

Analysis of Noise Level Generated by Stone Cutter Machine A Case Study in Marble Production Unit, South Aceh

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ABSTRACT

Marble, one of natural stone, has been widely produced since the last decade. In South Aceh, Marble stone is fabricated at Marble Production Unit that is located around Polytechnic of Aceh Selatan. The using of large-scale stone-cutting machines in Marble Production process tends to be a major noise source in Polytechnic of Aceh Selatan environment. The aim of this study is to analyze the noise level generated by Marble Cutting Machine in Marble Production Unit. The noise levels were analyzed by measuring Background Noise Level (BNL) and Sound Pressure Level (SPL). Sound Level Meter Type SL-814 was employed in the measurement. The results show that Background Noise Level measured is 53.03 dB in average. The highest Sound Pressure Level measured when the marble cutting machine was operated without workpiece is 94dB. In addition, the highest sound pressure level measured when marble cutting machine was operated with the workpiece is 96 dB. The values have generally exceeded the Threshold Noise Level allowed for education area, 55 dB. The noisy condition in campus environment would have impact on teaching and learning processes within the Polytechnic of South Aceh.

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I. Introduction

Marble Production Unit (MPU) is a marble stone processing industry in Tapaktuan, South Aceh. Marble Production Unit is located in the area of Polytechnic of Aceh Selatan, Tapaktuan, South Aceh. Aside from being a marble stone processing industry, MPU is also utilized as a Laboratory for student practice. The production stage of marble stone is processed through cutting activity. The solid-to-solid friction between cutting tool and marble generates force, vibration and also noise [1]. The use of large-scale stone cutting machines tends to produce high noise level and become a noise source in the Polytechnic of Aceh Selatan.

The effects of noise on human health depends on the intensity, frequency, and length of time someone is in or near the noise source. The Effects may vary both directly and indirectly. Direct effects include hearing loss, speech impairment, sleep disturbance and disruption. While indirect effects are long term effects on physical and mental health. Long time exposure to high-intensity noise affects worker comfort and performance. According to Regulation of Indonesian Minister of Manpower and Transmigration No. 13/Men/x/2011 about the limited value for physical and chemical factors in work place, the allowed noise level exposure for workers is 85 dB (A) with a maximum exposure time of 8 hours a day and 40 hours a week [2]. In addition, refer to Indonesian Minister of Living Environment Regulation No. Kep-48/MenLH/11/1996, the noise level allowed for education area is 55 dB [3]. Besides, the location of Marble Production Unit in the campus area can also reduce the quality of teaching and learning in Polytechnic of Aceh Selatan. Therefore, the noise generated by stone cutting machine in MPU is a serious problem and needs to get special attention.



II. Related Works

In the literature, there are several related works that study the noise level of stone cutting machine. For instance, Surya, D., 2013 performed noise level analysis for ceramic cutting in the wall. The results of this study revealed that the noise level produced on the ceramic cutting process on the wall reached 115.5 dB. The value is above the noise level resulting from the ceramic cutting process before being installed on the wall. Taufan, M., 2013 analyzed the noise levels generated from the cutting process of granite and ceramic by employed different cutting eyes. The level of noise generated in the granite cutting process is higher than the ceramic. In addition, Nasrul, 2014 analyzed noise levels from ceramic cutting machines with the application of foam and rubber as a silencer. The use of foam and rubber in cutting process resulted in reducing noise up to 10 dB and 5 dB. Muntazillah, 2016 analyzed the noise level of agate cutting machines. The noise level generated by the agate cutting machine reached 80.6 dB. A. A. R. Barbosa and S.R. Bertoli, 2017 identified the source of noise pollution from construction and assessed the occupational exposure to masonry saw cutting materials. The highest observed noise level measured reached 106.9 dB. In overall, the noise levels measured exceeded the allowed noise level without protection in work place. However, all of the related research mentioned were analyzed noise level from small-scale (portable) stone cutters. There is limited scientific publication of noise level study from large-scale stone cutting machines. In this study, noise level of large-scale marble stone cutting machine is analyzed. Resulted data are required for appropriate noise control planning.

III. Method

A. Objects

This research was conducted in Marble Production Unit, Polytechnic of Aceh Selatan, Tapaktuan, South Aceh, Indonesia. The object of this research is stone cutter machined Bridge Diamond Disc Stone Sawing Machines Type QJS 160, Shandong Gold Rhino Huaxing Machinery Co., Ltd. The machine mainly used for cutting granite and marble plate over 10 mm. The unit hired two fulltime male workers to operate the machine. The marble cutting process is shown in Fig. 1.



Fig. 1. Marble stone cutting machine and worker.

B. Noise Level Measurement

To determine noise level of marble cutting machine, there are two main parameters were measured; Background Noise Level (BNL) and Sound Pressure Level (SPL). Background Noise Levels (BNL) were measured when the machine in steady condition while Sound Pressure Levels (SPL) were measured when the machine was operated with and without workpiece. Sound Level Meter (SLM) Type SL-814 was employed to measure these parameters during working hours. The measurements were conducted by varying the distance from the noise source to the listeners. The distance was determined at 0 meters, 5 meters, 10 meters, 15 meters, 20 meters, 25 meters and 30 meters.

IV. Results and Discussion

A. Background Noise Level (BNL)

The background noise level measured seen in Table 1. Background noise levels indicates the environmental acoustic condition around Marble Production Unit.

Table 1. Background Noise Level (BNL)

Point	BNL (dB)
1	49.8
2	54.2
3	50.1
4	52.2
5	55.3
6	59.3
7	50.3

The table shows that background noise level measured around Marble Production Unit are between 49.8 dB and 59.3 dB with the average measured noise level is 53.03 dB. The values are still under the allowed noise level as stated in the Regulation of Indonesian Minister of Manpower and Transmigration No. 13/Men/x/2011. The specified noise level permitted is 85 dB with maximum exposure duration (work) for 8 hours/day or 40 hours/week. Referring to Ministry of Health Regulation No. 718 / Men.Kes / Per / XI / 1987 about noise related to health, the area with those noise level is suitable for recreation, housing and education center.

B. Sound Pressure Level (SPL) for operating machine without and withworkpieces

The sound presssure level was measured for operating machine without and withworkpieces is tabulated in Table 3 and Tabel 4.

Table 2. SPL for Operating Machine without workpieces

Point	SPL1 (dB)
1	94
2	90
3	89
4	82.1
5	79.3
6	71.4
7	59.3

Table 3 shows the noise levels generated from operated marble cutters are from 59.3 dB to 94 dB, with an average of 80.7 dB. The highest noise level was measured at the point of the noise source. While the lowest noise level was measured at a distance of 30 meters from the source. In general, the noise levels measured when the machine was operated are excessive the allowed noise level, 85 dBA.

Table 3. SPL for Operating Machine with workpieces

Point	SPL2 (dB)
1	96
2	91
3	86.3
4	75
5	74
6	72.3
7	74.3

Data in the table shows that the noise level generated from the cutting machine with workpiece are between 72.3 dB to 96 dB. The highest noise level during the process of marble cutting reaches 96 dB that is higher than noise level resulted from operated cutting machine without workpiece, 94 dB. At some point, the noise level measured appears to have exceeded the allowed noise level in work place, which is 85 dB. According to Indonesian Ministry of Health Decree based on Ministry of Health Regulation no. 718 / Men.Kes / Per / XI / 1987 about noise related to health, the noise level allowed for the education area is 55 dB. Due to marble production unit is located in the campus area, the noise level measured consequently has impact on lecture activities. Thus, the Marble production unit should be relocated to other appropriate industrial area.

C. *Effect of Distance on Noise Level*

Refer to Inverse Square Law, the sound pressure level will vary with distances of noise source to measurement point in the free field condition. The relation between background noise level and distance can be seen in Fig 2.

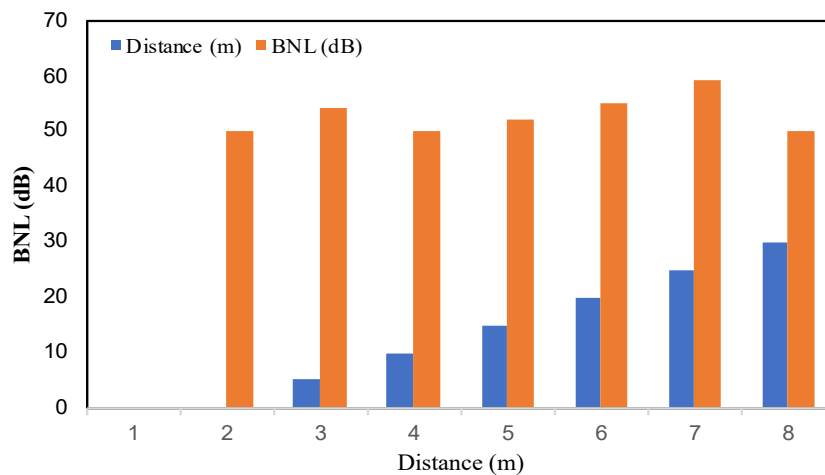


Fig. 2. BNL vs Distance

Figure 2 shows that there are no significant differences in the overall background noise level measured with distances variation. The background noise level around Marble Production Unit is almost consistent in 53.03 dB. Some small changes might be caused by some natural factors such as humidity, temperature, wind direction, and human activity. Added to that, sea wave also contributes to produce noise considering the location of Marble Production Unit is off the sea.

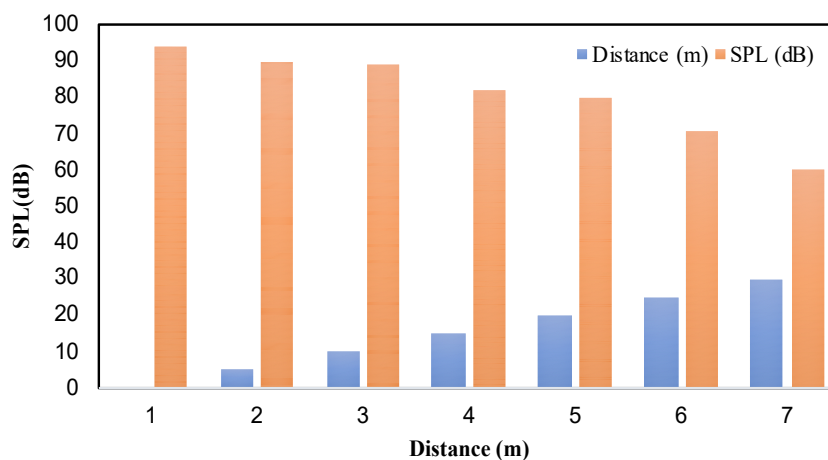


Fig. 3. SPL vs Distance in operated machine without work-piece

Figure 3 shows the relation between noise level resulted from operated marble cutting machine and distance. It can be seen that sound pressure levels (SPL) measured of operated marble cutting machine without work-piece was are almost constantly reduced by increasing in distances. It shows the noise reduction between 1 to 12 dB. The same condition occurred for sound pressure levels measured of operated marble cutting machine with work-piece (Fig 4.)

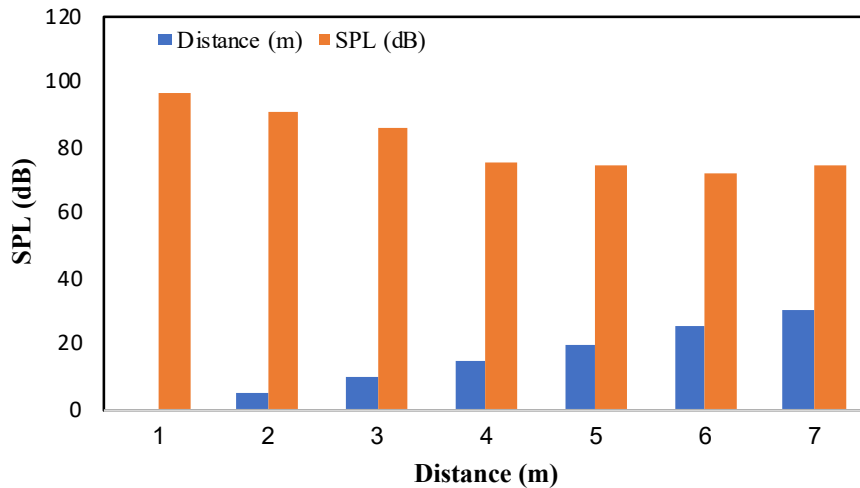


Fig. 4. SPL vs Distance in operated machine with work-piece

Fig 4 shows the relation between noise level resulted from operated marble cutting machine with work-piece and distance. The increasing in distance has reduce sound pressure levels measured of operated marble cutting machine with work-piece. The noise reduction occurred between 1 to 11.3 dB. Environmental meteorological conditions influenced the sound propagation [9-10].

V. Conclusion

Based on result and discussion, it can be concluded that the noise level measured generally has exceeded the permitted noise level for education area, that is 55 dB. Background Noise Level (BNL) measured is 53.03 dB in average. The highest Sound Pressure Level measured when the marble cutting machine was operated without workpiece is 94dB. In addition, the highest sound pressure level measured when marble cutting machine was operated with the workpiece is 96 dB. Noise levels generally decrease by increasing in distances. The noisy condition in campus environment would have impact on teaching and learning processes within the Polytechnic of South Aceh. The workers and students are generally felt disturbed by noise. To overcome the impact of noise on workers, workers are advised to use ear protection in the form of earmuff. While for the convenience in lecture activities, it is recommended to relocate the Marble Production Unit far away from education area.

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