

# The Effect of Variations of Mussels and Egg Shells on SCC (Self-Compacting Concrete)

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**Abstract:** Self-Compacting Concrete (SCC) could flow and fill molds without compaction (vibrator). use of cement in concrete mixes is crucial, resulting in increasing construction projects. Therefore, ideas or innovations are needed to reduce cement use by utilizing shellfish and eggshells as cement substitutes. This study used a quantitative method taken through experiments aimed at observing the effect of adding shells and eggshells as cement substitutes in Self-Compacting Concrete (SCC) concrete, with variations in eggshell substitution of 0%, 1.5%, 2.5%, 3.5%, and 4.5%, as well as a shell substitution of 5%, with a concrete compressive strength of 21 MPa, made of cylinders with a diameter of 15 cm and a height of 30 cm, testing fresh concrete using the slump flow method and concrete compressive strength testing was carried out at the ages of 3 days, 7 days, and 28 days. The compressive strength test results for the 28-day immersion in PDAM water yielded a maximum concrete compressive strength of 39.71 MPa at the 1.5% variation, and a minimum compressive strength of 31.22 MPa. The 7-day immersion in PDAM water yielded a maximum compressive strength of 26.35 MPa at the 1.5% variation, and a minimum compressive strength of 21.76 MPa at the 4.5% variation. Furthermore, for the 3-day immersion, the highest compressive strength at the 1.5% variation, with a compressive strength of 27.50 MPa, and the minimum achieved at the 4.5% variation, with a compressive strength of 24.07 MPa.

**Keywords:** Concrete Compressive Strength, Eggshell, Seashell, Self Compacting Concrete

## 1. Introduction

Over time, developments and advances in civil engineering technology have also necessitated various discoveries and innovations aimed at creating strong, durable, cost-effective structures that are able to utilize available natural resources. One such innovation is the use Self Compacting Concrete (SCC) in building construction.

Self-Compacting Concrete (SCC) is one of the innovative applications in the field of construction. SCC is concrete that can compact itself with a high slump value, in the process of

placing it in the formwork (Placing) and the compaction process (compaction), and SCC does not require a vibrator or compactor like conventional concrete. SCC also has high flowability, enabling it to flow into the formwork and achieve its maximum density on its own [1] general, SCC concrete consists of fine aggregate, coarse aggregate, water, admixtures, additives, and cement. Cement, as one of the main materials in the manufacture of SCC concrete, also plays a very important role in determining the quality and

performance of concrete. The use of the right type of cement and its proportion in the SCC concrete mixture greatly affects the flowability and final strength produced.

Cement of use in mixes is concrete very important, so that the more construction projects there are, the greater the use of cement, considering that 8-10% of total global CO<sub>2</sub> emissions come from the cement manufacturing process. ideas or innovations are needed to reduce or even end this problem, concrete innovations that consider environmental aspects are crucial to reduce excessive cement consumption and address advancements in civil engineering. an alternative material is needed to reduce cement usage by utilizing shell and eggshell as a partial substitute for cement, as shell and eggshell contain calcium oxide (CaO), magnesium oxide (MgO), and silica (SiO<sub>2</sub>), similar to those found in cement.

Self-Compacting Concrete (SCC) concrete that does not require vibrating equipment to compact with a sufficiently high slump value. The time and cost efficiency in the manufacture of SCC allows for the achievement of concrete quality in accordance with the plan. Concrete technology has developed so that it can meet various performance requirements that were previously unavailable, one of which is more specific fluidity, namely requiring fresh concrete made with a thin consistency without segregation, so that the flow performance of the concrete can be measured.

Based on the background and several key reasons, both in terms of concrete technology, waste utilization, and contribution to sustainable development, this research for mechanical properties SCC concrete using shell and eggshell substitutes.

This research is expected to contribute significantly to the field of materials engineering, particularly concrete, by introducing more environmentally friendly alternative materials to replace some of the cement, utilizing waste that is not properly utilized, and reducing the environmental impact and being more environmentally friendly and economical in the use of materials for concrete, particularly SCC concrete. and to provide an alternative solution for creating more efficient, cheaper, and more environmentally friendly concrete, as well as opening up new business opportunities for the production of cement substitute materials based on natural waste.

## 2. Literature Review

### 2.1. Concrete

Concrete is a building material and one of the most commonly used construction materials for bridges, roads, and buildings. Concrete is a mixture of several materials that form a single unit. Concrete is made from cement, fine aggregate, coarse aggregate, water, and admixtures. As it ages, concrete hardens and reaches its design strength (f<sub>c</sub>) at 28 days[2].

### 2.2. Self-Compacting Concrete (SCC)

Self-Compacting Concrete (SCC) is an innovative type of concrete that does not require vibration to fill spaces and compact. SCC concrete is able to flow under its own weight to completely fill formwork and achieve perfect density, even in constructions with dense reinforcement designs. SCC concrete

can flow faster on its own, thereby speeding up the casting process. SCC (Self-Compacting Concrete) is a type of concrete designed to fill molds and narrow spaces in reinforcement without segregation or separation of materials. It has good durability, so it can last a long time and withstand various environmental factors. It is more homogeneous and stable, with compressive strength made for high or very high quality and is more impervious. It has lower porosity, lower shrinkage, and a better and smoother concrete appearance. The production process of SCC requires an admixture in the form of a superplasticizer, which functions to improve flowability. The use of superplasticizers allows for a reduction in the water-cement ratio to a value of w/c = 0.3 or less[3]

### 2.3. Mussels

Mussels contain pozzolanic compounds, namely lime (CaO), alumina, and silica compounds, making them a potential alternative ingredient in concrete mixtures[4]. Shell waste has the potential to replace lime in cement production because the composition of waste that has been burned at a temperature of 700o C produces 55.10% CaO[5]



*Figure 1. Mussels Powder*

### 2.4. Egg shells

Eggshells become useless waste if their potential is not utilized as an alternative material for concrete mixtures. Additionally, similar research conducted[6].using eggshells produced an optimum compressive strength value of 23.19 MPa at a percentage of 2.5% relative to cement, confirming that eggshells can be used to make environmentally friendly concrete.



*Figure 2. Egg Shells Powder*

## 2.5. Sika Viscocrete-3115N

Polycarboxylate-based superplasticizers have made it possible to obtain high-flowable and self-compactable fresh concrete, in which fresh concrete is able to flow and compact using its own weight, resulting in hard concrete that is completely dense or compact without the need for compaction or vibration processes. Fresh concrete that belongs to the self-compacting concrete (SCC) category has a very high slump value (more than 20 cm), making measurement with an Abrams cone ineffective. Concrete produced with Sika Viscocrete-3115N exhibits excellent flowability (resulting in reduced placement and compaction efforts), strong self-compacting ability, extreme water reduction (demonstrated by high density and strength of concrete), reduced shrinkage and cracking, improved resistance to carbonation in concrete, improved finish, and Sika Viscocrete-3115N does not contain chlorine or other materials that can cause rust or be corrosive to steel reinforcement. Therefore, it is suitable for use in reinforced or prestressed concrete. Sika Viscocrete-3115N provides concrete with long workability, and depending on the mixing design and quality of materials used, self-compacting particles can be maintained for more than 1 hour at 30°C. For concrete mixes, use 0.8 - 2% of the binder weight of Sika Viscocrete 3115N[7].



Figure 3. Sika Viscocrete-3115N

## 3. Methodology

The research method used was quantitative, which is a research method that collects data from a large number of experiments. This study investigated the compressive strength of SCC (Self Compacting Concrete) using shell and eggshells as cement substitutes. The research method is designed to facilitate the implementation of a study so that it runs more accurately, effectively, and efficiently. The stages of the implementation procedure are illustrated in a flowchart.

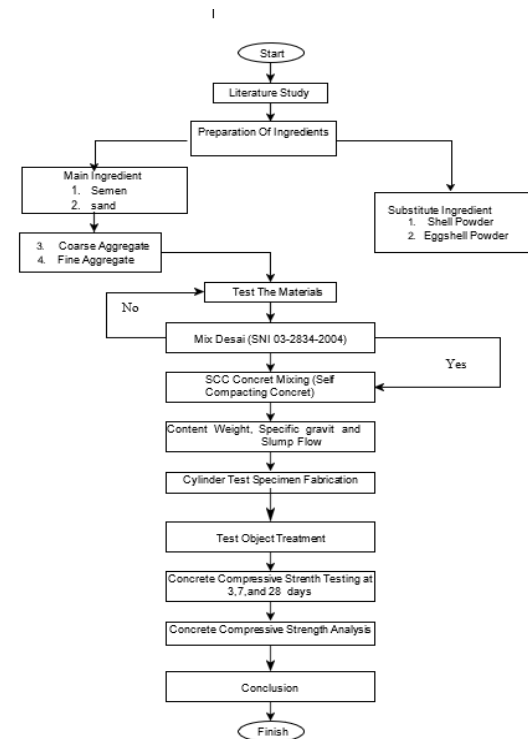


Figure 4. flowchart

Researchers also collected primary and secondary data. The primary data collected included testing the moisture content of coarse and fine aggregates, specific gravity and absorption tests of coarse and fine aggregates, bulk density tests of coarse and fine aggregates, sieve analysis tests of coarse and fine aggregates, abrasion and wear tests of coarse aggregates, and secondary data obtained in the form of references or journals related to research on concrete testing with substitute materials and SNI (Indonesian National Standards) regarding research on concrete mix designs.

### 3.1. Aggregate Characteristic Testing

Table 1 Aggregate Characteristic Testing

No	Test	Test Standard
A	Coarse Aggregate	
	1 Moisture Content	SNI 03-1971-2011[8]
	2 Specific Gravity and Absorption	(SNI 1969:2016)[9]
	3 Bulk Density	SNI 1973:2008
	4 Gradation	SNI 03-1968-1990
B	Fine Aggregate	
	1 Moisture Content	SNI 03-1971-1990
	2 Specific Gravity and Absorption	(SNI 1970:2016)[11]
	3 Bulk Density	SNI 1973:2008
	4 Gradation	SNI 03-1968-1990

### 3.2. Creating SCC Concrete Mix Designs and Making Test Specimens

The SCC concrete design uses (SNI 03 – 2834 – 2000)

[12]with a planned compressive strength of 21 MPa. Based on the aggregate test results, the mix design was made with the addition of 2% superplasticizer of the cement weight. After that, test specimens were made with different variations of the mix used. The test specimens were made using a cylindrical mold with a diameter of 15 cm and a height of 30 cm with 6 variations of test specimens as follows: (1) SCC concrete with 1.5% eggshell and 5% mussels variation (2) SCC concrete with 2.5% eggshell and 5% mussels variation (3) SCC concrete with 3.5% eggshell and 5% mussels variation (4) SCC concrete with 4.5% eggshell and 5% mussels variation Each variation was tested with three specimens each, cured for 3, 7, and 28 days.

### 3.3. Fresh Concrete Testing

Fresh concrete testing using the Slump Flow test method. This method is used to evaluate the ability of SCC concrete to flow and fill the mold. This test involves measuring the flow distance of SCC concrete after it is released from the mold. The slump flow test is conducted by pouring concrete paste into an Abraham cone. Once full, the cone is lifted and the diameter of the fresh concrete is measured to determine the slump flow value. The slump flow test is the simplest way to assess the flowability and workability of SCC concrete. The quality control of SCC concrete can be seen from the final diameter of the slump flow test and the results of the slump flow test or the diameter width of the SCC concrete paste. Based on the SCC specifications from EFNARC, it is required to be between 600 – 800 mm. After obtaining the slump flow test results, the concrete is then cast into a cylinder test mold.

### 3.4. Compressive Strength Testing

The test specimens were left undisturbed for 24 hours before the compressive strength test was conducted. The concrete compressive strength test was conducted after the SCC concrete had aged for three days using a compressive strength testing machine. The compressive strength was calculated by dividing the maximum load by the cross-sectional area in accordance with SNI [13].concrete specifications. The test was conducted on three test specimens, and the compressive strength was obtained from the average compressive strength of the three test specimens.

## 4. Result and Discussion

### 4.1. Result

*Table 2 Aggregate test results*

No	Testing	Fine Aggregate	Coarse Aggregate
1	Moisture Content	3.208 %	1.276%
2	Specific Gravity and Absorption		
	- Bulk Specific Gravity	2.625	2.751
	- SSD Specific Gravity	2.649	2.763
	- App Specific Gravity	2.688	2,785
	- Absorption	0.882	0.444
3	Bulk Density	1.630	1.520
4	Sieve Analysis	Zone 2	-

No	Testing	Fine Aggregate	Coarse Aggregate
5	Abrasion		B gradient

*Table 3 Slump Flow Test Results*

Variasi	Slump flow value (mm)	average (mm)
1.5%+5%	640	646,66
	620	
	700	
2.5%+5%	630	626,66
	630	
	620	
3.5%+5%	620	640
	660	
	640	
4.5%+5%	640	620.66
	610	
	630	

*Table 4 Concrete compressive strength test results*

Age/variation	Compressive strength (MPa)		
	3 days	7 days	28 days
1.5%+5%	27.502	26.350	39.706
2.5%+5%	26.747	24.957	37.537
3.5%+5%	25.182	22.926	33.670
4.5%+5%	24.069	21.765	31.218

### 4.2. Discussion

This study will only discuss the results of concrete compressive strength from variations in the mixture over 3, 7, and 28 days.

#### 4.2.1. Compressive strength for concrete aged 3 days

Based on the results of testing the compressive strength of concrete at 3 days, the highest compressive strength value was found in the 1.5% + 5% variation with an average value of 27.502 MPa, while the lowest value was found in the 4.5% + 5% variation with an average value of 24.069 MPa.

#### 4.2.2. Compressive strength for concrete aged 7 days

Based on outcome of testing the compressive strength of concrete at 7 days, the highest compressive strength value was found in the 1.5% + 5% variation with an average value of 31.457 MPa, while the lowest the value obtained in the 4.5% + 5% variation with an average value 21.765 MPa.

#### 4.2.3. Compressive strength for concrete aged 28 days

Based on the results of testing the compressive strength of concrete aged 28 days, the highest compressive strength value was found in the 1.5% + 5% variation concrete with average compressive strength his worth 39.706 MPa, while the lowest value at 3 days was found in the 4.5% + 5% variation with an average value 31.218 MPa.

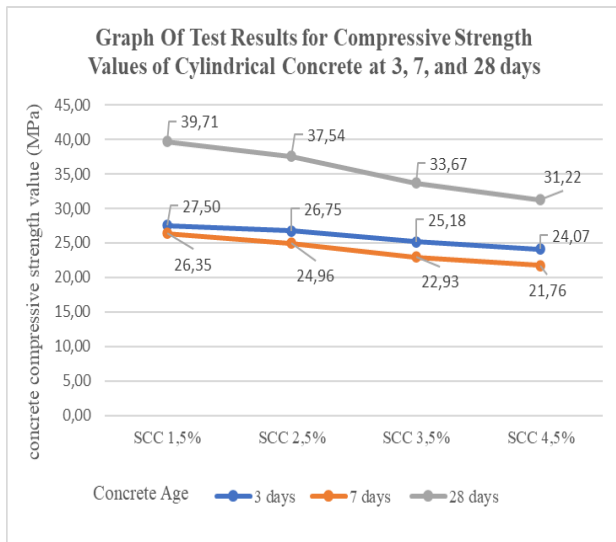


Figure 5. Compressive Strength Chart for Concrete at 3, 7, and 28 Days

## 5. Conclusion

From the study conducted and, it can be concluded that in this study the highest concrete compressive strength was obtained at 28 days of immersion with a variation of 1.5% which was 39.7062 MPa, while the lowest compressive strength at a variation of 4.5% was 21.7648 MPa at 7 days of immersion. The addition of shell powder and eggshell powder to concrete mixture resulted in a significant decrease in concrete compressive strength.

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