Grinding programme **COMBINES** noise reduction and preventative maintenance

Use of a ballastless track design on HSL-Zuid meant that there was a risk of exceeding the legal limits for noise emissions, which are based on conventional ballasted track. The problem is being countered with a carefully-tailored maintenance programme that combines acoustic and preventative grinding.

IN KING Amsterdam with the Belgian border, the HSL-Zuid high speed line was tested during February and March at speeds in excess of 300 km/h.

The Thalys test train, its interior bristling with measuring equipment, yielded a large volume of data. This included noise measurements that were of special interest to technicians from M+P Consulting Engineers, Speno International and BAM Rail, three companies which have worked together to develop a rail maintenance strategy for the line.

M+P is an engineering consultancy specialising in sound and vibration, Speno is a Swiss company well-known for its expertise in rail grinding, and BAM Rail is a construction firm forming part of the Infraspeed consortium that was commissioned by the Dutch government to design, build, finance and maintain the line from 2006 to 2031.

Most of the 100 km line uses Rheda 2000 ballastless track (RG 4.05 p201). The Rheda system was adapted to suit the Dutch conditions (Rheda 2000 NL) and consists of prefabricated sleepers anchored in a reinforced concrete slab poured on site. This produces a very rigid and strong trackwork which was laid as double track over 80 route-km; the sections of ballastless track include 16 high speed turnouts. In addition, there are 40 km of track, mainly consisting of connections to the rest of the Dutch network and the link to the Belgian network, which were laid on a conventional ballast bed.

The Rheda 2000 design offers major advantages in terms of durability, maintenance options and passenger comfort, but the decision to use it meant that the legal limits for noise emissions, which are based on the use of ballasted track, were in danger of being exceeded. To tackle this problem, BAM Rail and M+P worked with Speno in an extensive study to develop a cost-effective method of preventing the extra noise emissions.

**Noise mitigation at source**

Acoustic grinding smooths out irregularities in the contact surface between the rail and the wheel, reducing noise caused by the rolling contact. Consequently, the noise produced is effectively cut off at the source.

The rail is ground for the first time during track construction, removing the mill scale and imperfect surface left after the metal is rolled and any irregularities that may have occurred during construction. After this initial grinding, the rail is in good condition for future maintenance. Grinding at this stage is done in such a way as to meet the acoustic requirements. Rail roughness is the criterion used to determine whether the rail is acoustically sound.

Once the line becomes operational, the rail is ground to keep it in optimal condition; this is common on Dutch and other European railways. Grinding will also be carried out to reduce rolling noise; this process will be extensively used on HSL-Zuid. To date, acoustic grinding has not been used on such a large scale anywhere else in the world – more than 80 km of double track will be maintained in this way.

It is especially unusual as acoustic grinding has been fully integrated into the traditional grinding process, which is used to counteract the effects of incipient cracks caused by normal rail wear and to prevent them wherever possible. To facilitate this, BAM Rail and M+P have set up an Integrated grinding and evaluation programme.

The grinding is handled by Speno, which has developed a special technique for HSL-Zuid which it will continue to fine-tune in the future.

The noise produced and the mechanical condition of the entire rail section on

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Fitted with ETMS and instrumented by Siemens, this Thalys trainset seen south of Rotterdam is being used for pre-commissioning testing on HSL-Zuid at up to 330 km/h.

Photo: Peter Honig
the high speed line are checked periodically using a track inspection train. These periodic checks of noise levels and rail condition will prevent the rails from being ground unnecessarily. They will also ensure that rails which are in poor acoustic or mechanical condition between two scheduled grinding times will not cause environmental or safety problems. Compared to performing separate operations for acoustic grinding and preventative grinding, the integrated grinding process offers a cost reduction of at least 50%.

Grinding to cut noise
To mitigate the rolling noise effectively, the roughness of the rail should be reduced at certain wavelengths corresponding to acoustic frequencies that dominate the noise spectrum. Reducing the long wavelengths in rail roughness will reduce the low-frequency noise, whereas reducing the fine roughness will reduce the higher frequencies.

Vehicle speed is a relevant parameter in translating roughness wavelengths into acoustic frequencies – as speed rises, roughness with a certain wavelength will produce noise at an increasing frequency. For the specific application of rail grinding on HSL-Zuid, the rail roughness is reduced for wavelengths between 10 mm and 250 mm.

The Dutch Noise Calculation Scheme for railway noise (RMVR '96) is the legal basis for the calculation of the effect of noise reduction measures for HSL-Zuid. The Future Calculation Scheme includes a new procedure to convert a rail roughness reduction into a noise reduction. This procedure states that a reduction of the rail roughness in comparison with the defined Dutch average rail roughness constitutes a noise reduction at the source. This direct relationship between roughness level and noise implies that a rail roughness spectrum can be defined that provides the required noise reduction.

Measuring the grinding result
As the rail roughness reduction can be directly translated into a noise reduction, it is vital to be able to measure and monitor rail roughness on the high speed line.
Le programme de meulage associé réduction de bruit et entretien préventif

Aux Pays-Bas, l'emploi du concept de voie sans ballast Rheda 2000 sur la ligne à grande vitesse HSL-Zuid signifiait qu'il y avait un risque de franchissement des seuils légaux en matière d'émissions de bruit, mais cela sera contré grâce à un programme de maintenance soigneusement élaboré sur mesures, combinant un meulage à la fois pour des motifs acoustiques et des motifs préventifs. Les mesures de bruit réalisées lors d'essais à grande vitesse avec une rame Thalys ont été utilisées pour définir et développer la stratégie d'entretien de la ligne.

Schleifprogramm kombiniert Lärmminderung mit präventivem Unterhalt

Der Einsatz des schotterlosen Oberbaus Rheda 2000 auf der HSL-Zuid Hochgeschwindigkeitslinie in den Niederlanden bedeutete, dass die Gefahr bestand, die gesetzlichen Larm-Emissionslimiten zu überschreiten. Dies wird abgewendet, durch ein sorgfältig zusammengestelltes Unterhaltsprogramm, welches akustisches und präventatives Schießen kombiniert. Lärmessungen von Hochgeschwindigkeitsstests mit einer Thalys-Komposition wurden zur Definition und Entwicklung der Unterhaltstrategie dieser Linie verwendet.

El programa de amolado combina la reducción de ruido y el mantenimiento preventivo

La utilización del diseño de vía sin balasto Rheda 2000 en la línea de alta velocidad HSL-Zuid en los Países Bajos supuso el riesgo de que superaran los límites legales de emisiones acústicas, pero esto se está contrarrestando con un programa de mantenimiento meticulosamente concebido que combina amolado acústico y preventivo. Las mediciones de ruido que se obtuvieron de los controles de alta velocidad con un tren Thalys se utilizaron para definir y desarrollar la estrategia de mantenimiento de los carriles.

The monitoring programme

Monitoring rail roughness during operation of HSL-Zuid is needed to provide information about the exact development of roughness and to identify the moment when the maximum roughness level is reached and more acoustic grinding needs to be scheduled. Moreover, the regulatory authorities are informed about the noise reduction being achieved by rail grinding.

After measurements with the ARROW monitoring system, a huge amount of data needs to be analysed to extract the necessary information. BAM and M+P therefore devised a calculation and presentation method for the monitoring information.

The raw monitoring results are translated into an 'average acoustic track quality' number (Q_{ac,t-avg}) and then presented using a colour scheme which is explained in Fig 2.

The segments where grinding should be scheduled are clearly identified by the red colour. Failing segments are completely red, and local deviations within a segment are indicated by the red hatching. The segments where the acoustic condition is good are indicated by the green colours. The light green sections denote segments where grinding will be required in the near future.

The method of presentation is intentionally kept simple so all parties involved can immediately see the acoustic quality of the track, even if they do not have the necessary technical background to interpret the figures.

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