International Journal of Combined Research & Development (IJCRD)
eISSN: 2321-225X;pISSN:2321-2241 Volume: 4; Issue: 6; June -2015

Review on Papercrete

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Abstract: Papercrete is recently developed construction material which consists of repupled paper fiber with Portland cement or clay and other soil added. This type of material is considered environmental friendly material. Papercrete gets its name from the fact that the most formulas use a mixture of water and cement with cellulose fiber. The fibers usually acquired from recycled newspaper, lottery tickets and phone books.The mixture has the appearance and texture of oatmeal and is poured into forms and dried in the sun, much like the process for making abode. Concrete and wood are not known for their insulating qualities, however, papercrete also provide good insulation. Its R-value reported to be within 2.0 to 3.0 per inch; papercrete walls are typically 10 to 12 inches thick and usually pinned with rebars. Papercrete has very good shear strength as a block. Lateral load involves sideways force the wind load on the entire area of an outside wall. Papercrete blocks are lightweight, less than a third of the weight of comparably-sized abode brick. Papercrete is mold resistance and has utility as a sound proofing material. A revival of the alternative building material known as papercrete may offer a sustainable substitute for traditional material such as wood and concrete.

***Keywords*: *C*ellulose fiber, R-value, Shear strength, Sound proofing material, Insulation**

I. INTRODUCTION

A name of papercrete was derived from its materials. Generally, it was made up of paper, cement and water. It has been used to build environmental friendly house. However, there was not much research on papercrete. In a hollow concrete block containing recycled paper waste (RPW), the thermal conductivity of the RPW concrete was 0.35 W/m/k which was similar to that of concrete with expanded slate as aggregate, while results of sound insulation test were conformed to the requirements for partition walls. Papercrete have been reported: to be a cheap alternative building construction material; to have good sound absorption and thermal insulation; to be a lightweight and fire-resistant material.

The paper to be used can come from a variety of sources that could be obtained from local waste dumps in the area. The concept is very simple. Mix the dry ingredients with water to form slurry, cast the slurry into blocks or panels, and let it dry. When it hardens, papercrete is lightweight (it is 80% air), an excellent insulator, holds its shape even when it is wet, and is remarkably strong. Since all of the ingredients are available in the local area, the product is also cheap, and re-uses waste material that would otherwise end up in landfill.

Local landfills are clogged with waste paper and cardboard, and millions of people in the region live in substandard poorly constructed housing or have no housing at all. With papercrete, we can help solve some of these problems. Rather than throwing water paper and cardboard into landfills, we can turn it into a valuable building material. This is the opportunity to reduce waste, and create a new manufacturing industry in the village, creating jobs and a product that could be used across the country. The product is also highly sustainable, as it uses around 80% recycled materials, hence capturing carbon dioxide emissions by using waste as the main raw material.

The water absorption and fire resistance of papercrete were found to be high and increased with increasing waste paper content while the bulk density and compressive strength of papercrete were low and decreased with increasing waste paper content. Papercrete was recommended to be an effective and sustainable material for the production of lightweight and fire-resistant hollow or solid blocks to be used to make partition walls of especially high-rise buildings. Mix proportions were recommended for production of hollow and solid blocks using papercrete.

A. Basic of Paper and Papercrete

Paper is principally wood cellulose, which is considered a fibrous material. Cellulose is the second most abundant material on earth after rock. It is the main component of plant cell walls, and the basic building block for many textiles and for paper. Cellulose is a natural polymer, a long chain of linked sugar molecules made by the linking of smaller molecules.

The links in the cellulose chain are a type of sugar: ß-D-glucose. The cellulose chain bristles with polar -OH groups. These groups form many hydrogen bonds with OH groups on adjacent chains, bundling the chains together. The chains also pack regularly in places to form hard, stable crystalline regions that give the bundled chains even more stability and strength. This hydrogen bonding forms the basis of papercrete's strength.

B. Property of Portland cement in Papercrete

Portland cement is an integral component of papercrete. It is usually not used in fidobe or padobe. A simple paper and water mix takes a great deal of time to dry and it shrinks about 15-25 percent. Adding Portland cement in an amount equal in weight to the paper cuts drying time by about half and reduces shrinkage to about 3-5 percent. If nothing were added to paper and water, it would be less strong, highly flammable, and less resistant to bugs and mold.

No matter what mix you settle on, the great thing about generic papercrete is how it traps air.

When the water drains out and evaporates, it leaves thousands of tiny air pockets. This is what makes the material light and a good insulator. Adding solid material to the mix (sand, etc.) affects weight and insulating quality. The best mix is the one which best fits the application. Papercrete is a very forgiving material, but like any other mixture, varying the mix, admixtures and curing procedures results in tradeoffs in its properties. For example, adding more sand or glass to the mix results in a denser, stronger, more flame retardant material, but adds weight and reduces R-value. Heavy mixes with added sand, glass, etc. increase mass and strength to a point, but reduce workability.

C. Mixing Formula for a Fibercrete

The most common mixer in use is Mike McCain's tow mixer. It has a capacity of about 200 gallons (900 liters). The following is a starting formula for a 200-gallon batch of blocks. A 200-gallon batch will make 25-30 blocks in forms one foot (30 centimeters) wide x two feet (61 centimeters) long x five inches (13 centimeters) thick.

Tow mix is basically a trailer made from the rear end of a car, with the part that would attach to the drive shaft sticking upward and a lawn mower blade attached to it. The blade is surrounded by a large stock watering tank where the mixing occurs. There is a baffle on the side of the tank to force the slurry back into the blade as it circulates.

D. Mixer

It is the mechanical device used to break down the papers into pieces and make them into a blend by mixing it with water. The following are the types of mixers:

1. 5 GALLON (20 LITER)
2. 50 GALLON (212 LITER)
3. THE TOW MIXER - 200 GALLON (900LITER)
4. BIG MIXERS - 1000 GALLON (4240 LITERS)
5. ELECTRIC MOTOR

MIXERS E. Properties of

Papercrete\

i. Density and Shrinkage

The density of the papercrete has trend of decreases as a higher waste paper was included. Due to the low density of the waste paper, it reduced the overall density of the specimens. paper replacement ratio of papercrete affected increase of shrinkage a lot.

ii. Compressive Strength

The compressive strength of papercrete has been measured a number of times and is variously reported to be in the 140-160 lb./sq. inch range -- but compressive strength is probably not

the most accurate way to judge papercrete. Compressive strength is a measure of load at the instant of failure. This works for concrete because when concrete's load is exceeded, it literally explodes. When that point is reached, the compressive strength is known. But papercrete never fails catastrophically, it just compresses like squeezing rubber.

iii. Tensile and shear strength

Papercrete block is the equivalent of hundreds of pages of paper - almost like a catalog. Papercrete has very good sheer strength as a block. Lateral load involves sideways force - the wind load on the entire area of an outside wall for example. Because papercrete walls are usually a minimum of twelve inches thick and usually pinned with rebar, they are very strong laterally. No extremely long lengths of flat wall built with any kind of material should lack reinforcement. The reinforcement might be internal - using mesh or rebar, or external by curving the wall or connecting the wall to perpendicular walls at reasonable intervals. Structural testing will tell us the best way to design for papercrete construction.

iv. R- Value

"R-value" is a measure of a material's resistance to heat flow. The R-value of papercrete is reported to be between 2.0 and 3.0 per inch - the higher the number, the better. Two samples uses a 1:1 mix of Portland cement with Fly ash to paper, with about 12 shallow shovelfuls of sand added. The obtained R-values are of 2.24 and 2.16. From the percentage of Portland cement and fly ash was 65% Portland cement and 35% fly ash, makes blocks 12 inches (30 centimeters) thick and adds an average of about an inch (2.5 centimeters) of papercrete exterior stucco and about the same amount for interior finish. That means that his total R-value will be at between 30.24 (14 x 2.16) and 31.36 (14 x 2.24).That's quite good compared to an older standard wood frame wall of R- value 19. The R-value of hollow masonry block is only 1.75.

v. Fire

Block and roof panel mixes cure into a material which will not burn with an open flame. If an accelerant like gasoline is applied to it or it's held over an open fire for a prolonged period (30 seconds or more) it will begin to burn slowly like charcoal rather than rapidly like wood. It will eventually be reduced to ashes, but a single block will take several hours to be consumed.

II. APPLICATION OF PAPERCRETE

1. Can be used as a sound-proofing material.
2. Sufficient for roof loads in low-height buildings.
3. Load bearing construction block as well as insulation layer all in one.
4. Fire resistant: Conforms to any mould can be used in decorative moulds as well as for block work.
5. Papercrete could be used for simple furniture in homes provided that wire mesh is set into the papercrete for added strength.
6. Different shapes to decorate houses, flower pots.

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