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Effect of Retarder Usage on Concrete Characteristic

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Abstract: This research is experimental research aimed at to investigate the effect in using retarder onto concrete workability and compressive strength. The sample will be made of concrete cube with uniform size is 15 cm x 15 cm x 15 cm. the total amounts of cube are 96 pieces, each 32 samples for each data groups into 0%, 1%, 2% and 4%, the sample are then kept fresh with various time, 0 minute, 10 minutes, 15 minutes and 20 minutes. The fresh sample's feasibility and compressive strength will be examined at 7, 14, and 28 days concrete. The result shows workability concrete changing in case retarder addition. The higher retarder concentrations cause either increased slump value or easy-made concrete. The longer fresh concrete are storage will result in decreased in slump value or the concrete is viscous. In concrete with age 7, 14, 28 days, the highest pressure strength is 2%. Additions in 4% retarders are significantly degraded pressure strength. Concrete storage up to 20 minutes does not give significant concrete pressure strength.

Keywords: Retarder, Concrete, The Characteristic

1. Introduction

Concrete is a material that is often used in building construction. Zein, explained that the main constituent of concrete is cement. In the process of making cement it often causes problems because the cement industry contributes to greenhouse gas emissions estimated at around 1.35 billion tons per year or about 7% of total greenhouse gas emissions released directly into the earth's atmosphere throughout the world. Based on this, the researchers developed a cement replacement material, namely geopolymer concrete. Geopolymer concrete is one of the high quality concrete inventions that are environmentally friendly. [1]

The concrete forming material consists of: Aggregate is a granular material that is used together with the binding material to form concrete or hydraulic cement mortar. The use of aggregates in Indonesia generally comes from nature, but there are also those that use artificial aggregates such as nickel slag, steel mill waste, and others. Based on its size, the aggregate of concrete can be divided into two types, namely fine aggregates whose granules penetrate 4.75 mm hollow sieves, and coarse aggregates with all the granules left behind on a 4.75 mm sieve. The Regulation of the Ministry of Public Works of the Republic of Indonesia (SNI 03-1968-1990) explains that fine aggregates for concrete can be natural stones resulting from natural disintegration of rocks or in the form of artificial sand produced by rock breakers [2]. Hazrian, explained that the Aggregate is a concrete component that has the most role in determining the size. The aggregate for concrete is hard mineral granules that are close to round in shape with a grain size between 0.063 mm - 150 mm. Aggregates according to their origin can be divided into two, namely natural aggregates obtained from rivers and artificial aggregates obtained from broken rocks. In this case, the aggregate used is natural aggregate in the form of coarse aggregates (gravel), coarse sand, and fine sand. In concrete mixtures, aggregates are reinforcing materials, fillers, and occupy 60% - 75% of the total volume of concrete. [3].

Putra, explained that based on the Indonesian National Standard (SNI) number 15-2049-2004, portland cement is hydraulic cement produced by grinding portland slag (Clinker) mainly consisting of calcium silicate (xCaO SiO2) which is hydraulically ground together same as the additional ingredients in the form of one or more crystalline forms of calcium sulphate compounds ($CaSO_4$. xH_2O) [4].

For certain purposes, sometimes added concrete mixtures in the form of chemical additives and additional minerals / materials. These additional chemicals are usually in the form

of powder or liquid which chemically directly affects the condition of the concrete mixture. While additional minerals / materials are in the form of aggregates which have certain characteristics. The addition of these additional chemicals or minerals is expected to be able to change the performance and properties of the concrete mixture according to the desired conditions and objectives. Admixture is materials that are added to the concrete mixture during or during concrete mixing. The function of this material is to change the properties of concrete to be more suitable for certain jobs, or to save costs. Basuki explained that: The use of added ingredients in a concrete mixture must pay attention to applicable standards such as SNI (Indonesian National Standard), American Society for Testing and Materials or ACI (American Concrete Institute) and pay attention to the instructions in the trade manual [5]. One of the added ingredients in concrete is a Retarder (a chemical to slow the process of bonding concrete mixtures). Usually needed for concrete not made at concrete pouring sites. The process of binding the concrete mixture is about 1 hour. So if the concrete is mixed until pouring takes more than 1 hour, this chemical substance needs to be added. These additional substances are delivered in the form of sugar, sucrose, sodium gluconate, glucose, citric acid, and tartaric acid.

Technology Advance in concrete structure has been applied in developing building, real estate, transportation infrastructure. Such as road stiffening, bridge, irrigation, and so forth. The concrete structure usage is expected to guarantee safety and strength to building users. Attaining it needs good concrete quality and suitable to strength requirement so that it can be used as structure composition in the building like beam, column, plate, foundation, and so on.

One of the impact of concrete technology development is additive to enhance concrete qualities. In this case, concreted added with retarder can inhibit concrete fixing time. Retarder application is developed as there are mixing to pouring time.

Recently, workability problem in concrete is overcome by adding additive retarder which can change concrete discomfort with no water addition. By retarder in concrete mixture, the characteristic can be turned, yet misused it results to unwanted concrete features. Besides that, the designers are force to create good concrete's strength force. However, nowadays, it is a question of concrete characteristic in general. Therefore, the researcher interests to study effect of retarder usage on concrete characteristic in general; fresh concrete characteristic and its strength.

Concrete is mixture of both fine and rough aggregates (sand, pebble, rock, or another type of aggregate) and cement, combined with water in certain proportion. Astanto, said that. Concrete also can be defined as material and construction which the characteristic can be determined by planning and supervising its stuff. It is cement, water, and aggregate. [6]

Concrete strength is mainly affected by amount of water and cement taken or depended on water, cement, and the compact degrees. Influencing factors of concrete strength are: 1) proportion water and cement, 2) aggregate type and gradation, 3) cement quality, and 4) handling. The real strength of concrete is pressure power. Pressure strength value raise straightly with age and at age 28 days, it reaches maximum value. The definition of concrete's pressure strength is tension onto sample by giving burden until the sample gets destructed. Pressure strength concrete measurement is referred on SK SNI M-14-1989-F (Department of Public Work,). [2] Mulyono, explains that admixture is composition added onto concrete mixture when or during mixing. The purpose is adjusting concrete feature onto certain job or cheap estimation. [7]. Admixture or additive is defined in *Standard Definitions of Terminology relating to Concrete and Concrete Aggregates (ASTM C. 125-1995)* and ACI (American Concrete Institute), as material other than water, aggregate and hydraulic cement mixed into concrete or mortar before or during stirring. [8]

Additive in concrete mixture or mortar does not change macro-composition from other material, because it is used as substituent within concrete mixture itself. Since the substituent functions to repair or change certain characteristic of result concrete or mortar, the composition gradient in volume-weight tends to unchanged directly compared to plain composition of concrete without additive. Generally, additive of concrete is classified into two, chemical additive and mineral additive. Admixture additive is mixed either stirring and/or placing, while mineral additive only on stirring. According to standard of ASTM. C494, there are 7 types of chemical additive which shows composition and constant work procedure as long as the material given to concrete mixture fits to concrete proportions. [9]

Mulyono, describes that three characteristics of concrete must be paid attention are, ease application, segregation (pebble lumps), and bleeding (water raise). [7] Next, Murdock states that at least there are three detached definitions of workability: 1) compactibility (ability to be compact), 2) mobility (ability to flow within the cast), 3) stability (ability to be stable homogenous mass, coherent, and stable beyond application).[10] Workability observation of concrete in at the field is generally conducted with slump test. This test indicates concrete stability and mobility. Nawy, writes that slump test is useful to observe diversity of mixture gradients. On plain concrete, slump test is established to record consistency in mm concrete sample derivation during testing. [11]

2. Research Method

This research is established in Material Testing Laboratory Civil Engineering Education Department Universitas Negeri Makassar. The sample is fresh concrete with composition based on mix design and added with additive retarder 0%, 1%, 2% and 4% from plain cement weights. Duration time is conducted in 0 minutes, 10 minutes, 15 minutes, and 20 minutes after pouring to test slump and taking tester stuff 15 cm cube. Then it is placed by soaking in tap water.

Retrieving pressure strength data is taken from 7 days, 14 days, and 28 days samples. Data analysis uses the calculation of slump values, namely the slump value = the height of the slump tool minus the height of the concrete after a decline, and the calculation of concrete compressive strength using the formula: fc '= P / A where: fc' = concrete compressive strength (kg / cm^2), P = load (kg) and A = cross-sectional area (cm^2).

3. Result and Discussion

In this study, the mixed design used was concrete quality K-175 kg / cm^2. The making of specimens is divided into four groups, namely: mixture without additional retarder material, mixture with additional retarder material 1% of the weight of cement, mixture with additional retarder material 2% of cement weight, and mixture with additional retarder material 4% by weight of cement. In each mix group, slump tests were carried out and took cube specimens for a duration of 0 minutes, 10 minutes, 15 minutes, and 20 minutes after pouring. The results of the research and discussion are as follows:

3.1. Effect of Retarder Usage on Concrete Workability

Slump result of workability shows that increased retarder percentage also raises slump value. Concrete slump test at 0 min between mixture without retarder and mixture with 1% retarder additive shows 4 cm uplift, from 9 cm to 13 cm, or uplifted by 44,44%.

The slump test between mixture without retarder and mixture with 2% retarder additive shows 6 cm uplift or uplifted by 66,67%. The slump test between mixture without retarder and mixture with 4% retarder additive shows 8 cm uplift or uplifted by 88,89%.

Concrete slump test at 10 min between mixture without retarder and mixture with 1% retarder additive shows 3.9 cm uplift or uplifted by 44,83%. Slump test between mixture without retarder and mixture with 2% retarder additive shows 5,8 cm uplift or uplifted by 66,67%. And, slump test between mixture without retarder and mixture with 4% retarder additive shows 8 cm uplift or uplifted by 91,95%.

Concrete slump test at 15 min between mixture without retarder and mixture with 1% retarder additive shows 4 cm uplift or uplifted by 48,19%. Slump test between mixture without retarder and mixture with 2% retarder additive shows 5,9 cm uplift or uplifted by 71,08%. And, slump test between mixture without retarder and mixture with 4% retarder additive shows 8,1 cm uplift or uplifted by 97,59%.

While concrete slump test at 20 min between mixture without retarder and mixture with 1% retarder additive shows 3.9 cm uplift or uplifted by 50%. Slump test between mixture without retarder and mixture with 2% retarder additive shows 5,9 cm uplift or uplifted by 75,64%. And, slump test between mixture without retarder and mixture with 4% retarder additive shows 8,2 cm uplift or uplifted by 105,128%.

As for the result of concrete workability testing on each fresh concrete sample, the chart will be displayed in Picture 1 below:

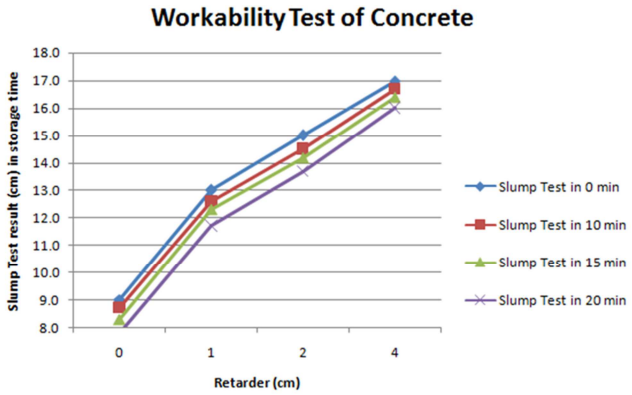

Figure 1. *Effect of Retarder Usage on Concrete Workability.*

Figure 1 also displays concrete's workability difference stored at 0 min, 10 min, 15 min and 20 min. Longer the mixture keeps idle then lower the slump value, while higher retarder dosage then higher initial slump test. Considering when making tester stuff is no excessive dense process because it will effect in raised cement paste water so it give impact to concrete pressure strength and control water usage on casting process.

3.2. Effect of Retarder Usage on Concrete Pressure Strength

Based on data, concrete pressure strength on 7 days age at 0 min is 110,667 kg/cm^2, this value decreases on 10 min storage as 92,444 kg/cm^2 or 16,5%. Fresh concrete storage during 15 min reduces concrete pressure strength into 79,556 kg/cm^2 or 28,11%. Next, different concrete pressure strength on 20 min storage is 23,5%. The difference in concrete pressure strength can be presented in Picture 2 below:

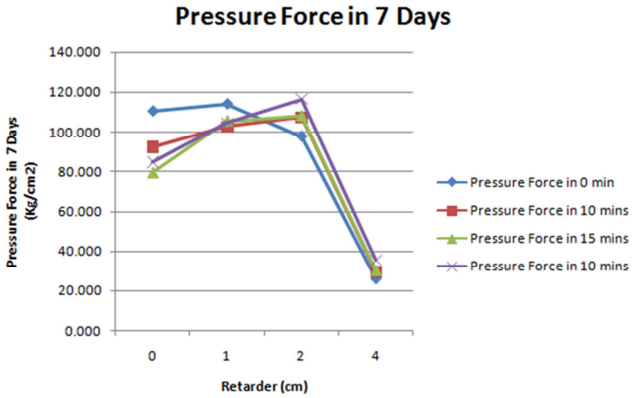

Figure 2. *Effect of Retarder Usage on Concrete Pressure Strength in 7 days.*

According to result graph on figure 2, it is viewed that the best concrete pressure strength is gained by adding 2% retarder with 20 minutes storage, with value 116, 444 kg/cm^2. It is relatively similar with concrete without retarder in 0 minute is 110,667 kg/cm^2 and concrete addition 1% retarder in 0 minute is 110,667 kg/cm^2.

Concrete pressure strength on 14 days is 144,667 kg/cm^2,

this value decreases as 10 min storage as 122,00 kg/cm^2 or 15,7%. And, different concrete pressure strength on 20 min storage is 23,5%. The difference in concrete pressure strength can be presented in Picture 3 below:

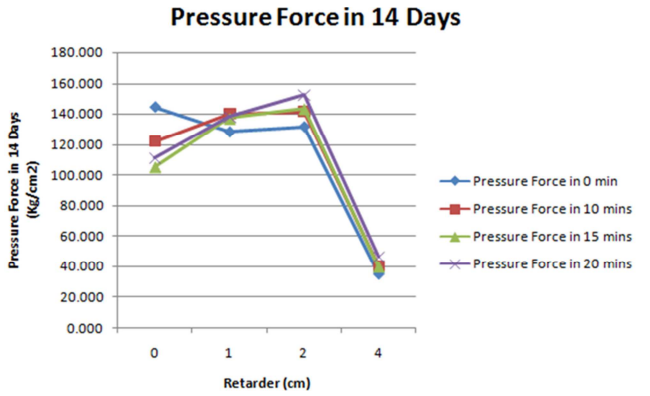

Figure 3. *Effect of Retarder Usage on Concrete Pressure Strength in 14 days.*

According to result graph on figure 3, it is viewed that the best concrete pressure strength is gained by adding 2% retarder with 20 minutes storage, with value 152,440 kg/cm^2. It is higher than concrete without retarder in 0 minute is 144,667 kg/cm^2.

Concrete pressure strength on 28 days, when concrete reaches it optimum strength, is 164,44 kg/cm^2 without retarder, this value decreases as 10 min storage as 137,778 kg/cm^2 or 16,2%, then its pressure strength is 118,89 kg/cm^2 or 27,7%. And, different concrete pressure strength on 20 min storage is 24,7%. The difference in concrete pressure strength can be presented in Picture 4 below:

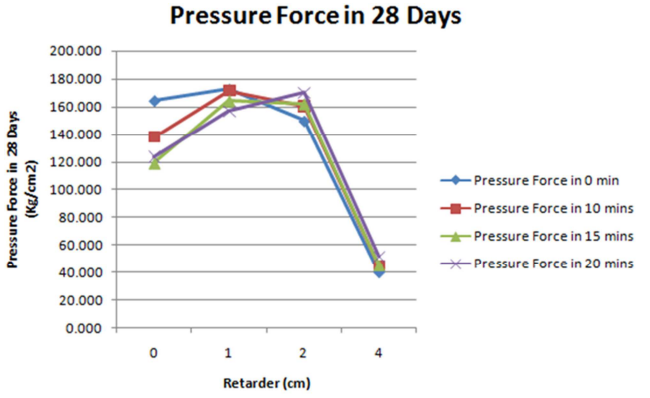

Figure 4. *Effect of Retarder Usage on Concrete Pressure Strength in 28 days.*

According to result graph on figure 4, it is viewed that the best concrete pressure strength is gained by adding 1% retarder with 0 minutes storage, with value 172,667 kg/cm^2. It is relatively similar with concrete 2% retarder in 20 minute storage is 170,220 kg/cm^2.

Description of the research result above is concrete pressure strength without retarder will degrade because of storage time. While adding 1% and 2% make its strength relatively stagnant with various concrete's storage time. The best concrete strength pressure is generated by retarder 2% addition. Yet, addition 4% retarder causes significantly deprivation of concrete strength pressure so this measure is not suggested onto concrete making.

4. Conclusion

The experiment result can be inferred: 1) Retarder addition influences concrete workability. The higher retarder concentrations cause either increased slump value or easy-made concrete. The longer fresh concrete are storage will result in decreased in slump value or the concrete is viscous, 2) Retarder addition influences concrete pressure strength. In concrete with age 7, 14, 28 days, the highest pressure strength is 2%. Additions in 4% retarders are significantly degraded pressure strength. Concrete storage up to 20 minutes does not give significant concrete pressure strength.

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