International Journal of Eco-Innovation in Science and Engineering (IJEISE) Vol.05 (2), 2022 (36-41)
https://ijeise.upnjatim.ac.id/ E-ISSN: 2721-8775

Article

Review Paper on the Level of Road Surface Damage in Mataram City

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Received: 09th November 2024; Revised: 25th November 2024; Accepted: 26th November 2024;
Available online: 30th November 2024; Published regularly: May and November

Abstract

In Mataram City, the capital of West Nusa Tenggara Province, many road sections have deteriorated, reducing road comfort, safety, and mobility efficiency. Typical forms of road damage, such as cracks, potholes, deformation, and surface wear, demand regular maintenance and repairs to extend road service life. This situation underscores the need for a thorough mapping of road pavement damage to provide a comprehensive overview of the road network's condition and to support effective maintenance planning. The mapping of pavement damage in Mataram City is also expected to inform more effective decision-making in road management. This study aims to review previous research on pavement damage mapping and apply the findings to road sections in Mataram City. This empirical, data-driven approach is anticipated to provide a thorough perspective on pavement conditions and serve as a foundation for the local government's efforts to create more effective and efficient road maintenance policies. This study employs a systematic literature review approach to analyze and synthesize existing research regarding pavement damage in road sections using the PCI and Binamarga Methods on Mataram City roads. This study is classified as qualitative research, focused on extracting and synthesizing information from academic papers. Based on the research results from several journal reviews, in the city of Mataram,, several roads still experience visual damage to the pavement surface, including cracking, depression, patching and utility cut patching, and potholes. In addition, the results show that several roads experience fair-level damage based on the PCI method, and some have less than 50% damage to the road surface based on the Binamarga method.

Keywords: Pavement Damage, PCI Method, Bina Marga Method, Mataram City

1. Introduction

Reliable road infrastructure is fundamental for supporting economic activities and urban mobility. In Mataram City, the capital of West Nusa Tenggara Province, many road sections have deteriorated, reducing road comfort, safety, and mobility efficiency. Typical forms of road damage, such as cracks, potholes, deformation, and surface wear, demand regular maintenance and repairs to extend the road service life [1], [2]. This situation underscores the need for a thorough mapping of road pavement damage to provide a comprehensive overview of the road network's condition and to support effective maintenance planning.

High traffic loads, especially from heavy vehicles, are one of the primary factors accelerating pavement damage in urban areas, with traffic volume often exceeding road design capacity [3]–[5]. Road damage can occur due to weather factors, such as high rainfall, which also contributes to road pavement damage [6], [7]. High temperatures in tropical regions, like Mataram, can negatively impact the structural

DOI:10.4186

integrity of pavement layers, particularly on the surface [8], [9] [10].

Mapping road damage is crucial for documenting damage patterns and identifying causative factors. To map accurate damage, field surveys and geospatial data are needed in road maintenance planning [11]–[13]. This approach enables the identification of critical damage points that can be prioritized for immediate intervention, thereby extending the overall lifespan of the road infrastructure. The mapping of pavement damage in Mataram City is also expected to inform more effective decision-making in road management. Maintenance and repairs are essential based on actual damage data, as this can reduce future repair costs [14].

This study aims to review previous research on pavement damage mapping and apply the findings to road sections in Mataram City. This empirical, data-driven approach is anticipated to provide a thorough perspective on pavement conditions and serve as a foundation for the local government's efforts to create more effective and efficient road maintenance policies.

2. Material and Method

This study employs a systematic literature review approach to analyze and synthesize existing research regarding pavement damage in road sections of Mataram City. The methodology does not involve direct data collection from the field but is based exclusively on secondary data from previously published research. This study is classified as qualitative research, focused on extracting and synthesizing information from academic papers.

Key data were extracted from the selected studies and categorized into the following themes:

- Types of Pavement Damage: Identification of common types of pavement damage, including cracks, potholes, surface deformation, and material degradation observed in Mataram City's road sections.
- Assessment Methods: Overview of the methodologies used in the literature to assess pavement conditions, such as visual inspection and field surveys

The results were compiled into a cohesive narrative, highlighting the following:

- Pavement Damage Overview: A summary of the prevalent types of pavement damage found in Mataram City, based on the studies reviewed.
- Effectiveness of Assessment Methods: An evaluation of the methods used for assessing pavement conditions, including their strengths, limitations, and applicability to Mataram City.

3. Results and Discussion

3.1. Types of Pavement Damage

Pavement damage can generally be categorized into two primary types: structural damage and functional damage[15], [16]. These categories help understand the underlying causes of road deterioration and guide appropriate repair strategies. Each type of damage requires different assessment methods and maintenance approaches [17]–[19].

Structural damage refers to the damage that affects the integrity and load-carrying capacity of the pavement structure[16]–[18]. Internal stresses, such as excessive traffic loads, weak subgrade material, or poor construction practices often cause this type of damage. Structural damage typically involves more profound layers of the pavement and can compromise the stability of the road [15], [17], [19]. Structural damage typically requires more extensive repairs, such as resurfacing or full reconstruction, especially when the subgrade or base layers are affected. These repairs are often more costly and time-consuming compared to functional damage[12], [16], [18], [19].

Functional damage, although it does not affect the road's structural integrity, can still cause a decrease in performance, making the road less comfortable and safe for users so that vehicle operating costs increase [12], [18]. Functional damage can generally be addressed with surface-level treatments such as sealing cracks or resurfacing the pavement. Functional damage can make roads uncomfortable, but it does not typically pose an immediate risk to the road's structural stability [17]. Therefore, these issues are usually resolved with more affordable and less invasive methods like resurfacing or crack sealing [19].

Pavement defects are commonly categorized in various ways, with each type influencing pavement performance, durability, and safety. A literature review of pavement defects reveals

several primary kinds of distress, often classified based on their origin, appearance, and impact on the pavement's structural integrity. Here's a summary of key pavement defect types based on commonly cited literature [1], [20], [21]:

- Cracking

a. Fatigue Cracking: Also called alligator cracking, due to repeated heavy loads.
b. Longitudinal Cracking: Cracks parallel to the centerline, often from joint issues.
c. Transverse Cracking: Cracks perpendicular to traffic, from temperature changes.
d. Reflection Cracking: Occurs over joints/cracks in underlying layers.
e. Edge Cracking: Near pavement edges, often from drainage issues or shoulder problems.

- Distortion

a. Rutting: Depressions in wheel paths from repeated loading.
b. Shoving: Horizontal displacement, often in high-braking areas.
c. Corrugation and Waves: Ripples across the surface from unstable mixes or traffic.
d. Depressions and Sags: Localized sinking due to subgrade settlement or compaction issues.

- Surface Wear and Polishing

a. Raveling: Loss of aggregates on the surface due to poor bonding.
b. Polishing: Smooth surface from worn aggregates, reducing skid resistance.
c. Bleeding: Excess asphalt binder at the surface, leading to slickness.

- Disintegration

a. Potholes: Round depressions from fatigue, moisture, and traffic.
b. Stripping: Loss of bond between aggregates and binder, usually from moisture.
c. Weathering: Gradual material breakdown from environmental exposure.

- Surface Defects

a. Flushing: Asphalt binder concentration at the surface, reducing texture.
b. Loss of Texture: Reduced skid resistance from polishing or binder issues.
c. Pop-outs: Small holes where aggregates detach, often from moisture.

- Environmental and Structural Issues

a. Thermal Cracking: Cracking from temperature-induced contraction.
b. Swelling: Surface elevation from moisture in subgrade layers.
c. Heaving/Frost Action: Pavement raising from freeze-thaw cycles.

These categories cover the most common pavement defects identified in the literature, highlighting causes and effects on pavement performance.

3.2. Road Damage Level Assessment Using PCI Method and Binamarga Method in Mataram City

The methods for assessing the level of road damage commonly used in Mataram City based on literature review analysis are the PCI method and the Binamarga Method.

The Pavement Condition Index (PCI) is a systematic method used to evaluate the condition of pavement surfaces based on the severity, extent, and type of distress observed [22]–[24]. The PCI method quantitatively measures road conditions and is widely used in infrastructure management to prioritize repairs. The evaluation involves identifying and scoring various distresses like cracks, potholes, rutting, and other surface deformations, then calculating a score that ranges from 0 (failure) to 100 (excellent condition) [25]–[27].

Research analyzing using PCI on Brawijaya Road in Mataram City identified several types of damage, such as alligator cracks and potholes, leading to a PCI score of 51, indicating poor pavement conditions [28]. This case highlights how PCI can quantify road degradation, guide maintenance and rehabilitation efforts. The study was also conducted using the Pavement Condition Index (PCI) method on the AA Gde Ngurah road section in Mataram City. The average PCI value was 70 with a fair rating, the largest percentage of damage was a good rating of 41% and followed by a satisfactory rating of 28%, this shows that most of the AA Gde Ngurah road conditions are in fairly good condition [13].

The Binamarga method is a road damage assessment method used to evaluate the physical condition of road pavements. This method identifies and measures various types of damage, such as cracking (including alligator, longitudinal, and transverse cracks), potholes, subsidence, and surface peeling. Based on the type and extent of the damage, the road is assigned a condition score that reflects its quality. This assessment helps

prioritize road repairs and maintenance to enhance user safety and comfort.

The study using the binarmarga method shows that the level of damage to the Darul Hikmah Road Section in Mataram City has a Nr (Damage Value) value of 33% [29]. This road damage value (Nr) is the total damage value on a road section. Another study was also conducted using the Bina Marga method on Prabu Rangkasari Road, Mataram City, obtaining damage value results (Nr) according to the calculation results based on field data for the north-south and south-north directions, namely 68.2% [30].

3.3. Results and Discussion Summary results of Literature Review of Research on road damage in Mataram City

Based on a review of several papers regarding road damage in Mataram City, a summary is obtained in Table 1.

Table 1. Summary results of Literature Review of Research on road damage in Mataram City.

No.	Road Name	Method	Result	Descrip.
1	Brawijaya Road	PCI	PCI Index Value : 51	Poor pavement conditions
2	AA Gde Ngurah Road	PCI	PCI Index Value : 70	Fair Pavement Conditions
3	Darul Hikmah Road	Bina Marga	Nr : 33	Damage Level Less Than 50% of Road Sections
4	Prabu Rangkasari Road	Bina Marga	Nr : 68,2	Damage Level More Than 50% of Road Sections

Based on the review results in Table 1 [11][30][13][28], there are two types of methods used to assess the level of road damage in the city of Mataram, namely the PCI method and the Bina Marga method. The results show that the PCI method used in assessing road damage on Brawijaya Road has a PCI Index value of 51 and on AA Gde Ngurah Road has a PCI Index value of 70. Based on the average results, road damage in Mataram using the PCI method is valued at 60.5, indicating Fair Pavement Conditions. The results show that the Bina Marga method used in assessing road damage on Darul Hikmah Road has a value of Nr 33 and on Prabu Rangkasari Road has a value of Nr 68,2. Based on the average results, road damage in Mataram City using the Binamarga method, namely Nr is 46.75, which shows a result of less than 50% road damage.

Based on the results of a review of several studies, the types of pavement damage on road sections in Mataram City that frequently occur are cracking, depression, patching and utility cut patching, and potholes [11][30][13][28].

4. Conclusion

Based on the results of research from several journal reviews, several roads in the city of Mataram still experience visual damage to the pavement surface, including cracking, depression, patching and utility cut patching, and potholes. In addition, the results show that several roads experience fair-level damage based on the PCI method, and some have less than 50% damage to the road surface based on the Binamarga method.

Acknowledgment

The author would like to express sincere gratitude to the Department of Public Works and Spatial Planning (Dinas PUPR) of Mataram City for their invaluable support and collaboration in conducting this research on road damage within Mataram City. The active participation and assistance provided by the Dinas PUPR team have been instrumental in the smooth progress and completion of this study. We hope that the findings from this research will contribute positively towards the improvement of road infrastructure in Mataram City, enhancing safety and comfort for all users. Once again, we extend our heartfelt thanks for the support and cooperation, and we look forward to further productive collaborations in the future.

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