

A STUDY ON STRENGTH AND DURABILITY OF A CONCRETE WITH COURSE AGGREGATE REPLACED WITH RECYCLED CONCRETE AGGREGATE

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ABSTRACT

Today environmental studies discussing the recycling and reuse of waste materials are getting great importance. Concrete waste, fly ash, rice husk and other different types of waste material produce a large amount of waste. Natural disaster such as earth quakes produce large amount of waste concrete. Removing the waste materials away from the disaster site causes financial and environment problems. In order to prevent these problems waste material should be recycled and reused. According to a study commissioned by Technology Information Forecasting and Assessment Council (TIFAC) 70% of the construction industry is not aware of recycling techniques. Central Pollution Board has estimated current quantum of solid waste generation in India to the tune 48 million tons per annum out of which waste from construction industry accounts for more than 25%. The total quantum of waste from industry in India is estimated to be 12 to 14.7 million tons per annum out of which 7-8 million tons are concrete and brick waste (Naguchi, 2012). In Present study the potential usage of waste concrete aggregate for making new concrete was researched. The properties of recycled aggregates were tested for use in concrete. New concrete were made with 10%, 20%, 30% and 40% coarse recycled aggregates replacing the natural aggregate. Various tests were performed on fresh and hardened and durable properties. The results indicate that the properties of the concretes made with natural aggregate and waste concrete aggregate up to 40% have only slight differences.
Keywords: Concrete aggregate, TIFAC, recycled aggregates.

INTRODUCTION

Cement is a standout amongst the most generally utilized development material bringing on an appeal for it. As a consequence of this, there is an expansion in the interest for its constituents like the coarse totals, sand, concrete and water. This increment sought after is creating broad quarrying of normal totals as it is

required as coarse totals in solid generation furthermore it frames the significant constituent by mass in cement.

Keeping in mind the end goal to possess property in development there has been store of substitution for various constituents of cement by optional building materials. as an option, counterfeit totals like manufacturing plant made sand chamber scoria, fly powder, stretched earth, broken blocks and steel might be utilized wherever fittingly. it's few advantages like low value, general accommodation of material, capacity, low vitality interest and usage underneath very surprising ecological conditions.

The point of any property development is to diminish the effect on setting of any development over its lifespan. Cement is that the primary material utilized in development all over the place the globe. as a result of expansion in Construction and Demolition exercises around the world, the solid squanders created due to pulverization conjointly will increment. in any case this waste isn't utilized for any reason that is totally misfortune inside the economy of the nation as an aftereffect of regular assets square measure draining at a quick pace. progressively the produced solid squanders cause genuine transfer issues in light of the fact that the districts don't appear to be prepared to understand the best response for it while not powerful the setting. We as a whole realize that the premier regular watch all over the place the globe just in the event of the greater part of the materials (paper, plastic, elastic, wood, concrete, and so forth.) is use to spare loads of the characteristic assets and

setting. Cement is such a chic and vitality overpowering material anyway it's dazzling that solid waste is seldom used by use the solid as a reused solid mix (RCA) to use for the improvement capacities. Rather it's basically discarded in landfills.

NEED FOR SUSTAINABILITY IN CONSTRUCTION

As the advancement in development is expanding there is a developing interest on normally accessible totals as they frame the essential constituents of development. With this emerges the issue of consumption of common assets which unfavorably influences nature. Then again as the development exercises expand so likewise there is an expansion in the obliteration of structures creating huge amounts of pulverization squanders which are of no utilization and simply discover their way into landfills. Be that as it may, over the time the transfer of these squanders have gotten to be troublesome attributable to absence of accessibility of area posturing genuine ecological perils.

APPLICATIONS OF DEMOLISHED WASTE AGGREGATE

At first the development and devastation squanders discovered their way into landfills. These days the use of reused totals in development ranges is wide. The applications change from nation to nation furthermore taking into account the nature of the decimated squanders.

- Concrete kerb: Demolished waste totals have been utilized as solid kerb. As indicated by building development and development innovation (1999), 10mm reused total and mixed reused sand are utilized for solid kerb as a part of the Lenthall road venture in Sydney.

- Granular base course material: According to Market Development Study for Recycled Aggregate Products, reused totals from pulverized squanders are utilized as granular base course as a part of the street development. It additionally said that reused totals demonstrated superior to anything regular totals when utilized as a part of the granular base course in the street development. They likewise found that when the street is based on wet

subgrade regions, reused totals will balance out the base and give an enhanced working surface to asphalt structure development

2.0 LITERATURE REVIEW

One of the genuine challenges of our present society is the confirmation of environment. A bit of the key parts in this thankfulness are the decreasing of the usage of essentialness and typical unrefined materials and use of waste materials. These subjects are getting great thought under down to earth change nowadays. The use of reused aggregates from advancement and destruction misuses is exhibiting approaching application being developed as other choice to vital (ordinary) sums. It moderates ordinary resources and reduces the space required for the landfill transfer.

The vast majority of the waste materials created by crushing structures are arranged by dumping them as area fill or for recovering area. In any case, with the interest for area expanding step by step, the areas, limit and width of the area that can get waste materials are getting to be restricted. Including the expense of transportation, that makes the transfer a noteworthy issue. Thus reuse of decimation waste gives off an impression of being a powerful arrangement and the most fitting and huge scale use would be to utilize it as totals to deliver concrete for new development Old bond and block work that have "accomplished the end of the road" can be reused and used as aggregate for new concrete, and also for different distinctive applications being developed. Any improvement activity requires a couple of materials, for instance, strong, steel, piece, stone, glass, earth, mud, wood, and so on. In any case, the bond strong remains the rule improvement material used as a piece of advancement business undertakings. For its fittingness and flexibility concerning the advancing environment, the strong must be such that it can screen resource, guarantee the earth, streamline and incite authentic utilization of essentialness. To achieve this, genuine highlight must be laid on the use of

misuses and reactions in bond and concrete used for new improvements. The utilization of reused aggregate is particularly to a great degree empowering as 75 percent of bond is made of sums. Taking all things into account, the aggregates considered are slag, power plant wastes, reused strong, mining and quarrying misuses, incinerator store, red mud, seethed earth, sawdust and foundry sand. The massive measures of demolished concrete are open at various advancement regions, which are in the blink of an eye speaking to a noteworthy issue of move in urban zones. This can without quite a bit of a stretch be reused as aggregate and used as a piece of bond. Imaginative work practices have been taken up all over the place all through the world for exhibiting its believability; money related sensibility and cost feasibility.

In this examination, the solid creation with fractional supplanting of the normal total by reused total is concentrated on.

M C Limbachiya, et al, in this examination the creators included examples from various hotspots for the study furthermore have applicable data in regards to the first solid quality.

RCA tests were made in single size division (20 - 5mm) using business plant for the era of beat rock all out, including vital jaw and assistant cone crushers and screens. Examination of physical qualities of RCA obtained from four unmistakable sources showed that RCA had 3 to 10% lower thickness and 3 to 5 times higher ingestion than NA in the drenched surface dry state, reflecting the porosity of bond paste enveloping the RCA. Mix diagram is as per U.K codal acquirements. Bond and water substance was kept up same for both N.A and R.C.A.replacement of coarse totals with RA was done at 0,20,30,50 and 100%

From the consequences of tests on crisp properties the creator infers that workability (droop) abatements and dependability (draining and isolation) increments with expansion in rate of substitution of coarse totals by RA yet

droop however lessens is well inside resistance of +/- 25mm yet at RA of more than half substitution steadiness diminishes extraordinarily and is only reasonable to be utilized as filler material.. Compressive quality at 28 days for 30% substitution by RA has no huge variety with that of NA yet past that there is continuous lessening in quality. To get same quality at higher substitution, water concrete proportion must be expanded. There is very little variety in flexural quality and modulus of flexibility amongst NA and RA concrete. In spite of the fact that diverse well springs of RA was considered, they dint influence the quality for a specific % of RCA.

3.0 MATERIALS

This chapter briefly outlines the test results of the properties of the materials used in the project. The relevant codes of practice have been mentioned for all tests in the reference and all the tests have been performed as per the relevant codal procedure and guidelines.

TESTS ON COARSE AGGREGATES

The decimated waste cement required for the present study was acquired from the building annihilation exercises which were experiencing close to our area. The devastated cement was smashed physically to acquire the totals with joined mortar in them. These totals were washed altogether to expel the stuck mortar to most extreme conceivable degree. At that point these reused totals were dried and utilized as coarse totals as a part of new concrete.



Crushing and washing of demolished concrete Sieve analysis on recycled aggregates-12.5 mm down size

S. no	IS sieves	Particle size D (mm)	Weight retained (kg)	Cumulative weight retained (kg)	Cumulative % weight retained	% finer (N)
1	25mm	25	0.02	0.02	2	98
2	20mm	20	0.192	0.212	21.2	78.8
3	16mm	16	0.16	0.372	37.2	62.8
4	12.5mm	12.5	0.32	0.692	69.2	30.8
5	10 mm	10	0.13	0.822	82.2	17.8
6	4.75mm	4.75	0.177	0.999	99.9	0.1
7	2.36mm	2.36	0.001	1.00	100	0
8	Pan	<2.36	0.00	1.00	100	0

Sieve analysis on natural coarse aggregate-12.5mm downsize

S. no	IS sieves	Particle size D (mm)	Weight retained (kg)	Cumulative weight retained (kg)	Cumulative % weight retained	% finer (N)
1	80mm	80	-	0	0	100
2	40mm	40	-	0	0	100
3	20mm	20	-	0	0	100
4	10mm	10	0.648	0.648	32.4	67.6
5	4.75mm	4.75	1.270	1.918	95.9	4.1
6	2.36mm	2.36	0.046	1.964	98.2	1.8
7	1.18mm	1.18	0.028	1.992	99.6	0.4
8	600u	0.6	0.002	1.994	99.7	0.3
9	300u	0.3	0.002	1.996	99.8	0.2
10	150u	0.15	0.002	1.998	99.9	0.1
11	Pan	<0.15	0.002	2.000	100	0

CRUSHING TEST

Aggregate crushing value: =29.86%

Test on natural aggregate:

Empty weight of measuring jar: 1.95kg
 Weight of sample + jar: 4.722kg
 Weight of sample (W₁): 2.772kg
 Weight of portion of sample passing 2.36mm sieve (W₂): 0.764kg
 Aggregate crushing value: =27.56%

Test on recycled aggregate:

Empty weight of measuring jar: 1.95kg
 Weight of sample + jar: 4.752kg
 Weight of sample (W₁): 2.558kg
 Weight of portion of sample passing 2.36mm sieve (W₂): 0.715kg
 Aggregate crushing value: =28.1%

Test on recycled aggregate:

Empty weight of measuring jar: 0.914kg
 Weight of sample + jar: 1.202kg
 Weight of sample (W₁): 0.288kg
 Weight of portion of sample passing 2.36mm sieve (W₂): 0.086kg



Recycled aggregates subjected to crushing test

Test on cement

PROPERTY	RESULT
FINENESS	0.04
SPECIFIC GRAVITY	3.279
STANDARD CONSISTANCY	30.5%
SETTING TIME	INITIAL- 80min FINAL-6hr 30 min

Selection of water-binder (w/b) ratio:

The water-binder ratio for the target mean compressive strength is chosen from figure 3.7, the proposed w/b ratio Vs. compressive strength relationship. The w/b ratio so chosen is checked against the limiting w/c ratio for the requirements of durability as per table 3.5 of IS: 456-2000, and the lower of the two values is adopted.

STRENGTH TESTS ON CONCRETE

In this investigation production of high strength concrete using recycled aggregates is attempted. The concrete grade M60 is the strength required to be produced using recycled aggregates. Many researchers have been carried out till now on recycled aggregate concrete for normal strength concrete and also they have been successful in replacing natural aggregate even up to 100% by recycled aggregates to produce normal strength concrete. So the next big step would be to try and use them in high strength concrete. Further the normal strength concrete is used in all the general construction works like buildings. And for this very less concrete is required as compared other type of construction works like for instance bridges. Also further only a small quantity of natural aggregates will be replaced by recycled aggregates. Hence the usage of demolished concrete recycled aggregates in new concrete is very less and hence only a small quantity of the demolished wastes generated will be used and the remaining will still be left as waste. But in case of high strength concrete, they are used in bridge constructions where large quantities of concrete are required. Hence we can use larger quantities of demolished wastes reducing the waste generation.

In the current study the specimens have been casted. Cube specimens for testing compression test, beam specimens for

flexure test and cylindrical specimens for split tensile strength have been cast and kept for curing for a period of 28 days and then tested for their respective strengths.



Specimen placed in cover



Specimen with sealant

RESULTS AND DISCUSSION:



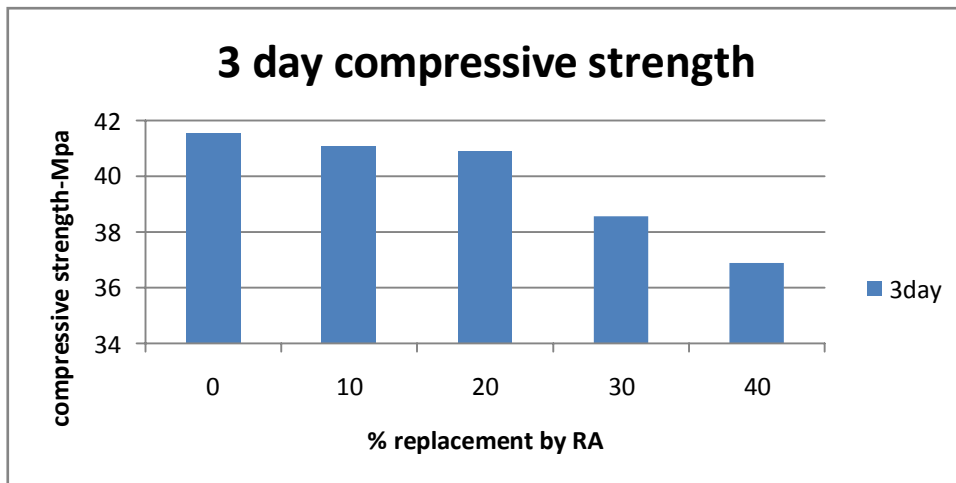
Compression test on cubes



Crushed specimen after test

Compression test results of concrete

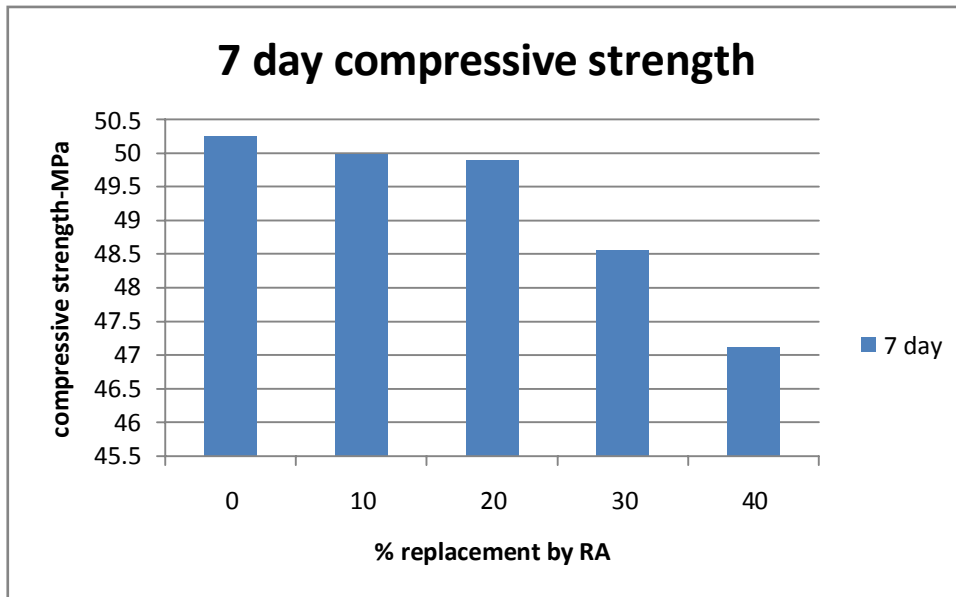
% replacement	3 days N/mm ²	7 days N/mm ²	14days N/mm ²	28 days N/mm ²	56 days N/mm ²	90 days N/mm ²
0%	40.52	49.99	51.88	69.3	71.23	70.12
10%	40.08	49.95	50.32	68.9	70.60	69.16
20%	40.45	49.93	52.32	68.3	70.13	68.14
30%	38.23	48.35	50.0	67.02	69.96	67.47
40%	36.78	47.10	47.22	59.21	59.12	57.39



3 day compressive strength on concrete

From the above figure 6.4 it can be concluded that at 3 days the maximum strength developed is for natural aggregate concrete and it is 41.52N/mm². Among recycled aggregate concrete the maximum 3 day strength developed is for 10% replacement with a strength reduction of

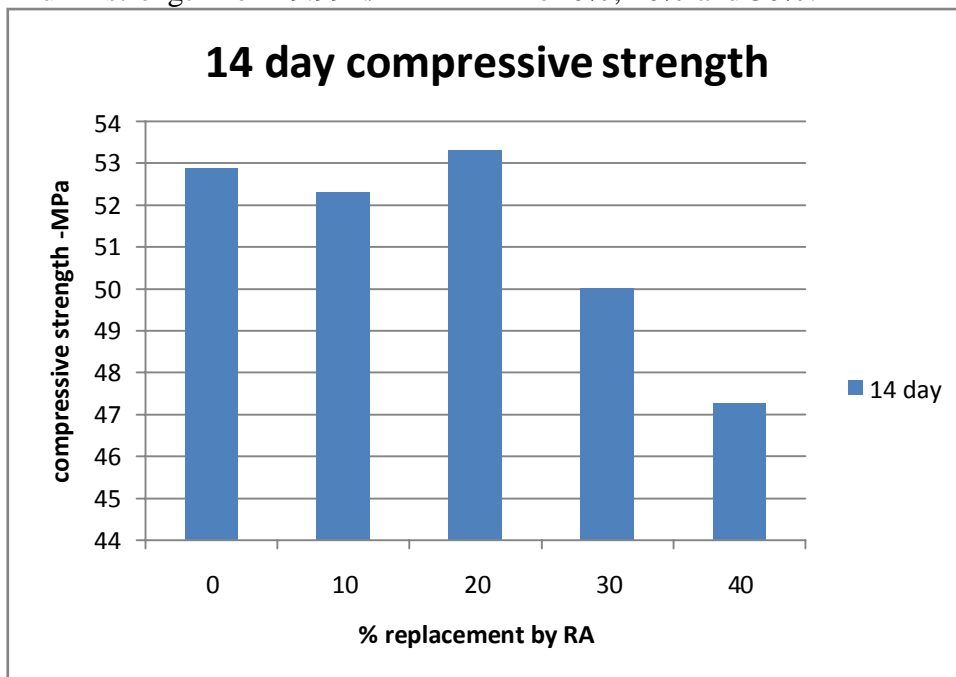
1.06%. And least strength was developed for 40 % replacement recycled aggregate concrete with a strength reduction of 11.175%. The other results ranged in the decreasing order of 0%, 20% and 30% respectively.



7 day compressive strength on concrete

From the figure 6.5 it can be seen that again the maximum strength developed at 7 days is for natural aggregate concrete with 50.24N/mm^2 . Once again the recycled aggregate concrete with 10% replacement has maximum strength of 49.99N/mm^2

with a strength reduction of 0.498% while the one with replacement ratio of 40% has least strength developed which is 47.12N/mm^2 with a strength reduction of 6.21%. The other results range in the order of 0%, 20% and 30%.



14 day compressive strength on concrete

From the above figure 6.6 it can be conclude that at 14 days, the maximum strength developed is for recycled aggregate concrete with a replacement ratio of 20% with strength of 53.32N/mm^2 . In fact it exceeds the 14 day strength of

natural aggregate concrete with a strength increment of 0.832%. the recycled aggregate concrete with a replacement of 40% develops the least strength of 47.28% with a reduction in strength of 10.59%.

SPLIT TENSILE STRENGTH RESULT AND ANALYSIS:



Split tensile strength results of concrete

Sl no	Percentage replacement	7 days Split tensile strength	28 days Split tensile strength
1	0	3.21	5.59
2	10	3.09	5.19
3	20	2.89	4.79
4	30	2.61	4.37
5	40	2.41	4.09

CONCLUSION

- From the compressive strength results of the concrete it can be concluded that both the natural and recycled aggregate concrete gain strength with age.
- But at any instant the strength of recycled aggregate concrete is lower than the strength of natural aggregate concrete.
- The greater the replacement ratio, the lesser is the strength developed in the concrete.
- The compressive strength of 40% recycled aggregate concrete is 14.36% lower than that of natural aggregate concrete while that of 10% recycled aggregate concrete is just 0.55% lower than that of natural aggregate concrete
- From the compression test results it can be concluded that up to 30% replacement of natural aggregates with recycled aggregates there is no considerable reduction in strength of concrete and hence can be considered as optimum replacement without compromise on strength.
- The same above conclusions follow for split tensile strength and flexural strength of concrete.
- The split tensile strength of 40% RAC is 26.46% lower than that of NAC while the split tensile strength of 10% RAC is 6.75% lower than that of NAC.

- The flexural strength of 40% RAC is 27.45% lower than that of NAC while that of 10% RAC is 3.48% lower than that of NAC.
- Hence from the strength results, 30% replacement is considered as optimum and two sets of cubes-one of NAC and other of 30% replacement RAC were casted for durability tests for a period of 28 days.
- In case of water absorption, the RAC exhibit higher water absorption values as compared to NAC. This is due to the presence of attached mortar present in the aggregates. The greater is the attached mortar, the more is the water absorption in the concrete.

REFERENCES:

- ❖ Aitkin, P.C., "High-performance Concrete", E & FN Spoon, UK, 1998
- ❖ de Garrard, F and Mailer, Y, "Engineering Properties of Very High Performance Concretes" High-Performance Concrete - From Material to Structure, (Editor- Mailer), E&FN Spoon, 1994, London, pp 85 -114.
- ❖ Had eel Mariah, Ghazi Al-Katie , Effect of basalt and limestone aggregate combinations on Super pave aggregate properties
- ❖ Hamadallah Mohammad Al-Baja ,The Use of Basalt Aggregates in Concrete Mixes in Jordan, ,Jordan Journal of Civil Engineering, Volume 2, No. 1, 2008
- ❖ Hamadallah M. Al-Baja Comparison between Composite Beam of Limestone and Basalt Concrete Jordan Journal of Civil Engineering, Volume 3, No. 3, 2009
- ❖ IS: 456 – 2000 (Fourth Revision) Indian Standard Plain and Reinforced Concrete Code of Practice.