EFFECT OF CURING WATER QUALITY ON MECHANICAL STRENGTH OF CONCRETE.

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A thesis submitted to the Department of Civil Engineering in partial fulfillment for the degree of Bachelor of Science in Civil Engineering

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DECLARATION

We hereby declare that this thesis represents our own work done after registration for a bachelor's degree in civil engineering at Sonargaon University, and was not previously included in a thesis or dissertation submitted to this or any other degree, diploma or other degree institution. We guarantee that the current work does not infringe any copyright. We also re-initiate the reassurance of the university against any loss or damage resulting from the breach of previous obligations. Effect of curing water quality on mechanical strength of concrete. We expect more hypotheses to continue to on this topic with advanced data in the upcoming future by others.

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Dedicated

to

"This thesis is dedicated to our honorable parents and teacher"

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ABSTRACT

The quality of the ingredients used in the production of concrete determines its strength. Mixing and curing water is one of the components required, and it should be suitable for producing concrete. Impurities in water can reduce concrete strength and induce corrosion of reinforcement, hence water quality is critical. In developing countries such as Bangladesh, the usage of fresh water is increasing, which can result in a decrease in freshwater availability. As a result, other sources of water were utilized as a substitute for concrete mixing and curing. This study examined the effects of various water sources on the mixing and curing of concrete. In this study, water samples were collected from different water sources (river water, sea water, effluent treatment plant and Fresh water), and their chemical properties were conducted based on standard laboratory procedures to identify the constituents. Experimental tests were conducted on workability of concrete and compressive strength of concrete. The results obtained from the compressive strength test of concrete cylinder cast at the curing ages of 28 days using river water, sea water, effluent treatment plant and fresh water. Compressive strength testing of cylinder using fresh water for mixing and other sources of water used for concrete curing only. River water shows improved performance for concrete curing, and it can be properly utilized for concrete production.

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CHAPTER 1
INTRODUCTION

1.1 Background and Significance of the study

Concrete is the most widely used construction material in the world, owing to its excellent compressive strength, durability, and versatility. The mechanical strength of concrete is crucial for the performance of concrete structures. However, concrete's mechanical properties are influenced by a variety of factors, including the quality of curing water. The curing process involves providing adequate moisture and temperature to the concrete to promote hydration, which is essential for the development of strength and durability.

Water quality is a critical factor in the curing process and can significantly affect the mechanical properties of concrete. Poor water quality can negatively impact the strength, durability, and overall performance of the concrete. The water used for curing should be clean, free of contaminants, and have the appropriate pH level to ensure the best possible outcomes for the concrete.

This topic has garnered a great deal of interest in recent years, as construction companies and researchers seek to improve the quality and performance of concrete structures. Understanding the effect of curing water quality on the mechanical strength of concrete is vital for ensuring the long-term durability and sustainability of concrete structures. In this essay, we will explore the relationship between curing water quality and the mechanical strength of concrete and its implications for the construction industry.

1.2 Objective of the Study

The objectives of this thesis are:

1. To assess the impact of curing water quality on the compressive strength of concrete.
2. To evaluate the effect of curing water quality on the tensile strength of concrete.

1.3 Organization of the thesis

This Thesis consists of five chapter organized as follows:

Section 1.01 Chapter 01: Introduction.

The Introduction is an introductory chapter that provides the reader with the background of the topic, the purpose and scope of the thesis.

Section 1.02 Chapter 02: Literature Review.

Literature review will explore the effect of curing water quality on the mechanical strength of concrete.

Section 1.03 Chapter 03: Methodology.

1.Prepare concrete specimens with varying water qualities, using water from different sources and with different levels of impurities.

2.Subject the specimens to compression tests to measure their mechanical strength, and analyze the data to determine any correlation between curing water quality and concrete strength.

Section 1.04 Chapter 04: Results and Discussion.

The study found that curing water quality can significantly affect the mechanical strength of concrete, with higher levels of impurities in the water leading to lower strength values.

Section 1.05 Chapter 05: Conclusions and Future Work.

This Chapter presents the conclusions and recommendations for further work on Research.

CHAPTER 2

Literature Review

Introduction:

Concrete is one of the most widely used building materials in the world. It is made up of a mixture of cement, water, and aggregates such as sand, gravel, or crushed stone. During the curing process, the concrete hardens and gains strength. The quality of the water used during curing can have a significant impact on the mechanical strength of the concrete. This literature review will explore the effect of curing water quality on the mechanical strength of concrete.

2.1 Literature Review

Many studies have been conducted to investigate the effect of curing water quality on the mechanical strength of concrete. One such study was conducted by Siddique et al. (2015) who investigated the effect of seawater on the compressive strength of concrete. The study found that the compressive strength of concrete decreased with an increase in seawater content. The researchers concluded that seawater should not be used as curing water for concrete [1].

In another study, Al-Amoudi et al. (2002) investigated the effect of using saline water on the mechanical strength of concrete [2]. The study found that the compressive strength of concrete decreased with an increase in the concentration of salt in the water. The researchers concluded that saline water should not be used as curing water for concrete.

Another study by N. K. Lee et al. (2019) investigated the effect of recycled wastewater on the mechanical properties of concrete. The researchers found that using recycled wastewater for curing had a negative impact on the mechanical strength of the concrete. Specifically, they observed a decrease in compressive strength and an increase in permeability. The researchers attributed these effects to the high levels of chloride and sulfate ions present in the recycled wastewater [3].

A study by S. Islam et al. (2018) investigated the effect of various curing methods on the mechanical strength of concrete. The researchers found that immersion curing in freshwater for 28 days resulted in the highest compressive strength of the concrete, followed by steam curing and air curing. The researchers noted that immersion curing allowed for the most effective hydration of the cement, resulting in a higher strength [4].

Another study by B. M. Das et al. (2017) investigated the effect of curing water temperature on the mechanical properties of concrete. The researchers found that using warm water for curing resulted in a higher compressive strength of the concrete, compared to using cold water. They attributed this effect to the accelerated hydration of the cement in warm water, which resulted in a more complete reaction [5].

Another study by M. H. Zhang et al. (2020) investigated the effect of seawater curing on the mechanical properties of concrete. The researchers found that seawater curing significantly increased the compressive strength of the concrete, and also improved its durability. However, they noted that the effect of seawater curing was influenced by the initial water-to-cement ratio of the concrete, and that a higher initial ratio resulted in a greater increase in strength [6].

Another study by A. K. Sinha et al. (2016) investigated the effect of curing water pH on the mechanical properties of concrete. The researchers found that using alkaline water for curing resulted in a higher compressive strength of the concrete, compared to using neutral or acidic water. They attributed this effect to the greater solubility of calcium hydroxide in alkaline water, which allowed for a more complete reaction between the cement and water [7].

2.2 Material and Method

Materials and method used in this study are explained in this section.

Experimental tests were conducted to examine the effect of using different sources of water for mixing and curing purposes on the mechanical properties of fresh and hardened concrete. The proportion by weight of all constituents (aggregates, cement, and water) was kept constant in all the mixes. Finally, different experiments were carried out on the properties of concrete with various curing water. The sources of curing water were variable in the concrete mixes. Experimental results of fresh and hardened concrete properties using different curing water (river water, sea water, ETP water, and fresh water) were compared to reference concrete specimens (control or fresh water). A total of 8 concrete samples were cast and tested on the 28th days of curing age for compressive strength.

2.2.1 Cement

The cement type used for the study was Portland Pozzolana Cement (PPC) with a grade of 32.5R and manufactured by the Shah Cement Industries Limited. The physical properties of cement are presented in Table 1.

The main oxide composition of Portland Pozzolana Cement (PPC) and their chemical abbreviations are:

1. Tricalcium Silicate (C3S): 50-60%
2. Dicalcium Silicate (C2S): 15-25%
3. Tricalcium Aluminate (C3A): 5-10%
4. Tetracalcium Aluminoferrite (C4AF): 10-15%

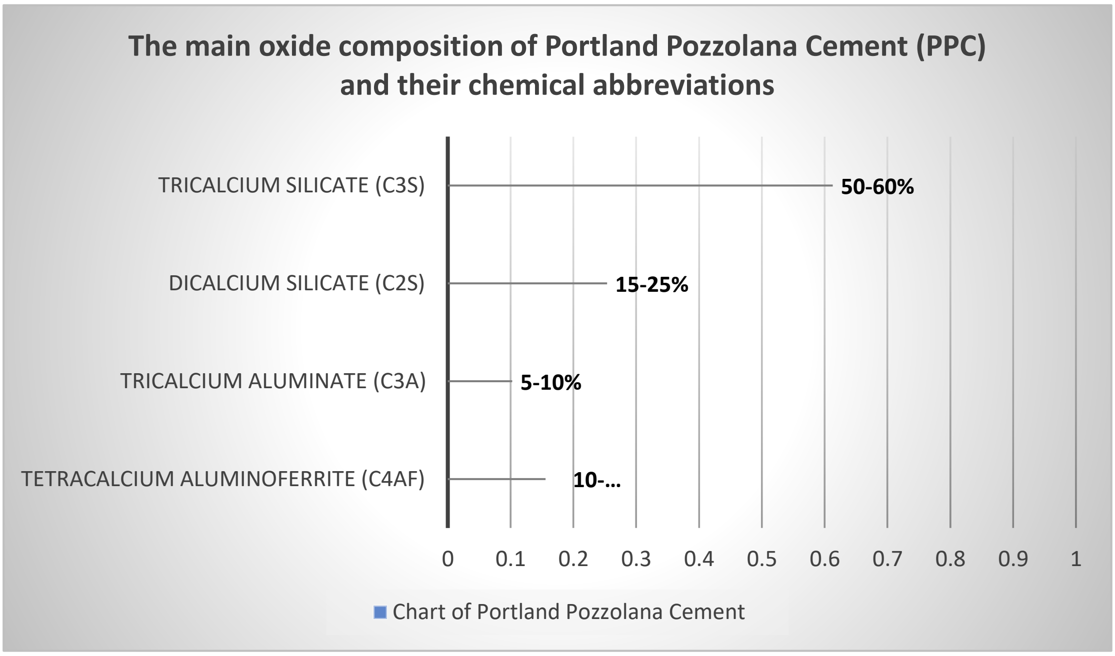

Figure 1 Chart of Portland Pozzolana Cement

PPC cement may also contain minor amounts of other oxides such as magnesium oxide (MgO), sulfur trioxide (SO3), and potassium oxide (K2O), among others, depending on the specific raw materials and manufacturing process used.

The chemical abbreviations for these minor oxides are:

- Magnesium oxide (MgO)
- Sulfur trioxide (SO3)
- Potassium oxide (K2O)

In summary, the main oxide composition of PPC cement includes C3S, C2S, C3A, and C4AF, while minor oxides may include MgO, SO3, K2O, among others.

Table 1: The Main Oxide Compositions and abbreviations in addition to the average of each commercially available Portland Pozzolana Cement (PPC) (wt%)

Oxide Constituent	Oxide Composition and abbreviation or Particulars	Average weight (%)
Silicon Dioxide	SiO_2	21.77
Aluminum Oxide	Al_2O_3	2.59
Sulfur Trioxide	SO_3	2.41
Calcium Oxide	CaO	57.02
Magnesium Oxide	MgO	2.71
Iron (iii) Oxide or Ferric Oxide	Fe_2O_3	0.65

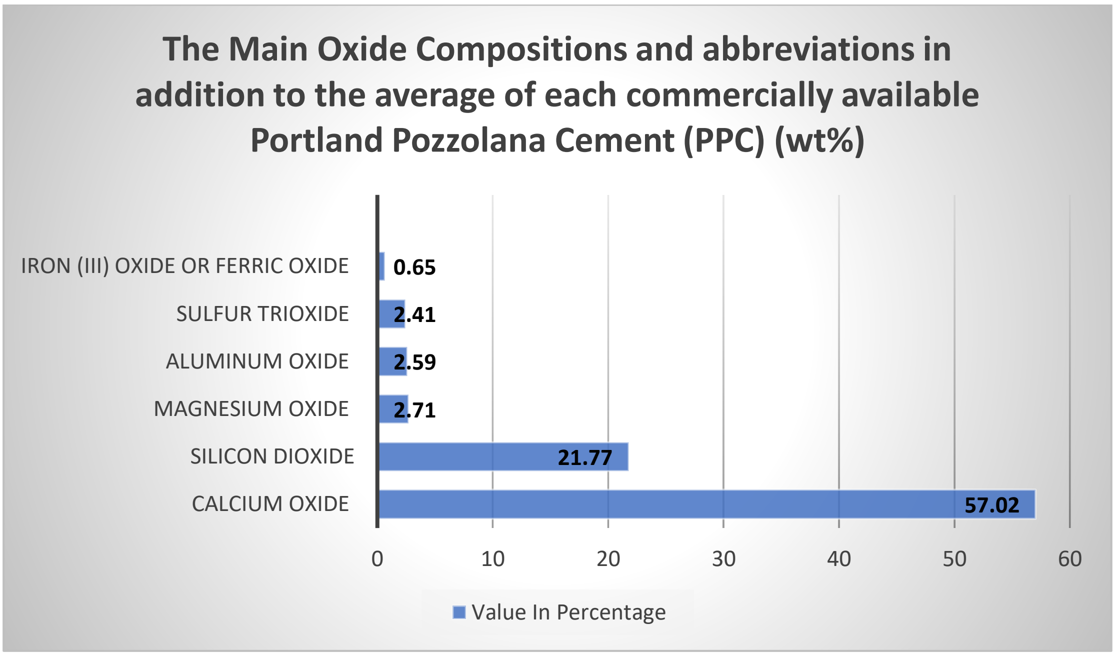

Figure 2 Chart of The Main Oxide Compositions and abbreviations in addition to the average of each commercially available Portland Pozzolana Cement (PPC) (wt%)

2.2.2 Fine Aggregate

Locally procured natural sand was used in the experimental program. Fine aggregate resulting from the natural disintegration of rocks and which has been deposited by streams or glacial agencies.

2.2.3 Coarse Aggregate

The coarse aggregate was prepared accounting to the specified mix type. The mix types included fully saturated coarse aggregate, partially saturated coarse aggregate, and oven dry coarse aggregate. In each case, a water content sample was taken following the saturation procedure in order to gauge the actual water content of each mixture.

2.3 Function of Aggregate in Concrete

Section 2.01: Function of Fine Aggregate in Concrete

Fine Aggregate perform the following function:

1. It assists in producing workability and uniformly in mixture.
2. It assists the cement paste to hard the coarse aggregate particles.
3. It helps to prevent possible segregation of paste and coarse aggregate particularly during the transport operation of concrete for a long distance.
4. Fine aggregate reduces the shrinkage of binding material.
5. It prevents the development of a crack in the concrete. [4]

2.3.1 Function of Water in Concrete

Water Cement Ratio Signifies the ration among the weight of water to the weight of cement applied in concrete mix.

Generally, water cement ration remains under 0.4 to 0.6 with adherence to IS Code 10262 (2009), for nominal mix (M10, M15 …… M25)

The strength of concrete is directly impacted by the water cement ratio. It enhances the strength if employed in perfect ratio and if the ratio improper, the strength will be reduced.

2.3.2 Properties of Concrete

Concrete is a Composite material obtained by mixing Cement, Sand, Aggregate and Water in suitable proportions. Concrete has become a universal building material which is extensively used in civil engineering construction.

It is necessary to know about important properties of concrete for every civil engineer to design a structure. Properties of concrete are controlled and influenced by the various factor, out of them mix proportion plays an important role in concrete strength and these proportions control the properties of strength.

2.3.3 Strength of Concrete

Type of Concrete Strength:

1. **Compressive Strength:**

   Compressive Strength of specimen treated in a standard manner which includes full compaction and wet curing for a specified period give results representing the potential quality of the concrete. There are three types of loading in compressive test:

   a. Uniaxial Loading
   b. Biaxial Loading
   c. Triaxial Loading

   There are three types of failure

   a. Tension Failure
   b. Shear Failure
   c. Companied Failure.

2. Tensile Strength

The direct measurement of tension under axial loading cannot be done in the field. The test is challenging to conduct, and the outcomes are unreliable. However, there is an indirect technique known as the splitting tensile test that involves loading a typical test cylinder in compression while it is on its side.

In most cases, flexure, torsion, or a mixture of loading are used to apply tensile stress to the concrete in the structure rather than pure tension. The impact of on the regulation of cracking has raised awareness of the significance of tensile strength, nevertheless. According to research, direct tension typically accounts for 10% of the compressive force and can reach up to 20% for high-strength concrete (8000-10000 psi Compressive)

2.3.4 Important of Water Cement Ratio

When part of the Portland cement has been substituted with a supplementary cementitious material or filler, this new cementing system can be characterized by two ratios: its w/c and w/b ratios. Which one of these two ratios is more useful in charactering the system? The answer is both: the w/c ratio is not passe (Barton, 1989). In the short term, the early mechanical properties are linked primarily to the w/c ratio, because the first hydrates that give the cement paste its strength are the ones that develop on the surface of the cement particles; supplementary cementitious materials and fillers are not as reactive as Portland cement particles and their reactivity depends on their type. Very roughly, it can be assumed that silica fume begins to react significantly within the first 3 days, slag within the first 28 days, and fly ash within the first 56e91 days following the casting of concrete, and filler never.

However, the initial network of capillaries of the cement paste is generally governed by the w/b ratio and no longer by the w/c ratio. Therefore, the w/b ratio will determine the size of the menisci that form in the cement paste as a consequence of the chemical construction that is observed when Portland cement hydrates in an external source of water, as will be seen in the following chapter. In the long term, the w/b ratio also influences the compressive strength and durability of cement paste made with blended cement containing supplementary cementitious materials.

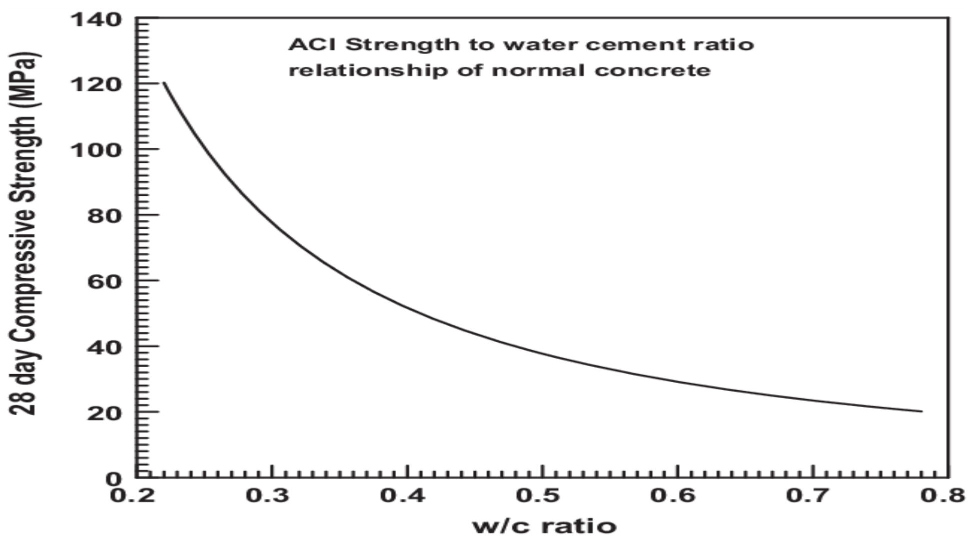

Figure 3: Strength to Water Cement Ratio Relationship of conventional concrete.

2.3.5 Curing Time

Curing plays a vital role in concrete strength development and durability. After adding water to the concrete mix (Cement, Sand & Aggregate), the exothermic reaction (hydration) takes place, which helps the concrete to harden. Hardening of concrete is not instant and continues for a longer period, which requires more amount of water for processing hydration. So, the concrete kept moist until the hydration reaction in concrete completes. This process called the curing of concrete.

2.3.6 Method

The quality of curing water plays a crucial role in determining the mechanical strength of concrete. The use of contaminated or hard water can negatively affect the hydration process, leading to reduced strength and durability of the concrete. Therefore, it is important to use clean and potable water for curing concrete to ensure optimal mechanical performance.

CHAPTER 3
Methodology

3.1 Material

In this study, four materials are used to reduce desired concrete mixture. The materials are cement, fine aggregate, natural coarse aggregate and fresh water.

3.1.1 Cement

The cement type used for the study was Portland Pozzolana Cement (PPC) with a grade of 32.5R and manufactured by the Shah Cement Industries Limited. The physical properties of cement are presented in Table 1.

The main oxide composition of Portland Pozzolana Cement (PPC) and their chemical abbreviations are:

1) Tricalcium Silicate (C3S): 50-60%
2) Dicalcium Silicate (C2S): 15-25%
3) Tricalcium Aluminate (C3A): 5-10%
4) Tetracalcium Aluminoferrite (C4AF): 10-15%

Figure 4: Portland Pozzolana Cement (Lab)

3.1.2 Coarse Aggregate

The study utilized strong, dense, clean, and free from any vegetable type coarse aggregate with a nominal maximum size of 20 mm (Fig. 3.01). Sieve analysis was conducted to get gradation or relative particle size distribution of coarse aggregate and presented in Fig. 3.01. The coarse aggregates were cleaned with water to keep the quality. The summary of physical properties is presented in Table 3.

Figure 5: Coarse Aggregate (Lab)

3.1.3 Fine Aggregate

Sylhet sand with a nominal maximum size of 4.75 mm was used. Fig. 3.02 shows air-dried fine aggregate before batching the concrete mix and sieve analysis. The physical properties of the fine aggregates were carried out on representative samples as per ASTM [35] and summarized in Table 2. The analysis of water absorption, bulk specific gravity, and saturated surface dry (SSD) was performed as per ASTM [36]. The particle size distribution curve attained from sieve analysis is presented in Fig. 3.02.

Figure 6: Fine Aggregate (Lab)

3.2 Particle Size Distribution

3.2.1 Sieve Analysis

For particle size distribution for both coarse and fine aggregate sieve analysis method ware uses according ASTM C136.

3.2.1.1 Apparatus

For sieve analysis, following apparatuses ware used-

(a) Balance;
(b) Sieves;
(c) Oven and
(d) Containers.

Figure 7: Apparatus (Lab)

3.2.1.2 Test Procedure

The sample were dried to a constant mass at a temperature of around 110° C and after drying sample were weighted. A set of IS sieve with suitable opening were used sieve the sample. Quantity of material was limited so that all the material could reach the sieve opening a number of times during sieve analysis. Sieving process was continued for a sufficient period until the particle were not passing through the sieve. On completion of sieving and percentage of cumulative weight retained was calculated.

3.3 Mix Properties of Concrete

For this Research mixture proportion of concrete were determine in accordance with following condition: -

a) Water/Cement Ratio 0.50
b) Same maximum grain size (20mm)
c) Same type and quantity of fine aggregate
d) Variable type and quantity of coarse aggregate
e) Mixing Ratio 1:2:3

3.3.1 Mix Proportion for Concrete Cylinder

To perform compressive and tensile strength test 100mm X 200mm Cylinder concrete was made. The mix proportion were 1:2:3 for Cement: Sand: Coarse Aggregate. Amount of concrete for a cylinder of each batch are shown in the following table:

Mix Ratio 1:2:3

Table 2: Estimation of materials for concrete cylinder

Mix Ratio	Coarse Aggr. (Kg)	Fine Aggr. (Kg)	Cement (Kg)	Water (Kg)	W/C Ratio%
1:2:3	21	13.50	6.21	3.105	0.50

3.3.2 Mixing of Concrete

A smooth, water tight surface was selected as platform and it were washed before mixing of concrete. Sand was measured for each mixing batches and was spread evenly to the platform. They’re required quantity of cement was dumped on the sand and spread evenly. Sand and cement we remixed properly until the mixture became uniform in color. Sand and cement mixture was spread evenly and required amount of coarse aggregate was spread on the mixture. After spreading coarse aggregate, whole mass was mixed with shovel properly until the mixture was uniform. Mixing ratio 1:2:3.

3.4 Preparation of mold and De-molding

3.4.1 Process of molding

1. For compressive and tensile strength test, steel cylindrical mold was used. Height and diameter of the mold were 200mm and 100mm respectively.
2. Molds were cleaned and grease was applied on the inner surface of the mold.
3. Concrete was filled in the mold in 3 layers.
4. Each layer was rodded 25 time in an even pattern using a tamping rod.
5. After tamping, the top surface is leveled.
6. The molded specimens were kept at normal temperature to dry

Molding of cylinder concrete specimens are shown in figure.

Figure 8: Mold of Cylinder

3.5 Process of De molding

After 24 hours of casting, the concrete specimens were removed from the mold and allowed for curing.

3.5.1 Curing

After De molding, the specimen was placed under water for 28 days. The specimens were fully immersed under water. Figure 3.6 shows curing of cylinder concrete specimens in various water.

Figure 9: Curing of concrete specimens in various water (Lab)

Total number of specimens for each test and their age and size are given below:

Table 3: Details of property, test method, number and size of specimens

Water	Mixing Ratio	Test Method	Age at Test (days)	Size of Specimen	No. of Specimen
Fresh water	1:2:3	ASTM C39	28	100 mm Dia X 200mm height Cylinder	02
River water					02
ETP water					02
Sea water					02

3.6 Compressive Strength Test

Compressive Strength test is a method to measure the strength of concrete. In this study, the compressive strength of specimens was measured according to ASTM C39. ASTM C39 determine the compressive strength of cylindrical concrete specimens such as melded concrete cylinders and drilled cores. However, this is limited to concrete strength test can be used for quality control i.e., acceptance of concrete to use in construction.

3.6.1 Apparatus

1. Compression testing machine and
2. Balance

3.6.2 Procedure

1. The weight of specimen was measured and then it was placed on the lower bearing block so the axis of the specimen is aligned with the center of thrust of the spherically seated bearing block.
2. Age, weight, type and peak load was provided in the screen of testing machine and a Compressive load of 0.25 MPa/s was applied continuously and without shock until failure.
3. Maximum load carried by the specimen during the test was recorded and the type of failure pattern noted.

Figure 10: Compressive Strength Test (Lab)

CHAPTER 4

Results and Discussion

4.1 Introduction

Compressive Strength of concrete is the engineering properties of concrete which design are concerned of it gives an overall view of quality of concrete as it is directly related to the structure of hardened concrete. Concrete has been made with different percentage of coarse aggregate form different source for target strength. PPC & Sylhet Sand were used as fine aggregate to make the concrete. Compressive strength has been tested for just 28 days.

4.1.1 Sieve Analysis

Fineness Modulus is defined as an index to the particle size not to the gradation. Fineness Modulus is calculated from the sieve analysis. It is defined mathematically as the sum of the cumulative percentage retained on the standard sieves divided by 100. The standard size sieves are 3 (75mm), 1.5 (37.5mm), 3/4 (19.0mm), 3/8 (9.5mm), No 4 (4.75mm), No 8 (2.36mm), No 16 (1.18mm), No 30 (600µm), No 50 (300µm) and No 100 (150µm). Always report the fineness Modulus to the nearest 0.01. In fineness Modulus, the finer the material the more the water demand is. It is used for the purpose of estimating the quantity of coarse aggregate to be used in concrete mix design.

Table 4: Result of Sieve Analysis of Fine Aggregate (Sand)

Sieve Analysis for Fine Aggregate						
Sieve No.	Sieve Opening (mm)	Material Retained (gm)	Material Retained (%)	Cumulative Percentage Retained (%)	F.M.	Percent Finer (%)
4	4.75	0	0	0	2.84	100
8	2.36	16	3.2	3.2		96.8
16	1.18	118	23.6	26.8		73.2
30	600 µm	181	36.2	63		37
50	300 µm	147	29.4	92.4		7.4
100	150 µm	30	6	98.4		1.6
Pan	-	8				
Total:				283.8		

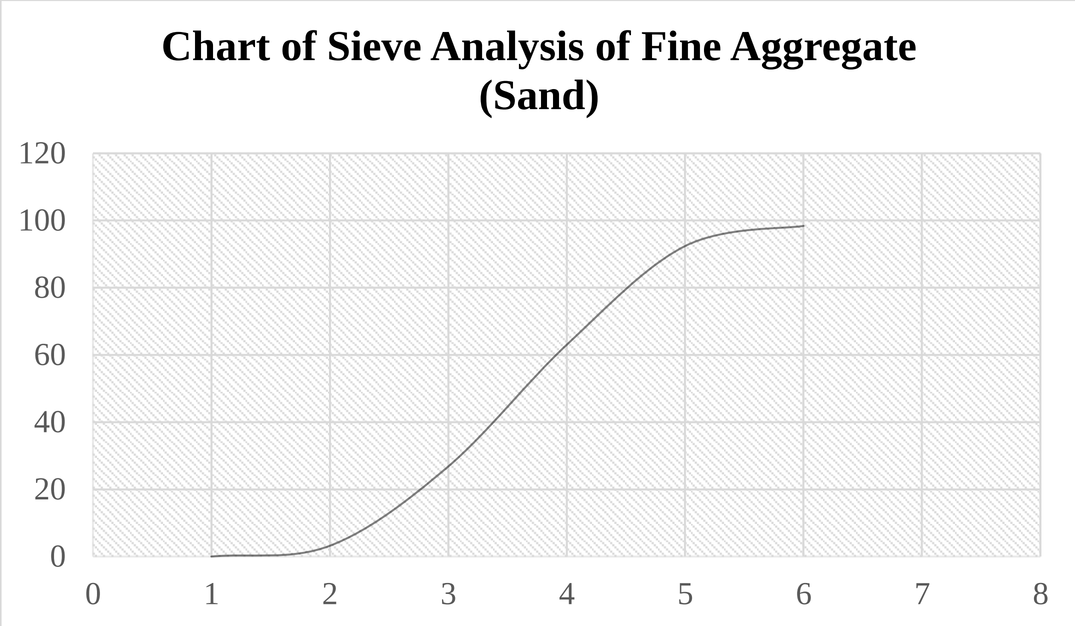

Figure 11 Chart of S Curve of Fine Aggregate

4.1.2 Sieve Analysis of Coarse Aggregate

Table 5: Result of Sieve Analysis of Coarse Aggregate (Stone)

Sieve Analysis of Coarse Aggregate						
Sieve No.	Sieve Opening (mm)	Material Retained (gm)	Material Retained (%)	Cumulative Percentage Retained (%)	F.M.	Percent Finer (%)
3”	75	0	0	0	7.069	100
1.5”	37.5	0	0	0		100
¾”	19	69	6.9	6.9		93.1
3/8”	9.5	931	93.1	100		0
#4	4.75	0	0	100		0
#8	2.36	0	0	100		0
#16	1.18	0	0	100		0
#30	600 µm	0	0	100		0
#50	300 µm	0	0	100		0
#100	150 µm	0	0	100		0
Pan	-	0				
Total:				706.9		

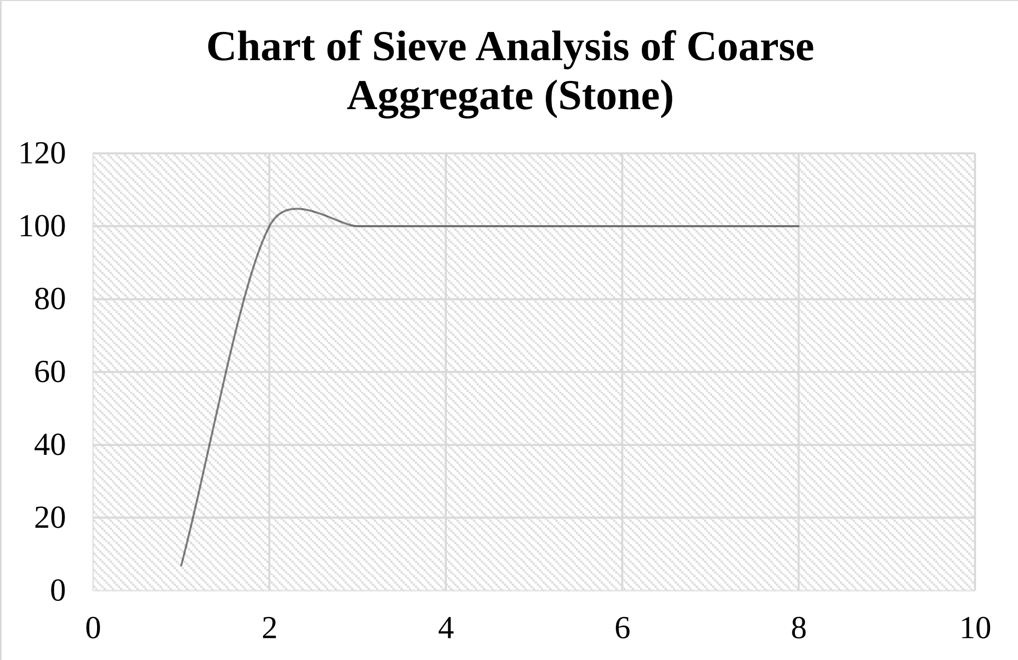

Figure 12 Chart of S Curve of Coarse Aggregate

Table 6 Specific Gravity for Fine Aggregate

Specific Gravity for Fine Aggregate			
Wt. of pycnometer filled with water to calibration, B gm	**Oven dry Wt. in air, A gm**	**Wt. of pycnometer with specimen and water to calibration mark, C gm**	**Wt. of saturated surface dry specimens S (gm)**
654	287	832	300
Test	**Formula**	**Calculation**	**Result**
Apparent Specific Gravity	$\frac{A}{B+A-C}$	$\frac{287}{654+287-832}$	2.63
Bulk Specific Gravity (Oven dry basic)	$\frac{A}{B+S-C}$	$\frac{287}{654+300-832}$	2.35
Absorption Capacity, D%	$\frac{(S-A)x100}{A}$	$\frac{(300-287)x100}{287}$	4.53
Bulk Specific Gravity (S.S.D. Basic), G	$\frac{S}{B+S-C}$	$\frac{300}{654+300-832}$	2.46

Table 7 Specific Gravity for Coarse Aggregate

Specific Gravity for Coarse Aggregate			
Wt. S.S.D sample in air, B (gm)	**Wt. S.S.D sample in water, C (gm)**	**Oven dry wt. of sample in air, A (gm)**	
1515	1000	1500	
Test	**Formula**	**Calculation**	**Result**
Apparent Specific Gravity	$\frac{A}{A-C}$	$\frac{1500}{1500-1000}$	3
Bulk Specific Gravity (Oven dry basic)	$\frac{A}{B-C}$	$\frac{1500}{1515-1000}$	2.91
Absorption Capacity, D%	$\frac{(B-A)x100}{A}$	$\frac{(1515-1500)x100}{1500}$	1
Bulk Specific Gravity (S.S.D. Basic), G	$\frac{B}{B-C}$	$\frac{1515}{1515-100}$	2.94

Table 8 Unit Weight of Fine Aggregate

Unit Weight of Fine Aggregate					
Condition	**G (kg)**	**Wt. of Bucket empty T (kg)**	**V=$\frac{\pi D^2}{4}x$h**	**M=$\frac{G-T}{V}$, kg/m^3**	**Average (kg/m^3)**
Free Condition	8.078	4	2.77x10^{-3}	1472	1587
Roding Condition	8.421	4	2.77x10^{-3}	1604	
Jiggling Condition	8.664	4	2.77x10^{-3}	1684	

Table 9 Unit Weight of Coarse Aggregate

Unit Weight of Coarse Aggregate					
Condition	**G (kg)**	**Wt. of Bucket empty T (kg)**	**V=$\frac{\pi D^2}{4} x$h**	**M=$\frac{G-T}{V}$, kg/m^3**	**Average (kg/m^3)**
Free Condition	8.249	4	2.77x10^{-3}	1533	1651
Roding Condition	8.696	4	2.77x10^{-3}	1695	
Jiggling Condition	8.780	4	2.77x10^{-3}	1725	

4.1.3 Water Test

Water test for concrete curing water quality helps to evaluate the impact of different types of water (Fresh, River, Sea and ETP Water) on the mechanical strength of concrete, which is crucial for ensuring durability and structural stability.

Following test data are given below:

Table 10: Water Quality Test of Water Sample (Lab)

Sample of Water	**pH Test**	**Conductivity Test**	**Dissolved Oxygen test**
River Water	7.03	132.4 µs/cm	8.61 mg/l
Sea Water	7.26	349 µs/cm	8.44 mg/l
ETP Water	6.97	1686 µs/cm	7.74 mg/l
Fresh Water	6.51	359 µs/cm	8.02 mg/l

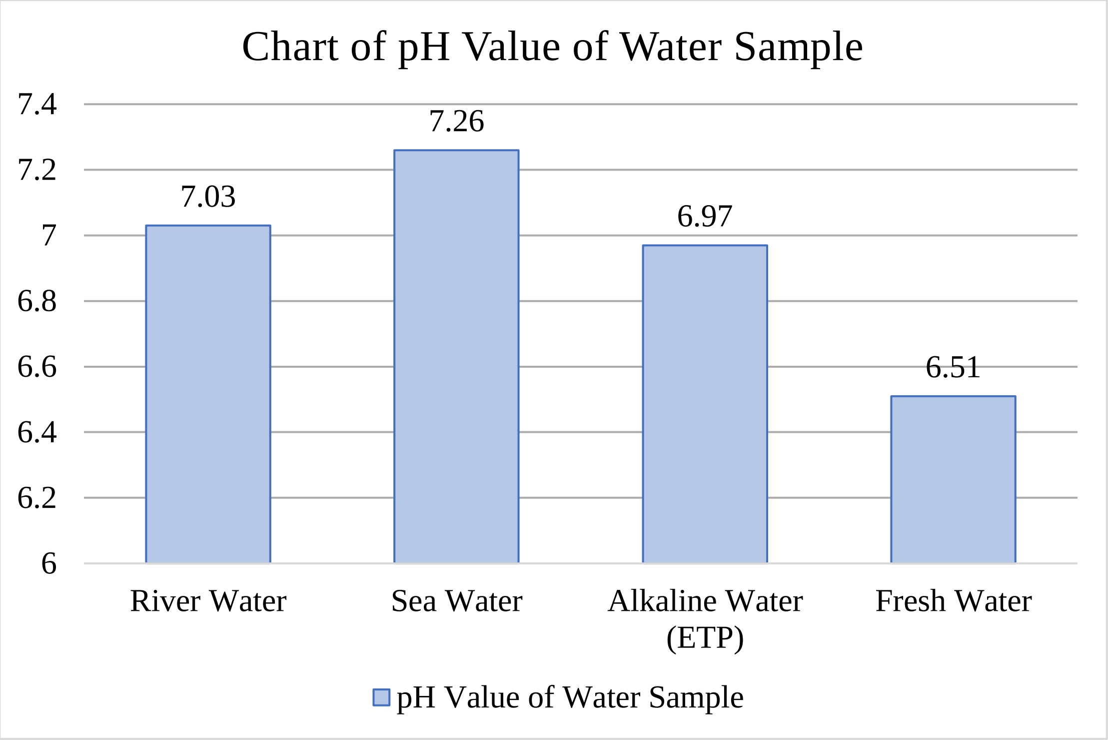

Figure 13 Chart of pH Value of Water Sample

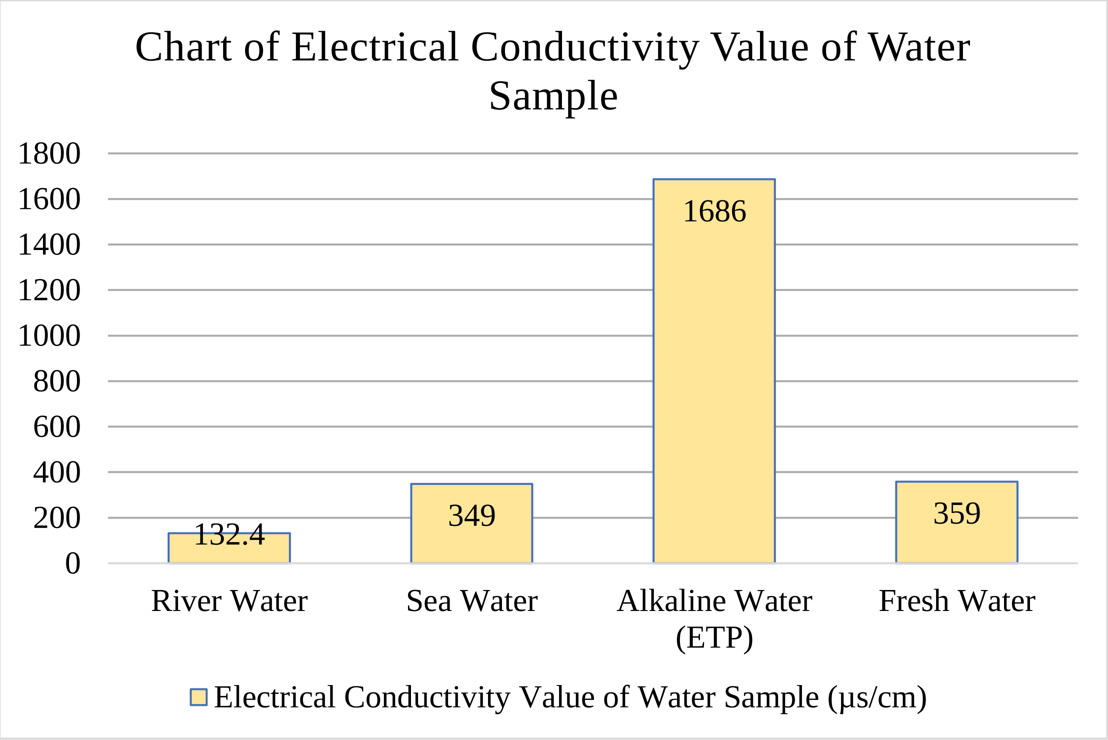

Figure 14 Chart of Electrical Conductivity Value of Water Sample

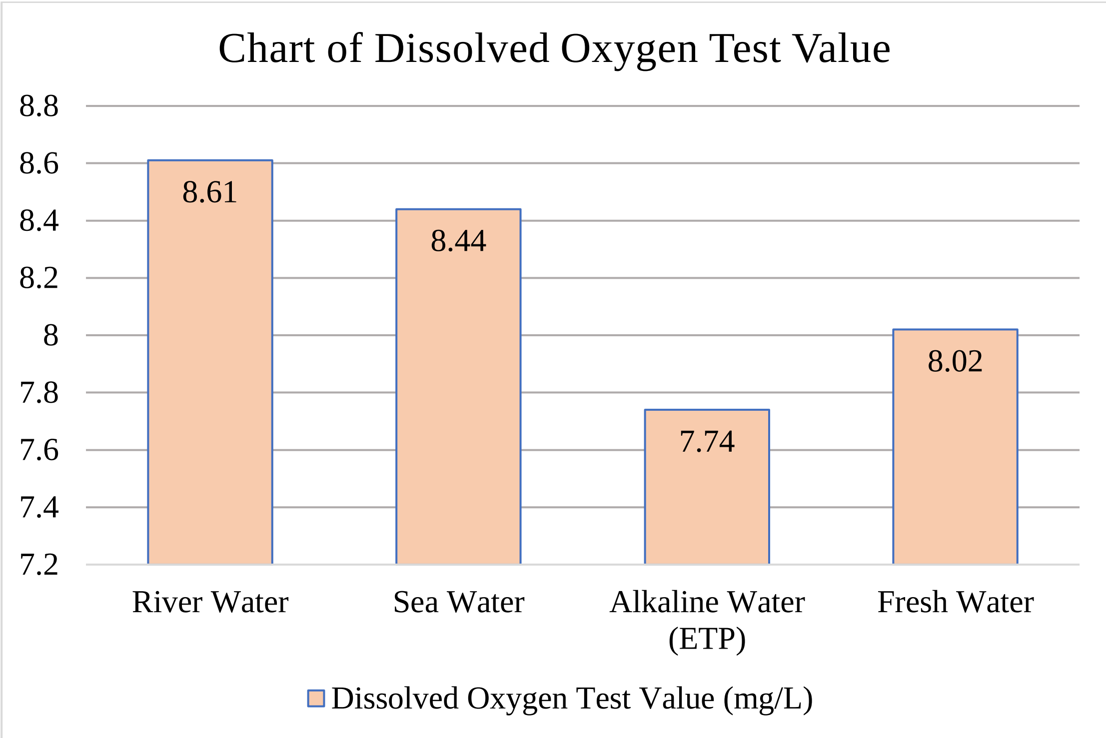

Figure 15 Chart of Dissolved Oxygen Test Value

Figure 16 Alkaline (ETP) water

4.2 Strength test

4.2.1 Compressive Strength Testing Results for varying mixes

Compressive Strength of concrete by applying natural aggregate were compared using normal curing. The compressive strength of cylinder was determined with the help of Universal Testing Machine (UTM).

Testing age =28 days

Loading rate for all cylinder =15 MPa/min

Table 11Compressive Strength Checking on Universal Testing Machine (UTM) (Lab).

Test Date	Sample of Water	Trial	Diameter (mm)	Mean Diameter(mm)	Length (mm)	Weight (kg)	Cross-Sectional Area of Cylinder A= $\pi(d/2)^2$	Load (kN)	Mean Load (N) F	Compressive Strength of Concrete C.S. = F/A (MPa)
06th Mar, 2023	Fresh water	1	102.70	102.74	202.00	4.13	8290.30	215.00	209*1000	25.21
		2	102.77		204.00	4.14		203.00		
	Rivers Water	1	102.74	102.25	204.00	4.18	8211.41	195.00	186*1000	22.65
		2	101.75		203.00	4.09		177.00		
	Sea Water	1	101.63	102.27	203.00	4.12	8214.62	175.00	169*1000	20.57
		2	102.91		204.00	4.22		163.00		
	Alkaline water	1	102.05	102.71	205.00	4.14	8285.45	221.00	214*1000	25.83
		2	103.36		206.00	4.30		207.00		

Calculation:

1. Cross-Sectional area of cylinder (A)= $\pi(d/2)^2$; = $\pi(102.74/2)^2$; =8290.27 mm^2
2. Compressive Strength of Concrete = F/A; = 209000/8290.27 = 25.21 MPa

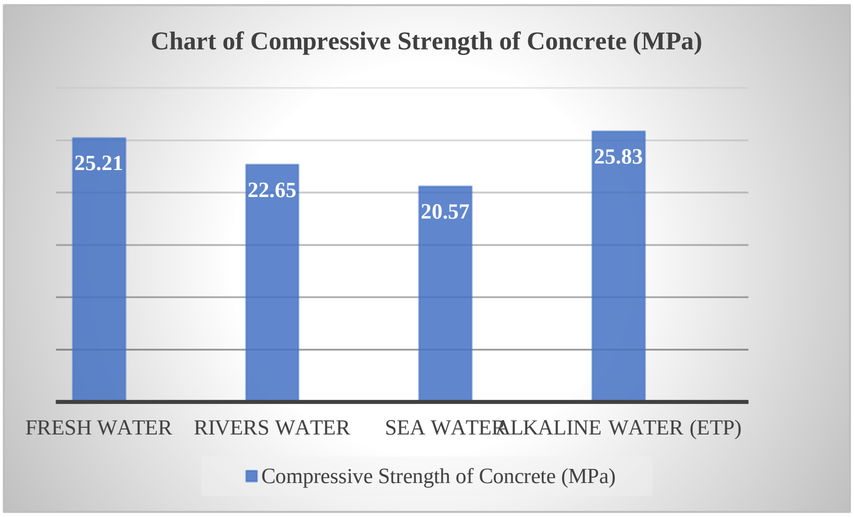

Figure 17 Chart of Compressive Strength of Concrete (MPa)

CHAPTER 5

Conclusions and Future Works

5.1 Conclusion

Specific water quality parameters, such as pH levels, Electrical Conductivity and Dissolve Oxygen were found to have a notable impact on concrete strength.

We found that using alkaline (ETP) water for curing resulted in a higher compressive strength of the concrete, compared to using neutral or acidic water. They attributed this effect to the greater solubility of calcium hydroxide in alkaline water, which allowed for a more complete reaction between the cement and water.

We also found that the compressive strength of concrete decreased with an increase in seawater content. Therefore, seawater should not be used as curing water for concrete.

The study highlights the importance of selecting appropriate curing water sources and controlling water quality parameters to ensure the optimal mechanical strength and durability of concrete structures.

5.2 Limitation & Recommendation

First of all, we aren't able to use Machine mixing, therefore, we had to use a hand mixing process. There the consistency and homogeneity of the mix can be difficult to achieve with hand mixing, which can affect the strength and durability of the final product.

The second limitation of not using an up-to-date Universal Testing Machine (UTM) for compressive strength testing is that the accuracy and reliability of the results may be compromised.

Thirdly, the limitation of using seawater or wastewater from Effluent Treatment Plants (ETP) for the long-term durability of concrete is the potential for increased chloride and sulfate ion content. Both seawater and ETP water may contain higher concentrations of these ions compared to freshwater sources. Elevated levels of chloride and sulfate ions can accelerate the corrosion of reinforcing steel within the concrete, leading to reduced durability and structural integrity over time.

Fourthly, the study's limitations include the focus solely on mechanical strength and the exclusion of other important properties, such as permeability and durability, which should be explored in future research.

5.3 Scope for Future Study

A Concrete Compressive strength test was performed at 28 days of curing with different types of water (Fresh, River, Sea, and ETP Water) with the strength test. We should need 56 days, and 120 days cured after the test getup high compressive strength also, we should need to test various types of water for curing concrete, to reduce the use of fresh water.

Further research can investigate the effects of different curing conditions and durations on concrete strength under varying water quality conditions.

Long-term studies can be conducted to evaluate the impact of curing water quality on the durability and service life of concrete structures in different environments

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APPENDIX

Concrete Mix Design

Weight Based Concrete Mix Design

- Specific Gravity of cement = 3.15
- Specific Gravity of Fine Aggregate = 2.5
- Specific Gravity of Coarse Aggregate = 2.8
- Water Cement Ratio = 0.50
- Sand Aggregate Ratio=0.44
- Cement Content=350 kg

Mix Design Calculation

Table 12: Mix Design

Material Required for preparing 1 cubic meter of concrete			
Item	Mass (Kg)	Volume (m3)	Volume (cft)
Cement	350	0.24	8.58
Coarse Aggregate	1142.42	0.68	23.87
Fine Aggregate	751.07	0.47	16.68
Water	175	0.18	6.18