International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Issue: 5 Volume No.6 Aug-Sept – 2022
DOI:10.46647/ijetms.2022.v06i05.017 ISSN: 2581-4621

Impact of partial replacement of coarse aggregate with electronic plastic waste on compressive strength of concrete

Simranpreet Singh[1], Sukhdeep Singh[2], Sabha Farooq[3]
[1]M.Tech Scholar, Dept. of Civil Engineering, CT University, Ludhiana
[3]Assistant Professor, Dept. of Civil Engineering, CT University, Ludhiana
[3]M.Tech Scholar, Dept. of Civil Engineering, CT University, Ludhiana

Abstract - The need for infrastructure development, electrical equipment, and plastic-manufactured goods has increased exponentially with the arrival of the twenty-first century. Demand growth was followed by a notable increase in construction debris and electronic-plastic (e-plastic). Due to its non-biodegradability and dangerous metallic waste, e-plastic waste, which consists primarily of wires and discarded plastic components from TVs, refrigerators, and other electronic devices, poses a serious ecological threat. Being the primary component of construction waste, cement considerably contributes to CO2 emissions, which cause global warming.. Situations become more distressing for towns with a large population when such waste is dumped or burned, either of which pollutes the environment.

Thus, the purpose of the article is to evaluate whether e-plastic waste can substitute some of the coarse aggregates in concrete. In the experiment, the compressive strength of an M40 concrete mix with weight replacements of coarse aggregates of 5 percent, 10 percent, 15 percent, and 20 percent made from e-plastic waste was measured and compared to a control mix. In the experiment, e-plastic wastes were made up of acrylonitrile butadiene styrene (ABS), a high-density polymer plastic, and poly-propylene (PP), a low-density plastic primarily found in electronic gadgets. For efficient test results, a total of 30 cube specimens with varying proportions of cement, fine aggregate, coarse aggregate, and e-plastic were created. According to the conclusions drawn from tests carried out in accordance with Bureau of Indian Standard (IS), a noticeable increase in compressive strength was seen at a 5 percent replacement of e-plastic. Nevertheless, a further rise in replacement showed a fall in compressive strength.

Keywords: Plastic waste, E-waste, E-plastic waste, Coarse aggregate replacement, Recycling, Reuse.

1. INTRODUCTION

Electronic garbage, sometimes known as e-waste, refers to outdated electrical or electronic equipment. E-waste includes used electronics that are intended for reuse, resale, salvage, recycling, or disposal. Due to the lack of regulatory control of e-waste processing in developing nations, there may be major health and environmental issues caused by informal processing of electronic trash in these nations (Subramanian). Lead, cadmium, beryllium, and brominated flame retardants are examples of pollutants that may be present in electronic junk components like CRTs (Cathode Ray Tube Even in developed nations, recycling and disposal of e-waste may pose a serious risk to both workers and communities, so extreme caution must be exercised to prevent both unsafe exposure during recycling operations and the leakage of hazardous materials like heavy metals from landfills and incinerator ashes. Recycled e-plastic is one of the new waste products used in the concrete industry. The reuse of recovered plastic in the concrete industry is thought to be the most practical application for addressing the disposal of vast amounts of recycled plastic material. Concrete can employ recycled plastic as coarse aggregate. However, it is crucial to stress that recycling garbage does not currently offer financial benefits due to high transportation costs and their impact on overall production costs. Additionally, it's critical to consider additional costs that are directly related to the type of trash, particularly those related to the necessity of detecting gas emissions during combustion and the presence of dangerous and polluting materials. Recycling of plastic Recycling is the process of pulling spent materials out of the trash stream and using them again in the production process. One of the popular practices in this environmentally conscious era is recycling. Three basic justifications for recycling are as follows: First, it protects the priceless natural resources; second, it reduces transportation and related expenses; and third, it prevents the environmental burden brought on by waste materials, i.e. space needs Recycling techniques and applications in construction:

1. Changes made to chemicals
2. Recycling mechanically
3. Thermostatization
4. Fillers

1) Chemical alterations – Depolymerization or chemical modification can be used to recycle plastics..Depolymerization can be accomplished in two ways: pyrolysis (heat decomposition) and hydrolysis (chemical decomposition; B.T. Ashwini Manjunath / Procedia Environmental Sciences 35 (2016) 731–739 733. Polyethylene terephthalate, for instance, and MMA (methyl methacrylate).

2) Mechanical recycling of plastics is the term for procedures that require melting, chopping, or granulating used plastic debris. Prior to mechanical recycling, plastics (HDPE, high density polyethylene, and thermoplastic polyolefin) must be sorted (TPO).

3) A thermoplastic is heated to extremely high temperatures during thermal processing, causing the plastic to flow. As the plastic cools, it is then transformed into a new product. This technique does not include changing the chemical makeup of the plastic, for example. PET

4) Fillers - Plastic waste can also be utilized as fillers in road building or in conjunction with virgin resins or other materials like concrete.

1.1 Advantages of using plastics in concrete:

The increasing popularity of plastic is a result of its advantageous qualities, which include: • Extreme versatility and the capacity to be adapted to fulfil unique technological requirements.

- Less weight than equivalent materials means less fuel is used during transportation.
- Longevity and durability.
- Tolerance to impact, water, and chemicals.
- Outstanding electrical and thermal insulation qualities.
- Less expensive production overall.
- At the melting point, as the temperature rises, the bonding capacity increases.

1.2 The main drawbacks of incorporating plastic in concrete are as follows:

- Because plastics have poor bonding abilities, concrete loses some of its compressive, tensile, and flexural strength.
- Since it melts when exposed to heat at high degrees, tt cannot be employed in furnaces due to its low melting point.

International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Issue: 5 Volume No.6 Aug-Sept – 2022
DOI:10.46647/ijetms.2022.v06i05.017 ISSN: 2581-4621

2. OBJECTIVE:

- To demonstrate that electronic trash may be disposed of by being used as building materials and using e-waste instead of coarse aggregate.
- To reduce the presence of harmful materials in specific electrical products.
- To create and advance e-waste management technology.
- To lessen pollution brought on by recycling e-waste in an unorganized area.
- To figure out the concrete's e-plastic aggregate's compressive and flexural strength.

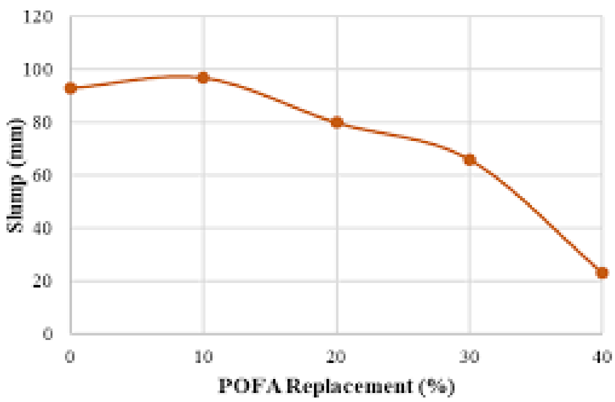
3. METHODLOGY

According to IS 10262-1982, the mix design for concrete of the M22 grade was carried out, and the following information was needed.
1) The compressive strength characteristic at 28 days is 40 N/mm2.
2) OPC cement is utilized (per IS 1489: 1991(part 1) and the cement's aforementioned qualities).
3) Course aggregate with a specific gravity of 2.825 and a free water absorption of 3.645 percent. This aggregate is made from crushed coconut shells that range in size from 12.5 to 20 mm in length and 2 to 8 mm in thickness. The above-mentioned cement qualities>>>>>>>.
4) Fine aggregate River sand was utilized as the fine aggregate in accordance with IS 383:1970 [159], which specifies grading zone II; the specific gravity was 6.18, and the free water absorption rate was 2.02 percent. Workability corresponding to compaction factor 75mm slump.
1.4:2.4:0.5 and a 0.7 w/c ratio. The weight of the cement is combined with the E-plastic aggregates in amounts of 0 percent, 20 percent, 30 percent, and 40 percent. Prior to mixing, the mould was put together and carefully lubricated to facilitate the removal of hardened concrete. The specimen is prepared using cubes with a typical mould size of 150x150x150 mm, 150 x 300 mm cylinders, and 150 x 150 x 300 mm beams. The mixture was thoroughly stirred with a shovel until it reached a plastic state.
A slump test was then conducted to determine the mix's W/C ratio before the mixture was injected into a greased cast iron mould and the water curing process was used. Prior to being demoded, the concrete cubes that had been molded had 24 hours to cure. The concrete was then placed into a curing tank to increase strength, encourage hydration, prevent shrinkage, and absorb heat until the age of the test. The cubes and cylinders underwent 7, 28, and 56 days of curing. Prior to testing, the cubes and cylinders were then weighed, and densities of the cubes at various testing intervals were measured. The specimen was removed from the curing tank before testing and kept outside in the open air for roughly three hours before being crushed. BS 1881 was used to evaluate the cubes' compressive strength, and the universal crushing machine Mix Design was used (IS 10292:1982)

4. RESULTS AND DISCUSSIONS

A M20 concrete mix grade is desired, and the Indian Standard technique of mix design is used to determine the design mix proportion. With a w/c ratio of 0.6.the mix proportion achieved is 1:1.4:2.4:0.5. E-plastic was added in amounts of 0%, 10%, 20%, and 30% by the weight of cement in the mixture.
Workability test results: To determine the workability of concrete as the amount of E-plastic waste increases, the Slump Cone Test was performed on fresh concrete with increasing percentages of E-plastic. where S1 contains 0% E plastic, S2 contains 0% E plastic, S3 contains 20% E plastic, and S4 contains 30% E plastic. Graph 1 illustrates the graphical representations of the Slump values of S1, S2, S3, and S4.

International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Issue: 5 Volume No.6 Aug-Sept – 2022
DOI:10.46647/ijetms.2022.v06i05.017 ISSN: 2581-4621



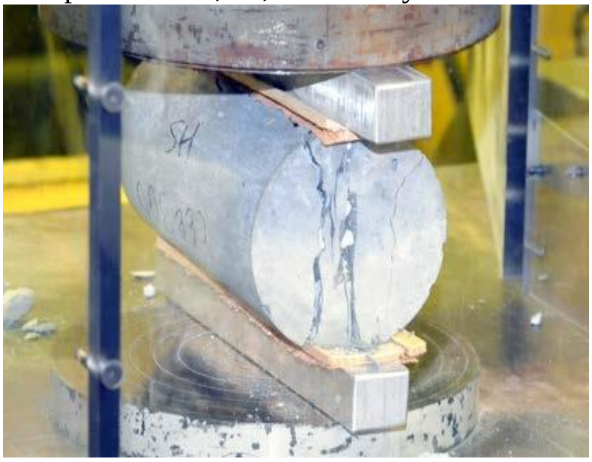
Compressive strength test results:
The compressive strength of concrete mixes containing and excluding E-plastic aggregates. S1 is a conventional mix, S2 contains 0% E-plastic, S3 contains 20% E-plastic, and S4 contains 30% E-plastic. Graph displays the compressive strength for 7, 14, and 28 days for all blends S1, S2, S3, and S4.

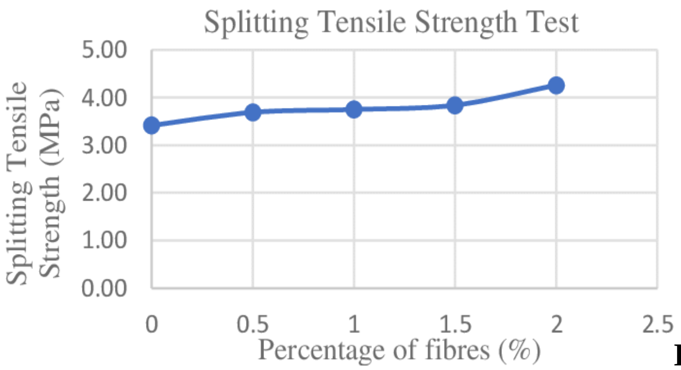
S.NO	FIBRE CONTENT (%)	COMPRESSIVE STRENTH FOR M30 (N/mm) 14 DAYS	COMPRESSIVE STRENTH FOR M30 (N/mm) 28 DAYS
1	0.0	33.36	35.25
2	0.5	34.97	38.45
3	1.0	35.34	38.23
4	1.5	33.26	33.00

Split tensile strength tests results The split tensile strength of all concrete mixes is shown; the test to determine it uses a cylinder specimen that is 300 mm long and 150 mm in diameter and is compressed in

DOI:10.46647/ijetms.2022.v06i05.017 ISSN: 2581-4621

a compression testing machine. Graph displays graphical representations of the split tensile strength of all mixes S1, S2, S3, and S4 for periods of 7, 14, and 28 days as indicated below.





L

CONCLUSIONS

The following conclusions can be drawn from the research done by various researchers:

1) Part of the aggregate in a concrete mixture can be replaced by plastics. As a result, the concrete's unit weight is decreased. This is helpful for applications that call for lightweight concrete that is not load-bearing, like concrete panels used for façade.

2) Adding plastics to the mix reduces the density, compressive strength, and tensile strength of concrete for a given w/c.

3) In the case of plastic concrete, the influence of the water-cement ratio on the development of strength is not significant. It's because the concrete's binding strength is decreased by the flexible particles. Consequently, the breaking of the link between the components of concrete results in.

3) In the case of plastic concrete, the water-cement ratio's influence on the development of strength is less noticeable. It's because the concrete's binding strength is decreased by the flexible particles. Therefore, the link between cement paste and plastic particles fails, which leads to the collapse of concrete.

4) The addition of polymers tends to make concrete more ductile, increasing its capacity to deform greatly before failing. Since it can expand and contract and freeze and thaw in response to extreme weather, concrete is advantageous in these circumstances

.5) The inclusion of recycled aggregates in the concrete of the buildings under investigation has been shown to be advantages from an energy point of view.

REFERENCES

[1] Ahmadi, B. and Al-Khaja, W. (2001), "Utilization of paper waste sludge in the building construction industry",Resour. Conserv. Recycl., 32(2), 105-113.

[2] Argos-Productos (2017), Cemento Gris Uso General, Argos, Medellin, Colombia.

DOI:10.46647/ijetms.2022.v06i05.017 ISSN: 2581-4621

[3] Arora, A. and Dave, U. (2013), "Utilization of E-waste and plastic bottle waste", Int. J. Stud. Res. Technol. Manage., 1(4), 398-406.
[4] ASTM C136/C136M-14 (2014), Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates, ASTM International, West Conshohocken, PA, USA.
[5] Beams Diaries of Structural Engineering, ASCE, 125(6), 653-660
[6] Gaidajis G., Angelakoglou K., Aktsoglou D., E- waste: Environmental Problems and Current Management, Journal of Engineering Science and Technology Review, 3 (1) , 193-199, 2010.
[7] Lakshmi, R. and Nagan, S. (2010), "Studies on concrete containing E plastic waste", Int. J. Environ. Sci., 1(3), 270-281
[8] Lakshmi, R., and S. Nagan. "Examinations on Durability Characteristics of E-plastic Waste Incorporated Concrete." Asian Journal of Civil Engineering
[9] Manjunath, A. (2016), "Partial replacement of E-plastic Waste as Coarse-aggregate in Concrete", Procedia Environ. Sci., 35, 731-739
[10] Nagajothi, P. Gomathi, and T. Felixkala. "Compressive Strength of Concrete Incorporated with E-fiber Waste."