A STUDY ON THE FEASIBILITY OF USING INDUSTRIAL WASTE WATER FOR CONCRETE MIXING AND CURING

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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

Department of Civil Engineering

Sonargaon University

147/I, Green Road, Dhaka-1215, Bangladesh

Section: 19A

Semester – Summer

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Dedicated

to

"Our Parents"

ACKNOWLEDGEMENTS

Thanks to Almightily Allah for his unlimited kindness, blessing and giving us the ability strength to complete this project.

We would like to express our deepest and sincere gratitude to our supervisor Mr. Saif Ahmed Santo, Lecturer & Coordinator, Department of Civil Engineering, Sonargaon University, for his expert guidance, constant attention, valuable suggestions, enthusiastic support and personal concern during the project and through the course of our study. We really enjoyed very much working with him. His fruitful ideas throughout the project have helped us accomplished this work successfully.

We are also grateful to all of our teachers of university for this co-operation and dedicated teaching for the achievement of the degree of B.Sc. in civil Engineering. Co-operation and assistance of all the officers and staff of Civil Engineering Department of Sonargaon University, Dhaka, Bangladesh are healthfully acknowledged.

ABSTRACT

Concrete an artificial stone like mass, is the composite material that is created by mixing binding material (cement or lime) along with the aggregate (sand, gravel, stone, brick chips etc.) water admixtures etc. in specific proportion. The strength and quality are depended on the mixing proportion. Water is the most important & least expensive ingredient of concrete. It plays an important role in mixing, laying, and compaction, setting & hardening of concrete. This research investigated the feasibility of using industrial waste water for mixing and curing of concrete by checking the compressive strength of concrete. Samples of water collected from three different sources, Tap water, Industrial Waste Water and Mineral water. 8-inch height and 4-inch diameter of cylinder samples were cast with these water samples. Compressive strength test was carried out on the cylinder and the findings were statically processed. The results indicated that sources of water used in mixing concrete have a significant impact on the compressive strength of the resulting concrete. Also, using Industrial Waste water for concrete casting and curing reduces the strength greatly. For important construction works, using industrial waste water will never be recommended. But for making concrete where strength is not important such as for creating blocks for embankment, waste water can be a good source as this will reduce the amount of waste mixing in the natural water sources and it will reduce water wastage in the concrete industry.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1
INTRODUCTION

1.1 Background and Motivations

Concrete is a construction material composed of cement commonly Portland cement and other cementations materials such as fly ash and slag cement, aggregate (generally a coarse aggregate made of gravels or crushed rocks such as limestone, or granite, plus a fine aggregate such as sand), water, and chemical admixtures. Concrete solidifies and hardens after mixing with water and placement due to a chemical process known as hydration. The water reacts with the cement, which bonds the other components together, eventually creating a stone-like material. Water is an essential component of concrete. A cement paste is created when water and a cementitious substance are combined during the process of hydration. The cement paste fills any gaps in the aggregate, binds it together, and promotes greater flow. A stronger, more resilient concrete will result from using less water in the cement paste, whereas a more fluid concrete with a larger slump will result from using more water. When making concrete, impure water might lead to issues with setting or early building failure. Additionally, it has been discovered (ABRAMS 1924) that impurities in water samples used to mix concrete might reduce the material's strength (Davies, et al. 1975). The process of hydration is likely to be hampered by impurities and harmful elements, which are primarily introduced from water used in mixing concrete. This prevents an efficient binding between the aggregate and matrix. Sometimes the contaminants make the aggregate less durable.

In this experiment three different type of water was taken for mixing and curing of concrete. The three types are Mineral Water, Normal Tap Water and Industrial Waste Water. Mineral water bought from local shop, Normal tap water was collected from domestic water supply of Dhaka WASA, and Industrial waste water collected from a water source near a tannery.

Three criteria should be considered in evaluating the suitability of water used for mixing concrete. One is whether the impurities in the waste water from questionable sources will affect the properties and quality of concrete and the other is the degree of impurity which can be tolerated. Both of these criteria have been studied to some extend in this work.

1.2 Research Objectives and Overview

This study analyzed the quality of water from different process. Then, tests were conducted on mortar and concrete. Particular attention on focused on various portable surface water used for concrete regional parts of including the campus of Sonargaon University, Dhaka-1215.

1. To determine the compressive strength of concrete by using different type of water.
2. To know different types of water effect on concrete compressive strength test.
3. To check if using industrial waste water can be a suitable alternative of traditional water used in concrete industry.

1.3 Outline of the Study

This study has been documented in the following manner.

Chapter 1 (Introduction): This chapter gives primary understanding of the problem statement and objective of the study.

Chapter 2 (Literature Review): This chapter has been devoted to review of the earlier studies to set the guidelines for present work.

Chapter 3 (Methodology): This chapter briefly describes the water collection, concrete mixing, curing and strength testing procedures.

Chapter 4 (Results & Discussions): Analysis and discussion of the obtained results are given in this chapter.

Chapter 5 (Conclusions and Recommendations): The specific conclusions drawn from this study and recommendations for further works are given in this chapter.

CHAPTER 2
Literature Review

2.1 Introduction

In Bangladesh the population is rapidly developing Simultaneously the construction industry is also developing. In construction industry there is no substitute of concrete. It is very important part of structure. concrete need a potable water but now a days specially in summer season the scarcity of water is a major global problem at that time we need to study other types of water that is a waste water and it is collected from the river. after testing waste water in a lab if it is given similar result than the potable water then we need to use this waste water for construction purpose (Mr. Asif Rashid Shaikh (Jul. - Aug. 2016))

Freshwater is the highest consumed natural entity of the plant earth. It is a renewable resource abundantly available in nature, however its quantity amenable to human extraction is limited. Water shortage is one of the most significant problems in human societies in recent decades. The most important reasons for water crisis are increasing population, improvement of lifestyle, climate change and lack of appropriate water resource manage. Use of waste water is found to be a natural alternative which can be used for concreting purposes.

Concrete production is consuming an enormous quantity of water for making fresh concrete. Around one billion tons of freshwater is used for washing aggregates, fresh concrete production, and concrete curing. The scarcity of water imposes difficulties to deliver fresh water to the peoples due to the speedy development of industries like concrete production, stone cutting, tannery industries, which consume large amounts of freshwater and generating different wastewater in huge amounts. This paper reviews the physical and chemical effects of wastewater, rheological properties, hardened properties, and durability of concrete. Potential decomposing agents were identified and common special effects on concrete properties were investigated in wastewater generated. Limited research is available for making concrete with wastewater. Therefore, there is a crucial need to develop different procedures and methods to have utilization of wastewater in concrete production. The use of wash water resulted in reduced workability of fresh concrete but increased their compressive strength. Use of reclaimed water, PVAW, tertiary treated wastewater and wash water in mixing were found to be superior but use of industrial water and secondary treated wastewater have a negligible effect on the strength properties. (Khan, March 2021)

Municipal wastewater, primary treatment, plain cement concrete, compressive strength, wastewater reuse, slump test ABSTRACT Reuse of Municipal wastewater is seems to be restricted for irrigation purposes only, whereas, the same can be used in plain cement concrete construction works without compromising the compressive strength. The only negative ingredient in municipal wastewater is the presence of sulphates. Four categories of water samples (Tap water, Primary Treated wastewater, 50%Tap water + 50% municipal wastewater and municipal wastewater) were used in the plain cement concrete cylinders which were tested for compressive strength, having 7-, 21- and 28-days curing age. It was found that municipal wastewater after primary treatment, if used in the mixing process of plain cement, will give 209 Kg / cm2 which is the required compressive strength of plain cement concrete. Therefore, Reuse of municipal wastewater in the construction works can save fresh water which is becoming scare day by day. (sham ul-Haque June 2005)

For any type of building activity, compressive strength is crucial. In construction projects, many types of water are used for compressive strength. A material or structural element's capacity to endure loads that, when applied, cause them to shrink in size is referred to as their compressive strength. A test sample is subjected to a force at its top and bottom until it breaks or deforms. Even if there are many different types of water at work, many of us are unable to decide which water is the best. Another one of them is compressive strength (DC Teychenné, 1975). In order to determine which form of water consumption in structures will be long-lasting, trials were crucial. The concrete cylinder test's compressive strength gives an understanding of all the properties of concrete. One can determine whether concrete pouring was done correctly or not by using this one test. One of the most crucial characteristics of concrete and mortar is its compressive strength. Therefore, the water strength significantly influences the mixture's performance characteristics and ensures the overall quality of the final product.

2.2 Concrete

Concrete is a composite material composed of aggregate bonded together with a fluid cement that cures over time. Concrete is the second-most-used substance in the world after water, and is the most widely used building material. Concrete, an artificial stone-like mass, is the composite material that is created by mixing binding material (cement or lime) along with the aggregate (gravel, stone, brick chips, etc.), water, admixtures, etc. in specific proportions. The strength and quality are dependent on the mixing proportions. The formula for producing concrete from its ingredients can be presented in the following equation:

Concrete = Binding Material + Fine & Coarse Aggregate + Water + Admixture (optional)

Concrete is a very necessary and useful material for construction work. Once all the ingredients cement, aggregate, and water unit of measurement mixed inside the required proportions, the cement and water begin a reaction with one another to bind themselves into a hardened mass. This hardens the rock-like mass in the concrete.

2.3 Concrete Strength

We know the properties of cement and concrete are considered with respect to the water cement ratio and how water affects the strength of concrete. Finally, we examine the Euro code and British standards in respect to the compressive strengths of concrete and different design mixes in the specification of concrete. (Sumit February 2016). These properties are varied significantly with temperature and also depend on the composition and characteristics of concrete batch mix as well as heating rate and other environmental conditions. Concrete is a general term of materials based on the mixing of aggregates and binders, which results in a rock-like substance with different compositions of cement, water, fine aggregations and coarse aggregates. (Gagg May 2014 Engineering Failure Analysis 40).

2.4 Aggregate (Coarse Aggregate & Fine Aggregate)

The uniformity and size of the particles used to classify aggregates. They can be separated into crushed aggregates and natural stone aggregates (sand and gravel stone chippings and crushed stones). The most common form of aggregate is a homogeneous bulk product. Standardized product attributes ensure the required levels of process capability and dependability. When the granular material's particles are small enough to pass through a 4.75 mm sieve, it is referred to as fine aggregate. For many different uses, aggregates are employed in a wide range of industries. They are a key ingredient in the creation of concrete and asphalt, but they can also be used as a filler, filter, or fundamental building block for roads and railroads. Our product line varies from nation to nation. A material or structure's capacity to defeat (resist) loads that result in. (L Evangelista, 2007).

Figure 2-1. Coarse Aggregates

Figure 2-2. Fine Aggregates

2.5 Effect of water on concrete strength

Water is a very important ingredient of concrete. Combining water with a cementitious material forms a cement paste by the process of hydration. Less water in the cement paste will yield a stronger, more durable concrete and more water will provide a free-flowing concrete with a higher slump (Olugbenga 2014).

It is very important and everybody known that the strength of concrete depends on the water and cement ratio. That is a similar concept to dilution in a solution. When that happens, the bonds forming from the crystallization of the cement matrix will be made more tenuous. The strength of the aggregate in the mix has little to do with the strength of the concrete if it is good aggregate. We can get a bucket of concrete, and sieve the coarse aggregate out of half of it and then make cylinders out of both halves, and the strength will be equivalent. Of course, for a given concrete, half of the mix water will go to hydrate the cement. The other half either evaporates, or provides the equilibrium moisture content within the concrete. If inadequate water is added, it will be difficult to compact the concrete, and that, of itself will provide in poor strength performance. So, the amount of water is an important factor considering the strength of concrete (Wilmshurst 2018).

2.6 The effect of industrial wastewater on concrete strength

The scarcity of water is a critical environmental issue worldwide due to various natural and/or artificial causes. The construction industry has serious impact on environment with regard to consumption of water. Hence, there is need to search alternative to fresh water for mixing and curing of concrete. The aim of this paper is to check suitability of reusing waste water effluent from industry in plain concrete production. The experimental work is carried out to evaluate the effect of replacement of mixing water by industrial waste water on compressive strength of concrete for M20 grade of concrete.

Concrete, as one of the essential construction materials, is responsible for a vast number of emissions. Using recycled materials and gray water can considerably contribute to the sustainability aspect of concrete production. Thus, finding a proper replacement for fresh water in the production of concrete is significant. The usage of industrial wastewater instead of water in concrete is considered in this paper. In this study, 450 concrete samples are produced with different amounts of wastewater. The mechanical parameters, such as slump, compressive strength, water absorption, tensile strength, electrical resistivity, rapid freezing, half-cell potential and appearance, are investigated, and a specific concentration and impurities of wastewater that cause a 10% compressive strength reduction were found. The results showed that the usage of industrial wastewater does not significantly change the main characteristics of concrete. Although increasing the concentration of wastewater can decrease the durability and strength features of concrete nonlinearly, the negative effects on durability tests are more conspicuous, as utilizing concentrated wastewaters disrupt the formation of appropriate air voids, pore connectivity and pore-size distribution in the concrete. (Ehshan Nasser Al Shariati 2021 Aug)

The use of waste water sludge in concrete mix resulted in no significant strength loss but the density of sludge concrete was found decreased when used treated water instead of tap water. It was observed that the sources of water used in mixing concrete have a significant impact on the compressive strength of the resulting concrete and regardless of the mixing water sources; the compressive strength of concrete increases with increase in curing age. (A.S.Parlikar August 2021)

2.6.1 Type of effect of Industrial waste water on concrete strength

The effect of industrial wastewater on concrete strength can vary depending on several factors, including the composition and characteristics of the wastewater, the concrete mix design, and the exposure conditions. Here are some potential effects:

i) Chemical Attack: Industrial wastewater may contain chemicals such as acids, alkalis, and sulfates that can react with the cementitious materials in concrete. These reactions can lead to the degradation of the cement paste, resulting in a loss of strength over time.

ii) Reduced Cement Hydration: Certain components present in industrial wastewater can interfere with the hydration process of cement, hindering the formation of calcium silicate hydrates (the primary strength-contributing phase in concrete). This can lead to lower early-age strength development and overall reduced strength.

iii) Aggregate Contamination: Industrial wastewater may contain contaminants that can affect the properties of aggregates used in concrete production. Contaminated aggregates can result in poor bonding with the cement paste, leading to reduced strength and durability.

iv) Increased Porosity: Some industrial wastewaters contain substances that can increase the porosity of the concrete matrix. Higher porosity can lead to a decrease in concrete strength as it reduces the interfacial bonding between the cement paste and aggregates.

V) Corrosion of Reinforcement: Industrial wastewater with high chloride or sulfate content can accelerate the corrosion of reinforcing steel embedded in concrete. Corrosion leads to the formation of rust, which occupies a larger volume than steel and causes internal pressure, resulting in cracking, spalling, and reduced concrete strength.

2.7 Summary

This chapter includes the overall motivation and current available literature regarding this study.

CHAPTER 3
Methodology

3.1 Introduction

The term "sieve analysis" is the sample operation of dividing a sample of aggregates into fractions each consisting of particles between specific limits. The analysis is conducted to determine the grading of material proposed for use as aggregates. The term Fineness Modulus (F.M) is a ready index of coarseness or fineness of material. It is an empirical factor obtained by adding the cumulative percentages of aggregates retained on each of the standard sieves and dividing this sum arbitrarily by 100. No. 100, No. 50, No. 30, No. 16, No. 8, No. 4, and 3/8 in. are the ASTM standard sieves. This test method conforms to the ASTM standard requirements of specification C136.

3.2 Procedure of Sieve analysis of Coarse Aggregate and Fine Aggregate

1. Dry the sample to constant weight at a temperature of 110 ± 50C.
2. Nest the sieve in order of decreasing size of opening from top to bottom and place the sample on the top sieve.
3. Agitate the sieves by hand or by mechanical apparatus for a sufficient period, say 1.5 minutes.
4. Limit the quantity of material on a given sieve so that all particles have the opportunity to reach sieve openings a number of times during the sieving operation. For sieves with openings smaller than 4.75mm (No. 4), the weight retained on any sieve at the completion of the sieving operation shall not exceed 6 kg/m2 (4 lb./in2) of sieving surface. For sieves with openings 4.75mm (No. 4) and larger, the weight in kg/m of sieving surface shall not exceed the product of 2.5 *(sieve opening in mm). In no case shall the weight be so great as to cause permanent deformation of the sieve cloth.
5. Continue sieving for a sufficient period and in such manner that after completion, not more than 1% weight of the residue on any individual sieve will pass that sieve during 1 minute of continuous hand sieving.

6. Determine the weight of each size increment by weighing on a scale or balance to the nearest 0.1gm of the total original dry sample weight. The total weight of the material after sieving should check closely with original weight of sample placed on the sieves.

Figure 3-1. Sieve Analysis (Fine Aggregates).

Figure 3-2. Sieve Analysis (Coarse Aggregates).

3.3 Preparation of Concrete Cylinders

The cylinder specimens are cast in steel, cast iron or any mold made of nonabsorbent material. Cylindrical specimens for testing should be (4 x 8) inch (100 x 200) mm. The mold must hold the concrete without any leakage. Before placing the concrete mix within the mold, the interior of the mold must be properly greased to facilitate easy removal of the hardened cylinder. The mixed concrete is placed into the molds in layers not less than 5 cm deep. The strokes per layer during the compaction must not be less than 30 in number. Compaction must reach the underlying layers allowing the majority of the air voids to escape. The specimens are stored undisturbed in a place with at least 90% relative humidity at a temperature of 27° ± 2°C for 24 hours. After this period, the samples are taken and submerged in clean and fresh water until the testing age is reached.

Figure 3-1. Preparing Cylinder Formwork.

3.4 Collecting water

Water was collected from three distinct sources. The mineral water was collected from market as bottled water. The tap water was taken from Wasa Supply source and the Industrial Waste Water was collected from a water source near a tannery.

Figure 3-2. Water Collection

3.5 Concrete Mixing

Concrete of mixing is a process of mixing the ingredient of concrete such as cement, sand, aggregate, water and admixture together to make concrete of suitable grade. To make the different grades of concrete mixing of concrete materials should be done properly as per the mix design of concrete to achieve the design strength of concrete. A concrete mixture ratio of 1 part cement, 2 parts sands and 4 parts aggregate will produce a concrete mix of approximately 3000 psi. Mixing water with the cement, sand and stone will form a paste that will bind the materials together until the mix hardness. Mixing of concrete is a very complex process. For making good quality concrete, we just have to follow some standard process of mixing its ingredients. It just does not up to making concrete, but making good quality concrete is important. Production of good quality and bad quality of concrete includes the same material, but the proportion and mixing method can be a differentiating factor. It requires proper care and knowledge for making good quality concrete.

Figure 3-3. Concrete Mixing.

3.6 Casting of Cylinder

The casting process of cylinders consists of mixing of materials, pouring concrete in layers and tamping of each layer carefully. For the casting process in this study, the cement, sand, fine and coarse aggregates were mixed carefully and water was mixed. After that, immediately the concrete was poured into the mold. The concrete was poured in three layers. Each layer was tamped 25 times.

Figure 3-4. Casting of Cylinder.

3.7 Curing

Curing is a process during which a chemical reaction (such as polymerization) or physical action (such as evaporation) takes place, resulting in a harder, tougher or more stable linkage (such as an adhesive bond) or substance (such as concrete). Some curing processes require maintenance of a certain temperature and/or humidity level, others require a certain pressure. Initial curing during the first 24 to 48 hours after molding, all test specimens shall be stored under conditions representative of the concrete in the structure or pavement. Following the period of initial cure, the specimens may be transported to the laboratory subsequent curing and testing.

Figure 3-5. Curing of Cylinder.

3.8 Preparation of Cylinder to Crush

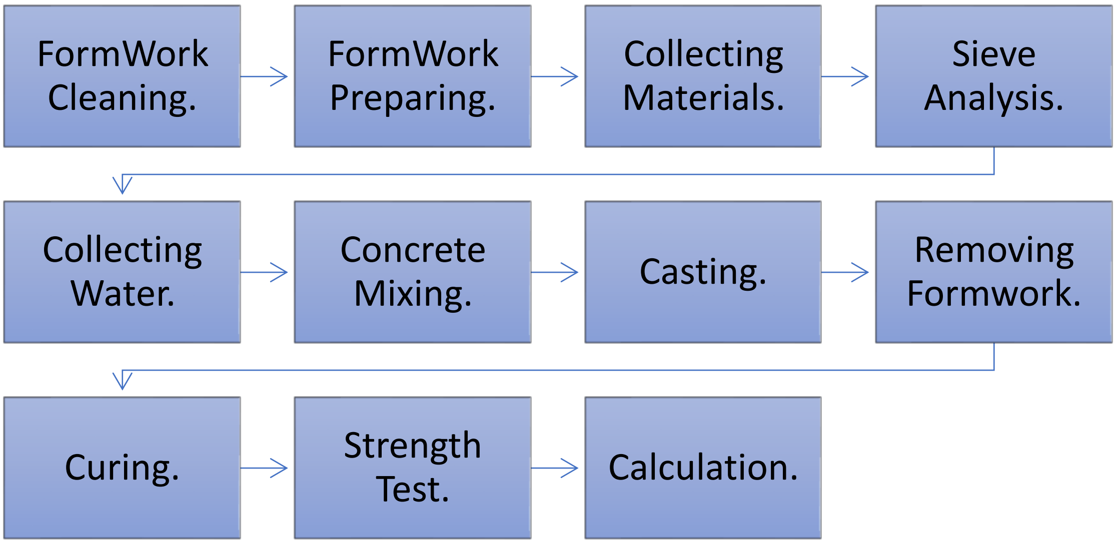
The cylinders were cured for 7 days, 14 days and 28 days. After each time limit, 3 different cylinders cured in 3 different water type was taken out and placed in the Universal Testing Machine (UTM) at the concrete lab of Sonargaon University (SU) for testing their compressive strength.

Figure 3-6. Preparation of Cylinder to Crush.

3.9 Compressive Strength Formula

Compressive strength is the maximum compressive stress that, under a gradually applied load, a given solid material can sustain without fracture. Compressive strength is calculated by dividing the maximum load by the original cross-sectional area of a specimen in a compressive test. The compressive strength is one of the most important and useful properties of concrete. The design strength of the concrete normally represents its 28th day. Compressive strength can be defined as the capacity of concrete to withstand loads before failure. Of the many tests applied to the concrete, the compressive strength test is the most important, as it gives an idea about the characteristics of the concrete. The compressive strength was calculated by using the equation: F = P/A Where, F is compressive strength of specimen in Pound per square inch (Psi). P is the maximum applied load by Pound. A is the cross-sectional area (inch square). Compressive strength test, mechanical test measuring the maximum amount of compressive load a material can bear before fracturing. The test piece, usually in the form of a cube, prism, or cylinder, is compressed between the platens of a compressive-testing machine by a gradually applied load.

3.10 Working Process



CHAPTER 4

Results and Discussion

4.1 Result of Fine Aggregate

The test sample of the aggregate (F.M) shall weigh, after drying, approximately the following requirement: Aggregate with at least 85% passing No. 4 Sieve 500gm and more than 5% retained on a No. 8 Sieve. Aggregates with at least 95% passing No. 8 Sieve 100gm.

Table 4-1. Sieve Analysis of Fine Aggregate.

Sieve no.	Retain (gm)	%Retain	%Cumulative Retain	%Finer	FM
#4	0	0	0	100	2.98
#8	24	4.8	4.8	95.2	
#16	143	28.6	33.4	66.6	
#30	174	34.8	68.2	31.8	
#50	125	25	93.2	6.8	
#100	26	5.2	98.4	1.6	
PAN	8	1.6	100	0	

4.2 Result of Coarse Aggregate

The weight of the test sample of coarse aggregate (C.A) shall conform to the following requirements: Aggregates with nominal maximum size of ¾ in.

Table 4-2. Sieve Analysis of Coarse Aggregate.

Sieve no.	Retain (gm)	%Retain	%Cumulative Retain	%Finer	FM
#3/4	196	19.6	19.6	80.4	7.194
#3/8	802	80.2	99.8	0.2	
#4	2	0.2	100	0	
Pan	0	0	100	0	

4.3 Calculation

1. Calculate percentages passing, total percentage retained, or percentages in various size fractions to the nearest 0.1gm on the basis of the total weight of the initial dry sample.

2. Calculate fineness modulus, when require, by adding the total percentage of material in the sample that is coarser than each of the flowing sieves (Cumulative percentage retained), and dividing the sum by 100.

4.4 Compressive Strength of Cylinders

Table 4-3. 7-day strength of cylinders

Water Type	Height of Cylinder	Diameter of the Cylinder	Compressive Strength (Psi)
Mineral Water	203	102.17	1557
Tap Water	205.5	101.9	1352
Waste Water	198	102	994

Table 4-4. 14-day strength of Cylinders

Water Type	Height of Cylinder	Diameter of the Cylinder	Compressive Strength (Psi)
Mineral Water	205.5	101.92	1653
Tap Water	203	102.19	1485
Waste Water	198.1	102.2	1361

Table 4-5. 28-day strength of Cylinders

Water Type	Height of Cylinder	Diameter of the Cylinder	Compressive Strength (Psi)
Mineral Water	205	100.51	2559
Normal Water	203.5	102.43	1971
Dirty Water	205.5	102.26	1554

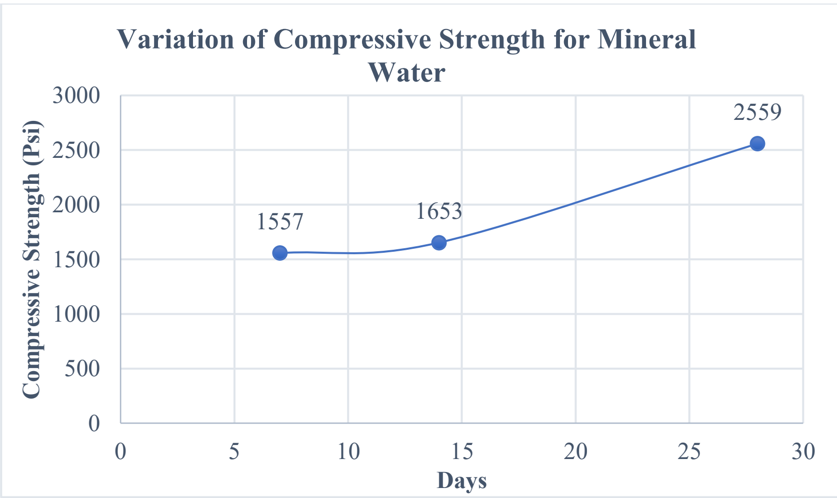


Figure 4-1. Variation of Compressive strength for mineral water

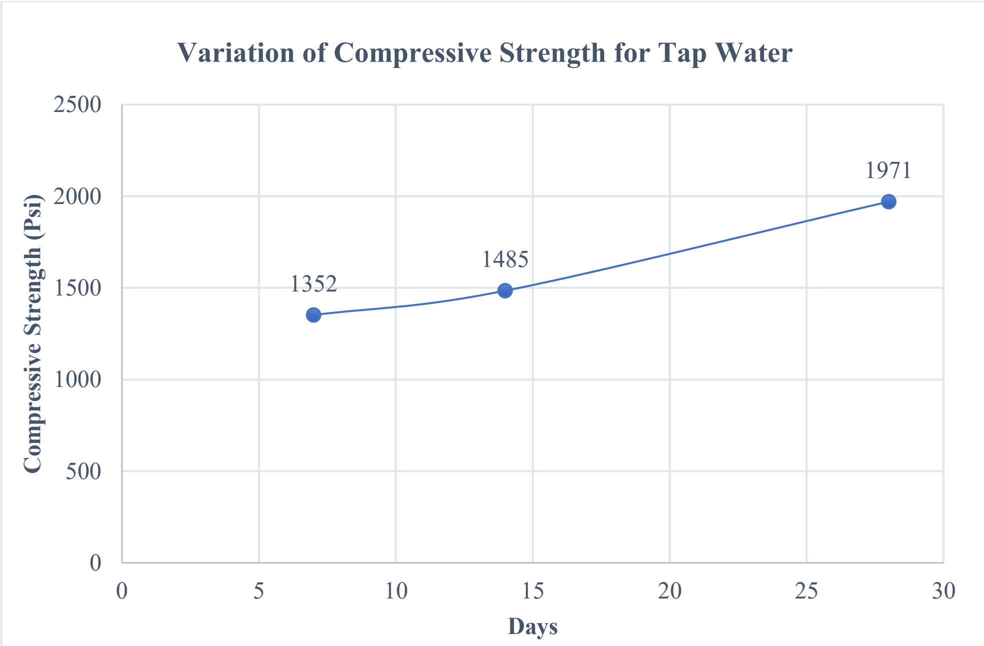


Figure 4-2. Variation of Compressive strength for Tap water

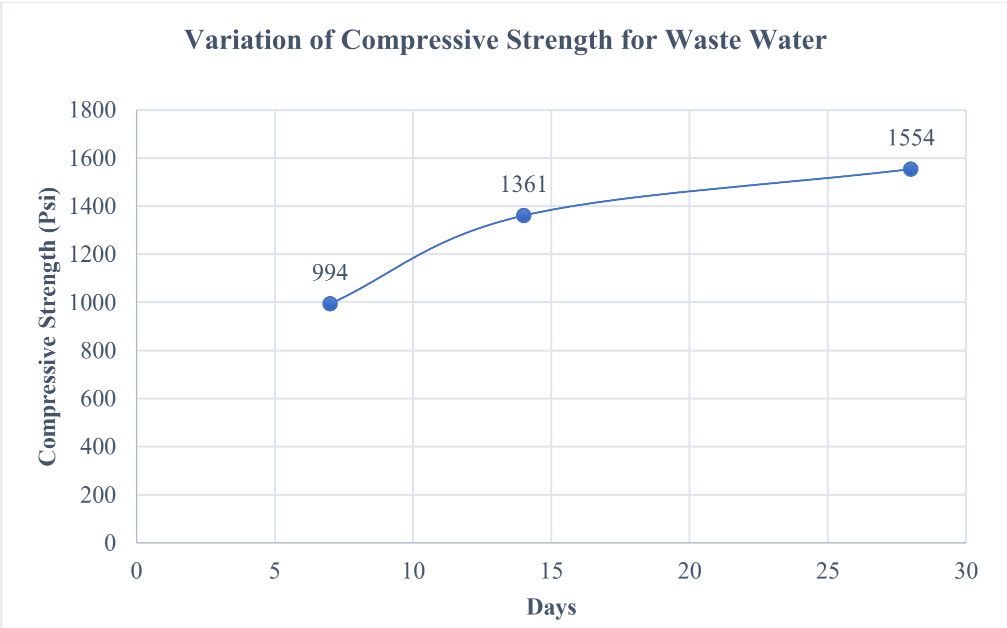


Figure 4-3. Variation of Compressive strength for waste water

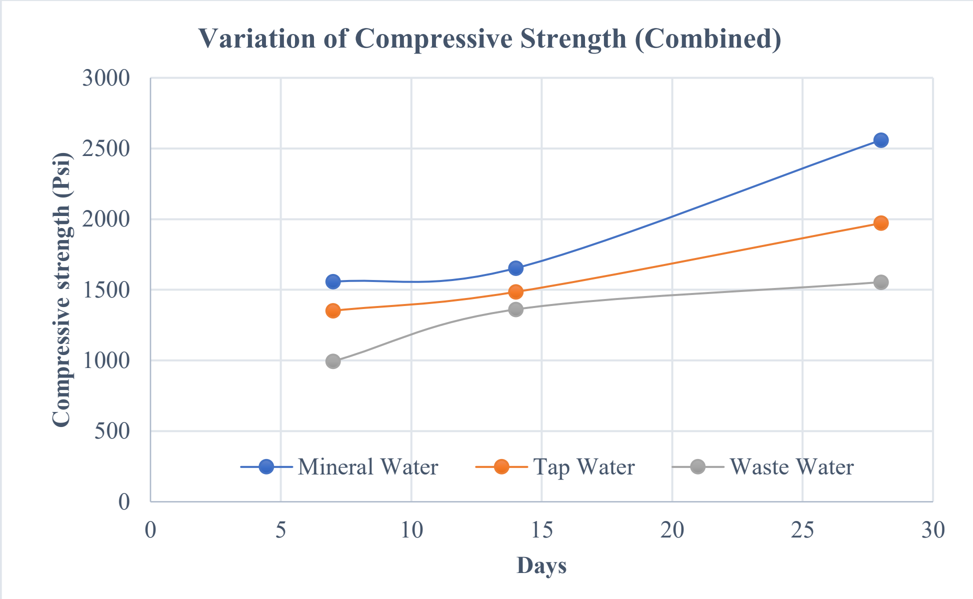


Figure 4-4. Combined graph of strength variation

When comparing mineral water to waste water, we find that mineral water has the maximum compressive strength. In 28 days, the concrete casted with waste water only reached 60% of the strength achieved by concrete casted with Mineral water. Again, the waste water casted concrete reached 78% of the strength achieved by the Wasa tap water concrete. As in day-to-day scenario, Wasa tap water is typically used in the construction industry, it can be said that concrete casted with waste water can reach a significant amount of the strength that is achieved in the day-to-day construction field. Although the strength is quite lower with respect to mineral water and if the actual strength of M20 concrete is considered, the waste water casted concrete is quite low.

CHAPTER 5

Conclusions and Future Works

5.1 Conclusions

After the experiment we get the below decision:

In 7 days:

Mineral water = 1557 psi

Normal water = 1352 psi

Waste water = 994 psi

In 14 days:

Mineral water = 1653 psi

Normal water = 1485 psi

Waste water = 1361 psi

In 28 days:

Mineral water = 2559 psi

Normal water = 1971 psi

Waste water = 1554 psi

From the obtained study result, it can be seen that using Industrial Waste Water maybe an alternative to the concrete industries where strength is not the prime concern such as Concrete block industry for embankment protection.

5.2 Limitations and Recommendations for Future Works

The following are some recommendations provided considering the previous discussion:

1. The other grades like M10, M15, M25, M30, M35, M40, M50, M60 may be used in future works.
2. BOD, COD, DO and other water quality parameters should be checked.
3. Use of either sea-water or salt water can be done.

REFERENCES

A.S.Parlikar, C.V.Naik, C.B.Nayak. August 2021. "An Experimental Study on Effect of Industrial Waste Water on Compressive Strength of Concrete." *International Journal of Innovative Research in Science, Engineering and Technology (IJIRSET)* Volume 10, Issue 8.

ABRAMS. 1924. *Design of Concrete Mixtures.* Kimberley Holland.

Davies, P.H, J.P. Goett Jr, J.R Sinley, and N.F. Smith. 1975. *Acute and chronic toxicity of lead to rainbow trout salmo gairdneri, in hard and soft water.* 2003.

Ehshan Nasser Al Shariati, Amir Mosavi. 2021 Aug. "The Effect of Incorporating Industrials Wastewater on Durability and Long-Term Strength of Concrete." *Materials (Basel)* 14(15): 4088.

Gagg, C. R. May 2014 Engineering Failure Analysis 40. "Cement and Concrete as an engineering material: an historic appraisal and case study analysis." *Article.*

HDonza, OCabreraE. FIrassar. 2002. *High-strength concrete with different fine aggregate.* Science Direct.

Mr. Asif Rashid Shaikh, Dr. V. M. Inamdar. (Jul. - Aug. 2016),. "Study of Utilization of Waste Water in Concrete." *IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)* Volume 13, Issue 4 Ver. II.

Olugbenga, ATA. 2014. *Effects of Different Sources of Water on Concrete Strength: A Case Study of Ile-Ife* . Nigeria: Department of Building, Obafemi Awolowo University, Ile-Ife, Nigeria.

Sumit, Paul. February 2016. *In book: Structural Design of Buildings (pp.105-112).* February 2016.

Wilmshurst, David. 2018. *quora.* Accessed 2018. https://www.quora.com/.