# "HIGH PERFORMANCE CONCRETE USING RECYCLED AGGREGATES"

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**Abstract:-** *Recycled aggregates are comprised of crushed, graded inorganic particles processed from the materials that have been used in the constructions and demolition debris. The aim for this project is to determine the strength characteristic of recycled aggregates for application in high performance concrete, which will give a better understanding on the properties of concrete with recycled aggregates, as an alternative material to coarse aggregate in structural concrete. The scope of this project is to determine and compare the properties of high performance concrete by using 100 % replacement of recycled aggregates.*

*Using waste materials for new products is a global trend undergoing rapid development. Use of recycling materials allows for a more efficient life cycle and contributes to environmental protection. In the construction field, this trend has gained importance because of the shortage of natural resources and because of environmental problems caused by storing building-demolition wastes. This situation has led to the search for new applications for these wastes, and their use as aggregates in concrete is an interesting alternative. The research carried out worldwide indicates that the problem associated with recycled aggregates in concrete is its reduced strength and durability. One solution for this is use to use recycled aggregate in high performance concrete. This project is an attempt to study the effect of recycled aggregate obtained from high strength parent concrete on the properties of high performance concrete.*

## 1. INTRODUCTION

Concrete is a globally accepted construction material in civil engineering industry because of its high structural strength, stability, and durability. The Indian construction industry consumes approximately 400 million tons of concrete every year and is expected to reach the billion ton mark in less than a decade. Deterioration, long term poor performance, and inadequate resistance to hostile environment, coupled with greater demands for more sophisticated architectural form, led to the accelerated research into the microstructure of cements and concretes. As a result, innovations of supplementary materials, advanced concretes and composites have been developed. Durability related problems frequently reported in concrete structures necessitated the development of a durable concrete that is less dependent on the quality of construction work.

## 2. MATERIALS & MIX PROPORTIONING

### 1.1.1Cement

Ordinary Portland cement of 53 grade available in local market is used in the investigation. The Cement used has been tested for various proportions as per IS 4031-1988 and found to be confirming to various specifications of are 12269-1987.The specific gravity was 3.1 and fineness was 2280cm$^2$/gm.

### 1.1.2 Fine Aggregate

Fine aggregate used in the investigation was river sand obtained from Local River conforming to zone II of Indian standard specification (IS 383-1970). The sand was first sieved through the 4.75mm IS sieve to remove any particles above 4.75mm size and then washed to remove the dust.

### 1.1.3 Coarse Aggregate

The material which is retained on IS sieve no. 4.75 is termed as coarse aggregate. There are two types of coarse aggregate used for the investigation. Normal coarse aggregate and recycled coarse aggregate. The recycled coarse aggregate used in the investigation was obtained from the demolished cubes tested in concrete technology lab of civil engineering department. They are derived from the final mix prepared in this investigation with natural aggregate. Hence the parent concrete from which recycled aggregate were obtained of grade 80 MPa at the age of 28 days, whereas the natural aggregates were obtained from nearby stone quarry.

### 1.1.4 Silica fume

Silica fume is a by-product from manufacturing silicon metal or ferrosilicon alloys. It is one of the important mineral admixture possessing pozzolanic properties.

### 1.1.5 Superplasticizer

Auramix 400 obtained from fosroc chemicals, is a high performance superplasticiser intended for applications where high water reduction and long workability retention are required, and it has been developed for use in self compacted concrete, Pumped concrete, concrete requiring long workability retention and high performance concrete.

### 1.2 Mix Proportioning

To produce high performance concrete, the major work involves designing an appropriate mix proportion and evaluating the properties of the concrete thus obtained. There are many standard method for mix design and mix proportioning methods. For this investigation the preliminary mix design was carried out by ACI method for M80 grade of high performance concrete with 100% natural coarse aggregates.

After the initial mix design the trial mixes are prepared and tested for the fresh properties of concrete. If the design mix fail to satisfy all requirements of fresh properties of concrete. Trial mixes are revised by fine tuning the mix proportions till all requirements are met. After doing the repeated trials we arrived at the final mixes.

## 3. EXPERIMENTAL METHOD

**Procurement of Materials**
⇩
**Testing of Materials**
⇩
**Arriving mix Proportion**
⇩
**Testing of fresh concrete**
⇩
**Casting & curing of concrete**
⇩
**Strength Investigation**
⇩
**Permeability Test**
⇩
**Durability Test**
⇩
**Result & Discussion**

## 4. DESIGN STEPS :-

Target strength = 80 Mpa
Max size of aggregate used = 16 mm
Specific gravity of cement = 3.15
Specific gravity of fine aggregate (F.A) = 2.66
Specific gravity of Coarse aggregate (C.A) = 2.82
Dry Rodded Bulk Density of fine aggregate = 1723.37 Kg/ $m^3$
Dry Rodded Bulk Density of coarse aggregate = 1663.01 Kg/ $m^3$

**Step-1**

Calculation for weight of Coarse Aggregate:
From ACI 211.4R Table 4.3.3 Fractional volume of oven dry Rodded C.A for 16 mm size aggregate is 0.72 $m^3$
Weight of C.A, = 0.72*1663.01 = 1197.36 Kg/ $m^3$

**Step-2**

Calculation for Quantity of Water:
From ACI 211.4R Table 4.3.4
Assuming Slump as 50 to 75 mm and for C.A size 16 mm the Mixing water = 285 lb/$yd^3$
Void content of FA for this mixing water = 35%
Void content of FA (V)
V = {1-(Dry Rodded unit wt / specific gravity of FA*1000)}*100
= [1-(1723.37/2.66*1000)]*100
= 35.21%
Adjustment in mixing water = (V-35)*4.55 = (35.21 – 35)*4.55 = 0.96
Total water required = 285 + 0.96 = 285.96 lb/$yd^3$ = 169.65 Kg/ $m^3$

**Step-3**

Calculation for weight of cement
From ACI 211.4R Table 4.3.5(b)
Take W / C ratio = 0.27
Weight of cement = 169.65 / 0.27 = 628.33 Kg/ $m^3$

**Step-4**

Calculation for weight of Fine Aggregate:
Cement = 628.33 / 3.15*1000= .199
Water = 169.65 / 1*1000= 0.169
CA = 1197.36 / 3*1000= 0.399
Entrapped Air = 2 / 100= 0.020
Total = 0.78 $m^3$
Volume of Fine Aggregate= 1-0.78
Weight of Fine Aggregate= 0.22*2.66*1000= 585.2 Kg/ $m^3$

**Step-5**

Super plasticizer:
For 0.6% = (0.6 / 100)*585.2 = 3.511 ml

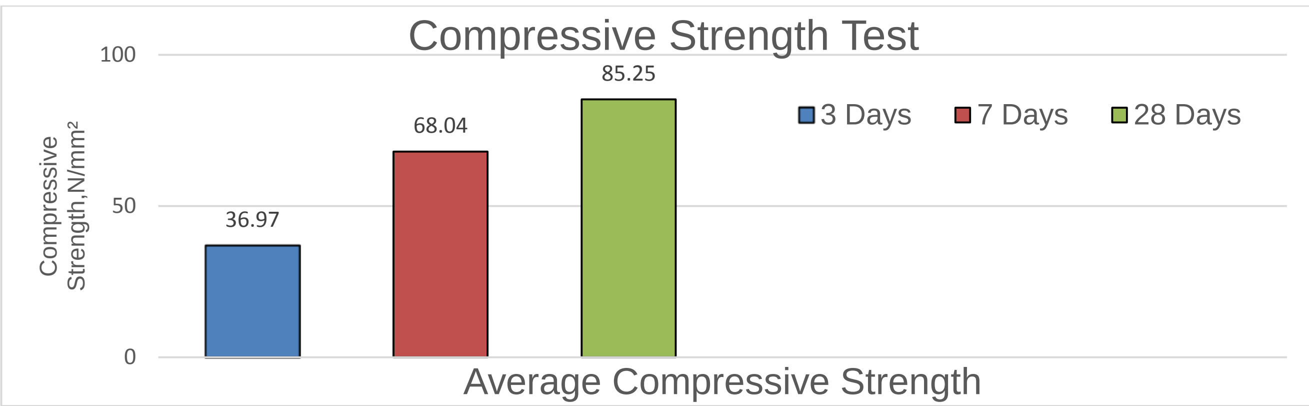
**Step-6**

Correction for water:
Weight of water (For 0.6%) =169.65 – 3.511 = 166.14 Kg/ $m^3$
Requirement of materials per Cubic meter
Cement = 628.33 Kg/ $m^3$
Fine Aggregate = 585.2 Kg/ $m^3$
Coarse Aggregate = 1197.36 Kg/ $m^3$
Water = 166.15 Kg/ $m^3$
Super plasticizers = 3.5012 Kg/ $m^3$
Silica fume =15% of cement =0.15*628.33 = 94 Kg/ $m^3$
So the final ratio becomes Cement : Fine agg (kg/m3) : Coarse agg (kg/m3) : Silica fume : Water (l/m3): Superplasticizer (l/m3)

## 5. RESULTS

### 5.1 Compressive strength results for natural aggregates

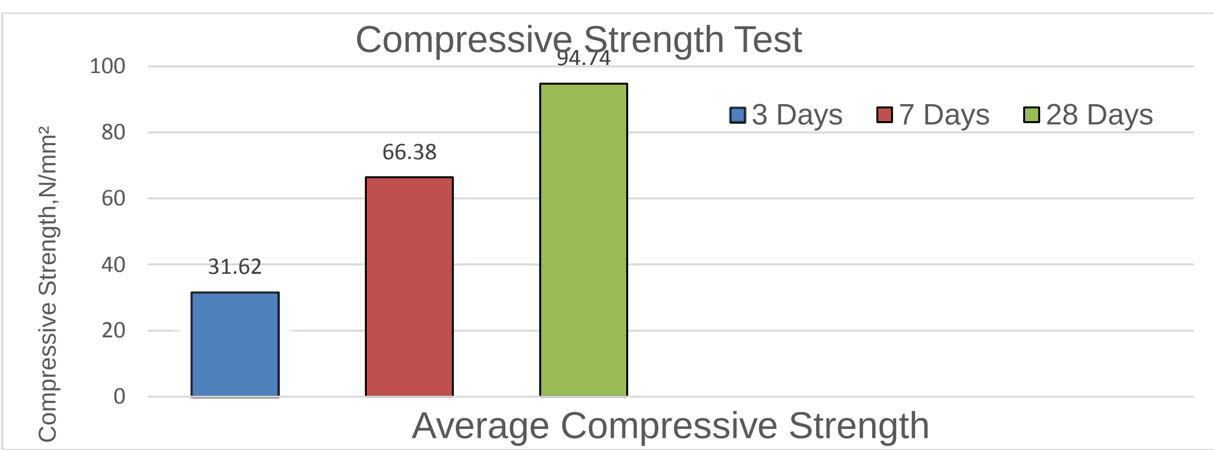
| | Specimen 1 | Specimen 2 | Specimen 3 | Average |
|---|---|---|---|---|
| **3 days, N/mm²** | 35.38 | 34.28 | 41.25 | 36.97 |
| **7 days, N/mm²** | 62.8 | 71.46 | 69.87 | 68.04 |
| **28 days, N/mm²** | 85.34 | 82.26 | 88.15 | 85.25 |




**Average compressive strength of natural aggregates at 3, 7, 28 days.**

### 5.2Compressive strength results for recycled aggregates

| | Specimen 1 | Specimen 2 | Specimen 3 | Average |
|---|---|---|---|---|
| **3 days, N/mm²** | 30.31 | 33.6 | 32.7 | 32.20 |
| **7 days, N/mm²** | 66.05 | 65.18 | 67.93 | 66.38 |
| **28 days, N/mm²** | 86.19 | 98.93 | 86.16 | 90.43 |




**Average compressive strength of recycled aggregates at 3, 7, 28 days**

## 6. CONCLUSIONS

The results of the experimental investigations are very encouraging to promote use of recycled aggregate in high performance concrete. From this study major conclusions drawn are:

- The recycled aggregate high performance concrete has shown higher compressive strength & split tensile strength at 28 days as compared with natural aggregate HPC.
- The strength of parent concrete from which recycled aggregate were derived has a greater impact on the properties of RCA concrete.
- The recycled aggregate HPC has shown two times higher water absorption as compared with natural aggregate HPC.
- The sorptivity coefficient was 3 times higher for natural aggregate HPC than that of recycled aggregate HPC.
- The recycled aggregate HPC shown better resistance to acid exposure as compared with natural aggregate HPC.

From this experiment investigation it is proved that recycled aggregate obtained from good quality parent concrete has a potential to replace natural aggregates completely in high performance concrete.

## 7. REFERENCES

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