Determination of Reverberation Time in Reverberation Room at Acoustic Laboratory in Syiah Kuala University

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***Abstract*-- In this paper we describes the reverberation time of acoustic laboratory, Syiah Kuala University. The volume of the room is 72.1m^3 with cut-off frequency of 200 Hz, used for measurement of random incidence absorption coefficient of material. The evaluation made shows that the reverberation room is fully compliant with the reverberation time and average surface absorption requirement of the ISO 3741. The background noise level is 26.8 dB (A-weighting).**

***Index Term*- reverberation time, reverberation room**

I. INTRODUCTION

Reverberation time is a basic indicator of acoustic quality of room. It affects the speech intelligibility and sound localization in an auditory space [1]. The RT of a room specifies the time needed to decrease energy by 60 dB from its original level after excitation signal is switch off [2]. The estimation of room reverberation time has been of interest to engineers and acousticians for nearly a century.

In this paper, we present the reverberation time of reverberant room of acoustic laboratory in Syiah Kuala University. The acoustic laboratory has one fully anechoic room, one reverberation room and one control room. Both of these are important tools in acoustics used in a variety of standardized measurements. The reverberation room is designed to create a diffuse or random incidence sound field. It is treated by hard flat, heavy and non-vibration material. All boundaries of this room will reflect the incidence sound wave. This room will create a highly diffused acoustical environment defined as sound field in which the acoustical energy flows equally in all direction. Reverberation room is widely used in measuring the absorption of materials, the sound power of noise sources, and the transmission loss [3].

II. DESIGN OF THE REVERBERATION ROOM

1.1 Construction

Reverberation room is of double construction. The outer wall is brick one and inner wall is of 4 inch thick IAC moduline hardliner panels.

The reverberation room interior walls, floor and ceiling surface are covered with 4 inch thick IAC moduline hardliner panels, which produce a satisfactory reverberation field. The reverberation room has a cut off frequency of 200 Hz. Sound insulation performance between control room and reverberation room with both door closed is 65.8 dB at 500 Hz.

1.2 Volume

The inner reverberation room dimension is 5.6 m (height) x 3.90 m (width) x 3.30 m (height). The total volume of inner room is 72.1 m3. Ratio of reverberation room maximum dimension to its minimum dimension is 1.7: 1. This ratio meets the ISO maximum criteria of 3:1.

1.3 Shape

According to ISO 3741, room proportion for rectangular room should not have any two dimensions that equals or closely approximates an integer. The ratio of dimension is as follow:

$$\frac{Ly/Lx}{0.70}, \frac{Lz/Lx}{0.59}, \frac{Lz/Ly}{0.85}$$

These numbers are all in compliance with ISO 3741 [4].

III. DETERMINATION OF REVERBERATION TIME

The instrument configuration used for reverberation time is shown in Figure I.

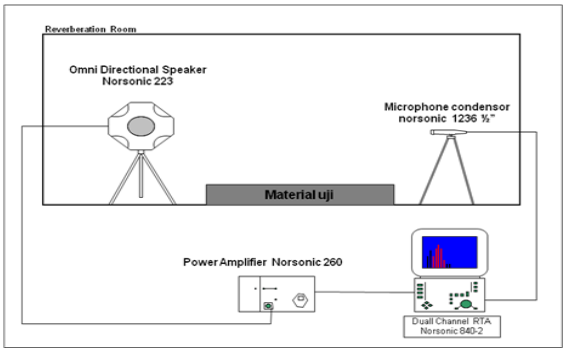

Fig. 1. Measurement Instrumentation

The pink noise generator inside the Norsonic N840 was utilized as source for reverberation time measurement. Broadband pink noise was broadcast through. The Omni-directional loudspeaker for a period of five second is to sufficiently energize the room and to achieve a steady state diffusive sound field. The pink noise generator was then

automatically triggered to cut off and the noise decay was measured using Norsonic real-time analyzer.

IV. RESULTS AND DISCUSSION

In order to obtain a suitable reverberation sound field, sound absorption surface of the room should be small.

4.1 Absorption Surface of the Reverberation Room

According to ISO 3741, the surface of reverberation room should be designed to be reflective with an absorption coefficient less than 0.06. The results of average absorption coefficient of surface are shown in Table I.

TABLE I
SOUND ABSORPTION COEFFICIENT OF SURFACES

F	200	250	315	400	500	630	800	1000
α	0.05	0.04	0.04	0.03	0.03	0.03	0.03	0.03
F	1250	1600	2000	3150	4000	5000	AVG	
α	0.03	0.03	0.03	0.04	0.05	0.05	0.04	

Based on ISO 3741 criteria, the surface absorption coefficients of reverberation room are within that criteria background noise. The average background noise level of reverberation room when air conditioning system not operating is 18.9 dB (A) and 20.8 dB (A) when air condition system operating.

Based on ISO 3741 criteria, the average background noise level is 26.8 dB (A) minimum and 32.8 dB (A) preferable. The background noise level inside the reverberation room is acceptable and lower than most common noise source.

4.2 Reverberation Time of the Reverberation Room

The result of average of reverberation time, which is generated by the reverberation room, is shown in Table II.

TABLE II
AVERAGE REVERBERATION TIME

F (Hz)	200	250	315	400	500	630	800	1000
ΔT_R (s)	2.03	2.53	2.95	3.38	3.50	3.58	3.59	3.51

F (Hz)	1250	1600	2000	2500	3150	4000	5000
ΔT_R (s)	3.79	3.70	3.54	3.24	2.88	2.35	1.99

As regard ISO 3741 that reverberation time in the frequency range of interest should be greater than V/S, where V is the room volume (m^3) and S is the total surface area (m^2) of test room.

Based on surface area of 106.4 m^2 and the room volume of 72.1 m^3 for minimum reverberation time criteria is 0.68 second. When this criteria is compared with the average reverberation time measurement results in table, it can be shown that the measured reverberation time in the frequency range of interest are well above this criteria [5].

V. CONCLUSION

1. The reverberation room is fully compliant with the reverberation time, average surface absorption requirement of the ISO 3741.
2. The background noise level (BNL) is 26.8 dB (A) which is minimum source requirement of the ISO 3741 criteria.

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