

Performance of Concrete Incorporating Demolition Concrete as Partial Replacement of Coarse Aggregate

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A thesis submitted in partial fulfillment of the requirement for the degree of

Bachelor of Science in Civil Engineering



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July 2025

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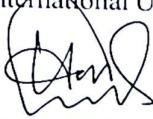
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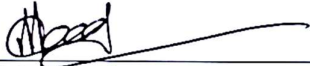
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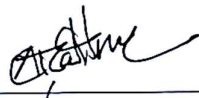
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DECLARATION

First and foremost, we thank Allah for providing us with a healthy body and a clear mind so that we can effectively perform our mission.

For his leadership and direction during the thesis time, we are extremely appreciative of our esteemed supervisor, Mr. Md. Masud Rana, Lecturer, Department of Civil Engineering, Faculty of Engineering, Daffodil International University. This endeavor was made possible by his unwavering patience, intellectual guidance, unrelenting support, active supervision, constructive criticism, useful advice, and reviewing numerous subpar papers and improving them on all fronts.

Lastly, we want to express our gratitude to our devoted parents and friends for their assistance, courage, and moral support during this study phase.

DEDICATION

This thesis is dedicated to our parents and our dear supervisor.

ACKNOWLEDGEMENT

We are grateful to Mr. Md. Masud Rana, who teaches in the Civil Engineering Department at Daffodil International University in Dhaka. This thesis was greatly aided by his extensive knowledge and intense interest in the subject of "Performance of Concrete Incorporating Demolition Coarse Aggregate as Partial Replacement of Coarse Aggregate." The successful completion of this task was mainly due to his undying patience, academic direction, continuous support, active direction, helpful critique, and insightful counsel, as well as his careful review and correction of many different editions.

In carrying out field work, competence and strong enthusiasm have proved valuable. We are incredibly appreciative of his continuous kindness, academic direction, unwavering support, enthusiastic and continuous supervision, helpful critique, insightful advice, and the innumerable hours he spent reading and revising multiple times throughout the process of learning. We were able to effectively finish this work because of his persistent support.

We sincerely thank our parents, whose strong patience and persistent support have been crucial to our success. Throughout this journey, we have been energized by their love, support, and faith in us. We really appreciate the sacrifices they made and the ideals that they have ingrained inside us.

Additionally, we would like to express our sincere gratitude to Dr. Mohammad Hannan Mahmud Khan, Head of the Department of Civil Engineering and Assistant Professor, for his helpful support in seeing our project through to completion. We would like to thank all of the faculty and staff of Daffodil International University's Civil Engineering department for their encouragement and support.

ABSTRACT

Currently, the entire world is working together to achieve the Sustainable Development Goals (SDGs) by 2030, and Demolition Coarse Aggregates (DCA) are a key component of this goal. The removal of coarse aggregates from remaining concrete is a major waste management problem and impacts the environment. Our research focus calls for promoting its reuse using the 5R strategy (Refuse, Reduce, Reuse, Recycle, and Rethink). In this study, 20 flexural beams and 60 cylindrical specimens were tested. The water-cement ratio in the concrete mix design was 0.54, and the proportions were 1:2.24:2.57 (M30 grade). The coarse aggregate was partially replaced with demolition coarse aggregates at percentages of 0%, 50%, and 100%. For the purposes of testing, all samples were cured for 14 and 28 days, ensuring reliable outcomes. For the purposes of this study, the unit weight, flexural tensile strength, split tensile strength, and compressive strength were determined. We additionally inquired into using a water-reducing admixture to improve the concrete's tensile and compressive strength as reformed with demolition coarse particles. As to our study results, adding admixture to normal concrete improved its compressive strength, split tensile strength, and flexural tensile strength. In addition, the addition of appropriate admixtures significantly improved the tested strength properties of concrete, while the use of demolition coarse aggregates decreased all of them for all percentages of aggregate replacement. Therefore, adding demolition coarse aggregates to concrete mixes as an admixture could offer a practical solution to manage waste sustainably and improve material performance.

Keywords: Demolition Coarse Aggregate, Compressive Strength, Tensile Strength, Flexural Strength, Admixture, Water-Cement Ratio, Waste Management.

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CHAPTER 1

INTRODUCTION

1.1 General

The global production of solid waste is increasing at an alarming rate. Globally, more than 1.3 billion tons of solid waste are produced annually, and by 2025, it is expected that the number would increase to 2.2 billion tons (Burke et al., 2012). In terms of both volume and weight, the construction sector is one of the sectors that produces an important amount of waste globally (Rodríguez et al., 2016). Solid materials comprise 40–85% of the varied mixture of components that comprise demolition coarse aggregates (DCA) (Mália et al., 2013). Concrete waste makes up the largest portion of inter materials, despite the fact that the building industry generates a lot of waste. However, growing interest has been made in the possibility of recycling DCA produced by various methods to make construction materials.

Because of poor waste management and construction methods, in developing countries the construction sector generates a large amount of waste. The growing construction sector generated by fast development, industrialization, and economic growth would cause these countries' DCA to increase significantly. In addition, as part of the construction process, old construction that does not meet current structural or functional standards is being removed, which increases the amount of DCA produced and compounds the capacity restrictions already existent in waste management. The majority of DCA is being wasted in landfills in the majority of developing countries, it impacts the environment, society, and economy (Nagapan et al., 2012).

In 2019, the worldwide aggregates market was estimated to be worth USD 463.3 billion. From 2020 to 2027, it will continue to grow at a 3.3% compound annual growth rate (CAGR) (Analysis-aggregates-Market.,n.d.). Because of their fast industrialization and urbanization, developing nations are responsible for a sizable amount of this demand. We can greatly reduce waste disposal and carry and conserve natural resources by using recycled aggregates from concrete waste for new construction. This has both economic and environmental benefits. In less developed nations, demolition coarse aggregates were

utilized to stabilize the base coarse aggregate of road constructions in place of natural coarse aggregates, protecting the natural reserve for future generations.

Recycled aggregates used from DCA in concrete significantly improve its environmental impact; however, in many developing nations, DCA is still not widely utilized in construction. The main reason for this is a lack of confidence or information about the process of recycling concrete waste into fresh concrete or other building materials.

One of the developing countries in Africa where DCA recycling is not practiced is Ethiopia (Nigussie, 2019). Recently, the country has experienced a rapid growth in the economy, primarily attributed to the construction boom. The demand for natural aggregates is rising as a result of the building industry's outstanding achievement. Additionally, because DCA is often disposed of in landfills, it generates a significant volume of DCA, which results in a shortage of land for infrastructure development. The identified issues will worsen and lead to social, environmental, and economic crises if proper and prompt solutions are not made. Therefore, it is imperative that DCA's viability for usage in the production of concrete or materials for construction in Ethiopia be investigated right away.

Studying the possibilities for recycling concrete waste into fresh concrete is the main goal of this work. Along with that, to determine DCA suitability for producing fresh concrete by defining its mechanical and physical characteristics and the performance of concrete specimens using DCA mainly in terms of permeability, strength, and workability.

This paper is structured as follows. There is discussion of the most current developments in recycling concrete waste to generate new concrete and construction materials. The significance of investigating at how DCA could possibly be applied in developing countries to promote sustainability in construction sectors is also covered.

1.2 Project objective

Evaluating the overall performance of concrete that incorporates demolition coarse aggregate in Bangladesh is the main goal of this study. The following goals have been set in addition to this main objective:

- a) To determine the concrete's compressive strength while using demolition concrete as a coarse aggregate.

- b) To determine the concrete's splitting tensile strength when demolition concrete is used as coarse aggregate.
- c) To determine the concrete's flexure tensile strength when demolition concrete is used as coarse aggregate.

CHAPTER 2

LITERATURE REVIEW

2.1 General

To ensure mixing concrete in a good ratio these days, raw ingredients are important. Good raw resources such coarse aggregate, sand cement, and water are needed to mix concrete in a sustainable way. All nations produce a significant amount of waste each year, but demolition coarse aggregate accounts for the largest portion of waste globally, at around 30% (Ferriz-Papi et al., 2022). We can utilize coarse aggregate in demolition coarse aggregate.

Recently, there has been a lot of discussion in using demolition concrete (also known as demolition coarse aggregate, or DCA) rather than some or all of the natural coarse ingredients of mix concrete. The need for green construction methods, minimizing the impact on environment, and slowing the depletion about natural resources are among the primary factors of this tendency. A complete research analysis on demolition concrete can be provided here.

2.1.1 Introduction to Demolition Concrete

Definition and Source: Concrete waste from demolished buildings, roads, and other structures are reused to produce demolition concrete, commonly referred to as demolition coarse aggregate (DCA). In order to generate aggregates that may be utilized in fresh concrete mixtures, it is usually crushed and processed.

Importance in Sustainability: Construction demolition waste is a green replacement for natural aggregates since it reduces landfill waste and the need for fresh aggregates.

2.1.2 Economic Implications

Cost-Effectiveness: Particularly when the demolition concrete arrives locally, the cost of construction demolition waste is typically less than that of natural aggregates. For building projects, this may lead to cost savings.

Quality Control: The differences in DCA quality can be significant. Deconstruction waste must be sorted, cleaned, and processed; this can raise expenses, particularly if the recycled aggregates are of low quality.

2.2 Concrete

Concrete is made by combining cement, water, fine and coarse aggregates. The Nabataea, which includes modern-day Syria and Jordan, used a forerunner to concrete at least 6500 BC to construct buildings that still stand today (Nick Gromicko, 2020). The concrete used for the floor was made by combining quicklime, which was made by burning limestone, with water and stone, and then it hardened. The Romans were the first to use concrete extensively, even though they weren't the first to manufacture it. The Romans were able to successfully use concrete in most of their structures by 200 BC (Scientific, 2022). To create the combination, they combined lime, seawater, and volcanic ash. The use of concrete is increasing daily these days. Parker's cement was first widely used as mortar for the 1,300-foot-long brick tunnel beneath the Thames River, which was the first tunnel beneath a navigable river (Wikipedia, 2025).

2.3 Properties of Concrete

Concrete frequently contains a substance whose compressive strength is greater than its tensile strength. Concrete's flexibility property is mainly sustained at lower stress levels. Concrete's low coefficient of thermal expansion causes it to decrease with time. Both split tensile and compression tests are crucial concrete parameters because they can be used to inform contemporary concrete structure designs (Mohammed et al., 2021). Concrete becomes stronger over time. Regular cement concrete can enhance its strength by more than 75 to 80 percent in just 28 days and by more than 90 to 95 percent over a year (Islam, 2010). It is often desirable to assess a concrete's compatibility even before the 28-day test results are revealed. Since concrete is the most often used construction material in the world, demolition coarse aggregates are rather prevalent (Trivedi et al., 2024).

2.4. Construction Waste in Bangladesh

Over the past several years, Bangladesh has seen a remarkable rise in development and urbanization. In the country's urban population, 30% stay in the Dhaka city (Hossain et al,

2024). The requirement for housing facilities to fulfill the demands of this massive inflow of people has led to a rapid growth of the construction sector in and around Dhaka. Waste generation is only one of the many negative impacts this increasing construction has on society and the environment. Using environmentally responsible and competitive construction methods is essential to a country's balanced growth. Therefore, managing construction waste properly continues to be an important issue. Construction and demolition wastes generate a significant amount of the waste stream that is disposed of in the city's landfills. According to estimates, the construction industry in Bangladesh generates a large amount of waste, with some reports suggesting that demolition coarse aggregate (DCA) can account for around 30% to 40% of all solid waste in urban areas. Most of the time, building waste management procedures are terrible. In order to implement different management methods, it is essential to think about working quickly.

2.5. Demolition Coarse Aggregate

The coarse aggregate was combined with these residual demolitions. Moreover, when coarse aggregates are substituted in a mixture. In the concrete mix, demolitions substitute a specific percentage of the coarse aggregate, such as 50%, 100%, etc. Fresh concrete's workability is assessed using the slump cone test. Additionally, casting cylinders are used to conduct compressive strength tests for 14 and 28-day curing times in order to examine the strength difference brought about by different percentages of this waste material (Daniel Yaw Osei et al., 2020). Finding out more about the performance and behavior of demolition coarse aggregate is the aim of this study. In this study, coarse aggregate is replaced by 0%, 50%, and 100% of demolition coarse aggregate, respectively with admixture and without admixture.

2.6. Compressive Strength Testing

Concrete's compressive test determines its strength or capacity. Compression testing is a popular testing method for determining a material's compressive strength or crush resistance as well as its capacity to recover when a specific compressive force is applied and sustained for a specific amount of energy. According to Test Method AS1012.9, the compression test was conducted (Sankaranarayanan et al., 2021). To comprehend how

strength behaves and how the concrete can sustain loads or prevent breaking, compressive strength is necessary.

2.7. Tensile Strength Testing

Concrete's tensile strength is one of its fundamental and significant characteristics that significantly influences the rate and the amount of structural cracking. Tensile strength is a destructive mechanical test that measures the amount of force a material can bear before breaking when extended or pulled. So, concrete develops cracks when tensile forces exceed its tensile strength. As a result, when tensile stresses exceed the concrete's tensile strength, cracks result. In addition, a method used to determine the tensile strength of concrete is the splitting tensile strength test on a concrete cylinder.(Mohamed et al., 2016).

2.8. Flexural Strength Testing

The maximum stress a material can sustain before cracking is known as its flexural strength, and it describes its capacity to withstand bending when an external force is applied. A specimen with a flat or rectangular cross-section is set up on two parallel supporting pins for this test. Using a loading pin, the loading force is applied at the center (Ahmed et al., 2016).

CHAPTER 3

METHODOLOGY

3.1. Introduction

Fine and coarse aggregates, cement, water, demolition concrete, and chemicals were all obtained locally for this study. River sand and Portland composite cement (PCC) were used in compliance with British Standard Code BS 12 (Gunathunga et al., 2023). Determining the characteristics of demolition coarse aggregate and confirming that they fall within the range of aggregate properties are crucial (Waste et al., 2020).

3.2 Collection of Raw Materials

3.2.1 Portland Composite Cement (PCC)

In this experiment, Portland composite cement is utilized. We purchased portland composite cement from the Ashulia Bazar. The characteristics of this cement are described.



Figure 3.1 Portland Composite Cement (PCC)

Table 3.1 Properties of cement

Properties	Average value of PCC from experiment
Normal consistency	27%
Initial setting time (min)	135
Final setting time (min)	290

3.2.2 Normal consistency test

The usual consistency is cement paste, allowing the 10 mm diameter needle of the Vicat plunger to extend 5 to 7 mm from the bottom of the standard Vicat apparatus. Standard cement consistency is another name for normal cement consistency. Its typical value is between 25% and 30%.

3.2.3 Initial and final setting time

At this point in time, the cement totally hardens and loses its flexibility. The last setting time. The final setting time of cement is the amount of time it takes to reach its maximum strength. Ordinary Portland cement takes 600 minutes to set completely.

3.2.4 Admixture

Make concrete more workable so it's simpler to mix and finish without increasing water content. We purchased admixture from the Ashulia Bazar.



Figure 3.2 Admixture

3.2.5 Coarse Aggregate

Concrete mixing characteristics determine the size of the fine and coarse aggregates. Crushed stone as coarse aggregate could not be available everywhere. This has led many people to switch to utilizing gravel as coarse aggregate. We purchased coarse aggregate from the Ashulia Bazar. The aggregate properties are shown in Table 3.2.

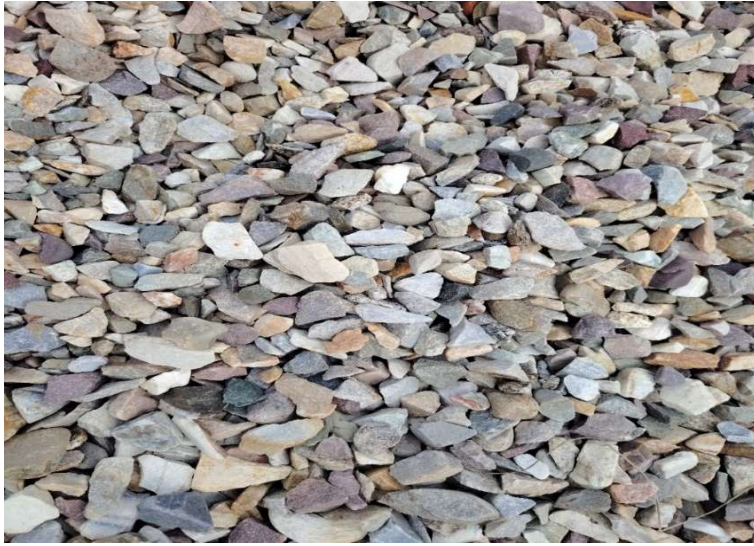


Figure 3.3 Coarse Aggregate

Table 3.2 Properties of Aggregate

Properties	Fine Aggregate	Coarse Aggregate	Demolition Aggregate
Fineness Modulus (FM) %	2.76	6.46	6.30
Specific gravity %	2.69	2.68	2.61
Moisture content %	0.89	0.50	1.73
Water absorption %	6.25	0.97	2.32
Unit Weight (kg/m ³)	1614.21	1512.69	1472.08

3.2.6 Water

The Civil Engineering lab's outside is where water is gathered. We look for dust and iron in the water. Concrete is produced from clean water.

3.2.7 Fine Aggregate

Concrete is a commonly utilized construction resource that is made up of water, cement, sand, and aggregates. One of the main ingredients in concrete is sand; without it, the concrete would not work properly. Sylhet sand gives higher compressive strength to concrete compared to other sands. We purchased coarse aggregate from the Ashulia Bazar.



Figure 3.4 Fine Aggregate

3.2.8 Demolition Coarse Aggregate

Demolition coarse aggregate is collected from Akran Bazar, Savar. We collect demolition coarse aggregate of our requirements and an ideal size, which we may easily utilize in concrete to replace coarse aggregate.



Figure 3.5 Demolition Coarse Aggregate

3.2.9 Procedure and casting the specimens

The lab for civil engineering at Daffodil International University served as the study's site. The purpose of this investigation is to ascertain the strength or capacity of a proportion of demolition coarse aggregate that has coarse aggregate substituted. To assess strength,

cylinders and beams must undergo split tensile and compressive tensile tests. Using grades of M30 plain cement concrete, for this experiment, 101.6 mm by 203.2 mm concrete cylinders were made. Every day, twelve cylinders and four beams each were created and tested after the concrete had cured for 14 days and 28 days. The beam and concrete cylinder were prepared using demolition coarse aggregate and admixture at different percentages.

60 molds are preparing for test Figure 3.6



Figure 3.6 Mold making

Mixing the concrete precisely and with great care. Since it is crucial to combine all of the materials (cement, water, demolition, fine, and coarse aggregate) to create pure concrete.

In Figure 3.7



Figure 3.7 Concrete mixing

Figure 3.8 shows our slump test results. While it evaluates the consistency of mixed concrete before it hardens and the slump test is important. It is used to determine if mixed concrete is workable and, as a result, that it can flow.



Figure 3.8 Slump Test

We filled the cylinder and beam one at a time after the concrete was ready. Three-layer tamping was used to fill the cylinder and beam. Then, to fill the cylinder, fill one third of it, tamp 25, and repeat the procedure. Following concrete filling of the mold, see Figure 3.9



Figure 3.9 Prepared of cylinder and beam.

The most important and crucial component of this research is curing. The mold needs to cure for 14 days and 28 days in order to reach its maximum strength.



Figure 3.10 Curing of cylinder and beam

We perform compressive and split tensile tests 14 and 28 days after curing (see Figures 3.11 and 3.12)



Figure 3.11 Compressive test

A beam of 152.4 mm in width, 152.4 mm in thickness, and 508 mm in length was made, together with cylinder molds measuring 101.6 mm in diameter and 203.2 mm in height. As previously shown, to make it easier to remove the cast cylinder and beam from the mold, crude oil was poured around the inside surfaces of the mold.



Figure 3.12 Spilt Tensile & Flexure test

A common technique for assessing the tensile strength of concrete is splitting tensile testing. The capacity of concrete to sustain cracking and splitting forces is determined by splitting tensile testing. Concrete's tensile qualities are important to determine its structural behavior, and splitting tensile testing provides useful information about these properties. Moreover, the results of tests can be applied to assess concrete's performance in concrete structures like beams, slabs or pavements to determine that it is acceptable for specific use.

When a material is put to bending stresses, its flexural qualities such as its stiffness and strength are evaluated using a 3-point flexural test, also called a 3-point flexural test (ASTM C78). Two supports are positioned with a certain distance between them to support the test specimen, which is usually a rectangular beam. Then a force must be applied to the center of the loading pin of the sample within the support.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

This chapter presents the results of the experiment and other tests and analyzes the different findings.

4.2 Result

4.2.1 Slump of Concrete:

Concrete slump changes after adding DCA and admixture. The concrete's slump when 0%, 50%, and 100% DCA are added is clearly visible; the proportions of water-cement ratio were 0.54 and 0.30 respectively. The slump values of the concrete increased when the water-cement ratio in the mixture was 0.54.

Note: (CS-Control Specimen), (50DCA- 50% of Demolition Coarse Aggregates), (100DCA- 100% of Demolition Coarse Aggregates), (50DCA(A)- 50% of Demolition Coarse Aggregates with Admixture), (100DCA(A)- 100% of Demolition Coarse Aggregates with Admixture)

Table 4.1 Slump flow examination and ratio with the activity of aggregate

Sl. No	Mix Combination	Slump Test (mm)
1.	CS	79
2.	50DCA	58
3.	100DCA	52
4.	50DCA(A)	73
5.	100DCA(A)	65

When we used chemicals while mixing concrete, the water cement ratio was 0.3, resulting in a decrease in the slump value. The super plasticizer was used at the rate of 1% per kg of cement.

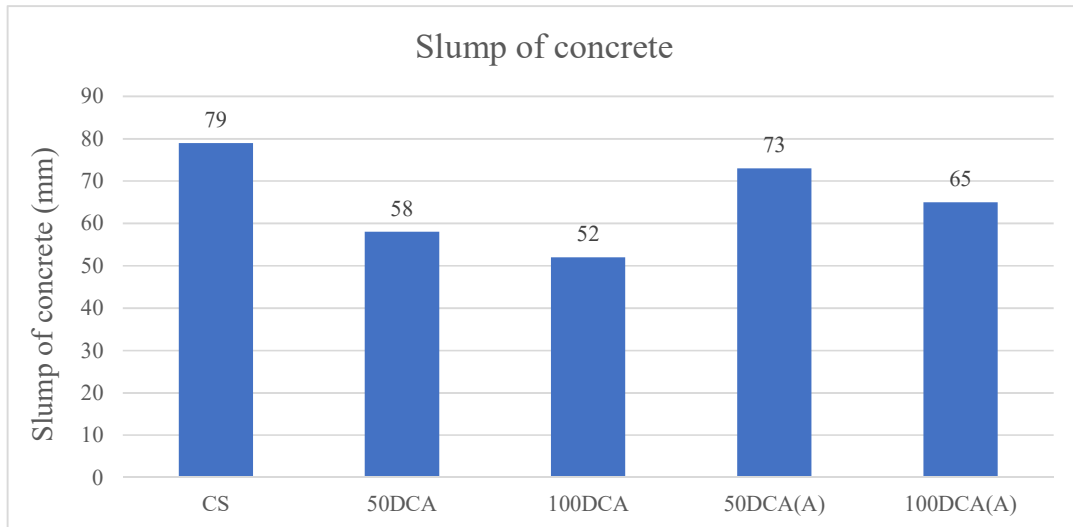


Figure 4.1 Slump flow examination and ratio with the activity of aggregate.

The mix's consistency in concrete, or its flexibility, is measured by slump, which can be utilized to measure the amount of water added to the mixture. It is extremely hard, dry, and challenging to work with low slump concrete. Concrete with a higher slump is more fluid and simpler to work with.

The amount of concrete that "slumps," or sinks, when taken out of an inverted 12-inch-tall cone is known as the slump value. The result may be close to zero, indicating that the concrete is very stiff and almost difficult, or it may be so highly wet and flow able that, when taken out of the cone, the concrete collapses completely. It can also serve as an indication that the mixture was not properly mixed. The purpose of the slump test is to ensure consistency with different concrete loads in the field.

The value of 50DCA(A) is smaller than CS, as stated in Table 4.2 then gradually lower by 50DCA, 100DCA(A) and 100DCA. Testing the mold revealed remarkable strength.

Table 4.2 Result of compressive strength (MPa) test for 14 days

SL. No.	Mix Combination	Compression load (KN)	Dia.(mm)	Compressive strength (MPa)	Average Compressive Strength (MPa)
1	CS	177	101.6	21.83	23.16
		190	100	24.19	
		185	100.2	23.46	
2	50DCA	160	100	20.37	21.36
		170	100	21.64	
		175	100.5	22.06	
3	100DCA	140	100.2	17.75	18.67
		147	100.5	18.53	
		155	100	19.73	
4	50DCA(A)	175	101.6	21.58	22.87
		190	100.5	23.95	
		182	100.2	23.08	
5	100DCA(A)	165	100	21.00	20.11
		160	101.6	19.73	
		154	100	19.60	

In Figure 4.2, the compressive strength 50DCA(A) value is close to CS. Then, progressively decreased by 50DCA, 100DCA(A) and 100DCA. It is found that the optimum value of compressive strength was attained for mix combination 50DCA(A) with demolition concrete aggregate.

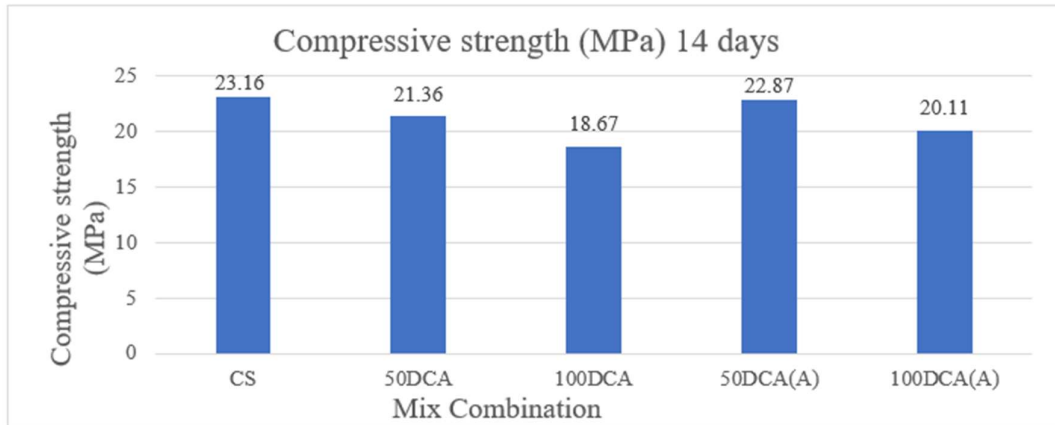


Figure 4.2: 14 days compressive strength (MPa).

The value of 50DCA(A) is smaller than CS, as stated in Table 4.3, then gradually lower by 50DCA, 100DCA(A), and 100DCA.

Table 4.3 Result of compressive strength (MPa) test for 28 days

SL. No.	Mix Combination	Compression load (KN)	Dia.(mm)	Compressive strength (MPa)	Average Compressive Strength (MPa)
1	CS	230	100.2	29.16	29.19
		225	100.5	28.36	
		236	100	30.04	
2	50DCA	210	101.6	25.90	26.42
		215	100	27.37	
		205	100.2	25.99	
3	100DCA	180	100	22.91	23.50
		185	100	23.55	
		191	100.5	24.07	
4	50DCA(A)	226	100	28.77	28.59
		230	100	29.28	
		220	100.5	27.73	
5	100DCA(A)	200	101.6	24.67	26.04
		215	100	27.37	
		205	100	26.10	

In Figure 4.3, the compressive strength 50DCA(A) value is close to CS. Then, progressively decreased by 50DCA, 100DCA(A) and 100DCA. It is found that the optimum value of compressive strength was attained for mix combination 50DCA(A) with demolition concrete aggregate.

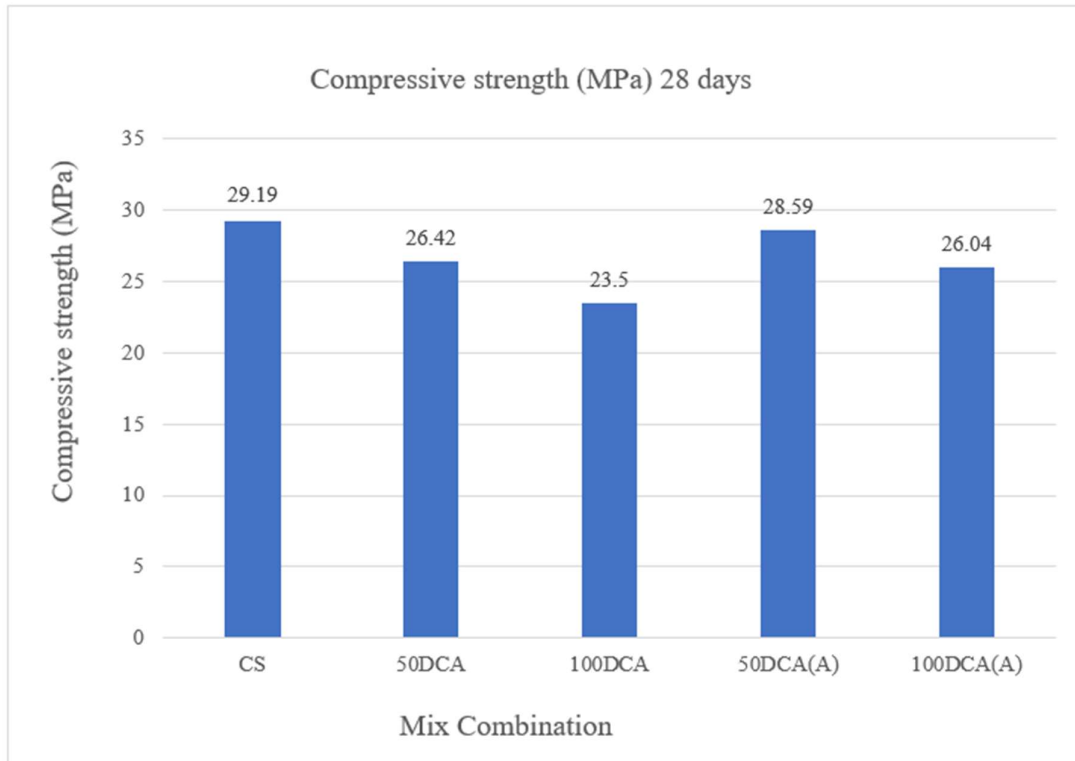


Figure 4.3: 28 days compressive strength (MPa).

Out of many tests applied to the concrete, this is the most important, which gives an idea about all the characteristics of concrete and the compressive strength of it. By this single test, one judges whether concreting has been done properly or not.

The water-cement ratio, cement strength, concrete material quality, quality control during production, and other factors all affect the concrete's compressive strength.

The test for compressive strength is carried out either on a cube or a cylinder. Various standard codes recommend a concrete cylinder or concrete cube as the standard specimen for the test.

Table 4.4 shows that the value of CS is greater than 50DCA(A), 50DCA, 100DCA(A), and 100DCA.

Table 4.4 Result of Spilt tensile (MPa) test for 14 days

SL. No.	Mix Combination	splitting load(KN)	Length (mm)	Dia. (mm)	Tensile strength (MPa)	Average Tensile strength (MPa)
1	CS	80	203.2	101.6	2.47	2.55
		75	203.2	100	2.35	
		90	202.5	100.2	2.82	
2	50DCA	60	203	100.2	1.87	1.70
		55	201	100.5	1.73	
		48	202.5	100	1.50	
3	100DCA	50	203	101.6	1.55	1.50
		55	203.2	100	1.72	
		40	202.5	100.5	1.25	
4	50DCA(A)	55	203.2	100	1.72	1.95
		65	203	101.6	2.00	
		60	203	100	2.12	
5	100DCA(A)	50	202.5	100.2	1.56	1.59
		48	203.2	100.5	1.49	
		55	203.2	100	1.72	

In Figure 4.4, the compressive strength 50DCA(A) value is close to CS. Then, progressively decreased by 50DCA, 100DCA(A) and 100DCA. It is found that the optimum value of tensile strength was attained for mix combination 50DCA(A) with demolition concrete aggregate.

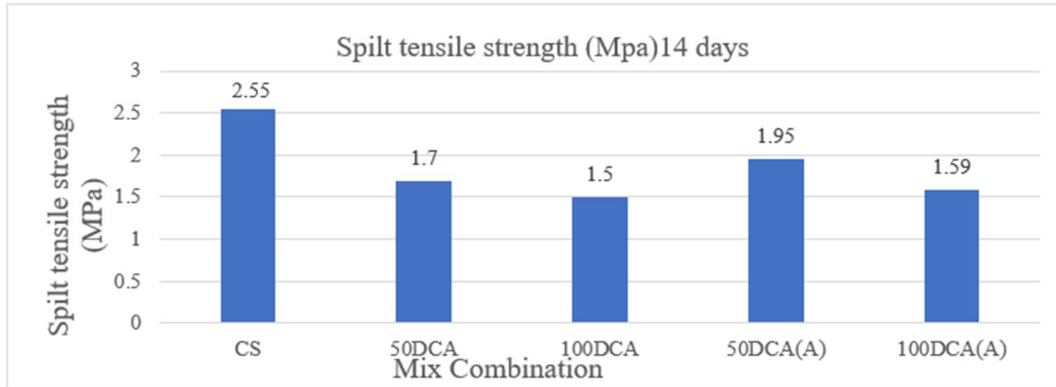


Figure 4.4: 14 days spilt tensile strength (MPa).

Table 4.5 shows that the CS value is greater than 50DCA(A), 50DCA, 100DCA(A), and 100DCA.

Table 4.5 Result of Spilt tensile (MPa) test for 28 days

SL. No.	Mix Combination	splitting load(KN)	Length (mm)	Dia. (mm)	Tensile strength (MPa)	Average Tensile strength (MPa)
1	CS	100	202.5	100	3.14	2.92
		95	203	100.2	2.97	
		85	203.2	100.2	2.65	
2	50DCA	75	202.5	100	2.35	2.08
		60	203.2	100.2	1.87	
		65	203.2	100.5	2.02	
3	100DCA	65	203.2	100	2.03	1.82
		50	202.5	100.2	1.56	
		60	203	100.2	1.87	
4	50DCA(A)	85	203.2	100.5	2.64	2.44
		70	202.5	100	2.20	
		80	201	101.6	2.49	
5	100DCA(A)	60	202.5	100.2	1.88	1.88
		55	203	100	1.72	
		65	201	100.2	2.05	

In Figure 4.5, the compressive strength 50DCA(A) value is close to CS. Then, progressively decreased by 50DCA, 100DCA(A) and 100DCA. It is found that the optimum value of tensile strength was attained for mix combination 50DCA(A) with demolition concrete aggregate.

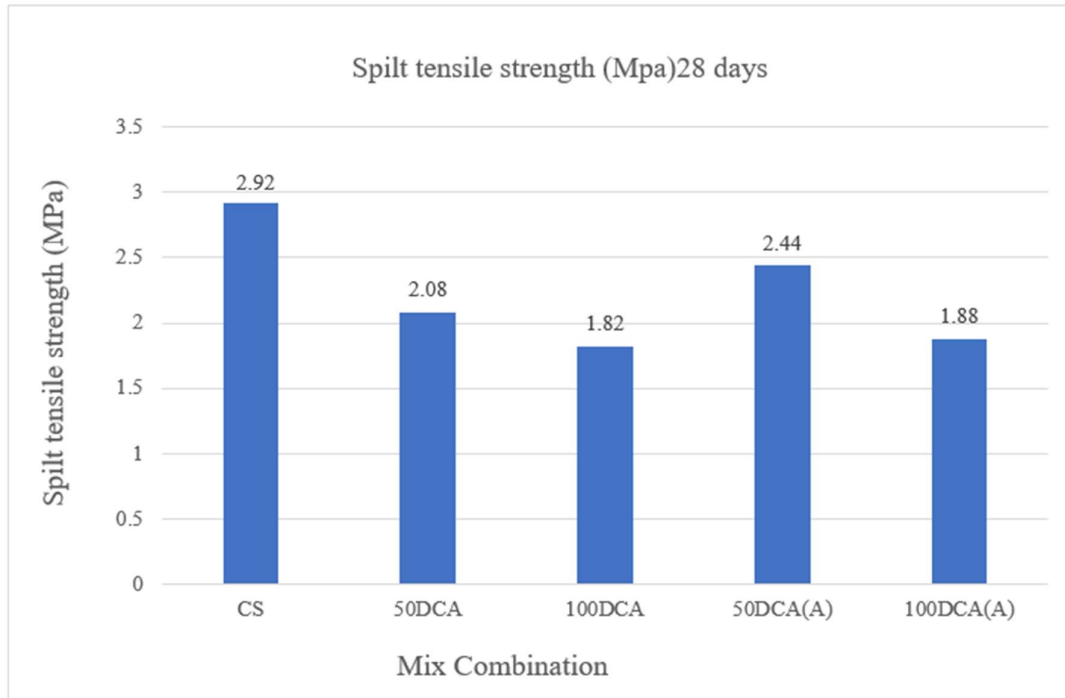


Figure 4.5: 28 days spilt tensile strength (MPa).

In Table 4.6, combine 14 days and 28 days to compare compressive strength.

SL No	Mix Combination	Compressive strength (MPa)	
		14 days	28 days
1	CS	23.16	29.19
2	50DCA	21.36	26.42
3	100DCA	18.67	23.50
4	50DCA(A)	22.87	28.59
5	100DCA(A)	20.11	26.04

Table 4.6 Result of compressive strength (MPa) combination.

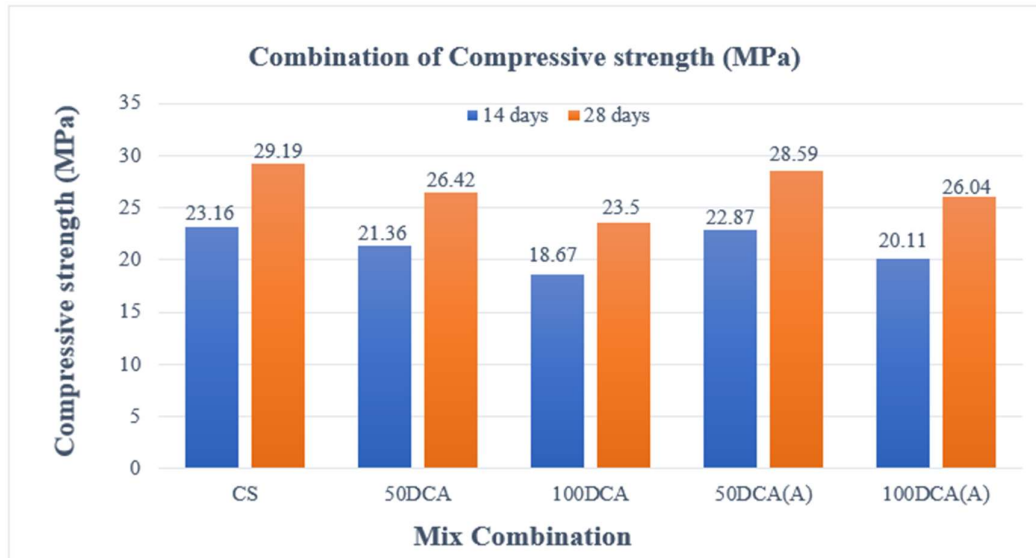


Figure 4.6 combination of compressive strength (MPa)

In this graph, it is indicated that at the end of 28 days, curing 50DCA(A) replacement of demolition aggregate has the maximum compressive strength of 28.59 (MPa).

In Table 4.7, combine 14 days and 28 days to compare split tensile strength.

Table 4.7 Result of split tensile strength (MPa) combination.

SL No	Mix Combination	Spilt tensile strength (MPa)	
		14 days	28 days
1	CS	2.55	2.92
2	50DCA	1.70	2.08
3	100DCA	1.50	1.82
4	50DCA(A)	1.95	2.44
5	100DCA(A)	1.59	1.88

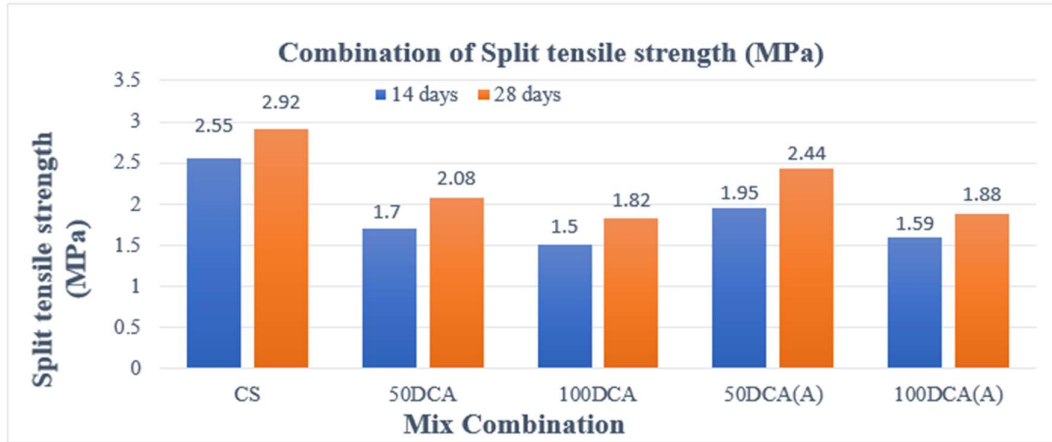


Figure 4.7 combination of split tensile strength (MPa)

In this graph, it is indicated that at the end of 28 days, curing 50DCA(A) replacement of demolition aggregate has the maximum split tensile strength of 2.44 (MPa).

Table 4.8 shows that the CS value is greater than 50DCA(A), 50DCA, 100DCA(A), and 100DCA.

Table 4.8 Result of flexural strength (MPa) for 14 days

SL. No	Mix Combination	Flexure load (KN)	Length (mm)	Width (mm)	Depth (mm)	Flexural strength (MPa)	Average flexural Strength (MPa)
1	CS	25	406.4	151.5	152.4	4.33	3.45
		15	406.4	152.4	152.4	2.58	
2	50DCA	16	406.4	151.5	152.4	2.77	3.11
		20	406.4	152	152.4	3.45	
3	100DCA	15	406.4	151	152.4	2.60	2.76
		17	406.4	152	152.4	2.93	
4	50DCA(A)	23	406.4	152.4	152.4	3.96	3.28
		15	406.4	151	152.4	2.60	
5	100DCA(A)	15	406.4	151	152.4	2.60	3.03
		20	406.4	151.5	152.4	3.46	

In Figure 4.8, the flexure strength 50DCA(A) value is close to CS. Then, progressively decreased by 50DCA, 100DCA(A) and 100DCA. It is found that the optimum value of flexure strength was attained for mix combination 50DCA(A) with demolition concrete aggregate.

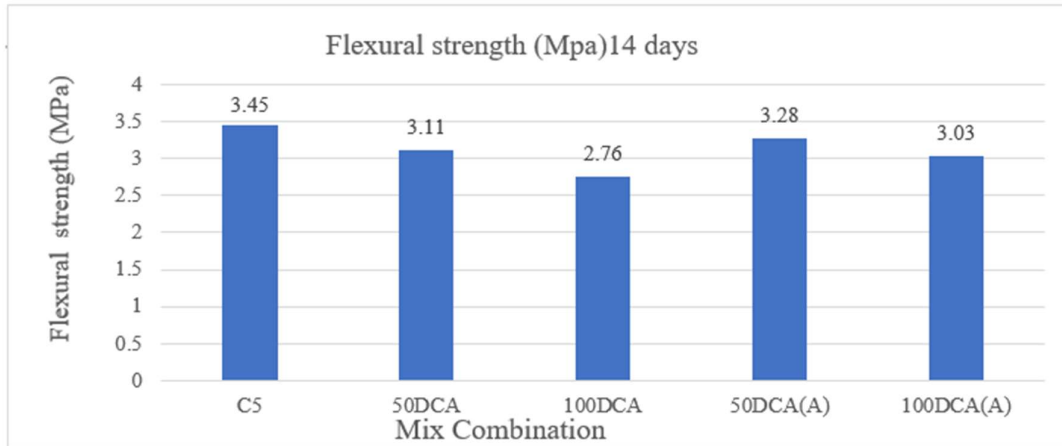


Figure 4.8: 14 days flexural strength (MPa).

Table 4.9 shows that the 50DCA(A) value is greater than CS, 50DCA, 100DCA(A), and 100DCA

Table 4.9 Result of flexural strength (MPa) for 28 days

SL. No	Mix Combination	Flexure load (KN)	Length (mm)	Width (mm)	Depth (mm)	Flexural strength (MPa)	Average flexural Strength (MPa)
1	CS	22	406.4	151.5	152.4	3.81	3.97
		24	406.4	152	152.4	4.14	
2	50DCA	23	406.4	151	152.4	3.99	3.55
		18	406.4	151.5	152.4	3.11	
3	100DCA	15	406.4	152.4	152.4	2.58	3.28
		23	406.4	151	152.4	3.99	
4	50DCA(A)	25	406.4	151.5	152.4	4.33	3.71
		18	406.4	152	152.4	3.10	
5	100DCA(A)	17	406.4	151.5	152.4	2.94	3.45
		23	406.4	152	152.4	3.97	

In Figure 4.9, the flexure strength 50DCA(A) value is close to CS. Then, progressively decreased by 50DCA, 100DCA(A) and 100DCA. It is found that the optimum value of flexure strength was attained for mix combination 50DCA(A) with demolition concrete aggregate.

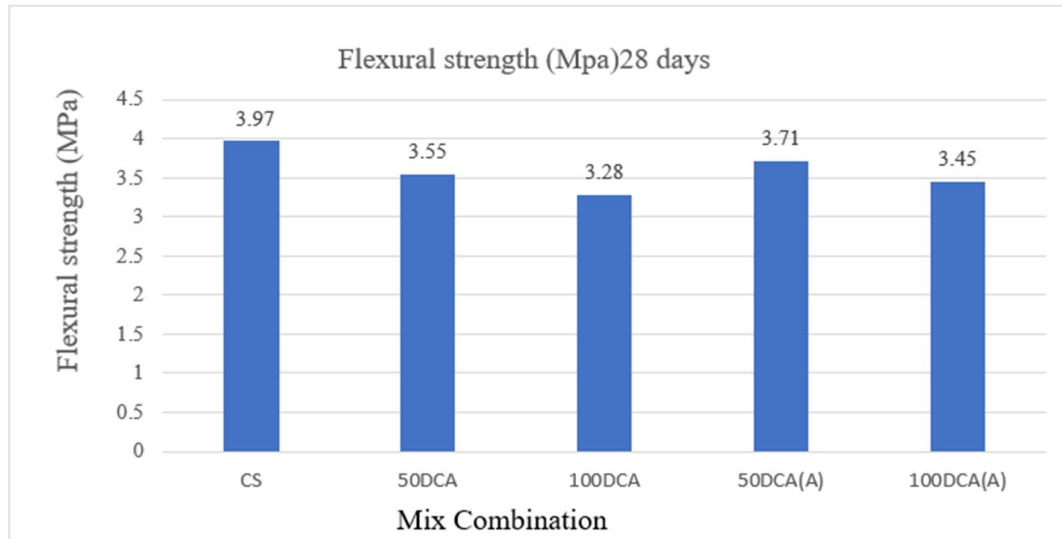


Figure 4.9: 28 days flexural strength (MPa).

In Table 4.10, combine 14 days and 28 days to compare flexural strength.

Table 4.10 Result of flexural strength (MPa) combination.

SL No	Mix Combination	flexural strength (MPa)	
		14 days	28 days
1	CS	3.45	3.97
2	50DCA	3.11	3.55
3	100DCA	2.76	3.28
4	50DCA(A)	3.28	3.71
5	100DCA(A)	3.03	3.45

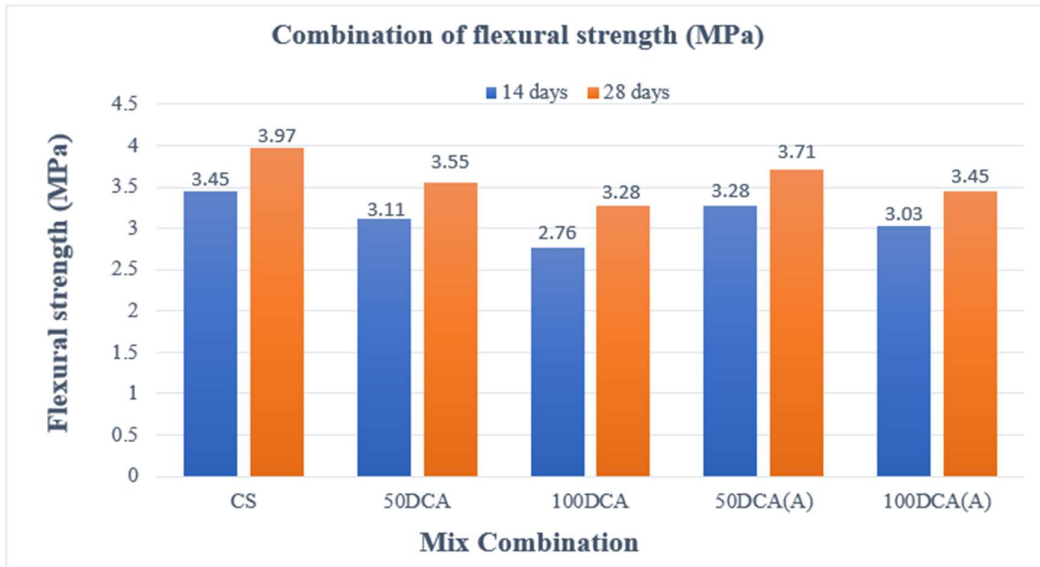


Figure 4.10 combination of flexural strength (MPa)

In this figure, it is indicated that at the end of 28 days, curing 50DCA(A) replacement of demolition aggregate has the maximum flexural strength of 3.71 (MPa).

CHAPTER 5

CONCLUSION

5.1 General

Creating concrete is more study and long-lasting than regular concrete by using coarse aggregate is the main objective of the study. For strength calculations and comparisons, 20 beam specimens and 60-cylinder specimens are cast and tested. Assessing the appropriateness of using coarse aggregate in structural concrete to partially replace demolition concrete aggregate is the aim of this study.

5.2 Conclusion

The conclusion of a demolition coarse aggregate focuses on understanding the importance and application of demolition aggregates in construction projects. Demolition coarse aggregates, which are often derived from recycled concrete and other construction waste, are essential in reducing the environmental impact of construction waste. They can be repurposed for use in road construction, foundation work, or as sub-base material for new structures, thus contributing to sustainability in the construction industry.

The use of demolition aggregates helps in minimizing the demand for natural resources, cuts down on landfill waste, and promotes a circular economy. Proper processing, sorting, and quality control are crucial to ensure these materials meet the standards required for their intended applications. By utilizing demolition aggregates effectively, the construction industry can lower costs, improve resource efficiency, and support eco-friendly building practices.

- ❖ The result shows that maximum compressive strength was 22.87 MPa and 28.59 MPa for 14 and 28 days curing periods respectively for 50DCA(A) mix combination.
- ❖ The result shows that maximum tensile strength was 1.95 MPa and 2.44 MPa for 14 and 28 days curing periods respectively for 50DCA(A) mix combination.

- ❖ The result shows that maximum flexural strength was 3.28 MPa and 3.71 MPa for 14 and 28 days curing periods respectively for 50DCA(A) mix combination.
- ❖ As a result of the findings, only 50DCA(A) of demolition coarse aggregate can be readily replaced with coarse aggregate in concreting to generate strong and safe concrete.

5.3 Recommendation

Before using demolition aggregates in new construction projects, it's essential to carry out thorough testing to ensure they meet the required standards for strength, durability, and size. The aggregates should be carefully sorted during demolition to separate concrete from other materials. Once sorted, the aggregates should be processed (crushed, cleaned, and graded) to ensure uniformity and suitability for reuse in construction. The use of demolition aggregate material to partially replace coarse aggregate is not going to result in increased costs, as we have shown above. It is therefore economically significant to use demolition coarse aggregate material in place of some of the traditional coarse aggregate. More experiments with a variety of combinations, such as partial replacement of the demolition aggregate and full replacement of the coarse aggregate in concrete, will produce better results.

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APPENDIX

Table. A1 Grain Size Analysis of Sylhet Sand

Sieve No.	Sieve size (mm)	Wt. retained (gm)	% Weight of retained	Cumulative % wt. of retained	% of finer	F.M.
#4	4.75	3.2	0.66	0.66	99.34	2.76
#8	2.36	10.5	2.15	2.81	97.19	
#16	1.18	61.6	12.64	15.45	84.55	
#30	0.6	239.8	49.22	64.67	35.33	
#50	0.3	135.2	27.75	92.42	7.58	
#100	0.15	36.9	7.57	99.99	0.01	
Pan	0.075	12.5				
Total		499.7				

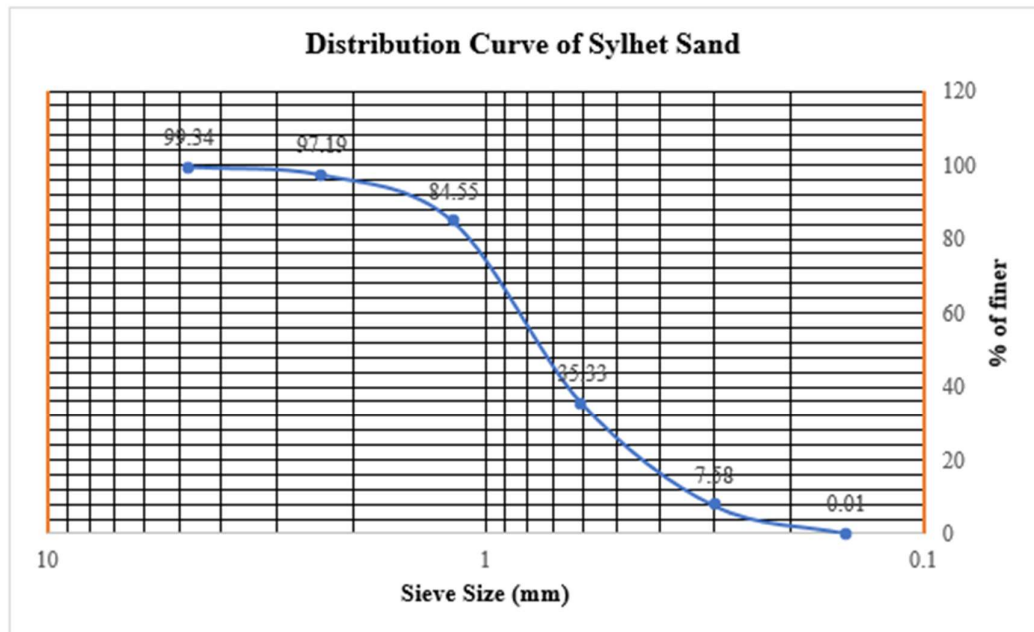


Figure. A1 Grain Size Distribution Curve of Sylhet Sand

Table. A2 Grain Size Analysis of Coarse Aggregate

Sieve No.	Sieve size(mm)	Wt.of retained (gm)	% Weight of retained	Cumulative % Wt.of retained	% of finer	F.M.
3 in	75	0	0	0	100	6.46
3/2 in	37.5	0	0	0	100	
3/4 in	19.5	467.8	46.84	46.84	53.16	
3/8 in	9.5	528.6	52.92	99.76	0.24	
#4	4.75	1.4	0.14	99.9	0.1	
#8	2.36	0	0	99.9	0.1	
#16	1.18	0	0	99.9	0.1	
#30	0.60	0	0	99.9	0.1	
#50	0.30	1	0.1	100	0	
Pan	0.075	2.4				
Total		998.8 gm				

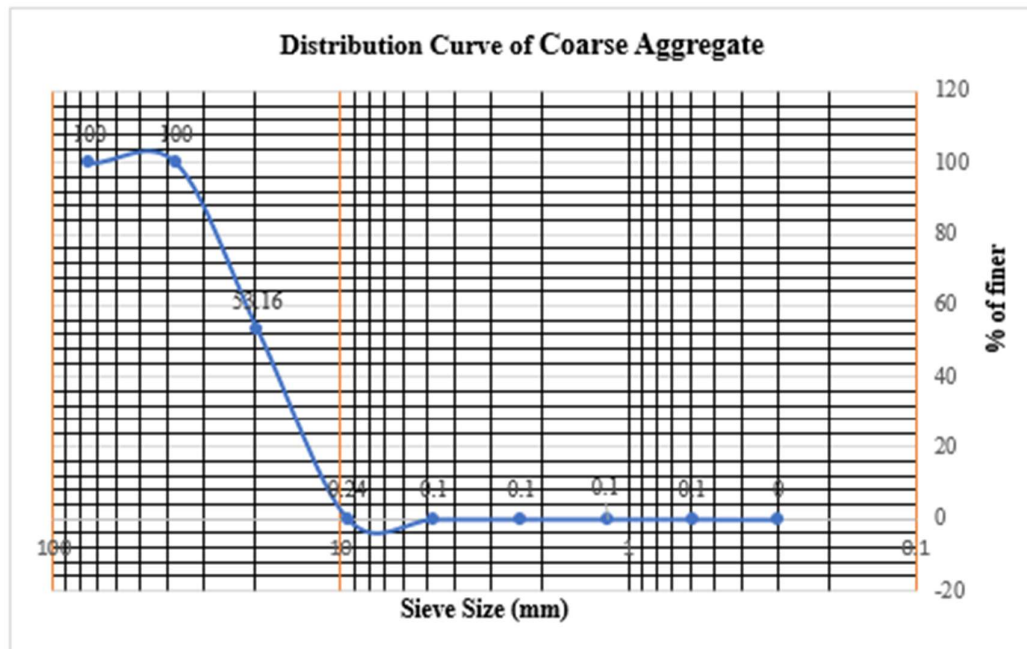


Figure. A2 Grain Size Distribution Curve of Coarse Aggregate

Table. A3 Grain Size Analysis of Demolition Coarse Aggregate

Sieve No.	Sieve size(mm)	Wt.of retained (gm)	% Weight of retained	Cumulative % Wt.of retained	% of finer	F.M.
3 in	75	0	0	0	100	6.30
3/2 in	37.5	0	0	0	100	
3/4 in	19.5	319.3	32.09	32.09	67.91	
3/8 in	9.5	664.7	66.80	98.89	1.11	
#4	4.75	8.1	0.81	99.7	0.9	
#8	2.36	0.4	0.04	99.74	0.26	
#16	1.18	0.6	0.06	99.8	0.2	
#30	0.60	0.8	0.08	99.88	0.12	
#50	0.30	1.1	0.11	99.99	0.01	
Pan	0.075	5.3				
Total		995 gm				

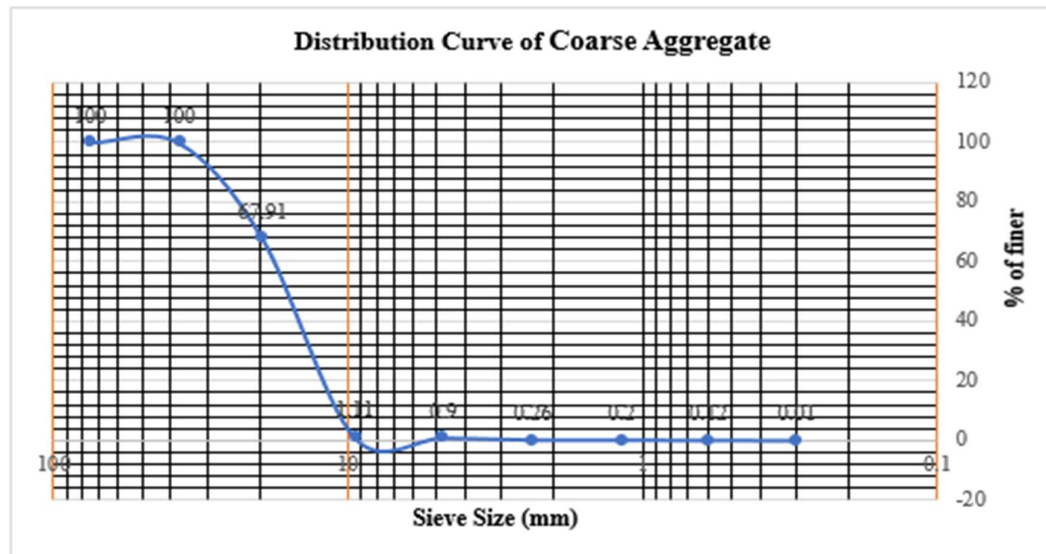


Figure. A3 Grain Size Distribution Curve of Demolition Coarse Aggregate

Table. A4 Specific Gravity, Water Absorption and Moisture Content of F.A

Name of the Item	Quantity	Bulk Specific Gravity	Absorption Capacity	Moisture Content
Weight of oven-dry specimen, A	495.6 gm	2.69	6.25	0.89
Weight of pycnometer filed with water, B	1900.4 gm			
Weight of pycnometer with specimen and water, C	2221.9 gm			
Weight of the saturated surface-dry specimen, S	526.6 gm			

Calculation:

Bulk specific gravity (Oven-Dry Basis), S_{od}

$$S_{od} = \frac{A}{(B+A)-C} = \frac{495.6}{(1900.4+495.6)-2221.9} = 2.69$$

Absorption Capacity

$$A \% = \frac{S-A}{A+100} = \frac{526.6-495.6}{495.6+100} = 6.25$$

Moisture Content:

$$MC = \frac{500-495.6}{495.6} * 100 = 0.89$$

Table. A5 Specific Gravity, Water Absorption and Moisture Content of C.A.

Name of the Item	Quantity	Bulk Specific Gravity	Absorption Capacity	Moisture Content
Weight of oven-dry specimen, A	497.5 gm	2.68	0.97	0.50
Weight of pycnometer filed with water, B	1808.9 gm			
Weight of pycnometer with specimen and water, C	2120.7 gm			
Weight of the saturated surface-dry specimen, S	502.3 gm			

Calculation:

Bulk specific gravity (Oven-Dry Basis), S_{od}

$$S_{od} = \frac{A}{(B+A)-C} = \frac{497.5}{(1808.9+497.5)-2120.7} = 2.68$$

Absorption Capacity

$$A \% = \frac{S-A}{A \times 100} = \frac{502.3 - 497.5}{497.5 \times 100} = 0.97$$

Moisture Content:

$$MC = \frac{500-497.5}{497.5} * 100 = 0.50$$

Table. A6 Specific Gravity, Water Absorption and Moisture Content of DCA

Name of the Item	Quantity	Bulk Specific Gravity	Absorption Capacity	Moisture Content
Weight of oven-dry specimen, A	491.5 gm	2.61	2.32	1.73
Weight of pycnometer filed with water, B	1809.6 gm			
Weight of pycnometer with specimen and water, C	2113.1 gm			
Weight of the saturated surface-dry specimen, S	502.9 gm			

Calculation:

Bulk specific gravity (Oven-Dry Basis), S_{od}

$$S_{od} = \frac{A}{(B+A)-C} = \frac{491.5}{(1809.6+491.5)-2113.1} = 2.61$$

Absorption Capacity

$$A \% = \frac{S-A}{A \times 100} = \frac{502.9-491.5}{491.5 \times 100} = 2.32$$

Moisture Content:

$$MC = \frac{500-491.5}{491.5} * 100 = 1.73$$

Table. A7 Unit Weight of FA, CA. and DCA

Materials	Weight of Bucket + Materials, Kg (G)	Weight of Bucket + Material, Kg (T)	Volume of Bucket, V (in3)	Unit Weight, Kg/m3 (M)
FA	7.17	2.40	0.002955	1614.21
CA	6.87	2.40	0.002955	1512.69
DCA	6.75	2.40	0.002955	1472.08

Calculation:

Unit weight of FA, U_{FA} .

$$U_{FA} = \frac{G-T}{V} = \frac{7.17-2.40}{0.002955} = 1614.21\text{Kg/m}^3$$

Unit weight of CA, U_{CA} .

$$U_{CA} = \frac{G-T}{V} = \frac{6.87-2.40}{0.002955} = 1512.69\text{Kg/m}^3$$

Unit weight of DCA, U_{DCA} .

$$U_{DCA} = \frac{G-T}{V} = \frac{6.75-2.40}{0.002955} = 1472.08\text{Kg/m}^3$$

Table. A8 Mix Design (Normal Weight Concrete)

Required Data	Unit
Compressive Strength(28 days)	30Mpa
Water/Cement	0.54
Slump	100 mm
Maximum size of course aggregate	19 mm
Dry rodded unit weight Bulk density of CA	1512.69 kg/m ³
Specific gravity of CA	2.68
Absorption capacity of CA	0.97 %
Surface moisture of CA	0.5 %
F.M of fine aggregate	2.76
Specific gravity of FA	2.69
Absorption capacity of FA	6.25 %
Surface moisture of FA	0.89 %
Specific gravity of cement	3.15
Calculation	
Weight of materials Required per m ³ of concrete	
Required water	200 kg/m ³
Air content	2 %
Water/cement	0.54
Cement content	370.37 kg/m ³
Bulk volume of dry rodded CA	0.624
OD weight of CA	943.9186 kg/m ³
SSD weight of CA	953.0746 kg/m ³
Expected weight of concrete	2355 kg/m ³
SSD weight of FA	831.56 kg/m ³
Volume of Materials	
Volume of water	0.2 m ³
Solid volume of cement	0.118 m ³

Solid volume of CA	0.356 m ³			
Volume of entrapped air	0.020 m ³			
volume of FA	0.307 m ³			
Total volume	1.00 Ok			
Check SSD weight of FA	825.28 kg/m ³			
Final Result :Quantity of materials (kg/m³)				
	Cement	FA	CA	
	370.37	831.56	953.0746	
Ratio:	1	2.245	2.573	(wrt. Weight)
	1	2.609	3.025	(wrt. volume)

Calculation:

- The compressive strength of the specimen can be calculated as:

$$f_c = \frac{P}{\pi\left(\frac{D^2}{4}\right)}$$

Where,

f_c : The compressive strength, (Mpa)

P: The maximum load sustained by the specimen, KN

D: The diameter of the specimen,

- The splitting tensile strength of the specimen can be calculated as:

$$T = \frac{2P}{\pi Ld}$$

Where,

T: Splitting tensile strength, (Mpa)

P: Maximum applied load indicated by testing machine, KN

L: Length,

d: Diameter

- The flexural strength of the specimen can be calculated as:

$$f_b = \frac{3PL}{2bd^2}$$

Where,

P: Maximum applied load indicated by testing machine, KN

L: Length,

b: Width of specimen,

d: Depth,