High Modulus Asphalt (EME)
Warm mixes
Wearing Course - Thin and Very Thin Layer

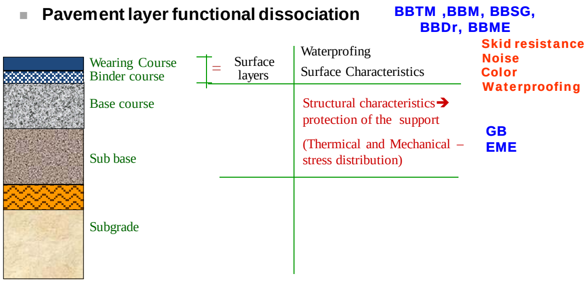


EME - High Modulus Asphalt

- Pavement structure
- Mechanical Performances of EME
- Mix design of EME
- Effect on Pavement design
- Production / laying
- Recent development in Europe
- Conclusion

Pavement structure

- Pavement layer functional dissociation



- Roads bear traffic
- Materials bear stress

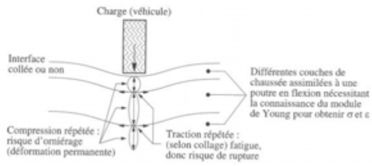
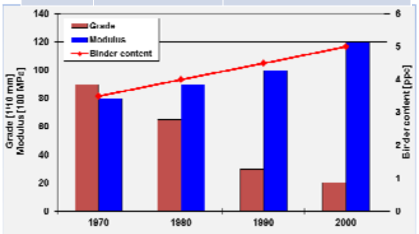


Figure 2.1. *Schématisation des sollicitations induites par le trafic*

- Pavement design
  - Calculation of stresses and strains in layers
  - mechanical characteristics of asphalt mixes (including modulus)
- Mix design to make Asphalt that can bear traffic

History - Evolution of Base course mixes

	GB	EME 2	EME 1
1970	80/100		
1976	Very hot summer		
1978	60/70 or 35/50	10/20	
1990	35/50		20/30
2000	35/50 or 20/30	10/20 or 20/30 or 25/35	



Evolution of Base course mixes

- Performance improvements
  - Stiffer
  - Improvement of fatigue behaviour
  - Higher rutting resistance
- Technical Economic optimisation
  - Thinner thickness
  - Better response to the increase of traffic agressivity
- Savings in raw materials, maintenance and related traffic disruption

Base course Asphalt Mixes

- **According to NF EN 13108-1 EB 14 Assise 35/50 (GB) and EB 14 Assise 10/20 (EME)**

Type	Max Aggr size	Binder	Binder Content (%)	Void content %	Thickness (cm)
GB	14 et 20	35/50 20/30	4 to 5	6 to 8	8 to 16
EME	10-14-20	10/20	4.5 to 6.2	3 to 6	6 to 15

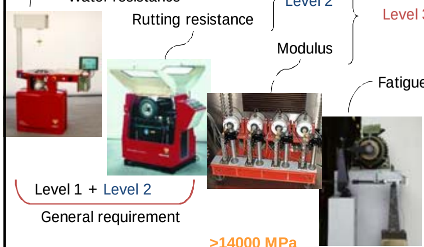
Base course mixes - Main properties

- **According to NF EN 13108-1 EB 14 Assise 35/50 (GB) and EB 14 Assise 10/20 (EME)**

	Type of mix	Giratory. (Voids %) C80 (D 10mm) C100 (D 14mm) C120 (D 20 mm)	Water sensitivity r/R ratio	Rut depth (60°C-100 mm) * 10.000 cycles (%) ** 30.000 cycles (%)	Stiffness modulus (15°C-10Hz) in MPa	Fatigue – admissible strain (@ 1 million de cycles)
	G.B Class 2	≤ 11	≥ 0.65	≤ 10*	≥ 9,000	$\geq 80.10^{-6}$
	GB Class 3	≤ 10	≥ 0.7	≤ 10*	≥ 9,000	$\geq 90.10^{-6}$
	GB Class 4	≤ 9	≥ 0.7	≤ 10**	≥ 11,000	$\geq 100.10^{-6}$
	EME Class 1	≤ 10	≥ 0.7	≤ 7.5**	≥ 14,000	$\geq 100.10^{-6}$
	EME class 2	≤ 6	≥ 0.75	≤ 7.5**	≥ 14,000	$\geq 130.10^{-6}$

Mix design of EME

Workability
Water resistance
Level 1
Rutting resistance
Level 2
Modulus
Level 3
Level 4
Fatigue resistance



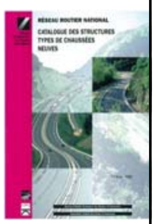
Level 1 + Level 2
General requirement
>14000 MPa
15° C -10Hz
>130 µdefs (10° C 25Hz)
Level 3 + Level 4
Fundamental Approach
In EN 13108-1

Mix design of EME

- **Mix design :**
  - **Low void content (Laboratory study 3 to 6 %)**
  - **Use of hard binder (rutting + Modulus) 10/20 15/25 20/30**
  - **Grading curve (D max 20 mm)**
  - **High Binder content ~ 5,7% (fatigue)**
- **Combination :**
  - **High resistance to rutting**
  - **High modulus** **14000 MPa [15°C - 10Hz]**
  - **High resistance to fatigue** **130 µdefs [10°C 25Hz]**

Results on Pavement design

Guide SETRA/LCPC1998) Pavement structure
for new roads



National Road Network TC6 / PF3 30 years		
Fiche	N° 1 GB2	N° 3 EME 2
BBTM	2.5	2.5
BBSG binder	6.0	6.0
Base	14.0	9.0
Foundation	14.0	10.0
Total thickness	36.5	27.5

-25%

Trafic : 20 Millions equivalent standard axle 130 kN,
Support E = 120MPa

Results on Pavement design

Pavement design guide SCETAUROUTE
for Motorways

Motorway T0+ / PF3		
Comparison	GB3	EME 2
BBTM	2.5	2.5
BBME	5.0	-
Base	11.0	10.0
Foundation	13.0	10.0
Total thickness	31.5	22.5

-28%

Trafic : 20 millions equivalent standard axle 130 kN,
Support E = 120MPa

Production - Laying

- **Hard binder (Higher viscosity)**
  - Mixing temperature 160-180 always < 190ºC
  - Minimal temperature for laying 145ºC
- **Production control**
  - Aggregates (grading curve)
  - Binder class and content
- **Compaction**
  - Quality of the sub base
  - Reach good in-place density
  - Warranty of Mechanical performances
- **Laying**
  - Bearing capacity of the sub base
  - Respect of thicknesses (Pavement Service Life)
  - Bonding between layers (tack coat)

Recent Development in Mauricius

- **EME 0/14**
  - Hard binder 20/30 (south africa)
  - Highway A13 10 cm on 6,9 km
  - Triolet 7cm on 5,6 km
- **25000 T of asphalt mix**
  - Improvement of performances allows significant thickness reduction without decrease of lifetime and also reduction of GHG

Conclusion

- **EME : Now ~ 20 years of experience**
- **Main steps for development are the followings :**
  - Knowledge of existing Base course
  - « Fundamental approach » Modulus Fatigue → Benefit of EME
  - Available ressources :
    - Hard binder
    - Aggregates (grading)
    - Eventually additives if no hard binder
- **Specific context : for example resistance to low temperature (ex Poland)**

↓

- Selection of component for EME mix design
- Evaluation of Mechanical performances (Modulus + Fatigue)