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Investigation on Pavement Service life based on Interfacial Behaviour of black Cotton soils with Ricehusk and Baggase Ash of Rural Roads

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ABSTRACT; *Many important decisions are necessary in order to successfully provide and manage a pavement network. At the heart of this process is the prediction of needed future construction events. One approach to providing a single numeric on the condition of a pavement network is the use of pavement* ***remaining service life*** *(RSL). This report presents the framework for replacing the current RSL terminology with one based on more exact construction event terms.*

Black cotton soil causes many problems to road constructed on it. About 20% of the soil found in India is expansive in nature. Roads on black cotton soils are known for bad condition. In rainy season black cotton soil absorbs water heavily which results into swelling and softening of soil. In addition to this it also loses its strength and becomes easily compressible. Black cotton soil has tendency to heave during wet condition. In summer season reduction in water content it shrinks and produces cracks. Thus as a result of this roads on black cotton soil suffer from early failures in pavement with heavy traffic excessive unevenness, ruts, waves and corrugations are formed. This study deals with improving the properties of black cotton soil through addition of locally available industrial wastes as Foundry Sand, Rice Husk Ash and Bagasse Ash. Laboratory tests were conducted on various proportions of mixes of black cotton soil and industrial wastes 0% to 60% at the interval of 10%. The soaked CBR value untreated soil is 2.08%. The soaked CBR value of mix soil: rice husk ash in the proportion of 60:40 is 10.04% which is increased by 79.28% in comparison with untreated soil. Stabilized pavement by using industrial wastes

saved 21.91% cost as comparison with conventional flexible pavement.

1, INTRODUCTION

The increasing traffic intensity, high tire pressure, increasing axle loads etc are causing early signs of distress to bituminous pavements throughout the world. The deterioration of the paved roads in tropical and subtropical countries differs from those in the more temperate regions of the world. This can be due to the harsh climatic conditions and sometimes due to the lack of good pavement materials and construction practices. Pavement performance can be defined as the ability of the road to meet the demands of traffic and environment during its design life. The reduction in the performance level of the pavement with time is termed as deterioration. Flexible pavements deteriorate due to many factors, predominantly traffic, climate, material, construction quality and time. These multiple parameters make the process very complex. The condition of the road at any time can be predicted approximately using performance models.

For managing the transport infrastructure system, prediction and modeling of their performance are the main inputs as well as major challenges. The predicted deterioration play major roles at both network level and project level. The overall facilities can be planned for justifying the budget and resources with help of deterioration models. The planning and scheduling of the maintenance work for individual project is dependent on the time at which the section becomes deficient in service. This can be predicted through accurate deterioration models. Development of appropriate transportation policy and evaluation of the economic impacts also depend on the performance and interplay between the infrastructure facility and its user (traffic). One such example is the imposition of axle load limits, which is responsible for the damage of the pavement at exponential rates.

2, LITERATURE REVIEW

Performance of pavement can be generally defined as to the change in their condition or function with respect to age. It can also be indicative of the ability of a pavement to carry the intended traffic and satisfy the environment during the design life, both functionally and structurally. With the increased economic and development activities in India, the traffic has increased multi fold during the last 3 decades resulting in the overstressing of road network. The development of higher stresses leads to performance failure of the pavements. If the pavements fail to carry the design loads satisfactorily, then the failure is of structural type. It is of functional type, if the pavement does not provide a smooth riding surface. The uneven surface not only causes discomfort, but also increases the Vehicle Operating Cost (VOC), thus influencing the overall transportation cost. This chapter gives a broad outline of the importance of pavement performance evaluation, type of models, applications of performance models in other countries for their Pavement Management System and the research studies carried out so far.

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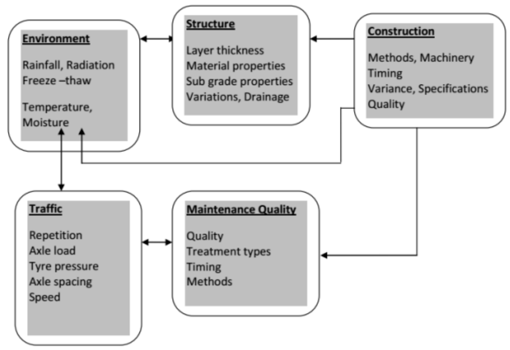

The main deteriorations include cracking, potholes, rutting along wheel path and roughness of road surface. The physical manifestation of the internal damage (cracking, rutting, potholes etc.) is known as distress. Percentage of distress gives an indication of the pavement condition. Different modes of distress occur either independently or simultaneously with mutual interaction. For planning purpose, the distress can be based on distress type and the most important are those, which trigger decisions.

PERFORMANCE EVALUATION OF PAVEMENTS;- In order to build more durable roads for tomorrow, it is imperative to find out how pavements and materials will perform under repeated heavy loads. The deterioration of the pavements show slow progress during the initial years after construction, but very fast progress during later years. Performance evaluation involves a thorough study of various factors such as subgrade support, pavement composition & its thickness, traffic loading and environmental conditions. The evaluation is broadly classified into (i) Structural evaluation and (ii) Functional evaluation. Pavement evaluation process is normally represented using four criteria, namely, Pavement Roughness (Reliability), Pavement distress (Surface condition), Pavement deflection (Structural failure) and Skid resistance (Safety). Certain terms are defined by researchers and are mentioned here before looking upon the models developed

GLOBAL SCENARIO;- Pavement prediction models have been used worldwide for Pavement Management System (PMS). In United States of America, Washington State Dept. of Highways developed the first PMS model in 1970's. Ohio Department of Transportation (ODOT) uses a deterministic prediction model for forecasting network condition. The state of Iowa has an Iowa pavement management program. This is characterized by the integration of a pavement performance modelling tool with a new pavement network optimization model which can be used for identifying and selecting cost effective projects for rehabilitation and maintenance.

3, STUDY OF IMPROVING PROPERTIES OF BLACK COTTON SOIL

Generally, lands with black cotton soils are fertile and very good for agriculture, horticulture, sericulture and aquaculture. Good irrigation systems exist, rainfall is high and people are affluent in these areas. Though black cotton soils are very good for agricultural purposes, they are not so good for laying durable roads. Good road network is a basic requirement for the all-round development of an area. Unfortunately, poor road network is hampering the full-fledged development of the otherwise prosperous areas. For developing a good and durable road network in black cotton soil areas, the nature of soils shall be properly understood. Black cotton soils absorb water heavily, swell, become soft and lose strength. Black cotton soils are easily compressible when wet and possesses a tendency to heave during

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wet condition. BC soils shrink in volume and develop cracks during summer. They are characterized by extreme hardness and cracks when dry. The stability and performance of the pavements are greatly influenced by the sub grade and embankment as they serve as foundations for pavements. On such soils suitable construction practices and sophisticated methods of design are to be adopted. In the present paper, reasons for poor condition of roads in B.C soils and measures to be taken for construction and improvement of roads on BC soils are presented.

Following are some of the important reasons for poor condition of roads in BC soil terrain.

- Nature of BC soils
- Poor drainage facilities
- Use of gravelly soil in base and sub-base
- Improper estimate preparations
- Plying of overloaded vehicles and iron wheeled tractors trolleys/carts
- Damage of roads during collection of materials
- Forming roads on canal banks and tank bunds

Improper Estimate Preparations





In the estimates prepared for repairs or improvement works the provisions made are not as per the site requirements Sub-base was done with red earth duly considering it as gravel. The base courses consist of coarse aggregates with red earth blind age. Both the black cotton soil and red earth absorbs water and becomes soft and compressible. For these roads, there is huge chance of water entering the embankment, sub grade, shoulder, sub-base and base and most of the water entering the pavement is likely to be absorbed by black cotton soil and red earth. If the blind age gravel in WBM layers is saturated lot of pot holes form on the bituminous surface. If the so called gravel base or sub grade are soaked sinking type of failures take place.

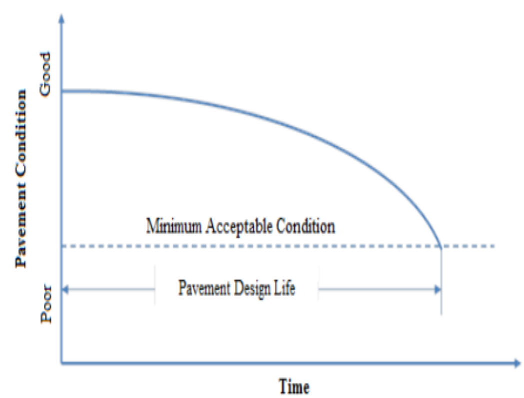
Forming Roads on Canal Banks and Tank Bunds

Road network in BC soil areas generally consist of roads running on canal and drain bunds. Inspection tracks formed on canal banks are converted as roads (in Guntur District). Maintaining these roads is extremely difficult. The durability of these roads depends on the type of soils with which the bunds are formed. Also these roads are prone to damage during canal draw down condition and at the times of silt clearance done by Water Users Associations or Irrigation Department. Lining of canals is the proper solution to improve the durability of roads but it involves huge expenditure. Reasons for frequent failure of canal slopes: Most of the canals run on BC soils which are highly plastic and expansive in nature.

PAVEMENT DESIGN AND MANAGEMENT CONCEPTS

It is helpful to review pavement engineering design basics in order to develop a common terminology to apply to pavement life issues. In this appendix, the basic concepts of pavement design and management are reviewed to establish a framework for pavement remaining life definitions presented in this report.

Figure 3 shows the basic concept of modern pavement design. This illustration starts with the construction of a new pavement structure. The pavement design life is the predicted time it will take for the structure to reach a minimum acceptable condition value. It is important to note that all current pavement design methods base the minimum acceptable condition on functional service criteria provided by a pavement structure and not an extreme condition that represents severe structural defects or prevents vehicle passage.



Using this system, resurfacing or reconstruction was indicated by the level of PSR. When the pavement PSR in an analysis cycle dropped below a minimum tolerable condition based on highway functional classification, resurfacing was

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indicated. Reconstruction was triggered if the PSR dropped below the reconstruction threshold. The default minimum tolerable condition and reconstruction PSR values are shown in table below. For some rural facilities, the average daily traffic (ADT) was also used to discriminate the minimum tolerable condition, with lower volume facilities having lower trigger points. In the late 1980s data submittal requirements for pavement roughness measurements reported as IRI was added.

Table. PSR threshold values used in the HPMS analytical process for minimum tolerable conditions for overlay and reconstruction.

Location	Facility Type	Minimum Tolerable Condition (PSR)	Reconstruction PSR
Rural	Interstate	3.0	2.0
	Other principal arterial	3.0/2.8 (6,000 ADT)	2.0
	Minor arterial	2.4	1.5
	Major collector	2.0	1.1
	Minor collector	1.8	0.8
Urban	Interstate	3.2	2.2
	Other freeway and expressway	3.0	2.0
	Other principal arterial	2.8	1.8
	Minor arterial	2.4	1.1
	Collector	2.0	1.0

4, RESULTS AND ANAYSIS

Design: The problems related to road construction on black cotton soil is minimized in this work, the flow of work as follows

Sample collection- The sample of black cotton soil was collected from vijayawada rural (nunna) is a town, municipality and revenue division in Krishna district in the state of Andhra Pradesh, India. delta, Various laboratory tests carried out on soil to determine the properties of black cotton soil Tests after addition of wastes- Three wastes are used in this work foundry sand, rice husk ash and bagasse ash to improve the properties of black cotton soil at 0 to 60% proportions independently. These wastes are easily available in local area.

DESIGN OF PAVEMENT THICKNESS

The construction of road by treating subgrade soil with foundry sand, rice husk ash and bagasse is suitable in locally area. This is illustrated with design of road as per IRC: 37 – 2001. The data considered for design of single lane pavement is given below:

i. Initial traffic in the year of completion of construction = A = 200 CV/day

ii. Growth rate per annum = r = 5.5 = 0.05

iii. Design life = n = 10 years

iv. Vehicle damage factor = F = 2.5

v. Single lane road = D = 100% = 1

vi. CBR of subgrade = 2.08%

For the subgrade soil treated with foundry sand, the CBR value is increased to 8.92% from 2.08% for proportion of 60:40. For the above data and CBR 8.92%, the pavement thickness obtained is 450mm. Therefore, the reduction in pavement thickness is 210 mm. For different wastes are as given in Table 8.

Wastes	CV/day	msa	CBR %	Thickness (mm)	Reduced thickness mm
Untreated BC Soil	200	2.2	2.08	660	-
Foundry sand	200	2.2	2.08%	450	210
Rice husk ash	200	2.2	2.08%	380	280
Bagasse ash	200	2.2	2.08%	470	190

COST ANALYSIS

The cost analysis for construction of flexible pavement by conventional method and construction of stabilized pavement is given in Table

Table 11 Cost analysis for conventional and stabilized road

Pro portion	Soaked CBR %	Cost of construction Rs
100:00	2.56 (Conventional flexible pavement)	11, 01, 400/-
60:40	10.04 (Stabilized pavement)	8, 60, 500/-

CONCLUSION

In the present study performance of three industrial wastes foundry sand, rice husk ash and bagasse ash in road construction on black cotton soil in rural areas are studied through laboratory investigation. The various tests like Liquid limit, standard proctor and CBR test were conducted. The following conclusions have been made from these test results.

1. The liquid limit values of black cotton soil decreased after addition of waste material. It has been seen that maximum decrement by 33.82% after addition of 40% foundry sand. Reduction in liquid limit improves the drainage property of soil.

2. The value of maximum dry density is increased continuously after addition of foundry sand. Maximum increased by 4.30% at 40% addition of foundry sand. Improvement in maximum dry density helps us to provide stable working platform mainly in rainy season.

3. The CBR value of black cotton soil increased after addition of all three waste material separately but for addition of 40% rice husk ash it increased maximum (10.04%) as compared to untreated soil (2.08%). Good CBR value increases the stability of soil.

4. As per IRC 37:2001 Pavement thickness for flexible pavement by conventional method of 2.08% CBR value is 660 mm and for rice husk ash stabilized road of 10.04% CBR value is 380mm. Stabilization saves the natural material.

5. Pavement thickness for stabilized road is reduced by 280mm and cost saving is 21.91% with respect to flexible pavement of 1km road length. It is economical to construction as well as maintenance of road.

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