ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

# Mechanical Performance of Concrete Made of RCA and Super Plasticizer

**J Ritesh, M.Tech AMIE,**
**Assistant Professor**
**Deparetment of Civil Engineering,**
**Gates Institute of Technology,**
**Gooty, Ananthapuramu.**

**M Anusha**
**B.Tech IV Year Student**
**Deparetment of Civil Engineering,**
**Gates Institute of Technology,**
**Gooty, Ananthapuramu.**

***ABSTRACT***

***Concrete is the world's second most consumed material after water, and its widespread use is the basis for urban development. It is estimated that 25 billion tons of concrete are manufactured each year.***

***Twice as much concrete is used in construction around the world when compared to the total of all other building materials combined. In New Zealand 27% of the total waste generated is construction and demolition waste (C&DW), and of this concrete represents 25%, i.e. 7% of the total waste1. Many countries have recycling schemes for C&DW to avoid dumping to landfill, as suitable landfill sites are becoming scarce particularly in heavily populated countries. In New Zealand a $10/tones landfill levy was introduced in 2008, and this will inevitably increase in the future as landfill sites become scarcer.***

***Charges or levies on landfill dumping often make recycling concrete aggregate a preferred option.***

## Introduction

Recycling of demolition rubble is not a new idea and some reported cases of recycling demolition waste date back to the 2nd World war .In several countries particularly in Europe it is an important process which is used to produce a useful source of aggregate for the construction industry.

However planning approvals to develop new quarries are running at only half the rate of aggregate extraction, which means that in the future the rate of production of crushed rock will be too slow to meet the aggregate demand of the construction industry. The use of secondary materials may not completely remove the problem of the resulting shortage of aggregate but it could alleviate it.

Recycling is the act of processing the used material for use in creating new product. The usage of natural aggregate is getting more and more intense with the advanced development in infrastructure area. In order to reduce the usage of natural aggregate, recycled aggregate can be used as the replacement materials. Recycled aggregate are comprised of crushed, graded inorganic particles processed from the materials that have been used in the constructions and demolition debris. These materials are generally from buildings, roads, bridges, and sometimes even from catastrophes, such as wars and earthquakes .To promote recycling, incentives should be given to demolition contractors by installing recycling plants in urban locations and allowing the use of recycled aggregate instead of natural aggregate for some purposes.

The recycled products from some recycling plants were examined and their physical properties were compared with those natural aggregates .The ability of

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

the recycled aggregates to comply with existing specifications ,particularly for use as granular sub base material, was also checked. The shear strength of the aggregates was examined in a shear box .The influence of density and vertical stress on the shear strength of the aggregates was investigated and an analysis was conducted on the test data using the militancy index defined by BOLTON (1986). At the end of this dissertation, the strengths and weaknesses of recycled materials are discussed and some suggestions are made for the improvement of materials which does not comply with current specifications .On a more general note, some proposals are made to the construction industry on how to come to terms with and accept recycled material as a useful aggregate source.

## INGRADIENTS OF CONCRETE

The word 'Concrete' came from Portland cement. Concrete is a composite material composed of aggregate bonded together with fluid cement which hardens over time. Concrete plays an important role in the construction industries. In the last few decades, many researchers have been carried on the properties of concrete by using waste materials and by-products like silica fume and manufactured sand. Some additives (such as pozzolonsor super plasticizers) are included in the mixture to improve the physical properties of the wet mix or the finished material.

High quantity of concrete is using now a days. The Hoover Dam, the Panama Canal, and the Roman pantheon all these constructions are come under famous concrete structures. At the period of Roman Empire the concrete is widely used. For example dams, multi storey car parks, super high ways, bridges all these large structures are usually construct with reinforced concrete. The Three Dam in china is the main example of largest concrete structure in the world. This structure consists of 2.72 million concrete cubic meters. Mostly common drinking water is suitable for mixing of concrete and aggregates. Concrete is in two types they are coarse aggregates and fine aggregates. These aggregates division is based on sizes, big size aggregates in concrete are comes under coarse aggregate and remaining small size aggregates are fine aggregates. Not only the size differences, fine modulus of coarse and fine aggregates are different based on mix design.

## APPLICATIONS

Nowadays, the applications of recycled aggregate in construction areas are wide. The applications are different from country to country

1) Aggregate Base Course, or the untreated aggregates used as foundation for roadway pavement, is the underlying layer which forms a structural foundation for paving.

2) Ready Mix Concrete -It is used for residential slab and foundation; walk and curb residential street; commercial slab and foundation and concrete paving per aggregate approval.

3) Pipe Bedding: Recycled concrete can serve as a stable bed or firm foundation in which to lay underground utilities.

4) Paving Blocks: Recycled aggregate have been used as paving blocks in some countries.

5) Building Blocks: Recycled aggregate has been used as building blocks.

6) Value engineering benefits: Produce specification sized recycled aggregates at own location. Avoid haul-off costs and landfill disposal fees. Eliminate the expense of aggregate material imports and exports. Increase project efficiency and improve job cost - recycled concrete aggregates yield more volume by weight (up to 15%).

7) Landscape Materials: Recycled concrete can be used in various landscape settings. Sized concrete rubble can serve as landscape feature. To date, recycled concrete aggregate has been used as boulder/stacked rock walls, underpass abutment structures, erosion structures, water features, retaining walls.

## MAIN INGREDIENTS

Three basic ingredients are present in preparation of concrete mixes, they are

1. Cement
2. Aggregate:

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

- Fine aggregate
- Natural coarse aggregate
- Recycled coarse aggregate

3. Super plasticizer

### Table (1): Mechanical and Physical Properties of Cement

| Property | | Result | Specifications Limits |
|---|---|---|---|
| Compressive Strength of Standard Mortar (M Pa) | 2 days | 21.4 | Not less than 10 |
| | 28 days | 47.7 | Not less than 42.50 Not more than 62.5 |
| Soundness (Lech atelier) (mm) | | 1 | Not more than 10 |
| Setting Time (min) | Initial | 135 | Not less than 60 |
| | Final | 180 | --------- |

**Limits of ESS 4756-1 / 2007 [7]*

### Table (2): Chemical Properties of Cement

| Property | Results |
|---|---|
| Silicon Oxide **$Si O_2$** | 21.0 |
| Aluminum Oxide **$Al_2O_3$** | 6.10 |
| Ferric Oxide **$Fe_2O_3$** | 3.00 |
| Calcium Oxide **Ca O** | 61.5 |
| Magnesium Oxide **Mg O** | 3.8 |
| Sulfur Oxide **$SO_3$** | 2.5 |
| Sodium Oxide **$Na_2O$** | 0.4 |
| Potassium Oxide **$K_2O$** | 0.3 |
| Loss on Ignition **(L.O.I)** | 1.6 |
| Insoluble Residue | 0.9 |

## AGGREGATES

The inert mineral materials such as sand, gravel, etc used for manufacture of concretes are known as aggregates.

## FINE AGGREGATE

Natural sand composed of siliceous materials was used as Fine Aggregate (FA) in thisstudy. Testing of sand was carried out according to the ESS 1109/2002 [8]. Table (3)shows the physical properties of the sand.

### Table (3): Physical Properties of Fine Aggregate

| Property | Results | Limits* |
|---|---|---|
| Specific Weight | 2.63 | ----- |
| Bulk Density (t/m3) | 1.78 | ----- |
| Clay and Fine Dust Content (% By Volume) | 1.4 | Not more Than 3 |

**Limits of ESS 1109 /2002 [8]*

## NATURAL COARSE AGGREGATE

The aggregate which pass through 75mm IS sieve and retain on 4.75mm IS sieve are known as coarse aggregates. Natural crushed stone (dolomite) was used in this study. Testing of natural coarse aggregate (NCA) was carried out according to the ESS 1109/2002 [8]. Mechanical and physical properties of the NCA comply with both ESS 1109/2002 [8] and the Egyptian Code ECCS203-2007 [9]. Table (4) shows the physical and mechanical properties of the Natural crushed stone (dolomite).

### Requirements of Good Aggregates:

1. It should be sufficiently strong.
2. It should be hard
3. It should be durable
4. It should have rough surface.
5. It should be in spherical or cubical in shape.

### Table (4): Physical and Mechanical Properties of Natural Coarse Aggregate

| Property | Results | Limits |
|---|---|---|
| Specific Weight | 2.61 | ---- |
| Bulk Density (t/m3) | 1.56 | ---- |
| Water Absorption % | 2.05 | Not more than 2.5 |
| Clay and Fine Dust Content | 2.4 | Not more than 4 |
| Flakiness Index % | 36.8 | Not more than 40 |
| Elongation Index % | 9.6 | Not more than 25 |
| Abrasion Index % | 17.8 | Not more than 30 |

## RECYCLED COARSE AGGREGATE:

Recycled aggregates to be produced from aged concrete that has been demolished and removed from foundations, pavements, bridges or buildings, is crushed and processed into various size fractions. The recycled aggregate include all kind of inorganic materials from the construction demolition waste concrete .Recycled aggregate is made of solely crushed concrete. Separation of concrete material already during the demolition phase is essential to

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

make it easier to produce the good quality recycled aggregate.

It is prudent to store old concrete separately to other demolition materials to help avoid contamination. Records of the history of the demolition concrete – strength, mix designs etc. –would seldom be available, but if available these are useful in determining the potential of the recycled aggregate concrete.

Recycled coarse aggregate

### Table (5): properties of RCA

| SR.NO. | PARTICULARS | VALUES | |
|---|---|---|---|
| | | Natural Aggregate | Recycled Coarse Aggregate |
| 1 | *Specific Gravity* | *2.4-3.0* | *2.35-2.58* |
| 2 | *Water Absorption* | *0.29%-0.3%* | *0.3%-0.32%* |
| 3 | *Bulk Density* | *1678.2 KN/m3* | *1469.8KN/m3* |
| 4 | *Crushing Values* | *18.4%* | *36.3%* |
| 5 | *Impact Values* | *17.65%* | *35.2%* |

## SUPER PLASTICIZER

Super plasticizers constitute of a relatively new category and improved version of plasticizer, the use of which was developed in Japan and Germany during 1960 and 1970, respectively. They are chemically different from normal plasticizers. The use of plasticizers permits reduction of water to an extent up to 30% without reducing the workability in contrast to the possible reduction up to 15% in case of plasticizers.

Super plasticizer which is also known as high range water reducers are chemical admixtures used where well-dispersed particle suspension is required. These polymers are used as dispersants to avoid particle segregation, and to improve the flow characteristics of concrete. Flocculation of cement particles occur in a concrete mix without super plasticizer which reduces the workability of concrete, however for the same water-cement ratio there is a uniform distribution of cement particles for a concrete mix with super plasticizer. Super plasticizers produce a homogeneous, cohesive concrete generally without any tendency for segregation and bleeding.

### Table (6): properties of super plasticizers

| S.NO | Name of the admixture | Relative density | Color | Dosage * |
|---|---|---|---|---|
| 1 | SNF | 1.24 at 25°C | Dark Brown | 0.5-2% |
| 2 | PCE | 1.08 at 25°C | Honey Brown | 0.4-1.2% |
| 3 | MPCE | 1.08 at 25°C | Golden Brown | 0.6-1.2% |

## EXPERIMENTAL INVESTIGATION

An experimental investigation has been planned to study the behavior of the cement with various percentage replacements of RCA. In the present work, M53 grade cement is used. Cement concrete of 1; 1; 2 is taken. Replacing materials i.e. RCA in varying percentages ranging from 0% to 100% i.e., 0%, 50%, 75% and 100% and super plasticizer is used as an admixture.

Cubes were tested for compressive strength test, and the average values have been presented. All the specimens were tested at 7days, 14 days, 21 days and 28 days of water curing.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

## MATERIALS USED IN THE EXPERIMENT

- Cement
- Fine aggregate
- Coarse aggregate
- Super plasticizer
- Water

## CEMENT

Ordinary Portland cement conforming to IS 10262:2009 Of 53 grades, ACC brand confirming to IS: 8112 standards have been used and chemical composition of cement is represented in.

Cement

## TESTS ON CEMENT

(a) Standard Consistency Test
(b) Initial setting time
(c) Final setting time
(d) Specific Gravity

## STANDARD CONSISTENCY TEST

In order to find out the initial setting time, final setting time soundness and compressive strength, a parameter is established which is known as standard consistency.

Take 500gms of cement and prepare its paste with 24% water. Put the paste into the vicarmould and smooth the top surface. The mould is shaken to expel air. Lower the plunger and note its depth of penetration. Try the paste with varying water percentage 1% each time approaching the consistency. The percentage of water corresponding to the penetration depth 33 to 35mm from bottom of mould will be the standard consistency of cement and is generally denoted by 'P'.

Normal consistency of cement (p) = 30 %

## INITIAL SETTING TIME

The time at which cement paste loses its plasticity after addition of water is known as the initial setting time.Take about 500gms of cement; add 0.85P water (where P is standard consistency).Fill the mould with the prepared paste and smooth the surface. Keeps the needle just touching the surface.Release it and note the penetration depth. Repeat the procedure until the needle fails to pierce the paste in the mould 33 to 35mm from bottom; this will be the initial setting time.Initial setting time of cement = 40min

## FINAL SETTING TIME

The time corresponding to paste becoming a hard mass is known as final setting time. After noting the initial setting time, go on checking for final setting time after every one hour. For first four hours and then according to the impression. Check for final setting time after a few minutes interval. Cement is supposed to be finally set if needle makes an impression but attachment fails to do so. Final setting time of cement = 600min.

Vicat apparatus

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

## SPECIFIC GRAVITY

This property is very important in mix design.

It is determined by correlating the rise of cement and kerosene levels in specific gravity bottle. Since, the cement on mixing with the water hardens so it is mixed with kerosene and the corresponding rise in bottle for specific gravity determination is found.

Specific gravity of cement =3.1

### Table (7): Test results

| S. NO | PARTICULARS | RESULTS |
|---|---|---|
| 1. | Specific gravity | 3.1 |
| 2. | Initial setting time | 40 min |
| 3 | Final setting time | 600 min |
| 4. | Consistency | 30% |
| 5. | Fineness | 3 |

Specific gravity of cement

## FINE AGGREGATE

The fine aggregates [sand] used througth out the experimental work. The specific particle size composition of the sand was prepared as per the I.S.Code 650-1966 and I.S. Code 383-1970. Sand was thoroughly washed with tap water to remove impurities like decayed vegetable matter, humus, organic matter and deleterious materials like clay, fine slit and fine dust and was oven dried for 24 hours and cooled to room temperature. This sand was used for the experiment work.

Fine aggregate

## TESTS ON FINE AGGREGATE

### Sieve analysis

The fineness modulus is a numerical index of fineness, giving some idea of the mean size of the particles present in the entire body of the aggregates.

Sieve analysis helps to determine the particle size distribution of the coarse and fine aggregates. This is done by sieving the aggregates as per IS: 2386 (Part I) – 1963. In this we use different sieves as standardized by the IS code and then pass aggregates through them and thus collect different sized particles left over different sieves. The apparatus used are a set of IS Sieves of sizes – 80mm, 63mm, 50mm, 40mm,31.5mm, 25mm, 20mm, 16mm, 12.5mm, 10mm, 6.3mm,4.75mm, 3.35mm, 2.36mm, 1.18mm, 600µm, 300µm, 150µm and 75µm. Balance or scale with an accuracy to measure 0.1 percent of the weight of the test sample. The sample for sieving should be prepared from the larger sample either by quartering or by means of a sample divider. The test sample is dried to a constant weight at a temperature of 110 + 5oC and weighed. The sample is sieved by using a set of IS Sieves. On completion of sieving, the material on each sieve is weighed. Cumulative weight passing through each sieve is calculated as a percentage of the total sample weight.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Fineness modulus is obtained by adding cumulative percentage of aggregates retained on each sieve and dividing the sum by 100.The results should be calculated and reported as the cumulative percentage by weight of the total sample. The percentages by weight of the total sample passing through one sieve and retained on the next smaller sieve, to the nearest 0.1 percent. The results of the sieve analysis may be recorded graphically on a semi-log graph with particle size as abscissa (log scale) and the percentage smaller than the specified diameter as ordinate.

Set of Sieves for fine Aggregate

## Specific gravity

The specific gravity of aggregates is defined as the ratio of the weight of a given volume of aggregate to the weight of an equal volume of water at the same temperature.

Specific gravity of fine aggregate

To determine the specific gravity of aggregates using pycnometer first weight a clean dry pycnometer with the cap accurate to 0.01g (W1) then pour oven dry aggregate in to the pycnometer and fill up 1/3 rd of the bottle and weight it (W2). Fill the pycnometer to half of its height with distilled water and mix it thoroughly with glass rod and place the screw top and fill the pycnometer, flush with hole in the conical cap. Dry the pycnometer from outside and weight it (W3). Remove the contents, wash the pycnometer, pour distilled water flush with the hole of the conical cap and weight it (W4). Repeat steps 2 and 3 two more times to arrive at an average value.

$$\text{Specific gravity} = \frac{(W2-W1)}{(W2-W1)-(W3-W4)} = 2.6$$

## Water absorption

Take 500gms of fine aggregate saturated surface condition shall be placed in the enamel tray and covered with distilled water. Agitate the sample with dry rod to remove any entrapped air. The sample shall remain immersed for 24±1/2 hours.The saturated and surface-dry sample shall be weighed (W1).The aggregate shall then be placed in the Pycnometer which shall be filled with distilled water. Any trapped air shall be eliminated by rotating the Pycnometer on its side, the hole in the apex of the cone being covered with the finger.The Pycnometer shall be dried on the outside and weighed (W2).The Pycnometer is completely refilled with distilled water and weighed (W3).The contents of the Pycnometer shall be emptied into the tray, care being taken to ensure that all the aggregate is transferred to the enamel tray. The sample shall be placed in the oven in the tray at a temperature of 100 to 110 ºC for 24±1/2 hours. It shall be cooled in the air-tight container and weighed (W4). Repeat the above procedure 2 to 3 times to arrive at an average value.

$$\text{Water absorption} = \frac{100(W1-W4)}{W4}$$

## Bulking of sand

The volume increase of fine aggregate due to presence of moisture content is known as bulking. Fine sand

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

bulks more as compared to coarse sand. Put sufficient quantity of oven dried sand loosely into container to about two thirds of the full, then level the top of sand. Push the steel rule vertically down through the sand at the middle to the bottom and measure the height of sand (h). Empty the container on a clean metal tray without any loss of sand and add one percent of water by weight of sand and mix thoroughly by hand. Put back the loose sand into the container without tamping it. Smooth and level the top surface of the moist sand and measure the depth (h1) at the middle with the steel rule. Repeat the above procedure with 2, 3, 4, 5 and so on percentages of moisture of the sample till the bulking of sand are maximum and starts dropping automatically to zero. Every time different sample is used.

$$\text{Percentage of bulking of sand} = \frac{100\,(h1-h)}{h}$$

## RECYCLED COARSE AGGREGATE

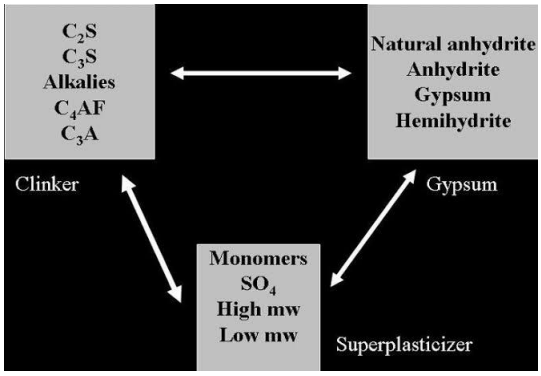
Recycled aggregate is collected from the demolition of buildings .The recycled aggregate include all kind of inorganic materials from the construction demolition waste concrete .Recycled aggregate is made of solely crushed concrete. Separation of concrete material already during the demolition phase is essential to make it easier to produce the good quality recycled aggregate.

Here we are considering the RCA as 60% of which is passing through the 25mm IS sieve and retains on 12.5 mm IS sieve, 40% of RCA which is passing through 12.5 mm IS sieve and retained on 4.75mm IS sieve.

Recycled Aggregate

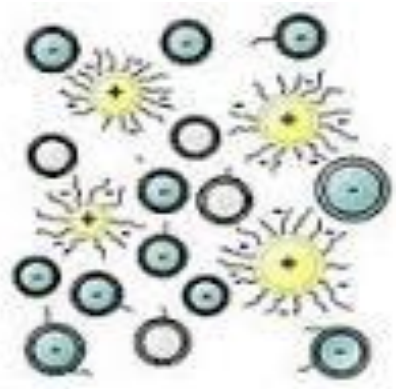
## FORMATION OF SUPER PLASTICIZER

The super plasticizer formation can be shown in below photograph




Formation of super plasticizer

And the super plasticizer can be visible like in below photograph



Visualization of super plasticizer

Here in this project we are using IS.91031999 code super plasticizer in order to reduce w/c ratio with same workability.

## TEST RESULTSAND ANALYSIS

### TESTS ON SPECIMENS

The tests conducted in our investigation are

- Compressive strength test
- Split tensile strength test

In all the above tests four specimens are tested for compressive and split tensile strength i.e. Compression tests for cubes of size 150 mm × 150 mm and split tensile strength for cylinders of size 150 mm × 300 mm.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

## COMPRESSION TEST

According to Cement Association of Canada (2003), compressive strength of concrete can be defined as the measured maximum resistance of a concrete to axial loading. Compression test is the most common test used to test the hardened concrete specimens because the testing is easy to make. The strength of the concrete specimens with different percentage of recycled aggregate replacement can be indicating through the compression test.

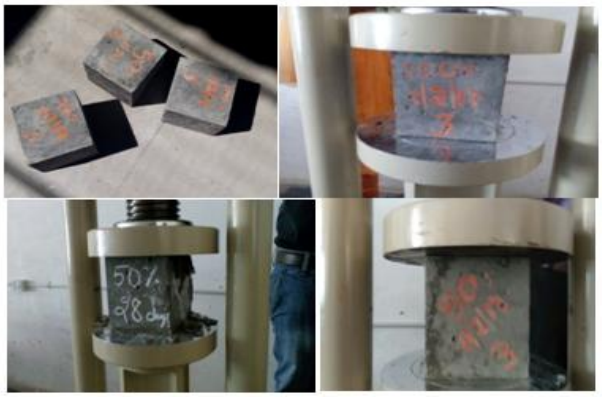
The specimens used in the compression test were 150 mm × 150mm.There are four specimens were used in the compression testing in every batch.Differences of the strength among the different percentage of recycled aggregate used inthe age of 7, 14, 21 and 28 days also indicated through the compression test. Thecompression test was carried out in the concrete technology laboratory of GATES institute of technology.

Apparatus and Test Procedure of Compression Test:
The apparatus and equipments used in the compression test were according to IS code

1. Testing Machine: 'Avery' testing machine.
2. Rubber Cap: A suitable diameter of rubber cap.
3. Ruler: 400mm long ruler to measure the height of specimen.
4. Balance: To measure the weight of the concrete specimens.
5. Veniere Caliper: To measure the diameter of the concrete specimens.

The test procedure was according to the procedures were as
Below:

1. The testing for the specimens should be carried out as soon as possible after took out from the curing room. The specimens need to get the measurements before the Testing.
2. The diameter and height of the specimens were measured and recorded. TheWeight of each specimen was measured and recorded too.
3. The platens of the testing machine were cleaned with a clean rag.
4. Cleaned the uncapped surface of the specimen and place the specimen in theTesting machine. The axis of the specimen was aligned with the centre of theThrust of the spherically seated platen.
5. Carefully placed the rubber cap on the specimen.
6. The platen was lowered to the rubber cap until the uniform bearing was obtained.
7. The force was applied and increased continuously at a rate equivalent to 20MPaCompressive stress per minute until the specimen failed.
8. Recorded the maximum force from the testing machine.



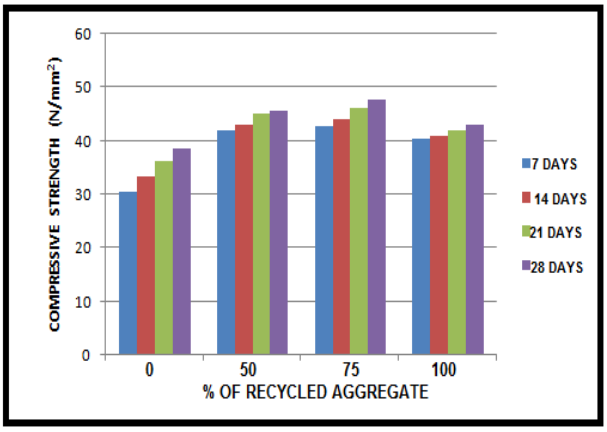
| SR.NO | % OF REPLACEMENT | STRENGTH (KN) | COMPRESSIVE STRENGTH (N/mm²) |
|---|---|---|---|
| 1 | Natural coarse aggregate | 685 | 30.44 |
| 2 | 50% of RCA | 945 | 42.00 |
| 3 | 75% of RCA | 965 | 42.88 |
| 4 | 100% of RCA | 910 | 40.44 |

Compression testing of cubes

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

## COMPRESSION STRENGTH VARIATION FOR 7,14,21,28 DAYS

| DAYS | COMPRESSIVE STRENGTH (N/mm²) FOR | | | |
|---|---|---|---|---|
| | 0 %RCA | 50%RCA | 75%RCA | 100%RCA |
| 7 | 30.44 | 42.00 | 42.88 | 40.44 |
| 14 | 33.33 | 43.11 | 44.00 | 40.88 |
| 21 | 36.22 | 45.11 | 46.22 | 42.00 |
| 28 | 38.67 | 45.77 | 47.77 | 43.11 |




## SPLITE TENSILE TEST

Normally, concrete is very strong in compression but weak in tension. Indirect tensile testis used to indicate the brittle nature of the concrete specimens that contained of different percentage of recycled aggregate replacement. Indirect tensile test also called as the Brazil of splitting test. According to the Composition and Properties of Concrete (n.d.),the indirect tensile test will give more uniform results than other tension tests. It alsomentioned that the result obtained by the indirect tensile test is closer to the true tensile strength of concrete than the modulus of rupture.

The indirect tensile test was just carried out after 28days of casting. It is because once theconcrete specimens reach day 28, the increased rate of concrete stress was uniform andthere is not much stress increased after 28days.The testing specimen was 150mm diameter and 300mm length. Four specimens wereused in the testing for every batch. The indirect tensile test was carried out in the concrete technology laboratory of GATES institute of technology.

Apparatus and Test Procedure of Indirect Tensile Test:
The following apparatus and equipments used in the indirect tensile test were according to IS codes

1. Testing Machine: 'Avery' testing machine.
2. Testing Jig: An appropriate size of steel jig.
3. Supplementary Bearing Bar or Plate: Width of 50mm and thickness of 20mm.
4. Bearing Strips: Two grade hardboard widths of 5mm thick, 25mm wide and300mm long.
5. Ruler: 400mm long, to measure the height of the concrete specimens.
6. Vernier Caliper: To measure the diameter of the concrete specimens.

The test procedure is according to the procedures were as below:

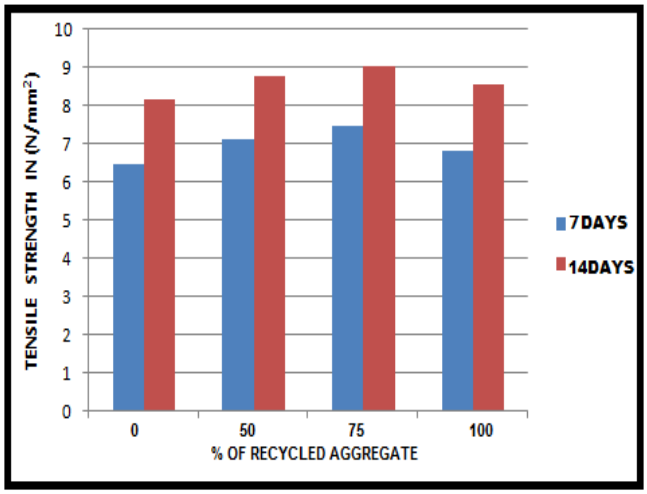
1. Measured the diameter and length of the specimen. Recorded the measurements.
2. Placed the specimen on the testing jig. Bearing strips were aligned on the top and bottom of the specimen and placed the bearing plate outside the bearing strips.
3. Applied a small initial force and the side constrain was removed.
4. Applied the force without shock and increased continuously at a constant rate of 15MPa.
5. Recorded the maximum force from the testing machine when the specimen Failed.

Tensile test of cylinder

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

## SPLITE TENSILE STRENGTH VARIATION FOR 7 AND 14 DAYS

| DAYS | TENSILE STRENGTH (N/mm²) | | | |
|---|---|---|---|---|
| | 0%RCA | 50%RCA | 75%RCA | 100%RCA |
| 7 | 6.50 | 7.14 | 7.49 | 6.81 |
| 14 | 8.18 | 8.77 | 9.05 | 8.55 |




## RECOMMENDATIONS FOR FURTHER STUDIES

Further testing and studies on the recycled aggregate concrete is highly recommended to indicate the strength characteristics of recycled aggregates for application in high strength concrete. Below are some of the recommendations for further studies.

- From past studies and results it is recommended that proper design mixes with different percentage of recycled concrete aggregates with natural aggregates should be prepared to achieve the adequate strength of the concrete and to reduce the consumption of NA.
- Although by decreasing the water/cement ratio, recycled aggregate can achieve high strength concrete. But the workability will be very low. Therefore, it is recommended that adding admixtures such as super plasticizer and silica fume into the mixing so that the workability will be improved.
- More investigations and laboratory tests should be done on the strength characteristics of recycled aggregate. It is recommended that testing can be done on concrete slabs, beams and walls. Some mechanical properties such as creeping and abrasion were also recommended.
- More trials with different particle sizes of recycled aggregate and percentage of replacement of recycled aggregate are recommended to get different outcomes and higher strength characteristics in the recycled aggregate concrete.
- By using RCA the burden of construction wastes can be reduced to a suitable extent.
- A suitable code of practice for recycled concrete aggregates should be prepared in which strength parameters about RCA are described.

## CONCLUSION

Research on the usage of waste construction materials is very important due to the materials waste is gradually increasing with the increased of population and increasing of urban development. The reasons that many investigations and analysis had been made on recycled aggregate are because recycled aggregate is easy to obtain and the cost is cheaper than virgin aggregate. Virgin aggregate need to mine but recycled aggregate can ignore this process.

This on-going research project is to determine the strength characteristics of recycled aggregate for potential application in the high concrete structural concrete. The study shows that when the water/cement ratio was decreased, the compressive strength can be decreased; in order to overcome this we are adding super plasticizer to maintain same workability when w/c ratio decreased. Furthermore, with the cheaper price of recycled aggregate compared to natural aggregate, the builders can carry out the construction task with lesser material costs.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Another result found in this research is the strength of concrete increases from 50% replacement of RCA to 75% replacement of RCA and decreases from 75% replacement of RCA to 100% replacement of RCA.

The 100% replacement of NA by RCA in concrete mixture may effect on chloride ions resistance, if proper design is not adopted.

## REFERENCES

[1] Nixon P. Recycled concrete as an aggregate for concrete – a review. MaterStruct1978; 11:371–8.

[2] Hansen T. Recycling of demolished concrete and masonry, RILEM report 6.London, UK: E&FN Spon; 1992. 336p.

[3] Katz A. Treatments for the improvement of recycled aggregate. J Mater CivilEng 2004; 16(6):597–603.

[4] Kou SC, Poon CS, Agrela F. Comparisons of natural and recycled aggregateconcretes prepared with the addition of different mineral admixtures. CemConcr Compos 2011; 33(8):788–95.

[5] Katz A. Recycling of partially hydrated concrete. In: Wascon 2000 –international conference on the science and engineering of recycling forenvironmental protection Harrogate. UK; 2000. p. 383–91.

[6] Sagoe-Crentsil KK, Brown T, Taylor AH. Performance of concrete made withcommercially produced coarse recycled concrete aggregate. CemConcr ResMay 2001; 31(5):707–12.

[7] Rahal K. Mechanical properties of concrete with recycled coarse aggregate.Build Environ 2007; 42(1):407–15.

[8] Corinaldesi V. Mechanical and elastic behavior of concretes made of recycled-concrete coarse aggregates. Construct Build Mater 2010; 24(9):1616–20.

[9] Fonseca N, de Brito J, Evangelista L. The influence of curing conditions on themechanical performance of concrete made with recycled concrete waste. CemConcr Compos 2011; 33(6):637–43. http://dx.doi.org/10.1016/j.cemconcom.

[10] Amorim P, de Brito J, Evangelista L. Concrete made with coarse concreteaggregate: Influence of curing on durability. ACI Mater J 2012; 109(2)195–204.

[11]GrdicZJ,Toplicic-Curcic GA, Despotovic IM, Ristic NS. Properties of self-compacting concrete prepared with coarse recycled concrete aggregate.Construct Build Mater 2010; 24(7):1129–33.

[12] Kou SC, Poon CS. Properties of self-compacting concrete prepared with coarseand fine recycled concrete aggregates. CemConcr Compos 2009; 31(9):622–7.

[13]Ajdukiewicz A, Kliszczewicz A. Influence of recycled aggregates on mechanical properties of HS/HPC. CemConcr Compos 2002; 24(2):269–79.