Acoustic Performance and Noise Control of Conference Halls: An Evaluation of the Conference Hall at the Al-Nahrain University, Iraq

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Abstract

In recent years, research has focused attention to the evaluation of the acoustics performance of conference halls. The acoustic environments of conferences halls is very important to enhance the effective performances in them. This research examines the acoustic performance of a conferences hall in Iraq.

A practical experiment was carried out at the Al-Salam conference hall at Al-Nahrain University in Baghdad city to evaluate the formal, acoustical performance and noise control. It was then compared with the measurements of the ANSI/ASA S12.60-2010, ISO 3882, DIN 18041 and Iraqi acoustics code MBI 503.

The results show that, at this conference hall, the reverberation time was lower or near the minimum requirements for the conferences halls according to the acoustics standards. The results also show that the background noise level was higher than the maximum recommended for conferences halls.

Keywords: Acoustics performance, Conference halls, Noise level, Reverberation time, Iraqi acoustics code.

Introduction

The qualities of performance spaces are deeply ingrained in human civilization. This was obvious in prehistoric times in the Gothic churches, the classical Greek open-air theaters, and in musical creations. Architects may create environments that improve auditory comfort by looking at how sound interacts with performance spaces.

Large auditoriums for events were first constructed by the ancient Greeks and Romans in the first century BC. From the beginning of the first century, Roman builders like Vitruvius began to investigate the idea of performing sound in huge gathering places. Acoustics has remained a mystery from those early times to the present. Due to insufficient self-sensitization, the majority of architecture specialists cannot comprehend it. More attention must be paid to listen and design acoustic environments in order to progressively come to appreciate what acoustics implies over an extended period of time. The fact that acoustics is non-visual is the fundamental reason architects haven't totally grasped it. Being visual beings, architects are unable to convey sound without using visuals.

Conference halls among many types of auditorium halls which are important buildings in the university campus at the Al Nahrain University due to the variety of cultural and scientific activities they offer that contribute to the development of scientific, social, and many other aspects for the employers and students. It is therefore necessary to ensure and develop proper acoustic spaces, studying all phenomena related to acoustic performance in terms of the sound pressure level, reverberation time, and the noise level, whether external or internal. A comfortable built environment is strongly correlated with suitable thermal, lighting, and acoustic techniques. The architects must come up with a system that prevents and regulates the building's acoustic environment in order to provide comfort for the occupants. Exposure to loud noise on a regular basis could impair tenants' ability to concentrate, their degree of contentment with their surroundings, and even their cognitive function. Previous studies have focused on many aspects related to the acoustic performance of auditoriums halls (Barron,2010; Bradley, 1986; T.J,2014; Ibrahim &Hasan,2014) , but none exist that look at this conference hall at the Al Nahrain University in Iraq.

In this context, this research carries out an experiment at the Al-Salam conference hall at Al-Nahrain University in Baghdad city to evaluate the formal, acoustical performance and noise control, in comparison with the ANSI/ASA S12.60-2010, ISO 3882, DIN 18041 and Iraqi acoustics code MBI 503.

Its aim is to verify the acoustic performance and noise control for Al-Salam conference hall in AL-Nahrain University then compared with the measurements of the ANSI/ASA S12.60-2010, ISO 3882, DIN 18041 and Iraqi acoustics code MBI 503.

Its objectives are:

1. To examine the acoustic performance and noise control for the Al-Salam conference hall at Al-Nahrain University in Baghdad city
2. To comparison between the acoustic performance and noise control of the selected conference hall with the international and local standards

Theoretical Background

Conference halls usually have formal specifications that impact on the acoustics and functionality of space. According to research, common shapes for conference halls are: [7,8,9,10] (ANSI/ASA S12.60-2010; ISO 3382-2:2014; ASTM E1414-11; ISO 9613-2:2007)

1. Rectangular: These are the most common shape and can be used for a variety of events. They are relatively easy to design and build, and provide good sightlines and acoustics for most types of events.
2. Square: These are similar to rectangular conference halls but can be more challenging to design and build. They can provide good sightlines and acoustics for smaller events, but they may not be effective for larger events.
3. Round: These can provide good sightlines and acoustics for smaller events. However, they may not be effective for larger events, as attendees in the back rows may have difficulty seeing and hearing clearly, it may also create sound defects (creep, concentration of sound) that need special acoustics treatments.
4. Irregular: Irregularly shaped conference halls such as those with irregularly shaped walls or irregularly spaced columns, can be more challenging to design and build. They may also have less predictable acoustics and may be more difficult to use for any event.

The size of a conference hall can vary significantly depending on the specific needs and requirements of the space. Here are a few general guidelines for the size of conference halls based on the number of attendees.

1. Small conference hall (up to 50 attendees): may be as small as 500 square feet (46 square meters) and can accommodate up to 50 attendees.
2. Medium conference hall (50 to 100 attendees): may be around 1,000 square feet (93 square meters) and can accommodate 50 to 100 attendees.
3. Large conference hall (100 to 250 attendees): may be around 2,500 square feet (232 square meters) and can accommodate 100 to 250 attendees.
4. Very large conference hall (250+ attendees): may be 4,000 square feet (372 square meters) or larger and can accommodate 250 or more attendees.

Evaluating the acoustics and noise control in a conference hall involves assessing the quality and clarity of the sound within the space, as well as the level of background noise and distractions. Some key factors to consider when evaluating the acoustics and noise control of a conference hall include:

Reverberation time: This refers to the amount of time it takes for sound to decay after it is produced. A long reverberation time can make it difficult to understand speech or other sounds in the space.

Sound absorption: The materials used in the construction of the conference hall, such as the walls, floor, and ceiling, can affect the level of sound absorption. Materials that are good at absorbing sound can help reduce the amount of echo and reverberation in the space.

Noise isolation: The conference hall should be designed to minimize the amount of noise that can enter the space from outside sources, such as traffic or other nearby rooms.

Sound system: The conference hall should have a high-quality sound system that is able to clearly amplify the voices of speakers and other sounds in the space.

Background noise: It is important to minimize any unnecessary background noise that could distract from the main event taking place in the conference hall. This could include HVAC systems or other equipment.

The optimum reverberation time for a conference room depends on the specific use of the space and the types of activities that will take place there. Generally, a longer reverberation time is more suitable for music performances, while a shorter reverberation time is better for speech and other types of presentations. For speech, a reverberation time of around 0.6 seconds is often considered to be optimal. This allows speech to be clearly understood, while still providing a sense of spaciousness and resonance in the room. A reverberation time that is too long can make it difficult to understand speech, while a reverberation time that is too short can make the space feel dry and uninviting. It is important to note that the reverberation time can be affected by a number of factors, including the size and shape of the room, the materials used in the construction of the space, and the type and placement of any sound-absorbing materials. [7,8,11,12,13,14] (ANSI/ASA S12.60-2010; ISO 3382-2:2014; ISO 3382-1:2017; ASTM E2235-09; ISO 11654:1997;MBI 503: 2013). The optimum reverberation time according to standards is shown in the Table 1.

Table 1: Optimum reverberation time in conference hall
Source: Authors

The Standards	$R_{t\,min}$(second)	$R_{t\,max}$ (second)
ANSI/ASA S12.60-2010	**0.6**	**1.2**
ISO 3382-1:2017	**0.6**	**1**
large conference hall with a volume up to 3,000 m³		

large conference hall with a volume between 3,000 m^3 and 10,000 m^3	**0.6**	**1.2**
DIN 18041		
For rooms with volumes up to 3,000 m^3: Speech frequency range (500 Hz - 4,000 Hz)	**0.6**	**0.8**
For rooms with volumes between 3,000 m^3 and 10,000 m^3: Speech frequency range (500 Hz - 4,000 Hz)	**0.6**	**0.9**
MBI 503:2013	**0.9**	**1.4**

Acceptable background noise level in acoustic halls, including conference halls, had been determined by international standards, as it should not exceed the values specified in the Table 2.

Table 2: The acceptable background noise level in conference hall
Source: Authors

The Standards	**Max (dB)**	**Min (dB)**
ANSI/ASA S12.60-2010	35	30
ISO 3382-1:2017	30	25
DIN 18041	35	30
MBI 503:2013	30	25

There are several methods that can be used to measure the reverberation time of a conference hall or other spaces. [7,8,9,15] (ANSI/ASA S12.60-2010; ISO 3382-2:2014; ASTM E1414-11; ISO 3382-1:1995)

1. Impulse method: This involves using a short, intense sound, such as a gunshot or a balloon burst, to measure the reverberation time in a space. This method is quick and easy to use but may not be as accurate as other methods.
2. ISO 3382 method: This involves using a swept-sine sound signal to measure the reverberation time in a space. This is more accurate than the impulse method but may be more time-consuming to perform.
3. Gated-noise method: This involves using a noise signal that is turned on and off at regular intervals to measure the reverberation time in a space. This is more accurate than the impulse method but may be more complex to perform.
4. Maximum-length sequence method: This involves using a special type of noise signal to measure the reverberation time in a space. This is highly accurate but may be more complex to perform than other methods.

To measure noise there are several methods that can be used in a conference hall.

1. Sound level meter: This is a portable device that can be used to measure the decibel (dB) level of noise in a space. It is quick and easy to use and is suitable for measuring noise levels in a variety of settings.
2. Octave-band analyzer: This is a device that can be used to measure the noise levels in specific frequency ranges (octave bands) in a space. It is more accurate than a sound level meter but may be more complex to use.
3. Noise dosimeter: This is a portable device that can be worn by an individual to measure the noise levels to which they are exposed over a period of time. It is useful for measuring noise levels in environments where the noise levels may vary significantly over time.

4. Noise mapping: This involves using specialized software and equipment to create a detailed map of the noise levels in a specific area. It is useful for understanding the distribution of noise levels in a space and for identifying sources of noise.

A Review of Literature

Many studies that examine acoustic performances of various spaces exist. Iannace et al. (2018) have analyzed a conference room within a secondary school in Switzerland. The architectural strategy established was centered on the selection of the room's shape and materials, while the acoustic solutions suggested offered intelligibility. The primary auditory indicators (T30, EDT, C80, D50, and STI) could be predicted through simulations using the Odeon program, which allowed for the optimization of the size and placement of the acoustic treatments for various audiences. Additionally, the acoustic treatment improved the speaker's sound emission without the use of amplifiers. Acoustic tests completed at the conclusion of the building's construction attested to the conference room's excellent acoustics [5] (Iannace *et al*. (2018). In Iraq, Ibrahim *et al*. (2014) has tested the Al-Rabat Concert Hall in Baghdad for RT30, EDT, C80, & G and noise level. The purpose has been to look into the acoustical environment of the hall and contrast the findings with ISO 3382. The measurement findings show that every parameter evaluated in this music hall is higher above the ISO 3382 standard levels The findings of this research were assessment of the acoustic comfort of classrooms constructed using a common design as presented in this research.

In comparison, in the Curitiba metropolitan region in Brazil, three constructive designs have been assessed. A total of six schools have been completed, two for each of the three designs. Based on the measurements of the reverberation duration, sound pressure level within and outside the classrooms, and sound insulation, the acoustic quality of the classrooms have been examined. The Brazilian Standards NBR 10151 and NBR 10152 have been followed while measuring ambient noise (internal and exterior). Reverberation time and sound insulation measurements have been conducted in accordance with ISO 140-4, ISO 140-5, ISO 717-1, and ISO 3382 international standards. Results of sound insulation and reverberation duration have been compared to benchmark values from the Brazilian Standard NBR 1279, as well as from the Standards ANSI S12.60 and DIN 18041. For all three construction designs examined, the results show that the assessed classrooms have low acoustical quality [6]. Zannin *et al*, (2009)

However, these previous studies did not specifically address conference halls in universities in terms of the efficiency of the acoustic and noise environments, Therefore, in this research an evaluation of acoustical performance and noise control for Al-Salam conference hall at Al-Nahrain University in Baghdad city were conducted as compared to Standards (ANSI/ASA S12.60-2010, ISO 3882, DIN 18041 and Iraqi acoustics code MBI 503).

Research Methodology

The aim of this research is to verify the acoustic performance and noise control for Al-Salam conference hall in AL-Nahrain University. The results of this work were obtained by in situ measurements of the reverberation time RT, sound level meter, noise levels, than the results compared to ANSI/ASA S12.60-2010, ISO 3882, DIN 18041 and Iraqi acoustics code MBI 503.

Practical measurement procedures included the selection of the study sample (Al-Salam conference hall in AL-Nahrain University). Fig. 1 shows the plan of the hall, while the Fig. 2 shows the section.

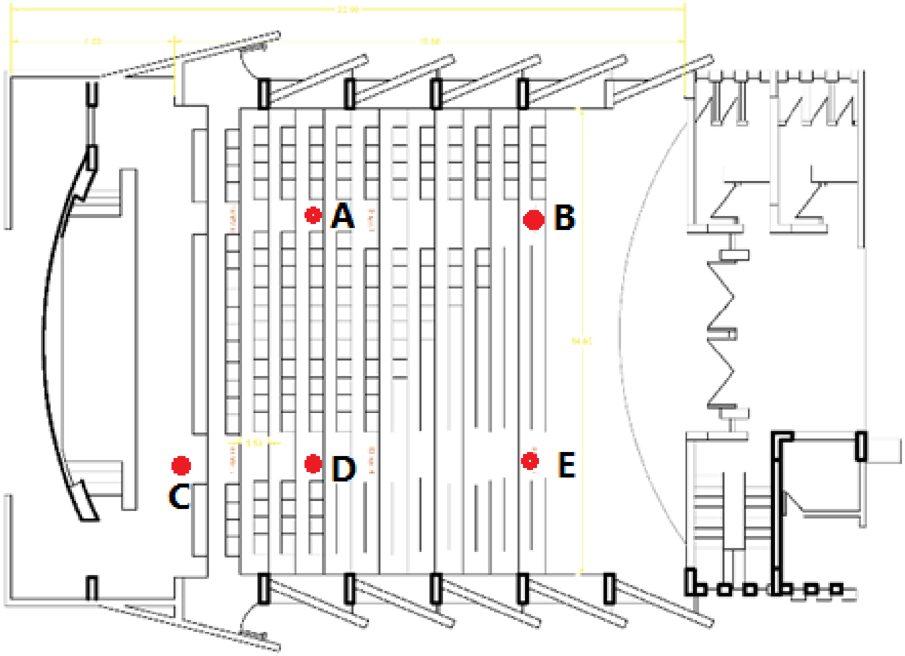
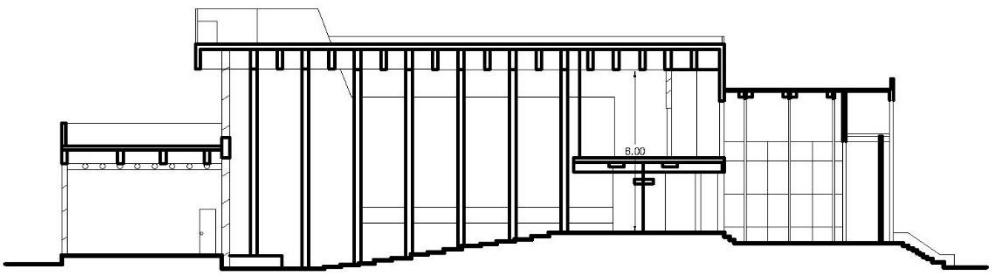
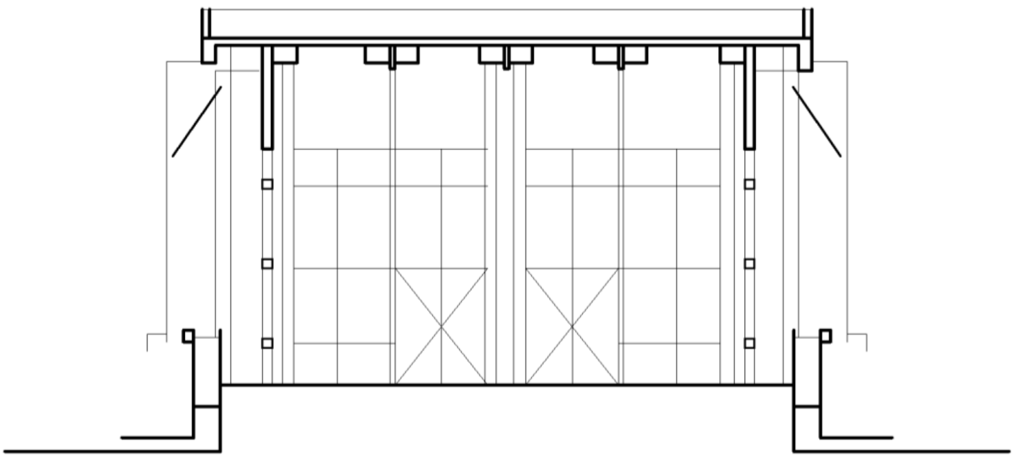


Fig. 1: Plan of the Al-Salam conference hall
Source: authors

Fig. 2: sections of the Al-Salam conference hall





Source: authors

Later, the Impulse method was adapted to measure the reverberation time and the sound level meter for noise level. The Al-Salam Hall is designed to be a center for conferences, lectures and seminars at the university. The volume of the hall is 2070 cubic meters. It has 228 chairs. The inner surfaces of the platform were covered with sound-reflecting wooden panels, while the side and back walls were covered with plasters, and the ceiling of the hall was covered with absorbent acoustic panels, as shown in the Fig. 3.

Fig. 3: Al-Salam conference hall
Source: authors

5 points have been chosen for acoustic measurements within the hall. SVAN957 Type 1 sound and vibration meter with analyzer instrument was used. Unoccupied state of RT30, and SPL used the impulse noise method, and all the measurements were performed in the octave bands.

Results and the Discussion

Figure 4 shows the locations of measurements and Table 3 shows the measurements locations, sound pressure levels, minimum and maximum noise level, and reverberation times.

Location A **Location B** **Location C**

Location D   Location E

Fig. 4: the location of measurements in Al-Salam conference hall
Source: Authors

Measurement location	**SPL dB**		**Min dB**		**Max dB**		**Rt $_{60}$**
	FAST	SLOW	FAST	FAST	SLOW	FAST	
A	31.6	30.1	26	28.3	50.9	52.3	0.8
B	29.3	28.5	22.4	23.8	65.5	60.7	0.6
C	33.7	31	25.6	27.7	48.3	42	0.6
D	32	33.1	26.1	28.4	52	52.8	0.8
E	31.1	38.1	26.6	28.6	40.8	50.6	1.07

The results show that the reverberation time was closer to the minimum requirements for the conferences halls according to acoustics standards ANSI/ASA S12.60-2010,ISO 3882, and DIN 18041, while it was lower than the Iraqi acoustics code MBI 503 reverberation time requirements. The results also show that the background noise level was higher than the requirements for the conferences halls according to the ANSI/ASA S12.60-2010,ISO 3882, DIN 18041, and Iraqi acoustics code MBI.

Conclusions

This experiment measured the acoustic performance and noise control for Al-Salam conference hall in Al-Nahrain University. The measurements were compared to the acoustics standards ANSI/ASA S12.60-2010,ISO 3882, DIN 18041, and Iraqi acoustics code MBI. The comparison showed the acoustic performance of reverberation time and background noise levels in this conference hall.

The results showed that the Al-Salam conference hall acoustics and noise control properties values are not matching with the international and local standard limits. The difference of evaluations in comparison with the acoustics standards indicated the need for acoustic treatments of the hall, especially in terms of background noise level. The decrease in the reverberation time also necessitates the addition of sound-absorbing materials that contribute to improving the acoustic environment to suit the nature of the acoustic performance of the hall and the multiplicity of acoustics activities that occupy it.

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