

The effect of rice straw fiber addition as sound silencer and its effect to concrete mechanical properties

Rahmi Karolina*, Raisa Muharrisa**, M.A.P. Handana

Department of Civil Engineering, Universitas Sumatera Utara, Jl. Perpustakaan
No. 1 Kampus USU Medan

*rachmie_caroline@yahoo.co.id, **raisamuharrisa@rocketmail.com

Abstract. In general, rice straw has not been used optimally, rice straw is currently still used as animal feed, paper-making materials and most of it is burned. In this research, rice straw is used as an added ingredient in the concrete mixture. The addition of rice straw fiber in this research uses 0%, 5%, 10%, 15%, and 20% variations of the volume. The addition of the straw fiber affects the concrete strength. In slump test, there is an increase in its values by 8, 10, 10, 10, and 1. In compressive strength test, there is a decrease by 70.76%, 68.61%, 54.35%, 53.49% of normal concrete. In the tensile strength test, there is a decrease in the concrete tensile strength value by 52.39 kg / cm², 38.31 kg / cm², 35.36 kg / cm², 25.49 kg / cm², 25.42 kg / cm². While on the sound attenuation test, there is an increase on sound absorption coefficient, the greater the variation of rice straw, the higher the sound absorption coefficient value. The relation between concrete strength and sound absorption coefficient shows that the greater the addition of rice straw fiber, the less the strength of concrete while the sound absorption coefficient is greater.

1. Introduction

Straw is a rice stem consisting of stems, shoots, leaf petals, leaves and rich in rough fiber. The content of paraffin, pentos and lignin from straw on moulding with a temperature of 150-250°C can act as an adhesive. The use of mixed straw for walls has the advantage of insulation and is easy to be nailed. (Stainforth, 1979 in Budi, 1991). This research is using rice straw as added material in normal concrete with variations of 0%, 5%, 10%, 15%, and 20% straw fiber to the volume of concrete. This research will test the strength of concrete by using rice straw fiber and without using one. In this research, the study about sound absorption coefficient of each addition of straw fiber will also be carried out. The sound absorption coefficient test is performed by using a frequency of 500 Hz, 1000 Hz, 1500 Hz, and 2000 Hz. Waste of rice straw has not been used effectively. In Indonesia rice straw is a large waste, but it is still used as animal feed and paper making. The straw fiber content is shown in table 1. as follows:

Table 1. The contents of rice straw fiber

Contents of Straw Fiber	
Length of fiber	1.1 - 1.5 mm
Diameter	9 - 13 μ m
Level of selulose	33 - 38 %
Level of lignin	17-19%
Level of pentose	27 - 32 %
Level of ash	6 - 8 %
Rough fiber	29.2%
Silica (SiO ₂) ^b	12 - 16 %

^aIdris dan Nadhiroh, 1976

^bJackson, 1977 dalam Wahyu, 1991

2. Scope of problem

1. Concrete quality of $f'c = 20$ Mpa.
2. The samples used are cylinders with 15 cm diameter and 30 cm height for compressive and tensile test.
3. Samples used for noise test have 11.2 cm diameter and 2 cm height.
4. Test : compressive strength, tensile strength and noise / silencer.
5. Silencer test are using 500 Hz, 1000 Hz, 1500Hz, and 2000 Hz frequencies.
6. The additional material for making concrete consists of short straw fiber with a size of about 3 cm. The fiber composition used in each samples are 5%, 10%, 15% and 20%.

3. Objectives

The objectives of this research are :

1. To know and to utilize agricultural waste, in this case, rice straw as a filler material in concrete against compressive strength, and tensile strength of concrete.
2. To know the difference in compressive strength and tensile strength and sound silencer of normal concrete with concrete added with rice straw fiber.

4. Research methods

The method used in this research is experimental tests in the laboratory. The characteristics of the material used are as follows:

4.1. Rice straw

Rice straw used is a post-harvest rice stem. The rice straw used in this research is dry straw. The cutting method of this rice straw fiber is done manually. Straw cutting is done to make straw with long fiber and short fiber, straw cutting is done by using a knife or sickle. The size of straw fiber cutting is about 3 cm.

4.2. Samples

In this research, the samples are cylindrical with a size of 15 cm diameter and 30 cm height. For noise test, samples used are with the size of 2 cm thickness and 11.2 cm diameter. Tests are carried out after the concrete reaches 28 days curing. Variations in straw fiber and the number of samples used can be seen in table 2.

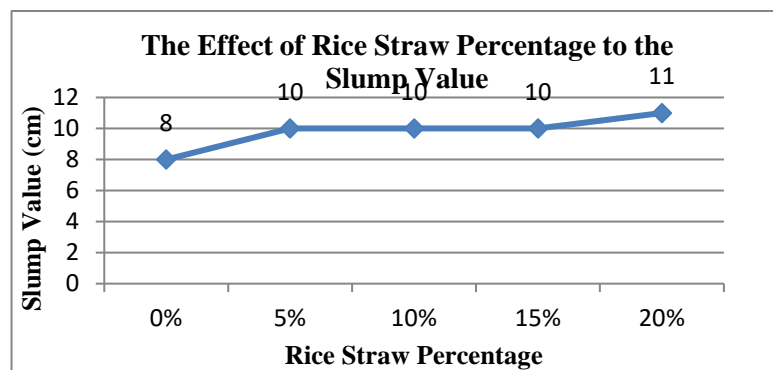
Table 2. Number of samples

Cement water Factor	Variations of Rice Straw Fiber Addition	Number of Samples			Amount
		Compressive $\phi 15 \times 30$ (cm)	Split Tensile $\phi 15 \times 30$ (cm)	Noise $\phi 11,2 \times 2$ (cm)	
0,5	Normal concrete	5	5	4	14
0,5	5%	5	5	4	14
0,5	10%	5	5	4	14
0,5	15%	5	5	4	14
0,5	20%	5	5	4	14
$\Sigma =$					70

5. Results and discussion

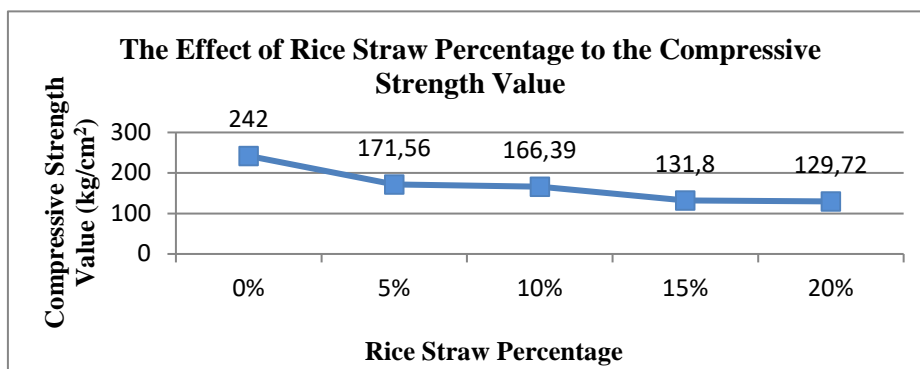
5.1. Slump

The slump value is always associated with the workability of concrete, this is influenced by several factors, i.e. the gradation and shape of the surface, aggregates, cement water factor, air volume on the concrete mixture, characteristics of cement and additional materials.

**Figure 1.** Graph of slump value to rice straw variations

5.2. Compressive strength

The concrete compressive strength test is carried out at 28 days curing which is intended to obtain an overview of the development of concrete compressive strength by using rice straw as additional material and the results are compared with normal concrete.

**Figure 2.** Graph of compressive strength results

From the test results of concrete cylinders at 28 days of curing, it shows that there is a decrease in strength at each increased level of rice straw usage. So that the graph is decreasing along with the addition of rice straw fiber. The highest compressive strength value is in normal concrete which is 242 kg / cm² and the lowest compressive strength is in the addition of 20% rice straw fiber which is 129.72%.

5.3. Split tensile strength

The concrete tensile strength test is carried out at 28 days curing which is intended to obtain an overview of the concrete tensile stress by using rice straw as additional material and the results are compared with normal concrete.

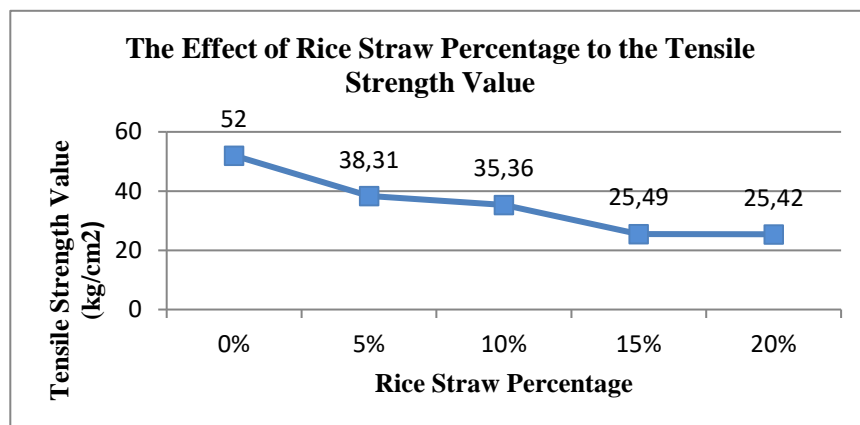


Figure 3. Graph of tensile strength results

From the test results of tensile strength on concrete cylinders at 28 days curing, the results shows that there is a decrease in the tensile stress of the concrete in each percentage addition of rice straw. So that the graph is decreases significantly along with the addition of rice straw. The highest tensile strength is in the percentage of 0% rice straw which is 52 kg / cm², while the lowest tensile strength is in the percentage of 20% rice straw which is 25.42 kg / cm².

5.4. Sound absorption coefficient

In this research, the sound silencer test is carried out by calculating the sound absorption coefficient of the fiber material used, i.e. rice straw fiber with frequencies of 500Hz, 1000Hz, 1500Hz, and 2000Hz.

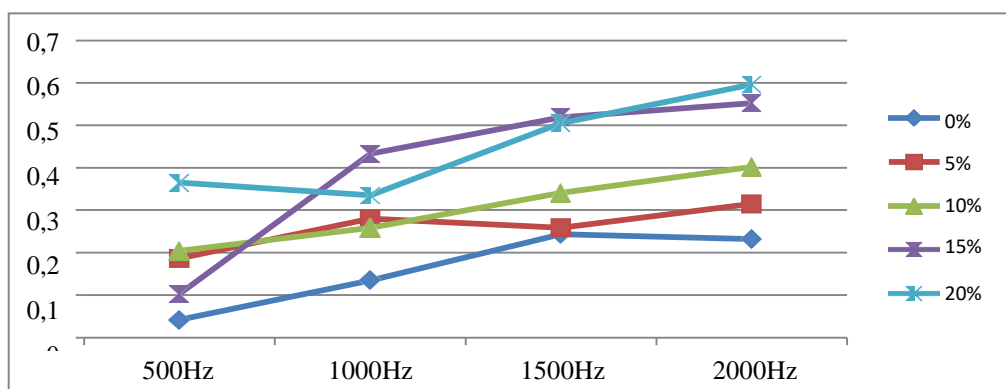


Figure 4. Graph of sound absorption coefficient value with every straw fiber variations to the frequencies

From the graph of sound absorption coefficient value above, it can be seen that there is an increase and decrease in the graph randomly because this test uses lab jack as a sound absorption coefficient test device that causes the sound absorption coefficient value obtained is ineffective. To get the sound absorption coefficient value effectively, using an *Oscilloscope* should be used.

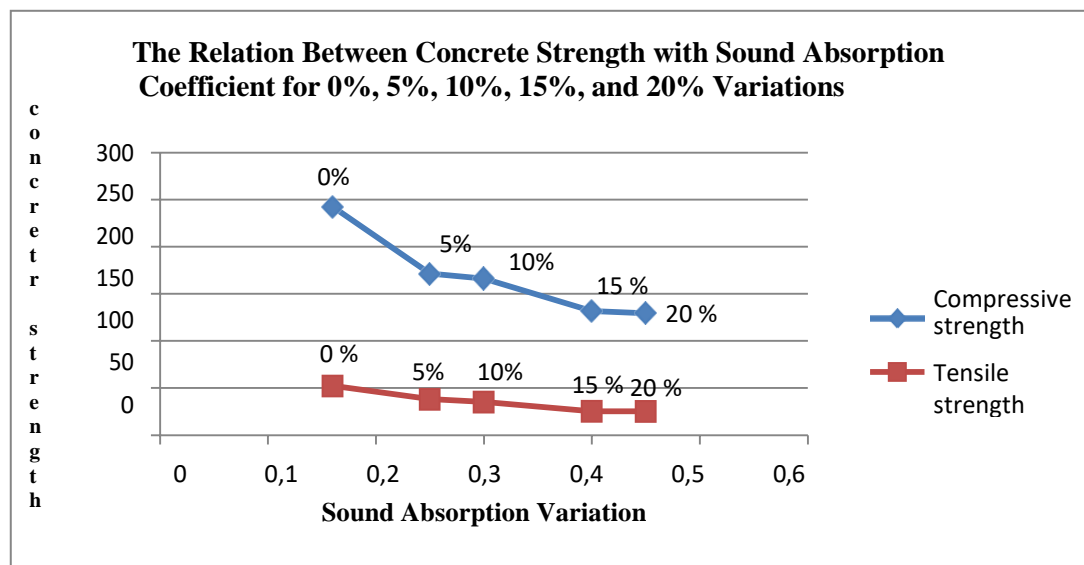


Figure 5. The relation between average concrete strength with average sound absorption coefficient on every rice straw fiber addition

From the graph above, it can be seen that the greater the addition of rice straw fiber, the weaker the strength of the concrete. On the contrary, the greater the addition of straw fiber, the higher the sound absorption coefficient value.

6. Conclusions

1. The addition of rice straw fiber usage to the concrete mixture can increase the slump value in each variation addition.
2. The use of rice straw fiber in concrete mixture with variations addition of 5%, 10%, 15% and 20% of the concrete volume has an impact on the decreasing compressive strength to 70.76%, 68.61%, 54.35%, 53.49% from normal concrete.
3. The tensile strength value obtained shows a graph that decreases in each addition of rice straw variations, i.e. 52.39 kg / cm², 38.31 kg / cm², 35.36 kg / cm², 25.49 kg / cm², 25.42 kg / cm².
4. The sound absorption coefficient value shows a graph that is increasing in each addition of rice straw variations.
5. The graph of the relation between the concrete strength and the sound absorption coefficient shows that the greater the addition of straw fiber, the lower the strength of the concrete. On the contrary, the greater the addition of straw fiber, the higher the coefficient of sound absorption.

7. Reference

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