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Annoyance of railway depots

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1. INTRODUCTION

Depots are large areas, often in city centers where rail vehicles are parked, composed and serviced mainly during the night. The noise produced by depots shows a large variety over time, as it emerges from various noise sources related to vehicles (compressors, fans, generators an transformers etc.), tracks (joints, switches, curve squeal) and facilities (washing plants, maintenance activities). The noise of these sources sometimes has a tonal or impulsive character, which causes a specific annoyance to residents. The annoyance highly depends on the type and number of sources, lay-out of the yards and operational planning. The fact that noise regulations for depots and shunting yards are in many Member States partly related to railway traffic noise and partly to industrial noise, contributes to the complexity of the problem.

An effective reduction of the annoyance can only be obtained by an integral approach where noise sources and their distribution, their annoyance, the operational rules and constraints, and legal constraints are considered.

As a subproject of Silence, a research project funded by the 6th Framework Programme of the European Commission, the work package G3 aimed to develop guidelines for an optimal lay-out and design, planning and operation of rail- and tramway depots.

2. METHOD

To understand the real annoyance of depot sounds and the relations between the different sounds, in this study a dedicated research to depot sounds is carried out. Different kinds of depot sounds at different sound pressure levels are compared mutually in subjective listening tests. In this way the annoyance is judged, resulting in a level dependent ranking of the annoyance per sound.

In the study the LAeq values of noise events with a duration of 6 seconds are considered. This means that the influence of long duration or high frequency of occurrence of the events is not investigated.

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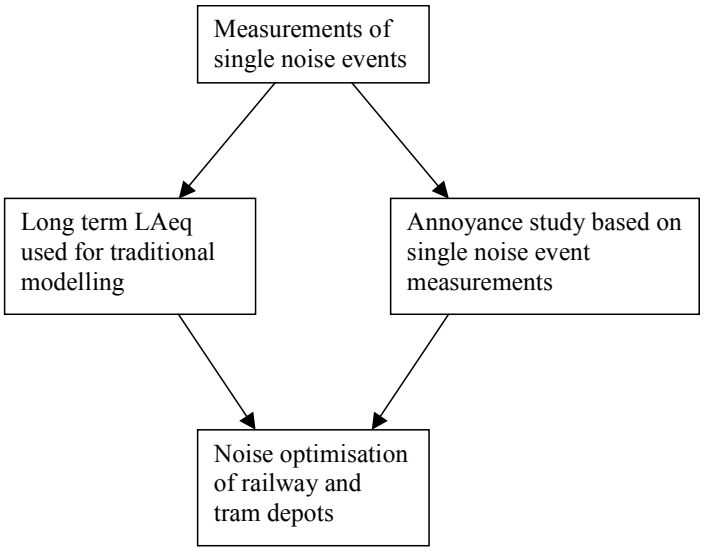
The results of both methods can be combined to find the best solutions for the noise situation at the depot. Also the annoyance method can be used without the long term LAeq modelling, to judge only the annoyance at the depot.



A. Annoyance study

All stimuli were presented at 5 different sound levels (–6 dB, –3 dB, 0 dB, +3 dB and +6 dB), where 0 dB means the reference level (LAeqt = 70 dB) described in the previous section. Each of the 45 resulting different stimuli was presented 30 times. The stimuli were presented in random order. The whole experiment was carried out in 5 - 30 minutes long sessions – two sessions per day. Listeners judged the annoyance of each stimulus using an 11 point scale (0-10).

3. RESULTS

The Pearson's coefficient of correlation calculated over all 45 stimuli for 23 subjects reveals significant concordance among subjects and therefore, group data is used in analysis data. The annoyance ratings averaged over 21 subjects for the nine sound sources versus sound level are plotted in Figure 1. According to the ANOVA test there are significant differences [F(32,22680)=29,651, p=0,0000] between sound sources presented at different sound levels.

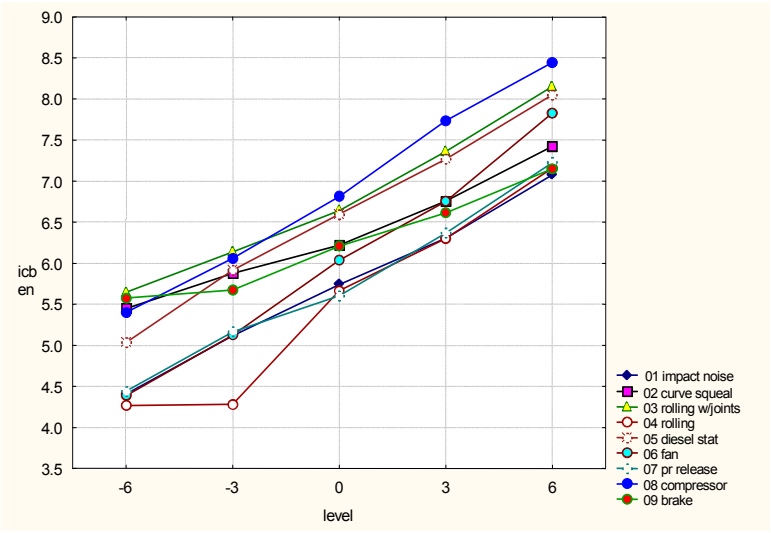


Figure 1: Perceived annoyance scale for nine different sound sources presented at five sound levels, x- axis: LAeqt level relative to 70 dB(A), y-axis: ICBEN score.

The 9 depot samples show a different dependency of the ICBEN level on the LAeqt level (64, 67, 70, 73, 76 dB(A)). Sample no. 6 'fan noise' and sample no. 8 'compressor noise' show a steeper line than for example the samples no. 2 and 9 'curve squeal' and 'brake noise'.
Also the absolute value of the ICBEN score is different for different noises. Samples no. 3 and 8 ('rolling over joints' and 'compressor') are overall more annoying than no. 1, 7 and 4 ('impact noise', 'pressure release' and 'rolling noise').

4. APPLICATION

Via simple steps the results of the annoyance study can be applied to a real situation.

5. DISCUSSION

The extrapolation of the ICBEN levels to levels experienced in daily practice (inside the houses) shows that the annoyance of depot noises depends on the level of the events experienced. The total annoyance of a depot can be dominated by a certain source because

- the level of the noise event is high
- the annoyance rating (ICBEN level) of the noise is relatively high.

The interdependency of the annoyance levels of figure 1 gives a good instrument for optimisation of annoyance at a depot. Following the lines in the figure the most dominant sources in terms of annoyance can be determined easily and the annoyance reduction can be predicted.

6. CONCLUSIONS

The subjective listening tests give a more subtle representation of the annoyance of depot noises than the existing European methods. According to the European methods correction factors of 3 to 10 dB(A) would be applied to almost all depot sounds. Many depot sounds show a combination of characteristics which is not accounted for in the methods. Also the European methods do not describe a dependency of the correction factors on the absolute levels of the noises. The relations between the different depot sounds are unclear.

This approach has several advantages over existing methodologies for assessing the annoyance of noise events based simply on dB(A). It is a technique that is designed to be applied for sources typically found at depots and takes into account the complex tonal, impulsive and low frequency elements that occur in various combinations in such sources. It therefore does not require additional compensation for these elements separately.

An extra dimension that can be brought in is that of the financial implications of the various noise control options, allowing a cost-benefit approach to be followed based on annoyance and not just noise level.
As this technique has been formulated from close study of typical depot sources, it can therefore be used either independently to ensure optimised, cost-effective, control of annoyance from depots, or in conjunction with the assessment of long term LAeqs for compliance with standards or legislation, so that noise control may be chosen to minimise annoyance and not simply levels of noise.

REFERENCES

1. 'Position Paper on EU noise indicators' ISBN 92-828-8953-X, 2000, www.europa.eu.int
2. M. Beuving, R.R.K. Jones, "Annoyance of depots – Guidelines for best practice", SILENCE_G.D9_27072007_DeltaRail.