DOI: 10.61782/fa.2025.0111

FORUM ACUSTICUM EURONOISE 2025

AIRBORNE SOUND INSULATION IN FIVE OFFICE BUILDINGS ACCORDING TO REQUIREMENTS OF ITALIAN REGULATIONS AND WELL BUILDING STANDARD

Di Blasio Sonja[1*] **Ferilli Francesca**[1] **Andreozzi Laura**[1]
Gualdana Ilenia[1] **Stigliano Enza**[1] **Siciliano Emanuele**[1]
[1] Lombardini22, Via Elia Lombardini, 22, 20143 Milano MI

ABSTRACT

In the recent years there has been a surge of interest around the activity-based offices and the application of Building Performance Certification Programs (LEED, WELL, BREEAM) in the Italian modern offices. In this framework, the relevance of acoustic comfort is increasing for occupants and building owners. In the enclosed offices used for video conferences, meetings and focused activities, adequate speech privacy is highly required by users. Sound that transmits from adjacent rooms through partitions can be distracting or disturbing and speech privacy can be impaired, mainly in receiving rooms where background noise is particularly low. The sound insulation performance of partitions is highly influenced by construction and constraints imposed by pre-existing conditions and modern design, such as curtain walls, glass fins and ducts crossings. On-site measurement campaigns regarding Airborne Sound Insulation, Reverberation Time and Background Noise Levels were performed in 5 different office buildings in Italy for 33 pairs of rooms. The analysis of results was carried out comparing the acoustic requirements of UNI 11367:2023 and WELL Building Standard. Moreover, the impact of construction, project constraints and different acoustic solutions has been investigated.

Keywords: *enclosed office, speech privacy, airborne sound insultation, on-site measurements, well building standard.*

**Corresponding author: s.diblasio@atmosbp.it.*

1. INTRODUCTION

The acoustic comfort in modern office buildings play a crucial role in shaping the productivity, well-being and satisfaction of occupants. Open workspaces are commonly designed to enhance communication, collaboration, and the sharing of knowledge [1]. However, the decreased privacy, both in terms of visibility and sound, can lead to interruptions and lack of concentration. Denielsson [2] found that noise disturbance was higher in large open-plan offices than in cellular ones. Activity-based offices are designed in order to provide open zones for different types of activities, for example open spaces for collaboration works, silent rooms for focused tasks that require concentration, spaces for phone calls and rooms for formal and informal meeting [3]. In this framework, Building Performance Certification Programs (LEED, WELL, BREEAM) define indexes for acoustic comfort assessment. In particular, WELL Building Standard introduces a mandatory pre-requirement to define label acoustic zones according to the activity types in the design and planning process. Furthermore, the improvement of speech privacy between adjacent rooms represents an important goal in the WELL sound concept. Despite the acoustic is the less accounted domain in the protocols [4], these protocols can represent an important tool to improve the relevance of acoustic comfort in Italy since the strong interest on the part of owners to have certified buildings. Indeed, the mandatory Italian regulations for private buildings (D.P.C.M. 5/12/1997) does not impose the requirements in terms of airborne sound insulation between adjacent rooms, reverberation time and background noise levels inside the office spaces. The technical Regulation, such as the UNI 11367:2023 [5], UNI EN ISO 3382-3:2022 [6] and ISO 22955:2021 [7] are emerging as guidelines for acoustic

comfort assessment, but their application in office design process is voluntary.
In the design process of office building, the acoustic consultants frequently face challenges imposed by the absence of mandatory regulations, pre-existing conditions, electrical and mechanical constraints and the main trends in contemporary architecture. Indeed, previous studies demonstrate the effects of the workmanship and lightweight buildings on sound transmission [8-10].
The present study involved 33 pairs of rooms in order to evaluate the effects of construction, pre-existing or designed constraints (i.e. light façade, ducts and cable tray crossings) and different acoustic solutions on airborne sound insulation and speech privacy. A comparison between requirements of UNI 11367:2023 and WELL Building Standard has been carried out in the analysis of results.

2. METHODOLOGY

2.1 Measurement procedure

Measurements of airborne sound insulation were performed in accordance with UNI EN ISO 16283-1:2018- Part 1 [5]. Sound pressure levels were measured in third octave bands in the frequency range from 50 Hz to 5000 Hz using class 1 sound level meter devices. An omnidirectional (dodecahedron) white noise source was used in two positions. For each source position, five fixed microphone positions were identified, where possible, considering the presence of the furniture.
Measurements of reverberation time were performed in accordance with UNI EN ISO 3382-2:2008 [11] using impulse response method and a clapper.

2.2 Case study

The measurement campaigns involved 33 pairs of rooms in five Italian office buildings located in Milan and Rome. They are multi-storey buildings characterized by the floor-to-ceiling glazing façade (except for one office) and open workspace that includes enclosed areas dedicated to specific functions (i.e. meeting, video conferences and focused activities). The sizes of the enclosed rooms analyzed vary from large (250÷100 m^3) to medium (100÷50 m^3) to small (50÷10 m^3). The 33 pairs of rooms have been selected in order to have a representative set of partitions with different characteristics. In particular, Table 1 shows the variety of partitions in terms of materials and the weighted sound reduction index (R_w), when it was possible to calculate. The list of types of junctions between partition and upper, lower and lateral elements is reported in Table 2. Figure 1 shows a schematic drawing and a picture of the glass fins, that are a typical T joint between the partition and lateral elements in modern buildings. The characteristics of the doors, the ceiling and the sound absorbing materials installed on walls are reported in Table 3, Table 4 and Table 5, respectively. Acoustic performance of the elements in terms of weighted sound reduction index (R_w) and weighted sound absorption coefficient (α_w) come mainly from laboratory certificates.

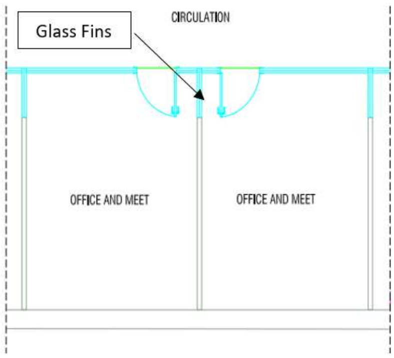

Figure 1. An example of glass fins.

Table 1. Types of partitions

ID	Description
PL4	single 75 mm metal frame with mineral wool and 4 standard plasterboard layers (R_w=54 dB)
PL4h	single 75 mm metal frame with mineral wool and 4 plasterboard layers: 2 high density and 2 standard gypsum boards (R_w = 56÷60 dB)
PL5	double 50 mm metal frame with mineral wool and 4 standard plasterboard layers + 1 plasterboard layer in the middle (R_w ~ 60 dB)
OPB	operable partition (R_w =50÷55 dB)
BRI	brick wall (variable thickness)
GL2	double glazed laminated glass (R_w= 44÷45 dB)
GL1	single glazed laminated glass (R_w=38 dB)

Table 2. Types of junction elements

ID	Description
Upper and lower elements	
FS_B	raised floor with acoustic barrier under the floor - structural slab
FS	heavy raised floor without acoustic barrier under the floor – structural slab/plasterboard barrier
SS	structural slab - structural slab
Lateral elements	
a	glazed facade mullion - glass walls/fins
b	glazed facade mullion - plasterboard wall
c	massive facade - glass walls/fins
d	massive facade - plasterboard/brick wall
e	plasterboard wall - glass wall
f	plasterboard wall - plasterboard wall

Table 3. Types of doors

ID	Description
OPd	opaque door (R_w = 40 dB) with drop-down seal not properly installed
GLd	glass wall without drop-down seal
SLd	sliding door

Table 4. Types of ceiling

ID	Description
0	no false ceiling
1	false ceiling in microperforated metal panels with polyester fiber in the cavity (α_w ~ 0.7)
2	suspended panels in polyester fiber (α_w = 0.8) or felt (α_w ~ 0.4)
3	false ceiling in acoustic plaster (α_w = 1.0)

Table 5. Types of sound-absorbing material on wall

ID	Description
0	no sound-absorbing panels
1	microperforated MDF panels with polyester fiber in the cavity (α_w = 0.7)
2	panel in polyester fiber (α_w = 0.8) or felt (α_w ~ 0.4)

3. RESULTS

3.1 Acoustic parameters used in the analysis

The list of parameters used in the analysis is reported below:

- **LA90**: the A-weighted level of background noise exceeded for 90% of the specified period due to HVAC systems.
- **$T_{30,mid}$**: the average of reverberation time values from 500 Hz to1 kHz.
- **$D_{nT,w}$**: weighted standardized level difference between source and receiving rooms.
- **SPP**: speech privacy potential.

SPP values are calculated as the sum of $D_{nt,w}$ and LA90. Indeed, WELL Performance Verification Guidebook (last version: Q4 2024) specifies that D_w can be calculated assuming a room reverberation time of 0.5 seconds unless the reverberation time is known through evaluation of credit S04 (Reverberation Time). Moreover, LA90 measurements are also indicated to evaluate background noise levels.
The limit values of WELL v.2 Standard (last version: Q3-Q4 2024) are reported in Table 6. Since the enclosed rooms are used for both in-person meeting, conferencing (i.e. video/phone call to communicate with external people) and focused activities the minimum SPP values vary. In the present study the limit related to intended use category of conferencing is used (see Tab.6).
The $D_{nT,w}$ has been selected compared to R'_w since it represents a direct link to the subjective perception of airborne sound insulation [5]. Regards to office spaces, the Italian regulation does not indicate the mandatory limit values of airborne sound insulation between adjacent room belonging to the same property unit. Therefore, the requirements set by UNI 11367:2023 for $D_{nT,w}$ in hospitals, schools and care homes are used as reference in the present study (see Tab.6).

Table 6. Limit values of airborne sound insulation for each standard. Both requirements, baseline and superior performance, are listed in accordance with UNI 11367:2023.

UNI 11367:2023		WELL v.2 Standard	
Minimum $D_{nT,W}$ [dB]		Minimum SPP	
baseline	superior	between enclosed areas x conferencing	between enclosed area and open area
45	50	85	75

The limit values reported in the Appendix B of UNI 11367:2023 are used as reference for the pairs of rooms separated by partition with door (see Tab.7).

Table 7. Limit values of $D_{nT,w}$ indicated in the Appendix B of UNI 11367:2023 for common spaces of the building connected through accesses or openings to rooms of a single property unit.

UNI 11367:2023	
Performance	Minimum $D_{nT,w}$ [dB]
optimum	40
good	36
baseline	32
poor	28

3.2 Effects of construction, pre-existing or designed constraints and acoustic solutions on airborne sound insulation

The results are presented by grouping pairs of rooms separated by similar partitions in terms of composition, junctions and acoustic treatment on crossings of ducts, cable tray and holes for monitor installation (labeled as electrical and mechanical systems in the tables). SPP values are not indicated in the rooms in which background noise levels were not measured.

Table 8 shows the results related to pairs of rooms separated by partitions composed of plasterboard wall and glass fins for T joint towards circulation (see Fig.1). Moreover, the partitions reach the light façade and they are crossed by ducts, cable tray and holes for monitor, which are acoustically treated during the workmanships according to the demands of the acoustic consultant. As can be observed in Table 8 the speech privacy is inadequate in the pairs of rooms separated by fins composed of single glazed laminated glass, as reflected by lower $D_{nT,w}$ and SPP values. Indeed, SPP less than to 60 represents a complete lack of privacy [12]. The presence of double glazed laminated glass fins between four pairs of adjacent rooms provides $D_{nT,w}$ values lower than minimum values imposed by UNI11367:2023. Nevertheless, SPP values from 79 to 91, was found. These results are adequate for rooms where confidential and total speech privacy is required. However, in these two pairs of rooms (Ed.2_A and E) background noise levels are higher compared to limit values imposed by WELL Standard itself (L_{Aeq} = 35÷40 dBA). The highest value of $D_{nT,w}$ equal to 44 dB is obtained in the following conditions: in the absence of crossing of ducts, cable tray and holes for monitor installation; and in the presence of massive façade and double glazed laminated glass fins.

Table 9 shows results related to pairs of rooms separated by operable partition that rest on plasterboard wall on both lateral sides. Despite the high acoustic performance of operable walls (R_w=50÷55 dB), $D_{nT,w}$ values (33 and 35 dB) are significant lower than limit values. These results are mainly caused by the presence of air gap between gasket and plasterboard joint, and between drop-down seal and floor. In a pair of rooms (Ed.2_D), the SPP value is equal to 76, corresponding excellent speech privacy. However, this result is influenced to high background noise levels (LA90 = 43 dBA and LAeq = 44 dBA).

Table 10 shows results related to pairs of rooms separated by partitions with the presence of glass or opaque door. Different types of junctions are present. Ducts and cable tray crossings are acoustically treated in one building on two, i.e. in the office building called Ed.5. The presence of glass door without drop-down seal and sliding door leads to a poor airborne sound insulation ($D_{nT,w}$ = 20 dB ÷25 dB), in addition to the absence of acoustic treatments in ducts and cable tray crossings. Totally lack of privacy between enclosed rooms and open area is also demonstrated by SPP less than to 60. It can be noted that the $D_{nT,w}$ slightly increase in the pair of rooms in which the portion of opaque wall is higher in terms of square meters (Ed.4_E). However, sound airborne insulation rests poor ($D_{nT,w}$ = 29 dB). As previous results, good speech privacy (SPP equal to 71) is obtained when the background noise levels (LA90/LAeq = 42 dBA) increase beyond limit values of WELL Standard itself (L_{Aeq} = 35÷40 dBA). Furthermore, the choice of opaque door with R_w equal to 40 dB and the proper acoustically treatment of ducts leads to an increase of $D_{n,Tw}$ values, equal to 32 dB ÷ 36 dB (see Tab.10). Consequently, the baseline and good performance level set by UNI11367:2003 were obtained. In all these cases, the drop-down seals were not properly installed, as observed during in-field measurements.

Table 8. Results related to pairs of rooms separated by plasterboard wall (PL), glass fins (GL) and joint with light façade (a). Electrical (El) and mechanical (Mec) systems are acoustically treated. Values of $D_{nT,w}$ and SPP that respect the limit values are reported in bold.

ID partition	Volume room [m³] S	Volume room [m³] R	Partition type	$R_{w,m}$[1] [dB]	Joint type	Ceiling	Wall panel	El/Mec systems	L_{A90} [dB]	T_{30} [s]	$D_{nT,w}$ [dB]	SPP
Ed.1_A	85	42	PL4+GL1 (13 m²)	48	FS_B/a	1	2	ducts	27	0.47	30	58
Ed.1_B	42	42	PL4+GL1 (13 m²)	47	FS_B/a	1	2	ducts	27	0.47	27	55
Ed.2_A	49	49	PL5+GL2 (13 m²)	51	FS/a	1	2	ducts cable tray	44	0.53	42	**86**
Ed.2_E	35	35	PL5+GL2 (10 m²)	51	FS/a	1	2	ducts cable tray monitor	52	0.34	39	**91**
Ed.2_F	35	35	PL4+GL2 (10 m²)	50	FS/a	1	2	ducts cable tray	41	0.40	38	79
Ed.3_C	74	43	BRI+GL2 (11 m²)	-	FS_B/c	2	-	-	39	0.67	44	83

[1] $R_{w,m}$ is the composite R_w of partition composed of different elements.

Table 9. Results related to pairs of rooms separated by operable partition (OPE). Electrical (El) and mechanical (Mec) systems are acoustically treated.

ID partition	Volume room [m³] S	Volume room [m³] R	Partition type	R_w [dB]	Joint type	Ceiling	Wall panel	El/Mec systems	L_{A90} [dB]	T_{30} [s]	$D_{nT,w}$ [dB]	SPP
Ed.2_D	70	54	OPE (16 m²)	55	FS/f	1	2	ducts cable tray	43	0.55	33	76
Ed.5_E	75	75	OPE (17 m²)	50	FS/f	3	0	ducts	-	0.78	35	-
Ed.5_F	75	75	OPE (17 m²)	50	FS/f	3	0	ducts	-	0.71	35	-

Table 10. Results related to pairs of rooms separated by glass (GL) or plasterboard wall (PL) with glass or opaque door (GLd and OPd, respectively). Electrical (El) and mechanical (Mec) systems are acoustically treated in the building called Ed.5. They are identified with an asterisk (*). Values of $D_{nT,w}$ that respect the limit values are reported in bold. The compliance with the highest requirement (good performance) is reported in bold underlined.

ID partitio n	Volume room [m³] S	Volume room [m³] R	Partition type	$R_{w,m}$ [dB]	Joint type	Ceiling	Wall panel	El/Mec systems	L_{A90} [dB]	T_{30} [s]	$D_{nT,w}$ [dB]	SPP
Ed.4_C	193	43	GL2+OPd (11 m²)	-	FS_B/g	0	0	cable tray	29	0.28	22	51

Ed.4_D	193	14	PL4+GLd (6 m^2)	-		2	0	ducts, cable tray	27	0.34	25	52
Ed.4_E	193	90	PL4+GLd (20 m^2)	-	FS_B/b	2	0	ducts	42	0.31	**29**	71
Ed.4_L	160	12	PL4+GLd (5 m^2)	-	FS_B/d	0	0	ducts, cable tray	32	0.41	20	52
Ed.5_A	121	58	PL4h+OPd (21 m^2)	49	SS/b	3	0	ducts*	-	0.69	**32**	-
Ed.5_B	121	121	PL4h+SLd (21 m^2)	-	SS/b	3	0	ducts*	-	0.63	21	-
Ed.5_C	150	58	PL4h+OPd (21 m^2)	49	SS/b	3	0	ducts*	-	0.58	**35**	-
Ed.5_D	121	121	PL4h+OPd (21 m^2)	49	SS/b	3	0	ducts*	-	0.69	**36**	-

Table 11 overleaf shows results related to pairs of rooms separated by opaque partitions with differences in terms of electrical and mechanical systems. Poor airborne sound insulation ($D_{nT,w}$ = 27 dB÷36 dB) is found when the ducts and cable tray crossings are not acoustically treated. The lowest performances involve the smallest portions of opaque walls in terms of square meters. The limit values for both baseline and superior performance of UNI 11367:2023 ($D_{nT,w}$ = 45 dB and 50 dB, respectively) are reached between adjacent rooms where ducts and cable tray crossings are absent or they are acoustically treated. SPP values from 82 to 93 represent exemplary privacy, especially in the cases where the background noise levels are lower than 40 dBA (Ed.3_A, Ed.3_B, Ed.3_E, Ed.4_H). The presence of false ceiling in mineral wool could have improved the sound airborne insulation in these cases. As can be also observed in Table 11, $D_{nT,w}$ values slightly lower ($D_{nT,w}$ = 41 dB ÷ 44 dB) than baseline performance values are found despite high-performing opaque partitions (R_w = 54 dB ÷ 60 dB) and the absence of weaknesses caused by electrical and mechanical systems.

4. CONCLUSIONS

The present study aims to evaluate the effects of construction, pre-existing or designed constraints (i.e. light façade, ducts and cable tray crossings) and different acoustic solutions. In five Italian office buildings 33 pairs of rooms have been selected in order to have a representative set of partitions with different characteristics. The results are analyzed comparing the requirements of UNI 11367:2023 and WELL Building Standard.

Regards to sound airborne insulation the study highlights that the lack of speech privacy is caused by the presence of fins composed of single glazed laminated glass, sliding doors and glass doors without drop-down seals. Pre-existing and designed constraints related to ducts and cable tray crossings can generate a negative impact on sound airborne insulation. However, the proper acoustic treatments of these points of weakness can significantly reduce the transmission loss between adjacent rooms. Even in some cases where R_w values respect the recommendation of WELL Building Standard [12], the measurements lead to results of airborne sound insulation slightly lower than baseline performance set by UNI 11367:2023. These results demonstrate the importance of the effect of workmanship, confirming the conclusion of previous studies [8].

Regards to comparison between the requirements of UNI 11367:2023 and WELL Building Standard the study highlights that a good and excellent speech privacy can be obtained although values of $D_{n,Tw}$ are lower than limits of baseline performance. Speech Privacy Potential can be a useful parameter to evaluate the degree of privacy between adjacent rooms. However, it is necessary to verify that adequate speech privacy is not achieved at the price of increasing background noise levels beyond limit values, which are recommended to reduce noise disturbance caused by the HVAC systems.

The present study suffers from some limitations. Accelerometer measurements would be useful to understand the contribution of each point of weakness on the transmission loss. Variation due to the measurement procedure performed by different operators can be influenced the results. Furthermore, a subjective analysis through questionnaires submitted to occupants could support the objective data. The frequency responses of $D_{nT,w}$ will be investigated in future studies.

Table 11. Results related to pairs of rooms separated by opaque wall (PL and BRI) subdivided into two groups based on differences in electrical (El) and mechanical (Mec) systems. Values of $D_{nT,w}$ and SPP that respect the limit values are reported in bold. The compliance with the highest requirements is reported in bold underlined.

ID partition	Volume room [m³] S	Volume room [m³] R	Partition type	$R_w/R_{w,m}$ [dB]	Joint type	Ceiling	Wall panel	El/Mec systems	L_{A90} [dB]	T_{30} [s]	$D_{nT,w}$ [dB]	SPP
Electrical and mechanical systems not acoustically treated												
Ed.4_A	43	42	PL4 (12 m²)	54	FS_B/d	0	0	ducts, cable tray	29	0.28	36	57
Ed.4_B	42	14	PL4 (7 m²)	54	FS_B/d	0	0	cable tray	27	0.34	30	51
Ed.4_F	13	13	PL4 (6 m²)	54	FS_B/e	2	0	ducts, cable tray	27	0.38	28	55
Ed.4_G	13	13	PL4 (6 m²)	54	FS_B/e	2	0	ducts, cable tray	28	0.38	27	55
Ed.4_M	26	25	PL4 (10 m²)	54	FS_B/d	0	0	ducts, cable tray	36	0.30	34	70
Electrical and mechanical systems acoustically treated												
Ed.1_C	19	19	PL4 (8 m²)	56	FS_B/e	1	2	ducts	25	0.48	44	70
Ed.2_B	41	27	PL4 (8 m²)	54	FS/e	1	1	ducts	41	0.40	41	82
Ed.2_G	250	70	PL5 (12 m²)	60	FS/h	1	1	ducts, cable tray	44	0.41	**49**	**93**
Ed.3_B	79	58	PL4+BRI (17 m²)	-	FS_B/d	2	0	ducts, cable tray	39	0.79	**48**	**87**
Ed.3_E	44	28	PL4+BRI (10 m²)	-	FS_B/d	1	0	ducts	38	0.65	**45**	83
Ed.5_G	89	89	PL5 (21 m²)	60	SS/i	3	0	ducts	-	0.70	43	**-**
Ed.5_H	89	121	PL5 (21 m²)	60	SS/i	3	0	ducts	-	0.71	**50**	**-**
Ed.5_I	250	58	PL5 (21 m²)	60	SS/i	3	0	ducts	43	0.68	**48**	**91**
Absence of electrical and mechanical systems												
Ed.2_C	54	27	PL5 (9 m²)	60	FS/e	1	1	-	41	0.40	44	**85**
Ed.3_A	87	79	PL4+BRI (17 m²)	-	FS_B/d	2	0	-	39	0.84	**50**	**89**
Ed.4_H	35	34	PL4 (6 m²)	54	FS_B/f	0	0	-	36	0.36	**51**	**87**

5. REFERENCES

[1] Kaarlela-Tuomaala A, Helenuis R, Keskinen E, Hongisto V. "Effects of acoustic environment on work in private office rooms and open-plan offices – longitudinal study during relocation" *Ergonomics*. 2009; 52(11):1423-1444.

[2] Danielsson, C.B. "Office Environment, Health & Job Satisfaction. An Explorative Study of Design's Influence"; *School of Architecture, KTH Royal Institute of Technology*: Stockholm, Sweden, 2005.

[3] Sirola, P., Haapakangas, A., Lahtinen, M., & Ruohomäki, V. (2022). "Workplace change process and satisfaction with activity-based office". *Facilities*, 40(15/16), 17-39.

[4] Fasano, S., Fissore, V. I., Puglisi, G. E., Shtrepi, L., Spigliantini, G., & Astolfi, A. (2021). "Acoustic comfort contribution to the overall indoor environmental quality in workplaces". *Euronoise* 2021.

[5] UNI EN ISO 16283-1:2018 - "Acustica in edilizia - Classificazione acustica delle unità immobiliari - Procedura di valutazione e verifica in opera".

[6] UNI EN ISO 3382-3:2022 – "Acoustics - Measurement of room acoustic parameters - Part 3: Open plan offices".

[7] ISO 22955:2021 – "Acoustics — Acoustic quality of open office spaces".

[8] Trevathan JW, Pearse JR. "The effect of workmanship on the transmission of airborne sound through light framed walls". *Appl Acoust*. 2008;69(2):127-131.

[9] Craik RJM, Steel JA. "The effect of workmanship on sound transmission through buildings: Part 1 - Airborne sound". *Appl Acoust*. 1989;27(1):57-63.

[10] Craik RJM. "The consequences of lightweight buildings on sound transmission". *Build Serv Eng Res Technol*. 1998;19(1): B1-B4.

[11] UNI EN ISO 3382-2:2008 – "Acustica - Misurazione dei parametri acustici degli ambienti - Parte 2: Tempo di riverberazione negli ambienti ordinari".

[12] WELL v2 – "Evidence behind the sound concept we". International WELL Building Institute pbc.