

Evaluation of Wall Panels Using Geopolymer Concrete

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ABSTRACT: This Project is done to find compression and flexural properties of Precast Geo polymer Concrete wall panels. Geo polymer precast concrete wall panels in configurations such as load bearing walls, partition walls, window panels and other shapes that provide an attractive, functional and durable facade. Precast wall panels use sandwich construction. Rely on these precast enclosure systems to achieve exceptional results on all-precast, parking garage, steel frame or cast-in-place commercial and institutional structures and buildings. All precast concrete panels are cast in a controlled environment. We can ensure minimal expansion and contraction for superior results every time. This dependability is just one of the reasons why construction professionals choose Green Concrete for the most complex construction projects.

KEYWORDS: Geo polymer concrete, Wall panels, Green concrete, compression strength, Flexural strength.

I. INTRODUCTION

The global use of concrete is second only to water. As the demand for concrete as a construction material increases, so also the demand for Portland cement. It is estimated that the production of cement will increase from about 1.5 billion tons in 1995 to 2.2 billion tons in 2015. On the other hand, the climate change due to global warming and environmental protection has become major concerns. The global warming is caused by the emission of greenhouse gases, such as carbon dioxide (CO₂), to the atmosphere by human activities. Among the greenhouse gases, CO₂ contributes about 65% of global warming. The cement industry is held responsible for some of the CO₂ emissions, because the production of one ton of Portland cement emits approximately one ton of CO₂ into the atmosphere. The environment must be protected by preventing dumping of waste/by-product materials in un-controlled manners. Several efforts are in progress to address these issues. These include the utilization of supplementary cementing materials such as fly ash, silica fume and granulated blast furnace slag and the development of alternative binders to Portland cement. In this respect, the Geopolymer concrete with a much lower environmental footprint shows considerable promise for application in the concrete industry. In terms of global warming, the Geo polymer technology could significantly reduce the CO₂ emission to the atmosphere caused by the cement industries.

II. OBJECTIVE OF THE PROJECT

To evaluate the different strength properties of Geopolymer concrete mixture with G.G.B.S replaced in percentage to flyash. Making workable, high strength and durable Geopolymer concrete containing G.G.B.S (Slag) without usage of ordinary Portland cement. Studying of chemical properties of reinforcing bars in both Geopolymer concrete beams and ordinary Portland cement concrete elements.

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III. MATERIALS

II.1 Wire Mesh

½ inch square wire mesh is one of reinforcing material used in fabrication. It is generally used in ferrocement technology. This project also includes the same technology

II.2 Weld Mesh

1½ inch square wire mesh is one of reinforcing material used in fabrication. It is generally used in ferrocement technology. This project also includes the same technology

II.3 Fly ash

Fly ash is the inorganic mineral residue obtained after burning of coal/lignite in the boilers. Fly ash is a portion of ash which can be collected from the bottom portion of the boilers. The characteristics of fly ash depend upon the quality of lignite/coal and the efficiency of boilers. India depends upon primarily on coal for the requirement of power and the power generation is likely to go up from 60,000Mw in the year 2010. The generation of fly ash is also likely to increase. The fly ash generation in India Thermal Stations is likely to shoot up to 170 million tonnes in 2010 from the present level of 100 million tonnes. The disposal of fly ash in the present method will be a big challenge to environment, especially when the quantum increases from the present level.

II.4 Copper Slag

Copper slag is one of the materials that is considered as a waste material which could have a promising future in construction industry as partial or full substitute of either cement or aggregates. It is a by-product obtained during smelting and refining of copper. To produce every ton of copper, approximately 2.2–3.0 tons copper slag is generated as a by-product material.

II.5 Ground Granulated Blast furnace Slag

Ground granulated blastfurnace slag (GGBS) is a hydraulic binder, i.e. a cement, which has been known and used for 150 years. It improves the quality and durability of concrete, and its production is virtually CO₂-free. Yet its many advantages in producing sustainable, high-quality concrete remain underappreciated and underused. Blast furnaces produce pig iron, together with a slag by-product: a tightly controlled and stable material with the same constituents, though in different proportions, to normal cement. If the slag is vitrified by rapid quenching as it comes from the blast furnace, its cementitious qualities are preserved. Dried and ground to a fine powder, GGBS can be used to make quality, sustainable concrete. To ensure its activation, GGBS is most often used with normal cement. It will typically replace 30 - 70% of cement on an equal weight basis. The manufacture of normal cement results in the emission of 930kg of CO₂/t of cement approximately 50% from decarbonation of the limestone raw material (process emissions), 40% from fossil fuel consumption, and 10% from generating the electricity used in the process. GGBS manufacture typically releases 35 kg of CO₂/t of GGBS: less than 4% of the carbon of normal cement.

II.6 Sodium Silicate

Sodium silicate is also known as water glass or liquid glass, available in liquid (gel) form. In present investigation sodium silicate 2.0 (ratio between Na₂O to SiO₂) is used. As per the manufacture, silicates were supplied to the detergent company and textile industry as bonding agent. Sodium silicate is used for the making of Geo polymer concrete.

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II.7 Thermocol

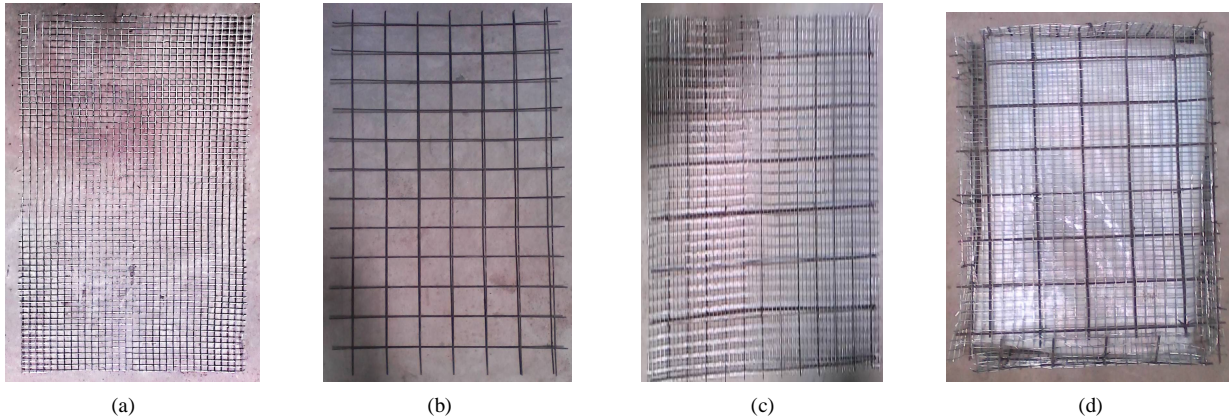
Thermocol is used as a infill material for the sandwich panel where it comes in between the geopolymer layer. It a name given to successfully restructured chemical bonding of polystyrene (a synthetic petroleum product) molecules and developed a substance named stretch polystyrene which nowadays is manufactured through a simple process. Thermocol is a good resister of cold and heat.

IV. EXPERIMENTAL WORK

Experimental program includes preparation of moulds, fabrication of meshes using chicken mesh and weld mesh, preparation of geopolymer mortar, casting of test specimens, atmospheric curing of 28 days, testing of specimen for compressive strength four point loading in order to get flexural strength.

III.1 Fabrication of Meshes

$\frac{1}{2}$ inch square wire mesh and $1\frac{1}{2}$ inch weld mesh are cut according to the required dimensions. The meshes were straightened using wooden hammer. There are two layers of wire mesh and one layer of weld mesh. The single layer of weld mesh comes in between the two layers of wire mesh and were sandwiched together using binding wires of 1mm. This bound mesh is folded for the panel dimension $450*300*100$ such that they fit inside the mould.



Fig(1): a) square weld mesh, b) Weld mesh, c) binding of two meshes, (d) folded mesh enclosing the thermocol

III.2 Preparation of Geo polymer Mortar

Mortar is prepared according to correct proportion of fly ash, copper slag, ground granulated blast furnace slag, sodium silicate. First the fly ash, copper slag and ground granulated blast furnace slag is dry mixed and sodium silicate is added gradually in order to nourished geo polymer mortar. The wall panel is designed for M20. So, various trial mixes were done using $100*100*100$ mm cube. Mix ratio is FA: CS: SI and MIX C is chosen as M20 mix.

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Table (1): Trial mixes

MIXTURE	RATIO	REPLACEMENT OF FLYASH WITH GGBS	COMPRESSIVE STRENGTH (N/mm ²)
MIX A	1:1:0.4	50%	33.3
MIX B	1:1:0.4	20%	28.2
MIX C	1:1:0.4	10%	21.2
MIX D	1:1:0.4	5%	15.3

III.3 Casting

The fabricated mesh is placed inside the mould (450*300*100mm) along with the thermocol and the goepolymer mortar is added inside the mould through several layers with the help of scoop. This shows the specimen is casted using the ferrocement technology. After filling the mould with geopolymer mortar, it is well compacted to remove air voids. After a few hours the mould is demoulded and the casted specimen is taken out.



(a)



(b)

Fig. 2 (a) mould for casting panel, (b) casted panel

III.4 Curing

The casted specimen is left in the dry atmosphere for ambient curing or heat curing, geo polymer does not need water curing or any other systems of curing. Hence it is a great advantage.

V. TESTING OF SPECIMEN

IV.1 Test for compressive strength

After 28 days from the date of casting, the test specimen is white washed and tested for compressive strength. The load is given as shown in the figure.

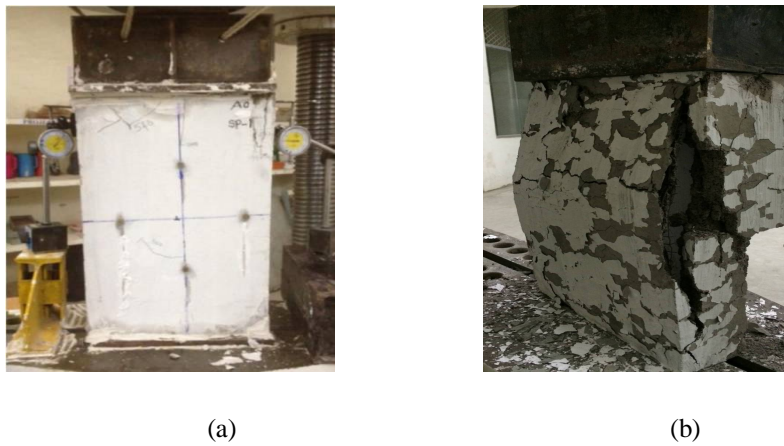


Fig. 3 (a) Test setup for compression in panel, (b) cracks in the panel

Table (2): Compressive strength results

MIXTURE	ULTIMATE LOAD (KN)	COMPRESSIVE STRENGTH (N/mm ²)
MIX C	622	20.6

IV.2 Test for flexural strength

After 28 days from the date of casting, the test specimen is tested for flexural strength using four point loading system. The load is given as shown in the figure.



Fig.3: (a) Test setup for flexural test, (b) Cracks formed in the panel

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Table (3): Flexural strength results

MIXTURE	ULTIMATE LOAD (KN)	FLEXURAL STRENGTH (N/mm ²)
MIX C	25.20	3.36

VI. RESULTS AND DISCUSSION

- Trial mixes are done and geopolymer concrete of M20 grade is achieved from the mix ratio 1:1:0.4 (10% of fly ash replaced with GGBS)
- Geopolymer mortar is liable to ferrocement technology with good workability.
- Compressive strength of wall panels of M20 grade from 28 days of ambient curing are 20.20 N/mm², 19.62 N/mm², 19.15 N/mm².
- Flexural strength of wall panels of M20 grade from 28 days of ambient curing are 3.36 N/mm², 3.20 N/mm², 3.86 N/mm².
- Ultimate load for test of compression is 622 KN.
- Ultimate load for test of flexure is 25.20 KN.
- Crack width for test specimen of compression test is 23 mm and the crack propagation is 450mm from top.
- Crack width for the test specimen of flexural test is 6 mm and the crack propagation is 82mm from top.

VII. CONCLUSION

Based on the experimental investigation, the following conclusions are drawn,

- The use of cement and natural resources is avoided and the desired strength is achieved.
- Cement is replaced 100% in order to reduce the carbon emission. Thus it reduces pollution and it is eco-friendly.
- The wall panels can be used for load bearing walls and partition walls with preferred connections.
- Geopolymer mortar is strong in compression and weak in tension as same as the conventional cement mortar.
- Geopolymer mortar can be used in ferrocement technology.
- There is no need for water based curing because of the ambient curing (specimen left in dry atmosphere).

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