FEASIBILITY STUDY ON GEOPOLYMER CONCRETE PAVER BLOCKS

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Abstract - This study focuses on developing affordable and sustainable paver blocks for pedestrian facilities. It addresses the depletion of natural resources and the environmental impact associated with traditional materials like Portland cement and crushed stone. Geopolymer concrete, using low calcium fly ash as a binder, is combined with recycled asphalt pavement aggregates to create lightweight paver blocks. Experimental tests are conducted to assess their compressive strength, flexural strength, and water absorption properties. Policymakers in India recognize the importance of environmentally friendly construction materials for pedestrian infrastructure. By incorporating recycled asphalt pavement aggregates into the geopolymer matrix, the study offers a sustainable solution that reduces waste and benefits the paving industry. The laboratory-produced paver blocks undergo tests for dimensions, water absorption, compressive strength, and abrasion resistance. The results demonstrate that the inclusion of recycled asphalt pavement aggregates produces high-quality paver blocks suitable for pedestrian facilities. Overall, this research highlights the use of geopolymer concrete and waste materials in constructing affordable and sustainable paver blocks. It offers a practical substitute for conventional materials while boosting waste management and environmental sustainability by using recycled materials and low calcium fly ash as a binder.

***Key Words*: Rap, Fly Ash, Geopolymer, Compressive Strength, Concrete, Pavers**

1.INTRODUCTION

Infrastructure development in India is crucial, requiring low-cost and durable building materials. Geopolymer concrete, made from industrial by-products like fly ash and slag, offers sustainable alternatives to cement, reducing environmental impact and utilizing available resources. It interacts with aluminosilicate materials and alkaline solutions to create geopolymers, which serve as binders in concrete. Fly ash's varying chemical compositions may affect the final geopolymer product. Low calcium fly ash is preferred over high calcium fly ash due to quick setting risks. Raw material composition, alkaline solution quantities, and curing process influence fly ash geopolymer mixes. Fly ash geopolymers, with reduced calcium content, offer durability in harsh environments compared to Ordinary Portland Cement (OPC). They resist sulphates, acids, and high temperatures. Fly ash geopolymer concrete reduces greenhouse gas emissions for long-term sustainability. Material selection and specimen preparation affect strength, setting time, curing, acid resistance, and specimen characteristics. Floor tiles, composed of clay, glass, or fiber, must meet aesthetic and performance requirements. Cost and local material availability impact sustainability, particularly for economically weaker segments. Utilizing waste materials in concrete reduces environmental hazards and preserves natural resources, promoting a greener environment.

India's focus on infrastructure development and cleaner technologies has led to the recognition of the need for better facilities for pedestrians and non-motorized vehicles. The use of geopolymer in construction materials like paver blocks offers a sustainable alternative to traditional methods. Geo-polymerization involves alkaline activation of silica and alumina-rich materials, resulting in a three-dimensional structure. Paver blocks enhance aesthetics and durability in various applications such as streets, parks, and parking areas. Utilizing waste materials and nonconventional methods can further promote sustainability in paver block production.

Geopolymer, a third-generation binder, encompasses inorganic polymers, alkali-activated cements, and other similar materials. It utilizes aluminosilicate minerals (e.g., kaolinite, feldspar) and industrial leftovers (e.g., fly ash, metallurgical slag) as raw materials. Alkali activators like sodium hydroxide, potassium hydroxide, and silicates are commonly used. Geopolymer cement concrete is produced by incorporating waste materials such as fly ash and ground granulated blast furnace slag (GGBS). The amount of trash generated, carbon emissions, and dependency on Portland cement are all decreased by this eco-friendly concrete. Chains or networks of inorganic molecules define geopolymers. They are also known as inorganic polymer cement or alkali-activated cement.

2. OBJECTIVE

- The study aims to compare the strength of normal concrete paver blocks and geopolymer paver blocks.
- It examines the water absorption capacity of both types of paver blocks.
- The research includes a cost comparison between geopolymer paver blocks and normal concrete paver blocks.
- Another objective is to assess the strength of the paver blocks.

3. MATERIALS

3.1: Composition of Geopolymer Concrete

Following materials are required to produce this concrete:

- Fly ash is a byproduct of thermal power plants.

- GGBS is a byproduct of steel plants.

- Fine aggregates and coarse aggregates are used as

required for a normal concrete.

-GPPC alkaline activator solution is used, which is

made using a catalytic liquid system.

-The alkaline activator solution consists of a mixture of alkali silicate and hydroxide solutions.

-The function of the alkaline activator solution is to activate geopolymeric source materials containing Si and Al, such as fly ash and GGBS.

Fig 1.1 Geopolmer Concrete

3.2: Mechanical Properties of Geopolymer Concrete

Geopolymer concrete exhibits high compressive strength, reaching up to 70 MPa (N/mm2). It demonstrates a rapid strength development, surpassing the strength of ordinary Portland cement concrete within 24 hours, with values exceeding 25 MPa. After 28 days of curing, the compressive strength ranges between 60 to 70 MPa. These findings are supported by a research paper by James Aldred and John Day, as well as test results conducted by SERC Chennai.

3.3: Other Properties of Geopolymer Concrete:

- Geopolymer concrete exhibits significantly less drying shrinkage compared to cement concrete, making it suitable for thick and heavily restrained structural elements.
- It has a lower heat of hydration when compared to cement concrete.
- Geopolymer concrete shows considerably better fire resistance than OPC (Ordinary Portland Cement) based concrete, as mentioned in a paper by James Aldred and John Day.
- According to ASTM 1202C, geopolymer concrete has a chloride permeability rating of 'low' to 'very low', providing improved protection to reinforcement steel against corrosion compared to traditional cement concrete.
- Geopolymer concrete demonstrates high

resistance to acid, performing well in exposure tests to 2% and 10% sulphuric acids.

Please note that these points provide a concise summary of the information given.

4. APPLICATIONS

4.1: Applications of Geopolymer Concrete

Geopolymer concrete, although sharing applications with cement concrete, has not gained widespread popularity. It has been utilized for pavements, retaining walls, water tanks, and precast bridge decks. Notably, the world's first structural building constructed with geopolymer concrete is The University of Queensland's Global Change Institute, a four-storey public building.

5. Results and Discussion

5.1 Ccompressive strength results

5.1.1 Ccompressive strength of Geopolymer concrete paver blocks

Table:5.1 Compressive strength test on Geopolymer concrete paver blocks

SN	Description of M-25 blocks	7 days (Mpa)	14 days (Mpa)	28 days (Mpa)
1	0% flyash	18	24	29
2	5%flyash	17	24.6	26.19
3	10%flyash	17.9	25	27.4
4	15%flyash	15	18.7	22

5.2 Water Absorption Results

5.2.1 Water Absorption of Geopolymer Concrete paver blocks

Table:5.2 Water Absorption of Geopolymer Concrete paver Blocks

SN	Description of M-25 blocks	Water Absorption (%)
1	0% flyash	7.5%
2	5%flyash	7.3%
3	10%flyash	7.21%
4	15%flyash	6.6%

6. FUTURE SCOPE

- Optimization of geopolymer concrete mix design for improved mechanical properties, durability, and workability.
- Exploration of alternative binders, activators, and

additives to enhance performance and sustainability.

- Utilization of waste materials and by-products to expand material resources and reduce reliance on natural resources.
- Development of specialized paver block designs for specific applications, such as permeable pavers for stormwater management or interlocking pavers for heavy traffic areas.
- Potential for structural applications in pavements, pathways, and low-rise constructions.
- Implementation of standardized regulations for quality control and industry acceptance.
- Assessment of the life cycle and environmental impact of geopolymer concrete paver blocks.
- Increasing awareness and acceptance among architects, engineers, contractors, and policymakers.
- Demonstrating economic benefits and reduced carbon footprint to drive market adoption and commercialization.
- Contribution to sustainable construction practices and waste reduction efforts.

7. CONCLUSION

The study investigated the effects of incorporating fly ash and shredded plastic in concrete blocks. The compressive strength of M-25 mixes with varying fly ash proportions (0%, 5%, 10%, and 15%) at 28 days of curing ranged from 22 MPa to 28.3 MPa. Optimum results were achieved with 10% fly ash, providing maximum strength at different curing periods. Additionally, blocks with the replacement of coarse aggregate by shredded plastic (2%, 4%, and 6%) exhibited compressive strengths ranging from 7 MPa to 16 MPa, depending on the curing duration. It was observed that as the percentage of shredded plastic increased, the water absorption of the blocks decreased. These concrete blocks have potential applications in partition walls, interior cladding, landscaping and garden features, as well as non-structural elements like boundary walls, boundary markers, and facades.

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