World Academy of Science, Engineering and Technology
International Journal of Mechanical and Mechatronics Engineering
Vol:7, No:6, 2013

# The Anti-Noise System for Rail Brakes on Hump Yards

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***Abstract*—**The friction between two metal surfaces results in a high frequency noise (squealing) which also occurs during the braking of wagons with rail brakes in the process of shunting at a marshalling yard with a hump. At that point the noise level may exceed 130dB, which is extremely unpleasant for workers and inhabitants. In our research we developed a new composite material which does not change braking properties, is capable of taking extremely high pressure loads, reduces noise and is environmentally friendly. The noise reduction results had been very good and had shown a decrease of the high frequency noise almost completely (by 99%) at its source. With our technology we had also reduced general noise by more than 30dBA.

***Keywords*—**Composite heavily fluid compound, hump yard, noise reduction, rail brakes.

## I. Noise Reduction

IN the past hump yards were located outside cities and therefore the inhabitants were not exposed to that noise, but an increase in the population growth has led to the fact that the local people are now living in their direct vicinity. The workers are also exposed to high levels of noise, which not only has a negative impact on their health but also on their effectiveness, especially as the intensity of the traffic has been enlarged as well. Public health experts agree that environmental risks constitute 25% of the burden of disease. Widespread exposure to rail noise contributes to this burden. One in three individuals is annoyed during the daytime and one in five suffers from sleep disorder at night because of the rail noise [1]. Noise is considered to be an unwanted or undesirable sound. It penetrates the work places, recreational areas and the homes and can create a disturbance at all hours of the day. However, Table I represents different noise abatement methods and their efficiency [2]. The abatement of noise is necessary not only for reasons of comfort but also because of other important health effects such as cardiovascular problems and cognitive impairment [1]. In June 2002, Directive 2002/49/EC relating to the Assessment and Management of Environmental Noise [3] was adopted by the European Parliament and the Council.

Directive aims to "define a common approach intended to avoid, prevent or reduce on a prioritized basis the harmful effects, including annoyance, due to the exposure to environmental noise". The European Commission considers noise as one of the main local environmental problems and therefore gives noise abatement a high priority.

Most hump yards still have standard steel brakes - retarders but some operators have decided recently and changed them for dimensionally equal braking segments (PUCK segments) (Fig. 1) which, due to their composition, eliminate the noise partially, but the chemical analysis showed [4] that they are environmentally inadequate because their composition includes mostly heavy metals - copper, tin, nickel, lead and their oxides. These data are alarming, because it is known that exposure to heavy metals (either dermal, oral or by inhalation) of living organisms is causing very serious health problems. However, according to Directive 1999/45/ES [5], Regulation (EC) No. 1272/2008 [6] and definition of ECHA Candidate List of substances of Very High Concern [7], EU or EEA suppliers of articles which contain substances on the Candidate List (lead oxides are just one of them) in a concentration above 0.1% (w/w) have to provide sufficient information to allow safe use of the article to their customers. According to this and because usage of braking segments at hump yards is very specific where during the braking of wagons the filings and airborne particles(which pollute extensive surroundings of hump yards) are created the producer should exactly inform the users about chemical composition and other characteristic of these segments.

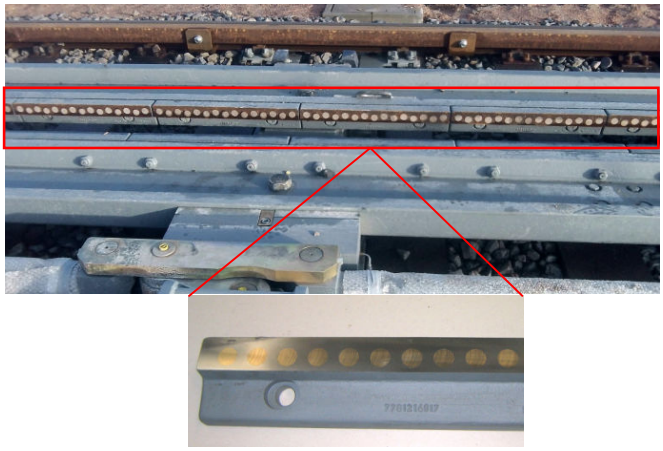


Fig. 1 The braking segment with environmentally inappropriate PUCK segments [8]

However, company Elpa developed a new, highly quality and environmental friendly Composite Heavily Fluid Compound (CHFC) friction agent, the so-called DBM-50 (Dry Braking Material), which has all the qualities required to

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prolong the brake/wheel lifetime and to reduce the noise formation and doesn't have a negative impact on the braking. According to these facts and according to our results the potential for the use of DBM-50 material is high.

## II. CHFC Material

CHFC material contains more than 40 % of solid particles, is capable of taking over extremely high pressure loads and is environmentally friendly. The characteristics of CHFC material are presented in Table II. However, more information cannot be given because they are confidential.

Because the CHFC material is very specific it cannot be applied to the wheels with ordinary technologies. Therefore, we developed a completely new, highly effective technology.

## III. BREMEX ANNSYS "Basic" Device

In our research we developed a device which would be capable of distributing the newly developed DBM-50 material directly onto the wheels, like a multipoint system. Our first developed device was mounted directly onto the existing brakes, where the parameters (speed, weight, compressed air etc.) from the operator were used. As a result, a significant noise reduction was achieved. Further development of our technology required an independent system where the regulation of individual parameters would be possible and where the system would stand alone and wouldn't be mounted onto the brake. The development of such a system was conducted throughout the years. When adequate technology had been ensured, the so-called anti-noise system BREMEX ANNSYS "Basic", a patent protection was acquired last year. The solution comprises essentially trackside sensors, electronics cabinets, reservoirs containing the composite material and special floating applicators that "capture" the wheels of the passing wagons. As the wagons pass the sensors, the sensors capture vital data based on the direction of the wheel, weight of the wagon and speed – this is transmitted directly to the electronics which are controlling the dosage.

TABLE I
Noise Abatement Methods [4]

| Noise abatement method | Overall noise reduction potential | Noise abatement effect | Comment |
|---|---|---|---|
| **At the source** | | | |
| Retrofitting with composite brake blocks | 8 – 10 dB(A) | Network wide | Considered method of choice for freight vehicles by the railway sector. |
| Wheel absorbers | 1 – 4 dB(A) | Network wide | Wheel maintenance difficulties may occur. Solutions for disk-brake wheel-sets exist but for tread-braked wheels development is still in progress. |
| Track absorbers | 1 – 4 dB(A) | Local | Track maintenance difficulties may occur, homologated in several countries |
| Removal of corrugation by grinding | Up to 20 dB(A) in comparison to poorly maintained track to achieve well maintained noise level | Local | Is usually a measure of standard track maintenance |
| Track renewal | Up to 10 dB(A) in comparison to old and poorly maintained track | Local | Is usually a measure of standard track maintenance |
| Acoustic rail grinding | 1 – 3 dB(A) | Local | Requires monitoring of the railways lines and usually frequent grinding with special grinding machines. Smooth wheels are a precondition for a good effect. Reduction potential depends on average rail surface quality of standard track. |
| Operation changes | Variable | Local | Negative effect on landscape, influence on railway maintenance procedures, unattractive for railway passengers and residents. |
| **Between source and inhabitant** | | | |
| Noise barriers | Depends on height, usually 5 – 15 dB(A) | Local | Negative effect on landscape, influence on railway maintenance procedures, unattractive for railway passengers and residents. |
| **Near inhabitant** | | | |
| Noise insulated windows | 10 – 30 dB(A) | Local | Effect is only achieved when windows are closed |

The applicators apply the environmentally friendly composite material directly onto the part of the wagon wheel flank being in contact with the rail brake. Timely and precise measuring of applied material onto a wagon wheel creates an intermediate layer of material which is decomposed thermally in the braking process. During the process the released kinetic energy is converted into a heat and not into a sound energy; the braking noise is reduced at its source.

The BREMEX ANNSYS "Basic" device is suitable for all types of track brakes and it is usually placed at the track before the brake/brakes (Fig. 2). By using one device it is possible that more brakes are supplied simultaneously. More than 80 % of parts have been developed and designed by us specifically for this system, in order to handle the highly viscous nature of the composite material and different external factors (high speeds, strong vibration, high pressure and friction, changeable weather, different geometry of wheel flanges, etc.).

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TABLE II
CHARACTERISTICS OF CHFC MATERIAL

| | |
|---|---|
| Appearance | Paste |
| Color | Gray |
| Odor | Mild |
| Solubility in water | Negligible |
| Hazardous reactive properties | None |
| Consistency – NLGI (DIN 51818, ASTM-D 217) | 2 |
| Worked penetration (ISO 2137) | 265-295 mm/10 |
| Density (at 20 °C) (ISO 12185) | 1.4 g/cm$^3$ |
| Viscosity (at 40 °C)(ISO 3104) | 26.5 mm$^2$/s |
| Flash point | > 300°C |
| Ignition temperature | > 350°C |
| Thermal decomposition | > 370°C |
| Drop point (ISO 2176) | Not applicable |
| Separation of base oil (40°C, 7 days) (DIN 51817) | 0 % |
| Behavior of the product in the presence of water (DIN 51807-1-40) | < 1 |



Fig. 2 BREMEX ANNSYS „Basic“ applicator

## IV. BREMEX ANNSYS “BASIC” DEVICE ON HUMP YARD

BREMEX ANNSYS “Basic” devices were installed at different hump yards, including at Brno-Malomerice Railway Station (Czech Republic), at Zalog-Drca (Slovenia) and at Nürnberg (DB Netze) (Germany - within the Conjuncture plan II (2009–2011): Less noise with new technology (Konjunkturprogramm II : WenigerLärmdurchneueTechnik) (Figs. 3 and 4).



Fig. 3 Deutsche Bahn’s yard

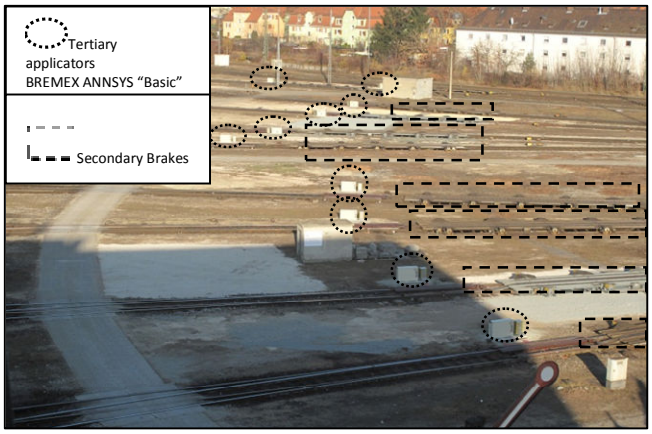



Fig. 4 BREMEX ANNSYS “Basic” applicators

## V. NOISE MEASUREMENTS

All the measurements have been done according to regulations [9] and by independent institutes. The measuring points had been exactly the same before and after the BREMEX ANNSYS “Basic” devices were installed.

The capacitor measuring microphones Brüel & Kjaer type 4189, for free field condition, diameter 0.5´, sensitivity 50mV/Pa, polarization voltage 0V, frequency range 6 Hz – 20 kHz have been used for electro-acoustic measurement. The two-channel modular precision sound analyzer Brüel & Kjaer type 2260 has been used for processing and evaluation of input data. The hand-held sound analyzer Brüel & Kjaer, type 2250 has been used as the next equipment for processing and evaluates input data.

## VI. RESULTS

### A. Hump Yard Brno-Malomerice

At the rail brake a difference of on averagemore than 23dB (A) was detected between the measurements before and after the implementation of the BREMEX ANNSYS “Basic” technology (Table III). The results have shown a high level of efficiency compared to the other known solutions presented in Table I.

TABLE III
NOISE REDUCTION AT THE HUMP YARD BRNOMALOMERICE

| Measuring point | Before the application* | After the application** | Difference |
|---|---|---|---|
| **M 1 (dBA)** | 112.97± 4,97 | 87.35 ± 8.09 | 25.62 |
| **M 2 (dBA)** | 107 ± 4.23 | 84.77 ±7.01 | 23.62 |

* Number of measurements: 18, ** Number of measurements: 29

### B. Hump Yard Zalog-Drca

The CHFC material is injected discreetly to single points of the braking surface. The decrease of noise caused by squealing of the brakes reached 30dB (A) soon after the device was installed (Table IV).

TABLE IV
NOISE REDUCTION AT THE HUMP YARD ZALOG-DRCA

| Measuring point | Before the application* | After the application** | Difference |
|---|---|---|---|
| **P 1 (dBA)** | 115 ± 5 | 85 ± 3 | 30 |
| **P 2 (dBA)** | 117 ± 4 | 84 ± 2 | 33 |

* Number of measurements: 4, ** Number of measurements: 5

### *C. Hump Yard Nürnberg*

Synergistic effects on the hump yard Nürnberg led the pilot project of the rail noise abatement under the Conjuncture plan of Germany 2009-2011 to results where the braking noise has been practically eliminated at its source. The noise reduction when the system had not been optimized was more than 20dB (A). On the day of submission the measurements for noise reduction after the optimization of the system had not yet been done and therefore they are not included in this paper.

## VII. CONCLUSION

The anti-noise system BREMEX ANNSYS "Basic" for rail brakes on hump yards enables the input of a high added value, because it eliminates the high frequency braking noise of 130 dB almost completely at its source (by 99%), but because other present noises reach 90dB or more, these noises also limit the measured common effect of our system on up to 30 dB reduction of general noise, which is, in comparison to other noise solutions, a significant added value to noise mitigation on railways. The BREMEX ANNSYS "Basic" system also ensures a safe stopping of the railway compositions because the CHFC material doesn't have a negative impact on the friction between brakes and wheels. However, this solution had been very well accepted by users [10] and had received also The European business award for the environment given by European Commission and The Certificate for the innovation of the global railway system given by International Union of Railways.

Last but not least, noise disrupts activity, disturbs sleep and hinders people carrying out their work. It can impede the learning process, psychological development, social activity and verbal communication, and impairs job performance and safety in the workplace and in transport. The Directive of The European Parliament and of The Council and other accepted Regulations resulting from these Directives must be taken into consideration when dealing with noise, mainly because a solution to these problems is possible.

## REFERENCES

[1] Burden of disease from environmental noise. Quantification of healthy life years lost in Europe,"*World Health Organization report*, 2011.
[2] J. Oertli and P. Hübner, "A 2007 Report on the state-of-the-art Noise Reduction in Rail Freight," *International Union of Railways*, pp 7., 2008.
[3] "Directive 2002/49/EC of the European Parliament and of The Council relating to the assessment and management of environmental noise," *Official Journal of the European Communities,* 2002.
[4] National Institute of Chemistry Slovenia, "Analysis Report forbraking segments," 2013.
[5] Directive 1999/45/EC of the European Parliament and of The Council concerning the approximation of the laws, regulations and administrative provisions of the Member States relating to the classification, packaging and labelling of dangerous preparation.*Official Journal of the European Communities,* 1999.
[6] "Regulation (EC) No 1272/2008 of the European Parliament and of The Council on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006.*Official Journal of the European Communities,*2008.
[7] Candidate List of Substances of Very High Concern for Autorisation, ECHA European Chemical Agency. http://echa.europa.eu/web/guest/candidate-list-table.
[8] Percy-Nicolas Weiß. Welcher Weg führt zur leiseren Gleisbremse?2. Internationales symposium Rangiertechnik in München, 2013.
[9] EN ISO 3095: "*Railway applications - Acoustics-- Measurement of noise emitted by railbound vehicles"*. 2005.
[10] Lärmreduktion direct am Gleis. *Güterbahnen*. 1/2003 pp 34-37.

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