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Danish Road Directorate

PRACTICAL USE OF NOISE REDUCING PAVEMENTS AND IMPLEMENTING RESEARCH THE DANISH EXPERIENCE

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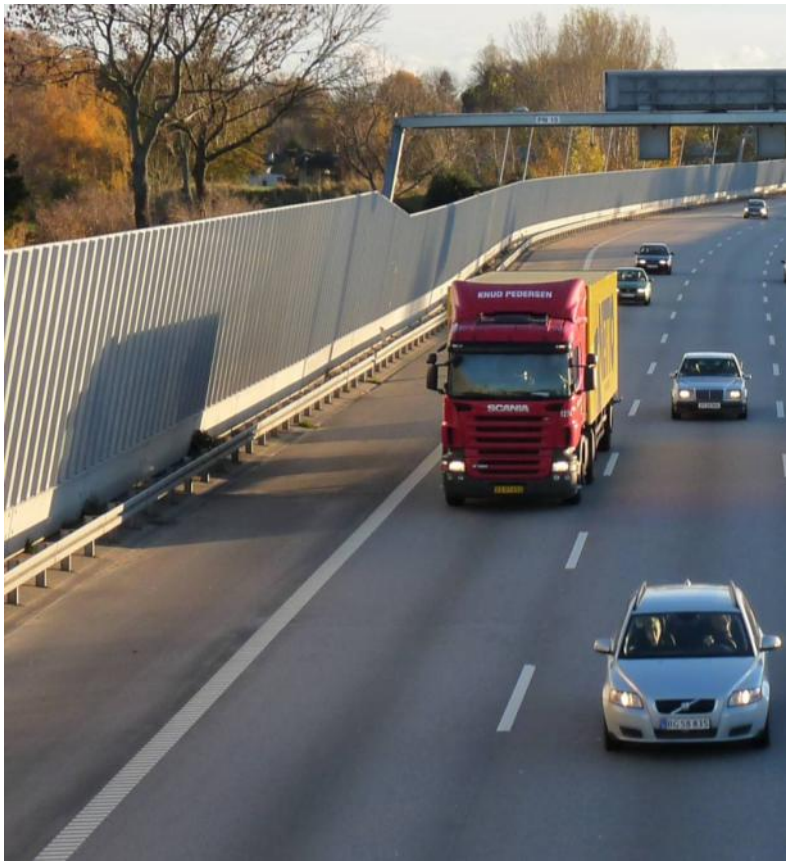


ROAD NOISE PROBLEM IN EUROPE IS HUGE

Case Denmark:

- 30 % of households exposed to over 58 dB (L_{den}) Environmental Protection Agency guideline
- Urban problem
- Effects:
  - Annoys people => Real estate prices
  - Impacts sleep => Health
  - Society economy
- Large focus on noise annoyance in the population
- Often main issue in public hearing on new road and infrastructure projects

THE COST OF THE NOISE PROBLEM

Noise reduces house prices:

- 1.2 % per dB urban roads => less tax
- 1.6 % per dB highways

Increased risk of cardio-vascular diseases:

- Annually 800-2200 at hospital
- Annually 200-500 early deaths in Denmark due to noise

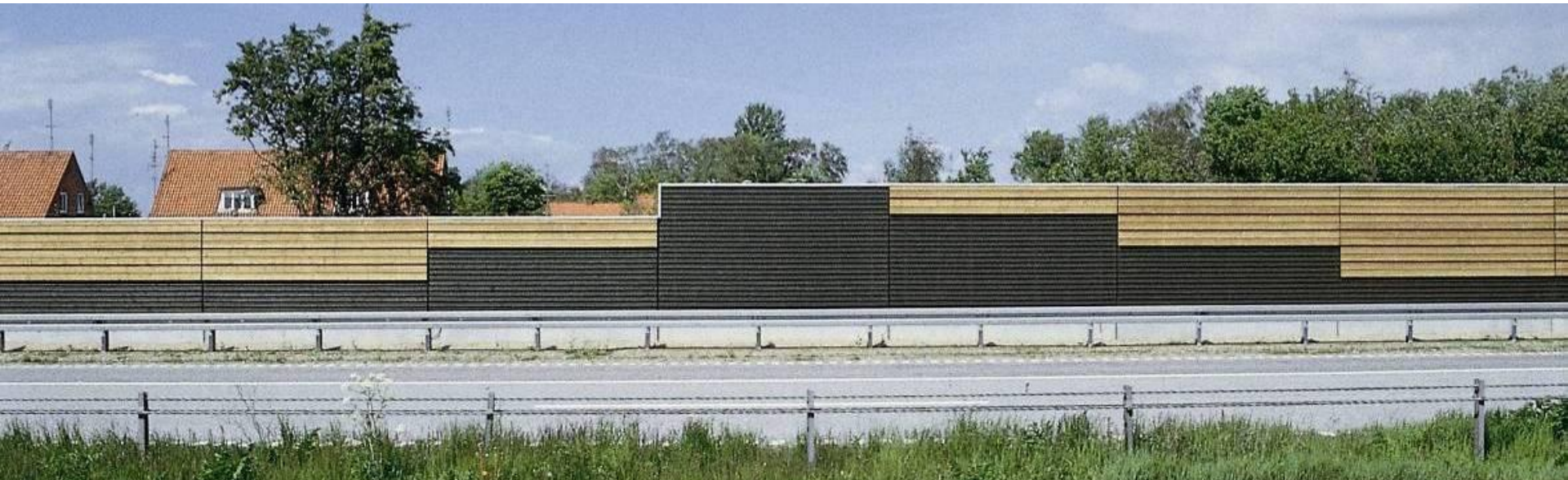
- Socio-economic costs of noise 0.8–1.2 billion € pr. year annually in Denmark (house and health)

- Small country 5 mill. inhabitants

THE BIGGEST PROBLEM
EXISTING ROADS AND DWELLINGS

Danish Road Directorate policy for noise management – 2009 Objectives:

- As many dwellings as possible below 58 dB (L_{den})
- To reduce the noise on as many dwellings as possible
- Ensure the best cost effectiveness in noise abatement
- Research in cost effective solutions



THE STATE ROAD NOISE ACTION PLAN

State road EU noise mapping

L_{den}	< 58 dB	58-63 dB	63-68 dB	> 68 dB	Total
Number dwellings		77.000	31.000	11.000	119.000

Goal to reduce the noise annoyance for as many dwellings as possible along the highway sections with the highest noise levels:

- New highways < 58 dB
- Noise barriers
- Noise reducing windows
- 55 mill. € over last 6 years
- Noise reducing pavements when pavements are renewed over 58 dB

APPLICATION OF NOISE REDUCING PAVEMENTS

- Pavement renewal on highways
- Noise reducing pavements are used:
  - Highways near residential areas noise over 58 dB
  - Highways near recreational urban areas over 58 dB
- The same for construction of new highways
- Research on integration of noise in Pavement Management Systems

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SRS SYSTEM FOR TENDERING NOISE REDUCING PAVEMENTS

Noise labeling of pavements by CPX trailer noise measurements

Noise class	Description	Noise reduction in dB
SRS standard	Good noise reduction	4.0 < x < 7.0
SRS special	Very good noise reduction	x > 7.0

NCC Roads A/S - Asfaltprodukter

SMA 6P tyndlagsskærvemastiks

Produktbeskrivelse:
SMA 6P er en tyndlagsbelægning af skærvemastiks-typen med en hvis støjreducerende effekt. SMA 6P fremstilles ved tilsætning af en

Gode resultater med SRS - støjreducerende asfalt

AB 6å Stålfalt B (50 km/t) A (80 km/t)
AB 6å Stålfalt med polymérmodificeret bitumen er Munck Asfalts flagskib inc
asfalt. Selv i små lagtykkelser opnås en helt ekstraordinær støjreduktion.

SMA 6 plus 8/11 B (50 km/t) B (80 km/t)
SMA 6 plus 8/11 er et godt eksempel på en all-round belægning, som kan a
steder. SMA 6 plus 8/11 har en mere åben struktur end almindelig SMA.

ARKIL A/S

- **Støjreducerende SRS-belægninger**, som via en veldesignet fordeling af hulrum i asfalten reducerer støjen fra bildæk. SRS-belægning leveres i støjklasse A,B og C.
- **Landbrugsasfalt**, udviklet i henhold til landbrugets egne krav, er meget tæt og

("Udbuds- og Anlægsforskrifter for Varmblandet
sfalt, Almindelig Arbejdsbeskrivelser (AAB)").

PANKAS AB SRS

PANgrip SRS

PANKAS SMA SRS

er producerer og sælger vi en række af
gne specialprodukter, fx. farvede
elægninger og støjdæmpende belægninger.

Σ > 25 SRS-products on market

Asfaltslidlag

- Asfaltbeton og Pulverasfalt
- Skærvemastik
- Tyndlagsbelægning
- Støjreducerende asfalt

Asfalt binde- og bærelag

Lemminkäinen A/S - N

Colas Danmark A/S · Fal

Støjreducerende slidlag				
Støjred. slidlag, Skanska Asfalt specialbelægning	SkanTOP XL	SkanTOP LN	SkanDRAIN LN	SkanGRIP LN
	SkanTOP XL Silence	SkanTOP LN 6+	SkanDRAIN 8 SkanDRAIN 1	SkanGRIP LN 6

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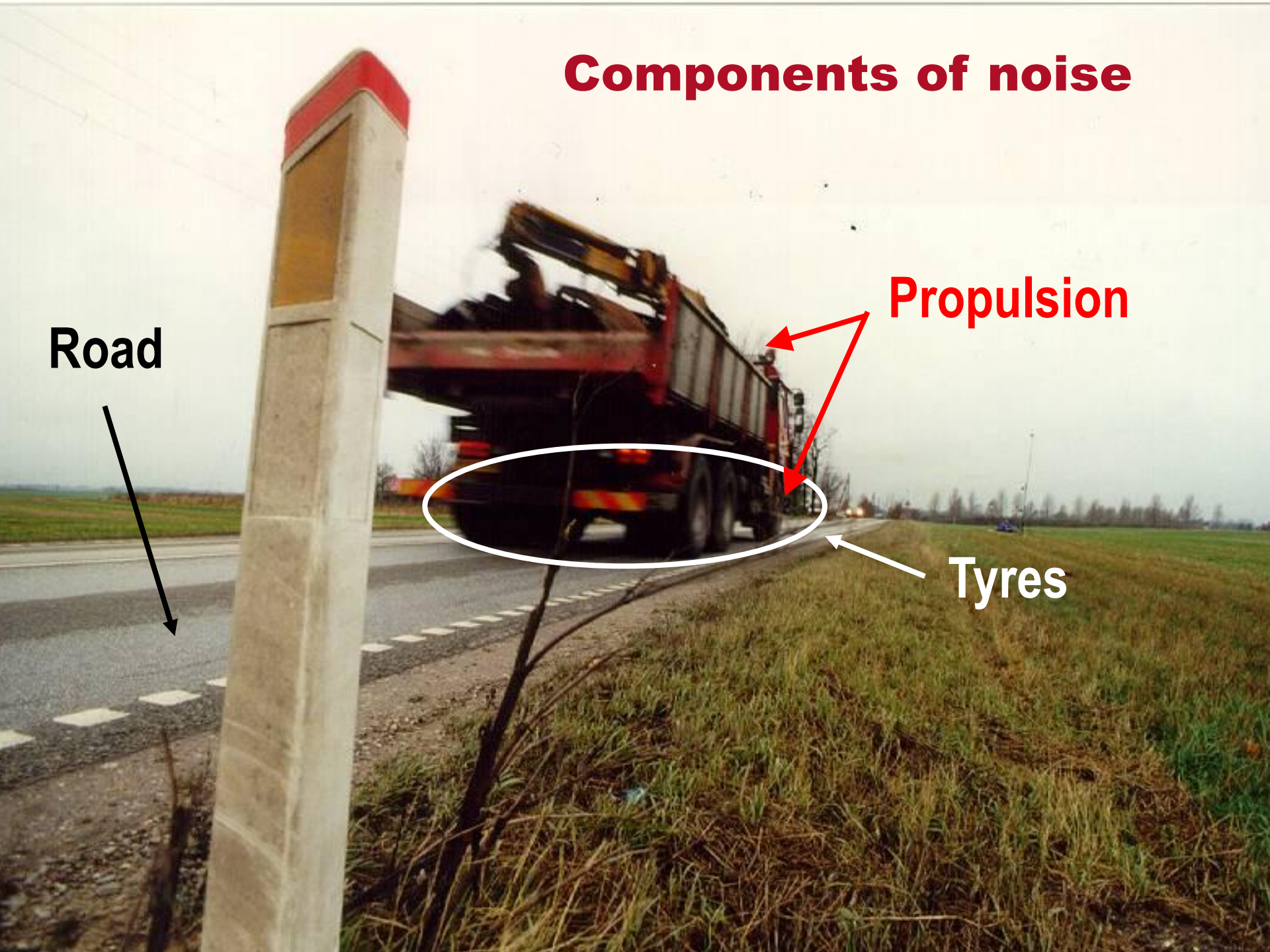
COPENHAGEN MUNICIPALITY POLICY

- Pavement renewal process
- Roads with more than 2000 vehicles/day

- Noise reducing pavements are used
- Tendered with the SRS system


Components of noise
Road
Propulsion
Tyres

Propulsion

L_{AFmax} [dB]
90
85
80
75
70
65
60
20
30
40
50
60
70
80
90
100
110
120
130
140
P_Prop
Speed [km/h]

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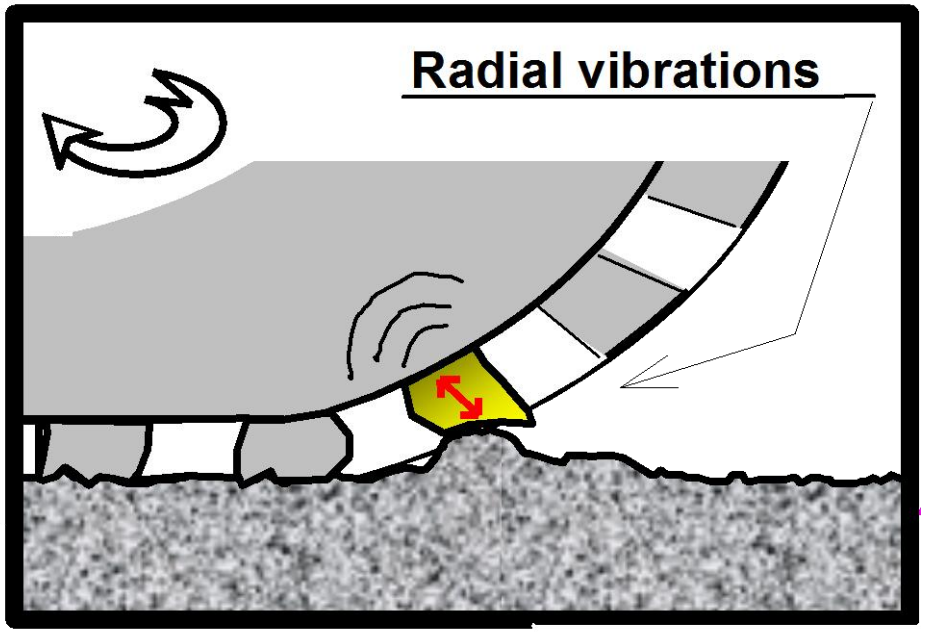
VIBRATION GENERATED NOISE

- The texture of the surface makes tyre vibrate
- Low frequency

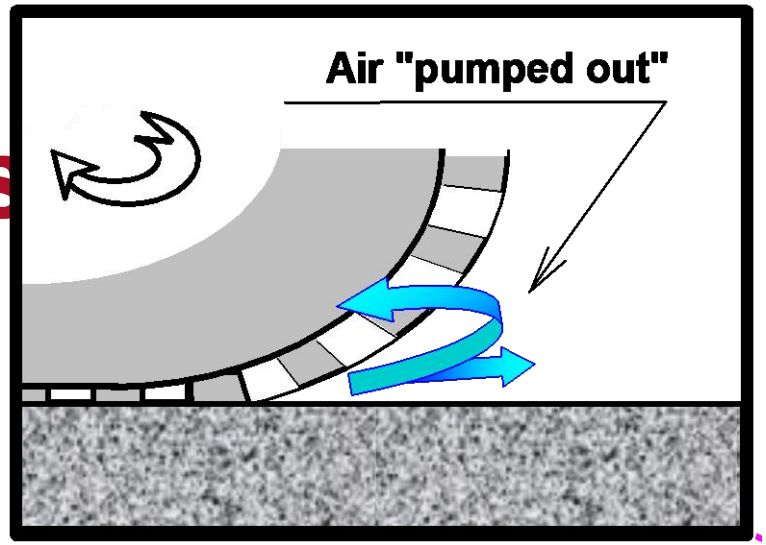
  under 1500 Hz

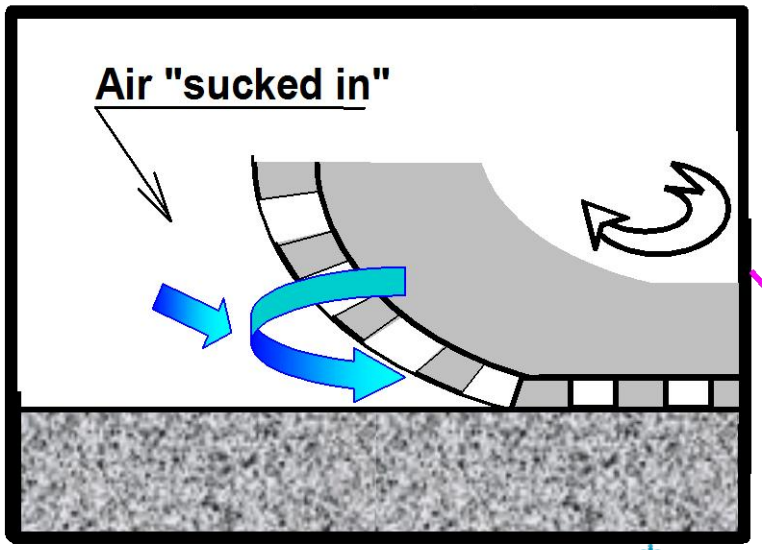


AIR PUMPING NOIS

- Air is pressed out and in between the rubber blocks of the tyre
- High frequency

  over 1000 Hz





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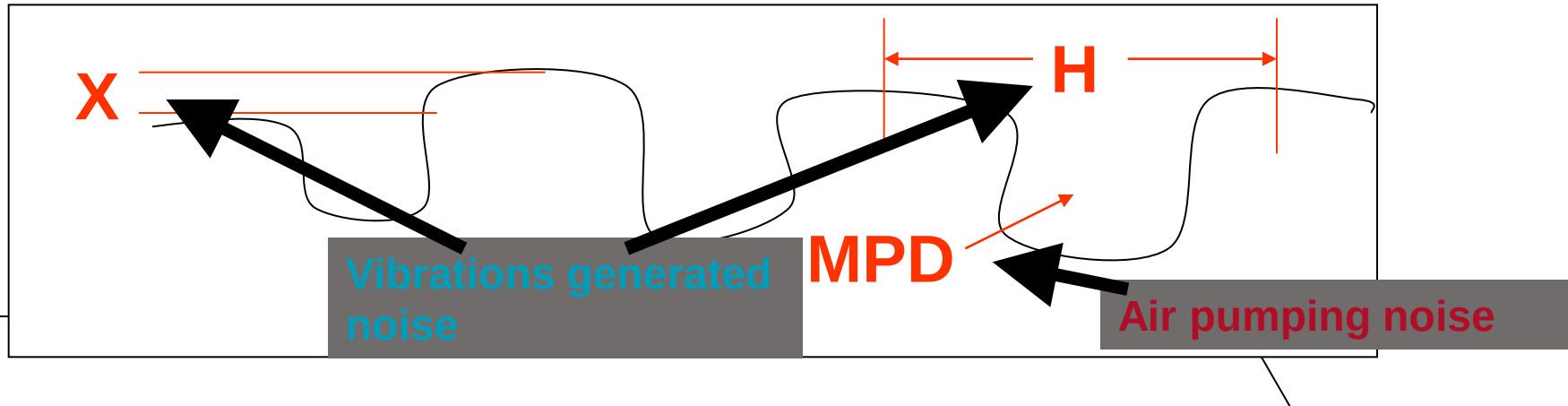
OPTIMISATION OF NOISE REDUCTION:

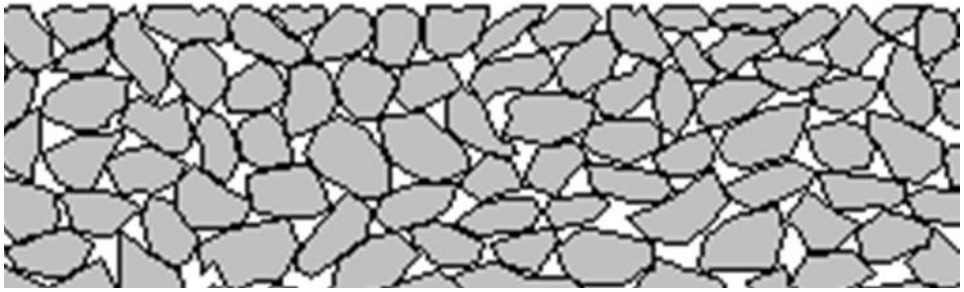
- The highest points of the surface same height. Reduce X
- Cubic aggregate and good compaction
- Distance between high points short. Reduce H
- Small aggregate size
- Holes in the surface as big as possible. Increase MPD

Large built in air void



POROUS ASPHALT

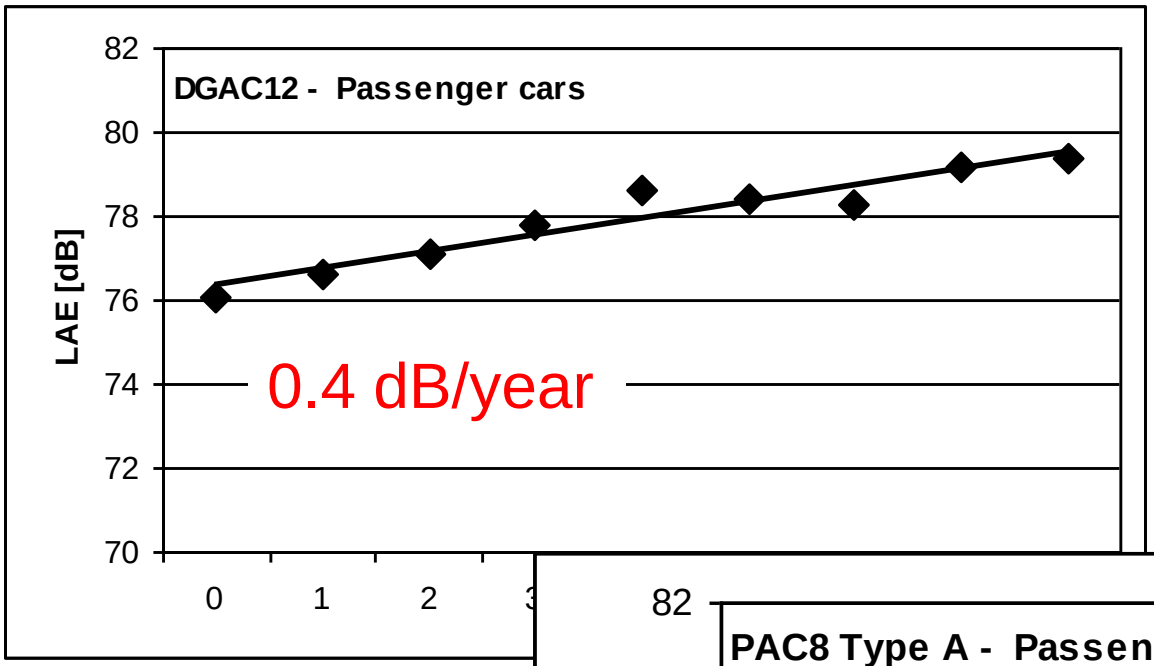
- One layer

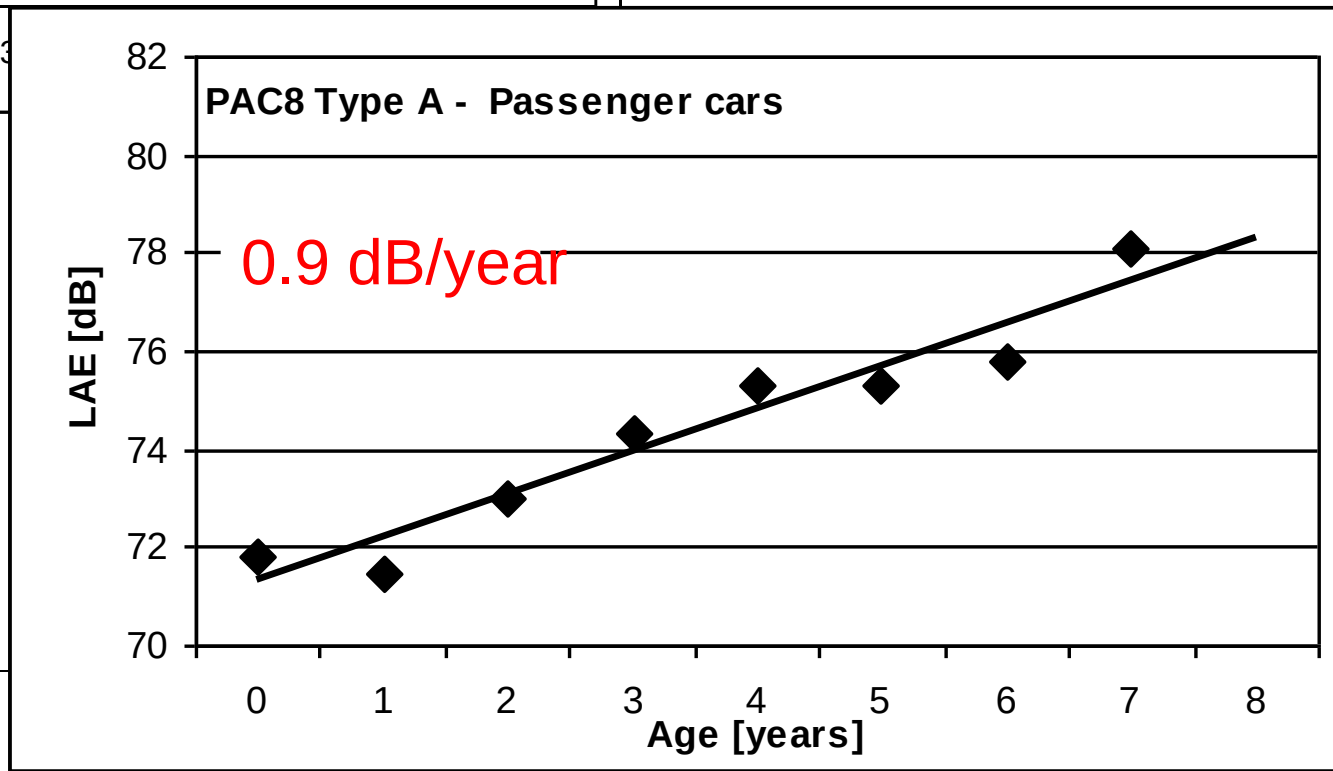


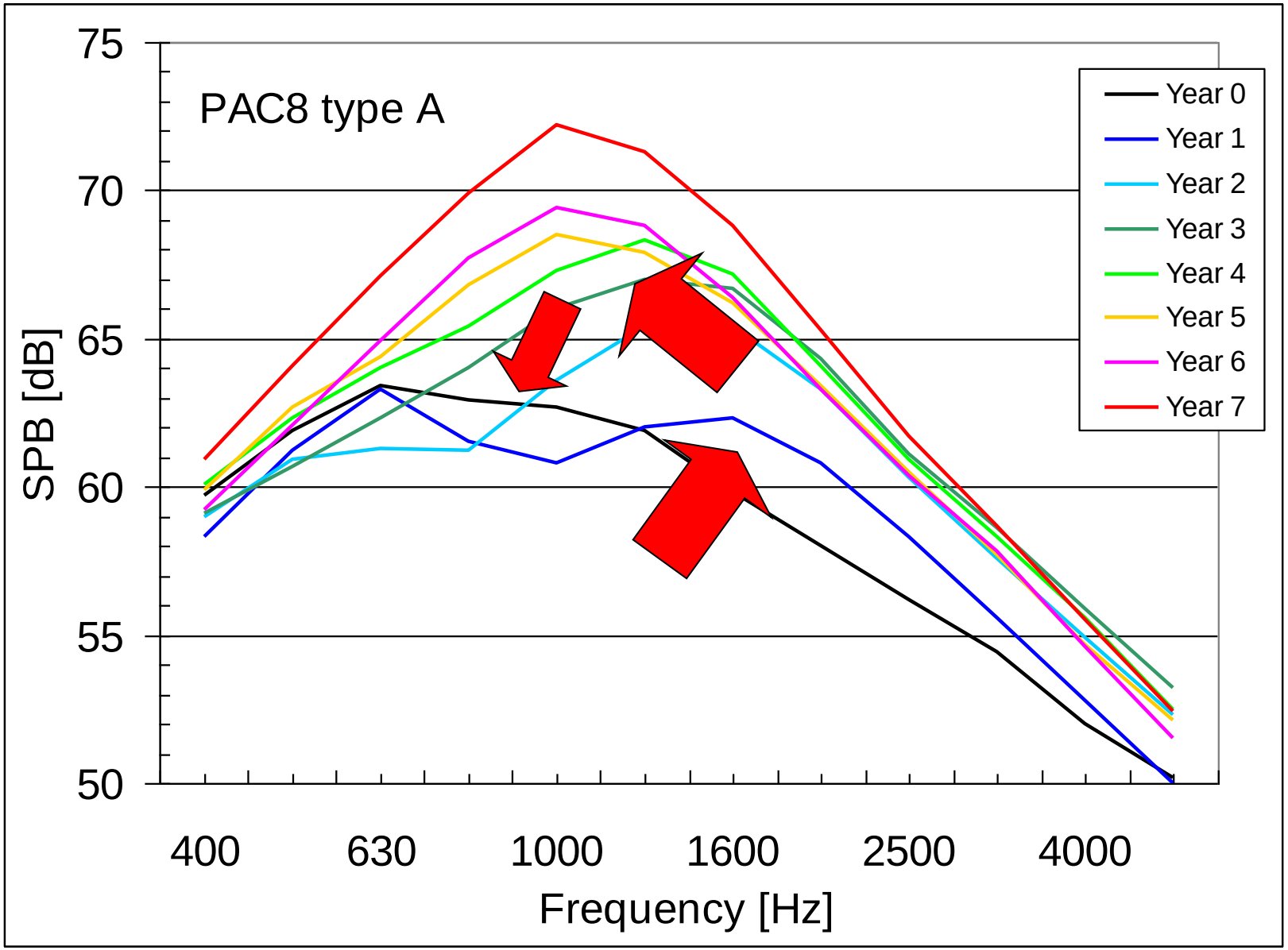
EXPERIMENT WITH SINGLE LAYER POROUS ASPHALT

Pavement	Aggregate size	Air void
PAC8 type A	8 mm	18-22 %
PAC8 type B	8 mm	> 22 %
PAC12	12 mm	> 22 %
OGAC12	12 mm	6 %
DGAC12	12 mm	3 %

POROUS ASPHALT





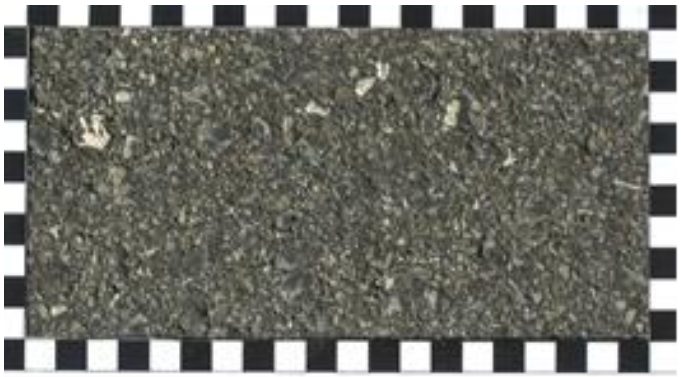

PAC8 type A
SPB [dB]
75
70
65
60
55
50
400
630
1000
1600
2500
4000
Frequency [Hz]
Year 0
Year 1
Year 2
Year 3
Year 4
Year 5
Year 6
Year 7

RESULT POROUS ASPHALT AVERAGE NOISE REDUCTION

Asphalt Pavement	Passenger Cars
Open Graded	- 1.7 dB
Porous 8 - A	3.3 dB
Porous 8 - B	3.3 dB
Porous 12	1.2 dB

NOISE REDUCING THIN LAYERS - SRS

- Open surface
- Not porous
- Small aggregate size



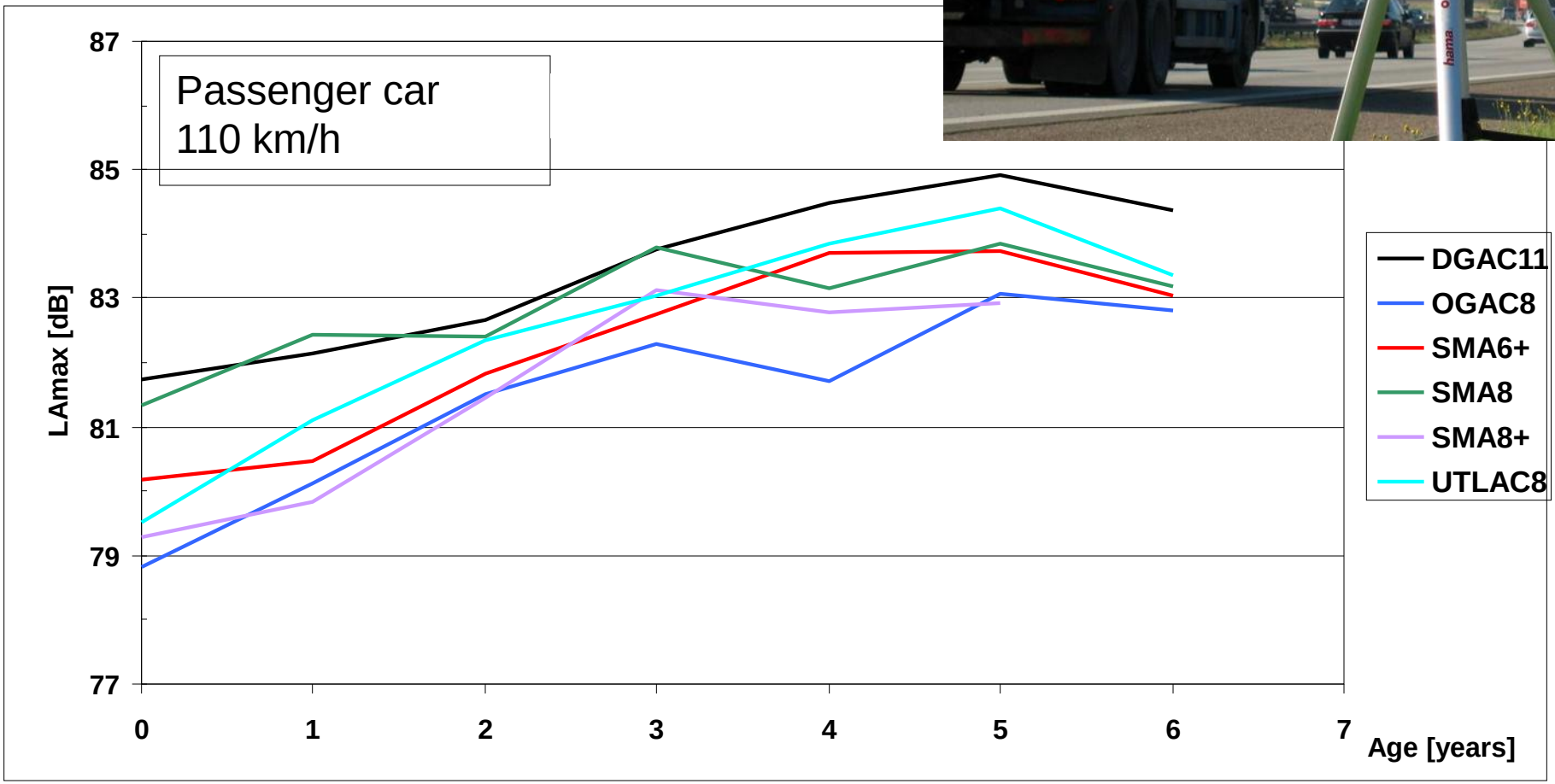
Dense reference

Thin layer - SRS

FIRST DANISH TEST OF NOISE REDUCING SRS PAVEMENTS ON HIGHWAY

Pavement	Aggregate size	Air void
SMA8	8 mm	12.4 %
OGAC8	8 mm	15.3%
UTLAC8	8 mm	14 %
SMA6+	6+8 mm	3 %
SMA8+	6+11	5.7 %
DGAC11	11 mm	2.8 %

PASSENGER CARS
M10 110 KM/H



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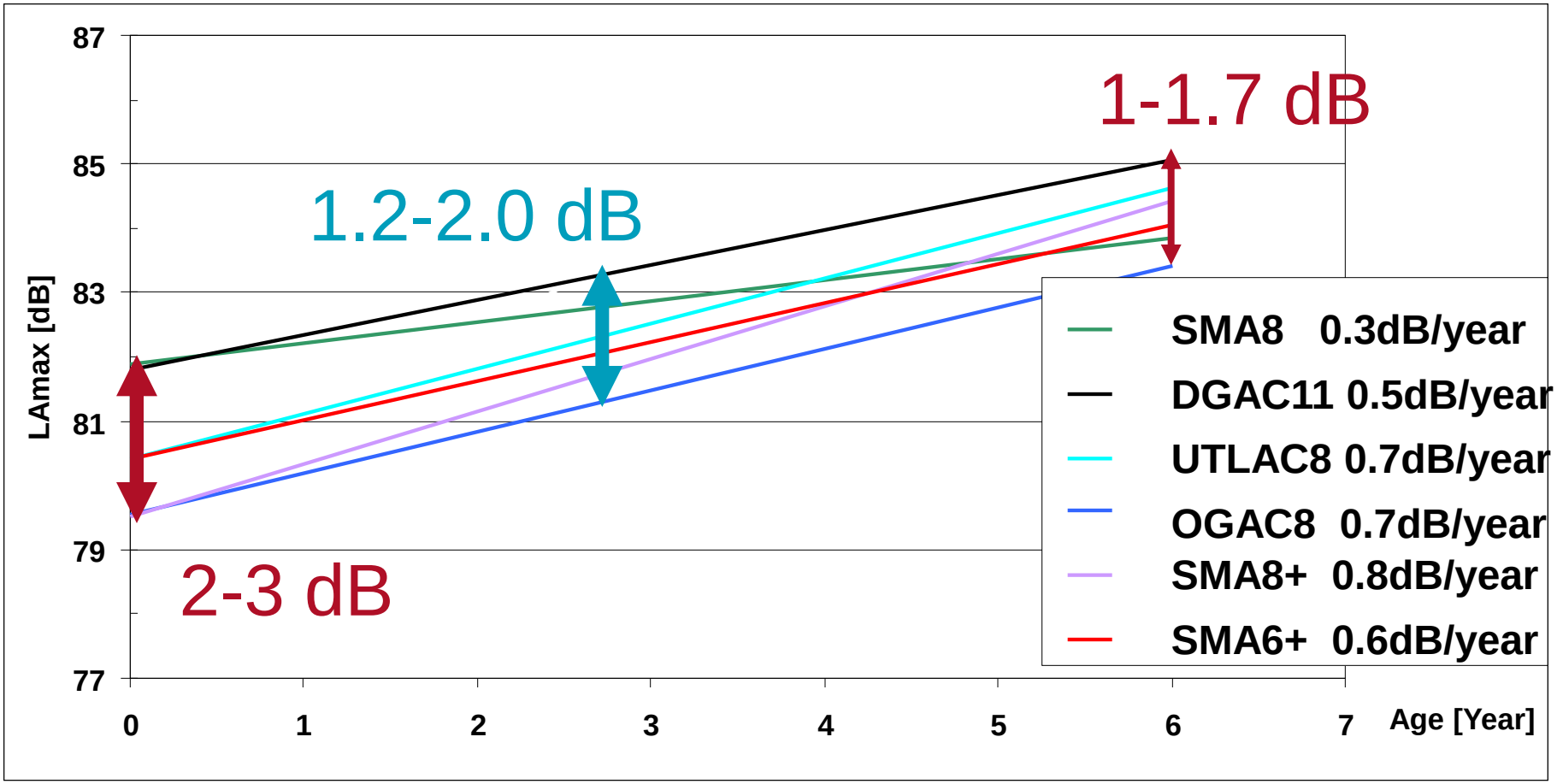
LINEAR REGRESSION



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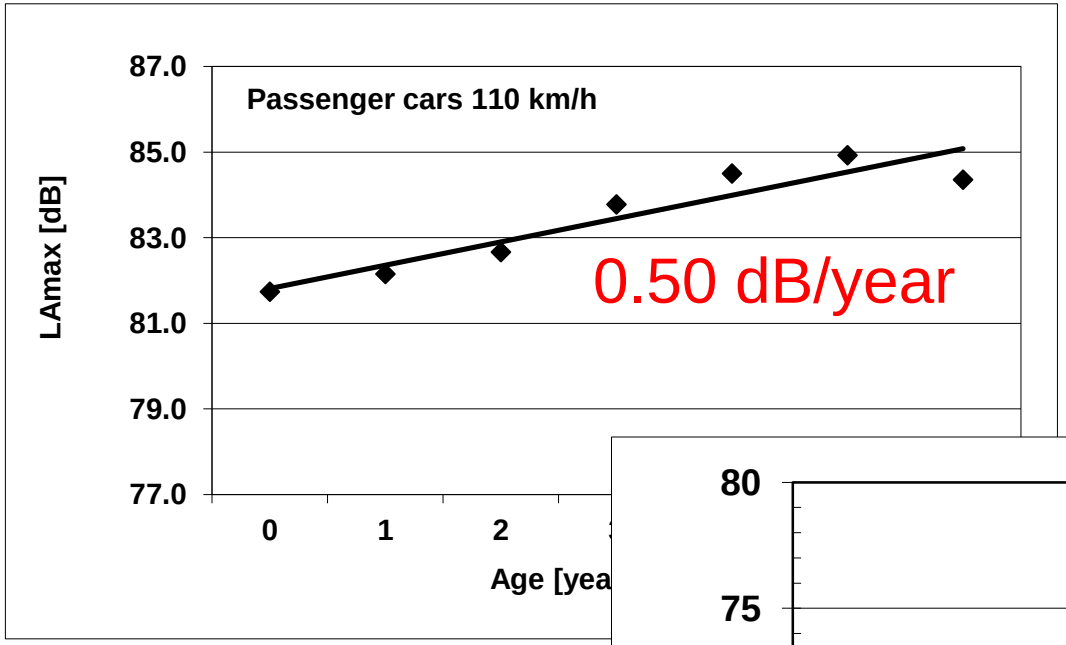
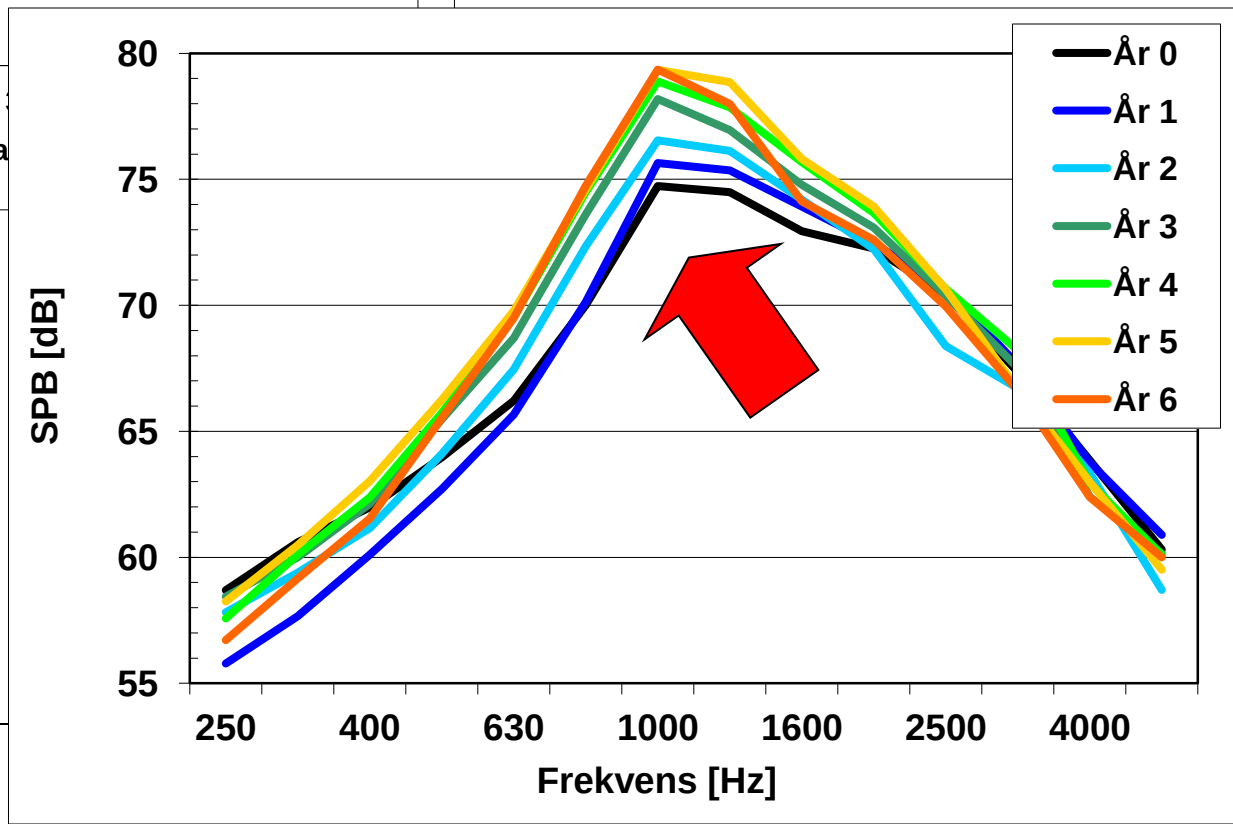
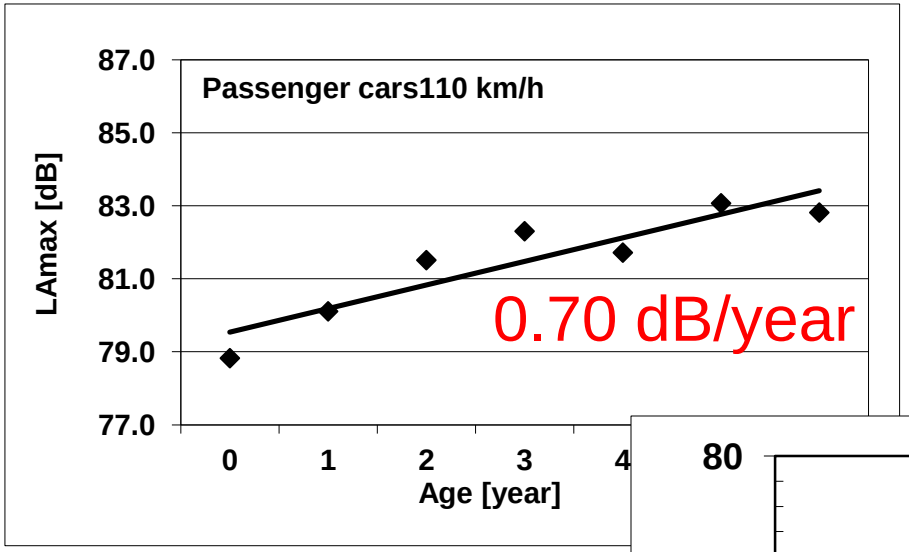
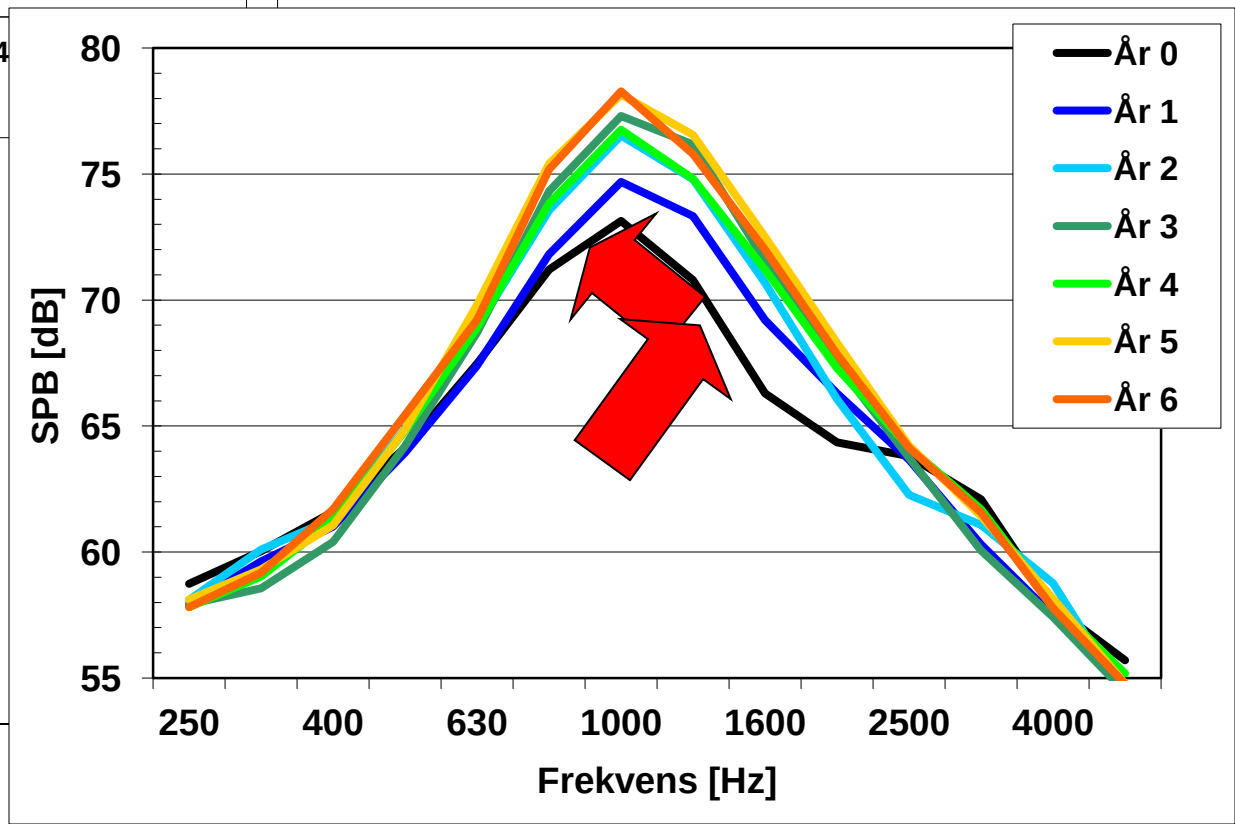
DENSE GRADED ASPHALT CONCRETE





OPEN GRADED ASPHALT CONCRETE





AVERAGE NOISE REDUCTION FIRST GENERATION SRS

Pave-ment	Passenger car	Heavy multi axle
	Average noise reduction [dB]	
OGAC8	2.0	2.7
SMA6+	1.2	0.4
SMA8	0.6	1.0
SMA8+	1.7	1.0
UTLAC8	0.9	1.6

CONCLUSION

- Politics for noise reducing pavements in place and active
- Noise reducing pavements are now used on state roads and in municipalities
- Because:
  - There is a need for ”low cost” noise reduction
  - Noise reducing pavement solutions are on the marked ready for use
  - Road engineers and politicians know the concept
  - The SRS system facilitates noise as a functional request in tendering process
- Cheap solution to be implemented in noise action plans
- Research ongoing for improvements


POROELASTIC PAVEMENT
FULL SCALE
TEST SECTION
Constructed in Denmark August 27th 2013