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Behaviour of Recycled Coarse Aggregate Concrete with Bakelite as Fine Aggregate

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Abstract - *A substantial growth in the consumption of plastic is observed all over the world in recent years that has led to dumping of huge quantities of plastic related wastes in the environment. Recycling of plastic waste to produce construction material like concrete appears as one of the best solutions for the disposal of plastic waste. This paper involves a partial replacement of Bakelite (E-plastic waste) as fine aggregates from 10% to 25% with 5% increment. Also, 40% of recycled aggregate and 60% of natural aggregate is used as coarse aggregate. Recycled aggregates come from reprocessing materials that have previously been used in construction. The main objective of this study is to reduce the wastage of plastic and to improve the eco-friendly environment. The investigation was done and the mechanical properties of concrete were discussed in the present study. The experiment was done with M30 grade concrete for a curing of 7 days, 28 days and 56 days from which its compressive strength, flexural strength, split tensile strength, shear strength and modulus of elasticity were taken and compared with the conventional concrete. The optimum replacement of Bakelite is at 15%.*

Key Words: **Bakelite, Recycled aggregate, Compressive cube strength, Flexural strength, Split tensile strength, Shear strength, Modulus of Elasticity.**

1. INTRODUCTION

Concrete is the most widely used material in construction industry. It is understood that concrete is the second most used material after water. Considering the usage and importance, several newer techniques have evolved over time. The complexity and deficiencies associated with it is not fully resolved.

Bakelite, is an early plastic. It is thermosetting phenol formaldehyde resin, formed from condensation reaction of phenol with formaldehyde. Bakelite material has been used to produce the various components for cars and consumer goods industry. The growth of Bakelite consumption increases Bakelite waste. Bakelite waste is prohibited from disposing of direct land filling and open burning, which becomes a waste management problem. The purpose of this research is the use of waste Bakelite aggregate as fine aggregate to replace natural sand material partially. The Waste Bakelite Fine Aggregate (WBFA) was mixed in concrete mixture with various proportion. The sample was tested for compressive strength, split tensile strength and flexural strength shear strength and modulus of elasticity.

To achieve rapid urbanisation every year smaller structures are demolished and newer and bigger ones are constructed. These demolished materials are often dumped on land and is not reused for any purpose. This practice effects the fertility of land. With the wave of sustainability also impacting the construction industry, scientist and engineers throughout the world are looking for sustainable and reusable construction materials. One such material is recycled aggregate concrete.

2. MATERIALS

2.1 Cement

Ordinary Portland Cement (53 grade) confirming to IS: 12269-1987 was used for all the concrete mixtures. The tests were conducted according to IS 4031-1988. The physical properties of cement are given in Table 1.

2.2 Fine Aggregate

Natural fine aggregate used for the experimental study was M-sand. Fine aggregate under saturated surface dry condition was used for casting. The physical properties of fine aggregate are given in Table 2. Sieve analysis was done. Results shows that fine aggregate was well graded which confirms to zone II of IS 383:1980.

2.3 Bakelite

Bakelite, is an early plastic. Bakelite is used as a replacement material in fine aggregate. Finely grounded plastic waste ranges in size from very fine powder to sand-sized particles were used as fine aggregate. The physical properties of bakelite are given in Table 2. Sieve analysis was done for bakelite as per the provision in IS: 2386 (Part 1)-1963. Results showed that fine aggregate was well graded which confirms to zone II of IS 383:1980.

2.4 Natural Coarse Aggregate

Crushed granite angular aggregate from a local source, having a maximum size of 20mm, was used. The physical properties of natural coarse aggregate are given in Table 2.

2.5 Recycled Coarse Aggregate

Recycled coarse aggregate of 20 mm size is used for the study. Recycled aggregate was obtained from the crushed remain of old building. The physical properties of recycled coarse aggregate are given in Table 2.

2.6 Water

Portable water which is available at the laboratory premises was used for mixing of concrete ingredients. Water from sources like industrial plants, sewage and other contaminated should not used for concrete making.

Table 1-: Physical Properties of Cement

Properties	Test Results
Specific Gravity	3.125
Standard Consistency(%)	33
Initial Setting Time (minutes)	87
Final Setting Time (minutes)	279

Table -2: Physical Properties of Aggregate

Materials	Specific Gravity	Water Absorption(%)
Fine Aggregate	2.69	1.2
Bakelite	1.4	6.38
Natural Coarse Aggregate	2.702	0.57
Recycled Coarse Aggregate	2.58	0.73

3. TEST ON CONCRETE

3.1 Preparation of Test Specimen

The mixtures were cast in 150×150×150mm cube moulds, 150×300mm cylinder moulds and 100×100×500mm beam moulds. For each mix 3 cubes, 6 cylinders and 3 beams and 3 half beams were cast.

In this project, 10% to 25% of waste plastic has been replaced in the increment of 5% with fine aggregate by weigh batching. Natural coarse aggregate of 60% and recycled coarse aggregate of 40% were used. Mix designation of various mixtures is given in Table 4. Compaction was done for all the specimens using vibrating table. The mould is striped after 24 hours. The test specimens were cured for 7 days, 28 days and56 days in a curing tank.

Table -3: Physical Properties of Cement

Percentage of Bakelite	Mix Designation
0	B0
10	B10
15	B15
20	B20
25	B25

3.2 Testing of Specimen

The specimens were demoulded for determining compressive cube strength, flexural strength, split tensile strength, shear strength and modulus of elasticity.

4. RESULTS

The casted specimens were demoulded for determining compressive cube strength, flexural strength and split tensile strength after a curing period of 7 days 28 days and 56 days.. Shear strength and modulus of elasticity were also determined after a curing period of 28 days.

Compressive Strength: Compression test is carried out to find out the compressive strengths of the conventional and WBAC cube specimens by using compression testing machine. The compression test results are shown in Fig. 1.

Flexural Strength: Flexural strength test was carried out and comparative results of conventional and WBAC are shown in Fig. 2.

Split Tensile Strength: Split tensile strength test was carried out and comparative results of conventional and WBAC are shown in Fig. 3.

Shear Strength: Shear strength test was carried out and comparative results of conventional and WBAC are shown in Fig. 4.

Modulus of Elasticity: Modulus of elasicity test was carried out and comparative results of conventional and WBAC are shown in Fig. 5.

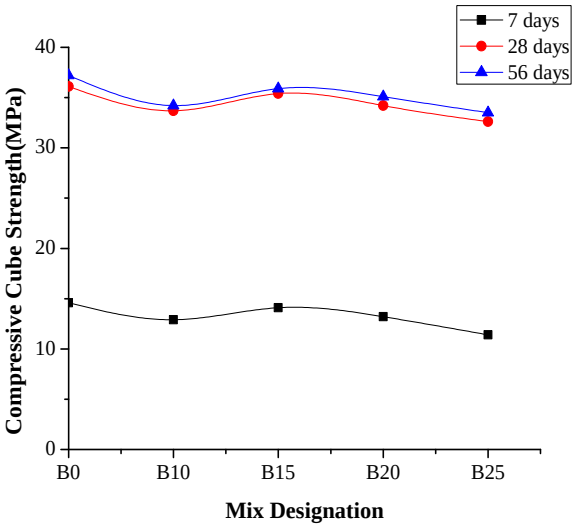

Fig -1: Compressive Cube Strength Result

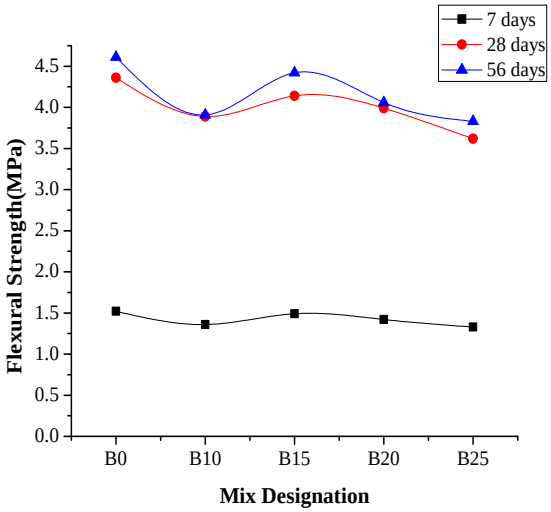

Fig -2: Flexural Strength Result

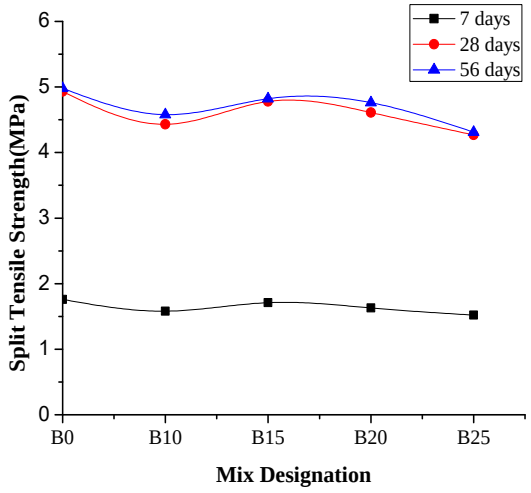

Fig -3: Split Tensile Strength Result

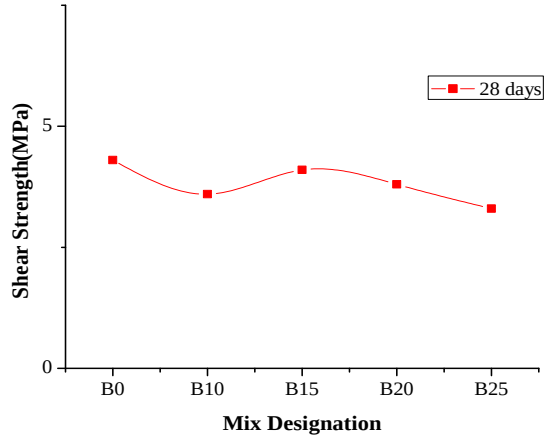

Fig -4: Shear Strength Result

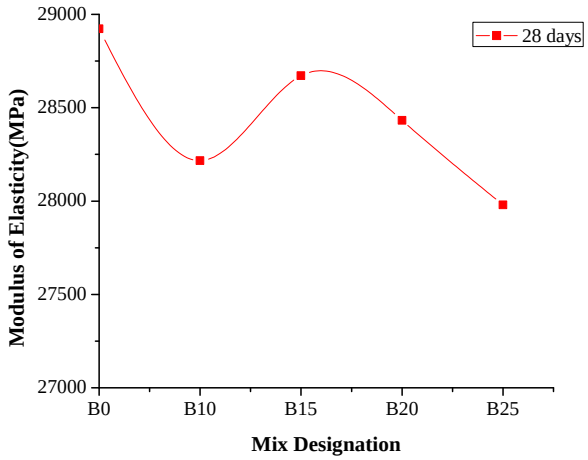

Fig -5: Modulus of Elasticity Result

5. CONCLUSIONS

From the above findings, it is concluded that E-Plastic waste up to 20% may be used for replacement of fine aggregate in concrete. It is also concluded that the use of industrial wastes such as bakelite waste in concrete provides some advantages, like reduction in the use of natural resources, disposal of wastes, prevention of environmental pollution and energy saving.

- Compressive cube strength value of control specimen is less than target compressive strength. This is because of the usage of 40% recycled aggregate.
- The compressive cube strength values of WBC mixture is less than that of the control concrete mixture.
- The optimum compressive cube strength of bakelite concrete is obtained at 15% of replacement of bakelite.
- In 15% replacement of bakelite, voids are filled completely to become a good denser concrete. For 15% replacement, powdered bakelite filling is good compared to 10% replacement.
- Flexural strength, split tensile strength, shear strength and modulus of elasticity also follow same pattern as that of compressive cube strength.

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