DOI: 10.61782/fa.2025.0221

COMPARATIVE ANALYSIS OF THE ACOUSTIC MODELING USING VARIOUS ROOM ACOUSTIC SIMULATION SOFTWARE

Chan-Hoon Haan[1*] **Chae-Hyun Han**[1]
[1] Department of Architectural Engineering, Chungbuk National University, Korea
Cheongju, 28644, Korea

ABSTRACT

Room acoustic simulation tools are widely used to predict the acoustic performances of indoor spaces, and they have become a predominant method of acoustic design since 1988. New algorithms have been adopted to operate the acoustic modeling programs after ray-tracing method was used at first. Accuracy and applicability to various spaces of these programs have been improved based on the commercial potential.

The present study aims to investigate the acoustical results from various room acoustic simulation software which are currently used as acoustic modeling programs. In order to this, round robin tests were undertaken using four acoustic simulation software. Room acoustic parameters of a simple classroom were measured including SPL, RT30, D50, C80, EDT, LF and STI. Also, room acoustic modeling was undertaken in the classroom using four different room acoustic simulation software, and the modeling results were compared with the measured values.

As a result, it was shown that most of the room acoustic results are similar. However, different results were drawn at the low frequency regions between the geometrical acoustic modeling and hybrid modeling which uses wave propagation analysis.

Keywords: *room acoustic simulation, acoustic modeling algorithm, software performance comparison, acoustic measurement.*

*__Corresponding author__: chhaan@cbnu.ac.kr

1. INTRODUCTION

Currently, many room acoustic simulation software programs are being used to predict the acoustic performance in rooms. Since they were made from early 1980' programs have been developed much adopting advanced technology and algorithms. At first, raytracing algorithm was mainly used to predict the acoustics in enclosed space however, more acoustic phenomenon can be considered using Lambert diffusion law, scattering coefficient and wave acoustics. The present study tries to exam the performance of some room acoustic prediction programs with different algorithms and compare the predicted results with measured values.

2. METHODS

2.1 Object room

A rectangular classroom was selected which have 7.8m wide, 10.8m long and 3m high which has formulaic form of small classroom. Table 1 shows the interior finishing materials of the room

Figure 1. Interior view of the object room.

Table 1. Interior finishing materials of the object room.

Part	Material	NRC
Wall	Paint on concrete	0.015
Floor	Linoleum tile	0.015
Window	glass	0.038
Door	glass	0.038
Ceiling	Absorption panel	0.54

Figure 2. Room acoustic measurement devices used.

2.2 Room acoustic prediction programs

Four room acoustic simulation software programs were used in the present investigation. (refer to Table 2). The algorithm of the three of 4 programs is based on the geometrical analysis and ray-tracing methods while one program has dual function of geometrical and wave propagation.

Table 2. Description of room acoustic simulation software programs used.

No.	Name	Country	Major algorithm
1	C-p	Sweden	Geometrical analysis
2	E-p	Germany	Geometrical analysis
3	O-p	Denmark	Geometrical analysis
4	T-p	Iceland	Hybrid(GAM+wave analysis)

2.3 Measurement of acoustic values in the object room

Acoustic parameters were measured at the five measurement points in the object room using omni-directional speaker and dummy head. Measured acoustic parameters include reverberation time (RT), Sound pressure level (SPL), Sound clarity (D50) and Early decay time (EDT). White noise was used as sound source with 75dB.

2.4 Simulation model of the object room

A 3D model of the object room was made using CAD and Sketch-up programs. Fig.3 shows the 3D model of the room. Sound absorption coefficients of the interior materials were applied to each prediction software based on the ISO 354-2003 standard data.

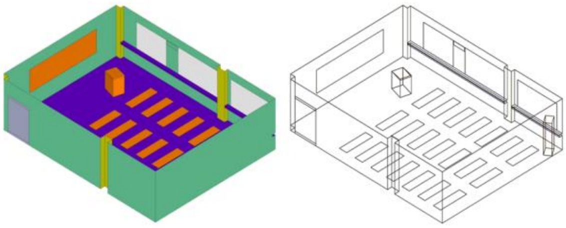


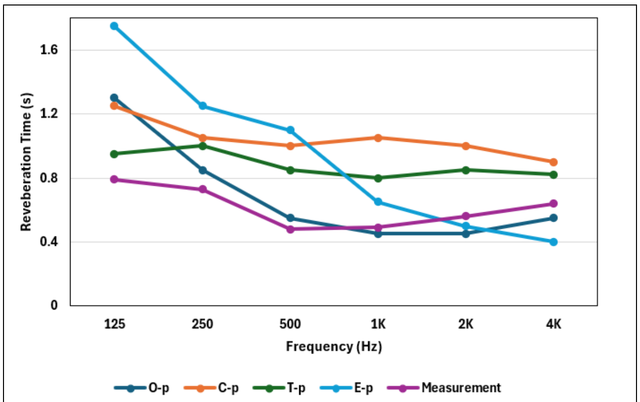
Figure 3. 3D model of the object room.

Table 3. Sound absorption data of interior materials used for room acoustic prediction programs.

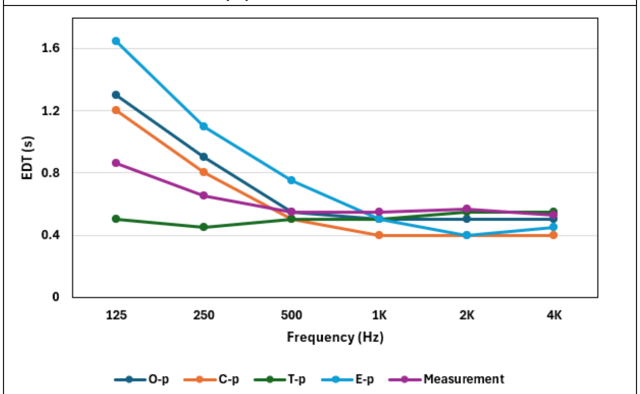
Material	63 Hz	125 Hz	250 Hz	500 Hz	1kHz	2kHz	4kHz	8kHz
Concrete wall	0.01	0.01	0.05	0.06	0.09	0.12	0.12	0.12
Floor	0.02	0.02	0.02	0.04	0.05	0.05	0.05	0.05
White board	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04
Glass	0.35	0.35	0.25	0.18	0.12	0.07	0.04	0.04
Metal panel	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02
Ceiling	0.11	0.12	0.4	0.47	0.64	0.64	0.64	0.64
Desk & chair	0.4	0.3	0.3	0.25	0.2	0.2	0.2	0.2

3. RESULTS

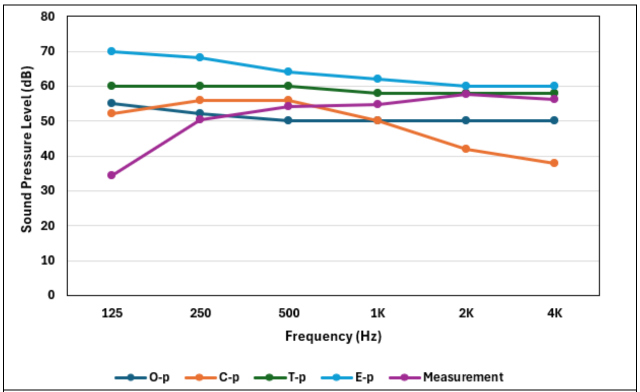
The measured and predicted values of acoustic parameters are shown in figure 4 displaying RT, EDT, SPL and D50. It was found that all the geometrical room acoustic programs seem to make similar curves of frequencies for room acoustic parameters while hybrid room acoustic program produced unvaried values at every frequency. Especially, hybrid room acoustic program has different acoustic values from those of geometrical programs at low-frequency regions. Generally, comparing the results of four acoustic parameters, the predicted values of O-p program are most close to the measured acoustic values with minimum deviation at each frequencies.



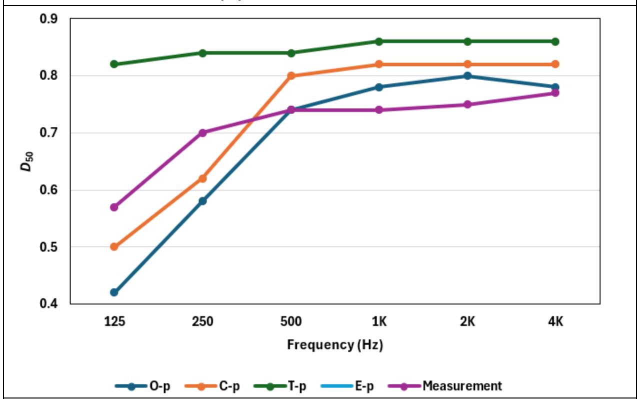
(a) Reverberation Time



(b) Early Decay Time



(c) Sound Pressure Level



(d) *Speech definition (D_{50})*

Figure 4. Comparison of measured acoustic values with the predicted values by four room acoustic programs.

4. DISCUSSIONS

Several investigations have been tried to compare the room acoustic prediction program software. The present study tried once again the similar work including newest program. The comparison was done only for the simple geometric room so, another work is needed to be undertaken using more complicate and larger spaces like music halls and auditorium. Also, definite and correct data of sound absorption materials are unconditionally required to predict real condition of acoustics in spaces.

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