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AN ACOUSTIC INVESTIGATION INTO SMALL THEATRE IN INDONESIA

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ABSTRACT

In architectural acoustics, specific acoustic characteristics and treatments are carefully observed and evaluated for performance design. In the case of Jakarta, the acoustic observations conducted in one small theatre at the complex of TIM Art Centre. The capacity of the theatre is for 250 people, generally used for theatre and musical drama, and sometimes are used for musical, choir, and chamber orchestra performances. The plan shape is shoebox, designed with a proscenium stage and two tiers of shallow balconies. Recently, the electro-acoustic is used for the performances, although it is not necessary. This paper evaluates the acoustic properties of the theatre in relation with its architectural design and the surrounding materials used for the theatre. The acoustic measurements involved are for reverberation time by applying different techniques. A computer simulation measurement technique is employed by using CATT Program V7. Besides, real time measurement is also conducted. The derived acoustic parameters are then confirmed with the theoretical predictions, in order to check the accuracy of the results. The results obtained from the measurements indicated that the RT values derived from computer simulation were shorter when compared to on site measurements and the theoretical predictions. Design of the theatre is appropriate regarding its RT for multi-purpose performances as well as the interior design for architectural point of view, and therefore the application of electro-acoustic is actually not necessary.

INTRODUCTION

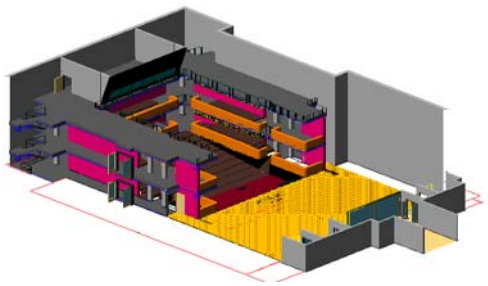
As part of the Building Physics Study for Architecture students, this paper evaluates the acoustic properties of one small theatre, "Teater Kecil", in the complex of TIM Art Centre Jakarta, in relation with its interior architectural design. The surrounding materials used for the theatre are also evaluated. The theatre is frequently used for multi-purpose performances.

The acoustic prediction and measurement involved is only the reverberation time (RT) values nevertheless adopting different techniques. The on site measurement is conducted as well as subjective evaluation. The derived RT is then verified with Sabine theoretical prediction, in order to compare the accuracy of the measurement method. Besides, a computer simulation measurement technique is employed by using CATT Program V7.2.

TEATER KECIL

Teater Kecil has a capacity of 250 people, generally used for theatre and musical drama, and sometimes is used for musical, choir, and chamber orchestra performances. The plan shape of the theatre is shoebox with 16 m length, main width is 14.80 m, designed with a proscenium stage and two tiers of shallow balcony to seat 55 audience. The height of the ceiling is 10.50 m and the volume is 2,790 m3.

a



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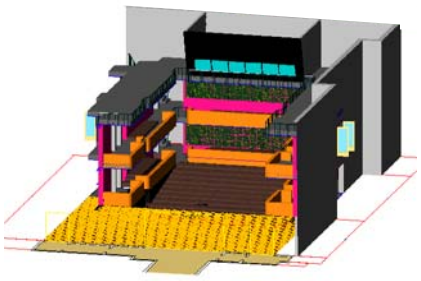


Figure 1a.b. 3D of Teater Kecil at TIM Art Centre - Jakarta

The surrounding wall consists of textured wood panel that should give good resonance to the music as well as give good diffusion to the surrounding areas. The other side of the walls are covered with light carpet. The rear wall made of holed wood panel 40x40 cm filled with absorbent material. These panels are acted as absorbent as well as diffusor surface. The seating is fully upholstered, they are fixed on the floor but can be removed and adjusted depend upon the style of performances. The floor is fully carpeted. It can be seen that those materials are dominant in contributing main absorbent within the theatre.

The upper level of auditorium is functioned as monitor room and service as well as ducting and cat walk, with a plastered rigid wall. The ceiling is made of gypsum board. From these material applied (in walls, ceiling and the finished materials) within the auditorium, it can be perceived that they are dominant in producing valuable reflections and diffusions. They make important contributions to the acoustic characteristics, depending on their nature and configurations. The acoustics then should cater 250 audience in the theatre.

RT PREDICTIONS AND MEASUREMENTS

Modern room acoustics has started with the reverberation time (RT) formula by W.C. Sabine in the 19th century. Until now, RT has been considered as the most important criterion for auditoria acoustics. The auditorium volume (V), its audience capacity and attendance, and the enclosed surfaces whether absorptive or reflective (A), all contribute to influencing the RT of the auditorium. The Sabine's equation is defined in seconds as :

$$RT = \frac{0.161V}{A}$$

When the frequency is over 1000 KHz, the effect of air absorption (m) is significant and the equation is rewritten as :

$$RT = \frac{0.161\ V}{A\ +\ 4m\ V}$$

The RT values of the theatre are calculated with different techniques, such as : Sabine calculation, subjective evaluation, computer simulation, and on-site measurements. With Sabine calculation for T60, the RT result at 500 Hz is 1.19 seconds, shorter than that the criteria for musical performance of 1.5-2.1 seconds. The same applied for the value at 1KHz of 0.99 seconds. This is predicted due to some parts of the surrounding are finished by absorbent materials.

Subjective criteria by audience have gained through questionnaires when Chanchiki Tornade Chindon Music performance held at the theatre. The criteria given such as : level of satisfactory audience, clarity, intelligibility, reverberant. The judgement of criteria fell into satisfactory and good, while the low frequency modes need to be strengthened. This method is adopted in order to comprehend the other adoped techniques.

The RT values then predicted by using CATT computer simulation technique, where the input criteria are : the coefficient absorbent of materials, frequencies, corners, and CAD drawing. Two sources on the stage and ten receivers on the seating area including the balcony have set to calculate their RT values. The drawing of auditorium can be rotated for supervision. The RT values can be seen at each frequency and position. It is observed that audience at the ground level gained RT between 1.2-1.6 seconds, whereas at the balcony between 0.7-1.1 seconds. The average RT value at 500 Hz derived is 0.38 seconds and at 1 KHz is 0.35 seconds.

The next test is on site measurements, with pink noise to represent the sound source and Condensor Microphone Bruel & Kjǽr type 4191 as the receiver. Three receiver positions were set in the seating area and the source was put at the stage level. The background noise was recorded 37.1 dBA. The RT result at 500 Hz is 0.9 seconds and at 1 KHz is 0.84 seconds.

Various techniques have been employed to derive RT values of the theatre. The results obtained from the on-site measurement and Sabine prediction values are in agreement, although at low frequencies the on site measurements are slightly higher, whereas at mid and high frequencies they are slightly shorter.

In evaluating the CATT RT values, they are shorter significantly in each frequency when compared with other two techniques. It is assumed that the difference due to averaging calculation in each position. The CAD drawing showed that in the balcony positions there were very little reflections, so that when the values were averaging they corresponded to the total values. The positions of sound source also need to be checked similar to the height of on site measurements.

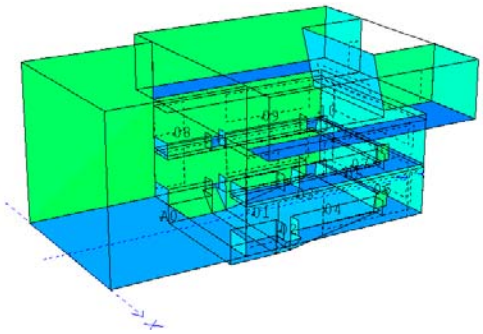
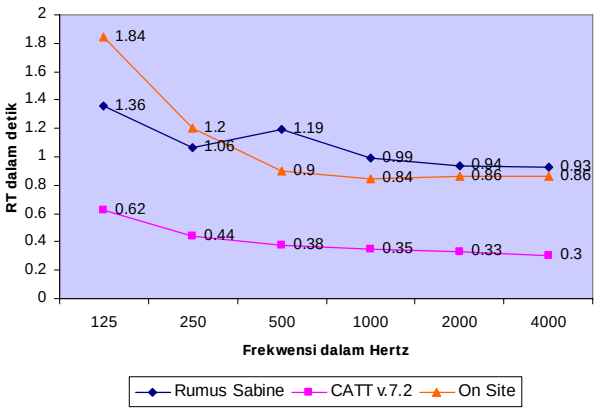


Figure 2. Source and Receiver Positions in the CAD Drawings of Teater Kecil.

Table 1. Comparison of RT Measurements by Applying



Different Tachniques

In order to design the RT values longer, certain modifications are proposed by adding more reflected surfaces and reduce absorbent elements, although the acoustic design is in agreement with its proper quality. It is, therefore, suggested to change the diffuser panel walls either into diffuser wood omni-diffuser type E-400 with **α** in 500 Hz 0.28, so that the RT

value in mid frequency will be 1.2 seconds; or with diffuser fibre-reinforced gypsum pyramid type E-400 with **α** in 500 Hz 0.1, to get the RT value of 1.27 seconds.

Recently, the electro acoustics is applied within the theatre for performances. For such small theatre, there is not crucial to strengthen the acoustics by adopting electro acoustics, since the acoustic problem could be overcome by natural acoustic design.

SUMMARIES

It was interesting to observe the acoustic characteristics of the small theatre at Teater Kecil of Jakarta, which is frequently used for multi-purpose performances. Obviously, the materials chosen as well as the design of shapes of the enclosures are important factors affecting the acoustic quality of the room. The absorption coefficient of the enclosure materials, the shape of the surrounding walls, the ceiling configuration, and the seating arrangement, create the specific acoustic character of the theatre. This means that in the building design, architectural and acoustical factors should be carefully determined and must be properly balanced.

From the results, it was found that small auditorium produced good acoustics. The Teater Kecil has good acoustics even without significant and special acoustic treatments, only by providing carefully selected interior architectural and acoustical design factors. The RT values are acceptable, uniform, and easy to be treated in small theatre with 250 audience. No serious acoustic problems encountered during the investigations.

The achievements of this study are : showing that various techniques and simple method can be applied in preliminary acoustic investigation; showing that the acoustic properties of the room rely on the relation with its architectural design of surroundings, and showing that speech-reinforcement system is not necessary be applied in a small theatre. Re-arranging the interior and the material is the most practical and efficient way to adjust the acoustic attributes of a theatre as desired.

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