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POSITION PAPER

Track maintenance for noise control by means of acoustic grinding

3rd June, 2015

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Executive Summary

The Community of European Railway and Infrastructure Companies (CER) welcomes the idea that track noise should be controlled in order to improve the overall noise performance of the railway system.

Preventive or corrective rail grinding shows that a maintenance strategy based on economic reasoning leads to significant positive environmental effects. A parallel and additional acoustic maintenance regime, which would significantly increase maintenance costs and bring few further noise reductions only, is not appropriate.

The wheel/rail combined acoustic roughness is the main excitation parameter for rolling noise

The noise generation mechanisms are known to be found in a shared and combined contribution of both the track and the rolling stocks components. Rolling noise is considered as the main source of the railway system. Its generation is also known to be shared between an excitation mechanism, which input parameter is the combined acoustic roughness, and a coupled response of the wheel/rail system.

In that respect, having a tight control of the combined acoustic roughness is a sizeable source of noise reduction. The European Commission's initiative to incentivize the retrofitting of the cast iron tread-brake blocks is therefore noticeable and necessary.

The term "combined acoustic roughness" means that the overall acoustic roughness, which is an input to rolling noise generation, will be steered by the major acoustic roughness coming either from the wheel or the rail. Therefore an optimum to be considered for the system efficiency is having acoustic roughness of both the wheel and the rail at a comparable level.

As a consequence, as the wheel/rail combined acoustic roughness is the input parameter that is steering the generation of rolling noise, there shall be no benefit to limit the rail acoustic roughness without having first proceeded with a high share of retrofit of the rolling stock with composite or disk brakes.

Furthermore, controlling the acoustic roughness as a factor in the excitation of the wheel/rail system has shown to be efficient in terms of noise mitigation as well. Provided that the wheel roughness is under control, the further noise reduction that can be expected by controlling the acoustic rail roughness in operation can reach up to a few dB (A)'s. In that respect, reprofiling techniques seem convenient to keep a smooth rolling surface of the rail.

Nonetheless, the track response should be considered as a whole, starting from the acoustic roughness parameters, but also the coupling effects between acoustic roughness growth and the dynamic response of the track.

Rail reprofiling is a maintenance technique that improves the life span of the rail

Rail reprofiling techniques have been used to improve the life span of the track components by

- removing a thin surface layer of metal from the rail to prevent the growth of micro-cracks,
- improving wheel/rail contact geometry and reducing fatigue stresses
- eliminating corrugation in curves
- reprofiling of worn rails.

Rail reprofiling techniques, and especially grinding, are first used to improve the lifespan of the rails. They also proved their efficiency to control the acoustic roughness of the rail, and therefore could contribute in many ways to reduce the environmental noise, at least as a first step of implementation.

Alternative techniques can limit the grinding wavelength, they remain experimental and are not used extensively at this stage

Other reprofiling techniques are also tested to improve or overcome the weaknesses of the grinding techniques. They are yet not as state-of-art and further investigations has to be done to safeguard the (acoustic) performance effectiveness and durability.

Preventive or corrective rail grinding is also known to have positive effects on railway noise

In general, preventive or corrective grinding contributes to smoothen the rail surface, by removing the acoustic roughness, which has a positive impact on the audible spectrum. This currently occurs after a transient period of 15 days to 1 month after the grinding operation (depending on the traffic of the line): actually, the rail acoustic roughness is often of slightly less quality just after grinding and needs this stabilisation period.
Some drawbacks shall also be mentioned:

- The grinding operation is noisy itself and often occurs during the night periods because of non-availability of the track on daytime due to potential high density of trains. Therefore, it is a source of complain from citizens living close to the tracks.
- Moreover, the track quality just after grinding being of poor quality, the transient time period during which the rail surface get stabilised to its best roughness quality may be critical. For instance a transient period of 1 month is in some cases considered as too long, and remains a strong source of complain for trackside citizens.
- The grinding operation remains a heavy maintenance organisation, requiring dedicated machines and a specific train path capacity for track works.
- The grinding operation often needs the removal of signalling equipment, level crossings, cables, etc.

Dealing with acoustic maintenance of the rail requests also to consider the negative impacts on environment, track works operation and costs.

Acoustic grinding is not grinding

The main parameters for rail grinding are:

- The grinding train speed
- Stone material
- Pressure of the stone on the rail
- Number of passes

Grinding and acoustic grinding are often steered by contradictory parameters, with results that may also be contradictory and that need to be balanced. An efficient integration of new acoustic parameters in an existing maintenance policy, depending on specific rules in each Member States may be critical.

Several elements that impact the definition of an acoustic rail maintenance policy need to be considered.

The following points may be critical while considering the definition and implementation of an acoustic maintenance scheme for the track.

Several track designs in Europe with several responses against roughness growth

The acoustic roughness is not the only parameter having an impact on the noise track behaviour: the dynamic stiffness of the track, especially at high frequencies, is also important. Dynamically stiff-padded tracks that are known to be less noisy may have their roughness growth quicker in time than soft padded tracks. Coupling effects between acoustic roughness and dynamic response need to be checked. Whether the time period, before a grinding operation is made necessary, is more or less than the "normal" natural period (i.e. without considering acoustic performance criteria), the impact on the maintenance scheme is then different and shall be checked.

Need for adapted survey and assessment tools

Being in the position to assess the rail acoustic roughness performance is made necessary as a complement of the maintenance policy itself:

- This is requested after grinding, as a quality check of the grinding operation. The acoustic roughness just after grinding is however not representative of the target roughness spectrum and needs to be technically considered for an application at industrial level.
- This is also requested for a periodic extensive survey of the network in order to identify when a new grinding operation needs to be performed. Such tools are used in some Member States. An extensive use of such measurement systems at industrial level (and accordingly their costs) has also to be considered.

Such a monitoring policy has to be defined, as a complement to the noise maintenance policy, taking consideration of potential added costs and new organisations to be setup. Moreover, standardisation of harmonised measuring methods at European level would be necessary.

Others impacts to be considered

A potential increase of grinding operations needs to be carefully examined, as it may have some impacts on:

- the train path capacity allocated for track works, especially in dense areas, where it is already limited, and where the noise mitigation demands are the most stringent.
- the adequate dimensioning of the industrial grinding train-fleet for this improved maintenance scheme. Actually, the number of grinding machines is limited in Europe because of their investment, capitalisation and operating costs. An increase of the grinding demand would have a significant impact on these costs, and an adaptation of the grinding machines to new sets of grinding parameters for acoustic grinding as well.
- measurements have shown, that at current noise level, acoustic grinding gives only a minor reduction of the noise level by much less than 2 dB(A), especially when rough wheels (of cast-iron tread braked freight waggons) are in operation

Reflecting about third parties' arguments

Some environmental associations and pressure groups call for acoustically monitored tracks, in particular in Germany. In their opinion, rails on the network are in general of poor acoustic quality. In order to bring some guarantee to the acoustic roughness quality of the track, they request a permanent acoustic monitoring (additionally to maintenance monitoring) of rails combined with an obligation for acoustic grinding if a certain level of noise emissions caused by wheel/rail noise is reached.

This would lead to a second maintenance regime in parallel. Besides of a considerable administrative effort this would lead to an increase of maintenance costs, while an additional noise-reducing effect cannot be expected. The cyclic preventive rail grinding is already regularly implemented on busy lines, being the noisiest parts of the rail network.

The need for a comprehensive cost benefit analysis

The various aforesaid arguments show that defining and implementing an efficient acoustic maintenance scheme is not straightforward. Several impacts and new developments need to be assessed (probably varying from Member State to Member State) in a feasibility study.
Moreover, the harmonisation of such a policy seems unreachable in the short term, and requires the development of new standards and industrial tools at European level.
Therefore, it is necessary to evaluate quantitatively benefits and costs associated with rail grinding policy, taking into account:

- The specific designs and dynamic behaviour of tracks in Europe and their impact on roughness growth,
- The state of the art in grinding works to keep a predefined level of acoustic rail roughness,
- The current wheel roughness levels (statistical distribution) of the rolling stock fleets operating in Europe and prospective evolution.
- The identification of an optimal timeline of the evolution of the wheel/rail combined acoustic roughness.
- The identification of sections of tracks to be grinded for acoustic purposes, steered by the real impact of environmental noise on the population

Provided that the wheel roughness is under control, the performance level regarding environment noise reduction, achieved with rail grinding technics, needs to be addressed.

The cost-benefit analysis shall also focus on the specific items that will have an impact on the rail maintenance schemes:

- the need for new measurement systems and standardisation assessment methods,
- the organisational aspects related to train path capacity and track works planning,
- the possible need for an adaptation of the industrial grinding trainsets to new maintenance requirements related to noise.

There are many direct or indirect impacts for which a tight cost-benefit analysis shall have to demonstrate the real benefits of a dedicated application of acoustic maintenance criteria of the track, especially related to the acoustic roughness of the rail surface, in the European noise policy.

Conclusion

The effect of the rail acoustic grinding will be very low if the wagons are not already silent (e.g. if they are not retrofitted).

Preventive or corrective rail grinding shows that a maintenance strategy based on economic reasoning leads to significant positive environmental effects. A parallel and additional acoustic maintenance regime, which would significantly increase maintenance costs and bring few further noise reductions only, is not appropriate.

Nevertheless, a comprehensive cost benefit analysis shall be carried out by the European Commission to demonstrate the positive effects of a new harmonised acoustic maintenance regime for the rail surface.

References

1. UIC/SBB Report "Rail Dampers, Acoustic Rail Grinding, Low Height Noise Barriers A report on the state of the art", Bern, October 2012, http://www.uic.org/spip.php?article3027

Acronyms

dB Decibel

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