INTERNATIONAL SEMINAR
NATURAL RUBBER
IN ROADS

IMPLEMENTATION OF NATURAL RUBBER MODIFIED ASPHALT CONCRETE IN THAILAND: A Case Study from the Department of Highways Research Project

Present by

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OUTLINE

- Overview of Research Study
- Project Information
- Key Findings from Completed Project

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Overview of Research Study

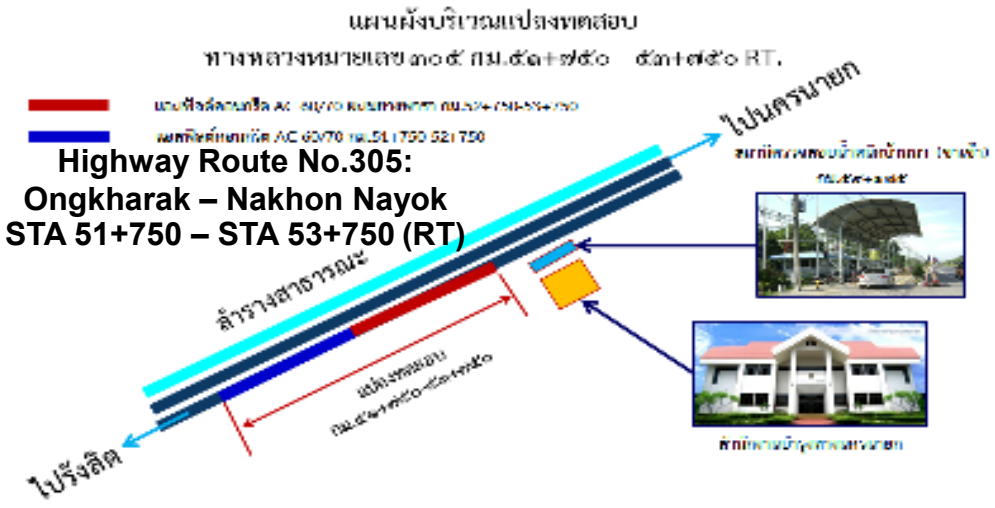
To promote usage of natural rubber in the road industry, increase demand of natural rubber, and thus help rubber small holders in Thailand as part of the Royal Thai Government's effort, the Department of Highways (DOH), Thailand launched a research project for implementation of using natural rubber in roads in late 2012

Research Objectives

- To investigate properties of natural rubber modified asphalt (NRMA) and natural rubber modified asphalt concrete (NRMAC) mixture
- To compare between NRMAC surfacing and conventional asphalt concrete (AC) surfacing
- To assess periodic post-construction performance of both NRMAC and AC surfacing

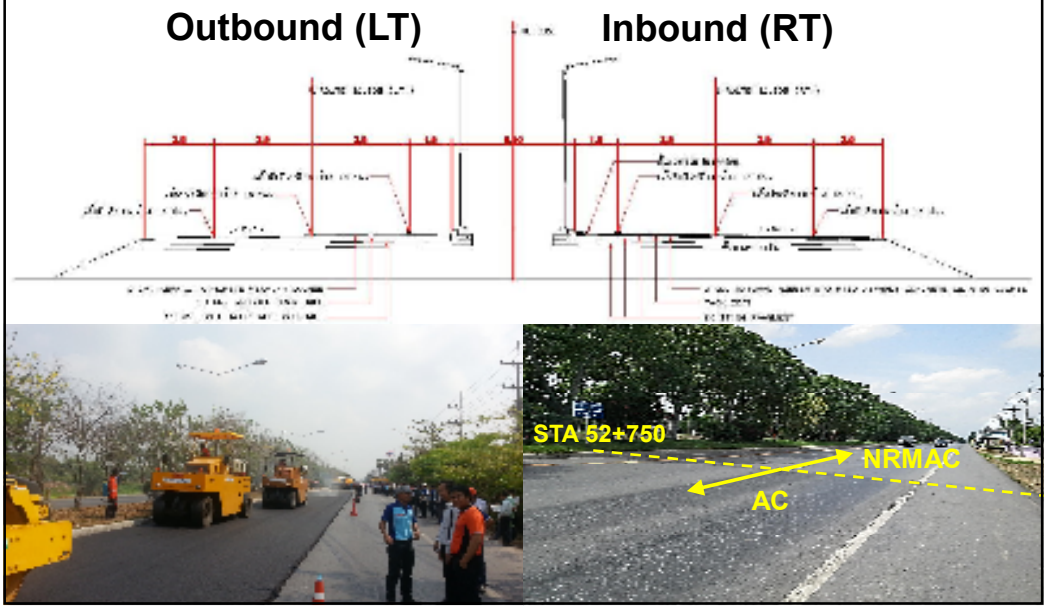
Project Location

Trial Section



(1) a 1-km long natural rubber modified asphalt concrete (NRMAC) surfacing between STA 52+750 and STA 53+750 and (2) a 1-km long conventional asphalt concrete (AC) surfacing between STA 51+750 and STA 52+750

Typical Cross-Section



Traffic Information

Traffic Data in 2012	Outbound (LT)	Inbound (RT)
Average Daily Traffic (veh/day)	7,570	11,348
% Heavy Vehicle	33.96	31.62

Ref: Traffic Count STA 54+100, Bureau of Highway Safety, Department of Highways

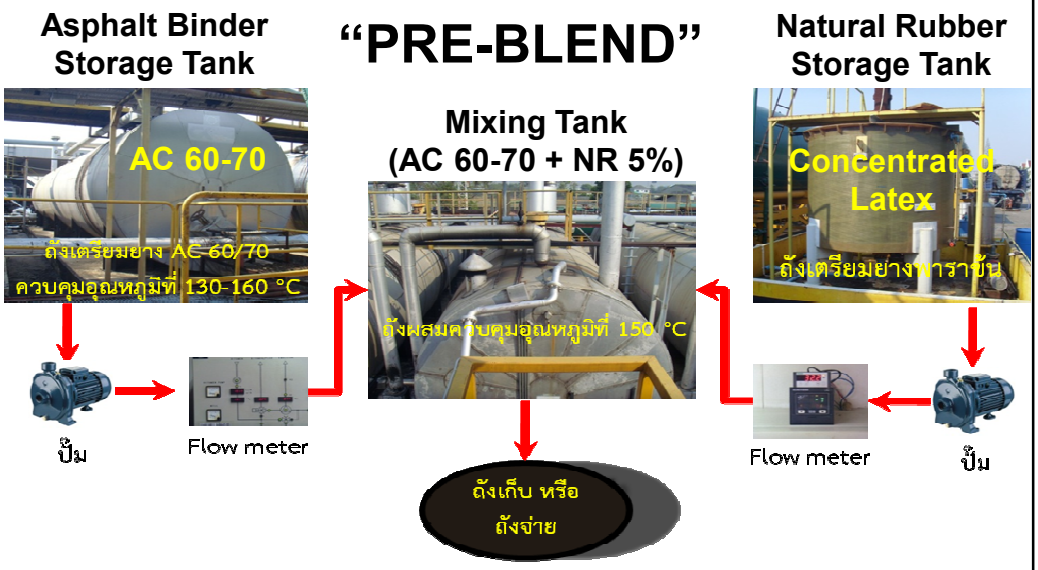
Number of vehicles weighed at the permanent weight station (static scale)

Year	2008	2009	2010	2011	2012
Total	309,580	145,202	325,386	299,138	287,028

Year	2013	2014	2015	2016
Total	357,854	525,931	317,346	332,328

Ref: Permanent Station STA 54+175, Office of Traffic Weight Control, Department of Highways

NRMA Production



NRMA Properties

No.	Properties	NRMA (AC 60-70 + NR 5%)	Specification	Test Method
1	Penetration, 25°C, 100 g, 5 s (0.1 mm)	60	50 - 70	ASTM D 5
2	Softening Point (°C)	53.1	Min 50	ASTM D 36
3	Ductility,13°C, 5 cm/min (cm)	> 50	Min 50	ASTM D 113
4	Flash and Fire Points (°C)	305	Min 220	ASTM D 92
5	Elastic Recovery, 25°C, 10 cm (%)	66.2	Min 50	ASTM D 6084
6	Storage Stability, 24 hrs, 163°C (°C) [Difference of softening point between top and bottom portion]	3.9	Max 4	ASTM D 5892

NRMA Properties (cont.)

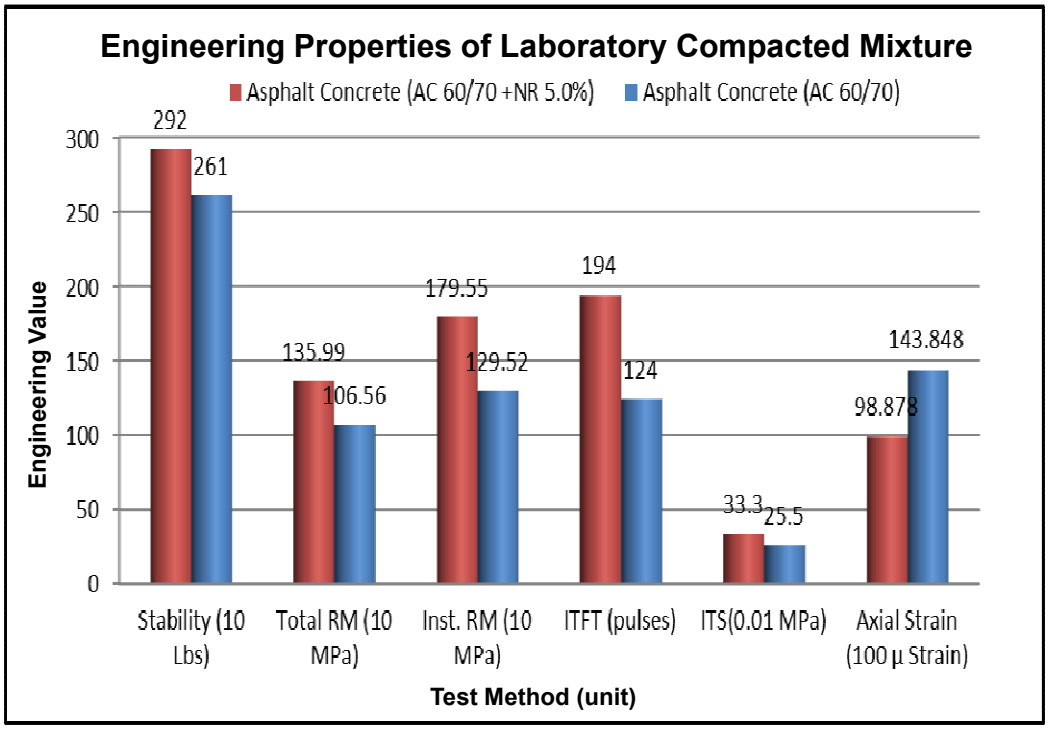
No.	Properties	NRMA (AC 60-70 + NR 5%)	Specification	Test Method
7	Brookfield Viscosity, Shear Rate 18.6 s^{-1}, Spindle 21, 150°C (mPa.s)	500	200 - 600	ASTM D 4402
Residue from Thin-Film Oven Test				
8	Weight Loss on Heating (% by weight)	0.06	Max 1.0	ASTM D 1754
9	Penetration, 25°C, 100 g, 5 s (% Retained Penetration)	86.7	Min 60	ASTM D 5
10	Difference in Softening Point (°C)	+1.7	Max +6	ASTM D 36
11	Elastic Recovery, 25°C, 10 cm (%)	36.2	Min 35	ASTM D 6084

NRMAC Mixture Properties

No.	Properties	AC Mixture	NRMAC Mixture
1	Asphalt Content (% by Mass of Aggregate)	5.0 (±0.3)	5.0 (±0.3)
2	Marshall Density (g/ml)	2.415 (2.403 – 2.424)	2.416 (2.408 – 2.422)
3	Marshall Air Voids (%)	4.0 (3.2 – 4.8)	4.0 (3.4 – 4.7)
4	Voids in Mineral Aggregate (%)	14.6 (>14.0)	14.5 (>14.0)
5	Voids Filled with Bitumen (%)	72.6 (67 – 77)	72.4 (67 – 77)
6	Marshall Stability (lbs)	2,610 (>2,300)	2,920 (>2,600)

NRMAC Mixture Properties (cont.)

No.	Properties	AC Mixture	NRMAC Mixture
7	Marshall Flow (0.01")	11.0 (10 – 12)	11.0 (10 – 12)
8	Marshall Stability / Marshall Flow (lbs / 0.01")	237 (>160)	265 (>200)
9	Strength Index (%)	87.9 (>75)	88.5 (>75)



Construction of Trial Section

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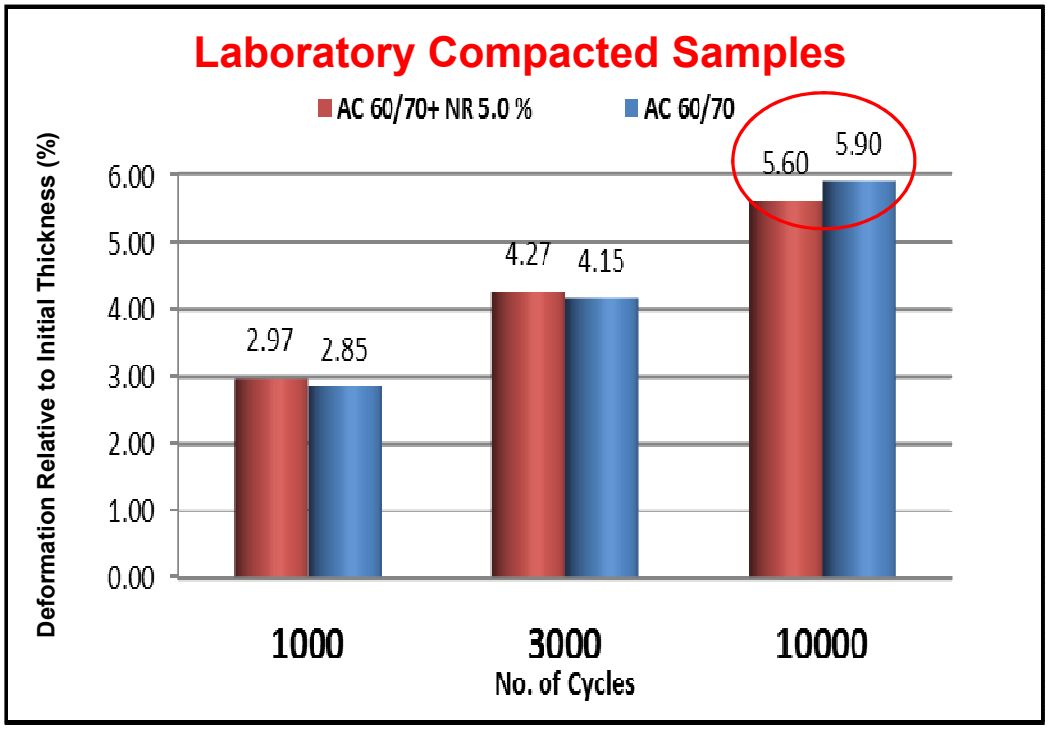
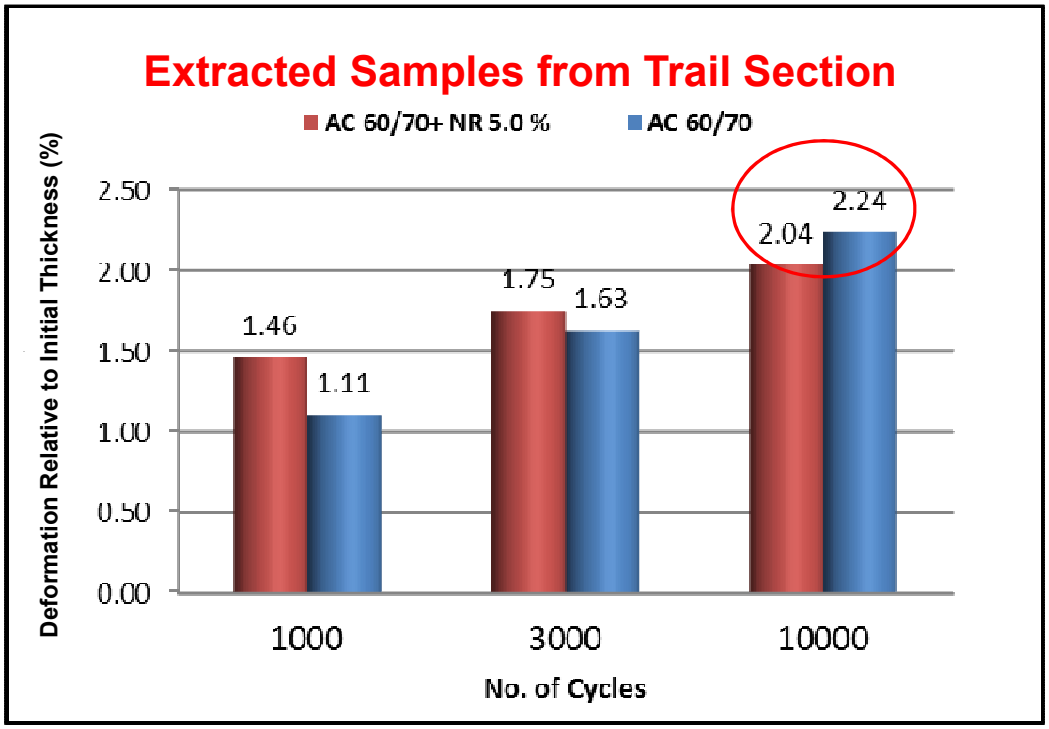
Pavement Rutting Tester

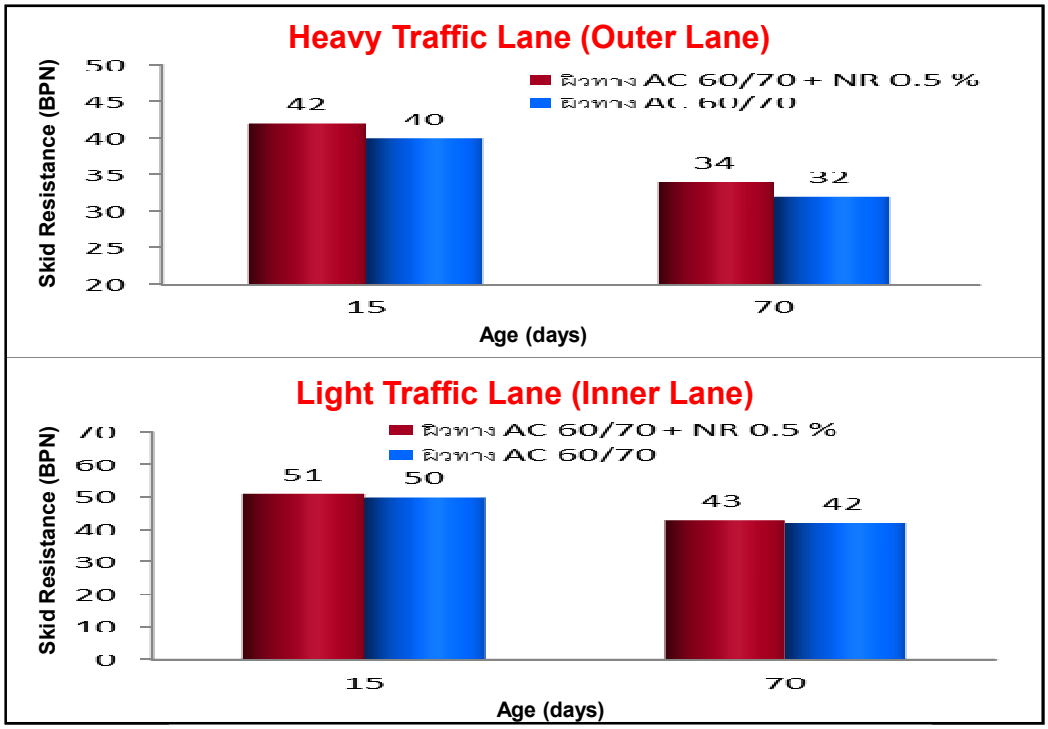
Mixture	AC			NRMAC		
No. of Cycles	**1,000**	**3,000**	**10,000**	**1,000**	**3,000**	**10,000**
Sample 1	2.73%	4.00%	6.04%	2.50%	4.00%	4.91%
Sample 2	2.92%	4.07%	5.37%	2.91%	4.23%	5.37%
Sample 3	3.06%	4.51%	6.40%	3.65%	4.89%	6.49%
Sample 4	2.70%	4.03%	5.80%	2.81%	3.95%	5.64%
Average	**2.85%**	**4.15%**	**5.90%**	**2.97%**	**4.27%**	**5.60%**



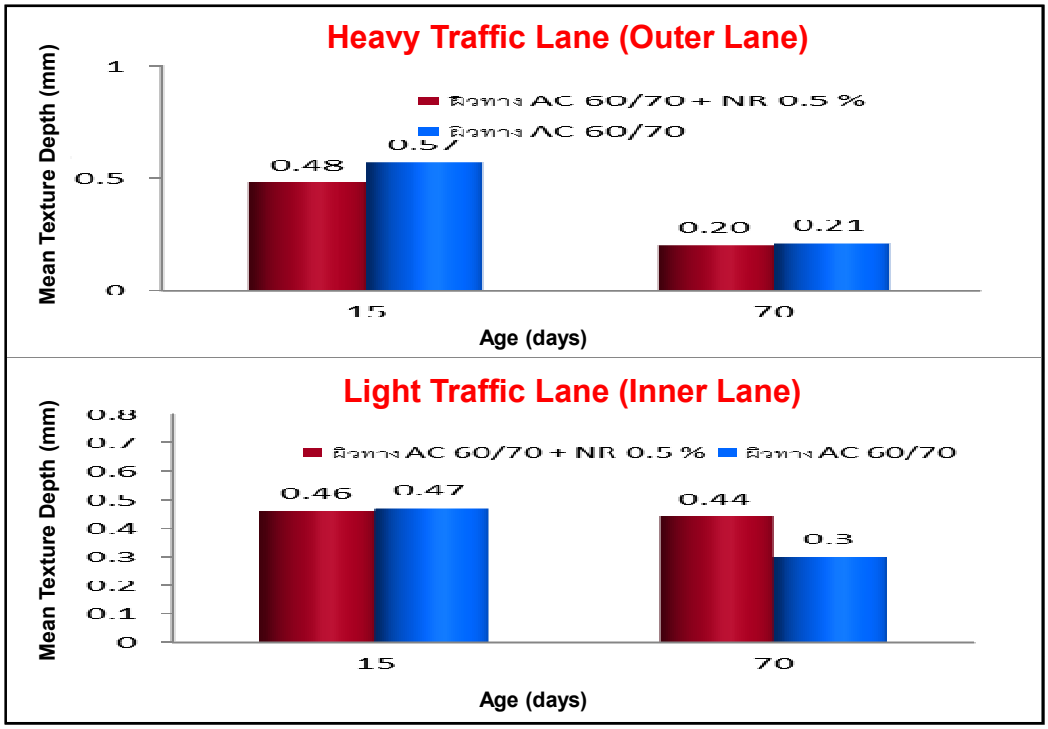
Mixture	AC			NRMAC		
No. of Cycles	**1,000**	**3,000**	**10,000**	**1,000**	**3,000**	**10,000**
Sample 1	1.19%	1.83%	2.23%	1.37%	1.58%	1.82%
Sample 2	1.02%	1.42%	2.25%	1.56%	1.91%	2.25%
Average	**1.11%**	**1.63%**	**2.24%**	**1.46%**	**1.75%**	**2.04%**



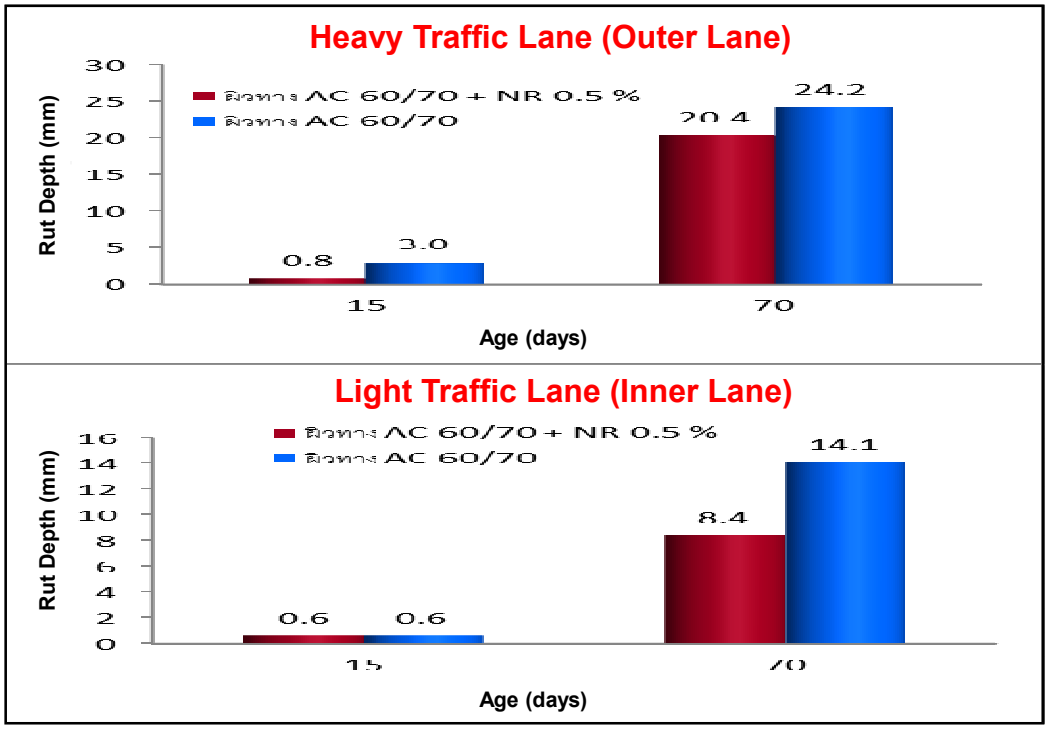
Skid Resistance Tester



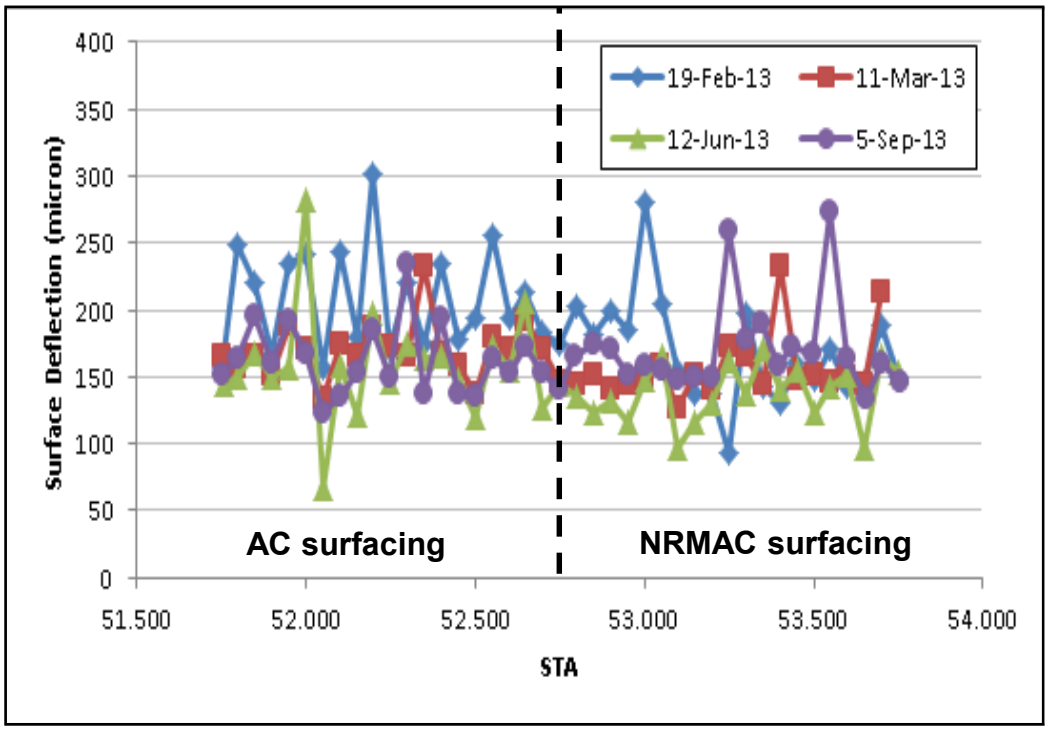
Mean Texture Depth




Road Assessment


Heavy Traffic Lane (Outer Lane)
Rut Depth (mm)
30
25
20
15
10
5
0
ผิวทาง AC 60/70 + NR 0.5 %
ผิวทาง AC 60/70
0.8
3.0
20.4
24.2
15
70
Age (days)
Light Traffic Lane (Inner Lane)
Rut Depth (mm)
16
14
12
10
8
6
4
2
0
ผิวทาง AC 60/70 + NR 0.5 %
ผิวทาง AC 60/70
0.6
0.6
8.4
14.1
15
70
Age (days)

Falling Weight Deflectometer



Key Findings from Completed Project

- NRMAC mixture exhibited better stability, elasticity, rutting & fatigue resistance than AC mixture
- NRMAC surfacing exhibited better load carrying capacity, rutting & skid resistance than conventional AC surfacing
- Service life of NRMAC road surfacing is anticipated to be prolonged, thus reduce cost of road maintenance

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Thank you!
Terima kasih

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