# EVALUATION OF ROAD ROUGHNESS BY USE OF TWO EFFICIENT ROAD PROFILERS

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## 1. Introduction

Nowadays, road roughness monitoring has become the most important part of highway engineering. With the development in technologies, demands of the customers for the road surface and pavement structure are going on increasing year by year. In this study, IRI is used as an index to monitor road roughness, which is related to ride quality. This research aims at monitoring road roughness conditions in local cities in terms of road network level and evaluating ride quality using a driving simulator (DS) based on the ISO standard. From this purpose, firstly, we used two compact road profilers developed by Kitami Institute of Technology (KIT) to collect a variety of profiles. Secondly, the different conditions of road roughness are statistically analyzed and evaluated based on the profile data obtained taking two wheel paths of the survey vehicle into account. Finally, ride quality of road surface is analyzed by use of the DS from stand point of road users. As regards evaluation of road surface, the ISO standard 2631 is adopted.

## 2. Outline of the Efficient Road Roughness Monitoring Device

Efficient road roughness measuring system consists of two small accelerometers, a GPS (Global Positioning System) sensor, a transducer and a PC for data processing. Principle of Pavement roughness measuring is very simple. Two accelerometers are mounted on the suspension system of a survey vehicle as shown in distorted **Figure1**[1]**.** After influence of resultant acceleration vehicle speed component is removed, IRI is calculated by cumulative vertical deviation at the suspension system in real time, together with positional data from GPS. Moreover, this system can be installed in any passenger cars, so that the road monitoring offers versatile operation for local governments.

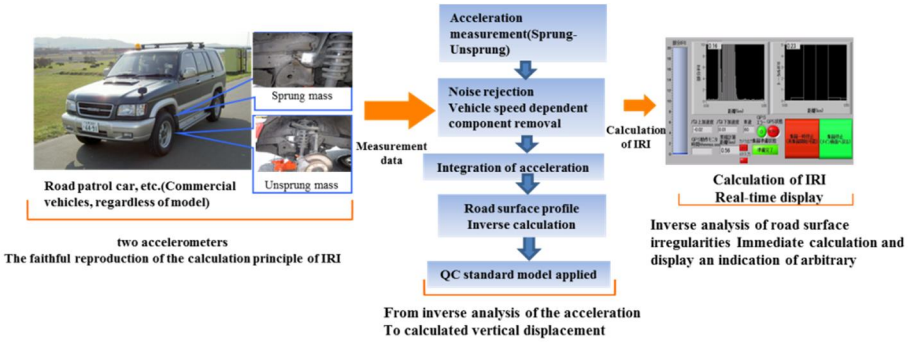


**Figure 1:** Overview of mobile profilometer (MPM)

## 3. IRI as Ride Quality Parameter

IRI is the International Roughness Index and measures pavement smoothness. The lower the calculated IRI, the smoother the pavement will ride. The higher the IRI, the rougher the pavement will ride. The units of IRI are usually in/mile, m/km, or mm/m. The equation of IRI is, as shown **Eq. (1)**.

$$IRI = \frac{\int_0^{L/v} | \dot{z}_s - \dot{z}_u | dt}{L} \quad (1)$$

Keywords: IRI, Mobile Profilometer, Driving Simulator, Ride Quality, Wheel Path.
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## 4. Analysis of Ride Quality on Objective Route Line

In May 2014 we have carried out road roughness measurement for high-standard highway located at outskirts of Kitami city by use of two compact mobile profilers. The total section length of the highway is 7800 meters. The profiler mounted at unspring and sprung masses of right and left sides of the survey vehicle. The IRIs of most smooth and rough sections calculated by ProVAL[2] software, According to NEXCO (Nippon Expressway Company) maintenance criteria for expressway. That is, IRI over than 3.5 m/km needs to repair, **Figure 2 and 3** shows the difference of road roughness for both wheel paths in terms of ride quality, specified by the road maintenance criteria.

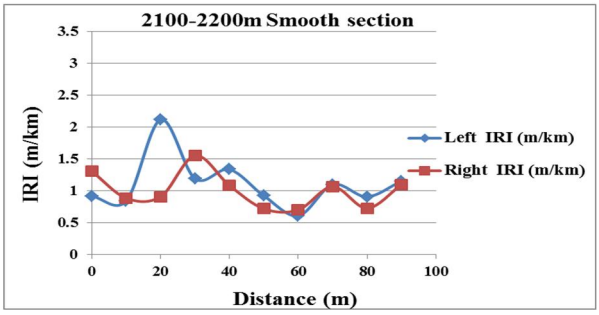


**Figure 2:** Ride quality conditions for smooth section

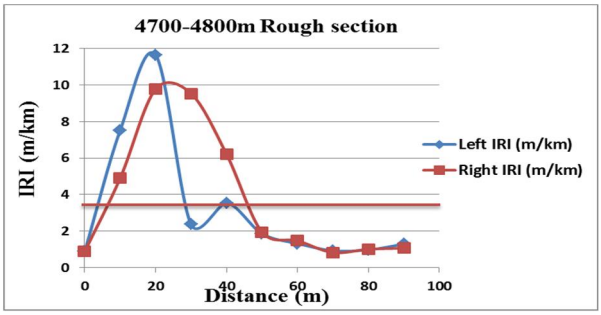


**Figure 3:** Ride quality conditions for rough section

## 5. Ride Quality Analysis by KITDS

KITDS[3] (as shown **Figure 4)**, which can evaluate and study different kind of road surface topics, such as taking actual road surface characteristics and vehicle actual motion data into DS to evaluate the ride quality, comfort of the passengers, safety, stability, and so on. According to this kind of advantages of the DS, this system is the best for further more evaluate the riding quality. For evaluate and compare of the riding quality of both wheel path, this experiment conducted by using driving simulator to obtain vertical acceleration data, to calculate Root Mean Square (R.M.S) and Crest Factor (CF) for completely identify ride quality condition of whole journey. The last results of the R.M.S. highest level, middle level and lowest level are applicable for ñfairly uncomfortableò, ña little uncomfortableò and ñcomfortableò respectively. The results of the ride quality on the measuring location are acceptable. Because there are no value included, uncomfortable or over than this.

**Figure 4:** Overview of KITDS

## 6. Conclusions

Results of this study are summarized below:

(1) Regarding frequent measurement of road surface at ease, the mobile profilometer makes it possible to acquire road profiles over both wheel paths, IRI and acceleration data at one time, and in real.

(2) KITDS has special feature for taking actual profile data as to analyzing the road surface condition in terms of ride quality of the passengers.

## 7. References

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