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Extra widening of National Highway –Studies on Materials Testing

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Abstract

The Government of India has decided to upgrade 6500 km length of existing 4- lane divided highways into Six-Lane divided carriageway under Phase-V of National Highway Development project (NHDP). The Project of " Six lane of Chilakaluripet - Nellore section of NH-5 from km 1182.802 to 1366.547 (length 183.620) in the state of Andhra Pradesh under NHDP Phase V has been executed as BOT (Toll) under phase V through Public Private Partnership (PPP) on Design-Build-Finance-Operate (DBFO) pattern. The Project Highway shall be widened/ developed to have 6-Lane dual carriageway with 1.5 m wide paved and 2.0 m earthen shoulders facilities for each carriageway having median width up to 4.5m. All the Major Bridges, Minor Bridges and Culverts in the corridor are also widened to match the new road and shall be conforming to 6-Lane road configuration. The proposed construction of road work will involve use of modern innovative techniques and modern construction practices based on trained and intuitive experience. All the Major and Minor Bridges and Culverts en route are also proposed to be widened. The engineering properties of the materials are studied and results are discussed.

1. INTRODUCTION

Transportation contributes to the economical, industrial, social and cultural development of any country. Of all the means of transportation the transport by road is the only mode, which could maximum service to one and all. India has the largest road transport system and occupies 2nd place I the context of road networks. The history of highway engineering gives us an idea about the roads of ancient times. Roads in Rome were constructed in large scale and it radiated in any directions in helping them in military operations. These human pathways would have been developed for special purpose leading to campsites, food, streams for drinking water. The next major mode of transport was the use of animals for transporting both men and materials. The modern roads largely follow Macadam's construction method. Use of bituminous concrete and cement concrete are most important developments. Various advanced and cost-effective construction technologies are used. Developments of new equipments help in faster construction of roads. Many easily and locally available materials are tested in laboratories and then implemented on roads for making economical and durable pavements.

All run way roads were classified into National highway (NH) roads traverse the length and breadth of the country and are of national importance for strategic, administrative and other purposes). State highways(SH) are the main arteries of traffic within a State, serving important cities, and connected to the National Highway system and important highways of adjacent States. Major district roads (MDR) take off from the main roads in a State to the interior of the districts .and Ordinary district roads(ODR) connect villages and group of villages with one another and to market places and district roads.

Table 1: Width of the roadways

S.No	Road Classification	Road width (m)
1	National highways (two lanes)	12.0
2	State highways (single or two lanes)	12.0

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3	Other district roads- i) single lane ii)Two lane	 7.5 9.0
4	Major district roads (Single or two lanes)	9.0
5	National Highways (Single lane)	7.5

Overview of highway Road:

The national highway (NH6) connects the two major cities namely Chilakaluripet and Nellore with a length of 183.620 km. The construction of the road focuses the international standard roads with facilities for uninterrupted flow of traffic with Enhanced safety features, Better riding surface, Better road geometry, Better traffic management and noticeable signage, divided carriageways, service roads and Bypasses.

2. METHODOLOGY:

The methodology and sequence of work is carried out by the following processFirst, selection of the location or site, which is proposed for the construction of road. Surveying of site is done and the soil samples over that place are taken for testing purpose. The soils are tested for their properties are studied.

Cleaning and grabbing is done as to clean the waste material such as large roots of tree which are cut off in excavation and large stones which cause obstruction during the process. Take the Original Ground levels (OGL) of the ground for every off sets proposed for road for that layer and note down the readings.

Fill the layer with morum or soil as the sub grade layer, make it to a level by the Grader machine and take the levels of the first layer by placing pegs at every end of the chain age for every 10 meters of length, take the readings and calculate the values by taking RL and BS. Take a dip of about 0.4 m which can be used for filling or cutting of soil. Mark the points on the peg by taking the staff readings.

Place a thread between two pegs and check the ground weather it is level or cutting/filling is required. After filling the material, level the ground by rollers for two layers.Supply the Granular Sub Base (GSB) from the plant to the site and dump by means of tipper. By grader make it to level and take the readings which are applied for sub grade. Roll the surface by roller such that the aggregate is crushed and made to a level.

Same method is also applied to Wet Mix Macadam(WMM) which is laid on GSB as base, take the levels, roll it perfectly and apply water on it such the material to sink and more compaction is done . Layer is cleaned with brushes as to take away the dust on the road, before 24 hrs of laying DBM applying of prime coat is done on WMM layer and before 1 hr of laying of DBM , tack coat is applied on the surface which is used as a binder which binds the surface of WMM and DBM.

Dense Bituminous Layer (DBM) layer is laid and is rolled well with rollers in such a way that no gaps are found in between the layer. Applying of water to the rollers while lying is seen as for rolling smoothly and to prevent from sticking of bitumen.

- Take the levels of the top layer of DBM and apply tack coat before laying Bituminous Concrete (BC). This process takes about 15 days after laying of DBM.
- Traffic is allowed as compaction is done by wheels of vehicles and surface smoothness is also improved on DBM layer. Laying of BC is done as the final layer and is laid by Pneumatic Tier Rollers(PTR) machines.
- After some days the road is cleaned well by means of brushes, borrowing machines and marking of pavement and kerb marking is done

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3.EMBANKMENTCONSTRUCTION:

General Description:

These Specifications shall apply to the construction of embankments including sub grades, earthen shoulders and miscellaneous backfills with approved material obtained from roadway and drain excavation, borrow pits or other sources. All embankments, subgrades, earthen shoulders and miscellaneous backfills shall be constructed in accordance with the requirements.

Materials and General Requirements

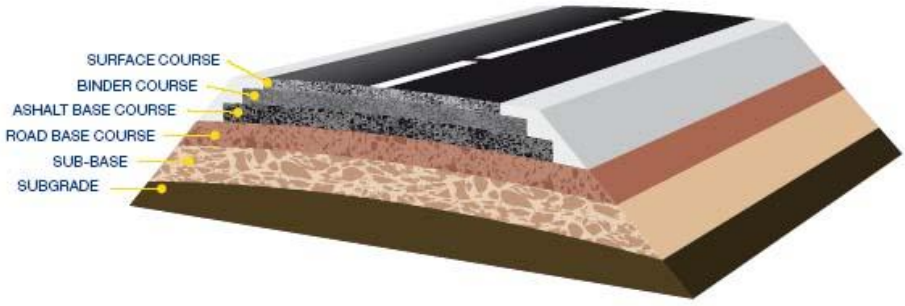
Physical requirements:

The materials used in embankments, sub grades, earthen shoulders and miscellaneous backfills shall be soil, moorum, gravel, a mixture. Such materials shall be free of logs, stumps, roots, rubbish or any other ingredient likely to deteriorate or affect the stability of the embankment.

Expansive clay exhibiting marked swell and shrinkage properties ("free swelling index" exceeding 50 per cent when tested as per IS: 2720 - Part 40} shall not be used as a fill material. Where an expansive clay with acceptable "free swelling index" value is used as a fill material, subgrade and top 500 mm portion of the embankment just below subgrade shall be non-expansive in nature.

Any fill material with a soluble sulphate consent exceeding 1.9 grams of sulphate (expressed as SO3) per litre when tested in accordance with BS : 1377 Test 10, but using a 2:1 water-soil ratio shall not be deposited within 500 mm, of concrete, cement bound materials or other cementitious materials forming part of the Permanent Works, Materials with a total sulphate content (expressed as SO3) exceeding 0.5 per cent by mass, when tested in accordance with BS : 1377 Test 9 shall not be deposited within 500 mm, The size of the coarse material in the mixture of earth shall ordinarily not exceed 75 mm when being placed in the embankment and 50 mm when placed in the sub grade.

Ordinarily, only the materials satisfying the density requirements given in Table 300*1 shall be employed for the construction of the embankment and the subgrade.



PAVEMENT DESIGN:

For existing pavement analysis, various engineering surveys and investigations have been carried out following the relevant MOST/IRC Specifications. The specification that followed are existing Road Condition, existing Pavement Condition,Benkelman Beam Deflection Testing, Existing Pavement Investigation through open pit, Existing Soil and Materials Investigations, Axle load and Traffic.

The existing road condition survey has been carried out by visual inspection and measurement. The road condition survey data for project road as recorded at site for pavement design evaluation. The pavement condition survey was undertaken to determine the condition of existing pavement. The structural capacity of the existing road has been analysed with Benkelman Beam Deflection test. Benkelman Beam Deflection surveys were carried out at 100 m in staggered way for entire length of the project road. Based on the pavement condition survey, homogeneous sections were made. Deflection measurements were taken on the wheel paths (0.9 m from Pavement edge). Deflections were measured at 11 points in a km, staggered in both the lanes. The measurements were taken as per the procedure mentioned in IRC – 81:1997. Atmospheric and pavement temperature

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measurements have also been recorded during Benkelman Beam Deflection survey. The soil sample at level was collected from the shoulder portion for sub grade moisture. The measured deflections were corrected by applying seasonal and temperature corrections. Benkelman Beam Deflection survey was carried out for evaluating the requirements of Strengthening of Flexible pavements following the CGRA procedure. Performance of flexible pavement was closely related to elastic deflection under the wheel load.

Existing pavement investigation

Test pits investigations were carried out at junction of pavement and shoulder at every 1 km interval, staggered in both the lanes for testing of sub grade material and pavement composition. Km wise existing pavement thickness has been observed and at the same location DCP testing has been done for each pit. The existing carriageway Sub-grade was investigated for its suitability to design the overlay and strengthen the existing carriageway and to assess the design parameter. The investigations were carried out along the existing road using trial pits at every 1 km interval, staggered in both the lanes. Sub-grade soil sample have been collected from the same pit locations to ascertain the pavement design criteria along with existing sub-grade soil classification and characteristic through laboratory tests. Detailed material investigation was carried out to familiarize with the sources, properties and characteristics of these basic ingredients, an Inventory programmer was undertaken to identify suitable sources of all construction materials such as soil, sand, stone aggregates.

Design Speed:

Design speed is the most important factor that affects the geometric design and is defined as the highest continuous speed at which individual vehicles can travel with safety on the highway when weather conditions are conducive. It directly affects the sight distance, horizontal curve, and the length of vertical curves. Since the speed of vehicles varies with driver, terrain etc, a design speed is adopted for all the geometric design.

Since there are wide variations in the speed adopted by different drivers, and by different types of vehicles, design speed should be selected such that it satisfies nearly all drivers. At the same time, a higher design speed has cascading effect in other geometric designs and thereby cost escalation. Therefore, an 85th percentile design speed is normally adopted. This speed is defined as that speed which is greater than the speed of 85% of drivers. In some countries this is as high as 95 to 98 percentile speed. Based on the type of road and type of terrain the Indian Road Congress (IRC) has suggested desirable or ruling speed as well as minimum suggested design speed and is tabulated in table 2.

Table 2: Design Speed

Type	Plain	Rolling	Hilly	Steep
NH &SH	100-80	80-65	50-40	40-30
MDR	80-65	65-50	40-30	30-20
ODR	65-50	50-40	30-25	25-20
VR	50-40	40-35	25-20	25-20

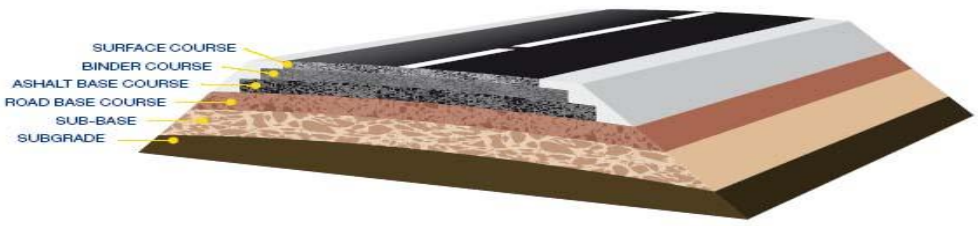

Figure 1: Cross section of layers in pavement

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Ordinarily, only the materials satisfying the density requirements given in Table 300*1 shall be employed for the construction of the embankment and the subgrade.

Laboratory Analysis:

The materials used in construction of pavement are tested in laboratory and results are discussed.

Embankment /SUB GRADE :

(a) Free Swell Index
(b) Atterbergs limit (casegrande method)
i. Liquid Limit
ii. Plasticity Index

(c)Grain size analysis
(d) modified proctor test
(e) Field density test

Free swell index:

The clay and specially the black cotton soils have a tendency to swell in small or more proportion when submerged in water. Free swell or differential free swell also termed as free swell index, is the in-crease in volume of soil without any external constraint when subjected to submergence in water. The free swell index of the collected sample has been calculated by as

Free swell index = (Vd- Vk/Vk)*100

Vd= volume of soil specimen read from the graduated cylinder containing distilled water

Vk= volume of soil specimen read from the graduated cylinder containing kerosene

Table 3: Table showing degree of expansiveness of soils

D FS (%)	Degree of Expansiveness
< 20	LOW
20 –35	MODERATE
35 –50	HIGH
>50	VERY HIGH

Free swell index has been calculated as Ws = 20.525 which is moderate which is acceptable for construction of pavement.

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Atterberg's Limit:

The plasticity index of the soil is determined by calculating the Atterberg's Limit. the liquid limit and plasticity indexes are calculated .

Moisture content = (Wt.of container +Wt.of wet smpl) - (Wt.of container + Wt.of dry smpl)

(Wt. of container + Wt. of dry sample) – (Empty Wt. of container)

Plasticity index (Ip) = Liquid limit – Plastic limit (Ip = Wl – Wp)

Result :

Liquid Limit (LL)% = 26.20 %
Plastic Limit (PL)% = 16.48%
Plasticity index (PL) = 10.42

Table 4: Results of the Atterberg's Limits

Description	**Liquid Limit (LL)**				**Plastic Limit (PL)**	
TEST NO	**1**	**2**	**3**	**4**	**1**	**2**
No. of blows	33	27	21	17	-	-
Container no.	51	52	53	54	55	56
MASS OF WET SOIL+CONTAINER W1	32.74	32.91	46.45	49.81	27.92	29.96
MASS OF DRY SOIL + CONTAINER W2	28.72	28.51	41.58	44.56	27.00	29.00
MASS OF CONTAINER W3	13.05	11.80	23.98	26.25	21.38	23.21
MASS OF WATER W4= W1-W2	4.02	4.40	4.87	5.25	0.92	0.96
MASS OF DRY SOIL W5= (W_3-W_1)	15.67	16.71	17.60	18.31	5.62	5.79
MOISTURE CONTENT =(W4/W5)*100	25.65	26.33	27.67	28.67	16.37	16.58

Grain size distribution test:

There is large variation in types of soils from site to site. Accordingly, their behavior is also varies. To make understanding of soil in easy manner, their grouping has been done depending on size of soil particles and their water absorption capacity. Ratio of soil of different sizes is worked out from sieve analysis and hydrometer/laser particle analyzer and capacity to absorb water is worked out from liquid limit, plastic limit tests. These tests are used to classify the soils. Sieving is used for gravel as well as sand size particles and sedimentation procedures are used for finer soils. For soils containing coarse and fine soil particles both, it is usual to employ both sieving and sedimentation. The results are shown in the table 5.

Table 5: Result of the grain size analysis

IS Seive Size (mm)	**Wt. retained (gm)**	**Cumulative wt. retained**	**Cumulative % retained**	**Cumulative % passing**	**Remarks**
100	-	-	-	-	
75	-	-	-	-	**Gravel** 1.20 %
20	0	0	0	100	

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4.75	13.5	13.5	1.20	98.80	
2	19.5	33.0	2.93	97.07	**Sand** 66.07 %
0.425	191.0	224.0	19.89	80.11	
0.075	533.5	557.5	67.27	32.73	
Pan					**Silt & clay** 32.73 %

Modified Procter Test:

Where the density and moisture control option is used, compaction of the embankment areas is required. The minimum number of tests required is outlined in the frequency manual. For mainline and shoulders, one test for each 1500 ft for each lift is required. For widening trenches 5 ft, one test each 1500 ft is required. Any failing tests require additional work on the subgrade in that area to obtain the required density. Soil compaction at the optimum moisture content requires the least amount of compactive effort to obtain 100 % maximum dry density. Therefore, drying excess moisture or adding water to a dry subgrade may be necessary to obtain this required density. The dry density should not be less than 1.75 gm/cc.

Calculation:

Diameter of the mould = 100 mm
Height of mould = 127.3mm
Volume of mould, V = 2247 cc

MDD : ----1.905g/cc
OMC : -------8.80%-

Table 6. Results of the modified Proctor Test

TEST NUMBER	1	2	3	4	5
% OF water added	4	6	8	10	12
Wt of mould +wet soil (gm)	11480	11672	11845	11811	11785
Wt of mould gm	7210	7210	7210	7210	7210
Wt of wet soil gm	4270	442	4635	4601	4575
Wt density ym gm/cc	1.900	1.985	2.062	2.047	2.036
DETERMINATION OF MOISTURE CONTENT & DRY DENSITY					
Container no	1	2	3	4	5
Wt of Wet soil + Container gm	50.76	52.47	53.06	55.53	
Wt of dry soil + container gm	49.57	50.68	50.64	52.44	57.80
Wt of Water gm	1.19	1.79	2.42	3.09	3.79
Wt of container gm	23.45	23.06	21.72	22.92	27.65
Wt of Dry soil gm	26.12	27.62	28.92	29.52	30.15
Moisture Content % (w)	4.55	6.48	8.36	10.46	12.57
Dry density yd =ym/1+(w/100)gm cc	1.817	1.864	1.903	1.853	1.808

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CBR Test:

It is the ratio of force per unit area required to penetrate a soil mass with standard circular piston at the rate of 1.25 mm/min. to that required for the corresponding penetration of a standard material. The California Bearing Ratio Test (CBR Test) is a penetration test developed by California State Highway Department (U.S.A.) for evaluating the bearing capacity of subgrade soil for design of flexible pavement.

Tests are carried out on natural or compacted soils in water soaked or un-soaked conditions and the results so obtained are compared with the curves of standard test to have an idea of the soil strength of the subgrade soil.

Table 6 : Permissible Variation in CBR Value:

CBR (%)	Maximum Variation in CBR Value
5	±1
5-10	±2
11-30	±3
31 and above	±4

Table 7: Results of CBR tests

S.NO	DESCRIPTION	MOULD NO 43 NO OF BLOWS:55		MOULD NO 44 NOOF BLOWS: 55		MOULD NO :45 NO OF BLOWS:55	
		Before Soaking	After Soaking	Before Soaking	After Soaking	Before Soaking	After Soaking
1	Mass of mould W1(gm)	6335	6335	6665	6665	7005	7005
2	Mass of Mould + Wet soil W2(gm)	11470	11555	11795	11869	12140	12211
3	Mass of Wet soil W2-W1(gm)	5135	5220	5130	5204	5135	5206
4	Wet Density Ym=(W2-W1)(gm)	2.282	2.320	2.280	2.313	2.282	2.314
5	Container no	100	104	105	109	107	106
6	Mass of Container W5(gm)	25.27	13.21	25.18	25.74	11.50	12.24
7	Mass of Container+Wet soil W3(gm)	54.67	39.08	52.04	55.41	40.53	36.52
8	Mass of container+ Oven Dried soil W4 (gm)	52.49	36.90	50.06	52.83	38.38	34.40
9	Water content %(w)=((W3-W4)/(W4-W5))*100	8.01	9.79	7.96	9.52	8.00	9.56
10	Dry Density Yd=Ym/(1=W/100)(gm/cm)	2.113	2.113	2.112	2.112	2.113	2.112

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Mould no	C.B.R at 2.5 min in%	C.B.R.at 5.0min in %
43	17.52	14.60
44	16.42	13.87
45	18.25	15.82
AVERAGE	17.40	14.7

Flakiness and Elongation Index:

The flakiness index and elongation index of the coarse aggregate has been calculated. The coarse aggregate having more flaky particles will adversely affect the strength of concrete. The flakiness index of the aggregate is the percentage by weight of particles in it, whose least dimension (thickness) is less than three fifth of their mean dimension. In the present analysis 3 kg of sample has been taken. The flakiness index is calculated by using the formula and the results are tabulated in table

$$\text{Flakiness index} = \frac{(w1+w2+w3+\ldots\ldots)}{(W1+W2+W3+\ldots.)} \times 100$$

$$\text{Elongation index} = \frac{(w1+w2+w3+.....)}{(W1+w2+W3+.....)} \times 100$$

Table 8: Results of Flakiness index

IS Sieve size mm		**No of aggregates taken for test**	**Total wt. of agg. taken(gms)A**	**Wt.of agg, retained on thickness gauge B**	**Wt .of agg. passing through thickness gauge C**	**Wt. of agg. Retained on length gauge after retained on thickness gauged**
passing	**retained**					
50	40					
40	25	200	8000	6962	1038	1013
25	20	-	-	-	-	-
20	16	200	4230	3681	549	546
63	50	200	2240	1950	290	287
16	12.5	200	1124	981	143	145
12.5	10	200	610	532	78	78
10	6.3	200	170	148	22	21
Total		200	16374gm	14254gm	2120gm	2090gm
		1.Flakiness index =(C/A)*100 = 12.95 2.Elongation index =(D/B)*100 = 14.66 3. Combined FI =1+2 = 27.61%				

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Table 40

Aggregate Impact Value:

	Trail No. 1	Trail No. 2	Trail No. 3
Wt. of surface dry sample passing I2.5mm and retained on 10mm IS sieves, W_1 (gm)	375.5	382.0	
Wt. of fraction Passing on 2.36mm IS sieve after test, W_2 (gm)	54.0	54.5	
Wt. of fraction retained on 2.36mm sieve after test, W_3 (gm)	321	327.	
Loss of Material W_1-(W_2÷W_3), W_4 (gm)	0.5	0.4	
AIV = (W_2/W_i) X 100 (%)	14.38%	14.2	
Average Value of AIV (%)	14	%	

Note : If W_4 > 1.0 g Discard & Retest

5. CONCLUSION:

In the present paper extra widening of National Highway 6 has been taken to study procedure of the widening of the road. The materials used have been tested in the laboratory to study the engineering properties of the material and its suitability to utilize for pavement. The pavement design investigations have been carried out following the relevant MOST/IRC Specifications. The structural capacity of the existing road has been analysed with Benkelman Beam Deflection test. Benkelman Beam Deflection surveys were carried out at 100 m in staggered way for entire length of the project road.

All the materials are tested in the laboratory satisfied the requirements of flexible pavement design according to the IRC (Indian Road Congress) and BIS (Bureau of Indian Standards) specifications. Free swell index has been calculated as Ws = 20.525 which is moderate which is acceptable for construction of pavement. The calculated Atterberg's results are Liquid Limit (LL)% is 26.20 %, Plastic Limit (PL)% is 16.48%, Plasticity index (PL) is 10.42. The flakiness index and elongation index are 12.95 and 14.66 respectively. The combined FI is resulted as 27.61%. It is found that all the values are in the permissible limits.

BIBIOGRAPHY

[1] Principles and practices "HIGHWAY ENGINNERING" by Dr. L.R.Kadyali and Dr.N.B.Lal.

[2] The Indian Road Congress (IRC).

[3] Guidelines for the Design of FLEXIBLE PAVEMENTS, IRC: 37 – 2007.

[4] MORTH (Ministry Of Road Transport And Highway)

[5] MOSRTH(Ministry Of Shipping, Road Transport And Highway)

[6] Hand book for road works.

[7] S.K. khanna and C.E.G. Justo, "Highway Engineering ", 2001.

[8] Bureau of Indian Standards (BIS).