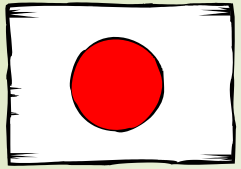

NAPA Scanning Tour of Japan

Abdul Dahhan P.E. - Illinois Department of Transportation

Dan Gallagher - Gallagher Asphalt Corp.

Presentation Outline

1. Background -compare & contrast U.S. & Japan business practices
2. Research and Technology
3. Recycling Practices - plant equipment and laboratory testing

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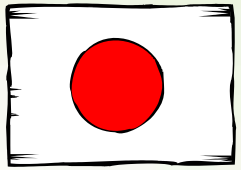
Why Visit Japan?



- The National Asphalt Pavement Association (NAPA) learned that, on average, Japan recycles 45+ percent in their asphalt mixtures.
- NAPA promotes the increased use of recycled products here in the United States and therefore organized a scanning trip with Japanese counterparts to facilitate this technology transfer.

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Scanning Trip Planned

- The trip was planned from December 1-10, 2014
- The US Delegation included 19 individuals representing NAPA contractor members, four (4) state DOT representatives, the National Center for Asphalt Technology (NCAT), NAPA staff, and a representative from the State Asphalt Pavement Associations
- Everyone arrived in Tokyo on December 2nd

- *Special thanks go to Brian Wood from Kentucky APA*
- *Andy Welch from Maxam Equipment*

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US Delegation

TaiseiTotec Plant Visit

Full Schedule

- Asphalt Plant Tour and Paving Site Visit
- Seminar on Recycling
- Technical Tour of Expressway (porous)
- Sightseeing in Kyoto
- Bullet Train to Tokyo
- Asphalt Plant Tour and visit to the Public Works Research Institute (PWRI)
- Contractor lab visit

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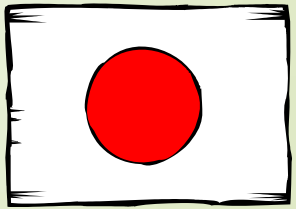
Industry Dynamics

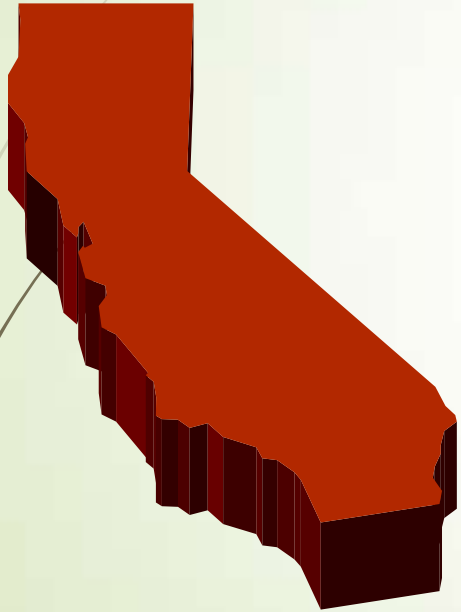
Putting it all into context

Japan 101

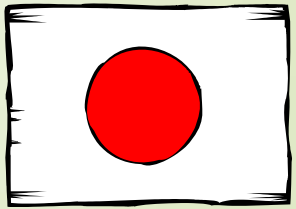
- Island nation in East Asia with the worlds 10th largest population (over 126 million people)
- Greater Tokyo area and surrounding prefectures is the largest metropolitan area in the world with over 30 million residents
- Japan consists of 6,852 islands, has108 volcanos, and experience earthquakes and tsunamis
- Average winter is 41.2F and summer is 77.4F



Size and scale

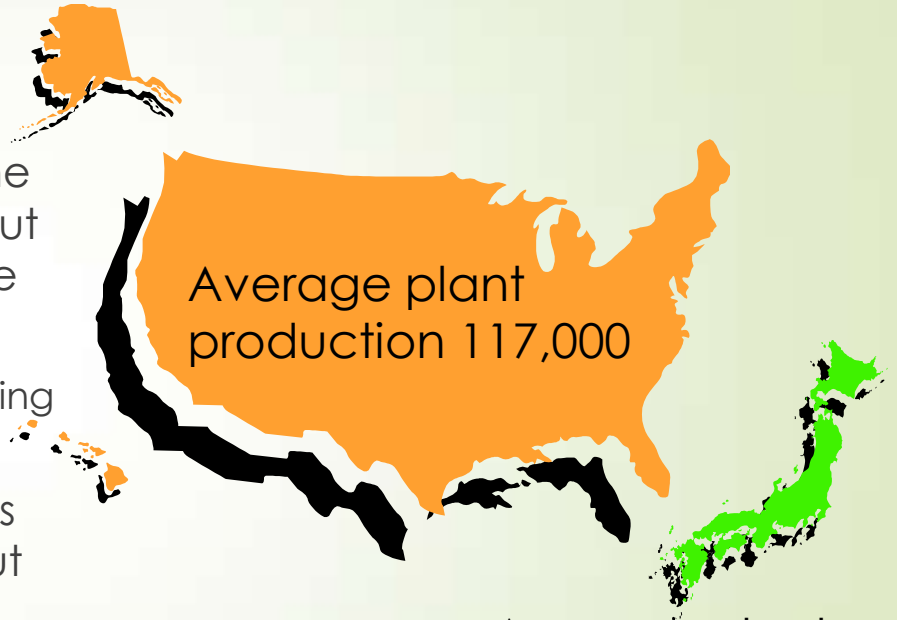


Japan's land areas is is145,925 square miles - slightly smaller than the state of California at 163,696 square miles



Size and scale compared to U.S.

- Japan has roughly half the population and only about 4% of the land area of the U.S.
  - Over 1,000 plants producing 50 million tons
- Unites States production is 350 million tons with about 3,000 Plants



General Observations

- Japanese culture is an interesting blend of old traditions and new technology
  - That contrast between old and new extends into their asphalt paving operations as well
- In some specific areas – the Japanese would appear to be more advanced than the US but in many ways, they are decades behind

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Asphalt in Japan Versus U.S.

Advanced

- Recycling over 45% and use of rejuvenators
- Performance-based specifications
- Workmanship & Safety

Lagging Behind

- Batch plants with low production
- Small projects with high unit costs
- Mix designs and materials

A few other things were more primitive

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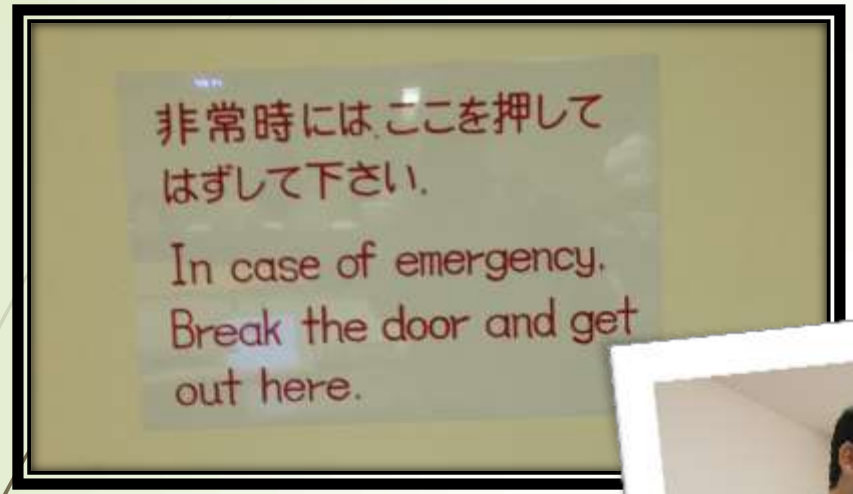
Seminar & Opening Reception

Information Exchange

Language Barriers



Technical Presentations

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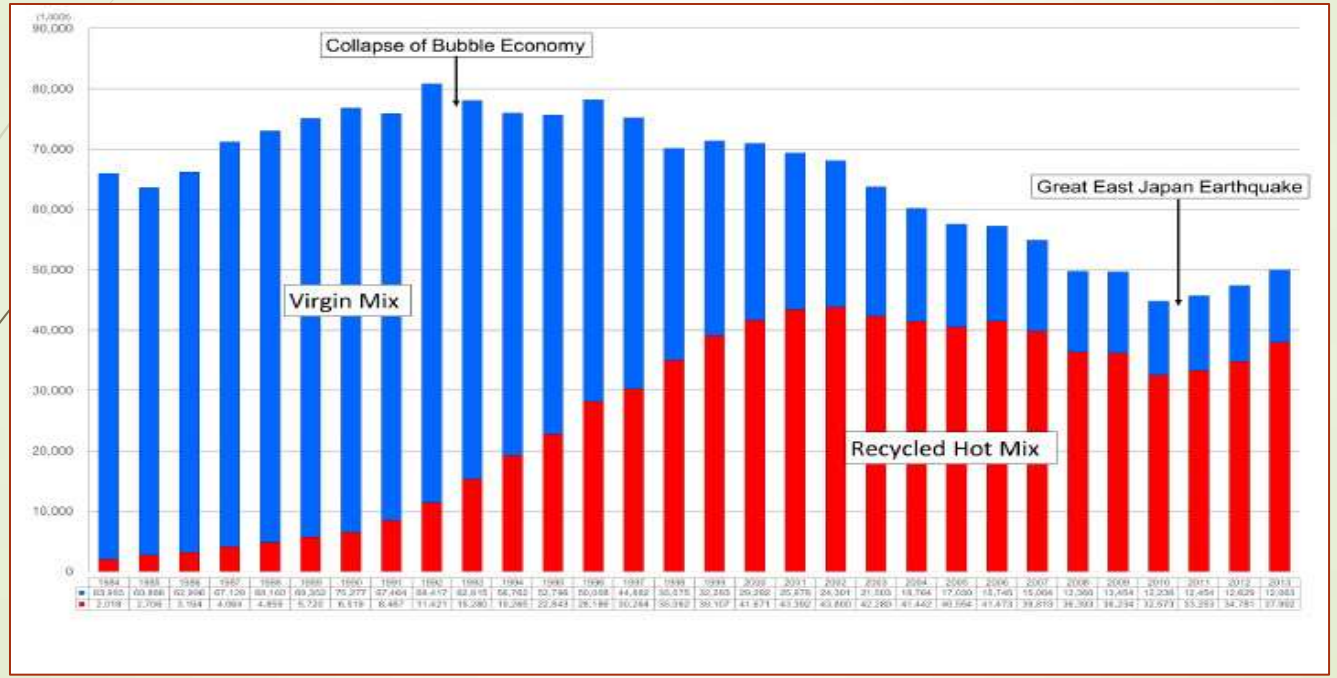
Recycling in Japan

- Government mandate
  - Legislation on recycling construction waste is stringent and fully implemented
  - **Japanese concluded in 1992 that RAP mixtures were as good as virgin mixes**
- Japan is a small country with large urban areas so waste disposal is an important issue

Japanese Asphalt Mix Products



Research and Technology

Public Works Research Institute

Japanese Name Plate

Presentations and discussions

Test Track with Driverless Trucks

Government Research

Similar to Turner Fairbanks and NCAT

Test Track @ 35 degree banking

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Nippo Visit

Facility Tour

Research Laboratory @ Nippo

Innovation

Ice-breaking pavement using rubber aggregates

Visited Two Plants

Taisei Rotec

Maeda Road

High RAP Mixtures

Typical Asphalt Plant in Japan

HMA Plant control room = Office setting


安全 環境

Classroom Element

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Cultural Differences

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Plant Safety

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Virgin Materials

- Handled and processed similar to the United States
- Mostly sandstone
- Covered cold feed bins to maintain low moisture content

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Clean and Covered

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Processing RAP

- Most of the RAP we saw was delivered in pieces (not milled)
- Delivered to the asphalt plant for processing
- Crushed, sized & screened

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Indoor Processing Facility

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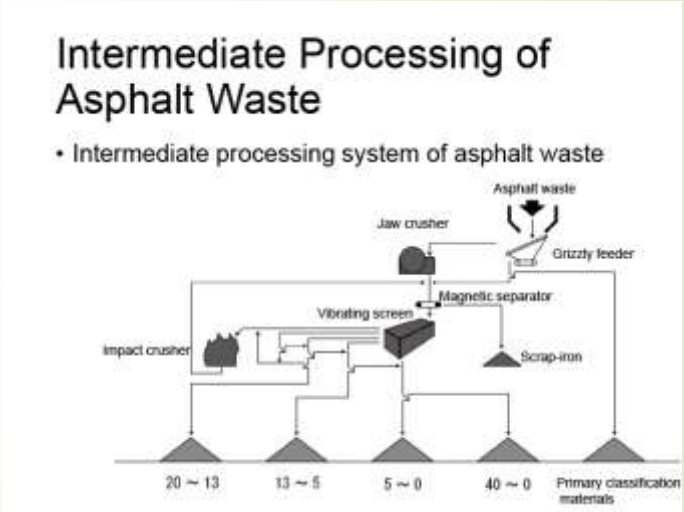
Rap Processing

- RAP is fractionated much like it is here in the U.S.
- The RAP processing facility we visited was indoors (strict dust and pollution requirements)



RAP Processing Facility

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Managing Materials

- Covered processing and bin storage
  - They keep RAP dry… reported at 1.5%-2.0% moisture
- RAP is tested for penetration grade

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RAP Parameters

- Liquid in RAP must have a penetration of 20 or more or it will be discarded
- Fractionated into 2 or 3 sizes to develop proper blend

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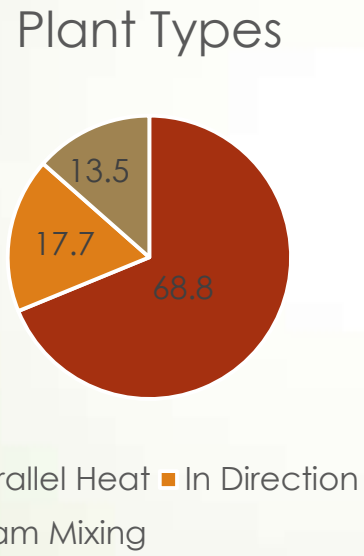
Rejuvenators

- The key to using high RAP mixtures is the introduction of a rejuvenating agent to condition the RAP
- It softens the hardened binder and activates the liquid

Recycling Methods in Asphalt Plants



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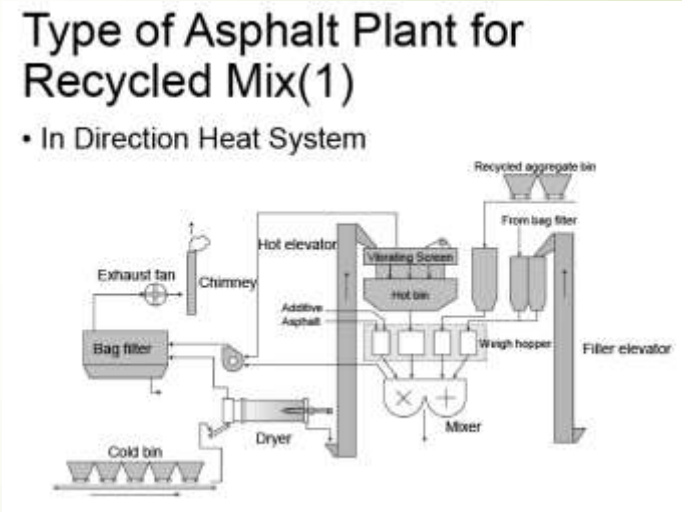
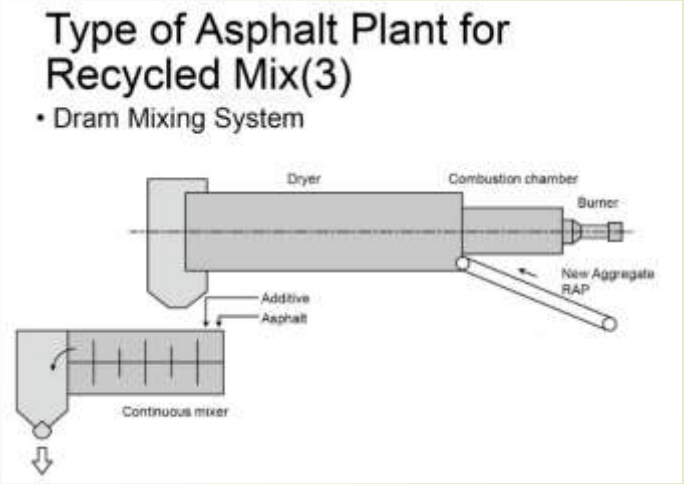
“In Direction” Heat System

- Appears most similar to a U.S. style batch plant utilizing superheated virgin aggregate to transfer to heat and dry the RAP
- Approximately 17.7% of the plants utilize this method but we did not visit one while there



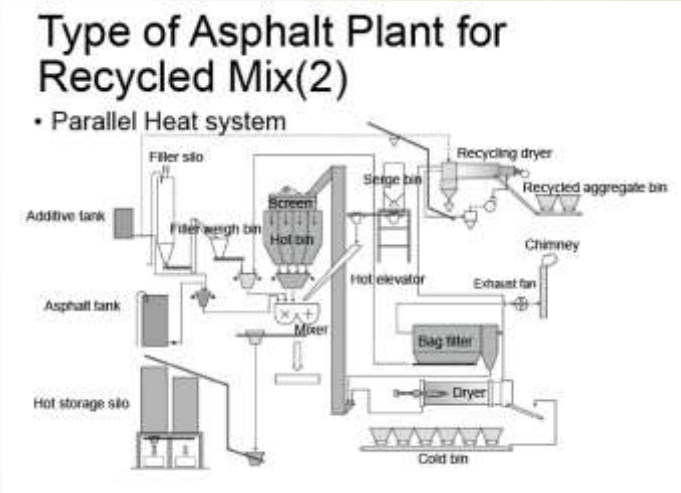
“Dram Mixing” System

- RAP is added into a parallel flow dryer away from the flame Not very common in Japan (13.5% of plants) and did not visit on our tour



Parallel Heat System

- Most common plant type (68.8%) and the type we visited while on our tour
- Parallel dryers… one for recycle and one for virgin materials



TaiseiRotec Plant

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Maeda Road Plant

- Parallel Heat System
- Batch plant producing 180 tons/hour
  - 270,000 tons/year
- 32 employees with dorm so that mix available 24 hours

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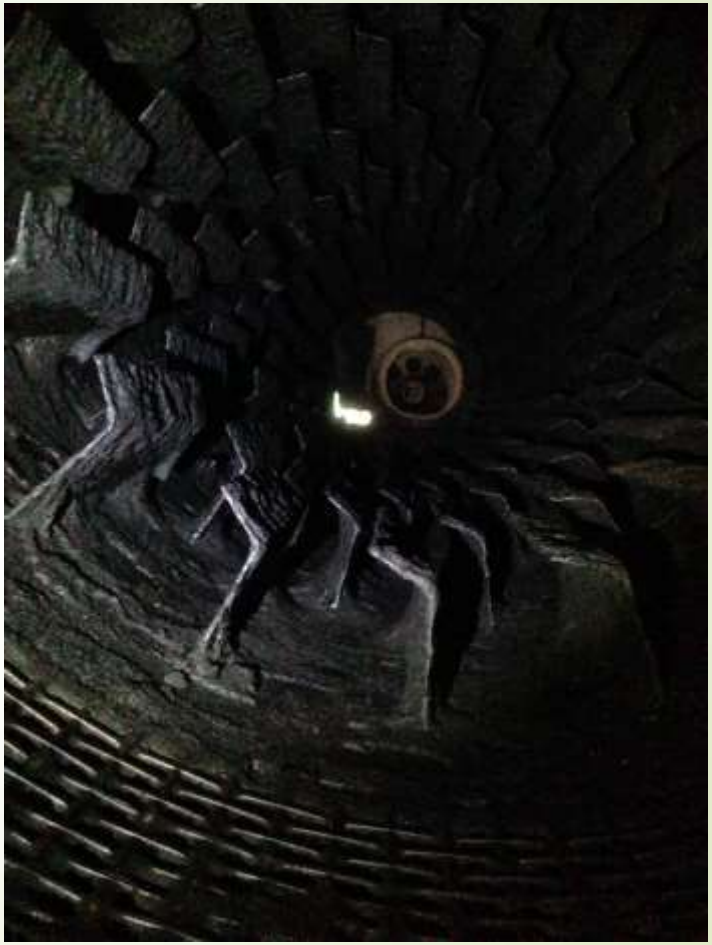
Inside the Plant



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RAP Dryer/Drum

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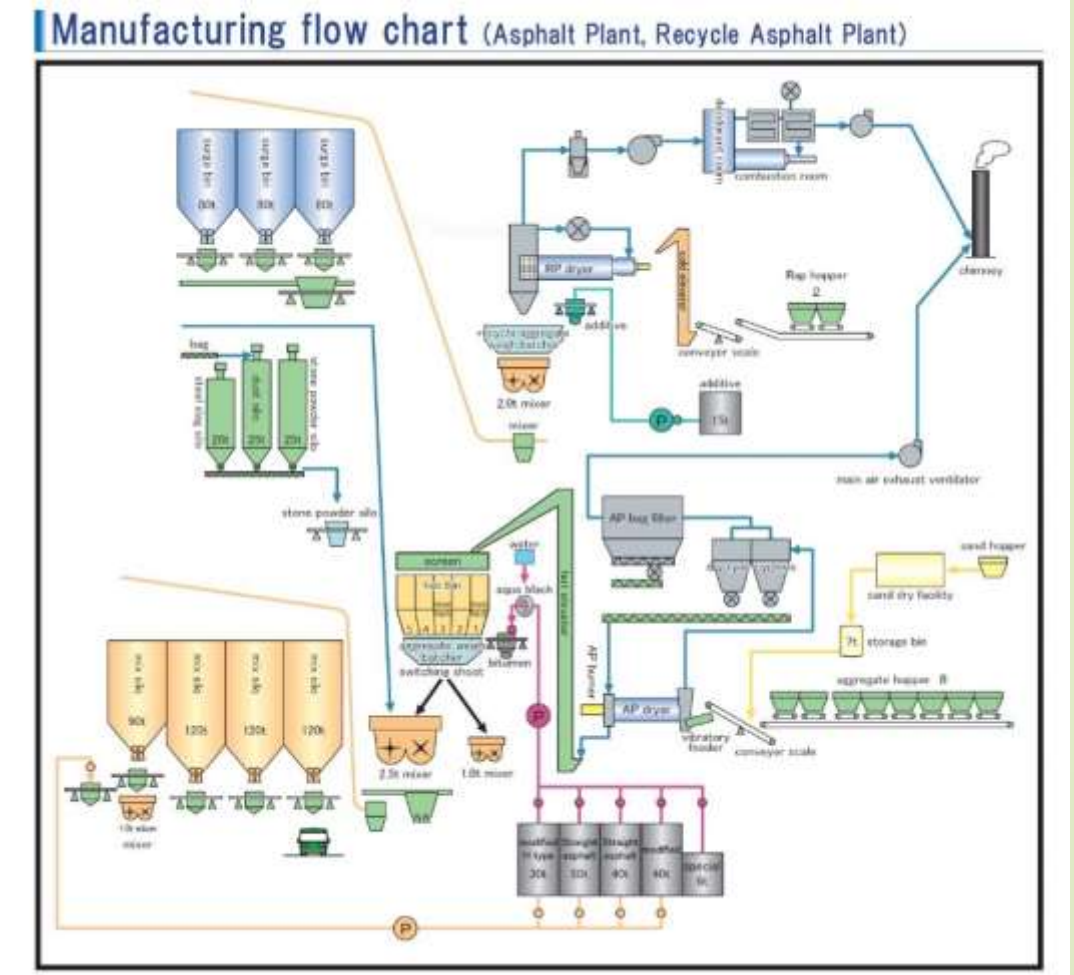
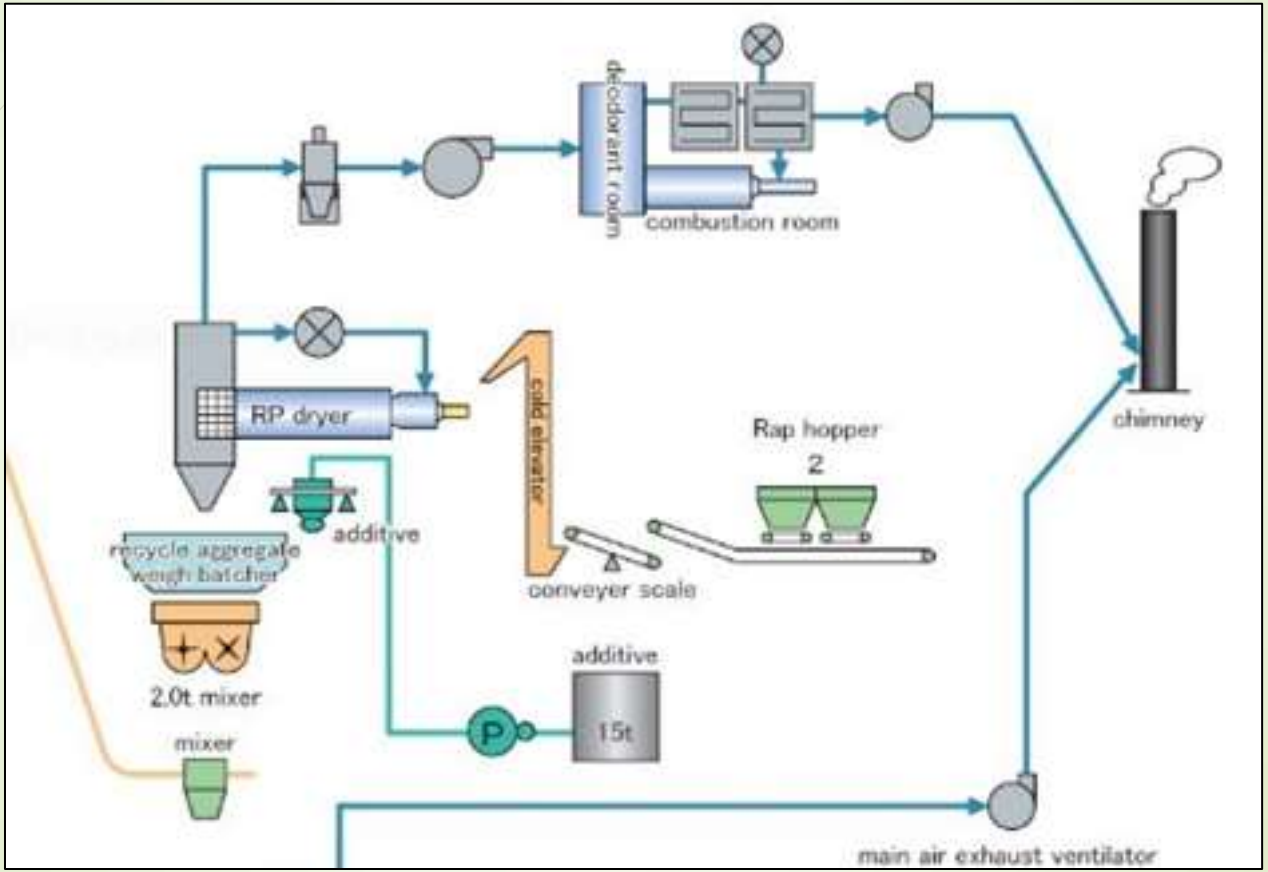
Material Flow

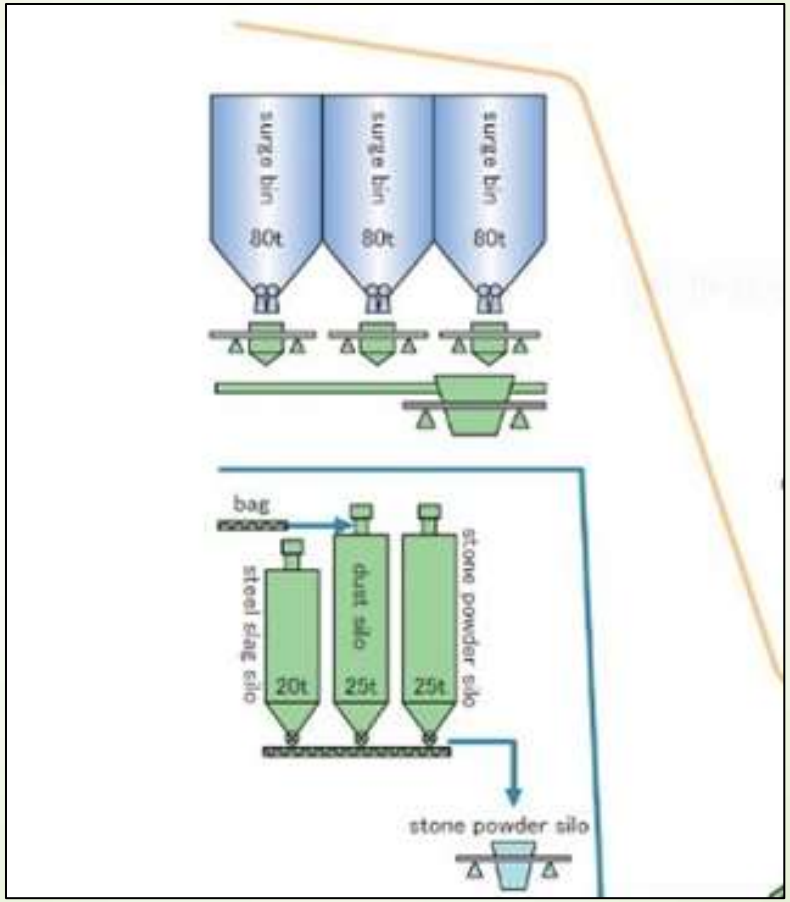
- RAP to dryer, pugmill with rejuvenator, and to surge bin (3 hours)
- Virgin materials dried and moved over screens (typical)
- RAP mixed with virgin aggregates and AC in the mixer



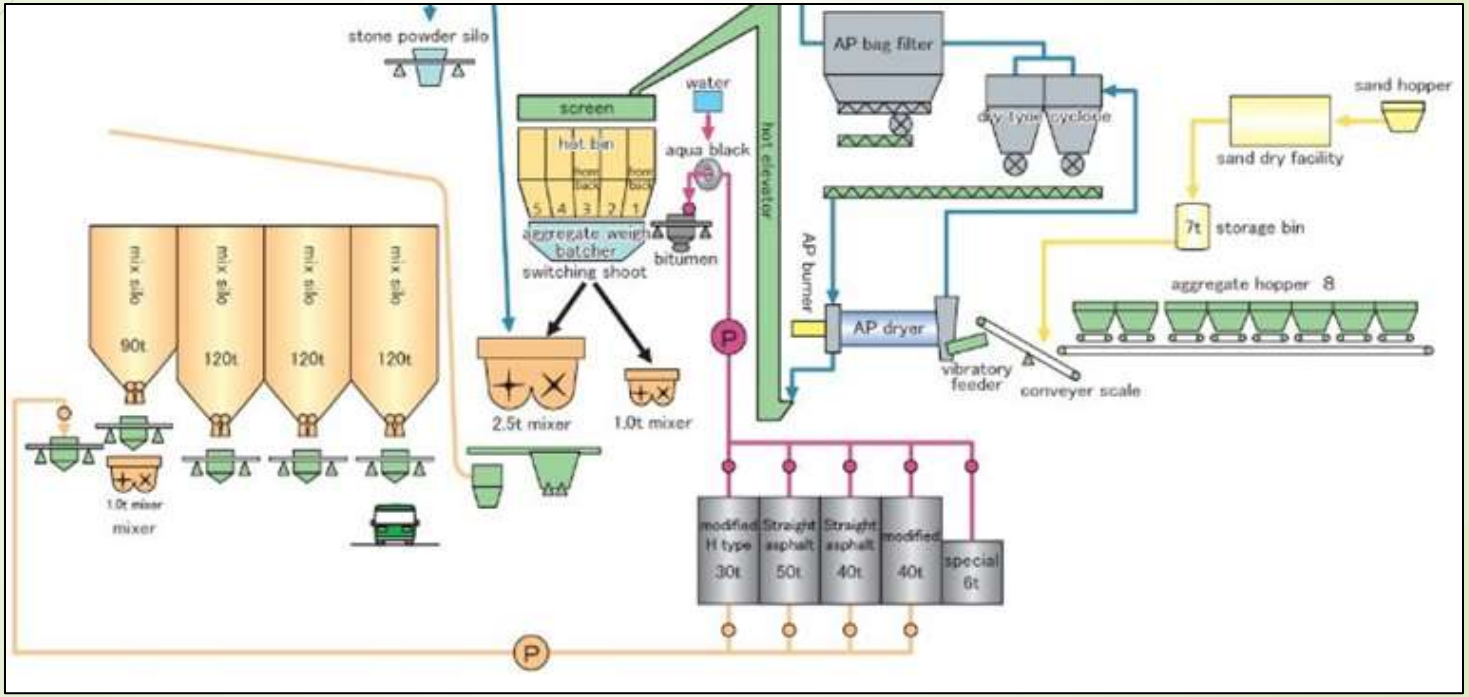
Phase 1


decolorant room
combustion room
chimney
RP dryer
cold elevator
Rap hopper
2
additive
recycle aggregate
weigh batcher
conveyer scale
2.0t mixer
additive
15t
mixer
main air exhaust ventilator

Phase 2


surge bin
80t
surge bin
80t
surge bin
80t
bag
steel slag silo
20t
dust silo
25t
25t
stone powder silo
stone powder silo

Phase 3


stone powder silo
screen
water
hot bin
aqua black
hot elevator
AP bag filter
dry type cyclone
sand hopper
sand dry facility
7t
storage bin
aggregate weigh batcher
switching shoot
bitumen
AP burner
AP dryer
vibratory feeder
conveyer scale
aggregate hopper 8
mix silo
90t
120t
120t
120t
2.5t mixer
1.0t mixer
mixer
modified H type 30t
Straight asphalt 50t
Straight asphalt 40t
modified 40t
special 6t

Rejuvenators

- Proprietary!
- One plant we visited indicated that their product was generally classified as a paraffinic oil

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Parallel Heating

- Heating and isolating the RAP with the rejuvenator makes a lot of sense
  - Adaptations would be required in US for drum plants and for higher production (Estimated cost 25mm)
  - Foaming the rejuvenator may be more feasible to minimize or eliminate conditioning times
- Potential for mixtures with higher RAP that demonstrate equivalent or better quality and performance

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Plant Controls

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Loading Operations

“Portable” Plant – No Recycle ability

Mix Design –

- Japan has established simple mix tests to evaluate mix designs
  - Those tests are the indirect tensile modulus (peak stress/deformation) and a wheel tracking test (dynamic stability)
- This allows the mix designer (contractor) to be innovative in developing combinations of materials (e.g. RAP, softer virgin binders, and rejuvenators) to meet the mix design criteria.

Mix Types

- They keep mix types to a minimum and simple descriptions
- Batched a virgin mix along with 45% and 60% RAP mixes for our inspection

I got tired of hanging out with Abdul

I was pretty popular over there.

自分撮り

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I'll Pass this over to Abdul now for the technical portion..

History of RAP Pavement Technology in Japan

1982 : Ministry of Construction started investigations on RAP mixture and conducted trial RAP pavement

1984: RAP pavement was paved, following the tentative RAP pavement guide

1992: It was confirmed that performance of RAP mixture is identical to virgin asphalt mixture

RAP pavement guide was published and used in practice

2004: RAP pavement Handbook was published

2010: The handbook was revised for the purpose of increase in recycle rate and improvement in RAP quality

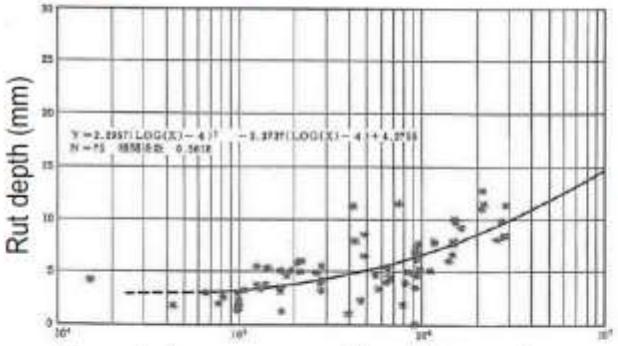
RAP Pavement Survey

1982-1984

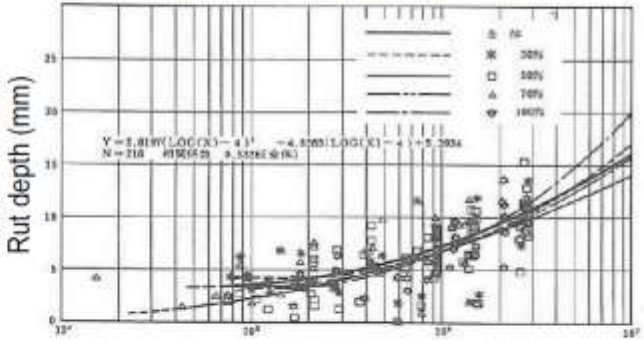
By Ministry of Construction

Virgin Asphalt Pavement vs RAP Pavement
- Rut depth -

Virgin Asphalt Pavement

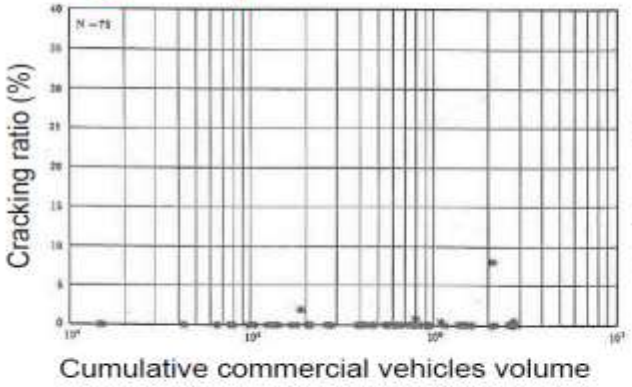


RAP Pavement

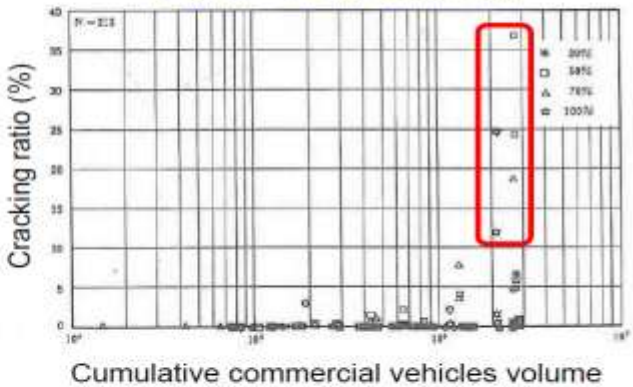


Virgin Asphalt Pavement vs RAP Pavement
- Cracking ratio -

Virgin Asphalt Pavement



RAP Pavement



Factors affecting the crack generation

- Cracking ratio exceeded 10% when cumulative commercial vehicle volume reached 5 millions
- Cracks were seen in the section paved by RAP mixture in three years
- Following factors were considered as causes of the cracks:
  - Pen grade: less than 20
  - Substandard RAP binder
  - Higher RAP percentage in indirect heating system

Developing RAP Quality Standard:

Content of RAP Binder	***3.8 %***	***Min***
Properties of RAP:		
RAP binder Penetration	***20***	***Min***
RAP Indirect tensile modulus	***1.70***	***Max***
Amount of RAP fines contributed to RAP mixture	***5.0 %***	***Max***

Indirect Tensile Test

- Test condition

✓ Curing time :
More than 5 hours

✓ Test temperature :
20 degrees Celsius

✓ Loading speed :
50mm/min

Indirect Tensile Modulus

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

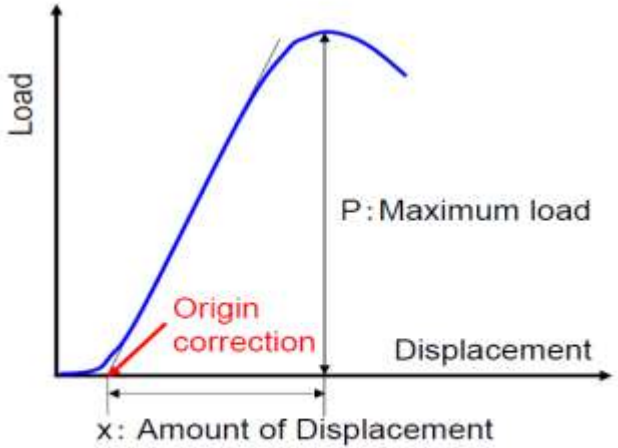
$$\text{Indirect tensile strength: } \sigma_t \text{(MPa)} = \frac{2 \times P}{\pi \times d \times L}$$

x : Amount of displacement

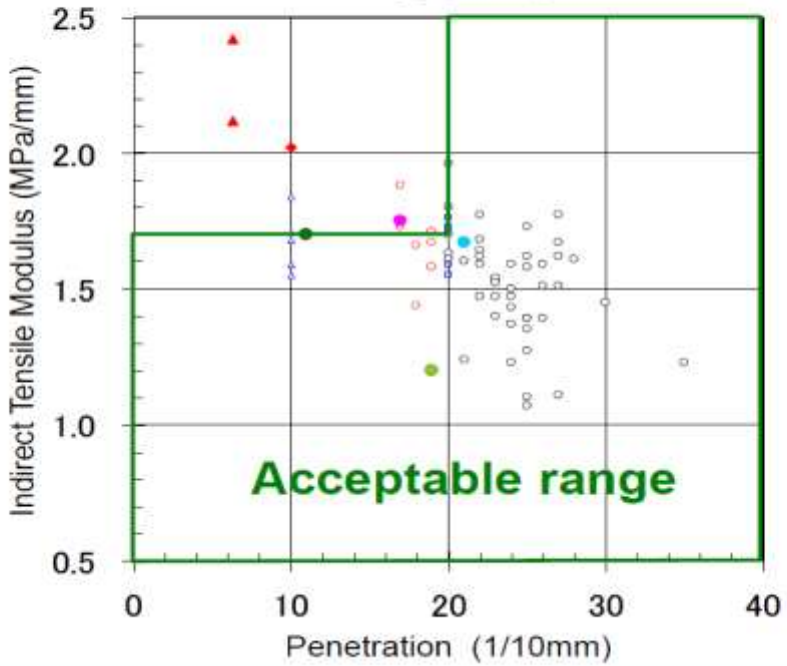
P : Maximum load at break

d : Thickness of the specimen

L : Specimens of diameter



Indirect Tensile Modulus of RAP Aggregates



Quality of Blended Binder

Blended Binder : RAP binder with virgin binder and/or rejuvenator

Evaluation of RAP Binder

- RAP binder is extracted to confirm its penetration
- Penetration of RAP binder is recovered by blending rejuvenator and/or virgin binder

Extraction Device

Penetration Test

Rejuvenator

Quality Standard of Blended Binder

Grade	Penetration 25°C (1/10mm)	Softening point (°C)	Ductility 15°C (cm)	Flash point (°C)
40 - 60	40 - 60	47.0 - 55.0	10 ≦	260 ≦
60 - 80	60 - 80	44.0 - 52.0	100 ≦	260 ≦
80 - 100	80 - 100	42.0 - 50.0	100 ≦	260 ≦

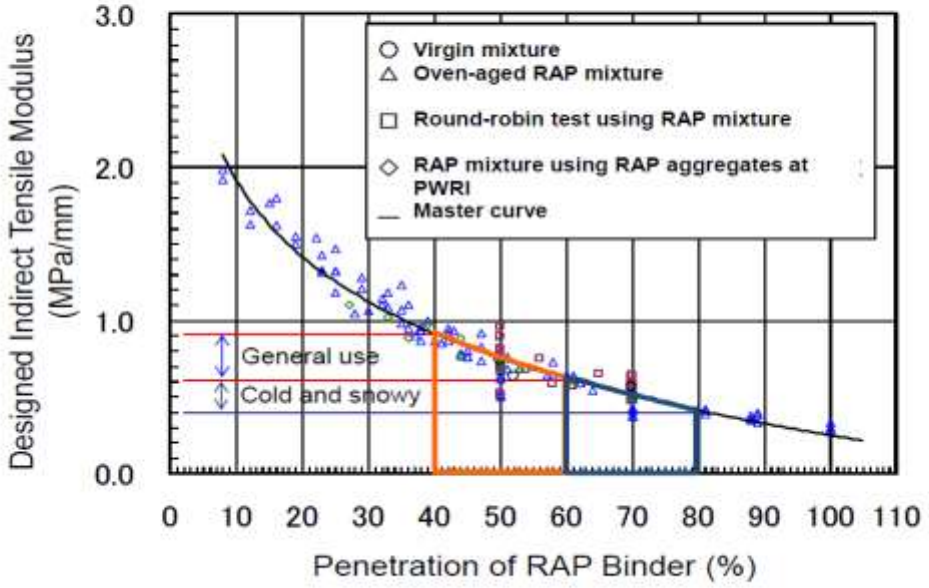
RAP Mix Design

Adjustments to the designed
penetration or indirect tensile modulus

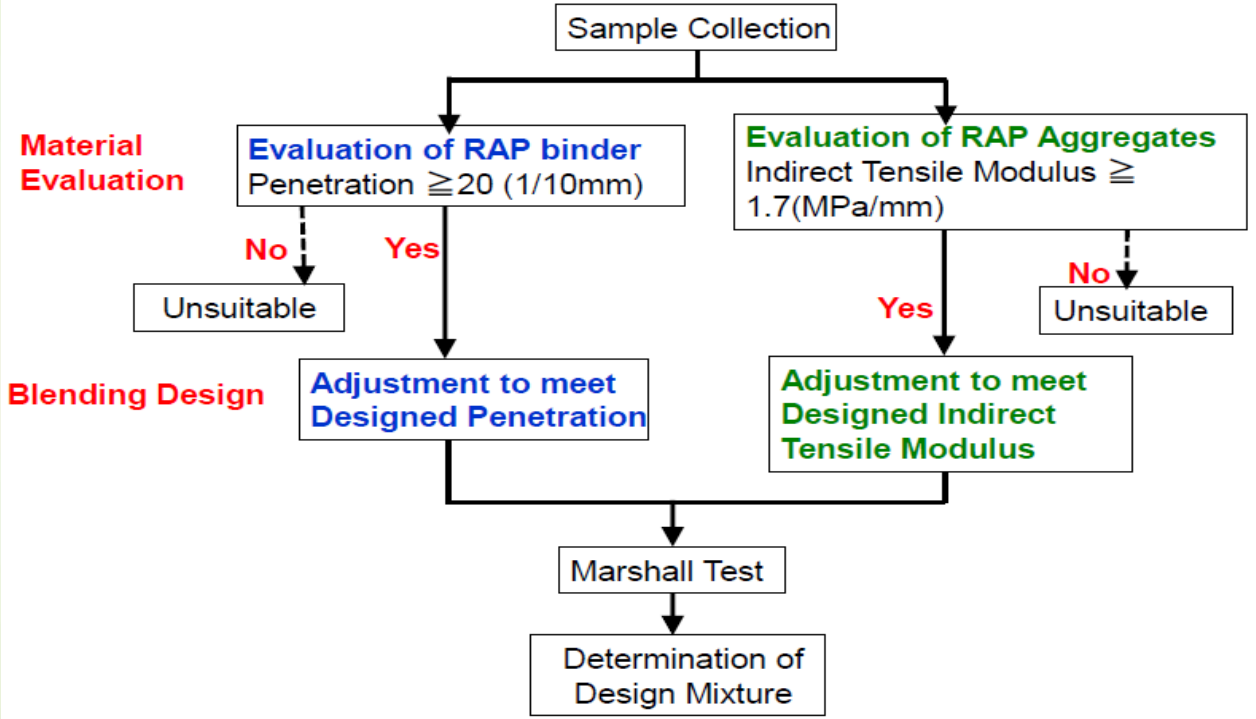
Use of RAP Mixture in Different Regions

Areas	Penetration grade (1/10mm)	Indirect tensile modulus (MPa/mm)
General use	40 ~ 60	0.60 ~ 0.90
Cold and snowy Regions	60 ~ 80	0.40 ~ 0.60

Penetration and Indirect Tensile Modulus of RAP Mixture

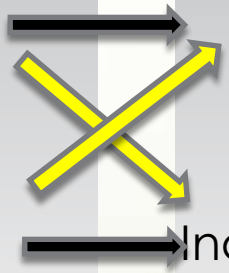


RAP Mix Design Procedure

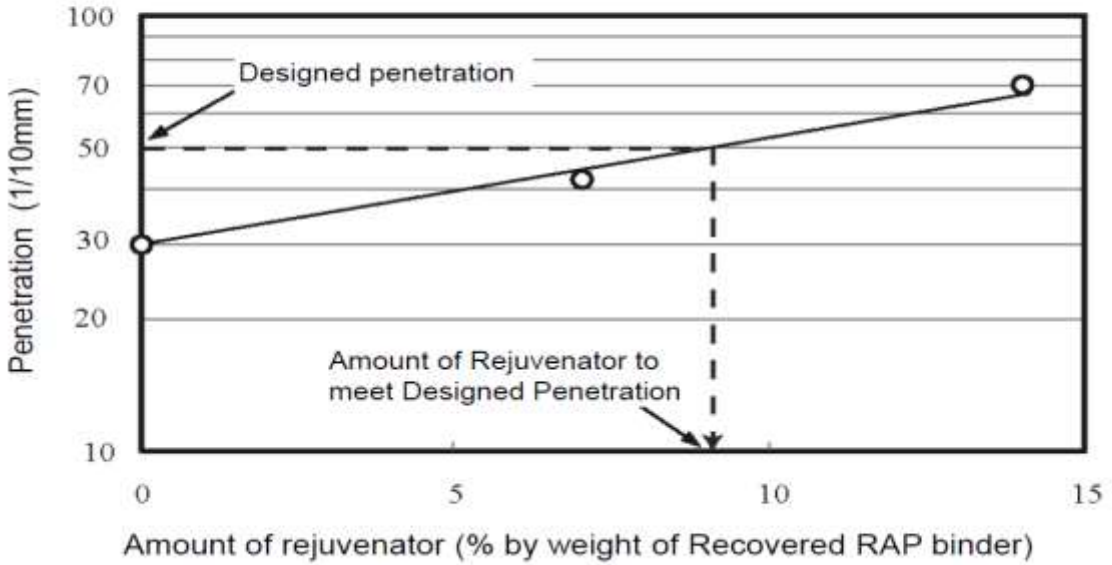


Adjusting RAP Mix Designs:

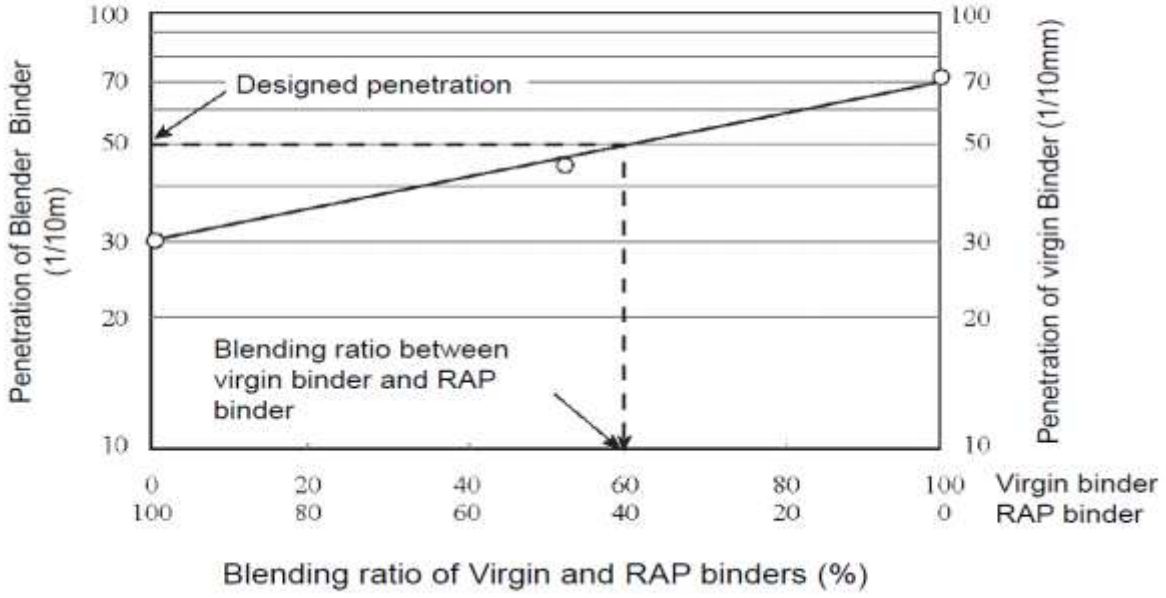
Adjustment Methods:	Specification Criteria:
Rejuvenator	Penetration grade
Virgin binder	Indirect tensile coefficient



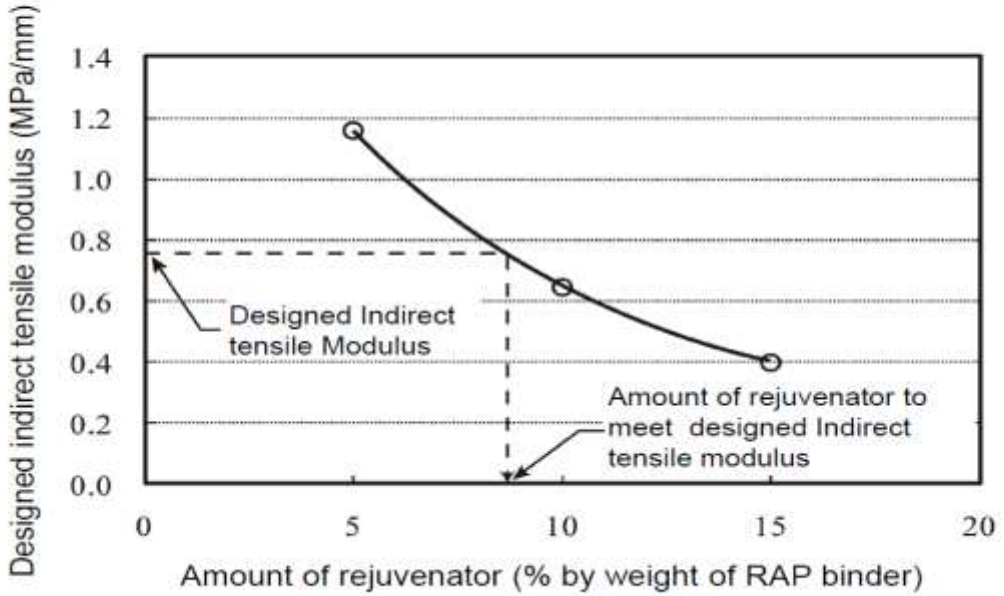
Adjustment to the Designed Penetration using Rejuvenator



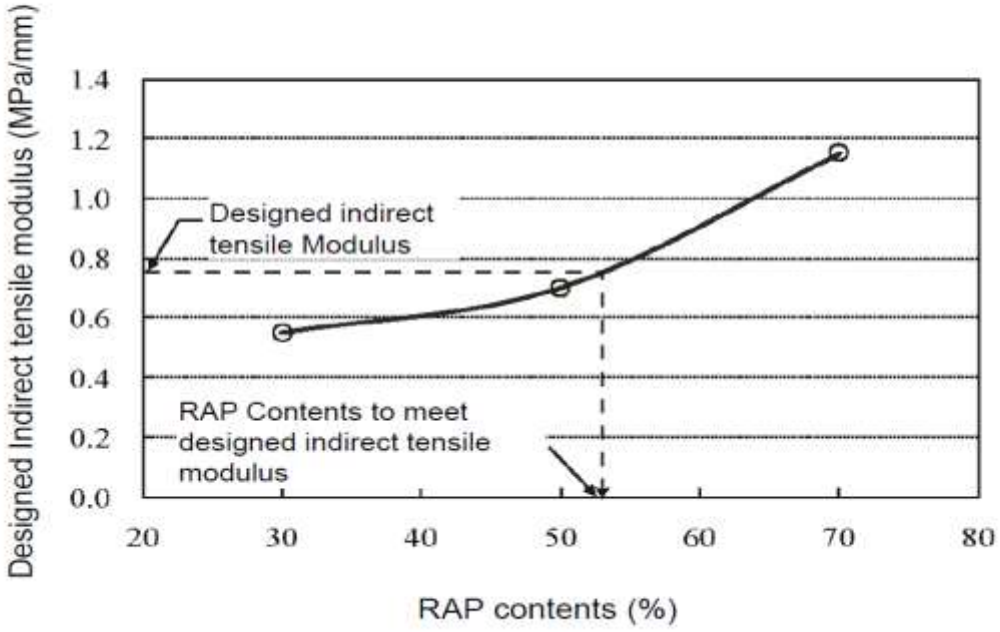
Adjustment of the Designed Penetration using Virgin Binder



Adjustment to the Designed Indirect Tensile Modulus using Rejuvenator



Adjustment to the Designed Indirect Tensile Modulus using Virgin Binder



Performance property for 3 years

$$Maintenance\ control\ index(MCI) = 10 - 1.48C^{0.3} - 0.29D^{0.7} - 0.47\sigma^{0.2}$$

※ C:Crack(%), D:Rutting(mm), σ:Smoothness(mm)

Virgin Aggregate %	40	40	40	100
RAP including Straight asphalt %	0	20	40	0
RAP including PMA %	60	40	20	0

In Summary:

- ✓ *Established quality standard for RAP.*
- ✓ *Same standard must be achieved for any binder, virgin mix or RAP mix.*

- ✓ *Pre heat the RAP Material.*
- ✓ *Combine with a rejuvenating agent & condition.*
- ✓ *Conditioning will activate the RAP AC & enable it to regain original properties.*

- ✓ *Virgin aggregate is heated & dried to a max of 400 F.*
- ✓ *Combine the conditioned RAP with virgin aggregate and new AC.*

- ✓ *Mix discharge temperature is kept around 325 F.*
- ✓ *Properties of new AC are not compromised, **NO** premature long term aging.*

Questions?

Field Operations

Asphalt Paving Project

Trucking Operations

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Paving Operations

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Compaction

Attention to Detail

Workmanship and Quality

Field Inspection

Abdul felt like he was 20 years younger running around the job site.

Abdul was know as that guy who always has a question ???

Protecting the unconfined edge

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Formed longitudinal joints

Formed the base, paving the surface in echelon

Tacking the longitudinal joint

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Tight Joints

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Excellent workmanship

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Clear Sound Walls

Clean and precise operations

Finished Product

“Porous” Pavements = OGFC

Double Layer Porous

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From roads to high speed rail…

Bullet Train

165 mph by train

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Vehicles

- New and used cars are expensive, car ownership fees and fuel levies are used to promote energy efficiency
- Parking

Closing Dinner & Reception

Gifts and Business Cards

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Observations

- Performance based specifications
- Emphasis on quality workmanship
- Use of rejuvenators to increase RAP percentage

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Final hours before flying home…

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Observations

- Performance based specifications
- Emphasis on quality workmanship
- Use of rejuvenators to increase RAP percentage

GALLAGHER ASPHALT

Questions?

Vehicles & Loading


11:15 PM
100%
Albums
Selfies
Select
分
Photos
Shared
Albums

自分撮り


1:41 PM
61%
Albums
Selfies
Select
Photos
Shared
Albums

Widescreen Test Pattern (16:9)

Aspect Ratio Test

(Should appear circular)