

EFFECTS OF RAILWAY-NOISE REDUCTION ON ANNOYANCE AFTER RAIL-GRINDING

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1. INTRODUCTION

The noise which goes out from the contact of wheels and rail is strongly influenced by the condition of the rail surface. Measurements [1] have shown that the noise level caused by passing passenger and freight trains on heavily corrugated rail surfaces can be up to 20 dB(A) higher than on even surfaces. Rail corrugation can be avoided by regularly grinding the rail surfaces. Grinding therefore presents an effective means for noise reduction, especially if exercised on extremely rough rails. Moreover it is achieved relatively quickly and inexpensively.

The community acceptance of these measures was to be determined in a pilot study. In particular, it was to be determined through opinion surveys and acoustic measurements in chosen rail sections to what extent the subjective noise annoyance and actual noise level had changed after the grinding of a rail section as opposed to the conditions before.

2. METHODS

Three test areas along the Munich-Rosenheim-Salzburg railway-line were chosen for this pilot study. Runs with an acoustic test car have shown that rails within these cities were in poor condition. Noise levels of passing trains were up to 20 dB(A) above those in rails of average condition.

Approximately 500 inhabitants in total were chosen in these areas, of which about 300 were given standardized questionnaires before and after rail grindings. The purpose of the inquiry was not revealed. The questions concentrated on areas of general noise annoyance, disturbances during various activities (e.g. relaxation and communication) and on the living conditions. For most questions verbal response scales were used ranging from 1 (not annoyed) to 5 (very annoyed). For the question on general total annoyance also a numeric response scale (0-10) was used. The questionnaire took advantage of previous studies on rail traffic noise (see Ref. [3], among others).

The first inquiry (before rail grinding) was made in the early summer of 1995 and the second (after rail grinding) in the fall of 1995. A further inquiry was

made in one of the areas in the summer of 1996, one year after the first inquiry. It was hoped that this third inquiry would provide information as to how public relations activities had affected the acceptance of the noise reduction measure "rail grinding"; an extensive report on this measure was printed in the local newspapers shortly before the last inquiry.

Acoustic measurements were made in a distance of 25 m from the nearest rail in the investigated sectors immediately after each inquiry. These measurements provided the basis for the calculated L_{eq} determined for each participating inhabitant. Moreover, the "acoustic" rail condition was tested by repeated runs with the acoustic test car.

In the following, only results for „Vaterstetten“ are presented since this was the only sector where all three inquiries and noise measurements had been completed. Since the unevenness of the rail was particularly severe in this area, it was expected that the noise reduction would be particularly noticeable here. The results for all sectors are presented in [2].

3. RESULTS OF NOISE MEASUREMENTS

As an example, the results from the acoustic test car runs [3] before and after rail grinding are given in Fig. 1 for the Vaterstetten sector.

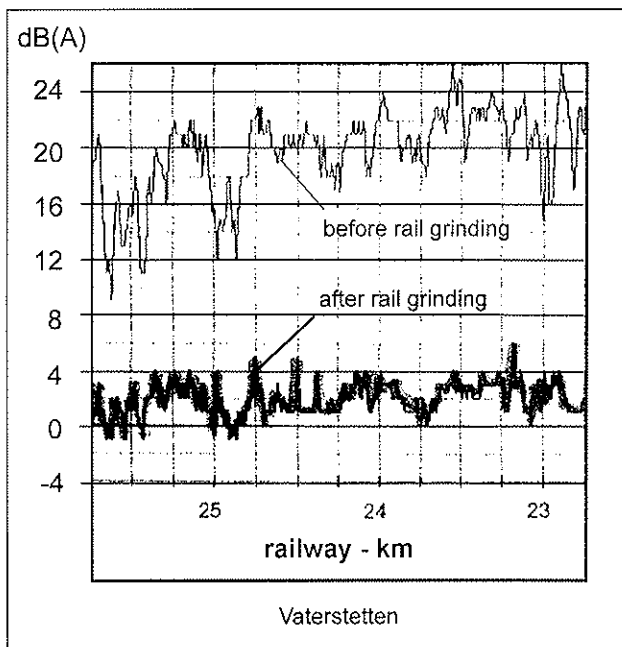


Fig. 1: Noise Level Plot as gained from Acoustic Test Car, before and after Rail Grinding

single type of train in the investigated sectors. These measurements were used to calculate the noise emission and immission levels. The results of these noise measurements and calculations for the Vaterstetten sector are compiled in table 1.

Fig. 1 shows that the noise reduction measured by the acoustic test car was about 20 dB(A) after rail grinding on this particular section of the track in the Vaterstetten sector (the noise reduction of the track in the opposite direction was less).

The results acquired with the acoustic test car cannot be applied directly to the noise immission levels of *all* types of trains, since the wheels of the acoustic test car are particularly well maintained and it is generally known that rail grinding is considerably more effective if passenger trains are concerned.

Noise measurements were therefore taken at a distance of 25 m from the tracks for each

Table 1: Noise Emission, in dB(A) (GZ = Freight train, PZ = Passenger train)

Investigated Sector		Noise Emission before Rail Grinding						Noise Emission after Rail Grinding						Noise Emission Difference before/after Grinding	
		Day			Night			Day			Night			Day	Night
		GZ	PZ	Σ	GZ	PZ	Σ	GZ	PZ	Σ	GZ	PZ	Σ		
Vaterstetten	Direction Rosenheim	66,3	69,4	71,1	68,9	66,4	70,9	62,0	61,4	64,7	64,6	58,4	65,6	6,4	5,3
	Direction Munich	66,8	69,8	71,6	68,3	65,3	70,1	60,2	57,5	62,1	61,7	53,0	62,2	9,5	7,9
	Total													8,2	6,7

Table 1 shows, that the noise reduction ΔL_{eq} achieved for freight trains after rail grinding was about 4 to 7 dB(A) and in the case of passenger trains about 6 to 12 dB(A), in total 7 to 8 dB(A). A further measurement was made with the acoustic test car after the third inquiry in July 1996, i.e. one year after rail grinding. The values from this test run were the same as those from the test run immediately after the rail grinding of September 1995. So it can be assumed that the good conditions of the rails did not deteriorate during the year that followed the grinding.

4. SURVEY RESULTS

81 questionnaires from Vaterstetten were analysed. Out of these 81 subjects (Ss) 64 were questioned again in a second inquiry immediately after the rail grinding. 46 of the Ss were still available for the third inquiry.

The distribution of the Ss among noise level classes is shown in the Fig. 2. The distribution is applicable to the same degree for day and night since the noise level is nearly the same for both periods.

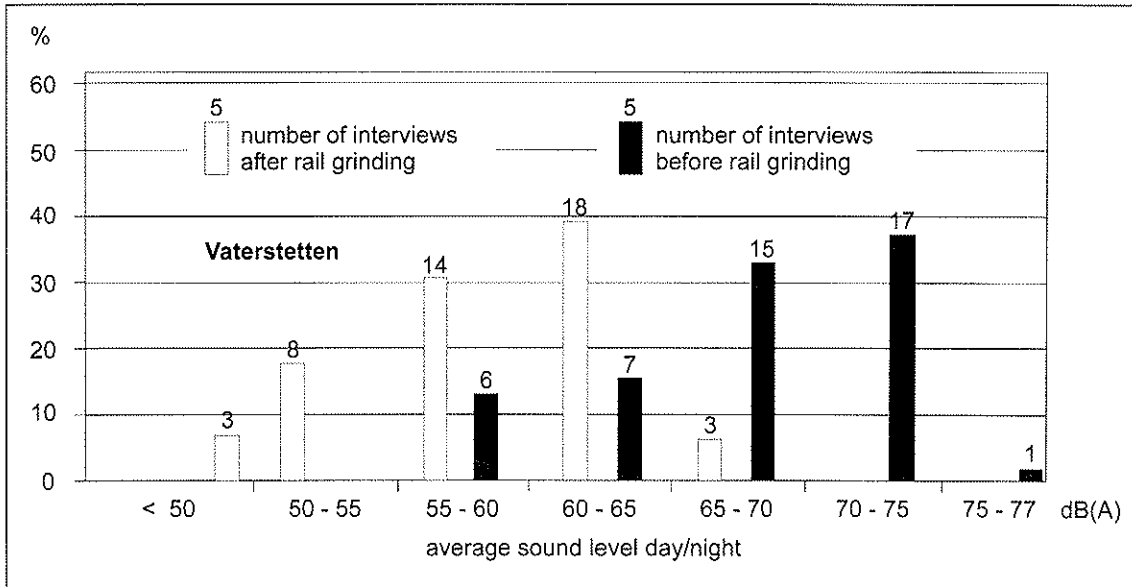


Fig. 2: Number of Interviews in Classes of Sound Level

The figure shows that the noise level distribution for the Ss has shifted by about 10 dB(A) after rail grinding, which was to be expected from the noise measurements. The noise range was between 55 and 75 dB(A) before the grinding and after grinding between 50 and 65 dB(A).

Fig. 3 shows the total annoyance means (11-point scale) from the three inquiries in Vaterstetten. Only those Ss were considered in the comparisons for which data were available for both times of measurement.

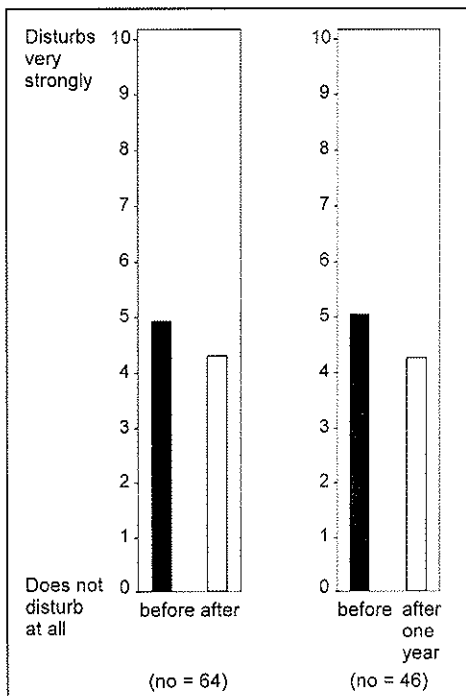


Fig. 3: Average total Disturbance

Fig. 3 shows that the mean annoyance decreased 0.6 scale units from the first inquiry before rail grinding to the second inquiry shortly after grinding (t-test for pair differences; $t=2.074$; $df=63$; $p<.05$ for the one-sided test) whereas the mean annoyance response between the second and the third inquiry changed only slightly. Compared to this, the mean annoyance difference between the first and third inquiries (of 0.8 scale units) was more distinctive ($t=2.256$; $df=45$; $p<.05$). (As this study is only a pilot study, the statistical tests were conducted in order to provide supplemental description, but not to test hypotheses.)

Corresponding comparisons for further reaction variables are shown in Fig. 4 for the three inquiry periods. The mean general annoyance during day and night as well as the mean disturbance responses for the

specific activities "telephoning and conversation indoors", "conversation outdoors", "relaxation" and "going to sleep" are shown here. For the sake of simplicity, the data of all Ss available for each inquiry period were considered.

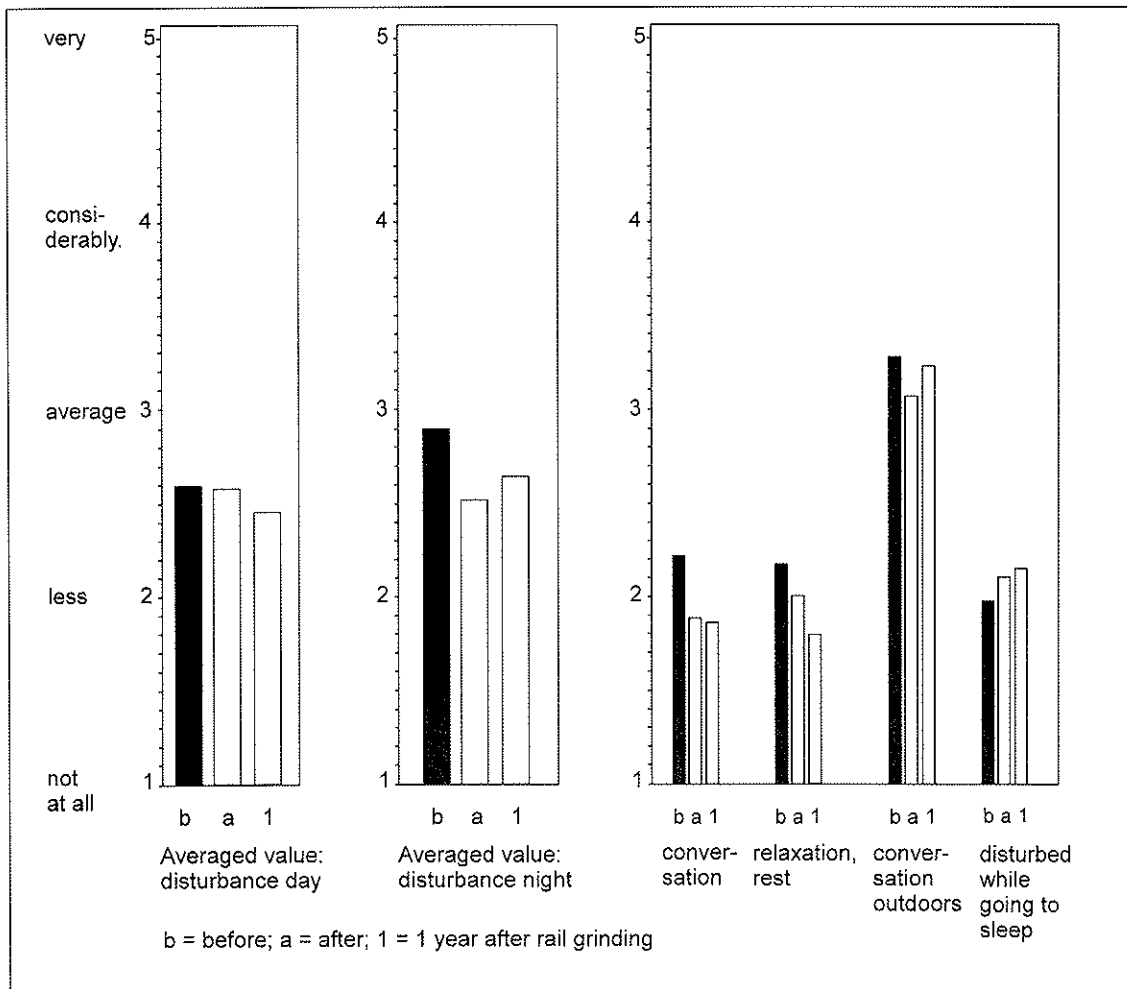


Fig. 4

The response differences between the first and the second inquiry are considerably smaller than the reaction difference in regard to total annoyance. In the case of two variables (sleeping and annoyance during the day), the mean reactions even increased shortly after grinding as compared to the situation before grinding. On the other hand, the corresponding differences between the first and third inquiry were more distinct for the six variables mentioned. This may be attributed partly to the public relations activities in between.

Except for "going to sleep", the mean reactions are higher for the first inquiry than in the third. These differences are, however, only in the case of the two variables (conversation and relaxation, both within the apartment) significantly ($\alpha=0.05$) higher than zero.

5. CONCLUSION

Noise which goes out from heavily corrugated rails can be considerably reduced by grinding. This noise reduction is more effective for passenger trains (mostly with disc brakes) than for freight trains (mostly with segmental shoe brakes). In this pilot study, the reduction in L_{eq} was between 7 and 8 dB(A) in the examined sections.

Inquiries with questionnaires on noise disturbance caused by rail traffic before and after rail grinding gave varying results, depending upon the reaction variable considered.

The general annoyance had decreased significantly. A comparison of the reactions concerning the period before grinding to that one year afterwards has also shown a significant decrease for the variables relaxation and communication indoors. It must be further examined to what degree public relations activities can improve the acceptance of rail grinding as a noise reduction measure among the public.

6. REFERENCES

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