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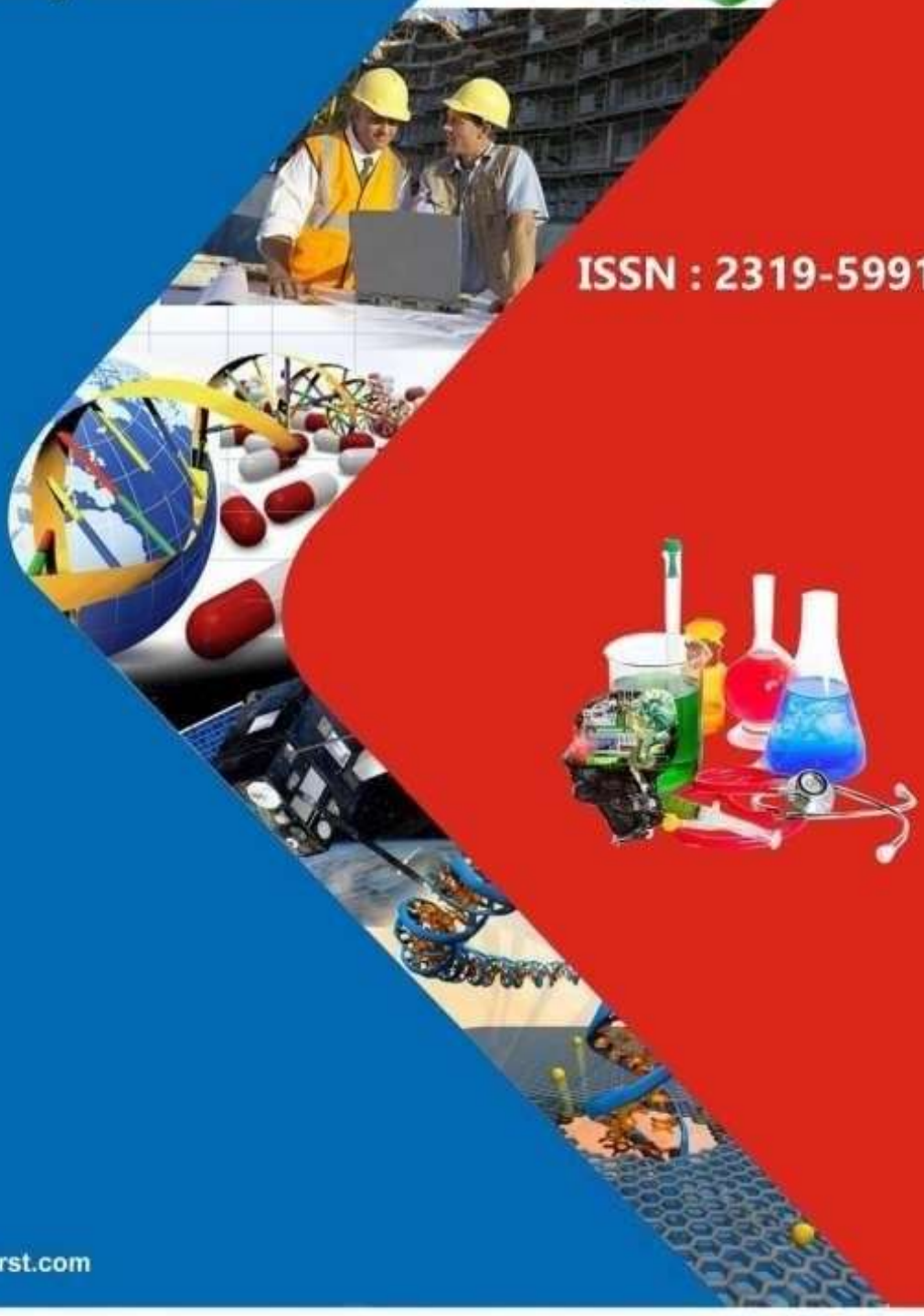

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DESIGN ASPECT OF FLEXIBLE PAVEMENT AND QUALITY CONTROL MANAGEMENT

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Abstract:

System between towns, urban groups and unmistakable domains is an essential section in the change of a nation. Lanes and railways give this system. Fast road lobbies have been a champion among the most fundamental establishments in the general money related change of the country. A turnpike black-top is a structure containing super constrained layers of arranged material over the typical soil-sub-survey, whose fundamental limit is to pass on the associated vehicle weights to give a surface of palatable riding quality, adequate slip insurance, great light reflecting traits and low commotion defilement. Finally to assume that we have thought about the purposes of intrigue and improvement of versatile asphalt sand we can express that roadways can be useful for the progress of the gathering, money related achievement and general headway of the country.

Keywords: pavement design, management systems in pavement design.

I.INTRODUCTION

Hyderabad Growth Corridor Limited (HGCL), a Joint Venture of Hyderabad Metro Development Authority (HMDA) and Infrastructure Corporation of Andhra Pradesh (INCAP), has awarded "The Consulting Services for Construction Supervision of Construction of Eight lane access Controlled Expressway as Outer Ring Road to Hyderabad City in the State

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of Andhra Pradesh, India in the Stretches from Shamirpet to Pedda Amberpet - From Km.61.700 to Km.95.000 (Northern Arc)" to NIPPON

KOEI – aarvee associates (JV) in association with Nippon Koei India Pvt. Ltd, being taken up with the loan assistance of Japan International Cooperation Agency Under JICA Phase - 2 Programme and Loan Agreement No ID-P:198 and the Agreement has been signed on 29th March"2010. The monthly progress report is prepared and submitted with respect to the Terms of Reference (TOR) to the agreement between Nippon Koei, Japan in joint venture with Aarvee Associates, India in association with Nippon Koei India Pvt. Ltd. The report includes Project background, salient features of Civil Works, scope of Consulting Services and monthly progress of works in comparison with the approved Work Programme in accordance with Clause 11 of the General Condition of Contract. The report also covers the mobilization of the Consultant and the Contractors.

II. PAVEMENT DESIGN

Pavement is the durable surface material laid down on an area intended to sustain vehicular or foot traffic, such as a road or walkway. In the past cobblestones and granite sets were extensively used, but these surfaces have mostly been replaced by asphalt or concrete There are two types of pavements:

- Flexible pavement
- Rigid pavement

A. Flexible Pavement Flexible pavements are those, which on the whole have low flexural strength and are rather flexible in their structural action under the loads. The flexible pavement layers reflect the deformation of the lower layers on to the surface of the layer as shown in Fig.1. A typical Flexible pavement consists of four components:

- surface course
- base course
- sub base course
- soil sub grade

Fig.1. A view of Flexible pavement components.

B. Rigid Pavement

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Rigid pavements are those posses note worthy flexural strength. The stresses are not transferred from grain to the lower layers as in case of flexible pavement layers. The rigid pavements are made of Portland cement concrete-either plain, reinforced or prestressed concrete. The plain cement concrete slabs are expected to take up to about 40 kg/cm2 flexural stress. The rigid pavement has the slab action and is capable of transmitting the wheel load stresses through a wide area below Figs.2 and 3

Fig.2. A view of rigid pavement.

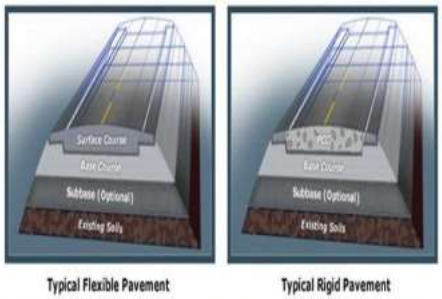

Fig.3.The difference between flexible and rigid pavement.

C. Functions of Pavement Components

- Soil Subgrade
- Sub-base and Base Course
- Wearing Course

Soil Subgrade: The soil subgrade is a layer of natural soil prepared to receive the layers of pavement materials placed over it. The load on the pavement is ultimately received by the soil subgrade for dispersion to the earth mass. It is essential that at no time, the soil subgrade is overstressed. It means that the pressure transmitted on the top of the subgrade is within the allowable limit, not to cause excessive stress condition or to deform the same beyond the elastic limit. It is necessary to evaluate the strength properties of a soil subgrade. This helps to designer to adopt the suitable values of the strength parameters for design purpose and in case this supporting layer does not cum upto the expectations, the same is treated or stabilized to suit the requirements.

Sub-base and Base Course: These layers are made of broken stones, bound or unbound aggregate. Some times in sub-base course a layer of stabilized soil or selected granular soil is also used. In some places boulders stones or bricks are also used as sun-base or soling course. When the subgrade consists of the grained soils and when the pavement carries heavy wheel loads, there is a tendency for these boulders stones or bricks to penetrate into the wet soil,

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resulting in the formation of undulation and uneven pavement surface in flexible pavement.

Grain Size Analysis (GSA): P This test is performed to determine the percentage of different grain sizes contained within a soil. The mechanical or sieve analysis is performed to determine the distribution of the coarser, larger-sized particles.

Significance: The distribution of different grain sizes affects the engineering properties of soil. Grain size analysis provides the grain size distribution, and it is required in classifying the soil.

Equipment: Balance, Set of sieves, Cleaning brush, Sieve shaker, Mixer (blender), 152H Hydrometer, Sedimentation cylinder, Control cylinder, Thermometer, Beaker, Timing device.

Test Procedure:

Sieve Analysis:

- Write down the weight of each sieve as well as the bottom pan to be used in the analysis.
- Record the weight of the given dry soil sample.
- Make sure that all the sieves are clean, and assemble them in the ascending order of sieve numbers (#4 sieve at top and #200 sieve at bottom). Place the pan below #200 sieve. Carefully pour the soil sample into the top sieve and place the cap over it.
- Place the sieve stack in the mechanical shaker and shake for 10 minutes.
- Remove the stack from the shaker and carefully weigh and record the weight of each sieve with its retained soil. In addition, remember to weigh and record the weight of the bottom pan with its retained fine soil.

III. FREE SWELL INDEX (FSI)

Object: To determine the free swell index of soils.

Apparatus:

- 425 micron IS sieve
- Glass graduated cylinders – 2 nos 100ml capacity
- Distilled water and kerosene.

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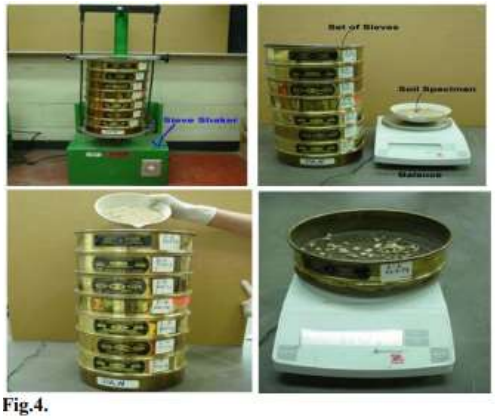

Fig.4.

Procedure:

- Take two 10 grams soil specimens of oven dry soil passing through 425-micron IS sieve. Each soil pecimen shall be poured in each of the two glass graduated cylinders of 100ml capacity.
- One cylinder shall then be filled with kerosene oil and the other with distilled water up tothe 100ml mark.
- After removal of entrapped air the soils in both the cylinders shall be allowed to settle. Sufficient time (not less than 24 hours) shall be allowed for the soil sample to attain equilibrium state of volume without any further change in the volume of the soils.
- The final volume of soils in each of the cylinders shall be read out.

III.METHODOLOGY

Alignment of the road is done by road surveying and details are mentioned in the report. Technical features of the project such as details of right of the way, No. of lanes, carriageway width, shoulder width are clearly mentioned according to the design of the pavement. All the required dimensions of the cross sectional elements of the road are calculated and mentioned accordingly. Traffic survey report on KKY road is made through manual counting of the traffic moments of the road. And a design period of 20 years is assumed based on the design data. Tests are to be conducted on bitumen, aggregates and sub soil for the pavement in the near by treatment plant and results been calculated. Finally design data of the road the KKY road is calculated and design procedure is mentioned. A complete report on KKY road is enclosed in this project Alignment of the road is done by road surveying and details are mentioned in the report. Technical features of the project such as details of right of the way, No. of lanes, carriageway width, shoulder width are clearly mentioned according to the design of the pavement. All the required dimensions of the cross sectional elements of the road are calculated and mentioned accordingly. Traffic survey report on KKY road is made through manual counting of the traffic moments of the road. And a design

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- Surveillance review

Seven noteworthy streets marked RD1-RD7 were chosen and review inside the contextual analysis territory. A point by point visual examination of the asphalt surface including the taking of Photographs was performed to record area, seriousness, degree of misery, the width of the street, the wearing course of the street, detail of seepage, the thickness of the black-top and shoulder width.

- Asphalt Condition Survey

Manual surface trouble reviews are routinely directed amid the itemized assessments that are done for applicant recovery ventures. Notwithstanding trouble overviews, this can incorporate geotechnical examinations, quality testing, coring, and research center testing. The reason for the undertaking level manual trouble overviews is to give a more exact and point by point examination of the asphalt weakening with a specific end goal to help with deciding suitable recovery medicines. The manual surface misery mapping technique comprises of a man strolling the asphalt area, recognizing and grouping the current pain includes and plotting them on a guide. Separating the test area ahead of time at 10 meter interims aids the mapping and rating process. In view of the split mapping and visual perception, the individual allots the seriousness and thickness appraisals for the pain composes distinguished utilizing the rating manual rules and photos as references.

- Waste Condition Assessment

Evaluation of the surface and sub-surface waste was led, as these components contribute essentially to the general Performance of the asphalt structure, Surface seepage is judged by the capacity of the asphalt surface to deplete water aswell as not enabling water to lake either on the bituminous surfacing or on the shoulder skirt (Adebanjo, 2013), Meeting One on one discussion with the staff of service of works and individuals inside Ifelodun environ, to comprehend individuals supposition concern plan strategy, nature of configuration, movement state of

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street, and significance of the street the level of systems for upkeeps this must take to thought to make my determination.

- Test Collection/Laboratory Test

Thirteen trail pits were burrowed at a profundity of 0.5m to 0.7 on the fizzled and unfailed part of the seven streets in Ifelodun Local Government region, and the point is to do arrangement of research facility trial of the subgrade layer of the asphalt. The accompanying research facility test were completed, for example, molecule estimate circulation (sifter investigation), Atterberg constrain (consistency restrain), particular gravity, compaction and California bearing proportion (CBR) In agreement to, British Standard Institute (BS 1377, 1990). Every one of the tests were done in geotechnical research facility of Department of Civil Engineering Osun State University, Osogbo (UNIOSUN)

IV.MODELLING

Expressway, a controlled access facility is intended to provide most efficient speedy movement of relatively high volumes of motorized traffic with higher degree of safety, comfort and economy. Alignment characteristics and parameters of physical dimensions should be such that the resulting road has inbuilt flexibility of adjustment for additional carriageways in foreseeable future without any extravagant or wasteful expenditure, because in a rapidly developing economy it may not always be possible to forecast the traffic growth accurately. Geometric and other elements should be preferably matched to the individual and collective requirement of traffic using the facility. Predominant vehicles trucks and passenger vehicles were considered in finalizing the basis for the design parameters like carriageway widths, Capacities, Design Speeds and other geometric elements.

ROAD DESIGN

1.Terrain Classification:

The general slope of the country classifies the terrain across the area. The terrain is an important parameter governing the geometric standards and the criteria given in the table 1 as shown below, are used in classifying terrain under these categories. While classifying a terrain, short isolated stretches of varying terrain were not taken into consideration.

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Table 1: Terrain Classification Recommended by IRC

Terrain Classification	Cross slope of the country	
Plain	0 – 10	More than 1 in 10
Rolling	10 –25	1 in 10 to 1 in 4
Mountainous	25 –60	1 in 4 to 1 in 1.67
Steep	>60	Less than 1 in 1.67

2.Design Speed:

Design speed is the basic criterion for determining all geometric features of horizontal and vertical alignments. The design speeds for various terrain conditions are given in the table 2 as shown below. Design speed is mainly be used to determine the following parameters:

• Horizontal alignment radii

• Length of Vertical Curves / K factors

• Geometric layout of the interchanges (specifically layout of the accesses, including length of taper and merging areas, and of weaving zones)

• Layout and characteristics of signs

Table 2: Design Speeds to be adopted for Different Terrain

Sl No	Road Classification	Design Speed (Km/h)				
		Plain Terrain		Rolling Terrain		Mountain Terrain
		Ruling	Minimum	Ruling	Minimum	Ruling
1	Expressway	120	100	100	85	80
2	Link Road	100	80	80	65	50

In fact, in urban areas, even in plain terrain, there could be geometric constraints and controls similar in their effects to mountainous terrain. Thus, design speed should be adapted in areas with densely built environment having important facilities and other environmental constraints. Also, considering the above, in areas with close accesses to the project corridors exists, the design speed should be adapted to suit the site conditions. This can be achieved by either decreasing design speed on the main carriageway, or by providing an auxiliary lane physically separated from main carriageway, with a different design speed from main carriageway. Design speed should also include provision for the approaches of adjacent road sections (State Highways, National Highways, and Local Roads). This will require speed to be reduced when approaching these sections. Normally, ruling design speed was taken as the guiding criterion for the purpose of the geometric design. Minimum design speed was however adopted where site condition and cost does not permit a design based on “Ruling Design Speed”. In the link road section, the design speed was taken as 100 Kmph and for the rest of the ORR the design speed is taken as 120 Kmph.

HORIZONTAL ALIGNMENT

3.Horizontal Curve:

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Horizontal curve consists of circular portion flanked by spiral transition at both ends. Design speed, super elevation and coefficient of side friction affect the design of circular curves. The provision of transition curves enhances the safety of the road users, as it will allow a smooth change in the rate of change of superelevation, and also reduces the centrifugal forces on the vehicle. Length of transition curve is determined on the basis of rate of change of centrifugal acceleration or the rate of change of super elevation. The rate of change of super elevation is considered to be 1:200, as prescribed in AASHTO, and the same rate has been adopted in this project.

4. Superelevation:

Superelevation is generally considered to counteract only a fixed percentage of the centrifugal force developed, so that the slow moving traffic will be aided. The radii beyond which super elevation is not required is shown in table 8 below. The value of super elevation, which should not be less than the camber, is restricted to 7%. It is calculated by the following formula.

$$e = \frac{V^2}{225\ R}$$

Where

'e' is Superelevation

'V' is the design speed in Km/h

'R' is the radius in meters

Table 8: Radii beyond which superelevation not required

Design Speed (Km/h)	Radius of Curve (m)
100	1800
120	2600

5. Traffic Surveys:

Introduction:

An accurate estimate of the traffic that is likely to use the project road is very important as it forms the basic input in planning, design, operation and financing. A thorough knowledge of the travel characteristics of the traffic likely to use the project road as well as other major roads in the influence area of the study corridor is, therefore, essential for future traffic estimation. Hence, detailed traffic surveys were carried out to assess the present day traffic and its characteristics.

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Table 1: Present and Projected traffic volume (PCUs) along the Project Corridor

Leg	2006	2011	2016	2021	2026	2031	2036
Leg-1	34,931	49,271	69,123	96,126	129,534	172,687	225,540
Leg-2	35,450	49,959	70,112	97,636	131,723	175,936	230,206
Leg-3	34,672	49,053	68,990	96,126	129,709	173,103	226,264
Leg-4	52,136	73,043	101,663	140,201	187,741	248,553	322,651
Leg-5	57,655	80,801	112,350	154,619	206,695	272,957	353,470
Leg-6	58,305	80,936	111,911	153,769	205,433	271,819	352,899
Leg-7	38,276	52,340	71,260	96,491	127,501	166,864	214,624
Leg-8	58,761	79,977	108,461	146,443	193,112	252,380	324,302
Leg-9	64,463	87,702	119,014	160,945	212,526	278,330	358,380
Leg-10	37,924	51,184	69,225	93,747	124,017	163,264	211,411
Leg-11	32,589	44,342	60,433	82,371	109,487	144,719	187,993
Leg-12	31,861	43,366	59,150	80,721	107,397	142,137	184,856

* Legs as detailed in Table 4.

Flexible pavement design has been carried out using the IRC: 37-2001 and AASHTO design methods. IRC: 37-2001, a modification to IRC: 37-1984 has been revised to incorporate the mechanistic design approach. In the new code pavement designs have been extended to cover up to traffic loading of 150 Msa. Design was also carried out using the AASHTO pavement design guidelines.

The scope of pavement design in this project can be divided into the following sections.

• Design of Flexible Pavement for the Main carriageway

• Design of Flexible Pavement for Service roads

In the design of flexible pavements, a subgrade CBR of 10% has been considered. Wherever the CBR of existing soils was found to be less than 10%, select subgrade material, with a thickness of 500mm, having a CBR of 10% or more has been considered in the design. If the CBR of the existing sub grade is more than 10% it will be loosened and re-compacted and then the new pavement layers will be laid on it. The availability of the soils with CBR more than 10% has been thoroughly investigated and is found to be in sufficient quantity.

V.CONCLUSION

Pavements from the fundamental supporting structure in thruway transportation each layer of asphalt has a huge number of capacities to perform which must be considered amid the development procedure. Different sorts of asphalts can be embraced relying on the movement prerequisites. Improper development of asphalt burdens to early disappointment of asphalts influencing the riding quality too. In the development of adaptable asphalt the quality control of materials utilized as a part of the development is generally essential. Mainly the materials utilized as a part of the development will chose by the national parkway of authority (NHAI).

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