

“TESTING OF HIGH PERFORMANCE CONCRETE USING RECYCLED AGGREGATES”

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Abstract:

Experiments and practicing of recycled aggregates has been increased a lot since past few years all over the world. Recycled Aggregates are nothing but the waste obtained from a demolished construction. Recycled aggregates contain crushed graded concrete, brick particles and crushed aggregates. In this experiment 0% and 100% replacement of natural aggregates is done with recycled aggregates. Also silica fume and super plasticizers are used as admixtures to obtain more effective properties of concrete. The RA was taken from a demolished house from a nearby residential area. Compressive strength, Tensile strength, Water absorption capacity and durability were tested for natural and recycled aggregates at the intervals of 3, 7, 21 days of curing. The results were seen as the strength of concrete blocks using recycle aggregates is almost similar to that of the strength of concrete block made using natural aggregates. The noticeable advantage was seen as the concrete made using recycled aggregate is very much cost effective.

Keywords: Recycled Aggregates, Natural Aggregates, Concrete Strength, High Performance Concrete, Properties of Concrete, Cost Effective.

I. Introduction

Concrete is highly and most commonly used construction material world wide because of its high strength properties Concrete contains a proper mix proportion of cement, aggregates (coarse and fine), sand and water. India's overall cement production capacity was nearly 545

million tonne in FY20. Of the total, 98% lay with the private sector and rest with public sector. The top 20 companies account for around 70% of the total cement production in India. Indian Construction Industry consumes approximately 400 million tonne of concrete every year. But along with the rise of demand some side factors are also affecting the market, one of which includes increased production costs along with employee salaries and increase in prices. This project study results to be very cost effective as the strength of natural and recycled aggregates are almost the same, but the costing of recycled aggregates is lesser than natural aggregate.

II. Mix Design of Materials

A. Materials:

Various materials are required in the composition of concrete like Concrete, Aggregate, Sand, Water and admixtures. Each material has their individual characteristics, composition and properties which plays very important role in gaining the strength of the concrete.

1. Cement

Ordinary Portland cement of grade 53 is used in this project which is easily available in any nearby local market. The cement has already been tested for various proportions as per IS 4031-1998 and specifications of IS 4031-1997. The below table shows the details of various properties of cement that has been used for this project.

Table 1.1.1 Physical Properties of Cement

Properties	Value
Normal Consistency	31%
Initial Setting Time	35 minutes
Final Setting Time	530 minutes
Specific Gravity	3.1

Table 1.1.2 Chemical Composition of Cement

Chemicals	Compositions (%)
Silicon Dioxide	20.9%
Aluminum Oxide	4.7%
Iron Oxide	3.4%
Calcium Oxide	65.4%
Magnesium Oxide	1.2%
Sodium Oxide	0.2%
Potassium Oxide	0.3%
Sulphur Tri-oxide	2.7%
Loss of Ignition	0.9%

2. Aggregates

Types of aggregates used in the projects are fine aggregates, coarse aggregates and recycled aggregates. All the aggregates are tested for their properties and is sieved through the required set of sieves to obtain the sieve analysis. The fine aggregates are obtained from the natural sand and crushed stone particles which is easily available in nearby area. It has been sieved through 4.75mm IS sieve and others were removed. The Coarse Aggregates were bought from the nearby local stone quarry. It was sieved according to the IS sieve and aggregates above 4.75mm were used. The Recycled Aggregates were obtained from a demolished building. The material obtained from the demolished construction was tested in the concrete lab of our Civil Engineering department. Various tests were conducted on all the aggregates as per IS 383-1970.

Table 1.2.1 Physical Properties of Fine Aggregates

Characteristics	Value
Specific Gravity	2.66
Bulk Density	1723.37 kg/m ³
Fineness Modulus	3.23

Table 1.2.2 Physical Properties of Coarse Aggregates

Characteristics	Value
Specific Gravity	2.82
Bulk Density	1663.01 kg/m ³
Fineness Modulus	7.17
Water Absorption	1.01%

Table 1.2.3 Physical Properties of Recycled Aggregates

Characteristics	Value
Specific Gravity	2.32
Bulk Density	1494 kg/m ³
Fineness Modulus	7.63
Water Absorption	4.10%

3. Silica

Silica fume is also known as microsilica, which is a non crystalline polymorph of silicon dioxide. It is a by product of the silicon and ferrosilicon alloy and consists of spherical particles with an average diameter of 150nm. The addition of silica fume in high performance concrete increases the strength of by 15%. Effect of silica fume decreases with the increase of cement content and decreases water-

cement ratio. Hence the proper mix proportion is necessary.

Table 1.3.1 Physical Properties of Silica Fume

Particle Size	< 1 μm
Bulk Density	576 kg/m ³
Specific Gravity	2.3
Specific Surface	20000 m ² /kg

4. Super Plasticizer

They are also known as high range water reducers. They are Aura mix 400 obtained from fosroc chemicals. These are additives used in making high strength concrete. Plasticizers are chemical compounds that enable the production of concrete with approximately 15% less water content and provide extra workability and durability to the concrete.

Table 1.4.1 Properties of Superplasticizers

Appearance	Light yellow colored liquid
pH	Minimum 6.0
Volumetric mass	1.09 kg/litre
Chloride content	Nil
Alkali content	Less than 1.5g

III. Literature Review

1. Utilization of Recycled Concrete Aggregates for High Performance alkali activated Concrete- Towards a sustainable building solution - CL

Hwang, MD Yehualow and DH Vo(2019).

The demand of concrete in construction industry results into the need of this project. The main purpose was to prepare environment friendly and highly sustainable concrete. Both natural and fine aggregates were replaced in specific proportion with recycled concrete aggregates which was obtained from demolishing waste. Cement powder was replaced by pozzolanic industrial wastes which made highly alkali activated concrete. The results showed that the alkali activated concrete has effective properties and better practice of sustainable concrete construction was achieved.

2. . High Performance Concrete using Recycled aggregate, Microsilica and Synthetic macro fibre – Ajibola Tijani (2015)

This project was initiated for a better, low maintenance and corrosion free prestressed concrete sleepers for rail transportation network in UK. The conventional ballasted rail track system incorporating steel tendon in prestressed concrete sleepers were predominantly used throughout the whole railway network in UK. In varying proportion (0%, 25%, 50%, 75%, 100%), the replacement were done using recycled aggregates, microsilica and synthetic macro fibre. Total 621 samples were tested for their workability, durability, density measurement, modulus of elasticity, compressive strength, flexural strength and tensile splitting strength test in different phases. The results were very positive and improving and showed that enhanced strength could be associated with densifying quality and pozzolanic action of micro silica.

3. Influence of field Recycled Coarse Aggregates on properties of Concrete – Chakradhara Rao and S.K. Bhattacharya (2011).

In this experiment a new term was introduced named “coarse aggregate replacement ratio(CRR) which is nothing but the ratio of weight of coarse aggregate

to total weight of coarse aggregate in a concrete mix. To analyze the behavior of concrete, CRR of 0, 0.25, 0.50 and 1.0 were obtained. Tests like compressive and indirect tensile strength test, modulus of elasticity, water absorption, volume of voids, density of hardened concrete and depth of chloride penetration are studied. Results showed that the strength of concrete cured in 7 days was better than that of the concrete cured in 28 days for all CRR.

4. Ecological High Performance Concrete – Wojciech Kubissa(2017)

The authors had used two different waste materials which are recycled concrete aggregates and fly ash, to obtain high performance concrete (HPC). Different types of cements and supplementary cementing materials were mixed with RAC. All the specimens were tested for their physical properties and strength properties in the curing of 28 days and 90 days. Results were positive and effective.

5. Long term Mechanical and Durability properties of Recycled aggregates prepared with incorporation of fly ash – Shi-CongKou and Chi-Sun Poon (2013)

Long term study on the mechanical and durability properties of concrete prepared replacing aggregates with recycled aggregates by 25%, 35% and 55%. Fly ash was used as a binding agent. Results were observed after 10 yrs. that the compressive strength and modulus of elasticity were lower with 100% replacement than that of controlled concrete. Fly ash improved the resistance to chloride ion penetration but also increased the depth of concrete.

IV. Result

The concrete blocks were made using natural aggregates and also by replacing natural aggregates to the recycled aggregates. 3 specimens were observed for 3 days, 7 days and 21 days for both type of concrete (with natural and with recycled aggregates). Comparison was done between the concretes on basis of their compressive strength and tensile strength.

The results of the Compressive strength test are shown in the table below.

Table 4.1 Compressive Strength of Concrete (N/mm²) using Natural Aggregates

Days	Specime n1	Specime n2	Specime n3	Average
3 days	34.08	35.28	40.15	36.50
7 days	63.02	69.98	70.03	67.67
21 days	75.34	78.21	81.16	78.23

Table 4.2 Compressive Strength of Concrete using Recycled Aggregates

Days	Specime n1	Specime n2	Specime n3	Average
3 days	30.31	34.02	32.01	32.17
7 days	64.08	66.37	65.28	65.48
21 days	84.0	89.71	91.13	88.28

Table 4.3 Graphical representation of Comparison between Compressive Strength of Concrete using Natural Aggregates and Recycled Aggregates

Concrete Mix Type	Specimen 1	Specimen 2	Average
Natural Aggregate	5.27	4.99	5.13
Recycled Aggregate	5.32	5.71	5.51

Table 4.4 Tensile Strength (N/mm²) for Natural Aggregates and Recycled Aggregates after 21 days of curing

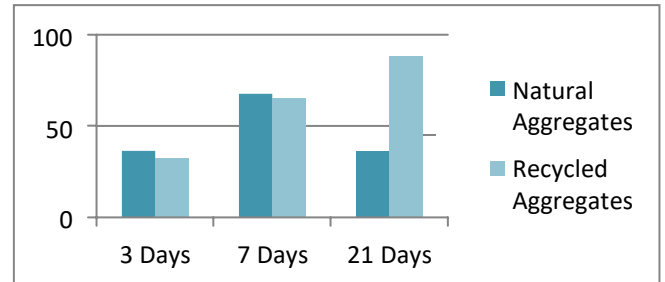
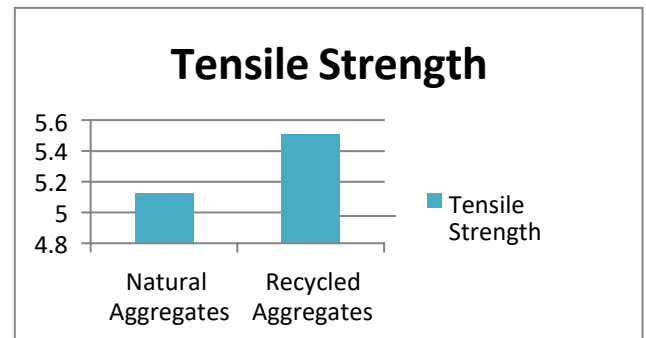


Table 4.5 Graphical representation of Comparison between Tensile Strength of Concrete using Natural Aggregates and Recycled Aggregates



v. Conclusion

The results show that the replacement of Recycled aggregates in place of Natural aggregates in High Performance Concrete is an effective experiment. The High Performance Concrete using Recycled Aggregates had shown higher Strength than concrete with natural aggregates. The HPC with recycled aggregates have also shown greater water absorption than natural aggregate. The HPC using recycled aggregates is also cost effective as the natural aggregates are quite expensive whereas you can get recycled aggregates from any local market at very cheap price or even you can obtain it from any demolition site. This experiment also proven that this method is so much eco-friendly as we are using

waste material only. The addition of admixtures like Silica fume and super plasticizer helps increasing the resistance and properties of concrete using recycled aggregates.

VI. References

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