INTERNATIONAL SEMINAR
NATURAL RUBBER IN ROADS

NATURAL RUBBER MODIFIED ASPHALT: MALAYSIAN EXPERIENCE, 1950 - 2016

by
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ORGANISED BY

PAST EXPERIENCE IN MALAYSIA

1950

100 yards of Kota Bharu – Kuala Krai road in Kelantan was laid by the Public Works Department using **5% rubber powder.**

Followed by other experiments, using **rubber powder and latex,** in other states: Perlis, Kedah, Johor, Melaka and Negeri Sembilan.

By **1958, 20 miles of rubberised pavement** were laid.

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PAST EXPERIENCE IN MALAYSIA

1950

Due to **frequent movement of personnel** in the Department, the records and observations were **incomplete and discontinuous.**

Nevertheless, there were indications that the rubber;

1. **Retard fatting up** of the pavement.
2. **Improve adhesion** between binder and aggregates.
3. **Improve resistance to stripping** of smaller stones.

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PAST EXPERIENCE IN MALAYSIA

1961

The Public Works Department initiated the use of **rubberised bitumen macadam** in resurfacing of Federal roads.

By **1963**, there were only 3 State Central Quarries (with asphalt plant) under the Department, and only **50 miles** were resurfaced with rubberised bitumen macadam.

By **1970's**, there were 9 State Central Quarries under the Department, 5 quarries have **latex injection equipment.**

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PAST EXPERIENCE IN MALAYSIA

1970's

When all the State Central Quarries under the Department have been **'rubberised'**;

1. Using rubber in roads would be a **standard feature.**
2. Not less than **1000 tons of rubber latex per year** would be consumed.

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PAST EXPERIENCE IN MALAYSIA

1968

A full-scale trial at two sites:

a. **KL – Seremban** (mile 17 - 18)

b. **KL – Bentong** (mile 14 ¼ - 14 ½)

Rubber in the form of **latex** was used:

a. Section 1 – **no latex (control)**
b. Section 2 – **1.5% latex**
c. Section 3 – **3.0% latex**

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PAST EXPERIENCE IN MALAYSIA

1968

The latex was added using a pneumatic spray at the pugmill (dry mixing).

A typical mixing sequence at the pugmill;

Time (seconds)	Operation
0	Stones in
+ 5	Bitumen and latex spray begin
+ 30	Bitumen and latex spray stop
+ 32	Filler in
+ 60	Mixing complete

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PAST EXPERIENCE IN MALAYSIA

3 years later

The trial sections failed due to rapid increase in traffic.

The damages were most severe around bends and on descending slopes.

One clear observation - there was no difference between sections with rubber and without.

PWD concluded 'there is nothing to be gained by adding rubber'.

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Types of rubber that had been used during early trial stage;

1. **Plain latex** (30% drc)
2. **Evaporated latex** (60% drc)
3. **Harcrumb** – lightly vulcanised powder (98% drc)
4. **Roborub** – lightly vulcanised powder (75% drc)
5. **Pulvatex** – unvulcanised powder (60% drc)

As each type was used separately at various locations, **no comparisons of performance were made.**

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PAST EXPERIENCE IN MALAYSIA

Nevertheless, the road trial on **Fullerton Road in Singapore** (after 10 years of observation) had shown that;

1. **Latex performed better** than rubber powder.
2. **Latex was more convenient to blend** at asphalt plant.

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PAST EXPERIENCE IN MALAYSIA

1988

Joint study between;

1. Public Works Department, Malaysia.
2. Transport Road Research Laboratory (TRRL), UK.
3. Rubber Research Institute, Malaysia.

Attempted to pre-blend bitumen with 2% rubber latex **(wet mixing).**

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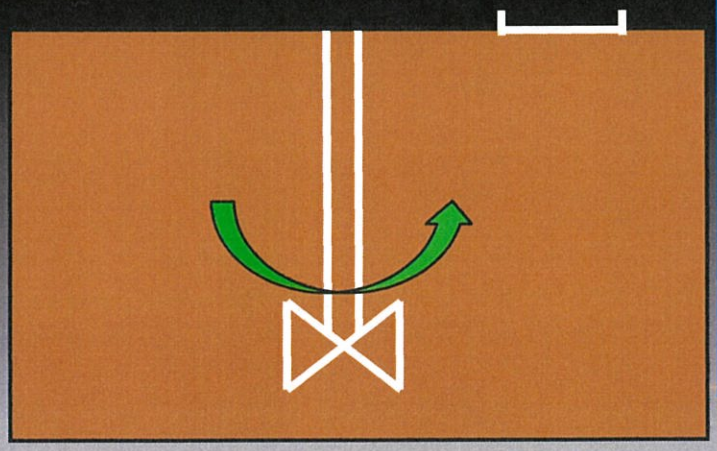
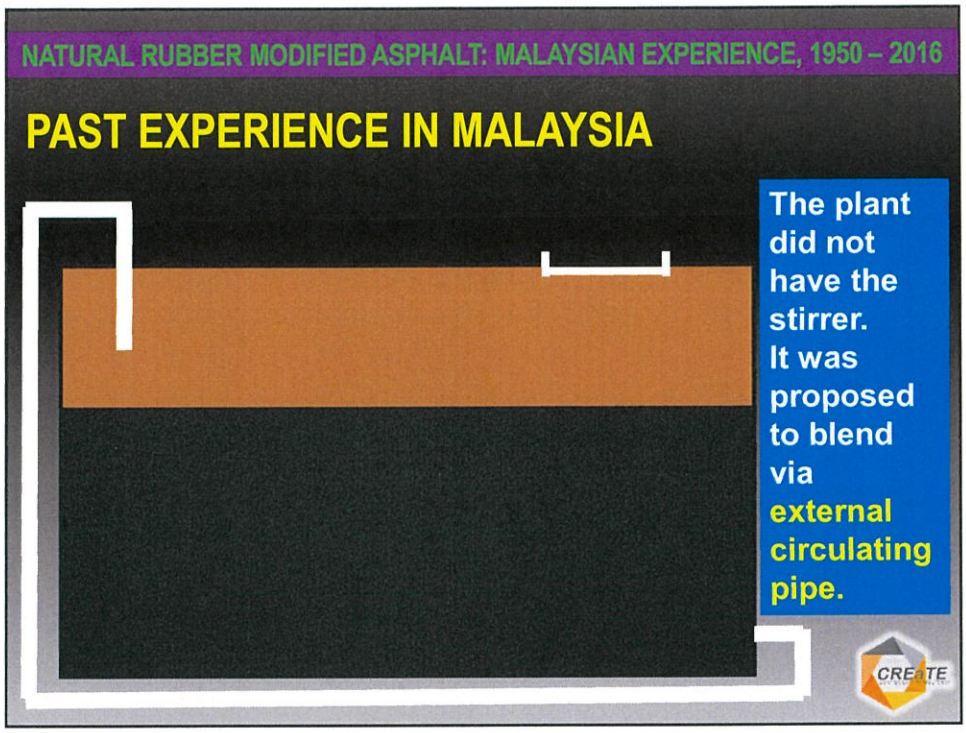
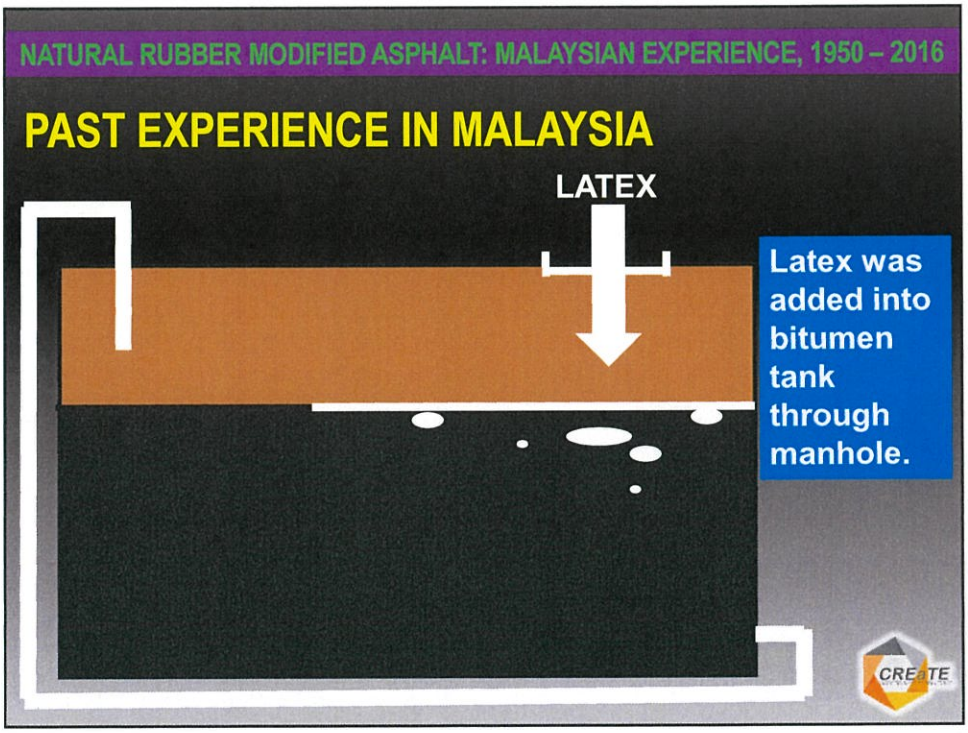
PAST EXPERIENCE IN MALAYSIA

1988



Should have propeller type stirrer fitted inside bitumen tank as described in TRRL Road Note 36.


NATURAL RUBBER MODIFIED ASPHALT: MALAYSIAN EXPERIENCE, 1950 – 2016
PAST EXPERIENCE IN MALAYSIA
The plant did not have the stirrer. It was proposed to blend via external circulating pipe.
CREATE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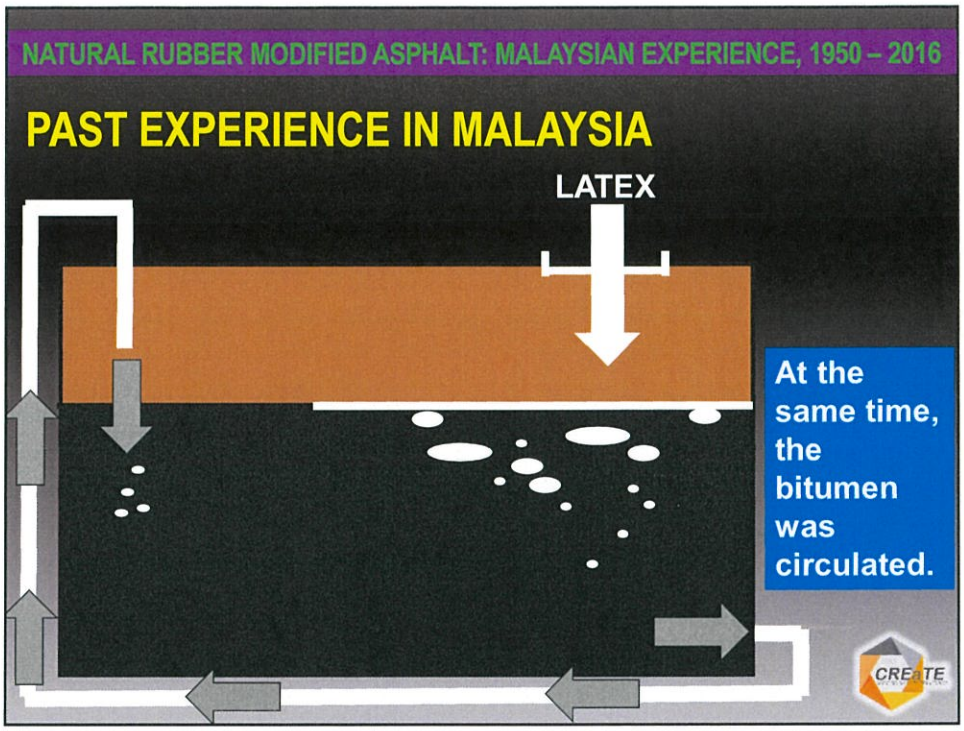
LATEX
Latex was added into bitumen tank through manhole.
CREATE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LATEX
At the same time, the bitumen was circulated.
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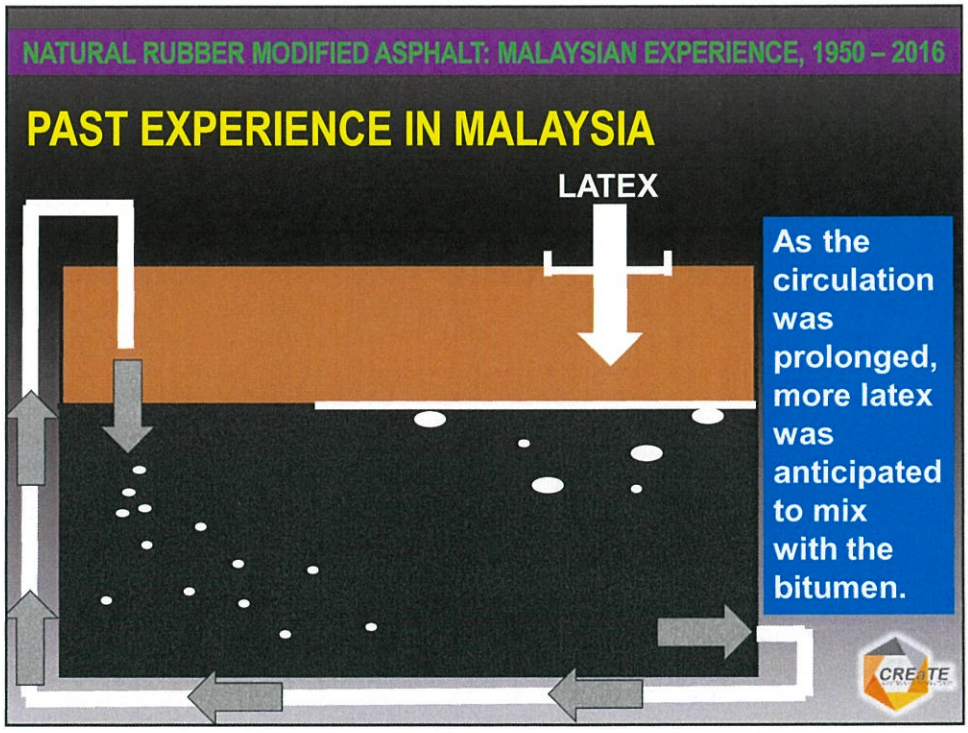
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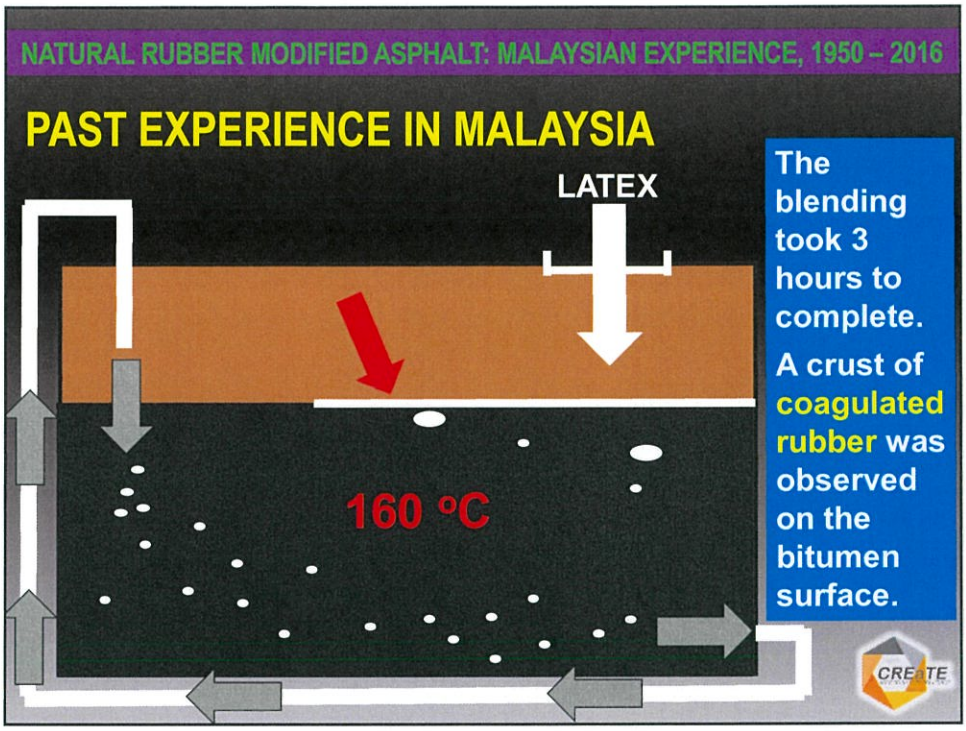
LATEX
As the circulation was prolonged, more latex was anticipated to mix with the bitumen.
CREaTE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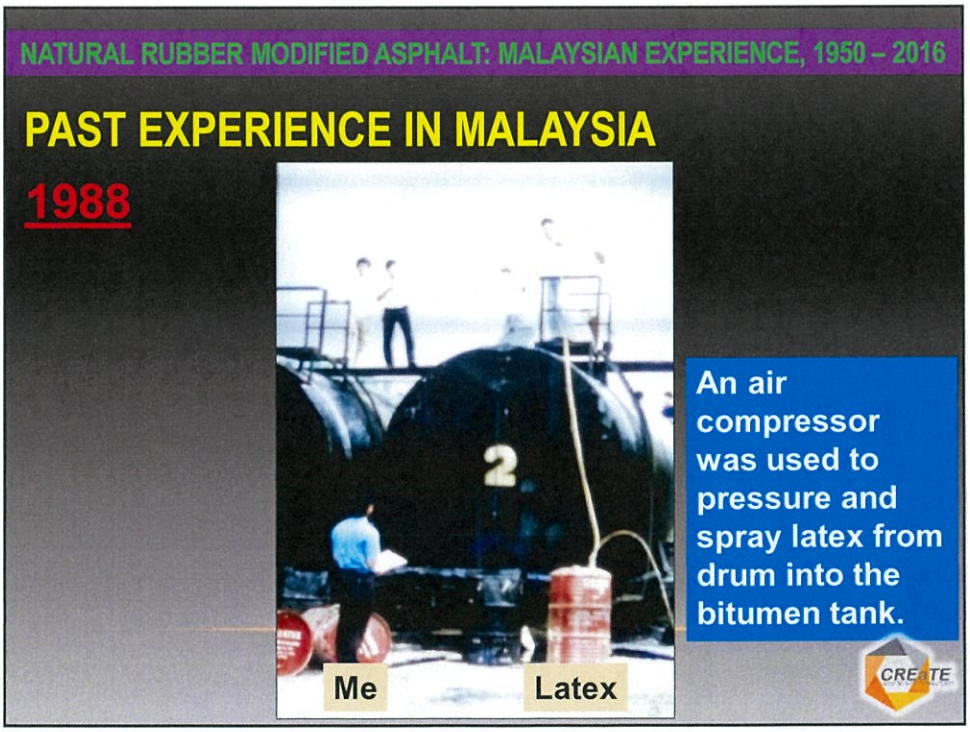
PAST EXPERIENCE IN MALAYSIA
LATEX
160 °C
The blending took 3 hours to complete.
A crust of coagulated rubber was observed on the bitumen surface.
CREATE


NATURAL RUBBER MODIFIED ASPHALT: MALAYSIAN EXPERIENCE, 1950 – 2016
PAST EXPERIENCE IN MALAYSIA
1988
Me
Latex
An air compressor was used to pressure and spray latex from drum into the bitumen tank.
CREATE

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PAST EXPERIENCE IN MALAYSIA

1988

Test sections were laid on Port Klang road more than 16 hours after the start of blending.

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PAST EXPERIENCE IN MALAYSIA

1988

Properties of rubberised bitumen during bending:

Time (hours)	Operation	Penetration 25 °C (0.1 mm)	Softening Point (°C)
0	-	103	47.5
7	Circulation	101	49.5
11	Storage	95	53.0
15	Storage	95	51.0

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PAST EXPERIENCE IN MALAYSIA

1988

Properties of rubberised asphalt:

Material	Bitumen Content (%)	Stability (N)	Flow (mm)
No Latex	6.1	11,600	2.7
Latex	6.2	12,620	2.8

A small increase in stability for the rubberised asphalt. Could be due hardening of the binder during blending and storage.

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1988

After 40 months, no significant difference was observed between the rubberised and non-rubberised test sections.

All test sections performed generally well with no cracks and significant ruts.

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PAST EXPERIENCE IN MALAYSIA

1988

Analysis on the binder extracted from top 3 mm layer did not indicate the rubberised binder has better resistance to age hardening than the normal binder.

It was not known whether rubber was actually present in the test sections as RRIM was not able to verify.

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PAST EXPERIENCE IN MALAYSIA

1993

Road trial on Rembau – Tampin.

Dry mixing – rubber was manually added into the pugmill.

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PAST EXPERIENCE IN MALAYSIA

1993

Rubber powder manually added into the pugmill.

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1993

Rubber powder and **crumb rubber** used in the trial, manually added into the pugmill.

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PAST EXPERIENCE IN MALAYSIA

1993

Rubber latex manually added into the pugmill.

NATURAL RUBBER MODIFIED ASPHALT: MALAYSIAN EXPERIENCE, 1950 – 2016

PAST EXPERIENCE IN MALAYSIA

1993

Road trial on **Rembau – Tampin.**

Constructed in **December 1993.**

Section 1 – **No rubber** (control)

Section 2 – **Rubber powder** from rejected domestic gloves

Section 3 – **Crumb rubber** from old tyres

Section 4 – **Rubber latex** from rubber trees

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PAST EXPERIENCE IN MALAYSIA

1993

Road trial on **Rembau – Tampin.**

Constructed in **December 1993.**

May 1997 – after 3 1/2 years, the **control section had mean rut depth of 2.3 mm.** Other sections had **zero or neglible ruts.**

All sections had **no cracks.**

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PAST EXPERIENCE IN MALAYSIA

2015 - 2016

The most recent road trials, using **rubber cup lump,** at **Tampin, Baling** and **Temerloh.**

Constructed in **December 2015** and **November 2016.**

A joint study between **Public Works Department** and **Malaysian Rubber Board.**

NATURAL RUBBER

Natural Rubber Latex – Sticky, milky colloid obtained by tapping rubber trees. Preserved in colloidal state by adding ammonia.

Dry Natural Rubber

- **Cup Lump** – Latex that coagulate naturally in collection cups.
- **Tree Lace** – Latex that coagulate naturally on tapping cut.
- **Smallholders' Lump** – Latex that coagulate by adding acid by smallholders.

NATURAL RUBBER

Dry Natural Rubber

- **Scrap Rubber** – Form at base of trees due to spillage from tappers bucket, rain flooding collection cups and overflowing latex from tapping cut.
- **Block Rubber** – Latex that coagulate under control and clean conditions at the factory using formic acid. Processed into higher grade block rubber.

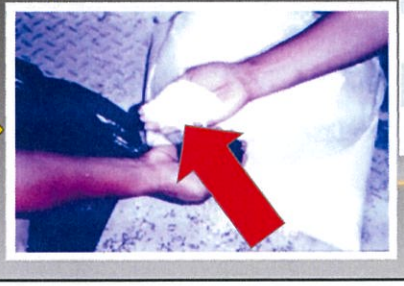
Only **Natural Rubber Latex** and **Dry Natural Rubber - Cup Lump** are included in the PWD specification for **'Natural Rubber Modified Asphalt'**

THE MOST EFFECTIVE RUBBER

Latex

Followed by

Rubber Powder



Shelf Life

Temperature °C	Storage Time (hours)
200	1
180	3
160	12
140	48
≤ 120	7 days

THE MOST EFFECTIVE RUBBER

Adding latex into bitumen

Pre-blending bitumen with rubber (wet mixing) is better than direct addition to asphalt mixes (dry mixing)

Procedures are described in the specification

NATURAL RUBBER MODIFIED ASPHALT: MALAYSIAN EXPERIENCE, 1950 – 2016

RUBBER ALTERS BITUMEN: THE MECHANISM

1. Grains of rubber absorb some oily constituents from bitumen. The grains, swollen to about 5 times, are dispersed in the bitumen.
2. Rubber partly dissolved in bitumen, properties are influenced by the dissolved rubber.
3. The change in bitumen properties is due partly to molecular dispersion of rubber in bitumen.

TRRL, UK "An increase in the degree of dispersion produces greater changes in the properties of the rubberised bitumen"

Mixing process has the greatest influence on the degree of dispersion.

NATURAL RUBBER MODIFIED ASPHALT: MALAYSIAN EXPERIENCE, 1950 – 2016

PAST EXPERIENCE IN MALAYSIA

2015 - 2016

The most recent road trials, using **rubber cup lump**, at **Tampin, Baling** and **Temerloh.**

Constructed in **December 2015** and **November 2016.**

Wet mixing of bitumen with rubber cup lump.


Rubber Cup Lump


Patented by Malaysian Rubber Board
Cup Lump Modified Binder (CMB)

FT10, GEMAS - ROMPIN, TAMPIN, NEGERI SEMBILAN

BEFORE

AFTER
(COMPLETED DEC 2015)

FT10, GEMAS - ROMPIN, TAMPIN, NEGERI SEMBILAN

Overlay @ wearing course 50 mm using CMB and bitumen grade 60-70.

CONTROL SECTION (Asphaltic Concrete)	Cup Lump Modified Asphalt Section (CMA)
500m	500m

FT4, GERIK - KUPANG, BALING, KEDAH

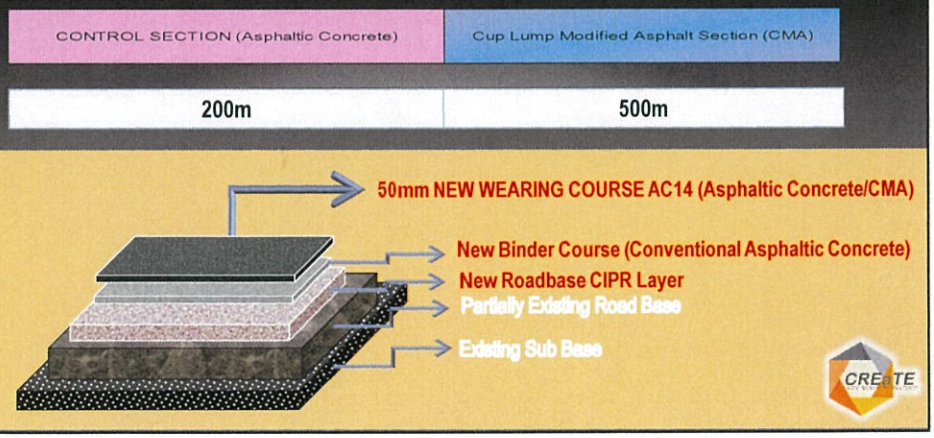
BEFORE

DURING

(COMPLETED NOV 2016)

FT4, GERIK - KUPANG, BALING, KEDAH

CIPR 200 mm + binder course 60 mm + wearing course 50 mm using CMB and bitumen grade 60-70.



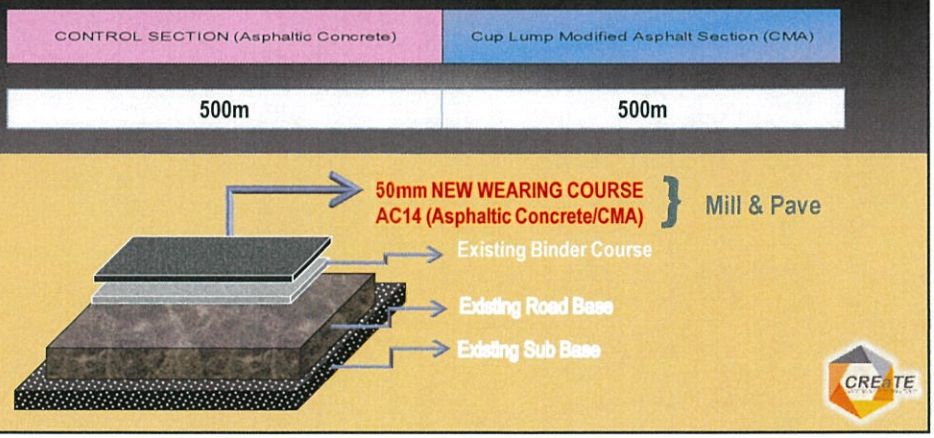
FT2, KL - KUANTAN, TEMERLOH, PAHANG

BEFORE

DURING
(COMPLETED NOV 2016)

FT2, KL - KUANTAN, TEMERLOH, PAHANG

Mill & Pave 50 mm using CMB and bitumen grade 60-70.



FT10, GEMAS - ROMPIN, TAMPIN, NEGERI SEMBILAN

Parameter	Normal Asphalt (60-70)	Cup Lump Modified Asphalt	Requirements
Stability	13,050	13,200	Min. 13,000 N
Flow	3.2	2.9	2.0 – 4.0 mm
Stiffness	4,200	4,600	> 2,000 N/mm
Air voids in mix	3.9	3.5	3.0 – 5.0 %
Voids in aggregate filled with bitumen	75.0	76.5	70 – 80 %

Very small difference in Marshall stability between cup lump modified asphalt and normal asphalt.

FT10, GEMAS - ROMPIN, TAMPIN, NEGERI SEMBILAN

Time After Construction	Rut Depth (mm)			
	Towards Rompin		Towards Gemas	
	60-70	CMA	60-70	CMA
12 months	0.92	0.80	1.41	2.02

After 12 months, there is no significant difference in rut depth between the rubberised and normal sections.

FT10, GEMAS - ROMPIN, TAMPIN, NEGERI SEMBILAN

Time After Construction	IRI (m/km)			
	Towards Rompin		Towards Gemas	
	60-70	CMA	60-70	CMA
12 months	1.85	2.21	2.19	2.53

After 12 months, there is no significant difference in IRI between the rubberised and normal sections.

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LESSONS LEARNT

1. Follow the correct mixing procedures.
2. Wet mixing, not dry mixing.
3. Do not keep rubberised bitumen for too long.

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CONCLUDING REMARKS

- What could be the most important factor for the success in using rubber in roads?
  Support from the Government.
- The Government should;
  - **Create a need** for the use of rubber in roads.
  - **Specify the binder** to be modified using rubber.
    - Will create **interest from the private sector** in venturing into rubber in roads technology.
    - If there is a **sizeable volume and demand,** the private sector will be encouraged to spend on R&D.
      - The main issue is on **handling the rubber** especially during mixing with bitumen.

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THANK YOU

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