

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
Paul MARSAC



IFSTTAR

Overview : figures (2010 EAPA)

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

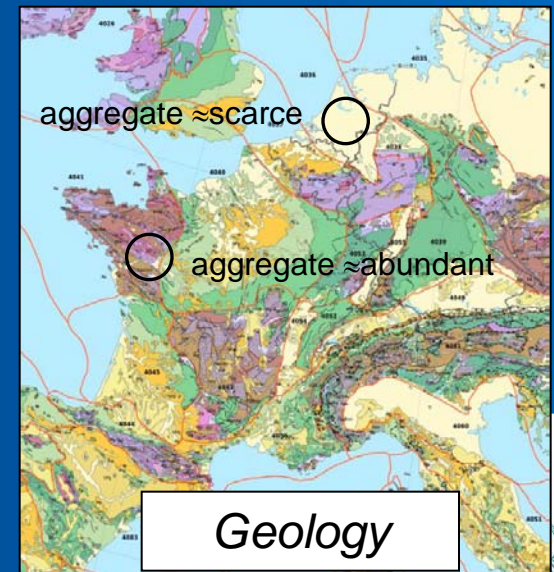
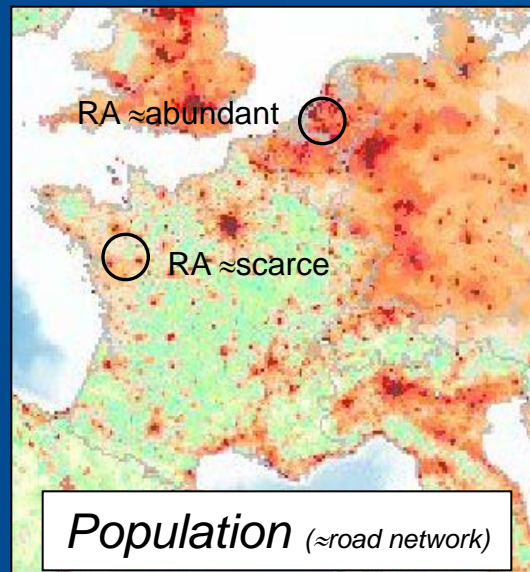
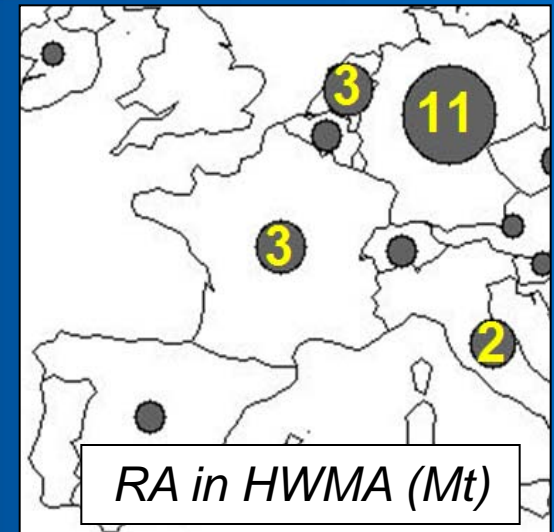
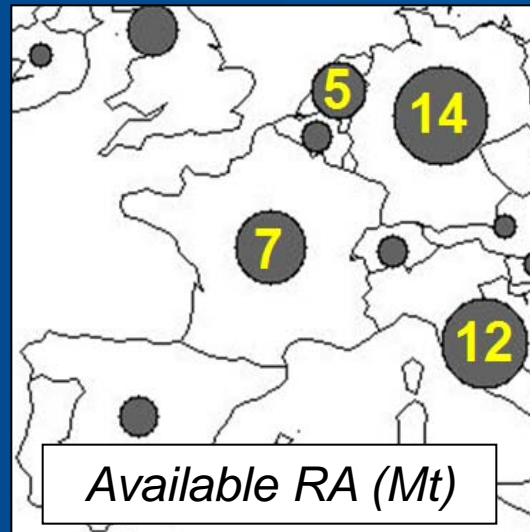
	HWMA production	avail. RA / HWMA prod. <i>(average recycling rate for 100% RA recycling)</i>
EU	300 Mt	17%
France	40 Mt	18%



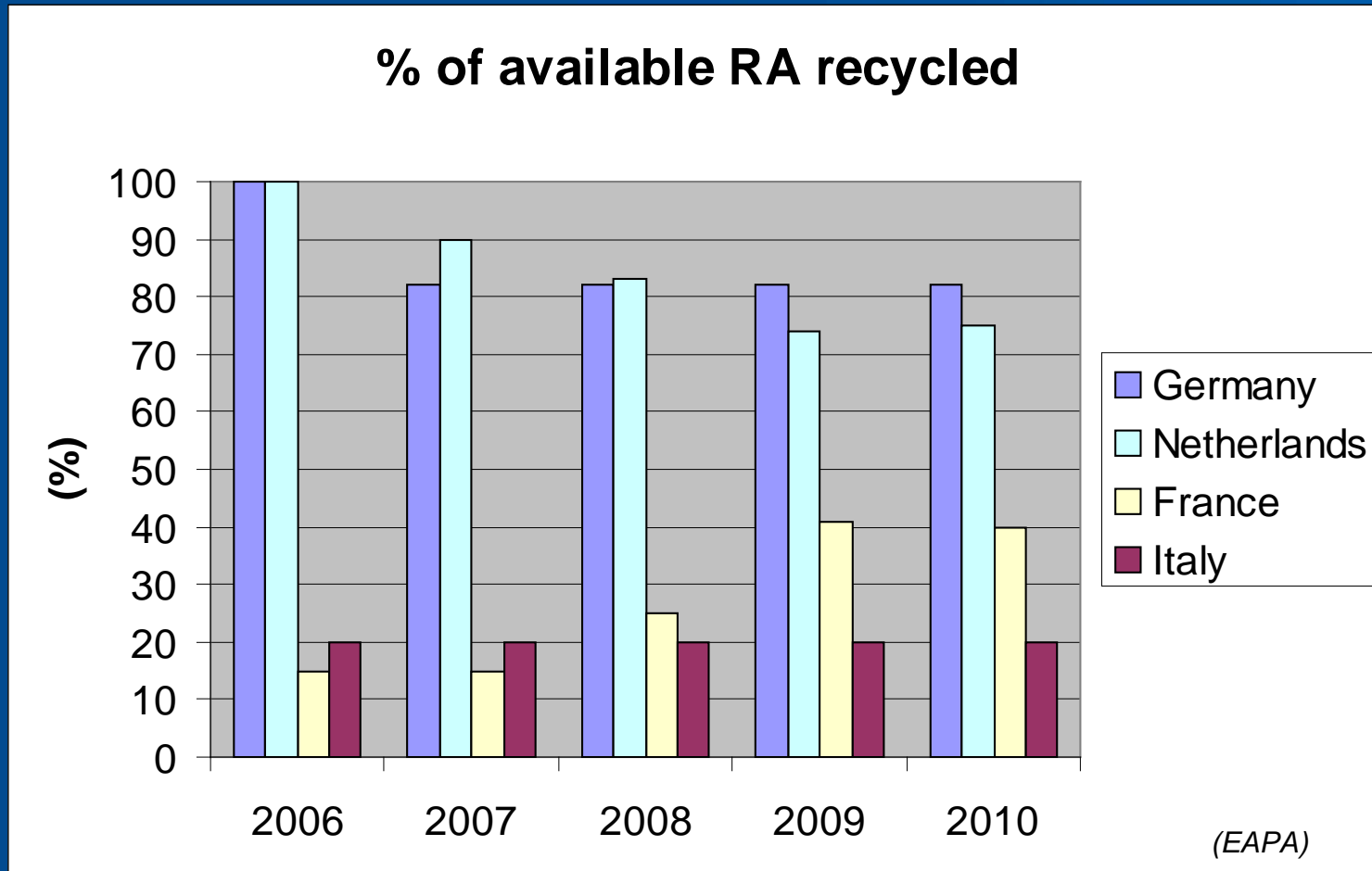
Overview : different practises in EU

Different local trade-off between :

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



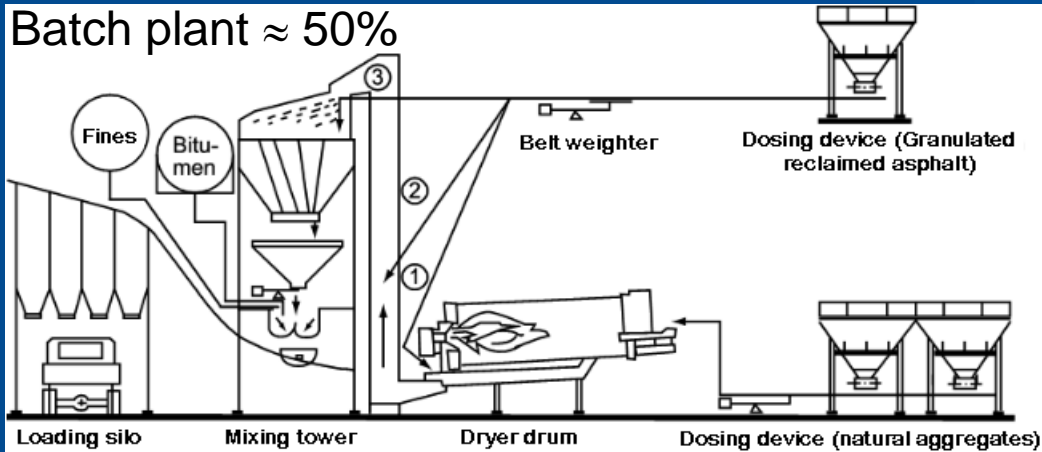
Overview : RA recycling trends



Mixing plant fittings

France \approx 500 mixing plants ($<$ 180 fit for hot recycling)

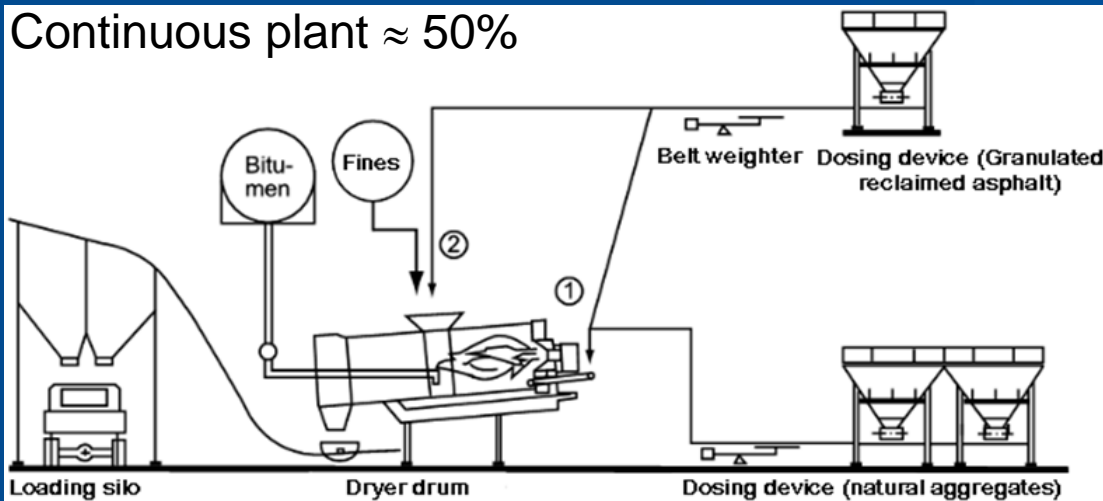
Batch plant \approx 50%



Max RA content $<$ 30%

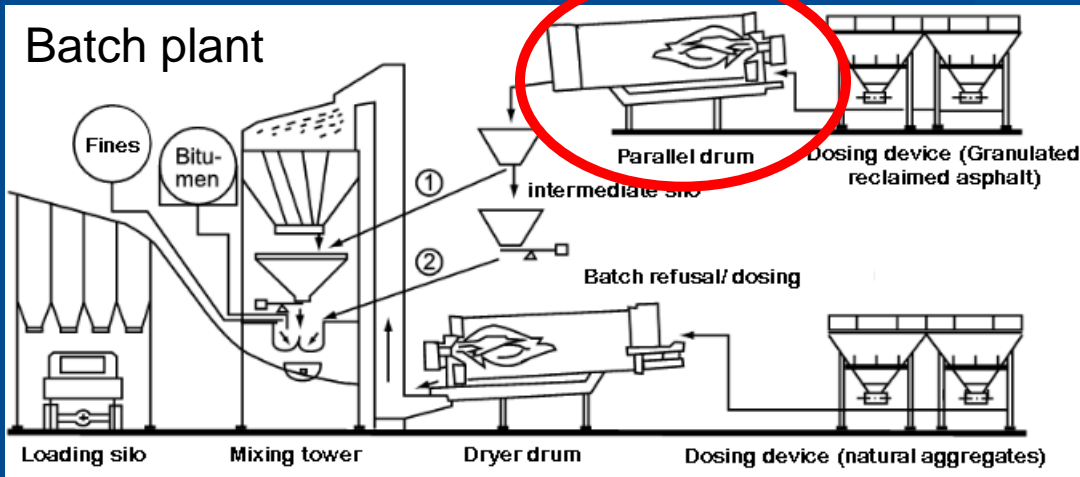
Limitation : RA water content

Continuous plant \approx 50%



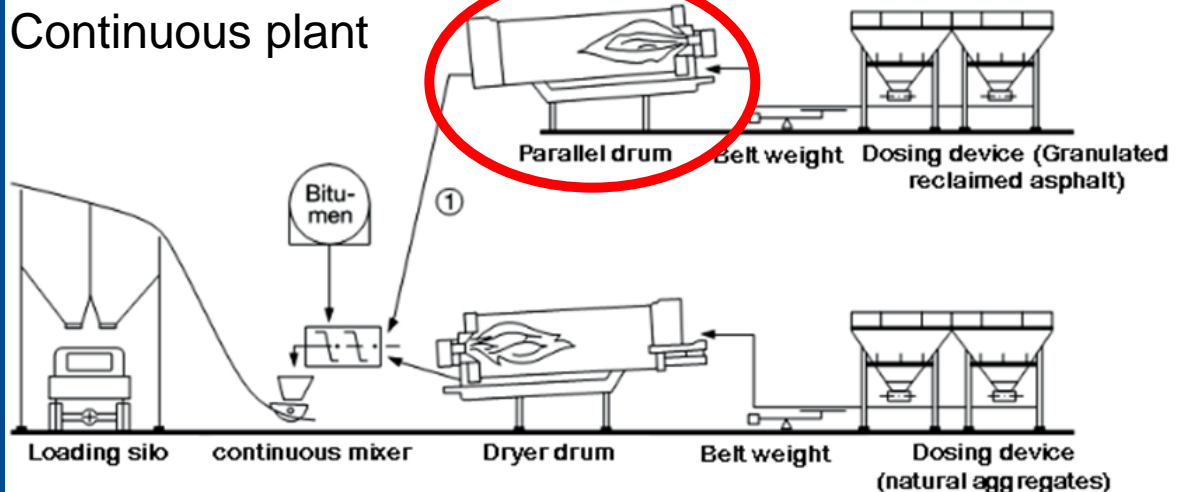
Mixing plant fittings

Some plants fit for high RA content



Parallel drum

Max. RA content \approx 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 $\leq 1\%$
synthetic materials, wood, plastics $\leq 0,1\%$

- 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			pen ≥ 5 and span ≤ 15 77 and span ≤ 8		
	aggregate	Grading curve	NS			span ≤ 10% span ≤ 15% span ≤ 4%		
		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 :

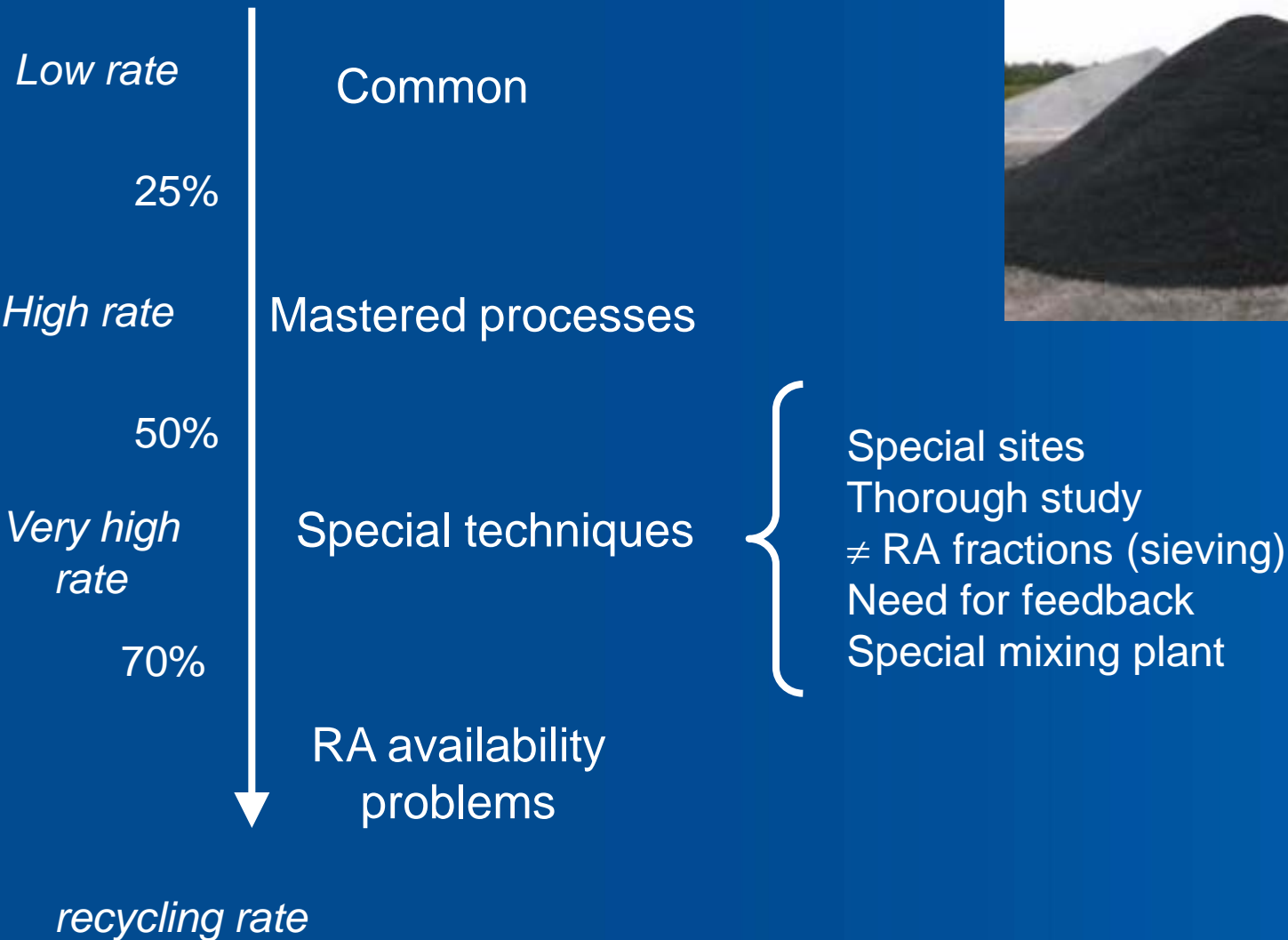
in France no new study needed if the rate of recycling is

< 10% in wearing course

< 15 % in binder, base, sub base courses



Mastering of the recycling techniques



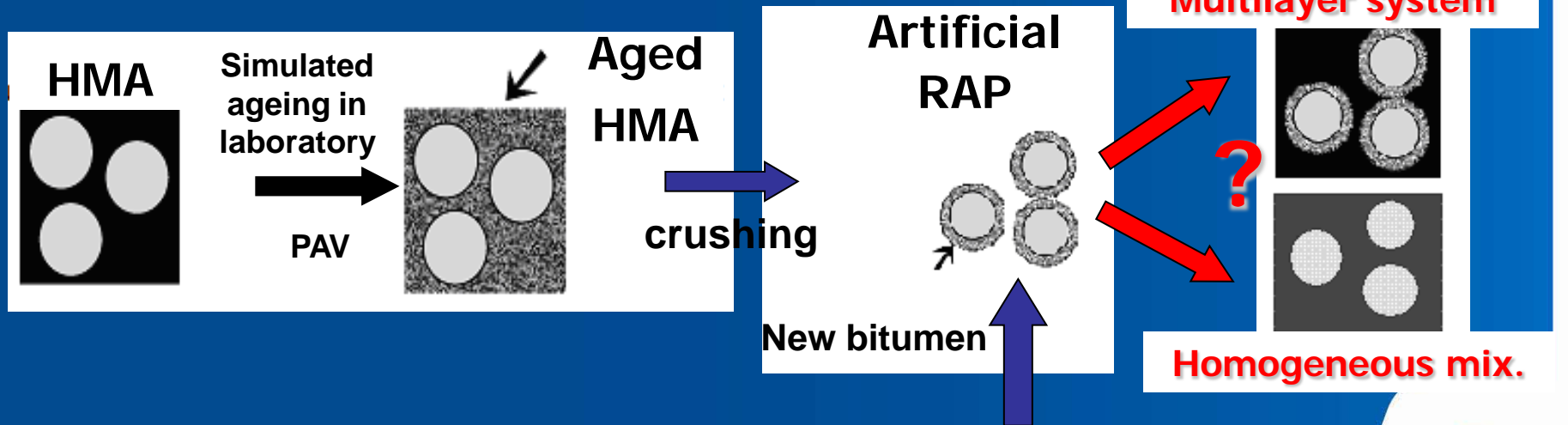
Research example : compatibility new-old binder

(*) 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



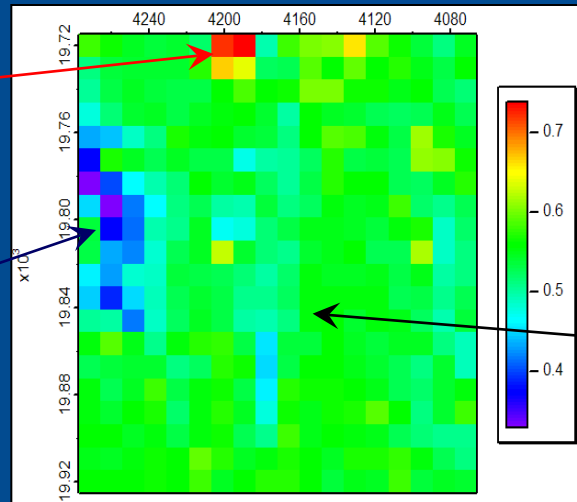
Research example : compatibility new-old binder

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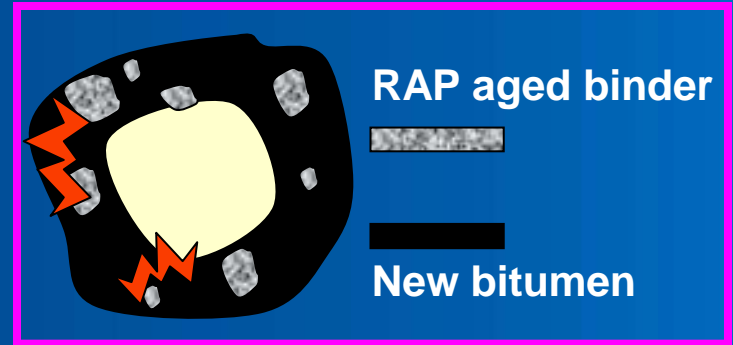
- Follow up of the spatial repartition of sulfates by X-rays Fluorescence microscopy and XANES microscopy in a synchrotron

Accumulation zone of sulphates (S^{6+})

Calcareous aggregate



Spatial repartition of sulfates



Bituminous area

- 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



Tendencias 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)

