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Flyash Based Rigid Pavement with Partial Replacement of E-Waste as Coarse Aggregate

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***Abstract*: E-Waste use is a partial solution to environmental and ecological concerns. The use of these materials not only helps to get them used in cement, concrete, and other building materials, but it also helps to minimize the cost of cement and concrete production. Fly ash, a waste product or by-product from thermal plants, may be used to partially replace cement in concrete, minimizing the risk of pollution. This project compares the use of e-plastic waste material as a coarse aggregate substitute for 5%, 10%, and 15% of M20 grade concrete, and fly ash as a cement replacement for 20% of M20 grade concrete. Different percentages of e-waste content and fly ash are compared to conventional concrete in terms of compressive and flexural strength.**

***Keywords*: e-plastic waste, fly ash, compressive strength, flexural strength, different percentage of replacement, optimum dosage, M20 grade of concrete.**

1. Introduction

All aspects of concrete are affected by fly ash. As part of the composite concrete mass, it can be employed as a fine aggregate as well as a cementitious ingredient. The addition of fly ash to concrete improves its strength, durability, and resistance to chemical assault. Its use also has a positive impact on the environment. The qualities of fly ash are determined by the type of coal used in its production. Siliceous fly ash is pozzolanic in general, but calcareous fly ash contains latent hydraulic characteristics. Before the flue gases reach the chimneys of coal-fired power plants, electrostatic precipitators or other particle filtration equipment capture fly ash, which, along with bottom ash collected from the furnace's bottom, is referred to as coal ash. E-plastic garbage is one of the world's fastest-growing trash streams. E-waste is primarily generated in India's main cities, such as Delhi, Mumbai, and Bangalore. Electrical or electronic items that have been loosely discarded, surplus, outmoded, or broken are referred to as E- Waste. Rapid technological advancements and low initial costs have resulted in an ever-increasing global glut of electronic garbage.

2. Methodology

A. Methodology of flyash based rigid pavement with partial replacement of e-waste as coarse aggregate

The diagram above shows a Flyash-Based Rigid Pavement with E-Waste as Coarse Aggregate partially replaced. First, we must compile a literature evaluation for this project, followed by the collecting of materials such as cement, M-sand, Flyash, coarse aggregate, and E-Plastic Waste that will be used in the process. The next step is to research the collected materials to see if they are suitable for the approach. Following a material investigation, materials were cast with 5%, 10%, and 15% of E-waste replaced with coarse aggregate and 20% of Flyash substituted with cement in concrete. After that, we must inspect the casted specimens after 7, 14, and 28 days of curing. Results and conclusions are the last stages of this research.

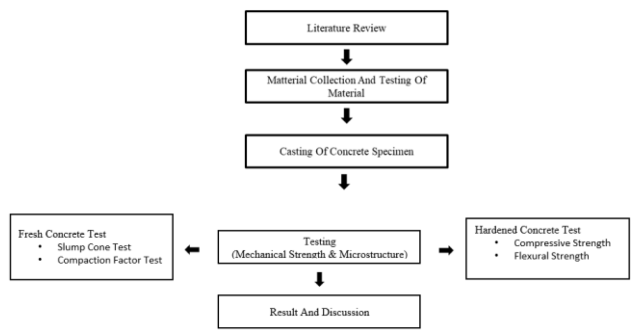

Fig. 1. Methodology

3. Major Components

A. Cement

Fig. 2. OPC cement

Cement is a binder, a substance that hardens, sets, and clings to other materials to bind them together in building. Cement is typically used to bind sand and gravel (aggregate) together rather than on its own. Ordinary Portland Cement (OPC) 53 grade cement must meet BIS specification IS: 12269-1987, with a specified strength of at least 53 MPa or 530kg/sqcum for 28 days. Because of its excellent particle size distribution and outstanding crystalline structure, 53 grade OPC delivers

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exceptional strength and durability to constructions.

B. M-Sand

M-Sand (manufactured sand) is a fine aggregate that is an environmentally benign and cost-effective alternative to river sand. It is made by crushing suitable stones and finely grading them to meet the standards of the IS standard. River sand can be replaced by manufactured sand. The demand for sand has risen dramatically as a result of the fast-growing construction sector, resulting in a scarcity of adequate river sand in most parts of the world. The use of artificial sand has increased as a result of the scarcity of good grade river sand for construction.

Fig. 3. M-Sand

C. Coarse Aggregate

Coarse aggregates are a type of construction material formed from rock extracted from the ground. Sand, gravel, crushed stone, slag, recycled concrete, and geosynthetic aggregate are all examples of coarse to medium grained particle material used in construction. These are particles with a diameter of more than 4.75mm. Gravel or stone that has been crushed, uncrushed, or partially crushed. The Sieve Analysis methodology is used to grade aggregate for use in concrete and other applications. When aggregate is mixed with cement or binding materials, it is referred to as bound material, and when it is utilized without cement or binding ingredients, it is referred to as unbound material. The tests are carried out in accordance with the IS: 383-1970.

Fig. 4. Coarse Aggregate

D. Flyash

Fly ash is a finely split residue produced by the combustion of ground or powdered bituminous coal or sub-bituminous coal (lignite), which is carried away by the flue gases of boilers that use pulverised coal or lignite. IS: 3812-1981 attests to this. It is widely available in the country as a waste product from a variety of thermal power plants and industrial operations that use pulverised coal or lignite as a boiler fuel. Recent research on Indian fly ashes has revealed that they have more potential as a construction material. Increased use of fly ash will not only save limited construction materials, but will also help to solve the problem of dumping this waste product from thermal power plants. Recent researches have also revealed the need for proper fly ash collection methods in order to produce quality and consistent fly ash, which are two of the most important characteristics of fly ash for usage as a construction material.

Fig. 5. Flyash

E. Electronic Waste (E-waste)

Any wasted electrical or electronic equipment is referred to as e-waste. This includes both working and broken goods discarded in the trash. Toxic compounds naturally leach from the metals inside e-waste when it is buried, making it extremely hazardous to the environment. Recycling e-waste is vital because it conserves natural resources and allows valuable materials to be recovered from electronic items that are either outdated or no longer in use. The recycling of e-waste is a partial answer to environmental and ecological issues. The supply of raw materials is being questioned due to the widespread usage of concrete as a construction material. As a result, other replacement materials must be discovered. One such solution for coarse aggregate in concrete is e-waste.

Fig. 6. Printed Circuit Board (PCB)

4. Results and Discussion

Test specimens of 150x150x150mm cube and 100x100x150mm prism size are used with M20 grade concrete, and the ratio is calculated using IS 10262 with a mix ratio of 1:1.5:3. 45 cubes and 30 prisms are cast with 20% flyash replaced with cement and 5%, 10%, and 15% e-waste replaced with coarse aggregate.

Mechanical Properties:

1. Compressive strength
2. Flexural strength

Table 1
Compressive strength test results

SPECIMEN DESIGNATION	7 DAYS (N/mm²)	14 DAYS (N/mm²)	28 DAYS (N/mm²)
1/A	14.2	20	28.8
1/B	8.8	11.1	19.1
1/C	4.5	14.6	21.3
1/D	11.1	16.4	18.2
1/E	12.8	13.7	18.6

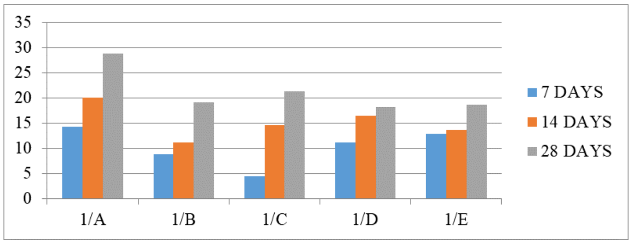

Fig. 7.

Table 2
Flexural strength test results

SPECIMEN DESIGNATION	7 DAYS (N/mm²)	14 DAYS (N/mm²)	28 DAYS (N/mm²)
1/A	2.75	3.5	4
1/B	2	3	3.5
1/C	2.25	3.75	4.5
1/D	1.75	2.75	3
1/E	2	2.75	3.75

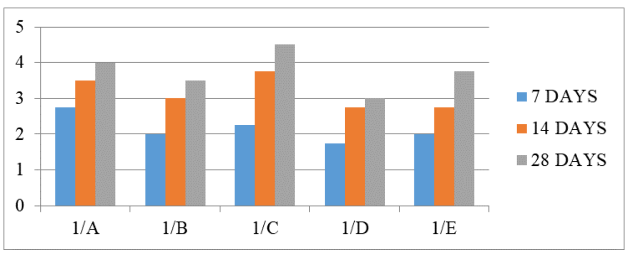

Fig. 8.

Note:

- 1/A – Conventional concrete.
- 1/B – 20% of Flyash replaced with cement.
- 1/C – 20% of Flyash replaced with cement and 5% of e-waste replaced with coarse aggregate.
- 1/D – 20% of Flyash replaced with cement and 10% of e-waste replaced with coarse aggregate.
- 1/E – 20% of Flyash replaced with cement and 15% of e-waste replaced with coarse aggregate.

5. Conclusion

The workability of e-waste concrete increases dramatically for the 15% replacement ratio, according to this paper, which is achievable due to e-decreased waste's moisture absorbing capacity. The inclusion of e-waste to the concrete reduces the weight of the concrete, which increases its performance. When the amount of e-waste replaced increased, the concrete's compressive and flexural capacity decreased. Compressive and flexure strength both reduced by 8% to 19%. This is related to the establishment of a weak link between cement pastes and e-waste, or the concrete's transition zone character. With the e-waste-replaced concrete, the amount of abrasion was reduced.

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