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Abstract. The Tsunami disaster in Aceh is a natural disaster of such a large scale that it is considered an international disaster. One of the measures taken for the reconstruction of damaged buildings is the use of lime taken from shells to partially replace the use of cement. In general, it can reduce global warming by reducing the use of cement in the manufacture of concrete. The research was conducted to determine the effect of the use of shellfish shells on the compressive strength of concrete. The maximum diameter of the aggregate used is 19 mm, the cement used is Portland cement type I. The concrete mix design used the American Concrete Institute (ACI) method with a slump design of 75-100 mm. The test object used was a cylinder with a diameter of 15 cm and a height of 30 cm. The variations in the use of shellfish shells powder were 0%, 2%, 4%, 6%, and 8%, and 0% shellfish shells powder is a comparison test object. For each variation of shell powder, 3 (three) cylindrical specimens were made with test times of 7 and 28 days. The test results show that for the split tensile strength of concrete at 28 days of concrete age with a variable of 2% and compressive strength of a variation of 4%. The addition of 2% clamshell powder can increase the split tensile strength of normal concrete by 10.48%, and an increase in concrete compressive strength of 21.98% in the substitution of 6% shell powder. The novelty obtained from this research is the use of shell powder with 6% substitution to replace cement, which produces a significant concrete compressive strength, namely 0% shellfish powder has a compressive strength of 26.610 MPa compared to 6% substitution, which has a strength of 32.460 MPa.

Keywords: Shellfish shells Powder, Concrete Strength, Portland cement, Slump Test.

1 Introduction

Rapid industrial development results in air pollution which results in the greenhouse effect. One of them is the cement factory industry, besides producing air pollution, it also damages the environment by mining limestone on a large scale as the basic material for making cement. This study tries to reduce the use of cement in the manufacture of concrete. Especially in the Aceh region and in Indonesia in general.

The use of shell ash substitution in the manufacture of concrete produces quite positive things on the compressive strength of concrete. So that the reduction in the use of cement (shell ash substitution) will have a positive impact on the environment. Avoid continuous mining of limestone (a mineral that cannot be renewed), while shell ash is an environmentally friendly material (renewable and environmentally friendly material).

The development of concrete continues to grow rapidly so it requires quite a lot of materials. Therefore, the research aim is to determine the effect of the use of shellfish shells on the compressive strength of concrete. These results reduce natural resources for making concrete. The search for alternative materials as substitutes or additional materials from natural resources or other artificial resources in the manufacture of concrete continues to be carried out so that both industrial waste materials and other waste materials can be used to replace or substitute concrete materials such as cement, coarse aggregate and fine aggregate as an innovation. One alternative that can be tested and developed is clamshells (geloinia expansa) as an additive or substitute for cement. Shellfish (geloinia expansa) is lives in mangrove ecosystems, especially in mud exposure with a size of up to 11 cm. In general, the functions of the mangrove ecosystem for shellfish include shelter and foraging for food [1]. Degradation of the mangrove ecosystem can affect the growth of shellfish. The idea of using shellfish powder is reasonable because portland cement materials consist of 60% to 70% of lime or CaO, and 17% to 25% consist of SiO2 [2].

According to the study, when the proportion of CCA increased, the slump and compaction factors of concrete declined, indicating that the concrete became less workable (stiff). At an early age, the compressive strength of CCA-cemented concrete was lower than the control, but it rose dramatically and outperformed the control at a later age (120 days and over). At an 8 percent CCA replacement rate, optimum compressive strengths of 57.10 N/mm2, 40.30 N/mm2, and 28.07 N/mm2 were obtained after 180 days for mixture proportions of 1:11/2:3, 1:2:4, and 1:3:6. Where cement mixes would be utilized for structural concrete, only 8% CCA substitution was shown to be appropriate [3].

Because of its natural high density and carbon content, PSC has been successfully employed to manufacture high quality ity of activated carbon. Experiments on adsorption Pb2+ by PSC, CAC, and PSC, CAC demonstrate that the amount of lead adsorbed is unclear. PSC can compete profitably with CAC, according to the results. Both Fre-undlich and Langmuir models plot the balance data nicely. Adsorption results indicate utilization of pseudo-second-order kinetic abilities and Elovich models in kinetic ads absorption research. The results can be well captured by the pseudo-second order model due to the strong correlation coefficient obtained using the pseudo-second-order kinetic model. As a consequence, the chemisorpionic reaction is most likely the major adsorption process. As a result, this model should be employed in design [4].

The current study looks at a mathematical model that was created using statistical methods to estimate the 28-day compressive strength of silica fume concrete with water-to-cementitious material (w/cm) ratios ranging from 0.3 to 0.42 and silica fume replacement percentages ranging from 5 to 30. For statistical modeling, the strength data of 26 concrete mixes were studied on more than 300 test specimens. The percentage of silica fume replacement has been linked to compressive strength ratios between silica fume and control concrete. The formula is independent of specimen parameters and applies to all sorts of specimens because it is created using strength ratios rather than absolute values of strength. When comparing the model's results to those of earlier researchers, it was discovered that predictions for both cubes and cylinders were within 7.5 percent of the experimentally obtained values [5].

The mechanism of sulfate attack and the effect of chosen supplemental cementitious materials (SCMs) in minimizing this attack in concrete are briefly discussed in this study. The link between sulfate resistance and SCM chemical, physical, and mineralogical composition has been established. Several models for estimating sulfate resistance in fly ash-containing concretes have been cited and discussed based on bench-scale studies. Sulfate resistance of concrete containing SCMs interground and optimized at the cement plant as opposed to concrete mixed at the concrete batch plant was also discussed in the report. The use of interground SCMs with clinker has shown increased sulfate resistance for concrete, owing to finer and better particle size distribution, which enhances reactivity and reduces permeability in concrete, according to the scant data available on the subject. The paper also suggests that sulfate optimization be based on 3-day strength rather than 1-day strength, as recommended by [6] . This may necessitate a larger sulfate input, which could increase sulfate resistance by reducing the system's porosity [7].

The shellfish contains 53.03% CaO and 0.82% SiO2 as a binder [8] . The use of shells powder in normal concrete produces an optimum compressive strength of 30.62 MPa. The effect of using clamshell powder in normal concrete mixtures results in a decrease in compressive strength along with an increase in the percentage of shellfish powder substitution [9] . The optimum compressive strength resulted in the use of 10% clamshell powder in the concrete mixture for 28 days of testing. The use of 10% shellfish powder resulted in a split tensile strength of concrete which was higher than the compressive strength of the control specimen. The greater the percentage of addition of clam shell powder, the lower the compressive strength of the concrete [10]. The results showed that shells powder can be used as a substitute for cement up to 20% in normal concrete. Although there is a decrease in concrete strength at this percentage [11]. 2018). The process of making clamshell powder is that the shells are cleaned by washing and then drying after it is crushed manually using a hammer. To get a good gradation, the crushing process is not done too difficult, because the crushing process that is too difficult will produce an aggregate size that is too fine, resembling dust (pass the 200 sieves). The crushed shells were obtained in powder form and then sieved using a sieve with sizes varying from 4.75 mm to 0.15 mm (ASTM sieve standard). The results, with a mixture proportion with a percentage of 0.5% obtained 5% A for compressive strength, and at 0.5% S + 2.5% A for split tensile strength so that the substitution of shell powder and the addition of coconut fiber have a good effect on the quality of concrete at a certain percentage addition [12].

In a magnesium sulphate media, ash (PSA) blended cement concrete. The specimens were made from 25 MPa designed features. PSA was used to replace cement in a volume range of 0 to 40%. There were 180 cube specimens cast and cured in water. 45 specimens were put into 1 percent, 3 percent, and 5 percent magnesium sulphate solutions after 28 days of curing, while others were cured in water and tested at 62, 92, and 152 days. The results showed that the control mix had a greater loss in compressive strength, which rose as MgSO4 concentration and exposure time increased, whereas the attack on the PSA blended cement concrete was less severe, with the lowest value observed at 10% PSA content. As a result, the findings of the research were reached. As a result, the study found that replacing 10% of cement with 10% PSA was the best way to prevent magnesium sulphate attack [13].

The characteristics of the concrete produced in these conditions include density = 2.716 g/cm^3, water absorption = 0.4%, shrinkage = 1.29%, thermal conductivity = 0.339 w/m°K, compressive strength = 56.9 MPa, fracture strength = 34 MPa and tensile strength = 7.46 MPa. Analysis of the fire resistance of concrete is experiencing a degradation of 22.67% with the assumption that the compressive strength value before combustion is 56.9 MPa and after combustion becomes 44 MPa. Based on the analysis of the acid resistance test of concrete after soaking with 5% NA_2SO_4 for 7 - 56 days, the mass change was 0.15-1.35% and the compressive strength increased by 7 - 8%. While immersion with 5% H_2SO_4 for 7 -56 days, there was a mass change of 0.25 - 1.60% the compressive strength degraded around 10 - 11%. Microstructure analysis by SEM showed that the cavities in the concrete were unevenly distributed with a cavity size of about 5-40μm and lumps of epoxy resin around 20μm. While the form of particles of sand and shell powder, the grain boundaries are not visible [14].

The use of OPC with 10% SDA in concrete improves thermal resistance 4 times that of control specimens. The use of an OPC mixture with an optimum value of 10% SDA in concrete improves thermal stability and thermal resistance of concrete [15]. The percentage of shellfish shell as a substitute was 0%, 5%, 10%, and 15% of the total sample of 72 samples. The results of the tests that were carried out, concluded that the compressive strength test has increased to normal concrete (0%) at a percentage of 5%, up 1.54 MPa, 10% increase by 3.11 MPa, 15% increase by 2.98 MPa. Then in the split tensile strength test the ratio of normal concrete (0%) also increased by a percentage of 5% up to 0.23 MPa, 10% increased 0.85 MPa, 15% increased by 0.82 MPa. The optimum percentage increase is in the percentage of 10% - 15% followed by an increase in performance of concrete [16].

The goal of this study was to look into using Anadara Granosa (Blood clam shell) clamshell waste as a new innovation in concrete technology, as well as to look into the effect of using Anadara Granosa clamshell powder as an aggregate replacement on concrete compressive strength. The sample size was formed up of 10 cm x 20 cm cylinders with clamshell powder variations of 10%, 20%, and 30% from the fine aggregate volume, then soaked for 28 days according to the Indonesian National Standard Procedure. The slump value exceeds the slump value of standard concrete with slump values of 0 percent = 160 mm, 10% = 165 mm, 20% = 180 mm, and 30% = 180 mm, according to the evaluation data. The goal of this study was to look into using Anadara Granosa (Blood clam shell) clamshell waste as a new innovation in concrete technology, as well as to look into the effect of using Anadara Granosa clamshell powder as an aggregate replacement on concrete compressive strength. The sample size was formed up of 10 cm x 20 cm cylinders with clamshell powder variations of 10%, 20%, and 30% from the fine aggregate volume, then soaked for 28 days according to the Indonesian National Standard Procedure. The slump value exceeds the slump value of standard concrete with slump values of 0 percent = 160 mm, 10% = 165 mm, 20% = 180 mm, and 30% = 180 mm, according to the evaluation data. Additionally, for regular concrete (0 percent), substitution concrete (10 percent), substitution concrete (20 percent), and substitution concrete (30 percent), the concrete compressive strength obtained after 28 days was 20.78 Mpa, 21.95 Mpa, 21.17 Mpa, and 24.28 Mpa, respectively. Following these findings, it was concluded that increasing the amount of Anadara Granosa clamshell powder substituted resulted in a higher concrete compressive strength test [17].

Pumice is a brightly colored granule that contains foam created from glass-walled bubbles and is commonly known as silicate volcanic glass granules. This pumice can be used as a fine aggregate in a concrete mix as a substitute for regular sand. Based on the results of the characteristic tests, it can be seen that when comparing the characteristics of pumice to those of normal sand, specific gravity and weight testing of quicksand produced results that were lower than those of normal sand, and absorption tests produced results that were higher than those of normal sand. The compressive strength of normal sand at BN is 250.95 kg/cm2, while the compressive strength of floating sand concrete at BPA is 224, 965 kg/cm2. Based on the findings, it can be inferred that while the quality of concrete is the same, the quality of K-250 is different when compared to the compressive strength of concrete in typical sand and pumice concrete. As a result, greater research into the usage of pumice instead of regular sand in concrete mixtures is required [18].

One of the most important new technologies for sustainable facilities and infrastructure is pervious concrete. Pervious concrete has been the subject of extensive research and development; yet, its long-term endurance remains a difficulty. The freeze-thaw resistance test with and without deicing salt, clogging test, and leaching test are used to investigate the endurance of pervious concrete, with or without crushed seashells. Crushed seashells replaced 60% of the natural particles in the control pervious concrete to generate the shell pervious concrete. The freeze-thaw resistance of the shell pervious concrete was lower than that of the control pervious concrete and was not proportional to mechanical strength. Furthermore, the drainage capacity of pervious concrete is significantly reduced when a blended material containing silty clay and sand is used as a clogging agent. The pervious concretes, on the other hand, remain permeable even after blockage (k > 0.5 mm.s1). Furthermore, when pervious concretes come into touch with demineralized water, they leach quickly. This experiment also revealed that several chemical qualities of broken shells (chloride ion and organic matter content) may have a greater impact on durability than the physical and mechanical properties of pervious concrete. Finally, this research demonstrates that pervious concrete with and without crushed shells has satisfactory durability for low traffic applications [19].

Portland cement, fine aggregate (sand), coarse aggregate (gravel), and water are the four basic constituent ingredients of concrete. Because of the widespread use of concrete in building, the need for concrete materials has increased, resulting in large-scale concrete mining, which has resulted in the depletion of natural resources in Indonesia to meet the demand for concrete. If necessary, alternative materials can be manufactured to alter specific features of concrete in order to make it more functional, cost-effective, and ecologically friendly. Cement, coarse aggregates, and fine aggregates can all be replaced with fly ash waste and blood clam shells. The goal of this study is to measure the compressive strength of concrete after varying the ratio of fly ash replacement with cement and blood clam shells with coarse and fine particles, as well as the inclusion of superplasticizer. Test specimen samples will be examined for workability, density, and compressive strength utilizing experimental procedures. The research variables are (1) linked variables: density and compressive strength, and (2) independent variables: fluctuation of 0%, 5%, 10%, and 15% of blood clam shell requires of total coarse aggregate weight. (1) Slump value of the samples 0 percent, 5 percent, 10 percent, and 15 percent consecutive is 97mm, 89mm, 151mm, 149mm, according to the research findings. (2) The density of concrete containing blood clam shells replaced with coarse aggregate in samples of 0%, 5%, 10%, and 15% is 2284 Kg/m3, 2308 Kg/m3, 2297 Kg/m3, and 2293 Kg/m3, respectively. (3) Concrete compressive strength testing at 28 days with blood clam shells replaced with coarse aggregate with samples of 0%, 5%, 10%, and 15% consecutively is 21.44 Mpa, 24.38 Mpa, 19.02 Mpa, and 19.34 Mpa, respectively. The composition of blood clam shell substitution with 5% coarse aggregate has a better compressive strength than the other compositions [20].

In order to lessen construction's reliance on virgin resources, efforts have been undertaken to include by-products and wastes from other industries as concrete alternatives. Seashell debris, such as oyster shells, mussel shells, and scallop shells, among others, comes from the fishing industry and is readily available in large amounts in some areas, where it is typically abandoned or landfilled with no re-use value. Previous research on using seashell trash as a partial replacement for conventional materials in concrete and other cement-based products is summarized in this study. The impact of adding seashells on the fresh and hardened properties of concrete are explored, as well as the features of various forms of seashell trash. Due to the high calcium oxide content, material properties suggest that seashell trash, like limestone, might be an innocuous material. However, proper treatment, such as high-temperature heating and crushing to produce the desired fineness, is preferred for a higher-quality material. While seashell waste has been utilized as a replacement for both cement and aggregate in the past, there is still a dearth of research into its durability and the real impact of seashell powder as a cement replacement material, according to previous studies. Despite the reduced workability and strength, the review suggests that seashell debris might still be used as a partial aggregate at a replacement level of up to 20% for appropriate concrete workability and strength for non-structural purposes [11].

Because of the rising building industry in Malaysia, concrete will be in more demand in the future. Ordinary Portland cement (OPC) is the most common precursor in the production of concrete. Each ton of OPC produced emits the same amount of carbon dioxide (CO2) as limestone quarrying and calcination. Clam shells, also known as fisheries trash, have a significant potential for partial cement replacement in concrete due to their chemical composition, which is similar to that of Portland cement. Cleaning, crushing, grinding, and calcination were used to prepare clam shells. The performance of concrete employing clamshells as a partial replacement for OPC is investigated in this study. The density, water absorption, compressive strength, and splitting tensile strength of clam shell concrete have all been investigated. These characteristics were compared to those of OPC (Ordinary Portland Cement) concrete. The optimum compressive strength was attained for the mix that replaced cement by 6 percent, based on mixes employing clamshells ash with proportions of 4 percent, 6 percent, and 8 percent by weight of cement. In the 28th day, the clamshells concrete has a higher compressive strength and density than the OPC. On the 28th day, specimens SC 6 percent have the highest splitting tensile strength compared to specimens SC 4 percent and SC 8 percent, but OPC concrete's splitting tensile strength (5.1MPa) is higher than specimens concrete SC 6 percent (4.4MPa). Future research for this project should include first investigations comparing degrees of calcination to measure the value and analyze durability testing of seashell concrete other than water absorption tests [21].

2 Materials and Methods

Concrete mix used the American Concrete Institute (ACI) and this mix method considers the economic side and also takes into account the availability of materials in the field, ease of work, as well as the durability and strength of concrete. The design plan is 25 MPa with a cylindrical specimen, with a diameter of 15 cm and a height of 30 cm with a water-cement ratio of 0.52. Percentage of shell powder 0%, 2%, 4%, 6% and 8%. Figures 1 to 3 of the process of making clamshell powder in this study.

The cement used was PC (Portland Cement) type I. This laboratory examination of cement was not carried out because it has met SNI-2049-2015. The only visual inspection is for the bag which was torn and there were no hard lumps in the cement. The examination of coarse aggregate, and fine aggregate as concrete forming material, has been carried out by previous researchers with the same aggregate. This examination was carried out for aggregates properties.

Table 1. Chemical Content of Shell Powder.

Component	Rate (% weigth)	Notes
CaO	**66.70**	-
SiO_2	**7.88**	-
Fe_2O_3	**0.03**	-
MgO	**22.28**	-
Al_2O_3	**1.25**	-

Fig. 1. Shellfish Shell.

Fig. 2. Process Shellfish shell Powder.

Fig. 3. Shellfish shell Powder.

Table 2. Bulk Density.

Materials	Bulk Density (kg/l)	Orchad	ASTM

Coarse Aggregate	**1.784**	-	**1.6 – 1.9**
Fine Sand	**1.855**	**>1.445**	-

The fine aggregate in this study can be used as a concrete-forming material with a volume weight of 1.855 kg/L. As suggested by ACI, according to Nawi (2000), the volume weight of a good aggregate is higher than 1.445 Kg/L. The volume weight of coarse aggregate has also met the specifications, namely 1.784 kg/L, ranging from 1.6 – 1.9 kg/L (ASTM).

Table 3. Specific Gravity.

Materials	Specific Gravity (SG)		Troxell	ASTM
	SG (SSD)	SG (OD)		
Coarse Aggregate	**2.66**	**2.60**	-	**1.60 – 3.20**
Fine Sand	**2.43**	**2.35**	**2.0 – 2.6**	**1.60 – 3.20**

In Table 3 it can be seen that the specific gravity of the saturated surface dry (SSD) coarse aggregate used has complied with the requirements required by Olorunoje and Olalusi (2003), namely for gravel 2.66 kg/L and the specific gravity of oven-dry aggregate (Oven Dry / OD) 2.60 kg/L. For surface dry saturated sand (SSD) density is 2.43 kg/L, and oven-dry sand aggregate (OD) is 2.35 kg/L. This aggregate has also complied with the provisions indicated by Nawi (2000), which ranged from 2.0 kg/L -2.6 kg/L and 1.6 kg/L -3.20 kg/L (ASTM).

Table 4. Absorbtion of Aggregates.

Materials	Absorbtion (%)	Orchad	ASTM
Coarse Aggregate	**2.35**	**0.4 – 1.9**	**0.2 – 4.0**
Fine Sand	**3.19**	**0.4 – 1.9**	**0.2 – 4.0**

Table 4 shows the results of the examination of the absorption value of coarse aggregate obtained is 2.35. The absorption of coarse aggregate is still following with the absorption value determined by ASTM, namely 0.2-4.0. While the absorption of fine aggregate is 3.19. The adsorption capacity of fine aggregate did not match that determined by ASTM, namely 0.4% - 1.9% and 0.2 % - 2.0%.

Table 5. Sieve Analysis.

No.	No. Sieve (mm)	Percentage of Coarse Aggregates (%)	Percentage of Fine Aggregates (%)
1	**31.5**	**0**	**0**
2	**19.1**	**0**	**0**
3	**9.52**	**29.68**	**0**
4	**4.76**	**39.96**	**0**
5	**2.38**	**30.00**	**16.89**
6	**1.2**	**0.12**	**28.32**
7	**0.6**	**0.04**	**21.90**
8	**0.3**	**0.07**	**18.20**
9	**0.15**	**0.11**	**12.80**
10	**The rest**	**0.05**	**1.89**
Total		**100**	**100**

The results showed that the coarse aggregate used in this study was passed the 19.1 mm sieve and was retained on the 9.52 mm sieve, which was 19 mm according to the mix design.

Table 6. Fineness Modulus.

Materials	FM (%)	ASTM
Coarse Aggregates	**5.98**	**5.50 – 8.50**
Fine Sand	**3.10**	**2.20 – 3.10**

The calculation resulted in the fineness modulus of coarse aggregate being 5.983%, the fine aggregate being 3.1%. This value corresponds to the conditions indicated by the ASTM standard.

Table 7. Mix Design SFP (Shellfish Powder) concrete 30 pcs of specimens.

Materials	0% SFP	2% SFP	4%SFP	6%SFP	8%SFP
Cement	**29.798**	**29.202**	**28.606**	**28.010**	**27.414**
SFP	**0.000**	**0.596**	**1.192**	**1.788**	**2.384**
Water	**12.001**	**12.001**	**12.001**	**12.001**	**12.001**
Fine Aggregates	**52.676**	**52.676**	**52.676**	**52.676**	**52.676**
Coarse Aggregates	**82.807**	**82.870**	**82.807**	**82.807**	**82.807**

Table 7 shows that the amount of each ingredient used to make the concrete mix. The variation percentage has used shellfish shell powder (SFP), with the unit weight of kilograms and the number of cylindrical specimens of 15 test objects. The use amount of cement was decreased from 0% to 8% in the variation of the addition of SFP.

3 Materials and Methods

3.1 Testing of fresh concrete slump

The slump data was obtained after mixing the material, the result as seen in Fig. 4, it can be seen that there is a difference in the slump value according to the percentage of shellfish shell powder substitution. The slump results at the normal concrete 0% of percentage were 8 cm. The percentages of shell powder were 2%, 4%, 6% and 8% (7.8 cm, 8.5 cm, 9.2 cm, and 8 cm).

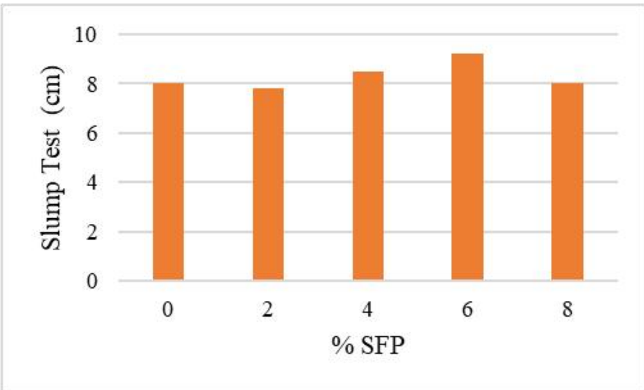

Fig. 4. The graph of slump value.

3.2 The strength of concrete test at 7 and 28 days

The results of Table 8 and Fig. 5 show that the compressive strength of plain concrete without using shellfish shell powder (0%) is 20.477 MPa at the age of 7 days. The compressive strength values of the specimens using 2%, 4%, 6%, and 8% shell powder were 27.365 MPa, 28.497 MPa, 24.723 MPa, and 25.176 MPa. The optimum compressive strength of the specimens using clamshell powder at the age of 7 days was 4% (28.497 MPa).

Testing of concrete at the age of 7 days with different percentages of shell powder obtained almost the same weight of the specimens, namely the average weight of the concrete specimens (0%) of 12.88 kg and the bulk weight of 2,429.25 kg/m3. While the specimens used the variable shell powder of 2%, 4%, 6%, and 8%, the weight of the specimens was 12.730 kg, 12.897 kg, 12.852 kg, and 12.757 kg, and each weighed

2401.89 kg/m3, 2433.33 kg/m3, 2424.84 kg/m3 and 2406.92 kg/m3. The result of testing of the compressive strength of concrete aged 7 (seven) days experienced an insignificant increase where the highest value was at 4% by 28.497 kg, and there was a decrease in variation of 6% to 24,723 kg.

Table 8. The strength of concrete at 7 days old.

Code Specimens	Substitution	Weigth of Cylinders	P Maximum Load (N)	Compressive Strength (MPa)
CNSFP	**0**	**12.880**	**261,666.66**	**20.477**
CSFP2	**2**	**12.730**	**483,333.33**	**27.365**
CSFP4	**4**	**12.897**	**503,333.33**	**28.497**
CSFP6	**6**	**12.852**	**436,666.66**	**24.723**
CSFP8	**8**	**12.757**	**444,667.00**	**25.176**

Table 9 showed that the value of the split tensile strength of plain concrete with the use of shellfish shell powder at variations of 2%, 4%, 6%, and 8% at the age of 7 days experienced an increase in the tensile strength value compared to the split tensile strength of the specimen without using clamshell powder. The average tensile strength of the object test of concrete without using shells powder is 1.915 MPa. The value of the tensile strength of the specimens used clamshell powder at variations of 2%, 4%, 6%, and 8% was 2.094 MPa, 2.084 MPa, 2.094 MPa, and 2.028 MPa. The optimum tensile strength of the specimens in the use of clamshell powder was 2% and 6% of 2,094 MPa. The results of the 7-day split tensile strength test did not include in 9-15% value of the compressive strength of teammates. However, the tensile strength value at 7 (seven) days of age increased with each use of the proportion of clamshell powder.

Table 9. The split strength of concrete at 7 days old.

Code Specimens	Substitution	Weigth of Cylinders	P Maximum Load (N)	Split Strength (MPa)
CNSFP	**0**	**12.990**	**135,333.00**	**1.925**
CSFP2	**2**	**12.937**	**148,000.00**	**2.094**
CSFP4	**4**	**12.768**	**147,333.00**	**2.084**
CSFP6	**6**	**12.713**	**148,000.00**	**2.094**
CSFP8	**8**	**12.992**	**143,333.00**	**2.028**

The compressive strength test aims to produce load data received by the concrete cylinder. The strength of concrete got from calculations between the maximum load and the cross-sectional area of the cylinder. The concrete compression testing at 28 days was shown in Table 10 and Fig. 5.

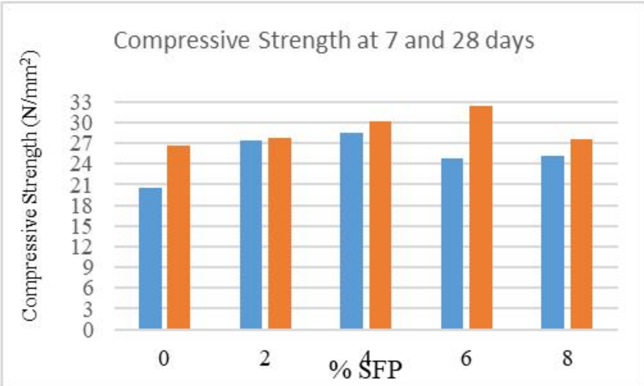

Fig.5. The graph of strength of concrete test at 7 and 28 days.

Fig. 5 shows that in the test, the average compressive strength of powdered shellfish shells concrete 0% of 28 days is 26.610 MPa. Normal concrete was used 2%, 4%, 6%, and 8% powdered clamshells is 27,705 MPa, 30,271 MPa, 32,460 MPa, and 27,554 MPa. Overall, it has shown that the effect of using shellfish powder on the compressive strength of concrete at 28 days has increased in succession. The optimum compressive strength that occurred in 6% of variable was 32.460 MPa.

Table 10. The the strength of concrete at 28 days.

Code Specimens	Substitution	Weigth of Cylinders	P Maximum Load (N)	Compressive Strength (MPa)
CNSFP	**0**	**12.915**	**470,000.00**	**26.610**
CSFP2	**2**	**13.078**	**489,333.33**	**27.705**
CSFP4	**4**	**13.097**	**534,666.67**	**30.271**
CSFP6	**6**	**12.802**	**573,333.33**	**32.460**
CSFP8	**8**	**12.773**	**486,666.67**	**27.554**

Table 10 shows that different percentages of the compressive strength results of concrete have been classified as plain concrete quality classes from the results obtained from the compressive test at 28 days of age, classified based on Nawi (200). The concrete used 0% powdered shellfish shell. It had classified as plain concrete, and also the 2%, 4%, 6%, 8% variables used clam fish shell powder had classified as concrete plain.

Table 11. The split tensile strength of concrete at 28 days.

Code Specimens	Substitution	Weigth of Cylinders	P Maximum Load (N)	Compressive Strength (MPa)
CNSFP	**0**	**12.498**	**165,333.00**	**2.339**
CSFP2	**2**	**12.933**	**182,667.00**	**2.584**
CSFP4	**4**	**12.903**	**170,000.00**	**2.405**
CSFP6	**6**	**12.792**	**156,000.00**	**2.207**
CSFP8	**8**	**12.898**	**170,000.00**	**2.405**

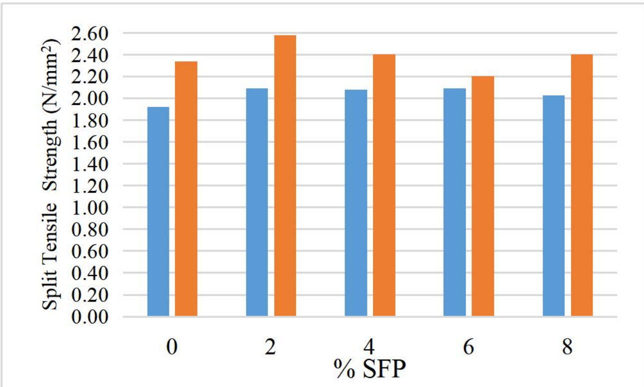

Fig.6. The graph of split tensile strength concrete 7 and 28 days.

Table 11 and Fig. 6 shows that the split tensile strength value of plain concrete with the use of shellfish shell powder at variations of 2%, 4%, 6%, and 8% of 7 and 28 days of age has an increase in split tensile strength compared to the split tensile strength of the test object without the use of shellfish powder. The average split tensile strength of the concrete specimens without the use of shellfish powder is 2,339 MPa. The tensile strength values of the test specimens with the use of shellfish powder with variations of 2%, 4%, 6%, and 8% were 2.584 MPa, 2.405 MPa, 2.207, and 2.405 MPa. The optimum tensile strength of the test object in the use of shellfish shell powder is at a percentage of 2% of 2.584 MPa. The tensile strength of concrete at 28 days has increased if comparated to the results of the tensile strength test at the age of 7 days.

3.3 The Comparison of the Value of Compressive Strength and Tensile Strength of Normal Concrete Age 28 Days

The Fig. 10 and Table 12, it can be seen that the compressive and split tensile strength test on average showed the compressive strength and split tensile strength of plain concrete without the use of shellfish powder (0% loose shell powder) at the age of 28 days is 26.610 MPa and 2.339 MPa. The compressive strength and split tensile strength of the test object using powdered shells of shellfish 2%, 4%, 6%, and 8%, were resulted in 27.705 MPa and 2.584 MPa, 30.271 MPa and 2.405 MPa, 3.460 MPa and 2.207 MPa, and 27,554 MPa and 2,405 MPa. The results show has been an increase in the compressive strength and tensile strength of concrete using loose shell powder. The optimum compressive strength at a percentage of 6% using shellfish powder is 32.460 MPa, while the optimum split tensile strength is at a 2% clam fish powder was 2.584 MPa.

From the results of testing the split tensile strength of concrete with the same proportion of the mixture, so that the value of the relationship between compressive strength and split tensile strength was theoretically obtained. Based on the theory of Nawi (2000), a good approach to calculate the tensile strength of concrete (f'ct) is the formula 0.1 f'c < f'ct <0.2 f'c. The theoretical relationship between compressive strength and split tensile strength is seen in Table 11. The split tensile strength of normal concrete without shellfish powder is 2.339 MPa, which is not in the range of 2.661 – 5.322 MPa. The split tensile strength of concrete using loose shell powder at a percentage of 2% is 2.584, which is not in the range of 2.770 - 5.541 MPa. The split tensile strength of concrete using shellfish shell powder at a percentage of 4% is 2.405, which is not in the range of 3.027-6.054 MPa. The split tensile strength of concrete using shellfish powder at a percentage of 6% was 2.207 MPa, which was not in the range 3.246-6.492 MPa. While the split tensile strength of concrete using loose shells powder with a percentage of 8% is 2.405 MPa, which is also not in the range of 2.755 - 5.511 MPa. The percentage values at the age of 28 days at 0%, 2%, and 8% are in the range, while the 4% and 6% percentages do not fall within the range of the compressive strength values. The split tensile strength value at the age of 28 days has a quite good increase from the split tensile strength value at the age of 7 days because the older the concrete increases the tensile strength value of the concrete also increases, and because there is also a factor of adding powdered shells of shellfish in each percentage.

Table 12. The relationship between compressive strength and split tensile strength of concrete .

Code Specimens	Substitution	Compressive Strength (MPa)	Split tensile strength (laboratorium)	Split tensile Strength (Nawi, 2000) (MPa)
CNSFP	**0**	**26.610**	**2.829**	**2.661 - 5.322**
CSFP2	**2**	**27.705**	**2.548**	**2.770 – 5.541**
CSFP4	**4**	**30.271**	**2.405**	**3.027 – 5.541**
CSFP6	**6**	**32.460**	**2.207**	**3.246 – 6.492**

CSFP8	**8**	**27.554**	**2.405**	**2.755 – 5.511**

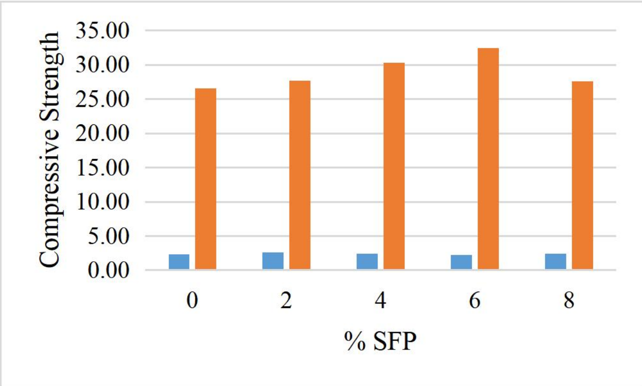

Fig.7. The graph of relationship of compressive strength and split tensile strength concrete of strength of concrete test at 28 days old.

4 Conclusion

The results showed that the use of clamshell powder could reduce the slump value. The percentage of shellfish powder substitution increased, the concrete mixture become less liquid were indicated by a decreased slump value. The result showed that the higher the percentages of shellfish powder used, the higher the water absorption capacity of the concrete.

The average compressive strength of the specimens in the compressive strength test of 7-day-old concrete using shells powder 0%, 2%, 4%, 6% and 8% of the cement weight is the concrete compressive strength of 20,477 MPa, 27,365 MPa, 28,497 MPa, 24,723 MPa, and 25,176 MPa.

The average compressive strength of control specimens in the compressive strength test at 28 days using shell powder with substitution variations of 0%, 2%, 4%, 6%, and 8% by weight of cement, the compressive strength of concrete is 26,610 MPa, 27,705 MPa, 30,271 MPa, 32,460 MPa, and 27,554 MPa. Based on the test results of normal concrete compressive strength at the age of 7 and 28 days showed the optimum compressive strength in the use of shells powder with a percentage of 4%, namely 28.497 MPa and 6%, namely 32.460 MPa. This shows a significant efficiency in the use of cement for concrete mix.

It has been estimated that the effect of shellfish shell is highest on the compressive strength of concrete. It was due to a large amount of lime content in the shellfish powder so that it increases the optimum compressive strength at 4% substitution. The effect on the splitting strength of the shellfish powder is not too influential on the increase in the split tensile strength of the concrete.

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