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LOA 5 D — Thin Noise-Reducing Asphalt Technology and Performance

DAV, Bergisch Gladbach, 18 June 2012

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Lehrstuhl für Verkehrswegebau — Prof. Dr.-Ing. Martin Radenberg

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Introduction — Environmental Noise Directive

Time Schedule of the Environmental Noise Directive 2002/49/EC

STAGE 1	Agglomerations (more than 250 000 inhabitants) Major Roads (more than 6 million vehicle passages per year) Major Railways (more than 60 000 train passages per year) Major Airports (more than 50 000 movements per year)	NOISE MAPPING 30 June 2007 ACTION PLANNING 18 July 2008
STAGE 2	Agglomerations (more than 100 000 inhabitants) Major Roads (more than 3 million vehicle passages per year) Major Railways (more than 30 000 train passages per year)	NOISE MAPPING 30 June 2012 ACTION PLANNING 18 July 2013

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Sources of Road Noise

- Noise from engine and drving train
- Noise generated by tyre/road contact
- Noise from wind around the vehicle (aerodynamic noise)

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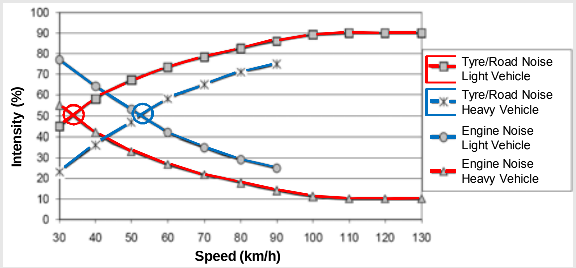
Tyre/Road Noise in Total Noise Emission

Common, dense-graden surface layers (AC, SMA)



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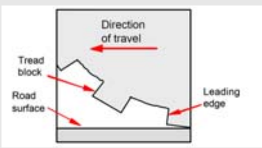
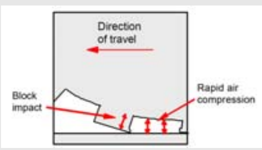
Mechanisms of the Tyre/Road Noise Generation

- Tyre rotation



- Vibrations in the tyre



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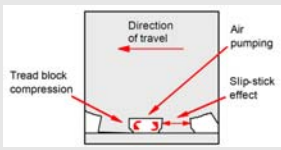
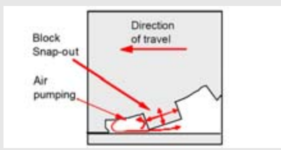
Mechanisms of the Tyre/Road Noise Generation



- Air pumping



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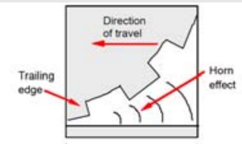
Mechanisms of the Tyre/Road Noise Generation

- Horn effect



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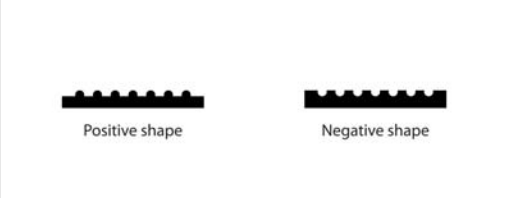
Optimisation of Noise Reduction Performance

Two Main Types of the Open Surface Shape



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Optimisation of Noise Reduction Performance

- Using a **small maximum aggregate size** of 5.6 mm to achieve an
  even and smooth pavement surface that could reduce noise generated from vibrations in the tyre.
- Using a **high void content** to achieve an
  open surface texture that can reduce noise generated from air pumping. The target void content is about 5–6%.
- Using **cubic aggregate** to achieve an
  even and smooth pavement surface that can reduce noise generated from vibrations in the tyre.
- Using a **low sand content** to achieve a
  highly open porous surface texture and dense structure of the layer.

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Optimisation of Noise Reduction Performance

Photograph of the LOA 5 D surface layer in
Mecumstraße in Düsseldorf after 30 months of service
(surface is 20 by 10 cm in size)

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Analysis and evaluation of surface texture parameters

- Optical 3D measurement analysis

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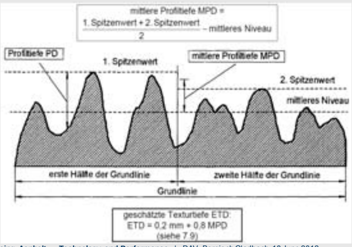
Optimisation of Noise Reduction Performance

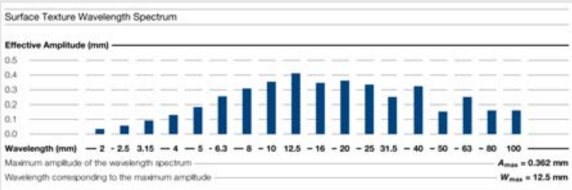
Acoustically Relevant Surface Texture Parameters

- Mean profile depth, **MPD,** and estimated texture depth, **ETD**



Optimisation of Noise Reduction Performance
Acoustically Relevant Surface Texture Parameters

- Maximum amplitude of the wavelength spectrum, $\mathbf{A_{max}}$
- Wavelength corresponding to the maximum amplitude, $\mathbf{W_{max}}$



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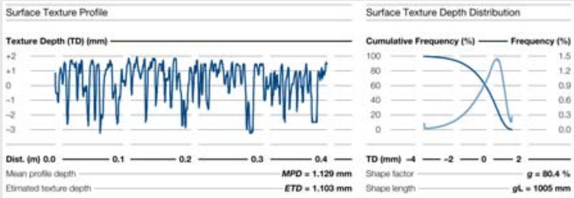
Optimisation of Noise Reduction Performance
Acoustically Relevant Surface Texture Parameters

- Shape factor, **g** (from a cumulative frequency distribution)
- Shape length, **gL** (product of **g** and $\mathbf{W_{max}}$)



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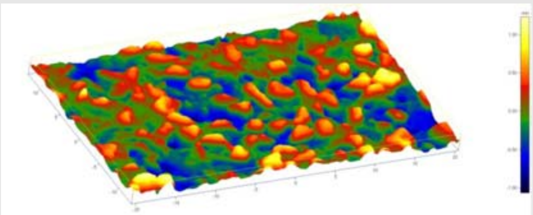
Analysis and evaluation of surface texture parameters — Graphical Output Examples

Mastic Asphalt, MA 8 S Shape factor, **g = 45 %**



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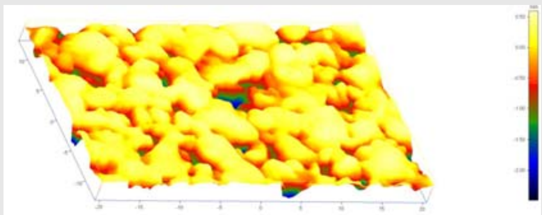
Analysis and evaluation of surface texture parameters — Graphical Output Examples

LOA 5 D Shape factor, **g = 85 %**



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Noise Measurements on the Test Pavements
Close-Proximity (CPX) Measuring Method

CPX measuring trailer with the towing vehicle

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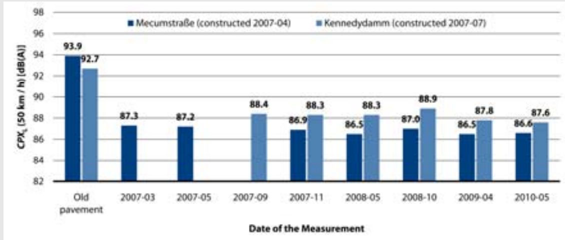
Noise Measurements on the Test Pavements
Close-Proximity (CPX) Measuring Method

CPX measuring trailer

Noise Measurements on the Test Pavements
Close-Proximity (CPX) Measuring Method

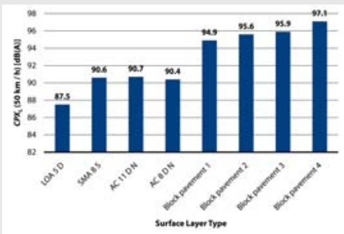
Position of the microphones near the reference tyre

Noise Measurements on the Test Pavements
Noise Emission Development over Time



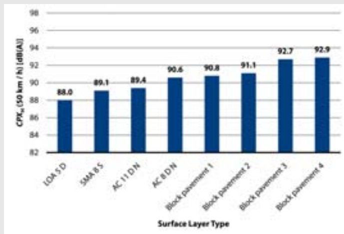
Noise Measurements on the Test Pavements
Comparisson of the Acoustical Properties of LOA 5 D with Other Surface Layers

Light vehicles at
50 km/h



Noise Measurements on the Test Pavements
Comparisson of the Acoustical Properties of LOA 5 D with Other Surface Layers

Heavy vehicles at
50 km/h



Recommendation of the Specification for LOA 5 D

Subject	Property	Test method	Requirement
Constituent materials	Percentage of crushed and broken surfaces in coarse aggregates	EN 933-5:1998	$C_{90/1}$
	Resistance to fragmentation of coarse aggregate	EN 1097-2:2010	LA_{20}, SZ_{18}
	Resistance to polishing of coarse aggregate for asphalt surfaces	EN 1097-8:2009	PSV_{51}
Mixture composition	Class of bitumen	EN 14023:2010	Polymer modified bitumen 25/55-55
	Percentage by mass passing 8 mm sieve	EN 933-1:1997/A1:2005	100 %
	Percentage by mass passing 5,6 mm sieve		90 to 100 %
	Percentage by mass passing 2 mm sieve		30 to 40 %
	Percentage by mass passing 0,125 mm sieve		12 to 18 %
	Percentage by mass passing 0,063 mm sieve		10 to 13 %
	Bitumen content by volume	—	12,5 to 13,5 %
Asphalt mixture	Minimum void content	EN 12697-8:2003	V_{min5}
	Maximum void content		V_{max6}
	Minimum voids filled with bitumen		VFB_{min65}
	Maximum voids filled with bitumen		VFB_{max75}
	Resistance to permanent deformation	EN 12697-22:2003+A1:2007	$PRD_{AIR\ 4,0}$
	Mean texture depth, *MTD*	EN 13036-1:2010	0,6 to 0,7 mm
	Shape factor, *g*	NA	NR, To be determined
	Shape length, *g*L	NA	NR, To be determined
Constructed asphalt layer	Layer thickness	EN 12697:2003	2,0 to 2,5 cm
	Compaction degree	EN 13108-20:2006	≥ 97 %
	Profile irregularity (by 4 m straightedge)	EN 13036-7:2003	≤ 3 mm

Thanks for your attention!

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