International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 04 | Apr 2021 www.irjet.net p-ISSN: 2395-0072

Experimental Study on Green Concrete Made With Recycled Aggregates

Mohammed Faiz uddin[1], Mohd Arsalan[2], M A Jaleel Farooqui[3], Mr. Mir Firasat Ali[4]

[1, 2, 3] B.E Students, Dept of Civil Engineering, ISL Engineering College, Hyderabad
[4]Assistant Professor, Dept of Civil Engineering, ISL Engineering College, Hyderabad

---***---

Abstract – *New technologies have evolved very fast to cater different difficulties in the construction industry. Production of concrete which will leave a substantial mark on the environment. The concrete is made with concrete wastes which are eco-friendly so called as* ***Green concrete****. In recent years demolished concrete waste and E-waste handling and management is the new primary challenging issue faced by the countries all over the world. It is very challenging and hectic problem that has to be tackled in an indigenous manner, it is desirable to completely recycle demolished concrete waste in order to protect natural resources and reduce environmental pollution. By the use of green concrete it is possible to reduce the CO2 emission in atmosphere. To avoid the pollution and reuse the material, the present study is carried out. Thus, green concrete is an excellent substituent of cement as it uses waste products, saving energy consumption in the production, greater strength and durability than the normal concrete.*

In this research paper an experimental study is carried out to investigate the feasibility and recycling of demolished waste concrete for new construction. The present investigation to be focused on recycling demolished waste materials in order to reduce construction cost and resolving housing problems faced by the low income communities of the world. The crushed demolished concrete wastes is segregated by sieving to obtain required sizes of aggregate, several tests were conducted to determine the aggregate properties before recycling it into new concrete. This research shows that the recycled aggregate that are obtained from site make good quality concrete. The compressive strength test results of partial replacement and full recycled aggregate concrete and are found to be higher than the compressive strength of normal concrete with new aggregate.

Key Words**: Eco-Friendly Concrete, Eco-Friendly Construction Material, Efficient Concrete, Green Concrete**

1. INTRODUCTION

Concrete is the most used man-made product in the world. Concrete is a major contributor to greenhouse gas emissions and creates problem for the disposal of waste concrete from demolished sites which in turn effects the environment. Therefore recycling of concrete waste is the need of hour. Concrete is also interesting in relation to other environmental problems than those related to CO2 emission. Due to all these above mentioned reasons civil engineers have come up with a new concept of concrete, named "GREENCONCRETE". The availability of natural resources to future generations has also been realized. The size of construction industry all over the world is growing at faster rate". Concrete is a widely used construction material consisting of cementing material, fine aggregate, coarse aggregate and required quantity of water, where in the fine aggregate is usually natural sand. The use of sand in construction results in excessive sand mining which is objectionable. Due to rapid growth in construction activity, the available sources of natural sand are getting exhausted. Waste can be used to produce new products or can be used as admixtures so that natural resources are limited and used more efficiently and the environment is protected from waste deposits.

Recycled demolished concrete are comprised of crushed, graded inorganic particles processed from the materials that have been used in the constructions and demolition debris. These materials are generally from buildings, roads, bridges. With the sharp development of construction and increase of people's awareness of environmental protection, waste control and management becomes one of the great challenges of modern society for the mission of sustainable development. Construction and demolition (C&D) waste constitutes one major portion of total solid waste produced in the world, including demolished concrete, bricks, and masonry, limestone, ceramic and other materials. Structures include buildings of all types, both residential and nonresidential, as well as roads and bridges. Components of C&D debris typically include concrete, asphalt, E-waste, wood, metals, gypsum wallboard and roofing". Main components of CDW are generally brick, concrete, wood, and ceramic tile. Except for soil and fine aggregates, the predominant materials, especially in buildings from the last century, are brick and cement block. Concrete and masonry waste can be recycled by sorting, crushing and sieving into recycled aggregate. This recycled concrete can be used to make concrete for road construction and building material. E-Waste for short or Waste Electrical and Electronic Equipment (WEEE) is the term used to describe old, end-of life or discarded appliances using electricity. It includes computers, consumer electronics, fridges etc. which have been disposed of by their original users. The processing of electronic waste in developing countries causes serious health and pollution problems due to the fact that electronic equipment contains some very serious contaminants such as lead, cadmium, beryllium and brominates flame retardants. Even in developed countries recycling and disposal of e-waste involves significant risk. In its simplest form, concrete is a mixture of paste and aggregates. Various materials are added such as fly ash, rice husk, PCB board, Glass fibre admixture to obtain concrete of desired property. The character of the concrete is determined by quality of the paste. The key to achieving a strong, durable concrete rests in the careful proportioning, mixing and compacting of the ingredients. As a key component in electronic equipment, large amounts of waste printed circuit boards (PCBs) are generated by all this consumption of electronic appliances. PCBs form about 3% by weight of the total amount of electronic scrap Printed circuit boards (PCB) are platforms on which integrated circuits and other electronic devices and connections are installed. In general, waste PCBs contains approximately 30% metals and 70% non-metals (Guo et al., 2008, Goosy and Kellner, 2002). The material presents in PCB can be further categorized in three groups that are organic, metals, and ceramics.

2. LITERATURE REVIEW

Green Concrete is a type of concrete which resembles the conventional concrete but the production or usage of such concrete requires minimum amount of energy and causes least harm to the environment. Green concrete is very low energy & resource consumption, no environmental pollution & sustainable development. Green cement concrete is produced by using recycled waste materials such as activated fly ash and recycled concrete aggregates. Other concrete alternatives can be equally used to significantly increase the sustainability and durability. Secondly, one must plan for structural designs involving environmentally friendly maintenance strategies which will need less of energy and resources. Although green concrete seems to be providing lot of benefits, still one needs to consider the potential barriers on its way. They are increase in cost of recycling and reusing along with use of additional energies and resources for the same and the fear of failure of the green concrete as it is made from reused products. One can conclude that overcoming the above demerits would help to use green cement concrete with a potentially new environmental friendly world.
S.S. Jain Subodh P.G. Autonomous College University of Rajasthan Jaipur says In order to estimate the environmental impact of a construction material, it is necessary to consider all stages in the life of the material. Each construction material is manufactured from some combination of raw materials, with some expenditure of energy, and with associated wastes. Therefore manufacture is an essential element in computing the environmental impact, and manufacture is probably the element most widely cited when considering the environmental impact of construction materials. Are the raw materials renewable? Are they scarce? Are they important to the global environment? How much energy is required in the manufacture? How much waste is produced during the manufacture? What impact do these wastes have on the environment? These questions are very important and this phase probably receives the most attention, both from the general public and from the government. The construction process also involves some expenditure of energy and produces some waste. There are several important questions. How much of each manufactured material is used? Can materials be used that have less environmental impact? How much energy is used? How much waste is produced? What is the impact of the waste on the environment? Some of these questions can only be answered for a specific structure. Increasing attention is being given to the construction phase as part of global and regional efforts to make development more sustainable. The lifetime of the structure has a direct impact on sustainability. When the structure deteriorates, it must be destructed and rebuilt. The lifetime is directly controlled by the durability of the construction materials. It is further influenced by the adaptability of the design to repair and renovation, and repair and renovation themselves have environmental impacts. Finally, the lifetime of a structure is influenced by cultural and market forces. When a structure no longer serves an important function (not necessarily the function for which it was constructed), it is likely to be destructed. And if it is not aesthetically pleasing, it may be destructed. So materials and design considerations directly affect the lifetime of a structure and the lifetime must be considered when computing environmental impact.

Ms. Monica C. Dhoka Carried out experimental study on green concrete and described the properties of, concrete and its strength with the use of waste materials. She described about green concrete in which we can reduce the pollution in environment by adopting suitable proportion of materials like cement and can improve the durability of concrete under the serve condition.

Bambang Suhendro Analysed that 8 to 10% of the world's total co2 emissions take place by manufacturing,cement and global warming gas is released by crushing lime stone and clays. He described the term green concrete which is the utilisation of waste material by replacing of quantity of cement. He discussed about environment pollution and its effects in this case study. Now a day's everyone is aware from the environmental effects and global warming which is being increased day due to production of these construction materials specially in industries by day so now many countries are utilising waste materials and replacing it of further materials which generally use in making concrete but to observe the proper strength in construction.

3. OBJECTIVES OF THE STUDY:

- To produce a concrete with the use of locally available materials (i.e. Green concrete).
- To study the strength properties of green concrete with partial replacement of natural aggregates.
- To investigate the effect of recycled coarse aggregate on the compressive strength of concrete.
- To investigate the effect of recycled coarse aggregate on the split tensile strength of concrete.
- To determine the optimum percentage of recycled coarse aggregate in the concrete

4. Materials:

Cement
The cement used in all mixtures was commercially available Ultratech 53 grade Ordinary Portland Cement conforming to IS 12269-1987 was used in this study. The specific gravity of cement was 3.15. The initial and final setting time were found as 36 minutes and 395 minutes respectively.

Fine aggregate
Locally available river sand passed through 4.75mm IS sieve is used as fine aggregate. The specific gravity of sand is 2.82 and fineness modulus of 2.5

Coarse aggregate
The Coarse aggregate are obtained from a local quarry is used. The coarse aggregate with a maximum size 20mm having a specific gravity 2.91 and fineness modulus of 3.06

Demolished waste
The Demolished wastes are obtained from a laboratory crushed specimen. The specimens were crushed manually using a hammer. The aggregates passing through IS sieve 20mm and retained on 12.5mm are taken. The specific gravity of aggregates is 2.85 and fineness modulus of 3.10.

E-waste
The E-wastes like printed circuit board are used. The PCB was crushed by using Jaw crusher. The aggregates passing through IS sieve 2.36mm.The specific gravity of aggregates is 2.85 and fineness modulus of 3.10.

4.1 Experimental Program

The mix design is produced for maximum size of aggregate is 20mm conventional aggregate and crushed recycled aggregate. The variation of strength of hardened concrete using solid wastes as partial replacement of conventional aggregate is studied by casting cubes and cylinders until 20%. The concrete was prepared in the laboratory using mixer. The cement, fine aggregate and coarse aggregate and solid wastes are mixed in dry state and then the desired water quantity is added and the whole concrete is mixed for 5 minutes, the concrete is poured in the moulds which are screwed tightly. The concrete is poured into the moulds in 3 layers by poking with tamping rod for cubes of 150×150×150 mm Size, cylinders of 150×300 mm size was tested for compression and split tensile strengths. The cast specimens are removed after 24 hours and these are immersed in a water tank. After a curing period of 7 and 28 days the specimens are removed and these are tested for compression and split strengths and the results are compared with conventional concrete.

The mix design procedure for control concrete adopted in the present work to obtain M-25 grade concrete is in accordance with IS: 10262-2009 and IS: 456-2000.

W/C Ratio -0.50
Cement (kg/m3) – 387.42
Fine aggregate (kg/m3) -747.12
Coarse aggregate (kg/m3) -1257.8
Water (kg/m3)-174.34

Apart from control mix, different mixes were used to examine the influence of adding RCDA (Recycled Crushed demolished) coarse aggregates and RCEA (Recycled Crushed E-waste) fine aggregates on the properties of concrete. Details of the mixes are given in Table-1.

NAC- Natural Aggregate Concrete, RCDA- Recycled Crushed Demolished Aggregate Concrete, RCEA- Recycled Crushed E-Waste Aggregate Concrete

Table-1: Properties of Concrete

MIX-ID	Cement	N.F.A	N.C.A	Rec.Agg	Water
NAC	387.42	747.12	1257.8	0	174.34
RCDA-5	387.42	747.12	1194.9	62.89	174.34
RCDA-10	387.42	747.12	1132.0	125.7	174.34
RCDA-15	387.42	747.12	1069.1	188.6	174.34
RCDA-20	387.42	747.12	1006.3	251.5	174.34
RCEA-5	387.42	709.76	1257.8	37.35	174.34
RCEA-10	387.42	672.41	1257.8	74.71	174.34
RCEA-15	387.42	635.06	1257.8	112.0	174.34
RCEA-20	387.42	597.70	1257.8	149.4	174.34

5. RESULTS AND DISCUSSIONS

5.1 Compressive strength

The concrete was mixed in high capacity tilting drum mixer. The minimum 15 specimens were cast for each type of recycled aggregate i.e. demolished and e-waste aggregate thereby making more than 30 specimens. Five sets of cubes were cast replacing fresh aggregate by coarse aggregate from demolished waste @ 0%, 5%, 10%, 15% and 20% by weight. 0% demolished waste means only fresh concrete has been used in both the mixes. All the specimens were re-moulded after 24 hours and cured by putting in water. Compressive strength of cubes has been determined using the compression testing machine.

% Replacement Recycled aggregate	Compressive Strength N/mm²	
	Concrete with Demolished Waste (28 DAYS)	Concrete with E-Waste (28 DAYS)
0%	31.23	31.35
5%	29.16	32.47
10%	28.00	34.23
15%	27.21	33.10
20%	25.85	29.56

Table-2: Compressive strength values

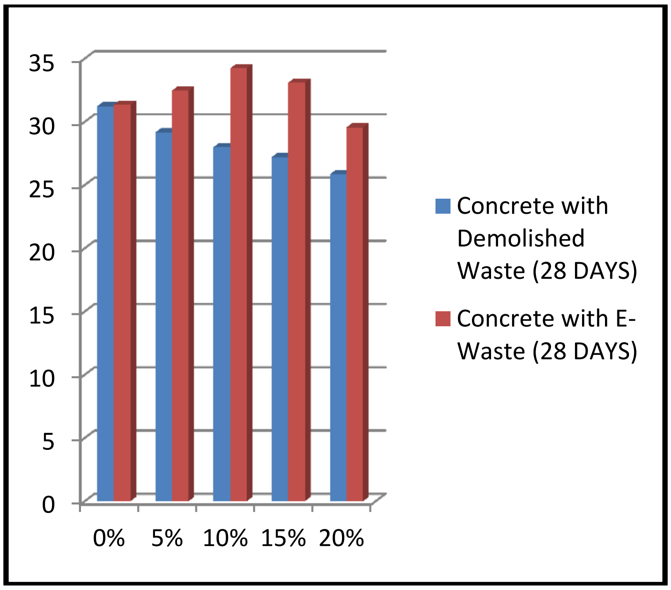

Fig-1: Graph between Demolished wastes vs. E-Waste

5.2 Split Tensile Strength:

The development of split tensile strength of concrete progresses in a manner similar to that of its compressive strength. However, it is possible that the interaction between the new cement paste and the adhered mortar of RCA may create improved bond strength, consequently leading to a lower probability of the presence of critical areas where failure can occur.

% Replacement Recycled aggregate	Split Tensile Strength N/mm²	
	Concrete with Demolished Waste (28 DAYS)	Concrete with E-Waste (28 DAYS)
0%	3.25	3.27
5%	3.22	3.93
10%	3.18	4.01
15%	3.11	3.45
20%	3.07	3.23

Table-3: Split Tensile strength Values

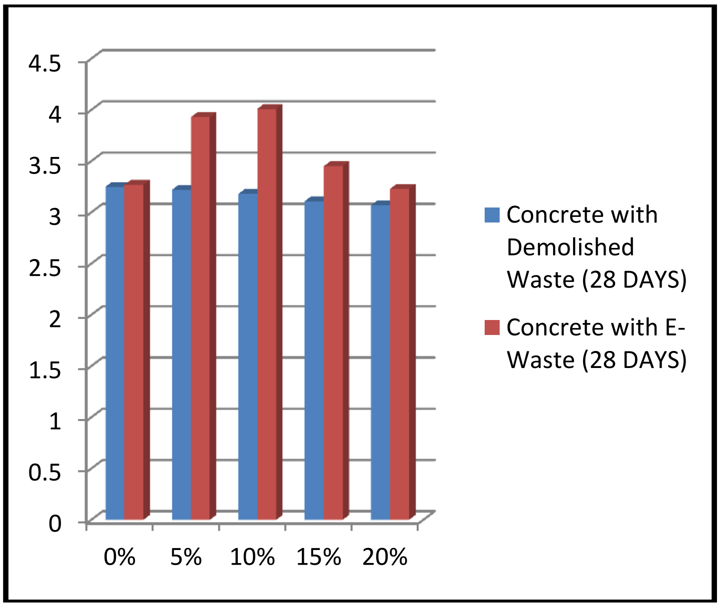

Fig-2: Graph between Demolished wastes vs. E-Waste

6. SUMMARY AND CONCLUSIONS

Demolished waste and E-waste are the main problem of country and from demolition of buildings. The aim of this work was to utilize the waste collected from demolition of buildings and E-waste collected and processed from electronics store. The following are the conclusions obtained after performing the above experiments

1) Increasing the recycled coarse aggregate percentage tends to decreases in the strength of concrete.
2) In printed circuit board chemical composition is silica 63.55% and copper 36.44%, due to this reason it can be seen an increases of compressive strength in concrete.
3) Concrete with PCB waste can be developed successfully with appropriate strength characteristics. The compressive strength increases with the increase in the percentage of pulverized PCB up to replacement (10%) of sand in concrete.
4) The maximum 28 days split tensile strength was obtained with 10% replacement of crushed PCB is greater than conventional concrete and the strength was obtained with replacement of demolished waste and demolished with admixture is near about same in conventional concrete.
5) The use of dismantled/ demolished aggregate in making fresh concrete will also help in reduction of solid waste dumping on existing landfill sites.
6) The reuse of dismantled concrete will help in improvement of overall environment of the region. Firstly by reduction in mining and secondly reduction in air pollution resulting from production of aggregates (dust pollution) and transportation of aggregate from mining to consumption point (vehicular pollution).
7) Thus, study shows that dismantled concrete is not solid waste but useful material to be recycled to prepare fresh concrete, which saves the cement and make the concrete economical.

ACKNOWLEDGEMENT

We are thankful to **Dr. Mohammed Masood,** Principal, ISLEC, for his encouragement throughout the project. We would also like to express our heartfelt thanks to **Ms. K. Nanchari,** Head of Civil Engineering Department, ISLEC for her help and unending cooperation with us during completion of this work.

REFERENCES

[1] Asif Husain and Majid Matouq Assas (2013), "Utilization of Demolished Concrete Waste for New Construction", World Academy of Science, Engineering and Technology, Vol.7, pp.531-536.
[2] A.N.Dabhade and Dr.S.R.Choudhari (2012), "Performance Evaluation of Recycled Aggregate Used in Concrete", International Journal of Engineering Research and Applications, IJERA, Vol.2 (4), pp.1387- 1391.
[3] Bashar Taha and Ghassan Nounu (2009), "Utilizing Waste Recycled Glass as Sand Replacement in Concrete", Journal of Materials in Civil Engineering, ASCE, Vol. 21(12), pp.709-721.
[4] B. Krishna Rao and R. Kamala (2012)"Reuse of Solid Waste from Building Demolition for the Replacement of Natural Aggregates", International Journal of Engineering and Advanced Technology, IJEAT, Vol.2 (1), pp.74-76.
[5] Claudio Javier Zega and Angel Antonio Di Maio (2011), "Recycled Concretes Made with Waste ReadyMix Concrete as Coarse Aggregate", Journal of Materials in Civil Engineering, ASCE, Vol. 23(3), pp.281-286.
[6] Christos G. Fakitsas (2012), "Effects of Recycled Concrete Aggregates on the Compressive and Shear Strength of High-Strength Self-Consolidating Concrete", Journal of Materials in Civil Engineering, ASCE, Vol. 24 (4), pp.356-361.
[7] Dr.S.S.Kulkarni and H.Pachpande (2012), "Strength Characteristics of Concrete with Recycled Aggregates and Artificial Sand", International Journal of Engineering Research and Applications, IJERA, Vol.2 (5), pp. 38-42.
[8] Gabriela Rajan and G. Murali (2012), "Experimental Study on Recycled Aggregate Concrete", International Journal of Engineering Research and Applications, IJERA, Vol.2 (2), pp. 407-410.
[9] Houari Hacene and Bourmattez Nadjoua (2013), "Waste and By-Products Recycled for Concrete", International Journal of Science & Technology Research, Vol.2 (6), pp.190-196.
[10]IS 10262 (2009), "Indian Standard Recommended Guidelines for Concrete Mix Design", Bureau of Indian Standard, New Delhi, India.
[11]IS 5816:1999 "Splitting tensile strength of concrete, Method of test" Bureau of Indian Standard, New Delhi, India.
[12]IS: 12269-1987 - 53 Grade Ordinary Portland cement (Reaffirmed 2004).

BIOGRAPHIES

Mir Firasath Ali, Assistant Professor, Department of Civil Engineering, ISLEC, Hyderabad, India

Mohammed Faiz Uddin, Student, Department of Civil Engineering, ISLEC, Hyderabad, India

Mohd Arsalan,
Student, Department of Civil Engineering, ISLEC, Hyderabad, India

M A Jaleel Farooqui,
Student, Department of Civil Engineering, ISLEC, Hyderabad, India