Modified concrete mix design using Sikacim, Sika Bonding, Lumajang Sand and Silica Sand

A B Ramadhan, A I Candra, D A Karisma*, A Ridwan, I Wibisono and Y S Muslihun

Civil Engineering Department, Kadiri University, Kediri, Indonesia

*dwifiaprilliakarisma@gmail.com

Abstract. The development of construction makes concrete a common and important building material used. Concrete is a composite material consisting of a mixture of aggregate cement, water with or without the use of added ingredients. In this era, concrete added materials are needed to meet construction needs. One of the added ingredients is Sikacim Concrete Additive and Sika Bonding Adhesive. Sikacim is able to accelerate hardening of concrete while sika bonding is able to increase adhesion. In addition to added materials, the quality of concrete constituent materials also influences the manufacturing of concrete. This study aims to modify the proportion of concrete mix using Lumajang sand and silica sand with the addition of added ingredients Sikacim Concrete Additive and Sika Bonding Adhesive. The test specimen used is in the form of a cube with a size of 15x15x15 cm. The method used is an experimental method with compressive strength testing carried out when the age of concrete reaches 3, 7, 14, and 28 days. Compressive strength testing using universal testing machine. Testing results optimum obtained compressive strength value generated is 944 kg/cm² in 28 days.

1. Introduction

The development of the world of construction is driving the increasing use of concrete as a structure strengthening material [1]. This is inseparable from the demands and needs of the community for increasingly advanced infrastructure facilities, such as bridges with long and wide spans, high-rise buildings (especially for columns and precast concrete), and other facilities [2]. The planning of these facilities leads to the use of high strength concrete that includes strength, durability, service life, and efficiency [3,4]. High strength concrete has a compressive strength of 60 Mpa-100 Mpa [5].

High Strength Concrete became a breakthrough developed in recent decades. High strength concrete has advantages compared to Normal Strength Concrete. High strength concrete has better resistance to acid, fire, and long-term resilience [6]. Determination of the optimum composition of each concrete constituent material and the methods that will be used during the process of making High Strength Concrete is essential [7]. Concrete generally consists of cement, aggregate, water, and admixture [8-10]. admixture need for high strength concrete [11]. Admixture could be divided into two, namely additives and chemical admixture [12]. Admixture are used to modify the properties and characteristics of concrete [13]. Admixture is mixed with cement or mortar, which is added before or during the stirring [14]. One of the added ingredients is Sikacim Concrete Additive (Superplasticizer), which serves to speed up the hardening process, reduce the amount of water, and facilitate casting. Reducing the amount of water is one way to get high strength concrete [15,16].
In making high strength concrete, it is determined by Mix Design, calculating and choosing concrete mix material by considering the quantity or comparison of each material so that the concrete reaches the required strength [17]. Besides, it is also important to note the value of concrete quality indicators based on the quality, durability, ease of work, and the economic value produced [18]. The purpose of this study is to determine the proportion of concrete material using Sikacim, Sika Bonding, Lumajang Sand, and Silica Sand.

2. Research methods
This study uses an experimental method conducted in the Civil Engineering laboratory of Kadiri University.

2.1. Material preparation
The material used in this study is Cement, fine aggregate, coarse aggregate, water, and added material. The cement used is Portland Cement Type 1. Portland Cement is Portland Cement used for all kinds of construction if no select properties are needed, for example, resistance to sulfate, heat hydration [19]. The Coarse aggregate used is a broken stone with a size of 10-20 mm. The fine aggregate used is Lumajang Sand is sand which comes from the vomit mixture of Mount Semeru in Lumajang, East Java. Lumajang sand has very good grain and gradation characteristics, with good interlocking strength so that it can affect the strength and durability of concrete. The water used is PDAM water at the Kadiri University Civil Engineering Laboratory with Ph7. The added ingredients used are Silica Sand, Superplasticizer, and Sika Bonding Adhesive. Silica sand is used to increase the compressive strength of concrete [20]. The superplasticizer used is Sikacim Concrete Additive, which serves to speed up the hardening process, reduce the amount of water, and facilitate casting [21]. Sika Bonding Adhesive functions as a binder when casting concrete and reduces corrosion on concrete [22].

![Figure 1. Sikacim concrete additive](image1)

![Figure 2. Sika bonding adhesive](image2)

2.1.1. Material test. Material inspection refers to ASTM C33 [23]. Material inspection is carried out on coarse aggregate (coral), fine aggregate (sand). The coarse aggregate is examined for coarse aggregate, which passes the no.200 filter, checks for specific gravity and absorption, checks for moisture content, and checks for wear. Fine aggregate is examined for water content, examination for sludge content, the examination of specific gravity and absorption. Material testing aims to determine whether the material used has met the requirements and specifications specified.
2.2. Mix design
Concrete mix design refresh to SK SNI T-151990-03 method. The test specimen used is in the form of a cube with a size of 15x15x15 cm. The compressive strength testing is carried out at 3, 7, 14, and 28 days of concrete. Each variation consists of 3 specimens. The requirement of concrete mix material in units of weight for 1 m³ of concrete is shown in table 1, and for 3 specimens shown in table 2.

| No. | Material            | Proportion (kg) |
|-----|---------------------|-----------------|
| 1   | Cement              | 1138.00         |
| 2   | Lumajang Sand       | 1630.57         |
| 3   | Silica Sand         | 371.55          |
| 4   | Coarse Aggregates   | 335.46          |
| 5   | Superplasticizer    | 46.71           |
| 6   | Bounding Adhesive   | 46.71           |
| 7   | Water               | 416.14          |

Table 1. The proportion of materials concrete for 1m³

| No. | Jenis Material      | Proportion (kg) |
|-----|---------------------|-----------------|
| 1   | Cement              | 13.83           |
| 2   | Lumajang Sand       | 19.81           |
| 3   | Silica Sand         | 4.51            |
| 4   | Coarse Aggregates   | 4.08            |
| 5   | Superplasticizer    | 0.57            |
| 6   | Bounding Adhesive   | 0.57            |
| 7   | Water               | 5.06            |

Table 2. The proportion of materials concrete for 3 cubes.

2.3. Specimen preparation and slump test
Making test specimens using cube molds with a size of 15x15x15 cm. Each variation of the mixture was made for 3 specimens. Material mixing uses electric concrete mixer and slump testing is carried out to determine the thickness of the concrete mix with the specified slump value of 3 cm - 6 cm.

2.4. Curing and compressive strength
Curing refers to ASTM C31 [24]. Concrete curing is done by immersing the test specimen in a soaking tub of clean water, which is carried out until the age of the concrete compressive strength test plan. Concrete compressive strength testing is done after the concrete is 3, 7, 14 and 28 days old, using the ASTM C 39 standard [25]. Compressive strength testing using Universal Testing Machine with type TC-325, 150 tons compressive capacity and with 220 VAC power with the load given until the specimen collapses when the maximum load can be held by the test specimen [6]. From the results of the concrete compressive strength test will be known whether the added concrete mixture used can produce the desired concrete compressive strength. The compressive strength of concrete is calculated using the following equation:

\[ K = \frac{P}{A} \]

Information
- \( K \) = Concrete compressive strength (kg/cm²)
- \( P \) = Maximum load (kg)
- \( A \) = The cross-sectional area of the test object (cm²)
Figure 3. Universal testing machine.

3. Results and analysis

3.1. Material testing results
Material testing is carried out in order to find out whether the material used has met the required specifications. Material test results are presented in table 3 and table 4 with the following description:

Table 3. Fine aggregate test results.

| No | Characteristics              | Standard | Result |
|----|------------------------------|----------|--------|
| 1  | Water content                | 2% - 5%  | 3.1%   |
| 2  | Mud content                  | Maks 5%  | 1.63%  |
| 3  | Absorption                   | Maks 2%  | 1.01%  |
| 4  | Specific gravity             |          |        |
|    | a. Bulk density              | 1.6 - 3.3| 3      |
|    | b. Dry surface-specific gravity | 1.6 - 3.4| 3.03   |
|    | c. Apparent specific gravity |          | 5      |

Table 4. Coarse aggregate test results.

| No | Characteristics              | Standard | Result |
|----|------------------------------|----------|--------|
| 1  | Water content                | 2% - 5%  | 2.4 %  |
| 2  | Mud content                  | Maks 5%  | 1.2%   |
| 3  | Absorpsi                     | Maks 2%  | 1.01%  |
| 4  | Specific gravity             |          |        |
|    | a. Bulk density              | 1.6 - 3.3| 2.35   |
|    | b. Dry surface-specific gravity | 1.6 - 3.4| 2.37   |
|    | c. Apparent specific gravity |          | 3.41   |

From table 3 and table 4 it can be seen that the material used has met the specified requirements.

3.2. Test specimens
Compressive strength testing is carried out when the age of concrete 3, 7, 14, and 28 days with the test results can be seen in the picture below:
Based on the graph above, it can be seen the relationship between the test object age variations of 3 days, 7 days, 14 days and 28 days to the compressive strength of high quality concrete with 15x15x15cm dimensions, the graph shows that the longer the age of high quality concrete there is an increase concrete compressive strength, where the maximum compressive strength occurs at the age of 28 days of concrete. High quality concrete compressive strength at 28 days at 944 kg/cm$^2$. Compressive strength at 3 days reaches 378 kg/cm$^2$, 7 days reaches 614 kg/cm$^2$, 14 days reaches 831 kg/cm$^2$.

### 4. Conclusion

Based on research, by using a design mix that is planned to use Lumajang sand, silica sand and added ingredients Sikacim Concrete Additive and Sika Bonding Adhesive produce high compressive strength values. Compressive strength has increased significantly with increasing age of concrete. The highest compressive strength is achieved with the concrete age of 28 days with an average compressive strength of 944 kg/cm$^2$.

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