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ABATEMENT OF RAIL NOISE – ESPECIALLY FOR INFRA-STRUCTURE

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1. Abstract

Environmental noise is an important issue causing one of the most common public complaints in Germany and within the EU. Noise causes health threats, like cardiovascular effects and cognitive impairment and has an enormous negative economic impact. The most important source for rail noise is freight trains that operate around the clock. The enormous ecological "Achilles' heel" of railway traffic is the noise. Especially during the nights, the noise impairment is up to 25 dB(A) above the threshold, which is to be aspired in terms of a precautious health protection of the people. Noise is of high relevance with respect to any expansion, upgrade or construction measures for railway infra-structure. Therefore, it is agreed to increase noise protection measures to a wide degree. There are a number of technical noise abatement measures for the locomotive, the wagon and also the infrastruc-ture available. Some of these measures on the infrastructure to abate railway noise are already and widespread used in Germany, especially noise barriers. In this presentation, we give an overview on further technical measures for infrastructure to efficiently abate railway noise, for example high-speed grinding or rail web shielding.

2. Introduction

One of the most pressing environmental issues in our cities is the problem of noise. Traffic noise from cars, railway vehicles and airports located in close proximity to the city is not only annoying for residents; it also leads to serious health issues and has an enormous negative economic impact. This is why making our cities quieter is of primary importance for city planners, engineers and politicians. The most important source for rail noise is freight trains that operate around the clock. Railway traffic has an important function for a sustainable mobility in Germany and Europe. Therefore, it is planned to transfer more traffic from the roads towards the railway. This is supported by the politicians and the majority of the people. However, in contrast to that is the enormous ecological “Achilles' heel”, the noise emissions. Especially during the nights, the noise impairment is up to 25 dB(A) above the threshold, which is to be aspired in terms of a precautious health protection of the people. Noise is a frequent reason for complains and of high relevance with respect to any expansion, upgrade or con-struction measures of railway infrastructure. Along of one of the most used railway corridors Rotter-dam-Genoa, the resistance of the people is high. Many people in Germany are protesting against railway noise and any more railway traffic in their region, especially in the Middle Rhine valley.

3. Technical measures to reduce railway noise

Railway freight traffic is mainly because of their braking technology the predominant railway noise issue in Europe, followed by high speed and inner-urban railway lines. The German Environment Agency recommends measures to reduce noise at the source, i.e. vehicles and tracks, which are more cost-effective and generally more effective. Freight trains still use cast iron brakes and are therefore much noisier. Wheel roughness together with rail roughness is the main source of noise in conventional rail, the main cause of wheel roughness being the use of cast iron brakes. This problem is still more urgent considering that these trains often operate at night. It is therefore necessary to replace the iron brakes by new composite or similar brakes, which has already started and shall be finally achieved by 2020. However, this is not enough to solve the problem of railway noise. The research study "Strategy for effective reduction of rail freight noise"1 gives a comprehensive overview for noise abatement measures. The study is published at the Homepage of the German Environment Agency. In the following sections, we will present some of the measures, especially for infrastructure.

3.1 Acoustical grinding / High speed grinding

In 2020, the breaking system of the freight wagons used in Germany will be changed from cast iron brakes to composite brakes. Acoustical or high speed grinding is one of the best measures available to reduce railway noise, especially in combination with retrofitted freight wagons.The wheels of the fright wagons and the rail will be smoother and quieter. The costs per year and km for the acoustical grinding are 800 € and for the high speed grinding 1.600 €. Depending on the wagon – retrofitted or not – the noise reduction is up to 3 dB(A). In contrast to the acoustical grinding is for high speed grinding track possessionsline closure not needed. However, this is not included in the costs of the high speed grinding.

Figure 1: Train for high speed grinding [2]

3.2 Gabion wall (5m and 2m)

An example for a gabion wall is shown in Figure 2. The noise reduction of a 5m gabion wall is up to 10 dB(A) and of a 2 m gabion wall it is up to 3 dB(A). The life cycle costs per year, km and dB(A) for the gabion wall is about 6.000 € for the 5m wall and 7.100 for the 2m wall.

Figure 2: Gabion wall [3]

3.3 Low noise barrier concrete / gabion

Without the shielded bogie a low noise barrier (Figure 3) has a reduction potential of 4 dB(A). This is due to noise reflection and absorption. In combination with shielded boogies, the noise reduction can be up to 10 dB(A). The life cycle costs per year, km and dB(A) for the Low noise barrier is about 6.600 € for concrete and 4.300 € for gabion walls. The gabion wall is cheaper because of lifespan of 70 years, concrete has a lifespan of 45 years.

Figure 3: Low noise barrier, gabion wall [4]

3.4 Rail web damper

The rail web damper is shown in Figure 4. For reducing the sound radiation, the rail damper increases the track decay rate by conversion of energy into heat. The noise reduction is up to 3 dB(A) depending on the rail roughness. The life cycle costs per year, km and dB(A) for the rail web damper is about 8.200 €. The lifespan is about 13 years.

Figure 4: Rail web damper [1]

3.5 Rail web shielding

The noise reducing of rail web shielding (Figure 5) is about 3 dB(A). The function is similar to that of the low noise barrier by reflection the noise. The noise reduction is up to 3 dB(A). The life cycle costs per year, km and dB(A) for the rail web shielding is about 8.500 €. The lifespan is about 13 years.

Figure 5: Rail web shielding [5]

3.6 Rail lubrication equipment / Friction modification

Both measures, the rail lubrication equipment (Figure 6) and the friction modification (Figure 7), reduces the curve squeal. The reduction of the curve squeal for both is up to 5 dB(A). The rail lubrication reduces the slip waves and the friction modification reduce the stick slip effect. The life cycle costs per year, km and dB(A) for the rail lubrication equipment is about 2.600 € and for the friction modification by 4.400 €. The lifespan for rail lubrication equipment is about 13 and for friction modification by 10 years.

Figure 6: Rail lubrication equipment [1]

Figure 7: Friction modification [6]

4. Life cycle costs of the measures to abate railway noise

Noise abatement is costly, so more money is needed to reduce the railway noise. All new measures presented in this document will emerge higher costs than the conventional parts. On the other hand, we have to take into account that noise is costly too, especially the health costs as well as losses for properties and re-modelling costs for buildings like sound-proof windows. Therefore, table 1 shows the life cycle costs of measures to reduce the railway noise for the infrastructure in Euro/dB(A).

Measures	Costs		Noise reduction
	Investment costs per km	Costs per year [Euro/dB(A)	
Acoustical grinding High speed grinding	/ /	800 € 1.600 €	1-3 dB(A)
Gabion wall 5m Gabion wall 2m	4,2 Mio. € 1,5 Mio. €	5.980 € 7.130 €	10 dB(A) 3 dB(A)
Low noise barrier concrete Gabion	1,1 – 1,3 Mio. €	6.600 € 4.250 €	4 dB(A)
Rail web damper	180.000 €	8.200 €	3 dB(A)
Rail web shielding	180.000 €	8.500 €	3 dB(A)
Rail lubrication equipment	40.000 €	2.600 €	5 dB(A)
Friction modification	149.400 €	4.400 €	5 dB(A)

Table 1: *Selection of measures for infrastructure to abate the railway noise with costs and noise reduction* [1]

5. Conclusions

Unlike road traffic noise, which occurs virtually everywhere, rail traffic noise is much more localized to specific transport corridors. However, depending on the type of train and the volume of trains, high levels of noise can be generated, especially along freight corridors on which most of the rail traffic is operated during the night. Therefore, it is contrived to restrict the access for noisy wagons or trains on certain sensitive lines and at certain times, especially during the night. The establishment of ambitious noise thresholds is necessary, but does not include current freight wagons, which typically have an operating life of up to 40 years. In terms of noise abatement, however, these wagons are the crucial problem. Due to that, there is an urgent need to refit freight wagons with quieter braking systems. After the refit of the freight wagon, it is important to introduce further noise abatement measures. The research study “Strategy for effective reduction of rail freight noise“ presents more than 25 of those measures for the freight wagon, the locomotive and the infrastructure. However, further new measures are necessary to achieve an efficient protection of the people from rail noise.

Abatement noise, especially but not only during the night, is important to reduce health risks as well as to improve the life quality.

6. References

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