SEMI-COLD MIXES WITH 100 % RECYCLED MATERIALS

Laurence Boulange[1], *Daniel Claudel*[1], *Herve Dumont*[2], *Jean Pierre Triquigneaux*[1]
[1]*EIFFAGE Travaux Publics, Research Center, Corbas, FRANCE*
[2]*EIFFAGE Travaux Publics, Technical Support for western France, Caen, FRANCE*

ABSTRACT

To meet a growing demand directly linked to the criteria of Sustainable Development, EIFFAGE has since 2003 developed a range of cold mixes made from 100 % recycled asphalt, reclaimed by plant fluxing oils. The regeneration techniques implemented cover a wide range and adapt to local industrial manufacturing possibilities in the form of a bitumen emulsion mix and more recently by a cold mix with fluxed bitumen.
The operations carried out since 2007 in France on low traffic roads were used to validate the best conditions for making and using this new product. The cold mix with fluxed bitumen can now ensure a high added environmental value renewal of the road surface: a cold technique consuming little energy, the conservation of non-renewable aggregates resources and better comfort for the working teams are some of the proven parameters

Keywords: Semi-cold mixes, sustainable, binder, vegetal oil, recycling

1. INTRODUCTION

Right from the beginning of the project, the technical choices were made to achieve maximum optimisation of the criteria set out in the Convention d'Engagement Volontaire (negotiated commitment agreement) **[1]**, a procedure which EIFFAGE Travaux Publics committed to in 2009. The recommendation for the use of cold techniques in the manufacture and application of bitumen mixes allows substantial energy savings to be made and enables emissions of greenhouse gases (GHG) to be decreased dramatically. The principle advantage of this asphalt mix is its flexibility of use; indeed, reshaping the existing carriageway and providing a new wearing course can now be carried out in one single operation.

The 100 % recovery of reclaimed asphalt pavement (RAP) contributes to the savings in resources of material being used to make up the bitumen mixes with regard to both aggregates and the bitumen binder that is regenerated and re-used to its maximum technical and economical potential. The use of plant-based flux in the binder recovery ensures the absence of GHG emissions into the atmosphere compared with oil fluxing agents.

Finally, the mixing and application processes of these products may be easily adapted to local industrial plants, avoiding long-distance and high energy-consuming transport that emits GHG.

2. DESCRIPTION OF THE TECHNIQUE

2.1. Resources

The aggregate mixes mainly come from stocks made up in coating plants where they are crushed and sieved; they may also come from planings from the existing carriageway. This operation is carried out carefully at a constant speed defined in order to obtain a regular grading close to the fraction between 0/10 and 0/14 inclusive. The quality of the deconstruction and, more specifically, of the attention paid to sorting the bitumen materials alone is one of the essential factors contributing to the success of the technique (figure 1).

Figure 1. Installation of the reclaimed asphalt pavement crushing and sieving plant

The coating binders consist of bitumen fluxed with plant ester **[2]**, for use in coating plants. The filler binder content in the asphalt mixes based on 100 % recycled material is 30 % to 50 % lower in relation to the content in traditional hot asphalt mixes. The presence of plant ester in this binder helps to regenerate the initial bitumen binder already present in the surface of the reclaimed asphalt pavement. This binder is compatible with many types of reclaimed asphalt pavement.

2.2. Development of the 100 % RAP-based mix at the Central Laboratory

This asphalt mix belongs to the category of semi-cold asphalt mixes under the current revision of the standard relating to hydrocarbon asphalt mix terminology **[3]**: reclaimed asphalt pavement is used cold (ambient temperature) with a hot plant-fluxed bitumen **[4]**.

The asphalt mix and coating binder formulae are developed at the EIFFAGE Travaux Publics central laboratory in Corbas in close association with the regional technical departments involved in the project. Three criteria are used for this development of recycled asphalt mixes: (i) the quality of the RAP coating using regenerated binder, (ii)

the cohesion of the mix after manufacture and (iii) the maturing and consolidation of the asphalt mix. These different criteria are assessed according to internal tests carried out at the Corbas central laboratory (Table 1).

Table 1

The quality of the coating is graded according to the coverage rate of the binder on the reclaimed asphalt pavement: grade 1 relates to a coverage rate of <50 %, grade 2 relates to a coverage rate between 50% and 75% and grade 3 is for a coverage rate above 75 %.
The improved cohesion and the resistance of the material to distortion are studied 30 minutes after manufacture of the asphalt mix according to an assessment system graded from 1 to 3. Grade 1 relates to a soft material in which no cohesive improvement in the asphalt mix can be observed; grade 2 relates to a material that is still soft in which the start of the asphalt cohesion may be observed; and grade 3 relates to a hard material that remains flat after several mechanical loads have been applied.
The maturing test is carried out by touch according to an assessment system graded between 1 and 3. Grade 1 relates to an asphalt mix that leaves sticky residue on the hand; grade 2 leaves a slight feeling of stickiness on the hand and grade 3 leaves no stickiness on the hand.
A grade of 1 condemns the product with regard to its future application on the jobsite.

Properties	New aggregates (standard BBSG 0/10 curve) + regenerated binder	100 % RAP –based asphalt mix	100 % RAP –based asphalt mix + activation
Coating quality	2	3	3
Cohesion of the mix	3	3	3
maturing	3	1	3

The current formulation of the regenerated binder used for the 100 % RAP-based asphalt mix helps to improve both the mixing of the RAP during manufacture of the asphalt mix and its cohesion (Table 1).

The properties of improved cohesion of the 100 % RAP-based asphalt mix are similar to those observed for an asphalt mix made from a mixture of new aggregates (according to a standard curve of BBSG (semi-coarse asphalt concrete) 0/10) with the regenerated binder. On the other hand, this 100 % RAP-based asphalt mix matures more slowly. This is why, in the last phase of the study, the Corbas central laboratory developed an activation system to improve the maturing process of the asphalt mix. It is a non-corrosive and non-ecotoxic emulsion-based product that interacts with the surface of the asphalt mix (Table 1).

3. MANUFACTURE AND APPLICATION ON SITE

The manufacture of the 100 % RAP-based asphalt mix is carried out at a temperature between 15 °C and 20 °C, with the regenerated binder brought up to a temperature of 160 °C. To obtain a good RAP coating, favourable conditions are required in terms of a temperature above 10 °C and a humidity level less than 4 % for the RAP.

100 % RAP-based mixes were first laid in the West of France in marine and temperate continental climates in 2007, 2008 and 2010 (figure 2); then in 2011 in the Auvergne, which has a contrasting continental climate (figures 3 and 4). The sites used were of low traffic use, typically T3 traffic (where the flow limit means lower than 150 commercial vehicles per lane per day) and relatively distorted base layers which particularly highlighted the reshaping and flexibility capacities of the product. Two passes were required during the compaction of the 100 % RAP-based asphalt mix to reach an acceptable density that is less than normal as it is for a semi-cold mix.

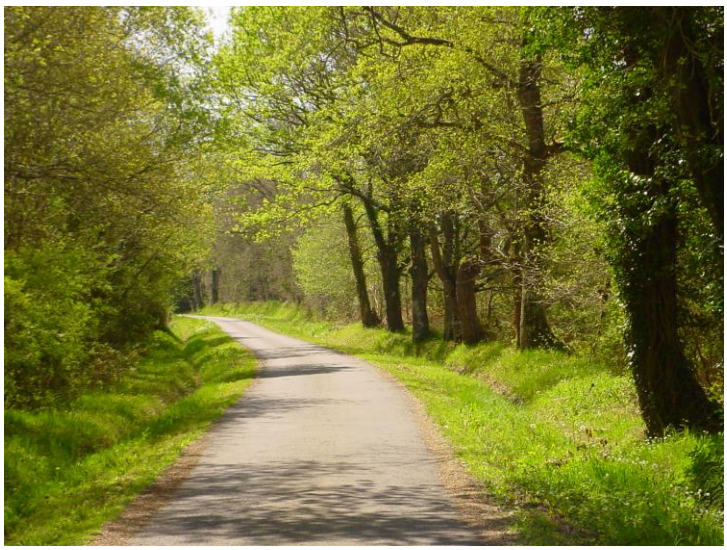

Figure 2. General appearance of the 100 % RAP-based asphalt mix after three years in the West of France

Figure 3. Laying the 100 % RAP-based asphalt mix on the jobsite in the Auvergne region

Figure 4. Compaction of the 100 % RAP-based asphalt mix on the jobsite in the Auvergne region

The regenerated binders for this 100 % RAP-based asphalt mix were made in the factories of APPIA Liants de l'Ouest and APPIA Liants Emulsions near Lyon. After they were manufactured, the regenerated binders were delivered and injected by an independent system into the manufacturing plant that can be of continuous or non continuous operation. The temperature of the 100 % RAP-based asphalt mix is typically 25 °C as it emerges from the coating plant.

The activation system developed in the laboratory was tested on the Auvergne jobsite. The emulsion applied straight after compaction using a VTO tandem roller without vibration accelerated the maturing process of the 100 % RAP-based asphalt mix, thus avoiding the need for any further sanding or gritting operations.

4. IN SITU MONITORING

Core samples were taken in 2010 from the 100 % RAP-based asphalt mix laid in 2007 and 2008 in the West of France. The asphalt presented a good, homogeneous and closed appearance (figure 2) that was well adapted to its use (roads of low traffic use).

The thicknesses of the cores varied from 4 cm to 5.5 cm, with their average voids content being 10 % for this 100 % RAP-based asphalt mix from 2007 and 13 % for the 2008 asphalt. The indirect tensile stiffness modulus was measured at 10 °C and 124 ms **[5]**: the values vary from 4159 MPa to 7300 MPa with an average of 6000 MPa for this 100 % RAP-based asphalt mix manufactured in 2007 and 5200 MPa for the 2008 mix.

These results are proof of a satisfactory development of the mechanical performance of the asphalt mixes and justification of their good behaviour.

5. CONCLUSIONS

This asphalt mix, consisting of 100 % RAP and regenerated anhydrous binder, supplements the offer already presented in terms of innovative cold recycling techniques **[6, 7]**.

The innovation of this asphalt mix lies in the formulation of the regenerated binder that helps to accelerate the cohesive strengthening of the 100 % RAP-based asphalt mix after it has been laid and its activation during compaction that helps to avoid any further treatment of the road surface.

Today, this asphalt mix helps to ensure the high added environmental value of the renewal of the wearing course, combining the use of a low energy-consumption cold technique, the preservation of the non-renewable aggregate resource, savings in bitumen binder and improved comfort for the operating teams.

REFERENCES

[1] Infrastructures routières, voirie et espace public, convention d'engagement volontaire des acteurs de conception, réalisation et maintenance des infrastructures routières, voirie et espace public urbain, F. Marmier, RGRA n° 875 pp. 25-28, 2009

[2] Liant bitumineux, composition et utilisation, French Patent FR 2768150 1997

[3] Bituminous mixtures – Test methods for hot mix asphalt - Part 26: Stiffness, European Standard NF EN 12697-26 / Annex C, 2004

[4] Procédé pour préparer un enrobé bitumineux routier, J. Marcilloux, D. Claudel, French Patent FR 2834305, 2001

[5] Asphalt - Terminology – Components and composition of mixtures – Implementation – Products – Techniques and processes French Standard NF P98-149, 2000

[6] Biochape, new innovating grave recycling emulsions - An experiment realised in Haute Garonne department, J.P. Triquigneaux, L. Valéry, RGRA n°833 pp. 63-68, 2004

[7] Biochape, cold mix asphalt ecological solution for regional road maintenance, Y. Meunier, M. Jourdan, RGRA n°837 pp. 40-41, 2005