PERFORMANCE ASSESSMENT OF MICROSURFACING WITH RECLAIMED ASPHALT PAVEMENT

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ABSTRACT

The use of recycled materials is part of a sustainable management approach. It allows for savings on limited resources and helps the protection of the environment by reducing the amount of dump sites and the transport of materials.
In 1998, Eurovia started to use reclaimed asphalt pavement in microsurfacing application and in 2001, signed a protocol with the French administration (Innovative Chart) to perform and assess the product.
Under the scope of the protocol two projects were performed. The first one in September 2002 on the National road 11 near Poitiers and the second one in July 2004 at Pont de Scorff in Brittany (RD 6)
The technique involves the production and laying of microsurfacing made from crushed/screened reclaimed asphalt in a 70 to 80 % proportion under different traffic and job site configurations.
This article summarizes the initial laboratory tests and the performance assessment of microsurfacing on the job sites between 3 to 5 years.
The general behaviour of the microsurfacing containing reclaimed asphalt is very satisfactory in comparison to the microsurfacing with 100% of virgin aggregates regarding the durability of the macro texture, skid resistance and surface integrity.

1. INTODUCTION

The road industry have to face the challenges of global warming and depletion of non renewable natural resources by proposing practical solutions, innovative, economically acceptable and consistent with sustainable development objectives.

Collection, crushing and screening of reclaimed asphalt pavement has become industrialised and should make available a dependable and homogeneous supply of materials for road construction.

Since 1998, Eurovia have been using reclaimed asphalt in microsurfacing application and in 2001 signed a protocol with the French administration (Innovative Chart) to perform and assess the product. Two jobsites have been assessed: RN 11 (86 – Poitiers) et RD 6 (56 - Pont de Scorff).

The paper resumes the initial laboratory tests and the performance assessment of microsurfacing on the job sites for 3 years for the RD6 and for 5 years for the RN11.

1.1. Laboratory studies

The laboratory tests used for the development of micro-surfacing formulas are:

- The hand mixing test, which is used to evaluate the compatibility between the aggregates, the emulsion and the breaking additives. This test can be used to determine the optimal proportions of the various ingredients so as to obtain a minimal mixing time.

- The breaking test which involves evaluating the time at the end of which the emulsion has completely broken on the aggregates. Blotting paper is applied to a slab of micro-surfacing over time with pressure of 0.2 MPa.

- The cohesion test (NF EN 12274-4) done with a Benedict cohesivimeter. This test allows us to evaluate the speed of curing of micro-surfacing by monitoring the change in cohesion over time, with measurements made at 5, 10, 15, 20, 30 and 60 minutes. We thereby define the time (cohesion time) for which the couple measured becomes greater than 20 kg/cm. This time allows us to set a minimum time for opening the road to traffic without risk for the surface.

- The modified WTAT (Wet Track Abrasion Test). The modifications to the standard WTAT test (ASTM D-3910) concern essentially the conditions for curing of test pieces in the climatic chamber. The purpose of this test is to evaluate the influence of the curing conditions (temperature, moisture content) on the mechanical properties at a young age of the micro-surfacing. This test can be done at three temperatures (10, 18 or 30°C) and at two different humidity levels (55 and 100%). An internal specification correlated with the site allows us to differentiate and validate the formulas.

Table 1 - Eurovia specifications

	Internal Specifications
Workability time (s)	**> 90 s**
Breaking time (min)	**< 20 min**
Cohesion time (min) : 20 kg.cm	**< 30 min**
WTAT	
% loss (18°C, 55 %)	**< 5 %**
% loss (18°C, 100 %)	**< 25 %**

1.2. Laboratory results

1.2.1. RAP Analysis

Table 2 - RAP bitumen analysis

	RAP from RN11	RAP from RD6
Bitumen content	5.8 pph	5.6 pph
Bitumen characteristics :		
- Penetrability (NF EN 1426)	16 1/10 mm	33 1/10 mm
- Ring and ball temperature (NF EN 1427)	65.6 °C	55.8 °C

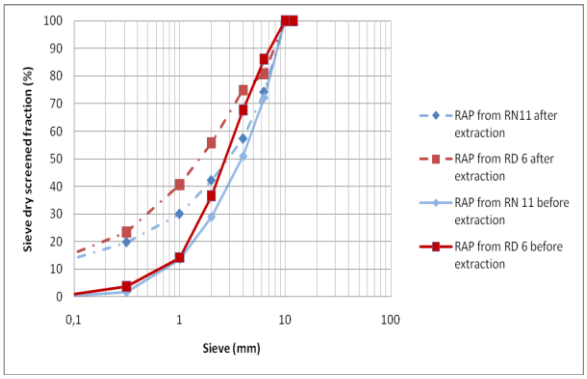


Figure 1 - RAP grading curves

1.2.2. Microsurfacing studies

For these two studies, the emulsion is a polymer bitumen emulsion (60%) : Emulvia Grip P. The emulsifier content in these two emulsions has been adapted in order to obtain 90 s of workability time at 25°C. The mix designs evaluated in the lab and the principal results are presented in the table 3. We tested the adding impact of virgin aggregates (0/2, 4/ or 4/6) on the microsurfacing characteristics.

Table 3 - laboratory results

Mix design	**80% RAP RD6+ 20% 0/2 from Guilligomarc'h quarry**	**80% RAP RD6 + 20% 4/6 from Guilligomarc'h quarry**	**80% RAP RD6 + 20% 0/6 from Guilligomarc'h quarry**	**80% RAP RN11 + 20% 0/2 from Mazières quarry**	**80% RAP RN11 + 20% 4/6 from Mazières quarry**
Water content	10 pph	9 pph	10 pph	10 pph	9 pph
Emulsion content	8 pph	8 pph	8 pph	8 pph	8 pph
Lime content	0.5 pph	0.5 pph	0.5 pph	0.5 pph	0.5 pph
Fibers	0.1 pph	0.1 pph	0.1 pph	0.1 pph	0.1 pph
Mixing time	90 s	100 s	90 s	90 s	100 s
Breaking time	10 min	10 min	10 min	15 min	10 min
Cohesion test :					
- 20 min.	20 kg.cm	17 kg.cm	20 kg.cm	20 kg.cm	20 kg.cm
- 30 min.	22 kg.cm	20 kg.cm	21 kg.cm	21 kg.cm	22 kg.cm
- 60 min.	23 kg.cm	21 kg.cm	22 kg.cm	23 kg.cm	24 kg.cm
Cohesion time	20 min.	30 min.	20 min.	20 min.	20 min.
WTAT test :					
- 18°C, humidity 55%	<1	<1	<1	1	1
- 18°C, humidity 100%	5	7	4	6	5

1.2.3. Laboratory Conclusion

Similar mechanical results have been obtained in the lab between a microsurfacing with virgin aggregates and 80% RAP+ 20 % of virgin aggregates.
The adding of 20 % of sand could improve the cohesion build up but not the visual aspect of the road (macrotexture…). To assure good surface performances, the following formulas were retained for jobsites (table 4):

Table 4 : Final mix designs for the RN 11 and RD 6

Sites	RN11		RD6	
Aggregates	80% RAP + 20 % 4/6	0/8 (reference)	70% RAP + 30 % 4/6 *****	0/6 d (reference)
Water content	10 pph	10 pph	10 pph	10 pph
Lime content	0.5 pph	0.5 pph	0.5 pph	0,5 pph
Fibers	0.1 pph	0.1 pph	0.1 pph	0,1 pph
Emulsion content	8 pph	11,2 pph	8 pph	11,4 pph

*****a slight modification on the site was done (70/30 to 80/20) to take into account the variations in the gradation

The change of the temperature during the laying day lead us to add, an additive to regulate the workability times. The max quantity of this additive is 0.5 pph / aggregates.

2. JOBSITES

2.1. RN 11

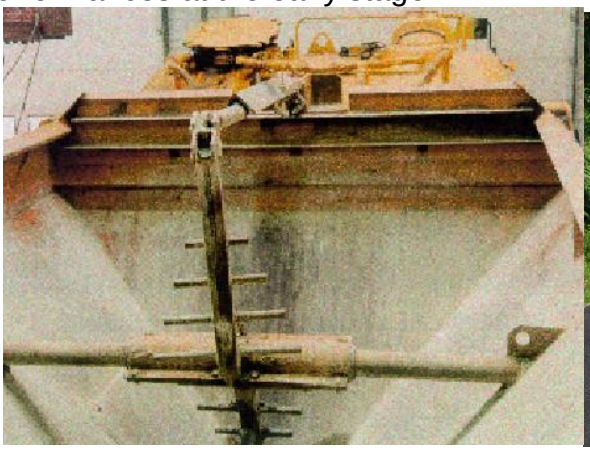
The job was done on 10 September 2002 south of Poitiers (86) on T1 traffic. (T1= 500 heavy vehicle per day).

The RAP was homogenized before being used. A 0/8 mm gradation was obtained by a specific crushing procedure. 20 % of 4/6 virgin aggregates from Mazières quarry was mixed with RAP.

The mixing and laying operation of the micro surfacing with reclaimed asphalt is done with the machine commonly used .In order to avoid lumps during manufacturing and laying, Eurovia developed a system to extend the use of standard hoper to the reclaimed materials. RAP becomes cohesive when stored, particularly when the air temperature is high and the storage period is long. Blocks can completely obstruct the hoper bottom. The system developed consists of a mechanical system that can be used for normal aggregates also (picture 1).

The laying day the air temperature was 22°C. A total surface of 3500 m² was laid (500 m * 7 m). On 10/9/02, a microsurfacing reference was laid: microsurfacing 0/8 with the Mazières quarry aggregates.

In comparison, we didn't observe a breaking time difference but a slow decrease of the cohesion build up with the formula containing RAP. The adding of a tyre compactor (2 passes) to expulse water from the microsurfacing allowed improving the mechanical performances at the early stage.



Picture 1 - Breaking cake system

Picture 2 - Laying of the microsurfacing

2.2. RD 6

The job was done on 7th June 2004 between Quévin and Pont Scorff (56) on a T2 traffic (T2=250 Heavy vehicle per day). As for the other site the RAP was crushed and homogenized to obtain a 0/8 gradation. The same specific machine was used on the

formula with RAP. During the laying day the air temperature was 22°C. The day after, the microsurfacing reference was laid: microsurfacing 0/6 d with the Guilligomarc'h (granite) quarry aggregates. The dosing quantity was between 10 to 11.6 kg/m² (without water) with the RAP and between 11.2 and 11.5 kg/m² for the reference.
We observed the same phenomena on the cohesion build up as we had seen on the RN 11.

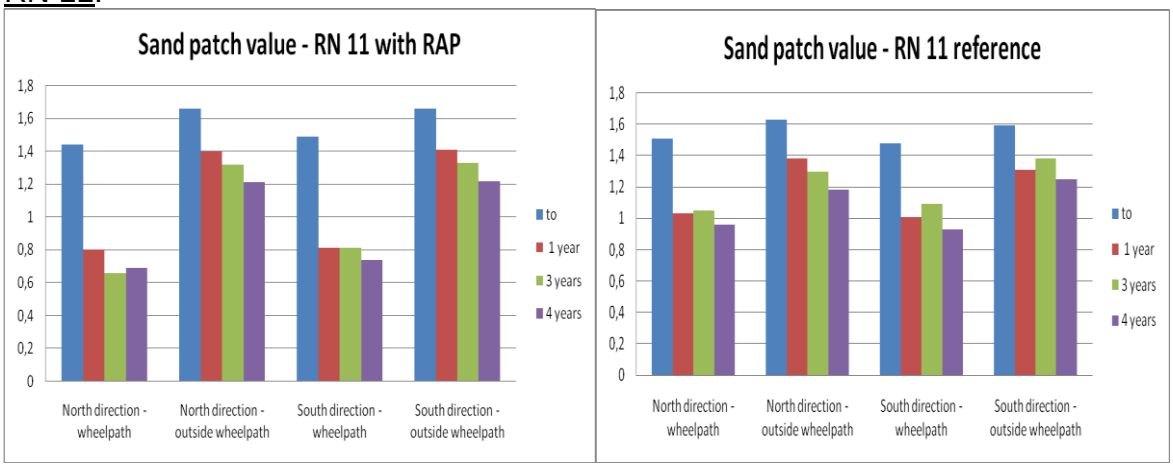
2.3. Jobsite assessments

These two sites have been assessed by the road authority (innovative Chart) and the following test performed: visual assessments, macrotexture: sand patch value, Breaking Force Coefficient (skid resistance) at three different speed: 40, 60 and 80 or 90 km/h according to the site.

2.4. Results

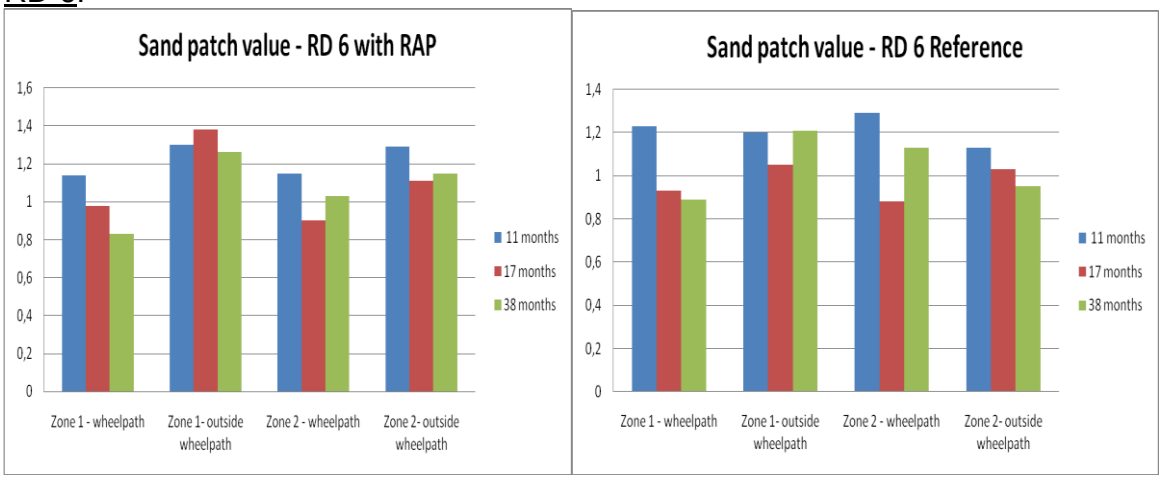
2.4.1. Evolution of the sand patch value

RN 11:



Figures 2 and 3 - Sand patch value on RN 11

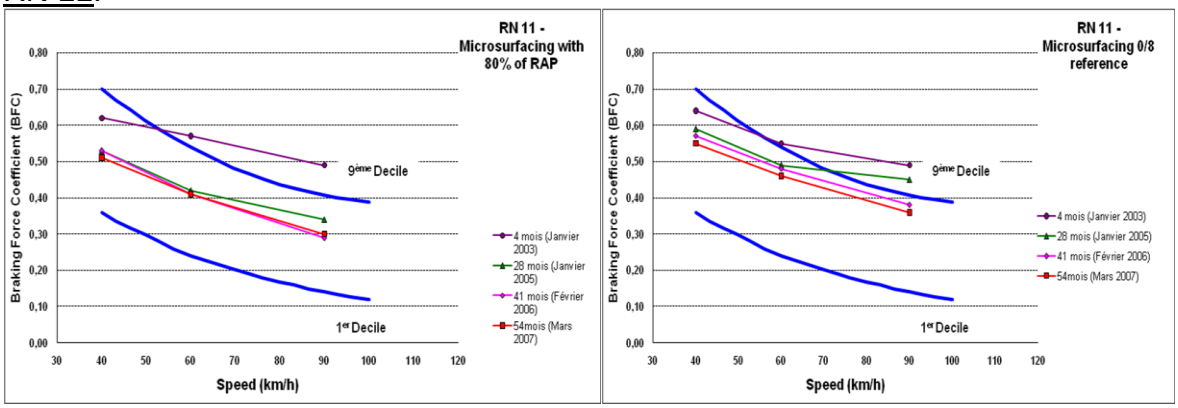
RD 6:



Figures 4 and 5 - Sand patch value on RD 6

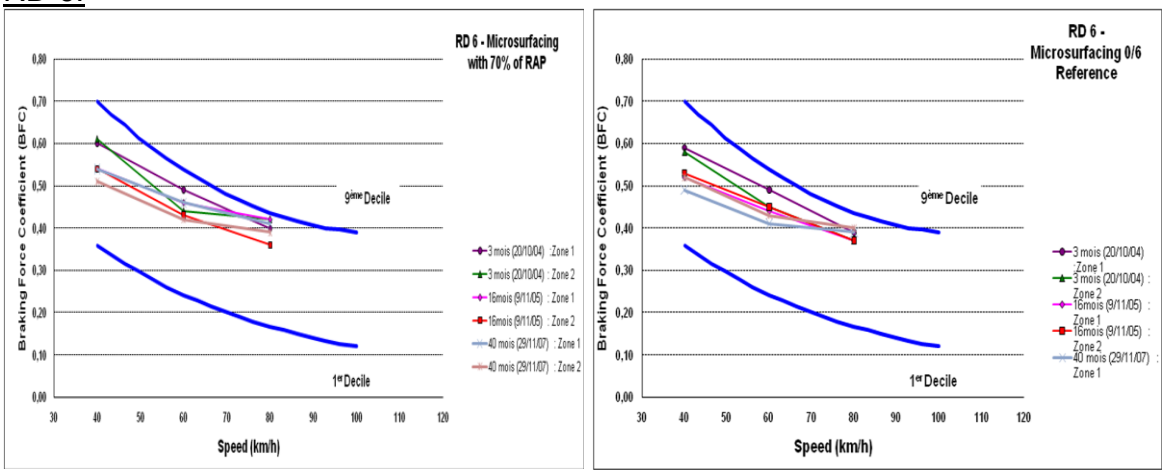
2.4.2. Evolution of the Braking Force Coefficient (BFC)

RN 11:



Figures 6 and 7 - BFC evolution for RN 11

RD 6:



Figures 8 and 9: BFC evolution for RD 6

2.4.3. Comments

RN 11:

After 5 years, the transversal profile between both formulas is the same. A rutting phenomenon was sometimes observed with the RAP formula in the wheel path areas. The macrotexture evaluated by the sand patch value (figures 2 and 3) shows weaker results in the wheel path areas with the RAP formula (around 0.7 against 0.9 without RAP). The macrotexture values remains stable between 1 year and four years.
The BFC results are very satisfying. The reference presents a skid resistance slightly higher: + 4 to + 6 points at 40 km/h and +9 to +11 points at 90 km/h.
We observe an evolution during the first few years for both formulas before stabilizing after 3 years.

RD 6

The general behaviour of the microsurfacing with RAP is similar to the reference formula and is in general satisfactory for the following points:

- Macrotexture

- Skid resistance: After 3 years the BFC values are slightly better with the formula with RAP.
- Surface aspect: less bleeding with the formula with RAP due in part to the gradation difference with the reference formula (0/6 d).

It's important to note that for both formulas, in the zone 1, after 3 years there is a reduction of macrotexture from 0,34 to 0,31 in the wheel path areas. In the other zone (opposite direction), this reduction is more uniform in the wheel path areas and outside the wheel path for both formulas (-0,12mm and -0,18 mm).
Some defects have been observed for both formulas: cracking phenomena and bleeding …

3. CONCLUSION

These experiments have shown that it was important before using a RAP is to crush, screen and homogenize it to obtain a well graded material.

Adding virgin aggregates to microsurfacing containing RAP allows to fulfil the surface characteristics requirements. A compromise must be reach to improve the grow of cohesion at early stage and the surface properties. Adding 0/6 seems to be the good comprise according to traffic and laying conditions (with a low filler content : < 4%).

The general behaviour of the microsurfacing containing reclaimed asphalt in the range between 70 to 80% is very satisfactory in comparison to the micro surfacing with 100% of virgin aggregates regarding the durability of the macro texture, skid resistance and surface integrity.