International Journal of Research
Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 04 Issue 14
November 2017

Study On Compressive Strength Of Concerete After Replacing Natural Coarse Aggregate With Recycled Aggregate

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ABSTRACT
Concrete is the world's second most consumed material after water, and it's across the board utilize is the reason for urban improvement. It is evaluated that 25 billion tons of concrete are produced every year. Twice as much concrete is utilized as a part of construction around the globe when contrasted with the aggregate of all other building materials joined. The reuse hardened concrete as aggregate is a demonstrated innovation - it can be pulverized and reused as an incomplete replacement for normal aggregate in new concrete construction. The hardened concrete can be sourced either from the pulverization of concrete structures toward the finish of their life – reused concrete aggregate, or from remaining new concrete which is deliberately left to hardened – leftover concrete aggregate. Reusing or recovering concrete materials has two fundamental favorable circumstances - it saves the utilization of common aggregate and the related environmental costs of abuse and transportation, and it saves the utilization of landfill for materials which can't be reused. Since waste minimization and decreasing the burden on landfills is a worldwide issue, broad research has been done worldwide on the utilization of reused aggregate in concrete. Our project plans to think about whether the reused coarse concrete aggregates can be utilized as a part of concrete blend utilized for construction supplanting the Natural coarse aggregates and furthermore the confinement of replacement. Tests have been done to locate the physical properties, for example, Specific gravity for Fine aggregates, Natural coarse aggregates, reused coarse aggregates, Cement and Water ingestions of Fine aggregates, Natural coarse aggregates, and Recycled concrete coarse aggregates. The workability tests, for example, Slump cone test, Compaction factor test, Vee-Bee test are done and the strength of 3D squares threw subsequent to supplanting the normal coarse aggregates with reused coarse concrete aggregates is tried at 7,14 and 28 days.

INTRODUCTION
Construction aggregates make up more than 80 percent of the aggregate total market, and are utilized primarily to build constructions and pavements. With the development exercises increasing tremendously, and we missing the mark regarding construction aggregates it has turned out to be important to locate a substitute hotspot for the material. Projections for building material necessity of the lodging part demonstrate a lack of aggregates to the degree of around 55,000 million cubic meters. At this stage the idea of utilizing reused aggregate has turned out to be a decent option. At the point when structures made of concrete are obliterated or remodeled, concrete reusing is an increasingly basic technique for using the rubble. Concrete was once routinely trucked to landfills for transfer, however reusing has various advantages that have made it a more appealing choice in this time of more noteworthy ecological mindfulness, more environmental laws, and and the desire to keep construction costs down.

NEED FOR RECYCLED AGGREGATE
Quick foundation improvement requires an extensive amount of development materials, arrive necessities and the site. For huge development, concrete is favored as it has longer life, low upkeep cost and better execution. For accomplishing GDP rate, littler structures are demolished and new towers are built. Security of condition is an essential factor which is specifically associated with the survival of humankind. Parameters like ecological cognizance, security of regular assets, reasonable advancement, assume an essential part in present day prerequisites of development works. Because of modernization, demolished materials are dumped ashore and not utilized for any reason. Such circumstances influence the richness of land.

Out of the aggregate improvement obliteration waste, 40% is of concrete, 30% ceramics, 5% plastics, 10% wood, 5%metal, and 10% unique mixes. As point by point by overall comprehension, advancement in overall improvement division predicts an extension being developed spending of 4800 billion US dollars in 2013. These figures show a gigantic improvement in the advancement region, ideal around 1.5 times in 5 years

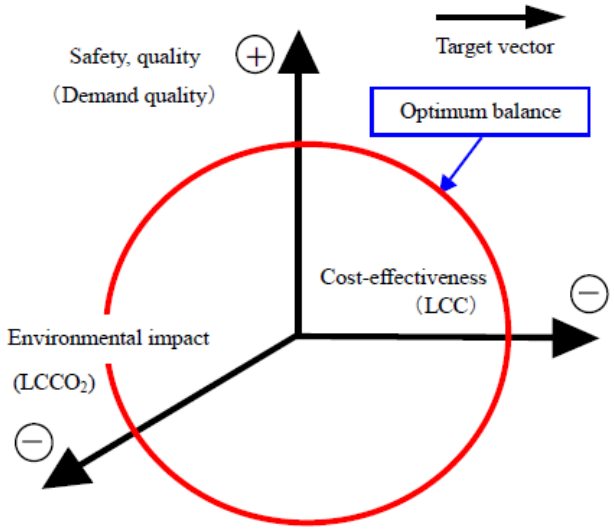

Figure 1: Impact of Recycled aggregates on Environment

As indicated by late research by the Fredonia gathering, it is guess that the overall enthusiasm for improvement aggregates may outperform 26 billion tons by 2012. Driving this demand is the most outrageous customer China 25%, Europe 12% and USA 10%, India is also in top 10 customers. From natural viewpoint, for making of typical aggregates of 1 ton, transmissions of 0.0046 million ton of carbon exist where regarding 1ton reused aggregate conveyed only 0.0024 million ton carbon is made. Considering the overall usage of 10 billion tons/year of aggregate for concrete era, the carbon impression can be settled for the customary aggregate and also for the reused aggregate

The usage of reused aggregate generally extends the drying shrinkage creep and porosity and diminishments the weight strength of concrete diverged from that of trademark aggregate concrete. The lessening in Compressive strength is around 10-30% as indicated by change in replacement of aggregate. Concrete aggregate gathered from decimation sites is put through a devastating machine. Pulverizing offices acknowledge just uncontaminated concrete, which must be free of junk, wood, paper and other such materials. Metals, for example, rebar are acknowledged, since they can be evacuated with magnets and other arranging gadgets and dissolved down for reusing somewhere else. The staying aggregate lumps are arranged by estimate. Bigger pieces may experience the crusher once more. Subsequent to pounding has occurred, different particulates are sifted through an assortment of strategies including hand-picking and water flotation. An exploration exertion has been done to coordinate society requirement for sheltered and financial transfer of waste materials. The utilization of waste materials spares common assets and dumping spaces, and keeps up a spotless situation. The ebb and flow concrete development rehearse is thought unsustainable on the grounds that, not just it is devouring colossal amounts of stone, sand and drinking water, yet in addition two billion tons every time of Portland cement, which discharges green-house gasses prompting an Earth-wide temperature boost. Tests has been directed for waste materials like-elastic tire, e-waste, coconut shell, impact heater slag, waste plastic, demolished concrete constituents, waste water and so forth. Development waste reuse

plants are currently introduced in different nations however they are incompletely answered for the waste issues.

INTRODUCTION TO CONCRETE

Concrete is the most comprehensively used man-made advancement material on the planet. It is obtained by mixing of fine aggregates, coarse aggregates and cement with water and now and again admixtures in required degrees. Fresh concrete or plastic concrete is normally mixed material which can be framed into any shape hardens into a stone like mass known as concrete. The hardness is a result of synthetic response amongst water and cement, which proceeds for long stretch prompting more grounded with age. The utility and elegance and also the strength of concrete structures, worked in the midst of the chief portion of the latest century with basic Portland cement (OPC) and plain round bars of delicate steel, the straightforward availability of the constituent materials (whatever may be their qualities) of concrete and the data that in every way that really matters any mix of the constituents prompts a mass of concrete have imitated despise. Strength was underlined without a thought on the robustness of structures. Because of the opportunities taken, the durability of concrete and concrete structures is on a southward outing; a journey that seems to have grabbed vitality on its approach to self– pulverization.

HIGH STRENGTH CONCRETE

High strength concrete has been characterized as a concrete which compressive strength is high contrasted with the normal evaluations of concrete. American Concrete Institute (ACI) characterizes a high-strength concrete as concrete that has a predetermined compressive strength for outline of 6000psi (41MPa) or more prominent. Different nations likewise determine a most extreme compressive strength, though the ACI definition is open-finished.

The strength of concrete basically relies on the cement glue and in increasingly the strength of glue increments with the fineness of cement substance. Consequently as the water cement (W/C) Ratio diminishes the concrete gets higher Strength however concrete end up noticeably unworkable.

HIGH PERFORMANCE CONCRETE

High performance of concrete (HPC) is widely been used in recent years, not only for its increased compressive strength, and to improve durability and economic benefits, but also for its positive impact on the environment.

Cement and concrete are key parts of both business and private construction in around the world; the cement and concrete ventures are enormous. Around the world, cement creation of 1.25 billion tons in 1991, as per the U.S Bureau of mines. What's more, now it might be more than 3.5 billion tones.

LIMITATIONS OF PROJECT

Water absorption of Recycled concrete coarse aggregates is 4 to 6 times of Natural coarse aggregates. In this way, the water necessity amid the blend is higher than blend proposed for Nominal blend of concrete utilizing Natural coarse aggregates. On the off chance that the redress is not done, at that point the concrete may not give fulfilling workability comes about and the compressive strength may reduce. Thus, revisions must be made considering the Water ingestion of Fine aggregates, coarse aggregates and Recycled concrete coarse aggregates. Contrasted and regular aggregates, waste reused aggregates have low particular gravity and high water ingestion qualities. It is in this manner not pragmatic to utilize waste aggregates for the surface layer.

CLASSIFICATION OF AGGREGATES

For the purpose of this report, the following classifications are adopted

NATURAL AGGREGATES

Construction aggregates produced from natural sources such as gravel and sand, and extractive products such as crushed rock. Crushed rock, Sand and gravel, Crushed river gravel belongs to Natural aggregates.

Figure 2: Sand

Figure 3: Gravel

FINE AGGREGATES

Sand is a normally happening granular material made out of finely separated shake and mineral particles. The creation of sand is exceedingly factor, contingent upon the nearby shake sources and conditions, yet the most widely recognized constituent of sand in inland mainland settings and non-tropical beach front settings is silica (silicon dioxide, or SiO2), normally as quartz.

Figure 4: Fine aggregates (Sand)

COARSE AGGREGATES

Coarse aggregate might comprise of normally happening materials, for example, rock, or coming about because of the devastating of parent shake, to incorporate regular shake, slags, extended muds and shales (lightweight aggregates) and other affirmed inactive materials with comparable attributes, having hard, solid, sturdy particles, adjusting to the particular necessities of this Section. Course aggregate might be handled from rock, stones, limestone, dolomite, sandstones, or other normally happening hard, solid, sturdy materials meeting the necessities of this Section.

Ordinary granite broken stone aggregates of size greater than 12mm are used for the study. Normally sizes used for coarse aggregate varies from 12 - 20 mm.

Figure 5: Coarse aggregates (Gravel)

RECYCLED AGGREGATES

Aggregates got from the preparing of materials already utilized as a part of an item as well as in construction. Reused Concrete Aggregate (RCA), Recycled Concrete and Masonry (RCM), Reclaimed Aggregate (RA), Reclaimed Asphalt Pavement (RAP), Reclaimed, Asphalt Aggregate (RAA), Glass Cullet, Scrap Tires, Used Foundry Sand are a portion of the Recycled concrete coarse aggregates.

Concrete constitutes 40% of the aggregate demolished construction. While Ceramics 30 %,

Metal 5 %, Plastics 5 %, Wood 10 % and 10 % of different materials.

In this way, reusing of concrete reduces dumping and decreases the effect on condition. In this undertaking we have chosen Recycled concrete as a substitute of Natural coarse aggregates. The aggregates which are demolished and construction waste are utilized as reused aggregate Recycling is the demonstration of preparing the utilized material for use in making new item. The use of characteristic aggregate is getting increasingly serious with the propelled advancement in framework range. Keeping in mind the end goal to reduce the use of characteristic aggregate, reused aggregate can be utilized as the replacement materials.

Figure 6: Recycled concrete coarse aggregates

MATERIALS USED

NATURAL COARSE AGGREGATES

Natural coarse aggregates have been utilized as a part of this examination. Ostensible coarse aggregate size of 20 mm is utilized. Coarse aggregates going through 20 mm sifter and held on 12.5 mm is utilized as a part of this venture. Material is purchased from the neighborhood advertise and is surface dried.

Coarse aggregates are materials which holds on an IS strainer 4.75mm gage. Just the aggregates which are holding on 4.75mm IS strainer are called as Coarse Aggregates.

The coarse aggregate utilized here with having greatest size of 20mm. We utilized the IS 383:1970 to discover the extent of blend of coarse aggregate, with 60% 20mm size and 40% 10mm.For most extreme strength and toughness, the aggregate ought to be stuffed and cemented as minimally as feasible therefore the degree of molecule sizes in aggregate to create close pressing is of extensive significance. It is fundamental that aggregate have great strength, hardness and climate resistance, their surface is free from debasements, for example, soil, sediment and natural issue which may weaken the bond with the cement paste and that no unfavorable chemical reaction takes place between them and cement.

Physical properties of coarse aggregate

Properties	Results Obtained
Specific gravity	2.74
Fineness Modulus	7.61

Sieve analysis of coarse aggregate

S.L No	Is Sieve Size	Weight retained (g)	Cumulative weight retained	Cumulative % weight retained (g)	Cumulative % passing
1	80mm	0.00	0.00	0.00	100.00
2	40mm	0.00	0.00	0.00	100.00
3	20mm	3376.50	3376.50	67.52	32.48
4	10mm	1385.00	4761.00	95.22	4.78
5	4.8mm	169.00	4930.00	98.60	1.40
6	2.4mm	70.00	5000.00	100.00	0.00
7	1.18 mm	0.00	5000.00	100.00	0.00

8	600mm	0.00	5000.00	100.00	0.00
9	300mm	0.00	5000.00	100.00	0.00
10	150MM	0.00	5000.00	100.00	0.00

NATURAL FINE AGGREGATES

Natural fine aggregates have been used in this research. Sand is sieved and is found that it belongs to sand zone III as per IS:383 1970. Sand is bought from local market and is surface dried.

Fine aggregates are materials passing through an IS sieve that is less than 4.75mm gauge. Simply the aggregates which are passing 4.75mm sieve are called as Fine Aggregates. The most important function of the fine aggregate is to provide workability and Uniformity in the mixture. The fine aggregate also helps the cement paste to hold the coarse aggregate particle in suspension.

Concrete is a composite material, the workability and the development of strength depend upon the age, the properties of the constituent materials and their combined action. The role of fine aggregate on strength and workability has to be deciphered before researching the possibility of total replacement of fine aggregate.

The purpose of mix proportioning is to produce the required properties in both plaster and hardened concrete by the most economical and practical combination of materials available they has been very little used reported of vast quantities of wastes have generated by mixing and quarrying industries only small amount of this wastes are used in road making and in manufacture of building materials such as light weight aggregate bricks and autoclave red bricks an attempt is made to study the affect of rock dust as fine aggregate on the strength and workability aspects of concrete mixes.

It is evident that the concrete strength development depends upon the strength of the cement motor and its synergetic with coarse aggregate. Pebbles as coarse aggregate, due to smooth surface texture impart lower mortar aggregate bond strength than that imparted by crushed coarse aggregates. In the present work, fine aggregate consisting of natural sand conforming to grading zone II of IS 383-1970 is used.

According to IS 383:1970 the fine aggregate is being classified in to four different zone, that is Zone-I, Zone-II, Zone-III, Zone-IV. Also in cone of coarse aggregate maximum 20 mm coarse aggregate is suitable for concrete work. But where there is no restriction 40 mm or large size may be permitted. In cone of close reinforcement 10mm size also used.

In this study it was used the sand of Zone-II, known from the sieve analysis using different sieve sizes (10mm, 4.75mm, 2.36mm, 1.18mm, 600µ, 300µ, 150µ) adopting IS 383:1963.

Physical properties of fine aggregate

S. No.	Property	Value
1	Specific Gravity	2.74
2	Fineness Modulus	2.73
3	Bulk density Loose Compacted	14.67 kN/m3 16.04 kN/m^3
4	Grading	Zone –II

Sieve analysis of fine aggregate

S.L No	IS Sieve Size	Weight Retained (g)	Cumulative weight retained	Cumulative % weight retained (g)	Cumulative % Passing
1	10mm	0.00	0.00	0.00	100.00
2	4.75 mm	10.00	10.00	1.00	99.00
3	2.36 mm	46.50	56.50	5.65	94.35
4	1.18 mm	188.00	24.50	24.45	75.55
5	600mm	288.00	532.50	53.25	46.75
6	300mm	358.00	890.50	89.005	10.95
7	150mm	109.00	1000.00	100.00	0.00

RESULTS OBTAINED

SPECIFIC GRAVITY

FINE AGGREGATES
Specific gravity of fine aggregates obtained is 2.6
NATURAL COARSE AGGREGATES
Specific gravity of coarse aggregates obtained is 2.76
RECYCLED CONCRETE COARSE AGGREGATES
Specific gravity of Recycled concrete coarse aggregates obtained is 2.44
CEMENT
Specific gravity of cement is 3.07
WATER ABSORPTION
FINE AGGREGATES
Water absorption of fine aggregates is 1 %.
NATURAL COARSE AGGREGATES
Water absorption of coarse aggregates is 0.65 %
RECYCLED CONCRETE COARSE AGGREGATES
Water absorption of Recycled concrete coarse aggregates is 2.7 %
BULK MODULUS OF SAND USED
Maximum % of bulking of sand is 24% corresponding to 4% water content
NORMAL CONSISTENCY AND INITIAL SETTING TIME OF CEMENT
1. The normal consistency obtained for 35mm penetration from top is 29% by weight of cement.
2. The initial setting time of given cement for 5mm penetration from bottom is 75min.
3. The Initial setting time of cement should not be less than the 30 minutes as per Indian Standard code.
FINENESS OF CEMENT
The fineness of cement is 3% of the total weight of sample taken. The fineness of cement should not be greater than 10 % as per Indian Standard Code.

MIX DESIGN

% of replacement	Water content	Cement content	Fine aggregates	Coarse aggregates
5	0.537	1	1.41	3.09
10	0.540	1	1.41	3.09
15	0.543	1	1.41	3.09

Table 11: Mix design
Note: Water content in liters Cement in Kg's Fine and coarse aggregates in Kg's

WORKABILITY TESTS

SLUMP CONE TEST

% of replacement	Slump (cm)
5	10 (shear)
10	12 (shear)
15	13 (shear)

Table 12: Slump cone test values

COMPACTION FACTOR TEST

% of replacement	Compaction factor
5	0.92
10	0.91
15	0.90

Table 13: Compaction factor values

VEE-BEE TEST

% of replacement	Vee-bee (seconds)
5	10
10	12
15	13

Table 14: Vee-Bee test values

COMPRESSIVE STRENGTHS AT 7, 14, 28 DAYS

COMPRESSIVE STRENGTH AT 7 DAYS:

For 5% replacement of coarse aggregates:

Cube	Load(KN)	Compressive strength(Mpa)
Cube1	450	20.0
Cube2	443	19.6
Cube3	475	21.1

Table 15: Compressive strength at 7 days for 5 % replacement
Average of the values of load = 456 KN.
Average compressive strength = 20.0 Mpa.
For 10% replacement of coarse aggregates:

Cube	Load(KN)	Compressive strength(Mpa)
Cube1	446	19.8
Cube2	439	19.5
Cube3	474	21.0

Table 16: Compressive strength at 7 days for 10 % replacement
Average of the values of load =453 KN.
Average compressive strength = 20.1 Mpa.
For 15% replacement of coarse aggregates:

Cube	Load(KN)	Compressive strength(Mpa)
Cube1	419	18.6
Cube2	399	17.7
Cube3	415	18.4

Table 17: Compressive strength at 7 days for 15 % replacement

Average of the values of load =411 KN.
Average compressive strength = 18.2 Mpa.

COMPRESSIVE STRENGTH AT 14 DAYS:

For 5% replacement of coarse aggregates:

Cube	Load(KN)	Compressive strength(Mpa)
Cube1	609	27.0
Cube2	599	26.6
Cube3	637	28.3

Table 18: Compressive strength at 14 days for 5 % replacement

Average of the values of load = 615 KN.
Average compressive strength = 27.3 Mpa.
For 10% replacement of coarse aggregates:

Cube	Load(KN)	Compressive strength(Mpa)
Cube1	599	26.6
Cube2	615	27.3
Cube3	559	24.8

Table 19: Compressive strength at 14 days for 10 % replacement

Average of the values of load = 591 KN.
Average compressive strength = 26.2 Mpa.
For 15% replacement of coarse aggregates:

Cube	Load(KN)	Compressive strength(Mpa)
Cube1	539	23.9
Cube2	561	24.9
Cube3	565	25.1

Table 20: Compressive strength at 14 days for 15 % replacement

Average of the values of load = 555 KN.
Average compressive strength = 24.6 Mpa.

COMPRESSIVE STRENGTH AT 28 DAYS:

For 5% replacement of coarse aggregates:

Cube	Load(KN)	Compressive strength(Mpa)
Cube1	712	31.6
Cube2	732	32.5
Cube3	725	32.2

Table 21: Compressive strength at 28 days for 5 % replacement

Average of the values of load = 723 KN.
Average compressive strength = 32.1 Mpa.
For 10% replacement of coarse aggregates:

Cube	Load(KN)	Compressive strength(Mpa)
Cube1	722	32.0
Cube2	681	30.2
Cube3	655	29.1

Table 22: Compressive strength at 28 days for 10 % replacement

Average of the values of load = 696 KN.
Average compressive strength = 30.9 Mpa.
For 15% replacement of coarse aggregates:

Cube	Load(KN)	Compressive strength(Mpa)
Cube1	631	28.0
Cube2	669	29.7
Cube3	662	29.4

Table 23: Compressive strength at 28 days for 15 % replacement

Average of the values of load = 654 KN.
Average compressive strength =29.0 Mpa.

GRAPHS

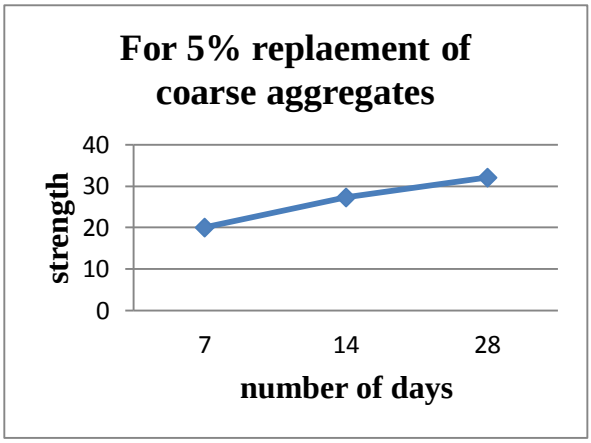

Figure 21: Graph of 5% compressive strength Vs number of day's replacement of coarse aggregates.

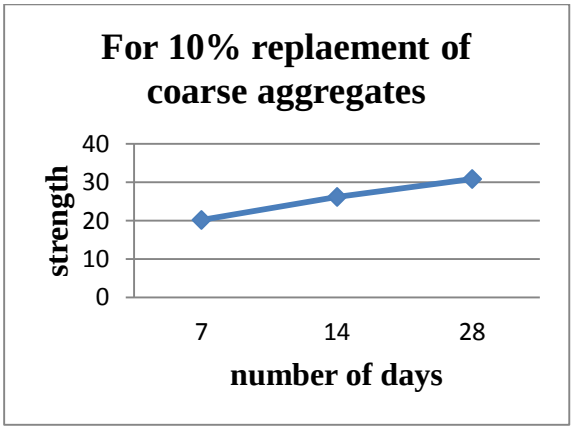

Figure 22: Graph of compressive strength Vs number of days 10% replacement of coarse aggregates

FOR 15 % REPLACEMENT OF COARSE AGGREGATES

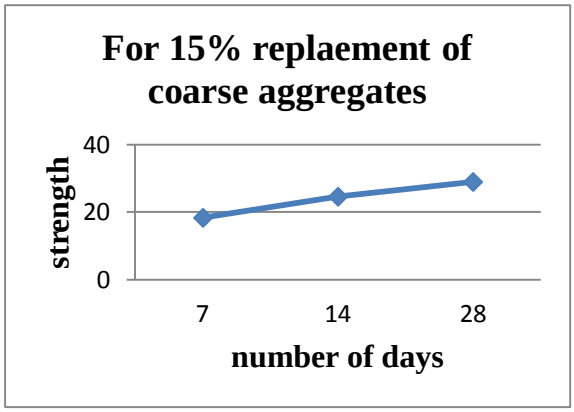

Figure 23: Graph of compressive strength Vs number of days 15% replacement of coarse aggregates

CONCLUSION

Reused aggregate possess moderately bring down bulk density, crushing and impact values and higher water absorption when contrasted with normal aggregate. The compressive strength of reused aggregate concrete is generally lower up to 15% than characteristic aggregate concrete. The variety additionally relies upon the original concrete from which the aggregates have been acquired.

This paper has discussed about properties of RCA, the impacts of RCA use on concrete material properties. .Aggregate properties are most influenced by the residual adhered mortar on RCA. Along these lines, RCA is less dense, more permeable, and has a higher water absorption limit than NA. While RCA and NA have comparative degree, RCA particles are more rounded in shape and have more fines. Supplanting NA in concrete with RCA diminishes the compressive strength by 13 %.

The pressure test result demonstrates decreasing pattern of compressive strength up to 15% replacement of reused aggregate following 28 days.

Reusing and reuse of building wastes have been observed to be a proper answer for the issues of dumping several thousand tons of trash went with lack of normal aggregates. The utilization of reused concrete coarse aggregates in concrete turns out to be important building materials in specialized, environment and economical respect.

Because of utilization of reused aggregate in construction, vitality and cost of transportation of normal assets and removal is essentially spared. This thusly straightforwardly reduces the effect of waste material on environment.

The compressive strength of blocks with replacement are higher than Target mean strength of the M20 concrete blend. Thus, a replacement up to 15% is acceptable.