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Impact Of Soil Cbr And Layered Materials On Flexible Pavement Design

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Abstract: The research examines how variations in soil CBR affect the required thickness of different pavement layers to ensure durability and cost-effectiveness. Additionally, the role of GSB, WMM, CTSB, and CTB in load distribution, stability, and longevity is analyzed using standard design methodologies such as IRC guidelines. The findings highlight that an optimal combination of high-strength base and sub-base layers can reduce pavement thickness, enhance service life, and lower maintenance costs. The study provides practical insights for engineers and policymakers in designing sustainable and economically viable flexible pavements.

Index Terms – GSB-Granular Subbase, WMM-Wet Mix Macadam, CTSB-Cement Treated Subbase, CTB-Cement Treated base

I. Introduction

The design of flexible pavements is a critical aspect of civil engineering that directly impacts the safety, durability, and sustainability of transportation infrastructure. Given the prevalence of road networks in urban and rural settings, understanding the principles behind flexible pavement design is essential for mitigating costs and enhancing performance under varied environmental and traffic conditions.

A pivotal factor in designing these pavements is the soil California Bearing Ratio (CBR), which serves as a key indicator of subgrade strength. The CBR value influences not only the thickness but also the composition of the layered materials used in pavement construction. Specifically, lower CBR values necessitate thicker and more robust pavement structures to effectively distribute traffic loads. Conversely, higher CBR values allow for thinner designs without compromising structural integrity, thus offering potential cost savings.

The layered approach in flexible pavements typically includes Bituminous Concrete (BC), Dense Bituminous Macadam (DBM), Wet Mix Macadam (WMM), Cement Treated Base (CTB), Cement Treated Sub Base (CTSB), and Granular Sub Base (GSB). Each material has unique properties contribute significantly to the pavement's overall performance, stability, and longevity. For example, GSB aids in drainage and initial load distribution, while CTSB and CTB enhance load-bearing capacities, especially under heavy traffic conditions. Impact Of Soil Cbr And Layered Materials On Flexible Pavement Design

II. Objectives Of Study

1. To design flexible pavement as per soil conditions and traffic for the selected stretch of highway.
2. To study how soil CBR affects the design and performance of flexible pavements.
3. To determine optimum thickness for pavement layers with alternate base (WMM, CTB) and subbase (GSB, CTSB) material.
4. the crack prevention layer has been introduced in between cement treated base and DBM (Dense Bituminous Macadam) layer as per codal provisions (IRC:37-2018) to avoid cracks propagation, if any, from the CTB to layers of bituminous in long run.
5. To compare traditional pavement layer cost with the cost of pavement layers using cement-treated base and subbase material.

6. To provide useful insights for engineers and policymakers to design cost-effective and long-lasting pavements.

III. Methodology

3.1 Pavement Options

The pavement crust for Carriageway Construction need to suggested with Conventional or Non-Conventional pavement layers which is Cost Effective and Economical, accordingly the Pavement crust with two options are considered for implementation and has been designed as per IRC: 37-2018.

Option-1: Conventional Pavement Design: BC+DBM+WMM+GSB+ Subgrade

Option-2: Non-Conventional Pavement Design: BC+DBM+CTB+CTSB+ Subgrade

3.2 Pavement Analysis

Flexible pavement is modelled as an elastic multilayer structure, stresses and strains at critical locations are computed using a linear layered elastic model:

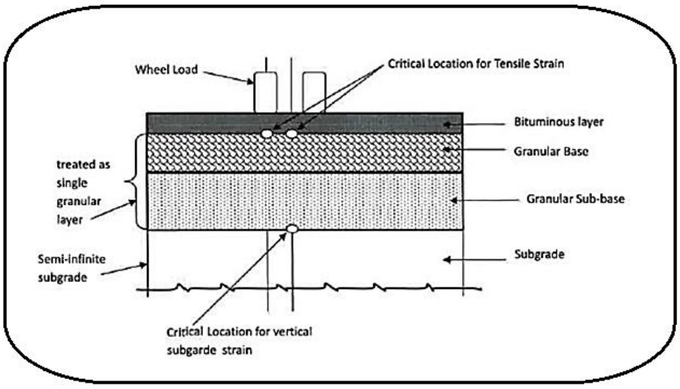


Figure 1: Critical Locations in Pavement

Tensile strains at the bottom of the lower bituminous layer and cement-treated base layer, the vertical subgrade strain on the top of the subgrade are considered as critical parameters for pavement design to limit cracking and rutting in the bituminous, cementitious and other layers respectively.

The strains were calculated at the following critical locations using IITPAVE software:

- Tensile Strain at Bottom of Bituminous Layers
- Vertical Compressive Strain on top of Subgrade
- Tensile Strain at Bottom of Cement treated base Layer

3.3 Performance Models

3.3.1 Fatigue Cracking Below Bituminous Layer:

- Bituminous layers (like Dense Bituminous Macadam - DBM, and Bituminous Concrete - BC in the document) are designed to distribute traffic loads
- However, repeated bending from heavy traffic can cause fatigue, leading to cracks starting at the bottom of these layers and propagating upwards
- This "bottom-up" fatigue cracking is a major concern as it weakens the pavement structure
- The below equations are used to estimate the fatigue life of bituminous layer
- The fatigue performance models from equations 3.3 and 3.4 of IRC 37-2018

$$N_f = 1.6064 * C * 10^{-04} \, [1/\varepsilon_t]^{3.89} * [1/M_{Rm}]^{0.854} \text{ (for 80 \% reliability)}$$

$$N_f = 0.5161 * C * 10^{-04} \, [1/\varepsilon_t]^{3.89} * [1/M_{Rm}]^{0.854} \text{ (for 90 \% reliability)}$$

C = 10M, and m=4.84[(Vbe/(Va+Vbe))-0.69]

- Va = per cent volume of air void in the mix used in the bottom bituminous layer
- Vbe = per cent volume of effective bitumen in the mix used in the bottom bituminous layer
- Nf= fatigue life of bituminous layer (cumulative equivalent number of 80 KN standard axle loads that can be served by the pavement before the critical cracked area of 20 % or more of paved surface area occurs)
- et = maximum horizontal tensile strain at the bottom of the bottom bituminous layer (DBM) calculated using linear elastic layered theory by applying standard axle load at the surface of the selected pavement system using IITPAVE
- MRm = resilient modulus (MPa) of the bituminous mix used in the bottom bituminous layer, selected as per the recommendations made in these guidelines

3.3.2 Fatigue Cracking Below CTB Layer:

- For Non-conventional pavements Cement Treated Base (CTB) layer has been used
- While CTB is strong, it's also rigid. Repeated loading can cause fatigue cracking within the CTB itself
- Cracks in the CTB can reflect upwards into the bituminous layers, accelerating their failure
- The below equations are used to estimate the fatigue life of cementitious base layer
- Fatigue performance models for Cement Treated Base

$$N = RF\left[\frac{\left(\frac{113000}{E^{0.804}} + 191\right)}{\varepsilon_t}\right]^{12}$$

- RF=reliability factor for cementitious materials for failure against fatigue=01 for Expressways, National Highways, Sate Highways and Urban Roads and for other categories of roads if the design traffic is more than 10 msa = 2 for all other cases
- N= number of standard axle load repetitions which the CTB can sustain
- E= elastic modulus of CTB material (MPa)
- £t= tensile strain at the bottom of the CTB layer (micro strain) using IITPAVE

3.3.3 Rutting Above Subgrade:

- Rutting is the formation of permanent depressions in the wheel paths
- While it's visible at the surface, it's often caused by deformation in the layers above the subgrade (base, subbase) and, critically, by the subgrade itself
- If the subgrade is weak or not properly compacted, it can deform under load and contributing to rutting in the entire pavement structure
- The below equations are used to estimate the rutting life of subgrade

$$N_R = 4.1656 \times 10^{-08}\,[1/\varepsilon_v]^{4.5337} \quad \text{(for 80 \% reliability)}$$

$$N_R = 1.4100 \times 10^{-08}\,[1/\varepsilon_v]^{4.5337} \quad \text{(for 90 \% reliability)}$$

- N = subgrade rutting life (cumulative equivalent number of 80 KN standard axle loads that can be served by the pavement before the critical rut depth of 20 mm or more occurs)
- e = vertical compressive strain at the top of the subgrade calculated using linear elastic layered theory by applying standard axle load at the surface of the selected pavement system (from IITPAVE)

IV. MATERIAL INVESTIGATIONS

4.1 Existing Ground Samples:

A total of 2nos of Existing ground sample have been collected from the project corridor. And named as OGL Sample-1 and OGL Sample-2. both have been tested for their basic properties, 1 sample belong to SC type of soil and other sample belongs to SM-SC Type of soil. Both the samples are meeting the requirement of MoRTH specifications for subgrade and embankment. Summary of the test results carried out on toe samples are presented in the following tables.

Table 1: Summary of Test Results of the Toe Sample

Existing Ground Sample															
Lab Sample No	Grain Size Analysis – Percentage passing from (IS Sieve)					Atterberg Limits (%)			Soil Class	MDD (gm/cc)	OMC (%)	Dry density at 97%	Soaked CBR @97% MDD	Free Swelling Index %	Subgrade Criteria
	4.75 mm	425	75	Gra	San	LL	PL	PI							
OGL-1	100	73	48	0	52	23	16	7	SM-SC	1.85	10.8	1.79	6.10	8	Pass
OGL - 2	74	41	30	26	44	43	21	22	SC	1.77	12.2	1.72	7.00	33	Pass

Note: The design of the flexible pavement utilized the minimum CBR value, representing the weakest subgrade condition. So, the value, 6.1 from OGL Sample-1 was taken to facilitate calculations.

4.2 Barrow Area Materials:

A total of 6 Borrow Area sample have been collected near to the project corridor. The location and Details of those samples is presented in the following table.

Table 2: Details of Barrow Area Samples

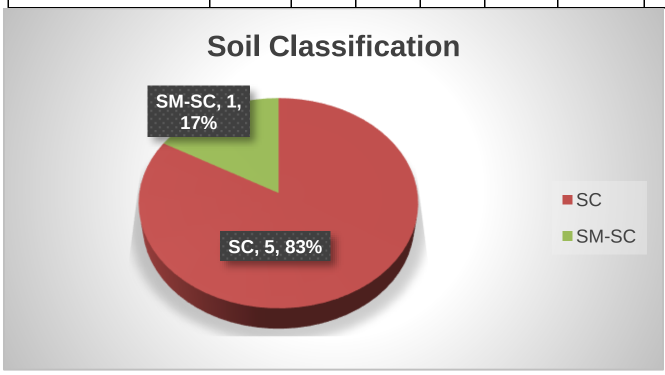
S. No	Borrow Area No	Offset	Area in Hectares	Remarks
1	Borrow Area-1	Nearby	33.65	Pond.
2	Borrow Area-2	2 KM	5.22	Pond.
3	Borrow Area-3	5 KM	39.6	Pond.
4	Borrow Area-4	2 KM	8.87	Pond.
5	Borrow Area-5	Nearby	6.96	Pond.
6	Borrow Area-6	Nearby	6.96	Pond.

This barrow area soils are tested in the laboratory to assess their characteristics viz., FSI, Grain size, Atterberg limits and laboratory CBR @97% of the MDD. In which 5 samples belong to SC type of soil and 1 sample belongs to SM-SC Type of soil.

Summary of the test results carried out on borrow area samples are presented in the following table. All the samples are meeting the requirement of MoRTH specifications for subgrade and embankment. Pie Chart showing the percentage distribution of soil classification and bar graph shows the CBR values of respected Borrow area samples is presented after table.

Table 3: Summary of Test Results of the Borrow area Sample

Lab Sample No	Grain Size Analysis					Atterberg Limits (%)			Soil Class	MDD (gm/cc)	OMC (%)	Dry density at 97%	Soaked CBR @97% MDD	Free Swelling Index %	Subgrade Criteria
	Percentage passing from (IS Sieve)														
	4.75 mm	425	75	Grav	Sand %	LL	PL	PI							
Borrow Area-1	76	46	35	24	41	32	24	8	SC	1.93	12	1.87	**7.73**	17	Pass
Borrow Area-2	98	60	48	2	50	30	16	14	SC	2.12	8.8	2.06	14.40	30	Pass
Borrow Area-3	77	40	32	23	45	33	17	16	SC	1.97	10.6	1.91	**10.71**	35	Pass
Borrow Area-4	100	65	45	0	55	34	20	14	SC	2.11	6.8	2.05	14.40	20	Pass
Borrow Area-5	100	63	39	0	61	37	16	21	SC	2.03	11.4	1.97	12.32	33	Pass
Borrow Area-6	97	58	42	3	55	22	16	6	SM-SC	2.04	9.8	1.98	19.55	30	Pass



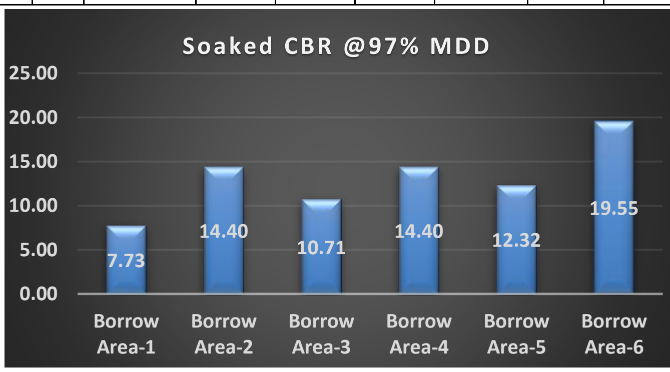


Figure 2: Soil classification of Borrow area sample *Figure 3: Soaked CBR @97% MDD*

V. DESIGN LOADING CALCULATIONS

5.1 Axle Load Analysis:

Direction wise VDF for each mode of commercial traffic has been estimated at selected location. Results of axle load survey have been presented in the following table.

Table 4: Direction wise VDF

Vehicle Type	Up Direction	Down Direction
Bus	1.59	1.55
2 Axle	4.62	5.46
3 Axle	9.92	7.41
M Axle	20.40	16.40
LCV	1.26	0.99

5.2 Traffic Volume Count Surveys:

Seven Day Traffic volume count using the videography has been carried out. The summary of the mode wise diverted AADT as Calculated have been presented in the following table and the seasonal correction factors estimated as for Motor Spirit Vehicle (MS)-0.98, High Speed Diesel Vehicle (HSD)-0.93.

Table 5: Direction wise AADT

Vehicle Type	Up Direction	Down Direction
Bus	179	170
2 Axle	212	205
3 Axle	178	150
M Axle	189	193
LCV	203	213

5.3 Traffic Growth Rates:

Following growth rates as given in “traffic report” have been used for the pavement design:

Table 6: Growth Rates as given in Traffic Report

Year	Bus	2 Axle	3 Axle	M Axle	LCV
2025-2025	5.0%	6.9%	5.0%	6.8%	5.0%
2026-2029	5.0%	6.9%	5.0%	6.8%	5.0%
2030-2031	5.0%	7.2%	5.0%	7.1%	5.0%
2032-2034	5.0%	6.4%	5.0%	6.3%	5.0%
2035-2038	5.0%	5.8%	5.0%	5.7%	5.0%
2039-2044	5.0%	5.0%	5.0%	5.0%	5.0%

5.4 Design MSA:

Design Traffic loading has been estimated by considering the latest traffic & growth rates and VDF as given above:

The Calculated design traffic MSA for 5^{th}, 10^{th}, 15^{th} & 20^{th} Years are Summarized as below:

Table 7: Design Traffic MSA

Design Period	Up Direction	Down Direction
5 Years	12	10
10 Years	28	23
15 Years	49	41
20 Years	77	63

From the above table it can be observed that the estimated design traffic at 20^{th} year for Up Direction is more than that of Down Direction, **the adopted design traffic loading for pavement design is 80 MSA.**

VI. FLEXIBLE PAVEMENT DESIGN

6.1 Calculation of Effective Subgrade CBR

Subgrade assessment involved California Bearing Ratio (CBR) testing of soil samples from three borrow areas, yielding values of 7.7, 14.4, and 19.6 and an existing ground sample exhibited a CBR of 6.1. Utilizing these data, effective subgrade CBR values were calculated to be 7.36, 11.87, and 14.85. For design input, these values were rounded to 7, 11, and 14.

6.2 Design Inputs for IIT Pave

The following modulus values of various pavement layers have been used in the design:

Table 8: Design Inputs for IIT Pave

Pavement Layer	Poisson Ratio, p	Elastic Modulus (E), MPa
Bituminous Concrete (BC)	0.35	3000 (Modified Bitumen)
Dense Bituminous Macadam (DBM)	0.35	3000 (VG 40)
Crack Relief Layer (WMM on CTB)	0.35	450
Cement Treated Base (CTB)	0.25	5000
Cement Treated Sub Base (CTSB)	0.25	600
Subgrade (SG)	0.35	Varies with Effective CBR

6.3 Pavement Design

6.3.1 Conventional Pavement Design (BC+DBM+WMM+GSB+Subgarde)

The actual strains at critical locations have been calculated using pavement design software (IITPAVE). The allowable strains in the pavement layers have been calculated based on two primary pavement distress limiting criteria: fatigue cracking and rutting using the performance models given in methodology. Results of the pavement design are shown in the table below, which are estimated using effective CBR values and DBM mix parameters of Va 3.2% and Vbe 10.5%.

Table 9: Pavement Crust Thicknesses for Conventional Pavement Design

S. No.	Description	Effective CBR		
		7%	11%	14%
1	Bituminous Concrete (BC) in mm	50	50	50
2	Dense Bituminous Macadam (DBM) in mm	130	120	110
3	Wet Mix Macadam (WMM) in mm	210	160	150
4	Granular Subbase (GSB) in mm	250	200	190
5	**Total in mm**	**640**	**530**	**500**
6	Tensile Strain (Et) below DBM	0.0001574	0.0001568	0.0001567
7	Vertical Strain (Ev) above SG	0.0002708	0.0002914	0.0002894
8	Fatigue life, mSA	81	82	82
9	Rutting life, mSA	210	151	155

6.3.2 Non-Conventional Pavement Design (BC+DBM+CTB+CTSB+Subgarde)

The actual strains at critical locations as have been calculated using pavement design software (IITPAVE). The allowable strains in the pavement layers have been calculated based on three primary pavement distress limiting criteria: fatigue cracking below Bituminous layer and CTB layer and rutting above subgrade. Results of the pavement design, including layer thicknesses and predicted design life, are shown in the table below, which are estimated using effective CBR values and DBM mix parameters of Va 3.2% and Vbe 10.5%.

Table 10: Pavement Crust Thicknesses for Conventional Pavement Design

S. No.	Description	Effective CBR		
		7%	11%	14%
1	Bituminous Concrete (BC) in mm	30	30	30
2	Dense Bituminous Macadam (DBM) in mm	40	40	40
3	Crack Relief Layer (WMM) in mm	100	100	100
4	Cement Treated Base (CTB) in mm	190	180	170
5	Cement Treated Sub-Base (CTSB) in mm	200	200	200
6	**Total in mm**	**560**	**550**	**540**
7	Tensile Strain (Et) below DBM	0.0001556	0.0001538	0.0001529
8	Tensile Strain (Et) below CTB	0.00005171	0.00005150	0.00005236
9	Vertical Strain (Ev) above SG	0.0001970	0.0001845	0.0001816
10	Fatigue life below DBM, msa	84	88	90
11	Fatigue life below CTB, msa	2238	2350	1927
12	Rutting life, msa	889	1197	1286

Cumulative Fatigue Damage Analysis

The treatment of fatigue cracking of cementitious is recommended at two levels. Thickness of the cemented layer is firstly evaluated from fatigue consideration in terms of cumulative standard axles. At the second level, the cumulative fatigue damage due to individual axles is calculated based on a model which uses 'stress ratio' (the ratio of actual stresses developed due to a class of wheel load and the flexural strength of the material) as the parameter.

- The fatigue criterion is considered satisfied if Σ(Ni/Nfi) is less than 1, where Ni is the actual number of axles of axle load of class i.
- The cumulative fatigue damage analysis has been done for Single, Tandem and Tridem Axle respectively considering flexural strength of cemented base as 1.4 Mpa.
- Here for this analysis the Expected Standard axle repetitions are taken from the axle load spectrum data for the detailed view of axle load spectrum analysis refer Appendix 2.
- The cumulative fatigue damage is computed as (0.98+0.174+0.007=0.379) in LHS Carriageway and (0.133+0.091+0.001=0.278) in RHS Carriageway as shown below.

VII. RESULTS AND DISCUSSIONS

The following tables provides a cost comparison between conventional and non-conventional pavement construction by considering 1 km of roadway having 11.5m(3-lane) width for Design traffic of 80MSA having Effective subgrade CBR values of 7%, 11% 14%.

Table 11: Cost Comparison of Conventional vs Non-Conventional Pavement Design for Effective CBR of 7%

Conventional Pavement Design with 7% CBR							
Item of Work	**Length (m)**	**Width (m)**	**Depth (m)**	**Quantity**	**unit**	**Rate (Rs)**	**Amount (Rs)**
GSB	1000	12.5	0.250	3125	Cum	1600	50,00,000
WMM	1000	12.5	0.210	2625	Cum	1700	44,62,500
DBM	1000	12.5	0.130	1625	Cum	8300	1,34,87,500
BC	1000	12.5	0.050	625	Cum	10180	63,62,500
Prime coat for DBM	1000	12.5		12500	Sqm	58	7,22,750
Tack coat for BC	1000	12.5		12500	Sqm	11	1,34,000
Tack coat for DBM	1000	12.5		12500	Sqm	11	1,34,000
						Total Amount	**3,03,03,250**
Non-Conventional Pavement Design with 7% CBR							
Item of Work	**Length (m)**	**Width (m)**	**Depth (m)**	**Quantity**	**unit**	**Rate (Rs)**	**Amount (Rs)**

Geo Composite Drainage Layer	1000	12.5		12500	Sqm	125	15,62,500
Cement treated Subbase	1000	12.5	0.200	2500	Cum	2200	55,00,000
Cement treated Base	1000	12.5	0.190	2375	Cum	2600	61,75,000
Crack Relief Layer (WMM)	1000	12.5	0.100	1250	Cum	1700	21,25,000
DBM	1000	12.5	0.040	500	Cum	8300	41,50,000
BC	1000	12.5	0.030	375	Cum	10180	38,17,500
Prime coat for DBM	1000	12.5		12500	Sqm	58	7,22,750
Tack coat for BC	1000	12.5		12500	Sqm	11	1,34,000
Tack coat for DBM	1000	12.5		12500	Sqm	11	1,34,000
						Total Amount	**2,43,20,750**
						Net Savings (CPD-NCPD)	**59,82,500**

Table 12: Cost Comparison of Conventional vs Non-Conventional Pavement Design for Effective CBR of 11%

Conventional Pavement Design with 11% CBR							
Item of Work	**Length (m)**	**Width (m)**	**Depth (m)**	**Quantity**	**unit**	**Rate (Rs)**	**Amount (Rs)**
GSB	1000	12.5	0.200	2500	Cum	1600	40,00,000
WMM	1000	12.5	0.160	2000	Cum	1700	34,00,000
DBM	1000	12.5	0.120	1500	Cum	8300	1,24,50,000
BC	1000	12.5	0.050	625	Cum	10180	63,62,500
Prime coat for DBM	1000	12.5		12500	Sqm	58	7,22,750
Tack coat for BC	1000	12.5		12500	Sqm	11	1,34,000
Tack coat for DBM	1000	12.5		12500	Sqm	11	1,34,000
						Total Amount	**2,72,03,250**
Non-Conventional Pavement Design with 11% CBR							
Item of Work	**Length (m)**	**Width (m)**	**Depth (m)**	**Quantity**	**unit**	**Rate (Rs)**	**Amount (Rs)**
Geo Composite Drainage Layer	1000	12.5		12500	Sqm	125	15,62,500
Cement treated Subbase	1000	12.5	0.200	2500	Cum	2200	55,00,000
Cement treated Base	1000	12.5	0.180	2250	Cum	2600	58,50,000
Crack Relief Layer (WMM)	1000	12.5	0.100	1250	Cum	1700	21,25,000
DBM	1000	12.5	0.040	500	Cum	8300	41,50,000
BC	1000	12.5	0.030	375	Cum	10180	38,17,500
Prime coat for DBM	1000	12.5		12500	Sqm	58	7,22,750
Tack coat for BC	1000	12.5		12500	Sqm	11	1,34,000
Tack coat for DBM	1000	12.5		12500	Sqm	11	1,34,000
						Total Amount	**2,39,95,750**
						Net Savings (CPD-NCPD)	**32,07,500**

Table 13: Cost Comparison of Conventional vs Non-Conventional Pavement Design for Effective CBR of 14%

Conventional Pavement Design with 14% CBR							
Item of Work	**Length (m)**	**Width (m)**	**Depth (m)**	**Quantity**	**unit**	**Rate (Rs)**	**Amount (Rs)**
GSB	1000	12.5	0.190	2375	Cum	1600	38,00,000
WMM	1000	12.5	0.150	1875	Cum	1700	31,87,500
DBM	1000	12.5	0.110	1375	Cum	8300	1,14,12,500
BC	1000	12.5	0.050	625	Cum	10180	63,62,500
Prime coat for DBM	1000	12.5		12500	Sqm	58	7,22,750
Tack coat for BC	1000	12.5		12500	Sqm	11	1,34,000
Tack coat for DBM	1000	12.5		12500	Sqm	11	1,34,000
						Total Amount	**2,57,53,250**
Non-Conventional Pavement Design with 14% CBR							
Item of Work	**Length (m)**	**Width (m)**	**Depth (m)**	**Quantity**	**unit**	**Rate (Rs)**	**Amount (Rs)**
Geo Composite Drainage Layer	1000	12.5		12500	Sqm	125	15,62,500
Cement treated Subbase	1000	12.5	0.200	2500	Cum	2200	55,00,000
Cement treated Base	1000	12.5	0.170	2125	Cum	2600	55,25,000
Crack Relief Layer (WMM)	1000	12.5	0.100	1250	Cum	1700	21,25,000
DBM	1000	12.5	0.040	500	Cum	8300	41,50,000
BC	1000	12.5	0.030	375	Cum	10180	38,17,500
Prime coat for DBM	1000	12.5		12500	Sqm	58	7,22,750
Tack coat for BC	1000	12.5		12500	Sqm	11	1,34,000
Tack coat for DBM	1000	12.5		12500	Sqm	11	1,34,000
						Total Amount	**2,36,70,750**
						Net Savings (CPD-NCPD)	**20,82,500**

Bar Graph Representing the Cost variations for Conventional & Non-Conventional Pavements at 3 different Subgrade CBRs:

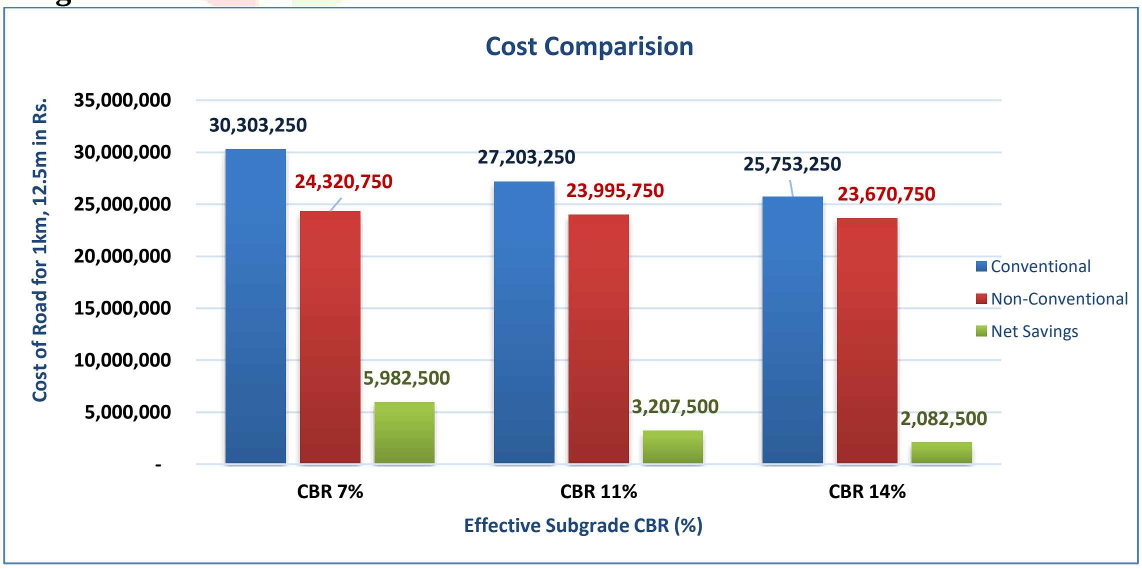


Figure 4: Cost comparisons at different subgrade soil conditions

VIII. CONCLUSIONS

- The analysis consistently demonstrates that non-conventional pavement designs are more cost-effective than conventional designs across all the considered CBR values (7%, 11%, and 14%). The cost savings, however, decrease as the CBR value increases.
- The highest cost saving is observed at a 7% CBR value, indicating that non-conventional pavement designs offer the most significant economic advantage in weaker subgrade conditions.
- The relative cost-effectiveness of non-conventional pavement designs in comparison to conventional designs is significantly influenced by the strength of the subgrade, which is quantified by the California Bearing Ratio (CBR) value.
- The adoption of non-conventional layers allows for thinner bituminous layers, consequently decreasing the use of costly bitumen.
- This design also minimizes the thickness of granular layers, leading to less aggregate usage – a positive outcome for environmental conservation.

The selection between conventional and non-conventional pavement designs should be tailored to specific site conditions, traffic loading, environmental factors, and available materials. A generalized cost comparison may not be universally applicable, and a detailed engineering and economic analysis is essential for each project.