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UTILISATION OF CLAMSHELLS AS AGGREGATE SUBSTITUTE IN PAVING BLOCKS

Arman Maulana[1*], Andi Sulfanita[2], Hendro Widarto[3], Adnan[4]

[1,2,3,4]Program Studi Teknik Sipil, Universitas Muhammadiyah Parepare, 91112, Indonesia

Email: [1*]*teknikarman46@gmail.com*

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ABSTRAK

Paving block menjadi lebih populer di kalangan konsumen karena sifatnya yang ramah lingkungan, mampu menghemat air tanah, mudah dipasang dan dipelihara, dan memiliki banyak bentuk yang menambah nilai estetika. Penelitian ini bertujuan untuk menentukan perbedaan kulit kerang terhadap daaya seraap aiir paving blocck dann kuaat tekann pavinng. Eksperimen dilakukan di laboratorium struktur dan bahan Universitas Muhammadiyah Parepare dari Agustus hingga Oktober 2023 untuk metode penelitian ini. Hasil penelitian menunjukkan bahwa daya serap paving block dipengaruhi oleh penambahan kulit kerang. Nilai daya serap air dari variasi 0%, 5%, 10%, dan 25% adalah 1,4 persen, 2 persen, 3,4 persen, dan 3,7 persen untuk umur perawatan 7 hari; 0,6 persen, 1,7 persen, 2,4 persen, dan 3,3 persen untuk umur perawatan 14 hari; dan 1,3%, 2,8 persen, 3,0 persen, dan 4,6 persen untuk umur perawatan 28 hari. Menurut hasil di atas, semakin banyak kulit kerang yang ditambahkan, semakin besar daya serap airnya.Kuat tekan menunjukkan bahwa penambahan kulit kerang mempengaruhi kuat tekan paving blok. Nilai kuat tekannya masing-masing 23,841 Mpa, 9,365 Mpa, 21.587 Mpa, dan 11.429 Mpa pada umur perawatan 28 hari. Seperti yang ditunjukkan di atas, semakin banyak kulit kerang yang ditambahkan, semakin rendah kuat tekannya

Kata Kunci: *Kuat Tekan; Kulit Kerang; Abu batu*

ABSTRACT

Paving blocks are becoming more popular among consumers because they are environmentally friendly, can save groundwater, are easy to install and maintain, and have many shapes that add aesthetic value. This study aims to determine the difference of shells on the water absorption capacity of paving blocks and the strength of paving blocks. Experiments were conducted at the structure and materials laboratory of Muhammadiyah University of Parepare from August to October 2023 for this research method. The results showed that the water absorption of paving blocks was influenced by the addition of seashells. The water absorption values of the 0%, 5%, 10%, and 25% variations were 1.4 percent, 2 percent, 3.4 percent, and 3.7 percent for the 7-day treatment period; 0.6 percent, 1.7 percent, 2.4 percent, and 3.3 percent for the 14-day treatment period; and 1.3%, 2.8 percent, 3.0 percent, and 4.6 percent for the 28-day treatment period. According to the above results, the more clamshells added, the greater the water absorption. The compressive strength shows that the addition of clamshells affects the compressive strength of block paving. The compressive strength values were 23.841 Mpa, 9.365 Mpa, 21.587 Mpa, and 11.429 Mpa at the 28-day curing age, respectively. The more clamshells added, the lower the compressive strength.

Keywords: *Compressive Strength; Clamshell; Stone Ash*

INTRODUCTION

Paving block is one of the building materials used as the top layer of road structures other than asphalt and concrete. Nowadays, many people choose paving blocks over other pavements such as cast concrete or asphalt (Badan Standarisasi Nasional, 1996).

The utilisation of shell waste is lacking, as it is only used as decoration, animal feed and cosmetics. Meanwhile, the presence of shells is increasingly disturbing the environment of the fishing village and damaging the beauty of the beach . (Budiarini, 2024). If waste is disposed of continuously without maximum treatment, it can cause a disturbance of balance, thereby causing the environment not to function in the sense of health, welfare, and biological safety.

Clamshell waste is a powder produced from grinding crushed clamshells, this powder can be used as a mixture or addition to the manufacture of concrete (Kusuma et al., 2012). The addition of homogency clamshell powder will make the mixture more reactive. Clamshell powder contains pozzolanic chemical compounds containing lime (CaO), alumina and silica compounds that are suitable for use as concrete raw materials (Siregar et al., 2009). Most of the fishermen's yards near the coast are almost covered with shell waste, therefore, to minimise the shell waste that is produced every day, in this study the shells will be used as an aggregate mixture (substitution) with some sand in the manufacture of paving blocks (concrete bricks) (Anggiani, 2022).

Based on research by Siregar (2009), clamshells contain pozzolanic chemical compounds containing lime (CaO), alumina and silica compounds that are suitable for use as a cement reducing agent. The advantages of clamshells can be utilised to make clamshells as raw material for making paving blocks. Clamshell waste is abundant in the Pecemengan area because people dispose of clamshell waste carelessly. By utilising this waste, it is expected to reduce the amount of waste and get alternative materials that can reduce the use of cement in making paving blocks (Ulfiyanti et al., 2019).

The advantages of paving blocks have led to the increasing use of paving blocks in construction projects. The increasing demand for paving block materials has led to innovations in material engineering to improve the quality of paving blocks. Concrete is the main material for construction that is widely used throughout the world. The more widespread use of concrete indicates also the more demand for concrete in the future. The development of the times in this era of rapid globalisation has resulted in an increasing amount of used goods/waste whose existence can be a problem for life, one of which is the existence of shell waste. For this reason, many things have been done in order to recycle in order to overcome the problem of the existence of this waste. One of them is the use of clamshell ash. In this study, shell ash was used as a substitute for cement by weight in the mix variation and compared with the use of lime as a substitute for cement to determine the value of compressive strength and split tensile strength that is better and expected to improve the quality of concrete (Rezeki, 2013). The addition of clamshell powder waste material is one method to improve the quality of paving blocks and reduce production costs.

Recently, the use of materials is very high, accompanied by the rapid development of development in Indonesia. One example is the use of paving blocks that we can see in various places. So in this study, the authors utilised clam shell waste as a substitute for fine aggregate in paving blocks. The purpose of this research is to analyse the use of clamshells on the water absorption of paving blocks, as well as the analysis of mechanical properties with the addition of clamshells affecting the compressive strength of paving blocks.

LITERATUR REVIEW

The compressive strength of concrete for normal concrete with variations in fine aggregate substitutes in the form of boiler ash, namely the results of the slump test show a decrease in the height of the slump value with the addition of boiler crust ash. In other words, the higher the percentage of boiler crust ash used, the higher the water absorption of concrete, the effect of boiler crust ash substitution on concrete compressive strength decreases in each - each addition of the percentage of boiler crust ash as a substitute for sand in the concrete mixture (Muhammad Irwansyah et al., 2020).

The use of turtle shell waste as a partial substitute for fine aggregate can increase the compressive strength value of paving blocks in each variation 0% obtained compressive strength value of 186.47 kg/cm2, 10% obtained compressive strength value of 254.69 kg/cm2, 20% obtained compressive strength value of 288.68 kg/cm2, and 30% obtained compressive strength value of 336.36 kg/cm2 . Where everything is in accordance with the quality of the plan, namely quality B. the use of turtle shell waste as a substitute for part of the fine aggregate makes the water absorption capacity decrease in each variation, namely in the 0% variation, the percentage of water absorption absorption is 4.89%, 10% gets the percentage of water absorption absorption of 4.75%, 20% gets the percentage of water absorption of 4.53%, and 30% gets the percentage of water absorption of 3.53%, but still meets the standard requirements of SNI 03-0691 (1996), which is between 3%-10% (Setiawan, 2020).

Inundation control is done by optimising water absorption into the soil. Porous paving blocks have a high porosity value because they have a higher ability to pass water. This research made porous paving blocks with fly ash (FA) waste cement substitution and blood clam shells (CK) as coarse aggregate. The ratio of materials for making porous paving blocks was 4; 3; 2.5; 2 and 1.5 with cement substituted with 30% FA. The infiltration rate of porous paving block through permeability coefficient was tested at the age of 28 days. The results showed the compressive strength of porous paving blocks, namely V1 = 1 PC : 4 KR of 14.83 MPa, V2 = 1(0.7PC + 0.3FA): 4 KR by 1.5 MPa, V3 = 1(0.7PC + 0.3FA): 3 CK of 4.66 MPa, V4 = 1(0.7PC + 0.3FA) : 2.5 CK of 4.58 MPa, V5 = 1(0.7PC + 0.3FA) : 2 CK by 8.75 MPa, V6 = 1(0.7PC + 0.3FA) : 1.5 CK at 4.50 MPa. The average permeability coefficient values of porous paving blocks are respectively V1 = 0.0045 cm/s, V2 = 0.0048 cm/s, V3 = 0.0040 cm/s, V4 = 0.0038 cm/s, V5 = 0.0051 cm/s, V6 = 0.0050 cm/s. The use of blood clam shell ratio 1(0.7PC + 0.3FA): 2 CK achieved the optimum permeability coefficient (Mayasari et al., 2022).

The utilisation of clam shell waste as a mixed material in the manufacture of paving blocks has shown significant potential. The use of clamshell waste not only supports the concept of recycling and reduces the impact of waste on the environment, but also contributes positively to the physical and mechanical properties of paving blocks. The use of clamshell waste as a partial replacement of fine aggregate can increase the compressive strength value of paving blocks in each variation. (Setyoningrum & Saefudina, 2024). Making paving blocks using a mixture of shell waste can also affect water absorption.

(Cahyaka et al., 2018), The coal industry produces bottom ash waste which has the same content as cement, namely silica (Si). Bottom ash obtained from PT Tjiwi Kimia contains 19.6% silica (Si) and contains 7.56% calcium (Ca). calcium (Ca) as much as 7.56%, so shell waste is needed as an additional mixture to make up for the calcium (Ca) deficiency in bottom ash. The effect of bottom ash waste and shell waste as a substitute for cement in paving blocks, because paving blocks are currently increasingly popular as an alternative to road pavement. Making paving blocks using Pasuruan sand, Gresik PPC cement, water from the paving block industry in Surabaya. from the paving block industry in Surabaya. Paving blocks are made with a size of 21 x 10.5 cm with a thickness of 6 cm with a composition of 1 cement: 3 sand. Tests in this study include testing compressive strength, water absorption and wear resistance. Test specimens were made with 6 variations, namely 0%, 10%, 20%, 30%, 40%, and 50% bottom ash by weight of cement, and each variation received an additional 2% shells by weight of cement. The compressive strength test results of 10%, 20%, 30% and 40% bottom ash were categorised as B grade, while 50% bottom ash was categorised as D grade. The water absorption test results of 10% and 50% of bottom ash belonged to quality D, while 20%, 30% and 40% of bottom ash belonged to quality B. The wear resistance test results of 10% and 20% bottom ash entered into quality B, while 30%, 40% and 50% bottom ash entered into quality A.

(Tayeh et al., 2019)The concrete industry has a plethora of negative impacts on the globe and environment. Also, with the depletion of natural resources that are used in concrete and cement production, many research attempts are focused on finding alternatives or incorporating waste materials into concrete mixes. Seashells are some of these waste materials that are rapidly accumulating on seashores and landfills, causing an environmental problem of their own. This review paper is focused on the utilization of various types of seashell waste materials in concrete as partial cement replacement. The utilization of seashells in concrete helps in seashell waste management and in producing cost-efficient concrete. The paper summarizes the previous research attempts to produce burnt seashell to partially replace cement in different proportions. It also presents the physical and mechanical properties of seashell ash and the produced concrete. The literature review has justified the use of seashell waste ashes for cement partial replacement in sustainable concrete. The study shows that incorporating seashell ash resulted in reduced early compressive strength of concrete. The strength increased with age due to hydration of calcium oxide, but it remained less than control samples, especially at high percentages of replacement. The flexural and splitting tensile strength was improved due to the development of good bonding between the binder matrix and aggregates and this increased the modulus of elasticity. However, some studies reported a decrease in splitting tensile strength. The absorption and porosity of concrete at low percentages of replacement are less than the standard. However, these values are increased with higher levels of replacement. Seashell ash generally reduces workability. The ash also reduces concrete permeability after long periods of curing. It can be established that there is a possibility for incorporating seashell in concrete as a binder material for sustainable construction purposes.

(Bamigboye et al., 2021), After examining the available literature reported by various researchers, it was noted that concrete produced with seashell ash has sufficient adequacy in lightweight structures due to its lower density compared to OPC concrete and for several structural applications pertaining to plastering. Also, Seashell usage in concrete helps in environmental sustainability and waste reduction. Seashells grinding and calcination have effects on the specific gravity, reactivity, and the resultant seashell ash surface area. Periwinkle and oyster seashells show to be top in quality types for producing seashell ash amongst various types of seashells. Also, the workability and setting time of the produced concrete are affected in general by the additions of seashell ash as cement replacement. The use of seashells increases the tensile strength properties of concrete. Despite all the researches performed in the past on seashell usage as a cement replacement, many more questions still need to be answered in order to further develop the use of seashells for cement production and to widen its applications areas for usage as sulphate, chloride, acid, and alkali resistant cement thereby increasing durability than conventional cement. Also, further research will need to be conducted on the performance of seashells in alkali-activated cement and the combined effect of seashell ash with various admixtures.

(Zhu et al., 2024), Studies have shown that in most cases, the incorporation of seashell aggregate will adversely affect the workability of concrete and mortar, which is mainly due to the high porosity and water absorption, angular shape, and rough surface of seashells. Similarly, the addition of seashells also prolongs the setting time and reduces the density of concrete and mortar. In terms of the mechanical properties of concrete and mortar, the use of shells as a substitute for aggregate reduces the mechanical properties to a certain extent. Although the strength of seashell concrete is satisfied, the lower limit for structural purposes. But given the difficulty of meeting the standards for its workability and chloride ion content, there still exists uncertainty about the use for structural purposes from the point of engineering safety. Consequently, shell concrete can still only be used for non-structural purposes. With the addition of seashell aggregates, the resistance to a chemical attack generally decreases and the shrinkage properties increase. However, there is still a lack of agreement on certain aspects of durability such as water permeability, freeze–thaw resistance, and porosity which depends largely on the particle size of the seashell aggregates, the particular method of treatment, the addition of other SCMs and other factors in their tests. Therefore, there is an optimum value for the amount of seashells. According to the results of most researchers, the replacement rate of seashell as aggregate should generally be limited to less than 20%.

METODE

1. Type of Research

This research method uses experimental research methods, namely by comparing between 4 mixture variations to find out how the compressive strength and water absorption of paving blocks. This research was conducted in the Civil Engineering laboratory of the Faculty of Engineering, Muhammadiyah University of Parepare. As for some of the materials used during the research, namely: Aggregate, Cement, Water, Shell Waste. This research focuses on variations in the mixture of shell waste that will be used as a substitute for some fine aggregates. The number of samples required in each variation is Normal paving block, paving block + 5% clamshell, paving block + 10% clamshell, paving block + 25% clamshell.

2. Data Analysis Methods

The data analysis method used in this study uses descriptive parametric analysis. Data from the concrete compressive strength test results obtained from the division between the maximum load of the test specimen and the cross-sectional area of the test specimen, presented in the form of tables and graphs. The steps taken are:

- Weigh the weight of the test specimen before measuring the compressive strength.
- Dimension measure and calculate the volume and surface area of test specimens
- Test the compressive strength of the specimens at the age of 7 & 28 days with a UTM tool
- Analyses the data of test specimen testing results

- Discussion of the characteristics of the test specimens according to the data analysis of the test results

3. Flowchart of Research

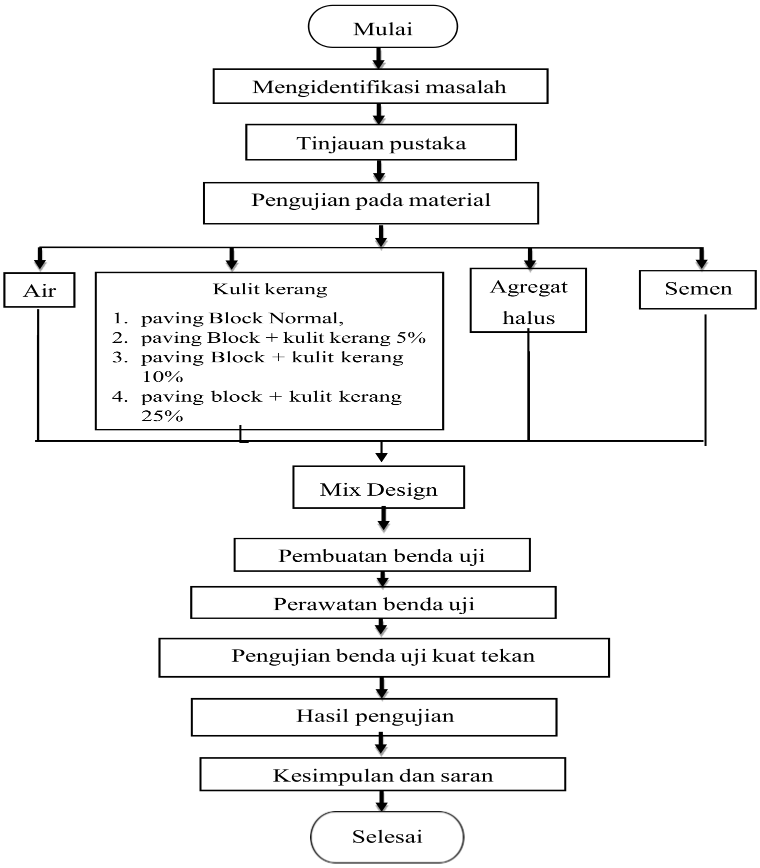

Figure 1: Flowchart of the research

RESULTS AND DISCUSSION

1. Characteristics Aggregate

Testing of aggregates based on (ASTM C33/C33M-18) and SNI (Indonesian National Standard) was carried out on fine aggregates and shells.

Table 1: Test results of fine aggregates

No.	Characteristics Aggregate	Eligibility	Results
1	Sludge content	Maks 5%	2.30%
2	Organic content	< No. 3	1
3	Water content	2% - 5%	2.25%
4	Weight of loose volume	1,4 - 1,9 kg/liter	1.44
5	Weight of solid volume	1,4 - 1,9 kg/liter	1.61
6	Absorption	0,2% - 2%	1.63%
7	Specific gravity	1,6 - 3,3	3.09
8	Fineness modulus	1,50 - 3,80	3.77

2. Paving block mix design

Concrete mix planning is calculated using the (Badan Standar Nasional Sni 7656:2012, 2012) method.as shown in table 2.

Table 2. Mixture Requirement of Each percentage for 1 m3 Paving block

Materials	BN	Percentage of shells		
		5%	10%	25%
W cement	2.15	2.15	2.15	2.15
W Stone dust	5.87	5.58	5.29	4.41
W Clam shells	0	0.23	0.47	1.16
W water	0.75	0.75	0.75	0.75

Figure 2. Concrete mix planning

2. Absorption Test

Figure 2 shows the results of the study, the average absorption (ASTM D570) and SNI (Indonesian National Standard) of paving blocks aged 7, 14, 28 days obtained in testing normal variations, 0%, 5%, 10%, and 25% of shells.

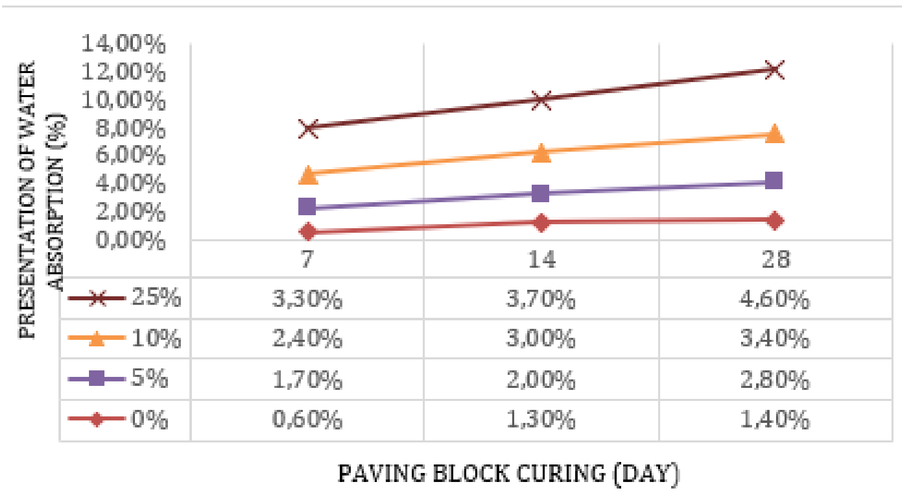

Figure 3: Relationship of water absorption to duration of paving block curing days

Figure 3, shows a recapitulation of the combined water absorption of paving blocks above, it can be seen that the lowest absorption value is obtained from a percentage of 0% at 1.40%, while the highest is found at a percentage of 25% with a curing period of 28 days, which is 4.60%. The results of testing the water absorption of 21x10x8 cm paving blocks also show that the addition of seashells affects the absorption of paving blocks with percentages of 0%, 5%, 10% and 25% having water absorption values of 1.4%, 2.0%, 3.4%, and 3.7% for a 7-day curing period, 0.6%, 1.7%, 2.4%, and 3.30% for a 14-day curing period, 1.3%, 2.8%, 3.0%, and 4.60% for a 28-day curing period.

3. Compressive Strength

Figure 3, shows the results of compressive strength testing on normal paving blocks and clam shell percentage paving blocks with a curing age of 7, 14 and 28 days.

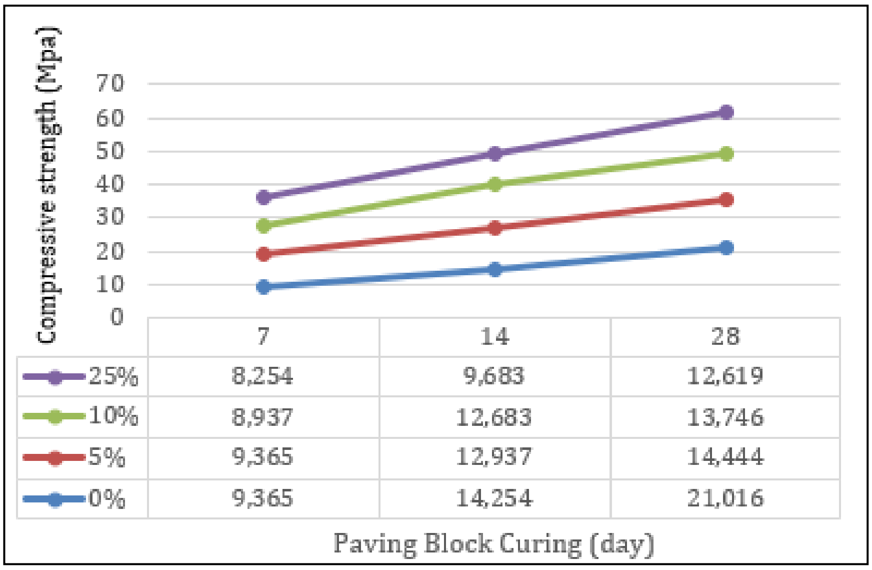

Figure 4: Relationship between compressive strength and curing days of paving blocks

Figure 5: Testing process of compressive strength of paving blocks

Figure 4, shows is the compressive strength of 21x10x8 cm paving blocks. The lowest compressive strength value is found in the 25% clamshell variation with a compressive strength value of 8.254 Mpa, at a treatment period of 28 days while the highest value is obtained at 0% with a compressive strength value of 21.016 Mpa at a treatment period of 28 days. The graph above also explains that the higher the percentage of added shells, the less the compressive strength value. The addition of shells to the concrete mix affects the compressive strength of paving blocks. The compressive strength values for variations of 0%, 5%, 10% and 25% for the 7-day treatment age are 9.365 MPa, 14.444 MPa, 13.746 MPa and 12.619 MPa. The 14-day treatment age is 14.254 MPa, 12.937 MPa, 12.683 MPa and 9.524 MPa. The 28-day maintenance age is 21.016 MPa, 9.365 MPa, 8.937 MPa and 8.254 MPa. So know that the higher the water absorption, the less the compressive strength value of the paving block with a mixture of shells.

CONCLUSIONS

Based on the percentage of clamshell utilisation on the water absorption of paving blocks. The value of water absorption of paving blocks shows that the addition of seashells affects the absorption of paving blocks. Water absorption with a percentage of clamshell content of 0%, 5%, 10%, and 25% with a curing age of 7 days consecutively water absorption of 1.4%, 2.0%, 3.4%, and 3.7%. Water absorption with a curing age of 14 days consecutively water absorption of 0.6%, 1.7%, 2.4%, and 3.30%. Furthermore, the water absorption with a curing 28 days of was 1.3%, 2.8%, 3.0%, and 4.60% respectively. While the results of compressive strength show that the addition of shells affects the compressive strength of paving blocks. The compressive strength value of paving blocks at the age curing of 28 days, the percentage of clamshell content of 0%, 5%, 10%, and 25% is 21.016 MPa, 9.365 MPa, 8.937 MPa and 8.254 MPa respectively.

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