INSTITUT FRANCAIS
DES SCIENCES
ET TECHNOLOGIES
DES TRANSPORTS,
DE L'AMENAGEMENT
ET DES RESEAUX

# RAP for a sustainable development

Australian Asphalt Pavement Association
Study Tour to Europe
Arche de la Défense
4th May 2012
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IFSTTAR

## Overview : figures *(2010 EAPA)*

| | RA | | |
|---|---|---|---|
| | available | recycled in HWMA | |
| EU | 50 Mt | 24 Mt | 47% |
| France | 7 Mt | 3 Mt | 40% |

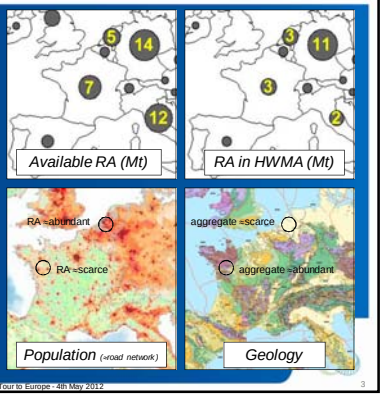
| | HWMA production | avail. RA / HWMA prod. *(average recycling rate for 100% RA recycling)* |
|---|---|---|
| EU | 300 Mt | 17% |
| France | 40 Mt | 18% |



## Overview : different practises in EU

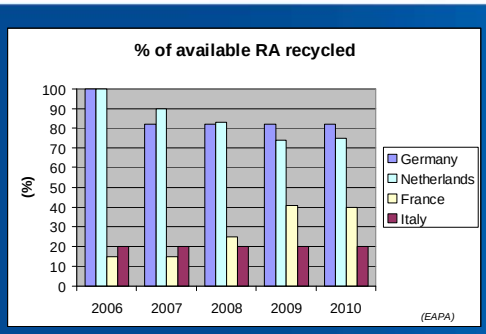
Different local trade-off between :

- RA availability
- Supply of aggregate
- Environmental legislation
- Incentive policies
- Landfill dumping fees
- Hauling costs
- Plants fit for recycling






## Overview : RA recycling trends

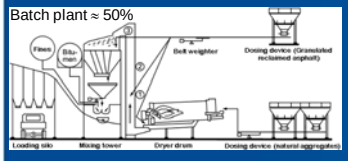




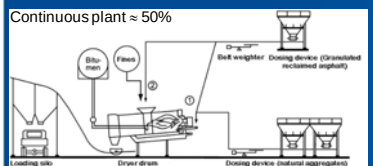

## Mixing plant fittings

France ≈ 500 mixing plants (< 180 fit for hot recycling)

Batch plant ≈ 50%



Continuous plant ≈ 50%



Max RA content < 30%

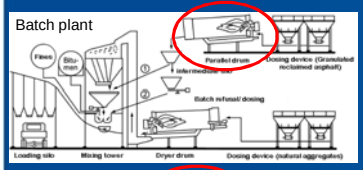
Limitation : RA water content



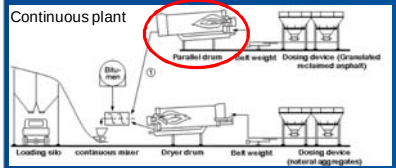
## Mixing plant fittings

Some plants fit for high RA content

Batch plant



Continuous plant



Parallel drum

Max. RA content ≈ 60%

## RA : product specifications *(EN 13108-8)*

Delivery ticket and product sheet shall contain :

- Identification
  supplier, designation (U RA d/D), date time of delivery
- Presence of foreign matter
  F1 ⇒ cement concrete, bricks, metal ≤1%
  synthetic materials, wood, plastics ≤0,1%
- Max. size of the RA particles (U)
- Binder content
- Binder type and properties
  paving grade, modified, hard grade, with additive
  mean Softening point (R&B) or Penetration (Viscosity at 60°C for soft asphalt)
- Aggregate grading, d and D(max)
- Feedstock quantity



## RA : product specifications *(EN 13108-8)*

If required :

- Source
  Mix type (EB..)
- Type and properties of aggregate
- Homogeneity of the feedstock



## Recycling rate / RA properties [1]

Recommended use of RA in HMA

| Pavement structure | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Wearing course | | 0% | 10% | 30% | 10% | 40% |
| | Binder course | | 10% | 20% | 30% | 40% | |
| | Base course | | | | | | |
| RA components properties | Binder | Span of the binder content | >2% or NS | | | ≤1% | |
| | | R&B or Pen | NS | | | | |
| | aggregate | Grading curve | NS | | | | |
| | | properties | NS | | | LA≤20 MDE≤15 PSV≥50 | NS |

Recycling rate depends on RA homogeneity

NS=not specified

[1] *Guide SETRA-utilisation des normes enrobé à chaud (2008)*



## Assessment of the resulting binder

Combination laws

only for pure bitumen, not too very different

$$\log pen_m = \frac{b_o}{100}\log pen_o + \frac{b_n}{100}\log pen_n$$

$$TBA_m = \frac{b_o}{100}TBA_o + \frac{b_n}{100}TBA_n$$

NF EN 13108-1
Annex A

$$\log(\log G_m^*) = \frac{b_o}{100}\log(\log G_o^*) + \frac{b_n}{100}\log(\log G_n^*)$$

$$b_o + b_n = 100$$



## Preliminary study in lab

- Assess the sources : homogeneity of RA
- Identification of components (on different road sections and pavement layers): binder content and residual properties, granularity of milling, EN 13108-8 requirements
- Formula of new mix with RA (rate of recycling, nature of bitumen or rejuvenator added, aggregates properties)
- Performances must be equal to those of new AC
- Traditional pavement design method

Policy to promote recycling :

in France no new study needed if the rate of recycling is
< 10% in wearing course
< 15 % in binder, base, sub base courses



## Mastering of the recycling techniques

*Low rate* — Common

25%

*High rate* — Mastered processes

50%

*Very high rate* — Special techniques

- Special sites
- Thorough study
- ≠ RA fractions (sieving)
- Need for feedback
- Special mixing plant

70%

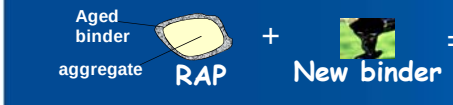
RA availability problems

*recycling rate*

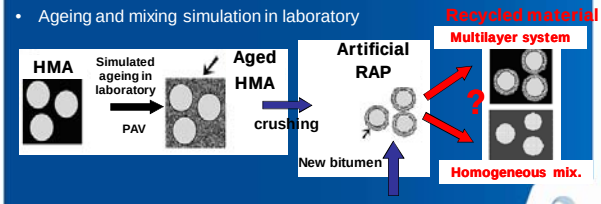
## Research example : compatibility new-old binder

(*) PhD work of Laëtita El Bèze

- Assess degree of heterogeneity RAP bitumen and new binder




- Ageing and mixing simulation in laboratory



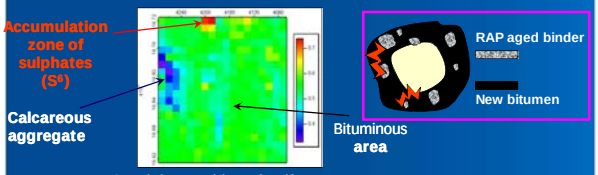

- Observation of the distribution of chosen tracers within recycled asphalts by microscopic techniques



## Research example : compatibility new-old binder

(*) PhD work of Laëtita El Bèze

- Follow up of the spatial repartition of sulfates by X-rays Fluorescence microscopy and XANES microscopy in a synchrotron




Spatial repartition of sulfates

- Proposed model: mobilization of the aged bitumen layer leading to partial homogeneity between aged and new binder
- To be confirmed on more realistic RAP



## Assessment after 30 years of experience in RAP

- Recycling rate RA in new HMA : 10 to 70%
  - Current average near 20 to 25%
- Global behavior : without major problem, even with PmB excepted on specific sites:
  - Degradations with cracks, fatigue, but also rutting sometimes observed
  - Due to hazardous parameters from RAP (hardening binder, heterogeneity,…) or higher rate recycling
- Maintenance study and mix design very important
- Difficulties to take into account the wear of old aggregates on the surface friction properties



## Tendencies et evolutions

- WMA techniques (but <2 or 3% of total HWMA production)
- Recycling essential to respect the topics of sustainable development
- European know-how sharing:
  - Harmonization of practices in Europe (Direct Mat project – RILEM SIB TG5)
  - Recommendation guide : state of the art, practical advises, specifications, prescriptions,..
- Researches:
  - Accelerated ageing, to predict and et anticipate the behaviors on field
  - Recycling with high rate, reach near 100%
  - Performances of binder after recycling : compatibility, homogeneity of mix, influent factors governing binders mixing, healing
  - Definition of de damage criteria on old AC, to assess the "level of recyclability"
  - Fast RA characterization
  - Inventory and monitoring of existing sites, long term performances survey



## Conclusion

- The in plant recycling of RA in HMA is a competitive solution in term of :
  - Environment
  - Technique
  - Economy
  - Energy
  - Sustainable development
- But researches still needed:
  - to improve the whole performances of material, essentially for the prediction of ageing and medium and long time performances
  - to assess the criteria regarding Sustainable Development (LCA)