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An Overview on Geopolymer as an Ecofriendly Concrete

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Abstract : As the construction industry continues to grow, the demand for concrete remains a top priority. However, traditional Ordinary Portland Cement (OPC) manufacture poses significant environmental challenges. Not only does it consume a substantial quantity of environmental resources & energy, then it also discharges a large volume of carbon dioxide into the atmosphere, contributing to climate change. To address these issues, it becomes crucial to explore alternative sources that can counter the adverse effects of carbon dioxide while remaining eco-friendly and maintaining concrete's ultimate strength. One such alternative is Geopolymer Concrete (GPC), which is synthesized from fly ash, an inorganic aluminum-silicate compound. GPC exhibits improved mechanical properties when related to OPC. Several factors influence the development of GPC, including curing conditions, workability, setting times, molarity of alkaline and ratio of solution of alkaline to binder. By embracing Geopolymer Concrete, the construction industry can move towards a more sustainable and environmentally friendly approach to building, reducing the carbon footprint associated with concrete production and its impact on the environment.

***IndexTerms* - GPC (Geopolymer Concrete), molarity. Aluminum-silicate, Fly-ash, Ground Granulated Blast-furnace Slag (GGBS).Ordinary Portland Cement (OPC)**

I. INTRODUCTION

Concrete is an extensively used in construction industries as a construction material for a number of structures such as roads, building, bridges, dam & retaining walls. In India, the demand for cement is projected to exceed half a billion tones by 2020, creating a shortfall of about 0.23 billion tones due to increased infrastructural activities [1]. To address environmental concerns, researchers have explored using by-product materials like fly ash to replace some of the Portland cement in concrete. GPC concrete, which includes up to 60-65 percent fly ash, has shown promise in provided that exceptional mechanical properties and improved durability performance [2]. Based on studies it is found that geopolymer concrete discovered positive results in terms of Strength and workability. The adding of water reducing admixture enhanced the handling of fresh GPC for up to 120 minutes without any adverse effect. Investigators initiate that higher applications of sodium hydroxide solution & curing temperatures among 30ºC to 90ºC directed to higher compressive strength in GPC. Furthermore, a higher application of sodium hydroxide solution added to improved compressive strength. The duration of rest period among casting and the beginning of curing for up to 60 minutes did not meaningfully disturb the compressive strength of GPC[3].

They observed that the GPC strength increased with the application of sodium hydroxide solution at all temperatures, but the amount of strength increase beyond 60∘C was not very momentous. These conclusions highlight the potential of geopolymer concrete as an environmentally friendly and durable alternative to traditional concrete, with the added advantage of using by product materials like fly ash. GPC has shown capacity in attaining higher compressive strength at given room temperature, especially when GGBS is used as a subsidizing material. Somewhat, it is based self-compacting GPC confirmed higher Strength than fly ash-based self-compacting GPC under ambient curing conditions. To ensure optimal performance, it is advisable to prepare solution of sodium hydroxide & silicate at minimum 24 hours before use In the search to reduce global warming and diminish CO2 emissions caused by cement production, geopolymer technology has emerged as a potential solution. The term "Geopolymer" was presented by Davidovits in the 1980s, suggesting that binders can be made through a polymer response of alkaline fluids by Silicon & Aluminum found in geological source materials or byproduct materials like GGBS & fly-ash. These geopolymer binders have the possible to reduce CO2 emissions to the atmosphere by around 80% related to traditional cement-based binders. The impact of climate alteration owing to global warming has become a substantial concern in recent years. Greenhouse gases, particularly CO2, contribute to about 67% of worldwide warming up. The industries of cement is accountable for around 6% of all CO2 productions since the manufacture of one ton of Portland cement produces an equivalent amount of CO2 into the atmosphere. Efforts are existence made to decrease the dependence on OPC in concrete manufacture to report these ecofriendly challenges Geopolymer concrete can be produced through a polymerization procedure of aluminosilicate resources like met kaolin, rice husk, fly-ash & GGBS. In light of worldwide sustainable expansion goals, there is a growing weight on reducing the usage of natural resources. Transformation has led to an increase in the release of manufacturing harmful solid wastes, such a slag, flyash, and redmud, contamination of heavy metals, colors, and drugs, which has become a cause for concern. The worldwide yearly production of FA is projected to range among 71 million tons to 1 billion ton.[9] The strength of GPC is attributed to the formation of gel of sodium aluminosilica hydrate generally denoted as (N-A-S-H) get through the process of geopolymerization. Lodeiro et al. delivered a comprehensive explanation of the geopolimaric mechanism, which involves three consecutive stages: Coagulation cum Condensation, Destruction Coagulation and Condensation with crystallization. The geopolymerization development initiates by the breakdown of the structure of alumino-silicate, facilitated through ions of hydroxide from an alkaline activator.

2. Literature Review

In this literature survey we discussed about geopolymer Concrete.

GPC emerged as a promising alternative to conventional concrete due to its eco-friendly & economical benefits. GPC demonstrates excellent performance in terms of high strength, making it suitable for various heavy performance applications, and it too exhibits opposition to chemical attacks. As per result it noted that ratio of sodium to sodium hydroxide is of 2.5-3.0 yielded favorable consequences related to other ratios when producing geopolymer concrete. Additionally, the research revealed that GGBS or silica fume (also known as micro silica) could be utilized as substitutes for fly-ash to surges the compressive strength of the GPC under different states of curing and Geopolymer Binders as OPC Alternatives: Geopolymer binders are considered as potential alternatives to Ordinary Portland Cement (OPC) binders. They are noted to give higher early Compressive strength and exhibit opposed against acid & sulphate attacks, in addition to being environmentally friendly. These findings support the viability of geopolymer concrete [1,3]. Reveals several important findings about geopolymer concrete: Compressive Strength and Curing Time: The Comp. strength of GPC increases as time of curing is progresses. Wherever, the rate of strength gain decreases after 24 hours of curing, indicating that the significant strength development occurs within the 24 hrs. Workability and Super plasticizer: Workability, or the ease of handling the GPC mix, improves with the addition of a super plasticizer. Specifically, when the super plasticizer is added 4% of mass of fly ash, the increases workability. However, using a higher dosage of super plasticizer (beyond 2%) can guide to a minor depletion in the strength of the GPC and Highlights important aspects of geopolymer concrete: Industrialized with Little Calcium Fly Ash: GPC concrete produce with sodium hydroxide with low calcium fly-ash and steam cure GPC exhibit high strength and workability which affect the strength[2,4].

Study conducted by [4] by which the guided for design of fly ash base GPC on standard grades the factor affect such as water quantity, fineness of fly-ash, grading of aggregates with to maintain specific ratio such as water to GPC is 0.35-0.40. Heat curing carries at 60 degree Celsius for duration 244 hrs. the specimen were tested 7 days,14 day and 28 days after and note the result of respective grade such as M10,M15,M20,M25,M30 And M40 etc.[D] Geopolymer concrete it has been observed that base on previous investigation on self-compaction concrete increasing dosage of NAOH molarity has adverse impact on fresh concrete properties but it improve the strength of concrete along with GGBS play very important role to enhanced the strength of concrete at room temp.

The researched observed that curing of specimen has been done at 70°C.To give high strength as compared to curing by long-term, which resulted in increased geopolymerization over time and the researchers also found that Geopolymer concrete had lower permeability, fewer pores, and a reduced void ratio, leading to enhanced durability compared to conventional concrete. [5,6] In study geopolymer concrete they found that a proportion of sodium hydroxide to sodium silicate at 60:40 resulted in the highest Compressive strength related to the ratios of 50:50 and 70:30. Geopolymer concrete (GPC) exhibited superior compressive strength when equated to conventional concrete at a mix proportion of M20. [7] Valuable information of geopolymer materials have discussed. Geopolymerization primarily involves 3 step: development of silicate network, the materialization of initial gel & di-solution of precursor. Various activators commonly used for geopolymer materials include lithium and sodium hydroxide, sodium silicate and calcium carbonate etc.[8] Suggested to conduct another researched on geopolymer concrete for durability check, specifically by used anhydrate sodium silicate alkaline activator.[13] Utilizing solid alkali activators is considered less hazardous compared to liquid activators commonly used and results in a mix that resembles cement, with water being the only additive required for activation and hydration.[10] Geopolymer concrete is superior to normal concrete in several aspects, include comp. strength, resistance to aggressive environments, workability, and high-temperature exposure. It produces a substance that is comparable to, or even surpasses, traditional cements in terms of various properties. Notably, the application of sodium hydroxide solution used in the geopolymer mix directly influences its compressive strength, meaning a higher concentration leads to greater compressive strength in the final product.[11] in geopolymer concrete one of one concept also applicable that is self-compacting geopolymer in that case The self-compaction Green Concrete (SCGC) is a unique type of concrete that eliminates the need for additional compaction. It possesses self-flowing and self-compacting properties, especially around heavily congested reinforcement areas. The production of SCGC involves the utilization of manufacturing byproduct such that GGBS, fly-ash, glass powder, ricehusk and silica fume Materials with high alumina and silica content can also be incorporated. By adding alkaline sol.of sodium silicate & sodium hydroxide raw material is activated, typically. Furthermore, the inclusion of super plasticizers, such as Viscosity Modifying Agent (VMA), allows the concrete to achieve flow ability.[15,16] Alternative Cement Materials: Investigating and promoting the use of alternative cementious materials like that GGBS rice husk, fly ash, and some amount of silica fume. These by-products can partially or entirely replace OPC, reducing CO2 emissions and optimizing resource utilization. Low-Carbon Concrete Technologies: Developing low-carbon concrete technologies that have a smaller carbon footprint during production, without compromising the quality and performance of concrete structures.[17,18] technologies that can capture CO2 emissions during cement production and store them safely to minimize their impact on the environment. Sustainable Construction Practices: Encouraging the adoption of sustainable construction practices, such as using locally sourced materials, optimizing construction processes, and promoting energy-efficient building designs. Recycling and Reuse: Promoting the recycling and reuse of construction materials to reduce the demand for new cement production and conserve natural resources.[19,20]

3. Conclusions

In conclusion, concrete continues to be widely used in construction, but its high demand in India could lead to potential shortages. To address environmental concerns, researchers have explored by partial replace of fly ash as for OPC, resulting in promising geopolymer concrete with excellent mechanical properties and enhanced durability. Factors such as the curing and conce. of sodium hydroxide solution and curing temperatures significantly influence its strength. Incorporating further enhances compressive strength by GGBS, making geopolymer concrete suitable for structural applications. Geopolymer technology offers an eco-friendly alternative to traditional concrete, reducing CO2 emissions and promoting sustainability. Additional research is imperative to investigate the long-term strength and potential applications of this material in sustainable construction practices. Understanding its durability, structural performance, and environmental impact over extended periods will provide valuable insights for the construction industry and enable us to make informed decisions in adopting eco-friendly building materials and methodologies. This research will contribute to enhancing the reliability and viability of this innovative solution, supporting the broader goal of creating a more sustainable and environmentally responsible construction sector.

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