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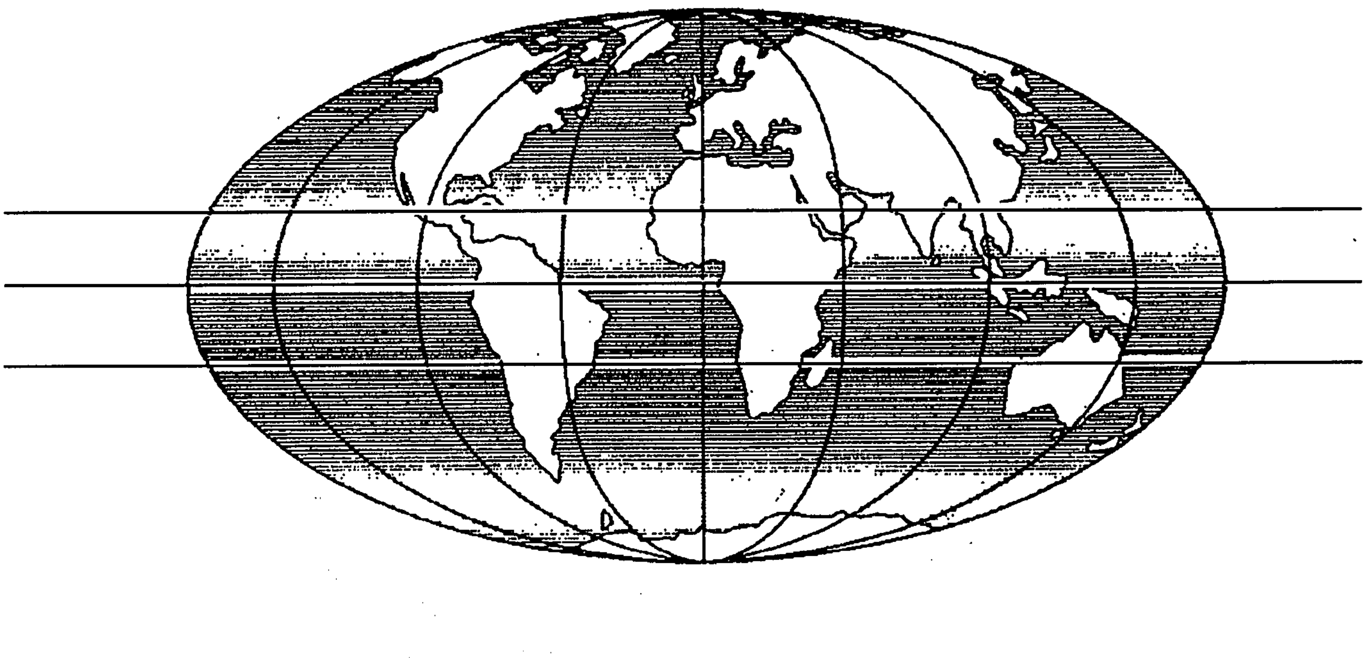

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AN ASSESSMENT OF THE SKID RESISTANCE AND MACROTEXTURE OF BITUMINOUS ROAD SURFACINGS IN MALAYSIA

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ABSTRACT

This paper summarises an assessment of the skid resistance and macrotexture of various types of bituminous road surfacings in Peninsular Malaysia. The surfacings were of different ages and had been subjected to a range of traffic levels. The findings from this study give an overall view of the skid resistance and macrotexture of bituminous road surfacings in Malaysia. These results indicate that the levels of skid resistance on straight sections of road are adequate. However the macrotexture of these roads is generally low, particularly on high speed roads where asphaltic concrete surfacings are used. Further work is needed to determine the importance of this in relation to the high incidence of traffic accidents in Malaysia. This study was carried out under a joint cooperative research programme between the Jabatan Kerja Raya (JKR) of Malaysia and the Transport and Road Research Laboratory (TRRL) of the United Kingdom.

1.0 INTRODUCTION

There has been considerable publicity on road safety in Malaysia recently. The increasing trend in traffic accident rates culminated in the formation of a Cabinet Committee on Road Safety chaired by the Prime Minister. One of the issues that has been discussed was the skid resistance and macrotexture of road surfacings, which had been mentioned as possible contributory factors towards the high incidence of traffic accidents in the country.

The fine scale microtexture of the surface aggregate is the dominant factor in determining skidding resistance at lower speeds. In bituminous surfacings this is characterised by the resistance to polishing of the aggregates. In Malaysia, granite aggregates are generally used in bituminous road surfacings. Therefore in this study, only bituminous surfacings with granite aggregates were investigated.

Macrotexture contributes to skidding resistance particularly at high speeds. The measurement of macrotexture is referred to as texture depth and is most commonly estimated by the sand patch test.

In view of the high traffic accident rates, the Training and Research Institute (ILP), Jabatan Kerja Raya, Malaysia, decided to carry out a comprehensive assessment on the skid resistance and macrotexture of bituminous road surfacings in Malaysia under a joint research programme with the Transport and Road Research Laboratory (TRRL) of the UK.

2.0 EXPERIMENTAL DESIGN

2.1 Site Selection

Three types of surfacings were investigated. They were:-

(a) Asphaltic concrete (AC)
(b) Dense bitumen macadams (DBM)
(c) Surface dressings

For each type of surfacing, sites were selected and grouped into four age categories; namely less than six months old, 6-12 months, 12-24 months and older than 24 months. They were also categorised as having a high or low traffic level, defined as a 24 hour flow of more or less than 250 commercial vehicles per lane. In this study, medium and heavy goods vehicles with an unladen weight in excess of 1.5 tonnes and buses were classified as commercial vehicles. For sites on minor rural roads where no counts were available, it was reasonably assumed that the traffic level was low.

Of a total of 81 sites located throughout Peninsular Malaysia, 79 were on 2-lane roads and the others on a 4-lane and 6-lane dual carriageway. The sites were categorised by surface type, age and traffic level. The number in each category is given in Table 1.

TABLE 1. Number of sites categorised by surface type, traffic and age

Surface Type	Traffic level	Age (months)				Total
		<6	6-12	12-24	>24	
Asphaltic concrete	low	3	-	2	3	22
	high	5	5	2	2	
Dense bitumen macadam	low	13	12	2	-	32
	high	-	1	-	4	
Surface dressing	low	5	3	9	10	27
	high	-	-	-	-	
Total						81

Normally in Malaysia, AC surfacings are laid on roads with relatively high traffic flows whereas DBM and surface dressings are used on minor rural roads. Therefore few suitable sites could be selected on AC roads with low traffic levels and few on DBM or surface dressed roads with high traffic levels.

A typical site was a relatively straight, flat road approximately 300 metres in length. The sites were located in areas where there were no junctions or other fixed hazards likely to cause a change in traffic speeds.

Care was also taken to ensure that the surfacings of the selected sites were of a reasonable quality and within JKR specifications. However the granite aggregates were not tested for their polishing properties.

2.2 Measurements on Site

On each site ten permanent markings were drawn on the road surfacing at 30 metre intervals. At each of these chainages, skid resistance measurements were made in the vergeside wheelpath using the TRRL Portable Skid Resistance Tester (Road Research Laboratory, 1969). The temperature of the road pavement at the time of the testing was recorded so that the skid resistance values could be corrected to a standardised temperature.

Texture depth measurements were carried out using the sand patch test at the same chainages as the skid resistance measurements.

3.0 RESULTS

The 81 sites were classified into the four age categories described above. The ages of the surfacings varied from zero for newly constructed untrafficked roads to six years.

3.1 Traffic Levels

Where possible the traffic levels were obtained from the classified 16 hour traffic counts conducted by the Highway Planning Unit (HPU). Traffic surveys carried out during the National Axle Load Survey (NALS) (Government of Malaysia, 1989) showed that the 16 hour figures accounted for approximately 71 per cent of the 24 hour flows for the heavy goods class and 86 per cent for all the other classes of vehicles. These factors were used to estimate the 24 hour traffic flows.

The commercial traffic levels on the 2-lane sites ranged from an average daily flow of 5 vehicles on a minor rural road to over 3,000 vehicles. The traffic flows on the 2 sites located on dual carriageways were 3,000 commercial vehicles per day on the 4-lane roads and 15,000 commercial vehicles on the 6-lane highways.

3.2 Effect of Temperature on Skid Resistance Measurements

The effect of temperature on the resilience of rubber exerts an influence on skid resistance measurements. In the UK skid resistance values are standardised to a temperature of 20 deg C. The formula suggested by Maclean and Shergold (1958) implies that the change in reading due to temperature is proportional to the measured value.

Work done by Beaven and Tubey (1978) in Malaysia showed that high road temperatures have a marked effect on skid resistance readings. They proposed that a modified version of the UK formula be used to convert readings to equivalent skid resistance values at 35 deg C, which would be a more realistic reference temperature to adopt for the tropics, i.e

$$SRV(35) = \frac{(100 + t)}{135} \times SRV(t) \qquad .....(1)$$

where SRV(35) = equivalent skid resistance value at 35 deg C
SRV(t) = measured skid resistance value
t = temperature at test site

A recent investigation by the ILP confirmed the validity of the above formula and therefore all skid resistance values presented in this paper have been adjusted to a temperature of 35 deg C using equation (1). This means that readings are 3 to 5 units lower than for comparable surfacings in the UK which are corrected to 20 deg C.

3.3 Skid Resistance Measurements

The average of ten readings was used to describe the skid resistance value (SRV) of a site. The number of sites in each group, categorised by age and surface type, and the range and mean SRV values for each group are summarised in Table 2.

TABLE 2. Skid Resistance Values

Surface type	Age (months)	No of sites	Skid resistance		
			min	max	mean
Asphaltic Concrete	<6	8	46	66	56
	6-12	5	49	61	55
	12-24	4	51	57	54
	>24	5	53	58	56
	Total	22	46	66	55
Dense Bitumen Macadam	<6	13	47	67	55
	6-12	13	51	59	55
	12-24	2	55	65	60
	>24	4	45	57	52
	Total	32	45	67	55
Surface Dressing	<6	5	58	76	66
	6-12	3	52	66	60
	12-24	9	53	66	59
	>24	10	45	67	55
	Total	27	45	76	58

3.3.1 Asphaltic Concrete

On the sites with AC surfacings, one had a flow of 4000 commercial vehicles per lane per day whereas on the others the flows ranged between 50 and 1500. Although the range of traffic levels on these sites was large, the effect of traffic on the skid resistance of AC surfacings was small. The average SRV of the eight low trafficked sites was 57 and the value for the 14 high trafficked sites was 54.

The skid resistance of the AC surfacings did not change with age, the mean SRV remaining at approximately 55 for each age category as shown in Table 2.

3.3.2 Dense Bitumen Macadams

The traffic levels on the DBM sites were relatively low with the highest volume of commercial vehicles being approximately 400 per lane. As in the case of the AC surfacings, the effect of traffic appeared to be small. The average SRV of the 27 low trafficked sites was 56 and the average value for the five high trafficked sites was 52.

The mean and range of SRV's for the DBM and AC sites were virtually identical for each age category (see Table 2).

3.3.3 Surface Dressings

All the surfaced dressed sites had similar low levels of traffic flow. Therefore in this case it was possible to consider only the effect of the age of the surfacings. On surfacings less than 12 months old the average skid resistance was approximately 15 per cent higher than on the AC and DBM sites (see Table 2). On sites older than two years the average skid resistance had decreased to a magnitude similar to the AC and DBM surfacings.

3.4 Texture Depth Measurements

The average of ten readings was used to describe the texture depth of a site. These results are summarised in Table 3.

3.4.1 Asphaltic Concrete

There was a general trend for texture depth to decrease as traffic intensity increased on the AC surfacings. The average texture depth on the eight low trafficked sites was 0.39mm and 0.33mm for the 14 high trafficked sites.

The mean texture depth did not vary significantly between each age category, with the mean value for all 22 sites being 0.35mm.

3.4.2 Dense Bitumen Macadams

The texture depths of the DBM sites were higher than on the AC surfacings. The majority of the DBM sites had texture depths in the order of 0.5mm, irrespective of age, except for the four sites located on roads older than two years where the texture depth was approximately double that of the other sites. These four sites, located in the same vicinity and carrying relatively high volumes of traffic, were constructed to a coarser grading specification which resulted in the higher texture depth measurements.

Of the other 28 sites only one had a high traffic flow. This site had a texture depth of 0.35mm compared with an average of 0.51mm for the 27 low trafficked sites.

TABLE 3. Texture Depth Measurements

Surface Type	Age (months)	No of sites	Texture depth (mm)		
			min	max	mean
Asphaltic Concrete	<6	8	0.28	0.45	0.37
	6-12	5	0.25	0.33	0.29
	12-24	4	0.20	0.52	0.37
	>24	5	0.30	0.41	0.37
	Total	22	0.20	0.52	0.35
Dense Bitumen Macadam	<6	13	0.37	0.59	0.47
	6-12	13	0.36	0.61	0.52
	12-24	2	0.47	0.55	0.51
	>24	4	0.78	1.24	0.94
	Total	32	0.36	1.24	0.55
Surface Dressing	<6	5	1.04	3.08	1.91
	6-12	3	0.53	2.33	1.63
	12-24	9	0.71	2.70	1.35
	>24	10	0.84	2.19	1.32
	Total	27	0.53	3.08	1.47

3.4.3 Surface Dressings

The texture depths of the surface dressed sites were significantly higher than on either the DBM or AC surfacings, with the mean of all 27 sites being approximately 1.5mm. The mean values decreased with age, as shown in Table 3, reducing from an average of 1.9mm for new seals to 1.3mm after two years in service.

4.0 DISCUSSION AND CONCLUSIONS

4.1 Skid Resistance

The results obtained indicated that the average SRV's of AC and DBM surfacings were similar at 55 while that of surface dressed sites was higher at 58.

There did not appear to be a large effect of traffic intensity on the skid resistance of AC and DBM surfacings, the average SRV being 57 and 56 respectively for the low trafficked sites, and 54 and 52 respectively on the high trafficked sites. The effect of traffic on skid resistance is not easy to establish (Szatkowski and Hosking, 1972) and there may be a further effect associated with different susceptibilities to polishing of the various sources of granite aggregates used in this study. However in this case, this effect is likely to be small.

On the surface dressed sites, the initial SRV had decreased by 15 per cent after two years trafficking to 55, a similar value to that on the AC and DBM sites.

These results therefore indicate that there is little difference in SRV between any of the surfacings except for relatively new surface dressed roads. It should be emphasised that a SRV of 55 at 35 deg C is high and is considerably higher than the minimum normally specified for low trafficked roads.

When compared with the UK investigatory levels for different categories of sites as indicted in the UK Department of Transport, Departmental Standard HD15/87 (1987), the SRV's obtained in Malaysia were adequate for the three types of surfacings investigated, all of which had granite aggregates.

This confirms that the granite aggregates tested are suitable for use in road surfacings on the major part of the Malaysian road network where the roads are relatively straight and flat.

4.2 Texture Depth

The results indicate that the average texture depths for AC, DBM and surface dressed roads were approximately 0.35mm, 0.55mm and 1.50mm respectively.

There was a 15 per cent reduction in the texture depth of AC surfacings between the low and the high trafficked sites from approximately 0.4mm to below 0.35mm. These texture depths were relatively low, but are typical of AC surfacings, Salt (1977).

Of the 32 DBM sites, only one had a high traffic flow apart from the four constructed to a coarser grading specification. The texture depth on this one high trafficked site was 0.35mm compared with an average of 0.51mm for the 27 low trafficked sites. This suggests that there is little difference in texture depth between AC and DBM mixes made with the same maximum sized aggregate and laid on roads with high traffic volumes.

All the surface dressed sites had low traffic levels. The measurements from these sites showed that the average texture depth decreased by 0.5mm after two years of trafficking. The average texture depth of 1.5mm is typical for this type of surfacing. However, if surface dressings are used on heavily trafficked roads, the retention of good surface texture becomes more dependent upon correct design and construction procedures.

5.0 FURTHER WORK

It would be necessary to extend the work described in this paper to determine the importance of the findings of this assessment in relation to the high incidence of traffic accidents.

1) The work should be repeated for 'difficult' site conditions.

2) Close cooperation with the Malaysian police is necessary to identify accident causes. Accidents in dry and wet weather should be investigated in detail to determine if SRV or texture depth have played any part in the cause of the accidents.

3) Factors such as vehicle speeds, classes of road, traffic intensities and weather conditions would need to be studied.

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