

# The Effectiveness of IRI Compared To SDI System for Assessing the Quality And Performance Of Materials Used In Flexible Pavement In Java, Indonesia

Hary Agus Rahardjo<sup>1, a</sup>, Suparman<sup>2</sup>

<sup>1,2</sup>Universitas Persada Indonesia Y.A.I, Indonesia

<sup>a</sup>email: haryagus30@yahoo.co.id

**Abstract.** Technological developments regarding the tools and methods used to determine the level of damage to roads, does not necessarily assure benefits to its users. Need further analysis and testing to determine its effectiveness. In terms of damage to the road using flexible pavement, IRI (International Roughness Index) method needs to be studied and compared with the SDI (Surface Distress Index) method which has been used in Indonesia. Damage to the roads using flexible pavement indicates the quality of materials used in flexible pavement. The method used in this study is a survey directly in the field using both methods. Then the results were compared and analyzed using statistical analysis. The purpose of this study was to determine the effectiveness of IRI compared to SDI. The result reveals that there are no significant differences between IRI and SDI. In other words, IRI can be used singly replace SDI.

## 1. Introduction

For the past couple of decades, roads in Indonesia are using flexible pavement. Besides being easy to build, have a cheaper price compared to rigid pavement, as well as easier to fix. In addition, they have a great advantage that their surface can be used again for rehabilitation [1].

Related to efforts for the roads maintenance and repair in order to function properly, the initial step necessary is the identification of the damage that requires repair. This identification includes the type, level, area of damage, and the locations. In Indonesia, relating to weaknesses in law enforcement, overloading is also among the most important causes of the deterioration of flexible pavements as indicated by Sadeghi [2].

There are several methods that can be used for that purpose, among others, IRI (International Roughness Index) and SDI (Surface Distress Index). The use of IRI or SDI is not only useful for controlling the quality of flexible pavement but also can be used to determine the performance of the materials used in the construction of flexible pavement. The more damaged areas in flexible pavement, the lower the performance of the material used.

With advances in technology, the IRI method considered more practical. But the question that arises is whether IRI method accurate enough and suitable to be applied in Indonesia. It is given that the flexible pavement in Indonesia, though still function properly, is often uneven or bumpy, unlike in developed countries where they have the smooth and flat surface roads. Finally, using a combination of IRI and SDI methods simultaneously is common in practice [3].



## 2. Aim and Objectives

The aim of this study is to investigate the effectiveness of IRI compared to SDI. Therefore, the objectives of writing this paper is to prove that the use of IRI effective enough for the road conditions in Indonesia, so that it can be used singly replaces the SDI method. The results of this study then can be a reference for the management of the road in all regions in Indonesia.

## 3. Methodology

This research began with a review of literature on IRI and SDI method to get an overview of the functions, mechanisms and results of measurements obtained with a focus on its application for road construction. Furthermore, data acquisition in the form of primary data obtained through direct surveys on roads in the West Java region using IRI and SDI method. The 22.5 km of roads divided into segments, each segment length is 100 m. Thus, this case study uses both qualitative and quantitative data [4]. The collected data is then analyzed using statistical analysis method.

## 4. IRI and SDI to Observe Flexible Pavement

Flexible pavements consist of natural granular material and then covered with one or more waterproof bituminous surface layers, so that they become flexible. Tropical country like Indonesia with a fairly high rainfall, flexible pavement damage often occurs. Moreover, the overloaded vehicles, which are common in developing countries, also accelerated the deterioration of the road [5]. Therefore, it is necessary to arrange the maintenance and repair of roads continuously.

According to government regulations, road maintenance consists of routine maintenance and periodic maintenance. Routine maintenance is the maintenance performed every year and includes a coating of pavement and gravel roads, vegetation control, turf, as well as cleaning and painting of traffic signs. While periodic maintenance normally carried out every four or five years and includes work overlay, closing holes, drainage improvements, road shoulders, and replacement of traffic signs [6].

To determine the level of damage or condition of existing road, then IRI or SDI method is used. IRI can describe a longitudinal profile of a road and used as a standard road surface unevenness [7]. The IRI, which is a profile-based statistic, is shown to be an ideal predictor (or independent variable) since it has the advantage of being repeatable, reproducible, and stable with time [8]. But must be careful at the time of measurement, because of the variation of speed during the measurement process has a large influence on the IRI measurement [9]. SDI is an assessment system of pavement condition conducted by visual observation directly in the field and can be used as a reference in maintenance effort. SDI value that indicates in good condition does not necessarily indicate similar conditions to the value of IRI, because SDI values obtained from the road surface conditions while the value of IRI is more directed to the road surface roughness [10].

## 5. Result and Discussion

Length of roads surveyed is 22,500 kilometers long starting from Ciawi Bogor City up to Puncak, Bogor Regency, West Java Province. Road section consists of two 2-way lanes, and pavement width is 7-10 meters with 3.5-5 meters per lane. Damage to roads is observed directly every 1.00 meter based on the method of SDI, while the IRI system by using the tool HAWKEYE. Having recapitulated, frequency distribution data of the road conditions, both for the value of IRI and SDI values are shown in Table 1 and Table 2 and Figure 1 and Figure 2 below.

Table.1. IRI Frequency Distribution

Category	IRI	Frequency	%
<b>Good</b>	<4	14,600	64.89%
<b>Fair</b>	4 - 8	7,700	34.22%
<b>Poor</b>	8 - 12	200	0.89%
<b>Bad</b>	>12	-	0.00%

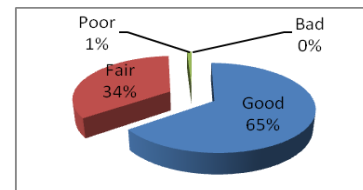


Fig.1. IRI Frequency Distribution

Table.2. SDI Frequency Distribution

Category	SDI	Frequency	%
<b>Good</b>	<50	14,000	62.22%
<b>Fair</b>	50 - 100	8,200	36.44%
<b>Poor</b>	100 - 150	300	1.33%
<b>Bad</b>	>150	-	0.00%

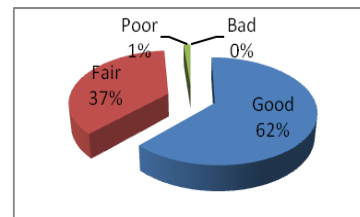


Fig.2. SDI Frequency Distribution

The table shows that there is no significant difference between the results of IRI and SDI. For the category of good conditions, IRI states that 64.89% roads are in Good condition, whereas 62.22% expressed by SDI. The IRI results appear higher compared with the results of SDI. But for Fair and Poor condition, results of IRI by 34.22% and 0.89% is lower than the results of SDI which constituted 36.44% to fair condition and 1.33% for Poor condition. There is an inconsistency between the resulting IRI and SDI, sometimes higher, sometimes lower. This differs from the findings of Sinurat, who is stating that the results of IRI relatively lower than the results of SDI [11].

But to know the effectiveness of IRI compared to SDI or to know is there any similarity between the two methods, it is then performed on the comparative sample Hypothesis independent non-parametric statistics. The test results of two mean between IRI and SDI t - Test: Paired Two Sample for Mean is shown in Table 3 below.

Table 3. t – Test: Paired Two Sample for Mean

	IRI	SDI
Mean	4.368387097	55.57983871
Variance	1.7760367	795.4870705
Observations	62	62
Pearson Correlation	0.715083787	
Hypothesized Mean Difference	0	
df	61	
t Stat	-14.78837517	
P(T<=t) two-tail	7.72045E-22	

In this hypothesis test, define  $H_0$ : there is no significant difference between the mean test based on the value of the road surface roughness (IRI) with the road surface distress index (SDI), with  $\alpha = 5\%$ . Statistical calculation at above table shows that the p value (7.72%) > 5% and t table (1.999) > t stat. Thus,  $H_0$  is accepted, it means that there is no difference between IRI and SDI significantly. In other words IRI can be used as effectively as SDI. Thus, the combination use of IRI and SDI simultaneously [3] is no longer needed for the conditions in Indonesia. As stated by David N. Ammons and T. Dwane Brinson, it could be added here, however, that comparisons of cities across the street condition ratings are viable when each city uses the same rating system and when the ratings are considered approximate rather than absolute [12].

## 6. Conclusion

From the discussion above it can be concluded that there is no significant difference between the value generated by IRI or SDI. In other words, IRI can be used singly replace SDI. Despite fluctuating results or inconsistent result between the two methods, but the difference is not significant. For further research, it is recommended to consider the level of vehicle speed that is used to perform measurements using the IRI method. It is intended to get more accurate results.

## 7. References

- [1] Saurabh Jain et al. *Design of Rigid and Flexible Pavements by Various Methods & Their Cost Analysis of Each Method*. International Journal of Engineering Research and Applications. Vol. 3, Issue 5, Sep-Oct 2013, pp.119-123.
- [2] J. M. Sadeghi. And M. Fathali. *Deterioration Analysis of Flexible Pavements under Overweight Vehicles*. Journal of Transportation Engineering © ASCE. Vol.133. No. 11. November 2007. Pp.625-633.
- [3] M. Yoga Mandala Putra. *Functional and Structural Evaluation Method Using AASHTO 1993 in Flexible Pavement Management. Case Study: Medan – Lubukpakam segment*. Civil Engineering Journal. ISSN 0853-2982. Vol. 20 No. 3 Desember 2013. Pp. 245-254.
- [4] Yin, Robert K. *Case Study Research: Design and Methods*. 5<sup>th</sup> edition. Thousand Oaks, California: SAGE Publications, Inc. 2014.
- [5] J. M. Sadeghi. And M. Fathali. *Deterioration Analysis of Flexible Pavements under Overweight Vehicles*. Journal of Transportation Engineering © ASCE / Vol.133. No. 11. November 2007. Pp.625-633.
- [6] Regulation of the Minister of Public Works of the Republic of Indonesia Number 13 / PRT / M / 2011 on Procedures for Road Maintenance and Surveillance.
- [7] Park, Kyungwon. et al. *Applicability of the International Roughness Index as a Predictor of Asphalt Pavement Condition*. Journal of Transportation Engineering © ASCE / DECEMBER 2007. pp.706-709.
- [8] Williams, Lakeasha N. et.al. *Predicting Pavement Condition Index Using International Roughness Index in a Dense Urban Area*. Journal of Civil Engineering Research. 2015, 5(1): pp. 10-17.
- [9] Du, Yuchuan. et al. *Measurement of International Roughness Index by Using Z-Axis Accelerometers and GP*. Research Article. Hindawi Publishing Corporation. Volume 2014, Article ID 928980, 10 pages.
- [10] Minarti, Eka. Et.al. *Observation of Road Damage Based on Surface Distress Index (SDI) and International Roughness Index (IRI)*. Civil Engineering Journal. Syah Kuala University. ISSN 2302-0253. Volume 3, No. 3, Agustus 2014. pp. 163- 173.
- [11] Doan Sinurat. *Comparative Study on Determining The Road, Base On Visual Observation and Parvid Equipment*. Civil Engineering Journal, University of North Sumatera. Vol.3 No.1. 2014.
- [12] David N. Ammons and T. Dwane Brinson. *Condition Ratings: Their Use among North Carolina Cities*. PUBLIC MANAGEMENT BULLETIN. School of Government. The University of North Carolina at Chapel Hill Street . NO. 5. January 2011. Pp.1-12.