International Journal of Advance Research in Science and Engineering
Volume No.07, Special Issue No.03, April 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

EXPERIMENTAL STUDY ON GREEN CONCRETE

Prof. Rahul Hodage[1],Mr.Shrikant Shitole[2]and Mr. Deepak Yewale[3]

[1]Asst Prof. Civil Engineering ,SPPU, Pune, (India)

[2]Civil Engineering, SPPU, Pune, (India)

[3]Civil Engineering, SPPU, Pune, (India)

ABSTRACT

Green concrete is a revolutionary topic in the history of concrete industry. Concrete is an environmental friendly material and the overall impact on the environment per ton of concrete is limited. The paper covers the aspect on how to choose a material for green concrete. It presents the feasibility of the usage of by product materials like fly ash, query dust, marble powder/ granules, plastic waste and recycled concrete and masonry as aggregates in concrete. The use of fly ash in concrete contributes the reduction of greenhouse emissions with negative impacts on the economy. It has been observed that 0.9 tons of CO2 is produced per ton of cement production. Also, the composition of cement is 10% by weight in a cubic yard of concrete. Thus, by the use of green concrete it is possible to reduce the CO2 emission in atmosphere towards eco-friendly construction technique. To avoid the pollution and reuse the material, the present study is carried out. Thus, green concrete is an excellent substituent of cement as it is cheaper, because it uses waste products, saving energy consumption in the production. The concrete is made with concrete wastes which are eco-friendly so called as Green concrete. Over and above all green concrete has greater strength and durability than the normal concrete.

Keywords: Concrete, Eco-Friendly Concrete, Eco-Friendly Construction Material, Efficient Concrete, Green Concrete

I. INTRODUCTION

The concrete which is made using wastes which is eco-friendly is called as Green concrete. Green concrete is a revolutionary topic in the history of concrete industry. It was first invented in Denmark in the year 1998. The CO2 emission related to concrete production, inclusive of cement production, is between 0.1 and 0.2 ton per ton of produced concrete. Since concrete is the second most consumed entity after water it accounts for around 5% of the world's total CO2 emission (Ernst Worrell, 2001). However, since the total amount of concrete produced is so vast the absolute figures for the environmental impact are quite significant. The solution to this environmental problem is not to substitute concrete for other materials but to reduce the environmental impact of concrete and cement. Usage of quarry rock dust along with fly ash and micro silica reported satisfactory properties. The potential environmental benefit to society of being able to build with green concrete is huge. It is realistic to assume that technology can be developed, which can have the CO2 emission related to concrete production. With the large consumption of concrete this will potentially reduce the world's total CO2 emission by 1.5 - 2%..There is a large potential in investigating the possible use of these for concrete production. Well-known residual products such as silica fume and fly ash may be mention.

II. LITRATURE REVIEW

Published by prof.chetan M vyas,prof.darshana R Bhatt July-2013	Imact of properties of raw material specially properties of recycled aggregate Is studied.recycled material is not nearly as sound or durable as aggregate.
Prof.chiraggarg and akash Jain Feb-2014	Paper cover the aspect on how to choose material for green concrete.green concrete has gretter strength and durability than normal concrete.
Ananthkamath K and mohammad khan 2017	In this paper reference in the carbon dioxide emission of green Concrete and normal concrete is studied
Bambangsuhendro2014	In this paper different characterstics of green concrete are studied (compared like strength sutability, advantages etc but more importance is given to the impact of green concrete on environment.
Vandanasingh July-2016	When fly ash and marble powder is the raw material used in green concrete than increase in percentage of fly ash and marble powder there is increase

III.MATERIALS FOR GREEN CONCRETE

Green construction materials are composed of renewable, rather than non-renewable resources. Green materials are environmentally responsible because impacts are considered over the life of the product. Depending upon project-specific goals, green materials may involve an evaluation of one or more of the following criteria.

3.1 Coarse Aggregate:

Aggregate contents have direct and far-reaching effect on both the quality and cost of concrete. Unlike water and cement, which do not alter in any particular characteristic except in the quantity in which they are used, the aggregate component is infinitely variable in terms of shape, size and grading etc. With coarse aggregates graded infractions between 5mm and 40mm, differences in particle shape and surface texture affect the bulk void content and frictional properties of concrete. Generally the requirement of course aggregate in concrete is more than 50%. Similarly sand required is about 30%. They contribute in large quantity so its availability and effect on environment must be carefully examined. Following source of coarse aggregate are discussed:

- Fresh Local Aggregate
- Recycled Demolition Waste Aggregate
- Recycled Concrete Material (RCM)
- Ground Granulated Blast Furnace Slag (GGBS):

a. Fresh Local Aggregate:

Many places there are stone quarry available. Though these may not be of high quality stone like granite, basalt, Dolomite etc. but they may be of little lower quality. These can be used in making concrete with the help of appropriate mix design - may be for lower characteristic strength.

b. Recycled Demolition Waste Aggregate:

Construction industry produces huge waste called demolition waste or MALWA. It is estimated that per capita waste generation (including Municipal waste) generally range from 0.4 to 0.8 Kg per day per person. The waste contributes to greenhouse gas emissions and thus waste prevention and/or its recycling will reduce greenhouse gases and methane gas emissions etc. Therefore, for sustainability of resources, it is necessary that all waste must be scientifically managed. The waste distribution shows that there is about 50% demolition waste in the dump. In order to have sustainability of resources this demolition waste must be recycled and used.

c. Recycled Concrete Material (RCM)

Recycled Concrete Material (RCM), also known as crushed concrete is similar to demolition waste. Primary sources of RCM are demolition of existing concrete pavement, building slabs & foundations, bridge structures, curb and gutter and from commercial or private facilities. This material is crushed by mechanical means into manageable fragments. The resulting material is in the form of Coarse Aggregate. Comprised of highly angular conglomerates of crushed quality aggregate and hardened cement, RCM is rougher and more absorbent than its virgin constituents

d. Ground Granulated Blast Furnace Slag (GGBS):

In India more than 10 million tons of Blast Furnace Slag is produced every year and it is increasing with the increase in steel production. Blast furnace slag is a waste product from the manufacture of pig iron. Iron ore, as well as scrap iron, is reduced to a molten state by burning coke fuel with fluxing agents of limestone and dolomite. Blast furnace slag is a non-metallic co-product produced in the process of steel production. BFS consists primarily of silicates, aluminates, silicates, and calcium-alumina-silicates.

Crushed Air-Cooled Blast Furnace Slag may be broken down as typical aggregate with the help of processing equipment to meet gradation specifications. Thus, blast furnace slag can be available as an aggregate as construction materials and acceptable as coarse or fine aggregate for use in green Concrete.

3.2 Fine Aggregate (Sand):

Following source of Fine aggregate are normally used. Some are discussed here:

1. Fresh River Sand
2. Manufactured Sand
3. Recycled Glass aggregate.

a. Recycled glass aggregate :

Glass is formed by super cooling a molten mixture of sand (silicon dioxide), soda ash (sodium carbonate), and/or limestone to form a rigid physical state. Glass aggregate is a waste product of recycled mixed glass from manufacturing and post-consumer waste. Glass aggregate, also known as glass cullet, is 100 percent crushed material that is generally angular, flat and elongated in shape. This fragmented material comes in variety of colours or colourless. The size varies depending on the chemical composition and method of crushing. When glass is properly crushed, this material exhibits fineness modulus & coefficient of permeability similar to sand. It has very low water absorption. High angularity of this material, compared to rounded sand, enhances the stability of concrete mixes. Such material can be easily used in concrete construction as fine aggregate and give a better cohesive mix which will save on the consumption of cement.

3.3 Partial replacement of cement with Fly Ash:

Fly ash is a by-product produced during the operation of coal-fired power plants. The finely divided particles from the exhaust gases are collected in electrostatic precipitators.

These particles are called Fly ash. Grey to black represents increasing percentages of carbon, while tan colour is indicative of lime and/or calcium content.

Fly ash particles are very smooth and quite spherical in shape. These particles range from 1 to 150 m in diameter. Based on its composition, fly ash is classified into two groups: ASTM Class C or high calcium fly ash and ASTM Class F or low calcium fly ash are the two categories of fly ash.

a. Use of Fly ash & Economic Impact:

Fly ash can be used as part replacement of Cement in Concrete. Finer the fly ash, better is its reactivity and lesser is its water requirement. Fly ash particles finer than 10 microns get adsorbed on cement particles giving a negative charge causing dispersion of cement particle flocks, thereby releasing the water trapped within the cement particle flocks and improves workability.

b. Advantages Of Using Fly Ash in Concrete:

● Utilization of fly ash as a part replacement of cement or as a mineral admixture in concrete saves on cement and hence the emission of CO2.

● Use of good quality fly ash in concrete has shown remarkable improvement in durability of concrete, especially in aggressive environment.

● Some of the technical benefits of the use of fly ash in Green Concrete are:

a) Higher ultimate strength

b) Increased durability

c) Improved workability

d) Reduced bleeding

e) Increased resistance to alkali-silica reactivity.

f) Reduced shrinkage.

3.5 Micro Silica:

Micro Silica is a by-product of producing silicon metal or ferrosilicon alloys. One of the most beneficial uses for Micro Silica is in concrete. Because of its chemical and physical properties, it is a very reactive pozzolan. Concrete containing Micro Silica can have very high strength and can be very durable. Micro Silica is available from suppliers of concrete admixtures and, when specified, is simply added during concrete production. Placing, finishing, and curing silica-fume concrete require special attention on the part of the concrete contractor.

High-strength concrete is a very economical material for carrying vertical loads in high-rise structures. Until a few years ago, 6,000 psi concrete was considered to be high strength. Today, using Micro Silica, concrete with compressive strength in excess of 15,000 psi can be readily produced.

Micro Silica for use in concrete is available in wet or dry forms. It is usually added during concrete production at a concrete plant. Micro Silica-concrete has been successfully produced in both central-mix and dry-batch plants. Assistance is readily available on all aspects of handling Micro Silica and using it to produce consistent, high-quality concrete.

3.6 Use of Marble powder:

Marble as a building material especially in palaces and monuments has been in use for ages. However the use is limited as stone bricks in wall or arches or as lining slabs in walls, roofs or floors, leaving its wastage at quarry or at the sizing industry generally unattended for use in the building industry itself as filler or plasticizer in mortar or concrete. The result is that the mass which is 40% of total marble quarried has reached as high as millions of tons. This huge unattended mass of marble waste consisting of very fine particles is today one of the environmental problems around the world (Corinaldesi et al., 2010). One of the logical means for reduction of the waste marble masses calls for utilizing them in building industry itself. Some attempts have been made to find and assess the possibilities of using waste marble powder in mortars and concretes and results about strength and workability were compared with control samples of conventional cement sand mortar/concrete.

IV.COMPARISON OF ORDINARY AND GREEN CONCRETE

In comparison to ordinary Portland cement

- Green concrete features greater corrosion resistance,
- substantially higher fire resistance (up to 2400° F),
- high compressive and tensile strengths, a rapid strength gain,
- lower shrinkage.

Green concrete's greatest appeal may be its life cycle greenhouse gas reduction potential -- as much as 90% when compared with ordinary Portland cement as shown in table 2.1. Researchers at the TTC continue to work on ways to replace Portland cement with cementitious binders made from industrial waste. Some next generation green concrete could last several times longer than ordinary concrete.

V.SUITABILITY OF GREEN CONCRETE IN STRUCTURES

- Reduce the dead weight of a facade from 5 tons to about 3.5 tons.
- Allow handling, lifting flexibility with lighter weight.
- Good thermal resistance
- Provide good fire resistance.
- Sound insulation than the traditional granite rock.
- Improve damping resistance of building.
- Speed of construction, shorten overall construction period.

IJARSE
ISSN: 2319-8354

VI.ADVANTAGES OF GREEN CONCRETE

Green concrete is part of a movement to create construction materials that have a reduced impact on the environment. It is made from a combination of an inorganic polymer and 25 to 100 percent industrial waste. Here is a list of 4 benefits to using green concrete for your next project.

6.1 Lasts Longer:

Green concrete gains strength faster and has a lower rate of shrinkage than concrete made only from Portland cement. Structures built using green concrete have a better chance of surviving a fire (it can withstand temperatures of up to 2400 degrees on the Fahrenheit scale). It also has a greater resistance to corrosion which is important with the effect pollution has had on the environment (acid rain greatly reduces the longevity of traditional building materials). All of those factors add up to a building that will last much longer than one made with ordinary concrete. Similar concrete mixtures have been found in ancient Roman structures and this material was also used in the Ukraine in the 1950s and 1960s. Over 40 years later those Ukrainian buildings are still standing. If buildings don't constantly have to be rebuilt, fewer construction materials are needed and the impact to the environment during the process of making those materials is reduced.

6.2 As Industrial Waste:

Instead of a 100 percent Portland cement mixture, green concrete uses anywhere from 25 to 100 percent fly ash. Fly ash is a by-product of coal combustion and is gathered from the chimneys of industrial plants (such as power plants) that use coal as a power source. There are copious amounts of this industrial waste product.

Hundreds of thousands of acres of land are used to dispose of fly ash. A large increase in the use of green concrete in construction will provide a way to use up fly ash and hopefully free many acres of land.

6.3 Energy Consumption:

If you use less Portland cement and more fly ash when mixing concrete, then you will use less energy. The materials that are used in Portland cement require huge amounts of coal or natural gas to heat it up to the appropriate temperature to turn them into Portland cement. Fly ash already exists as a byproduct of another industrial process so you are not expending much more energy to use it to create green concrete. Another way that green concrete reduces energy consumption is that a building constructed from it is more resistant to temperature changes. An architect can use this and design a green concrete building to use energy for heating and cooling more efficiently.

6.4 CO2 Emissions:

In order to make Portland cement–one of the main ingredients in ordinary cement–pulverized limestone, clay, and sand are heated to 1450 degrees C using natural gas or coal as a fuel. This process is responsible for 5 to 8 percent of all carbon dioxide (CO_2) emissions worldwide. The manufacturing of green concrete releases has up to 80 percent fewer CO_2 emissions. As a part of a global effort to reduce emissions, switching over completely to using green concrete for construction will help considerably.

VII. LIMITATIONS OF GREEN CONCRETE

Although Green Concrete seems very promising to an environment friendly sustainable development, the cardinal concern is its durability. Refutations are being made constantly raised regarding the service life of structures made with Green Concrete. Further split tensile strength of Green concrete has been found much less than that of conventional concrete. Another challenge before green Concrete is that of a market until the properties of Green Concrete are at par with the conventional concrete, Green Concrete is unlikely to find many customers.

Several researches have argued that Green Concrete may be durable by using stainless steel reinforcements but prediction is that by using stainless steel, the cost of the concrete increases considerably. Even after this Green Concrete is not as durable as conventional concrete.

The limitations of Green Concrete can be summarized as follows:-

- By using stainless steel , cost of reinforcements increases
- Structures constructed with Green Concrete has comparatively less life.
- Split tensile strength is less than the conventional concrete.
- Not as durable as conventional concrete.

Given these limitations coupled with urgent need of reduction in greenhouse gas emission, has sparked off a number of researches across the globe to make Green Concrete more durable and bring it up to the mark of conventional concrete.

VIII.APPLICATION AND PROPERTIES

8.1 Applications

a. Liquid adhesive:

Polyguard green concrete liquid adhesive is a rubber based adhesive in solvent solution which is specifically formulated to provide excellent adhesion with the polyguard waterproofing membrane under many kinds of surface conditions. In addition it is formulated to promote adhesion of the polyguard membranes to green concrete. Green concrete liquid adhesives an integral part of the polyguard waterproofing system and sufficient liquid adhesive must be used on surfaces to condition them to be dust free so that the substrate is suitable for the application of polyguard waterproofing membranes. Polyguard green concrete liquid adhesive will be a green colour in appearance.

Other applications of green concrete

- Pervious – Manage Storm Water
- Parking, Paving and UTW as shown in Figure 3.1
- Impervious-Green Roofs
- Concrete as a Finish Material
- High Mass Buildings
- Insulating Concrete Forms

b. Production of masonry units using green concrete:

Masonry units may be manufactured using construction and demolition waste (C&DW). C and DW is used in the manufacture of recycled crushed aggregate (RCA) after crushing. The RCA is then used as the main ingredient in a 14MPa green concrete plaster brick. This has several advantages in terms of reducing embodied energy and preserving the environment:

• The C&DW would normally be dumped in landfill sites, thereby impacting on sensitive areas. Thus using RCA in the manufacture of concrete masonry products eases the pressure on the landfill sites. • Using RCA means that less virgin materials such as sand and stone have to be quarried, thereby directly lessening the mining impact on the environment. • The embodied energy involved in quarrying of aggregates and then transporting them to the site of manufacture is saved.

The end result is a truly green building product. The 14MPa concrete plaster brick is an engineering grade, load-bearing, structural concrete masonry unit as approved by the Concrete Manufacturers Association (CMA).All concrete masonry produced by members of the CMA is naturally thermally efficient, and has the effect of creating walling with high insulation and thermal properties. This results in buildings with reduced heating and cooling energy consumption. The walling helps to ensure that buildings stay warm in winter and cool in summer, thereby lessening the need for artificial climate control.

8.2 HARDENED PROPERTIES:

a. Compressive strength

The 150 mm size concrete cubes, concrete the compressive strength . The results of standard cubes are compiled in Table-3.2. The Indian standard method resulted in highly conservative results of compressive strengths for the M20 grades of concrete. Compressive strength were obtained as per IS: 516-1959..The 7 days and 28 days compressive strength of green concrete is 6.49% and 9.49% higher than controlled concrete respectively The authors suggest that a slightly less strength of concrete at early age, in some degree, is beneficial to the durability of the concrete. Table 3.2 gives a comparison

Compressive Strength Mpa (M20)					
Conventional Concrete	7 days	17.698	19.876	17.204	18.26
	28 days	26.187	25.502	25.253	25.31
Eco. Concrete (Flyash +Micro SIlica)	7 days	15.14	16.34	16.52	16
	28 days	24.213	25.098	24.035	24.48
Eco. Concrete (Flyash+ GGBFS)	7 days	16.124	17.502	16.521	16.71
	28 days	24.502	24.998	25.253	24.91
	7 days	12.04	13.56	14.42	13.34

Eco.Concrete (Sugarcane Baggase Ash)	28 days	19.28	21.23	18.27	19.59
Eco.Concrete(Recycled Aggregate)	7 days	16.211	16.951	17.011	16.72
	28 days	23.152	24.121	25.132	24.13
Eco.Aggregate(Marble owder)	7 days	15.13	14.9	15.19	15.07
	28 days	18.25	18.99	20.23	19.15
Eco.Aggregate(Glass Waste)	7 days	17.24	17.28	16.25	16.92
	28 days	20.24	19.25	20.19	19.89

IX.SCOPE OF GREEN CONCRETE

Green Concrete is a revolutionary topic in the history of concrete industry. Concrete is an indispensible entity for a developing country like India which desperately needs continuously expanding infrastructure. India is the second largest producer of cement in the world. Further India would be facing an exponential growth in the concrete demand by 2011 (Schumacher, 1999).

Being produced in voluminous quantities in India, the concrete industry has a considerable part in the net CO2 emission of the country. The net CO2emissions from the construction agencies are greater than any other industry. In order to act in a responsible manner towards a sustainable development of the nation, Green Concrete is the need of the hour. India being a developing country produces concrete in large quantities which result in huge volume of CO2 being emitted in the atmosphere each year. Thus we can deduce that for a greener future, India needs to adopt Green Concrete into practice as soon as possible. The other advantageous factor is the economy. As Green Concrete is made with concrete wastes and recycled aggregates which are cheaper than theconventional substitutes, and also with most of the industries facing problems with their waste disposal, put it out of question to discard it.

Thus the scope for Green concrete can be summarized as follows:-

- Green concrete is a revolutionary topic in the history of concrete industry.
- As green concrete is made with concrete wastes it does take more time to come in
- India because industries having problem to dispose wastes.
- Also having reduced environmental impact with reduction in CO2 emission

X.CONCLUSION

The overview of the present state of affairs regarding concrete types with reduced environmental impact has shown that there is considerable knowledge and experience on the subject. The Danish and European environmental policies have motivated the concrete industry to react and will probably also motivate further development of the production and use of concrete with reduced environmental impact. The somewhat vague environmental requirements that exist have resulted in a need for more technical requirements and most important goal is to develop the technology necessary to produce and use resource saving structures i.e. Green Concrete. This applies to structural design, specification, manufacturing, performance, operation and maintenance.

In 1994 cement industry consumed 6.6 EJ of primary energy, corresponding with 2%

of world's energy consumption. Worldwide 1126 Mt CO2 or 5 of the CO2 production original from cement production. The carbon intensity of cement making amounts to 0.81 kg CO2 / kg of cement. In India, North America and china, the carbon intensity is 10% higher than an average. Specific carbon emissions range from 0.36 kg to 1.09 kg CO2 / kg cement mainly depending on type of process, clinker cement ratio and fuel used.

The potential environmental benefit to society of being able to build with Green Concrete is huge. It is realistic to assume that the technology can be developed which can halve the CO2 emission related to concrete production and the large energy consumption of concrete and the following large emission of CO2 this will mean a potential reduction of total CO2 emission by 2% (Obla 2009).

Seventeen different energy efficiency impthan 52% per option, depending on the reference case and local situation. The use of waste instead of fossil fuel may reduce CO2 emission by 0.1 – 0.5 kg / kg cement. At the end of pipe technology to reduce CO2 emissions may be CO2 removal. Probably the main technique is combustion under oxygen while recycling CO. However considerably research is required for all unknown aspects of this technique.

It is important to keep a holistic cradle to cradle perspective when it comes to the use of a material. Based on a research, it was concluded that the occupant for 99% of life cycle energy use of a single family home. Less than 1% of the life cycle energy used in that home was due to manufacturing cement and producing concrete. The global cement industry accounts for approximately 5% of global CO2 emissions. So whatever way one looks at it focusing on just the production of concrete accounts for a very small percent of overall CO2 emissions. This is not to say that progress should not be made in reducing the CO2 emission from concrete as produced. However one should keep in mind that whatever CO2 emission reductions that are possible will still account for a best of 2% global

CO2 reduction rovement options are identified. The improvement ranges from a small percent to more.

REFERRNCES

[1.] "Concept of green concrete using Construction Demolishment Waste As Recycled Coarse Aggregate" – International Journal of Engineering Trends And Technology – Volume 4 Issue 7 –July 2013 – ISSN: 2231-5381

[2.] "Green Concrete : Efficient And Eco Friendly Construction Material" – Impact :IJRET Volume 2 Issue 2 Feb 2014 –ISSN(E):2321 – 8843

[3.] "Green Concrete For Sustainable Construction" – IJRET Volume 2 Issue 11 Nov 2013 – ISSN (E) : 2319-1163 ; ISSN(P):2321-7308

[4.] "To Study The Effect On Properties Of Concrete Of Marble Powder And Fly Ash By Replacement Of Cement" – SSRG-IJCE- Volume 3 Issue 7 July 2016- ISSN : 2348-8352

[5.] "Green Concrete" – IJIR Volume 3 Issue 1 2017 – ISSN : 2454-1362

[6.] "Environmental Lyfe Cycle Inventory OF Single Family Housing" – Gajda ,J VanGeen, Martha G , Medgar l, SN2582a, Portland Cement Association , Skokie , PCA 2002

WEBLINKS:

[1.] http://www.ieagreen.org.uk/

[2.] http://en.wikipedia.org/Pervious_Concrete

[3.] http://www.enercon.com

[4.] http://www.epa.gov/nrmrl/news/news102008.html

[5.] http://www.greenconcretedenmark.dk/

[6.] http://www.perviousblog.com