Why the evaluation of train noise will need to go with Soundscapes

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Abstract

To consider the environment of trains under the view of soundscape brings a new perspective in the evaluation of trains and the respective sound quality under scrutiny.
The evaluation of soundscapes brings subject-related methodological procedures into this area. With such suitable measurements a way was found that allowed to rely on different dimensions on reaction to these specific environments. Improving the sound quality of an environment imposes not only to reduce loudness but also to account for the qualitative appreciation as a cognitive judgment given by listeners and particularly, for the interaction between acoustic dimensions and other sensory modalities in qualitative judgments of given environments. Getting a better understanding of sound quality in this field requires a multidisciplinary research domain connecting various themes: studies on the subject and his capability in perception and interpretation; studies on the subject inside the respective society and the connection with others via language regarding the construction and the sharing of knowledge. The concept will be introduced.

Motivation

Other than the sound quality resarch and sound design for the automobile or white goods, we need to consider another important aspect of the railway, namely the „public service“. Train and train stations are not purchased by individual buyers, they are used by the public and in the majority of cases passengers do not have the choice to select trains according to their acoustical flavor. But if we consider the train system as one of the optional means of transportation among several different transportation systems, then it can be worthy to create the ride comfort and the environment with enhanced quality, as comfort sound quality, to achieve more modal shift to trains. With appropriate application of the sound quality and soundscape technology in the railway system, the train operators could get support in the resolve process of civil appeals, especially when complaints arise in spite of the noise condition, in that the measured noise level do not excess the permitted noise level limit value. Another aspect is that, the sound quality analysis can be used if a priority has to be determined, if there are several noise sources to be reduced at the same time under the restricted expense and time limit. So even if the results of the study on the sound quality and soundscapes are not directly linked to the visible consumption of the consumer, it can draw out crucial solutions and enhance the efficiency in the railway operation fields.

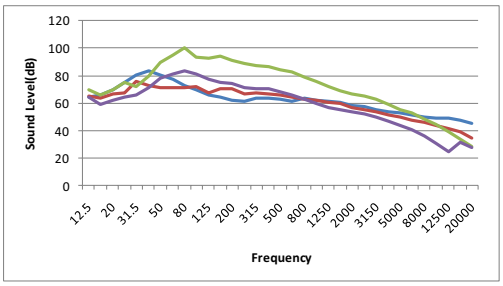

Abbildung 1: Steel-box bridge for trains with booming noise radiation.

As an example, the booming noise radiation (60Hz-100Hz) from a steel-box railway bridge causes complains from the residence, although the additional noise level increase due to the railway bridge construction is not so considerable, since the residence already have been exposing to relatively noisy environment with intensive road traffic (Abbildung 1). Measured noise level in Leq after the bridge construction did not yield much information for the solution of the civil complains. Trains have been passing the same section before the construction of the bridge, the elevated noise source position due to the bridge, that is the visual effect of the noise source, and the tonal noise characteristics of the box resonance brought the receivers additional perceptual impression of the noise increase. Applying Soundscapes can bring more special meaning for the train passengers, because they have more possibilities to perform various activities in the train than in the fast moving car. Korean Train are composed of various types of the coaches, for example for the high speed train the passengers can choose a ticket for a normal coach, coach with film movie, coach for peoples accompanied by babies, extra separated section for business peoples, first class coach and restaurant coach. For a special purpose designed trains exist also such as sightseeing trains with various entertainment coaches, seaside tour train is so reconstructed that the tourist could enjoy the seaside through the enlarged big windows on the side walls (Abbildung 2). Train stations become also more multifunctional. Conference rooms and meeting rooms are in the railway station buildings, many business people can save time and stress to get the meeting place throughout the road traffic

jam or by transferring trains. Book cafes, exhibitions and stages for concerts and performances can be found inside of many stations. The change of the spaces of the railway environment made it possible to perform various activities for the railway users and depending on the activities and noise receiver types, different concentration areas are demanded.

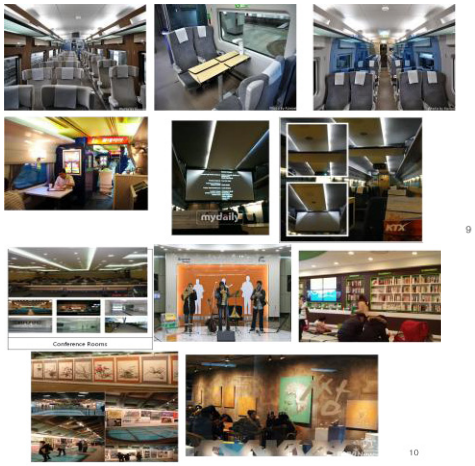

Abbildung 2: Various designs and constructions of the passenger coaches and spaces inside of the railway stations.

These are closely related to the influencing factors on the acoustical perception and required specifications for the noise reduction plans.

Noise issues

The main noise events causing civil appeals and annoyance in the railway can be summarized as follows;

- Additional noise sources of the high speed train
- Tonal noise due to the introduction of the slab track system for the high speed sections
- Brake noise of the high speed train at platform
- Diesel noise
- Freight trains
- Curve noise inside of the metro train due to the additional construction of new lines

Abblidung 3 shows the differences between the sound level measured on the high speed train inside the tunnel with the slab track system and the sound level measured inside a tunnel with the ballast track system. Around 80Hz and in the range of 400Hz~800Hz increased the sound level due to the slab track structure inside the tunnel, the former case is more induced from the aerodynamic flow feedback and it's transmission, the latter case is considered to be related to the slab track structure, so the annoying noise quality of the both cases was quite different, according to the complains of the passengers, a part of the rolling stocks was reconstructed to reduce the noise in 60Hz~100Hz.

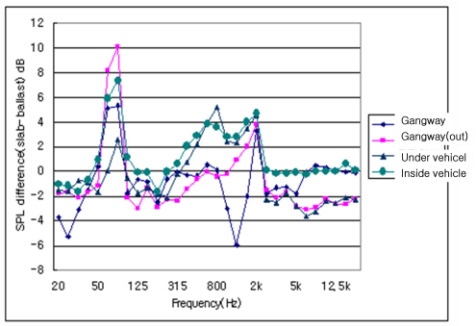

Abbildung 3: Booming noise annoyance inside the high speed train in a tunnel with slab track system.

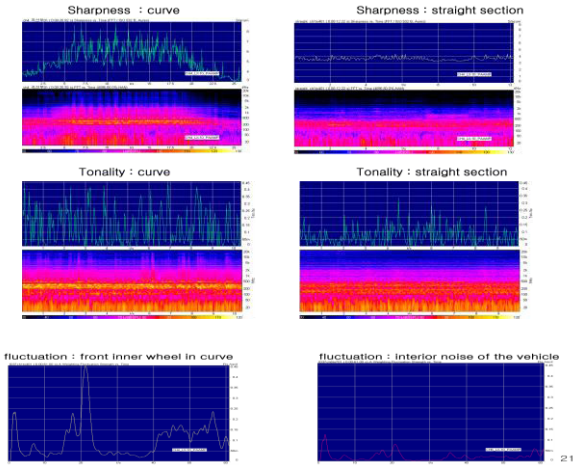

Abbildung 4: Different Sound Quality characteristics according to the noise receiving location and vehicle driving conditions

Another main noise is the curve noise in the metro systems. Abbildung 4 shows sound quality characteristics of the curve noise and noise in the straight section measured at a same receiver position(top) and different fluctuation changes of the same noise source, front inner wheel at curving, according to the receiver positions.

Summary

Owing to the complexity of the railway noise sources and the transmission paths, mostly a priority has to be chosen for the noise recution measures when complains arrise. Reduction of the main noise source level is no more the only target – the possibility and feasibility are often limited in the railway system - many-sided investigations about the noise receiving condition and environment are required to realize the optimal acoustical field with enough perceptual satisfaction. Possible items for the application of the sound quality study and the soundscapes can be for example the interior of the passenger coaches, sound design of the spaces in the railway stations and noise shileding facilities in the open spaces near railway passings. Description of sound scapes, definition of the procedure, perceptual study and laboratory set up for the reproduction and design of the acoustical railway environment will be followed and are in progress.