A COMPARATIVE STUDY ON THE COMPRESSIVE STRENGTH OF CONCRETE BY USING BROKEN PILE HEAD CONCRETE AND NATURAL COARSE AGGREGATES

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



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Section: 24(A+E)

Semester: Spring-2025

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To

"Our Beloved Parents"

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ABSTRACT

This thesis presents a comparative study on the compressive strength of concrete using two different types of coarse aggregates—broken pile head concrete and natural stone aggregate—along with different types of fine aggregates. The main goal of this research is to find out whether broken pile head concrete, which is usually treated as construction waste, can be reused as a replacement for natural aggregates in concrete, without significantly affecting the strength and performance of the final product. To achieve this, concrete samples were prepared using both natural coarse aggregates and broken pile head concrete. Each type of coarse aggregate was combined with three different fine aggregates: river sand, manufactured sand (M-sand), and crushed stone dust. These combinations helped us understand how both coarse and fine aggregates affect the compressive strength of concrete. The compressive strength of all concrete samples was tested after 7 and 28 days of curing. The results showed that concrete using broken pile head aggregates can perform quite similarly to conventional concrete made with natural stone, especially when used with M-sand. Although there was a slight reduction in strength in some cases, the values were still within acceptable limits for most structural applications. This means that recycled concrete materials, like pile head waste, can be a good alternative to natural aggregates in many situations. Using recycled materials in concrete production not only reduces the demand for natural resources but also helps in managing construction and demolition waste in an eco-friendly way. This study supports sustainable construction practices and shows that with proper selection of materials, we can produce concrete that is both strong and environmentally responsible. In this study, it is observed that The Indian pakur stone and Sylhet sand gave better compressive strength value (14.70 Mpa) and brocken Pile head concrete and sylhet sand Strength value (12.16 Mpa) method for 7 days test. The Indian Pakur Stone and sylhet Sand gave high compressive strength Value (19.58 Mpa) and (recycled concrete) and Sylhet sand strength for 28 days curing test. The study demonstrates that the method and duration of curing greatly affects the strength characteristics of concrete. Hence, quality control for proper field curing is the utmost importance.

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CHAPTER 1
INTRODUCTION

1.1 Background and Motivations

Concrete, a vital construction material, is traditionally composed of cement, water, fine aggregates (such as sand), and coarse aggregates (such as gravel or crushed stone). Aggregates form the largest portion of concrete, typically making up about 70-80% of its volume. Their quality directly influences the overall strength, durability, and performance of the concrete. Over the years, the construction industry has heavily relied on natural aggregates, which are extracted from quarries and riverbeds. However, the increasing demand for concrete, coupled with the environmental consequences of aggregate extraction, has led to the exploration of more sustainable alternatives.

One promising alternative is the use of recycled aggregates (RA), which are obtained from processed construction and demolition waste, particularly discarded concrete structures. By reusing old concrete as aggregate, the industry can help conserve natural resources, reduce waste, and lower the environmental impact of construction activities. However, while recycled aggregates offer environmental benefits, their properties—such as shape, texture, and particle size—differ from those of natural aggregates, which can impact the quality of concrete, especially its compressive strength.

Compressive strength is a critical parameter in concrete performance, as it determines the material's ability to resist compressive loads without failure. As the use of recycled aggregates in concrete production continues to rise, understanding the impact of RA on compressive strength is essential. This study aims to compare the compressive strength of concrete made with recycled aggregates versus that made with natural aggregates. It will examine various factors such as the proportion of recycled aggregates, the method of processing, and the curing conditions that affect the mechanical properties of concrete.

By conducting this comparative analysis, the study seeks to provide insights into the feasibility and performance of concrete with recycled aggregates, contributing to the growing body of knowledge on sustainable construction materials. The results will offer valuable

information for the adoption of recycled aggregates in real-world applications, advancing the goal of more sustainable and resource-efficient construction practices.

1.2 Background of Study

Bangladesh is one of the fastest growing countries of the world. Old unplanned low-rise buildings and structures are being demolished to build high rise buildings and mega structures. Dhaka alone produces approximately 3000 tons of solid waste per day including construction waste (Chowdhury et al., 2016). Millions of tons of demolished concrete waste are being generated every year and on the other hand demand for aggregates for new construction is rising day by day. Natural resources are being emptied to meet the demand of this huge number of aggregates. If no alternative 2 is found, natural resources will run out soon. The scarcity of natural resources will push the price of the aggregates and concrete's reputation of being a cheap construction material will be at stake. The best alternative in this regard will be the recycling and reusing of demolished concrete waste to produce recycled aggregates which in turn will be used to produce Recycled Aggregate Concrete (RAC). Moreover, the waste consists of some inert type of solid waste including metal, mortar, concrete, brick, plastic, timber, ceramic and glass; approximately 80% of which can be reused. This indicates a high economic value of construction and demolished waste (Zheng et al., 2017). The major challenge in recycling and reusing concrete demolished waste is its low performance of strength and durability. When demolished concrete is crushed, a certain amount of mortar and cement paste from the original concrete remains attached to the recycled aggregate. The presence of this adhered mortar on the surface of crushed concrete aggregate generally degrades the quality of the recycled aggregate and consequently the fresh and hardened properties of concrete made from it (de Juan and Gutiérrez, 2009). Previous studies have shown a wide range of variations of strength and durability of recycled aggregate concrete along with its low performance. Strength and durability of concrete can be improved by using different types of admixtures in the concrete (Cu, 2016; Musbah et al., 2019). Although the effect of admixtures on Natural Aggregate Concrete (NAC) has been well established but its effect on Recycled Aggregate Concrete (RAC) is yet to be properly explored. Here, in this study super plasticize has been used as an admixture in recycled aggregate concrete and its effect on mechanical and durability performance has been observed and compared with natural aggregate concrete.

1.3 Research Objectives and Overview

Research Overview

This research explores the use of pile demolished concrete (PDC) and stone chips as coarse aggregates, combined with various types of fine aggregates (natural sand, crushed sand, and recycled fine aggregates), to evaluate their impact on the compressive strength of concrete. The study aims to promote sustainability in concrete production by reducing the use of natural aggregates and minimizing construction waste.

Research Objectives:

The objectives of the study are following:

1. To determine the compressive strength of concrete by using broken pile head concrete (recycle aggregate) and natural aggregate.
2. To assess the compressive strength of concrete by using different types of fine aggregate.
3. To compare the compressive strength of concrete by using different types of coarse aggregate.

CHAPTER 2
LITERETURE REVIEW

2.1 Introduction

Recycled aggregate concrete (RAC) may be an alternative to using natural aggregate (NA) in concrete. Recycling demolished concrete into aggregate helps the environment in many ways. Recycling preserves NA resources, landfill spaces and reduces generation of waste. The use of recycled aggregate concrete was first recorded in 1860 in Germany. Gradually it became popular in other countries as there was a shortage of landfill spaces for dumping demolished concrete. In Bangladesh, demolished concrete waste is seen to be used as filler materials only. It was previously thought that the recycled aggregate results in poor quality concrete, but a number of researchers have studied the mechanical and durability properties of recycled aggregates concrete and the outcomes contradict this idea.

Many studies have been conducted to investigate the performance of broken pile head (recycled aggregate). Recycling demolished concrete into aggregate helps the environment in many ways. Recycling preserves NA resources, landfill spaces and reduces generation of waste. The use of recycled aggregate concrete was first recorded in 1860 in Germany. Gradually it became popular in other countries as there was a shortage of landfill spaces for dumping demolished concrete.

Rao et al. (2007) discussed the potential of recycled aggregate concrete (RAC) and found that, while the compressive strength of RAC is typically 10–15% lower than that of conventional concrete, proper treatment and mix design optimization can bridge the gap. The research also emphasized the environmental benefits and cost-effectiveness of recycled concrete.

Tam et. al. (2007) further examined the properties of recycled concrete aggregates (RCA) and found that concrete containing RCA can perform adequately in structural applications if processed properly. Their work supports the idea of using broken concrete waste in new concrete mixes, especially in non-critical structural elements. Zhao et al. (2019) focused more specifically on waste generated from foundation works, including broken pile heads. They concluded that this type of waste concrete can be reused effectively, especially when combined with admixtures or supplementary contentious materials to improve the quality.

2.2 Aggregate

This thesis explores the use of recycled concrete aggregates (RCA) combined with various types of fine aggregates to evaluate their effect on the compressive strength of concrete. The study aims to address the environmental concerns associated with traditional construction materials by utilizing RCA, which can reduce waste and conserve natural resources. Different fine aggregates, such as river sand, manufactured sand, and others, were incorporated into concrete mixes with varying proportions of RCA. The compressive strength of each mix was tested to determine the optimal combination for achieving sustainable yet durable concrete. The findings highlight the potential of RCA and alternative fine aggregates in improving the performance of concrete, contributing to more sustainable construction practices and reducing the ecological impact of the construction industry.

Recycled Aggregate:

Recycled aggregate from piled demolished concrete is produced by crushing concrete debris from demolished structures, such as buildings and pavements, which are often collected in large piles. This aggregate is processed to remove contaminants like steel and other foreign materials, leaving behind crushed concrete that can be reused in new construction projects. Using recycled aggregate from demolished concrete helps reduce the demand for natural resources, minimizes construction waste, and lowers the environmental footprint of the construction industry. Although recycled aggregates may exhibit slightly lower strength and durability compared to virgin materials, proper processing and mix design can enable them to be effectively used in a variety of concrete applications.

Indian Pakur Stone:

Indian Pakur stone, primarily composed of basalt, is widely used in reinforced cement concrete (RCC) due to its high strength, durability, and suitability for various construction applications. Sourced from the Pakur region in Jharkhand and West Bengal, this stone is known for its excellent compressive strength, low water absorption, and high abrasion resistance. With a specific gravity between 2.6 and 2.8, Pakur stone is ideal for use in RCC, providing enhanced stability and longevity for structures like roads, bridges, and buildings. Its properties ensure that the concrete mix maintains its integrity under load and harsh environmental conditions, making it a preferred choice for high-performance concrete.

Sylhet Sand:

Sylhet sand is a fine-grained aggregate primarily composed of silica (SiO_2), with trace amounts of feldspar, mica, and clay. It typically has a grain size range of 0.075 mm to 4.75 mm, and its low clay and silt content (below 5%) makes it ideal for construction purposes. With a specific gravity of 2.60–2.70, it is durable, strong, and provides excellent work-ability in concrete, mortar, and brick production. Its fine texture and low water absorption enhance its suitability for high-quality construction applications.

Local Sand:

Local sand refers to sand sourced from nearby riverbeds, quarries, or coastal areas. Its composition typically includes silica (SiO_2), with varying amounts of clay, silt, and other minerals depending on the location. The grain size usually ranges from fine to medium, and its suitability for construction depends on factors like low clay content, appropriate grain shape, and minimal impurities. Local sand is commonly used in concrete, plastering, and mortar, provided it meets the required quality standards, such as low water absorption and optimal grain distribution for better work-ability.

Cement:

Shah Popular Portland Composite Cement is CEM - II /A-M which is a cement consisting of Clinker, Gypsum, Pulverized Fuel Ash (PFA), Blast Furnace Slag and Limestone designated by the recommendation of BDS EN 197-1: 2010; CEM -II/A-M (V-S-L), 42.5 N. PCC is the most suitable cement for constructions in Bangladesh. CEM – II /A-M contains 80- 94% Clinker, which is substantially higher than CEM– II/B-M containing 65–79% which provides us extra advantage in strength development and better of concrete performance. Both slag & fly ash (PFA) are used in PCC. Percentage of SiO_2 in PFA is higher than slag which is advantageous to gain more long-term strength and ensure production of durable concrete. This type of cement is used for constructions all over the world and it has been used during the last few decades. The hydration process of normal cement produces Calcium Silicate Hydrate CHS & Calcium Hydroxide $Ca(OH)_2$. Calcium Hydroxide $Ca(OH)_2$ does not contribute to gain strength, and it is the weak part of reaction which is not suitable for concrete. Since PFA contains higher portion of reactive silica and slag contains alumina, it helps to convert $Ca(OH)_2$ into CSH to gain further Compressive.

Water:

The water-cement ratio (W/C ratio) is crucial in determining the strength, work-ability, and durability of concrete. A 0.45 W/C ratio means that for every 1 kg of cement, 0.45 kg of water is used in the mix. This ratio is ideal for achieving high compressive strength while maintaining good work-ability and proper hydration of the cement particles.

Key points:

1. Strength: A 0.45 ratio provides sufficient water for hydration, promoting strength development while avoiding excess water that weakens the mix.
2. Work-ability: The mix will have moderate work-ability, suitable for most construction purposes without making the mix too dry or too wet.
3. Durability: Proper hydration leads to denser and more durable concrete, with reduced permeability and better resistance to environmental factors.
4. Consistency: It ensures a consistent, stable mix for reliable concrete performance in structural applications.

Overall, a 0.45 water-cement ratio is commonly used in medium to high-strength concrete mixes, offering an optimal balance between work-ability and strength.

2.3 Summary

The study evaluates how the combination of these materials affects concrete's compressive strength compared to conventional mixes using only natural aggregates. It is expected that using PDRC may slightly reduce the compressive strength due to the inherent properties of recycled aggregates, while Indian Pakur stone will likely enhance the strength.

CHAPTER 3
METHODOLOGY

3.1 Introduction

The methodology of this study is designed to investigate the compressive strength of concrete made with different recycled aggregates and local sand sources. Specifically, the research focuses on the use of recycled concrete aggregate (RCA) combined with local sand from Sylhet, compared to Indian Pakur stone aggregate combined with local sand and Sylhet sand. The study aims to determine the effect of these varying materials on the compressive strength of the concrete, providing valuable insights into their suitability for sustainable construction practices.

To achieve this, a series of controlled experiments were conducted to prepare concrete samples using different proportions of the aggregates. Concrete mixtures were designed with various combinations of recycled concrete aggregate (RCA), Indian Pakur stone, and local sands from Sylhet, followed by curing under standardized conditions. The compressive strength of the concrete was then evaluated at different ages (7and 28 days) to understand the material performance over time.

The methodology also includes the analysis of the properties of the materials used, such as particle size distribution, specific gravity, and water absorption, as well as a thorough examination of the factors that affect concrete strength, such as mix proportions, curing conditions, and the type of aggregate used. By comparing the compressive strengths of concrete with different aggregates, the research aims to assess the potential of using locally sourced materials and recycled aggregates as a sustainable alternative to conventional concrete production.

3.2 Methodology Overview

This study evaluates the compressive strength of concrete using recycled concrete aggregate (RCA) with local sand from Sylhet, as well as Indian Pakur stone with both local sand and Sylhet sand. The concrete mixtures were prepared by varying the aggregate types and sand sources, with standard mix proportions. The concrete specimens were cured for 7, 14, and 28 days, and their compressive strength was tested using a compression testing machine. Material properties, including particle size distribution, specific gravity, and water absorption, were analyzed for both the aggregates and sand. The results were compared to determine the impact of different material combinations on the compressive strength of concrete, offering

insights into the feasibility of using recycled and locally sourced materials for sustainable construction.

3.3 Collection of Materials

All of the materials are brocken pile head concrete, Indian Pakur Stone, Sylhet Sand, Local Sand and Shah Special Brand PCC Cement. High-quality materials will be selected to ensure accurate and repeatable results. The Recycled Concrete (Pile Demolished Concrete) will be of uniform size and will be properly processed to remove impurities.



Brocken pile head concrete.



Indian Pakur Stone

Figure 3.1: Coarse Aggregate.



Sylhet Sand



Local Sand

Figure 3.2: Fine Aggregate

Sieves Analysis of Aggregate

At First, we completed sieve analysis of fine aggregate and replaced recycled aggregate through NO. 100, NO. 50, NO. 30, NO. 16, NO. 8, NO. 4 sieves. Then coarse aggregate sieve analysis was completed by NO.100, NO.50, NO.30, NO.16, NO.8, NO.4, 3/8in, 3/4in, 3/2in, and 3in sieves. For particle size distribution for both fine aggregates, partially recycled aggregate, and coarse aggregate, the sieve analysis method was used according to AASHTO T27.



Figure 3.3: Sieves Analysis.

Specific Gravity & Absorption of Aggregate

The specific gravity & absorption of course, fine and partially replaced recycled fine aggregate (RFA) was determined according to AASHTO T84



Figure 3.4: Specific Gravity Test

Unit Weight Test

The unit weight of fine aggregate, and partially replaced recycled aggregate (RFA) and coarse aggregate was determined according to AASHTO T19.



Figure 3.5: Unit Weight Test.

Concrete Mixing

Mix design using recycled concrete is a method of creating new concrete by using crushed old concrete as a replacement for natural aggregates like gravel or stone. This helps reduce waste and save natural resources. Recycled concrete can be used fully or partly in the mix, depending on the strength and durability needed. Along with recycled concrete, regular sand and cement are used to prepare the mix. The water-cement ratio is carefully adjusted to make sure the concrete stays strong and workable. This eco-friendly approach is useful for sustainable construction and reduces the environmental impact of building materials.



Figure 3.6: Concrete Mixing

Preparation of Cylinder

To test the strength of concrete, a cylinder is made in the lab. First, clean the mold properly and apply oil inside it to prevent sticking. Then, fresh concrete is poured into the mold in layers (usually 2 or 3 layers). Each layer is compacted using a rod to remove air bubbles. After filling, the top surface is leveled smoothly. The mold is then kept undisturbed for 24 hours. After that, the cylinder is removed from the mold and placed in water for curing for 7 to 28 days. Later, the cylinder is tested in a machine to check its compressive strength.



Figure 3.7: Mold Ready for Casting

Casting of Cylinder

Casting a concrete cylinder is done to prepare a sample for strength testing. First, the cylinder mold is cleaned and a thin layer of oil is applied inside. Fresh concrete is then poured into the mold in two or three layers. Each layer is compacted properly using a steel rod to remove any air bubbles. After filling the mold, the top surface is leveled smoothly. The mold is then kept undisturbed in a safe place for 24 hours. After that, the concrete cylinder is taken out of the mold and placed in water for curing



Figure 3.8: Casting of Cylinder

Curing

Cylinder curing is the process of keeping concrete test cylinders in water or a moist place to help them gain strength. After casting, the cylinder is kept in the mold for 24 hours. Then, it is removed and placed in a curing tank filled with water at a controlled temperature. The cylinder stays in the water for 7 to 28 days. Proper curing helps the concrete become strong and ready for strength testing in the lab.



Figure 3.9: Curing of Cylinder

Preparation to Crush the Concrete Cylinders

The cylinders were submerged for as long as 7 days. After that were withdraw 12 pcs cylinder are made by cylinders (Stone + Sylhet sand) 3 pcs, (stone + local sand) 3 pcs, (brocken pile head concrete + Sylhet sand) 3 pcs, (brocken pile head concrete + local sand) 3 pcs from the dream. In Sonargaon University (SU) Lab, after that the cylinders were 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 they were kept submerged for as long as for 28 days. Then we kept another test for 28 days. After that we are withdrew from the dram and crush the cylinders and noted down the value.



Figure 3.10: Preparation to Crush the Concrete Cylinders

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. UTM is one of the best multi-purpose equipment for R&D labs or the QC department

Compressive Strength Test

The compressive strength test is used to measure how much pressure concrete can resist before it fails. A standard concrete cylinder or cube is prepared and cured for a specific time, usually 7 or 28 days. After curing, the sample is placed in a Compression Testing Machine (CTM), which applies load slowly until the concrete breaks. The highest load is divided by the area of the specimen to find the compressive strength. This test helps ensure the concrete is strong and safe for construction.



Figure 3.11: Place the cylinder in UTM Machine.

Compressive Fracture of Cylinder

Compressive fracture of a cylinder means the concrete cylinder breaks when too much load (pressure) is applied. In the test, the cylinder is kept in a machine that pushes from the top and bottom. As the load increases, small cracks appear. Finally, the cylinder breaks, usually with vertical or slanted cracks. This shows how much strength the concrete had before breaking.



Figure 3.12: Compressive fracture of Cylinder after 7 Days



Figure 3.13: Compressive fracture of Cylinder after 28 Days

Compressive Strength Formula

Compressive strength tells us how much pressure concrete can take before it fails or breaks. To find this strength, we perform a test on a concrete cylinder or cube in a laboratory. The concrete sample is placed in a machine that applies pressure slowly until the sample breaks. The highest load the sample can take before breaking is noted.

To calculate the compressive strength, we use this formula:

Compressive Strength (f^c) = Load at failure (in pounds) / Cross-sectional area (in square inches)

The result is measured in psi, which means pounds per square inch.

This value helps engineers decide if the concrete is strong enough for buildings, roads, or other structures. Strong concrete usually has higher psi, while weaker concrete has lower psi. Proper curing and good mix design help increase this strength.

The result is expressed in psi (pounds per square inch). This test helps to check if the concrete is strong enough for building purposes.

Summary

brocken pile head concrete methodology means using old or broken concrete to make new concrete. First, the waste concrete is collected from old buildings or roads. Then, it is crushed into small pieces using machines. These pieces are cleaned to remove dust, steel, or other materials. After cleaning, the recycled concrete is used instead of new stone (aggregate) in the concrete mix. This process helps reduce waste, save natural resources, and protect the environment. Recycled concrete is useful for making roads, pavements, and sometimes buildings.

CHAPTER 4
RESULT AND DISCUSSION

4.1 Introduction

With growing emphasis on sustainability in construction, the use of recycled concrete aggregate (RCA) as a substitute for natural aggregates has gained significant attention. This study focuses on evaluating the compressive strength of concrete using two types of coarse aggregates—recycled concrete and Indian Pakur stone in combination with two commonly used fine aggregates: local sand and Sylhet sand. By comparing these mix designs, the study aims to determine the structural viability of RCA and the influence of sand type on overall concrete performance. The findings contribute to the development of eco-friendly construction practices without compromising strength and durability standards.

4.2 Specific Aim for the Study

This study aims to compare the compressive strength of concrete using recycled concrete and Indian Pakur stone aggregates, combined with local and Sylhet sand, to evaluate the potential of recycled aggregates as a sustainable alternative in concrete production.

Table 4.1: Sieve Analysis of Local Sand

Sieve No.	Sieve Size (mm)	Material Retain (gm)	% Material Retain	Cumulative % Retain	Percent Finer
#4	4.75	0	0	0	100
#8	2.36	2	0.2	0.2	99.8
#16	1.18	5	0.5	0.7	99.3
#30	0.6	9	0.9	1.6	98.4
#50	0.3	653	65.3	66.9	33.1
#100	0.15	264	26.4	93.3	6.7
Pan	0.075	67	-	-	-
Total		1000		FM = 1.627	

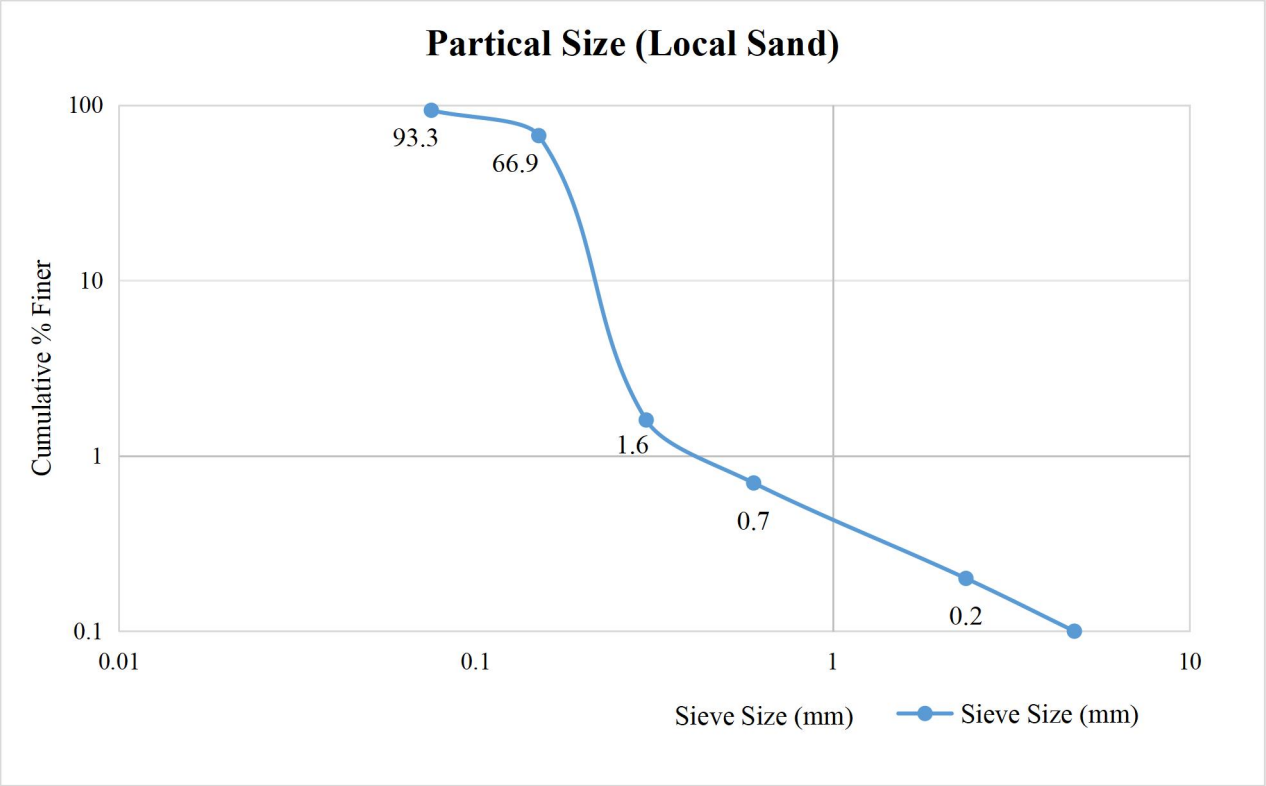


Figure 4.1: Sieve Analysis of Local Sand

Table 4.2: Sieve Analysis of Sylhet Sand

Sieve No.	Sieve Size (mm)	Material Retain (gm)	% Material Retained	Cumulative % Retain	Percent Finer
#4	4.75	12	1.2	1.2	98.8
#8	2.36	47	4.7	5.9	94.1
#16	1.18	124	12.4	18.3	81.7
#30	0.6	230	23	41.3	58.7
#50	0.3	437	43.7	85	15
#100	0.15	131	13.1	98.1	1.9
Pan	0.075	19	-	-	-
Total		1000		FM = 2.498	

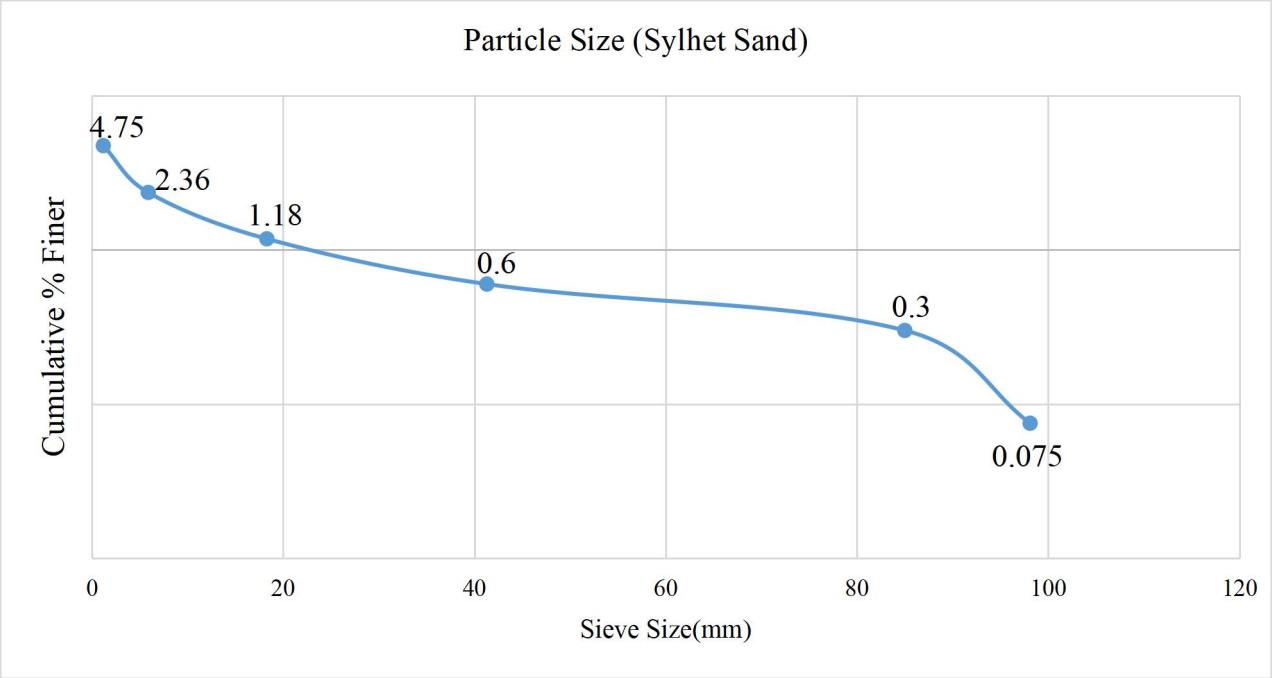


Figure 4.2: Sieve Analysis of Sylhet Sand

Table 4.3: Sieve Analysis of Broken Pile Head Concrete

Sieve No.	Material Retain (gm)	% Material Retain	Cumulative % Retain	Percent Finer
#3/4	197	19.7	19.7	80.3
#3/8	731	73.1	92.8	7.2
#4	72	7.2	100	0
#8	0	0	100	0
#16	0	0	100	0
#30	0	0	100	0
#50	0	0	100	0
#100	0	0	100	0
Total	1000		FM = 7.125	

Table 4.4: Sieve Analysis of Natural Coarse aggregate

Sieve No.	Material Retain (gm)	% Material Retain	Cumulative % Retain	Percent Finer
#3/4	307	20.47	20.47	79.53
#3/8	1136	75.73	96.2	3.8
#4	57	3.8	100	0
#8	0	0	100	0
#16	0	0	100	0
#30	0	0	100	0
#50	0	0	100	0
#100	0	0	100	0
Total	1500		FM = 7.1667	

Table 4.5: Unit Weight of Local Sand:

Condition	Weight of Bucket	Weight of Bucket & Materials	Weight of Materials	Volume of Bucket m^3	Unit Weight
Shoveling	4000	7387	3387	0.00278	1218
Roding	4000	7552	3552	0.00278	1277
Tiggling	4000	7800	3800	0.00278	1366
Average Unit Weight =					1287

Volume of Bucket = 0.00278 m^3

Table 4.6: Unit Weight of Sylhet Sand

Condition	Weight of Bucket	Weight of Bucket & Materials	Weight of Materials	Volume of Bucket m^3	Unit Weight
Shoveling	4000	7293	3293	0.00278	1184
Roding	4000	7487	3487	0.00278	1254
Tiggling	4000	7689	3698	0.00278	1330
Average Unit Weight =					1256

Volume of Bucket = 0.00278 m^3

Table 4.7: Unit Weight of Broken Pile Head Concrete

Condition	Weight of Bucket	Weight of Bucket & Materials	Weight of Materials	Volume of Bucket m^3	Unit Weight
Shoveling	4000	7708	3708	0.00278	1334
Roding	4000	7985	3985	0.00278	1433
Tiggling	4000	8317	4317	0.00278	1552
Average Unit Weight =					1439

Volume of Bucket = 0.00278 m^3

Table 4.8: Unit Weight of Natural Coarse Aggregates

Condition	Weight of Bucket	Weight of Bucket & Materials	Weight of Materials	Volume of Bucket m^3	Unit Weight
Shoveling	4000	7809	3809	0.00278	1370
Roding	4000	8316	4316	0.00278	1552
Tiggling	4000	8587	4587	0.00278	1650
Average Unit Weight =					1524

Volume of Bucket = 0.00278 m^3

Table 4.9: Specific Gravity of Local Sand

Test	Formula	Calculation	Result
Apparent Specific Gravity	A/B+A-C	282/(654+282-832)	2.71
Bulk Specific Gravity S.S.D Basis	B/B+S-C	282/(654+300-831)	2.92
Bulk Specific Gravity Oven Dry Basis	(S-A/A) ×100	[(300-282)/(2450-1490)] ×100	6.38
Absorption Capacity D%	S/B+S-C	300/(654+300-831)	2.43

Table 4.10: Specific Gravity of Sylhet Sand

Test	Formula	Calculation	Result
Apparent Specific Gravity	A/(B+A-C)	290/653+290-833	2.63
Bulk Specific Gravity S.S.D Basis	S/(B+S-C)	(300/653+300-833)	2.50
Bulk Specific Gravity Oven Dry Basis	A/(B+S-C)	290/653+300-833	2.42
Absorption Capacity D%	(S-A/A) ×100	(300-290/290) ×100	3.44

Table 4.11: Specific Gravity of Broken Pile Head Concrete(Recycled Concrete)

Test	**Formula**	**Calculation**	**Result**
Apparent Specific Gravity	A/(A-C)	1676/(1676-912)	2.19
Bulk Specific Gravity S.S.D Basis	B/(B-C)	1783/(1783-912)	2.04
Bulk Specific Gravity Oven Dry Basis	A/(B-C)	1676/(1783-912)	1.92
Absorption Capacity D%	[(B-A) ×100]/A	[(1783-1676)/1676] ×100	6.38

Table 4.12: Specific Gravity of Natural Coarse Aggregate

Test	Formula	Calculation	Result
Apparent Specific Gravity	A/(A-C)	2388/2388-1490	2.65
Bulk Specific Gravity S.S.D Basis	B/(B-C)	2450/2450-1490	2.55
Bulk Specific Gravity Oven Dry Basis	A/(B-C)	2388/2450-1490	2.49
Absorption Capacity D%	(B-A/A) ×100	(2450-2388/2388) ×100	2.60

Table 4.13: Compressive strength Test after 7 days

SL. No.	Coarse Agregate	Mix properties	Sand Item	Water Cement Ratio	Compressive Strength (Psi)	Average Strength (PsiI)	Average Strength (Mpa)
01	Natural Coarse Aggregate	1:1.5:3	Sylhet Sand	0.45	2192	2133	14.70
					1993		
					2214		
		1:1.5:3	Local Sand	0.45	1758	1847	12.73
					1790		
					1993		
02	Brocken pile head concrete	1:1.5:3	Sylhet Sand	0.45	1784	1764	12.16
					1820		
					1689		
		1:1.5:3	Local Sand	0.45	1783	1692	11.66
					1610		
					1684		

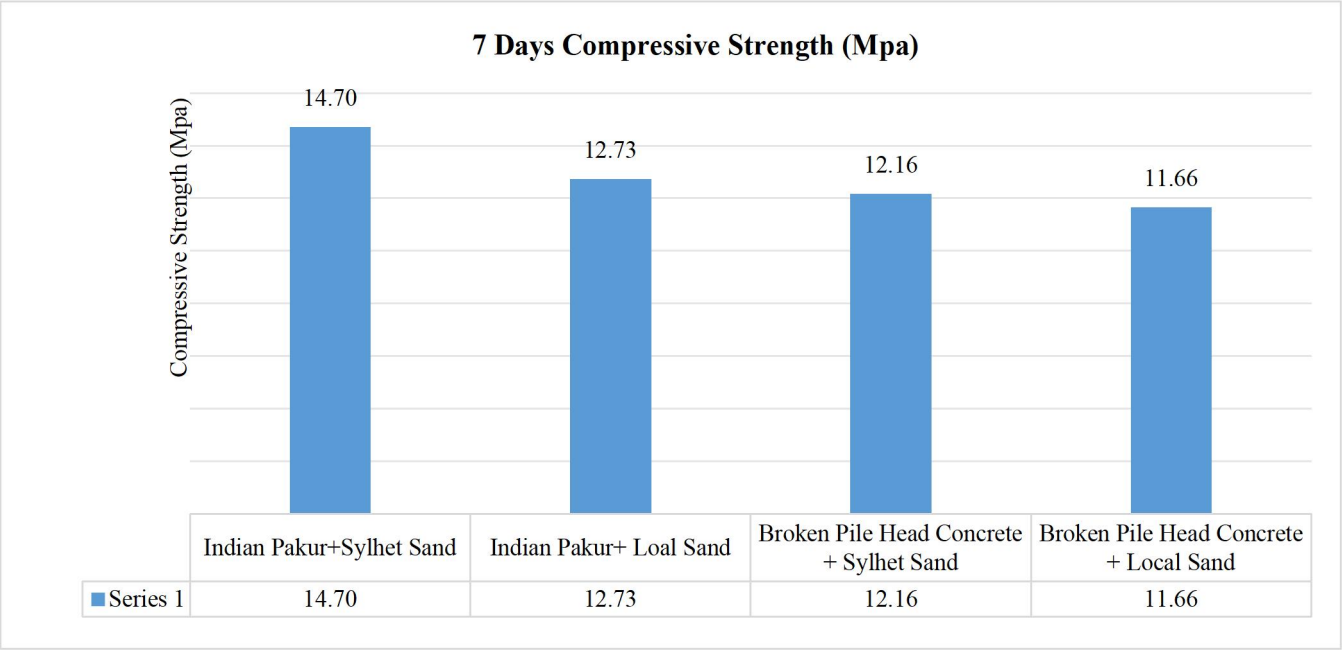


Figure 4.3: Compressive Strength Test after 7 Days.

Table 4.14: Compressive Strength Test after 28 days

SL. No.	Coarse Agregate	Mix properties	Sand Item	Water Cement Ratio	Compressive Strength (Psi)	Average Strength (Psi)	Average Strength (Mpa)
01	Natural Coarse Aggregate	1:1.5:3	Sylhet Sand	0.45	2167	2840	19.58
					3119		
					3233		
		1:1.5:3	Local Sand	0.45	2620	2614	18.00
					2512		
					2710		
02	Brocken pile head concrete (Broken Pile Head Concrete)	1:1.5:3	Sylhet Sand	0.45	2480	2400	16.54
					2320		
					2400		
		1:1.5:3	Local Sand	0.45	2240	2201	15.71
					2153		
					2210		

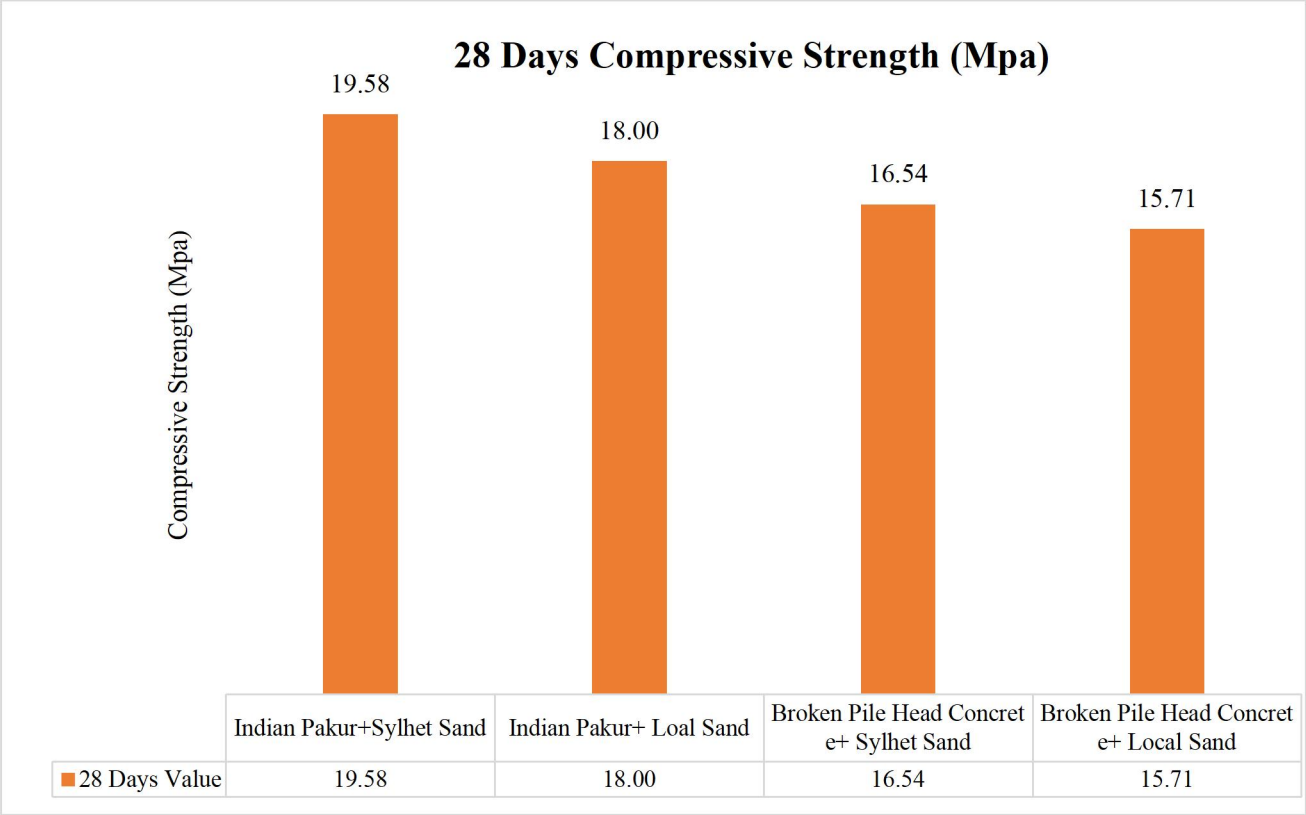


Figure 4.4: Compressive strength Test after 28 Days.

Table 4.15: Summary of the cylinder Test Result

Type of Stone	7 Days Test Result (Mpa)	28 Days Test Result (Mpa)
Sylhet Sand		
Natural Coarse Aggregate	14.70	19.58
Brocken Pile Head Concrete	12.16	16.54
Local Sand		
Natural Coarse Aggregate	12.73	18.00
Brocken Pile Head Concrete	11.66	15.71

With Sylhet sand than Natural Coarse Aggregate. At 28 days, Natural Coarse Aggregate with Sylhet sand reached 19.58MPa, while Broken Pile Head concrete with sylhet sand reached only 15.71MPa. The test results show that Broken Pile Head Concrete (Recycle Concrete) performed better. For With Sylhet sand than Natural Coarse Aggregate. At 28 days, Natural Coarse Aggregate with Sylhet sand reached 19.58MPa, while Broken Pile Head concrete with sylhet sand reached only 15.71MPa. The test results show that Broken Pile Head Concrete (Recycle Concrete) performed better. For Natural Coarse Aggregate with local Sand, the compressive strength is 19.58Mpa. For recycle concrete the compressive strength is very close to the highest value. This suggests that recycled concrete can be a strong and reliable alternative to natural stone. with local Sand, the compressive strength is 19.58Mpa.

For recycle concrete the compressive strength is very close to the highest value. This suggests that recycled concrete can be a strong and reliable alternative to natural stone.

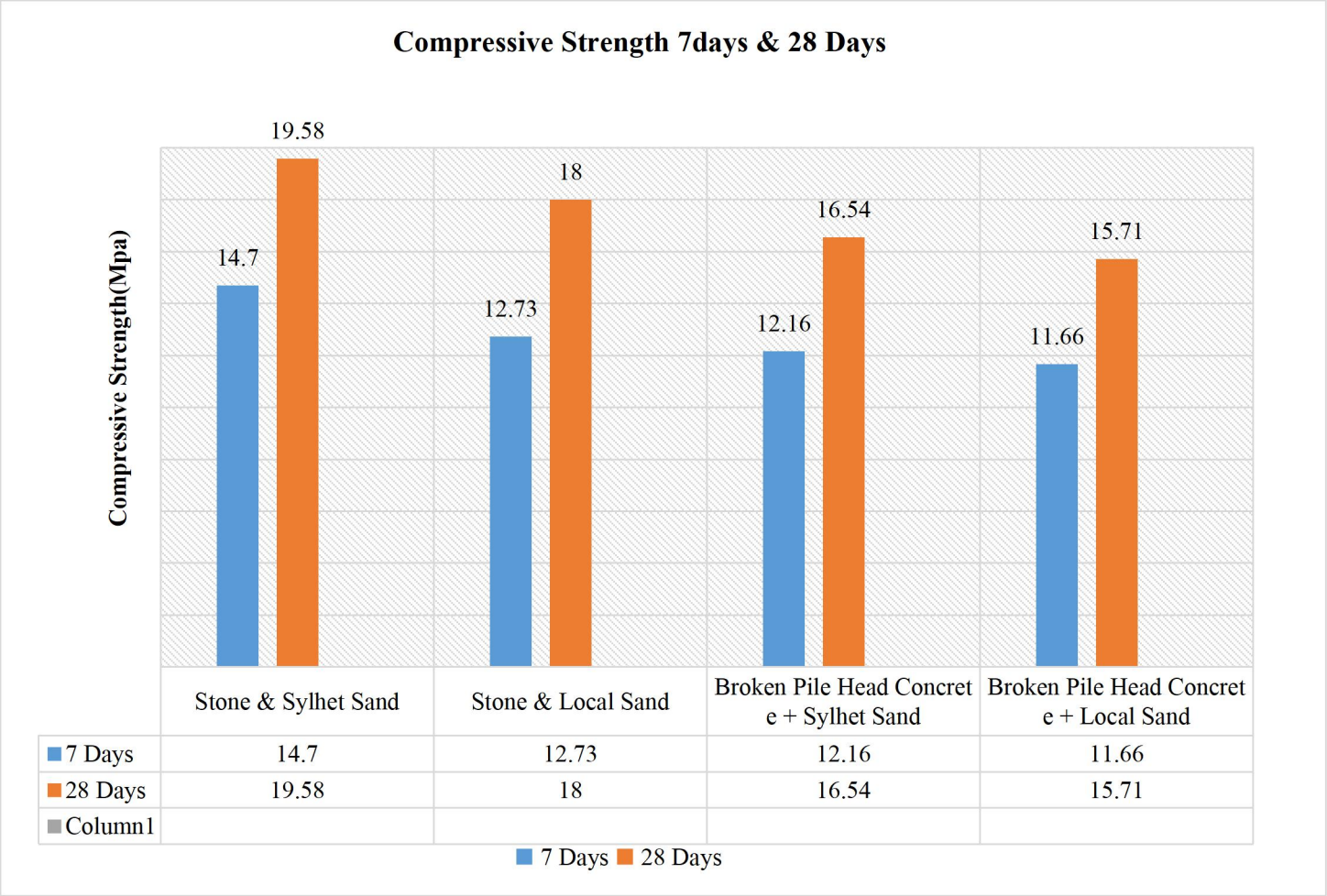


Figure 4.5: Compressive strength after 7 & 28 days.

4.3 Summary

This research investigates the compressive strength of concrete incorporating Broken Pile Head Concrete and Indian Pakur stone as coarse aggregates, combined with local and Sylhet sand as fine aggregates. The study aims to assess the impact of these aggregate combinations on concrete strength, focusing on the potential of RCA to replace natural aggregates, promoting sustainability in construction while maintaining structural integrity.

CHAPTER 5
CONCLUSION AND RECOMMENDATION

5.1 **Conclusion**

This study investigated the compressive strength performance of concrete made using recycled concrete aggregates sourced from broken pile head concrete, in comparison with conventional natural coarse aggregates. Two types of fine aggregates Sylhet sand and local sand were used to observe their influence on strength development over time. Conclusions: The main findings of the study are mentioned below -

1) At 7 days, the Indian pakur stone (natural aggregate) with Sylhet sand achieved the highest early strength (14.70 Mpa). Other hand, followed by broken pile head concrete (recycled aggregate) with sylhet (12.16 Mpa), Indian pakur stone (Natural Coarse Aggregate) with Local sand (12.73 Mpa), and broken pile head concrete (recycled aggregate) with Local sand (11.66 Mpa).

2) Indian Pakur and sylhet sand (Natural Coarse Aggregate) reached 19.58Mpa, while Broken Pile Head Concrete with Local sand remained at 15.71Mpa.

3) It is observed from the 7 days & 28 days result, local sand perform better than sylhet sand. On other hand the performance the recycled aggregate is quite similar to that of natural aggregate. It is advised to utilize recycled aggregate in construction projects since its performance is quite comparable to that of natural aggregate.

4) These results indicate that with proper fine aggregate selection, recycled aggregates can match or even outperform conventional mixes in long-term strength.

In conclusion, recycled concrete aggregate from broken pile heads has proven to be a viable alternative to natural aggregate in concrete production. When combined with suitable fine aggregates, especially local sand, it can produce concrete with sufficient strength for

structural use. This approach not only addresses the issue of construction waste management but also promotes sustainable practices by reducing the demand for natural resources, lowering costs, and minimizing environmental impact.

This investigation yielded the following key findings

1) Recycled aggregates can be successfully used with various types of sand and stone to produce with acceptable strength and durability.

2) The mechanical properties of recycled aggregate concrete vary depending on the type and proportion of sand and stone used.

3) Local sand showed better performance in compressive strength when combined with recycled coarse aggregate, compared to Sylhet sand.

4) High-temperature behavior and shrinkage resistance were influenced by the type of fine aggregate used.

5) The combination of recycled aggregate with selected fine aggregates showed potential for use in low to medium strength concrete applications.

5.2 Limitations

- Lack of advanced laboratory testing equipment.
- Due to the limitation of the cylinder, we could not do the 14-days & 21-days test.
- Limited availability of high-quality recycled aggregates.
- Inconsistent quality of local sands and stones.
- Lack of skilled technicians for accurate mix preparation and testing.
- Limited temperature range during durability testing.

5.3 Recommendations for Future Works

- Future studies should explore the use of different sands (e.g., M-sand, river sand, desert sand) in combination with recycled aggregates to identify the most suitable pairing.
- Investigations should focus on optimizing the mix design for structural-grade applications.
- Durability studies should be conducted in extreme weather conditions to simulate real-life scenarios.
- More advanced testing equipment and techniques should be used to achieve precise results.
- Alternative sustainable materials, such as industrial by-products or go-polymers, can be explored in combination with recycled aggregate for eco-friendly construction.

REFERENCES

[1] Tam, V.W.Y., Tam, C.M., & Wang, Y. (2007). Optimization on proportion for recycled aggregate in concrete using two-stage mixing approach. Construction and Building Materials, 21(10), 1928–1939.DOI: 10.1016/j.conbuildmat.2006.05.040.

[2] Rao, A., Jha, K. N., & Misra, S. (2007). Use of aggregates from recycled construction and demolition waste in concrete. Resources, Conservation and Recycling, 50(1), 71–81. https://doi.org/10.1016/j.resconrec.2006.05.010.

[3] Mindess, S., Young, J. F., & Darwin, D. (2003). Concrete (2nd Edition). Prentice Hall.

[4] Neville, A. M. (2012). Properties of Concrete (5th Edition). Pearson Education.

[5] IS 516:1959 – Method of Tests for Strength of Concrete, Bureau of Indian Standards (BIS), New Delhi.

[6] Limbachiya, M. C., Leelawat, T., & Dhir, R. K. (2000). Use of recycled concrete aggregate in high-strength concrete. Materials and Structures, 33, 574–580. https://doi.org/10.1007/BF02480538.

[7] Katz, A. (2003). Properties of concrete made with recycled aggregate from partially hydrated old concrete. Cement and Concrete Research, 33(5), 703–711. https://doi.org/10.1016/S0008-8846(02)01029-4.

[8] IS 383:2016. Indian Standard: Coarse and Fine Aggregate for Concrete – Specification (Third Revision). Bureau of Indian Standards, New Delhi.

[9] Padmini, A. K., Ramamurthy, K., & Mathews, M. S. (2009). Influence of parent concrete on the properties of recycled aggregate concrete. Construction and Building Materials, 23(2), 829–836. https://doi.org/10.1016/j.conbuildmat.2008.03.006.

[10] Tavakoli, M., & Soroushian, P. (1996). Strengths of recycled aggregate concrete made using field-demolished concrete as aggregate. ACI Materials Journal, 93(2), 182–190.

[11] Poon, C.S., et al. (2004). Use of recycled aggregates in concrete. Resources, Conservation and Recycling, 42(3), 273–283.