Exploring Reverberant Room Acoustics: A Comprehensive Analysis

BHAGYASHREE MAHALI (SC21B020), ANKAJ KUMAR (SC23M044),
SAI KUMAR (SC20M046), MOHD BABAR MALIK (SC23M048), KRISHNA VAMSI (SC23M107)

Department of Aerospace Engineering,
Indian Institute of Space Science and Technology
Thiruvananthapuram, India

***Abstract*—This experimental study investigates the sound pressure level (SPL) characteristics of reverberant rooms, aiming to provide insights into their acoustic behavior. The analysis employs a comprehensive experimental setup, including measurements of SPL at various locations within the room under different conditions. Factors such as room geometry, surface materials, and occupancy are systematically varied to assess their impact on reverberation and SPL distribution. The findings contribute to a deeper understanding of reverberant room acoustics and offer practical implications for architectural and acoustic design.**

***Keywords*—Spectroscopy, Carbon fibre, resin, polarisation, spectrum**

I. Introduction

A. Introduction to Reverberant Room Acoustics

Reverberant room acoustics is a fascinating field that delves into the intricate interplay between sound and space. In the built environment, rooms serve as vessels that shape the propagation of sound waves, influencing the auditory experience within them. Understanding the acoustic properties of reverberant spaces is crucial not only for architects, acousticians, and engineers but also for musicians, educators, and anyone interested in optimizing the auditory environment.

Reverberation occurs when sound waves reflect off surfaces within a room, leading to multiple reflections that persist after the direct sound has ceased. This phenomenon enriches the auditory experience by adding a sense of spaciousness, warmth, and continuity to sound. However, excessive reverberation can also degrade speech intelligibility and music clarity, posing challenges in various settings such as concert halls, classrooms, auditoriums, and recording studios. The study of reverberant room acoustics encompasses a broad range of topics, including the measurement and analysis of reverberation time, early reflections, frequency response, and spatial distribution of sound energy. Researchers use sophisticated measurement techniques, such as impulse response analysis and acoustic modeling, to characterize the acoustic behavior of rooms and evaluate the effectiveness of acoustic treatments and design interventions.

II. Experimental Setup

The experimental setup for this experiment includes:

- Instrument: A Reverberant room with different side dimensions.
- Components: A speaker is kept inside the room in different positions and microphones also placed inside the room.
- Illustration: The setup is detailed in Figure 1 of the document.
- Frequency: The frequency is varied from 100-5000 hz.

Fig. 1: Model image

Fig. 2: Front view

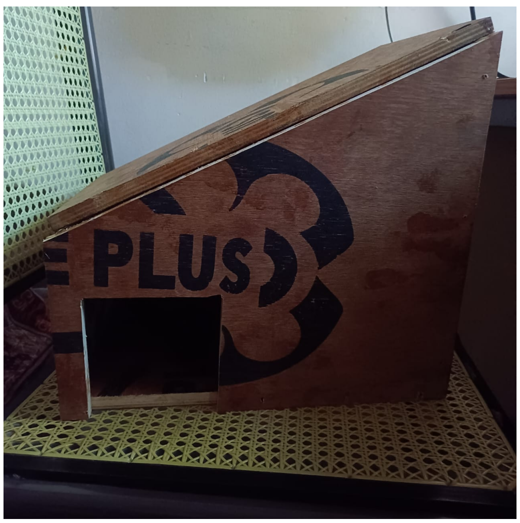

Fig. 3: Side view

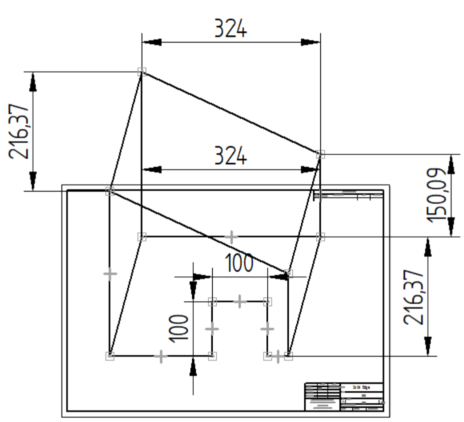

Fig. 4: Draft of room

The dimensions of the room are:
Length L = 32.4cm
Width W = 22.4cm
Height H = 15cm one side other side 30 cm
The thickness of the material(wood) is 1.2 cm

III. Procedure

1) **Model Preparation:** The model is kept on a table and a speaker is kept at opening of the room and at the centre of the room.
2) **Microphone Adjustments:** The microphones are placed at four sides in the room.
3) **Data Collection:** The SPL vs TIME graph and data is collected by using the INVH app in mobile.
4) **Plotting graphs:** The graphs are plotted by using the data which is obtained by testing.

IV. Results

The Graphs shown below are for SPL(Sound Pressure Level) vs TIME graphs for different frequencies.

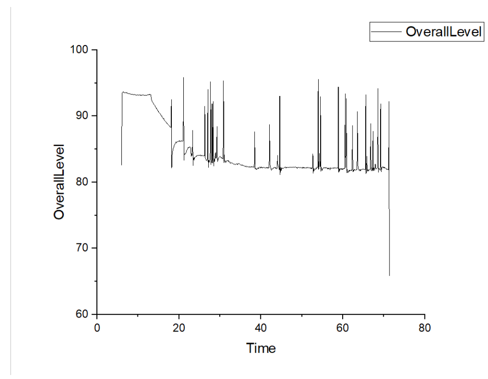

Fig. 5: 100hz

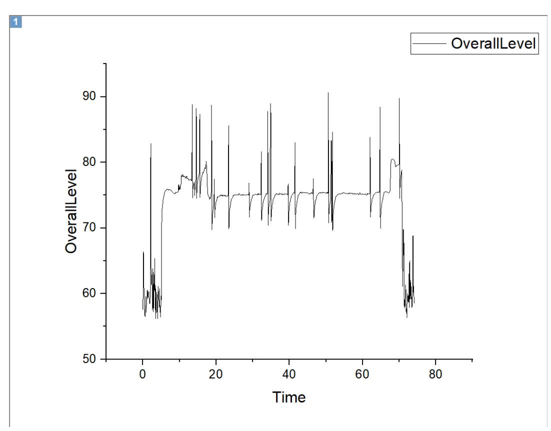

Fig. 6: 500hz

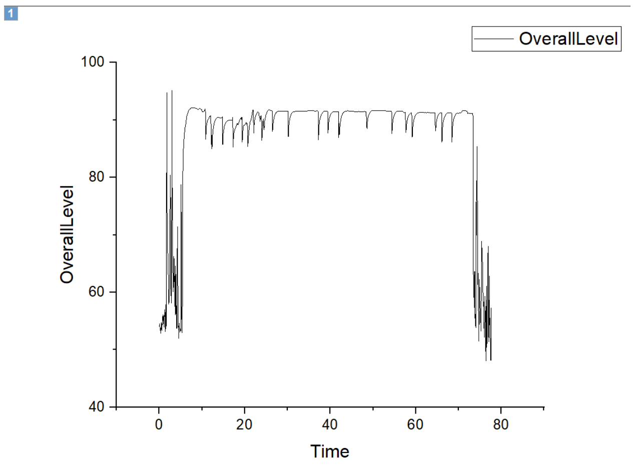

Fig. 7: 1000hz

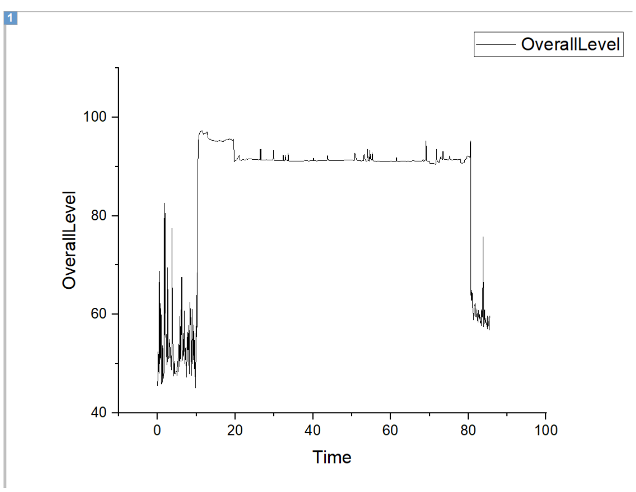

Fig. 8: 3000hz

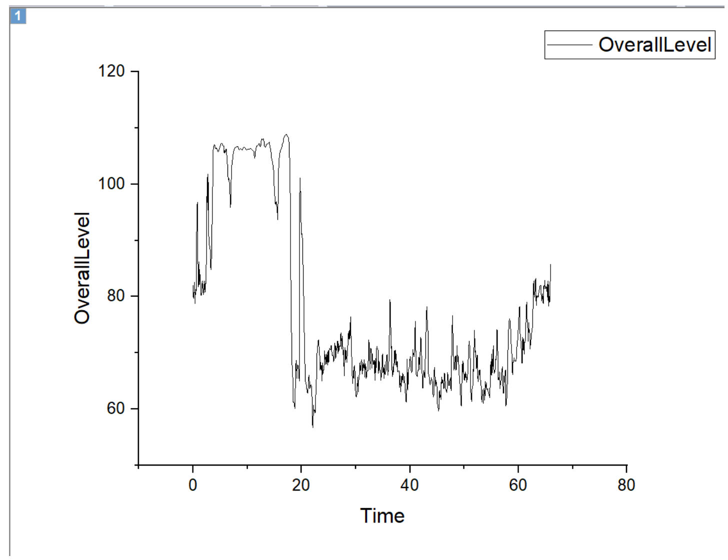

Fig. 9: 1500-5000hz

The Fig-7 shows the frequency continuously vary from 1500hz - 5000hz for 60 seconds.

V. Observations/Conclusion

1. There is variation in SPL over time, as indicated by the fluctuating values. This variability might suggest changes in the sound environment, such as different sound sources or varying distances from the sound source.
2. Some extreme SPL values stand out in the data, indicating instances of particularly loud or quiet periods.
3. The SPL values seem to range from around 40 dB to over 98 dB, indicating a wide range of sound levels.
4. Sudden spikes or drops in SPL could indicate noise events or changes in the sound environment.
5. If the data spans a longer duration, periodic patterns might emerge, indicating regular intervals of sound events or quiet periods.
6. Any unexpected or irregular patterns in the data could indicate anomalies or unusual events in the sound environment.

References

[1] http://sites.poli.usp.br/d/pme5422/Arquivo/ISO
[2] ”Reverberation Time in Rectangular Rooms” by M. R. Schroeder - This classic paper from 1965 presents a fundamental analysis of reverberation time in rectangular rooms and provides formulas for estimating reverberation time based on room dimensions and absorption coefficients.
[3] ”Reverberation Time Measurement in Concert Halls” by T. Lokki and K. Paloheimo - This paper discusses reverberation time measurement techniques specifically tailored for concert halls, where accurate control of reverberation time is crucial for achieving optimal acoustics.
[4] ”Perceptual Acoustics of Concert Hall Reverberation” by T. Hidaka, D. R. Begault, and R. P. Hellman - This paper investigates the perceptual aspects of concert hall reverberation, including the effects of reverberation time on listener preferences and perceived sound quality.