inter·noise 94
YOKOHAMA-JAPAN, AUGUST 29-31

COMMUNITY RESPONSE TO RAILWAY NOISE WITH SPECIAL RESPECT TO HIGH-SPEED TRAINS

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1. INTRODUCTION

Railway as a means of transport in goods and passenger traffic is gaining in importance worldwide. Existing railway lines are therefore being further developed, new tracks laid and new tracked-vehicle techniques developed.

These measures aim at increasing the traffic-regulation capacity and reducing the run time between the destinations by increasing the train speed. In Germany, for example, it is planned to increase the capacity of double lines from presently approx. 240 trains/24 h to approx. 275 trains and the speed of fast passenger trains from presently 200 km/h to 300 km/h.

A great number of studies on community response to railway noise were undertaken in the seventies and eighties, which essentially referred to the railway lines existing at that time. These lines generally carried mixed passenger and goods traffic at speeds of up to approx. 200 km/h.

The objective of this paper is to provide a survey of the existing studies on community response to railway noise and to analyze in particular those studies which concern themselves with high-speed trains carrying passengers at speeds of over 200 km/h. In a second step the differences in noise emission along conventional and high-speed lines are to be worked out. Finally it is to be reviewed to which extent the results obtained in the studies on existing railway lines are applicable to the conditions of high-speed lines when taking their specific acoustic properties into account.

2. DISTURBANCE REACTIONS WITH CONVENTIONAL AND HIGH-SPEED RAILWAY LINES

The studies on community response to railway noise available by the year 1989 were thoroughly analyzed and commented on in the papers by R.Schuemer et al. (1) and U.Moehler et al. (2,3). These studies include both laboratory and field studies and were mainly conducted in the area of conventional railway lines. The results of these studies can be summarized as follows:

- In comparison with other parameters, the energy-equivalent mean noise level L_{Aeq} is best suitable for predicting general annoyance and disturbance reactions due to railway noise.

- The area in which railway noise causes the most serious disturbance reactions is that of communication, whereas sleep is the area in which it causes the least annoyance.

- Railway traffic noise is, with the same L_{Aeq}, less annoying than road traffic noise. This difference in annoyance depends on the disturbance variable and the time of occurrence considered (during day/at night) as well as on the noise level.

In Germany, for example, the difference in annoyance between railway and road traffic noise has been taken into account in the laws on immission control by providing for a "railway bonus" of 5 dB(A) with respect to the L_{Aeq}.

Field studies on community response to railway noise were undertaken in France and Japan along the high-speed lines existing in these countries.

Some important results obtained in these studies in connection with the issue of this paper are the following:

- The first results of a French study (4) conducted along a high-speed line carrying railroad traffic at speeds of up to 300 km/h seem to show that surpride effects to high speeds by the community affected are to be found to a limited extent only and that sleep disturbance particularly in the small hours of the day as well as interference with communication outdoors and when watching television are the most serious effects. (The statement on disturbance of sleep is contradictory to the results obtained in the above-mentioned studies undertaken along conventional railway lines, according to which sleep disturbance is comparatively slight.)

- Japanese surveys (5,6) show that - with the same L_{Aeq} - high-speed trains (Shinkansen) at a max. speed of 210 km/h appear to be less annoying than the noise caused along conventional railway lines. The authors assume that this is to be attributed to the impulse noise of the rail joints of conventional railway lines. A comparison of two high-speed railway lines (i.e. of Tokaido Line and New Sanyo Line) showed that community response to railway noise along the Tokaido Line - which at the time of questioning was eight years older than the Sanyo Line - was less violent than to that along the Sanyo Line which at the time of questioning was only eight months old. One can thus conclude that disturbance reactions are influenced by habituation to railway noise.

3. COMPARISON OF NOISE EMISSIONS OF CONVENTIONAL AND HIGH-SPEED TRAINS

The technical standard of wheels, bogies and brakes of high-speed trains must be higher than that of conventional trains. The ICE in Germany and the TGV in France are, for example, equipped with the considerably quieter disk brakes, while block brakes are used in goods traffic presently and certainly also in the future. On the other hand, the aerodynamic noise increases at bogies and current collectors of high-speed trains at speeds over 250 km/h; they may become the predominant sources of noise.

These differences in noise emission are documented in Barsikow's (7) and Lamure's (8) reports. Figure 1 below shows a comparison of the mean noise level referred to one pass-by per hour of a high-speed train (ICE, length of train 420 m, equipped with disk brakes), a conventional passenger train (Intercity, length of train 340 m, equipped with disk brakes) and of a goods train (length of train 500 m, equipped with tread brakes) by the example of the Regulation "SCHALL 03" (9) applicable in Germany to the calculation of noise emissions along railway lines.

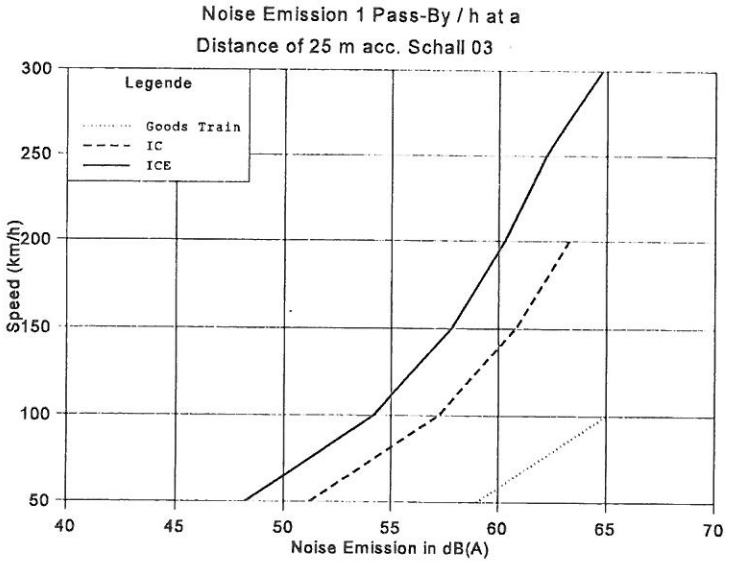

Figure 1 - Noise Emission of One Pass-By per Hour at a Distance of 25 m Each

The above Figure shows that, at the same speed, the ICE generally is over 10 dB(A) quieter than a goods train - referred to the L_{Aeq} of the same number of pass-bys. So it becomes apparent, for example, that both a high-speed train (ICE) passing at a speed of 300 km/h and a goods train passing at a speed of 100 km/h equally contribute to the overall noise level with approx. 65 dB(A) each.(According to (10), the peak level of approx. 93 dB(A) of the ICE would at these speeds be approx. 5 dB(A) above that of the goods train. According to (8), the relations concerning the TGV are in the same order of magnitude.)

The share of pass-bys of high-speed trains referred to the total number of pass-bys during the day amounts to approx. 25 % and at night to only 5 % on frequently used existing railway lines in Germany (e.g. the section Augsburg-Munich). This means that also the L_{Aeq} share of high-speed trains is far below the overall L_{Aeq}.

4. CONCLUSIONS

Comparing the results of the sociological studies available so far, which were undertaken along high-speed railway lines, with those obtained along conventional railway lines, and taking into account the acoustic differences described above, the following conclusions can be drawn concerning the evaluation of high-speed railway lines with respect to community response to railway noise:

- The general annoyance due to railway traffic noise is relatively best described by the L_{Aeq} (mean noise level calculated on the basis of all noise events). On principle, a distinction is thus to be made whether high-speed railway traffic uses tracks of its own (as it is, in part, the case with the TGV in France and with the high-speed trains in Japan) or whether it is regulated together with the goods-train traffic and the remaining passenger-train traffic (as it is the case, for example, in Germany).

- At night there is generally no railway traffic on high-speed tracks exclusively used by high-speed trains so that disturbance of sleep - i.e. getting to sleep and sleeping through without waking - should be irrelevant along these lines; on the other hand, and contrary to conventional railway lines, waking reactions were noticed in the small hours of the day. Similar to conventional railway lines the interference with communication seems to be the area in which railway noise is at its most annoying.

- With mixed railway traffic - i.e. high-speed railway traffic and conventional goods and passenger-train traffic - disturbance and interference exclusively referring to high-speed railway traffic may be irrelevant. Taking into account that generally the share of high-speed trains in the noise emissions is far below the overall noise level L_{Aeq} during the day and at night on the one hand, and considering that the L_{Aeq} is the best indicator of annoyance reactions on the other hand, it can be concluded that it is not necessary to take high-speed trains specifically into account with mixed railway traffic.

Concerning the evaluation of annoyance caused by noise of high-speed trains alone it is still to be investigated whether or not annoyance reactions with the same L_{Aeq} are the same with conventional and high-speed trains. The aerodynamic noise of high-speed trains is possibly to be evaluated in a different way due to the frequency spectrum

or location of the source of noise within the area of the current collector than the wheel-rail noise generally predominant with conventional trains. Apart from that, non-acoustic moderators such as the personal attitude of the individual affected towards high-speed trains may influence the reactions.

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