

DIFFERENCES IN THICKNESS VARIATION OF ABSORBING MEDIA FROM PATCHWORK AND PLYWOOD WASTE ON NOISE INTENSITY REDUCTION

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Article Info

Article history:

Received July 21, 2022

Revised June 25, 2024

Accepted July 28, 2024

Keywords:

Noise

Reducer

Patchwork

Plywood

ABSTRACT

Differences in Thickness Variation of Absorbing Media from Patchwork and Plywood Waste on Noise Intensity Reduction.

Noise is one of the most dangerous factors in the work environment, so it is essential to control it. This study aims to determine the variation in the thickness of the damping medium from patchwork and plywood waste, with a focus on reducing the intensity of noise in yarn cutting machines. This study employs an experimental pretest-posttest design without a control group. population comprises all noise sources present in the production room of PT Trisula Textile Industries. The yarn-cutting machine with the highest noise is the sample used in this study. The sampling technique is purposive sampling. The test was carried out on 36 noise, temperature, and humidity measurement results. The results of noise intensity measurements before treatment ranged from 97.26–97.43 dBA. After applying variance 1 dampers, the average noise intensity decreased by 5.66%, variation 2 by 8.89%, and variation 3 by 11.89%. The one-way ANOVA test shows a p value of 0.0001 or < 0.05. According to the decision rules, it means that there is a difference in each thickness variation has a difference. When applied in areas with high noise levels, industries can use thicker plywood boards and install wheels on the dampers so that the tools can be used practically. Researchers can then use different types of damping media and thicker patchwork variations.

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INTRODUCTION

Noise is one of the most dangerous factors in the work environment, so it is essential to control it ⁽¹⁾. Hearing loss is the leading cause of disability globally, with a total of 466 million people experiencing it. Noise exposure in developing countries has functional, social, emotional, and economic impacts on industrial workers ⁽²⁾. Noise, whether it is present for a short time or for a long time, is the cause of healthThe occurrence of hearing loss must be considered in terms of three aspects of noise waves, namely frequency, intensity, and time ⁽⁴⁾.

Workers who are exposed to noise for a certain time will experience physical and psychological disorders. The impact of noise on the environment primarily manifests as disturbing noise pollution from various sound sources. Noise impacts health by causing psychological disorders such as discomfort, difficulty concentrating, difficulty sleeping, and irritability. Prolonged exposure to noise can lead to psychosomatic diseases such as gastritis, heart disease, stress, and fatigue ⁽⁵⁾. When physically stressed, noise can cause permanent or temporary ear damage, as well as emotional stress, irritability, and insomnia ⁽⁶⁾. Noise not

only negatively affects the hearing system, but also disrupts the vestibular system, increases blood pressure, increases heart rate, disrupts sleep, is associated with work-related stress, and causes fatigue when working in noisy environments ⁽⁷⁾.

Previous research has shown The reduction in noise intensity with patchwork media reached 5.79%. Noise intensity dropped from 89.7 dB to 84.5 dB (5.2 dB) ⁽⁸⁾. Other research using 3 cm foam media and different types of 3 cm, 6 cm, and 9 cm patchwork was able to lower noise by 7.04% to 8.51%, 11.39% to 13.29%, and 14.44% to 15.68%, respectively, which is a drop of 12.89 dB to 14.19 dB ⁽⁹⁾. The research uses absorbent materials from carpets, plywood, and glasswool to reduce noise intensity by 33.29 dB, or 31.3% ⁽¹⁰⁾. The research uses the medium Plywood 4 mm, which can reduce noise by ± 8.5 dB ⁽¹¹⁾.

PT Trisula Textile Industries is an industry that produces finished fabrics from modern polyester fibre and polyester rayon blends. The Texturising Department's production process involves processing filament yarns in a machine, leaving behind unused yarn that is then cut in the Cutting Waste room. The yarn cutting machine cuts the yarn using hot steam and wind, causing noise. According to the measurement results, the average noise in the waste cutting room, especially in the yarn cutting machine, is 97.70 dBA at point 1, 97.90 dBA at point 2, and 97.40 dBA at point 3.

According to the Regulation of the Minister of Health Number 70 of 2016 concerning Health Standards and Industrial Work Environment Requirements, the noise NAV is 85 dBA ⁽¹²⁾. Thus, the intensity of the noise in the space cutting waste on the engine cutting yarn exceeds CASH. Researchers use patchwork waste as a medium to reduce noise intensity, utilizing three thickness variations: 4 cm, 8 cm, and 12 cm, while the outer layer is made of 9 mm plywood.

MATERIALS AND RESEARCH METHODS

This study's design is pretest-posttest, with no control. This study compares the decrease in noise intensity before and after the treatment, namely with the variation in the thickness of the media from patchwork and Plywood with a thickness of 4 cm, 8 cm, and 12 cm and Plywood 9 mm. Measurements were carried out 36 times. Noise intensity measurements were carried out at PT Trisula Textile Industries, which is located on Jalan Mahar Martanegara No. 170, RT 001, RW 012, Baros Village, Central Cimahi District, Cimahi City, West Java 40521, Indonesia. The sampling will take place at the cutting waste facility of PT Trisula Textile Industries in May 2023. The primary data is derived from the results of noise intensity measurements conducted on the engine cutting yarn in the cutting waste area, while the secondary data pertains to the number of production rooms equipped with noisy machines. Six noise measurements were conducted on the variation in fabric thickness: plywood: 9 mm: 4 cm, 9 mm: 8 cm, and 9 mm: 12 cm. Referring to the National Standardisation Agency in 2017 ⁽¹³⁾, the noise measurement point is adjusted to the type of zone to be measured, namely near the industrial boundary with other areas or in the industrial environment where the noise level is measured, and preferably near residential areas. Measurement tools are The sound level meter The microphone used has been calibrated and meets the requirements of national or international standards by pointing the microphone vertically; the microphone height is 1.2–1.5 meters from the floor, and measurements are taken in accordance with SNI 7231:2009 ⁽¹⁴⁾. Noise measurements were made for 10 minutes and recorded every 5 seconds in dBA units. We analyzed the data using both univariate and bivariate methods (one-way Anova test and post-hoc test).

RESEARCH RESULTS AND DISCUSSION

Temperature measurements were carried out before and after the installation of the damper in the yarn cutting machine area with the following results:

Table 1. Air Temperature Before and After Treatment in the *Yarn Cutting Machine area* of PT Trisula Textile Industries

Repetition	Thickness Media Variations					
	9 mm: 4 cm (°C)		9 mm : 8 cm (°C)		9 mm : 12 cm (°C)	
	Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-Test	Post-Test
1	27,8	28,4	27,8	28,2	27,9	29,7
2	27,9	28,3	28,1	28,1	27,8	28,8
3	28,0	28,3	28,4	28,1	27,7	28,4
4	27,7	28,0	28,2	28,0	28,3	29,0
5	28,1	28,2	27,9	28,0	28,3	29,2
6	28,2	28,2	27,7	28,2	28,3	29,5
Min.	27,7	28	27,7	28	27,7	28,4
Max.	28,2	28,4	28,4	28,2	28,3	29,7

The air temperature before installing the noise suppressor ranges from 27.7oC to 28.4oC, while after installing the silencer ranges from 28.2 °C to 29.7 °C.

Moisture measurements were also carried out before and after the installation of the damper in the yarn cutting machine area with the following results:

Table 2. Air humidity before and after treatment in the *Yarn Cutting Machine Area* of PT Trisula *Textile Industries*

Repetition	Thickness Media Variations					
	9 mm: 4 cm (%)		9 mm : 8 cm (%)		9 mm : 12 cm (%)	
	Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-Test	Post-Test
1	64	65	60	63	55	50
2	64	65	63	64	53	48
3	64	64	63	64	53	48
4	63	64	63	63	53	55
5	63	64	64	64	55	55
6	63	65	64	64	55	53
Min.	63	64	60	63	53	48
Max.	64	65	64	64	55	55

The air humidity before the noise suppression is installed ranges from 53% to 64%, while after the noise cancellation is installed ranges from 48% to 65%.

Furthermore, the results of noise measurements before and after installing the silencer are presented in table 3.

Table 3. Noise Intensity Before and After Reducing Waste in the *Waste Cutting Room* on *Yarn Cutting Machines* in 2023

Repetition	Thickness Media Variations					
	9 mm: 4 cm (dB)		9 mm : 8 cm (dB)		9 mm : 12 cm (dB)	
	Pre-Test	Post-Test	Pre-Test	Post-Test	Pre-Test	Post-Test
1	97,30	91,80	97,27	88,63	97,31	85,71
2	97,43	91,83	97,26	88,68	97,28	85,73
3	97,40	91,87	97,32	88,60	97,33	85,78
4	97,33	91,85	97,33	88,65	97,29	85,74
5	97,28	91,84	97,27	88,67	97,34	85,76
6	97,29	91,81	97,28	88,62	97,32	85,72
Min.	97,28	91,80	97,26	88,60	97,28	85,71
Max.	97,43	91,87	97,33	88,68	97,34	85,78
Average	97,34	91,83	97,29	88,64	97,31	85,74

The thickness of the 9 mm:4 cm damping medium is able to reduce the noise from 97.34 dB to 91.83 dB. The thickness of the 9 mm : 8 cm damping media is able to reduce the noise from 97.29 dB to 88.64 dB, The thickness of the 9 mm : 12 cm damping media is able to reduce the noise from 97.31 dB to 85.74 dB. Thus, the damping media from patchwork and plywood with the three variations above has not been able to reduce noise to meet the threshold value according to the Regulation of the Minister of Health Number 70 of 2017 for Noise NAV, which is 85 dB/8 working hours.

Furthermore, the results of univariate analysis of each noise value due to treatment using a damper can be seen in table 4.

Table 4. Univariate Test of Noise Intensity Reduction

Variable	N	Mean	Min.	Max.	Standard Deviation
Thickness Variation 9 mm : 4 cm	6	5,5050	5,44	5,60	0,05505
Thickness Variation 9 mm : 8 cm	6	8,6467	8,58	8,72	0,05164
Thickness Variation 9 mm : 12 cm	6	11,5717	11,55	11,60	0,02483

Table 4 shows that the thicker the patchwork used, the greater the noise that can be suppressed. The mean noise reduction resulting from the three treatment variations was 5.50 dB (± 0.055 dB), 8.65 dB (± 0.051 dB), and 11.57 dB (± 0.024 dB).

Bivariate analysis to see the significance of the difference in each treatment is presented in table 5.

Table 5. Anova Noise Intensity Test on *PT Trisula Textile Industries Yarn Cutting Machine*

	df	F	P Value
Differences in media variations in reducers from patchwork and plywood to reduce noise intensity	2	26244,522	0,0001

Table 5 shows a *p-value* of 0.0001 or $< \alpha$ (0.05) so H_0 was rejected. Thus, it was concluded that there was a difference in the decrease of the three treatments.

Table 6. *LSD Post Hoc* Test Noise Intensity Reduction at Noise Sources

(J) Medium Thickness	(J) Medium Thickness	Mean Difference (I-J)	P Value
4	8	-3,14167*	0,0001
	12	-6,06667*	0,0001
8	4	3,14167*	0,0001
	12	-2,92500*	0,0001
12	4	6,06667*	0,0001
	8	2,92500*	0,0001

The results of the post-hoc test showed a *p-value* of 0.0001 or below α , which means that the average noise reduction of the three treatment variations was different from each other.

The tolerated temperature ranges from -10 oC to 50 oC (SNI 7231:2009). If the temperature in the room drops, the relative humidity will rise, and if the temperature rises, the relative humidity will fall. According to Mukono (2000), indoor humidity is one of the factors that affect room temperature ⁽¹⁵⁾.

The level of humidity tolerated in the work environment is up to 90%. Humidity does not affect the results of noise intensity measurements (SNI 7231:2009). Changes in humidity are caused by a variety of factors. The high and low humidity are influenced by several factors, including temperature, air pressure, wind movement, the amount and quality of irradiation, and vegetation all influence high and low humidity ⁽¹⁶⁾.

Changes in temperature and humidity after passing through a damper can occur because an object's temperature determines its ability to transfer or receive heat from one object to another ⁽¹⁷⁾. Heat transfer is the transfer of energy from one area to another as a result of the temperature difference between these areas, from a higher fluid to a fluid that has a lower temperature. When an object with a high temperature is placed in a room with a lower temperature, the object's temperature will drop to match the room temperature ⁽¹⁸⁾.

The noise intensity produced by the machine cutting yarn ranges from 97.26 dB to 97.43 dB. High levels of noise cause stress that activates the sympathetic nervous system, throws off the balance of the endocrine and immune systems, and ultimately causes vascular dysfunction. Stress hormones, oxidative stress, and pro-inflammatory mediators cause tissue damage ⁽¹⁹⁾. High noise intensity ⁽²⁰⁾ will have an impact on health. It was explained that out of a total of 55 respondents, it was known that as many as 35 respondents (63.66%) experienced hearing loss due to prolonged and continuous exposure to noise, which caused work stress. According to the study, 25 out of 32 respondents who were exposed to noise

that exceeded NAV experienced hearing complaints. Of the 25 respondents, as many as 11 experienced hearing loss, which also interfered with their work activities. ⁽²¹⁾.

Noise risk control can be done through engineering control, namely installing noise suppression devices with damping media made from patchwork waste and plywood. Plywood and patchwork are two examples of noise-absorbing materials. The absorption mechanism occurs through the porous material, and then the absorbed energy is converted into heat due to friction between the sound waves and the porous cell wall ⁽¹⁾. This becomes a foundation Researchers use patchwork media to reduce noise. The patchwork media effectively reduces noise by 5.79%, reducing it from 89.7 dB to 84.5 dB (5.2 dB). Researchers also used additional media to lower the noise intensity. This is in accordance with the research on damping materials using carpets, plywood, and glasswool, which can reduce noise by 33.29 dB, or 31.3% ⁽¹⁰⁾.

The damper in this study is constructed from plywood and patchwork waste, varying in thickness. The noise cancellation device consists of four sides measuring 98 x 94 x 85 cm with iron supports and a height of 63 cm. The addition of damping media from patchwork and plywood waste with various variations has been proven to be able to reduce noise in yarn cutting machines, both on plywood with a thickness of 9 mm. The addition of damping media from patchwork and plywood waste with various variations has been proven to be able to reduce noise in yarn cutting machines, both on plywood with a thickness of 9 mm (4 cm), 9 mm (8 cm), or 9 mm (12 cm). The addition of damping media from patchwork and plywood waste with various variations has been proven to be able to reduce noise in yarn cutting machines, both on plywood with a thickness of 9 mm (4 cm), 9 mm (8 cm), or 9 mm (12 cm), even though the results have not met the NAV.

The sound absorption efficiency of a material at a given frequency is expressed by the sound absorption coefficient ⁽²²⁾. The surface either absorbs or does not reflect the coefficient of sound absorption. Some of the factors that affect the process of reducing noise intensity by mufflers include the number, size and type of material, time density, and surface impedance ⁽²³⁾.

Statistically, the decrease in noise intensity due to treatment variations differed significantly from each other. This means that the thickness of the media has a meaningful impact on reducing noise. A study utilizing fabric waste media from the production process with thickness variations of 10 cm, 15 cm, and 20 cm was able to reduce noise by up to 12.33%. The 20-cm media thickness lowers the noise from 87.80 dB to 77.01 dB by 10.79 dB ⁽²⁴⁾.

Addition plywood The noise suppressor is a barrier or inhibitor that functions to reflect sound waves. Media usage plywood 4 mm can reduce noise by ± 8.5 dB ⁽¹¹⁾. The selection of plywood as a media is based on research results that indicate it is heat-resistant, ergonomic, and resistant to cracking ⁽¹⁰⁾. Plywood also has a large mass, making it able to reduce vibration propagation ⁽²⁵⁾.

CONCLUSIONS AND RECOMMENDATIONS

The average reduction in noise intensity in yarn cutting machines before and after treatment with 9 mm plywood absorbing media (4 cm) was 5.55 dB, 8.64 dB, and 11.57 dB, respectively. Each treatment variation showed a significant difference, with a p-value of 0.0001 or less for each of the 9 mm, 8 cm, and 12 cm measurements. This indicates that a thicker media can reduce noise more effectively, despite the results not being able to reduce noise below the noise-attenuation threshold (NAV). The next suggestion for researchers is to use a variety of thicker patchwork and plywood and pay attention to the density of the time in the media so that there is no gap for air to enter the damping medium.

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