Session: Tyre-road and rolling noise

Separation of airborne and structure-borne tire-road noise based on vehicle interior noise measurements

Roland Sottek[1], Bernd Philippen[2]
HEAD acoustics GmbH, Ebertstr. 30 a, 52134 Herzogenrath, Germany,

[1] *E-Mail: roland.sottek@head-acoustics.de*
[2] *E-Mail: bernd.philippen@head-acoustics.de*

Vehicle interior noise consists of a superposition of broadband contributions from powertrain, wind and tire-road noise. Tire-road noise has become increasingly important referring to overall acoustic comfort, especially for (luxury) sedan cars with pleasant low-noise engine sounds. An interior noise recording during a coast-down (engine switched off) contains different components: a mixture of wind along with airborne and structure-borne tire-road noise shares. The separation of the mixture into these components requires appropriate algorithms and additional measurements. Therefore, structure-borne excitation signals as well as the airborne noise radiation of all four tires are measured during a coast-down test from maximum vehicle speed to standstill, simultaneously to an artificial head recording in the vehicle interior. Based on the fact that wind and tire-road noise are uncorrelated, the evaluation of the multiple coherence between the excitation signals and the simultaneous binaural recording allows calculating speed-dependent FIR filters to separate the different components.

A new approach describes the physical system as a **M**ultiple-**I**nput-**M**ultiple-**O**utput (MIMO) model. The tire-road noise shares can be synthesized using transfer functions estimated from road measurements using an **O**perational **P**ath **A**nalysis (OPA); the uncorrelated wind noise can be determined as the difference signal between interior noise and synthesized tire-road noise. In the case of uncorrelated excitation signals OPA is very efficient and accurate; no additional laborious transfer function measurement is required. The assets and possible drawbacks of OPA for characterizing wind as well as airborne and structure-borne tire-road noise in comparison to coherence filtering will be discussed.

Keywords:
- tire-road noise separation
- acoustic comfort
- binaural auralization
- multiple coherence filtering
- operational path analysis