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An Experimental Exploration of Rigid Pavement Using E-Waste as a Partial Replacement.

[1]John Mohammad Hajam, [2]Er.Brahamjeet Singh, [3]Dr.Sandeep Singla

[1]M.Tech. Scholar, Civil Engg. Deptt. RIMT University Punjab
[2,3]Professor, Civil Engg. Deptt. RIMT University Punjab

1. ABSTRACT:
The solid waste is considered one of the fastest growing waste in the world, mostly the waste from the electric and electronic equipment. The utilization of the wastes is the true solution to the environmental problems and the use of these E-waste materials reduces the cost of the concrete while construction. Rapid growth of population and widespread utilization has clearly increased the development of the construction industry which caused the huge demand for sand, gravels. Environmental problem occurs when the rate of extraction of sand, gravels and other materials exceeds the rate of generation of natural resources ; therefore, an alternative resource is essential to replace the material used in concrete. Electric and electronic wastes are most widely used now-a-days which provides comfort and ease of exchange of information. These E-Wastes materials have serious human health issues as these E-Wastes contain highly toxic chemicals such as lead, cadmium, mercury, beryllium, polyvinyl chloride (PVC) and phosphorus compounds. Which require a great care in disposal to avoid the adverse impacts. Hence, E-Wastes can be incorporated in concrete pavements to make a sustainable environment. This paper explores to find the Strength Evaluation of E-Waste as a partial replacement of course aggregate in concrete pavements USING M35 Concrete. Further the comparison of Strength, Cost Analysis and Economical with the normal concrete pavements.

Keyword: E-Wastes, coarse aggregate, partial replacement

1. INTRODUCTION:

E-Waste refers to the old, end of life of electronic appliances such as computers, laptops, TVs, DVD players, mobile phones, mp3plyers, mp4 players, etc. which have been disposed off by the original users .Now-a-days, the world is facing a real challenge is disposal of wastes without inducing any environmental issue which is not possible in true words because, these waste contain highly toxic chemicals. Hence, E-Wastes can be incorporated in concrete to make a sustainable environment. Concrete is the second most essential material consumed after water. Concrete is the most widely used man-made construction materials in the world. Slightly more than a ton of concrete is produced each year for every human being on the planet fundamentally, concrete is economical, strong, and durable. One of the major challenges with the environmental awareness and scarcity of space for land-filling is the wastes/byproducts utilization as an alternative. In India, the primary source of E-Waste is public and private sector institutions which leads 70% of the total waste of total wastes (Balasubramanian, et al. 2016). The estimated annual generation of E-Wastes is 4,00,000 tons that is (10%-15%) approximately. The wastes generated from the top cities such asMumbai, New Delhi, Banglore and Chennai were calculated to be 10,000tons, 9,000tons, 8,000tons and 6,000tons respectively but, from these sources only 4% is recycled (Vivek, et al.,2015). Utilization of crushed E-Waste materials as a conventional concrete and thereby reducing the cost of the concrete.
The main sources of E-Waste are given as under:

1) IT and Telecom equipment.
2) Large household appliances.
3) Small house hold appliances.
4) Consumer and lighting equipment.
5) Electrical and electronic tools.
6) Toys and sports equipments.
7) Medical devices.

1.1 E-Waste:

This is an electrical and electronics waste .E-Waste refers to the old ,end of life of electronic appliances.

• **Advantages of E-Waste as a partial replacement of course aggregate:**

1. E-Waste can be utilized in construction.
2. Load on the rivers for aggregates can be minimized.
3. Eco-friendly, and no hazard to the nature.
4. Easily available throughout the India after processing
5. Black marketing can be reduced

2. LITERATURE REVIEW:

Krishna *et al.* (2017) Subodh kuwar, (May 2016) has conducted an experimental study on plastic components of E-Waste in concrete used in rigid pavements. The strength properties of specimens were observed with the use of waste plastic in various percentages (5%, 10%, 20% and 25%). The data present in this paper showed that there is a great potential for the utilization of waste plastic fiber in concrete which can be cost effective and eco-friendly.

Prakash et al., (Nov. 2017) has presented experimental study to determine the effects of E-waste recycled concrete aggregate (RCA) under the curing conditions of 2.1 PH in H2SO4 and 0.5N in HCL severely .The replacement percentages of RCA were 0%, 5%, 10%, 15%, respectively (M25 grade). The partial replacement of RCA to achive the mechanical properties (compressive and flexural strength) and chemical properties (corrosion resistance and alkali attack) of concrete by utilizing E-Waste as compared with the ordinary conventional concrete. The modern study brings a new hope that the major work has been replacing of E-Waste in the production of low cost concrete in civil engineering society.

S.R..Shamila, (2017) has carried out an experimental work on the utilization of E-Waste as coarse aggregate in concrete. It is experimented with the replacement level of 0 % to 30% and the mechanical properties of concrete were observed and exhibited a good strength gain. The addition of considerable amount in the concrete mix improves the strength for control mix as well as E-Waste concrete.

[Shini Shanmugan and Ramesh kannan]: Utilization of E-Waste printed circuit board by partial replacement of sand in concrete. Waste printed circuit boards (pcbs) with approximately 30% metals and 70% nonmetals have large amount of silica in its refined form and is inert in nature. Hence, it forms an ideal replacement material of fine aggregates in concrete and results in less deviation of strength parameters.

3. EXPERIMENTAL RESULTS:

Out of the many tests applied to the concrete the compressive strength test is the one of the important test which gives us the idea about all the characteristics of the concrete. The test results of compressive strength, flexural strength, bond strength obtain from the experimental study are given in a table as well as in graphical form as under:

The following three tests are to be done on M35 concrete using E-Waste with it.

Table 1: Compressive Strength of M35 with using E-Waste

E-Waste (%)	7 days compressive strength (N/mm2)	28 days compressive strength (N/mm2)	60 days compressive strength (N/mm2)
0	29.99	36.60	37.213
5	26.56	33.38	35.651
10	23.82	32.12	36.231
15	21.79	29.93	30.221

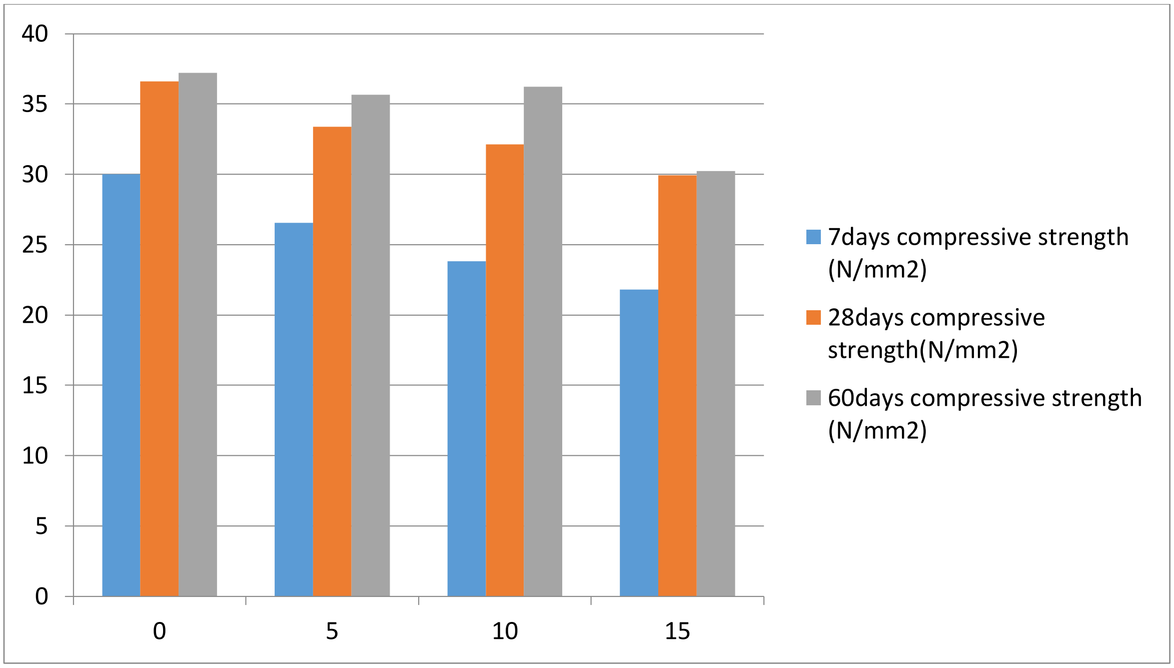

Fig.1 Compressive strength

This graph and table shows the E-Waste % 7 days compressive strength (N/mm2), 28 days compressive strength (N/mm2), 60 days compressive strength (N/mm2). In 0% and 5% compressive strength % decreases and in 10% strength is increased and again is decreases in E –waste content percentage 15%

Table 2: Flexural Strength Test of M35 with using E-Waste

E-Waste (%)	7 days flexural strength (N/mm2)	28 days flexural strength (N/mm2)	60 days flexural strength (N/mm2)
0	10.216	11.922	13.225
5	9.575	10.052	12.863
10	8.964	9.564	11.521
15	7.977	8.053	9.365

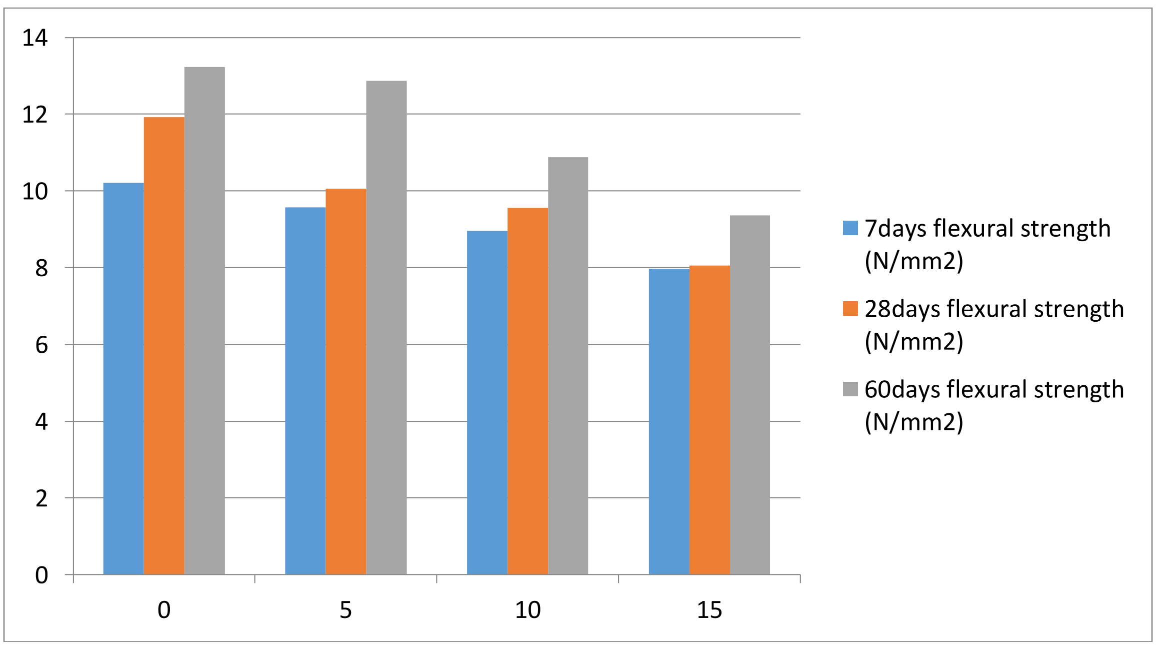

Fig 2

Flexural Strength goes on increasing for 28 days and 60days for E-Waste and with the increase in percentage of E-Waste, it slightly goes on decreasing . So more days to be tested, more strength to be gained.

Table 3: Average bond strength after 28 days using E-Waste

E-Waste (%)	Ultimate load (KN/mm2)	Yield stress(KN/mm2)
0	0.465	0.379
5	0.405	0.302
10	0.345	0.235
15	0.239	0.198

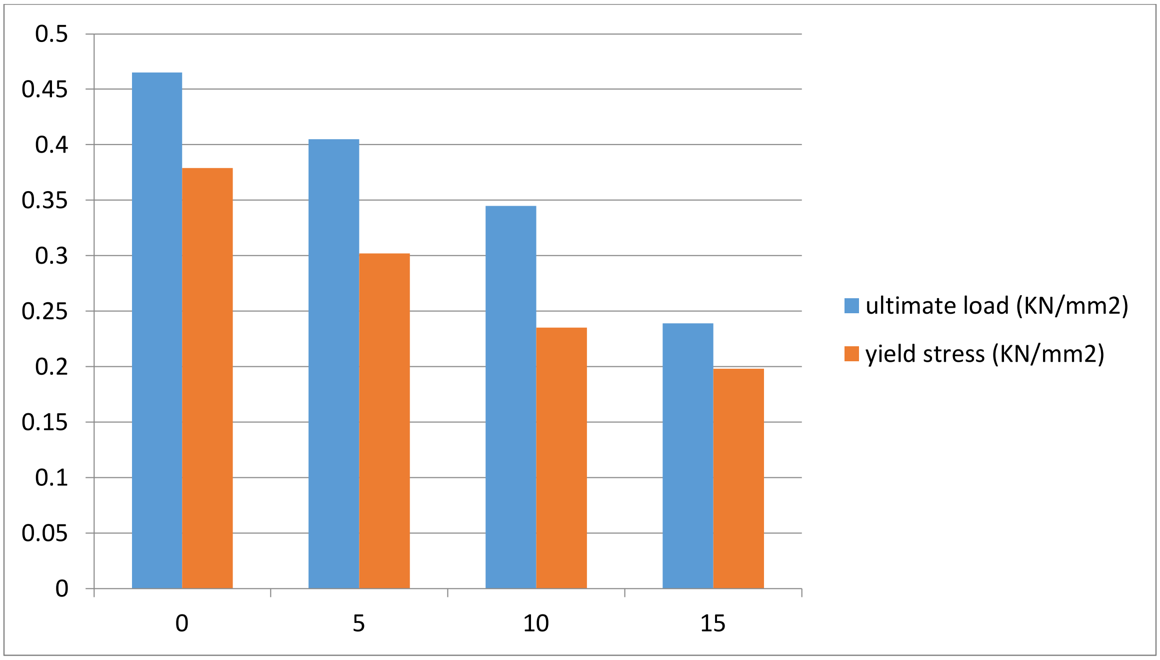

Fig. 3 Average bond strength

There is gradual increase at the lower percentages and a slightly decrease with the increase in percentage of E-waste.

4. COST ANALYSIS:

Cost analysis is the main key in the future development of the technology where E-Waste is a product which can be obtained without investing much more money. This E-Waste can be later on used for construction purposes. The cost comparison between the course aggregate and E-Waste is given as under:

CITY	COST OF AGGREGATE (Per KG)	COST OF E-WASTE (Per KG)
DELHI	4	RS. 4.2
BANGALORE	3.9	RS. 3.2
MUMBAI	3.8	RS. 3.5
PUNE	3.4	RS. 4.2

Note: The processing cost for the E-Waste will be RS. 4 per kg. Transportation cost for the E-Waste may vary from place to place. If the crusher is available within the company the cost may get reduced.

6. CONCLUSION:

1. The study concludes that E-Waste can replace course aggregates up to 10%
2. This provides an effective way to disposal E-Waste.
3. The strength of concrete is increased up to 10% of the E-Waste.
4. This makes concrete more flexible hence, can easily bear the seismic loads.
5. It reduces the stress on natural resources.
6. It saves the land which is used to dispose the E-waste.
7. It reduces the risk the environmental pollution and human health.

7. RAFRANCES:

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