JOURNAL LA MULTIAPP
VOL. 06, ISSUE 03 (470-481), 2025
DOI: 10.37899/journallamultiapp.v6i3.394

Sustainable Utilisation of Beach Sand as Fine Aggregate Replacement and Its Effect on Concrete Strength with Admixtures Reinforcement

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Article Info

Article history:
Received 29 April 2025
Received in revised form 16 May 2025
Accepted 10 June 2025

Keywords:
Beach Sand
Compressive Strength
Admixture
Replacement

Abstract

This research was conducted to review the feasibility of beach sand from the Batu Bolong village of West Lombok Region as an alternative fine aggregate in concrete manufacturing. The background of this research is based on the decreasing supply of sand from rivers and mountains. The main objective of this research was to evaluate the compressive strength of concrete using beach sand, both with and without a washing process, and assess whether this material could be applied in structural construction. In addition to technical aspects, the local community's habit of utilizing beach sand is also part of the consideration in this study. The result oh the tests showed that the compressive strength of normal concrete without admixtures at 3, 7, and 28 days of age were 16.42 MPa, 19.21 MPa, and 23.39 MPa, respectively. The addition of the "BETON MIX" admixture increased the strength to 20.78 MPa, 23.38 MPa, and 26.44 MPa. Meanwhile, concrete using washed beach sand showed compressive strengths of 22.67 MPa, 23.61 MPa, and 25.16 MPa. The concrete with unwashed beach sand produced strengths of 21.72 MPa, 22.40 MPa, and 23.08 MPa. The results of this study indicate that sand from Batu Bolong beach has the potential to be a substitute for fine aggregate in concrete. However, its use must still consider ecological impacts so as not to disturb the balance of the coastal environment.

Introduction

Concrete itself is the result of mixing cement, fine aggregate, coarse aggregate, water, and additives if needed (Vitri & Herman, 2019). According to Hover (2011), water plays an important role in triggering chemical reactions during the concrete curing process. In Indonesia, concrete is widely used because of its easy to perform, can be customized to suit construction needs, as well as its high durability, resulting in relatively low maintenance costs (Danish et al., 2022). Concrete is one of main favorite of material to use (Fitriani & Farida, 2017). Fine aggregates in Indonesia are gained from river sand and mountain sand. Beach sand is still rarely used because it has fine grains, a round shape, uniform gradation and containing a certain amount of salt content (Siswoyo, 2009). According to Ramadhany (2023), this salt content can reduce the quality of concrete and cause corrosion of reinforcing steel, which in turn can damage the overall concrete structure.

Therefore, beach sand is less than ideal for use as a concrete mix (Ifana, 2004). However, in some coastal areas, beach sand is still used due to its easy availability (Dara & Sugiri, 2014). According to Rahmat et al. (2016); Susanto (2021), admixtures are additives other than cement, water, sand, and gravel, which are added in powder or solution form to the fresh

ISSN: 2716-3865 (Print), 2721-1290 (Online)

concrete mix. The aim is to modify concrete properties, accelerate or slow down hardening time, and improve concrete performance when it hardens (Dang et al., 2014; Pradipa, 2023).

One type of admixture used for this research is the "Aquaproof concrete mix series," which is a liquid with Superior Plasticizer technology. This product can improve the quality of concrete, improve workability, reduce water demand by 10-30%, accelerate hardening, and make concrete more watertight (Faqihuddin et al., 2021; Purwanto et al., 2024). To assess the quality of concrete with a mixture of beach sand. In this reasearch compressive strength testing was carried out using a Compression Testing Machine (CTM). Research by Tata (2019) on Mongoli, Sosowomo, and Loto beach sand aggregates showed that Loto sand produced a concrete compressive strength of 22.84 MPa. By decreasing the FAS to 0.4, the compressive strength increased to 26.64 MPa, up 16.64% compared to FAS 0.48, thus proving the significant effect of FAS on concrete quality.

Brazilun (2024) examined the use of Sampur beach sand as a fine aggregate in concrete and studied the effect of treatment on compressive strength. The results showed that washed sand produced the highest compressive strength of 22.14 MPa, while sand that was only watered reached 17.52 MPa, and sand without treatment produced the lowest compressive strength, which was 16.36 MPa, in line with research Wahyudi (2022). This finding confirms that washing beach sand significantly increases the strength of concrete compared to other treatments (Alwi et al., 2025). Amir et al. (2022) and Atmaja & Irwansyah (2021), examined the compressive strength of concrete with a fine aggregate of Bunga beach sand and river sand at a plan quality of 24 MPa, tested at 7, 14, and 28 days. As a result, the average compressive strength of Indrayaman Village beach sand reached 18.34 MPa (7 days), 22.66 MPa (14 days), and 25.23 MPa (28 days), while Sei Balai Village beach sand was 17.92 MPa, 22.24 MPa, and 25.06 MPa, respectively. Based on this issue, the author suggests a scientific study on the utilization of beach sand as a concrete mix material to anticipate if river sand and mountain sand, especially in the Lombok area, are depleted. In this study, beach sand from the Batu Bolong area and concrete reinforcing admixtures were used as additional materials to test the compressive strength of the resulting concrete.

Methods

To complete this research, a quantitative experiment was done at the Civil Engineering Laboratory of Universitas Muhammadiyah Mataram. The main goal of the study was to see if beach sand from the Batu Bolong location could be used like normal fine aggregate in concrete by looking at their compressive strength. Was checked how normal concrete, normal concrete with an admixture, concrete using washed beach sand with admixture, and concrete using unwashed beach sand with admixture react (Rifki et al., 2023). Every type was tested at its ages of 3 days, 7 days, and 28 days. To get the best results, a wide range of laboratory tests was included in the research. All the materials were put through various tests based on national and international guidelines to find out if they could be used for making concrete. Before being used for mix design and experiment sample production, Portland cement, fine aggregates (sand from the river and beach), coarse aggregate (crushed stone), distilled water, and the plasticizer were tested and confirmed to meet standards for construction work routines. The entire testing process followed the sequence outlined in Table 1, which presents the tests conducted and their respective purposes:

Table 1. Testing Process Overview

Type of Test	Objective	Standard/Reference
Moisture Content	Determine water content in aggregates	Gravimetric Method
Silt Content	Evaluate cleanliness of fine aggregate	Sieve No. 200 / Washing Method
Salt Content	Measure salinity in beach sand	AS 2758.1-2009

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Gradation (Sieve Analysis)	Determine particle size distribution	ASTM C136 / SNI 03-1968
Specific Gravity	Identify aggregate density and quality	ASTM C127 & C128
Absorption Capacity	Measure water absorption potential of aggregates	ASTM C127 & C128
Slump Test	Assess concrete workability	ASTM C143 / SNI 03-1972
Compressive Strength Test	Evaluate concrete strength over time	ASTM C39 / SNI 1974:2011

When the tests on materials were done, the SNI 03-2834-2000 standards were used to help choose the right ratios of each ingredient for the best strength, ease of handling, and durability. The mixes for all of the ecosystems were prepared following set conditions. To find out the effect, the same concrete was prepared four times using different types. These features are given in Table 2.

Table 2. Concrete Mix Variations

Code	Description	Fine Aggregate	Admixture	Sand Condition
M1	Normal Concrete (Control)	River Sand	None	Standard
M2	Normal Concrete with Plasticizer	River Sand	BETON MIX	Standard
M3	Concrete with Washed Beach Sand + Plasticizer	Washed Beach Sand	BETON MIX	Washed
M4	Concrete with Unwashed Beach Sand + Plasticizer	Unwashed Beach Sand	BETON MIX	Unwashed

The process continued with blending the dry ingredients, and then adding both water and plasticizer to match the mix being prepared. Immediately after mixing, slump tests were done to check the fresh mixture's workability, and the fresh concrete was poured in three layers into cylindrical molds (with a diameter of 15 cm and a height of 30 cm), and each layer was tamped to remove air bubbles. Within twenty-four hours, the specimens were taken out of the mold and fully cured by immersion in water, as in a usual site scenario. Strength tests were done on the cured mixture at 3, 7, and 28 days using a CTM, just like it says in SNI 1974:2011. To guarantee that the load was applied evenly, each specimen was given a cap on its ends before every test. All the mixes were tested thrice, and the findings were added together to eliminate minor irregularities.

Result and Discussion

Aggregate Testing Result

In this study, the results of aggregate testing analysis include several important data, namely: testing data on water content of aggregates, silt content of aggregates, salt content of beach sand aggregates, aggregate gradation, loose and solid unit weight of aggregates, specific gravity and absorption of aggregates, and abrasion testing of coarse aggregates using Los Angeles machine.

Table 3. Aggregate Test Analysis Results

Testing		Fine aggregate	Coarse aggregate	Beach sand
Modulus of Fine Grain (MFG)		2,72	7,09	2,51
Aggregate moisture content		1,92	2,74	1,70
Sludge content of aggregate		2,85	2,74	-
Salt content		-	-	0,001
Aggregate volume weight	Retrieved	1,361	1,460	1,691

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	Solid	1,434	1,560	1,965
Aggregate gradation		Limit No.2	Max. 40mm	Boundary No.4
The specific gravity of aggregate		2,5	2,6	3,5
Absorption		0,6	2,7	0,7
Abrasion		-	20,49	-

Source: Research Data, 2024

Table 4. Sand Content of Batu Bolong Beach

Material Test sample	Weight (grams)	Percentage (%)
Silica sand	234,18	26,02
Iron sand	264,20	52,84
Total	500	99,676

Source: Research Data, 2024

Slump Testing

The following are the results of the slump test on the tested specimens.

Table 5. Slump Test Analysis Results

No.	Test sample	Age	Slump Test Value		
			I	II	III
		(Days)	(cm)	(cm)	(cm)
1	Normal concrete without plasticizer	3	8,4		
		7	8,7		
		28	9,0		
2	Normal concrete with plasticizer	3	9,0		
		7	8,9		
		28	9,1		
3	Concrete with beach sand washed with plasticizer	3	9,0		
		7	9,0		
		28	9,2		
Continued					
Continued Table 3. Slump test analysis result					
4	Concrete with beach sand without leaching with plasticizer	3	9,0		
		7	9,0		
		28	9,0		

Source: Research Data, 2024

Based on the data in Table 5, it’s shown that concrete without plasticizer has the lowest settlement rate, ranging from 8.4 to 9.0 cm. Meanwhile, the test specimens treated with plasticiser showed a greater rate of settlement, ranging from 8.9 to 9.2 cm.

Testing The Compressive Strength of Concrete

Concrete compressive strength testing was carried out in the Laboratory of the Civil Engineering Study Programme, Faculty of Engineering, Muhammadiyah Mataram University, using the SNI 1972: 2011 method.

Table 6. Compressive Strength Test Results of Normal Concrete Without Plasticiser

Sample Name					

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	Age (Days)	Test Sample Weight (kg)	Field Area (mm^2)	Compressive Force (kN)	Compressive Strength (MPa)
Normal Concrete Without Plasticiser	3	13.4	17662.5	296	16.76
	3	13.4	17662.5	304	17.21
	3	13.5	17662.5	270	15.29
AVERAGE					**16.42**
Normal Concrete Without Plasticiser	7	13.5	17662.5	398	22.53
	7	13.5	17662.5	338	19.14
	7	13.2	17662.5	282	15.97
AVERAGE					**19.21**
Normal Concrete Without Plasticiser	28	13.5	17662.5	452	25.61
	28	13.4	17662.5	384	21.75
	28	13.4	17662.5	403	22.81
AVERAGE					**23.39**

Source: Research Data, 2024

In Table 6. The results of the compressive strength test of normal concrete without plasticiser obtained the average compressive strength at the age of 3, and 7 days have a compressive strength that is not according to plan, namely >20 MPa and reaches the plan compressive strength at the age of 28 days, namely 23.39 MPa.

Table 7. Compressive Strength Test Results of Normal Concrete With Plasticiser

Sample Name	Age (Days)	Test Sample Weight (kg)	Field Area (mm^2)	Compressive Force (kN)	Compressive Strength (MPa)
Normal Concrete with Plasticiser	3	13.5	17662.5	348	19.70
	3	13.3	17662.5	379	21.46
	3	13.4	17662.5	374	21.17
AVERAGE					20.78
Normal Concrete with Plasticiser	7	13.6	17662.5	402	22.76
	7	13.2	17662.5	415	23.50
	7	13.3	17662.5	422	23.89
AVERAGE					23.38
Normal Concrete with Plasticiser	28	13.5	17662.5	483	27.35
	28	13.4	17662.5	473	26.78
	28	13.5	17662.5	445	25.19
AVERAGE					26.44

Source: Research Data, 2024

In Table 7, normal concrete without plasticiser obtained the highest compressive strength value equal to 21.04 MPa, while normal concrete with plasticiser has a higher compressive strength of 26.44 MPa. This can happen because the effect of the applied plasticizer gives more strength to the concrete with a plasticizer (Sabrina et al., 2017; Riyana & Walujodjati, 2022). In addition, this concrete cure also has the advantage of not only strengthening the quality of the concrete, increasing the level of smoothness in the concrete mixture but also accelerating the rate of increase in the strength of the concrete and waterproofing.

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Table 8. Compressive Strength Results of Unwashed Beach Sand Concrete With Plasticizer

Sample Name	Age (Days)	Test Sample Weight (kg)	Field Area (mm^2)	Compressive Force (kN)	Compressive Strength (N/mm2)
Unwashed Beach Sand Concrete	3	14.4	17662.5	382	21.63
	3	14.3	17662.5	391	22.14
	3	14.8	17662.5	378	21.40
AVERAGE					21.72
Unwashed Beach Sand Concrete	7	14.9	17662.5	398	22.53
	7	14.7	17662.5	392	22.19
	7	14.8	17662.5	397	22.48
AVERAGE					22.40
Unwashed Beach Sand Concrete	28	15.2	17662.5	407	23.04
	28	15	17662.5	411	23.27
	28	15	17662.5	405	22.93
AVERAGE					23.08

Source: Research Data, 2024

Based on data obtained in Table 8, compressive strength value of the unwashed beach sand concrete sample with plasticizer has the highest average compressive strength at the age of 28 days, namely 23.08 MPa. When compared with concrete samples with washed beach sand and plasticizer which have the highest average compressive strength at the age of 28 days, namely 25.16 MPa, the compressive strength of unwashed beach sand concrete with plasticizer at the age of 28 days has a lower average compressive strength of 3.36% than normal concrete with plasticizer and 2.08% lower than washed beach sand concrete with plasticizer (Agung, 2007). This can occur not only because of the uniform gradation of the beach sand aggregate, but also because of the salt content still contained in the beach sand which has a high water absorbing property (Arulmoly & Konthesingha, 2022).

Table 9. Compressive Strength Results of Washed Beach Sand Concrete With Plasticiser

Sample Name	Age (Days)	Test Sample Weight (kg)	Field Area (mm^2)	Compressive Force (kN)	Compressive Strength (MPa)
Beach Sand Concrete Wash with *plasticizer*	3	14.6	17662.5	398	22.53
	3	14.3	17662.5	418	23.67
	3	15.1	17662.5	385	21.80
AVERAGE					22.67
Beach Sand Concrete Wash with *plasticizer*	7	15	17662.5	415	23.47
	7	14.8	17662.5	435	24.65
	7	15	17662.5	401	22.71
AVERAGE					23.61
Beach Sand Concrete Wash with *plasticizer*	28	15.2	17662.5	450	25.48
	28	13.9	17662.5	417	23.61
	28	14.3	17662.5	466	26.38
AVERAGE					25.16

Source: Research Data, 2024

In the compressive strength test data in Table 9, it can be seen that the compressive strength value of washing beach sand concrete with a plasticizer has the highest average compressive strength at the age of 28 days, namely 25.16 MPa. When compared with normal concrete with plasticizer, which has an average compressive strength of 26.44 MPa, the compressive

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strength value of washed beach sand concrete with plasticizer has a compressive strength of 1.28% lower than normal concrete with plasticizer and 2.08% higher than unwashed beach sand concrete with plasticizer. This can occur because the gradation of the beach sand aggregate used is uniform, with the average aggregate retained on the No.50 and 100 sieves, so the beach sand used is less good at binding the mixture (Kuncoro, 2021).

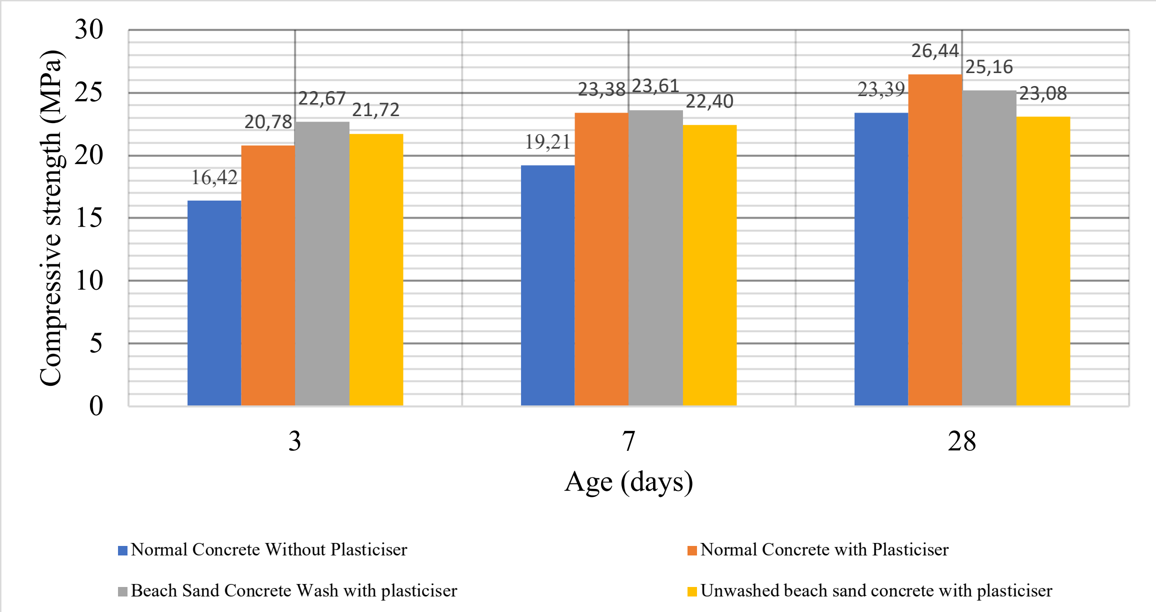

Figure 1. Graph of Overall Compressive Test Results

Source: Research Data, 2024

Figure 1 shows the compressive strength test results of various types of concrete, including normal concrete without plasticizer, normal concrete with plasticizer, concrete with washed beach sand using plasticizer, and concrete with beach sand without washing but using plasticizer, at the age of 3, 7, and 28 days. Concrete with washed beach sand and plasticizer had compressive strengths of 22.67 MPa, 23.61 MPa, and 25.16 MPa, while concrete with unwashed beach sand showed compressive strengths of 21.72 MPa, 22.40 MPa, and 23.08 MPa. in line with Halawa & Hulu (2024), research which states that At 28 days, the compressive strength of normal concrete with plasticiser was 1.28% higher than that of washed beach sand concrete and 3.36% higher than that of unwashed beach sand concrete.

Referring to Pd T-07-2005-B, concrete made from beach sand, whether washed or unwashed, falls into the category of medium-strength concrete (20 MPa - <35 MPa), so it can be used for both non-structural (such as cyclopean concrete, pavements, masonry, and working floor slabs) and structural (such as reinforced concrete, bridge girders, diaphragms, curbs, culverts, and bridge substructures). However, the use of beach sand for reinforced concrete should be avoided due to the salt content that can cause corrosion of reinforcement, as well as the sand's characteristics of high water absorption and uniform grain size (Natarajan et al., 2019). If use cannot be avoided, it is necessary to wash the sand to reduce the salt content and adjust the aggregate gradation by adding other sands (Fookes, 1980).

Critical Evaluation of Beach Sand Utilisation in Concrete

Subject to the use of BETON MIX, beach sand samples from Batu Bolong, both washed and unwashed, can function as part or all of the fine aggregates in concrete and have positive results. However, what the study found offers information that must be considered before trying any such substitution, mainly in structural construction (Fellows & Liu, 2021). First, it is important to mention that mixing washed beach sand and a plasticizer produces

ISSN: 2716-3865 (Print), 2721-1290 (Online)

compressive strength of 25.16 MPa at 28 days, which is not much lower than the river sand and plasticizer control concrete (26.44 MPa) (Hasss, 2023; Fendria, 2021). Proper cleaning of beach sand with salt and silt removed can result in its sands being used successfully in many common applications (Nursari et al., 2025). This is in line with findings by Brazilun (2024), where treating tanjung Bunga beach sand by washing made the treated sandrocks and pebbles stronger since fines and salts were flushed out and not able to influence the cement's composition.

On the other hand, when beach sand was not washed and BETON MIX was added, the strength of the mixture after 28 days was only 23.08 MPa (Erdiansyah, 2024; Kurniawan, 2017). This situation shows that salt, left-over organic substances, and fines reduce cement hydration, raise porosity, and affect strength and durability. This observation agrees with what both Ramadhany (2023) and Arulmoly & Konthesingha (2022) have concluded about the effects of high chloride in untreated seawater on concrete sands. Building elements with steel inside may expand because of salt, which can cause them to spall and fail ahead of time (Amran et al., 2022; Haryata, 2018).

This study is different from others because it uses both forms of reinforcement, aggregate treatment and chemical mixtures. Several investigations have separately examined washed sand or admixtures, but this research uses both to check if adverse results from inferior aggregates can be reduced by effective chemical technology. BETON MIX admixture is valuable because it clearly helps increase strength early in the curing process for all of the samples (Dewi et al., 2024). As shown by the example, the use of the admixture in the control mix made with river sand increases the mix's 3-day compressive strength by over 4 MPa (16.42 to 20.78 MPa) (Klarens et al., 2016; Suranto et al., 2022). This follows the findings by Purwanto et al. (2024) and Faqihuddin et al. (2021) that plasticizers enhance workability and fasten the development of early-age strength, lower water-cement ratios, and make the concrete more dense.

Still, even with the positive changes from admixtures, this study shows that cleaning sand from the beach is necessary. For the 28-day test, unwashed sand exceeded the required strength by 4% less than the washed sand when working with BETON MIX. This also follows Salmawati's (2023) point that keeping beach sand clean is truly necessary, particularly for any constructions where steel reinforcement is involved. Align with research from Alvarizi et al. (2025), Postponing sand treatment results in more water going into the mix, which can reduce the water's overall consistency and cause variations. Previous research by Siswoyo (2009) and Dara & Sugiri (2014) observes the same thing.

It is also significant that the study provides region-specific information that can be used in practice. Amir et al. (2022) and Atmaja & Irwansyah (2021) previously studied how beach sand can withstand stress in different Indonesian areas, but this study concentrates on Batu Bolong beach in Lombok to give specialized data useful for decision-makers, engineers, and contractors nearby. Based on the outcome obtained, washed and unwashed beach sand as concrete (both over 20 MPa) is classified as medium strength, as outlined in Pd T-07-2005-B, so these can be suitable for paving, curbs, and even small structural foundations.

Replacing inland sand with beach sand may partially solve the problem of running out of sand (Friedman, 1967). Still, the environment plays a big role in the problem. When beach sand is removed uncaringly, it can throw coastal areas out of balance and lead to more erosion, as was outlined by Danish et al. (2022) in their detailed overview of various types of concrete. This way, although it can be done, the process to use beach sand in construction should always have regulators involved and involve sustainable methods (Rizki, 2022).

ISSN: 2716-3865 (Print), 2721-1290 (Online)

Conclusion

From the tests conducted, it can be concluded that the Batu Bolong beach sand meets the regulatory standards as a raw material for concrete. The average compressive strength of normal concrete without plasticizer at 3, 7, and 28 days was 16.42 MPa, 19.21 MPa, and 23.39 MPa, respectively, while normal concrete with plasticizer recorded 20.78 MPa, 23.38 MPa, and 26.44 MPa. Concrete with unwashed beach sand showed compressive strengths of 21.72 MPa, 22.40 MPa, and 23.08 MPa, while concrete with washed beach sand produced 22.67 MPa, 23.61 MPa, and 23.08 MPa. Compared to normal concrete with plasticizer, washed beach sand concrete has 1.28% lower compressive strength, and unwashed beach sand concrete is lower by 3.36%. Thus, although the compressive strength of beach sand concrete is relatively lower, the concrete is still eligible for use in structural and non-structural construction.

Suggestions

For future research, it is recommended to compare the combination of river sand and beach sand to obtain more specific results and minimize the use of beach sand. The number of mixture variations can be adjusted to the conditions and needs of the research. Given the salt content of beach sand, which can damage reinforcement and have a negative impact on marine ecosystems, the commercial use of beach sand as fine aggregate is not recommended. If necessary, beach sand should be washed to zero percent salt content and combined with other types of sand. In addition, in the concrete testing process, periodic maintenance from manufacture, soaking, and compressive testing needs to be carried out to prevent errors in recording the age of the concrete and ensure that the increase in compressive strength can be monitored optimally.

Acknowledgment

In this research, the author would like to thank to everyone that willing to collaborate and assist in useful discussions and constructive suggestions and were willing to help in the process of developing this research. This research is also supported by the Faculty of Engineering, which has provided Civil Engineering laboratory facilities and the resources needed for this research, as well as logistical and administrative assistance. The author is also grateful to LPPM UMMAT for funding the financial needs that have been very helpful in the process of this research. The author would also like to thank the students who helped in collecting the research data. I would also like to thank my family, who always prayed, supported, and motivated me during the research.

References

Agung Fajar, M. (2007). Pengaruh Bahan Tambah Superplasticizer (Sikament-NN) terhadap Kuat Desak Beton f'c 20 MPa dengan Variasi Pengurangan Air.

Ahmad, T. E., Rais, A., Azhari, D. R., Minsaris, L. O. A., Lestari, D. A., & Arifin, W. A. (2021, July). Penggunaan iso cluster unsupervised classification dalam mengenali garis pantai, Studi Kasus: Rarowatu Utara, Sulawesi Tenggara. In *Seminar Nasional Ilmu Komputer (SNASIKOM)* (Vol. 1, No. 1, pp. 53-69).

Alvarizi, D. F., Dzaky, M. H., Ilham, M., Ramadhan, N., Yudin, M. R., & Prastyo, Y. (2025). Efisiensi Penggunaan Raw Water dan Faktor-Faktor yang Mempengaruhi Kuantitas Pemakaian Raw Water yang Berlebih Saat Regenerasi Demin Plant Pada PT XYZ Menggunakan Metode 5W+ 1H dan Observasi Interview. *Journal of Technology and Engineering*, *3*(1), 25-35. https://doi.org/10.59613/journaloftechnologyandengineering.v3i1.181

ISSN: 2716-3865 (Print), 2721-1290 (Online)

Alwi, A., Okviyani, N., Idris, R. N., & Ani, A. (2025). Kinerja Mekanik Bata Ringan Menggunakan Aplus Dan Pasir Pantai. *Device*, *15*(1), 111-118. https://doi.org/10.32699/device.v15i1.9250

Amir, A. A., Mahmud, M., & Guntur, A. (2022). Analisa Kuat Tekan Beton Menggunakan Pasir Sungai Sandang Muliasari Unaaha dan Kerikil Amonggedo Pondidaha Kabupaten Konawe. *Jurnal Teknik Sipil*, *3*(2), 423-428. https://doi.org/10.31284/j.jts.2022.v3i2.3405

Amran, M., Huang, S. S., Onaizi, A. M., Murali, G., & Abdelgader, H. S. (2022). Fire spalling behavior of high-strength concrete: A critical review. *Construction and Building Materials*, *341*, 127902. https://doi.org/10.1016/j.conbuildmat.2022.127902

Arulmoly, B., & Konthesingha, C. (2022). Pertinence of alternative fine aggregates for concrete and mortar: A brief review on river sand substitutions. *Australian Journal of Civil Engineering*, *20*(2), 272-307. https://doi.org/10.1080/14488353.2021.1971596

Atmaja, S. H., & Irwansyah, M. (2021). Analisa Kuat Tekan Beton Menggunakan Agregat Halus Pasir Pantai Bunga dan Pasir Sungai. *Jurnal Bidang Aplikasi Teknik Sipil dan Sains*, *1*(1), 9-18.

Brazilun, M. (2024). Pengaruh Pasir Pantai Tanjung Bunga Sebagai Agregat Halus Terhadap Kuat Tekan Mortar Geopolimer. *Jurnal Sains dan Pendidikan Fisika*, *20*(2), 228-237. https://doi.org/10.35580/jspf.v20i2.3695

Dang, Y., Xie, N., Kessel, A., McVey, E., Pace, A., & Shi, X. (2014). Accelerated laboratory evaluation of surface treatments for protecting concrete bridge decks from salt scaling. *Construction and Building Materials*, *55*, 128-135. https://doi.org/10.1016/j.conbuildmat.2014.01.014

Danish, A., Ozbakkaloglu, T., Mosaberpanah, M. A., Salim, M. U., Bayram, M., Yeon, J. H., & Jafar, K. (2022). Sustainability benefits and commercialization challenges and strategies of geopolymer concrete: A review. *Journal of Building Engineering*, *58*, 105005. https://doi.org/10.1016/j.jobe.2022.105005

Dara, J. Y., & Sugiri, A. (2014). Kajian penanganan dampak penambangan pasir besi terhadap lingkungan fisik Pantai Ketawang Kabupaten Purworejo. *Teknik PWK (Perencanaan Wilayah Kota)*, *3*(1), 220-229. https://doi.org/10.14710/tpwk.2014.4450

Dewi, S. S., Asfar, A. M. I. T., Asfar, A. M. I. A., Nurannisa, A., Damayanti, W., & Erfiana, I. (2024). *Eco-Substrate Innovative dari Limbah Serbuk Gergaji*. Jawa Timur: Penerbit Kbm Indonesia.

Erdiansyah, M. N. (2024). Pengaruh Penambahan Serbuk Alumunium Sebagai Bahan Pengisi Terhadap Kuat Tekan Beton. *Jurnal Pilar Teknologi Jurnal Ilmiah Ilmu Ilmu Teknik*, *9*(2), 27-39. https://doi.org/10.33319/piltek.v9i2.207

Faqihuddin, A., Hermansyah, H., & Kurniati, E. (2021). Tinjauan Campuran Beton Normal dengan Penggunaan Superplasticizer Sebagai Bahan Pengganti Air Sebesar 0%; 0, 3%; 0; 5% Dan 0, 7% Berdasarkan Berat Semen. *Journal of Civil Engineering and Planning (JCEP)*, *2*(1), 34-45. https://doi.org/10.37253/jcep.v2i1.4389

Fellows, R. F., & Liu, A. M. (2021). *Research methods for construction*. John Wiley & Sons.

Fendria, R. (2021). *Desain Beton High Early Strength (HES) dengan Campuran Superplasticizer* (Doctoral dissertation, Universitas Medan Area).

ISSN: 2716-3865 (Print), 2721-1290 (Online)

Fitriani, S., & Farida, I. (2017). Penggunaan limbah cangkang telur, abu sekam, dan copper slag sebagai material tambahan pengganti semen. *Jurnal Konstruksi*, *15*(1), 46-56. https://doi.org/10.33364/konstruksi/v.15-1.583

Fookes, P. G. (1980). An introduction to the influence of natural aggregates on the performance and durability of concrete. *Quarterly Journal of Engineering Geology and Hydrogeology*, *13*(4), 207-229. https://doi.org/10.1144/GSL.QJEG.1980.013.04.02

Friedman, G. M. (1967). Dynamic processes and statistical parameters compared for size frequency distribution of beach and river sands. *Journal of Sedimentary Research*, *37*(2), 327-354. https://doi.org/10.1306/74D716CC-2B21-11D7-8648000102C1865D

Halawa, O., & Hulu, W. (2024). Pengaruh Penambahan Abu Kulit Durian Terhadap Kuat Tekan Dan Porositas F'C 20 Mpa. *Jurnal Dunia Pendidikan*, *4*(3), 1716-1730. https://doi.org/10.55081/jurdip.v4i3.2163

Haryata, A. B. (2018). Perbandingan Respon Struktur Akibat Beban Gempa Dinamik Pada Gedung Bertingkat Menurut SNI 03-1726-2002 Dan SNI 03-1726-2012 (Studi Kasus: Gedung Bank Mandiri Syariah Yogyakarta).

Hasss, N. A. (2023). *Pengaruh Penambahan Abu Tongkol Jagung Hibrida (Zea Mays L.) Terhadap Kuat Tekan Beton= Effect of Hybrid Corn Cob Ash (Zea Mays L.) Addition on Compressive Strength of Concrete* (Doctoral dissertation, Universitas Hasanuddin).

Hover, K. C. (2011). The influence of water on the performance of concrete. *Construction and Building Materials*, *25*(7), 3003-3013. https://doi.org/10.1016/j.conbuildmat.2011.01.010

Ifana, Y. C. (2004). Perbedaan Nilai Propertis Marshall Aspal Beton antara Agregat Halus Pasir Pantai dan Pasir Sungai (Penelitian Laboratorium Jalan Raya).

Klarens, K., Indranata, M., Antoni, A., & Hardjito, D. (2016). Pemanfaatan Bottom Ash dan Fly ash Tipe C sebagai Bahan Pengganti dalam pembuatan paving block. *Jurnal Dimensi Pratama Teknik Sipil*, *5*(2).

Kuncoro, A. M. (2021). *Efek Pengaruh Pemakaian Pasir Laut Sebagai Campuran Aspal Beton (Laston) Dengan Pengujian Marshal Test* (Doctoral dissertation, Universitas Islam Lamongan).

Kurniawan, W. (2017). *Pengujian Kuat Tekan Beton Dengan Penambahan Silica Fume dan Superplasticizer Dengan Pasir Silika Sebagai Agregat Halus* (Doctoral dissertation, UAJY).

Natarajan, S., Neelakanda Pillai, N., & Murugan, S. (2019). Experimental investigations on the properties of epoxy-resin-bonded cement concrete containing sea sand for use in unreinforced concrete applications. *Materials*, *12*(4), 645. https://doi.org/10.3390/ma12040645

Nursari, E. E., Ningrum, W., Yunata, E. E., Suaebah, E., & Firdaus, R. A. (2025). Sintesis Nanopartikel Silika Dari Beberapa Material Dengan Metode Sol-Gel: Kata Kunci: Silika, Karakterisasi, Metode Sol-Gel. *Inovasi Fisika Indonesia*, *14*(1), 115-123. https://doi.org/10.26740/ifi.v14n1.p115-123

Pradipa, B. R. C. (2023). Material Penyusun Dan Formula Campuran Beton PT. Adhi Persada Beton Pabrik Margorejo. *IKRA-ITH Teknologi Jurnal Sains dan Teknologi*, *7*(3), 121-139.

ISSN: 2716-3865 (Print), 2721-1290 (Online)

Purwanto, H., Setiobudi, A., Amiwarti, A., & Kurniawan, R. (2024). Analisis Penambahan Cairan Bahan Kimia (Chemical Admixture) Damdex dan Sikacim Pada Beton K-250. *Jurnal Deformasi*, *9*(2), 126-137. https://doi.org/10.31851/deformasi.v9i2.17574

Rahmat, R., Hendriyani, I., & Anwar, M. S. (2016). Analisis Kuat Tekan Beton Dengan Bahan Tambah Reduced Water Dan Accelerated Admixture. *INFO-TEKNIK*, *17*(2), 205-218. https://dx.doi.org/10.20527/infotek.v17i2.2497

Ramadhany, M. A. (2023). *Studi Perendaman Pasang Surut Air Laut terhadap Kuat Lentur dan Korosi pada Beton yang Menggunakan Agregat Limbah Beton* (Doctoral dissertation, Universitas Fajar).

Rifki, M., Prasetiowati, S. H., Masduqi, E., & Setyaningrum, A. (2023). Karakteristik Beton dengan Campuran Pasir Pantai sebagai Agregat Halus. *Jurnal Rekayasa Lingkungan*, *23*(1). https://doi.org/10.37412/jrl.v23i1.176

Riyana, H., & Walujodjati, E. (2022). Pengaruh Substitusi Sebagian Agregat Halus dengan Abu Limbah Kulit Sapi Terhadap Kuat Tekan Beton. *Jurnal Konstruksi*, *20*(2), 271-280. https://doi.org/10.33364/konstruksi/v.20-2.1210

Rizki, F. (2022). *Upaya Peningkatan Mutu Proyek Dengan Metode Lean Construction Pada Proyek Freespan Correction Pipa Gas Offshore Di PT XYZ* (Doctoral dissertation, Institut Teknologi Sepuluh Nopember).

Sabrina, N. A., Wibowo, W., & Supardi, S. (2017). Kajian Pengaruh Variasi Penambahan Bahan Retarder Terhadap Parameter Beton Memadat Mandiri dengan Kuat Tekan Beton Mutu Tinggi. *Matriks Teknik Sipil*, *5*(4). https://doi.org/10.20961/mateksi.v5i4.36915

Salmawati, S. (2023). *Pengaruh Pasang Surut Air Laut terhadap Korosi Beton Silinder yang Terbentuk oleh Agregat Limbah* (Doctoral dissertation, Universitas Fajar).

Siswoyo, M. P. (2009). Pasir Pantai Selatan Jawa Timur Dalam Mortar. *Jurnal Teknik Sipil dan Perencanaan*, *11*(2), 109-120. https://doi.org/10.15294/jtsp.v11i2.1719

Suranto, M., Supratikno, S., Atmaja, P. S., & Budiyono, S. (2022). Pengaruh Penambahan Gula Pasir dan Abu Sekam Padi sebagai Substitusi Semen terhadap Kuat Tekan Beton Umur 3 Hari, 14 Hari, dan 28 Hari. *Portal: Jurnal Teknik Sipil*, *14*(2), 110-119. http://dx.doi.org/10.30811/portal.v14i2.3012

Susanto, M. V. O. (2021). *Pengaruh Penambahan Serbuk Limbah Cangkang Kulit Telur (Sebagai Campuran Semen) Terhadap Kuat Tekan Beton K-225* (Doctoral dissertation, Universitas Islam Lamongan).

Tata, A. (2019). Sifat mekanis beton dengan campuran pasir pantai dan air laut. *Teknologi Sipil: Jurnal Ilmu Pengetahuan dan Teknologi*, *3*(1), 65-71.

Vitri, G., & Herman, H. (2019). Pemanfaatan limbah kelapa sawit sebagai material tambahan beton. *Jurnal Teknik Sipil Institut Teknologi Padang*, *6*(2), 78-87. https://doi.org/10.21063/jts.2019.V602.078-87

Wahyudi, M. R. (2022). *Analisis Perbandingan Pasir Pantai Kasan Dengan Pasir Pantai Labu Terhadap Kuat Tekan Beton* (Doctoral dissertation, Universitas Medan Area).

ISSN: 2716-3865 (Print), 2721-1290 (Online)