A COMPARATIVE STUDY ON M15 AND M20 CONCRETE STRENGTH VARIATION USING HAND MIXING AND MACHINE MIXING METHOD

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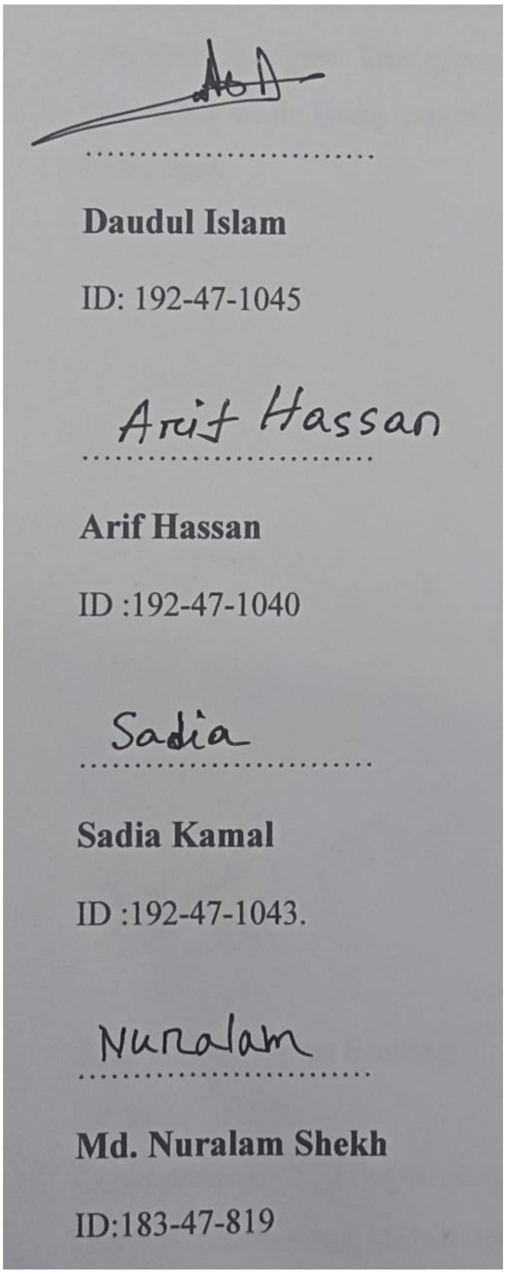
DECLARATION

This report is our original creation, and we hereby state that it hasn't been submitted anyplace for any kind of honor. The entirety of the information shown here is the result of our own labor, which was devoted to finishing a laboratory experiment including a volume study of a road close to our university. When additional sources of information were utilised, they were acknowledged, and the reference section listed the information's original locations.



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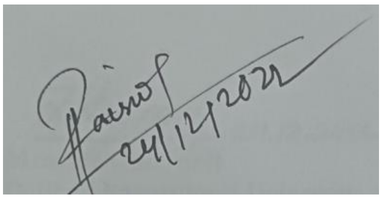
Certificate of Approval

This is to certify that the thesis on "**A COMPARATIVE STUDY ON M15 AND M20 CONCRETE STRENGTH VARIATION USING HAND MIXING AND MACHINE MIXING METHOD**". It is the eventual record of thesis done by **Daudul Islam; ID: 192-47-1045, Arif Hassan; ID: 192-47-1040, Sadia Kamal; ID: 192-47-1043, Md. Nuralam Shekh; ID:183-47-819** for the partial completion of the requirements for the Daffodil International University's Bachelor of Science in Civil Engineering degree. This group designed and completed the entirety of the work for this thesis while being supervised and advised by Daffodil International University instructors.



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ABSTRACT

Concrete is one of the oldest and most widely used building materials in the world, mostly because it is inexpensive, readily available, has a long lifespan, and can withstand harsh weather conditions.There are many ways to produce concrete in this modern day like Ready mixing, Machine mixing and Hand mixing concrete. The primary goals of this experiment are to determine the most cost-effective concrete and to compare the effects of hand mixing and machine mixing on the compressive and split tensile strengths of concrete.In the current experimental study, concrete mixes with proportions M15 and M20 were used. A total of 72 cylinders, 4 inches in diameter and 8 inches high, were cast and tested experimentally. These cylinders were used to measure the compressive strength and tensile strength of concrete after 7, 14 and 28 days. Samples were removed from the curing tank just prior to testing. A compression test was performed using a compression tester (UTM). We found the maximum compressive strength is 2442 psi for M20 and 2151 psi for M15 concrete by using Machine mix procedure. The value of Hand mix concrete is 1619 psi for M20 and 1431 psi for M15 grade concrete. Again, in the split tensile strength test we get better value for Machine mix rather than Hand mix concrete. So, it is clear that the Machine mixing concrete is more effective than Hand mixing concrete for any types of constructions.

Keyword: Hand mixing, Machine mixing, Compressive strength, Split tensile strength, Economical cost.

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CHAPTER 1

INTRODUCTION

1.1 BASIC CONCEPT

Concrete may potentially be a structural material that is frequently employed in the building sector. Cement, fine aggregate (sand), and coarse aggregate make up the majority of it (Natural gravels or chippings). To create concrete, these component parts are combined with water in the right proportions. The aggregates serve as the filler ingredients that provide concrete strength, while the cement acts as a binder to hold them together. Unlike other building materials, which are only shaped for use on the job site, concrete has the unusual distinction of being the only construction material created on the site. The mixture grading, aggregate/cement ratio, as well as the water/cement ratio, all affect the compressive strength of concrete. The hardened concrete must be strong and reach a certain compressive strength in order for the freshly mixed concrete to be able to be put correctly. Knowing concrete that complies with a required strength is the goal of concrete mix design. The water/cement ratio and subsequently the level of compaction are the two most crucial factors impacting the strength of concrete at a specific age. The compressive strength of fully compacted concrete is inversely related to the water-to-cement ratio. The four most crucial characteristics of concrete are workability, longevity, resistance to compressive stress, and ability to prevent rust on steel. Concrete must be produced using an efficient production method in order to generate good concrete with the aforementioned features and to fully realize these potential properties. The production of concrete frequently involves the use of either mechanical or manual mixing techniques. One of the key characteristics of concrete that is dependent on mixing consistency is the adequate strength requirement. Uncertainty about the design or necessary concrete strength will undoubtedly have a negative impact on the construction.

1.2 BACKGROUND OF STUDY

In today's markets, time is very valuable. So, we need to focus on time work to fulfill all requirement and reducing the cost. Reducing cost only possible if we can use our time properly and use modern equipment. For construction work concrete play's a very important roles to increase or reduce the cost. There are many types of concrete is available in market, but chosen the right type of concrete can save our time and reduce the cost. Site mix (Machine Mixing & Hand mixing) and Ready-mix concrete is very famous in our country. By using Ready mix concrete, we can save our time but we cannot use Ready mix concrete everywhere because of road systems and limited company. So, many times we need to depend on Site mix concrete. Concrete is very important for every construction. So, we also need to focus on its strength. If, the Site mix and Ready-mix concrete strength is close and good enough for construction then we can use both of them and it will be easier to select the type of concrete we need to use.

1.3 SCOPE OF THIS STUDY

The method of mixing the concrete can vary depending on the size of the project and the site's characteristics. Whether concrete is mixed by a machine or by hand, it is important to maintain its qualities and quality because it is used for both large-scale and small-scale construction projects. Analyzing significant engineering characteristics of machine mixing, hand mixing, and variation was the primary goal of this work.

1.4 OBJECTIVE OF WORK

The objectives of present study are:

- To analyze the mechanical properties and workability of Machine Mixing Concrete and Hand mixing Concrete properties.
- To compare the mechanical properties of Machine Mixing Concrete and Hand mixing Concrete properties.
- To identify the economical concrete.

1.5 CONTEXT OF WORK

Many ready-mix concrete companies have already been developed in Bangladesh now-a-days. But, because of low limitation of transport facilities and narrow road, we cannot use ready mix concrete in everywhere. In Bangladesh we have many little constructions work so we need to depend on site mix concrete because of those problem and for little construction ready mix concrete in very expensive. Site mix concrete also have some other advantage. In site mix we need less time for producing concrete and we can balance the water cement ratio according to our demand and we don’t need to wait for concrete arrival on site, we can creat as much concrete as we need and continuously do our work. The study's findings are thus consistent with the theoretical perspectives of both hand and machine mixing of concrete.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter presents some background information of the characteristics and properties of Machine Mixing concrete and Hand mixing concrete. A small survey work has been done to gather proper information about the details of Machine Mixing concrete, such as its ingredients and mixing procedures, its extensive functions. Though due to high confidentiality maintained by different manufacturers, a small number of information could have been collected regarding the use of Machine Mixing concrete in the context of the country. The summary of this chapter includes a comparative study of this work, highlighting the importance of each piece. Only a few pertinent works have been highlighted in the following section out of the many works that have been done in the field.

2.2 LITERATURE REVIEW

(J. M. R. I. Shohag, K. K. Islam, M. N. I. Bhuiyan, 2022) This study's main goal is to compare plain concrete with reinforced concrete's compressive and split tensile strengths. Concrete can be made more reasonably priced and with less environmental damage by using hair as a fiber. In compressive and tensile strength tests, it appears that male hair fibers containing 2% and 1.5% of male hair produce the greatest results.

(Samiksha Dhakal, Rajendra Shrestha, and Sachin Joshi, 2022) The main objective of this study is to replaced sand and coarse aggregate were partially with crumb rubber and EPS (expanded polystyrene) in different percentages for Grade M20 and M15 concrete samples. According to the experiment's findings, concrete brick manufactured by partially substituting crumb rubber for coarse aggregate and EPS for sand had more compressive strength than regular brick.

(Dr. Ramakrishna Hegde, Prof. Shrinath Rao K, Shashank H, Shivaraja Hanumantha Madar, Askarali Hajaresab Jakathi, Pujari Varunkumar Vijaykumar, 2018) This study's major goal is to use scrap from demolished columns as a coarse aggregate. The compressive strength was determined to be greater than 30 N/mm2 with up to 30% replacement of new coarse material. However, as the percentage was raised, the strength gradually decreased.

(R.K. Majhi, A.N. Nayak, 2019) The study's objective is to replace regular Portland cement with large volume ground granulated blast furnace slag (GGBFS) (OPC). Concrete's compressive strength over the short and long terms decreases when RCA and GGBFS content rises. Due to the lower quality of RCA than NCA and the lower hydraulic activity of GGBFS than OPC, bond strength of concrete also drops when RCA and GGBFS content levels rise.

(K.Param Singh, U.Praveen Goud, S.Madan Mohan, Dr. S. Sreenatha Reddy, 2016) The study's main goal was to create an M25 concrete mix and determine its compressive strength utilizing various mix design techniques. According to the test results, adding 30% fly ash to cement boosted strength to its highest level at 28 days, whereas the rate of strength enhancement in comparison to normal Portland cement concrete (OPCC) is slower in the early days.

(Abebe Demissew, 2022) With a focus on cost-effectiveness, this study aimed to compare a few different concrete mix design approaches, including those used by the American Concrete Institute (ACI), British Department of Energy (DOE), Ethiopian Building Code of Standards (EBCS), and Indian Standards (IS). The IS and ACI procedures recorded the maximum compressive strength at 7 days of curing, and at 14 days of curing, they continued to record the best compressive strength. The ACI and IS techniques were expected to reach the maximal compressive strength on the 28th day of curing.

(Saman Khan, Roohul Abad Khan, Saiful Islam, Sohaib Nazar, Nadeem A Khan, 2015) Determine the mechanical performance of polypropylene fiber reinforced concrete (PFRC) under compression and split tensile loading is the goal of this investigation. Excrement's higher compressive strength from fiber content is caused by the bonding of the fiber and aggregate, not the cement paste. In order to increase the endurance of concrete before failure, the fibers serve as anchors between the cement paste and the fine and coarse particles.

(James Isiwu AGUWA, 2010) The study's goal is to ascertain how hand mixing affects concrete's compressive strength. The results showed that the compressive strengths of concrete cubes significantly increased for all ages investigated from one to four times of rotation but remained practically constant after that.

(Ratod Vinod Kumar, Koudagani Venkatesh, 2016) The study's goal is to ascertain the compressive strength of concrete for M20 Grade when silica fume is used in place of cement. Compressive strength has been seen to rise up to a particular proportion (10% cement replacement with silica fume) when cement is replaced. However, silica fume reduces the strength of cement when it is used more frequently.

(J. M. R. I. Shohag, S. Chowdhury, A. Hasan, 2022) The main objective of this research is to use steel fibers as fiber reinforcement to improve concrete's compressive and tensile strengths. At 2% steel fiber mixing, the compressive strength and split tensile strength of concrete are found to be at their highest levels. In the end, it can be concluded that steel fiber-reinforced concrete is more durable and pliable than normal concrete.

2.2.1 Machine Mixing concrete (MMC)

The process of combining the components of concrete with a concrete mixer machine is known as machine mixing. It works incredibly well to satisfy the demands of quick mixing times, ideal uniformity, and homogeneous concrete quality. A. M. Neville, author of Properties of Concrete, claims that machine mixing of concrete not only imparts the mixture's homogeneity but also allows the mix to be discharged without disrupting that uniformity. Because it assures the concrete's continuous homogeneity, machine mixing is best suited for major projects that require vast volumes of concrete. There are several different types of concrete mixers available today, driven by gasoline, diesel, or electricity.

The Process of Machine Mixing of Concrete:

- First, moisten the interior surfaces of the concrete mixer's drum.

- Sand is added to the mixer first, then coarse aggregates, and finally cement.
- In the mixing apparatus, combine the components when they are in the dry state. Normal range is between 1.5 and 3 minutes.
- Add the appropriate amount of water gradually while the machine is running after the dry materials have been thoroughly mixed. Don't use more water than is necessary. Because it weakens you, it is not recommended.
- After adding the water, you should mix the concrete in the drum for at least two minutes.
- Remix the concrete if there is any segregation after removing it from the mixer.

Precautions to be Taken While Machine Mixing of Concrete:

- Before use, the cement mixer machine must be wet.
- Make sure to blend for the recommended amount of time, speed, and rotations per the mixer machine's makers
- After the cement mixer has finished mixing and discharging the concrete, it should be used within a half-hour.
- If your mixing is batch type then, after discharging one batch of concrete, the within surface of the mixer drum should be cleaned thoroughly. If not, lumps of hardened concrete from the mixture of previous batch may form a part of the subsequent batch and deteriorate the quality of concrete.
- If your mixing is continuous, you must clean the concrete mixer.
- At regular intervals, the interior of the concrete mixer should be carefully inspected to look

Figure 2.1: Machine mixing of concrete

2.2.2 Hand mixing concrete (HMC)

Concrete is conventional when it is hand mixed on site. Ordinary concrete can be made by roughly measuring the materials (cement, sand, aggregate and water). Hand mixing of concrete refers to the process of manually combining the various components of concrete. For minor tasks that just need a small amount of concrete, hand mixing is another option. Now-a-days Machine The process of mixing concrete is almost complete, and only very special circumstances would allow for manual mixing. It should be noted that more cement is needed for hand mixing than for machine mixing to produce concrete with the same strength. If the mixer breaks down because of mechanical issues and the concrete process needs to be finished, blending concrete by hand may also be necessary. The sole cost-effective alternative for small-scale projects is conventional concrete of standard quality. Conventional concrete requires a high level of control; otherwise, the quality of the mixture may suffer.

Figure 2.2: Hand mixing of concrete

Advantages of Using Hand mixing Concrete (HMC) In Building and Construction Processes

- Low Cost
- Hand mixing concrete is good for small projects.
- Labors cost are low.
- Made as per demand.
- Made when needed.

Disadvantages of Using Hand mixing Concrete (HMC) In Building and Construction Processes:

- Lots of wasted.
- The exact quality of the concrete is not accuracy.
- Not environmentally friendly.
- Quality and Consistency are not maintained.
- The mix ratio is not same in mixing time.

2.2.3 Apparatus of a Hand mixing Concrete

- Slump set

- Trawl
- Steel tape
- S. S tray
- Water bucket
- Balance
- Tamping rod

2.3 MATERIALS

The characteristics of the cement, fine aggregates, coarse aggregates, and water used in the mix design of concrete of M15 and M20 grades were examined in a laboratory and are listed below.

2.3.1 Cement

Cement is an ingredient used in making concrete. Cement is a mixture of clay and limestone. Both are heated to very high temperatures and then ground into a fine powder. The heating process is essential to activate the chemical binding action and hydration processes found in cement. There are multiple types of cement and various cement categories used, depending on the manufacturer. Some of the different types of cement include:

- Portland Cement
- Pozzolana Portland Cement
- Quick Drying Cement
- Quick Hardening Cement
- White Cement
- Expansive Cement
- Colored Cement

Cement is a vital component that is used to make concrete. Without it, concrete would not be as strong. Concrete driveways would not last as long as they do without cement. Mixing cement into concrete also helps make the material easier to work with and use. It can be spread, smoothed, and even shaped like concrete blocks. Thanks to the continued chemical binding and hydration processes in cement, the concrete continues to also strengthen with time.

2.3.2 Fine aggregates

Sand is a granular substance made up of tiny mineral fragments. The content of sand varies, but the grain size is what distinguishes it. Concrete sand, pit sand, natural and river sand, and fill sand are the four basic forms of sand used in construction. Sand is a crucial component in the majority of construction projects since it may be used with lime or cement to make fine mortar for plastering and for fusing bricks or stones, among other uses. Concrete is made using cement, coarse aggregate, and sand. Sand and lime or cement were also combined by construction workers to create screed for footing.

2.3.3 Coarse aggregates

Coarse aggregate is stone which are broken into small sizes and irregular in shape. Aggregate which has a size bigger than 4.75 mm or which retrained on 4.75 mm IS Sieve are known as Coarse aggregate. Aggregates are employed in concrete in the building sector because of their affordability and the strength they give concrete. Concrete attributes including abrasion resistance, hardness, elastic modulus, and other qualities like durability, strength, and affordability are significantly influenced by the coarse aggregate. Other uses for coarse aggregate include drainage, filtration, filling, and backfilling. The vapor and moisture barriers beneath the slab can also be built using aggregatete.

2.3.4 Concrete

The word concrete comes from the Latin word "concretus" (meaning compact or condensed), the right passive participle of "concrescere", from "con-" (together) and "crescere" (to grow Concrete, usually hydraulic cement concrete is a composite material composed of fine and coarse aggregate bonded together with a fluid cement (cement paste) that hardens over time— most usually a cement binder with a lime base, like Portland cement, but occasionally with other hydraulic cements, like a calcium aluminate cement.

It is different from other non-cementitious varieties of concrete that all bond some type of aggregate, such as asphalt concrete with a bitumen binder, which is typically used for road surfaces, and polymer concretes that employ polymers as a binder. The Hoover Dam, the Panama Canal, and the Roman Pantheon are all notable examples of concrete construction. The traditional Romans were the first large-scale users of concrete technology, and the Roman Empire made extensive use of concrete. The concrete dome of the Pantheon is the largest unreinforced concrete dome in the world because the Colosseum in Rome was largely constructed from concrete. Today, ferroconcrete is typically used to construct big concrete structures like dams and multi-story parking garages. Concrete use declined with the fall of the Roman Empire until it was revived in the middle of the eighteenth century. When it comes to the amount of fabric used globally, concrete has surpassed steel. These benefits apply to concrete as a building material:

- Except for cement, concrete is the most cost-effective engineering material over the long term. It is frequently constructed using locally accessible coarse and fine aggregate
- Because concrete has a high compressive strength, the impacts of corrosion and weathering are minimal. Its strength can match that of a hard natural stone when properly prepared.
- Green concrete is pliable and may be easily shaped into any
- Concrete and steel have about comparable coefficients of thermal expansion, making concrete extremely resilient in compression and having limitless structural applications.
- The concrete is extensively utilized in the construction of foundations, walls roads, airfields, buildings, water retaining structures, docks and harbors, dams' bridges, silos, etc.
- Using the Genting technique, concrete can even be sprayed on and injected into tiny crevices for repairs.
- Concrete can be poured in awkward situations because it is frequently pumped
- It requires little to no maintenance and is robust and fire resistant.

The disadvantages of concrete are often as follow:

- Concrete breaks readily because it has a low durability. Steel bars or mesh must therefore be used to reinforce it.
- Hardened concrete expands when wet, but freshly laid concrete contracts when
- Creep occurs when concrete is subjected to continuous loading, which reduces the pre-stress of pre-stressed concrete structures.
- Concrete is prone to soleplate and alkali attack, which can cause it to crumble.
- Concrete lacks elasticity by nature, which makes it less resistant to earthquakes.
- There are some properties of concrete:
- **Tensile Strength:** Concrete is incredibly brittle under strain. The durability of regular concrete is between 7 and 10 percent of the compressive strength.
- **Flexural Strength:** Plain concrete's flexural strength is almost entirely based on its tensile strength. However, investigations reveal that the strength in tension is significantly outclassed by the modulus of rupture.
- **Shear strength:** It is the primary determinant of short columns' compressive strength
- **Elastic Properties:** Concrete isn't completely elastic under any weight, and even low loads might cause a noticeable permanent setting. At any point in the loading process, the deformation is not proportional to the stress.
- **Durability of Concrete:** Concrete's durability is frequently loosely defined as how long the substance lasts under different environmental circumstances. Concrete's durability is frequently loosely defined as how long the substance lasts under different environmental circumstances. The period of time before the material begins to show signs of distress is considered the durable life.

It means the concrete or reinforced concrete structure should show distress. for instance, plain concrete is unaffected by processes like carbonation whereas corrosion from carbonation affects RC structure. The potential to increase concrete's durability is one of the key benefits of using steel fibers in concrete mixes. Concrete's pore interconnectivity along with a drop in water content together reduce permeability of Steel Fiber's concrete. Reduced permeability improves the long-term durability and resistance of concrete structures to many types of deterioration.

2.3.5 Aggregates in Concrete

Our CEMEX Aggregate operations have the technical, operational, and manufacturing capabilities to create products that satisfy the demands and requirements of our customers.Rough and angular particles will strengthen the concrete because they adhere to the cement paste more effectively (IMCP 2006; Mindess et al. 2003; Kosmatka et al. 2002; Mehta and Monteiro1993). About 60% to 75% of all concretes have a crushed aggregate foundation To meet the needs of our clients and be prepared to handle the wide range of uses for aggregate materials, CEMEX provides an honest range of aggregates. These qualities make aggregate materials a crucial component in the construction and upkeep of highways, sidewalks, parking lots, airport runways, railroad tracks, and a variety of other structures and roadways. At CEMEX, we're constantly looking for innovative methods to employ aggregates to improve heat absorption, drainage, and other environmental pressures. An appropriate mixture of cement and aggregates, such as sand and gravel, can, for instance, be used to create a material that allows for the absorption of water while reducing the absorption of heat, thereby reducing the "urban heat island" effect, which significantly raises the temperature of paved areas.

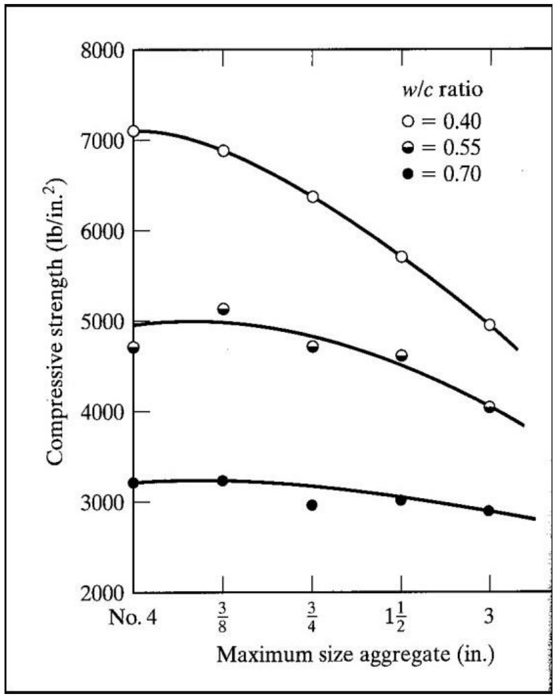


Figure 2.3: Effect of maximum size of aggregate on compressive strength (Source: Cordon and Gillespie1963)

2.3.6 Water

Fresh Concrete is mixed with movable water that is devoid of organic material and oil paint. Water was added to the concrete in the required quantities after being measured out in a graduated jar. Weigh batching was used to remove the additional components from the concrete blend's medicine. The ph value shouldn't be less than 6, it should be highlighted.

Selected physical properties of water

- molar mass 18.0151 grams per mole
- melting point 0.00 °C
- boiling point 100.00 °C
- maximum density (at 3.98 °C) 1.0000 grams per cubic centimeter
- density (25 °C) 0.99701 grams per cubic centimeter

- vapour pressure (25 °C) 23.75 torr
- heat of fusion (0 °C) 6.010 kilojoules per mole
- heat of vaporization (100 °C) 40.65 kilojoules per mole
- heat of formation (25 °C) −285.85 kilojoules per mole
- entropy of vaporization (25 °C) 118.8 joules per °C mole
- viscosity 0.8903 centipoise
- surface tension (25 °C) 71.97 dynes per centimeter

2.4 Concrete mix

A good concrete mix design creates the foundation of a sound infrastructure. Concrete mix design involves a process of preparation during which a mix of ingredients creates the required strength and durability for the concrete structure. Making an excellent concrete mix is a difficult process since each element in the mixture has a different set of qualities. It is necessary to understand the relationship between the water cement ratio and the desired strength since the combination design depends on having enough cement, fine aggregate, and coarse aggregate available. The mix design with the desired strength was not finished in the study since the goal was to investigate the impact of adding steel fiber on the mechanical characteristics of concrete. Instead, the mix ratio that is frequently used in Bangladesh and other nearby nations including some of India and Pakistan was employed. In order to achieve this, two alternative concrete mix ratios (by volume) = 1:2:4 and water cement ratio 0.45 (by weight) were cautiously maintained in this investigation..

2.4.1 Water Content

The most important component for workability is water content, so adding more water to concrete will make it more workable (Mindess et al. 2003). However, it's best to avoid using too much water to avoid bleeding and segregation (IMCP 2006; Mindess et al. 2003; Mehta and Monteiro 1993). For a given cement content, adding more water will also raise the water-cement ratio (w/c), and the increased w/c will boost workability (Kosmatka et al.

2002). 2.5.2 Paste volume reduces the workability of cement because it lubricates the particles (Ferraris and Gaidis 1992; Dhir et al. 2004). Less cement enhances the rigidity of concrete with poor workability for a given water content (Lamond and Pielert 2006; Mehta and Monteiro 1993). Strong cement content concrete exhibits high cohesion and turns sticky (Lamond and Pielert 2006; Kosmatka et al.2002; Mehta and Monteiro 1993). To prevent a negative effect, the requisite workability should be achieved with the proper cement content.

2.4.2 Aggregates

Sand, gravel, and crushed stone are examples of inert granular materials known as aggregates. Portland cement and water are other essential components of concrete.

Aggregates must be free of absorbed chemicals, clay coatings, and other fine contaminants that could cause concrete to degrade in order to make a suitable concrete mix. The two main categories of fine and coarse aggregates make up 60 to 75 percent of the total volume of concrete. The majority of the particles in fine aggregates typically pass through a 3/8-inch filter and are made up of natural sand or broken stone. Any particle larger than 0.19 inches is considered a coarse aggregate, which typically has a diameter between 3/8 and 1.5 inches.Gravels constitute the bulk of coarse aggregate used in concrete with crushed stone making up most of the remainder.

2.4.3 Water to Cement Ratio

Because they alter the porosity of both cement paste and the interfacial transition zone between the coarse aggregate and cement paste, the strength at any given age may depend on w/c and how much the cementitious materials have hydrated (Wassermann et al. 2009; IMCP 2006; Mindess et al. 2003; Kosmatka et al. 2002; Mehta and Monteiro 1993). Strength diminishes with increasing w/c because, as shown in a Figure, capillary porosity increases (Wassermann et al. 2009; IMCP 2006; Dhir et al. 2004; Mindess et al. 2003; Kosmatka et al. 2002; Schulze 1999; Mehta and Monteiro 1993). It is more effective to use less cement and less water to increase strength than to use more cement and more water (Popovics 1990). Under addition to being strong in compression, concrete has other positive qualities. Better is the durability if the compression strength is higher. In RCC, bond strength is crucial. Compressive strength also provided information about the level of control used during construction. Therefore, testing for compressive strength is essential for maintaining the quality of concrete. When a static load tends to crush concrete, the concrete's compressive strength can be used as a measure of how well it can withstand that load. The most frequent type of testing for concrete is its compressive strength; as many of its desirable properties are correlated with its strength, the compressive strength of concrete in structural design is crucial. Compressive strength also provides a truthful and accurate indicator of how the strength is impacted by an increase in the fiber volume dosing rate in the test specimens. While durability isn't the controlling factor, the compressive strength should be taken into consideration when choosing the w/c (Kosmatka et al. 2002). The range of w/c varies in support of the project's purpose and structural needs; style of construction (for example, rigid pavement construction uses normal strength concrete (3,000-6,000 psi) whereas structural elements use high strength concrete (6,000-9,000 psi); and conditions (e.g., weather and curing conditions).

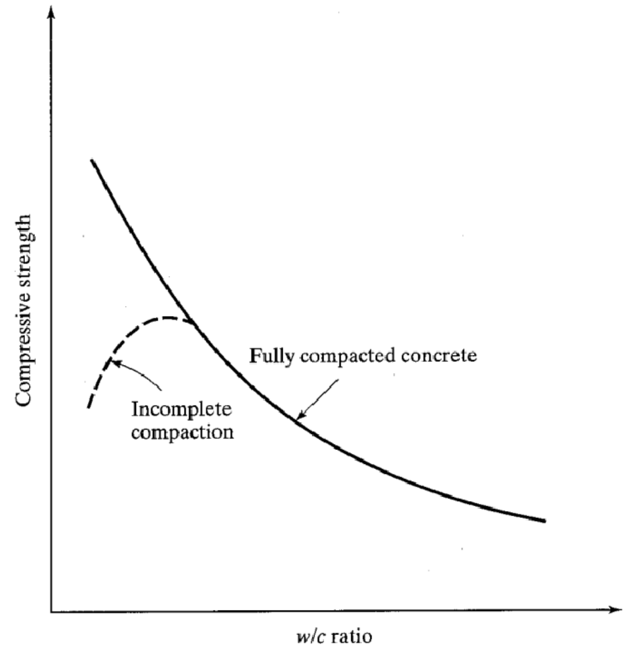


Figure 2.4: Relationship between the compressive strength & the water to cement ratio (source: Mindess et al. 2003)

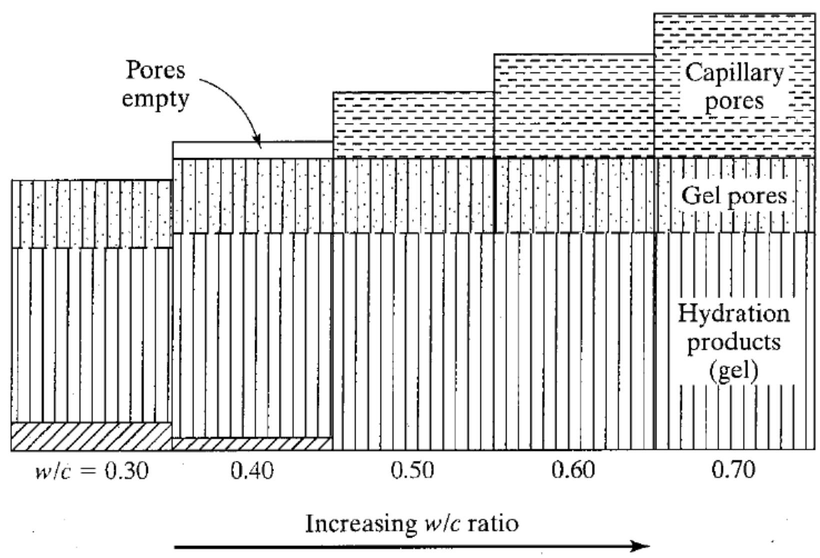


Figure 2.5: Relationship between porosity & w/c (Source: Mindess at al.2003).

2.5 Compression Test on Concrete Cylinder

The measurement of concrete's compressive strength is important because it provides as a standard for the material's quality. In general, compressive strength is used to describe other strengths. N/mm2 is the measurement unit for strength. This method can be applied to create preliminary compression tests to check the suitability of the materials to maintain the suitable mix proportions.

2.6 Summary

The current study, which compares the qualities of hand and machine-mixed concrete in the context of Bangladesh, is significant, as evidenced by the review of a number of literatures.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

In the current experimental study, concrete mixes with proportions M15 and M20 were used. Relevant to Bangladesh, the mixed construction method of M15 and M20 is mainly used in various construction sites. The details of the experimental investigation are as follows. In structural design, the compressive strength of concrete cylinders is one of the most common performance measurements made by engineers. Here, the compressive strength of a concrete cylinder is determined by applying a continuous load across the cylinder until failure occurs. This test is performed on a compression testing machine called UTM (Universal Testing Machine).

Figure 3.1: Universal Testing Machine

3.2 METHOD

This study's goal was to compare the strength deviation of hand-mixed concrete versus machine-mixed concrete. Concrete mixes of classes M15 and M20 were prepared. A total of 72 cylinders, 4 inches in diameter and 8 inches high, were cast and tested experimentally. To measure the compressive strength of hand-cast concrete, two sets of 18 cylinders were cast using M15 and M20 concrete and two sets of 18 cylinders were manufactured using Machine Mixing concrete. These cylinders were used to measure the compressive strength and tensile strength of concrete after 7, 14 and 28 days. Samples were removed from the curing tank just prior to testing. A compression test was performed using a compression tester (UTM).

3.3 CYLINDERS

Compressive strength results are typically used to ensure that the concrete mix provided meets the required requirements. Cylindrical specimens are tested according to ASTM39. Standard specimen sizes are 4 x 8-inch (100 x 200 mm) or 6 x 12-inch (150 x 300 mm) concrete cylinders. Smaller samples are easier to prepare and handle in the field or in the laboratory. We made the cylinder size (4 x 8) inches.

Figure 3.2: 4 inch × 8 inches of size of cylinder

3.4 INGREDIENTS

Following are the laboratory-tested physical characteristics of cement, fine aggregate, coarse aggregate, steel fibers, and water used in mix designs for grade M15 and M20 concrete:

- Cement: In this work, regular Portland cement (OPC) from a single batch was used throughout the study.
- Fine Aggregate (sand): Local sand with an FM value of 2.79 and a specific gravity of 2.68 was used as the fine aggregate. The sand is washed and sieved to remove harmful substances and oversized particles.
- Coarse Aggregate: The coarse aggregate from Brick Chips was used FM value of 7.59 and the specific gravity of 3.18.
- Water: The water used for experiments was potable water.

3.5 FINENESS MODULUS OF COARSE AGGREGATE

Coarse aggregate fineness is the index of the average size of the coarse aggregate particles. This is calculated by sieve analysis using standard sieves. Add and subtract the cumulative percentage retained on each sieve by 100 to get the fine aggregate value. Because the fineness factor increases with aggregate size, coarse aggregate has a higher fineness factor than fine aggregate. When counting from the smallest sieve size to the greatest sieve size, the modulus is a numerical value that represents the average particle size. Therefore, all sizes of sieves are required in the calculation of coarse aggregate.

Table 3.1: Data Table of Standard particle size of Coarse Aggregate

Maximum size of coarse aggregate	Fineness modulus range
20mm	6.0 - 6.9
40mm	6.9 - 7.5
75mm	7.5 - 8.0
150mm	8.0 - 8.5

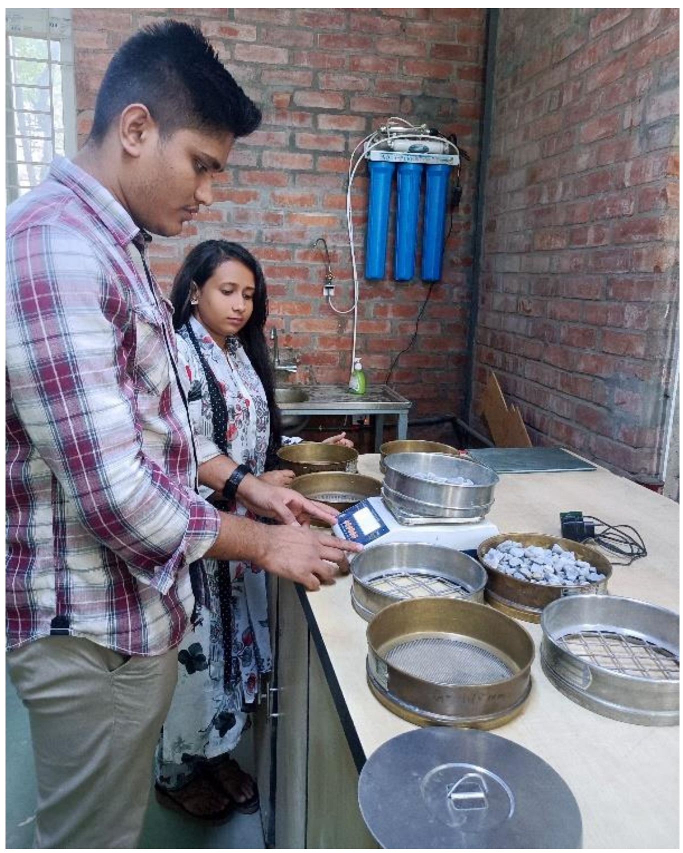


Figure 3.4: Data Table of Sieve Analysis of Coarse

3.6 FINENESS MODULUS OF FINE AGGREGATE

The Fineness Modulus of Sand is an index range that suggests the mean size of the sand particles. It is calculated through acting the sieve evaluation check with general IS sieves. The fineness modulus of fine aggregate a range from 2.2 to 3.2.

Table 3.2: Data Table of Standard particle size of Fine Aggregate

Type of sand	Fineness modulus range
Fine sand	2.2 - 2.6
Medium sand	2.6 - 2.9
Coarse sand	2.9 - 3.2

Figure 3.5: Sieve Analysis Graph of Fine Aggregate

3.7 MIX DESIGN

In order to manufacture high-quality concrete, it is necessary to select materials and the required concrete quality. In concrete mix design, the proportion of concrete mix is determined in relation to the ratio of cement, sand and coarse aggregate. M10, M15, M20, etc. are all concrete grades. It is the name of the type of concrete mixture. The letter M stands for the mixture and the number is the declared characteristic compressive strength of a cylinder after 28 days in N/mm^2. We chose M15 and M20 grades.

Figure 3.6: Concrete mixing

3.7.1 Different Types of Concrete Grades

Proper design of a concrete mix should achieve a ratio of components that yields concrete with high durability performance over the design life of the structure.

Table 3.3: Different types of concrete grades and their uses.

Concrete Grade	Mix Ratio (cement: sand: aggregates)	Compressive Strength
M7.5	1:4: 8	7.5 MPa
M10	1:3: 6	10 MPa

M15	1:2: 4	15 MPa
M20	1:1.5: 3	20 MPa

3.7.2 Table of Total Volume of all materials

Table 3.4: M20 Machine Mixing Concrete

Mixing Ratio	Raw Materials	Amount
M20	Cement	8.70 kg
	Sand (Sylhet)	0.49 cft
	Aggregate	0.67 cft
	Water	0.55%

Table 3.5: M15 Machine Mixing Concrete

Mixing Ratio	Raw Materials	Amount
M15	Cement	7.19 kg
	Sand (Sylhet)	0.35 cft
	Aggregate	0.70 cft
	Water	0.55%

Table 3.6: M20 Hand Mixing Concrete

Mixing Ratio	**Raw Materials**	**Amount**
M20	Cement	8.70 kg
	Sand (Sylhet)	0.49 cft
	Aggregate	0.67 cft
	Water	0.55%

Table 3.7: M15 Machine Mixing Concrete

Mixing Ratio	Raw Materials	Amount
M15	Cement	7.19 kg
	Sand (Sylhet)	0.35 cft
	Aggregate	0.70 cft
	Water	0.55%

3.8 CONCRETING

Cast steel, cast iron, or any other non-absorbent material is used to create cylinder samples. The utilized molds must maintain their original shape and dimensions even under challenging circumstances. Concrete must be sealed tightly against the formwork. The interior of the mold needs to be well lubricated before adding the concrete mixture to ensure that the hardened cylinder may be withdrawn without difficulty. Layers of concrete mixture no less than 5 cm thick are poured into the mold. There must be at least 25 strokes each layer while compressing. The majority of the air spaces should be able to escape once compression reaches the bottom layer. Samples are kept undisturbed for 24 hours at a humidity level of at least 90% and a temperature of 27 2 °C. The samples are then taken out and submerged in new, clean water till the test period is reached after this time. Here are the steps of pouring concrete: Cleaning: Clean all the tools used to make concrete, including the cylinders, bowls, jugs, and rods. Weighing: To produce a superior concrete mix, weigh each ingredient (cement, aggregate, and sand) precisely.

3.9 FORMWORK

The formwork uses steel and plastic molds. Formwork for all concrete structures must be dense, rigid and strong. If the formwork is not tight, excessive leakage will occur when pouring the concrete. This leakage can cause unsightly surface ridges, honeycombs, and sand streaks after the concrete cures. The formwork must safely withstand the concrete pressure during installation. Don't take shortcuts. Proper placement of the right formwork material and the right braces can prevent the formwork from collapsing or slipping when pouring concrete.

3.10 PREPARATION OF THE SPECIMEN

- At first Plastic pipe was cut by perfect shape and Sand, Cement and aggregate were measured dry separately by volume according to required proportion.
- Aggregates were soaked thoroughly in water before use.
- The Fine Aggregate (local sand), The Coarse Aggregate were mixed in SSD condition on a clean platform.
- The cement was added and mixed thoroughly once till the color was uniform.
- The required quantity of water was then added gradually and the composition was mixed thoroughly.
- The mold was lubricated by mobile oil and was placed on a level surface before placing of concrete in the mold.
- The mixtures of concrete were placed in three layers and each layer was compacted

by temping rod about 25 blows.

- After placing and compacting of top layer the top surface was made level by mortar.
- The forms were scaled at the top and the specimens were allowed to get hardened for 24 hours.

Figure 3.8: Materials Mixing

Figure 3.7: Preparing Plastic Mold

3.11 SLUMP TEST

The test instrument is a Slump Cone with Tamping Rod and Base Plate. The slump cone must first be filled with freshly mixed concrete that has been stamped three times with a steel rod. The top of the slump cone is used to level the concrete, and the cone is removed once the sample's slump has been assessed. It is crucial that the design of the concrete mix, in relation to the water-cement rail and workability, is strictly managed in order to guarantee that concrete achieves its highest strength potential while maintaining its ease of placement onsite. Size: 300mm in height, 200mm in lower and upper diameters.

Figure 3.9: Slump Test

3.11.1 Relation Between Workability and Slump

3.12 CASTING

After mixing, concrete is immediately poured. A steel mold is carefully filled with concrete. Concrete must be compressed in order to develop properties like strength, durability, and impermeability and to become dense and void-free. Concrete loses strength as a result of voids. The spaces weaken durability by increasing permeability. Concrete contains air that has been trapped in the form or voids after it has been mixed, transported, and poured. The seal's objective is to release as much of the undesirable trapped air as is practical. The target is typically less than 1%. With an iron rod, compaction is performed, and excessive temperature must be carefully avoided to prevent water, cement, and finer particles from rising to the surface and causing uneven concreting.

Figure 3.10: Temping and Casting of Concrete Cylinder

3.13 CURING

Curing is the process of keeping concrete at its ideal temperature while limiting moisture loss. More specifically, curing is the process of keeping concrete at an ideal moisture content and temperature for the duration of the time immediately following placement. This allows the cement to continue to hydrate until the desired homes are built to the point where they meet the requirements for service. In order to give the cement time to hydrate, it may be done both after it has been installed and during the production of concrete goods. If concrete is to develop its potential energy and sturdiness, curing should be done for a suitable amount of time since cement hydration does take time—days, even weeks instead of hours. The control of temperature may also be a part of curing because it affects how quickly cement hydrates. Curing is primarily intended to keep the concrete moist by minimizing moisture loss from the concrete during the time that it is developing strength.

After casting, the molded specimens are kept in the lab for 24 hours at room temperature following the addition of water to the dry materials. Following this time, the specimens are removed from the molds and are currently submerged in clear, easy water. In the current experiment, the specimens are cured for 28 days.

Figure 3.12: Curing of concrete cylinder

3.14 LAB TEST

Although concrete has been subjected to various tests, this one is the most significant and provides information on all of the concrete's qualities. It is decided whether the concrete was appropriately put on this one teston. The water-cement ratio and cement strength are just two of the many variables that affect the compressive and split tensile strength of concrete. Compressive and split tensile strength tests, such as the quality of concrete materials, quality control of concrete production, etc., are performed on cubes or cylinders. After curing, it is necessary to test the cured cylinder to determine the compressive strength of the concrete. Laboratory experiments include experimental setup, testing, and data collection of structural models and Universal Testing Machines (UTMs). Experiments were conducted at UTM of the CE Department of Daffodil International University, Bangladesh. Concrete cylinders are cast to standard sizes and aged for 7, 14 and 28 days. The sample was removed from the curing tank and excess water was wiped off the sample surface. Place the specimen vertically on the platform of the compression tester and horizontal on platform of tensile tester. The cap at the end of the cylinder contributes to even application and load distribution. Make sure the load platform touches the top of the cylinder before applying the load. At a pace of 315 kn/min, he applied the load steadily, uniformly, and without interruption. The sample was loaded till it was ruined.

Figure 3.13: Specimen Measurement

Figure 3.14: Compressive Test process is going on UTM and Failure surface under Compressive load

Figure 3.15: Split Tensile Test Process is going on UTM

CHAPTER 4

RESULTS & DISCUSSION

4.1 INRODUCTION

This chapter deals with the presentation of results obtained from Compressive and tension test conducted on concrete specimens. The main objective of the research program was to understand the compressive strength and tensions strength between Hand mixing and Machine Mixing concrete. The experimental program consisted of casting, curing and testing of controlled concrete and concrete mix with varying proportions of 7days, 14 days and 28 days.

The experimental program included the following:

- Determination of the coarse aggregate's fineness modulus
- Calculating a fine aggregate's fineness modulus
- Calculating the slump values for various materials quality mixing percentages.
- Determination of Compressive strength of different percentages of Machine Mixing and Hand mixing Concrete.
- Determination of Tensile strength of different percentages of Machine Mixing and Hand mixing Concrete.
- To compare the outcomes and deviations of hand-mixed and machine-mixed concrete qualities.

4.2 FINENESS MODULUS OF COARSE AGGREGATE

4.2.1 Data Table and Graph of Sieve Analysis of Coarse Aggregate

Table 4.1: Data Table of Sieve Analysis of Coarse Aggregate

Sieve No(mm)	Retain(gm)	%Retain	Cumulative % Retain	FM
40.00	0.00	0.00	0.00	7.59
20.00	1190.45	59.52	59.52	
10.00	799.32	39.97	99.49	
4.75	10.23	0.51	100.00	
2.36	0.00	0.00	100.00	
1.18	0.00	0.00	100.00	
0.60	0.00	0.00	100.00	
0.30	0.00	0.00	100.00	
0.15	0.00	0.00	100.00	
Pan	0.00	0.00		

Fineness modulus of coarse aggregates = (sum of cumulative % retained)/ 100. So, FM = 759.01/100 = 7.59

4.2.2 Sieve Analysis Graph of Coarse Aggregate

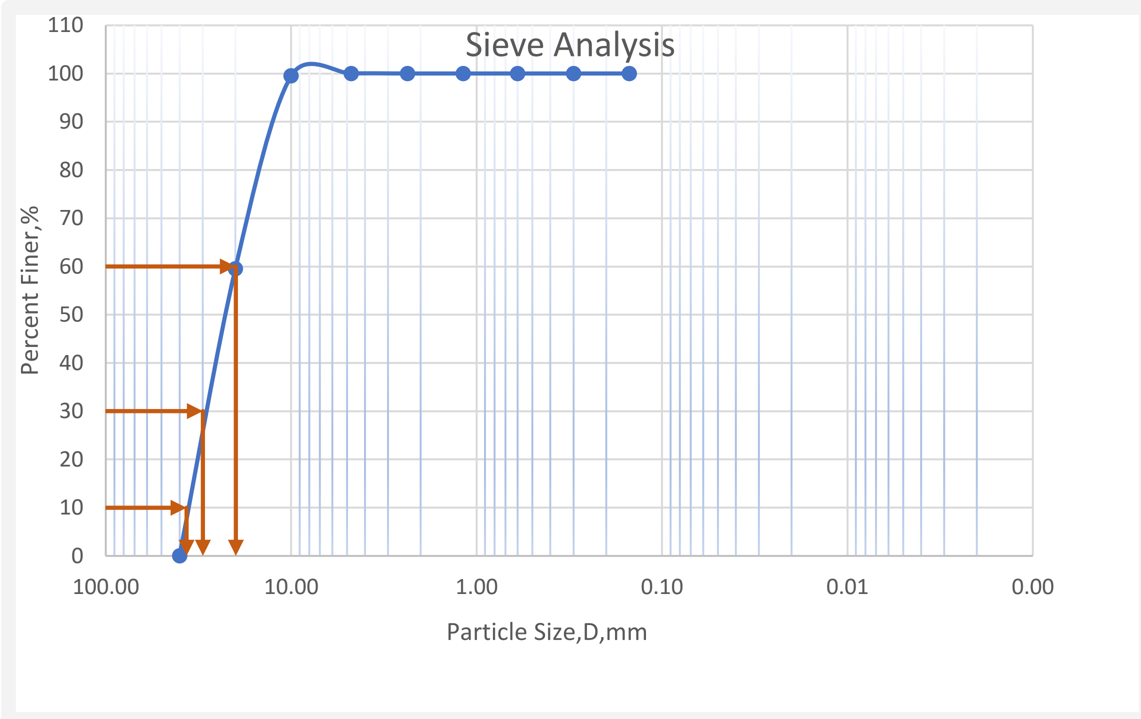


Figure 4.1: Sieve Analysis Graph of Coarse Aggregate.

D60 = 19.9, D30 =29.9, D10 =36.6, CC =0.5426, CU =1.2290

4.2.3 Specific Gravity and Water Absorption Capacity of Coarse Aggregate:

- Dry weight after 24 hours in oven, A=3500 gm
- Weight of Saturated Surface Dry in air, B=3800 gm
- Weight of Saturated Surface Dry in water, C=2400 gm
- Bulk specific gravity (OD) =A/B-C=2.50
- Bulk specific gravity (SSD)= B/B-C=2.71
- Apparent Specific Gravity =A/A-C=3.18
- % Of water Absorption =(B-A/A) x100=8.57%

4.3 FINENESS MODULUS OF FINE AGGREGATE

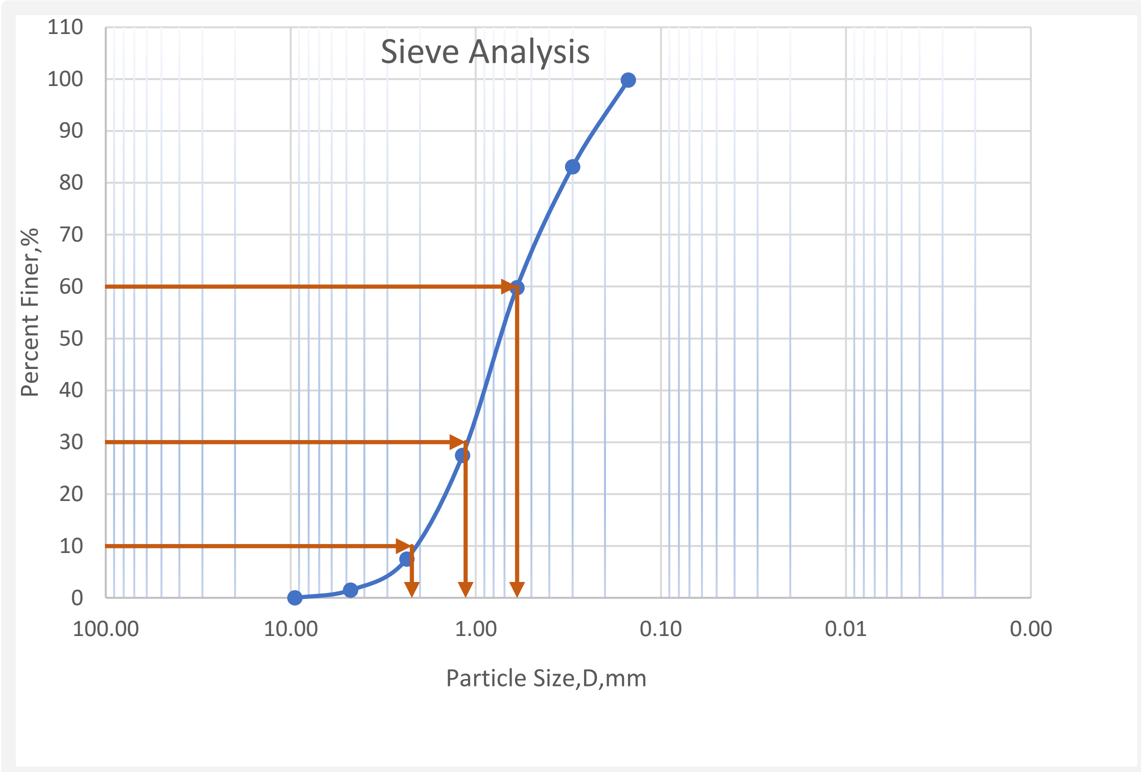
4.3.1 Data Table and Graph of Sieve Analysis of Fine Aggregate

Table 4.2: Data Table of Sieve Analysis of Fine Aggregate

Sieve No(mm)	Retain(gm)	%Retain	Cumulative % Retain	FM
9.50	0.00	0.00	0.00	2.79
4.75	15.04	1.50	1.50	
2.36	59.81	5.98	7.49	
1.18	199.59	19.96	27.44	
0.60	323.13	32.31	59.76	
0.30	233.06	23.31	83.06	
0.15	167.20	16.72	99.78	
Pan	2.17	0.22	100.00	

Fineness modulus of fine (sand) aggregates = (sum of cumulative % retained) /100 So, FM =279/100 = 2.79

4.3.2 Sieve Analysis Graph of Fine Aggregate



4.3.3 Specific Gravity and Water Absorption Capacity of Fine Aggregate:

- Dry weight after 24 hours in oven, A =494 gm
- Weight of Pycnometer + water, B =1530 gm
- Weight of Pycnometer + SSD sand + water, C=1840 gm
- Weight of the saturated surface-dry Sand, S=500 gm
- Bulk specific gravity (OD) =(A/B+S-C) =2.60
- Bulk specific gravity (SSD)=(S/B+S-C) =2.63
- Apparent Specific gravity = (A/B+A-C) =2.68
- % Of water absorption = (S-A /A) x100) =1.21

4.4 SLUMP TEST RESULT AND DISCUSSION

4.4.1 Data Table of Slump Test

Table 4.3: Slump Test Result of Hand Mixing Concrete

Hand mixing Concrete	
Grade Of Concrete	Slump Value
M20	74 mm
M15	59 mm

Table 4.4: Slump Test Result of Machine Mixing Concrete

Machine Mixing Concrete	
Grade Of Concrete	Slump Value
M20	68 mm
M15	61 mm

4.4.2 Discussion

Our mean slump values for M20 and M15 (Hand Mix Concrete) were 74 mm and 59 mm, respectively, and for both M20 and M15, they were 68 mm and 61 mm (Machine Mix Concrete). The slump is also known as a collapse slump, shear slump, or real slump. The optimal situation calls for a genuine downturn. A collapse slump will generally mean that the mix is too wet or that it is high workability mix, for which the slump test is not appropriate. Low workability mixes with slump (10–40) mm are often used in foundations with minimal reinforcement, low workability mixes with slump (50–90) mm are typically used for regular reinforced concrete, and very dry mixes with slump (0–25) mm are typically used for creating roads. Therefore, it appears that our slump value falls within the region of medium workability and is appropriate for the cylindrical strength test.

4.5 COMPRESSIVE STRENGTH TEST

Concrete is typically used in structural applications primarily to counteract compressive pressures. When an unreinforced concrete member is compressed, the member fails in its vertical plane along the diagonal. The lateral tensile forces are what cause the vertical crack. The application of an axial compression load causes a flow in the concrete that manifests as a microcrack along the vertical axis of the member, which then spreads due to lateral tensile strains.

4.5.1 Test Results and Calculation

Each set of 9 cylinders for M15 and M20 composition for both Hand mixing and Machine Mixing concrete respectively have been prepared. That means total number of 36 cylinders for both criteria have been prepared during the test. 7th, 14th and 28th days have been selected as per ASTM method for determining compressive strength of the cylinders.

The compressive strength was calculated as follows:

Compressive strength = Failure load / cross sectional area.

The results from the compression test are in the form of the maximum load the cylinder can be before it ultimately fails. The result of compression test and the corresponding compressive strength is shown in tables and figures.

Table 4.5: Compressive strength obtained from test after 28days of curing (Hand mixing Concrete)

Compressive Strength

Sample	M15	M20
7 days	877 psi	1342 psi
14 days	1225 psi	1896 psi
28 days	1431 psi	2151 psi

Table 4.6: Compressive strength obtained from test after 28days of curing (Machine Mixing Concrete)

Compressive Strength		
Sample	**M15**	**M20**
7 days	1002 psi	1503 psi
14 days	1418 psi	2039 psi
28 days	1619 psi	2442 psi

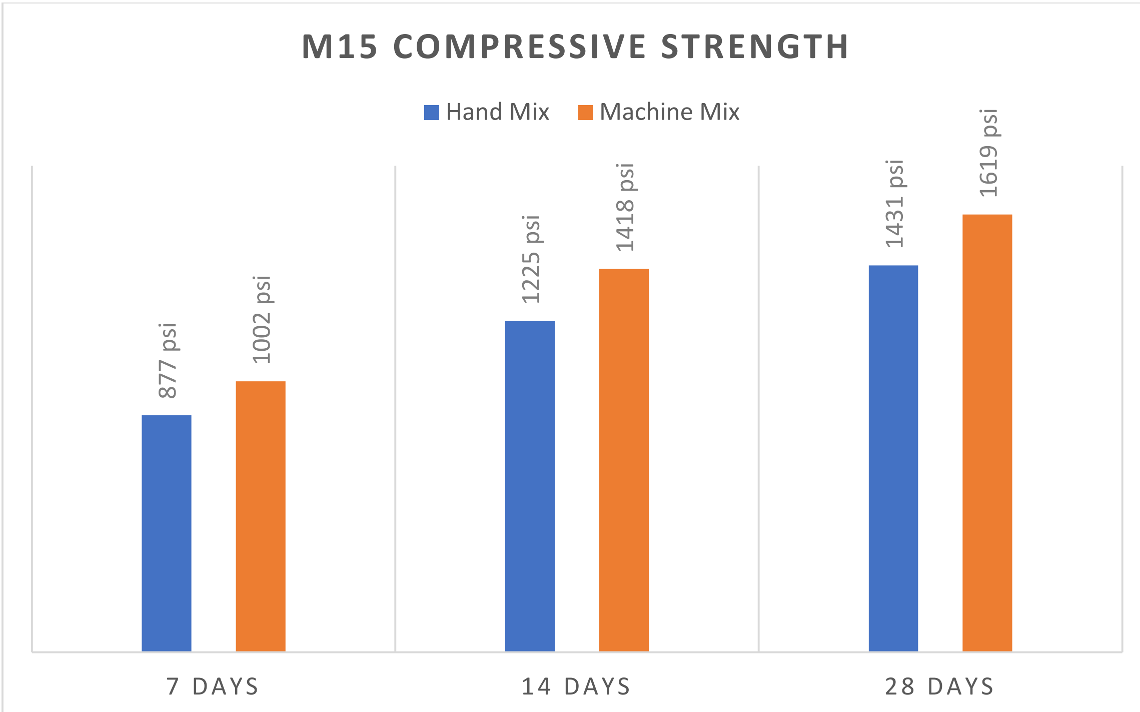


Figure 4.4: Compressive Strengths of HMC Vs MMC (28 days) for M15 concrete

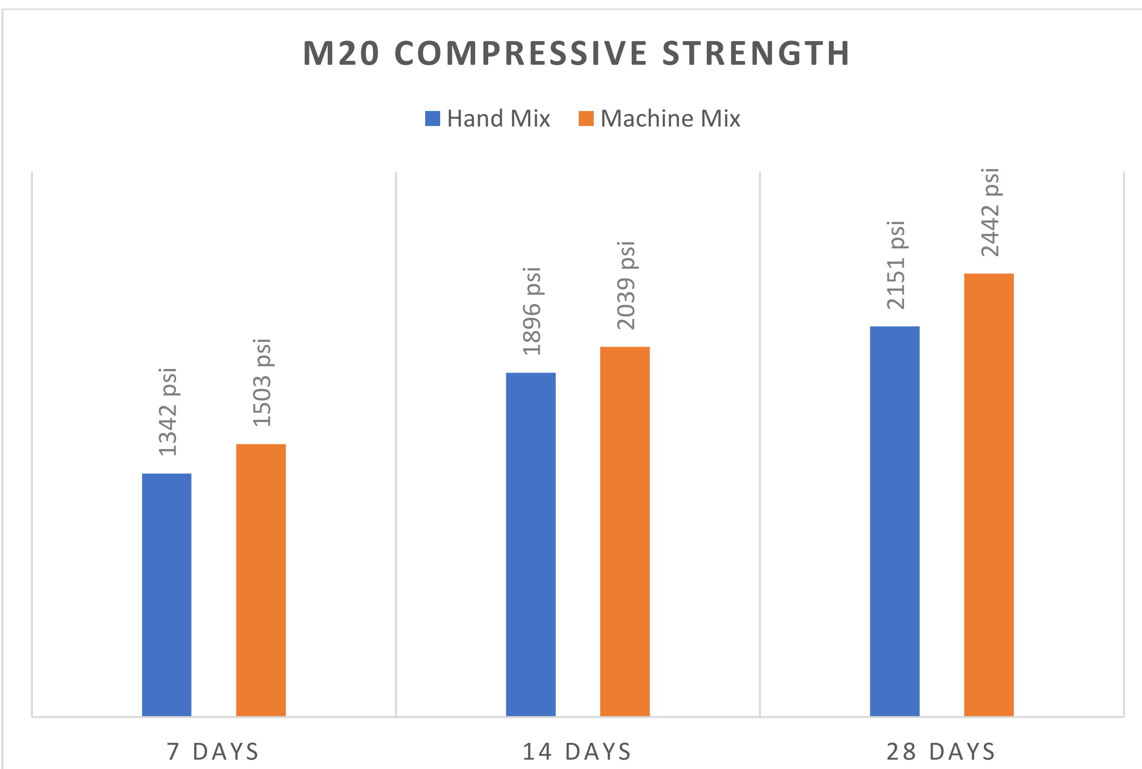


Figure 4.5: Compressive Strengths of HMC Vs MMC (28 days) for M20 concrete

4.5.2 Discussion

In order to manufacture high-quality concrete, it is necessary to select materials and the required concrete quality. The letter M stands for the mixture and the number is the declared characteristic compressive strength of a cylinder after 28 days in N/mm². For M15 the minimum compressive strength is 2175 psi and for M20 the strength is 2900 psi. In our experiment we found 1431 psi and 2151 psi for M15 and M20 Hand mix concrete, and for machine mix concrete the experimental result is 1619 psi and 2442 psi for both M15 and M20 concrete. By analysis the results, we can see that there is a difference between the standard and our experimental results. There are many admixtures that can helps us to gain more strength in our concrete. So, it is recommended that for finding accurate result for both Hand and Machine mix concrete we need to use some admixture.

4.6 SPLIT TENSILE STRENGTH TEST

A key and important attribute of concrete is its tensile strength. With an awareness of its value, a concrete structure element's design is revised. The tensile stresses that were created as a result of applying the compressive load at the point where the concrete specimen might break are used to calculate the tensile strength of the specimen. a technique for testing concrete's tensile strength that involves splitting a cylinder along its vertical diameter. It is a deceptive technique for determining the tensile strength of concrete.

4.6.1 Test Results and Calculation

Each set of 9 cylinders for M15 and M20 composition for both Hand mixing and Machine Mixing concrete respectively have been prepared. That means total number of 36 cylinders for both criteria have been prepared during the test. 7th, 14th and 28th days have been selected as per ASTM method for determining Tensile strength of the cylinders.

The Tensile strength was calculated as follows: $T = 2P / \pi DL$.

Where,

D = Diameter, L =Length, P = Applying load

The result of compression test and the corresponding compressive strength is shown in tables and figures:

Table 4.7: Tensile strength obtained from test after 28days of curing (Hand mixing Concrete)

Split Tensile Strength		
Sample	**M15**	**M20**
7 days	110 psi	142 psi
14 days	170 psi	202 psi
28 days	200 psi	215 psi

Table 4.8: Tensile strength obtained from test after 28days of curing (Machine Mixing Concrete)

Split Tensile Strength		
Sample	**M15**	**M20**
7 days	115 psi	160 psi
14 days	187 psi	211 psi
28 days	217 psi	242 psi

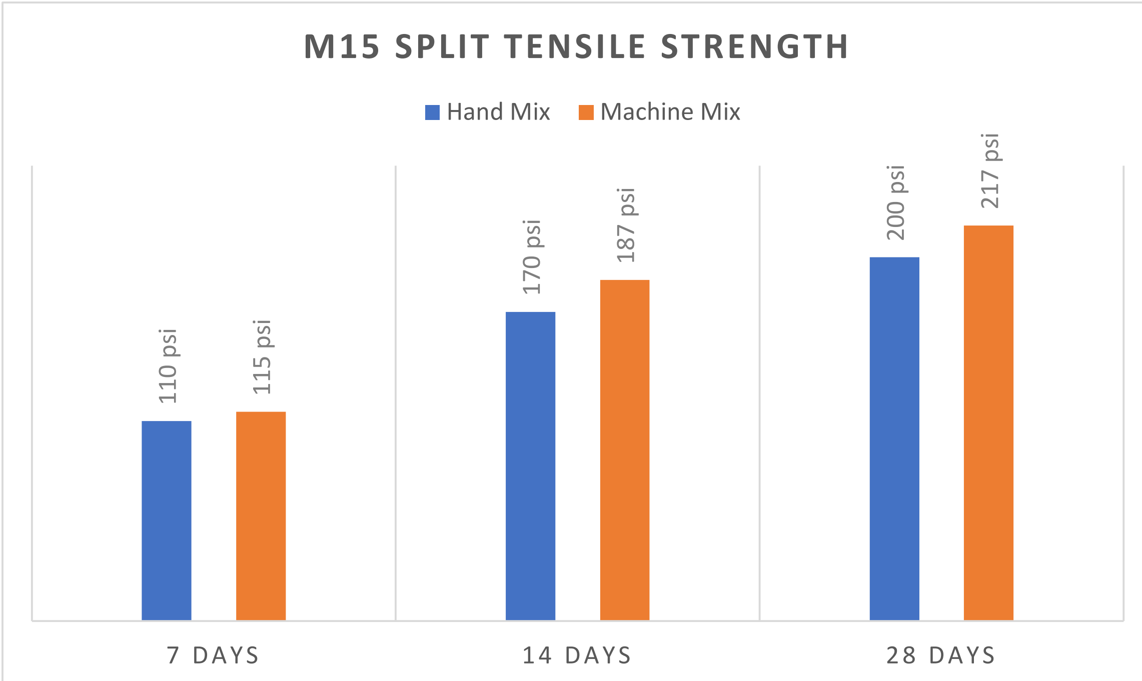


Figure 4.6: Tensile Strengths of HMC Vs MMC (28 days) for M15 concrete

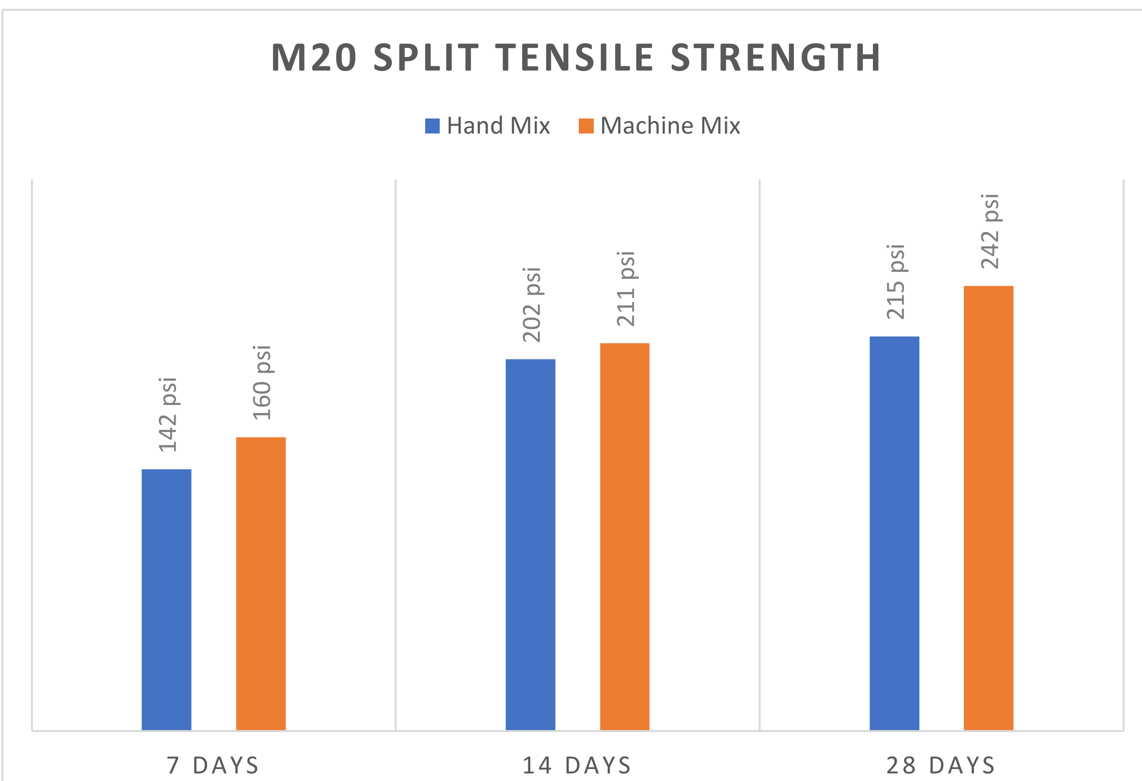


Figure 4.7: Tensile Strengths of HMC Vs MMC (28 days) for M20 concrete

4.6.2 Discussion

Tensile strength is basic and important properties of concrete. Tensile strength for concrete specimen is determine as the tensile stresses developed because of application of the compressive load at that the concrete specimen might crack. The standard value for M15 and M20 concrete is 360 psi and 450 psi. In our experiment we got 200 psi and 215 psi for Hand mix concrete and 217 psi and 242 psi for Machine mix concrete. So, it seems a clear difference between standard and our experimental value. For finding proper result we recommended to use some admixture to reach the standard value.

4.7 COST ANALYSIS

Feasibility is an essential feature of any building material or technology that hits the market. There is potential for new material to emerge, but it may be blocked due to lack of cost-effectiveness in its use. Therefore, it is compared with the production cost of site-mixed concrete, taking into account the market prices of various concrete components.

4.7.1 Costing of The Basis Of Current Study

<table>
<tr><td colspan="3">Hand mixing Concrete and Machine Mixing Concrete Materials Cost</td></tr>
<tr><td>Materials Type</td><td>M15 Cost Per Cubic meters</td><td>M20 Cost Per Cubic meters</td></tr>
<tr><td>Cement – 520tk (per bags)</td><td rowspan="4">206 TK</td><td rowspan="4">223TK</td></tr>
<tr><td>Aggregate - 180tk (per cft)</td></tr>
<tr><td>Sand (Sylhet Sand) - 60tk (per cft)</td></tr>
<tr><td>Transportation – 200tk</td></tr>
</table>

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 INTRODUCTION

Fewer works have been done in the past to study the parameters of MMC (Machine Mix Concrete) and compare them to the parameters of Hand mixing concrete in Bangladesh. This present study was conducted within a hope to make some initial approach to study the result between Hand mixing and Machine Mixing concrete in Bangladesh.

5.2 CONCLUSIONS

In many cases only in-situ concrete is used, since there is very nominal variation in the results of the parameter. Machine mix concrete is typically recommended for large scale projects where high volume is required. Moreover, Hand mix is a better option for small-time construction projects like renovation where concrete volume is smaller. In our experiment we got our slump value is perfect for concrete, so it is clear that our concrete mix design and water cement ratio is okay. All the parameters were controllably tested in the laboratory and the variation between the strengths are higher in Machine mix concrete. After analyzing the cost per cubic meter of Machine mix concrete and hand mix concrete it has been determined that the cost of Machine mix concrete was much lower. So, in the sense, the use of machine mix concrete in further construction projects can be stood up economically rather than using hand mix concrete. But there was an important thing: we can see that the standard results for M15 and M20 are much higher than our experimental results. So, for solving this problem we can use some admixture in concrete to help him to gain more strength. So. It is recommended that to use some admixture both Hand and Machine mix concrete to reach the standard results.

5.3 LIMITATIONS

Though a comparison between MMC and HMC has been studied in this project but there are some limitations we faced during this project –

- The materials we used is not fully dry in conditions, so it makes difference in water ratio.
- We use plastic pipe as a mold, casting is so hard in plastic mold and it will loss some water during casting and it effect in strength.
- Our curing tube was full of sample so, we need to bring our own tube for curing our sample.
- Our UTM machine is old and not good enough to provide accurate value.

So, this is all limitations we faced during our project and we try to overcome this as much as we can to make our thesis work successful.

5.4 FUTURE RECOMMENDATIONS

Some future recommendations are given below:

- Due to high percentage of advantages are delivered by MMC, the use of MMC over HMC can be recommended in the future for all sorts of construction projects.
- The amount of research works should be increased to understand the parameters of MMC.
- Hope the concrete research sectors would be more helpful towards the research relating to MMC in the nearest future.

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