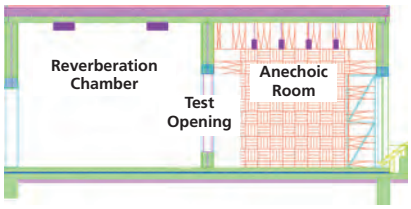
New Sound Transmission Loss Test Facility for Acoustic Evaluation of Smart Lightweight Panels



The sound transmission loss (STL) quantifies the propagation of incident acoustic energy through a structure to a neighboring fluid. It is an important measure not only in building acoustics but also in the aircraft, automotive, railway and marine industries as it is directly linked to noise exposure and acoustic comfort of passengers. A low STL permits a high transmission of acoustic energy through the structure resulting in high noise levels, e.g. in the cabin of an aircraft. The growing use of stiff and lightweight structures such as carbon-fiber-reinforced-plastics (CFRP) in the transportation sector poses great acoustic challenges especially in the low-frequency domain (< 500 Hz) where the STL typically drops. The urgent need of lightweight-compliant sound abatement methods promotes the development of smart structures with active structural acoustic control (ASAC). The new sound transmission loss test facility makes it possible to determine the STL of passive and active structures with method precision conforming to the relevant ISO standards.

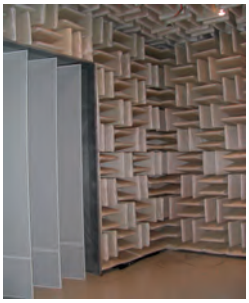
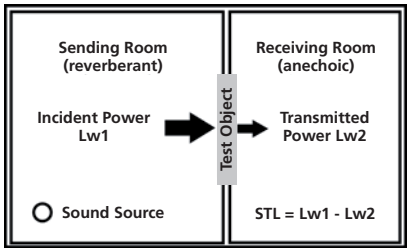


Fig. 2:
Anechoic room of the test facility.



Characteristics and Functionality of the Test Facility

The sound transmission loss test facility consists of a reverberation chamber and an anechoic room. The rooms are connected by a test opening of 2.5 x 2.5 m^2 which can be used for the integration of flat or curved test structures such as aircraft panels. Additionally, both rooms can be used independently according to DIN EN ISO 3741/3745. The lower cut-off frequency is 100 Hz for both rooms. If necessary, the test opening can be closed by means of a highly sound absorbing double-panel construction with surfaces compliant to each room. The reverberation room is typically used as the sending room for STL measurements, providing a diffuse sound field excitation of the test object. Furthermore, it facilitates quick sound power measurements based on the temporal and spatial average sound pressure level (SPL). The anechoic room is typically used as the receiving room for STL measurements providing semi-free field conditions due to the sound-absorbing walls and ceiling. It moreover provides suitable conditions for sound intensity probe and microphone array measurements, allowing a determination of the sound intensity distribution on the structural surface. Given the need of a directional acoustic excitation of a structure for STL measurements, a sound source can alternatively be placed in the semi-anechoic room. In this case, the transmitted sound power has to be evaluated in the reverberation chamber.

Application for Future Research in Active Structural Acoustic Control

The activities of the Institute of Composite Structures and Adaptive Systems in the field of ASAC are focused on the development of smart lightweight structures with improved acoustic properties, especially in the challenging low-frequency domain. The new test facility will provide the experimental conditions necessary for the investigation and validation of numerically designed and optimized ASAC systems. A future research topic will be to investigate the transmission of sound through double-panel structures such as fuselage parts in order to derive more advanced actuator, sensor and signal processing schemes for ASAC.

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