



# Utilization of Very High RAP Contents

Lessons Learned from the Japan Scan Tour

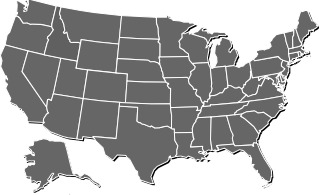



Japan Tour Delegates and Hosts  
at Maeda Road Asphalt Plant  
December 2014

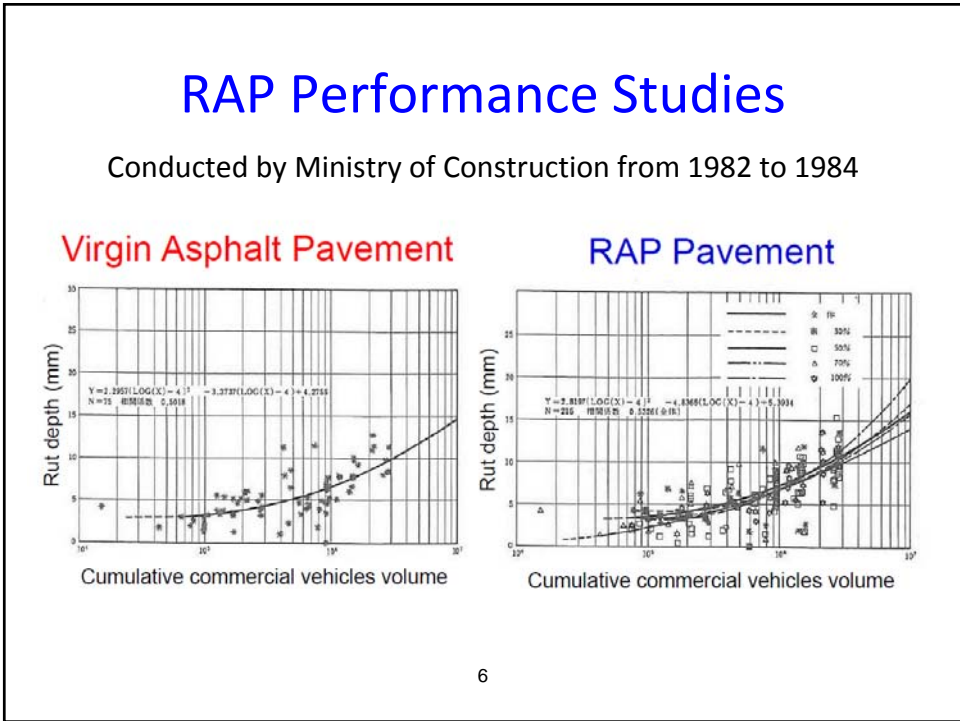
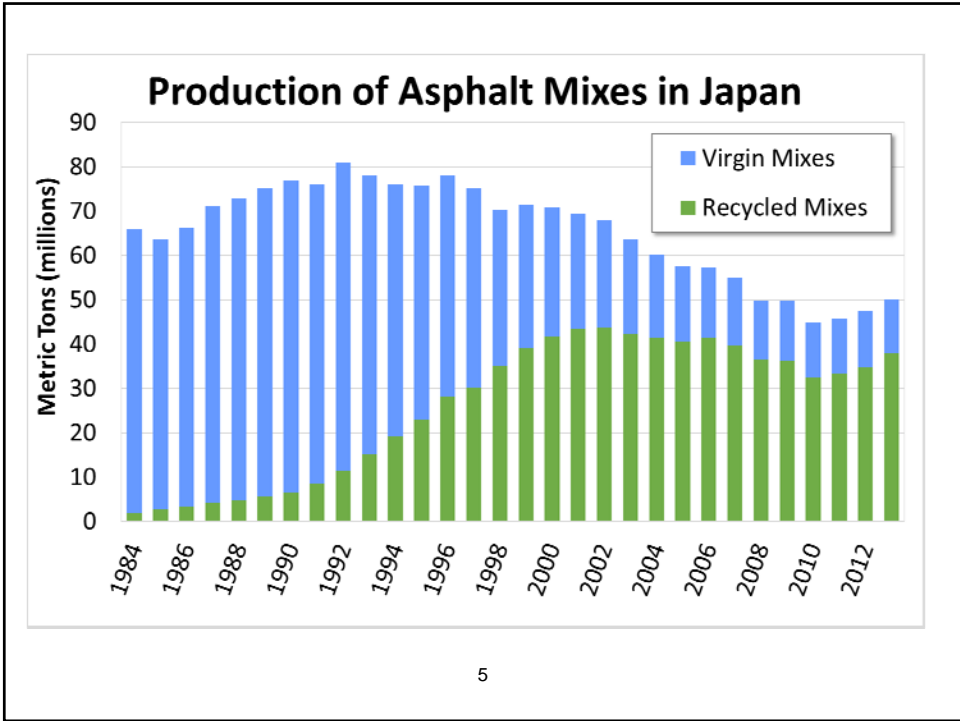


## Comparisons

|                              | U.S.                      | Japan                   | %     |
|------------------------------|---------------------------|-------------------------|-------|
| <b>Land Area</b>             | 3,806,000 mi <sup>2</sup> | 145,925 mi <sup>2</sup> | 3.8%  |
| <b>Population</b>            | 321 million               | 128 million             | 40%   |
| <b>Miles of Paved Roads</b>  | 2,605,331                 | 791,189                 | 30.4% |
| <b>No. of Asphalt Plants</b> | ~3000                     | 1150                    | 38%   |
| <b>Asphalt Mix Tons/Yr.</b>  | 350 million               | 55 million              | 15.7% |

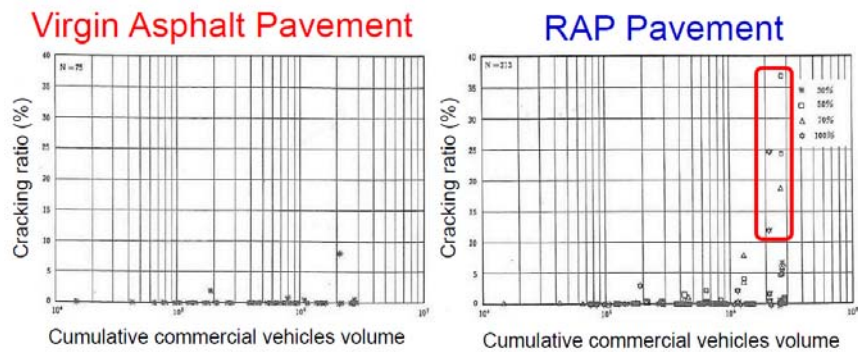
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# RAP Performance Studies

Conducted by Ministry of Construction from 1982 to 1984



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## RAP Management



1. RAP source is not restricted
2. Processing achieves uniformity and low moisture contents
3. RAP is tested for quality standards
4. RAP is fractionated
5. RAP stockpiles are covered

# RAP Quality Specifications

| Characteristic                           | Spec. Limit |
|--|-------------|
| Min. Asphalt Content                     | 3.8%        |
| Min. Pen. of Recovered AC                | 20          |
| Max. P <sub>200</sub> of Unextracted RAP | 5.0%        |



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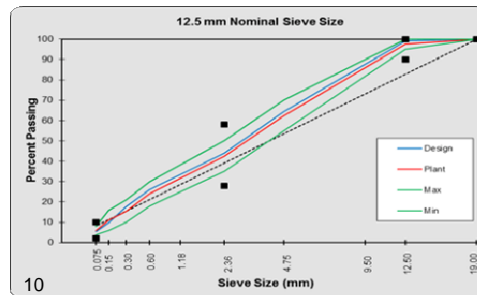
## Mix Design Criteria

| Parameter                     | Criteria          |       |
|-------------------------------|-------------------|-------|
| Air Voids (%)                 | 3–6               |       |
| Voids Filled with Asphalt (%) | 70–85             |       |
| Stability (kN)                | Traffic ≥1000 vpd | ≥7.35 |
|                               | Traffic <1000 vpd | ≥4.90 |
| Flow (1/100 cm)               | 20–40             |       |



## Typical Surface Mix Gradation

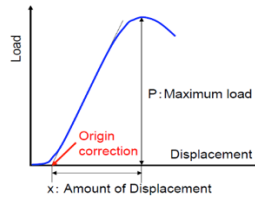
| Sieve Size | Design Gradation | Expected Plant Gradation | Specification Gradation Range |
|------------|------------------|--------------------------|-------------------------------|
| 19 mm      | 100              | 100                      | 100                           |
| 13.2 mm    | 99.2             | 97.5                     | 95–100                        |
| 4.75 mm    | 64.4             | 62.5                     | 55–70                         |
| 2.36 mm    | 44.1             | 42.5                     | 35–50                         |
| 0.60 mm    | 26.0             | 24.0                     | 18–30                         |
| 0.30 mm    | 17.7             | 15.5                     | 10–21                         |
| 0.15 mm    | 9.7              | 11.0                     | 6–16                          |
| 0.075 mm   | 5.5              | 6.0                      | 4–8                           |



## IDT “modulus” Performance Test



- Marshall specimen
- 20°C
- load @ 50 mm/min.



$$\text{Indirect tensile modulus (MPa/mm)} = \frac{\sigma_c}{x}$$

$$\text{Indirect tensile strength: } \sigma_t \text{ (MPa)} = \frac{2 \times P}{\pi \times d \times L}$$

$x$ : Amount of displacement  
 $P$ : Maximum load at break  
 $d$ : Thickness of the specimen  
 $L$ : Specimen of diameter

| Project Type           | IDT Modulus (MPa/mm) |
|------------------------|----------------------|
| General Use            | 0.60 - 0.90          |
| Cold and Snowy regions | 0.40 – 0.60          |

## Soft Asphalts and Rejuvenators



### High Pen. Asphalts

- Penetration-based blending charts



### Rejuvenators

- Formulations are Trade Secrets
- Typical dosage rates: 5 to 10% of RAP binder, based on target IDT modulus
- Spec ranges on viscosity, flash point, TFOT viscosity ratio and mass loss.

## Asphalt Plants in Japan

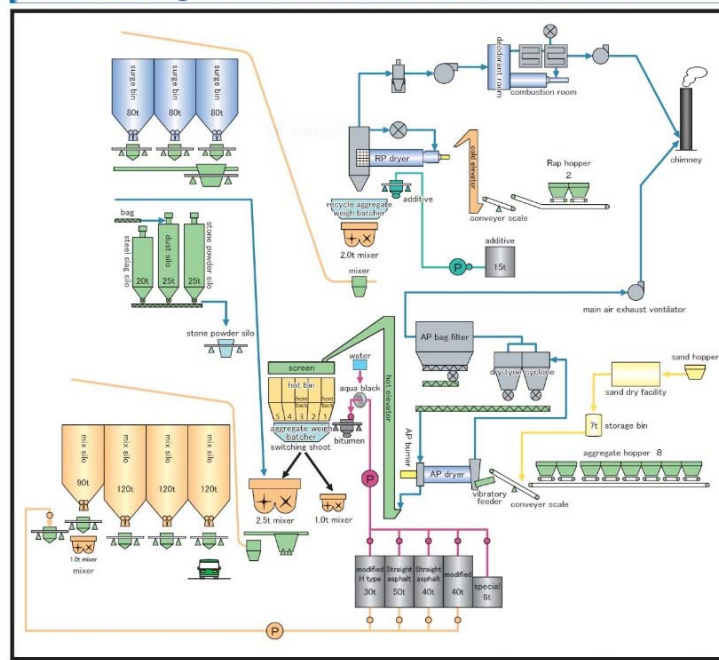
- 1150 total plants
- 84% are batch plants
- Plants visited in Tokyo were very sophisticated



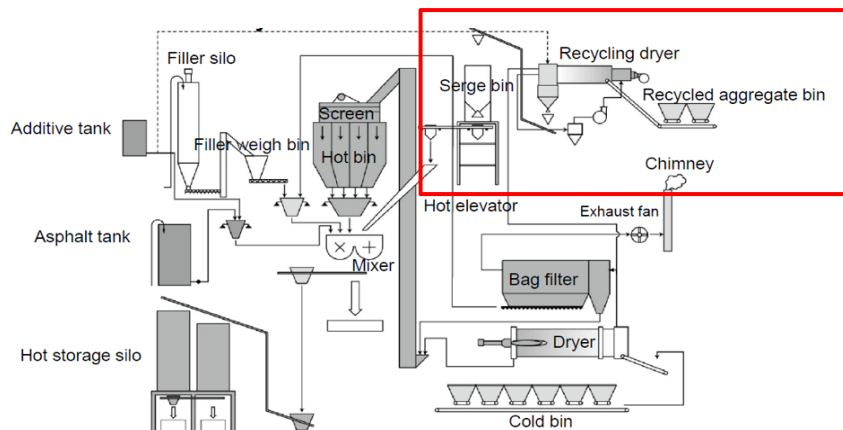
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### Manufacturing flow chart (Asphalt Plant, Recycle Asphalt Plant)



## 2/3 of Batch Plants use Parallel Heating System for RAP





## Parallel RAP Dryer

- Low moisture content of RAP prior to drying/heating
- RAP dryer at one site was 8 ft. diameter by 33 m long with a capacity of 110 tph
- Exhaust gases thru thermal oxidizer to eliminate smoke
- RAP exit temp. ~330°F
- Hot RAP mixed immediately with rejuvenator and stored for 2-3 hours prior to mixing with virgin materials



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Mixes were produced for us with all virgin materials, 45% RAP and 60% RAP. All of the mixes looked and handled the same.

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Double Layer PFC



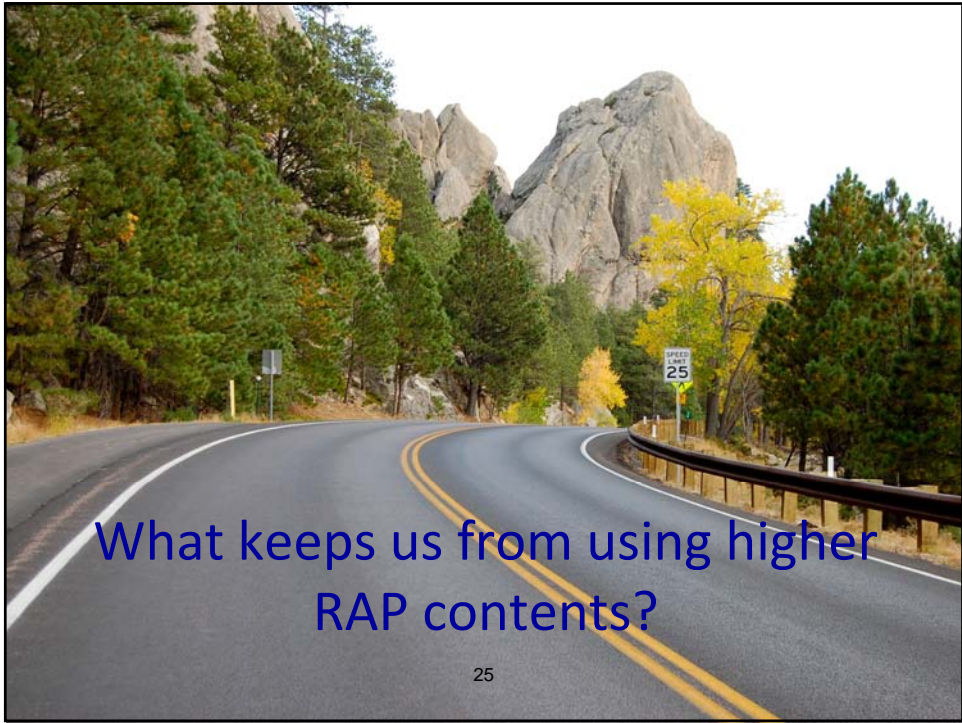
Cooling Pavement Technologies



## Key Takeaways

- Motivation to use high RAP contents in Japan is primarily from a conservation perspective.
- Specifications are fairly simple and include a simple IDT test to avoid brittle mixes.
- RAP dried separately, rejuvenator added and allowed time to condition the RAP.
- Japan has culture of quality, and integrity.
- Limited number of contractors who are willing to heavily invest in sophisticated plants and R&D.







***Thank you!***

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Director

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