

# International Journal of Innovative Research in Science, Engineering and Technology

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## Utilization of E-Waste in Construction Management

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**ABSTRACT:** Rapid growth of world population and widespread urbanization has remarkably increased the development of the construction industry which caused a huge demand for sand and gravels. Environmental problems occur when the rate of extraction of sand, gravels, and other materials exceeds the rate of generation of natural resources; therefore, an alternative source is essential to replace the materials used in concrete. Now-a-days, electronic products have become an integral part of daily life which provides more comfort, security, and ease of exchange of information.

Disposal or dumping of these E-Wastes also causes major issues because it is highly complex to handle and often contains highly toxic chemicals such as lead, cadmium, mercury, beryllium, brominated flame retardants (BFRs), polyvinyl chloride (PVC), and phosphorus compounds. Hence, E-Waste can be incorporated in concrete to make a sustainable environment.

This paper also provides a detailed literature review on the behaviour of concrete with incorporation of E-Wastes. Many research shows the strong possibility of using E-Waste as a substitute of aggregates . This paper presents result of an experimental program carried out to study the suitability of use of E-waste in concrete partial replacement of coarse aggregate.

**KEYWORDS:** E-Waste, experimental program, partial replacement, electronic product.

### I.INTRODUCTION

#### 1.1 GENERAL

Research concerning the use of Electronic waste to augment the properties of concrete has been going on for recent years. Non recycling Waste materials are posing serious pollution problems to the human and the environment. So, new effective waste management options need to be considered. Efforts have been made in the concrete industry to use non-biodegradable components of E-waste as a partial replacement of the coarse or fine aggregates. In the recent decades, the efforts have been made to use electronic waste from various sources in concrete for the replacement of cement, fine and coarse aggregate. The use of these materials in concrete come from the environmental constraints in the safe disposal of these products. Use of E-waste materials not only helps in getting them utilized in cement, concrete and other construction materials, it helps in reducing the cost of cement and concrete manufacturing, but also has numerous indirect benefits such as reduction in landfill cost, saving in energy, and protecting the environment from possible pollution effects.

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## 1.2 WASTE SOURCE

Table 1.1 Forms of waste

| Forms of waste      | Source  |
|---------------------|---|
| Biodegradable waste | food waste etc.                                       |
| Construction waste  | Building demolition                                   |
| Electronic waste    | Electrical products like computer, television, CD etc |
| Hazardous waste     | Inorganic waste                                       |

## 1.3 ELECTRONIC WASTE (E-WASTE)

E-waste is a popular, informal name for electronic products coming to the end of their “useful life”. As per the Hazardous Wastes (Management and Handling) Rules, 2003, e-waste can be defined as “Waste Electrical and Electronic Equipment including all components, sub-assemblies. Electronic waste, abbreviated as E-waste, consists of discarded old computers, TVs, refrigerators, radios –basically any electrical or electronic appliance that has reached its end of life.

An estimated 50 million tons of E-waste are produced each year worldwide. The total E-waste generated in India is about 1, 46,180 tons per year. The environmental protection agency estimates that only 15-20% of E-waste is recycled, the rest of these electronics go directly into landfills and incinerators. The processing of electronic waste in developing countries causes serious health and pollution problems due to the fact that electronic equipment contains serious contaminants such as lead, cadmium, Beryllium etc.

The use of these materials in concrete come from the environmental constraints in the safe disposal of these products. Use of E-waste materials not only helps in getting them utilized in cement, concrete and other construction materials, it helps in reducing the cost of cement and concrete manufacturing, but also has numerous indirect benefits such as reduction in landfill cost, saving in energy, and protecting the environment from possible pollution effects.

## II. MATERIALS USED

### 2.1 AGGREGATE( COARSE AND FINE)

Various properties of aggregates can influence the performance of concrete; therefore various considerations have to be kept in mind while selecting the material.

### 2.2 CEMENT

Ordinary Portland cement of 53Grade was used as it satisfied the requirements of IS: 269-1969.

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### 2.3 WATER

IS: 456-2000 water, used for mixing and curing of concrete. Permissible limits for solids in water are as per IS: 456-2009

### 2.4 Fly Ash

Helps to reduce, bleeding, segregation in fresh concrete. And it significantly improves the long term strength, durability and reduce heat of hydration.

### 2.5 E- PLASTICS

E-Plastics that cannot be degraded further been powdered into course particles. These plastics consist mainly of high density polyethylene (HDPE).

### III. PRELIMINARY TEST

| PROPERTI ES                | OBTAIN ED RESULT | REQUIREMENT AS PER IS 12269:1987 |
|----------------------------|------------------|----------------------------------|
| Fineness of cement         | 6.0 %            | Not more than 10%                |
| Standard consistency       | 30%              | Between (26-33)%                 |
| Initial setting time       | 38 min           | Not less than 30 min             |
| Final setting time         | 346 min          | Not greater than 600 min         |
| Specific gravity of F.A    | 2.46             | Range 2.4-2.6                    |
| Fineness modulus of F.A    | 2.48             | Range 2.2 -2.6                   |
| Specific gravity of C.A    | 2.67             | Range 2.6-2.8                    |
| Fineness modulus of C.A    | 2.85             | Range 2.8- 3.2                   |
| Water absorption of F.A    | 6.68%            |                                  |
| Water absorption of C.A    | 2.97%            |                                  |
| Specific gravity of cement | 3.17             |                                  |
| Water cement ratio         | 0.54             | 0.65                             |
| Aggregate impact value     | 22.99%           |                                  |

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## IV. TEST CONDUCTED

### 4.1 PARAMETERS STUDIED

The experiments are conducted on four series of test specimens. The following properties were studied for all the three grades of concrete.

#### Mechanical Properties

- ✓ Compressive strength of concrete – cubes
- ✓ Split tensile strength of concrete – cylinders

### 4.2 DESCRIPTION OF TEST 4.2.1WORKABILITY

The workability is defined as the property of concrete which determines the amount of useful internal work necessary to produce full compaction.

#### 4.2.2 MEASUREMENT OF WORKABILITY

Some of the tests measure the parameters very close to workability and provide useful information. The following tests are commonly employed to measure workability.

- \* Slump cone test
- \* Compacting factor test

##### 4.2.2.1SLUMP CONE TEST

Slump cone test is the most commonly used method of measuring consistency. It doesn't measure all factors contributing to workability. It is used as a control test and gives an indication of uniformity of batches.

##### 4.2.2.2 COMPACTING FACTOR TEST

Compacting factor test is more precise and sensitive than the slump cone test. This test gives an idea for degree of compaction and adopted to find the workability of concrete where aggregate size does not exceed 20mm and the mixes are comparatively dry

### 4.2.3 COMPRESSIVE STRENGTH OF CUBE

This test is done according to IS: 516-1959. The specimens of size 150 x 150 x 150 mm are used to determine the compressive strength. Test are carried out at the end of 28 days using compressive Testing Machine (CTM) of 2000 KN capacity. Typical test setup for testing compressive strength of cube .

### 4.2.4 COMPRESSIVE STRENGTH OF CYLINDER

The cylindrical specimens of size 150 mm diameter x 300 mm height are used to determine the compressive strength as per IS: 516 – 1959. Tests are carried out at the end of 28 days using Compressive Testing machine (CTM) of 2000 KN capacity. The young's modulus was obtained from stress strain curve for each mix. Typical test setup for testing compressive strength of cylinder

### 4.2.5 SPLIT TENSILE STRENGTH OF CYLINDER

The cylindrical specimens of size 150 x 300 mm are used to determine the split tensile strength as per IS: 516 – 1959. Test were carried out at the end of 28 days using Compressive Testing Machine (CTM) of 2000 KN capacity. Typical test setup for testing split tensile strength of cylinder .

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## V. TEST RESULT

### 5.1 WORKABILITY TEST RESULTS

Slump Cone Test

Slump Value = 48mm.

### 5.2 COMPRESSIVE STRENGTH TEST

The compressive strength of the concrete cubes of M20 grade are determined from the compression testing machine. The results are shown in Table 5.1.

| COMPRESSIVE STRENGTH (N/MM <sup>2</sup> ) |              |            |             |
|---|--------------|------------|-------------|
| % OF E-WASTE REPLACED                     | % OF FLY ASH | FOR 7 DAYS | FOR 28 DAYS |
| 0%  | 0%           | 20.58      | 22.41       |
|   | 10%          | 30.86      | 36.42       |
|   | 20%          | 27.25      | 36.05       |
|   | 30%          | 30.15      | 40.19       |
| 5%  | 0%           | 23.35      | 28.45       |
|   | 10%          | 35.86      | 45.86       |
|   | 20%          | 31.76      | 45.75       |
|   | 30%          | 35.48      | 49.97       |
| 10%                                       | 0%           | 21.05      | 25.32       |
|   | 10%          | 31.20      | 41.17       |
|   | 20%          | 30.00      | 39.71       |
|   | 30%          | 34.15      | 46.52       |
| 15%                                       | 0%           | 19.38      | 23.37       |
|   | 10%          | 27.83      | 38.81       |
|   | 20%          | 25.91      | 37.44       |
|   | 30%          | 30.29      | 40.57       |
| 20%                                       | 0%           | 19.30      | 22.65       |
|   | 10%          | 26.32      | 36.60       |
|   | 20%          | 23.22      | 33.89       |
|   | 30%          | 27.26      | 39.44       |
| 25%                                       | 0%           | 18.47      | 19.68       |
|   | 10%          | 25.22      | 35.61       |
|   | 20%          | 21.39      | 32.11       |
|   | 30%          | 25.93      | 37.40       |

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From the results it is noted that the compressive strength decreased with the increase in replacement of E plastic. But the strength is acceptable upto 25% replacement. Above 25% the cubes do not satisfy the required strength. Hence 25% replacement can be adopted based on the compressive strength result.

### 5.3 SPLIT TENSILE STRENGTH TEST

The Split tensile strength of the concrete cylinder of M<sub>20</sub> was determined from the compression testing machine. The results are shown in Table 5.2

SPLIT TENSILE STRENGTH (N/MM<sup>2</sup>)

| % OF E-WASTE | % OF FLY ASH | FOR 7DAYS | FOR 28DAYS |
|--------------|--------------|-----------|------------|
| 0%           | 0%           | 2.53      | 2.95       |
|              | 10%          |           |            |
|              | 20%          | 3.77      | 3.9        |
|              | 30%          | 2.93      | 3.7        |
|              |              | 4.01      | 4.25       |
| 5%           | 0%           | 2.94      | 3.79       |
|              | 10%          |           |            |
|              | 20%          | 4.28      | 4.95       |
|              | 30%          | 3.4       | 4.79       |
|              |              | 4.65      | 5.30       |
| 10%          | 0%           | 2.82      | 3.64       |
|              | 10%          |           |            |
|              | 20%          | 3.88      | 4.69       |
|              | 30%          | 3.00      | 4.51       |
|              |              | 4.07      | 4.82       |
| 15%          | 0%           | 2.54      | 2.47       |
|              | 10%          |           |            |
|              | 20%          | 3.61      | 3.93       |
|              | 30%          | 2.78      | 4.24       |
|              |              | 3.89      | 4.37       |
| 20%          | 0%           | 2.48      | 2.43       |
|              | 10%          |           |            |
|              | 20%          | 3.06      | 3.73       |
|              | 30%          | 2.41      | 3.96       |
|              |              |           |            |

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|            |            |      |      |
|------------|------------|------|------|
|            |            | 3.75 | 3.77 |
| <b>25%</b> | <b>0%</b>  | 2.34 | 2.20 |
|            | <b>10%</b> | 2.89 | 3.48 |
|            | <b>20%</b> | 2.24 | 3.66 |
|            | <b>30%</b> | 3.40 | 3.47 |

**Table 5.2 Split Tensile Strength of concrete**

The Split tensile strength of normal concrete is 10% of its compressive strength. From the results the split tensile strength also decreased with increase in replacement of plastic. Up to 25% replacement the split tensile strength is also acceptable. Above 25% the replacement is not safe based on split tensile strength also.

### VI. COST COMPARISION

| Sl. no | Description  | Cost in Rs            |              |
|--------|--------------|-----------------------|--------------|
|        |              | Conventional concrete | E- concrete  |
| 1      | Cement       | 2600/-                | 2600/-       |
| 2      | Sand         | 7000/-                | 7000/-       |
| 3      | Aggregate    | 1050/-                | 600/-        |
| 4      | E-Waste      | -                     | 500/-        |
| 5      | Fly ash      | -                     | 700/-        |
| 6      | Other        | 9800/-                | 6000/-       |
|        | <b>Total</b> | <b>20450/-</b>        | <b>17400</b> |

**Net Profit = 17.528%**

### VII. CONCLUSION

Following conclusions can be drawn from the usage of post-consumer E plastic waste as partial replacement of coarse aggregate in concrete, Usage of recycled post-consumer plastic waste in concrete as ingredient reduces the cost of construction and can solve its disposal problems to significant extent. Improvement in the mechanical properties of concrete are observed such as compressive strength, split tensile strength, The compressive strength and split tensile strength of concrete containing aggregate noticeably decreased when it was replaced by more than 25% . The compressive strength test of E-concrete decreases with increase in the replacement level and the best behavior is at 5% replacement. The compressive strength will increase in approximately 27%. So we suggest Compressive strength of concrete with E-waste satisfied the requirement of normal concrete and also cost will reduced upto approximately 18%.

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