

Hot Mix Asphalt Recycling Experiences in Taiwan



Chui-Te Chiu

Professor, Department of Civil Engineering
Chung Hua University, Taiwan

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Outlines

- ✓ Backgrounds
- ✓ Pavements in Taiwan
 - Pavement Structures & Materials
 - Performance & Maintenance Works
- ✓ Hot Mix Recycling in Taiwan
 - Special Conditions
 - Production and Quality Control
 - Future Development
- ✓ Conclusions

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Backgrounds

- ✓ 23°46'N, 121°0'E; Marine Tropical, MAAT >20°C, No winter except in mountains.
- ✓ Length 384km, Width 128km, Area: 35,801 km², Population:23 million.
- ✓ Mostly mountainous (75%) in the east and gently sloping plains(25%) in the west.

Taiwan Highway System



Road Length in Taiwan

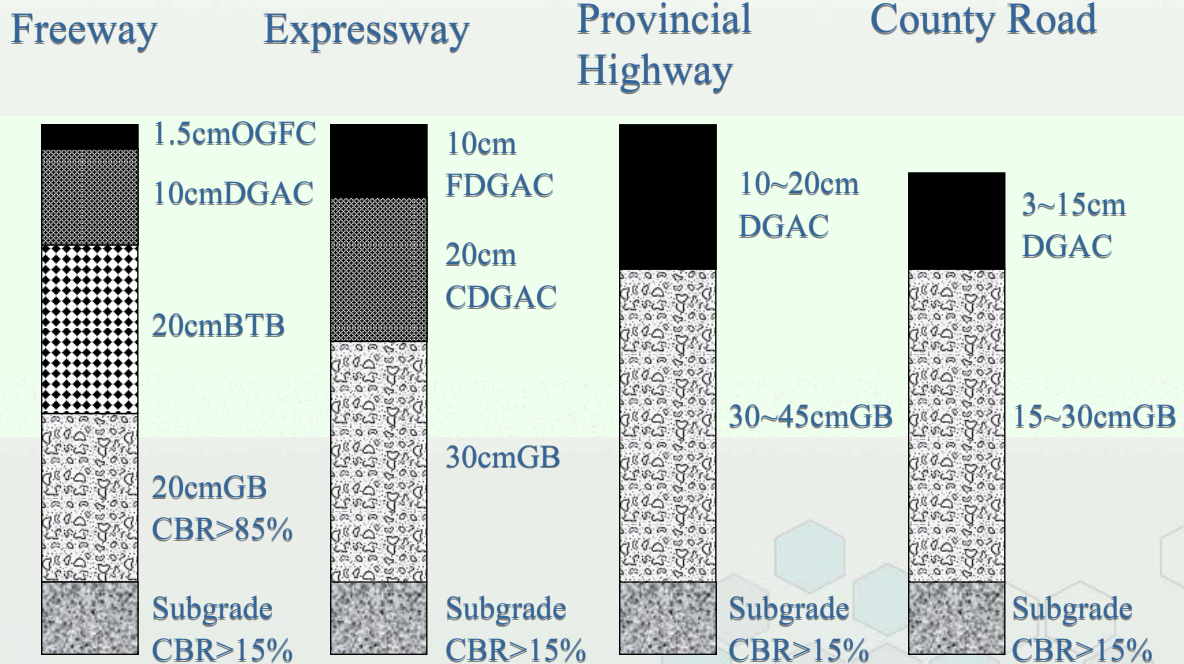
- ✓ Total road length approx. 38,000km, 56% highways, road density 1,100m/km²

As in 2003, Unit: Km

Total	Highways						City Streets
	Sum	Freeways	Provincial Highways	County Roads	Country Roads	Special Roads	
37,342	20,947	872	4,621	3,426	11,613	415	16,395

- ✓ Asphalt pavements are used on more than 95% of highways.
- ✓ Annual consumption of HMA: 13 million metric tons.

Pavement Structure in Taiwan



Asphalt binder: Typical Pen85/100 (AC-10), some AC-20

Maintenance Works

- ✓ Freeway: mostly OGFC functional distress, every 4 to 6 year, mill & repave 5cmDGAC+1.5cmOGFC.
- ✓ Expressway & provincial highway: mill & repave 5cmDGAC, deep reclamation on particular sections, some sustain for only 2 to 4 years due to extension works for utility lines, others for 4 to 6 years typically.
- ✓ County roads: 5 cm overlay in rural area, mill & repave 5cmDGAC in urban area, typically sustain for 4 to 6 years.

Typical Mill & Repave Works



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Hot Mix Recycling in Taiwan

- ✓ Trials in 1998, Central Plant Hot Mix Recycling
- ✓ 2002, Recycling Mandate for Provincial Highways
- ✓ 2006, Accredited 105 Hot Recycling Plants (65%).
- ✓ Cold Milling, sending RAP back for hot recycling, and paving back on the pavement.
- ✓ In-Place Recycling was not adopted in consideration of air quality in urban area, road width, manholes, and strong hot mix industries.

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Extension works for utility lines



Manholes on pavements



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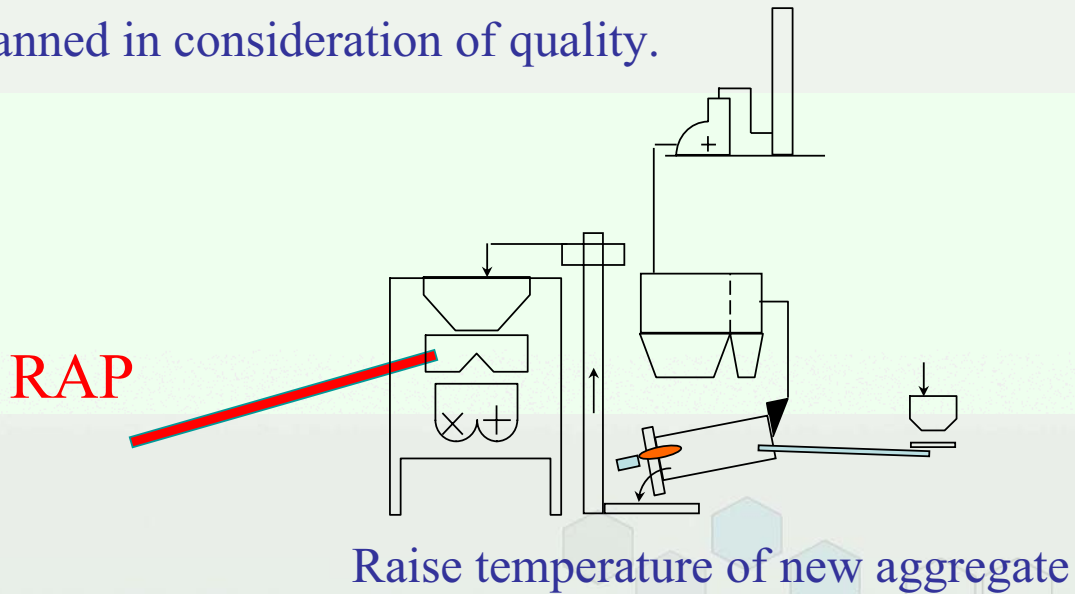
Typical Batch Plant in Taiwan



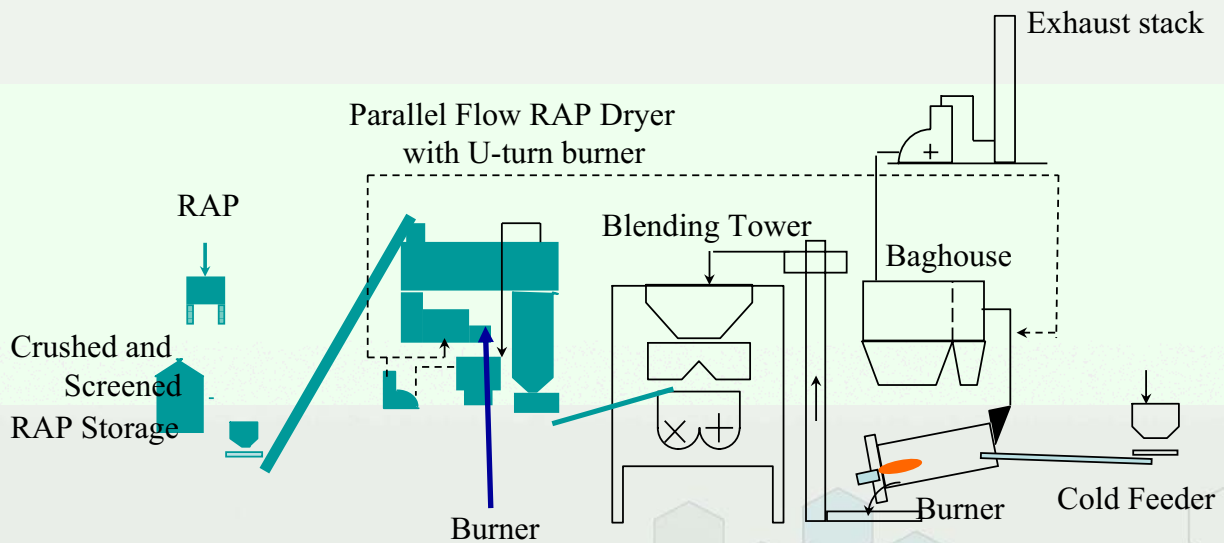
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Heat Transfer in Pugmill?

Banned in consideration of quality.



Typical Hot Mix Recycling Plant in Taiwan



RAP temperature around 120°C

Parallel flow RAP dryer With U turn burner



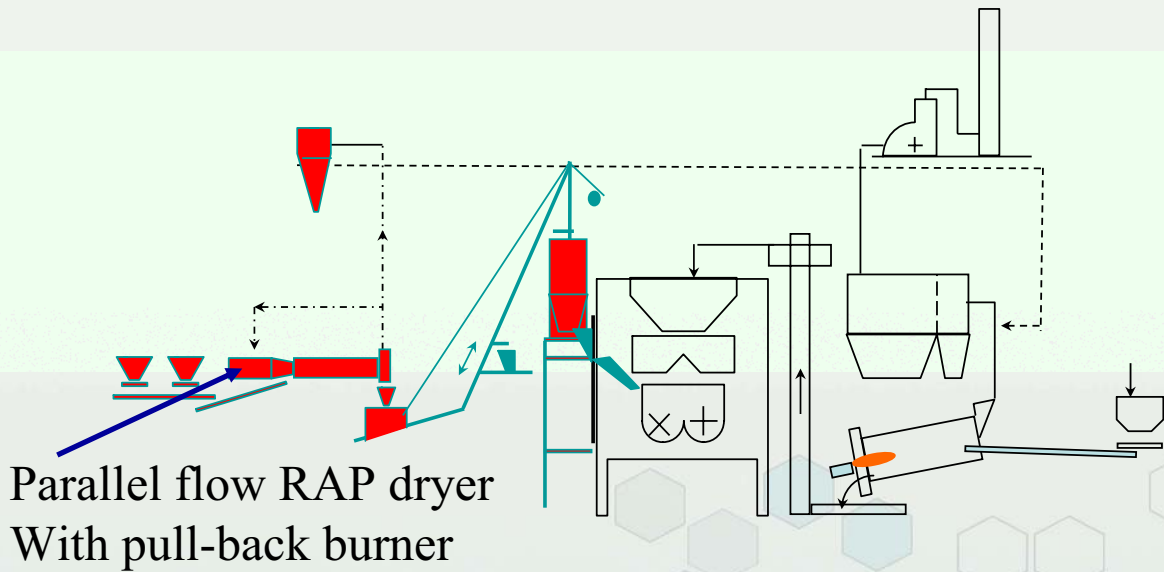
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Add RAP dryer on Batch Plant



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Typical Hot Mix Recycling Plant in Taiwan

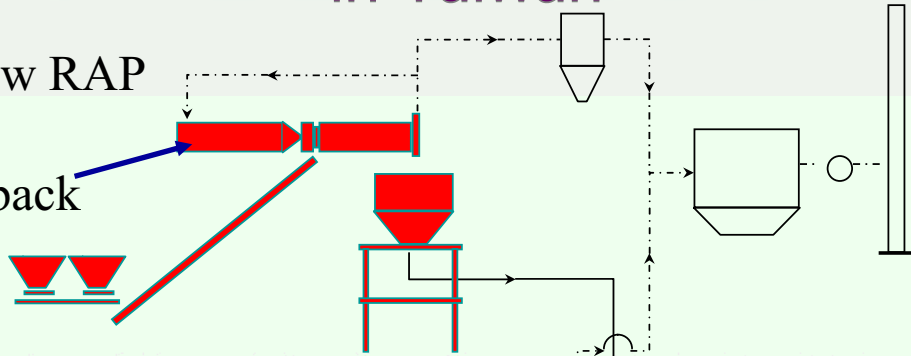


Add RAP dryer on Batch Plant

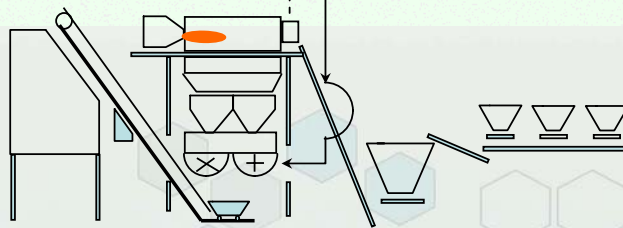


Typical Hot Mix Recycling Plant in Taiwan

Parallel flow RAP
dryer
With pull-back
burner



Batch plant with dryer
drum screening
system





Special Conditions for Recycling HMA

- ✓ Requiring RAP dryer and the plant need to be accredited.
- ✓ Maximum RAP%: 40%
- ✓ Check recovered viscosity to assure the same quality as virgin HMA
- ✓ Set mandate for recycling.



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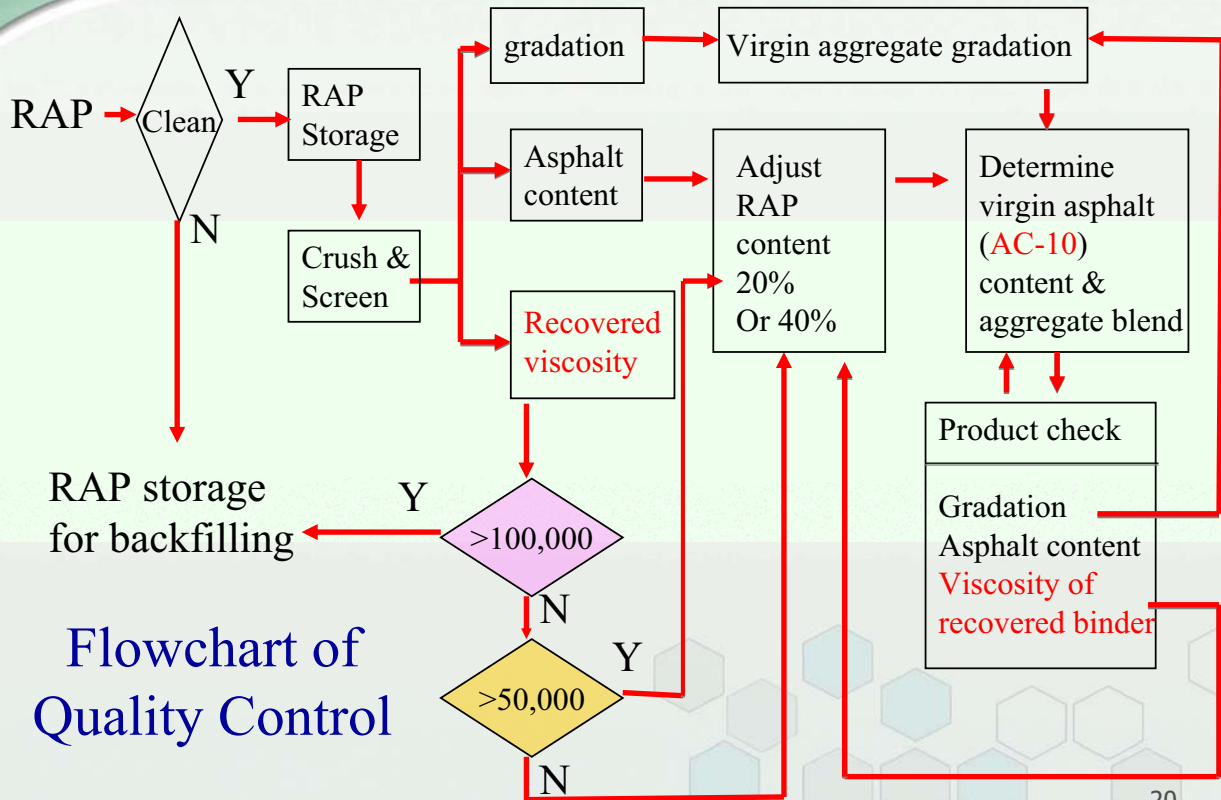


Taiwan Highway Bureau

Added provisions for recycled HMA in Technical Specifications

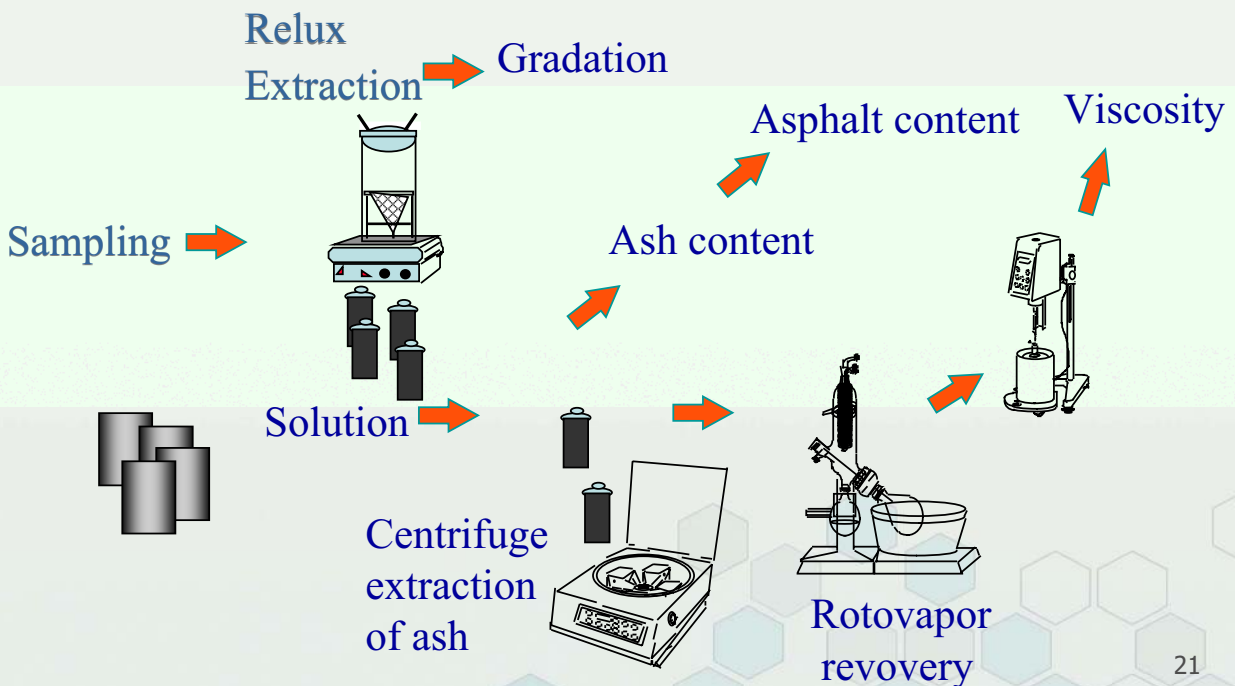
- ✓ $RAP\% < 40\%$, $AC\%$ of RAP $> 3.8\%$ (3.0%), Pen. of recovered binder of RAP > 20 .
- ✓ No particular rejuvenator is required as long as the target viscosity is specified and verified in mix design.
- ✓ The viscosity of recovered binder is checked every 2,000 metric ton to be within 35% of target viscosity specified in mix design.

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Flowchart of Quality Control

Tests for quality check



Relux Extraction



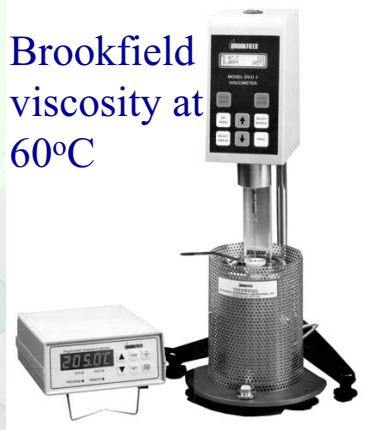
Centrifuge extraction of ash



Rotovapor recovery



Brookfield
viscosity at
60°C



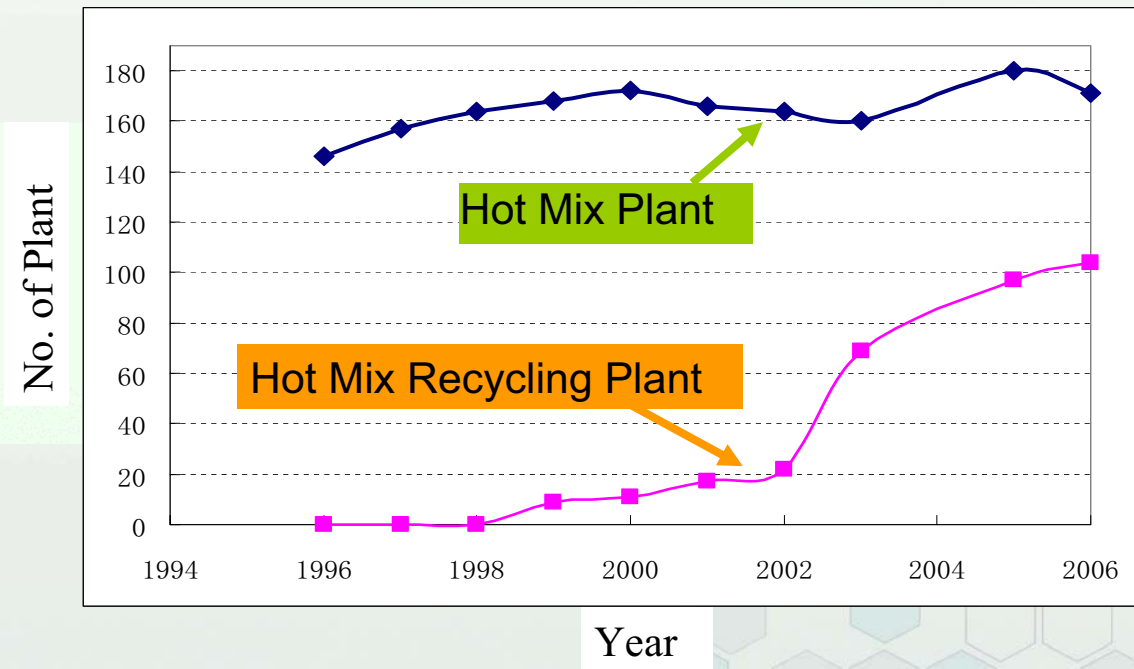
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Hot Mix Recycling is a successful program in Taiwan

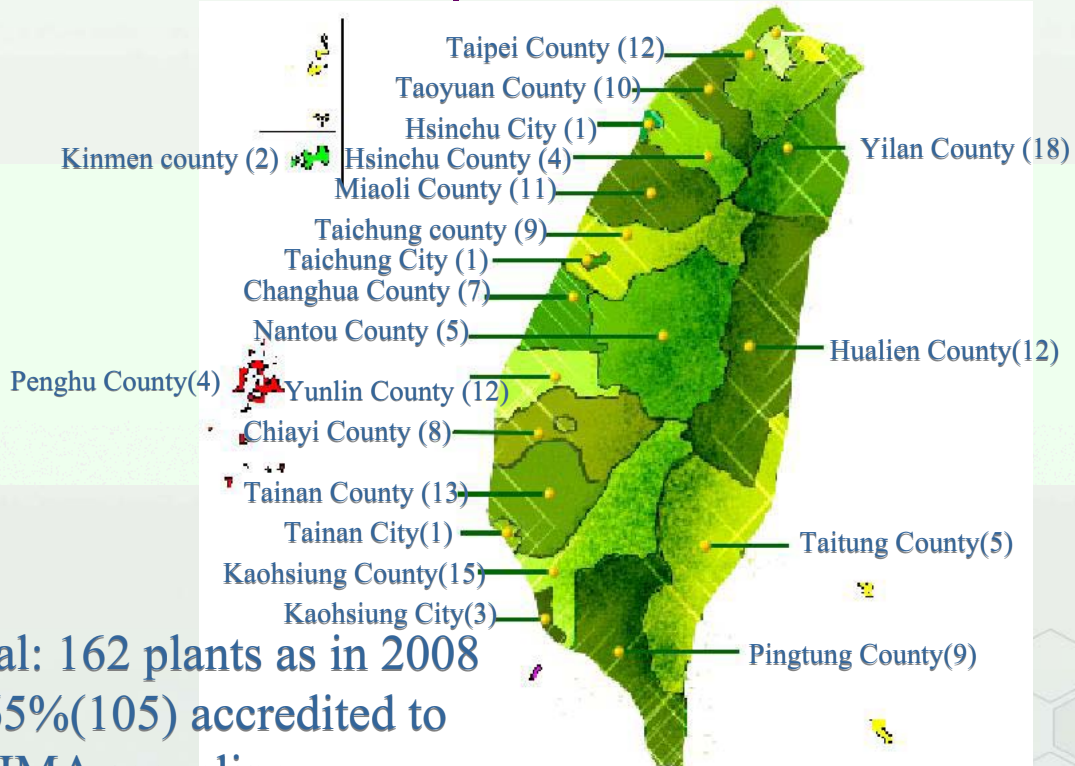
New Construction			
Year	Recycled HMA (M³)	PCC goal %	Actual %
2002	25,244	>10%	47%
2003	18,707	>20%	33%
2004	195,009	>30%	41%
Maintenance Work			
2002	126,644	>20%	43%
2003	615,070	>30%	53%
2004	1,712,527	>40%	69%

Source: 

Increasing Trend of Hot Mix Recycling Plant in Taiwan



Hot Mix Asphalt Plants in Taiwan



Total: 162 plants as in 2008
 65%(105) accredited to
 HMA recycling

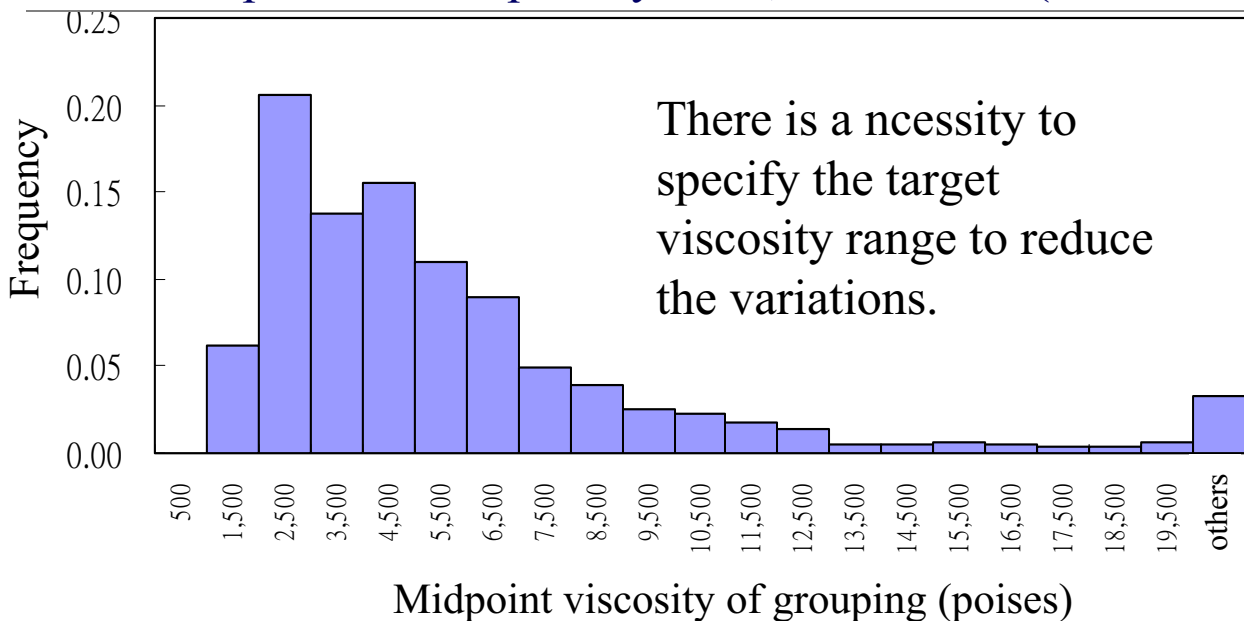
How hard is our RAP?

Year	No. of Test	No. of Pen. <20
2003	82	6 (7%)
2004	66	13 (19%)
2005	56	15 (27%)
2006	35	10 (29%)

Getting harder.

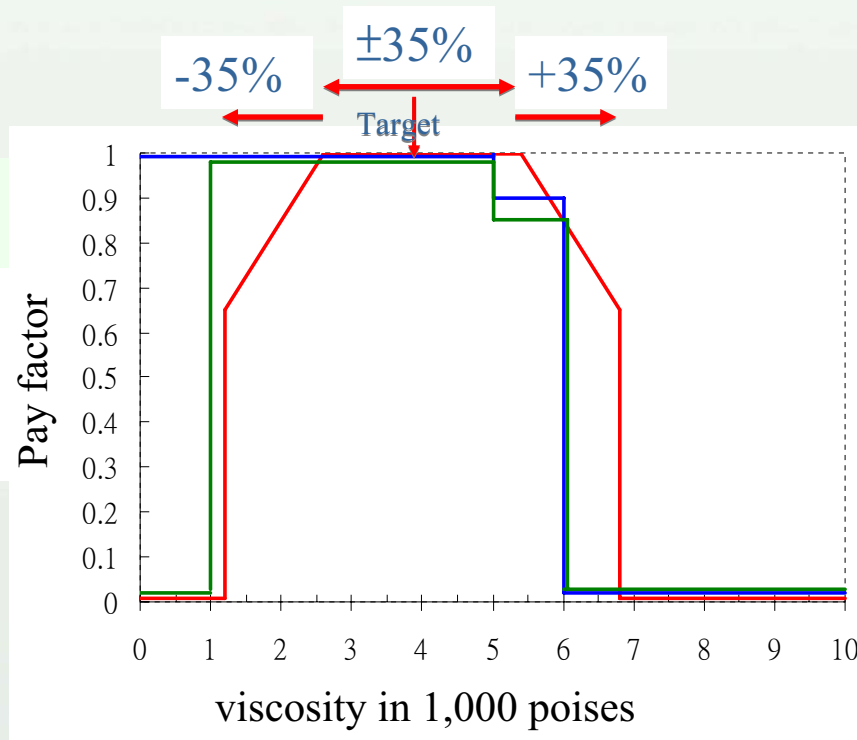
Source:  Material Lab of THB

Histogram of viscosities of recovered binder from recycled HMA products sampled by THB, 2003~2006 (n=722)



Source:  Material Lab of THB

Payfactor Proposed by Taiwan Highway Bureau, 2007



Source:  Material Lab of THB

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Conclusions

- ✓ In ten years, Taiwan is very successful in hot mix recycling.
- ✓ Key Success Factors (KSF): Mandate, Using RAP dryer, Accreditation of Recycling Plants, Softer RAP, Climate (No low temperature issue).
- ✓ We are now considering of using rejuvenators or reducing RAP % due to harder RAP.
- ✓ Future development will focus on sound integration of pavement management system, beneficial use of other waste materials, and innovative procuring processes.

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Beneficial Use of Waste Materials

Sewage Sludge Ash



Waste Glass



Scrap Tires



Coal Fly Ash/Bottom Ash

Waste is misplaced material.

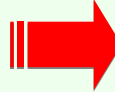


Residual soil



C & D Waste

Steel Slag



MSW IBA

Asphalt Rubber Trials in Taiwan

Home Made AR Blender





Thank you

