Experimental Investigation on E- Waste Concrete Using Non Woven Fabric Liner

Thulasirajan Krishnan[1], Jayanth Ramannagari[2], I Niranjan Reddy[3], Prakash Vivek[4], G Sandeep Kumar Reddy[5], K Anand Babu[6],

[1-6]Department of Civil Engineering, Annamacharya Institute of Technology and Sciences, Tirupati, - 517520

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Abstract - *Electronic waste (E-waste) is a growing problem worldwide, with millions of tons of e-waste generated each year. The disposal of e-waste in landfills not only poses environmental and health hazards, but also wastes valuable resources that could be reused or recycled. In recent years, there has been increasing interest in developing sustainable solutions to address the e-waste problem. One such solution is the incorporation of E waste in concrete. From then literature review it is inferred that the E waste was added to the concrete by partial replacement of Coarse Aggregates. So, in the present study, the fine aggregate was replaced with 0, 5%, 10% and 15% of E waste in concrete along with the effect of CPF liner was studied. The density, compressive strength, split tensile strength, Rebound Number and Ultra sonic pulse velocity were studied. From the test results, the Optimum percentage of E waste to be added was found to be 10 %. The quality of E-waste concrete improved by the incorporation of CPF liner .*

Key Words: Cover Concrete, Strength, Density, CPF Liner

1. INTRODUCTION

Electronic waste (e-waste) is a growing problem worldwide, with millions of tons of e-waste generated each year. The disposal of e-waste in landfills not only poses environmental and health hazards, but also wastes valuable resources that could be reused or recycled. In recent years, there has been increasing interest in developing sustainable solutions to address the e-waste problem[1].

One innovative solution is the use of e-waste in concrete production. Concrete is the most widely used construction material in the world, and its production contributes to a significant amount of global carbon emissions. Incorporating e-waste as a partial replacement for coarse aggregates in concrete can reduce the amount of e-waste in landfills and decrease the carbon footprint of concrete production.

However, using e-waste in concrete production presents some challenges, such as the need to ensure consistent quality and performance of the resulting concrete. This is where controlled permeable formwork liners (CPFLs) come into play. CPFLs are materials used in concrete casting that allow for the control of permeability and surface texture of the resulting concrete [2].

The replacement range of E-waste is in between 5-15%. The current study deals with the strength of concrete partial replacement of E-Waste. Compared to Conventional concrete E-Waste based concrete shows more Workability. However, the slump values slightly increased to 13mm compared to conventional concrete.

1.1 Existing Problems

As the demand for electronics continues to rise, electronic waste, or e-waste, is becoming a worldwide issue. With unique data, the following are some current issues with e-waste:

Recycling e-waste informally: A significant amount of e-waste is improperly recycled and ends up in informal recycling facilities in developing nations, where workers extract valuable metals using risky and inefficient methods [3].

Impacts on health and the environment: E-waste disposal mistakes can pollute water and soil, harming human health and the environment. Lead, mercury, cadmium, and flame retardants are among the toxic substances in e-waste that can accumulate in the food chain and cause respiratory and neurological issues.

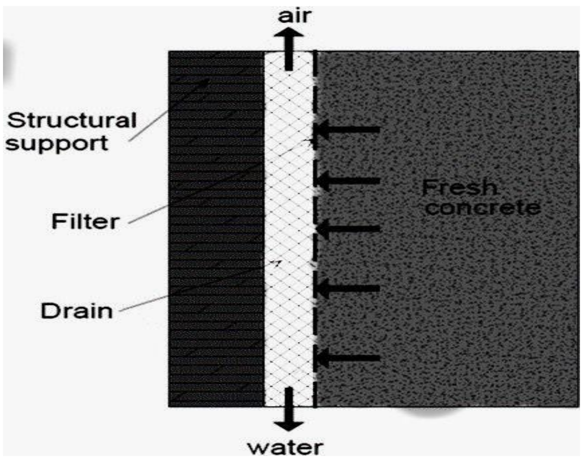

Fig:1.1 Elements of CPF system

1.2 Objective of Study

- To study the strength of E waste concrete by varying the percentage of E waste as 0%,5% 10% and 15%
- To compare the compressive Strength, split tensile strength, rebound number and UPV of M25 grade of concrete with and Without E-Waste.
- To evaluate the optimum percentage of E waste to be added in the M25 grade concrete based on the mechanical properties and Nondestructive tests.

2. MATERIALS AND METHODS

2.1 MATERIALS

The components used to prepare concrete samples of various grades are discussed in the following sections. This section details the components' chemical and physical properties.

2.1.1 CEMENT

Portland Pozzolana Cement is known as PPC[4]. It is a form of hydraulic cement made by mixing pozzolanic ingredients with Ordinary Portland Cement (OPC) clinker. Fly ash, volcanic ash, and burned clay are some of the pozzolanic components utilized in the production of PPC cement. While volcanic ash and burnt clay are naturally occurring pozzolanic materials, fly ash is a byproduct of coal-fired power plants. In comparison to OPC cement, PPC cement has a number of benefits, including a lower heat of hydration, a longer setting time, and greater durability. PPC cement is frequently used in construction for common projects like roads, bridges, dams, and buildings. It is also used in precast concrete products such as pipes, poles, and railway sleepers. In general, PPC cement is a great substitute for OPC cement.

Table-1: Properties of cement

CEMENT [PPC]	VALUES
Specific Gravity	3.15
Fineness	5%
Standard consistency	33.5 %

2.1.2 COARSE AGGREGATE

The primary purpose of coarse aggregate in concrete is to provide bulk and strength to the material. It is responsible for providing most of the compressive strength of the concrete, while the cement binds the aggregate together. The size and shape of the coarse aggregate used can affect the workability, strength, and durability of the concrete [5].

Table -2: Properties of Coarse aggregates

COARSE AGGREGATE	VALUES
Specific Gravity	2.67
% of water absorption	0.80%
Fineness Modulus of CA 20mm size	7.54
Shape	Angular

2.1.3 FINE AGGREGATE

Fine aggregate, also referred to as sand, is a granular material that is incorporated into mortar and concrete. It is commonly made out of regular or fabricated sand particles that reach in size from 0.075mm to 4.75mm. Because it helps to fill in the spaces between the larger coarse aggregates, fine aggregate is an essential component in the production of concrete. As a result, it gives the concrete a smooth surface and boosts its overall strength and durability. Mortar, which is used to join bricks or other masonry units together, is also made with fine aggregate. The workability, strength, and long-term durability of the finished product can all be affected by the gradation, shape, texture, and cleanliness of the fine aggregate.

Table - 3: Properties of Fine Aggregates

FINE AGGREGATE	VALUES
Specific Gravity	2.29
% of Water Absorption	5.28%
Fineness modulus of FA	2.78

2.1.4 CONTROLLED PERMEABILITY FORMWORK

A type of formwork system called Controlled Permeability Formwork (CPF) liner is used in the construction industry to produce concrete structures with a particular surface finish. The semi-permeable membrane that makes up the CPF liner is sprayed inside the formwork prior to pouring the concrete. The use of CPF liner has numerous advantages, including improved aesthetics, reduced costs for labor and materials, increased durability, and resistance to water.

Fig -1: Controlled Permeable Formwork

2.1.5 E-Waste

Electronic waste includes things like computers, smartphones, and televisions that are no longer in use. If not disposed of properly, these devices contain materials that can be harmful to human health and the environment. Due to the short lifespan of electronic devices and the rise in their production, e-waste is becoming a growing concern. Recycling and properly disposing of electronic waste can help conserve natural resources, reduce the amount of waste in landfills, and prevent the release of toxic substances into the environment.

Fig -2: E-Waste

2.2 TEST METHODS

The methods used to test specimens with and without CPF are described in this section.

2.2.1 METHODOLOGY

Prior to beginning the research, the papers that had already been published were reviewed. Substantial tests are being done to explore and to some extent supplant coarse total with electronic waste. Natural sand is used as a fine aggregate in this experiment, while natural aggregate is used as a coarse aggregate. E-waste is partially replaced by coarse aggregate in the fiber concrete mixture in proportions of 0%, 10%, 20%, and 30%, respectively. All samples were prepared using an M25 mix design with a water-to-cement ratio of 0.50 and a ratio of 2.01:2.85. One set of dice without e-waste and two sets of dice for each portion of e-waste substitution were made for the pressure resistance test. After seven days of curing, the first set was tested, and the second set was tested after 28 days. On both sets of samples, an ultrasonic pulse velocity test was also carried out. Two sets of cubes were made for each portion of the e-waste substitute and tested for 28 days for the split tensile and flexural strength tests.

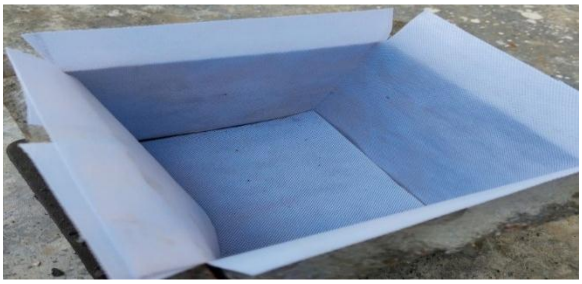

Fig -3: Controlled Permeable Formwork Liner

2.2.2 COMPRESSION TEST

A material's maximum compressive load before breaking or deforming is known as its compressive strength. It is a crucial quality in engineering and construction, particularly when designing structures made of metals, concrete, and masonry. Compressive not entirely settled by applying a compressive power to an example of the material until it falls flat, and afterward estimating the power at which disappointment happens. This value is frequently utilized to evaluate a material's quality, durability, and suitability for a particular purpose. The composition of a material, its manufacturing process, and the environment in which it is utilized can all have an impact on its compressive strength.

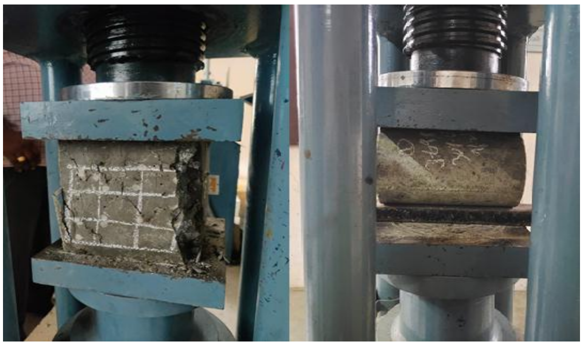

Fig -4: Compression Test

2.2.3 REBOUND HAMMER

In the construction industry, a tool called a rebound hammer is used to measure the strength and hardness of concrete. It works by measuring a spring-loaded hammer's rebound when it hits a surface, like a concrete slab or beam. The user can estimate the material's compressive strength by observing how the hammer's rebound is affected by its density and strength. The rebound hammer is a non-destructive testing method, which means that it does not harm the concrete or necessitate taking samples for testing in a laboratory. It is a useful tool for quality control during construction and evaluating the strength of concrete in existing structures.

Fig-5: Rebound Hammer

2.2.4 UPV

Non-destructive testing known as ultrasonic pulse velocity (UPV) is used to evaluate the quality and integrity of concrete structures. In the UPV test, high-frequency sound waves are applied to a concrete structure, and the amount of time it takes for the waves to travel through the material is recorded. Because the concrete's density and strength are strongly correlated with the speed of sound waves, engineers can use UPV measurements to assess the concrete's structural integrity and potential vulnerabilities.

Fig-6: UPV

3 RESULTS AND DISCUSSION

3.1 VISUAL INSPECTION

The surface of the specimens was visually examined and the surface is shown in Figure 3 .1. The surface of the plain concrete NC specimens contained numerous blowholes and air voids. CPF samples, on the other hand, had a uniform surface without blowholes and air voids.

(a)Without CPF (b)With CPF

Fig-6: Surface of Cube Specimens

3.2 SPLIT TENSILE STRENGTH

The Split Tensile Strength of concrete specimens is shown in figure 3.2. The Split Tensile Strength of concrete increases by: 2.351%, 20.331%, 7.883% for 5%, 10%, 15% of E-waste respectively for With CPF liner. The Split Tensile Strength of concrete increases by:12.554%, 16.883%, 8.225% for 5%, 10%, 15% of E-waste respectively for without CPF liner. The Optimum percentage E- waste for Split Tensile strength is 10%.

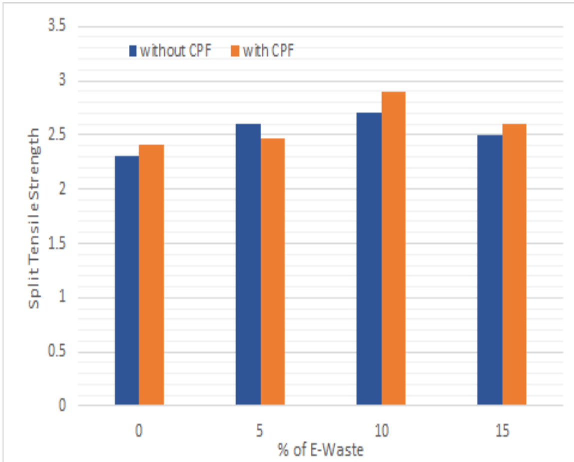

Chart-1: Split Tensile Strength of Concrete.

3.3 COMPRESSIVE STRENGTH

The Compressive Strength of concrete specimens is shown in fig 3.3. The Compressive Strength of concrete increases by 9.5%, 28.35%, 3.393% for 5%, 10%, 15% of E-waste respectively for with CPF liner. The Compressive Strength of concrete increases by:10.77%, 27 620%, 4.543% for 5%, 10%, 15% of E-waste respectively for without CPF liner. The Optimum percentage E- waste for Compressive strength is : 10%.

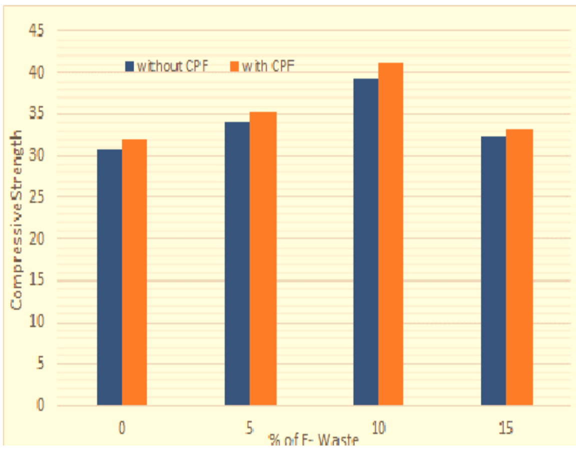

Chart-2: Compressive Strength of Concrete

3.4 DENSITY

The density of the concrete specimens is shown in figure 3.4. The Density of concrete decreases by: 0.414%, 1.987%, 4.347% for 5%, 10%, 15% of E-waste respectively for with CPF liner. The Density of concrete decreases by: 0.412%, 0.563%, 2.33% for 5%, 10%, 15% of E-waste respectively for without CPF liner.

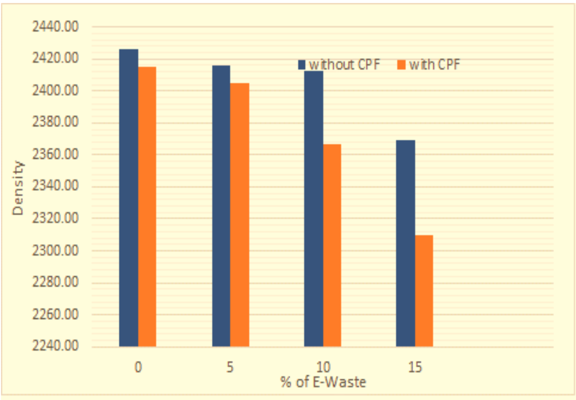

Chart-3: Density of Concrete

4 CONCLUSIONS

The following are the findings of the experimental investigation of CPF liner with E waste as fine replacement in M25 grade of concrete:

1. The use of CPF liner, allows air and water to escape from the concrete surface.

2. The utilization of CPF liner improved the strength properties, rebound hammer and UPV

3.The addition of E waste improved the mechanical properties of concrete

4. The optimum percentage of E waste used to replace the fine aggregate was 10 %.

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