EXPERIENCE OF ROAD PAVEMENT NOISE LEVEL AND SKID RESISTANCE MEASUREMENT IN LITHUANIA

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Wednesday, October 16, 2019
OUTLINE

- Introduction
- Tyre/road noise measurements
- Skid resistance measurements
- Results and interpretation
- Technical regulations in LT
- Conclusions
Vilnius Gediminas Technical University is one of the biggest technical universities in Lithuania:

- 10,500 students
- 940 employees
- 14 science institutes
- 34 laboratories

Department of Roads

Road Research Laboratory

Road Research Institute

1922

1999

2009
ROAD RESEARCH INSTITUTE

- Personnel of 40 (incl. laboratory):
  - 12 PhDs
  - 4 PhD candidates
MAIN ACTIVITIES

- National and international researches and feasibility studies
- Laboratory testing of building materials’ in transport communications
- Road safety audits and evaluation of safety measures impact
- General and partial expertise of transport communications structure
- Expertise of technical projects of transport communications and other civil engineering structures
- Consultations on the issues of transport communications’ design, construction, operation and modernization
- Design of new building materials and technologies
- Training courses
INTERNATIONAL PROJECTS

Recently finished:
- USE-IT – Users, Safety, security and Energy In Transport Infrastructure
- FOX – Forever Open infrastructure across (X) all transport modes

Ongoing:
- SKILLFUL – Skills and competences development of future transportation professionals at all levels
- BE OPEN – European forum and oBsErvatory for OPEN science in transport
- RIMA - Robotics for Inspection and Maintenance
- Pavement LCM - A complete package for Life Cycle Management of green asphalt mixtures and road pavement
NATIONAL PROJECTS

Recently finished:

- The model of pavement structure resistant to static and impact loading adapted to changing climate conditions (No. VP1-3.1-ŠMM-10-V-02-022). The project was partly funded by the European Social Fund. 2013-2015.

- The effect of different additives on bitumen linear viscoelastic region and resistance to aging (No. 09.3.3-LMT-K-712-03-0058). The project was funded by European Social Fund. 2017-2018.

Ongoing:

- Analysis of bitumen modification using nano materials to prolong the whole service-life of asphalt (No. 09.3.3-LMT-K-712-02-0111). The project is funded by the European Social Fund. 2017-2019.

- **Road traffic noise mitigation under development of noiseless pavements** (No. S-MIP-17-137). The project is funded by a grant from the Research Council of Lithuania. 2017-2020.

- **Modular pavements** (No. 01.2.2-LMT-K-718-01-0044). The project is funded by the European Regional Development Fund. 2017-2021.
- Long-term static loading resistant asphalt concrete AC11VSTAT (No. 6257)
- Long-term static loading resistant asphalt mix SMA11STAT (No. 6258)
- High load resistant roller compacted concrete (No. 6407)
- Roller compacted concrete (No. 6408)
- Heavy traffic load and cold weather resistant bitumen modified with the combination of crumb rubber and polymers (No. 6533)
- Crumb rubber powders modified bitumen (No. 6534)
- Heavy traffic load resistant bitumen modified with the combination of crumb rubber and polymers (No. 6535)
- Crumb rubber modified bitumen (No. 6536)
Considerable noise exposure on EU inhabitants

Negative noise effects
- Health effects
- Effect on fauna
- Monetary effects

Motorization and urbanization contribute to increasing noise levels

Road transport noise is a huge challenge for NRAs

Need to combine conventional and innovative noise abatement and mitigation solutions
• 20% of EU citizens are exposed to noise levels that are higher than 65 dBA
• Negative impact for quality of living (reduction of work efficiency; health problems; nuisance)
• Annual socio-economic costs in EU because of roads and railways noise are ~40 billion EUR, of which 90% are because of light and heavy vehicle traffic
• It is expected that the costs will increase to 60 billion EUR by 2050
INTRODUCTION
SKID RESISTANCE

LOSS OF SKID RESISTANCE IS DIRECTLY LINKED WITH AN INCREASED ACCIDENT RISK, ESPECIALLY ON THE WET ROAD SURFACES

Gothie (1996):

<table>
<thead>
<tr>
<th>Skid resistance</th>
<th>Accident rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.60</td>
<td>Optimal</td>
</tr>
<tr>
<td>0.45</td>
<td>20 times higher</td>
</tr>
<tr>
<td>0.30</td>
<td>300 times higher</td>
</tr>
</tbody>
</table>

\[
 f_{sp} = \frac{1}{\lambda} \\
\lambda \text{ - wave length}
\]
LOW NOISE ASPHALT MIXES IN LAB

Physical and mechanical properties

Noise reduction characteristics

Durability properties
LOW NOISE PAVEMENTS AROUND LITHUANIA
TEST ROAD OF LOW NOISE PAVEMENTS
TEST ROAD OF LOW NOISE PAVEMENTS

- Constructed on a highway A2 Vilnius-Panevėžys in September, 2015
- Constructed on a right side in the direction to Panevėžys from 56.07 km to 57.57 km
- Two lane dual carriageway road
- AADT in different parts of this highway varies from 7000 to 10000 veh./day
- Speed limit is 110 km/h
- Test Road is 1.5 km in length and consists of 9 short sections where asphalt wearing layer constructed from different asphalt mixtures
- To minimize probability of future asphalt cracks at the joints both lanes and emergency lane was constructed at the same time, using three asphalt pavers
- Emergency lane were constructed of the same asphalt mixtures as on the traffic lanes for mixtures with higher air void content to ensure that water could be easily drained from the traffic lanes
- For all other sections emergency lane was constructed of AC 8 VN
Noise level measurements of passing vehicles using Statistical Pass-By (SPB) method;

Tyre/road noise measurements using Close-ProXimity (CPX) method;

Mean texture depth (MTD) measurements using volumetric patch method;

Mean profile depth (MPD) measurements using laser texture measurement devices;

Sound absorption measurements in impedance tube using standing wave ratio;

Road condition visual assessment;

Mechanical and physical properties;

Skid resistance;

Other measurements.

TEST ROAD OF LOW NOISE PAVEMENTS
# TYPES OF PAVEMENT WEARING LAYER
**TEST ROAD OF LOW NOISE PAVEMENTS**

<table>
<thead>
<tr>
<th>Pavement types</th>
<th>Air Voids</th>
<th>Layer thickness</th>
<th>Section length</th>
<th>Pavement width</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA 8</td>
<td>24.94 %</td>
<td>4.0 cm</td>
<td>100 m</td>
<td>11.25-11.60 m</td>
</tr>
<tr>
<td>SMA 8 S</td>
<td>2.4 %</td>
<td>3.0 cm</td>
<td>175 m</td>
<td>8.55-8.75 m</td>
</tr>
<tr>
<td>SMA 11 S</td>
<td>1.96 %</td>
<td>3.0 cm</td>
<td>175 m</td>
<td>8.55-8.75 m</td>
</tr>
<tr>
<td>AC 11 VS</td>
<td>2.26 %</td>
<td>3.0 cm</td>
<td>175 m</td>
<td>8.55-8.75 m</td>
</tr>
<tr>
<td>AC 8 PAS-H</td>
<td>3.92 %</td>
<td>2.5 cm</td>
<td>175 m</td>
<td>8.55-8.75 m</td>
</tr>
<tr>
<td>TMOA 5</td>
<td>5.59 %</td>
<td>2.5 cm</td>
<td>175 m</td>
<td>8.55-8.75 m</td>
</tr>
<tr>
<td>SMA 5 TM</td>
<td>7.15 %</td>
<td>2.5 cm</td>
<td>175 m</td>
<td>11.25-11.60 m</td>
</tr>
<tr>
<td>SMA 8 TM</td>
<td>8.26 %</td>
<td>2.5 cm</td>
<td>175 m</td>
<td>11.25-11.60 m</td>
</tr>
</tbody>
</table>
RESULTS OF LOW NOISE PAVEMENTS TEST ROAD
NOISE EVOLUTION WITH SRTT TYRES, 80 KM/H, SLOW LANE
RESULTS OF LOW NOISE PAVEMENTS TEST ROAD

NOISE EVOLUTION WITH SRTT TYRES, 80 KM/H, FAST LANE

![Graph showing noise evolution with different pavement types and years.]
RESULTS OF LOW NOISE PAVEMENTS TEST ROAD
NOISE EVOLUTION WITH SRTT TYRES, 80 KM/H

<table>
<thead>
<tr>
<th>Road Type</th>
<th>Slow lane</th>
<th>Fast lane</th>
<th>Slow lane</th>
<th>Fast lane</th>
<th>Slow lane</th>
<th>Fast lane</th>
<th>Slow lane</th>
<th>Fast lane</th>
<th>Slow lane</th>
<th>Fast lane</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA 8</td>
<td>92</td>
<td>98</td>
<td>94</td>
<td>98</td>
<td>92</td>
<td>98</td>
<td>94</td>
<td>98</td>
<td>92</td>
<td>98</td>
</tr>
<tr>
<td>SMA 8 S</td>
<td>94</td>
<td>98</td>
<td>96</td>
<td>98</td>
<td>94</td>
<td>98</td>
<td>96</td>
<td>98</td>
<td>94</td>
<td>98</td>
</tr>
<tr>
<td>SMA 11 S</td>
<td>92</td>
<td>98</td>
<td>94</td>
<td>98</td>
<td>92</td>
<td>98</td>
<td>94</td>
<td>98</td>
<td>92</td>
<td>98</td>
</tr>
<tr>
<td>AC 11 VS</td>
<td>94</td>
<td>98</td>
<td>96</td>
<td>98</td>
<td>94</td>
<td>98</td>
<td>96</td>
<td>98</td>
<td>94</td>
<td>98</td>
</tr>
<tr>
<td>AC 8 PAS-H</td>
<td>94</td>
<td>98</td>
<td>96</td>
<td>98</td>
<td>94</td>
<td>98</td>
<td>96</td>
<td>98</td>
<td>94</td>
<td>98</td>
</tr>
<tr>
<td>TMOA 5</td>
<td>92</td>
<td>98</td>
<td>94</td>
<td>98</td>
<td>92</td>
<td>98</td>
<td>94</td>
<td>98</td>
<td>92</td>
<td>98</td>
</tr>
<tr>
<td>SMA 8 TM</td>
<td>94</td>
<td>98</td>
<td>96</td>
<td>98</td>
<td>94</td>
<td>98</td>
<td>96</td>
<td>98</td>
<td>94</td>
<td>98</td>
</tr>
<tr>
<td>SMA 5 TM</td>
<td>92</td>
<td>98</td>
<td>94</td>
<td>98</td>
<td>92</td>
<td>98</td>
<td>94</td>
<td>98</td>
<td>92</td>
<td>98</td>
</tr>
<tr>
<td>SS</td>
<td>94</td>
<td>98</td>
<td>96</td>
<td>98</td>
<td>94</td>
<td>98</td>
<td>96</td>
<td>98</td>
<td>94</td>
<td>98</td>
</tr>
</tbody>
</table>

CPX80, dBA

2015 - 2019
NOISE MEASUREMENT WITH DIFFERENT TYPE OF TYRES

- CPX transport tyres
- Yokohama V905
- Kelly HP
- Good Year EfficientGrip Performance
- Leao Winter Defender Grip
- Michelin Energy E-V
- Continental ContiPremium Contact 5
- Dunlop Sport BlueResponse
# RESULTS OF NOISE MEASUREMENT WITH DIFFERENT TYPE OF TYRES

<table>
<thead>
<tr>
<th>Type of tyre (label value)</th>
<th>PA 8</th>
<th>SMA 8 S</th>
<th>SMA 11 S</th>
<th>AC 11 VS</th>
<th>AC 8 PAS-H</th>
<th>TMOA 5</th>
<th>SMA 8 TM</th>
<th>SMA 5 TM</th>
<th>Special Pavement</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPX Transport Tyres</td>
<td>97,3</td>
<td>96,7</td>
<td>97,6</td>
<td>98,0</td>
<td>97,6</td>
<td>96,8</td>
<td>97,4</td>
<td>96,5</td>
<td>95,1</td>
</tr>
<tr>
<td>Yokohama V905 (71 dBA) (Winter tyre)</td>
<td>96,8</td>
<td>96,7</td>
<td>97,5</td>
<td>97,8</td>
<td>97,4</td>
<td>96,8</td>
<td>97,2</td>
<td>96,6</td>
<td>94,9</td>
</tr>
<tr>
<td>Kelly HP (69 dBA)</td>
<td>98,1</td>
<td>98,2</td>
<td>99,2</td>
<td>99,5</td>
<td>99,1</td>
<td>98,2</td>
<td>98,9</td>
<td>98,0</td>
<td>95,1</td>
</tr>
<tr>
<td>Good Year EfficientGrip Performance (68 dBA)</td>
<td>99,9</td>
<td>99,8</td>
<td>100,6</td>
<td>101,0</td>
<td>100,6</td>
<td>99,9</td>
<td>100,1</td>
<td>99,5</td>
<td>96,6</td>
</tr>
<tr>
<td>Leao Winter Defender Grip (Winter tyre/Studded)</td>
<td>98,6</td>
<td>99,9</td>
<td>100,2</td>
<td>100,1</td>
<td>100,0</td>
<td>99,9</td>
<td>99,4</td>
<td>99,7</td>
<td>100,2</td>
</tr>
<tr>
<td>Michelin Energy E-V (70 dBA)</td>
<td>98,1</td>
<td>96,9</td>
<td>97,5</td>
<td>97,8</td>
<td>97,6</td>
<td>97,0</td>
<td>98,4</td>
<td>96,8</td>
<td>93,7</td>
</tr>
<tr>
<td>Continental ContiPremium Contact 5 (71 dBA)</td>
<td>98,8</td>
<td>98,8</td>
<td>99,9</td>
<td>100,1</td>
<td>99,8</td>
<td>98,9</td>
<td>99,1</td>
<td>98,5</td>
<td>95,1</td>
</tr>
<tr>
<td>Dunlop Sport BlueResponse (68 dBA)</td>
<td>99,3</td>
<td>99,5</td>
<td>100,5</td>
<td>100,7</td>
<td>100,3</td>
<td>99,6</td>
<td>99,6</td>
<td>99,2</td>
<td>95,8</td>
</tr>
<tr>
<td>SRTT</td>
<td>98,3</td>
<td>98,6</td>
<td>99,4</td>
<td>99,4</td>
<td>99,1</td>
<td>98,4</td>
<td>98,9</td>
<td>98,2</td>
<td>99,0</td>
</tr>
<tr>
<td>AAV4</td>
<td>98,0</td>
<td>98,7</td>
<td>99,6</td>
<td>99,4</td>
<td>99,1</td>
<td>98,6</td>
<td>98,5</td>
<td>98,3</td>
<td>100,9</td>
</tr>
</tbody>
</table>
SKID RESISTANCE MEASUREMENTS

2016-2018 National project

Over 500 km of measurements including:

- Different types of asphalt mixtures (SMA, AC, DPA)
  - Different year of construction

Monthly measurements

- Same route
- Different types of asphalt mixtures
  - Different year of construction

Custom measurements

- Roads
- Airports
RESULTS OF FRICTION COEFFICIENT MEASUREMENT
ROAD NO.102, 18.00-19.5 KM, SPEED 60 KM/H
TECHNICAL REGULATIONS IN LITHUANIA

LOW NOISE PAVEMENTS

LIETUVOS AUTOMOBILIŲ KELIŲ DIREKCIJOS
PIE SUISIKIMO MINISTERIJOS
DIREKTORIUS

ĮSAKYMAS
DĖL MAŽAŽRIUKŠMIŲ ASFALTO VIRŠUTINIŲ SLUOKSNIŲ IRENGIMO
REKOMENDACIJŲ R TM 18 PATVIRTINIMO

2018 m. gegužės 28 d. Nr. V-121

Vilnius

Vadovaudamasis Lietuvos automobilių kelių direkcijos prie Susisiekimo ministerijos
moostatų, patvirtintą Lietuvos Respublikos susisiekimo ministro 2006 m. lapkričio 30 d. įsakymu
Nr. 3-457 „Dėl Lietuvos automobilių kelių direkcijos prie Susisiekimo ministerijos moostatų
patvirtinimo“, 10.24 paprašo,

tvirtinu Mažažriukšmių asfalto viršutinių sluoksnii įrengimo rekomendacijas R TM 18
(pridėdama).

SKID RESISTANCE

Suvestinė redakcija nuo 2018-07-10


LIETUVOS AUTOMOBILIŲ KELIŲ DIREKCIJOS
PIE SUISIKIMO MINISTERIJOS GENERALINIO DIREKTORIAUS
ĮSAKYMAS
DĖL AUTOMOBILIŲ KELIŲ DANGOS KONSTRUKCIJOS ASFALTO SLUOKSNIŲ ĮRENGIMO TAIŠYKLIŲ ĮT ASFALTAS 08 PATVIRTINIMO

2009 m. sausio 12 d. Nr. V-16

Vilnius

Vadovaudamasis Lietuvos automobilių kelių direkcijos prie Susisiekimo ministerijos
moostatų, patvirtintą Lietuvos Respublikos susisiekimo ministro 2006 m. lapkričio 30 d. įsakymu Nr. 3-457 „Dėl Lietuvos automobilių kelių direkcijos prie Susisiekimo ministerijos moostatų patvirtinimo“ (Žin. 2006, Nr. 133-5041). 9.7.7 ir 13.4 punktai,
tvirtinu Automobilių kelių dangos konstrukcijos asfalto sluoksnii įrengimo taisykles ĮT ASFALTAS 08 (pridėdama).

GENERALINIS DIREKTORIUS

VIRGAUDAS PUODŽIUKAS
- Maximum allowable noise values for low noise pavements (CPX method)
- SMA 8 S; SMA 11 S; AC 11 VS indicated as reference asphalt pavements and their noise values

<table>
<thead>
<tr>
<th>Dangos (asfalto mišinio) rūšis ir tipas</th>
<th>Padangos ir dangos kontaktos šokio lygis išmatuotas didelio artumo metodu (CPX), panaudodami SRTT tipo padangas, dBA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50 km/h</td>
</tr>
<tr>
<td>PA8</td>
<td>88</td>
</tr>
<tr>
<td>SMA 5 TM</td>
<td>87</td>
</tr>
<tr>
<td>SMA 8 TM</td>
<td>88</td>
</tr>
<tr>
<td>AC 5 V TM</td>
<td>87</td>
</tr>
<tr>
<td>SMA 8 S(^1)</td>
<td>90</td>
</tr>
<tr>
<td>SMA 11 S(^1)</td>
<td>90</td>
</tr>
<tr>
<td>AC 11 VS(^1)</td>
<td>90</td>
</tr>
</tbody>
</table>

\(^1\) SMA 8 S, SMA 11 S ir AC 11 VS triukšmo lygio vertės nurodomos kaip referencinės, atspindinčios tradicinių dangos (asfalto mišinio) rūšių ir tipų triukšmo lygio vertes.
TECHNICAL REGULATIONS FOR FRICTION COEFFICIENT

<table>
<thead>
<tr>
<th>Type</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SRT -3 (blocked wheel)</td>
<td></td>
</tr>
<tr>
<td>Highways</td>
<td>0.45</td>
</tr>
<tr>
<td>Main roads</td>
<td>0.40</td>
</tr>
<tr>
<td>National/regional roads</td>
<td>0.35</td>
</tr>
<tr>
<td>ViaFriction (fixed slip rate)</td>
<td></td>
</tr>
<tr>
<td>Highways</td>
<td>0.55</td>
</tr>
<tr>
<td>Main roads</td>
<td>0.50</td>
</tr>
<tr>
<td>National/regional roads</td>
<td>0.45</td>
</tr>
</tbody>
</table>
EXPOSED AGGREGATE CONCRETE (EAC) DEVELOPMENT
PROJECT „MODULAR PAVEMENTS“ (NO. 01.2.2-LMT-K-718-01-0044) FINANCED FROM THE EUROPEAN REGIONAL DEVELOPMENT FUND UNDER GRANT AGREEMENT WITH THE RESEARCH COUNCIL OF LITHUANIA (LMTLT). FROM 2017 TO 2021

- Surface texture properties
  - Mean profile depth
  - Mean texture depth
  - Skid resistance
  - Aggregate peak number

- Durability and mechanical properties
  - Resistance to freezing and thawing
  - Compressive strength
  - Flexural strength
  - Splitting strength
  - Resistance to polishing
EXPOSED AGGREGATE CONCRETE (EAC) PROCESS
PROJECT „MODULAR PAVEMENTS“ (NO. 01.2.2-LMT-K-718-01-0044) FINANCED FROM THE EUROPEAN REGIONAL DEVELOPMENT FUND UNDER GRANT AGREEMENT WITH THE RESEARCH COUNCIL OF LITHUANIA (LMTLT). FROM 2017 TO 2021

„Weaker“ retarder for EAC 5

Mixing and compacting

EAC 5

„Stronger“ retarder for EAC 8

Hardening and washing

EAC 8
CONCLUSIONS

- Skid resistance measurements show that low noise asphalt mixtures have higher skid resistance by 11.4% than traditional asphalt mixtures mainly influence by the open texture and higher air void content in the layer.

- Higher traffic volumes and higher percentage of heavy duty vehicles on the first traffic lane, resulted faster acoustical ageing due to surface texture densification.

- After 5 years of exploitation PA 8 mixture still shows the best noise absorption properties in the lane which is forbidden for heavy vehicles (fast lane). In slow lane noise absorption properties steadily decreasing (+5.2 dBA in the period of 2015-2019).

- Based on the current noise level results it can be said that low noise asphalt pavements has similar or even better noise reduction properties than porous asphalt at the same time maintaining good stability and strength after five years of exploitation. But still further monitoring of acoustic and durability conditions of the low noise pavements is needed.
OUR TEAM MEMBERS RELATED TO ERPUG ACTIVITIES

- PhD Rita Kleizienė – FWD, TSD, pavement structure analysis;
- PhD student (4th grade) Dovydas Skrodenis – pavement surface characteristics.