

The Effect of Shell as a Substitution of Coard Aggregate with Superplasticizer Additional on the Compression Strength of Concrete

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ABSTRACT

Concrete is a type of building structure material, both buildings, bridges, and roads. Concrete is a construction material obtained from mixing sand, gravel, or crushed stone, cement, and water. To improve the properties of concrete, several kinds of additives that have certain functions are added to the concrete mixture, to improve or improve the properties of concrete, namely increasing the workability, durability, and hardening time of the concrete. Shells with excellent quality and shape are used as craft materials, while bad shapes can cause waste which results in a series of other problems, especially the cleanliness of the surrounding environment. This study aims to determine the effect of shells as a substitution of coarse aggregate with superplasticizer added material on the compressive strength of concrete. The specimens used were cylindrical with a diameter of 15 cm and a height of 30 cm. The composition of the shells determined in this study was 0%, 5%, 10%, 15%, 20% and 0.5% superplasticizer added. The planned concrete quality is $F_c = 25\text{MPa}$. The value of the compressive strength of concrete increased with the addition of shells by 5% and decreased in the addition of shells above 5% with 0.5% superplasticizer added. The compressive strength of normal concrete and 0.5% superplasticizer concrete is 28.26 MPa and 29.15 MPa at the age of 28 days and the compressive strength of shell concrete with a composition of 5%, 10%, 15%, and 20% added with superplasticizer 0,5% produces a compressive strength of 30.78MPa; 26.78MPa; 24.71 MPa, and 22.93 MPa at the age of 28 days.

Keywords: *compressive strength, Blood clam shell, Superplasticizer*

1. INTRODUCTION

1.1. Background

The need for housing for the people of Indonesia is increasing. This is accompanied by an increase in the number of people in the country. To meet the needs of cheap and decent housing for the people in the country, innovative steps are needed by utilizing existing waste.

Environmentally friendly concrete is concrete composed of environmentally friendly materials. An example of environmental damage due to the use of natural resources is the destruction of rock hills. The increasing need for concrete materials triggers the mining of stone, one of the constituent materials of concrete as coarse aggregate, on a large scale which causes a decrease in the number of natural resources available for

concrete purposes. Coarse aggregate is the most dominant constituent of concrete. The shells are made of lime so that it can be used as a coarse aggregate for concrete.

In this study, shell waste was used as a substitute for coarse aggregate. Indonesia is an archipelagic country, with millions of potentials. With an area of 5.8 million km of water and a coastline of 81,000 km, Indonesia has enormous potential in terms of managing marine resources, one of which is shellfish.

So far, most people, especially the Kenjeran area, only use mussel meat, while clam shells have not been used optimally. This causes problems in the form of shellfish waste that accumulates in coastal areas. Considering the composition of mussel shells is more than the meat, which is about 70% shell and 30% meat.

So far, some of the shells of excellent quality and shape are used for craft materials, while those that are not utilized have caused a series of other problems, especially environmental hygiene, thus disturbing the health of the surrounding community. One of the ways to use shells is to substitute them for making concrete. Shellfish is a waste that can be used as a substitute for coarse aggregate.

Research on the use of clam shells is still being developed to get a better composition of ingredients. The percentage of clam shells as well as the addition of appropriate superplasticizer additives are still being conducted. The use of different superplasticizers will affect the result. In this study, the superplasticizer used was 0.5% polycarboxylate superplasticizer for all concrete mixtures.

In the literature review according to I.G.A. Neny Purnawirati and Fransiska Moi (2021) [3] in the results of the study using flying ash added materials and superplasticizers amounting to 0.4% of cement weight obtained strong concrete press results of 14.34 MPa at the age of 28 days and 18.12 MPa at the age of 56 days. Meanwhile, based on the results of the research of Restu Andika and Hendramawat Aski Safarizki (2019) [5] regarding the utilization of shell shells on strong concrete presses obtained an increase of 7 MPa in a mixture of 5% and 3 MPa in a mixture of 7.5%.

According to Andi Afdilla Amiruddin, et al. (2017) [2] regarding the utilization of kerrang shell waste and ceramic waste as a substitute for fine aggregates and coarse aggregates obtained strong decreases in concrete press by 10.94%, 3.80%, 23.60% and 25.88% against normal concrete mixtures. Related research was also conducted by Sudirman Latjemma, et al. (2020) [8] on the use of kerrang skin as a coarse aggregate obtained a mixed result of 5% 25.92 MPa, a mixture of 10% 24.28 MPa and 32.11 MPa, and a mixture of 15% 23.02 MPa and 34.92 MPa.

In addition, Rinaldhi Ridha and Hieryco MManalip (2020) [6] also conducted research on the effect of the use of rice conch caangkang powder as cement substitusi obtained partial substitution results can only be done with a maximum addition of 5%.

Based on the above background, the problems that will be discussed in this research are:

1. What are the characteristics of the compressive strength of concrete with shellfish proportions of 0%, 5%, 10%, 15%, and 20% as a substitute for coarse aggregate and superplasticizer added with a concentration of 0.5% in the concrete mixture?
2. What is the percentage of addition of shells as a substitute for coarse aggregate in the concrete

mixture to produce optimal concrete compressive strength?

3. What is the effect of adding superplasticizer to shell concrete?

1.2. Concrete

Concrete is a set of mechanical and chemical interactions of the constituent materials and meets the limit strength required by the planner and meets serviceability which can also be interpreted as reliable service by meeting economic criteria. [4]. The definition of concrete is a mixture of Portland cement or other hydraulic cement, fine aggregate, coarse aggregate, water, with or without additives that form a solid mass.

1.3. Blood Clam Shell

Blood clams belong to the family Arcidae and the genus Anadara. Blood clams belong to the class Lamellibranchiata along with oysters, mussels, and the like. The following is the chemical composition of blood clam shells:

Table 1. Chemical Composition of Blood Shells

chemical components	Composition (%)
CaO	66,70
SiO ₂	7,88
Fe ₂ O ₃	0,03
MgO	22,28
Al ₂ O ₃	1,25

(Source: Addriyanus, 2015) [1]

1.4. Additives

Admixtures are materials that are added to a concrete mixture other than cement, aggregates, and water. This added material is given immediately before or when the process of mixing the concrete mixture begins. In general, the function of added materials is to produce concrete that is better in terms of workmanship, quality, and economy. [7].

A slump of concrete is an indicator of the dilution of concrete. In terms of implementation, the slump figure shows the ease of workability (workability). The thinner the concrete, the easier it is to work, but the thickness of the concrete mixture has certain limitations, according to the type of construction. Too thick concrete will easily become brittle and break easily, too watery-even concrete will flow easily and have low strength.

1.5. Compressive Strength of Concrete

The main strength of concrete is its compressive strength. The value of the compressive strength of concrete increases with increasing age and at the age of

28 days, the concrete reaches its maximum strength. 28 days old. The loading on the compressive strength test is in the form of a load that works continuously distributed through the center of gravity. The formula for calculating the compressive strength of concrete, namely:

$$f'c = \frac{P}{A}$$

Information:

$f'c$ = compressive strength of concrete (kg/cm²)

P = load (kg)

A = cross-sectional area (cm²)

2. RESEARCH METHODS

2.1. Tools and materials

The manufacture and testing of the compressive strength of the specimens were conducted at the Materials Testing Laboratory of the Civil Engineering Department of the Sriwijaya State Polytechnic, Palembang. Concrete making materials are as follows: coarse aggregate, fine aggregate, Portland cement, shells, and additives (Superplasticizer).

Meanwhile, the equipment used included: equipment for the source of aggregate (a set of 0.075 mm to 38 mm sieves, a density spoon, scales, brushes, a set of truncated cones, cylindrical vessels, pounding rods, and Rudolf's vessels); equipment for sourcing cement (a set of mixers, a spatula, a set of Vicat tools, and a le chatelier tube); equipment for casting sources (stir box, stirrer, cylindrical vessel, spec box, density spoon, a set of Abrams cones).

2.2. Test Object

Concrete is a set of mechanical and chemical interactions of the constituent materials and meets the limit strength required by the planner and meets serviceability which can also be interpreted as reliable service by meeting economic criteria. [4]. The definition of concrete is a mixture of Portland cement or other hydraulic cement, fine aggregate, coarse aggregate, water, with or without additives that form a solid mass.

The sample used is a cylinder with a diameter of 15 cm and a height of 30 cm. Samples were tested at the age of 7,14, and 28 days. The number of samples is 54 samples as shown in the following table:

Table 2. Research Sample

No.	Test object code	Blood Clam Shell (%)	Testing Age (Days)		
			7	14	28
1	BN	-	3	3	3
2	BSP	-	3	3	3
5	BK5% SP 0,5%	5	3	3	3
4	BK10% SP 0,5%	10	3	3	3
5	BK15% SP 0,5%	15	3	3	3
6	BK20% SP 0,5%	20	3	3	3
TOTAL			54		

Information:

BN	: Normal Concrete
BSP	: Concrete Superplasticizer
BK5% SP0.5%	: 5% Shell Concrete superplasticizer 0.5%
BK10% SP0.5%	: 10% Shell Concrete superplasticizer 0.5%
BK15% SP0.5%	: Concrete Shells 15% superplasticizer 0.5%
BK20% SP0.5%	: 20% Shell Concrete superplasticizer 0.5%

3. RESULTS AND DISCUSSION

3.1. Calculation of Concrete Mix (Mix Design)

This concrete mix design uses the SNI 03-2834-2000 standard. The provisions used for this concrete mixture are as follows: (i) concrete with a compressive strength of FC 25MPa for 28 days; (ii) Batu Raja Type 1 Portland cement is used; (iii) the design slump height is taken from 60-180 mm; (iv) the maximum coarse aggregate grain size is 40 mm; (v) fine aggregate used zone 2; (vi) maximum water-cement factor of 0.52; (vii) the number of shells is taken from the percentage of coarse aggregate.

3.2. Concrete Compressive Strength Test Results

Table 3. Mixed Proportion

NO.	Cement (kg/m ³)	Water (Kg/m ³)	coarse aggregate (Kg/m ³)	fine aggregate (Kg/m ³)
1	394,23	135,903	657,676	1087,201

Table 4. Compressive Strength of Concrete

No.	Test object code	Average Compressive Strength of Test Objects at Age (MPa)		
		7	14	28
1	BN	18,37	24,87	28,26
2	BSP	18,95	25,65	29,15
5	BK5% SP 0,5%	20,00	27,08	30,78
4	BK10% SP 0,5%	17,41	23,57	26,78
5	BK15% SP 0,5%	16,06	21,74	24,71
6	BK20% SP 0,5%	14,91	20,18	22,93

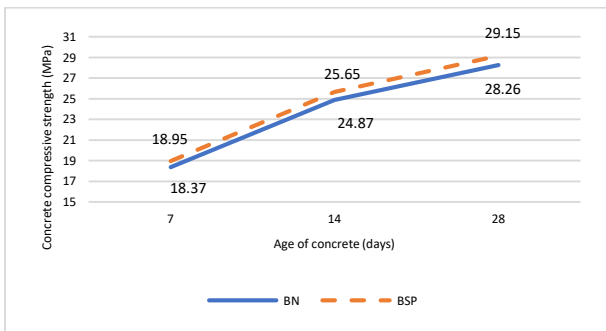


Figure 1 Graph of Compressive Strength Test for Normal Concrete and Superplasticizer Concrete

From Figure 1, the average compressive strength of normal concrete at the age of 7, 14, and 28 days is 18,37 MPa; 24,87 MPa; and 28,26 MPa. while the compressive strength of concrete with 0.5% superplasticizers added at the age of 7, 14, and 28 days was 18,95 MPa; 25,65 MPa; and 29,15 MPa. From the results of testing the compressive strength of concrete with 0.5% superplasticizer added material, it increased at the age of 28 days by 29,15 MPa compared to normal concrete compressive strength of 28,26 MPa.

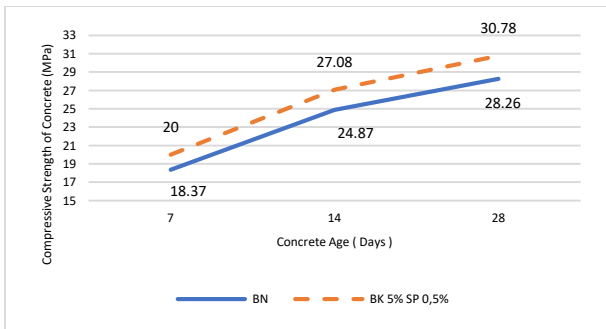


Figure 2 Graph of Compressive Strength Test of Normal Concrete and Shells 5% Superplasticizer 0.5%

From Figure 2, the average compressive strength of normal concrete at the age of 7, 14, and 28 days is 18,37 MPa; 24,87 MPa; and 28,26 MPa. while the compressive strength of concrete with added 5% shellfish superplasticizers 0,5% at the age of 7, 14, and 28 days is 20,00 MPa; 27,08 MPa; and 30,78 MPa. From the results of testing the compressive strength of concrete with added material of 5% shellfish superplasticizers 0,5% increased at 28 days of age by 30,78 MPa compared to normal concrete compressive strength of 28,26 MPa.

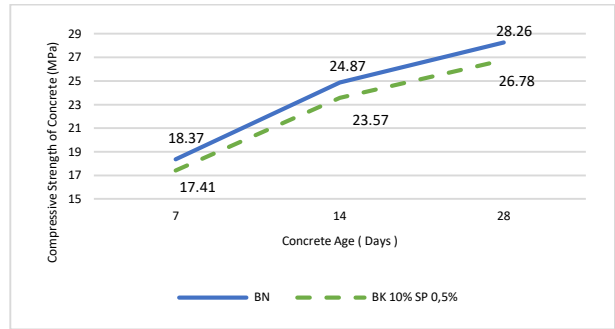


Figure 3 Graph of Compressive Strength Test of Normal Concrete and Shells 10% Superplasticizer 0.5%

From Figure 3, the average compressive strength of normal concrete at the age of 7, 14, and 28 days is 18,37 MPa; 24,87 MPa; and 28,26 MPa. while the compressive strength of concrete with 10% superplasticizers 0.5% shells added at the age of 7, 14, and 28 days was 17,41MPa; 23,57 MPa; and 26,78 MPa. From the results of testing the compressive strength of concrete with added material of shellfish 10% superplasticizer 0.5% decreased at 28 days of age by 26,78 MPa compared to normal concrete compressive strength of 28,26 MPa.

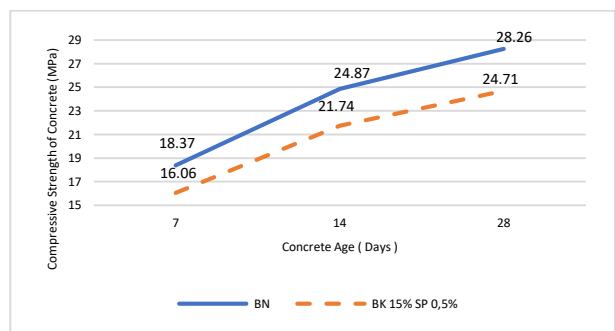


Figure 4 Graph of Compressive Strength Test of Normal Concrete and Shells 15% Superplasticizer 0.5%

Figure 4 shows that the average compressive strength of normal concrete at the age of 7, 14, and 28 days is 18,37 MPa; 24,87 MPa; and 28,26 MPa. while the compressive strength of concrete with 15% superplasticizer 0.5% shells added at the age of 7, 14, and 28 days was 16,06 MPa; 21,74 MPa; and 24,71 MPa.

From the results of testing the compressive strength of concrete with added material of 15% superplasticizer 0.5% shells, decreased at 28 days of age by 24,71 MPa compared to normal concrete compressive strength of 28,26 MPa.

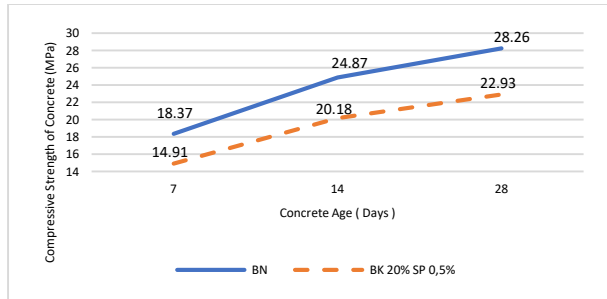


Figure 5 Graph of Compressive Strength Test of Normal Concrete and Shells 20% Superplasticizer 0.5%

Figure 5 shows that the average compressive strength of normal concrete at the age of 7, 14, and 28 days is 18,37 MPa; 24,87 MPa; and 28,26 MPa. while the compressive strength of concrete with 20% superplasticizers added shells of 0.5% at the age of 7, 14, and 28 days was 14,91 MPa; 20,18 MPa; and 22,93 MPa. From the results of testing the compressive strength of concrete with added ingredients of 20% superplasticizers 0.5% shells decreased at 28 days of age by 22,93 MPa compared to normal concrete compressive strength of 28,26 MPa.

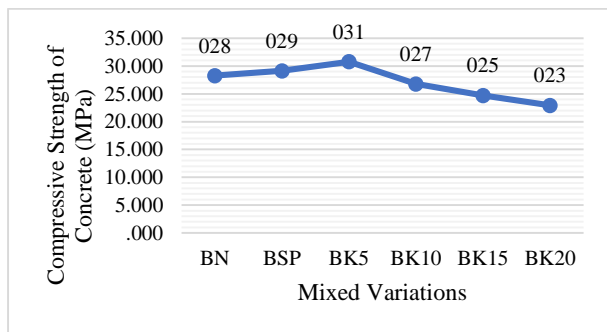


Figure 6 Comparative Graph of the Effect of Addition of Shellfish Shells and 0.5% Superplasticizer

From Figure 6. at the age of 28 days, the normal compressive strength of concrete without a mixture of shells and superplasticizer is 28.26 MPa, the compressive strength of concrete with the addition of 0.5% superplasticizer is 29.15 MPa, and the compressive strength of concrete with the addition of shells 5 %; 10%; 15; and 20% with 0.5% superplasticizer which is 30.78MPa; 26.78MPa; 24.71MPa; and 22.93MPa. That the compressive strength of concrete has increased after the addition of a superplasticizer and experienced a considerable increase after adding 5% shells, but after adding shells exceeding 5% composition, the compressive strength of concrete experienced a

considerable decrease, so that the composition of the addition of shells was good. for concrete mixtures not to exceed 5%.

4. CONCLUSION

Based on the test results, the compressive strength of normal concrete and 0.5% superplasticizer concrete is 28.26MPa and 29.15MPa, while the compressive strength of shell concrete with a composition of 5%, 10%, 15%, and 20% added with superplasticizer 0, 5% yielded compressive strength of 30.78 MPa, 26.78 MPa, 24.71 MPa, and 22.93 MPa. The compressive strength of concrete increased after being added with 0.5% superplasticizer added and for the addition of shells it increased at a percentage of 5% while the compressive strength of concrete with the addition of shells above 5% decreased, so that the characteristics of a good concrete mixture to use were shell concrete. shellfish with a composition of 5% with added material as superplasticizer as much as 0.5%.

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