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Using a constructive pavement texture index for skid resistance screening

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Abstract

Skid resistance measurement is one of the major measurements used to assess road safety. Typical devices used for measuring skid resistance include single point checking type and continuous measurements type. However, conducting periodic full roadway network skid resistance survey can be a relatively time consuming and difficult task because of the limited water carrying capacity used by all kinds of devices, including the continuous types. On the contrary, measurement of pavement surface texture can be conducted easily and continuously by most profilers. This research investigates the relation between pavement skid resistance and surface texture. The focus is on the development of a texture index that can serve as a screening indicator to filter out the high-risk pavement sections for further skid resistance measurement. Two measuring devices, GripTester (GT) and National Taiwan University laser profiler (NTU Profiler), were used to collect data on pavement skid resistance and texture in a network of 555 sections, respectively. The pavement texture index of the mean difference of elevation (MDE) is calculated at a 1 mm profile interval, which is a very promising indicator to represent pavement skid resistance. Through a sensitivity study, the MDE threshold of 0.15 mm is observed to provide a relatively reasonable screening function that filters out 29.01% of the entire surveyed network for further skid resistance inspection. It averted more than 70% skid resistance measurement capacity of the entire network. The accuracy of correct judgment by the selected threshold is about 80%, only 3.78% of roadway sections considered for further inspection of the recommended list are not included.

Keywords: Skid resistance; Pavement texture; Macrotexture; Laser profiler; GripTester

1. Introduction

Skid resistance is an important pavement characteristic for vehicle driving safety. A wet pavement surface with insufficient skid resistance can be hazardous to moving vehicles, particularly to motorbikes, which are widely used in many Southeast Asian countries. Fig. 1(a) presents the extremely high density of motorcycles in the peak hours, and Fig. 1(b) displays the increase in the number of motorcycles in the past 20 years in Taiwan. Thus, detecting pavement skid resistance has become one of the important tasks for keeping roadways safe.

Many devices have been developed and manufactured for measuring pavement skid resistance. Some are designated for laboratory use or in given spots, such as the British Pendulum Tester (BPT) and the Dynamic Friction Tester (DFT). Other devices, such as the locked wheel

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tester, measure the longitudinal friction over a distance by locking the measuring wheel's brake. Various types of continuous friction measurement equipment (CFME) can also be applied continuously on a pavement surface. However, providing a constant and steady water supply during testing is essential in the application of all devices. This major shortcoming prevents the testing of devices for continuous long distance measurement. Therefore, inspecting all traffic lanes of entire roadway network to evaluate the skid resistance performance using friction measuring devices has always been a challenge, not to mention the outcomes from various measuring devices are often not compatible.

In order to promote the exchange of road research results among countries that might use several kinds of friction testers, International Friction Index (IFI) provides a standard scale converted from different devices and a basis for international harmonization. [1,2] The research results concluded that the testing speed, device types, pavement texture, and friction values obtained from individual devices are primary parameters used to calculate the IFI. It indicates that neither pavement texture nor measured friction values can describe IFI separately, and it is essential to collect both pieces of information for composing IFI. However, for the circumstance that no texture measurement devices are available or the friction measuring capacity cannot cover whole roadway network, the commonly adopted method is sampling which may result in the probability of missing locations with insufficient skid resistance.

Owing to the fact that the current skid measuring devices have their limits of long distance surveying because of water supply limitation, this study aims to develop a texture index through a laser profiler survey. In this study, data of skid resistance measured by a CFME (Grip Tester) were collected simultaneously with the laser profiler to develop the relation between texture index and skid resistance. The goal is to develop a pavement surface texture measuring method with the corresponding index that can efficiently screen an entire highway network, and identify suspicious low skid resistance segments for more detailed skid inspection.

2. Texture indices

Previous research findings have indicated that pavement texture is an important factor in determining skid resistance [2–7]. In addition, many research results have shown that microtexture and macrotexture have various degrees of effect on the friction at different testing speeds. The macrotexture has more effect on skid resistance at high speeds, whereas microtexture is the dominant factor of skid resistance at lower speeds [8–10]. The definitions of microtexture and macrotexture are given by PIARC [2]. A vehicle traveling at low speed has enough time to discharge water between pavement and tire. As the speed increases, the time and opportunity to discharge water decreases. Under this circumstance, macrotexture controls the thickness and retention time of the water film. If the macrotexture is poor, hydroplaning may occur because of thick water film and long retention time. Thus, open graded friction courses and porous pavements which can provide better macrotexture are widely used to improve the friction by draining off the surface water film. Benedetto's research [9] also produced similar results. When the testing speed was set at 40 kph, the skid number (SN) obtained from locked wheel testers was very sensitive to the macrotexture but not to the microtexture. The research indicated that this result was because of the thickness of the water film. Skid resistance remains nearly stable when the thickness of the water film is smaller than the microtexture. With increasing water film, skid resistance drops sharply until the macrotexture reaches its capacity and skid resistance will no longer change.

2.1. Mean profile depth (MPD) and mean texture depth (MTD)

The MPD and the MTD are two well-known indices for evaluating the pavement texture [11–19]. MPD is calculated by 2D pavement profile based on laser measurements; MTD is a volumetric-type index which can be measured by sand patch method. Fig. 2 illustrates the definition and calculation of MPD. A segment of pavement profile is divided

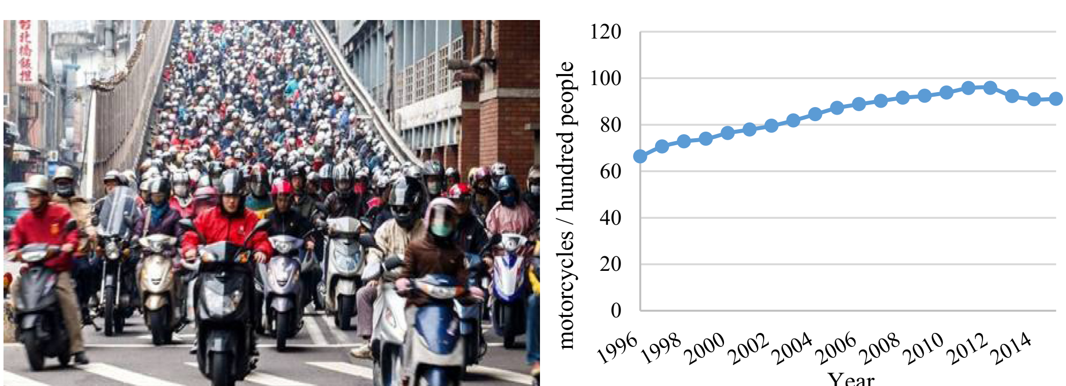

Fig. 1. (a) A typical photo of motorcyclists at the morning peak, and (b) increasing curves of motorcycles owned by hundred people. (Source: Ministry of Transportation and Communication).