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Performance Evaluation of Flexible Pavement on National Highway-18 Kurnool District of Andhra Pradesh

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ABSTRACT

An efficient and adequate transportation system is one of the key indicators of a nati prosperity, its developmental status and overall economic growth. The roads pass through a with extreme climatic conditions from heavy rainfall to desert conditions; diverse terrains f plains to extremely high mountains, plateaus and varying soil grades, rocky and gravell marshy land. Over the past four decades, the share of total rail and road traffic carr passengers and goods is gradually increasing because of fast and ever-increasing indus commercial, and other socioeconomic development activities, the road transport vel population, especially the vehicles carrying goods, has also increased phenomenally during period. Because of economies in road transportation, overloading by truck operato common. The majority of the arterial road system experiences overloading, as much as 1 20-tonne axle loads versus the permissible legal limit of 10.2 tonnes. The existing road netv has shown signs of premature distress because of the unexpected demands of growing tr volume and heavier axle loads. The network has fallen short of its structural capacity and h it is greatly overstrained. The majority of allocated funds are utilized for providing mainten and rehabilitation measures to the existing network rather than for new construction. With background, in the present study, a road section is identified in Kurnool district of An Pradesh to carry out the pavement performance study on distresses. For the selected stre data was collected on rutting, raveling, potholes, edge failures, traffic, etc. The detailed ana was performed using NCSS statistical tool and to develop a pavement performance mode the selected stretch.

Background

Performance prediction models represent a key element of road infrastructure asset management systems or pavement management systems. Thus successful implementation of these systems depends heavily on the performance prediction model used as the accuracy of the predictions determines the reasonableness of the decisions. Several pavement performance prediction models have been proposed over the years. Many of these models are developed for application in a particular region or country under specific traffic and climatic conditions. Therefore they cannot be directly applied in other countries or conditions. Although much research has been devoted to performance modelling of pavements, a comprehensive model that can predict pavement performance accurately has yet to be developed. The available models can be broadly classified into three groups; empirical, mechanistic-empirical and subjective models. Various empirical models are proposed for application at network and project levels. The mechanistic-empirical models are often developed in connection to design systems and therefore have not been widely applied in pavement management systems (PMS), but have the potential to be applied at a network level. The subjective models are mostly developed for strategic (investment) planning at the network level. Thus, the review showed that there is a need to develop improved models for use both at the network level and the project level. Assessing the level of compaction of sub-surface soils can be essential to designing and building structures, particularly those subject to transient or cycling loads. A perfect example is roadways. If the soil beneath a roadway is not compacted sufficiently, then over time the cycling loads of passing traffic will compact the soil further, leading to surface failure such as large cracks, potholes and displaced pavement. For the evaluation purpose he Dynamic Cone Penetrometer Test (DCPT) was in the study.

Methodology

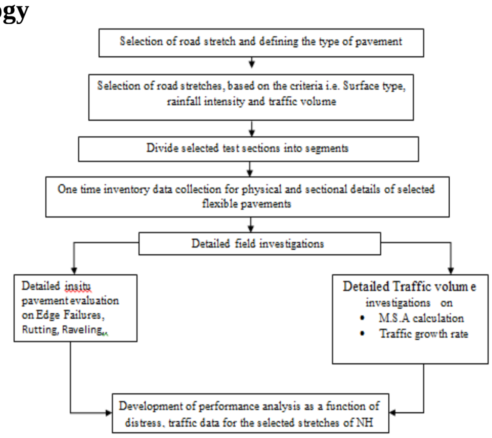

Figure 1. Proposed Methodology

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The proposed methodology for the study is mentioned in flow chart of Figure 1.

Data Collection

Rutting

Rutting of pavement can represent a major hazard to users as well as being an early indicator of pavement failure. Rut depth measurements are therefore usually included in most of the road monitoring programmers. In the present investigation the rut depth was measured using 3 m straight edge positioned at different locations across the profile and the high and low points were determined. The maximum rut depth is 12 mm towards Kurnool and 11 mm towards Kamala for January and depth is 12.3 mm towards Kurnool and 11.4mm towards Kadapa for March respectively. This may be due to the many factors such as traffic, sub grade moisture content etc. One can observe from above data that in both instances the rut depth is within the limits.

Traffic data

Traffic volume counts are needed to determine the traffic using the highway so that planner gets accurate idea of the need for the improving the pavement surface. Traffic counts are carried out on continuous basis or for limited period. The volume study for selected stretch done for NH-18 at 273+550 to 274+550 have considered 2 days 24hours data, conducted have considered all the slow moving and fast moving vehicles at regular intervals of 1 hour. In this work, it has have considered only commercial vehicles such that the gross weight of vehicle is more than 3 tons for calculation of M.S.A because the pavement deterioration is directly proportional to the load under repetition. Design traffic in terms of million slandered axles has been determined at selected stretch where both volume count surveys were conducted. The traffic loading in terms of cumulative number of standard axles for the given period has been computed using the following relationship.

$N = 365 * [\underline{(1+r)^n -1}\ ]*A*D*F*L$

N = Cumulative no. of standard axles to be calculated for the design in terms of MSA.

A = Cumulative vehicles per day=5056

D = Directional distribution factor =0.5

L = Lane distribution factor =0.75

n = Design life in years =15

r = Annual growth rate =7.5%

F = Vehicle damage factor =5.00

1. 24 Hours Traffic count =7601.5
2. 24 Hours Traffic count = 7565.

A = 5056

N = 90.37 msa

Dynamic Cone Penetration Test (DCPT)

The dynamic cone penetration test (DCPT) was originally developed as an alternative for evaluating the properties of flexible pavement or sub grade soils. The conventional approach to evaluate strength and stiffness properties of asphalt and sub grade soils involves a core sampling procedure and a complicated laboratory testing program such as resilient modulus, Marshall tests and others (Livneh et al. 1994). Due to its economy and simplicity, better understanding of the DCPT results can reduce significantly the effort and cost involved in the evaluation of pavement and sub grade soils. The Figure 2 shows the DCP equipment setup and typical data penetration curve.

From the above graph it is observed that, the rate of penetration is uniform up to a depth of 572mm for 240 blows. From there, the rate of penetration increased adversely due to the reason that the cone of the Dynamic Cone Penetrometer entered the subgrade soil. As the subgrade soil is soft compared to the above layers, i.e. The granular sub-base (200mm), Wet Mix Macadam (250mm), Dense Bituminous Macadam with Wearing Coat (140mm), the penetration rate increased (12.3cm) with less number of blows (14 blows) after 572mm depth. Within 572mm depth, the minimum and maximum penetration values for a single blow are 0 mm and 5mm respectively. As per the code provisions the permissible penetration value for a single blow is 5mm.

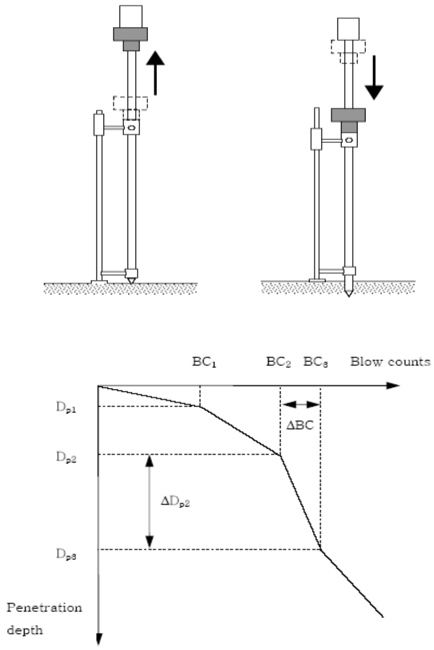

Figure 2. DCP Equipment and Typical output of the data.

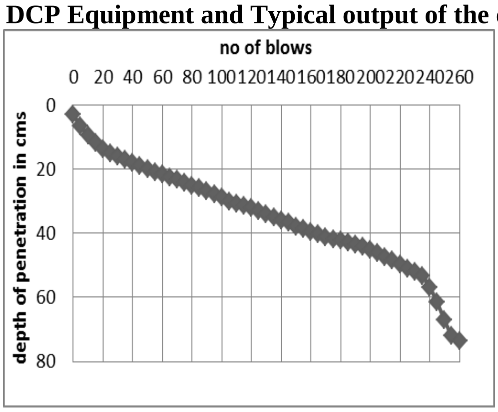

Figure 1. DCP Results for Selected Chainages

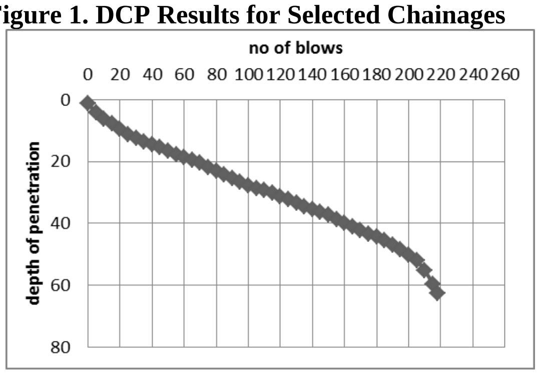

Figure 2. DCP Results for Selected Chainages

From the above graph it is observed that, the rate of penetration is uniform up to a depth of 502mm for 200 blows. From there, the rate of penetration increased adversely due to the reason that the cone of the Dynamic Cone Penetrometer entered the subgrade soil. As the subgrade soil is soft compared to the above layers, i.e. The granular sub-base (200mm), Wet mix Macadam (250mm), Dense Bituminous Macadam with Wearing Coat (140mm), the penetration rate increased (12.3cm) with less number of blows (18 blows) after 502mm depth. Within 502mm depth, the minimum and maximum penetration values for a single blow are 0 mm and 5mm respectively. As per the code provisions the permissible penetration value for a single blow is 5mm.

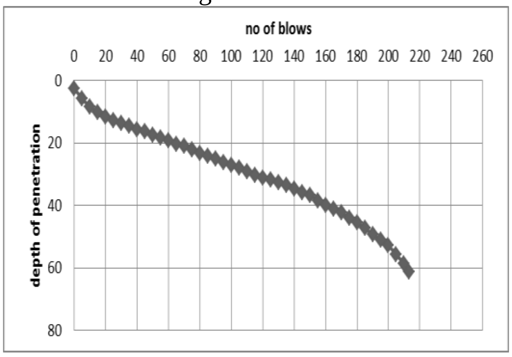

Figure 3. DCP Results for Selected Chainages

From the above graph it is observed that, the rate of penetration is uniform up to a depth of 528mm for 200 blows. From there, the rate of penetration increased adversely due to the reason that the cone of the Dynamic Cone Penetrometer entered the subgrade soil. As the subgrade soil is soft compared to the above layers, i.e. The granular sub-base (200mm), Wet mix Macadam (250mm), Dense Bituminous Macadam with Wearing Coat (140mm), the penetration rate increased (8.5cm) with less number of blows (13 blows) after 528mm depth. Within 528mm depth, the minimum and maximum penetration values for a single blow are 0 mm and 4mm respectively. As per the code provisions the permissible penetration value for a single blow is 5mm.

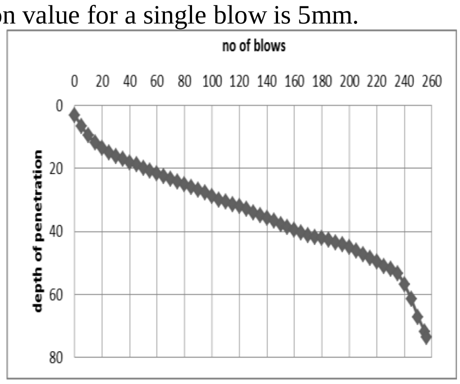

Figure 4. DCP Results for Selected Chainages

From the figure below 5 it is observed that, the rate of penetration is uniform up to a depth of 533mm for 235 blows. From there, the rate of penetration increased adversely due to the reason that the cone of the Dynamic Cone Penetrometer entered the subgrade soil. As the subgrade soil is soft compared to the above layers, i.e. the granular sub-base (200mm), Wet mix Macadam (250mm), Dense Bituminous Macadam with Wearing Coat (140mm), the penetration rate increased (20.2cms) with less number of blows (21 blows) after 533mm depth. Within 533mm depth, the minimum and maximum penetration values for a single blow are 0 mm and 5mm respectively. As per the code provisions the permissible penetration value for a single blow is 5mm.

From the above graph it is observed that, the rate of penetration is uniform up to a depth of 533mm for 235 blows. From there, the rate of penetration increased adversely due to the reason that the cone of the Dynamic Cone Penetrometer entered the subgrade soil. As the subgrade soil is soft compared to the above layers,

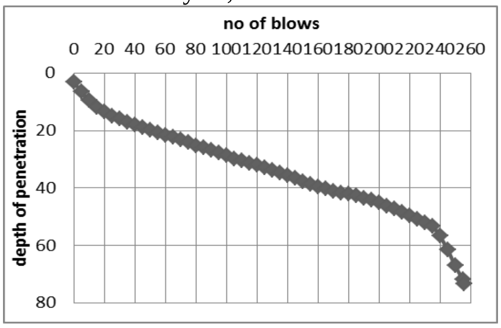

Figure 5. DCP Results for Selected Chainages

i.e. The granular sub-base (200mm), Wet mix Macadam (250mm), Dense Bituminous Macadam with Wearing Coat (140mm), the penetration rate increased (20.2cms) with less number of blows (21 blows) after 533mm depth. Within 533mm depth, the minimum and maximum penetration values for a single blow are 0 mm and 5mm respectively. As per the code provisions the permissible penetration value for a single blow is 5mm.

Conclusion

Based on the filled investigation and analysis in this paper the nominal effects of pavement roughness on vehicle-pavement interaction are demonstrated. In this investigation it is observed that the maximum characteristic rut depth is 9.42 mm. This value is well within the limit of permissible value given by IRC 37 -2002. It is concluded that the rate of rut depth progression is relatively increasing, and it has increased from 5 mm to 9.42 mm since the last 10 months. It is further concluded that the traffic volume on this road is comparatively high compared to the last year traffic data . Especially commercial vehicles per day is very high. By conducting the DCP test it is conclude that the strength of the existing road is good.

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