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CHARACTERIZATION OF BIO-PLASTIC CHAR PYROLYSIS IN CEMENT CONCRETE

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Abstract:
The paper deals with the development of low carbon and sustainable biochar enhanced concrete materials. Recently, carbonised biomass known as biochar with combination of plastic pyrolysis has been found to be an effective partial replacement for cement.Various studies have reported improved mechanical strength and thermal properties with the inclusion of plasticbiochar in concrete. The disposal of plastic waste in environment is considered to be a serious problem due to its low biodegradability and presence in large quantities. The Polyester plastic waste material is added for concrete mixtures. The solution of Polyester was based on its increased strength, hardness and resistance to high temperatures compared with other plastics. It is partial replacement of cement by volume in concrete with percentage ranging from 1%, 3% and 5% of M30 Concrete.

Keywords: Plastic Char, Biochar, Rice-straw, Polyester Compressive strength.

1. INTRODUCTION:

Concrete is the mostly used material in the world for construction. Developing of countries, there is a huge demand for the concrete. Since 6500 BC, the concrete structures were developed and over a period, this material went through a lot of changes. In the 19th century, the concrete was used mainly for industrial buildings. By increasing the demand of concrete, the new more methods were developed. Concrete causes damages to the top soil of the earth. Concrete is the mixture of cement, aggregates and water, additionally chemical mixtures are added if requires. The worldwide demand for new concrete building is increasing at a rapid pace to keep up with urban development. Recycling plastics is a possible option but burning plastic releases toxic substance for solving the disposal of large amount of plastic materials. It can be used to new plastic waste products after processing. The utilization of waste HDPE in concrete is a partial solution for environmental problem. Polyester It has stronger material properties, harder, opaque and more resistant to high temperatures. Polyester is used In a wide variety of applications, including plastic bottles, milk jugs, shampoo bottles, bleach bottles, cutting boards and piping. Polyester plastic has a high-impact resistance and melting point.
Cement is the most important ingredient in concrete. Cement comprises about 10 to 15% of concrete mix by volume. But producing of more cement, the carbon dioxide are. Cement industry is the one of the main producer of carbon dioxide and creates more impact on environment. Many developing countries are trying to develop substitutes for cement by easily available materials such as rice straw, rice husk ash, food waste, plastic waste, fly ash etc., have been found to be partial substitutes for cement.

2. MATERIALS USED:

1. Cement
2. Aggregate
3. Water

4. Bio-plastic char

1) *Cement:*
It is a binding material is used for construction. Cement binds other materials together fastly. Cement is seldom used on its own, but rather to bind fine aggregate and coarse aggregate together. In construction of the structures OPC and PPC cements are used.

2) *Fine aggregate*:
Fine aggregates are sand which is made by erosion or broken pebbles and weathering of rocks which is transported from land or seas or rivers or any other marine environment. Sand ranging in size from 0.06mm to 2mm.

3) Coarse aggregate:
Coarse aggregates are the granular materials and irregular which is gravel, crushed stone and used for preparing concrete. These aggregates are naturally occurred and obtained by blasting quarries or crushing them by hand or crushers. These coarse aggregates are particulates that are greater than 4.75mm. Ranging in size is between 9.5mm and 37.5mm in diameter.

4) Water:
Water is the key component which is used to form as a paste when mixed with cement that binds the aggregate together. Water is used because it causes the hardening of concrete through a process called hydration. The amount of water in concrete controls many fresh and hardened properties of concrete including workability, compressive strength, permeability, durability and weathering for cracking. Water cement ratio of the weight of water to the weight of cement used in a concrete mix. Water cement ratio that is used is 0.4 to 0.6.

5) Bio-plastic char:
Bio-plastic char is the combination of rice straw and plastic waste (thermocol). Rice straw is the byproduct of the rice paddy milling industry, but the straw makes up about the same (by weight) of the harvested and dried rice paddy. As well as, thermocol is using as a plastic waste. Thermoplastic polymer of styrene can be molded into objects. It is made with leaky proof property and temperature variations.

3. METHODOLOGY:

- The collected rice straw is taken in a tray and spreaded throughout the tray.
- To allow them expel the moisture content quickly.
- After filling the tray, keep it in hot air oven at a temperature of 100^0C to 300^0C for 24 hours.
- This helps to remove the moisture that is present in the rice straw.
- Take the dried sample is taken into a tray and cut it into small pieces.
- As well as, take the polyester plastic (thermocol) into a tray an separate into single pieces such that it fits into crucibles.
- Take the dry rice straw and thermocol into a tray in the proportion of 95% of rice straw and 5% of thermocol.

- Then the pieces of rice straw and thermocol are placed in the crucibles and kept it in a muffle furnace at a temperature of 420^0C to 500^0C for about 30 minutes.
- Muffle furnace is used in the experiment because the preparation of bio-plastic char should be in the absence of oxygen.
- The process of thermal decomposition of materials in an inert atmosphere is called pyrolysis. It is also called thermo chemical process.
- During pyrolysis process, the dry rice-straw and plastic gets convert into a black powder called "Bio-plastic char".
- Repeat the process until required amount of bio-plastic char is obtained.
- Now, replace the bio-plastic char with cement partially in a structural member to determine the compressive strength.

Tests on cement:

1. *Specific gravity of cement:*
    - Clean the flask and dry it. Now, weigh the empty flask with stopper which is considered as W_1.
    - Next, fill the cement half of the flask and weigh it W_2.
    - Add water to the cement to the top of the flask. Mix well to remove the air bubbles and weigh it, W_3.
    - Empty the flask. Now, fill the flask with water completely and weigh it with stopper and it is W_4.

$$\text{Specific gravity of cement} = \frac{w_2 - w_1}{(w_2 - w_1) - (w_3 - w_4)}$$

2. *Fineness of cement:*
    - Take 100gm of cement into the empty pan. And weighed as W_1.
    - The cement sample should be free from lumps.
    - Place the sample of cement into the 90µ IS sieve and close it with a lid.
    - Continuously shake the sieve gently in all directions for 15 minutes.
    - Now, note down the weight of the retained cement sample and weighed as W_2.

$$\%\text{ weight of the residue} = \frac{Weight\ of\ the\ sample}{Total\ weight\ of\ the\ sample}$$

Tests on Fine aggregates :

1. *Specific gravity of fine aggregate:*
    - Clean the pycnometer and dry it. Now, empty weight of the pycnometer is determined as W_1.
    - Fill the pycnometer with sand of 1000g of clean sample and it is weighed as W_2.
    - Now, add water into the pycnometer which is already filled with sand. And weighed it as W_3.
    - Now, the sample is discharged and cleaned it. Completely fill with water and weigh it. It is determined as W_4.

$$\text{Specific gravity of fine aggregate} = \frac{w_2 - w_1}{(w_2 - w_1) - (w_3 - w_4)}$$

2. *Bulking of sand:*
    - Take the sample of sand and fill into the measuring cylinder pf 200ml.

- Don't compact the sand, make the necessary by using the steel rod.
- Place the sample into the container.
- Fill the measuring cylinder with 100ml water.
- And pour the sand into the measuring cylinder. Stir it with the help of steel rod.
- Allow it to settle sometime.
- The sand will be the below 200ml. now, note down the value, X.
- Repeat the same procedure for 2 more samples.

$$\text{Bulking of sand} = \frac{200-X}{X} * 100\%$$

3. Fineness modulus of fine aggregate:

- Take all the IS sieves and arrange them in descending order.
- Take 1kg of sand into a tray and break the lumps.
- Pour the sample at the top of the sieve and shake the sieves continuously for 10 to 15 minutes.
- Now, take the weight of the retained sample into the IS sieves.

4. COMPRESSIVE STRENGTH

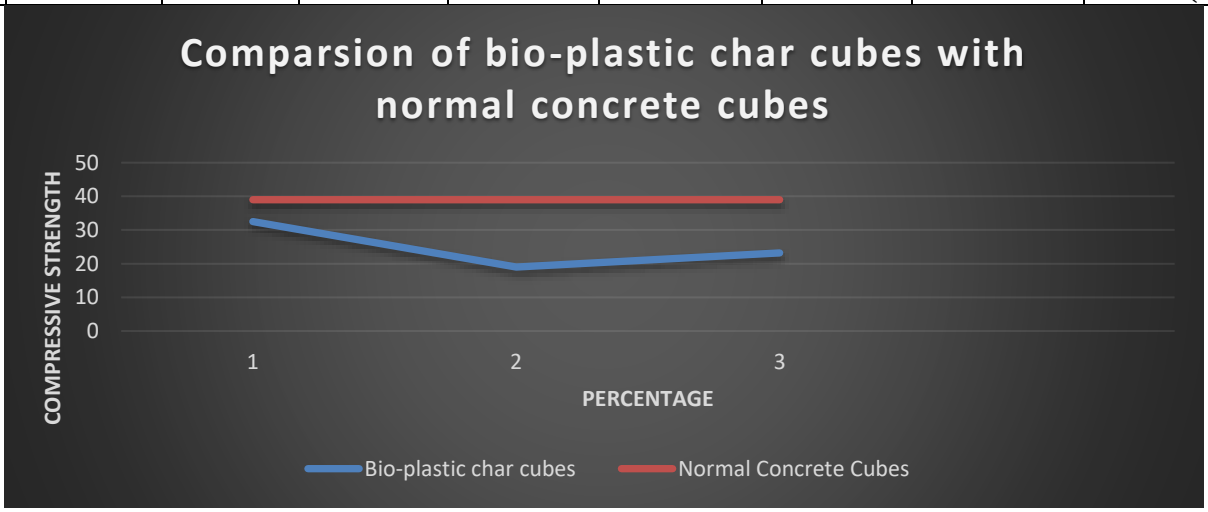
Compressive strength is the ability of material or structure to carry the loads on its surface without any crack or deflection. A material under compression tends to reduce the size, while in tension, size elongates. The compressive strength of the concrete cube test provides an idea about all the characteristics of concrete. Compressive strength of concrete depends on many factors such as water-cement ratio, cement strength, quality of concrete material, quality control during the production of concrete, etc. Test for compressive strength is carried out either on a cube or cylinder. Various standard codes recommend a concrete cylinder or concrete cube as the standard specimen for the test. American Society for Testing Materials ASTM C39/C39M provides Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens. Remove the specimen from the curing tank and dry it under the sun for a day. Place the specimen under the machine that the load shall be applied to the opposite sides of cube cast. Align the specimen centrally on the base plate of the machine. Rotate the movable portion gently by so that it touches the top surface of the specimen. Apply the load gradually without shock and continuously @ 140kg/cm^2/minute till the specimen gets crack or fails. Record the maximum compressive load obtained for the load applied.

5. RESULTS:

Sample 1:

M30 CEMENT CONCRETE CUBES WITH PLASTIC CHAR								
MIX RATIO	% PLASTIC CHAR USED	GRAMS	MOULD PLACED	OPENED	PLACING IN CURING TANK	FOR 28 DAYS		
						OPENED	CRUSHED	STRENGTH (N/mm2)
1:0.75:1.5	1	25	08-09-2022	09-09-2022	09-09-2022	07-10-2022	11-10-2022	34.5
1:0.75:1.5	3	75	13-09-2022	14-09-2022	14-09-2022	12-10-2022	17-10-2022	19 (Fail)

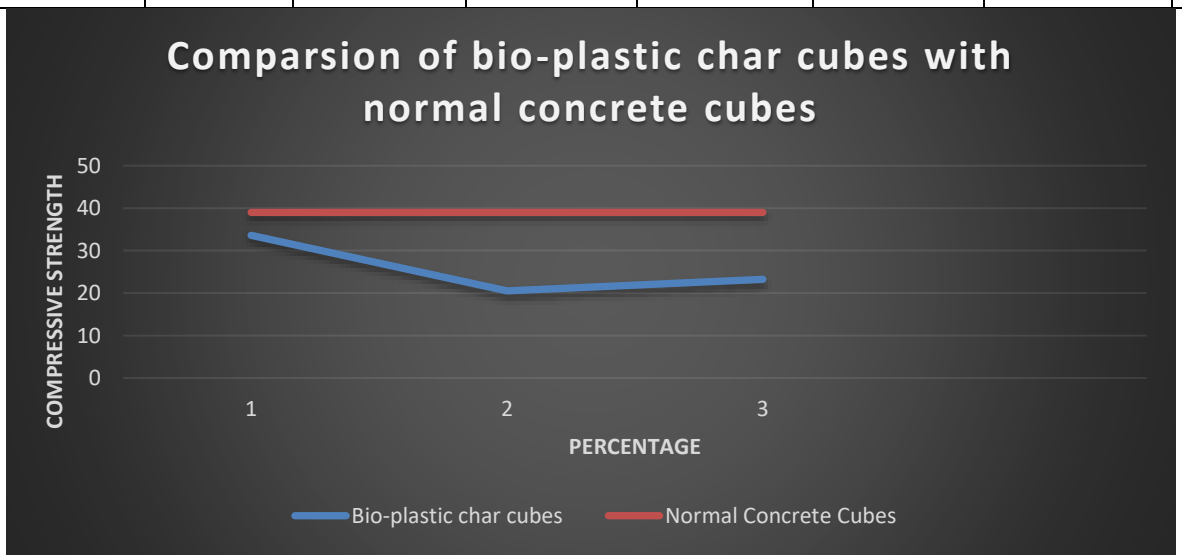
1:0.75:1.5	5	125	25-09-2022	26-09-2022	26-09-2022	25-10-2022	26-10-2022	23.24 (fail)



Graph for Sample 1

Sample 2:

M30 CEMENT CONCRETE CUBES WITH PLASTIC CHAR								
MIX RATIO	**% PLASTIC CHAR USED**	**GRAMS**	**MOULD PLACED**	**OPENED**	**PLACING IN CURING TANK**	**FOR 28 DAYS**		
						OPENED	**CRUSHED**	**STRENGTH (N/mm2)**
1:0.75:1.5	1	25	17-10-2022	18-10-2022	18-10-2022	15-11-2022	16-11-2022	33.6
1:0.75:1.5	3	75	18-10-2022	20-10-2022	20-10-2022	17-11-2022	18-11-2022	20.52(Fail)
1:0.75:1.5	5	125	18-10-2022	20-10-2022	20-10-2022	17-11-2022	18-11-2022	23.29(Fail)



Graph for Sample 2

6. CONCLUSION

Bio-plastic char pyrolsis done by the combination of rice straw and plastic to shows the strength. The maximum use of plastic char in cement concrete cubes is at 1% of its weight, then by adding more than 1% of plastic char in cement concrete cubes it loses it original characteristic strength . The characteristic compressive strength of cement concrete cubes(150mmX150mmX150mm) with some % replacement of plastic char of its weight. The cement concrete cubes with 1% replacement of plastic char with its weight(30gm) help to achieve it maximum characteristic compressive strength, if we add more than 1% plastic char in cement concrete, the concrete cube loses its original strength.

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