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Utilization of Green Concrete in Building Construction for Better Sustainable Environment

Tabish Anwar, Ahsan Rabbani*
Department of Civil Engineering, Kalinga University, Raipur (C.G)
**E-mail: rabbani.ahsan@gmail.com*

ABSTRACT: Green Concrete is a concept of thinking about the environment into concrete considering every aspect from the manufacture of raw materials to structural design, and service life. The raw materials of concrete consist of cement, sand and crushed aggregates. Partial or 100% replacement of these raw materials by waste products may decrease the cost, and reduce the environmental pollution. It observed that 0.9 tons of CO_2 produced per ton of cement production. Thus, by the use of green concrete, it is possible to reduce the CO_2 emission in atmosphere towards eco-friendly construction. "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs is known as sustainable development". The paper gives various ideas about how to choose a material to obtain green concrete. In this research work, the focus is the utilization of waste materials like fly ash, rubber tyre, and recycled concrete as a replacement for cement, sand, and aggregate. The rubber tyres first chopped into small particles and after that mix it with fly ash and sand mix. As a binding material, some amount of potassium permanganate used, which gives high strength and durability to the concrete.

Keywords: Cleaner technologies; eco-friendly concrete; efficient concrete; fly ash; green concrete

INTRODUCTION

Concrete is the most used man-made product in the world. Concrete is a major contributor to greenhouse gas emission problem for the disposal of waste concrete from demolished sites which in turn effects the environment. Green concrete has nothing to do with color. It is concept of using eco-friendly materials in concrete, to make the system more sustainable. Green concrete is often and also cheap to product, because for example, waste products are used as a partial substitute for cement, sand and aggregate. Today the word green is not just limited to color; it represents the environment, which is surrounding us. Green concrete is a term given a concrete that has had extra steps taken in the mix design and placement to insure a sustainable structure and a long life cycle with a low maintenance surface e.g. Energy saving, CO_2 emission, waste water. About 0.9 ton of carbon dioxide is produced for every 1 ton of cement produced. Carbon dioxide is one of the greenhouse gases which are responsible for global warming. Major ingredient in the production of concrete aggregate without aggregate it is impossible to produce concrete. Aggregate are mined from the rock mines and the rate with which concrete is produced there will be significant reduction in naturally occurring materials. The traditional ingredient is replace by waste ingredient by using fly ash, tyre rubber and recycled concrete in place of cement, sand and coarse aggregate. Concept of green concrete shown in figure 1.

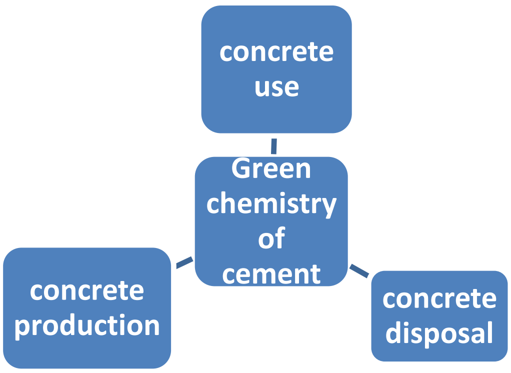

Figure 1 concept of green concrete.

Litrature Review

Anita Bhatia et al. 2016 worked on green concrete in which they concluded that green concrete is very low energy and resource consumption, no environmental pollution and sustainable development. The waste material as an alternative we can help to reduce the environmental problems and protect the naturally available materials for the future generation.

Dhiraj Kumar Tiwari et al. 2015 studies about the green concrete and concluded that green concrete capable for sustainable development is characterized by application of industrial wastes to reduce consumption of natural resources and energy and pollution of environment. Green concrete has the good thermal and fire resistance.

By the year 2030 the number of tires from motor vehicles is expect to reach 1200 million representing almost 5000 million tires to be discarded in a regular

Table 1 physical properties of tire rubber

Compound component	**Tyre rubber (% by weight)**	**Tyre rubber and regenerated crump rubber (% by weight)**
Regenerated crump rubber (including 2% of sulphur)	0	15
Tyre rubber based compound comprising		
Tyre rubber	47.3	40.2
Oil/plasticizer	10.4	8.8
Carbon black	35.4	30.1
Zinc oxide	1.4	1.2
Stearic acid	0.5	0.4
Antidegradants	1.4	1.2
Process acids (struktol^R)	1.9	1.6
Curatives	1.7	1.4
Sub total	100	85
Total	**100**	**100**

basis. Tire landfilling is responsible for a serious ecological threat. Mainly waste tires disposal areas contribute to the reduction of biodiversity also the tires hold toxic and soluble components (B.S. Thomas, 2015).
The analytical results have shown the same trend for compressive strength and flexural tensile strength as obtained in the laboratory. It can be concluded that the rubberized concrete is highly resistant to the aggressive environments and can be implemented in the areas where there are chances of acid attack (Yilmaz and Degirmenci, 2009).
The processed used tires are typically subjected to two stages of magnetic separation and screening. Various size fractions of rubber are recovered in more complex procedures. In micro-milling process, the particles made are in the range of 0.075–0.475 mm (Thomas Blessen Skariah, 2015).

MATERIAL AND METHODS

Various materials used in this research are crushed tyre rubber powder, Fly ash, recycled concrete and Cement.

Tyre rubber powder

A lot of waste is generated from automobiles and one of these is tyres. The powder of crushed waste tyres can be used as a substitute of raw material in the concrete, used tyres are also available in large quantities and are extremely cheap for the production of rubber powder. Table 1 shows the physical properties of tyre rubber used in this research work. Figure 2 shows the crushed waste tyre rubber powder.

Figure 2 Tyre rubber powder

Fly ash

Fly ash is a promising green concrete solution being heralded for sustainability is high volume fly ash cement. It is a byproduct of coal combustion from coal burning power plants, and in the past, almost 75% of fly ash product made its way to landfills. A replacement of 20% of the ordinary Portland cement by fly ash results in concrete with high sulfate resistance. Fly ash, when mixed with $Ca(OH)_2$ a constituent of cement and water, forms a compound similar to Portland cement and is extremely strong and durable. Table 2 shows chemical composition of fly ash and cement used in this research work. Table 3 shows physical properties of fly ash and cement.

Table 2 chemical compositions of fly ash and cement

Chemical composition (%)	fly ash	Cement
SIO_2	56.86	20.87
Al_2O_3	23.51	4.35
Fe_2O_3	4.39	3.93
CaO	0.83	60.20
MgO	0.60	2.74
Na_2O	0.39	0.08
K_2O	1.40	0.23
Loss of Ignition (LOI)	1.68	2.19
SO_2	--	2.71

Table 3 Physical properties of fly ash and cement

Physical properties	Fly ash	Cement
Density (gm/cm^3)	2.26	3.14
Particle size (µm)	32.50	14.73
Blain fineness(m^2/kg)	--	501.8

Figure 3 Cement and Fly ash

Table 4 Physical properties of coarse and fine aggregate

Physical property	RCA	NCA	FA
Nominal maximum size(mm)	20	20	5
Water Absorption (%)	2.03	0.60	1.32
Bulk density in compacted condition (kg/m^3)	1250	1510	1620
Fineness modulus	6.79	6.76	2.88
Aggregate impact value (%)	12.7	10.0	--
Specific gravity	2.48	2.53	2.69
Moisture content (%)	1.57	0.17	0.31

Mix proportioning

Type I ordinary Portland cement of 53 grades. Natural siliceous river sand, which was locally available for construction activities. Coarse aggregate used was crushed granite stone with the size ranging between 12.5mm and 20mm. Water used for mixing and curing of concrete was ordinary potable water and mixture which is light brown in colour with the pH of six**.**

Compressive Strength Test

The compressive strength of normal, mixture of fly ash and tyre rubber powder casted and was tested using compression testing machine. To evaluate the mechanical strength characteristics of concrete reinforced with tyre rubber powder, detailed experimental investigation was carried out. Totally 10 cube specimens of size 150× 150× 150 mm with 3 mixes were casted and tested.

Flexural Strength Test

The test was carried out confirming to IS 516 – 1959 to obtain flexural strength of concrete at the age of 14 and 28 days. The flexural strength of concrete is determined by the beam testing, for this standard size of 150*150*700 mm.

RESULTS AND DISCUSSION

From Table 5 it was found that with the addition of rubber tyre powder in concrete compressive strength increases and from Table 6 it was found that with the increase in weight fraction of rubber powder in the concrete flexural strength first increases upto 20% then it decreases.

Table 5 Comparative Strengths of concrete in N/mm^2 at different days

Compressive Strength Mix	7 Days (N/mm^2)	14 Days (N/mm^2)	28 Days (N/mm^2)
Mix A (Plain concrete)	12.2	18.1	24.8
Mix B (Fly ash concrete)	11.7	16.6	24.1
Mix C (TRP+fly ash concrete)	12.8	18.4	25.4

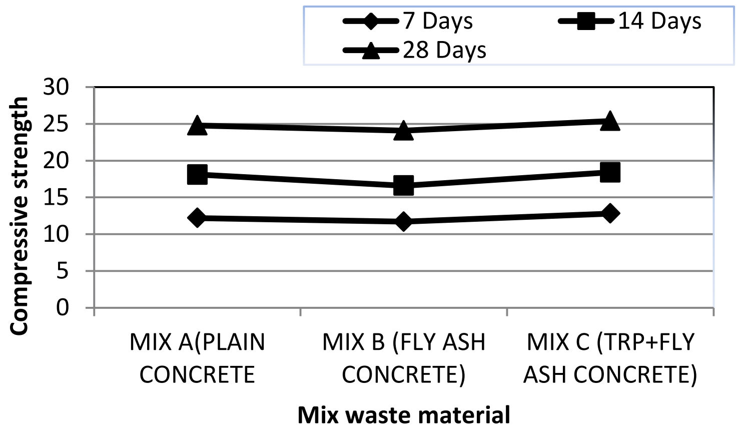

Figure 4 Compressive strength of waste material

Table 6 Flexural strength of concrete

Tyre rubber powder (%)	Recycled concrete (%)	Fly ash (%)	Flexural strength	
			14 Days	28 Days
0%	0%	0%	4.68	5.96
10%	50%	10%	4.93	6.21
20%	50%	20%	4.98	6.40
50%	50%	50%	4.59	5.70
100%	50%	50%	4.37	5.56

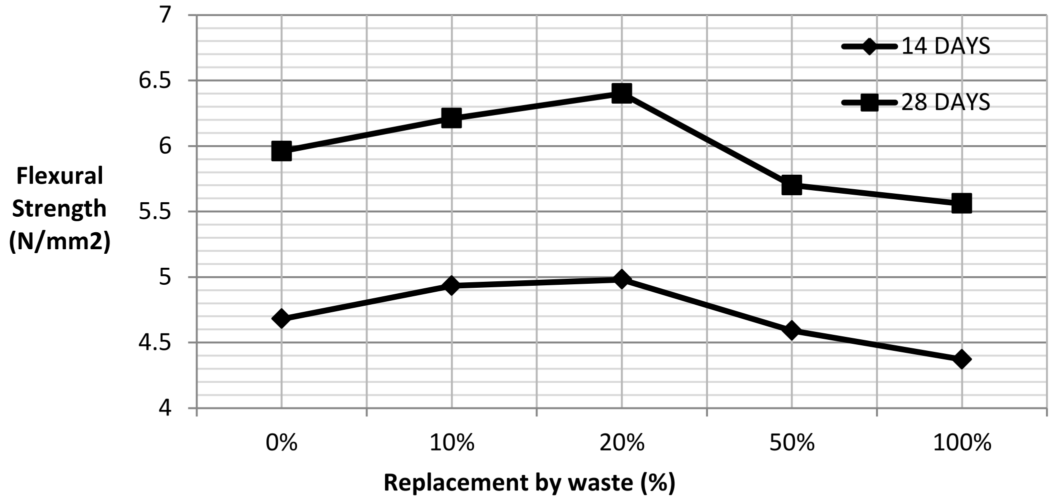

Figure 5 flexural strength of waste material

CONCLUSIONS

This experimental investigation revealed the potential utilization of tyre rubber powder as fine aggregate that can promote it as eco-friendly green concrete since the use of natural river sand is minimized. Tire rubber powder inclusions in amount of 1.0%, and 2% increase the compressive strength of concrete. Quantity of sand can be reduced by 0.5% for every 10% of fly ash used. The importance of curing method for quality assessment and predicting later age compressive strength is highlighted regardless of the material used in the concrete that will help the designer to improve the design of construction.

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