BITUMEN AND PMB. ACTUAL QUESTIONS 2017 SAINT-PETERSBURG

Serge KRAFFT

European and international experience in the production, storage and transport of modified bitumen.

EIFFAGE

Organisation: 4 branches, 7 businesses

Eiffage operates seven business lines, structured as four branches. This spectrum of expertise enables the Group to provide integrated services, and to finance, design, build, equip, promote, operate and maintain buildings, engineering structures, facilities and infrastructure.

INFRASTRUCTURES

Road
Civil engineering
Metal

€4.4 billion revenue
23,500 employees

CONSTRUCTION

Construction
Property

€3.5 billion revenue
11,800 employees

ENERGY

Energy

€3.6 billion revenue
24,500 employees

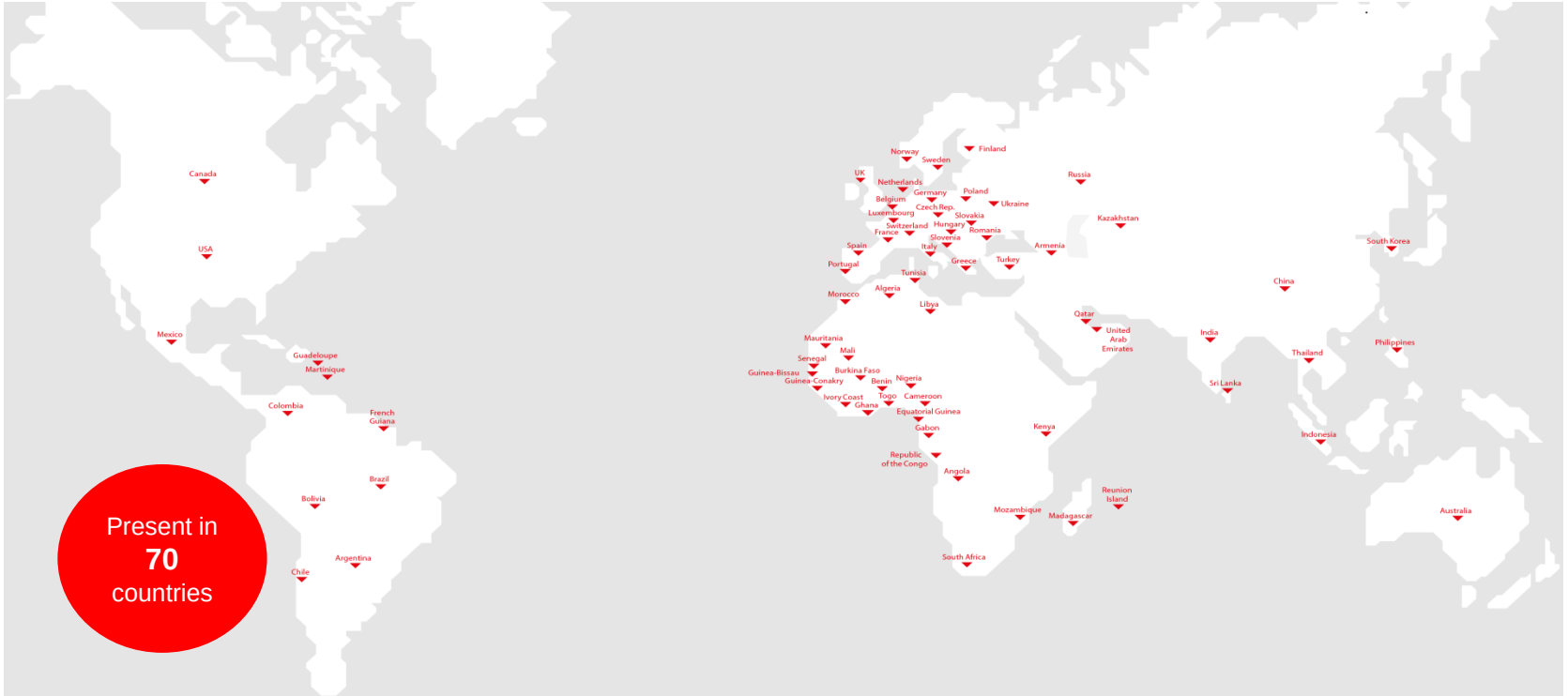
CONCESSIONS

PPP and concessions
Motorways
APRR and AREA

€2.2 billion revenue
4,100 employees

In 2015

Eiffage around the world



Present in **70** countries

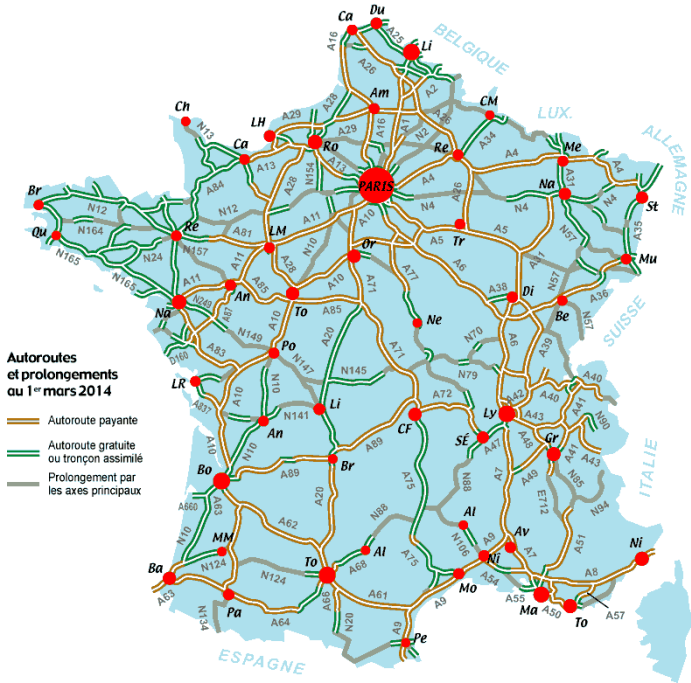
The french road network - 2014

- **Main roads network**
  - Concession (Highways/Motorways) 9 048 km
  - Free Highways and motorways 2 601 km
  - National roads 8 898 km

- **Secondary roads network**
  - Department road 377 965 km
  - Urban and small roads 666 350 km

Total : 1 064 862 km

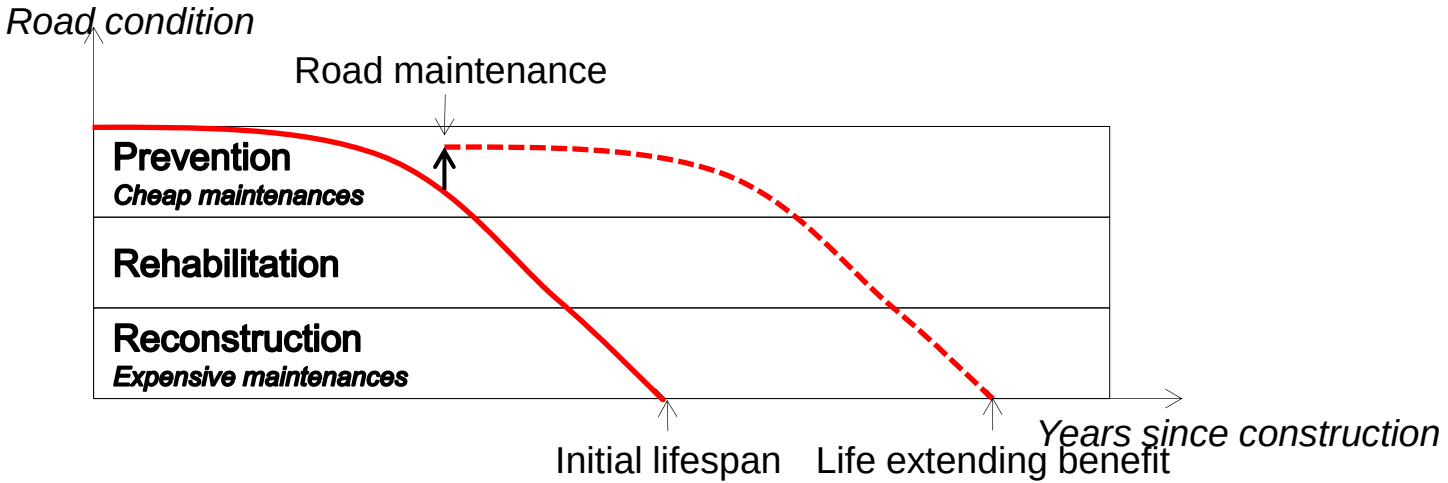
2 000 M€



EIFFAGE

Economical Issues

– Budget : -30% (2008/2014)



EIFFAGE

A mix design based on performances – (EN 13108-20)

4 3 2 1

- Water sensitivity (EN 12697-12)
- Gyratory shear compacting (EN 12697-31)
- Rutting test (EN 12697-22)
- Stiffness modulus (EN 12697-26)
- Resistance to fatigue (EN 12697-24)

EIFFAGE

A mix design based on performances – (EN 13108-1)

		General characteristics								Fundamental characteristics	
1	2	3	4	5	6	7	8	9	10	17	18
Standard article		4.2	5.2.1			5.2.2	5.2.4	5.2.6 table 7	5.2.10	5.4.2	5.4.4
BBAC 1 0/10	EB 10 wearing course or binder course	Type (for the modified bitumen) and class to be declared			10 mm	Binder course: $V_{min\ 4}$ to $V_{max\ 8}$ (60 gyrations) Wearing course: $V_{min\ 3}$ to $V_{max\ 7}$ (60 gyrations)	Binder course: $ITSR_{70}$ (≥ 70 %) Wearing course: $ITSR_{80}$ (≥ 80 %)	– P_{15} (≤ 15 % – 60 °C and 10 000 cycles) – Vi = 4 % – Vs = 7 %	According to the binding medium	– $S_{min5500}$ (≥ 5 500 MPa at 15 °C, 10 Hz or 0,02 s) – Vi = 4 % – Vs = 7 %	– $\varepsilon_{6\text{-}130}$ (≥ 130.10^{-6} at 10 °C, 25 Hz) – Vi = 4 % – Vs = 7 %
BBAC 2 0/10	EB 10 wearing course or binder course	Type (for the modified bitumen) and class to be declared			10 mm	Binder course: $V_{min\ 4}$ to $V_{max\ 8}$ (60 gyrations) Wearing course: $V_{min\ 3}$ to $V_{max\ 7}$ (60 gyrations)	Binder course: $ITSR_{70}$ (≥ 70 %) Wearing course: $ITSR_{80}$ (≥ 80 %)	– P_{10} (≤ 10 % – 60 °C and 10 000 cycles) – Vi = 4 % – Vs = 7 %	According to the binding medium	– $S_{min5500}$ (≥ 5 500 MPa at 15 °C, 10 Hz or 0,02 s) – Vi = 4 % – Vs = 7 %	– $\varepsilon_{6\text{-}100}$ (≥ 100.10^{-6} at 10 °C, 25 Hz) – Vi = 4 % – Vs = 7 %

EIFFAGE

A mix design based on performances – (EN 13108-1)

		General characteristics								Fundamental characteristics	
1	2	3	4	5	6	7	8	9	10	17	18
Standard article		4.2	5.2.1			5.2.2	5.2.4	5.2.6 table 7	5.2.10	5.4.2	5.4.4
BBAC 1 0/10	EB 10 wearing course or binder course	Type (for the modified bitumen) and class to be declared			10 mm	Binder course: $V_{min\ 4}$ to $V_{max\ 8}$ (60 gyrations) Wearing course: $V_{min\ 3}$ to $V_{max\ 7}$ (60 gyrations)	Binder course: $ITSR_{70}$ (≥ 70 %) Wearing course: $ITSR_{80}$ (≥ 80 %)	– P_{15} (≤ 15 % – 60 °C and 10 000 cycles) – Vi = 4 % – Vs = 7 %	According to the binding medium	– $S_{min5500}$ (≥ 5 500 MPa at 15 °C, 10 Hz or 0,02 s) – Vi = 4 % – Vs = 7 %	– $\varepsilon_{6\text{-}130}$ (≥ 130.10^{-6} at 10 °C, 25 Hz) – Vi = 4 % – Vs = 7 %
BBAC 2 0/10	EB 10 wearing course or binder course	Type (for the modified bitumen) and class to be declared			10 mm	Binder course: $V_{min\ 4}$ to $V_{max\ 8}$ (60 gyrations) Wearing course: $V_{min\ 3}$ to $V_{max\ 7}$ (60 gyrations)	Binder course: $ITSR_{70}$ (≥ 70 %) Wearing course: $ITSR_{80}$ (≥ 80 %)	– P_{10} (≤ 10 % – 60 °C and 10 000 cycles) – Vi = 4 % – Vs = 7 %	According to the binding medium	– $S_{min5500}$ (≥ 5 500 MPa at 15 °C, 10 Hz or 0,02 s) – Vi = 4 % – Vs = 7 %	– $\varepsilon_{6\text{-}100}$ (≥ 100.10^{-6} at 10 °C, 25 Hz) – Vi = 4 % – Vs = 7 %

EIFFAGE

Modification of bitumen – How to do it ?

- Fibers
  - Cellulose, Glass, Polyester, …
- Natural asphalts
  - Gilsonite, Trinidad, …
- Waxes
  - Viscosity modifiers
- Plastomers
  - Polyethylene, EVA ✓
- Crumb rubber ✓

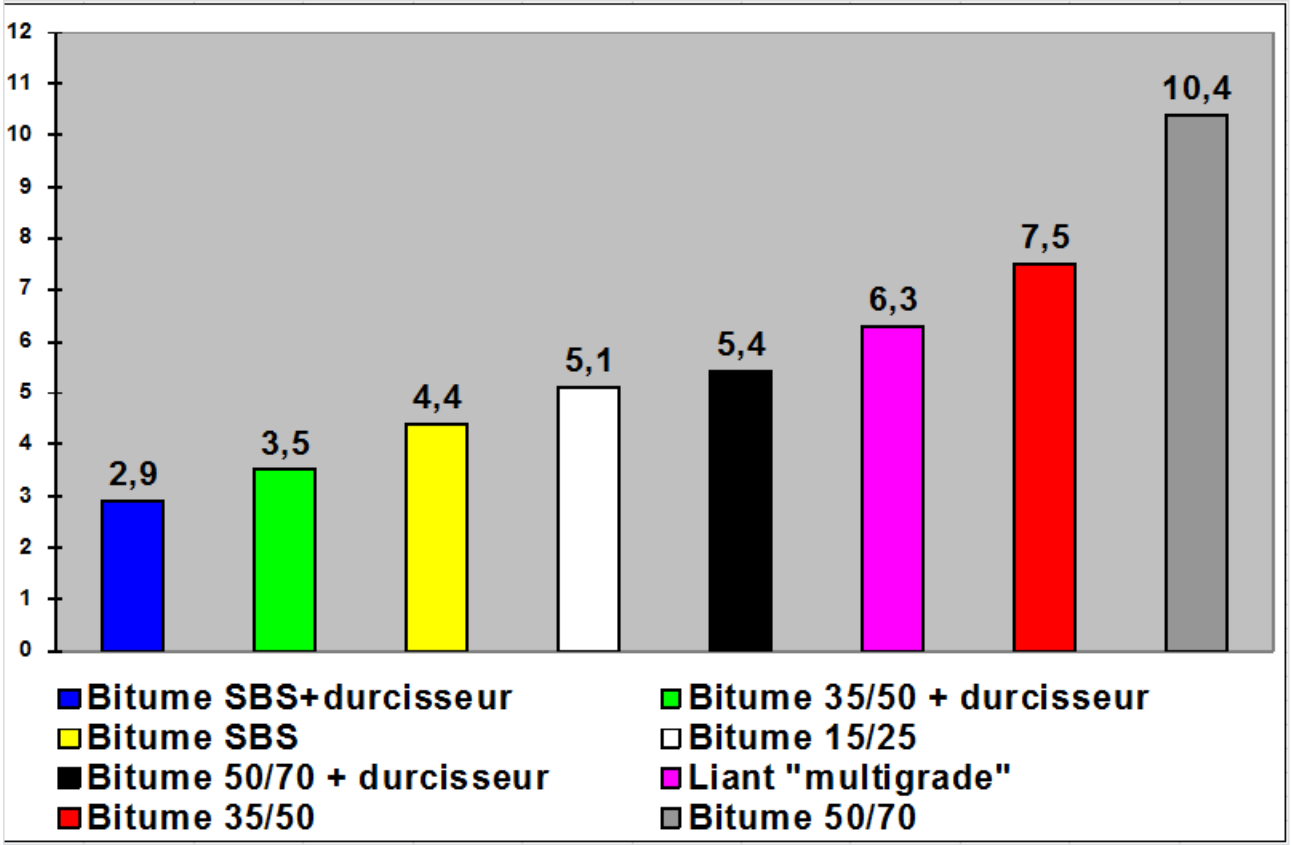
- Elastomers – SBS ✓

<u>What we are expecting :</u>

- Enhance thermomechanical properties of binder :
  - Softening point
  - FRAASS
  - Elastic Recovery

- Enhance thermomechanical properties of asphalt concrete :
  - Resistance to rutting
  - Resistance to fatigue
  - Modulus

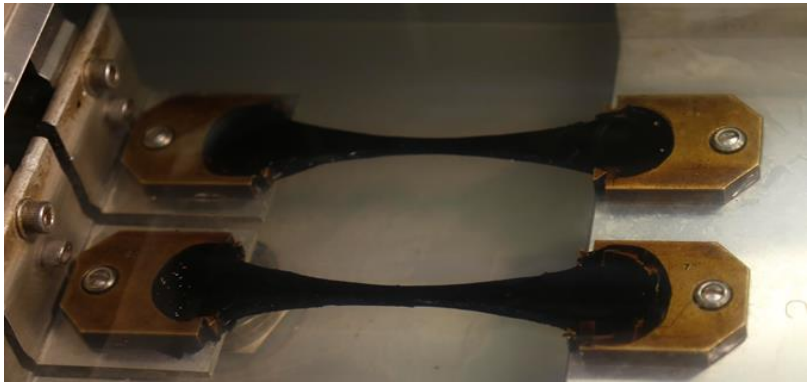
Resistance to rutting



EIFFAGE

Performances of bitumen modified by SBS

	PmB from Eiffage range
Penetration ($^1/_{10}$ mm) *25˚C, 100g, 5s*	45-80
Softening Point (˚C) *Glycerol, auto device*	≥ 67
FRAASS (˚C) *auto device*	≤ -14
Elastic Recovery (%) *25˚C*	≥ 85



EIFFAGE

BBTM – Very Thin Overlay

- **Description**
  - Gap-graded asphalt concrete
  - Grading : 0/4, 0/6 or 0/10
  - Polymers modified bitumen - SBS
  - **Thickness : 2,5 cm (50 à 70 kg/m²)**
  - European standard EN 13108-2

- Can be used for a wide range of road types and traffic flow
- Suitable for even the heaviest traffic
- Recommended to regenerate surface properties for early road maintenance

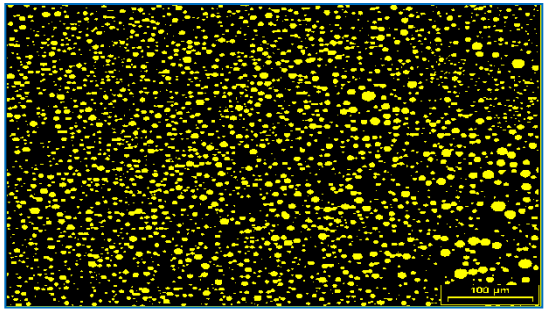
EIFFAGE

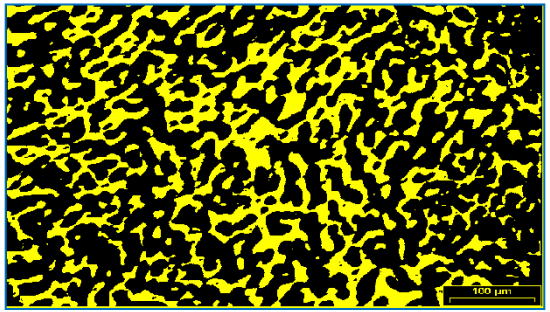
Benefits of BBTM

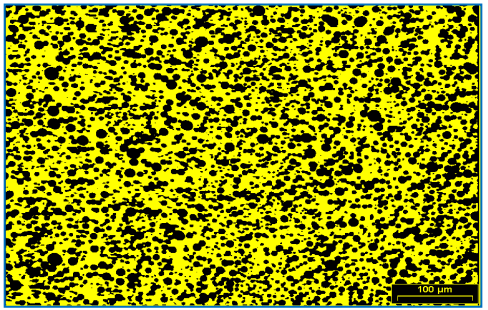
- Very thin layer ensures long-term savings in natural resources.
- High grip levels guarantee better safety for road users, especially in bad weather conditions.
- New overtop layer, suitable for top-down cracking
- High speed deployment (10 to 20 m/mn)
- But also cost-effective maintenance.

EIFFAGE

Polymer modified Bitumen – SBS content

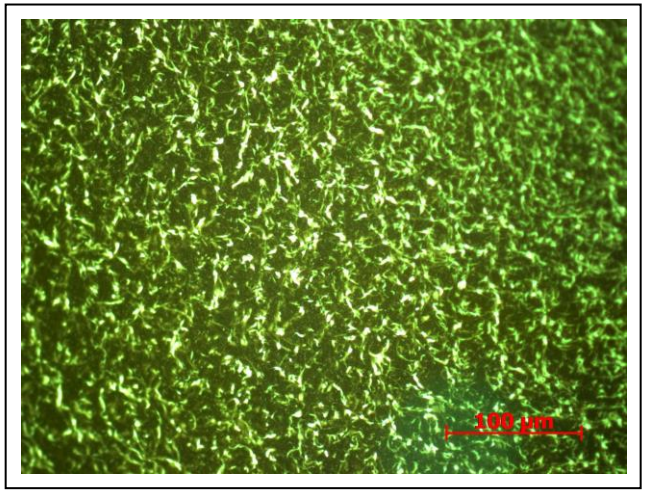






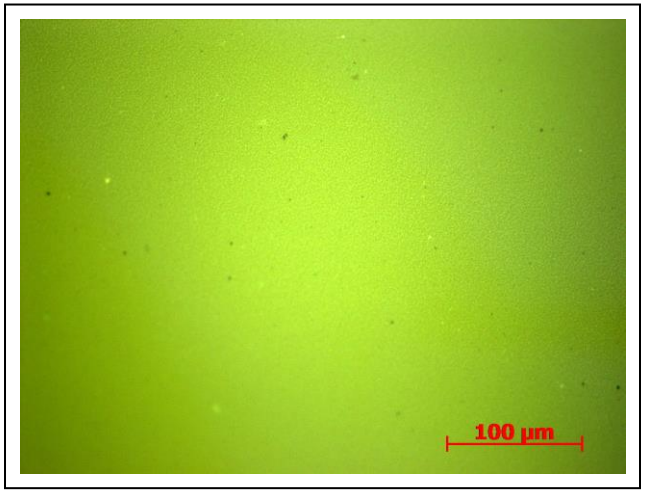
SBS content < 3 %	SBS content ~ 5 %	SBS content > 7 %
Softening point ↗	Softening point ↗ ↗	Softening point ↗ ↗ ↗
FRAASS ↘	FRAASS ↘↘	FRAASS ↘↘↘
Elastic recovery ↗	Elastic recovery ↗ ↗	Elastic recovery↗ ↗ ↗
Storage ?	Storage ↘↘	Storage - No!

Cross Linking



Without cross linking

Cross linking agent



With cross linking

Bitumen modified with high SBS content

EIFFAGE

Transport of PmB

- **For safety reasons:**
  - Filled by the top
  - Empty by the bottom
- **No specific trucks**
  - No heat system
  - No mixing system
- **What append to PmB**
  - 1° maturation ↗
  - 2° temperature ↘
  - 3° very few segregation(*)

- **At last => to be able to “extract” the PmB from the truck**

Storage of PmB

- **Very few tanks on the asphalt plant**
  - Needs accurate forecasts
  - very few of them have internal mixer

- **What append to PmB**
  - 1° reheating ↗
  - 2° circulation ↘
  - 3° duration ↘

EIFFAGE

Existing advantages of using PmB

Step 1
Transport of neat bitumen

Step 2
Binder plant

Step 3
Delivery of PmB

Step 4
Mixing plant

Step 5
Job-site

- *Investment in binder plant*
- *Long lead-time - Needs accurate forecasts*
- *Storage and use : need a hot and stirred silo for storage, continuous heating,..*
- *Distance from binder plant to asphalt plant*
- *Maximum storage time*

EIFFAGE

The PmB in pellets form

An innovative granule

- **Product form :** Cold and solid
- **Composition :** SBS & bitumen
- With the **same mixing time** sequence in the pugmill and similar asphalt performance

A new generation of Polymer modified Bitumen (PmB)

Avoids the use of binder plant to provide better performances bitumen, as PmB.

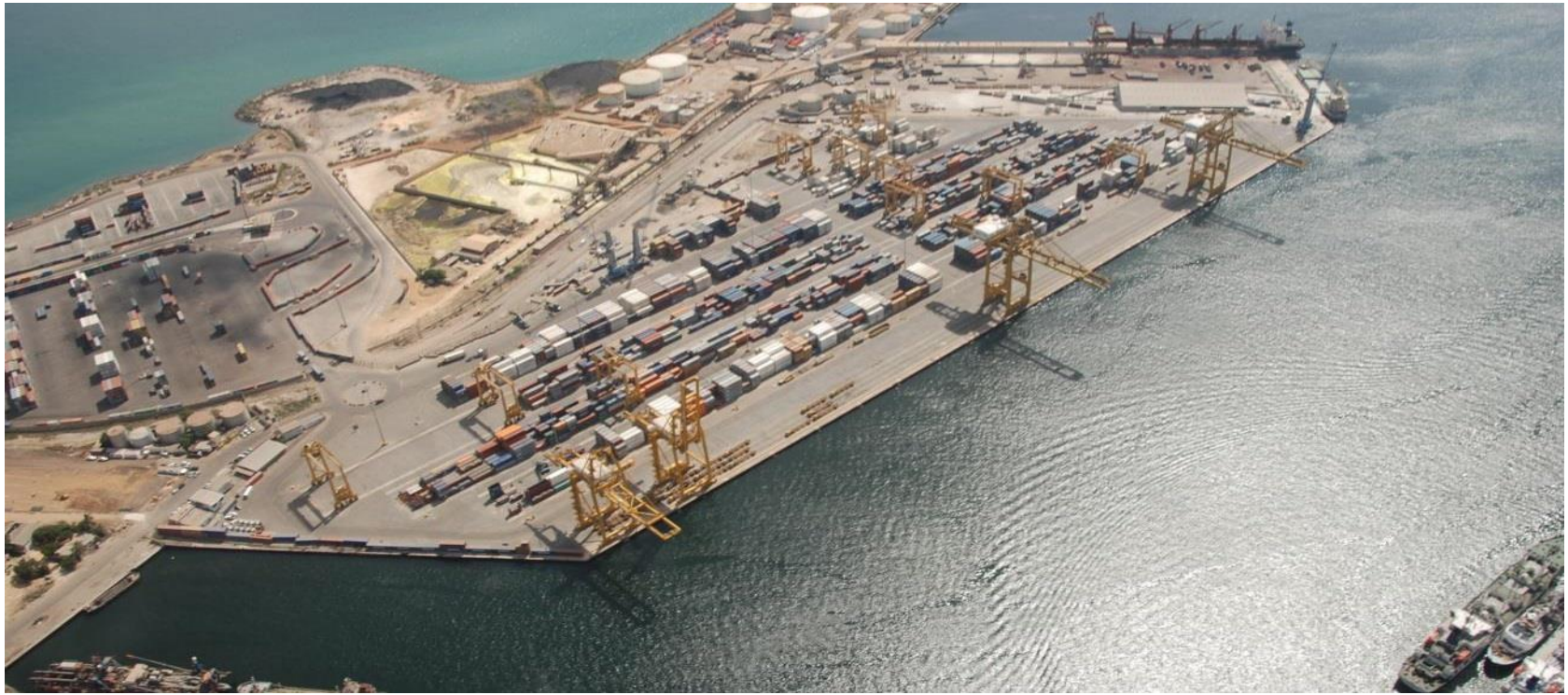
EIFFAGE

Millau Viaduct - France

“Motorway of the Future” - Senegal

Jakarta Airport - Indonesia

Port of Dakar - Senegal



Guiana Space Centre – Kourou – French Guiana