REDUCTION IN GREEN HOUSE GAS AND AGRICULTURAL SOLID WASTE IN GREEN CONCRETE

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Abstract

All over the world, the real estate is growing very fast and the civil constructions need a very high demand of various construction materials in which concrete is the core material and to make it tones of natural resources are being consumed, leaving a question mark on environmental issues. Concrete is the single most widely used construction material in the world and second most used material after water and the cement industry is one of two largest producers of carbon dioxide, creating up to 5-8% of worldwideman-made emissions of this gas, of which 50%is from the chemical process and 40% from burning. Ferrock, is an innovative iron based binding compound, present a carbon-negative alternative to cement that utilizes a variety of waste streams to produce a versatile building material. Here we made it for ordinary purpose and testing its behavior in the normal atmosphere and in lab conditions.

Key words: Ferrock, Carbon-negative, Recycled byproducts, Global climate change, Iron based binder, Glass powder, Agricultural waste, Oxalic acid, XRD analysis, SEM analysis.

I. Introduction

The cement is the main ingredient material of concrete and worldwide cement produce approximately 8% Carbon Dioxide (CO_2), a greenhouse gas, main reason for the global warming and can be solved by finding alternative to concrete. The cement industry is an energy intensive industry with energy typically accounting for about 40 % of operational costs, i.e. excluding capital costs but including electricity costs.The production of cement involves the consumption of large quantities of raw materials, energy, and heat. Cement production also results in the release of a significant amount of solid waste materials and gaseous emissions.

In addition to the generation of CO2 the cement manufacturing process produces millions of tons of the waste product cement kiln dust each year contributing to respiratory and pollution health risks. The main environmental issues associated with cement production are consumption of raw materials and energy use as well as emissions to air. Waste water discharge is usually limited to surface run off and cooling water only and causes no substantial contribution to water pollution. The

storage and handling of fuels is a potential source of contamination of soil and groundwater. Additionally, the environment can be affected by noise and odors.

The cement production needs the very high amount of energy. Energy cost represents 40% of total production costs involved in producing of 1 tone of cement. Thermal energy demand (fuel) and electrical energy demand are the most important. Specific energy consumption depends on size and plant design, raw materials properties and its moisture, specific caloric values of fuel, throughput of kiln, type of clinker and many other factors. Thermal energy demand is in range of 3000 - 6500 MJ per 1 tone of clinker, the electricity demand ranges from 90 to 150 kWh per 1 tone of cement.

Emissions to air and noise emissions arise during the manufacture of cement. Furthermore, with regard to the use of waste, odors can arise, e.g. from the storage and handling of waste. In this section, ranges of air pollutant emissions are presented for the process of cement production, including other process steps, such as the storage and handling of, e.g. raw materials, additives and fuels including waste fuels. The main constituents of the exit gases from a cement kiln are nitrogen from the combustion air; CO2 from calcination of CaCO3 and combustion of fuel; water vapors from the combustion process and from the raw materials; and excess oxygen

The green concrete concept derives from saving of various natural resources without compromising with the future generation needs, durability, low cost, recycle and reuse of waste materials without wasting space, time and money on their disposal.

The ferrock is made of 90 % recycled materials so the cost for making this will be lower than cement when manufactured as bulk. The other factor is that one of the major issues faced by human is the carbon dioxide, which is the major reason for green house effect and other chain problems like global climate change etc…. ferrock is a carbon-negative substance and it takes CO_2 for its reaction, to attain its strength, past studies says that it will take the CO_2 even after attaining the initial strength.

II. Literature Review

Anita Bhatia (2016), et.al. found a paper on green concrete in which they concluded that green concrete is very low energy and resource consumption, no environmental pollution and sustainable development. One can conclude that overcoming the above demerits would help to use the green cement concrete with a potentially new environmental friendly world. With the waste material as an alternative we can help to reduce the environmental problems and protect the naturally available materials for the future generation.

KasiRekha (2015), et.al. found about the brick wastes and concluded that the recycled brick aggregate concrete is made used for the production of low grade recycled aggregate suitable for concrete production. The results showed that recycled brick aggregate concrete performed better

than granite aggregate concrete at high temperature. The fire resistance of recycled brick aggregate concrete is better than the fire resistance of granite aggregate concrete.

Alejandro Lanuza,(2017) et.al.made new findings on "Ferrock: A life cycle comparison to ordinary portland cement", studied about an alternative iron binder for concrete where he collected raw materials from industrial wastes. The result showed that the binder attains strength in 4 days of curing and it absorbs CO_2 for the reaction to achieve its strengths. Ivan Menz student of Pittsburgh Swanson School of Engineering published paper on "Green Cement: Finding an alternative to portland cement" in that he mentioned the future of ferrock and what are its advantages from other replacements. In this he gives the importance of finding new alternatives instead of ordinary portland cement

AgbenyekuEmem-obongEmmanuel,(2014) et.al.made new findings on "Blended rice husk ash concrete; a marginal green construction material from extended hydration", from his study he states the strength of cement blended with pozzolanas normally improves with age since pozzolanas react more slowly but can produce concrete with close characteristics as normal concrete beyond age 28days. He states the strength of cement blended with pozzolanas normally improves with age since pozzolanas react more slowly but can produce concrete with close characteristics as normal concrete beyond age 28days.The strength of 10%RHA/OPC concrete (78.79MPa) was higher than the strength of the control specimen (77.03MPa) at 150-days; which proves that pozzolanas can produce concrete with close characteristics as normal concrete beyond age 28-days, thereby making it a suitable green construction material. It can be a major cost reduction factor in rural housing and development; where buildings of less structural emphasis are needed. As such, it can be employed in the construction of simple foundations and concrete composites.

Ing. MiroslavStajanča,(2012) et.al. made new findings on "Environmental impacts of cement production", from his study he states that Output from the cement industry is directly related to the state of the construction business in general and therefore tracks the overall economic situation closely. The cement industry is an energy intensive industry with energy typically accounting for about 40% of operational costs, i.e. excluding capital costs but including electricity costs. Traditionally, the primary solid fossil fuel used was coal. A wide range of other solid, liquid or gaseous fossil fuels are used, such as petroleum coke, lignite, natural gas and oil (heavy, medium or light fuel oil). In addition to these traditional types of fossil fuels, the cement industry has been using large quantities of waste fuels or biomass fuels, for more than 15 years. This paper presents the review of the main environmental impacts related to the cement production based on the Reference Document on Best Available Techniques in the Cement, Lime and Magnesium Oxide Manufacturing industries.

Garg and Jain (2014), et.al.studied on green concrete: efficient & eco-friendly construction materials. It presents the feasibilityof the usage of by product materials like fly ash, quarry dust, marble powder/granules, plastic waste and recycled concrete and masonry as aggregates in concrete. It concluded that, it focuses on known benefits and limitations of a range of manufactured and recycled aggregates. Use of concrete product like green concrete in future will not only reduce the emission of CO2 in environment and environmental impact but it is also economical to produce.

Dhoka (2013), et.al.carried out "green concrete: using industrial waste of marble powder, quarry dust and paper pulp" The green concrete is prepared by using industrial waste of marble powder, quarry dust with proper proportions". The versatility of green concrete& its performance derivate will satisfy many futureneeds. Wangchuk et.al. (2013), studied that green concrete for sustainable construction. It is characterized by application of industrial wastes to reduce consumption of natural resources and energy and pollution of the environment. Replacement of materials over nominal concrete is what makes green concrete more environmental friendly concrete. Marble sludge powder, quarry rocks, crushed concrete and fly ashes are some of the materials used for making green concrete, a sustainable construction. With green concrete technology we can save the natural materials.

Verma Ajay,(2012) et.al. concluded in there paper that concrete is the most important engineering material and the addition of some other materials may change the properties of concrete. With increase in a trend towards the wider use of concrete for high rise buildings there is a growing demand of concrete with higher compressive strength. There are two types of materials crystalline and noncrystalline. Micro silica or silica fume is very fine non crystalline material. Silica fume is produced in electric arc furnace as a by-product of the production of elemental silicones or alloys containing the silicon. Silica fume was initially viewed as cement replacement material and in some area it is usually used as replace by much smaller quantity of silica fume may be used as pozzolanic admixtures. Silica fume increases the strength of concrete more 25%. Silica fume is much cheaper than cement therefore it very important from economical point of view.

N. K. Amudhavalli,(2012) et.al.concluded that Portland cement is the most important ingradient of concrete and is a varsetile and relatively high cost material. Lasrge scale production of cement is causing enviornmental problems on one hand and depletion of natural resourses on other hand. This threat to ecology has led to researchers to use industrial by products as supplementrycementatious material in making concrete. This paper represents the detail experimental study on compressive strength, flextural strength and split tensile strength. Consistency of cement depends upon its fineness. Silica fume is having greater fineness than cement and greater surface area so the consistency increases greatly, when silica fume percentage increases.

Umesh Sharma,(2014) et.al.studied about the silica fume & concluded that concrete is the most important engineering material in a construction industry because of its inherent strength properties. Micro silica primarily of very fine smooth spherical silicon oxide particles with an extremely high surface area. Micro silica particle are 100 times smaller than as that of cement particle. Silica fume is usually categorized as a supplementary cementitious material. These material exhibit pozzolanic properties, cementitious properties and a combination of both properties due to this properties it can affect the concrete behaviourin many ways. Silica fume is a material which may be a reason of Air Pollution. This is a by-product of some Industries. Use of micro-silica with concrete decreases the air pollution. Silica fume also decrease the voids in concrete.

Mohammed Tarek Uddin1,(2015) et.al.studied about the demolished brick waste replacement as an aggregate and they concluded that investigations were carried out to explore the possibility of recycling of demolished brick aggregate concrete as coarse and fine aggregate. The compressive strength of mortar portion of concrete is higher than the compressive strength of recycled aggregate concrete; it indicates that failure of concrete specimen is initiated in recycled coarse aggregate.

Kakamare M.S.,(2015) et.al.studied about the Sustainable Construction Materials & Technology in which they concluded that green concrete is a type of concrete which resembles the conventional concrete but the production or uses of such concrete requires minimum amount of energy and causes least harm to environment. Green concrete is a very low energy and resource consumption, no environmental pollution, sustainable development. Green Concrete has good thermal and fire resistance, sound insulation than the traditional granite rock.

Dhiraj Kumar Tiwari,(2015) et.al. studied about the green concrete and concluded that green concrete capable for sustainable development is characterized by application of industrial wastes to reduce consumption of natural resources and energy and pollution of environment. Application of green concrete is an effective way to reduce environment pollution and improve durability of a concrete under severe conditions. Green concrete has the good thermal & fire resistance.

Praveer Singh,(2016) et.al.studied about the silica fume and comes to the conclusion that cement is becoming a scarce resource all over the world because of increase in demand day by day. The use of silica fume as a pozzolana material has increased in recent years because when mixed in certain proportions it enhances the properties of both fresh and hard concrete. Addition of silica fume in proper proportion improves durability attack by acidic waters and improving concrete conditions.

Tae Hyoung Kim,(2016) et.al. studied about the CO_2 emission from concrete and concluded that concrete, a common construction material, is known to emit large amount of environmentally hazardous waste during the processes related to its production, construction, maintenance, and demolition. The CO_2 emitted in a concrete production affect the acidification and global warming.

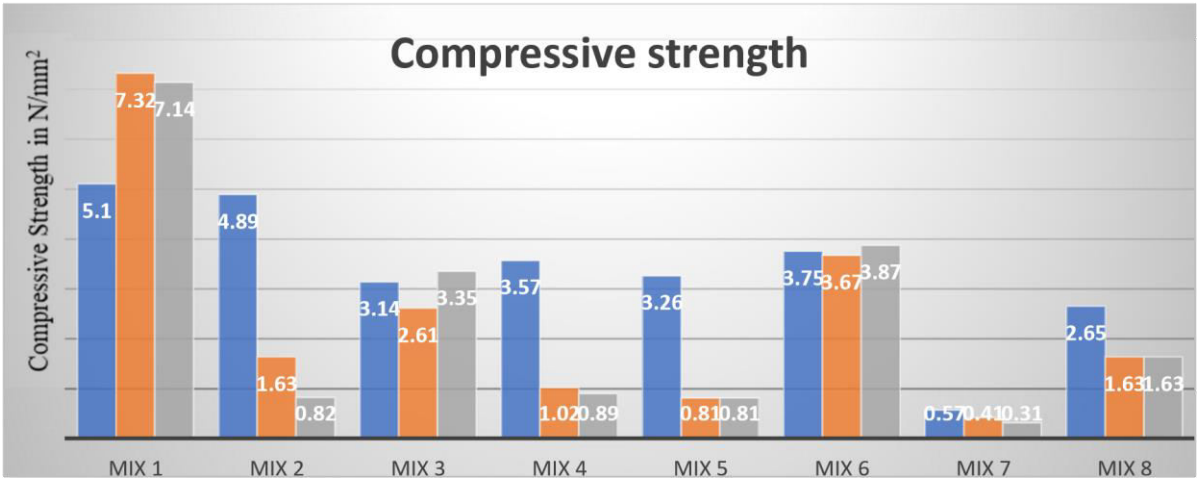
III. Result and Conclusion

Mortar Compressive Strength

Following results are observed in compressive strength, when mortar cube of 1:3 with ferrock and fine aggregate is made. Values of compressive strength for various mixes are reported in the following table.

Mix	I	II	III	IV	V	VI	VII	VIII
Characteristic Compressive Strength in N/mm^2	6.52	2.45	3.03	3.57	1.62	3.76	0.43	1.97

Table. Characteristic compressive strength



- The mortar cube with only ferrock completely gained a compressive strength of 2.45 N/mm^2.
- The strength of the above mix are given in chart.

Cube Compressive Strength

The result observed in cube compressive strength for M20 concrete by calculating the mix design is 2.2 N/mm^2. The result thus obtained is prepared by undergoing 4 days of curing. It is observed that the inner part of the cube where not reacted and the strength is not achieved beacause of lack of contact with the CO_2.

The mortar cubes were tested after the 14 days of curing in atmospheric conditions. The first mortar cubes where tested in both ordinary condition and also in the generator room from the results it shows that the cubes placed in the generator room achieved higher strength than

Fig. Cubes tested.

IV. Discussion

- The result obtained from the green concrete prepared is less compared to the conventional concrete. Therefore, we discussed with the chemistry professor and as per his suggestion we tried 8 mixes of different ratios using mortar cubes.

- In each mix 3 cubes are being made and tested the average value of the strength is being taken.
- The curing is done in the generator room instead of ordinary environment where the percentage of CO_2 present is comparatively high.
- From the 8 mixes, the mix which have 60% of iron powder, 20% of sugar cane bagasse ash, 10% of glass powder, 5% of lime powder, 5% of oxalic acid gain more characteristic compressive strength of 6.52 N/mm^2 than other mixes.

Ferrock is an iron-based binder material which is used as replacement for the cement in our project which is made completely made from industrial and agricultural wastes thus this will help to reduce the environmental problems caused by the environment by using these wastes and it reduce the cost of concrete. By using the waste products from industry huge amount of resource can be saved for future. This material is a carbon negative material so that it absorbs CO_2 for curing instead of water to achieve its strengths and releases hydrogen gas as by product this can be used for other purposes when used as bulk in precast industry after having studies on it.

The study show that it shows more tensile strength than ordinary concrete thus the amount of steel can be reduced thus the self-weight can be reduced also if the reaction takes place properly the complete strength achieved by the ordinary concrete in 28 days can be achieved in 4 days.

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