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Split Tensile Strength and Workability Characteristics of GGBS, Fly Ash, Over Burnt Bricks based Geo-Polymer Concrete

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Keywords

Split tensile strength, Workability, Geopolymer Concrete (GPC), Fly Ash, Ground granulated blast furnace slag (GGBS), Over burnt bricks (OBB), Sodium hydroxide (NaOH), Sodium Silicate (Na_2SiO_3), Splitting tensile strength (f_{spt}).

ABSTRACT:
Carbon dioxide (CO2) pollutants are mostly caused by the manufacturing of cement. The environmentally friendly and inventive geopolymer concrete (GPC) replaces conventional Portland cement-based concrete. This is acquisition consideration in the construction manufacturing due to its potential environmental benefits and advantageous material properties. Two crucial factors in structural design are the concrete's Splitting tensile strength (f_{spt}) and compressive strength (f_c). A simple yet precise method of predicting the value of this characteristics is something that many academics are interested in because tensile testing are difficult, expensive and time-consuming to do. Instead of employing Portland cement as the binder material, a geopolymer (GP) binder is used to create GPC. Usually, an alkaline activator liquid is used to activate aluminosilicate source materials such fly ash, slag, or natural clay in order to form the GP binder. These source materials are rich in silica (SiO_2) and alumina (Al_2O_3) it react with the activator to form a solid binder through a process called geopolymerization. The goal of the present study is to understand better the split tensile workability features of GPC, which is produced by varying the quantities of GGBS to fly ash (4 No's), alkali molar activators (4 No's), and coarse aggregate to over burnt brick (6 No's). The variation of Split tensile strength and workability of GPC with different material proportions mentioned above is presented. The workability trended worse as the overburnt brick content increased, according to the test results. The molarity changes with workability. Sufficient outcomes are maintained for all mix proportions within the 50-115mm range of workability. The workability decreases as the molarity rises; workability rises when molarity falls. It also matters what kind of binder is used in place of the workability. Workability will change based on the binder's content. Furthermore, when over burned bricks expand and are replace by aggregate in the percentages of 10 percent, 20 percent, 30 percent, 40 percent, and 50 percent, workability decreases at that point. In this study replacing up to 20% of the over burned bricks produced satisfactory workability outcomes.

1. Introduction

Concrete production, while a fundamental component of the construction industry, has several disadvantages and associated challenges. These disadvantages can be environmental, economic and social in nature. GPC offers several advantages over ordinary Portland cement-based concrete. The splitting tensile strength (f_{spt}) of the GPC is significant parameter in structural design. Since tensile tests are challenging, costly, and time-consuming to perform many academics are interested in a conventional forward but accurate way of determining the value of this property. The variance in the workability and split tensile strength of GPC with the various material proportions described above is shown. The test findings showed that the workability trended worse as the overburnt brick content rose. Workability affects the molarity. For all mix proportions, adequate results are maintained within the workability range of 50-115mm. As the molarity increases, the workability

falls. When molarity decreases, workability increases.
Geopolymerization has gained attention as an environmentally friendly alternative to traditional Portland cement-based concrete. It offers the potential to reduce carbon emissions associated with cement production, as well as the use of industrial by- products like fly ash or slag. GPC has been used in various construction submissions including construction, infrastructure and repair and rehabilitation projects. Researchers continue to explore and optimize geopolymerization processes and formulations to expand its use and improve its performance. The present research investigates the split tensile strength of fly ash, GGBS, over burnt bricks-based GPC and its durability.

The exploration of alternative materials in concrete production has been a focal point in the construction industry to enhance sustainability and performance. This study delves into the investigation of split tensile strength characteristics concerning GPC incorporated with GGBS and Fly Ash, while also examining the effects of partial replacement of coarse aggregates with over burnt bricks [1]. In recent times, the utilization of supplementary cementitious materials like GGBS and Fly Ash has gained significant attention due to their possible in enhancing concrete properties and reducing the carbon footprint associated with conventional concrete production. GPC known for its eco-friendly nature and remarkable durability has emerged as a promising alternative to OPC-based concrete [2].
Moreover, the incorporation of over burnt bricks as a partial replacement for coarse aggregates presents an innovative approach near sustainable construction practices. This study aims to evaluate the split tensile strength properties of such a composite material, where the synergistic effects of GGBS, Fly Ash, and over burnt bricks in GPC will be analyzed comprehensively. Understanding the split tensile strength characteristics is pivotal as it assesses the concrete's ability to resist tensile stresses, indicating the situation performance under tension and its potential for use in various structural applications [3].
GPC has gained attention due to its potential as a sustainable alternative to conventional concrete. Works by Davidovits (1994) and Hardjito et al. (2005) emphasized the geopolymerization process, where aluminosilicate materials react with an alkaline solution to produce a binder, offering higher compressive strengths and excellent resistance to chemical attacks compared to OPC. Studies have extensively explored the use of GGBS and Fly Ash as
Supplementary cementitious materials in concrete [4]. Research by Siddique and Singh (2011) examined the use of over burnt bricks in concrete, reporting improved mechanical properties and sustainability benefits due to reduced waste generation. Split tensile strength is a crucial parameter in evaluating concrete's resistance to tensile stresses [5]. Studies such as Li et al. (2019) and Ismail and Al- Hashmi (2009) investigated split tensile strength properties of concrete incorporating supplementary materials, emphasizing their influence on enhancing tensile strength and crack resistance. However, limited research specifically explores the combined effects of GGBS, Fly Ash, and over burnt bricks on split tensile strength in Gpc Concrete [6]. Sharma et al. (2020) investigated the mechanical properties of GPC with GGBS and Fly Ash but did not incorporate over burnt bricks as coarse aggregate replacements, leaving a gap in understanding the holistic impact on split tensile strength. However, limited research specifically explores the combined effects of GGBS, Fly Ash, and over burnt bricks on split tensile strength in Gpc Concrete [7].
Sharma et al. (2020) investigated the mechanical properties of GPC with GGBS and Fly Ash but did not incorporate over burnt bricks as coarse aggregate replacements, leaving a gap in understanding the holistic impact on split tensile strength, while individual studies have explored the properties of GGBS, Fly Ash- based GPC, and the use of over burnt bricks in concrete separately, a comprehensive understanding of their combined influence on split tensile strength is lacking [8].
This literature review underscores the necessity for further research to elucidate the synergistic effects of these materials on split tensile strength properties, opening the door for high-performing, environmentally friendly concrete solutions in the building industry.

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Figure 1: overburnt bricks with the size of coarse agreegates

2. Research Significance

This research is therefore important as it tries to compare the Split tensile strength of gpc concrete made with the cementitious materials GGBS and Fly ash proportions (25:75, 50:50, 75:25 and 100:0) with different molarities in geo polymer concrete such as 2, 4, 6 and 8 with alkaline activators of NaOH and Na_2SiO_3 along with over burnt bricks as the coarse aggregates. In recent times there has been important decline in the capacity utilization of all cement manufacturing plants given rise to the emergence of a strong local burnt bricks manufacturing. In addition, durability tests also conducted to study the effect of different solutions on strength characteristics of fly ash, GGBS based GPC.

3. The Objective of Current Study

The main objective of the project is to study the Split Tensile strength and workability of GPC using GGBS and fly ash with different molarities along with replacing coarse aggregate with over Burnt bricks for M-20 design mix.

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Figure : Geopolymer concrete mix for workability

Figure: cylinders (size 100X200mm) for self-curing.

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Fig: split tensile strength setup a) test setup using CTM b) after test samples

To study Split tensile strength of GPC by limited replacement of coarse aggregate by over burnt bricks up to 50%. To prepare GPC by the random proportion of cementitious materials GGBS and fly ash (100:0, 75:25, 50:50, and 25:75) with different molarities in GPC such as 2, 4, 6 and 8 with alkaline activators of NaOH and Na2SiO3 for M-20 design mix. To study the Split tensile strength of GPC for all molarities along with varying percentages of GGBS, fly ash and over Burnt bricks.

4. Materials

In this study there were used three different alkaline activators of NaOH and Na_2SiO_3 that are the direct chemicals related to the activity and the by-product of other chemical processes. Using alkaline mixes there were activated mixtures of two mineral admixtures GGBS and fly ash. The research material was obtained from Thermal power plants and steel mills.

a. Fly ash
b. GGBS
c. Fine aggregate
d. Coarse aggregate
e. Alkaline Activators (NaOH, Na2SiO3)
f. Over burnt bricks for partial replacement.

Sodium hydroxide and sodium silicate are combined to create an alkaline activator solution, with one liter of potable water used for each mix. Alkaline activators create an alkaline environment for fly ash and GGBS to release silica and alumina, which are crucial for the formation of GPC. To make sodium hydroxide solution (NaOH solution), dissolve flakes in potable water. The solution should be prepared at least before 24 hours to use it and locally available 16mm have been used as coarse aggregate and 16 mm of over burnt brick for partial replacement of coarse aggregate. The over burned bricks have been reduced to the necessary size. The mix's fine aggregate is river sand. To make all geopolymer concrete mixes more workable, SP-430 is utilized for the production of geopolymer concrete.

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Requirement of materials in Kg for casting six cylinders of size 100mm diameter and 200mm long.

GGBS: Fly Ash	Coarse Aggregate(kg)	Fine Aggregate(kg)	GGBS(kg)	Fly Ash(kg)	NaOH Solution(ml)	Water needed for NaoH	Na_2Si0_3 Solution(ml)	Super Plasticizer (ml)
100:0	9.54	8.03	4.14	0	714	1 lit	1831.68	10ml
75:25	9.54	8.03	3.10	1.03	714	1 lit	1831.68	10ml
50:50	9.54	8.03	2.07	2.07	714	1 lit	1831.68	10ml
25:75	9.54	8.03	1.03	3.10	714	1 lit	1831.68	10ml

5. Experimental Programme

The experimental programme consisted of finding the Split tensile strength of GGBS and Fly Ash based GPC with different Coarse aggregate to Burnt brick in different volume proportions for different GGBS to Fly Ash ratios with different molarities by casting and testing of cylinders of size 100 mm dia x 200 mm long at their 7 days and 28 days ambient curing.

5.1 Mixing, Casting and Curing Of Bgpc Specimens:

The same standard methods that are used to produce concrete are also employed to produce BGPC. The new BGPC was layered three times, compacted with a tamping rod, and then the cylinder specimens were put on a table vibrator for fifteen seconds. Following casting, the cylinder has been demolded after a day and left in a dry laboratory setting for specimens cured for the designated amount of time—7 or 28 days.. To find the split tensile strength after 7 and 28 days, 576 cylinders in total were cast. For every parametric change, six identical cylinders—three for each strength of seven and twenty-eight days—were cast.

Table 1: Chemical composition of fly ash and blast furnace slag used for research (mass %)

Symbol	Type	SiO_2	Al_2O_3	$Fe2O_3$	TiO_2	MgO	CaO	Na2O	K_20	$P2O_5$	Total
F1	Calcareous fly ash	45.17	21.79	4.58	1.85	1.49	21.06	0.23	0.19	-	96.36
G	Blast Furnace slag	41.50	9.92	0.95	0.63	6.49	37.52	0.22	0.36	-	97.59

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The mixture of fly ash, ground and screens blast furnace slag, and powdered alkaline material was combined. The following lists the prepared amounts of slag and ash from blast furnaces (Table 3). Sodium silicate and hydroxide were combined to activate each combination. Mixtures for additional research were thus obtained.

6. RESULTS AND DISCUSSIONS

Table 2: Split tensile strength of GPC (7D & 28D)
For (ALC/Binder) =0.6, GGBS 25: FA 75

Sl. No	Designation	Molarity (M)	(GGBS: FA)	C A: BB		$(\frac{BB}{CA})$ Ratio	Split tensile strength (MPa)	
							7D	28D
1	2MA1			1	C50B50	1	0.9	1.01
2	2MA2			2	C60B40	0.67	0.96	1.05
3	2MA3	2		3	C70B30	0.43	1	1.15
4	2MA4			4	C80B20	0.25	1.08	1.28
5	2MA5			5	C90B10	0.11	1.24	1.46
6	2MA6			6	C100B0	0	1.41	1.74
7	4MA1			1	C50B50	1	1.02	1.17
8	4MA2			2	C60B40	0.67	1.09	1.24
9	4MA3			3	C70B30	0.43	1.14	1.35
10	4MA4	4		4	C80B20	0.25	1.2	1.4
11	4MA5			5	C90B10	0.11	1.29	1.5
12	4MA6			6	C100B0	0	1.56	1.9
13	6MA1		25:75	1	C50B50	1	1.09	1.22
14	6MA2			2	C60B40	0.67	1.13	1.27
15	6MA3	6		3	C70B30	0.43	1.23	1.39
16	6MA4			4	C80B20	0.25	1.29	1.48
17	6MA5	6		5	C90B10	0.11	1.36	1.59
18	6MA6			6	C100B0	0	1.8	2.21
19	8MA1			1	C50B50	1	1.15	1.31
20	8MA2			2	C60B40	0.67	1.19	1.39
21	8MA3	8		3	C70B30	0.43	1.4	1.53
22	8MA4			4	C80B20	0.25	1.49	1.87
23	8MA5	8		5	C90B10	0.11	1.57	2.21
24	8MA6			6	C100B0	0	1.96	2.73

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Table 3: Split tensile strength of GPC (7D & 28D)
For $(\frac{ALC}{Binder}) = 0.6\,,\ GGBS\ 50{:}\,FA\ 50$

Sl.No	Designation	Molarity (M)	(GGBS: FA)	CA : BB		$(\frac{BB}{CA})$ Ratio	Split tensile strength (MPa)	
							7D	28D
1	2MB1			1	C50B50	1	1.23	1.37
2	2MB2			2	C60B40	0.67	1.29	1.51
3	2MB3	2		3	C70B30	0.43	1.37	1.69
4	2MB4			4	C80B20	0.25	1.49	1.99
5	2MB5			5	C90B10	0.11	1.9	2.25
6	2MB6			6	C100B0	0	2.3	2.68
7	4MB1			1	C50B50	1	1.37	1.64
8	4MB2			2	C60B40	0.67	1.53	1.99
9	4MB3			3	C70B30	0.43	1.89	2.35
10	4MB4	4		4	C80B20	0.25	2.25	2.96
11	4MB5			5	C90B10	0.11	2.7	3.5
12	4MB6		50:50	6	C100B0	0	2.99	4.1
13	6MB1			1	C50B50	1	1.62	2.1
14	6MB2			2	C60B40	0.67	1.99	2.3
15	6MB3	6		3	C70B30	0.43	2.55	2.6
16	6MB4			4	C80B20	0.25	2.9	3.15
17	6MB5	6		5	C90B10	0.11	3.25	3.4
18	6MB6			6	C100B0	0	3.45	3.9
19	8MB1			1	C50B50	1	1.98	2.43
20	8MB2			2	C60B40	0.67	2.35	2.51
21	8MB3	8		3	C70B30	0.43	2.68	3.1
22	8MB4			4	C80B20	0.25	3.1	3.45
23	8MB5	8		5	C90B10	0.11	3.45	4.2
24	8MB6			6	C100B0	0	4	4.67

Table 4: Split tensile strength of GPC (7D & 28D)
For $(\frac{ALC}{Binder}) = 0.6\,,\ GGBS\ 75{:}\,FA\ 25$

						Split tensile strength (MPa)

Sl.No	Designation	Molarity (M)	(GGBS : FA)	CA : BB		$(\frac{BB}{CA})$ Ratio	7D	28D
1	2MC1			1	C50B50	1	1.34	1.68
2	2MC2			2	C60B40	0.67	1.41	1.89
3	2MC3	2		3	C70B30	0.43	1.59	1.99
4	2MC4			4	C80B20	0.25	1.89	2.4
5	2MC5			5	C90B10	0.11	2.45	2.63
6	2MC6			6	C100B0	0	2.8	3.1
7	4MC1			1	C50B50	1	1.59	2.2
8	4MC2			2	C60B40	0.67	1.82	2.36
9	4MC3			3	C70B30	0.43	2.3	2.68
10	4MC4	4		4	C80B20	0.25	2.61	3.15
11	4MC5			5	C90B10	0.11	3.1	3.45
12	4MC6		75:25	6	C100B0	0	3.35	3.86
13	6MC1			1	C50B50	1	1.96	2.39
14	6MC2			2	C60B40	0.67	2.16	2.6
15	6MC3	6		3	C70B30	0.43	2.63	3
16	6MC4			4	C80B20	0.25	2.99	3.56
17	6MC5	6		5	C90B10	0.11	3.45	3.9
18	6MC6			6	C100B0	0	3.89	4.1
19	8MC1			1	C50B50	1	2.45	2.68
20	8MC2			2	C60B40	0.67	2.89	3.4
21	8MC3	8		3	C70B30	0.43	3.4	3.79
22	8MC4			4	C80B20	0.25	3.67	4.2
23	8MC5	8		5	C90B10	0.11	4.1	4.8
24	8MC6			6	C100B0	0	4.36	5.9

Table 5: Split tensile strength of GPC (7D & 28D)
For $(\frac{ALC}{Binder}) = 0.6\,,\ GGBS\ 100{:}\,FA\ 00$

Sl.No	Designation	Molarity (M)	(GGBS : FA)	CA : BB		$(\frac{BB}{CA})$ Ratio	Split tensile strength (MPa)	
							7D	28D
1	2MD1			1	C50B50	1	1.99	2.26
2	2MD2	2	100:00	2	C60B40	0.67	2.43	2.9
3	2MD3			3	C70B30	0.43	2.97	3.68

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4	2MD4			4	C80B20	0.25	3.6	4.65
5	2MD5			5	C90B10	0.11	4.2	5.1
6	2MD6			6	C100B0	0	4.9	6.45
7	4MD1			1	C50B50	1	2.9	3.15
8	4MD2			2	C60B40	0.67	3.86	4.45
9	4MD3			3	C70B30	0.43	5.12	6.35
10	4MD4	4		4	C80B20	0.25	5.91	7.1
11	4MD5			5	C90B10	0.11	6.99	7.85
12	4MD6			6	C100B0	0	7.86	9.2
13	6MD1			1	C50B50	1	3.3	3.45
14	6MD2			2	C60B40	0.67	4.1	4.73
15	6MD3	6		3	C70B30	0.43	4.75	6.86
16	6MD4			4	C80B20	0.25	6.1	7.61
17	6MD5	6		5	C90B10	0.11	7.15	9.1
18	6MD6			6	C100B0	0	8.1	9.36
19	8MD1			1	C50B50	1	3.39	3.96
20	8MD2			2	C60B40	0.67	4.56	5.17
21	8MD3	8		3	C70B30	0.43	5.12	7.36
22	8MD4			4	C80B20	0.25	6.79	8.1
23	8MD5	8		5	C90B10	0.11	7.93	9.9
24	8MD6			6	C100B0	0	8.36	10.2

The split tensile strength results of GPC prepared by using different GGBS to fly ash proportions 4 numbers (100:0, 75:25, 50:50 & 25:75), alkaline molar activators 4 numbers (2, 4, 6 & 8) and different Coarse aggregate to burnt brick proportions 6 numbers (50:50, 60:40, 70:30, 80:20, 90:10 & 100:0), are Tabulated in Tables 2 to 5. The variation of split tensile strength of GPC with different material proportions stated above is presented graphically

Table 2: shows the GPC of GGBS to Fly ash binder content split tensile strength for seven and twenty-eight days, fly ash 25:75 of Alkali activators with molarities of 2M, 4M, 6M, and 8M is used, and burned bricks are partially substituted for coarse aggregate. With zero percent overburnt concrete, the split tensile value is high. Tensile strength after then is good, at 10% of OBB. Low split values at 50% OBB replacement level.

The GPC of GGBS to Fly Ash Binder Content Split Tensile Strength for 7 Days and 28 Days is displayed in Table 3. Alkali activators with molarities of 2M, 4M, 6M, and 8M are employed in a 50:50 ratio with GGBS to Fly Ash, and burned bricks are used in place of some coarse aggregate. The highest strength was obtained for 8M and 6M with partially OBB 10% & 20% when comparing Gpc at 50:50 (GGBS: Fly ash) binder percentage with standard concrete.

Table 4 displays the GPC of GGBS to fly ash binder content split tensile strength for 7 to 28 days. Over burnt bricks are utilized in partially replacement of coarse aggregate, and fly ash 75:25 of Alkali activators with molarities of 2M, 4M, 6M, and 8M is used. As the amount of GGBS in the binder content increases, the split tensile strength increases quickly along with the molarity variation.
Maximum results at 8 molarity of 10%, 20%, and 30% of substituted OBB with coarse aggregate, and satisfactory results at 4 molarity.

Table: 5 displays the GPC of GGBS to fly ash binder content split tensile strength for 7 to 28 days. Over

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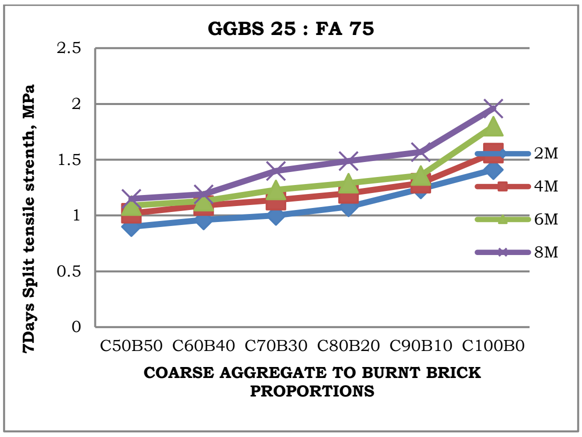
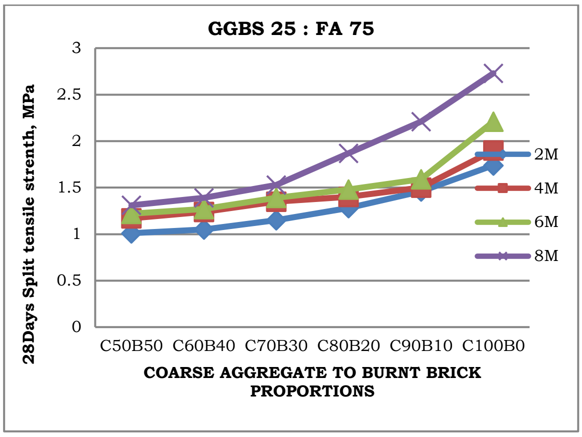
burnt bricks are utilized in partially replacement of coarse aggregate, and fly ash 100:00 of Alkali activators with molarities of 2M, 4M, 6M, and 8M is used. In contrast to regular concrete, GGBS 100% had good results at all molarities, including 2M, 4M, 6M, and 8M of 10%, 20%, 30%, and 40%. High split tensile strength values were obtained with GGBS 100%.

7. GRAPHS (Split tensile strength of GPC 7D & 28D)

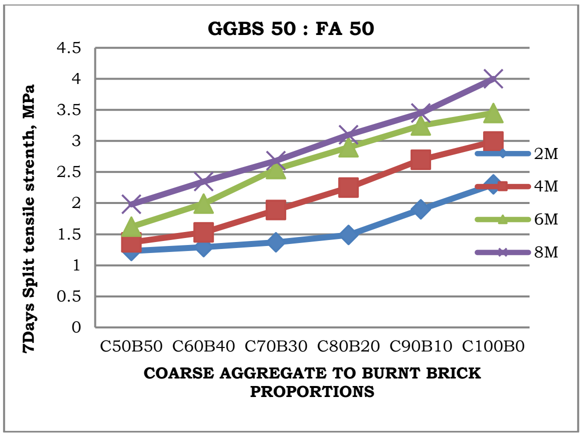


Graph-A

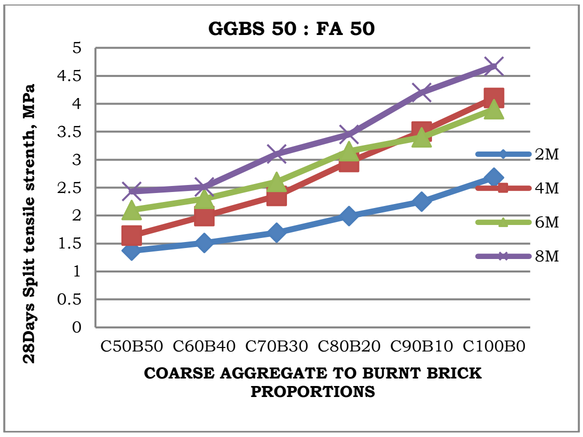


Graph-B

Graph-A & Graph-B Shows on X-axis split tensile strength, on Y-axis, coarse aggregate to overburnt Bricks proportions for 7Days and 28 days. (GGBS 25: FLYASH 75) With various alkali activators like 2M, 4M, 6M, 8M.



Graph-C



Graph-D

Graph-C & Graph-D Shows on X-axis split tensile strength, on Y-axis, coarse aggregate to overburnt Bricks proportions for 7Days and 28 days. (GGBS 50: FLYASH 50) With various alkali activators like 2M, 4M, 6M, 8M.

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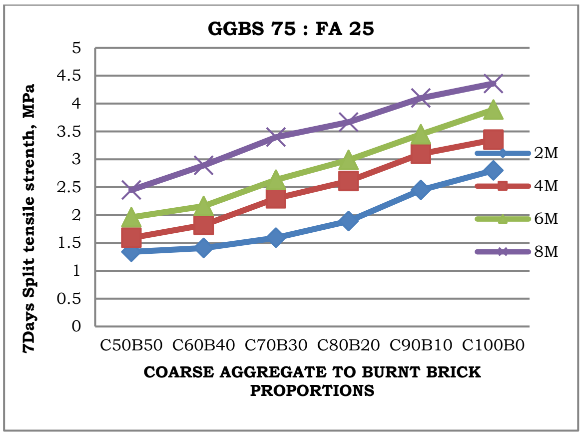
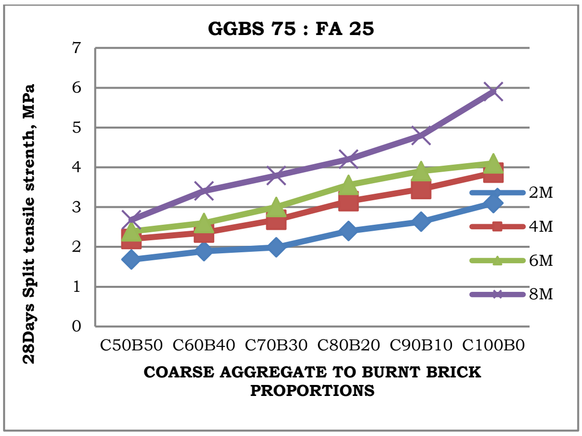
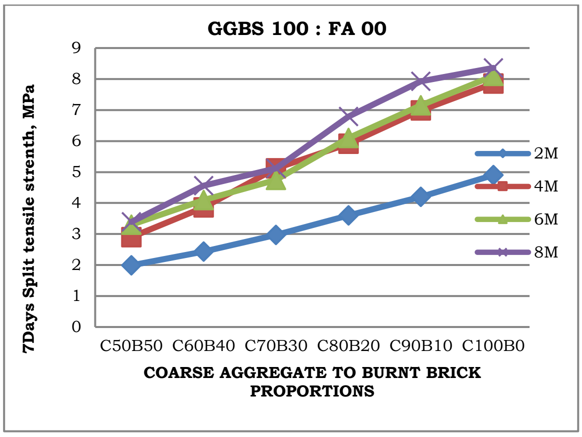


Graph-E

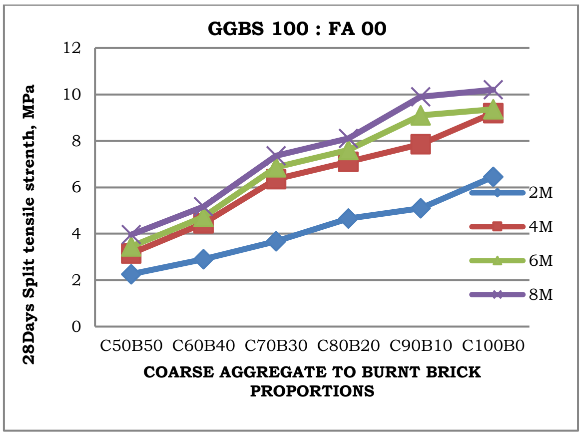


Graph-F

Graph-E & Graph-F Shows on X-axis split tensile strength, on Y-axis, coarse aggregate to overburnt Bricks proportions for 7Days and 28 days. (GGBS 75: FLYASH 25) With various alkali activators like 2M, 4M, 6M, 8M.



Graph-G



Graph-H

Graph-G & Graph-H Shows on X-axis split tensile strength, on Y-axis, coarse aggregate to overburnt Bricks proportions for 7Days and 28 days. (GGBS 100: FLYASH 00) With various alkali activators like
2M, 4M, 6M, 8M.

1. The split tensile strength variation during seven and twenty-eight days is displayed in Graphs A and B. On the x-axis, brick replacement is partially indicated, and on the y-axis, split tensile strength values are indicated. The graphs above illustrate a slight change in split tensile strength between split values of 7 and 28 days.
2. Graphs C and D illustrate the differences in split values over seven and twenty-eight days. In
5. Value when the GGBS content is 100% in the binder. Furthermore, provided high split

contrast to 7 days, 28 days split values show a modest increase. Additionally, 50:50 ratio binder (GGBS: Fly ash) is yielding positive outcomes.

3. The split tensile strength variation over 7 and 28 days is displayed in Graphs E and F. Split tensile values are rising along with GGBs. 10% and 20% molarity produced good results. The ggbs percentage is rising, but the split tensile strength is unaffected. In comparison to conventional concrete, there were high split values at 8 molarity and medium split values at 2 molarity.
4. The variance is displayed across 7 and 28 days in Graphs G and H. The split tensile values exhibit a high

strength values at molarity 2. obtained favorable results using binder concrete at 2M,

4M, 6M, and
8M at 100 GGBS. Up to 50% of OBB replacement is necessary to achieve satisfactory outcomes.at full ggbs

7. Conclusions:

1. From Table 2 to 5, for any constant alkaline molar activator, GGBS to fly ash ratio selected, 7D and 28D Split tensile strength of Overburnt GPC increased for increase in burnt brick (BB) to coarse aggregate proportion. This has proved that the BB can be used up to suitable proportions (50:50) to coarse aggregate. This can help in use of waste materials like BB, resulting reduction in the depletion of naturally available coarse aggregates.
2. From Table 2 to 5, for any constant alkaline molar activator, BB to Course aggregate ratio selected the 7D and 28D Split tensile strength of overburnt GPC is improved for increase in GGBS to Fly ash ratio. This has proved that, as the GGBS proportion increased, the Split tensile strength of GPC is increased.
3. From Table 2 to 5, for any constant BB to Coarse aggregate ratio, GGBS to Fly ash ratio selected the 7D and 28D Split tensile strength of GPC is increased with increase in alkaline molar activator. This has shown that with rise in alkaline molar activator the split tensile strength of overburnt brick GPC increased.
4. From, Table 2 to 5, it is also observed that for 100% Coarse aggregate, the split tensile strength value of overburnt brick GPC is increased, however C50BB50 proportions showed acceptable behavior.
5. The test findings showed that when the overburnt brick content grew, the workability trended worse. Workability has an impact on the molarity. As molarity increases, workability diminishes. Molarity decreases with increasing workability.
6. The type of binder that is employed in lieu of the workability is also important. Workability will vary according to the contents of the binder. Additionally, workability declines when over burned bricks grow and thus are substituted by aggregate in the 10, 20, 30, 40, and 50% percentage.
7. In this investigation, workability results were good when up to 20 percent of the over burned bricks were replaced.

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