



A REVIEW OF ANALYSIS OF HIGHWAY FAILURE AND THEIR MAINTENANCE

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Abstract

A well-developed transportation infrastructure is essential for economic, industrial, social and cultural development of a country. Due to this need, human being has developed three modes of transport, i.e., by land, by water and by air. The road network has expanded from 4 lakh km in 1947 to 20 lakh km in 1993 and almost 55 lakh kms as on 31 March, 2015. India has less than 3.8 kms of road per 1000 people; including all its paved and unpaved roads. In terms of quality, all season, four or more lane highways; India has less than 7.kms of highway per 1000 people as of 2010. Inadequate maintenance of roads accounts to an act of disinvestment and sacrifice of past investment in roads. Roads have been receiving decreasing share of total Five-Year Plan expenditure (decreasing from 6.7% in first plan to 3% in second plan). The Vehicle Operating Cost increases at a rapid rate as the condition of existing pavements starts deteriorating. The loss due to bad conditions of the main road network would be around Rs.12000 crore per annum. Pavement structure can be destroyed in a single season due to water penetration. Defects in flexible pavements is a problem of multiple dimensions, phenomenal growth of vehicular traffic (in terms of no. of axle loading of commercial vehicles), the rapid expansion in the road network, non-availability of suitable technology, material, equipment, skilled labour and poor funds allocation have all added complexities to the problem flexible pavements. Maintenance of a road network involves a variety of operations, i.e., identification of deficiencies and planning, programming and scheduling for actual implementation in the field and monitoring. The essential objective should be to keep the road surface and appurtenances in good condition and to extend the life of the road assets to its design life. The purpose of the proposed study is to discuss the possible causes of pavement failures, and recommends better ways to minimize and hopefully eliminate the causes of failures in pavements.

Keywords: Highway, Transport, Maintenance, Road Network.

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1. Introduction

Human sensitivity has revealed a need for movement that has led to a gauge of society's progress since the dawn of time. The history of civilization is the history of this mobility or mode of transportation. Modern, effective transportation is a fundamental component of every nation's infrastructure and is essential to its proper development. Transport refers to the movement of people and things from one location to another in either British or American English. The word comes from the Latin words *trans* (meaning "across") and *portare* ("to carry"). A road network is one of the most crucial requirements for any country's economic growth, particularly in developing countries. As a result, many emerging nations engage heavily in road building, and many developing countries recognize the importance of heavy investment in road capital development. Only a handful prioritize road repair. It is considered more attractive to begin new building than to preserve what is currently in place. However, water penetration can damage a pavement structure in a single season. Maintenance operations may be necessary at various times throughout the year, although their frequency varies depending on traffic, topography and climatic conditions, road type, grading and repairing potholes and ruts for paved roads, and so on.. They include repairing pot holes, surface patching, sealing of cracks and Road surface marking. Transportation contributes to the economic, industrial, social and cultural development of any country. Transportation is vital for the economic development of any region since every commodity produced whether it is food, clothing, industrial products or medicine needs transport at production and distribution stages. The inadequate transportation facilities retard the process of socio-economic development of the country. The adequacy of transportation system of a country indicates its economic and social development. India is a vast country having extreme variation in climatic conditions. North-Eastern region gets very heavy rainfall and annual rainfall as much as 600 cm per year has been recorded, whereas the deserts of Western India get very less rainfall. Even in a particular area the difference between maximum and minimum temperature of the year may be as high as 420c. North India experiences heavy snowfall during winter at altitudes above 2000m. These climatic conditions have great influence on the type of problems existing on the road as only 47% are surfaced roads, balance being earthen roads.

2. Review of Literature

Zulufiqar Bin Rashid¹, Dr. Rakesh Gupta (2017) emphasised on the parameters influencing the performance of pavements and to identify them. For efficient maintenance of road pavements, the deficiencies in our existing highway system need to be clearly understood. Proper design, regular inspection and maintenance of pavement is of utmost importance and in preserving the investment made on highway system and in providing comfort and safety to the road user.

DR. NDEFO OKIGBO (2012) studied the conditions of the roads in Nigeria and their effects to the citizen, government and the economy of the country. Some of the identified causes were; poor design and construction, poor maintenance of already built highways, use of low quality materials in construction, poor workmanship and poor supervision of construction work.

Mr. Devidas Chavade, Mr. Kedarnath (2018) worked on the on-going researches about the defects in Flexible and Rigid pavement and the maintenance in Flexible and Rigid pavements. The essential objective should be to keep the road surface and appurtenances in good condition and to extend the life of the road assets to its design life. Broadly, the activities include identification of defects and the possible cause there off, determination of appropriate remedial measures; implement these in the field and monitoring of the results.

Aaron Steinfield, BenedicteBougler, Dan Empey emphasise on snow removal and how it is critical for winter highway maintenance operations. However, it is subject to significant risk due to adverse operating environmental conditions such as total visual whiteout, low tire/road traction, difficulty for detecting roadway boundaries and obstacles buried in or obscured by snow.

Ameh Fioklou, Alice Alipour- (2022) Probability of failure estimation for highway bridges under combined effects of uncorrelated multiple hazards. The objective of this paper is to study the vulnerability of bridges under multi-hazard conditions, which includes the effect of floodinduced scour and earthquakes. The failure probability expressed in the form of fragility curves was evaluated at the component and system-level

Liguo Jiang ,Shuping Huang (2022) The aim of this paper is to provide a framework to bridge the earthquake induced structural damage and the system functional performance of highway networks in high-intensity seismic region, and give decision support on the network system rehabilitation in post-earthquake emergency response. The use of a BN method was described to analyze connectivity reliability and critical units of the highway network in high-intensity seismic region, with an application on the actual highway network in the Wenchuan earthquake. connectivity reliability of highway units, which is quantified based on physical structural damage in the Wenchuan earthquake, is used as prior probability of BN. The BN structure and CPTs are established through the analysis of event tree and success tree. Then, the connectivity reliability of highway segments and OD pairs can be calculated in the BN model with the information of highway unit states. The most reliable paths of OD pairs can be derived based on the connectivity reliability of highway segments. In addition, the combination of sensitivity analysis and Bayesian updating is applied in the BN model to identify critical units and their reinforcement priority.

SurajoAbubakar Wada worked on road deterioration. Road deterioration is a critical situation for road sector because of the high cost for construction of new roads and maintenance of existing roads and routes. Therefore, better funding and management should be provided in order to keep the pavements in good condition and from getting damaged due to the aforementioned distresses.

Sandeep Panchal, Amit Kr. Shrivastava (2021) The highway stretch considered in this study is subjected to the landslide disaster frequently. So, landslide hazard assessment is required for planning and execution of construction activities along the highway corridor. Analytic hierarchy process (AHP) has been implemented for preparation of landslide hazard map. There were 10 causative factors which are considered in this study. Distance from road, lithology and geology are the major contributing factors in landslide occurrence according to the weightage assigned using AHP. A landslide inventory containing details of 215 landslides was used to train and test the final output. The landslide inventory had also helped in deciding the pairwise comparison of the different causative factors and sub-factors. 70% of the landslides were used for training and 30% landslide data is used for testing purpose. The landslide hazard map was divided into four zones.

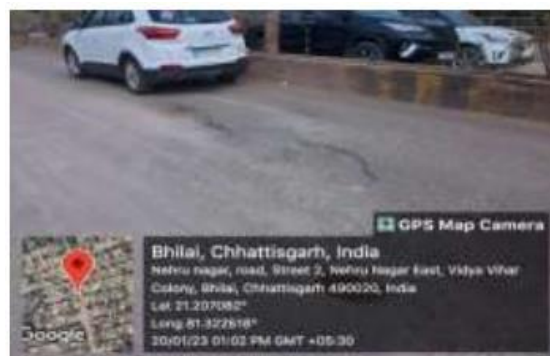
3. Analysis and Research

The use of plastic waste in road construction, also known as plastic roads, is a relatively new concept, and while there have been some promising results from initial projects, more research is needed to fully evaluate their long-term effectiveness. Here are some potential results of plastic roads:

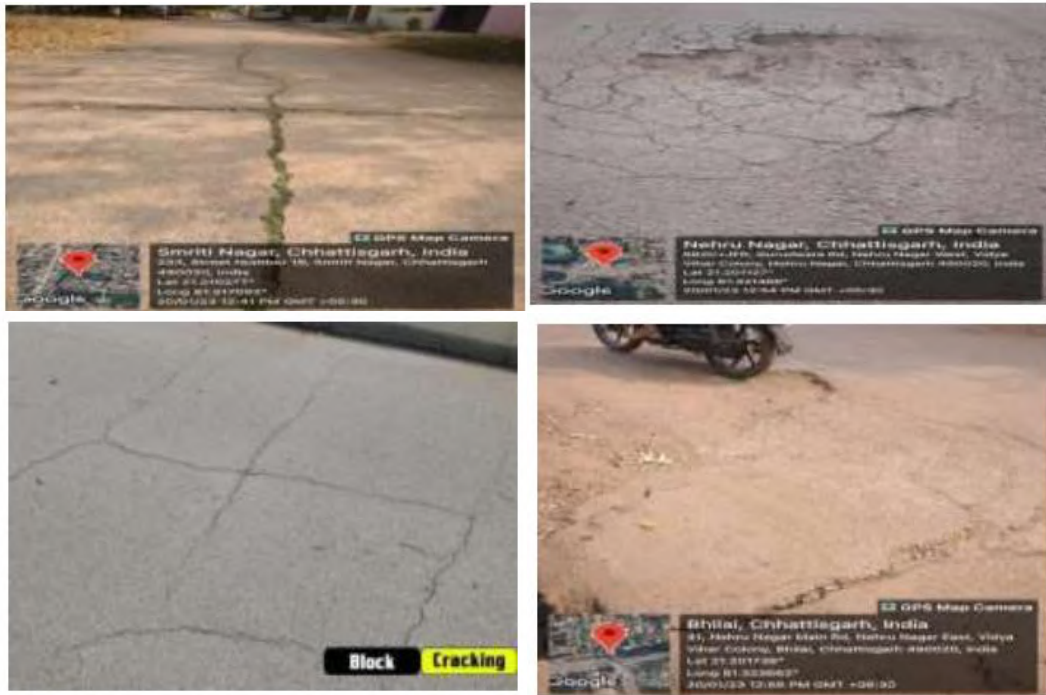
- **Increased Durability:** Plastic roads have shown to have better resistance to cracks, potholes, and rutting compared to traditional asphalt roads. This is because the plastic polymer in the road construction material has a higher melting point than asphalt, making it more durable under heavy traffic loads and extreme weather conditions.
- **Reduced Maintenance Costs:** Plastic roads are expected to require less maintenance than traditional roads due to their increased durability and resistance to damage. This could result in long-term cost savings for municipalities and governments.
- **Improved Sustainability:** The use of plastic waste in road construction materials can help reduce the amount of plastic waste that ends up in landfills or the environment. This can help to reduce the environmental impact of plastic waste and promote a circular economy.
- **Better Skid Resistance:** The addition of plastic polymers in road construction materials has shown to improve skid resistance and reduce the risk of accidents caused by slippery road surfaces.
- **Potential Challenges:** Despite the potential benefits, there are also some challenges associated with plastic roads, such as the potential release of microplastics into the environment, limited availability of plastic waste for road construction, and potential issues with the compatibility of plastic materials with existing road construction equipment.

4. Types of Failures in Flexible Pavements and their Causes and Repair Techniques

4.1 Potholes Failure



4.2 Cracking Failure



4.3 Ravelling Failure



4.4 Corrugation & Shoving Failure



4.5 Rutting Failure



5. Roads Safety Measures and Accident Records

Wearing seat belts have been brought under law after proven studies that these two things reduce the severity of injury during accidents. Wearing seatbelts and helmets doubles the chances of survival in a serious accident. Safety gears keep you intact and safe in case of accidents.

Year	Number of Road Accidents	Number of Deaths	Number of Injuries
2015	501,423	146,133	500,279
2016	480,652	150,785	494,624
2017	464,910	147,913	470,975
2018	467,044	151,417	469,418
2019	449,002	151,113	451,361

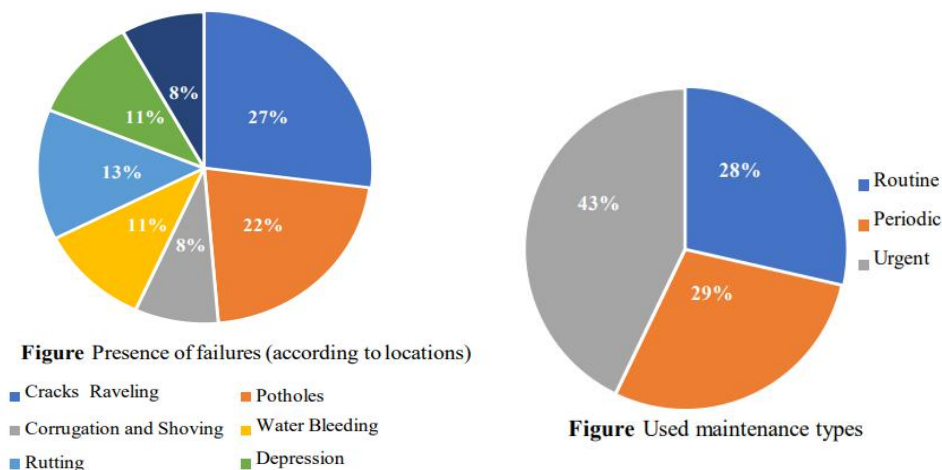
6. Results and Discussion

Overall, the results of plastic roads are promising, but more research and evaluation are needed to determine their long-term effectiveness and sustainability. The success of plastic roads will depend on a variety of factors, including the quality of the plastic waste used, the construction process, and the maintenance practices. Maintenance procedures are taken into action under some maintenance types for the collected different types of failures. This maintenance types were collected from the respective authorities which are shown in the Methodology and Data Collection section.

Table

No	Types of Failures		Maintenance Types
1	Cracks	10	Routine
2	Potholes	8	Urgent
3	Raveling	3	Periodic
4	Water Bleeding	4	Routine
5	Corrugation and Shoving	5	Urgent
6	Depression	4	Urgent

Table indicates the maintenance types and the presence of failures according to locations. The chart below (Figure 14) shows the failure presence percentage of each failure types which points out that cracks and potholes are failures with the highest number. The chart shown in Figure 15 represents the used maintenance types in percentage and it is also seen that the most performed maintenance is urgent maintenance. Both charts are based on the data shown in Table 1.



7. Conclusion

- Proper design, regular inspection and maintenance of drainage system is of utmost importance in preserving the investment made on highway system and in providing comfort and safety to the road user.
- The classifications of all types of distresses have been identified. The cause and treatment is different for different severity levels of each distress.
- The defects in existing highway system and in maintenance practices must be clearly understood and eradicated.
- The influencing parameters considered in this study are cracks and cracking pattern, roughness, pot holes and deflections. The above parameters have been classified according to their severity levels.
- Maintenance decision can be taken based on the criteria of reaching any one or all of the influencing parameters to their maximum acceptable limits.
- The small distress (cracking, potholes, shoving, rutting, etc.) must be repaired before any major maintenance (overlay, renewal coat) is done. Even reduced thickness of overlay will show better results if minor defects are repaired before overlays are done.

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