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Research on Fire Resistance Potency of Ferro-Geopolymer Concrete

N. Senthamilalagan[1], S. Bharathidasan[2]
[1]PG Student, M. Tech Structural Engineering, Prist University, Puducherry Campus, India.
[2]Head of the Department, Department of Civil Engineering, Prist University, Puducherry Campus, India.

Abstract: Fire is also one of the most significant possible threats to most buildings and structures. As structural materials deteriorate due to exposure to high temperatures, the building can collapse. As a result, the use of fire safety materials to mitigate thermal damage to structural members is important. Ferrocement is a cementitious composite substance made of hydraulic cement mortar and tightly spaced layers of continuous and relatively small sized wire mesh. Mortar is an excellent insulator, and reinforcing wire mesh can minimise surface spalling more effectively than plain concrete. Similarly, geopolymer mortar has good fire resistance due to its ceramic-like properties. The performance of ferrocement factor in this study is made of geopolymer and its fire resistance is investigated.
Keywords: Ferrocement, Geopolymer concrete, Fire resistance, wire mesh, Flexural strength, Compressive Strength.

I. INTRODUCTION

The use of ferrocement as a fire safety material necessitates a thorough understanding of how fire affects this material. The majority of previous research has concentrated on the individual properties of ferrocement products. Furthermore, geopolymer mortar is found to be more thermal and fire resistant than ordinary cement mortar. Welded wire mesh, galvanised iron mesh, and chicken mesh are the three varieties of wire mesh used in ferrocement.

These meshes are used in a variety of shapes and sizes. The volume fraction of the wire mesh is determined by its thickness, spacing, and mesh form. Joseph Davidovits proposed in that binders could be formed by a polymeric reaction of alkaline liquids with silicon and aluminium in geological source materials or by-product materials such as fly ash, metakaolin, silica fume, and rice husk ash. The word geopolymer was coined to describe these binders.

II. LITERATURE REVIEW

Shan Li ET AL (2021) found that the fire performance of each CES column specimen was evaluated by analysing the fire resistance time, axial displacement-time curve, temperature-time curve, rotational angle of end support, post-fire conditions of the concrete surface and failure mode. The experimental study showed that the addition of polypropylene fibre was effective in minimizing explosive concrete spalling in high-strength CES columns to achieve comparable fire resistance time as those of normal-strength CES columns.

Thomas Thienpont et al (2021) found that Application of the determined GRF allows for an explicit reliability-based design for fire exposed concrete slabs, without requiring the application of full-probabilistic methods. Therefore, a deterministic design method is presented, which enables to perform a quick check of the burnout bending resistance of a concrete slab exposed to a natural fire, and allows for the evaluation of (delayed) bending failure that can occur during or after the cooling phase, that would otherwise remain undetected.

Pinghua Zhu et al (2020) found that the mechanical properties, thermal conductivity and fire resistance of SiO2 ACP, and the compressive strength of SCC with or without ACP coating in the simulated tunnel fire were tested. The results showed that ACP exhibited excellent mechanical and durable performances and low thermal conductivity. The 40 mm thickness of ACP has a strong thermal insulation capacity and can effectively withstand tunnel fire up to 2.5 h. The SCC samples under the protection of ACP did not undergo compressive strength degradation and destruction of microstructure.

Yusuke Shintani et al (2021) found that the test results showed that the failure times of the columns under multi-loading conditions were shorter than those of the columns under axial loading condition because of the double curvature bending on the core concrete. The double curvature bending was observed to be more severe than the single curvature bending in the eccentrically loaded furnace test. The lower column was subjected to an ISO-834 standard fire and a displacement control horizontal force was applied to the top of the column until a horizontal displacement of 1/50th of the heating length of the column was attained after 2 or 4 h of fire.

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III.MATERIAL PROPERTIES

The following materials used in this study

A. Cement

Control specimens are made with ordinary Portland cement of grade 53 according to Indian Standards. Some of the cement's assets are listed here.

S. No	Property	Result
1	Specific Gravity	3.18
2	Consistency	28%
3	Initial setting time	29 min
4	Final setting time	263 min

Table 1: Properties of Cement

B. Geopolymer

Geopolymer is a combination of the following compounds,

1) Pozzolans
2) Activator solution
3) Alkali powder
4) water

Figure 1: geopolymer mortar cube

C. Fly ash

Fly ash, similar to Portland cement, is one of the most widely used by-product products in the building industry. It is a finely divided inorganic, non-combustible residue obtained or precipitated from the exhaust gases of every industrial furnace.

D. Activator

In this study, water soluble high alkaline sodium silicates and hydroxides are used. The alkali silicate (Na2SiO3), also known as water glass, is bought in bulk from a local supplier with a modulus ratio of 2.15.

E. Water

Ordinary portable water used for this study

F. Fine Aggregate

As fine aggregate for geopolymer mortar and cement mortar mixes, locally available river sand with a basic gravity of 2.65 was used.

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IV. EXPERIMENTAL INVESTIGATION

A. Compressive Strength

The compressive strength is calculated using normal UTM. Geopolymer mortar performs far better than cement mortar when exposed to 900oC. The 10M concentration produces better results than the other blends.

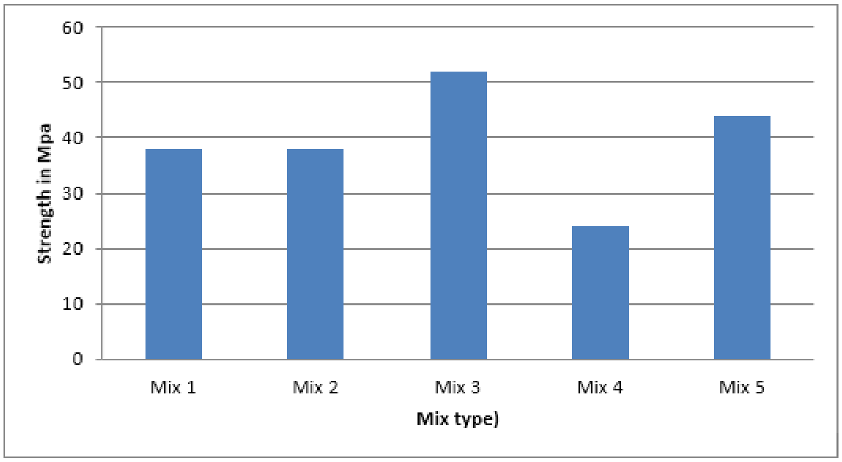

Figure 2: Mortar cube strength

B. Specimen Preparation

The prepared mortar is put in ferrocement moulds up to 5mm in diameter and vibrated for 5 minutes. The remaining mortar is then poured into the mould. The mortar is mounted in the vibrator so that it is well sealed within the mesh.

Figure 3: Specimen used for Study

C. Curing of Specimen

Since the polymerisation process necessitates curing at high temperatures, the curing of Geopolymer composite specimens was left undisturbed for 24 hours at an elevated temperature of 75 °C. After curing, the specimens were removed from their moulds and allowed to cool until any physical properties, such as dimension and mass measurements, were registered.

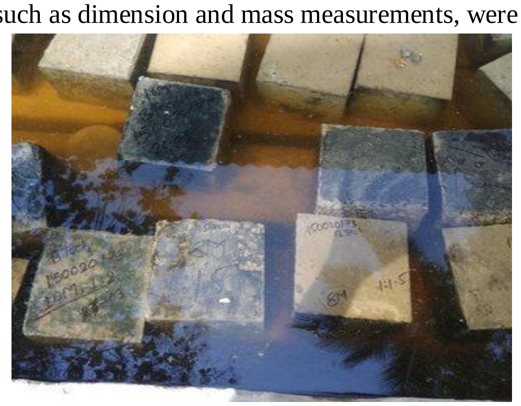

Figure 4: Curing of Geopolymer mortar cubes

D. Flexural Strength after Exposed

Prior to fire exposure, it was discovered that increasing the wire mesh material greatly improved the flexural intensity. However, the post-fire flexural strength and durability of ferrocement were barely affected by the wire mesh material.

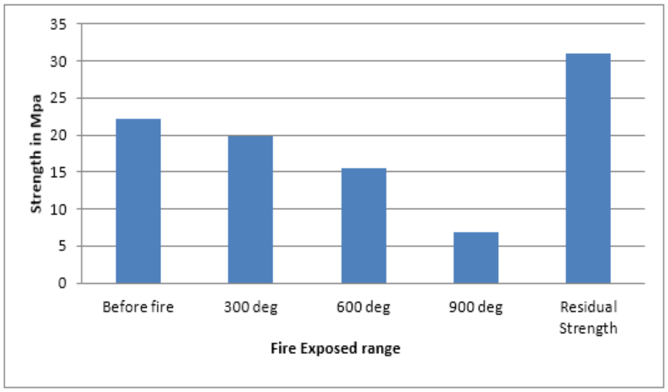

Figure 5: Flexural Strength at different stage

E. Fire Exposure

Due to expose of fire the specimen loses considerable weight. The flash is already a burnt material or residue. Thus, the burning of flash does not show any particle size variation. the following figure table shows the weight loss in various fraction after fire

Loss of weight at 900 degree		
2 % FG	1.5 % FG	1% FG
0.253	0.040	0.16

Table 2: Weight loss

V. CONCLUSIONS

The following results drawn at the end of this experimental investigation

A. The effect of wire mesh volume fraction on post-fire mechanical properties, specifically flexural strength and durability, as well as cracking patterns of ferrocement jackets, was investigated experimentally. Due to its post-fire flexural strength as compared to ferrocement, the ferro-Geopolymer concrete jacket was found to be a suitable solution for fire safety.

B. The highly porous structure of geopolymer mortar allows the internal steam pressure to be released during heating. As a result, less tensile stress is applied in the geopolymer mortar during heating than in ferrocement, decreasing the chance of spalling in the geopolymer. This comparison was performed with the two ferrocement at the same strength levels.

C. Since the Ferro-Geopolymer concrete is made of previously burned fly ash, the weight loss was unaffected by the blast. However, after being exposed to fire, the ferrocement loses a significant amount of weight.

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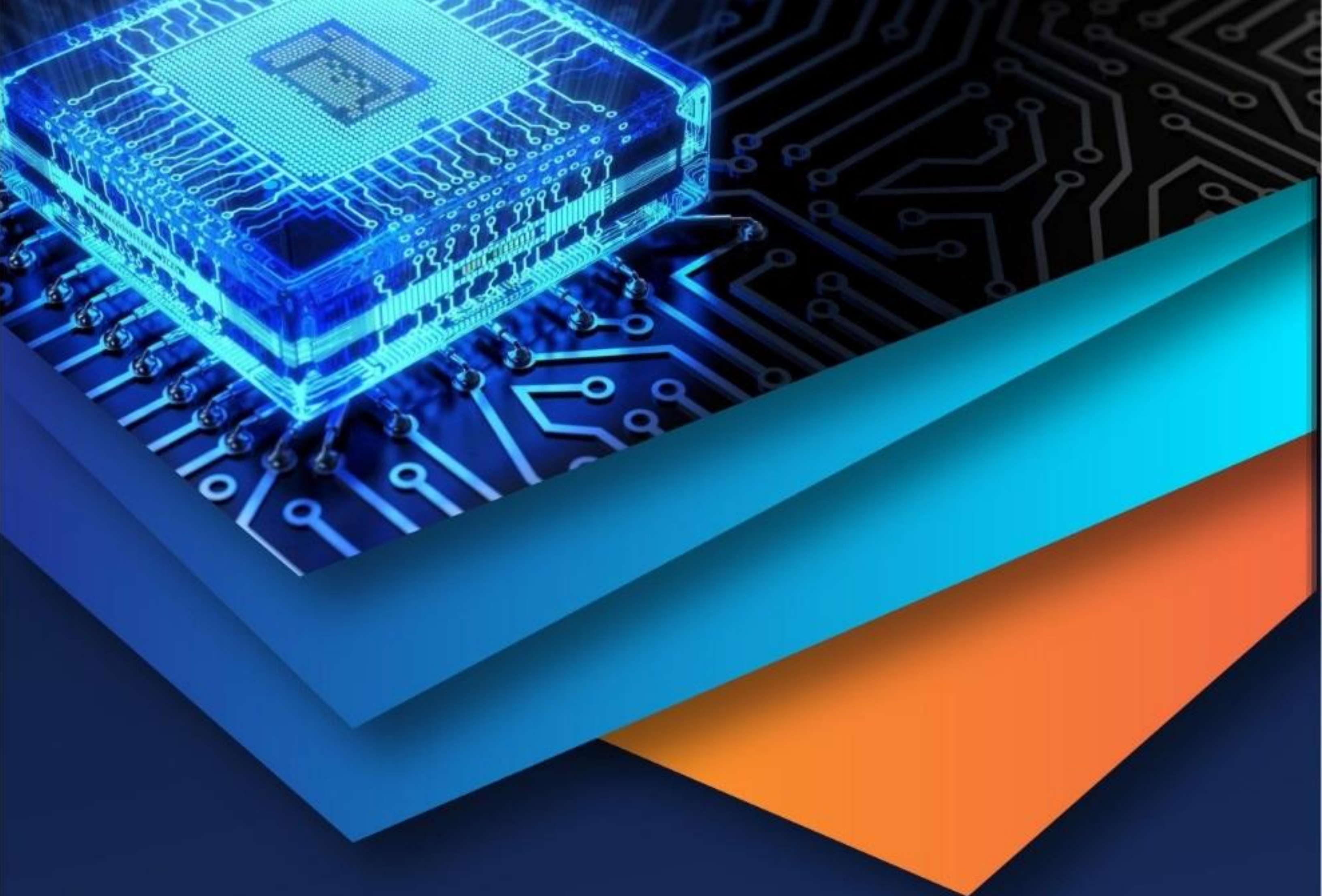

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