16th World Meeting

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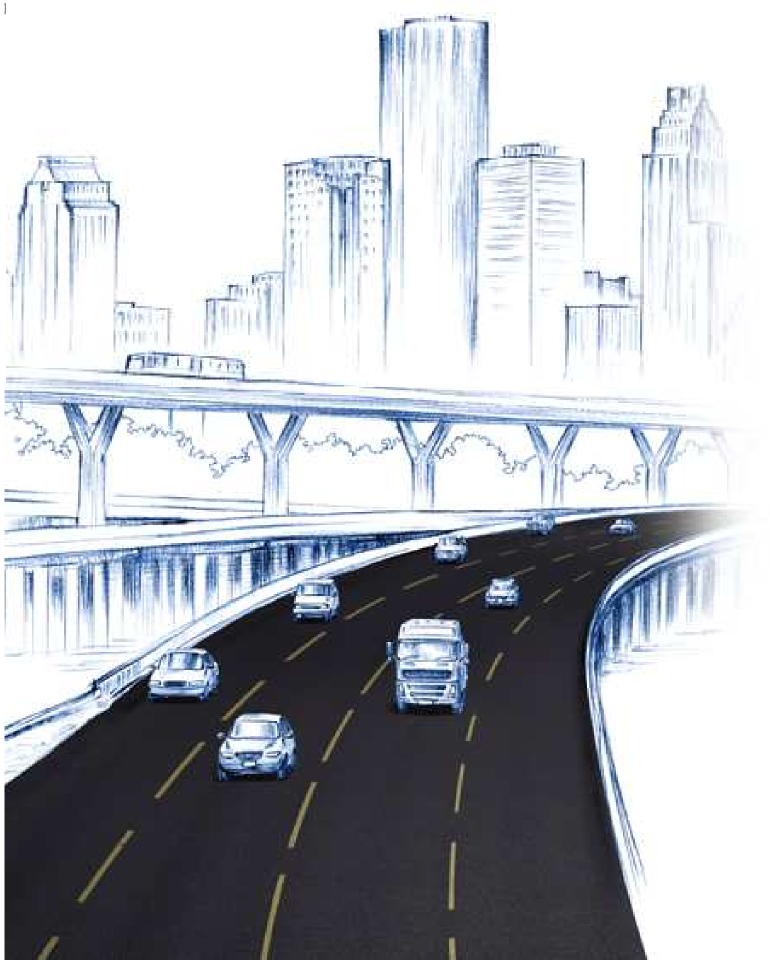

The development of EME in Europe requires an appropriate approach for the climate

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Introduction

- Growing and heavier traffic: roads stressed more
- “Enrobés a Module Elevé” – EME
  - Increased stiffness
  - But remains ‘flexible’
    - Bitumen – visco-elastic behaviour
    - Less prone to cracking in comparison to concrete
  - Bitumen: harder than normal ‘pen grade road bitumen’
    - Depending climate: 10/20 to 20/30
    - Optimisation bitumen/mix design: balance stiffness (rutting) and fatigue

Development and History

France – 2 classes - requirements :

- Performance of the asphalt mix:
  - Compaction – workability
    (voids by gyratory)
  - Resistance to rutting
    (French wheeltracking at 60°C – 30000 cycles)
  - Stiffness of the mix
    (2 point bending test, 15°C and 15 Hz)
  - Resistance to fatigue
    (2 point bending test, 10°C and 25 Hz)
  - Durability - water sensitivity

Overview requirements EME

			EME class 1	EME class 2
Gyratory compaction	% voids @ C80 (D 10 mm) C100 (D 14 mm) C120 (D 20 mm)	%	<10	<6
Rutting resistance	60℃ & 30000 cycles	%	7.5	7.5
Dynamic modulus	15℃ & 10 Hz	"MPa"	14000	14000
Fatigue resistance @ 1 million cycles	10℃ & 25 Hz	µstrain	100	130
Duriez (water sensitivity)	r/R ratio		> 0.7	> 0.75

Requirements binder in EME

- Good quality mineral
- Hard bitumen: EN13924
  - + (new) rheological tests: DSR – BBR – DDT
- Bitumen film thickness – minimum percentage bitumen (assure durability)

MODULE DE RICHESSE (Richness modulus)!

- Measure for film thickness on the aggregate skeleton

% bitumen = $\alpha \times K \times \varepsilon^{1/5}$

Module de Richesse

K = "module de richesse" (Minimum 3.4 in France – EME 2 – advised 3.6)

% bitumen = α x K x $\varepsilon^{1/5}$

α = 2.65/ γG

γG = apparent density of the aggregates mix

ε= conventional specific surface = 0.25G + 2.3S + 12s + 135f

G = percentage on sieve 6.3 mm

S = percentage of mineral through sieve of 6.3 mm and on sieve of 300 µm

s = percentage of mineral through sieve of 300 µm and on sieve of 75 µm

f = percentage through sieve of 75 µm

Module de Richesse (cont.)

- Bitumen amount also determined by the used aggregates/minerals!
  - Density
  - Specific surface
  - Gradation curve
- Changing film thickness can influence the durability of the road !

- **DANGER:** Fixing the bitumen percentage in the tender or specification standard!
- Prescribe the binder content in volume percent or use this ***Module de Richesse*** formula in the tender document!

Effect changing parameters

AGGREGATES	PORPHYRY TYPE	PORPHYRY TYPE	BASALT TYPE	BASALT TYPE
Gradation> % passing sieve			Change gradation	
• 31.500	100	100	100	100
• 6.300	55.4	55.4	55.4	57.5
• 0.315	12.6	12.6	12.6	18.7
• 0.080	7.6	7.6	7.6	8.2
Calculation G	45%	45%	45%	43%
S	43%	43%	43%	39%
s	5%	5%	5%	10%
f	8%	8%	8%	8%
Eta ε	**11.96**	**11.96**	**11.96**	**13.38**
Aggregate density (g/cm)	**2.7**	**2.7**	**3.0**	**3.0**
Alpha = 2.65/ aggr.dens	0.9815	0.9815	0.8833	0.8833
BINDER				
Binder [ppc] - on aggregates	**5.7**	**5.2**	**5.2**	**5.2**
in mix	5.4%	4.9%	4.9%	4.9%
K (module de richesse > 3.4)	**3.67**	**3.23**	**3.58**	**3.5**

Change mineral; other γ

Go to min binder content

Sharing the road
16th World Meeting
International Road Federation

EME in Europe

EME in Europe

Adaptation mix and/or bitumen type and performance requirements

- Depending country/ climate/traffic loading/ available minerals

U.K. • High Modulus base (3.5% bit) replaced by EME (M.R.= 3.6 (> 5.4% bit))

BE • EME class 2 – extra demands on the bitumen

NL • some test sections – French tests – 15/25 bitumen

Moderate climate (Oceanic climate): 10/20 or 15/25 bitumen

EME in Europe

Poland

- Combination requirements EME class 1 and 2
  - Climate more severe
  - Lower traffic load

Finland

- EME better than concrete

Continental and Nordic climate

20/30 bitumen

Other approach EME mix and binder design

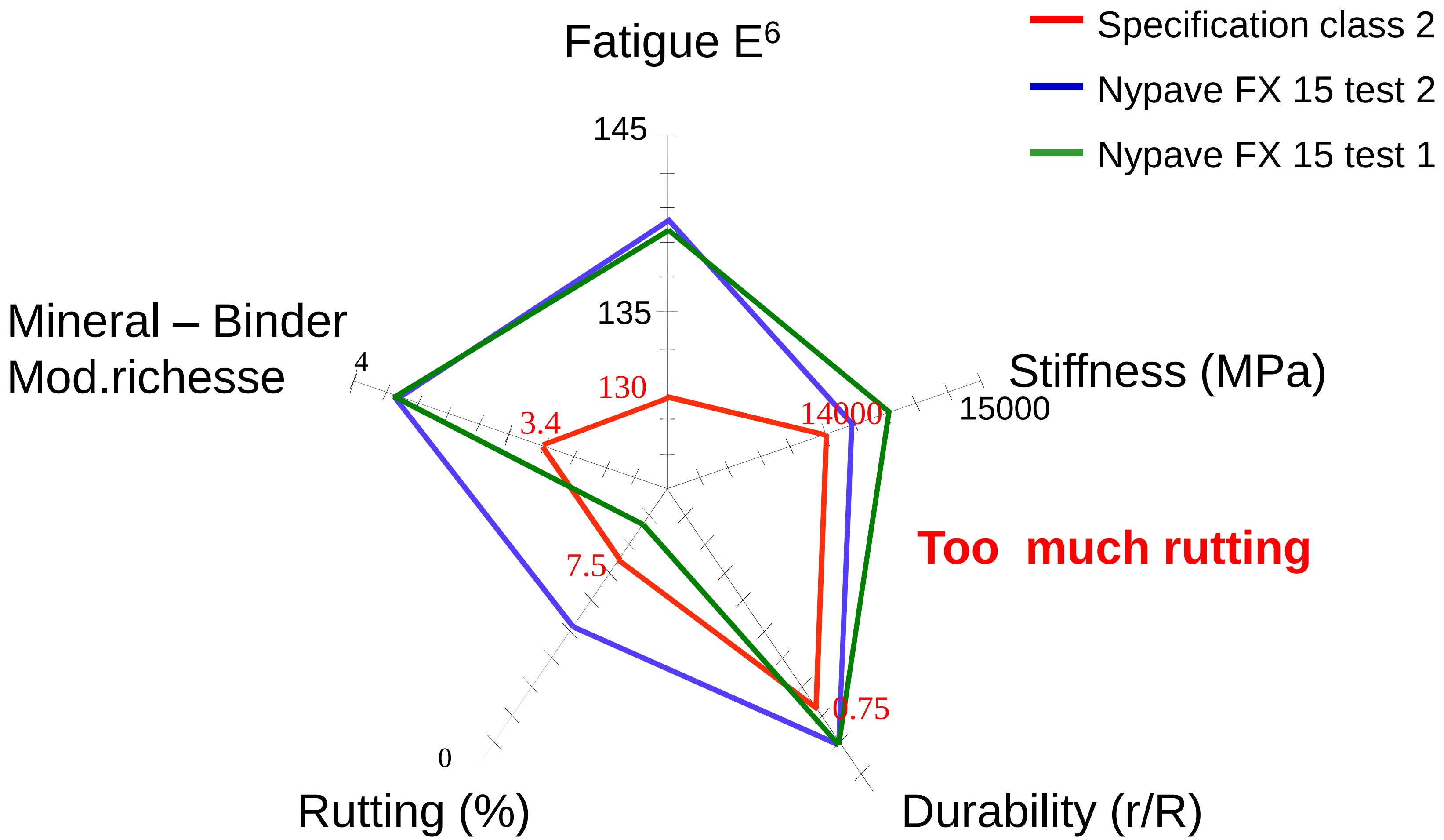
Nynas approach: Binder

- Not all hard binders fit for purpose
- Optimisation balance stiffness and fatigue
  - ***Stiffness bitumen*** ~ stiffness asphalt (high S)
    - Selection simple
  - ***Fatigue***: Literature not unambiguous
    - Phase angle, p.i., m from BBR, ...
    - Nynas: alternative via fatigue measurements on the bitumen – rheometer
  - ***Raw material:*** selection and processing
    - **Nypave FX 20 and Nypave FX 15**

Nynas approach: Mix

- Demonstrate fit for EME class 2
- **Suspicion**: most critical = stiffness and fatigue
- **Attention**: despite stiff and hard bitumen, rutting because of high bitumen percentage
- **Optimisation** gradation curve needed!
  - Not decrease bitumen percentage

Optimisation mix



Design calculation models

- Some ‘inexperienced’ users believe that road design calculation models predict reality
- Very high stiffness levels are used to calculate reductions of thickness of more than 50%
- This can result in exploding risk levels and early life failure

Do not apply thickness reduction of more that 20 to 25% versus the original structure!

EME = Optimization

Mix design

- Not ‘standard’ Marshall thinking – change in mix design – performance testing

Binder

- Not all hard bitumen are suitable
  - Balance between sufficient stiffness and resistance against fatigue remains the main challenge

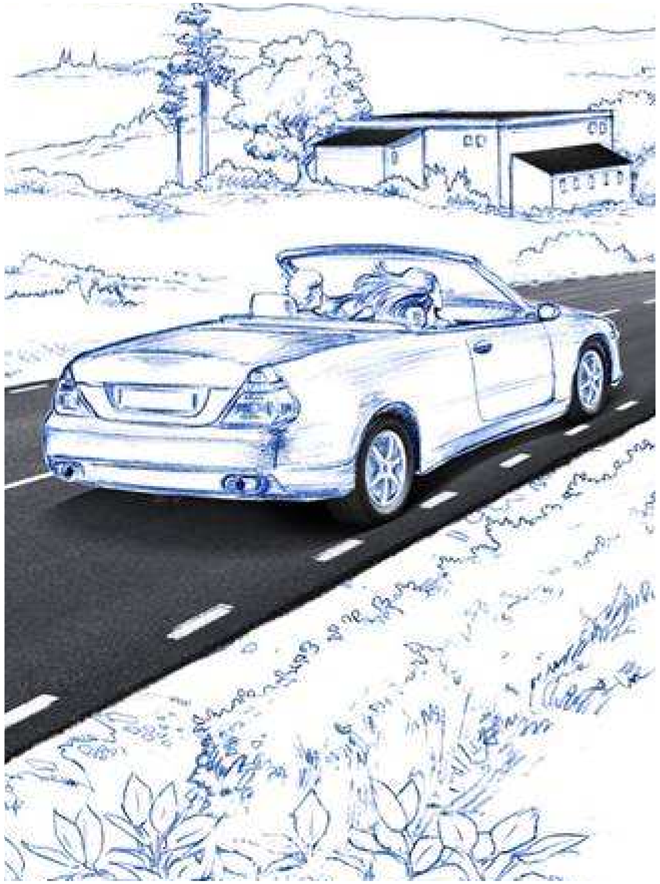
Application

- “Optimisation” compaction

Conclusions

- **Binderfilm thickness is of utmost importance**
- **Neglecting this "law of nature" will cause early life damage**
- **Be careful with translating stiffness in thinner constructions**

EME Technology needs a *co-operation* between Government, specifier, asphalt producer, contractor and bitumen supplier



EME requires as much
‘High tech‘ knowledge
as a feel for the mix

Hope for more “EME believers” in Europe and to success for EME (BINDERS) in the future