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Enhancing Recycled Concrete Performance by Using Chemical Activators

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ABSTRACT

The need for sustainable and eco-friendly construction materials and processes is rising significantly. In these circumstances, recycling of concrete can be a lifesaver. Although, various recycling techniques have already been introduced. But none of them can fulfill the term recycle refers to. They mostly focus on merely reusing coarse aggregates (CA) or fine aggregates (FA). To come out of this, this paper is focused not only on the reuse of both coarse and fine materials (RCA, RFA) but also on introducing a new process in which those materials can be used in their old form, as recycling refers to. In this experiment, we use all kinds of materials recollected from recycled concrete (fine, coarse, recycled cement particles). Those materials are vetted into two parts. One is for recycling coarse aggregates and one is for rebuilding concrete using recovered fine, coarse, and cement particles. First, we discuss the collection and treatment system procedure of recycled demolished concrete. The second part will consist of various standardized tests for reuse and evaluation. The third part will describe the treatment needed for the materials for chemical (Using Na_2SiO_3, NaOH, and Na_2CO_3) reactivation. Finally, we will test the recycled material's performance as concrete and establish an authentic process of recycling and reusing concrete materials. With that, we obtain the most optimum usage of recycled concrete aggregate mixing ratio Cement: CA (coarse aggregate): RCA (recycled coarse aggregate): FA (fine aggregate): RFA (recycled fine aggregate) is 1: 2: 2: 0.8: 1.2: 0.8 (With molar solution of Na_2SiO_3 and NaOH + KOH) and other ration of mixing with their respected properties (Compressive Strength).

INTRODUCTION

The demand for houses and major infrastructure projects increases the amount of construction waste. Consequently, concrete waste has evolved into a global environmental hazard that necessitates a rapid response. Concrete waste that is not properly disposed of can be harmful to the environment. As a result, concrete waste is a source of pollution that, if not managed properly, can become a major problem in any country.

About 0.9 tons of carbon dioxide is produced for every 1 ton of cement. Carbon dioxide is one of the greenhouse gases that is responsible for global warming. As cement is the main binding material of concrete we can't stop or reduce it's production. However, the concrete results from this study will require less cement than usual. It can reduce the production of cement by 30 percent as well as the emission of greenhouse gases by 28 percent.

Aggregates are mined from the rock mines, and the rate at which concrete is produced will significantly reduce naturally occurring materials. Disposal of construction and demolition waste has become a major problem these days, according to the report of the Technology, Information, Forecasting, Assessment Council the total amount of waste from the construction industry is estimated to be 12 to 14.7 million tons per annum. Out of which 7.8 million tons are concrete and brick waste. Because of the increasing problems caused by this waste, many countries have started researching how to use these materials as sources. The resulting concrete from the study will create a cycle or chain for coarse aggregates like gravel, stone and bricks. This will reduce mining and the depletion of these mining resources. Implementation of this study could reduce landfill spaces by 30-40 percent.

Since concrete waste is seen as having little or no value, contractors may opt to dispose of it in landfills rather than recycling facilities. Furthermore, contractors and project owners may suffer additional costs as a result of managing concrete waste. In this context, treating concrete waste is no longer an option but is required. It is estimated that construction and demolition debris is about 15-30% of all solid waste by weight, and it represents a significant component of municipal solid waste. Construction waste is also a cost to the environment that threatens its resilience. The implementation of this study can reduce the construction cost by up to 35 to 45 percent. Moreover, the recycling process can create an employment opportunity with a higher future in the construction industry.

To solve all of these problems, our experiment is divided into four major parts to obtain the optimum solution.

In the first part, we will introduce different types of dismantling or crashing processes with different crushers like primary crusher, heating girders, eccentric rotor-type mechanical grinder, screw mill, wet scrubber/levigator and smart crusher. We will also describe our collection process from different construction sites and landfills. Moreover, the percentage of different materials present in the waste and their quality evaluation will also be done. In the second part, we will test the quality of the materials (coarse) by various standardized tests such as impact

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value test, specific gravity test and water absorption test, Los Angeles abrasion test. For fine aggregate grading, deleterious substances and soundness tests will be conducted.

In the third part, we will reactive cement particles present in the dust and fine particles to enhance the strength of the concrete made by it. For this, we will use mechanical, thermal and chemical reactivation. We will compare these activation methods and also recommend the most suitable one to be implemented.

And finally, we will make concrete blocks of different ratios of recycled fine, recycled coarse and cement to test. With the test results, we will represent different concrete mix processes with their representative compressive strength. As mentioned, different studies are only focused on recycling coarse particles whereas we will recycle the concrete waste at an optimum rate. Besides, the present cement particles also reduce the demand for binding materials like cement which could be economically beneficial.

LITERATURE REVIEW

Shima, Tateyashiki, Matsuhashi, & Yoshida, 2005 introduced a method of recycling concrete. To promote the recycling of concrete, a technology to produce high-quality recycled aggregate had been developed. This technology employs the heating and rubbing method (Shima, 2005).

Hasan, Sagar, & Ray, 2022 showed the current condition of construction waste management and its barriers and future threads to to the industry as well as the environment (Hasan, 2023).

Sajedi & Razak, 2011 compared three methods for activation of OPC-slag mortars (OSM): (a) prolonged grinding of binders (mechanical method), (b) elevated temperature curing of mortars (thermal method), and (c) use of chemical activators such as NaOH, KOH, and Na_2SiO_3, 9.35H2O (chemical method) (Sajedi, 2011).

Chowdhury, Raihan, Islam, & Ramiz, 2016 investigated current landfill usage, predicted future condition of Bangladesh and compares to the other countries of the world (Chowdhury, 2016, December.).

Tam, 2008 described economic benefits of recycling waste concrete and their future possibilities (Tam, 2008).

Yuan, Lu, & Xue, 2021 developed a big data-probability (BD-P) model to estimate construction waste composition based on bulk density (Yuan, 2021).

Menard *et al.*, 2013 presented alternative methods for the processing of concrete waste. The mechanical stresses needed for the embrittlement of the mortar matrix and further selective crushing of concrete were generated by either electric impulses or microwaves heating. Tests were carried out on lab-made concrete samples representative of concrete waste from concrete mixer trucks and on concrete waste collected on a French demolition site (Ménard, 2013).

Jin & Chen, 2015 discussed the current status of concrete recycling in the U.S. construction industry based on results from a two-part questionnaire survey. The first part of the survey collected information on the recycling practices of surveyed concrete companies. The second part adapted questions from a study conducted in Australia and Japan to examine the awareness, benefits, difficulties, and recommended methods related to concrete recycling (Jin, 2015).

Badraddin, Rahman, Almutairi, & Esa, 2021 aimed to highlight challenges to concrete recycling (Badraddin, 2021).

Lotfi, Eggimann, Wagner, Mróz, & Deja, 2015 concentrated on the second demonstration project of C2CA, where EOL concrete was recycled on an industrial site. After recycling, the properties of the produced Recycled Aggregate (RA) were investigated, and results were presented (Lotfi, 2015).

Aamer Rafique Bhutta *et al.*, 2013 developed porous concrete with acceptable permeability and strength using recycled aggregate from waste crushed concrete (Bhutta, 2013).

Ahmed, Tiznobaik, Huda, Islam, & Alam, 2020 described two full-scale field studies of the foundation system and municipal sidewalk constructed with recycled aggregate concrete (RAC) are presented. In addition to this, the long-term performance of RAC examined for 5 years in terms of in-place comparative strength is reported (Ahmed, 2020).

Rabbani, M. L. (2017) examined on low cost roofing system. In this studied he casted several low cost slab. In this purposes he use concrete without reinforcement.

Sun, Chen, Xiao, & Liu, 2020 evaluated the feasibility of preparing self-compacting concrete (SCC) by incorporating waste concrete recycling materials (Sun, 2020).

Kou, Poon, & Chan, 2007 tried to methodically outlining findings on the impact of including Class F fly ash on the characteristics of concrete, one may overcome the shortcoming of the use of recycled aggregates (Kou, 2007).

Singh, Ishwarya, Gupta, & Bhattacharyya, 2015 described the opportunities for using geopolymers created by the alkaline activation of aluminosilicates in building construction are provided together with a review of recent developments in the field (Singh, 2015).

Zhao *et al.*, 2020 evaluated the industrial scale manufacturing of new blocks, the viability of employing RCA derived from existing precast concrete blocks (Zengfeng, 2020).

Nixon, 1978 reviewed the current level of knowledge on the use of recycled concrete as an aggregate in fresh concrete, it was suggested what more research is required before a proper evaluation of the material can be made (Nixon, 1978.).

Sagoe-Crentsil, Brown, & Taylor, 2001 described about concrete built with synthetic fine sand and recycled coarse concrete aggregate had undergone performance testing for both its fresh and hardened qualities (Sagoe-Crentsil, 2001).

Limbachiya, Leelawat, & Dhir, 2000 demonstrated how the inclusion of coarse RCA affects the durability, bulk engineering, and ceiling strength of such concretes (Limbachiya, 2000.).

Shi *et al.*, 2016 reviewed the available enhancement methods for recycled concrete aggregate and identifies their benefits and drawbacks to make it easier to choose and create new, effective enhancement techniques for recycled concrete aggregate (Shi, 2016.).

Shi, Jiménez, & Palomo, 2011 reviewed five types of alkaline cements were available. Additionally covered were the basic chemical and structural properties of aluminosilicate- based alkaline cements, as well as the most significant developments in our knowledge of synthetic gels. In the end, the article concluded that hybrid cements were a technologically sound building material (Shi C. J., 2011).

Baikerikar, 2014 evaluated quick overview of green concrete and it's benefits and drawbacks (Baikerikar, 2014.).

Verian, Ashraf, & Cao, 2018 described the possibilities and difficulties of replacing natural aggregate (NA) in concrete mixes with recycled concrete aggregate (RCA). (Verian, 2018)

Serpell & Lopez, 2013 reviewed the results of a fractional factorial experiment intended to screen variables for their impact on the strength created by pastes including components activated from hydrated cement pastes obtained from laboratories (Serpell, 2013.).

Elahi, Hossain, Karim, Zain, & Shearer, 2020 evaluated the construction of the materials and AAB's new features. Fly ash, slag, metakaolin, silica fume, rice husk ash, palm oil fuel ash, and other pozzolans are examined for their chemical, physical, and mineralogical characteristics in order to create AAB (Elahi, 2020.).

Yang, Song, & Song, 2013 reviewed an evaluation process for AA concrete's CO_2 reduction. From conception through pre-construction, every stage was taken into account by the analyzed system. (Yang, 2013)

Karim, Hossain, Manjur A Elahi, & Mohd Zain, 2020 evaluated the strength development of alkali-activated binders (AAB) fabricated from slag, fly ash (FA), rice husk ash (RHA), and palm oil fuel ash (POFA) (Karim, 2020.).

MATERIALS AND METHODS

In this research, all kinds of materials that are recollected from recycled concrete (fine, coarse, recycled cement particles) were employed and used. Those materials are vetted in two parts. One for recycling coarse aggregates and one for rebuilding concrete using recovered fine, coarse, and cement particles. Now, we discuss the procedure of collection and treatment system of recycled demolished concrete briefly.

Waste Concrete

Waste concrete is concrete that has been crushed and categorized based on its diameter using sieve analysis. Particles retained in the 4.75mm sieve are classed as coarse aggregate, whereas particles passing through the sieve are classified as fine particle. They are then prepared for additional treatment and quality testing.

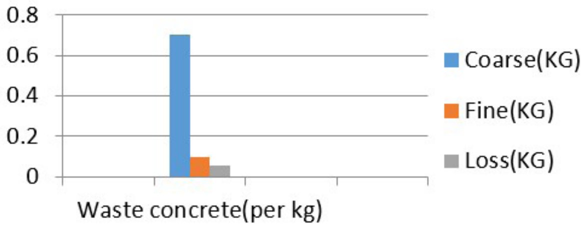

Figure 1: Waste aggregates in per kg of waste concrete

Figure 2: Photograph of Waste Aggregates

Recycle of Coarse Aggregate

Regardless of whether it is contaminated or not, the concrete needs to be broken down by crushers and screening machines to obtain reusable concrete aggregates. Waste concrete from buildings and roadways contains steel bars and other reinforcing materials. So, we must remove those impurities and contaminations during the crushing process. In general, heavy crushing equipment can reduce old concrete to 5mm-50mm. According to various studies, the coarse recycled concrete aggregate can replace about 30% of natural crushed coarse aggregate without a significant impact on any performance of concrete. Waste concrete from building and demolition even being crushed by crushers, still contains a small amount of combustibles such as wood chips and plastic chips. To produce purer and more valuable recycled concrete aggregate, the calcination and grinding process is added after crushing, sieving, and contamination removal

Test for Recycled Coarse Aggregates

Coarse aggregates are irregular and granular materials used in the production of concrete, such as gravel, or crushed stone. Coarse is usually found naturally and may be obtained by blasting quarries or crushing them with hand or crushers. However, in this situation, recycled coarse aggregate refers to coarse aggregate (stone) recycled from broken destroyed concrete using sieve analysis and retained in a 4.75mm filter. The durability of recycled course aggregates gets studied in the Los Angeles abrasion test, impact test, specific gravity, and water absorption test.

Los Angeles Abrasion Test

Aggregate toughness and abrasion resistance such as crushing, degradation, and disintegration are measured using the Los Angeles abrasion test. AASHTO T 96 or ASTM C 131: Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine is used to perform this test. The aggregate used in the surface course of highway pavements is vulnerable to wear owing to vehicular movement. When cars move on the road, the soil particles between the pneumatic tires and the road surface abrade the road aggregates. The Los Angeles test machine is used in the laboratory to measure aggregate abrasion resistance.

Impact Test

The impact test is a form of quality control test for highway pavements that is used to assess the acceptability of aggregates for use in highway pavement construction. When we used to build roads,aggregates must be able to withstand impact loads as well as abrasion and crushing.
The equipment is comprised of the following items according to IS: 2386 (Part IV) – 1963:

(i) A testing machine weighing 45 to 60 kg with a metal base and a painted bottom surface of at least 30 cm in diameter. It is supported on a least 45 cm thick, flat, and level concrete floor. Additionally, the machine has to have ways to secure its foundation.

(ii) A cylindrical steel cup with a minimum thickness of 6.3 mm and interior dimensions of 102 mm and depth of 50mm.

(iii) A case-hardened, cylindrical metal hammer or tup weighing 13.5 to 14.0 kg, 50 mm long, and 100.0 mm in diameter at the lower end, with a 2 mm chamfer at the bottom edge. The hammer should be concentric with the cup and be able to easily move between the vertical guidelines. The hammer's free fall should be within 380±5 mm.

(iv) A cylindrical metal measuring device for measuring aggregates with an internal diameter of 75 mm and a depth of 50 mm.

(v) A tamping rod that is 230 mm long, 10 mm in diameter, and rounded at one end.

(vi) A balance with a minimum weight capacity of 500g that is readable and accurate to 0.1 g.

The aggregates in the test sample range in size from 10.0 mm to 12.5 mm. Aggregates can be dried by heating them at 100-110° C for 4 hours and then cooling them. (i) Sieve the material via IS sieves of 12.5 mm and 10.0 mm. The test material consists of aggregates that pass through a 12.5mm filter and are retained on a 10.0mm sieve.

Figure 3: Photograph for Impact Test

Specific Gravity and Water Absorption Test

Aggregate specific gravity testing is used to detect the strength or quality of the material, whereas water absorption testing determines the water holding capacity of coarse and fine aggregates. The primary goal of these tests i,(i) To figure out the material's strength or quality. (ii) To determine aggregate water absorption. Specific gravity is the weight ratio of a particular volume of aggregate to an equivalent amount of water. It is a measurement of the material's strength or quality. Low specific gravity aggregates are often weaker than ones with higher specific gravity values. There are three ways of testing for determining the specific gravity of aggregates based on aggregate size: more than 10 mm, 40 mm, and lower than 10 mm. The following test procedure is used for samples bigger than 10 mm and 40 mm.

Figure 4: Photograph for Water Absorption and Specific Gravity test

Recycle Fine Aggregate

Aggregate is the granular material needed to make concrete or mortar, and fine aggregate is when the particles of the granular material are so small that they pass through a 4.75mm sieve. Recycling fine aggregates are solids that pass through a 4.75mm screen and are obtained from recycled broken concrete. These components contain sand, cement particles, dust, and other undesirable organic matter and deceased vegetation such as algae, moss, and so on. These materials have no industrial use and are utilized as inexpensive filler materials, and untreated fine materials disrupt the natural life cycle of soil, causing soil, water, and air pollution. As a result, these materials are handled as though they had a value and can be employed in concrete production and other applications. The recycled fine materials must pass various standardized tests, such as Grading, Clay Lumps and Friable Particles in Aggregate, Soundness Test of fine Aggregate and Deleterious Particles.

Figure 5: Photograph of Sieve analysis

Grading of Recycle Fine Aggregate

The fineness modulus technique, which classifies aggregate size by passing aggregates through a sieve in accordance with the IS standard, determines the aggregate gradation. When the aggregate size is smaller than 4.75mm, the aggregates are graded in accordance with IS code 383.

A set of sieves with sizes of 10.0mm, 4.75mm, 2.36mm, 1.18mm, 0.6mm, 0.3mm, and 0.150mm were needed for the fine aggregate grading test, along with several small trays, a temperature-controlled oven, and a pan for collecting the fines that passed through the 0.150mm sieve.

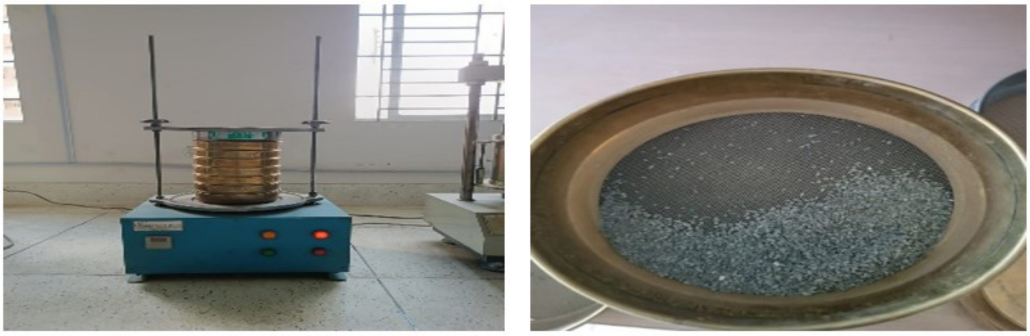

Figure 6: Photograph of procedure of fine aggregate grading test

Clay Lumps and Friable Particles in Aggregate

A number of tests are conducted to establish the material's physical properties in order to guarantee that the aggregate used for building functions as intended. The determination of Clay Lumps and Friable Particles in Aggregate is one of these assays.

The bonding between the processed aggregate and cementitious material may be hampered by the presence of too many clay lumps in the aggregate intended for use in Portland cement or hot mix asphalt. If the material is integrated into the building or pavement, this will cause weak areas and pop-outs as well as spalling, raveling, or stripping. When there are too many friable particles and clay, the performance of aggregate meant to serve as a drainable base or subbase may also be harmed. This kind of substance frequently fills the drain ability-intentional empty gaps, eventually causing pavement breakdown. So, the materials are weighed, and calculations are made to determine the percentage of clay lumps and friable particles.

Balance, accurate to 0.1 percent of the weight of the sample to be tested, adequate capacity to calculate sample weight, and compliance with AASHTO M 231. Containers that are rust-resistant and have the right size and shape to allow the sample to be spread out evenly on the bottom. Sieves that meet AASHTO M 92 standards. Oven with the ability to maintain a temperature of 110° ± 5°C free air circulation.

AASHTO T 11, Amount of Material Finer Than the No. 200 (75 m) Sieve in Aggregate, should be applied to the test sample first. The sample must be dried at a temperature of 230° ± 9°F (110° ± 5°C) to a consistent dry weight. The original material should be properly sieved to remove anything smaller than No. 16 (1.18 mm) sieve. The No. 16 (1.18 mm) sieve over the sample. The test sample is the weight maintained on this sieve, and must weigh a minimum of than 25 grams.

percent of clay lumps and friable particles =p. weight of test sample retained on the No. 16 (1.18 mm) sieve =M and weight of material retained on the No. 20 (850 μm) sieve=Rand P = {(M-R)/M} x 100
Here,
M=1000gm; R=995 gm

Figure 7: Photograph of clay lumps and friable particles in aggregate

Making Concrete from Recycled Fine and Course Waste
Concrete is manufactured from standardized coarse and fine components with cement's binding qualities. Concrete needs to be strong enough to support the building's weight, including both live and dead loads. In this experiment, we constructed concrete using recycled materials. As a result, there are some concerns regarding its effectiveness, strength, and quality. Here, in order to get a satisfactory strength value, we activate cement particles. There are several techniques for activating this activation.

Activators
As alkaline activators, chemicals NaOH, KOH, and Na_2SiO_3, nH20 were employed. Alkaline activators were dosed as a mixture of NaOH, KOH and Na_2SiO_3, which were employed in pallets for varied molar ratios (Ms) of 0.25, 0.50, 0.75, and 1.00. These activators were first dissolved in the water used for mixing and they were added.

Component's Quantity and Proportion
Both fine and coarse aggregates, both of which include some cement particles were used. As a result, activators are utilized in this procedure to lessen the cement's volume. Here, we employ various ratios for the ingredients that are detailed below.

Table 1: Specimen using 50% cement and an RCA: RFA ratio of 2.25:4.25

Experiment no:	Chemical activators	Percentages of cement(%)	Ratio of fine aggregates	Ratio of coarse aggregates
1	NaOH	50	2.25 as volume	4.25 as volume
2	Na_2SiO_3	50	2.25 as volume	4.25 as volume
3	NaOH+KOH	50	2.25 as volume	4.25 as volume
4	NaOH+ Na_2SiO_3	50	2.25 as volume	4.25 as volume
5	Cement	50	2.25 as volume	4.25 as volume

Table 2: Specimen using 75% Cement and an RCA: RFA ratio of 2.25:4.

Experiment no:	Chemical activators	Percentages of cement(%)	Ratio of fine aggregates	Ratio of coarse aggregates
1	NaOH	75	2.25 as volume	4 as volume
2	Na_2SiO_3	75	2.25 as volume	4 as volume
3	NaOH+KOH	75	2.25 as volume	4 as volume
4	NaOH+ Na_2SiO_3	75	2.25 as volume	4 as volume
5	Cement	75	2.25 as volume	4 as volume

RESULTS AND DISCUSSION

A variety of constructions, including bridges that have been destroyed, are used to gather aggregate. The varied architectures shown in the chart below each have a different percentage of coarse and fine particles. We can see from the aforementioned data that the rate of fine aggregate is low. It took place as a result of the structure's support. The concrete's outside protective layer, the fine particles, causes it to deteriorate day by day. The most useful and valuable aggregates are coarse aggregates, which are secured by cement binding. Therefore, coarse aggregate recycling rates are high and in good shape.

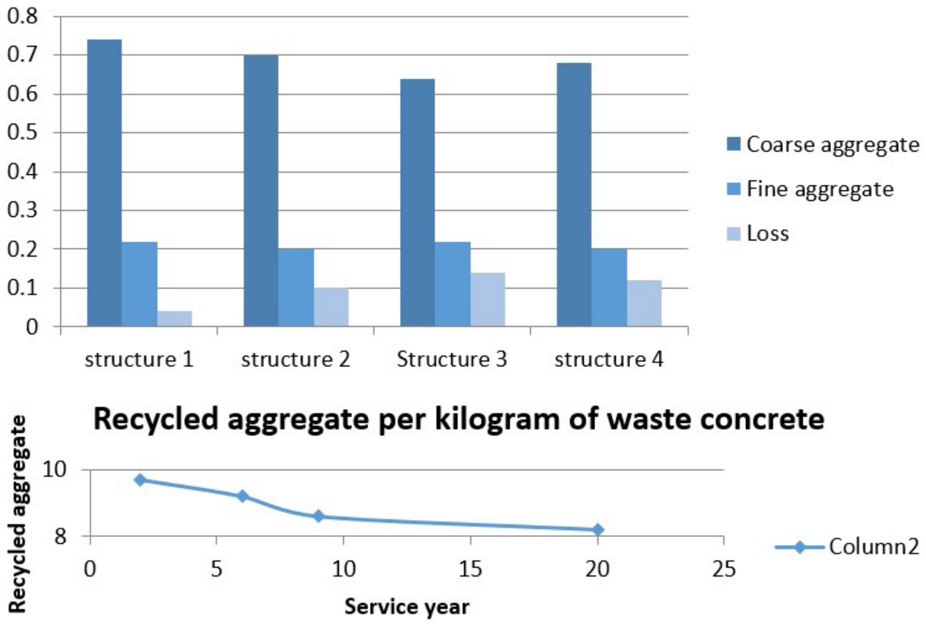

Figure 8: Recycle aggregates from 1kg of waste concrete

Recycle of Coarse Aggregate

Stone aggregates are extremely useful due to their strength, ability to fill holes, enhance outdoor environments, and low cost. It is taken from rivers or other natural sources and is damaging to the environment. The outcome of recycled course aggregates is suitable for future concrete building. The following are the standardized test values:

Los Angeles Abrasion Test

Abrasion value of the concrete increased with its service life but it is still usable in all structural work such as water bound macadam sub base course, WBM base course with bituminous surfacing, bituminous bound macadam, WBM surfacing course, bituminous penetration macadam, bituminous surface dressing, cement concrete surface course, and bituminous concrete surface course, etc.

Table 3: Los Angeles Abrasion test result

Experiment no:	W_1 (gm)	W_2 (gm)	W_1-W_2 (gm)	Abrasion Value = $\{(W_1-W_2) / W_1\}*100$	Year of concrete service
1	5000	3872	1128	22.56	19
2	4995	3572	1423	28.49	2

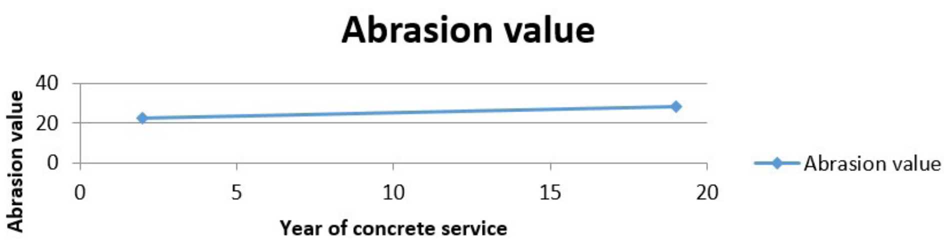

Figure 9: Abrasion test result

Impact Test

The impact test is a sort of highway pavement quality control test that is used to verify the viability of aggregates for use in highway pavement construction. The impact test values are below:

Table 4: Impact Value test result

Experiment no:	W_1 (gm)	W_2 (gm)	Impact Value (percent) = (W_2 / W_1)*100	The mean of two observation
1	369	50	12.6	12.15% or taking 12%
2	376	44	11.7	

So, with a value of 12%, it is determined that the sample aggregates are of a strong kind and suitable for structural work.

Specific Gravity and Water Absorption Test

The specific gravity test aids in stone identification. Water absorption indicates aggregate strength. Aggregates with higher water absorption are more porous in nature and are typically regarded undesirable until they pass strength, impact, and hardness testing.

Table 5: Result of Specific Gravity and Water Absorption test

Experiment no:	W1 (gm)	W2 (gm)	W3 (gm)	Specific gravity of aggregates = W3/(W2-W1)	Apparent specific gravity =W3/(W3-W1)	Water absorption ={(W2-W3)/W3} *100%.
1	1184.23	2167	2083	2.12	2.32	4.03
2	1281.3	2331	2160	2.06	2.46	7.92

The specific gravity of aggregates used in road building typically ranges from 2.5 to 3.0, with an average of 2.68. Water absorption should not exceed 0.6 per unit weight. We can see that the specific gravity of the aggregates is appropriate, but the water absorption rate is significant due to the presence of cementitious components. This may be decreased by milling the aggregates more properly and lowering the cement content on the aggregates outer surface.

Grading of Recycle Fine Aggregate

Aggregates account for 70 to 80% of the overall volume of concrete, as you are all aware. The bonding of the concrete components is affected by the size of the particles. Improper aggregate size and quality have an influence on aggregate strength and durability. The grading of aggregates is the process of determining the aggregate size used in building projects. Because recycled aggregates contain sand and used alkaline. Particles, they cause issues with fine aggregate grading. The grading results are presented in the tab.6 below. The result is very close to grade one because of the passing of aggregate in

Table 6: Result of Grading Test

IS Sieve size(mm)	Weight of retained (gm)	Cumulative weight retained (gm)	Percentages of cumulative weight retained (%)	Percentages of passing (%)	Grading zone I	Grading zone II	Grading zone III	Grading zone IV
1.0	0	0	0	0	100	100	100	100
4.75	0	0	0	0	90-100	90-100	90-100	95-100
2.36	163	163	39.95	60.01	60-95	75-100	85-100	95-100
1.18	54	217	53.19	46.81	30-70	55-90	75-100	90-100
0.6	38	255	62.5	37.5	15-34	35-59	60-79	80-100
0.3	38	293	71.81	28.19	5-20	8-30	12-40	15-50
0.150	25	318	77.94	22.05	0-10	0-10	0-10	0-15
Passing from 0.150	27	345	84.56	15.44				

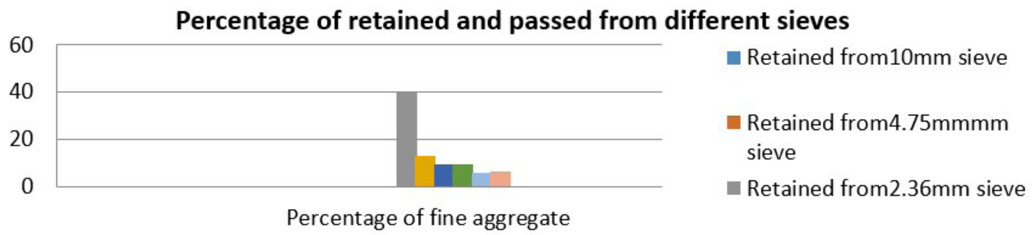

Figure 10: Percentage of fine aggregates

0.150mm sieve and the passing materials mostly contain used cement powder which creates the most problems in nature and human health. This makes it difficult to obtain an acceptable value; instead, we may employ these particles to separate from others and treat them independently in accordance with their sieve size.

Clay Lumps and Friable Particles in Aggregate

Aggregate impurities can be detected using the test for clay lumps and friable particles. The approved value in this experiment is around 1.7% and the value we have is 0.5%. so its an acceptable and the rate of clay lumps and friable particles is very low and it is useable.

Concrete Cube Test Result with Recycled Concrete

The cube test results for the various cement content ratios are shown in the table 7 and 8:

Table 7: Compressive strength test Result with Recycled Concrete Aggregate

Exp no:	Chemical activators	Percent of cement (%)	Ratio of fine agg.	Ratio of coarse agg.	Compressive strength of concrete N/mm^2
1	NaOH	50	2.25 of the volume of cement	4.25 of the volume of cement	7.3
2	Na_2SiO_3	50	2.25 of the volume of cement	4.25 of the volume of cement	8.2
3	NaOH+ KOH	50	2.25 of the volume of cement	4.25 of the volume of cement	7.71
4	NaOH+ Na_2SiO_3	50	2.25 of the volume of cement	4.25 of the volume of cement	6.75
5	Cement	50	2.25 of the volume of cement	4.25 of the volume of cement	5

Table 8: Compressive strength test Result with Recycled Concrete Aggregate

Exp no:	Chemical activators	Percent of cement (%)	Ratio of fine agg.	Ratio of coarse agg.	Compressive strength of concrete N/mm^2
1	NaOH	75	2.25 as volume	4 of the volume of cement	8.53
2	Na_2SiO_3	75	2.25 of the volume of cement	4 of the volume of cement	9.6
3	NaOH+ KOH	75	2.25 of the volume of cement	4 of the volume of cement	8.9
4	NaOH+ Na_2SiO_3	75	2.25 of the volume of cement	4 of the volume of cement	8.31
5	Cement	75	2.25 of the volume of cement	4 of the volume of cement	8.1

Concrete Cube Test Result with New Aggregates

The outcome is highly unsatisfactory for building, therefore we added more cement and used Ra and Rc in different ratios to boost strength, as shown in table 9, 10, 11, 12 and 13 respectively.

Table 9: Compressive strength test Result with New Aggregate

Experiment no:	Chemical act	Percentages of cement(%)	Ratio of new fine aggregates	Ratio of recycle fine aggregates	Ratio of new coarse aggregates	Ratio of recycle coarse aggregates	compressive strength of concrete N/mm^2
1	NaOH	90	1.81 as volume	0.21 as volume	0 as volume	4 as volume	14.78
2	Na_2SiO_3	90	1.81 as volume	0.21 as volume	0 as volume	4 as volume	15.74
3	NaOH+KOH	90	1.81 as volume	0.21 as volume	0 as volume	4 as volume	13.86
4	NaOH+ Na_2SiO_3	90	1.81 as volume	0.21 as volume	0 as volume	4 as volume	15.32
5	Cement	90	1.81 as volume	0.21 as volume	0 as volume	4 as volume	12.5

Table 10: Compressive strength test Result with New Aggregate

Experiment no:	Chemical activators	Percentages of cement(%)	Ratio of new fine aggregates	Ratio of recycle fine aggregates	Ratio of new coarse aggregates	Ratio of recycle coarse aggregates	Compressive strength of concrete N/mm^2
1	NaOH	100	1.8 as volume	0.2 as volume	2 as volume	2 as volume	14.81
2	Na_2SiO_3	100	1.8 as volume	0.2 as volume	2 as volume	2 as volume	16.4
3	NaOH+KOH	100	1.8 as volume	0.2 as volume	2 as volume	2 as volume	13.21
4	NaOH+ Na_2SiO_3	100	1.8 as volume	0.2 as volume	2 as volume	2 as volume	15.62
5	Cement	100	1.8 as volume	0.2 as volume	2 as volume	2 as volume	15.56

Table 11: Compressive strength test Result with New Aggregate

Experiment no:	Chemical activators	Percentages of cement(%)	Ratio of new fine aggregates	Ratio of recycle fine aggregates	Ratio of new coarse aggregates	Ratio of recycle coarse aggregates	Compressive strength of concrete N/mm^2
1	NaOH	100	2 as volume	0 as volume	2 as volume	2 as volume	15.64
2	Na_2SiO_3	100	2 as volume	0 as volume	2 as volume	2 as volume	16.2
3	NaOH+KOH	100	2 as volume	0 as volume	2 as volume	2 as volume	17.4
4	NaOH+ Na_2SiO_3	100	2 as volume	0 as volume	2 as volume	2 as volume	15.84
5	Cement	100	2 as volume	0 as volume	2 as volume	2 as volume	15.32

Table 12: Compressive strength test Result with New Aggregate

Experiment no:	Chemical activators	Percentages of cement(%)	Ratio of new fine aggregates	Ratio of recycle fine aggregates	Ratio of new coarse aggregates	Ratio of recycle coarse aggregates	Compressive strength of concrete N/mm^2
1	NaOH	100	1.8 as volume	0.2 as volume	4 as volume	0 as volume	14.8
2	Na_2SiO_3	100	1.8 as volume	0.2 as volume	4 as volume	0 as volume	15.71
3	NaOH+KOH	100	1.8 as volume	0.2 as volume	4 as volume	0 as volume	13.74
4	NaOH+ Na_2SiO_3	100	1.8 as volume	0.2 as volume	4 as volume	0 as volume	14.97
5	Cement	100	1.8 as volume	0.2 as volume	4 as volume	0 as volume	14.80

Table 13: Compressive strength test Result with New Aggregate

Experiment no:	Chemical activators	Percentages of cement(%)	Ratio of new fine aggregates	Ratio of new fine aggregates according to sieve o.3mm and 0.150mm	Ratio of recycle fine aggregates according to sieve 2.36mm, 1.18mm and 0.6mm	Ratio of recycle coarse aggregates	Compressive strength of concrete N/mm^2
1	NaOH	100	0.8 as volume	1.2 as volume	2 as volume	2 as volume	13.6
2	Na_2SiO_3	100	0.8 as volume	1.2 as volume	2 as volume	2 as volume	16.47
3	NaOH+KOH	100	0.8 as volume	1.2 as volume	2 as volume	2 as volume	15.14
4	NaOH+ Na_2SiO_3	100	0.8 as volume	1.2 as volume	2 as volume	2 as volume	14.37
5	Cement	100	0.8 as volume	1.2 as volume	2 as volume	2 as volume	15.73

The chart below shows the compressive strength of various cement compositions together with the presence of RCA, RFA, RA, and RC.

The data shows that 100% cement content with RA present as RCA in a ratio of 2 to 2 produces the greatest results. The RFA might lose some strength since it includes microscopic particles less than 0.150 mm. To remedy the problem, we created a cube with 10% RFA, which provides us with an appropriate number in Table 7 and we also created a set of cubes with 2.36mm, 2.36mm, and 0.6mm of RFA, along with 0.3mm and 0.150mm of FA, which are shown in Table 1.4.1 (e). In a number of ways, Table 9 is acceptable. The graph below, which also includes the value from Table 11 is constructed for examination of the compressive strength increased with cement concentration.

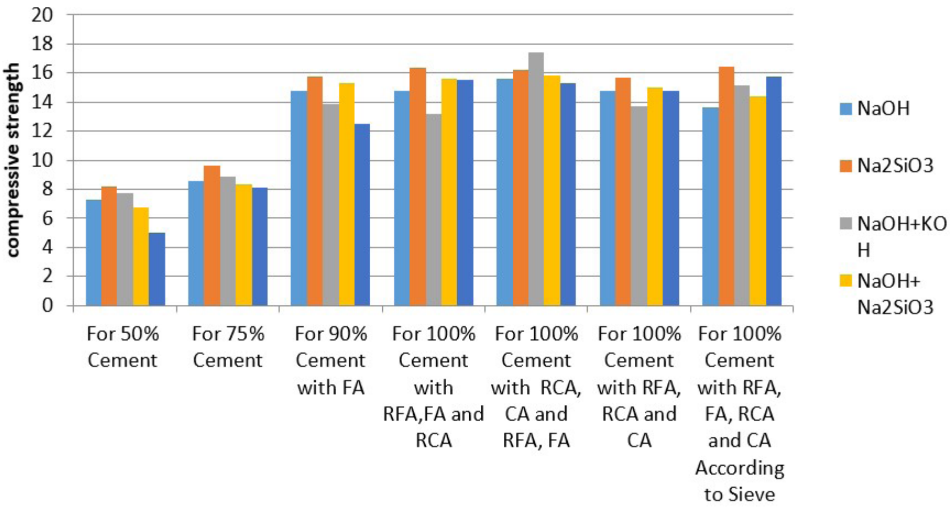

Figure 11: Compressive Strength for different cement content

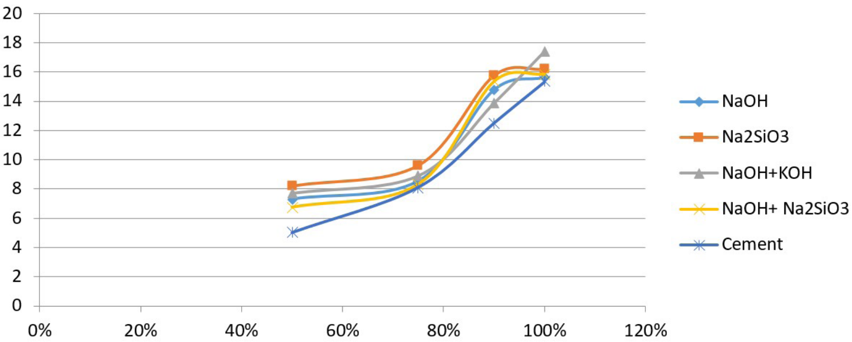

Figure 12: Increasing compressive strength according to cement content

CONCLUSION

In this study, we effectively separated the recycled concrete into fine and coarse particles and graded them with care. With a little grading procedure, we have excellent value in coarse and fine aggregate. Finally, we are able to obtain a reasonable compressive result in the cube test. Therefore, when handled and processed properly, such cubes with RCA and RFA are quite acceptable and may be utilized to construct a concrete chain. The concrete can be used for lean-concrete, median barriers, walkways, curbs, gutters, riverbank protection, and as a base for drainage structures. These are used as aggregate in many different applications, such as bituminous concrete, lean concrete, building and bridge construction, road construction aggregates, and tile manufacturing. As a result, less cement will be produced, less natural resources will be used, and less pollutants will enter the environment. Additional recharging opportunities exist in this sector, such as the qualities of cementitious fine aggregates as a source of raw materials for cement manufacture and the activation of alkaline.

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