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Effect of Compaction Method on Concrete Compressive Strength (No Air Added)

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ABSTRACT
Concrete is the main material in the manufacture of structures, which is a combination of aggregate, cement, and water. Previous research has determined that the optimum composition for the target is 17.17 MPa. This study aims to improve the quality of plain concrete by reducing the need for extra reinforcement, so as to demonstrate the physical and mechanical properties of plain concrete without reinforcement. Porosity is very important to consider in determining the strength of concrete. When porosity is high, the strength of the material is reduced, while low porosity increases the strength. Porosity is the result of high seawater pressure and the use of higher density aggregates. To balance the weight of aggregate and paste, the most appropriate separation method will be selected from the three operations performed: separation by sieving or screening, separation by sieving, and separation by vibrating. This is very important in the implementation of concrete construction to reduce the risk of earthquakes and achieve the maximum level of safety. After the investigation was completed, the most effective construction method was the use of vibrators, with a maximum pressure of 19,816 MPa for 28 months.
Keyword: Concrete, Physical Properties and Compaction Methods.

I. INTRODUCTION

A construction material that is extensively employed in a variety of undertakings is concrete. Today, a diverse array of structures are constructed using concrete materials. A significant role is played by concrete construction, necessitating the maintenance of high quality concrete. A substantial amount of research has been conducted to investigate alternative methods of utilizing concrete construction in a variety of disciplines with greater efficiency and efficacy, resulting in higher-quality concrete. The structural material concrete is extensively utilized in society and plays a significant role. Concrete construction systems offer numerous advantages over alternative materials, which is why this is so simply explained. There are numerous advantages to using concrete as a construction material. It is effortless to modify the structure of any building due to the exceptional compressive strength of concrete. Concrete is also highly resistant to fire and necessitates relatively minimal maintenance costs.

Effectiveness and efficiency are additional factors that are critical in the selection and application of concrete as a construction material. Typically, concrete is composed of materials that are readily accessible, simple to work with, and possess the necessary durability and strength for construction projects. Porosity is a critical factor in determining the compressive strength of concrete. High porosity results in a reduction in strength, whereas low porosity leads to an increase in strength. A superb opportunity to optimize the potential of your concrete is provided by this method. You are able to achieve the best potential results by optimizing the performance and efficacy of your concrete. Further, the utilization of aggregate sizes that are more consistent can contribute to the reduction of porosity. To guarantee that the aggregate and paste are separated by minimal cavities, the most appropriate compaction method will be chosen from the three alternatives that have been evaluated. In order to ensure that the concrete can handle the utmost burden, it is imperative to compact the concrete in order to eradicate air cavities and achieve the highest possible density and strength[2].

It is the objective of this investigation to ascertain the impact of the compaction method on

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the compressive strength of concrete in the absence of air addition.

II. METHODOLOGY

The Materials and Construction Laboratory, Department of Civil Engineering, Faculty of Engineering, Tanjungpura University, served as the research site. The experimental procedure employed in this study involves the preparation of a number of test specimens to be tested in accordance with SNI testing standards. The data obtained will be analyzed to determine the impact of compaction methods on the strength of concrete.

1.1 Materials

Materials utilized in the production of concrete include:

1. The cement utilized was PCC cement.
2. The sand employed is Medium Sand.
3. A maximum particle size of 40 mm is required for the stone to be used.
4. Water from the faucet is employed.
5. The normal compressive strength is anticipated to be 17.17 Mpa.

1.2 Equipment

The equipment utilized in this investigation consists of a compression testing machine, a bearing block, a compressometer, a cylinder sealer, a sandblasting machine, an oven material, a sandblasting machine, a mixer, a Los Angeles machine, a vicat machine, and other equipment.

1.3 Research Procedures

The implementation of this investigation is divided into several phases, which include the following:

1. Material preparation and inspection

a. A compilation of fundamental theories and prior research journals that substantiate this investigation.

b. Material preparation and testing, including fine aggregate (sand), coarse aggregate (stone), water testing, and cement testing.

2. Combine planning strategies

Calculation of a concrete mix with a compressive strength of 24 MPa. The calculation of the necessity for the creation of test objects, including three variations of concrete samples without additional air, struck, penetrated, and vibrated.

3. Casting of test specimens

For each sample variation, test artifacts such as large cylinders (up to 13), small cylinders (up to 5), and cube molds (up to 10) were assembled. Concrete mixer machines were employed to facilitate the casting of the test specimens.

4. Experimental specimen treatment

The treatment of test objects involves submerging them in a container of water that is maintained at ambient temperature. Treatment commences one day following casting and concludes one day prior to scheduled testing.

5. Evaluation of volumetric weight

Using electric scales with an accuracy of 0.05 kg, the volume weight of concrete slinders was tested at 3, 7, 14, 21, and 28 days of age as concrete.

6. Strength testing performed under compression

In accordance with SNI 03-1974-2011, this investigation employs an MTB brand compressive testing equipment with a capacity of 2000 kN and an accuracy of 5 kN to evaluate the compressive strength of concrete at 3, 7, 14, 21, and 28 days of age.

1.4 Analysis Method

1. Volume weight can be calculated by the formula:

$$W_c = \frac{m}{V} \quad (1)$$

Where:

Wc = volume weight (kg/m^3)
m =concrete weight (kg)
V = concrete volume (m^3)

2. The compressive strength can be calculated by the formula:

$$f_c = \frac{P}{A} \quad (2)$$

Where

f_c =compressive strength values(MPa)
P = maximum test loads(N)
A = area of contact (mm^2)

III. RESULTS AND DISCUSSION

2.1 Material Testing Results

References to SNI and ASTM are made when discussing material testing methods.

2.1.1 Sand Test

The concrete mix material utilized in this investigation is zone II sand, specifically medium sand. It is imperative that the material satisfy the

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specifications; therefore, the following testing is required:

a. Organic Content Testing (SNI 7656:2012)
The results of this test indicate that the organic content of fine aggregate is situated at the third position on the organic plate. This test specimen is suitable for the production of concrete due to its organic content, which satisfies the standard.

Figure 1. Organic Content Experiment Results

b. Sludge Content Testing (SNI 03-4142-1996)

In this research, the silt content in the fine aggregate is 0.320%. The amount of silt in a fine aggregate mixture should not exceed 5% by dry weight, as per SNI 03-2834-2000. The fine aggregate that has been tested still satisfies the standard, as its value is less than the standardized value.

c. Moisture Content Testing (SNI 1971:2011)
Fine aggregates' water content significantly influences the workability of concrete mixtures. It was determined that the moisture content of fine aggregates was 3.005% by testing samples with a minimum mass of 500 grams.

2.1.2 Cement Tests

Specific gravity testing (SNI 15-2531-1991) The average specific gravity of Portland cement is 3.15 g/cm3, as indicated by the test results. Three experiments will be conducted in this investigation, and the results will be averaged. The initial experiment's calculation is illustrated below.

Table 1. Test Results

Test	I	II	III	Unit
Weight of test specimen	64	64	64	grams
Volume at the outset	0.5	0.5	0.5	ml
Final volume	20.7	21	20.9	ml
Specific gravity of cement	3.17	3.15	3.14	grams/ml
Average	3.15	gram/ml		

This was succeeded by the use of a Vicat instrument to evaluate the cement's consistency. Portland cement's fineness is a critical factor that can influence the rate of reaction between water and cement particles. The higher the fineness of the Portland cement granules, the more rapid the cement hydration reaction will be, as hydration commences at the particle surface. In a composition, such as concrete or plastering mortar, cement is a binder that is responsible for the binding of fine and coarse aggregates with water. This test was implemented to ascertain the fineness of Portland cement. The normal consistency of Portland cement with a peneteration of 10mm is produced with a moisture content of 26%, as indicated by the calculation results. The cement bonding time test was also conducted. Cement bonding time is the duration of time necessary for cement to solidify, from the moment it reacts with water to the point that it becomes cement paste, until the cement paste is sufficiently rigid to withstand pressure. Binding time testing is designed to determine the initial and ultimate binding times. Based on the experimental results, the initial binding time of pcc cement (normal consistency) at a 25 mm impact is 70 minutes.

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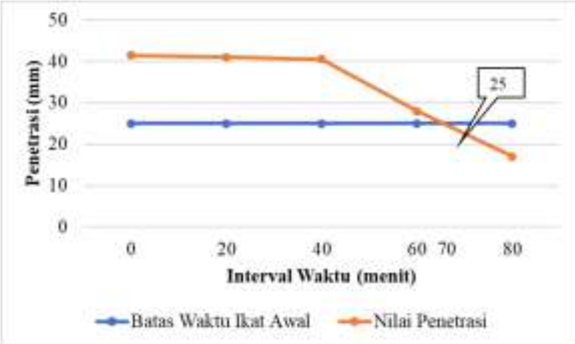

Figure 2. Portland cement initial binding test graph

2.1.3 Water Tests

The pH level is a metric that quantifies the proportion of unbound hydrogen ions and hydroxyl ions in water. The water is considered acidic when the concentration of unbound hydrogen ions is considerable. Conversely, water is classified as basic or alkaline when the quantity of unbound hydroxyl ions is greater. Outside of this range, the quality and hardening process of concrete can be influenced. The pH of water that is adequate for concrete mixing should be between 6 and 8. The objective of this examination is to ascertain the pH of the water. The pH criterion for potable water is 6.5 to 8.5, as per Permenkes 492/Menkes/Per/IV/2010. The experiment revealed that the pH value of the faucet water that was analyzed was 6, indicating a mild acid. This suggests that the water is less suitable for use, but it can still be used in concrete mixtures.

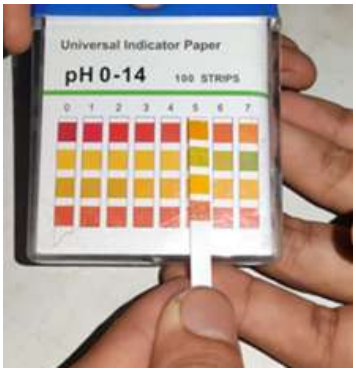

Figure 3. Litmus paper test results

TDS (Total Dissolved Solid) is a measure of the entire volume of solid solution in water. Every liquid must contain dissolved particles that are invisible. These particles may be solid or non-solid, such as microorganisms. Water with a total dissolved solids (TDS) value of less than 300 is suitable for use in concrete mixtures. The objective of this examination is to quantify the quantity of substances or particles that have been dissolved in water. The maximal TDS standard is 500 mg/L, as per SNI 3553 Year 2015. The TDS value of the municipal water used in the concrete mix is 290 mg/L, which satisfies the aforementioned criteria.

Figure 4. Experiment Results

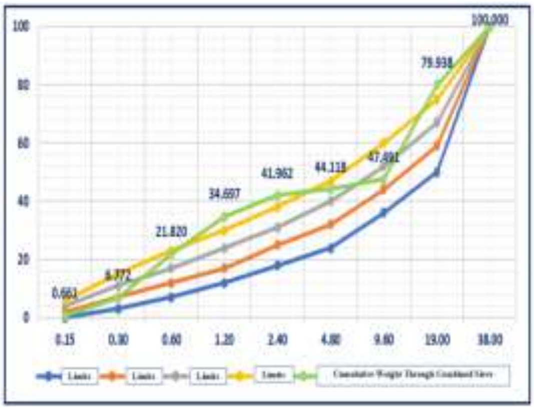

Figure 5. Graph of Gradation Analysis of Mixture Max Size 40 mm

According to the graph above, the mixture's gradation is in close proximity to the category with a maximum measurement of 40 mm.

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2.2 Concrete Mix Results

The concrete mix results are as follows: the ACI 522R-10 Report on Pervious Concrete was used to calculate the concrete mix.

Table 2. Concrete mixture composition

No.	Materials	Volume	Unit
1	Weight of Cement	286,549	Kg/m^3
2	Weight of Water	148,713	Kg/m^3
3	Weight of Coarse Aggregate	1139,429	Kg/m^3
4	Weight of Fine Aggregates	850,141	Kg/m^3
Total		2285,351	2424,832

2.2.1 Volume Weight Testing

The concrete sample can be tested after it has dried. Prior to testing, concrete undergoes treatment by immersing it in a water reservoir to maintain a consistent temperature. The concrete must be weighed prior to being capped in order to ascertain its weight. The weight of the concrete is then divided by the volume of the concrete to determine the dried volume weight. Concrete volume weight testing was conducted at 3, 7, 14, 21, and 28 days of age. The volume weight test results are illustrated in Figure6 below:

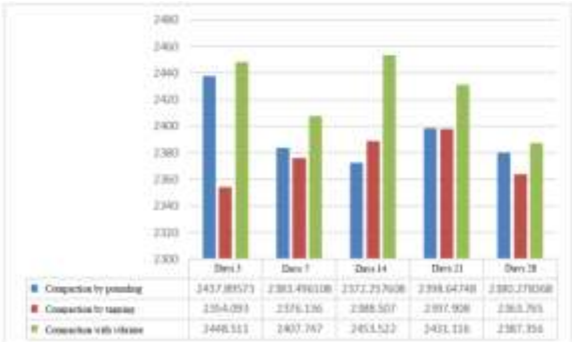

Figure 6. Bar Chart of Average Volume Weight of Concrete

According to Figure 6, the volume weight value of concrete compaction by vibrator is relatively high in comparison to that of concrete compaction by penetrating or hammering and by striking.

2.2.2 Compressive Strength Testing

The compressive strength of the concrete is assessed using a digital compressive testing equipment after it has been capped. In order to ascertain whether the concrete satisfies the specifications, compressive strength testing is implemented. The compressive strength of concrete was tested at 3, 7, 14, 21, and 28 days of age in this study.

The subsequent summary illustrates the outcomes of the concrete compressive strength test:

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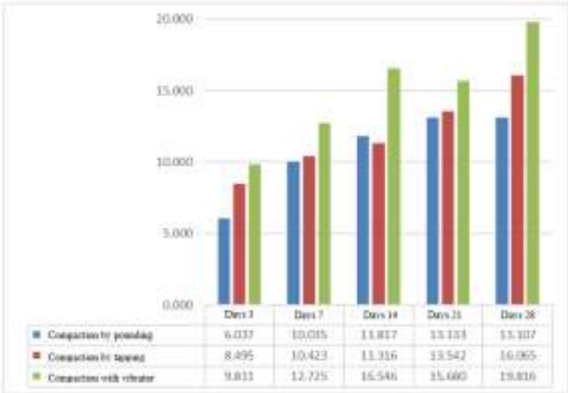

Figure 7. Bar Chart of Compressive Strength

According to Figure 7, it is evident that the compressive strength of concrete is relatively high when compacted using a vibrator, as opposed to when compacted using pounding and striking.

IV. CONCLUSION

The average compressive strength value at the age of 28 days was 19.816 MPa, and based on the test findings of this research, it can be stated that utilizing a vibrator for compaction is the best outcome when employing the standard concrete compaction technique. By using the tapping technique, the average compressive strength value at 28 days was 16.065 MPa, while the hammering method produced an average compressive strength value of 13.107 MPa. In order to increase the qualities of regular concrete, it is determined that vibrator compaction of normal concrete yields better results than pierced or hammered concrete and knocked concrete.

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