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Analysis and Testing of Recycled Aggregate Concrete and Re-Use of RAC in New Constructing Structures

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Abstract

As the population of the world is growing up with the passage of time, they also need more space shelter and construction. However the shortage or depletion of natural resources is a thread to the construction sector as it uses concrete so 60 to 75% aggregate present in it. In addition the building demolishing have negative impact on the environment and ecosystem as it produces a lot of waste. Now the world is moving toward sustainability so it drawn the attention of the construction sector toward reuse of recycled aggregates that present more than 70% of the concrete volume. The problem is that the recycled aggregate must fulfill the required quality and low cost before use in concrete. Considering these problem we conduct an experimental study on it. We conclude that the usage of recycled combination to update a part of the normal coarse combination results the tensile strength and compressive power with a value depends at the coarse mixture alternative percent and grading of coarse aggregate. At 25% coarse aggregate replacement percentage and well grading of course aggregate gives us satisfactory result.(Al-Azzawi 2006), (Belagraa and Beddar 2013),(Chandio, Memon et al. 2020).

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1.Introduction

Recycled Aggregate

The replacement of old and degraded structures and transport systems with new ones is a common occurrence in many areas of the world today. Changes in purpose, structural degradation, city reorganization, extension of transportation pathways and increased traffic load, natural catastrophes (earthquake, fire, and flood), and other factors all contribute to this situation.. In the EU, for example each year, over 850 million tonnes of building and demolition debris are created, accounting for 31% of total waste creation. Building demolishing debris alone is expected to generate 123 million tonnes of building waste in the United States per year. Dumping this debris in landfills has been the most favored method of disposal.

Large piles of construction waste are generated as a result, posing a unique problem of human contamination of the environment. As a result, laws have been enacted in developed countries to limit the waste in the form of bans and special taxes imposed on those who create wastes land.

On either hand, as concrete manufacturing and use increases, natural aggregate, the most significant component of concrete, is used more frequently. China, for example, produced 20 billion tons of aggregates in 2018. Because of the upcoming new large projects, production is likely to increase. This condition raises the issue of natural aggregates preservation, and many European nations have imposed fines on the usage of virgin aggregates.

Recycling demolished concrete then using it to make an alternate aggregate for structural concrete may be a solution to these issues. Recycled aggregate concrete is generated by crushing demolished concrete in two steps, then screening and removing contaminants including reinforcement, paper, wood, plastics, and gypsum. Such recycled concrete aggregate is used to make recycled aggregate concrete (RAC). The primary goal of this research was to discover the fundamental parameters of RAC

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based on coarse recycled aggregate percentage and relate them to the attributes of natural aggregate concrete. Because fine recycled aggregate is generally discouraged in structural concrete, it was not regarded for RAC processing.

Components of Recycled Aggregate Concrete

Concrete's three essential components are water, aggregate (rock, sand, or gravel), and Portland cement. Cement, when combined with water and aggregates, usually in powder form, works as a binding agent. This mixture, or concrete mix, will be placed and stiffened into the long-lasting compound.

- Portland Cement
- Recycled Aggregate and sand
- Water
- Admixtures (when necessary)

Figure 1. 1 Ingredients of concrete

Portland Cement

It's the most widely utilized form of cement worldwide, and it is a key component of concrete and mortar. It was created in England in the mid-19th century from other forms of hydraulic lime and typically made from limestone it's a fine powder made by burning ingredients in a kiln, crushing the clinker, and adding small amounts of additional ingredients. There are variety of Portland cement, the most popular of

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which is called Ordinary Portland Cement (OPC), which is greyish,although there is white Portland cement.

The 'raw feed' or 'kiln feed' is an incorporated raw material that is heated to 1400 to 1500 degrees Celsius in a rotating kiln. The raw feed starts on the cold side of the kiln and works its way to the hot side before dropping out and cooling.The rotary kiln, in its most basic form,is a tube with a long flame at one end that can be up to 200 m in length and 6 m in diameter. Clinker is a kiln-formed substance made up of rounded nodules ranging in size(1-25mm) in diagram.

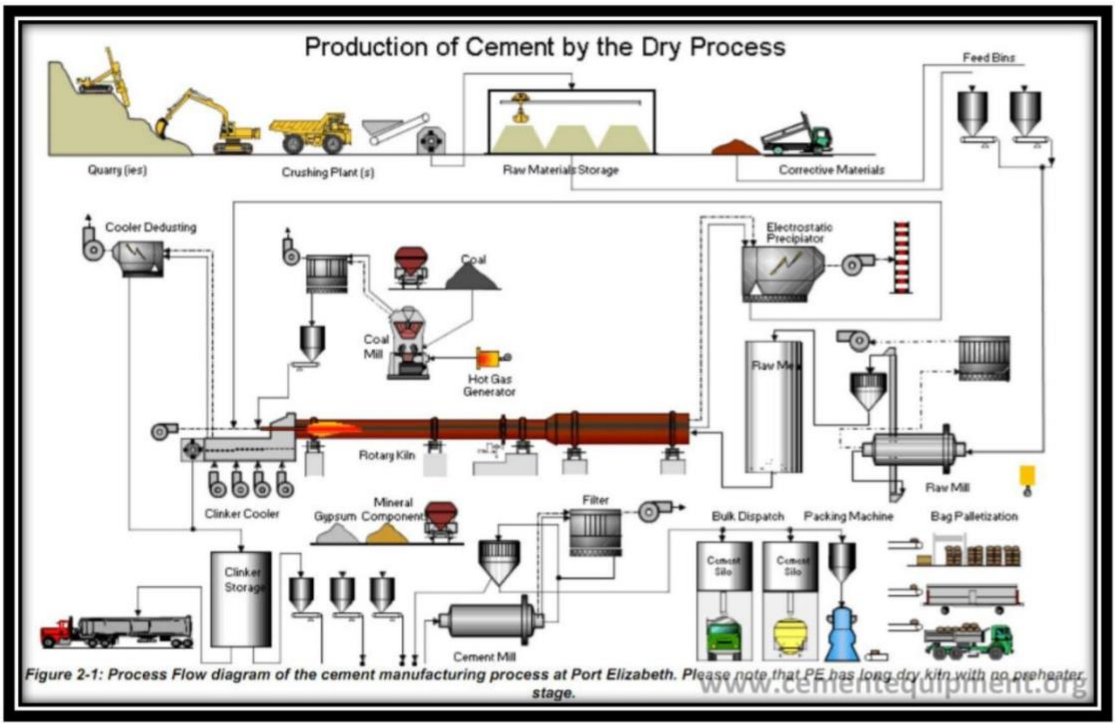

Figure1.2: Schematic diagram of cement manufacturing process

Aggregates

The term aggregate comes from the Latin “aggregate”, which signifies a collection of materials.Aggregates, like sand or stone, are inert filler elements used in concrete.Since aggregate makes up a minimum of three-quarters of the concrete volume, it's no surprise that its quality is extremely important. While undesirable aggregate cannot produce strong concrete, aggregate properties have a significant impact on the concrete's durability and structural efficiency.

a) Fine aggregates or sand:

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Sands are the most common type of fine aggregate. Natural sand or crushed stone are the most frequent fine aggregates, with the majority of particles passing via a 9.5 mm filter. This can originate from primary, secondary, or recycled sources, much like coarse aggregates.

b) Coarse aggregates or gravel:

Particulates with a diameter more than 4.75mm, but typically ranging from 9.5mm to 37.5mm, are classified as coarse aggregates. They can be derived from primary, secondary, or recycled sources.

• Water

Hydration Hydration is the method of mixing water with a cemented substance to produce cement paste. The cement paste holds the aggregates intact, fill up voids, and increases the material flow. Water accounts for 14 to 21% of the overall volume of concrete. It is critical to ensure the following while producing a concrete mix:

a) The concrete mix is workable.
b) The desired attributes of hardened concrete are achieved, including resilience to freezing-thawing as well as deicing agents, water permeability, impact resistance, and strength.
c) Economy: Because the water-to-cement ratio is so important to the product's quality, the water demand should be kept to a minimum in order to minimize cement usage and as a result lower the cost.

The quality of concrete is determined by:

1. W/C Ratio – Advantage of reducing water.
2. Increased compressive and flexural strength.
3. Decreased permeability.
4. Improved weathering resistance.
5. Reduced shrinkage cracking capacity.

The less water utilized, the higher the concrete quality, as long as it can be adequately consolidated.

• Admixtures

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Admixtures are concrete additives that are introduced into the mixture right during or prior to mixing, in addition to Portland cement, water, and aggregates. Water-reducing admixtures are utilized in concrete to lessen the amount of adding water needed to achieve a desired slump, lower the water/cement ratio, lower cement content, and maximize slump. The water content of typical water reducers is reduced by 5% to 10%. Following list consists of some of the important admixtures for concreting.

a) Air-entraining
b) Water-reducing
c) Plasticizers
d) Accelerators
e) Retarders
f) Super plasticizers

a) Air-entraining agents

Air-entraining admixtures are used in concrete to deliberately produce and stabilize tiny air bubbles. Concrete subjected to freezing and thawing cycles can benefit greatly from air entrainment. Concrete's resistance to surface cracking induced by chemical deicers is greatly improved by entrained air. Furthermore, fresh concrete's work ability is greatly enhanced, and segregation and bleeding are minimized or eliminated. Miniature air bubbles are equally scattered in the cement paste in air entrained concrete. Entrained air can be created in a concrete using an air entraining cement,an air-entraining admixture, or combo of both techniques. A Portland cement that has an air-entraining additive mixed in with the clinker during manufacturing process is known as an air-entraining cement. On the other side, an air-entraining admixture is directly applied to the concrete mix, either prior or in the course of mixing process.

b) Water Reducing Admixtures

Water reducing admixtures are utilize to minimize the amount of mixed water necessary to generate concrete of a desired slump, decrease water/cement ratio, lower cement quantity or enhance slump of concrete. Most water reducers minimize the amount of water in the air by about 5% - 10%. When a water reducing admixture is added to concrete without lowering the water amount, a mixture with a higher slump is created. The rate of slump failure, on the other

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hand, does not decrease and, in most situation, increases. Excessive slump loss reduces work ability and speeds up the concrete pouring process.

Plasticizers

Plasticizers are used to make the mixture more fluid and increase its work ability. Plasticizers are utilized for,

- Reducing the amount of water used (5% - 10%) for slump.
- Greater level of work ability.
- Steel reinforcement that is clogged.
- Strength Increment.

Lignosulphonic acid and synthesized raw materials are two important types.

c) Accelerators

Accelerators are being used to speed up the setting/hardening process at an initial stages.

It is used for a variety of purposes including:

- Removing forms earlier or reducing cure time.
- Construction of a structure sooner or renovation work.
- Low-temperature impacts are accounted for.

Salts or Hydrochloride Accelerators, such as Calcium Chloride, and Chloride-Free Accelerators (carboxylic acid), are both important forms of accelerators.

d) Retarders

To decelerate the hydration process, retarders are utilized. Retarders are also utilized for,

- Hot climate concreting or long range transit.
- Mass concrete work.
- Oil well cement grouting (200 C).

e) Super plasticizers

Plasticizers with greater decrease in water content is referred to as super plasticizers. High range water reducers are another name for them. Super plasticizers are used for,

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- Decreased in water demand (at least 12%).
- Higher range of workability.
- Steel reinforcement that is clogged.
- Strength Increment.

Notable Super plasticizers are Melamine based compounds and carboxylate based compounds.

1.2 Research significance

- The significance of our research is to compare the compressive, tensile strength and flexural strength of Natural concrete with recycled concrete mixed at a fixed ratio.
- By substituting recycled aggregates with natural aggregates in proportions of 25%, 50%, and 100%.

1.3 Project Aim

This project's aim is to find the strength of recycled aggregate for use in high-Performance (strength) concrete structures. This will allow us to understand the qualities of recycled aggregate concrete. Is it possible to utilize a coarse aggregate alternative in structural concrete?

1.4 Project scope

The scope of project is the:

- Analysis and research of recycled aggregate.
- Use varied percentages of recycled aggregate to create the specimen.
- Research and testing of high-strength concrete utilizing recycled aggregate.
- Assessment and suggestions for future research.

1.5 Advantages

There are several benefits of using recycled aggregate. The advantages of recycled aggregate are as under:

a) Sustainability

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Recycled aggregate will reduce the amount of waste material sent to the landfill. The amount of quarrying will be reduced as a result. As a result, less natural aggregate will be used, and the life of landfill sites will be extended.

b) Market is wide

The market for recycled aggregate are wide. According to environmental council concrete of organization, recycled concrete can be used for sidewalk, curbs, bridge substructure and superstructure, concrete shoulder, residential driveways, general and structural fills.

c) Job Opportunities

Many individuals will be included in this modern technology, including specialized and skilled professionals, ordinary laborers, drivers, and others. A Scottish development program is being prepared, as per Scottish executive (2004). This program will result in the creation of 150 new employment in the Scotland industry.

d) Environmental Benefit

The main benefit is the improvement in the environment. According to the Commonwealth Research and Industrial Organization (CSIRO), disposal of waste accounts for up to 40% of total waste generated every year (about 14 million tons). Because the source of urban aggregate can be depleted by recycling these materials, Natural aggregate is suitable for high-end applications.

e) Conservation Of Energy

On-site recycling is possible. As per Kajima Research Institute, Kajimma is working on the development of recycled crushed concrete, which will be employed on construction sites thanks to this technology, which is based on the recycling of aggregate in building.

f) Recycling's Economics

Apart from that, according to the aggregate advisory service, a recycling facility may take segregated materials at the lowest cost than a landfills without taxes, and recycled aggregate could be utilized in construction projects with a cheaper process than original aggregate.

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2.Experiments

In this chapter we will discusses the hardened test of concrete.Hardened test of concrete sample consist of compression and indirect tensile.

2.1 Testing on Hardened Concrete Specimens

The tests used to suggest the strength of concrete can be classified as destructive and nondestructive tests. Concrete is a mixture of Portland cement, water and aggregate that consists of rock sand. This chapter contains of two types of hardened concrete testing. There are many methods that we can used to indicate the strength of concrete. Generally, concrete is weak in tension however strong in compression. The engineers can compare the value of trying out to the designed value used for the construction of building.

They are compression test, indirect tensile test. All the procedure used was according to the ASTMC39 C39M-15.

2.1.1 Compression Test

The strength of the concrete specimens with distinctive percentage of recycled aggregate substitute may be indicating through the compression test. The compression test also revealed differences in strength between the distinctive percentages of recycled aggregate used in the age 28 days, compression test is the best common test used to test the hardened concrete specimens because the testing is easy to make. The specimens used in the compression test were 6"X6"X6" in dimension .There are 3 specimens were used in the compression testing in every groups.

2.1.1 Apparatus for Compression Test.

The apparatus used (as shown in figure 2.1 and 2.2) in the compression test were done according to ASTM C39 C39M-15 Standard Test.

1) Ruler: 400mm lengthy ruler to measure the peak of sample.
2) Balance: measuring the weight of the concrete samples.
3) Testing Machine:(Universal Testing Machine) UTM
4) Sulphur aping: UTM load should be uniformly distribution on specimen.

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Figure 2.1 Placing of concrete block before testing

Figure 2.2 Failure pattern in concrete block after testing

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2.1.1.1 Test Procedure of Compression Test

The test procedure was according to the ASTMC39 C39M- 15 Standard Test.

2.1.1.1 The procedures were as below:

1. Place the prepared concrete mix in the cube mould for casting.
2. Eliminate the concrete dice from the concrete cube after it has set for 24 hours.
3. Submerge the take a look at specimens in water for the desired amount of time.
4. The specimen must be kept in water for 28 days, with the water being adjusted every 7 days.
5. Before putting the concrete specimen on the UTM make sure that the specimen is completely dry.
6. In order to continue with test, the load of the samples have to be stated, and it must no longer be much less than 8.1 kg.
7. In the space between the bearing surfaces, testing specimens are set up.
8. The presence of any free material or grit at the metallic plates of the gadget or specimen block ought to be prevented.
9. The concrete cubes are positioned on bearing plate and aligned nicely with the middle of thrust inside the checking out machine plates.
10. The loading have to be carried out axially on specimen without any shock and extended on the rate of 140kg/sq. cm/min. till the specimen disintegrate.
11. The specimen begins to crack at a certain stage as a result of the continuous application of load, and the final collapse of the specimen must be noted.

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2.1 Indirect Tensile Test

Brittle nature of the concrete sample is signified by using Indirect tensile test on different percentage of recycled aggregate. As compared to other tension tests the indirect tensile test will give more uniform results of the concrete properties.It was absorb that the result obtained from the indirect tensile test is approximately equal to the true tensile strength of concrete as compared to the modulus of rupture. It is because once the concrete specimens reach day 28, the increased rate of concrete stress was uniform and there is not much stress increased after 28days. The testing specimen was 150mm diameter and 300mm length. The indirect tensile test was just carried out after 28days of casting.

The apparatus used in the indirect tensile test were according to ASTM C496/C496M-11 Standard.

2.1.1 Apparatus for Indirect Tensile Test

1) Testing Machine: UTM (Universal Testing Machine).
2) Supplementary Bearing Plate.
3) Bearing Strips: 2 grade hardboard widths of 5mm thick, 25mm wide.
4) Ruler: 400mm lengthy, to measure the peak of the concrete specimens.
5) Vernier Caliper: To measure the diameter of the concrete specimens

The test procedure is according to the ASTM C496/C496M- 11.

2.1.1 Preparation of Samples

1. The specimen size is cylinder of diameter 15 cm and height of 30 cm. Metal mould with a mean internal diameter of 15 cm +/- 0.2 mm and a height of 30 cm +/- 0.1 cm was used. To avoid concrete adhesion, cover the mould with a thin layer of mould oil before use.
2. Approximately 5 cm thick layers of concrete are poured into the mould. Each layer is either compacted by hand or vibrated. When compacting by hand, a tamping bar is used, and the stroke of the bar must be evenly distributed. Each layer's number of strokes shall not exceed 30. The stroke should go all the way through to the underlying layer, and the bottom layer should be rodded all the way through.
3. After compacting the top layer, use a trowel to finish the concrete surface level with

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the top of the mould, then cover it with a glass or metal plate to inhibit water evaporation.

4. Curing: For 24 hours the test specimen should be held at a temperature of 27°C. Following this time, the specimens are removed from the moulds and immersed in clean fresh water or a saturated lime solution for the curing duration indicated (such as 7 or 28 days). Every seven days, the water or solution should be renewed.

2.1.1.1 Procedure for Indirect Tensile Test.

1) Measure the diameter and length of the specimen recorded the measurements.
2) Put the sample in UTM and bearing strips were aligned on the top and bottom of the specimen and located the bearing plate outside the bearing strips.
3) Carried out a small preliminary force and the aspect constrain turned into eliminated.
4) Implemented the force without shock and expanded constantly at a regular rate of 15MPa.
5) Recorded the most pressure from the testing machine whilst the specimen failed. Setup of Indirect Tensile Test

Figure 2.3 Setup of Indirect Tensile Test

This test approach covers the determination of splitting tensile strength of cylindrical specimens. That is the maximum stress that a fabric can resist while being stretched or pulled

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earlier than failing or breaking. Tensile strength isn't always similar to compressive strength and the values may be pretty unique. Such test is performed according to ASTM C496-06.

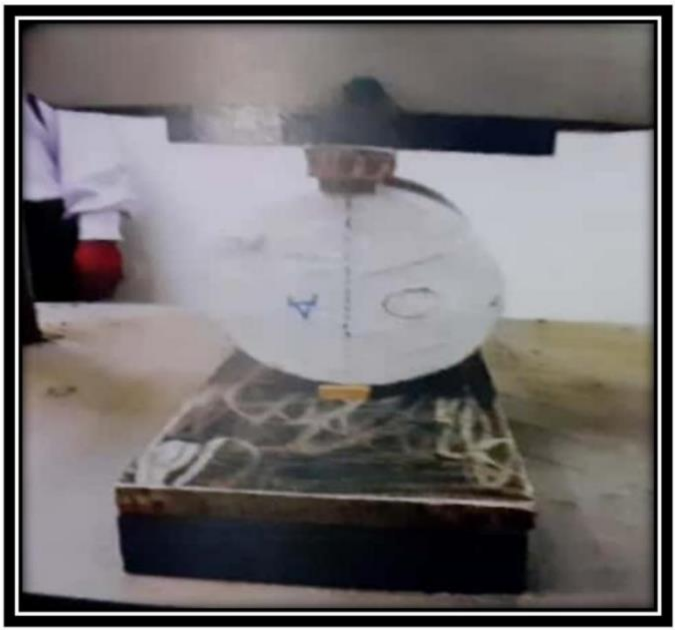

Figure 2.4 Placing of concrete sample before testing

Figure 2.5 Failure pattern in concrete sample after Testing

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3. Results & Discussion

3.1 Hardened Concrete

Concrete has advanced a certain strength in a solid state. Reaction keeps with and produced hard, strong and sturdy strong fabric.

3.1.1 Compressive Strength Test (Standard of test)

AASHTO Designation: T 22-051

ASTM Designation: C 39-04a

3.1.1.1 Compressive Test Result and Analysis

The compression take a look at suggests that an increasing fashion of compressive strength within the early age of the concrete specimens. however, it indicates that the strength of recycled combination specimens is lower than natural mixture specimens. Tables given below shows the compressive strength with different % of recycled aggregates. Figure below shows a graphical demonstration of variation strength in term of height which shows that the compressive strength comes down when we increasing the quantity of Recycled aggregate in the mixture.

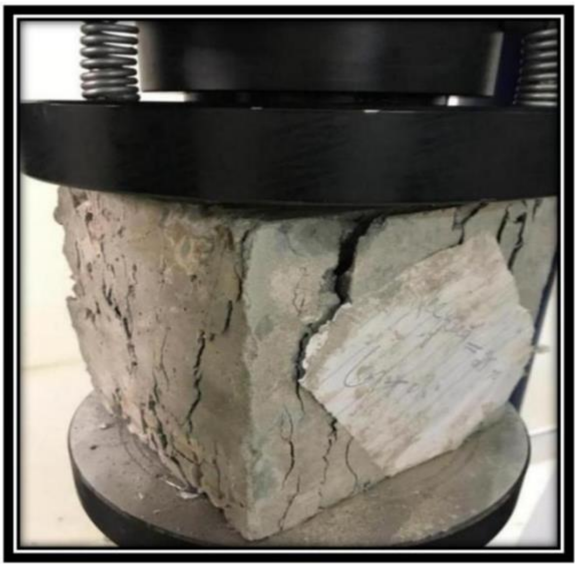

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Figure 3.1 Failure pattern under compressive load

The mark strength for this project is + 4000Psi. From the obtained result, it proven that there are handiest two batches that did not come across the mark strength, that are first batch with 50% recycled combination and second batch with one hundred% recycled combination. The reduction in strength by using of recycled aggregate is because of presence of blended cement in these concrete specimens that may lessen the compressive power at the same time as the use of the recycled combination, the compressive strength of the concrete specimens for 100% recycled aggregate with 0.50 water/cement ratio is2644.603Psi. The strength of recycled aggregates can be improved by adding of admixtures and super plasticizer and also by taking minimum w/c ratio.

3.1.1.1 Compressive Test Result Of Specimen After 28 Days Of Curing

Table 3.1: Compressive Test Result of Specimen C-100

Specimen	Area (in^2)	Reading (KN)	Calibrated Reading (KN)	Strength (MPa)	Psi
C-100	36	690	672.471	28.9536205	4199.375

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C-100	36	696	678.4464	29.2108948	4236.69
C-100	36	698	680.4382	29.2966529	4249.128

Table 3.2: Compressive Test Result of Specimen RC-25%

Specimen	Area (in^2)	Reading (KN)	Calibrated Reading (KN)	Strength (MPa)	Psi
RC-25%	36	686	668.4874	28.7821044	4174.499
RC-25%	36	685	667.4915	28.7392253	4168.28
RC-25%	36	680	662.512	28.5248301	4137.184

Table 3.3: Compressive Test Result of Specimen RC-50%

Specimen	Area (in^2)	Reading (KN)	Calibrated Reading (KN)	Strength (MPa)	Psi
RC-50%	36	510	493.209	21.2353934	3079.939
RC-50%	36	501	484.2459	20.849482	3023.967
RC-50%	36	497	480.2623	20.6779659	2999.091

Table 3.4: Compressive Test Result of Specimen R-100%

Specimen	Area (in^2)	Reading (KN)	Calibrated Reading (KN)	Strength (MPa)	Psi
RC-100%	36	400	383.66	16.518699	2395.839
RC-100%	36	440	423.496	18.2338606	2644.603
RC-100%	36	405	388.6395	16.7330942	2426.935

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3.1.1.1 Compressive Test Result of Specimen After 7 Days Of Curing

Table 3.5: Compressive Test Result of Specimen C-100

Specimen	Area (in^2)	Reading (KN)	Strength (MPa)	Psi
C-100%	36	580.549	24.99587	3625.35
C-100%	36	576.549	24.82364	3600.37
C-100%	36	568	24.45556	3546.99

Table 3.6: Compressive Test Result of Specimen RC-25

Specimen	Area (in^2)	Reading (KN)	Strength (MPa)	Psi
RC-25%	36	537.371	23.13681	3355.72
RC-25%	36	530.34	22.83409	3311.81
RC-25%	36	525	22.60417	3278.46

Table 3.7: Compressive Test Result of Specimen RC-50

Specimen	Area (in^2)	Reading (KN)	Strength (MPa)	Psi
RC-50%	36	418	17.99723	2610.28
RC-50%	36	410	17.65278	2560.32
RC-50%	36	408.5	17.5882	2550.96

Table 3.8: Compressive Test Result of Specimen R-100

Specimen	Area (in^2)	Reading (KN)	Strength (MPa)	Psi
R-100%	36	340	14.63889	2123.2
R-100%	36	345	14.85417	2154.42
R-100%	36	337	14.50973	2104.46

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Table 3.9: Compressive Test Result of Specimen R-100

Specimen	**Area (in^2)**	**Reading (KN)**	**Strength (MPa)**	**Psi**
R-100%	36	340	14.63889	2123.2
R-100%	36	345	14.85417	2154.42
R-100%	36	337	14.50973	2104.46

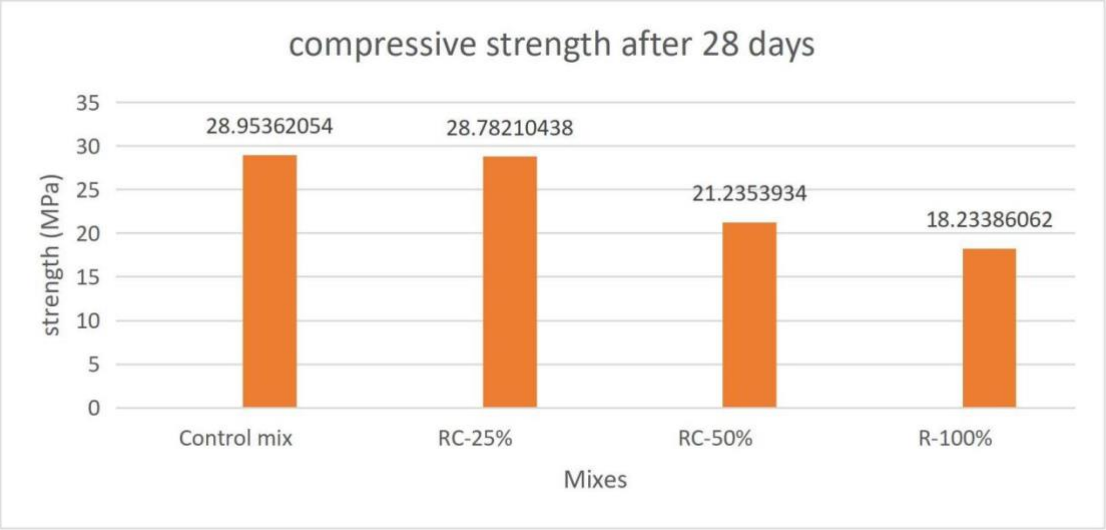

Table 3.10: Summary of compressive test of specimen after 28 days

Recycled Aggregate	Reading (KN)	Calibrated Reading (KN)	Strength (MPa)	Strength Activity Index
Control mix	690	672.471	28.95362	100
RC-25%	686	668.4874	28.7821	99.40762
RC-50%	510	493.209	21.23539	73.34279
R-100%	440	423.496	18.23386	62.9761

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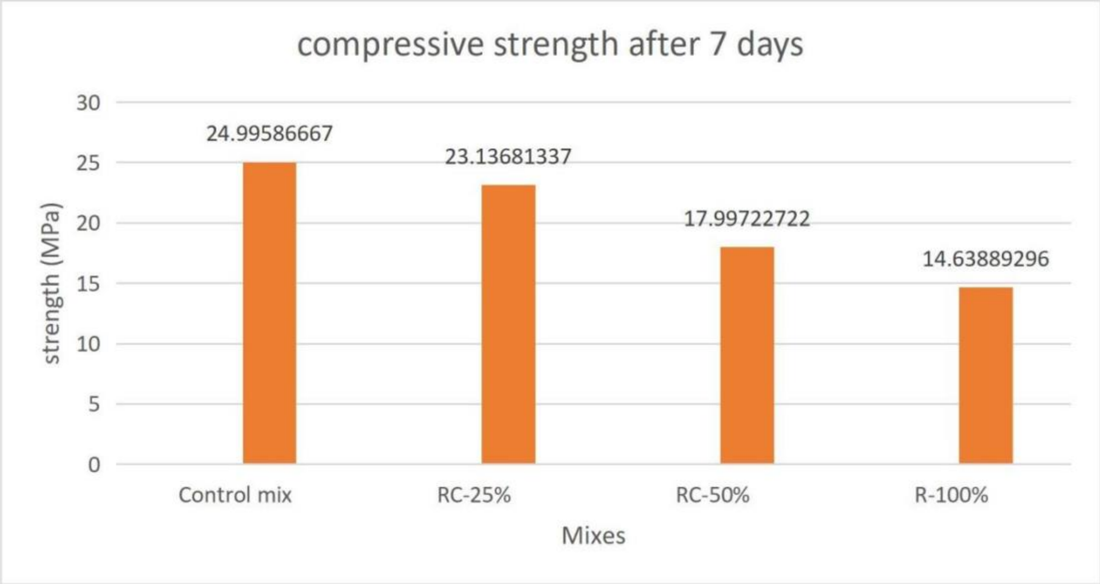

Table 3.11: Summary of compressive test of specimen after 7 days

Recycled Aggregate	Reading (KN)	Strength (MPa)	Strength Activity Index
Control mix	580.549	24.995867	100
RC-25%	537.371	23.136813	92.562557
RC-50%	418	17.997227	72.000813
R-100%	340	14.638893	58.565255

The results additionally indicates that the concrete specimens with greater substitute of recycled aggregate gets the lowest strength when as compared to the concrete specimens with much less recycled mixture. Fig 6.2 shows the compressive strength remained while percentage of recycled aggregate placement expanded. The compressive strength used from each batches have been primarily based on day 28 and 7 strength. The compressive strength of 0% recycled aggregate was occupied as the 100% compressive strength and RC-25% was taken 99.4% in 28 days of curing and 92.5% in 7 days of curing. Which is under control condition.

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3.1 Tensile Strength Test (Standard of test)

ASTM Designation C 496/C 496M-04

3.2.1 Tensile Test Result and Analysis

The indirect tensile test indicates a reducing fashion of indirect tensile strength when the share of recycled mixture increased. Tables below suggests the average tensile strength recorded at some stage in the take a look at. Table 6.3 suggests a graphical representation of variant of tensile strength.

Table 3.12: Tensile Strength Test of C-100

Specimen	Reading (KN)	Calibrated Reading (KN)	Strength (MPa)	Psi	Strength Activity Index
C-100	260	244.234	3.347239	485.477	100
C-101	258	242.242	3.319941	481.518	99.18447
C-102	250	234.275	3.21075	465.681	96.71106

Table 3.13: Tensile Strength Test of RC-25

Specimen	Reading (KN)	Calibrated Reading (KN)	Strength (N/mm^2)	Psi	Strength Activity Index
RC-25	212	196.431	2.692094	390.456	80.42726
RC-25	211	195.435	2.678445	388.476	80.0195
RC-25	208	192.447	2.637498	382.537	78.7962

Table 3.14: Tensile Strength Test of RC-50

Specimen	Reading (KN)	Calibrated Reading (KN)	Strength (N/mm^2)	Psi	Strength Activity Index
RC-50%	196	180.496	2.473712	358.782	73.903
RC-50%	194	178.505	2.446414	354.823	73.0875
RC-50%	190	174.521	2.391819	346.905	71.4564

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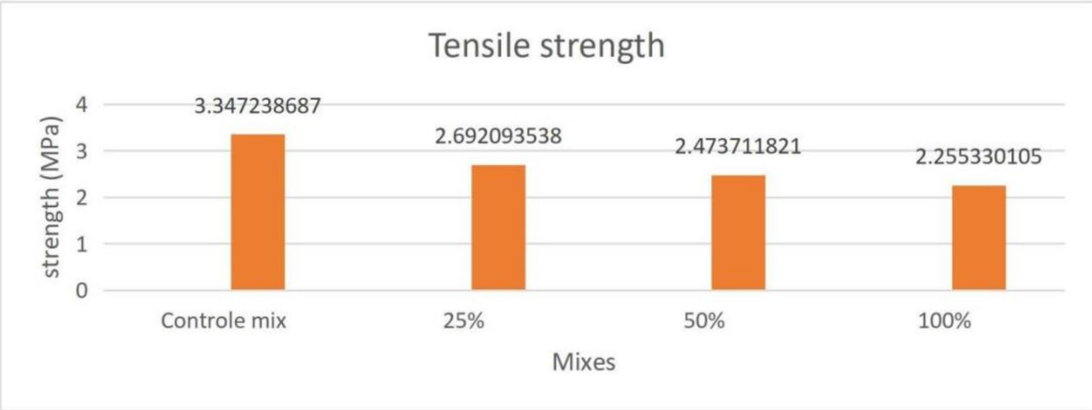
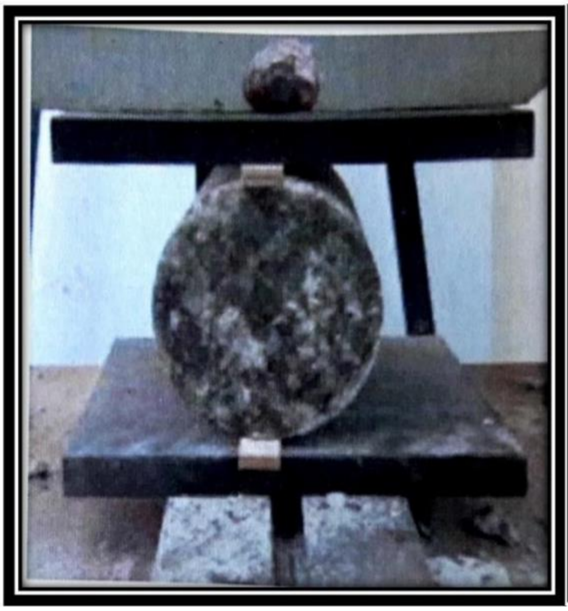
Table 3.15: Tensile Strength Test of R-100

Specimen	Reading (KN)	Calibrated Reading (KN)	Strength (MPa)	Psi	Strength Activity Index
RC-100%	180	164.562	2.25533	327.109	67.3788
RC-100%	176.5	161.076	2.207559	320.18	65.9516
RC-100%	178.3	162.869	2.232127	323.743	66.6856





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C D

Figure 3.2 Failure pattern under Tensile Load

From the Table 1.3 it indicates that the tensile strength is step by step reducing for the concrete specimens that with the alternative recycled mixture. The common tensile strength for the concrete specimens of one hundred% recycled aggregate is 2.255N/mm^2. The tensile strength of C-100 and RC-25% are in a control state and we can use it in load bearing components.

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5. Conclusion

Following conclusion were made in this research

1. There is slight decrease in compressive strength of concrete by the replacement of aggregates by recycled aggregates. This decrease in compressive strength progressively increases by the increase in recycled aggregate percentage. However, it has been observed that there is 37% reduction in compressive strength, if we use 100% recycled aggregates in concrete.
2. Due to the dumping of hundreds of thousands tons of debris, recycling has been found an appropriate solution to the problem of shortage of natural aggregate.
3. Recycling of construction resources has grown alongside demand for aggregates. Recycled aggregates compete sympathetically with herbal aggregates in lots of markets as avenue base fabric
4. Recycled resources can supplement herbal assets and prolong the life of natural-mixture deposits, thus sustaining the life of the operation. Recycling tends to be lucrative, and in most situations, it can satisfy demand for lower-value product applications like road base, allowing higher-quality content to be used for higher-value applications.
5. Compression strength (Graph) increases for different concrete specimen in the following order: R100 %< RC50 %< RC25% < C100%.
6. According to ASTM C618 those mixes whose strength is about or more 75% of the control mix can be used in the load bearing components of the building.
7. In our result RC25% having about 99% strength by comparing it with control mix .so our research work suggest that using RC25% is good for constructing sustainable building without compromising the strength.
8. RC50% will be suitable for low loaded area like water tank slab, top roof slab.
9. RC100% is suitable for drains, floor and ground stairs.

6. References

✧ Belagraa1, L., & Beddar , M. (2013). Study of the Mechanical Performance of a

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Copyright © authors 2023
DOI: https://doi.org/10.5281/zenodo.7979691

Recycled Aggregate Concrete with Admixture Addition. Retrieved from http://www.scirp.org/journal/ojce)

- Al-Azzawi, A. A. (2016, oct). MECHANICAL PROPERTIES OF RECYCLED AGGREGATE CONCRETE. ARPN Journal of Engineering and Applied Sciences, 11.
- Chandio, F. A., & Memon, B. A. (2020, june). Effect of Gap Gradation on Compressive Strength of Recycled Aggregate Concrete. QUEST RESEARCH JOURNAL, 11, 1. Retrieved from https://www.researchgate.net/publication/345941558_Effect_of_Gap_Gradation_on_Compressive_Strength_of_Recycled_Aggregate_Concrete?enrichId=rgreq0f5c75e22b715cc9e218e8e428c46cd7XXX&enrichSource=Y292ZXJQYWdlOzM0NTk0MTU1ODtBUzo5NTg0ODM0NjE1OTkyMzJAM TYw NTUz
- civil read. (2018). civil read. Retrieved from Compressive Strength of Concrete | Cube Test, Procedure, Apparatus & Results: https://civilread.com/compressive-strength-of-concrete- test/
- Standard, A. (n.d.). Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine1. U.S. Department of Defense.
- (Wilburn and Goonan 1998). Aggregates from natural and recycled sources; economic assessments for construction applications; a materials flow study. https://doi.org/10.3133/cir1176
- Ngo, Nelson, Shing Chai (2004) *High-strength structural concrete with recycled aggregates.* http://sear.unisq.edu.au/id/eprint/21
- Roz-Ud-Din Nassar, Parviz Soroushian (2012), Strength and durability of recycled aggregate concrete containing milled glass as partial replacement for cement. https://doi.org/10.1016/J.CONBUILDMAT.2011.10.061
- Obla, Kim, Lobo (2007), Crushed Returned Concrete as Aggregates for New Concrete.
- (Anderson, Uhlmeyer et al. 2009), Use of Recycled Concrete Aggregate in PCCP.
- (Park 1999) ;The Use of Recycled Building Rubble in the Reconstruction of Demolished Buildings
- (Rahman, Hamdam et al. 2009), Assessment of recycled aggregate concrete
- (Malešev, Radonjanin et al. 2010), Recycled Concrete as Aggregate for Structural Concrete Production
- (greenback, 1977; Frondistou Yannas, 1977): Recycled aggregates and recycled aggregate concrete second state-of-the-art report developments 1945–1985
- (Limbachiya, Leelawat et al. 2000); Use of recycled concrete aggregate in high-strength concrete. http://dx.doi.org/10.1617/s11527-021-01871-y.
- (Parekh and Modhera 2011), Assessment I recycled aggregate concrete. https://www.researchgate.net/publication/285432281_Assessment_I_recycled_aggregate_concrete
- (M. C. Limbachiya, T. Leelawat and R. K. Dhi 2000); Use of Recycled and Secondary Aggregates in Concrete. http://dx.doi.org/10.13140/RG.2.1.4378.2166
- (Larbi Belagraa 2013); Study of the Mechanical Performance of a Recycled Aggregate Concrete with Admixture Addition. http://dx.doi.org/10.4236/ojce.2013.32011
- (Bilal Masood,2019) ; Influence of Bentonite on Mechanical and Durability Properties of High-Calcium Fly Ash Geopolymer Concrete with Natural and Recycled Aggregates

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