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Green Concrete: A step towards eco-friendly environment

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Abstract

The building industry is embracing green concrete more and more since it has many inherent benefits and few drawbacks compared to traditional concrete. To encourage the usage of green concrete in the construction sector for significant infrastructure projects, more research and development projects, interdisciplinary collaborations, public awareness campaigns, materials and the creation of codes and standard documents will be necessary. Concrete contributes about 5% of global CO2 emissions since it is the second most utilized material after water. Reducing the environmental impact of cement and concrete, rather than replacing them with alternative materials, is the answer to this environmental issue. The ability to use green concrete in construction has enormous potential benefits for society's environment. It is reasonable to believe that technology will be created that will cut the CO2 emissions associated with the production of concrete in half. As society has grown more conscious of the deposit issues associated with residual products over the past few decades, demands, limitations, and levies have been put in place. The need for high-quality concrete products, the desire to lessen greenhouse gas emissions and carbon footprints, the need to conserve natural resources, and the limited amount of landfill space in urban areas are the main factors contributing to the growing demand for green concrete. Green concrete encourages the sustainable use of waste materials as substitutes for the traditional concrete-making materials. Green concrete is superior to regular concrete in many ways. Because it makes use of recycled materials and aggregates, it lessens the additional pressure on landfills and minimizes aggregate waste. Consequently, there are fewer net CO2 emissions. The economy also benefits greatly from material reuse. An essential component of sustainable development is green concrete. A common substitute of concrete in green building techniques is green concrete

Keywords: Green Concrete; Recycled Glass; Glass fiber; Cement; Reduce Carbon Emission

1. Introduction

Approximately half of the billions of tons of glass garbage produced worldwide each year is dumped in landfills. While landfills are rapidly filling up and approaching a critical scenario, the pace of waste glass production is rapidly increasing. Glass is said to be a non-biodegradable substance that takes more than a million years to break down. Additionally, glass's poisonous ingredients may be harmful to the environment, which calls for immediate and ongoing attention. Glass toxicity is typically associated with specific materials, such as lead oxide in crystal glasses, pigments based on cadmium in colored glass and arsenic and antimony trioxide in antique glasses. Therefore, it is crucial to create a sustainable glass sector by focusing on recycling and reuse as the primary sustainability goals that may preserve a significant quantity of resources, reduce greenhouse gas emissions, and lower energy and cost consumption. Glass is thought to be an infinitely reusable material that could, in theory, retain its quality even after advanced sorting, cleaning, and melting procedures, which is why the global recycling rate is so low. In 2018, about one-fifth of the glass produced globally was recycled. Although its approach is not totally sustainable or economical, recycling glass trash is a convincing attempt to reduce the flaws in glass manufacture. Maintaining a consistent particle size distribution, guaranteeing quality and purity from recycled sources, and creating ideal mix designs through extensive testing are

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some of the difficulties associated with using glass powder in concrete making. Among the aforementioned difficulties, evaluating long-term durability is essential, particularly in challenging environments. The availability and affordability of premium glass powder may present further difficulties, potentially restricting its application. When glass powder may need to be blended with other materials, compatibility testing is crucial, and health and safety executives may need to take safeguards throughout preparation, handling, and mixing. Lastly, to optimize glass powder's advantages while resolving issues, a thorough life cycle analysis is required. Concrete Production, has more information about this utilization. Using glass trash in the creation of concrete is one possible substitute method that might both lower the need for cement and avoid the energy-intensive remolding process that produces significant CO2 emissions.

2. Cement Market Analysis (Apr-May ’2024 and May 2024)

Regionally, cement prices have declined by Rs 2-3 per bag in the west and south, by Rs 6 per bag in the east, remain flat in the central region, and increased by Rs 6 per bag in the north. All India average prices remained flat quarter-on-quarter, reflecting localized demand-supply dynamics. The eastern states are identified as new, untapped markets with significant growth potential, likely to benefit the bottom line of cement companies. The sector's outlook is stable according to ICRA, with Crisil Ratings noting the highest capacity addition in the last decade expected by FY24 as shown in fig.1and fig.2. This reflects confidence in growth prospects driven by infrastructure and housing investments.

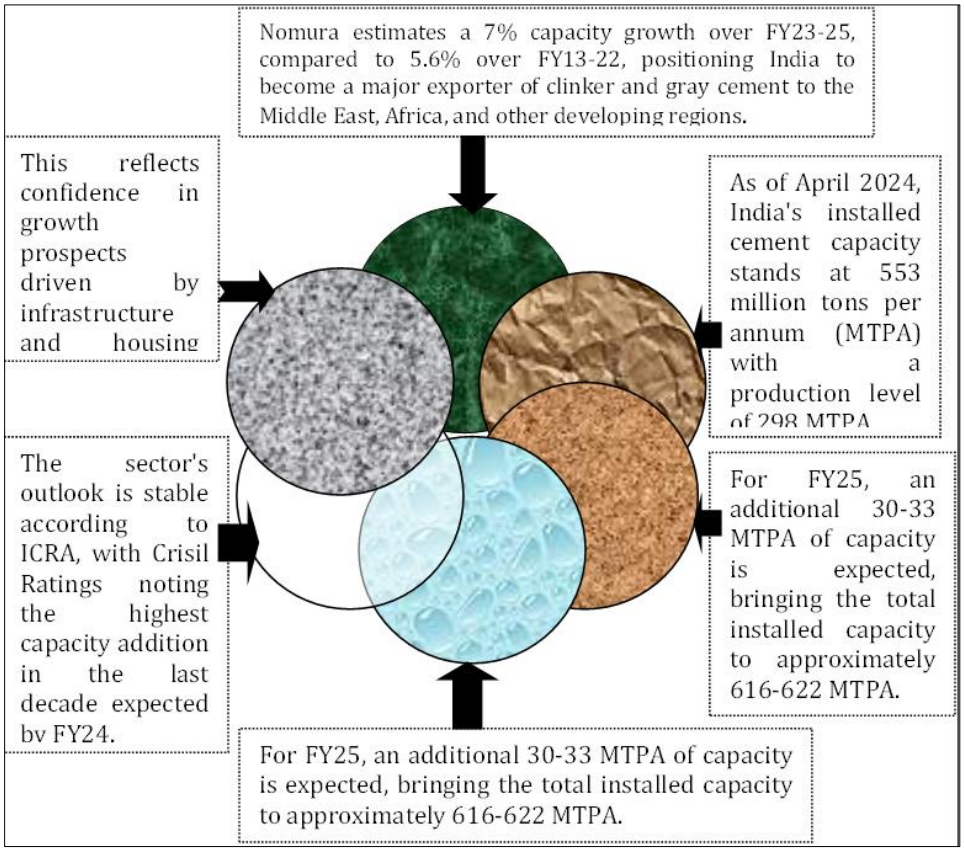

Figure 1 Cement demand

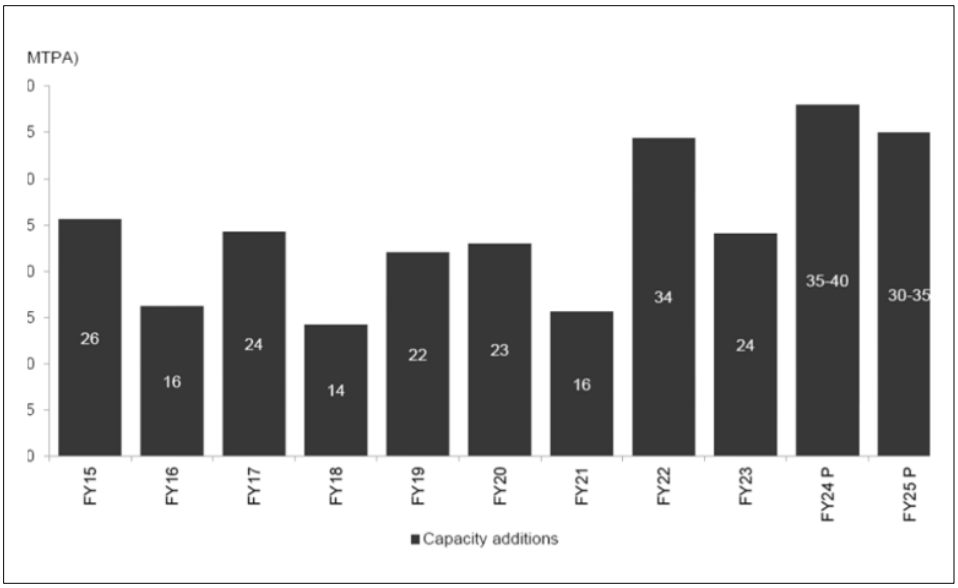

Figure 2 Cement capacity addition the highest in over a decade in financial year 2024

3. What is recycled glass?

Recycled Glass is a brittle material, but when glass fibers are cured with matrix (resin) they get good mechanical properties. There are different types of Glass Fibers that is S- glass fiber and E-glass fiber, where S-glass fiber glass is a high performance alternative to standard fiber glass that is E-glass. Brazil is known for its leadership in the application of recycled glass in the production of sporting goods. Turkey is a powerhouse in the application of recycled glass in ceramic production. Recycled glass is used as an ingredient in the manufacture of ceramic tiles and floors, helping to reduce environmental impact and increase energy efficiency.

3.1. Uses and Application of Recycled Glass

- Recycled glass is used for the manufacture of products such as soccer balls and other sports equipment. Its commitment to the environment goes beyond glass, and its aluminum recycling projects made it a world leader in aluminum can recycling in 2021.
- The Netherlands is also at the forefront of the application of recycled glass in the textile industry.
- Recycled glass is used for the manufacture of fiberglass, which is used in the production of clothing and other textile products. In general, Northern Europe tops the sustainability lists in the textile sector with the technological solutions implemented in this sector.
- Norway is one of the leading countries in the application of recycled glass in the automotive industry. Most car manufacturers use recycled glass in the production of their vehicles, a commitment to the circular economy and increased energy efficiency.
- Recycled glass is used for the manufacture of substrates for crops and in the construction of greenhouses. This helps improve soil quality and reduce the need for fertilizers and pesticides.
- Portugal is a benchmark in the application of recycled glass in construction. In the country, recycled glass is used for the manufacture of building blocks and coatings, which reduces the need for raw materials and increases energy efficiency in construction. In addition, Portugal is also investing in the research and development of new applications for recycled glass. In its commitment to sustainability.

4. What is glass fiber?

These days, glass, a non-metallic fiber, is employed extensively in industry. Since 1713, glass yarn spinning has been used to create textiles. Bundles of spun glass fiber bound together by silk threads were used to create a glass garment for Broadway actress Georgia Cayan that was displayed at the World's Columbian Exposition in Chicago in 1893. However, the cloth was too stiff to drape, making it too heavy to wear. Forms of silica, primarily sand, limestone, stone ash, and borax, are the key elements of glass fibers. Another name for glass fiber is fiberglass. It is composed of glass strands that are incredibly fine. Fiberglass is a material that is sturdy, strong, and lightweight. Although it is less stiff and has considerably less strength qualities than carbon fiber, the material is usually far less brittle and the raw

materials are far less costly. In comparison to metals, it has very advantageous bulk strength and weight characteristics, and molding procedures make it simple to manufacture. The most well-known and ancient performance fiber is glass. Glass fibers have been produced since the 1930s. The four main categories of glass fiber goods are chopped strands, assembled roving's, direct draw roving's, and mat products.

4.1. Different Types of Glass Fiber

As to the raw material glass used to make glass fibers or nonwovens of glass fibers as shown in fig.3, the following classification is known:

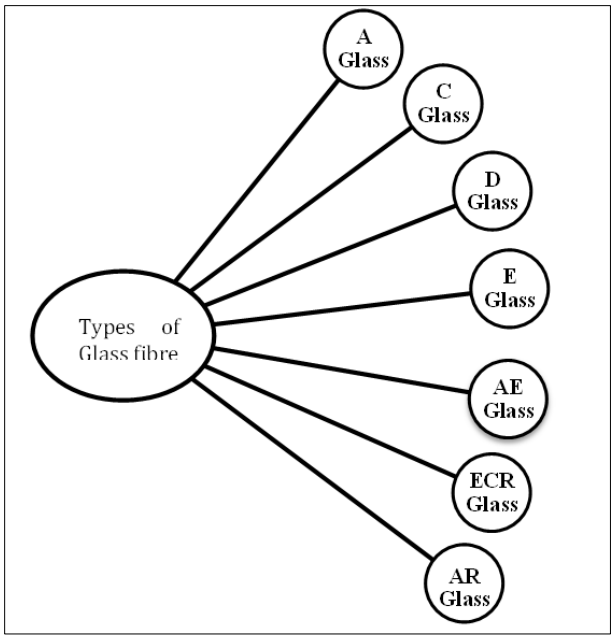

Figure 3 Different types of Glass fibres

- **A-Glass:** With regard to its composition, it is close to window glass. In the Federal Republic of Germany it is mainly used in the manufacture of process equipment.
- **C-Glass:** This kind of glass shows better resistance to chemical impact.
- **D- Glass:** An important type of glass fiber is D-type glass fiber. Boron contains the trioxide compound intensively. Boron trioxide is used as a starting material for the synthesis of other boron compounds such as boron carbide in the production of fluids for glass and enamels, and in the production of heat resistance and thermal shock resistance borosilicate glasses.
- **E-Glass:** This kind of glass combines the characteristics of C-glass with very good insulation to electricity. E-glass is basically a calcium alumino-borosilicate glass containing less than 1% alkali calculated as Na2O.
- **AE-Glass:** Alkali resistant glass.
- **ECR-Glass:** It is also called electronic glass fiber. It has a good waterproofing ratio, high mechanical strength, electrical acidic and alkali corrosion resistance. It shows better properties than E-Type glass fiber. The biggest advantage is a more environmentally friendly glass fiber.
- **AR-Glass:** Alkali Resistant (AR: Alkali Resistant) Glass Fibers are specially designed for concrete construction. They contain alkaline zirconium silicates. They are effective to prevent concrete cracking. This adds strength and flexibility to concrete. They are also used for asbestos changes. They have alkali strength and strength. It is very difficult to dissolve in water. Not affected by pH changes. They are easily added to stainless steel and concrete mixtures. Intensive Magnesium and Calcium added fibers. It is ideal for applications with high acidic strength and mechanical strength.

R-glass, S-glass or T-glass fibers are trade names of equivalent fibers having better tensile strength and modulus than E-type glass fibers. Higher acidic strength and wetting properties are obtained with a smaller filament diameter. Generally, glass consists of quartz sand, soda, sodium sulphate, potash, feldspar and a number of refining and dying additives. The characteristics, with them the classification of the glass fibers to be made, are defined by the combination of raw materials and their proportions. Textile glass fibers mostly show a circular.

5. Conclusion

- Green concrete is stronger and shrinks less quickly than concrete composed only of Portland cement. Buildings constructed with green concrete, which can tolerate temperatures as high as 2400 degrees Fahrenheit, have a higher chance of surviving a fire. Moreover, it is more resistant to corrosion, which is crucial given the impact of pollution on the environment (acid rain significantly shortens the lifespan of conventional construction materials). All of those elements work together to create a structure that will endure far longer than one constructed with regular concrete. Ancient Roman buildings have comparable concrete compositions, and in the 1950s and 1960s, the Ukraine also used similar material.
- A structure made of green concrete is also more resilient to temperature variations, which lowers energy use. This can be used by an architect to create a green concrete building that uses less energy for heating and cooling.
- One of the primary elements of regular cement, Portland cement, is made by heating pulverized limestone, clay, and sand to 1450 degrees Celsius using coal or natural gas as fuel. Five to eight percent of global carbon dioxide (CO2) emissions are caused by this mechanism. Up to 80% less CO2 is released during the production of green concrete. Making the complete transition to green concrete for building will significantly aid in the worldwide drive to reduce emissions.
- Recycling glass is an ethical and sustainable way to address this issue in the future. Glass is a useful material for a more sustainable future since it is strong and adaptable and can be recycled endlessly without losing its qualities.
- Remember that every ton of recovered glass prevents about 300 kg of CO2 from being released into the atmosphere, therefore enhancing glass recovery methods and machinery is also environmentally friendly.
- Since glass fiber is less expensive than carbon fiber or Kevlar, its use as a reinforcing agent in the composites sector is on the rise.
- E-glass is seen to be the greatest option for general-purpose applications, and many kinds of glass fiber, such as S glass or ECR glasses, have been brought to the market for high-tech applications

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