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Acoustical design of Awaza Convention Center

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Abstract

Awaza Convention Center in Turkmenbashi is designed and constructed by Polimeks Inc. to host the visiting top officials in Turkmenistan. The construction was completed in September 2015. In the form of a state pavilion, the building represents the power of Turkmenistan with its stately stature serving its valuable guests. The complex sits on a total area of 185,000 m^2 with an indoor area of 52,700 m^2, and includes 9 floors. There are two conference halls with 2,000 and 500 seats, one banquet hall with a seating capacity of 450 and another with a capacity of 250, and a press conference hall with a capacity of 130. The center also houses a 130-seat multipurpose meeting room for heads of states, a hall for signing bilateral protocols, and a meeting hall for government delegations. Additionally, there are six smaller conference halls with a seating capacity of 30 to 100 for special events, a 100-capacity reception hall and six special office rooms for the heads of states. Acoustical design of all these halls is conducted to meet acoustical design criteria limits for specific activity held in each space. Among those, the main auditorium imposed a challenge with its multi-function use. Stage pit, stage shell, stage tower, interior wall and ceiling surfaces are specifically designed to accommodate different activities including conference, concert and opera.

Keywords: Multi-purpose auditoria, conference halls, room acoustics, reverberation time, clarity.

Acoustical design of Awaza Convention Center

1 Introduction

In the form of a state pavilion Awaza Convention Center in Turkmenbashi designed and constructed by Polimeks was built to host the visiting top officials in Turkmenistan (Figure 1). The complex covers a total area of 185,000 m^2, includes 9 floors and 52,700 m^2 indoor area. The construction was completed in 2015.

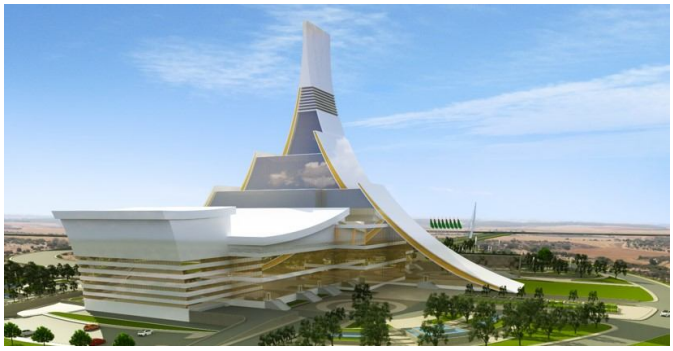


Figure 1: Awaza Convention Center, exterior view

The complex has two conference halls with 2,000 and 500 seats, two banquet halls, one with a seating capacity of 450 and the other with a capacity of 250, and a press conference hall with a capacity of 130. The centre also accommodate a 130-seat multipurpose meeting room for heads of states, a hall for signing bilateral protocols, a meeting hall for government delegations, six small conference halls with a seating capacity of 30 to 100 for special events, a 100-capacity reception hall and six special office rooms for the heads of states. Among those, the main auditorium imposed a challenge with its multi-function use (Figure 2). Room and building acoustics design of all these halls are conducted to meet acoustical design criteria limits for specific activity held in each space.

Figure 2: Multi-purpose auditorium

2 Room acoustics design of the halls

In the process of acoustical design of halls initially the criteria are set in accordance with the function of the halls and their volume [1,2,3]. The main auditorium with 2015 seating capacity is a multi-function hall, which will accommodate conference, concert and opera use. In Table 1 the acoustical design criteria for main auditorium is presented.

Table 1: Acoustical design criteria for multi-purpose auditorium

Parameter	**Optimum Range**
Conference use	
Reverberation Time,T30 (500Hz - 1000Hz average)	1,1 s - 1,3 s
Speech Transmission Index, STI	> 0 ,6
A-Weighted Sound Pressure Level, SPL-A	maximum difference <10dBA
Concert use	
Reverberation Time,T30 (500Hz - 1000Hz average)	1,6 s - 1,8 s
Clarity, C80	>-2, <+5
Lateral Fraction, LF80	>0,2
A-Weighted Sound Pressure Level, SPL-A	maximum difference <10dBA
Opera use	
Reverberation Time,T30 (500Hz - 1000Hz average)	1,3 s - 1,5 s
Clarity, C80	>-1, <+5
Lateral Fraction, LF80	>0,2
Speech Transmission Index, STI	> 0 ,6
A-Weighted Sound Pressure Level, SPL-A	maximum difference <10dBA

2.1 Material information

In adjustment to different scenarios of use the interior geometry and finish materials of the main hall, which is mostly out of wood is kept identical, while the stage set and stage materials are revised. Sound absorptive material application areas inside the main hall are initially set for satisfying speech activity, as the dominant use of the hall will be conference. For concert case an orchestra shell is included inside the stage. In this scenario, the side and back stages are open and included into the stage tower volume. In opera case, side stages are open, while the back stage is separated from the stage tower volume by the full length back curtain. Orchestra pit is designed for opera and musicals. Acoustical draperies inside the stage are applied in different amounts in different scenarios. Sound absorptive material application locations inside the main hall, stage tower and orchestra pit and their applied scenarios are listed Table 2.

Table 2: Sound absorptive material types and application areas for different scenarios of use in multi-purpose auditorium

Location	Material type	Conference	Concert	Opera
Main hall and orchestra pit				
Main hall – under roof slab	25 mm 48-52 kg/m^3 mineral wool with acoustical fleece	✓	✓	✓
Back wall, back ceiling surfaces	16 mm thick perforated wood, %12 perforation ratio with 48-52 kg/m^3 mineral wool inside 20cm gap	✓	✓	✓
Decorative slotted wood wall panels	25mm 110 kg/m^3 mineral wool with acoustical fleece	✓	✓	✓
Orchestra pit back wall	Molton (300g/m^2) cotton curtain	- (pit closed)	- (pit closed)	✓
Orchestra pit front wall @ h: 80 cm	16mm thick perforated wood, %7.4 perforation ratio with 48-52 kg/m^3 mineral wool backing	- (pit closed)	- (pit closed)	✓
Stage				
Stage tower ceiling	50 mm 48-52 kg/m^3 with acoustical fleece, 10 cm air gap behind	✓	✓	✓
Back stage ceiling	25 mm 48-52 kg/m^3 mineral wool with acoustical fleece	- (back stage closed)	✓ (back stage open)	- (back stage closed)
Side stages	-	- (side stages closed)	✓ (side stages open)	✓ (side stages open)
Stage back curtain	Molton (300g/m^2) cotton curtain	✓	-	✓
Legs masking the wings		✓ (total # 8)	-	✓ (total # 12)
Side stage curtains		✓	-	-
Border/frieze curtains		✓ (total # 4)	✓ (total # 2)	✓ (total # 2)
Mid separator		✓	-	-
Turkmen carpet	-	✓	-	-
Stage/ orchestra shell	-	-	✓	-

The other halls within the complex for which acoustical design and simulations held are 500-seated conference hall, two banquet halls one with 450 and the other with 250 seating capacity, 130-seated multipurpose meeting room for heads of states, 130-seated press conference hall, a hall for signing bilateral protocols, VIP cinema hall, six meeting rooms, three with a seating capacity of 100 and three with 30. For these halls acoustical criteria are set in regards to their

volume and function as given in Table 3 [1, 2]. In order to provide the acoustical parameter limits, the acoustical material types and locations applied within these halls are listed in Table 4.

Table 3: Reverberation time design ranges for different halls

Hall name	Volume (≈)	Reverberation time criteria (500-1000 Hz)
500-seated conference hall	5400 m³	0.9 s – 1.1 s
450-setaed banquet hall	2950 m³	0.9 s – 1.0 s
250-setaed banquet hall	2511 m³	0.9 s – 1.0 s
130-seated multipurpose meeting room for heads of states	1550 m³	0.8 s – 1.0 s
130-seated press conference hall	620 m³	0.6 s – 0.8 s
Hall for signing bilateral protocols	500 m³	0.6 s – 0.8 s
VIP cinema hall	530 m³	0.4s – 0.5 s
100-seated meeting rooms	550 m³, 436 m³, 320 m³	0.6 s – 0.8 s
30-seated meeting rooms	513 m³, 490 m³, 460 m³	0.6 s – 0.8 s

Table 4: Sound absorptive material types and application areas applied within different halls

Hall name	Material type	Location
500-seated conference hall	Perforated gypsum with mineral wool backing; mineral wool behind acoustically transparent fabric or acoustical fleece; carpet	Ceiling surfaces - entrance corridor; behind ceiling decorative grills, wall surfaces; floor
450-setaed banquet hall	25 mm Baswaphon; carpet	Cove ceilings; floor
250-setaed banquet hall	110 kg/m^3 mineral wool behind acoustically transparent fabric; carpet	Wall surfaces - short sides; floor
130-seated multipurpose meeting room for heads of states	25 mm Baswaphon; micro-perforated wood panels; carpet	Ceiling surfaces behind wooden carcass; wall surfaces - partially; floor - partially
130-seated press conference hall	Fabric over MDF; linear perforated wood panels with mineral wool backing; carpet	Wall surfaces - partially; wall and ceiling panels - partially; floor
Hall for signing bilateral protocols	Slotted perforated gypsum board with mineral wool backing; micro-perforated wood panels	Behind ceiling grills; wood wall surfaces
VIP cinema hall	Fabric over MDF; 40 mm Teknofoam; 338 g/m^2 cotton velvet curtain; carpet	Fabric covered wall-ceiling surfaces; Side and back wall surfaces - partially; floor
100-seated meeting rooms	110 kg/m^3 mineral wool behind acoustically transparent fabric; carpet	Behind wood slats on side and back walls; floor
30-seated meeting rooms	110 kg/m^3 mineral wool behind acoustically transparent fabric; carpet	Behind wood slats on walls; floor

2.2 Acoustical simulations

The acoustical conditions of halls are analysed by simulations over the given geometry of the concept designs and proposed materials. Simplified graphical model of each hall is developed and then imported in ODEON version 12.15 [4]. The 3D OpenGL view of multi-purpose auditorium is given in Figure 3a. The source location in acoustical model is shown in plan and section views as given in Figure 3b-c. The 3D OpenGL views of all modelled halls listed in Table 3 and 4 are given in Figure 4. In these views darker colours indicate sound absorptive material application areas. Acoustical simulations are held multiple times until the desired acoustical parameter limits are satisfied. Interior material finishes and geometry/form of interior surfaces are revised accordingly.

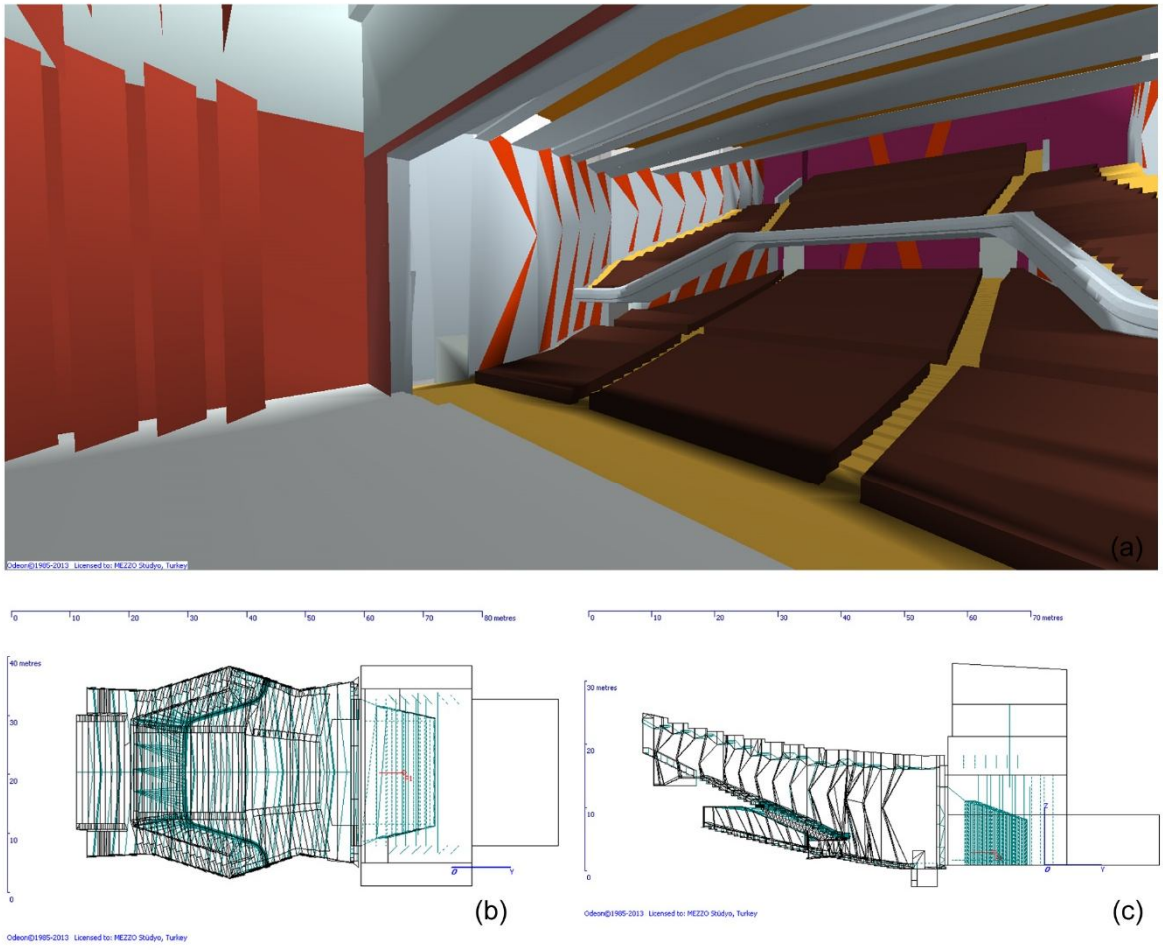


Figure 3: Multi-purpose auditorium acoustical model a) 3D Open-GL view, b) plan view, with source position (red), c) section view (red)

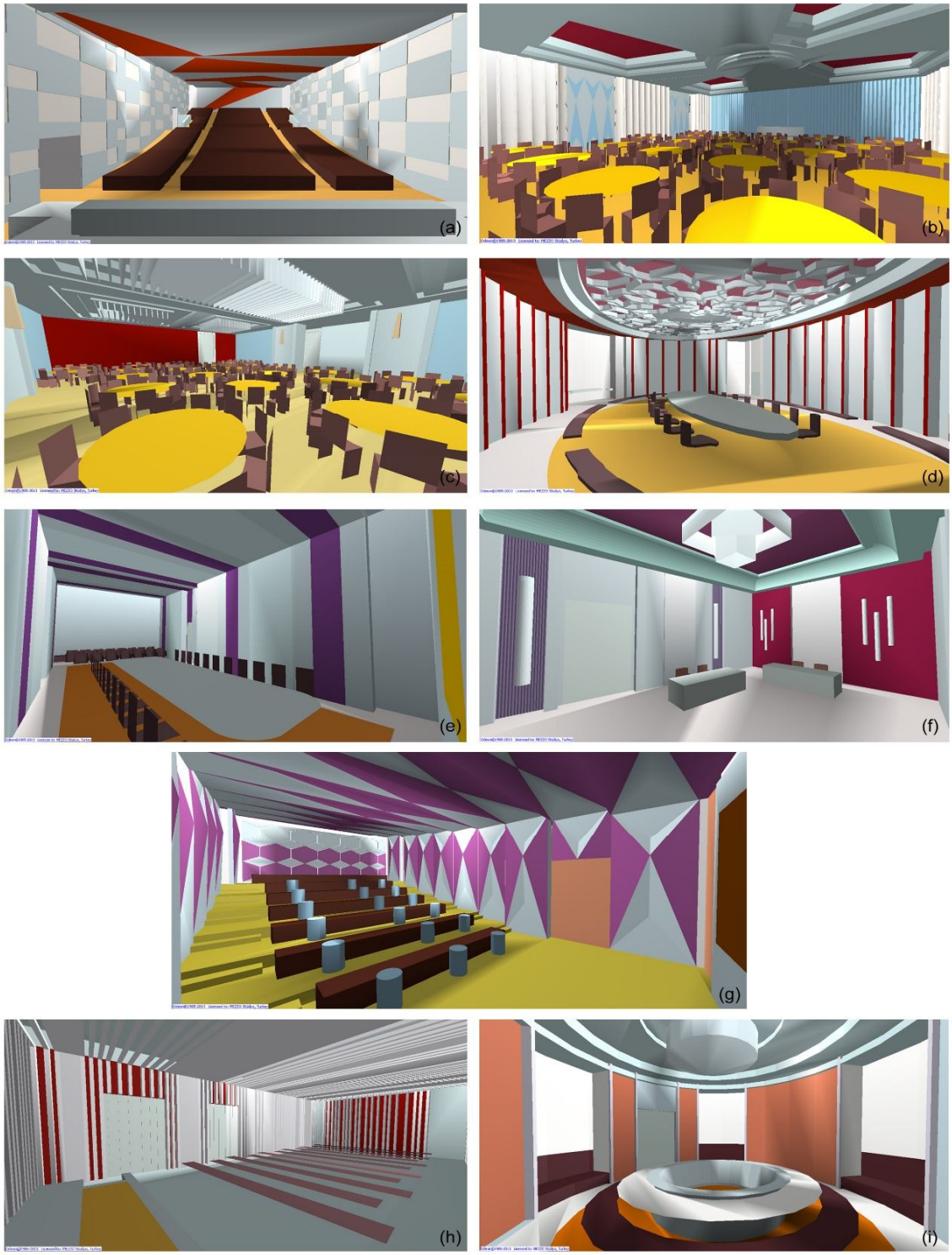


Figure 4: 3D Open-GL views of; a) 500-seated conference hall, b) 450-setaed banquet hall, c) 250-setaed banquet hall, d) 130-seated multipurpose meeting room for heads of states, e)130-seated press conference hall, f) hall for signing bilateral protocols, g) VIP cinema hall, h) 100-seated meeting room, i) 30-seated meeting room

3 Results

Under this section finalized acoustical simulation results for proposed design solutions are presented. Reverberation time distribution maps are obtained for three different scenarios of use in multi-purpose auditorium (Figure 5). Detailed acoustical parameter results for multi-purpose auditorium are given in Table 5. Reverberation time distributions (T30) over octave bands for all examined halls are presented in Figure 6. Acoustical parameter results for 100-seated and 30-seated meeting rooms are listed in Table 7.

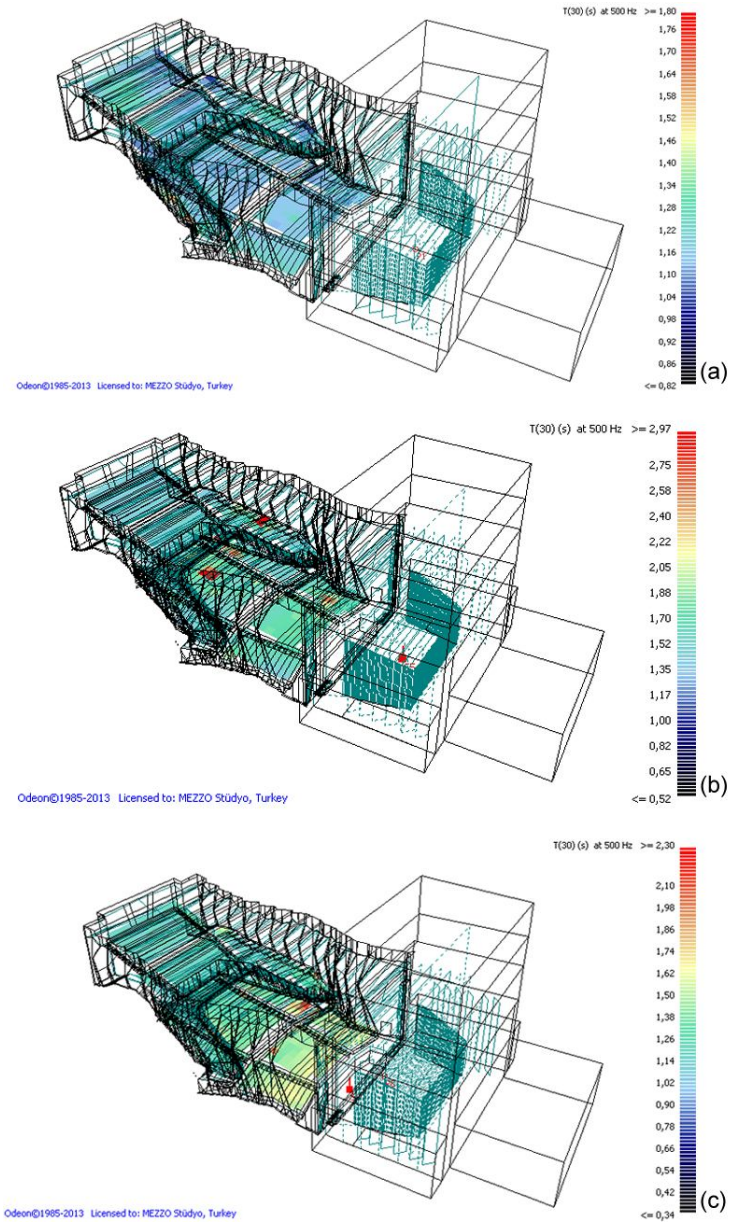
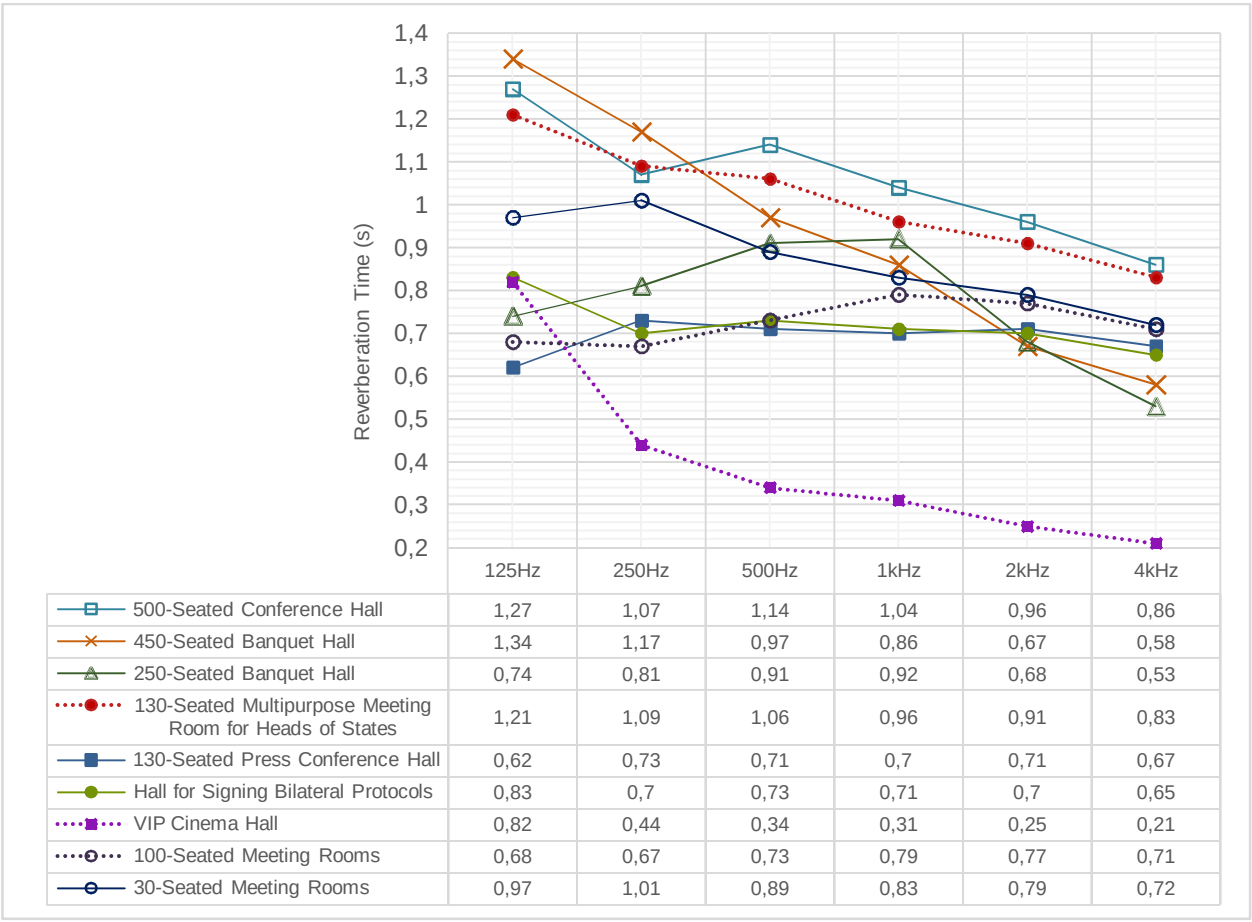


Figure 5: Multi-purpose auditorium T30 distribution maps for 500 Hz a) conference use b) concert use c) opera use

Table 5: Acoustical parameter results for multi-purpose auditorium

Parameter	Hall averages
Conference use	
Reverberation Time,T30 (500Hz - 1000Hz average)	1.12s
Speech Transmission Index, STI	0.60
A-Weighted Sound Pressure Level, SPL-A	9dB
Concert use	
Reverberation Time,T30 (500Hz - 1000Hz average)	1.65s
Clarity, C80	0.3dB
Lateral Fraction, LF80	0.67
A-Weighted Sound Pressure Level, SPL-A	7dB
Opera use	
Reverberation Time,T30 (500Hz - 1000Hz average)	1.37s
Clarity, C80	1.3 dB
Lateral Fraction, LF80	0.63
Speech Transmission Index, STI	0.6
A-Weighted Sound Pressure Level, SPL-A	8dB



	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz
500-Seated Conference Hall	1,27	1,07	1,14	1,04	0,96	0,86
450-Seated Banquet Hall	1,34	1,17	0,97	0,86	0,67	0,58
250-Seated Banquet Hall	0,74	0,81	0,91	0,92	0,68	0,53
130-Seated Multipurpose Meeting Room for Heads of States	1,21	1,09	1,06	0,96	0,91	0,83
130-Seated Press Conference Hall	0,62	0,73	0,71	0,7	0,71	0,67
Hall for Signing Bilateral Protocols	0,83	0,7	0,73	0,71	0,7	0,65
VIP Cinema Hall	0,82	0,44	0,34	0,31	0,25	0,21
100-Seated Meeting Rooms	0,68	0,67	0,73	0,79	0,77	0,71
30-Seated Meeting Rooms	0,97	1,01	0,89	0,83	0,79	0,72

Figure 6: T30 distributions over 1/1 octave bands for halls within Awaza Congress Center

Table 6: Acoustical parameter results for multi-purpose auditorium

Acoustical Parameter	100-seated meeting rooms			30-seated meeting rooms		
	Room 1	Room 3	Room 3	Room 1	Room 3	Room 3
T30 (s) 500-1000 Hz average	0.76	0.70	0.68	0.86	0.86	0.68
STI average	0.67	0.69	0.69	0.66	0.66	0.72
SPLA difference (dBA)	5	5	3	6	7	7

4 Conclusions

The design goals of multi-purpose halls are unique as acoustical parameters and optimum values change according to the intended use based on different functions. As in Awaza case, the hall is planned to be used for conference, symphonic music concerts and opera which requires totally different acoustical conditions contrary to each other. Acoustical design of a hall that serves to different acoustical needs is commonly a challenge when the geometry of hall cannot be altered to ensure the specific acoustical conditions. For the main auditorium in Awaza Convention Center Complex, the optimum ranges for different acoustical parameters are defined at first. The design of hall interior is held constant for different scenarios; on the other hand stage area is altered to match the specific needs of different functions with the use of removable sound absorptive materials and architectural components.

The acoustical criteria set based on function for other rooms within the complex such as banquet halls, meeting rooms, press conference hall, hall for signing bilateral protocols, VIP cinema hall and other conference halls with less capacity are achieved by selection of acoustically proper materials and revising geometry/form of surfaces matching with interior design.

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