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# THE NEXT GENERATION OF LOW NOISE ASPHALT ROAD SURFACES

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**ABSTRACT**
To meet the needs of today's transport networks, road surfacing materials need to provide adequate friction for safety purposes, but they must also offer appropriate levels of performance in terms of noise and other factors such as ride quality. The work described in this paper has led to the development of surfacing materials with texture properties that have been optimised to give adequate friction and low noise. Prototype materials have been developed and laid on the TRL test track. These surfaces have been shown to perform well in terms of friction and noise and have since been developed into commercial products for the UK. Initial results on the performance of the new materials have been very encouraging and it is anticipated that they will soon find popular use as part of highway authority's mitigation strategy for road noise.

## 1 - INTRODUCTION
Road traffic noise remains a major source of nuisance; highway authorities and the road surfacing and tyre industries are engaged in continuous innovation to reduce noise generation. However, for safety, the primary function of a road surface should be to provide adequate road/tyre friction, especially in wet conditions. The surface texture required to maintain wet friction at speed is a source of tyre-noise generation. In the UK, on the trunk road network, new asphalt surfacings on high-speed roads must have a minimum sand patch texture depth (SPTD) of 1.5 mm [1]. More generally, the new Highway Authorities Product Approval Scheme (HAPAS) offers three levels of certification for "thin surfacing" materials. These correspond to SPTDs of 1.5 mm, 1.2 mm and 1.0 mm at new, with a further stipulation of a maximum drop in texture of no more than 40% after two years of trafficking [2]. This has led to the need to design surfaces that provide an optimum balance between friction and noise.
To meet this objective, a research project named MARS (MAcrotexture and Road Safety) was set up under the UK LINK Transport Infrastructure and Operations Programme, which is supported by the Department of the Environment, Transport and the Regions and the Engineering and Physical Sciences Research Council. The Transport Research Laboratory (TRL) was the principal research contractor and the other partners were Associated Asphalt Ltd., CSS (formerly the County Surveyors Society), Dunlop Tyres Ltd., Jean Lefebvre (UK) Ltd. and Lafarge Redland Aggregates Ltd. The results of the work are more fully described in TRL Report 455 [3]. The project included measurements of tyre/road contact pressure distributions, characterisation of surface texture profiles in relation to measured friction and noise, and modelling of the contact interface. This led to recommendations for the requirements of a road surface texture to provide adequate friction yet low noise levels. These requirements are described in this paper, along with the results of a trial of prototype materials and the exploitation of this work in the development of new commercial products.

## 2 - SURFACE REQUIREMENTS
While low-speed wet friction is generated by the microtexture of the road surface, the current UK specifications for SPTD are based upon the requirement to maintain an adequate proportion of that low-speed friction at increased speeds [4]. More recent research at TRL [5], funded by the Highways Agency, has shown that the fall in wet friction with speed is more marked on surfaces with low texture

depth, particularly below 0.7 mm (here the texture depth is measured as the sensor-measured texture depth (SMTD) which is based upon the rms amplitude of texture measurements using a vehicle-mounted laser displacement device [6] and may be an underestimate of SPTD).

In this project, alternative ways of characterising surface texture, in addition to the simple concept of texture depth, were examined by measuring the detailed texture profile of short sections of a number of roads. These included the use of Fourier analysis to determine the amplitude of the texture in discrete wavelength bands, as has been used in the study of tyre-noise generation, see below. However, no characteristic was superior to texture depth in explaining the fall in friction with speed. Therefore, it was concluded that texture depth remains an appropriate method for specifying road surfaces in order to maintain high-speed wet friction. However, it is clear that this form of measurement is not suitable for describing the geometry or shape of the road surface texture, which will be as important as the texture depth in determining other performance factors such as noise.

Research on tyre/road noise generation has shown that the peak level of pass-by noise is influenced strongly by the amplitude of texture in certain wavelength ranges. Abbott and Phillips [7] reported that noise levels measured using the statistical pass-by (SPB) method [8] are related to the texture amplitude in the wavelength range 56-226 mm. Therefore, the objective of optimising road surface texture to provide adequate friction and low noise will be served by providing sufficient texture depth but with limited amplitude at wavelengths above about 50 mm. The longer wavelengths in this range can be controlled using current paving technology. The size of the aggregate particles used in the surface of roads is generally 20 mm or less but uneven distribution can increase texture amplitudes at longer wavelengths. Furthermore, aggregate that is unevenly-shaped and laid in a way that leads to an angular geometry at the tyre interface will lead to high contact stresses, which could cause vibration of the tyre and generate noise. In summary, a road surface is required that will provide adequate texture depth and an even and homogenous running surface on all scales.

## 3 - PROTOTYPE SURFACINGS

Prototype asphalt surfaces, designed to meet the requirements of this optimum texture, were laid on the TRL test track. The materials were gap-graded, paver-laid thin surfacings with small aggregate sizes (14 mm, 10 mm and 6 mm). The aggregate shape was closely specified to be highly cubical and controlled by selection using sieves. The materials were laid with even surfaces and the texture depth is produced by the open texture of the mixes. Table 1 shows the results of texture measurements and light-vehicle noise measurements made on the three new surfaces. The noise measurements were made in a similar way to the SPB method using the methodology of the EU tyre noise test, but using just two vehicles, each fitted with commercial production tyres as described in the table. Noise measurements were also made on a section of hot-rolled asphalt with rolled-in 20 mm aggregate chippings for comparison. This type of dense surfacing was commonly used on UK main roads for many years before the introduction of modern thin surfacing technology and is still present on much of the road network.

| Surface | Thickness (mm) | SPTD (mm) | Pass-by noise level at 90 km/h (dB(A)) | |
|---|---|---|---|---|
| | | | Ford Escort 185/60 R14 | Vauxhall Vectra 215/45 R15 |
| 6 mm prototype | 15 | 1.4 | 71.6 | 74.4 |
| 10 mm prototype | 20 | 2.4 | 77.9 | 79.1 |
| 14 mm prototype | 30 | 3.9 | 80.2 | 81.2 |
| 20 mm chipped rolled asphalt | 40 | 2.2 | 82.9 | 84.5 |

**Table 1:** Texture and noise results for prototype surfaces on the TRL track.

Friction measurements were made at five speeds between 20 km/h and 130 km/h and are shown in Figure 1. The surfaces have similar friction at all speeds. The friction measurements are for a locked wheel, using a smooth tyre and were made using an ASTM trailer owned by Highways Agency at 1 mm nominal water depth [5]. This is not a condition typical of a vehicle manœuvre but it is an appropriate method of characterising the skidding resistance of a road surface.

## 4 - IMPLEMENTATION

The three paving contractors who were partners to this project have subsequently produced commercial products based upon the prototypes. These have generally been laid in urban situations for the purpose

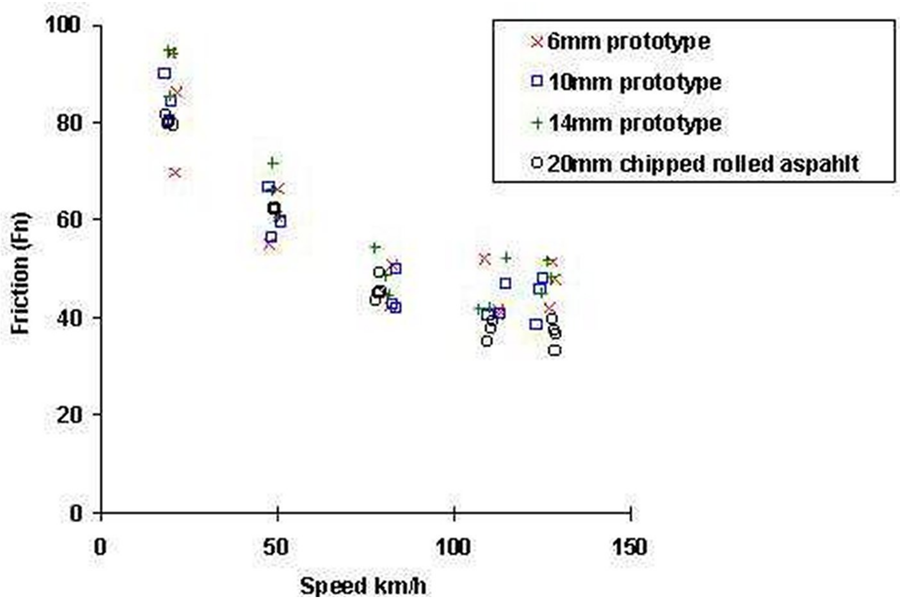


**Figure 1:** Locked-wheel friction of prototype surfacings.

of noise reduction and the initial performance has been very good. The HAPAS scheme mentioned above has an optional requirement for noise measurements, based upon the SPB method, using reference speeds of 70 km/h and 80 km/h. Light-vehicle noise measurements have been made at sites where the new products have been laid and some results are summarised in Table 2.

| Surfacing Aggregate Size (mm) | Light-vehicle pass-by noise level (dB(A)) | |
|---|---|---|
| | 70 km/h | 80 km/h |
| 6 | 68.3 | 70.0 |
| 10 | 70.9 | 72.2 |
| 14 | 76.3 | 78.0 |

**Table 2:** Results from the Lafarge Redland Aggregates Ltd. commercial products.

These materials are different from the prototypes in including a modified bitumen binder and slightly more fines in the mix, to ensure durability. As a result they have typical texture depths of 1.0-1.3 mm, 1.3-1.5 mm and 1.5-1.8 mm SPTD for the 6 mm, 10 mm and 14 mm materials respectively.

## 5 - CONCLUSIONS

A study of the optimum surface requirements for a road surface in terms of friction and noise has led to the development of new asphalt road surfacing products with texture that provides good high-speed wet friction combined with very low noise levels.

These materials also have added advantages, associated with thin layers. These include being quick to lay (therefore reducing traffic disruption), requiring small amounts of high-specification aggregate and being relatively inexpensive.

For all these reasons, it is anticipated that these materials will form an important part of future strategies for the mitigation of traffic noise.

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