

# Pavement Recycling with Asphalt Emulsion and Foamed Asphalt In Thailand



By

**Dr. Tunwin Svasdisant**

**Bureau of Highway Maintenance Management  
Department of Highways, Thailand**

# Presentation Outline

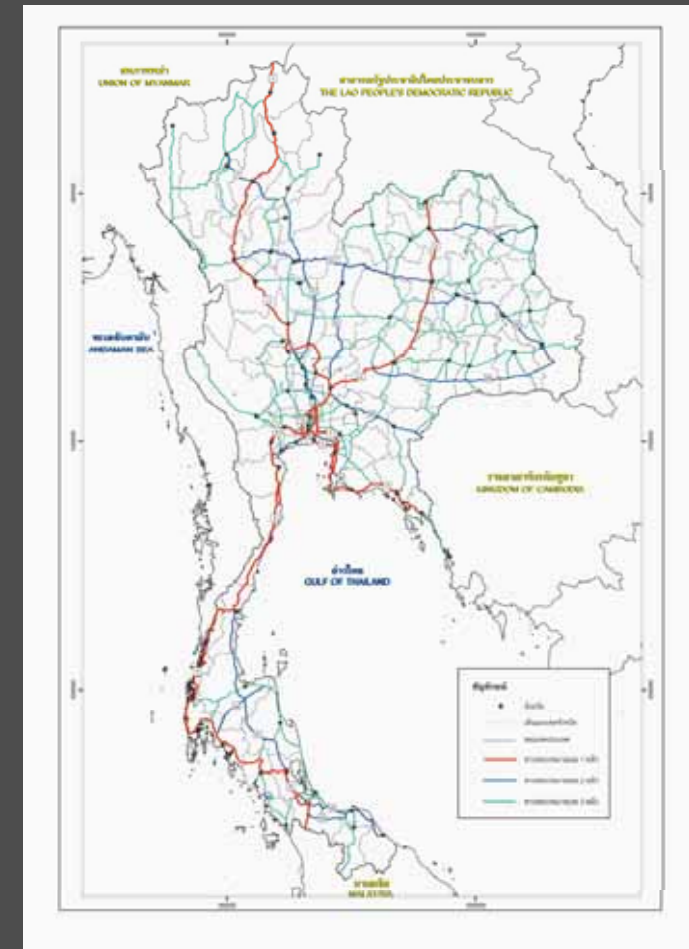
- ◆ Pavement In-Place Recycling in Thailand
- ◆ Asphalt Stabilizers: Foamed Asphalt and Asphalt Emulsion
- ◆ Machines and Equipment
- ◆ Pilot Projects
  - Job mix design and properties
  - Construction process
- ◆ Conclusions and Recommendations

# Presentation Outline

- ◆ Pavement In-Place Recycling in Thailand
- ◆ Asphalt Stabilizers: Foamed Asphalt and Asphalt Emulsion
- ◆ Machines and Equipment
- ◆ Pilot Projects
  - Job mix design and properties
  - Construction process
- ◆ Conclusions and Recommendations

# Pavement In-Place Recycling in Thailand

- ◆ Pavement in-place recycling has been introduced in Thailand since 1992.
- ◆ More than 20 billion bahts were spent on projects involving pavement recycling during the last 5 fiscal years.
- ◆ Most of pavement recycling in Thailand are pavement in-place recycling using Portland cement as the stabilizing agent.



# Projects Involving Pavement Recycling

Year	Budget (Million Bahts)	Budget (Million US\$)	Approx. Area (m <sup>2</sup> )	Approx. Length (2-lane-km)
2006	2,327	78	3,000,000	280
2007	2,990	100	4,000,000	362
2008	3,724	124	5,000,000	454
2009	3,776	126	5,000,000	454
2010	9,033	301	12,000,000	1,090
<b>Total</b>	<b>21,850</b>	<b>728</b>	<b>29,000,000</b>	<b>2,640</b>

# Pavement In-Place Recycling in Thailand

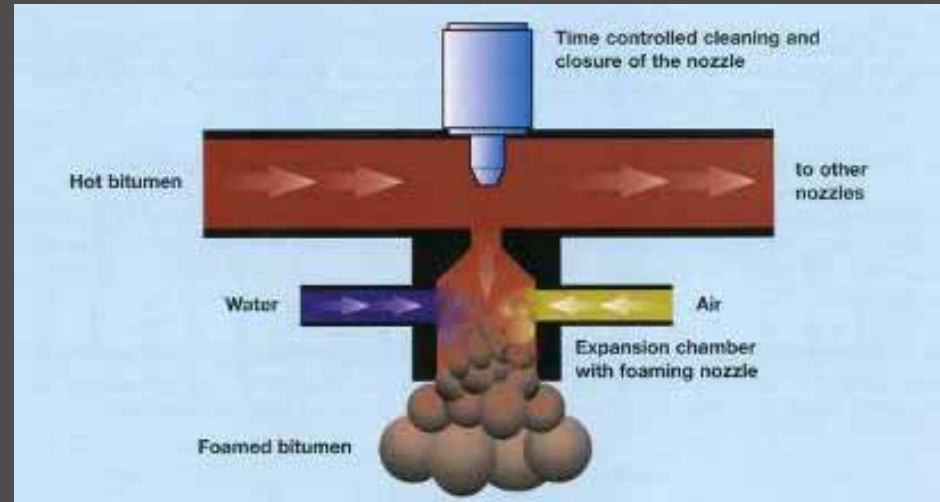
- ◆ Pavement recycling with cement stabilizer is not suitable for the pavement with AC layer 15 cm or thicker.
- ◆ High RAP proportion -> High percent cement required -> Shrinkage cracks
- ◆ Foamed asphalt and asphalt emulsion were introduced to solve this problem.

# Presentation Outline

- ◆ Pavement In-Place Recycling in Thailand
- ◆ Asphalt Stabilizers: Foamed Asphalt and Asphalt Emulsion
- ◆ Machines and Equipment
- ◆ Pilot Projects
  - Job mix design and properties
  - Construction process
- ◆ Conclusions and Recommendations

# Foamed Asphalt

- ◆ **Foamed Asphalt** = Hot asphalt (AC 60-70) + Water + Air
- ◆ When water comes in contact with hot asphalt, the water vaporizes and hence increases the surface area and decreases the viscosity of the asphalt.
- ◆ The foamed asphalt adheres to the fine particles and acts as a mortar binding the larger particles together.



**Source:** Wirtgen Cold Recycling Manual (2004)

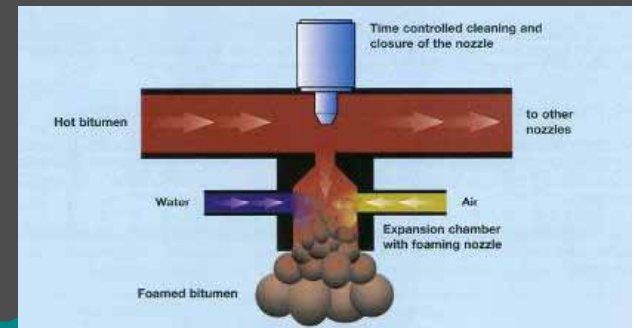


# Presentation Outline

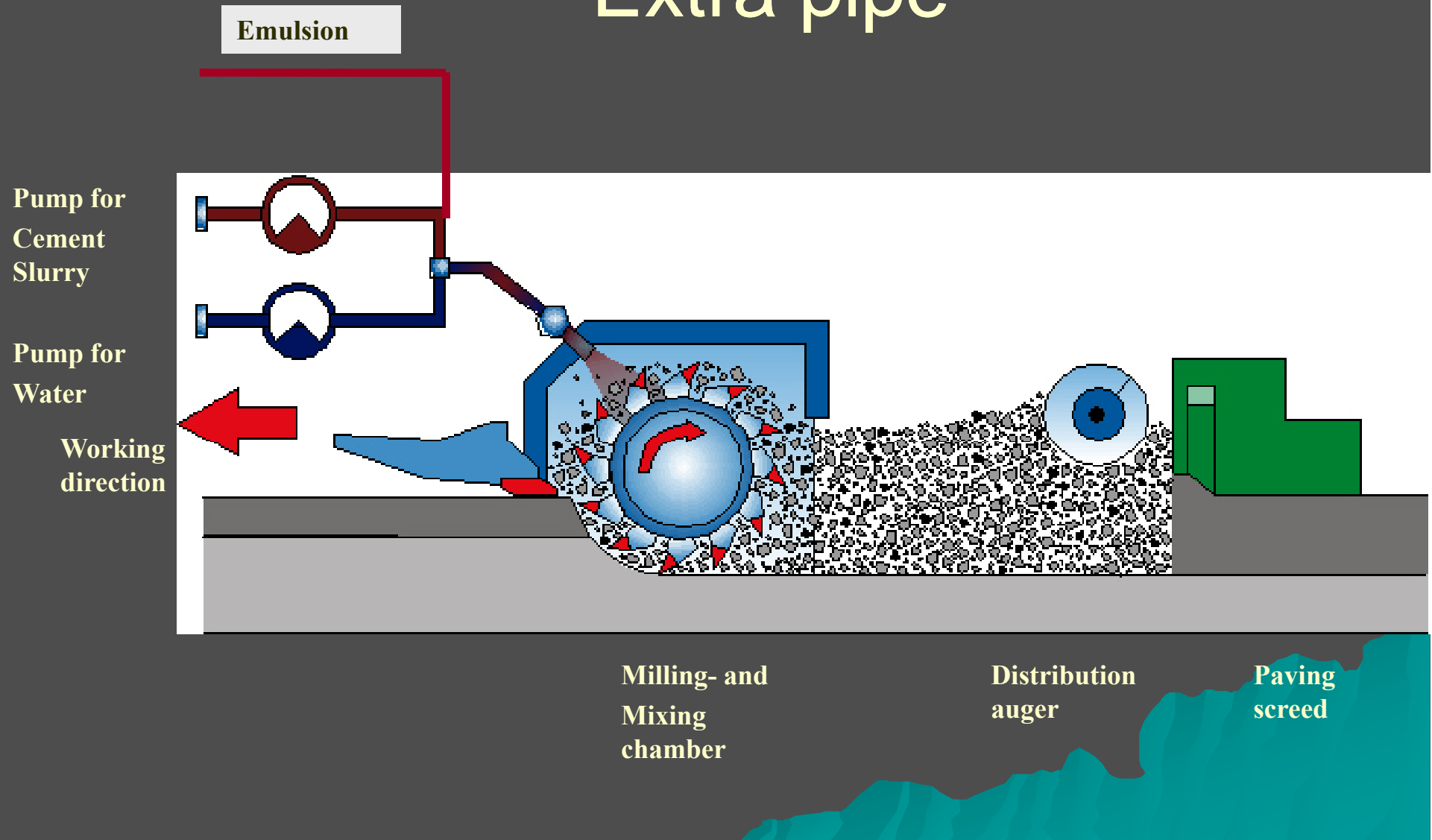
- ◆ Pavement In-Place Recycling in Thailand
- ◆ Asphalt Stabilizers: Foamed Asphalt and Asphalt Emulsion
- ◆ Machines and Equipment
- ◆ Pilot Projects
  - Job mix design and properties
  - Construction process
- ◆ Conclusions and Recommendations

# Machines and Equipment

- ◆ The existing machine and equipment were capable of pavement in-place cement recycling process.
- ◆ Some modifications are required in order to apply foamed asphalt / asphalt emulsion to the mixing chamber.
- ◆ For foamed asphalt, extra equipment are required for foaming process.



# Asphalt Emulsion Recycling : Cement Recycling Extra pipe

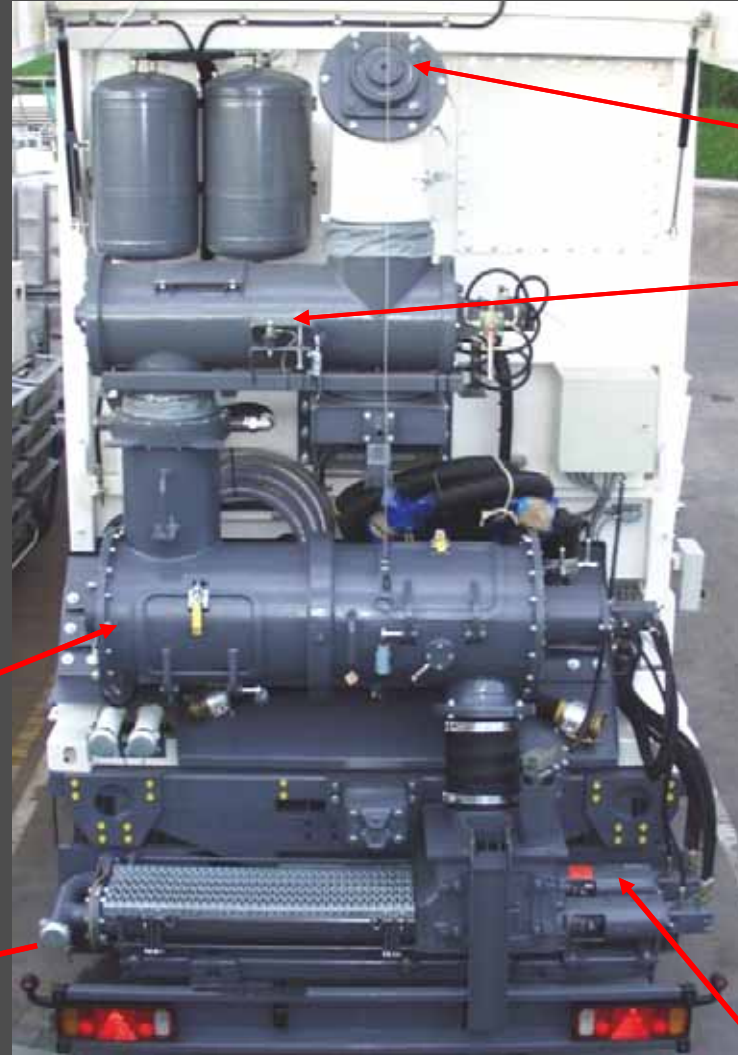


# Slurry mixer WM 1000

## Mixing area



**Slurry mixer**  
**Cement + Water + Emulsion**

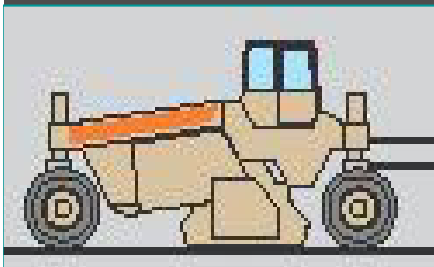


**Feed screw**

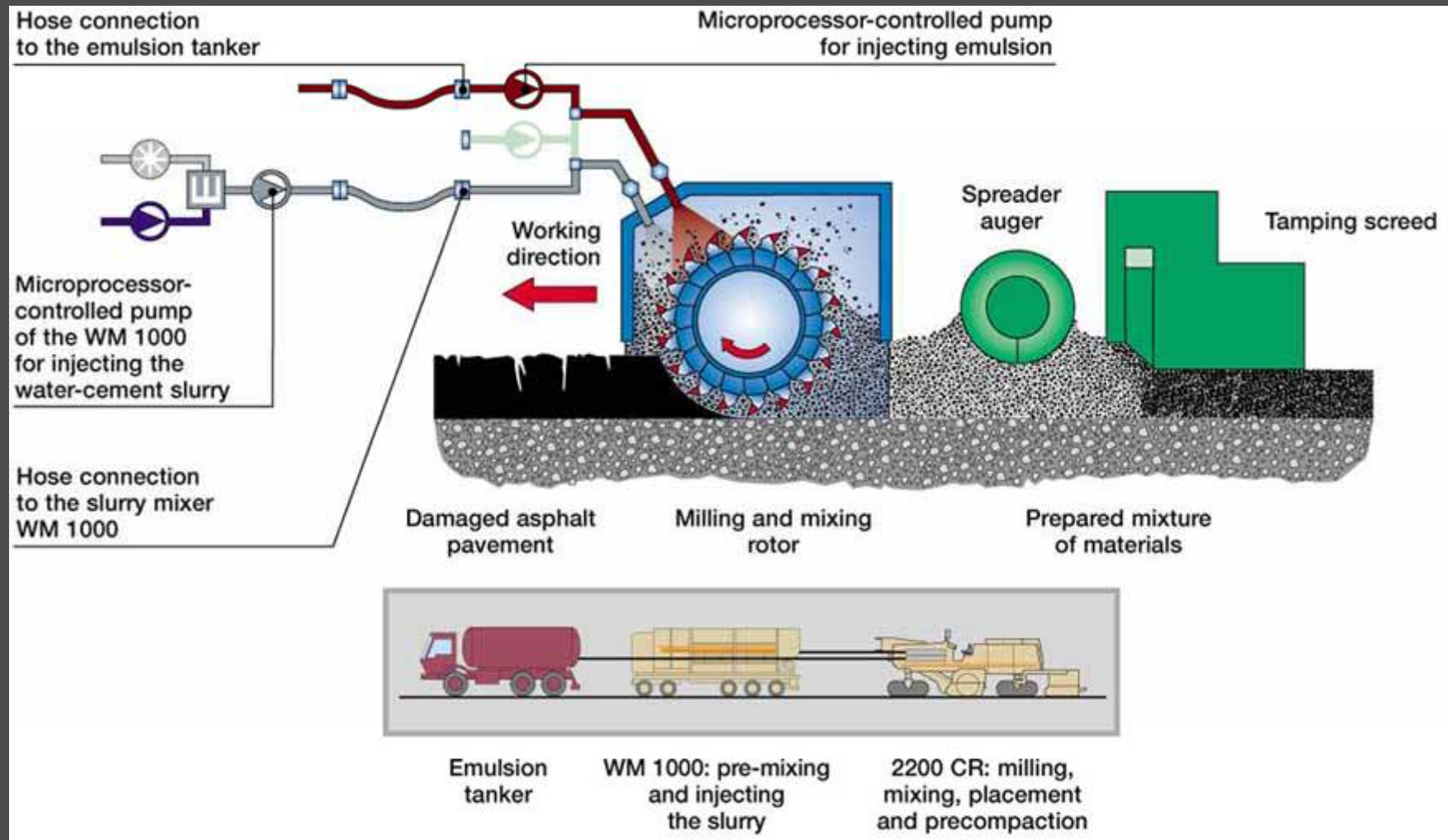
**Weighing equipment**

**Delivery pumps**

**Slurry pipe to the Recycler**



# Foamed Asphalt : Extra spray bar



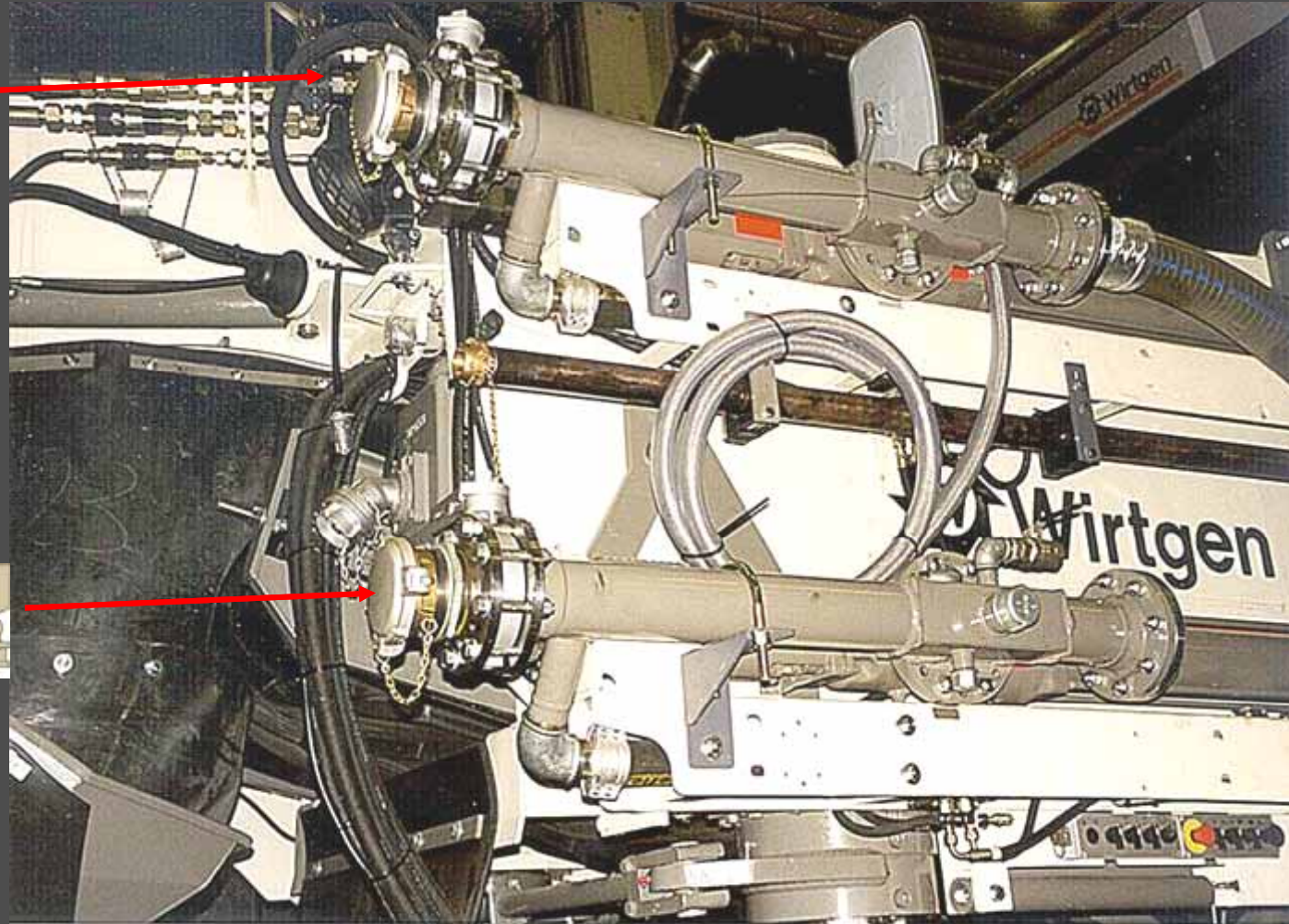




Foamed Asphalt



Cement Slurry

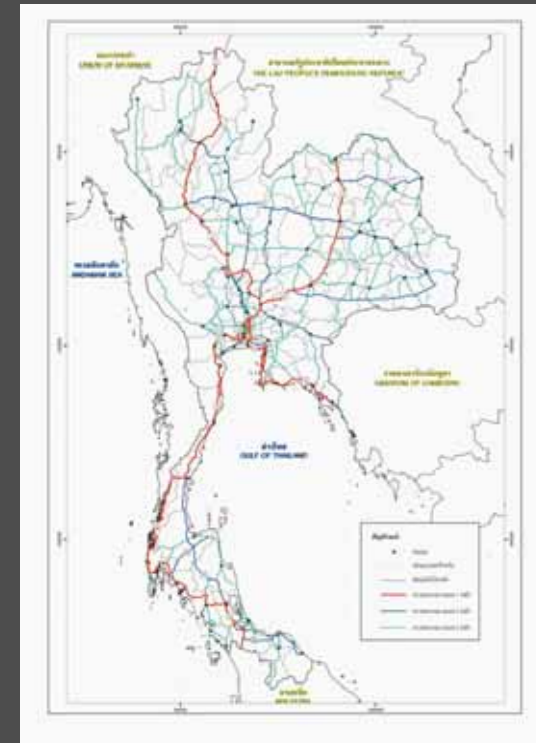


# Presentation Outline

- ◆ Pavement In-Place Recycling in Thailand
- ◆ Asphalt Stabilizers: Foamed Asphalt and Asphalt Emulsion
- ◆ Machines and Equipment
- ◆ **Pilot Projects**
  - Job mix design and properties
  - Construction process
- ◆ Conclusions and Recommendations

# Pilot Projects

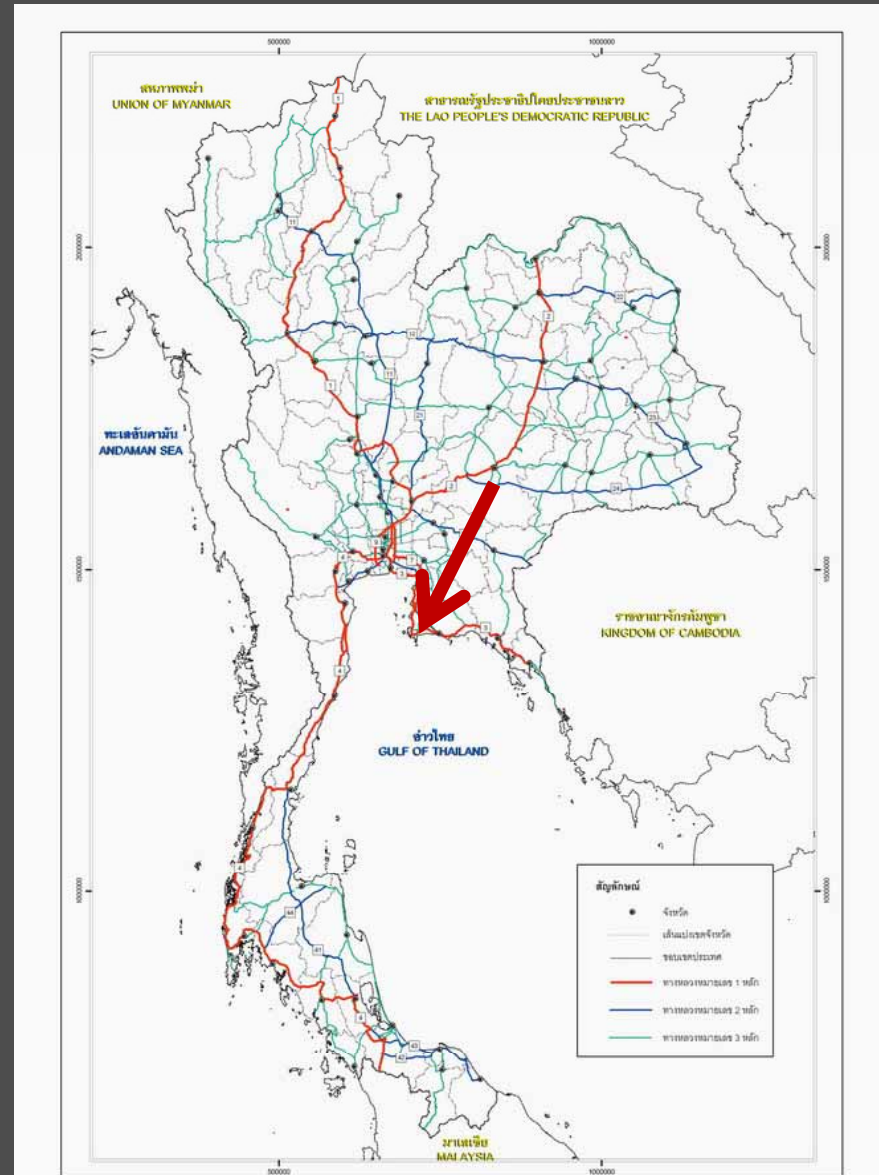
- ◆ Since 2007, there have been 2 foamed asphalt pilot projects and 3 emulsion asphalt pilot projects in Thailand.





# Foamed Asphalt Recycling Pilot Projects

- ◆ The first foamed asphalt recycling project was at highway no. 304, which is the main rout linking the North-Eastern part of Thailand to Laem Chabang Port at the East coast.



# Test sections

The project was divided into two sections.

## The First Section

RAP 60 : Dust-Stones 40 70:30 by weight



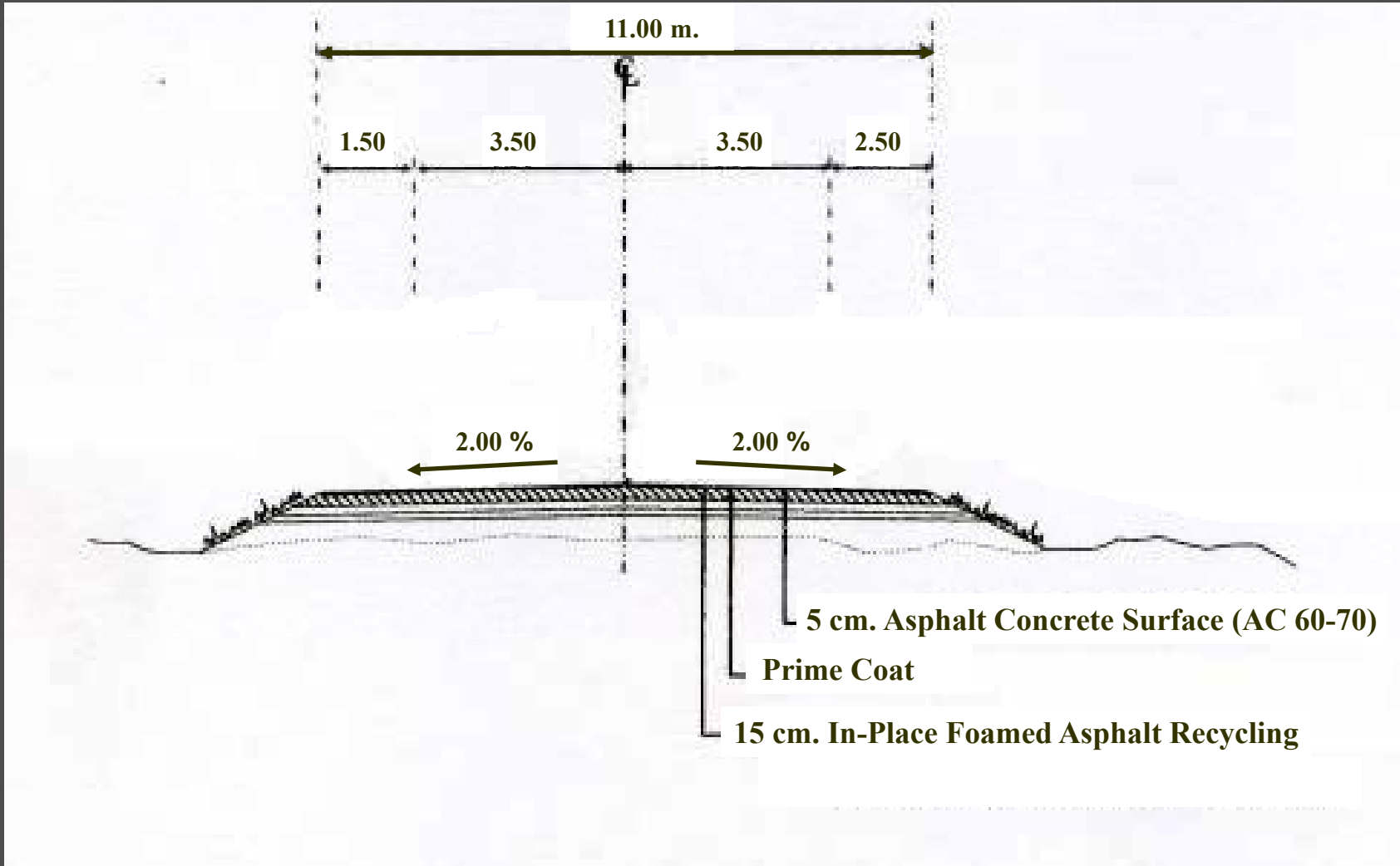
## The second section

RAP 100



**RAP = Reclaimed Asphalt Pavement**

# Cross Section



# Job Mix Design of the Recycling Materials



# Job Mix Design

Item	Mix 1	Mix 2
	RAP 60	RAP 100
Aggregate		
Optimum Moisture Content	6.2 %	6.0 %
Portland cement	1.0 % by weight of aggregate	
Foamed Asphalt		
Amount of Foamed Asphalt	2.0 % by weight of total aggregate	
Asphalt Cement	AC 60-70	
Asphalt Temperature	170° C	
Water	3.5 % by weight of asphalt	
Expansion ratio	10	
Half-life	9 sec	

# Specification

The Indirect Tensile Strength (ITS) and field density were used as the primary properties for quality control of foamed asphalt recycling materials.

Item	Mix 1	Mix 2
	RAP 60	RAP 100
Aggregate materials passing the No. 200 sieve	5.0 % - 7.5 %	< 5.0 %
Foamed Asphalt by weight of aggregate	2.0 % - 3.0 %	2.0 % - 2.5 %
Indirect Tensile Strength (ITS)	> 317.3 kPa	> 276.0 kPa
Density	≥ 97 % Modified Proctor	

# Laboratory Testing

## 1. Indirect Tensile Strength (ITS)

ASTM D 6931

The ITS tests were conducted at 25°C (77°F)

Test specimens were loaded to failure at the rate of 50.8 mm/min  
(2 in./min)



# Laboratory Testing (cont'd)

## 2. Unconfined Compressive Strength (UCS)

Following to AASHTO T 208





# Laboratory Testing (cont'd)

## 3. Resilient Modulus (MR)

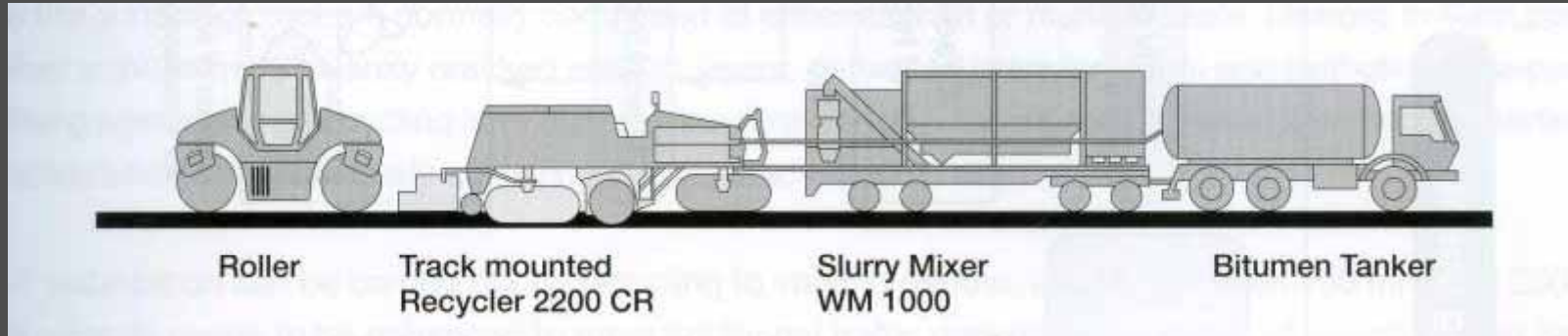
ASTM D 4123 and AASHTO TP31



# Presentation Outline

- ◆ Pavement In-Place Recycling in Thailand
- ◆ Asphalt Stabilizers: Foamed Asphalt and Asphalt Emulsion
- ◆ Machines and Equipment
- ◆ **Pilot Projects**
  - Job mix design and properties
  - **Construction process**
- ◆ Conclusions and Recommendations

# Recycling Train



**Source:** Wirtgen Cold Recycling Manual (2004)



# Construction Processes

- ◆ Milling, mixing and paving the recycled materials



# Construction Processes (cont'd)

- ◆ **Single Smooth Drum Vibrating Roller (High-Amplitude Vibration)**



- ◆ **Pneumatic Tyre Roller**



# Construction Processes (cont'd)

- ◆ **Motor Grader** was used to cut the required final levels



- ◆ **Single Smooth Drum Vibrating Roller** (Low-Amplitude Vibration)





# Construction Processes (cont'd)

- ◆ Pneumatic Tyre Roller was used to finish the compaction processes



- ◆ Spray the water to cure the recycled base for 3 days



# Construction Processes (cont'd)

- ◆ Prime Coat



- ◆ Asphalt Concrete Overlay





# Problems Experienced

- ◆ Foamed asphalt recycling required special heated tank with circulation system for asphalt to achieve the temperature of 170 oC at site.
- ◆ High modification cost and close attention for quality control are required for foamed asphalt recycling.

# Lessons Learned

- ◆ Foamed asphalt recycling can be done with % filler < 5% (100% RAP) but with cement added.
- ◆ Operating parameter such as speed of the recycling train and the temperature of the AC binder greatly affect the quality of the recycling materials.

# Emulsion Asphalt Recycling Pilot Project

Highway No. 347  
the out skirt of  
Bangkok



# Comparison of JMFs and Properties

	Test sections					
	Foamed asphalt			Emulsified asphalt		
	1.1	1.2	2	1	2	3
RAP : Aggregates	70:30	100:0	100:0	51:49	42:58	41:59
% Asphalt	2.0	2.0	2.0	3.0 / 1.95	3.0 / 1.95	2.5 / 1.63
% Cement	1.0	1.0	1.0	2.0	2.0	1.0
% OMC	6.2	6.0	7.6	5.8	6.6	4.2
% Passing No. 200	<b>5.8</b>	<b>0.7</b>	<b>NA.</b>	<b>16.9</b>	<b>1.0</b>	<b>6.4</b>
Density (t/m <sup>3</sup> )	2.061	2.004	1.887	2.21	2.248	2.347
ITS soaked (kPa)	NA	NA	306	381	270	272
ITS unsoaked (kPa)	<b>353</b>	<b>307</b>	<b>300</b>	<b>480</b>	<b>353</b>	<b>364</b>
AC type	AC 60-70	AC 60-70	AC 60-70	Css-1s	Css-1s	Css-1s
Remarks	Fresh dust stones			Crushed rock base	Fresh crushed rocks	Fresh crushed rocks

# Conclusions

1. Based on the results of several test sections, it can be concluded that pavement in-place recycling using foamed asphalt and asphalt emulsion recycling can be done in Thailand with satisfied results.

# Conclusions

2. The existing machine and equipment for cement recycling could be modified to perform foamed asphalt / asphalt emulsion recycling. (cost for foamed asphalt is more expensive)

# Conclusions

3. Foamed asphalt recycling can be done with 100% RAP (% filler < 5%) However,
  - Portland cement was added to improve the strength of the recycling materials, especially in soaked condition
  - % filler greatly affect the strength of the recycling materials.

# Conclusions

4. Long term performances of the test sections are still under investigation.
5. Asphalt emulsion recycling is more preferable option in Thailand because of its lower modification cost and no problem with the AC temperature control at site.



# Recommendations

1. A small test section to calibrate the operating parameters of the recycling process is definitely necessary.
2. Conditions of the recycling machine and equipment such as milling bits should be checked daily.

# Recommendations

3. To produce foamed asphalt from AC 60-70, the minimum AC temperature of 160 °C is required
4. Circulation system in the AC storage tank for foaming process should be installed.
5. Less amount of prime coat per square meter is required for asphalt recycling material base comparing to cement recycling base.



# 7<sup>th</sup> ICPT Conference

International Conference on  
Road & Airfield Pavement Technology (ICPT)



**Queen Sirikit National Convention  
Center (QSNCC) Bangkok, Thailand  
3-5 August 2011**

[www.icpt2011.org](http://www.icpt2011.org)

Hosted by



Supported by



Managed by





## Important Date



<b>5 Nov 2010 (FRI)</b>	<b>Deadline for submission of abstract &amp; Best Paper for Student Awards</b>
<b>15 Nov 2010 (MON)</b>	<b>Abstract notification and instruction for full paper preparation</b>
<b>1 Feb 2011 (TUE)</b>	<b>Deadline for submission of full paper.</b>
<b>1 April 2011 (FRI)</b>	<b>Full paper notification and instructions for slide preparation</b>
<b>5 May 2011 (THU)</b>	<b>Deadline for submission of final camera-ready</b>
<b>15 April 2011</b>	<b>Deadline for early bird registration to the 7th ICPT 2011 Conference</b>
<b>15 July 2011</b>	<b>Deadline for pre-registration to the 7th ICPT 2011 Conference</b>