A study on the noise reduction of rail systems

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Introduction

In line with the national research project „Development of Technology for Railway Noise and Vibration“, noise reducing devices are being developed to enhance the track decay rate of track systems. The overall project is aimed at reducing noise radiation from rails.

More and more slab tracks are being constructed in high speed lines and in metro railway lines, however there are also many railway lines with conventional ballasted tracks. For the optimization of conventional tracks and for effective planning of new railway tracks, a systematic study is required in order to achieve low-noise performance. According to the track type, the noise characteristics and the vibration characteristics are investigated by means of a noise prediction model that was developed by the Korea Railraod Research Institute and by means of field measurement results. A priliminary experimental study on vibration damping materials is introduced and discussed.

Noise Characteristics of the rail systems

In 2011-2013, the Korea Railroad Research Institute developd a prediction model for wheel/rail noise radiation for railways, this model can be used for train speeds up to 400km/h and even higher[1]. Based on the theory of rolling noise calculation by Remington and Thompson, this model is built by means of various experimental field results in such areas as noise level, accereration level and acoustical roughness level of vehicles, tracks, and bridges. Field tests are performed also along various korean railway lines in order to verify the characteristics of propagation of the railway noise to the reciever positions. With this model the soud power levels of the wheels, rails, sleepers, ballast/slabs can be predicted both for the continuous rail support structures and for the discrete rail support track structures. Figure 1 shows an example of the sound power calculations for rolling noise from a track.

In Figure 2 the sound power levels from the pass-by of a high speed train with a train speed of 350 km/h are shown. The values are calculated for 1-hour equivalent levels. We were able to obtain this rail noise informations through a noise map; the sound power calcuation results were induced from a microphone array test system that was also developed by the Korea Railroad Research Institute(Figure 3). Figure 4 shows the predicted decay rates from different types of railway tracks. Due to the different pad stiffnesses and the dynamic stiffnesses of the fastening systems, noise reduction devices and low noise track structures will be developed according to the detailed analysis results of the noise realted properties of existing korean track structures.

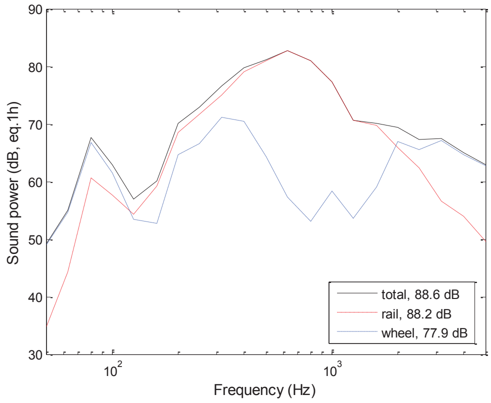

Figure 1: Predicted sound power level of a high speed line with the slab track system[1]

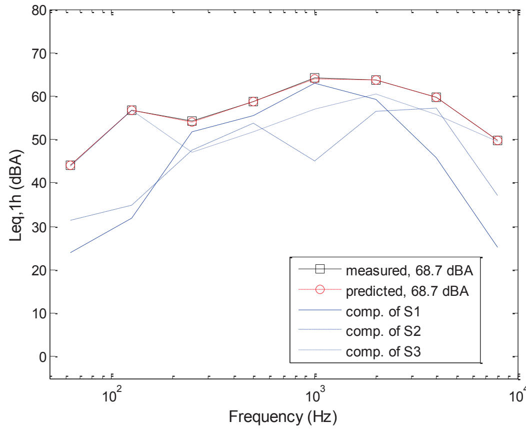

Figure 2: Predicted and measured sound power level of a high speed line with the slab track system, S1(rail), S2(wheel), S3(the rest part)[1]

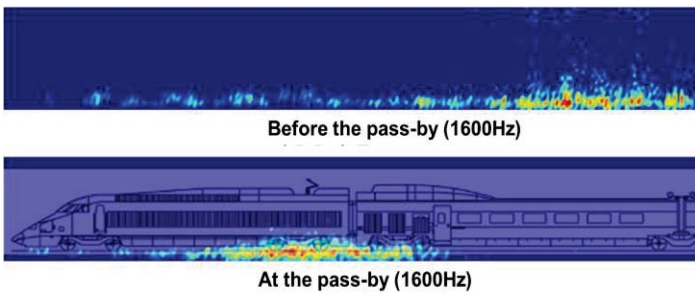

Figure 3: Noise source map of a high-speed train produced through a microphone array test[2]

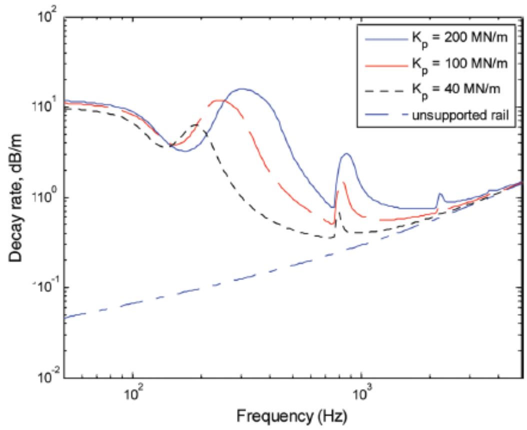

Figure 4: Decay rates predicted for different types of railway tracks[3]

Development of damping materials and strucutres

In some slab track lines, due to the lower track decay rate, rail vibration levels are higher than those levels for ballast tracks with soft pads. This way of planning a track system is chosen because of the requirements of track design, for which soft pads are needed in order to protect the rails, sleepers and ballast from the impactive force of train pass-by. Therefore, the requirements of this system often contradict the requirements of a low-noise track system. There exist also track systems using which low noise performance is targeted but in which the structral track safety is also considered at the same time. Mostly, such systems have certain complicate structures and are expensive.

It is one of the crucial targets of this project to find a economical low-noise device to solve the noise problem. First, alternative materials are studied that have the properties of high damping and good dynamic stability. Figure 5 shows experiment results of tests of the loss factor, compressive strength, and sitffness of ploymer(resin) concrete.

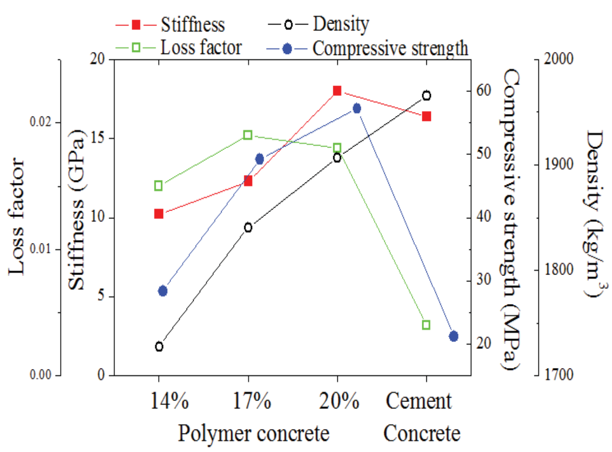

Figure 5: Test results of the various properties of a resin concrete sample compared to those of a cement concrete sample.

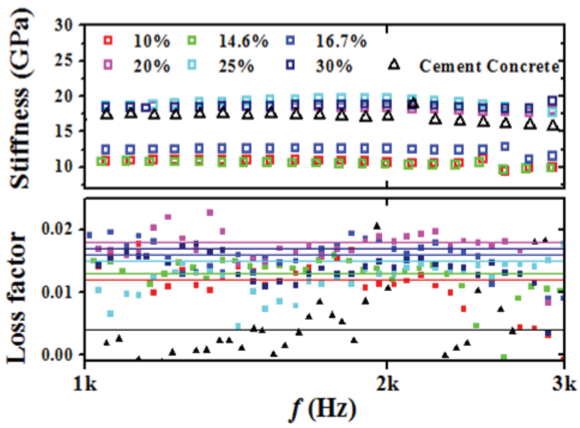

Figure 6: Test results on the various properties vs. frequency of a resin concrete sample compared to those of a cement concrete sample

According to the types of the compounds present in the resin concrete samples, useful dynamic material properties and significantly shorter hardning time can be observed through the tests; these materials are comparable to the materials of conventional track components.

In the furure, optimal material compounds and device structures will be suggested and developed.

Acknowledgement

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References

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