

# An Experimental Study on The Effect of Disinfectant Sodium Hypochlorite (NaClO) Liquid on Density and Compressive Strength Concrete

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## Abstract

The increasing use of disinfectants based on Sodium Hypochlorite (NaClO) for the need of preventive spraying for the COVID-19 pandemic, raises concerns about a decrease in strength in concrete structures. Therefore, the authors researched whether spraying disinfectants based on Sodium Hypochlorite (NaClO) would penetrate the density of the concrete, as well as ascertain whether the concrete structure might experience a massive decrease in compressive strength after spraying. The purpose of this study was to determine the effect of spraying and penetration of Sodium Hypochlorite (NaClO) disinfectant on the compressive strength of concrete. The method used in this research is experimental by doing a trial mix which being worked on at the Becakayu Toll Road Concrete Batching Plant Laboratory - PT. Waskita Beton Precast, Tbk. From the results of the research, the quality of K-500 concrete samples decreased in density by 0.74% in the NaClO-S treatment at the age of 7 days, 0.92% in the NaClO-R treatment at the age of 7 days, 1.09% in the NaClO-S treatment at the age of 14 days, 1.28% in the NaClO-R treatment at the age of 14 days, 1.61% in the NaClO-S treatment at the age of 28 days, 1.55% in the NaClO-R treatment at the age of 28 days. A Comparison of the compressive strength of NaClO-R treatment with Air-R treatment on K-500 quality concrete samples at the age of 7, 14, and 28 days sequentially was 13%, 27%, and 15% higher in the Air-S treatment. The biggest difference in the compressive strength value occurred in the k-500 quality concrete sample at the age of 14 days, namely 352.61 Kg / Cm<sup>2</sup> for NaClO-S treatment versus 482.73 Kg / Cm<sup>2</sup> for Water-S treatment.

## Keywords

Compressive Strength, Density, Sodium Hypochlorite (NaClO)

## 1. Introduction

The choice of the use of concrete in the development of infrastructure development is one of the things that are in great demand in today's modern era. Some of the advantages that make concrete attractive to construction actors are that it has large compressive strength, is durable, is resistant to fire, the raw material for making concrete is easy to obtain and does not experience decay. Mulyono (2003) Research on concrete continues to develop every day, in order to improve the quality and function of concrete for the better and to keep pace with the increasing demand for high-quality concrete in the world of infrastructure.

Environmental factors are a very crucial issue for all types of industries without exception. The outbreak of the COVID 19 pandemic in the world has forced governments around the world to take preventive steps to fight the fast spread of COVID 19. Massive spraying of disinfectants is one of the main options being carried out. The increasing use of disinfectants based on sodium hypochlorite (NaClO) for the need for prevention of the COVID-19 pandemic, raises concerns about a decrease in strength in concrete structures. Therefore, a study is required on whether the spraying of a disinfectant based on sodium hypochlorite (NaClO) will penetrate the density of concrete, as well as to ascertain whether the concrete structure will experience a massive decrease in compressive strength after spraying (Fepy Supriani and Mukhlis Islam, 2017).

Fepy Supriani and Mukhlis Islam (2017) conducted a study on the effect of treatment methods in concrete treatment on the compressive strength and durability of concrete. The aim is to determine the effect of concrete treatment on the compressive strength of concrete. Concrete plan 20 MPa, with a slump of 60-100 mm. The specimen is cubic with side 15 cm. The compressive strength test was carried out at 28 days and 56 days. The treatment of concrete treatment consists of 9 variations, namely, untreated, soaking, and watering. The results of the optimum compressive strength in general for 28 days were produced by concrete with freshwater immersion treatment that was 31.3 MPa. Treated concrete placed outdoors without treatment has the second-highest compressive strength value, which is 28.6 MPa. The compressive strength value of concrete treated with watering and covered with gunny sacks for 28 days is still below the compressive strength of untreated concrete. From this

research, it can be concluded that with increasing age the treated concrete has better strength (Fepy Supriani and Mukhlis Islam, 2017).

From the many previous studies, it can be concluded that the effect of immersion in concrete in different materials affects the value of the compressive strength of concrete. The concentration of sodium hypochlorite disinfectant (NaClO) results in low pH (M. K. Dr. Padoli, 2014) the effect of low pH has the potential to damage the concrete blanket and cause a decrease in the compressive strength and density of the concrete, as explained by previous studies (J. Pandiangan, M. Olivia, 2014).

This research will be a new experimental study, due to the absence of previous research on the effects of immersion and exposure to the disinfectant concentration of sodium hypochlorite (NaClO). This research will further study the physical properties of concrete after immersion and exposure to a disinfectant based on sodium hypochlorite (NaClO) that has a low pH. (M. K. Dr. Padoli, 2014). The physical properties of the concrete to be studied are the density and compressive strength of the concrete, using type 1 OPC cement and Type F Admixture.

## 2. Method

The method used in this study is experimental, namely the method of research conducted by experimenting to obtain data that connects the variables under investigation. The independent variable in this study is sodium hypochlorite (NaClO) that is assumed to affect the density and compressive strength when sprayed and penetrated on a fixed variable, namely concrete, with the K-175, K-300, and K-500 concrete quality variants. The research processes and procedures will refer to SNI (Indonesian National Standard), ASTM (American Society for Testing and Materials), and previous journals by related research.

In the initial process, material preparation is carried out, which is then carried out by aggregate testing to determine the quality of the aggregate used. The aggregate test carried out includes a colloid content test, sieve analysis test, specific gravity, absorption, clay lump test, organic impurities. for fine aggregates), density, abrasion test for coarse aggregates (abrasion test) then a mix design is carried out, after the composition of the mixture is obtained then a concrete mix trial is carried out with the initial slump flow test. If the test results match the specifications, fresh concrete is poured into the sample molds. The test samples printed in this study were printed using a cylindrical print, with dimensions of Ø10.85 cm and a height of 20 cm. (Badan Standarisasi Nasional, 1993)

In making the sample Mix design uses cement OPC type 1 (Semen Gresik), fine aggregate sand ex. Jambi, fine aggregate sand ex. Leles, coarse aggregate screening size 5 - 10 mm ex. Rumpin, clean water (PAM Aetra), additive type F (Consol P200 New) and use of 5.25% sodium hypochlorite (NaClO) concentrate in "Bayclin" products as a disinfectant and penetration solution.[5]

Table 1. Trial Mix Design

Material	Unit	TM K175	TM K300	TM K500
		K175 (Kg/m <sup>3</sup> )	K300 (Kg/m <sup>3</sup> )	K500 (Kg/m <sup>3</sup> )
OPC Type I	Kg/m <sup>3</sup>	270	350	440
Soft Agregat Ex. Jambi	Kg/m <sup>3</sup>	480	429	495
Soft Agregat Ex. Leles	Kg/m <sup>3</sup>	476	426	491
Screening 5/10 Ex. Rumpin	Kg/m <sup>3</sup>	879	913	828
Clean Water Aetra	Ltr/m <sup>3</sup>	175	175	130
Admixture Type F	Ltr/m <sup>3</sup>	-	-	4,11
W/C Ratio		0,648	0,5	0,295

The dosage for sodium hypochlorite (NaClO) is 0.1% (Environmental Health Criteria 216 Disinfectants and Disinfectants By-Products - WHO, 2000) with a calculation of  $0.1\% \times 1000\text{ml} / 5.25\% = 19\text{ ml}$ . The dissolving dose per liter is 19 ml (Craun et al., 2004).

Table 2. Research Design

CONCRETE QUALITY	K-175 (Non-Structure)	K-300 (Structure)	K-500 (High-Quality)
DAYS	7, 14, 28	7, 14, 28	7, 14, 28
SOAK IN WATER	9	9	9
SOAK IN NaClO (0.1%)	9	9	9
WATER SPRAY	9	9	9
NaClO SPRAY (0.1%)	9	9	9
TOTAL SAMPLE	36	36	36
		108	

The method used in this study includes eight main activities, namely:

- Examination of the physical and mechanical properties of the concrete mixture (Badan Standardisasi Nasional, 2008; SNI 1970, 2008);
- Making concrete mixture using the SK SNI-03-2834-2000 method (Pusjatan-Balitbang PU, 1993);
- Slump (workability) testing (SNI 1972:2008, 2008);
- Spraying the sample using sodium hypochlorite (NaClO) disinfectant (Craun et al., 2004);
- Penetration of the sample using sodium hypochlorite (NaClO) disinfectant (Craun et al., 2004);
- Density testing/inspection after spraying and penetration of sodium hypochlorite on concrete samples (Tujuan, 1990);
- Testing / checking the compressive strength of concrete at the age of 7, 14 and 28 days after spraying and penetration of sodium hypochlorite on concrete samples (Tujuan, 1990);
- Data analysis and discussion of research results.

### 3. Results and Analysis

The results of the discussion contain the following descriptions:

#### 3.1. The Results of Testing for Change in Density of Concrete

The test results are grouped on each sample quality, the length of age of the sample, and the treatment of the sample. Sample treatment has the following code:

- NaClO-S, is a treatment by spraying samples with Sodium Hypochlorite
- NaClO-R, is a treatment by soaking samples on Sodium Hypochlorite
- Water-S, is a treatment by spraying samples with water
- Water-R, is a treatment by soaking samples on water

Table 3. Density Change In Concrete Quality K-175

No	Sample Code	Days	Initial Density (kg/m <sup>3</sup> )	Final Density (kg/m)	(%)
1.	TRIALMIX NaClO-S	7	2154,97	2065,97	-4,13%
2.	TRIALMIX NaClO-R	7	2144,53	2146,83	0,11%
3.	TRIALMIX Water-S	7	2166,17	2086,9	-3,66%
4.	TRIALMIX Water-R	7	2163,2	2151,3	-0,55%
5.	TRIALMIX NaClO-S	14	2146,23	2027,57	-5,53%
6.	TRIALMIX NaClO-R	14	2162,53	2194,83	1,49%
7.	TRIALMIX Water-S	14	2155,5	2048,27	-4,97%
8.	TRIALMIX Water-R	14	2158,8	2189	1,40%
9.	TRIALMIX NaClO-S	28	2145,93	2016,3	-6,04%
10.	TRIALMIX NaClO-R	28	2167,83	2198,3	1,41%
11.	TRIALMIX Water-S	28	2145,9	2025,3	-5,62%
12.	TRIALMIX Water-R	28	2174,9	2198,3	1,08%

Based on table 3 the average density change in the concrete quality of K-175 has decreased by 4.13% in the NaClO-S treatment at the age of 7 days, 3.66% in the Water-S treatment at the age of 7 days, 0.55% at Water-R treatment at 7 days, 5.53% in NaClO-S treatment at 14 days, 4.97% in Water-S treatment at 14 days, 6.04% in NaClO-S treatment at 28 days, 5.62% on Water-S treatment at 28 days.

However, there was an increase of 0.11% in the NaClO-R treatment at the age of 7 days, 1.49% in the NaClO-R treatment at the age of 14 days, 1.40% in the Water-R treatment at the age of 14 days, 1.41% in the NaClO-R treatment at the age of 28 days, 1.08% in the Water-R treatment at the age of 28 days.

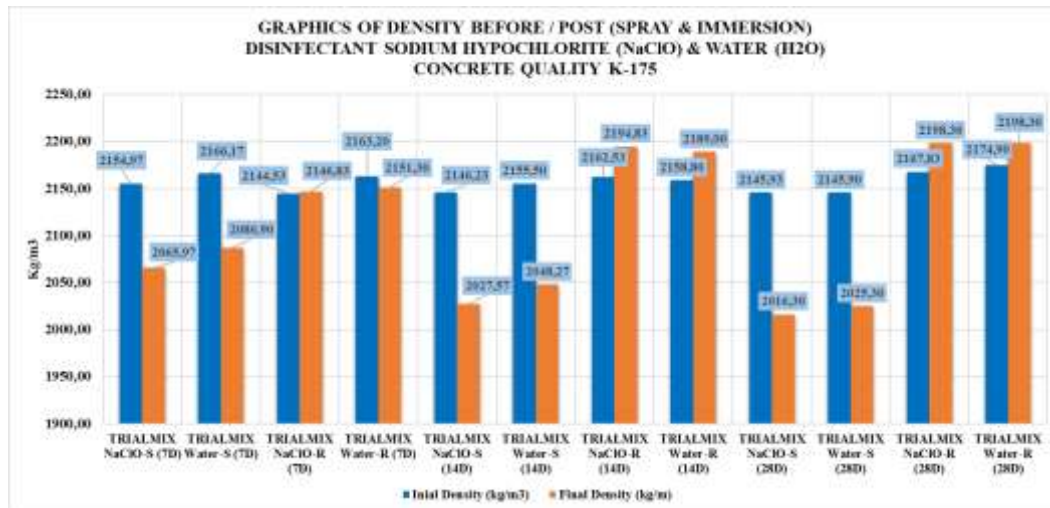


Figure 1. Density Change Graph Concrete Quality K-175  
Source: Research Data, 2020

Table 4. Density Change in Concrete Quality K-300

No	Sample Code	Days	Initial Density (kg/m <sup>3</sup> )	Final Density (kg/m)	(%)
1.	TRIALMIX NaClO-S	7	2272,03	2212,67	-2,61%
2.	TRIALMIX NaClO-R	7	2231,60	2263,87	1,45%
3.	TRIALMIX Water-S	7	2326,13	2269,60	-2,43%
4.	TRIALMIX Water-R	7	2272,37	2281,57	0,40%
5.	TRIALMIX NaClO-S	14	2261,43	2212,27	-2,17%
6.	TRIALMIX NaClO-R	14	2298,40	2325,10	1,16%
7.	TRIALMIX Water-S	14	2270,63	2219,77	-2,24%
8.	TRIALMIX Water-R	14	2262,53	2293,77	1,38%
9.	TRIALMIX NaClO-S	28	2299,03	2225,30	-3,21%
10.	TRIALMIX NaClO-R	28	2244,03	2264,97	0,93%
11.	TRIALMIX Water-S	28	2266,47	2203,67	-2,77%
12.	TRIALMIX Water-R	28	2277,13	2297,40	0,89%

Based on table 4, the average density of concrete samples of K-300 Quality has decreased by 2.61% in the NaClO-S treatment at the age of 7 days, 2.43% in the Water-S treatment at the age of 7 days, 2.17% in the treatment NaClO-S at 14 days, 2.24% in Water-S treatment at 14 days, 3.21% in NaClO-S treatment at 28 days, 2.77% in Water-S treatment at 28 days.

However, there was an increase of 1.45% in the NaClO-R treatment at the age of 7 days, 0.40% in the Water-R treatment at the age of 7 days, 1.16% in the NaClO-R treatment at the age of 14 days, 1.38% in the Water-R treatment at the age of 14 days, 0.93% in the NaClO-R treatment at the age of 28 days, 0.89% in the Water-R treatment at the age of 28 days.

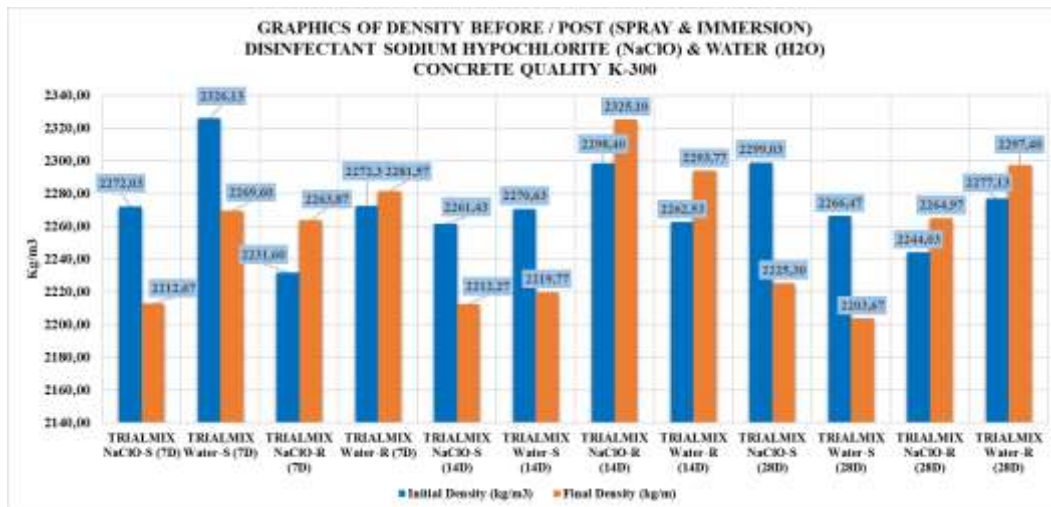


Figure 2. Density Change Graph Concrete Quality K-300  
 Source: Research Data, 2020

Table 5. Density Change in Concrete Quality K-500

No	Sample Code	Days	Initial Density (kg/m <sup>3</sup> )	Final Density (kg/m <sup>3</sup> )	(%)
1.	TRIALMIX NaClO-S	7	2345,03	2327,70	-0,74%
2.	TRIALMIX NaClO-R	7	2357,03	2335,30	-0,92%
3.	TRIALMIX Water-S	7	2357,97	2380,27	0,95%
4.	TRIALMIX Water-R	7	2360,73	2384,60	1,01%
5.	TRIALMIX NaClO-S	14	2354,17	2328,60	-1,09%
6.	TRIALMIX NaClO-R	14	2370,40	2339,97	-1,28%
7.	TRIALMIX Water-S	14	2355,17	2387,90	1,39%
8.	TRIALMIX Water-R	14	2325,03	2358,60	1,44%
9.	TRIALMIX NaClO-S	28	2355,07	2317,23	-1,61%
10.	TRIALMIX NaClO-R	28	2390,20	2353,27	-1,55%
11.	TRIALMIX Water-S	28	2325,83	2376,70	2,19%
12.	TRIALMIX Water-R	28	2323,07	2362,27	1,69%

Based on table 5, the average density of concrete samples of K-500 Quality has decreased by 0.74% in the NaClO-S treatment at the age of 7 days, 0.92% in the NaClO-R treatment at the age of 7 days, 1.09% in the treatment NaClO-S at the age of 14 days, 1.28% in the NaClO-R treatment at the age of 14 days, 1.61% in the NaClO-S treatment at the age of 28 days, 1.55% in the NaClO-R treatment at the age of 28 days.

However, there was an increase of 0.95% in the Water-S treatment at the age of 7 days, 1.01% in the Water-R treatment at the age of 7 days, 1.39% in the Water-S treatment at the age of 14 days, 1.44% for the Water-R treatment at the age of 14 days, 2.19% for the Water-S treatment at the age of 28 days, 1.69% for the Water-R treatment at the age of 28 days.

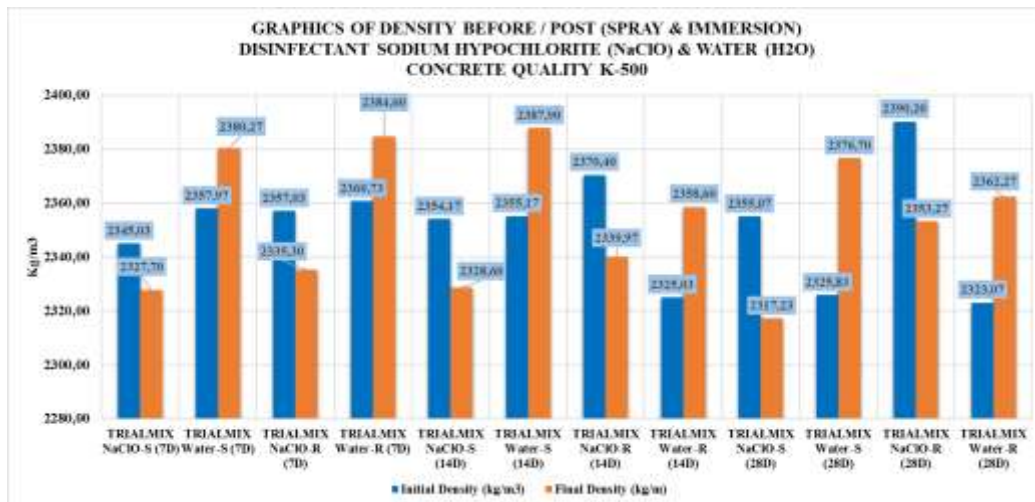


Figure 3. Density Change Graph Concrete Quality K-500  
Source: Research Data, 2020

### 3.2. Compressive Strength Results

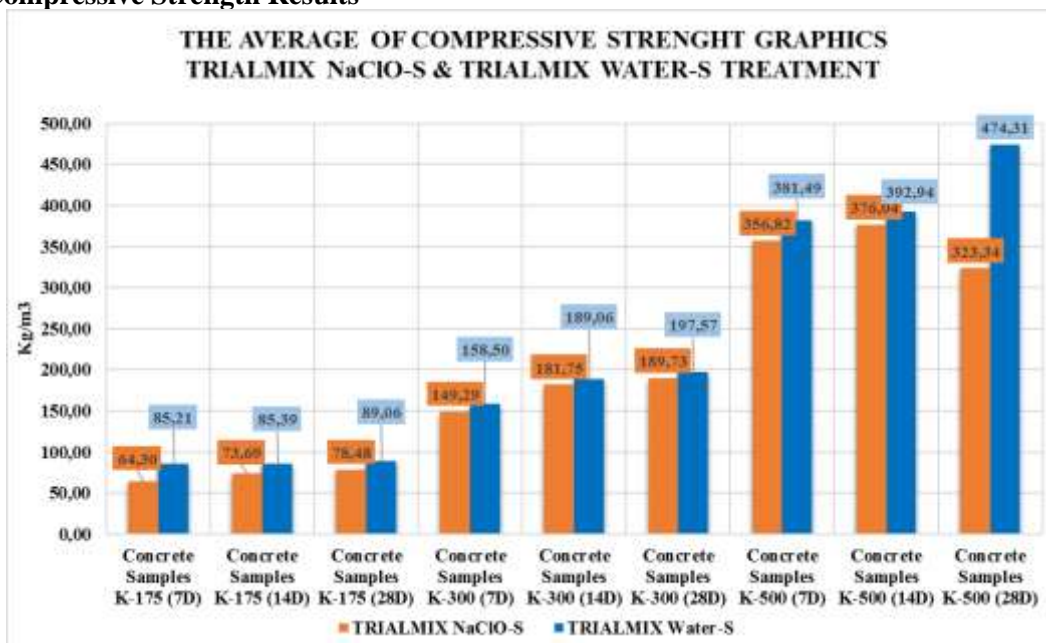


Figure 4. The Average of Compressive Strength Graphics Trialmix NaClO-S & Trialmix Water-S Treatment  
Source: Research Data, 2020

Based on the graph of the average compressive strength of the concrete with TRIALMIX NaClO-S & TRIALMIX Water-S treatment, it can be seen that the comparison of the compressive strength of the NaClO-S treatment with the Water-S treatment on concrete samples with quality K-175 at the age of 7, 14 and 28 days respectively were 25%, 14%, and 12% higher in the Water-S treatment. Comparison of the compressive strength of NaClO-S treatment with Water-S treatment on K-300 quality concrete samples at the age of 7, 14, and 28 days were 6%, 4%, and 4% higher in the Water-S treatment, respectively. As well as the comparison of the compressive strength of NaClO-S treatment with Water-S treatment on K-500 quality concrete samples at the age of 7, 14 and 28 days were 6%, 4%, and 32% higher in the Water-S treatment, respectively. The biggest difference in the compressive strength value occurred in the k-500 quality concrete sample at the age of 28 days, namely 323.34 Kg / Cm<sup>2</sup> for NaClO-S treatment compared to 474.31 Kg / Cm<sup>2</sup> for the Water-S treatment.

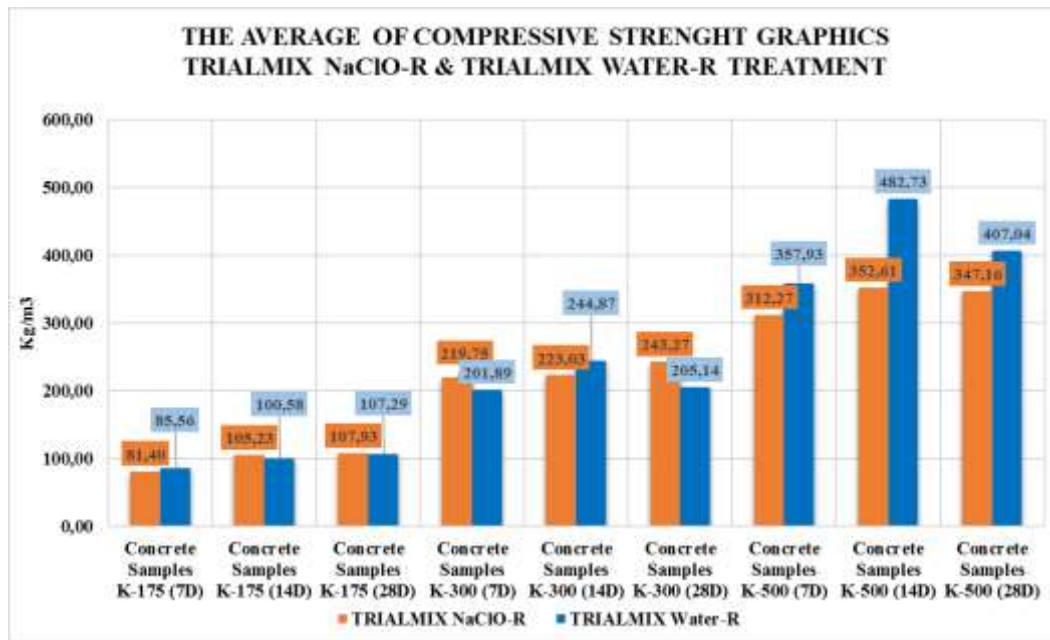


Figure 5. The Average of Compressive Strength Graphics Trialmix NaClO-R & Trialmix Water-R Treatment  
 Source: Research Data, 2020

Based on the graph of the average compressive strength of the concrete with TRIALMIX NaClO-R & TRIALMIX Water-R treatment, it can be seen that the comparison of the compressive strength of the NaClO-R treatment with the Water-R treatment on concrete samples with K-175 quality at the age of 7 days is 5% higher. In the Water-R treatment, it was inversely proportional to the age of 14 and 28 days, namely 5%, 1% higher in the NaClO-R treatment. Comparison of the compressive strength of NaClO-R treatment with Water-R treatment on K-300 quality concrete samples at the age of 14 days was 9% higher in the Water-R treatment, inversely proportional to the age of 7 and 28 days respectively, namely 9%, 19% higher in the NaClO-R treatment. As well as the comparison of the compressive strength of NaClO-R treatment with Water-R treatment on K-500 quality concrete samples at the age of 7, 14, and 28 days respectively were 13%, 27%, and 15% higher in the Water-S treatment. The biggest difference in the compressive strength value occurred in the k-500 quality concrete sample at the age of 14 days, namely 352.61 Kg / Cm<sup>2</sup> for NaClO-S treatment versus 482.73 Kg / Cm<sup>2</sup> for Water-S treatment.

#### 4. Conclusions

Based on the results of the research that has been done, it can be concluded:

1. The spraying treatment of Sodium Hypochlorite (NaClO) disinfectant caused a decrease in density in all concrete grades (K-175, K-300, K-500) and at all concrete ages (7, 14, 28 days). The soaking treatment of Sodium Hypochlorite (NaClO) disinfectant caused an increase in density in the concrete quality of K-175, K-300 and at all ages of concrete (7, 14, 28 days), inversely proportional to the quality of K-500 concrete which experienced a decrease in density at all ages concrete (7, 14, 28 days).
2. The spraying treatment of Sodium Hypochlorite (NaClO) disinfectant caused a low average compressive strength value of all concrete qualities (K-175, K-300, K-500) compared to normal curing concrete at all ages of concrete (7, 14, 28 days), whereas for the soaking treatment of Sodium Hypochlorite (NaClO) disinfectant in concrete quality (K-175, K-300) there is no difference in the average compressive strength value that is too significant compared to normal curing concrete at all ages of concrete (7, 14, 28 days. ), inversely proportional to the soaking treatment of Sodium Hypochlorite (NaClO) disinfectant which causes a lower average compressive strength value in the quality of K-500 concrete compared to normal curing concrete at all ages of concrete (7, 14, 28 days)

#### 5. Acknowledgment

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