International Journal of Innovative Research in Computer Science & Technology (IJIRCST)
ISSN: 2347-5552, Volume-10, Issue-3, May 2022
https://doi.org/10.55524/ijircst.2022.10.3.51
Article ID IRP1199, Pages 312-316
www.ijircst.org

A Study on Utilization of Waste Materials and Eco-Friendly Construction Materials to Make Green Concrete

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ABSTRACT- Tyre is rubber member that provides cushion against the shocks and support load. Tyre is waste material which cause many environmental effects in all the parts of the world representing very serious threat to ecology. One of the possible solutions for the use of scrap tyre rubber is to incorporate it into concrete, to replace some of the natural aggregate. Waste rubber tyre is one of the significant environmental problems worldwide. The waste tyres rubber is not easily biodegradable even after long-period of landfill treatment. The land filing of waste tyre creates soil and water pollution, because the waste tyre rubber holds toxic and soluble components. Burning of tyres results in serious fire hazards and produce many harmful gases. Due to rapid increase in waste tyres many countries banned the disposal of waste rubber tyre in landfills. Hence, the civil engineering use the waste tyres in projects .Rubber tyre c are a waste material that is ideal for use in concrete applications. This has an additional advantage of saving in natural aggregates used in production of concrete which are becoming increasingly scarce. In this essence, our present study aims to use of waste rubber tyre as partial replacements of rubber (10,20,30%) with coarse aggregate. Ordinary Portland cement (OPC) and natural aggregates, which are the key constitutes of concrete, are suggested to recycled or substituted in order to address the sustainability concern. Here by product have been targeted to reduce carbon footprints.

Fly ash is a by-product at thermal power stations. An industrial by-product may be inferior to traditional materials used construction applications, but, the lower cost of these inferior materials make it an attractive alternative if adequate performance can be achieved. The use of fly ash is accepted worldwide due to saving in cement, consuming industrial waste and making durable or workable materials, especially due to improvement in the quality fly ash products.

KEYWORDS- Green Concrete, Flyash, Tyres, Recycled Coarse aggregate, Fine aggregate ,Cement and Software 2007.

I. INTRODUCTION

An estimated 1050 million tyres reach the end of their useful lives every year and 5060 millions more are expected to be discarded in a regular basis by the year 2030.As increasing tyres the land is filling with waste which will reduce the permeability of soil that will cause flood hazards. Tyre burning, which was the easiest and cheapest method of disposal, causes serious fire hazards. By the year 2030 the number of tyres from motor vehicles is expect to reach 1200 million representing almost 5000 millions tyres to be discarded in a regular basis. Tyre land filling is responsible for a serious ecological threat. Mainly waste tyres disposal areas contribute to the reduction of biodiversity also the tyres hold toxic and soluble components .Secondly although waste tyres are difficult to ignite this risk is always present. Once tyres start to burn down due to accidental causes high temperature take place and toxic fumes are generated beside high temperature causes tyre to melt, thus producing oil that will contaminate soil and water.

II. OBJECTIVES

- To reduce the use of cement and natural resource such as natural river sand, coarse aggregates that are used for making concrete.
- To study the effectiveness of concrete by partial replacement of cement by fly ash and coarse aggregate by waste tyre rubber.
- To determine the strength of new mix design concrete of grade M20.
- To determine the various test results like compressive test, flexural test etc.
- To reduce carbon dioxide emission from the cement industry.
- To find the alternative of basic materials which are used in construction from past many years.
- To reduce the wastage of concrete environmental pollution.

III. LITRATURE REVIEW

Ashok Admute et al. (April, 2017)[6] in this paper conventional concrete is responsible for amount of carbon-dioxide emission to some extent. So to reduce the emission, various types of concrete are developed using waste products from industrial and agricultural use like blast furnace slag, silica fume, fly ash which requires low amount of energy and also cause least harm to the environment. Silica fume is a material which may cause air pollution; this is the byproduct of some industries. Addition of micro silica in cement reduces the air pollution and makes concrete more sustainable; as well as the optimum replacement of cement with silica 5% to 15% leads to increase in strength whereas the 20% replacement leads to decrease in strength of concrete. Silica fume is finer than cement and more reactive to concrete ingredients so it increase the normal consistency of cement and achieves more strength in less time as compare to conventional concrete. By replacing the fine aggregates with demolished brick waste, there is no significant effect on any strength of concrete, but the overall cost of concrete reduces up to 20% so economically the concrete is more economical than conventional concrete.

Abdul Aziz Abdul Samad et al. (February, 2017)[7] this paper studies the past and present research on green concrete utilizing agricultural waste and construction waste. Agricultural waste such as palm oil fuel ash (POFA) and rice husk ash (RHA) together with recycled concrete aggregate (RCA) from construction waste will be used as part replacement of cement and aggregate respectively. The utilization of agricultural waste with pozzolanic properties and construction waste shows an enhancements in the compressive and tensile strength of concrete. Further addition of palm oil fibers as binders essential upgrades the concrete flexural strength and cracking properties. From observation of past and present research work, replacing cement by POFA and RHA by up to 20% and 10% strength enhances the concrete strength by up to 10%. Adding 0.1%-0.2% of POF have also been recorded to have improve its strength and cracking properties with 50% RCA shows an improvement to its concrete compressive strength but slight reduction in its flexural strength was observed.

Jing Yu et al. (March 18, 2018)[8] this study explores the possibility of using no less than 80% fly ash as binder material, to develop a kind of green concrete with ultrahigh-volume Indian fly ash and target characteristics compressive strength of 30mPa. By using a low water/binder ratio of 0.3and properly combining raw materials, even when 80% of the cement by replaced Indian fly ash, a type of UHVFA concrete with adequate strength and workability for structural use in Indian construction is developed. The compressive strength of concrete can reach over 20Moa at 28-day age under equivalent heat curing. This can be used in precast concrete industry. Compared with commercial grade 30 concrete, the developed green concrete shows a reduction of around 70% in CO_2 emission, a reduction of more than 60% in embodied energy and a reduction of about 35% in material cost. The future directions of research to help achieve 100% utilization of fly ash generated in India have been suggested.

Neeraj Agarwal (July 2018)[9] this paper the amount of concrete produced is so vast the absolute figures for the environmental impact are quite significant, due to the large amounts of cement and concrete produced. Since concrete is the second most consumed entity after water it accounts for around 5% of the world's total CO_2 emission. we can replace cement by glass up to 30% to 35%. we can replace cement by (glass + fly ash) up to 30% but not more than 45%. 28 days strength obtain from (glass + fly ash) is more than 28 days strength of glass replacement. On strength criteria by (glass + fly ash) replacement is better than by only glass-replacement. It reduces the CO_2 emission up to 35%.

Vishvanath kanthe et al. (July, 2018)[10] this research paper describes the study of combine effect of fly ash (FA) and rice husk ash (RHA) on properties of concrete as partial replacement of ordinary Portland cement (OPC). These by-products are having high pozzolanic reactivity. In this research, the composition of mix was used with 10% RHA along with 10,20 and 30% FA as partial replacement of cement. The SEM and EDX result shows the porous structures of RHA particle with higher content of silica. The pores absorbed the water at the time of mixing reducing the workability, this effect can be compensated by adding the spherical particles of FA to improves the workability. The residual plot falls in a straight line for 7 and 28 days strength result hence it may considered as given regression model is adequate for the optimized the experimental work. This type of ternary blend concrete can effectively utilize up to 30% the industrial and agricultural byproduct with reduced cost of 20.1% and an environmental problem.

IV. MATERIALS AND METHODS

A. Materials

The materials such as cement, fine aggregate, coarse aggregate, water, fly ash and rubber. The methodology adopted is also present in this paper.

B. Cement

Cement is most important properties of concrete and acts as binding material. Ordinary Portland cement is the one of the most widely used type of Portland cement. Ordinary Portland cement has initial setting time not less than 30 minute and final setting not less than 10 hours.

C. Water

Potable tap water available in the laboratory with pH value of 7.0 ±1 and confirming to the requirements of IS: 456-2000 was used for mixing concrete and curing the specimens as well.

D. Fly Ash

Fly ash was used in this experiment are obtained from thermal plant.

E. Tyres

One of the possible solutions for the use of scrap tyre rubber is to incorporate it into concrete, to replace some of the natural aggregate.20mm size used and Specific Gravity 1.15.

F. Tests

The tests performed to conduct the experiment are Workability test, Compressive Strength test, Split Tensile strength test and Flexure Strength test.

G. Workability Test

The workability test is performed to describe how easily fresh mixed concrete can be mixed. The workability test includes slump test, compaction factor test, Flow test and Vee-Bee test. Only the slump test is performed in this thesis.

H. Slump Test

The Slump Test was conducted as per Indian Standards. A Slump Test is used to determine the consistency of concrete. The consistency indicates how much water has been used in the mix. Slump is measured of concrete's workability or fluidity. It is an indirect measurement of concrete consistency.

Figure 1: Shows Detrermination of Slum Value

I. Compressive Strength Test

150 mm x 150 mm x 150 mm concrete cubes were tested as per IS 516-1959. all the specimens were tested in saturated surface dry condition,after wiping out the surface moisture. For each mix, six identical specimens were tested at the time of 3 days, 7 days and 28 days. The test was conducted in compression testing machine.The load was applied at the rate of 140kg/cm2/min until the failure of the specimen. The maximum load applied to the specimen until failure was recorded. The ultimate load to the cross sectional area of the specimen is equal to the ultimate compressive strength.
Calculation for compressive strength of concrete:

Compressive strength = load/area

= (P/A) (N/mm2)

Where
P = Applied load (N)
A = Area of the specimen (mm2)

J. Flexural Strength Test

Flexural Strength is the ability to resist an applied bending force. Concrete as we know is strong in compression and weak in tension. Flexural strength test was carried out at the age of 7 days and 28 days on the 100 mm x 100 mm x 500 mm specimen using Flexural Strength Testing Machine by subjecting the specimen to two point loading to determine the flexural strength as per IS: 516-1959.Flexural Strength test of concrete is the indirect test of tensile strength of concrete.

fb = FL/BD2

K. Split Tensile Strength Test

This is an indirect test to determine the tensile strength of Cylindrical specimens. Splitting tensile strength tests were carried out at the Age of 7 and 28 days for the concrete cylinder specimens of size 150 mm Diameter and 300 mm height in 1200 kN compression testing machine as per IS: 5816-1970.

T=2F/ πDL

V. MIX CALCULATION

Total volume of cement, fly ash, sand, coarse aggregate and waste tyre

Total weight of cement = **54.64 kg**

Total weight of fly ash = **13.6 kg**
Total weight of sand = **103 kg**
Total weight of coarse aggregate = **184.5 kg**
= **185 kg**
Total weight of waste tyre = **20.5 kg**
= **21 kg**

VI. RESULTS AND DISCUSSIONS GENERAL

The properties such as compressive Strength, split tensile strength and Flexural Strength and workability are presented in this paper. Sieve analysis of coarse aggregate and fine aggregate are also discussed below in this paper.

VII. COARSE AGGREGATE SIEVE ANALYSIS

A 20 mm nominal size of aggregate was used as a coarse aggregate that conformed to Indian standard specification given in BIS 383:1970.Table 1 shows the sieve analysis for 20 mm coarse aggregate. The total weight of sample is 10kg.

Table 1: Sieve analysis for 20 mm coarse aggregate

Sieve size (mm)	Weight retained (gm)	% retained	Cumulative % retained	% Passing	Limits as per BIS 383:1970
40	0	0	0	100	100
20	208	2.08	2.08	97.92	85-100
10	8904	89.04	91.12	8.88	0-20
4.75	820	8.2	99.32	0.68	0-5

FINE AGGREGATE SIEVE ANALYSIS

A 4.75 mm size of aggregates was used as a fine aggregate that conformed to Indian standard specification given in BIS 383:1970. The table 1 shows sieve analysis of 4.75 mm fine aggregate. The total weight of sample is 1kg.

Table 2: Sieve analysis of 4.75 mm fine aggregate

B	Weight retained (gm)	% Retained	Cumulative % Retained	% Passing	Limits for zone II as per BIS 383:1970
10 mm	0	0	0	100	100
4.75 mm	13	1.3	1.3	98.7	90-100
2.36 mm	1	0.1	1.4	98.6	75-100
1.18 mm	385	38.5	39.9	60.1	55-90
600 micron	169	16.9	56.8	43.2	35-59
300 micron	267	26.7	83.5	16.5	8-30
150 micron	120	12	95.5	4.5	0-10

A. Compressive Strength

The compressive strength results at the different ages such as 3 days, 7 days and 28 days, are presented in Table 3. The proportion of cement, fly ash and waste tyres as 80:20:10, 75:25:20 and 70:30:30. The proportion 70:30:30 shows reduction in compressive strength at 3 days, 7 day and 28 days, respectively over conventional concrete. The optimum cement fly ash and waste tyres proportion is 75:25:20 which yields high compressive strength at all ages when compared to conventional concrete having compressive strength at 3 days 7 days and 28 days are as 8.37, 14.34 and 20.24. The ratio 80:20:10 show reduction in compressive strength at 3 days and at 7 and 28 days it also gives higher strength. The table 3 shows the results of compressive strength at different days.

Table 3: Compressive Strength in water curing at 3 days, 14 days and 28 days

Age of testing	Proportion cement : Fly Ash : waste Tyre	Compressive strength (MPa)
Day 3	80:20:10	7.12
	75:25:20	7.32
	70:30:30	6.98
Day 7	80:20:10	17.18
	75:25:20	19.11
	70:30:30	11.13
Day 28	80:20:10	21.11
	75:25:20	23.18
	70:30:30	20.40

VIII. CONCLUSIONS

- Workability of concrete was increased as the percentage of fly ash increased by replacement of cement. However, workability of all concrete mixes up to 25% cement replacement was suitable in structural uses. Workability decreased as the percentage of waste tyres increase.
- Compressive strength of concrete was increased as increased fly ash and waste tyres by replacing the cement and coarse aggregate but up to 25% replacement was suitable for structural uses.
- The CO2 which may cause many respiratory problems to human health and global warming. As the experiment has done the CO2 was decreased up to 30% to decrease these problems up to 30%.
- The waste tyres which also causes many health hazards to human health by releasing harmful gases on burning and also reduces the permeability on soil as it is dumped on soil surface. As the experiment has done the waste tyres are reduced up to 30% to decrease these problems up to 30%.
- As we know concrete is strong in compression but weak in tension. The waste tyres contain iron on it which increases its tensile strength.
- The use of waste tyres in concrete is used in special circumstance, such as earthquake resistant structures, foundation for railways and machineries, noise reduction.
- The scrap value of concrete was zero now it is increased.
- The flexural strength of concrete was increased as fly ash and waste tyres by replacing the cement and coarse aggregate but up to 25% replacement was suitable for structural uses.
- In this concrete the recycling use of waste materials such as waste tyres, fly ash and waste aggregate were used. So increased concrete industry use of waste products by 25%. Hence green concrete consumes less energy and become economical.

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