

# SOUND PROOFING PANEL MADE FROM PATCHWORK AND GYPSUM AS A GREEN MATERIAL INNOVATION

**Centaury Harjani<sup>1</sup>, Patricia P. Noviandri<sup>2</sup>**

<sup>1</sup>. Product Design, Faculty of Architecture and Design, Duta Wacana Christian University, Jl. Wahidin Sudirohusodo 5-25, Yogyakarta, Indonesia

<sup>2</sup>. Architecture, Faculty of Architecture and Design, Duta Wacana Christian University, Jl. Wahidin Sudirohusodo 5-25, Yogyakarta, Indonesia

Email: centaury\_h@staff.ukdw.ac.id

## **Abstract**

Jogjakarta as a student city and tourism has become a target for investors to invest their capital. Hotels, housing, apartments, shop houses, malls, and many other new buildings were built in Jogjakarta. One effort to support the environmental-friendly building movement is to develop new materials that can support environmentally friendly development itself. Composite materials with silencer properties can be considered to be developed into building materials. Composites that use industrial waste materials are one of the innovations in building materials. At present, the garment industry in Indonesia leaves traces of patchwork waste that is stacked/ignored. Fabrics are materials that have sound muffling capabilities. The character of the fabric that is capable of absorbing the fabric of patchwork can be processed into sound absorption material. This article compares the dampening effect between patchwork panels and patchwork composites. Patchwork experiments are used to be processed and developed into building materials that can reduce indoor noise. The results of this study are patchwork material which is arranged in layers and is considered capable of reducing noise and is a green material alternative.

**Keywords:** absorption material, green building material, patchwork composite

## **Abstrak**

**Judul:** *Panel Peredam Suara yang Terbuat dari Kain Perca dan Gypsum sebagai Inovasi Material Hijau*

*Jogjakarta sebagai kota pelajar dan pariwisata telah menjadi target bagi investor untuk menanamkan modalnya. Hotel, perumahan, apartemen, ruko, mal, dan banyak bangunan baru lainnya dibangun di Jogjakarta. Salah satu upaya untuk mendukung gerakan bangunan ramah lingkungan mengembangkan bahan baru yang dapat mendukung pembangunan yang ramah lingkungan itu sendiri. Bahan komposit dengan sifat peredam dapat dianggap dikembangkan menjadi bahan bangunan. Komposit yang menggunakan bahan limbah industri menjadi salah satu inovasi dalam material bangunan. Saat ini, industri garmen di Indonesia meninggalkan sisa-sisa sampah berupakain perca yang ditumpuk / diabaikan. Kain merupakan material yang memiliki kemampuan meredam suara. Karakter bahan kain yang mampu absorb suaramembuat kain perca dapat diproses menjadi material absorpsi suara. Artikel ini membandingkan efek peredam antara panel kain perca dan komposit kain perca. Percobaan kain perca digunakan untuk diproses dan dikembangkan menjadi bahan bangunan yang dapat mengurangi kebisingan dalam ruangan. Hasil penelitian ini yaitu material kain perca yang disusun secara layer dinilai mampu mereduksi suara bising dan merupakan alternatif green material.*

**Kata kunci:** *efek peredam, bahan bangunan hijau, komposit kain perca*

## Introduction

Green material is all about environmentally friendly. “It focuses on single issues, for example the inclusion of recycled or recyclable plastic, or consideration of energy consumption”, based on Tracy Bhamra and Vicky Lofthouse (2007).

Green product start its fame in the late of 1980 because there were many human that relize about the benefit from green/natural product. It is keep grow until now, because the awareness about environment.

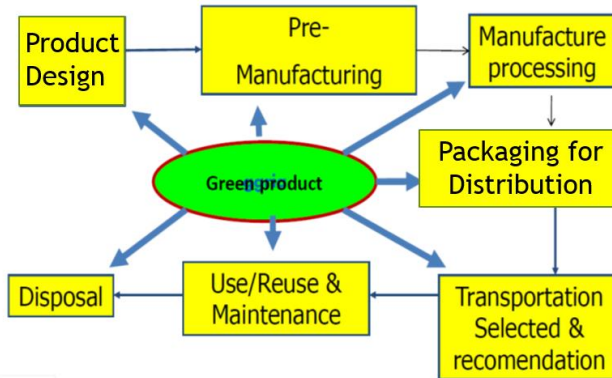


**Figure 1. Timeline of key events in green product consumerism from 1980 to 2010**

Source: Air Quality Sciences, 2010.

A product is called a green product if it fulfills a material life cycle. There are product elements that can be categorized as included in the green product:

1. Product Design, every product that is made has been planned well starting from the design concept, manufacturing process, and waste management.
2. Manufacturing Process, consists of pre-manufacturing, manufacture process, and packaging. In this process a product is called a green product if it does not consume a lot of energy (electricity and water).
3. Distribution, distribution of products that are green if the mode of transportation does not use too many different transportation modes. If too much material selection contributes to air and energy pollution, the product cannot be considered a green product.
4. Disposal, waste produced by green products can be reprocessed either into new material (recycle) or the same material is reused (reuse).

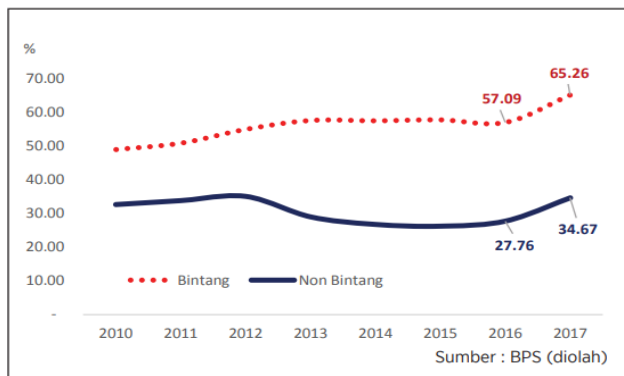


**Figure 2. Life Cycle Analysis**

Source: Presentation Materials of GBC Indonesia, 2018

There are many pollution in this earth, our environment start being polluted. One of the reason is because of the using of new material that cannot be renewed. Recycle is one of the solution in order to reduce the using of new material. Utilization of any waste material from industry, such as fabric patchwork, can be the alternative.

There is large amount of this patchwork that can be used for green environmentally products. One among of them is interior product, ie noise reduction panel. Interior product become one of the choice because there is enhancement in the construction project, for example is the grow up of hotel construction. There is a significant accretion in the rates of Hotel occupancy in DIY like in this figure.



**Figure 3. Development Rates of Hotel Occupancy in DIY**

Source: Regional Economic and Financial Studies of the Special Region of Yogyakarta, 2017.

The figure show that in 2018 rates of Hotel occupancy increase about 8% than in 2017. This is one reason why hotels grow up in Yogyakarta, and it need's about product interior also grow up. It is indicates that many people (tourist) are coming to Jogjakarta, so the noise in this city should increase. Because of that in this paper will compare two kind of the way processing recycle fabric patchwork into material that can reduce the noise.

## Methodology

Denim and drill fabric patchwork (from garment industry in Jogjakarta) were used as the material in this research. Literature study and material experiment were used to find the comparison result. Compare both of material between composite material from fabric patchwork with layering and tube/rolling fabric. The biggest hope in this recycle material is it can be used for home decoration and reduce the amount of the fabric patchwork waste in our environment.



**Figure 4. Composite Fabric with gypsum – Layering Fabric – Tube/Rolling Fabric**

Source: Author, 2017, 2018

In the making of the composite, fabric that already cutted, gypsum and water as the adhesive, were used in the making of the panel and the composition will be describe in this table below:

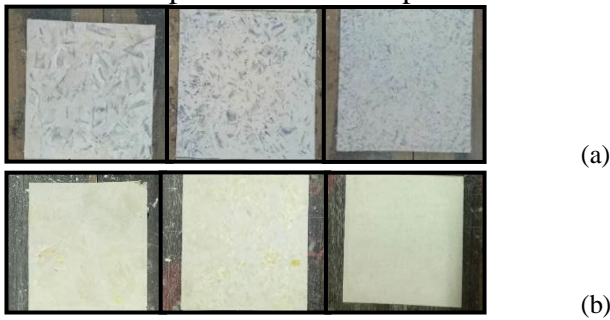
**Table 1. Composition of the Fabric Composite**

Scale 1 : 1 : 1	Gypsum	Water	Fabric
amount	266gr	266gr	266gr

Source : author, 2018

There are three size of the cutted fabric i.e.  $\pm 1150 \text{ mm}^2$  (large),  $\pm 200 \text{ mm}^2$  (medium), and  $\pm 45 \text{ mm}^2$  (small); so there will be three variant of each fabric composition, such as: composite gypsum with denim (large), composite gypsum with denim (medium), composite gypsum with denim (small), composite gypsum with drill (large), composite gypsum with drill (medium), and composite gypsum with drill (small).

Here are the picture of the composite:



**Figure 5. Patchwork Composite (a) Denim Fabric Composite with Gypsum, (b) Drill Fabric Composite with Gypsum**

Source: Author, 2018

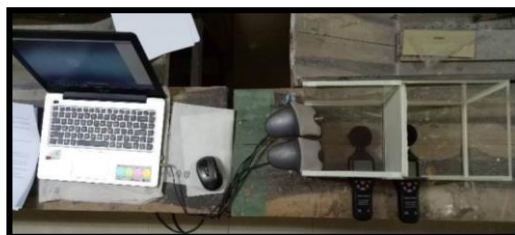
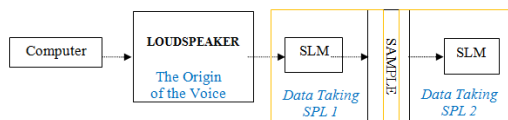
The second one, is layering and tube/rolling fabric. This panel uses the same material as the fabric composite. There are two kinds of fabric layering, namely layering with denim and layering with drill. Fabric tube/rolling is same as the layering denim, we make two kinds of fabric tube/rolling with denim and drill.



**Figure 6. Patchwork Panels (a) Layering Denim and Drill, (b) Tube / Rolling Denim and Drill**

Source: Author, 2017

The samples will be tested with the same way, in order to get the noise reduction that can be compared. All the sample of the panel will be test with this scheme:



**Figure 6. Testing Method**

Source: Author, 2018

## Results and Discussion

There are five frequency (125 Hz, 250 Hz, 500 Hz, 1000 Hz, and 2000 Hz) that being tested. The result of the noise reduction from all samples can be seen at Table 2.

**Table 2. Noise Reduction of Material Samples (dB)**

Sample	125	250	500	1000	2000
Gypsum + Drill (Small)	6.4	12.3	12.2	2.4	11.5
Gypsum + Drill (Medium)	5.3	8.5	11.1	2.0	13.7
Gypsum + Drill (large)	6.1	9.2	10.8	1.9	11.3
Gypsum + Denim (small)	5.9	8.4	12.3	2.5	12.3
Gypsum + Denim (medium)	4.5	11.3	11.2	1.8	12.4
Gypsum + Denim (large)	8.6	11.6	11.2	2.8	12.7
Tube / Rolling Denim	11.9	6.0	12.8	12.1	9.4
Tube / Rolling Drill	10.3	7.2	11.3	15.0	7.0
Layering Denim	12.5	8.3	12.6	16.3	9.9
Layering Drill	9.1	6.3	8.9	10.1	4.4

Source : Author analysis, 2018

There are ten samples compared for noise reduction material and here are the result:

**Table 3. Result of the Highest Noise Reduction in Each Frequency**

Frequency (Hz)	NR (dB)	Sample
125	12.5	Layering Denim
250	12.3	Gypsum+Denim (Small)
500	13.7	Tube / Rolling Denim
1000	16.3	Layering Denim
2000	13.7	Gypsum+Drill (Medium)

Source : Author analysis, 2018

Table 3 describe about the highest noise reduction every frequencies as the result of comparison. Gypsum and Drill with small size can reduce noise until 12.3 dB in 250Hz frequency. Tube / Rolling Denim can reduce noise until 13.7 dB in 500Hz frequency, and Layering Denim can reduce noise from frequencies 125 Hz as big as 12.5 dB and for 1000 Hz as big as 16.3 dB. Gypsum and Drill in medium size can reduce noise until 13.7 dB in 2000Hz frequency.

The comparisson of noise reduction average from each sample (table 4). The highest noise reduction, in the first rank is the sample of layering from denim, sample tube/rolling from denim in the second rank, and sample tube/rolling from drill in the third rank. All of them have noise reduction above 10 dB. The three samples which have higher noise reduction are samples with patchwork panel types. This means that compared to patchwork compocites, patchwork panels especially layering are more effective at reducing noise.

**Table 4. Rank Of The Sample Based On The Average Of Noise Reduction (NR)**

Sample	Average	Rank
Gypsum + Drill (Small)	9.0	5
Gypsum + Drill (Medium)	8.1	8
Gypsum + Drill (large)	7.9	10
Gypsum + Denim (small)	8.3	6
Gypsum + Denim (medium)	8.2	7
Gypsum + Denim (large)	9.4	4
Tube / Rolling Denim	10.5	2
Tube / Rolling Drill	10.2	3
Layering Denim	11.9	1
Layering Drill	8.0	9

Source : Author analysis, 2018

The three types of samples that have a high noise reduction level are analyzed about the green products criteria. The criteria for material that is a green product are seen in the effective design angle, manufacturing process, distribution process, and the presence of additional waste. Of the three samples can be analyzed related only three criteria. In this study, the panel distribution process is unknown. This is because the panels are made in sample size.

Layering Denim has a design that is easy to make, no need to cut it. Layering denim design concept shows aesthetics through an easy and effective way to reduce sound. In terms of manufacturing, denim layering is done in a relatively fast time. How to cut and fold for one 25x25 cm panel does not take more than half an hour. In terms of the amount of waste produced, in the denim layering the waste produced is small. This is because there is no need to cut the shape anymore. The patchwork shape can be used directly as a panel material. The use of fabric waste is more needed for this model panel so that in the aspect of waste utilization, denim layering is the best waste user among the three samples.

In the Tube / Rolling Denim and drill samples, the concept seen from an aesthetic angle is very interesting because it can be made into certain patterns. However, in the manufacturing process it takes a long time. Tube / Rolling made from denim requires more time than a drill because it often has to be done repeatedly so that the results obtained are neater. On the criteria for waste from production, the type of tube / rolling has more residual waste in the form of small pieces. This is due to the manufacturing process, the fabric waste is cut into smaller sizes that make it easy to roll. While on the use side of the material both tube / rolling samples use less fabric waste than the layering panel.

**Table 5. Comparisson of Green Product Criteria**

Sample	Design	Manufacture	Disposal
Layering Denim	Easy	Fast	Few, need many fabric waste
Tube / Rolling Denim	Hard	Slow and often repeated	Lots of leftover, few fabric waste
Tube / Rolling Drill	Hard	Need time	Lots of leftover, few fabric waste

Source : Author analysis, 2018

## INTERNATIONAL PROCEEDINGS

LOCAL GENIUSES GENERATE FUTURE DESIGN, 16-17 November 2018

Layering denim is a material that effectively absorbs noise and can be an alternative to new products on the green label. Aside from being a noise reducing panel, layering denim panels can be a space divider with aspects of beauty for interior spaces in today's modern buildings. People who have a concern about green material can choose this alternative material as an alternative material for noise reduction panels in residential / interior scale.

## Conclusion

Composite from gypsum and large drill is the most ineffective panel in reduce the noise and layering from denim is the most effective panel in reduce the noise (frequency 125 Hz, 250 Hz, 500 Hz, 1000 Hz, and 2000 Hz). The density of the panel is not significant reducing the noise. The best technique in recycling fabric patchwork as a green material innovation for reduce noise is layering.

## Acknowledgements

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For further research can research about:

- the chemical and healthy aspect on the material, check about the recycle material is it safe or not for housing.
- the differences between the origin panel with the development panel, check what the superiority of the panel.

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