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A sustainable alternative using fly Ash and Bio mass Waste: A Revie

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Abstract:

This paper describes how waste can become a valuable resource, offering economic, environmental, and structural benefits to the construction sector. The construction industry is one of the largest consumers of natural resources and one of the highest generators of waste.With increasing pressure for sustainable development, there is a growing need to rethink traditional building materials.Recent advancements in material science and waste processing have opened the door to Utilizing fly ash, plastic waste, biomass ash, and demolition debris Creating low-cost, durable, and eco-friendly alternatives to conventional materials.

Keywords:- Biomass waste, Eco-friendly structures, recycling, bricks, etc.

INTRODUCTION:

The increasing worldwide population necessitates a rise in energy production to meet the demands of contemporary life. Since 1950, there has been a dramatic increase in the world's population, and with it, a corresponding increase in demand for energy. Most of this growth has happened in developing countries, which already have to deal with acute energy shortages. There were 7.7 billion people on Earth in 2019, and experts predicted the number would rise to 8.5 billion by 2030. It is projected that between 2019 and 2030, the resident populations of Sub-Saharan Africa (which now has a very small population) and Central and Southern Asia (which also has a relatively small population) would grow by 0.3 billion and 0.2 billion, respectively. There will likely be 9.7 billion people on Earth by 2050, according to statistics [1]. Energy is becoming more important on a global scale. The developed world continues to use vast amounts of energy, despite the growing need in developing countries.

The rate of global population growth remains constant. The growing human population and improved living conditions in many developing nations will drive up the need for energy. The highest energy use is seen in the most populous and industrialized countries. This is because of the region's dependence on the industry, its broad use of cars, and its reliance on home consumption owing to families having multiple home devices [1]. While the majority of the globe shifts to low-carbon energy sources, it falls on developing countries to provide for the billions of people who still lack access to the most basic forms of modern energy [2,3]. As the world's population and per capita consumption continue to rise, it is urgent to create sustainable patterns of consumption and production that meet the basic and immediate needs of a growing population [4]. Contemporary studies in the fields of recycling and energy conservation are primarily motivated by the desire to lower cooling costs in hot, arid regions by finding new uses for industrial and agricultural wastes to produce inexpensive construction materials that restrict the flow of heat inside buildings. Numerous studies have examined the potential of industrial and agricultural wastes as raw materials for a wide range of building products, and many have found promising applications [5].

The ever increasing volume of fly ash quantities in the world has not been remotely matched by its utilization. Australia is an example where such utilization has been minimal. The most important and popular use of fly ash in Australia has been in the partial replacement of portland cement. The use of fly ash in concrete is to the extent of maximum of 25% replacement of Portland cement. This conservatism can be understood in the context of concrete where the ash is mixed raw, and the effects of high volume replacement are still subject to research. It is however not quite justifiable that the brick industry should take similar conservative attitude. Environmental concerns have been raised in some parts of the world where coal is the main power generating resource and where bricks are also the main building material. Such concerns have resulted in legislation to oblige the brick industry to incorporate at least 25% by weight of fly ash and or bottom or pond ash in the brick making mixture if the industry is within 50 km from a coal power generation plant. Some successful ventures have been reported where fly ash was incorporated in the mixture at the rate of 20% to 50%. Nevertheless, there is only little evidence that incorporation of fly ash in the brick mixture has exceeded the 30% by volume, even when the legislation was obeyed. Reasons behind such reluctance are not clear. A most probable reason is the fear of change in many small factories and the ingrained conservatism in the attitude of stake holders of the large producers. Added to this is the fact, that with an existing clay brick factory, the incorporation of fly ash is a potential addition of cost. The possible incompatibility of the ash with the clay and shale during the various processes of production including the crucial one of firing may be a legitimate difficulty. At high temperatures beyond 1000 ºC, the temperature and length of time of firing become very sensitive to the type of ash and of course to the clay and shale if in the same mixture. This would be the case as long as the factory still uses the ash as partial replacement to the main clay and shale ingredients. The situation may become completely different when the ash is the only ingredient of the bricks mixture. Compatibility is no more an issue in such a case. So far, few attempts at manufacturing bricks from more than 80 % fly ash have been made. The engineers now believe that fly ash on its own can be an excellent raw material for brick making. This has now been proven and a patent is taken for the manufacture of bricks from fly ash. The response of the ash to firing temperature at 1000 ºC and beyond can be accurately controlled even in small factories. The potential savings with this approach are many. Savings in production and transportation costs and producing bricks of superior qualities to those of standard clay bricks are in addition to the environmental solution that such venture may bring about

The term biomass means the biodegradable fraction of products, waste and residues of biological origin from agriculture (including vegetal and animal substances), forestry and related industries including fisheries and aquaculture, as well as the biodegradable fraction of industrial and municipal waste.[6] Otherwise, biomass excludes organic materials such as fossil fuels which have been transformed by geological processes into substances such as coal or petroleum. At present, agricultural by-products are mainly used as combustion feedstock for biofuels.[7][8][9] The most important biomasses are the residues from woodworking (wood shavings, sawdust) or forest activities, the wastes from farms and agro-business, the organic fraction of municipal solid wastes, and the plants deliberately grown for energetic purposes.

An innovative way of utilization could be related to the use of agricultural waste as alternative raw materials for obtaining building products, in particular, ceramic bricks. This kind of ceramic products are produced from natural raw materials with a very wide-ranging overall chemical and mineralogical composition. For this reason, bricks can tolerate the presence of different types of urban and industrial wastes (fly ash from coal-burning thermal power plants, sludge from the glazing lines of ceramic tile manufactures, from plating plants of metallurgical and mechanical industry and from the mining industry), even in considerable percentages as confirmed by several researches [10][11].

WHY FLY ASH AND BIOMASS WASTE ARE USED

Bricks have been widely used as a building material throughout the world, with the global annual production of approximately 1391 billion units (Zhang, 2013). There are two types of bricks, namely cement-based and clay-based bricks. The clay-based brick has been generally preferred by manufacturers because it is cheaper and has a higher fire resistance, higher durability, longer service life, and lower production energy than the cement-based brick (Munoz et al., 2014, Ashmarin and Vlasov, 2005, Madurwar et al., 2014, Reddy and Jagadish, 2003, Lipiatt, 2007). Meanwhile, the high demand for clay in the brick production has led to its over-exploitation, which results in the reduction of this non-renewable material in a number of rapidly growing some countries around the world. [12] Therefore, it is crucial to identify environmentally friendly alternative materials to replace clay in bricks due to the extraction of non-renewable clay deposits.[13]

Increasing demand for sustainable construction has driven interest in innovative building materials. Fly ash and biomass ash possess pozzolanic properties suitable for partial or full replacement of clay in bricks. This project investigates the performance of bricks made from a blend of fly ash and biomass waste, aiming to reduce environmental impact and improve material efficiency. Bricks made with ash can offer better insulation, enhancing energy efficiency in buildings. Reduces dependency on clay and firewood, potentially lower in production costs and creating a market for waste-based products.[14][15]

Bricks will always be the necessity of building materials and in future soil for the making of bricks would not be available in plenty as the use of land is rapidly increasing, at that time fly ash will fulfil the necessity of clay bricks as these bricks are made by the industrial wastes. Moreover the building structures are getting heavier with time, the use of fly ash bricks would be more efficient as its strength is more than that of clay bricks[16]

TEST PERFORMED ON FLY ASH BRICKS

In fast growing today's world development of new building materials and Processing & utilization of industrial waste is being given the top priority in the program of building research at a very high rate. This is important for achieving maximum disposal of wastes and conservation of scarce resources and materials.[17] The properties studied water absorption, hardness, efflorescence, soundness, shape and size, crushing strength and basic compressive strength of the prism using different mortar mixes normally 1: 3, 1: 4 and 1: 5 cement-sand mortars. In general bricks are made by top fertile agricultural soil but by using fly ash, 28 percent of top fertile agricultural soil is saved. Use of fly ash in brick making also is beneficial in diverse ways. [18][19]. As compared to conventional clay bricks fly ash bricks are stronger, more durable and yet more economical. Also, the process of fly ash brick manufacturing results in lesser pollution. Being less permeable as compared to clay bricks dampness related issues are far lesser in case of fly ash bricks than their clayey counterparts.[20]

RESLUTS FROM FLY ASH BRICKS

Fly Ash Bricks were found to be sufficiently hard as scratching by the finger nail on the surface left no impression on it as compared to normal bricks. The Efflorescence of all bricks tested were found to be slight as white or grey deposits were less than 10% on surface of the bricks which is almost same as that in the normal bricks. A ringing sound in the Fly ash Bricks was observed to be far better than that in normal bricks. Structure of the bricks was found to be compact, homogeneous and free from any defects like holes, lumps etc as compared to normal bricks. The average absorbed moisture content of clay bricks is found to be 11.93% and for fly ash bricks are found to be 9.77%. Thus there is net 18.10% decrease in moisture absorbed for fly ash bricks as a part to clay bricks. The crushing strength of clay bricks is found to be 8.14 N/mm2 and for fly ash bricks is found to be 18.81 N/mm2. Thus there is net 56.72% increase is crushing strength for fly ash bricks as a part to clay bricks. The crushing strength by prism of clay bricks is found to be 1.31 N/mm2 and for fly ash bricks is found to be 1.8 N/mm2. Thus there is net 27.22% increase is crushing strength by prism for fly ash bricks as compared to clay bricks. The crushing strength by prism of clay bricks is found to be 1.19 N/mm2 and for fly ash bricks is found to be 1.56 N/mm2. Thus there is net 23.71% increase is crushing strength by prism for fly ash bricks as compared to clay bricks. The crushing strength by prism of clay bricks is found to be 1.21 N/mm2 and for fly ash bricks is found to be 1.59 N/mm2. Thus there is net 23.90% increase is crushing strength by prism for fly ash bricks as compared to clay bricks.[21]

TEST PERFROMED ON BIOMASS WASTE

The physical (linear shrinkage, loss on ignition, density, water absorption and porosity), mechanical (bending strengths) and thermal properties of the obtained clay bricks were determined. Linear shrinkage was determined by measuring the length of the sample before and after drying using a caliper according to the standard ASTM C210-95. Loss on ignition was determined by measuring the mass loss of the sample between the drying and firing steps. Water absorption of these lightweight bricks was determined using the standard procedure ASTM C 373-88. The samples were dried at 110 °C for 24 h and weighed to constant mass. They were then cooled for 24 h and totally immersed in water. After soaking for 24 h, they were dried and reweighed to constant mass.The bulk porosity and saturated density were determined according to the test procedure recommended by Hornain et al. [22] by means of water saturation under vacuum. Thermal conductivity was obtained through a heat flux meter method. This method followed the standards ASTM C518, ISO 8301 and NF EN 12667. The measurement area was 60x40 mm2 with a thickness of the sample greater than 10 mm. This apparatus produced a temperature gradient along the thickness of the sample and measured heat flux that gave through the software the thermal effusivity. Thermal conductivity was deduced using the formula: k E2qC p (W/m K) with q the bulk density (kg/m3) and Cp the specific heat capacity (J/kg C).All the characterizations were performed on 6 samples the coefficient of variation of all the obtained values, defined as the ratio of the standard deviation to the mean.[22]

CONCLUSION

The reuse of these wastes clearly presents several advantages whether it is on an technological aspect or on an economical point of view it leads for example to a reduction of the costs due to the use of wastes by substitution of the clay matter and a reduction of transportation costs due to the production of lighter products. A life cycle assessment is currently realized to determine the environmental impacts of these new matters and will be published in due course.

FUTURE EXTENSION

Instead of Fly Ash, investigations can be done on waste material such as saw dust, lime sludge, rice husk etc. Thermal conductivity can also be investigated for such type of brick. Work can be extended by using Fly Ash, Biomass Waste. Fly ash bricks can be used partially with clay so that economically fly ash bricks can be better used. Industrial wastes should be better used in brick making for strengthening purpose and also profitable for cleaning society.

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