastic	Max. 6 %
iii) Plasticity Product		Non Plastic	Max. 60
iv) Uniformity Coefficient		36.67	>10
v) Water absorption			
40MM		0.71%	Max. 2 %
20MM		0.93%	Max. 2 %
10MM		1.16%	Max. 2 %
Stone Dust		1.62%	Max. 2 %
vi) Aggregate Impact Value		10.26%	Max. 40 %
vii) 10% Fine Value		209.27 KN	Min-50KN
viii) 7 Days Unconfined Compressive Strength (UCS) as per IRC 37 & IRC SP 89	150MM Cube	5.79 N/mm^2	1.5 to 3.0 N/mm2
ix) Elastic Modulus E for Cement Treated Sub Base at 7 Days Strength		5790	2000 to 4000 MPA

IV. RESULT AND DISCUSSION

Following are the combinations of Cement are used for trials with results achieved:

A. DLC Hammer Casting

Table7. Combinations used for trials by DLC Hammer Casting

Sr. No.	Percentage of Cement	Unconfined Compressive Strength for 7 days of Curing (MPa)
1	2.410	5.79
2	4	7.36

B. Resulting Points

1) *Use of CTB/CTSB Method in Construction of Flexible Pavement Results in Minimizing crust Thickness, Hence it Reduces the Requirement of Material:* Following graph shows the comparison of crust thickness for CTB/CTSB method and traditional method. It shows the thickness of WMM and DBM layer is reduced by CTB/CTSB method.

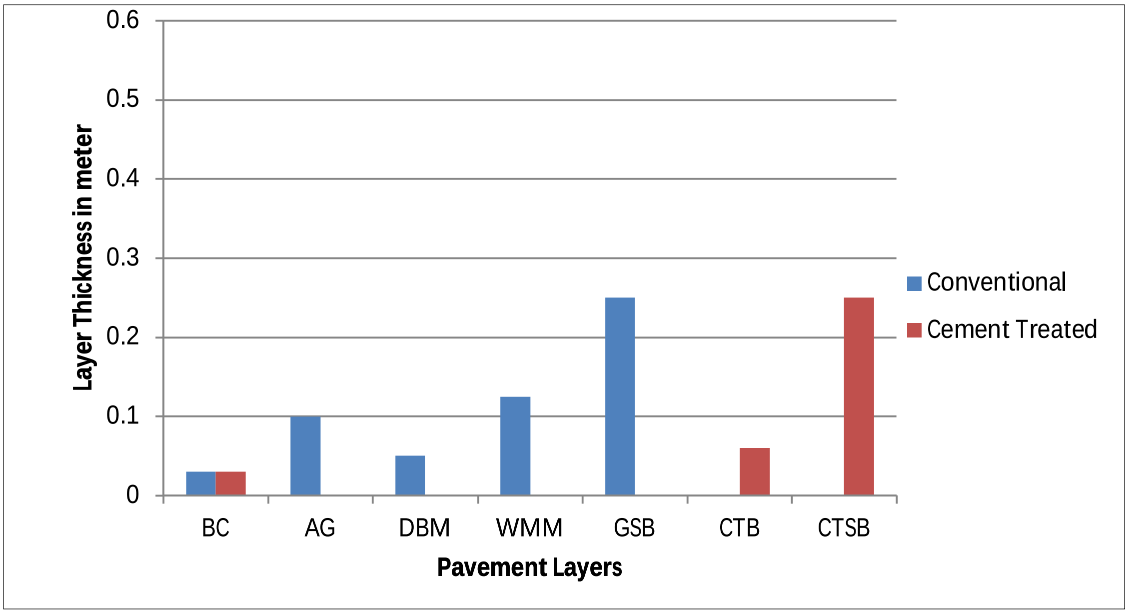

Fig.3 Layer Thickness Graph

2) *Required Quantity of Material:* The required quantity of material for each layer in both the methods is different. Following figure shows the difference of quantity of material required for both methods in each layer.

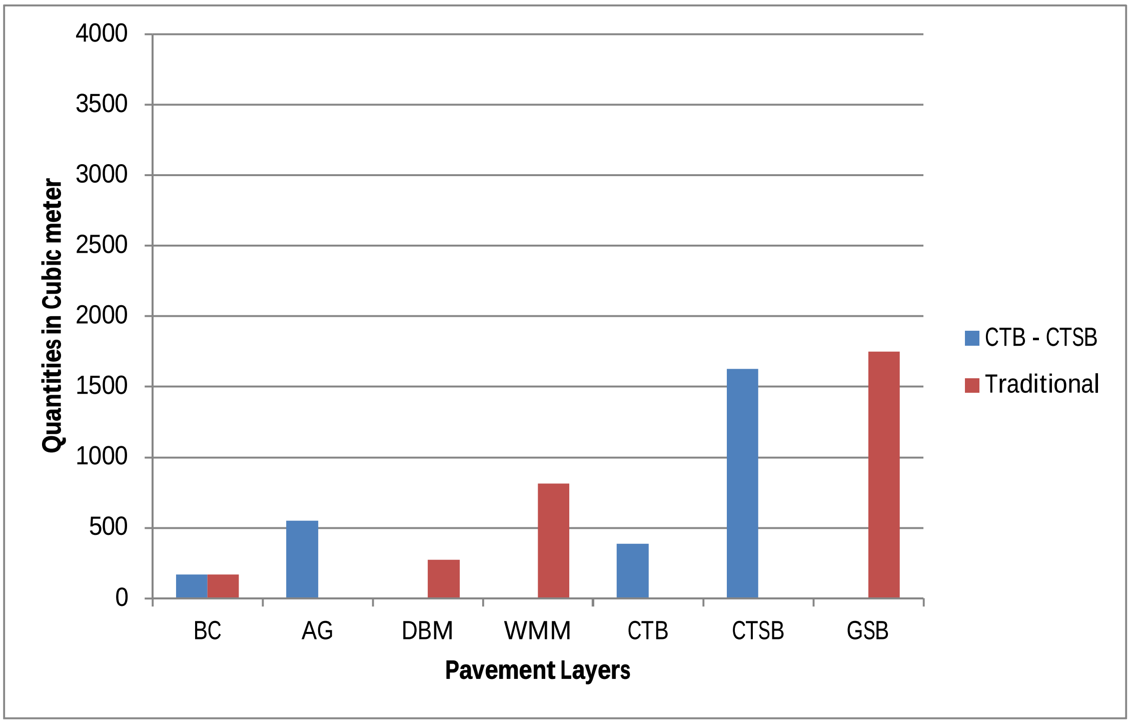

Fig.4 Quantity of materials

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 7 Issue V, May 2019- Available at www.ijraset.com

3) Cost Comparison

Table8. Bill of Quantities (BOQ) Rates

LAYERS	RATES
Granular Sub Base (GSB)	1136 ₹ per Cum.
Wet Mix Macadam (WMM)	1296 ₹ per Cum.
Dense Bituminous Macadam (DBM)	9469 ₹ per Cum.
Semi Dense Bituminous Course (SDBC)	11010 ₹ per Cum.
Cement Treated Sub Base Course (CTSB)	1663 ₹ per Cum.
Cement Treated Base (CTB)	1736 ₹ per Cum.
Aggregate Layer (AG)	1296 er Cum.

C. Comparison Between Costs Of Ctb/Ctsb Roads With Conventional Service Roads

Table 9. SERVICE ROAD WITH CTB/CTSB

Layers	Thickness (mm)	Rates (Rs.)	Quantity in 1 Cum	Cost (Rs.)
SDBC	30	11010	165	1816650
AG	100	1296	550	712800
CTB	60	1736	390	677040
CTSB	250	1663	1625	2702375
TOTAL				5908865

Table 10. CONVENTIONAL SERVICE ROAD

Layers	Thickness (mm)	Rates (Rs.)	Quantity in 1 Cum	Cost (Rs.)
SDBC	30	11010	165	1816650
DBM	50	9469	275	2603975
WMM	125	1296	812.5	1053000
GSB	250	1136	1750	1988000
TOTAL				7461625

Difference: - Rs.7461625 – Rs.5908865 = Rs.1552760 i.e. **21%**

V. CONCLUSION

The characteristics of Cement Treated Sub-Base/Base are studied in this study. The concept, mechanism and requirements of CTB/CTSB are studied from the literature review. The mechanical properties and characteristics of this material are tested in laboratory. The experiments for the combinations of cementitious materials to be added in soil are performed and the result for unconfined compressive strength is checked. The results obtained are acceptable as per MoRTH.

The use of CTB/CTSB saves the material required for the construction of flexible pavement. The transportation charge, fuel consumption, machineries required is less for CTB/CTSB method than the traditional method. Hence the initial cost of construction is less for CTB/CTSB method. The CTB/CTSB is having more strength as compare to the traditional material. So the maintenance work required for CTB/CTSB will be less. It will save the maintenance cost and affects the life cycle cost of the project.

Hence following are some point that we can conclude from our study :-

1) Longer Life of pavements.
2) Speed of the Project Completion is accelerated.
3) Reduced Use of Aggregates.
4) Less local construction traffic due to fast construction.
5) Transportation/haulage is reduced.
6) Reduced Project Cost (approx. 15 lakhs per KM)
7) Reduced thickness of pavement.
8) Reduction of bitumen consumption due to strong Sub Base.
9) Aggregate consumption is less for the case of stabilized base compared to that of the conventional method.
10) Uniform distribution of Load in Cement treated service road as compared to conventional road.
11) Resistance against cracking and fatigue cracking.
12) Best option in low lying water clogged area.

REFERENCES

[1] Francisco A, Auxi B, Antonio R, Jesús A, María DC. Construction of road sections using mixed recycled aggregates treated with cement in Malaga. Resources, Conservation and Recycling. Spain; January 2012; (58):98-106

[2] Halsted, Gregory EL, David R, Adaska, Wayne S., Guide to Cement-Treated Base (CTB),EB236 Portland Cement Association, Skokie, Illinois, USA, 2006, 20 pages.

[3] Mukesh Sah. “How To Do Mix Design Of Concrete As Per Is Code 10262 | SSD Condition” [Online], 2018. Available From URL: https://www.youtube.com/watch?v=zNmzS6OOMFA

[4] “Feasibility Study on Cement-treated base (CTB)” [Online], 2015. Available From URL: https://prezi.com/6c_jqfo7emeo/feasibility-study-on-cement-treated-base-and-sub-base-layers/

[5] Sagar TP. “Performance Analysis of Cement Treated Base/Sub-Base Method over Traditional Method in Flexible Pavements” [Online], 2017. Available From URL: http://ijsrd.com/Article.php?manuscript=IJSRDV5I60028

[6] “User Guidelines for Waste and Byproduct Materials in Pavement Construction” [Online], 2016. Available From URL: https://www.fhwa.dot.gov/publications/research/infrastructure/structures/97148/app5.cfm

[7] Soil Stabilization in Pavement Structures. A User's Manual. Federal Highway Administration. Washington, DC, 1980; Volumes 1 and 2, Report No. FHWA-IP-80-2.