Comparative Study on Compressive Strength of Demolished Concrete Aggregate and Conventional Concrete Aggregate for Construction Materials

By

Mainuddin

Abubakkar Siddique

Sabbir Ahmed

Mokbul Hossain

Md. Amirul Islam

Md. Manik

A thesis submitted to the Department of Civil Engineering
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Department of Civil Engineering

Sonargaon University

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

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BY

Mainuddin	(BCE1901016128)
Abubakkar Siddique	(BCE1801013138)
Sabbir Ahmed	(BCE1903018120)
Mokbul Hossain	(BCE1903018121)
Md. Amirul Islam	(BCE1901016301)
Md. Manik	(BCE1903018119)

Supervisor

Tinvi Islam Tisha
Lecturer
Department of Civil Engineering.

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

Department of Civil Engineering
Sonargaon University
147/I, Green Road, Dhaka-1215, Bangladesh

Section: 18 (B)
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The thesis titled "Comparative Study on Compressive Strength of Demolished Concrete Aggregate and Conventional Concrete Aggregate for Construction Materials.
" Submitted by Mainuddin, Sabbir Ahmed, Abubakkar Siddique, Mukbul Hossain, Md. Amirul Islam and Md. Manik has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Bachelor of Science in Civil Engineering in 2023.

....

1. Tinvi Islam Tisha — Chairman

Lecturer, Department of
Civil Engineering,
Sonargaon University

……………………………........

2. Internal / External Member — Member

………………………………..

3. Internal / External Member — Member

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It is hereby dedicated that except for the content where specific reference has been made to the work of others, the studies contained in this research are the result of the investigation carried out by the author's. No part of this research has been submitted to any other university or educational institution for any award or degree.

Name	ID	Signature
Mainuddin	(BCE1901016128)	
Abubakkar Siddique	(BCE1801013138)	
Sabbir Ahmed	(BCE1903018120)	
Mokbul Hossain	(BCE1903018121)	
Md. Amirul Islam	(BCE1901016301)	
Md. Manik	(BCE1903018119)	

Dedicated

to

"Our Beloved Parents"

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ABSTRACT

The concrete structure has been designed on the basis of strength criteria. The compressive strength of concrete is traditionally determined by 28 days cured cylinder test and this strength is used in designing concrete structures. We used recycled aggregate in concrete can be useful for the environment harmful. In this reports the basic materials of recycled coarse aggregate and compares these properties with natural aggregates. Concrete materials like compressive strength, flexure strength, etc. are explained here for mixed of recycled aggregate with new aggregate. Design Code guidelines for the recycled aggregate of concrete in various countries are stated here with their effects on concrete work. Usually recycled aggregate in Bangladesh along with its future need and successful use are discussed here. We performed our work in three ways. Firstly, we made 6 nos concrete cylinders by using fresh aggregate 100%. Secondly 6 nos concrete cylinders by using recycled aggregate 100%. Thirdly, we made 6 nos concrete cylinders by using fresh aggregate 50% and recycled aggregate 50% mixed. For this study, we have made the cylinder of 4” (dia) and 8” (height). The total cylinders for the experiment are 18 nos. The maximum load was found after 28 days for 100% fresh aggregate concrete.

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CHAPTER 1

INTRODUCTION

1.1 General

We can try to keep our environment totally neat and clean. An environmentally friendly approach to the disposal of waste materials, a difficult issue to cope with in today's world, would only be possible through a useful recycling process. European, American, Russian, and Asian countries used recycled aggregate and also reused waste materials. Many countries are giving infrastructural laws relaxation for increasing the use of recycled aggregate. This paper reports the basic properties of recycled aggregate and also compares these properties with natural aggregates. Basic concrete materials like compressive strength, flexure strength, workability, etc. Recycled concrete is made on-site at most Maryland and Virginia locations by crushing returned or demolition concrete. Sometimes it is referred to as RCA (Recycled concrete aggregate). By decreasing construction waste from landfills, the use of Recycled concrete not only helps protect the environment but also saves money for reusing materials and avoiding disposal fees. When the structures made of concrete are demolished, concrete recycling is a control at the crushing facility, well-graded and beautifully pleasing materials can be provided as a substitute for landscaping stone. Recycled concrete aggregate has many uses but is most often used as a sub-base layer and construction road material. More recently a third type of aggregate has emerged Recycled concrete aggregate (RCA) which is produced by crushing concrete retained from demolished highways, building and structures. Aging infrastructure, scarce landfill space, cost savings, and environmental benefits all fuel the growing demand for concrete recycling. Concrete from demolition sites is crushed, processed to remove metal such as reinforcing steel and then screened to proper sizes. The crushed concrete is then reused as aggregate for fill, road base or even new concrete many of the same applications as conventional crushed stone. There are two approaches to recycling concrete. One approach is to haul the concrete debris to a permanent recycling facility or quarry for crushing and screening. The alternative is to crush and screen the material at the demolition site. Using portable crushers on site reduces construction costs eliminates the need to transport the material to and a quarry recycling facility. Transportation costs, energy use and wear and tear on roads and equipment are all reduced. Recycled concrete currently supplies about 5% of aggregate use. The bulk of recycled aggregate – 68% - is used as base road.

The reminder is used for new concrete mixes (6%), asphalt (9%) and fill. In developing countries, the raw materials for construction are not easily available. The skill required is of low level and it has superior strength properties as does not compare to conventional reinforced concrete. These are the reasons for which the recycled aggregates is considered to be an appropriate confinement material in developing countries such as Bangladesh. Procedures that are technically sound and economically feasible and are needed to upgrade the deficient structures. On such strengthening technique currently being studied is the confinement of concrete columns. The use of recycled aggregates is an external confinement to concrete cylinder is investigated in this study.

1.2 Compressive Strength

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. Compressive strength is one of the most important properties of concrete and mortar. The strength of the binder (cement) therefore has a significant effect on the performance characteristics of the mixture and ensures the overall quality of the finished product. The M describes the mix design of concrete while the strength digits in N/mm^2. Therefore, concrete is known for its compressive strength. The usage of the right concrete grades depends on advice given by the structural engineer. The formula for calculating the compressive strength of cement is the maximum load carried by the mortar specimen (cube) which means the load point on the compressive testing machine at which the specimen starts breaking is divided by the surface area (contact area). Because of the high capital risk in the construction industry, instead of testing the strength on the 28th day, the strength can be checked on the 7th and 14th day based on the concrete strength psi to predict the construction works target strength. [1]

1.3 Background and Motivation

In public market, it is very difficult to get several of Portland composite cement (PCC) cement.This brands of cement are currently used as an adhesive in a mixture of concrete. In the ready mix business there is also a tight competition, so in order to be able to exist they substitute cement. Problem arise at the time of testing cube and cylinder test objects that is the testing of concrete samples in various ages.

The test data are often obtained at the ages 7 days, 14 days, and 28 days that the compressive strength of the concrete in accordance with the planned compressive strength is even greater. However, the 28 days sample test often results in a smaller value than the quality of the plan. To determine the value of compressive strength in the test at age less than 28 days.

1.4 Research Objectives

- To study the behavior of the concrete cylinder with recycled aggregates.
- To carry out different tests on recycled aggregates & natural aggregates & compare their result.
- To reduce the impact of waste materials on the environment.

1.5 Outline of the study

It is suitable for the most common and well-accepted measurement of concrete strength to assess the performance of a given recycled aggregate and fresh aggregate. It is removing waste from our environment. Recycled aggregates have enough strength. It also protects our environment from pollution. Recycled aggregates carry enough load.

1.6 Recycled aggregates – An overview

The construction industry generates huge amounts of debris that need to be recycled and reused as recycled aggregates (RAs) for partial or total substitution of natural aggregates. Recycling reduces waste and reduces energy consumption and hence contributes to a more sustainable construction industry. In this chapter, the need for recycling and the current situation worldwide is highlighted. RA properties are discussed. RAs have a relative density lower than that of virgin materials and higher water absorption. A state-of-the-art RA concrete performance at the fresh and hardened state is summarized.

The recycled pieces are carefully screened to remove any steel, metal or other debris that could compromise the integrity and are then crushed down to size depending on the specific needs of a particular project.

1.6.1 General

Concrete is one of the most widely used materials globally. In 2009, the International Energy Agency reported that ~25 Gt of concrete is used each year globally which is equivalent to > 3.8 tons of concrete per person per year. The urbanization growth rate in Bangladesh is very high due to industrialization. The growth rate in Bangladesh is reaching 7.2% of GDP. Rapid infrastructure development requires a large number of construction materials, land requirements & the site. For large construction, concrete is preferred as it has a longer life, low maintenance cost & better performance. For achieving the GPD rate, smaller structures are demolished & new towers are constructed. Protection of environment is a basic factor which is directly connected with the survival of the human race. Demolition to make space for new structures generates a large volume of waste. Among various types of construction and demolition waste, concrete waste accounts for 50% of the total waste generation.

Recycling concrete features both cost savings and environmental benefits:

- ✓ Reduced disposal of concrete in a landfill.
- ✓ Conservation of natural resources.
- ✓ Recycling concrete helps reduce construction waste and extend the life of landfills as well as saving builders disposal or tipping fees.
- ✓ Reduced cost for raw materials.
- ✓ Energy savings from less processing and transportation.
- ✓ It also reduces transportation costs because concrete can often be recycled in areas near the demolition or construction site.

1.6.2 Characteristics of Recycled Aggregates

- ✓ It is made of cement, sand and water.
- ✓ It behaves like concrete materials.
- ✓ Heavy equipment is required for crushing.
- ✓ Available constituent materials.
- ✓ It is special form of normal concrete.
- ✓ It is may or may not resistive to cracking.
- ✓ It can be cast into any shape.

1.6.3 Application of Recycled Aggregates

- Application of recycled concrete aggregates (RCA) and crushed bricks (CB) into pavement materials is an ideal waste management solution. By appropriate material design, the RCA and CB could be used in permeable concrete as the pavement base which meets the principle of 'sponge city'. Residential base- When installing a new driveway, walkway, or patio, you will need to first lay down a layer of reliable base material. Many homeowners choose to work with RCA because it is extremely affordable while also living up to the highest performance standards.
- Commercial/Municipal base- Because commercial parking lots and municipal roads are so heavily trafficked, it's extremely important that they feature a study base layer comprised of materials. RCA meets the requirements for constructing safe roadways. In some cases, contractors also elect to use RCA as a base material for constructing new buildings. Finally, recycled concrete aggregates are a great option for laying down pipe bedding and utilities or improving drainage to whiten a property.
- General construction – You may see construction sites where RCA is laid down at the project entrance in order to stop the tracking of mud.

1.6.4 Advantages of Recycled Aggregates

- Increased protection from seepage.
- Cost saving – There are no detrimental effects on concrete & it is expected that the increase in the cost of cement could be offset by the lower cost of Recycled concrete aggregates.
- Save the environment –There is no excavation of natural resources and less transportation. Also, less land is required.
- Save time – There is no waiting for material availability.
- Reduced space wastage in landfills.

1.6.5 Disadvantages of Recycled Aggregates

- If the amount of aggregate mixed into concrete is too much, it can significantly impact the strength of the material.
- Duration procurement of materials may affect life of the cycle of the project.
- Very high water absorption up to 6%
- It is higher drying shrinkage and creep.
- The aggregate and concrete used must be refined or else there could be serious challenges such as cracks and uneven surfaces.

CHAPTER 2

LITERATURE REVIEW

2.1 Concrete

Concrete in construction is structural material consisting of a hard, chemically inert particulate substance, known as aggregate (usually sand and gravel), that is bonded together by cement and water. Concrete having a 28-day compressive strength of at least 21 MPa (3000 psi) is normally considered high strength. High compressive strengths are achieved by using a low water-to-cementations materials ratio, requiring the use of water-reducing admixtures to provide adequate workability. At first, it is necessary to study the behavior of recycled aggregates. In this experimental investigation was carried out by several researches on the behavior of a concrete cylinder with recycle aggregates. Three types of concrete mixed were designed by the volume method with same cement water ratio. The aggregates are two type. One is fine aggregate and another is coarse aggregate. The recycled aggregate concrete has a compressive strength of at least 76% and modulus of elasticity from 60% to 100% of the control mix.

2.2 Cement

In general, adhesive substances of all kinds, but in a narrower sense, the binding materials are used in building and civil engineering construction. Cements of this kind are finely ground powders that, when mixed with water, set to a hard mass. Setting and hardening result from hydration, which is a chemical combination of the cement compounds with water that yields submicroscopic crystals or a gel-like material with a high surface area. Because of their hydrating properties, constructional cements, which will even set and harden under water are often called hydraulic cements. The most important of these is Portland cement. This article surveys the historical development of cement its manufacture from raw materials, its composition and properties, and the testing of those properties. The focus is on Portland cement, but attention also is given to other types, such as slag-containing cement and high-alumina cement. Construction cements share certain chemical constituents and processing techniques with ceramic products such as brick and tile, abrasives, and refractories. For detailed description of one of the principal applications of cement, see the article building construction. Cements may be used alone (i.e. “neat” as grouting materials) but the normal use is in mortar and concrete in which the cement is mixed with inert material known as aggregate. Mortar is cement mixed with sand or crushed brick chips that must be less than approximately 5 mm (0.2 inch) in size. Concrete is a mixture of cement, sand or other fine aggregate and coarse aggregate that for most purposes is up to 19 to 25 mm (0.75 to 1 inch) in size but the coarse aggregate may also be as large as 150 mm (6 inches) when concrete is placed in large masses such as dams. Mortars are used for binding bricks, blocks, and stone in walls or as surface renderings. The origin of hydraulic cements goes back to ancient Greece and Rome. The materials used were lime and a volcanic ash that slowly reacted with it in the presence of water to form a hard mass. This formed the cementing material of the Roman mortars and concretes of more than 2,000 years ago and of subsequent construction work in Western Europe.

Volcanic ash mined near what is now the city of Pozzuoli, Italy, was particularly rich in essential alum inosilicate minerals, giving rise to the classic pozzolana cement of the Roman era. To this day the term pozzolana, or pozzolan, refers either to the cement itself or to any finely divided alum inosilicate that reacts with lime in water to form cement. (The term cement, meanwhile, derives from the Latin word cementum, which meant stone chippings such as were used in Roman mortar not the binding material itself). There are four stages in the manufacture of Portland cement:
(1) Crushing and grinding the raw materials,
(2) Blending the materials in the correct proportions,
(3) Burning the prepared mix in a kiln, and
(4) Grinding the burned product, known as “clinker,” together with some 5 percent of gypsum (to control the time of set of the cement.

The three processes of manufacture are known as the wet, dry, and semidry processes and are so termed when the raw materials are ground wet and fed to the kiln as a slurry, ground dry and fed as a dry powder or ground dry and then moistened to form nodules that are fed to the kiln. It is estimated that around 4–8 percent of the world’s carbon dioxide (CO2) emissions come from the manufacture of cement, making it a major contributor to global warming. Some of the solutions to these greenhouse gas emissions are common to other sectors such as increasing the energy efficiency of cement plants, replacing fossil fuels with renewable energy and capturing and storing the CO2 that is emitted. In addition, given that a significant portion of the emissions are an intrinsic part of the production of clinker, novel cements and alternate formulations that reduce the need for clinker are an important area of focus.
A first approximation of the chemical composition required for a particular cement is obtained by selective quarrying and control of the raw material fed to the crushing and grinding plant. Finer control is obtained by drawing material from two or more batches containing raw mixes of slightly different composition. In the dry process, these mixes are stored in silos; slurry tanks are used in the wet process. Though mixing of the dry materials in the silos is ensured by agitation and vigorous circulation induced by compressed air. In the wet process, the slurry tanks are stirred by mechanical means or compressed air or both. The slurry, which contains 35 to 45 percent water, is sometimes filtered, reducing the water content to 20 to 30 percent, and the filter cake is then fed to the kiln. This reduces the fuel consumption for burning.

2.3 Portland Composite Cement

Portland composite cement is the common type of cement in general use around the world as a basic ingredient of concrete, mortar, stucco and non-specialty grout. Several types of Portland composite cement are available. Portland composite cement is a caustic materials meaning that it has the ability to chemically bum your skin if you are not handling it with enough care.
Concrete is a composite material consisting of aggregate (gravel has and sand), cement, and water. It’s one of the most widely used substance on earth and as such Portland cement manufacturing is currently vital to the world is economy. It is one of the construction industry largest cause of climate changing carbon dioxide emission. Portland cement can be used on its own or as a mixture with other components.

2.5 Water Cement Ratio

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 more difficult to work with and form. Workability can be resolved with the use of plasticizers. Water cement ratio produced by conventional mixing technologies are usually prepared with water cement ratio 0.45 for testing their 7 days, 14 days and 28 days' compressive strength.

2.5.1 Aggregates

Naturally aggregate is consists of well graded fine aggregate that has pass. (sieve 2.36 mm). It makes the shape of concrete. Brick aggregates are made by crushing clay-burnt bricks mechanically or by hand. Though used extensively in construction, most of the time brick aggregate concrete is used without prior knowledge of its engineering properties due to handful of research on this aggregate.

Fig. 2.1: Coarse Aggregates.

2.5.2 Recycle Aggregate

Recycling and reuse of building rubble present interesting possibilities for economy on waste disposal sites and conservation of natural resources. This paper examines the possibility of using brick as coarse aggregate for a new concrete. Either natural sand, coarse aggregates or both were partially replaced (50, and 100%) with brick aggregates. The test results indicate that it is possible to manufacture concrete containing bricks with characteristics similar to those of natural aggregates concrete.

Fig. 2.2: Recycle Aggregates.

2.6: Fine Aggregate:

Fine aggregates are essentially any natural sand particles won from the land through the mining process. Fine aggregates consist of natural sand or any crushed stone particles that are ¼ inch or smaller. This product is often referred to as ¼ inch minus as it refers to the size or grading of this particular aggregate.Fine aggregate (sand) fills voids between aggregates. It forms the bulk and makes mortar or concrete economical. It provides resistance against shrinking and cracking. It is naturally available.

Fine aggregate is the essential ingredient in concrete that consists of natural sand or crushed stone. The quality and fine aggregate density strongly influence the hardened properties of the concrete. The concrete or mortar mixture can be made more durable, stronger and cheaper if you made the selection of fine aggregate on basis of grading zone, particle shape, surface texture, abrasion skid resistance, absorption and surface moisture.

Fig. 2.3: Fine aggregate.

Different sizes of sand are necessary for different works. Sometimes, sand is termed as fine, medium and coarse. It is difficult to distinguish one type of sand from others when such terms are used. It is advisable to express sand in terms of fineness modulus.

According to F.M. sand can be classified as under:

Types of Sand	Range of Fineness Modulus
Fine Sand	2.2- 2.6
Medium Sand	2.6- 2.9
Coarse Sand	2.9- 3.2

Sand having a fineness modulus more than 3.2 will not be suitable for making satisfactory concrete.

Properties of Fine Aggregate:

- Size of Fine Aggregates.
- Strength.
- Shape of Fine Aggregates.
- Specific Gravity.
- Surface Texture of Fine Aggregates.
- Water Absorption.
- Surface Index of Fine Aggregates.
- Soundness.
- Surface Moisture.
- Specific Surface of Fine Aggregates.

2.7 Sieve Analysis of Fine and Coarse Aggregate

Sieve analysis forms the basic essential test for determining the gradation of aggregates. The main property investigated in this test is the particle size. Sieve analysis is the method of dividing a sample of aggregates into various fractions each consisting of particles of same size. The sieve analysis is carried out to determine the particle size distribution in a sample of aggregate, which we call gradation. The aggregate fraction from 4.75 to 75 micron is referred to as fine aggregates.

Fig. 2.4: Sieve

In practice, each fraction contains particles between definite limits, these being the openings of standard test sieves. Before sieving, the soil should be air dried in order to avoid lumps of fine particles and also to prevent clogging of the finer sieves. Sieves should also be cleaned before use.

The term sieve analysis is given to the operation of dividing a sample of aggregates into fraction each consisting of particles between specific limits. The analysis is conducted to determine the grading of material proposed for using as aggregates. The term fineness modulus (F.M) is a ready index of coarseness or fineness of material. It is an empirical factor obtained by adding the cumulative percentages of aggregates retained on each of the standard sieves and dividing this sum arbitrarily by.No.100, No.50, No.30, No.16, No.8, No.4, 3/8 in, ¾ in, 1.5 in, 3 in. are the ASTM standard sieves. This test method confirms to the ASTM standard requirements of specification C136.

CHAPTER 3

METHODOLOGY

3.1 preparation of Cylinder

The Comprehensive strength of the concrete cylinder is one of the most common performance measures 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 using a compression 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 (100X200) 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 30 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.

Fig. 3.1 (a): Preparation of Cylinder

Fig. 3.1(b): Mold Ready for Casting

3.2 Concrete Mixing

A concrete mixer is a device that homogeneously combines cement, aggregate such as sand or stone and water to from concrete. A typical concrete mixer uses a revolving drum to mix the components. This process is so crucial that if the concrete making ingredients aren't mixed properly, it can lead to concrete failure under compression load. A concrete mixture ratio of 1-part cement, 1.5 parts sands, and 3 parts aggregate will produce a concrete mix of approximately 3000 psi. Mixing water with the cement, sand and brick chips will from a paste that will bind the materials together until the mix hardens.

The primary goal of concrete mixing is to make the concrete mass homogeneous and uniform in color while maintaining the required consistency.

Production of good quality and bad quality of concrete includes the same material, but the proportion and mixing methods can be differentiating. As a result, sufficient precautions should be followed while mixing concrete.

Fig. 3.2: Mixing of Sand Cement and brick chips.

3.3 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 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 been rejection and ultimately all factor 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 component. [2]

Fig. 3.3: Casting of Cylinder

3.4 Curing

The curing of concrete is the process of keeping the concrete damp or moist and warm after the initial setting of concrete or removal of formwork. Proper curing of concrete maintains the satisfactory moisture content and favorable temperature inside the concrete so that hydration of cement may continue until the desired properties are developed. The curing of concrete must be continued for a reasonable period of time to achieve its desired strength and durability.

Initial curing during the first 24 to 48 hours after molding, all test specimens are stored. After curing, a large amount of water needs to be disposed of on the curing side. But water cooler than 50c is not suitable for curing concrete. As the hydration reaction in concrete expels heat and keeps concrete warm, using cold water less than 50c on concrete may lead to cracking and failing. Alternate drying and wetting on the concrete surface causes volumetric changes in concrete and ultimately leads to cracking.

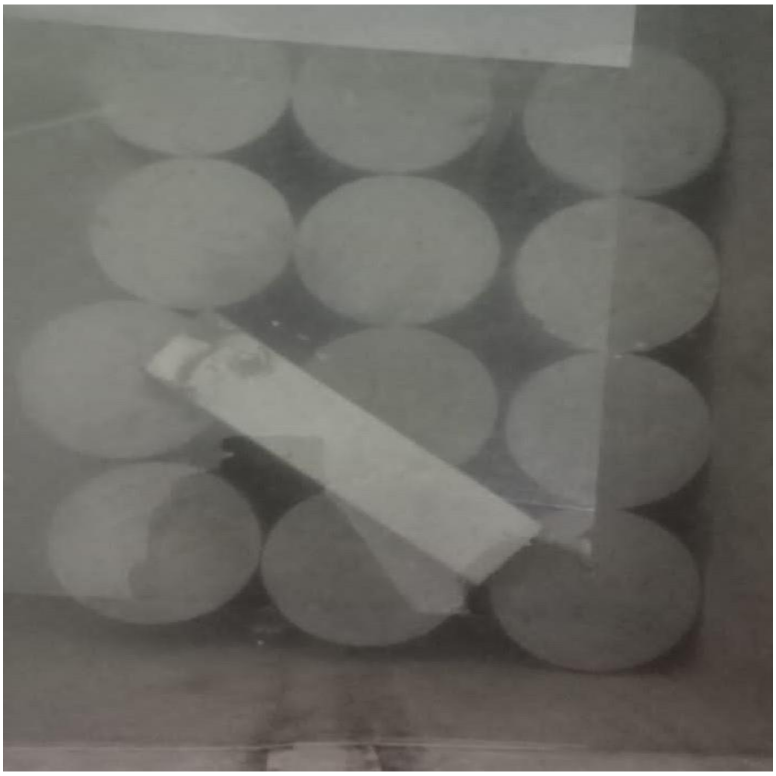

Fig. 3.4: Curing of Cylinder.

3.5 Preparation to Crush the Concrete Cylinders

The cylinders were kept submerged as long as for 7 days,14 days and 28 days. After that were withdraw 6 pcs cylinder are made by cylinders' fresh aggregate 2 pcs and mixed (50% fresh aggregate and 50% recycle aggregate) 2 pcs and also recycle aggregate 2 pcs from the dram. In this way we were taken another 12 cylinder from the dram at 14 days and 28days. In Sonargaon University (SU) Lab, after that the cylinders had been 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 7days, 14 days and 28 days. At first 7 days and 14 days we kept test the 12 cylinder. Then we kept another test for 28 days. After that we are withdrew from the dram and crushing the cylinders and noted down the value.

Fig. 3.5: Preparation of Cylinder

3.6 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 is 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.

Compression Test

Compressive strength of materials 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.

3.7 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 fresh aggregates, mixed aggregates and recycled aggregates [3].

Fig. 3.6: Place the cylinder in UTM machine.

3.8 Compressive Fracture of Cylinder

For 7 days, 14 days, and 28 days tests, the specimen was kept at the center of the UTM machine and crushed one by one and noted the value. Total crushed 18 specimens in Sonargaon University lab. The cylinder failed at the top strength of its capacity [4]

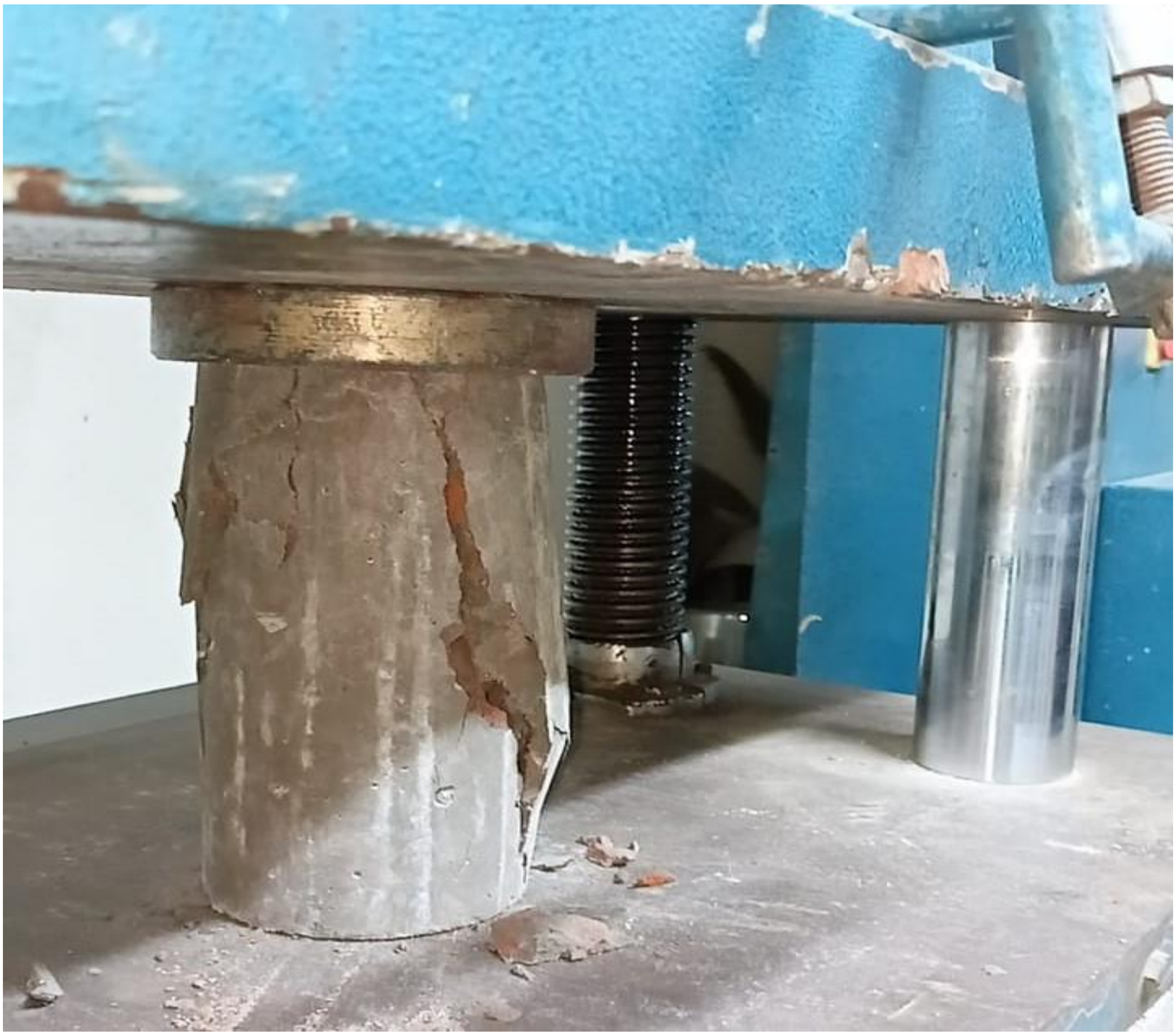

Fig. 3.7: Compressive fracture of Cylinder

3.9 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. Compressive strength is one of the most important and useful properties of concrete. The design strength of the concrete normally represents its 28th day [4]. 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:

$F = P/A$

Where, 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 load [5].

CHAPTER 4

RESULT AND DISCUSSION

4.1 Result of Fine Aggregate

The test sample of the aggregate (F.M) shall weight, 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 4.1: Result of aggregate sieve analysis

Sieve No.	Retain	% Retain	Cumulative % Retain	FM	Finer
#4	0	0	0		100
#8	27	5.4	5.4		94.6
#16	73	14.6	20		80
#30	174	34.8	54.8	265.6/100 =2.66	45.2
#50	172	34.4	89.2		10.8
#100	35	7	96.2		3.8
Pan	19	3.8	100		0

4.2 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 4.2: Result of Coarse Aggregate:

Sieve No.	Retain	% Retain	Cumulative % Retain	FM	Finer
#3/4	2049	40.98	40.98		88.2
#3/8	2750	55.00	95.98		0
#4	196	3.92	100		100
#8	0	0	100	636.96/100	
#16	0	0	100	=6.36	
#30	0	0	100		
#50	0	0	100		
			636.96		

4.3 Specific Gravity of Coarse Aggregate

Table 4.3: Data sheet for specific gravity of coarse 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
1890 gm	1880 gm	1245 gm

Table 4.4: Specific gravity of coarse aggregate:

Test	Formula	Calculation	Result
Apparent specific Gravity	A	1880	0.74
	B + A - C	1890+1880-1245	
Bulk Specific Gravity (Oven Dry Basic)	A	1880	2.91
	B - C	1890-1245	
Bulk Specific Gravity (S.S.D. Basic), G	B	1890	2.93
	B - C	1890-1245	
Absorption Capacity, D%	(B - A) x 100	(1890-1880)x100	0.531
	A	1880	

The specific gravity of the normal aggregate after oven drying was found 2.91 for coarse aggregate. We found the specific gravity of the apparatus to be 0.74. Apparent capacity reduction received 0.531 and bulk SSD received 2.93.

4.4 Specific Gravity of Fine Aggregate

Table 4.5: Data sheet for 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	Wt. of S.S.D sample In Air, S gm
652 gm	300 gm	535 gm	315 gm

Table 4.6: Specific gravity of fine aggregate:

Test	Formula	Calculation	Result
Apparent Specific Gravity	$\frac{A}{B + A - C}$	$\frac{300}{652+300-535}$	0.719
Bulk SG (Oven Dry Basic)	$\frac{A}{B + S - C}$	$\frac{300}{652+315-535}$	0.694
Absorption Capacity, D%	$\frac{S - A}{A} \times 100$	$\frac{315-300}{300} \times 100$	5
Bulk SG (S.S.D. Basic), G	$\frac{S}{B + S - C}$	$\frac{315}{652+315-535}$	0.729

The specific gravity of the normal sand as fine aggregate after open drying was found 0.694. 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.

4.5 Results of 7 Days Compressive Strength Test of cylinder

Table 4.7:Seven Days Compressive Strength Test of cylinder

SL. NO	Types of cylinder	Mix Properties	Water Cement (Ratio)	Compressive Strength(psi)	Average Strength (psi)	Average Strength (MPa)
1	Fresh aggregates	1:1.5:3	0.45	2850	2797.5	19.58
				2745		
2	Mixed aggregates	1:1.5:3	0.45	2545	2477.5	17.35
				2410		
3	Recycle aggregates	1:1.5:3	0.45	2310	2330	14.92
				1950		

4.6 Results of 14 Days Compressive Strength Test of cylinder

Table: 4.8: Fourteen Days Compressive Strength Test of cylinder

SL. NO	Types of cylinder	Mix Properties	Water Cement (Ratio)	Compressive Strength(psi)	Average Strength (psi)	Average Strength (MPa)
1	Fresh aggregates	1:1.5:3	0.45	3156	3188	22.32
				3220		
2	Mixed aggregates	1:1.5:3	0.45	2850	2822.5	19.76
				2795		
3	Recycle aggregates	1:1.5:3	0.45	2385	2417.5	16.93
				2450		

4.7 Results of 28 Days Compressive Strength Test of cylinder

Table 4.9: Twenty Eight Days Compressive Strength Test of cylinder

SL. NO	Types of Cement	Mix Properties	Water Cement (Ratio)	Compressive Strength(psi)	Average Strength (psi)	Average Strength (MPa)
1	Fresh aggregates	1:1.5:3	0.45	3390	3405	23.84
				3420		
2	Mixed aggregates	1:1.5:3	0.45	2955	2924.5	20.47
				2894		
	Recycle aggregates	1:1.5:3	0.45	2780	2712.5	18.99
				2648		

4.8 Comparison Chart

The comparison between different types of cylinders are given below

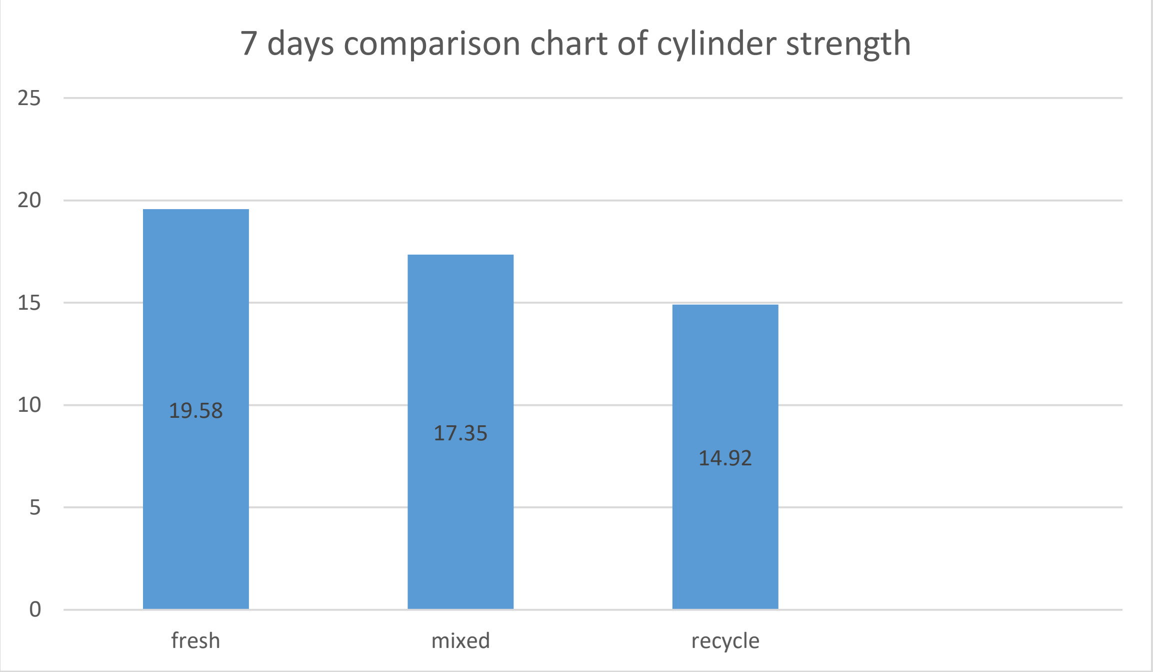

Fig. 4.2: 7-days comparison chart of cylinders' strength

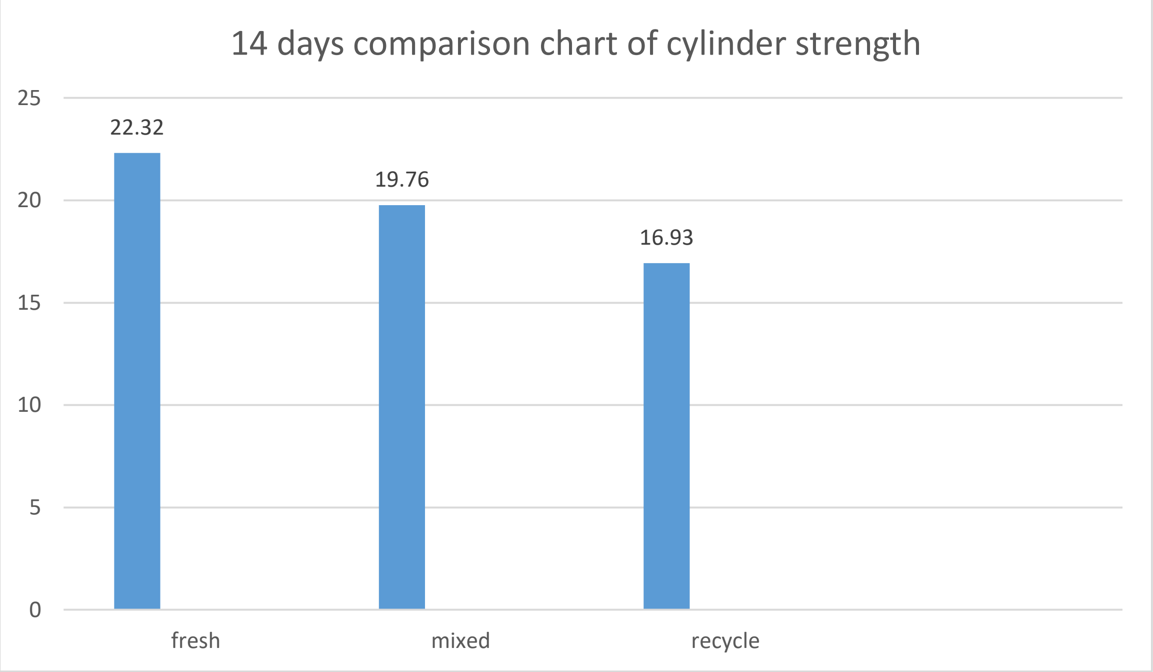

Fig. 4.3: 14-days comparison chart of cylinders' strength

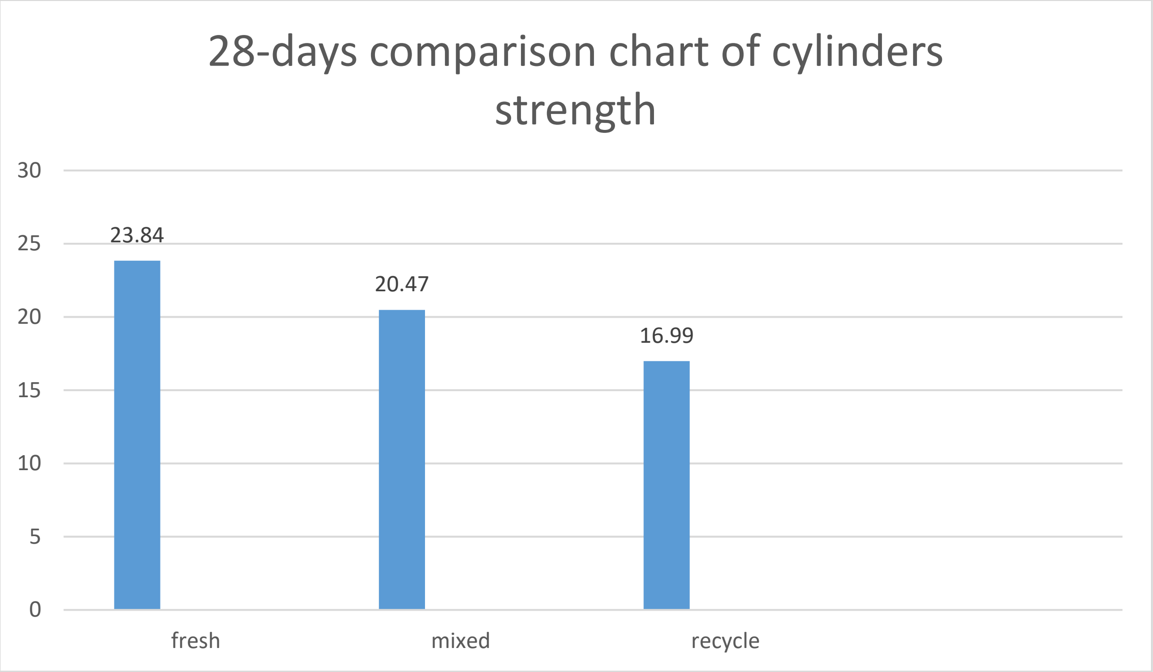

Fig: 28-days comparison chart of cylinders’ strength

CHAPTER 5

CONCLUSIONS

5.1 Decision

After the experiment, we get the following decisions:

1. The comparison of compressive strength of concrete by using different types of aggregates.
2. In 28 days, the compressive strength test result fulfills nearby the conditions of an M20 grade.
3. We get the almost highest compressive strength of concrete in 28 days which is the fresh aggregates.
4. Overall we get similar type results of compressive strength using the cylindrical test.
5. We get almost the lowest strength of concrete in 7 days which is the Recycled aggregates. Because these aggregates absorbed huge water.
6. Recycled aggregate possesses relatively lower bulk density, crushing, and impact values and higher water absorption as compared to natural aggregate.
7. Recycling helps in conserving natural resources, saving energy, reducing pollution, and creating employment opportunities. It also reduces the amount of waste that is sent to landfills.

5.2 Recommendation

The following are some recommendations provided considering the previous discussion:

1. It was advisable to use 25 to 50% recycled coarse aggregate in low-rise structures, pavement design, drainage structures, road construction, etc.
2. The recycled concrete aggregate should be studied by using chemical stabilization to improve the strength of concrete.
3. This fill also resolves environmental issues raised due to the dumping of demolition debris and construction waste.
4. The use of recycled aggregate in construction reduces the impact of waste material on the environment and also reduces the excavation and transportation of natural aggregate from natural resources.

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