

## Eco-Friendly Concrete Using Fly Ash and Recycled Aggregates

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### Abstract

There Is a growing demand for the development of new type concrete due to its high strength, performance, durability, serviceability and overall economy in long term. high performance concrete meets all of the above criteria to fulfil our needs. high performance concrete provides new possibilities of lighter and larger structures with economy and resource consumption than that of traditional concrete, steel and other building materials. in the present work we have taken recycled aggregates in different percentages to replace the natural aggregates and the use of fly ash as replacement of cement. the aim of my work is to prepare a concrete of high strength with the usage of recycled aggregates as they are the waste materials generally used for land filling and other works which pollute the environment. So, to protect the environment and make it properly usable we are using the recycled aggregates here to make a ecofriendly high-performance concrete.

**Keywords:** high performance concrete, recycled aggregates, fly ash, super plasticizers, coarse aggregates, permeability, compressive strength, tensile strength, flexural strength.

### Introduction

high performance concrete has low permeability and diffusion and also has high durability and long life in severe environments. to increase the strength of concrete water to cement ratio should be decreased. due to which other properties will also improve. high performance concrete can be prepared by adding mineral admixture to the concrete at lower water to binder ratio. the high performance concrete is not made by special materials but it was made by same materials by which normal concrete is made. only difference in making high performance concrete is that its ingredients and proportion are specially taken. silica fume, fly ash and pozzolanic material were used to make high performance concrete. these materials are finer than the cement that fills the voids of cement by which concrete would be denser and hence increases its strength and also leads to lesser micro cracking in concrete. dense concrete will more durable and possessed high strength

### Proposed methodology

In this paper, the experimental work planned in this investigation consists of mix proportioning of high-performance concrete with varying percentage replacement of recycled coarse aggregate with natural coarse aggregate. In this investigation we were used workability test, compressive test, indirect tensile test, flexural test, and permeability test. Six batches of concrete mixes were prepared that will consist of 0% minimum recycled coarse aggregate and

50% maximum recycled aggregate with every mix differ by 10% from 0% to 50%. all batches consist of 30% of fly ash and water/binder ratio as 0.36. the natural coarse aggregate replaced for investigating the effect of replacement on HPC. compressive strength of concrete cubes was noted on 21, 28, and 56 days. the 28 and 56 day split tensile strength, permeability and flexure strength were tested.

#### **A. Material Properties:**

1. Cement: OPC grade 43 conforming to is: 8112-1989 was used in the present experiment work. the various laboratory tests confirming to is: 4031-1996 specification was carried out and the physical properties were found consistency 30%, specific gravity 3.15, fineness  $0.223\text{m}^2/\text{g}$ .
2. Fly ash: the fly ash is used as cementitious material which have physical properties as below specific gravity 2.1, initial setting time 45min, final setting time 280min, consistency 35, soundness 0.06, fineness  $368\text{m}^2/\text{kg}$ .
3. Fine aggregate: ordinary sand from local river was used which have properties below specific gravity 2.65.
4. Coarse aggregate: locally available crushed stone with maximum graded size of 20mm and 10mm will be used as coarse aggregate as per is:393-1978.
5. Chemical admixture: the chemical admixture that is also termed as super-plasticizer will interact with cement particle to form a membrane of absorbed charge molecule which avoid physically the particles behavior of approaching each other for stick by which flocculation is prevented. polycarboxylic ether based super plasticizer supplied by fosroc chemical India private limited was used in the present research work.
6. Recycled aggregate: recycled coarse aggregate used in the investigation was obtained From the Demolished Materials.

#### **B. Slump Test:**

The workability of the fresh concrete was measured by means of the conventional slump test. workability is that property of freshly mixed concrete which determines the ease and homogeneity, with which it can be mixed, placed consolidated and finished. slump test is the most commonly used method of measuring consistency of fresh concrete, is: 1199-1959 describes it as a measure of workability of observing the manner in which concrete slumps. the slump test for various recycled aggregate percentage replacements to natural aggregate show that when increases the percentage of recycled coarse aggregate there is decrement in the workability. the slumped concrete takes various shapes and according to the profile of slumped concrete, the slump is termed as true slump, shear slump or collapse slump. if a shear or collapse slump is achieved, a fresh sample should be taken and the test repeated. a collapse slump is an indication that the mix is too wet. only a true slump is of any use in the test. a collapse slump will generally mean that the mix is too wet or that it is a high workability mix, for which the slump test is not appropriate. very dry mixes having slump 0 – 25 mm are typically used in road making, low workability mixes having slump 10 – 40 mm are typically used for foundations with light reinforcement, medium workability mixes with slump 50 – 90 mm, are typically Used For Normal Reinforced Concrete Placed With Vibration, High

Workability Concrete With Slump > 100 Mm Is Typically Used Where Reinforcing Has Tight Spacing, And/or The Concrete Has To Flow A Great Distance.

The approximate magnitude of slump for different workability as given in IS: 456-2000 is tabulated below.

#### Suggested Ranges of Workability

Placing Conditions	Degree Of Workability	Slump In(Mm)
Binding concrete; shallow sections; pavements using pavers	Very low	10-25
Mass concrete; lightly reinforced sections in slabs; beams; walls; columns; floors; hand placed pavements; canal lining; strip footing	Low	25-75
Heavy reinforced sections in slabs, beams, columns, slip form work, pumped concrete	Medium	50-100
Trench fill; insitu piling	High	100-150
Tremie concrete	Very High	150-200

#### C. Test for Compression:

Only one type of compression test specimens is used as cube. Cube moulds were 150mm size conforming to IS: 10086-1982. The specimens were tested for compressive strength on compressive testing machine provided with two steel bearing platens with hardened faces load is applied till specimen breaks.

#### D. Split Tensile Strength Test:

Split tensile strength is an indirect test method as the failure of the cylinder followed by indirect tension.

Horizontal tensile stress =  $2P/\pi DL$

Where P = Compressive load on the cylinder.

L = Length of cylinder.

D = Diameter of cylinder.

#### Flexure Strength Test:

In the present investigation, the flexural strength test has been performing by three point bending. The sample is placed on two supporting pins a fix distance apart and a third loading pin is moving downward from above at a constant rate until sample failure. The flexural strength is expressed as:

Flexural stress ( $\sigma_f$ ) =  $3FL/2bd^2$

Where F = Load at a given point on a load deflection curve.

L = Support span

b = Width of beam

d = Depth or thickness of tested beam

#### E. Permeability Test:

For the permeability test concrete cube were prepared. Hydrostatic pressures were applied in only one side and measured the amount of water passes through it during a known time interval

and with the help of these all data we can find the coefficient of permeability by the following formula. To prevent the leakage of water from other side we used wax.

The codal formula for coefficient of permeability as follows:

$$K = QL/ATH$$

Where

K = permeability coefficient in cm/sec;

Q = Amount of water collected during test when steady state establish (ml);

A = Single side area of concrete specimen in cm<sup>2</sup>;

T = Time required to reach Q to study state (sec);

H/L = Pressure head to thickness ratio of specimen.

### III. Results And Discussion

Six control mixes with partial replacement of cement with fly ash and natural aggregate with fixed weight percentage of fly ash as 30% and five different percentage of recycled aggregate (10%, 20%, 30%, 40% and 50%) had been casted to study the effect on compressive strength at 21, 28 and 56 days and for permeability analysis. further twenty four cylinders also cast to study the effect of split tensile strength and twenty four beams also casted to see the effect of flexure strength. The Indian standard mixed proportioning guideline as mentioned in IS 10262:2009 has been used for mix proportioning.

The specimens were cast by fixed amount of fly ash and varying the percentage of recycled aggregate as 10%, 20%, 30%, 40% and 50%. Further the water to binder ratio for all mixes was maintained at 0.36. Super Plasticizer dosage for all the mixes were 0.5% by weight of cement. A comparative study is carried out to study the impact of partial replacement of recycled aggregate with natural aggregate on properties of Hockfield properties of concrete were selected for this study which was flow ability, compressive strength, spit tensile strength, flexural strength and durability.

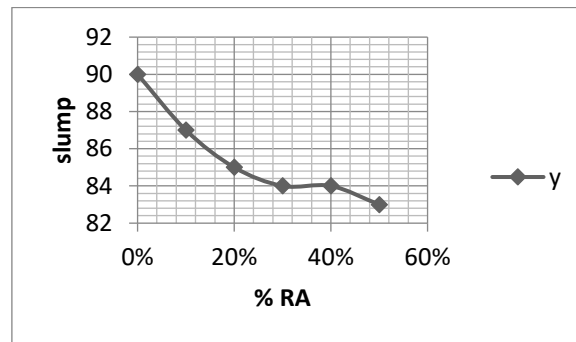
#### A. Slump Test Results:

The slump test for various recycled aggregate percentage replacements to natural aggregate show that when increases the percentage of recycled coarse aggregate there is decrement in the workability.

#### Slump Test Results

Percentage of R.A. (%)	Slump (mm)
0% R.A.	90
10% R.A.	87
20% R.A.	85
30% R.A.	84
40% R.A.	84
50% R.A.	83

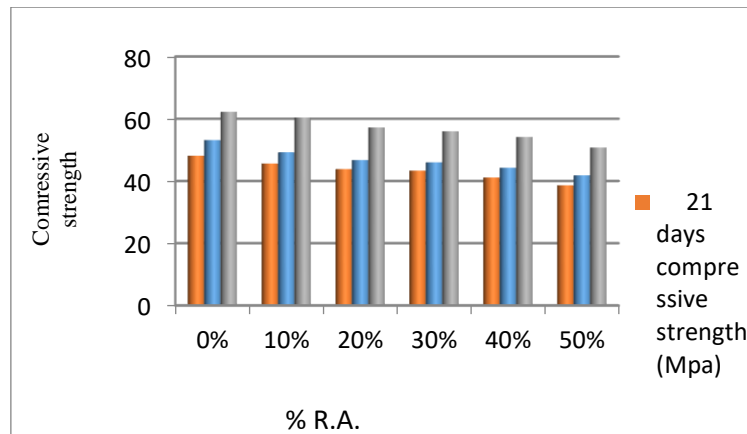
For the various batch mixes of concrete, the slump result is shown in figure below:



**Percentage Recycled Aggregate versus Slump value**

**B. Compressive Strength Test Results**

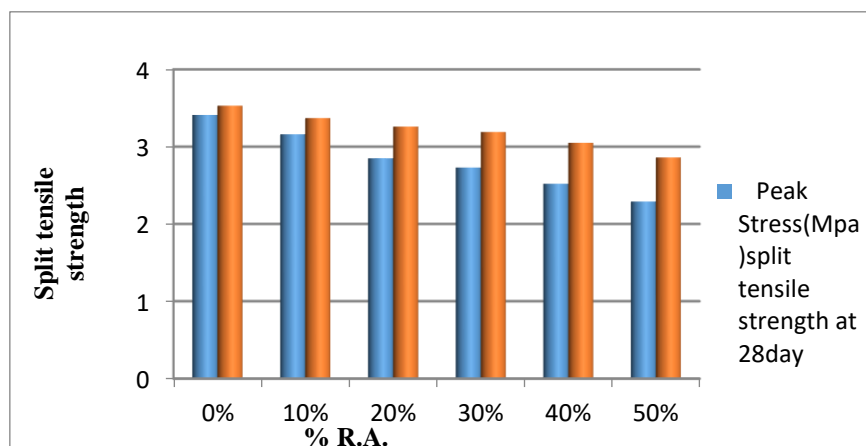
The compressive strength test was performed on 150 x 150 x150 mm cubes after 21, 28 and 56 days. The compressive strength of recycled aggregate concrete is lowered as compared to Natural Aggregate Concrete. The results of cube compressive strength test are also shown graphically



**Compressive Strength Test Results**

**C. Split Tensile Strength Test Results**

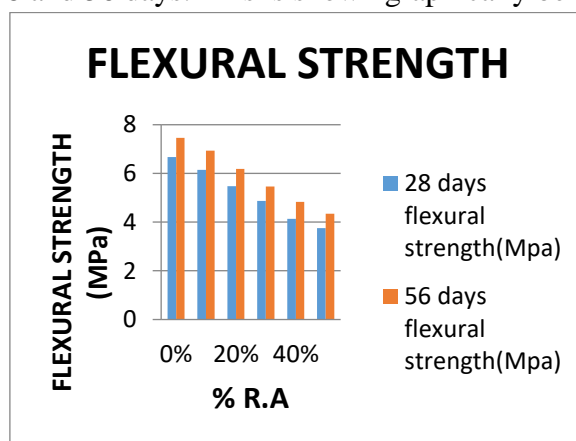
The split tensile strength is an indirect method of analyzing tension failure of cylindrical test specimens, such as flexural cracking in beams. The Split tensile test was performed on 150 x 300mm cylinders after 28 and 56 days and is shown graphically.



## Split Tensile Strength Test Results

### D. Flexure Test Results

Flexural strength of any structure can be determined by knowing the maximum stress at the time just before it fails in flexure test. With the help of stress versus strain deflection curve flexural modulus would be calculated. The flexural strength tests were performed on 100 x100 x 500 mm beams after 28 and 56 days. This is shown graphically below.



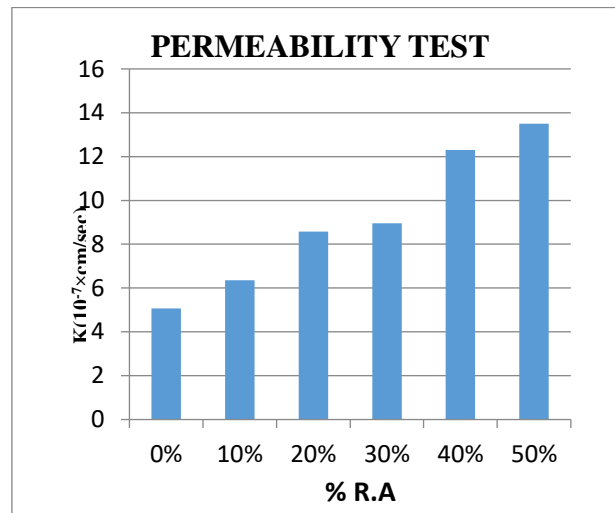
### Flexural Strength Test Results

### E. Permeability Test Results

The results of water absorption test are given in table 4.9 and figure 4.5 for various percentage of recycled aggregate. From the water absorption values it's shown that with increasing the values of recycled aggregate it will absorb more water than concrete with natural aggregate. The permeability test was conducted on the cube size of 150mm after 28 days. The coefficient of permeability was obtained from the help of water passes through the cube at a fixed time interval and a constant pressure head. The results of permeability test as shown in table below and graphically.

### Permeability Test Results

% R.A.	Q (ml)	H (kg/cm <sup>2</sup> )	T (sec)	K (cm/sec)
0%	1300	10	172800	$5.07 \times 10^{-7}$
10%	1650	10	201600	$6.36 \times 10^{-7}$
20%	2600	10	172800	$8.58 \times 10^{-7}$
30%	1160	10	86400	$8.95 \times 10^{-7}$
40%	1590	10	86400	$1.23 \times 10^{-6}$



### Permeability Test Results

#### IV. Conclusion

1. From the present investigation and limited observations reported, on the effect of partial replacement of natural coarse aggregate with recycled coarse aggregate in HPC cast with fly ash percentage replacement to cement at 30% by weight of cement, water to powder ratio for all mixes maintained at 0.36, and with super plasticizer dosage at 0.5% by weight of cement, following conclusion can be drawn:
2. The slump value varied between the ranges of 83-90 mm.
3. With increase in percentage of recycled aggregate from 0% to 50%, a decrease in compressive strength was recorded.
4. Minimum percentage decrease in compressive strength is found in between 20% to 30%.
5. The value of split tensile strength ranges between 2.86Mpa and 3.83Mpa. The values of flexural strength ranges from 3.75Mpa to 6.75Mpa.
6. The decrease in split tensile strength is minimum at 30% recycled aggregate replacement to natural aggregate.
7. At 50% replacement by recycled aggregate to natural aggregate, the decrease in compressive strength would find to be 21%.
8. Permeability showed the increasing trend when percentage of recycled aggregate would increase. At 0% replacement concrete will be almost impermeable. And at 50% replacement the permeability will be more than ten times of 0% permeability. At 10% replacement of recycled with natural aggregate the coefficient of permeability will be minimum.

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