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THROUGH HEALTIER LEARNING ENVIRONMENTS IN TURKISH SCHOOLS

Konca Şaher[1,2] **Ayşe Öztürk**[3,4] **Ayça Şentop Dümen**[2,5] **Yücel Demiral**[4,6] **Altay Ozankan**[7]
[1] Kadir Has University, Istanbul, Turkey
[2] Turkish Acoustical Society, Turkey
[3] Izmir Economics University, Izmir, Turkey
[4] Occupational Hygienist Society, Turkey
[5] İstanbul Bilgi University, Turkey
[6] Dokuz Eylül University, Izmir, Turkey
[7] BLX Research Laboratory, Izmir, Turkey

ABSTRACT

Turkish Acoustical Society (TAKDER) and Occupational Hygienists Society (IHIDER) of Turkey organized a series of events for International Noise Awareness Day (INAD) 2023 in collaboration with, Acoustical Society of Italy and Acoustical Society of Spain with the theme "Keep your hearing, keep your health: Educational facilities". As part of INAD 2023 activities, a research project for assessment of acoustic conditions in schools and teachers' noise exposure and its health effects was started as a joint project between TAKDER and IHIDER. This short paper introduces the preliminary results of this project, including evaluation of the acoustical quality in four Turkish schools of four institution levels: kindergarten, primary school, middle school, and secondary school. The acoustic performance of schools was analyzed by on-site measurements of sound insulation, reverberation time, ambient noise levels and speech intelligibility. The findings of the survey were analyzed in reference to the national regulation. The results indicate that most of the building elements and school spaces do not comply with acoustic criteria. The findings are further to be discussed in collaboration with professionals from variety of disciplines to transform schools through a healthier and more comfortable learning environment for children and teachers.

Keywords: *classroom acoustics, noise exposure, sound insulation, educational facilities,*

1. INTRODUCTION

Turkish Acoustical Society, Occupational Hygienists Society of Turkey, Acoustical Society of Italy and Acoustical Society of Spain, have together organized a series of events for International Noise Awareness Day 2023 with the theme "Keep your hearing, keep your health: Educational facilities". The organized events and studies were dedicated to students, teachers, acousticians, occupational health experts and acousticians. One of the dedicated events was the online International Symposium on 26th April 2023 which focused on the student drawing competitions held in three countries with a common theme: "Sounds that Unite Us" and presentations on experiences of noise and projects on acoustics at schools to raise awareness. As part of these events, Turkish Acoustical Society and Occupational Hygienists Society of Turkey started a joint research project in educational facilities in Turkey.

The project was planned as a pilot study on the determination of acoustic conditions in four schools and measurement of teachers' noise exposure and assessment of its health effects. The schools were selected from public

*Corresponding author: konca.saher@khas.edu.tr.

schools of four educational levels: kindergarten, primary school, middle school, and secondary school.

This short paper reports on the findings of the first part of this study which tries to satisfy the first project aim by measuring sound insulation, reverberation time, internal ambient noise levels (for both unoccupied and occupied situations) and speech transmission index in the selected four schools.

2. MEASUREMENTS

2.1 Selected Schools

Four schools were selected for the study: a kindergarten, primary school, middle school and secondary school (Figure 1). The schools are selected as representative of typical state schools with masonry partitions and concrete slabs built after 1970‘s.

The kindergarten was nearby a low traffic artery. There were two other schools, small businesses, and residential buildings in the surrounding area. The building was two stories high with classrooms both on the ground and first floor. The building was reinforced concrete with a masonry facade and with double glazed windows. Internal partitions were masonry, doors were wooden with no particular insulation. Internal finishes were mainly reflective with painted ceilings, painted walls, and vinyl floors. The classrooms in the kindergarten were adjacent to kitchen and toilets. Toilets were accessible only from classrooms thus the partition included doors to toilets.

The primary school was on a relatively quiet side road in a high-density residential settlement with several apartments facing the school’s playground. The building had a masonry façade with double glazing. Internal partitions were also masonry, doors were wooden with no apparent insulation. The classroom interiors were of painted ceiling, painted walls and ceramic floor. Plan layout was favorable in terms of horizontal sound transmission between classrooms, for all of them were detached with administrative rooms. The administrative rooms, on the other hand, had the disadvantage of being adjacent to classrooms on both sides and facing the main corridor.

The middle school was also on a relatively quiet side on the road in a low-density residential settlement. The 3-story building had a masonry façade with double glazing with classrooms on all floors. All internal partitions were masonry, and the doors were wooden. The ceilings and walls were painted, and floors were ceramic. A longitudinal plan layout was preferred that aligned classrooms at both sides of the corridor. It was noted that absorptive suspended ceiling panels were used in the corridors.

The secondary school was on a side road in a low-density residential settlement. The 3-story building was also reinforced concrete with masonry façade and internal partitions. The internal finished are paint on walls and ceiling and ceramic on the floor. Classrooms were detached from each other with intruding corridors and flexible rooms.

Volumes of the classrooms ranged between approximately 110 m^3 to 180 m^3.

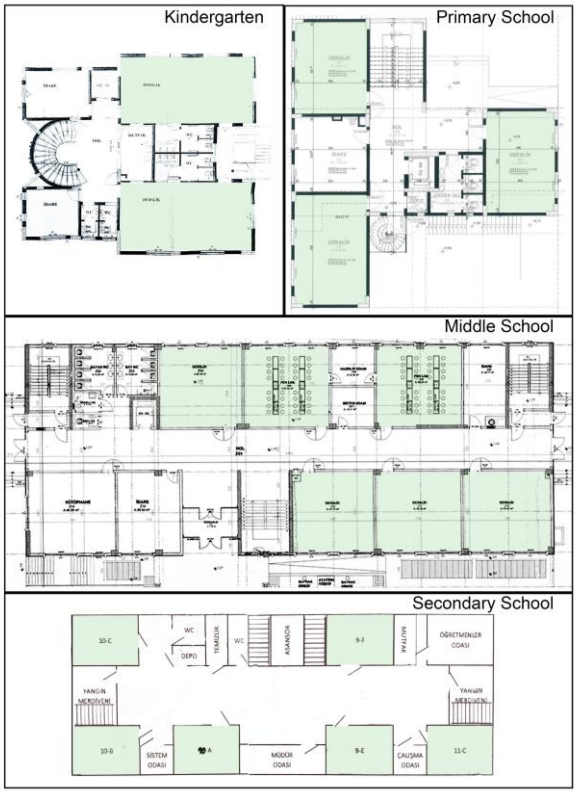

Figure 1. Plan layouts of selected schools.

2.2 On-site Measurements

Four types of measurements were done at each school. Internal ambient noise levels were measured with a Class-1 sound level meter which was placed at 1.5 m from the ground, at least 1 m far from all surfaces. Measurements were made for unoccupied (5 minutes) and occupied

conditions (45 minutes) during lectures. Airborne sound insulation of wall partitions and slabs was measured in compliance with EN ISO 16283-1 [1] and impact sound insulation of slabs between classrooms was measured a in compliance with EN ISO 16283-1 [2]. Reverberation time values were measured in classrooms and corridors according to EN ISO 3382-2 [3]. Speech intelligibility measurements were made using STIPA signal and speech transmission index values were calculated according to IEC 60268-16 [4]

3. RESULTS

The results of measurements in four schools are summarized in Table 1. The results are shown in comparison with limit values in Turkish Regulation on the Protection of Buildings Against Noise [5]. The limit values are given for different performance classes between A to F. In this study, the minimum limit values for new buildings which are described as Class C are taken as the reference values.

The findings indicated that the partitions between classrooms and other types of rooms did not comply with airborne sound insulation requirements. None of the slabs between classrooms complied with the Regulation criteria except for the Kindergarten. However, in general slabs performed better in terms of airborne sound insulation and the performance results were 3-4 dB less than the limit values. The impact sound insulation of all the slabs measured were very poor and non-compliant. The measured impact sound insulation values were over 10 dB higher than the recommended regulation value of 54 dB between the classrooms which suggests high annoyance levels could be accepted. The lowest impact sound insulation level was measured at the kindergarten floor which has vinyl.

The reverberation time values were over the recommended reverberation time of 0.8 s for classrooms and recommended 1.2 s reverberation time of 1.2 s for school corridors were exceeded in all the school except for the kindergarten. The kindergarten complied with reverberation time requirements even though the measured classroom has a larger volume. The lower reverberation time in the kindergarten could be due to the excessive amount of furniture inside the classroom.

The internal ambient noise levels of classrooms in empty condition, were below the recommended limit values, because of the quiet surrounding of all schools. Occupied noise levels during lectures will be further analyzed; however, the values are consistent with some literature. Calculated STI values in classrooms without background noise are in the range of 0.52 and 0.64. These values are in the category of fair and good according to ISO 9921. [6] However, occupied background noise levels are to be further calculated to analyze STI values in noise.

4. CONCLUSIONS

The findings of the initial acoustic survey were analyzed in reference to the national guidelines. All the measured buildings were constructed in the similar years and the constructions are similar (reinforced concrete structures, concrete slabs, masonry partitions) and the results indicated that most of the building elements and school spaces do not comply with the national guidelines. These results indicate that main building elements such as wall partitions, slabs and finishes inside these schools need to be mitigated. The results of this survey will further be discussed collaboratively with architects, engineers, acoustic consultants, teachers, local authorities and officials of Ministry of Education to develop and agree on policies and tools to design and transform schools in the next phase of the project.

Table 1. Measured acoustic parameters. (The values in italics indicate non-compliance with the Regulation limit values.)

			Kind Gart.	Prim. Sch.	Mid. Sch.	Sec. Sch.	Criteria
Internal Noise Levels	**L_{Aeq}, Unocc.**	**Class**	30.5 dB	29.5 dB	29.5 dB	32.9 dB	35 dB[1]
	L_{Aeq}, Occ.	**Class**	78.0 dB	65.9 dB	65.9 dB	66.4 dB	NA
Air-borne Sound Ins.	**$D_{nT,A}$, Walls**	**Class/ Class**	NA	NA	*43.1 dB*	NA	52 dB[1]
		Class/ Cor.	*29.7 dB*	*25.5 dB*	*27.7 dB*	*27.7 dB*	38 dB [2]
		Class/ Adm.	NA	*43.3 dB*	NA	NA	52 dB[1]
	$D_{nT,A}$, Slabs	**Class/ Class**	52.4 dB	*48.4 dB*	*51.8 dB*	*50.5 dB*	52 dB[1]
Impact Sound Ins.	**$L_{nT,w}$, Slabs**	**Class/ Class**	*60.4 dB*	*75.3 dB*	*63 dB*	*77.2 dB*	54 dB[1]
Rev. Time	**T_{mid}**	**Class**	0.80 s	*0.97 s*	*1.28 s*	*1.35 s*	0.8 s[1]
	T_{mid}	**Cor.**	0.83 s	*1.56 s*	*1.81 s*	*1.91 s*	1.2 s
Speech Trans. Index	**No noise**	**Class**	0.64 s	0.65 s	0.58 s	0.52 s	NA

Notes: Turkish Regulation limit values [5]
[1] Limits are for C Class (the minimum requirements for new buildings.)
[2] Limits are decreased 14 dB for partitions with doors according to Regulation. (52-14=38dB)

5. ACKNOWLEDGMENTS

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6. REFERENCES

[1] EN ISO 16283-1: Acoustics – Field measurement of sound insulation in buildings and of building elements – Part 1: Airborne sound insulation, International Organization for Standardization, Geneva, Switzerland, 2014

[2] EN ISO 16283-2: Acoustics – Field measurement of sound insulation in buildings and of building elements – Part 2: Impact sound insulation, International Organization for Standardization, Geneva, Switzerland.

[3] EN ISO 3382-2: Acoustics - Measurement of Room Acoustic Parameters – Part 2: Reverberation Time in Ordinary Rooms, International Organization for Standardization, Geneve, Switzerland, 2008.

[4] IEC 60268-16: Sound system equipment - Part 16: Objective rating of speech intelligibility by speech transmission index, 2020.

[5] Ministry of Environment and Urbanism. Regulation on the Protection of Buildings Against Noise. Turkey: 2017.

[6] ISO 9921: Ergonomics. Assessment of speech communication. Geneva, Switzerland, 2003.