

Experimental Study on Connections of Geopolymer Concrete Wall Panels

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ABSTRACT:The object of this project is to develop independent and creative thinking, correlating fundamental and theoretical knowledge obtained in the course to the application in the field. The project involves in production of Precast Geopolymer concrete wall panels are used extensively for high-rise construction because of the ease and speed of assembly, and the high quality of the precast wall panels. The connections between panels are extremely important since they affect both the speed of erection and the overall integrity of the structure. This report presents the results of preliminary tests and trials for research program conducted to investigate the behaviour and the capacity of connection configurations used for precast Geopolymer concrete wall panels subjected to monotonic shear and flexure loading. Since Geopolymer concrete is a carbon dioxide emission free cementitious material. The geopolymer concrete is such a vital and promising one. In this present study the main limitations of fly ash based geopolymer concrete is considered to be an environmentally pollution free construction material.

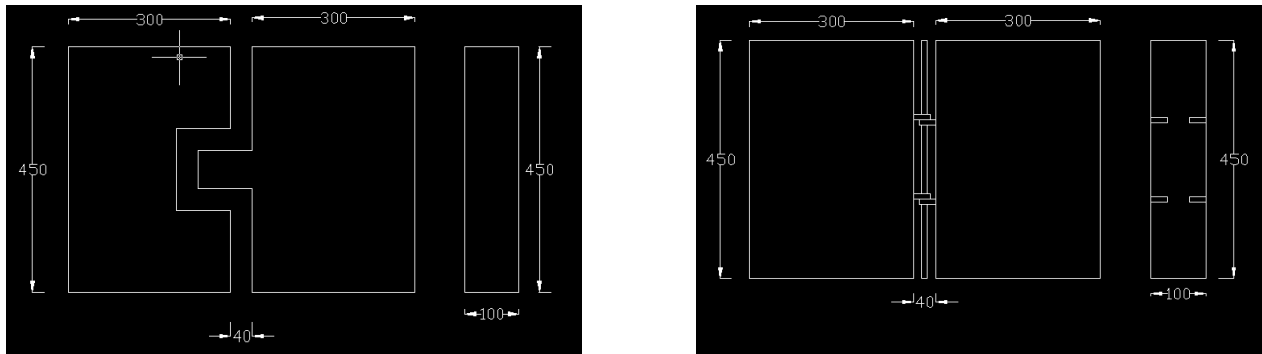
KEYWORDS: Geopolymer concrete, Mesh reinforcement, Connections, wall panels.

I. INTRODUCTION

Behaviour of the connections typically used for precast geopolymer concrete wall panels greatly influences the structural integrity of the entire structure. Current design sources (1, 2, 3, 4) provide very limited information to describe the behaviour and design of such connections. The information available in the literature (5,6, 7, 8, 9), which mainly describes the shear friction concept and the dowel action mechanism of initially cracked concrete, is not directly applicable to the behaviour of such connections. This paper discusses the results of three phases of an experimental program undertaken to examine the behaviour of nine connection configurations. The first phase (10) included (our types of connections: a dry-packed plain surface connection, a dry packed connection with continuity reinforcement, and dry-packed connections with two types of mechanical shear connectors, in addition to the continuity bars. The second phase (11) included two different types of dry-packed multiple shear key configurations. The third phase (12) was the result of a recent innovation in horizontal connections for load-bearing shear wall panels using vertical post-tensioning tendons to replace the continuity bars. It pass through galvanized ducts (the top panel to the base of the structure. 3 While the panels are temporarily braced, the gap between panels which is necessary for alignment purposes. is dry-packed. After the erection of several stories, the tendons are post-tensioned, the ducts are grouted and the temporary braces are removed. The testing included connections which support hollow-core slab with and without post-tensioning, and post-tensioning connections without hollow-core slab. All the connections were subjected to a monotonic shear load up to failure.

1.1 Objective and Scope

The primary objective of this paper is to investigate the limit states behaviour of nine connection configurations used for precast concrete load-bearing shear wall panels. Eight prototype precast concrete shear wall panel specimens were used to test two different connections currently used by the construction industry. The study attempted to identify the wall panel of each component used for these types of connections. The results of the experimental program were used to predict the strength of such connections before and after cracking. The casted wall panels with the provision for connections between them are Jig-saw and Sling aligned connection.



(a)

(b)

Fig. 1. CAD drawing of connections (a) Jig saw (b) Sling aligned

II. MATERIALS

2.1 Fly ash

The combustion of pulverised coal at high temperatures and pressures in power stations produces different types of ash. The 'fine' ash fraction is carried upwards with the flue gases and captured before reaching the atmosphere by highly efficient electro static precipitators. This material is known as Pulverised Fuel Ash (PFA) or 'fly ash'. It is composed mainly of extremely fine, glassy spheres and looks similar to cement.

2.2 Copper Slag

The slag is a black glassy particle and granular in nature and has a similar particle size range like sand. The specific gravity of the slag is 3.91. The bulk density of granulated copper slag is varying from 1.9 to 2.15 kg/ m³ which is almost similar to the bulk density of conventional fine aggregate.

2.3 Ground granulated blast furnace slag

Ground granulated blast furnace 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.

2.4 Sodium Silicate (Na₂SiO₃)

It is also commercially available in the market. The sodium silicate solution (A53) with a ratio of SiO₂ to Na₂O is approximately 2 was used. That is 29.4% SiO₂, 14.7 % Na₂O and 55.9 % of water.

2.5 Geo-Polymer Mortar (Grouting material)

The geopolymer panel is an ideal construction technology for emerging countries, because it offers many characteristics fulfils the population demand. In this respect geopolymer panel is very promising technique. Geopolymer, a new material, the term geopolymer describes a family of mineral binders with chemical composition same as zeolite. Geopolymer are inorganic materials of cementations nature derived from the alkaline activation of alumina-silicate materials which can be either readily available natural material such metakaolin tic clay or industrial by-products such as FA and GGBS.

III. MIX PROPORTIONS

The following are the different mix types used for the casting of specimens,

1. MIX A - 1:1:0.4 (Replace 5% of fly ash weight by GGBS)
Fly ash: Copper slag: Sodium Silicate
2. MIX B - 1:1:0.4 (Replace 10% of fly ash weight by GGBS)
Fly ash: Copper slag: Sodium Silicate
3. MIX C - 1:1:0.4 (Replace 15% of fly ash weight by GGBS)
Fly ash: Copper slag: Sodium Silicate

IV. TESTING OF WALL PANELS

4.1 Test set-up

The testing was carried out in a loading frame of 100T capacity. The specimen size of the wall panel is 450x600 mm and thickness 100mm. All the specimens were white washed in order to facilitate marking of cracks. Demec gauges were used to measure the strain at compression zone and tension zone and one dial gauges were fixed which is used for measuring deflections at several locations one at mid span which is shown in Figure 3. The beams were subjected to four-point loading under a load control mode. The development of cracks was observed in the connection.



Fig. 2. Testing of panel

4.2 General Observation

Vertical flexural cracks were observed in the constant-moment region and final failure occurred due to crushing of the compression concrete with significant amount of ultimate deflection. Crack formations were marked on the wall panel at every load interval at the tension steel level. It was noticed that the first crack always appears close to the mid span of the wall panel connection. The Flexural strength for Jig saw connection is 20kN and the Flexural strength for Sling Aligned connection is 23kN.



(a)



(b)

Fig. 3. Tested specimens (a) Sling aligned connection (b) Jig saw connection

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Fig. 4. Crack patterns

V. CONCLUSION

The industrial waste materials which are used as a grout material for binding the wall panels along with reinforcement is explained with their properties and the respective test on procured materials were in compliance with the provisions given in the standards. Based on the study of collected journals, trial mixes were designed and the casted cubes were tested for compressive strength at the end of 28 days. The Mix B (mix ratio of Fly ash, Copper Slag: Na_2SiO_3 is kept as 1:1:0.4, with no addition of super-plasticiser) gives a better strength (31 N/mm^2) than Mix A (26.5 N/mm^2). The Mix C (35 N/mm^2) is omitted because the required strength (M30) is attained. The efficiency of above mentioned connections is to be tested and discussed.

REFERENCES

- [1] Nataraja M. C., Chandan G. N. and Rajeeth T.J., 'Flow properties of cement mortar using Copper slag as fine aggregate', *Journal of Civil Engineering Technology and Research*, Vol. 2, No. 1, pp.23-31, 2014.
- [2] Junwei Song, 'Strength properties of copper slag admixed concrete', *Journal of Chemical and Pharmaceutical Research*, Vol. 6, No. 4, pp.250-254, 2014.
- [3] Gnanasundar G, Gopalakrishnan. N, Madheswaran C. K., 'Effect of molarity in geopolymer concrete', "International journal of civil and structural engineering", Vol. 4, No 2, pp.107-115, 2013.
- [4] Alessandro Palmeri, Gary P. Robinson and Simon A. Austin, 'Design methodologies for one way spanning eccentrically loaded minimally or centrally reinforced precast RC panels', "Engineering Structures 56", pp.1945, 2013.
- [5] Abang Abdullah Abang Ali, Farzad Hejazi, Hafez Taheri, Mohd Saleh Jaafar and Ramin Vaghei, 'Performance of Precast concrete wall to wall connections', *ASEAN Conference on Environment-Behaviour Studies*, pp. 369-385, 2012.
- [6] Abdul Aleem M. I., 'Geopolymer concrete and its chemical reaction on Si-Al molecules', *Indian Journal of Science and Technology*, Sri Ramakrishna Institute of Technology, Coimbatore, 2012.
- [7] Abdul Aleem M. I. and Arumairaj P. D., 'Curing methods of geopolymer concrete made with fly ash and M-Sand', *Indian Journal of Science and Technology*, Vol. 5, No. 3, 2012.
- [8] Ambily, Madheswaran C. K., Muthiah S., Sharmila, 'Behaviour of Geopolymer concrete', *International journal of civil and structural engineering*, Vol.2, No.2, pp.673-688, 2011.