Road Handling Using International Roughness Index and Surface Distress Index Method

Andrew Ghea Mahardika\textsuperscript{1*}, Herawati\textsuperscript{2}, Taufik Rachman\textsuperscript{1}, Budi Nuryono\textsuperscript{1}, Hetty Fadriani\textsuperscript{1}, Iman Hidayat\textsuperscript{1}, Givy Devira Ramady\textsuperscript{1}

\textsuperscript{1}Sekolah Tinggi Teknologi Mandala, Bandung, Indonesia
\textsuperscript{2}Universitas Kristen Maranatha, Bandung, Indonesia

*andrewhinata@gmail.com

Abstract. Determination using field survey data and rough meter III tools, as well as theoretical sources on the determination and evaluation program of the International Roughness Index (IRI) method and the calculation of the Surface Distress Index (SDI) for flexible pavement based on research results from sta 00 + 000 to 02+ 700 IRI values: the average condition is moderate, 02 + 700 to 07 + 635 has a value of light damage to severe damage, SDI value: from sta 00 + 000 to 2 + 700 has a value of the good condition, 02 + 700 to 6 + 800 has a moderate condition value, and sta 02 + 600 to 7 + 635 has light damage to severe damage condition.

1. Introduction
A sidewalk condition survey needs to be carried out annually both structurally and non-structurally to determine the current state of road facilities. After the road was first opened to traffic, every surface system has gone through a gradual phase of destruction. Road damage is caused among others due to excessive repetitive traffic loads (Overload), heat or air temperature, water and rain, and poor initial quality of road products. Therefore, in addition to being properly planned, the roads must be well maintained in order to serve traffic growth during the planned life. Routine and frequent road maintenance is needed to ensure road protection and comfort for users, as well as to ensure durability until the expected age [1].

The International Roughness Index (IRI) or road unevenness was developed by the World Bank in the 1980s. IRI is used to describe a longitudinal profile of a road and is used as a standard for road surface unevenness. One of the factors/service functions (functional performance) of a road pavement that has a significant impact on the driver's comfort is the degree of road flatness (International Roughness Index, IRI) (riding quality). For the classification of road conditions based on IRI values [2]–[4].

2. Methodology
The Roads are infrastructure to support the pace of the economy and play an important role in the progress of a region's development. In order to fulfill the needs of the population to carry out different forms of economic operations, both mobility and transportation of goods and services, Indonesia, as a developing country, urgently requires the quality and quantity of roads [5]. Damage to roads will cause many losses that can be felt by users directly because it will certainly hamper the speed and comfort of road users and cause many victims as a result of road damage that is not immediately handled by the authorized agency [6].
Assessment of surface conditions is carried out by means of a pavement condition assessment system according to DGH (2011) from research conducted so that various types of damage are obtained with different dimensions [7]. The most dominant types of damage are usually found, namely potholes, in addition to cracks (cracking), grooves (ruts), upheaval, bumpy roads, raveling, and graded pression. Based on the problems that exist on Jalan Jendral Sudirman, Kubu Babusalam District, Rokan Hilir Regency, Riau Province, which will be studied, the authors will combine road unevenness data using the IRI method obtained by using the rough meter and SDI methods which will produce a road condition and type of handling qualitatively [8].

To assess the level of current road systems, a pavement status assessment must be conducted on a regular basis, both structurally and non-structurally. After the road was first opened to traffic, every surface system has gone through a gradual phase of destruction [8]. Road damage is caused among others due to excessive repetitive traffic loads (Overload) [9], heat or air temperature, water and rain, and poor initial quality of road products [10]. The International Roughness Index (IRI) or road unevenness was developed by the World Bank in the 1980s. IRI is a metric for measuring road surface unevenness and is used to define a road's longitudinal profile. One of the factors/service functions (functional performance) of a road pavement that has a significant impact on the driver's comfort is the degree of road flatness (International Roughness Index, IRI) (riding quality). The classification of road conditions based on the IRI value can be seen in Table 1, the relationship between the IRI value and the road condition classification [11], [12].

| Value IRI | Conditions   |
|-----------|--------------|
| < 4       | Good         |
| 4 - 8     | Moderate     |
| 8 - 12    | Light Damage |
| > 12      | Heavy Damage |

Roughometer III is a tool used for road flatness testing (IRI) in this project. They are relatively inexpensive and easy to install, and also provide objective, repeatable ruggedness results. Roughometer III is the third roughness measurement device used by the World Bank, which has advantages over previous versions Figure 1.

![Figure 1. Roughometer III Installation Scheme](image)

The search After all the instruments are installed then the rough meter III tool can be operated, the road data we surveyed will be stored in the rough meter III tool, the unevenness value (IRI) is obtained by connecting the rough meter controller with a Personal Computer (PC), along with the results of the survey data generated on Table 2.
3. Result and Discussion

Based on the problems and research methods presented, the data obtained from the survey results are then discussed so that the type and level of damage can be identified according to the road conditions in the road segment at the point being analyzed. Where the results of the analysis of the points obtained are in the form of road condition data by means of visual survey data collection, namely the category of road damage, size, and percentage of road damage using the Bina Marga method. The road surface layer on the road segment is at the point with the AC road surface layer (asphalt concrete) which consists of multiple segments/sections. The data used are primary data and secondary data. The road points are what is analyzed. The data processing is carried out in stages as Data Analysis, Determining the International Roughness Index (IRI) Value, Estimating the RCI Value and IRI assessment variables, Calculating Value of Surface Distress Index (SDI).

Data Analysis From the results of the field implementation, the results of the data were obtained as documentation of the video recording of the field survey implementation and the results of the IRI

| Hole Path Category | SDI Value |
|--------------------|-----------|
| Nothing            | -         |
| < 10/km            | SDI⁰ +    |
| 10-50/km           | SDI⁰⁺     |
| >50/km             | SDI⁰⁺     |

Figure 2. Installed DMI

Figure 3. Built-in Controllers and Interfaces

Figure 4. Sensor Value At Position 0° = 2.79V

Figure 5. Distance Calibration using a car DMI
value data obtained through the Roughmeter III survey tool which resulted in the RCI calculation analysis and SDI Value Data Analysis

![Graph of SDI value on a road section](image)

**Figure 6.** graph of SDI value on a road section

The road damage data used in this study is the result of a survey of road conditions using the SDI method, which is a direct visual survey in the field using a distance measuring instrument. The types of road damage that are found on roads are based on the results of the road condition survey. Cracks

Based on the field survey, crack damage was found with a gap width of > 3 mm. Common causes of cracks in the field are poor pavement material, subgrade, or the part of the pavement under the surface layer that is less stable.

Holes (potholes) At several points on the road, there is a type of hole damage. Hole-type road damage can accommodate and absorb water into the surface layer. Holes occur as a result of damage in the form of cracks that are not repaired immediately, so that water can seep into the surface layer combined with load repetitions for a long time.

Grooves or tires rutting, From the survey results in the field, in several road segments, besides cracks and other damage holes were found, namely tire grooves or ruts. The grooves occur on the wheel tracks parallel to the axles of the road. Damage in the form of a groove occurs because the pavement layer is less dense which experiences additional compaction due to repetition of traffic loads on the wheel track and the asphalt mixture with low stability can also cause plastic deformation which can form a groove.

4. Conclusion

This literature based on the results of the analysis and discussion that has been carried out regarding the functional performance evaluation of road pavements, it can be concluded as follows:

a. The IRI value on the road that is analyzed at Sta 0 + 000 - 2 + 700 has a moderate average condition value and Sta 2 + 700 - 7 + 635 has light damage to a heavy damage condition.

b. The SDI value on the road that is analyzed at Sta 0 + 000 - 2 + 700 has a good condition value, Sta 2 + 700 - 6 + 800 has a moderate condition value, and Sta 6 + 800 - 7 + 635 has a condition value Light damage to heavy damage.

c. 3. Rating of road conditions based on a combination of IRI values and SDI values starting from Sta 0 + 000 - 2 + 600 has a rating of moderate conditions, and Sta 02 + 600 - 7 + 635 has a value for lightly damaged conditions to heavily damaged.

To realize prime road performance on the analyzed road sections at the intersection of the research results with the results according to the analysis and then suggestions for development as follows:

a. Lack of quality concrete material, causing porous concrete and concrete age.

b. Uneven subgrade bearing capacity due to differences in soil properties in adjacent locations or due to implementation errors such as poor density.

References

[1] A. Ragnoli, M. R. De Blasiis, and A. Di Benedetto, “Pavement distress detection methods: A review,” *Infrastructures*, vol. 3, no. 4, p. 58, 2018.

[2] H. H. Joni, M. M. Hilal, and M. S. Abed, "Developing International Roughness Index (IRI)
Model from visible pavement distress," in *IOP Conference Series: Materials Science and Engineering*, 2020, vol. 737, no. 1, p. 12119.

[3] M. Surbakti, S. Samsuri, R. Anas, and A. P. Tarigan, “Evaluation of Road Maintenance Program Based on International Roughness Index (IRI) and Surface Distress Index (SDI),” in *Proceedings of the International Conference on Civil, Offshore and Environmental Engineering*, 2021, pp. 764–771.

[4] P. Múčka, “International Roughness Index specifications around the world,” *Road Mater. Pavement Des.*, vol. 18, no. 4, pp. 929–965, 2017.

[5] T. Nguyen, B. Lechner, and Y. D. Wong, “Response-based methods to measure road surface irregularity: a state-of-the-art review,” *Eur. Transp. Res. Rev.*, vol. 11, no. 1, pp. 1–18, 2019.

[6] M. Mubaraki and H. Sallam, “The most effective index for pavement management of urban major roads at a network level,” *Arab. J. Sci. Eng.*, pp. 1–12, 2020.

[7] M. Mubaraki, “Highway subsurface assessment using pavement surface distress and roughness data,” *Int. J. Pavement Res. Technol.*, vol. 9, no. 5, pp. 393–402, 2016.

[8] A. K. Sandra and A. K. Sarkar, “Development of a model for estimating International Roughness Index from pavement distresses,” *Int. J. Pavement Eng.*, vol. 14, no. 8, pp. 715–724, 2013.

[9] A. Ghea Mahardika, H. Fadriani, Muntiyono, S. Afiyah, and G. Devira Ramady, “Analysis of Time Acceleration Costs in Level Building Using Critical Path Method,” *J. Phys. Conf. Ser.*, vol. 1424, p. 12025, 2019, doi: 10.1088/1742-6596/1424/1/012025.

[10] A. Sidess, A. Ravina, and E. Oged, “A model for predicting the deterioration of the international roughness index,” *Int. J. Pavement Eng.*, pp. 1–11, 2020.

[11] P. Paikun, E. Suminar, A. Irawan, and S. Bahri, “Determining road-handling according to the level of damage using surface distress index (sdi) method,” *astonjadro j. Rekayasa sipil*, vol. 10, no. 1, 2021.

[12] B. Setiadji and D. Purwanto, “Surface Distress Index Updates to Improve Crack Damage Evaluation,” in *11th Asia Pacific Transportation and the Environment Conference (APTE 2018)*, 2019, pp. 274–281.