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Noise Study and Simulation in Auditorium Badan Geologi Bandung

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ABSTRACT

An auditorium is a space specifically designed for conferences and scientific events, playing a crucial role in shaping the experience of both the audience and participants. This study focuses on the Auditorium Badan Geologi in Bandung, a key facility at a geological research center that serves as a platform for exchanging knowledge and ideas among scientists, researchers, and geology practitioners. Located at Jl. Diponegoro No. 57, this auditorium faces challenges related to external noise due to its proximity to a busy main road. To assess the quality of its acoustic environment, this study utilizes NoiseTools.net and IBANA-Calc software. The analysis results indicate that the Auditorium Badan Geologi meets the standards for an auditorium space; however, external noise disturbances prevent its acoustic conditions from fully complying with outdoor environment standards. The successful indoor acoustic performance is attributed to the selection of matte wood HPL material covering the entire wall surface. Meanwhile, to address outdoor acoustic issues, the addition of vegetation and the replacement of facade materials with soundproof materials are necessary.

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1. INTRODUCTION

The auditorium is a room specifically designed to watch various performances, such as theatre and music. Acoustic design in theatrical performances must be able to provide satisfaction for every audience member in various locations. This is very important so that they can hear clearly every articulation of the actor's conversation. In this way, the dramatic nuances and effects presented can be properly captured and understood by the audience (Hedy et al., 2007). The acoustic parameters of noise originating from outside the room can affect the audience's listening experience. Therefore, it is important to adjust the noise level to the main function of the space. The application of acoustic materials to space elements is very important to achieve ideal acoustic balance (Syah & Nurhasan, 2024).

As a place for geological research and information, the Auditorium Badan Geologi is the main facility for holding various events such as educational workshops, seminars and public lectures. This auditorium is an important place for the development of knowledge between geology researchers, scientists and practitioners. However, in research, environmental quality is also a big influence besides participant participation.

Located on the edge of Diponegoro Street No. 57, Auditorium Badan Geologi is an interesting object to study the noise aspect of the room. Building an auditorium in a location close to a busy road certainly presents its own challenges. Various sources of noise, such as the sound of vehicles and nearby crowds, can have a significant impact on the experience of events taking place in the auditorium. Therefore, this research aims to explore in depth the potential for noise in the auditorium while simultaneously applying simulations to design solutions that can improve the acoustic conditions, using Nosietools software. net and IBANA-Calcul.

1.1. Literature Review

Acoustics can be interpreted as anything related to sound or sounds. The term acoustics comes from the English word, namely "acoustics", which refers to the science of sound or the science of sound (Echols & Shadily, 1987). Acoustics is the study of sound, including how sound is produced and transmitted, and its impact. This science also explores how a space or medium responds to sound and the characteristics of sound perceived by the ear. It is important to understand that acoustics is not about designing interiors; Misconceptions regarding the role of acoustics can result in incorrect implementation. As a branch of physics, every aspect of acoustics can be explained empirically (Deassy, 2015).

Acoustics are essential in building design to create a comfortable sound environment (Ishak et al., 2022). The primary principle of interior acoustic design is to reinforce or direct useful sound while eliminating or attenuating sound that is undesirable for human hearing (Siska et al., 2018). Acoustics play a central role in an auditorium, given that the function of such a space is closely linked to audio and visual elements (Putra & Nazhar, 2020).

An auditorium is a space designed for public gatherings, performances, and similar events; a multifunctional auditorium, meanwhile, is not specifically tailored for speech or music alone, but rather for a diverse range of activities—such as weddings, product exhibitions, and celebrations like birthdays (Mediastika, 2005). Auditoriums should be configured to keep the audience as close as possible to the sound source, thereby reducing the distance sound must travel (Doelle, 1985). During events held within an auditorium, various issues can arise that cause discomfort, such as echoes, the intrusion of external noise, and uneven sound distribution (Wafa et al., 2020).

2. METHODOLOGY

2.1 Material

Based on the Decree of the Minister of the Environment Number KEP-48/MENLH/11/1996, noise is defined as unwanted sound from human activities and environmental comfort. By understanding and analyzing noise through various theories, its source can be identified, its intensity level measured, and effective control strategies can be developed. This aims to minimize errors and optimize the benefits of using the auditorium.

2.2 Standard

The standards applied refer to Environmental Decree Number KEP-48/MENLH/11/1996 concerning Noise Level Standards in Indonesia for various types of areas, such as housing, offices, industry, hospitals, schools and places of worship. The noise level standard that must be met to ensure comfort and good acoustic quality in a room is 55 dB. In addition, room noise guidelines from the US Department of Housing and Urban Development were used as parameters in measuring noise levels in the Auditorium Badan Geologi Bandung. Data collection was carried out using the Decibel x Pro Sound Meter application as a tool for measuring.

2.3 Method

This research adopts a quantitative descriptive approach, namely research that explains data using numbers or statistics, examine and analyse data from a sample drawn from a population, thereby identifying relative occurrences, distributions, and relationships between variables (Agung & Zarah, 2016). This research aims to present data in numerical form. In this case study, analysis and simulation were carried out at the Auditorium Badan Geologi Bandung. Noisetools.net and IBANA-Calc software were used to calculate the effect of sound insulation on noise as well as determine the indoor noise level perceived by the user inside.

3. RESULTS AND DISCUSSIONS

3.1 Results

3.1.1 Building Specifications

The Auditorium Badan Geologi is located on Diponegoro Street No. 57, Bandung, West Java. The orientation of the building faces north with boundaries as in Figure 1.



Figure 1. Location of the Auditorium Badan Geologi in Bandung.

Source: Google Maps, 2023

- North Boundary : Diponegoro Street
- Western Boundary : Center for Volcanology and Geological Hazard Mitigation
- Southern Limit : Geological Agency of the Ministry of Energy and Minerals
- Eastern Boundary : Geological Survey Center

The Auditorium Badan Geologi is interesting to study because it is located on the side of a busy road with high noise levels. Even though it is 55 meters from the gate to the auditorium room, motorbike riders often have very high noise levels.

3.1.2 Field Measurements

Measurements of noise levels in the Auditorium Badan Geologi were carried out by direct measurements in the Auditorium Badan Geologi environment, which is close to the main road, because the main source of noise in the Auditorium Badan Geologi mostly comes from motorized vehicles. The Auditorium Badan Geologi is located on Jl. Diponegoro No. 57, Bandung. This road is included in the secondary arterial road category which is designed for a minimum design speed of 30 km/hour with a minimum road width of 11 meters, and fast traffic must not be disturbed by slow traffic according to PUPR No. 05/PRT/M/2018.



Figure 2. Diponegoro Street as a Secondary Arterial Road
Source: Google Maps, 2023

The measurements were taken at 16.50, which is when you get home from work, meaning the road is quite busy and running smoothly. Noise levels were measured using Decibel X software: dB Sound Level Meter made by SkyPaw Co., Ltd., based in Hanoi, Vietnam, via the Iphone 7 device. Measurements were taken on December 28, 2023 at 16.50.

3.1.3 Analysis Using NoiseTools.net Software

At this stage, the data from measurements in the field will be analysed using the NoiseTools.net application to calculate the pressure level of a noise source by considering the sound attenuation to determine the distribution of the building's sound range. In addition to sound pressure level data, there needs to be input regarding humidity and temperature.

- Location : Bandung
- Date : December 28, 2023
- Time : 16.00 WIB
- Humidity : 75%
- Temperature : 29°C

In this further analysis, the Auditorium Badan Geologi has a gate with a height of 1.5m. The barrier is a black iron fence. The distance between the receiver and the barrier is 55 m, with a receiver height of 1.5 m. After obtaining the required data, the data was then analyzed using NoiseTools.net software with multi frequencies.

3.1.4 Analysis Using IBANA-Calc Software

Based on the results of analysis using NoiseTools.net, the sound pressure level (SPL) reaching the building is 27.3 dB. When compared with the Environmental Noise Standards from KEP-48/MENLH/11/1196 which require the noise standard in a place to be 55 dB, the Auditorium Badan Geologi Bandung meets the standards as an auditorium.

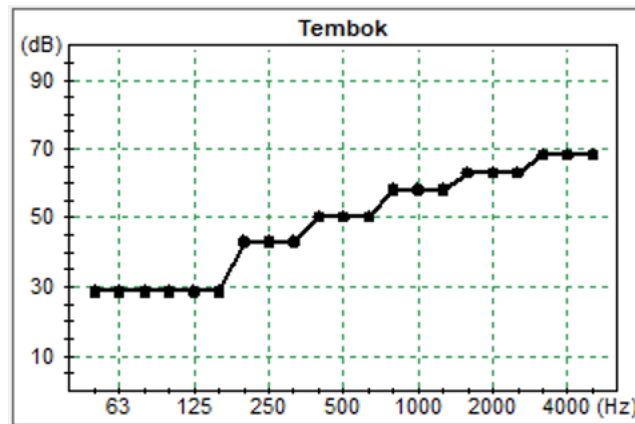


Figure 6. Wall coefficient simulation with IBANA-Calc

The Auditorium Badan Geologi uses walls made of red brick with a layer of plaster, which is then coated with wood-patterned HPL Doff. Meanwhile, the material used for doors and windows is wood. The simulation results can be found in figures 7 and 8.

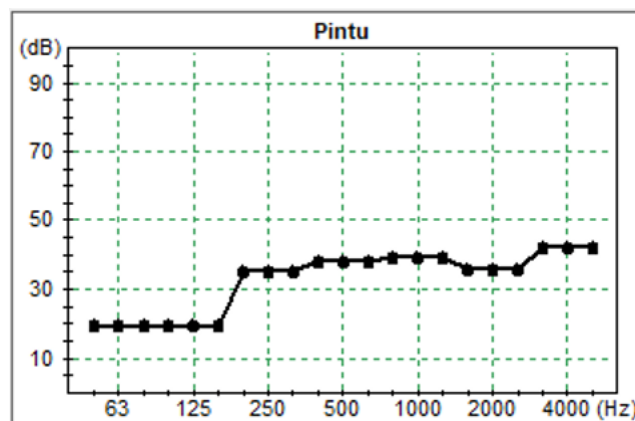


Figure 7. Door coefficient simulation with IBANA-Calc

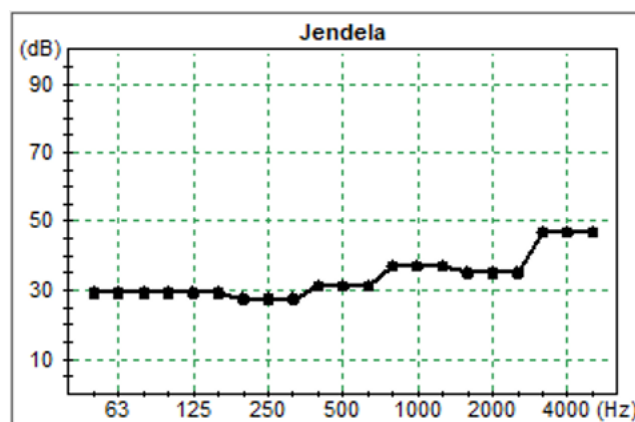


Figure 8. Window coefficient simulation with IBANA-Calc

The material used for the door and window frames is wood with a thickness of 15 cm. Meanwhile, the windows are equipped with 1 cm thick glass, which is then covered using light

gray curtains. With these material specifications, the results of the analysis obtained can be seen in Figure 9.

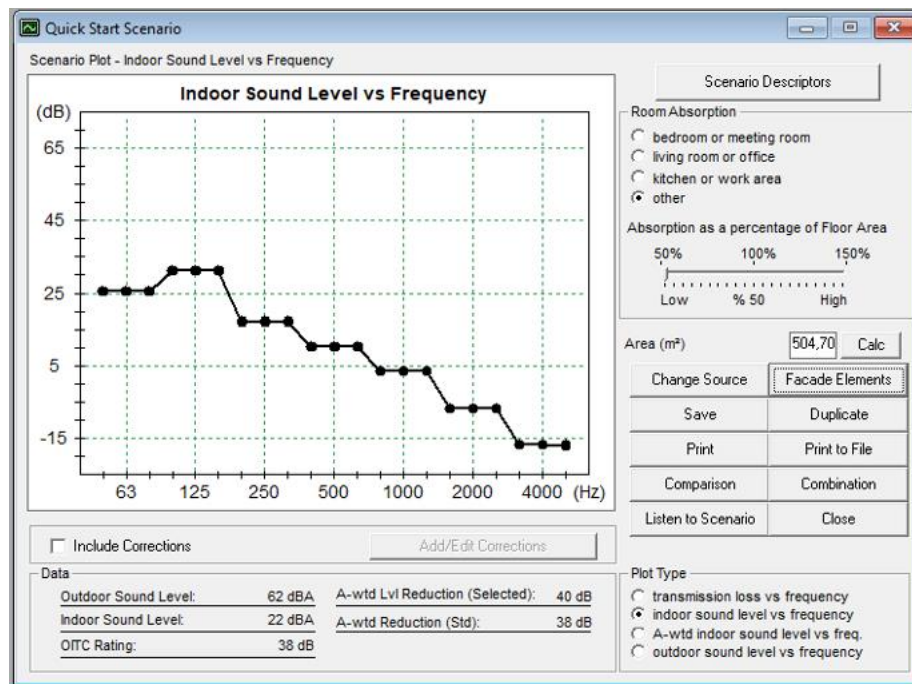


Figure 9. Noise simulation results with IBANA-Calc

The simulation results obtained are presented in Table 1:

Table 1. Noise simulation results with IBANA-Calc.

No	Item Result	Noise(dBA)
1	Outdoor Sound Level	62
2	Indoor Sound Level	22
3	OITC Rating	38
4	A-wtd Lvl Reduction	40
5	A-wtd Reduction	38

The simulation results show that the outdoor noise level reaches 62dB, which is considered high when compared to the Noise Level Standard based on KEP-48/MENLH/11/1996, which sets a noise limit of 55dB. Meanwhile, the indoor noise level of 22dB has met the comfort standards set by the US Department of Housing and Urban Development, which requires indoor noise limits not to exceed 58dB.

3.2 Discussion

Based on the simulation results that have been carried out using Nosietools.net and IBANA-Calc software, a conclusion can be drawn where the Auditorium Badan Geologi located on Jl. Diponegoro has met the noise level standards for a room used for various activities has met the comfort standard of 22 dB. Meanwhile, for the outdoor area has not met the standard, namely having a noise of 62 dB from a maximum noise of 58dB.

Here are some recommendations that can be made to reduce noise to meet the standards:

A. Making a Hedge

Vegetation has the ability to absorb and block sound waves, so hedges can reduce sound. After research, the ability of vegetation to reduce noise is highly dependent on the roof of the vegetation. If the headline cover level is low, the sound can be reduced by about 1.25 dBA or

1.69% compared to the vegetation range. At medium and high roof levels, noise can be reduced by about 2.46 dBA (3.32%) and 5.72 dBA (7.82%) (Imam et al., 2018).



Figure 10. Hedge
Source: Berkeluarga.com

B. Soundproofing materials on building exteriors

The materials recommended for soundproofing are as follows:

Table 2. Soundproof Material

No.	Materials	Soundproof (%)
1.	Mineral Wool	85-95%
2.	Acoustic Foam	60-80%
3.	Gypsum Board	50-70%
4.	Acoustic Sealant	10-20%
5.	Glasswool	70-90%
6.	Greenwool	80-95%

Based on the table above, it can be seen that mineral wool and greenwool materials have the highest soundproofing level, at 95%.

4. CONCLUSIONS

The conclusion of this study is that the Auditorium Badan Geologi has a good noise level. So that if events are held, it will not disturb and provide comfort to the audience. The noise level obtained is below the maximum noise standard in the interior of the building, the materials used along with the openings in the Auditorium Badan Geologi room are appropriate to deny noise from outside. Meanwhile, for the outside of the building, the noise is still above the comfortable noise standard. Therefore, a recommendation was made, namely the addition of plant fences or the application of exterior materials that can help reduce sound.

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