Journal of
Advanced Civil and Environmental Engineering
Vol.7, No.2, 2024, pp 178-183
ISSN: 2599-3356
DOI: http://dx.doi.org/10.30659/jacee.7.2.178-183

Concrete Resistance in the Marine Environment: The Effect of Seawater Immersion (Curing) on Compressive Strength

Didik Setya Purwantoro[1], Muhammad Nur Fajar[1]*, Hasriadi Muchtar[1], Mohammad Aris[1], and Wilis Sutiono[1]

[1] *Program Studi Teknik Sipil, Fakultas Teknik, Universitas Muhammadiyah Sorong*
** Corresponding author: muhammad.n.fajar53@gmail.com*

(**Received:** 10th October 2024 ; **Revised:** 9th December 2024 ; **Accepted:** 27th December 2024)

Abstrak: Concrete is the most commonly used type of construction material but is affected by premature damage when exposed to the marine environment. The most common cause of damage is corrosion in the reinforcing steel. The problem that arises during the planning and construction stage of the beach safety building is the impact of seawater on the quality of the concrete we design. The research conducted is an experimental test with research in the laboratory by comparing the compressive strength value of normal concrete soaked in freshwater, saltwater in the laboratory and seawater in situ and the age of the used concrete is only 28 days. concrete that is immersed in seawater will experience a significant decrease in compressive strength value compared to normal concrete immersed in fresh water. For normal concrete soaked with seawater in the laboratory, the compressive strength value decreased from 29.96 MPa to 28.06 MPa. Meanwhile, concrete soaked in situ in seawater experienced a decrease in compressive strength value from 29.96 MPa to 25.55 MPa.

Keyword: *Fresh Water, Salt Water, Insitu, compressive strength*

1. Introduction

Concrete is the most commonly used type of construction material because it has high strength to withstand compressive forces and its ease of obtaining [1], [2], [3]. but it is affected by premature damage when exposed to the marine environment. The most common cause of damage is corrosion in the reinforcing steel.

Many of Indonesia's coastal areas face serious environmental problems, such as flash floods, abrasion, and infiltration of saltwater inland [4], [5]. To overcome this problem, it is necessary to build a beach safety building. [6] The problems that arise during the planning and construction stage of coastal safety buildings are the impact of seawater on the quality of the concrete we design and its long-term impact on the concrete construction we use.

In previous research conducted by Hunggurami in 2014 [7], Hendriyani in 2016 [8] and Pujianto in 2019 [9] through this study explained that concrete with freshwater treatment produces less compressive strength than using seawater treatment.

Based on the description, the author found a difference in opinions related to the influence of seawater on the compressive strength value of concrete, so it is necessary to re-test using local materials of Sorong City, where Sorong City is a coastal area that has the potential to have the same case.

2. Method

The research conducted is an experimental test with research in the Laboratory referring to SNI 03-2834, regarding "Procedures for Making Normal Concrete Mix Plans" with a test specimen measuring 15 cm x 15 cm x 15 cm in the shape of a cube, for details of the number of samples can be seen in table 1.

Tabel 1. Specimen Details

Benda Uji	Curing			Total Test Specimens
	Fresh Water (T)	Seawater in the Laboratory (LL)	Seawater Insitu (LI)	
Normal Concrete	3	3	3	9

Preparation

At the preparation stage in this study, all things related to the support of the implementation of the research process to be carried out are carried out. The preparation includes literature study, the implementation of material procurement such as coarse aggregate, extraction of fine aggregate, and cement by placing an order, as well as the extraction of seawater that will be used as a concrete treatment medium in this study.

Material Inspection and Testing

Testing of material characteristics is carried out to ensure whether the materials used in this study have met the specifications or not. The examination of material characteristics carried out in this study refers to the Indonesian National Standard (SNI). and conducted at the Civil Engineering Laboratory of the University of Muhammadiyah Sorong.

Concrete Planning and Mixing

The design of the concrete mixture was carried out using the DoE (Department of Environment) method based on SNI 03-2834, and the determination of the rencan compressive strength value of f'c 24 MPa. The design of the concrete mixture is carried out after the characteristics test has been determined in order to design how the aggregate, cement, water, and additives are needed. The order in mixing is, gravel, sand, cement then water and additives if used. The manufacture of concrete mixtures refers to SNI-03-2834 "Procedures for Making Concrete Mixtures"

Curing

After the test piece is opened from the mold, weighing is carried out on each test piece before concrete treatment is carried out. Concrete treatment (curing) is carried out with 3 different media, namely immersion in a tank filled with fresh water, immersion in a tank filled with seawater, and sample immersion in the coastal sea. The immersion of the test specimen is carried out for 28 days.

Concrete Compressive Strength Testing

After the treatment period ends, the test piece is weighed again to determine the weight after the treatment. Then a compressive strength test was carried out on the test piece with a life of 28 days. Compressive strength testing was carried out using the Compression Machine Test at the Civil Engineering Laboratory of the University of Muhammadiyah Sorong.

3. Results And Discussion

3.1 Testing of Concrete Component Materials

After the entire series of tests is carried out, the recapitulation of the test results of material characteristics as concrete mixing can be seen in Table 2.

Tabel 2. Recapitulation of Material Characteristics Test Results

No	Test Name	Interval	Standard Test	Value	Information
1	Aggregate Gradation a. Fine Aggregate b. Coarse Aggregate	 Zone 1-4 Zone 1-3	SNI 03-2834-2000	 Zona 3 Zona 2	Qualify
2	Berat Isi Agregat a. Fine Aggregate - Dense - Loose b. Coarse Aggregate - Dense - Loose	 1,4-1,9 gr/cm³ 1,6-1,9gr/cm³ 	 SNI 1973-2008 	 1,66 gr/cm³ 1,54 gr/cm³ 1,74 gr/cm³ 1,60 gr/cm³	 Qualify
3	Berat Jenis Agregat a. Fine Aggregate - Bulk Specific Gravity - Specific Gravity SSD - BJ Semu b. Coarse Aggregate - Bulk Specific Gravity - BJ Kering Muka - BJ Semu	 1,6-3,3 % 1,6-3,2 % 	 SNI 03-1970-1990 SNI 1961-2016 	 2,32 gr/cm³ 2,33 gr/cm³ 2,36 gr/cm³ 2,32 gr/cm³ 2,53 gr/cm³ 2,35 gr/cm³	 Qualify
4	Penyerapan Air a. Fine Aggregate b. Coarse Aggregate	 Maks 2% 0,2-4 %	 SNI 03-1970-1990 SNI 1961-2016	 1,78 % 1,80 %	Qualify
5	Sludge Content	Maks 5%	SNI 03-2847-2002	0,88 %	Qualify

Source: Test Data Processing Results, 2024

Based on the table above, it can be concluded that all cement and aggregate characteristics testing meet the requirements that have been set by SNI which are references and can be used as concrete mixing materials.

3.2 Proportion of Concrete Mix

After the calculation (Job Mix Design), the proportions of the mixture can be seen in table 3.

Tabel 3. Proportion of Concrete Mix at Each Variation (kg)

Specimen Code	Cement	Water	Fine Aggregate	Coarse Aggregate
BN	13.973	7,161	22,072	38,072

Source: Test Data Processing Results, 2024

3.3 Compressive Strength Test Results

The following is a table of compressive strength results of Normal concrete with curing variations of fresh water (T), seawater in the laboratory (LL) and seawater (LI)

Tabel 4. Compressive Strength Results of Concrete with Freshwater Curing

TEST SPECIMEN	CURING	TEST RESULTS kN	W0 Kg	W1 Kg	CONCRETE QUALITY (MPa)	Average (MPa)
A1	Fresh Water (T)	**680**	8165	8260	30	**29.96**
A2		**790**	8420	8525	35	
A3		**553**	8410	8500	25	

Source: Test Data Processing Results, 2024

Based on table 4, it can be seen that for normal concrete with freshwater immersion (Curing) has an average compressive strength of 29.96 MPa, and the results meet the concrete quality targeted in the JMD calculation.

Tabel 5. Compressive Strength Results of Concrete with Salt Water Curing in Lab.

TEST SPECIMEN	CURING	TEST RESULTS kN	W0 Kg	W1 Kg	CONCRETE QUALITY (MPa)	Average (MPa)
B1	Seawater in the Laboratory (LL)	**635**	8210	8315	28	**28.06**
B2		**650**	8460	8585	29	
B3		**610**	8130	8246	27	

Source: Test Data Processing Results, 2024

Based on table 5, it can be seen that for normal concrete with seawater immersion (Curing) in the laboratory has an average compressive strength of 28.06 MPa, and the results meet the quality of concrete targeted in the JMD calculation.

Tabel 6. Compressive Strength Results of Concrete with Salt Water Curing (insitu)

TEST SPECIMEN	CURING	TEST RESULTS kN	W0 Kg	W1 Kg	CONCRETE QUALITY (MPa)	Average (MPa)
C1	Insitu Seawater (LI)	**580**	8295	8412	26	**25.55**
C2		**595**	8089	8210	26	
C3		**550**	8260	8400	24	

Source: Test Data Processing Results, 2024

Based on table 6, it can be seen that for normal concrete with in situ seawater soaking (Curing) has an average compressive strength of 25.55 MPa, and the results meet the quality of concrete targeted in the JMD calculation.

3.4 Comparison of Compression Test Results

The following is a comparison of the compressive strength results of Normal concrete with curing variations of fresh water (T), seawater in the laboratory (LL) and seawater (LI)

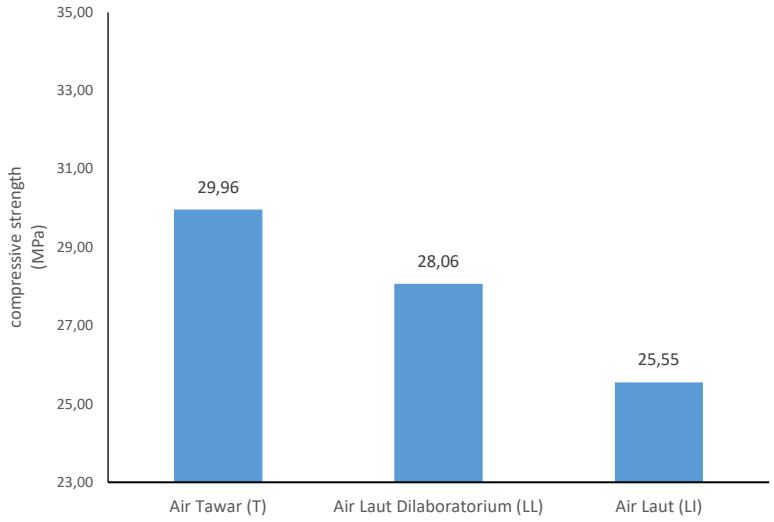

Fig 1. Normal Concrete Compressive Strength Value
Source : Test Data Processing Results, 2024

Based on Figure 1, the results of the concrete compressive strength test show that the compressive strength value of normal concrete (BN) with freshwater curing (T) is greater when compared to laboratory seawater (LL) and seawater (LI) curing. This is because seawater contains chemicals in the form of chloride (CI), sodium (NA), and sulfate (SO4) which cause mortar damage through physical and chemical reactions, and concrete that is immersed in seawater will experience a significant decrease in compressive strength value compared to normal concrete immersed in fresh water. These results are certainly inversely proportional to the results obtained from previous studies.

4. Conclusion

Based on the tests that have been carried out, the compressive strength value of concrete will decrease if immersed in seawater. For normal concrete soaked with seawater in the lab, the compressive strength value decreased from 29.96 MPa to 28.06 MPa. Meanwhile, concrete that was immersed in situ in seawater experienced a decrease in compressive strength value from 29.96 MPa to 25.55 MPa. This is because seawater contains chemicals in the form of chloride (CI), sodium (NA), and sulfate (SO4) which cause mortar damage through physical and chemical reactions.

Reference

[1] H. Arifin, M. N. Fajar, D. S. Purwantoro, A. Maysyurah, and M. Aris, "Pengaruh Penambahan Superplasticizer Terhadap Kuat Tekan Pada Beton Campuran Air Laut," Publikasi Riset Orientasi Teknik Sipil (Proteksi), vol. 6, no. 1, pp. 89–93, Jun. 2024, doi: 10.26740/proteksi.v6n1.p89-93.

[2] N. Rahmawati, I. Lakawa, and D. Pekerjaan Umum dan Penataan Ruang Kabupaten Wakatobi, "Pengaruh Cangkang Kerang Laut Terhadap Kuat Tekan Beton," Sultra Civil Engineering Journal (SCiEJ, vol. 2, no. 1, 2021.

[3] Afrianto Sulaiman, Satria Agung Wibawa, and Yayu Sriwahyuni Hamzah, "Pemanfaatan Limbah Cangkang Kerang Darah (Anadara Granosa) Sebagai Pengganti Sebagian Agregat Halus (Pasir) Pada Campuran Beton Untuk Mengetahui Nilai Workability Dan Kuat Tekan Beton," Rancang Bangun Teknik Sipil, vol. 8, no. 3, pp. 19–27, 2022, [Online]. Available: http://e-journal.janabadra.ac.id/

[4] Didik Santoro, M. Yamin, and Muh. Mahrus, "Penyuluhan Tentang Mitigasi Bencana Tsunami Berbasis Hutan Mangrove Di Desa Ketapang Raya Kecamatan Keruak Lombok Timur".
[5] F. Aripatra Maitindom, Y. Maruanaya, I. Tampubolon, and S. Marei, "Sosialisasi Keberadaan Mangrove Bagi Masyarakat Kampung Boratei Distrik Teluk Kimi Kabupaten Nabire," Jurnal Pengabdian kepada Masyarakat Nusantara, vol. 5, no. 1, pp. 951–955, Feb. 2024, doi: 10.55338/jpkmn.v5i1.2037.
[6] Brama Lesmono, Umboro Lasminto, and Bambang Sarwono, "PERENCANAAN BANGUNAN PENGAMAN PANTAI UNTUK MENGATASI ABRASI DI PANTAI PULAU DERAWAN".
[7] Hunggurami, E., Utomo, S., Wadu, A. (2014). Pengaruh Masa Perawatan (Curing) Menggunakan Air Laut Terhadap Kuat Tekan dan Absorpsi Beton. Jurnal Teknik Sipil Universitas Nusa Cendana, Kupang.
[8] Hendriyani, R., Pratiwi, R., Aprilianus, Y. 2016. Pengaruh Jenis Air Pada Perawatan Beton Terhadap Kuat Tekan Beton. Tugas Akhir Jurusan Teknik Sipil Universitas Balikpapan. Balikpapan.
[9] A. Pujianto, H. Prayuda, B. C. Zega, and B. Afriandini, "Kuat Tekan Beton dan Nilai Penyerapan dengan Variasi Perawatan Perendaman Air Laut dan Air Sungai," Semesta Teknika, vol. 22, no. 2, 2019, doi: 10.18196/st.222243.
[10] Badan Standarisasi Nasional. (2002). SNI 032847-2002: Tata Cara Perhitungan Struktur Beton untuk Bangunan Gedung. Dinas Pekerjaan Umum. Jakarta.