CONCENTRATED POLYMER MODIFIED BITUMEN IN PELLETS. PART 1

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In France, for over 25 years now, bitumen modified by SBS (Styrene-Butadiene-Styrene) has become technically the most cost-effective and efficient solution. Polymer Modified Bitumen (PMB) with SBS has been then used successfully over the entire national road network in a good number of areas usually with high traffic. Elastic behavior and greater cohesion conferred by the PMB with SBS improve considerably resistance to rutting, thermal cracking, fatigue, and aging asphalt concrete. Moreover, the cross-linking reaction makes PMB easier to store and transport.

For over the last 25 years, according to French experience, surface course lifespan is extended substantially with PMB. In this way, maintenance savings offset the initial extra cost.

Pellets of Polymer Modified Bitumen, highly concentrated in SBS

Producing PMB with elastomer requires investments in industrial plants (binder plants) and the implementation of the whole production process. Knowledge and the control of this technology are not immediate. Therefore, beyond the expensive investments required, some countries may face issues to access quickly to this technology.

Pellets of PMB, highly concentrated in SBS, could be a solution. It is used as an alternative to PMB produced in binder plants. These pellets are ready-to-use as it is directly introduced and quickly dispersed into the pug mill of the asphalt plant. This solution offers more flexibility and facilitates the production of asphalt mixes modified with elastomer. Then, the pellets are solid and cold, very easy to store, transport and dose. The PMB pellets dosage is adjusted according to the required performances. It is mainly dedicated to solve the following issues: high traffic zones; thin layers of the asphalt mix; high thermal stress; need for strong inter-granular cohesion; durability of surface characteristics (texture, adhesion, noise reduction)

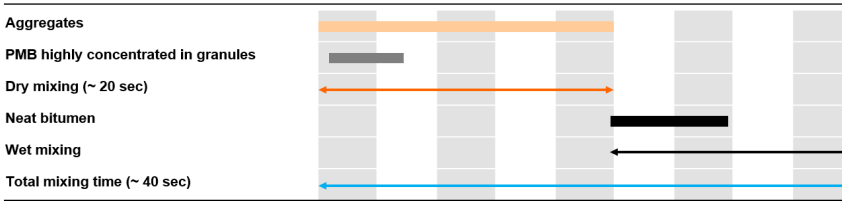

Fig. 1. Example of mixing cycle in a batch plant

Pellets of PMB, highly concentrated in SBS, are designed to be introduced directly into either continuous or discontinuous asphalt mixing plant. For the

manufacturing process, the pellets are introduced almost at the same time as aggregates and in any case before the neat bitumen.

During the mixing phase, the highly energized moving hot aggregates generates a homogeneous and quick dispersion of PMB in pellets among aggregates. There is no change in the production rate compared to a standard PMB.

For the manufacturing process, the following parameters are not disturbed by using the PMB highly concentrated in pellet form: manufacturing directives and instructions given; aggregates temperature; neat bitumen temperature; no increase in the mixing time

Therefore, with this innovative solution, it is possible to carry out construction projects with small tonnages without having to go through a full truck of PMB, as it has been the case so far.

Performance obtained with pellets of PMB highly concentrated in SBS

Using pellets of PMB highly concentrated in SBS does not change asphalt mix performance compared to PMB manufactured in a binder plant. To demonstrate it, various methods are used in laboratory. The tests are done on asphalt mixes but also on binders. The results are compared with French requirements and also with those obtained with neat bitumen and PMB produced in a binder plant.

Asphalt mixes performance

Various asphalt mixes are evaluated. One of them is composed of 20 % of Reclaimed Asphalt Pavement (RAP).

Different types of binders are tested: 50/70 penetration grade neat bitumen: AC_i; standard PMB manufactured in a binder plant: AC_i^{PMB}; 50/70 penetration grade neat bitumen + Pellets of PMB highly concentrated obtained directly in asphalt mixing plant: $AC_i^{P.PMB}$.

The asphalt mix AC_1 is produced and used for road and highway maintenance. The asphalt mix AC_2 presents a very poor resistance against rutting. Therefore, it is exclusively used in the laboratory to emphasize the improvement capacity of a PMB like binder.

Table 1

Asphalt mixes composition

Formulation	Aggregates origine	RAP	Total binder content
AC_1	Cemex – Salles-sur-Garonne	20 %	5.0 %
AC_2	CSL – Décines	0 %	5.7 %

Water resistance

Interaction between the aggregates and the hydrocarbon binder film is a key factor in the asphalt mix lifespan. In case of lack of adhesion, water and moisture may cause substantial damage on the surface course. The water sensitivity test is

a way to evaluate the quality of this interaction and then evaluate the behavior of the asphalt mix on the roadway.

Various methods are available to assess water sensitivity. Most tests determine the mechanical characteristic variation after conditioning asphalt mix in water. In Europe, water sensitivity of bituminous mixtures is assessed according to the standard EN 12697-12 and more specifically in France with method B. The Table 2 presents the water sensitivity results obtained for the different asphalt mixes tested. The French requirement for the surface course is also indicated in the following table.

Table 2

Water resistance

Water sensitivity (EN 12697-12 – Method B)	**AC_1^{PMB}**	**$AC_1^{P.PMB}$**	**Surface course French requirement - EN 13108-1**
i/C (%)	84	92	≥ 70

The asphalt mix $AC_1^{P.PMB}$ result fully satisfies the surface course requirement. With the pellets of PMB, the asphalt mix is classified as very resistant to water.

Considering the test precision, the two asphalt mixes tested present the same water resistance.

Workability

The workability laboratory test aims to simulate the expected asphalt mix behavior during the implementation on the work site.

In France, a new workability test method appears in the late 60s and is still currently used today. This test method requires a Gyratory Shear Compactor.

In the 90s, the Strategic Highway Research Program carried out in the USA recommended the use of a Superpave Gyratory Compactor (SGC).

> *"Use of the Superpave system, and thus the SGC, has proven so successful that it is now used in all 50 states and elsewhere worldwide" (MS 2 – Asphalt Mix Design Methods – Chapter 4 – Laboratory Mixture Testing)*

The workability tests on asphalt mixes are standardized as EN 12697-31 and AASHTO T312 respectively for European and American methods.

As the tests are done in France, the following results are obtained according to European standards.

Experience demonstrates that a correlation exists between results from the gyratory shear compactor and the asphalt mix behavior on the work site.

The result after 10 gyrations corresponds approximately to the asphalt mix behavior after the paver screed. With 15 % voids, both mixes tested may show the same bulking at the paver screed.

Table 3

Gyratory Shear Compactor

Gyratory Shear Compactor (EN 12697-31)		**AC_1^{PMB}**	**$AC_1^{P.PMB}$**	**Surface course French requirement - EN 13108-1**
Voids	V_{10} (%)	15.4	14.3	n.r.
	V_{80} (%)	6.9	6.1	4 to 9
	V_{200} (%)	3.8	3.3	n.r.

The result after 80 gyrations matches with an 8 cm thickness asphalt mix layer after compaction.

The results after 200 gyrations give additional information about a potential "excess" of workability of the mixture or in the case of an over-compaction.

All this information are meaningful to set the parameters for the implementation process on the work site. The workability of the two asphalt mixes tested is the same; there should be no difference in behavior during implementation on the work site. In addition, both complies with the requirement.

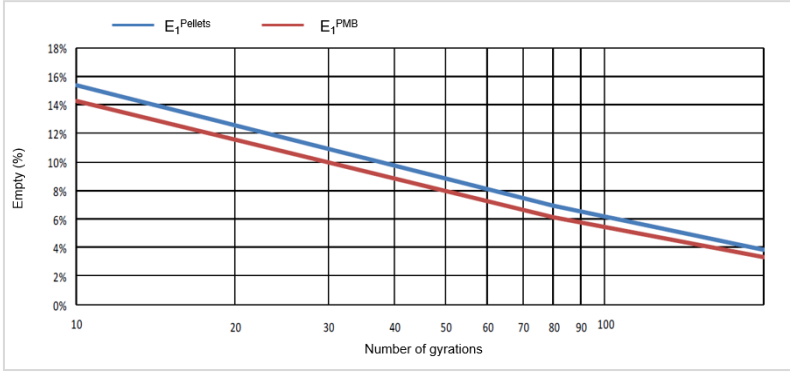

Fig. 2. Gyratory compactor graph results