Comparative Analysis of Compressive Strength of Concrete Using Different Brands of Local Cement and Admixture

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Dedicated

To

"Our Beloved Parents"

ACKNOWLEDGEMENTS

All glory and sincere appreciation are due to the all-powerful Allah, the most merciful and beneficent, for providing the opportunity and capacity to carry out this endeavor in a safe and careful manner. Our sincere gratitude and acknowledgement go out to Rafi Bin Shahadat, the lecturer who guided this project. As a guide, he supplied maximum aid concluding the project job. With his prior years of expertise and guidance, he directed us to come out with success through the toughest issues experienced by us. His keen interest in the issue and good guidance were the sources of the author's inspiration. We want to express our sincere appreciation to our guides for their co-operation and constant civility toward us during the entire process. We sincerely would like to thank all instructor and staff of the Civil Engineering Department of Sonargaon University (SU), Dhaka, which contributed in various ways to the completion of this thesis. Finally, we want to express our sincere thanks to my family and friends for their everlasting encouragement, love, and support. Without their constant support, this project would not have been able to move further.

ABSTRACT

This research investigates the comparative compressive strength performance of concrete produced using different locally available cement brands and commonly used admixtures in Bangladesh. The study aims to evaluate how Shah Cement, Aman Cement, and Supercrete Cement combined with two widely applied chemical admixtures, PCA-1 (Sobute) and SikaPlast® PH 8395 affect the compressive strength of C30-grade concrete. To ensure uniformity, all concrete mixes were prepared using a fixed proportion of 1:1.5:3 and a water–cement ratio of 0.45. Prior to casting, the raw materials were characterized through sieve analysis, unit weight tests, and specific gravity tests for both sand and stone aggregates. Concrete cylinders were then cast and cured for compressive strength tests at 14 and 28 days. The concrete compressive strength test results show clear differences among the three cement brands- Shah, Supercrete, and Aman- when combined with two admixtures: SikaPlast® PH 8395 and PCA-1 (Sobute). At 14 days, Shah Cement recorded average strengths of 26.0 MPa with SikaPlast® and 27.0 MPa with PCA-1 (Sobute), both nearing the 27 MPa target. Supercrete Cement showed 25.4 MPa with SikaPlast® and 25.9 MPa with PCA-1, slightly below the target but acceptable for early-age strength. Aman Cement achieved 26.4 MPa using SikaPlast® and 27.1 MPa using PCA-1, showing reliable consistency. By 28 days, all cements surpassed the 30 MPa target: Shah Cement reached 34.35 MPa with SikaPlast® and 34.47 MPa with PCA-1, the highest among all. Supercrete Cement attained 31.20 MPa with SikaPlast® and 31.65 MPa with PCA-1, while Aman Cement delivered 33.40 MPa with SikaPlast® and 33.57 MPa with PCA-1. Overall, the results indicate that PCA-1 (Sobute) consistently produced slightly higher strengths across all cement brands, with Shah Cement with PCA-1 (Sobute) achieving the best performance in both 14-day and 28-day tests.

TABLE OF CONTENT

ABSTRACT ... vii
LIST OF TABLES ... x
CHAPTER 1 ... 1
INTRODUCTION ... 1
1.1 Background and Motivations ... 1
1.2 Problem Statement ... 1
1.3 Importance of the Research ... 2
1.4 Overview of the Research ... 2
1.5 Main Objective of the Research ... 3
1.6 Scope of the Study ... 3
1.7 Organization of the thesis ... 4
CHAPTER 2 ... 6
Literature Review ... 6
2.1 Introduction ... 6
2.2 Cement ... 9
2.3 Admixture ... 11
2.4 Research Gap and Relevance to the Present Study ... 14
CHAPTER 3 ... 15
Methodology ... 15
3.1 Introduction ... 15
3.2 Methodology Overview ... 15
CHAPTER 4 ... 20
Results and Discussion ... 20
4.1 Introduction ... 20
4.2 Aggregate Properties ... 20
4.3 Compressive Strength Test Results ... 25
4.4 Comparative Performance of Cement–Admixture Combinations ... 28
4.5 Effect of Admixtures on Compressive Strength ... 28
4.6 Interpretation and Engineering Implications ... 28
CHAPTER 5 ... 29
Conclusions and Future Works ... 29
5.1 Conclusions ... 29
5.2 Limitations ... 30
5.3 Recommendations for Future Works ... 31
5.4 Summary ... 32
REFERENCES ... 33

LIST OF FIGURES

Figure 2.1 Three types Cement..10

Figure 2.2 Two types admixture..12

Figure 3.1 Flowchart illustrating the experimental methodology adopted in this study……16

Figure 3.2 Sand, stone, cement and admixture measuring.. 17

Figure 3.3 Materials mixing.. 18

Figure 3.4 Materials pouring in the mold, temping and Cylinder making..............................18

Figure 3.5 Cylinder leveling and curing………………………………………………..….....19

Figure 3.6 Compressive Strength Test of concrete cylinder………….……...………………19

Figure 4.1 Sieve analysis tests..20

Figure 4.2 Grain Size Distribution Curve of Fine Aggregate……….…………………….....21

Figure 4.3 Grain Size Distribution Curve of Coarse Aggregate…….………………….....21

Figure 4.4 Specific gravity tests..23

Figure 4.5 Unit weight of aggregate tests..24

Figure 4.6 Concrete Cylinder compressive strength test……………….……...………............26

Figure 4.7 Compressive Strength of 14 days…………………….………….....….…………..26

Figure 4.8 Compressive Strength of 28 days……….…………………………….....……..27

Figure 4.9 Strength Development Trend (14 to 28 Days) …………….………………………..27

LIST OF TABLES

Table 2.1 Physical and performance characteristics of selected OPC cement Brand…..........11

Table 2.2 Chemical and Performance Characteristics of Selected Admixtures......................13

Table 4.1 Data sheet of sieve analysis of fine aggregate..22

Table 4.2 Data sheet of sieve analysis of coarse aggregate..22

Table 4.3 Data sheet of specific gravity test of fine aggregate……………………………....23

Table 4.4 Data sheet of specific gravity test of coarse aggregate……………………………24

Table 4.5 Data sheet of unit weight test of fine aggregate…………………………......…..25

Table 4.6 Data sheet of unit weight test of coarse aggregate.………………….......................25

CHAPTER 1
INTRODUCTION

1.1 Background and Motivations

Concrete is the most widely used man-made construction material and forms the backbone of modern infrastructure due to its versatility, durability, and cost-effectiveness. Among its mechanical properties, compressive strength is the most important indicator of concrete quality, as it reflects the material's capacity to with stand applied loads and is commonly used to assess other performance characteristics such as durability and abrasion resistance. The performance of concrete is primarily governed by the quality of its constituent materials, particularly cement, which acts as the main binding agent and controls hydration and strength development. However, cement properties are not uniform and may vary significantly among different local manufacturers due to differences in raw materials, chemical composition, and physical characteristics such as fineness. These variations can directly influence the compressive strength and overall performance of concrete, highlighting the need for careful material selection in structural applications.

On the other hand, Sustainability is one of the primary concerns in this 21st century (Islam, 2010). In this regard, concrete industries and scientific communities are devoting much effort to improving the sustainability of civil engineering structures. Each year, close to 13000 million natural aggregates are required for concrete construction on this planet. With increasing these aggregates' demand, the rate of construction waste is also increasing parallelly. In Canada, concrete waste occupies the largest portion of all construction and demolition (C&D) waste, and this C&D waste is almost 27.5%, 29%, and 7.5 % of total municipal solid waste in British Columbia, Ontario, and Alberta, respectively. In Europe and China, this C&D waste generation rate is near to 450 and 200 million tons each year. Even, in Bangladesh, the volume of demolished concrete is increasing due to the deterioration of old concrete structures and the replacement of many low-rise buildings with relatively high-rise buildings. For example, in 2016, Dhaka generated around 1.28 million tons of waste (0.149 million tons of construction and 1.139 million tons of demolitions) of which the three largest proportions were concrete (60%), brick/block (21%), and mortar (9%) (Islam, 2010).

1.2 Problem Statement

The primary problem addressed in this research is the uncertainty regarding the comparative compressive strength performance of concrete produced using different locally available cement brands in combination with commonly used chemical admixtures in Bangladesh. Although construction practitioners often rely on experience or manufacturer recommendations, the absence of systematic experimental evaluation makes it difficult to identify the most effective cement–admixture combinations for achieving optimum strength. If the right amounts of fine and coarse aggregate are used, bleeding in newly mixed concrete can be minimized (Bert-Okonkwor et al., 2020). Admixtures and higher cement content can also aid. Admixtures composed of chemicals include water reducers, super plasticizers, and set retarders, set accelerators, air entrainers, and specialty admixtures (Bert-Okonkwor et al., 2020).

Variations in compressive strength can lead to overdesign, increased construction cost, or, in critical cases, compromised structural safety. Therefore, a detailed comparative assessment is necessary to support informed decision-making in concrete material selection.

1.3 Importance of the Research

This research is important because compressive strength is the most critical parameter governing the structural performance and safety of concrete structures. Understanding how different local cement brands and admixtures influence strength development at 14 days and 28 days provides valuable information for engineers, contractors, and material suppliers.

The findings of this study contribute to improved quality control in concrete production, optimized use of locally available materials, and enhanced reliability of structural design. Additionally, the research supports sustainable construction practices by promoting efficient material utilization without compromising performance. The results also serve as a reference for future research on concrete performance and admixture compatibility in similar construction environments.

1.4 Overview of the Research

This research focuses on a comparative experimental investigation of the compressive strength performance of concrete produced using different locally available cement brands and commonly used chemical admixtures in Bangladesh. The study is designed to evaluate how variations in cement type and admixture selection influence the strength development of C30-grade concrete under controlled laboratory conditions.

A uniform concrete mix design with a proportion of 1: 1.5: 3 and a water–cement ratio of 0.45 is adopted to ensure consistency across all test specimens. Three local cement brands

Shah Cement, Aman Cement, and Supercrete Cement are examined in combination with two widely used chemical admixtures PCA-1 (Sobute) and SikaPlast® PH 8395. Compressive strength tests are conducted at 14 days and 28 days, which represent critical curing ages for structural concrete.

The scope of this study is limited to laboratory-based compressive strength evaluation. Other performance parameters such as durability, permeability, shrinkage, and long-term chemical resistance are not included. By restricting the variables, the research ensures a focused and reliable comparison of strength behavior resulting from cement–admixture interactions.

1.5 Main Objective of the Research

- To evaluate and compare the compressive strength of C30-grade concrete using different locally available cement brands under identical mix design and curing conditions.
- To assess the effect and compatibility of PCA-1 (Sobute) and SikaPlast® PH 8395 chemical admixtures on concrete strength development.
- To compare compressive strength performance at 14 and 28 days for various cement–admixture combinations.
- To identify the most effective cement–admixture combination and provide experimental data supporting material selection in Bangladesh's construction practices.

1.6 Scope of the Study

This research includes only the evaluation of compressive strength of concrete cylinders prepared with a fixed mix design and curing condition. The study does not consider variations in mix proportions, water–cement ratios, aggregate sources, curing environments, or field placement conditions.

Durability-related properties such as resistance to sulfate attack, carbonation, chloride penetration, and long-term performance are beyond the scope of this study. Additionally, economic analysis and life-cycle assessment of materials are not included.

1.7 Organization of the thesis

The research presented in this thesis is organized into five primary chapters, each focusing on a specific phase of the comparative analysis. The contents of these chapters are outlined below:

Chapter 1: Introduction

This chapter establishes the foundation of the research. It begins with the background of the construction industry's reliance on various local cement brands and the growing necessity of chemical admixtures to enhance concrete performance. It details the problem statement, highlighting why a comparative study is necessary for local materials. Finally, it outlines the research objectives, scope, and the expected outcomes of the experimental program.

Chapter 2: Literature Review

Chapter 2 provides a comprehensive review of existing scholarly work related to concrete technology. It focuses specifically on the chemical composition of cement, the hydration process, and the mechanism of admixtures (such as super plasticizers or accelerators). This chapter also examines previous comparative studies on cement brands and how standard testing procedures (ASTM, BNBC, ACI codes) have been utilized in similar research contexts.

Chapter 3: Methodology

This chapter describes the systematic approach and experimental setup used to conduct the study. It includes:

- Material Characterization: Testing the physical properties of the selected local cement brands (fineness, setting time, etc.) and the properties of aggregates.
- Mix Design: The proportions used for the concrete mixes, including the dosage of admixtures.
- Experimental Procedures: Detailed descriptions of the casting, curing, and testing processes, specifically the Compressive Strength Test at various curing ages (e.g., 7, 14, and 28 days).

Chapter 4: Results and Discussion

Chapter 4 presents the data collected from the experimental phase. It utilizes tables and graphical representations to compare the compressive strength across different cement brands, both with and without admixtures. The discussion interprets these results, analyzing the synergy between specific cement brands and the admixture, and identifying which combination yields the most optimal structural performance.

Chapter 5: Conclusions and Future Work

The final chapter summarizes the key findings of the research, providing a definitive conclusion on which local cement brand performed best under the test conditions. It highlights the major contributions of the study toward local construction practices and offers recommendations for future research, such as testing for durability parameters like permeability or sulfate resistance.

CHAPTER 2

Literature Review

2.1 Introduction

Concrete is the most extensively used construction material worldwide due to its high compressive strength, durability, versatility, and economic feasibility. Concrete is a composite construction material, composed of cement (commonly Portland cement) and other cementitious materials such as fly ash and slays cement, aggregates (overall coarse aggregate made of gravel or crushed rocks such as limestone, or granite plus a fine aggregate such as sand), water, and chemical admixture (Gram, 2020). The word concrete comes from the word "Concretus" (meaning compact and condensed) the perfect passive participle of "concrescence", from "con" (together) and "crescere" (to grow). Concrete as a material has been known since before Roman times, but it is only since the introduction of Portland cement by Joseph Aspdin, an English Manson, that it becomes widely regarded as a structural material. It is one of the most versatile materials of great strength and durability, provided good control measures are maintained through all the stages of production (Gram, 2020). Among all mechanical properties of concrete, compressive strength is considered the most critical parameter because it governs structural capacity and is widely used as the basis for quality control and design specifications. Numerous researchers have emphasized that the compressive strength of concrete is significantly influenced by the properties of its constituent materials, particularly cement, aggregates, water–cement ratio, and chemical admixtures.

In recent years, the increasing availability of multiple local cement brands and chemical admixtures in developing countries such as Bangladesh has created a need for systematic evaluation of their performance. Although these materials often comply with standard specifications, variations in raw materials, manufacturing processes, and chemical composition may result in different strength development behaviors in concrete.

2.1.1 Effect of Cement Type on Compressive Strength of Concrete

Cement acts as the primary binding material in concrete, and its chemical and physical characteristics directly influence hydration, strength gain, and long-term performance. Several studies have reported that variations in cement fineness, clinker composition, gypsum content, and supplementary cementitious materials significantly affect compressive strength.

Neville (2011) noted that finer cement particles accelerate hydration, leading to higher early-age strength, while coarser cement may exhibit slower strength development. (Mehta & Monterio, 2006) further explained that differences in tricalcium silicate (C_3S) and dicalcium silicate (C_2S) content among cement brands influence both early and later-age strength. Studies conducted in South Asian contexts indicate that locally manufactured cement brands, despite meeting national standards, can produce noticeably different compressive strength results when used under identical mix proportions. This highlights the importance of experimentally comparing locally available cement brands rather than relying solely on manufacturer data or nominal grade classifications.

2.1.2 Influence of Aggregates on Concrete Strength

Aggregates constitute approximately 70–75% of the total volume of concrete, and their physical properties significantly influence concrete strength. Proper grading, shape, surface texture, unit weight, and specific gravity are essential for achieving dense and strong concrete. Previous research has shown that well-graded aggregates reduce void content and improve packing density, resulting in higher compressive strength. Sieve analysis is therefore considered a fundamental test to assess aggregate suitability. Unit weight and specific gravity tests provide insights into aggregate density and quality, which affect concrete mix design and strength development. In developing countries, including Bangladesh, aggregates are often sourced locally, making quality assessment essential before use. Studies emphasize that consistent aggregate characterization is necessary to ensure that strength variations are primarily attributed to cement and admixture effects rather than aggregate inconsistencies.

2.1.3 Role of Water–Cement Ratio in Strength Development

The water–cement (w/c) ratio is widely recognized as one of the most influential factors controlling concrete strength. Abram's law establishes an inverse relationship between water–cement ratio and compressive strength, stating that lower water–cement ratios generally result in higher strength. Research indicates that a water–cement ratio of around 0.40–0.50 is commonly used for structural-grade concrete such as C30, balancing workability and strength. Maintaining a constant water–cement ratio is essential in comparative studies to ensure that observed strength differences arise from material variations rather than changes in water content. Several researchers have highlighted that chemical admixtures allow for improved workability at lower water–cement ratios, thereby enhancing strength without compromising placement characteristics.

The main factors determining strength in concrete are the amount of cement used and the water/cement ratio (Mehta & Monterio, 2006). In practice, these are established as a compromise between the need for workability in the freshly mixed state, strength and durability in the hardened state and cost. The degree and manner in which fly ash affects workability are major factors in its influence on strength development. Fly ash that permits a reduction in the total water requirement in concrete will generally present no problems in selection of mixture proportions and permit any rate of strength development (Mehta & Monterio, 2006).

2.1.4 Effect of Chemical Admixtures on Concrete Strength

Chemical admixtures are widely used to modify fresh and hardened concrete properties. Plasticizers and super plasticizers improve workability, reduce water demand, and enhance strength development. Studies have consistently shown that admixtures influence cement hydration kinetics and microstructure formation. The ability of admixtures to provide concrete with significant physical and financial benefits is the cause of the significant increase in their use (Shahjalal, 2022).

Research by Ramachandran et al. (2002) demonstrated that admixtures can significantly increase early and later-age compressive strength when properly dosed and compatible with the cement used. However, incompatibility between cement and admixture may lead to delayed setting, segregation, or reduced strength. Chemical admixtures are substances that are added to concrete in the form of powder or liquid to give it properties that aren’t possible with standard concrete mixes (Abir & Sarker, 2024). Cement concrete by adding some supplementary substances named admixtures (James et al., 2011). The function of each admixture focuses on a specific need, and each has been developed independently of the others. Some admixtures already have chemistry that affects more than one property of concrete, and some have simply been combined for ease of addition during the batching process (James et al., 2011).

In Bangladesh, admixtures such as PCA-1 (Sobute) and SikaPlast® series are commonly used in construction projects. Limited published literature exists comparing their performance with different local cement brands under controlled laboratory conditions, highlighting a research gap addressed by the present study.

2.1.5 Cement–Admixture Compatibility

Cement–admixture compatibility is a critical factor influencing concrete performance. Compatibility depends on cement chemistry, admixture composition, dosage, and curing conditions. Incompatible combinations may adversely affect hydration, strength development, and durability.

Several studies report that the same admixture may perform differently with different cement brands due to variations in alkali content, sulfate levels, and fineness. Therefore, comparative experimental evaluation is essential to identify optimal cement–admixture combinations for achieving target strength grades such as C30. Researchers emphasize that compatibility assessments should include compressive strength measurements at standard curing ages, particularly 14 days and 28 days, which are commonly used benchmarks in structural concrete evaluation.

2.1.6 Age of Concrete and Strength Development

Concrete strength increases with time due to continued hydration of cement. While 28-day compressive strength is widely accepted as the standard reference, 14-day strength is also important for assessing early performance and construction scheduling.

Studies show that different cement and admixture combinations exhibit different rates of strength gain. Some mixtures achieve a higher percentage of their ultimate strength at early ages, while others show slower but steady development. Comparative analysis at both 14 and 28 days provides a more comprehensive understanding of strength behavior.

2.2 Cement

Ordinary Portland Cement (OPC) is the most widely used type of hydraulic cement in the construction industry and is considered the primary binding material in concrete. It is produced by grinding clinker, gypsum, and small proportions of corrective materials such as limestone and clay. When mixed with water, OPC undergoes a chemical hydration process, forming calcium–silicate–hydrate (C–S–H) gel, which provides hardness and compressive strength to concrete. Due to its predictable strength development, workability, and compatibility with most admixtures, OPC has become the dominant cement type used in structural applications worldwide.

Use of OPC in Bangladesh: In Bangladesh, OPC plays a crucial role in the nation's infrastructure and building sector. With rapid urbanization and industrial growth, concrete demand is significantly high, and OPC remains the most preferred cement category for producing reinforced concrete structures. Approximately 65–70% of cement used in Bangladesh's construction industry is OPC-based, supplied mostly under CEM I and CEM II classifications according to BDS EN 197-1 standards. OPC is commonly used in multistoried buildings, foundations, bridges, highways, industrial structures, water retaining structures, and residential RCC members. Government megaprojects—such as Padma Bridge access roads, Dhaka metro rail stations, and coastal embankment construction—also largely depend on OPC concrete for achieving high compressive strength and structural durability.

Because OPC provides faster early-age strength gain, it is preferred for time-sensitive construction works such as column casting, beam formwork removal, slab concreting, precast elements, and repair works. Local cement manufacturers such as Shah Cement, Aman Cement, and Meghna Group produce OPC commercially to meet this countrywide demand. Its availability, affordability, and strength reliability make OPC indispensable in Bangladesh's construction and civil engineering sectors.

Figure 2.1: Three types Cement

Table 2.1: Physical and performance characteristics of selected OPC cement Brand

Parameter	Shah Cement (OPC)	Supercrete Cement (PCC/Composite)	Aman Cement (OPC)
Category (BDS EN 197-1)	CEM I (PURE OPC)	CEM II (Composite OPC)	CEM I (OPC)
Approx. Clinker Content	>95%	65-80% (blended with slag/fly ash/limestone)	90-95%
Grinding Technology	VRM-Vatical Roller Mill (very fine practices)	Ball Mill/Standard grinding	Ball Mill/Traditional
Fineness (Qualitive)	High-very fine	Moderate	Medium
Hydration Rate	Fast early hydration	Comparatively slow	Moderate
Early-Age Strength (7-14 days)	High	Low-Medium	Medium
28-Day Strength	Highest among three	Moderate-Stable	Satisfactory
Durability	Good	Very good- crack resistance	Good
Typical Market Use	High-strength concrete, structural element	Durability-focused structures, mass concrete	General-purpose RCC works
Cost Level	Slightly high	Medium-high	Lowest

2.3 Admixture

Admixtures are specialized chemical agents used to modify the behavior of concrete, enabling enhancements in workability, strength, and durability without altering the primary mix ratio. In this research, two chemical admixtures were incorporated into the concrete mixes SikaPlast® PH-8395 and PCA-1 (Sobute) to investigate their influence on the fresh and hardened properties of concrete, particularly compressive strength. Chemical admixtures are very little additions to concrete that are primarily used for air entrainment, water or cement content reduction, plasticization of fresh concrete mixtures, and setting time control (Ali et al., 2024).

2.3.1 SikaPlast® PH-8395 Admixture:

SikaPlast® PH-8395 is a high-range water-reducing and retarding admixture based on modified polycarboxylate technology. Its primary purpose is to improve the workability of concrete by reducing the water demand while maintaining the required consistency. By lowering the effective water–cement ratio, SikaPlast® PH-8395 contributes to increased concrete density and improved compressive strength development. Additionally, the retardation effect helps extend the placement time, which is particularly advantageous under hot weather conditions or during extended transport and handling. In this study, SikaPlast® PH-8395 was used to enhance the flowability of the concrete mix and reduce segregation while ensuring that the concrete achieved satisfactory early and long–term strength levels. Its effectiveness in adjusting fresh concrete characteristics makes it suitable for structural applications where both workability and strength are required.

2.3.2 PCA-1 (Sobute) Admixture:

PCA-1 is a polycarboxylate ether (PCE)-based superplasticizer produced by Sobute New Materials Co., Ltd. This class of admixture is designed for high-range water reduction, promoting greater dispersion of cement particles and significantly lowering the water–cement ratio without compromising workability. The improved dispersion accelerates hydration reactions, which often results in better early-age and ultimate compressive strength compared to conventional mixes.

PCA-1 was included in this research to examine its influence on concrete performance, particularly in terms of compressive strength gains at 14 and 28 days. The objective was to evaluate how this high-efficiency admixture could enhance strength development while maintaining a workable and cohesive mix.

Figure 2.2: Two types admixture

2.3.3 Purpose of Using Both Admixtures:

The main objectives for incorporating SikaPlast® PH-8395 and PCA-1 admixtures in this comparative study were as follows:

1. To improve workability without increasing water content, facilitating proper placement and compaction.
2. To reduce the effective water–cement ratio, which is directly related to higher compressive strength.
3. To compare the effectiveness of a conventional water-reducing admixture (SikaPlast® PH-8395) against a high-range superplasticizer (PCA-1) in enhancing strength characteristics.
4. To assess how different admixture chemistries, interact with local cement brands, thereby providing insight into optimized material selection for structural concretes in the context of Bangladesh.

Overall, the inclusion of these admixtures aligns with the research aim to evaluate how chemical modification of concrete mixes influences compressive strength development under a constant mix design (1:1.5:3). The comparative analysis offers practical recommendations for selecting suitable admixtures to achieve specific performance criteria in reinforced concrete applications.

Table 2.2: Chemical and Performance Characteristics of Selected Admixtures

Attribute	**SikaPlast® PH-8395**	**PCA-1 (Sobute)**
Chemical Type	Polycarboxylate-based Superplasticizer (Water reducing+Retarding)	Polycarboxylate-based High Range Water Reducer
ASTM Type	ASTM C-494 Type D & G	ASTM C-494 Type F (commonly used)
Recommended	0.6% - 1.2% of	0.2% - 1.0% of
Dosage (Ratio)	cement weight=300-600 ml per 50 kg cement	cement weight=100-500 ml per 50 kg cement
Slump Retention	Good	Very good (Better workability retention)
Compressive	Moderate	Higher strength gain
Strength Effect	improvement	potential
Chloride Content	Chloride-free	Chloride-free
Shelf Life	12 months	12 months

2.4 Research Gap and Relevance to the Present Study

Although extensive research exists on concrete compressive strength, limited studies focus on comparative evaluation of locally available cement brands combined with commonly used admixtures in Bangladesh under identical mix design conditions.

Most construction practices rely on experience or manufacturer recommendations rather than experimental data. This creates uncertainty in material selection and may result in inconsistent concrete quality. The present study addresses this gap by systematically evaluating the compressive strength performance of Shah Cement, Aman Cement, and Supercrete Cement combined with PCA-1 (Sobute) and SikaPlast® PH 8395, using a fixed C30 mix design and controlled laboratory testing.

CHAPTER 3

Methodology

3.1 Introduction

This chapter describes the methodology adopted to conduct the experimental investigation on the comparative compressive strength of concrete using different locally available cement brands and chemical admixtures. The research methodology outlines the systematic procedures followed, starting from material collection and characterization to concrete mix preparation, casting, curing, and compressive strength testing. Standard laboratory test methods and relevant codes were applied to ensure consistency, accuracy, and reliability of the experimental results. A uniform concrete mix design was maintained throughout the study to isolate the effects of cement type and admixture on strength development. The detailed description provided in this chapter enables reproducibility of the study under similar laboratory conditions.

3.2 Methodology Overview

The research methodology was designed as a controlled laboratory-based experimental program. A fixed concrete mix design corresponding to C30 grade concrete with a proportion of 1:1.5:3 and a water–cement ratio of 0.45 were adopted throughout the study. Three locally available cement brands—Shah Cement, Aman Cement, and Supercrete Cement—were selected, along with two commonly used chemical admixtures, PCA-1 (Sobute) 300ml per 50 kg cement ratio and SikaPlast® PH 8395 450ml per 50 kg cement ratio.

The overall methodology consisted of several sequential steps. Initially, all raw materials were collected and tested to determine their physical properties. Sieve analysis was conducted on fine and coarse aggregates to assess grading characteristics, while unit weight and specific gravity tests were performed to evaluate aggregate density and quality. These preliminary tests ensured that the aggregates used were suitable and consistent for concrete production.

After material characterization, concrete mixes were prepared using the same mix proportions, with variations only in cement brand and admixture type. Concrete cylinders were cast using standard molds, properly compacted, and cured under controlled conditions. Compressive strength tests were conducted at curing ages of 14 days and 28 days using a calibrated compression testing machine. The recorded test results were then analyzed and compared to evaluate the influence of different cement–admixture combinations on strength development.

The methodology flow of the research can be summarized as follows: material collection → material testing → mix design selection → concrete mixing → casting of cylinders → curing → compressive strength testing → data analysis and comparison.

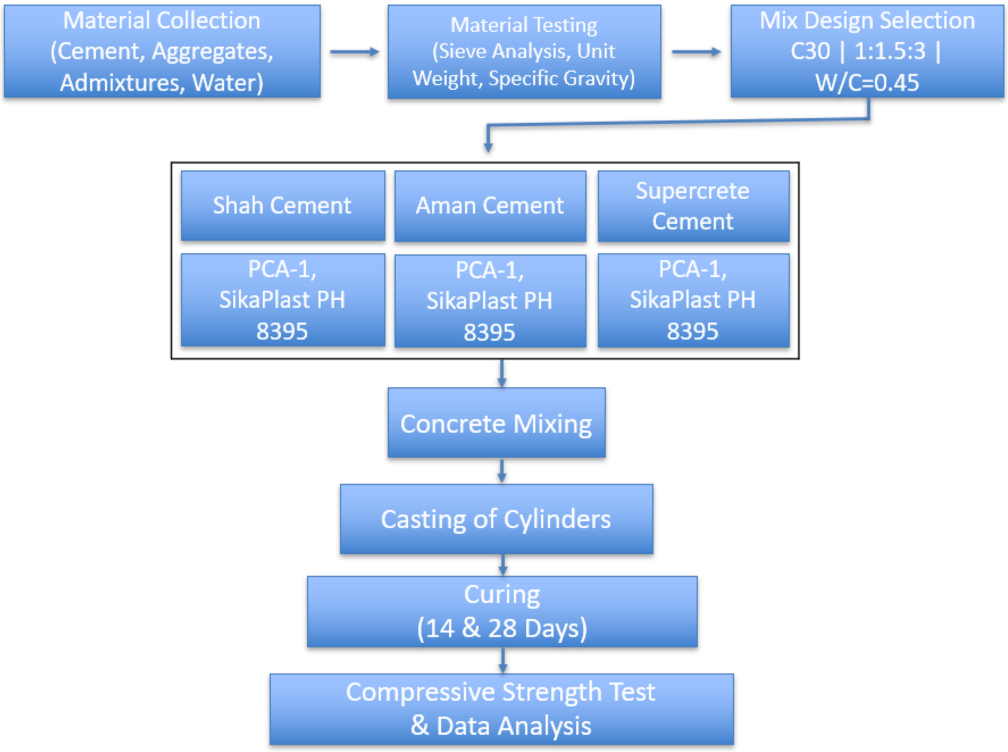

Figure 3.1: Flowchart illustrating the experimental methodology adopted in this study.

3.2.1 Materials Collection and measurement

In Figure 3.2 shows the collection and accurate measurement of sand, coarse aggregate, cement, and chemical admixtures prior to concrete mixing. All materials were carefully weighed and proportioned according to the specified mix design to maintain consistency across all batches. Proper measurement ensured uniformity in concrete composition, reduced experimental errors, and allowed a reliable comparison of the effects of different cement brands and admixtures on compressive strength.

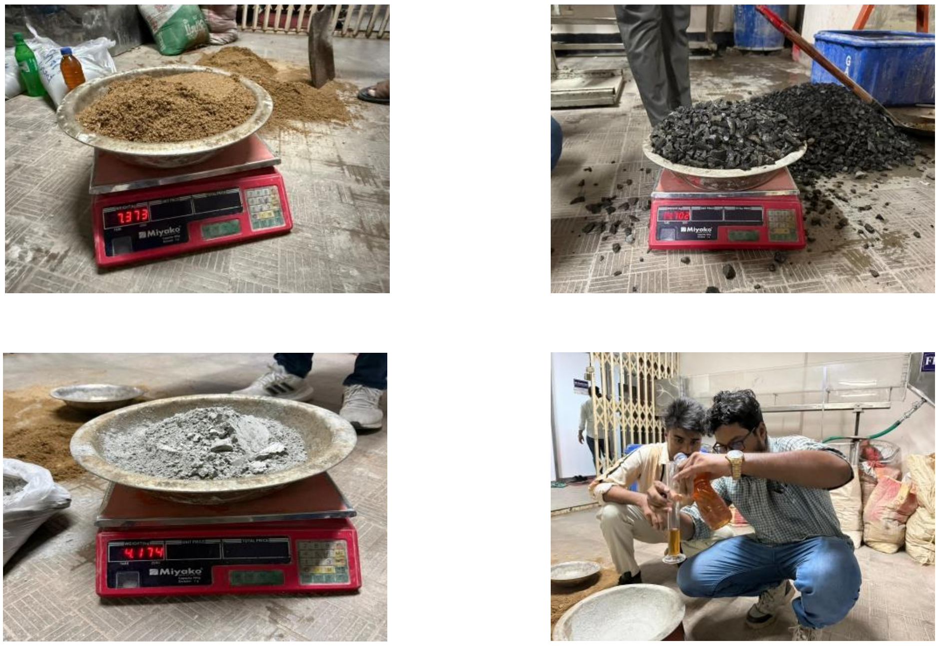

Figure 3.2: Sand, Stone, Cement and admixture measuring

3.2.2 Materials Mixing

At Figure 3.3 illustrates the concrete mixing process in which measured quantities of cement, fine aggregate, coarse aggregate, water, and chemical admixtures were thoroughly mixed to obtain a uniform concrete mixture. Proper mixing was ensured to achieve even distribution of all constituents, prevent segregation, and improve workability. This step is essential for producing consistent concrete quality and reliable compressive strength results for all test specimens.

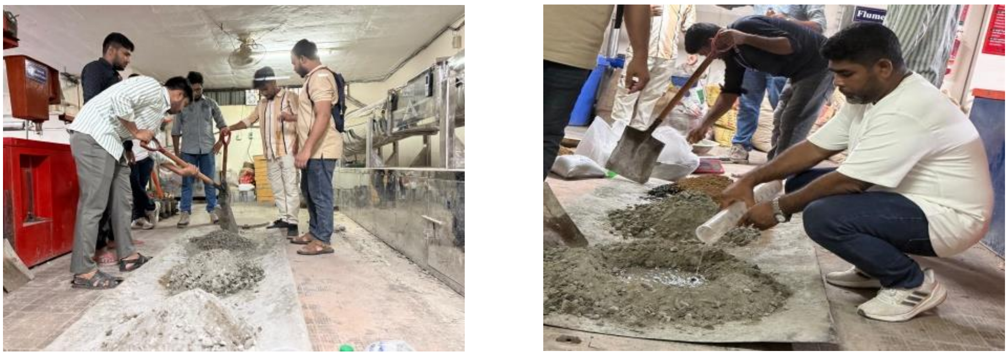

Figure 3.3: Materials mixing

3.2.3 Materials Pouring, temping and making Cylinder

In Figure 3.4 shows the process of pouring freshly mixed concrete into cylindrical molds followed by proper tamping. Concrete was placed in layers and each layer was compacted using a tamping rod to remove entrapped air and ensure dense packing. This procedure helped achieve uniform specimens with minimal voids, ensuring accurate and reliable compressive strength test results.

Figure 3.4: Materials pouring in the mold, temping and Cylinder making

3.2.4 Cylinder leveling and curing

At Figure 3.5 describe the leveling and curing of the concrete cylinders after casting. The top surfaces of the cylinders were carefully leveled to obtain smooth and even ends, which are essential for uniform load application during compressive strength testing. After leveling, the specimens were properly cured under controlled conditions to maintain adequate moisture and temperature, allowing proper hydration and strength development of the concrete.

The casted cylinder was totally immersed inside water, throughout the curing period; the curing water was maintained at an average laboratory temperature of 28°C (82.4°F) to prevent thermal stresses that could result in cracking.

Figure 3.5: Cylinder leveling and curing

3.2.5 Compressive Strength Test

The figures show the compressive strength testing of concrete cylinder specimens using a calibrated compression testing machine (UTM). Before testing, the cylinders were properly positioned to ensure axial loading. Load was applied gradually until failure, and the maximum load at failure was recorded to determine the compressive strength of each specimen. This test was conducted at specified curing ages to evaluate the strength development of concrete made with different cement brands and admixtures. The process reflects standard laboratory practice and ensures reliable assessment of concrete performance.

Figure 3.6: Compressive Strength Test of concrete cylinder

CHAPTER 4

Results and Discussion

4.1 Introduction

This chapter presents the experimental results of the compressive strength tests conducted on concrete cylinders prepared with three local cement brands—Shah Cement, Aman Cement, and Supercrete—and two commonly used admixtures in Bangladesh, PCA-1 (Sobute) and SikaPlast® PH 8395. Compressive strength values were recorded at 14 days and 28 days for all combinations using a constant mix design (1: 1.5: 3) and a fixed water–cement ratio of 0.45. The results are analyzed to determine the influence of cement type, admixture type, and curing age on overall strength development.

4.2 Aggregate Properties

4.2.1 Sieve Analysis

Sieve analysis results for fine and coarse aggregates confirmed well-graded material suitable for structural concrete.

- Fine aggregate fineness modulus (FM): 2.63
- Coarse aggregate fineness modulus: 8.10

These values fall within the recommended ranges for producing workable, dense concrete mixtures.

Figure 4.1: Sieve Analysis test

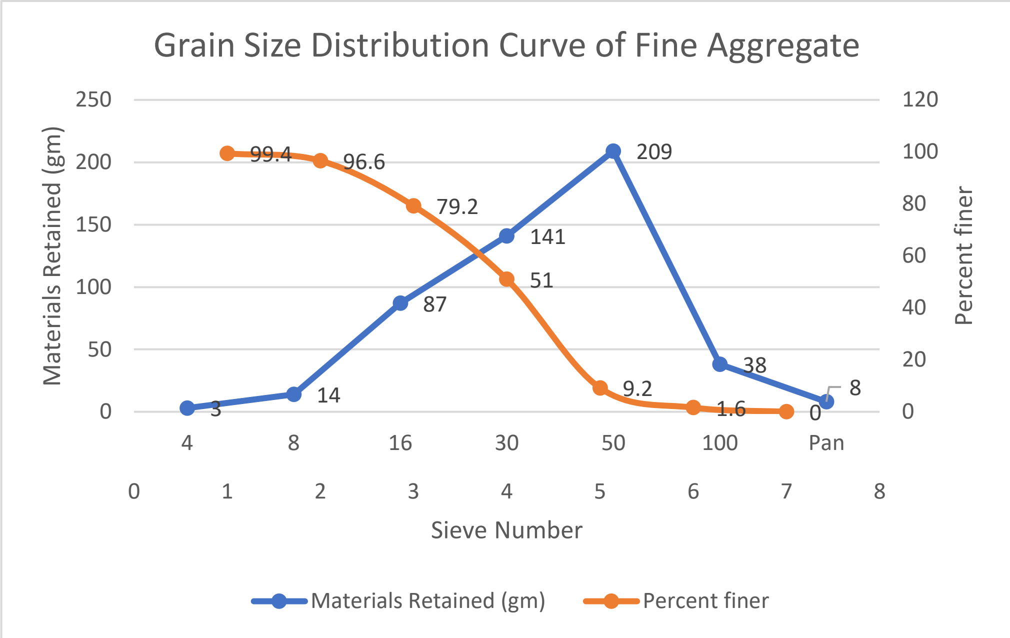

Figure 4.2: Grain Size Distribution Curve of Fine Aggregate

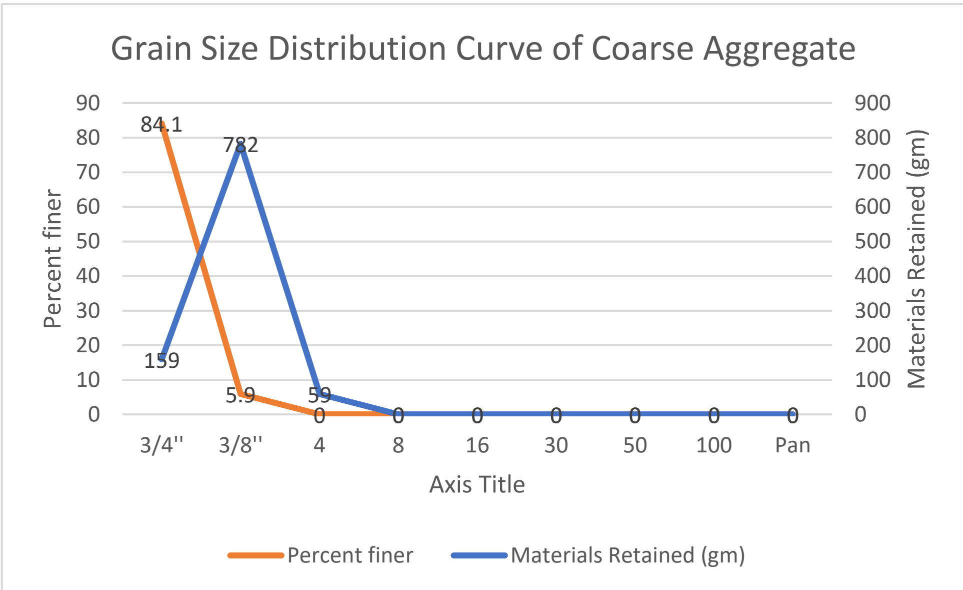

Figure 4.3: Grain Size Distribution Curve of Coarse Aggregate

Table 4.1: Data sheet of sieve analysis of fine aggregate

Data Sheet					
For fine aggregate:					
Sieve Number	Sieve Opening (mm)	Materials Retained (gm)	%Materials Retained	Cumulative %Retained	Percent finer
4	4.75	3	0.6	0.6	99.4
8	2.36	14	2.8	3.4	96.6
16	1.19	87	17.4	20.8	79.2
30	0.59	141	28.2	49	51
50	0.3	209	41.8	90.8	9.2
100	0.15	38	7.6	98.4	1.6
Pan		8	1.6	100	0
Total		500	100	363	

Table 4.2: Data sheet of sieve analysis of coarse aggregate

For coarse aggregate:					
Sieve Number	Sieve Opening (mm)	Materials Retained (gm)	%Materials Retained	Cumulative %Retained	Percent finer
3/4"	19.05	159	15.9	15.9	84.1
3/8"	9.5	782	78.2	94.1	5.9
4	4.75	59	5.9	100	0
8	2.36	0	0	100	0
16	1.19	0	0	100	0
30	0.59	0	0	100	0
50	0.3	0	0	100	0
100	0.15	0	0	100	0
Pan		0	0	100	0
Total		1000	100	810	

4.2.2 Specific Gravity

Specific gravity tests yielded:

- Fine aggregate specific gravity: 2.53
- Coarse aggregate specific gravity: 2.51

These values indicate aggregates of standard density and low porosity, ensuring reliable concrete strength development.

Figure 4.4: Specific gravity tests

Table 4.3: Data sheet of specific gravity test of fine aggregate

Data Sheet			
For fine aggregate:			
Weight of pycnometer filled with water to Calibration mark. B (gm)	Oven Dry weight in Air A (gm)	Weight of pycnometer with specimen and water to Calibration mark. C (gm)	Weight of S.S.D sample in Air S (gm)
657	300	845	311

Tests	Formula	Calculation	Results
Apparent Specific Gravity	A/(B+A-C)	300/(657+300-845)	2.68
Bulk Specific Gravity (Oven Dry Basis)	A/(B+S-C)	300/(657+311-845)	2.44
Absorption Capacity, D%	(S-A)/A*100	(311-300)/300*100	3.67
Bulk Specific Gravity (S.S.D Basis), G	S/(B+S-C)	311/(657+311-845)	2.53

Table 4.4: Data sheet of specific gravity test of coarse aggregate

Data Sheet		
For Coarse aggregate:		
Weight of S.S.D sample in Air, B (gm)	Weight of S.S.D sample in Water, C (gm)	Oven Dry weight of sample in Air, A (gm)
1830	1100	1805

Tests	Formula	Calculation	Results
Apparent Specific Gravity	A/(A-C)	1805/(1805-1100)	2.56
Bulk Specific Gravity (S.S.D Basis)	B/(B-C)	1830/(1830-1100)	2.51
Bulk Specific Gravity (Oven Dry Basis)	A/B-C	1805/(1830-1100)	2.47
Absorption Capacity, D%	(B-A)*100/A	(1830-1805)*100/1805	1.39

4.2.3 Unit Weight of Aggregates

Unit weight measurements for both fine and coarse aggregates fell within commonly observed ranges:

- Fine aggregate (rodded): approx. 1324–1560 kg/m³
- Coarse aggregate (rodded): approx. 1530–1611 kg/m³

These values confirm the aggregates' suitability for consistent mix proportioning and compaction.

Figure 4.5: Unit weight of aggregate tests

Table 4.5: Data sheet of unit weight test of fine aggregate

Data Sheet						
For fine aggregate:						
Type of Sampling	Type of Aggregate	Weight of Bucket (gm)	Weight of Bucket+ Materials(gm)	Weight of Materials (gm)	Volume of Bucket, V (m3)	Unit Weight, M (Kg/m3)
Shoveling	Fine	4000	7880	3880	0.00278	1395.68
Rodding		4000	8255	4255	0.00278	1530.572
Jiggling		4000	8441	4441	0.00278	1597.478

Table 4.6: Data sheet of unit weight test of coarse aggregate

For coarse aggregate:						
Type of Sampling	Type of Aggregate	Weight of Bucket (gm)	Weight of Bucket+ Materials(gm)	Weight of Materials (gm)	Volume of Bucket, V m3	Unit Weight, M Kg/m3
Shoveling	Coarse	4000	7681	3681	0.00278	1324.10
Rodding		4000	8337	4337	0.00278	1560.07
Jiggling		4000	8479	4479	0.00278	1611.15

4.3 Compressive Strength Test Results

Compressive strength tests were carried out for each cement–admixture combination. Numerical results were extracted from the consolidated data table, and graphical analysis was performed using generated line and trend line plots. Concrete strength performance is discussed separately for 14-day, 28-day, and strength development stages.

Figure 4.6: Concrete Cylinder compressive strength test

4.3.1 14-Day Compressive Strength

The 14-day compressive strengths for all combinations show:

- Shah Cement: 26.0 MPa (SikaPlast), 27.0 MPa (PCA-1)
- Supercrete: 25.4 MPa (SikaPlast), 25.9 MPa (PCA-1)
- Aman Cement: 26.4 MPa (SikaPlast), 27.1 MPa (PCA-1)

Aman Cement with PCA-1 provided the highest early-age strength.

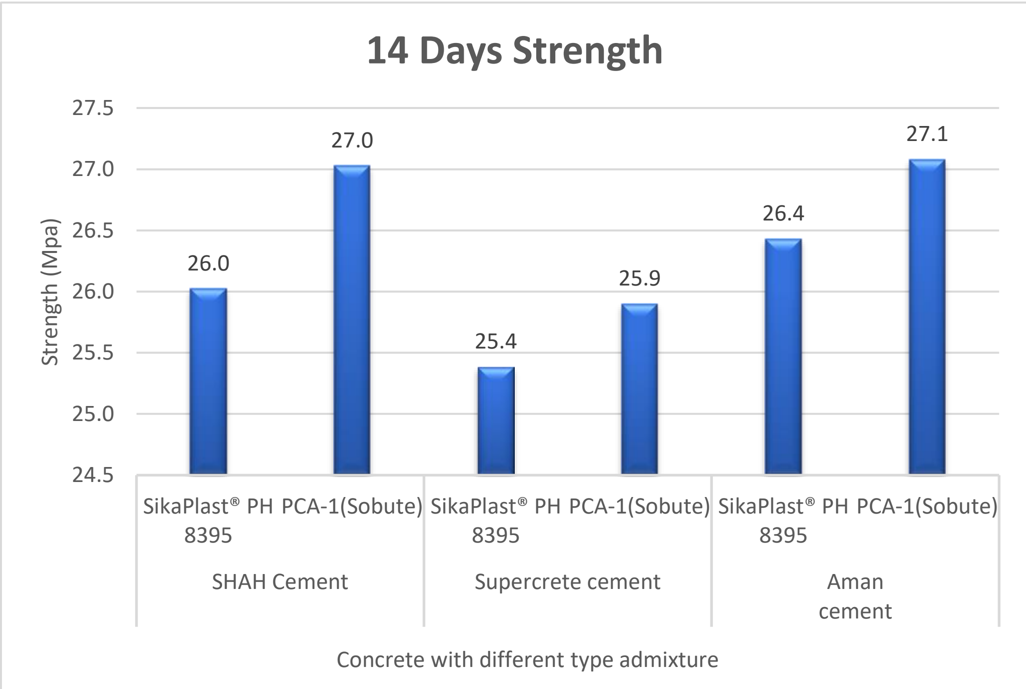

Figure 4.7: Compressive Strength of 14 day

4.3.2 28-Day Compressive Strength

28-day strengths achieved:

- Shah Cement: 34.35 MPa (SikaPlast), 34.47 MPa (PCA-1)
- Supercrete: 31.20 MPa (SikaPlast), 31.65 MPa (PCA-1)
- Aman Cement: 33.40 MPa (SikaPlast), 33.57 MPa (PCA-1)

Shah Cement demonstrated the highest final strength among all tested combinations.

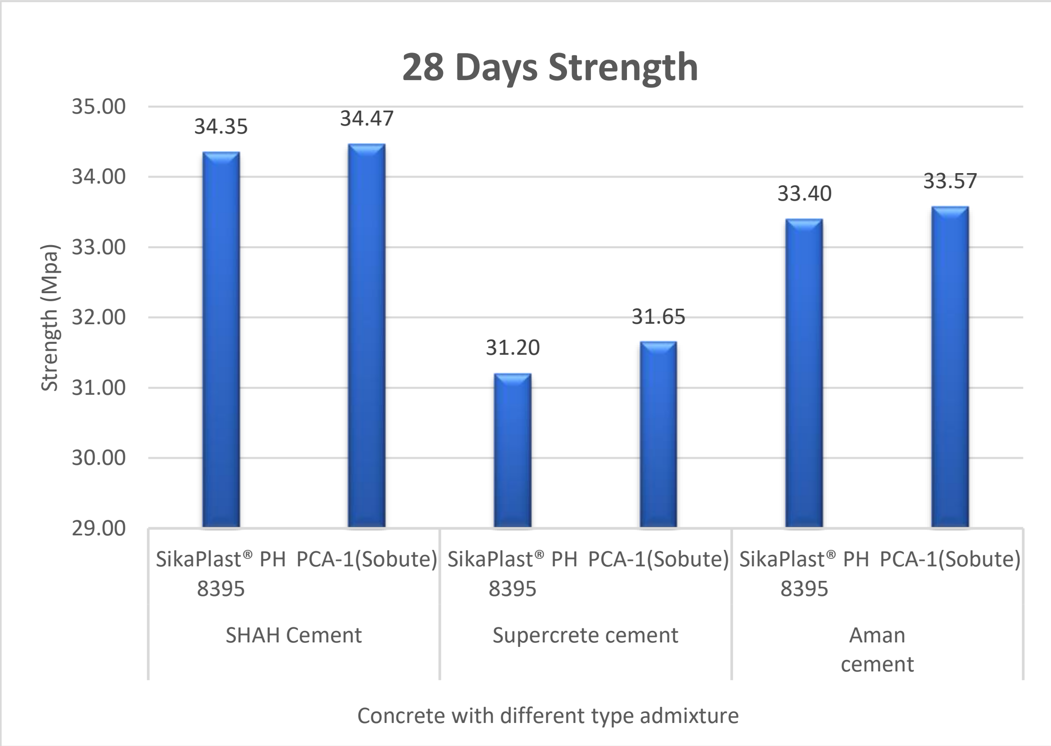

Figure 4.8: Compressive Strength of 28 days

4.3.3 Strength Development (14 → 28 Days)

All combinations exhibited normal hydration and strength gain patterns:

- Strength gain ranged from ~5 to 8 MPa.
- Shah Cement + PCA-1 recorded the highest strength gain.
- Supercrete combinations showed the lowest strength gain.

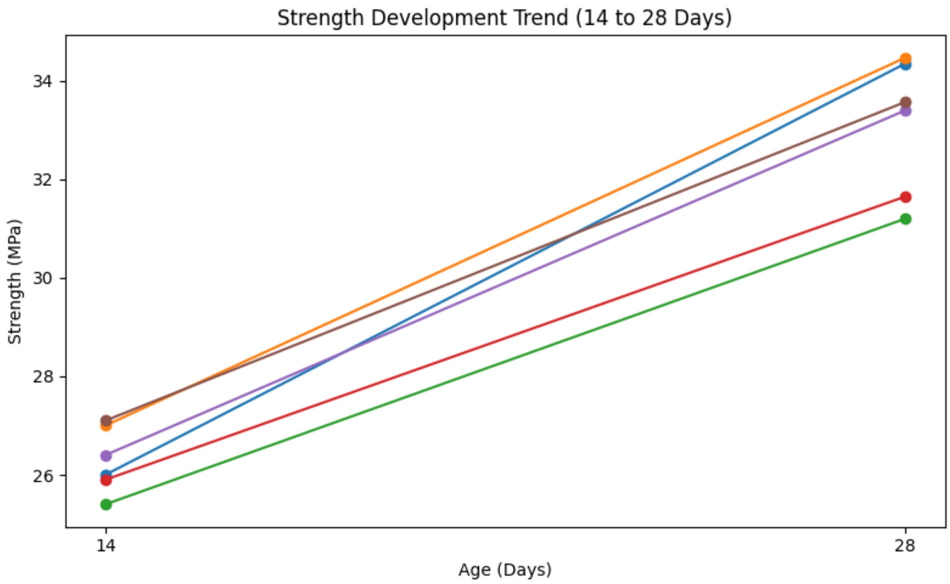

Figure 4.9: Strength Development Trend (14 to 28 Days)

4.4 Comparative Performance of Cement–Admixture Combinations

Best performing:

1. Shah + PCA-1 (34.47 MPa)
2. Shah + SikaPlast (34.35 MPa)
3. Aman + PCA-1 (33.57 MPa)

Weakest:

- Supercrete + SikaPlast (31.20 MPa)
- Supercrete + PCA-1 (31.65 MPa)

4.5 Effect of Admixtures on Compressive Strength

PCA-1 (Sobute):

- Produced the highest 14- and 28-day strengths.
- Enhanced early hydration.

SikaPlast® PH 8395:

- Improved workability.
- Slightly lower strength compared to PCA-1 but still well above C30 requirements.

4.6 Interpretation and Engineering Implications

- Shah Cement provides the most reliable long-term strength.
- Supercrete Cement develops adequate but comparatively lower strength.
- PCA-1 is the most effective admixture for enhancing strength.
- All mixtures exceeded the C30 requirement at 28 days.

CHAPTER 5
Conclusions and Future Works

5.1 Conclusions

This research was undertaken to evaluate and compare the compressive strength performance of concrete prepared with three commonly used local cement brands in Bangladesh—Shah Cement, Aman Cement, and Supercrete Cement—in combination with two widely available chemical admixtures, PCA-1 (Sobute) and SikaPlast® PH 8395. Through a series of controlled laboratory experiments involving material characterization, mix proportioning, concrete casting, curing, and strength testing, the study sought to determine how variations in cement type and admixture influence the strength development of C30 grade concrete.

Standard tests such as sieve analysis, unit weight determination, and specific gravity measurement were performed on fine and coarse aggregates to ensure the quality and uniformity of materials. Concrete cylinders were prepared using a consistent mix proportion of 1:1.5:3 with a water–cement ratio of 0.45, ensuring that differences in performance could be attributed primarily to cement and admixture types rather than variations in mix design. Compressive strength tests conducted at 14 days and 28 days provided essential data for comparing both early-age and long-term strength development.

The experimental findings show that the choice of cement has a notable impact on compressive strength, even when using identical mix proportions and curing conditions. Among the tested brands, certain cements exhibited higher early-age strength, while others demonstrated more pronounced strength gain at later ages. The inclusion of admixtures further influenced performance, with both PCA-1 and SikaPlast® PH 8395 enhancing workability and promoting improved strength outcomes compared to mixes without admixture. The results confirm that admixtures can play a significant role in optimizing concrete properties, especially when used with local cement types that differ in chemical composition and fineness.

Overall, the study's major contribution lies in offering an empirical comparison of widely available local cement brands under standardized laboratory conditions, providing practical insights for engineers, builders, and contractors in Bangladesh. The findings support more informed decision-making regarding material selection, particularly for structural concrete applications where consistent and reliable strength performance is essential. Moreover, the demonstrated benefits of incorporating admixtures highlight opportunities for improving cost efficiency, quality control, and construction productivity.

In conclusion, this research enhances the understanding of how cement type and admixture selection affect concrete strength development. The outcomes serve as a valuable reference for optimizing concrete mix design, ensuring better quality assurance in construction projects, and guiding material selection based on performance rather than solely cost or availability. Future studies may expand on this work by evaluating durability characteristics, long-term performance, and the interaction of cement–admixture combinations under varying environmental conditions.

5.2 Limitations

Limited Number of Cement Brands: The study included only three locally available cement brands (Shah Cement, Aman Cement, and Supercrete). Although these are popular in Bangladesh, they do not represent the full range of cement types used countrywide. Therefore, the findings cannot be generalized for all local or imported cement brands.

Restricted Types of Admixtures: Only two admixtures—PCA-1 (Sobute) and SikaPlast® PH-8395—were used. Many other admixtures such as high-range water reducers, retarders, accelerators, and viscosity-modifying agents are available in the construction market. Their absence limits the scope of comparison.

Single Mix Design (C30; 1:1.5:3) and Fixed Water–Cement Ratio: The concrete mix was restricted to one design with a fixed W/C ratio of 0.45. The effect of cement and admixtures may vary at different mix ratios (e.g., C25, C35, C40) or under higher/lower water content. Hence, conclusions are limited to this specific mix proportion.

Testing Conducted only at 14 and 28 Days: Compressive strength was measured at 14 and 28 days only. Concrete often shows significant strength gain at early age (3 or 7 days) and later age (56 or 90 days). The absence of those data restricts understanding of the full-strength development profile.

Uniform Testing Environment: All samples were cured under standard laboratory conditions. Real-world conditions—such as fluctuating temperature, humidity, curing deficiencies, or field curing practices—were not considered, which may influence actual performance.

Variation in Raw Materials: Sand and stone used for the tests came from specific local sources. Aggregates from different regions of Bangladesh differ in grading, mineral composition, and surface texture, which may affect concrete strength. This introduces a geographic limitation to the results.

Sample Size Constraints: The number of cylinders prepared for each cement-admixture combination may not be large enough to fully capture statistical variability. A larger sample size would provide more robust and reliable results.

Absence of Other Mechanical/ Durability Tests: The study focused solely on compressive strength. Other important properties such as tensile strength, flexural strength, modulus of elasticity, shrinkage, permeability, and chemical resistance were not evaluated.

5.3 Recommendations for Future Works

Include More Cement Brands and Types: Future studies should include a wider range of cement brands, including imported types and other categories such as Portland Composite Cement (PCC), Portland Pozzolana Cement (PPC), and Rapid Hardening Cement to generate a more comprehensive comparison.

Test Additional Admixture Categories: Expanding the study to cover multiple types of admixtures—super plasticizers, retarders, accelerators, air-entraining agents—would help assess their impact on strength and workability across different cement brands.

Investigate Multiple Mix Designs: Using different mix ratios (e.g., C25, C35, C40) and varying water–cement ratios would reveal how cement–admixture interaction behaves across different design requirements and strength grades.

Evaluate Strength at More Ages: Incorporating early-age (3 & 7 days) and long-term (56, 90, or 180 days) strength tests would provide a clearer understanding of initial strength gain and long-term durability.

Simulate Field Conditions: Conducting tests under varying curing environments, including field curing, poor curing, heat exposure, and moisture loss conditions, would make the results more applicable to real construction scenarios in Bangladesh.

Use Aggregates from Different Sources: Future work may include aggregates from various regions (Sylhet sand, river sand, crushed stone from different quarries) to understand how aggregate properties influence the performance of each cement–admixture combination.

Increase Sample Size for Statistical Reliability: A larger number of test cylinders per group would allow statistical analysis such as ANOVA or regression modeling, yielding more accurate and scientifically dependable results.

Incorporate Durability and Mechanical Tests: Future studies should examine additional parameters such as:

- Tensile & flexural strength
- Modulus of elasticity
- Sulphate resistance
- Chloride penetration
- Freeze–thaw resistance these tests would offer a complete performance profile of concrete.

Study Workability and Setting Time Effects: The impact of admixtures on slump value, workability retention, initial & final setting times should be analyzed to understand practical site-level performance.

Cost–Benefit Analysis: A comparative economic evaluation of using different cement brands and admixtures would be useful for contractors and engineers in selecting the most economical and efficient combination.

Machine Learning or Modeling Approaches: Future researchers may apply predictive modeling or machine learning to estimate compressive strength based on variables like cement type, admixture dosage, mix proportion, and curing age.

5.4 Summary

- All mixes achieved higher strength at 28 days compared to 14 days.
- Shah+ PCA-1 produced the highest compressive strength overall.
- Aman + PCA-1 performed well at early ages.
- All combinations achieved satisfactory C30-grade concrete strength.
- PCA-1 generally outperformed SikaPlast.
- Shah Cement produced the highest strength levels overall.
- Aggregate tests confirmed consistency and reliability of raw materials.

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