研究成果報告

Pavement Condition Survey in Kagawa Prefecture by ROMDAS

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Highway is one of the most important areas among the various facilities of infrastructure. Therefore, most of the organizations related to the infrastructure management system pay higher attention to the pavement which is the most important facility of highway management. An effective pavement management system (PMS) helps to carry out all the preservation and necessary maintenance operations of the pavement. In order to implement a pavement management system, data collection that indicates existing condition of pavement and its relevant facilities is an important concern for its management organization. At present, Road Measurement Data Acquisition system (ROMDAS) is one the most popular and efficient systems which is being widely used to collect pavement data in many industrialized countries as well as developing countries. The objective of this survey is to collect roughness data (International Roughness Index, IRI) of the pavement in Kagawa prefecture. In addition, this study is carried out for collecting the pavement condition in visualized form by video log survey as well as the exact location of the pavement by global positioning system (GPS) survey.

Keywords: Pavement Management System (PMS), International Roughness Index (IRI), ROMDAS, Calibration, Data Processing

1. Introduction

A comprehensive pavement management system (PMS) is the key to better reconstruction, restoration and maintenance decision-making. An operating PMS provides agency management with the ability to better plan and manage highway, street, and road pavements [1]. The Pavement Management System is a set of tools or methods that can assist decision makers in finding cost effective strategies for providing, evaluating, and maintaining pavements in a serviceable condition. It provides the information necessary to make these decisions. In general, an effective PMS consists of two basic components. The first one is a comprehensive database, which contains current and historical information on pavement condition, pavement structure, and traffic. The second component is a set of tools that allow the decision makers to determine existing and future pavement conditions, predict financial needs, and identify and prioritize pavement preservation projects [2].

Therefore, every agency involved in pavement management system should have a comprehensive database which is the fundamental component of a PMS. In order to fulfill this requirement and create a strong database pavement condition survey is necessary that helps to generate the current information of pavement condition which is used to predict the future condition by using different tools and models. The objective of this study is to collect roughness data (International Roughness Index, IRI) of the pavement in Kagawa prefecture. In addition, this study is carried out for collecting the pavement condition in visualized form by video log survey as well as for collecting the GPS data to get map with roughness value of different sections by using ArcGIS software. The pavement surveyed in this study was approximately 174 km in length in one direction. Roughness data was collected with 100 meters interval in both directions of the pavement which made 348 km in total.

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1.1 ROMDAS

The "ROad Measurement Data Acquisition System" (ROMDAS) has been developed by Data Collection Ltd. (DCL) as a generic system for collecting data on road condition and travel time. ROMDAS is useful to carry out various type of surveys such as roughness surveys, travel time and congestion surveys, condition rating surveys, inventory surveys, moving traffic surveys, transverse profile/rutting surveys, video log surveys, recording the location of digital photographs, creating voice records, collecting global positioning system (GPS) data, collecting skid resistance, as a digital trip meter [3].

2. Methodology

2.1 Calibration

Framework of data collection process shown in Figure 1 includes various steps which tend to proceed to the final goal of this study. At beginning of this survey,

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all the necessary equipments were calibrated. Z-250 reference profiler was calibrated using shims in Saitama.

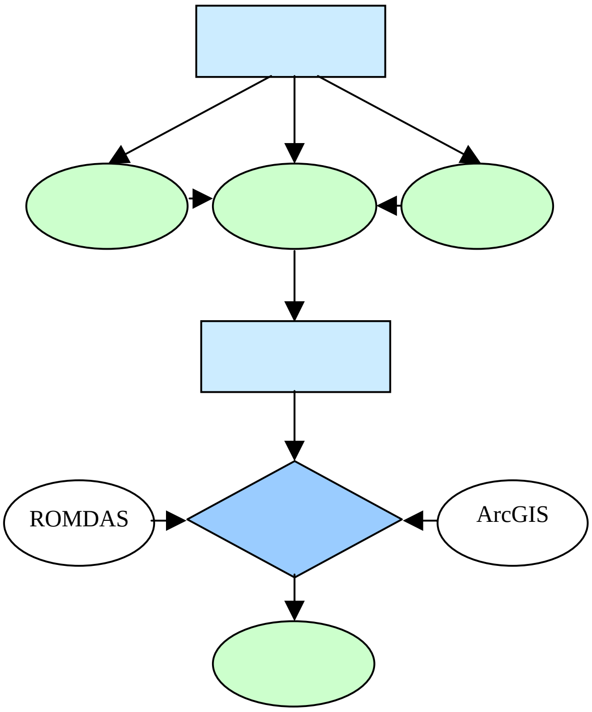

Fig. 1. Framework of Data Collection Process

Moreover, Odometer was calibrated in Public Works Research Institute in Tsukuba selecting a 300 meters section with four runs. Both the calibrated Z-250 profiler and odometer are used in order to calibrate the ROMDAS bump integrators. Two types of data are normally used to calibrate the bump integrators in ROMDAS systems. One is the roughness value of the sample sections by using Z-250 reference profiler and another one is the count per section by bump integrator. Three different 100 meter sections (smooth section, medium rough section and rough section) were selected in Public Work Research Institute in Tsukuba for this purpose and two IRI were determined by Z-250 profiler along the way of two different wheel paths for every individual section to calibrate two bump integrators separately. Vehicle and ROMDAS were operated in those sections closer with three different speeds (30 km/h, 45 km/h and 60 km/h) to record the bump integrators reading. For each of the sections, there were five runs with every individual speed which made 15 runs in total for each section. Regression analyses of the mean value of bump integrators reading and determined IRI by Z-250 profiler provide the roughness calibration coefficients for both the bump integrators which have been given below.

Bump Integrator 1: $IRI = 0.0013x + 0.4122$ (30 km/h)
$IRI = 0.0008x + 1.4783$ (45 km/h)
$IRI = 0.0008x + 1.1289$ (60 km/h)
Bump Integrator 2: $IRI = 0.0015x + 1.1239$ (30 km/h)
$IRI = 0.0012x + 1.1529$ (45 km/h)
$IRI = 0.0009x + 1.0895$ (60 km/h)

Where, x is Bump Integrator Reading (Count/km)

After the calibration of both the bump integrators, the coefficients determined in the aforementioned processes were stored in the ROMDAS software for the data processing of raw data in order to get the final output of this study.

2.2 Raw Data Collection

Data collection in this study was carried out in Kagawa prefecture situated in Shikoku island of Japan. During the roughness survey, additional data (location reference points, video log data and GPS measurements) were also recorded. Kilometer posts along the pavement were used as location reference points (LRP) to create reference points for the identification of exact location. Moreover, video log survey was carried out for making the pavement condition visualized and GPS survey helped to find the exact location in terms of longitude, latitude, altitude and also to draw GIS map by using ArcGIS software.

3. Data Processing

ROMDAS converts raw roughness data into calibrated roughness through calibrated equations. If equations are available for different speeds, ROMDAS applies the appropriate equation given the vehicle speed at the time of the measurement. This removes the constraint of trying to operate the vehicle at a single survey speed under all conditions. GPS data (longitude, latitude and altitude) along with roughness value were processed by ArcGIS software which provides the map of the pavement along with the indication of their respective roughness value.

4. Data Representation and Reporting

Data representation plays a significant role in visual analysis of various data collected during the survey. Charts, diagrams and other tools are very convenient for such purposes. . In general, the processed roughness data by using ROMDAS software is recorded in an MS Access file which was rearranged in this study with the reference of video file in an excel sheet for its better understanding. Table 1 shows typical roughness data recorded in the excel sheet which includes important columns of the roughness data. Kamitenjin to Tokushima, at the top of the first column, represents the origin and destination of the pavement section. C_ROUGH_1 and C_ROUGH_2 represent the processed roughness value in term of IRI of 100 meters interval by bump integrator 1 and bump integrator 2 respectively. CALIB_RGH shows the average IRI of two bump integrators that is the final roughness of that sampling interval. “Video 5” in the first column refers that file named "Video 5" contains the video log survey data of this section.

Table 1. Processed Roughness Data in Excel Sheet

Kamitenjin to Tokushima	CHAINAGE	LRP FROM	LRP TO	LRP NO.	C_ROUGH_1	C_ROUGH_2	CALIB_RGH
	0	0	0	1	0	0	0
Video 5	100	0	100	1	4.81	4.55	4.68
	200	100	200	1	2.77	2.23	2.5
	300	200	300	1	2.32	1.67	1.99
	400	300	400	1	2.13	1.3	1.72
	500	400	500	1	2.21	1.5	1.86
	600	500	600	1	3.27	2.35	2.81
	700	600	700	1	2.06	1.29	1.67
	800	700	800	1	2.27	1.33	1.8
	900	800	900	1	3.39	3.05	3.22
	943	900	943	1	2.01	2.07	2.04
	1043	0	100	2	6.52	4.27	5.4
	1143	100	200	2	2.41	1.55	1.98

GPS data were processed by ArcGIS software and presented as GIS map of the pavement section with the indication of different roughness value by using different color convention. In Figure 2, pavement section with green, yellow and red colors show that roughness values are within 0 to 2.0 m/km, 2.0 to 3.0 and 3.0 to above respectively. The outcome of this analysis shows that only little portions of the pavement have roughness value more than 3.00 m/km which need higher attention than others for maintenance operations to keep the pavement in acceptable level.

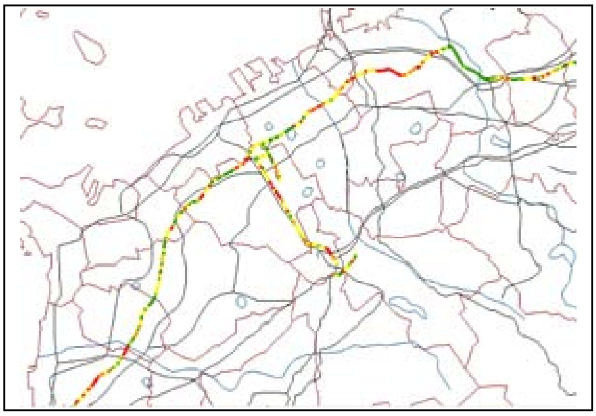

Fig 2. GIS Map with Roughness Value

Moreover, Collected data such as roughness and others can be used for analyze roads for economic or policy studies (for example HDM4, dTIMS). Based on these investigations, it is possible to produce a range of reports such as statistics, economic indicators, and other.

5. Conclusion

A roughness survey of 174 km pavement in Kagawa prefecture in Shikoku Island of Japan by Road Measurement Data Acquisition System (ROMDAS) is explained in this paper. In order to make the survey clearly understandable, this paper includes all the procedures followed to carry out this survey. At the introductory stage, this study deals the calibration of various ROMDAS equipments for using during the survey. Calibration includes Z-250 reference profiler calibration, odometer calibration and roughness meter calibration. Successful calibration of all the necessary equipments proceeds the survey to data collection. Pavement surveyed in this study was 174 km in length which makes a 348 km length in total in both ways. Raw roughness data was collected at a 100 meters interval of that 348 km pavement. Moreover, video log data and GPS data was also recorded during the data collection of this survey. Finally, raw roughness data was processed by using ROMDAS and ArcGIS software in order to produce the final product of this survey.

An investigation of the roughness values found by both the bump integrators shows that higher roughness value (average 2.80) belongs to the bump integrator 1 (left wheel path) while the average roughness value for bump integrator 2 is 2.24. This finding roughly refers that roughness value is inversely proportional to the distance between wheel path and shoulder.

Roughness data found in this study is well organized with every 100 meters interval. However, video of the right-of-way of all the pavement is not so clear to predict the roughness by visualization. Due to shortage of storage capacity, highest resolution was not set during the survey which inhibits the picture frame quality. Moreover, due to having difficulties to setup the GPS equipments, it was not possible to collect GPS data for the whole pavement. GPS data was collected approximately for the pavement of 74 km out of 174 km which is around 42.5% of the total pavement.

5.1 Recommendation for Future Study

For better data representation and understanding, integration of roughness value, GPS data, video logging data and GIS data is necessary which can be carried out in future. In addition, for the calibration of bump integrators, regression analysis of IRI value and count/km is possible by using raw data (count/km) instead of using their mean value. Moreover, it might be possible to develop calibration equations as a function of count/km as well as vehicle speed.

References

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3) Hunter, P. K., and Porter, H. A., 2005. ROMDAS for Windows User's Guide, Data Collection Limited, Motueka 7161, New Zealand.