Low frequency noise and induced vibration from air-traffic and military training – processes and new mitigation measures

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Sound from military activity, aircrafts and explosions do propagate over large distances. Their low frequency component may contribute to human annoyance by inducing building vibration, involving both rattling and whole body vibrations. Here, we present the overview from a broad study on low frequency sound induced vibration. Our primary application is the noise and excited by aircrafts and the vibration they induce in buildings. The study involve a range of full-scale field measurements, laboratory experiments, simulations, and design of countermeasures. The first full-scale field measurements were initiated in 1994, and were then focusing on the ground effect on the low frequency sound propagation over long distances from heavy weapons and military training. These were followed by a set of low frequency noise and vibration measurements due to blast induced sound in typical wooden residential buildings close to military training grounds. These full-scale measurements detected a basic mechanism for the vibration generation in buildings, namely that the indoor floor vibrations are induced by the indoor sound. Later, the same mechanism was detected for military aircrafts during training. To improve our capabilities within this field, a five-year research program was initiated by the Norwegian Defence Estate Agency in 2010. The program involved the development of a new numerical method for calculating the vibration generation due to the low frequency sound. As the understanding of the low frequency sound transmission is crucial also for the mitigation of vibration, a set of laboratory experiments concerning sound transmission in the lowest frequency range were conducted. By comparing the laboratory measurements and the numerical simulations of the low frequency sound transfer, we were able to detect basic mechanism for low frequency sound transmission, which have allowed us to better design countermeasures. To this end, an outcome of the study was a set of countermeasures for reducing sound induced vibration, by applying increased stiffness for walls and roofs.
Biographical sketch, Finn Løvholt

Finn Løvholt is a researcher at the independent research foundation NGI in Norway, where he has worked the last 15 years. He also holds an adjunct position as Associate Professor at the University of Oslo. Løvholt received his Master degree in Physics at the University of Life Sciences, Ås Norway, in 1998, and received his PhD at the University of Oslo, Department of Mathematics within the field of fluid dynamics. He has wide experience as a researcher and advisor within a range of fields related to wave propagation, ground vibration, and acoustic. Over a period of almost 10 years he has been leading a research activity at NGI funded by the Norwegian Defence Estate Agency on outdoor low frequency sound propagation and vibration on buildings. He has further been involved in research and development projects related to seismic wave propagation for offshore site characterisation, and blast induced vibration in sensitive clays for evaluation of landslide triggering. Finn Løvholt has assisted the United Nations (UN-ISDR) with technical work for the Global Assessment Report (GAR), quantifying the global tsunami hazard and risk. Another important example of the application of his research includes the modelling of landslide-induced water waves, where he is presently leading a four-year national research project under the FRIPRO young talents research program funded by the Research Council of Norway.