A COMPARATIVE STUDY ON THE COMPRESSIVE STRENGTH OF CONCRETE BY USING DIFFERENT TYPES OF CEMENT AND SAND FOR GRADE M15

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A thesis submitted to the Department of Civil Engineering in partial fulfillment for the degree of Bachelor of Science in Civil Engineering



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147/1, Green Road, Dhaka-1215, Bangladesh

Section: 23A

Fall-2024

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Board of Examiners

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Dedicated

to

"Our beloved parents"

ACKNOWLEDGMENTS

All praises and profound gratitude to the Almighty Allah Who is the most beneficent and the most merciful for allowing great opportunity and ability to bring this effort to fruition safety and peacefully.

We sincerely acknowledge and express our deep sense of gratitude to TAMANA HAQUE HIMI (Lecturer) the guide of this project. As a guide she gave a maximum help and coordination in finishing the project work. With her past years of experience and teaching steered us to come out with success through most difficult problems faced by us. Her active interest in this topic and valuable advice was the source of the author's inspiration.

We sincerely would like to thank all instructors and staffs of the Civil Engineering Department of Sonargaon University (SU), Dhaka, which contributed in various ways to the completion of this thesis work.

Finally, we would like to express our deepest gratitude to our entire group members whose support and manual labor contributed in various ways for the completion of this thesis work.

The authors acknowledge the experimental facilities provided by strength of materials laboratory, Department of Civil Engineering of Sonargaon University (SU).

The authors also acknowledge the efforts of all staff of strength of materials laboratory who conducted this study

ABSTRACT

Concrete construction is becoming increasingly complex and the importance of producing structures that are both cost effective and durable has never been higher. Many experimental works have performed to determine the compressive strength of different types of cement. The objectives of the study are to determine the compressive strength of concrete by using two different types of Cement for grades M15. The Materials used for the experiment are OPC & PCC Cement, LC Black stone, Sylhet sand and local Sand. The mass of the specimens was recorded carefully. For 7 days, the values of compressive strength of concrete for OPC 13.57 Mpa and 11.87 Mpa for Sylhet Sand and local Sand respectively of grade M15 and the values of compressive strength of concrete for PCC 9.07 Map and 6.17 Mpa for Sylhet Sand and local Sand respectively of grade M15. For 28 days, the values are 26.67 Mpa and 18.00 Mpa for Sylhet Sand and local Sand respectively for the same types of cements for OPC and the values are 22.08 Mpa and 11.04 Mpa for Sylhet Sand and local Sand respectively for the same types of cements for PCC of grade M15. For 28 days, the highest compressive strength of the concrete found 26.67 Mpa for OPC with Sylhet Sand of M15 and the lowest compressive strength is 11.04 Mpa for PCC with local Sand of grade M15. The compressive strength of OPC cement was better than the PCC cement for the grade M15.

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CHAPTER 1

INTRODUCTION

1.1 General

Civil engineering Professional:

Civil engineering is a professional engineering discipline that deals with the design, construction, and maintenance of the physical and naturally built environment, including public works such as roads, bridges, canals, dams, airports, sewage systems, pipelines, structural components of buildings,andrailways.Tennessee Valley Authority civil engineers monitoring hydraulics of a scale model of Tellico Dam

Civil engineering is traditionally broken into a number of sub-disciplines. It is considered the second-oldest engineering discipline after military engineering and it is defined to distinguish non-military engineering from military engineering. Civil engineering can take place in the public sector from municipal public works departments through to federal government agencies, and in the private sector from locally based firms to Fortune.

General Discussion:

1. Concrete is a composite construction material made by mixing cement, water, and aggregates (such as sand, gravel, or crushed stone). It is widely used in construction due to its durability, strength, and versatility.
2. Concrete compressive strength is a fundamental property that defines its ability to withstand loads that tend to reduce size. The compressive strength test provides valuable insights into the overall quality of the concrete.
3. Cement is a vital construction material used as a binder in the building and construction industry. Cement's versatility and durability make it a cornerstone of modern construction.
4. Sand is a naturally occurring granular material composed of finely divided rock, mineral particles, or organic material. Sand plays a critical role in construction and development, making it a fundamental resource for modern infrastructure.
5. Ordinary Portland Cement:OPC cement stands for Ordinary Portland Cement. It's the most commonly used type of cement in the construction industry. OPC cement is manufactured by grinding clinker, gypsum, and other materials like limestone, fly ash, or slag to a fine powder. The amount of Clinker in OPC is (95-100) %.

6. Portland Composite Cement: PCC is used as a base material for the foundation of buildings and structures. It provides a strong, stable, level surface for constructing the superstructure. The amount of Clinker in PCC is (67-79) %.
7. Concrete Grade M15 follows a 1:2:4 (Cement: Sand: Aggregate) mix ratio of cement, sand, and coarse aggregates. The “M” in M15 stands for mix, with 15 indicating the compressive strength in Map.

Cement:

A cement is a binder, a chemical substance used for construction that sets, hardens, and adheres to other materials to bind them together. Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together. Cement mixed with fine aggregate produces mortar for masonry, or with sand and gravel, produces concrete. Concrete is the most widely used material in existence and is behind only water as the planet's most-consumed resource

Cement powder in a bag, ready to be mixed with aggregates and water. Cement block construction examples from the Multiplex Manufacturing Company of Toledo, Ohio, in 1905

Cements used in construction are usually inorganic, often lime- or calcium silicate-based, and are either hydraulic or less commonly non-hydraulic, depending on the ability of the cement to set in the presence of water (see hydraulic and non-hydraulic lime plaster).

Hydraulic cements: set and become through a between the dry ingredients and water. The chemical reaction results in mineral hydrates that are not very water-soluble. This allows setting in wet conditions or under water and further protects the hardened material from chemical attack. The chemical process for hydraulic cement was found by ancient Romans who used with added lime (calcium oxide).

Non-hydraulic cement (less common) does not set in wet conditions or under water. Rather, it sets as it dries and reacts with in the air. It is resistant to attack by chemicals after setting.

The word "cement" can be traced back to the Ancient Roman term used to describe masonry resembling modern concrete that was made from crushed rock with burnt lime as binder. The volcanic ash and pulverized brick supplements that were added to the burnt lime, to obtain a were later referred to as cemented, cimentum, cement, and cement. In modern times, organic polymers are sometimes used as cements in concrete.

World production of cement is about 4.4 billion tonnes per year of which about half is made in China, followed by India and Vietnam.

The cement production process is responsible for nearly 8% (2018) of global CO_2 emissions which includes heating raw materials in a by fuel combustion and release of CO_2 stored in the calcium carbonate (calcination process). Its hydrated products, such as concrete, gradually reabsorb atmospheric CO_2 (carbonation process), compensating for approximately 30% of the initial CO_2 emissions.

Ordinary Portland Cement (OPC)

Ordinary Portland Cement (simply called cement / OPC) refers to the hydraulic binding material produced by intimate grinding of high-quality Portland cement clinker and appropriate amount of high purity gypsum. OPC is the most commonly used cement for a wide range of applications. UltraTech OPC has been used in various types of constructions like reinforced cement concrete, pre-cast, prestressed concrete structures and slip form construction. It has applications in monumental structures, high-rise towers, skyscrapers, and towers. It is also used in large infrastructures like Canals, Bunkers, chimneys, water retaining structures & Bridges. UltraTech is the primary supplier of cement for several major new infrastructural projects in India.Ordinary Portland cement (simply called ordinary cement) refers to the hydraulic binding material ground by mixing Portland cement clinker, 6% ~ 15% blended materials, and appropriate amount of gypsum, code-named P• O.The maximum amount of active blended materials mixed in cement should not exceed 15% of the total mass. They are allowed to be replaced by kiln ash ainactive blended materials which should be no more than 5% and 10% of the cement mass respectively.The maximum amount of inactive blended materials mixed in cement should not exceed 10% of the total mass.According to Portland Cement, Ordinary Portland Cement (GB175-1999), the national standard, the strength grades of ordinary cement can be divided into: 32.5, 32.5 R, 42.5, 42.5 R, 52.5, 52.5 R, and their ages should be no less than the numerical value in Table 4.3. The initial setting time of ordinary cement should not be earlier than 45 min, and final setting time should not be later than 10 h. The screenings left on the square-hole sieve of 0.08 mm should not exceed 10%. And boiling stability must be qualified. The ignition loss of cement should be less than 5.0%.Ordinary Portland Cement (OPC) is the most widely used as a construction material & has enormous applications in residential, commercial and industrial areas. Apart from these advantages, it also contributes in global CO2 emissions approximately 4–8% [Gunasekara et al., 2015]. India is the second biggest nation in the cement manufacturer, which contributes approximately 7–8% of worldwide cement manufacture with a capability of 234 Million Tons for every year [CMA, 2013]. Also the CO2 emanation from the Indian cement manufacturer will be approximately

835 Million Tonnes by 2050 which is 5.1 times more than present CO2 emissions [IEA, 2014] study also revealed that nearly 0.95 Kg of CO2 (i.e. 0.55 kg CO2 generates directly from cement production and also it requires the fuel for combustion which additionally emits 0.40 Kg of CO2) emission occurs during manufacturing of cement for every 1 Kg [Davidovits J., 1994]. So it is essential to utilize substitute SCM to achieve sustainability in concrete construction. Meanwhile, the massive amount of industrial or agro industrial wastes such as metal slag, fuel ash, rice husk, SCBA etc. are being obtained from power generation, sugar mills, metal, and non-metal industries. These industrial waste leads to various disposal and storage problem (Chusilp et al., 2009a). Also the industrial or agro-industrial wastes which are rich in silica and alumina are preferred as SCMs due to their availability in abundance, required minimal processing, and have superior pozzolanic activity [Deepika et al., 2017]. SCM improves the characterisation of concrete, which is mainly depend upon the pozzolanic activity of the SCM and further SCM also fulfils the credibility of the concrete industry from the point of environmental [Mehta P. K., 2004]The nature of the SCM should be pozzolanic. Generally, pozzolanic defined as rich source of silica and alumina, normally these are not cementitious material, but has tendency to react with calcium hydroxide and water to form cementitious compound [American Society for Testing and Materials, 2014]. To be a pozzolanic material, strength activity index (SAI) should be at least 75% [American Society for Testing and Materials, 2019], which can be obtained by looking at the compressive quality created between mortars comprise of pozzolanic material and a control mix [American Society for Testing and Materials, 2018]. One of agro-industrial waste is SCBA. India is the second biggest nation in the production of Sugarcane. Total production of Sugarcane in India is approximately 303.6 million tons [ISMA, 2017]. Mainly, SCBA is drawn from boilers of Sugar mills as an incineration residual ash. After the extraction of juice from Sugarcane by squashing it, a disposed fibrous residual substance of Sugarcane is obtained which is termed as bagasse [Bahurudeen and Santhanam, 2013]. Initially, bagasse was utilized for paper production. But now bagasse is most commonly used in the cogeneration boilers as a fuel feedstock of Sugarcane mills to produce electricity due to its high calorific value [STAI, 2009]. Fig. 1 describes the entire structure of SCBA ashes derived from its agricultural sources. Since the thermal efficiency of a sugar mills boilers is about 60–70% which produces SCBA containing partial burned or unburned bagasse with extreme black colour [Rasul et al., 2000]. The total amount of bagasse ash generated annually in India amounts to be about 9 million tons, which is a large quantity to be disposed; this would be a basic worry for sugar mill due to the restrictions of land and environment for disposal [Bahurudeen and Santhanam, 2014]. The

disposal of SCBA leads to cause environment problems as these are fine particle which may cause air pollution and also may effect water bodies and land nearby to the discarding zone [Batra et al., 2008]. Use of SCBA is least and uncontrollable; a few utilization of SCBA is as an economy material for backfill or compost which is less when contrasted with its amount [Rerkpiboon et al.

Portland Composite Cement (PCC):

Portland Composite Cement is CEM-II/A-M which is a cement consisting of Clinker, Gypsum, Pulverized Fuel Ash (PFA), Blast Furnace Slag and Limestone designated by the recommendation of BDS EN 197-1: 2010; CEM -II/A-M (V-S-L), 42.5 N. PCC is the most suitable cement for constructions in Bangladesh. CEM – II /A-M contains 80-94% Clinker, which is substantially higher than CEM – II/B-M containing 65 – 79% which provides us extra advantage in strength development and better of concrete performance.

Both slag & fly ash (PFA) are used in PCC. Percentage of SiO2 in PFA is higher than slag which is advantageous to gain more long-term strength and ensure production of durable concrete. This type of cement is used for most of constructions all over the world and it has been used during the last few decades.The hydration process of normal cement produces Calcium Silicate Hydrate CHS & Calcium Hydroxide Ca(OH)2. Calcium Hydroxide Ca(OH)2 does not contribute to gain strength and it is the weak part of reaction which is not suitable for concrete. Since PFA contains higher portion of reactive silica and slag contains alumina, it helps to convert Ca(OH)2 into CSH to gain further Compressive strength.

Courage Aggregate (Indian Store):

The 'indian Stone', so the narrative goes, is the weight you supposedly gain not long after moving to the city. PA. The 'indian Stone', so the narrative goes, is the weight you supposedly gain not long after moving to the city. Stone size 20mm down size.

Different two types Sand:

Sand is an important building material. It abundantly occurs in nature and is formed by the decomposition of rocks. Sand particles consist of small grains of silica (SiO2). It forms a major ingredient in concrete, lime mortar, cement mortar, etc. Sylhet Sand and local Sand

.

1.2 History of OPC and PCC Cement

Portland cement is the most common type of cement in general use around the world as a basic ingredient of concrete, mortar, stucco, and non-specialty grout. It was developed from other types of hydraulic lime in England in the early 19th century by Joseph Aspdin, and is usually made from limestone. It is a fine powder, produced by heating limestone and clay minerals in a kiln to form clinker, and then grinding the clinker with the addition of several percent (often around 5%) gypsum. Several types of Portland cement are available. The most common, historically called ordinary Portland cement (OPC), is grey, but white Portland cement is also available. Its name is derived from its resemblance to Portland stone which is quarried on the Isle of Portland in Dorset, England. It was named by Joseph Aspdin who obtained a patent for it in 1824. His son William Aspin is regarded as the inventor of "modern" Portland cement due to his developments in the 1840s.[1]

Portland Composite Cement is CEM-II/A-M which is a cement consisting of Clinker, Gypsum, Pulverized Fuel Ash (PFA), Blast Furnace Slag and Limestone designated by the recommendation of BDS EN 197-1: 2010; CEM -II/A-M (V-S-L), 42.5 N. PCC is the most suitable cement for constructions in Bangladesh.

1.3 Objectives

The objectives of the Study are following:

1. To determine the compressive strength of concrete by using two different types of fine aggregate.
2. To know the compressive strength of concrete for different types of Cement.
3. The comparison of compressive strength of concrete by using different types of cement for grade M15.

CHAPTER 2
LITERATURE REVIEW

This section presents literature relevant to Compressive Strength of Concrete in different types of sand OPC and PCC cement casting conditions. Curing of concrete products may start after 19/20 hours of costing the concrete and can be done in various ways and methods.

Ahmed, Ali. (2016) accomplished an article on "Influence of Mix Proportion of Sylhet and Local River Sand on the Compressive Strength of Concrete" in the magazine of different types Sylhet Sand, local Sand compressive strength. In their studied was aimed to observe the effect of mix proportion of Sylhet and locally available river sand on the compressive strengths of concrete. A series of laboratory tests is carried out for six different mix proportions 5:0, 4:1, 3:2, 2:3, 1:4 and 0:5 of Sylhet sand and local river sand, respectively. For all of the mix ratios, compressive strengths are determined at 28 days. The compressive strengths increase by designing the appropriate gradation of sand mix, which is determined by fineness modulus of both types of sand and their mixes. The results indicate that the best of the corresponding six mix proportions of Sylhet and local sand is 3:2.

Zarin, Nazia et al. (2019) accomplished an article on "Concrete Compressive Strength Characteristics for Different Proportions of Commonly used Sands in Bangladesh" in the magazine of commonly used in sand Bangladesh. In their studied was Concrete, a proportionate mixture of cement, water and aggregates (and sometimes admixture), is the most widely used man-made construction material, comparatively economical, easy to prepare, offering continuity and solidity and fast to bind with other materials. An experimental study has been performed to see the effect of different mix proportions of coarse sand (Sylhet sand) and fine sand (local sand) on compressive strength of concrete using burnt clay bricks as coarse aggregate. Ordinary Portland cement was used as a binding agent for three different mix ratios (cement: fine aggregate: coarse aggregate), namely: 1:1:2, 1:1.5:3 and 1:2:4. In each batch, local sand was varied (0%, 25%, 50%, 75% and 100%) with Sylhet sand in concrete mix ratios. In this study, an attempt was made to investigate the effect of the variation of fine aggregates for two sets of brick aggregates (machine broken and manually broken) on compressive strength of concrete. A total of 180 concrete cylinders were cast using a specific water-to-cement ratio of 0.45 and tested under compression as per ASTM standards. The findings of this study revealed that for higher cement content (1:1:2) better compressive strength is

attained using a higher percentage of local sand whereas for lower cement content (1:2:4) maximum compressive strength is attained by using an equal mix of local and fine sand. Moreover, for mix ratio 1:1.5:3, higher compressive strength is obtained with machine broken brick chips at 0-25% local sand.

K[1], Muktha et al. (2016) accomplished an article on "Comparative Study on OPC and PPC Composites with Foundry Sand as Partial Replacement for Fine Aggregate an Experimental Approach" in the magazine of OPC PCC Cement and Replacement for fine Aggregate. In their studied was for the last decales, there is an enormous increase in the construction activities. In respect of these, there are many factors which have to be considered in order to make the construction project an ideal one. At the presume tune, due to simultaneous awareness increase on environment, energy and natural rexroes, increasing attention should be paid to the utilization of industrial by products in construction imdustry, Scarcity of natural resources, load bearing capacity city of soils, economic design of structural elements, necessity of high raised buildings, disposal problems etc. Are the main crunches which the construction industry is encountering at present.The present work deals with the performance of concrete, where the fine aggregate is partially replaced with foundry sand. The experimental work has been carried out in different stages. All the materials used for concreting are tested and their proportions are envied for M25 grade of concrete mix with water cement ratio 0.5 in accordance with BIS specification. On fresh concrete workability tests such as slump and compaction factor test were conducted. On hardened concrete compression test is conducted in accordance with BIS specification. An attempt has been made to compare the results with that of the conventional concrime and also between concrete made with 43 Grade ordinary Portland Cement Concrete and Portland Pozzolanic Cement Concrete. From the result of the present investigation in is evident that the performance of concrete with 20% parnal replacement of fine aggregate with foundry sand is better than observed for conventional concrete further it is observed that PPC concrete is perfecting better than OPC concrete at all levels of replacement.

Rumman, R. (2015) accomplished an article on "Durability Performance of Locally Produced OPC and PCC Cement Concretes" in the magazine of OPC PCC Cement and concrete. In their studied was Concrete is the most important building material used in Bangladesh. Since design life of concrete structures is usually very long, compressive strength being the only criteria to determine concrete quality may give rise to severe catastrophic incidents in future. Comparative study on strength and durability characteristics of locally produced cements is

very important since very few publish research are found in this area. Ordinary Portland cement (CEM 1) and Portland Composite Cement (CEM II) are the two locally produced cement types in Bangladesh, former one being more popular. However. CEM II concrete is expected to have bender durability and it abo contains less clinker resulting less CO, emission during production, In this study, Rapid Chloride Permeability Test (RCPT) was performed on concrete made from both types of cement as a cause of durability. It was observed that both the cements produce concrete of comparable strength. However, CEM II concrete exhibited better durability performance at later ages and the trend shows its permeability becoming even less with time. According to the results found, because CEM II performed better in the long run, if this cement is made popular besides CEM L it can give a more sustainable atal cost effective solution

Ahmed, Mohiuddin. (2016) accomplished an article on "Improvement of Sub Base Soil Using Sand-Cement Stabilization" in the magazine of Sub base soil Using Sand and cement. In their studied was the most available construction material in Bangladesh, Sand-cement stabilization is more cost effective and environment friendly for the construction of sub-base pavement layer in perspective of Bangladesh. The researchers conducted an investigation for the use of cement stabilized fine to medium sand in the construction of roads Sands from various location such as Mymensingh, Fajilpur Munshigonj and Sunamgonj are procured for this research work. Although Sunamgunj and Fujilpur sand are slightly expansive, those sand can be easily used as a substitute of unbounded material. According to the laboratory tests, all of the four types of sand have satisfied the criteria of sub-base layer strength on 14 days the sand-cement material with 8 to 10% cement proved to be adequate for sub-base layers of heavily trafficked roads. It observed that, sand sample with 8% cement moves obtained from Fajilpur and Sunamgonj fulfill the specification requirements of sub-base layer for low traffic roads. On the basis of quantitative evaluation, appropriate sand-cement stabilization systems for roads need to be exercised and suggested.

2.1 Background and Motivation

Industrial by-products' productive use grant a chance to relocate the utilization of limited natural resources on a large scale. As Iron slag is a byproduct obtained in the manufacture of pig iron in the blast furnace and is produced by the blend of down-to-earth constituents of iron ore with limestone flux. Iron and steel slag can be distinguished by the cooling process when removed from the furnace in the industry. Mostly, the slag consists of magnesium, aluminum

silicates, calcium, and manganese in various arrangements. Even though the chemical composition of slag is the same, the physical properties of the slag vary with the varying method of cooling. The slags can be used as cement's major constituents as they have greater pozzolanic properties.

The history of the use of iron and steel slag dates back a long way. The European Slag Association (2006) has reported on the earliest reports on the use of slag, where in it is mentioned that Aristotle used slag as a medicament as early as 350 B.C. In the past, the application of steel slag was not noticeable because enormous volumes of blast furnace slag were available. Through awareness of environmental considerations and, more recently, the concept of sustainable development, extensive research and development have transformed slag into a modern industrial product that is effective and beneficial.

The American Society of Testing and Materials (ASTM) (1999) defines blast furnace slag as "the non-metallic product consisting essentially of calcium silicates and other bases that is developed in a molten condition at the same time as iron in a blast furnace." Slag was considered essential in the production of iron, but once it served its purpose in refining the metal, it was strictly a nuisance with little or no use. The use of slag became a common practice in Europe at the turn of the 19th century, where the incentive to make all possible use of industrial by-products was strong and storage space for by-products was lacking. Shortly after, many markets for slag opened in Europe, the United States, and elsewhere in the world.

2.2 Cement

One of the most important building materials is cement which is a binding agent that sets and hardens to adhere to building units such as stones, bricks, tiles, etc. Cement generally refers to a very fine powdery substance chiefly made up of limestone (calcium), sand or clay (silicon), bauxite (aluminum), and iron ore and may include shells, chalk, marl, shale, clay, blast furnace slag, and slate [3].

In cement production plants raw ingredients are processed and heated to form a rock-hard substance, which is then ground into a fine powder to be sold. Cement mixed with water causes a chemical reaction and forms a paste that sets and hardens to bind individual structures of building materials.

Cement has become an integral part of urban infrastructure. It is used to make concrete as well as mortar and to secure the infrastructure by binding the building blocks. Concrete is made of cement, water, sand, and gravel mixed in definite proportions, whereas mortar consists of

cement, water, and lime aggregate. These are both used to bind rocks, stones, bricks, and other building units, fill or seal any gaps, and make decorative patterns.

Cement mixed with water silicates and aluminates, making a water-repellent hardened mass that is used for water roofing [4]. Cement is a binder, a substance used in construction that sets, hardens, and adheres to other materials, binding them together. Cement is seldom used solely, but it is used to bind sand and gravel (aggregate) together. Cement is used with fine aggregate to produce mortar for masonry or with sand and gravel aggregates to produce concrete. Cements used in construction are usually inorganic, often lime or calcium silicate-based, and can be characterized as being either hydraulic or non-hydraulic, depending upon the ability of the cement to set in the presence of water (see hydraulic and non-hydraulic lime plaster).

Non-hydraulic cement will not set in wet conditions or underwater; rather, it sets as it dries and reacts with carbon dioxide in the air. It is resistant to attack by chemicals after setting [4].

Hydraulic cements (e.g., Portland cement) set and become adhesive due to a chemical reaction between the dry ingredients and water.

Results in mineral hydrates that are not very water-soluble and are therefore quite durable in water and safe from chemical attack. This allows setting in wet conditions or underwater and further protects the hardened material from chemical attack [5].

In Britain particularly, good-quality building stone became ever more expensive during a period of rapid growth, and it became a common practice to construct prestige buildings from the new industrial bricks and to finish them with stucco to imitate stone. Hydraulic lines were favored for this, but the need for a fast set time encouraged the development of new cements. Most famous was Parker's "Roman cement". This was developed by James Parker in the 1780s and finally patented in 1796. It was, in fact, nothing like the material used by the Romans, but a "natural cement" made by burning sectarian nodules that are found in certain clay deposits and that contain both clay minerals and calcium carbonate [5]. The burned nodules were ground to a fine powder. This product, made into a mortar with sand,sets in 5–15 minutes. The success of "Roman cement" led other manufacturers to develop rival products by burning artificial hydraulic lime cements of clay and chalk. Roman cement quickly became popular but was largely replaced by Portland cement in the 1850s. In addition to the benefits of cement, the construction industry apparently was unaware of Seaton’s work. The same principle was identified by Frenchman Louis Vicar in the first decade of the nineteenth century. Vicar went on to devise a method of combining chalk and clay into an intimate mixture and burning this produced "artificial cement" in 1817, considered the "principal forerunner "of Portland cement, and "Edgar Dobbs of Southward patented a cement of this kind in 1811".

In Russia, Eger created a new binder by mixing lime and clay. His results were published in 1822 in his book A Treatise on the Art of Preparing a Good Mortar, published in St. Petersburg. A few years later, in 1825, he published another book, which described the various methods of building and embankments.

William Aspin is considered the inventor of "modem" Portland cement. Portland cement, the most common type of cement in general use around the world as a basic ingredient of concrete, mortar, stucco, and non-specialty grout, was developed in England in the mid-19th century and usually originates from limestone. James Frost produced what he called "British cement" in a similar manner around the same time, but did not obtain a patent until 1822. In 1824, Joseph Aspin patented a similar material, which he called Portland cement, because the render made from it was in color similar to the prestigious Portland stone, which was quarried on the Isle of Portland, Dorset, England. However, Aspdins' cement was nothing like modern Portland cement but was a first step in its development, called proto-Portland cement [1]. Joseph Aspins' son, William Aspdin, had left his father's company and, in his cement manufacturing, apparently accidentally produced calcium silicates in the 1840s, a middle step in the development of Portland cement. William Aspin's innovation was counterintuitive for manufacturers of "artificial cements", because they required more lime in the mix (a problem for his father), a much higher kiln temperature (and therefore more fuel), and the resulting clinker was very hard and rapidly wore down the millstones, which were the only available grinding technology at the time. Manufacturing costs were therefore considerably higher, but the product set reasonably slowly and developed strength quickly, thus opening up a market for use in concrete [2]. The use of concrete in construction grew rapidly from 1850 onward and was soon the dominant use for cement. Thus, Portland cement began to play a predominant role. Isaac Charles Johnson further refined the production of meso-Portland cement (the middle stage of development) and claimed to be the real father of Portland cement.

Setting time and "early strength" are important characteristics of cements. Hydraulic limes, "natural" cements, and "artificial" cements all rely on their belie content for strength development. Belie develops strength slowly. Because they were burned at temperatures below 1,250 °C (2,280 °F), they contained no elite, which is responsible for the early strength of modern cements. The first cement to consistently contain elite was made by William Aspin in the early 1840s. This was what we call today "modem" Portland cement. Because of the air of mystery with which William Aspin surrounded his product, others (e.g., Vicar and Johnson) have claimed precedence in this invention, but recent analysis of both his concrete and raw cement has shown that William Aspdin's product made at Northfleet, Kent, was a truealite-

based cement. However, Aspdin's methods were "rules of thumb." Vicat is responsible for establishing the chemical basis of these cements, and Johnson established the importance of sintering the mix in the kiln. The next development in the manufacture of Portland cement was the introduction of the rotary kiln, which allowed for a stronger, more homogeneous mixture and a continuous manufacturing process.

2.3 Modern Cements

Modern hydraulic cements began to be developed from the start of the Industrial Revolution (around 1800), driven by three main needs.

• Hydraulic cement render (stucco) for finishing brick buildings in wet climates.

• Hydraulic mortars for masonry construction of harbor works, etc., in contact with sea water.

• Development of strong concretes. Modern cements are often Portland cement or Portland cement blends, but other cements are used in industry.

Table 2.1: Chemical Composition of Ordinary Portland Cement

Ingredient	Percentage
Lime (CaO)	62
Silica (SiO2)	22
Alumina (Al2O2)	5
Calcium Sulphate (CaSO4)	4
Iron Oxide (Fe2O3)	3
Magnesia (MgO)	2
Sulphur (S)	1
Alkali	1
Total	100

Chemical Composition of Portland composite cement

Portland Composite Cement is CEM-II/A-M which is a cement consisting of Clinker, Gypsum, Pulverized Fuel Ash (PFA), Blast Furnace Slag and Limestone designated by the recommendation of BDS EN 197-1: 2010; CEM -II/A-M (V-S-L), 42.5 N. PCC is the most suitable cement for constructions in Bangladesh. CEM – II /A-M contains 80-94% Clinker, which is substantially higher than CEM – II/B-M containing 65 – 79% which provides us extra advantage in strength development and better of concrete performance.

Both slag & fly ash (PFA) are used in PCC. Percentage of SiO2 in PFA is higher than slag which is advantageous to gain more long-term strength and ensure production of durable concrete. This type of cement is used for most of constructions all over the world

2.4 Properties of Cement

It is always desirable to use the best cement in constructions. Therefore, the properties of cement must be investigated. Although desirable cement properties may vary depending on the type of construction, generally cement possesses following properties (which depend upon its chemical composition, thoroughness of burning and fineness of grinding).

- Provides strength to masonry.
- Stiffens or hardens early.
- Possesses good plasticity.
- An excellent building material.
- Easily workable.
- Good moisture-resistance

2.5 Sand

Sand is a naturally occurring granular material composed of finely divided rock and mineral particles. It is defined by size, being finer than gravel and coarser than silt. Sand can also refer to a textural class of soil or soil type, i.e., a soil containing more than 85% sand-sized particles by mass. The composition of sand varies depending on the local rock sources and conditions, but the most common constituent of sand in inland continental settings and no tropical coastal settings is silica (silicon dioxide, or sio2), usually in the form of quartz. The second most common type of sand is calcium carbonate, for example, aragonite, which has mostly been created over the past half billion years by various forms of life, like coral and shellfish. It is the primary form of sand apparent in areas where reefs have dominated the ecosystem for millions of years, like the Caribbean [2]. Sand is a loose, granular material blanketing the beaches, riverbeds, and deserts of the world. Composed of different materials that vary depending on location, sand comes in an array of 10 colors, including white, black, green, and even pink. The most common component of sand is silicon dioxide in the form of quartz. The earth's landmasses are made up of rocks and minerals, including quartz, feldspar, and mica [3].

2.6 Properties of Sand

Quartz is a very hard mineral, ranking a 7 on the Mohs hardness scale. Pure quartz is transparent to translucent, and the crystals are often hexagonal. A lot of sand,especially that found on beaches, is made of basalt, an igneous rock extruded from volcanoes. Much of the crust of the earth's oceans is made out of basalt, which is magic, which means that it's made of iron and magnesium minerals, such as plagioclase and pyroxene. Other types of sand are made up of tiny bits of coral and crushed snail and clam shells [5]. Sand can also come in many colors. Some beaches in Hawaii are famous for black sand, whereas beaches in the Caribbean are famous for pink sand. Because sand is composed of so many materials, it is possible to study grains of sand under a microscope and discover where they are from and what they are made of.Sand Available in Bangladesh.

Chemicals determined by x-ray analysis for local sands.This test was conducted by the Atomic Energy Commission. A graded sample for individual particle size was used for Ottawa sand. A graph of x-ray analysis was given in Figures 16 through 21 with typical values. The samples retained on sieves #30, #40, #50, and #100 are analyzed. The percentages of #30, #40, #50, and #100 are 2, 28, 45, and 25, respectively. The value of #40 can be divided between #30 and #50 equally. So the weight age values of #30, #50, and #100 were 0.16, 0.59, and 0.25, respectively. Figure 22: Variation of quartz content in different sands the quartz content in sand is very important since it is chemically inert and strong enough to carry loads. From X-ray analysis, the values of quartz content were plotted in a bar, which shows that. Sand II W is best suited with Ottawa sand based on the consideration of quartz content. From X-ray analysis, the values of quartz content with grain size were plotted in a bar, which shows that the percentage of quartz content increases with the decrease in grain size. 11 This is because in larger particles, there is a tendency to adhere foreign particles to their surface. On the other hand, in smaller particles, there is a low tendency to adhere foreign particles. So, there are fewer impurities in smaller particles, and for that reason, the quartz content is comparatively higher than that of larger particles. Figure 23, Variation of quartz content with grain size in different sands from the bur chart, shows that quartz content decreases after acid washing for both sands. This is because disintegration of particles results from acid action, i.e., relatively smaller particles get smaller. In smaller particles, the quantity of quartz is relatively high, and after acid washing, this smaller particle disintegrated and washed out. As a result, quartz content decreases. Another reason is the presence of acid. Fe reacts with SiO2 and forms Fe3Si. As a result, it decreases. On the other hand, Fe is very strong and is not disintegrated upon acid action rather than reacting with Si02. So, for decreasing quartz content, the relative proportion

of Fe may increase, or for reacting with SiO2, Fe content may decrease. The Fe content of the acid-washed sample is the result of the above two actions. In sand 1,fe content increases, and in sand II, Fe content decreases after acid washing.

2.7 ASTM Standard Graded Sand

Sand is produced by processing silica rock particles obtained by hydraulic mining of the ortho-quartzite situated in open-pit deposits near Ottawa, Illinois.

1. Made of local (French-sourced) natural silica sand (silica content: 99%).
2. Having a water content lower than 0.1%.
3. The constituent grains of this sand are uncrushed and of rounded form.
4. The sand is used for testing hydraulic cement in accordance with ASTM C109.

Square Mesh Size in (mm) Percent Passing Sieve (%)

Average Grading C778

Table 2.2: The Average Grading is as Follows

16 (1.180)	100	100
30 (0.600)	97	96 to 100
40 (0.425)	69	65 to 75
50 (0.300)	26	20 to 30
100	1	0 to 4

2.8 Aggregate

The inert materials used in concrete are termed as ‘aggregate’. It is defined as: "Aggregates are the inert materials that are mixed in fixed proportions with a binding material to produce concrete”. The inert materials mean they don't interact chemically with the other components. These can be considering as the "bones" of the concrete, bulking it up and influencing its strength and durability. The quality of the aggregate directly affects how well the concrete mixes, hardens, and lasts over time. To ensure strong, long-lasting concrete, the aggregate must be clean and free of soft particles or organic matter, like soil. These impurities can weaken the concrete by causing unwanted chemical reactions.

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2.9 Function of Aggregate in Concrete

Aggregate is a crucial component of concrete, constituting 60-80% of its volume and 70-80% of its mass. It plays a critical role in shaping the concrete's properties. Primarily, aggregate provides bulk to the concrete, around which the binding materials form a thin film. Ideally, the voids in the coarse aggregate are filled by the fine aggregate, and the remaining gaps are occupied by the binding materials. These binding materials, as their name suggests, function by adhering to individual aggregate particles and solidifying them into a cohesive mass with the assistance of water.

Beyond its role in providing volume, aggregate offers a multitude of benefits to the final product. These include enhanced stability, resistance to wear and erosion, and the achievement of other desired physical characteristics. Notably, the use of aggregate as a filler presents a significant cost advantage for concrete producers. Since cement can be seven to eight times more expensive than stone and sand, incorporating well-graded aggregates, which are considerably cheaper, can maintain strength without compromising on budget.

The significance of aggregate extends beyond its economic benefits. It plays a vital role in shaping the concrete's strength, thermal and elastic properties, dimensional stability, and volume stability. Furthermore, aggregate helps to mitigate shrinkage, a property that primarily affects cement. By incorporating aggregate into the concrete mix, the level of shrinkage can be effectively controlled, thereby preventing the formation of cracks.

2.10 Strength of Aggregate

The strength of concrete is demonstrably influenced by a confluence of factors, including the binding materials, water, and the characteristics of the aggregates themselves. These aggregate properties encompass size, shape, surface texture, grading, and mineralogy, each exerting a variable degree of influence. Consequently, achieving the desired concrete strength necessitates a meticulous approach, involving the selection of appropriate aggregate types and the determination of their optimal composition within the mix.

In Bangladesh, construction projects commonly utilize two primary types of coarse aggregate: brick aggregate and stone chips. Notably, stone chips generally exhibit superior strength compared to brick aggregate. The growing scarcity of natural sand in Bangladesh compels researchers to explore alternative sources and partial replacements with brick fines to enhance concrete strength. Encouragingly, studies have yielded promising results with the incorporation of brick fines as a substitute for natural sand in varying proportions. These findings bolster the pursuit of suitable alternatives within the realm of brick fines.

Furthermore, the use of high-quality brick fines demonstrably accelerates the early-age development of compressive strength in concrete. This translates to achieving the desired strength even before the projected timeframe, signifying a highly advantageous outcome. It becomes evident that the compressive strength of concrete is significantly dictated by the nature of the aggregate. Consequently, the identification of suitable replacements for coarse aggregates, such as slag, has become increasingly crucial.

Due to the inherent difficulty of measuring the crushing strength of individual aggregate particles, the necessary information must be gleaned from indirect tests. These tests may include the crushing value of bulk aggregate or its resistance to abrasion.

2.11 Types of Aggregate

Classification of Aggregates Based on Size

Aggregates are available in nature in different sizes. The size of aggregate used may be related to the mix proportions, type of work, etc. The size distribution of aggregates is called the "grading of aggregates.

Following are the classifications of aggregates based on size: Aggregates are classified into 2 types According to Size

1. Fine aggregate.
2. Coarse aggregate

.2.12 Fine Aggregate

When the aggregate is sieved through a 4.75-mm sieve, the aggregate passed through it is called "fine aggregate. Natural sand is generally used as a fine aggregate; silt and clay also fall under this category. The soft deposit consisting of sand, silt, and clay is termed "loam. The purpose of the fine aggregate is to fill the voids in the coarse aggregate and act as a workability agent. The fine aggregate should not be larger than 3/16 inch in diameter.

2.13 Coarse Aggregate

When the aggregate is sieved through a 4.75-mm sieve, the aggregate retained is called coarse aggregate. Gravel, cobble, and boulders fall under this category. The maximum size of aggregate used may be dependent on some conditions. In general, 40-mm-size aggregate is used for normal strengths, and 20-mm-size aggregate is used for high-strength concrete. The size range of various coarse aggregates is given below.

2.14 Qualities of Aggregates

Since at least three-quarters of the volume of concrete is occupied by aggregate, it is not surprising that its quality is of considerable importance. Not only is the aggregate limiting the strength of concrete, as weak aggregates cannot produce strong concrete, but the properties of the aggregate also greatly affect the durability and structural performance of the concrete.

1. Aggregates should be strong, hard, dense, durable, clear, and free from veins and adherent coatings.
2. Aggregates should be free from injurious amounts of disintegrated pieces, alkalis, vegetable matter, and other deleterious substances.
3. Flaky and elongated pieces should not be present in aggregate mass. o Aggregate crushing value should not exceed 45 percent for aggregate used for concrete other than for wearing surfaces and 30 percent for concrete for wearing surfaces, such as runways, roads, and pavements.
4. Aggregate impact value should not exceed 45 percent by weight for aggregates used for concrete other than for wearing surfaces and 30 percent by weight for concrete for wearing surfaces, such as runways, roads, and pavements.

The abrasion value of aggregate, when tested using a Los Angeles machine, should not exceed 30 percent by weight for aggregates to be used in concrete for wearing surfaces and 50 percent by weight for aggregates to be used in other concrete

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2.15 Water Cement Ratio:

Within concrete, the single most critical factor influencing a multitude of properties is undeniably the quantity of water employed in the mixture. In the realm of concrete mix design, a specific ratio is established, termed the water-to-cement ratio (w/c). This ratio expresses the relationship between the weight of water and the weight of cement used within the mix. These two crucial ingredients are responsible for the cohesive properties of concrete.

The w/c ratio exerts a profound influence on the ultimate strength and durability of the cured concrete. A lower w/c ratio signifies a lesser amount of water relative to the cement content. This translates to a denser and stronger concrete with enhanced durability. Conversely, a higher w/c ratio indicates a greater proportion of water, resulting in a more porous and weaker concrete with diminished durability.

CHAPTER 3
METHODOLOGY

In this study, Cylindrical specimens size for testing was 4 x 8 inch (100 x 200) mm.

Total specimen number = 24 Nos

Condition 1:

Ordinary Portland Cement (Crown Cement).

Indian Stone

Sylhet Sand and local Sand

Numbers of Cylindrical specimen = 12 Nos

Condition 2:

Portland Composite Cement (Shah Cement).

Indian Stone

Sylhet Sand and local Sand

Numbers of Cylindrical specimen = 12 Nos

3.1 Preparation of Cylinders

The Comprehensive strength of the concrete cylinder is one of the most common performance measurers performed by the Engineers in the structural Design. The comprehensive strength of concrete cylinders is determined by applying continuous load over the cylinder until failure occurs. The test is conducted on a compressions-testing machine.

The cylinder specimens are cast in steel, cast iron or any mold made of non-absorbent material. Even under severe conditions, the molds used must retain its original shape and dimensions. Cylindrical specimens for testing should be 4x8 inch (100*200) mm. The mixed concrete is placed in to the molds in layers than 5 cm deep. The strokes per layer during the compaction must not be less than 24 in number. Compaction must reach the underlying layers allowing the majority of the air voids to escape.

The samples are taken and submerged in clean and fresh water until the testing age is reached.



Figure 3.1: Mold Ready for Casting



Figure 3.2: Preparation of Cylinder

3.2 Collection of Materials

The procurement of materials for the concrete production process was conducted as follows. Coarse and fine aggregates were obtained from Dubai LC, Sylhet Sand and local Sand Ordinary Portland Cement (OPC) was acquired from Crown Cement and Portland Composite Cement (PCC) was acquired from Shah Cement

- Ordinary Portland Cement:OPC cement stands for Ordinary Portland Cement. It's the most commonly used type of cement in the construction industry. OPC cement is manufactured by grinding clinker, gypsum, and other materials like limestone, fly ash, or slag to a fine powder. The amount of Clinker in OPC is (95-100) %.



Figure 3.3: Ordinary Portland Cement(OPC)

- Portland Composite Cement: PCC is used as a base material for the foundation of buildings and structures. It provides a strong, stable, level surface for constructing the superstructure. The amount of Clinker in PCC is (67-79) %.



Figure 3.4: Portland Composite Cement (PCC)

Fine Aggregate

Fine aggregate refers to a specific size classification of fine aggregate, where the particles are primarily smaller than 4.75 millimeters and fall within a designated particle size distribution, often used in concrete mixtures. The quality and fine aggregate density strongly influence the hardened properties of the concrete.

In this study, Sylhet sand and local sand used as fine aggregate



Figure 3.5: Sylhet Sand



Figure 3.6: Local Sand

Coarse Aggregate

1. Coarse aggregate is a construction material made from rock that is larger than 3/16 inches but less than 2 inches in size. Coarse aggregates refer to irregular and granular materials such as sand, gravel or crushed stone and are used for making concrete.
2. In this study, black stone used as coarse aggregate.



Figure 3.7: Course aggregate (Indian stone)

3.3 Concrete Mixing

Concrete Mixing

1. A concrete mixture ratio of 1 part OPC cement, 2 parts sands and 4 parts aggregate will produce a concrete mix for grade M15.
2. A concrete mixture ratio of 1 part PCC cement, 2 parts sands and 4 parts aggregate will produce a concrete mix for grade M15
3. Two different sets containing total number of 24 cylinders respectively casted. Water cement ratio 0.50 used and mixing properties 1:2:4 (Cement: Sand: Aggregate) followed respectively.



Figure 3.8: Mixing of Sand Cement and Stone chips

3.4 Casting of Cylinder

Casting is a manufacturing process in which a liquid material is usually poured into a mold, which contains a hollow cavity of the desired shape, and then allowed to solidify. The solidified part is also known as a casting, which is ejected or broken out of the mold to complete the process. Casting is most often used for making complex shapes that would be otherwise difficult or uneconomical to make by other methods.

In addition to the exact geometry of the component, the possible casting and molding methods must also be taken into account in advance in order to obtain an optimum cast part under series production conditions, too.

Besides various changes to the construction, initial experiences with regard to future component properties, rejections and rework are also gained during pilot production. It is extremely important to have the rejections and, ultimately, all factors that restrict the output under control by the start of series production at the latest. This is the only way to achieve high productivity and low costs at the same time in order to be able to maintain the specified price for the compone



Figure 3.9: Casting of Cylinders.

3.5 Curing

1. Curing is the process of maintaining satisfactory temperature and moisture conditions in concrete long enough for hydration to develop the desired concrete properties
2. In this study, after 24 hours of casting the concrete specimens were removed from the molds and allowed for curing. (emersion curing method) for all the cylinders by maintaining temperature and moisture condition.



Figure 3.10: Curing of Cylinder.

3.6 Preparation to crushed of Cylinders

The cylinders were kept submerged as long as for 7 days. After that were withdraw 12 cylinders of M15 grade are made by cylinders PCC cement 3 pcs and OPC cement 3 pcs and M15 grade are made by cylinders PCC cement 3 pcs and OPC cement 3 pcs from the dram. In Sonargaon University (SU) Lab, after that the cylinders has placed in the center of Universal Testing Machine (UTM) one by one (take help from the manual) to find out the crushing of each cylinder.Then were kept submerged as long as for 21 days.Then we kept another test for 21days.After that withdrew from the dram and crushing the cylinders and note down the value.

3.7 UTM Machine

UTM machine is also known as UTM tester, materials testing machine or material testing Frame and that's why manufactures gave a common name`Universal testing machine' and this machine used to test the compressive strength of materials. UTM machines have different roles

stripped of capabilities or marketed for specific industries & sectors which play unique roles in the development of infrastructure, roads, and highways. UTM is one of the best multi-purpose equipment for R&D labs or the QC department.



Figure 3.11: Preparation of Cylinder

3.8 Compression Test:

This is compressive strength of materials means this is completely opposite of Tensile strength testing as mentioned above, basically a maximum pressure has to apply on any object up to its break points. This is called compressive strength of any object. This test also useful to find how much load can bear on bridges pillars, building beams or etc.

3.9 Compressive Strength Test:

Compressive strength test, mechanical test measuring the maximum amount of compressive load a material can bear before fracturing. The test piece, usually in the form of a cylinder is compressed between the platens of a compression testing machine by a gradually applied load. Brittle materials such as rock, brick, cast iron, and concrete may exhibit great compressive strengths but ultimately, they fracture. The crushing strength of concrete, determined by breaking a cylinder, and often called the cylinder strength. Some ductile metals, such as mild steel, have very great compressive strengths; but the actual values are difficult to measure.

When a load is applied to a ductile metal, it deforms elastically up to a certain point, and then plastic deformation occurs. Increasing loads may even completely flatten a test piece without any definite fracture occurring, so that value can be obtained for the compressive strength for two different grade M15 respectively.



Figure 3.12: Place the cylinder in UTM machine

3.10 Compressive Fracture of Cylinder

For 7 days and 21 days test, the specimen was kept the center of UTM machine and crushed one by one and noted the value. Total crushed 24 specimen in Sonargaon University lab.

3.11 Compressive Strength Importance

a) Effect of cement:

The Inhaling high levels of dust may occur when workers empty bags of cement. In the short term, such exposure irritates the nose and throat and causes choking and difficult breathing. Cement industry is one of the main producers of carbon dioxide, a potent greenhouse gas. Concrete causes damage to the most fertile layer of the earth, the topsoil Compressive strength increases with the increasing of cement content Cement dust may enter into the systemic circulation and thereby reach the essentially all the organs of body and affects the different tissues including heart, liver, spleen, bone, muscles and hairs and ultimately affecting their micro-structure and physiological performance.

b) Effect of aggregate / cement ratio:

Well graded aggregates result in the least amount of voids in a given volume. Less voids result in excessive paste availability in a unit volume and more lubrication

Decreasing the aggregate/cement ratio increases the compacting factor due to the increase in the amount of fines (cement) in the mix and decreasing aggregate content, which acts as lubricant and leads to a decrease in the internal friction between the aggregates particles, and as a result, compacting factor increases.

c) Effect of aggregate properties:

Aggregates influence the properties of concrete/mortar such as water requirement, cohesiveness and workability of the concrete in plastic stage, while they influence strength, density, durability, and permeability, surface finish and color in hardened stage.

Aggregate is commonly considered inert filler, which accounts for 60 to 80 percent of the volume and 70 to 85 percent of the weight of concrete. Although aggregate is considered inert filler, it is a necessary component that defines the concrete's thermal and elastic properties and dimensional stability.

d) Effect of admixture:

Admixtures have increased both compressive strength and durability of concrete.

e) Effect of the specimen size:

Concrete strength decreased as the specimen size increased and the decrease was more obvious in the specimens with low aspect ratio.

f) Effect of the rate of loading:

As rate of loading increases, compressive strength, modulus of elasticity, and the slope of the descending portion of the stress-strain curve of concrete increase.

g) Effect of the moisture content:

- The results indicate that, with increasing moisture content, the compressive strength decreases initially and then increases. The effect of moisture content on compressive strength increases with the increasing porosity.

h) Effect of the temperature of the testing:

- The compressive strength can be classified into four distinct patterns of strength loss: 23–200°C, 200–400°C, 400–600°C, and 600–800°C. From 23 to 200°C, the compressive strength of specimens increases with temperature.

3.12 Compressive Strength Formula

Compressive strength is the maximum compressive stress that, under a gradually applied given solid material can sustain without fracture. Compressive strength is calculated by dividing the maximum load by the original cross-sectional area of a specimen in a compressive test. The compressive strength is one of the most important and useful properties of concrete. The design strength of the concrete normally represents its 28th day. Compressive strength can be defined as the capacity of concrete to withstand loads before failure of the many tests applied to the concrete, the compressive strength test is the most important, as it gives an idea about the characteristics of the concrete.

The compressive strength was calculated by using the equation:

$F = P/A$

Were, F is compressive strength of specimen in Pound per square inch (PSI). P is the maximum applied load by Pound. A is the cross-sectional area (inch square).Compressive strength test, mechanical test measuring the maximum amount of compressive load a material can bear before fracturing. The test piece, usually in the form of a cube, prism, or cylinder, is compressed between the platens of a compressive-testing machine by a gradually applied



Figure 3.13: Compressive fracture of Cylinder

CHAPTER 4

RESULT AND DISCUSSION

4.1 Portland Composite Cement (Shah Cement)

Table 4.1 Normal consistency test

Water%	23%	25%	26%	27%	28%
Penetration mm	1mm	3.5mm	6mm	9.5mm	13.5%

- Normal consistency=27.3%

4.2 Portland Composite Cement (Shah Cement)

Table 4.2 Initial Setting time test

Time	30min	45min	60min	75min	90min	100min
Penetration mm	40mm	38.5mmmm	35mm	29.5mm	26mm	21.5mm

- Initial Setting time =92 Minute

4.3 Ordinary Portland Cement (Crown Cement)

Table 4.3 Normal consistency test

Water %	23%	24%	25%	26%
Penetration mm	1mm	1.8mm	5.5mm	1.2mm

- Normal consistency=25.8%

4.4 Ordinary Portland Cement (Crown Cement):

Table 4.4 Initial Setting time test

Time	30min	45min	60min	75min	90min
Penetration mm	31mm	26mm	17mm	8mm	3mm

- Initial Setting time=48minute

4.5 Result of Fine Aggregate

The test sample of the aggregate (F.M) shall weigh, after drying, approximately the Following

Requirement:

Aggregate with at least 85% passing No. 4 Sieve 500gm

And more than 5% retained on a No. 8 Sieve.

Aggregates with at least 95% passing No. 8 Sieve 100gm

Table 4.5: Result of fine aggregate (Local Sand)

Sieve No	Sieve Size	Mass Retained(gm)	%Retain	Cumulative % Retain	FM	%Finer
#4	4.75	0	0	0	161.4/100=1.6	100
#8	2.36	3	0.3	0.3		99.7
#16	1.18	6	0.6	0.9		99.1
#30	600	15	1.5	2.4		97.6
#50	300	637	63.7	67.1		33.9
#100	150	256	25.6	91.7		8.3
Pan	Pan	83	8.3	100		0

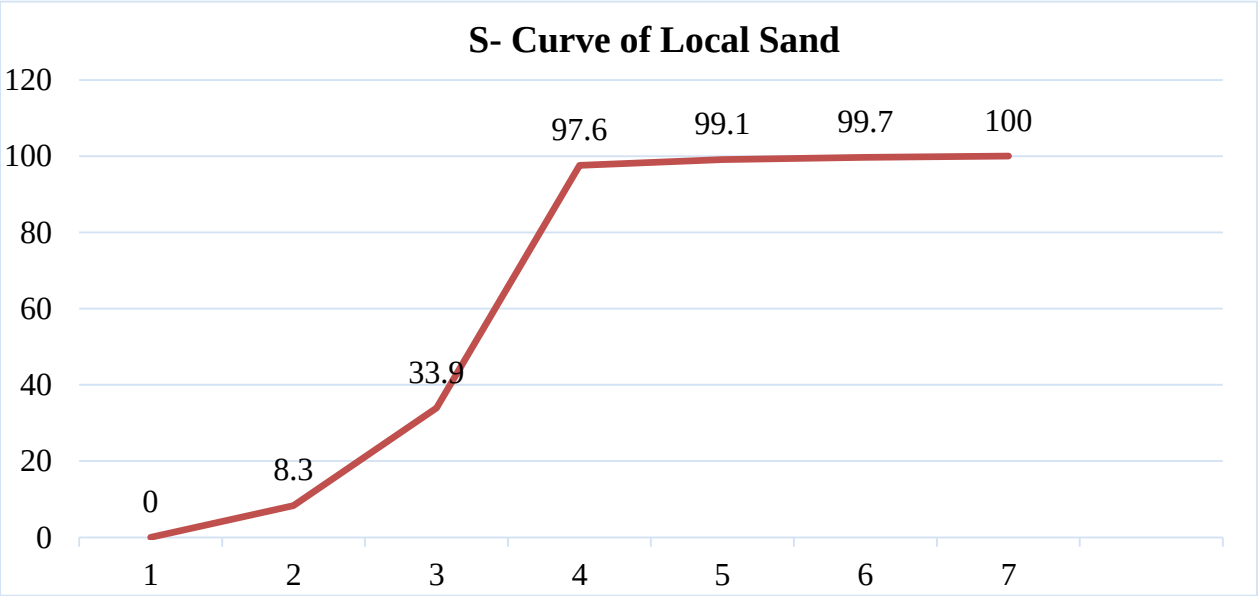


Figure: 4.1 S curve from sieve analysis of Local Sand

Table 4.6: Result of fine aggregate (Sylhet Sand)

Sieve No	Sieve Size	Mass Retained(gm)	%Retain	Cumulative % Retain	FM	%Finer
#4	4.75	16	1.68	1.68	272.4/100=2.7	98.4
#8	2.36	51	5.1	6.1		93.3
#16	1.18	183	18.3	25		75
#30	600	230	23.0	48		52
#50	300	442	44.2	92.2		7.8
#100	150	62	66	98.9		1.1
Pan	Pan	11	1.1	100		0

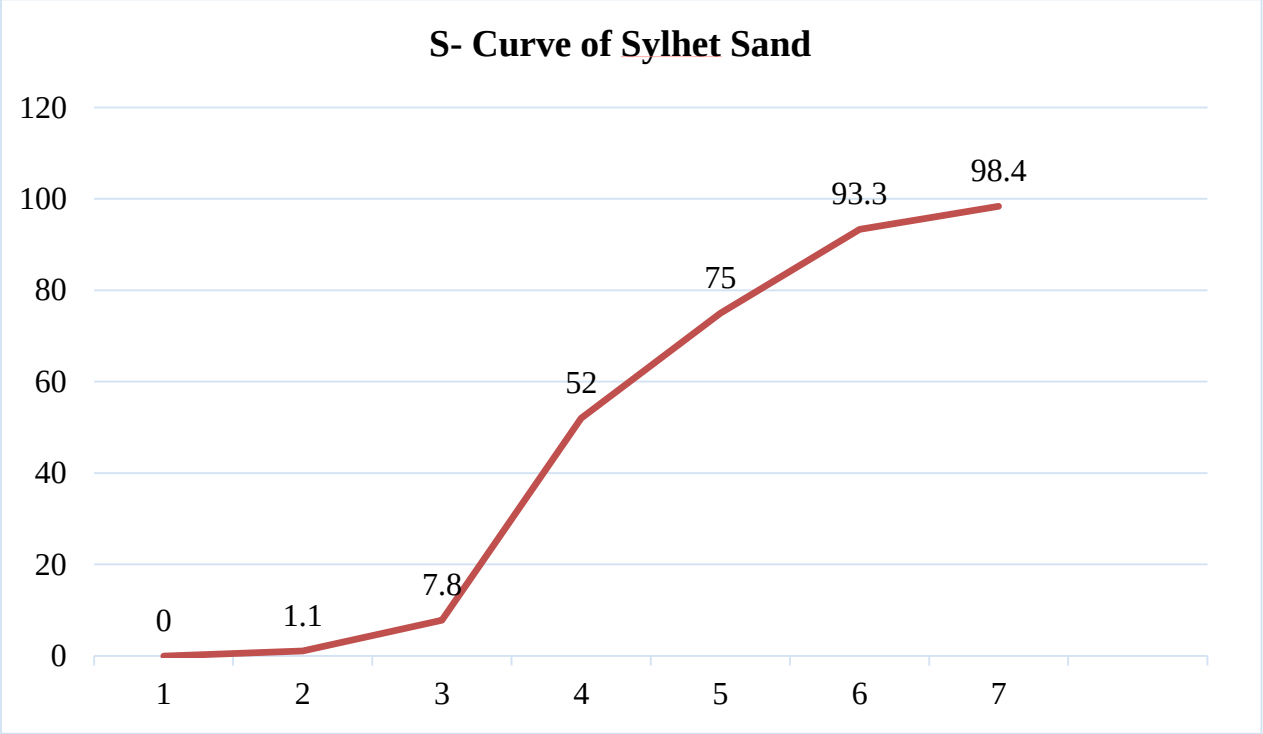


Figure: 4.2 S curve from sieve analysis of Sylhet Sand

4.6 Result of Coarse Aggregate:

The weight of the test sample of coarse aggregate (C.A) shall conform to the following Requirements:

Aggregates with nominal maximum size of ¾ in.10 lbs.

Table 4.7: Result of Coarse Aggregate

Sieve No	Retain	%Retain	Cumulative % Retain	FM
#3/4	573	57.3	57.3	392.6/100=3.9
#3/8	1080	108	165.3	
#4	47	4.7	170	

4.7 Sieve Analysis Normal Sand.

Table 4.8: Sieve Analysis Normal Sand

Sieve No	Retain	%Retain	Cumulative % Retain	FM
4	0	0	0	161.4/100=1.6
8	3	0.3	0.3	
16	6	0.6	0.9	
30	15	1.5	2.4	
50	637	63.7	66.1	
100	256	25.6	91.7	
Pan	83	8.3	100	

4.8 Specific Gravity of Coarse Aggregate

Table 4.9: Specific Gravity of Coarse Aggregate

Wt. of psychomotor filled with water to calibration, B gm	Oven Dry Wt. in air,A gm	Wt. of psychomotor with Specimen and water to Calibration mark C gm
2370	2287	1587

4.9 Specific Gravity of Stone

Table 4.10: Specific Gravity of Stone

Test	Formula	Calculation	Result
Apparent Specific gravity	$\frac{A}{A-c}$	$\frac{2287}{2287-1587}$	3.26
Bulk Specific gravity(open Dry Basic)	$\frac{B}{B-c}$	$\frac{2370}{2370-1587}$	3.02
Bulk Specific gravity(S.S.D. Basic),G	$\frac{A}{B-c}$	$\frac{2287}{2370-1587}$	2.92
Absorption Capacity,D%	$\frac{(B-A)x100}{A}$	$\frac{(2370-2287)x100}{2287}$	3.62

The Specific gravity of the normal stone course aggregate after oven drying was found 3.02 specific gravity for coarse aggregate. We found the specific gravity of the apparatus to be 3.62 and bulk specific gravity oven dry ac obtained from 2.92. Apparent capacity reduction received 3.26 and bulk SSD received 2.1

4.10 Specific Gravity of Fine Aggregate

Table 4.11: Specific Gravity of Fine Aggregate

Wt. of pycnometer filled with water to calibration, B gm	Oven Dry Wt. in air,A gm	Wt. of pycnometer with Specimen and water to Calibration mark C gm
653	281	831

The specific gravity of the Sylhet sand as fine aggregate after open drying was found 0.694. Specific gravity for fine aggregate. We found the specific gravity of the apparatus to be 0.719 and bulk specific gravity oven dry ac obtained from 0.694. Apparent capacity reduction received 5 and bulk SSD received 0.729.

4.11 Specific Gravity of Normal sand

Table 4.12: Specific Gravity of Normal sand

Test	Formula	Calculation	Result
Apparent Specific gravity	$\frac{A}{B+A-c}$	$\frac{281}{653+281-831}$	2.72
Bulk Specific gravity (open Dry Basic)	$\frac{A}{B+S-c}$	$\frac{281}{653+300-831}$	2.30
Absorption Capacity, D%	$\frac{(S-A)x100}{A}$	$\frac{(300-281)x100}{281}$	6.76
Bulk Specific gravity (S.S.D. Basic),G	$\frac{S}{B+S-c}$	$\frac{300}{653+300-831}$	2.45

4.12 Unit Weight of Fine Aggregate

Table 4.13: Data sheet for unit weight of Local Sand

Shoveling		Rodding	Jiggling	Volume of bucket
7765gm		8144gm	8301gm	0.00278m

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4.13 Unit Weight of Fine aggregate (Local Sand)

Table 4.14: Data sheet for unit weight of Local Sand

Condition	Wt. of bucket	Wt. of bucket + Material	Wt. of material	Volume of bucket	Unit weight	Avarage unit
Shoveling	4000	7765	3765	0.00278	1354	1463
Rodding	4000	8144	4144	0.00278	1490	
Jiggling	4000	8301	4301	0.00278	1547	

4.14 Unit Weight of Fine Aggregate

Table 4.15: Data sheet for unit weight of Local Sand

Shoveling	Rodding	Jiggling	Volume of bucket
8095 gm	8387 gm	8536 gm	0.00278 m3

4.15 Unit Weight of Fine Aggregate

Table 4.16: Data sheet for unit weight of Sylhet Sand

Condition	Wt. of bucket	Wt. of bucket + Material	Wt. of material	Volume of bucket	Unit weight	Avarage unit
Shoveling	4000	8095	4095	0.00278	1473	1560
Rodding	4000	8387	4387	0.00278	1578	
Jiggling	4000	8536	4536	0.00278	1631	

4.16 Unit Weight of course Aggregate

Table 4.17: Data sheet for unit weight of Indian stone

Shoveling	Rodding	Jiggling	Volume of bucket
7793 gm	8212 gm	8417 gm	0.00278 m3

4.17 Unit Weight of course Aggregate

Table 4.18: Data sheet for unit weight of course Aggregate

Condition	Wt. of bucket	Wt. of bucket + Material	Wt. of material	Volume of bucket	Unit weight	Avarage unit
Shoveling	4000	7793	3793	0.00278	1364	1489
Rodding	4000	8212	4212	0.00278	1515	
Jiggling	4000	8417	4417	0.00278	1588	

4.18 Result of 7 Days Compressive Strength Test of Grade M15.

Table 4.19: 7 Days Compressive Strength Test Result.

SL No	Type of cement	Mix properties	Sand item	Water cement ratio	Compressive strength (PSI)	Average strength (PSI)	Average strength (MPA)
01	OPC	1:2:4	Local	0.5	1681	1721	11.87Mpa
					1841		
					1669		
			Sylhet	0.5	1865	1967	13.57Mpa
					2000		
					2038		
02	PCC	1:2:4	Local	0.5	883.65	896	6.17Mpa
					1000.84		
					804.77		
			Sylhet	0.5	1407	1316	9.07Mpa
					1247		
					1295		

7 Days Comparison Chart of grade M15

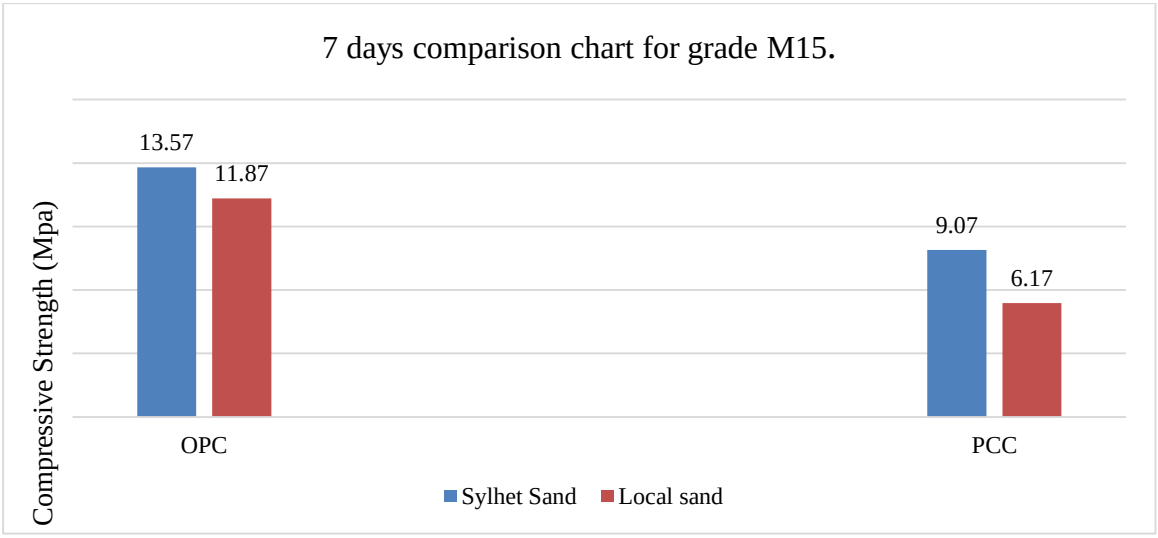


Figure 4.3: 7 Days Test Result

4.19 Result of 28 Days Compressive Strength Test of Grade M15.

Table 4.20: 28 Days Compressive Strength Test Result.

SL No	Type of cement	Mix properties	Sand item	Water cement ratio	Compressive strength (PSI)	Average strength (PSI)	Average strength (MPA)
01	OPC	1:2:4	Sylhet	0.5	3716	3867	26.67Mpa
					3999		
					3886		
			local	0.5	2470	2611	18.00Mpa
					2636		
					2728		
02	PCC	1:2:4	Sylhet	0.5	3086	3202	22.08Mpa
					3213		
					3307		
			local	0.5	1546	1601	11.04Mpa
					1661		
					1598		

28 Days Comparison Chart of M15.

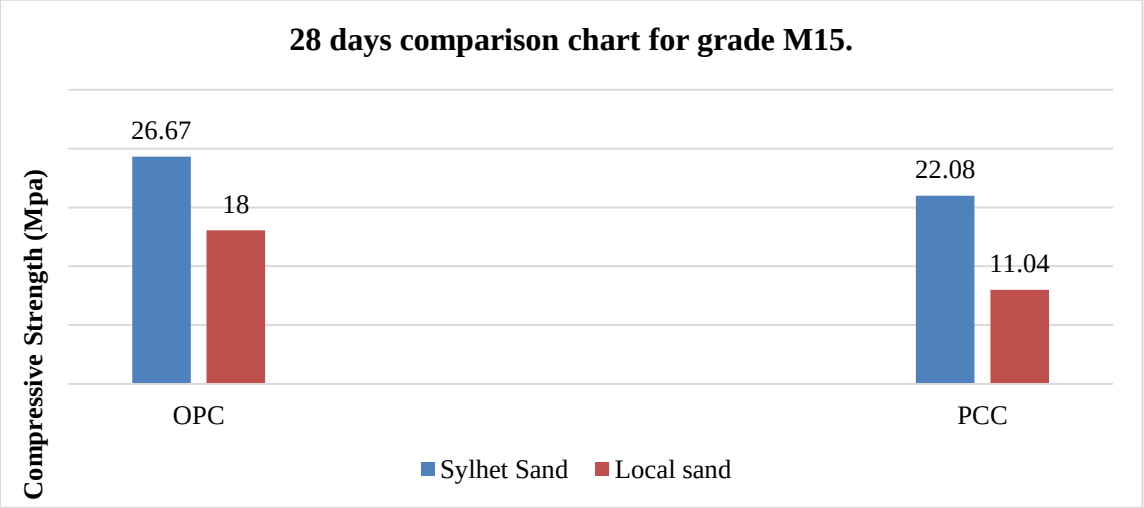


Figure 4.4: 28 Days Test Result

After the experiment shows below the result:-

• For Grade M15 Compressive strength of the concrete with local sand is to reach 11.87 Mpa in 7 day & 18.00Mpa in 28 days of OPC

• For Grade M15 Compressive strength of the concrete with Sylhet Sand is to reach 13.57 Mpa in 7 day & 26.67 Mpa in 28 days of OPC

• For Grade M15 Compressive strength of the concrete with local Sand is to reach 6.17 Mpa in 7 day & 11.04 Mpa in 28 days of PCC

• For Grade M15 Compressive strength of the concrete with Sylhet Sand is to reach 9.07 Mpa in 7 day & 22.08Mpa in 28 days of PCC

CHAPTER 5
CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

By conducting experiments and data analysis, presented in the previous chapters, the key findings of the study have been presented below:

1.In 7 days, compressive strength test result of OPC and PCC doesn't fulfill conditions of M15 grade.

2. In 28 days, compressive strength test result of OPC and PCC fulfill nearby the conditions of M15 grade.

3. In 7 days, compressive strength test result OPC and PCC doesn't fulfill conditions of M15 grade.

4. In 28 days, compressive strength test result of OPC and PCC fulfill the conditions but, OPC fulfil the condition of grade M15.

The OPC Cement give highest compressive strength and PCC cement give lowest compressive strength for grade M15. Overall OPC cement was better than PCC Cement .

5.2 Recommendation:

The following are some recommendations provided considering the previous discussion:

1. More work or study can be done in further with others local cement types.

2. The other grade like M7, M15, M25, M30, M35, M45, M50 and M55 may be worked in further.

3. Different water cement ratio can also be worked in further.

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