

SURFACE DRESSING OF LOW GRANULARITY (SINGLE 2/4 MM AND SINGLE DOUBLE CHIPPING 4/6-2/4 MM)

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ABSTRACT

With an estimated consumption of 7 tons/year/resident, aggregates are an essential resource to national and regional plannings. A rational mining of these natural deposits fits logically into a sustainable development approach.

In this context, experimental low granularity surface dressings have been monitored during several years after laying. Indeed, the development of bituminous formulas with discontinuity in their grading curves involves the production and stockpiling of some types of aggregates, mainly 2/4 mm. These aggregates are developed after 3 crushing/screening cycles and washed. So, as they have a considerable carbon footprint and a high manufacturing cost, their using optimization is crucial.

Therefore, 2 types of surface dressing, using 2/4 mm and 4/6 mm aggregates, have been tested on 3 experimental sites: Single 2/4 mm and single 4/6 - 2/4 mm surface dressing (double chipping), with an anhydrous binder fluxed with a vegetable flux or a special controlled breaking cationic emulsion. After 2 and 3 years, no difference can be noticed with an usual surface dressing behavior. However, these smaller wearing course aggregates allows an important noise reduction.

These encouraging results enabled the promotion of this type of aggregates, especially through the development of a regional technical using form and the drafting of a regional using guide.

Keywords: Aggregate, Emulsions, Macrotecture, Noise reduction, Surface dressing

INTRODUCTION

Aggregates are an fundamental resource in town and country developments (road construction). French national average consumption is thus estimated at 7 t/year/resident [1]. Nowadays, some grading category, for example 2/4 mm, are under-exploited and because of their manufacturing process, these aggregates got a high cost and a significant carbon footprint.

The idea of experimentations presented in this document, was first of all, to check if the laying of surface dressings made with these aggregates would be technically feasible and then, to follow their performances along several years under traffic.

This paper is divided into 2 parts. First, general points on low granularity surface dressings and then a second part on the monitoring of these experimentations.



Figure 1: Low granularity surface dressing laying – RD5

1. GENERAL POINTS

1.1 Components

Aggregates characteristics (accordance with NF EN 13043, 12271 and NF P 18-545)

European and French normative field available in appendix.

The 3 more important 4/6 and 2/4 mm aggregates expected specifications are:

- Graded, clean and dry aggregates,
- A flakiness rate lower than 20 % (for 4/6 mm aggregates),
- A cleanliness rate lower than 0,5 % (checked with 0,063 mm sieve).

Because of a low proportion of bitumen in these experimentations, moisture content of these aggregates must be controlled.

Bitumen's characteristics

The first kind of bitumen used in these experimentations is an anhydrous bitumen fluxed (bitumen modified with an elastomer fluxed with a vegetable flux). This bitumen is the one used by the contractor to lay surface dressings in this country (Burgundy).

Another kind of bitumen (used for the RD 124 [2] construction site) is a special controlled breaking cationic emulsion. The bitumen is modified with an elastomer and lightly fluxed. This choice depended on the laying period (later than other experimentations).

Binder/aggregates adhesion specifications (accordance with NF EN 12271)

The active adhesion rate and the global adhesion rate must be both at least of 90 % (or higher).

1.2 Bitumen and aggregates proportioning

Two types of surface dressings have been tested on these experimentations: single 2/4 mm and single (double chipping) 4/6-2/4 mm surface dressings.

Single 2/4 mm surface dressings proportioning:

- 2/4 mm aggregates : 5 Liters/m²
- Bitumen : from 0,8 to 1,1 Kilograms/m² (anhydrous bitumen)

Single 4/6 - 2/4 mm (double chipping) surface dressings proportioning:

- 2/4 mm aggregates: 5 L/m²
- 4/6 mm aggregates: 3 L/m²
- Bitumen: 1,3 Kg/m² (emulsion) and 1,0 Kg/m² (anhydrous bitumen)

(for record, bitumen and aggregates proportioning of control sections, single 6/10-4/6 mm (double chipping) surface dressings :

- 4/6 mm aggregates: 5 L/m²
- 6/10 mm aggregates: 7 L/m²
- Bitumen: 1,6 Kg/m² (emulsion))

1.3 Laying

Binder and aggregates must both answer to laying specifications.

Aggregates laying characteristics :

Aggregates proportioning precision must be +/- 10 %,

Aggregates transverse distribution variation must stay under 10 %.

Bitumen spraying characteristics:

Bitumen proportioning precision must be +/- 5 %,

Bitumen transverse distribution variation must stay under 10 %.

As bitumen proportioning are low and aggregates are smaller than usually, laying equipment must be controlled before and on the first meters of laying to check the proportioning and transverse distribution of both aggregates and bitumen.



Figure 2 : Aggregates proportioning control



Figure 3 : Bitumen proportioning control

2. EXPERIMENTATIONS

2.1 Construction sites

Low granularity surface dressings have been laid on three experimental construction sites (on prefectural roads). They are located in Burgundy, a French region with a continental climate (harsh winters).

Table 1: Presentation of experimental construction sites.

Road	Formula	Length (m)	Traffic category *
RD 5 (2008)	2/4 mm	400	T5
	4/6-2/4 mm	400	
RD 34 (2009)	2/4 mm	600	T3
	4/6-2/4 mm	600	
RD 124 (2009)	4/6-2/4 mm	300	T5

(* classification available in appendix)



Figure 4 : Visual appearance of a single 4/6-2/4 mm (double chipping) surface dressing.

2.2 Performances monitoring

The monitoring dealt with two main surface characteristics: the skid resistance and the noise reduction.

The skid resistance has been followed from 6 months to 2 (or 3) years after laying. The monitoring device used is the sand patch test (known as NF EN 13036-1).

Table 2: Skid resistance.

Road	Formula	6 months	1 year	2 years	3 years
RD 5	2/4 mm	1,10	0,89	0,89	0,96
	4/6-2/4 mm	1,35	1,12	1,16	1,22
RD 34	2/4 mm	0,70	0,89	0,92	<i>not applicable</i>
	4/6-2/4 mm	1,05	1,26	1,28	<i>not applicable</i>
RD 124	4/6-2/4 mm	-	0,93	1,00	<i>not applicable</i>
<i>Control section</i>	<i>6/10-4/6 mm</i>	<i>2,13</i>	<i>1,71</i>	<i>1,78</i>	<i>1,79</i>

The results can be presented in two points.

On the one hand, macrotexture level of both experimental surface dressings is very acceptable at final acceptance time. Moreover, a French road administration form requires at least 0,40 mm macrotexture values six weeks after laying (Circulaire n° 2002-39 du 16 mai 2002).

On the other hand, these experimentations show that even after 2 and 3 years under traffic and despite a value decrease, macrotexture is widely higher than 0,40 mm.



Figure 5 : Sand patch test – Macrotexture value (mm)

Because of their low granularity, it was interesting to follow the impact of these aggregates on noise reduction.

It has been monitored only on one experimental construction site (RD 5) with a monitoring device called “the isolated vehicle traffic noise measurement” (known as NF EN 11819-1).



Figure 6 : Instrumentation of noise measurement – RD5

Table 3: Noise level (dB(A)).

Road	Formula	6 months	1 year	2 years	3 years
RD 5	2/4 mm	75,1	-	-	73,9
	4/6-2/4 mm	78,1	-	-	73,1
Control section	6/10-4/6 mm	80,7			80,1

From laying to 3 years after, the noise level have always been lower on low granularity surface dressings. However, the most important result is the huge noise level difference (at least 6 dB) with an usual surface dressings. To illustrate this, when the volume is 3 dB lower, the noise level is half lower. So, these experimentations reduced by 4 the noise level.

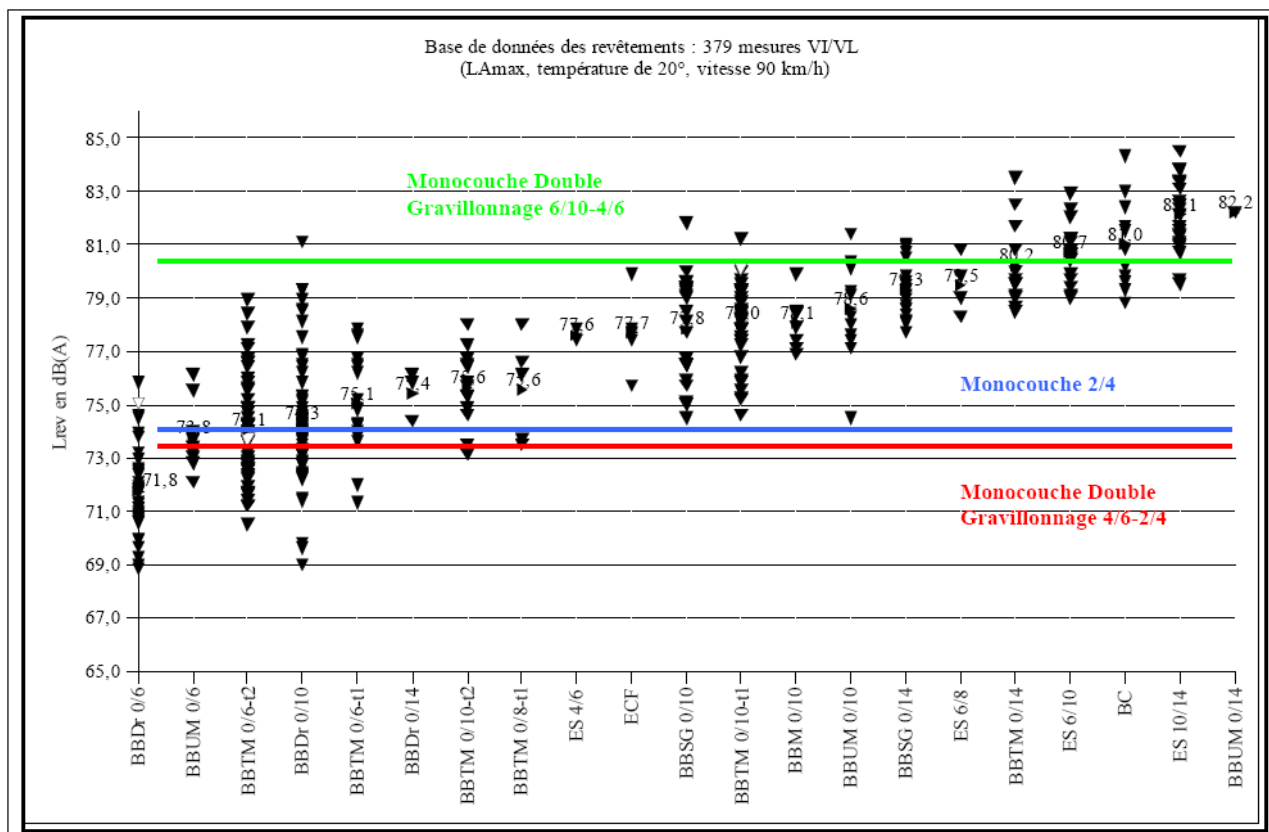


Figure 7 : Acoustic measurements at 3 years compared to average values of different types of surface course (database DL Strasbourg-France)

CONCLUSION

The outcome of these experimentations is very promising. First, the laying of these surface dressings happened with no difficulties and no deteriorations can be noticed after this first monitoring period. Then, the noise level recorded on the single 2/4 mm section is quite low, therefore it could be useful for villages crossing. Finally, it allows the setting up of a 2/4 mm aggregates promotion organization thanks to the production of a regional technical using form widely broadcast by the Autun Civil Engineering Laboratory and the Burgundy Regional Federation of Civil Engineering, to road managers, road owners and contractors.

The next step is the drafting of a regional technical using guide (for these aggregates) which has recently received the IDRIM [3] approval.

ACKNOWLEDGEMENTS

We would like to thank all our partners who helped us to make a success of these experimentations:

- The Conseil Général de la Nièvre (CG 58),
- Granulats Bourgogne Auvergne (GBA) LAFARGE,
- TRACYL (EUROVIA),
- The SETRA,
- The CETE de Lyon, Département Laboratoire d'Autun.

REFERENCES

- [1] Union Européenne des producteurs de granulats (UNPG) – Rapport annuel 2009/2010 – Page 6 rubrique « En bref »
- [2] RD 124 : one of the three experimental construction sites – Prefectural road
- [3] IDRRIM : Institut des Routes, des Rues et des Infrastructures pour la Mobilité.

APPENDIX

List of French and European norms that must have been respected in these experimentations:

- **AFNOR NF EN 13043:** « Granulats pour mélanges hydrocarbonés et pour enduits superficiels utilisés pour la construction des chaussées, aérodromes et d'autres zones de circulation » appropriée à l'emploi envisagé et donc à la performance requise.
- **AFNOR NF P 18 545:** « Granulats – Eléments de définition, conformité et codification » (article 8 : couches de roulement utilisant des liants hydrocarbonés)
- **AFNOR NF EN 12271:** « Enduits superficiels : Spécifications »
- **AFNOR NF EN 13036-1:** « Adhérence: Profondeur Moyenne de Texture »
- **AFNOR NF EN ISO 11819-1:** « Mesurage de l'influence des revêtements de chaussées sur le bruit émis par la circulation-Acoustique-Partie 1 : Méthode statistique au passage »

- Circulaire n°2002-39 du 16/05/2002 relative à l'adhérence des couches de roulement neuves et aux contrôle de la macrotecture – Direction des Routes – NOR : EQUR0210090C
- Guide technique – Enduits superficiels d'usure – SETRA LCPC Ed. 1995.
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Traffic category classification:

It depends on the number of heavy goods vehicle (by direction/by day):

Traffic category	Number
T0	Between 750 and 2000
T1	Between 300 and 750
T2	Between 150 and 300
T3	Between 50 and 150
T4	Between 25 and 50
T5	Between 0 and 25

(Guide technique: Conception et dimensionnement des structures de chaussée – SETRA/LCPC)