JICE Journal Innovation of Civil Engineering
Vol. 3, No. 1, pp. 12-18, March 2022
e-ISSN: 2775-5592

POTENTIAL OF CORN HUSK AS A SUBSTITUTE FOR MAKING ENVIRONMENTALLY FRIENDLY BRICK

Anas Choirul Basyar[1], **Meriana Wahyu Nugroho**[2*]

[1,2] Civil Engineering Department, University of Hasyim Asy'ari, Jombang, 61471, Indonesia

e-mail: rian.sipilunhasy@gmail.com

ABSTRACT

Currently, environmentally friendly building materials continue to be developed, one of which is by utilizing corn husks. This research was conducted to determine the quality produced based on the Indonesian National Standard with the experimental design method. Using corn husk as a substitute for brick-making was 5%, 10% and 20%. This research went through 2 stages of testing, namely compressive strength and wear strength. The number of specimens for each variation was 5 for compressive strength and 3 for wear, with 69 specimens. The best test for compressive strength of 7 days is produced by a test object with a percentage of 5% cube, which can produce an average compressive strength of 49.154 kg/cm² and meets the quality standard of SNI 03-0349-1989 class III. the percentage of 5% cube meets the class III quality standard with an average compressive strength value of 57,257 kg/cm². However, the best compressive strength of the brick-shaped test object is produced by the 10% test object that meets the class IV quality standard with an average compressive strength of 30,183 kg/cm². In the wear test, all variations of the bricks did not meet the quality standard of SNI 03-0691-1996.

Keywords: *Brick; Corn Skin; SNI 03-0349-1989; SNI 03-0691-1996; Compressive Strength; Timeworn.*

1. Introduction

Sources of natural fiber that are available and still need to be researched are the use of corn husks that have low economic value and are environmentally friendly [1]. Corn husks can still be used as a product with high selling value. So far, its utilization is mainly used as handicrafts, traditional food wrappers, and animal feed [2], [3]. So far, the existing corn husks have been used in construction and building materials [1], [4-6].

In the construction sector, corn husk can be used as a natural soil stabilizer [4], [6]. In building materials, corn husks are widely used as a building material for sound-absorbing materials [7], [8]. With the development of technology, corn husks can be applied to several types of concrete, such as polymer concrete and lightweight composite concrete. The higher the corn husk, the lower the physical properties, so the polymer concrete becomes lighter, but the water absorption value increases [2], [9].

The utilization of corn husks in construction materials can still be developed. Corn husks still have the potential to be used as building materials such as wall building materials, one of which is brick [2], [8].

2. Material and Methods

Mix design refers to previous research; namely, the percentage of added or substituted materials used is 5%, 10% and 20% [10]. In the experimental reference, the elemental composition of the concrete block plan was mixed using a mixture of 1 cement: 4 sand [11]. The test specimens were

Vol. 3, No. 1, pp. 12-18, March 2022
e-ISSN: 2775-5592

made in bricks with a size of 10x15x30 cm and the form of a cube measuring 15x15x15 cm. Maintenance and testing of the test object include a compressive strength test and a wear test. The compressive strength test is carried out when the specimen's age includes 7 and 28 days. At the same time, the wear test is carried out when the test object is 28 days old. After testing the test object is completed, the results are recorded and documented. The next stage compares the feasibility of the compressive strength test using SNI 03-0349-1989 and the wear test using SNI 03-0691-1996.

Figure 1. Dry corn husk before mashing

Figure 2. Dry corn husk after mashing

Figure 3. The test object is in the form of bricks

Figure 4. Cube-shaped test object

2.1. Research Steps

Data collection is carried out first to determine the design mix and determine the materials and compositions used. Next, prepare materials, mix designs and make test objects with a predetermined amount. The tests applied are compressive strength and wear strength tests. Continue to the next stage with data processing and data analysis so that the final result is a conclusion. The following flowchart of the stages of the research carried out can be seen in Figure 5.

Data collection was carried out first to determine the design mix and the materials and compositions used. Next, prepare materials, mix designs and make test objects with a predetermined amount. The tests applied are compressive strength and wear strength tests. Finally, continue to the next stage with data processing and analysis so that the final result is a conclusion.

2.2. Sample Test

1. Compressive Strength Test
   - The cubes and bricks to be tested are dried first after going through the immersion process and the objects to be tested are 7 and 28 days old.
   - Calculate the compressive strength by using the formula [12]:

$$\text{Compressive Strength} = \frac{P}{A}\,(\text{kg/cm}^2) \qquad (1)$$

Whereas:

P = Maximum Load (N);
A = Surface area of sample (mm²);

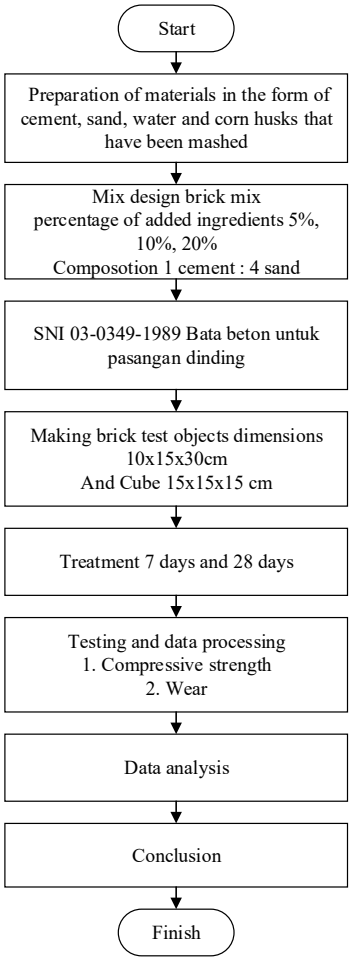

Figure 5. Research Flowchart

2. Timeworn Strength Test
   - The bricks to be tested are dried first after going through the immersion process and the objects to be tested are 28 days old.
   - Calculating the wear strength using the formula [13]:

$$\text{Timeworn} = \frac{A \times 10}{BJ \times I \times w} \text{ mm/min} \qquad (2)$$

Whereas:
A = The difference in weight of sample before and after worn (gram)
BJ = Average density
I = Surface area of worn area (cm²)
W = Timeworn (minutes)

3. Result and Discussion

3.1. Compressive Strength

1. Concrete Bricks Compressive Strength in 7 and 28 days

The samples tested were three variations. Each variation consisted of 5 samples. Therefore, the total samples tested for compressive strength were 60 samples.

Table 1. Concrete Bricks Compressive Strength in 7 and 28 days

Days	Variation	Compressive Strength (f'c) (kg/cm²)					Average
		1	2	3	4	5	
7 Days	5%	23,2	17,1	19,3	15,1	20,4	19,05
	10%	20,3	14,3	16,9	17,7	17,2	17,32
	20%	7,5	7,3	8,8	6,8	7,6	7,64
28 Days	5%	18,7	33,7	36,3	36,1	26,9	28,37
	10%	34,9	25,5	25,3	34,7	30,3	30,18
	20%	15,8	12,9	11,9	12,8	13,9	13,39

Source: Data Analysis, 2021

The compressive strength value resulting from a 5% sample of concrete blocks with a 7-day age test was an average compressive strength value of 19,055 kg/cm². A sample of 10% with testing at the same age obtained an average compressive strength of 17,321 kg/cm². In comparison, the sample of 20% bricks produces an average compressive strength of 7.641 kg/cm². From the three sample variations, there was a decrease in the compressive strength value. The highest average compressive strength value in the form of bricks tested at the age of 7 days was at the composition variation of 5%. The composition of 10%, and the lowest was the composition of 20%. The three variations still do not meet the quality standard of SNI 03-0349-1989.

The compressive strength value of a 5% sample of concrete blocks with a 28-day age test obtained an average value of 28.375 kg/cm². The 10% sample with the test at the same age obtained an average compressive strength value of 30,183 kg/cm². In comparison, the sample of 20% of bricks produces an average compressive strength of 13,392 kg/cm². From the three variations of the sample, there is an increase and then a decrease in the quality produced in contrast to the 3 variations of samples tested at the age of 7 days. Where the highest average compressive strength value in the form of bricks tested at the age of 28 days was at the composition variation of 10%, then the composition was 5%, and the lowest was at the composition of 20%. Therefore, the three variations that meet the quality standard of SNI 03-0349-1989 are variations of 5% and 10%, which are classified as quality IV. When comparing the compressive strength values between samples in the form of bricks aged 7 and 28 days, it can be seen in Figure 6 below:

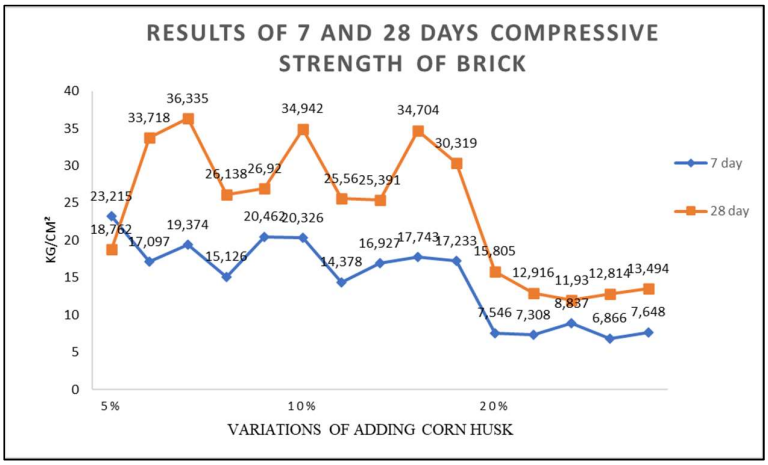

Figure 6. Concrete Bricks Compressive Strength in 7 and 28 days

2. Cubics Compressive Strength in 7 and 28 days

Table 2. Cubics Compressive Strength in 7 and 28 days

Days	Variation	Compressive Strength (f'c) (kg/cm²)					Average
		1	2	3	4	5	
7 Days	5%	39,3	52,2	66,3	42,6	45,1	49,15
	10%	20,1	22,6	24,8	16,9	22,3	21,38
	20%	15,6	8,3	10,4	7,3	19,3	12,23
28 Days	5%	77,4	58,9	60,2	39,5	50,1	57,25
	10%	46,6	34,1	45,5	42,1	50,1	43,70
	20%	17,5	14,8	22,4	21,1	21,5	19,51

Source: Data Analysis, 2021

The compressive strength value obtained by the 5% variation sample tested at 7 days got an average of 49,154 kg/cm². Compared to the previous test in the form of bricks, the results obtained by this cube test object are 2.5 times better. This is because, at the time of making the test object in the form of bricks, it was made with a wooden mold, while the cube-shaped test object was printed with an iron mold. The value of the compressive strength variation of 10% cube when it produces an average value of 21.382 kg/cm², which is 23% better than the brick-shaped test object. In the 20% variation test object, the average compressive strength is 12.236 kg/cm², which is 60% better than the block-shaped test object. Of the 3 variations, the highest compressive strength value was at the 5% variation, then the 10% variation, and the lowest was at the 20% variation.

The value of the compressive strength variation of 5% cube tested at the age of 28 days obtained an average compressive strength of 57.257 kg/cm². This value is two times larger than the test object in the form of bricks and meets the class III quality standard based on SNI 03-0349-1989. Compressive strength variation of 10% cube obtained an average compressive strength of 43,707 kg/cm², where this value is 44% greater than the brick-shaped test object and meets the class IV quality standard based on SNI 03-0349-1989. The value of the compressive strength variation of 20% cube obtained an average of 19,515 kg/cm². Compared to the average compressive strength of the concrete block specimens, the cube specimens were 45% larger but did not meet the quality standard of SNI 03-0349-1989. From the variety of cube specimens tested at 28 days of age, the highest value was obtained by a variation of 5% cube, then 10% cube, and the lowest was 20% cube.

The comparison of the compressive strength of the cube between the ages of 7 days and 28 days can be seen in Figure 7 as follows:

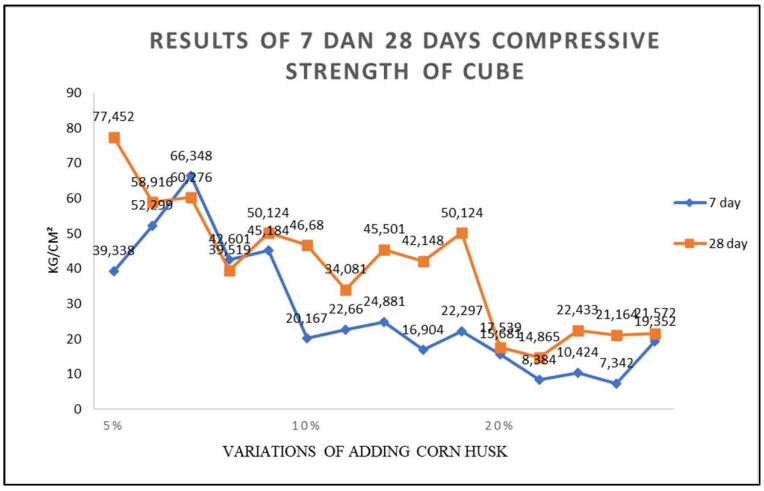

Figure 7. Cubics Compressive Strength in 7 and 28 days

3.2. Timeworn Strength

The worn strength test used a brick-shaped sample with dimensions of 10x15x30 cm. The sample to be tested was 28 days old, with 9 samples tested.

Table 3. Timeworn Strength in 28 Days

Variation	Timeworn Strength (mm/min)			Average
	1	2	3	
5%	0,00147	0,0064	0,0091	0,010
10%	0,0054	0,0032	0,0066	0,005
20%	0,0018	0,0014	0,0028	0,002

Source: Data Analysis, 2021

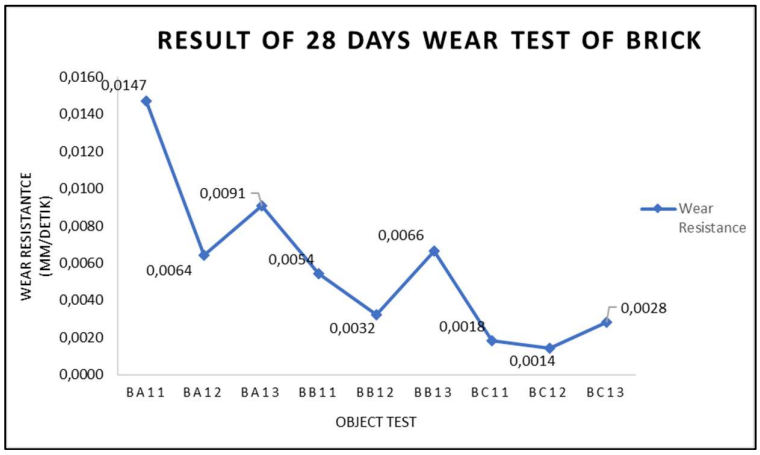

Figure 8. Concrete Bricks Timeworn Strength in 28 days

The test object with a variation of 5% obtained an average wear strength of 0.010 mm/minute. The composition of 10% obtained an average wear strength value of 0.005 mm/minute. The composition of 20% average wear strength value is 0.002 mm/min. From sample variations, the lowest value is on the 2nd test object at a variation of 20% with a wear strength value of 0.0014, and the highest wear is in the 1st test object with a 5% variation with a wear strength value of 0.0147. This value does not meet the wear standard based on SNI 03-0691-1996. The overall wear strength value can be seen in Figure 8.

4. Conclusions

The results of the compressive strength testing that has been carried out, it was found that corn husks as a substitute in making bricks were classified as suitable for use based on SNI 03-0349-1989, which met the quality standards of class III and IV with the best average compressive strength value resulting in a 5% cube test object of 57.257 kg/cm² and 10% brick test object is 30,183 kg/cm². However, the wear strength test did not meet the quality standard of SNI 03-0691-1996, with the lowest average wear value of 0.002 mm/second.

Vol. 3, No. 1, pp. 12-18, March 2022
e-ISSN: 2775-5592

References

[1] N. H. Sari, I. N. G. Wardana, Y. S. Irawan, and E. Siswanto, "The Effect of Sodium Hydroxide on Chemical and Mechanical Properties of Corn Husk Fiber," *Orient. J. Chem.*, vol. 33, no. 6, pp. 3037–3042, 2017.

[2] A. Maghfirah, L. Hakim, and M. Hamid, "Manufacturing and Characterization Process of Polymer Concrete with Aggregate from Pumice Stone and Corn Husk Fiber as a Filler," *J. Technomaterials Phys.*, vol. 1, no. 1, pp. 6–14, 2019.

[3] A. P. Hendriyani and A. Citraningrum, "Pengaruh Pola Pelapis Dinding dari Kulit Jagung Terhadap Penurunan Kebisingan Ruang Kelas (Studi Kasus : SD Negeri Polowijen 1 Malang)," *J. Mhs. Arsit. Univ. Brawijaya*, vol. 6, no. 4, 2018.

[4] N. T. Duong, T. Satomi, and H. Takahashi, "Potential of Corn Husk Fiber For Reinforcing Cemented Soil With High Water Content," *Constr. Build. Mater.*, vol. 271, p. 121848, 2021.

[5] L. Lyu *et al.*, "Sound Absorption Properties of Multi-Layer Structural Composite Materials Based on Waste Corn Husk Fibers," *J. Eng. Fiber. Fabr.*, vol. 15, pp. 1–8, 2020.

[6] K. Q. Tran, T. Satomi, and H. Takahashi, "Improvement of Mechanical Behavior of Cemented Soil Reinforced With Waste Cornsilk Fibers," *Constr. Build. Mater.*, vol. 178, pp. 204–210, 2018.

[7] N. H. Bhingare, S. Prakash, and V. S. Jatti, "A Review on Natural and Waste Material Composite as Acoustic Material," *J. Pre-proof*, p. 106142, 2019.

[8] M. Said L, Nurmin, and S. Zelviani, "Studi Analisis Koefisien Absorbsi Papan Akustik Pada Ketebalan Bervariasi Berbahan Dasar Limbah Kulit Jagung Dan Sabut Kelapa (Solusi Alternatif Ramah Lingkungan)," *J. Fis. dan Ter.*, vol. 7, no. 1, p. 24, 2020.

[9] P. Sooksaen, V. Boodpha, P. Janrawang, and P. Songkasupa, "Fabrication of Lightweight Concrete Composites Using Natural Fibers in Thailand," *Key Eng. Mater.*, vol. 765, pp. 305–308, 2018.

[10] M. P. Haryani, K. A. Sambowo, and Anisah, "Pengaruh Limbah Plastik Jenis Pet Dan Pp Dengan Tanah Diatomae Sebagai Subtitusi Agregat Halus Dalam Paving Block," *J. Pensil*, vol. 10, no. 3, pp. 166–176, 2021.

[11] J. . Sutanto, W. N. Sari, R. E. Hendriyono, G. H. Purwoko, and M. N. Kusuma, "Pemanfaatan Bio-Slurry sebagai Bahan Batako Berdampak terhadap Kesejahteraan Masyarakat Desa Galengdowo Kabupaten Jombang," *J. Abdi MOESTOPO*, vol. 3, no. 1, pp. 13–19, 2020.

[12] Badan Standardisasi Nasional, "SNI 03-1974-1990 Metode Pengujian Kuat Tekan Beton," *Nasional, Badan Stand.*, 1990.

[13] D. S. Nasional, "Standar Nasional Indonesia 0028-1987-A.", 1987.