DB NETZE

Abstract of the

Final Report

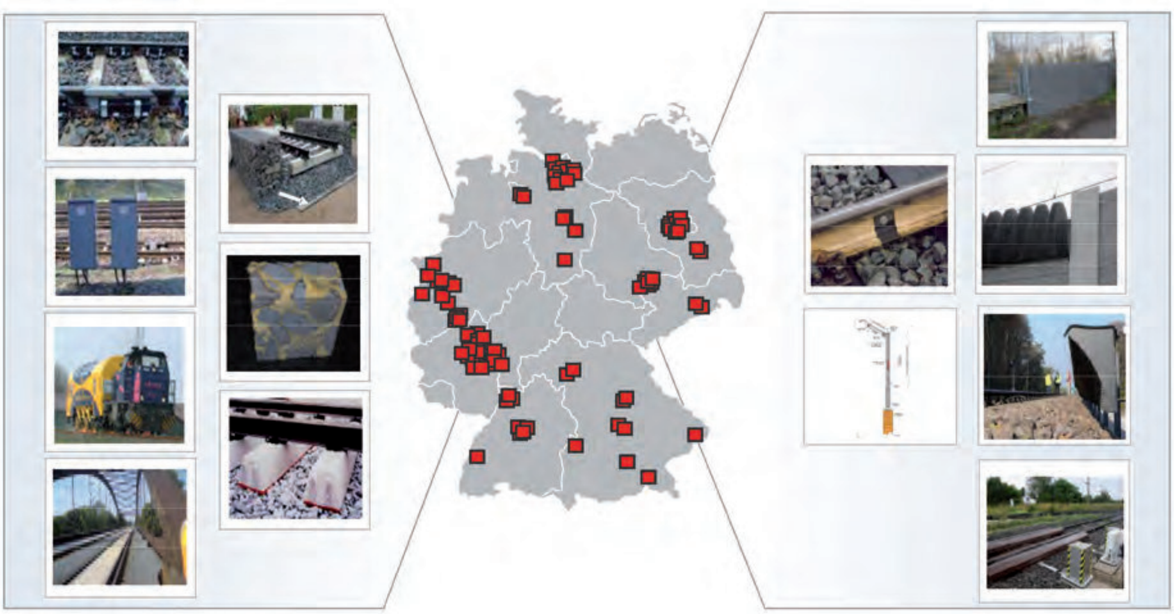
15.06.2012

Innovative measures for preventing noise and vibration on the track

Die Bundesregierung

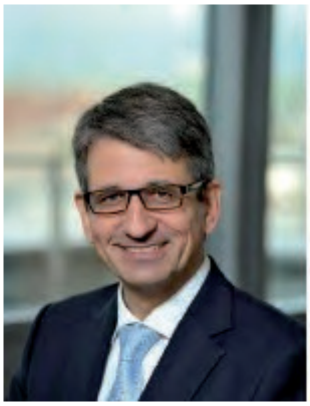
Wir bauen Zukunft

Sponsored by the German Government
on the basis of a decision by the
German Bundestag, Deutsche Bahn
AG tested innovative noise reduction
technology under the economic
stimulus programme II 2009-2011



Preface by the Chairman of the Board of DB Netz AG

In view of the political goal of "We are building a future", the German Federal Ministry of Transport, Construction and Urban Development (BMVBS) made available government funds of 100m euros to DB Netz AG for its project "Individual measures for the reduction of noise and vibration on the track", as part of the government's economic stimulus programme II. These funds enabled us to trial innovative noise reduction technologies which so far have not been part of standard noise reduction measures. The aim of these trials was to gain practical insight into the suitability of these technologies under rolling stock conditions and to demonstrate the contribution they can make to reducing noise. Apart from the aspect of noise reduction, technologies with the aim of reducing the vibration emissions of rail transport were used. These measures shall make an important contribution to enabling further growth in rail freight transport and at the same time reducing the exposure to noise and vibration for local residents.



Oliver Kraft
Chairman of the Board of DB Netz AG

Since the Federal Emissions Control Act came into force in 1974, the measures to reduce noise have been solely conventional, such as sound-absorbing walls and embankments as well as passive measures on the buildings themselves in the form of sound insulation on façades and windows. Within the framework of the economic stimulus programme II it was possible to trial new solutions and create the prerequisites for more efficient further development in this area. This programme did not only focus on involving small and medium-sized enterprises in the process of innovation but also encouraged universities and industry to drive forward the development of further innovative technologies. An introduction of the revised calculation regulations for the noise immissions from rail traffic - Noise 03 [2012] - is envisaged for 2012. This will also result in a regulation for the official approval procedure of new technologies in noise reduction effects. Therefore I am quite confident that the innovation process started here will make steady progress. DB Netz AG is ready to actively support this pathway.

At this point I would like to express my sincere thanks to the Land Transport Department at BMVBS and the project management, the staff of the Federal Office for Railways, the experts of the Railway Accident Fund and the staff of DB Netz AG for their collaboration. Their dedication, creativity and expert knowledge made the implementation of the 82 measures possible.

Oliver Kraft (Chairman of the Board of DB Netz AG)
Frankfurt am Main, 30.04.2012

Rail web dampers were fitted in 29 instances. Five products from four different manufacturers were used (types 1 to 5).

No .	Place	Track length [km]
20	Böblingen-Renningen	0.350
21	Mannheim-Neuostheim	0.650
22	Berlin-Ringbahn	2.322
24	St. Goar	1.700
25	Oberwesel	2.750
26	Bingen	1.100
27	Kaub	3.200
28	St. Goarshausen	7.200
29	Osterspai	3.000
37	Garßen near Celle	4.400
39	Bonn-Bad Godesberg	3.610
40	Bad Honnef	0.600
41	Augsburg-Ulm	0.200
68	Leipzig Güterring, Wahren – Engelsdorf	4.543
70	Leipzig Güterring, Wahren viaduct, Dortmunder-Str. – Beuthstraße	2.200

No .	Place	Track length [km]
73	Elbtal (Stadt Wehlen, Rathen, Königstein)	10.760
74	Schallstadt Leutersberg	1.610
86	Emmerich - Oberhausen	14.380
87	Koblenz-Ehrenbereitstein	0.600
88	Gau-Algesheim	0.400
91	Hamburg Poppenbüttel	3.200
92	Bremen, Roonstraße	1.560
93	Rhens	1.400
94	Braubach	1.790
95	Kaub	4.200
100	Schkeuditz	3.039
101	Königs-Wusterhausen	5.200
102	Filsen	1.640
103	Lorch-Lorchhausen	4.800

Total length	92.404 km

Table 1: Overview of the 29 measures taken with RWDs

3.1.1.2. Acoustic effect

The reduction in airborne noise level ascertained by the measurements relates to the overall sound level of passing trains with components from rolling noise, drive noise, generator units and aerodynamic noise. The rail web dampers act only to lower the level of the rolling noise component from rails and sleepers. However, since the measurements for all train types took place in a speed range in which rolling noise dominates (from 50 to 200 km/h), it can be assumed that the measurement results reflect the reduction in rolling noise level as a result of using rail web dampers (RWDs). Frequencies in the 500 - 2,000 Hz range are decisive for the perception of rolling noise. Some measurements made at lower speeds were disregarded for determining the effectiveness of different types of damper because of the above-mentioned noise components.

The damper effectiveness also varies with the different wheelsets used, such as on freight trains with block brakes, ICEs with disc brakes and wheel dampers or electric traction cars with wheel disc brakes.

The surface roughness of wheel and rail has no significant influence on the effectiveness of the dampers; they do determine how strongly the wheel and rail are excited to vibration, but not how intensely these vibrations die down.

Following the calculation method of Noise 03 [2012], the tables below show the reduction (in octaves) in the noise level D_{RWD} for the five different types of damper and an A-weighted total level for comparison against the Noise 03 [1990] classification. Positive values indicate a reduction in level, negative values indicate an increase in level.

Rail web damper type 1										
	Frequency [Hz]	63	125	250	500	1000	2000	4000	8000	Total level
Train type		Level reduction D_{RWD} [dB]								
ICE		0	0	0	1	2	3	2	3	2
IC		1	1	0	0	1	2	1	4	1
Local		0	0	1	1	1	2	1	2	1
ET_S		1	0	2	2	3	3	2	3	3
Freight		0	0	0	1	1	1	0	1	1
Average		0	0	1	1	2	2	1	3	2

Table 2: Measurement results for rail web damper type 1

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Rail web damper type 2										
	Frequency [Hz]	63	125	250	500	1000	2000	4000	8000	Total level
Train type		Level reduction D_{RWD} [dB]								
ICE		-1	-1	-1	0	2	2	1	2	1
IC		0	0	1	0	1	2	1	1	1
Local		0	0	0	1	2	2	1	0	2
ET_S		-	-	-	-	-	-	-	-	-
Freight		0	0	0	1	2	2	1	0	2
Average		0	0	0	1	2	2	1	1	2

Table 3: Measurement results for rail web damper type 2

Rail web damper type 3										
	Frequency [Hz]	63	125	250	500	1000	2000	4000	8000	Total level
Train type		Level reduction D_{RWD} [dB]								
ICE		1	0	1	1	3	3	2	2	2
IC		0	0	0	1	4	2	1	0	2
Local		0	0	0	0	2	2	1	1	2
ET_S		-1	0	1	1	0	1	0	-2	1
Freight		0	0	0	1	3	2	2	2	3
Average		0	0	0	1	2	2	1	1	2

Table 4: Measurement results for rail web damper type 3

Rail web damper type 4										
	Frequency [Hz]	63	125	250	500	1000	2000	4000	8000	Total level
Train type		Level reduction D_{RWD} [dB]								
ICE		-	-	-	-	-	-	-	-	-
IC		0	0	0	2	2	0	1	2	1
Local		0	0	0	1	2	1	0	1	1
ET_S		0	0	-1	1	2	1	0	-1	1
Freight		1	0	1	2	3	1	1	1	2
Average		0	0	0	2	2	1	1	1	1

Table 5: Measurement results for rail web damper type 4

This means with three of the five types there is a reduction in the A -weighted total level of 2 dB, averaged over the train types. The type 5 rail web damper was only fitted in one of the measures.

Measures were not tested on line sections with high speed traffic or on non-ballasted track. Results on this are also not available from any other project. Nevertheless, it may be assumed that at least the same effectiveness can be achieved particularly on non-ballasted track. The elastic rail fastenings required with non-ballasted track lead to an increase in the noise radiated from the rails. Where there is a higher proportion of rail radiated noise, reducing the rail vibrations can lead to a greater effect in the total noise emissions.

3.1.1.3. Previous application experience

Rail web dampers cannot be fitted on bridges with open rail track (see section 3.4) or in the area of expansion joints, switches, insulated joints, track switching devices, axle counters or continuous automatic train control (LZB) equipment.[8]

3.1.1.4. Cost consideration

The services in respect of supply and fitting the rail web dampers were awarded in a competitive process.

Construction costs

The construction costs for the rail web damper measures, including their fitting in combination with other technologies, amounted to 20.9 million euros. The track length fitted out was 92.4 km. On average, this results in a specific annual cost of 17.4 thousand euros/km for an estimated (accounting) service life of 13 years.

Operating costs

No operating costs are incurred for the technology.

Maintenance costs of the technology

During the trials, maintenance costs arose for repairs to one product because the fastening elements of the type 3 rail web damper worked loose and had to be refitted. Since up to now this maintenance outlay has arisen only for a single product and can be avoided with

[8] Approval document for time-limited operational trials of the Federal Railways Office of 21.04.2010

3.1.2 Rail web shielding

3.1.2.1. Technology

Rail web shielding does not reduce the vibration energy of rails but their airborne sound radiation. One characteristic feature of rail web shielding is low mass elements. The vibration energy of the rails is radiated unattenuated as airborne noise. Radiation into the environment is reduced though by a sheet steel jacket around the rail web and foot, lined inside with synthetic resin. Therefore this technology does not reduce structure-borne noise in the rail but prevents airborne noise radiation from the rail web and foot. The mode of operation resembles that of a mini noise shield.

Accordingly the track decay rate is not affected here.

Figure 5: RWS fitted

Source: DB Netz AG, LeDosquet

Figure 6: Cross section of RWS

Source: Sekisui

Rail web shielding was fitted in 12 instances

No.	Place	Track length [km]
31	Hamburg Harburg	2.600
32	Hamburg Hausbruch	9.600
33	Hamburg Rahlstedt	2.600
34	Hamburg Rahlstedt/Tonndorf	5.200
35	Hamburg Tonndorf	7.600
36	Hamburg Mariental	2.800
68	Leipzig Güterring	1.800
70 /71	Leipzig Güterring (joint application 70 & 71)	1.800
86	Emmerich -Oberhausen	3.680
88	Gau-Algesheim	0.200
92	Bremen	0.740
98	Löf	1.200
Total		39.820

Table 9: Overview of RWS fitting sites

technology. No measurement results are currently available for use on lines with high speed traffic or non-ballasted track. Nevertheless, it may be assumed that at least the same or better effectiveness can be achieved particularly on non-ballasted track, where there is increased noise radiated from the rails. Where there is a higher proportion of airborne radiation from the rails, reducing this can lead to a greater lowering of total noise emissions.

3.1.2.3. Previous application experience

Rail web shielding cannot be fitted on bridges with open rail track (see section 3.4) or in the area of expansion joints, switches, insulated joints, track switching devices, axle counters or continuous automatic train control (LZB) equipment.

3.1.2.4. Cost consideration

Construction costs

The services in respect of supply and fitting the rail web shielding were awarded in a competitive process with RWDs. The construction costs for the rail web damper measures amounted to 6.5 million euros. The track length fitted out was 39.8 km. On average, this results in a specific annual cost of 12.6 thousand euros/km for an estimated (accounting) service life of 13 years.

Operating costs

No operating costs are incurred for the technology.

Maintenance costs of the technology

At the time of drawing up the report, a figure cannot be put on the maintenance costs for the technology.

Maintenance difficulties due to the technology

When track is fitted with RWS, follow-up costs for maintenance measures arise which on average amount to 11.70 thousand euros per km and year:

- for mechanical maintenance of the tracks, since only machines with a low working speed can be used
- when rails are replaced, track is renewed or permanent barriers are fitted to adjacent track for work safety reasons or when fitting earthing clamps, the shielding must be removed and later refitted, and
- when additional measures are needed during maintenance to safeguard the cable usually laid on the rail foot.

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