JURNAL ONLINE SKRIPSI
MANAJEMEN REKAYASA KONSTRUKSI POLINEMA

Journal homepage: http://jos-mrk.polinema.ac.id/ **ISSN: 2722-9203 (media online/daring)**

EFFECT OF TIME AND DEPTH IMMERSION WITH SEAWATER ON COMPRESSIVE STRENGTH OF HIGH-QUALITY CONCRETE

Anisah Nur Fadhilah[1,*], Qomariah[2], Nawir Rasidi[3]
Construction Engineering Management Student[1], Lecturer of Civil Engineering Department[2], Lecturer of Civil Engineering Department[3]
Email: *anisahnurf17@gmail.com*[1], *qomariah@polinema.ac.id*[2], *nawir.rasidi@polinema.ac.id* [3]

ABSTRACT

The use of concrete on land and around the sea has different treatments, which affect the strength of concrete. In carrying out concrete treatment, pay attention to not only the quality of the water used but also the time and depth of the concrete immersion to produce good quality concrete. This study aims to determine the effect of immersion time and depth using fresh water and seawater on the concrete of compressive strength and to obtain the most optimal depth and time with seawater immersion. The quality of the concrete plan is 42 MPa with cylinder samples with a diameter of 15 cm and a height of 30 cm as many as 70 samples. Immersion is carried out with a treatment duration of 21 days, 28 days, and 56 days with variations in immersion depths of 0, 1/3h, 1/2h, and h. The data needed for this study are the results of compressive strength testing and absorption testing results on concrete, The immersion method used in this study is the water curing method. The research process carried out is by testing the physical properties of aggregates, calculating mix design and material requirement analysis, making test objects and testing fresh concrete, carrying out concrete treatment with water curing immersion methods with fresh water and seawater, conducting absorption and compressive strength testing, and analyzing data. The results showed that the compressive strength of concrete with differences in depth and time using seawater greatly affects the strength of concrete so that it produces higher compressive strength compared to fresh water. This hypothesis is caused by alkaline conditions that can strengthen the reaction of Ca (OH) 2, the formation of Friedel salts in concrete due to chloride content in seawater, and the influence of Sika Viscocrete 3115 N which can withstand carbonation in concrete. So based on all results, concrete with the most optimal seawater immersion at a depth of 1/2h with immersion for 56 days is 73.56MPa with a percentage increase of 19% compared to freshwater immersion.

Keywords: high-quality concrete, compressive strength of concrete, concrete treatment, seawater, immersion time, immersion depth

1. INTRODUCTION

The improvement of the structure carried out at this time certainly led to an increase in the use of concrete as the basic material for building structures. Concrete with good quality results is not only produced in processes that pay attention to the material or manufacturing process but also from the concrete treatment process. Curing is one of the methods that can be used to produce good-quality concrete. Maintenance of concrete serves to maintain the moisture content of the concrete and prevent excessive evaporation of water to produce the quality of concrete as planned.

In its implementation, this study aims to analyze the influence and optimum value of the time and depth of immersion of using seawater on the compressive strength of high-quality concrete, before planning concrete mixtures based on SNI 03-2834-2000. The main test conducted in this study was a compressive strength test on concrete with the influence of differences in soaking time and depth with the quality of the mixture design plan of 42 MPa. Thus, the main objective of this study was to evaluate the effect of curing times of 21 days, 28 days, and 56 days as well as the difference in immersion depth of 1/3h, 1/2h, and h using seawater on the compressive strength of the resulting high-quality concrete.

2. METHODS

Specimen Planning

The planning of this study used a concrete mixture with a quality of 42 Mpa. In this study, a cylindrical specimen with a diameter of 15 cm and a depth of 30 cm

was used. The specimens used in this study were 70 specimens with all mixtures using Fly Ash type C at 15% and Superplastizer namely Viscocrete 3115 N at 0.8%. Here is the approximate number of concrete mix specimens:

Table 1. Approximate Number of Specimens

Immersion Time			Immersion Depth			Total
			1/3h	1/2h	h	
21	Compressive Strength	NW		2		2
		FW	2	2	2	6
		SW	2	2	2	6
	Absorption	NW		2		2
		FW	2	2	2	6
		SW	2	2	2	6
28	Compressive Strength	NW		2		2
		FW	2	2	2	6
		SW	2	2	2	6
	Absorption	NW	2	2		2
		FW	2	2	2	6
		SW	2	2	2	6
56	Compressive Strength	NW		2		2
		FW	2	2	2	6
		SW	2	2	2	6
Total Needs						70

Source: Personal Data

Physical Properties Testing

Testing Physical Properties on Fine Aggregates and Coarse Aggregates.

1) Fine Aggregate
   a. Moisture Content
   b. Organic Content
   c. Spesific Gravity
   d. Fineness Modulus
   e. Fill Weight
   f. Graduation
2) Coarse Aggregate
   a. Moisture Content
   b. Organic Content
   c. Spesific Gravity
   d. Fineness Modulus
   e. Fill Weight
   f. Gradation

Fresh Concrete Testing

The characteristics of the mixture in fresh concrete indirectly affect the hardened concrete. Fresh concrete testing includes slump, Air content, and fill weights

1) Slump Test
   One form of testing fresh concrete is to perform slump testing on fresh concrete. According to SNI 1972:2008, a concrete slump is a decrease in depth on the upper surface of the concrete that is measured after the slump test mold is lifted. The value of the slump is a limitation to know the level of ease and quality of concrete work
2) Air Content
   This test is carried out to determine the level of air contained in concrete, which certainly affects the quality of concrete. The higher the air content in concrete, the more cavities that can affect the quality of concrete.
3) Fill Weight
   This content weight testing is to find out the weight data of concrete union contents. Based on ASTM the weight of the contents is tested using cylindrical molds. The calculation of the weight of the contents on concrete refers to the SNI equation 03-1973-1990, as follows:

$$D = \frac{W}{V} \quad (1)$$

Explanation:
D = Weight of concrete contents (Kg/liter)
W = Weight of the specimen (Kg)
V = Water weight (liter)

Casting and Maintenance of Specimen

Using a mixture of type C Fly Ash and Superplastizer, namely Viscocrete 3115 N in the process of making test specimens. Pour the mortar into a cylindrical mold and flatten the surface using a spatula. Open the cylinder mold after the test specimen hardens, the test specimen that has been removed from the mold is then curing 3, namely without using water, using fresh water, and using seawater with a difference in soaking

(a) (b)

Figure 1. Fly Ash (a) and Viscocrete 3115 N (b)

(a) (b) (c)

Figure 2. Immersion 1/3h (a), Immersion 1/2h, and Immersion h (c)

depth of 1/3h is 10 cm, 1/2h is 15 cm, and h is 30 cm and a difference in soaking time of 21 days, 28 days, and 56 days.

Compressive Strength Test

(a) (b)

(c)

Figure 3. Compressive Strength Specimen 1/3h (a), Compressive Strength Specimen 1/2h (b), and Compressive Strength h (c)

Compressive strength testing of cylinders 15 x 30 cm is carried out using a compressive test machine by the planned concrete life.

3. ANALYSIS AND DISCUSSION

Physical Properties Testing

Table 2. Fine Aggregate Test Result

Types of Testing	Test Results	Quality Standars	Reference
Fineness Modulus	2,95 %	2 % - 3 %	SNI 03-6820-2002
Gradation	Zone 2		SNI 03-2834-2000
Spesific Gravity			
- Bulk	2,31 gr/cm^3	2,5 – 2,7	
- JPK / SSD	2,35 gr/cm^3	2,5 – 2,7	SNI 1969-2008
- Apparent	2,41 gr/cm^3	2,5 – 2,7	
- Absorption	1,69 %	0% - 3%	
Moisture Content	1,50 %	1% - 5%	SNI 03-1971-1990
Organic Content	1 Grid	1 - 3	SNI 03-2816-2014

Source: Personal Data

1) Fine Aggregate

The fine aggregate used in this study was Lumajang Sand. The following table summarizes the results of testing the physical properties of Lumajang Sand:

Based on the lumajang sand analysis data above, it can be concluded that lumajang sand has met the standards as normal fine aggregate

Table 3. Coarse Aggregate Test Result

Types of Testing	Test Results	Quality Standars	Reference
Fineness Modulus	5,58 %	5 % - 8 %	SNI 03-2834-2000
Spesific Gravity			
- Bulk	2.71 gr/cm^3	2,5 – 2,7	
- JPK / SSD	2.75 gr/cm^3	2,5 – 2,7	SNI 1969-2008
- Apparent	2.82 gr/cm^3	2,5 – 2,7	
- Absorption	1.49%	0% - 3%	
Moisture Content	1.29%	0.5% - 2%	SNI 03-1971-1990
Hardness	6.54%	6% - 7,2%	ASTM C-33

Source: Personal Data

2) Coarse Aggregate

The coarse aggregate used in this study was in the form of crushed stone with a maximum size of 2 cm or 20 mm. A summary of the test results of the physical properties of coarse aggregate crushed stone is listed in the following table.

Based on the results of testing the physical properties of crushed stone, it can be concluded that the crushed stone material used meets the standards in each reference used.

Mix Design Result

The standard for calculating the proportion of concrete constituent material mixture refers to SNI 03-2834-2000. Based on the results of testing the physical properties of the material, a mixture plan analysis was carried out with a signaled compressive strength target of 42 Mpa. The following table summarizes the material requirements for 70 test specimens.

Table 4. Result of Material Requirements Analysis

Material	Number of Specimens	Cylindrical Specimen Requirment (Kg)	Total Needs
Cement	70	2.876	201.353
Water		1.024	71.647
Sand		2.823	197.575
Gravel		5.862	410.342
Fly Ash		0.431	30.203
Superplastizer		0.023	1.611

Source: Personal Data

Fresh Concrete Testing

The following are the results of fresh concrete testing which includes slump, air content, and fill weight:

Compressive Strength Testing

After the specimen goes through the curing period according to time variations and into immersion, a compressive test is carried out by applying pressure until the specimen collapses. The average targeted compressive strength (fcr') is 51.51 MPa. Below are the results of compressive strength testing:

Table 6. Compressive Strength Test Results

Immersion Days	Compressive Strength (MPa)						
	No Water	Fresh Water			Sea Water		
		1/3h	1/2h	h	1/3h	1/2h	h
21	66.70	63.85	61.24	57.81	69.17	68.37	58.22
28	46.32	59.75	69.64	80.11	71.11	66.00	57.73
56	57.40	46.07	54.56	58.02	56.79	73.56	63.63

Source: Personal Data

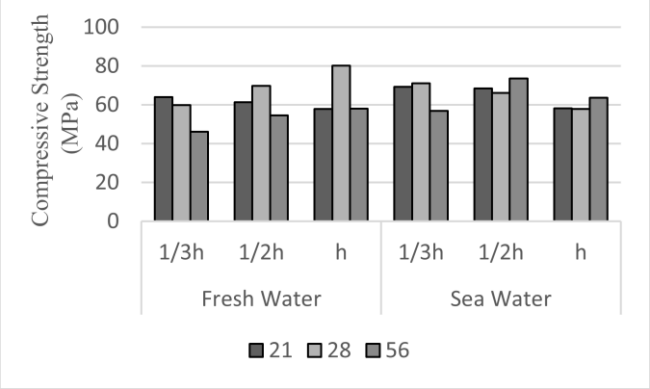

Figure 3. Compressive Strength Test Result

Based on the results of the graph, it is obtained as follows, if at the depth of immersion at a depth of 1/3h, the highest average compressive strength value is obtained at the time of soaking with seawater for 28 days, which is 71.105 MPa. At a depth of 1/2h immersion, the highest average compressive strength value was obtained at 56 days of seawater immersion, which was 73.56 MPa. And at depth h, the highest average compressive strength value was obtained at immersion with seawater for 56 days, which was 63.63 MPa.

If at the soaking time of 21 days, the highest compressive strength value was obtained in soaking using seawater with a depth of 1/3h, which is 69.17 MPa. At a soaking time of 28 days, the highest compressive strength value was obtained in soaking using seawater with a depth of 1/3h, which is 71.11 MPa. And at a soaking time of 28 days, the highest compressive strength value was obtained

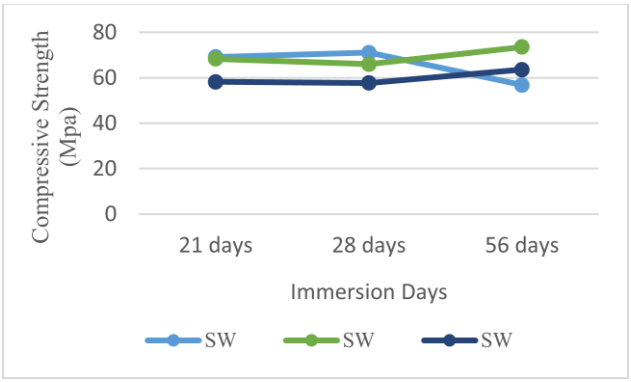

Figure 4. Compressive Strength Graph with Immersion Time Variation

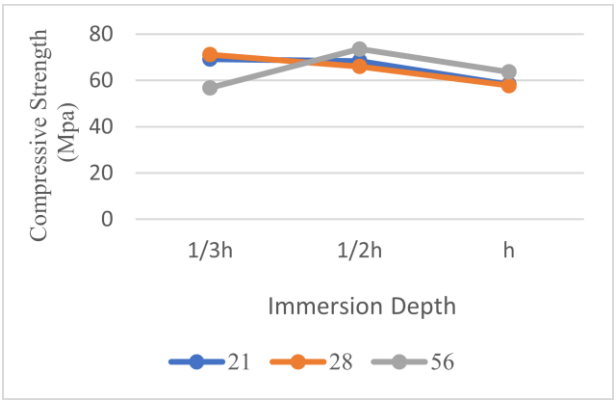

Figure 5. Compressive Strength Graph with Immersion

in soaking using seawater at a speed of 1/2h, which is 73.56 MPa

Below is a graph of the effect based on the time and depth of immersion in seawater:

Based on the graph, it is obtained that the depth and time of immersion using seawater greatly affect the compressive strength of concrete. The concrete treatment process using fly ash and Sika Viscocrete 3115 N with seawater can increase the compressive strength of concrete, this hypothesis is caused by alkaline conditions that can strengthen the reaction of Ca (OH) 2, the formation of Friedel salts in concrete due to chloride content in seawater, and the influence of Sika Viscocrete

Table 5. Result of Fresh Concrete Testing

Fresh Concrete Testing	Test Results	Quality Standars	Reference
Slump	4.8 cm	2.5 – 5 cm	SNI 03- 2834-2000
Air Content	4.8%	<6.5%	ASTM C231
Fill Weight	2.68 kg/lt		

Source: Personal Data

3115 N which can withstand carbonation in concrete. So based on all results, concrete with the most optimal seawater immersion at a depth of 1/2h with immersion for 56 days is 73.56 MPa with a percentage increase of 19 % compared to freshwater immersion.

4. CONCLUSION AND SUGGESTION

Conclusion

Based on the results of the study, the following conclusions can be described:

1) The use of seawater in immersion greatly affects the strength of concrete, there is an increase in compressive strength in immersion using seawater compared to immersion with fresh water. At altitudes of 1/3h with times of 21, 28, and 56 days there was an increase with percentage increases of 5.32%, 11.36%, and 10.72%, at altitudes of 1/2h with times of 21 and 56 days there was an increase with percentage increases of 7.13% and 19%, and altitudes h with times of 21 and 56 days there was an increase with percentage increases of 0.41% and 5.61%. And there was a decrease in compressive strength in seawater immersion compared to freshwater immersion at an altitude of 1/2h within 28 days with a percentage decrease of 3.65% and depth h at 28 days with a percentage decrease of 22.38%.
2) The depth of concrete immersion using seawater greatly affects the strength of concrete. At the immersion time of 21 days, there was a decrease in compressive strength at a depth of 1/2h and h by 0.8% and 10.15%. At the 28-day immersion time, there was a decrease in compressive strength at a depth of 1/2h and h by 5.11% and 8.27%. At the immersion time of 56 days, there was an increase in compressive strength at a depth of 1/2h by 16.77% and then a decrease in compressive strength at a depth of h by 9.93%.
3) The time of immersion concrete using seawater is very influential on the strength of concrete. At an altitude of 1/3h, there was an increase in compressive strength on day 28 by 1.94% and then a decrease in compressive strength on day 56 by 14.31%. At an altitude of 1/2h experienced a decrease in compressive strength on day 28 by 2.38% and then increased compressive strength on day 56 days by 7.56%. At altitude, h experienced a decrease in compressive strength on day 28 by 0.49% and then increased compressive strength on day 56 days by 5.90%.
4) Based on these results, the concrete treatment process using fly ash and Sika Viscocrete 3115 N with seawater can increase the compressive strength of concrete, this hypothesis is caused by alkaline conditions that can strengthen the reaction of Ca (OH) 2, the formation of Friedel salt in concrete due to chloride content in seawater., and the influence of Sika Viscocrete 3115 N which can resist carbonation in concrete.
5) Concrete with the most optimal seawater immersion at a depth of 1/2h with immersion for 56 days is 73.56 MPa with a percentage increase of 19 %.

Suggestion

Based on the research that has been done, suggestions can be given for better further research as follows:

1. It is expected that various parties who want to plan the manufacture of columns or any structural made of concrete that will be entered to pay attention to immersion, which can do immersion of half or less than half at the depth of immersion.
2. If you want to do this research again, you are expected to use other concrete qualities besides high-quality concrete and the use of fly ash that is different from this research.
3. Pay attention to the treatment of the specimen, because it is very influential on the testing time.
4. Be more thorough in performing each procedure.

REFERENCE

[1] Guo, Q., Chen, L., Zhao, H., Admilson, J., & Zhang, W. (2018). The effect of mixing and curing sea water on concrete strength at different ages. In *MATEC Web of Conferences* (Vol. 142, p. 02004). EDP Sciences.

[2] Wila, A. T., Hunggurami, E., & Nasjono, J. K. (2022). Pengaruh Perawatan Water-Curing Dengan Variasi
Lama Perawatan Dan Tinggi Perendaman Terhadap Kuat Tekan Beton. *Jurnal Teknik Sipil*, *11*(2), 183-188.

[3] Uzda, R., Setiady, M. L., & Suat, R. A. (2021). Studi Ekperimental Variasi Curring Air Laut Terhadap Uji Kuat Tekan Beton Menggunakan Air Laut. *KERN: Jurnal Ilmiah Teknik Sipil*, *7*(1), 35-40.

[4] Nasional. B.S (2000). SNI 03-6468-2000. Tata Cara Perencanaan Campuran Tinggi dengan Semen Portland dengan Abu Terbang. Badan Standarisasi Nasional.

[5] Nasional. B.S (2000). SNI 03-2843-2000. Tata Cara Pembuatan Beton Normal. Badan Standarisasi Nasional

[6] Mulyono, T., 2004. Teknologi Beton, Andi, Yogykakarta.

[7] Nawy, Edward G., 1985. Beton Bertulang. Suatu Pendekatan Dasar, Terjemahan oleh Bambang

Suryoatmono, 1990, PT ERESCO, Bandung.

[8] Nasional. B.S (2002). SNI 03-6820-2002. Spesifikasi Agregat Halus untuk Pekerjaan Adukan dan Plesteran dengan Bahan Dasar Semen. Badan Standarisasi Nasional

[9] Standard, A.S.T.M.(2003). ASTM C33M. Standard Specification for Concrete Aggregates, Annual Books of ASTM Standards USA: Association of Standard Testing Materials.

[10] Mulyono, T., 2015, Teknologi Beton : Dari Teori ke Praktek, UNJ, Jakarta

[11] Tjokrodimuljo, 2007. Teknologi Beton. Biro penerbit, Yogyakarta

[12] Mulyono, T., 2005. Teknologi Beton, Andi, Yogykakarta.

[13] Nasional. B.S (2002). SNI 03-6861.1-2002. Spesifikasi Bahan Bangunan Bagian A (Bahan Bangunan Bukan Logam). Badan Standarisasi Nasional

[14] Standard, A.S.T.M.(2020). ASTM C494-82. Standard Specification for Chemical Admixtures, Annual Books of ASTM Standards USA: Association of Standard Testing Materials

[15] Nasional. B.S (2011). SNI 03-1971-2011. Metode Pengujian Kadar Air Agregat. Badan Standarisasi Nasional

[16] Nasional. B.S (2008). SNI 2816: 2014. Metode Uji Bahan Organik dalam Agregat Halus untuk Beton. Badan Standarisasi Nasional

[17] Nasional. B.S (2014). SNI 2816: 2014. Metode Uji Bahan Organik dalam Agregat Halus untuk Beton. Badan Standarisasi Nasional

[18] Nasional. B.S (2008). SNI 1973:2008. Cara Uji Berat Isi, Volume Produksi Campuran, dan Kadar Udara Beton. Badan Standarisasi Nasional

[19] Standard, A.S.T.M.(2017). ASTM C-29M-03. S Standard Test Method for Bulk Density (Unit Weight) and Voids in Aggregates, Annual Books of ASTM Standards USA: Association of Standard Testing Materials

[20] Nasional. B.S (2008). SNI 1972:2008. Cara Uji Slump Beton. Badan Standarisasi Nasional

[21] Nasional. B.S (2012). SNI ASTM C136:2012. Metode Uji untuk Analisis Saringan Agregat Halus dan Agregat Kasar. Badan Standarisasi Nasional

]

[22] Nasional. B.S (2008). SNI 1969:2008. Metode Uji Berat Jenis dan Penyerapan Air. Badan Standarisasi Nasional

[23] Nasional. B.S (2008). SNI 1970:2008. Cara Uji Berat Jenis dan Penyerapan Air Agregat Halus. Badan Standarisasi Nasional

[24] Nasional. B.S (2013). SNI 4810:2013. Tata Cara Pembuatan dan Perawatan Spesimen Uji Beton di Lapangan. Badan Standarisasi Nasional

[25] Nasional. B.S (2011). SNI 1974:2011. Cara Uji Kuat Tekan Beton dengan Benda Uji Silinder. Badan Standarisasi Nasional