Aboveground Low Vibration Emission Ballasted Track with Concrete Trough

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Introduction

Measures for the mitigation of vibration emission from aboveground railway traffic are urgently needed. A newly developed type of aboveground ballasted track fulfills this demand. The german track building company Grötz GmbH developed a new track form: SYSTEME GRÖTZ BSO/MK, an unreinforced concrete trough supports and contains a standard ballasted track on a ballast mat. The trough confines the ballast. Thus an extremely stable ballast bed is achieved, resulting in a very smooth, high quality track with low emission and next to zero maintenance costs.

Figure 1: Sketch of SYSTEME GRÖTZ BSO/MK, ballast resting on ballast mat

SYSTEME GRÖTZ BSO/MK insertion loss effects – Theory

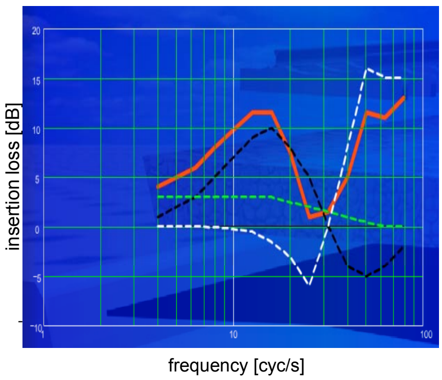

Figure 2: Insertion loss typically achievable with SYSTEME GRÖTZ BSO/MK (orange); component effects: ballast mat and mass of trough (white), bending stiffness of trough (black), good and stable track quality (green)

Only with the combination of all these factors an insertion loss can be achieved that is showing no negative values.

Pilot Project Baden-Baden Station

A 300 m section of SYSTEME GRÖTZ BSO/MK has been installed in 1997. Since then this section was completely maintenance free. Measurements performed by imb-dynamik could show:

- The insertion losses predicted were achieved in reality. Certain corrections for the simulation could be derived.
- Vibrations emission of this section did not increase over a period of five years, which is an extraordinary finding for a ballasted track. Track quality was virtually unchanged during this period and is similar to slab track.

The Sinzheim Project

DB is actually realising their new Rhine Valley Line Karlsruhe-Basel. Two new tracks are added. In Sinzheim next to Baden-Baden the new line approaches the village of Sinzheim, where some 200 houses were affected. Since only a small increase of vibration immission could be tolerated, an aboveground low vibration emission ballasted track was required. (No requirements were fixed for secondary airborne noise since the agreement with the residents was agreed upon in 1994.)

Insertion loss requirements Sinzheim

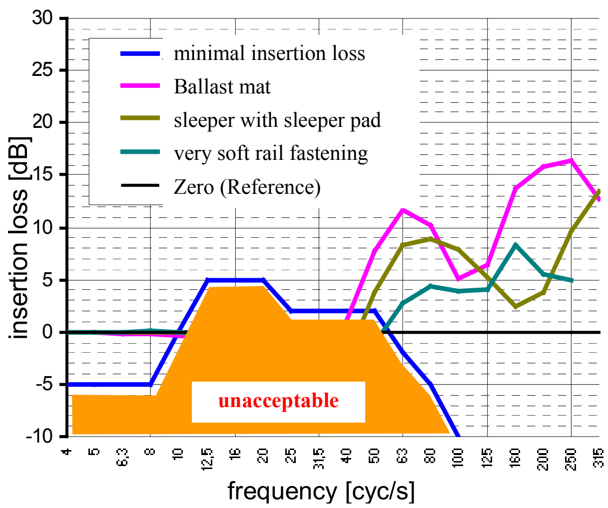

Figure 3: Insertion loss required in Sinzheim (blue); typical insertion losses achievable with ballast mat (magenta), sleeper pad (gold), very soft rail fastening (turqoise); shaded region: off limits. Insertion loss always given against standard ballasted track with usual degradation

The insertion loss required for Sinzheim (figure 3) is very demanding: No negative values are accepted within the 10 to 50 cyc/s range due to wooden and concrete ceilings structures in the neighborhood. An overall insertion loss of 4,5 dB in the frequency range 4 – 100 cyc/s was to be met as well.

Usual measures largely consisting of the insertion of elastic elements only – like ballast mats or very resilient fastenings – do not suffice as shown in figure 3. A combined effort of some effects is necessary (cf. figure 2).

The task was further complicated due to strongly varying subsoil conditions, which affected the very important subgrade stiffnesses. These effects had to be taken into account in the forecast simulations.

Sinzheim insertion loss prediction and results

All forecast calculations have ben performed with the imb-dynamik train-track simulation iSi, variant iSi-Grötz. The working principles of the model are given in figure 4.

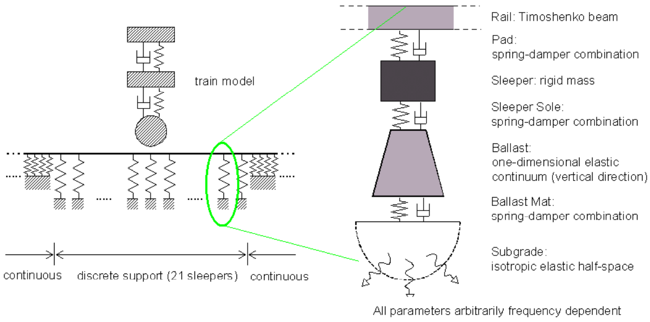

Figure 4: Block diagram imb-dynamik train-track simulation iSi, ballasted track

For Sinzheim a ballast mat type Clouth 4015 with stiffness of 0,15 N/mm³ was selected. Figure 5 shows the insertion loss forecast for this mat.

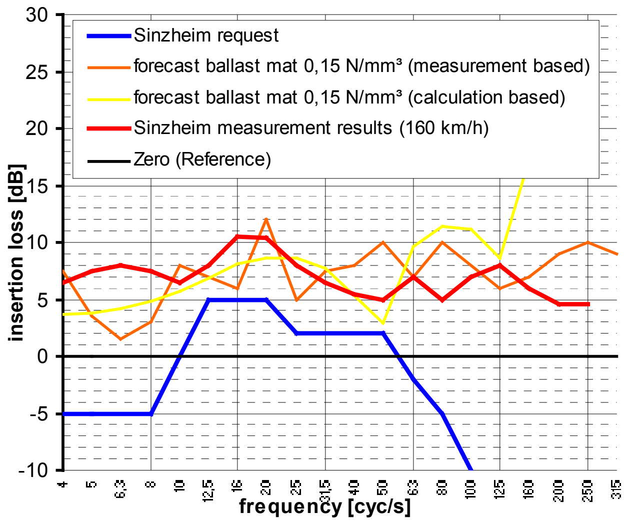

Figure 5: A comparison of SYSTEME GRÖTZ BSO/MK insertion loss forecasts with Sinzheim requirements and measurement results

The new track is not yet under full service, speed limit is now 160 km/h compared to the final 250 km/h. However first measurement campaigns have already been performed to check the insertion losses achieved.

Figure 5 contains the average insertion losses achieved, averaged over all subsoil conditions investigated. For all cross sections under test the Sinzheim requirement was fully met.

Table 1 gives some one-figure data for different situations.

situation	average 4-100 cyc/s	wooden floor 12,5-20 cyc/s	concret. floor 25-40 cyc/s	floating floors 50-80 cyc/s
requirement Sinzheim insertion loss	+ 4,5 dB -40%	+ 5 dB -44%	+ 2 dB -21%	- 2,5 dB -25%
insertion loss GRÖTZ BSO/MK	+ 7,5 dB -58%	+ 10 dB -68%	+ 7 dB -55%	+ 6 dB -50%

Table 1: Comparison of requirements and results (insertion loss against conventional ballasted track) in dB and %

With the Sinzheim measurement results a wide data base now exists for further and even more precise forecasts.

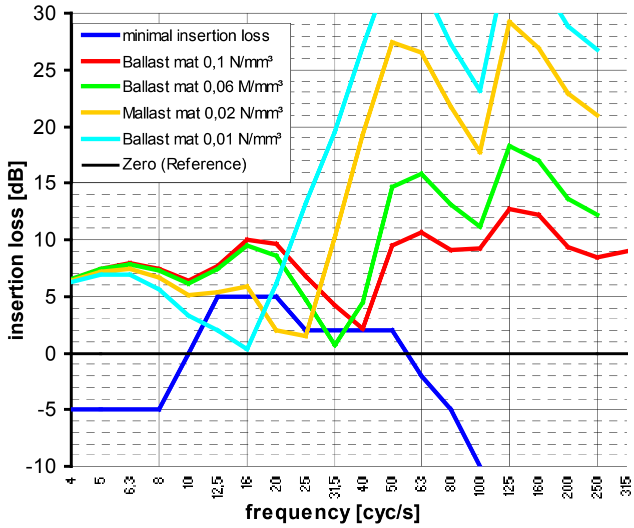

Figure 6: Insertion loss performance for various ballast mats, based on Sinzheim results

With the new superstructure SYSTEME GRÖTZ BSO/MK there exist a track which

- can be tailored exactly according to the local needs
- achieves very high and warranted insertion losses
- is virtually maintenace free
- has passed all tests demanded by german railroad authorities.

Literature

(1) www.imb-dynamik.de.

(2) Müller-Boruttau, Frank H.; Rosenthal, Volker; Breitsamter, Norbert: So trägt das Schotterbett Lasten ab - Messungen in situ am Oberbau SYSTEME GRÖTZ BSO/MK. ETR, march 2001