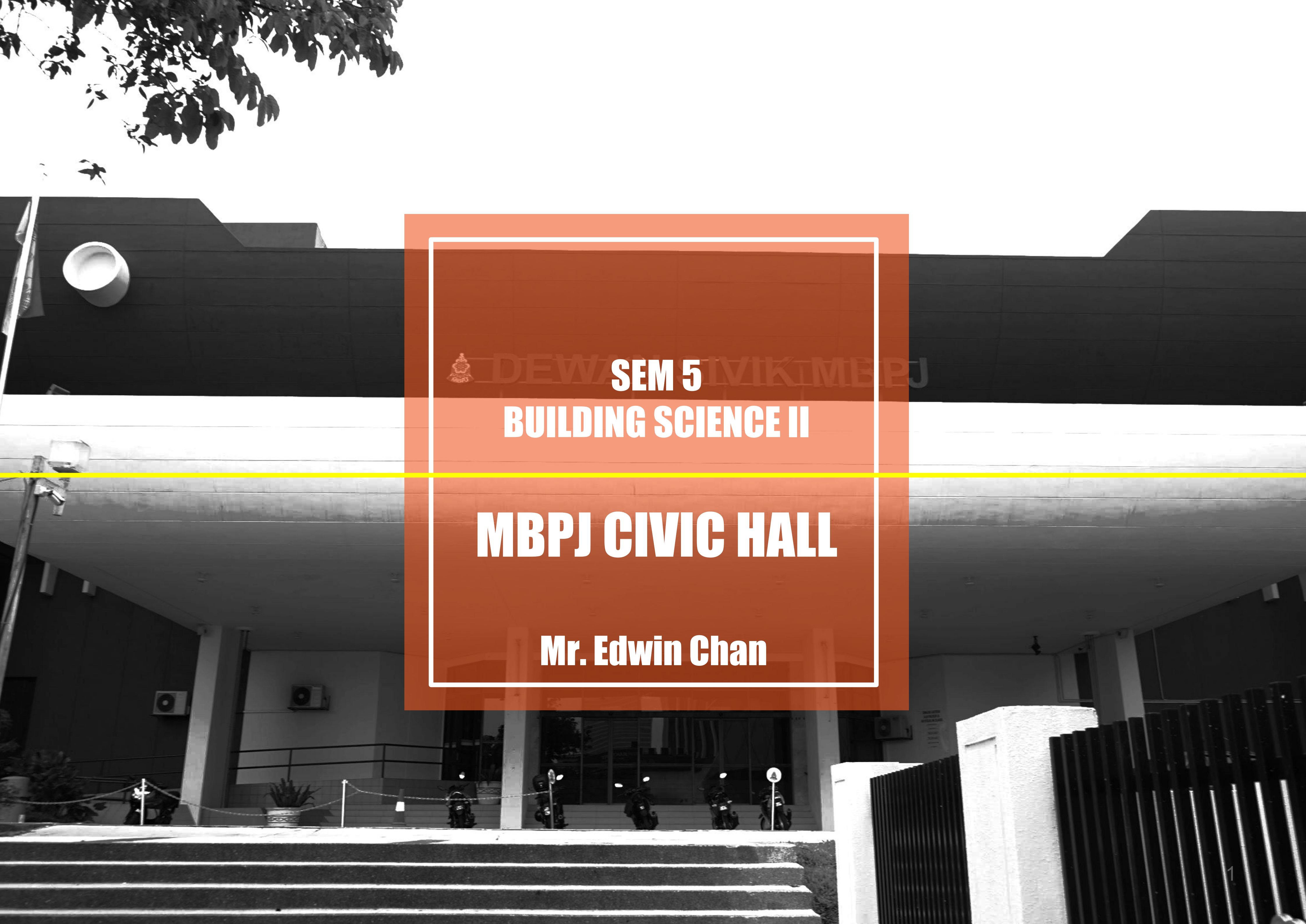

SEM 5
BUILDING SCIENCE II

MBPJ CIVIC HALL

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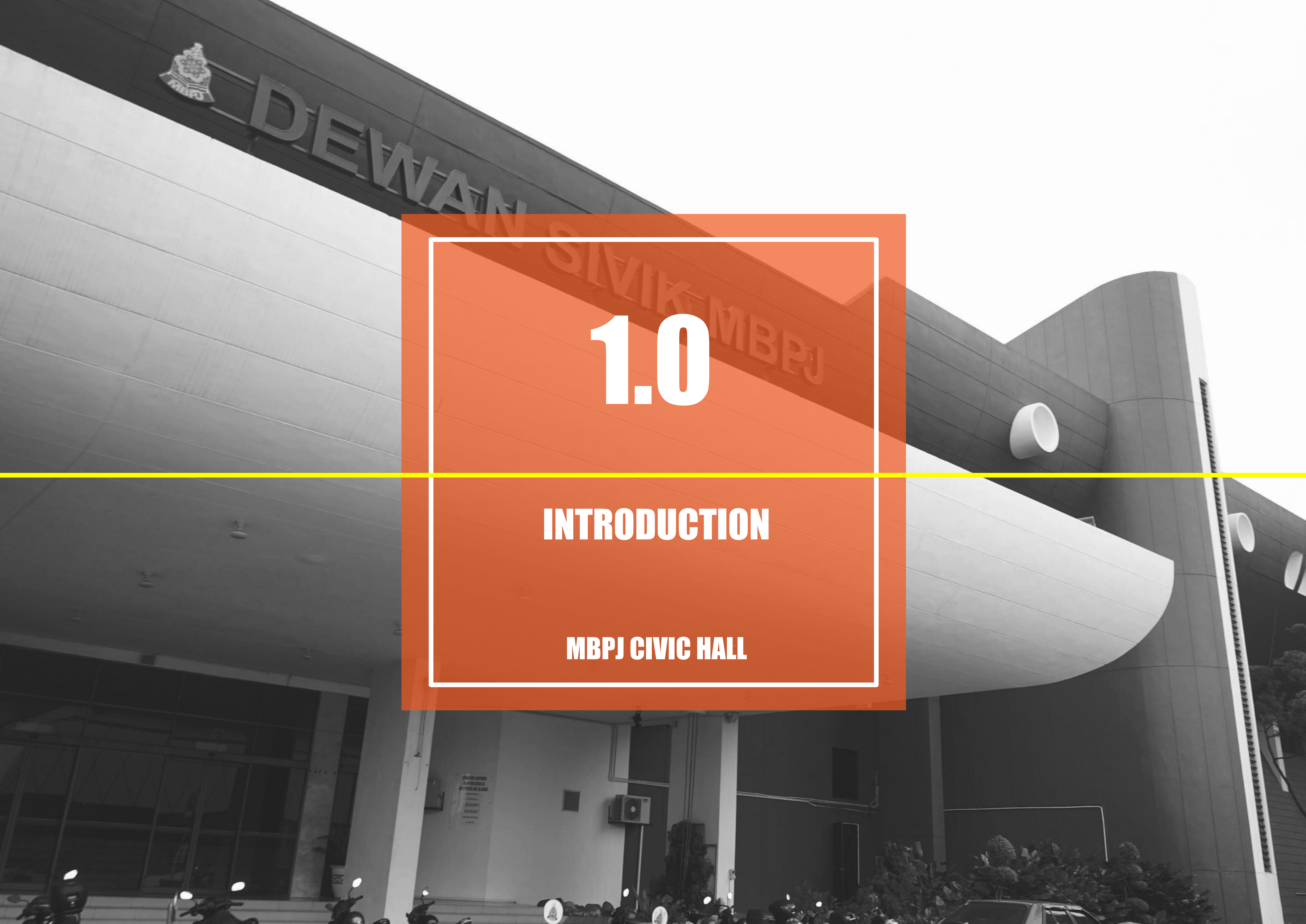
1.0

INTRODUCTION

MBPJ CIVIC HALL



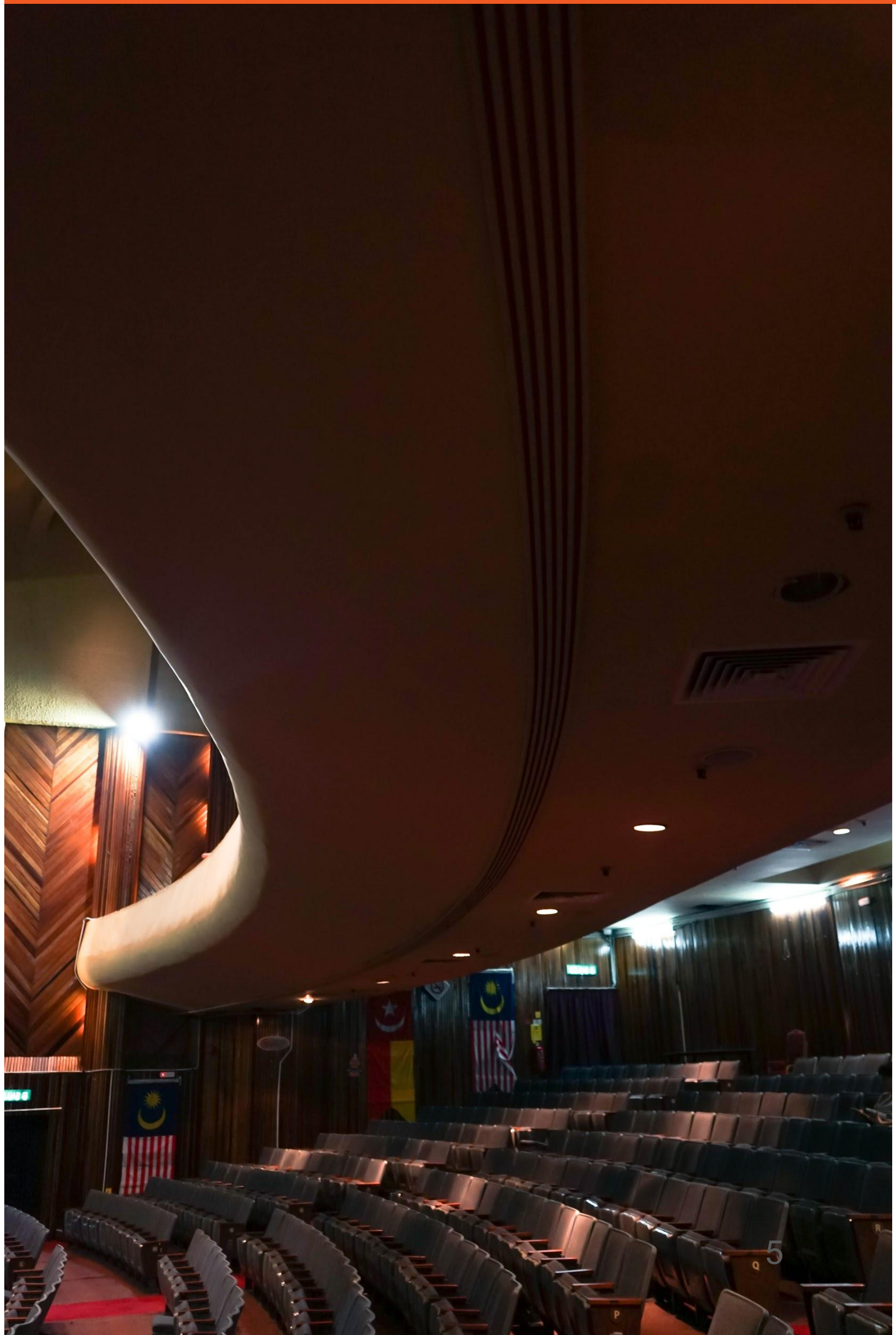
1.0 INTRODUCTION

1.1 OBJECTIVES

In a group of nine, students are to conduct a case study on a local auditorium.

An auditorium is caters to allow an audience to watch performances at venues such as theatres and music halls. A successful auditorium is well-designed acoustically in terms of its spatial layout and absorption rate.

Students are to study the local auditoriums to learn about the propagation of sound waves through reflection, absorption of sounds through materials, strategies of noise control and calculation of the reverberation time.



1.2 METHODOLOGY

To study the acoustic properties of the auditorium, various tools were used to measure the sound intensity at various parts. The data was then compiled into a report to draw conclusions from the nature of sound in this enclosed space.

1. Digital sound level meter

- A digital sound level meter is an instrument that gives constant and objective measurement of sound level in a space.
- The A-scale, which is the same as human ear respond to the loudness of sound and a weighted sound level are read as (dBA)
- The devices were used to measure sound intensity level (SIL) at different location in the auditorium with a constant sound source of 5000Hz

2. Standard measuring tape

- A standard measuring tape was used to get accurate dimensions for the study of plans and sections.
- It was used to measure the height and dimension throughout the auditorium.

1.2 METHODOLOGY

3. Digital cameras (DSLR)

- DSLR was used to capture important material found in the auditorium.
- The images were then used as a reference for the report

4. Portable bluetooth speaker

- Portable bluetooth speaker was used to represent the acoustic performance for the recording of sound level meter.
- Constant volume and frequency of 5000 Hz was played on stage for recording purposes.
- Sound level recordings helped identify sound concentration, sound shadows and background noise within the hall

1.3 MBPJ CIVIC HALL

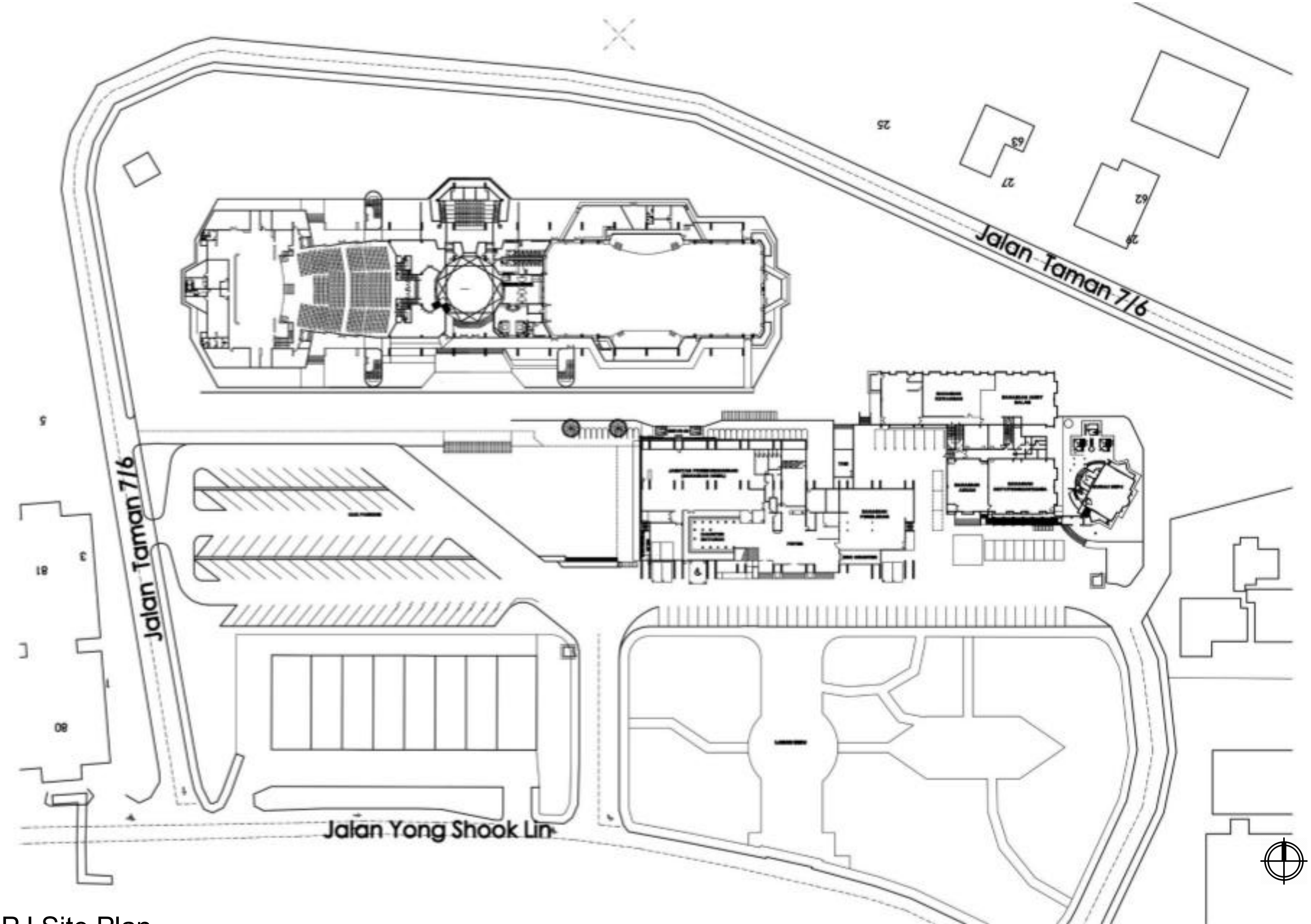
The building of Petaling Jaya Civic Centre, which is also known as Dewan Sivik. This building has taken 5 years to complete from the year 1973 to 1978. It spans for 2.5 acres of land with the built up area of 4562 square meters.

The Civic Hall is Majlis Bandaraya Petaling Jaya's (MBPJ) municipal building. It aims to represent society's civic values with a unique architectural aesthetics. The building is equipped with multi-functional spaces that cater to musicals, exhibitions, celebrations and performances.

Petaling Jaya Civic Centre is a well known brutalist building in Malaysia. The spaces comprises of a theater, 6 badminton courts, conference rooms, auditorium and also recreational facilities. In the year 2001, the 6 badminton courts have been retrofitted into a banquet hall which could fit 1000 people.

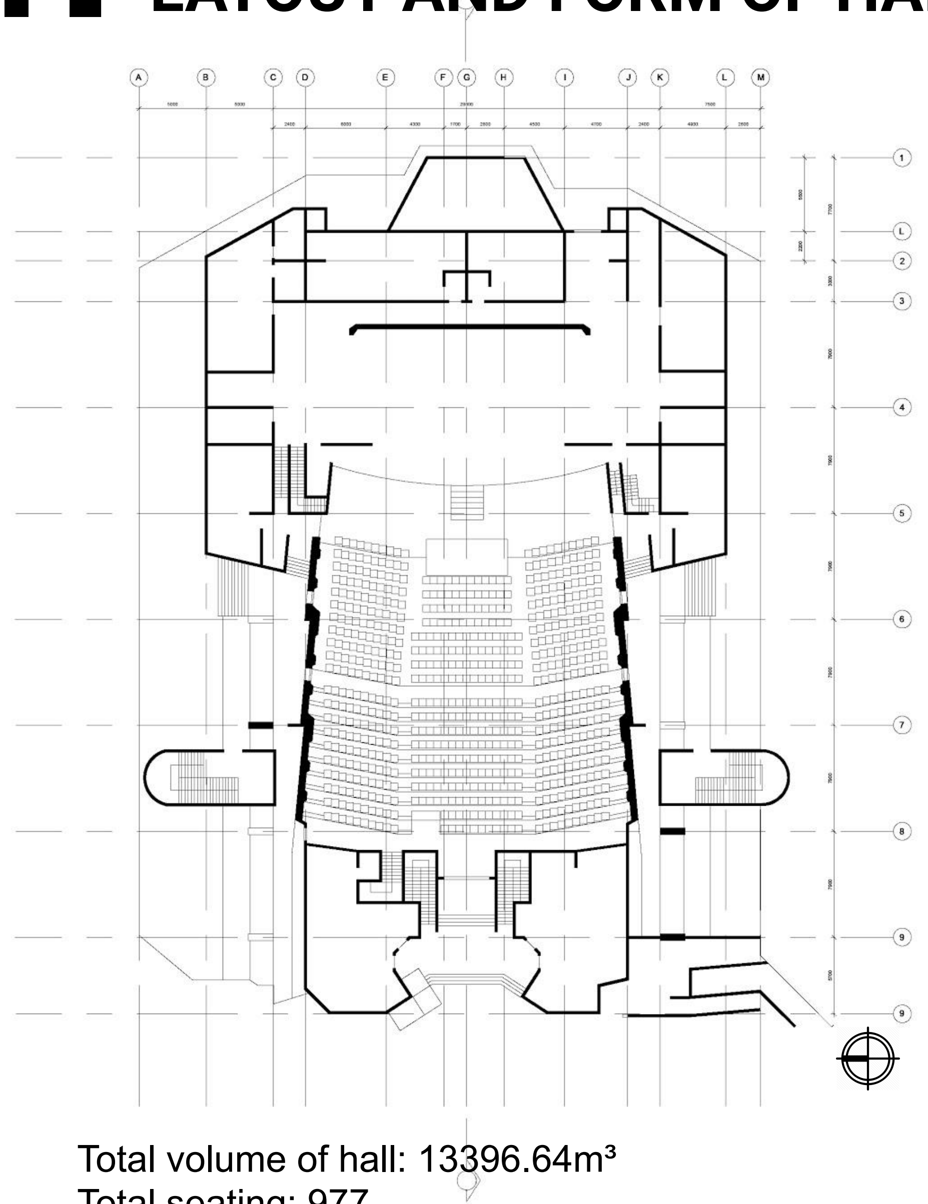
As a modernist landmark for Malaysia, we decided to choose MBPJ Civic Hall as the subject of our case study due to its significance in acoustic performances through the past.

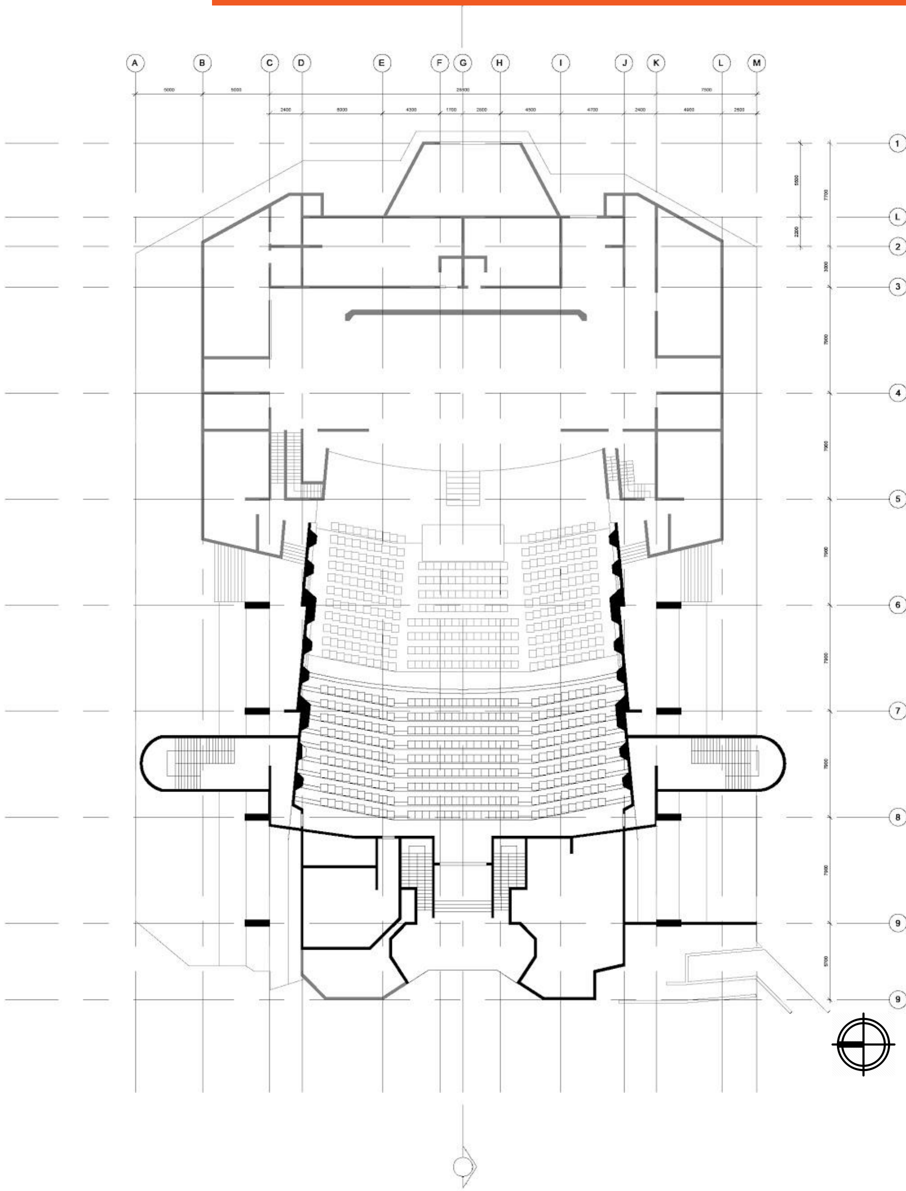
1.4 LAYOUT AND FORM OF HALL



MBPJ Site Plan

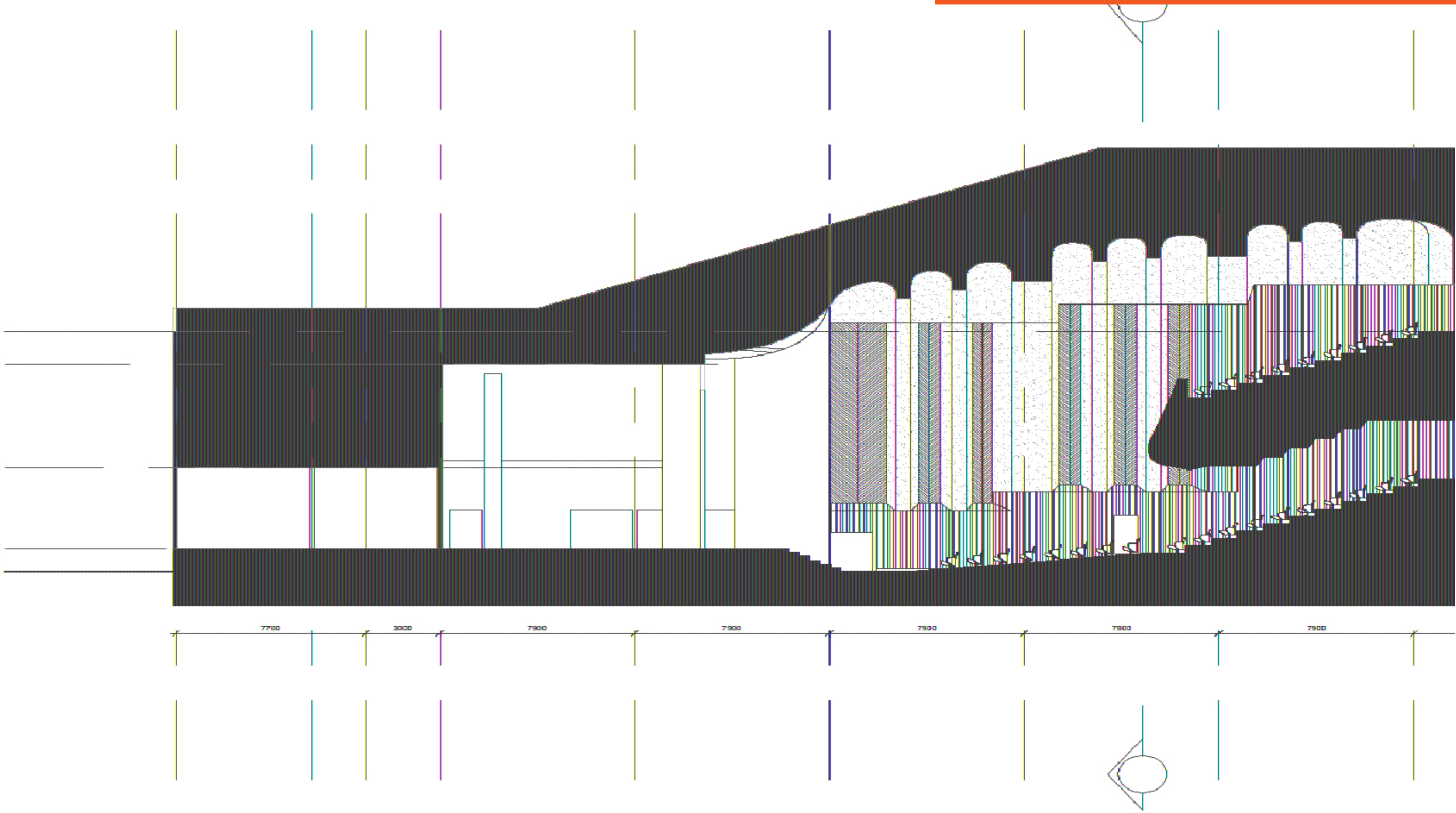
1.4 LAYOUT AND FORM OF HALL





Total volume of hall: 13396.64m³
Total seating: 977
The Civic Hall is tapering in width towards the stage on plan. The seats are arranged in a fan position to maximise views and locate the audience as close as possible to the sound source, thereby reducing the distance it has to travel. (Ginn, 1978)

1.4 LAYOUT AND FORM OF HALL



- The audience is also ramped upwards making it easier for sound to reach the audience as it travels at a grazing incident. (Long, 2006)
- The sound source is also raised up at 1.2m on stage in order to secure a free flow of direct sound waves (without reflection) to every auditor. (Long, 2006)
- The ceiling is coffered with many protruding ribs with a convex ceiling towards the top of the stage. A balcony is also found to be protruding into the hall making a mezzanine level.

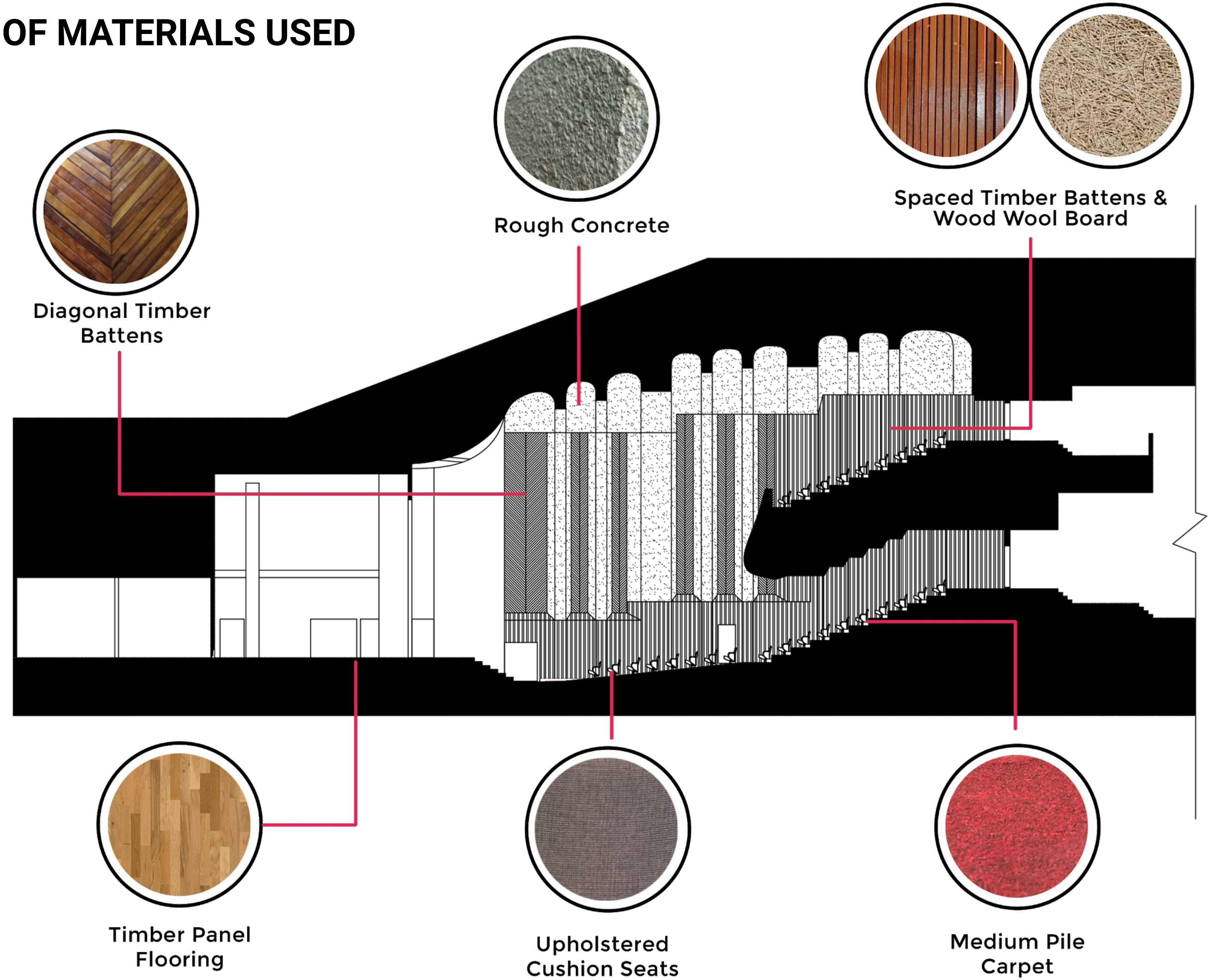
2.0

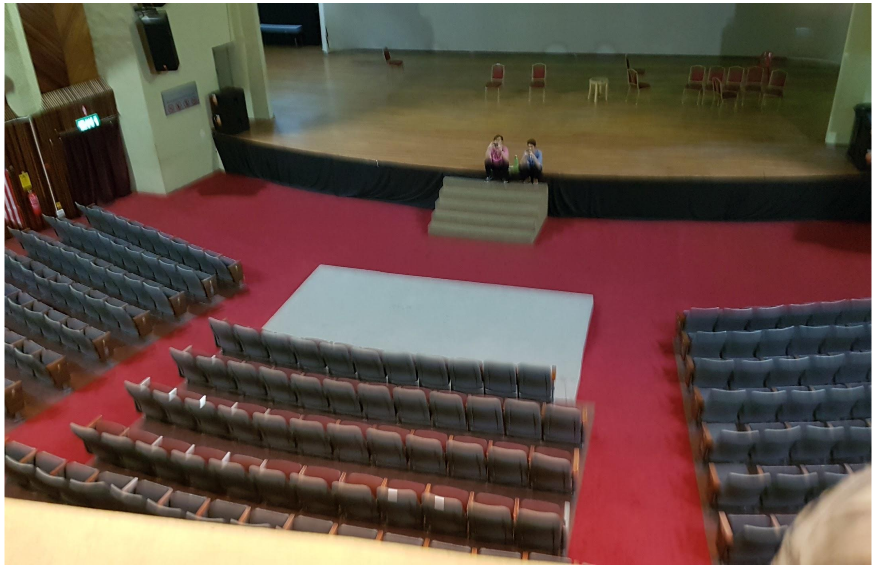
MATERIALITY

MBPJ CIVIC HALL

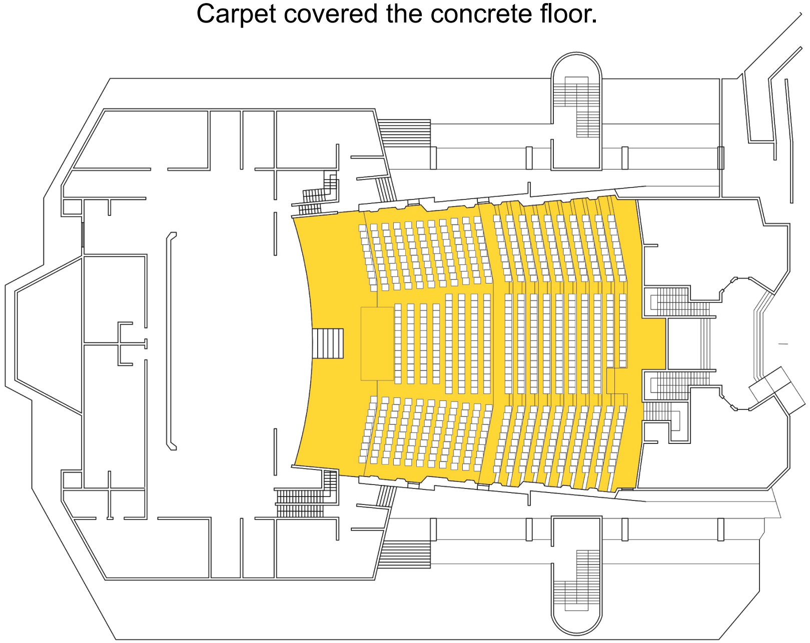
2.0 MATERIALITY

2.1 TYPES OF MATERIALS USED





Carpet covered the concrete floor.



Location of Medium Pile Carpet Flooring indicated on plan.

2.2 MEDIUM PILE CARPET FLOORING

The concrete floor of MBPJ is a sound reflector with a sound absorption coefficient of 0.02, reflecting 98% of the sound energy. Medium pile carpet is used to covered the concrete because carpets can absorb the impact noise created by footsteps on raw concrete, reducing the noise in the auditorium. The sound wave can be absorbed by the carpet because carpet is porous. Porous materials will convert the incident sound to heat energy because of the frictional resistance. It mainly absorbs sound waves at high frequencies and lesser of low frequencies. (Russ, 2019)

AREA

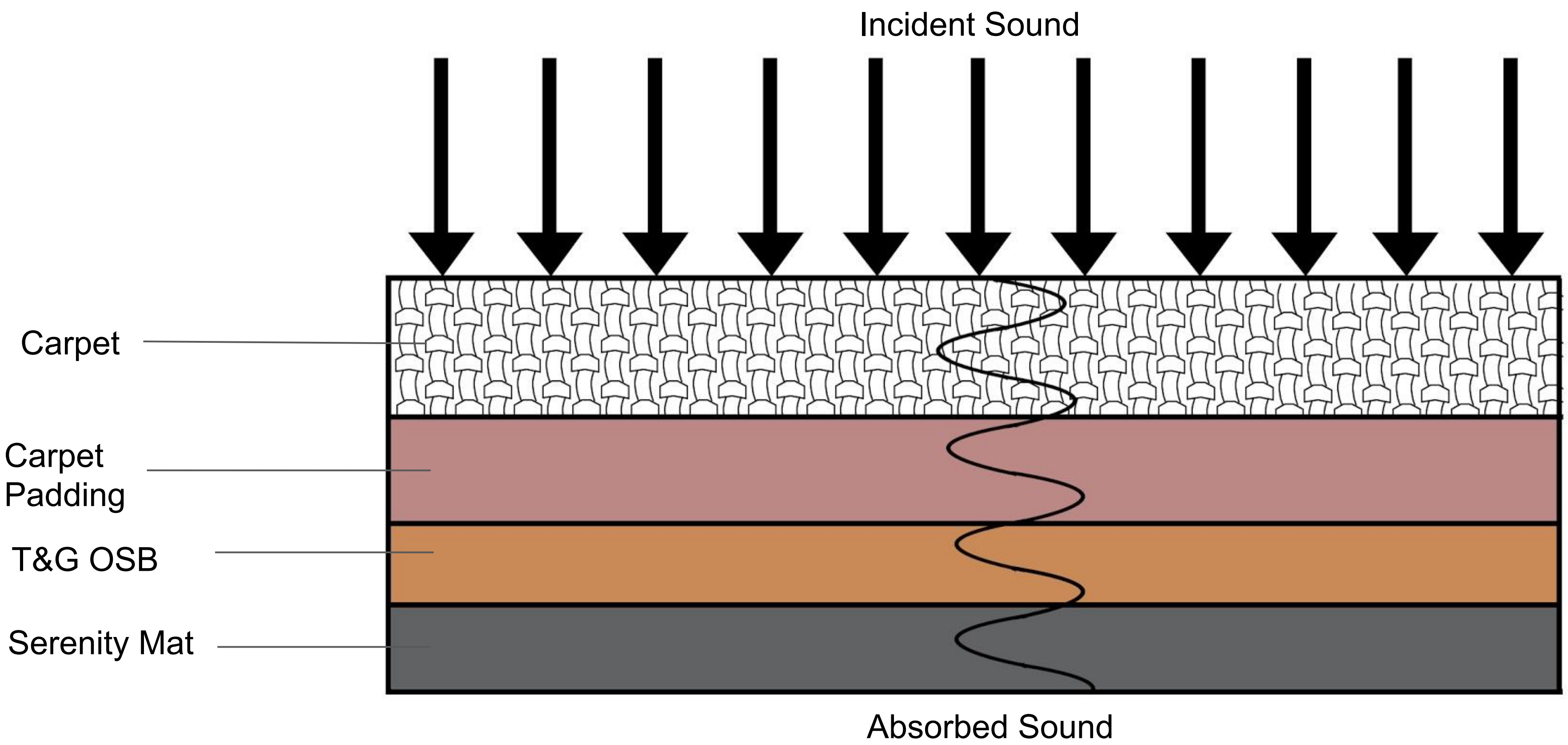
- Ground Floor: 640m²
- Balcony Floor: 310m²
- Staircase Risers : 130m²

ABSORPTION COEFFICIENT

Total Area: 1080m²
Absorption coefficient: 0.4

Total Absorption Coefficient: 1080 x 0.4 = 432sabines

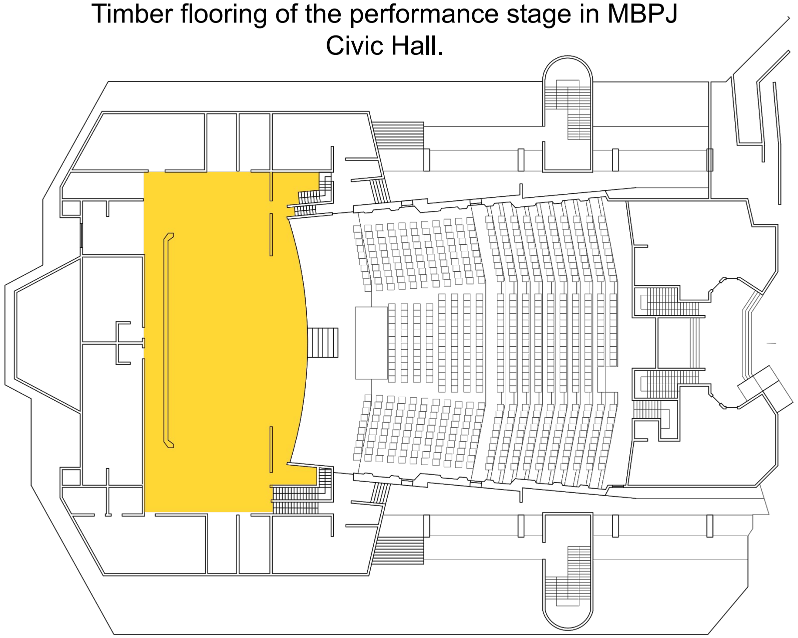
2.3 FLOOR DETAILED DIAGRAM



Sound absorption diagram for the carpet flooring.

2.0 MATERIALITY

Timber flooring of the performance stage in MBPJ Civic Hall.



Location of Timber Flooring indicated on plan.

2.4 TIMBER FLOORING

Timber flooring is used for the stage to provide a suitable performance surface for the performers. Timber flooring is more suitable for performing art activities compared to carpeted flooring because of the smoothness of surface for dance. It is also a hard wearing surface that allows for the frequent vigorous activities to occur on it than carpeted flooring.

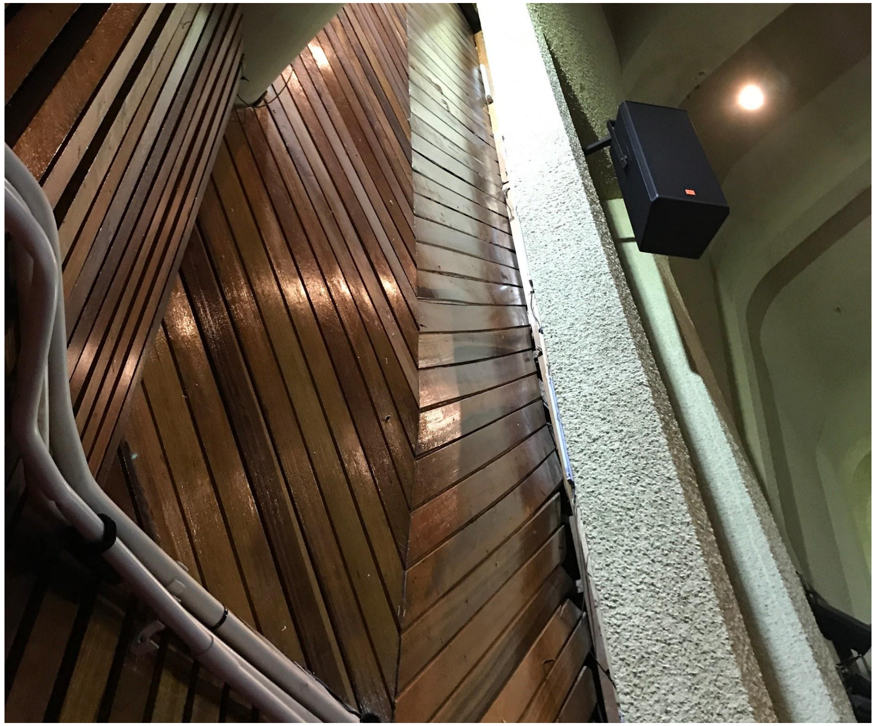
AREA

- Stage Flooring: 231.58m²

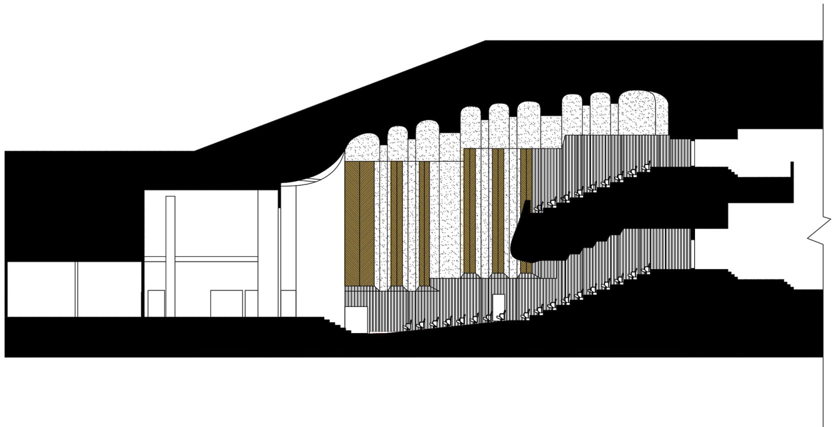
ABSORPTION COEFFICIENT

Total Area: 231.58m²
Absorption coefficient: 0.1

Total Absorption Coefficient:
231.58 x 0.1 = 423.16sabines



Diagonal timber battens arranged at an angle.



Location of Diagonal Timber Battens indicated on section.

2.5 DIAGONAL TIMBER BATTENS WALL

Timber battens are lined along the interior walls of the MBPJ Civic hall auditorium. Sound energy is converted into a small amount of heat energy by the interlocking cells of wood through frictional resistance and vibrations.

When timber panels are laid flat against a solid surface, its solid surface is exposed to sound waves and channels the reflection of sound (Asdrubali, 2017). Some of the timber battens are arranged at an angle to create sharp edges. The sharp edges difracts the sound produced at the stage causing the sound waves to dispersal in other directions.

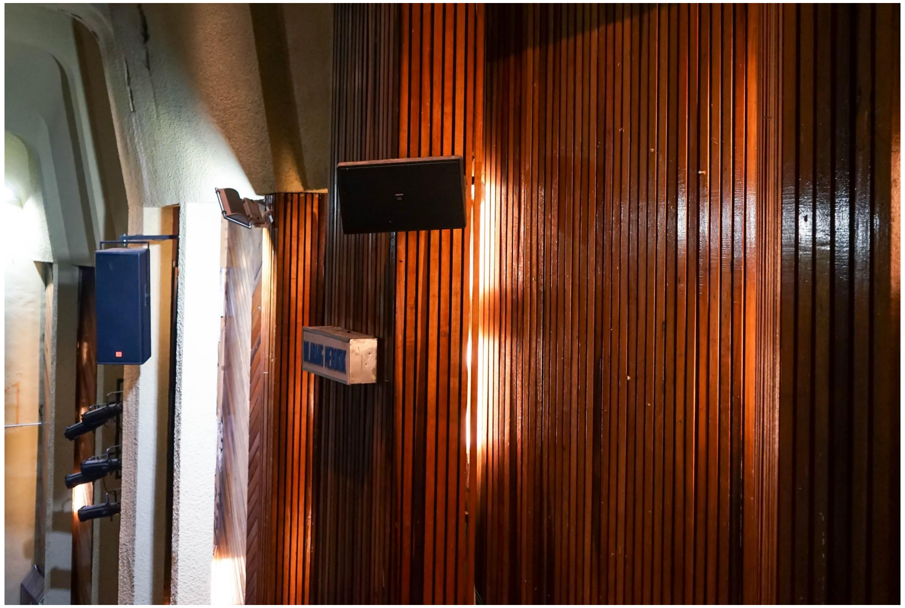
AREA

- Diagonal Timber Wall (Left): 78m²
- Diagonal Timber Wall (Right): 78m²

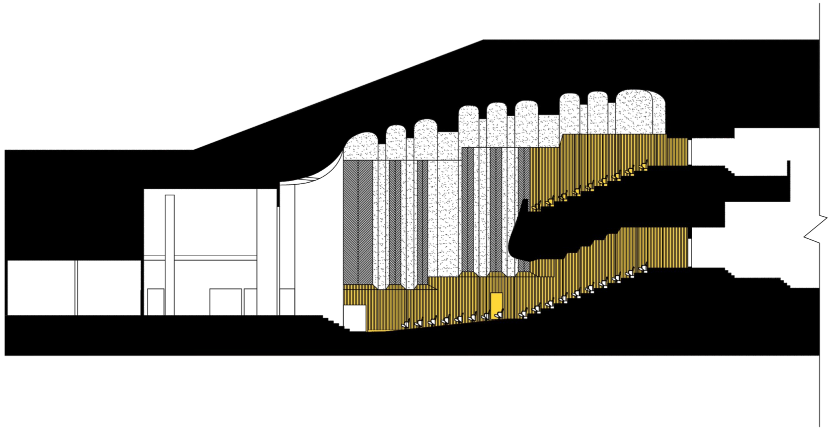
ABSORPTION COEFFICIENT

Total Area: 156m²
Absorption coefficient: 0.1

Total Absorption Coefficient: 156 x 0.1 = 15.6sabines



Vertical spaced timber battens on the side of the hall.



Location of Vertical Timber Battens indicated on section.

2.6 VERTICAL SPACED TIMBER BATTENS

Timber acoustic panelling are arranged with air gaps in between to dampen the amplitude of sound waves and to increase the amount of sound absorption within the hall. The small dimension of the air gap allow high frequency (small wavelength) sounds to be absorbed while reflecting low frequency (large wavelength) sounds.

As such, the spaced timber battens function as both an absorber and reflector in the hall and line up majority of the walls in the hall.

AREA

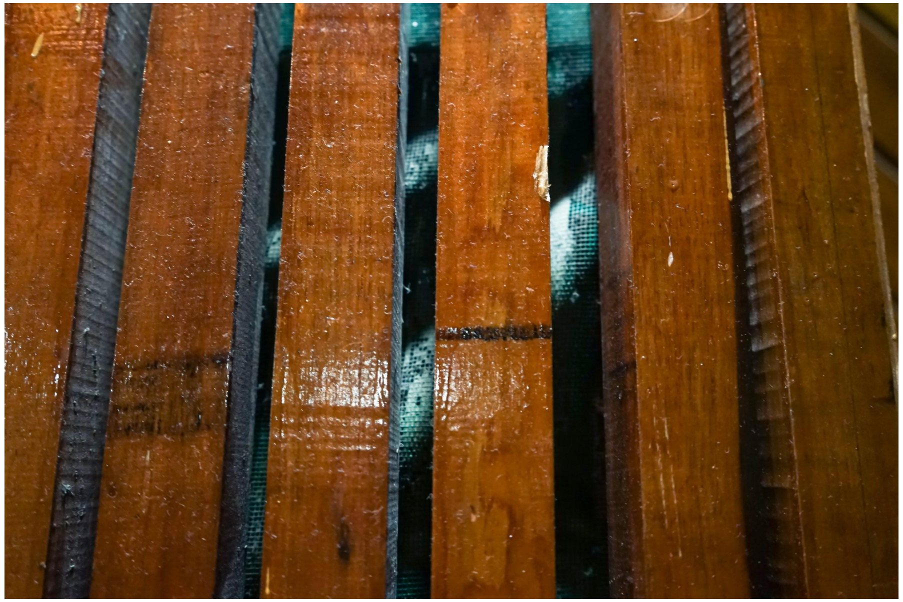
- Vertical Timber Wall (Left): 212m²
- Vertical Timber Wall (Right): 212m²
- Vertical Timber Wall (Back) : 315m²

ABSORPTION COEFFICIENT

Total Area: 739m²
Absorption coefficient: 0.1

Total Absorption Coefficient: 739 x 0.1 = 73.9

2.7 WOOD WOOL BOARD



Wood wool board beneath vertical timber battens.

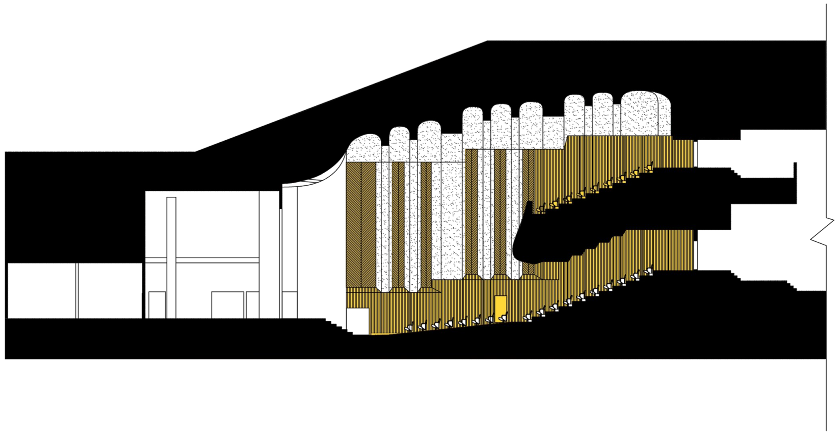
To enhance the sound insulation of walls, a layer of porous sound absorption material is installed behind the timber panels. This forms a board resonator which effectively further dampens the low pitch sounds that are problematic for lightweight materials like timber.

Wood wool board is installed underneath the spaced timber battens to create a board resonator. Wood wool boards are efficient porous sound absorption materials. The sound absorption properties of wood wool board increases with increase thickness especially for low frequencies (Johansson, 1994).

Wood wool boards also have moderate performance in sound insulation. The wood wool board is attached to a concrete wall making the sound insulation very strong producing a sound reduction of 35-55dB. The air cavity within the timber battens and wood wool boards also increases the sound reduction.

AREA

- Wood Wool Board (Left): 290m²
- Wood Wool Board (Right): 290m²
- Wood Wool Board (Back) : 315m²



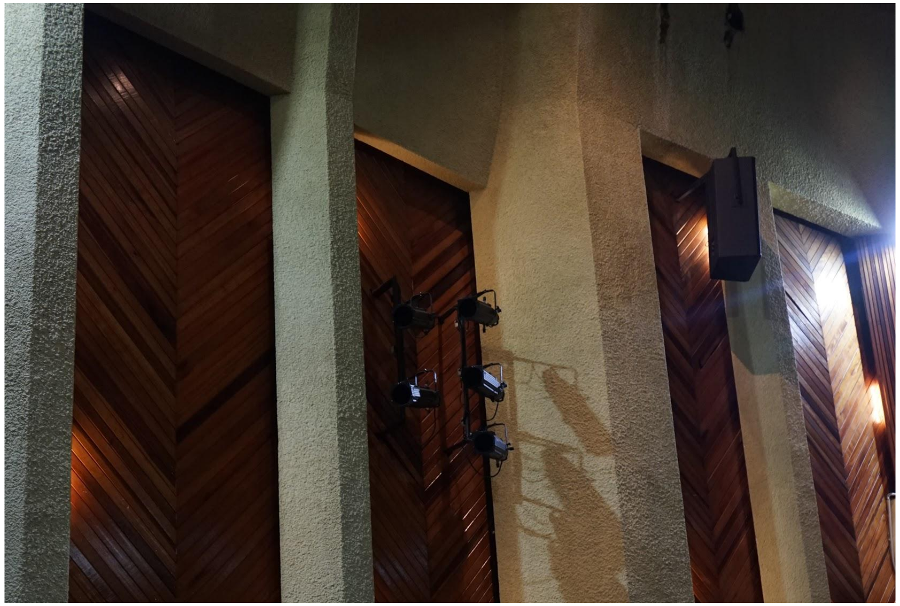
Location of Wood Wool Board indicated on section.

ABSORPTION COEFFICIENT

Total Area: 895m²
Absorption coefficient: 0.5

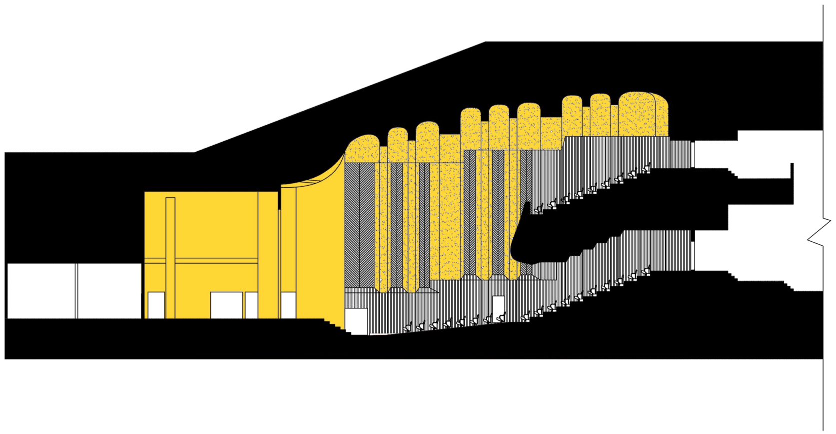
Total Absorption Coefficient: 895 x 0.5 = 447.5sabines

2.8 CONCRETE WALL



Rough concrete wall finish on the side of the hall.

MBPJ Civic Hall uses rough concrete for its interior wall surface. The sound absorption coefficient of rough concrete is higher than smooth concrete due to the internal reflection happening within the uneven and porous surface of rough concrete. The uneven surface of rough concrete increases the diffraction of sound causing the sound wave to be broken up and spread out evenly throughout the auditorium. This allows a balanced distribution of sound so there are no “dead zone” present. (Niall Holmes, 2014)



Location of Rough Concrete Wall indicated on section.

AREA

- Concrete Wall (Left): 150m²
- Concrete Wall (Right): 150m²
- Concrete Wall (Back) : 610m²
- Concrete Wall (Front) : 250m²

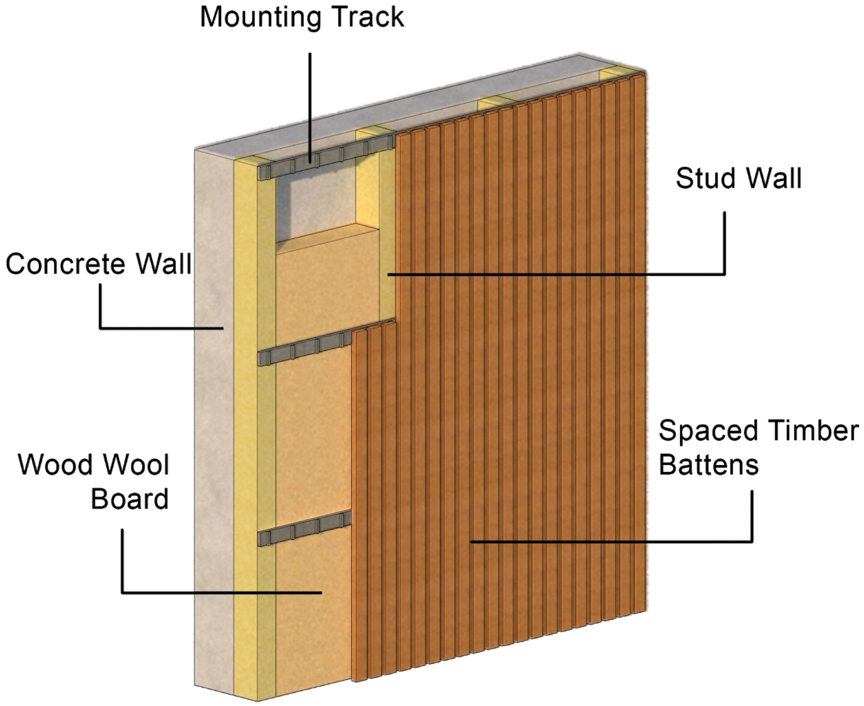
ABSORPTION COEFFICIENT

Total Area: 1160m²

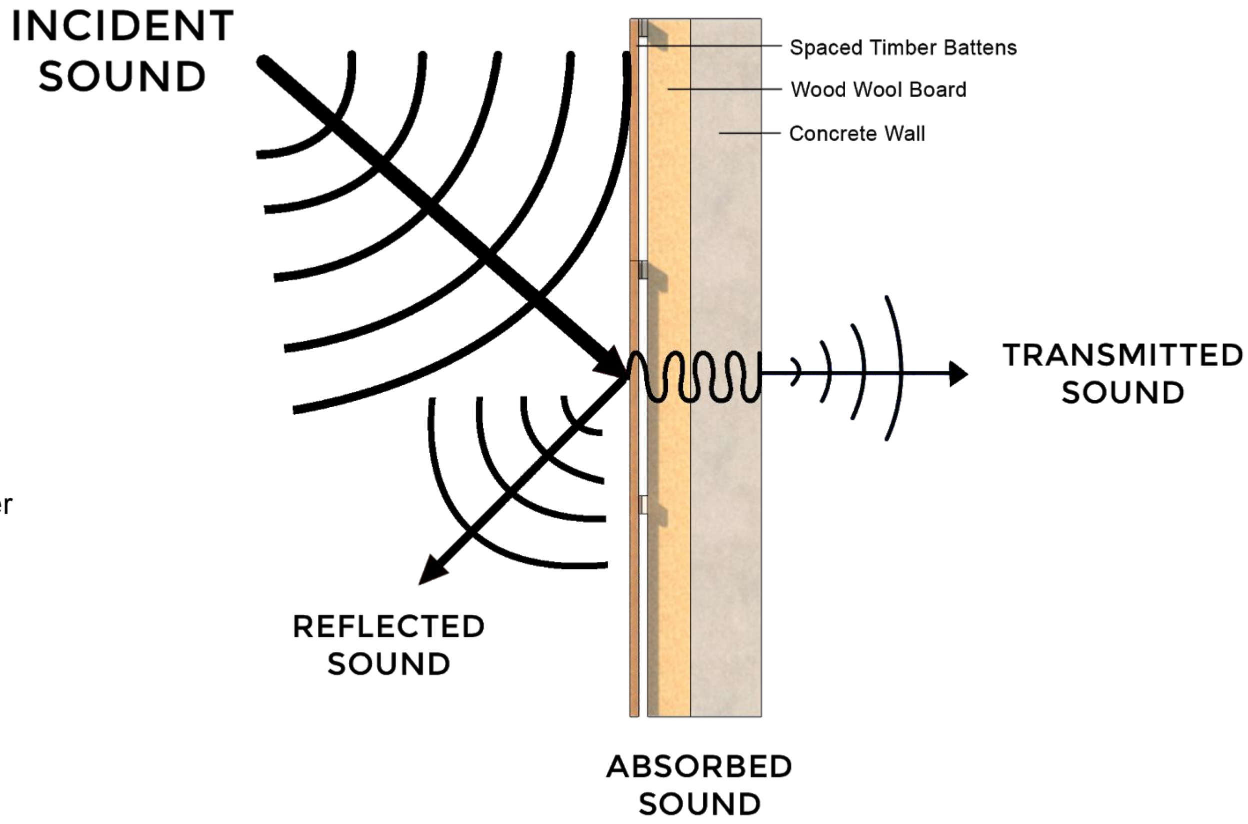
Absorption coefficient: 0.02

Total Absorption Coefficient: 1160 x 0.02 = 23.2sabines

2.9 WALL DIAGRAMS

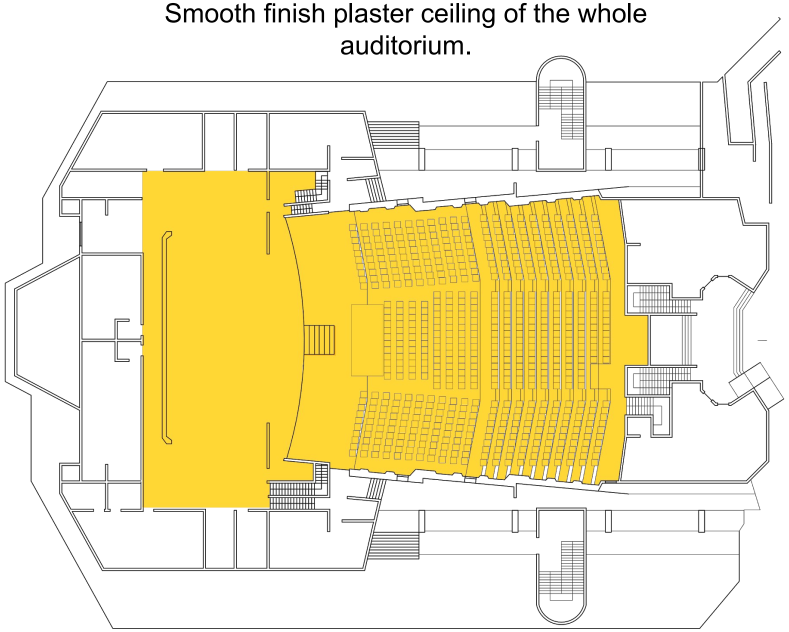


Wall details



Sound absorption diagram for wall.

Smooth finish plaster ceiling of the whole auditorium.



Location of Smooth Finish Plaster Ceiling indicated on plan.

2.10 SMOOTH FINISH PLASTER CEILING

Plaster is very common in the use for concert halls due to their acoustics properties. To prevent vibrations through the structure, a thicker coat of plaster is applied to the ceiling surfaces.

AREA

- Whole Auditorium: 855m²
- Under Balcony: 310m²

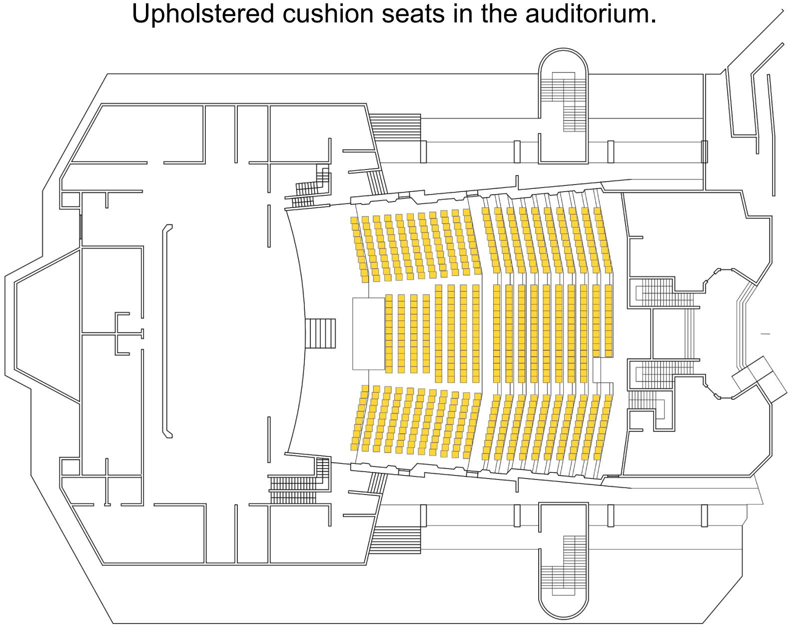
ABSORPTION COEFFICIENT

Total Area: 1165m²
Absorption coefficient: 0.02

Total Absorption Coefficient: 1165 x 0.02 = 23.3sabines

2.0 MATERIALITY

Upholstered cushion seats in the auditorium.



Location of Upholstered Cushion Seats indicated on plan.

2.11 UPHOLSTERED CUSHION SEATS

Padded seats add to the acoustical absorption of an empty auditorium that possesses the absorption coefficient of a person. This allows the space to achieve a similar quality of sound regardless of its filled capacity. The porous material of cushion increases the surface area for sound absorption resulting in a good absorption coefficient.

AREA

- Per Seat: 0.25m²

ABSORPTION COEFFICIENT

Number of Seats: 977
Total Area: 244.25m²
Absorption coefficient: 0.4

Total Absorption Coefficient: 244.25 x 0.4 = 97.7sabines

2.0 MATERIALITY

2.12 ABSORPTION COEFFICIENT

Materials	Area	Total Area	Absorption coefficient (sabines)	Calculation	Total Absorption Coefficient (sabines)
Medium Pile Carpet Flooring	• Ground Floor: 640m² • Balcony Floor: 310m² • Staircase Risers : 130m²	1080m²	0.4	1080 x 0.4 = 432	**432**
Timber Flooring	• Stage Flooring: 231.58m²	231.58m²	0.1	231.58 x 0.1 = 423.16	**423.16**
Diagonal Timber Battens Wall	• Diagonal Timber Wall (Left): 78m² • Diagonal Timber Wall: 78m²	156m²	0.1	156 x 0.1 = 15.6	**15.6**
Vertical Spaced Timber Battens Wall	• Vertical Timber Wall (Left): 212m² • Vertical Timber Wall (Right): 212m² • Vertical Timber Wall (Back) : 315m²	739m²	0.1	739 x 0.1 = 73.9	**73.9**

2.0 MATERIALITY

2.12 ABSORPTION COEFFICIENT

Materials	Area	Total Area	Absorption coefficient (sabines)	Calculation	Total Absorption Coefficient (sabines)
Wood Wool Board	• Wood Wool Board (Left): 290m² • Wood Wool Board (Right): 290m² • Wood Wool Board (Back) : 315m²	895m²	0.5	895 x 0.5 = 447.5	**447.5**
Concrete Wall	• Concrete Wall (Left): 150m² • Concrete Wall (Right): 150m² • Concrete Wall (Back) : 610m² • Concrete Wall (Front) : 250m²	1160m²	0.02	1160 x 0.02 = 23.2	**23.2**
Smooth Finish Plaster Ceiling	• Whole Auditorium: 855m² • Under Balcony: 310m²	1165m²	0.02	1165 x 0.02 = 23.3	**23.3**
Upholstered Cushion Seats	• Per Seat: 0.25m² • Number of Seats: 977	244.25m²	0.4	244.25 x 0.4 = 97.7	**97.7**
OVERALL TOTAL				21.5 + 432 + 89.5 + 447.5 + 23.2 + 23.3 + 97.7 =	**1134.7**

3.0

SOUND SOURCE & PROPAGATION

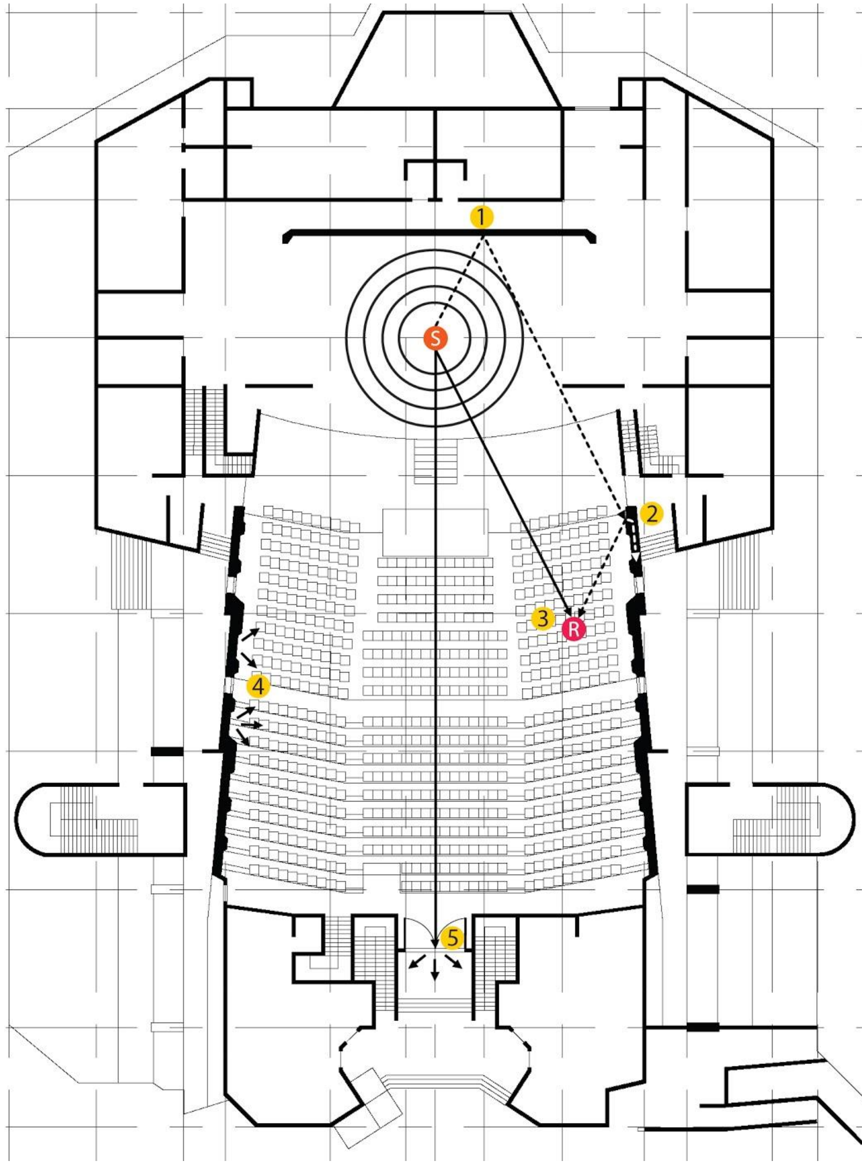
MBPJ CIVIC HALL

3.1 SOURCE OF SOUND

Sound travels from its source in a continuously extending spherical wavefront that reduces in intensity the further away it is from the source.

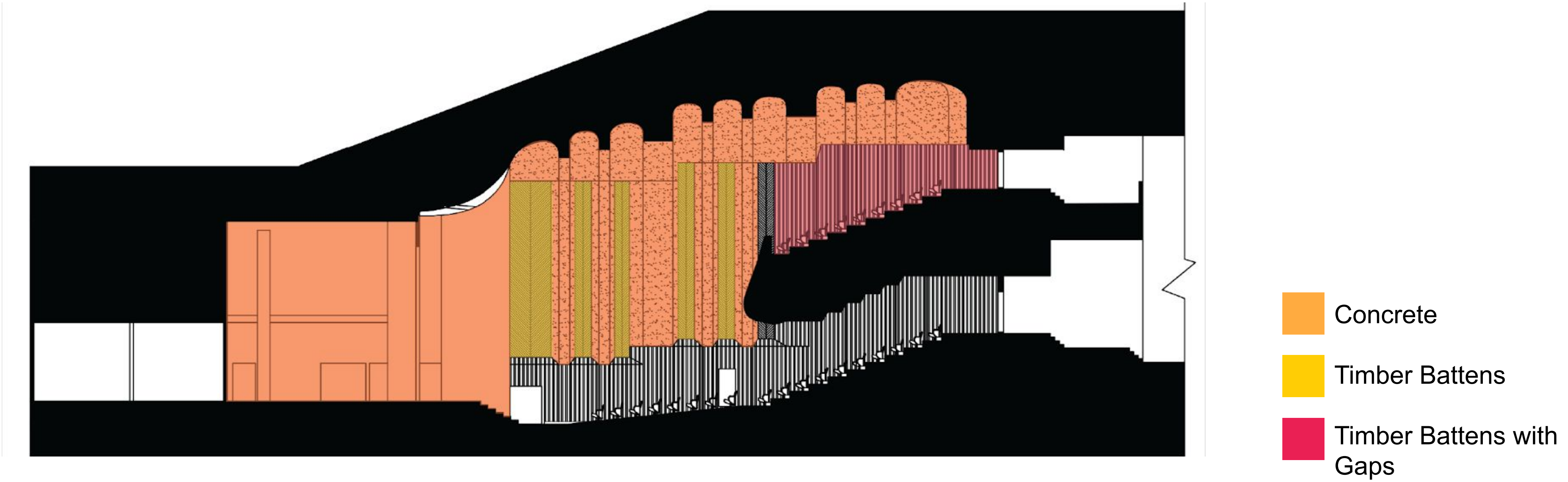
In geometrical acoustics, sound waves propagate in a straight line away from the sound source until it encounters the room's boundaries in which it will either be reflected, absorbed or transmitted through the boundary. (Ginn, 1978)

1 - Reflected sound
2 - Sound absorbed by material
3 - Direct sound
4 - Diffused sound because of surface irregularity
5 - Transmitted sound through boundary



3.2 REFLECTED SOUND

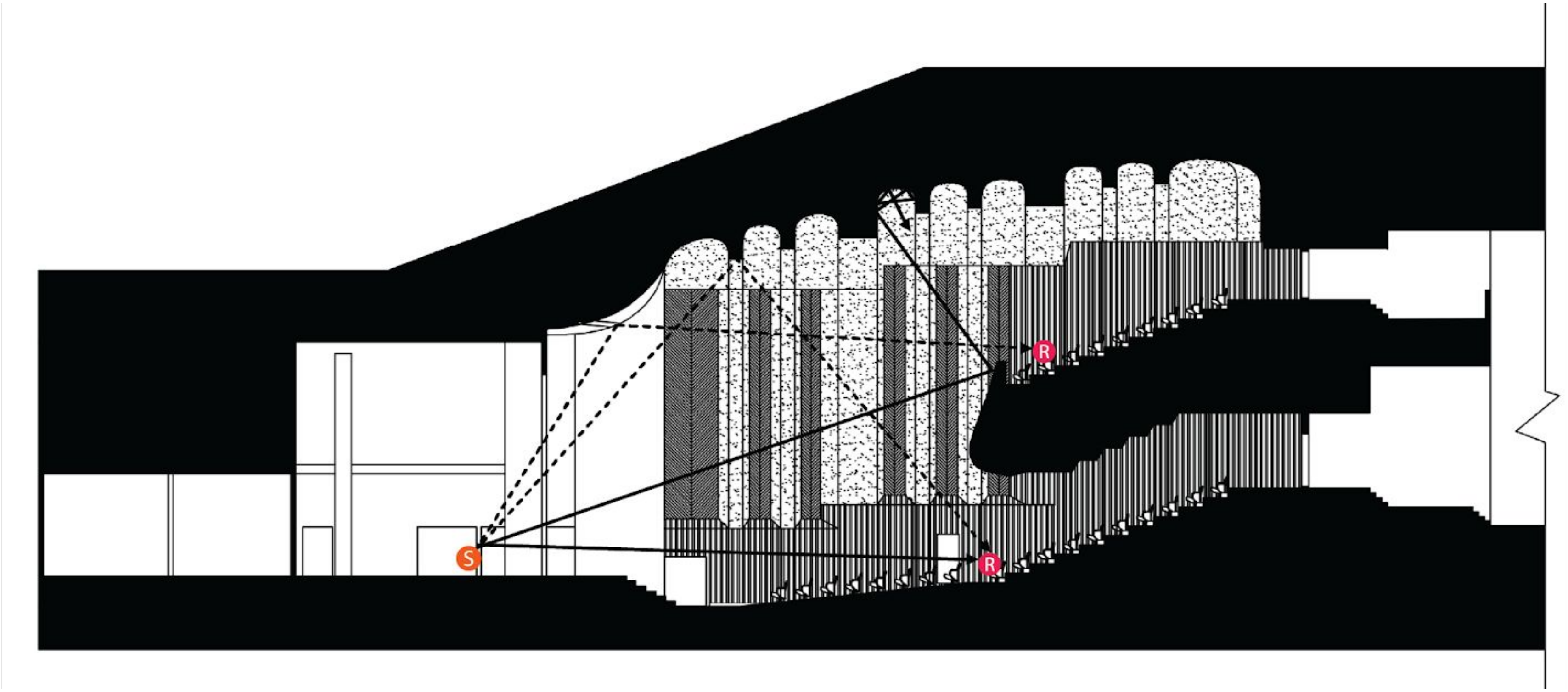
3.2.1 LOCATION OF SOUND REFLECTOR



- Reflectors are surfaces that are hard and rigid in its material. They have a low absorption coefficient and function to reflect sound waves from the source to the receiver.
- Concrete is used prominently in the first third of the hall. It is placed near the sound source in order to produce a powerful reflection following quickly after sound is produced (Leslie, 1965)
- Timber battens have a gap in between them that absorb sound with rock wool. Due to the small dimensions of the gap, only high frequency noise (small wavelength) will be absorbed while high frequency noises (large wavelength) will be reflected.
- The amount of reflectors increase in surface area the further away it is from the sound source for the remote seats to receive enough reflected sound for adequate listening (Leslie, 1965).

3.2 REFLECTED SOUND

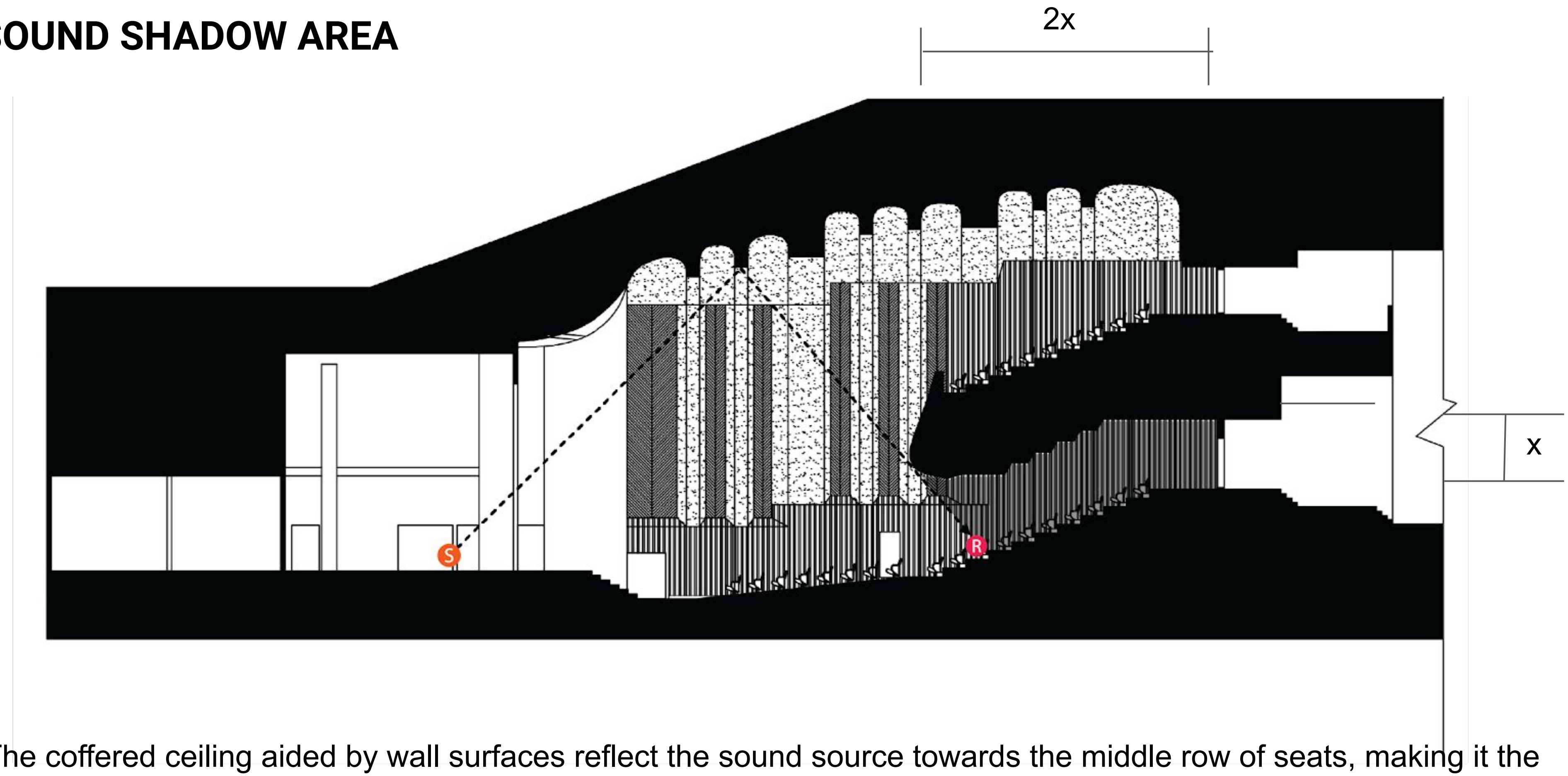
3.2.2 DIRECT AND INDIRECT SOUND



- The audience on the ground floor receives direct source of sound from stage. It is amplified by the reflected sound off of the protruding ribs from the ceiling and from wall surfaces.
- The balcony does not receive direct sound source of sound as sound waves propagate into the coffer ceiling and diminish before it reaches the receiver. Lower frequency sounds will not be affected by the coffers in the ceiling because of its small dimension.
- The balcony only receives reflected sound that is dispersed off the convex surface above the stage, thus making its sound reading lower than the ground floor.

3.2 SOURCE OF SOUND

3.2.3 SOUND SHADOW AREA

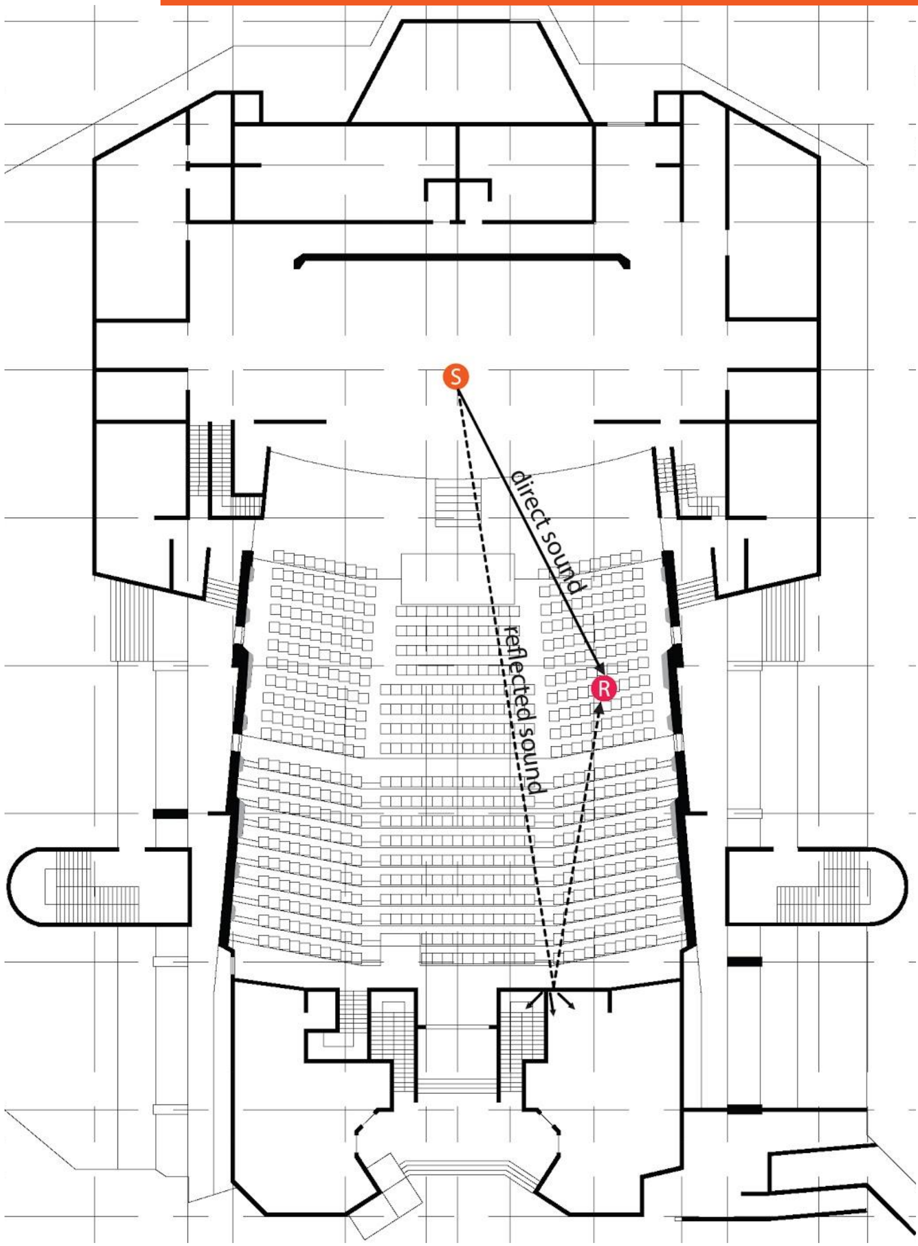


- The coffered ceiling aided by wall surfaces reflect the sound source towards the middle row of seats, making it the most conducive seating in the hall for loudness of sound.
- Sound shadow occurs underneath the long balcony which depth exceeds twice the height of hall (Leslie, 1965). Poor audability is created in the remote seats under the balcony due to the cut-off of direct and reflected sounds. This results in a lowest sound reading of 43dB in the space.

3.2 SOURCE OF SOUND

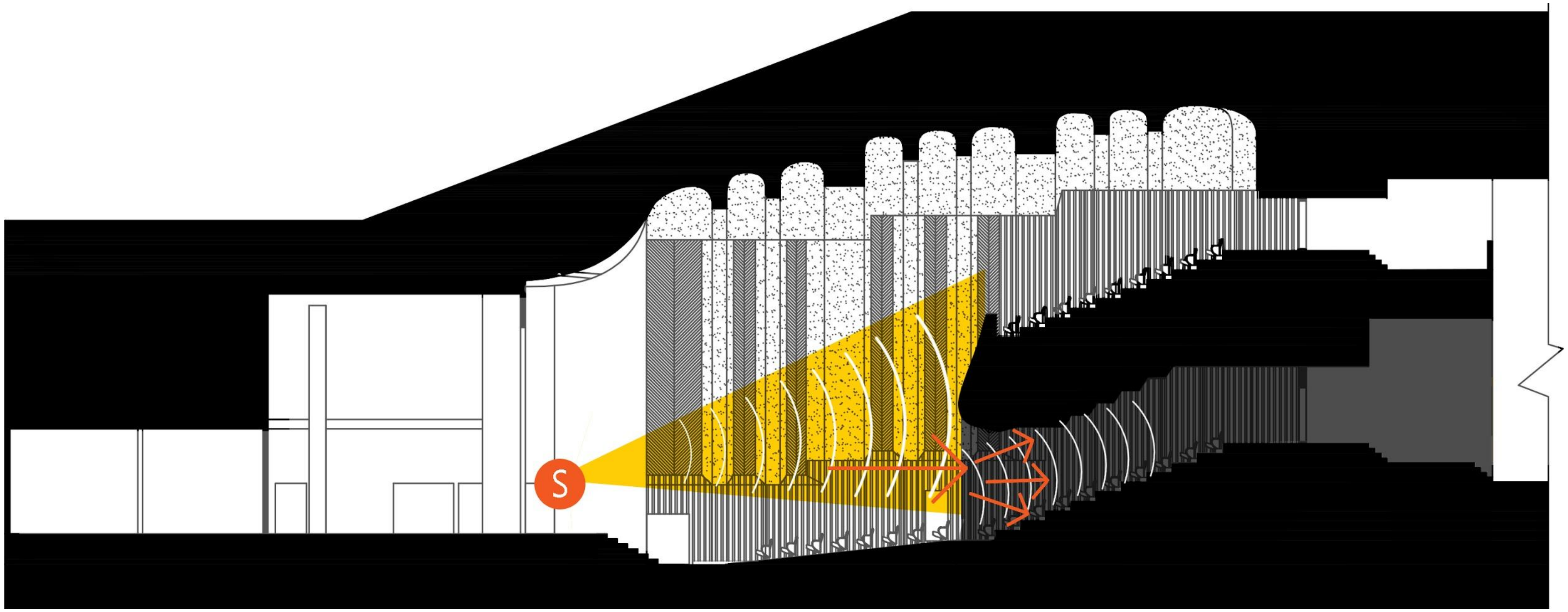
3.2.4 LONG-DELAYED REFLECTION

- Long-delayed reflections occur when the distance of the reflected sound is longer than the direct sound.
- The reflected sound reaches the receiver at a slower rate than the direct sound due to the further distance it has to travel.
- The receiver hears an overlap in sound that results in masking of speech making it unintelligible.



3.3 DIFFRACTION OF SOUND

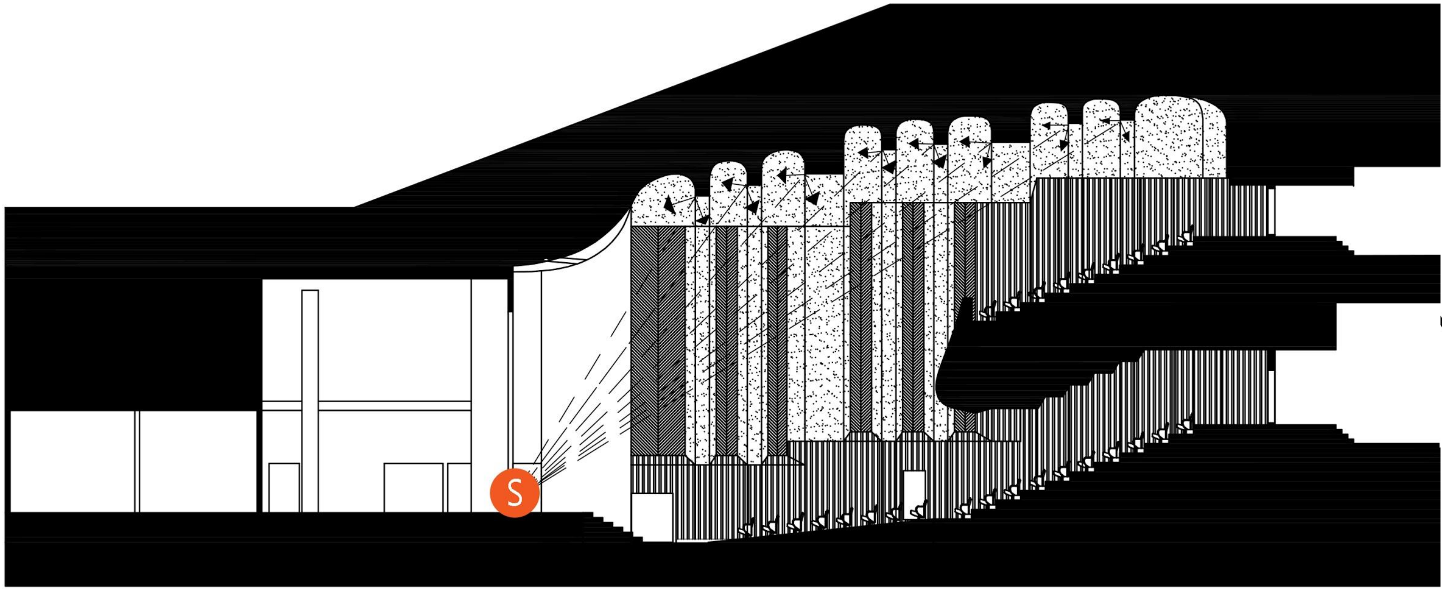
3.3.1 DIFFRACTED SOUND

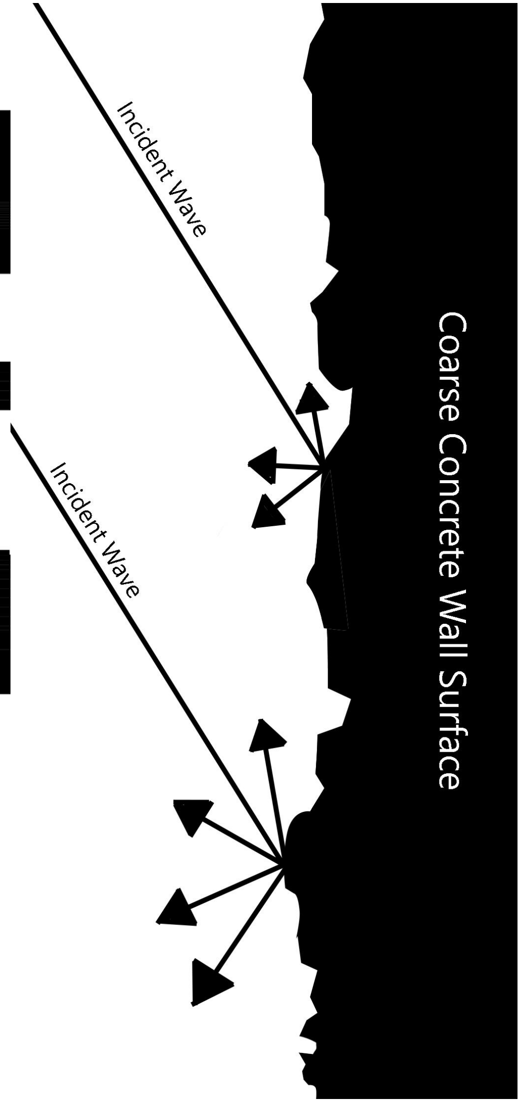


- Diffracted sound occurs at the region below the balcony due to its curved profile.
- The deep gallery cast an acoustic shadow on the audience underneath, causing a noticeable loss in the high frequency sounds (with short wavelengths) which do not bend around the protruding balcony edge. This condition creates poor hearing conditions under the balcony. It is the diffraction, however, that lessens this acoustical defect, but only at the lower region of the audio-frequency range. (Leslie, 1965)

3.4 Diffused/Dispersed Sound

3.4.1 COFFERED CEILING





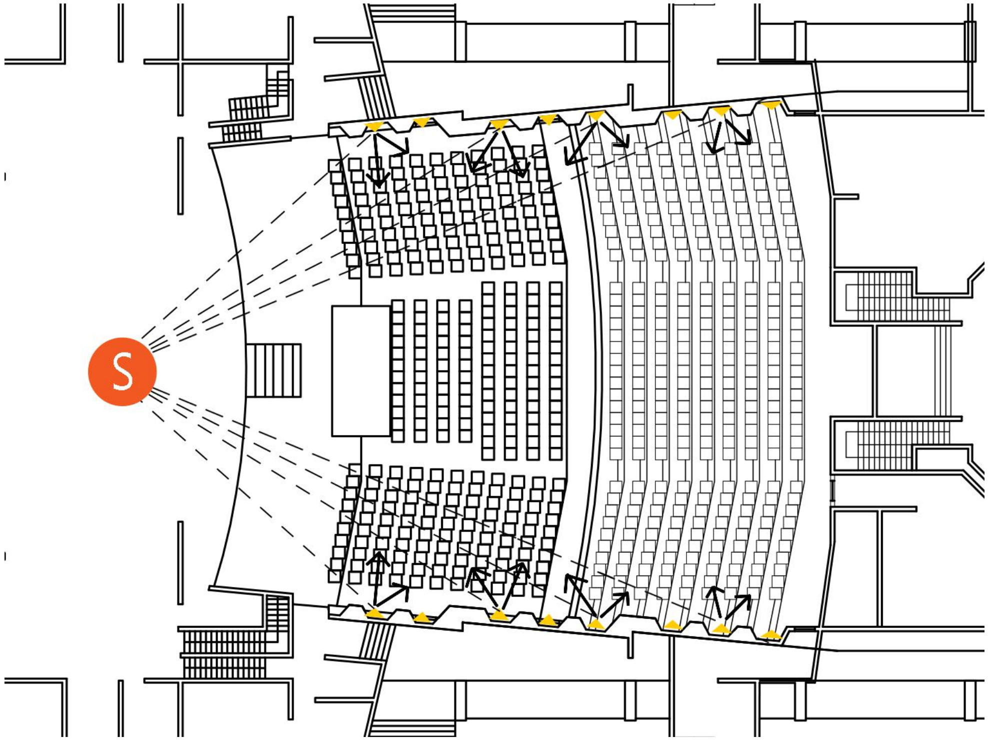
- The sound energy produced from the stage propagates in all directions, the sound diffusion occurs when sound waves hit irregular or sharp surfaces such as the diagonally arranged timber battens or sharp corners of the coffered ceiling.
- It is important to promote uniform distribution of sound, the natural qualities of speech and music, and prevents the various acoustical defects such as echoes.

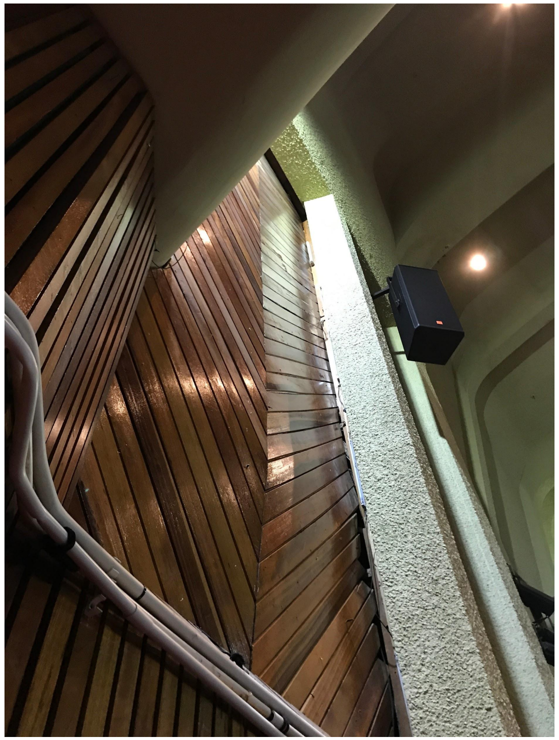
3.4 DIFFUSED/DISPERSED SOUND

3.4.1 DIAGONAL TIMBER BATTEN

Sound diffusion in the hall is created by several ways:

a) Application of irregular surfaces. The high density arregreate concrete wall surface disperses the soundwaves to multiple directions for a wider sound coverage in the hall.
b) Mixed use of sound reflector and surface treatments. The use of diagonal timber battens, carpet and concrete finishes have more contact surface that diffuse incident sound to a spreading manner. The concert hall require some “liveliness” in the space therefore diffusers are applied to support direct sound produced from stage.





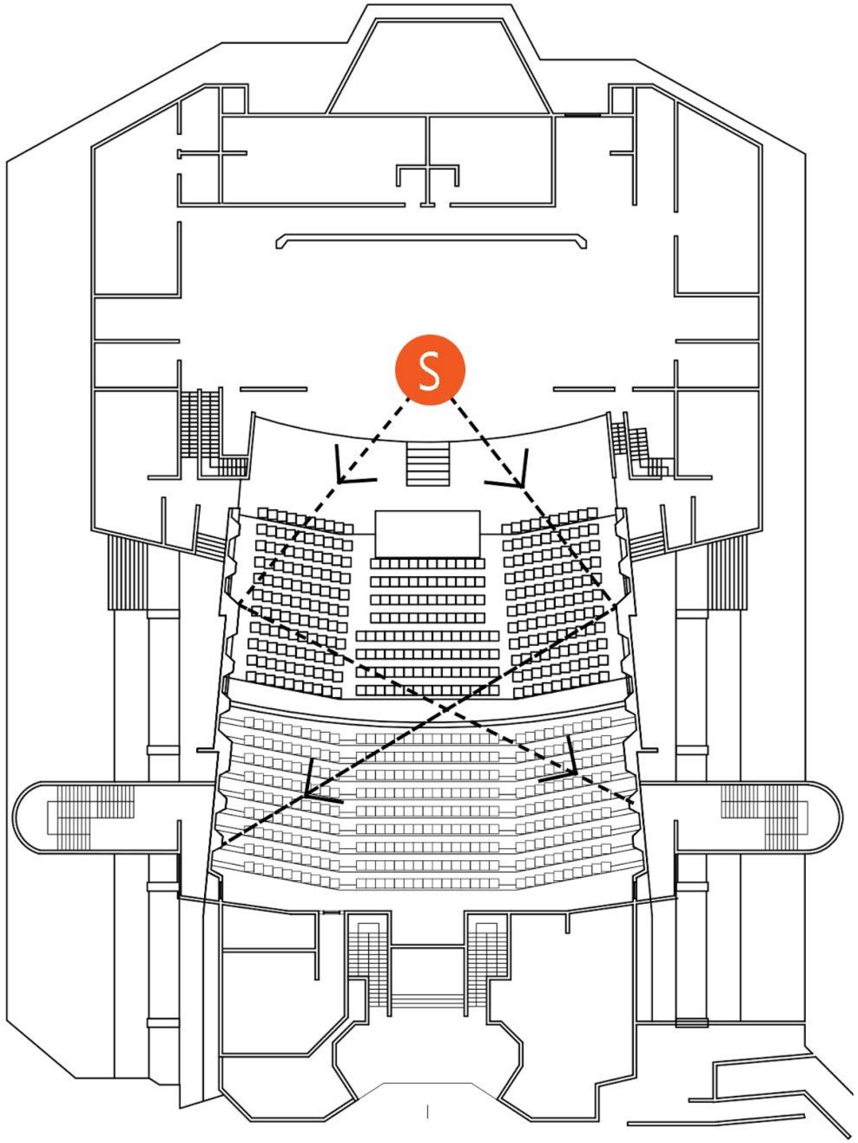
3.4 DIFFUSED/DISPERSED SOUND

3.4.2 FLUTTER ECHO

Flutter echo is a phenomenon in which rapid successions of noticeable echoes following a short burst of sound. It is created because sound bounces off parallel walls with reflective surfaces. (Leslie, 1965)

Flutter echo is avoided by:

- The tapering width of the hall towards the stage arranged with irregular angles of timber battens
- The inclusion of absorptive materials behind the timber battens that line the wall that helps absorb sound.

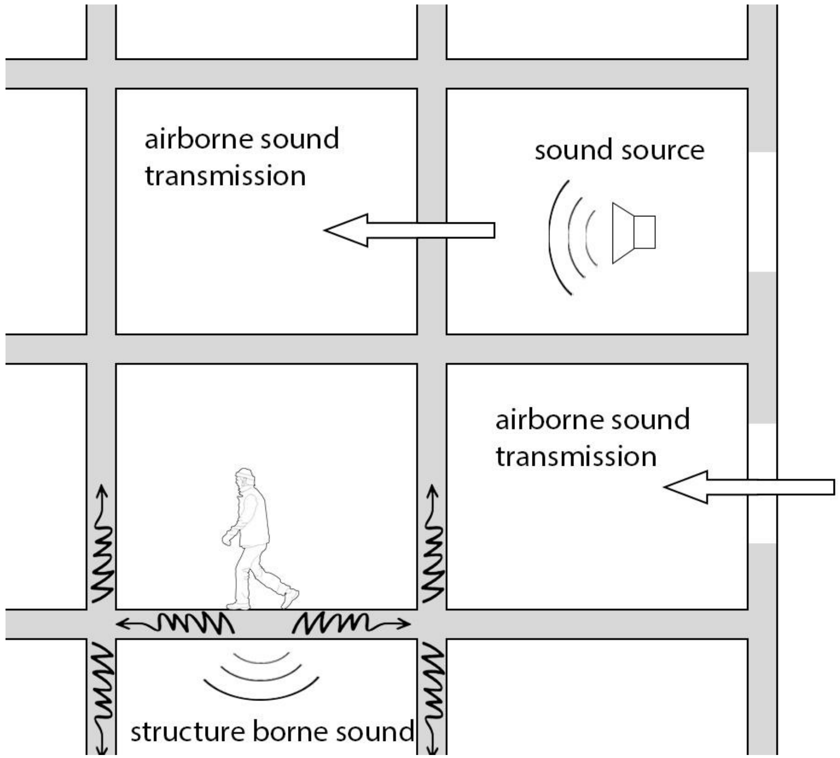


3.5 TRANSMISSION OF SOUND

3.5.1 Structure-borne Sound and Air-borne Sound

Structure borne sound is created by vibrations through the solid parts of a building. The energy will travel throughout the structure and reradiate airborne sound in adjacent spaces. This type of direct structure-borne sound can be controlled at the source by resilient mounting of mechanical equipment, by the use of resilient or cushioning materials at the point of impact (with flooring materials such as carpeting), and by special isolated constructions. (NOVA Acoustics, 2019)

Air-borne sound is transmitted along continuous air paths through openings. Air-borne noise travels through windows and doors causing a major sound leakage. Air-borne sound can be minimised through the use of sound insulation. It blocks the sound from travelling to a connected space of a building. (NOVA Acoustics, 2019)

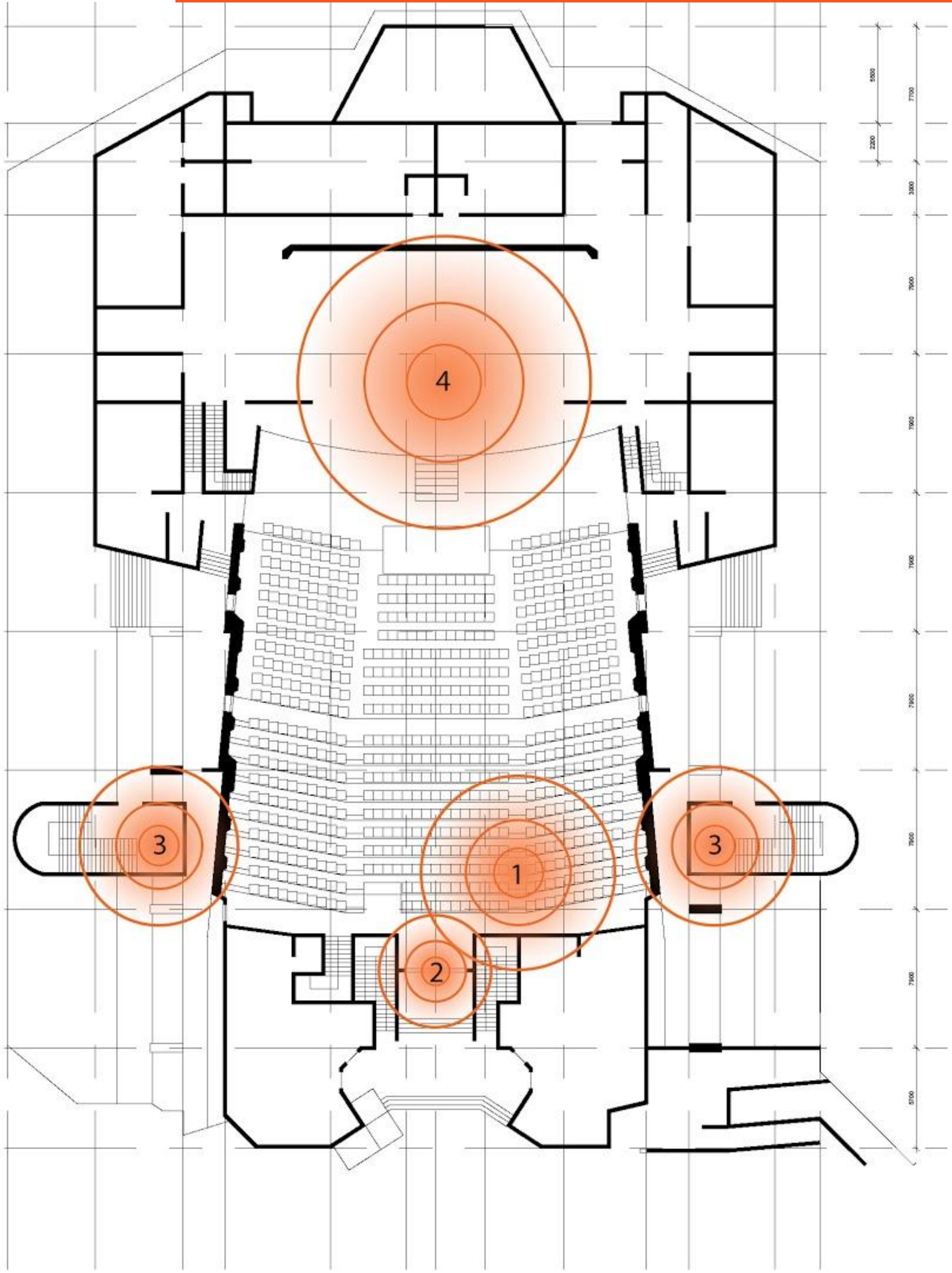


3.5 TRANSMISSION OF SOUND

3.5.2 Structure-borne Noise and Air-borne Noise

Structure-borne noise

1. Vibration of air condition noise
2. Closing of Door
3. Footsteps created through concrete floor finish at the emergency exit route
4. Footsteps created through wooden floor finishing at the stage



3.6 SOUND REINFORCEMENT SYSTEM

3.6.1 Sound Reinforcement System

Due to the long span of the auditorium, sound reinforcement system is needed to accommodate the large volume, especially in areas which have sound shadow.

Civic Hall auditorium uses a center channel system, which is quite unique among many other auditoriums.This system gives a maximum realism as the amplified sound comes from the same direction as its source , thus providing a more comfortable acoustic experience to the audience.

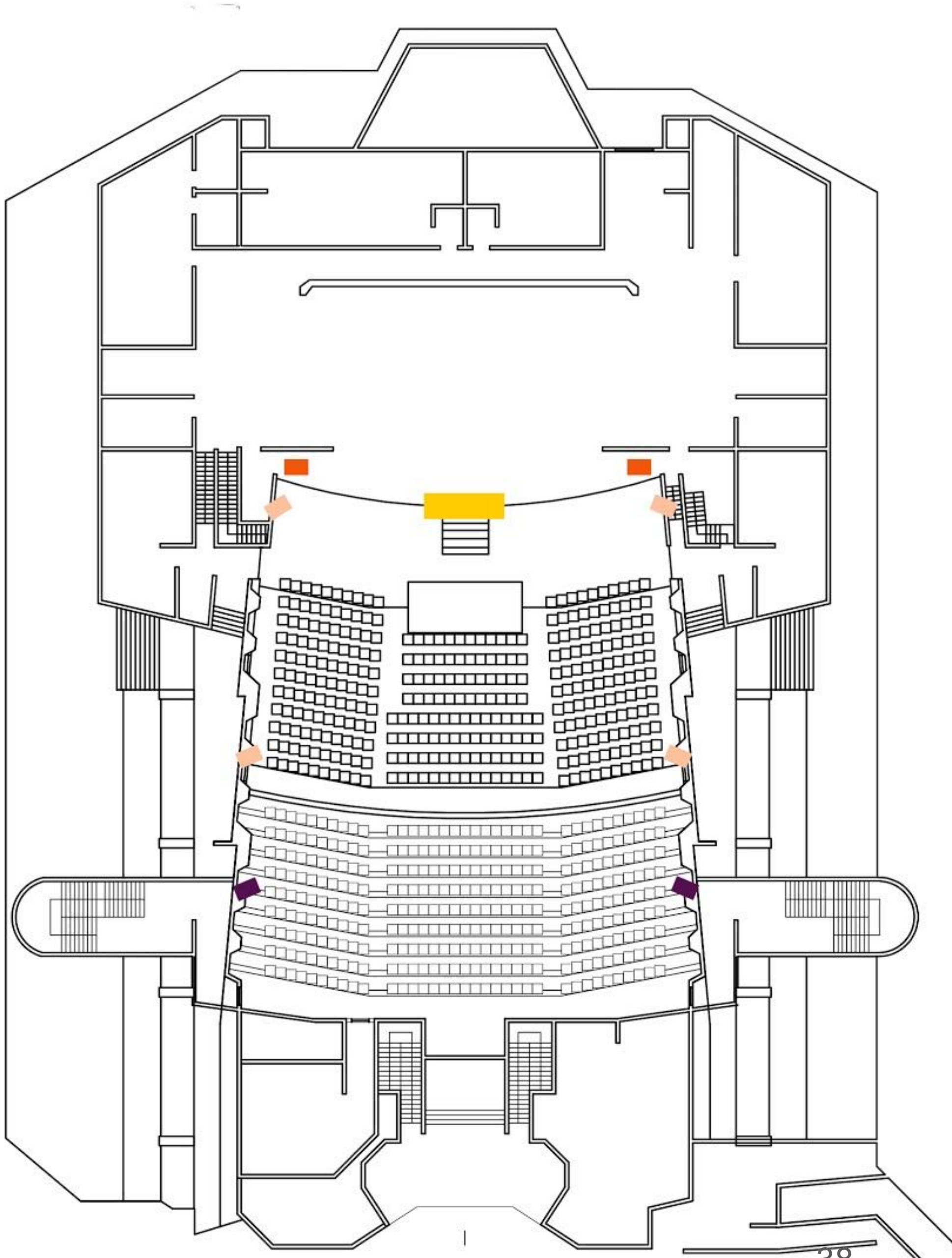
Type of speaker used in Civic Hall

A) 18 inch JBL Subwoofers MRX 518S

B) Center Channel Speaker

C) JBL MRX525 Dual 15’ Two – Way Speaker System

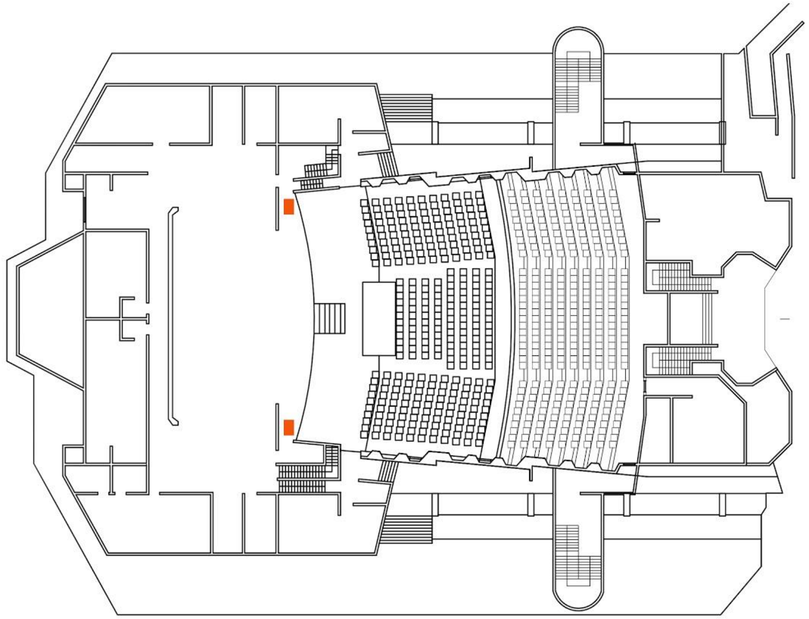
D) JBL Control SB-210



The location of sound reinforcement system

3.6 SOUND REINFORCEMENT SYSTEM

A) 18 inch JBL Subwoofers MRX 518S



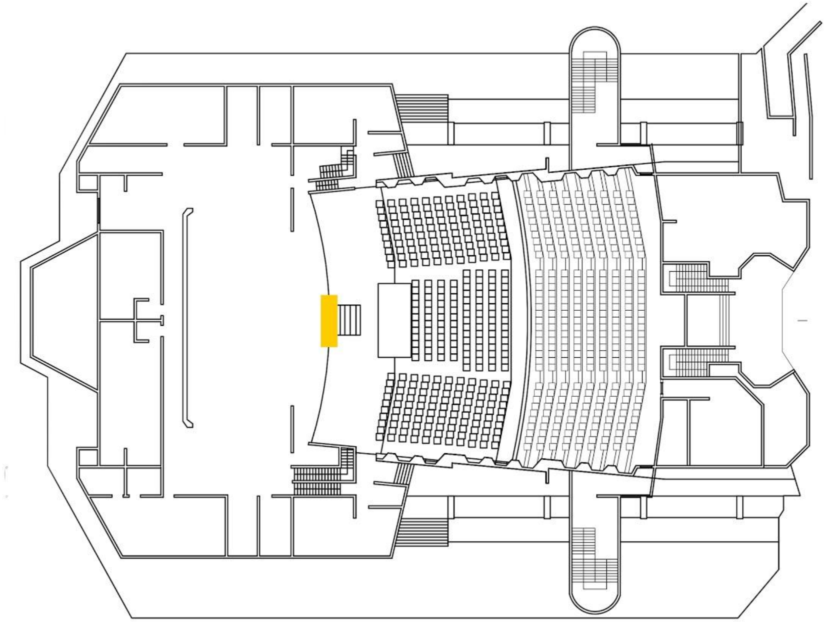
Specifications

Quantity: 2
Located: Front Stage (side)
Frequency range (-10db): 40 Hz -200 Hz
Power Rating: 500w/ 1000w/ 2000w/ 2hrs
Grille: Powder coated, black, 16 gauge perforated steel with acoustically transparent black screen backing.
Dimensions (HxWxD): 560mm x 535mm x 700mm

The MRX518S is a compact, high power subwoofer system containing a 2044G 457 mm (18") woofer in a front-loaded, vented enclosure. The enclosure is designed to present a minimum frontal area. The system offers complete input connection flexibility for compatibility with a variety of cabling schemes. The MRX518S is supplied with pins +1/-1 connected to the woofer. This may be easily configured to work with cabling systems intended to drive subwoofers on pins +2/-2.

3.6 SOUND REINFORCEMENT SYSTEM

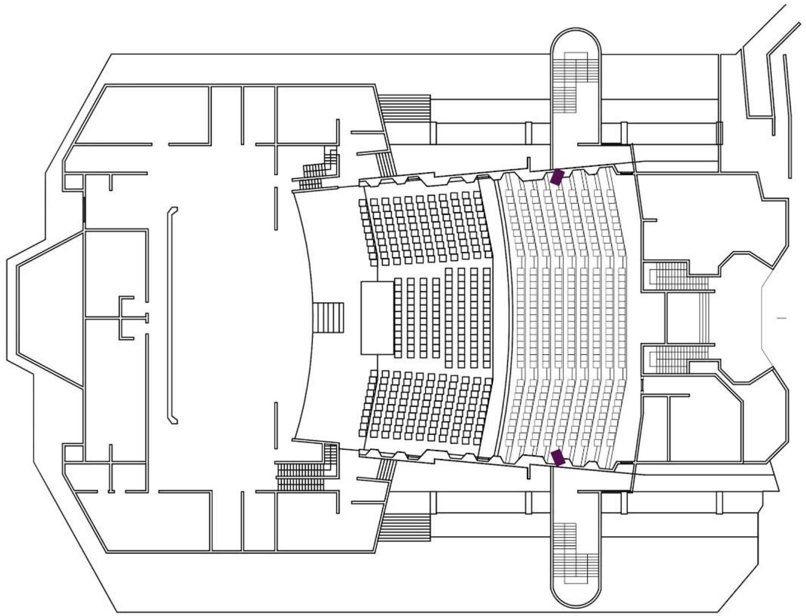
B) Center Channel Speaker



Specifications

Quantity: 1
Located: In the middle of the span towards the front
Frequency range (-10db): 42 Hz -320 Hz
Power Rating: 800w Continuous Program Power; 400w continuous pink noise
Grille: Thermoset composite coated steel, weathermax multi-layer foam
Dimensions (HxWxD): 355mm x 590mm x 570mm

C) JBL MRX525 Dual 15’ Two – Way Speaker System

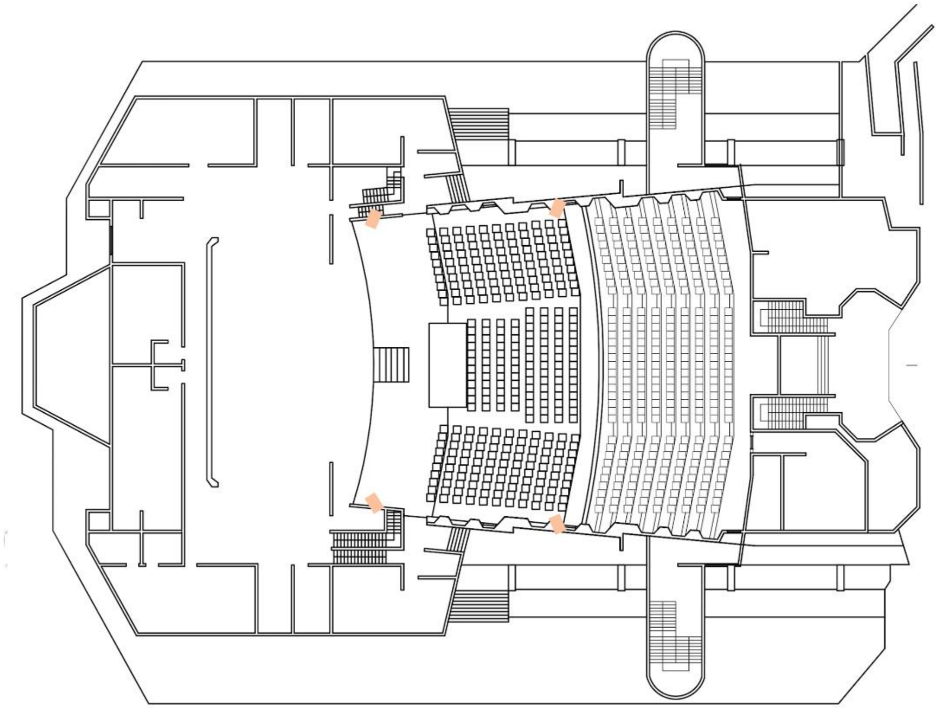


Specifications

Quantity: 4
Located: Side of the wall (front & middle)
Frequency range (-10db): 40 Hz -200 Hz
Power Rating: 800 W/ 1600 W/ 3200 W, 2 hrs
Grille: Powder coated, black, 16 gauge perforated steel with acoustically transparent black screen backing.
Dimensions (HxWxD): 1240 mm x 535 mm x 460 mm

The MRX525 is an excellent choice when the application calls for high performance and simplicity. A pair of MRX525s and a single, high-power amplifier is a complete sound system capable of reinforcing bass and kick drum or playing high-level music in clubs and other venues. The MRX525 is comprised of two 380 mm (15 in) 265H Differential Drive® woofers with combined power handling of 800 watts (continuous).

D) JBL Control SB-210



Specifications

Quantity: 2
Located: Side of the wall (back)
Frequency range (-10db): 42 Hz -200 Hz
Power Rating: 800w Continuous Program Power; 400w continuous pink noise
Grille: Thermoset composite coated steel, weathermax multi-layer foam
Dimensions (HxWxD): 355mm x 590mm x 570mm

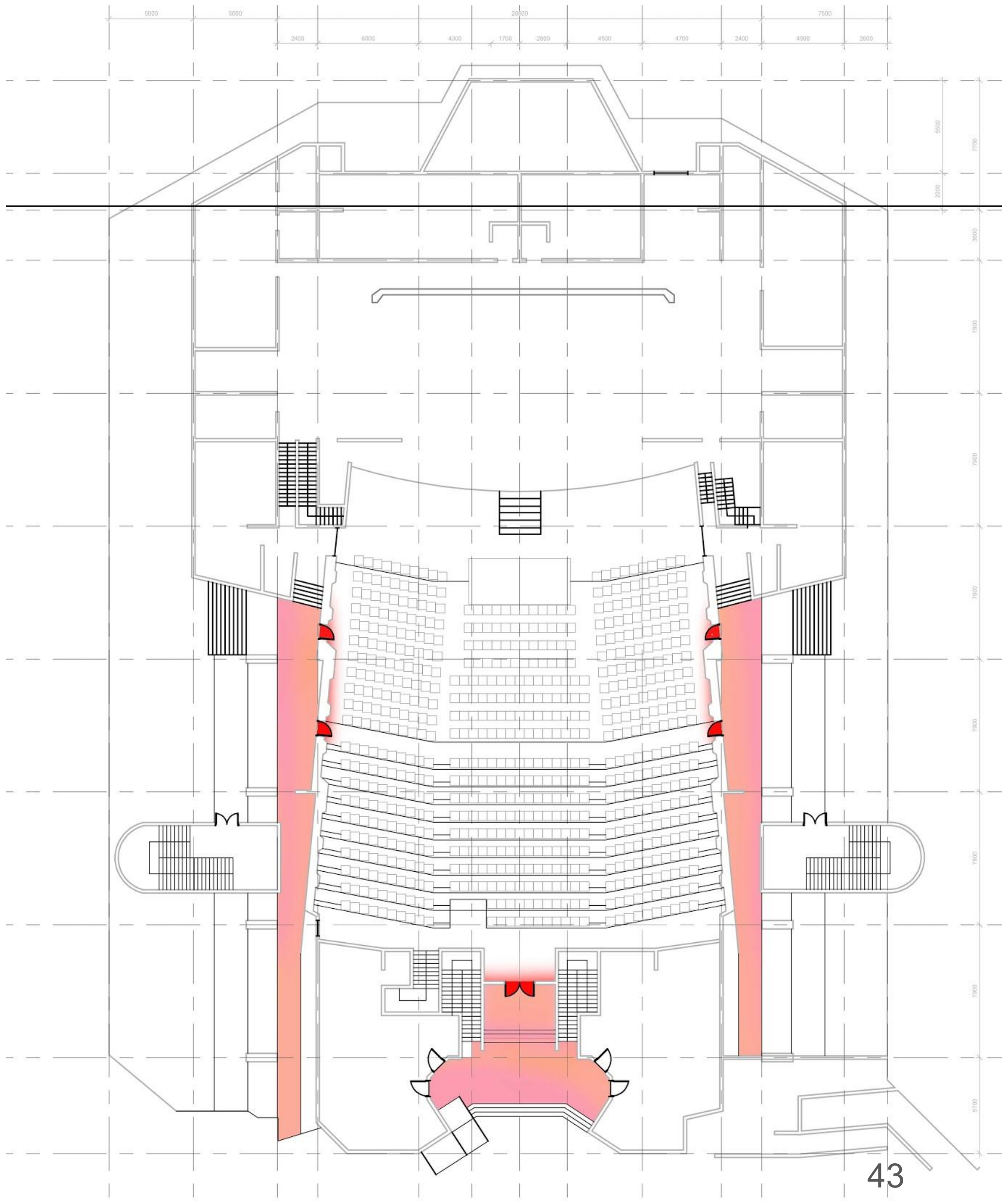
JBL Control SB-210 Subwoofer provides low frequency reinforcement for a wide variety of sound system application. Its compact size, high output and outdoor capable design make it one of the most versatile for a large port opening and compact front dimensions without compromising driver size. The internal angled baffle allows for a large port opening and compact front dimensions without compromising driver size. The SB210 produces warm, punchy low-end sound.

3.7 NOISE INTRUSION

While the sound quality within the auditorium may be well controlled. Sounds from the spaces adjacent to the auditorium may reverberate or reflect into the hall (Leslie, 1965)

The space next to the hall is a foyer that has a long reverberation time and echo. When placed next to the hall this may particularly disturb audiences seated nearby doorways.

The main entrance is placed on the center facing the stage the double swing doors are placed recessed within a cavity. cladded and tiled with hard marble the cavity space creates echoes of footsteps as you enter the auditorium

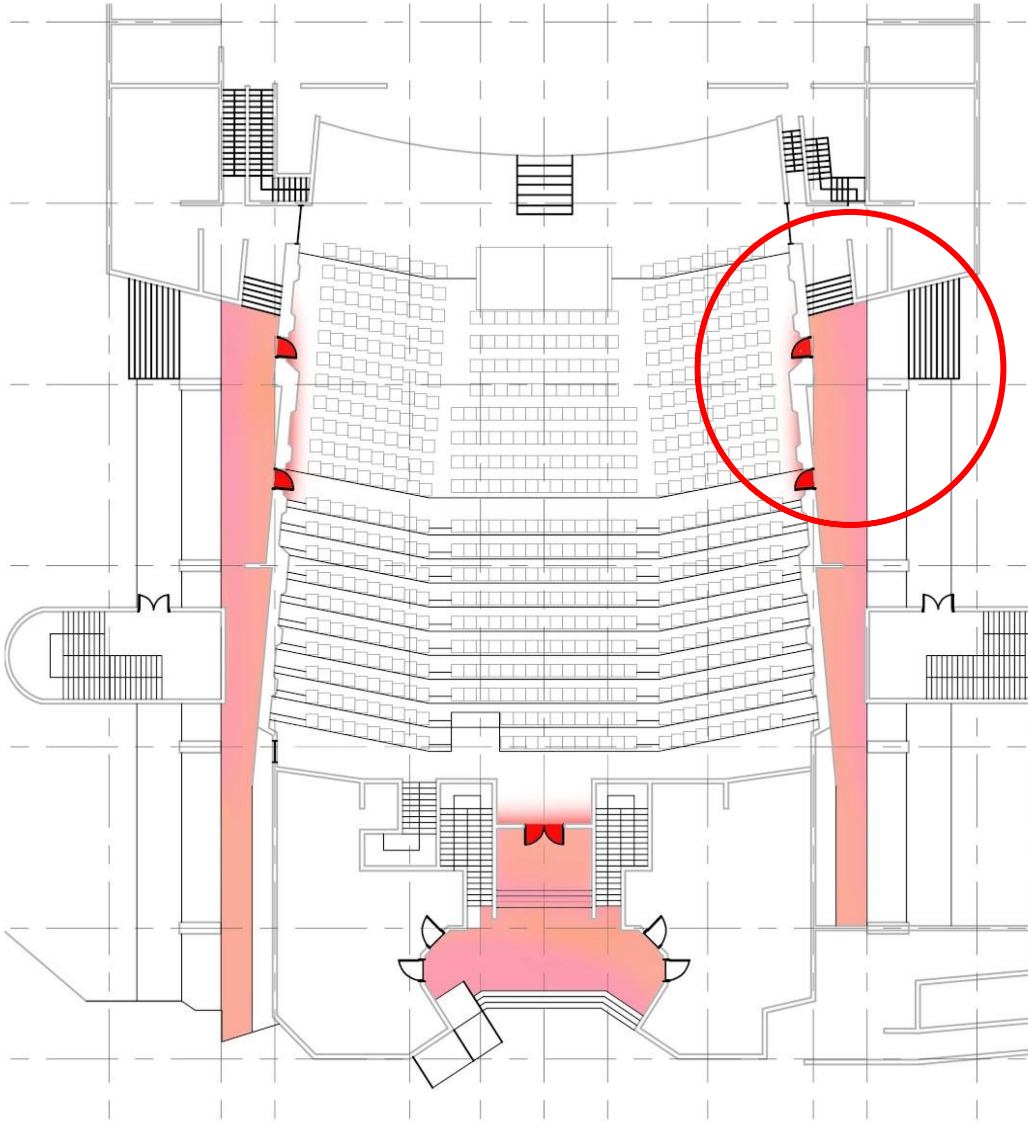


3.7 NOISE INTRUSION

The doors on each side of the auditorium opens to an open air corridor. While draped with curtains, it is not preventive of sound intrusion from the traffic outside as it does not possess enough sound absorption qualities, effectively lacking a sound lock for the area.

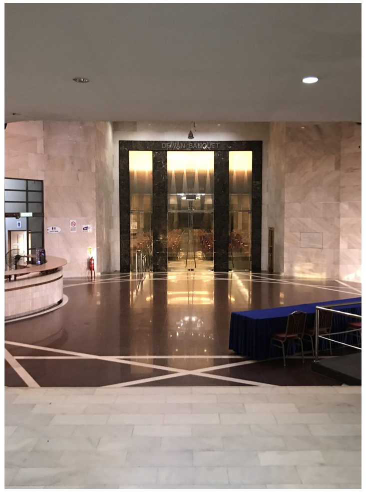
MATERIALITY

PAINTED WOOD **CONCRETE**

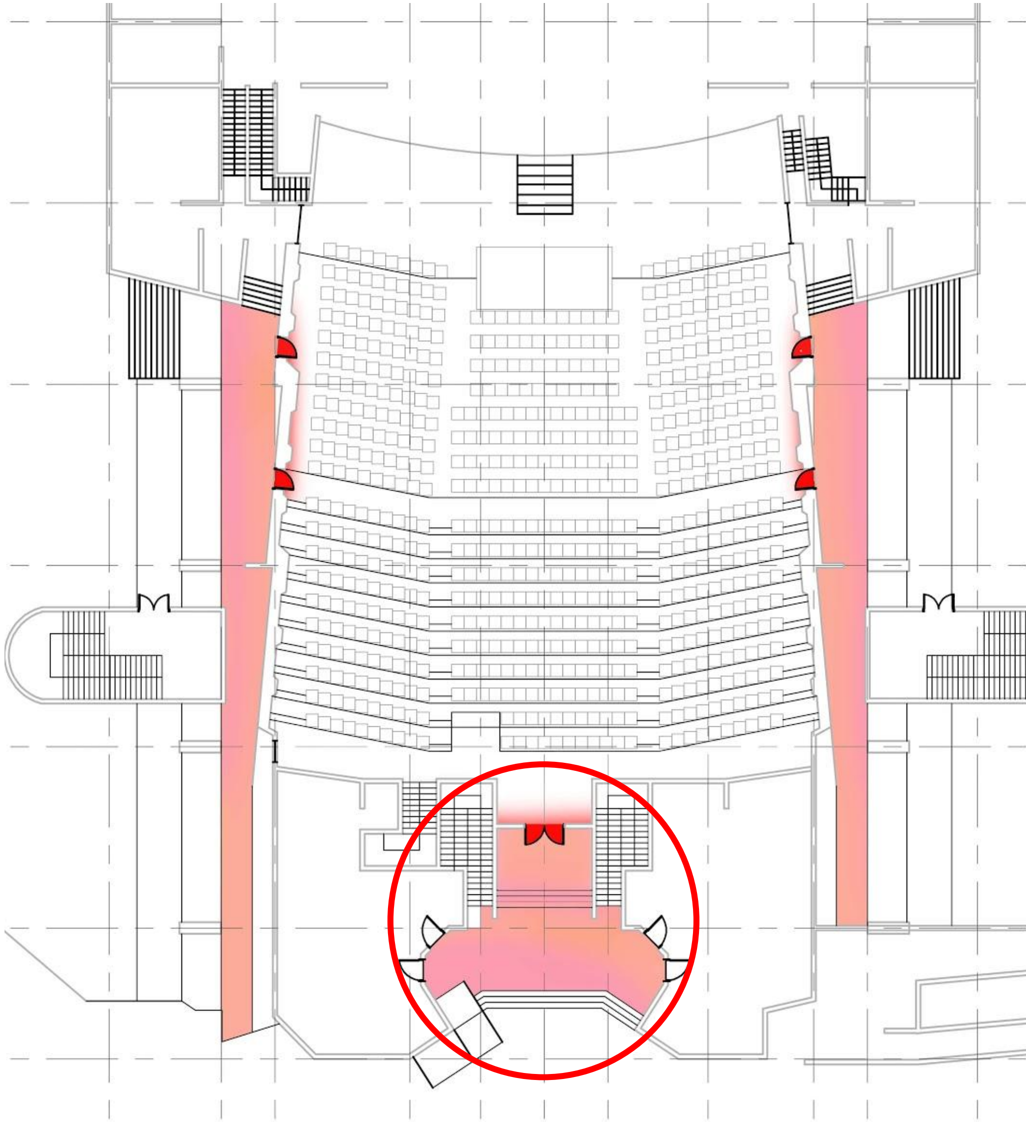


Location of doors in the image above

3.7 NOISE INTRUSION



The foyer of the Civic Hall is tiled in marble. It is adjacent to the hall and produces echo that may reverberate into the hall. The hall does not have a buffer zone to avoid noise intrusion from the coupled space into the auditorium during a performance



MATERIAL

PAINTED WOOD

MARBLE TILE

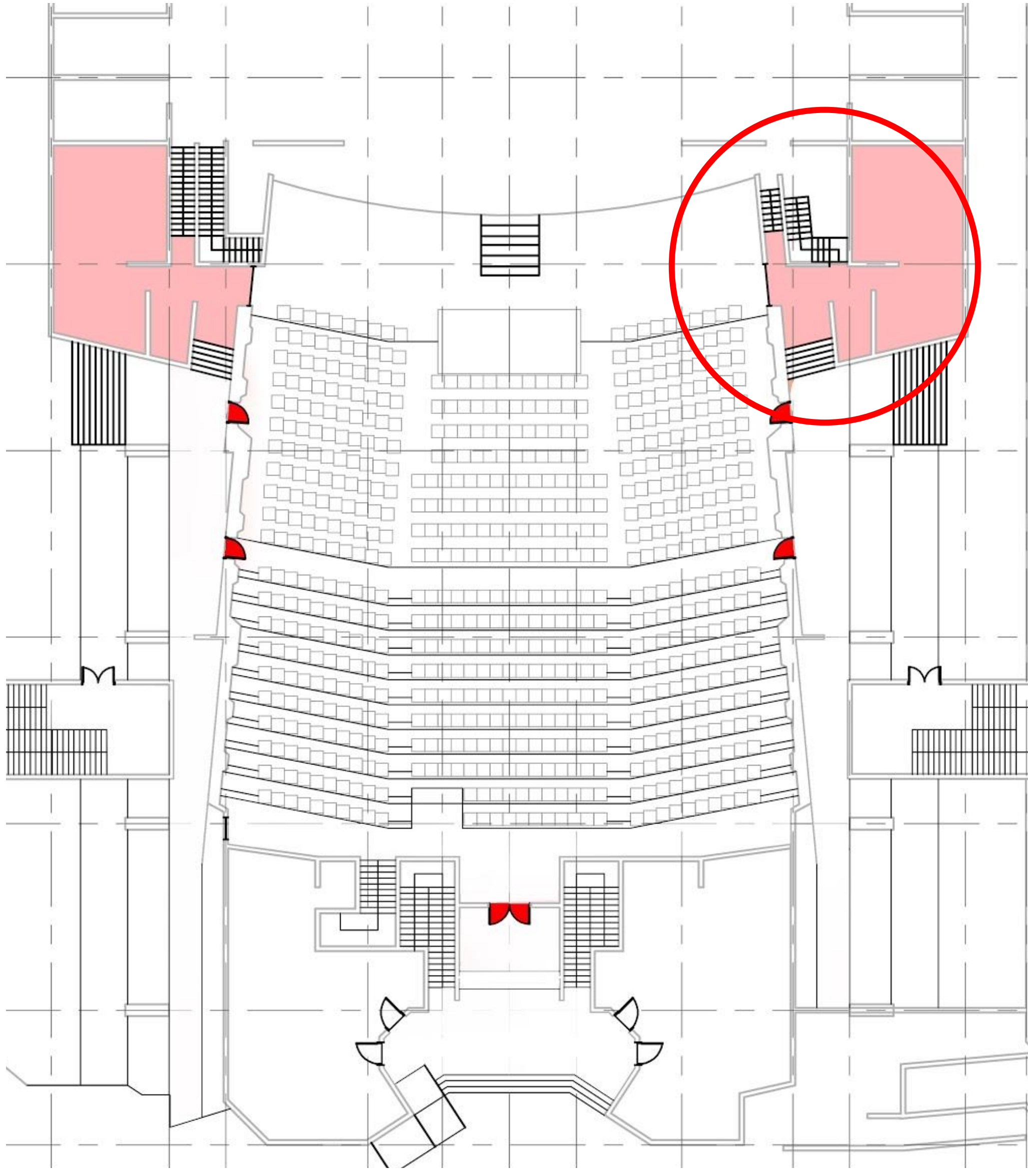
3.7 NOISE INTRUSION

The male and female toilets are located at both the right and left of stage and are offset in through a corridor. No noise preventive measures are taken to prevent noise from within the toilet to travel into the hall.

MATERIAL

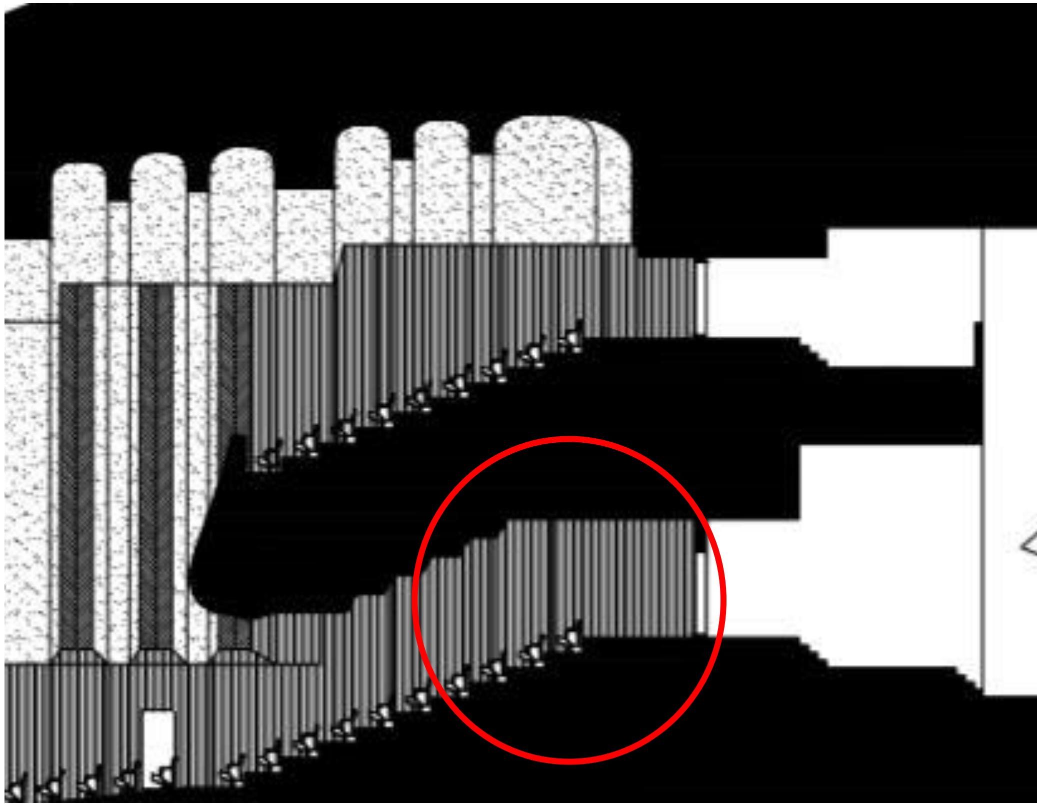
RED CARPET

WOODEN PANELING

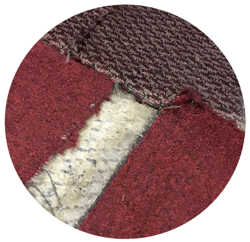


3.7 NOISE INTRUSION

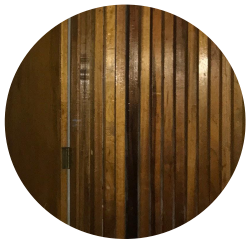
Many of the air conditioning ducts use blowers which gush out air which creates noise within the hall.



MATERIAL



RED CARPET



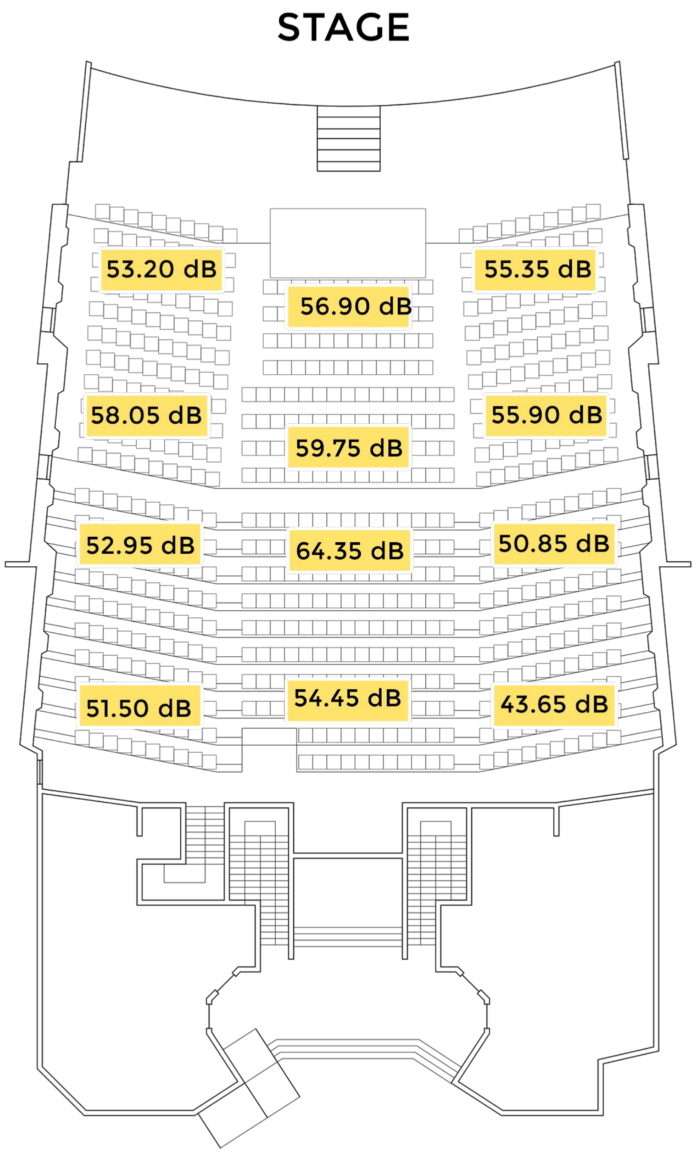
WOODEN PANELING

4.0

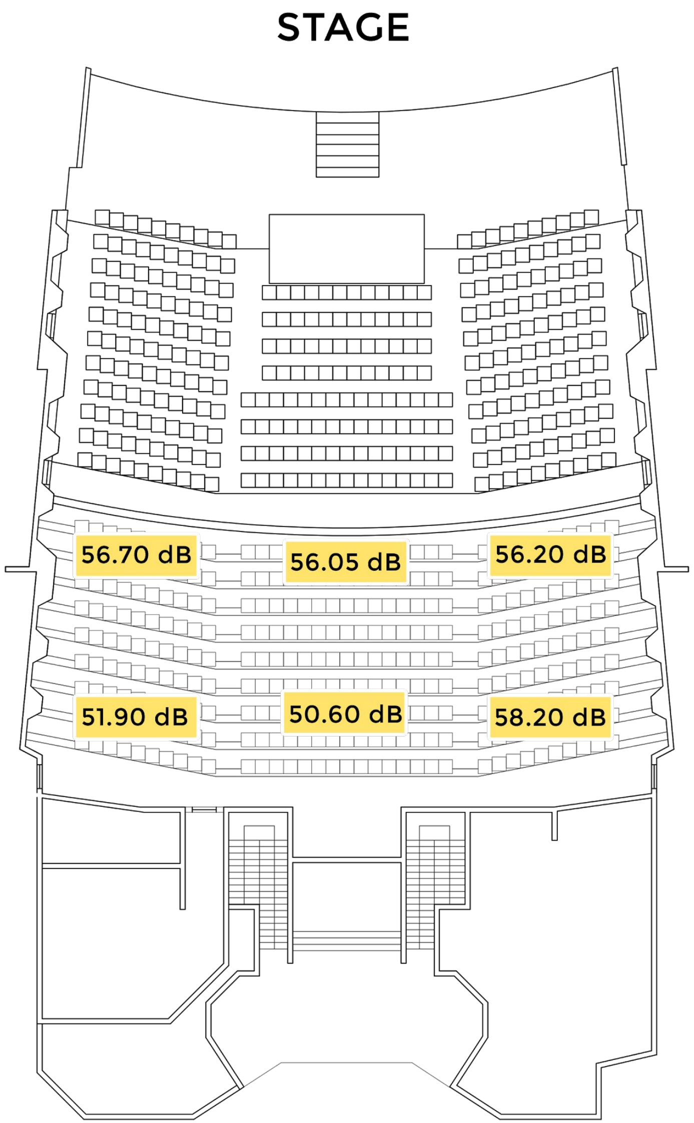
CALCULATIONS OF SOUND

MBPJ CIVIC HALL

4.1 SOUND READING



Ground Floor Seating Plan



Balcony Floor Seating Plan

4.2 REVERBERATION TIME

$V = 13396.64m^3$
$A = 1134.7$ sabines

$RT = 0.16V/A$

$RT = 0.16(13396.64)/1134.7$
$=$ **1.89seconds**

The auditorium function as a multipurpose hall mainly for theatre and philharmonic events. The ideal reverberation time is 1.5-2.0 seconds. Civic hall has a reverberation time of **1.89 seconds**. That means the time required for the sound to “fade away” and decay in a closed space is 1.89 seconds

As a multipurpose hall the reverberation time is too high. Based on the calculation and the overall acoustic design properties, civic hall is ideal **for music performances** and **public speech.**

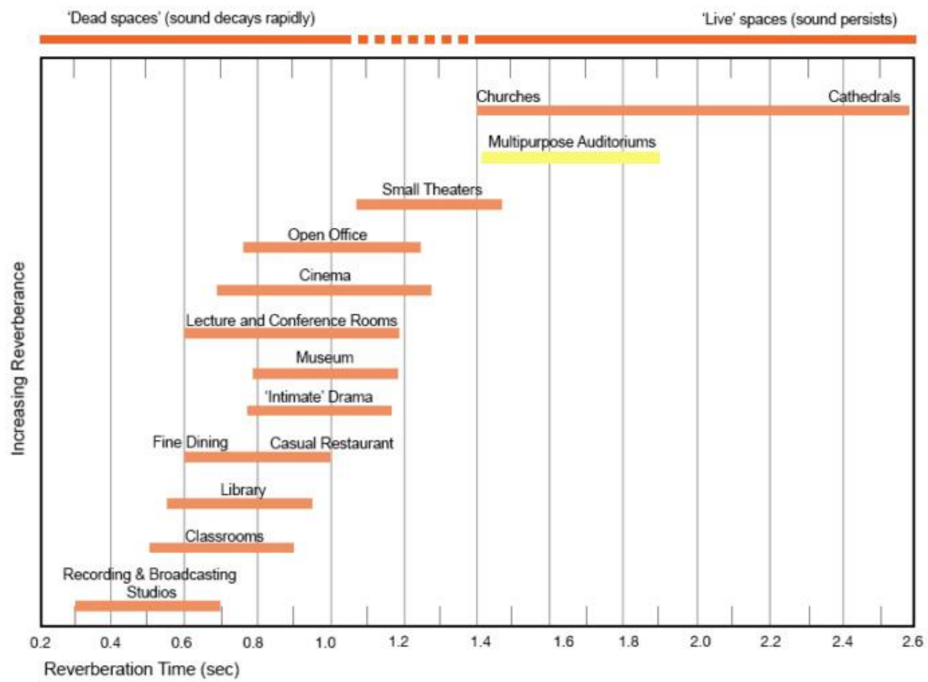


Diagram shows the ideal reverberation times for the following spaces and functions. The optimum reverberation time for multipurpose auditoriums is between 1.5-1.9s. (Paek, 2019)

5.0

CONCLUSION

MBPJ CIVIC HALL

5.0 CONCLUSION

The following are requirements for good hearing conditions in an Auditorium according to (Long, 2006)

1. There should be adequate loudness in every part of the Auditorium particularly at the seats furthest away from the source
2. There should be uniform distribution of sound in every part of the room
3. The auditorium should have optimum reverberation characteristics for the performers and audience
4. The auditorium should be free from acoustical defects
5. Noise and vibration which interfere with performance should be reasonably reduced from every part of the room

As such, we will look at these following criteria and evaluate whether MBPJ Civic Hall is suitable for its purpose as an acoustic multipurpose theatre.

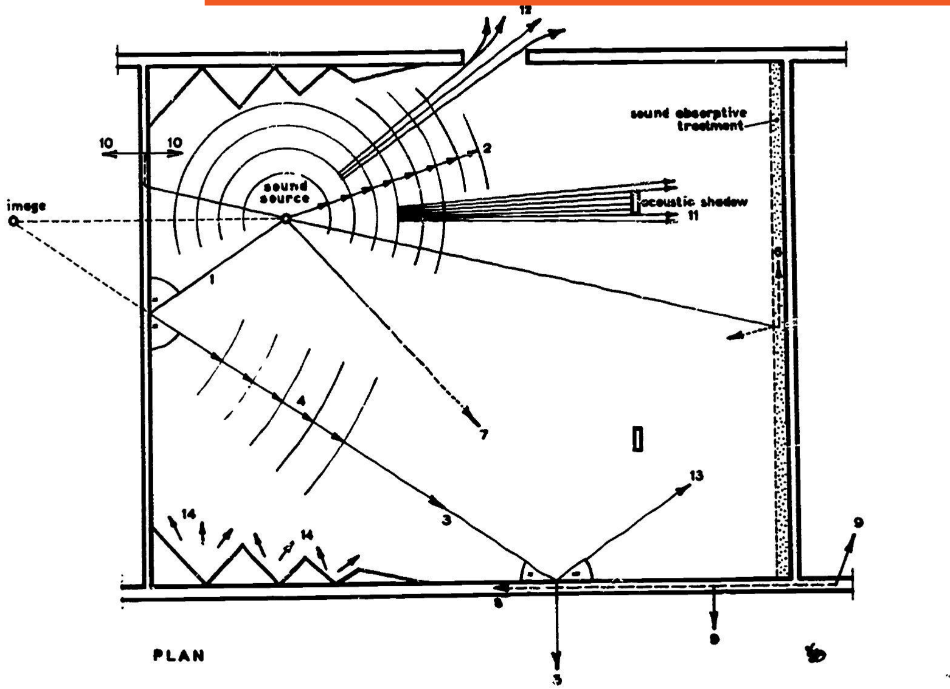


Diagram above illustrates the way sound rays travel in an enclosed space (Long, 2006)

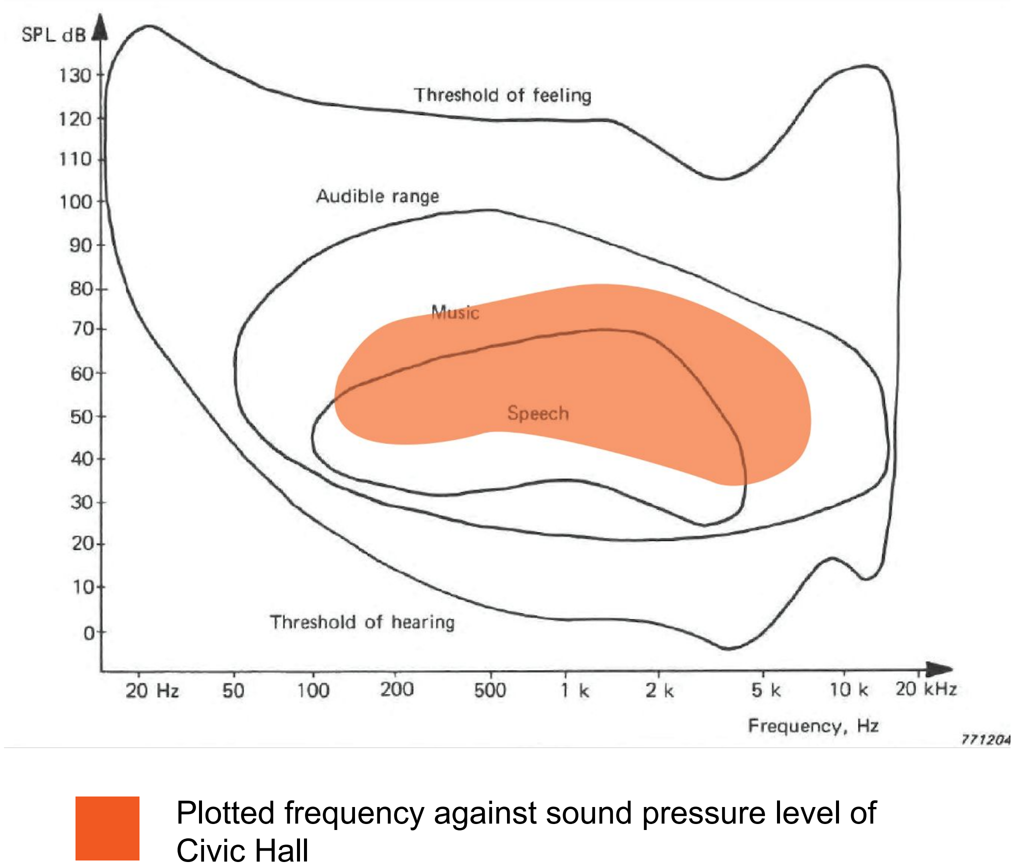
1.Indirect Sound
2. Direct wave front
3. Reflected sound
4. Reflected wave front
5. Sound transmitted through enclosure
6. Sound absorbed at wall surface
7. Sound absorbed in the air
8. Sound energy dissipated within the structure
8. Structure-borne sound conducted to other parts of the building
11. Acoustic shadow
12. Diffraction of sound through opening
13. Multiple sound reflections contributing to reverberation
14. Diffused sound due to surface irregularities

5.0 CONCLUSION

1. Based on the readings from our sound level meter, it is found that the loudness of sound dissipates from the front to the back of the auditorium.

   The lowest sound reading is 43.65dB located at the back row of seats on the right from the entrance and the highest sound reading is 64.35dB in the middle of the hall.

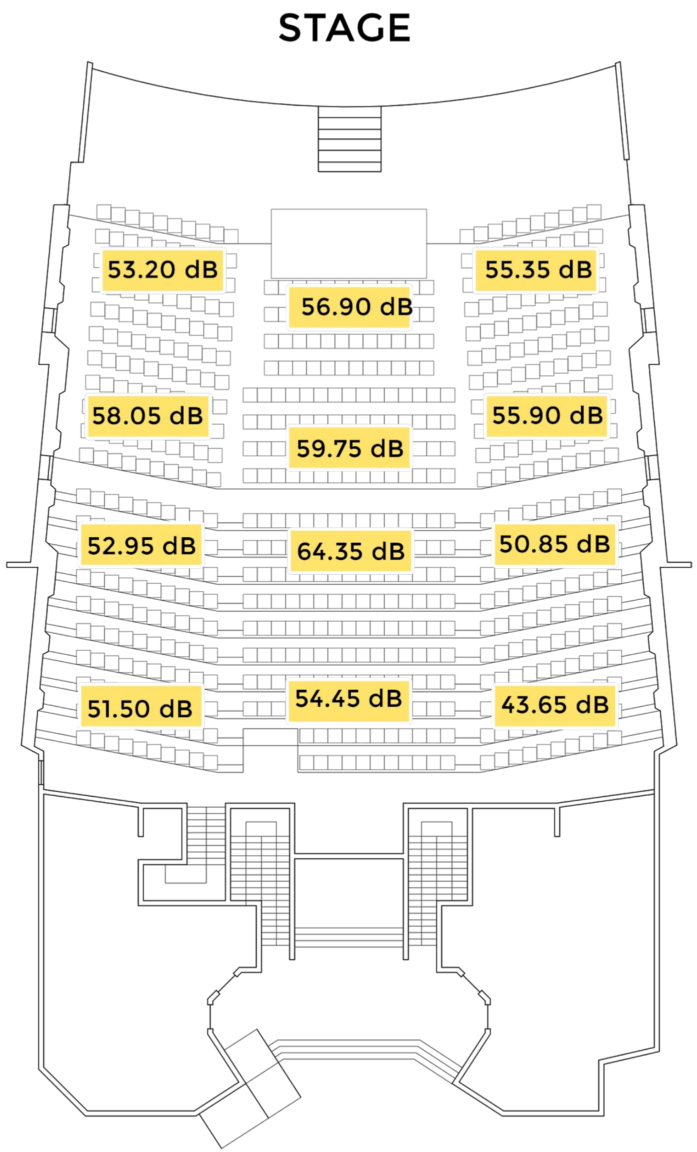
   However, they are all still within the threshold of hearing which is the minimum intensity level perceptible by the ear at a particular frequency which varies from age to age. (Ginn, 1978)



Audible range of frequencies and sound pressures bounded by threshold of hearing and feeling with rough regions for speech and music (Ginn, 1978)

5.0 CONCLUSION

2. The distribution of sound to the rest of the auditorium is not uniform throughout the entire room. However, this is slightly aided by the auditorium's sharp edges to diffuse the sound so that the sound fills up the entire room. Besides, sound dispersion further enhance the quality of sound by producing natural ambience.



Ground Floor Seating Plan

5.0 CONCLUSION

3. The reverberation time for Civic Hall is 1.89s, which means it is optimum to be used as a multipurpose hall. The reverberation time is optimum to enable all frequency component of speech and music to grow and decay at such rates during their transient state and remain a steady sound level..

Hence, it results in perfect intelligibility of speech and ideal condition for the production, transmission and appreciation of music.

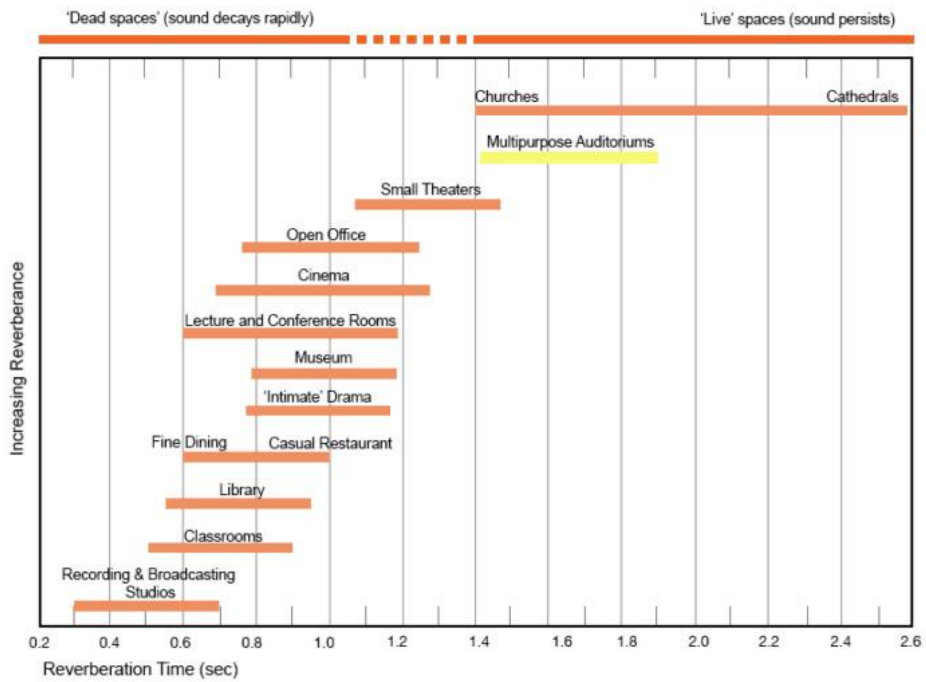


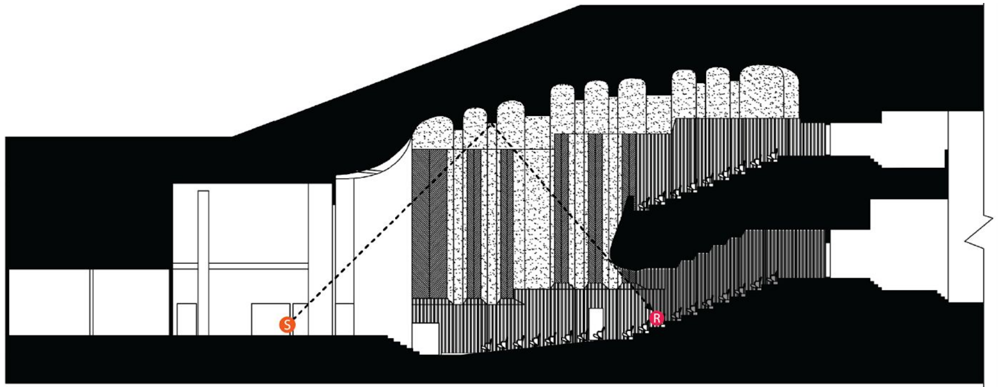
Diagram shows the ideal reverberation times for the following spaces and functions. The optimum reverberation time for multipurpose auditoriums is between 1.5-1.9s. (Paek, 2019)

5.0 CONCLUSION

4. The gallery protrudes too far into the auditorium bringing the audience closer to the source but casting a sound shadow across the seatings below the space. This is because there is insufficient direct and reflected sound energy to the area. As such, it produces the lowest sound reading in the entire hall.

The hall avoids flutter echo (a short burst of repeated sounds following a large sound) by introducing parallel walls.

As such, there are a few acoustical defects that have yet to been dealt with in the hall that affects the user's listening experience.



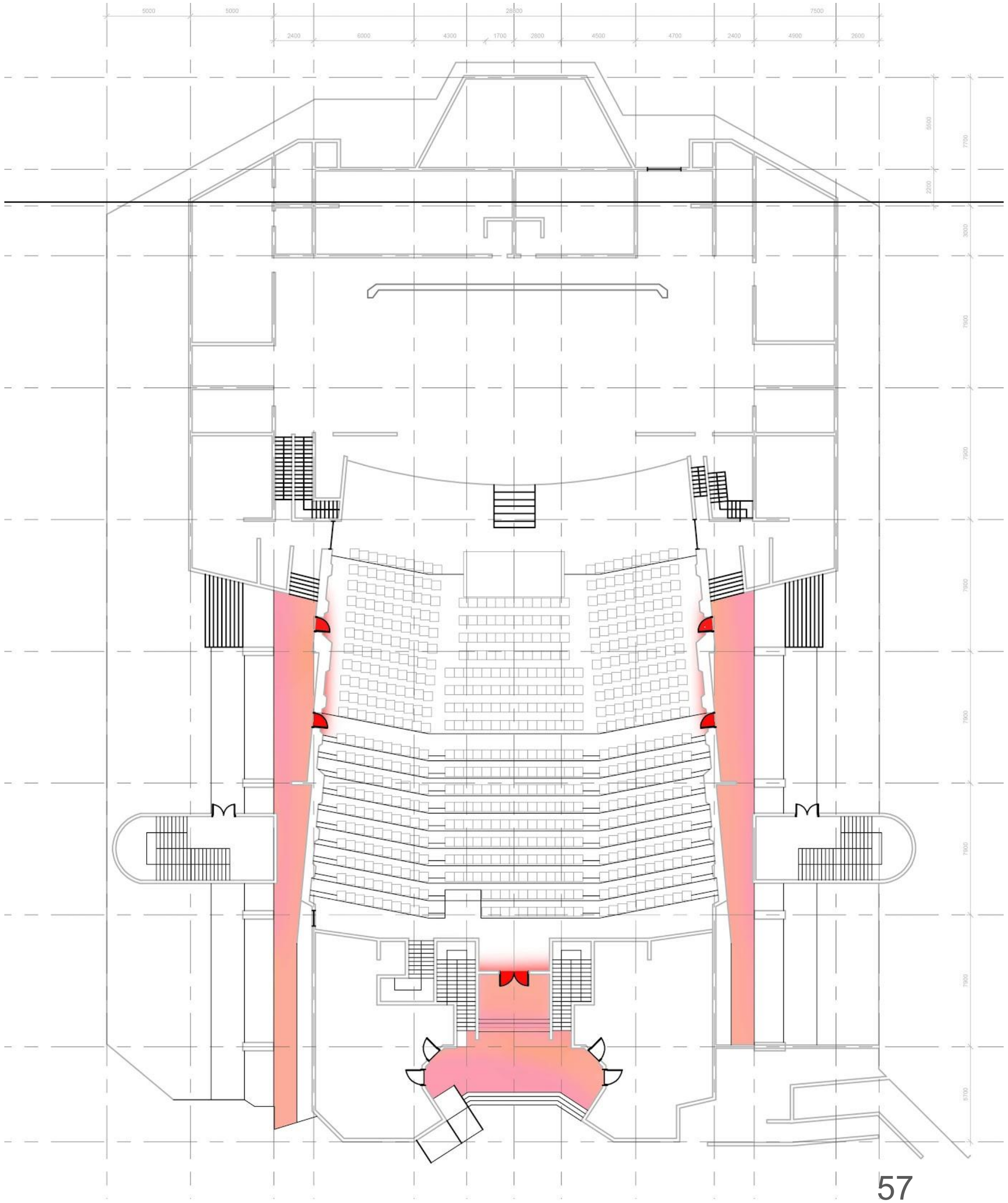
Sound shadow is cast by protruding balcony.

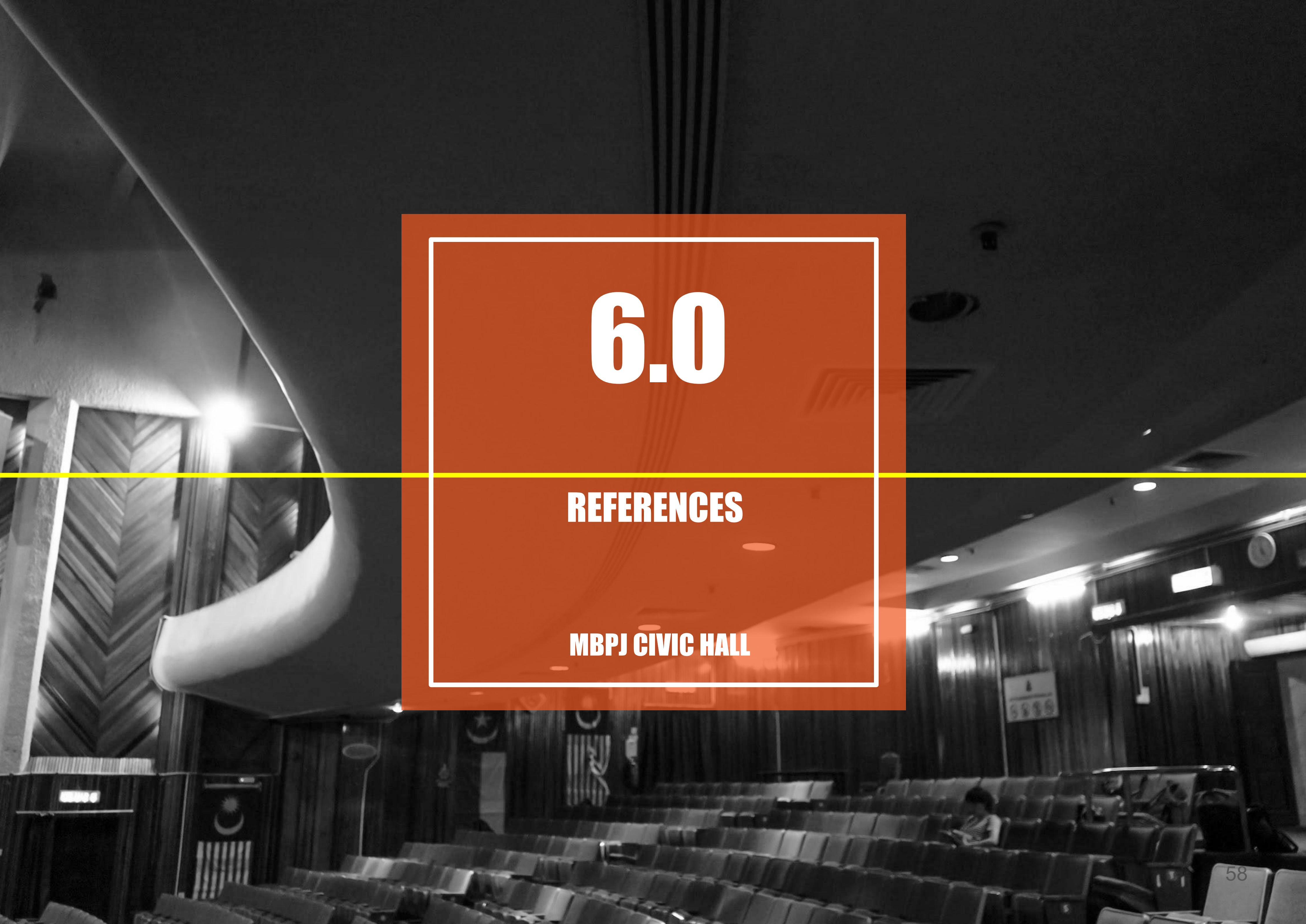
5.0 CONCLUSION

5. A minimal attempt has been made to create buffer zones. Thus, sounds from the spaces adjacent to the hall may reverberate or reflect into the hall. This may particularly disturb audiences seated nearby doorways. Multiple doors that lead to the outdoor corridors also bring in noise intrusion from the external environment.

Noise intrusion is also prevalent in the front portion of the auditorium with two corridors leading to toilets on each side of the stage.

Further adding to the auditoriums problems many of the air conditioning ducts uses blowers creating white noise as the air gushes out.





6.0

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