ANALYSIS OF FLEXIBLE PAVEMENT DAMAGE OF HIGHWAYS USING SDI AND IRI METHODS (CASE STUDY OF NOA-GOLOWELU ROAD)

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Abstract: The Noa Golowelu Road Section (Bts. Kab) is one of the provincial roads located in West Manggarai Regency. This road was built in 2021 with a flexible pavement type. The current condition of the road pavement is damaged at certain segment points, so that the damage can affect the safety, comfort and smoothness of road users passing through the road. This study aims to determine the type and level of damage using the IRI (International Roughness Index) and SDI (Surface Distress Index) methods and the appropriate handling for this road section. In this study, the length of the segment to be studied is 3 km. The assessment of the road pavement condition was obtained visually by conducting a field survey using the SDI method, while the IRI value was obtained by conducting a survey using a car and utilizing the Roadroid application. Roadroid application is one of the applications on Android developed by a Swedish company that functions to measure road unevenness. Based on the research results using the IRI and SDI methods, the IRI value is 7,01 with a damage level of 1% Good, 77% Moderate, 15% Light Damage and 7% Severe Damage. In the SDI method, the SDI value is 74 with a damage level of 33% Good, 47% Moderate, 13% Light Damage, 7% Severe Damage. Based on the results of this study, the damage that occurred on the road section can be recommended as a repair method, namely Routine Maintenance.
Keywords: *IRI, SDI, Handling Type.*

INTRODUCTION

One of the progresses of a region is through adequate road infrastructure. The existence of roads will have an impact on the progress of the economic, social, cultural and political sectors in a region. The road network plays a very important role, especially in

the development between regions, so that it can support the movement of transportation between regions (Irianto & Rochmawati, 2020).

Noa-Golowelu Road is one of the connecting roads for distributing food such as rice, coffee, cloves and other food needs. This route is also an alternative route for local people to the super premium city, Labuan Bajo (Koromath et al, 2022). This road section has become the main road for the community to mobilize for the community's economy, so a stable road condition is needed (Yunus et al, 2022).

Jalan Noa - Golowelu (Bts. Kab) uses the Flexible Pavement type and road type (2/2UD) with a length of 24.20 km and a width of 3 m, built in 2021 with a length of 16 km of road segment worked on and completed in 2021. Basically, every road infrastructure development has been designed according to plan and generally considers the planned life of 20 years (Road Pavement Design Manual 2024). Which means that it is not expected that the road will not be damaged in the first 5 years. Damage to the road will certainly cause many losses felt by the community because it will hinder the speed and comfort of road users in carrying out travel activities (Lailatul Jannah et al, 2022).

The current condition of the road is already damaged. Several points in certain segments have experienced degradation, such as holes, cracks, subsidence in the pavement structure from the surface layer to the lower foundation layer, and cracks in the edge of the road. If this condition is left unchecked, total damage to the road body will eventually occur. Since its completion in 2021, maintenance during the operational period or utilization of this road was carried out in 2022 but was only prioritized on road segments that experienced a high level of damage. Until early 2025, the level of damage was getting bigger, and spread to many segments along the intended road section.

Handling of constructed highways must be carried out based on recommendations for the level of damage, so that the type of handling can be determined, such as routine maintenance, periodic maintenance, improvement, or reconstruction. Several methods that can be used and used as references in determining the condition of road pavement and repair methods are the IRI (International

Roughness Index) method and the SDI (Surface Distress Index) method.

The IRI method is a method for assessing road pavement, to show the unevenness of the road surface conditions that make it uncomfortable for drivers to drive carefully (Hasrudin 2022). The SDI method analyzes the damage to be studied referring to 4 categories of damage, namely Crack Area, Crack Width, Number of Holes, and Wheel Mark Depth. So that from the results of visual observations and direct surveys in the field, the right type of treatment is obtained for repairing the road section.

The objectives of this research are threefold. First, the study aims to determine the value of road flatness using the International Roughness Index (IRI) method. Second, it seeks to identify the level of road damage through the Surface Distress Index (SDI) method. Third, the research intends to determine the appropriate type of treatment to be carried out based on the specific types of damage observed in the field.

METHOD

The type of research that will be used is quantitative. In the study, the data will be obtained from visual observations and conducting surveys by car using the Roadroid application. The results of the data that will be obtained are presented in the form of tables and graphs.

The location of the research that will be carried out is on the Noa-Golowelu Road (Bts.Kab), Kuwus District, West Manggarai Regency, East Nusa Tenggara Province. The following is a map of the research location shown in Figure 1.1

Figure 1.1 Research Location

The length of the road segment to be studied on the Noa-Golowelu road section (Bts.Kab) is 3 km long. The data taken in this study include the area of cracks, crack width, number of holes and wheel marks.

Data analysis in this study was obtained visually and by field survey using a car with the help of the Roadroid application to determine the smoothness of the road. The method used to analyze data such as the road sections reviewed are divided into several segments, identifying the type of damage, documenting all road damage, determining the magnitude of the road damage value using the IRI and SDI methods to determine the type of handling with the help of the Microsoft Excel application.

RESULT

1. Road Condition Assessment

Based on the results of visual observations and field surveys using a car with the help of the Roadroid application. The condition values based on the IRI and SDI methods on the Noa-Golowelu road section (Bts.Kab) are obtained, each of which is described below:

a. Road section condition value based on IRI

IRI value measurement or better known as road flatness index measurement is carried out using a car and the help of the Roadroid application. The calculation results can be presented in the graph in Figure 1.2. below:

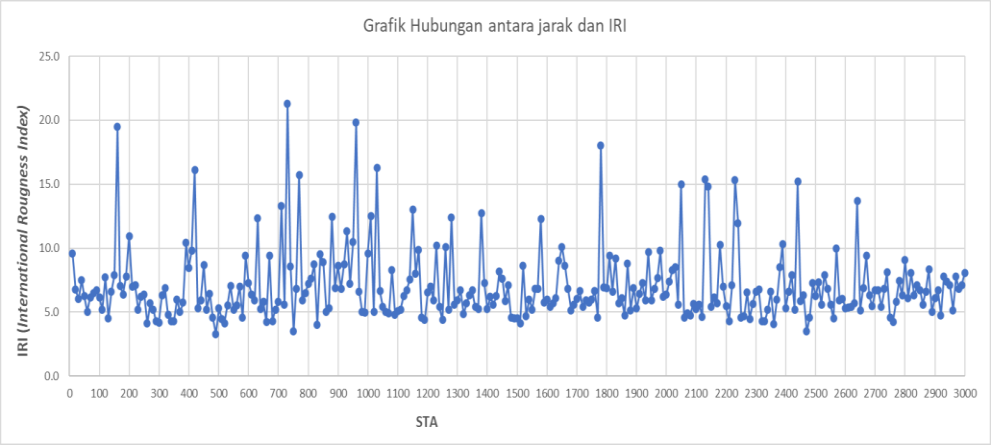

Figure 1.2 IRI Value Graph for the Noa-Golowelu road section

From the IRI value graph for the Noa-Golowelu road section from STA 0+000 to STA 0+3000, an average IRI value of 7.01 was obtained with moderate damage conditions and the type of handling was Routine maintenance.

The percentage of the condition of the Noa-Golowelu road section based on the IRI value can be presented in Figure 1.3 below

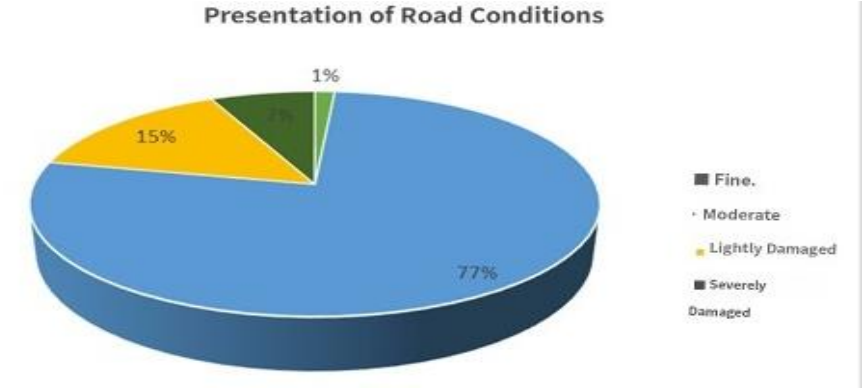

Figure 1.3 Percentage of road section conditions based on IRI value

Based on the figure above, it is known that the road condition is 1% fine/good condition, 77% moderate condition, 15% slightly damaged condition and 7% severely damaged condition.

b. Road section condition value based on SDI

Damage analysis using the SDI method, the damage to be studied refers to 4 categories of damage, namely Crack Area, Crack Width, Number of Holes, and Wheel Mark Depth. Based on the calculation results, it can be presented in the form of a graph in Figure 1.4 below:

Figure 1.4 SDI Value Graph for the Noa-Golowelu road section

Based on the SDI Value Graph for the road section above from STA 0+000 - STA 0+3000, the average SDI value is 74 with moderate road conditions and routine maintenance handling types. The percentage of the condition of the Noa-Golowelu road section based on the SDI value can be presented in Figure 1.5 below:

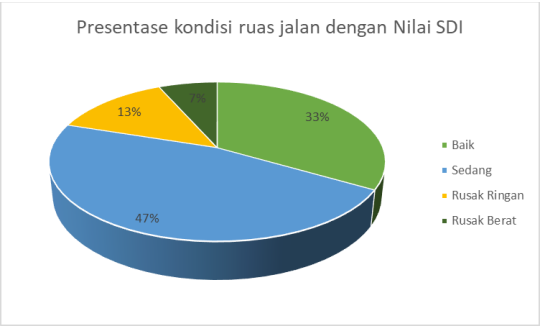

Figure 1.5 Percentage of road section conditions based on SDI value

Based on the SDI road condition value above, it is found that the road condition is 33% in good condition, 47% in moderate condition, 13% in slightly damaged condition and 2% in severely damaged condition.

2. Type of Handling

Determination of the type of handling is the final result of the assessment of the condition of the Noa-Golowelu road section using the IRI and SDI methods. Determination of the type of road handling based on the IRI and SDI methods can be seen in the following table.

Table 1.1 IRI value based on SDI value (Sanjaya at al, 2017)

IRI	**SDI**			
	< 50	**50 – 100**	**100 – 150**	**> 150**
< 4	Good	currently	currently	slightly damaged
4 - 8	currently	currently	currently	slightly damaged
8 – 12	slightly damaged	slightly damaged	badly damaged	badly damaged
> 12	Moderately damaged	badly damaged	badly damaged	badly damaged

Table 1.1 illustrates the relationship between International Roughness Index (IRI) values and Surface Distress Index (SDI) classifications as presented by Sanjaya et al. (2017), showing a clear progression of road condition deterioration as both indices increase. Roads with an IRI value of less than 4 consistently fall within the "Good" or "currently adequate" categories across SDI levels below 150 and only shift to "slightly damaged" when the SDI exceeds 150. As the IRI increases to the 4–8 range, the surface condition remains categorized as "currently adequate" for SDI values below 150, again transitioning to "slightly damaged" only at higher SDI levels. In the intermediate IRI range of 8–12, the road condition classification transitions more noticeably, shifting from "slightly damaged" at

lower SDI levels to "badly damaged" as SDI reaches 100 or more. At the highest roughness level, with an IRI greater than 12, the condition is consistently categorized as "badly damaged" across almost all SDI ranges, indicating severe surface distress, moderately damaged appearing only at the lowest SDI range. Overall, the table demonstrates a strong correlation between increasing roughness and distress levels, where higher IRI and SDI values are associated with progressively poorer road performance.

Table 1.2 Type of road handling based on IRI and SDI values (Sanjaya at al, 2017)

IRI	**SDI**			
	< 50	**50-100**	**100-150**	**> 150**
< 4	routine	routine	Rehabilitation	Reconstruction
4-8	routine	routine	Rehabilitation	Reconstruction
8-12	Rehabilitation	Rehabilitation	Reconstruction	Reconstruction
> 12	Reconstruction	Reconstruction	Reconstruction	Reconstruction

Table 1.2 demonstrates a systematic relationship between road roughness (IRI) and surface distress levels (SDI) in determining the appropriate type of road handling, as outlined by Sanjaya et al. (2017). The data reveal that roads with low IRI values (below 8) generally require only routine maintenance when SDI values are below 100, indicating minimal structural deterioration. However, as SDI values increase to the 100–150 range, the required intervention shifts toward rehabilitation, reflecting the onset of more serious surface defects. In contrast, higher roughness levels (IRI above 8) consistently necessitate rehabilitation or full reconstruction, depending on the severity of the SDI, which underscores the compounding effect of both indices on maintenance decisions. Notably, when IRI exceeds 12, reconstruction becomes mandatory across all SDI categories, indicating that extremely poor ride quality

independently signals substantial structural decline regardless of surface distress levels.

DISCUSSION

The findings of this study highlight the condition of the examined road segment as assessed through two complementary evaluation methods, namely the International Roughness Index (IRI) and the Surface Distress Index (SDI). The IRI assessment, conducted using the Roadroid application, yielded a value of 7.01, which categorizes the road as moderately damaged. This level of roughness indicates that the pavement surface exhibits noticeable irregularities that affect ride quality but have not yet progressed to severe structural failure. Consequently, the appropriate intervention recommended by the IRI method is routine maintenance, reflecting the need for preventive rather than restorative measures.

Similarly, the analysis based on the SDI method revealed a damage level of 74, which also places the road within the moderate damage category. This result suggests that visible surface defects such as cracks, minor deformation, or surface wear, are present, yet remain within a threshold that does not necessitate major rehabilitation. The SDI-based classification further reinforces the conclusion that routine maintenance is sufficient to address the current condition and prevent further degradation. The alignment between the SDI findings and the IRI results strengthens the reliability of the damage assessment by demonstrating methodological consistency across surface and structural indicators.

Considering both evaluation techniques, the convergence of results provides strong empirical support for recommending routine maintenance as the most appropriate treatment strategy for the observed road segment. This methodological agreement underlines the value of integrating multiple diagnostic tools in road condition assessments to achieve a more comprehensive and

accurate understanding of pavement performance. Moreover, these findings imply that timely implementation of routine maintenance will likely extend the pavement's service life, minimize future repair costs, and prevent the escalation of damage to levels requiring extensive rehabilitation or reconstruction. Ultimately, the study emphasizes the importance of adopting proactive maintenance strategies informed by empirical data to enhance roadway sustainability and operational efficiency.

CONCLUSION

Based on the results and discussion, it can be concluded that the condition of the analyzed road segment falls within the moderate damage category as consistently indicated by both the IRI and SDI assessment methods. The IRI value of 7.01, obtained through the Roadroid application, and the SDI value of 74 both confirm that the road exhibits surface irregularities and defects that affect performance but have not yet reached a level requiring major structural intervention. The convergence of these two independent evaluation techniques strengthens the validity of the overall assessment and supports the determination that routine maintenance is the most appropriate treatment strategy at this stage. Implementing routine maintenance promptly is therefore essential to prevent further deterioration, extend pavement service life, and avoid the escalation of damage that would necessitate more costly rehabilitation or reconstruction in the future.

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