ANALYTICAL STUDY ON FLEXURAL BEHAVIOUR OF FERRO GEOPOLYMER SLAB WRAPPED WITH FRP SHEET

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Abstract
As infrastructure ages and starts to deteriorate more, modernizing concrete structures has become more crucial. Because of advancements in construction methods, the issue has gotten worse. This study examined the flexural properties of ambient-cured ground granulated blast furnace slag and fly ash-based geo polymer ferro wall panels with an activator blend of sodium hydroxide and sodium silicate solutions and distinguished wire mesh layers with 2 and 3 layers with chicken mesh and galvanized iron mesh types. Wrapping CFRP or GFRP around the wall panel for flexural performance testing is one method of investigating the utilization of CFRP or GFRP to increase the strength of wall panels. To validate the test results, a three-dimensional (3D) finite element (FE) analysis was also performed. The study's findings showed that the better binding between the geo polymer wall panel, wire mesh, and rebar caused the specimens of geo polymer ferro-wall panels to exhibit crack breadth and crack spacing. The created FE model offered an accurate forecast of the tested slabs' flexural performance and could be applied to additional parametric research.
***Keywords**: Geo Polymer, FRP, Flexural Strength, FEM Model*

Introduction
Concrete is the most versatile, dependable, and long-lasting building material. There must be a lot of Portland cement used to make concrete. Ordinary Portland Cement (OPC) usage pollutes the environment since it releases CO2. Geo polymer concrete was created to reduce the harm that Portland cement manufacturing does to the environment. In 1978, Professor Joseph Davidovits made the initial suggestion for the development of geo polymers, mineral binders with an amorphous structure. Davidovits (1988; 1994) proposed that silicon (Si) and aluminum (Al) in a source material with a geological origin or in by-product materials like fly ash and rice husk ash be reacted with an alkaline liquid to produce binders. Because the chemical process that results in these binders is a polymerization process, he coined the term "Geo polymer" to characterize them. Alumino silicate powder and an alkaline liquid interacted to form this category of solid solids. Modernizing concrete structures has become more and more important as infrastructure gets older and starts to deteriorate more. The problem is worse because construction techniques have improved. When choosing the appropriate expansion techniques or materials for a structure's retrofit, a structural engineer must make a difficult choice. Retrofitting is the science and technique of adding new features, technologies, and components to existing structures or structural components to improve their

performance. A reinforced concrete structure that has already been built can be retrofitted through repair, rehabilitation, or strengthening. Many scholars nowadays have suggested a variety of materials, procedures, and strategies for strengthening flexure-deficient RC beams. Structure overloading can occasionally result in extreme deformations and corrosion, both of which demand today's attention. Today's building industry often calls for strengthening, retrofitting, and repair work to counteract all these effects on reinforced concrete structures. All of these potential ways to produce damage will call for a range of potential repair methods, from which the most efficient one will be selected in each specific situation. In some circumstances, even recently constructed structures need to be repaired and strengthened in order to remove flaws caused by mistakes in the design or construction. It has always been highly difficult to repair a concrete structure or one of its components, and effective solutions frequently required substantial work. To deal with structural elements damaged by unexpected events like fire, earthquake, foundation movement, impact, and overload, specialized procedures of strengthening, stiffening, and repair are required. Retrofitting is a method for enhancing a building's structural capabilities, such as its strength, stiffness, ductility, and stability. It takes understanding of the technical, economic, and social components of the problem to retrofit a structure. The best option is determined by a wide range of factors, the most crucial of which are the overall cost, the duration of construction (ultimately with the potential of continuous building use), the simplicity of technology application, etc. Both new and restored structures must adhere to the text's design specifications. Siqi Lin et al (2019) investigated that More confinement may be required at the mid-zone, as columns frequently collapsed around the mid-zone in real-world engineering situations when subjected to an increasing compression load brought on by the vertical ground motion during an earthquake. To strengthen the columns, fiber-reinforced polymer (FRP) materials have been applied frequently. It has been suggested to use complete, partial, and non- uniform wrapping techniques. In order to improve the axial performance of concrete columns, this work proposes a better wrapping scheme. It will have a greater load carrying capacity, better FRP usage along the height of the specimens, and more ductile behavior. This is due to the fact that axially loaded columns' central zones often produced more deformation than their ends, necessitating stronger confinement. A new wrapping design that applies more FRP to the column's central zone is suggested. Behaviors of the several specimens' arrangement of FRP sheets along the height were explored, depends on the manner in which FRP materials were applied. From the intermediate zone to the conclusion, decline progressively. In comparison to specimens reinforced using the present wrapping scheme, those reinforced using the suggested wrapping scheme demonstrated more ductile behavior's and achieved greater load carrying capacity and FRP expense efficiency. Rami Eid a & Patrick Paultre (2017) proposed that new design equations for the amount of transverse steel reinforcement (TSR) to ensure ductile behavior of reinforced-concrete columns have been introduced as a result of the evolution of earthquake-resistance requirements. Existing columns must be strengthened in order to meet the TSR requirements of the new codes. The use of fiber-reinforced polymer (FRP) composites as confinement reinforcement is one way to strengthen reinforced-concrete columns. The development of a single stress-strain model that can accurately depict the axial behavior of reinforced concrete columns that are round, square, or rectangular and are either internally or externally constrained with TSR, FRP, or both. The effective confinement index, a non-dimensional measure that takes into account the mechanical and geometrical characteristics of the concrete, transverse steel reinforcement, and FRP, is related to the behavior of confined concrete. Yu-Fei Wu &You-Yi Wei (2010) proposed that the effective confinement index, a non- dimensional measure that takes into account the mechanical and geometrical characteristics of the concrete, transverse steel reinforcement, and FRP, is related to the behavior of confined concrete. The aspect ratio of the cross-section and the number of CFRP layers were taken into consideration. Concrete rectangular columns perform better when contained by FRP jackets. For square sections as opposed to rectangular sections, CFRP wrapping is more effective. The strength advantage in constrained concrete columns declines from one to two aspect ratios, becoming negligible for aspect ratios greater than two. Based on the test findings from this work and data gathered from the literature, a new model for the strength of FRP restricted rectangular concrete columns is provided. The number of confining FRP layers increased the ultimate strength and ductility of the CFRP-confined concrete, and the improvement in strength and ductility was more pronounced for lower strength concrete than for normal to high strength concrete.

Materials and Methods

Class c fly-ash (Fig 1) type is used in this study along with ground-granulated blast furnace slag (Fig 2) is used as a binder for the wall panel member. Alkali activator such as sodium hydroxide (Fig 3) and sodium silicate gel (Fig 4) is used for the test. Fine aggregate which passed under 4.32-micron sieve is used for the binding property for the mortar. Chicken mesh of diameter 2mm and galvanized wire mesh of diameter 2 mm is used as an alternating material for coarse aggregate. Frp sheets were properly investigated to be used for wrapping.

Figure 1 Fly-ash

Figure 2 GGBS

Figure 3 Sodium Hydroxide

Figure 4 Sodium Silicate gel

Mixing and Curing

The mixing process was started with dry mixing of fly-ash and GGBS for 1 min is done. then the fine aggregate is added for dry mixing for one min. After completing the dry mix, the alkali activator is mixed for wet mixing with various proportion ratios. The fresh mortar is mixed for 3 min for the proper dispersion of materials used. The mix proportion is shown in table.1. The fresh mortar is casted in 70.6mm x70.6mm x70.6 mm mortar cube for compressive strength and binding property of the material used along with 100 x 200 mm diameter and height with respectively for the compress meter and extensometer test for the property of stress and strain values. After casting the specimens, the molds were cured under ambient temperature of around 37 degrees Celsius for 24 hours and then demolded. then the specimens are cured under ambient temperature for 3,7,28 days for the test.

Testing Method

The compressive strength is test upon 3,7,28 days, the longitudinal compress meter and lateral extensometer is tested for 3 days for the test results.

Table 1 Mix Proportion

Specimen Id	Fly-ash (Kg)	GGBS (Kg)	NaOH (Kg)	Na2SiO3 (ml)	Fine aggregate (Kg)	Water for NaOH (ml)
For Liquid -binder ratio 0.45						
Wp-1	0.220	0.512	0.015	0.075	1.46	25
For Liquid -binder ratio 0.4						
Wp-2	0.220	0.512	0.011	0.069	1.46	20
For Liquid -binder ratio 0.38						
Wp-3	0.220	0.512	0.009	0.066	1.46	16

FEM Model

A three-dimensional model is developed in Abaqus for the analysis of the wall panel. The model is developed with the required property of geo polymer. The input parameters for the required data for the fem model is analyzed and taken from the experimental value. The study's primary goal is to create a framework for modelling the flexure behavior of beams that have been retrofitted with FRP. This involves a number of interesting theoretical and practical elements. Important topics include boundary condition, meshing, convergence, element type, and material model. Use the ABAQUS/visualization CAE module (also available separately as ABAQUS/Viewer) to read the output database and see the analysis's findings. The ABAQUS viewer presents the results and finite element models from ABAQUS graphically. It pulls data from the output database, including model and result information. The output information that is shown can be controlled. Plots such as un deformed shapes, deformed shapes, loads, x-y data, stress fluctuation, and time history animation, for instance, can be obtained through ABAQUS Viewer.

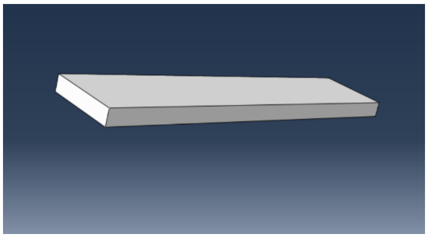

Figure 5 Wall Panel Model

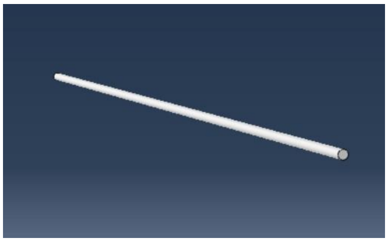

Figure 6 Reinforcement Model

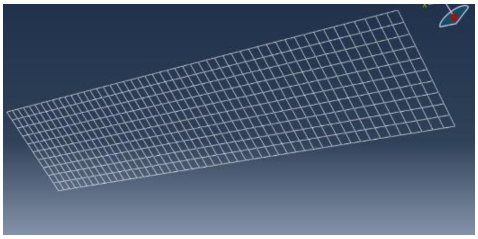

Figure 7 Wire Mesh Model

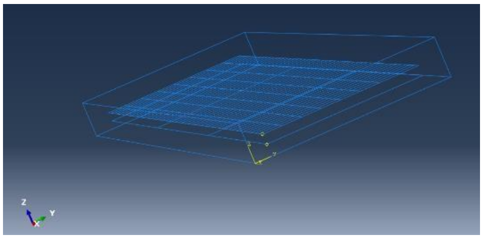

Figure 8 Assembly of Wall Panel

Result and Discussion

The preliminary test that is carried out for the fly-ash, GGBS, Fine aggregate is performed with regard to Indian standard code. The wet mix mortar property is analyzed and calculated with regards to Indian standard code. The compressive strength and split tensile strength are performed and calculated as per IS 2550:1981, IS 5896:1999 respectively. The slump cone test is carried out for geo-polymer mortar based on IS 1199-1959 . The optimum test results obtained for various mortar mix ratio based on alkaline activator ratio and liquid-binder ratio is arrived to for determining the flexural strength of ferro wall panels in the future progress.

Conclusion

The compressive strength for the various mix proportion is taken upon the respective days. To analyze beams that have been strengthened or retrofitted with CFRP plates, a finite element model was created. The finite element calculations and experimental data are in good accord. Orthotropic and isotropic elastic. After arriving the experimental results, the data to be incorporated in FEM model to do following analysis.

- The behaviors of the ferro geo-polymer wall panel before and after retrofitting.
- The stiffness of the CFRP-retrofitted ferro geo-polymer wall panel is increased compared to that of the control ferro geo-polymer wall panel .
- Finite element method (XFEM) may be developed to represent the cracks in the ferro geo-polymer wall.

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