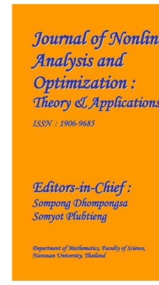
Journal of **N**onlinear **A**nalysis and **O**ptimization
Vol. 15, Issue. 1, No.10 : 2024
ISSN :**1906-9685**



ENVIRONMENTAL APPLICATION OF BIOCHAR FROM RICE STRAW AND PLASTIC COMPOSITE AS A PARTIAL REPLACEMENT OF CEMENT IN CONCRETE

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Abstract:
Biochar is a fine powder obtained from dried rice straw and single-use plastic. In today`s construction, the use of biochar has proven to be the most economical. The combination of rice straw and plastic biochar was found to act as reinforcement for the mortar slurry, resulting in higher ductility than the control at flexural failure. Biochar is a high-carbon solid produced by the pyrolysis of organic biomass in an oxygen-poor environment. Rice straw is produced as a byproduct during rice harvesting. Approximately 800 million to 1 billion tons of rice straw is produced annually around the world, of which approximately 600 million to 800 million tons are produced annually in Asia.2 billion tons of single-use plastic waste is generated worldwide each year. To alleviate these problems, the combination of rice straw and plastic biochar was partially replaced with cement to meet the strength requirements higher than the conventional mortar and to benefit economically and ecologically.
Keyords:*Rice-straw, Single use plastic, Biochar, Biochar mortar cubes, Compressive strength*

1. INTRODUCTION

- Due to the rapid growth in demand in the new construction sector, the cement manufacturing process has become a very serious problem as it has a significant impact on CO2 emissions into the atmosphere. Despite the environmental concerns associated with cement production, cement-based materials are used in modern building construction due to their cost-effectiveness compared to advanced counterparts such as alkali-activated materials and other conventional alternatives. Is still preferred. The quickest way to reduce carbon emissions in construction is to replace cement with additives, especially those derived from waste sources. The use of biochar as a filler and partial cement replacement in cementitious materials has been extensively studied in the literature. The mechanical and physical properties of cement composites have been shown to change with the addition of biochar as a filler. The addition of biochar could lead to an improvement in the initial strength of mortar, regardless of the water-cement ratio. Many researchers have observed that the use of pozzolanic materials increases the compressive strength of mortar. The increase in compressive strength can be attributed to the decrease in water content, filler effect, and increase in pozzolanic reaction. The fineness of the pozzolan makes the pozzolan reaction stronger, and the small particles can also fill the voids in the mortar mixture, increasing the compressive strength of the mortar.[1,2,3,4] Many developing countries are trying to develop alternatives to cement from locally available raw materials, such as agricultural and industrial waste and coconut shell ash. For example: Materials such as rice husk ash (RHA), fly ash (FA) have proven to be economical as partial replacements for cement. These materials can be used as a cement replacement with a content up to 40%. Rice straw ash is pozzolanic and meets the minimum requirements of ASTM Classes N, F, and C for pozzolans, making it suitable for use as a replacement for Portland cement. [5,6]The compressive strength of RSA cement motors was found to be slightly higher than that of ordinary Portland cement (OPC) cement motors.[7] This study is an experiment to evaluate the strength of cement mortar by partially replacing treated rice straw and disposable plastic biochar in cement at doses of 1%, 3%, 5%, and 7%.

2. MATERIALSUSED

A. *Cement*

Cement is generally a binder in general, but in a narrower sense it also includes adhesives used in architecture and civil construction. This cement is a finely ground powder that hardens into a hard mass when mixed with water. [8,9,10]Hardening and hardening occur due to hydration, the chemical bonding of cementitious compounds with water, resulting in the creation of microscopic crystals or gel-like substances with large surface areas. Construction cement that set and harden in water due to their moisturizing properties are often called hydraulic cement. The most important of these is Portland cement.

B. *Rice-straw and plastic Ash*

Rice straws and single-use plastics are residual waste.[11,12] Rice straw and plastic ash refers to the residue leftafter pyrolyzing rice straw and plastic at a ratio of 20:80.

C. *Fineaggregate*

Sand is usually used as a fine aggregate. [13,14,15,16] The size of the sand varies from 70 microns to 4.75 mm, and the most common mineral found in the sand is quartz (also known as silicon dioxide), which makes it highly weather resistant. It is produced by the combination of silicon and oxygen. Feldspar is the most abundant mineral group on the Earth's surface, making up approximately 65% of Earth's rocks. When wind and sea blow up on the coast, these tiny particles are carried onto the beach, where the combination forms sand. [17]Sand is a non-renewable resource that will never exist again. It is available from a variety of sources, including desert sand, river sand, sea sand, beach sand, volcanic sand, and olivine sand, and comes in a variety of colors, including white, black, red-orange, white-gray, and light brown., The sand used in construction must be inert and not react with other ingredients, since sea sand is not used in concrete, but mainly river sand and sea sand. [18]Sand also mixes concrete evenly, fills the gaps between concrete, and increases the strength of concrete. Using sand in concrete prevents shrinkage, improves the structure, and provides a smooth surface. [19]Construction costs are reduced due to increased concrete volume. Sand reduces the porosity of concrete. This reduces the amount of voids and reduces the occurrence of cracks. [20]Sand increases the permeability of the concrete, helping gases and heat to escape evenly from the concrete without pressure buildup, thereby reducing the tendency of the concrete to crack.

3. MIX CALCULATION

- **Quantity of Mortar:**

Volume of mortar= 1 m^3
Mix Ratio –1:3

Dry volume of mortar = Wet volume x 1.33

Dry Volume = 1.0 m^3x 1.33 = 1.33 m^3

- **Quantity of cement:-**

Quantity of Cement = (Dry Volume of mortar x Cement ratio) / (Sum of the ratio)

Quantity of cement = (1.33 x 1) /(1+3)=0.3325 m^3

Density of Cement = 1440 kg/m^3

Weight of Cement = 1440 x 0.3325 = 478.8Kg

- **Quantity of Sand:-**

Cement: Sand:: 1:3

Quantity of Sand = Quantity of Cement x 3

Quantity of Sand = 0.3325 m^3 x 3= 0.9975 m^3

1 m^3=35.3147 Cubic Feet (CFT)

Quantity of sand = 0.9975 x 35.3147 = 35.226 CFT

Density of sand = 1920 kg/m^3

Weight of the sand= 0.9975 m^3 x 1920 kg/m^3 = 1915.2 kg =>1.9152 tonnes

- **Quantity of water:-**

Water cement ratio = weight of water/weight of cement

W/C—>0.50

weight of water = (weight of cement)x(w/c ratio)

Weight of water = 478.8 kg x 0.5 =239.4 kg (Litre)

- **Weight of ingredients**

Volume of cube = length*breadth*height

= 0.075*0.075*0.075

= 0.00042 m3

Weight of cement = 0.00042*478.8

= 0.2kg

= 200 gm

Weight of fine aggregate = 0.00042*1915.2

= 0.8 kg

= 800gm

4. METHODOLOGY

A. *Materialsand grade of mix*

- Forthismixrequiredmaterials[21]aredryrice straw,Single-use plastic,a Combination of Rice Straw and plastic Biochar,cement,and fineaggregates.
- Selecttheappropriatemix ratioand[22]calculatetheproportioningofmaterialsintheformof ratios.
- In this 1:3 mix ratio should be taken and [23] it is mentionedintheabovecalculations.

B. *Measuringofmaterials*

- Calculate[24] therequired quantityofmaterials forthecubes asperdesign mixratio. Nextmeasure [25]the materialsquantityandcastthecubesaccordingly.

C. *Preparingthe concrete*

- First,take [26]the requiredamount of thematerials asperthedesign mix.
- Castthe[27]biocharcubes of size75mmx75mmx75mm in 1%,3%, 5%and7%.
- Dry[28,29,30] them for 24 hours and then remove the molds. Place the cubes in water forcuring.
- Testthecubesfor3days, 7 days,and 28daystoobtainthe results.

D. *Mixingofconcrete*

1) Drymix:-

- First dry mixing should be done by placing and mixing all the ingredients withoutpouringwater.
- Drymixmakes theingredientsuniform.

2) Wet mix:-

- Afterdrymixingplacethewaterasperthew/cratioandmixtheingredientswithin5 minutesof pouringthe water.
- Fastmixingmakesgoodstrengthand[31] takinga longtimeto mix reduces the slump also.

E. Placingofconcrete

- Then place the concrete in the molds of which were previously prepared within30 minutesofmixingand [32]fix the mould stightly to avoid the leakage of water be foreplacingof concrete.
- Delay in placing makes the concrete harden and reduces the properties of concretelikeworkability, strength,durability, resistancetoweather etc.,

F. Compactionandfinishing

- Compaction should be done to makes the mix dense, to avoid pores and goodcompaction improves the strength of concrete, it should be done with machinecompaction.
- For smooth finishing of the surface, [33,34]finishing should be done by using trowels andremovingaccess concreteto makean even surface.

G. Demouldingandcuring

- After24hrs demouldthe mouldsand removethe cubes.
- Then curing takes place, [35] here curing should be done by placing the cubes in thewaterand maketheburlaps wetduringcuringperiod of 3 days ,7days and 28 days.
- Proper curing should be maintained throughout the entire time because propercuring leads to increase in strength, [36] reduces shrinkage cracks and improves goodhydrationprocess.
-

5.EXPERIMENTATION

A. Compressiontest

Compression strength test is used to measure the force required to compress thematerial. [37] Compression tests are conducted by loading the test specimen between two plates, and thenapplying a force to the specimen by moving the crossheads together.[38] During the test, the specimen iscompressed, and deformation versus the applied load is recorded.[39] It is one of the most importantpropertiesofconcrete and mortar.

B. Apparatus

- Specimen(concretecube),
- CTM(Compressiontestingmachine)

C. Procedure

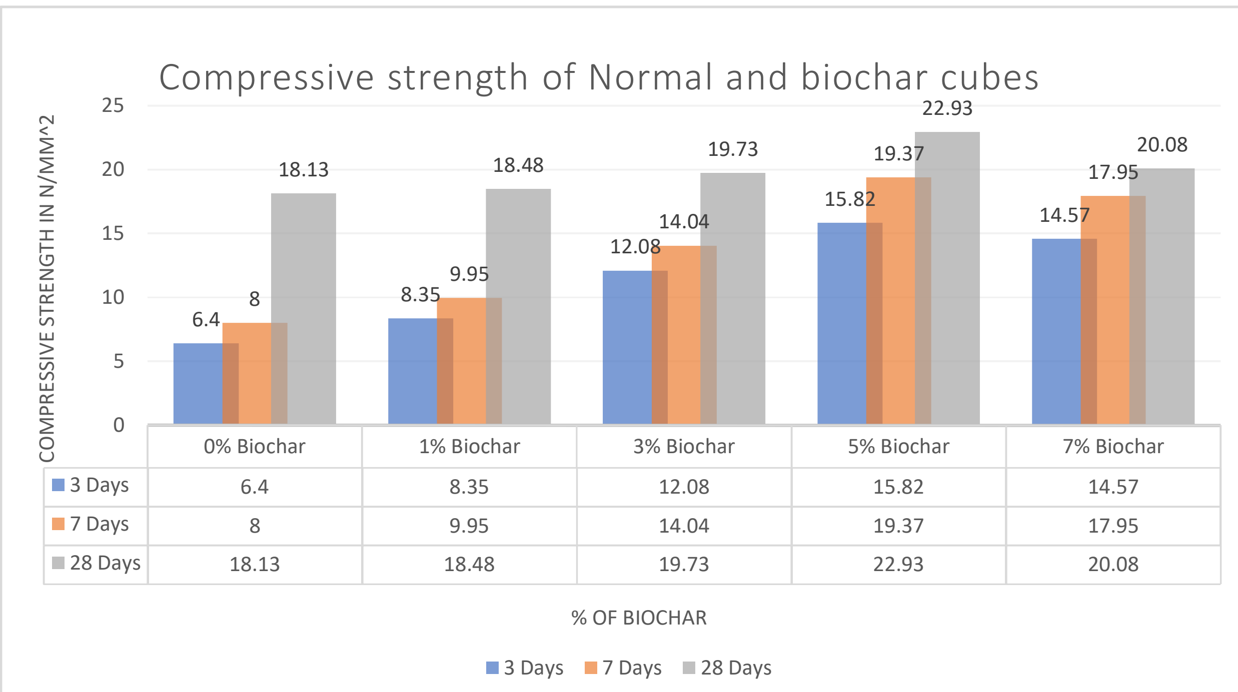
- Cleanthecubewitha drycloth toremovewater contentonthe surfaceafter curing.
- Removeexcess concrete on the surfacewitha troweland makethecubeeven.
- Liftthecubecarefullyand [40] placeit in themiddle oftheCTM.
- Settheloaded springtomake contact withthe surface.
- Aftercontact ismadesetthe loadingdegreeto0.
- Then applythe loadgraduallyonto thecube.
- Notethereadingswhenthefirstbreak(crack)formedand finalbreakage(ultimateload)was.

6.RESULT

Table–1:CompressivestrengthofMORTARcubeswhenbiocharispartiallyreplacedwithcementindifferentpercentages

% ofBiochar	Compressivestrengthfor3 daysof curing (inN/mm^2)	Compressivestrengthfor7 days ofcuring(in N/mm^2)	Compressivestrengthfor28 days ofcuring(in N/mm^2)
0	6.4	8	18.13
1	8.35	9.95	18.48
3	12.08	14.04	19.73
5	15.82	19.37	22.93
7	14.57	17.95	20.08

Fig.1 COMPRESSIVESTRENGTHOFNORMALANDBIOCHAR



5. CONCLUSION

Biochar which is obtained from the combination of dry rice-straw and plastic waste has an advantage that it goes through thecarbon sequestration process which leads to greater strength.
From the results, it is finally concluded that addition of bio char in the cement concretehelpsinincreasingthecompressivestrength.Replacement of 3% and 5% biochar has a greater increase in strengthCompressivestrengthhasreducedfor7%replacementofbiochar with cement than the 5% of Biochar.

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