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Original Research Paper

Surface texture and friction characteristics of diamond-ground concrete and asphalt pavements

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ABSTRACT

Recently, diamond grinding has gained increasing attention as pavement preservation treatment to restore desired surface characteristics, particularly friction. Compared to other pavement preservation treatments such as surface overlays and high friction surface treatments, diamond grinding may cost less, save construction time, or require minimum maintenance. Diamond grinding produces longitudinal, continuous, and line-type texture that contains corrugations with evenly spaced ridges. The improved surface texture will immediately enhance pavement surface friction and reduce the possibility of hydroplaning in rainy weather. However, little information has been documented on the texture characteristics and long-term friction performance of diamond-ground pavements. A field evaluation was conducted to examine the surface texture and friction characteristics in diamond-ground concrete and asphalt pavements by the authors. Five pavement test sections, including two diamond-ground concrete pavements, one diamond-ground concrete bridge deck, one diamond-ground asphalt pavement, and one transversely tined concrete pavement, were selected for evaluation. Laser scanner testing was performed to capture both macro and microtexture profiles. Locked wheel testing was performed to measure the friction numbers. The test results were examined and compared so as to evaluate two performances, after construction and long-term friction performance of diamond-ground pavements. It was found that longitudinal diamond grinding can provide durable, satisfactory surface friction performance for both concrete and asphalt pavements.

1. Introduction

Diamond grinding is a widely accepted practice to remove bumps and rectify surface defects on concrete pavements. It has been effectively used as part of concrete pavement restoration (CPR) since 1965 (ACPA, 2006; Caltrans, 2005). A study surveyed a total of 76 diamond-ground concrete pavements from 9 states and found that the average life of a typical diamond-ground concrete pavement was about 14 years (Rao et al., 1999). It was also found that after diamond grinding, the pavement surface texture increased, and skid resistance improved considerably and the ground surfaces could last for 8–15 years. Although diamond grinding has been mainly

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used to correct pavement profile, it has also found other methods, such as restoring pavement cross-sections with rutting greater than 13 mm (NDOR, 2002). To date, the identified advantages of diamond grinding include better ride quality, enhanced safety, quieter travel surface, extended service life, and reduced rehabilitation costs. Compared to other pavement preservation treatments such as overlays and high friction surface treatments, diamond grinding may cost less, save construction time, and produce minimum traffic interruption during construction. Diamond grinding also allows treating local problems and small areas. In addition, diamond grinding always produces an immediate increase in surface friction regardless of the effect of existing pavement and grinding operation.

Consequently, diamond grinding has gained increasing attention as pavement preservation treatment to restore desired surface characteristics such as ride, noise, friction, and drainage on existing pavements. The International Grooving and Grinding Association (IGGA) has developed guide specifications for use of diamond grinding in three different operations, city streets, asphalt pavements, and pavement preservation (IGGA, 2014a, 2014b, 2014c). Federal Highway Administration (FHWA) has also provided requirements for diamond grinding for concrete pavement preservation (FHWA, 2005). Although diamond grindings in different operations may have a different purpose, i.e., to provide desired surface characteristics or to eliminate surface defects, diamond grindings in most operations follow similar procedures so as to provide longitudinal and continuous diamond grinding on pavements. In short, diamond grinding will inevitably restore surface friction characteristics through providing line-type texture that contains corrugations with evenly spaced ridges. The immediate result is the improved surface texture that will ultimately enhance pavement surface friction and reduce the possibility of hydroplaning in rainy weather.

However, little information has been documented on the texture characteristics and long-term friction performance of diamond-ground pavements. Wet pavement friction is dominated by both surface macrotexture and microtexture (Kummer and Meyer, 1967; PIARC, 1987). Macrotexture provides channels for removal of water and reduces dynamic hydroplaning development (Gallaway et al., 1979; TRB, 1972). Microtexture punctures and drains the viscous water film between tire and pavement reducing the viscous hydroplaning development. Good microtexture reduces the likelihood of hydroplaning development (Browne, 1975; Ong et al., 2005). Also, microtexture may play an important role in reduction of dry pavement skidding accident. In reality, lane-departure crashes account for 53% of all roadway fatalities (Nelson et al., 2011). The Indiana crash data also suggests that during summer time, up to 88% of lane-departure crashes occur on dry pavements (ISP, 2012). Recently, diamond grinding has been used in Indiana on different pavements, including concrete pavements, asphalt pavements, and bridge decks. This paper documents the texture and friction test data and analysis results on these diamond-ground pavements. Such information will be useful to pavement engineers in better understanding the long-term friction performance and the proper use of diamond grinding in pavement and bridge deck preservations.

2. Test sections and field tests

2.1. *Test sections*

In order to examine the texture and friction characteristics of longitudinally diamond-ground hot mix asphalt (HMA) and Portland cement concrete (PCC) pavements, a total of five pavement test sections, four diamond-ground test sections and one transversely tined test section, as shown in Table 1, were selected for field testing and evaluation. The selection of these five test sections was based on pavement type, purpose of grinding, and performance comparison. The test section on SR-162 was classified as minor arterial and diamond grinding was used to re-profile the surface of new asphalt pavement. The test section on US-24 consisted of two lanes in each direction, and was classified as rural expressway. The pavement was newly constructed concrete pavement. Diamond grinding was completed to remove localized bumps before opening to traffic. The test section on US-50, consisting of two lanes in each direction, was classified as principal arterial in urban area. This section has several signalized intersections and the purpose of diamond grinding was to improve surface smoothness and friction of the new concrete pavement, particularly on intersection approaches. The diamond-ground bridge deck is located on I-80 in the north of Indiana and diamond grinding was used solely to restore polished deck surface. All of the above four test sections have high traffic volumes. In particular, the section on US-50 and the bridge deck on I-80 have heavy truck traffic. The friction track is part of the test track constructed by the Indiana Department of Transportation (INDOT) for validating friction test system and is not to the public.

Although IGGA has developed specifications for conventional diamond grinding of city streets, diamond grinding asphalts, and diamond grinding for pavement preservation, respectively. These three specifications are aimed at providing the same final surface finish, i.e., longitudinal, corduroy-type texture with ridge peaks approximately 1.5–4.8 mm above the grooves. In the FHWA diamond grinding checklist for concrete

Table 1 – General information on selected pavement test sections.

Road	Classification	Pavement type	Grinding year	AADT	Truck traffic
SR-162	Minor arterial	HMA	2008	5095	9.6%
US-24	Rural expressway	PCC	2012	8757	36.6%
US-50	Principal arterial	PCC	2008	33,143	5.7%
I-80	Interstate	PCC deck	2013	25,932	24.4%
Friction track	N.A.	Tined PCC	N.A.	N.A.	N.A.