A Comparative Study of Compressive Strength of Concrete with Different Types of Sand in Different Periods of Time

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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

Department of Civil Engineering

Sonargaon University

147/I, Green Road, Dhaka1215, Bangladesh

Section: 16B (Tirana)

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Dedicated

to

"Our Beloved Parent's"

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ABSTRACT

Concrete is a mixture of cement, sand and Brick chips in some specified proportion which is generally used for R.C.C and C.C. In first case of the Concrete compressive loads such as the load of the wall above it, therefore it is very much necessary to test the Concrete for its compressive strength. This paper discusses the variation of Concrete compressive strength after 7, 14, 28 days with different types of sand (Local sand, Sylhet sand. In the experiment, 30 Cylinder specimens of 4 inch diameter by 8 inch height were tested to identify the compressive strength of Concrete using universal testing machine (UTM).

In this experiment, curing process is used to increase the strength of Concrete cylinder. Curing process must be followed to achieve desired concrete properties. Curing is necessary to ensure that the concrete will have sufficient moisture available to develop required properties. The results show that the compressive strength of Concrete sylhet sand is higher than that of the local sand. The difference in compressive strength of Concrete tends to be greater as the difference in sand fineness increases.

NOTATION

f'_c: 7, 14 & 28 days compressive strength of cylinder specimen of brick chips concrete.

f'_c: 7, 14 & 28 days compressive strength of concrete made with brick chips.

W'_a: Water absorption of concrete made with brick chips in %.

W'_a: Water absorption of concrete made with brick chips in %.

When x=0, then W at= W'_a

X: Percent of replacement.

F.M: Fineness modulus.

MP_a: Mega Pascal.

Psi: Pound per square inch.

S.S.D: Saturated Surface Dry.

W/C: Water Cement ratio.

C.C: Crushed Concrete.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1 General

Compressive strength or compression strength is the capacity of a material or structure to with stand loads tending to reduce size, as opposed to tensile strength, which withstands loads tending to elongate. In other words, compressive strength resists compression (being pushed together), whereas tensile strength resists tension being pulled apart). In the study of strength of materials, tensile strength, compressive strength, and shear strength can be analyzed independently. Some materials fracture at their compressive strength limit; others deform irreversibly, so a given amount of deformation may be considered as the limit for compressive load. Compressive strength is a key value for design of structures. Compressive strength is often measured on a universal testing machine, these ranges from very small table-top systems to ones with over 53 KN capacities. Measurements of compressive strength are affected by the specific Test Method and conditions of measurement. Compressive strengths are usually reported in relationship to a specific technical standard Compressive strength is measured on materials, components, and structures. By definition, the ultimate compressive strength of a material is that value of non-axial compressive stress reached when the material fails completely. The compressive strength is usually obtained experimentally by means of a compressive test. The apparatus used for this experiment is the same as that used in a tensile test.

1.2 Objectives of Compressive Strength Test

- To determine the compressive strength of concrete with different type of sand.
- To compare the compressive strength of locally available sand with the sylhet sand.
- To determine the actual sand type with the best compressive strength.

CHAPTER-2
LITERATURE REVIEW

2.1 Research Background

The pervious concrete system and its corresponding strength are as important as its permeability characteristics. The strength of the system not only relies on the compressive strength of the pervious concrete but also on the strength of the soil beneath it for support.

Previous studies indicate that pervious concrete has lower compressive strength capabilities than conventional concrete and will only support light traffic loadings. The authors of this work investigated prior studies on the compressive strength on pervious concrete as it relates to water-cement ratio aggregate-cement ratio, aggregate size, and compaction and compare those results with results obtained in laboratory experiments conducted on samples of pervious concrete cylinders created for this purpose [1].

The loadings and types of vehicles these systems can withstand will also be examined as well as the design of appropriate thickness levels for the pavement. Since voids are supposed to reduce the strength of concrete [1], the goal is to find a balance between water, aggregate, and cement in order to increase strength and permeability, two characteristics which tend to counteract one another. In this study, also determined are appropriate traffic loads and volumes so that the pervious concrete is able to maintain its structural integrity [2].

The end result of this research will be a recommendation as to the water-cement ratio, the aggregate-cement ratio, aggregate size, and compaction necessary to maximize compressive strength without having detrimental effects on the permeability of the pervious concrete system using the particular local materials available in central Florida.

This research confirms that pervious concrete does in fact provide a lower compressive strength than that of conventional concrete; compressive strengths in acceptable mixtures only reached an average of around 1700 psi. Extremely high permeability rates were achieved in most all mixtures regardless of the compressive strength.

2.2 CEMENT

Cement, one of the most important building materials, 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, slate [3].

The raw ingredients are processed in cement production plants 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 is an integral part of the 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, where as 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 to make decorative patterns. Cement mixed with water silicates and aluminates, making a water repellant 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 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 in organic; 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 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 so are quite durable in water and safe from chemical attack. This allows setting in wet condition 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 a stucco to imitate stone. Hydraulic limes 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 material used by the Romans, but was 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 burnt nodules were ground to a fine powder. This product, made into a mortar with sand, set 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, of making cement and concrete, as well as the benefits of cement the construction apparently 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 Treatiseon the Artto Preparea Good Mortar published in St. Petersburg. A few years later in 1825, he published another book, which described the various methods of buildings 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 mid19th 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, Asp dins' cement was nothing like modem Portland cement but was a first step in its development, called proto-Portland cement [1]. Joseph Aspdins' 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 counter intuitive 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 of 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 cements. Thus, Portland cement began its predominant role. Isaac Charles Johnson further refined the production of meso-Portland cement (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 upon their belite content for strength development. Belite develops strength slowly. Because they were burned at temperatures below 1,250 °C (2,280 °F), they contained no alite, which is responsible for early strength in modem cements. The first cement to consistently contain alite was made by William Aspdin in the early 1840s: lbis was what we caji today "modem" Portland cement. Because of the air of mystery with which William Aspdin surrounded his product, others (e.g., Vicat 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 "rule-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.

It was not as durable, especially for highways, to the point that some states stopped building highways and roads with cement. Bertrainh. wait, an engineer whose company had worked on the construction of the new York city's catskill aqueduct, was impressed with the durability of Rosendale cement, and came up with a blend in the us the first large-scale use of cement was rosendale cement, a natural cement mined from a massive deposit of a large dolostone rock deposit discovered in the early 19th century near rosendale, new York rosendale cement was extremely popular for the foundation of buildings (e .g., statue of liberty, capitol building, Brooklyn bridge) and lining water pipes sorel cement was patented in 1867 by french manstan is lassorel and was stronger than Portland cement but its poor water resistance and corrosive qualities limited its use in building construction. The next development with the manufacture of Portland cement was the introduction of the rotary kiln which allowed a stronger, more homogeneous mixture and a continuous manufacturing process.

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: Components of physical & chemical characteristics

Property	Portland Cement	Calcareous (ASTM C618 Class C) Fly Ash	Calcareous (ASTM C618 Class C) Fly Ash	Slag Cement	Silica Fume
SiO_2 content (%)	2.9	52	35	35	85-97
Al_2O_3 content (%)	6.9	23	18	12	-
Fe_2O_3 content (%)	3	11	6	1	-
CaO content (%)	63	5	21	40	<1
MgO content (%)	25	_	_	_	_
SO_3 content (%)	1.7	_	_	_	_
Specific surface (m^2/kg)	370	420	420	400	15000-30,000
Specific gravity	3.15	2.38	2.65	2.94	2.22
General use in concrete	Primary binder	Cement replacement	Cement replacement	Cement replacement	Property enhancer

[a] Values shown are approximate: those of a specific material may vary.

[b] Specific surface measurements for silica fume by nitrogen adsorption (BET) method, others by air permeability method (Blaine).

2.3 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-resistant

2.4 Types of Cement are Available in Bangladesh

Bangladesh Cement Manufacturers List

1. ALHAJ MOSTAFA-HAKIM CEMENT INDUSTRIE LIMITED

Chittagong based cement manufacturing company in Bangladesh, which is a manufacturer of ordinary port land cement (OPC) and having capacity 1,70,00 m.t

2. PREMIER CEMENT MILLS LIMITED.

Brand Name: Premier Cement
Type of cements is ordinary Portland cement (POC) & Portland composite cement (POC)

3. SHA CEMENT INDUSTRIES LTD.

[A unit of Abul Khair group shah cement ind.ltd is the largest and 100% local owner cement product teaching plan in Bangladesh]

Product/ brand name: Shah Cement special, Shah Cement popular, cement ready mix concrete.

4. MIR CEMENT LTD

[Mir cement ltd. is one of the leading cement companies in Bangladesh, which is a concern of Mir Akhter Hossian Ltd. - a renowned construction company in Bangladesh

Products: ordinary Portland cement (Opc) & Portland composite cement (pcc), Mir cement,so offers customized cement solutions.

Brand name: Mir cement

5. MADINA CEMENT INDUSTRIES LTD.

Products: ordinary Portland cement (opc) & Portland composite cement (pcc) Brand name: Tiger Cement.

6. MONGLA CEMENT FACTORY

[Mongla Cement Factory is a concern of Sena Kalyan Sangstha (SKS) and it is producing one of the best quality cements in Bangladesh.]

Products: Portland Grey Cement, Ordinary Portland and Composite Portland Cement.

Brand name: ELEPHANT BRAND

7. M.I CEMENT FACTORY LTD.

[M.I cement factory ltd. is one of the leading manufacturers of cement in Bangladesh crown cement is a pioneer cement exporter in Bangladesh.]

Products: Ordinary Portland cement (opc) & Portland composite cement (pcc).

Brand name: crown cement.

<u>Other companies' are-</u>

1. Cemex cements Bangladesh Ltd.

2. Holcim (Bangladesh) Ltd.

3. Aman cement mills Ltd.

4. Olympic cement Ltd. (ocl).

5. Noapara cement mills Ltd.

6. Dub Bangladesh cement mills Ltd.

7. Meghna cement mills Ltd. (Bashundhara group).

8. Bashundhara industrial complex ltd Bashundhara cement: (Bashundhara Group)

9. Confidence cement limited. (cel)

10. S. Alam cement limited.

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 non-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, for example, 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 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 earth's oceans is made out of basalt, 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.

2.7 Types of Sand Available in Bangladesh

Chemical determined by x-ray analysis for local sands this test was conducted in atomic energy commission composition of graded sample for individual particle size was were used for Ottawa sand graph of x-ray analysis was given in figure 16 through figure typical values 21.

The sample that retained on sieve #30, 17 #50 and #100 are analyzed. The % presence 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 weight age value of #30, #50 and #100 was 0.16, 0.59 and 0.25 respectively. Figure 22 Variation of quartz content in different sand Quartz content in sand is very important since it is chemically inert and strong enough to carry load. From X-ray analysis the values of quartz content were plotted in 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 bar which shows that percentage of quartz content increases with the decrease in grain size.

This is because in larger particle there is a tendency to adhere foreign particles with its surface. On the other hand, in smaller particles there is low tendency to adhere foreign particles. So, there are lower impurities in smaller particles and for that quartz content is comparatively higher than that of larger particles Figure 23, Variation of quartz content with grain size in different sand from bur chart it is also seen 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.

Since in smaller particle 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 that with the presence of acid. Fe reacts with SiO2 and form Fe3Si. As a result, decreases. On the other hand, Fe is very strong and is not disintegrated upon acid action rather than it reacts 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 acid washed sample is the resultant of above two actions In Sand 1 Fe content increases and for Sand II Fe content decreases after acid washing 18 6.3 Graph with correlation for strength for correlation any order of polynomial may be used.

2.8 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.

a. Made of local (French Source) natural silica sand (silica content 99%).

b. Having a water content lower than 0.1%.

c. The constituent grains of this sand are uncrushed and of rounded form.

d. The sand is used for testing hydraulic cement in accordance with ASTM C 109.

Table 2.2: The average grading is as follows:

Square mesh size in (mm)	Percent passing sieve (%)	
	Average grading	C778
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

2.9 Aggregate

Concrete is an artificial stone manufacture form a mixture of binding materials and inert materials with water. 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". These act as fillers or volume increasing components on the one hand and are responsible for the strength, hardness, and durability of the concrete on the other hand. Aggregate is an essential ingredient to make concrete used in construction. The quality of the material strongly influences the performance of concrete including how well it mixes and hardens as well as its durability long term. A quality aggregate will be clean and free of any soft particles or vegetable matter. If organic compounds such as soil are included in the mix, this can cause chemical reactions that can compromise the strength and properties of the concrete.

2.10 Function of Aggregate in concrete

Aggregates are the important constituents of the concrete which give body to the concrete and also reduce shrinkage. Aggregates occupy 70 to 80 % of total volume of concrete. The aggregate give volume to the concrete, around the surface of which the binding materials adheres in the form of a thin film. In theory the voids in the coarse aggregate is filled up with fine aggregate and again the voids in the fine aggregate is filled up with the binding materials. Finally, the binding materials as the name implies, binds the individual units of aggregates into a solids mass with the help of water. The aggregate gives volume, stability, resistance to wear or erosion, and other desired physical properties to the finished product. Using aggregate as a filler can help concrete producers save a lot of money. Cement usually costs seven-or eight-times what stone and sand cost. Cement is necessary, but the strength can still be retained when using well-graded aggregates that cost significantly less. Aggregates make up 60-80% of the volume of concrete and 70-80% of the mass of concrete.

Aggregate is also very important for strength, thermal and elastic properties of concrete, dimensional stability and volume stability. Cement is more likely to be affected by shrinkage. Including aggregate in the mix can control the shrinkage level and prevent cracking.

2.11 Strength of Aggregate

The water and binding materials are important factor affecting the strength of concrete. The size of the aggregates, shape, surface texture, grading and mineralogy are known to affect concrete strength in varying degrees. So the strength of concrete depends on the type of aggregate used and it is a mere obligatory approach to find out suitable composition of aggregate in order to attain desired concrete strength. Generally in Bangladesh frequently two types of coarse aggregates are being used in construction work. One of them is brick aggregate and other is stone chips. Amongst them generally stone chips give higher strength than brick aggregates. As the availability of natural sand in Bangladesh are huge demand, the investigators find it imperative to look forward to enhance the concrete strength by finding and utilizing alternative sources and also try different partial replacement with the brick fine aggregates. Again some investigators have found some progressive results while using Brick fine aggregate as an alternative material of natural sand at different ratios which influence our search for finding the suitable alternative material in brick fine aggregate.

Use of 1stclass brick fine aggregate accelerates the rate of gain in compressive strength at the early age of concrete which is a very good sign as it gives desired strength even before the probable time period estimated.

So, we can clearly see that the compressive strength of aggregate is being dictated to a great extent by the nature of aggregate and hence finding a suitable alternative of coarse aggregate in the form of slag has become more essential. Since the testing of crushing strength measurement of individual aggregate particle is very difficult, the desired information has to be obtained from indirect test like crushing value of bulk aggregate or resistance to abrasion.

2.12 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 grading of aggregates.

Following are the classification of aggregates based on size:

Aggregates are classified into 2 types According to Size:

1. Fine aggregate
2. Coarse aggregate

Fine Aggregate

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

Table 2.3: Size of Fine Aggregate

Fine aggregate	Size variation
Coarse Sand	2.0mm – 0.5mm
Medium sand	0.5mm – 0.25mm
Fine sand	0.25mm – 0.06mm
Silt	0.06mm – 0.002mm
Clay	<0.002

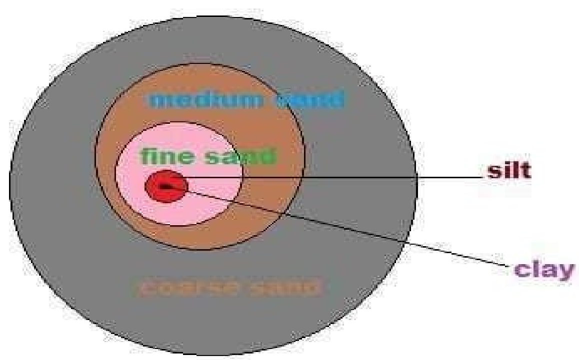

Figure 2.1: Size of Fine Aggregate.

Coarse Aggregate

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

Table 2.4: Size of Coarse aggregate

Coarse aggregate	**Size**
Fine gravel	4mm – 8mm
Medium gravel	8mm – 16mm
Coarse gravel	16mm – 64mm
Cobbles	64mm – 256mm
Boulders	>256mm

2.13 Chemical Reaction of Brick Fine aggregate in Concrete:

Brick fine aggregate as pozzolana reacts with lime in presence of water to form hydraulic compounds. Calcium carbonate and water is produced when carbon dioxide reacts with calcium hydroxide. The chemical reactions are following: Portland cement + Water → Calcium Silicate Hydrate

$Ca (OH) 2 + CO2 \rightarrow CaCo3 + H2O$

Extra amount of hydraulic cement is formed when reacts with lime. The reaction is following:

Pozzolana + Ca (OH) 2 + water → C-H-S (Glue)

The former reaction of Portland cement with water is fast reaction which provides early strength to concrete where the later reaction of pozzolana with liberated lime in presence of water is slow reaction which effect early age strength. But after some time, the brick fine aggregate provides extra amount of C-H-S which contribute to strength of concrete.

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 the aggregate is limiting the strength of concrete, as weak aggregates cannot produce a strong concrete, but also the properties of aggregate greatly affect the durability and structural perform of the concrete.

- Aggregates should be strong, hard, dense, durable, clear and free from veins and adherent coating.
- Aggregates should be free from injurious amounts of disintegrated pieces, alkalis, vegetable matter and other deleterious substances.
- Flaky and elongated pieces should not be present in aggregate mass.
- 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.
- 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.

Abrasion value of aggregate when tested using 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.

2.15 Water Cement Ratio

In concrete, the single most significant influence on most or all of the properties is the amount of water used in the mix.

In concrete mix design, the ratio of the amount of water to the amount of cement used (both by weight) is called the water to cement ratio (w/c). These two ingredients are responsible for binding everything together.

The water to cement ratio largely determines the strength and durability of the concrete when it is cured properly. The w/c ratio refers to the ratio of the weights of water and cement used in the concrete mix. A w/c ratio of 0.4 means that for every 100 lbs of cement used in the concrete, 40 lbs of water is added.

The water-cement ratio is the ratio of the weight of water to the weight of cement used in a concrete mix. A lower ratio leads to higher strength and durability, but may make the mix difficult to work with and form. Workability can be resolved with the use of plasticizers or super-plasticizers. was first developed by Duff A. Abrams and published in 1918. Refer to concrete slump test. The 1997 Uniform Building Code specifies a maximum of 0.5 ratios when concrete is exposed to freezing and thawing in a moist condition or to de-icing chemicals, and a maximum of0.45 ratio for concrete in a severe or very severe sulfate condition.

Concrete hardens as a result of the chemical reaction between cement and water (known as hydration, this produces heat and is called the heat of hydration). For every pound (or kilogram or any unit of weight) of cement, about 0.35 pounds (or 0.35 kg or corresponding unit) of water is needed to fully complete hydration reactions.

However, a mix with a ratio of 0.35 may not mix thoroughly, and may not flow well enough to be placed. More water is therefore used than is technically necessary to react with cement. Water–cement ratios of 0.45 to 0.60 are more typically used. For higher-strength concrete, lower ratios are used, along with a plasticizer to increase flow ability.

Too much water will result in segregation of the sand and aggregate components from the cement paste. Also water that is not consumed by the hydration reaction may leave concrete as it hardens, resulting in microscopic pores (bleeding) that will reduce final strength of concrete. A mix with too much water will experience more shrinkage as excess water leaves, resulting in internal cracks and visible fractures (particularly around inside corners), which again will reduce the final strength. Mindess et al. (2003) proposed that the strength of concrete decreases with an increase in W/C ratio and proposed a relationship between compressive strength and W/C ratio as shown in

Fig.2.2 Similar conclusion was also drawn by Wassermann et al. (2009), Dhir et al. (2004), Kosmatka et al. (2002), Schulze (1999), Mehta and Monteiro (1993). Popovics (1990) suggested that to increase the concrete strength, it is more efficient and economical to reduce the water content than to use more cement.

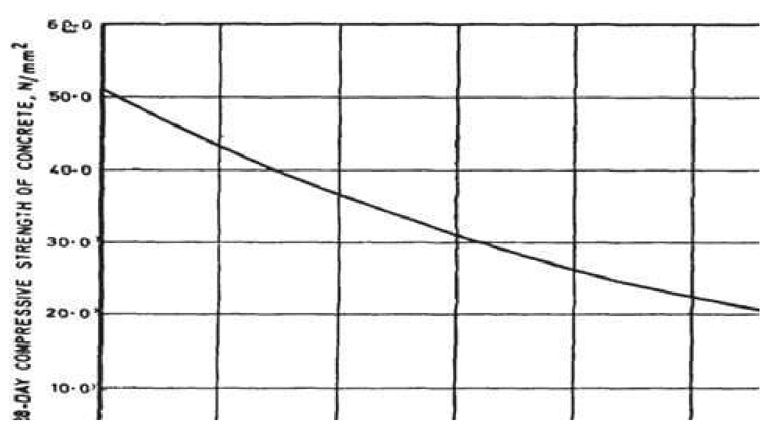

Figure 2.2: Relationship between compressive strength and W/C ratio

A well establish fact in the cement in fine aggregately speaks that an excessive water content leads to reduction in strength in the cement mortar, but insufficient water content incurs a poor workability. Hence, a method for determining the optimum water content and influence of w/c ratio on cement mortar is obviously desirable.

Haach, Vasconcelos, & Lourenço investigated the influence of aggregate grading and w/c ratio on the workability and compressive strength of mortar. Authors observed that increase in w/c ratio has reduced the value of mechanical properties and increased the workability.

Zhou et al observed that dynamic compressive strength of cement mortar increased with decrease in water content. The dynamic compressive strength of saturated specimen was 23% lower than that of totally dry specimen.

They observed that fracture behavior of low w/c ratio mortar is more brittle than that of mortar with high w/c ratio.

The compressive strength of cement mortar is considered to be one of the most important aspects of masonry structures. The compressive strength of cement mortar at the age of 28 days has decreased with an increase in cement-to-sand proportions. The decrease in cement content requires more water for making mortar workable

2.16 SPECIFIC GRAVITY AND WATER ABSORPTION CAPACITY OF FINE AGGREGATE

The test method for specific gravity and water absorption capacity covers the determination of bulk specific gravity, apparent specific gravity and water absorption of fine aggregate. In this study saturated surface dry aggregate had been used to determine the specific gravity of fine aggregate. The test method for specific gravity and water absorption capacity conforms to the ASTM standard requirements of specification C128-97.

CALCULATION:

Table 2.5: 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 with specimen and water to calibration mark	Wt of S.S.D sample in Air (S gm)
653	290	833	900

Tests	Formula	Calculation	Results
Apparent Specific gravity	$\frac{A}{B+A-C}$	$\frac{290}{653+290-833}$	2.64
Bulk Specific Gravity (Oven Dry Basis)	$\frac{A}{B+S-C}$	$\frac{290}{653+300-833}$	2.42
Absorption Capacity , D%	$\frac{S-A}{A}\times100$	$\frac{300-290}{290\times100}$	3.45
Bulk Specific Gravity (S.S.P Basis). G	$\frac{S}{B+S-C}$	$(\frac{300}{653+300-833})$	2.5

2.17 SPECIFIC GRAVITY AND ABSORPTION CAPACITY OF COARSE AGGREGATE

The test method for specific gravity and absorption capacity of coarse aggregate conforms to the ASTM standard requirements of specification C127.

CALCULATION:

Table 2.6: 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)
1630gm	790 gm	1235 gm

Tests	Formula	Calculation	Results
Apparent Specific gravity	$\frac{A}{A-C}$	$\frac{1235}{1235-790}$	2.77
Bulk Specific Gravity (S.S.P) Basis	$\frac{B}{B-C}$	$\frac{1630}{1630-790}$	1.94
Bulk Specific Gravity (oven Dry Basis)	$\frac{A}{B-C}$	$\frac{1235}{1630-790}$	1.47
Absorption Capacity , D%	$\frac{(B-A)\times100}{A}$	$(\frac{1630-1235}{1235})\times100$	32.23

CHAPTER 3

METHODOLOGY

3.1 Materials

In this study, four materials are used to produce desired concrete mixture. The materials are cement, fine aggregate, coarse aggregate and potable water.

3.2 Cement

Cement is used as a binding materials which is used to set, harden and to bind the materials with its adhere properties. Shah Special cement is one of the most used cement in Bangladesh. We used Shah Special cement for research purpose. Shah Special cement is ordinary Portland cement shown in figure 3.2.1 Shah Cement Portland Cement surpasses the requirements of BDS EN 197-1:2000 CEM-I 52.5 N Grade. It is produced from high-quality clinker ground with high purity gypsum. Shah Cement Portland Cement provides high strength and durability to structures because of its optimum particle size distribution, superior crystalline structure, and balanced phase composition. It was used for its high early strength and very fast setting time. Cement was uniform in color, there were no hard lumps and cement was cool when hand was plunged into the bag before using.

Figure 3.1: Cement

3.3 Fine Aggregate

It is the aggregate most of which passes through No.4 (4.75m) sieve and contain only that much coarser material as is permitted by the specifications. Same types of sand were used as the fine aggregate for both NAC and RAC in this study as shown in the figure. The sand were oven dried before being use to obtain SSD.

Figure 3.2: SAND

3.4 Coarse aggregate

Brick chips were used as coarse aggregate for research purpose shown in figure 3.4.3

Figure 3.3: Coarse Aggregate

3.5 Particle Size Distribution

Sieve Analysis

For particle size distribution for both coarse and fine aggregate sieve analysis method were used according to ASTM C136.

Apparatus

For sieve analysis, following apparatuses were used-

a. Balance;

b. Sieves;

c. Oven and

d. Containers.

3.6 Test Procedure

The samples were dried to a constant mass at a temperature of around 110°C and after drying samples were weighted. A set of IS sieves with suitable openings were used to sieve the samples. Quantity of materials was limited so that all the materials could reach the sieve opening a number of times during sieve analysis. Sieving process was continued for a sufficient period until the particles were not passing through the sieve. On completion of sieving, the materials retained on each sieve were weighted on balance. Cumulative weight retained into each sieve and percentage of cumulative weight retained was calculated. Fineness modulus was obtained by taking the sum of the cumulative percentage of samples retained on each sieve and dividing the sum by 100.

3.7 Mix Proportions of Concrete

For this research mixture proportion of different groups of concrete were determined in accordance with following conditions-

a. water/cement ratio 0.45,

b. Same maximum grain size (19.5mm)

c. Quantity of fine aggregate (Local & Sylhet Sand)

d. Quantity of coarse aggregate.

e. Mixing ratio 1:2:4.

3.8 Mix Proportions for Concrete cylinder

To perform compressive and tensile strength test, 4 inch by 8 inch cylinder concrete were made. The mix proportions were 1:2:4 for cement: sand: coarse aggregate. Amount of concrete for a cylinder of each batch are shown in the following table:

Table 3.1: Estimation of materials for concrete cylinder (5*6=30 Nos)

Batch No	% Replacement	Cement (kg)	Sylhet Sand (kg)	Local Sand (kg)	Coarse Aggregate (kg)	Water(kg)
1	S=100%	2.93	6.44	0	11.97	1.31
2	L=100%	2.93	0	6.44	11.97	1.31
3	L+S=75+25%	2.93	1.61	4.83	11.97	1.31
4	S+L=75+25%	2.93	4.83	1.61	11.97	1.31
5	L+S=50+50%	2.93	3.22	3.22	11.97	1.31

3.9 Mixing of Concrete

A smooth, watertight surface was selected as platform and it were washed before mixing of concrete. Sand was measured for each mixing batches and was spread evenly to the platform. The required quantity of cement were dumped on the sand and spread evenly. Sand and cement were mixed properly until the mixture became uniform in color. Sand and cement mixture was spread evenly and required amount of coarse aggregate was spread on the mixture.

3.10 Preparation of mold and Demolding

Process of molding:

a. For compressive and tensile strength test, steel cylindrical mold were used. Height and diameter of the mold were 4 inch by 8 inch respectively.
b. Molds were cleaned and grease was applied on the inner surface of the mold.
c. Concrete were filled in the mold in 3 layers.
d. Each layer was ridded 25 times in an even pattern using a tamping rod.
e. After tamping, the top surface is leveled.
f. The molded specimens were kept at normal temperature to dry.

Molding of cylinder concrete specimens is shown in figure:

Figure 3.4: Mold of Cylinder.

Process of Demolding

After 24 hours of casting, the concrete specimens were removed from the mold and allowed for curing

Figure 3.5: Demold of Cylinder.

3.11 Curing

After demolding, the specimens were placed under water up to 7 days, 14 days and 28 days. The specimens were fully immersed under water. Figure 3.6 shows curing of cylinder concrete specimens.

Figure 3.6: Curing of concrete specimens

Total number of specimens for each test and their age and size are given below:

Table 3.2: Details of property, test method age at test, Number and size of specimens

Name of Property	Test Method	Age at Test(days)	Size of Specimens	No. of specimens
Compressive Strength	ASTM C39	7	4inch dia×8 inch height Cylinders	10
		14	4inch dia×8 inch height Cylinders	10
		28	4inch dia×8 inch height Cylinders	10

3.12 Compressive Strength Test

Compressive strength test is a method to measure the strength of concrete. In this study, the compressive strength of specimens was measured according to ASTM C39. ASTM C39 determines the compressive strength of cylindrical concrete specimens such as molded concrete cylinders and drilled cores. However, this is limited to concrete having unit weight more than 800kg/ m3.

In this method, axial compressive load is applied to the cylinder specimen at a standard load rate the machine can provide. Load is applied until the failure occurs. The strength test can be used for quality control i.e. acceptance of concrete to use in construction.

Apparatus

a. Compression testing machine and

b. Balance.

Procedure

a. The weight of specimen was measured and then it was placed on the lower bearing block so the axis of the specimen is aligned with the center of thrust of the spherically seated bearing block.

b. Age, weight, type and peak load was provided in the screen of testing machine and a compressive load of .25 MPa/s was applied continuously and without shock until failure.

c. Maximum load carried by the specimen during the test was recorded and the type of fracture pattern was noted.

Figure 3.7: Compressive Strength Test

CHAPTER 4

TEST RESULTS ANALYSIS & DISCUSSION

4.1 Introduction

Compressive strength is one of the most important engineering properties of concrete which designs are concerned of. It gives an overall view of quality of concrete as it is directly related to the structure of hardened concrete. Concrete has been made with different percentage of coarse aggregate from different sources for target strength. OPC, Sylhet& Local sand was used as fine aggregate to make the concrete. Compressive strength has been tested for 7, 14 & 28 days.

4.2 Sieve Analysis of Fine and coarse Aggregate

This test method conforms to the ASTM standard requirements of specification C 136.

Apparatus

Balance: sensitive to within 0.1% of the weight of the sample Sieves: ASTM Standard Mechanical sieve shaker

Sampling

Sieve analysis of fine aggregate has been performed according to ASTM C 136/C (2004) standard specification. The procedure is as follows:

Procedure:

Step- 1

Take sample of fine aggregate (as per ASTM standard specification, the aggregates must be completely dry). This is determined by weighing the material on a digital scale. Also weigh each sieve of the mechanical sifter, and the pan, and record the weights.

Step-2

Place the aggregate in the top sieve of the well-cleaned mechanical sifter (sieves used are # 4, # 8, # 16, # 30, # 50 & # 100). This apparatus is used for shaking the aggregates (similar to the principle used in a paint-mixing machine) and sieving them. The mechanical sifter has a bottom pan (to receive the material passing # 100 sieve) and a lid to close the sifter during the test. After placing the lid on the sifter, agitate the sifter for about 10 minutes.

Step-3

Determine the weight of aggregates that are retained in each of the sieves, by weighing each of the sieves (along with the retained aggregates), and subtracting the weight of each sieve. Also record all the weights of aggregates retained in each of the sieves. To ensure that all materials are collected, clean each sieve carefully using the proper type of brush. Use the paint brush for the finer sieves, the copper brush for intermediate sieves and the steel wire brush for the coarse sieves. Also verify whether the sum of weights of aggregates, retained in all the sieves, and the bottom pan is equal to the initial weight of the aggregates taken.

Step-4

Tabulate the data and determine the percent retained in each sieve. From these values calculate the (cumulative) percentage of material that would have been retained in the sieve if the whole volume of material was to be sifted in that sieve alone. Then add the percentage of material retained in all the sieves and divide by 100 to get the fineness modulus. Also prepare a column to determine the cumulative percentage passing through the sieve to plot the fineness modulus curve (as specified in CSA 23.1).

Step-5

- Aggregate with at least 85% passing no. 4 sieve and more than 5 % retained on a No. 8 sieve.
- Aggregate with at least 95% will be passing by No. 8 sieve.

To calculate the fineness modulus, the sum of the cumulative percentages retained on a definitely specified set of sieves needs to be determined, and the result is then divided by 100.

$$\text{F.M} = \frac{\mathcal{E}(CumlativePercentretained\ )}{100}$$

Table 4.1: Determination of fineness modulus of Shylet sand

Sieve No	Sieve Opening (mm)	Materials Retained (gm)	% Material Retained	% Cumulative Wt retain
#4	4.75	0	0	0
#8	2.36	44	5.5	5.5
#16	1.18	259	32.375	37.875
#30	0.60	286	35.75	73.625
#50	0.30	170	21.25	94.875
#100	0.15	31	3.875	98.75
#200	0.075	10	1.25	100
Pan	-	0	0	-
Total		800		410.625

$$F.M = \frac{\text{Total Cumulative Retained of Sand}}{100}$$

$$= \frac{410.625}{100} = 4.11$$

Table 4.2: Determination of fineness modulus of local sand

Sieve No	Sieve Opening (mm)	Materials Retained (gm)	% Material Retained	% Cumulative Wt retain
#4	4.75	0	0	0
#8	2.36	0	0	0
#16	1.18	1	0.13	0.13
#30	0.60	4	0.53	0.66
#50	0.30	582	77.6	78.26
#100	0.15	119	15.86	94.12
#200	0.075	25	3.33	97.45
Pan	-	19	-	-
Total		750gm		270.62

$$F.M = \frac{\text{Total Cumulative Retained of Sand}}{100}$$

$$= \frac{270.62}{100} = 2.70$$

4.3 Gradation of Various Types of Sand

This test method covers the determination of particle size distribution of different types of sand by sieving. The sieve analysis of sand is determined according to the test procedure described in ASTM standard (ASTM C 136-01). The result of this test both for Sylhet sand and local sand is given below:

Table 4.3: Grain size distribution of Sylhet sand

Sieve No	Sieve Opening (mm)	Materials Retained	% Material Retained	Cumulative % Retained	% Finer
#4	4.75	0	0	0	100
#8	2.36	44	5.5	5.5	94.5
#16	1.18	259	32.375	37.875	62.125
#30	0.60	286	35.75	73.625	26.375
#50	0.30	170	21.25	94.875	5.125
#100	0.15	31	3.875	98.75	1.25
#200	0.075	10	1.25	100	0
Pan	-	0	-	-	-
Total		800			

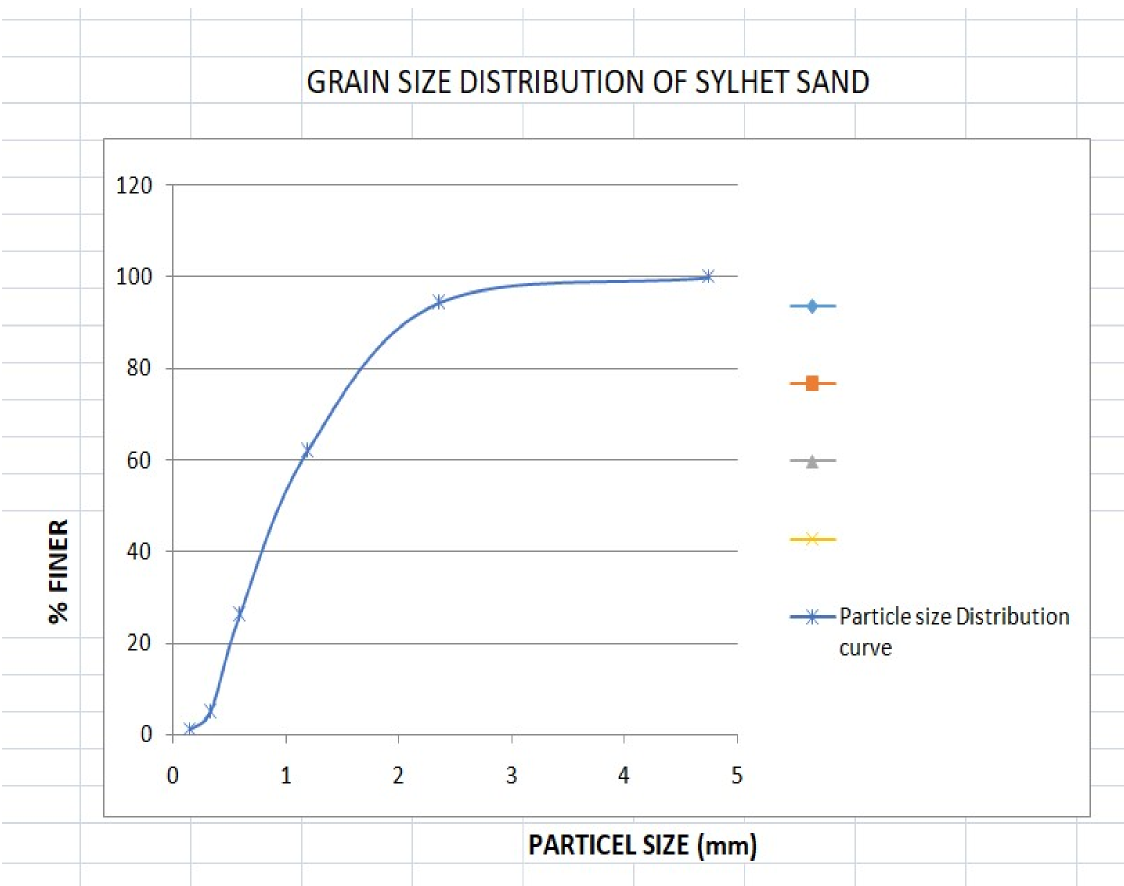

Figure 4.1: Grain size distribution of sylhet sand

Table 4.4: Grain size distribution of local sand

Sieve No	Sieve Opening (mm)	Materials Retained	% Material Retained	% Cumulative Wt retain	% Finer
#4	4.75	0	0	0	100
#8	2.36	0	0	0	100
#16	1.18	1	0.13	0.13	99.87
#30	0.60	4	0.53	0.66	99.34
#50	0.30	582	77.6	78.26	21.74
#100	0.15	119	15.86	94.12	5.88
#200	0.075	25	3.33	97.45	2.55
Pan	-	19	-	-	-
Total		750gm			

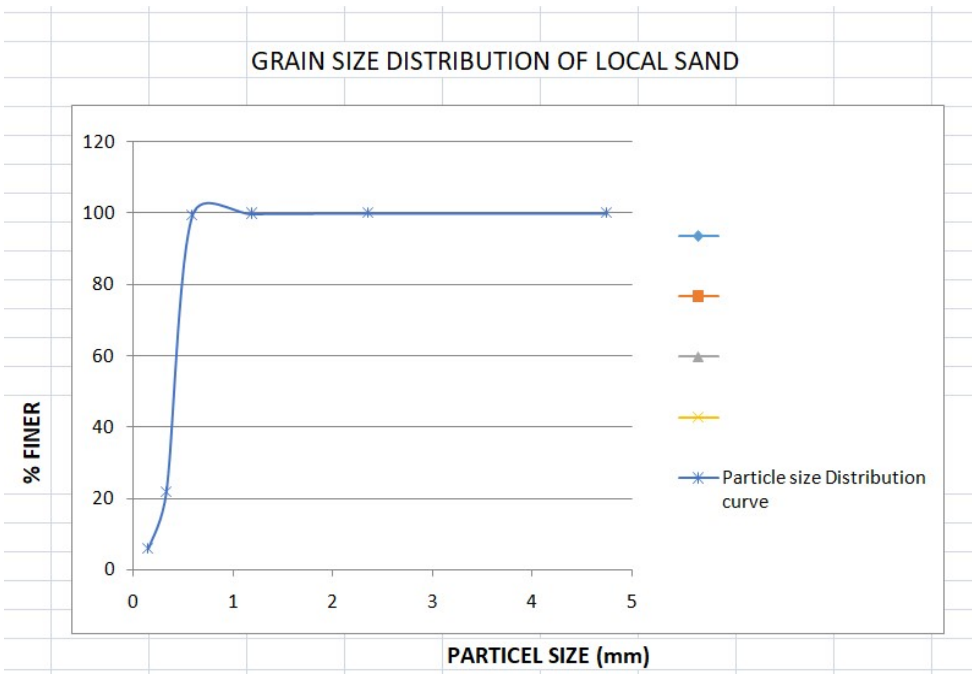

Figure 4.2: Grain size distribution of local sand

4.4 Sieve Analysis of Coarse Aggregate:

Table: 4.5 Sieve Analysis of Natural Aggregate

Sample Collection = 1000gm

Sieve No	Sieve Opening (mm)	Material Retained (gm)	Cumulative Wt retain	% Cumulative Wt retain	% Finer	F.M
$\frac{3}{4}$"	19.05	550	550	55	45	
$\frac{3}{8}$"	9.5	412	962	96.2	3.8	$\frac{251.2}{100}$ =2.512
#4	4.75	38	1000	100	0	
Total		1000		251.2		

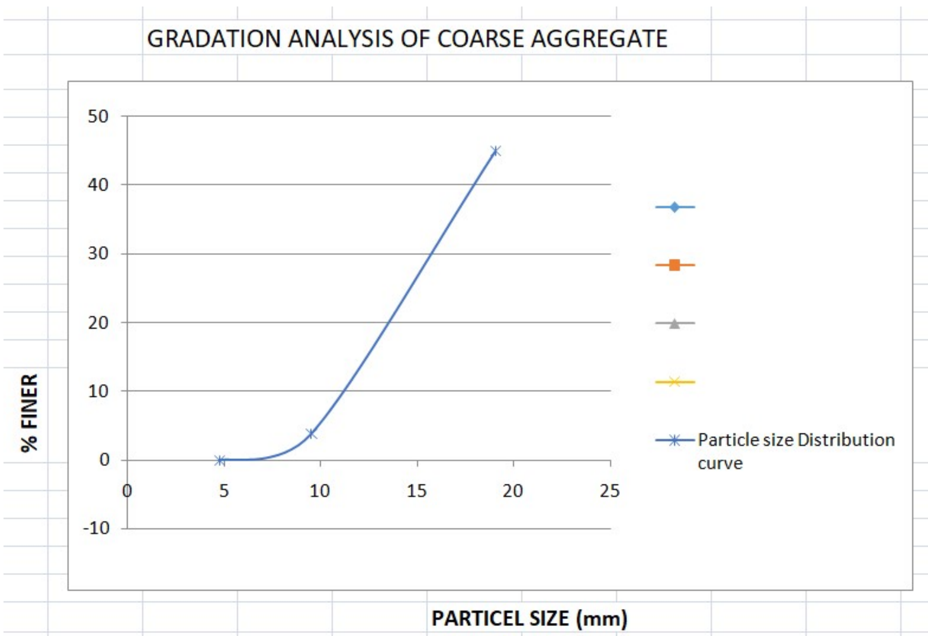

Figure 4.3: Gradation analysis of coarse aggregate

4.5 Compressive Strength Test Results for Varying Mixes

Compressive strength of concrete by using local sand and sylhet sand were compared using normal curing. The compressive strength of cylinder was determined with the help of compression testing machine (UTM). Table 4.5.6, 4.5.7, 4.5.8 gives the result of compressive strength of concrete of both local and sylhet sand concrete at the age of 7, 14 and 28 days.

Table 4.6: (7 Days Compressive Test Results)

Mix	Load (kn)	Load (lb)	Area (in2)	Stress (psi)	Avg. Stress (psi)
S=100%	75	16860	12.56	1342.35	1387.09
S=100%	80	17984	12.56	1431.847	
L=100%	50	11240	12.56	894.90	912.8
L=100%	52	11689.6	12.56	930.7	
L+S=75+25%	65	14612	12.56	1163.37	1136.525
L+S=75+25%	62	13937.6	12.56	1109.68	
S+L=75%+25%	70	15736	12.56	1252.86	1342.367
S+L=75%+25%	80	17984	12.56	1431.847	
L+S=50+50%	68	15286.4	12.56	1217.07	1190.22
L+S=50+50%	65	14612	12.56	1163.37	

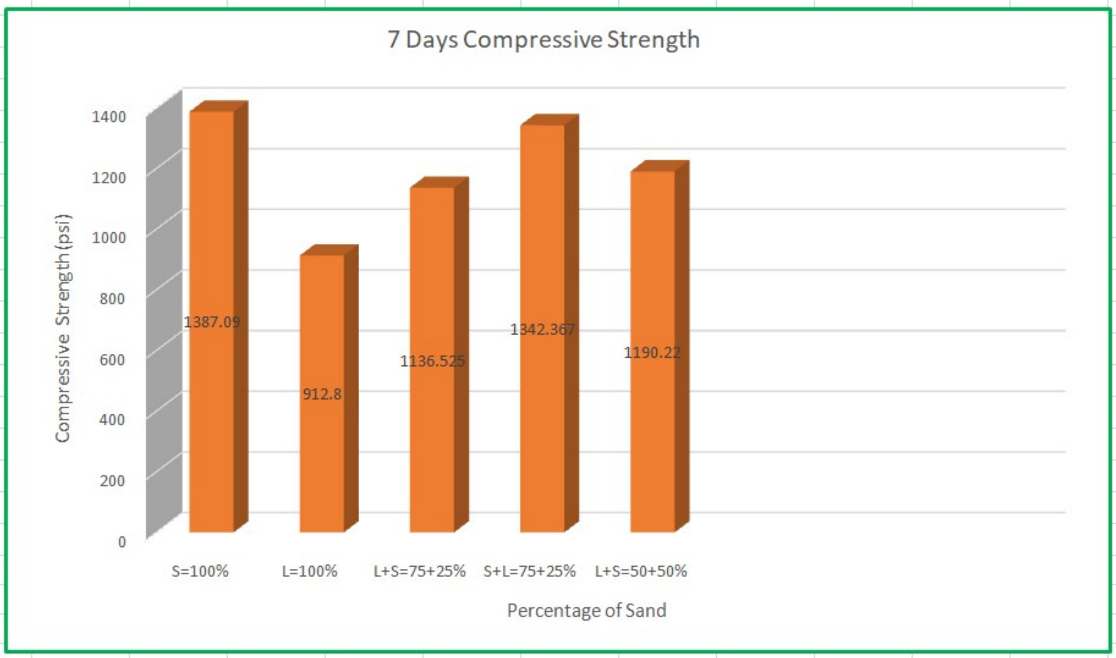

Figure 4.4: Compressive Strength Test (7 days)

Figure 4.4: The properties of compressive strength of concrete obtained by volumetric replacement of sylhet sand & local sand 7 days normal water curing.

The figure 4.4 shows maximum compressive strength 1387.09 Psi for100% sylhet sand use. The minimum value of compressive strength at same duration is 912.8 Psi for 100% local sand use.

Table 4.7: (14 Days Compressive Test Results)

Mix	Load (kn)	Load (lb)	Area (in2)	Stress (psi)	Avg. Stress (psi)
S=100%	97	21805.6	12.56	1736.11	1771.9
S=100%	101	22704.8	12.56	1807.707	
L=100%	58	13038.4	12.56	1807.707	1082.82
L=100%	63	14162.4	12.56	1127.57	
L+S=75+25%	75	16860	12.56	1342.35	1261.81
L+S=75+25%	66	14836.8	12.56	1181.27	
S+L=75%+25%	95	21356	12.56	1700.31	1655.565
S+L=75%+25%	90	20232	12.56	1610.82	
L+S=50+50%	85	19108	12.56	1521.34	1503.44
L+S=50+50%	83	18658.4	12.56	1485.54	

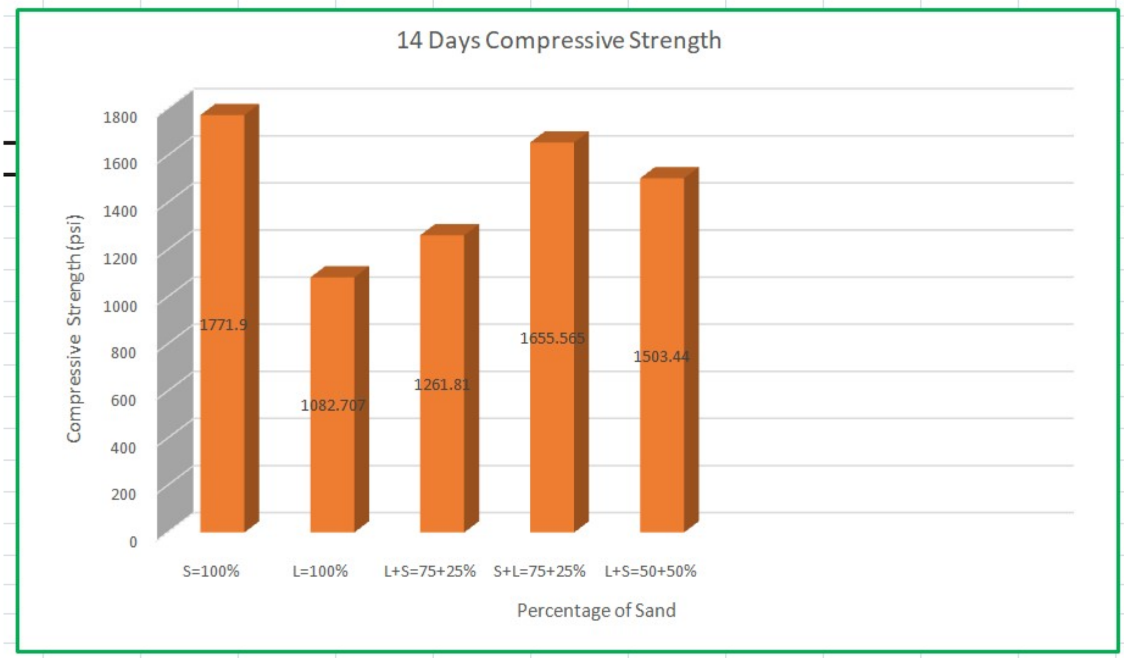

Figure 4.5: Compressive Strength Test (14 days)

Figure 4.5: The properties of compressive strength of concrete obtained by volumetric replacement of sylhet sand & local sand 14 days normal water curing.

The figure4.5 shows maximum compressive strength 1771.9 Psi for100% sylhet sand use. The minimum value of compressive strength at same duration is 1082.707 Psi for 100% local sand use.

Table 4.8: (28 Days Compressive Test Results)

Mix	Load (kn)	Load (lb)	Area (in2)	Stress (psi)	Avg. Stress (psi)
S=100%	135	30348	12.56	2416.2	2460.96
S=100%	140	31472	12.56	2505.73	
L=100%	105	23604	12.56	1879.29	1915.09
L=100%	109	24503.2	12.56	1950.89	
L+S=75+25%	113	25402.4	12.56	2022.48	2058.275
L+S=75+25%	117	26301.6	12.56	2094.07	
S+L=75%+25%	125	28100	12.56	2237.26	2299.9
S+L=75%+25%	132	29673.6	12.56	2362.54	
L+S=50+50%	125	28100	12.56	2237.26	2174.617
L+S=50+50%	118	26526.4	12.56	2111.974	

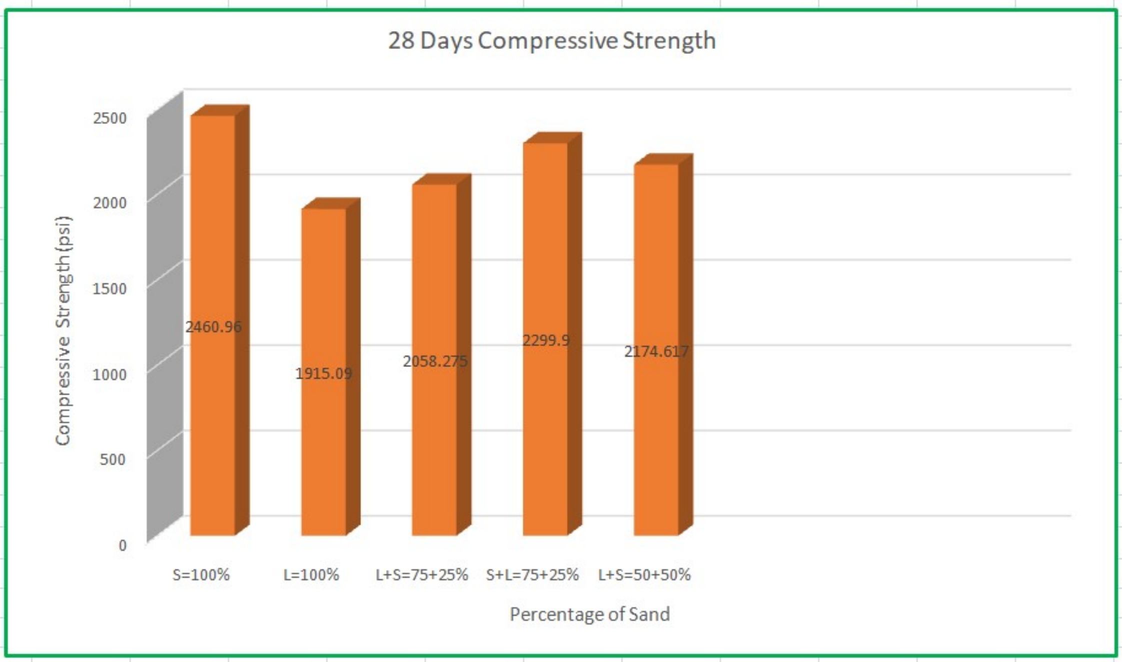

Figure 4.6: Compressive Strength Test (14 days)

Figure 4.6: The properties of compressive strength of concrete obtained by volumetric replacement of sylhet sand & local sand 28 days normal water curing.

The figure 4.6 shows maximum compressive strength 2460.96 Psi for100% sylhet sand use. The minimum value of compressive strength at same duration is 1915.09 Psi for 100% local sand use.

Table 4.9: Comparative Difference of 7 Days, 14 Days, 28 Days Compressive Test Results

Mix	7 DAYS	14 DAYS	28 DAYS
S= 100%	1387.09 Psi	1771.9 Psi	2460.96 Psi
L= 100%	912.8 Psi	1082.82 Psi	1915.09 Psi
L+S= 75+25%	1136.525 Psi	1261.81 Psi	2058.275 Psi
S+L=75+25%	1342.367 Psi	1655.565 Psi	2299.9 Psi
L+S= 50+50%	1190.22 Psi	1503.44 Psi	2174.617 Psi

CHAPTER 5
CONCLUSIONS

5.1 Conclusions

In this experiment we use some process to increase the strength of concrete cylinder, there is curing process. Curing process must be followed to achieve desired concrete properties. Curing is necessary to ensure that the concrete will have sufficient moisture available to develop required properties. The results show that the compressive strength of concrete of sylhet is higher than that of the local sand the difference in compressive strength of concrete tends to be greater as the difference in sand fineness increases.28 days strength of concrete is average about 45% higher than 7day strengths. The durability of sylhet sand concrete under acid and sulphate attack is higher inferior to that of conventional concrete.

There is also a significant argument that the laboratory test result showed that the compressive strength of local sand & sylhet sand mixed use can meet the requirements of high strength concrete standard.

This study has shown that local sand & sylhet sand mixed use is a useful resource and can be used in the production of high-strength or high-performance structural concrete subjected to the strength and durability tests, and had been shown to perform satisfactorily and in a comparable manner to concrete.

Hence this research work concludes that, local sand can be used as an alternative material for sylhet sand and thereby the sustainability can be achieved.

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