Jurnal Teknologi

Full paper

Performance of Micro Surfacing on Expressway

Nazaruddin Jamion[a], Mohd Rosli Hainin[b*], Haryati Yaacob[b]

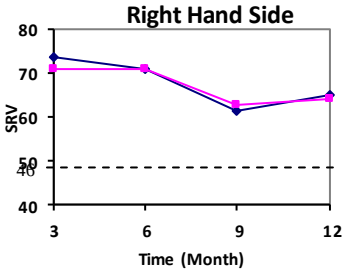
[a]Bina Masyhur Sdn. Bhd., 166, Jalan TU2, Taman Tasik Utama, 75450 Ayer Keroh, Melaka, Malaysia
[b]Construction Research Centre, Faculty of Civil Engineering, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor, Malaysia

*Corresponding author: mrosli@utm.my

Article history

Received :1 May 2014
Received in revised form :
14 September 2014
Accepted :1 Oktober 2014

Graphical abstract



Abstract

Micro surfacing is developed from a slurry seal technique. It is a mixture of polymer modified bitumen emulsion with 9.5 mm chipping, quarry dust, cement, additive and water. The emulsion used in micro surfacing is CQS-1h and added with natural latex as its polymer modifier. This study was carried out to evaluate the performance of micro surfacing applied on the expressway. In 2008, a number of preventive maintenance projects in North South Expressway used micro surfacing especially in the northern region. This study involved particular sections of expressways located at km 58.60 to km 59.60 south bound and km 84.60 to km 85.60 southbound from Bukit Kayu Hitam. The Portable Pendulum Tester was used to evaluate skid resistance performance while the texture depth of micro surfacing was measured using Sand Patch Test. The surface irregularities data was collected using a 3 m rolling straight edge while the rutting measurement was based on 3 m static straight edge. The measurements were carried for every 3 months starting from April 2009 to 1 year of the operation period. The result shows that the skid resistance, texture depth, surface irregularities and rut depth for micro surfacing comply with the specification requirements after one year of operation. The pendulum test value obtained is greater than 46 with a texture depth of 0.50 mm. The average number of surface irregularities is below 4.0 mm while the rut depth average value is less than 5.0 mm. This study shows that the micro surfacing was performing well on the expressway. It has proven effective in restoring friction characteristic, filling ruts and re-establishing the transverse profile of road surface.

Keywords: Micro surfacing; expressway; skid resistance; surface irregularity

1.0 INTRODUCTION

Flexible pavement surface is associated with several distresses which include rutting, low skid resistance and surface irregularity which are resulted from undulation, raveling, bleeding, polishing etc. To solve the problem, the surface layer needs to be re-profiled and restored in order to improve the skid resistance. In some cases resurface is adequate, but it is necessary to mill the existing pavement and inlay with a new wearing course. This conventional method is costly compared to a new method such as a chip seal, slurry seal or micro surfacing. Micro surfacing is said to be the best compared to chip seal and slurry seal because of a limitation of a chip seal and slurry seal function [1, 2]. Chip seal cannot solve rutting problem and slurry seal take a long time to cure and reopen to traffic. Micro surfacing can be used to restore or improve skid resistance properties of existing surface. It also can solve rutting and the surface irregularity problem, besides re-profiling existing surface.

Micro surfacing is recommended for preventive maintenance before the road surface starts to crack. Micro surfacing is not to provide a structural improvement for the roadway but rather to repair pavements with surface distresses such as coarse aggregate loss and raveling or to improve surface frictional resistance [3].

Micro surfacing is defined as a modified version of slurry seal and was introduced in Canada in the early 1990s. Micro surfacing is used to restore the pavement surface characteristics and to preserve pavement surfacing [4, 5]. This surfacing mixture can be designed to correct rutting, improve skid resistance, seal surface cracks and protect pavement surfacing against hardening and improve surface texturing [6]. For that reason, Malaysia has been using micro surfacing since 2008. In Malaysia, micro surfacing has been used to improve skid resistance and to prolong a pavement's life span. Since micro surfacing is a new type of surface pavement in Malaysia, this study was carried out to examine the performance of micro surfacing under Malaysian condition.

2.0 OBJECTIVE

This study evaluates the performance and effectiveness of Type 3 micro surfacing in Malaysian Expressway. Type 3 is the suitable type of aggregate gradation to be used for primary, interstate

routes and expressway. The properties investigated include skid resistance, texture depth, rutting and irregularities of micro surfacing. This is intended to determine the performance of micro surfacing, whether can restore friction characteristic, filling ruts and re-establishing the transverse profile of the road surface or not.

3.0 MICRO SURFACING SPECIFICATION AND DESIGN

There are two types of Micro Surfacing defined by the International Slurry Seal Association [5]. The selection of the gradation is chosen based on the recommendations by the International Slurry Seal Association.

The Type 2 aggregate gradation is used to fill surface voids, address surface distresses, seal and provide a durable wearing surface. It is suitable for urban streets, residential streets and airport runways. The Type 3 aggregate gradations are used to provide maximum skid resistance and improved wearing surface.

This type of micro surfacing surface is appropriate for heavily travelled pavements, rut filling or for placement on highly textured surfaces requiring larger size aggregate to fill voids. It is suitable for primary and interstate routes [5]. The best type of aggregate gradation to be used for the expressway is Type 3, because of the function of expressway is similar with interstate routes. The function of the expressway and interstate routes are to link the one state to another state. Therefore, Type 3 was used in this study. These are described in Table 1.

Table 1 Types of micro surfacing [5]

Sieve Size (mm)	Percent Passing	
	Type 2	Type 3
9.50	100	100
4.75	90 – 100	70 – 90
2.40	65 – 90	45 – 70
1.18	45 – 70	28 – 50
0.600	30 – 50	19 – 34
0.300	18 – 30	12 – 25
0.150	10 – 21	7 – 18
0.075	5 - 15	5 - 15
Application Rate	5.4 – 10.8 kg/m^2	8.1 – 16.3 kg/m^2
Location	Urban, Residential Streets and Airport Runways	Primary and Interstate Routes

Mix design is carried out to ensure good performance of micro surfacing. This is to select suitable materials and their proportions for micro surfacing mixture. This is also to ensure that the mix design can follow the specification requirement and achieve the required performance on site. Based on the design mix, the best proportion of the material to be used will be known. The mixing time test is used to predict how long the material can be mixed in the machines before it begins to break. Mixing time cannot be too long because it will affect the setting time and curing time. An ideal time is required to ensure that the mixture be able to mix without breaking in the slurry machine. Hand mix method was used to get a mixing time The material used in micro surfacing was crushed granite, filler which was Portland cement, additive and the binder which was a cationic emulsion (CQS-1h). The specification of mix design and mix design results are shown in Table 2.

Table 2 Mix design–micro surfacing [5]

Test	Specification	Result
Cement (%)	0.0 – 3.0	0.5
Binder Content (%)	5.5 – 10.5	6.51
Emulsion (%)	-	10.5
Water (%)	As required	8.0
Additive (%)	As needed	2.5
Wet Track Abrasion (g/m^2)	< 807	450
Mixing Time (Sec.)	> 120	120
Cohesion for 30 minutes (kg.cm)	> 12	28
Cohesion for 60 minutes (kg.cm)	> 20	31

4.0 PERFORMANCE MONITORING

This study was carried out in order to investigate the performance of micro surfacing in Malaysia. In 2008, many preventive maintenance projects at North South Expressway used micro surfacing especially in northern regions. This study selection sections of roads located at km 58.60 to km 59.60 south bound and km 84.60 to km 85.60 southbound, from Bukit Kayu Hitam.

The properties investigated include skid resistance, texture depth, rutting and irregularities of micro surfacing. This is intended to determine the performance of micro surfacing, whether can restore friction characteristic, filling ruts and re-establishing the transverse profile of the road surface or not. The performance of micro surfacing in this specific road section has been monitored for one year. The British Pendulum Tester was used to evaluate skid resistance performance while the texture, depth of micro surfacing was measured using the Sand Patch Method. The British Pendulum Test is based on BS EN 13036-4:2003 and the Sand Patch Test is based on BS EN 13036-1:2002. The roughness data were collected using rolling straight edge while the routine measurement was based on 3m straight edge. The measurements were done periodically every 3 months. All tests were conducted on the fast lane from km 58.60 to km 59.60 and slow lane from km 84.60 to km 85.60. Data were collected at every 200 m intervals at Right Hand Side (RHS), Centre of Lane (COL) and Left Hand Side (LHS) of the lane. RHS and LHS were considered as wheel path area and COL was considered as undisturbed area. Figure 1 shows the schematic diagram of test locations.

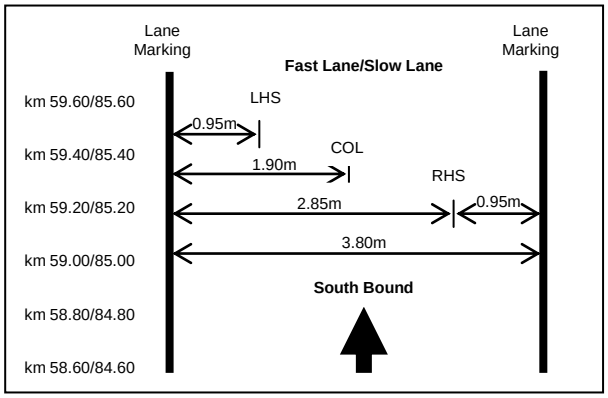


Figure 1 Schematic diagram of the test locations

4.1 Skid Resistance

Table 3 shows the average skid resistance value in 12 months. Figure 2 illustrates the relationship between skid resistance value and time. According to JKR/SPJ/2008 section 4 clause 4.13.8.5, skid resistance value of the complete material on the carriageway shall have a minimum average value of 46 (corrected to 35°C) as measured by the British Pendulum Tester or equivalent [3]. Skid resistance value for micro surfacing reduces every month, but within 12 months the skid resistance value was still more than 46. The skid resistance decreased by 12.93 % after 12 months of operations. This occurred because of aggregate breaking and polishing by the traffic.

Table 3 Average skid resistance value within 12 months

Skid Resistance Value (SRV)			
Location		km 58.60 to km 59.60	km 84.60 to km85.60
1st (3 months)	Right Hand Side	73.51	70.93
	Center Of Lane	75.55	72.89
	Left Hand Side	72.93	69.65
2nd (6 months)	Right Hand Side	71.09	70.79
	Center Of Lane	72.58	71.35
	Left Hand Side	69.66	69.71
3rd (9 months)	Right Hand Side	61.19	62.89
	Center Of Lane	62.11	62.77
	Left Hand Side	63.22	64.07
4th (12 months)	Right Hand Side	64.88	64.10
	Center Of Lane	62.03	62.48
	Left Hand Side	63.60	62.05

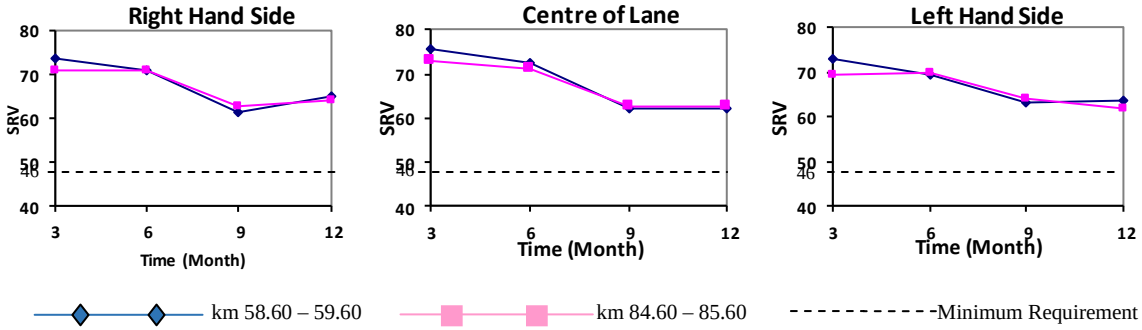


Figure 2 Average skid resistance value versus time

4.2 Texture Depth

Table 4 presents the results of texture depth in 12 months. The relationship is shown in Figure 3. Texture depth of road surface is considered in good condition if more than 0.50 mm within 12 months, texture depth for micro surfacing is more than 0.50 mm [4]. The texture depth increased by 16.54 % after 12 months of operation. This happened because of the aggregate breakages and dislodgement. The dislodge aggregates left a surface void.

The value of texture depth for this research is higher than the study by Suffian [7]. Suffian [7] found that newly trafficked micro surfacing registered an average surface texture depth of 0.55 mm and after eight weeks of trafficking the texture depth was maintained at 0.39 mm [7].

Table 4 Average texture depth within 12 months

Texture Depth (mm)			
Location		km 58.60 to km 59.60	km 84.60 to km 85.60
1st (3 months)	Right Hand Side	1.40	0.92
	Center Of Lane	1.31	1.22
	Left Hand Side	1.61	1.14
2nd (6 months)	Right Hand Side	1.42	1.00
	Center Of Lane	1.52	1.16
	Left Hand Side	1.81	1.06
3rd (9 months)	Right Hand Side	1.77	1.40
	Center Of Lane	1.61	1.62
	Left Hand Side	1.88	0.98
4th (12 months)	Right Hand Side	1.69	1.30
	Center Of Lane	1.52	1.59
	Left Hand Side	1.56	1.22

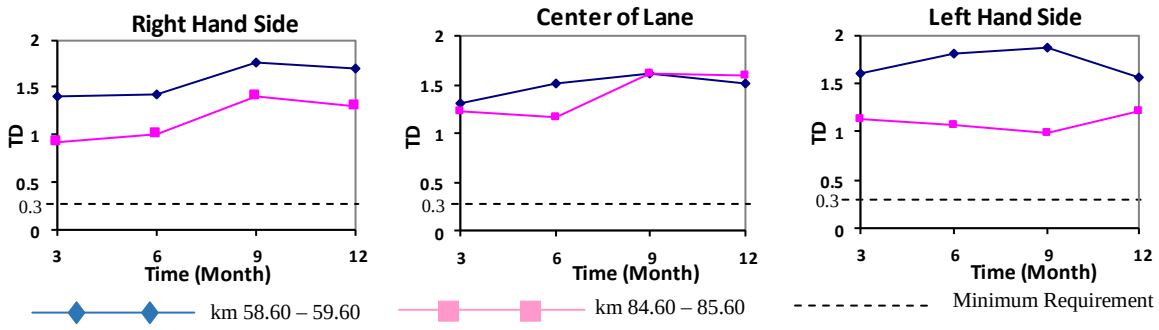


Figure 3 Average texture depth versus time

4.3 Surface Irregularities

The results of surface irregularities are presented in Table 5 and the relationship is illustrated in Figure 4. Road surface irregularities are considered in good condition if less than 3.8mm[1]. Within 12 months, surface irregularities for micro surfacing are still less than 3.8 mm. The surface irregularities, increased by 27.73 % after 12 months of service. This occurred due to the bad jointing in the transverse joint.

Table 5 Average surface irregularities within 12 months

Surface Irregularities (mm)			
Location		km 58.60 to km 59.60	km 84.60 to km 85.60
1st (3 months)	Right Hand Side	2.27	2.30
	Center Of Lane	2.12	2.42
	Left Hand Side	2.16	1.93
2nd (6 months)	Right Hand Side	1.20	1.30
	Center Of Lane	2.97	1.32
	Left Hand Side	1.15	1.09
3rd (9 months)	Right Hand Side	2.99	1.39
	Center Of Lane	2.50	1.90
	Left Hand Side	2.84	1.31
4th (12 months)	Right Hand Side	2.79	2.34
	Center Of Lane	3.37	2.56
	Left Hand Side	3.53	2.25

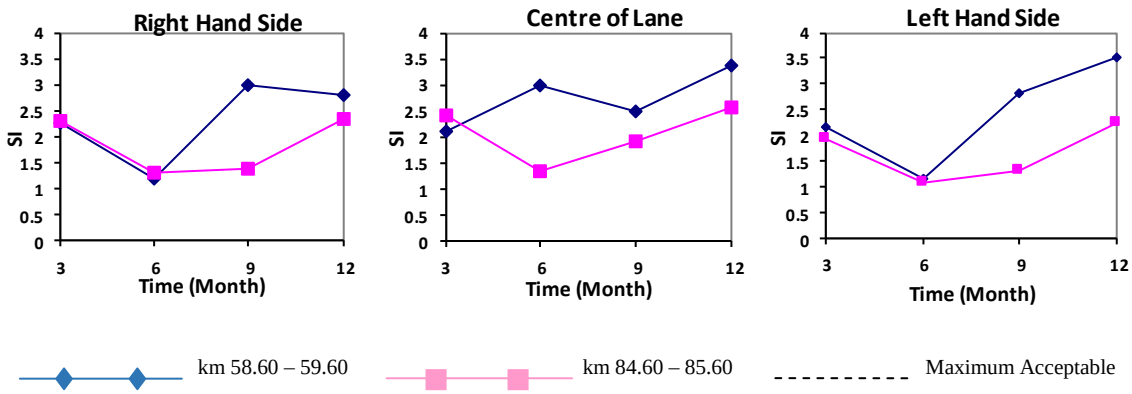


Figure 4 Average surface irregularities versus time

4.4 Rutting

Table 6 shows the results of rut depth in 12 months and Figure 5 illustrated the relationship. Road with rutting less than 5.0 mm is considered as in a good condition [1]. Within 12 months, rut depth for micro surfacing is still below than 5.0 mm. The rut depth decreases 9.01 % after 12 months of operation. This is due to aggregate breakages and dislodgement. This is also because of bad jointing at the longitudinal and transverse joint.

Table 6 Average rut depth within 12 months

Rut Depth (mm)			
Location		km 58.60 to km 59.60	km 84.60 to km 85.60
1st (3 months)	Right Hand Side	2.00	4.33
	Center Of Lane	2.50	3.83
	Left Hand Side	3.00	3.33
2nd (6 months)	Right Hand Side	1.67	3.67
	Center Of Lane	2.50	2.75
	Left Hand Side	3.33	1.83
3rd (9 months)	Right Hand Side	2.33	3.67
	Center Of Lane	3.00	2.84
	Left Hand Side	3.67	2.00
4th (12 months)	Right Hand Side	3.00	4.17
	Center Of Lane	2.92	3.59
	Left Hand Side	2.83	3.00

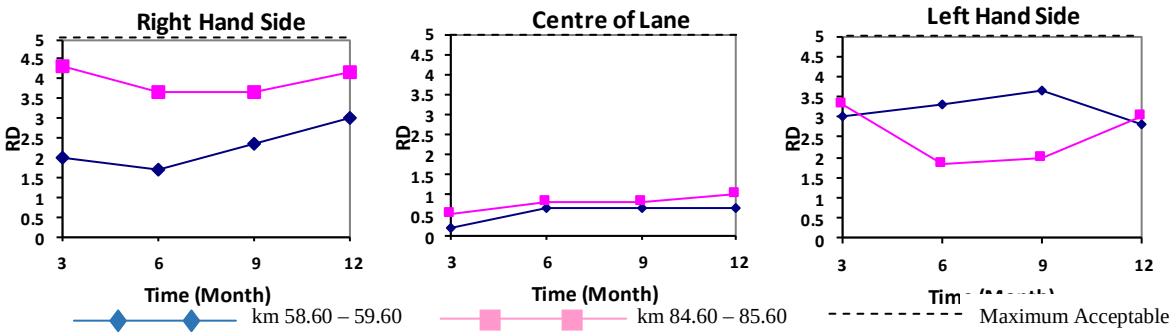


Figure 5 relationship between rut depth and time

5.0 CONCLUSIONS

The conclusions that can be drawn out from this study are as follows:

1. The micro surfacing average skid resistance value for one year is 63.19 by using the British Pendulum Tester. This is higher than 46 as per required by the Public Work Department of Malaysia specifications [6].
2. The micro surfacing average texture depth for one year is 1.48 mm. This is higher than 0.50 mm, which is in good condition as recommended by Ahmad [1].
3. The average micro surfacing irregularities after one year is 2.81 mm. This is lower than the 3.8 mm, which is in good condition as recommended by Ahmad [1].
4. The average micro surfacing rut depth for one year is 2.42 mm. This result is lower than 5.0 mm, which is in good condition as recommended by Ahmad [1].
5. The Type 3 micro surfacing was performing well on the expressway in Malaysia. It has proven effective in restoring friction characteristic, filling ruts and re-establishing the transverse profile of the pavement. However, micro surfacing surface will perform better, if the problem of dragging mark, bad joint, aggregate breakages and dislodgement can be solved. The quality of the micro surfacing is very much dependent on the material used, mixing and laying process. To solve it, workmanship must be good, selection of materials and the mix design must be implemented carefully.

References

[1] Ahmad, S. K. 2008. *Data Collection Strategies in Malaysia.*
[2] BS EN 13036. 2003. *Road and Airfield Surface Characteristic–Test Method.*
[3] David, K. H., John, J. E., Romuoldo, D., Shane, M. 1994. *Design, Construction and Performance and Micro-surfacing for Urban Pavements.* Washington D.C.
[4] Hixon, C. D. and Ooten, D. A. 1993. *Nine Years at Microsurfacing in Oklahama.* Washington D.C.
[5] International Slurry Surfacing Association (ISSA). 2005. *Recommended Performance Guidelines Micro-surfacing.*
[6] Jabatan Kerja Raya Malaysia (PWD). 2008. *Standard Specification for Road Works, Section 4: Flexible Pavement.* 139: 145.
[7] Suffian, Z. 2005. *Performance of Micro Surfacing.* Kuala Lumpur.