Use of SMA in Europe

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Introduction

- What is EAPA
- Types of asphalt used in Europe
- Introduction into Stone Mastic Asphalt - SMA
- Current developments
- European Standards for SMA
- Conclusions

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EAPA is a non-profit association

- Founded in 1973 and nowadays
- Based in Brussels, Belgium

EAPA represents the majority of the European asphalt paving industry

- The manufacturers of asphalt and asphalt paving companies
- Material and equipment suppliers

EAPA's mission

- To promote the good use of asphalt and the maintenance of a sustainable European road network

Objectives

- Represent its members in the institutions of the EU
- Promote the effective and sustainable use of asphalt and new developments
- Participate in European standardisation and legislation activities
- Collect, exchange and promote knowledge as well as best practices
- Improve the image of ‘’asphalt ‘’ in Europe

Activities

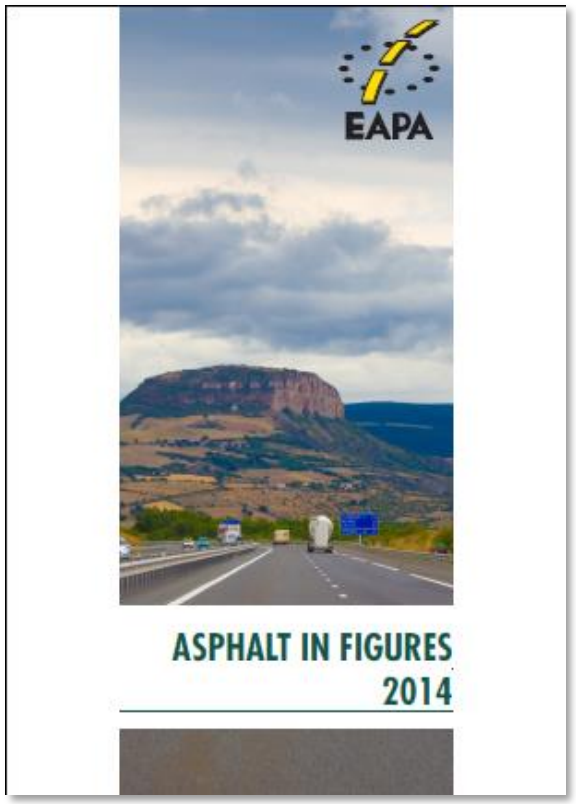
www.eapa.org

- Contacts
- Information, Data and Statistics
- Advantages of Asphalt Pavements
- News
- Events
- Members Only area

Activities

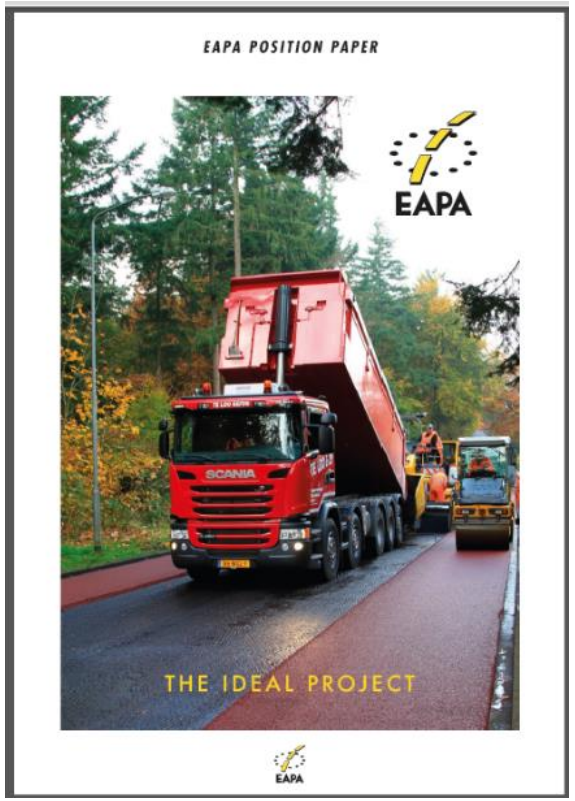
Asphalt in Figures

Providing Statistical Data on www.eapa.org



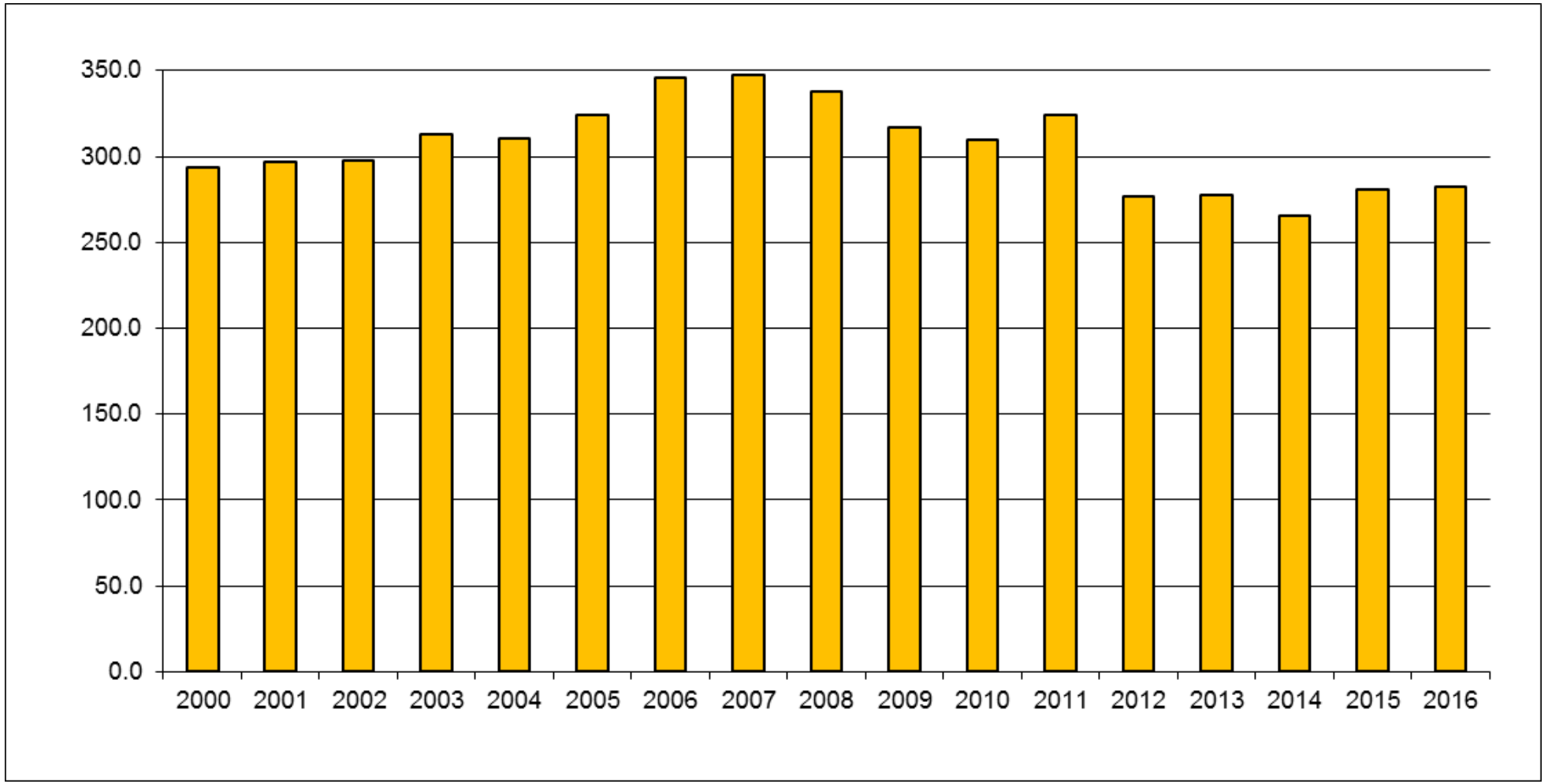
EAPA Newsletter

Position Papers



Asphalt used in Europe

In million tonnes per year



Total Production of Hot and Warm Mix Asphalt in Europe from 2000 to 2016

Asphalt used in Europe

- European countries > 10 million tons/year

Country	2016
France	34
Germany	41
Great Britain	22
Italy	23
Poland	19
Spain	13
Turkey	40
Europe	282
Japan	± 42
USA	340

Picture of Asphalt in Figures 2016

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Surface layers used in Europe

Data of Asphalt in Figures 2016

picture of Asphalt in Figures 2016

Country	Surface course [%]	Binder course [%]	Base course [%]
Belgium	**55**	0	45
Croatia	**63**	2	36
Czech Republic	**56**	24	20
Denmark	**50**	5	45
Estonia	**63**	28	9
Finland	**91**	0	9
Hungary	**69**	23	8
Lithuania	47	24	29
Netherlands	37	9	**54**
Norway	**80**	10	10
Slovakia	**72**	16	12
Slovenia	**55**	7	38
Spain	**73**	19	8
Turkey	30	41	29

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Mostly used Surface Layers in Europe

Country	% of total annual hot and warm mix asphalt production in 2016		
	Asphalt Concrete	SMA	Porous Asphalt
Austria	33	6	0
Belgium	38	14	1
Croatia	59	3	10
Czech Republic	49	6	0
Denmark	36	13	0
Estonia	61	2	0
Finland	73	12	
Germany	20	9	
Hungary	61	6	
Lithuania	40	5	
Netherlands	18	10	9
Slovakia	68	5	
Slovenia	49	6	0
Spain	62	1	0
Turkey	27	4	

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Introduction - SMA – Stone Mastic Asphalt

- It was developed in Germany in the mid-1960s
- Studded tyres were widely used -> wear
- Asphalt Concrete not good enough
- Mastic asphalt expensive and labour intensive to lay

- German standard for SMA in 1984
- Since then used in Europe and across the world
- European standard (EN 13108-5) in 2006
- This standard specifies a technical framework which allows national application documents in each country

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Introduction

- Stone Mastic Asphalt (SMA) used in many countries
- Used for surface and binder courses of highways, roads, airports, harbours, etc.
- In all countries except Ireland: SMA is used for runway surfaces; mostly SMA 11

Widely used because of its

- High stability
- High durability
- Ability to be applied in thin layers
- Noise reduction
- Lower Rolling resistance

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Functional Pavement Characteristics

The main functional characteristics of SMA are:

- Skid resistance, evenness (transverse and longitudinal), visibility and aquaplaning
- Resistance to permanent deformation “stability” (pavement performance) and durability
- Noise reducing surface and recyclable / recycling.

Skid resistance

Depends on:

- Selection of aggregate type
  - Polished Stone Value for skid resistance for long(er) period
  - Level depends on local aggregate availability and experience of use

- Design of surface texture
  - Aggregate size
  - Degree of mortar filling of the voids
  - Larger aggregate: more texture depth
  - Smaller aggregate: less Rolling resistance

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Skid resistance

- Important to ensure mixes are not overfilled with mastic.
- Otherwise loss of skid resistance, loss of texture under traffic and rutting.

- SMA mixes have thicker binder film than most conventional mixtures.
- In some countries for improving initial skid resistance (during first few weeks) they apply a bit grit (aggregates 1- 3mm) to surface during the final passes of compaction

Aquaplaning

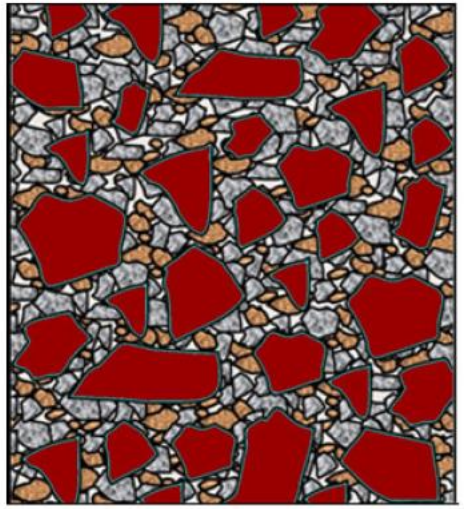
- The high (negatively) surface texture gives more capacity to store / remove water.

- Good riding comfort (because it is smooth pavement)

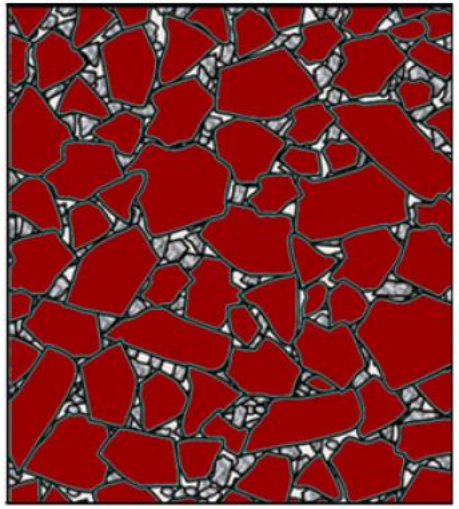
- Low Rolling Resistance

Stability

- It is so called Stone-skeleton mixture
- High resistance to rutting/ permanent deformation
- It was developed for this reason



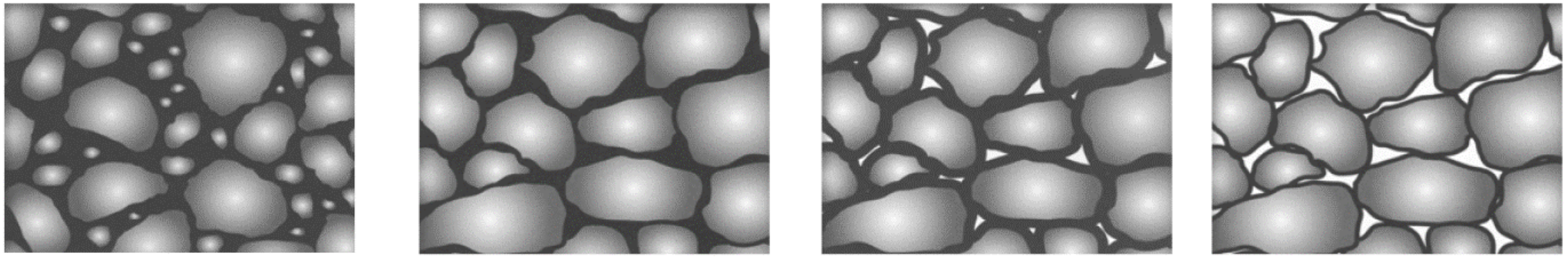
Fine graded mix
with sand / fine-material skeleton



SMA graded mix
with stone skeleton

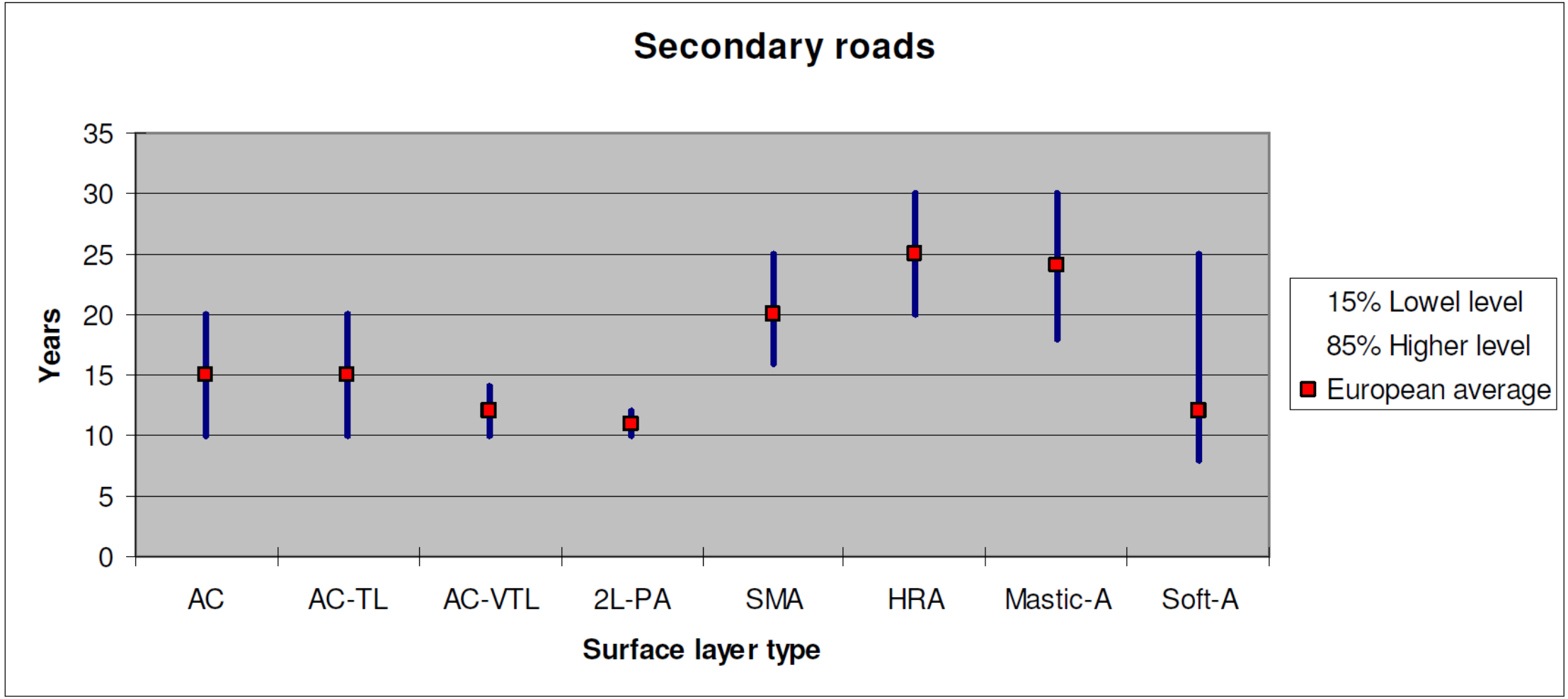
Durability

- SMA is durable, wear-resistant material
- Is impervious due mastic mortar
- Mortar / mixture has high binder content



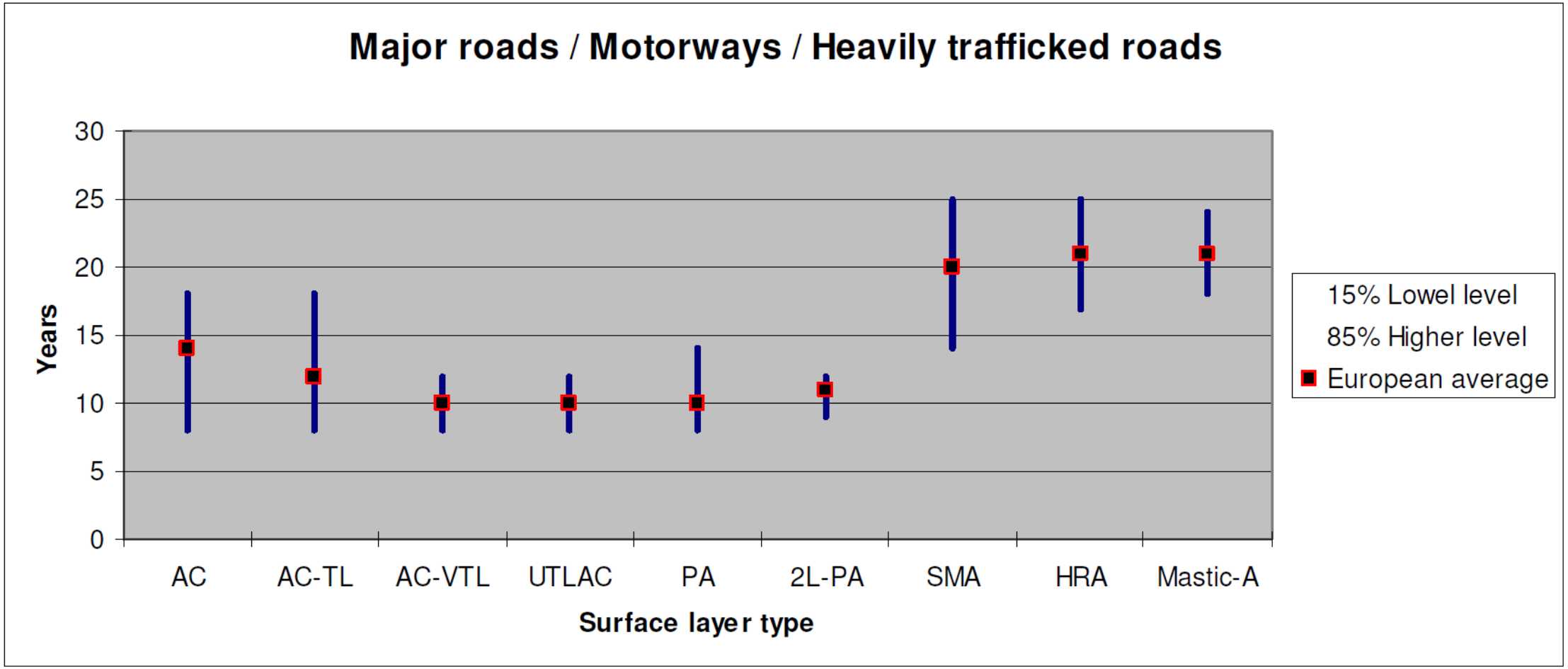
Difference in structure between Asphalt Concrete (AC), SMA, BBTM (Thin Layers of Asphalt Concrete) and Porous Asphalt (PA)

Durability of Surface Layers



Source: EAPA Position Paper Long Life Pavement (1997)

Durability of Surface Layers



Source: EAPA Position Paper Long Life Pavement (1997)

Noise

- For reducing tyre-road noise: macrotexture and porosity of the road surface are important

- The relatively open surface texture of SMA and the smoothness (negative texture) offers the advantageous noise reducing properties

- SMA pavements with a maximum aggregate size of 11 mm (0/11 mm) or less (0/6 mm) have given up to 2 - 3 dB(A) less noise compared with dense asphalt concrete

Recycling

- SMA can be 100% reused / recycled
- Reclaimed asphalt back in SMA difficult due accurate control of grading

SMA for Heavy Duty Pavements

- SMA used in heavy duty pavements because of its stone-skeleton
- High quality aggregate used
- For heavy duty pavement the structure below SMA needs to be good (too)

Applied thickness: at least 2.5 x nominal aggregate size

- So for SMA 6: ≥ 15 – 20 mm and for SMA 16: ≥ 40 – 50 mm

In some cases Polymer modified Bitumen (PmB) is used:

- To be on the safe side
- In case a higher rutting resistance is needed

For low volume road normal Paving grade bitumen is used

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Practice of SMA in Europe

- General - grading's used in Europe
- Drainage Inhibitors
- Modified Binders
- Mixture Design

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Practice of SMA in Europe

All countries using SMA have / report very positive experiences with SMA

The major SMA types are SMA 8, SMA 11 and SMA 16.

- There are national preferences for other grading's
- Germany and the Netherlands they also use SMA 5
- Sweden also uses SMA 4
- In the Nordic countries often SMA 16 to give increased resistance to studded tyres

Generally, crushed aggregates are recommended for both the coarse and fine mineral fractions

- For the fine fractions sometimes partly uncrushed aggregate (natural sand) is used

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Practice of SMA in Europe

Mixture composition requirements for various grading's

SMA Type	Percentage passing sieve 63 µm	Percentage passing sieve 2 mm	Binder content, %	
			On 100% aggregate	"in" mixture
5 – 6	6 – 12	27 – 40	5.6 – 8.0	5.3 – 7.4
8	6 – 12	20 – 35	6.5 – 7.5	6.1 – 7.0
9.5 – 10	6 – 11	21 – 32	5.3 – 6.8	5.0 – 6.4
11 – 12	6 – 11	18 – 32	5.3 – 7.5	5.0 – 7.0
14	6 – 11	15 – 30	6.5	6.1
16	5 – 10	15 – 30	6.4	6.0

The mixture design is generally based on the volumetric properties

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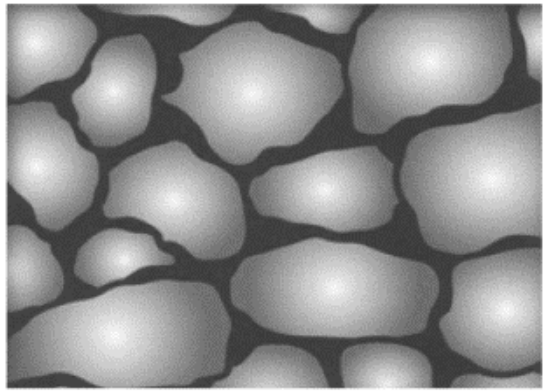
Mixture Design

The essential characteristics of SMA concept are the volumetric parameters

- SMA is gap graded bituminous mixture with an aggregate skeleton, formed by relatively coarse aggregate particles, which is filled by a mastic of bitumen, filler and fine aggregate (sand),
- It is essentially to determine the right volumetric proportion of the constituent materials
- The right distribution of skeleton voids (VCA) and mastic portions.



A higher void content in the aggregate structure can be achieved

by creating a larger gap in the aggregate grading

Drainage Inhibitors

The mastic in SMA is a filler-sand mixture which is overfilled with binder and therefore a drainage inhibitor needed

The remaining void content in the final SMA mixture generally is in general 3 - 6% (by volume)

Due to the thick binder film required in SMA: drainage inhibitor is necessary

- In general fibres are used such as **cellulose** and **specific organic materials**
- Drainage inhibitors are active during: storage, transport and laying of hot SMA
- After compaction: no influence to the performance of the mixture

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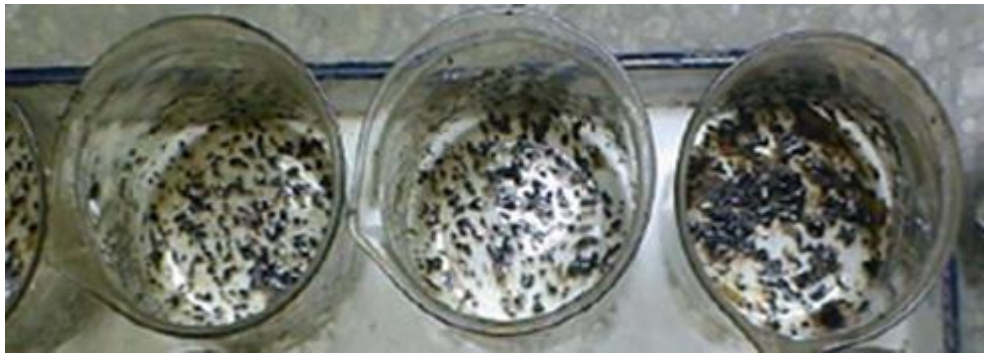
Drainage Inhibitors

- Cellulose fibres are added mostly in pelletised form
- Dosed (automatically or manually) in the mixer through pipe for better distribution

- The required amount of inhibitor is based on practical experience.
- To measure drainage inhibiting capacity for SMA: binder drainage test (EN 12697-18) Schellenberg test.



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Grading SMA versus Asphalt Concrete

Modified Binders

Modified binders are used in SMAs

- To increase the resistance to permanent deformation
- To increase the durability of the pavement surface
- To reduce application and damage risks especially in cases of very thin layers

- Use of PmB can reduce need for drainage inhibitor (although this can still be necessary with some PMBs)

***Production**, Laying and Compaction*

Batch plants and drum mixers can be used for producing SMA

- SMA is sensitive to overfilling of the aggregate structure with mastic
- Therefore accurate aggregate supply control is important because of volumetric design

- The addition of the fibres can take place in several ways.
- Automatic dosing
- Pelletized fibres easy to use

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*Production, **Laying** and Compaction*

Before the start of the project a trial production of SMA is recommended

No special attention needed during laying

Laying by hand is not recommended

- Due to the high internal cohesion of the mixture
- Difficult to obtain the optimum evenness, durability and density of the mixture

*Production, Laying and **Compaction***

For SMA surface courses only steel wheel rollers are to be selected

- Start with a static pass
- Followed by one oscillating pass to give satisfactory intermediate compaction
- Number of total passes depends on specified voids and density

- Use a trial section to verify process and to check compaction equipment achieves the required/specified density

- Thin layers -> quick cooling -> early compaction

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Current Developments

- SMA Binder Courses (SMA BC)
- SMA as base course layer / Triple SMA
- Noise-Reducing SMA (SMA NR)

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SMA Binder Courses

- Rutting in pavements often due to binder layer (layer just below surface layer)
- Due to high shear stresses in that layers due to truck loadings
- SMA has good rutting resistance due to stone-skeleton
- SMA is also impermeable (Important for binder courses)

- Sections in Sweden and Germany: SMA for Binder Courses
- Promising solution for highly stressed binder courses

- SMA binder courses can be used as temporarily surface layer

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SMA Base Courses

Traditional pavement design: strain level at the bottom of the asphalt structure

- Strain level at the bottom of the base layer
- More bitumen -> better fatigue
- SMA –> more bitumen -> better fatigue

- Rich bottom layer concept

-> Perpetual pavement in Poland

Triple SMA

- Innovative **triple SMA** layer for heavy duty pavements: service roads at a refinery in Gdansk (Poland)

- Slow moving traffic

- They used
- 60 mm highly modified SMA anti-fatigue base course layer (SMA 16 PmB 45/80-80)
- 90 mm binder course of SMA 22 PmB 25/55-80
- 50 mm surface course SMA 16 PmB 45/80-80.

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Noise-Reducing SMA

Tire/road surface interaction noise important in many countries

SMA mixture design with improved noise reduction (SMA NR) successfully applied in e.g. Austria, Denmark and Germany. In Germany more than 4 dB(A)

Mixture design: higher void content + optimised surface texture (small aggregate)
No gritting

Characteristics of Layer		SMA 8 S (NR)	SMA 5 S (NR)
Paving thickness	mm	25 – 40	20 – 30
Compaction degree	%	≥ 97	≥ 97
Void content	Vol.-%	9.0 – 14.0	9.0 – 14.0
Evenness (4 m section of measurements)	mm	≤ 3.0	≤ 3.0

Characteristics of Noise Reducing SMA (FGSV, Germany, 2014)

User / Environmental Benefits

- Longer service life and lower maintenance -> lower CO2 footprint
- Less user delays and congestions
- Reduced risk of aquaplaning
- Low levels of traffic noise.
- 100% recyclable

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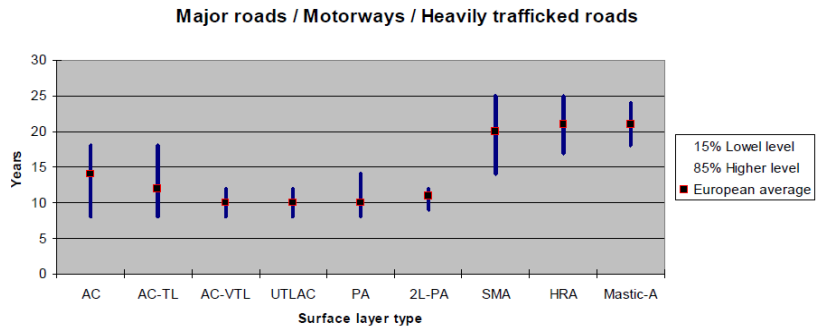
Cost Effectiveness

Initial material costs/tonne can be higher than of standard Asphalt Concrete (AC):

- due to higher binder content
- need for high quality aggregates
- requirement for a drainage inhibitor (and modified bitumen
- Reduced production capacity, if extra mixing time is required for drainage inhibitor

But:

- SMA can be applied in thinner layers compared to AC
- Longer performance life than AC
- Less maintenance costs, less user delay costs etc.
- In the end SMA is cheaper



European Asphalt Standards

- Product standards (EN 13108 series)
- Standards for Test Methods (EN 12697 series)

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EN 13018-5 - SMA

Contents

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EN 13018-5 - SMA

The test methods are shown in the EN 12697 series

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EN 13018-5 - SMA

EN 13108-20 = Type Testing

EN 13108-21 = Factory Production Control

SMA Product Standard EN 13108-5

SMA	D4	D5	D6	D8	D10	D11	D12	D14	D16	D20	D22
Passing sieve (% by weight)											
31.5 mm											100
22.4 mm										100	90 - 100
20.0 mm									100	90 - 100	
16.0 mm								100	90 - 100		
14.0 mm						100	100	90 - 100			
11.2 mm					100	90 - 100	90 - 100				
10.0 mm				100	90 - 100						
8.0 mm			100	90 - 100							
6.3 mm		100	90 - 100								
5.6 mm	100	90 - 100									
4.0 mm	90 – 100										
2.0 mm	25 – 45	20 - 40	20 - 40	20 - 40	20 - 35	20 - 35	20 - 35	15 – 30	15 – 30	15 – 30	15 – 30
0.063 mm	5 - 14	5 - 14	5 - 14	5 - 14	5 - 13	5 - 13	5 - 13	5 - 12	5 - 12	5 - 12	5 – 12
Min. binder content % by weight	B_{min} 5.0 – 7.6										
Void content Marshall % by volume	V_{max} 3.0 – 8.0 V_{min} 1.5 – 6.0										

Conclusions

SMA has several advantages compared to other asphalt (surface) mixture

- SMA is **safe** - good skid resistance, good evenness and minimized aquaplaning.
- SMA is **noise reducing**
- SMA can have **low Rolling Resistance**
- SMA has **high resistance to permanent deformation**
- SMA is **durable** and **sustainable** -> **greener**
- SMA has **longer service** life and gives good return on investment
- SMA is **economically attractive** - less maintenance costs and convincing life-cycle costs

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