

# Development of Pavement Management System by Functional Evaluation for Rural Road

Pradhan Singh Chouhan  
M.E (Transportation Engineering),  
SGSITS, Indore

Mr. Yusuf Sultan  
Asst. professor, CE & AMD,  
SGSITS, Indore

**Abstract**— Rural roads in Madhya Pradesh play an important role in the social and economic development of the state in India. Thus, the maintenance of these rural roads is challenging. For their maintenance (periodic or daily), the funds required are not in abundance, hence to use of resources in proper manner, the detailed strategies for maintenance are required. The present study deals with development of maintenance management system for rural roads in the state of Madhya Pradesh. There are two ways in which pavement evaluation can be done – one is the Functional Evaluation and other is Structural Evaluation. The pavement distresses and riding comfort i.e., roughness of the roads is considered in functional evaluation whereas structural properties i.e., modulus reaction, pavement deflection etc. of the pavement are considered in structural evaluation. In the present study we have considered functional evaluation in which various pavement distresses are studied which prevails on the roads considered. To conduct the study Four sample roads section in the Indore and Ujjain region were selected. On the selected stretches flexible pavement distresses such as cracking, rutting, pothole and patching data in terms of extent and severity would be collected by visual inspection. In addition, roughness data would be collected along the wheel path using MERLIN. On the selected stretches for a length of 1.0 KM each, the distress and roughness data has been collected and rating was done on the basis of Pavement Condition Index (PCI) and International Roughness Index (IRI) values. On the selected stretches flexible pavement distresses such as cracking, pothole, patching and rutting data in terms of extent and severity would be collected by visual inspection. In addition, roughness data would be collected along the wheel path using MERLIN.

**Keywords**— Functional Evaluation, PMGSY, MERLIN, Rural Road.

## I. INTRODUCTION

The Pavement Management System (PMS) is a bunch of instruments or techniques that can help chiefs in discovering financially savvy methodologies for giving, assessing, and keeping up pavements in a functional condition. It gives the data important to settle on these choices. PMS comprises of two fundamental segments: A complete information base, which contains current and verifiable data on pavement condition, pavement structure and traffic; and another part that comprises of a bunch of devices that permits us to decide existing and future pavement conditions, foresee monetary necessities and distinguish and organize pavement conservation ventures.

The idea of pavement management was first examined in the mid-1970s. It very well may be idea of as a bunch of apparatuses for the individuals who are liable for settling on choices about pavements, for example, pavement planners, support staff, public works staff, and even nontechnical chiefs.

These instruments empower the people to all the more likely recognize and apply practical procedures to keep their pavements in the most ideal condition.

## A. Factors Affecting Pavement's Performance

- **Traffic:** Traffic is one of the principal factors which influences pavement execution. The pivot load range, wheel load reiterations, hub arrangements, characterized traffic volume all influences the exhibition of pavement.
- **Moisture:** Moisture is the primary driver of any pavement disappointment. It is the highest foe of any pavement which prompts total disturbance of pavement. The presence of dampness diminishes molecule interlocking and prompts molecule relocation as lopsided settlement and different troubles.
- **Subgrade:** The subgrade is the help of any pavement since all the wheel load is eventually borne by the lower most layer of pavement for example subgrade layer. The California bearing ratio (CBR) estimation of subgrade is the pointer of burden bearing limit of subgrade. The troubles like rutting, reflection breaking and so forth happened because of low bearing limit of subgrade which straightforwardly influences pavement execution.
- **Quality of Construction:** The development quality assumes a significant function in execution of pavements. The utilization of good quality totals and folio material prompts great toughness of pavements. The thickness of pavements should be carefully following with the IRC code arrangements and quality check should be done at normal stretches.
- **Maintenance:** The support of pavement at customary stretches prompts great execution in since quite a while ago run. In the event that any pavement is conceded comparing to any support action, at that point it will prompt enormous monetary misfortune just as helpless pavement execution. Different troubles can be limited if appropriate support is done at required time stretches.

## B. Functional Evaluation

Functional Evaluation is the conclusion or examination of outside surface states of the pavement. The appraisal of pavements is required to apply opportune upkeep procedures.

The different bothers present on a pavement are questionable in nature and their movement is unavoidable if legitimate support isn't finished. Non-damaging procedure is utilized in useful assessment of pavements. Utilitarian Evaluation predominantly manages pavement trouble assessment and riding quality assessment. Further, riding quality assessment includes Roughness assessment and Safety assessment.

### C. *Functional Evaluation: Parameters*

- **Roughness:** Pavement Roughness is one of the indicators of comfort quality of road users. It is defined as the undulations caused in vertical direction in the smoothness profile of pavement with respect to its planar surface. It is an undesirable deviation which affects the riding quality. It can be measured using various equipments such as Bump Integrator, MERLIN etc. The unit of measurement are m/km, mm/km etc.
- **Rut Depth:** Rutting is defined as the longitudinal depression caused along the wheel path of vehicles due to repeated movement. It can be measured using straightedge, It mainly occurs due to low load carrying capacity of the subgrade and subsequent layers of flexible pavement.
- **Pot Holes:** Potholes are the bowl-shaped depressions formed on the surface of pavements due to regular dislodgement of aggregate particles. These are localized distress which majorly affects the riding quality of road users. The potholes should be maintained timely because with time the severity level increases and may be hazardous to traffic movements.
- **Patching:** Patching is defined as an aid provided or repair work done on pavement in order to treat any localized distress like pothole, raveling etc. However, a patching itself comes into a category of distress because it also affects the riding quality of vehicles.

## II. LITERATURE REVIEW

Aakash Gupta, (2019) Rural roads in Himachal Pradesh assume a huge function in the monetary and social development of the state in India. About 79% of the all-out length of the roads has been contributed by rural roads in Himachal Pradesh. The support of this huge organization of rural roads is trying for the specialists of public interstates. Likewise, the assets needed for their intermittent or every day upkeep are not in plenitude, subsequently legitimate support procedures are needed to utilize the assets in an appropriate way. The current examination manages the development of upkeep management plan of the rural road network in Himachal Pradesh. The investigation likewise targets developing a numerical model to anticipate the pothole volume utilizing mean breadth and most extreme profundity of pothole as info boundaries. It has been discovered that a non-straight model predicts a decent estimation of volume of pothole with coefficient of assurance for example  $R^2 = 0.85$  which shows an excellent relationship between noticed volume and assessed volume of potholes.

Khalifa, Nasradeen & Zulkiple (2019) Around the world, the public road has a significant function to continue and to build the area's economy, while its upkeep has a basic and indispensable influence in the life of road pavement. The road pavement maintenance management system (PMMS) is a systematic strategy for review and rating the pavement condition which guarantee an opportune support tackling through and through all undetected pavement absconds. It is trust that the end from this examination will permit applicable specialists to utilize a condition of human expressions road support system that is viable to Highway Development and Management (HDM-4) investigation.

Singh, Aditya & Chopra (2018) Expanding traffic load and lacking assets for support are the key variables which are liable for the consistently weakening state of the Indian Road Network. This issue has prompted a wide-scale research in the territory of pavement support and management procedures for which devices like Highway Development and Maintenance (HDM-4) have been developed. HDM-4 is a product bundle planned by the World Bank which goes about as a ground-breaking system for examination of road management and venture options and consequently, is exceptionally helpful in deciding the correct road network methodologies. This apparatus has been intended for use over a wide scope of natural conditions and to empower a HDM-4 model to precisely foresee the pavement execution for a particular area, it should be adjusted. This examination intends to align a HDM-4 model to foresee pavement weakening because of underlying breaking and raveling in a chose road area in Patiala (Punjab, India).

Francisco Dalla Rosa and Nasir G. Gharaibeh (2017) chipped away at the development of IRI forecast model alongside the approval cycle particularly for low to medium traffic stacking conditions. The traffic conditions were primarily engaged when contrasted with other pain boundaries.

Prasanna Kumar R et al (2017) assessed the pavements dependent on both useful assessment and underlying assessment boundaries. The examination contemplated the previous part of a chose road from Budalur to Pudupatti and the investigation of different sorts of undulations information.

J.R. Prasad et al (2013) additionally attempted to develop Relationship among IRI and Visual Surface Distresses. Knock integrator was utilized to get the ideal information. A condition among visual surface upsets and IRI Index esteems was developed.

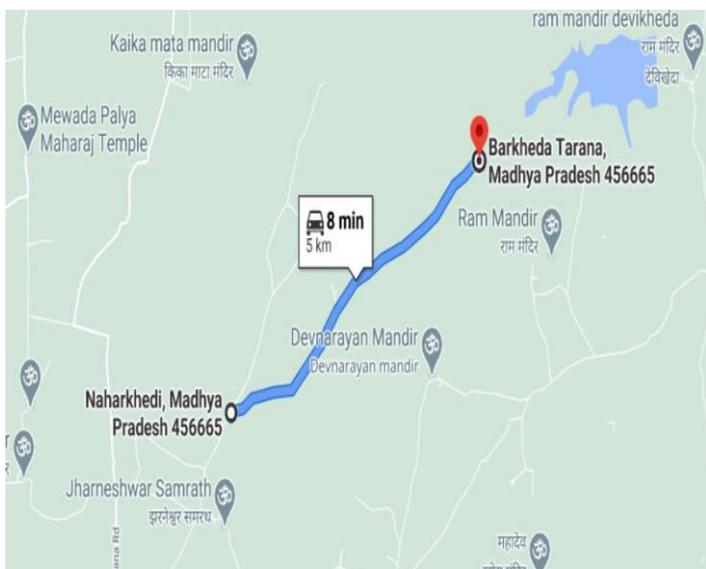
## III. METHODOLOGY

### A. Selection of Rural Road Stretches

Four roads have been chosen in the region of Ujjain and Indore for the practical assessment as given in Table 1. The length of every road has been taken as 1.0 km to direct the different testing. The 1.0 km length has been chosen remembering that the chose 1.0 km road stretch portrays the full length of the road as far as traffic volume and climatic variables. Each chose road has been partitioned into areas of 200 m to decide the estimations of different upsets.

**Selected Rural Roads**

S. No.	Name of the road	Year of completion
1	Tarana Limbadit road to Barkheda	2014
2	Ujjain Tarana road to Nipaniya	2015
3	Makdone road to Chikli	2013
4	Khankri brahman to jhumki	2013



**Tarana Limbadit road to Barkheda**

**B. Measurement of Pavement Distresses**

Pavement Distresses are fundamentally the deformities on the pavement which are effectively noticeable to unaided eye. There are different sorts of upsets, for example, raveling, cracking, patching, potholes, delamination, rutting, bleeding and so on however in the current examination, the bothers which are normal on the chose rural road extends has been considered. Thus cracking, patching, potholes and rutting has been considered and estimated in the current examination.

**C. Measurement of Rutting.**

Rutting is characterized as the longitudinal sadness caused along the wheel way because of rehashed development of vehicles on a similar way. In the current investigation, rutting has been controlled by utilizing the 3-m straightedge as appeared in which decides the trench profundity.

**D. Measurement of Volume of Potholes**

The volume of potholes has been estimated by supplanting the known volume of sand with the bowl of pothole. This strategy for deciding the pothole was bulky and needs labor; consequently, to destroy such practice a numerical model has likewise been found to decide the volume of pothole. Aside from deciding the volume of pothole, the mean measurement

and greatest profundity of pothole has likewise been recorded relating to every volume of pothole. The volume of pothole has been connected with the mean breadth and most extreme profundity of pothole in the current examination.

**E. Measurement of Patching**

Patching which is ordinarily used to sabotage any pain on pavement has been estimated utilizing straightforward estimating tape. Regularly, the patching is done fit as a fiddle or square shape, thus making it simpler to compute the territory of patching.

**F. Measurement of Cracking**

Different sorts of cracking, for example, longitudinal cracking, cross over cracking, gator cracking, weakness cracking, edge cracking, reflection cracking and so forth has been found on the chose rural road extends. The broke part of the roads has been estimated utilizing a basic estimating tape changing over the region in around a square shape or a square zone which makes it simple to figure the region. All the various sorts of cracking have been summarized to decide the last broke region of every specific road.

**G. Rating of Pavement Sections**

The distress information has been gathered on the chosen rural road extends. The distress boundaries for example cracking, potholes and patching have been essentially found on the chose rural roads. Every pavement segment has been evaluated dependent on the rating system given in IRC: 82-2015 as appeared in Table 2. The weightage to each distress boundary is additionally given in Table 3 which decides the significance of each distress comparing to its seriousness in support procedures or pavement execution. The distress information gathered on every road stretch has been changed over into rate by partitioning the complete territory of distress to the absolute region of pavement area. The normal of the multitude of appraisals of each chose rural road has been portrayed as definite rating of that specific road stretch.

**Pavement Distress Based For MDR(s) and Rural Roads**

Distress (%)	Range of Distresses		
Rutting	>20	10 to 20	<10
Cracking	>20	10 to 20	<10
Patching	>20	5 to 20	<5
Pothole	>1	0.5 to 1	<0.5
Rating	1	1.1 to 2	2.1 to 3
Condition	Poor	Fair	Good

**Weightages of Distresses [2]**

Distress	Weightage Assigned (Fixed Multiplier factor)

Rutting	0.75
Cracking	1
Patching	0.75
Pothole	0.5

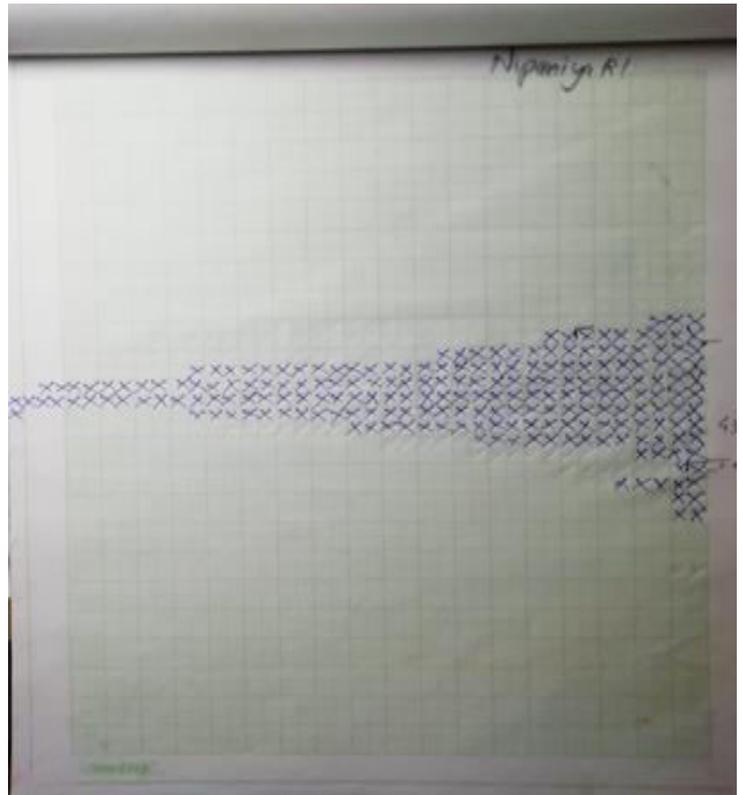
#### H. Measurement of International Roughness Index

International Roughness Index is a proportion of the perfection of the road which thus supportive in planning the upkeep exercises required. The unpleasantness file of the roads is essentially the summation of undulations caused in the solace ride of road clients because of the presence of different pavement distresses, for example, cracking, raveling, potholes and so forth Different supplies can be utilized to decide the unpleasantness file, for example, knock integrator, network study vehicle and so on however in the current investigation MERLIN i.e Machine for Evaluating Roughness with Low-cost Instrumentation has been utilized to decide the IRI esteem in mm/km. MERLIN has been utilized in light of the fact that its prudent and simple to use when contrasted with different supplies.

$$IRI = 0.593 + 0.0471 * D$$

Where, IRI = International Roughness Index in mm/km D = D-value in mm

A similar strategy has been led on all the chose rural road extends lastly in the wake of taking the normal of the relative multitude of readings IRI has been acquired.



Graph mounted on MERLIN at Road 2 (RHS)

#### IV. RESULTS

Pavement Maintenance Management System for rural roads was studied and rating are done on the basis of data collected distress parameters such as cracking, potholes, rutting, patching and the IRI value and the impact of each distress in terms of extent and severity needs to be considered.

After conducting the Visual Survey followed the measurement of the distresses was done. Then with the help of MERLIN the test for roughness was conducted and the results as obtained from the tests is represented in the form of a table as shown below:

Pavement Performance on Basis of IRI

Road	Average D value (mm)	IRI (m/km)	Pavement condition
1	59.6	3.4	VERY GOOD SURFACE PROFILE
2	53.15	3.096	VERY GOOD SURFACE PROFILE
3	66.61	3.73	VERY GOOD SURFACE PROFILE
4	130	6.716	FAIR SURFACE PROFILE



Collection of Roughness data by MERLIN at Road 2

**Pavement Performance on Basis of Distress**

Road	Final PCI	Road condition
1	2.2125	GOOD
2	2.25	GOOD
3	2.155	GOOD
4	2.1225	GOOD

## V. CONCLUSIONS & FUTURE SCOPE

Rural Roads, which assume an imperative function in Indian monetary framework, need prompt consideration as for its support and management. This research work is an interest towards the advancement of a thorough, logical Pavement Maintenance and Management System (PMMS) for rural roads by functional evaluation. This has been accomplished by gathering intermittent data on chose four rural road of Madhya Pradesh and by creating pavement deterioration models and an enhanced support system for these rural roads. They chose roads have pavement structure with Water Bound Macadam (WBM) base course and Pre-Mix Carpet (PMC) surface course.

- The selected four rural road stretches in the vicinity of Madhya Pradesh has been found to be in fair condition on the basis of weightage and rating given corresponding to distress type and level of distress. The PCI values of all 4 roads are 2.212, 2.250, 2.155 and 2.122 respectively.
- The International Roughness Index of all the roads has been found to be at satisfactory level. The IRI value of all 4 road are 3.400, 3.096, 3.730 and 6.716 m/km respectively.
- The IRI value of Road 4 is high that means the road section requires routine maintenance.
- Also, the rut depth has not been found very significant on the selected rural road stretches. Hence, rutting has no impact on the pavement performance and not been taken in rating of pavements.

The constraints of the study and thus the extension for additional examinations is as per the following:

- Functional distresses just were seen on the study zones chosen, henceforth the study can be stretched out to other districts of the nation, where climatic conditions will impact the distresses.
- Further this study can be continued to measure the structural evaluation. Where the structural Evaluation will help to measure the pavement deflection, modulus reaction and many data to know the pavement condition and help us to develop pavement management system.
- The pavement Maintenance and Management System will be more productive if all conceivable and attainable upkeep activities including restoration activities are thought of.

- Broad pavement condition data were gathered for a very long time which included both functional and structural condition of the pavement areas.

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