Green Concrete: An alternate building material

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Abstract - *The rapid expansion of construction projects has helped humanity by meeting societal needs like infrastructure, buildings, etc. and by greatly boosting the nation's economy. In addition, it greatly contributes to the production of a large quantity of building waste and uses resources unnecessarily. A building or construction project's overall environmental, economic, and social implications are examined when using sustainable construction, which combines ethical environmental practices. Benefits of sustainable construction include reduced resource use during construction and operation, less environmental effect, little construction waste, reduced planning risk, and increased building viability. Concrete makes up around 5% of all global CO2 emissions and is the second most utilized material after water. An average of 927gm of carbon dioxide is created for every 1000kg of cement. One of the most efficient materials that has had a significant influence on the environment is cement.*

***Key Words*: Green concrete, cement, coarse aggregate, fine aggregate, sustainable.**

1.INTRODUCTION

The Latin word "concrettus" (meaning compact or condensed), which is the perfect passive participle of "concrescere" (for "con-" (together) and "crescere" (to grow), is where the term "concrete" originates. Many old constructions have been built with concrete. Roman concrete, also known as opus cementitious, was created during the Roman Empire using quicklime, pozzolana, and a pumice aggregate. It may be found in many Roman buildings. Roman structural concrete differs from modern structural concrete in two key ways. First off, the mix's fluid fluidity makes it easy to pour into molds rather than manually stacking the aggregate, which was frequently thought of as rubber in Roman practice. Second, while Roman concrete could only rely on the strength of the concrete bonding to resist stress, modern concrete assemblies have significant strength in tension because to inherent reinforcing steel. Cement (typically Portland cement) and other cementitious materials like fly ash and slag cement, aggregates (typically a coarse aggregate made of gravel or crushed rock such as limestone or granite, plus a fine aggregate such as sand), water, and chemical admixtures are all ingredients in concrete, which is a composite building material. Concrete is typically thought of as being composed of two phases: the paste phase and the aggregate phase. More than any other man-made substance, concrete is utilized all over the world. As of 2006, more than one cubic meter of concrete is produced annually for every person on the planet, or nearly 7.5 cubic kilometers.

1.1 What is green concrete?

"Green concrete" refers to concrete that is produced from recyclable concrete waste. Green concrete is created by using as many recycled resources as feasible and producing it with the least amount of carbon emissions. The alternative name for green concrete is resource-saving constructions with less environmental effect, such as waste water, energy, and CO_2 emissions. The concept of "green concrete" is novel in the history of the concrete industry. Dr. WG created this for the first time in 1998 in Denmark. Slag, waste from power plants, recycled concrete, trash from mining and quarries, waste glass, ash from incinerators, red mud, burnt clay, sawdust, and foundry sand are examples of concrete wastes. The phrase "green concrete" refers to concrete that has undergone additional mix design and installation stages to provide a long lifespan and low maintenance surface, such as reducing energy consumption, CO_2 emissions, and waste water. The Centre for Green Concrete seeks to lessen concrete's negative effects on the environment. New technology is created to make this possible (1Neeraj Agarwal, 2. G., 2018). The technique takes into account all stages of the life cycle of a concrete building, such as structural design, specification, manufacture, and maintenance, and it incorporates all performance characteristics, such as

1) Mechanical properties (strength, shrinkage, creep, static behavior etc.)

2) Fire resistance (spalling, heat transfer etc.)

3) Workmanship (workability, strength development, curing etc.)

4) Durability (anti-corrosion measures, frost protection, new degrading processes, etc.)

5) Thermodynamic characteristics (input to other characteristics)

6) Environmental aspects (CO_2-emission, energy, recycling etc.)

1.2 Suitability of green concrete in structures

The following features improve the acceptability of green concrete for use in structures: o Lower the dead load of the building and the crane age load; enable for easier handling and lifting of lighter loads.

- 30% reduction in CO_2 emissions.
- 20% increase in the waste products used by the concrete industry.
- Better sound insulation and thermal and fire resistance than conventional concrete.
- The building's damping resistance should be improved.
- Utilizing fresh varieties of leftover items that were previously landfilled or disposed of in different ways.
- Sustainable development without environmental deterioration. It needs fewer upkeep and repairs.
- The water cement ratio concrete has stronger compressive strength behaviour than regular concrete. green concrete has about the same flexural strength as regular concrete.
- CO_2-neutral fuels produced from waste must replace fossil fuels in the manufacturing of cement by at least 10%.
- Use of the concrete industry's own waste materials. (USMAN, 2017)

1.3 Suitability of green concrete in structures

1.3.1 Lasts Longer:

Compared to concrete created simply from Portland cement, green concrete strengthens more quickly and shrinks at a slower pace. Given that green concrete can resist temperatures of up to 2400 degrees Fahrenheit, buildings made with it are more likely to survive a fire. Additionally, it has better corrosion resistance, which is crucial given the negative environmental impact of pollution (acid rain drastically shortens the lifespan of conventional construction materials). A structure created using all of those elements will survive a lot longer than one made with regular concrete. Ancient Roman constructions have been discovered using concrete compositions similar to this one, and this material was also employed in the Ukraine in the 1950s and 1960s.

1.3.2 Uses Industrial Waste:

Green concrete employs any percentage of fly ash, ranging from 25 to 100 percent, in place of a 100 percent Portland cement mixture. A byproduct of burning coal, fly ash is collected from the chimneys of industrial facilities (like power plants) that utilize coal as a fuel. This industrial waste material is widely distributed. Fly ash is disposed of on hundreds of thousands of acres of land. Fly ash may be used up by a significant rise in the usage of green concrete in building, which should free up several acres of land.

1.3.3 Reduces Energy consumption:

In order to utilize less energy, use more fly ash and less Portland cement while mixing concrete. In order to heat the ingredients necessary to make Portland cement to the proper temperature, enormous volumes of coal or natural gas are required. Fly ash is already produced as a byproduct of another industrial process, so using it to make green concrete doesn't require any additional energy. A structure made of green concrete is more resilient to temperature variations, which is another way it lowers energy usage. This may be used by an architect to create a green concrete structure that uses energy for heating and cooling more effectively.

1.3.4 Reduces CO_2 emissions:

Pulverized limestone, clay, and sand are heated to 1450 degrees C using natural gas or coal as the fuel to create Portland cement, one of the key components of regular cement. 5 to 8% of the world's total carbon dioxide (CO_2) emissions are attributable to this process. Up to 80% less CO_2 is released during the production of green concrete. Completely transitioning to utilizing green concrete for building will significantly aid in the worldwide effort to cut emissions.

1.4 Scope in India

In the history of the concrete industry, the concept of "green concrete" is groundbreaking. Due to the difficulty Indian enterprises have in disposing of waste and the country's decreased environmental effect due to lower CO_2 emissions, green concrete takes longer to arrive in India. We can significantly minimize the amount of product waste by using green practices. Numerous non-biodegradable goods can also be utilized, solving the problem of how to dispose of them.

2. PROJECT OVERVIEW

2.1 Glass as cementitious material

Every year, millions of tons of waste glass are produced worldwide. Glass is disposed of in landfills after it becomes garbage, which is unsustainable because glass does not disintegrate in the environment. Silica is the main component of glass. Use of milled (ground) waste glass as a partial replacement for cement in concrete might be a significant step toward the development of sustainable infrastructure systems (environmentally friendly, energy-efficient, and cost-effective). Waste glass is anticipated to undergo pozzolanic interactions with cement hydrates and produce secondary Calcium Silicate Hydrate (C-S- H) when it is ground down to micron-sized particles. The results of the compressive strength test revealed that recycled glass mortar and concrete outperformed the control samples in terms of strength. It was determined that a 20% substitution of waste glass for cement made financial and environmental sense. According to the aforementioned ASTM standard, the specific gravity and fineness of the clear and colorful waste glass powders (made in a ball mill) were 3.01 and 0.9% (#200 sieve) and 3.02 and 0.9%, respectively. (1Neeraj Agarwal, 2018)

2.2 Fly ash as cementitious material

Fly ash is an extremely fine powder that has a propensity to float far in the air. It is known to damage air and water when improperly disposed of and to induce respiratory issues when breathed. It reduces the yield when it settles on leaves and crops in the fields surrounding the power plant. The residue left behind after burning pulverized coal comprises 80% fly ash and 20% bottom ash. Fly ash from Indian power plants has the appearance of cement powder and is light to mid-grey in hue. Fly ash concrete may be used in lieu of PCC, which will result in significant cement and energy reductions as well as cost benefits. (Aboginije Ademilade, May,2012). Utilizing fly ash has a number of advantages. Although fly ash has the potential to replace 100% of Portland cement, replacement levels beyond 80% often demand for a chemical activator. The ideal replacement amount, according to studies, is at around 30%. Fly ash may also make concrete more durable and enhance other characteristics.

It is especially well suited for mass concrete applications since it produces less heat of hydration. The optimal quantity of fly ash in concrete has various technical advantages and enhances concrete performance in both the fresh and hardened states. The addition of fly ash to concrete improves the workability of flexible concrete as well as the strength and durability of hardened concrete. In general, fly ash helps concrete by lowering the amount of water needed for mixing and enhancing paste flow characteristics. (Rangan, 2014)

2.3 Fly ash as aggregates

Fly ash may be used to create a variety of lightweight aggregates for concrete. In addition to employing furnace bottom ash in concrete construction, fly ash pellets may also be joined chemically with cement or lime or thermally using fusion. There are several positive traits of these materials. Midway through the 1990s, Pacific Power investigated the viability of producing sintered fly ash aggregates (Powellite) and the use of such aggregates in the manufacture of concrete. For the purpose of creating synthetic coarse and fine aggregates, fly ash was palletized and burned at a regulated temperature. These fly ash aggregates have a bulk density range of 650–790 kg/m3, a specific gravity range of 1.20–1.47, and extremely high absorption of 16.4%–24.8%. Fly ash as an aggregate demonstrated extremely promising results in these aspects. (ASHOK ADMUTE, 2017)

Silos, domes, and other bulk storage structures are used to store fly ash. Fly ash can be transported via pipelines utilizing pneumatic conveyance under positive or negative pressure, air slides, bucket conveyors, and screw conveyors. Bulk tanker trucks, rail trains, barges, and ships are used to carry fly ash to markets. Super sacks or smaller bags can be used to package fly ash for unique uses.

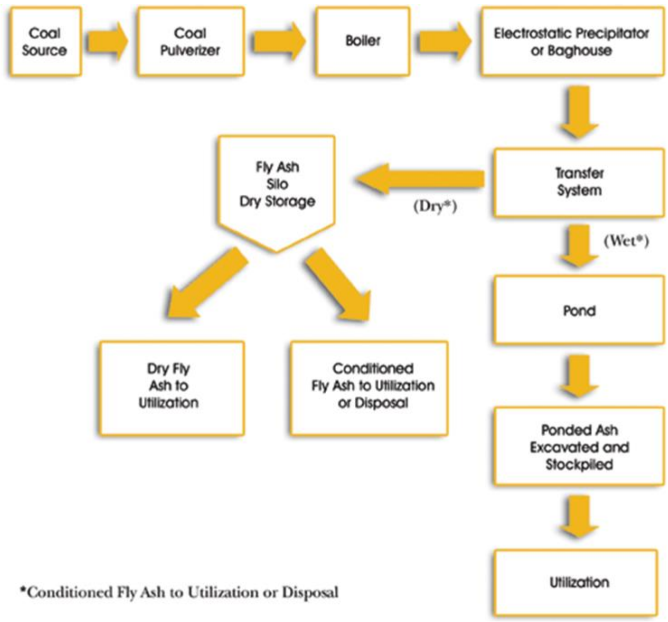

Fig - 1: Manufacturing cycle of Fly ash

2.4 Recycled concrete and masonry as aggregates

Typically used for road surface applications, coarse recycled concrete and masonry (RCM) is graded aggregate made from waste concrete and masonry that has been cleaned and sorted. Small amounts of blended stony material, such as bricks, gravel, crushed rock, or other types of stony material, may be present in the material. Crushed concrete fines is another name for fine recycled aggregates. Concrete's workability, bleeding rate, finish ability, and susceptibility to plastic cracking may be affected by the concrete's form, grading, and excessive particles. With no appreciable performance loss in cement-based goods, manufactured sand may replace a considerable amount of natural sand. (Rangan, 2014)

2.5 Waste plastic as concrete composite

Plastic is a material that is being developed for a variety of purposes, including product packaging, bottling, plastic buckets, plastic glass, bottles, and mugs, as well as furniture, kitchenware, and car components. Unfortunately, this low-cost, versatile, and sturdy material is non-biodegradable MSW, whose disposal is increasingly dangerous. Plastics are divided into two categories. The first kind is thermoplastic, which may be recycled in the plastics industry by being melted down. Polyethylene, Polypropylene, Polyamide, Polyoxymethylene, Polytetrafluorethylene, and Polyethylenerephthalate (PET) are among these polymers.

Thermosetting plastic is the second kind. Because of the chains' strong meshed crosslink bonds, this plastic cannot be melted by heating. Phenolic, melamine, unsaturated polyester, epoxy resin, silicone, and polyurethane are some examples of these plastic kinds. These plastic wastes are currently buried or burned for disposal. (Ade Asmi Abdul Azis, 2012) These procedures are pricey, though. Rebeiz (1996) used an unsaturated polyester resin based on recycled polyethylenerephthalate (PET) plastic waste to study the tensile characteristics of unreinforced and reinforced polymer concrete. (ASHOK ADMUTE, 2017)

2.6 Marble waste as filler material

Marble has been commonly used as a building material since ancient times. Disposal of the waste materials of the marble industry, consisting of very fine powders, is one of the environmental problems worldwide today. However, these waste materials can be successfully and economically utilized to improve some properties of fresh and hardened properties of mortar and concrete.

3. CONCLUSION

Green technology is used in contemporary construction projects to provide rising demand and greater market prices for their facilities. Even the majority of infrastructure owners' profit from decreased continuing operating costs, better occupancy rates, and increased building values. The majority of these green technologies are used in buildings to integrate the various regulatory systems that are inserted into them. As previously said in this study, construction businesses may increase output while maintaining a high-performance system of operations by effectively managing infrastructure activities. They can also decrease operating expenses.

According to all indications, the perspective of this study suggests that energy efficiency may be enhanced by eliminating excessive energy usage and saving as much as 30% of energy expenses, making green technology of the biggest importance. However, the majority of industrialized nations, like the USA, China, and the UK, are swiftly exploiting the horizon and prospects in the adoption of green technology. However, the majority of developing nations, including South Africa, are still having difficulty implementing this green technology in their building sectors. This is likely due to the implementation costs. However, this study shows that in such poor nations as South Africa, resource conservation and sustainable building can only be accomplished when green technology is used effectively to construction projects. It is important to do further study to understand how different stakeholders see the progressive adoption of green technologies. Last but not least, in the twenty-first century, sustainable development has received the majority of focus. Green technology adoption in building projects is recognized as being essential for any built environment in any country to fulfill its sustainable goals.

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