Evaluation Of The Impact Of Adding Accelerator Additives On The Initial Strength Of High Performance Concrete

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Abstract. *Concrete Quality High (High Performance Concrete/HPC) is type concrete that has strength press equivalent or more tall of 41 .4 MPa . In context its use at the extraction level mine lower ground , HPC must can reach strength press as needed as soon as possible maybe so that the floor panels at the extraction level can skipped by the transport loader ore with fluent . For reach objective this , material additive form accelerator added to in HPC mixture with objective speed up the hardening process concrete without reduce quality And the quality . In study This is a variation addition accelerator of 1% and 2% of weight of cement used , with product selected accelerator is Sika Rapid 505 and Sika Rapid 610 ID. Study carried out at the Grasberg Block Cave Underground Batching Plant. Results testing show that at the 10th hour, value strength press HPC reaches 17.8 MPa with addition Sika Rapid 505 by 2%. Use Sika Rapid 505 too increase strength Press HPC on 28th day , reached 77.64 MPa . Use accelerator on concrete performance tall in a way significant increase strength press beginning compared to with HPC without accelerator.*

Keywords: *High Performance Concrete, Admixture, Accelerator, Initial Strength, Compressive Strength, Rigid Pavement*

INTRODUCTION

PT Freeport Indonesia (PTFI) is an Indonesian company engaged in the exploration, mining, processing and marketing of copper, gold and silver concentrate in the Tembagapura highlands, Mimika, Papua. Is an affiliated mineral mining company of Freeport-McMoRan (FCX) and Mining Industry Indonesia (MIND ID). PTFI mines and processes ore to produce concentrate containing copper, gold and silver. Grasberg Block Cave is one of PT Freeport Indonesia's underground mines which is currently under development and actively operating. Grasberg Block Cave is capable of producing 150,000 tons of ore/day [16]. With large production achievements every day, PT Freeport Indonesia requires a variety of adequate and high quality production facilities. One of them is High Performance Concrete which is used as floor panels or work floors from the extraction level where heavy loader equipment transports ore to the next production facility . High Performance Concrete (HPC) or high quality concrete is concrete that has a compressive strength that is required to be equal to or above 41.4 MPa [5]. The HPC concrete used at the extraction level must be able to reach the required compressive strength as quickly as possible so that the floor panels at the extraction level can be immediately passed by the loader carrying the ore. An admixture in the form of an accelerator is added to the HPC mixture with the aim of speeding up the hardening process of the concrete so that the required initial strength is achieved but does not reduce the quality and quality of the concrete produced. The admixture material itself is an additional material that is mixed into the concrete mixture during mixing to change the properties of the concrete, both fresh concrete and hardened concrete to achieve the desired goal or purpose of mixing concrete according to needs in the field. Some of the admixture materials used in mixing concrete in the Underground Mine area are Superplastizicer, Stabilizer and Accelerator. The accelerator functions to speed up the setting time and speed up the hardening of the concrete so that the concrete can be used immediately but with high quality and good quality [7]. With the addition of the accelerator admixture, it is hoped that High Performance Concrete can experience a high increase in initial compressive strength and reach the planned compressive strength. In this test, a comparison will be made between High Performance Concrete without accelerator mixture and High Performance Concrete which was treated with the addition of Sika Rapid 505 and Sika Rapid 601 accelerators at 1.0% and 2% for 20 cylinder samples that will be compressed using a UCS machine. . To test the Initial Strength of High Performance Concrete which has been treated with the addition of an accelerator, 5 boxes measuring 50 cm x 50 cm x 20 cm in internal dimensions will be used to carry out the hammer test. The hammer test was carried out 8, 10, and 12 hours after making the test object in the box.

THEORETICAL FOUNDATION

High Performance Concrete

High Performance Concrete (HPC) or high quality concrete according to SNI 036468-2000 (Pd T-18-1999-03) [5] is defined as concrete that has a required compressive strength greater than or equal to 41.1 MPa. High quality concrete has a higher compressive strength than normal concrete and is intended for the construction of multi-storey buildings, piers, silos, chimneys, tunnels, aprons, dams and bridge structures. Some ways to improve the performance of concrete into high quality and high performance concrete is to reduce the porosity of the concrete by reducing water in the concrete mix. Adding mineral additives such as silicafume or fly ash, adding fiber (fibrous concrete), concrete with compacting (mandicompacting concrete) [11]. According to the American Concrete Institute (ACI), HPC is concrete that meets a combination of specific performance requirements and uniformity that cannot always be achieved when using conventional materials and mixing, placing and curing practices for concrete. normal. High quality concrete is also usually called high performance concrete because it has several properties that are superior to normal concrete, including high compressive strength so that the dimensions of structural elements can be slimmer.

Materials Tsmbah

Additives are materials other than the main elements in concrete (water, cement and aggregate) that are added to the concrete mixture during concrete mixing with the aim of changing one or more properties of the concrete while it is still fresh or after it has hardened. The functions of added materials include: accelerating hardening, increasing the workability of fresh concrete, increasing the compressive strength of concrete, increasing ductility or reducing the brittle nature of concrete, reducing hardening cracks and so on. Added materials are given in relatively small quantities with strict supervision so as not to overdo it which results in worsening the properties of the concrete (Tjokrodimuljo, 1996) [21]. Added materials according to their intended use are divided into two groups, namely admixtures and additives. Additives are additional materials that are mixed during the process of making the mixture in the batching plant, while admixtures are additional materials that are mixed during the process of making concrete in the field [7]. Additives are usually in the form of mineral additives while admixtures are chemical admixtures. (Tjokrodimuljo, 1996) [21]. The various types of chemical additives according to ASTM C494-82 are as follows:

a. Type A (water reducing admixtures).
b. Water reducing admixtures are added materials that reduce the mixing water needed to produce concrete with a certain consistency.
c. Type B (retarding admixture).
d. retarded Admixture is an added material that functions to delay the setting time of concrete. For example, due to hot weather conditions where the rate of loss of working properties of concrete is very high.
e. Type C (accelerating admixture).
f. Accelerating admixtures are additional materials that function to accelerate the setting and development of initial strength of concrete.
g. Type D (water reducing and retarding admixture).
h. Water reducing and retarding admixture is an additive that has a dual function, namely reducing the amount of water required for a concrete mixture of a certain consistency and preventing initial setting.
i. Type E (water reducing and accelerating admixtures).

Water reducing and accelerating admixtures are additives that have a dual function, namely reducing the amount of water to produce concrete with a certain consistency and speeding up initial setting.

a. Type F (water reducing high range admixtures).

Water reducing high range admixtures are additives that function to reduce the amount of mixing water needed to produce concrete with a certain consistency, by 12% or more. The reduction in water content in this material is higher, with the aim of increasing the strength of the concrete produced with less water but with a higher level of workability. This type of additive is a superplasticizer, the recommended dose 12 is around 1-2% of the cement weight. Excessive dosage will cause a decrease in the compressive strength of the concrete.

b. Type G (water reducing high range retarding admixtures).

Water reducing high range retarding admixtures are additives that function to reduce the amount of mixing water used to produce concrete with a certain consistency, by 12% or more and also to inhibit the setting of the concrete. This type of additive is a combination of a superplasticizer with a setting time delayer.

Quality Concrete

Concrete is a mixture of cement, aggregate , water and material plus with the right dose And created with ingredients choice , quality And passed test appropriateness For needs casting [3]. Quality concrete is Wrong One part important for determine its application on structure building . Quality concrete Alone can vary in accordance use And election composition materials used . Strong characteristics quality concrete is mark strong concrete obtained from analysis statistics object test quality concrete , where possibility there is mark strong press the one below mark strong press characteristics limited only 5%. For the test , enter stir concrete into the print cylinder size test cylinder 15/30 cm for make a number of object test . After two day open print And soak to in water for 1 ,3,7,14 and 28 days . Then lift And do testing each object test . Each object test Possible will give mixed results And matter This influence quality concrete . By Because That required calculation standard deviation for check is strong press concrete fulfil condition or No .

RESEARCH METHODOLOGY

Research Location

The research location was carried out at the Grasberg Block Cave Underground Batching Plant. For compressive strength testing using a UCS machine and compressive strength testing using the hammer method, it is carried out in the QA/QC room.

Figure 1 *GBC Underground Batching Plant*
(source: Documentation Personal)

Data Collection Stage

This stage describes how to obtain the required data, this data includes primary data and secondary data. the following is the description:

a. Primary data is data obtained directly from direct observations at the Grasberg Block Cave Underground Batching Plant.
b. Secondary data is data that is used as a reference in preparing the final assignment, where the data is obtained from related agencies along with literature from existing research results both at the Grasberg Block Cave Underground Batching Plant and carried out in other places related to the addition of admixture accelerator to HPC.

Types Research

Type research conducted is study experiment , where study This For know initial strength and strong press concrete maximum with material additional sika rapid accelerator . In study this is the data obtained is from results testing carried out at *the Grasberg Block Cave Underground Batching Plant* . Samples made is concrete hard that results the mixture is taken from *mixer* scale compositional production the mix using 80 MPa HPC concrete mix design from *Grasberg Block Cave Underground Batching Plant* which was later added with material *admixture accelerator* form sika rapid 505 and sika rapid 610D, ie as following :

1. Addition Sika Rapid 505 as much as 1% with comparison cement weight
2. Addition Sika Rapid 505 as much as 2% with comparison cement weight
3. Addition Sika Rapid 610D as much as 1% with comparison cement weight
4. Addition Sika Rapid 610D as much as 2% with comparison cement weight

Testing will be done form test strong press use UCS machine on day to 1, 3, 7, 14, 28 with object test form concrete hard cylinder measuring 15 cm x 30 cm, 30 pieces , 10 pieces is HPC concrete without additional admixture, 20 pieces is HPC concrete with addition sika rapid 505 and 610D variations of 1% and 2% for get initial strength value and mark press maximum from HPC concrete without addition of admixture accelerator with given concrete addition of sika rapid 505 accelerator and Sika Rapid 610D. Besides That For know strong press early (Early Strength) then done hammer test testing with object test form concrete printed hard on box wood rectangle measuring 50 cm x 50 cm x 20 cm totaling 5 pieces , 1 piece box form concrete hpc without addition of admixture, 2 pieces box form concrete hpc with addition sika rapid 505 variations 1% and 2%, and 2 pieces box form concrete hpc with addition sika rapid 610D variations of 1% and 2% which will be tested with a hammer test at the 8th , 10th and 12th hours after printing .

Tools And Material

1. Mixture used is mixture HPC production 80 MPa from the GBC Underground batching plant with composition mixture following the mix design from GBC Underground batching plant. On working on trial mix in the field mixed mux design used based on actual mix on moment HPC production is carried out .
2. Admixture Accelerator

Admixture Accelerator used is Sika Rapid 505 and Sika Rapid 610D. Accelerator is material add the ones that work For speed up time tie And hardening concrete .

3. Wooden Box

Wooden box measuring 50 cm x 50 x 20 cm

4. Print Cylinder

Print Cylinder measuring 15/30 cm

Research Flow Chart

Figure 2 Research Flow Diagram

ANALYSIS AND DISCUSSION

Results Data Testing *Hammer Test* HPC + Sika Rapid 505

For know mark strong press HPC concrete with or without addition *accelerator* then do it test *hammer test*

Jam	CF80	CF80 + 1%	CF80 + 2%
8	0	0	0
10	0	0	17.8
12	0	15.95	23.2
14	12.15	20.3	26.75
16	18.9	25.45	0

Table above is conclusion results test *hammer test* on HPC concrete with And without addition Sika Rapid 505 *accelerator* at 8 , 10, 12, 14, 16 hours .

Results Data Testing *Hammer Test* HPC + Sika Rapid 610 ID

Jam	CF80	CF80 + 1%	CF80 + 2%
8	0	0	0
10	0	10.5	10.6
12	0	13.8	14

Table above is conclusion results test *hammer test* on HPC concrete with And without addition Sika Rapid 610 ID *accelerator* at 8 , 10, 12 hours .

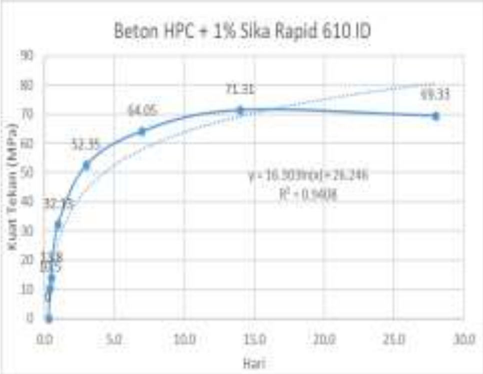
Results Data Test Strong Press HPC + Sika Rapid 505

In original HPC concrete the compressive strength is obtained on day 1 was 20.44 MPa, day 3 was 54.17 MPa, day 7 was 64.11 MPa, day 14 was 68.26 MPa, and day 28 was 74.41 MPa. HPC concrete with the addition of Sika Rapid 505 1% accelerator admixture for the first day the compressive strength obtained was 27.86 MPa, on the 3rd day it was 52.02 MPa, on the 7th day it was 62.66 MPa, on the 14th day it was 63.33 MPa, and on the 28th day it was 70.08 MPa.

HPC concrete with the addition of admixture Sika Rapid 505 1% accelerator for the first day the compressive strength obtained was 27.86 MPa, on the 3rd day it was 52.02 MPa, on the 7th day it was 62.66 MPa, on the 14th day it was 63.33 MPa, and on the 28th day it was 70.08 MPa. From the test results and comparisons above, it can be seen that HPC concrete with the addition of the Sika Rapid 505 accelerator admixture of 2% experienced a faster increase in compressive strength tests with higher compressive strength results compared to ordinary HPC concrete and HPC concrete with the addition of the Sika Rapid Accelerator admixture. 505 as much as 1%. This comparison can be seen in the following graph:

HPC + Sika Rapid 610 ID Compressive Strength Test Results Data

Done test press HPC concrete with addition of the Sika Rapid 610 ID accelerator by 1% of weight of cement, objects test made as many as 5 pieces . The specimen is tested press use machine ucs on day to 1, 3, 7, 14, 28. Results from testing strong press is as following :



From the graph And table above can seen increase strong press early (early strength) begins from the 10th hour after making object test And experience increase fast start from 10 o'clock until with the 168th hour or day 7th . After That increase happen in a way stagnant until on day 14.

Planning Pavement Rigid According to AASHTO 1993

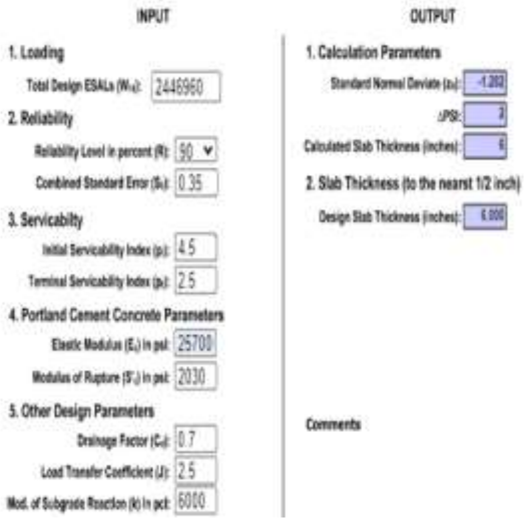
Parameter Determination

The parameters used is secondary data . Primary data used only elastic modulus value And *flexural* strength taken from results testing strong press HPC concrete + Sika Rapid 505 2% is 17.8 MPa .

Parameter		Nilai	Sumber
Umur Rencana	=	1 Tahun	-
W18	=	2.446.960	Data Primer
CBR	=	90%	Data Sekunder
Mutu Beton	=	14 MPa	Data Primer
Fc	=	142.76 kg/cm2	Data Primer
Indeks Permukaan Awal (Po)	=	4.5	AASHTO 1993
Indeks Permukaan Akhir (Pt)	=	2.5	AASHTO 1993
Loss of Serviceability (Δpsi)	=	2	AASHTO 1993
Reliability (R)	=	90	AASHTO 1993
Standard Normal Defiation (Zr)	=	-1.282	AASHTO 1993
Standard Defiation (So)	=	0.35	AASHTO 1993
Modulus of Subgrade Reaction (k)	=	6000 pci	Data Sekunder
Ec	=	2570000	Data Primer
Flexural Strength (Sc)	=	2030 psi	Data Primer
Drainage Coeficient (Cd)	=	0.7	AASHTO 1993
Load Transfer Coeffecient (J)	=	2.5	AASHTO 1993

Calculations Thick Pavement Rigid

$$\log_{10} W_{18} = Z_R S_o + 7.35\log_{10}(D+1) - 0.06 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.5-1.5}\right]}{1+\frac{1.624\times10^{7}}{(D+1)^{8.46}}} + (4.22-0.32p_t)\times\log_{10}\frac{S_c C_d\left[D^{0.75}-1.132\right]}{215.63\times J\times\left[D^{0.75}-\frac{18.42}{(E_c/k)^{0.25}}\right]}$$



So, thick effectively obtained from the equation above is D = 6 inches or equivalent with 15.24 cm.

CONCLUSIONS AND SUGGESTIONS

a. Conclusion

Based on the description and explanation in the previous chapter regarding the use of the Sika Rapid 505 and Sika Rapid 610 ID accelerators on the initial compressive strength *of high performance concrete* to speed up *repair work on floor extraction panels* , it can be concluded as follows:

1. The use of an accelerator for high performance concrete has a significant impact on initial strength and an increase in compressive strength compared to HPC concrete without the addition of an accelerator.
2. High performance concrete without the addition of an accelerator cannot be hammer tested at the 8th, 10th and 12th hours. HPC can only be hammer tested at the 14th hour with a result of 12.15 MPa.
3. HPC with the addition of Sika Rapid 505

1% can be tested with a hammer test at the 12th hour with a result of 15.95 MPa, while HPC with the addition of Sika Rapid 505 2% can be tested with a hammer test at the 10th hour with a result of 17.8 MPa.

4. Giving a 2% dose of Sika Rapid 505 has a superior impact on HPC compared to giving a dose of Sika Rapid 505 of 1%, HPC dries faster and has a higher compressive strength compared to ordinary HPC and HPC with the addition of Sika Rapid 505 1%.
5. After calculating the rigid pavement design using the AASHTO 1993 method, HPC with the addition of a 2% dose of Sika Rapid 505 with a compressive strength of 17.8

MPa was able to be passed by the loader in the 10th hour with the required concrete slab thickness of 6 inches or 15.24 cm.

b. Suggestions

1. Further research needs to be carried out on the amount of use of variations in the dosage of the Sika Rapid 505 and Sika Rapid 610 ID accelerators in order to obtain the maximum compressive strength percentage value for the initial strength of high performance concrete.
2. More samples of initial strength test objects must be made so that the comparison of test results between variations can be more accurate according to applicable standards.
3. Further research needs to be done on determining the percentage composition of water cement, superplasticizer and accelerator factors to prevent bleeding or segregation.
4. Further research needs to be done on the effectiveness of using the Sika Rapid 610 ID accelerator and the ideal dose percentage required.

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