

Recycling of asphalt pavements : interest of user and owner -

Performance : mechanical properties, durability, chemical and structural stability



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General remarks on the recycling

- A practice existing in the asphalt industry since 1970s
- Road context well suitable to the recycling of materials

- with or without change in function

recycling = adding of the reclaimed asphalt to new asphalt mixes, with the aggregates and the old bitumen performing the same function as in their original application

re-use = utilisation of reclaimed asphalt as foundation, fill or base course material, with the recovered aggregate and bitumen performing a lesser function than in the original application

- Possibility to make value with materials not coming from roads (for example, demolition concrete, tyres, glass, blast furnace slag, fly ashes)
- More and more economic incentives for recycling of materials

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Main reasons for recycling asphalt mixes

- Optimisation of use of natural resources (virgin aggregates)
- Limitation of waste deposits (less dumping of material)
- Preservation of the environment by the reduction of the exploitation of new quarries



Taking into account the sustainable development precepts during the whole life cycle of roads :

- Durability of mechanical performances
- Health, Safety, Environment along building and operating phases



General practice of achieving nearly 100% of material recycling by means of environmentally friendly and energy efficient processes

Issues for the road owners

- Decrease of detrimental impacts to the environment
- Decrease of storage sites for wastes (tighter controls on pollution levels and removal of hazardous substances dispersion)
- Saving of materials (aggregates, bitumen) by the re-use of whole or part of it (cost savings to the owners)
- Reducing the need for transport of materials for the works
- Optimizing of the quality-to-cost ratio of road infrastructure maintenance/rehabilitation
- Incentives measures for environmentally friendly road recycling practices



Economical, environmental and sustainable development issues

Issues for the contractors

- Propose environmentally friendly products
- Reuse the two ingredients of asphalt pavements, aggregates and bitumen, and restore the desired properties of the mixture :
 - use of intrinsic characteristics of aggregates from reclaimed asphalt (for example, polishing stone value and strength of stones in Reclaimed Asphalts)
 - mobilize the reclaimed asphalt binder :
 - how to regenerate the initial properties of the binder? add of rejuvenating agents?
 - how the rejuvenated binder ages over time?
 - from which level of hardening, the binder of reclaimed asphalt is not anymore usable as binder (« black rock »)?

Source of Reclaimed Asphalts (RA)

Road maintenance

- Milling
- Demolition



Asphalts from reject and surplus production



Quality of Reclaimed Asphalts (RA)

Dismantling of wearing courses
(generally thin surfacing courses)

Milling step

Management of RA in storage sites

Mixing of RA coming from
different construction sites



RA from unique source



RA from different sources

Asphalt from reject
and surplus production

Difficulty to
characterize RA
from different
sources

- > closed circuit
- > open circuit

« milling and simultaneous recycling and re-use »
« recovery, storage, later re-use »

Major steps in the recycling process of RA

- > To succeed in improving the recycling of asphalt pavements in new high performing asphalt layers, necessity to take into account all the phases :

- Characterization of the material in the road
- The dismantling phase
- Characterization of the RA aggregates
- The mix design with RA
- The introduction of the RA into the asphalt plant
- The performance characterization of the pavement materials made with RA



Problems arising in using RA clearly more complex than in using virgin natural aggregates and fresh binders

Different ways of RA recycling (*)

- **According to the place where mixing is carried out :**
 - in-situ
 - in-plant
- **According to the process temperature :**
 - cold recycling
 - hot recycling → warm recycling
- **According to the characteristics of material to be recycled**
- **According to the type of binder :**
 - ciment or lime and cement
 - bituminous emulsion
 - foamed bitumen
 - cement and emulsion or foamed bitumen
 - bitumen

Research undertaken by contractors : the French Innovation Charter (1)

- **Fruitful partnership between government and private :**
 - Public : road manager
 - a quality and economical road network
 - Private : contractors, engineering
 - expertise, notoriety, help to exportation development, competitive sector
- **Contribution from government :**
 - Experimental road sites at disposal
 - Survey by public road laboratories

Research undertaken by contractors : the French Innovation Charter (2)

➤ Examples of French innovative recycling projects :

- THERMOCOL RED process from COLAS
 - hot regeneration of porous asphalt mixes by thermo-recycling
- ECOCHAPE process from APPIA
 - cold asphalt mixes with 100% of crushed and sifted aggregates from milling or demolition
- RAFTED process from APPIA
 - hot regeneration of porous asphalt mixes at high recycling rate (50%) in specific drum mixer asphalt plant

Key problem : characterization of Reclaimed Asphalts ?

- Improving characterization of RA and technical evaluation of RA as a raw material:
 - considering the heterogeneity of the material
 - considering the specific industrial process for producing the asphalt mix
- Need of better production/characterization of RA in laboratory:
 - How to produce a RA in laboratory? Laboratory mixture ageing protocol? -> organisation of interlaboratory test



RILEM, TC « Advanced Testing of Bituminous materials », Task Group 5 « Recycling of Bituminous Materials » (responsible : Chantal de la ROCHE)

Key problem : evaluation of materials recycling potential?

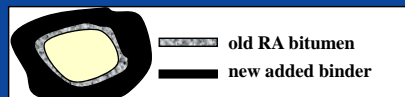
- **Need of recycling potential criteria :**
 - For neat materials
 - For materials susceptible to be recycled
 - For recycled materials
- **Potential use of RA in new asphalt mixes in consideration of :**
 - Chemical compatibility of new binders with old bitumens in RA
 - Physical performance of the resulting binder
 - Environmental impact of RA



**French Research Project of LCPC, called « OPTIMIRR » (responsible :
Chantal de la ROCHE)**

A research development in progress (1) : chemical compatibility of new binder with old RA bitumen (*)

- **Aim** : to assess the degree of homogeneity / heterogeneity between RA bitumen with the new added binder



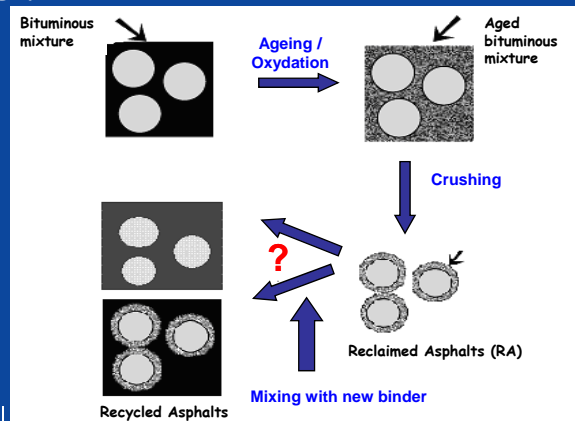
- **Means** : to observe the distribution of chosen tracers within recycled asphalts by microscopic techniques



**Laboratory research study to understand the binder's
mixing mechanisms involved during hot recycling**

A research development in progress (2) : chemical compatibility of new binder with old RA bitumen (*)

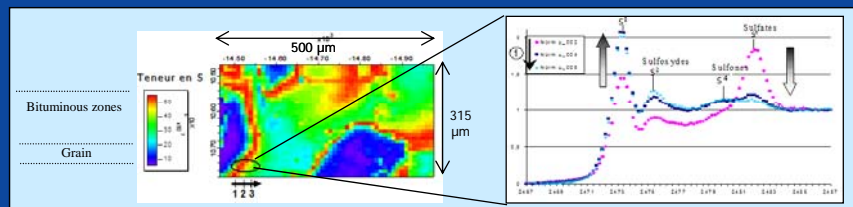
➤ Experimental procedure : to simulate in laboratory the hot recycling process



A research development in progress (3) : chemical compatibility of new binder with old RA bitumen (*)

➤ Preliminary results :

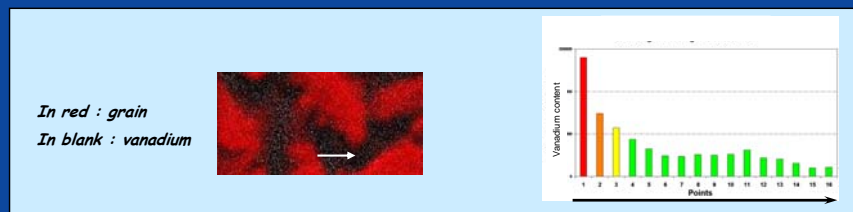
follow-up of the sulfur redox state in the laboratory model of recycled asphalt
(use of XANES microscopy - K edge of sulfur)



A research development in progress (4) : chemical compatibility of new binder with old RA bitumen (*)

➤ Preliminary results :

follow-up of the vanadium content in the laboratory model of recycled asphalt
(use of X-rays Fluorescence microscopy - K edge of vanadium)



Recycling of asphalt pavements : conclusions

- A practice existing in the asphalt industry since 1970s
- Road context well suitable to the recycling of materials



But there is still a need to progress in using of Reclaimed Asphalts and in restoring of the desired properties of the mixture

Research in progress :



- Characterization of Reclaimed Asphalt aggregates, an important issue related to the possible re-use for these materials
- Increasing the percent of material recycling by means of environmentally friendly and energy efficient processes -> warm recycling
- Assessment of how often a Reclaimed Asphalt can be reused in new asphalt pavements