ACOUSTICS2008/3012
Investigation of a vibro-acoustic reciprocal method to derive the contact forces of building equipment

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Structure-borne sound caused by installations can be derived from the injected structure-borne sound power into the connected building element. Theoretically, this is as simple as summing the products of force and velocity at each contact point of the installation. The velocity can be well approximated by the velocity measured close to the contact point. But to measure the force, installation and building element would have to be separated to insert a force sensor. This is generally impractical or even impossible. In this paper, a method is analyzed to derive the force between an installation and a building element in a vibro-acoustic reciprocal way. First, a dedicated volume sound source is placed in an adjacent room and the transfer function of its volume acceleration with the acceleration of the building element is determined. Next, the sound pressure is measured at the source's position while the installation is operating. Since most installations have an important lower frequency contribution, below 50 Hz, the sound source must cover this frequency range with sufficient level. Moreover, an accurate measure of the in-situ volume acceleration of the used source is required. Finally, the method is compared to other methods that approximate the injected structure-borne sound power.