24th Roads Pavements Forum

Feedback on the 10th International Conference on Concrete Pavements

Louw du Plessis

7 November 2012

CSIR
our future through science


ISCP
10TH INTERNATIONAL CONFERENCE
ON CONCRETE PAVEMENTS
SUSTAINABLE SOLUTIONS TO
GLOBAL TRANSPORTATION NEEDS
JULY 8-12, 2012
QUÉBEC CITY, QUÉBEC, CANADA
SPONSORED BY:
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Contents

- 12 Workshops running concurrently with conference presentations

  - Pavement thickness Design
  - Innovative concrete Materials
  - Pavement Preservation
  - Municipal concrete Paving
  - Modeling concrete durability
  - Sustainability of concrete pavements LCCA
  - Pre-cast concrete pavements
  - Case studies on design & construction of airfield pavements
  - CRCP
  - Concrete overlays
  - SHRP2 R02 Geotechnical solutions for Transportation
  - Smooth, Safe and Quiet concrete pavements

Contents

- 83 papers in 3,5 days presented in parallel sessions covering a wide range of topics including
  - Pervious Pavements
  - Pre-cast / pre-stressed concrete pavements
  - Composite Pavement design & performance
  - Mix designs
  - Riding quality and distress mechanisms
  - Innovations in concrete pavements
  - Airfield pavements
  - Surface characteristics and overlays
  - Pavement mechanics


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Aut. Henri IV
Aut. Duplessis
Ch. St-Louis
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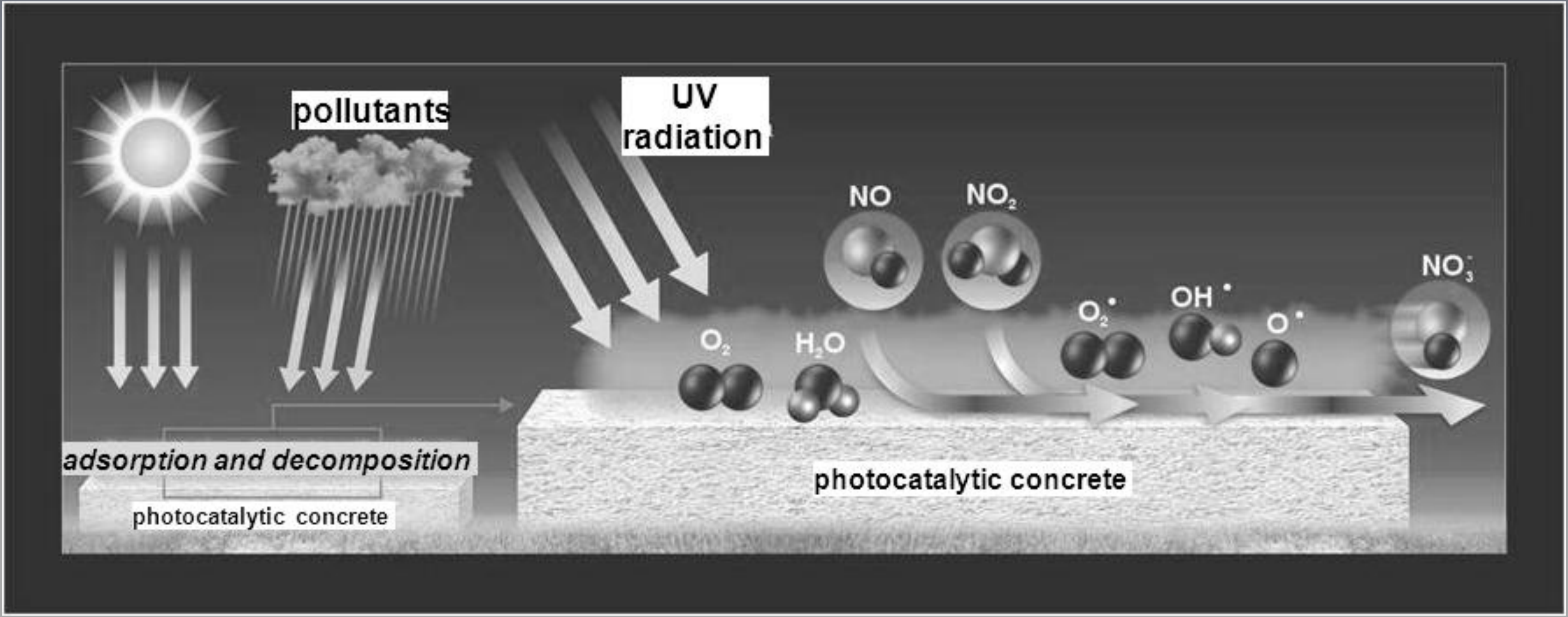
PLESSIS

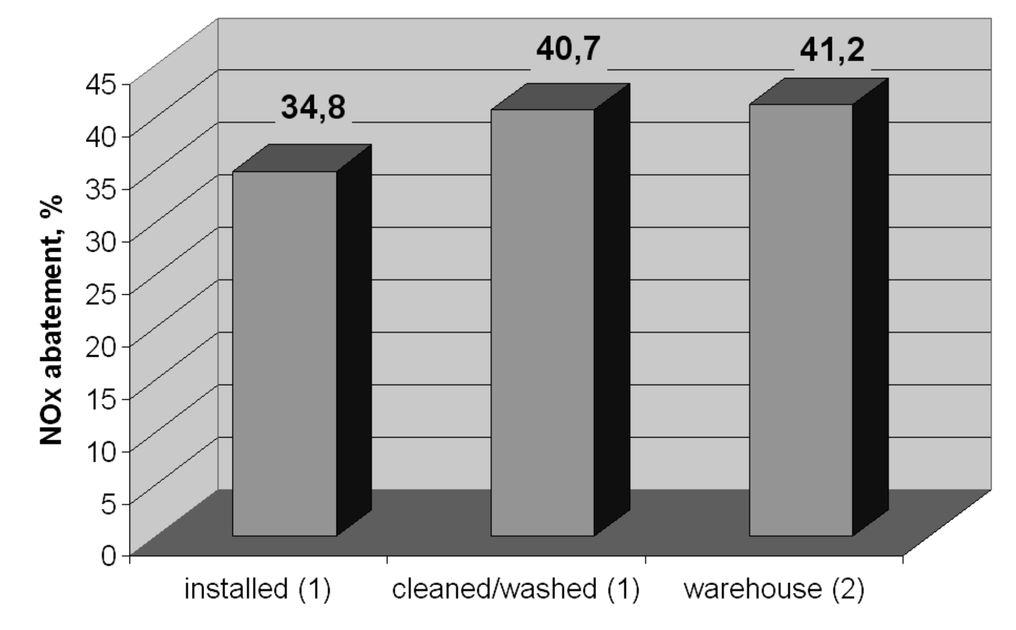
Environmentally friendly concrete

Photocatalytic cementitious materials

- Treat concrete surfaces with Titanium Dioxide (TiO_2) and under UV radiation converts harmful pollutants such as Nitrogen oxides (No_x) and ammonia into non- noxious compounds and the production of ozone.



- Possible to remove 10-30kg of Nitrogen oxides per year for a 1 000m^2 area of cement based pavement.
- Measuring the effectiveness of photocatalytic surface in real conditions has been carried out in several pilot projects. Data from these projects in Italy, beginning in 2002, yielded NO_x reduction of approximately 60% compared to untreated asphalt surface
- Concrete blocks treated with Titanium Dioxide demonstrated to give contribution to the air quality improvement in Japan,Italy, France, Belgium and North America



No_x absorption with treated paving blocks in a city street (in Italy)

Pervious Pavements (5 papers)

- High inter-connecting void content, direct drainage of water, noise reduction

Mix design

Open graded material, consisting of coarse aggregate, little or no fine aggregates, admixtures and water. Lack of fine aggregate results in a high void content typically between 15 and 35%. (watch out for ravelling). For parking lot trial area:

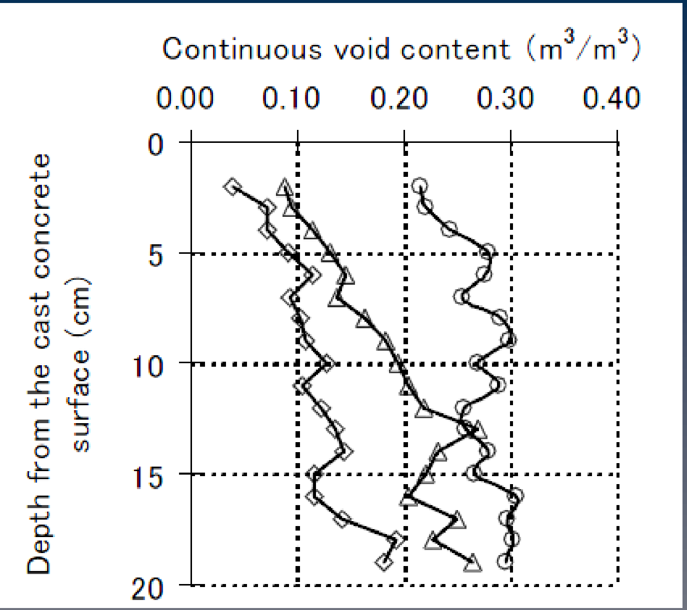
- Coarse aggregate < 13.2mm
- Cement with 25% slag
    - With superplasticiser, air entraining agent, retarder and viscosity modifier

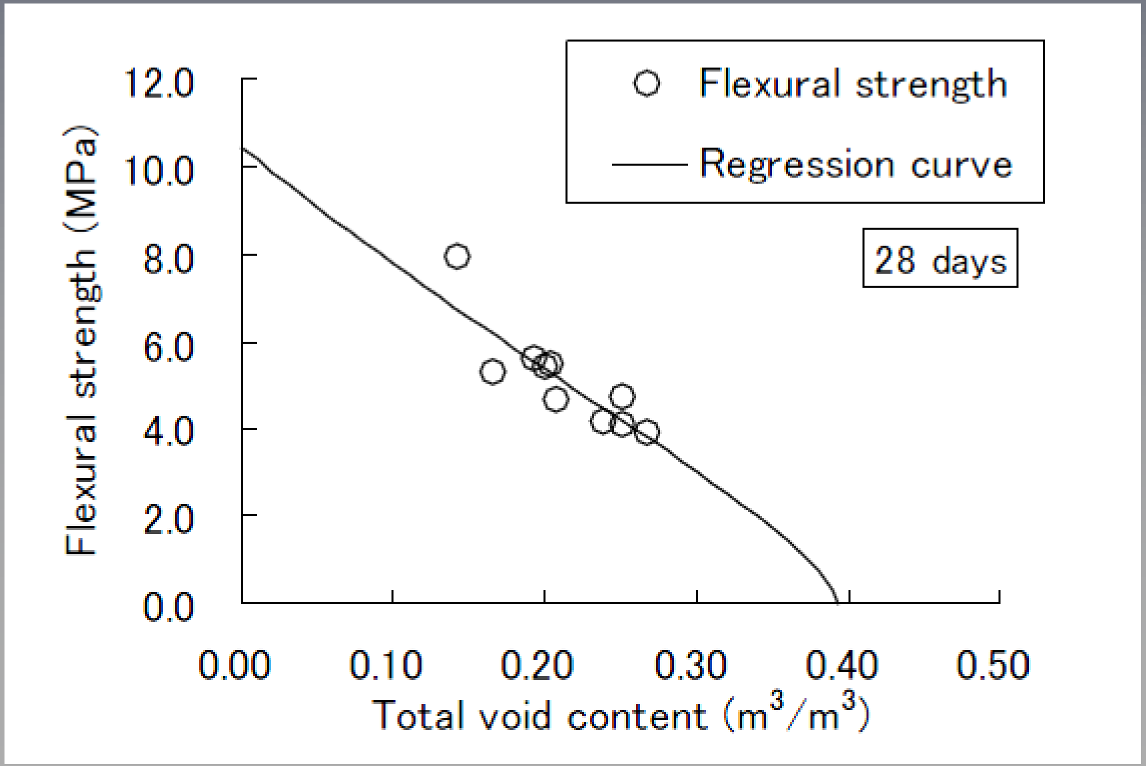
Pavement design of test area

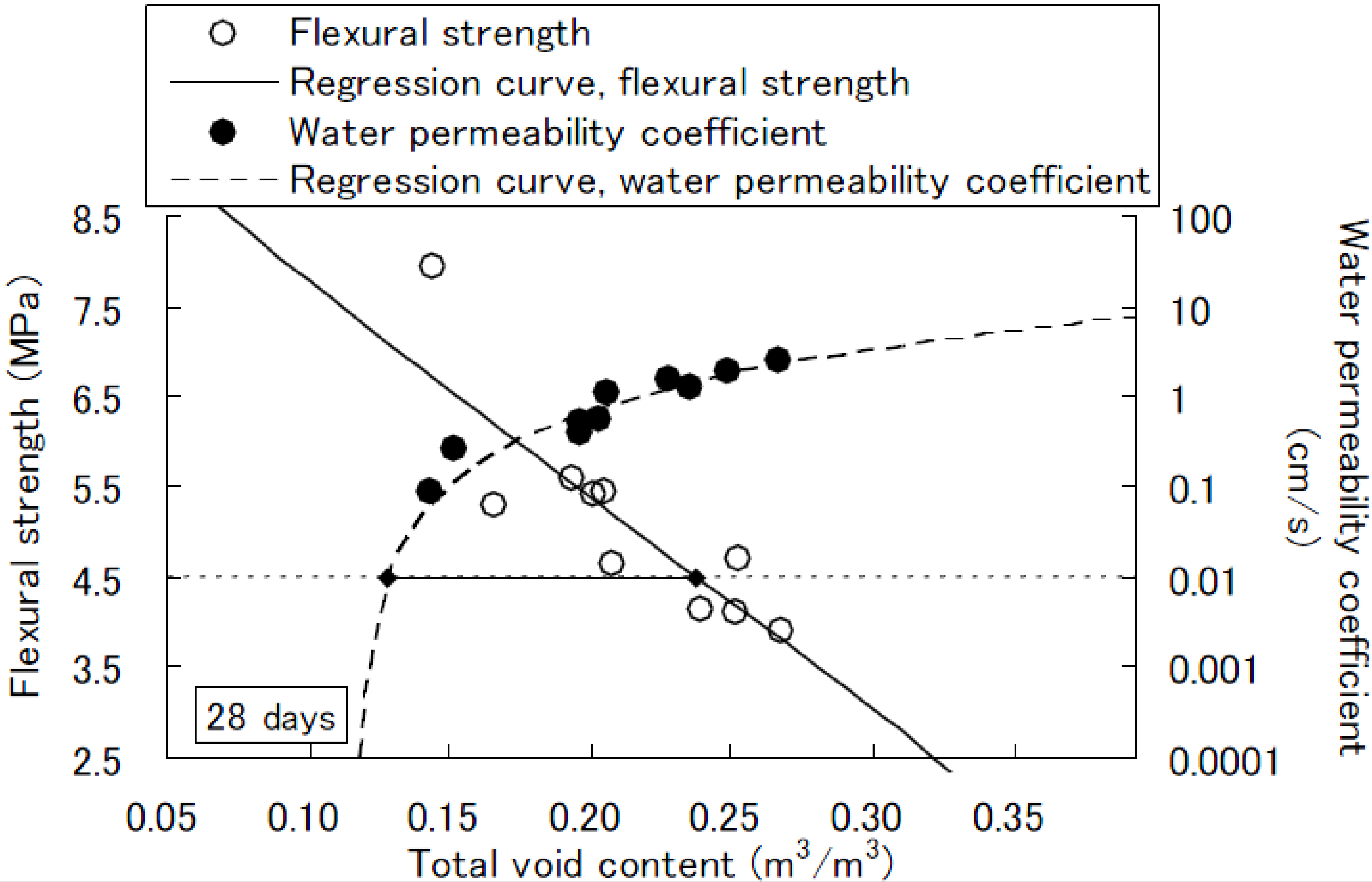
- 190 mm of pervious concrete and
- 200 mm of open granular base,
- 600 mm of select subgrade

Concrete performance for trail section:

- Compressive strength minimum of 15 MPa at 28 days (for a trail section they got 14 MPa)
- Void Content between 15 to 25% (got 32%)
- Splitting tensile test 1.1 – 1.4MPa
- Flexural strength 1.0 – 3MPa
- Filtration rate 17 300 – 22 900 mm/h (moderate porosity concrete = 8 500 mm/h)

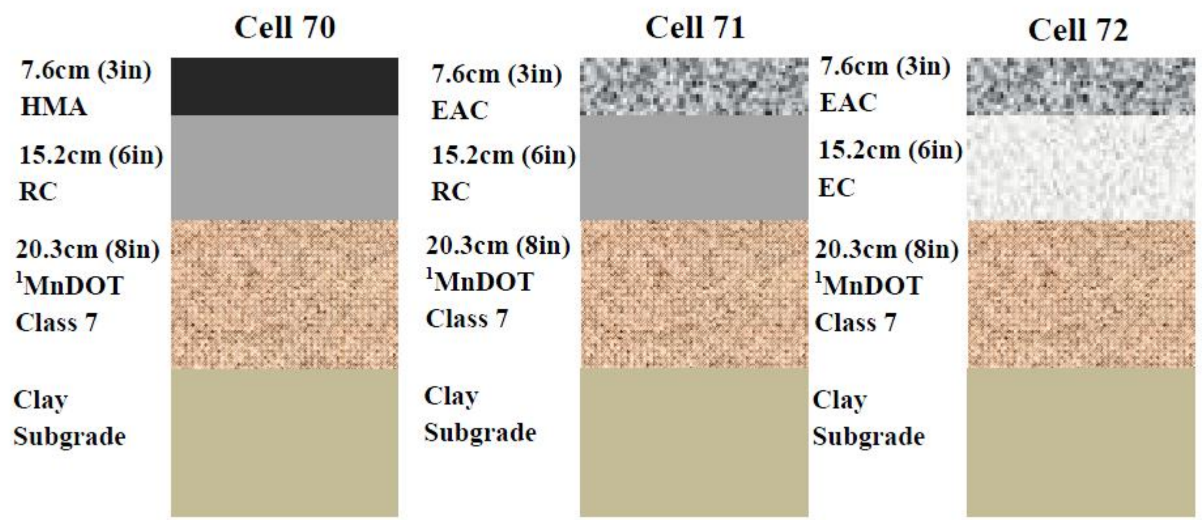

Continuous void content (m3/m3)
0.00 0.10 0.20 0.30 0.40
0 5 10 15 20
Depth from the cast concrete surface (cm)


Flexural strength
Regression curve
28 days
12.0 10.0 8.0 6.0 4.0 2.0 0.0
Flexural strength (MPa)
0.00 0.10 0.20 0.30 0.40 0.50
Total void content (m3/m3)


Flexural strength
Regression curve, flexural strength
Water permeability coefficient
Regression curve, water permeability coefficient
8.5
7.5
6.5
5.5
4.5
3.5
2.5
Flexural strength (MPa)
100
10
1
0.1
0.01
0.001
0.0001
Water permeability coefficient (cm/s)
28 days
0.05
0.10
0.15
0.20
0.25
0.30
0.35
Total void content (m3/m3)

Composite Pavements (5 papers)

- ***HMA on PCC is*** defined as relatively thin HMA layer(s) over a newly placed, but sufficiently hardened, PCC layer (any type).



[1]MnDOT Class 7 base is a densely graded unstabilized base (*4*).

Figure 1. Composite pavements constructed at MnROAD.

Goals of using composite structures

- HMA/PCC composite pavements, the PCC substructure is the primary load carrying layer and is designed to provide a durable, long-lasting pavement with low fatigue damage and a strong base, while the HMA layer is primarily a functional layer with excellent surface characteristics that can be renewed rapidly.

- For PCC/PCC composite pavements, both PCC layers provide structural capacity, but the lower PCC layer is the primary load carrying layer (because of the greater thickness) and is expected to provide a durable and strong base which is economical to construct and promotes the ideals of sustainability and energy efficiency.
  - The upper PCC layer is expected to provide excellent surface characteristics over a long time period that can be renewed rapidly (through diamond grinding or other texturing methods).

Performance comparisons HMA/PCC

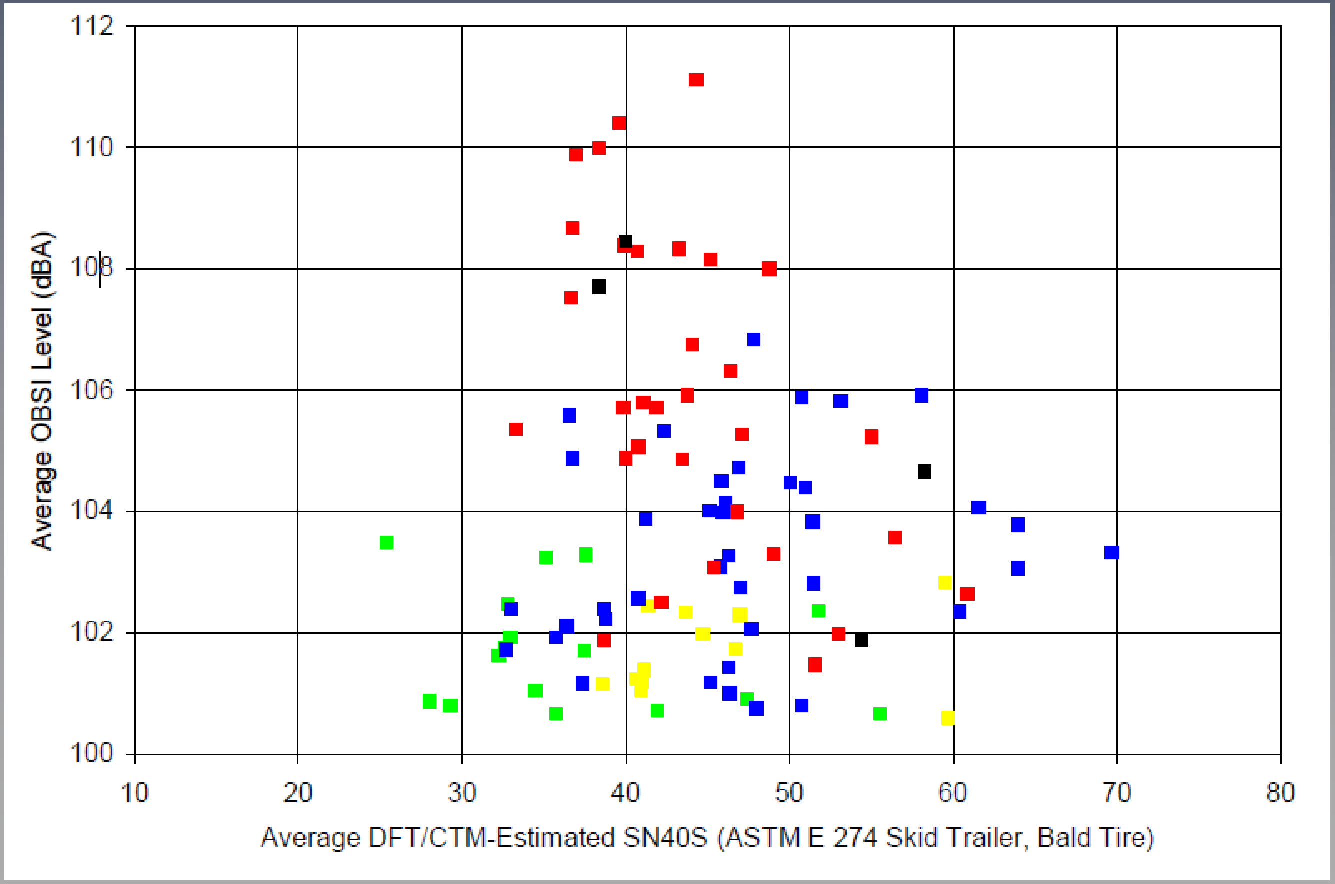
Distress Type	Conventional HMA Pavement	Conventional PCC Pavement	Composite HMA/JPC & HMA/CRC
Bottom-Up Fatigue Cracking	Yes, major design concern.	Yes, major design concern.	Fatigue cracking does not occur in HMA layer since the HMA is almost always in compression. Bottom-up and top-down fatigue cracking in JPC and CRC (for punchouts) are reduced because of insulating effects of HMA.
Low Temperature or Shrinkage Transverse Cracking in HMA	Yes, this is major problem in many areas.	N/A	No, was not observed on any HMA/JPC or HMA/CRC composite projects surveyed. The bonded HMA layer does not move independently of the PCC layer.

Performance comparisons: HMA/PCC

Distress Type	Conventional HMA Pavement	Conventional PCC Pavement	Composite HMA/JPC & HMA/CRC
Top Down Fatigue Cracking in Wheelpath	Yes, has occurred on some projects.	Yes, longitudinal cracking has occurred on some projects.	Top-down fatigue cracking does not occur in HMA layer since the HMA is almost always in compression. PCC longitudinal cracking in wheelpath of HMA/JPC may be reduced or eliminated due to insulating effects of HMA.
Permanent Deformation	Yes, rutting is major design concern.	N/A, however, wear from studded tires may occur.	Rutting minor on most HMA/PCC composite pavements due to high quality materials and thin layer. Also, the stiff PCC layer completely eliminates base/subbase/subgrade rutting.
Transverse Joint Reflection Cracks	No, does not occur.	N/A	Yes, occurs, for HMA/JPC. Control through saw and seal technique. No, does not occur with HMA/CRC.
Joint Faulting	N/A	Yes, major design concern.	Yes, can occur, but little faulting comes through the HMA surface. Faulting must be considered in design of HMA/JPC.

Quieter Pavements

- False argument that quieter pavement sacrifice safety
  - There is no relationship between friction and noise



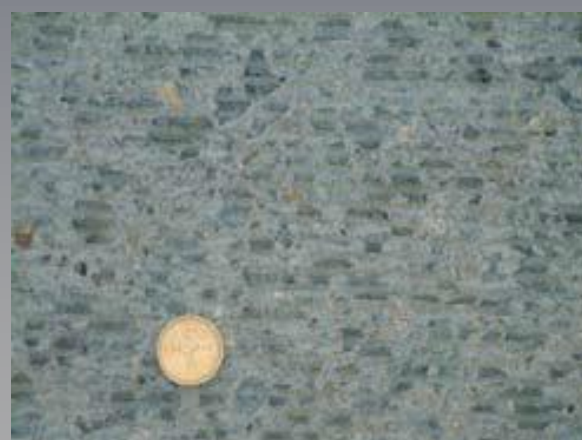
- Mechanisms of Tyre-pavement noise
  - “tread impact”, which is the radial vibration or the direct individual impact of the tire on the pavement, like a hammer;
  - “air pumping”, which is air compression that escapes thousands of times, the pressure relief causing the noise;
  - “stick-slip”, where the tire loses momentarily its friction and slip, also called tangential movements;
  - “stick-snap”, which is a suction effect that creates adhesion between the tire and the pavement
- Main factors: Texture, Porosity and Stiffness
  - For a quiet pavement you need small negative texture (max 10mm spacing and 5mm deep)
  - The higher the porosity (>20%), the better the sound absorption
  - Less noisy If the stiffness of the pavement approaches stiffness of the tyre (little effect)

Transverse tining

Longitudinal tining

Shot-blasting

Grinding



Longitudinal grooving

Exposed aggregate

- Quieter pavements can be quiet, safe and durable
- National Concrete Pavement Technology Centre at Iowa State Univ evaluated 1600 test sections in the US and Europe (2009)

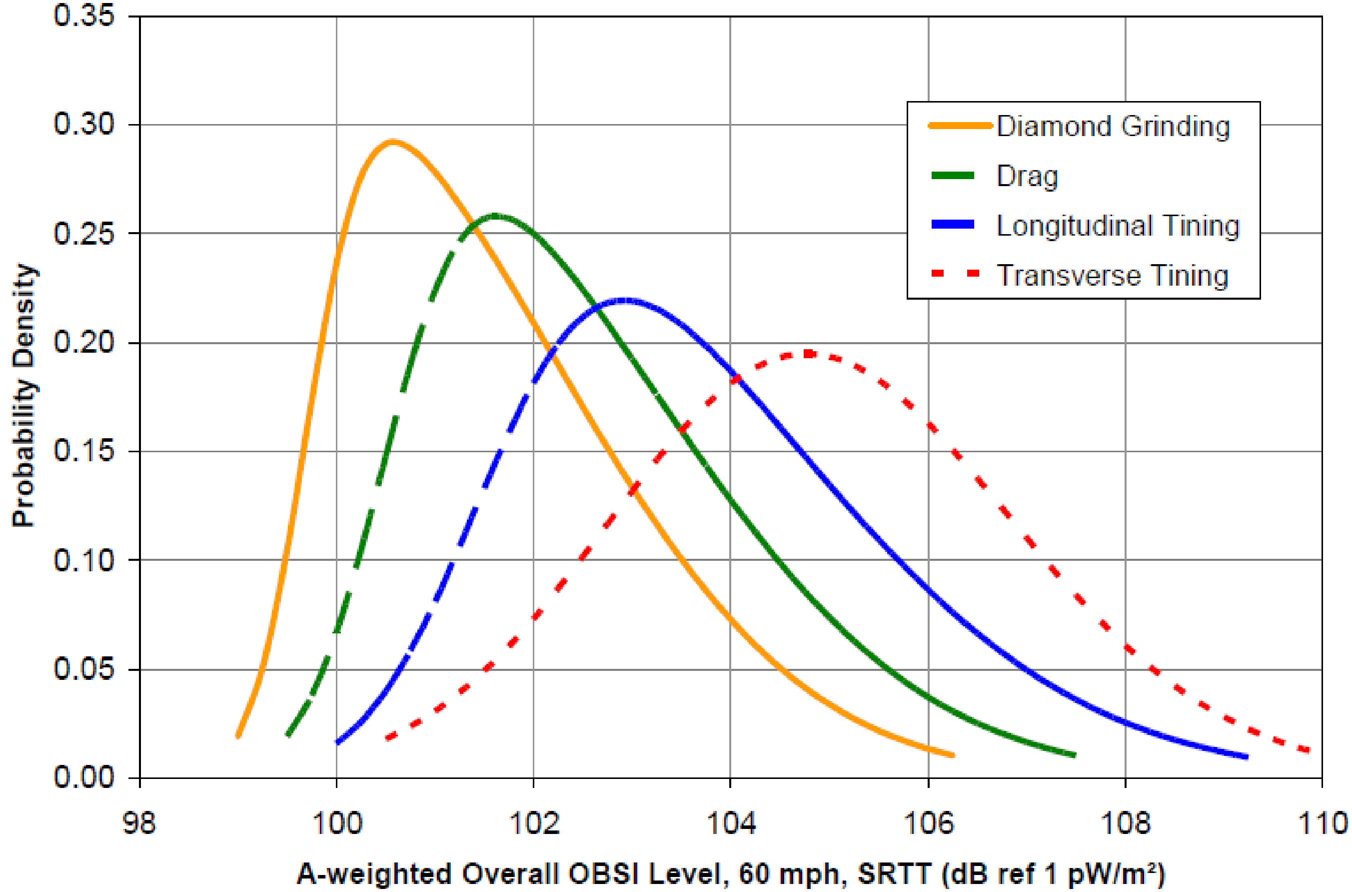


Figure 2. Normalized distributions of OBSI noise levels for conventional concrete pavement textures.

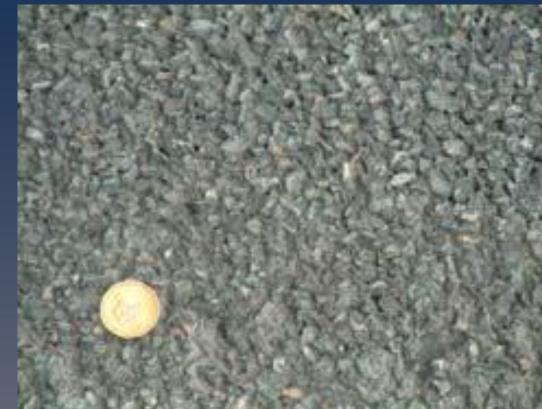
- 2nd Paper

Different asphalt pavements were tested:
Stone-mastic asphalt (SMA),
open graded (OG),
thin open-graded (Thin-OG),
dense-graded (DG),
micromilling (MM)
microsurfacing (MS) were among the flexible pavements tested.

Concrete sections:
Transverse tining,
longitudinal tining,
longitudinal grooving,
exposed aggregate,
shot-blasting

SMA

OG



Thin OG

DG

MM

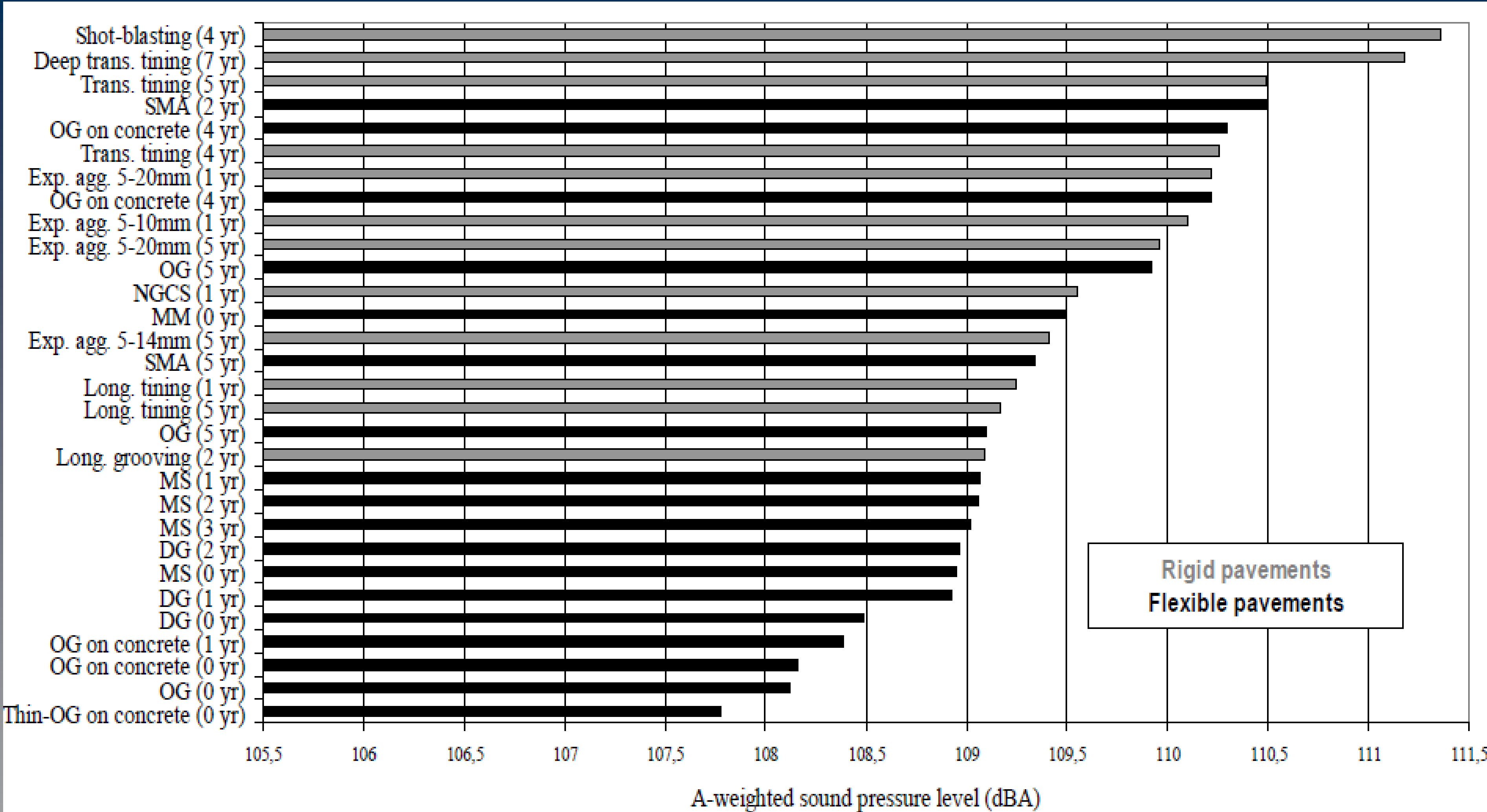
MS

Results.

- Concrete pavements are in general louder, but some textures show Promising results.
- Transverse tining and shotblasting are the louder rigid pavement textures
- Longitudinal tining and grooving are the quieter.
- Exposed aggregate is in the middle.

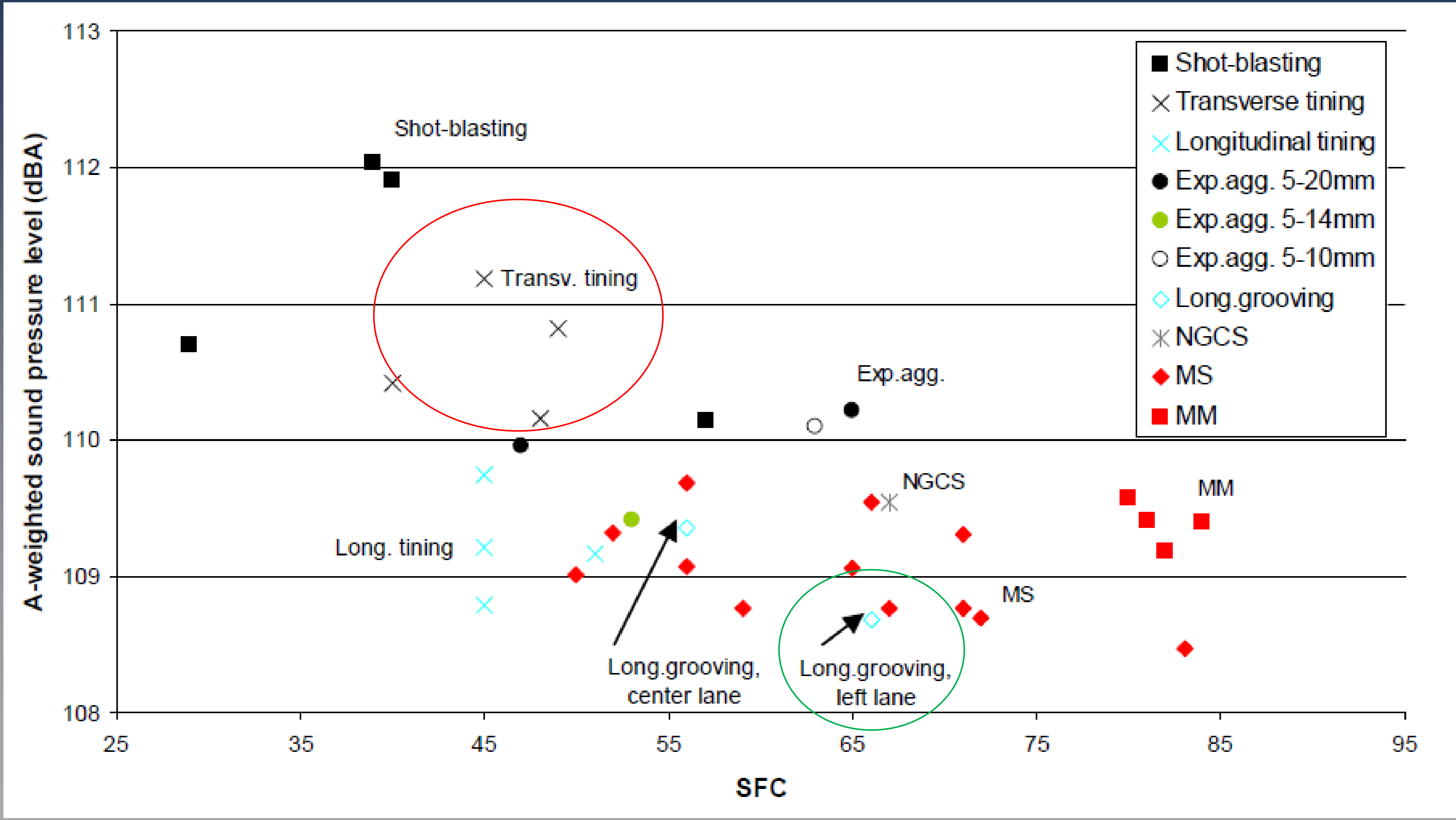
Flexible pavements:

- Thin-OG and OG being the quietest.
- MM and SMA of about the same age were found to be louder.



Shot-blasting (4 yr)
Deep trans. tining (7 yr)
Trans. tining (5 yr)
SMA (2 yr)
OG on concrete (4 yr)
Trans. tining (4 yr)
Exp. agg. 5-20mm (1 yr)
OG on concrete (4 yr)
Exp. agg. 5-10mm (1 yr)
Exp. agg. 5-20mm (5 yr)
OG (5 yr)
NGCS (1 yr)
MM (0 yr)
Exp. agg. 5-14mm (5 yr)
SMA (5 yr)
Long. tining (1 yr)
Long. tining (5 yr)
OG (5 yr)
Long. grooving (2 yr)
MS (1 yr)
MS (2 yr)
MS (3 yr)
DG (2 yr)
MS (0 yr)
DG (1 yr)
DG (0 yr)
OG on concrete (1 yr)
OG on concrete (0 yr)
OG (0 yr)
Thin-OG on concrete (0 yr)
105,5
106
106,5
107
107,5
108
108,5
109
109,5
110
110,5
111
111,5
A-weighted sound pressure level (dBA)
Rigid pavements
Flexible pavements

Noise vs skid resistance



Concrete Pavement Surface properties that effect Tyre-pavement noise

- Avoid (flatten) texture that repeats itself at intervals of 25 mm or larger.
- Avoid extremely smooth (e.g., floated or polished) surfaces; instead, some fine texture (that is on the scale of 3 to 6 mm) should be provided.
- Texture should be “negatively” oriented, meaning that any “deep” texture should point down (e.g.,grooves) rather than up (e.g., fins).
- Gooves” should, if possible, be oriented in the longitudinal direction, as opposed to the transverse direction.
- If grooves are oriented in the transverse direction, they should be closely spaced and randomized

Figure 6. Variability of drag texture surface and its effect on OBSI noise level.

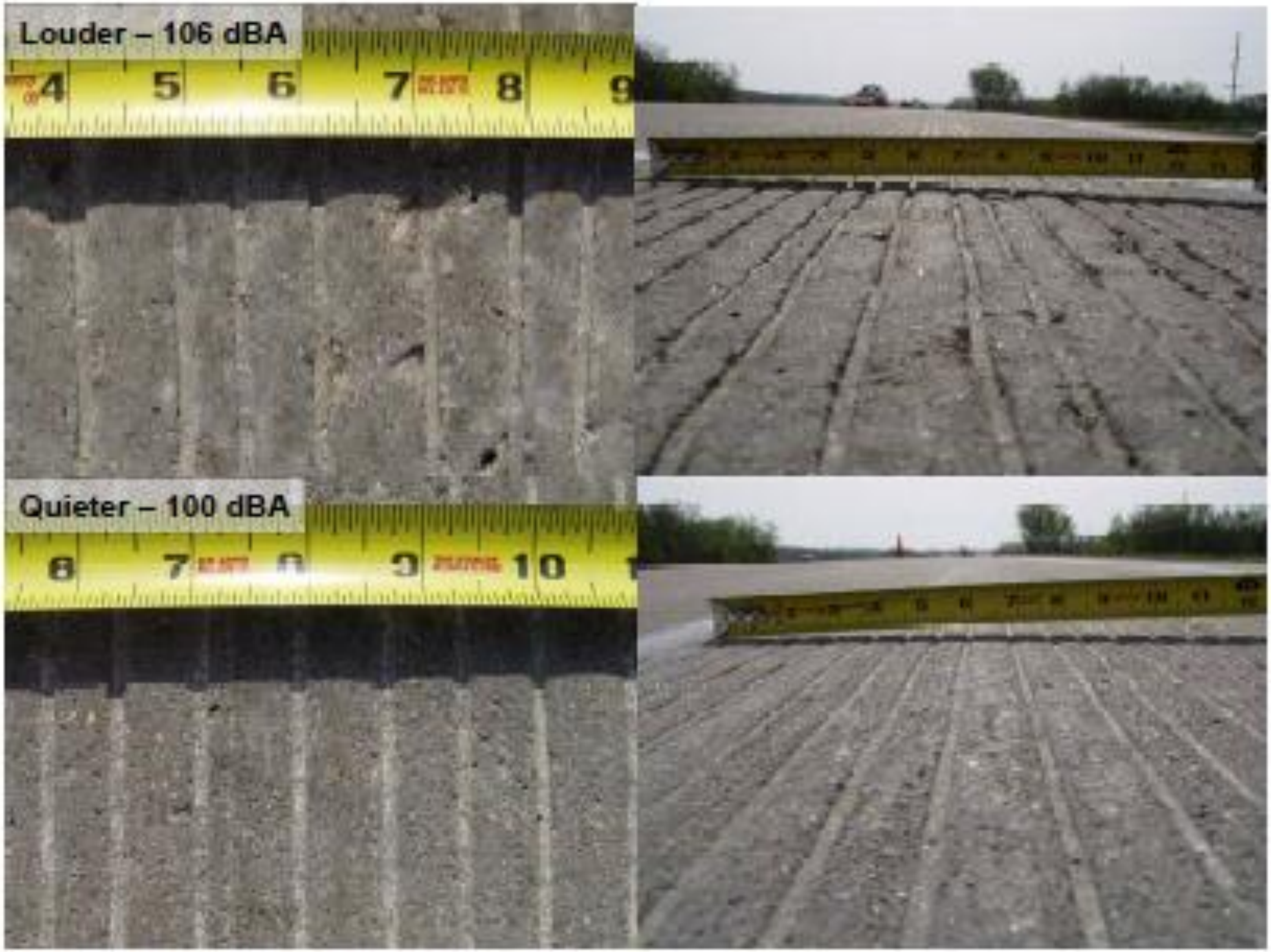


Figure 7. Variability of longitudinal tined surface and its effect on OBSI noise level.


Louder – 111 dBA
Quieter – 103 dBA

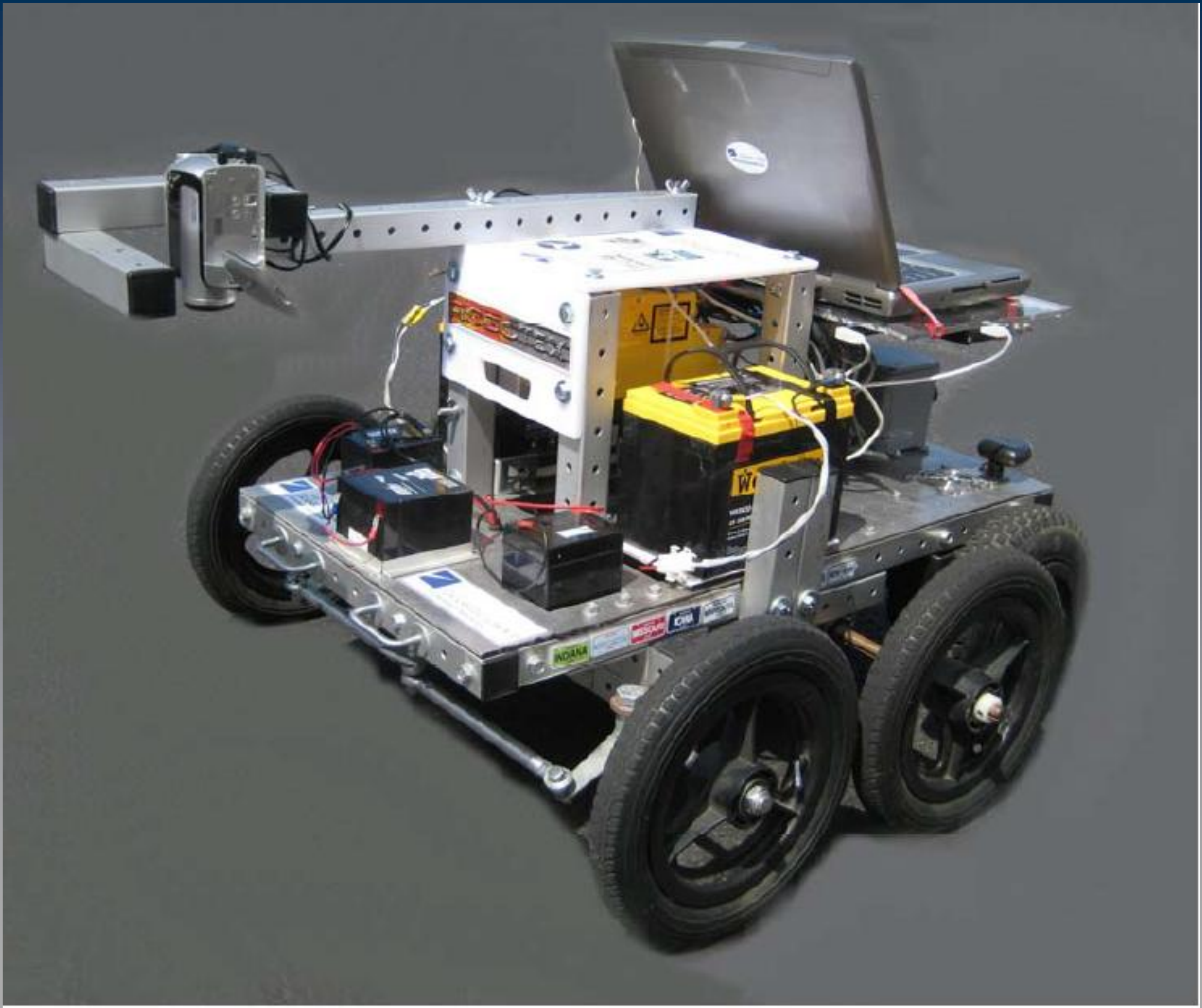
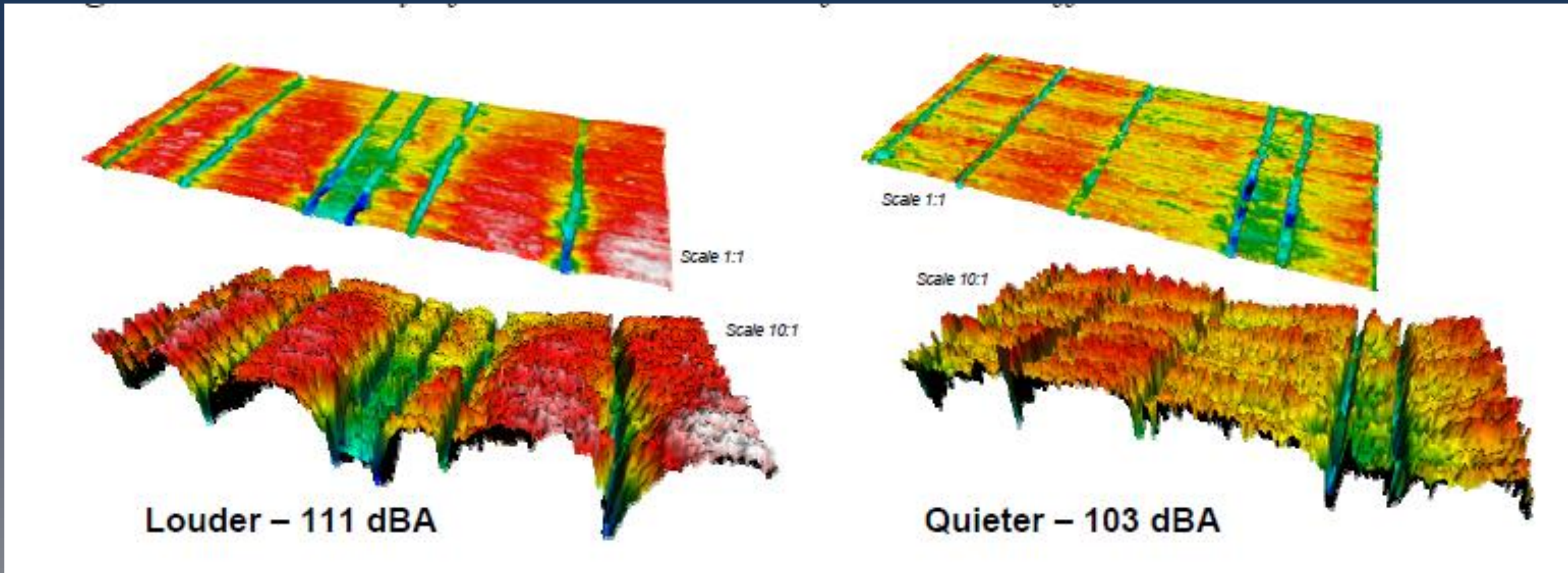


Figure 10. Robotic-based Texture (RoboTex) Measurement System.


Scale 1:1
Scale 10:1
Louder – 111 dBA
Scale 1:1
Scale 10:1
Quieter – 103 dBA

Better practices

- Concrete Material selection
  - Agg gradation: for tining and drag surfaces adequate mortar concentration near the surface
  - Agg selection: select fine aggregates with friction in mind (rather use siliceous sands than calcareous sands)
- Mortal quality: high strength, low permeability, wear resistant. (lower the w/c through by adding chemical admixtures)
  - Avoid sticky mortars (deform under the action of tining)
  - Avoid too fluid mortars (they cause close-up of grooves)

Better practices

- Paving equipment
  - Minimize vibrations
  - Uniform paver motion: Smooth and consistent as possible. No sudden start/stops or rapid adjustments
- Texture equipment
  - Minimize vibrations,
  - Cleanliness
- Grinding equipment
  - Large heavy grinding equipment: good control over the intended depth and lateral cover
  - Control fin height
  - Vibrations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