COMPARATIVE ANALYSIS OF COMPRESSIVE STRENGTH OF CONCRETE WITH DIFFERENT CHEMICAL AS ADMIXTURES

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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: 23D

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DECLARATION

It is hereby declared that, except for the contents where specific references are made, the work embodied in this thesis is the result of an investigation carried out by the authors under the supervision of **Kushal Acharja Topu**, Lecturer, Department of Civil Engineering of Sonargaon University.

Neither this thesis nor any part of it is concurrently submitted to any other institution in` candidature for

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Dedicated

to

"OUR PARENTS, FAMILY AND TEACHERS"

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ABSTRACT

This study was carried out to evaluate the effect of chemical admixtures on the compressive strength of concretes. The concretes were produced with the concrete
mix ratio of 1:1.5:3, while water to cement (w/c) ratios of 0.46 were adopted. Different concrete mixtures were produced using two chemical admixtures (Dr. fixit and Super Strength) applied at the rate of 1%, 2%, 3%, 4% , 5% 6% , and 9% (weight of the cement), during the production process. Laboratory results of the fine aggregate used for the concrete production showed that it was well graded met international standards. All the concretes were produced and tested in accordance to American Society for Testing and Materials (ASTM) standard procedures. Results indicated that the concrete produced with the chemical admixtures showed better concrete performances both in the fresh and hardened state. After 28 days of casting, concrete produced with Dr. fixit admixture had the best compressive strength (24 MPa); compared with the compressive strength of the concrete produced with the Super strength admixture (26 MPa), and the control concrete samples that had compressive strength of 26 MPa. In addition, the fresh concrete produced with chemical admixtures gave a better slump than the fresh concrete produced without any chemical admixture. Likewise, Super strength admixture performs better among the two admixtures used, given a more linear relationship between the slump and water/cement ratio. These results showed the importance of chemical admixtures when higher compressive strength becomes a vital factor in structural construction.

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CHAPTER 1
INTRODUCTION

1.1 General

Concrete is one of the most widely used construction materials, known for its strength, durability, and versatility. The compressive strength of concrete is a critical property that determines its ability to withstand axial loads without failure. It is a key factor in ensuring the safety and stability of structures such as buildings, bridges, and highways.

Compressive Strength of Concrete

Compressive strength refers to the capacity of a material or structure to resist axial load or compression. In concrete, this strength is typically measured in Mega Pascal (MPa) or pounds per square inch (psi). The compressive strength of concrete depends on several factors, including the water-to-cement ratio, curing conditions, the type and proportion of aggregates, and the mix design.

Role of Chemical Admixtures

Chemical admixtures are substances added to concrete in small quantities during mixing to modify its properties. These admixtures play a significant role in enhancing various aspects of concrete performance, such as workability, setting time, durability, and most importantly, its strength. By improving the quality of the mix, chemical admixtures can improve the compressive strength of concrete.

Impact of Chemical Admixtures on Compressive Strength

When used in appropriate quantities, chemical admixtures can significantly improve the compressive strength of concrete. The combination of admixtures with the right proportions of cement, water, and aggregates can result in a concrete mix that is not only stronger but also

more durable, with reduced permeability and better resistance to environmental factors.

In summary, chemical admixtures provide a means to enhance the compressive strength of concrete by optimizing hydration, improving workability, controlling setting times, and enhancing durability. Their use allows for more efficient, cost-effective, and sustainable construction practices, making them indispensable in modern concrete technology.

1.2 Objective

The objectives of the thesis are as follows

To review literature on the effects of different chemical and other non-chemical compounds on concrete performance.

To assess the compressive strength of concrete with various mixing ratios using different chemical compounds.

To evaluate and compare the strength of normal concrete with concrete enhanced with chemical additives.

1.3 Scope of Studies

Typically, a thesis contains the following chapters: an introduction; a literature review; a description of methodology; a report and discussion of results; and conclusion.

Chapter 1: Introduction

This chapter provides the background and motivations of the research. The overall objectives and expected outcomes are also described in this chapter.

Chapter 2: Literature Review

This chapter reviews the related works in the concrete strength test field with a special focus on chemicals.

Chapter 3: Methodology

This chapter describes the methodology adopted to carry out the research.

Chapter 4: Results

This chapter describes the collected date and time of different materials for our research work.

Chapter 5: Conclusion

This chapter summarizes the conclusions

Chapter 6: Limitations and Recommendations

This chapter contributions of this study limitation and provides recommendations for future studies.

CHAPTER 2
LITERATURE REVIEW

2.1 General

The compressive strength of concrete is one of the most important properties that determine its structural performance. Various factors influence the compressive strength of concrete, including its mix design, water-cement ratio, curing conditions, and the use of admixtures. Chemical admixtures are added to concrete to enhance specific properties, such as workability, setting time, durability, and ultimately, strength. This literature review focuses on the impact of different chemical admixtures on the compressive strength of concrete, analyzing recent research findings.

2.2 Types of Chemical Admixtures

Chemical admixtures are typically categorized into several groups based on their purpose and effect on the concrete mix.

Water-Reducing Admixtures (Plasticizers)

These admixtures reduce the water content in a concrete mix without altering its workability. By reducing the water-cement ratio, they help to improve the compressive strength. They are especially useful in high-strength concrete and in mixtures where a low water-cement ratio is required. [2]

Superplasticizers (High-Range Water Reducers)

These are more potent than standard plasticizers and can significantly reduce the water content while maintaining or increasing workability. Superplasticizers have been shown to improve the compressive strength of concrete by enhancing the density and reducing the porosity of the hardened material. [1]

Retarding Admixtures

These slow down the setting time of concrete, allowing more time for mixing, transporting, and placing. While they may initially reduce the early-age compressive strength, their influence on long-term strength can be beneficial by allowing the hydration process to occur more uniformly. [5]

Accelerating Admixtures

These admixtures are used to speed up the setting and hardening process. They are often used in cold weather to ensure that concrete sets and gains strength rapidly. However, their impact on the long-term compressive strength can be variable, and excessive use may reduce durability. [3]

Air-Entraining Admixtures

These admixtures introduce tiny air bubbles into the concrete, which helps improve the freeze-thaw resistance. While air entrainment may decrease compressive strength slightly, it enhances durability in certain environments, making it valuable for exposure to harsh weather conditions.

Shrinkage-Reducing Admixtures

These reduce the shrinkage of concrete during curing, helping to minimize cracking. While these admixtures primarily affect the dimensional stability and durability of concrete, their impact on compressive strength is usually indirect. [7]

2.3 Factors Influencing the Effectiveness of Admixtures

The impact of chemical admixtures on the compressive strength of concrete depends on several factors.

Mix Design

The proportions of cement, water, aggregates, and admixtures significantly affect how each admixture influences the final compressive strength.

Curing Conditions

Proper curing is critical for the hydration of cement. The presence of admixtures can either enhance or inhibit the curing process, thus affecting the final strength.

Type and Quantity of Admixture

The type of admixture (e.g., superplasticizer vs. accelerator) and the dosage used will determine its effects on strength. Excessive or improper dosages may have a detrimental effect on the concrete's properties.

Environmental Conditions

Exposure to extreme temperatures, humidity, and other environmental factors can alter the effectiveness of admixtures and, consequently, the compressive strength of concrete. [12]

2.4 Conclusions

Chemical admixtures play a vital role in enhancing the compressive strength of concrete, although their effects can vary depending on the type of admixture and the conditions under which they are used. Water-reducing and super plasticizing admixtures generally provide the most significant improvements by reducing the water-cement ratio, thereby increasing density and reducing porosity. However, other types of admixtures, such as retarders and accelerators, have more nuanced effects on the compressive strength, with their influence varying based on curing conditions and the specific mix design.

Future research should focus on the long-term effects of admixtures on compressive strength and durability, as well as on developing more sustainable admixtures that can reduce environmental impact without compromising performance. Additionally, the interaction between various admixtures, particularly in high-performance concrete, warrants further investigation to optimize their combined effects on the properties of concrete.

CHAPTER 3

METHODOLOGY

3.1 General

Concrete methodology refers to the systematic and scientific approach to producing concrete that involves the selection and characterization of materials, mix design, mixing, transportation, placement, curing, testing, and quality control. The methodology is designed to produce high-quality concrete with the desired properties for various construction applications, including strength, durability, workability, and consistency. By following a well-defined methodology, concrete producers can ensure that the concrete they produce meets the required specifications and standards and is suitable for its intended use.

3.2. Material Characterization:

Aggregates, cement, and water, should be characterized for their chemical and physical properties, including particle size distribution, specific gravity, and chemical composition.

3.2.1 Stone Chips

We use them hard enough to resist wear and tear and maintain their shape and size over time.10 and 20 mm size stone chips were used for concrete and we wash them very well.



Figure 3-1. Stone Chips

Table 3-1. Physical properties of coarse aggregate

Bulk specific gravity (SSD)	2.6
Absorption capacity (%)	2.3
Dry robbed unit weight (kg/m^3)	1528.52
Fineness modulus (FM)	2.28
Void (%)	40.75
Aberration capacity (%)	2.23

3.2.2 Cement

We use the PCC (Portland Composite Cement) Cement. Our cement was mixing clinker 80%-94%, B.F. Slag fly Ash, Limestone 6% - 20% and gypsum 0%-5%.



Figure 3-2. Cement

3.2.3 Sand

We collect the sand with a fineness modulus of 2.0 to 2.5 is commonly used for concrete production. Then we sieve the sand.



Figure 3-3. Sand

Table 3-2. Physical properties of fine aggregate

Bulk specific gravity (SSD)	2.5
Absorption capacity (%)	2.91
Fineness modulus (FM)	2.76

3.2.4 Chemical

Dr. Fixit

Method of Application:

Charge cement & aggregates to concrete mixer as per the mix design mix in dry state for 1-2 minutes. Stat addition of 75-80% mixing water & mix for 2-3 minutes. Add Dr. Fixit WP Admix 1litre per 100 kg cement into the remaining mixing gauging water, then add to concrete mixer & mix for another 2 minutes. Place the concrete or apply plaster, as needed. Cure the applied mortar or concrete as per good construction practices.

Super Strength

Super Strength ready-to-use liquid accelerating concrete admixture is a convenient solution for speeding up the curing and setting process of concrete. With its easy application, it enhances construction efficiency and productivity.

Application Area

Foundation base, grate beam, slab beams, columns, slab, underground water tanks, precast blocks, tiles installation, precast pile, mortar for brickworks & floor tiles, plastering, concrete pavement, swimming pool, staircase, industrial floor, balcony, culvert, bathroom, etc.

Mixing rules

Use 200 ml super strength for each 50 kg/ 1 bag of cement. The dosage of application could be little or more as per requirement.



Figure 3-4. Dr. Fixit & Super Strength Chemical

3.3 Mix Proportion and Preparation

The mix proportion refers to the ratio of the components in the concrete. It can be designed either by weight or volume, with the most common method being weight-based. The main aim is to achieve the desired strength, workability, and durability for a specific application.

The proportion of materials typically consists of:

Cement (Binding material)

Fine aggregate (Sand)

Coarse aggregate (Gravel or crushed stone)

Water (For hydration)

Admixtures (To modify specific properties)

Concrete mix ratio like 1:1.5:3 (cement: sand: coarse aggregate) for M20 grade concrete, but the specific proportions vary depending on the requirements.

Table 3-3. Quantity of Concrete Cylinder Crushing

Cylinder Size :- 4"x 8" Volume:-0.0582 Cft Mix Ratio :-1:1.5:3 Water Ratio :-0.46					
SL No.	Percentage of Admixture	Without Admixture Cylinder Nos	Dr.Fixit Cylinder Nos	Super Strength Cylinder Nos	Total Cylinder Nos
1	N\A	6	0	0	90
2	1%	0	6	6	
3	2%	0	6	6	
4	3%	0	6	6	
5	4%	0	6	6	
6	5%	0	6	6	
7	6%	0	6	6	
8	9%	0	6	6	
Total Quantity		6	42	42	

3.3.1 Data Collection

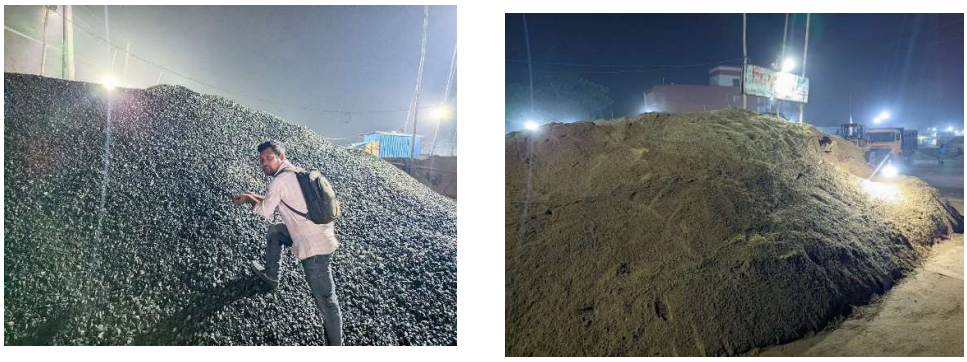


Figure 3-5. Sample collection



Figure 3-6. Sieve Analysis





Figure3-7. Two Item Admixture



Figure 3-8. weighting



Figure 3-9. Cylinder preparation





Figure 3-10. Concrete cylinder casting





Figure 3-11. Concrete cylinder curing







Figure 3-12. Concrete cylinder crushing

3.3.2 Testing of mechanical properties

The mechanical properties of the concrete are evaluated, including its compressive strength, tensile strength, and flexural strength. The tests are conducted according to relevant standards, such as ASTM or ISO

CHAPER 4

RESULTS

4.1 Sieve Analysis of Fine and Coarse Aggregate:

Table 4-1: Sieve analysis for fine aggregate

Sieve Number	Sieve Opening (mm)	Materials Retained (gm)	% Materials Retained	Cumulative % retained	Fineness Modulus
#4	4.75	0	0	0	2.76
#8	2.36	34	3.4	3.4	
#16	1.19	218	21.8	25.2	
#30	0.59	332	33.2	58.4	
#50	0.3	322	32.2	90.6	
#100	0.15	77	7.7	98.3	
Pan		17		275.9	

Table 4-2: Sieve analysis for fine aggregate

Sieve Number	Sieve Opening (mm)	Materials Retained (gm)	% Materials Retained	Cumulative % retained	Fineness Modulus
3/4”	19.05	302	30.2	30.2	8.27
3/8”	9.5	680	68	98.2	
3/16”	4.8	0	0	98.2	
#4	4.75	18	1.8	100	
#8	2.36	0	0	100	
#16	1.19	0	0	100	
#30	0.59	0	0	100	
#50	0.3	0	0	100	
#100	0.15	0	0	100	
Pan				826.6	

4.2 Unit Weight and Voids in Aggregate:

Table 4.3: Unit wt. for coarse aggregate						
Type of Aggregate	Wt. of Bucket (gm)	Wt. of Bucket +Material (gm)	Wt.to Material (gm)	Average wt. of Material	Volume of Bucket V (cum)	Unit Weight (kg/cum)
Stone	4000	7924	3924	4234	0.00277	1528.520
	4000	8292	4292			
	4000	8486	4486			
Total			12702			

Table 4.4: Percent of voids in coarse aggregate			
Unit wt. of Aggregate (kg/m^3)	Bulk Sp. Gr. (O-D basis)	Density of water (kg/m3)	% Void
1528.520	2.545	998	40.75%

4.3 Specific Gravity and Absorption Capacity of Coarse Aggregate:

Table 4.5: Specific Gravity and Absorption Capacity of Coarse Aggregate

Wt. of S.S.D. Sample in Air, B (gm)	Wt. of S.S.D. Sample in Water, C (gm)	Oven Dry Wt. Of Sample in Air, A (gm)
1466	903	1433

Tests	Formula	Calculation	Results
Apparent Specific Gravity	$\frac{A}{A-C}$	$\frac{1433}{1433-903}$	2.704
Bulk Specific Gravity (S.S.D. Basis)	$\frac{B}{B-C}$	$\frac{1466}{1466-903}$	2.604
Bulk Specific Gravity (Oven dry Basis)	$\frac{A}{B-C}$	$\frac{1433}{1466-903}$	2.545
Absorption Capacity, D%	$\frac{B-A}{A}\times 100$	$\frac{1466-1433}{1433}\times 100$	2.3%

4.4 Specific Gravity and Absorption Capacity of Fine Aggregate:

Table 4.6: Specific Gravity and Absorption Capacity of Fine Aggregate

Wt. of pycnometer Filled with water to Calibration mark B gm	Oven Dry Wt.in Air A gm	Wt. of pycnometer with Specimen and water to Calibration mark. C gm	Wt. of S.S.D. Sample in Air S gm
660	291.5	840	300

Tests	Formula	Calculation	Results
Apparent Specific Gravity	$\frac{A}{B+A-C}$	$\frac{291.5}{660+291.5-840}$	2.614
Bulk Specific Gravity (Oven Dry Basis)	$\frac{A}{B+S-C}$	$\frac{291.5}{660+300-840}$	2.429
Absorption Capacity, D%	$\frac{S-A}{A}\times 100$	$\frac{300-291.5}{291.5}\times 100$	2.915 %
Bulk Specific Gravity (S.S.D. Basis), G	$\frac{S}{B+S-C}$	$\frac{300}{660+300-840}$	2.5

4.5 Compressive Strength of Cylindrical Concrete Specimens:

Table 4-7. Average Data as per days

Material	Days		
	14 Days	21 Days	28 Days
Without Admixture	3396	3937	3795
With Admixture (Dr. Fixit)	2856	2987	3101
With Admixture (Super Strength)	2956	3355	3365

Table 4-8. Data without Admixture 14 days

14 Days Report					
Without Admixture					
SL No.	Cylinder Nos	% of Admixture	Load (kN)	Crushing Strength (psi)	Avg.Crushing Strength (psi)
1	1	N/A	195	3477	3396
2	1	N/A	190	3315	

Table 4-9. Data with Dr. Fixit 14 days

14 Days Report					
Dr.Fixit					
SL No.	Cylinder Nos	% of Admixture	Load (kN)	Crushing Strength (psi)	Avg.Crushing Strength (psi)
1	1	1%	170	3071	3120
2	1	1%	175	3168	
3	1	2%	185	3213	3323
4	1	2%	195	3433	
5	1	3%	168	2948	2864
6	1	3%	162	2779	
7	1	4%	138	2437	2515
8	1	4%	145	2593	
9	1	5%	149	2599	2581
10	1	5%	145	2564	
11	1	6%	151	2701	2923
12	1	6%	180	3145	
13	1	9%	150	2606	2668
14	1	9%	155	2730	
Total	14				

Table 4-10. Data with Super Strength 14 days

14 Days Report					
Super Strength					
SL No.	Cylinder Nos	% of Admixture	Load (kN)	Crushing Strength (psi)	Avg.Crushing Strength (psi)
1	1	1%	200	3052	2831
2	1	1%	180	2611	
3	1	2%	187	2467	2531
4	1	2%	157	2595	
5	1	3%	220	3007	3033
6	1	3%	190	3059	
7	1	4%	185	2848	2761
8	1	4%	195	2674	
9	1	5%	190	3386	3316
10	1	5%	200	3245	
11	1	6%	177	2869	3052
12	1	6%	215	3234	
13	1	9%	180	3136	3169
14	1	9%	172	3203	
Total	14				

Table 4-11. Data without Admixture 21 days

21 Days Report					
Without Admixture					
SL No.	Cylinder Nos	% of Admixture	Load (kN)	Crushing Strength (psi)	Avg.Crushing Strength (psi)
1	1	N/A	195	3526	3937
2	1	N/A	190	4348	

Table 4-12. Data with Dr. Fixit 21 days

21 Days Report					
Dr.Fixit					
SL No.	Cylinder Nos	% of Admixture	Load (kN)	Crushing Strength (psi)	Avg.Crushing Strength (psi)
1	1	1%	170	3461	3431
2	1	1%	175	3401	
3	1	2%	185	3400	3243
4	1	2%	195	3087	
5	1	3%	168	2972	2824
6	1	3%	162	2676	
7	1	4%	138	2725	2985
8	1	4%	145	3245	
9	1	5%	149	2863	3003
10	1	5%	145	3144	
11	1	6%	151	3140	2957
12	1	6%	180	2773	
13	1	9%	150	2547	2467
14	1	9%	155	2387	
Total	14				

Table 4-13. Data with Super Strength 21 days

21 Days Report					
Super Strength					
SL No.	Cylinder Nos	% of Admixture	Load (kN)	Crushing Strength (psi)	Avg.Crushing Strength (psi)
1	1	1%	200	3529	3370
2	1	1%	180	3211	
3	1	2%	187	3439	3121
4	1	2%	157	2803	
5	1	3%	220	3928	3637
6	1	3%	190	3346	
7	1	4%	185	3323	3388
8	1	4%	195	3454	
9	1	5%	190	3359	3448
10	1	5%	200	3536	
11	1	6%	177	3148	3455
12	1	6%	215	3763	
13	1	9%	180	3140	3065
14	1	9%	172	2989	
Total	14				

Table 4-14. Data without Admixture 28 days

28 Days Report					
Without Admixture					
SL No.	Cylinder Nos	% of Admixture	Load (kN)	Crushing Strength (psi)	Avg.Crushing Strength (psi)
1	1	N/A	195	3770	3795
2	1	N/A	190	3820	

Table 4-15. Data with Dr. Fixit 28 days

28 Days Report					
Dr.Fixit					
SL No.	Cylinder Nos	% of Admixture	Load (kN)	Crushing Strength (psi)	Avg.Crushing Strength (psi)
1	1	1%	170	3194	3135
2	1	1%	175	3076	
3	1	2%	185	3456	3480
4	1	2%	195	3504	
5	1	3%	168	2983	3191
6	1	3%	162	3398	
7	1	4%	138	2835	2749
8	1	4%	145	2662	
9	1	5%	149	3231	3375
10	1	5%	145	3519	
11	1	6%	151	2544	2672
12	1	6%	180	2801	
13	1	9%	150	3213	3103
14	1	9%	155	2994	
Total	14				

Table 4-16. Data with Super Strength 28 days

28 Days Report					
Super Strength					
SL No.	Cylinder Nos	% of Admixture	Load (kN)	Crushing Strength (psi)	Avg.Crushing Strength (psi)
1	1	1%	200	3524	3561
2	1	1%	180	3598	
3	1	2%	187	2737	3196
4	1	2%	157	3655	
5	1	3%	220	4057	3762
6	1	3%	190	3467	
7	1	4%	185	3231	3213
8	1	4%	195	3195	
9	1	5%	190	3623	3618
10	1	5%	200	3612	
11	1	6%	177	2992	3013
12	1	6%	215	3033	
13	1	9%	180	3267	3189
14	1	9%	172	3111	
Total	14				

4.6 Compressive Strength Comparison Graph

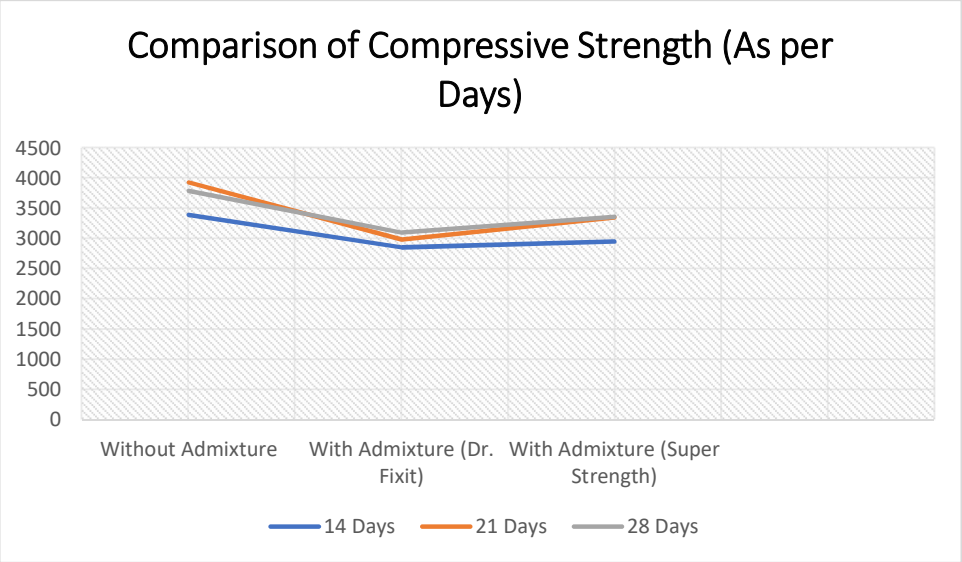


Figure 3-13. Graph

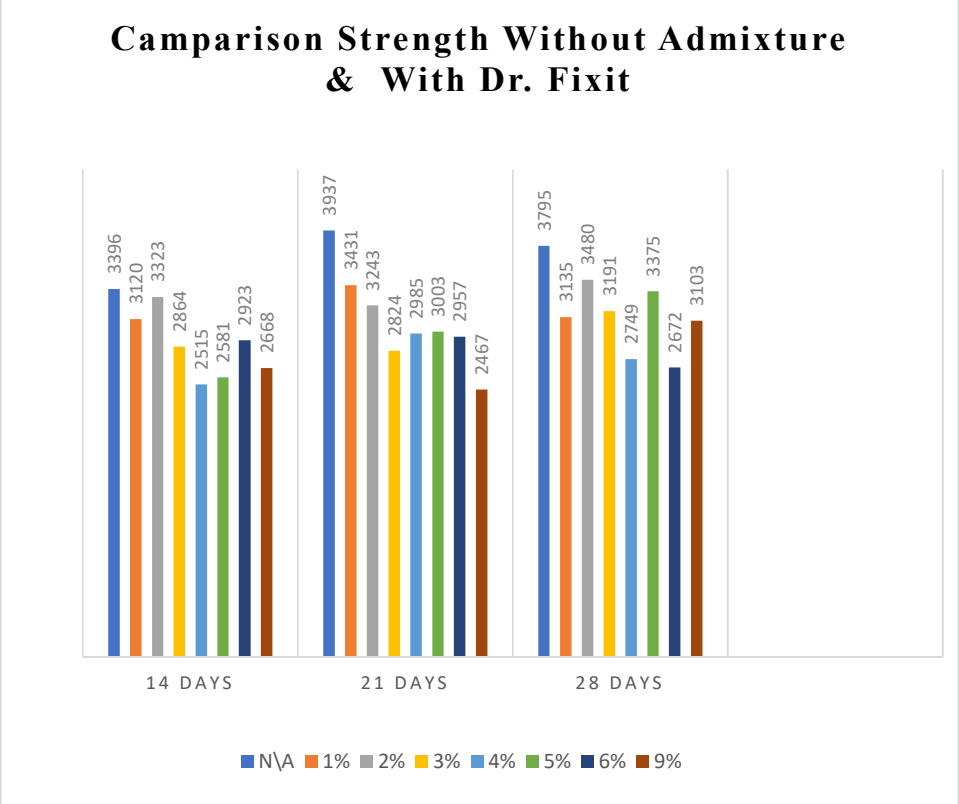


Figure 3-14. Graph

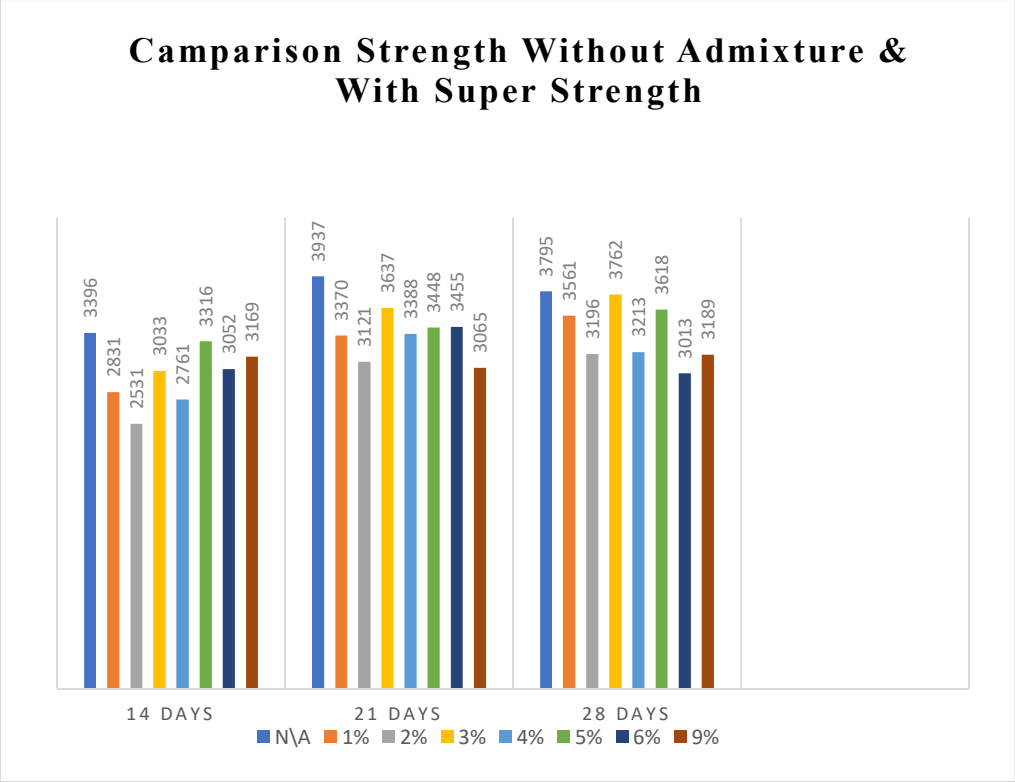


Figure 3-15. Graph

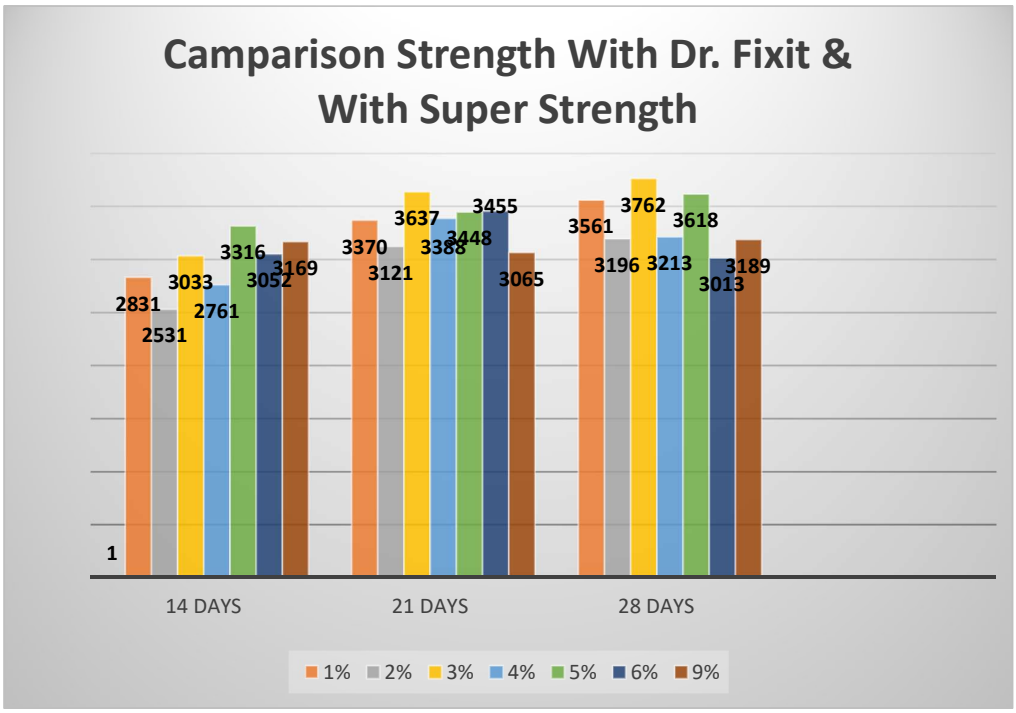


Figure 3-16. Graph

CHAPTER 5
CONCLUSION

The compressive strength of concrete is one of its most critical properties, as it directly affects the structural integrity and durability of concrete structures. Chemical admixtures are often used in concrete mixtures to enhance specific properties, such as workability, setting time, and strength development. This section presents the results and discusses the influence of various chemical admixtures on the compressive strength of concrete.

Chemical admixtures play a significant role in enhancing the properties of concrete, particularly in terms of compressive strength and durability. Superplasticizers offer the best improvements in strength when used to reduce the water-cement ratio, while accelerators provide faster early strength development. Retarders are particularly useful in hot weather conditions, although they might slightly reduce early strength. Air-entraining agents, while reducing compressive strength, offer advantages in terms of durability, particularly in freeze-thaw environments.

Selecting the right chemical admixture depends on the specific requirements of the concrete mix, such as desired strength, workability, and exposure conditions. Careful mix design and dosage control are essential to achieving optimal performance.

CHAPTER 6
LIMITATIONS AND RECOMMANDATION

LIMITATIONS

The effect of chemical admixtures on compressive strength can vary depending on mix and conditions. Some admixtures can react with cement, potentially reducing strength. Adding admixtures can raise costs and complicate mix design.

RECOMMANDATION

Proper Mixing Admixture is effect on concrete strength. Proper curing is crucial to achieve maximum strength Select Suitable Admixture Choose the right admixture based on project needs and environmental conditions. Quality control is a vital factor for gain strength.

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..…Thanks and Best Wishes…..