Vibration State of the Art Report 2

Impact and regulations

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Impact and regulations

Content of presentation

- Impact on buildings and fear of damage
- Impact on humans and perception
- Annoyance
- Complaints
- Legal obligations
- Standards and descriptors
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Impact on buildings – Fear of damage

- Very common when the vibration exceeds the perception threshold level that fear of property damage occurs
- German Standard DIN 4150: 5 mm/s
- Norwegian Standard NS 8141-2:2013: 14 mm/s
- Known cases – very few and only minor damages
- Sensitive equipment – this is a risk since there are equipment and processes that tolerates very low levels
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Impact on humans

Threshold of perception according to ISO 2631
1.0 mm/s rms at 1 Hz and 0.1 mm/s rms at 10 Hz
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Impact on humans

> Alterations of sleep rhythm and sleep depth are reported already at 0.4 mm/s rms (frequency weighted) and cardiovascular reactions are reported from 0.3 mm/s rms (frequency weighted)

> Noticeable increase in vibration levels differ from 10% up to 40% in rms between different studies

> There are a lot of differences between people and also a lot depends on surrounding factors

> Health impact is not known
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Annoyance

- Very few studies have been done concerning railway vibration annoyance compared to studies for noise.

- Some annoyance may occur already at the threshold of perception 0.1 mm/s rms but it is more likely at a level of 0.4 mm/s rms that annoyance will start to occur.

- There are a lot of differences between people and also a lot depends on surrounding factors.
Complaints

- Can occur beside existing, modified or new infrastructure
- Record and monitor complaints are important
- Explain difference between noise (audible) and vibration (perceivable as trembling), and possibly additional noise from pottery (rattling)
- Explain - very low risk of damage to buildings and other constructions
- Only if high amplitudes are expected (buildings close to track, soft ground, heavy traffic) - indicative measurement
- Only if legally obliged - interpret measurement result and decide about detailed assessment and possibly mitigation measures
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Legal obligations

- Very few countries with legal vibration limits
- In many countries assessment is required for new lines and significant rebuilt lines
- In some countries assessment is required for increase in traffic volume, train speed, train type or axle loads
- In many countries assessment is required when new buildings are planned close to railways
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## Standards and descriptors

<table>
<thead>
<tr>
<th>Quantity</th>
<th>reference</th>
<th>symbol</th>
<th>unit</th>
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</thead>
<tbody>
<tr>
<td>rms weighted acceleration</td>
<td></td>
<td>$a_{\text{eff}}$</td>
<td>m/s$^2$</td>
</tr>
<tr>
<td>rms vibration velocity</td>
<td></td>
<td>$v_{\text{eff}}$</td>
<td>m/s</td>
</tr>
<tr>
<td>maximum rms vibration velocity</td>
<td></td>
<td>$v_{\text{eff, max}}$</td>
<td>m/s</td>
</tr>
<tr>
<td>maximum rms vibration velocity level</td>
<td></td>
<td>$V_{\text{dB}}$</td>
<td>dB</td>
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<tr>
<td>Vibration dose value</td>
<td>BS6472</td>
<td>VDV</td>
<td>m/s$^{1.75}$</td>
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<tr>
<td>Particle velocity</td>
<td>BS7385</td>
<td>pvth</td>
<td>m/s</td>
</tr>
<tr>
<td>Maximum transient vibration value (running rms)</td>
<td>ISO 2631</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vibration dose value</td>
<td>ISO 2631</td>
<td>VDV</td>
<td>m/s$^{1.75}$</td>
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<tr>
<td>Maximum acceleration</td>
<td>Ö Norm S 9012</td>
<td>$E_{\text{max}}$</td>
<td>m/s$^2$</td>
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<tr>
<td>Risk of exceeding a limit value by 5%</td>
<td>NS 8176</td>
<td>$V_{w,95}$</td>
<td>mm/s</td>
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<tr>
<td>Mean equivalent acceleration</td>
<td>Ö Norm S 9012</td>
<td>$E_{\text{r}}$</td>
<td>m/s$^2$</td>
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<td>Maximum weighted rms acceleration level</td>
<td>UNI 9614</td>
<td>$L_{aW}$</td>
<td>dB re 10$^{-6}$ m/s$^2$</td>
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<tr>
<td>Maximum weighted rms velocity level</td>
<td>SS 460 4861</td>
<td>$L_{vW}$</td>
<td>mm/s</td>
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<tr>
<td>Maximum weighted vibration strength</td>
<td>DIN 4150</td>
<td>$K_{B_{\text{Fmax}}}$</td>
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<tr>
<td>Mean vibration strength</td>
<td>DIN 4150</td>
<td>$K_{B_{\text{FTr}}}$</td>
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</table>
Key points

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Challenge to inform the public!

> Very few cases of only minor damage – risk is close to zero
> Threshold of perception is low – humans are sensitive
> Annoyance and health impact are not fully known
> A lot of differences between countries concerning descriptors
> What about measurements and mitigation measures?

Thank you for your attention! Do you have any questions?