IN-SITU ESTIMATION OF SOUND TRANSMISSION LOSS USING A SCANNING SOUND INTENSITY P-U PROBE

CÁSTOR RODRÍGUEZ-FERNÁNDEZ[1*], DANIEL FERNÁNDEZ-COMESAÑA[2]

1: Sound of Numbers, S.L.
Av. Peregrina 21 P92A 15220 Ames - A Coruña - Spain
castor@soundofnumbers.net, http://www.soundofnumbers.net

2: Microflown Technologies
Tivolilaan 205 - 6824 BV Arnhem - The Netherlands
fernandez@microflown.com, http://www.microflown.com

Keywords: Building acoustics, sound intensity, sound insulation, sound transmission loss.

Abstract *The assessment of sound insulation by acoustic intensity measurements is a versatile alternative to the standard two-room method, particularly in the presence of flanking transmission or when it is necessary to show local contributions. An extension of traditional intensity-based methods of estimating Sound Transmission Loss (STL) can be achieved by using measurements in both sides of the sample under investigation via a sound visualization technique such as Scan & Paint. Such approach is suitable for in-situ tests, avoiding the necessity of a reverberant source room and an anechoic receiving room. Sound pressure maps, acoustic particle velocity and sound intensity can be used to describe the acoustic power transmitted through a partition or element. Furthermore, visual representations of the acoustic field over the investigated area can reveal structural weakness or leakages, key information for applying appropriate noise control strategies. In this paper, scanning sound intensity measurements with a PU probe are performed in both sides of the sample to estimate sound transmission loss. Results are validated via comparisons with estimations obtained through the standard two-room method. It is demonstrated that the in-situ estimations of sound transmission loss are in good agreement with the standardized procedure. In addition, sound maps provide detailed information of both excitation distribution in the source room and the most critical emission points in the receiving room.*

1. INTRODUCTION

The standard two-room method for assessing sound insulation (sound transmission loss) of a constructive element requires complex and big facilities such as test chambers, and a tough procedure where many variables must be controlled [1-2].

A novel method for measuring Sound Transmission Loss using Sound Intensity is shown in this paper. The combination of using PU probes instead of the traditional PP probe for Sound Intensity measurements and acquiring and managing the data with the Scan & Paint method [3] enables to capture a large amount of information with a simple and fast measurement procedure.

2. SCAN AND PAINT

The sound visualization technique used in this paper is called “Scan and Paint” [3]. The acoustic signals of the sound field are acquired by manually moving a single transducer across a measurement plane whilst filming the event with a camera. In the post-processing stage, the sensor position is extracted by applying automatic color detection to each frame of the video. It is then possible to split the long recording into multiple segments by applying a spatial grid algorithm. Each fragment of the signal will be linked to a grid cell, depending upon the position of the probe during the measurement. Spectral variations across the space are computed by analyzing the signal segments of each grid section.
Only the 2D location relative to the background image is computed at this point, so it is later required to

define the relation between 2D coordinates and 3D coordinates, to establish a relationship between pixels and meters in the measured plane. The camera should be placed perpendicular to the measurement area so as to avoid any visual errors caused by the camera projection.

3. EXPERIMENTAL EVALUATION

Thanks to the invaluable cooperation of the windows manufacturer Aluminios Cortizo, a validation test was performed on a standardized chamber, where tests according to ISO 10140 are being usually performed.

3.1. Measuring procedure

With the setup shown in Figure 1, using only one noise source position, we could perform Sound Intensity scans on both sides of the sample. This test facility has been designed for windows sound insulation tests, thus the sample is composed by a brick wall and a window frame. The scanning is basically performed over the window sample.

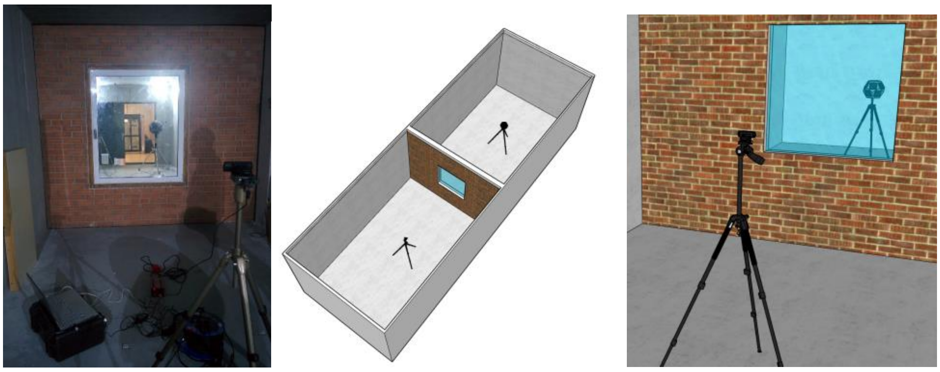

Figure 1 - Scanning measurement setup

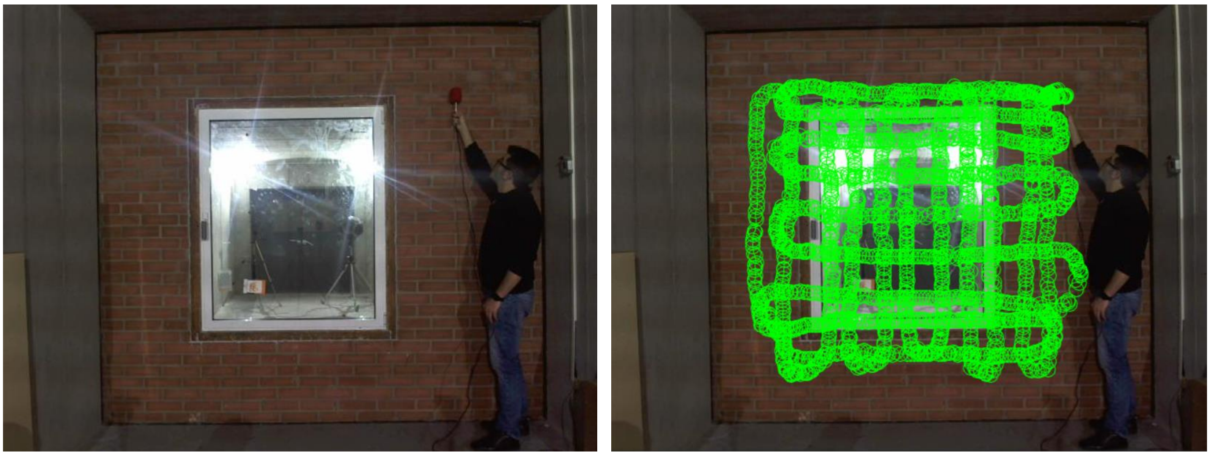

Figure 2 - Receiver room scanning

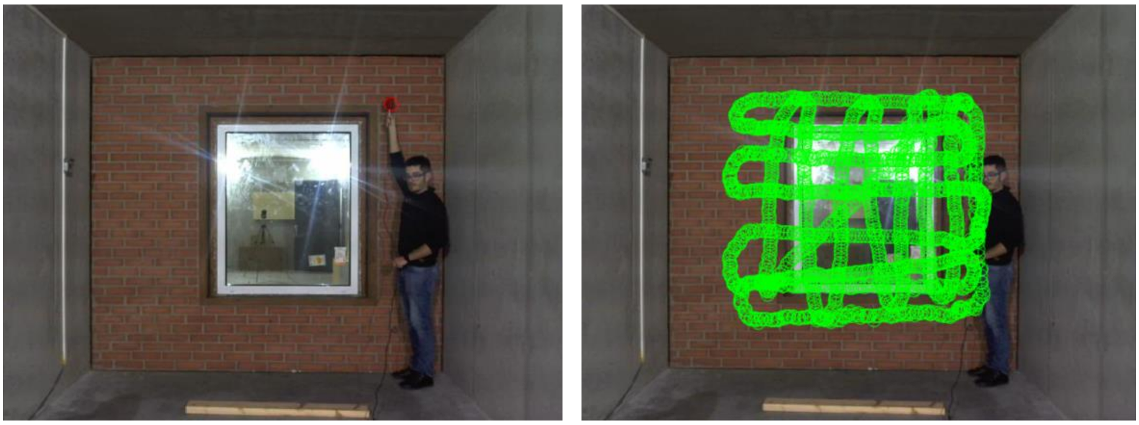

Figure 3 - Source room scanning

Scan&Paint software captures the position and acquires the sound data: sound pressure and particle velocity, in every position. It can be seen in Figure 2 and Figure 3 all the tracked positions when performing the scanning on both sides of the sample.

3.2. Data analysis

The data is processed following a grid structure. Actually, Transmission Loss is calculated getting the data from two grids: the incident and the transmitted as it can be seen in Figure 4. On those screenshots the grids definition and the probe positions in the scanning are highlighted.

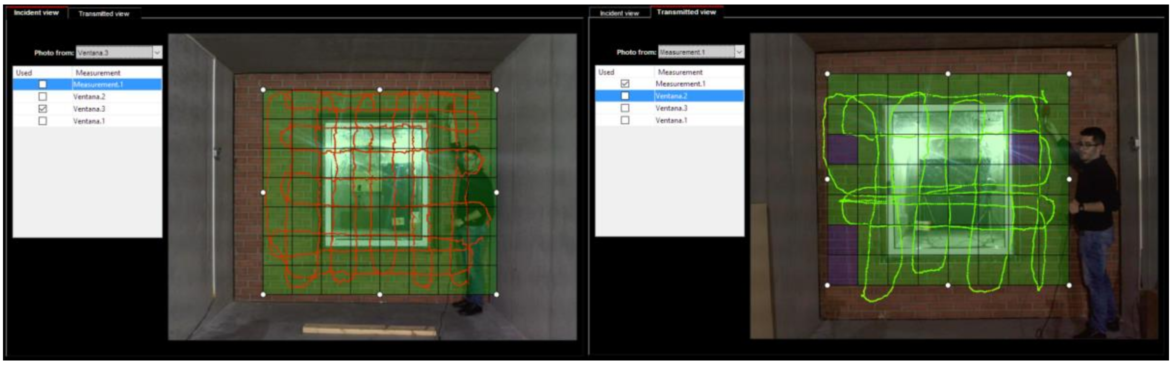

Figure 4 - Grid configuration for TL calculations

As shown in Figure 5, three different scanning distances from the sample have been chosen. The values acquired were quite similar, showing the diffusivity of the sound field in the source room, so only the closest scanning surface has been chosen.

Figure 5 – Source room positions

3.3. Results

Scan&Paint software can be used to calculate Transmission Loss and display the results in an overlaid colormap, as it can be seen in Figure 6 and Figure 7. Figure 6 shows the averaged Transmission Loss in the frequency bands between 100 Hz and 3150 Hz. Figure 7 displays Transmission Loss in the 4000 Hz frequency band.

The abrupt change of the Transmission Loss values between the window and the brickwall can be clearly seen in these figures. The space resolution of the colormap could be improved processing the data with a grid with smaller cells and even a more detailed scanning. But, in this case, this rough scanning contains information enough for assessing the overall Transmission Loss of the window. It should be noted that this level difference window-brickwall is different from the flanking transmission, defined as the sound transmitted through the lateral concrete walls.

In Figure 7 it can also be seen the different Transmission Loss values in the frame area. This would help to perform product enhancement following a more detailed analysis.

As the aim of this study is focused on comparing the Scan&Paint Transmission Loss PU measurement procedure with the standard ISO 10140, a region of interest has been defined with a black thick square as shown in both Figure 6 and Figure 7. It could be defined in some other region too.

Scan&Paint software can process the Transmission Loss spatial values and create a frequency averaging graph as it can be seen in Figure 8, where the results are also compared with the Transmission Loss values obtained following the process defined in the ISO 10140.

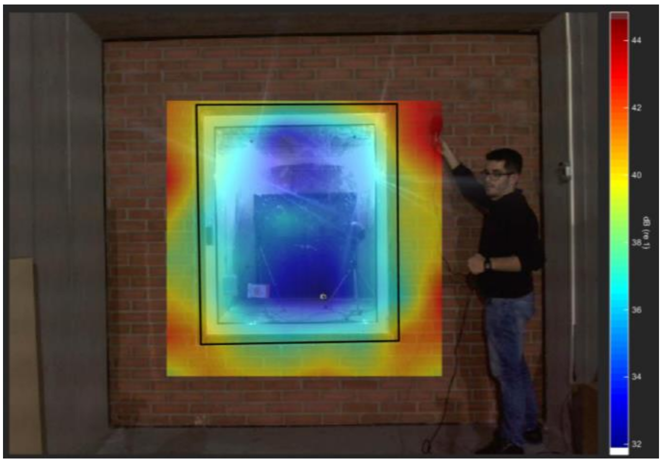

Figure 6 - Averaged Transmission Loss 100Hz-3150Hz

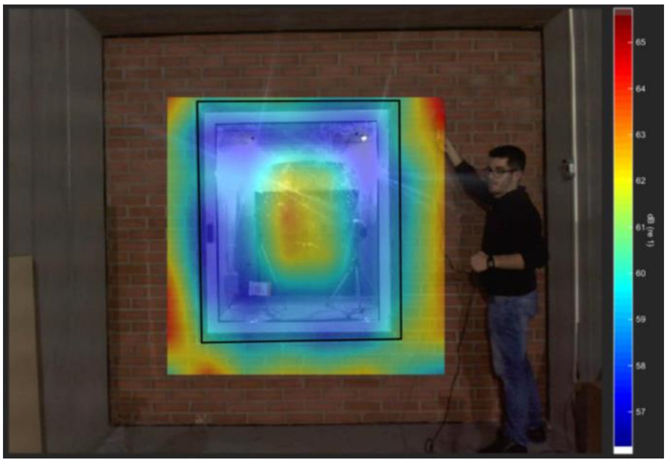

Figure 7 - Transmission Loss in 4000Hz band

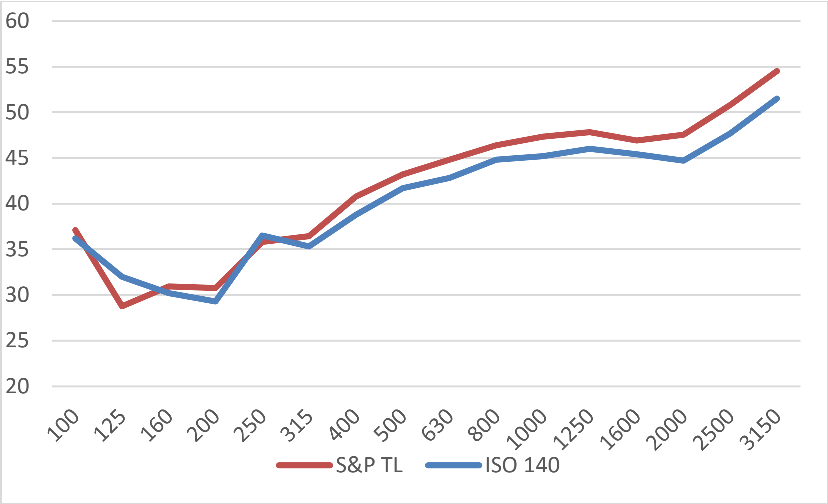

Figure 8 - Comparison of Sound Transmission Loss results

4. CONCLUSIONS

As shown in Figure 8, a very good agreement is obtained between the Sound Transmission Loss measured in the test chamber using the sound intensity method and a PU probe, compared with the standardized 2 room method.

More successful measurements have been performed, but due to the customer privacy cannot be currently published.

It is demonstrated that a new method for measuring Sound Transmission Loss using Sound Intensity is possible with the proposed approach. The usage of Microflown PU probe in combination with the software tool Scan & Paint enables capturing additional information compared to the traditional methodology, such as the spatial distribution over the sample visualized through color maps, for detecting weak points, leakages or mounting defects.

5. REFERENCES

[1] Lai, J.C.S.; Qi D., 1993. "Sound Transmission Loss Measurements Using the Sound Intensity Technique Part 1: The Effects of Reverberation Time", Applied Acoustics 40, 311 – 324.

[2] van Zyl, B-G-; Erasmus, P-J.; Anderson, F., 1987. “On the Formulation of the Intensity Method for Determining Sound Reduction Indices”, Applied Acoustics 22, 213 - 228.

[3] Fernandez Comesana, D.; Steltenpool, S.; Carrillo Pousa, G.; de Bree, H-E.; Holland, K., 2013. “Scan & Paint: Theory and Practice of a Sound Field Visualisation Method”, ISRN Mechanical Engineering 2013, Article ID 241958.