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Environmental Benefits of Green Concrete

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Abstract- ***A Green Concrete is a revolutionary topic in the history of concrete industry. This was first invented in Denmark in the year 1998 . Green concrete has nothing to do with colour. It is a concept of thinking environment into concrete considering every aspect from raw materials manufacture over mixture design to structural design, construction, and service life. Green concrete is very often also cheap to produce because for example, waste products are used as a partial substitute for cement, charges for the disposal of waste are avoided, energy consumption in production is lower, and durability is greater. Green concrete is a type of concrete which resembles the conventional concrete but the production or usage of such concrete requires minimum amount of energy and causes least harm to the environment. The CO2 emission related to concrete production, is between 0.1 and 0.22 t per tonne of produced concrete. However, since the total amount of concrete produced is so vast the absolute figures for the environmental impact are quite significant, due to the large amounts of cement and concrete produced. Since concrete is the second most consumed entity after water it accounts for around 5% of the world's total CO2 emission. The solution to this environmental problem is not to substitute concrete for other materials but to reduce the environmental impact of concrete and cement. 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 halve the CO2 emission related to concrete production. During the last few decades society has become aware of the deposit problems connected with residual products, and demands, restrictions and taxes have been imposed. And as it is known that several residual products have properties suited for concrete production, 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 mentioned. The concrete industry realized at an early stage that it is a good idea to be in front with regard to documenting the actual environmental aspects and working on improving the environment rather than being forced to deal with environmental aspects due to demands from authorities, customers and economic effects such as imposed taxes. Furthermore, some companies in concrete industry have recognized that reductions in production costs often go hand in hand with reductions in environmental impacts. Thus, environmental aspects are not only interesting from an ideological point of view, but also from an economic aspect. Green concrete has manifold advantages over the conventional concrete. Since it uses the recycled aggregates and materials, it reduces the extra load in landfills and mitigates the wastage of aggregates. Thus, the net CO2 emission are reduced . The reuse of materials also contributes intensively to economy. Green concrete can be considered elemental to sustainable development since it is eco-friendly itself. Green concrete is being widely used in green building practices.***

Keywords--: Green concrete, recycled, cement, coarse and fine aggregates.

A. Introduction

Concrete is the most common material used in the construction of civil engineering structures. Due to its environmental impact, it is also one of the most costly ones. Ordinary concrete typically contains about 12% cement and 80% aggregate by mass (Neville, 1996). Global construction industry uses approximately 1.6 billion tonnes of cement and 10 billion tonnes of sand, gravel, and crushed rock every year (Mehta, 2001). The world's yearly cement production of 1.6 billion tonnes accounts for about7% of the global loading of carbon dioxide (CO2) into the atmosphere (Mehta, 2001). Mining large quantities of raw materials for the production of cement such as limestone and clay, and fuel such as coal, often results in extensive deforestation or denudation and top-soil loss (Mehta, 2001).

Concrete structures have service lives of several decades to more than a century. Those structures that are no longer able to fulfill their original purpose after their service life will be demolished. The demolished materials are considered as construction and demolishing (C&D) waste, and concrete constitutes a large part of this waste. The annual worldwide output of concrete and masonry rubble has been estimated roughly as one billion tonnes (Mehta, 2001). In Canada, the C&D waste is estimated as 11 million tonnes per year, and approximately 42% (by weight) of this amount is reused or recycled. Concrete constitutes 52% of C&D waste, and approximately 73% of it is reused in low-value applications as filler material or as road sub-grade (George and Michael, 2001). In Canada, the total aggregate supply is around 350.5 million tonnes per year in 2003 figures (Panagapko, 2003). Continuous use of natural aggregates (NA) and cement to produce conventional concrete has negative effects on the environment. These effects can be summarized as follows:

1. The presence of some substances in concrete, including useful and unwanted additives, can cause health concerns due to toxicity and (usually naturally occurring) radioactivity.[4] Wet concrete is highly alkaline and should always be handled with proper protective equipment. Concrete recycling is increasing in response to improved environmental awareness, legislation, and economic considerations. Conversely, the use of concrete mitigates the use of alternative building materials such as wood, which is a natural form of carbon sequestering.
2. Impact of the NA production on the quality of the surface and groundwater resources is a significant concern. The excavation of aggregate resources alters the slope of the land, and hence changes water drainage patterns. In addition, by excavating the aggregate deposits that serve as underground water reservoirs, the water storage capacity of the ground is diminished.
3. Disposal of construction and demolition waste has become a major problem these days, according to the report of Technology, Information, Forecasting, Assessment Council the total amount of waste from construction industry is estimated to be 12 to 14.7 million tons per annum. Out of which 7.8 million tons are concrete and brick waste. Because of increasing problems of these wastes many countries have started researches to use these materials as source.
4. Surface runoff, when water runs off impervious surfaces, such as non-porous concrete, can cause severe soil erosion and flooding. Urban runoff tends to pick up gasoline, motor oil, heavy metals, trash and other pollutants from sidewalks, roadways and parking lots. Without attenuation, the impervious cover in a typical urban area limits groundwater percolation and causes five times the amount of runoff generated by a typical woodland of the same size. A 2008 report by the United States National Research Council identified urban runoff as a leading source of water quality problems.
5. The presence of some substances in concrete, including useful and unwanted additives, can cause health concerns. Natural radioactive elements (K, U, Th, and Rn) can be present in various concentration in concrete dwellings, depending on the source of the raw materials used. For example, some stones naturally emit Radon, and Uranium was once common in mine refuse. Toxic substances may also be unintentionally used as the result of contamination from a nuclear accident.[62] Dust from rubble or broken concrete upon demolition or crumbling may cause serious health concerns depending also on what had been incorporated in the concrete. However, embedding harmful materials in concrete is not always dangerous and may in fact be beneficial. In some cases, incorporating certain compounds such as metals in the hydration process of cement immobilizes them in a harmless state and prevents them from being released freely elsewhere.

OBJECTIVE OF PROJECT

1. The main objective is to establish a efficient way to use green concrete, that would helpful to prepare a healthy environment. As green concrete reduces the emission of green house gases like carbon di oxide and other gases .

2. Extensive use of GC in the construction industry will result in savings in energy consumption and consequently reductions in GHG emissions in the long term.

IMPACT ON ENVIRONMENT DUE TO CONCRETE

The main constituent of concrete, cement, during its production has a substantial effect on the environment by releasing carbon dioxide (CO2). Similarly, extensive mining of stone to produce coarse aggregates creates many new fault lines in the natural rocky terrain, making it prone to earthquakes and causing diversion of flow of water from its natural course. Due to excessive mining of sand, the river course is being changed, leading to floods.

1. About 0.9 tons of carbon dioxide is produced for every 1 ton of cement produced. Carbon dioxide is one of the green house gas which is responsible for global warming.
2. Major ingredient in the production of concrete is aggregates without aggregates it is impossible to produce concrete. Aggregates are mined from the rock mines and the rate with which concrete is produced there will be significant reduction in naturally occurring materials.
3. Disposal of construction and demolition waste has become a major problem these days, according to the report of Technology, Information, Forecasting, Assessment Council the total amount of waste from construction industry is estimated to be 12 to 14.7 million tons per annum. Out of which 7.8 million tons are concrete and brick waste. Because of increasing problems of these wastes many countries have started researches to use these materials as source.

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GREEN CONCRETE

Green concrete is conventional concrete made up of waste cementitious material; its use reduces the environmental impact of conventional concrete; therefore, replacing concrete ingredients with Construction and Demolition Waste is recommended.

Green Concrete is cheap to produce because waste products are used as partial substitute for cement, charges for the disposal are avoided, energy consumption in production is lower, and durability is greater. Waste can be used to produce new products or can be used as admixtures so that natural resources are used more efficiently and the environment is protected from waste deposits. Concrete recycling is increasing due to improved environmental awareness, governmental laws and economic benefits.

Concrete is the most vital material used in construction. While demolishing buildings, a lot of building debris gets accumulated, which is generally dumped in low lying areas or wastelands, thereby closing the natural water drains or storage places for rain water. Recycling of demolished materials is carried out in many recycling plants, so that construction material, mainly coarse aggregate and sand, is produced from demolished debris or waste ready mix material and reused in construction. Similarly, there are substitutes for cement to reduce the CO2 emissions. Concrete produced with recycled / waste material or with substitutes has less impact on the environment and may be termed as Green Concrete. Green concrete is made up of environment friendly materials as well as recycled material from construction and demolition waste, and can be used for construction purposes.

Replacement material for green concrete

USE OF RECYCLED AGGREGATES

Construction and Demolition disposal has emerged as a major problem in all over the world. In USA, approximately 135 million tons of Construction and Demolition waste is generated annually. Wastes' arising from construction and demolition constitutes one of the largest streams within the European Union and many other countries. It is now widely accepted that there is significant potential for reclaiming and recycling demolished debris for use in value added applications to maximize economic and environmental benefits. As a result recycling industries grew up. Many governments throughout the world have now introduced various measures aimed at reducing the use of primary aggregates and encouraging reuse and recycling, where it is technically, economically, or environmentally acceptable. Recycling industries in many parts of the world converts low value waste into secondary construction material such as aggregate grades, road materials and aggregate fines. While accepting the need to promote the use of Recycled Concrete Aggregate (RCA) in wider applications, it must be remembered that the aggregate for concrete applications must meet the requirements set in relevant specifications for its particular use. The gap between these interests has to be reduced in steps that are manageable and the use of RCA in structural concrete has to be promoted gradually. Similarly considerable attention is required to the control of waste processing and subsequent sorting, crushing, separating and grading the aggregate for use of the concrete construction industry. In addition, there is an urgent need for legislative or regulatory measures to implement sustainable Construction & Demolition waste management strategy and encourage recycling for use in value added applications. A number of different processes are possible for the crushing and sieving of Construction & Demolition waste. Such material often contains foreign matter in the form of metals, wood, hardboard, plastics, papers etc. Hence, a process scheme has to be adopted which removes large pieces of these materials, mechanically or manually, before crushing and thorough cleaning of the crushed product.

1. It has been reported that there is a loss in compressive strength of concrete when recycled aggregates are used for production of concrete as direct replacement to natural aggregates.
2. Therefore it can be used as partial replacement to natural aggregates.
3. The lower compressive strength recorded for concrete produced with recycled aggregate was due to higher water cement ratio, which was required to facilitate mixing due to absorption of the recycled fine particles.
4. Recycled aggregate concrete will have higher water absorption than conventional concrete, it is mainly due to adhered mortar with recycled aggregates.
5. Recycled aggregate concrete will have slightly higher drying shrinkage; this is mainly because of increase in water/cement ratio.
6. Recycled aggregate concrete has better resistance to carbonation it is mainly due to porous recycled aggregates and presence of old mortar attached to crushed stone aggregate.
7. Recycled aggregate concrete provides better resistance to freezing and thawing than concrete produced by mixing natural aggregates.
8. For concrete producers, the use of coarse RCA is unlikely to pose any problem in the production of concrete that is stable in the fresh state and able to develop properties comparable to the corresponding Normal Aggregate Concrete in hardened state. This is of great importance to reduce inhibition of concrete specifiers and producers towards using RCA.
9. The key engineering and durability properties of RCA concrete are similar to corresponding Normal Aggregate Concrete, providing the mixes are of equivalent strength achieved through adjustment in the w/c ratio
10. Overall, the practical benefits resulting from the current work are not only on environmental and economical fronts, but they could also provide the construction industry with technical information on a marketable product, which is presently under utilized.

USE OF QUARRY DUST

Common river sand is expensive due to excessive cost of transportation from natural sources. Also large-scale depletion of these sources creates environmental problems. As environmental transportation and other constraints make the availability and use of river sand less attractive, a substitute or replacement product for concrete industry needs to be found. River sand is most commonly used fine aggregate in the production of concrete poses the problem of acute shortage in many areas. Whose continued use has started posing serious problems with respect to its availability, cost and environmental impact.

In such a situation the Quarry rock dust can be an economic alternative to the river sand. Quarry Rock Dust can be defined as residue, tailing or other non-voluble waste material after the extraction and processing of rocks to form fine particles less than 4.75mm. Usually, Quarry Rock Dust is used in large scale in the highways as a surface finishing material and also used for manufacturing of hollow blocks and lightweight concrete prefabricated Elements. Use of Quarry rock dust as a fine aggregate in concrete draws serious attention of researchers and investigators. In the recent past good attempts have been made for the successful utilization of various industrial by products (such as fly ash, silica fume, rice husk ash, foundry waste) to save environmental pollution. In addition to this, an alternative source for the potential replacement of natural aggregates in concrete has gained good attention. As a result reasonable studies have been conducted to find the suitability of granite quarry dust in conventional concrete. The utilization of Quarry rock dust which can be called as manufactured sand has been accepted as a building material in the industrially advanced countries of the west for the past three decades. As a result of sustained research and developmental works undertaken with respect to increasing application of this industrial waste, the level of utilization of Quarry Rock Dust in the industrialized nations like Australia, France, Germany Nov 2014 (Volume 1 Issue 6) JETIR (ISSN-2349-5162) and UK has been reached more than 60% of its total production. The use of manufactured sand in India has not been much, when compared to some advanced countries.

1. The durability of quarry dust concrete under sulphate attack is higher compared to conventional concrete.
2. The durability of quarry dust concrete under acid action is also better than conventional concrete.
3. The effects of quarry dust on the elastic modulus property are good with conventional concrete containing natural sand.
4. The fine quarry dust tends to increase the amount of super plasticizers needed for the quarry mixes in order to achieve the rheological properties.

Replacement of natural sand with Quarry Rock Dust, as full replacement in concrete is possible. However, it is advisable to carry out trial casting with Quarry Rock Dust proposed to be used, in order to arrive at the water content and mix proportion to suit the required workability levels and strength requirement. However, more research studies are being made on Quarry Rock Dust concrete necessary for the practical application of Quarry Rock Dust as Fine Aggregate.

Current scenario in India

About 35% of the total population in India comprises the urban population. The demand of building materials for 2021-22 is estimated to be about 380 million tonnes of cement, 50 million tonnes of steel, 600 billion number of bricks, 400 million cubic meters aggregate, and 40 million cubic meters of timber. There is a considerable amount of shortage of conventional and traditional building materials in India. Of late, fine aggregates are being imported and manufactured sand/stone dust is being used as replacement.

On the other hand, the re-development of housing and infrastructure as well as new construction to meet the increasing demand generates large volume of construction and demolition wastes. Indiscriminate dumping and non-utilization of generated debris results in fugitive air pollution and other hazards of solid waste dumping in drains, water bodies, empty plots and mixing up with municipal solid waste.

The Swachh Bharat Mission of Government of India has aimed for processing of 100% solid waste, including construction and demolition waste, in major cities and towns. The Ministry of Urban Development wants all the states to set up Construction and Demolition waste recycling facilities in all the cities and town with population over 1 million.

The proper management and processing of Construction and Demolition waste would be a win-win situation for all stakeholders. It would avoid indiscriminate dumping, land and air pollution, and would make available the building construction materials that are in short supply. It would also reduce the pressure on natural resources that are being otherwise exploited for building and road construction materials.

The Government is focusing on 100% utilization of waste material from construction and demolition industries. Construction and demolition waste in India in %age clearly shows that concrete holds majority of its parts.

As per the charts, it is unambiguous that 91% of total waste is Construction and Demolition waste and concrete hold more than half of Construction and Demolition waste alone. But India recycles only 1% of its Construction and Demolition waste.

Construction works using concrete are increasing all over the world for infrastructural development, which in turn increases the demand for construction materials. Aggregates are the main constituent of concrete. Due to continuous mining by blasting, the availability of aggregates has emerged as a major problem in recent times. In order to overcome this, there is an urgent need to find alternatives / replacement to some extent. Now a days, recycling of demolished materials is being done in many recycling plants, so that construction material (mainly coarse aggregate and sand) is produced from demolished debris or waste ready mix material and reused in construction.

Similarly, there are substitutes to cement to reduce the CO2 emissions. The concrete produced with recycled / waste material or with substitutes has less impact on environment and may be termed as Green Concrete. It is a concept of translating environment into concrete considering every aspect from raw materials manufacture over mix design to structural design, construction, and service life.

ADVANTAGES OF GREEN CONCRETE

1. Much change is not required for the preparation of green concrete compared to conventional concrete.
2. Reduces environmental pollution.
3, Have good thermal and acid resistance.
4. Compressive and split tensile strength is better with some materials compared to conventional concrete.
5. Saving the use of cement

Another alternative in reducing CO2 emissions through: (a) the substitution of cement with flay ash, (b) the use of
ground granulated blast furnace slag from steel plants, (c) use of micro silica, (d) the use of pozzolanic materials and
limestone powder, (e) various kinds of ash from the burning of domestic waste and bio-fuels, and (f) crushed waste glass.

6. Green concrete is economical compared to conventional concrete. Saving the use of cement, another alternative in reducing CO2 emissions through: (a) the substitution of cement with flay ash, (b) the use of ground granulated blast furnace slag from steel plants, (c) use of micro silica, (d) the use of pozzolanic materials and limestone powder, (e) various kinds of ash from the burning of domestic waste and bio-fuels, and (f) crushed waste.

DISADVANTAGES OF GREEN CONCRETE

Structures constructed with green concrete have comparatively less

1. Life than structures with conventional concrete.
2. Compressive strength and other characteristics are less compared to conventional concrete.
3. Water absorption is high.
4. Shrinkage and creep are high compared to conventional concrete.
5. Flexural strength is less in green concrete. The lack of a holistic approach in engineering education and research

The shift from reductionistic to holistic construction practices must begin by reforming the present system of education and research in the fields of concrete science and technology. Greening of the entire concrete construction industry will have to proceed before green concrete replaces conventional concrete as the material of choice for general construction.

6. In addition to strive for minimal environmental impact during the use cycle of concrete (since the process of making cement, concrete manufacture until, for example 50 years, concrete buildings that have been used dismantled / broken), which is no less important aspect in the success of efforts to conserve the environment are: (a) government policies/institutions/ industries through various forms of regulation, (b) the willingness of the user community, and (c) the willingness of the industry itself to change the perception.

CONCLUSIONS

1. There is significant potential in waste materials to produce green concrete. Right to 10 percent of the world's total CO2 emissions come from manufacturing cement. Green concrete is defined as a concrete which uses waste material as at least one of its components, or its production process does not lead to environmental destruction, or it has high performance and life cycle sustainability. Various efforts that have been conducted to arrive at some alternatives that are able to significantly reduce high energy consumed and environmental impacts during fabrication process of cement, including implementing the concept of industrial ecology and green chemistry as well as nanoengineering that study the behaviour of the structure and organization of nanoparticles of cement in the mix for achieving higher performance have been discussed. The cleaner technologies in concrete production, such as substituting relatively high percentage of cement by fly ash (upto100%), the use of other natural pozzolans, development of concrete with recycling or waste materials, and developing nano-concrete by integrating CNT's or self sensing CNT's in the concrete mix for higher performance developed have also been addressed in this paper. Several efforts that have been done so far in implementing the concept of green concrete and material development of nano-silica in Indonesia have also been reported. Problems in the realization of and potential barriers to green concrete as well as political scenarios that have been adopted by several countries through implementation of various priority and deregulation in various fields are also discussed. Hopefully this paper will be useful for all of us in order to mobilize all parties to participate actively to the conservation and protection of the global environment the world, through the use of green concrete.
2. The replacement of traditional ingredients of concrete by waste materials and by products gives an opportunity to manufacture economical and environment friendly concrete.
3. Partial replacement of ingredients by using waste materials and admixtures shows better compressive and tensile strength, improved sulphate resistance, decreased permeability and improved workability.
4. The cost per unit volume of concrete with waste materials like quarry dust is lower than the corresponding control concrete mixes.
5. A detail life cycle analysis of green concrete by considering various parameters is very much necessary to understand the resultant concrete properties.

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