

Figure 2: Reflection Index in one-third octave bands for three sound sources with different directional characteristics; upper row: without correction for directivity; lower row: with correction for directivity

Analytical Model

As no rigid connection between loudspeaker and microphone grid is mandatory, both microphone positions and loudspeaker orientation towards the noise barrier are prone to misalignments. Therefore, an analytic model was developed to investigate these influences. To describe the sound source, a spherical harmonics cap model was used [3].

In a first step, the microphone positions were randomly distributed with a maximum distance of 75 mm around the ideal position. Secondly, the loudspeaker orientation was altered with a maximum error of 7.5 degrees. The value for both positioning uncertainties is based on laboratory measurements of the authors. For both simulations, the reflectivity of the barrier was chosen to be $r = 0.9$. The resulting measurement uncertainties are shown in Figure 3. The results again demonstrate the influence of the sound source used for these measurements. The uncertainty due to loudspeaker misorientation, especially in the higher frequency range, is exceeding the mispositioning of the microphones in front of the barrier.

Measurements

Measurements were performed in front of a plane concrete wall to prove the model outcomes. For each setup, 20 consecutive measurements (with intentional mispositioning of the microphone resp. misalignment of the loudspeaker) were performed. Their results are shown in Figure 4 in terms of the variation coefficient. As expected, uncertainties occur mainly in the higher frequency range where the sound source possesses a stronger directivity. Also, the uncertainties due to loudspeaker misorientation exceed the microphone mispositioning error. The remaining discrepancies between analytical model and measurements can easily be explained by the differences of the loudspeaker model and the sound source used as

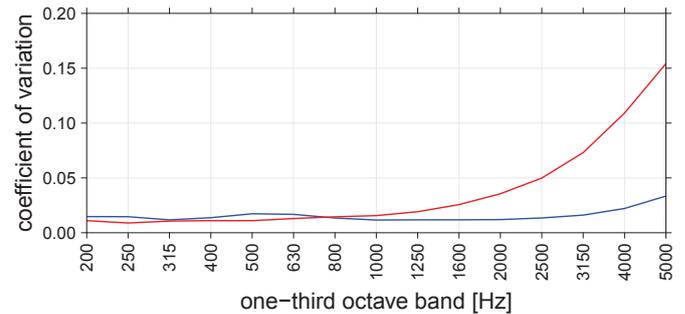


Figure 3: Simulated uncertainty due to random microphone misalignment (blue line, max. misalignment distance is 75 mm), and due to loudspeaker misorientation (red, max. angle deviation is 7.5 degrees)

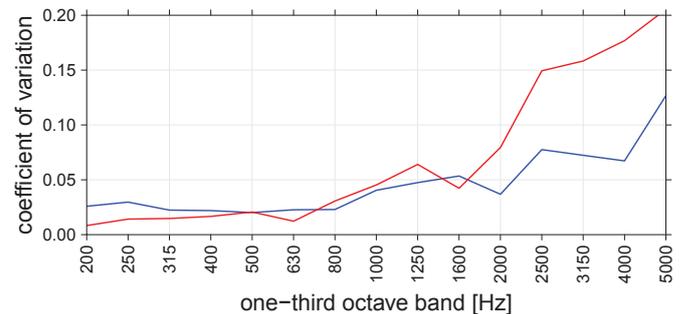


Figure 4: Measured uncertainty due to random microphone misalignment (blue) and loudspeaker misorientation (red); microphone position displacement 60 cm out of central line

the loudspeakers used in the measurements comprised a stronger radiation pattern than captured with the analytical model.

Conclusions

For measuring the sound reflection properties of noise barriers, focus has to be laid on the correct choice of the sound source. Strong radiation patterns result in an increased measurement uncertainty.

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