

# Comparison of Mixtures Using Seawater and Brackish Water on Concrete Quality on Rigid Pavement

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**Abstract:** This study aims to evaluate the effect of using seawater and brackish water on the quality and strength of concrete applied in the construction of rigid pavements in coastal areas, specifically in Karimun Regency, Riau Islands. In these regions, freshwater resources are highly limited, making seawater and brackish water alternatives potential solutions to support construction activities. This research is important to ensure that the use of non-potable water sources does not significantly reduce the quality and strength of concrete, and can serve as an innovative and economical solution for infrastructure development in coastal areas facing water availability challenges. The results of this study are expected to serve as a reference for construction practitioners and local policymakers in decision-making regarding the use of seawater and brackish water in road and infrastructure development projects in coastal regions. The methodology involved preparing cylindrical specimens with a diameter of 15 cm and a height of 30 cm, targeting a strength of 30 MPa. Compressive strength tests were conducted at ages of 7, 14, and 28 days, with three samples for each variation. These variations included the use of seawater and brackish water as mixing materials, along with immersion curing methods. The test results showed that concrete using seawater achieved an average compressive strength of 33.72 MPa, approximately 112.4% of the planned target strength, while concrete using brackish water had an average strength of 30.25 MPa, around 100.8%. Based on these data, it can be concluded that seawater still demonstrates a feasible strength level for coastal applications, whereas brackish water shows less optimal results and is less recommended for long-term use. The final conclusion emphasizes that seawater can be used as an alternative water source in concrete production, while the use of brackish water should be avoided to maintain optimal concrete quality and strength.

**Keywords:** Concrete, Seawater, Brackish Water, Compressive Strength, Rigid Pavement

## Introduction

Rigid pavement or rigid pavement is a type of road construction that uses concrete as the main material. Concrete is known to have high compressive strength and good resistance to heavy traffic loads, so it is often used on highways, ports, and airports. However, the quality of concrete is greatly influenced by the materials it makes up, including water.

In the Riau Islands Province area, especially in Karimun district, there are 3 (Three) islands, namely durai, alai, and north kundur where the availability of fresh water is very limited, on the island to get fresh water they always collect rainwater, especially in the rainy season. The people in this place always use brackish water to bathe as another alternative in the dry season. Alternatively, seawater and brackish water are becoming more accessible options. However, the use of water with high salinity in concrete mixtures raises concerns about the quality and durability of concrete, especially in the long term.

Seawater covers about 71% of the Earth's surface. This water has a salty taste because it contains various dissolved minerals, especially sodium *chloride* (*NaCl*) as well as other elements such as magnesium, calcium, sulfate, potassium, and small amounts of other ions (Pinet, 2019; Millero, 2013). Seawater has a high salt content, especially sodium *chloride* (*NaCl*), which can trigger corrosion in steel reinforcement and lower the strength of concrete.

Brackish water is **water that is the result of mixing between fresh water and seawater**, so it has a higher salinity than fresh water but lower than seawater. Brackish water has a lower salinity content than seawater, but it is still higher than freshwater. Therefore, it is important to know the extent of the influence of each type of water on the quality of concrete, especially on rigid pavements that demand high strength and durability. Brackish water is generally found in **river mouths, estuaries, lagoons, coastal swamps, and pond areas** that receive the influence of sea tides and freshwater flows from rivers (Effendi, Hefni, 2003).

This study aims to compare the quality of concrete mixed using seawater and brackish water, focusing on mechanical characteristics such as the compressive strength of concrete. The results of this study are expected to provide practical recommendations for the implementation of construction in coastal areas, as well as support the efficiency of local resources without sacrificing the quality and safety of structures.

## Methodology

The preparation of tools and materials in the research is the first step in starting an experiment to be carried out. In order to find out the influence of water type (seawater and brackish water) on the compressive strength of concrete, material samples as concrete making materials can be considered based on good physical properties and meet standards. For water (seawater and brackish water) sourced from Karimun C. For coarse aggregates and fine aggregates, testing is carried out first and then a sample of *Concrete Formula Mix Design* is carried out, Manufacturing of a mix formula design using the same slump value, the same type and type of cement, and the same type and composition of the coarse aggregate. The planned concrete quality is  $F_c = 30$  Mpa.

This research must go through a systematic stage to achieve valid and satisfactory results. In general, the sequence of stages of this research includes; Research preparation by preparing materials or studies in advance, the researcher begins by identifying and formulating the problem to be researched, literature review to deepen understanding of the problem, sampling for aggregate tests. The purpose of sampling in accordance with the ASTM D75 standard is to obtain representative coarse and fine samples so that the test can more accurately reflect natural and material conditions. The location of the sample in the center of the mound is required (randomly).

## Results and Discussion

### Analysis of Concrete Compressive Strength Test Results

This research uses equipment available in private laboratories in Karimun Regency with testing test materials, namely for the next time concrete compressive strength testing is carried out. The first stage is carried out in the study to determine the Influence of the Type of Water used (freshwater, seawater and brackish water) on the Compressive Strength of Concrete is to conduct material tests on the materials that will be used as test material samples. The material results are as follows:

#### 1. Coarse Aggregate Test

**Table 1.** Aggregate Moisture Content

Nomor Contoh	Agregat Kasar	
	I	II
Test Weight before in the oven (gram)	W <sup>1</sup>	2001.81    2001.98
Test Weight after in the oven (gram)	W <sup>2</sup>	1983.74    1983.62
Moisture Content (%)	$\frac{W^1 - W^2}{W^1} \times 100\%$	0.90    0.92
		<b>0.91</b>

Tabel

2.

Specific gravity and coarse aggregate absorption test

Testing	Unit	Coarse Aggregate		Notasi
		I	II	
SSD weight	Gram	3036.06	3013.99	Bj
Weight of the SSD test object in water (grams)	Gram	1891.34	1876.62	Ba
Oven dry test piece weight (grams)	Gram	3024.81	2999.81	Bk
Account	Rumus	I	II	Average
Dry Bulk Specific Gravity	$\frac{Bk}{Bj - Ba}$	2.64	2.64	2.64
Dry Saturated Specific Gravity (SSD)	$\frac{Bj}{Bj - Ba}$	2.65	2.65	2.65
Apparent Specific Gravity	$\frac{Bk}{Bk - Ba}$	2.67	2.67	2.67
Water absorption ( % )	$\frac{(Bj - Bk) \times 100\%}{Bk}$	0.37	0.47	0.42

**Tabel 3.** Uji Pengujian Berat Isi Dan Rongga Udara Dalam Agregat Kasar

<b>Gross Aggregate Loose Contents Weight</b>			
<b>Sample</b>		<b>I</b>	<b>II</b>
Mold weight + loose aggregate (grams)	A	5548.17	5553.36
Mold weight (grams)	B	1351.05	1350.88
Volume Mold (Ltr)	C	3	3
	<u>A - B</u>	1.40	1.40
Aggregate Loose Contents Weight (kg/ltr)	C	1.40	
Aggregate Loose Contents Weight		1399.93	
Air cavities		46.86%	
<b>Solid Fill Weight</b>			
<b>Sample</b>		<b>I</b>	<b>II</b>
Mold weight + loose aggregate (grams)	A	5991.06	5902.05
Mold weight (grams)	B	1350.97	1350.95
Volume Mold (Ltr)	C	3	3
	<u>A - B</u>	1.55	1.52
Aggregate Solid Contents Weight (Kg/	C	1.53	
Aggregate Solid Content Weight (Kg/m3)		1531.87	
Air cavities		41.86%	

**Table 4.** Sludge Testing Material Pass Screening No 200

<b>Sample Number</b>	<b>Coarse Aggregate</b>		
		<b>I</b>	<b>II</b>
Weight of the Test Piece before washing, oven dry ( gram )	W <sup>1</sup>	3000.3	3002.48
Test Weight after Washing Restrained No.200, Oven Dry ( gram )	W <sup>2</sup>	2996.36	2991.31
	$\frac{W^1 - W^2}{W^1}$	X	0.13      0.37
Value (%)	W <sup>1</sup>	100%	<b>0.25 &lt; 1 %OK</b>

**Table 5.** Analysis of Coarse Aggregate Sieve

<b>Strainer (mm/inch)</b>	<b>Crowd Held Back</b>				<b>Track-track (e)</b>	<b>Cumulative Percentages</b>	
	<b>Gram</b>		<b>Percent</b>			<b>Cumulative Held (f)</b>	<b>Lolos (g)</b>
	<b>Mass Restrained Test 1 (a)</b>	<b>Mass Restrained Test 2 (b)</b>	<b>Restrained Mass Test 1 (c)</b>	<b>Mass Restrained Test 2 (d)</b>			
76,2 mm (3")	0	0	0 %	0 %	0 %	100 %	
63,5 mm (2 ½")	0	0	0 %	0 %	0 %	100 %	
50,8 mm (2")	0	0	0 %	0 %	0 %	100 %	
36,1 mm (1 ½")	0	0	0 %	0 %	0 %	100 %	

Strainer (mm/inch)	Crowd Held Back				Track-track (e)	Cumulative Percentages	
	Gram		Percent			Cumulative Held (f)	Lolos (g)
	Mass Restrained Test 1 (a)	Mass Restrained Test 2 (b)	Restrained Mass Test 1 (c)	Mass Restrained Test 2 (d)			
25,4 mm (1")	0	0	0 %	0 %	0 %	100 %	
19,1 mm (¾")	1103.43	1111.13	36.79 %	37.3 %	37.05 %	62.95 %	
12,7 mm (½")	745.63	931.45	24.86 %	31.27 %	28.07 %	34.89 %	
9.52 mm (3/8")	104.38	222.1	3.48 %	7.46 %	5.47 %	29.42 %	
4.75 mm (No.4)	786.98	537.08	26.24 %	18.03 %	22.14 %	92.72 %	
2.36 mm (No.8)	-	-	0 %	0 %	0 %	7.28 %	
1.18 mm (No.16)	-	-	0 %	0 %	0 %	92.72 %	
0.6 mm (No.30)	-	-	0 %	0 %	0 %	7.28 %	
0.3 mm (No.50)	-	-	0 %	0 %	0 %	92.72 %	
0.15 mm (No.100)	-	-	0 %	0 %	0 %	7.28 %	
0.075 mm (No.200)	-	-	0 %	0 %	0 %	92.72 %	
Gentleman	258.6	176.9	8.62 %	5.94 %	7.28 %	100 %	
Sum	2999.02	2978.66	100 %	100 %	100 %	0 %	
Starting Weight	3000.28	3000.96					
Modulus Kehalusan							7.29

### 1. Fine Aggregate Test

**Table 6.** Fine Aggregate Moisture Content

Sample Number	Fine Aggregate	
	I	II
Test Weight before in the oven (gram)	W <sup>1</sup>	1502.35    1502.19
Test Piece Weight after oven (gram)	W <sup>2</sup>	1422.39    1421.18
Up to Air (%)	$\frac{W^1 - W^2}{W^1} \times 100$	5.32    5.39    5.75

W <sup>1</sup>	5.36
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**Table 7.** Specific Gravity and Fine Aggregate Absorption Test

Testing	Unit	I	II	Notasi
SSD test body weight	Gram	395.43	387.72	Year
Glass Weight + Lid + Water	Gram	2172.48	2172.48	Three
Glass Weight + Lid + Water + Test Piece	Gram	2414.48	2408.54	Bt
Oven dry test strip weight	Gram	392.68	386.48	Bk
Account	Rumus	I	II	Average
	$Bk$	2.56	2.55	2.55
Dry Bulk Specific Gravity	$Ba + Bj - Bt$			
Dry Saturated Specific Gravity	$\underline{Y}$	2.58	2.56	2.57
Peruran ( SSD )	$\underline{ea}$			
	$\underline{Bk}$	2.61	2.57	2.59
Apparent Specific Gravity				
	$( Bj - Bk ) X$	0.70	0.32	0.51
Water absorption ( % )	$\frac{100\%}{Bk}$			

**Table 8.** Testing Weight Test of Contents and Air Cavities in Fine Aggregates

Fine Aggregate Loose Fill Weight			
Sample		I	II
Mold weight + loose aggregate (grams)	A	5688.03	5724.59
Mold weight (grams)	B	1352.12	1352.12
Volume Mold (Ltr)	C	3	3
	$A - B$	1.45	1.46
Aggregate Loose Contents Weight (kg/ltr)	C		1.45
Aggregate Loose Contents Weight (Kg/m <sup>3</sup> )			1451.40
Air cavities			43.05%
Solid Fill Weight			
Sample Number		I	II
Mold weight + Solid aggregate (grams)	A	6127.78	6129.83
Mold weight (grams)	B	1351.42	1351.14
Volume Mold (Ltr)	C	3	3
	$A - B$	1.59	1.59
Aggregate Solid Content Weight (kg/ ltr)	C		1.59
Aggregate Solid Content Weight (Kg/m <sup>3</sup> )			1592.51
Air cavities			37.52%

**Table 9. Sludge Rate Testing of Material Passing Screening No. 200**

Sample Number	Fine Aggregate	
	I	II
Weight of the Test Piece before washing, oven dry ( gram )	W <sup>1</sup>	2001.35    2001.61
Test Weight after Washing Restrained No.200, Oven Dry ( gram )	W <sup>2</sup>	1952.58    1951.25
Value (%)	$\frac{W^1 - W^2}{W^1} \times 100\%$	2.44    2.52
		<b>2.48    &lt; 5 %OK</b>

**Table 10. Fine Aggregate Sieve Analysis**

Strainer (mm/inch)	Crowd Held Back				Track-track (e)	Cumulative Percentages	
	Gram		Percent			Cumulative Held (f)	Lolos (g)
	Mass Restraint Test 1 (a)	Mass Restraint Test 2 (b)	Restrained Mass Test 1 (c)	Mass Restraint Test 2 (d)			
76,2 mm (3")	0	0	0 %	0 %	0 %	0 %	100 %
63,5 mm (2 ½")	0	0	0 %	0 %	0 %	0 %	100 %
50,8 mm (2")	0	0	0 %	0 %	0 %	0 %	100 %
36,1 mm (1 ½")	0	0	0 %	0 %	0 %	0 %	100 %
25,4 mm (1")	0	0	0 %	0 %	0 %	0 %	100 %
19,1 mm (¾")	0	0	0 %	0 %	0 %	0 %	100 %
12,7 mm (½")	0	0	0 %	0 %	0 %	0 %	100 %
9.52 mm (3/8")	0	0.96	0 %	0.05 %	0.03 %	0.04 %	99.96 %
4.75 mm (No.4)	0	0	0 %	0 %	0 %	0 %	100 %
2.36 mm (No.8)	18.96	16.39	0.95 %	0.83 %	0.89 %	0.93 %	99.07 %
1.18 mm (No.16)	316.85	294.22	15.89 %	14.83 %	15.36 %	16.29 %	83.71 %
0.6 mm (No.30)	950.46	1002.53	47.68 %	50.53 %	49.1 %	65.39 %	34.61 %
0.3 mm (No.50)	440.84	446.56	22.11 %	22.51 %	22.31 %	87.7 %	12.3 %
0.15 mm (No.100)	225.72	183.22	11.32 %	9.23 %	10.27 %	97.98 %	2.02 %
0.075 mm (No.200)	33.02	35.45	1.66 %	1.79 %	1.72 %	99.7 %	0.3 %
Gentleman	6.64	5.25	0.33 %	0.26 %	0.29 %	100 %	0 %
Sum	1992.49	1984.58	100 %	100 %	100 %		
Total Weight	2033.77	2033.53					
Modulus Kehalusan	2.68						

### 1. Mix Formula Design

The preparation of a mix formula (DMF) design for each sand sample refers to SNI 7656 of 2012. The mixed design used in this study uses a medium quality concrete composition, namely 30 Mpa

**Table 11.** *Design Mix Formula*

Yes	Descri ption	Table/Graph/ Account	Grades/ Results
<b>Data Assignment</b>			
1	Compressive Strength	Set	30 MPa
2	Standard Deviation	Data or Set	7.0 MPa
3	Added Value (Margin)	1.34 x Deviation Standard	9 MPa
4	Strong Average Targeted	(1) + (3)	39 MPa
5	type of cement	Set	PCC Type I
6	Aggregate Type: Rough Soft	Aggregate Data	Broken
7	Uses of Concrete	Set	Pavement and slab floor
8	Concrete Design	Set	Concrete without additives air
<b>Test Results</b>			
<b>Coarse Aggregate</b>			
9	Crude Aggregate Moisture	Test Results	0.91 %
10	Agregat Max	Test Results	19 mm
11	Modulus of Stone Fineness (FM)	Test Results	7.29
12	Aggregate Relative Specific Gravity (Gs)	Test Results	2.65
13	Absorption of Crude Gross Aggregate Contents	Test Results	0.42 %
14	Weight (Loose)	Test Results	1399.93 kg/m <sup>3</sup>
15	Weight (Solid)	Test Results	1531.87 kg/m <sup>3</sup>
<b>Fine Aggregate</b>			
16	Fine Aggregate Moisture	Test Results	5.36 %
17	Modulus of Sand Fineness (FM)	Test Results	2.68
18	Relative Specific Gravity of Sand	Test Results	2.57
19	Sand Absorption	Test Results	.51 %
20	Sand Contents Weight (loose)	Test Results	1451.40 kg/m <sup>3</sup>
21	Sand Contents Weight (Solid)	Test Results	1592.51 kg/m <sup>3</sup>
<b>Semen</b>			
22	Specific Gravity of Cement	Test Results	3.01

Yes	Descri ption	Table/Graph/ Account	Grades/ Results
<b>Data Assignment</b>			
<b>Composition Calculation</b>			
23	Mixing Water	Me	190
24	Slump Plan	Table 3.5	25 - 75
25	Cement Water Ratio ( <i>w/c</i> )	Table 3	0.42
<b>With Absolute Volume</b>			
26	Volume Semen	= (23)/(25)/(22)	0.151 m3
27	<b>Cement Weight</b>	= (23)/(25)	<b>452.38 kg</b>
28	Mineral Additives	Not Used	-
29	Mixing Water Volume	= (23)/ 1000	0.190 m3
30	<b>Water Weight</b>	(23)	<b>190 kg</b>
31	Air Rate	Table 2 & View (8)	2%
32	Total Aggregate Volume	=1-[(26)+(29)+(31)]	0.64 m3
33	Gross Aggregate Volume	Test Results x (32)	
34	<b>Gross Aggregate Weight</b>	=(33)*(12)*1000	<b>1186.70 kg</b>
35	Fine Aggregate Volume	Test Results x (32)	0.19 m3
36	<b>Fine Aggregate Weight</b>	=(35)*(18)*1000	<b>492.43 kg</b>

Thus, it can be known the rust of the mixed material after it is corrected  
Water in 1m3 requires:

Semen	:	452.38 kg	=	452.38 kg
Coarse Agregat	:	1186.70 kg	(-0.49%) =	1186.70 kg
Sand	:	492.43 kg	(-4.85%) =	492.38 kg
<hr/>				
Water	:	190.00 kg (-0.05 kg)	=	189.95 kg
Total = 2321.41 kg				

## 1. Effect of Seawater Use on Concrete Compressive Strength on Rigid Pavement

**Table 13.** Results of Seawater Concrete Quality Compressive Strength Test at 7, 14 and 28 days of age

"UJI KUAT TEKAN SILINDER BETON"													
Beton dengan memakai Air Laut													
Mutu Beton	: FC 30 Mpa												
Nilai Slump	: 100 mm												
Jenis Semen	: PCC ( Portland Composit Cement )												
SAMPEL	Beton Umur 7 Hari		Beton Umur 7 Hari ( Sesuai SNI )		Beton Umur 14 Hari		Beton Umur 14 Hari ( Sesuai SNI )		Beton Umur 28 Hari		Beton Umur 28 Hari ( Sesuai SNI )		KET.
NO.	Kuat Tekan ( Mpa )	%	Kuat Tekan ( Mpa )	%	Kuat Tekan ( Mpa )	%	Kuat Tekan ( Mpa )	%	Kuat Tekan ( Mpa )	%	Kuat Tekan ( Mpa )	%	
1	22,08	73,60	19,5	65%	27,69	92,29	26,4	88%	33,80	112,67	30,00	100%	
2	21,91	73,04	19,5	65%	27,74	92,47	26,4	88%	33,57	111,91	30,00	100%	
3	21,51	71,72	19,5	65%	28,14	93,80	26,4	88%	33,80	112,67	30,00	100%	
RATA-RATA	21,84	72,78	19,5	65%	27,86	92,85	26,4	88%	33,72	112,42	30,00	100%	Memenuhi

### 1. The Effect of Brackish Water Use on Concrete Quality on Rigid Pavement

**Table 14.** Results of Concrete Quality Testing with Brackish Water Mixture at the age of 7, 14 and 28 days

"UJI KUAT TEKAN SILINDER BETON"													
Beton dengan memakai Air Payau													
Mutu Beton	: FC 30 Mpa												
Nilai Slump	: 100 mm												
Jenis Semen	: PCC ( Portland Composit Cement )												
SAMPEL	Beton Umur 7 Hari		Beton Umur 7 Hari ( Sesuai SNI )		Beton Umur 14 Hari		Beton Umur 14 Hari ( Sesuai SNI )		Beton Umur 28 Hari		Beton Umur 28 Hari ( Sesuai SNI )		KET.
NO.	Kuat Tekan ( Mpa )	%	Kuat Tekan ( Mpa )	%	Kuat Tekan ( Mpa )	%	Kuat Tekan ( Mpa )	%	Kuat Tekan ( Mpa )	%	Kuat Tekan ( Mpa )	%	
1	20,38	67,94	19,5	65%	27,01	90,02	26,4	88%	30,29	100,97	30,00	100%	
2	19,93	66,43	19,5	65%	26,61	88,70	26,4	88%	30,52	101,72	30,00	100%	
3	19,93	66,43	19,5	65%	27,63	92,10	26,4	88%	30,01	100,02	30,00	100%	
RATA-RATA	20,08	66,93	19,5	65%	27,08	90,27	26,4	88%	30,27	100,90	30,00	100%	Memenuhi

**Table 15.** Results of Concrete Quality Testing with Freshwater Mixture At the age of 7, 14 and 28 days

"UJI KUAT TEKAN SILINDER BETON"													
Beton dengan memakai Air Tawar													
Mutu Beton	: FC 30 Mpa												
Nilai Slump	: 100 mm												
Jenis Semen	: PCC ( Portland Composit Cement )												
SAMPEL	Beton Umur 7 Hari		Beton Umur 7 Hari ( Sesuai SNI )		Beton Umur 14 Hari		Beton Umur 14 Hari ( Sesuai SNI )		Beton Umur 28 Hari		Beton Umur 28 Hari ( Sesuai SNI )		KET.
NO.	Kuat Tekan ( Mpa )	%	Kuat Tekan ( Mpa )	%	Kuat Tekan ( Mpa )	%	Kuat Tekan ( Mpa )	%	Kuat Tekan ( Mpa )	%	Kuat Tekan ( Mpa )	%	
1	22,65	75,49	19,5	65%	28,65	95,49	26,4	88%	34,08	113,61	30,00	100%	
2	22,76	75,87	19,5	65%	28,54	95,12	26,4	88%	34,48	114,93	30,00	100%	
3	22,65	75,49	19,5	65%	28,48	94,93	26,4	88%	34,93	116,44	30,00	100%	
RATA-RATA	22,68	75,62	19,5	65%	28,55	95,18	26,4	88%	34,50	115,00	30,00	100%	Memenuhi

### 1. Comparison of Seawater and Brackish Water Use on Concrete Quality on Rigid Pavement

**Table 16.** Comparison of Concrete Quality Test Results with a Mixture of Seawater and Brackish Water at the age of 7 hari

SAMPEL	TANGGAL		DIMENSI CONTOH (MM)		LUAS PERMUKAAN	UMUR	BERAT		DENSITY		BACAAN BEBAN MAX		KUAT TEKAN		KUAT TEKAN		SPEC	KET.
							A. Payau	A. Laut	A. Payau	A. Laut	A. Payau	A. Laut	Air Payau		Air Laut			
NO.	CETAK	UJI	DIAMETER	TINGGI	(mm <sup>2</sup> )	(hari)	(gr)	(gr)	(gr/cm <sup>3</sup> )	(gr/cm <sup>3</sup> )	(KN)	(KN)	MPa	(%)	MPa	(%)	(%)	
1	30/06/2025	07/07/2025	150	300	17662,50	7	12190,0	12875,0	2,301	2,430	360	390	20,38	67,94	22,08	73,60	40%	
2	30/06/2025	07/07/2025	150	300	17662,50	7	12570,0	12985,0	2,372	2,451	352	387	19,93	66,43	21,91	73,04	40%	
3	30/06/2025	07/07/2025	150	300	17662,50	7	12245,0	12565,0	2,311	2,371	352	380	19,93	66,43	21,51	71,72	40%	
RATA-RATA											354,7	385,7	20,08	66,93	21,84	72,78	0,40	Memenuhi

**Table 17.** Comparison of Concrete Quality Test Results with a Mixture of Seawater and Brackish Water at the Age of 14 Days

SAMPEL	TANGGAL		DIMENSI CONTOH (MM)		LUAS PERMUKAAN	UMUR	BERAT		DENSITY		BACAAN BEBAN MAX		KUAT TEKAN		KUAT TEKAN		SPEC	KET.
							A. Payau	A. Laut	A. Payau	A. Laut	A. Payau	A. Laut	Air Payau		Air Laut			
NO.	CETAK	UJI	DIAMETER	TINGGI	(mm <sup>2</sup> )	(hari)	(gr)	(gr)	(gr/cm <sup>3</sup> )	(gr/cm <sup>3</sup> )	(KN)	(KN)	MPa	(%)	MPa	(%)	(%)	
1	30/06/2025	14/07/2025	150	300	17662,50	14	11955,0	11855,0	2,256	2,237	477	489	27,01	90,02	27,69	92,29	65%	
2	30/06/2025	14/07/2025	150	300	17662,50	14	11550,0	11850,0	2,180	2,180	470	490	26,61	88,70	27,74	92,47	65%	
3	30/06/2025	14/07/2025	150	300	17662,50	14	12155,0	12050,0	2,294	2,294	488	497	27,63	92,10	28,14	93,80	65%	
RATA-RATA											478,3	492,0	27,08	90,27	27,86	92,85	0,65	Memenuhi

**Table 18.** Comparison of Concrete Quality Test Results with a Mixture of Seawater and Brackish Water at the age of 28 days

"UJI KUAT TEKAN SILINDER BETON"																		
Perbandingan Mutu Beton dengan Campuran Air Payau Dan Air Laut																		
															Tanggal Uji : 28/07/2025			
Mutu Beton	: FC 30 Mpa																	
Nilai Slump	: 100 mm																	
Jenis Semen	: PCC ( Portland Composit Cement )																	
SAMPSEL	TANGGAL		DIMENSI CONTOH (MM)		LUAS PERMUKAAN	UMUR	BERAT		DENSITY		BACAAN BEBAN MAX.		KUAT TEKAN		KUAT TEKAN		SPEC	KET.
							A. Payau	A. Laut	A. Payau	A. Laut	A. Payau	A. Laut	Air Payau		Air Laut			
NO.	CETAK	UJI	DIAMETER	TINGGI	(mm <sup>2</sup> )	(hari)	(gr)	(gr)	(gr/cm <sup>3</sup> )	(gr/cm <sup>3</sup> )	(KN)	(KN)	MPa	(%)	MPa	(%)	(%)	(%)
1	30/08/2025	28/07/2025	150	300	17662.50	28	12530.0	11860.0	2.385	2.385	535	597	30.29	100.97	33.80	112.67	100%	
2	30/08/2025	28/07/2025	150	300	17662.50	28	12615.0	12450.0	2.381	2.381	539	593	30.52	101.72	33.57	111.91	100%	
3	30/08/2025	28/07/2025	150	300	17662.50	28	12635.0	12025.0	2.385	2.385	530	597	30.01	100.02	33.80	112.67	100%	
RATA-RATA											534.7	595.7	30.27	100.90	33.72	112.42	1.00	Memenuhi

### The Effect of Seawater Use on Concrete Quality on Rigid Pavement

From the test results, it shows that concrete with a mixture of seawater has a fairly good development of compressive strength. At the age of 7 days, concrete with seawater reaches a compressive strength of 21.84 MPa, at the age of 14 days it reaches 27.03 MPa, and at the age of 28 days it reaches 33.72 MPa. The compressive strength value at 28 days has exceeded the planned quality of 30 MPa, even slightly lower than concrete with fresh water (34.50 MPa). This suggests that the use of seawater in the manufacture of concrete is still possible to be used, particularly in non-structural constructions or constructions that are not directly related to the risk of reinforcement corrosion, such as rigid pavement. However, the chloride content in seawater needs to be considered because it can potentially accelerate the corrosion of reinforcing steel when used on reinforced concrete.

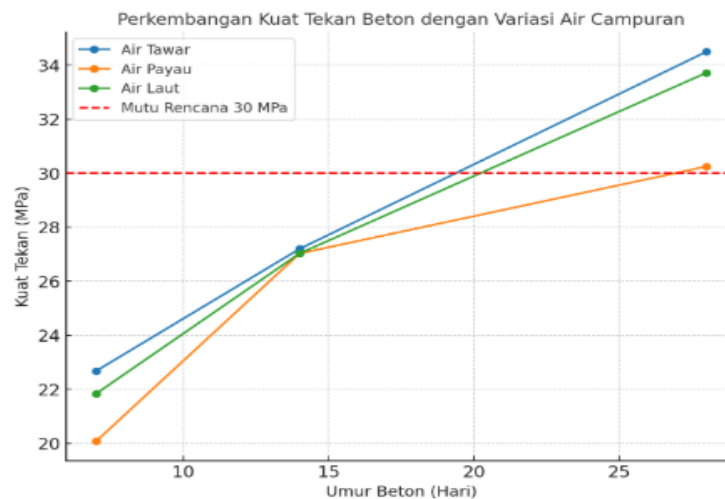
### The Effect of Brackish Water Use on Concrete Quality on Rigid Pavement

The use of brackish water gives different results than seawater and fresh water. At the age of 7 days, the compressive strength of concrete with brackish water is 20.08 MPa, at 14 days it reaches 27.03 MPa, and at 28 days it reaches 30.27 MPa. This compressive strength value indicates that concrete with brackish water can still meet the 30 MPa plan, but the result is the lowest among all variations. This is likely due to the unstable salt content in brackish water, which can interfere with the cement hydration process. Thus, although concrete with brackish water is still technically feasible to meet the compressive strength target, its quality is less than optimal compared to the use of fresh water and seawater.

### Comparison of Concrete Quality with Seawater and Brackish Water

In comparison, concrete with seawater produced better quality compared to brackish water at each age of the test. At 7 days of age, concrete with seawater was higher (21.84 MPa vs 20.08 MPa). At 14 days of age, both types of water produce the same compressive strength (27.03 MPa). Meanwhile, at the age of 28 days, concrete with seawater is superior again with a compressive strength of 33.72 MPa compared to brackish water concrete of 30.27 MPa. A significant difference at 28 days of age shows that the use of seawater is more stable in

supporting the hydration process and the formation of concrete strength compared to brackish water as shown in Figure 3.1



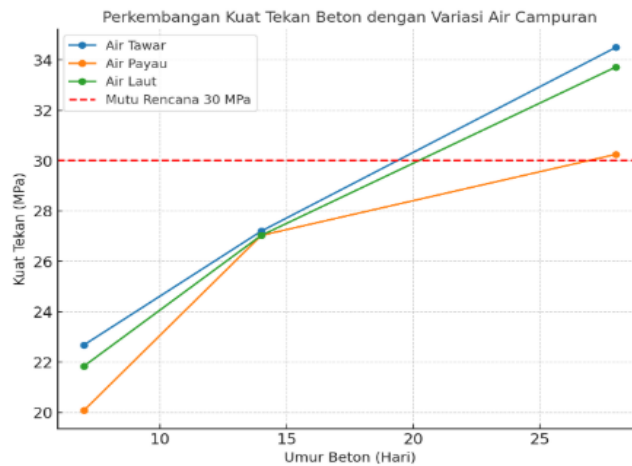
**Figure 1.** Development of Compressive Strength of Concrete with mixed water variations at the age of 7, 14 and 28 days

Figure 1 development of compressive strength of concrete with mixed water variations at ages 7, 14 and 28 days shows varied development. At a young age (7 days), concrete with fresh water has the most optimal hydration, while concrete with brackish water shows the lowest compressive strength due to the salt content that inhibits the initial hydration reaction. At the age of 14 days, concrete with brackish water and seawater begins to "catch up" with freshwater performance. And the age of 28 days of concrete using fresh water and seawater produces concrete with a very good final quality even exceeding the quality of the plan (30 MPa). Meanwhile, concrete that uses brackish water is only slightly above the quality planned, showing a more real long-term negative effect than seawater. Concrete that uses seawater, although initially lower, at the age of 28 days is close to the yield of concrete with fresh water. This shows that the use of seawater can still produce high-quality concrete if the mix of design and maintenance is right. while concrete that uses Brackish Water even though there is an improvement, the final result is still the lowest. This suggests the ion content in brackish water may interfere with hydration or lower the density of concrete, so its compressive strength is smaller.

### **Recommendations for Alternative Water Use in Coastal Areas of Karimun Regency, Riau Islands**

Based on the test results, it can be recommended that seawater can be used as an alternative to mixing concrete in the archipelago, especially Karimun Regency, if the availability of fresh water is limited. This is because concrete with a seawater mixture is able to exceed the quality of the plan of 30 MPa and is only slightly different compared to freshwater concrete. On the other hand, the use of brackish water should not be

recommended because the quality of the concrete produced tends to be lower and has the potential to reduce long-term resistance due to unstable salt content. For rigid pavement construction that does not require reinforcement, the use of seawater is still worth considering. However, for reinforced concrete construction, the use of seawater must still be avoided to prevent the risk of corrosion in the reinforcing steel.



**Figure 2.** Development of Compressive Strength of Concrete with mixed water variations at the age of 7, 14 and 28 days

Figure 2 development of compressive strength of concrete with variations in mixed water at the ages of 7, 14 and 28 days shows the development of compressive strength of concrete from the age of 7 days to 28 days with variations in the use of freshwater, brackish water, and seawater. In general, the entire concrete mixture experiences an increase in compressive strength as it ages, according to the cement hydration theory.

At 7 days of age, concrete with fresh water showed the highest compressive strength (22.68 MPa), followed by concrete with seawater (21.84 MPa), and concrete with brackish water (20.08 MPa). This indicates that in the early stages, the mineral content in seawater does not significantly inhibit the cement hydration process, while in brackish water, it is possible that the unstable salt content reduces the effectiveness of the formation of cement-binding compounds.

At 14 days of age, the three variations of concrete almost equal the compressive strength value, which is about 27 MPa. This shows that the development of the strength of concrete with seawater and brackish water is still in line with normal concrete (fresh water), although with slight differences.

At 28 days of age, there was a more pronounced difference. Concrete with fresh water reaches 34.50 MPa, concrete with seawater reaches 33.72 MPa, while concrete with brackish water is only 30.25 MPa. Concrete with seawater can still exceed the planned compressive strength target (30 MPa) and approach the yield of concrete with fresh water, so it can be considered feasible as an alternative mixing agent in island areas. In contrast, concrete with brackish water showed the lowest value, although it still met the minimum standard, but a significant difference with both fresh and seawater showed less stable quality.

Overall, the graph emphasizes that seawater is better and better than brackish water in supporting the development of concrete compressive strength. Therefore, for the condition of

archipelagic areas such as Karimun Regency, Riau Islands where the availability of fresh water is limited, seawater can be used as an alternative, while brackish water should be avoided.

## Conclusion

Based on the results of the concrete compressive strength test at the age of 7, 14, and 28 days with freshwater, brackish water, and seawater treatment media, it can be concluded that concrete using fresh water shows the highest compressive strength at all test ages (7, 14, and 28 days) with an average compressive strength result of 22.68 MPa (75.62%), 28.55 MPa (95.18%), 34.5 MPa (115%), followed by concrete with seawater, with an average compressive strength of 21.84 MPa (72.78%), 27.86 MPa (92.85%), 33.72 MPa (112.42%) and the lowest is concrete with brackish water with an average compressive strength yield of 20.08 MPa (66.93%), 27.08 MPa (90.27%), 30.27 MPa (100.9%). However, all samples still met the concrete quality of the  $f_c'$  30 plan ( $\geq 30$  MPa at the age of 28 days). Concrete with seawater (average compressive strength 33.72 MPa / 112.42%) has a lower compressive strength than concrete with fresh water (average compressive strength 34.5 MPa / 115%) at the age of 28 days. This shows that seawater can be used as an alternative to mixing concrete in the archipelago, especially for rigid pavements without rebar, without significantly degrading quality. Concrete using brackish water (average compressive strength 30.27 MPa / 100.9%) produced lower compressive strength compared to the other two groups, namely concrete using fresh water (average compressive strength 34.5 MPa / 115%) and concrete using seawater (average compressive strength 33.72 MPa / 112.42%) at the age of 28 days. This indicates the need for special attention to brackish water quality. The use of seawater or brackish water has the potential to save freshwater needs in the archipelago, making it cost-efficient. However, for reinforced concrete, long-term durability considerations are required due to the risk of corrosion.

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