ACOUSTIC MONITORING OF A ROAD NETWORK: INVESTIGATION OF THE AGEING EFFECT OF THIN LAYER ASPHALT

Auscultation acoustique d’un réseau routier : étude du vieillissement d’un enrobé très mince

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Content

• Method for acoustic monitoring
  ➢ CPX equipment
  ➢ specific methodology for long networks
  ➢ reliability assessment

• Application on Nantes’ ring road
  ➢ Ageing of low noise very thin asphalt
Acoustic monitoring: CPX equipment

Test vehicle with common test tire from the market

- 3 microphones: 2 side positions (ISO CD 11819-2), 1 back (research)
- Calibration \{vehicle + tire\} on a reference test track, \textit{initial} and \textit{periodic}, \textit{>>} test equipment correction factor
- Check of background noise \textit{(Anfosso-Lédée et al., SURF2004, Toronto)}
Acoustic monitoring: CPX equipment

Noise level acquisition:
- Simultaneous with tachometer
- Noise levels integrated on each sample $\Delta m$
- $\Delta m = 1$ wheel rotation
- Manual or automatic start

$\Delta m$ : sample length  $\Rightarrow$  $L_{Aeq[\Delta m]}(V)$

$\Delta L$ : section length  $\Rightarrow$  $L_{Aeq[\Delta L]}(V)$ average of $L_{Aeq[\Delta m]}(V)$

Post processing
Drop-out identification, speed correction or statistical regression, averaging on sections $\Delta L$
Acoustic methodology

Specificity of measurements on long networks

- Needs a **compromise** between **cost** & **accuracy**
  - sampling $\Delta m=2m$ ? averaging $\Delta L=20m$ ?
  - only 1 run ?

- **Speed** correction
Acoustic methodology: speed effect

Noise Level (dBA)

Distance (m)

Speed (km/h)

Roundabout

Built-up area

Portorož, Slovenia
Acoustic methodology: speed effect

Speed correction of noise levels:

\[ L_p(V_{\text{ref}}) = L_p(V) + a \log\left(\frac{V_{\text{ref}}}{V}\right) \]

With \( a \) between 25 and 35

- Define an average \( a = 30 \)
- Reject measurements where speed deviates from \( V_{\text{ref}} \pm 20\% \)
  \[ \Rightarrow \text{abs(error)} \leq 0.5 \text{ dB(A)} \]
Acoustic methodology: sampling/averaging

Fine sampling (~ 2m) still important for dropout identification

Compromise cost (number of runs sampling and averaging length) / accuracy checked by Round Robin Test
Method assessment

- Round robin test: 2 test sites

Ring road (meas. ~ 26 km)
constant speed 90 km/h

interurban road (~ 30 km)
different speeds: 110, 90, 70, 50 km/h
Analysis at ref. speed 70 and 90 km/h
Method assessment

• Round robin test
  ➢ 5 CPX equipments
  ➢ 6 runs
  ➢ sampling $\Delta m = 2 \text{ m}$
  ➢ check of different processings:
    ➢ $\Delta L = 20\text{m}$ or $100\text{m}$
    ➢ 1 run (repeated 6 times) or average results on 2 runs (repeated 3 times)
  ➢ reliability assessment (ISO 5725)
Method assessment: repeatability

![Graph showing repeatability standard deviation (dB(A)) vs distance (m) for srj(20m) and srj(100m).]
## Method assessment: reliability

<table>
<thead>
<tr>
<th>Section length $\Delta L$</th>
<th>r (dB(A))</th>
<th>R (dB(A))</th>
<th>Num. of values</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta L = 20$ m</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 run</td>
<td>1.3</td>
<td>2.1</td>
<td>2242</td>
</tr>
<tr>
<td>avg of 2 runs</td>
<td>0.9</td>
<td>1.9</td>
<td>2242</td>
</tr>
<tr>
<td>$\Delta L = 100$ m</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1 run</td>
<td>1.1</td>
<td>2.0</td>
<td>448</td>
</tr>
<tr>
<td>avg of 2 runs</td>
<td>0.8</td>
<td>1.8</td>
<td>448</td>
</tr>
</tbody>
</table>

Portorož, Slovenia
Comparison of acoustic results

Histogram of noise levels ($L_{Aeq[100m]}$) measured on ring-road

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Portorož, Slovenia
An application on Nantes’ ring road

40 km long suburban motorway

High volume of traffic (60000 to 95000 veh/day on avg, ~12% heavy trucks)

Important policy for noise mitigation:

- Noise barriers
- Creation of an Observatory on Noise
- Information campaign toward road users
- Speed limit to 90 km/h
- **Integrated program for pavement resurfacing with VTAC 0/6 class 2 (semi-porous thin layer)**
An application on Nantes’ ring road

VTAC 0/6 class 2
An application on Nantes’ ring road
Nantes' ring road: noise measurements

- CPX measurement on ~26 km, incl. all VTAC 0/6 sections and ancient DAC 0/10 sections
- Average on 2 runs (for better accuracy) on 100 long sections
- Measurements at 80 km/h
Nantes’ ring road: noise analysis

Overall CPX noise level (dB(A))

Distance (km)
Nantes’ ring road: noise analysis

Age of the VTAC 0/6 pavement (years)

CPX noise level @ 80 km/h (dB(A))

y = 0.9 x + 92.4
R² = 0.75

y = 10.5 log₁₀(x) + 89.6
R² = 0.82
Nantes’ ring road: noise analysis

![Graph showing the average noise level at 80 km/h over the years.]

- Age of the section (years)
- Avg noise level @ 80 km/h (dB(A))

- VTAC 0/6
- DAC 0/10

Portorož, Slovenia
Conclusions

• CPX is a relevant tool for acoustic monitoring of a network

• Adaptation of the methodology described in ISO CD 11819-2 is necessary for long networks: use longer sections (100 m) and one single run

• Speed influence on noise levels has to be addressed for a clear output of results

• VTAC 0/6 on Nantes’ ring road show a “log” trend in noise evolution between 3 to 9 years, leading to a 4.3 dB(A) difference