EXPERIMENTAL INVESTIGATION AND COMPARISON BETWEEN DEMOLISHED AGGREGATES AND ORIGINAL AGGREGATES

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ABSTRACT

Now-a-days Demolished Concrete waste handling and management is a challenging job for all civil masterminds all over the world. Every year a lot of tons of construction concrete waste is produced through demolition of Structures. According to the Building Material Promotion Council (BMPTC), India generates an estimated 150 million tons of construction and demolition (C&D) waste every year. Utilizing this recycled aggregate is certainly an important step towards sustainable development in the concrete industry and management of construction waste. Recycling the Demolished Concrete will reduce the environmental pollution and protect the natural resources. Construction and demolished waste are generated due to natural disasters, or for future development the old buildings are replaced by new ones, and war inflicted damages. The use of recycled aggregate obtained from the waste concrete, as a component of the new concrete mixture, implies a thorough understanding of its fundamental properties. The main idea of the current research project is concentrated on utilizing the Demolished Concrete waste and reducing the generation of construction waste, and to investigate variability of natural aggregate properties and recycled aggregates properties, collecting Demolished Concrete from the building location. By performing some fundamental procedures like collecting, crushing and sieving for getting the aggregates of required size and shape. Eventually by conducting the physical tests and Mechanical tests on obtained recycled aggregates the properties are determined.

Keywords: *Demolished Concrete waste, recycled aggregate, crushing, sieving, physical tests and Mechanical tests.*

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CHAPTER - I

INTRODUCTION

1.0 BACKGROUND

Concrete is a very strong, composite and versatile mouldable construction material, which is most widely used man-made product in the world. The word Concrete comes from the Latin word "Concretus" which means compact. Production of Thermal pollution from concrete is approximately 8 billion Giga Joule/ year. Thus, by recycling this concrete waste which is generated by demolition of structures is very Economical [6]. There are different methodologies to recycle the concrete waste. This concrete recycling helps to reduce the waste landfill sites and more amount of concrete.

1.1 INTRODUCTION

One of the major summonses of our present society is the protection of nature. Some of the important factors in this aspect are the reduction of the production of waste and consumption of energy and natural raw materials. These aspects are getting considerable attention under sustainable development nowadays. The use of recycled concrete waste aggregates from construction and demolition wastes is showing positive application in construction as alternative to primary (natural) aggregates. It conserves the natural resources and reduces the space required for the landfill disposal [2].

This paper presents the experimental results of physical and mechanical recycled coarse aggregate concrete and results are compared with the natural crushed aggregate concrete.

1.2 WHAT IS RECYCLED AGGREGATE?

Recycled Aggregates is a term that describes crushed cement concrete or asphalt pavement from construction debris that is reused in other building projects. Recycled aggregates can be used for many purposes based on the strength of the aggregates they are

- Pavements
- Building constructions
- Fillings
- constructing gutters

1.3 SOURCES OF RECYCLED AGGREGATES

Construction and demolished waste generally generated due to natural disasters and for the future development of the old buildings which are replaced by new ones [6]. Mainly the war inflected damages can generate lot of waste the best exam is Russia and Ukraine war (Refer Fig 1 to Fig 3).

Fig. 1 concrete waste due to natural disaster

Fig. 2 Concrete waste due to old buildings are replaced by new ones

Fig. 3 Concrete waste due to war inflected damage

1.4 PROPERTIES OF RECYCLED AGGREGATE

The use of recycled concrete aggregate is obtained from the waste concrete, and it is used as a component of the new concrete mixture, which implies a basic understanding of its properties. Which considerate that some of them may significantly different from the properties of aggregates obtained from natural resources. [6] their differences primarily depend on the quantity and quality of cement mortar, which is attached to the grains of recycled aggregate then, on the quality of the original concrete from which the aggregate is made by recycling and also on recycling methods. In many cases where the recycled aggregate comes from many different sources that have uneven quality, i.e., variations in the properties of recycled aggregate may differ with the natural aggregates. The main properties vary due to:

- Quantity and quality of cement mortar.
- Recycling methods.
- Uneven quality.
- Natural aggregates

1.5 BENEFITS OF RECYCLING

Recycling is very beneficial in concrete industries. There are so many benefits in recycling the aggregates, some of them are:

- Saves natural resources
- Economic benefits
- Saves space for waste disposal
- Sustainability
- saves energy

CHAPTER - II

STATE OF THE ART

2.0 GENERAL

Several pieces of research have been made and numerous reports were submitted regarding the advantages of using recycled aggregates in construction industry. Adding further, the crucial anchor is comparing the properties of natural aggregates and artificial aggregates.

2.1 INFERRED LITERATURE REVIEW

Mukesh limbachiya (2000) published a paper on "Use of recycled concrete in highstrength concrete" in Materials and Structures - The results of a test programme to study the use of recycled concrete aggregate (RCA) in high-strength, 50 N/mm2 or greater, concrete is described. The effects of coarse RCA content on the ceiling strength, bulk engineering and durability properties of such concretes have been established. The results showed that up to 30% coarse RCA had no effect on concrete strength, but they're after there was a gradual reduction as the RCA content increased. A method of accommodating the effects of high RCA content, involving simple adjustment to water/cement ratio of the mix is given [1].

Amnon katz (2003) Published a paper on "Properties of concrete made with recycled aggregate from partially hydrated old Concrete" in Cement and Concrete Research - having a 28-day compressive strength of 28 Mpa was crushed at ages 1, 3 and 28 days to serve as a source of aggregate for new concretes, simulating the situation prevailing in precast concrete plants. The properties of the recycled aggregate and of the new concrete made from it, with nearly 100% of aggregate replacement, were tested [2].

Xiao, J. Z, et al (2006) Published a paper on "Relationships between the mechanical properties of recycled aggregate concrete: An Overview" in Materials and Structures - The paper examines the factors affecting the physical, chemical, mechanical, permeation and compositional properties of recycled aggregates sourced from construction and demolition waste, intended for concrete production. Classifications based on their composition and contaminants have been studied. The data were collectively subjected to statistical analysis and a performance-based classification, mainly for use in concrete construction, is proposed.

The results allowed producing a practical means of measuring the quality of recycled aggregates, which can be used to produce concrete with predictable performance [3].

Abbas, A., Fathifazl, et al (2009) Published a paper on "Durability of Recycled aggregate concrete designed with equivalent mortar volume method" in Cement & Concrete Composites - Results of a comprehensive investigation about the durability of structural-grade concrete made with recycled concrete aggregate (RCA) are presented. The RCA-concrete mixes were proportioned using a new concrete mix design method, termed the equivalent mortar volume (EMV) method [4].

Qasrawi, H., & Marie, I. (2013) Published a paper on "Towards better understanding of concrete containing recycled concrete aggregate" in Advances in Materials and Science Engineering - The effect of using recycled concrete aggregates (RCA) on the basic properties of normal concrete is studied. First, recycled aggregate properties have been determined and compared to those of normal aggregates. Except for absorption, there was not a significant difference between the two. Later, recycled aggregates were introduced in concrete mixes. In these mixes, natural coarse aggregate was partly or totally replaced by recycled aggregates. Results show that the use of recycled aggregates has an adverse effect on the workability and air content of fresh concrete [5].

Babak Rouhi Broujeni, et al (2016) Published a paper on "Construction and Demolition waste Management" in Engineering Technology & Applied science research - Journal of Solid Waste Technology and Management 42In Tehran, an average of about 50,000 tons per day of construction and demolition wastes are produced from which over 30,000 tons per day are dumped in landfills. According to the research, more than 57% of these construction and demolition wastes are placed in the first category (non-dangerous waste) and have the potential for being recycled and reused. This article provides some management solutions including proposing methods for collecting and reusing construction waste in accordance with current market needs in Iran. The main aim of this paper was to show that the existing C&Ds have good potential for being reused and recycled [6].

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Er. Rajan Vinayak1, Er. Gurprit Singh Bath2, et al (2017) Published a paper on
"Comparision of properties between Natural aggregates & Recycled aggregates" in International Journal of Innovative and emerging research in Engineering - This paper shows the Effective utilization of waste concrete can be obtained by recycling the waste concrete to the aggregates. Whereas

the natural aggregates are decreased and there is critical shortage for production of new concrete and deteriorated structures create very serious problem. They crushed the waste concrete into aggregates of different sizes, Aggregates has its own properties depending on the various sizes. They discussed the properties and tests of the RCA. Finally, they concluded that the Recycled Aggregates can be used in place of Natural Aggregates in the fresh concrete [8].

Punitha P (2019) Published a paper on "Study of Natural aggregates and testing of Recycled aggregates" in International journal for Research & Development in Technology - In this research concrete waste is from the demolished structure has been collected and coarse aggregate of fully replaced and used for preparing fresh concrete. This paper gives the details about sources of natural aggregates, recycled aggregates and its properties. It also gives importance of RCA and the test which are to be conducted in RCA. Finally, the tests had been conducted on the collected sample waste and tests results are mentioned [9].

F. De Larrard, H. Colina, et al (2019) Published a paper on "Concrete Recycling" - There are various patterns of construction and demolition waste (CDW) recycling plants combining different stages of the process like extraction of metallic elements and light elements, crushing, screening and clay flocculation. While most recycled plants have very simple processes and are hard to combine all the previous equipment's, processes that are more complex could be proposed in practice and / or in the scientific literature [10].

Chen, W, et al (2019) Published a paper on "Adopting recycled aggregates as sustainable construction material : A review of the scientific literature" This study summarized the existing research topics focusing on RA, gaps of current research, suggestions for promoting RA usage, and research directions for future work. A research framework was also proposed linking the existing research themes into trends in RA research. This review work serves as a foundation work to bridge the gap between scientific research and industry practice, as well as to guide the directions in RA-related academic work using an interdisciplinary approach [11].

Mohammed Seddik Meddah (2020) Published a paper on "Recycled Concrete Aggregates and Their Influences on Performances of Low and Normal Strength Concretes". It is mentioned that using up to 30% of the RCA indicated no significant negative impact on the key mechanical and durability properties of the RCA-concretes, even some strength enhancement was observed up to 50% replacement ratio [12].

Sajjad Pourkhorshidi (2020) Published a paper on "Using Recycled aggregates from construction and demolition waste in Unbound layers of Pavements" This literature tells that use of CDWs in the construction of pavements has proven to be a viable solution to exploit their residual positive properties. The recycling processes and the correct classification and selection of the raw waste materials is of great importance in the quality of the final product, i.e., of the constructed layers. Minor additional caution should be used when their use is foreseen in foundation or base layers [13].

A.H. Buller, et.al (2020) Published a paper on "Reuse of construction anmd demolished waste as aggregates in concrete : A review" in International journhal of computer engineering in research trends - This literature reveals that the use of demolished construction waste in concrete as a coarse aggregate with the different percentage (0% to 100%), but the use of 50% Recycled aggregates in concrete replaced with natural aggregates has a satisfactory result in green concrete. The percent difference of water absorption NCA and RCA is recorded equal to 117%. The test results are mentioned [14].

Marija Nedeljkovi, Jeanette Visser, et al (2021) Published a paper on "Use of fine recycled concrete aggregates in concrete: A critical review in Journal of Building Engineering - This paper discusses the state-of-the-art of the fine recycled concrete aggregates (FRCA), focusing on their physical and chemical properties, engineering properties and durability of concretes with FRCA. This paper sets the foundations for better understanding the quality of FRCA obtained either from parent concrete specifically produced in the laboratory, with controlled crushing and sieving of the recycled aggregates or from field structures [15].

Syed Minhaj SaleemKazmi, et al (2022) Published a paper on Recycled aggregate concrete: mechanical and durability performance" in Handbook of Sustainable Concrete and Industrial Waste Management Recycled and Artificial Aggregate - Recycling construction and demolition waste in the production of recycled aggregate concrete is an attractive approach in terms of environment and economy. However, the inferior properties of recycled aggregate concrete are a big hurdle in replacing the natural aggregates with recycled aggregates. Currently, the structural applications of recycled aggregate concrete are quite limited. This chapter discusses the reasons behind the inferior mechanical and durability performance of recycled aggregate concrete [16].

CHAPTER - III

METHODOLOGY

3.0 RECYCLING MATERIALS

Before performing the methodology, we need to collect the materials required for the testing process. We have collected raw concrete waste from the demolished building site in our locality (Refer Fig 4). For recycling process, we need the concrete aggregates of a particular type. We have opted slab concrete aggregate for our project (Refer Fig 5).

Fig. 4 Demolished concrete waste.

Fig. 5 Slab concrete waste.

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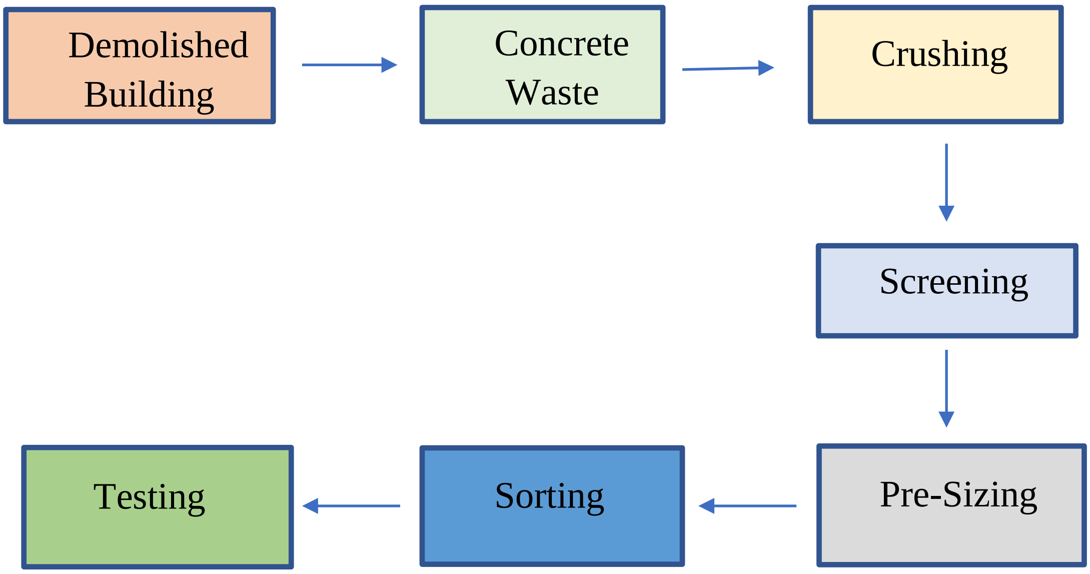
3.1 METHODOLOGY

Before conducting the tests to the concrete waste, we need to recycle the concrete waste using methodology [12]. This methodology is opted to crush the concrete waste into particular sizes and clean them for the testing process.



3.1.1 The use of recycled aggregates from construction and demolition wastes is showing prospective application in construction as alternative to primary (natural) aggregates. For that the first step is to collect the raw concrete waste from the selected demolished building.

3.1.2 Crushing

After the aggregates are collected then the next step is we need to break the aggregates into required sizes. Strike the slab with a sledge hammer about 12 inches from the point where the pickaxe touches the underside of the slab. Do this repeatedly, and after a short time the slab will break up into small pieces. For our project we broke the pieces into nearly 20mm to 40mm sizes (Refer Fig. 6).

Fig: 6 Crushing of aggregates

3.1.3 Screening

Waste concrete recycling Screening is the second unit operation in large waste management. If the amount of recycled waste is more then we can use mechanical Screens. The main purpose of screening is to remove solid materials that could Cause damage to performance level of the concrete.

Fig: 7 Screening of aggregates

3.1.4 Pre-Sizing

After the screening process completed now have to pre-size the crushed aggregates. Based on our requirements we have to check the sizes nearly if the aggregates don't meet our requirements, then again, we need to crush the aggregates which doesn't pass pre-sizing.

Fig 8: Pre – sizing of aggregates

3.1.5 Sorting

Using sieves, we need to sort the aggregates for our required sizes after the completion of the step pre-sizing. Now the aggregates are ready for the testing process to find their strength

Fig 9: Sorting of aggregates

3.1.6 Testing

After the completion of all the steps then the recycled aggregates are prepared and that are used for the Experimental investigation. Use these aggregates we need to conduct the physical and mechanical tests (Refer Fig. 9)

Fig. 10 Aggregates ready for testing

CHAPTER - IV

EXPERIMENTAL INVESTIGATION

4.0 ANALYSIS OF EXPERIMENTAL INVESTIGATION

STEP 1: First we need to arrange the number of recycled aggregates is required for the experimental investigation.

STEP 2: We have to conduct different physical and mechanical tests to find the strength and water content properties.

STEP 3: The results for each test has to be noted down and find the suitability of aggregates for each test.

STEP 4: Finally, the results of recycled aggregates have to be compared with natural aggregates and check wheatear it is suitable for recycling are not.

4.1 TESTS TO BE CONDUCTED

We have conducted physical and mechanical tests to find the strength and suitability of the aggregates.

Physical Tests: Physical tests are conducted to know the basic properties of aggregates include surface texture and grain shape, dustiness, porosity, frost resistance, resistance to abrasion and polishing.

Mechanical Tests: Mechanical tests are conducted to find the strength, toughness, resistance and durability of the aggregates.

4.2 PHYSICAL TESTS

- Sieve Analysis (IS: 383(1970))
- Specific gravity and water absorption (IS:2386:part-3(1963)) Flakiness and Elongation Index (IS:2386: Part-1(1963))

4.2.1 Sieve Analysis

The sieve analysis determines the gradation (the distribution of aggregate particles, by size, within a given sample.

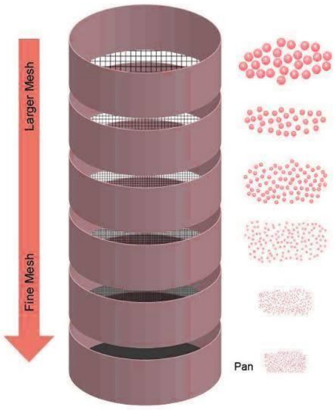


Fig .11 Sieve analysis Apparatus.

Test procedure

- Before conducting this test make sure the collected and crushed material is aware of moisture content make sure it is dry.
- The crushed raw material of 2kg is taken for the test.
- Now the weighted material is placed on the sieve of order 80mm, 40mm, 20mm, 10mm, and 4.75mm respectively in required Quantity.
- Make sure the upper surface is covered with lid to not to fall off from edges.
- By circulating the sieve stack in clock and anti-clock wise perform the sieve analysis (Refer Fig 11 to Fig 13).
- Note down the values retained on each sieve.

Fig .12 Weighing the aggregates

Fig .13 Sieving the aggregates

4.2.2 Specific gravity and water absorption

Specific gravity test of aggregates is done to measure the strength or quality of the material while water absorption test determines the water holding capacity of the coarse and fine aggregates.

Fig .14 Specific Gravity and Absorption test Apparatus

Test procedure

- About 2 kg of aggregate sample is washed thoroughly to remove fines, drained and placed in wire basket and immersed in distilled water at a temperature between 22- 32º C and a cover of at least 5cm of water above the top of basket.
- Immediately after immersion the entrapped air is removed from the sample by lifting the basket containing it 25 mm above the base of the tank and allowing it to drop at the rate of about one drop per second. The basket and aggregate should remain completely immersed in water for a period of 24 hour afterwards.
- The basket and the sample are weighed while suspended in water at a temperature of 22° – 32°C. The weight while suspended in water is noted = W1g.
- The basket and aggregates are removed from water and allowed to drain for a few minutes, after which the aggregates are transferred to the dry absorbent clothes. The empty basket is then returned to the tank of water jolted 25 times and weighed in water= W2 g.
- The aggregates placed on the absorbent clothes are surface dried till no further moisture could be removed by this cloth. Then the aggregates are transferred to the second dry cloth spread in single layer and allowed to dry for at least 10 minutes until the aggregates are completely surface dry. The surface dried aggregate is then weighed = W3 g
- The aggregate is placed in a shallow tray and kept in an oven maintained at a temperature of 110° C for 24 hrs. It is then removed from the oven, cooled in an air tight container and weighted=W4 g.

Fig .15 Dipping the aggregates

Fig .16 Soaking the for 24hr in water (25 times)

4.2.3 Flakiness and Elongation Index

This test is used to determine the particle shape of the aggregate and each particle shape being preferred under specific conditions.

Fig .17 Flakiness and Elongation test Apparatus.

Preparation of material

- Prepare aggregate sample for the test by sieving between IS sieve 6.3 mm size at the bottom and 63 mm IS sieve at top.
- A separate sample retains on each sieve.
- The collected aggregate sample should have at least 200 numbers of individual aggregate for accurate test results from each range of IS sieve (Refer Fig .16).
- We take a range of aggregate samples retained on 6.3 mm IS Sieve.
- Take the weight of the total aggregate sample collected for tests as W1.

Test procedure for Flakiness index

Try to pass the aggregate width-wise through the slot of 10 mm to 6.3 mm on a flakiness gauge. A separate sample passed through this slot and weight (W2) (Refer Fig .17 to Fig .18).

Fig .18 Aggregate Sample

Fig .19 Separating the passed Aggregates

Test procedure for Elongation index

Try to pass the aggregate lengthwise through the slot of 10 mm to 6.3 mm on the length gauge. A separate sample retains on this slot and weighted it(W2) (Refer Fig .17 and Fig 19).

Fig .20 Separating the retained aggregates

4.3 MECHANICLE TESTS

- Crushing Value Test (IS:2386:part-4(1963))
- Los Angeles Abrasion (IS:2386) (Part IV) – 1963
- Impact Value Test (IS:2386-4 (1963) part-4)

4.3.1 Crushing Value Test

Aggregate crushing value is defined as the percentage by weight of the crushed (or finer) material obtained when the test aggregates are subjected to a specified load under standardized conditions, and the strength of the aggregate used in road construction is expressed by numerical index.

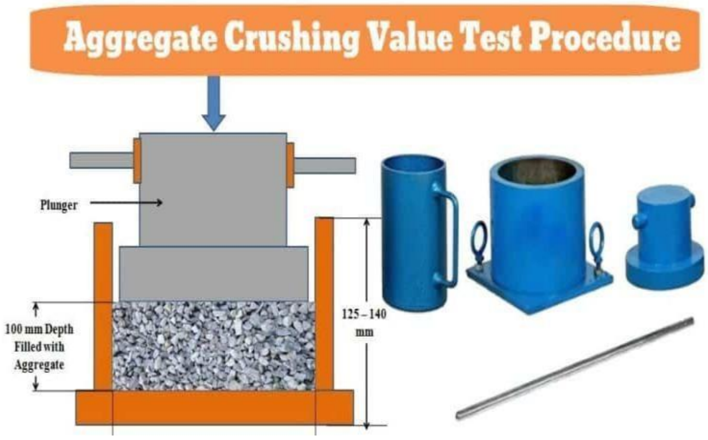


Fig .21 Crushing Value Test Apparatus

Test procedure

An aggregate sample passing through a 12.5 mm IS sieve and retained on a 10mm IS sieve is selected for the process.

- To fill the cylindrical measure mould 3-4 Kg of sample aggregate is sufficient.

- Place a steel cylinder with a plunger on the loading plate of the compression testing machine (Refer Fig .21).
- Operate Compression machine such that 40 tonnes of the load is applied on aggregate in approximately 10 min (Refer Fig .22).
- Take out the crushed aggregate sample and sieve on with 2.36mm IS sieve (Refer Fig .23).

Fig .22 Filling the cylinder with aggregate

Fig .23 Strokes given using Tamping rod

Fig.24 Load is applied using CTM

4.3.2 Los Angeles Abrasion

The Los Angeles (L.A.) Abrasion Test is widely used as an indicator of the relative quality of aggregates. It measures the degradation of standard gradings of aggregates when subjected to abrasion and impact in a rotating steel drum with an abrasive charge of steel balls.

Fig .25 Los Angeles Abrasion test Apparatus

Test procedure

2.5 kg of sample is taken for the test process

- Sample is placed in the abrasion machine along with the steel balls The abrasion machine rotates 30 to 33 revolutions per minute.
- The machine is stopped after the desired number of revolutions and material is discharged to tray (Refer Fig .25).
- The material coarser than 1.7mm sieve is weighted (Refer Fig.26).

Fig.26 Sample after 500 revolutions

Fig .27 Dry sample is taken out sieved and weighed

4.3.3 Impact Value Test

The aggregate impact value is a determining measure of resistance to sudden impact or shock, which may differ from its resistance to gradually applied compressive load.

Fig .28 Impact Value test Apparatus

Test procedure

- 0.5 kg of recycled aggregates are taken for the test.
- Using impact testing machine give 15 blows at an interval of not less than one sec between 1 sec gap (Refer Fig .28).
- Remove the crushed aggregate from the vessel and pass it through 2.36 sieve.
- Note the values of the results.

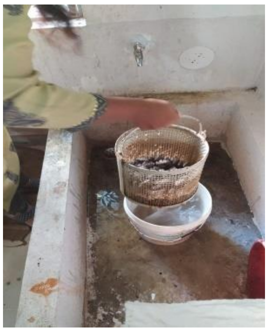
Fig .29 Applying Impact load to aggregates

4.3.4 GLIMPSE OF TESTS

1. PHYSICAL TESTS

a) Sieve Analysis :

b) Specific gravity and Water absorption Test :



c) Flakiness and Elongation Test :

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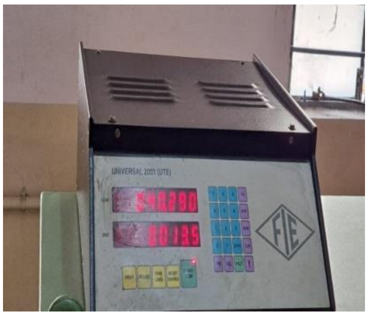
2. MECHANICAL TESTS

a) Crushing Value Test :



b) Los Angeles Abrasion Test :

c) Impact Value Test :

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CHAPTER - V RESULTS AND DISCUSSIONS

5.0 RESULTS OBTAINED FROM TESTS

In this chapter the results which are obtained from the tests are discussed.

5.1 SIEVE ANALYSIS RESULTS FOR RECYCLED AGGREGATES

Table 1**:** Sieve analysis results

Sieve sizes (mm)	**Weight Retained in kg**	**Cumulative weight retained in kg**	**Cumulative % retained**	**Cumulative % passing**
80	0	0	0	100
40	0	0	0	100
20	1.510	1.510	74.38	25.62
10	0.433	1.943	95.714	4.286
4.75	0.087	2.030	100	0
2.36	0	2.030	100	0
0.6	0	2.030	100	0
0.3	0	2.030	100	0
pan	0	2.030	100	0
Total	2.03		670.094	

Calculations

Fineness Modulus = Cumulative % retained /100

Fineness Modulus = 670.094/100

Fineness Modulus = 6.7

Table 2: Standard values for Natural Aggregates.

Maximum size of coarse aggregate	Fineness modulus range
20mm	6.0 – 6.9
40mm	6.9 – 7.5
75mm	7.5 – 8.0
150mm	8.0 – 8.5

 Fineness modulus of 6.7 means the average size of particle of the coarse aggregate sample is in between 5^{th} and 6^{th} sieves that is between 10mm to 20mm.

5.2 SPECIFIC GRAVITY AND WATER ABSORPTION RESULTS FOR RECYCLED AGGREGATES

Table 3: Specific gravity and water absorption results

S. No	Observations	Weight in Kg
1.	Weight of the container + Sample + Water (W1) =A	3.372
2.	Weight of wet container (W2) = B	2.754
3.	Weight of surface dried aggregates (W3) = C	0.990
4.	Weight of dry aggregates (W4) = D	0.882

A = weight of sample + vessel + water = 3.372Kg B = weight of vessel and water = 2.754Kg

C = weight of saturated surface dry sample = 0.990Kg

D = weight if oven dry sample = 0.882kg

Calculations

Specific Gravity = D/(C-(A-B))

= 0.882/ (0.990- (3.372-2.754))

= 2.3

Water Absorption = C-D/D

= 0.990-0.882/0.882

Water Absorption = 12.2%

 Generally Specific gravity of coarse aggregate normally used in road construction ranges from about 2.5 to 3.0 with an average of about 2.68.

5.3 FLAKINESS INDEX RESULTS FOR RECYCLED AGGREGATES

Table 4: Flakiness index results

Size of Aggregates	Corresponding thickness gauge size (mm)	Total weight of aggregates retained in sieves (in kg)	Total weight of aggregates passed throw gauge (in kg)
40-20	6.95	3.36	0
20-16	10.8	1.70	0.790
16-12.5	8.55	0.270	0.181
12.5-10	6.75	0.10	0.018
Total		5.43	0.989

Calculations

$$\text{Flakiness Index} = \frac{\text{Total weight of aggregates passed through gauge X 100}}{\text{Total weight of aggregates reatined on sieves}}$$

Flakiness Index = 0.989/5.43 x 100

Flakiness Index = 18.2 %

5.3.1 Elongation Index Results for Recycled Aggregates

Table 5: Elongation Index Results

Size of Aggregates	Corresponding thickness gauge size (mm)	Total weight of aggregates retained in sieves (in kg)	Total weight of aggregates retained throw gauge (in kg)
40-20	40.5	3.36	0
20-16	32.4	1.70	0.690
16-12.5	25.6	0.270	0.170
12.5-10	20.6	0.10	0.027
Total		5.43	0.817

Calculations

$$\text{Elongation index} = \frac{\text{Total weight of aggregates retained on gauge X 100}}{\text{Total weight of aggregates reatined on sieves}}$$

Elongation Index = 0. 817/5.43 x100

Elongation Index = 15.1 %

5.4 CRUSHING VALUE TEST RESULTS FOR RECYCLED AGGREGATES

Weight of mould + Aggregates (W1) = 11.398 Kg.

Weight of the Empty mould (W2) = 8.398 Kg.

Weight of the aggregate passing through 2.36mm sieve (W3) = 0.074 Kg

Aggregate Crushing value = W3 / (W1 – W2) * 100

= 0.074 / 3 * 100

= 2.466 %

Table 6: Aggregate Crushing Value standard results

Aggregate Crushing Value (%)	Quality of Aggregate
< 10	Very strong
10 – 20	Normal
> 20	Poor

- The obtained Aggregate Crushing Value (ACV) is 2.466%.
- From the above table as the obtained value is <10% we conclude that the Quality of the aggregate is Very strong.
- Hence the aggregate is suitable for road and building construction purposes.

5.5 LOS ANGELS ABRASION TEST RESULTS FOR RECYCLED AGGREGATES

Original weight of Aggregates (W1) = 2.5kg

Weight of Aggregates passing through 1.75mm sieve (W2) = 1.026kg

Abrasion Value = W2 / W1 *100

Abrasion Value = 1.026 / 2.5 *100

Abrasion Value = 41.01 %

 The results indicate that the Abrasion degradation of the material. The aggregate was 41.01%. As per IRC (Indian Road Congress) specifications the standard values limit rages are considered.

Table 7: Suitability for the Test Result Obtained

Test	Value	Suitability
Los Angeles Abrasion test	41.01%	WBM surfacing course Bituminous penetration macadam

5.6 IMPACT VALUE TEST RESULTS FOR RECYCLED AGGREGATES

Original weight of Aggregates (W1) = 0.5kg

Weight of Aggregates passing through 2.36mm sieve (W2) = 0.1kg

Impact Value = W2/W1 *100

Impact Value = 0.5/0.1 *100

Impact Value = 20 %

- We have obtained the value of 20% for Impact test. As per the IRC recommendations the suitability is mentioned.

Table 8: Standard value classifications

Aggregate impact value (%)	Classification
<10	Exceptionally Strong
10 – 20	Strong
20 – 30	Satisfactory for Road Surfaces
>35	Weak for road Surfacing

Table 9**:** Suitability for the Test result obtained

Test	Value	Suitability
Impact value test	20%	Bituminous surface dressing penetration macadam, bituminous carpet concrete.

5.7 COMPARISON BETWEEN NATURAL AGGREGATES AND DEMOLISHED AGGREGATES

The recycled aggregates results are obtained from the tests and these recycled aggregates results are compare with the natural aggregates standard values.

Table 10: Comparison between Natural Aggregates and Demolished Aggregates

Test Conducted	Natural Aggregates (Strong)	Demolished Aggregates
Fineness Modulus	5.5 to 8.0	6.7
Specific gravity and water absorption	2.5 – 3.0, 0.1 – 2%	2.3, 12.2%
Flakiness Index Elongation Index	below 15% below 15%	18.2% 15.1%
Crushing value Test	Ranges	2.466%
Los Angeles Abrasion Test	Ranges	41.01%
Impact Value Test	Ranges	20%

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CHAPTER - VI

CONCLUSION

Every year hundreds of million tons of construction and demolition waste is produced in the country and around 7000 tons of waste per month is generated from the construction industry. The increase in waste every year is leading us to face numerous hazardous issues on the earth. To minimize this problem and also for better sustainable development of constructions there needs to be an alternative method through which the process of disposal of construction and demolition waste can be short numbered by making the right use of it. One of such method is recycling the demolished material into building and construction materials like different aggregates for different works. And through detailed experimental study on the process of making and testing the recycled demolished construction aggregates we can understand the possibility of replacing the natural aggregates with the recycled aggregates from construction demolition waste.

Recycling aggregate from demolished waste can help economically by saving aggregate costs, the transportation costs compared to natural aggregates and also plays a key role in sustainable development of the community. As the difference is not very significant the recycled aggregates are a good replacement for the natural aggregates.

- The fineness modulus test value is found to be 6.7 for the recycled aggregates and ranges from 5.5 to 8.0 for the natural aggregates.

- The specific gravity value of recycled aggregates is found to be 2.46 where it is 0.04 lesser than the natural aggregate range value (i.e., 2.5 to 3.0).

- The water absorption value of recycled aggregates is 4.2% which is 2.2% more than the natural aggregates value range (i.e., 0.1 to 2%).

- The flakiness index value is found to be 18.2% for Recycled Aggregates which is 3.2% more than the natural aggregates value range (i.e., below 15%).

- The elongation index value is found to be 15.1% for Recycled Aggregates which is 0.1% more than the natural aggregates range (i.e., below 15%).

- The Crushing test value is found to be 2.466% for Recycled Aggregates and less than 10 % is the range value for natural aggregates.

- 7)The abrasion test value is found to be 41.01% for the recycled aggregates and 40% to 50% is the range value for natural aggregates.

- The impact test value is found 20% for Recycled Aggregates and 20% to 30% is the range value for natural aggregates.

From this experimental investigation we can show that the construction and demolition waste can be recycled and used as aggregates for numerous constructions works and we can hence reduce the production of waste from the construction industry. Through this method of waste reduction, we can also minimize several economic and environmental issues every year caused by disposing the waste in open lands and the requirements for aggregates will also be easily satisfied from creating a new kind of aggregate from recycling the demolished material waste.

Partial replacement of recycled aggregates with natural aggregates is the preferable method of using recycled aggregates in construction. Since the recycled aggregates were already used the strength will be a bit less compared to natural aggregates to balance the lack of its strength partial replacement have to be done.

FUTURE SCOPE

- The experimental investigation of recycled aggregates in this paper are taken from a specific part of the construction that is slab. Other concrete parts like columns, plastering, walls etc. of the construction can also be analysed for using as recycled aggregates.
- If the recycled aggregates don't obtain enough strength characteristics, then the recycled aggregates strength can be improved with the help of Admixtures which enhances the strength capacity.

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