Xournals

Academic Journal of Physical Sciences

ISSN UA | Volume 01 | Issue 01 | June-2018

Papercrete: A Partial Replacement of Concrete Ingredients

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Available online at: www.xournals.com

Received 30th January 2018 | Revised 5th March 2018 | Accepted 1st June 2018

Abstract:

Along with the sources such as deforestation and burning of fossils fuels, cement manufacturing industry is one of the chief sources to release carbon dioxide. In earth atmosphere, 7% of green-house gas emission is contributed only by the global cement industry. There is a need to develop substitute binders to reduce the environmental effects related with cement manufacturing and consuming natural assets constantly and also for making the concrete industry justifiable. For preparing concrete just like other materials such as GGBS, Rice Husk, Glass Powder, Fly ash, Phospogypsum etc., paper sludge ash is considered as the alternative binding material and also have great impact on the environment. To develop cost-effective building materials from paper sludge ash is the most important to comfort environmental effect and to produce low cost concrete. Portland cement is partially replace by the papercrete which is considered as new composite material prepared by the waste papers. This papercrete not only reduce the amount of cement but also works as the environment friendly buildings materials. This study presents the impacts of paper sludge made papercrete on the environment and its preparation.

Keywords: *Paper Sludge, Cement, Environment Pollution, Papercrete*

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Introduction

Cement is a substance act as binder which sets and hardens and binds other alternative materials along with it. The word cement came from the Romans, after that "opus caementiciumto" is the word which were used by the UN agency which resembles with the fashionable concrete in which, calcined lime with the combination of rock is present and describing the masonry. Later, the additives of calcined lime to get a hydraulic binder such as volcanic ash and small grained brick additives were brought up as cimentum, cäment and cement.

The non-hydraulic cements sets in the air because it dries and reacts with carbon dioxide but does not fix in wet conditions or atmosphere and underwater.

Replacement of a number of cement at the time of combining with pozzolanas, like as and activated metal silicates creates the hydraulic cement. Hydrates are indicated by the chemical action that does not dissolve, protected from chemical attack and durable in water. This is best for the wet environment and condition and for underwater, also protects from the chemical attack to the hardened material. Volcanic ash is used as the action for portland cement which is found by ancient Romans. Up to four hundredth of cement is represented as pozzolanas. In masonry, an element within the production of mortar and of concrete is measure by the most necessary uses of cement square. Cement makes a thick paste with the combination of water and has fine grayish color. Concrete is prepared when the cement paste is mixed with sand and gravel and dried.

Heating of sedimentary rock or chalk with clay in the rotator oven and at extreme temperature forms the portland cement which is factory made, and also provide onerous nodules of clinker which at the time of ball mill, unites with mineral. Vital quantity of fuel such as coal or crude oil coke is consumed by the firing method. The impacts have minimized by the step of makers by three ways in which first is to increase the employment of by-product from alternative industries, to reduce needs of primary material next to the landscaping once production and mud suppression measures. Second is to reduce cement clinker by exchanging the grinding method from alternative industries by product and to use the waste product as many fuels along with the investment in additional economical plant and larger emissions management. Third and last is for the improvement of instrumentality potency and for cutting back clinker edge time, which is helped by the use of grinding (Patel *et al*., 2014).

Potential Uses of Paper Sludge

For the improvement of soil, paper mill sludge is very helpful in a great amount. De- ink paper sludge have high cellulose content and is potentially lower toxic compounds therefore differs in composition in mills and very useful as soil conditioner. It can be also used as compost in land applications by reducing the sludge mass and volume by composting processes of paper sludge. This causes degradation of toxic compounds, reduce odor, decrease carbon- nitrogen ratio and inhibits the growth of plants.

It is found by the previous research that, as the amount of paper mill sludge increases, the biomass decreases due to the nitrogen deficiency, thus causes suppression of corn plant growths. It is also observed that immobilization of soil available nitrogen and phosphorus is caused by the paper sludge and found various strategies to overcome deficiency symptoms and biomass suppression such as delaying seeding or Nitrogen supplementation.

Uses in Construction Industry

According to the previous studies, the sewage sludge ash particle's shape is not spherical and its compressive strength and flexural strength of mortar is greater as compare to the control. According to Liaw*et al*., through the process of granulation and sintering procedures, co-generation ashes and paper sludge can be reused in construction bricks as the raw material as they examined some properties such as compressive strength, water absorption rate of light weight aggregates which are made up from co generation ashes. Various contents of the waste such as 0, 3, 5, 8 and 10% are included in five concrete mix as replacement to the fine sand.

For the purpose of non-constructional masonry construction, sludge waste are proven to be used as a replacement for mineral fillers in concrete. From various reviews of literature, authors drawn a conclusion regarding the potential use of paper sludge that, the paper sludge cannot fulfill all the hydration characteristics alone, although it can be used in construction industries. It is suggested that as an active set retarder material, another by product including GGBS, rice husk ash, glass powder etc. should be used (Amit and Islam, 2016).

Raw Material for Papercrete

1. **Paper:**

The property of the papercrete is dependent on the microstructure of the paper because paper is the main ingredient of papercrete. For manufacturing the paper,

first, wood log or fragments are treated chemically to make the lignin binder soluble and to make the cellulose fibers free. Excess water is removed by pressing pulp to make the paper. The quality and strength of the paper, which is an anisotropic material, varies which depends on various factors such as the percentage of recycled paper, the amount of water in the pulp, type of wood, the way of pulping and the speed of drying. In the production of paper, half of the paper fiber comes from the recovered fibers however, the recovered fibers are not much strong.

2. Water-Proofing Admixtures

As paper is completely water soluble material, it is the main and superior ingredient in the papercrete mix. Therefore, waterproofing admixtures which is one of the additives is added to minimize the water absorption. There are two approaches such as internal and external which are included in water proofing admixtures which are used by mix means of mix optimization. Powder Waterproof 105, Conplast WP 90, and Styrene Butadiene Rubber (SBR) latex polymer are the few examples of internal water proofing admixtures and Zycosil and Prime seal 604 with Rain coat are the examples of external water proofing admixtures.

3. Tow Mixer

Tow mixer is the special mixer which is designed for the purpose of manufacturing papercrete through which it can be easily manufactured and can be made with easily available parts, inexpensively and in one day. It functions with the combination of mixer and a dispenser. Tow mixer is much effective than others, although a concrete mixer also can be used. A rear axis from an automobile is used by the tow mixer to drive the impeller. It is made by turning the drive shaft to the vertical position and by removing the axle from the automobiles. Tank was mounted and there is a hole cut on the bottom of livestock tank for providing the extension to the drive shaft through the hole. A lawn mower blade is fixed on the drive shaft and the hole created was then sealed.

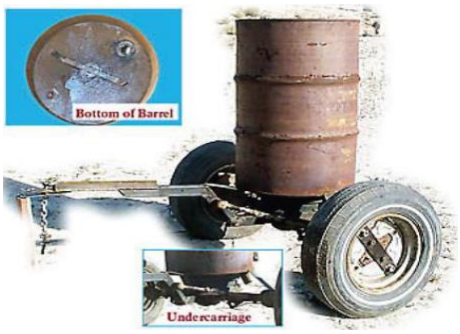

Figure 1: Tow Mixer (Shermale and Varma, 2015)

Manufacturing of Papercrete Bricks

- **Generation of Pulp for Papercrete Bricks**

The collected papers cannot be used directly to produce papercrete. Paper has to convert into slurry form which is called pulp before adding the other ingredients with it. Before soaking the paper to make pulp, pins, threads and other material should be removed from paper. After that the paper should be torn into the pieces and then dipped into the water for 3 to 5 days to make degraded paste. The obtained paper pulp has residual water which is not good for ingredient mixing.

- **Casting of Papercrete Bricks**

The dry ingredients such as cement and sand were taken out and mixed uniformly after the generation of paper pulp. The required amount of paper pulp is taken out and the dried mixed sprinkled over it and mix uniformly. These mixes is then placed into the mold for approximately 30 minutes. The machine oil is applied to the inner surface of the mold before putting the mixes into the cast to make removal of bricks easy and also to prevent from damaging. Mixes are poured into the cast and allow to settle down for approximately 15 minutes the remove from the cast and put on the table then let it be air dried for 28 days (Shermale and Varma, 2015).

Figure 2: Casting of Bricks

Figure 3: Prepared Papercreate Brick (Shermale and Varma, 2015)

Review of Literature

Balwaik and Raut, (2011) researched on use of paper sludge by partial replacement of cement in concrete and performed many tests to test concrete specimens such as comparison test, splitting tensile test and flexural test which are conducted to evaluate the mechanical properties till 28 days. Result showed that the 10% addition of waste paper pulp increases the compressive, splitting tensile and flexural strength and if the waste paper pulp is further increased, the strengths reduces gradually. They concluded that paper pulp and paper industry disposal costs can be saved by the use of waste paper pulp in concrete and greener concrete can be produced for construction.

Ahmad *et al*., (2013) examined the probability of using waste paper sludge as partial replacement of cement for new concrete. They replaced the cement with 5%, 10%, 15% and 20% of waste paper sludge for M-25 mix and then tested tensile strength, compressive strength, water absorption and dry density up to 28 days further compare with conservative concrete. After the testing and examination they found that up to 5% by weight and less than 90µm by particle size of waste paper sludge ash can be used for the replacement of cement to prevent reduction in work ability.

Chakraborty, *et al*., (2014) dealt with experimental investigation for calculating the ideal percentage of hypo sludge used for making concrete. They used three different grades of concrete which are M15, M29 and M25, also used five different replacement level of cement with hypo sludge which are 10, 20, 30, 40 and 50%. The compressive and tensile strength of the concrete were tested at the 7 and 28 days of duration. Their result showed that up to 20% replacement level of cement with hypo sludge can improve the strength of lower grade concrete.

Yousuf, Adil and Rafique, (2014) studied on the replacement of hypo sludge with the cement present in concrete. They have taken 5%, 10%, 15% and 20% replacement of hypo sludge in consideration for M- 15 and then examined for its compressive strength, tensile strength, water absorption for 28 days and compared with conventional concrete. They found that compressive strength increased up to 17% and splitting strength increased up to 15% at the replacement of 15%. An increase in the percentage of water absorption is noticed by them.

Singh, Saleem and Geeta, (2015) reported on the results of utilization of paper waste in concrete mix which are used for the construction projects. They conduct their research before assuring the proper mechanical strength of resulting concrete. They found that 3.0% and 1.4% compressive strength and 0.5% and 2.0% density increased and slump value decreased up to 6.3% by the replacement of 10-15% of waste paper sludge respectively, whereas 1.9% of strength decreased on adding 20% of paper waste. They also noticed 1.5%, 2.2% and 3.0% reduce in cost of concrete production with addition of 10%, 15% and 20% waste paper sludge respectively.

Varkey *et al*., (2016) examined the use of waste paper sludge for making low cost concrete and for reducing the disposal problem of waste paper sludge. They partially replaced the cement with 2.5%, 5% and 7.5% of waste paper sludge and then tested for compressive strength, splitting strength and flexural strength and compared with conventional concrete. By these analysis they found that waste paper sludge is ideal to be used at the place of cement which has improved the strength performance of concrete.

Shinde, Khobare, and Patil, (2017) investigated on application of paper waste as additional material in concrete mixes. They find out that, an increase of 3.0% and 1.4% in compressive strength is caused by the addition of 10% and 15% of paper waste respectively in concrete mixes while it decrease up to 1.9% on addition of 20% of paper waste. Based on the results of their study, they concluded that it will be conveniently allowed to mix 10% of paper waste in concrete mix.

Abhishek, (2017) worked on the experimental investigation on strength of concrete and ideal percentage of hypo sludge of 10%, 20%, 30% and 40% replacement with cement. The main aim of their study was to notice the behaviour of concrete during the hypo sludge addition with different proportion. They conducted many test such as compression strength, split tensile strength and flexural strength to observe the behaviour of concrete. He concluded and considered 30% of hypo sludge replacement as an ideal content to provide good strength to the concrete.

Vishnu *et al*., (2017) presented on the study of compressive strength, flexural strength of concrete. Worked on mixing the plastic and paper waste in cement concrete in the proportion of 0%- 10% and observed the behaviour of mixed concrete. From their study and its results they concluded that the compressive strength and flexural strength got decreased along with the increase in plastic ratio. It also reduced the density of concrete, i.e. compressive strength, flexural strength and Density is inversely proportional to the plastic ratio added to the cement concrete.

Karada and Awchat, (2017) studied to find out an alternate source of cement, fine aggregate and as an

admixture. Many researches are being directed for the finding of cheaper materials. The variation among the amount of waste in production of paper comes according to the regions depends on different recycling rate. They find out that 20%of sludge can replaced the cement in concrete and it is an effective replacement of fine aggregate. The strength of mix containing sludge increased in all aspects when compared with control sample.

Conclusion

This is the world of comfort and facilities and full of development. In this paper, the impacts of paper sludge made papercrete on the environment and its preparation is discussed. After studying many researches it is concluded that the reduction or reuse of some materials that is used in the field of concrete production can largely put an effect over the environment, which would eventually lead to pollution free and better surrounding. This practice is at the top now a days. There is need to investigate the structural behaviour of reinforced papercrete structural members such as beams, slabs etc. It is also needed and necessary to study the performance of in filled frame with papercrete bricks under earthquake.

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