STUDY ON STRENGTH OF CONCRETE MADE WITH DIFFERENT TYPES OF AGGREGATE

Fall-2019

A thesis submitted to the Department of Civil Engineering, Sonargaon University, in partial fulfillment of the requirement for the degree of Bachelor of Science in Civil Engineering.

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DECLARATION

We thereby declare that the research reported in this thesis has been performed by us and this thesis work or any part of it has not been submitted elsewhere for any other purpose except when due reference is made in the text of the thesis.

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CERTIFICATION

This is to certify that the thesis paper on “STUDY ON STRENGTH OF CONCRETE MADE WITH DIFFERENT TYPES OF AGGREGATE” is done by Pijush Kumar Hore, Md. Amzad Hossain, Al-Mamun, Arfur Rahman Anik and Bidduyut Kumar Saha for partial fulfillment of the requirement of the degree of Bachelor of Science (B.Sc.) in Civil Engineering.

This thesis has been carried out under my guidance and is record of the successful work.

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ABSTRACT

Concrete structure has been designed on the basis of strength criteria. The compressive strength of concrete traditionally determined by 28 day's cured cylinder test and this strength is used in designing concrete structures. A mixer of Sylhet sand was used as fine aggregate and round headed stone chips; angular shape stone chips and brick chips were used as coarse aggregate. After testing the concrete cylinder, the maximum compressive strength was found for 07 day's cured cylinder 3121.02 psi which coarse aggregate was angular shape stone chips and tensile strength was found for 07 day's cured cylinder 1099.79 psi which coarse aggregate was also angular shape stone chips. Again, the maximum compressive strength was found for 28 day's cured cylinder 3596.60 psi which coarse aggregate was angular shape stone chips and the maximum tensile strength was found for 28 day's cured cylinder 1200.85 psi which coarse aggregate was also angular shape stone chips. We have also found the failure pattern of cylinder made by different types of coarse aggregate. It is observed that the failure pattern of round headed stone chips is Shear, for angular shape stone chips the failure pattern is Columnar and for brick chips the failure pattern is Cone and Shear.

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CHAPTER-I
INTRODUCTION

1.1 GENERAL

Concrete is a very strong and versatile moldable construction material. It consists of cement, sand and aggregate (e.g., gravel or crushed rock) mixed with water. The cement and water form a paste or gel which coats the sand and aggregate. When the cement has chemically reacted with the water (hydrated), it hardens and binds the whole mix together. The initial hardening reaction usually occurs within a few hours. It takes some weeks for concrete to reach full hardness and strength. Concrete can continue to harden and gain strength over many years.

1.1.1 EARLY HISTORY:

Surprisingly, concrete has a very long if somewhat episodic history. In a Neolithic settlement excavated at Yiftahel in southern Galilee in Israel, a floor of burnt lime plaster was found. It is thought to be the earliest use of concrete. The fragments of a kiln were found on the site - the lime to make the concrete may have been burnt in it. The lime had been mixed with stone and laid 30-80mm deep and given a smooth finish. Mesolithic hut floors at Lepenski Vir in Serbia (the former Yugoslavia) were also made of a lime-bound concrete. Egyptian murals from the second millennium BC depict the making of mortar and concrete. Around 500 BC, at Camiros on Rhodes, the ancient Greeks built a 600,000-liter capacity underground cistern lined with fine concrete.

1.1.2 ROMAN CONCRETE:

The above discoveries hardly point to the intensive use of concrete; otherwise, due to its durability, concrete would likely have been found at many more ancient sites. We have to turn to the Romans for the widespread use of concrete. The Romans discovered that by mixing lime and rubble with pozzolana[2] sands and water, they could make a very strong building material which they called opus cementitious. It even had the added bonus of being able to set under water, so it could be used in the construction of aqueducts and harbors. Perhaps most notable of the many Roman concrete structures that are still standing today are the Coliseum and the Pantheon in Rome. The Romans typically used concrete to construct walls and roofs. Forms were used with the stone and mortar being placed in alternating layers, with the mortar being pounded into each layer of stone. Finished concrete was then faced with brick or tiles. Of particular note is the dome of the Pantheon. Built in 127 AD, heavy travertine (a type of limestone) was used in the wall concrete, whilst broken pumice was used as lightweight aggregate in the 43-meter diameter dome in order to reduce the lateral thrust on the walls. Originally a temple dedicated to all the pagan Roman gods, it has since served as the Roman Catholic Church of St. Mary and the Martyrs.

1.1.3 FROM THE ROMANS TO THE VICTORIANS:

After the fall of the Western Roman Empire (AD 476), construction techniques used by the Romans were generally abandoned, but not necessarily lost. Three Saxon concrete 'pan' mixers dated around 700 ADS have been discovered in an excavation in Northampton. They consist of 2-3-meter diameter shallow bowls excavated in bedrock, each with a center socket that would have held a vertical shaft. Concentric grooves in their bases are thought to have been worn by mixing paddles fixed to a horizontal beam that rotated around the center shaft.

The Normans also had knowledge of concrete, and, like the Romans, used it for wall in-fill. They found that pounded tiles and bricks mixed in with lime mortar and sand produced a similar reaction to that of the Roman pozzolana (the crushed tiles and bricks providing the needed silica and alumina).The use of hydraulic setting pozzolanic concrete in the construction of the 150 mile (240 km) long Canal du Midi has been documented. Constructed between 1667 and 1681, it links Toulouse with Site on France's Mediterranean coast.

1.1.4 DEVELOPMENT OF NATURAL AND PORTLAND CEMENTS:

At this point, to continue our historical account of concrete, we have to digress a bit and look at the development of Portland cement, the essential ingredient that binds modern concrete together. In 1756, John Smeaton, an engineer from Leeds, was commissioned to build the third lighthouse on the Eddy stone Rocks in the English Channel near Plymouth. The first lighthouse, built of timber, had burnt down, the second, also of timber, had been blown down in a gale. Smeaton chose to build his lighthouse of interlocking cut blocks of stone. He experimented with various ingredients to find a quick-setting mortar for use in the construction of the base which was washed by the sea at high tide.

His experiments led him to use a burnt lime from South Wales and a truss (volcanic tuff) from Italy. His lighthouse stood and operated for over two hundred years, from 1759 to 1876, when it was replaced by the present lighthouse. It was dismantled down to the base and re-erected on Plymouth Hoe, where it can be seen today. Smeaton outlined his researches on mortar in a book titled, A Narrative of the Eddy stone Lighthouse.

In 1796, a Mr. Parker of London took out a patent on a process to produce cement by heating septarian nodules found on the shore at Harwich. The nodules were of marl, which is a mix of clay and limestone. The nodules had the right proportions of silica and alumina (from the clay) and calcium (from the limestone), that, when burnt and ground down, produced a cement which set faster and was stronger than the traditional lime mortar. He called his product Roman cement. Other producers of similar "natural" cements sprang up in the early 19th century. In 1813, Joseph Aspdin (1788-1855), a Leeds bricklayer, bought a copy of Smeaton's book, and this likely inspired his own research into cement. In 1824, he patented his "Portland Cement". It was made by calcining limestone, mixing and slaking the burnt lime with puddled clay, then drying the mix, breaking it into lumps and burning it again (double burning), before grinding the resultant clinker down to a powder between millstones. Gypsum was added to prevent flash setting.

Supplied in barrels, his dry powder was easily mixed with water and sand to produce a strong mortar which set quickly. He developed his new cement to produce exterior renders which could be lined-out to give the appearance of Portland stone, hence the name. It was also intended for casting various architectural moldings and features (stucco work). Joseph's younger son William (1815-1864), fell out with his family and moved to Rotherhithe in London in 1841, where he set up a business and further developed his father's product into the Portland cement that we know. He added more limestone (the soft local chalk) to the mix and calcined it at a much higher temperature.

By the end of the 19th century, improved manufacturing techniques (e.g., horizontal rotary kilns and ball mills) had ensured sufficient consistency of product so that Portland cement overtook and superseded the production of natural cements

Thus, we can tell that Concrete is the most widely used man made construction material in the world and is secondly only to water as the most utilized substance on the planet. It is obtained by mixing cementations materials, water and aggregates in required proportion. The mixtures when placed in forms and allowed to cure, hardens into a rocks-like mass known as concrete (Gambhir), 1993. As soon as the components of concrete have been mixed together, the cement and water react to produce a cementing gel that bonds the fine and coarse aggregate into a stone like material. The chemical reaction between cement and water, an exothermic reaction producing heat, is termed hydration. Sand and surki are commonly used as fine aggregate in Bangladesh. Brick aggregate (crushed brick), stone aggregate (crushed stone) are commonly used as coarse aggregate in Bangladesh. The properties of concrete depend several factors such as the quality of the ingredients Proportion of mix, workability, proper compaction and curing. The properties of concrete divided into two main groups: properties of fresh concrete such as workability consistency and properties of hardened concrete such as compressive strength, tensile strength and modulus of elasticity. Among the various properties of concrete, its compressive strength is considered to be more important and is taken an index of its overall quality. Many other properties of concrete appear to be generally related to its compressive strength.[17]

1.2 OBJECTIVES OF THE STUDY

- To study of Compressive and Tensile strength of concrete by using different type of coarse aggregate.
- To compare of Compressive and Tensile strength of concrete using different type of coarse aggregate.
- To find out the failure pattern of concrete using different type of coarse aggregate.
- To study of economically effective concrete using different type of coarse aggregate.

1.3 CHARACTERSTICS OF COARSE AGGREGATE

Generally, aggregate properties affect not only the concrete mixture proportions but also the behavior of fresh and hardened concrete. Due to considerable overlap between the two, it is more appropriate to divide the study of aggregate properties into three categories that are based on microstructural and processing factors.

Characteristics dependent on porosity: density, moisture absorption, strength, hardness, elastic modulus, and soundness.

Characteristics dependent on prior exposure and processing factors: particle size, shape and texture. Characteristics dependent on chemical and mineralogical composition: strength, hardness, elastic modulus, and deleterious substances present.

A knowledge of certain aggregate characteristics (i.e., density, grading, and moisture state) is required for proportioning concrete mixtures. Porosity or density, grading, shape, and surface texture determine the properties of plastic concrete mixtures.

The mineralogical composition of aggregate affects its crushing strength, hardness, elastic modulus, and soundness which, in turn, influence various properties of hardened concrete containing the aggregate.

The most important characteristics of coarse aggregate are as below.

1.3.1 RESISTANCE TO FREEZE THAW:

(Important in structures subjected to weathering) – The freeze thaw resistance of an aggregate is related to its porosity absorption, and pore structure. Specifications require that resistance to weathering be demonstrated by the magnesium sulfate test.

1.3.2 ABRASION RESISTANCE:

Important in pavements, loading plat-forms, floors, etc. Abrasion resistance is the ability to withstand loads without excessive wear or deterioration of the aggregate.

1.3.3 CHEMICAL STABILITY:

(Important to strength and durability of all types of structures) Aggregates must not be reactive with cement alkalis. This reaction may cause abnormal expansion and map-cracking of concrete.

1.3.4 PARTICLE SHAPE AND SURFACE TEXTURE:

(Important to the workability of fresh concrete) Rough textured or flat and elongated particles, due to their high surface area, require more water to produce workable concrete than do rounded or cubical aggregates.

1.3.5 GRADING:

(Important to the workability of fresh concrete) The grading or particle size distribution of an aggregate is determined by sieve analysis.

1.3.6 SPECIFIC GRAVITY (DENSITY):

The specific gravity of an aggregate is the ratio of its weight to the weight of an equal volume of water at a given temperature. Most normal weight aggregates have a specific gravity ranging from 2.4 to 2.9. It is not a measure of aggregate quality. It is used for certain computations in a mix design.

1.3.7 ABSORPTION AND SURFACE MOISTURE:

The moisture conditions of aggregates are designated as:

Oven-Dry: Fully absorbent.

Air-Dry: Dry at the surface but containing some interior moisture, thus somewhat absorbent.

Saturated Surface-Dry: Neither absorbing water from, nor contributing water to the concrete mix.

Wet with free moisture: Containing an excess of moisture on the surface.

Batch weights of materials must be adjusted for moisture conditions of the aggregates.

1.3.8 DRY-RODDED UNIT WEIGHT:

Dry-rodded unit weight is the mass (weight) of one cubic meter (foot) of dry coarse aggregate that is compacted, by rodding in three equal layers, in a standard container. For any one aggregate the dry-rodded unit weight varies with the size and gradation.

1.4 ADVANTAGE OF DIFFERENT TYPE OF COARSE AGGREGATE

1.4.1 ROUND HEADED STONE CHIPS

- Compressive and Tensile strength is high.
- Available in different size.
- Water absorption capacity is less than other coarse aggregate.
- It requires less cement paste for bonding as compared to other shapes.
- Rounded aggregates result the minimum percentage of voids (32 – 33%).
- Gives more workability.

1.4.2 ANGULAR SHAPE STONE CHIPS

- Compressive and Tensile strength is higher than any other coarse aggregate.
- Available in different size.
- Develop good bond because of irregularity in shape.
- Suitable for making all types of concrete.
- They give 10-20% more compressive strength due to development of stronger aggregate-mortar bond.
- Useful in high strength concrete manufacturing.

1.4.3 BRICK CHIPS

- Available in everywhere within the country.
- Easy to get than any other coarse aggregate.
- Easily can make different types of size.
- Cost is less than other aggregate.
- Develop good bond of concrete because of irregularity in shape.
- It has a higher absorption capacity which can hamper hydration of concrete.

1.5 DISADVANTAGE OF DIFFERENT TYPE OF COARSE AGGREGATE

1.5.1 ROUND HEADED STONE CHIPS

- Cost is high.
- Not available everywhere within the country.
- Can't develop higher bond due to less interlocking between the particles.
- Provide less concrete bond due to smooth surface.
- Voids between aggregate particles higher than other aggregate due to round head shape.

1.5.2 ANGULAR SHAPE STONE CHIPS

- Cost is higher than any other coarse aggregate.
- Not available everywhere within the country.
- Sometimes it is difficult to make different in shape.

1.5.3 BRICK CHIPS

- Provide less compressive and tensile strength than other coarse aggregate.
- Need proper concrete ratio to get expected result.
- Due to high porosity, it provides low compressive strength.
- The presence of salts in brick can cause sulfate attack which can render disintegration and expansion of concrete.
- It has a higher absorption capacity which can hamper hydration of concrete.

CHAPTER-II

LITERATURE REVIEW

2.1 GENERAL

A literature review of the effect of coarse aggregate grading compressive strength on the performance of Portland cement concrete, use of Sylhet sand some proportioning methods is presented in this chapter.

Since concrete is a large hardened mass of heterogeneous its properties are flanked by a large number of variables related to difference types and amounts of ingredients, the difference in mixing, transporting, placing and curing and the difference in specimen fabrication and test details. Because of the many variables, methods of checking the quality of concrete must be employed. The usual procedure is to cast strength of the concrete in the structure. The reliability of this assumption should always be questioned because of different curing condition for the specimen and the structure, because poor workmanship in placing in the structure may not be reflected in tests of specimens and because poor testing procedures may provide false results. A pattern of tests should be used rather than placing reliance only a few tests to cheek uniformity and other characteristics of concrete. Statistical methods as given in ACI standard 214 should be used where large quantities concrete are involved.

Most concrete is proportioned for a given compressive strength at a given age and consequently, a compressive test is most frequently used. A 4 x 8 in the cylinder is most commonly required but the large cylinder is frequently used with mass concrete to be placed dams. Compressive strength may also be determined from modified cube tests made on beam specimens remaining after flexural tests and on cores of various size cut from hardened concrete. The details of all strength tests are given in ASTM standards. [01]

2.2 BACKGROUND OF THE STUDY

The role of coarse aggregate in concrete is central to this report. While the topic has been under study for many years, an understanding of the effects of coarse aggregate has become increasingly more important with the introduction of high strength concretes, since coarse aggregate plays a progressively more important role in concrete behavior as strength increases. In normal-strength concrete, failure in compression almost exclusively involves debonding of the cement paste from the aggregate particles at what, for the purpose of this report, will be called the matrix-aggregate interface. In contrast, in high-strength concrete, the aggregate particles as well as the interface undergo failure, clearly contributing to overall strength. As the strength of the cement paste constituent of concrete increases, there is greater compatibility of stiffness and strength between the normally stiffer and stronger coarse aggregate and the surrounding mortar. Thus, microcracks tend to propagate through the aggregate particles since, not only is the matrix -aggregate bond stronger than in concretes of lower strength, but the stresses due to a mismatch in elastic properties are decreased. Thus, aggregate strength becomes an important factor in high-strength concrete. This report describes work that is aimed at improving the understanding of the role of aggregates in concrete. The variables considered are aggregate type, aggregate size, and aggregate content in normal and high-strength concretes. Compression, flexural, and fracture tests are used to better understand the effects aggregates have in concrete.

At present stone aggregate is widely used as coarse aggregate to produce concrete. But in Bangladesh, use of stone aggregate is costly. The brick aggregate is easily available. Due to the availability of brick aggregate and scarcity of stone aggregate has led to the use of substitutes or replacements of stone aggregates for concrete making. Several studies have been performed of the different physical and mechanical properties of concrete while stone aggregates were replaced completely brick aggregates or brick aggregates were used as substitutes. But there are no extensive studies of the properties of concrete while stone aggregate is replaced partially by brick aggregate. So, it is necessary to develop and investigate the properties of concrete while stone aggregates are replaced partially by brick aggregate.

Early prediction of concrete compressive strength enables to know quickly about the concrete and its probable weakness and decide to continue the construction or manage the destruction program. Therefore, prediction of the compressive strength of concrete has been an active area of research. Several methods for early estimation have been introduced in some previously published studies. These attempts were made to predict the 2X day's concrete compressive strength from early days' test results but those had some limitations Many efforts are made on using different techniques as computational modeling, statistical techniques. A number of research efforts have concentrated on using a multivariable regression model to improve the accuracy of prediction. In a recent study multivariable power equation is chosen as an effective model for prediction of the strength of different ages of concrete.

In the above equation compressive strength of a particular day variables Age which is considered as the dependent variable on the has significant correlation with the strength of the water-cement ratio (W/C), cement (C), water (W), sand (FA), Aggregate (CA) content and density of concrete (ρ) and then the becomes it is expected that the strength gains pattern of stone aggregate concrete would be quite similar to that of stone aggregate concrete, the effectiveness of the proposed mathematical model for strength prediction is also tested with these stone aggregate concrete test results. Determined predict the strength of concrete for a particular age directly. To know about the strength history of the corresponding day it is required individually. Some recent studies considered the early day's strength result as an important index for the prediction of concrete strength and the aim of this study is also to predict the concrete compressive strength from early days' strength result. Previously many parameters have been considered for prediction of concrete strength which influences its strength gaining characteristics. In this study, an attempt is made to predict the concrete strength from an early day's concrete strength test result. The model is developed by exploring the concrete strength gain pattern with age. [02]

2.3 PREVIOUS WORK

Walker and Bloem (1960) studied the effects of coarse aggregate size on the properties of normal-strength concrete. Their work demonstrates that an increase in aggregate size from I 0 to 64 mm (%to 2Y. in.) results in a decrease in the compressive strength of concrete, by as much as I 0 percent; however, aggregate size seems to have negligible effects on flexural strength. The study also shows that the flexural-to compressive strength ratio remains at approximately 12 percent for concrete with compressive strengths between 35 MPa (5,100 psi) and 46 MPa (6,700 psi). Bloem and Gaynor (1963) studied the effects of size and other coarse aggregate properties on the water requirements and strength of concrete. Their results confirm that increasing the maximum aggregate size reduces the total surface area of the aggregate, thus reducing the mixing water requirements; however, even with the reduction in water, a larger size aggregate still produces lower compressive strengths in concrete compared to concretes containing smaller aggregate. Generally, in lower strength concretes, the reduction in mixing water is sufficient to offset the detrimental effects of aggregate size. However, in high-strength concretes, the effect of size dominates, and the smaller sizes produce higher strengths. Cordon and Gillespie (1963) also reported changes in concrete strength for mixes made with various water-to-cement ratios and aggregate sizes. They found that, at water-to-cement ratios from 0.40 to 0.70, an increase in maximum aggregate size from 19 mm (%in.) to 38 mm (I Y. in.) decreases the compressive strength by about 30 percent. They also concluded that, in normal-strength concrete, failure typically occurs at the matrix-aggregate interface and that the stresses at the interface which cause failure can be reduced by increasing the surface area of the aggregate (decreasing the aggregate size). If the strength of the concrete is sufficiently high, such as with high strength concrete, failure of the specimen is usually accompanied by the fracture of aggregate particles; therefore, in high-strength concrete, compressive strength depends on aggregate strength, not necessarily aggregate size. [03]

2.4 COMPRESSIVE STRENGTH

The common design compressive strengths required by the construction industry for cast-in place, precast and pre-stressed structures range from 3000 to 8000 psi. These design strengths are economically met with the use of lightweight aggregate. Some lightweight aggregate concretes can obtain strengths above 8000 psi; however, not all lightweight aggregates are capable of obtaining these strengths.

A common concept used to indicate the maximum compressive and/or splitting tensile strengths of concretes using lightweight aggregate is a “strength ceiling.” A mixture reaches its strength ceiling when using the same aggregate, it possesses only slightly higher strength with higher cement content. This property is predominantly influenced by the coarse aggregate fraction of the mixture. The strength ceiling can be increased by reducing the maximum size of the coarse aggregate.

As with normal weight concrete, water reducing and mineral admixtures can be used with lightweight concrete to improve the workability, placing, and finishing.

Kahn (2004) investigated the development of 8,000 psi, 10,000 psi, and 12,000 psi compressive strengths for high-performance lightweight concretes for precast, prestressed bridge girders. A strength ceiling of about 11,600 psi was found using a ½-in. expanded slate aggregate and normal weight natural sand. Laboratory and field mixtures were developed that met the 8,000 psi and 10,000 psi design strength, with the field mixtures attaining higher strengths. Oxylipin

(2005) investigated 8,000 psi and 4,000 psi design strengths for lightweight concretes used for beams and decks, respectively. Test beams were prepared and tested for material properties. A test mixture was designed for normal weight and lightweight high-performance concretes. The average 28-day compressive strength of the normal weight mixture was close to the 8,000-psi design strength; however, the average 28-day compressive strength of the lightweight mixture was below the 8,000-psi design strength. After 1 year, the average compressive strength for the normal weight mixture was above the 8,000-psi design strength, and the average compressive strength for the lightweight mixture was still below the design strength. The low compressive strength was attributed to excess water in the mixture.

Testing was also performed on the actual mixtures used for the bridge beams and deck. For the bridge beams, the average 28-day compressive strength was at or near the target value of 8,000 psi. The average 28-day compressive strength of the deck was above the specified 4,000 psi design strength. From these results, the importance of water control in mixture production is apparent. Therefore, it was determined that better water control was needed during mixture production. [04]

2.4.1 CONCRETE

Concrete is the only major building material that can be delivered to the job site in a plastic state. This unique quality makes concrete desirable as a building material because it can be molded to virtually any form or shape. Concrete provides a wide latitude in surface textures and colors and can be used to construct a wide variety of structures, such as highways and streets, bridges, dams, large buildings, airport runways, irrigation structures, breakwaters, piers and docks, sidewalks, silos and farm buildings, homes, and even barges and ships. The two major components of concrete are a cement paste and inert materials. The cement paste consists of Portland cement, water, and some air either in the loam of naturally entrapped air voids or minute intentionally entrained air bubbles. The inert materials are usually composed of fine aggregate, which is a material such as sand, and coarse aggregate, which is a material such as gravel, crushed stone, or slag. When Portland cement is mixed with water, the compounds of the cement react to form a cementing medium. In properly mixed concrete, each particle of sand and coarse aggregate is completely surrounded and coated with this paste, and all spaces between the particles are filled with it. As the cement paste sets and hardens, it binds the aggregates into a solid mass. Under normal conditions, concrete grows stronger as it grows older. The chemical reactions between cement and water that cause the paste to harden and bind the aggregates together require time. The reactions take place very rapidly at first and then more slowly over a long period of time. [05]

2.5 MATERIALS REQUIREMENTS

- Aggregates
- Cement
- Round headed stone chips
- Angular shape chips
- Bricks chips
- Water

2.5.1 AGGREGATES

Since aggregate usually occupies about 75% of the total volume of concrete, its properties have a definite influence on the behavior of hardened concrete. Not only does the strength of the aggregate affect the strength of the concrete, its properties also greatly affect durability (resistance to deterioration under freeze-thaw cycles). Since aggregately is less expensive than cement it is logical to try to use the largest percentage feasible. Hence aggregates arc usually graded by size and a proper mix has specified percentages of both fine and coarse aggregates.

Fine aggregate (sand) is any material passing through a No. 4 sieve. Coarse aggregate (gravel) is any material of larger size. Fine aggregate provides the fineness and cohesion of concrete. It is important that fine aggregate should not contain clay or any chemical pollution. Also, fine aggregate has the role of space filling between coarse aggregates. Coarse aggregate includes: fine gravel, gravel, and coarse gravel, in fact, coarse aggregate comprises the strongest part of the concrete. It also has the reverse effect on the concrete fineness. The coarser aggregate, the higher is the density and the lower is the fineness. [06]

2.5.1.1 FINE AGGREGATE

The term "Sand" is defined as the aggregate with the restriction that it refers to the material resulting from natural disintegration and abrasion of rock or of completely friable sandstones (ASTM Designation C 125). Sand is the most common fine aggregate Sand should be free foreign materials like organic matter, clay etc. The sand grains may be of sharp angular or round. Sand showing a proper gradation in size from fairly coarse to fairly fine be preferable to either uniformly coarse or uniformly fine sand. The quality of sand is determined by sieve analysis. The coarseness or fineness of sand can be identified by fineness modulus the sum (the cumulative percentage retained in each sieve prescribed by ASTM divided by 100). [07]

Figure 2.1: Fine Aggregate

2.5.1.2 COARSE AGGREGATE

The strength of concrete is dependent on size, shape, grading, surface texture mineralogy of the aggregate, strength, stiffness [5]. Mehta and Monteiro (1993) suggested that the effect of aggregate strength on the compressive strength of concrete is not considered in the case of normal-strength concrete, as it is much stronger than the transition zone and cement paste matrix.

Mehta and Monteiro (1993) also explained that the transition zone and the cement paste matrix would fail before the aggregate and thus nullify the effect of the strength of aggregate. Komatke et al. (2002) also suggested that the aggregate strength is usually not a factor in normal strength concrete as the failure is generally determined by the cement paste- aggregate bond. Much research has linked the bonding of the aggregate to the strength of concrete. Neville and Brooks (1987) explained that greater aggregate surface areas result in better bonding between the aggregate and the cement paste. They also observed that rough aggregates tend to exhibit better binding than smooth aggregates. Jones and Kaplan (1957) made similar observations as Neville and Brooks (1987) but linked the surface properties to the cracking stress suggesting rough aggregates would crack at a higher stress compared to smooth aggregates, ft. can be seen that compressive strength decreases with an increase in maximum coarse aggregate size especially for concretes with low water-cement ratios. It should be noted that the compressive strength is more sensitive to the water-cement ratio than the maximum aggregate size. [06]

Figure 2.2: Different Types of Coarse Aggregate

2.5.2 CEMENT

Construction documents often specify a cement type based on the required performance of the concrete or the placement conditions. Certain cement manufacturing plants only produce certain types of Portland cement. In the most general sense, Portland cement is produced by heating sources of lime, iron, silica, and alumina to clinker temperature (2,500 to 2,800 degrees Fahrenheit) in a rotating kiln, then grinding the clinker to a fine powder. The heating that occurs in the kiln transforms the raw materials into new chemical compounds. Therefore, the chemical composition of the cement is defined by the mass percentages and composition of the raw sources of lime, iron, silica, and alumina as well as the temperature and duration of heating. It is this variation in raw materials source and the plant-specific characteristics, as well as the finishing processes (i.e. grinding and possible blending of gypsum, limestone, or supplementary cementing materials), that define the cement produced.

Chemical tests verify the content and composition of cement, while physical testing demonstrates physical criteria. In Cl 50/M 85 and C595/M 240, both chemical and physical properties are limited. In L 1157, the limits are almost entirely physical requirements.

Chemical Jesting includes oxide analyses (SiO2, CaO. Al2O3, Fe2O3. etc.) to allow the cement phase composition to be calculated. Type II cement are limited in Cl 50/M 85 to a maximum of 8 percent by mass of tricalcium aluminate (a cement phase, often abbreviated CTA). Certain oxides are also themselves limited by specifications: for example, the magnesia (MgO) content which is limited to 6 percent maximum by weight of Portland cement, because it can impact soundness at higher levels.

Typical physical requirements for cement are air content, fineness, expansion, strength, heat of hydration, and setting time. Most of these physical tests are carried out using mortar or paste created from the cement. This testing confirms that a cement has the ability to perform well in concrete; however, the performance of concrete in the field is determined by all of the concrete ingredients, their quantity, as well as the environment, and the handling and placing procedures user. Although the process for cement manufacture is relatively similar across North America and much of the globe, the reference to cement specifications can be different depending on the jurisdiction. In addition, test methods can vary as well, so that compressive strength requirements (for example) in Europe don't translate' directly to those in North America. When ordering concrete or construction projects, work with a local concrete producer to verify that cement meeting the requirements of the project environment and application is used, and one that meets the appropriate cement specification. [08]

Figure 2.3: Portland Cement

2.5.3 ROUND HEADED STONE CHIPS

The aggregate with rounded shape has the minimum percentage of voids ranging from 32 to 33%. It gives a minimum ratio of surface area to given volume and hence requires minimum water for lubrication. It gives good workability for the given amount of water and hence needs less cement for a given water cement ratio. The only disadvantages are that the interlocking between its particles is less and hence the development of bond is poor. This is why rounded aggregate is not suitable for high strength concrete and for pavements subjected to tension. [09]

Figure 2.4: Round Headed Stone Chips

2.5.4 ANGULAR SHAPE STONE CHIPS

The aggregate with angular shape has the maximum percentage of void ranging from 38 to 45%. It requires more water for lubrication and hence it gives the least workability for the given water cement ratio. For constant water cement ratio and workability, the requirement of cement increase. The interlocking between the aggregate particles is the best and hence the development of bond is very good. This is why angular aggregate is very suitable for high strength concrete and for pavements subjected to tension. [10]

Figure 2.5: Angular Shape Stone Chips

2.5.5 BRICKS CHIPS

Long-lasting, colorfast crushed brick chips are perfect for use in low-maintenance landscaping. Use with a heavy-grade landscape fabric to keep brick from sinking into soil and to help prevent weeds. [11]

Figure 2.6: Brick Chips

2.5.6 WATER

Just as water is a source of life for all living things, so it is the primary ingredient for the beginning of all concrete. Without water or too little water, all that exists is a pile of rocks and powder. The opposite can also adversely affect the development of concrete. Too much water and concrete will become a soupy mixture resembling clam chowder rather than a functional structural material.

Water is imperative for two reasons. One is to hydrate the cement and the second is to create a workable substance. Hydration of the cement is necessary to form bonds with the aggregate which in turn give concrete its strength. Conversely, the presence of water-filled spaces within the concrete is detrimental to its strength. Indications are that concrete strength is directly related to porosity and the water-cement ratio (W/C). This is shown by the hydration process. As hydration of cement progress, the volume of solids increases. This volume is in the space previously occupied by the anhydrite cement. The increase in solids volume indicates a decrease in porosity.

Porosity affects strength but strength itself is a result of bonding. Developing bonds in mixtures with high W/C ratios is difficult due to the distances between particles. A high W/C ratio means a mixture with a high porosity. Therefore, a high porosity means weaker bonds which in turn lead to lower strength.

The amount of water required to complete hydration and achieve maximum strength has long been debated. As previously discussed, the strength of concrete is developed through bonds. These bonds develop through a chemical reaction of cement and water. This reaction produces calcium silicate hydrate. One gram of cement requires 0.22 grams of water in order to fully hydrate. However, the volume of the products of hydration is greater than the volume of cement and water used in the reaction. Specifically, it requires a volume of 1.2 mL of water for the products of hydration for 1mL of cement. This equates to a W/C ratio of 0.42 for complete hydration (Aitkin and Neville, 2003). [12]

As noted previously, some of the water is required for the workability of the concrete. This added water is needed because of flocculation that occurs to the particles of cement. This flow decreases workability and impedes hydration. It is possible to include admixtures which eliminate flocculation. Water once used to counteract this effect is now used for hydration, thereby reducing the amount of water needed.

Water and its application in pervious concrete are extremely critical. Since fines are eliminated from pervious concrete, strength relies on the bond of the cement paste and its interface with the aggregate. As with conventional concrete, too little water results in no bonding and too much water will settle the paste at the base of the pavement and clog the pores. The correct amount of water will maximize the strength without compromising the permeability characteristics of the pervious concrete.

The concepts of hydration and workability will be considered when creating mixtures of pervious concrete with varying ratios of cement, aggregate, and water. Water will be added to various mixtures of aggregate and cement in experiments designed to maximize hydration and optimize compressive strength. The goal is to determine an appropriate range of W/C ratios that will yield high compressive strengths in the previous concrete. [13]

Figure 2.7: Water

2.6 GRADING OF AGGREGATE

Grading of aggregate means particle size distribution of the aggregate. If all the particle of an aggregate were of one size, more voids will be in the aggregate mass. One the other hand an aggregate having particles of varying size will exhibit smaller voids. The principle of grading is that the smaller particles fill up the voids left in larger size particles. By adopting proper percentages, of various size aggregate, composite aggregate mix con is developed which will be thoroughly Graded. Properly graded aggregate and cement. The grading of aggregate is expressed in terms of percentages by weight retained on a series of sieves, 75 mm, 20 mm, 4.75 mm coarse are used for grading of coarse aggregate, whereas 10 mm, 4.75 mm, 2.36 mm, 1.18 mm, fine are used for grading of fine aggregate. Grading determines the workability of the mix, which controls segregation, bleeding water cement ratio, handling, placing and other characteristics of the mix. These factors, also affect the economy, strength, volume change and durability of hardened concrete. The is no universal ideal grading for the aggregate. However, I S.I. has specified certain limits within a grading must lie to produce a satisfactory concrete. But these limits depend on upon the shape, surface texture, type of aggregate and amount of flaky or elongated material variations in the grading of sand, causes a large variation in workability, strength and other properties. But the variation in the grading of coarse aggregate does not affect these properties to the extent of fine aggregate. [14]

2.6.1 FINE AGGREGATE GRADING

Over the years, there have been several approaches to specifying the grading requirements for fine aggregate. First, type grading curves were given as representing ‘good’ grading. The division into zones was based primarily on the percentage passing the 600 pm (No. 30 ASTM) Sieve. The main reason for this was that a large number of natural sands divide themselves at just that size, the grading above and below being approximately uniform. Furthermore, the content of particles finer than the (No 30 ASTM) sieve has a considerable influence on the workability of the mix and provides a fairly reliable index of the overall specific surface of the sand. Thus, the grading zones largely reflected the grading of natural sands available in the United Kingdom. Little of these sands are now available for concrete making and a much less restrictive approach to grading is reflected in the requirements. This does not mean that any grading will do rather, given that grading is one feature of aggregate, a wide range of grading may be acceptable but a trial-error approach is required. Specifically, requires any fine aggregate to satisfy the overall grading limits of table 2.1 and also one of the three additional grading limits of the same table, but one in ten consecutive samples is allowed to fall outside the additional limits. The additional limits are, in effect, a coarse, a medium, and a fine grading. Other Considerations for Fine Aggregate. Very fine sand will increase the water demand of the mix, while very coarse sand could compromise its workability.

ASTM C33 requires that the sand is less than 45 percent retained on any one sieve. Too much material on one sieve means gap-grading, which will increase the water demand of the amount of material passing the #50 and #100 sieves will affect workability, slab surface texture, and bleeding. Increased bleeding will occur as the portion passing the #50 sieve increases. The flatwork finish ability of a mix also increases as the portion passing the #50 sieve increases.

ASTM C33 limits the amount of material passing the #200 sieve to 3 percent for natural sand that contains clay. Clay is a very fine particle that greatly increases the water demand of a mix, reduces strength significantly, and promotes bleeding.

Sieve Size		Percentage by mass passing sieves				ASTM C33-93
		BS 882:1992				
BS	ASTM	Overall grading	Coarse grading	Medium grading	Fine grading	
10.0 mm	3/8 in	100				100
5.0mm	3/16 in	89-100				95-100
2.36mm	8	60-100	60-100	65-100	80-100	80-100
1.18mm	16	30-100	30-90	45-100	70-100	50-85
600mm	30	15-100	15-54	25-80	55-100	25-60
300mm	50	5-70	5-40	5-48	5-70	10-30
150mm	100	0-15				2-10

Table 2.1: BS and ASTM Grading Requirements for Fine Aggregate

For crushed stone, fine aggregate, the permissible limits are increased to 20 percent except for heavy duty floors. [01]

2.6.2 COARSE AGGREGATE GRADING

Coarse in general terms, the ratio of coarse to fine aggregate. When crushed rock, coarse aggregate is used, a slightly higher proportion of fine aggregate is required than with gravel aggregate in order to compensate for the lowering of workability by the sharp, angular shape of the crushed particles.

The requirements of ASTM C 33-93 for the grading of coarse aggregate are reproduced in Table. The actual grading requirement depends, to some extent, on the shape and surface characteristics of the particles. For instance, sharp, angular particles with rough surface should have a slightly finer grading in order to reduce the possibility of interlocking and to compensate for the high friction between the particles. The actual grading of crushed aggregate is affected primarily by the type of crushing plant employed. A roll granulator usually produces fewer fines than other types of crushers, but the grading depends also on the amount of material fed into the crusher. The larger the maximum size of the coarse aggregate, the lower the water demand of the mix. For example, a mix containing 1 inch-maximum-size aggregate when both mixes are adjusted to the same slump. ASTM C33 generally limits the amount of material passing the #200 sieve to 1 percent for natural coarse aggregate containing clay. As stated above, clay is a very fine particle that greatly increases the water demand of a mix, reduces strength significantly, and promotes bleeding. [01]

2.7 MODULUS OF ELASTICITY

The modulus of elasticity of a given concrete depends on the relative amounts of aggregate and paste and their individual module. The modulus of elasticity of normal weight concrete is typically higher because of the higher modulus of the normal weight aggregate as compared to that of the lightweight aggregate. Typically, the modulus of elasticity for normal weight concrete ranges from 3 to 4 x106 psi. Lightweight concretes usually have a modulus of elasticity of about ½ to ¾ that of a normal weight concrete.

AASHTO addresses the lower modulus of elasticity of lightweight concrete by specifying an equation which includes a term for the unit weight. This equation should be further investigated for typical high-performance, high-strength lightweight concretes, because the modulus term is an extremely important component of prestress loss and deflection calculations. If the modulus is not accurately predicted, the other calculations will also be in error.

Kahn (2004) obtained the modulus of elasticity values for high-performance lightweight concretes in the range of 2,980 psi to 4,680 psi. Ozyildirim et al. (2005) obtained the modulus of elasticity values of about 3,000 psi for high-performance lightweight concrete. Ozyildirim’s investigation also showed that the modulus of elasticity for the lightweight concretes was, as expected, lower than the normal weight concrete mixtures. Modulus of elasticity was measured for the beam and deck mixtures used in the investigation and compared to theoretical equations used by ACI. The values for the beam mixtures were a close match; however, the measured values for the deck mixtures were lower than the predicted values of the theoretical equations. Stiffey (2005) conducted an investigation to determine a new equation that more accurately predicts the modulus of elasticity of lightweight concrete. The current equations specified by

ACI 318 (ACI, 2005) and ACI 363 – Guide for High Strength Concrete have been found to be inaccurate for lightweight concrete. A percent difference statistical analysis between Stiffed stated that further research is needed to verify the proposed equations for all types of lightweight aggregate.

Lightweight aggregates have a significant effect on modulus of elasticity as discussed above. Modulus of elasticity is vital to accurately predict girder camber, girder deflections, and prestress losses. The verification or modification of existing EC models for lightweight concrete with compressive strengths up to 10,000 psi is necessary if high performance, lightweight concrete is to receive widespread use. [15]

2.8 DRYING SHRINKAGE

Drying shrinkage is the reduction in concrete volume due to water loss and is important because it can affect the extent of cracking, prestress loss and warping in concrete structures. For normally cured concretes, lightweight concretes exhibit greater drying shrinkage than normal weight concretes at lower strengths. At higher strengths, the drying shrinkage of lightweight concretes is similar to that of normal weight concretes. The use of partial replacement of lightweight sand with normal weight sand has been shown to reduce the drying shrinkage.

Steam curing aids in reducing the drying shrinkage of lightweight concrete by approximately 10 to 40%. The lower ranges of these drying shrinkage values are similar to typical normal weight concretes.

Vincent (2003) investigated the creep and shrinkage of the lightweight, high strength concrete used in the Chickahominy River Bridge in Virginia. He tested both standard cure and match cured specimens, as well as concrete produced in the lab and concrete produced in a precast plant. He compared his results with creep and shrinkage results from Meyerson (2001) who had tested high-performance, high-strength normal weight concrete of similar strength. Vincent noted that the shrinkage strains of the lightweight concrete were 30% higher than the normal weight concrete.

Kahn (2004) showed that the 620-day drying shrinkage values for 8,000 psi and 10,000 psi design strengths were 820 and 610 macrostrains, respectively. Ozyildirim et al. (2005) showed that the one-year drying shrinkage for lightweight concrete ranged from 555 to 615 macrostrain, while the normal weight concrete tested had drying shrinkage of 505 macrostrains at one year.

Currently the AASHTO models for creep and shrinkage do not address unit weight; however, this is an area in which uncertainty remains, and which would benefit from further research. Researchers have generally found that lightweight concrete experiences more drying shrinkage than normal weight concrete. This appears to be especially true for high performance, lightweight concrete. Further study of drying shrinkage of high performance, lightweight concrete is required so that modifications to existing equations that predict prestress loss due to drying shrinkage can be made. [01]

2.9 COMPACTION

The amount of compaction can have considerable effects on the function of pervious concrete. A higher degree of compaction that takes place when the concrete is placed will directly lead to a higher level of strength in the concrete. This is due to the densification of the concrete and the elimination of voids. These are the same voids necessary for the permeability of the water. Too much compaction will, therefore, result in a loss of permeability through the concrete and a failure of the pervious concrete system. [16]

2.10 UNIVERSAL TESTING MACHINE (UTM)

Universal Testing Machine (UTM) is the cylindrical and cubic concrete compressive load test machine. After completing the curing period of the test specimens, all specimens were kept in dry place for few hours for attaining surface dry condition. The testing was carried out in the loading frame and the compressive load was applied with UTM load machine, which meaning Universal Testing Machine which capacity of 1000 KN. Concentric compressive load was applied on all the specimens. In this machine we get the load in KN.

Figure 2.8: Universal Testing Machine

CHAPTER-III

METHODOLOGY

3.1 GENERAL

We've collected different types of coarse aggregate (angular shape stone, round headed stone and brick chips), sand (Sylhet) as a fine aggregate and cement (Bashundhara) as a binding material from the market and an ongoing construction site for our specimen of cylinder.

For the tensile and compressive strength test of cylinder, we've used 100 mm (4 inch) dia and 200 mm (8 inch) cylinder mold for make the concrete cylinder. Totally we've made 36 no's of cylinder by above three types of coarse aggregate. Firstly, we've made 12 no's by round headed stone, secondly by angular shape stone and finally by brick chips. Here we used total 36 no's cylinder by two part which was 18 no's for 07 days curing and balance 18 no's for 28 day's curing.

3.2 DETERMINING THE PROPERTIES OF CONCRETE INGREDIENTS

We've determined the properties of concrete ingredients which is as below-

3.2.1 SIEVE ANALYSIS OF BOTH COARSE AND FINE AGGREGATE

Particle size determinations on large samples of aggregate are necessary to ensure that aggregates perform as intended for their specified use. A sieve analysis, or gradation test determines the distribution of aggregate particles by size within a given sample.

This information can then be used to determine compliance with design and production requirements. Data can also be used to better understand the relationship between aggregates or blends and to predict trends during production.

Figure 3.1: Sieve Analysis

3.2.2 SPECIFIC GRAVITY OF BOTH COARSE AND FINE AGGREGATE

Aggregate specific gravity is useful in making weight volume conservation and in calculating the void content in compacted sample. It is defined as the ratio of the mass of a unit volume of a material at a stated temperature of the mass of the same volume of gas-free distilled water at a stated temperature.

Figure 3.2: Determination of Specific Gravity

3.2.3 UNIT WEIGHT OF COARSE AGGREGATE

The unit weight of a material can be defined as the weight of a given volume of graded aggregate. It effectively measures the volume that the graded aggregate will occupy and includes both solid particles and the voids between them. The unit weight of fine and coarse aggregates within the ASTM grading limits are generally in the range of 1450 – 1750 kg/cum. The unit weight values are used in designing concrete mixtures. Voids in between aggregate particles that can be filled by the mortar can also be calculated.

Figure 3.3: Determination of Unit Weight of Coarse Aggregate

3.3 PREPARATION OF CYLINDER MOLD

Before casting the cylinder, we must have to clean the cylinder mold on a proper way with some lubricant. Otherwise we'll not get the right shape of the cylinder.

Figure 3.4: Preparation of Cylinder Mold

3.4 MIXING PROPORTION OF CONCRETE MORTAR

We used M20 concrete for our test. The range of mix proportions recommended for applications are:

Mixing Ratio of M20 Concrete:

Cement: Sand: Round headed stone = 1:1.5:3
Cement: Sand: Angular shape stone = 1:1.5:3
Cement: Sand: Brick Chips = 1:1.5:3
Water Cement Ratio = 0.45

3.5 MIXING OF MATERIALS

For casting the cylinder, we mixed the materials with the above ratio.

Figure 3.5: Mixing of Materials

3.6 PLACING OF MATERIALS ON THE CYLINDER MOLD

For placing of materials, we have filled up the cylinder mold by three equal layers.

Figure 3.6: Filling the Cylinder Mold by Weight Materials

3.7 COMPACTING OF MATERIALS

The process of removal of entrapped air and of uniform placement of concrete to form a homogeneous dense mass is termed as compaction. In this study hand compaction was done layers each layer compacted with 25 blows of standard fall height. After the completion of proper compaction, the surface is roughly smoothened by trowel and stored on a horizontal plane up to removal of mold so that both the top and bottom surface remain horizontal and parallel to each other. Without proper compacting it is not possible to get the correct shape of cylinder.

Figure 3.7: Compacting of Materials

3.8 SLUMP CHECKING

The concrete slump test measures the consistency of fresh concrete before it sets. It is performed to check the workability of freshly made concrete, and therefore the ease with which concrete flows. It can also be used as an indicator of an improperly mixed batch. The test is popular due to the simplicity of apparatus used and simple procedure. The slump test is used to ensure uniformity for different loads of concrete under field conditions.

Figure 3.8: Slump Checking

3.9 CUSTING OF CYLINDER

Figure 3.9: Cylinder After Casting

3.10 DE MOLDING

The hardened cubical concrete specimen was brought out removing the mold after 24 hours of its casting. Then leveling of specimen on its surface by permanent marker pen was gone so that they can be separated without any confusion: Much care was taken while removing the mold so that the specimens do not affected adversely.

Figure 3.10: De Molding of Cylinder

3.11 CURING OF CYLINDER

The physical properties of concrete depend largely on the extent of hydration of cement and the resultant microstructure of the hydrate cement. Hydration of cement is activated in the presence of water. For this reason, curing of concrete is obviously required. Structural design is generally based on the *7* days strength, about 65-*7*0 percent of which is reached at the end of the first week after placing. In this study water curing method was used for curing of concrete. Test specimens were immersed under normal water in curing tank for 28 days.

Figure 3.11: Curing of Cylinder

3.12 TESTING SPECIMEN

Figure 3.12: Cylinder Ready for Test

3.13 TESTING OF CYLINDER

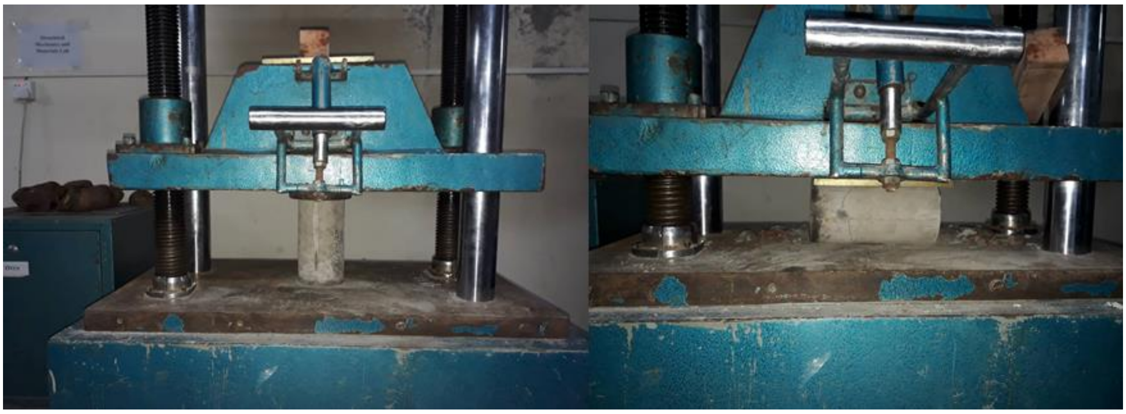

Figure 3.13: Testing of Cylinder

CHAPTER-IV

DATA ANALYSIS

4.1 GENERAL

In this Chapter the laboratory tested data and calculation are described. In the laboratory, load had imposed by UTM (Universal Testing Machine). It includes the test results and analysis of the test results from various laboratory tests conducted in this study.

4.2 SIEVE ANALYSIS

4.2.1 SEIVE ANALYSIS FOR FINE AGGREGATE

Table 4.1: Sieve Analysis of Fine Aggregate

Sieve Number	Sieve Opening (mm)	Materials Retained (gm)	%Materials Retained	Cumulative % Retained	Percent finer
4	4.75	0	0	0	100
8	2.36	22	4.4	4.40	95.60
16	1.19	138	27.60	32.00	68.00
30	0.59	151	30.20	62.20	37.80
50	0.30	145	29.00	91.20	8.80
100	0.15	36	7.20	98.40	1.60
Pan		8	Total =	288.20	

Fineness Modulus $= \frac{288.20}{100}$

$=2.88$

4.2.2 SEIVE ANALYSIS FOR COARSE AGGREGATE

Table 4.2: Sieve Analysis of Coarse Aggregate

Sieve Number	Sieve Opening (mm)	Materials Retained(gm)	%Materials Retained	Cumulative % Retained	Percent finer
$^3/_4$”	19.05	75	5.36	5.36	
$^3/_8$”	9.5	1259	89.93	95.29	
4	4.75	64	4.57	99.86	
8	2.36	0	100	100	
16	1.19	0	100	100	
30	0.59	0	100	100	
50	0.30	0	100	100	
100	0.15	0	100	100	
Pan		2	Total =	700.51	

Fineness Modulus $= \frac{700.51}{100}$ $=7.00$

4.3 SPECIFIC GRAVITY

4.3.1 SPECIFIC GRAVITY FOR FINE AGGREGATE

Table 4.3: Specific Gravity of Fine Aggregate

Wt. of Pycnometer Filled with water to calibration mark B (gm)	**Oven dry Wt. in Air A (gm)**	**Wt. of Pycnometer Specimen with water to calibration mark C (gm)**	**Wt. of S.S.D. sample in Air S (gm)**
1234	500	1545	526

Test	**Equation**	**Calculation**	**Results**
Apparent Specific Gravity	$\frac{A}{B+A-C}$	$\frac{500}{1234+500-1545}$	2.65
Bulk Specific Gravity (S.S.D. Basis)	$\frac{A}{B+S-C}$	$\frac{500}{1234+526-1545}$	2.33
Absorption Capacity, D%	$\frac{S-A}{A} X100$	$\frac{526-500}{500} X100$	5.20
Bulk Specific Gravity (S.S.D. Basis), G	$\frac{A}{B+S-C}$	$\frac{500}{1234+526-1545}$	2.33

Result: Absorption Capacity, D = 2.33%

4.3.2 SPECIFIC GRAVITY FOR COARSE AGGREGATE

Table 4.4: Specific Gravity of Coarse Aggregate

Wt. of S.S.D. sample in Air B (gm)	**Wt. of S.S.D. sample in Water C (gm)**	**Oven dry Wt. of Sample in Air A (gm)**
2000	12400	1920

Test	Formula	Calculation	Results
Apparent Specific Gravity	$\frac{A}{A-C}$	$\frac{1920}{1920-1240}$	2.82
Bulk Specific Gravity (S.S.D. Basis)	$\frac{B}{B-C}$	$\frac{2000}{2000-1240}$	2.63
Bulk Specific Gravity (Oven Dry Basis)	$\frac{A}{B-C}$	$\frac{1920}{2000-1240}$	2.53
Absorption Capacity, D%	$\frac{B-A}{A} X100$	$\frac{(2000-1920)}{1920} X100$	4.25

Result: Absorption Capacity, D = 4.25%

4.4 UNIT WEIGHT OF COARSE AGGREGATE

This experiment was done to find the Unit weight and of coarse aggregates, values are given in the below table:

Volume of the mold, V = $(\pi d^2/4) * h$
Here, Día, d = 6", Height, h = 6"
So, Volume, V = $(\pi * 6^2/4) * 6 = 169.65$ in^3 = 0.1ft^3

Table 4.5: Unit Weight of Coarse Aggregate

Sample	Wt. of the mold (gm)	Wt. of the specimen with mold (gm)	Wt. of the specimen (gm), W	Volume of the mold (ft^3), V	Unit weight (W/V) gm/ft^3	Unit weight kg/ft^3
Free condition	4000	7764	3764	0.1	37640	37.64
Temping condition	4000	8291	4291	0.1	42910	42.91
Jacking condition	4000	8362	4362	0.1	43620	43.62

4.5 TESTED LOAD OF COLUMN ON UTM

We made total 36 no's Cylinder. We firstly casting 12-cylinder by 100% Round headed stone chips (06 no's cylinders for 07 days and 06 no's cylinders for 28 days). Then we used 100% Angular shape stone chips for 12-cylinder casting (06 no's cylinders for 07 days and 06 no's cylinders for 28 days) and 100% Brick chips for 12-cylinder casting (06 no's cylinders for 07 days and 06 no's cylinders for 28 days). We used 03 no's cylinder (07 days and 28 days) for compressive and 03 no's cylinder (07 days and 28 days) for tensile strength test for Round headed stone chips, Angular shape stone chips and Brick chips. The crushing load is given below:

Table 4.6: 07 Day's Cylinder Test Report of Round Headed Stone Chips

Sample-1: Round Headed Stone Chips							
Name of Test	**Obs. No**	**Weight of Cylinder (gm)**	**Load (KN)**	**Load (lb.)**	**Area (sq. inch)**	**Load (Psi)**	**Avg. Load (Psi)**
Compressive Strength	01	3881	165	36960	12.56	2942.68	2805.94
	02	4109	145	32480	12.56	2585.99	
	03	3942	162	36288	12.56	2889.17	
Tensile Strength	01	4039	51	11424	12.56	909.55	903.61
	02	3895	45	10080	12.56	802.55	
	03	3924	56	12544	12.56	998.73	

Table 4.7: 07 Day's Cylinder Test Report of Angular Shape Stone Chips

Sample-2: Angular Shape Stone Chips							
Name of Test	**Obs. No**	**Weight of Cylinder (gm)**	**Load (KN)**	**Load (lb.)**	**Area (sq. inch)**	**Load (Psi)**	**Avg. Load (Psi)**
Compressive Strength	01	3980	182	40768	12.56	3245.86	3121.02
	02	3922	165	36960	12.56	2942.68	
	03	4130	178	39872	12.56	3174.52	
Tensile Strength	01	4070	65	14560	12.56	1159.24	1099.79
	02	3960	59	13216	12.56	1052.23	
	03	3995	61	13664	12.56	1087.90	

Table 4.8: 07 Day's Cylinder Test Report of Brick Chips

Sample-3: Brick Chips							
Name of Test	**Obs. No**	**Weight of Cylinder (gm)**	**Load (KN)**	**Load (lb.)**	**Area (sq. inch)**	**Load (Psi)**	**Avg. Load (Psi)**
Compressive Strength	01	3339	148	33152	12.56	2639.49	2692.99
	02	3351	155	34720	12.56	2764.33	
	03	3415	150	33600	12.56	2675.16	
Tensile Strength	01	3381	49	10976	12.56	873.89	879.83
	02	3407	52	11648	12.56	927.39	
	03	3387	47	10528	12.56	838.22	

Table 4.9: 28 Day's Cylinder Test Report of Round Headed Stone Chips

Sample-1: Round Headed Stone							
Name of Test	**Obs. No**	**Weight of Cylinder (gm)**	**Load (KN)**	**Load (lb.)**	**Area (sq. inch)**	**Load (Psi)**	**Avg. Load (Psi)**
Compressive Strength	01	4061	190	42560	12.56	3388.54	3507.43
	02	3913	215	48160	12.56	3834.39	
	03	3997	185	41440	12.56	3299.36	
Tensile Strength	01	3937	55	12320	12.56	980.89	1040.34
	02	3864	59	13216	12.56	1052.23	
	03	4051	61	13664	12.56	1087.90	

Table 4.10: 28 Day's Cylinder Test Report of Angular Shape Stone Chips

Sample-2: Angular Shape Stone Chips							
Name of Test	**Obs. No**	**Weight of Cylinder (gm)**	**Load (KN)**	**Load (lb.)**	**Area (sq. Inch)**	**Load (Psi)**	**Avg. Load (Psi)**
Compressive Strength	01	4007	175	39200	12.56	3121.02	3596.60
	02	3960	218	48832	12.56	3887.90	
	03	4120	212	47488	12.56	3780.89	
Tensile Strength	01	4029	75	16800	12.56	1337.58	1200.85
	02	3865	62	13888	12.56	1105.73	
	03	3927	65	14560	12.56	1159.24	

Table 4.11: 28 Day's Cylinder Test Report of Brick Chips

Sample-3: Brick Chips							
Name of Test	**Obs. No**	**Weight of Cylinder (gm)**	**Load (KN)**	**Load (lb.)**	**Area (sq. Inch)**	**Load (Psi)**	**Avg. Load (Psi)**
Compressive Strength	01	3431	145	32480	12.56	2585.99	2704.88
	02	3299	148	33152	12.56	2639.49	
	03	3760	162	36288	12.56	2889.17	
Tensile Strength	01	3370	62	13888	12.56	1105.73	1022.51
	02	3425	58	12992	12.56	1034.39	
	03	3580	52	11648	12.56	927.39	

CHAPTER-V

RESULTS AND DISCUSSION

5.1 GENERAL

After calculated all the laboratory tested data, we've described the results of compressive and tensile strength in this chapter. It also included the test results, which shown in graph in this chapter.

5.2 RESULTS

1. The maximum compressive strength was found for 07 day's cured cylinder 3121.02 psi (avg.) which coarse aggregate was angular shape stone chips.

2. The maximum tensile strength was found for 07 day's cured cylinder 1099.79 psi (avg.) which coarse aggregate was also angular shape stone chips.

3. The maximum compressive strength was found for 28 day's cured cylinder 3596.60 psi (avg.) which coarse aggregate was angular shape stone chips.

4. The maximum tensile strength was found for 07 day's cured cylinder 1200.85 psi (avg.) which coarse aggregate was also angular shape stone chips.

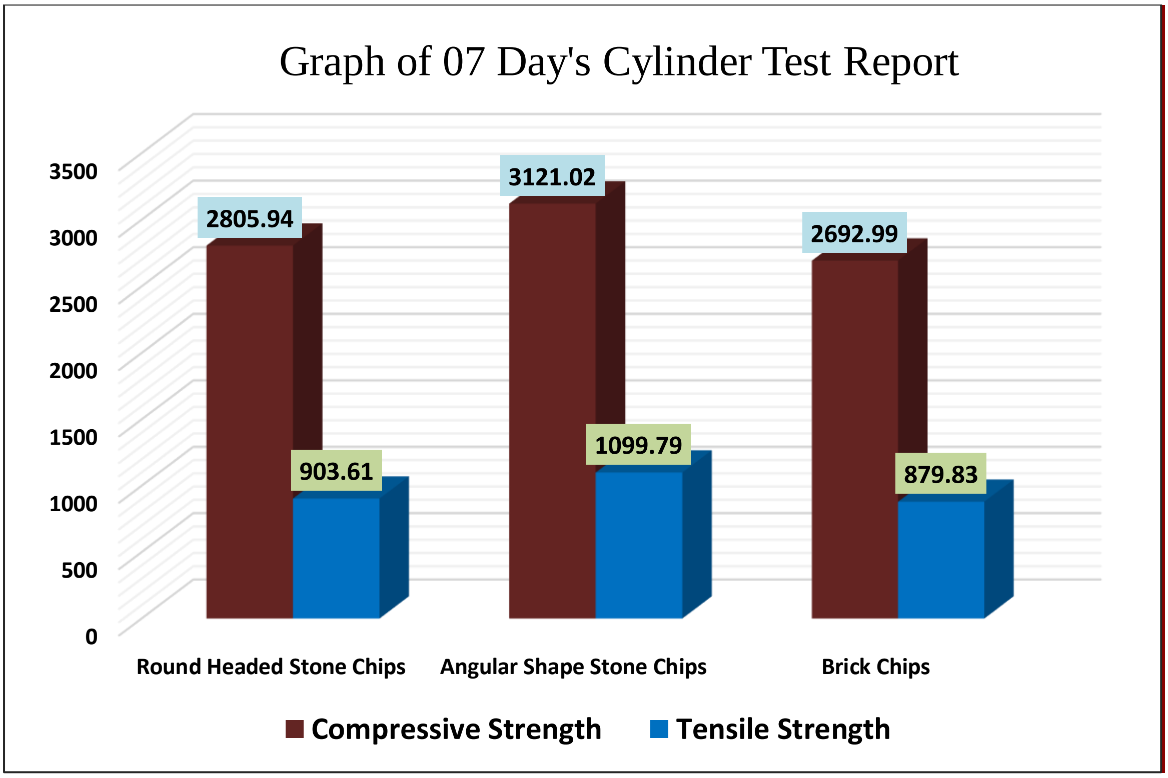

Figure 5.1: Graph of 07 Day's Cylinder Test Report

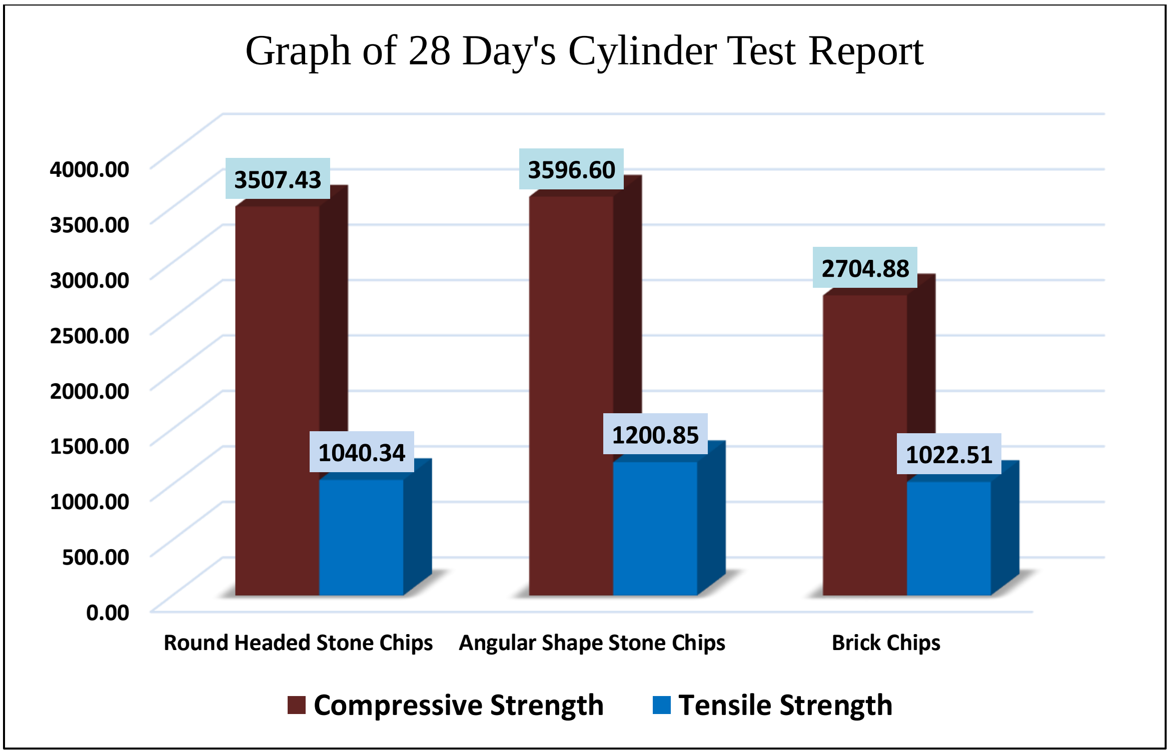

Figure 5.2: Graph of 28 Day's Cylinder Test Report

5.3 FAILURE PATTREN OF DIFFERENT TYPES OF COARSE AGGREGATE

5.3.1 ROUND HEADED STONE CHIPS

Figure 5.3: Failure Pattern **Shear** of Round Headed Stone Chips on Compression

5.3.2 ANGULAR SHAPE STONE CHIPS

Figure 5.4: Failure Pattern **Columnar** of Angular Shape Stone Chips on Compression

5.3.3 BRICK CHIPS

Figure 5.5: Failure Pattern **Cone and Shear** of Brick Chips on Compression

5.4 DISCUSSION

This paper investigates the compare of strength of concrete by using different types coarse aggregate. In this thesis project, we formed 36 concrete cylinder using different type of coarse aggregate. We collected different type of coarse aggregate from different ongoing construction project inside the Dhaka city. The effect of fineness modulus of both fine and coarse aggregates maximum size of coarse aggregate on the compressive strength of concrete was studied on the thesis work. Water cement ratio, the aggregate was kept constant. Both 07 and 28 day's compressive and tensile strength was measured to evaluate the result. A mixer of Sylhet sand was used as fine aggregate and round headed stone chips, angular shape stone chips and brick chips were used as coarse aggregate. We used 4-inch x 8-inch cylinder mold and made 04 (03 cylinders in each set) set of cylinders for each type of coarse aggregate for 07 and 28 day's compressive and tensile strength test. Each set (03 no's) of cylinder was crushed by UTM (Universal Testing Machine) to found the compressive and tensile strength. After testing the concrete cylinder, the maximum compressive strength was found for 07 day's cured cylinder 3121.02 psi (avg.) which coarse aggregate was angular shape stone chips and tensile strength was found for 07 day's cured cylinder is 1099.79 psi (avg.) which coarse aggregate was also angular shape stone chips. Again, the maximum compressive strength was found for 28 day's cured cylinder 3596.60 psi (avg.) which coarse aggregate was angular shape stone chips and the maximum tensile strength was found for 28 day's cured cylinder is 1200.85 psi (avg.) which coarse aggregate was also angular shape stone chips. As we know the brick chips are available everywhere in Bangladesh and the result between angular shape stone chips and brick chips is not much more different, thus we can use the first-class brick chips instead of angular shape stone chips for normal concrete. The cost of concrete made by brick chips is also less than stone chips.

CHAPTER-VI

CONCLUSION AND RECOMANDATION

6.1 GENERAL

This chapter was set out to represent the conclusion of this project. Lastly, some testing, investigations and studies were also recommended after the conclusion, to further the strength characteristics of different types of aggregates concrete for the application in high strength concrete.

6.2 CONCLUSION

Research on the usage of different types of coarse aggregate is very important due to strength of concrete mostly depends on the type of coarse aggregate. Concrete structure has been designed on the basis of strength criteria. It is very important to choose the right type of aggregate for design the concrete structure. The compressive strength of concrete traditionally determined by 28 day's cured cylinder test and this strength is used in designing concrete structures. From our research it is proved that angular shape coarse aggregate is most effective for both compressive and tensile strength due to their rough surface and good interlocking.

6.3 RECOMMENDATION

This is a short scale research work due to the limitation of time and resource. To get the more accurate result large scale research should conduct changing various parameters. Few guidelines were suggested for future study on this topic.

- The use of salt water should be welcomed and not feared for casting and curing of concrete during construction most especially in the costal environment.
- Water / Cement ratio that will give the minimum value of slump with adequate workability, as well as minimum cement content, should be used with maximum aggregate size in order to minimize the shrinkage cracking.
- Mix ratio was constant in this study research should be revised for different mix ratio.
- This study should perform for coarse aggregate and it is necessary to prepare standard grading requirement for both fine and coarse aggregate.

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