Lecture Notes

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Experiment - 9: In-situ tests on road surface characteristics

Introduction

The pavement surface gives rise to some of the functional properties of the pavement, for example, slope, unevenness[1], skid resistance, noise due to tyre-pavement interaction, water drainage and splash, and so on[2]. Undulations at different scales give rise to these functional properties. The undulation data (that is, elevations at different points) collected from the pavement surface is analysed either in spatial domain or, in frequency domain. Spatial domain representation indicates elevations of different points along the longitudinal distance of the road. In frequency domain, the road surface undulations are discretized as sinusoildal waves of various amplitude and frequencies[3], and represented as a characteristic amplitude-frequency plot. This is schematically shown in Figure 1. It is postulated that various frequency ranges contribute to the slope, unevenness, coefficient of friction of the pavement surface etc. (refer Figure 1).

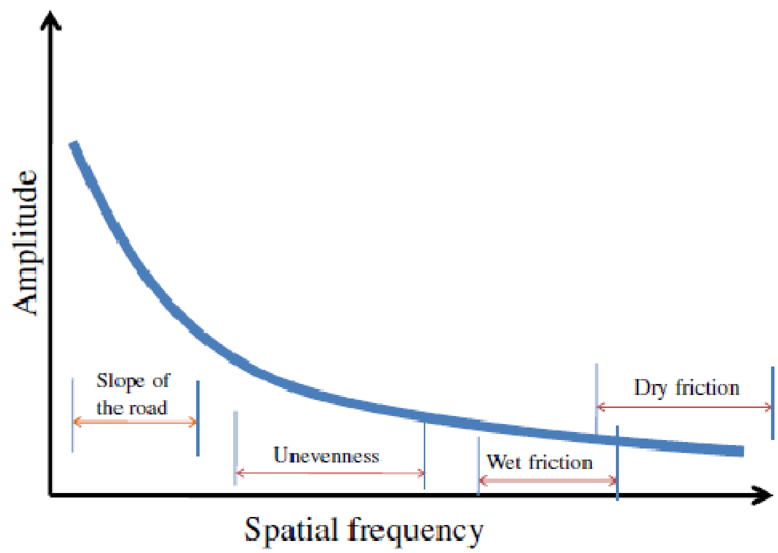

Figure 1: Characteristic amplitude-frequency plot for a road surface.

Sometimes these demarcations are also identified in terms in terms of wavelength ranges (PIARC 1987). Figure 2 shows a popularly used representation of the various wavelength ranges that are hypothesized to affect the various engineering properties (PIARC 1987).

[1] Also known as 'roughness'.
[2] Please review Section 14.3 titled 'Functional evaluation of pavement' of 2nd edition of Chakroborty and Das (2019).
[3] The frequency is therefore called as spatial frequency.

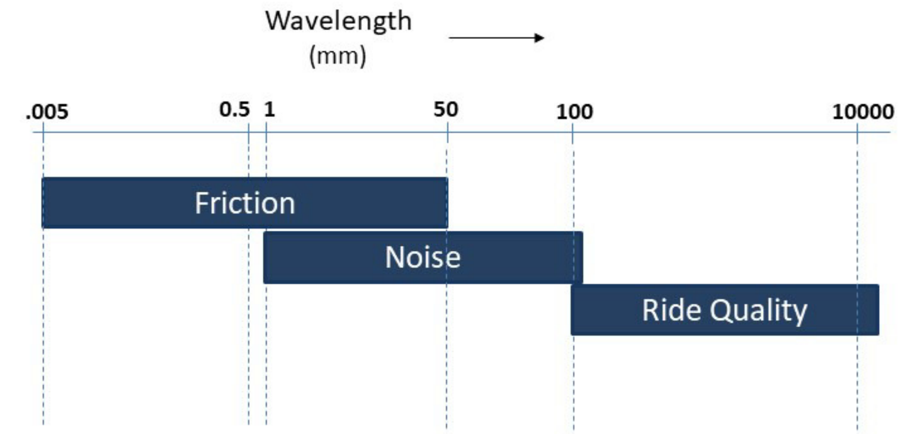

Figure 2: Illustration of the wavelength ranges that affect certain engineering properties.

Principles of Sand Patch Test and British Pendulum Tester

Various equipment/ techniques for measuring the pavement surface undulations capture data at different scales, for example, road profilers measures undulations at the 'unevenness scale' (Douangphachanh *et al.* 2013), sand patch measures undulations at a smaller scale, (Hall et al. 2009), while high resolution cameras can measure at even finer scale (Slimane *et al.* 2008) and so on.

One of the popular techniques for characterizing pavement surface undulations (at an appropriate scale) is the sand patch test (Chamberlin and Amsler 1982). In this test, a known volume of uniformly shaped sand beads is uniformly spread over a pavement surface, such that the sand beads form a circle. Figure 3 shows a slice of a hypothetical pavement surface covered with sand beads. Since, the volume of the sand placed on the surface is already known, the ratio of volume and the area of the circle, gives an index called the Mean Texture Depth (MTD) (Chamberlin and Amsler 1982). This is one kind of a measure of road undulations.

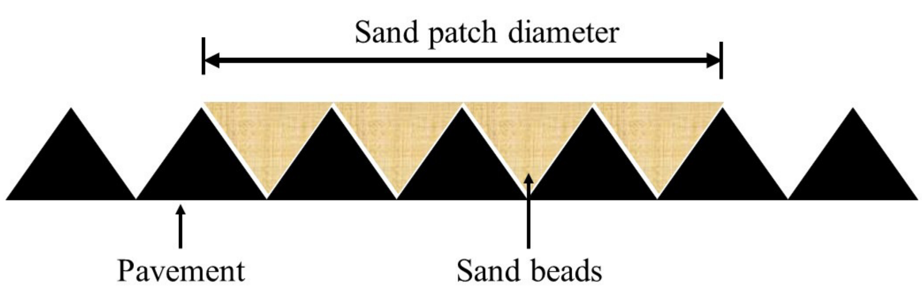

Figure 3: Schematic illustration of the sand patch test.

Measurement of pavement friction is an important functional evaluation of pavement from the point of view of reducing accidents (Serigos *et al.* 2014). The British Pendulum Tester (BPT) is one of the popular equipment used for measuring skid resistance (ASTM 2013). On its body a pendulum arm and a graduated scale are attached (see Figure 4). The pendulum arm has a rubber slider attached to it via a spring. The pendulum arm can be released, and the rubber slider comes in contact with the specimen[4]. Due to the friction between the slider and the specimen, some energy is lost. Hence, the pendulum arm does not reach the same vertical height where from it is released. The position up to which the pendulum reaches is measured by the graduated scale. This information can be used to estimate the loss in energy, and can be equated to the work done against the skid resistance.

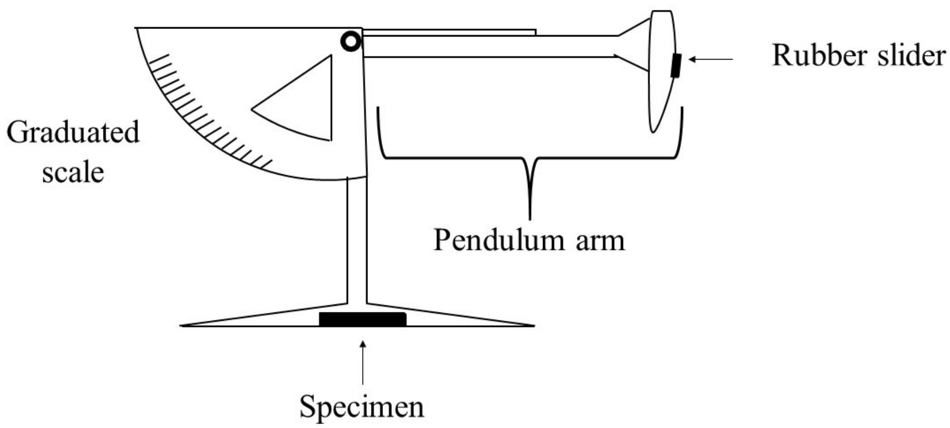

Figure 4: Schematic illustration of the British Pendulum Tester.

Tasks

The tasks involved in this laboratory exercise are the following:

- Estimation of skid resistance by BPT at various points of a given stretch
- Estimation of MTD at various points on the same stretch
- Comparison of results

Methodology

Each group is generally assigned a 300 meter pavement stretch[5] near the Transportation Engineering laboratory. The BPT testing is conducted at every 10 meters marked equidistantly on the stretch. Three readings are taken at each spot for dry and wet surface conditions each. After the surface gets completely dried up, sand patch testing is done at each of these 10 points. Further, the following analysis is done.

Plot the spatial variation of dry and wet skid resistance. Check whether the skid resistance values under wet conditions are consistently lower than those of dry conditions. Plot the spatial variation of MTD. Examine whether the trends of these spatial variations are similar.

Collate information on the average skid resistance values and the MTD values measured by all the groups and plot the data.

Explore whether the past researchers have found any empirical correspondence between the MTD value and the skid resistance, or, these indices are meaningful at different scales and thus, such correspondence is insignificant.

[4] Pavement surface in the present case.
[5] With uniform surface conditions, visually examined.

Discussions

Find out the limitations of testing by BPT. Find out why BPT does not exactly estimate the coefficient of friction.

Acknowledgement

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References:

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