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# Influence of unbound materials prosperities on routing potential of low volume roads

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**ABSTRACT**

*Rural roads are the tertiary road system in total road network which provides accessibility for the rural habitations to market and other facility centres. In India it consistutes about 85% of the total road network. However, merely creating the road assets is not enough and it has to be maintained periodically and preserved carefully. Majority of these roads are provided with flexible pavement. But the rate of deterioration of flexible pavement is much higher than the rate of deterioration of a rigid pavement and hence maintenance cost involved is higher. The Government of India lunched the Pradhanamantri Gram Sadak Yojana (PMGSY) in December – 2000 with an aim to provide all weather roads to rural areas. It was proposed to take up 173,000 unconnected habitations of population above 500 (250 in case of hilly, desert and tribal areas) under PMGSY programme. With this background in the present study, fifteen low volume roads were identified in Warangal, Guntur and Kurnool districts in Andhra Pradesh to carry out the pavement performance study. The main objective of this study is to evaluate the influence of unbound material properties such as Water Bound Macadam (WBM) base course gradation (grading II and grading III) granular sub-base gradation, sub-base and subgrade field densities and subgrade moisture content on the rutting potential of low volume roads. The detailed analysis was carried out using the SPSS stastical tool and permanent deformation (rutting) model has been developed.*

## INTRODUCTION

### GENERAL

More than 80% of roadway mileage in the world carries less than 200 vehicles per day and would therefore be classified as low volume roads. Roads located in the rural areas make up a large fraction of the low volume roads simply because of the lower population in rural areas. Low volume roads make up a substantial proportion of network of most developing countries. Unfortunately, the poor condition of these roads hindered the economic developments and has suppressed poverty alleviation effort in many countries and one among them is India. India is a vast country having an area of more than 3 million kilometres of roads network, making it the largest in the world. Low Volume Roads (LVRs) consist of 2.65 million km. These roads form a critical link to the nation for better transportation system, and to provide mobility to the rural areas. Vast rural road network in the country has been developed recently which not only measure the agricultural production and the size of the markets but also provide better prices, reduction in transport cost and the creation of better health, employment and educational opportunities to rural population in India

The development of rural infrastructure is crucial for the sustainable development of rural economic as well as the welfare of the rural poor. Inadequate rural connectivity and lack of mobility pose serious constraint to accelerated rural development. The critical role played by roads in economy development is being realized now. The PMGSY is an example for this healthy development.

**LITERATURE REVIEW**

An attempt has been made to review the literature on rutting and various rutting models developed across the world by various research agencies and researchers.

**RUTTING**

Rutting is one of the major structural distress mechanisms in flexible pavements. Because of the increase in tyre pressure and axle loads in recent years, rutting has become the dominant mode of failure of flexible pavement in many countries. There are various reasons for rutting depending on configuration and structural capacity of various layers and environmental conditions.

Rutting is a longitudinal depression in the wheel paths of flexible pavements with or without transverse displacement. It can be measured with 3 m straight edge or with profiler at regular intervels. Rut is a physical distortion of surface and it also prevents the cross drainage of water during the rains, leading to accumulation of water in rut and causing the potential of hydroplaning related problems. The hydroplaning phenomenon consists of the buildup of a thin layer of water between the pavement and tyre and results in the tyre losing contact with the surface, with the consequent loss of steering control. With increasing magnitudes and repetitions of loads and increased tyre pressures, the rutting problem has become severe in many highway pavements. Ruts filled with water can cause vehicle hydroplaning, can be hazardous because ruts tend to pull a vehicle towards the rut path as it is steered across the rut. Generally the permissible limit of the rutting for National Highways and low volume roads are 20mm and 50mm (IRC-37-2000 and IRC-SP-20) respectively.

**3 ORIGINS OF RUTTING**

Garba (2002) reported that there are two basic origins of rutting (i) deep structural problems and (ii) asphalt mixture rutting near the surface. Deep structural rutting occurs in the unbound layers, aggregate base and subgrade below the Hot Mix Asphalt. Typically only thin pavement sections, less than 200 mm, exhibit subgrade rutting. This thickness will depend on the pavement materials, subgrade strength and traffic loads. Mix related rutting occurs when the HMA materials deform under traffic. In the most severe case, the mix will be pushed out and up at the edge of the wheel paths. In most cases this is limited to the top 100 mm of HMA. Below this depth, the shear stresses, which cause this deformation, are usually lower. However, there are rare cases where rutting may be caused by the HMA materials further down in the pavement.

**TYPES OF PAVEMENT RUTTING**

Rutting throughout the asphalt pavement structure is caused by over-stressing the underlying base or subgrade layers. This overstressed condition can be the result of inadequate thickness design for the applied traffic or for the strength properties of the underlying materials.

Moisture infiltration into the base or subgrade can also weaken these layers to the point that they deform permanently under repeated traffic. A more common form of pavement rutting occurs in the asphalt mix itself. Here the underlying layers perform fine and their boundary lines are unaffected by the distress occurring near the surface of the asphalt pavement. Rutting of this type is often observed at intersections, bus stops, freeway off ramps, or under extreme loading situations on airport runways and dock loading facilities.

The type of rutting of most concern to bituminous mix designers is deformation in the bituminous layers. A weak mixture will accumulate small, but permanent deformations with each truck pass, eventually forming a rut characterized by a downward and lateral movement of the mixture. The rutting may occur in the bituminous surface course, or the rutting that shows on the surface may be caused by a weak underlying bituminous course.

Since rutting is an accumulation of very small permanent deformations, one way to increase mixture shear strength is to use not only stiffer bitumen but one that also behaves more like an elastic solid at high pavement temperatures. Thus, when a load is applied, the bitumen will act like a rubber band and spring back to its original position rather than deformation.

## FACTORS AFFECTING RUTTING

Rutting is strongly influenced by traffic loading, pavement thickness, subgrade strength and moisture content, and gradation. Climate can also have a large influence especially when the pavement subgrade undergoes seasonal variations in bearing capacity, or when bituminous courses are subjected to high temperatures. Ruts develop within pavement layers when traffic loading causes layer densification and/or when stresses induced in the pavement materials are sufficient to cause shear displacements within the materials.

The susceptibility to rutting can be linked to the material attributes such as excessive asphalt content, excessive fine grained aggregate, high percentages of natural sand, rounded aggregate particles, excessive permissible moisture in the mix or granular materials and soils, temperature susceptible asphalt cement, and cold weather paving leading to low density. Other factors affecting rutting are temperature, precipitation, time, type and the extent of loading.

**Review:**

Rutting is one of the major failures in flexible pavements. Because of the increase in tyre pressure and axle loads in recent years, rutting has become the dominant distress in flexible pavements. There are various causes of rutting depending on the configuration and structural capacity of various layers and environmental conditions. An attempt has been made in this study to find influence of various parameters such as WBM (Gr.III & Gr.II) aggregate gradation, subbase gradation, subbase and subgrade field density and subgrade moisture content on the observed rut depth on the selected pavement stretches. In order to achieve this objective fifteen stretches were identified in Warangal, Guntur and Kurnool of Andhra Pradesh state. The data on above mentioned parameters has been collected from all the fifteen stretches. The model has been developed for each stretch and it was observed that there is significant influence of all the parameters on the rut depth.

## CONCLUSIONS

Based on the field studies and analysis the following conclusions are There is a considerable influence of the Base gradation (WBM Gr-III &Gr-II) and Subbase gradation on the rut depth. In this study, the upper limit values of standard gradation have been taken as the datum to find the RMSE Values of Base and subbase layers of all the stretches. It has been assumed that when the base and subbase course layers are constructed with upper limit of the standard gradation, one can expect minimum rut depth. Based on the assumption the RMSE values are calculated for all the selected stretches. After analyzing the data it was observed that even the rut depth is zero, the RMSE value is high for some of the chainages of selected stretches. In most of the cases with the increase in RMSE values, there is a increase in rut depth values in the most of the selected stretches. There is a proportionality relation exits between the RMSE value and rut depth. That is as the gradation curve deviates from the upper limit of the standard gradation curve, one can expect an increase in the rut depth. The coefficient of determination is high for all the stretches, so the base and subbase gradations are considerably influencing the rut depth.

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