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Performance of pavement preservation with Ralumac Micro surfacing at LATAR highway

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Abstract: Maintaining pavement to desired level of serviceability as required by Malaysian Highway Authority (MHA) give immense pressure to highways operators. Pavement distress such as roughness, rutting and cracking are common problems that occur after the highway has been operational. Pavement preservation has been sought as a potential alternative for managing all the pavement distress. This paper evaluates the performance of pavement preservation with Ralumac Micro surfacing for slow lane and fast lane from KM23.70 to KM24.10 Eastbound at LATAR highway. The evaluation comprises of International Roughness Index (IRI), texture depth and skid resistance. The result revealed that micro surfacing treatment has significant improvement on roughness, rutting, and skid resistance even after 36 months operational. The performance of Ralumac Micro surfacing at slow lane is slightly lower than Ralumac Micro surfacing at fast lane as it affected by heavy vehicles.

1. Introduction

Pavement maintenance treatment can be categorized into three main categories: routine maintenance, preservation, and rehabilitation. Routine maintenance is reactive and often comprises relatively inexpensive and corrective actions to address specific problems that may compromise safety, such as localised potholes. Preservation treatments are proactive and consist of well-timed and executed activities to prevent premature distresses and to slow the rate of deterioration. Finally, rehabilitation consists of structural enhancements that renew the service life of an existing pavement and improve its load carrying capacity.[1]

The current practices of most highway agencies concentrate on the corrective maintenance rather than preservation treatment which are either ignored or treated as a low priority [2,3]. Most current maintenance activities have budget issues and only focus on removing deteriorated pavement sections or to defer the repair works. This approach has impacts on the environment and on safety to road user, and may thus affect the costs associated with maintenance [3].

Pavement preventive maintenance is a proactive, planned strategy that extends the life of the pavement and provides a cost-effective solution for pavement management. [4]. Its include fog seal, chip seal, slurry seal, micro surfacing, crack treatment, and thin hotmix overlays. The selection of a pavement preventive maintenance should be based on the condition of the existing pavement, traffic volume, and environmental conditions. Other factors include experience, budget constraints, and availability of the technology or materials [5].

Micro surfacing is the important method in the preventive maintenance applied by highway agencies. Even more importantly, Micro surfacing is poised above all other treatments to comply strict environmental regulations and to optimize budget availability [6]. According to Koichi Takamura [7] Micro surfacing is more “eco-efficient” than hot mix overlay because of less material being used, less transportation of materials and lower overall emissions during the life of the treatment. Micro surfacing performs best when applied to correct surface friction, oxidation, raveling and rutting on pavements that have adequate structural capacity [8] and cost-effective maintenance technique for higher severity cracks for at least a year [9].

Micro surfacing is a cold-applied paving mixture composed of polymer-modified asphalt emulsion, crushed aggregate, mineral filler, water and a hardening-controlling additive, proportioned, mixed and uniformly spread over a properly prepared surface [10]. It can be used a blanket cover on pavements suffering from loss of skid resistance, oxidation, raveling and surface permeability. In addition, Micro surfacing can be used to fill ruts and improve rideability by removing minor surface irregularities. This treatment can last on average 8 to 9 years [11]. This study was carried out to evaluate performance of Micro surfacing from KM23.70 to KM24.10 Eastbound LATAR after 36 months operational. Evaluation of surface roughness, rutting, texture depth, and skid resistance are carried out at slow lane and fast lane to determine effectiveness micro surfacing.

2. Objective

This study evaluates the performance of pavement preservation with Ralumac Micro surfacing for slow lane and fast lane from KM23.70 to KM24.10 Eastbound at LATAR highway after 36 months operational. The evaluation comprises of International Roughness Index (IRI), pavement rutting, texture depth and skid resistance.

3. Specification and Mix Design

The aggregate gradation for Micro surfacing according to JKR specification as illustrated in Table 1. In order to improve more on skid resistance for Ralumac Micro surfacing at LATAR highway, the ASTM sieve size 4.75mm and 3.35mm were changes to 5.0mm and 3.15mm as per Table 2.

Table 1. Aggregate gradation JKR/SPJ/2008-S4.

ASTM Sieve Size (mm)	% Passing by weight
8.0	90 -100
4.75	60 – 74
3.35	45 – 58
2.0	36 – 50
1.0	23 – 38
0.710	20 – 33
0.090	5 – 12

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Table 2. Aggregate gradation of Ralumac Micro surfacing at LATAR.

ASTM Sieve Size (mm)	% Passing by weight	Quarry Dust	Chipping	Combined (dust & chipping)
8.0	90 -100	99.29	75.06	94.54
5.0	60 – 74	82.89	16.19	70.37
3.15	46 – 58	61.36	5.78	50.54
2.0	36 – 50	45.28	3.94	37.97
1.0	23 – 38	31.11	3.05	26.48
0.710	20 – 33	26.41	2.74	22.64
0.090	5 - 12	8.51	3.01	7.52

The sieve analyses were carried out by taking representative samples of each individual coarse and fine aggregates. The combined aggregate used for Ralumac Micro surfacing was blended in the proportion of quary dust:chipping = 3:1.

The bitumen used for the manufacturing of the Ralumac is from Shell pen. Grade 80/100. The average penetration is 86.82 while average softening point is 46.43 °C. The Ralumac emulsion content included Bitumen 80/100, Peral 416, and Latex.

The average test result for Ralumac emulsion used for this project is Binder residue test is 67.40%, penetration (0.1mm) is 50.44mm and softening point is 58.5°C. The laboratory mix for Ralumac Micro surfacing is shown in Table 3.

Table 3. Laboratory Mix for Ralumac Micro surfacing.

Item Description	Requirement / Results
Combined aggregates	100%
Ralumac emulsion	10 – 12% by the weight of aggregate
Cement	2% by the weight of aggregate
Water	8 – 10% by the weight of aggregate
Additive	0.05% by the weight of aggregate
Cohesion test	
30 minutes	16.28 kg-cm
60 minutes	22.67 kg-cm
Wet track abrasion test	38.67 g/ft^2
Mix time	60 ec

4. Methodology

This study has been carried out to determine the performance of Ralumac Micro surfacing system from KM23.70 to KM24.10 Eastbound for both lanes; slow lane and fast lane at LATAR highway as shown in Figure 1. These performance tests are International Roughness Index (IRI), rutting, texture depth and skid resistance have been measured on the Ralumac Micro surfacing.

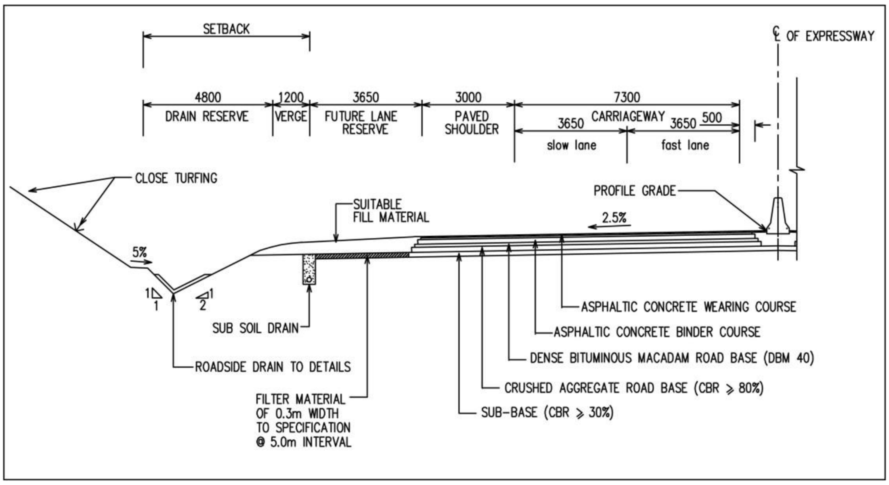

Figure 1. Pavement cross section at KM23.70 to KM24.10 Eastbound.

IKRAM Road Scanner (IRS) were used to capture pavement functional condition data, survey mapping information and roadside asset details whilst travelling at highway speed. This fully-featured vehicle contains a compact workstation capable of capturing and storing individual data elements for roughness, rutting, texture and surface condition, as well as providing high-detail video images of road and road side assets along the LATAR highway.

Meanwhile skid resistance was performed using the Grip Tester (GT) along the left wheel path of the road. The GT has one test wheel, fitted with apparatus containing transducers, instrumentation, actuation controls, a water supply and automatic control system. It uses measurements representing the friction force on a test wheel operated at a constant load and longitudinal reference slip. During a test run, water was sprayed ahead of the measuring wheel by a self-watering system to produce 0.25 mm thick water film and the test wheel is brought to the road surface by means of the actuation system. The information was process and the Grip Number was converted to SCRIM (Sideway-force Coefficient Routine Investigation Machine) value by the following relationship:

$$\text{SCRIM value} = 0.85 \times \text{Grip Number} \quad (1)$$

Figure 2. IKRAM Road Scanner (IRS) and Grip Tester (GT).

The data performance of Ralumac Micro surfacing has been collected since 2014 and has been evaluated for every 100m. The test results have been compared to MHA advisory condition criteria as illustrated in Table 4 and Table 5

Table 4. MHA Advisory Condition Criteria for Roughness, Rutting, and Texture Depth.

Parameter / Condition Criteria	Roughness (IRI)	Mean Rut Depth (mm)	Texture Depth (mm)
Good	< 2.0	< 5.0	> 0.5
Fair	2.0 – 3.0	5.0 – 10.0	0.3 – 0.5
Poor	3.0 – 3.8	10.0 – 20.0	< 0.3
Bad	≥ 3.8	≥ 20.0	N/A

Table 5. Skid Resistance Indicative Condition Criteria.

Condition Criteria	SCRIM Value
Acceptable Level	≥ 0.38
Investigatory Level	< 0.38

5. Result and Discussion

The data performance of roughness, rutting, texture depth and skid resistance on Ralumac Micro surfacing has been calculated and discussed in the next subsection.

5.1. Roughness

Table 6 and Figure 3 indicate the pavement roughness for Ralumac Micro surfacing after 36 months operational at fast lane is improved up to 34% at KM23.90 while at slow lane it is increased up to 25% at KM23.80 from original pavement condition. Furthermore, overall pavement condition at slow lane is more 5% roughness compare to roughness at fast lane as surveyed at KM23.80. This occurred due to the slow lane receive more traffic loadings as it was designed mainly for heavy vehicles. However, overall roughness for the Ralumac Micro surfacing after 36 months operational are still less than 2.0mm/km which are shown as a good rating as per Table 4 although Annual Average Daily Traffic (AADT) had increased by 24%.

Table 6. Pavement roughness for Ralumac Micro surfacing.

KM	Lane	0 mth (AADT 56,031)	12 mth (AADT 66,520)	24 mth (AADT 67,616)	36 mth (AADT 69,530)	Performance after 36 mth	Performance at Slow Lane vs Fast Lane
23.70	Fast Lane	2.25	1.98	1.79	2.04	+10%	+13%
	Slow Lane	1.99	1.76	1.81	1.80	+10%	
23.80	Fast Lane	1.77	1.61	1.41	1.75	+1%	-5%
	Slow Lane	1.47	1.69	1.32	1.84	-25%	
23.90	Fast Lane	2.20	1.33	1.47	1.45	+34%	+18%
	Slow Lane	1.49	1.13	1.81	1.22	+18%	
24.00	Fast Lane	1.77	1.33	1.54	1.40	+21%	-18%
	Slow Lane	1.72	1.58	1.83	1.72	0%	
24.10	Fast Lane	1.65	1.30	1.80	1.39	+16%	-24%
	Slow Lane	1.63	1.77	1.62	1.83	-13%	

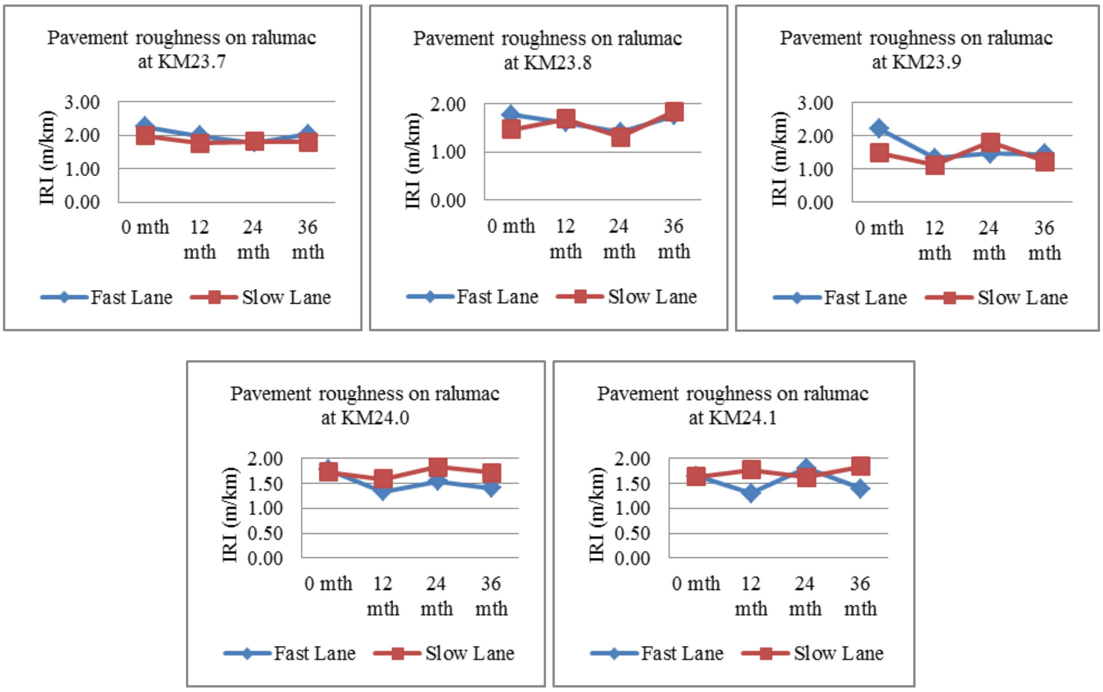

Figure 3. Pavement roughness at fast lane and slow lane.

5.2. Rutting

Table 7 and Figure 4 indicate the overall pavement rutting for Ralumac Micro surfacing after 36 months operational at fast lane is increased up to 63% as surveyed at KM23.70. Meanwhile pavement rutting at slow lane is increased up to 117% as surveyed at KM24.10 from original pavement condition. Furthermore, overall pavement condition at slow lane is more 36% rutting compare to rutting at fast lane as surveyed at KM23.70 and KM23.80. This occurred due to the slow lane receives more traffic loadings as it was designed mainly for heavy vehicles. However, overall pavement rutting on Ralumac

Micro surfacing after 36 months operational are still less than 5.0mm which are shown as a good rating as per Table 4 although Annual Average Daily Traffic (AADT) had increased by 24%.

Table 7. Pavement rutting for Ralumac Micro surfacing.

KM	Lane	0 mth (AADT 56,031)	12 mth (AADT 66,520)	24 mth (AADT 67,616)	36 mth (AADT 69,530)	Performance after 36 mth	Performance at Slow Lane vs Fast Lane
23.70	Fast Lane	1.60	2.81	2.50	2.60	-63%	-36%
	Slow Lane	2.70	3.99	3.20	4.05	-50%	
23.80	Fast Lane	2.00	2.52	2.90	2.36	-18%	-36%
	Slow Lane	2.20	3.47	2.40	3.71	-69%	
23.90	Fast Lane	1.40	2.38	2.59	1.96	-40%	-37%
	Slow Lane	2.20	3.50	3.09	3.12	-42%	
24.00	Fast Lane	2.20	2.19	3.04	1.71	+22%	-48%
	Slow Lane	2.30	3.23	3.29	3.26	-42%	
24.10	Fast Lane	2.30	2.05	5.34	2.39	-4%	-52%
	Slow Lane	2.30	4.07	3.16	4.99	-117%	

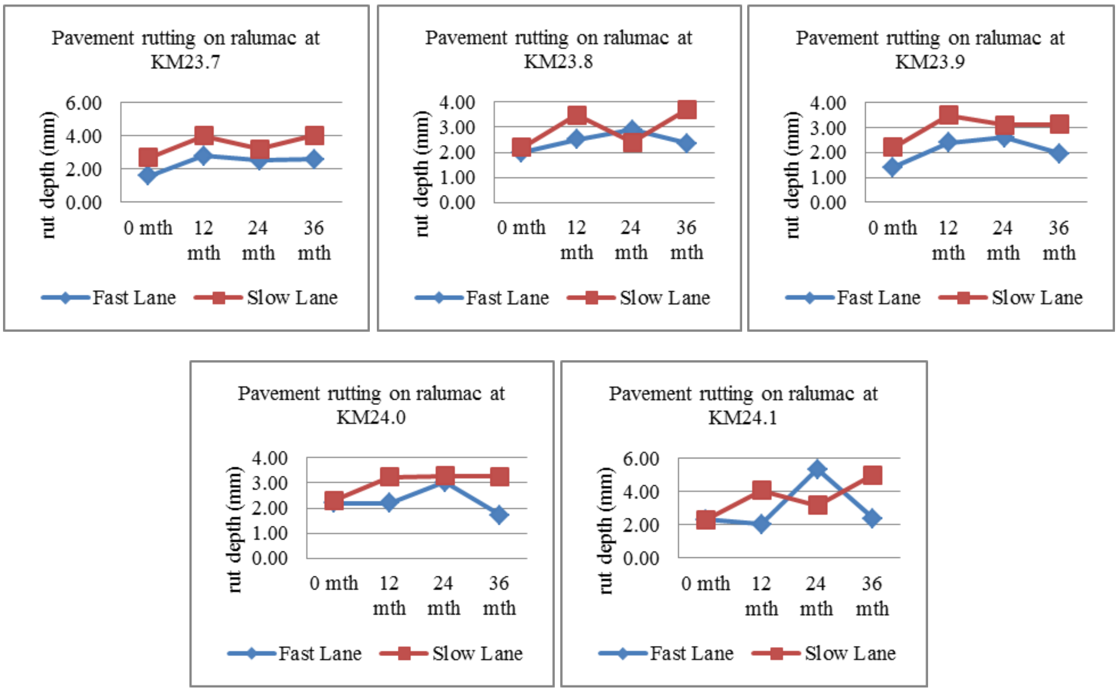

Figure 4. Pavement rutting at fast lane and slow lane.

5.3. Texture Depth

Table 8 and Figure 5 indicate overall texture depth for Ralumac Micro surfacing after 36 months is remain above 0.5mm which are shown as a good rating as per Table 4. The pavement condition with Ralumac Micro surfacing at slow lane is lower up to 57% texture depth compare to fast lane as surveyed at KM23.90. However, the trend of texture depth at both lanes has been improved every year although Annual Average Daily Traffic (AADT) had increased by 24%.

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Table 8. Texture depth for Ralumac Micro surfacing.

KM	Lane	0 mth (AADT 56,031)	12 mth (AADT 66,520)	24 mth (AADT 67,616)	36 mth (AADT 69,530)	Performance after 36 mth	Performance at Slow Lane vs Fast Lane
23.70	Fast Lane	1.00	0.60	0.68	0.75	-25%	-34%
	Slow Lane	0.90	0.48	0.50	0.56	-38%	
23.80	Fast Lane	0.90	0.61	0.67	0.72	-20%	-35%
	Slow Lane	0.60	0.48	0.44	0.53	-11%	
23.90	Fast Lane	0.90	0.61	0.62	0.77	-14%	-57%
	Slow Lane	0.50	0.43	0.44	0.49	-1%	
24.00	Fast Lane	0.50	0.57	0.55	0.78	55%	-48%
	Slow Lane	0.50	0.44	0.49	0.53	5%	
24.10	Fast Lane	0.40	0.49	0.27	0.56	40%	-2%
	Slow Lane	0.60	0.42	0.26	0.55	-9%	

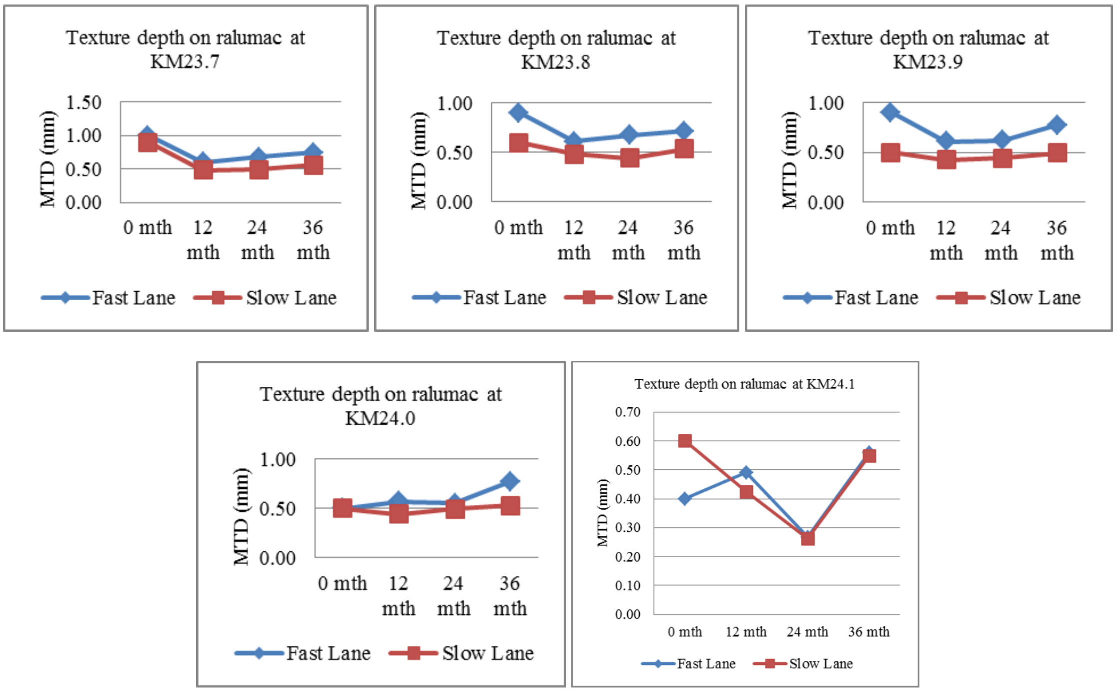

Figure 5. Texture depth at fast lane and slow lane.

5.4.Skid Resistance

Table 9 and Figure 6 show that the overall skid resistance for Ralumac Micro surfacing after 36 months operational at fast lane is still improved up to 24% as surveyed at KM23.70. Meanwhile skid resistance on Ralumac Micro surfacing at slow lane is decreasing from initial pavement condition until 21% as surveyed at KM24.10. Overall skid resistance at slow lane had decreased up to 36% compare to at the fast lane as surveyed at KM23.70. This occurred due to the slow lane receives more heavy vehicles. However, overall skid resistance for the micro surfacing after 36 months operational are still above 0.38 which are shown as a good rating as per Table 5 although Annual Average Daily Traffic (AADT) had increased by 24%.

Table 9. Skid resistance for micro surfacing.

KM	Lane	0 mth (AADT 56,031)	12 mth (AADT 66,520)	24 mth (AADT 67,616)	36 mth (AADT 69,530)	Performance after 36 mth	Performance at Slow Lane vs Fast Lane
23.70	Fast Lane	0.55	0.55	0.62	0.68	+24%	-36%
	Slow Lane	0.51	0.53	0.52	0.5	-3%	
23.80	Fast Lane	0.60	0.55	0.65	0.75	+24%	-29%
	Slow Lane	0.56	0.54	0.56	0.58	+3%	
23.90	Fast Lane	0.62	0.57	0.61	0.64	+3%	-16%
	Slow Lane	0.60	0.53	0.54	0.55	-9%	
24.00	Fast Lane	0.61	0.56	0.59	0.62	+2%	-24%
	Slow Lane	0.61	0.5	0.50	0.5	-18%	
24.10	Fast Lane	0.61	0.53	0.57	0.61	0%	-27%
	Slow Lane	0.60	0.49	0.49	0.48	-21%	

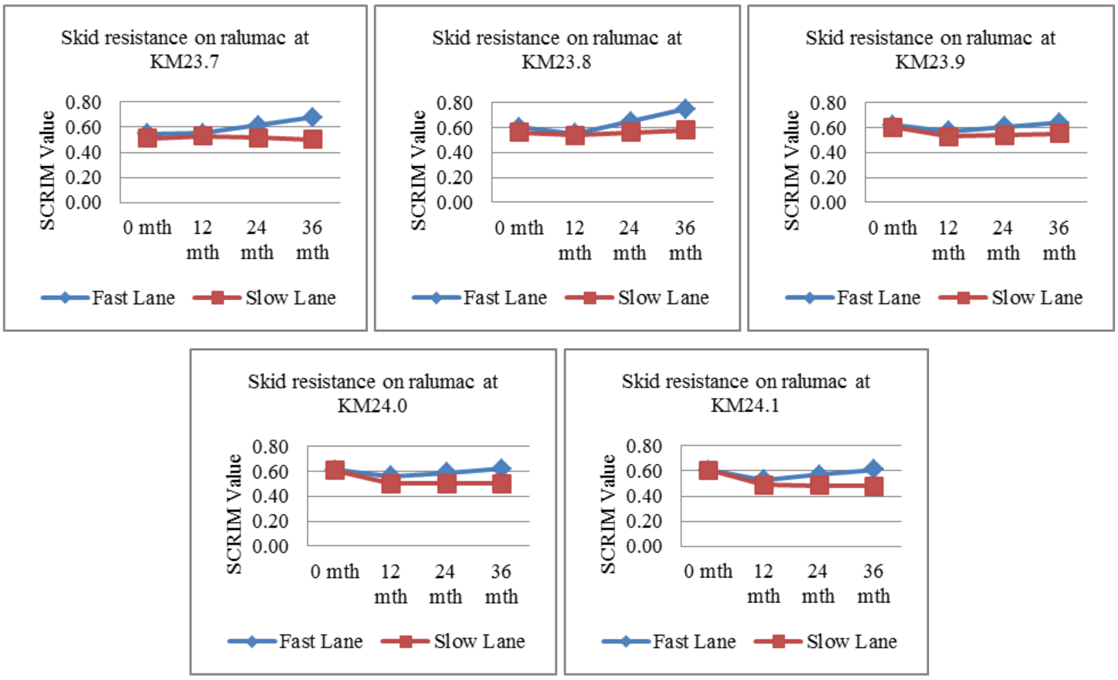

Figure 6. Skid resistance at fast lane and slow lane.

6. Conclusions

Overall performance of Ralumac Micro surfacing on roughness, rutting, texture depth, and skid resistance after 36 months operational are above the requirement by MHA and achieved good rating. The Ralumac Micro surfacing performed differently on fast lane and slow lane as summarized in Table 10.

Table 10. Performance of Ralumac Micro surfacing after 36 months operational.

No	Indicators	Performance
1	Roughness	16% more roughness at slow lane compare to fast lane
2	Rutting	42% more rutting at slow lane compare to fast lane
3	Texture depth	35% less texture depth at slow lane compare to fast lane
4	Skid resistance	26% less skid resistance at slow lane compare to fast lane

This is mainly due to the slow lane of LATAR highway receives more traffic loadings from heavy vehicles. The extra traffic loadings affect condition of pavement structure underneath the micro surfacing subsequently affect it performance. The service life of pavement also is slightly decreased as the traffic volume increased [12]. Currently, the heavy vehicles contribute 2% of AADT and traffic growth is 24% for LATAR highway. This paper recommends continuous monitoring on the performance of Ralumac Micro surfacing at this section to verify the actual service life as it shall extent until 8.5 years [12].

7. References

[1] Al-Mansour A and Sinha KC 1994 Economic analysis of effectiveness of pavement preventive maintenance *Transportation Research Record* 1442
[2] Association ISS 2010 *Recommended performance guidelines for micro surfacing (A143 Revised)*.
[3] Bae A and Stoffels SM 2008 Economic effects of microsurfacing on thermally-cracked pavements *KSCE Journal of Civil Engineering* **12**(3) 177-185
[4] Ben Broughton S J L, Yoo-Jae Kim 2012 "30 Years of Microsurfacing: A Review ISRN Civil Engineering **2012**
[5] Chan S, Lane B, Kazmierowski T and Lee W 2011 Pavement peservation: A solution for sustainability *Transportation Research Record: Journal of the Transportation Research Board* (2235) 36-42
[6] Gransberg D D and Tighe S M 2012 Microsurfacing best practices in North America *Seventh International Conference on Maintenance and Rehabilitation of Pavements and Technological Control*
[7] Takamura K, Rolf Wittlinger K P L and Aktiengesellschaft B A S F 2001 Microsurfacing for preventive maintenance: Eco-efficient strategy *International Slurry Seal Association Annual Meeting* Maui, Hawaii
[8] Dong Q, Stephen B H, Richards H and Yan X 2013 Cost-effectiveness analyses of maintenance treatments for low-and moderate-traffic asphalt pavements in Tennessee *Journal of Transportation Engineering* **139**(8) 797-803
[9] Torres-Machi C, Osorio-Lird A, Chamorro A, Videla C, Tighe SL and Mourgues C 2018 Impact of Environmental assessment and budgetary restrictions in pavement maintenance decisions: Application to an urban network *Transportation Research Part D: Transport and Environment* **59** 192-204
[10] James Wilde W, Thomas L T and Wood J 2014 *Cost-effective Pavement preservation solutions for the real world* (Department of Transportation: Research Services & Library)
[11] Zaniewski J and Mamlouk M 1999 Pavement preventive maintenance: Key to quality highways *Transportation Research Record: Journal of the Transportation Research*

Board (1680): 26-29
[12] Zhang, Y. and J. P. Mohsen 2018 "A Project-Based Sustainability Rating Tool for Pavement Maintenance." Engineering **4**(2): 200-208.