ISSN No.: 2454- 2024 (online)

International Journal of Technical Research & Science

UPGRADING PAVEMENTS FOR NH-18 (NEW NH-40)

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Abstract-The correct budget allocation for road maintenance, which represents a significant infrastructure investment in urban roads, requires the accurate prediction of the deterioration of bituminous hot mix asphalt (HMA). In this study, three different deterioration models have been developed that can predict the future performance of pavements in highway roads. First, the current condition of the pavements was measured by using the pavement condition index (PCI), which is approved by the PAVER system. Then, three different models were developed to predict deterioration in the PCI as a function of pavement age, and applied to urban road networks in Samsun (Turkey). The models used were deterministic regression analysis, multivariate adaptive regression SP-lines (MARS) and artificial neural networks (ANN). Certain live project work was doing on Rehabilitation and upgrading of NH-18 (New NH-40) from Km 18/350 to Km 56/000 (Chittoor to Kurnool Road section) to two lane with paved shoulders in the state of Andhra Pradesh under corridor approach through Engineering, procurement & construction (EPC) Basis contract.

Keywords: Artificial neural networks, auto level, soil investigation, surveying.

1. INTRODUCTION

The highway engineering teaches concepts in highway planning and design. Highways are mostly useful for the import and export goods, highway capacity, vehicle performance on given highway materials and highway classification are investigated along with how these relate to safety .intersections and interchanges are explored with high quality simulations and relevant activities. Intermodal systems, mass transit facilities, land use, transportation relationships, economy and environmental impacts are running. Highway engineering is an engineering discipline branching from civil engineering that involves the planning, design, construction, operation, and maintenance of roads to ensure safe and effective transportation of people and goods. Highway engineering became a prominent towards latter in modern world. Highway planning involves the estimation of current and future traffic volumes on a road network. Some considerations are adverse effects on the environment such as noise pollution, air pollution, and other ecological impacts[1].

These advancements have allowed for newer highway safety innovations. The older mode of travel obviously was on the foot tracks. The first road period was started on B.C 1900 on Roman Empire. The road pavements are generally constructed on low Embankments, above the general ground level or the adjoining land, whatever possibility in order to avoid the difficult drainage and maintenance problems. It may be said that the Highway Engineering deals with various phases likes Traffic and Transportation site, studies and analysis, planning of road network, Alignment, design of road Geometrics, pavement design, Highway traffic operation, safety and Administration.

2. METHODOLOGY

2.1 Site Clearance

The use of top soil obtained from clearing and grubbing shall be decided by engineer. Site clearing works are to be carried out using the following equipment or any combination that is applicable. Structures that cannot practicably be cleared by hydraulic excavators, then this demolitions will be carried out using pneumatic tools, explosives other specialized equipment depending on the size and type of structure .Before commencing demolition using explosives if required, all necessary permits and licenses will be obtained and a blasting plan and safety precautions will be prepared before commencement of blasting work.

2.2 Construction Procedure

The right of ways deserved and set out according to the data stated in the drawing .To determine whether site is free from obstruction and in case of nonconformity, photographs shall be taken of structures, landscaping, trees and shrubs, fences, telephone and electrical poles and other so called obstructions as are payable under individual measured items apart from the general site clearances in the bill of quantities. If not covered under clearing and grubbing shall be measures according to the measure of measurements jointly with engineers. The locations of this shall be identified according to the survey data of offset from the centre line of the proposed alignments in road constructions. Removal of landscaping trees shall be carried out in consultation with the Engineers and prior approval of the concerned authority. Fencings or others that are to be relocated or salvaged shall be carried out according to the Drawings or as per instructions given by the Engineers (Consultant).authorities, (Hand over from client) Obtained confirmation that the right way lands have be acquired but the employers or relevant authorities[2]. Access roads to the site shall be constructed if required to enable vehicles, equipment's and plants to be brought into the site. The site clearance team shall then proceed to clear the trees, vegetation, undergrowth, bushes and minor structures by hydraulic excavators or UCB and or manually. Material designated in the contract or directed by the Engineer to be salvaged, shall be removed and stored within the Right of way and shall be the property of the Employer or the Government whichever is specified in the contract. Excavation back filling resulting from uprooting of trees and stumps shall be done with suitable soil to the required compaction; Joint survey of existing ground level shall be carried out. In case joint survey is not feasible independent survey shall be carried out by the contractor and subsequently approval of Engineer shall be obtained. Daily progress reports shall be recorded.

2.3 Engineering Surveys for Highway Alignment

Before a highway alignment is finalised in a new highway project, engineering surveys are to be carried out. These engineering surveys may be completed in the following four stages:

- Map study
- Reconnaissance survey
- Preliminary surveys and
- Final location and detailed surveys

2.3.1 Map Study

If the topographic map of the area is available, it is possible to suggest the likely routes of the road. In India, topographic maps are available from the Survey of India, with 15 or 30 meter contour intervals. The main features rivers, hills valleys, etc. are also shown on these maps. By careful study of such maps, it is possible to have an idea of several possible alternate routes so that further details of these may be available the probable alignment can be located on the following details available on the map. Thus from the map study alternate routes can be suggested. It may also be possible from map study to drop a certain route in view of any unavoidable obstructions undesirable ground, en route. Map study thus gives a rough guidance of the routes to the further surveyed in the field.

2.3.2 Reconnaissance

The second stage of engineering surveys for highway alignment is the reconnaissance survey. During the reconnaissance, the engineer the site and examines the general characteristics the before deciding along the proposed alternative routes of the map in the field. Only very simple survey instruments are used most feasible routes for detailed studies, a field survey party may inspect a fairly broad stretch of land by the reconnaissance party to collect additional details rapidly, but not accurately. All relevant details which are not available in the map are collected and noted down. Some of the details to be collected during reconnaissance are given below:

2.3.3 Preliminary Survey

The main objectives of the preliminary survey are,

- To survey the various alternate alignments proposed after the reconnaissance and to collect all the necessary physical information and details of topography, drainage and soil.
- To compare the different proposals in view of the requirements of a good alignment.
- To estimate quantity of earth work materials and other construction aspects and to work out the cost of alternate proposals.
- To finalise the best alignment from all considerations.

2.3.4 Final Location and Detailed Survey

The alignment finalised at the design office and the preliminary survey is to be first located on the field by establishing the centre line, Next detailed survey should became out for collecting the information necessary for the preparation of plans details for the highway project.

2.3.4.1 Location

The centre of the road finalised in the drawings is to be transferred on during the location survey. This is done using a transit theodolite and by staking of the centre line. The location of the centre line should follow, as closely as alignment the preliminary surveys major and minor control points are established on the ground and centre pegs are driven, checking the geometric design requirements. However modifications in the final location may be made in the field, if found essential. The centre line stakes are driven at suitable intervals, say at 50 me intervals in plain and rolling terrains and at 20 metre in hilly terrain.

2.3.4.2 Detailed Survey

Temporary bench marks are fixed at intervals of about 250 m and at all drainage and under pass structures. Levels along the final centre line should be taken at all staked points. Levelling work is of great importance as the vertical alignment, earth work calculations and drainage details are to be worked out from the level notes.

The cross section levels are taken up to the desired width at intervals of 50 to 100m in plain terrain, 50 to 75 m in rolling terrain, and 50 m in 20 m in terrain. The cross sections may be taken at closer intervals at horizontal curves and where there is abrupt in cross slopes[4]. All river valleys etc should be surveyed in detail up to considerable distances on either side.

All topographical details are noted down and also plotted using conventional signs. Adequate hydrological details are also collected and recorded. A detailed soil survey is carried out to enable drawing of the profile, The depth up to which soil sampling is to be done may be 1.5 to 3.0 m below ground line or finished grade line of the road whichever is lower, However in case of high embankments, the depth should be to the height of the finished embankments The spacing of auger borings very much depends upon the soil type and its variations CBR value of soils along the alignment may be determined for designing the pavements. The data during the detailed survey should be elaborate and complete for preparing detailed plans, designs and estimates of the project.

2.4 Soil Tests

2.4.1 Liquid Limit

About 120g of specimen passing through 425 micron sieve is mixed thoroughly with distilled water in the evaporating dish to form a uniform paste. A portion of the paste is placed in the cup of the liquid limit device. Level the mix so as to have a maximum axis of the cup, holding the perpendicular to the cup .Now, rotate the handle at a rate of about 2 revolutions per second and the no of blows are counted till the two parts of the soil sample come into contact at the bottom of the groove. Some soils tend to slide on the surface of the cup instead of flowing. If this occurs, the result should be discarded and the test should be repeated. Take about 20g of soil near the close groove and determine the water content of the soil by oven drying method. By altering the water content of the soil and repeating the foregoing operations, obtain at least 5 readings in the range of 10-50 blows. The liquid limit is determined by plotting the graph on the semi-logarithmic graph between the number of blows as abscissa on a logarithmic scale and the corresponding to 25 blows shows the value of Liquid Limit.

2.4.2 Plastic Limit

About 30g of oven dried soil specimen passing through IS 425 micron sieve is taken and mixed thoroughly with distilled water until the soil mass becomes plastic enough to be easily moulded into a ball with fingers. Take a portion of the ball and roll it on a glass plate with the palm of the hand to from the soil mass into a thread of uniform diameter throughout its length. Take care that diameter should be around 3mm. The crumbled threads are kept for water content determination. Repeat the test with 2 more samples. The plastic limit is then taken as the average of three water content values.

2.4.3 Grain Size Analysis

The sieves of size 4.75mm, 2mm, 1mm, 600microns, 300microns, 150microns and 75 microns, the order of decreasing aperture size, after ensuring that all of them are clean are taken and arranged with receiver pan placed at the bottom. About 1 Kg of oven dry soil is taken in the top most sieve and the sieves are shaken for about 15minutes. Holding the sieves inclined at angle of 15degrees to the vertical, the shaking is done in a circular motion.

Weights of soil retained on each sieve is tabulated, a grain size distribution curve with logarithm of the aperture size on x-axis and % passing through the sieve on y-axis is drawn. The Value of D_{10}, D_{30} and D_{60} are determined and the uniformity co-efficient (C_u) and the co-efficient of curvature (C_c) are calculated.

2.4.4 California Bearing Ratio

Soil of weight 5 Kgs is taken and OMC water content is added and mixed thoroughly the cylinder mould with an extension collar and perforated base plate was taken and thin film of oil is applied to the inside of mould. Spacer disk of 150mm dia and 50mm height was placed and the soil is placed in 5 layers with 56 blows on each layer with a rammer of drop 450mm and weight 4.89 Kgs using heavy compaction.

The surcharge is placed on the soil sample and the mould with surcharge and soil sample is placed under the CBR testing machine applying load of penetration at the rate of approximately 1.25mm per a minute and a proving ring of 50KN capacity is used. The corresponding loading for the penetration up to 12.5mm is tabulated under graph between penetration in mm and load in Kgs is plotted and the CBR value at 2.5mm and 5mm is taken and the greater between the two is noted as the CBR value of that sample.

$$\text{CBR}= \frac{\text{Load sustained by specimen at 2.5 or 5mm penetration}}{\text{Load sustained by standard aggregate at the corresonding penetration level}} \times 100$$

2.5 Cross Sectional Design

Detailed design would be undertaken only if the proposal is approved and the Chief Executive of the RTA determines that the project should proceed. In addition, post approval modifications could occur. Any post-approval modifications that were not consistent with the approved project would require an application for modification in accordance with section 75W of the Environmental Planning and Assessment Act, 1979. To ensure that the design development process adequately incorporates the key principles established during the study and inherent in the concept design, the development of the detailed design would be in accordance with any approval issued by the Minister for Planning. Provided it is consistent with the terms of any approval, detailed design would.

2.6 Estimations

The estimations are to be carried out for the entire works of the high alignment and it is pre estimated to identify and make over budget. And for every individual work it is estimated as cost, number of labours, materials, and execution of the project will be done very easily.

3. RESULTS AND DISCUSSIONS

3.1 Survey Work

Table-3.1 TBM List and OGL'S

Chainage	OGL Below PCL	FRL Submitted	Difference
23000	339.787	339.953	0.166
23020	340.155	340.299	0.144
23040	340.491	340.666	0.175
23060	340.826	341.035	0.209
23080	341.120	341.405	0.285
23100	341.482	341.774	0.292
23120	341.911	342.144	0.233
23140	342.354	342.513	0.159
23160	342.738	342.877	0.139
23180	343.061	343.212	0.151
23200	343.320	343.513	0.193
23220	343.587	343.781	0.194
23240	343.791	344.016	0.225
23260	344.029	344.228	0.199
23280	344.249	344.439	0.19
23300	344.477	344.651	0.174
23320	344.673	344.863	0.19
23340	344.852	345.074	0.222
23360	345.072	345.308	0.236
23380	345.346	345.594	0.248
23400	345.696	345.932	0.236
23420	346.142	346.321	0.179
23440	346.548	346.739	0.191
23460	346.891	347.157	0.266
23480	347.213	347.575	0.362
23500	349.027	349.248	0.221
23520	349.501	349.655	0.154
23540	350.047	350.031	-0.016
23560	350.372	350.373	0.001
23580	350.596	350.683	0.087
23600	350.818	350.960	0.142
23620	351.031	351.204	0.173
23640	351.214	351.415	0.201
23660	351.395	351.595	0.2

23680	351.553	351.767	0.214
23700	351.707	351.940	0.233
23720	352.152	352.280	0.128
23740	352.339	352.526	0.187
23760	352.424	352.686	0.262
23780	352.456	352.765	0.309
23800	352.548	352.925	0.377
23820	352.731	353.085	0.354
23840	352.876	353.245	0.369
23860	352.986	353.401	0.415
23880	353.070	353.473	0.403
23900	353.229	353.603	0.374
23920	353.301	353.661	0.36
23940	353.406	353.767	0.361
23960	353.531	353.872	0.341
23980	353.707	353.977	0.27
24000	353.870	354.086	0.216
24020	354.013	354.206	0.193
24040	354.169	354.335	0.166
24060	354.321	354.471	0.15
24080	354.375	354.539	0.164
24100	354.425	354.607	0.182
24120	354.515	354.742	0.227
24140	354.623	354.878	0.255

3.2 Soil Tests

3.2.1 Liquid Limit

Table-3.2 Liquid Limit Test Results at 24+000 Km

Water Content	No. of Blows
31.22%	17
29.65%	24
29%	29
27.60%	34

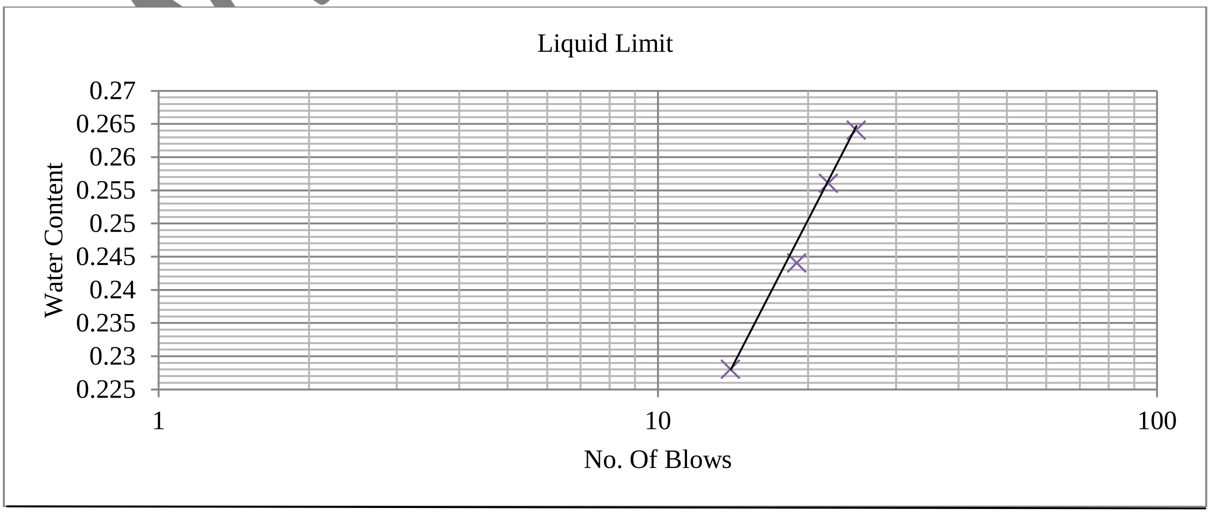

Fig. 3.1 Liquid Limit Test Results at 24+000 km =29.5 %

3.2.2 Plastic Limit

Table-3.3 Plastic Limit Test Results at 24+000 Km

Description	Trial-1	Trial-2	Trial-3	Trial-4
Container No	5	6	7	8
Wt. of Container (g), W1	30.54	32.03	33.02	31.03
Wt. of Container (g) +Wet Soil (g), W2	59.8	60	59	59.3
Wt. of Container (g) + dry Soil (g), W3	52.83	53.6	53.65	53.185
Water Content (%) (W2-W3)/W3-W1)*100	31.22%	29.65%	28.80%	27.6%

The plastic limit of the soil sample at 24+000 km =27.6%

3.2.3 Grain Sieve Analysis

Table-3.4 Grain Size Analysis Test Results at 24+000 KM

S. No.	IS Sieve NO.	Wt of soils retained (g)	Cumulative % wt. retained	% wt. Retained	Cumulative % passing through	Remarks
1	100mm	0	0	0	100	Gravel 7.40
2	75mm	0	0	0	100	
3	19mm	0	0	0	100	
4	4.75mm	74	74	7.4	92.6	
5	2mm	136	210	21	79	sand 58.40
6	425mic	240	450	45	55	
7	75mic	228	658	65.8	34.2	
8	pan					Silt & Clay
9	Total					34.2

Gravel = 7.40
Sand = 58.40
Silt & Clay = 34.20

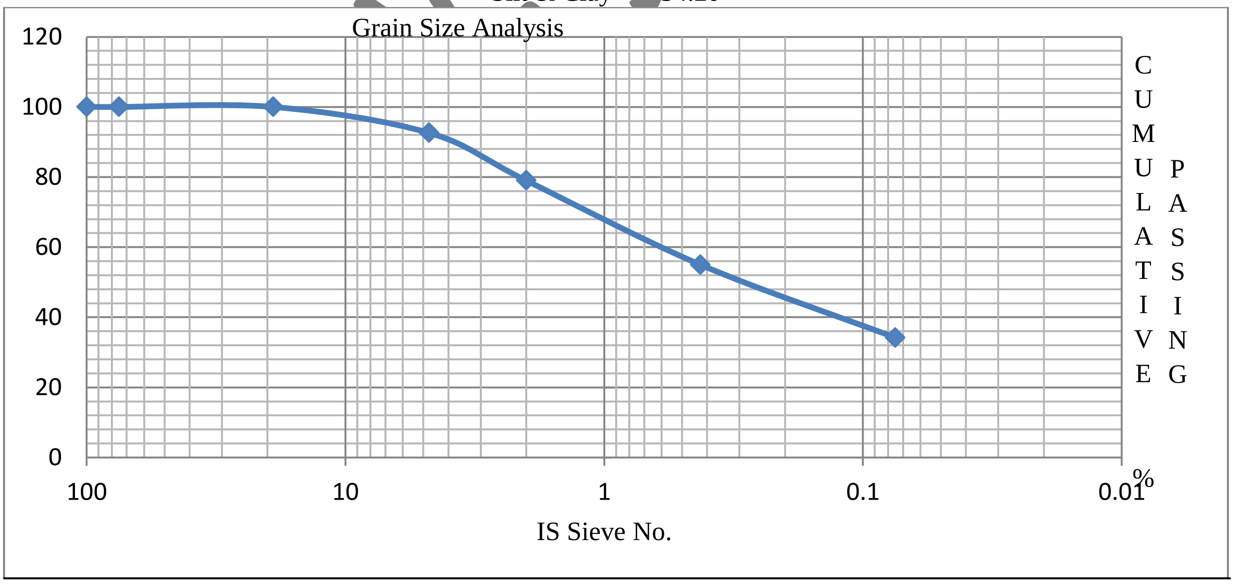

Fig. 3.2 Grain Size Analysis Test at 24+000 KM

From graph

D_{10}=0.115

D_{30}=0.24

D_{60}=0.49

Coefficient of uniformity, $C_u = \frac{D60}{D10} = 4.26$

Coefficient of curvature, $C_c = (D_{30})^2 / (D_{10} \times D_{60}) = 1.06$

ISSN No.: 2454- 2024 (online)

International Journal of Technical Research & Science

3.2.4 Compaction Test

Table-3.5 Compaction Test Results at 24+000 km

Particulars	Test No.					
	11	22	33	44	55	66
Weight of mould , W1 (g)	6875	6875	6875	6875	6875	6875
Weight of mould + compacted soil, W2 (g)	10860	11142	11420	11590	11572	11432
Weight of compacted soil W3= (W2-W1)	3985	4267	4545	4715	4697	4557
Wet density, = (W2-W1)/V	1.771	1.896	2.02	2.096	2.088	2.026
Bin (container) No	86	85	84	83	82	81
Wt of bin, W4	39.99	40	44.11	39.56	42.24	41.62
Wt. of Bin + wet soil, W5	144	147.37	150.27	150.18	156.69	157.16
Wt. of Bin + dry soil, W6	141.24	142.6	143.76	141.22	145.64	144.07
Wt. of water, W7= W5-W6	2.76	4.77	6.51	8.96	11.05	13.09
Wt. of dry soil, W8=W6-W4	101.25	102.6	99.65	101.66	103.4	102.45
Water content W = (W7/W8)*100 (%)	2.73	4.65	6.53	8.81	10.69	12.78
Dry density =Wet density/1+W (g/cc)	1.724	1.812	1.896	1.926	1.886	1.796

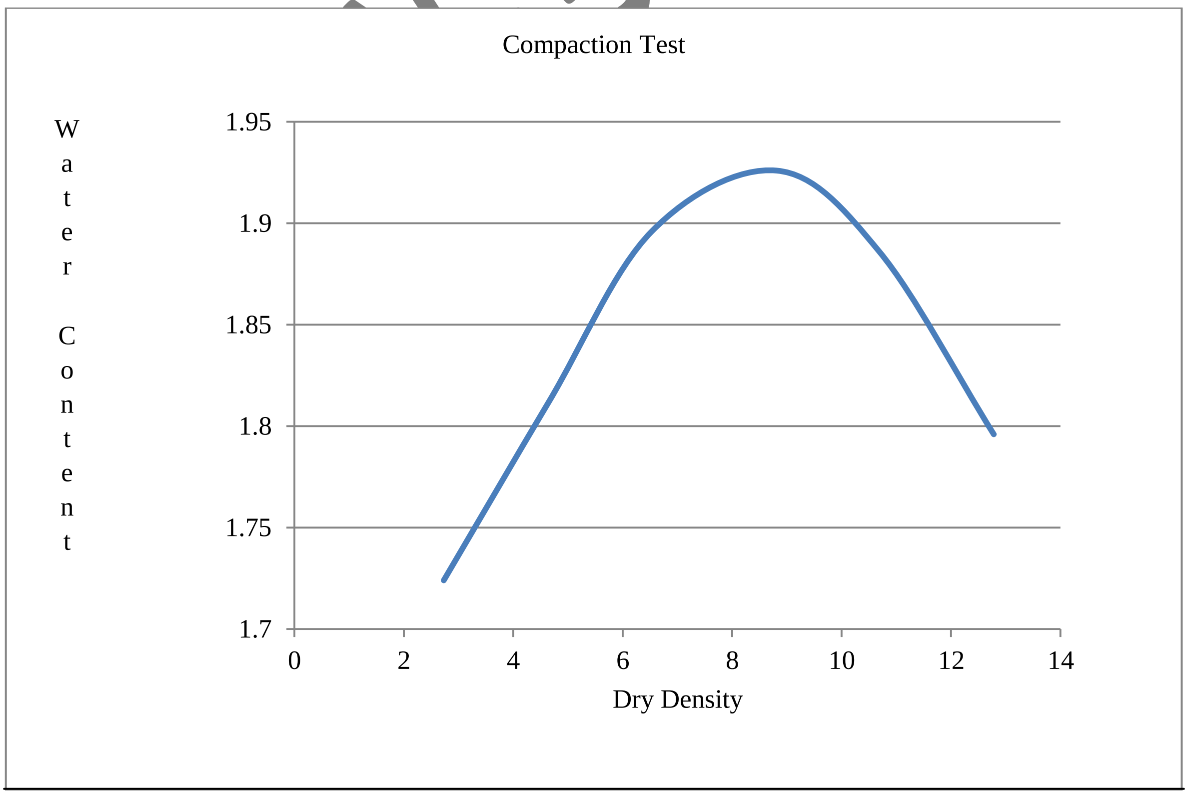

Fig. 3.3 OMC for 24+000 Km =8.81 %

3.2.5 California Bearing Ratio

Table-3.6 CBR @ 24+000

Compaction	Units	Before soaking	After soaking	Before soaking	After soaking	Before soaking	After soaking
Mould		10	10	11	11	12	12
No. Of Blows per layer		10	10	30	30	65	65
Weight of Mould	(gm)	7180	7180	6958	6958	7107	7107
Weight of Mould + Wet soil	(gm)	11340	11401	11377	11420	11832	11872
Weight of Wet soil	(gm)	4172	4233	4459	4452	4725	4765
Bulk density	(gm/cc)	1.854	1.881	1.462	1.988	2.11	2.114
Dry density	(gm/cc)	1.705	1.695	1.804	1.79	1.93	1.915
Compaction	(%)	88.52	88	93.66	92.63	100.2	99.42
Expansion	(mm)						
expansion ratio							
moisture content							
container no.		69	70	71	72	73	74
weight of container	a	43.33	40.8	43.8	38.95	41.48	42.21
weight of wet soil container	b	160.5	161.4	160.8	161.75	162	161.5
weight of soil	c	151.07	149.52	151.35	149.48	152.24	150.06
weight if dry soil	d=(b-c)	9.42	11.25	9.23	11.96	9.7	10.62
moisture content	e=(c-a)	111.95	107.69	109.76	107.46	108.45	104.66
Remarks	(d/e)×100	8.75	11	8.78	10.8	8.81	10.6

Table-3.7 CBR Test Values

Penetration mm	**Load**	
0.5	**Reading**	**kg**
1	14	87.92
1.5	20	125.6
2	26	163.28
2.5	31	194.68
3	35	219.8
3.5	40	251.2
4	47	295.16
45	52	326.56
5	60	376.8
5.5	63	395.64
6	65	456.2

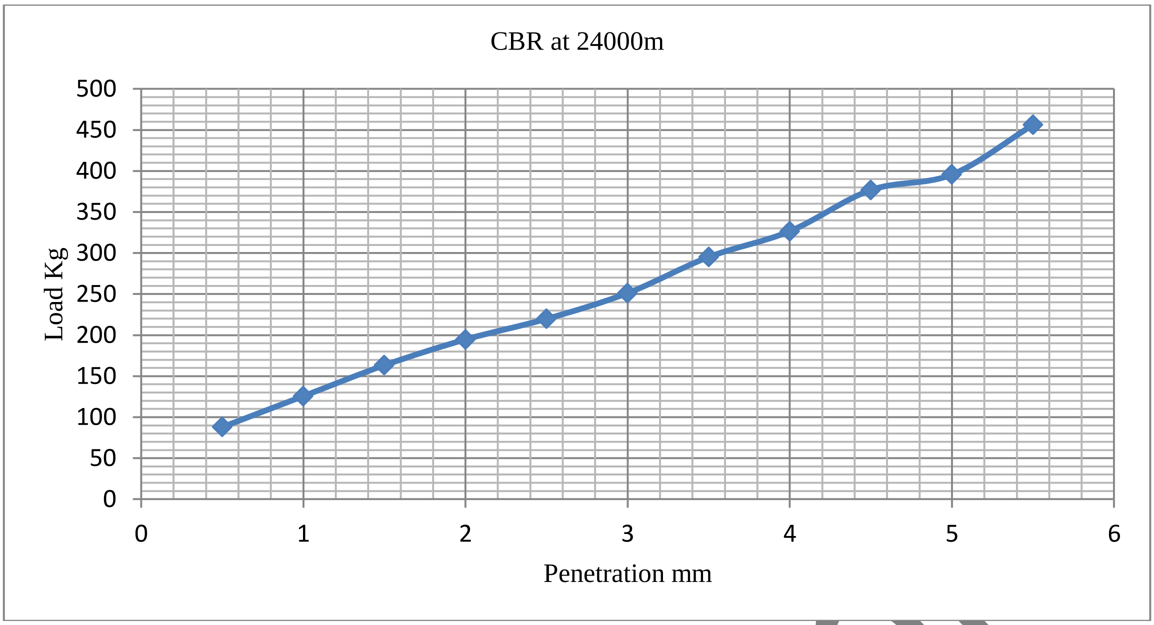

Fig. 3.4 CBR at 24+000 km

CBR value (2.5mm) =16.04
CBR value (5mm) =15.59

Table-3.8 Design Values

Station	Fore Bearing		Corrected Bearing	H. Dist	Cum. Dist.	Latitude	Departure	Northing	Easting
	D.M.S	Degrees’				N	E		
P87								1808020.555	490267.633
P88								1807982.036	490157.325
P89	250*24' 00"	250.4000	250.3987	157.008	157.008	-52.672	-147.909	1807929.364	490009.416
P90	255*12' 55"	255.2153	255.2127	222.579	379.587	-56.809	-215.207	1807872.555	489794.209
P91	254*57' 20"	254.9556	254.9518	208.733	588.319	-54.194	-201.575	1807818.362	489592.634
P92	257*38' 24"	257.6400	257.6349	127.359	715.678	-27.273	-124.405	1807791.089	489468.230
P93	275*57' 02"	275.9506	275.9442	236.879	952.557	24.531	-235.605	1807815.620	489232.625
P94	244*44' 36"	244.7433	244.7357	180.035	1132.593	-76.838	-162.815	1807738.782	489069.810
P95	241*11' 06"	241.1850	241.1762	204.301	1336.894	-98.497	-178.989	1807640.285	488890.820
P96	240*09' 23"	240.1564	240.1463	213.972	1550.866	-106.513	-185.578	1807533.772	488705.243
P97	246*21' 12"	246.3533	246.3420	119.251	1670.116	-47.853	-109.229	1807485.920	488596.014
P98	256*24' 34"	256.4094	256.3968	187.770	1857.886	-44.163	-182.503	1807441.757	488413.512
P99	256*34' 32"	256.5756	256.5617	210.930	2068.816	-49.020	-205.155	1807392.737	488208.357
P100	256*23' 13"	256.3869	256.3718	210.379	2279.195	-49.570	-204.456	1807343.168	488003.901
P101	256*46' 33"	256.7758	256.7594	129.847	1987.733	-29.740	-126.395	1807412.017	488287.116

Table-3.9 Total Values for Design

1987.733	**Total Distance**	
Design Value		
Station	**N**	**E**
P100	1807343.207	488004.084
N	E	Error
0.039	0.183	
0.187		Lenoir Error
10623.654		Accuracy 1 in meter

Table-3.10 Super Elevation Details

Super Elevation Details			
		Percentage	
	Chainage	**Left**	**Right**
Stating Super elevation	12522.299	-2.500	-2.500
Stating Curve	12550.870	0.000	-2.500
At 2.5%	12579.441	2.500	-2.500
Starting Full Super elevation	12630.870	7.000	-7.000
Ending Full Super elevation	12685.614	7.000	-7.000
At 2.5%	12737.043	2.500	-2.500
Ending Curve	12765.614	0.000	-2.500
Ending Super elevation	12794.185	-2.500	-2.500

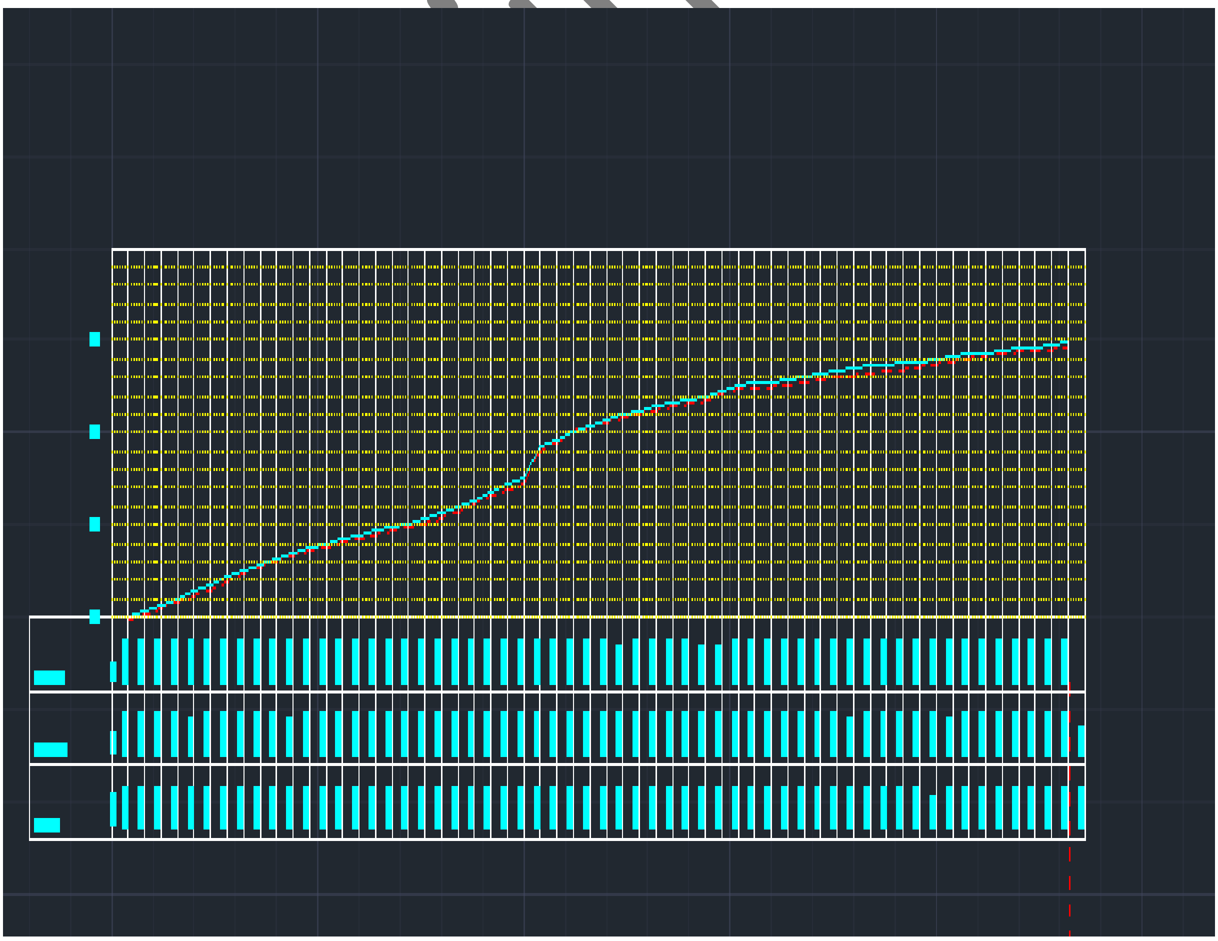

Fig. 3.5 Longitudinal Cross Section of the Alignment in Auto CADD

ISSN No.: 2454- 2024 (online)

International Journal of Technical Research & Science

Table-3.11 Estimation for the Entire Project

S. No.	Name Of Work	Cost
1.	Clearing And Grubbing	639735.00
2.	Forming Embankment	8909063.00
3.	Removal Unserviceable Soils	1551110.00
4.	Granular Sub-Base	44966285.00
5.	Wet Mix Macadam	66662045.00
6.	Prime Coat	4632920.00
7.	Tack Coat	3436626.00
8.	Dense Bituminous Macadam	141790856.00
9.	Bitumen Concrete	66159150.00
10.	Thermoplastic Compounds	5701759.00
11.	Gravel Shoulders	4695100.00
12.	Reflective Pavement Marker	1703382.00
13.	Name Board	56407.00
	Total	350328678.00

CONCLUSION

Traffic volumes and the expectations of neighbouring land owners and road users are increasing for gravel roads. Interviews with state and local officials reveal a number of reasons for this increase, including:

- An increasing population on the urban fringe as former urban residents builds houses in the rural areas surrounding urban areas.
- An increase in the number of houses and cabins near lakes and other desirable natural features.
- Increased traffic accessing recreation areas.
- Increased number of trips by traditional rural residents.

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