A Comparative Study of M_{10} and M_{15} Concrete's Strength Using Hand Mixing Method & Machine Mixing Method

Project and Thesis submitted in partial fulfillment of the requirements for the award of Degree of Bachelor of Science in Civil Engineering

Name	ID
Shazzad Hossain	191-47-899
Md.Ruhul Amin	191-47-940
Sabbir Hossain	191-47-996

Supervised by

J.M. Raisul Islam Shohag

Lecturer

Department of Civil Engineering

Daffodil International University

DEPARTMENT OF CIVIL ENGINEERING

DAFFODIL INTERNATIONAL UNIVERSITY

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Certification

The thesis titled "**A Comparative Study of M_{10} and M_{15} Concrete's Strength Using Hand Mixing Method & Machine Mixing Method**" Submitted by Shazzad Hossain, Md. Ruhul Amin and Sabbir Hossain have been accepted as satisfactory in partial fulfillment of the requirements for the degree of Bachelor of Science in Civil Engineering on October 2022. To the best of our knowledge, the thesis contains no materials previously published or written by another individual except where due reference is prepared in the capstone itself.

Name	**Signature**
Shazzad Hossain ID: 191-47-899	Sazzad
Md. Ruhul Amin ID: 191-47-940	Ruhul
Sabbir Hossain ID: 191-47-996	Hossain

Supervised by

03/11/2022

J.M. Raisul Islam Shohag
Lecturer
Department of Civil Engineering
Faculty of Engineering
Daffodil International University.

The thesis titled "A Comparative Study of M10 and M15 Concrete's Strength Using Hand Mixing Method & Machine Mixing Method" submitted by Shazzad Hossain, Md. Ruhul Amin and Sabbir Hossain have been accepted as satisfactory in partial fulfillment of the requirements for the degree of Bachelor of Science in Civil Engineering on 16-Oct-2022.

BOARD OF EXAMINERS

Mr. J.M. Raisul Islam Shohag
Supervisor
Department of Civil Engineering
Daffodil International University

03/11/2022

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Department of Civil Engineering
Daffodil International University

3.11.22

Dr. Muhammad Mukhlesur Rahman
Member (External)
Deputy Secretary
Ministry of Textiles and Jute
Govt of Bangladesh

16/10/2022

DECLARATION

The dissertation entitled “A Comparative Study of M_{10} and M_{15} Concrete’s Strength Using Hand Mixing Method & Machine Mixing Method” has been performed under the supervision of J.M. Raisul Islam Shohag (Lecturer), Department of Civil Engineering, Daffodil International University, Dhaka, Bangladesh and got approved in partial fulfillment of the requirement for the Bachelor of Science in Civil Engineering. To the best of our knowledge and belief, the capstone contains no materials previously published or written by another person except where due reference is made in the capstone itself.

Name of the supervisor

J.M.Raisul Islam Shohag
Lecturer
Department of Civil Engineering
Daffodil International University

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Name	**Signature**
Shazzad Hossain ID: 191-47-899	
Md.Ruhul Amin ID: 191-47-940	
Sabbir Hossain ID: 191-47-996	

Dedicated to

Our Parents

Abstract

The concrete cylindrical compression test was used in our studies of compressive strength tests as a partial replacement for fine aggregate. M_{10} concrete mix has a cement, fine aggregate and coarse aggregate ratio of 1:3:6, whereas M_{15} has a cement, fine aggregate and coarse aggregate ratio of 1:2:4.

Both Hand Mixing and Machine Mixing have been utilized in the production of concrete cylinders, and both M_{10} and M_{15} ratios have been achieved. When making concrete, it is common practice to mix the components by hand rather than using a mixer machine. Concrete mixing without a mixer is reserved for low-volume projects when both the quantity of concrete needed and the need of a consistent mix are minimal. Machine mixing refers to combining the concrete materials in a concrete mixer.

We began by sieving fine aggregates (sand) and course aggregates (stone chips). The slam test was then performed by mixing M_{10} and M_{15} concrete by hand and machine. We ended up making 36 concrete cylinders in total. On the UTM machine, we tested the compressive strength of those concrete cylinders.

Experiment were done to analyze the compressive strength of M_{10} and M_{15} concrete using hand mixing method and machine mixing method. Also, we compare compressive strength of M_{10} and M_{15} Concrete between hand mixing and machine mixing method. The Highest Compressive strength achieved by Hand Mixing method for M_{10} 4.46 N/mm^2 at 28 days. Study result reveals that highest Compressive strength achieved by Machine Mixing method for M_{10} 9.29 N/mm^2 at 28 days, the Highest Compressive strength achieved by Hand Mixing method for M_{15} 4.46 N/mm^2 at 28 days, the Highest Compressive strength achieved by Machine Mixing method for M_{15} 9.55 N/mm^2 at 28 days.

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List of Abbreviation

ASTM	American Society for Testing and Materials
CRE	Constant Rate of Extension
DIU	Daffodil International University
FM	Fineness Modulus
IS	International Standard
KN	Kilo Newton
MPa	Mega pascals
UTM	Universal Testing Machine

CHAPTER 1: INTRODUCTION

1.1 Background of the Study

The compressive strength of a structure has the most significant impact in its durability. The design parameters are influenced by a variety of variables, including specimen size and form, application of loading, material porosity, and transition zone porosity. Concrete's primary qualities, such as elastic modulus and compression strength, are correlated subjectively and quantitatively with its compressive strength, making it a significant feature. It is also essential in structural design, as the load-bearing capability of structures is correlated with concrete compressive strength. Typically, the concrete strength of structures is measured by casting and breaking smaller pieces of the same concrete. The majority of nations have their own standards for compressive testing of concrete, which vary in a number of ways, but most notably in the specimen used. Bangladesh also adheres to this testing standard. Cylindrical specimen (8" × 4") are utilized in the Bangladesh. This study examines the literature and tests on the relationship between cylinders and slab specimens of concrete, including testing standards and techniques, factors affecting the cylinder strength/cube strength, and a comparison of the strength test results of both specimens. The purpose of this study was to get a detailed understanding of the growth in strength of concrete with time and the difference in strength between cylinder and cube shapes. Concrete's compressive strength was determined by laboratory testing. In Dhaka, the availability of fine aggregates of natural sand is limited. In my research on compressive strength tests, fine aggregate was partially replaced with quarry dust. Alternately substituting quarry dust in fine aggregate mixing ratios between M10 and M15. For the research of workability, the mix proportions for M15 concrete are prepared with reference to IS: 10262-2009 and IS: 456-2000 (Srinivasa & Venkatesh, 2015)[1]. The ages at which the strengths were measured were 7, 14, and 28 days. The compression test compressive strength significantly increased from 0% replacement to 20% replacement. At 30% replacement, the comparable compression test compressive strength decreases marginally. There was a strong association between the compression test and the compressive strength. It was noticed that the addition of quarry dust, which would replace the fine material in a certain proportion, improved the qualities of concrete.

This study demonstrates that gravel can be utilized as a partial replacement for natural sand in the production of concrete.

1.2 Problem Statement

The strengths that were measured using 36 concrete cylinders that were cast, cured, and crushed at the ages of 7, 14, 21, and 28 days were 7, 14, 21 and 28 days respectively (Yang & Cao, 2016). These strengths were measured using the curing ages[2]. The grading of the aggregate, the ratio of the aggregate to the cement, and the water-to-cement ratio are the three factors that define the compressive strength of concrete. Concrete that has just been mixed needs to be pliable so that it may be correctly placed, but concrete that has been allowed to solidify needs to be long-lasting and acquire a certain compressive strength. The production of concrete that has the appropriate strength is the goal of the design process for concrete mixes. More than any other factors, the ratio of water to cement and the degree of compaction affect the strength of concrete at a specific age. The percentage of water to cement has an inverse relationship with the compressive strength of concrete after it has been thoroughly compacted. Its workability, durability, resistance to compressive stress, and ability to prevent corrosion in steel are the four most important qualities of concrete. Concrete can also prevent corrosion in its own form.

1.3 Objective of the Study

The main objective of this study is to analyze the overall M_{10} and M_{15} ratios of hand mixed and machine mixed compressive strength test. Apart from this central objective, other specific objectives are as follows:

1. To analyze the compressive strength of M_{10} & M_{15} concrete using Hand mixing method and Machine mixing method.

2. To compare the compressive of M_{10} & M_{15} concrete strength between Hand Mixing Method & Machine Mixing Method.

1.4 Significance of the Study

Most engineers think that "compressive strength" is the most important of the three ways to measure the strength of a concrete structure. A material or structure's compressive strength is how well it can stand up to loads that try to make it smaller. Most of the time, it is measured with a Universal Testing Machine (UTM) and reported according to a technical standard that has already been set. According to the International Standard (IS), "The "Strength of Concrete" usually means its "Compressive strength," which is measured by the "Typical Compressive strength of (8" × 4") size concrete cylinder tested at 28 days." The "Distinctive strength of Concrete" is just called "the strength of Concrete." Also, it's important to note that the Compressive-strength values of each of the thirty-six (36) Concrete-samples at all Curing-ages [1, 3, 7, 14, 21 and 28 days] for both Strength grades M10 and M15 were found to vary by only a small amount.

1.5 Scope of the Study

During the experiment of this studies M_{10} and M_{15} grade of concrete was insincere and the mixtures were altered by exchanging hand mixed and semi-automated machine mixed. By using a compression testing machine, we determined that the strength of the concrete was measured in terms of its compressive strength.

1. The tested concrete's compressive strength M_{10} and M_{15}.
2. There is a correlation between the percentage of substitute material and the change in compressive strength.
3. It is possible for us to sand and concrete material for fine aggregate.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

In this chapter, the existing literature relevant to the entitled of research has reviewed. During the literature review process, several resources, such as books, articles of journal, articles in news reports, published doctoral repository, websites etc. have examined. The objective wise literature analysis is done in this chapter to gain a better insight to the research problem.

2.2 M-10 and M-15 Ratios Concept of Engineering

The concrete cylinder test is a good indicator of all of the other qualities of concrete because it measures the concrete's compressive strength. Simply by looking at this one indicator, you will be able to determine whether or not the concrete work was completed successfully. In the construction of residential and light commercial buildings, we use concrete with a compressive strength of 15 MPa (2200 psi), whereas in the construction of major industrial and institutional buildings, we use concrete with a compressive strength of 30 MPa (4400 psi) or more (Georgy et al., 2022) [5].

Yang and Wang (2022) studies The compressive strength of concrete is influenced by a wide variety of parameters, including the ratio of water to cement, the strength of the cement, the quality of the concrete material, the quality control of the production process, and many more. [4] For the purpose of determining a material's compressive strength, a cube or cylinder is typically utilized. As the standard test specimen, a concrete cube or cylinder is required by a number of different codes. ASTM C39/C39M is the designation given to the standard test technique that has been issued by the American Society for Testing and Materials (ASTM) for the purpose of assessing the compressive strength of cylindrical concrete specimens.

2.2.1 M_{10} and M_{15} for Concrete Sand, Cement and Aggregate

This page explains how much cement, sand, and aggregate 1 cubic meter of M15 concrete requires [5]. In addition, we will learn how much cement is needed for M15 concrete and how to calculate the amount of cement, sand, and aggregate needed for 1 cubic meter of M15 grade concrete.

Numerous concrete grades, including M25, M20, M15, M10, M7.5 and M5, are considered minimum mix range of concrete. The initial M in the situation signifies both the mix and a numerical value. 25, 20, 15,10,7. The compressive strength of concrete increases during the 28-day period following curing, as demonstrated by the features [6].

Concrete is classified into the hypothetical mix classes of M25, M20, M15, M10, M7.5, and M5. The letter M denotes the mix, and the numerals 25, 20, 15,10,7, and 5 indicate the the compression strength of the concrete. 28 days after the process of curing [7].

Table 2.1: various concrete grades and their compressive strength in N/mm^2

Grade of concrete	Compressive strength
M25	25 N/mm^2
M20	20 N/mm^2
M15	15 N/mm^2
M10	10 $N|mm^2$
M7.5	7.5 N/mm_2
M5	5 N/mm^2

What You Need to Know Different varieties of concrete are categorized based on their strength and the ingredients used to make them, which are commonly cement, sand, and aggregate. Concrete's minimum strength for a certain slope is determined by testing it again 28 days after it was first poured. Concrete's compressive strength is measured in mega Pascals (MPa) or newton’s per millimeter squared (N/mm2), where M stands for mix and MPa reflects the complete compressive strength qualities of the concrete. Concrete grades are based on the material's compressive strength.

Table 2.2: varying grades of concrete, each with their own unique compressive strength measured in N/mm^2

Grade of concrete	Compressive strength
M25	25 N/mm^2
M20	20 $N|mm^2$
M15	15 N/mm^2
M10	10 N/mm^2
M75	75 N/mm^2
M5	5 $N|mm^2$

The grades of concrete are defined by their minimum required strength after 28 days of initial construction as well as the strength and composition of the concrete-making materials used in the mix. Concrete quality is expressed in terms of its compressive strength, which is measured in N/mm2 or MPa.

The quality of concrete can be divided into three categories. There are three types of concrete: 1) regular concrete, 2) regular concrete, and 3) high strength concrete. Normal grade concrete, which uses nominal mix ratios of cement, sand, and aggregate, has a weaker compressive strength than standard grade concrete [8].

Based on the notional mix proportions of cement, sand, and aggregate, standard concrete grades include M25, M20, M15, M10, M7.5, and M5.

Construction of skyscrapers, factories, stores, offices, homes, apartments, bridges, dams, and other massive constructions requires standard grade and high strength concrete.

Table 2.3: Various forms and grades of concrete

Grade of concrete	Concrete types	Mix
m5,m7.5, m10, m15, m20	normal grade of concrete	nominal mix ratio
m25,m30, m35,m40, m45	standard grade of concrete	design mix ratio
m50,m55, m60,m65, m70	high strength grade of concrete	design mix ratio

Depending on the grade of concrete being produced, there are two sorts of mix ratios for concrete: the nominal mix and the design mix. The IS456 code book recommends that lower and normal grades of concrete, including M25, M20, M15, M10, M7.5, and M5, have a fixed cement sand and aggregate ratio[9].

The IS 456 code manual for design mix concrete stipulates that numerous parameters, such as huge pile structures, seismic susceptibility, resultant force of column, climatic influences, and cleanliness of lime natural sand, must be considered whenever making plus high strong concrete grades.

Table 2.4: mix ratio that determines the grade and mix ratio of concrete

Grade of concrete	Nominal mix ratio
M25	1:1:2
M20	1:1.5:3
M15	1:2:4
M10	1:3:6
MZ5	1:4:8
M5	1:5:10

The letter M denotes the mix, and the digits 10 and 15 show that the compressive strength of the concrete is 15N/mm^2 once it has been allowed to cure for 28 days. The ratio of water to cement, sand, and aggregate in m15 concrete is 1:2:4 with one component cement, two parts sand and four parts aggregate all together. The material known as M15 is produced by adding water to one part cement, two parts sand and four parts aggregate, then mixing the resulting mixture. The volume of cement, aggregate, and sand required for m10 and m15 concrete expressed in cubic meters, cubic feet, and kilograms, respectively [10].

Table 2.5: M15 concrete cement quantity in bags and kilograms, aggregate and sand quantities in cubic meters, cubic feet, and kilograms

Grade of concrete	bags	Kg	Cft	m^3
cement quantity	6.34	317		0.22
Sand quantity	---	713	20	0.44
Aggregate quantity	---	1364	39	0.88

Concrete is a mixture composed of lime, aggregate with sand. Designing a concrete mix is the process of determining the correct proportions of various ingredients to obtain the desired strength. Accurate concrete mix design makes concrete building inexpensive. Large structures, such as bridges and dams, necessitate enormous quantities of concrete; employing the correct proportions of elements makes the structure inexpensive. To calculate or identify the correct mix of cement, silica and aggregate necessary in 100 square feet of concrete, one must be conversant with the different concrete grades.

Table 2.6: Concrete grades require different amounts of cement, sand, aggregate and water

Amount of Cement, Sand, Aggregate and Water in Different Grades of Concrete				
Mix	Ratio	Cement in Kgs	Sand in Kgs	Water in Litres
M5	1:5:10	141.00	785.00	70.50
M7.5	1:4:8	174.00	773.00	87.00
M10	1:3:6	226.00	753.60	113.00
M15	1:2:4	322.00	717.80	161.00
M20	1:1.5:3	403.20	672.00	201.60
M25	1:1:2	565.00	565.00	282.50
M30	1:1:3	452.00	452.00	226.00
The above values are approximate values and may change according to the presence of moisture content in the constituents.				

2.3 Water-Cementing Materials Ratio and Strength Relationship

The most widely used metric for evaluating concrete's quality is its strength (compressive or flexural). Durability, permeability, and wear resistance are now seen as equally as critical, if not more so, than fire resistance when it comes to the life-cycle design of buildings.

The compressive strength of concrete is related to the inverse of the water-cement (or water-cementing materials) ratio within the typical strength range used in construction. Strength and other desirable qualities of concrete under specific work conditions are controlled by the amount of mixing water used per unit of cement or cementing materials for fully compacted concrete made with clean, sound aggregates.

Cementations paste binders in concrete vary in strength depending on the type of cement used, the amount of reactive paste components, and the level of hydration. Concrete hardens and strengthens over time in the presence of water and the right temperature. As a result, the strength at a particular age is dependent on the original water cementations material ratio as well as the degree to which the cementitious materials have hydrated. It's not hard to see why prompt and thorough care is so important [11].

Although the water-to-cement ratio in concrete should be constant, there can still be variations in the concrete's strength. Changes in (1) aggregate size, grading, surface texture, shape, strength, and stiffness; (2) binding agent kind and nature; (3) entrained-air information; (4) the occurrence of mixes; and (5) curing size can all contribute to these distinctions.

2.3.1 Strength

It is required that the average of any series of three consecutive strength tests meet or exceed the specified compressive strength, $\int_{c}^{\prime}$, at 28 days. This requirement applies to any series of strength tests[12].

Allowances for variances in the concrete's ingredients, mixing, transportation, and placement, as well as the making, curing, and testing of concrete cylinder samples, should indeed be built into the specified strength to arrive at an accurate average strength. These variations are necessary to account for. The term "$\int_{c}^{\prime}$ " refers to an average strength that is higher than "$\int_{c}^{\prime}$," and is the strength that is required by the mix design. In the following section of this chapter, under the heading "Proportioning," we will discuss the essential parts of $\int_{cr}^{\prime}$, in further detail. Tables 9-1 and 9-2 provide a summary of the required levels of tensile and shear strength, respectively, which can vary according on the conditions of the environment.

Table 2.7: Maximum water-cement ratios and minimum design strengths for various exposures

Exposure condition	Concrete's maximum water-to-cement ratio	Minimum compressive design strength, $\int_{c}^{\prime}$ MPa (psi)
Protected concrete from exposure to freezing and thawing, deicing agents, and corrosive substances.	Based on strength, workability, and surface polish, determine the water-cementations material ratio.	Select strength based on structural requirements

Concrete designed to be impermeable to water when exposed to it	0.50	28 (4000)
Moisture-exposed, freezing-and-thawing-exposed concrete or deicers	0.45	31 (4500)
Reinforced concrete requires special protection against chlorides present in de-icing salts, salt water, brackish water, and spray from these environments.	0.40	35 (5000)

On occasion, flexural strength is substituted for compressive strength on paving projects; nevertheless, flexural strength is avoided due to its increased unpredictability.

2.3.2 Water Cementations Material Ratio

Calculating the water-to-cement-materials ratio is as easy as dividing the mass of water by the amount of cement (Portland cement, blended cement, fly ash, slag, silica fume, and natural pozzolans). While designing a mix, the ratio of water to cementitious materials must be kept as low as possible while yet providing adequate resistance to environmental hazards [13].

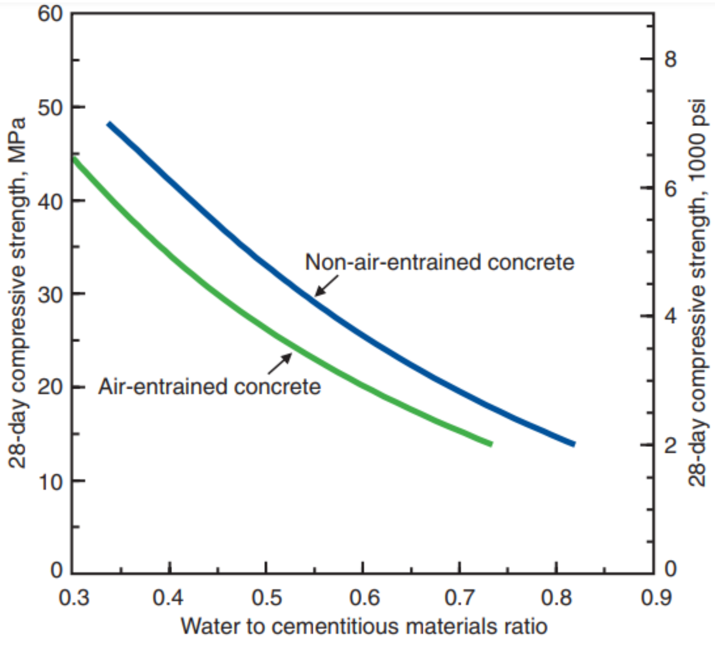

Figure 2.1: Based on compressive strength, concrete with coarse aggregate between 19 and 25 millimeters (34 and 1 inch) has a 1:2:1 water-to-cementing-materials ratio.
ASTM C 31 requires 28 days of curing in moist circumstances for cylinder strength.
In mix design, the water to cementations materials ratio, W/CM, is often used synonymously with water to cement ratio (W/C); however, some specifications differentiate between the two ratios. Traditionally, the water to cement ratio referred to the ratio of water to Portland cement or water to blended cement.

2.3.3 Aggregates

Because of their impact on the fresh concrete's workability, two features of aggregates have a significant impact on the proportioning of concrete mixtures.

1. Evaluation
2. The nature of particles

Because grading impacts how much concrete can be produced from a given amount of cementation ingredients and water, it is crucial for achieving a cost-effective mixture. Aggregates should be crushed as coarse as possible under the circumstances of the project. The greatest size that can be employed is determined by the size and shape of the structural core, the amount and placement of reinforcing steel, and or the slab height. The concrete's manageability and scalability in the worksite are also affected by the grading. When there isn't enough aggregate in the 9.5 mm (3 8 in.) range, the concrete can have undesirable qualities such increased shrinkage, increased water demand, and poor practicability and normal furniture . traditional tables. The durability could be impacted as well. A wide range of choices exist for achieving desirable aggregate grading [14].

The maximum size of crushed aggregate should always be one-fifth the narrowest length adjacent formed sides, or multiple the free space across solitary rebar or wire, bunches of bars, or prestressing tendons or ducts. A decent rule of thumb is to keep aggregate sizes to no more than three-quarters of the free space among reinforcement and the form. A ground slab should not be more than a third of its thickness if it is not strengthened. When practical or financially necessary, smaller sizes may be used.

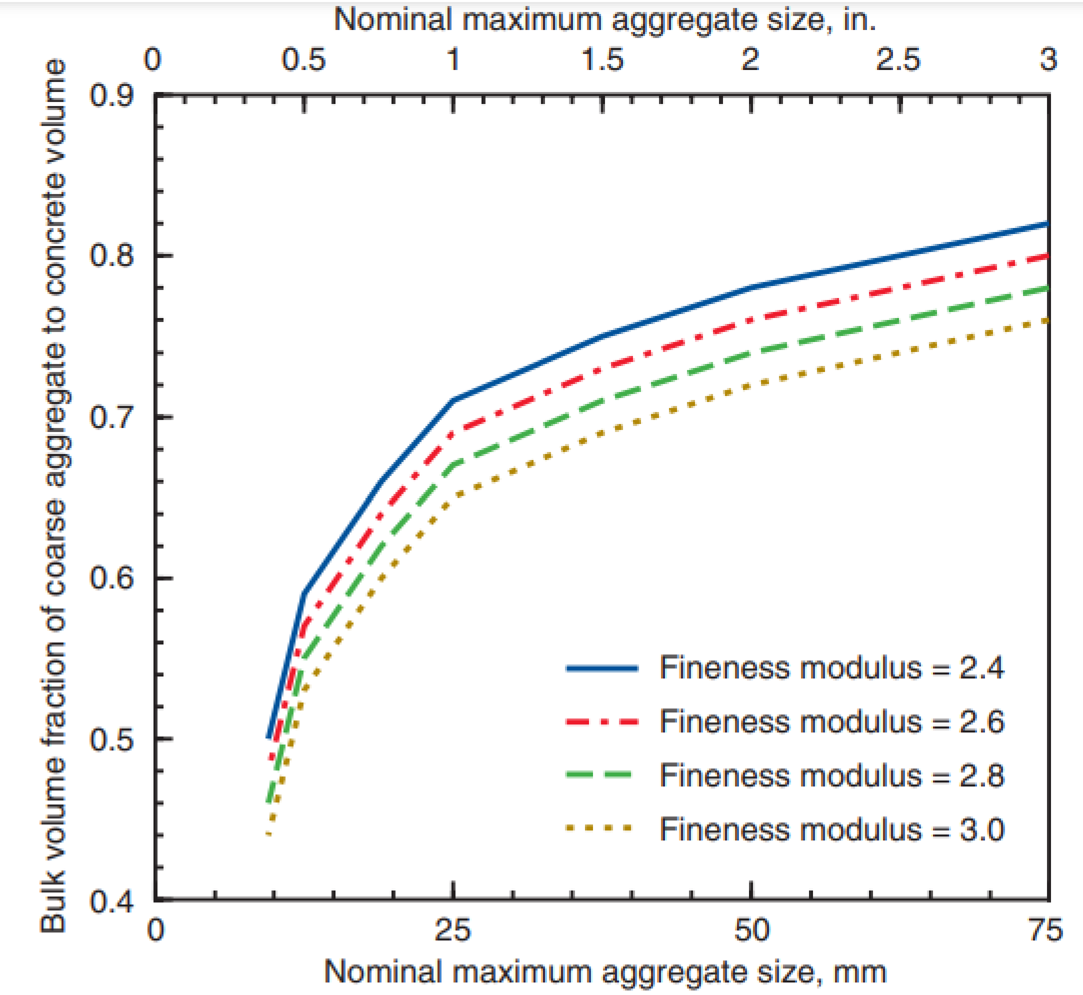

Figure 2.2: Per-unit-volume coarse aggregate. Bulk amounts based on ASTM C 29 dry-rodded aggregates. For pumpable concrete, they can be reduced by 10%.

Depending on the aggregate source, shape, and grading, the maximum size of fine aggregates that will generate maximum strength for a given cement concentration will vary. The highest allowable size for high-compressive-strength concrete (more than 70 MPa or 10,000 psi) is around 19 mm (3 4 in.). Additionally, crushed stone aggregate, as opposed to rounded-gravel aggregate, can occasionally be used to obtain higher strengths.

Based on the task at hand, the amount of paste in the combination, and the size of the coarse aggregate, an optimal fine-aggregate grading can be determined. A finer grading (lower fineness modulus) is preferred for more manageable mixing of leaner combinations. Coarser grading (a greater fineness modulus) is utilized to maximize efficiency when working with more expensive, concentrated blends [15].

2.3.4 Slump

Concrete should always have the right consistency, plasticity, and practicability for the task at hand. How easy or difficult it is to put, consolidate, and finish concrete is referred to as its "workability." Freshly mixed concrete has flow ability when it is consistent [16].. How readily concrete may be shaped depends on its plasticity. More aggregate or less water in a concrete mix makes for a less plastic and less workable composition that is harder to shape. Very dry, crumbly combinations are not considered to have plasticity, nor are very wet, fluid mixtures. The consistency of concrete can be evaluated with the help of the slump test. The higher the slump, the more water there is in the mixture for a standard cement-to-aggregate ratio. When comparing two or more identical mixtures, slump is a good indicator of their workability.

2.3.5 Water Content

Water content in concrete is influenced by aggregate size, shape, thickness, slump, water to fastening materials ratio, dry density, cementing materials type and content, additives, and external conditions. Water usage can be reduced by using curved aggregates, water-lowering admixtures, or industrial waste, as well as raising the flow rate and aggregate size, decreasing the rain materials ratio, and increasing the slump. Higher temperatures, higher cement contents, lower slump, a higher water-to-cement ratio, clearer aggregate appearance, and a lower texture aggregate ratio, on the other hand, will all need more water [17].

2.3.6 Cementing Materials Content and Type

Typically, the cemented materials content is decided by the selected water-cementing materials ratio and water content; however, requirements frequently contain a minimum cement content in addition to a maximum water-cementing materials ratio. Minimum cement content standards assist to maintain adequate durability and finish ability, enhance the wear resistance of slabs, and ensure that vertical surfaces have an acceptable look. This is essential, despite the fact that strength requirements can be satisfied with lesser cementing material contents. However, overly large quantities of cementing ingredients should be avoided in order to preserve economy in the mixture and to prevent detrimental effects on workability and other qualities.

2.4 Compressive Strength of Concrete

Compressive strength of concrete is affected by many factors, including water-to-cement ratio, degree of compaction, cement-to-aggregate ratio, binding strength of mortar, and aggregate grading, shape, strength, and size. Fell and Newton (1970) Measuring the compressive strength of hardened concrete at 28 days is a standard way to assess the quality of a concrete job[18]. A concrete specimen can be broken in a compression testing machine to perform this test. Standard concrete examples are either 150 mm (3.94 in) cubes or 150 mm (9.8 in) cylinders in diameter. The strength of a cylinder is approximately 80% that of a cube (Hiramatsu & Oka, 1966) [19].

2.5 Effect of Ingredients on Compressive Strength of Concrete

Only five of the combinations that were examined by Nagashima et al. (1992) had a cube compressive strength that was greater than the requisite 25N/mm^2. The researchers tested a total of twelve samples. Following that, it was recommended that these five samples be utilized in the process of constructing the reinforced load-bearing structural components of the structure. The four remaining combinations had compressive strengths that ranged from 19.3N/mm^2 to 17.9N/mm^2, whereas the other three combinations had values that were greater than 20N/mm^2 and were therefore appropriate for use in the building of plain concrete. They came to the conclusion that the compressive strengths of the various aggregates are distinct from one another. According to Kamst et al. (1999), river gravel is the type of aggregate that produces the most workable concrete [21]. Crushed quartzite and crushed granite come in second and third, respectively. The compressive strength of granite aggregate concrete is the lowest, followed by river gravel and lastly quartzite aggregate concrete. In addition to suggesting that people who work with concrete make use of aggregate derived from quartzite[22], he also provided models of compressive strength that were based on how old the concrete was when it was cured. Test results among 108 samples of concrete cylinders (150mm300mm) tested with six nominal sizes of coarse aggregate (12.5, 19.0, 25.0, 32.0, and 38.0 mm) and six cement contents (150, 200, 250, 300, 350, and 400 kg/m3 of concrete) considering a water-cement ratio of 0.5 by weight show that the strength of concrete increases with the increase in cement content of concrete. These test results were published by Lamothe and Nunes (1983), When the cement concentration in the concrete is set at 150 kg/m3, a commensurate rise in the strength of the concrete occurs whenever the size of the coarse aggregate is increased [23] However, when the cement concentration in the concrete is greater than 150 kg/m3, the strength increases up to a coarse aggregate size of 25 mm but then begins to decrease beyond that point [24].

According to the findings of a research project (Freeda et al., 2013), it was found that in order to make quarry dust concrete workable, an increased amount of water was required in comparison to standard concrete. The ratio of water to cement was increased from 0.5 to 0.65 in increments of 0.05, and during this process, the compressive strength and split tensile strength of all quarry dust concrete grades tended to drop by a certain proportion at each increment [25].

2.6 Research Gap

In Bangladesh, there have only been a handful of studies conducted to determine the effect that different aggregate sources have on the compressive strength of concrete. Researchers reveal that the source of coarse aggregate had significant variance in the compressive strength of various grades of nominal concrete mix in the research paper that was released by (Zhao et al., 2018). The research that has been done on this research topic is one of the few that has been done in this experiment. This means that the research cannot cover an emerging city like Dhaka. This research will be carried out in the rivers sources from where supplies are made in Chittagong city in order to satisfy the gap in research that exists between established cities and developing cities.

CHAPTER 3: MATERIAL AND TEST PROGRAM

3.1 Material

Materials that are used in the creation of artificial parts and buildings are known as engineering materials. One of the most fundamental roles of any engineering material is to resist strain without rupturing or buckling under the load.

3.1.1 Water Used

In the calculating ratio for cement, we used sixty percent for M-15 and thirty-five percent water. For M-10, we used sixty percent for M-15. In order for the concrete to be mixed properly, the water must be devoid of any contaminants. We are able to determine the qualities of the cement, such as how the concrete flows, by varying the amount of water content in relation to the cement. However, this will also have an effect on the strength of the concrete. When there is an abundance of water, concrete will flow freely; however, this will result in a reduction in the concrete's strength.

3.1.2 Portland Cement

As a fundamental component of concrete, mortar, stucco, and grout that is not considered speciality grout, Portland cement is by far the most prevalent form of cement used in conventional construction around the world. Limestone is typically used in the production of this type of hydraulic lime, which was invented by Joseph Aspdin in England at the beginning of the 19th century from previous varieties of hydraulic lime. It is a fine powder that is manufactured by first forming clinker by burning limestone and clay minerals in a kiln to generate clinker, then grinding the clinker, and then adding between 2 and 3 percent of gypsum and an experimentally used brand of Bangladeshi cement called Fresh Cement. The following is a list of the cement ratios that we employed for our experiment:

$4.68 \times 2 = M\ 15\ (in\ Kilogram)$

$3.28 \times 2 = M\ 10\ (in\ Kilogram)$

3.1.3 Aggregates

Gravel, crushed stone, and sand are all types of aggregates, which are formed from natural resources and extracted from quarries and pits. A multitude of construction and building applications employ aggregates. When coupled with a binding medium like as water, cement, or asphalt, they are utilized in the manufacturing of composite materials such as asphalt concrete and Portland cement concrete. Our excremental used stone chips measures:

$21.22 \times 2 = M\ 15\ (in\ Kilogram)$

$22.65 \times 2 = M\ 10\ (in\ Kilogram)$

3.1.4 Use Sand for Experiment

Sand is a combination of different sized rock grains and other granular elements. Its primary distinguishing characteristic is its particle size, which places it between gravel and silt on the spectrum. And ranging in size from 0.062 mm all the way up to 2.0 mm. Sand is the material that we utilized for the sample:

$10.54 \times 2 = M\ 15\ (in\ Kilogram)$

$11.07 \times 2 = M\ 10\ (in\ Kilogram)$

Figure 3.1: Sylhet sand collect for experimental

We use a mixture of different kinds of sand from Sylhet's rivers and hills. Compared to other types of sand, this one has bigger particles that are all about the same size. Its FM range is from 2.3 to 2.9. For this study, Sylhet sand was used, and its FM was found to be 2.72.

3.2 Equipment and Tools

All items that are considered to be machinery and equipment fall under this category. This includes industrial fixtures, devices, and support facilities, as well as tangible personal property that forms an ingredient or component thereof. This also includes repair parts and replacement parts.

3.2.1 Semi-Automatic Concrete Mixer Machines

According on the project delivery method, these brick mixing are also classified. A sources of energy hopper is used to load cement, sand, as well as other materials, which are subsequently put into the mixing machine for finishing blending. The drum can be tipped to facilitate unloading. Cement, grit, and other materials are manually added to the mixing drum of hand-feed construction of foundation. Both of these types of concrete mixers are widely used in construction projects in Bangladesh, which is located on the subcontinent of India. 30 minutes per sample pair for every study.

Figure 3.2: Semi-automatic Concrete Mixer Machines

Though gasoline engines can be used to power portable concrete mixers, electric motors that are fed from the mains are by far the most common power source.

3.2.2 Concrete Slump Test

The concrete slump test is used to determine how consistent freshly mixed concrete is before it hardens. The workability of freshly created concrete, and consequently the ease with which concrete flows, is evaluated during this step of the process. It is also possible to use it as an indicator of a batch that was not mixed properly. The straightforward nature of the process and the straightforward nature of the instrument used in the test contribute to its widespread use. Under real-world situations, the slump test is used to guarantee that varied loads of concrete have the same uniform slump.

Figure 3.3: Concrete Slump Test and Observed

In order to be helpful in the test, a slump must be genuine. In most cases, a collapse slump indicates that the mixture is either excessively moist or that it is a high workability mix, both of which indicate that the slump test is not suited for the mixture. Very dry mixes with a slump of 0 to 25 millimeters are typically used in the construction of roads and pavements. Low workability mixtures with a slump of 10 to

40 millimeters are commonly utilized for light reinforce constructions. Mixtures with a slump between 50 and 90 millimeters are commonly utilized for vibration-placed, conventionally concrete slabs. In instances where reinforcement is studded, high workability clay with such a slump greater than 100 millimeters is often employed.

3.2.3 Ranging Rod

We are used ranging rod (see Fig. 3.4) are used to mark areas and to set out straight lines on the field. They are also used to mark points which must be seen from a distance, in which case a flag may be attached to improve the visibility.

Figure 3.4: Red color selected Ranging Rod tools.

3.2.4 UTM Machine

To determine the tensile and compressive strengths of materials, experts turn to a universal testing machine (UTM), also known as a universal tester, materials testing machine, or materials test frame. The modern term for a tensile testing machine is tensometer, but the term has been used for a while. The "universal" in its name indicates that it is capable of conducting a wide variety of standard tensile and compression tests on a wide variety of materials, components, and structures.

Figure 3.5: UTM Machine use for Compression Test

A load frame is a pair of sturdy uprights that hold up a piece of machinery. One leg is all that holds up certain miniature machinery. A force transducer or other load-measuring device is necessary. Many quality management and regulatory bodies stipulate that periodic calibration is necessary. Adjustable cross head (crosshead) can be raised or lowered at the touch of a button. This is typically done at a consistent rate, earning the device the moniker "constant rate of extension" (CRE) machine. The crosshead speed may be programmed on some machines, and they can also be set to perform constant force testing, constant deformation testing, and so forth. Technology such as electromechanical, servo-hydraulic, linear drive, and resonance drive are all put to good use.

Specimen reaction to cross head motion can be measured by using an elongation or deformation measurement device. Extensometers see occasional use in practice. Device for displaying test results; an output is required. Dial or digital screens and chart recorders can be found on certain older devices. The ability to analyze and print from many modern equipment is made possible by their computer interface.

Controlled conditioning is a necessary pre-requisite for many types of examinations. A customized environmental chamber can be set up around the testing specimen or the machine can be placed in a controlled room. Many testing procedures require special test fixtures, specimen holding jaws, and other sample preparation tools.

3.2.5 Digital Scale Machine

Digital weight machine used for analytical balance is a class of balance designed to measure small mass in the sub-milligram range. The measuring pan of an analytical balance (0.1 mg or better) is inside a transparent enclosure with doors so that dust does not collect and so any air currents in the room do not affect the balance's operation. This enclosure is often called a draft shield.

Figure 3.6: Digital Scaling Machine use for Weight Measures

Electronic analytical scales measure the force needed to counter the mass being measured rather than using actual masses. As such they must have calibration adjustments made to compensate for gravitational differences. We use an electromagnet to generate a force to counter the sample being measured and output the result by measuring the force needed to achieve balance. Such a measurement device is called an electromagnetic force restoration sensor.

3.2.6 Mold cylinder

To make cylinder test specimens, concrete cylinder molds are utilized. Molds for cylinders are made of plastic or steel. The plastic concrete cylinder molds are in contrast to the reusable molds. The molds are available in several sizes, including: 8"×4" (height × diameter).

Figure 3.7: Mold cylinder

3.2.7 Other Tools

Head Pan: Head pans are made of iron and are used to transport excavated soil, cement, or concrete to the working site, etc. They are most frequently found on construction sites.

Hoe: Hoe is also used to extract soil, however in this case, the metal plate is angled sharply with respect to the wooden handle.

Spade: The spade is used to excavate foundation trenches, etc. A metal plate is attached at the end of the long wooden handle.

Trowel: Trowel is used to lift and apply small amounts of cement mortar. It is composed of steel and has a wooden handle for gripping. Trowels may have pointy or bull-nosed ends.

3.3 Compression Test Procedure

Compression testing, along with tensile and deflection testing, is one of the most fundamental types of mechanical testing. Compression tests entail applying a compressive force to a test specimen (often having a cube shaped or cylindrical shape) using platens or specific components on a universal testing machine. These tests are designed to determine how a material reacts to breaking forces. During the test, a pressure model is drawn that displays the material's endurance deformation, Poisson’s ratio, shear modulus, yield strength, and even in some instances, its compressive strength.

3.3.1 Perform Compression Test

Multiple steps of manufacturing offer producers the opportunity to evaluate the integrity and security of their material, elements, and finished goods through compression testing. This method could have been used to test the structural stress of a car windshield and the durability of construction-related concrete, to name two promising utility. Though that's not always true, materials with a high tensile strength typically have a low compressive strength. In a similar manner, materials having a high compressive strength typically have a low tensile strength. Due to the brittle nature of materials including concrete, metals, plastics, ceramics, composites, and corrugated materials like cardboard, compress testing is frequently employed in quality controls. These polymers are frequently employed in load-bearing capacities that require a high level of building structure, despite being treated to compression.

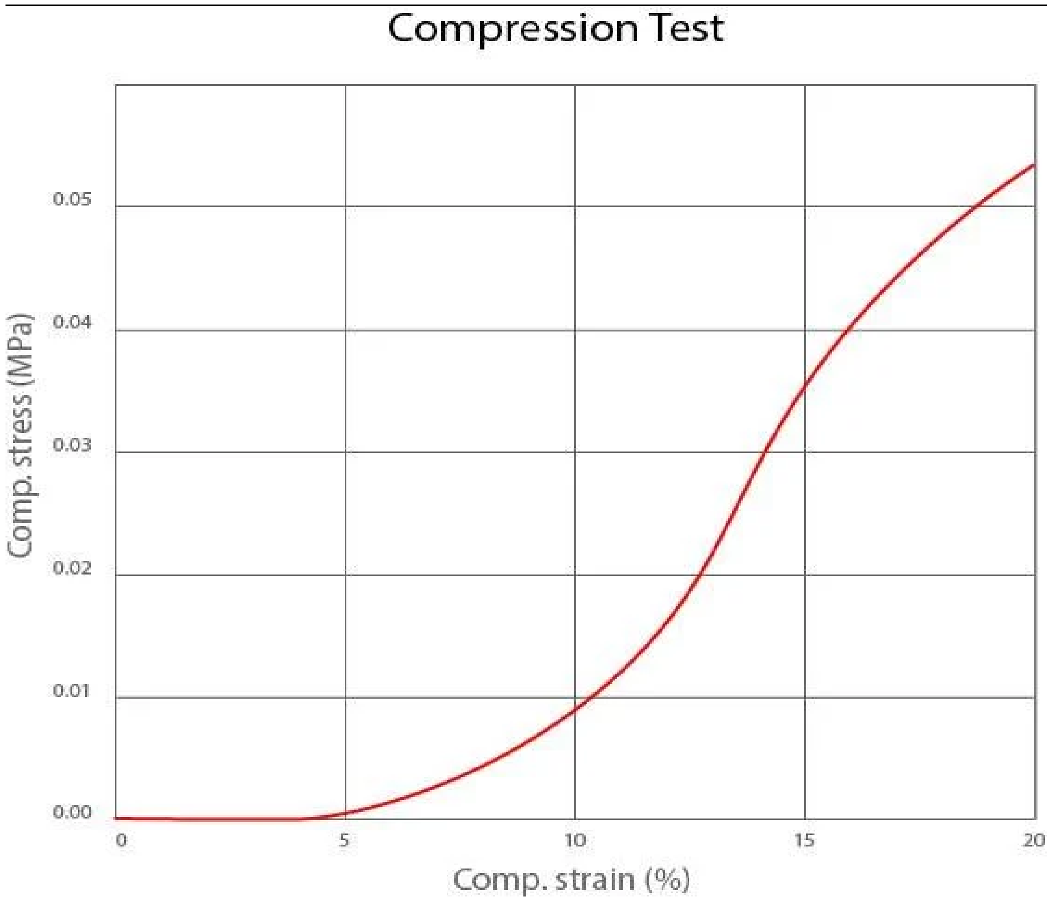

Figure 3.8: Compression Test Model; Source: Hiramatsu (1966)

In contrast to strength test, compressing experiments are often conducted on manufactured things as opposed to raw materials. Fracture toughness testing must be conducted on products such as tennis balls, golf balls, water bottles, protective receptacles, similar materials, and upholstery. Scientists may build water bottles with thinner walls to reduce plastic pollution, but these jars must nonetheless be sturdy enough to endure being stacked and transported. Buckling load can assist a designer determine the correct product durability and capacity use.

3.3.2 Ultimate Compressive Strength

The ultimate compressive strength of a material is the compressive stress at which the material fully fails. When brittle materials achieve their ultimate compressive strength, they are crushed and the load decreases significantly. Materials with greater ductility (the majority of plastics) do not rupture but continue to deform until the load is no longer applied to the specimen but rather between the two compression platens. In certain instances, compressive strength might be expressed as specified deformations, such as 1%, 5%, or 10% of the original height of the test specimen.

CHAPTER 4: METHODOLOGY

4.1 Experimental Analysis

Experiments and tests on sand and crushed stones were carried out in line with in order to characterize and categorize the materials. These tests included the determination of particle size distribution, natural moisture content, and relative density. It was determined in accordance with that the bulk densities of the sand and crushed stones, as well as their water absorption rates, should be determined.

4.2 Preparation of Specimens

Mix design is the process of determining how to make the most use of available materials in the most cost-effective manner in order to generate concrete with the desired workability, durability, and strength. The workability of the concrete mix was improved through the use of air-entrained concrete subjected to mild exposure conditions when the mix was designed. In order to achieve the desired workability, it was decided to use stone chips as aggregate and a water-to-cement ratio of 0.60 for M-15 and 0.35 for M-10. The quantity of sand was calculated with the help of the absolute volume approach. The mix design led to a mix ratio of 1:2:4 for M-15 and 1:3:6 for M-10, which was employed in the manual fabrication of 36 concrete cylinder for the compressive strength test. The mix ratio was determined as a consequence of the mix design. In accordance with the procedures, the preparation of the ingredients, the mixing, and the sample were all performed out.

4.3 Fineness Modulus

When testing an aggregate, one can calculate its Fineness Modulus (FM) empirically by adding up the proportion of the sample that was retained on each sieve in a sequence and then dividing by 100. The Fineness Modulus is the product of this procedure.

4.3.1 Calculation of FM of Sylhet Sand (Fine Aggregate)

Table 4.1: Calculation of FM of Sylhet Sand (Fine Aggregate

Sieve No.	Retained	% Retained	Cumulative % of Retained
#4	2	0.67	0.67
#8	20	6.67	7.34
#16	123	41	48.34
#30	124	41.33	89.67
#50	25	8.33	98
#100	2	0.67	98.63
#Pan	4	---	---

Total sample 300gm

$$\therefore FM = \frac{0.67+7.34+48.34+89.67+98+98.67}{100}$$

$= 3.43$

4.3.2 Calculation of FM Coarse Aggregate (Stone Chips)

Table 4.2: Calculation of FM Coarse Aggregate (Stone Chips)

Sieve	Retained	Cumulative Retain	Cumulative % of Retained
25mm	35	35	3.5
19.5mm	309	344	34.4
12.5mm	494	838	83.8
9.5mm	142	980	98
#4	18	998	99.8
#8	0	998	99.8
#16	0	998	99.8
#30	01	999	99.9
#50	01	1000	100
#100			
Pan			

$\therefore FM = \frac{715.5}{100} = 7.185$

4.4 Slump Test

A trial mix was done in order to assess the slump before the actual mixing of the concrete that would be used to cast the cubes. The slump test is an extremely helpful tool for identifying changes in the homogeneity of a mixture that has been prepared with predetermined nominal proportions. It is a common procedure that is utilized all around the world on the day-to-day and hour-to-hour variations in the components that are being fed into the mixer or mixing platform if it is being done by hand. In this particular investigation, a slump of forty millimeters was determined in accordance with, and it satisfied, the value that was chosen for the design.

Figure 4.1: Slump test results = 0

4.5 Hand Mixing

On a galvanized iron tray that was hard, clean, and non-porous, a batch mix of ingredients that was meant to have a volume ratio of 1:3:6 was mixed by hand for M10 and 1:2:4 for M15. Before adding the coarse aggregate, the sand and cement were thoroughly combined, and the mixing process was then maintained until the mixture was consistent. This was accomplished by turning the mixture from one side to the other three times. After that, water was added, and the mixture was stirred once more, this time from side to side, until it was the same color throughout and had the same consistency. It was done in such a way that the water could not escape by itself or with the cement when it was supplied gradually. The mixing was altered to include 1, 2, 3, 4, 5, 6, and 7 rotations, respectively. Eighteen (18) cylinders with a size of $8''\ (\text{height}) \times 4''\ (\text{diameter})$ each were cast and allowed to cure for 7, 14 and 28 days, respectively, for each number of turns. In accordance with the standards for determining the compressive strength, a total of 8107 mm^2 of mold was prepared in order to generate 36 cylindrical.

4.6 Compressive Strength

Test For the purpose of conducting the crush test on the concrete cubes in accordance with at the curing ages of 7, 14 and 28 days an electrically driven UTM compression machine was utilized. The average compressive strength was measured by crushing three cubes on each day for each number of turns, and the results were recorded. During the crushing test, great care was taken to position the cubes correctly and align them with the axis of the push of the compression machine. This was done to ensure that the cubes were subjected to an even load throughout the crushing process.

CHAPTER 5: RESULTS AND DISCUSSION

5.1 Results

The ASTM guidelines are adhered to during each and every one of these tests to ensure that they are of the highest quality. The evaluation took place on a Universal Testing Machine (UTM), which served as the setting (UTM). A compression strength test was carried out on M10 and M15 using hand mixed and machine mixed cylinders at 7, 14, and 28 days into the curing phase.

5.1.1 UTM Machine Test

Table 5.1: M_{10} day wise load during curing period (Hand Mixing)

Mixing Grade	Type of Mixing	7 Days (KN)	14 days (KN)	28 days (KN)	Failure Pattern	
					Days	Types
M_{10}	Hand Mixing	26	35	43	7	Bonding
		24	33	26	14	Bonding
		22.5	30	36	28	Bonding
	Avg.	24.17	32.67	35	---	---

Table 5.2: M_{10} day wise load during curing period (Machine Mixing)

Mixing Grade	Type of Mixing	7 Days (KN)	14 days (KN)	28 days (KN)	Failure Pattern	
					Days	Types
M_{10}	Machine Mixing	26	48	70	7	Bonding
		32	47	80	14	Aggregate
		40	80	69	28	Bonding
	Avg.	32.67	58.30	73	---	---

Table 5.3: M_{15} day wise load during curing period (Hand Mixing)

Mixing Grade	Type of Mixing	7 Days (KN)	14 days (KN)	28 days (KN)	Failure Pattern	
					Days	Types
M_{15}	Hand Mixing	25	26	38	7	Bonding
		26	25	27	14	Bonding
		23	25	40	28	Bonding
	Avg.	24.67	25.33	35		

Table 5.4: M_{15} day wise load during curing period (Machine Mixing)

Mixing Grade	Type of Mixing	7 Days (KN)	14 days (KN)	28 days (KN)	Failure Pattern	
					Days	Types
M_{15}	Machine Mixing	50	60	82	7	Bonding
		55	56	70	14	Aggregate
		42	55	73	28	Aggregate
	Avg.	49	57	75		

5.1.2 Compressive Strength

Table 5.5: M_{10} day wise Compressive Strength Test (Hand mixing)

Mixing Grade	Type of Mixing	7 Days (N/mm^2)	14 days (N/mm^2)	28 days (N/mm^2)
M_{10}	Hand Mixing	3.07	4.16	4.46

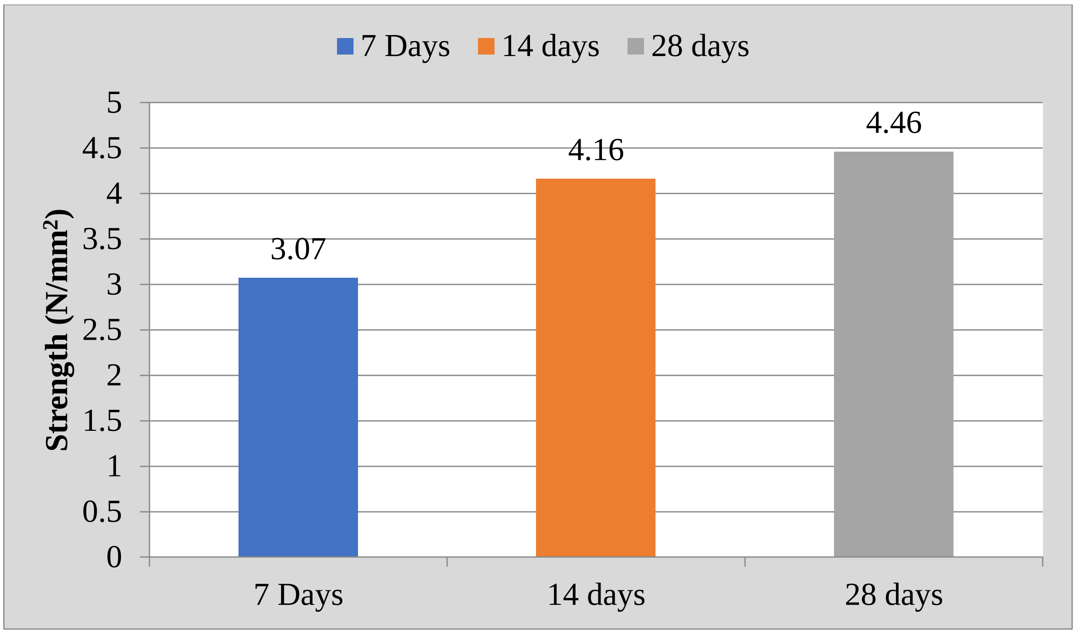

Figure 5.1: M_{10} day wise Compressive Strength Test (Hand mixing)

Table 5.6: M_{10} day wise Compressive Strength Test (Machine mixing)

Mixing Grade	Type of Mixing	7 Days (N/mm^2)	14 days (N/mm^2)	28 days (N/mm^2)
M_{10}	Machine Mixing	4.16	7.42	9.29

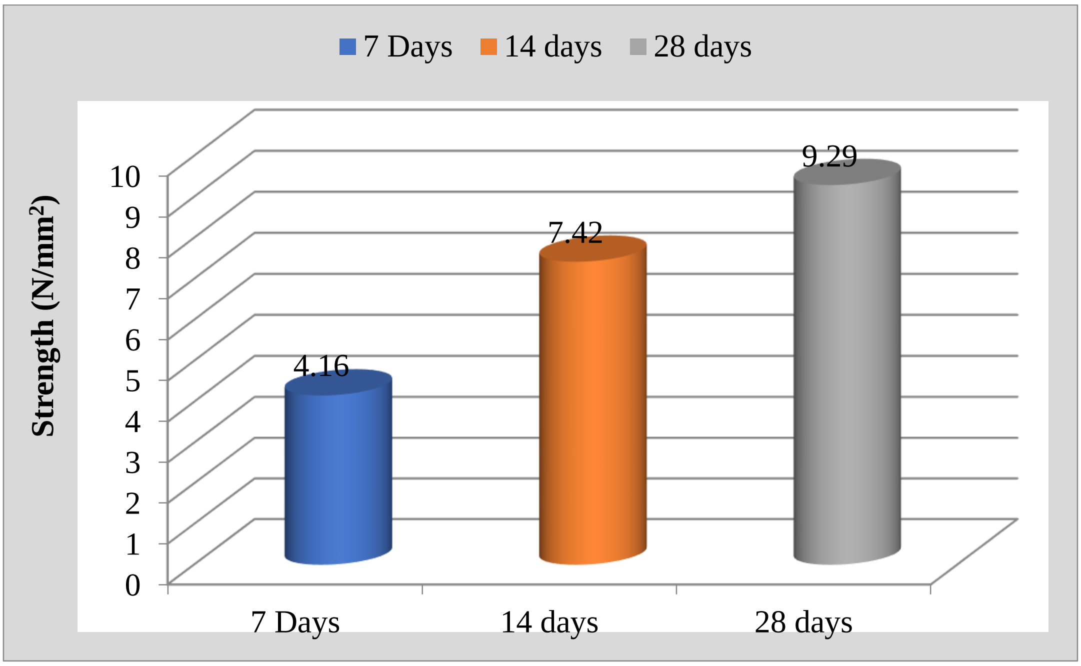

Figure 5.2: M_{10} day wise Compressive Strength Test (Machine mixing)

Table 5.7: M_{15} day wise Compressive Strength Test (Hand mixing)

Mixing Grade	Type of Mixing	7 Days (N/mm^2)	14 days (N/mm^2)	28 days (N/mm^2)
M_{15}	Hand Mixing	3.14	3.22	4.46

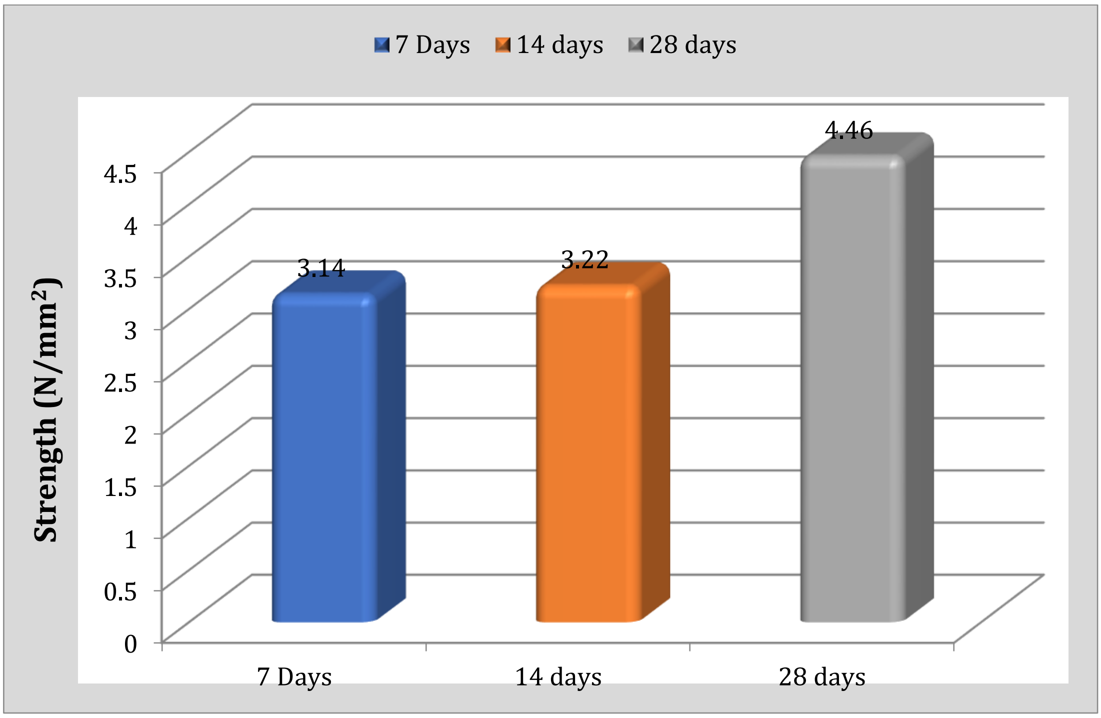

Figure 5.3: M_{15} day wise Compressive Strength Test (Hand mixing)

Table 5.8: M_{15} day wise Compressive Strength Test (Machine mixing)

Mixing Grade	Type of Mixing	7 Days (N/mm^2)	14 days (N/mm^2)	28 days (N/mm^2)
M_{15}	Machine Mixing	6.24	7.26	9.55

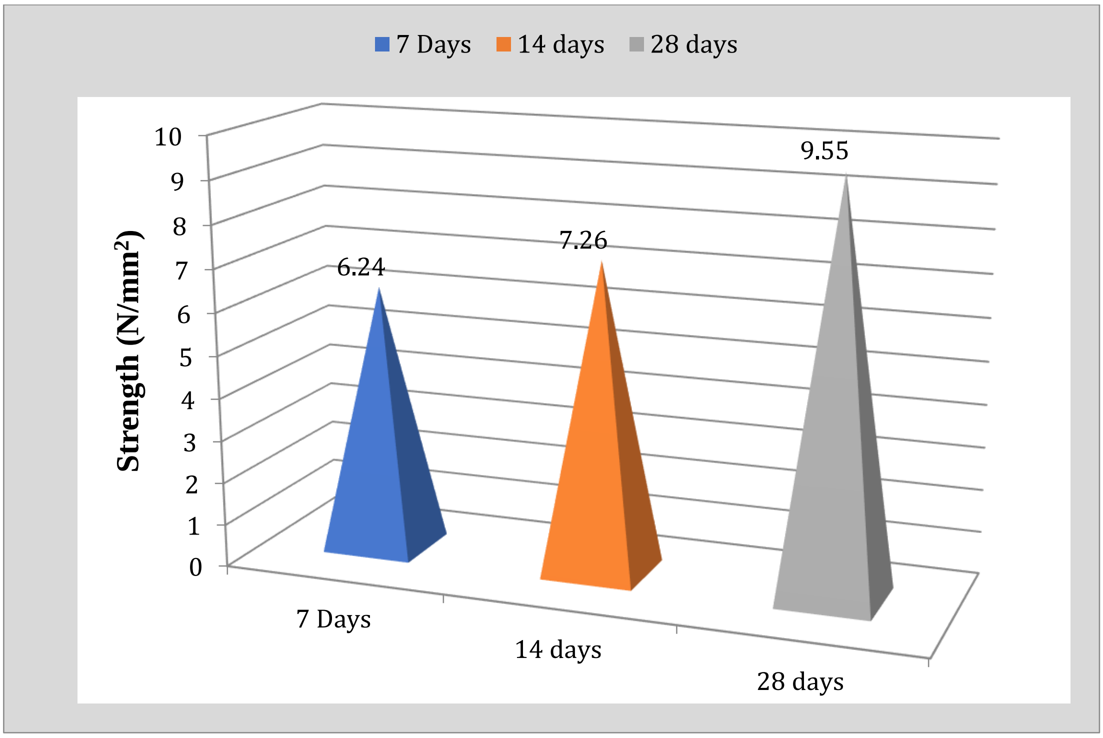

Figure 5.4: M_{15} day wise Compressive Strength Test (Machine mixing)

Table 5.9: Compare the Compressive Strength between Hand Mixing Method and Machine Mixing Method Results of M_{10} and M_{15} Concrete at 28 days

Mixing Grade	Type of Mixing	28 days (N/mm^2)
M_{10}	Hand Mixing	4.46
M_{10}	Machine Mixing	9.29
M_{15}	Hand Mixing	4.46
M_{15}	Machine Mixing	9.55

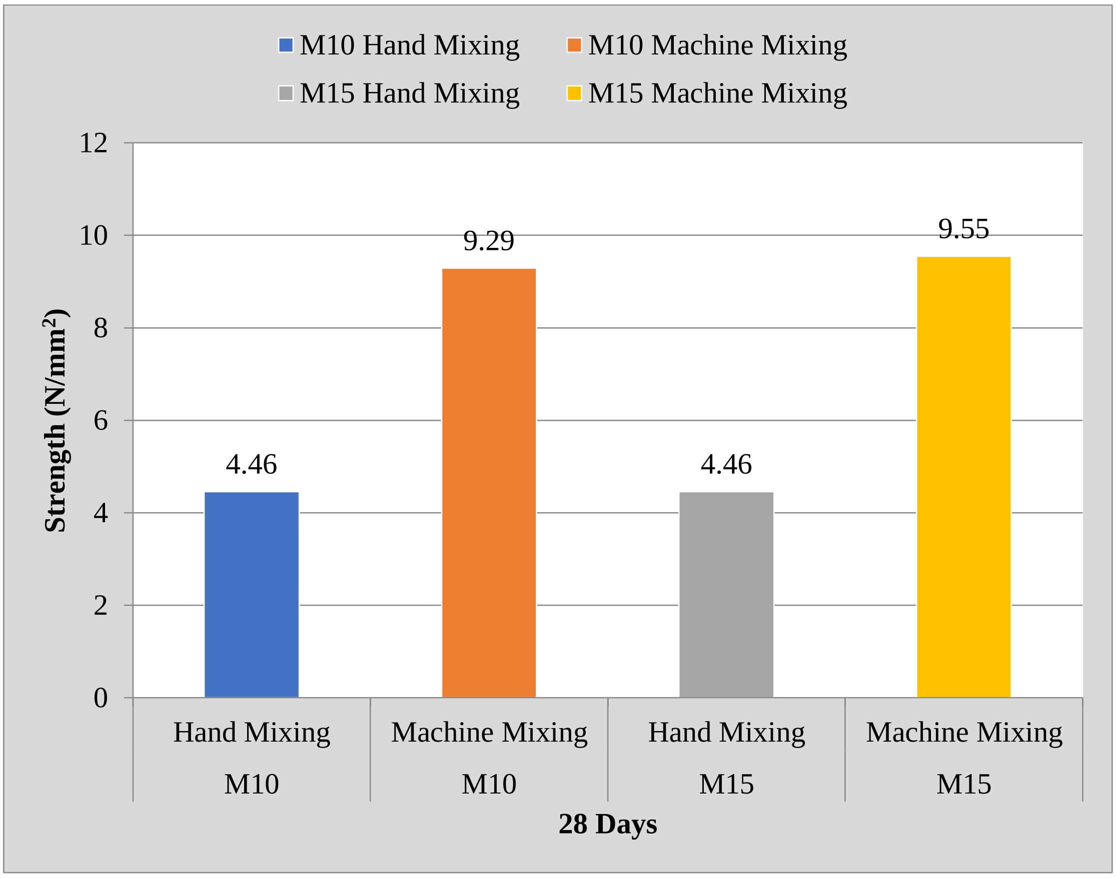

Table 5.5: Compare the Compressive Strength between Hand Mixing Method and Machine Mixing Method Results of M_{10} and M_{15} Concrete at 28 days

5.1.3 Slump Test Results

During the course of the test, the slump, also known as the vertical settlement, will be measured and documented in millimeters of the specimen's overall subsidence. We are 4 time tested slump and there are existing value are 0 (zero) has been found and workability very low.

5.2 Discussion

Table 5.5 displays the compressive strength for M10 ratios for various brands of cement, exhibiting the results of cylindrical crushing at 4.46 N/mm^2 for the best performance at 28 days, but considerably 7, 14 days respectively for hand mixing. Also, compressive strength for M10 ratios for various brands of cement are shown in table 5.6. This table displays the results of cylindrical crushing at 9.29 N/mm^2 with the maximum performance at 28 days, while reasonable performance at 7, 14 days was discovered with machine mixing.

Table 5.7 reveals the comparative M15 compressive strength ratios for several brands of cement. The results of cylindrical crushing at 28 days show the maximum performance, 4.46 N/mm^2, however manual mixing was determined to be reasonably effective at 7, 14 days.

And M15 compressive strength ratios for various brands of cement are shown in table 5.7. These ratios showed the optimum performance of cylindrical crushing at 28 days with 9.55 N/ mm^2; however, machine mixing found reasonable performance at 7, 14 days.

CHAPTER 6: CONCLUSION

In the course of this exploratory research project, an effort was made to employ quarry dust in place of the fine aggregates that are typically found in concrete. The following is a list of some of the inferences that can be made based on the findings of this investigation:

▪ For M_{10} Hand Mixing method:

The result achieved by Hand Mixing method at 7 days is 24.17 KN for M_{10} ratio. The result achieved by Hand Mixing method at 14 days is 32.67 KN for M_{10} ratio. The result achieved by Hand Mixing method at 28 days is 35 KN for M_{10} ratio.

▪ For M_{10} Machine Mixing method:

The result achieved by Machine Mixing method at 7 days is 32.67 KN for M_{10} ratio.The result achieved by Machine Mixing method at 14 days is 58.30 KN for M_{10} ratio.The result achieved by Machine Mixing method at 28 days is 73 KN for M_{10} ratio.

▪ For M_{15} Hand Mixing method:

The result achieved by Hand Mixing method at 7 days is 24.67 KN for M_{15} ratio. The result achieved by Hand Mixing method at 14 days is 25.33 KN for M_{15} ratio.The result achieved by Hand Mixing method at 28 days is 35 KN for M_{15} ratio.

▪ For M_{15} Machine Mixing method:

The result achieved by Machine Mixing method at 7 days is 49 KN for M_{15} ratio. The result achieved by Machine Mixing method at 14 days is 57 KN for M_{15} ratio. The result achieved by Machine Mixing method at 28 days is 75 KN for M_{15} ratio.

▪ Highest Compressive strength:

The Highest Compressive strength achieved by Hand Mixing method for M_{10} 4.46 N/mm^2 at 28 days. The Highest Compressive strength achieved by Machine Mixing method for M_{10} 9.29 N/mm^2 at 28 days. The Highest Compressive strength achieved by Hand Mixing method for M_{15} 4.46 N/mm^2 at 28 days. The Highest Compressive strength achieved by Machine Mixing method for M_{15} 9.55 N/mm^2 at 28 days.

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