Effect of Sea Water Immersion on Accelerated-Stone Ash Concrete

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DOI: 10.29322/IJSRP.12.02.2022.p12209
http://dx.doi.org/10.29322/IJSRP.12.02.2022.p12209

Abstract- Concrete working in a port / wharf environment requires special attention and materials because seawater is an aggressive environment for concrete. One example of the technology used is the use of accelerators to maintain the quality of concrete. Efforts to obtain high-strength concrete are to improve the quality of the constituent materials, such as aggregate hardness and fineness of cement grains. The quality of concrete can also be done by adding additives to reduce water consumption and accelerate hardening. In this study, the addition of materials to the concrete mixture, accelerator and stone ash is used. In this test using the experimental method, there are 2 variants of the concrete test consisting of test objects with accelerator added materials. In the compressive strength test, 36 samples of cylindrical specimens of 150mm x 300mm were used to be tested. The method of testing the material using concrete mix planning uses SNI 2002. From the results of compressive strength, By the addition of accelerator material, the compressive strength of concrete can be maintained by 2% and still had compression strength 46 MPa. And if the concrete added with accelerators and rock ash, the compressive strength of concrete in sea water immersion still can be increased by 17 % (54 MPa). This resulted that combined accelerator and stone ash as additive shall be considered as additive in concrete immersed in sea water.

Index Terms- Compression Strength, Strength Concrete, Accelerator, Sea Water Immersion, Stone Ash

I. INTRODUCTION

High strength concrete is defined as concrete which has a required compressive strength greater than 41.4 MPa. Efforts to obtain high-strength concrete are to improve the quality of the constituent materials, such as aggregate hardness and fineness of cement grains. The quality of concrete can also be done by adding additives to reduce water consumption and accelerate hardening [1]. To be able to make high quality concrete, a low water cement factor value is needed, which ranges from 0.20 to 0.30, where the function of water in the concrete manufacturing process is only as a chemical reaction aid that occurs in concrete. In the work of high quality concrete in the field, to facilitate the work of concrete because considering it uses a little water, an admixture material in the form of a plasticizer is needed to facilitate concrete mixing [2]. Various additive material, such as Cane pulp ash, Silica Fume, Fly Ash already researched for enhance concrete performance [3].
The problem is that concrete construction projects in Indonesia are not always located in areas that are free from the influence of sea water [4]. Although the concrete is mixed using fresh water, in the end it will still be contaminated with water. Actually, concrete that is affected/related to seawater is required to use Type V Cement, which is a type of cement that is resistant to the sulfate environment [5]. However, this type of cement has never been found sold in building material shops around Surabaya. As a result, even for the manufacture of concrete in aggressive environmental areas, such as in areas around the coast, the community still uses Type I PC cement which is actually not recommended for the manufacture of concrete that is in contact/affected by seawater, but is forced to use it because there is no other choice [2], [3], [7].

In this case, to facilitate the manufacture of high-strength concrete, it is necessary to have other additional materials, namely accelerators. In working on the accelerator accelerates and also dilutes the concrete thereby reducing the amount of water use. In this study, the variant of concrete with accelerator added material will be discussed. With 2 treatments of concrete, the concrete treatment is seawater immersion and concrete with fresh water treatment. So that later this research will help determine the level of concrete strength in two treatment conditions.

Factors that will affect the compressive strength of high-quality concrete, there are four main parts that affect the quality of the strength of the concrete, namely 1). Absorption of qualified materials. 2). The process of mixing concrete aggregate with cement paste. 3). Casting process in the field. 4). Concrete curing process. In the use of aggregate in its use, it is used with a certain composition in order to get a concrete mixture that is economical and has a high compressive strength value (High Quality Concrete). There are several ways to improve the performance of concrete to become high-quality and high-performance concrete: 1. Reducing the porosity of concrete by reducing water, 2. Adding Accelerator additives.

II. THEORIES

2.1. Portland Cement

Portland cement is a fine powder obtained by grinding clinker (which is obtained by burning a good and even mixture of lime and materials containing silica, alumina, and iron oxide), with gypsum as an additive in sufficient quantities. This fine powder when mixed with water, after some time can become hard and is used as a hydraulic binder [6]. Type I is portland cement for general purposes, usually does not require special properties, for example, buildings, sidewalks, bridges, and others.

2.2 Accelerator

Accelerator is a chemical admixture that dissolves lumps by coating cement paste so that the cement can be evenly distributed in the concrete mix and has an effect in increasing the workability of concrete to a considerable degree. This material is used in relatively small quantities because it is very easy to cause bleeding. Plasticizers can reduce water up to 40% from the initial mixture and speed up the setting time of the concrete mixture.[2]

2.3. Stone Ash

The most important property of concrete is the compressive strength of concrete. The compressive strength of concrete is usually related to porosity. The higher porosity of the concrete then the lower the compressive strength of the concrete. The porosity of concrete can be minimized by the use of rock ash filler. Stone/ rock ash can be used with the requirement pass #200 sieve [7].

2.4 Sea Water

The salt content in seawater (salinity), is measured measure of the amount of material dissolved in per kilogram of sea water; or equivalent part per thousand (1/1000). Salinity describes amount of material which dissolved in sea water [7] generally ranges from between 3.43 to 5%. Ability water to dissolve the salt tend variety and depends where the sea is, but the ratio of principal components which contained inside it relatively constant. Component main is calculated to know weakness and possibility of collapse buildings in the affected area water sea. Sea water physical characteristics are pH=7.77, Specific gravity = 1.022, Na=9.29 part per thousand, Cl=17.087 part per thousand.

The effect of seawater chemistry on concrete mainly caused by attack of Magnesium Sulfate ($MgSO_4$), which is exacerbated by the presence of chloride in it, the reaction will hinder development concrete. Usually classified as part from attack sulfate by sea water that causes concrete look Becomes whitish; Besides that the concrete will expand; previously preceded by happening spalls and cracks. Finally in section concrete attacked by sulfate will become soft forming layers like mud.

When first subjected to sulfate attack, compression strength of the concrete will rise, then how to gradually experience loss strength, and eventually the concrete expands. This attack was seen as the result of presence of Potassium (KS) and Magnesium Sulfate (MgS) in seawater which can cause onset of attack sulfate in concrete. Attack started since ready-to-react concrete with Calcium Hydroxide ($CaOH_2$) which appears in the cement. The process happens such as the chemical reaction [7].

Actually the attack of Magnesium Sulfate (MgS) needs attention, because if reacts with Calcium Sulfate (CSH) to is ambivalent; on the one hand power the reaction produces gypsum which is profitable cement, but in other side reaction of MgS with calcium hydroxide which mixed with hydrate silica (SiO2) as results from reaction with cement gel, kind of material which nature own power glue, will shape material new which different, that is (MSH). This material is no own ability stick as case cement material [7].

Chloride ion as an adverse cause strength concrete, can strike with different forms, but generally the attack came from results chemical reaction that expansive (expand) from a kind of salt, which Friedls salt name (Calcium-Chloro-Aluminate); the chemical formula for friedls salt is written as ($3CaO.Al_2O_3.CaCl_2.H_2O$). This salt has the ability to expand ranging from low to moderate. Friedls salt is formed from large solution Calcium Chloride which enter into concrete as a result of rising ability absorption water by concrete. Attack process chloride on concrete written in reaction chemical [11].

III. METHODS

This research is then deployed in several steps.

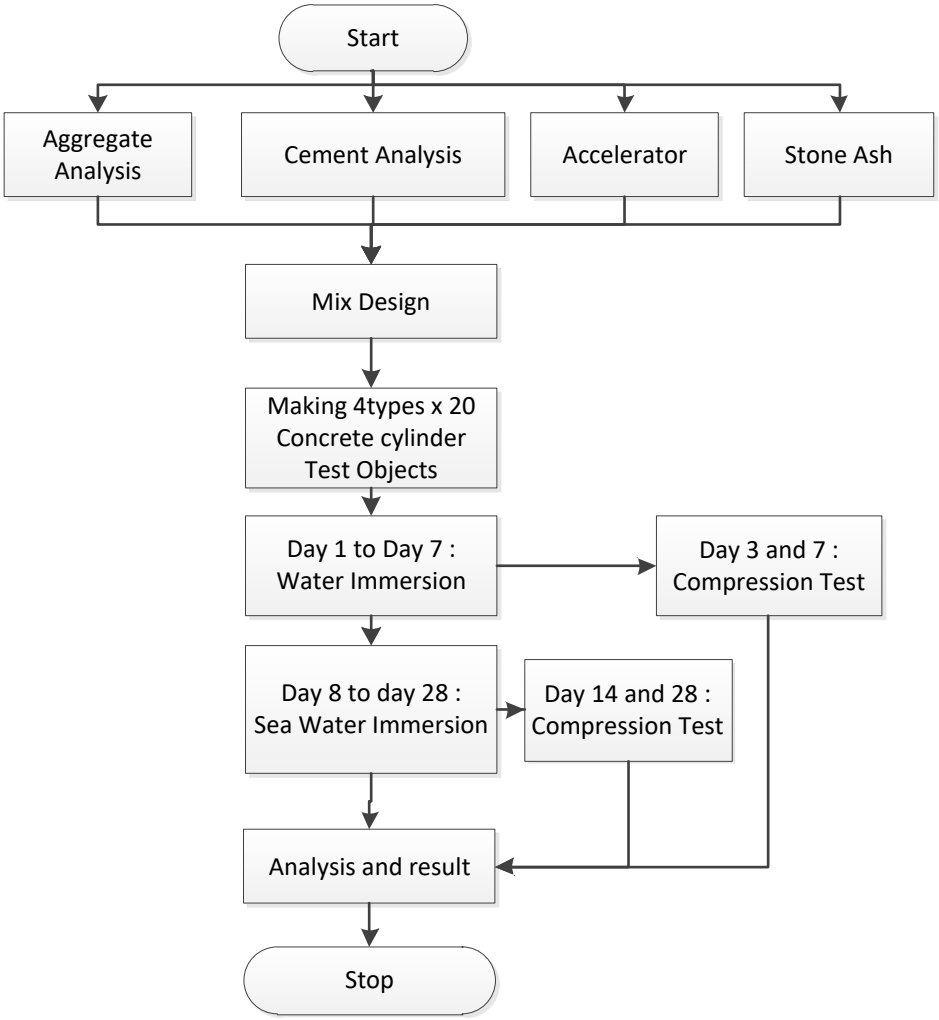

Figure 1. Research flow chart

The first step is to analyze aggregates and cement, Accelerator and Stone ash. And the Mix design with SNI 03-2834-2000 deployed. The mix design the produced 4 type concrete: 1) Normal Concrete for immersed in fresh water, 2) Normal concrete immersed in seawater. 3) Normal concrete added by accelerator immersed in sea water, and 4) Concrete added by accelerator and stone ash immersed in sea water. Process of making and curing of 4 various type mixture is then proceeded with 20 of 15x30cm cylinder specimen for each type. All of 80 specimens then immersed in fresh water. In the age of 3 days, compression strength test then carried out. The type 1 specimens still immersed in fresh water and the type 2, 3 and 4 then immersed in sea water.

IV. RESULT AND DISCUSS

4.1 Compression strength test result.

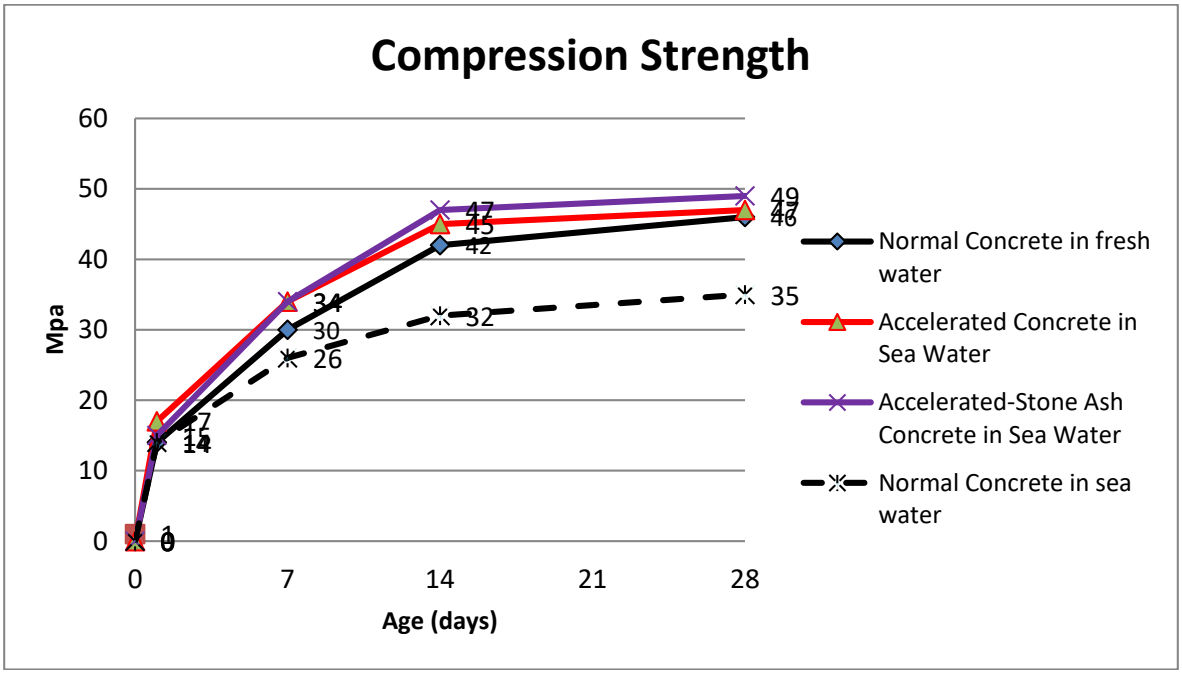

Figure 2. Compressive strength comparison of concrete.

Seawater immersion can reduce the compressive strength of normal concrete by 26% compared to concrete immersed in fresh water. This compression strength is reduced by destruction of inner molecular-chemical reaction. By the addition of accelerator material, the compressive strength of concrete can be maintained by 2% and still had compression strength 46 MPa. And if the concrete added with accelerators and rock ash, the compressive strength of concrete in sea water immersion still can be increased by 17 % (54 MPa).

4.2 Discuss

At the first time immersed in seawater, seawater begins to seep into the pores of the concrete, the concrete begins to be exposed to sulfate attack. Concrete began to be attacked by sulfate salts marked with increase in compressive strength [7]. This could happen, because generally attack came from Calcium Chloro-Aluminate which have the ability expand. At the time of entry into the pores concrete, salt friedls still in condition floating start, so that the existing cavities on the concrete will be forced to become denser. As a result if carried out a pressure test, his strength will increase; but if soaked more old, salt friedls will continue grow / expand until push cavities in excess of the concrete.

As a result, the cavities (pore) in the concrete experience pressure which more bigger, so that if the compressive strength test is carried out the pressure will decrease; this incident can observed in Figure 2. Accelerators compete by increasing the speed of the hydration reaction of cement while the penetration of chlorine and sodium definitely destroys the C-S-H bond. This resulted in Compressive strength of acceletrated concrete still almost same as the concrete in fresh water. The Stone ash additive (as pass the #200 sieve) resist the intrusion of NaCl material through the pores of the concrete so the compressive strength is higher than others.

V. CONCLUSION

Based on the results of this research, it can be concluded:
a. Seawater immersion can reduce the compressive strength of normal concrete by 26%.
b. By the addition of accelerator material, the compressive strength of concrete can be maintained by 2%.
c. By the addition of accelerators and rock ash, the compressive strength of concrete in sea water immersion still can be increased by 17 %.

ACKNOWLEDGMENT

Appreciation for the Civil Engineering Laboratory, Bhayangkara Surabaya University, and Ubhara Independent Research Number TUG/09/FTK/01/2019.

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