Effect of ETHICS on the flanking transmission of outer walls

Lutz Weber

Fraunhofer-Institut für Bauphysik (IBP), D-70569 Stuttgart, Germany, Email: lutz.weber@ibp.fhg.de

Introduction
External thermal insulation composite systems (ETHICS) are used to minimize the heat losses of outer walls. They consist of a heat insulating layer (mostly mineral wool or polystyrene) which is fixed to the outside of the wall and covered by a plaster coat. The construction behaves as a mass-spring-mass system, which considerably changes the acoustical properties of the supporting wall. Whereas the effect of ETHICS on the direct sound transmission has been investigated quite extensively [1], the knowledge of flanking transmission is only small. For this reason, the effect of ETHICS on the flanking transmission of outer walls was analysed in detail by measurements of airborne and structure-borne sound combined with additional acoustical calculations.

Measurement
The measurements of flanking transmission were carried out in a diagonal test facility. The measuring arrangement comprised a separating wall with high mass per unit area and a flanking wall carrying the ETHICS. The two walls were connected by a T-junction (see Figure 1). The investigated situation corresponds to two adjacent rooms with continuous outer wall belonging to different flats.

Because of the large variety of possible constructions, the investigations were limited to three representative examples including most practical applications. The flanking walls under test had the following technical specifications (the number in brackets denotes the measured resonance frequency of the system):

| Setup 1         | Wall: 300 mm aerated concrete, \(m'' = 165 \text{ kg/m}^2\) ETHICS: 80 mm polystyrene, 8,0 kg/m\(^2\) plaster (315 Hz) |
| Setup 2         | Wall: 300 mm vertical coring bricks, \(m'' = 240 \text{ kg/m}^2\) ETHICS: 80 mm mineral wool, 9,6 kg/m\(^2\) plaster (115 Hz) |
| Setup 3         | Wall: 175 mm solid lime sand stone, \(m'' = 336 \text{ kg/m}^2\) ETHICS: 80 mm mineral wool, 12,0 kg/m\(^2\) plaster (100 Hz) |

The construction of the separating wall was always the same (240 mm solid lime-sand stone, \(m'' = 440 \text{ kg/m}^2\)). Apart from measurements of the flanking transmission the vibration reduction index of the junction and the structural reverberation time of the wall with and without ETHICS were determined.

Results
Transmission paths
In principle flanking transmission could take place along three different paths: along the supporting wall (path 1), the insulating layer (path 2) and the outer plaster coat (path 3). To find out which of these paths is most important, a vertical gap was cut into the ETHICS opposite to the junction. Since the gap had no influence on the acoustical behaviour (see Figure 2), the ETHICS can not noticeably contribute to flanking transmission.

Flanking transmission
Since the interaction between ETHICS and supporting wall changes the direct transmission of sound, it is to be expected, that this also applies to the flanking transmission. This was investigated by measuring the flanking transmission of the outer wall with and without ETHICS. From Figure 3 it can...
be seen, that the influence of ETHICS on the flanking transmission is only small. An interesting effect occurs near the resonance frequency of the systems, where the ETHICS causes an enlargement of sound insulation. This may be due to the removal of sound energy from the supporting wall by the ETHICS. At frequencies above and below resonance the difference of sound insulation with and without ETHICS stays below the fluctuation of the measuring data.

Figure 3: Flanking transmission along path Ff with and without ETHICS as a function of frequency (measurement on setup 2). Apart from the attachment of the ETHICS both measurements were performed under exactly the same conditions.

Theoretical approach
To a first approximation the acoustical effect of ETHICS can be described by a reduction of the structural reverberation time of the supporting wall. Application of the calculation model according to DIN EN 12354-1 [2] leads to the following expression:

\[
R_{Ff,E} = R_{Ff} + 10 \log \left( \frac{T_{s,F} T_{s,f}}{T_{s,F,E} T_{s,f,E}} \right) \text{[dB]} \tag{1}
\]

- The flanking transmission along ETHICS (inside of the insulating layer and the outer plaster coat) can mostly be neglected.
- The attachment of ETHICS does not substantially change the vibration reduction index.
- The acoustical effect of ETHICS on the flanking transmission is mainly due to the reduction of the structural reverberation time of the supporting wall (especially near the resonance frequency).
- Normally the effect of ETHICS on the flanking transmission of outer walls can be neglected, so that it needs not to be considered in acoustical dimensioning of buildings.

The above statements are valid for usual buildings. In special cases, as e.g. separating walls in double-leaf construction bridged by ETHICS or outer walls consisting of lightweight elements, a more detailed consideration of the acoustical behaviour of ETHICS may be necessary.

Figure 4: Measured and calculated flanking transmission for a wall with ETHICS (setup 2). The calculation was performed by means of equation (1).

Summary
The effect of ETHICS on the flanking transmission of outer walls was examined experimentally and theoretically. The investigations comprised different types of ETHICS and walls. Since all measurements showed similar results, the following conclusions are valid for all building conditions:

- The flanking transmission along ETHICS (inside of the insulating layer and the outer plaster coat) can mostly be neglected.
- The attachment of ETHICS does not substantially change the vibration reduction index.
- The acoustical effect of ETHICS on the flanking transmission is mainly due to the reduction of the structural reverberation time of the supporting wall (especially near the resonance frequency).
- Normally the effect of ETHICS on the flanking transmission of outer walls can be neglected, so that it needs not to be considered in acoustical dimensioning of buildings.

The above statements are valid for usual buildings. In special cases, as e.g. separating walls in double-leaf construction bridged by ETHICS or outer walls consisting of lightweight elements, a more detailed consideration of the acoustical behaviour of ETHICS may be necessary.

References

Acknowledgement
The investigations were financed by the Bundesamt für Bauwesen und Raumordnung (BBR), Germany.