



Latest results of quiet pavement studies in Europe and Asia - Findings from study tours April-May 2007

By Ulf Sandberg, Chalmers University of Technology
and the Swedish National Road and Transport Research Institute (VTI)



Studies by Hong Kong officials
during the European tour

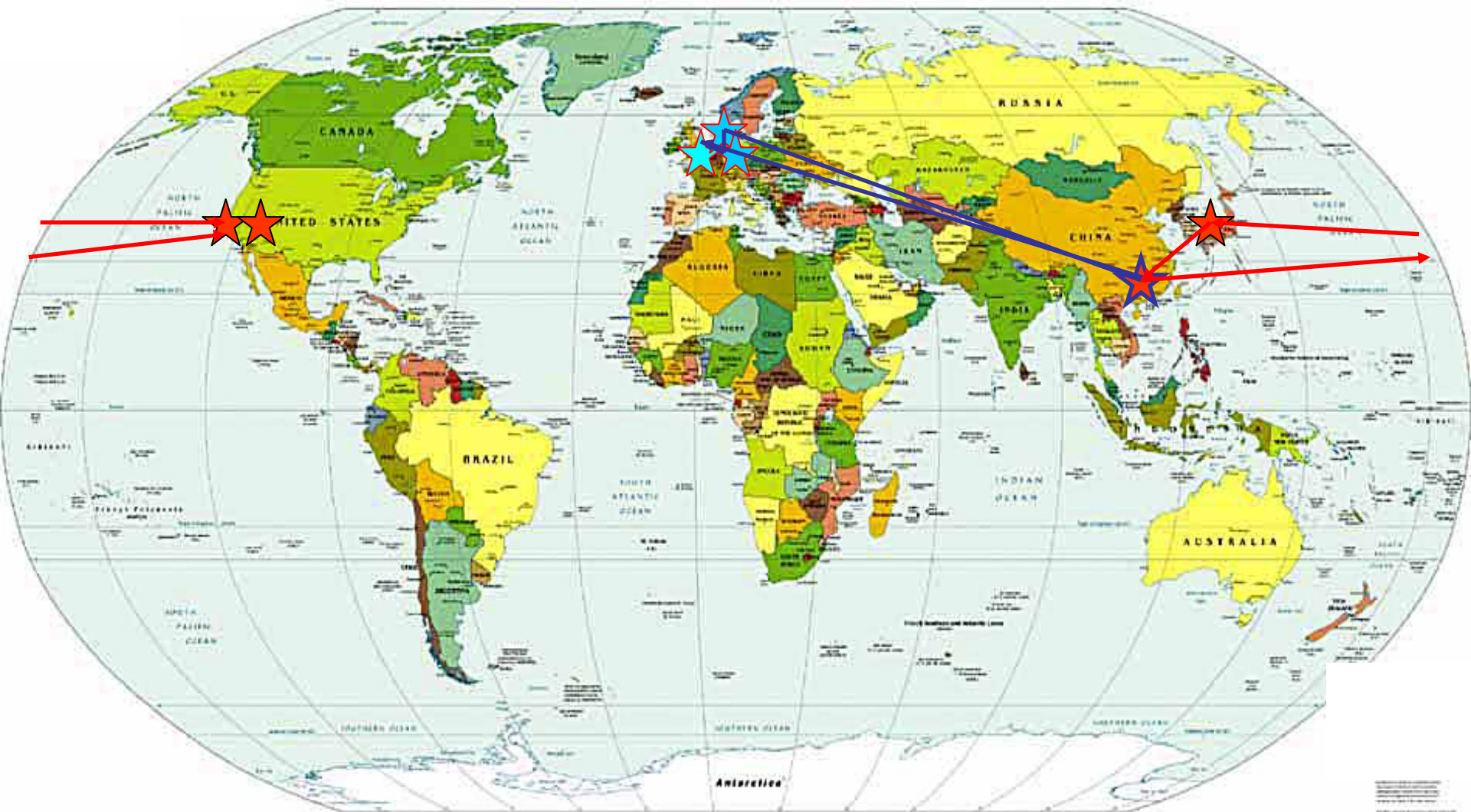
Acknowledgements

- The study tours reported here were funded by the Hong Kong Environment Protection Department (EPD)
- The author is grateful for the permission by the EPD to present this work
- The author is also grateful to Chalmers University of Technology for sponsoring the participation in the ADC40 summer meeting



Travel locations and routes

Ballined Vex of the World April 2000



The Netherlands



Dutch paving policy: use porous asphalt on all national roads

Single layer "ZOAB": ≥ 40 mm thick, 16 mm max aggr.size, voids content target 20 %

**Porous asphalt currently laid
on 70 % of the national
highway system.**

Target: 100 % by 2010

IPG



Innovatie Programma Geluid Wegverkeer (IPG)

Innovative Noise Reduction Program for Road Traffic

Budget: 54 million Euros for the 4 years 2004-2007

This day probably
something went wrong....



The Kloosterzande test track



>32 pavements, each 80 m long

half of them seen here

Focus on double-layer porous asphalt concrete (DPAC),
called two-layer porous asphalt (TLPA) in the Netherlands

A photograph of a green car driving on a road. In the foreground, a cross-section of the road surface is shown, revealing two layers of porous asphalt. The top layer is a thin, dark, porous material, and the bottom layer is a thicker, lighter-colored, porous material. The car is in motion, blurred, and is driving on the top layer of the porous asphalt. The background shows a highway with a guardrail and some buildings under a cloudy sky.

Top layer: 25 mm thick, 8 mm max aggr.size, voids content target 20 %, mod. binder

Bottom layer: 45 mm thick, 16 mm max aggr.size, voids content target 25 %

TLPA currently laid on 100 km (65 miles) of motorways



Noise reduction goal (TLPA pavements implemented at the end of 2007):

6 dB(A) initially;

4 dB(A) as a lifetime average (at least 7 years)

Drop in noise reduction: 0.20 – 0.25 dB(A) per year

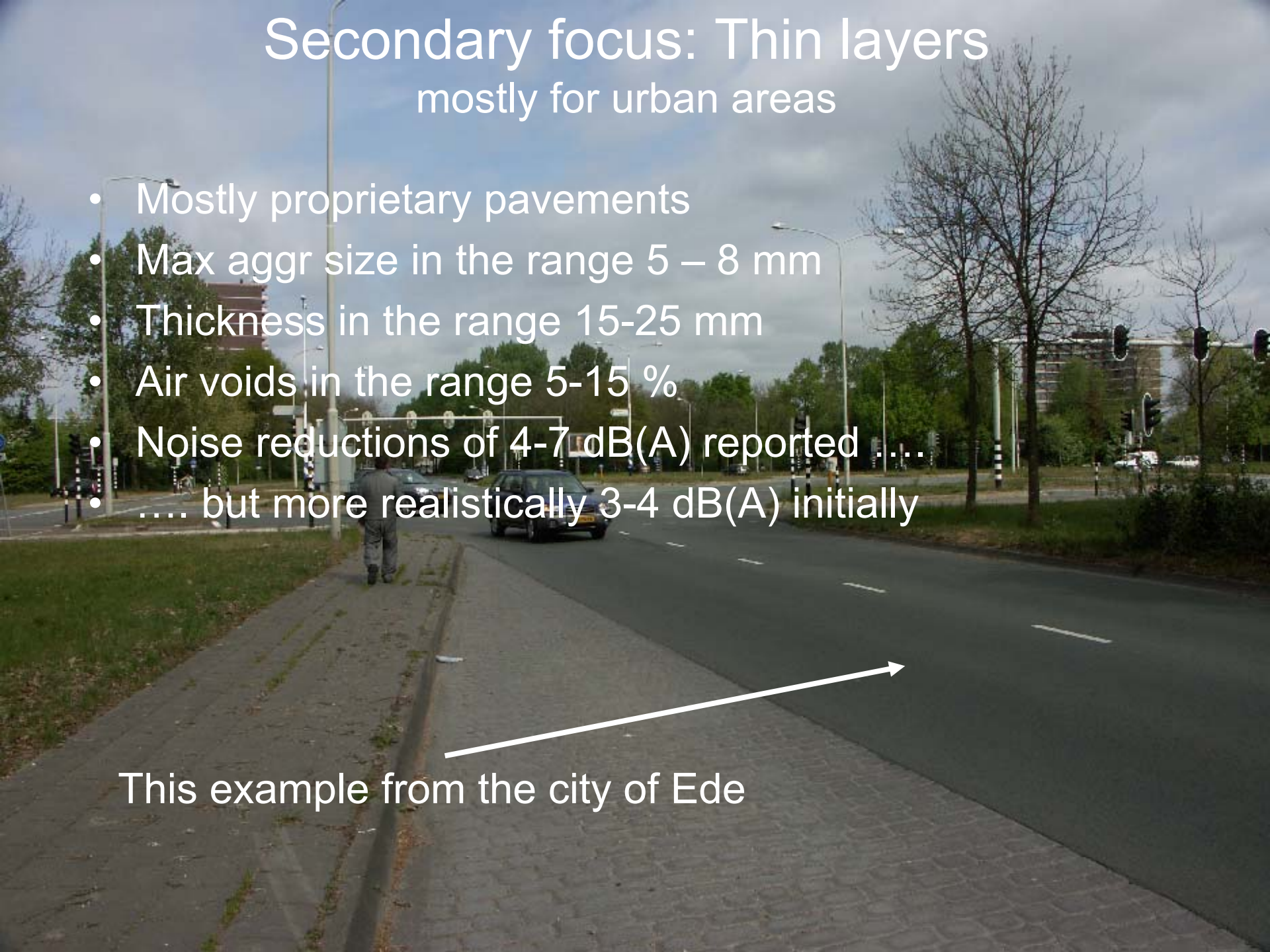
Goal seems to be essentially achieved now in 2007

Reference pavement: Dense asphalt concrete 0/16 (similar to HMA 5/8")

Secondary focus: Thin layers mostly for urban areas

- Mostly proprietary pavements
- Max aggr size in the range 5 – 8 mm
- Thickness in the range 15-25 mm
- Air voids in the range 5-15 %
- Noise reductions of 4-7 dB(A) reported
- but more realistically 3-4 dB(A) initially

This example from the city of Ede



"Microflex 0/6" in Ede

- Proprietary pavement, made by Heijmans Infrastructuur
- Max. aggr. size: 6 mm
- Thickness: appr. 20 mm
- Air voids: appr. 13 % (when new)
- Noise reduction: appr. 4 dB(A) at 50 km/h



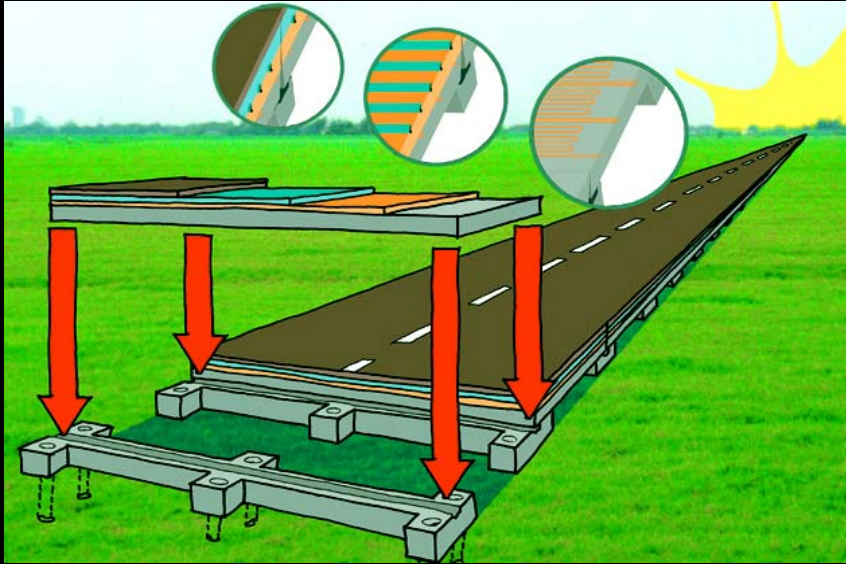
Futuristic designs still under trial

- Modieslab
- Rollpave
- Poroelastic road surface



Modieslab

(Courtesy of Jasper der Kooij)





(a) Installation of foundation piles



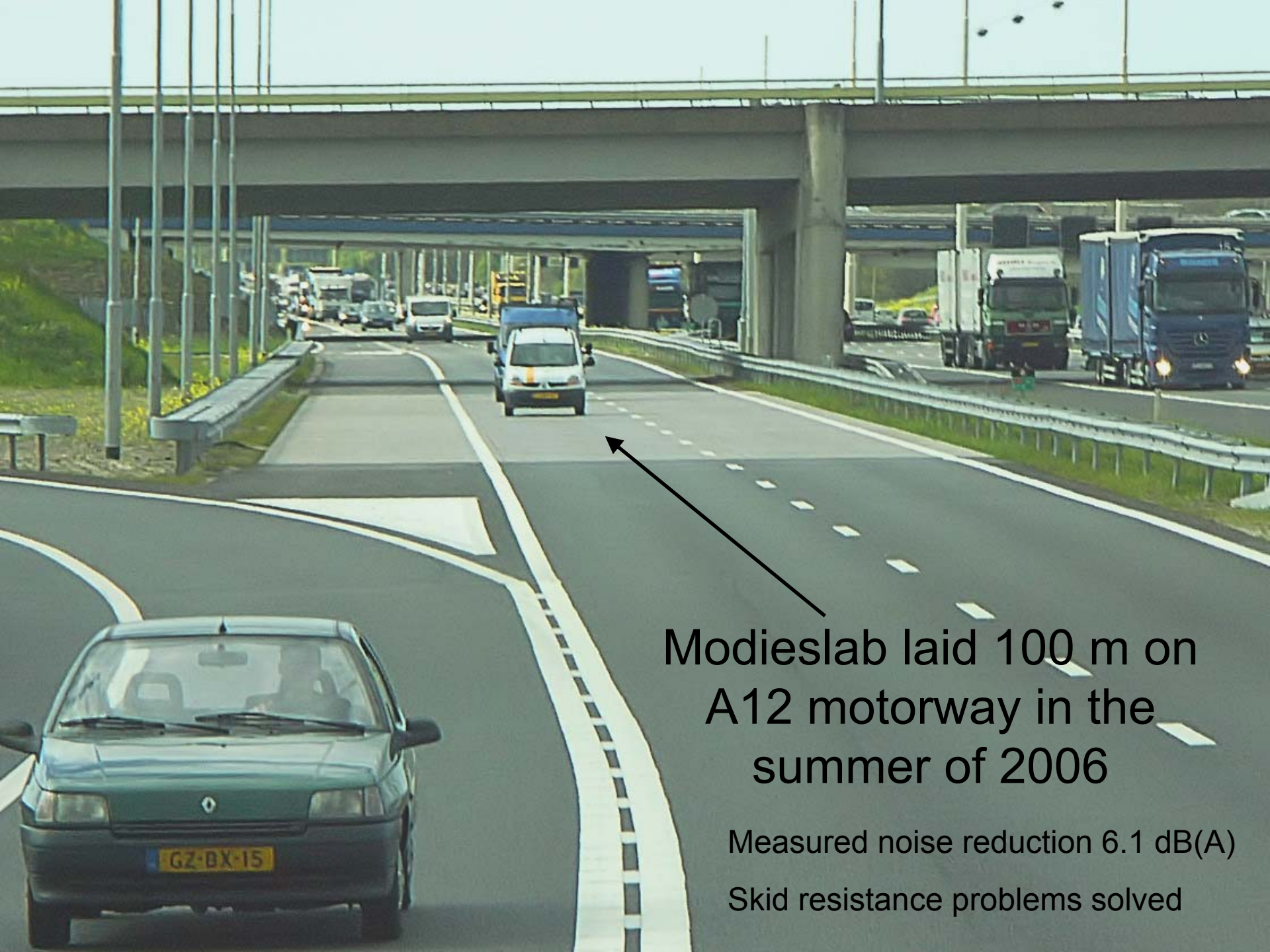
(b) Installation of pile caps on top of piles



(c) Backfilling of ground around piles and



(d) Installation of concrete slab on top of

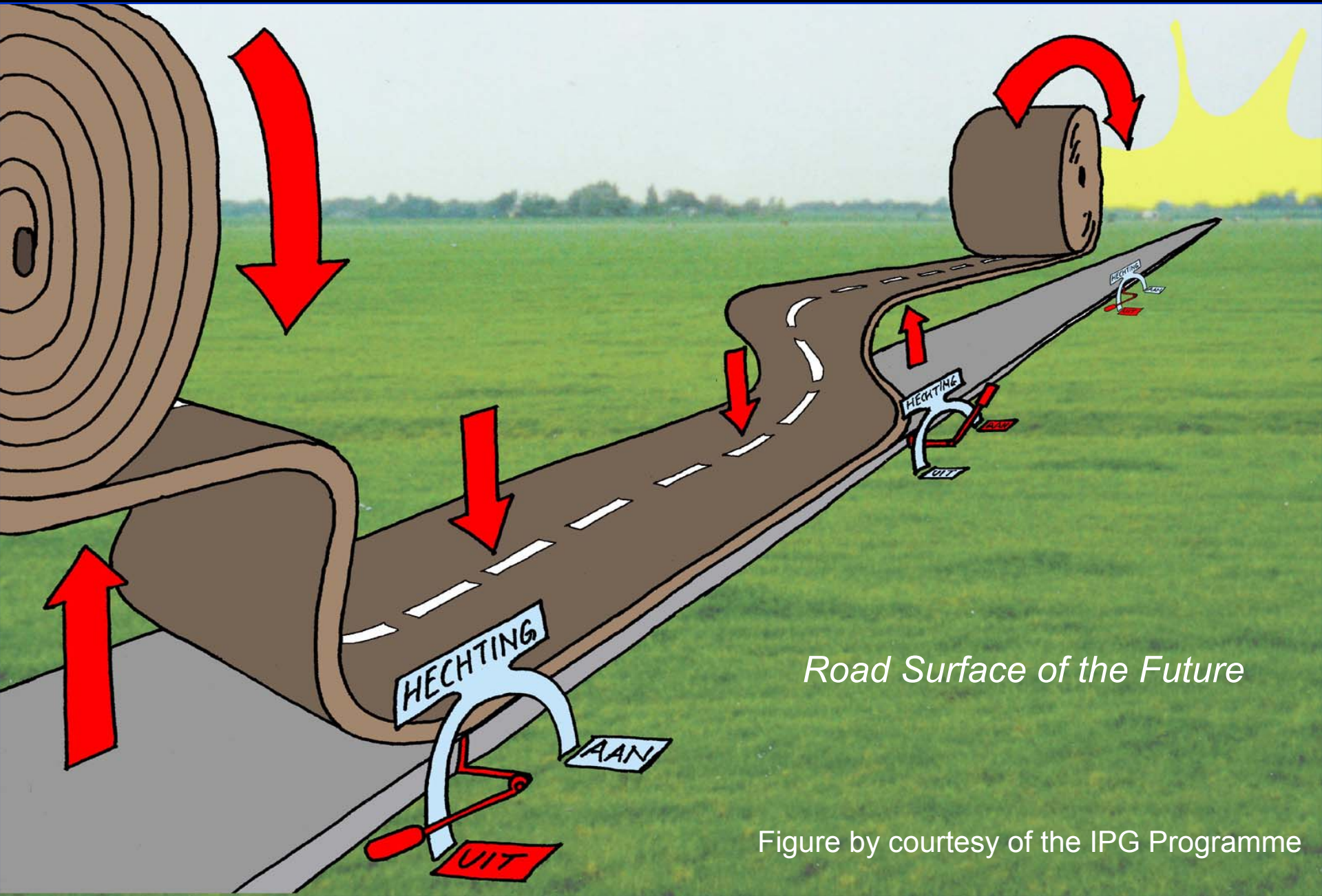


Modieslab laid 100 m on
A12 motorway in the
summer of 2006

Measured noise reduction 6.1 dB(A)

Skid resistance problems solved

Rollpave – using “The Adhesive Road” concept



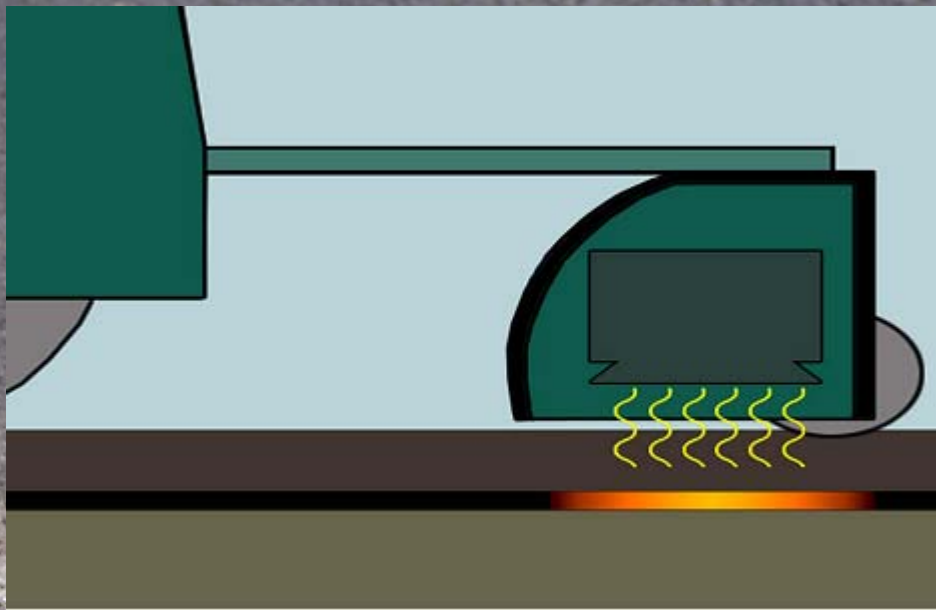
Road Surface of the Future

Figure by courtesy of the IPG Programme

On a yard, 30 rolls, each 50x3.75 m (165'x12'), were constructed
These were brought out on the motorway, rolled out and glued, to
cover 500 m of two lanes + shoulder of motorway surface

*“The rollable road” – from
Road Surface of the Future*





Binder melted by
electromagnetic heating of
wire mesh

- 30 mm thick single layer porous asphalt, 8 mm max aggr.
- The goal was a noise reduction of 6 dB(A)
- The measured noise reduction was 4+ dB(A)
- New construction made in winter weather January 2007
- New construction in a curve to be made in summer 2007
- Joints will be improved

The actual site of the Rollpave full-scale experiment:
500 m on the A35 motorway



"Mr Rollpave"

A man in a dark suit, white shirt, and patterned tie is crouching on a dark asphalt road surface. He is smiling and looking down at his hand, which is touching the pavement. The background shows a road with a white guardrail, yellow and black striped traffic cones, and some trees and buildings in the distance.

**Tests at
Kloosterzande
test track with
poroelastic
surfaces impor-
ted from Japan.
Coop. with PWRI**

**NOTE: The picture is not
from the current test site; it
is from Japan**

The author at the poroelastic test
section at Public Works Research
Institute in Japan

Initial noise reduction 7-10 dB(A)
New test constructions will be
made in October 2007

The background of the image is the German flag, consisting of three horizontal stripes of black, red, and gold from top to bottom.

Germany

Shift in German paving policy on motorways:
Abandon the burlap drag cement concrete; replace
with SMA or other treatments with higher texture



Focus on single-layer porous asphalt concrete (PAC), in Germany called PA



45 mm thick, 8 mm max. aggr.size (some oversize up to 11 mm),
voids content target 22-28 %, actual > 22 %, mod. binder

Comprehensive testing ongoing on various roads in Bavaria
Further work to reduce clogging is conducted in "Leiser Verkehr 2"

Results of monitoring noise reduction versus time



For previous generation of PA 0/8:

Initial noise reduction: 6-7 dB(A) (= 5-6 dB(A) compared to Dutch ref surface)

Drop with time: 0.4 dB(A) per year

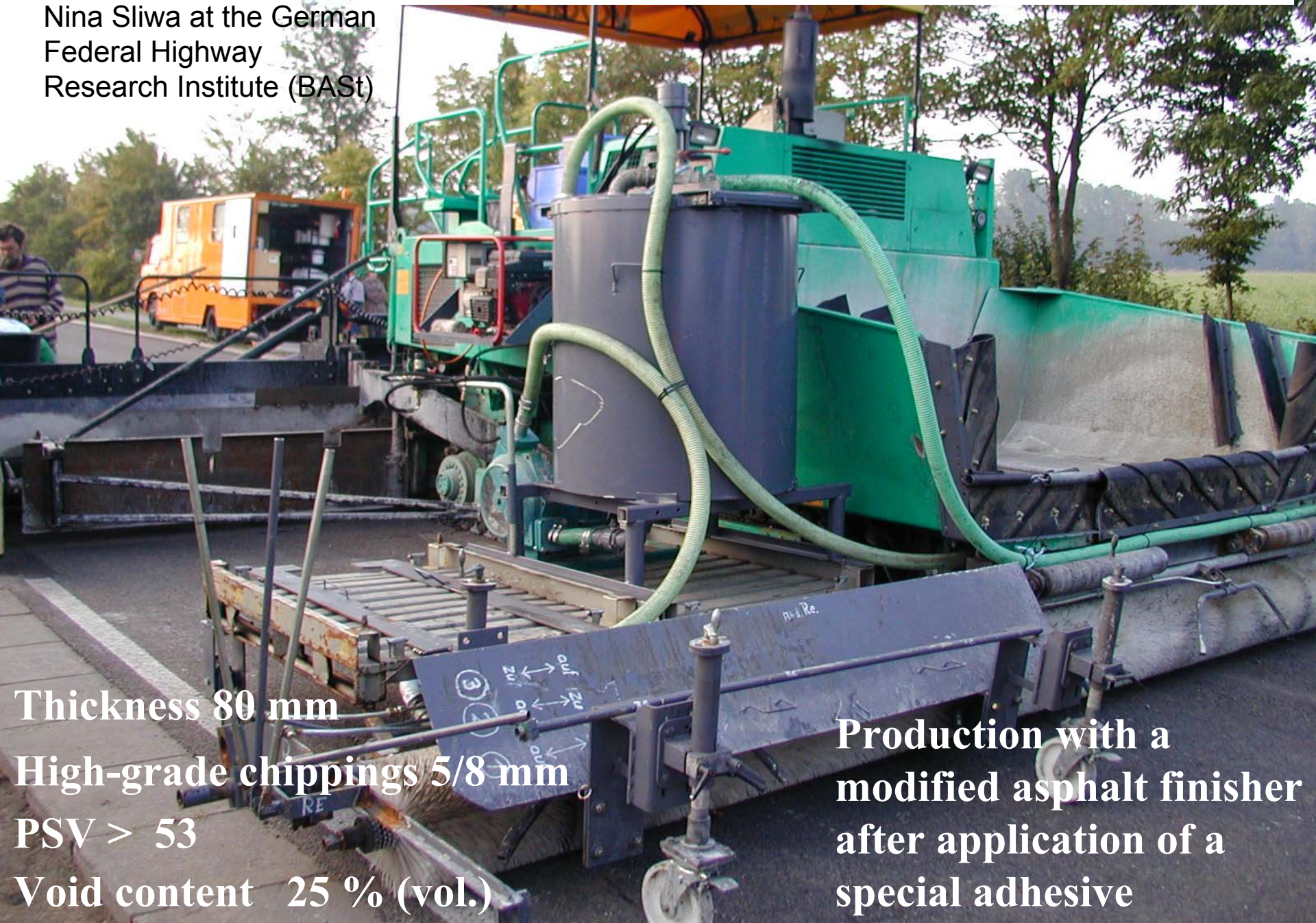
For new generation of PA 0/8:

Initial noise reduction: 7-9 dB(A) (= 6-8 dB(A) compared to Dutch ref surface)

Drop with time: 0.25 dB(A) per year

Data kindly supplied by
Nina Sliwa at the German
Federal Highway
Research Institute (BASt)

PRODUCTION OF POROUS CEMENT CONCRETE



Thickness 80 mm

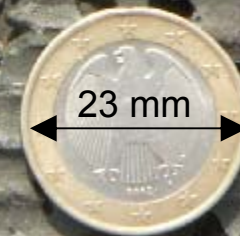
High-grade chippings 5/8 mm

PSV > 53

Void content 25 % (vol.)

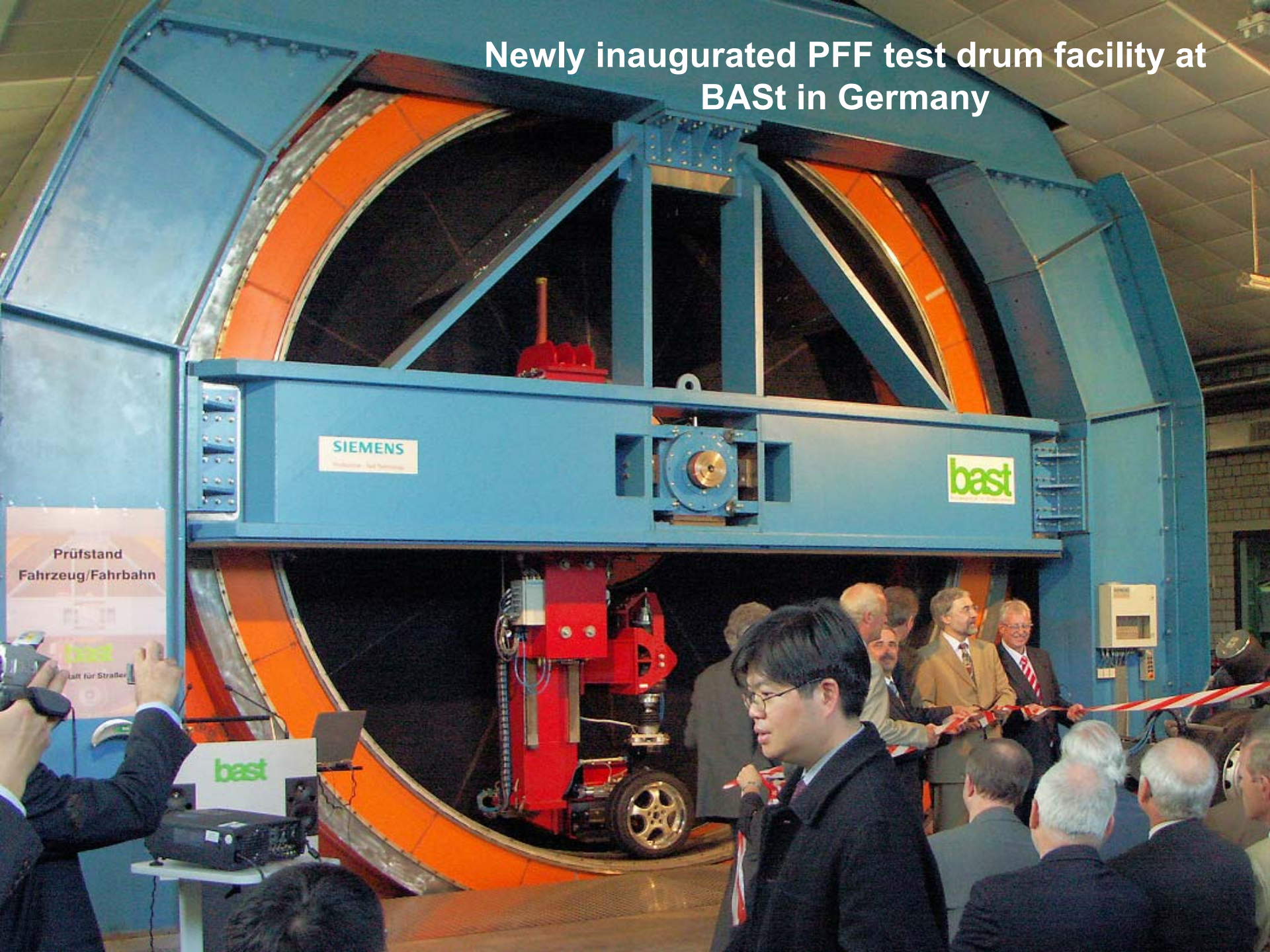
Production with a
modified asphalt finisher
after application of a
special adhesive

Porous cement concrete smoothed by diamond grinding

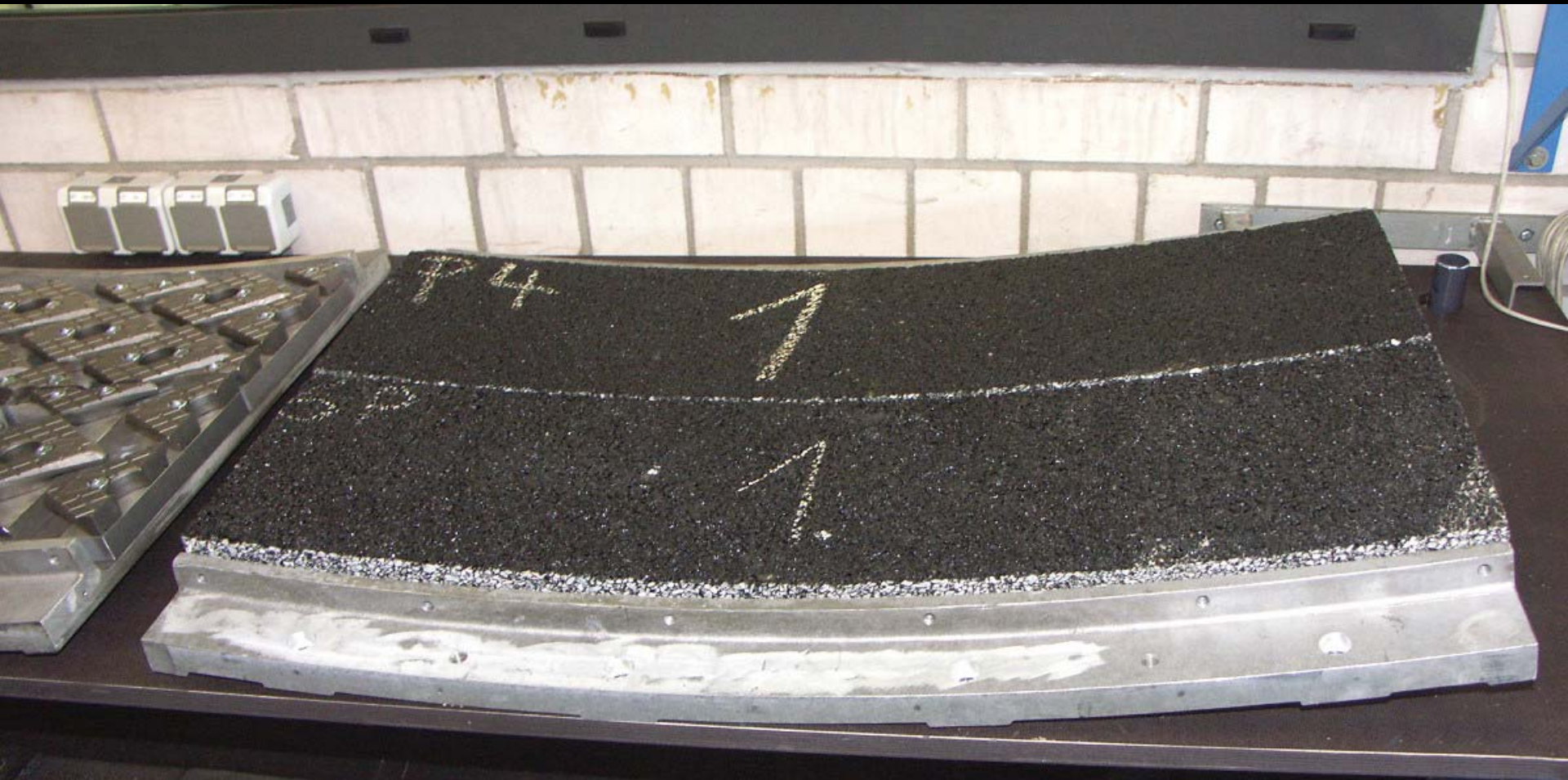


To be removed this summer due to cracks and
poor adhesion to the basecourse

Newly inaugurated PFF test drum facility at BAST in Germany



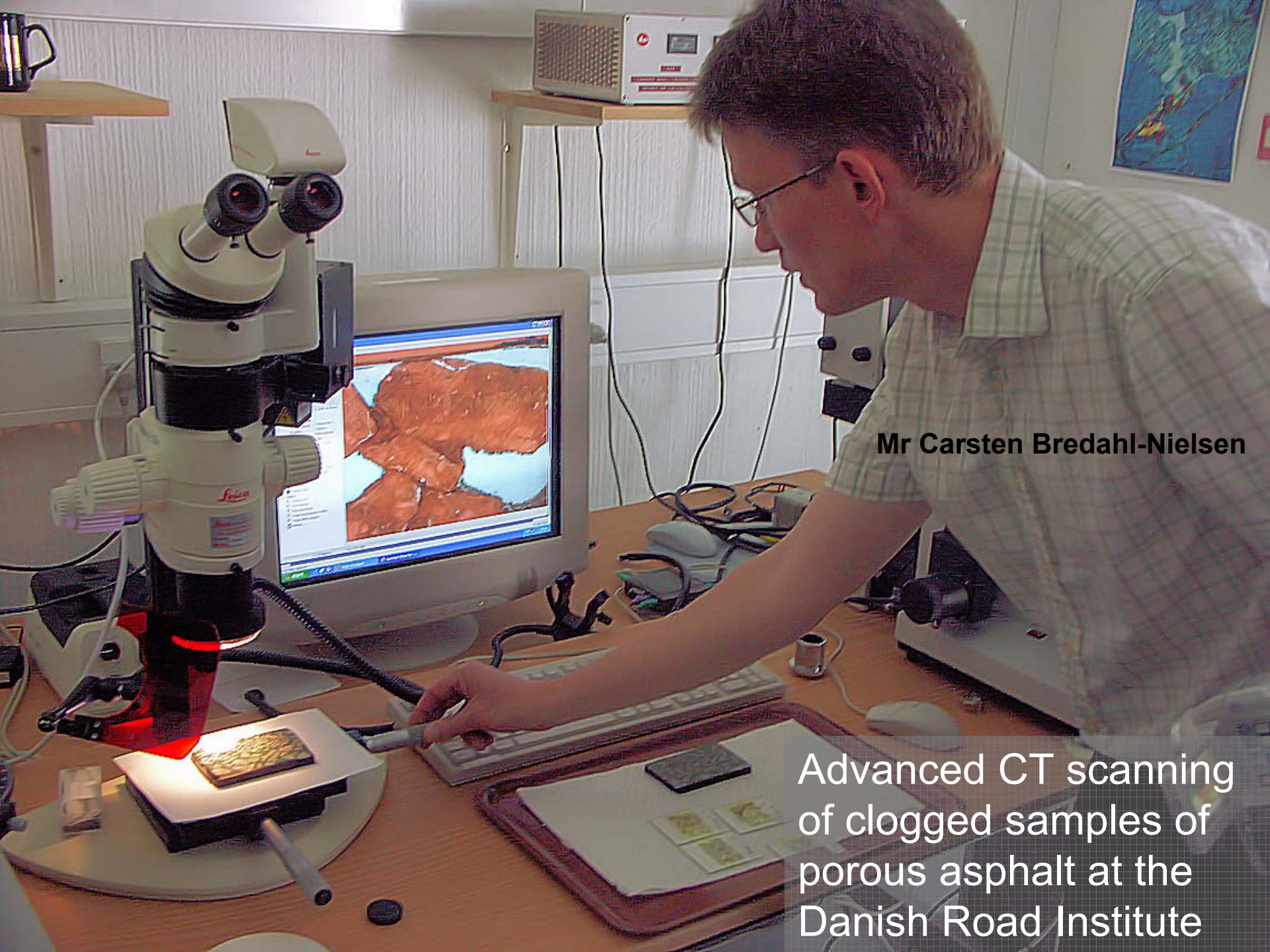
Samples of "quiet" thin layers from DRI in Denmark to be tested



**Samples from Denmark and Sweden to be fitted in Germany
into curved caskets like above
and then mounted on the inner circumference of the drum**

The image shows the flag of Denmark, which consists of a red field with a white Scandinavian cross. The cross is centered and extends to the edges of the flag. The word "Denmark" is written in red, bold, sans-serif capital letters across the center of the white cross.

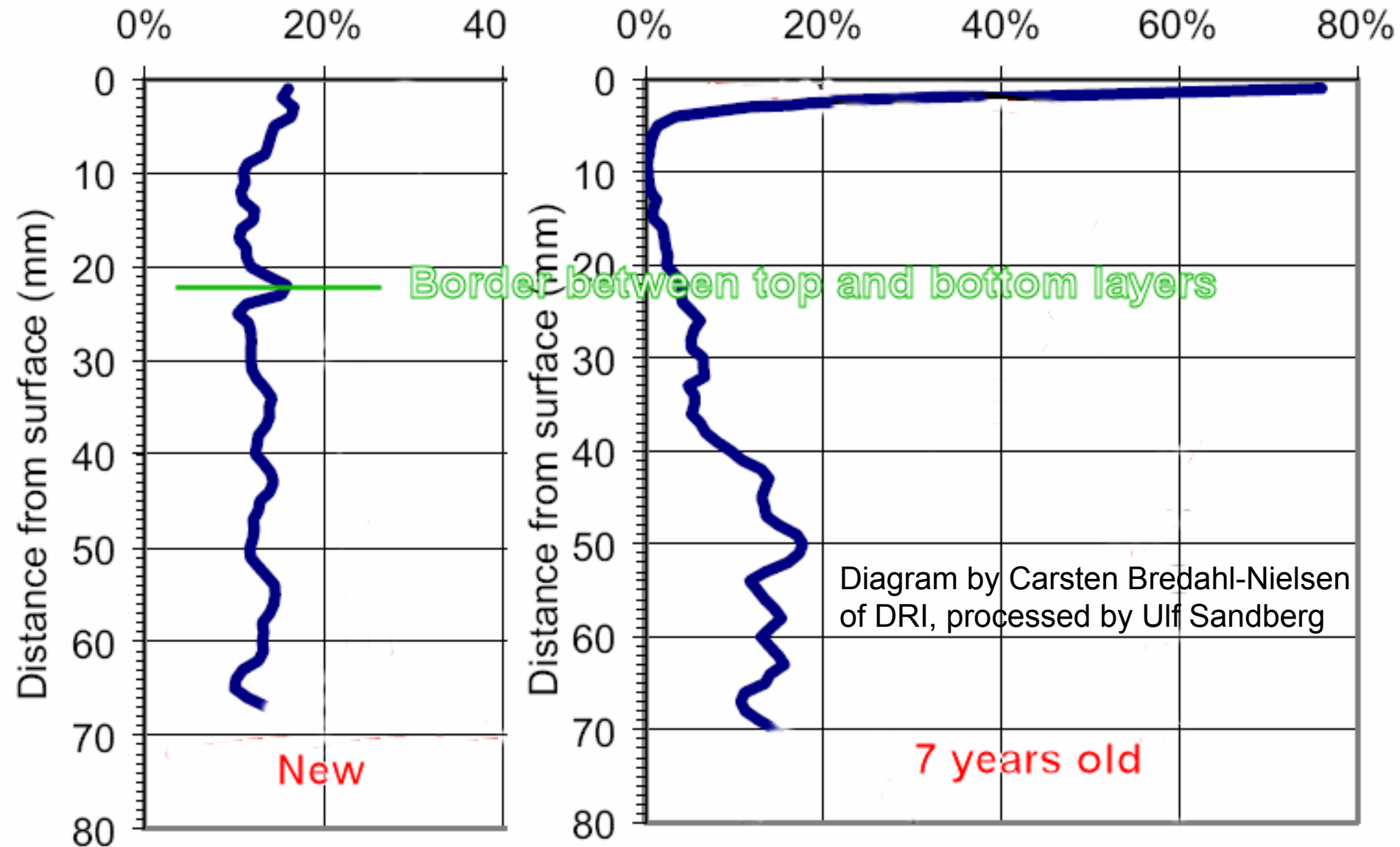
Denmark



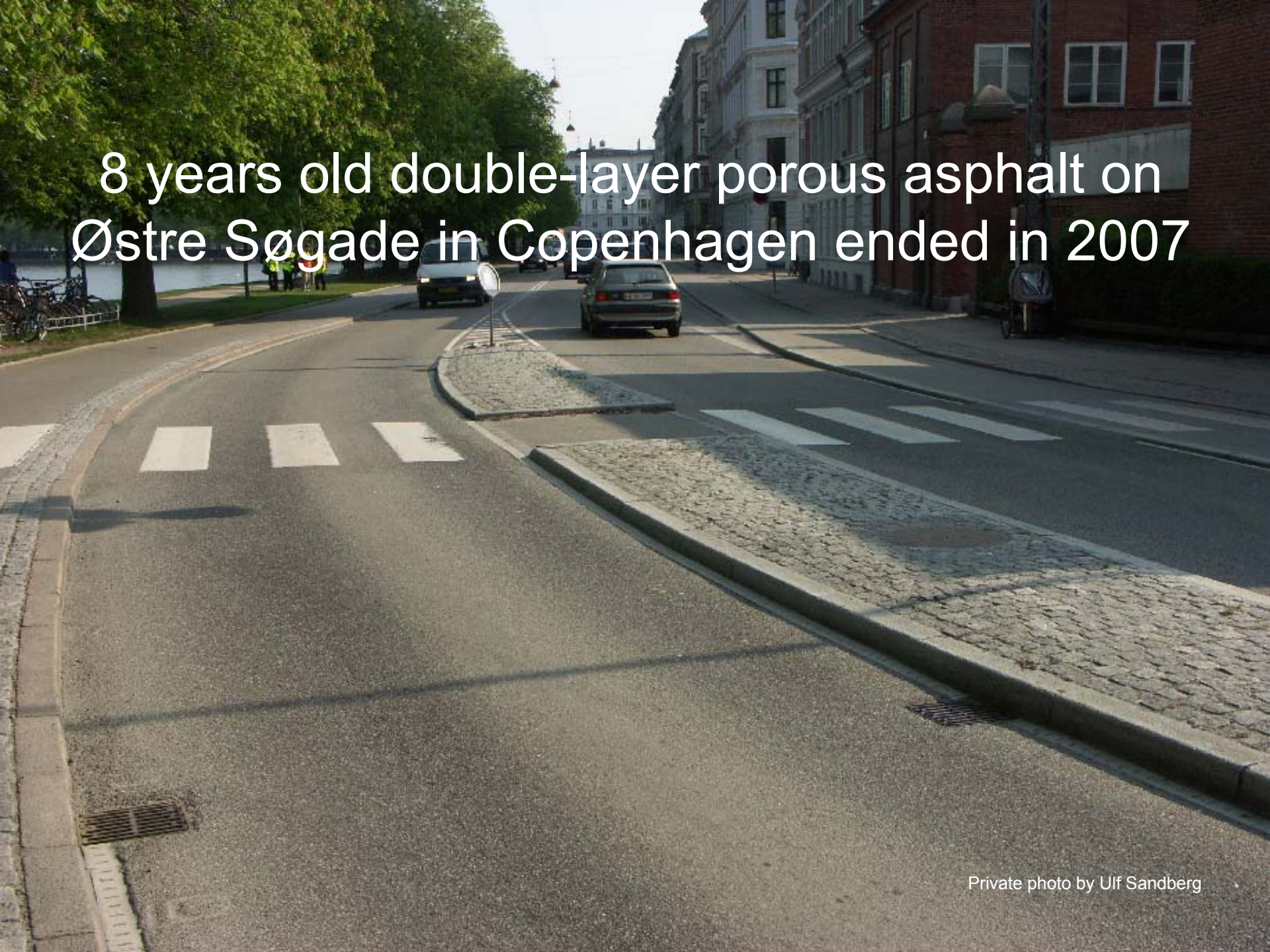
Mr Carsten Bredahl-Nielsen

Advanced CT scanning
of clogged samples of
porous asphalt at the
Danish Road Institute

Measurements of air voids content of 70 mm thick pavement sample of double-layer porous asphalt as a function of distance from the top.
Sample of new pavement (left) vs 7 years old one (right)



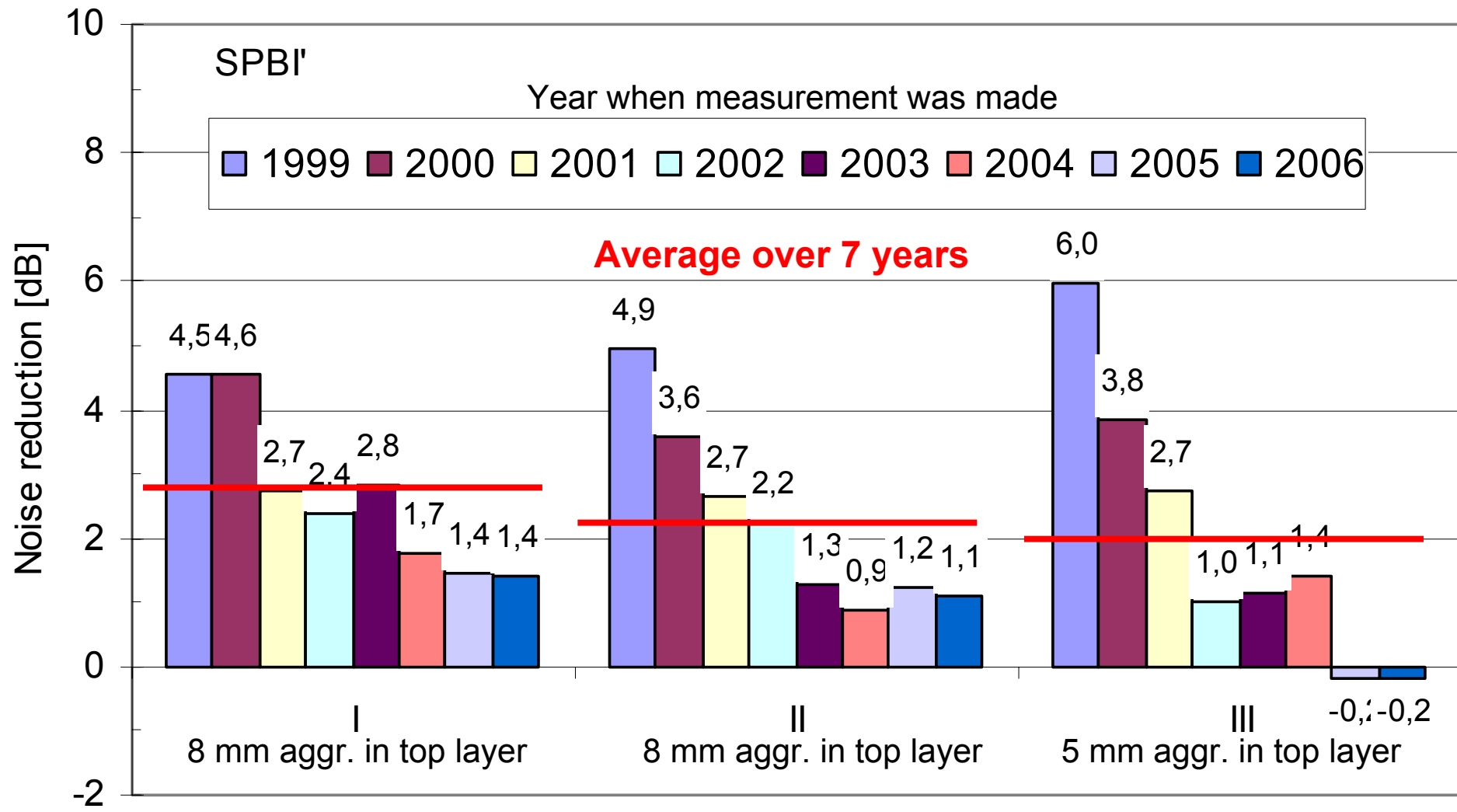
8 years old double-layer porous asphalt on
Østre Søgade in Copenhagen ended in 2007



Results of the experiment in central Copenhagen with double-layer porous asphalt


Note: 50 km/h, mixed traffic !

[J Kragh, Danish Road Institute, yesterday]



Kerbside drainage should have been better





Private photo by Ulf Sandberg

Initial noise reduction 4 dB(A)

(corresponds to 6 dB(A) with Dutch
reference surface)

Ravelling so far only from gas station exit

2 years old double-layer porous asphalt
(70 mm thick, 8 mm max. aggr.) on Lyngbyvej in
Copenhagen (60 km/h)



Another double-layer porous asphalt laid also over
light-controlled intersection in Copenhagen
No apparent ravelling yet

Thin layers

Test road with 4 thin layer pavements
Near Copenhagen international airport
(60 km/h)

Noise reductions:

Initially: 1-3 dB(A) (1 dB higher comp. to Dutch ref surface)

After 1-2 years: 1 dB(A) less



Japan

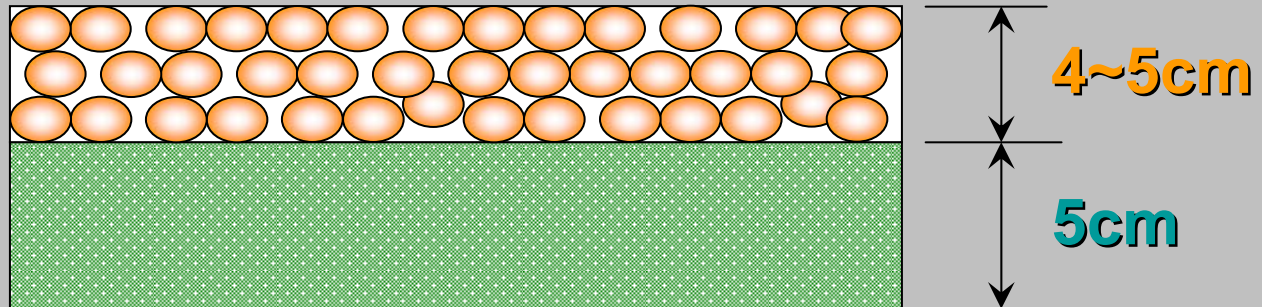
Noise Reducing Pavement used widely in Japan

Surface layer ; Porous Asphalt Mixture

**Binder layer ; Dense-graded Asphalt Mixture /
Coarse-graded Asphalt Mixture**

Properties of Porous Asphalt Mixture

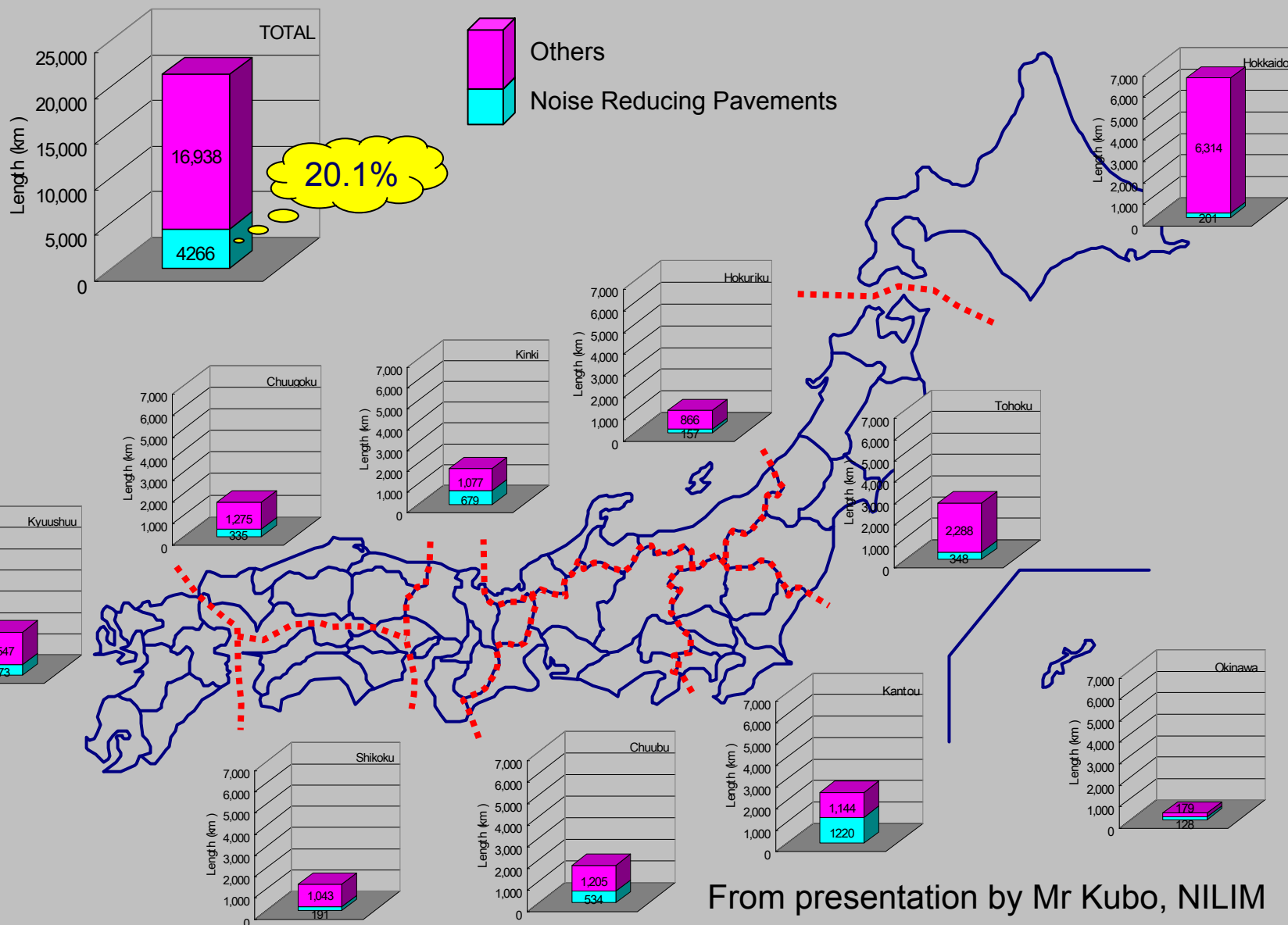
- Maximum Particle Size: 5 ~ 13mm
- Air Voids: 17 ~ 23%
- High Viscosity Modified Asphalt



Constructed Length of Noise Reducing Pavements

National Roads [Managed by MLIT]

2005.4.1



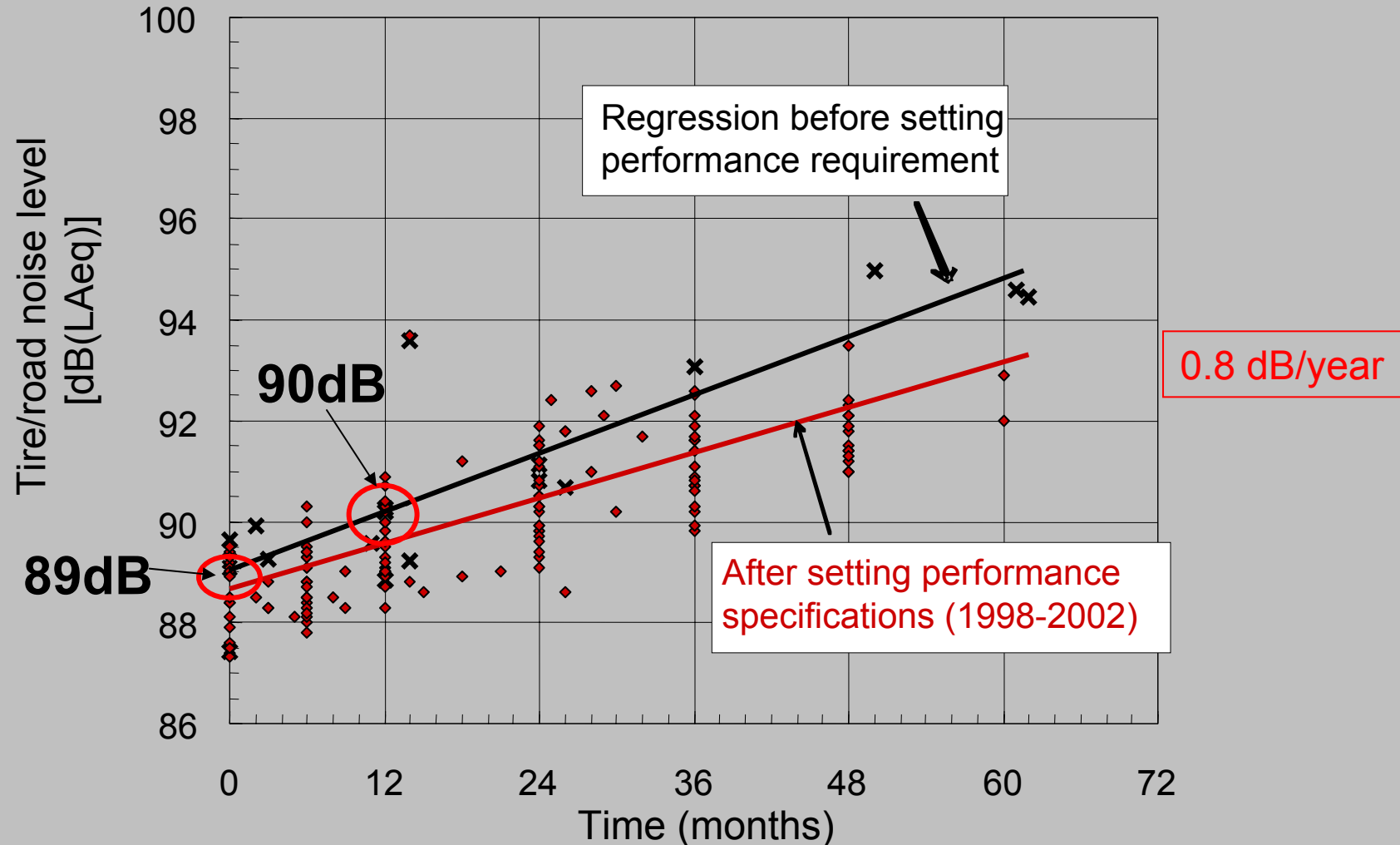
From presentation by Mr Kubo, NILIM

Porous asphalt laid over central area in Tsukuba, Japan
Quite high volume of mixed traffic, accelerating and turning



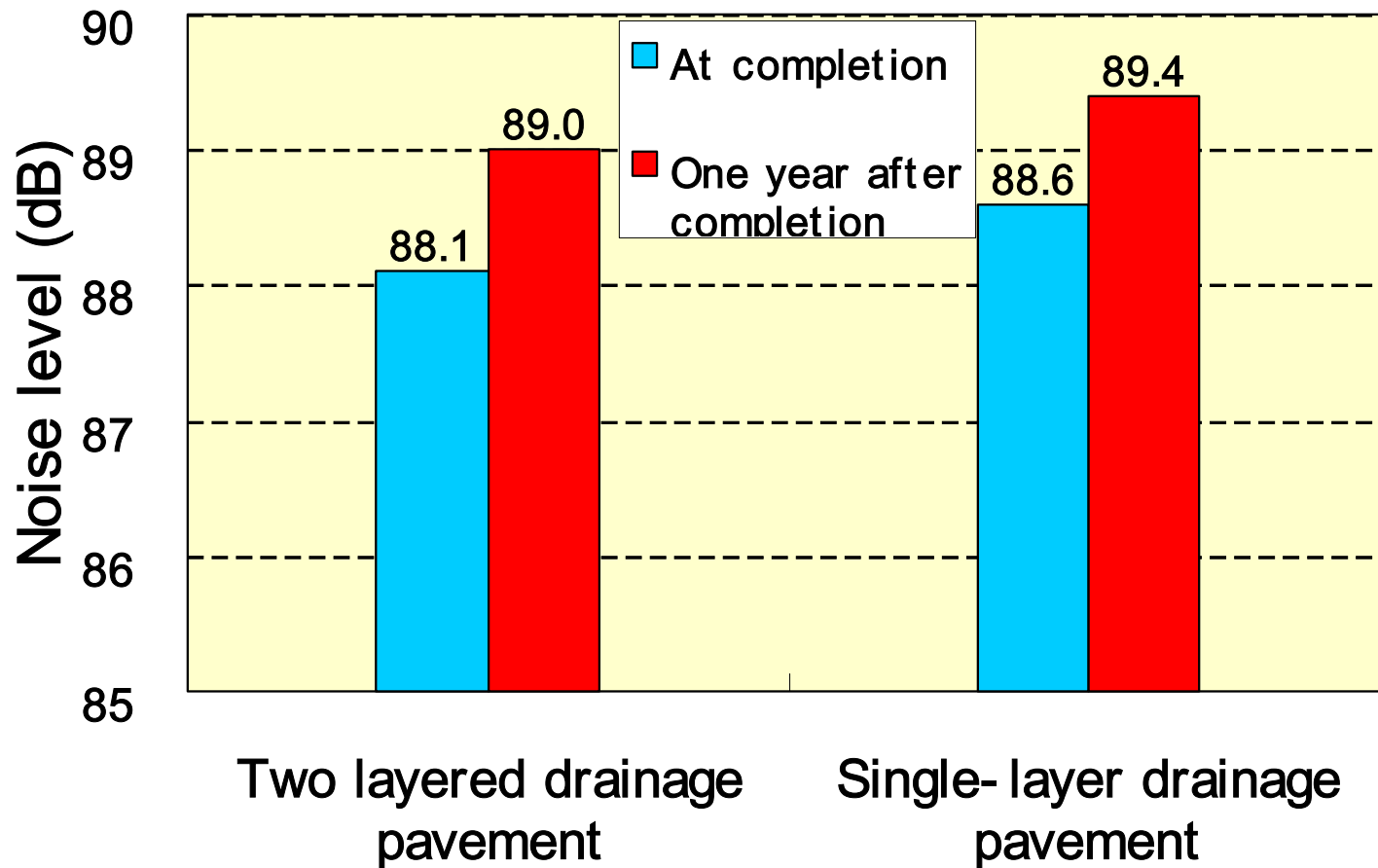
Regression of tire/road noise performance

From presentation by Mr Kubo, NILIM



Noise level for each kind of drainage pavement

From presentation by Mr Kubo, NILIM



Wider application,
for example in urban streets



Hibiya dori Avenue in central Tokyo


Abatement of the heat island effect by porous asphalt retaining water

Epoxy cover to increase strength
and improve water retention



Filling the pores with water
absorbing and retaining material

Conventional porous asphalt
(basic material)



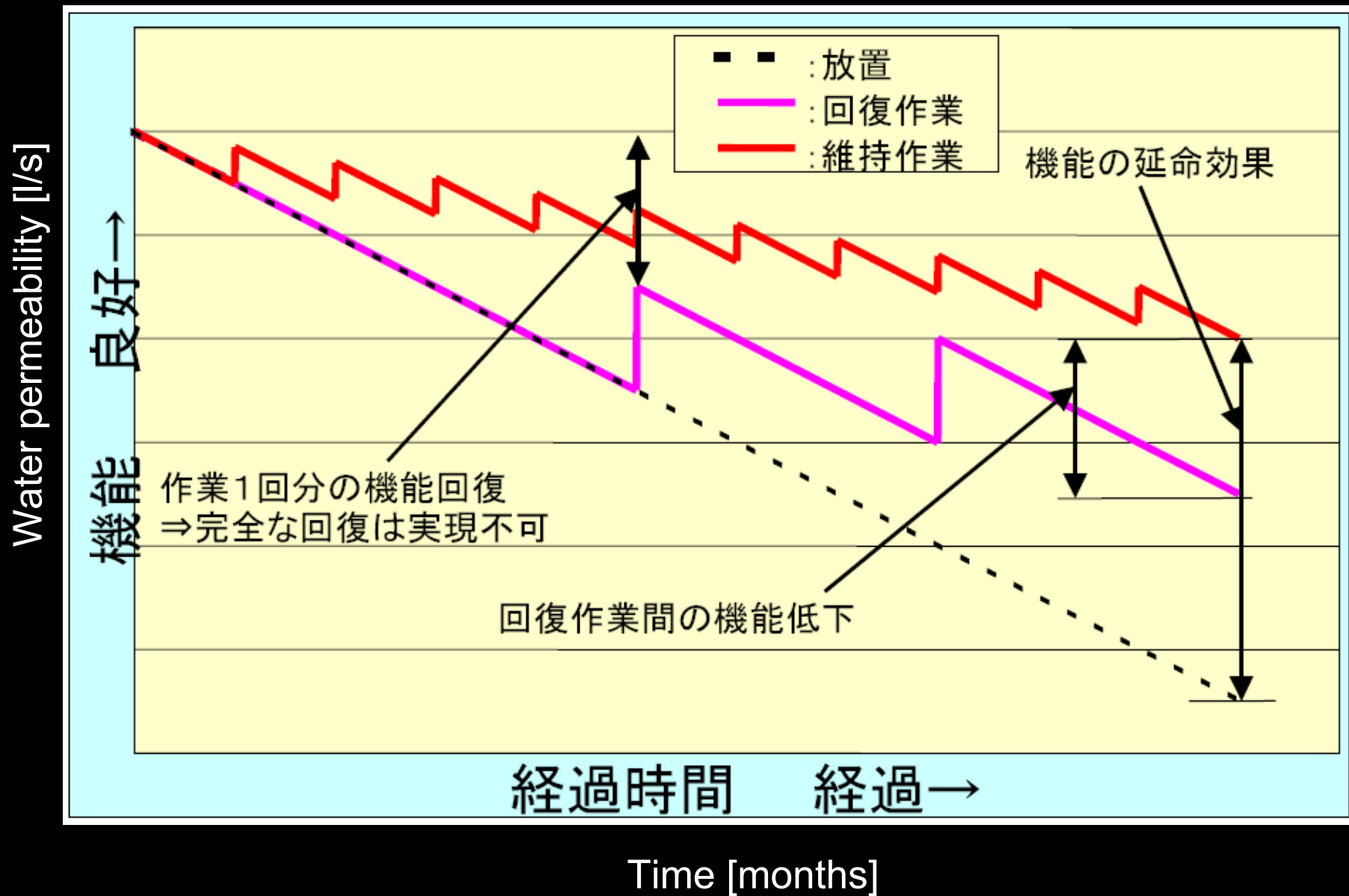
Trial on street in Tokyo
with water-retaining
material in the bottom
of porous asphalt



Trial on street in Tokyo with epoxy-
covered porous asphalt

Cleaning of clogged porous asphalt

Advantage of doing maintenance work once per month instead of recovery
3-4 times per year




Cleaning of clogged porous asphalt

New machine relying entirely on blowing high-pressurized air



Machine developed by Romantec

A close-up photograph of a Romantec machine, a type of road cleaning equipment, in operation. The machine is mounted on a vehicle, with a large black tire visible on the right. The machine's main body is dark grey and features a large, flexible, corrugated metal hose on the left side. A horizontal metal plate is positioned at the bottom of the machine, and a fine mist of water or cleaning solution is being sprayed from it onto the road surface. The road surface is light-colored and appears to be asphalt or concrete. The background is slightly blurred, showing more of the machine and the road.

Romantec machine in operation, 10-20 km/h
Most effective: cleaning once per month

Improved poroelastic road surface laid on road with high traffic volume – View after half a year

Failed and removed part

Remaining part – still OK

Glued on basecourse with
double-sided adhesive tape

Failed and removed part



The image shows the flag of Sweden, which consists of a blue field with a yellow Scandinavian cross. The cross is centered and extends to the edges of the flag. The word "Sweden" is written in a bold, blue, sans-serif font, positioned in the center of the yellow cross.

Sweden

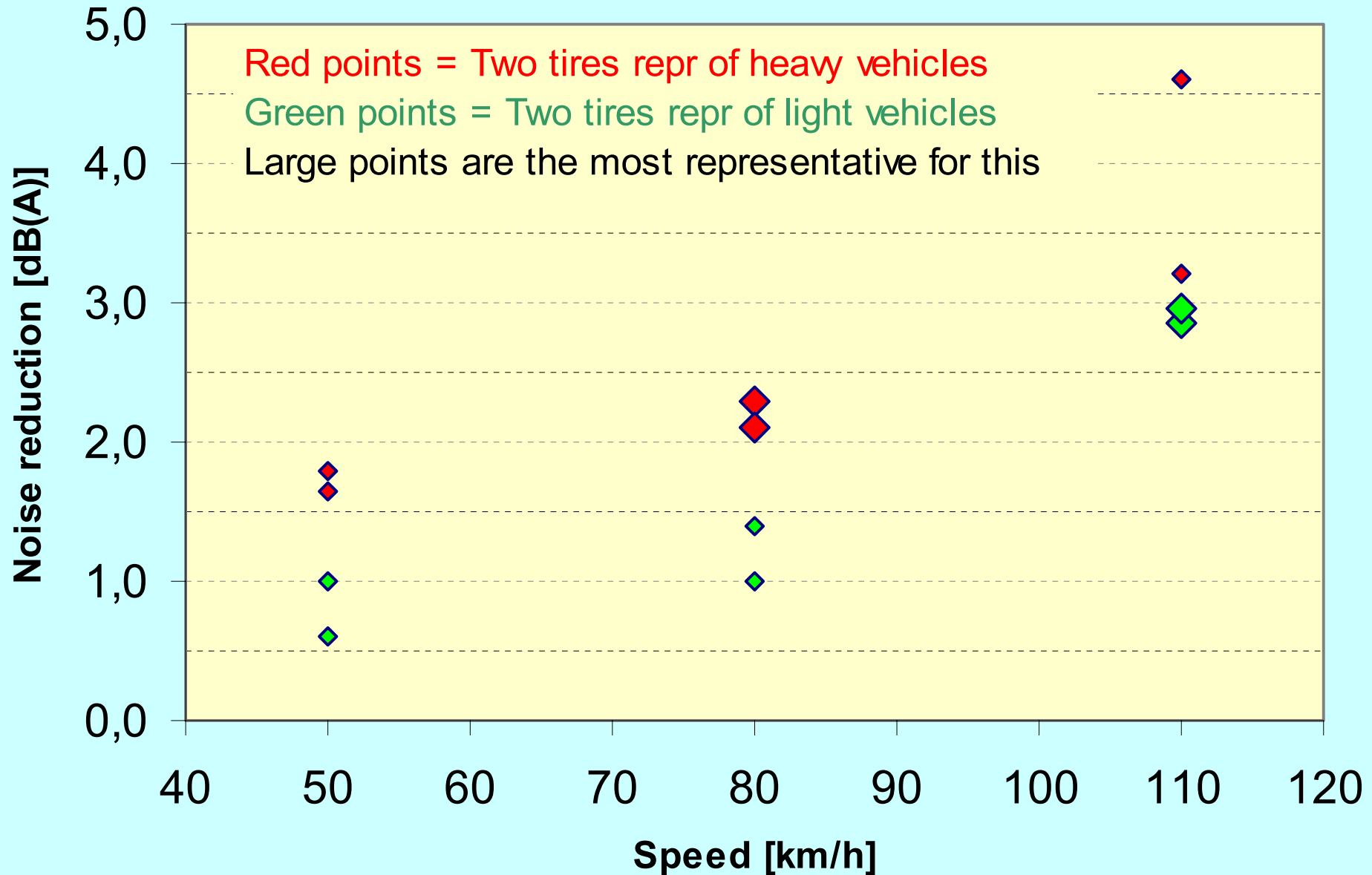
SMA 0/16



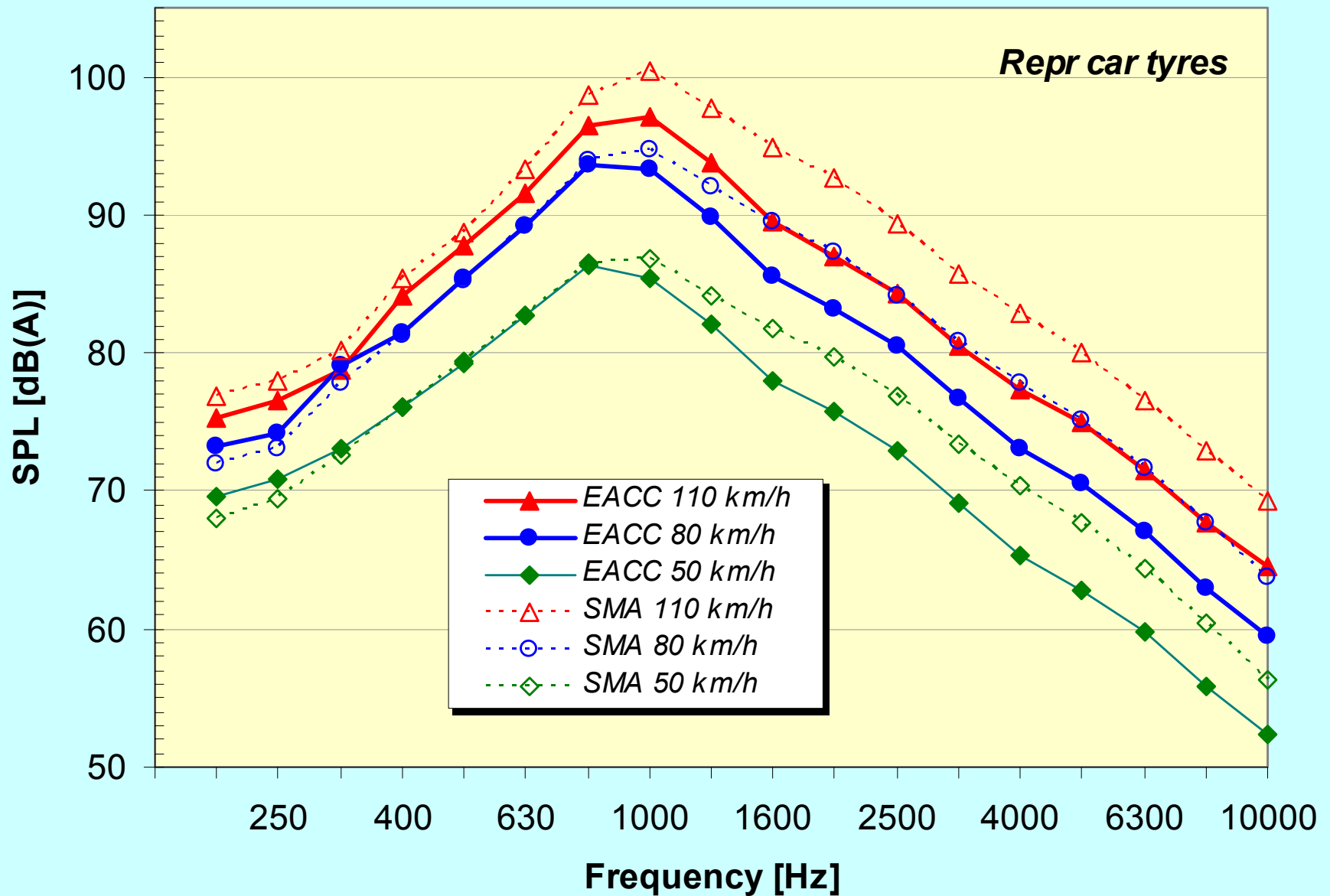
EACC 0/16



Sound level diff. between SMA 16 and EACC 16



Comparison of spectra of SMA 0/16 and EACC 0/16





1.2 m

x

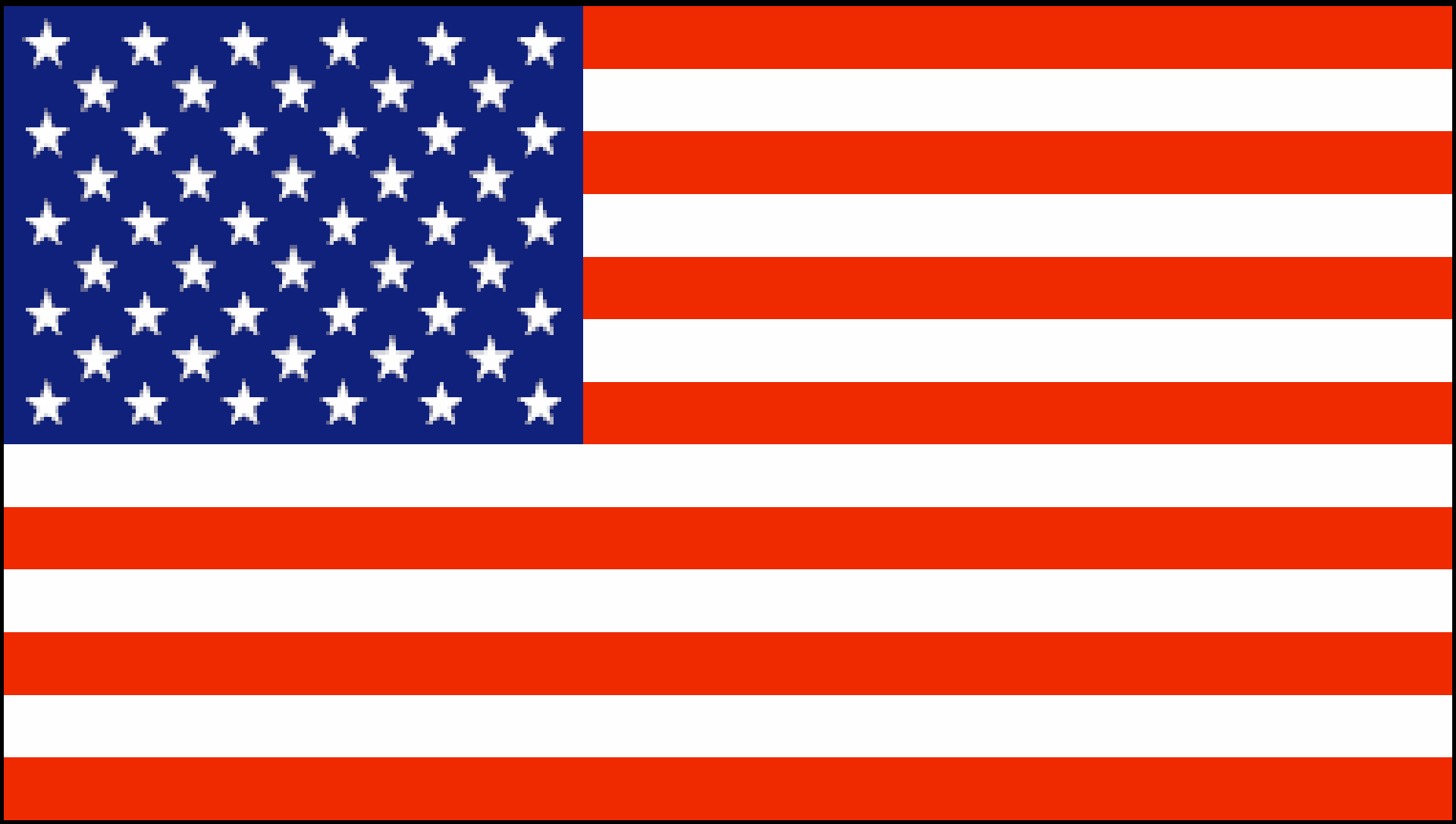
0.25 m

Samples of asphalt rubber being prepared by VTI for testing in Germany

47 mm thick

United States of America

California and Arizona



The image shows the interior of the Iron Hog Saloon, a bar with walls densely decorated with Route 66 memorabilia. Two men are seated at the bar. The man on the left wears a striped polo shirt and khaki shorts, while the man on the right wears a red t-shirt and jeans. The bar counter is cluttered with various items, including a Budweiser sign, a NASA logo, and a 'MAIN STREET US' sign. The background is a wall of Route 66 shields and other memorabilia.

Studies at Route 66 (Iron Hog Saloon), CA

.... but that is another story

The end