SSRG International Journal of Civil Engineering
ISSN: 2348 – 8352 /doi:10.14445/23488352/IJCE-V7I6P108

Volume 7 Issue 6, 65-70, June 2020
©2020 Seventh Sense Research Group®

Influence of the Sea Water in the Mechanical Behaviour of the Fiber Reinforced Concrete

Kalyani A[1], Kannan D[2], Vasanth Kumar B[3], Abdul Wahdud G[4]

[1]Professor,
[2-4] Students,

Department of Civil Engineering,
Sri ManakulaVinayagar Engineering College,
Puducherry.

Received Date: 24 May 2020
Revised Date: 25 June 2020
Accepted Date: 30 June 2020

Abstract

This experimental study reports the results of using seawater as a mixing and curing component with Ordinary Portland Cement to check their compressive strength. Usually, the salt present in the seawater tends to reduce the strength of the concrete and hence basalt was added to increase the bonding of the concrete. All the preliminary tests were conducted and the results were found respectively. Basalt fibers are taken in proportions of 0%, 0.33%, 0.66% and1%. The compressive strength and the acid attack tests were carried out on the basalt fiber reinforced seawater concrete. Cube specimens of size 150mmx150mmx150mm were used for conducting compressive strength and acid attack. In this experimental study, we conclude that in the basalt fiber reinforced seawater concrete, there is an increase in the strength of the specimen with the increase in the basalt fiber concentration of basalt fiber in the concrete.

***Keyword** – Sea Water, Salinity, Fiber Reinforced Concrete, Basalt Fiber, Compression Strength, Acid Attack.*

I. INTRODUCTION

Because of the population growth and economic development, water resources in many regions of the world are pushed to their natural limits. According to the World Meteorological Organization(WMO), more than half of the world population would not get enough drinking water, by 2025. Concrete is the second most-consumed product in the world, after water. In the concrete industry, several billion tons of fresh water is used for mixing, curing, and cleaning water around the world. From the viewpoint of saving the freshwater, it believes that the possibility of sea water as mixing water in the concrete will be an innovative one. If the use of seawater as mixing water is permitted, it will be more convenient, economical in the construction field, especially in the coastal regions. Also, salts present in the seawater can reduce the strength of the concrete. Hence, basalt fiber is used as an additive material to increase the binding in the concrete and hence increase the strength of concrete. In this paper, conventional mix 1: 1.41:2.43 (M30) and basalt fiber reinforced seawater concrete mix 1:1.42:2.44 (M30) with water to binder ratio is maintained at 0.45 was used in the present study. Properties of concrete in the fresh state such as workability and hardened state such as compression test and effect of the acid attack were considered in the study.

II. OBJECTIVE

- To study the effect of seawater on the mechanical behavior of concrete
- The study helps to determine the strength of the basalt fiber reinforced concrete in the effect of seawater and freshwater
- To study the effect of compressive strength, the effect of the acid attack on concrete mixed and cured in seawater
- To suggest the possibility of usage of seawater as mixing water and curing medium
- To give a better solution to society

III. MATERIALS AND METHODOLOGY

A. MATERIALS

The physical properties of cement, fine aggregates, coarse aggregates, basalt fiber, and water used for mix design of M30grade of concrete were tested and properties of the above materials are given below.

a) CEMENT

The cement is to be ordinary Portland cement 43 grade and shall conform to IS 8112:2013 physical properties of OPC as determined are shown in Table 1. Other types of cement might be used if any special properties such as high early strength and sulfate resistance are needed. The cement should be of uniform consistency.

Table1:Properties of Cement

SI. No	Physical Property	Experimental Value	Nominal Range
1	Fineness (m^2/kg)	330	300 – 350
2	Soundness	0.8	< 10
3	Initial setting time (min)	30	≥ 30
4	Final setting time (min)	600	≥ 600
5	Specific gravity	3.16	3.15 – 3.19
6	Standard consistency	27.4%	22% - 30%

b) COARSE AGGREGATE

The coarse aggregate used was the locally available gravel which was passed through a 20 mm IS sieve. The coarse aggregate is tested as per Indian Standard specification IS 383. The water absorption and the specific gravity of the gravel were found to be 0.37% and 2.7 respectively.

c) FINE AGGREGATE

The fine aggregate used in this study is M-sand which was passed through IS 4.75 mm sieve. The fine aggregate is tested as per Indian Standard specification IS 383. The fineness modulus and the specific gravity of the M-sand were found to be 2.0 and 2.56 respectively.

d) BASALT FIBER

The basalt fiber used in this study is chopped basalt fiber of length 6 mm and an aspect ratio of 200 to 300. The physical properties of the chopped basalt fiber are enlisted in Table 2

Fig.1Basalt Fiber

Table2: Physical Properties of Basalt fiber

Property	Value
Length	6 mm
Diameter	20 µm
Density	2670 Kg/m^3
Tensile Strength	3000 MPa
Elastic Modulus	7.9 GPa
Elongation Percentage	3.1%

e) WATER

The quality of water used for the mixing of mortar is of vital importance. The water used should be free from impurities such as clay, loam, salts, acid, and others. As per IS 456, the pH of the water should be greater than 6.0 as like drinking water. The tests such as pH and total hardness are conducted on the seawater used in our project and the values are found to be 9.89 and 9727.27 mg/l respectively.

B. TESTS AND METHODS OF PREPARATION OF SPECIMEN

a) BATCHING OF MATERIALS

Different batching methods are available on construction sites. In this project weight batching is conducted. It is the correct method of measuring the materials. The batching is done according to the prepared conventional mix proportions.

b) BLENDING OF MATERIALS AND CASTING OF SPECIMEN

Blending is one of the most important factors to make concrete workable. The materials are mixed by hand throughout the project. Firstly the mixing tray is cleaned with water and the coarse aggregate, gravel, and fine aggregate, M-sand, are mixed thoroughly with about 50% of water. The cement and the remaining water are poured into the mix and the materials are mixed until homogeneity is achieved. Later the concrete is put into the metallic tray and the slump cone test is conducted. Then the concrete is poured into the appropriate molds for compression test and acid attack test. Then, the molds are placed in the vibrating machine to obtain maximum compaction. Fig.2 shows the slump cone test on fresh concrete.

Fig.2 Slump Cone Test

Fig.3 Hardened Concrete Specimen

c) CURING OF SPECIMEN

The specimens were kept in shade for 24 hours. After that, they are demoulded and kept for curing in the water tank. Fig.4 shows the specimens in the water tank

d) COMPRESSIVE STRENGTH

Compression strength is the ability of the material to bear the compressive load. It depends on many factors such as water-cement ratio, quality of concrete, cement strength, etc., it's carried out in cubes. A sample of 3 cubes of size 150mm is cast to find out the compressive strength of the concrete. The curing ages of concrete are 7 days, 14 days, and 28 days. After proper curing, the cubes are tested for compression strength in a Compression Testing Machine. Fig.5 shows the compression test on concrete

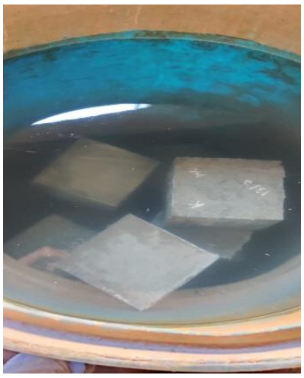


Fig.4 Specimen in Water Tank

Fig.5 Compression test on concrete

e) ACID ATTACK

The residual mass of concrete specimens after chemical exposure is shown in Figures 4.4 and 4.5. The mass loss of Sample 4 was only 4.9% at 28 days in H_2SO_4 exposure whereas it was as high as 7.75% for conventional concrete at 28 days. This indicates that the rate of deterioration of BFRC is lesser as compared to conventional concrete during chemical exposure. Once exposed to acid mediums, basalt fibers containing alkalis (Na, K, Ca, Al) are replaced by hydrogen ions from the acid and become less prone to corrosion as these metal ions form a protective layer on the surface of the fiber. The medium of the cement is basic which makes the concrete neutral when immersed in an acid solution. Sample 1 retained 82.57% compressive strength after immersion for 28 days in H_2SO_4 whereas control concrete retained 72.36%.

Fig.6 Acid Attack on Concrete

IV. RESULTS AND DISCUSSION

Several tests were conducted to know the concrete properties. The results of the compression test and the effect of acid attack of mix proportion 1:1.41:2.43 for conventional mix and the mix proportion 1:1.42:2.44 for basalt fiber reinforced seawater concrete are tabulated and discussed below and are represented in graphical form.

A. COMPRESSION TEST RESULTS

The tests were conducted on hardened 150mm x150mmx 150mm size specimens. The results of mix 1:1.41:2.43 are revealed in the following Table 3. Tables 4,5,6,7 show the compression test results obtained from mix 1:1.42:2.44 with varying percentages of basalt fiber at 7 days, 14 days, and 28 days.

Table 3 Compression Strength of Conventional Concrete

No. of curing days	Specimen	Compressive Strength (N/mm^2)	Average Compressive Strength (N/mm^2)
7 Days	C1	19.82	19.79
	C2	20.12	
	C3	19.43	
14 days	C1	27.16	27.16
	C2	26.97	
	C3	27.16	
28 days	C1	30.83	31.34
	C2	31.85	
	C3	31.36	

Table 4 Compression Strength of Basalt Fiber Reinforced Sea Water concrete at 7 days

Basalt Fiber (%)	Specimen	Compressive Strength (N/mm^2)	Average Compressive Strength (N/mm^2)
0	C1	18.96	18.83
	C2	19.12	
	C3	18.42	
0.33	C1	20.36	21.14
	C2	21.81	
	C3	21.26	
0.66	C1	23.15	22.88
	C2	22.63	
	C3	22.85	
1	C1	21.34	21.28
	C2	21.04	
	C3	21.45	

Table 5 Compression Strength of Basalt Fiber Reinforced Sea Water Concrete at14 days

Basalt Fiber (%)	Specimen	Compressive Strength (N/mm^2)	Average Compressive Strength (N/mm^2)
0	C1	24.40	24.70
	C2	24.56	
	C3	25.13	
0.33	C1	26.96	27.20
	C2	27.38	
	C3	27.25	
0.66	C1	29.78	29.86
	C2	29.84	
	C3	29.96	
1	C1	28.45	28.62
	C2	28.66	
	C3	28.74	

Table 6 Compression Strength Test of Basalt Fiber Reinforced Sea Water Concrete at28 days

Basalt Fiber (%)	Specimen	Compressive Strength (N/mm^2)	Average Compressive Strength (N/mm^2)
0	C1	28.42	28.18
	C2	27.65	
	C3	28.46	
0.33	C1	31.65	31.78
	C2	31.86	
	C3	31.84	
0.66	C1	33.96	34.36
	C2	34.35	
	C3	34.78	
1	C1	32.56	32.52
	C2	32.88	
	C3	32.12	

Chart 1 Graphical Representation of Compressive Strength of Conventional concrete

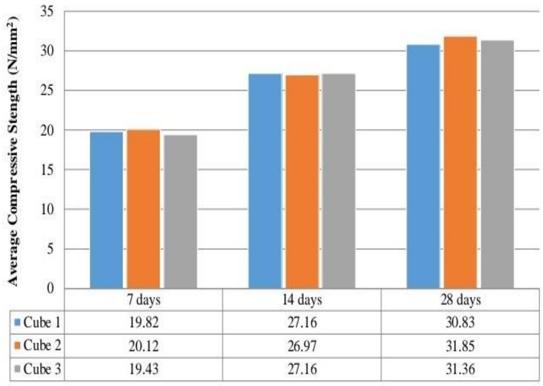


Chart 2 Graphical Representation of Compressive Strength of Sea Water Concrete at 7 days

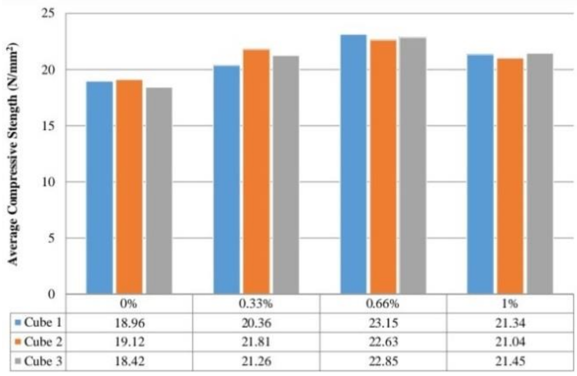


Chart 3 Graphical Representation of Compressive Strength of Sea Water Concrete at 14 days

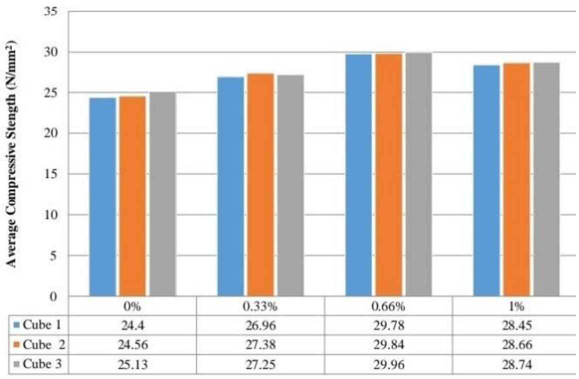


Chart4 Graphical Representation of Compressive Strength of Basalt Fiber Reinforced Sea Water Concrete at 28 days

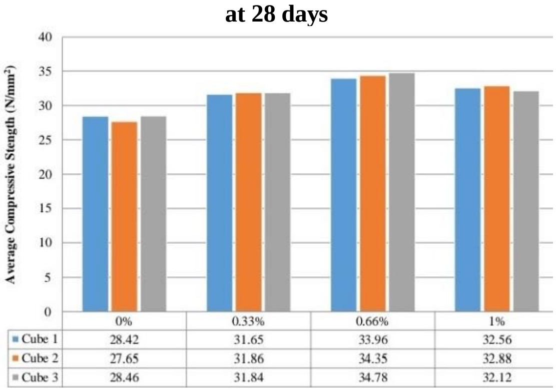
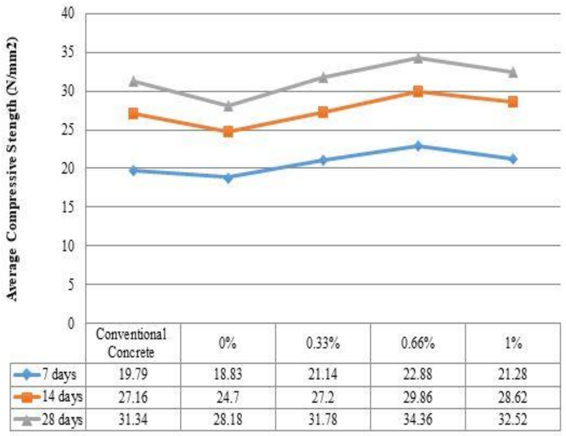


Chart 5 Comparison of Conventional Concrete to Basalt Fiber-reinforced Sea Water Concrete



B. EFFECT OF ACID ATTACK

The tests were conducted on hardened 150mm x150mmx 150mm size specimens. The results of percentage retained weight after the acid attack on the concrete of mix 1:1.41:2.43 and 1:1.42:2.44 are revealed in following Table 7. Table 8 shows the compression test results obtained from the two mixes with varying percentages of basalt fiber at 7 days, 14 days, and 28 days.

Table7 Retained Weight of Concrete Specimens

Sample		**Reduced Weight (%)**		
		7 days	**14 days**	**28 days**
Conventional Concrete		1.97	3.86	7.75
Basalt Fiber Reinforced Sea Water Concrete	0%	2.13	4.1	8.13
	0.33%	1.8	3.41	6.77
	0.66%	1.57	2.31	5.6
	1%	1.16	2.02	4.9

Table 8 Compressive Strength of Concrete Specimen after Acid Attack

Sample		**Compressive Strength (N/mm^2)**		
		7 days	**14 days**	**28 days**
Conventional Concrete		17.88	16.17	14.68
Basalt Fiber Reinforced Sea Water Concrete	0%	15.78	13.96	10.36
	0.33%	19.42	17.28	14.68
	0.66%	20.56	18.32	16.84
	1%	19.54	17.16	15.16

Chart 6 Percentage Reduction in Weight of Concrete Specimens

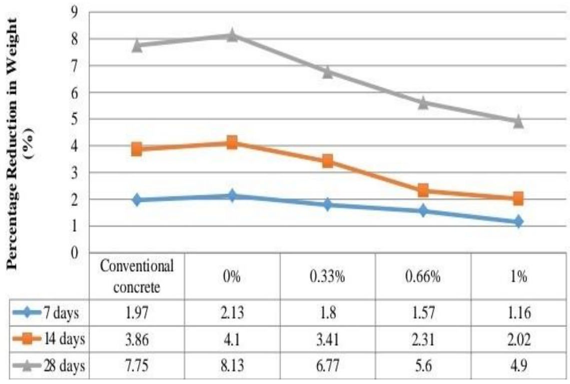
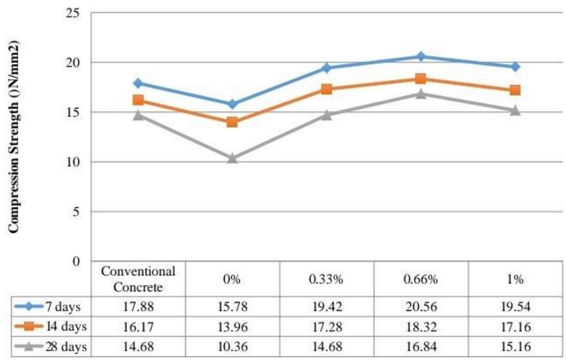


Chart 7 Compressive Strength of Concrete Specimen after Acid Attack



V. CONCLUSION

The following conclusion can be drawn from our experimental studies:

1. In this project, the strength and durability of the Basalt Fiber Reinforced Sea Water Concrete were analyzed in terms of Compressive strength and Acid Attack test
2. The basalt fibers are used at different concentration levels as 0%, 0.33%, 0.66%, and 1% to find the optimum level of concentration
3. At 0% concentration of basalt fiber of concrete with seawater mixing and seawater, curing shows reduction in their compressive strength as the salts present in the seawater reduces the strength of the concrete
4. The compressive strength of the Basalt Fiber Reinforced Sea Water Concrete increased gradually with the increase in the percentage concentration of basalt fiber up to 0.66% and the compressive strength reduced at 1%. Hence the optimum basalt fiber concentration for a basalt fiber reinforced seawater concrete is **0.66%**
5. The compressive strength of the Basalt Fiber Reinforced Sea Water Concrete at 0.33%, 0.66%, and 1% concentration increased up to 1.4%, 9.6%, and 3.77% respectively compared to Conventional Concrete at 28days
6. After the Acid Attack, the percentage reduction in weight of the Basalt Fiber Reinforced Sea

Water Concrete at 0% concentration is 4.9% higher than the percentage reduction in weight of Conventional Concrete at 28 days.

7. Hence the Sea Water Concrete without Basalt Fiber does not show any resistance to the effect of acid and also the deterioration increases as compared to Conventional Concrete
8. When the concentration of basalt fiber is increased to 0.33%, 0.66%, 1% the percentage weight retained by the concrete specimen increased by 12.65%, 27.74%, and 36.77% respectively compared to Conventional Concrete exposed to acid attack at 28 days
9. Hence the increase in basalt fiber concentration increases the bonding of the concrete mix and increases the retained weight of the concrete specimen with an increase in fiber concentration
10. After the Acid Attack, the compressive strength of the Basalt Fiber Reinforced Sea Water Concrete at 0% loses more than half its compressive strength when compared with the same specimen without acid attack
11. The 0.33% concentrated basalt fiber seawater concrete does not show any significant change in the compressive strength comparing to conventional concrete after an acid attack
12. The 0.66% and 1% concentrated Basalt Fiber Reinforced Sea Water Concrete increased up to 14.71% and 3.27% respectively compared to Conventional Concrete exposed to acid attack at 28 days

ACKNOWLEDGEMENT

It is a pleasure to express our deep sense of our gratitude to our guide Mrs. A. Kalyani and all our professors have been on our side and helping us with our project. We also sincerely thank our lab technicians for their help with our project.

REFERENCES

[1] Bassiouni M.T., Nehdi M.L, Durability of self-consolidating concrete to sulfate attack under combined cyclic environments and flexural loading, Cement and Concrete Research 39(3)(2009) 206-226.

[2] Gopal M. (2010) Concrete in Seawater, Retrieved November 8, 2010, from http://www.theconstructor.org/concrete/concrete-in-seawater/843/.

[3] Nikhil A. Gadge and Prof. S. S. Vidhale, Mix Design of Fiber Reinforced Concrete (FRC) Using Slag & Steel Fiber, International Journal of Modern Engineering Research (IJMER)3(6)(2013) 3863-3871.

[4] Abram D.A., Tests of impure water for mixing concrete(1924).

[5] A.Belciya Mary, M.Jeyanthi Rehabilitation of RC Column using Glass Fiber Reinforced Polymer, International Journal of Engineering Trends and Technology (IJETT), 47(2)(2017) 118-124.

[6] Neville A.M. Properties of Concrete. Dorling Kindersley India Pvt. Ltd. India. 5th edition, (2013) 483-531.

[7] Sagargawande, Yogeshdeshmukh, Comparative Study of Effect of Salt Water and Fresh Water on Concrete. International research journal of engineering and technology. (2017).

[8] Stark D.C., Long term performance of plain and reinforced concrete in seawater environment, portland cement Association, RD 119, retrieved from http://www.cement.org/tech/cct_pca_research_tech.asp. (2001) .