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Paper An Experimental Study On Highway Failure And Their Remedies On JK Road In Bhopal City (M.P.)

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Abstract: Highway maintenance serves the primary purpose of providing a smooth and safe road surface for users at a minimal cost. However, paved roads in tropical and sub-tropical climates often suffer from different forms of deterioration compared to those in temperate regions, as harsh climatic conditions, inadequate design and quality control, high loads, and insufficient assessments contribute to failures. In the city of Bhopal, the JK road connecting Raisen Road to Minal Mall has a total length of 2 km, with approximately 55% of the road length in a state of failure. This study aims to investigate and classify the failure types of flexible pavements, identify their causes, and determine the most appropriate maintenance techniques. Common forms of flexible pavement failures include various types of cracks, potholes, raveling, water bleeding, corrugation, shoving depression, and rutting, which are gradually worsened by inadequate planning, inspection, and treatment. The possible reasons for flexible pavement failures include the use of improper bituminous mixes with low-quality materials, heavy traffic loads, heavy rainfall, and inadequate pavement drainage. To ensure the prolonged lifespan of road surfaces, proper maintenance is critical.

Index Terms **–** Highway, Jk Road, Bhopal City

I. INTRODUCTION

Highways play a critical role in a nation's transportation infrastructure, facilitating efficient transportation of goods and people. However, highways are vulnerable to various factors that can cause failures, such as traffic loads, weather conditions, construction quality, and maintenance practices. Highway failures can lead to decreased functional capacity, and longer travel times, and pose significant safety risks to road users. Therefore, effective highway maintenance is essential to prevent, minimize, or mitigate the impact of highway failures. This dissertation aims to identify the types and causes of highway failures, analyze different highway maintenance techniques and strategies, and evaluate the maintenance management system. A highway pavement is a layered structure constructed above the natural soil subgrade, designed to distribute vehicle loads to the subgrade. The pavement structure must provide a surface of acceptable ride quality for adequate skid resistance or favorable light-reflecting properties and low noise pollution. The primary types of flexible pavement failures include fatigue cracking, rutting, and thermal cracking. Fatigue cracking in flexible pavement results from horizontal tensile strain at the bottom of the asphaltic concrete layer.

II. FAILURE MAY BE CAUSED BY

- Inadequate Stability
- Excessive application of stresses
- Plastic deformation Failures in sub-base or Base course
- Inadequate stability
- Loss of binding action
- Loss of bearing course materials
- Inadequate wearing course
- Rutting due to high variation in ambient temp.
- Uncontrolled heavy axle loads.
- Limitation of pavement design procedures to meet local environmental conditions.

Highway failures are a major concern for highway maintenance agencies around the world. The failure of a highway can cause significant damage to vehicles and result in serious accidents. To address this issue, it is important to classify highway failures based on their appearance, location, and extent. This helps in identifying the underlying causes of failure and in developing appropriate maintenance strategies to prevent future failures.

Fatigue cracking is a common type of highway failure that occurs due to repeated loading of the pavement. This can be caused by heavy vehicles or changes in temperature. The cracks usually appear in a pattern of interconnected small cracks, resembling a spider web. If left unattended, these cracks can grow and lead to serious pavement distress.

Another type of highway failure is rutting, which is characterized by the formation of depressions in the wheel paths of the pavement. Rutting is caused by the accumulation of permanent deformation in the pavement due to the repeated loading of heavy vehicles. This can also be exacerbated by poor drainage, which can lead to the accumulation of water in the pavement layers.

Longitudinal wheel path cracking is another common type of highway failure that occurs due to the repeated loading of the pavement. This type of cracking usually occurs in the wheel paths and it is caused by the shear stresses generated by the tires of heavy vehicles. Transverse cracking, on the other hand, is caused by the tensile stresses generated by the expansion and contraction of the pavement due to temperature changes.

Bleeding is a type of highway failure that occurs when the asphalt binder in the pavement rises to the surface and forms a film on the pavement. This can be caused by a variety of factors, including high temperatures, over-application of asphalt, or the use of low-quality asphalt.

Shoving is a type of highway failure that occurs when the pavement layer is pushed or displaced due to traffic loads. This can be caused by a lack of stability in the pavement layers or poor bonding between the layers. Depressions, on the other hand, are caused by the settlement of the pavement layers due to poor compaction or inadequate support.

Edge cracking is another common type of highway failure that occurs along the edges of the pavement. This can be caused by a lack of support at the edges of the pavement or by the infiltration of water into the pavement layers.

To address these types of highway failures, various maintenance strategies can be employed. For example, crack sealing and patching can be used to address fatigue cracking and longitudinal wheel path cracking. Rutting can be addressed through the use of asphalt overlays or the addition of stabilizing agents to the pavement layers. Transverse cracking can be addressed through the use of reflective crack control treatments or the addition of reinforcement to the pavement layers.

Bleeding can be addressed through the use of surface treatments or the removal and replacement of the affected pavement layers. Shoving can be addressed through the use of resurfacing or the addition of a new

layer of pavement. Depressions can be addressed through the use of leveling or milling techniques, followed by the addition of new pavement layers.

Edge cracking can be addressed through the use of shoulder reconstruction or the addition of new pavement layers along the edges of the pavement different categories based on their appearance, location, and extent. The most common types of highway failures include fatigue cracking, rutting, longitudinal wheel path cracking, and transverse cracking, In conclusion, highway failures can be classified into bleeding, shoving, depressions, and edge cracking. These failures can be caused by a variety of factors, including repeated loading, changes in temperature, poor drainage, and inadequate support. To address these failures, various maintenance strategies can be employed, including crack sealing, patching, overlays, stabilization, surface treatments, resurfacing, leveling, milling, shoulder reconstruction, and the addition of new pavement layers.

III. LITERATURE REVIEW

Highway failure and maintenance are critical aspects of transportation infrastructure management, given the significant role of highways in facilitating economic growth and social development. Highway failure can result from various factors, including traffic loads, weather conditions, and design defects. It can lead to significant economic losses, environmental impacts, and social disruption. Therefore, effective highway maintenance strategies are essential for ensuring the longevity and sustainability of transportation infrastructure. Several studies have explored the causes of highway failure and proposed maintenance solutions. For instance, Zhang et al. (2019) conducted a comprehensive review of the causes and consequences of pavement distress, including rutting, cracking, and potholes. They identified the primary causes of pavement distress as traffic loading, environmental conditions, and material properties. They proposed several maintenance strategies, including preventive maintenance, corrective maintenance, and rehabilitation, to address these issues. Another study by Hossain et al. (2020) examined the impact of weather conditions on pavement distress and proposed maintenance solutions. They found that weather conditions, particularly temperature fluctuations, can cause significant pavement distress, including cracking, rutting, and potholes.

1. Several studies have explored the causes of highway failure and proposed Remedies and solutions. For instance, Zhang et al. (2019) conducted a comprehensive review of the causes and consequences of pavement distress, including rutting, cracking, and potholes. They identified the primary causes of pavement distress as traffic loading, environmental conditions, and material properties. They proposed several Remedies strategies, including preventive Remedies, corrective Remedies, and rehabilitation, to address these issues.

2. Another study by Hossain et al. (2020) examined the impact of weather conditions on pavement distress and proposed Remedies solutions. They found that weather conditions, particularly temperature fluctuations, can cause significant pavement distress, including cracking, rutting, and potholes. They recommended Remedies solutions such as seal coating, crack sealing, and pothole patching to address these issues.

IV. REMEDIES OF HIGHWAY FAILURE

Highway failures can have significant impacts on the safety and functionality of roads, as well as the economy and society at large. Remedies for highway failure can help to prevent, minimize, or mitigate the effects of highway failures. Here are some remedies that can be employed:-

1. Regular inspection and maintenance: Regular inspection and maintenance of highways can help to identify and address potential issues before they become major problems. This can include crack sealing, patching, resurfacing, and other maintenance techniques.
2. Proper design and construction: Proper design and construction of highways can help to ensure that they are durable and able to withstand the stresses of heavy traffic loads, extreme weather conditions, and other factors that can cause failures.
3. Quality control: Quality control measures can help to ensure that materials and construction practices meet high standards, reducing the risk of failure.

4. Proper drainage: Proper drainage can help to prevent the accumulation of water in the pavement layers, reducing the risk of rutting and other types of failure.
5. Use of appropriate materials: The use of appropriate materials, such as high-quality asphalt, can help to ensure that the pavement is durable and able to withstand heavy traffic loads.
6. Innovative maintenance techniques: Innovations in maintenance techniques, such as the use of recycled materials and new technologies can help to reduce costs and improve the durability of highways.
7. Public education: Educating the public on the importance of safe and responsible driving can help to reduce the stress on highways and prevent some types of failures, such as rutting and depression.

V. STUDY AREA

Bhopal City is a city in the central Indian state of Madhya Pradesh with an area of 463 km^2 The historical name of this city is Bhojpal and the nickname is City of Lake or City of Education. Every year different types of road failures occur in Bhopal City. Road condition within Bhopal City is not good throughout the year due to the occurrence of this failure. Therefore, different types of problems occur to the road users such as unsafe journeys, road accidents, loss of lives, etc.
Work area is JK Road, Bharat Nagar, Indrapuri, Bhopal, Madhya Pradesh on the west side of Bhopal city. JK road is connected with Raisen road to minal mall which is 2km long it is flexible pavement this road is very commonly used for transportation in this area as well as this road is very busy and very crowded. The map of the JK roads Area is shown in the figure 1.

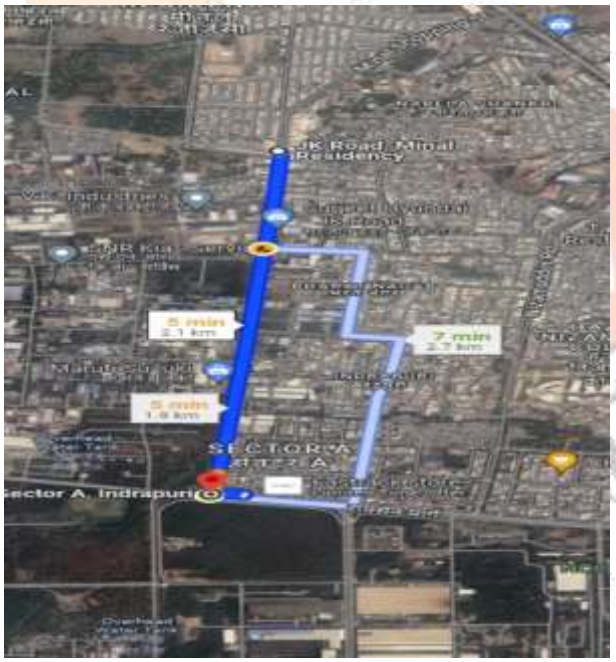


Fig. 1:- JK road map which is the study area

VI. METHODOLOGY AND DATA COLLECTION

Different types of road failures are identified within Bhopal City on JK road which are given as alligator cracking, block cracking, slippage cracking, longitudinal cracking, transverse cracking, potholes, raveling, water bleeding, corrugation, and shoving, depression and rutting. The causes of failures and their maintenance procedures are collected by field failures and their maintenance procedures are collected by field investigation, information collection from respective authorities such as Bhopal City Corporation and Roads and Highway Department, and consideration of public opinion. Field investigation was done in 2021 to 2022 where failures were observed carefully to identify them and to find out their causes of them at each location. Here, public opinion was collected by group discussion with people to achieve an idea about the causes of failures.
The methodology for flexible pavement design involves traffic analysis, subgrade evaluation, pavement layer thickness design, material selection, pavement cross-section design, construction specification, and maintenance and rehabilitation. These steps ensure that the pavement is designed and constructed to the desired standards and can sustain the anticipated traffic loads over its design life.

1. Traffic Analysis: The first step in flexible pavement design is to estimate the traffic volume and load characteristics. This can be done by conducting a traffic survey and collecting data on vehicle types, axle loads, and frequencies.
2. Subgrade Evaluation: The next step is to evaluate the subgrade soil conditions by conducting soil tests such as the California Bearing Ratio (CBR) test. The CBR value of the subgrade soil determines the thickness of the pavement layers required to support the anticipated traffic loads.
3. Pavement Layer Thickness Design: Based on the traffic analysis and subgrade evaluation, the pavement layers are designed. The pavement layers
4. Typically consist of four layers: surface course, binder course, base course, and sub-base course. The thickness of each layer is determined based on the anticipated traffic loads and the CBR value of the subgrade soil.
5. Material Selection: The materials used for the pavement layers are selected based on their strength, durability, and cost-effectiveness. The surface course is typically made of asphalt concrete, while the binder course and base course can be made of either asphalt concrete or cement concrete. The sub-base course is usually made of crushed stones or gravel.
6. Pavement Cross-Section Design: The pavement cross-section design involves determining the thickness of each pavement layer and the required slope and drainage system. The pavement slope and drainage system should ensure that the pavement remains dry and free of standing water to prevent premature failure.
7. Construction Specification: The construction specification involves specifying the material requirements, compaction requirements, and quality control measures to ensure that the pavement is constructed to the desired design standards.
8. Maintenance and Rehabilitation: Flexible pavements require periodic maintenance and rehabilitation to ensure their longevity and sustainability. Maintenance activities may include crack sealing, patching, and surface treatment, while rehabilitation activities may include overlay or reconstruction.

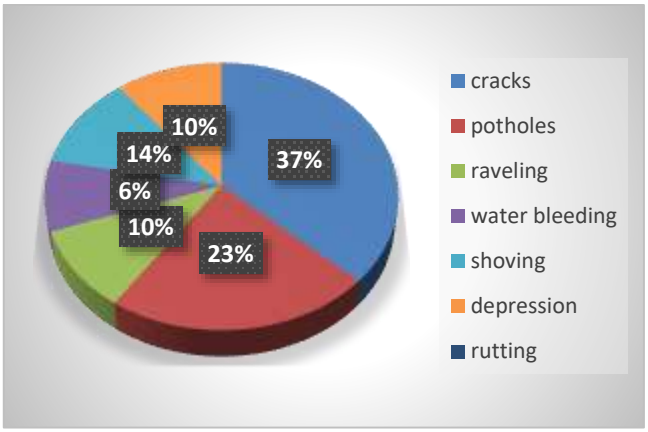
VII. RESULT AND ANALYSIS

Maintenance procedures are taken into action under some maintenance types for the collected different types of failures. These maintenance types were collected from the respective authorities which are shown in the Methodology and Data Collection section.

Table 1: Total failure present on the pavement

No.	Types of failure	Failure present	Remedies type
1	cracks	16	routine
2	potholes	12	urgent
3	raveling	6	periodic
4	Water bleeding	4	routine
5	shoving	9	urgent
6	depression	7	urgent
7	rutting	5	periodic
Total failure		59	

Table 1 indicates the maintenance types and the presence of failures according to locations. The chart below (Figure 02) shows the failure presence percentage of each failure type which points out that cracks and potholes are failures with the highest number. The chart shown in (Figure 03) 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.



Fig, 2:- the presence of failure

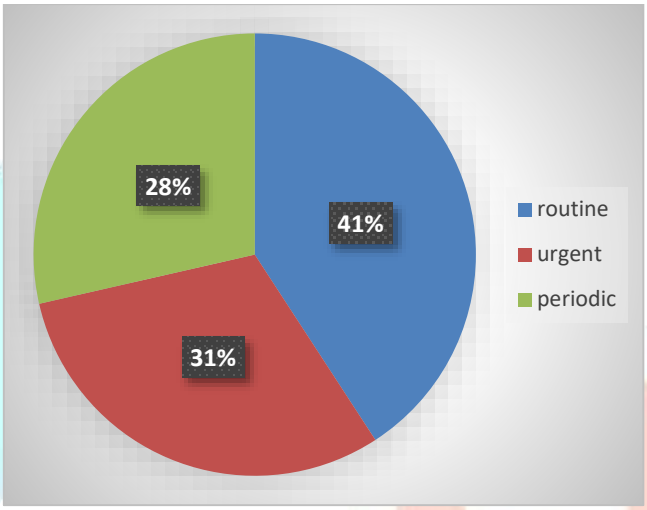


Fig. 3:- Used Maintenance Types

VIII. RECOMMENDATION

Improved Ride Quality: One of the primary goals of highway maintenance is to improve the ride quality of the road. The removal of potholes, cracks and other pavement distresses, and the application of surface treatments can lead to a smoother and more comfortable ride for road users.

2. Increased Safety: Highway maintenance activities such as repairing guardrails, fixing drainage issues, and improving pavement markings can increase road safety. By addressing these issues, the risk of accidents and injuries can be reduced.

3. Extended Pavement Life: Regular maintenance activities such as crack sealing, patching, and surface treatments can extend the life of the pavement by preventing further deterioration and reducing the need for costly repairs or reconstruction.

4. Improved Drainage: Proper drainage is critical to the longevity of the pavement. Maintenance activities such as cleaning ditches, culverts, and catch basins, and repairing or replacing damaged drainage structures can improve the drainage system and prevent water damage to the pavement.

5. Enhanced Aesthetics: Highway maintenance activities such as repainting road markings and removing litter and debris can improve the aesthetics of the road and make it more visually appealing.

6. Reduced Traffic Congestion: Maintenance activities such as quick pothole repairs and efficient traffic control during maintenance work can help reduce traffic congestion and travel delays. Implement advanced traffic management systems that utilize real-time data and intelligent technologies to optimize traffic flow and reduce congestion.

IX. CONCLUSION

Highway failures have a significant impact on transportation systems, posing challenges to safety, mobility, and economic growth. This paper has explored various remedies for addressing highway failure and enhancing infrastructure. By implementing preventive measures, adopting effective maintenance

techniques, employing rehabilitation methods, and embracing innovative solutions, the resilience and efficiency of highway systems can be improved. Preventive measures play a vital role in reducing highway failures. Incorporating design considerations for resilient highways, ensuring proper drainage systems, using durable materials, and implementing slope stability measures are essential steps. Regular monitoring and inspection programs help identify potential issues early on, enabling proactive intervention. Maintenance techniques are crucial for preserving the condition of highways. Routine maintenance practices like crack sealing and pothole repair prevent minor issues from escalating.

REFERENCES

[1] Al-Kaisy, A., & Al-Azzawi, M. (2016). A review of pavement maintenance management systems. Journal of Engineering and Applied Sciences, 11(9), 1849-1857.
[2] Baker, P. R. (2018). Pavement Asset Management. John Wiley & Sons.
[3] Chakraborty, S., Karmakar, S., & Chakraborty, S. (2016). A review on pavement failure and its maintenance. International Journal of Engineering Research and General Science, 4(3), 242-249.
[4] Fanous, F. (2019). Sustainable Transportation Infrastructure: Pavements, Materials, and Management. CRC Press.
[5] Federal Highway Administration. (2019). Pavement Management Systems. Retrieved from https://www.fhwa.dot.gov/pavement/pms/
[6] Haas, R., Hudson, W. R., & Zaniewski, J. P. (2020). Modern Pavement Management. Springer.
[7] Hafeez, I., Akbar, A., & Lodi, S. H. (2016). Maintenance management of flexible pavement: a review.
[8] International Journal of Scientific Research in Science, Engineering and Technology, 2(6), 194-199. Huang, Y. H. (2018). Pavement analysis and design. Pearson.
[9] Li, X., Li, X., Zhang, H., Li, Q., & Li, W. (2019). The research progress of asphalt pavement maintenance technology. Journal of Cleaner Production, 213, 669-683.
[10] Little, D. N. (2015). Life-cycle cost analysis for pavement design. CRC Press.
[11] Lytton, R. L., Uddin, W., & Sandoval, V. A. (2017). Performance-Based Asphalt Mix Design Procedures. Transportation Research Board.
[12] Ma, T., Liu, J., & Zhang, X. (2018). Pavement maintenance strategy under uncertainty: A review. Journal of Cleaner Production, 172, 4004-4014.
[13] NAPA. (2021). Asphalt Pavement Maintenance and Preservation. Retrieved from https://www.asphaltpavement.org/index.php?option=com_content&view=article&id=194&Itemid=125
[14] Paul, S. C., & Bhattacharjee, S. (2017). Assessment of the causes and remedial measures for premature pavement failure: A case study. Journal of Traffic and Transportation Engineering, 4(2), 152-160.
[15] Shahin, M. Y. (2018). Pavement management for airports, roads, and parking lots. CRC Press.
[16] Sharma, M. K., & Sharma, M. (2018). Road maintenance management: An overview. Journal of Civil Engineering and Environmental Sciences, 4(1), 011-018.
[17] Ullidtz, P., & Frost, M. (2015). Pavement Engineering: Principles and Practice. CRC Press.