

FLY ASH INTERLOCKING BRICK BY USING GEOPOLYMER CONCRETE.

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Abstract - Geopolymer results from the reaction of a source material that is rich in silica and alumina with alkaline liquid. It is essentially cement free concrete. This material is being studied extensively and shows promise as a greener substitute for ordinary Portland cement concrete in some applications. Research is shifting from the chemistry domain to engineering applications and commercial production of geopolymer concrete. It has been found that geopolymer concrete has good engineering properties with a reduced global warming potential resulting from the total replacement of ordinary Portland cement. The research undertaken at Curtin University of Technology has included studies on geopolymer concrete mix design, structural behavior and durability. This paper presents the results from studies on mix design development to enhance workability and strength of geopolymer concrete. The influence of factors such as, curing temperature and $R_{\text{Si/Al}}$, aggregate shape, strengths, moisture content, preparation and grading, on workability and strength are presented. The paper also includes brief details of some recent applications of geopolymer concrete. **Keywords:** Alumino-silicate binder; cement replacement; geopolymer; fly-ash; mix design; precast concrete.

Key Words: fly ash, chemical, geopolymer concrete, brick, interlocking brick, compressive strength, eco-friendly.

1. INTRODUCTION

In construction industry concrete is main for casting purpose. The primary binder material ordinary Portland cement [opc] is used in the concrete. Geopolymer concrete is a mixture of cement, sand, aggregate, chemicals. For improving workability chemicals can be used. For improving binding property reaction of alkaline solution is must. This reaction between source material and alkaline solution they forms alumina silicate gel. This gel used for improving binding property for geopolymer concrete cement is required but in this project ordinary Portland cement is totally avoided and that place fly ash used. Use of concrete and environment impact Utilization of concrete as a major construction material is a worldwide phenomenon and the concrete industry is the largest user of natural resources in the world. Generally geopolymers are a typically inorganic and alumina-silicate based ceramic material material similar to zeolite.

1.2 OBJECTIVES

Objective of this study is

1. Progress the brick work is fast.

2. No need to mortar layer between the bricks.
3. Light in weight.
4. To develop salient properties of geopolymer brick.

2. METHODOLOGY

2.1 materials

1. Fly ash- generally fly ash is combustible by product thermal power plant. In class c fly ash having more CaSO_4 , free lime, calcium rich glass, MgO . In f class fly ash having more glass, alumina, silicate glass.
2. Chemicals-(NaOH , Na_2SiO_3) - this chemicals used for improving workability of concrete. And improving binding property of concrete.
3. Aggregates- aggregates is main part of concrete. For geopolymer concrete 10mm aggregate and fine aggregate (free from clay and dust) is used.
4. Distilled water- locally available portable water is used.

2.2 Equipments:

1. Hand mixing spade
2. Tray
3. Trowel
4. Scoop
5. Mould
6. Spanner
7. Oven at 60 degree celcius
8. CTM
9. Slump cone apparatus
10. Tamping rod.
11. Weighing balance.

2.3 Mixing.

Firstly, the 150x150 and 100x100 area cubes are casted by using GPC. Compressive strength of GPC decreases as the water to geo polymer solid ratio by mass increase. As the water to GP solid ratio increased workability developed.

1. Dry mixing of material according to proportion for min 3 min and wet mixing is done for 3 min at least by hand mixing.
3. Slump cone test to determine amount of extra water.
4. Fill the mould in three layers each layer tamping in 25 no. of blows.

5. Lift the mould and do the vibration for 10 sec
6. Keep the mould at room temperature for 1 day.
7. Keep the cubes in oven for 24 hrs. at 60°C or keep the cubes for air curing for 14 days, 28 day.



fig.no. 1 cube casting



fig no.2 geopolymer work

Mixture changes according to structural members.

2.4 Procedure

1. To prepare interlocking bricks, the same procedure is carried out only the different is mould and proportion.
2. For preparing interlocking bricks, the wooden mould of size:
3. Big- 300x230x100 mm
4. Small- 150x140x100 mm
5. While preparing interlocking bricks, the same things and precaution taken. Trial mix method used to find out the brick proportion.
6. Brick size-
7. Big - 300x230x100 mm
8. Small- 110x100x100 mm
9. One day at room temperature and then oven curing.



Fig. no. 3 mould grising



fig no.4 brick casting

2.5 ADVANTAGES

1. Similar to traditional concrete
2. Low shrinkage
3. Low heat of hydration
4. Precast product made
5. High pressure taking
6. Reduction in drying shrinkage
7. Strong, durable and it increase performance
8. To replace cement which is the major contributor of greenhouse gas by GPC
9. Introducing binder material in concrete
10. Reduce CO₂ emission and eco- friendly concrete
11. Develop cost efficient product
12. High tensile strength.

2.6 Application

1. Precast concrete product like
2. Railway sleepers
3. Electric power poles
4. Retaining wall
5. Water tank
6. Pavement
7. Marin structure
8. Waste containments
9. Airport
10. Aircraft pavement
11. Toxic ways
12. Buildings

2.7 Scope

1. conventional concrete
2. To reduce CO₂ emission
3. To utilize the waste material such as fly ash and quarry dust.
4. To achieve a new type of concrete which is flexible in nature.

2.8 Economical benefit

1. it offers several economic benefit over PCC
2. 10 to 30% cheaper than that of PCC
3. Further more, the very little drying shrinkage, the low creep, the excellent resistance to sulphate attack and good acid resistant offer by GPC may

yield additional economic benefit when it is utilized in practical application.

- The same thing carried by precast product.

3. Testing

Mainly three test we have conducted

- slump cone test
- compression test
- water absorption test

3.1 Slump cone test

Slump cone test performed for checking the workability of concrete and therefore the ease with which concrete flows. This test is very simple so it used for checking workability. The height of slump cone apparatus is 30 cm. When doing GPC work then it gives 24 standard value.



Fig. no. 5 slump cone testing

3.2 compression test

Compression testing machine are universal testing machine. It gives compressive strength of any material or products



Fig no. 6 compression testing.

Results of Cube Testing (150x150x150mm)

1-Mix design

Na(OH ₂)	Na ₂ sio ₃	Fly ash	Water	Dust	FA
1.54	3.38	15.38	2.35	28kg	42kg

Table no.1 (mix design)

No	Wt.	Load	Compressive Strength (N/mm)	Remark
1	8.19	460KN	20.5	14day
2	8.44	570KN	25.3	28day
3	8.44	710KN	31.55	24 hr.
4	8.19	720KN	29.11	7 day

Table no. 2 (testing report of table no. 1)

2. Mix no.2

NaOH ₂	Na ₂ sio ₃	Fly ash	Water	Dust	FA
0.36	1 KG	10	2.35	28kg	20kg

Table no.3 (mix design)

No	Wt.	Load	Compressive Strength (N/mm)	Remark		
1	8.44	570KN	25.33	24 hr.		
2	8.44	310KN	13.77	28day		
3	8.19	320KN	14.22	24 hr.		
4			7.93	440KN	19.55	7 day

Table no. 4 testing in table no. 2

Mix No. 3

For brick

Large brick 300x230x100

NaOH ₂	Na ₂ sio ₃	Fly ash	Water	Dust	FA
0.3	0.93	3.6	1.36	28kg	12.32kg

Table no.5 mix design for brick

No.	Size	Compressive Strength (N/mm)	Avg.
1	300x230x100	28.50	29.64
2	300x230x100	30.90	
3	300x230x100	29.54	

Table no. 6 testing result of table no. 6

4. Rate analysis

For 100 bricks

	Quantity	Rate per kg	Rs.
Na ₂ SiO ₃	24 kg	20	480
Na(OH ₂)	7.5 kg	36	270
Fly ash F	90 kg	3.5	315
Water	34 liter	5	170
10 mm Aggregate	308 kg	18	14
F.A.	176 kg	25	11
Total material cost			1260
Labour + other (30%)			+378
Total cost			1638

Table no. 7 rate analysis

For each brick 1638/100 = Rs. 16.38 RS.

5. Conclusions

1. It means that nearly cost of one brick is Rs.16.
2. Other normal brick having low cost require mortar + plaster inside, outside + Labour cost which is not required here.
3. Here if we use hollow interlocking bricks instead of solid interlocking bricks. Then the volume of brick can be reduced by 40%
4. If we consider above Rs.16 per brick is sufficient.
5. If hollow brick is used in this place, then 40 % volume is reduced so cost will be reduced by 40% and weight of bricks also get reduced by 40% so cost of brick will be around Rs 9 to 10 per brick and weight of brick will be around 3.4 to 3.5 kg thus we can achieve more economy but due to restraint of time for the project we could not practically work on hollow interlocking precast bricks by GPC.



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