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IMPACT OF FIRE ON MECHANICAL PROPERTIES OF CONCRETE AND CEMENT PARTIALLY REPLACEMENT WITH GGBS

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Abstract - *Cement, fine aggregates, coarse aggregates, and water are all used to make concrete. It serves as a white cell in the creation of enormous infrastructure, such as buildings, highways, and bridges. Ordinary Portland cement is the primary component in concrete manufacture. The use of lime in the cement manufacturing process results in a substantial amount of carbon dioxide emissions, which contributes to the greenhouse effect and global warming. As a result, in order to decrease such emissions, you must utilise different materials in each manufacture. Ground granulated blast furnace slag, which is derived from iron blast furnaces and may be utilised in concrete production, was one of the beneficiaries. The use of GGBS as a partial substitute for cement in concrete is examined in this study. GGBS was discovered to improve the qualities of concrete and to be used in the manufacturing of concrete without dumping into the ground, making it an environmentally friendly product. To analyse the impacts on concrete in terms of colour and strength characteristics, concrete specimens of grades M30 and M35 are induced into a temperature range of 200oC to 800oC in phases and then observed and measured. Furthermore, because fires do not occur in a controlled setting such as a furnace, the specimens are exposed to open flames to imitate the conditions in a real-life fire catastrophe structure, and the results are recorded.*

Key Words: *Concrete, GGBS, Fire exposure, Temperature 200oC, 400oC, 600oC and 800oC.*

1. INTRODUCTION

Concrete is perhaps the most widely utilized building material on the planet. It is second only to water in terms of per capita use. However, environmental sustainability is equally crucial in terms of the harm caused by raw material exploitation and carbon dioxide emissions during cement production. This resulted in research projects aimed at reducing cement usage by substituting alternative additional materials for cement. These materials are less energy-intensive industrial waste or by-products that are readily available. When mixed with carbon hydroxide, the compounds known as pozzalona display cementation capabilities. Fly ash, silica fume, metakaolin, and ground granulated blast furnace slag are the most commonly used pozzalonas. When mixed with concrete, the various admixtures Performance was tested to achieve a lower life cycle cost. Pozzalonic characteristics can be found in a variety of by-products and processed foods. When mixed with concrete, the various admixtures Performance was tested to achieve a lower life cycle cost. Pozzalonic characteristics can be found in a variety of by-products and processed foods. Natural pozzalonas, such as GGBS, have recently been discovered to provide a partial alternative for cement. With the usage of GGBS, a relatively new technology, several ways are performed to increase the durability of concrete and to produce high performance concrete. The issue with GGBS is that it requires a lot of water when combined with regular Portland cement.

The properties of concrete containing GGBS as a partial replacement for cement are the subject of this article. As we all know, blast furnace slag is a by-product of the iron-making industry. Iron ore, coke, and limestone are fed into the furnace, and the molten slag that results floats above the molten iron at temperatures between 15000 and 16000 degrees Celsius. The chemical makeup of molten slag is around 30% to 40% SIO_2 and 40% CAO, which is approximately identical to the chemical composition of Portland cement. After the iron has been removed, the residual molten slag, which is mostly siliceous and aluminous waste, is water quenched and rapidly cooled, resulting in Glassy crystalline granulates.

1.2 APPLICATION OF GGBS:

Blast furnace slag (BFS) and steel furnace slag (SFS) have been used as industrial byproducts for about a century in the United States and 150 years in Europe. For many years, ground granulated blast furnace slag (GGBS) has been employed as a cementitious component in composite cements and concrete. The manufacturing of bricks from unground granulated blast furnace slag was the first industrial commercial usage (about 1859). (GBS). Its cementitious capabilities were found in the second part of the nineteenth century, and by the end of the century, the first GBS-containing cements had been manufactured. The usage of GGBS as a separately ground ingredient added to the concrete mixer with Portland cement has gained favor since the late 1950s. Pure GGBS is referred to as "slag cement" in some areasfibers is given be

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2. EXPERIMENTAL INVESTIGATION ON SELF-COMPACTING CONCRETE

In this experimental study, percentage of GGBS (replacement for cement) is to be determined to enhance the strength, fire resistance and durability of concrete specimens.To find optimum % of GGBS, one set of concrete specimens with 10%, 20%, 30%, 40%, 50% replacement of cement with GGBS. The optimum values of GGBS and from concrete specimens are to be used for the evaluation of strength and durability properties of concrete specimen.

CONCRETE SPECIMENS

- Concrete cube dimensions 150 x150 x 150 mm
- Concrete cylinder dimensions 300 x 150 mm
- Concrete Beams dimensions 100 x 100 x 500 mm

MUFFLE FURNANCE

Process of inducing in high temperature: The temperature required for the testing of specimen is given by muffle furnace. A muffle furnace is a heating device functions electrically and the readings are shown by digital scale. Cubes and cylinders, after cured for 28 days they are taken out of water and dried for 2 hours in sunlight and are kept inside the muffle furnace for about an hour. The temperature can be set using a knob as seen in the figure. Temperatures set are 200^{o}C, 400^{o}C, 600^{o}C and 800^{o}C and each specimen is kept inside for an hour as mentioned earlier. Then the specimen are carefully taken out of the furnace and kept in normal temperature to cool down so that tests can be carried out.

In this experimental study, cement is replaced with GGBS as 10%, 20%, 30%, 40% and 50% of concrete specimens were casted respectively cubes and cylinders are casted for each GGBS percentage along as adopted. The specimens were taken out of the curing tank just prior to the test. After that they are placed in muffle furnace, raising of temperature is like in 10 minutes up to 800^{0}C as the compressive strength and Split tensile test is performed using compressive testing machine as per IS 834 (standard fire).

3. RESULTS AND DISCUSSION

Table 1: Compressive Strength 7 Days

S. No	% GGBS	Weight of Specimen	(N/mm^2)
1.	0	8.7	20.8
2.	10	8.6	24.2
3.	20	8.8	29.07
4.	30	8.9	31.5
5.	40	8.9	29.3
6.	50	8.6	24.5

Table2: Compressive Strength 28 Days

S. No	% GGBS	Weight of Specimen	(N/mm^2)
1.	0	8.6	32.0
2.	10	8.9	32.4
3.	20	8.9	39.1
4.	30	8.7	40.0
5.	40	8.6	34.8
6.	50	8.8	31.1

Table 3: Split Tensile Strength 7 Days

S. No	% GGBS	Weight of Specimen	(N/mm^2)
1.	0	13.6	2.3
2.	10	13.8	3.2
3.	20	13.6	3.6
4.	30	13.7	3.8
5.	40	13.8	3.2

6.	50	13.6	2.6

Table4: Split Tensile Strength 28 Days

S. No	% GGBS	Weight of Specimen	(N/mm^2)
1.	0	13.8	2.6
2.	10	13.5	3.6
3.	20	13.7	4.1
4.	30	13.8	4.3
5.	40	13.6	3.8
6.	50	13.7	3.0

Table 5: Flexural Strength 7 Days

S. No	% GGBS	Weight of Specimen	(N/mm^2)
1.	0	12.8	2.7
2.	10	12.6	3.9
3.	20	12.9	4.5
4.	30	12.5	4.9
5.	40	12.7	4.1
6.	50	12.6	3.8

Table 6: Flexural Strength 28 Days

S. No	% GGBS	Weight of Specimen	(N/mm^2)
1.	0	12.5	3.13
2.	10	12.7	5.51
3.	20	12.9	6.20
4.	30	12.6	6.90
5.	40	12.8	5.20
6.	50	12.6	4.40

Table 7: Fire resistance for Compressive strength for 28 Days

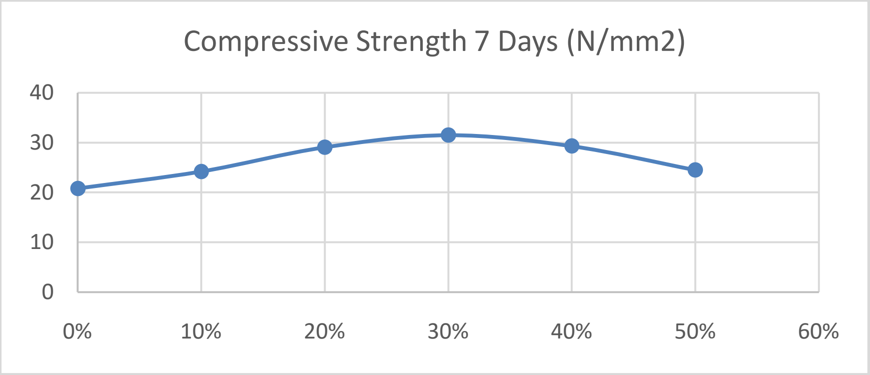
S. No	% GGBS	Before fire exposure (N/mm^2)	After fire exposure (N/mm^2)	
			Air curing	Water curing
1.	0	32.0	27.0	25.3
2.	10	32.4	27.5	25.6
3.	20	39.1	34.8	29.6
4.	30	40.0	35.0	30.1
5.	40	34.8	29.0	24.3
6.	50	31.1	27.1	22.2

Table.8: Fire resistance for Split Tensile strength for 28 Days

S. No	% GGBS	Before fire exposure (N/mm^2)	After fire exposure (N/mm^2)	
			Air curing	Water curing
1.	0	2.6	1.3	1.27
2.	10	3.6	1.7	1.56
3.	20	4.1	1.9	1.76
4.	30	4.3	2.1	1.91
5.	40	3.8	1.4	1.33
6.	50	3.0	1.0	0.90

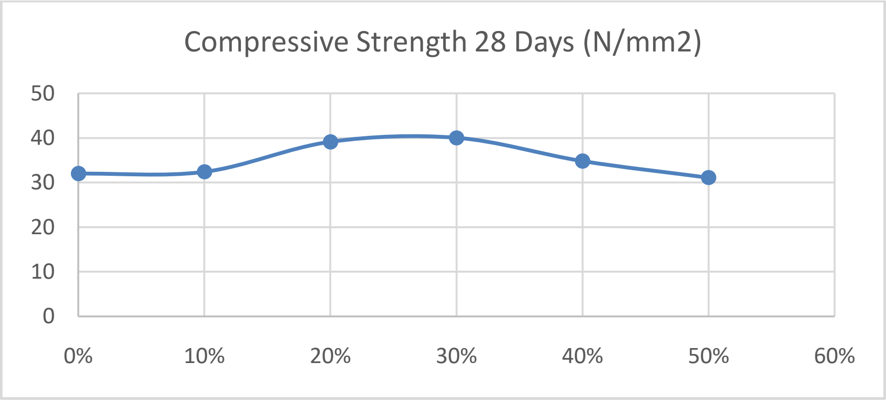
GRAPHS

Graph 1: Compressive Strength 7 Days



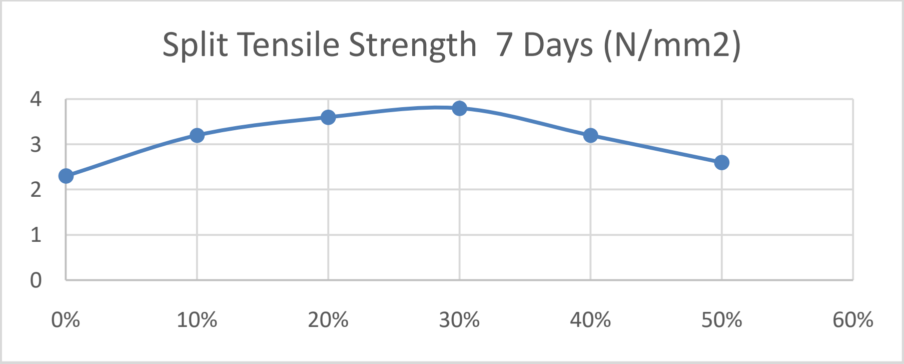
% - GGBS

Graph 2: Compressive Strength 28 Days



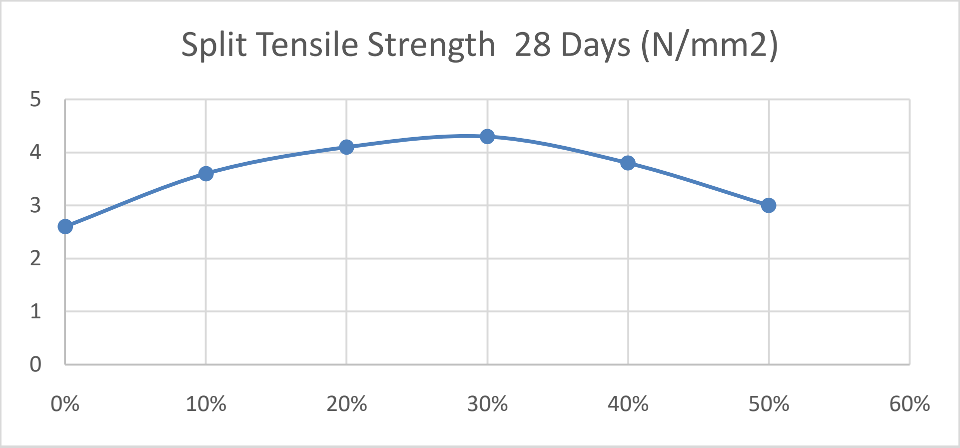
% - GGBS

Graph 3: Split Tensile Strength 7 Days



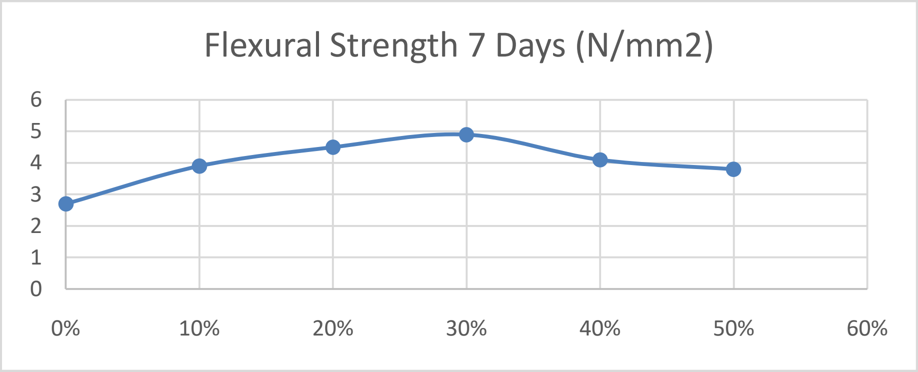
% - GGBS

Graph 4: Split Tensile Strength 28 Days



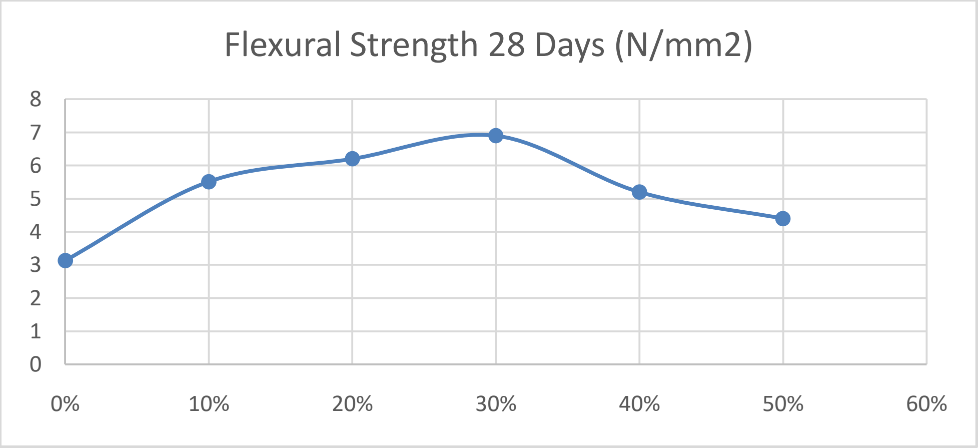
% - GGBS

Graph 5: Flexural Strength 7 Days



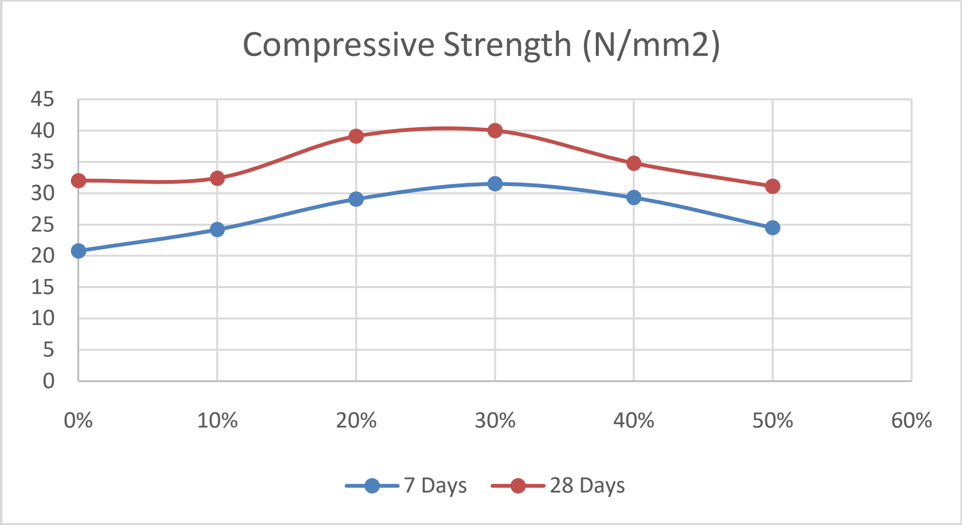
% - GGBS

Graph 6: Flexural Strength 28 Days



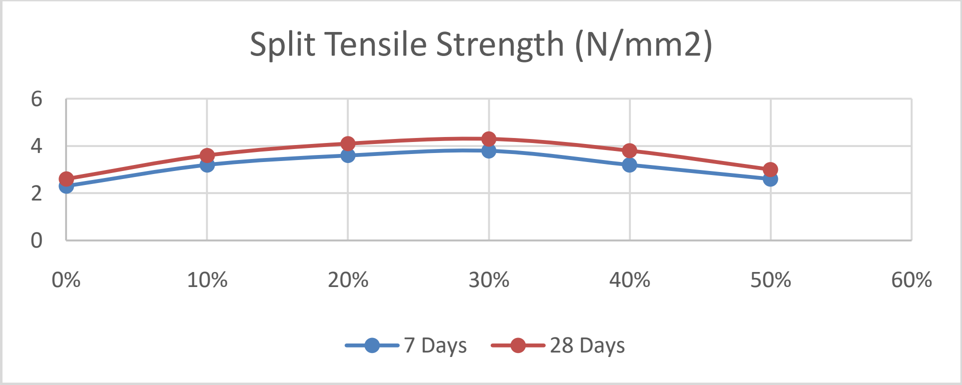
% - GGBS

.Graph7: Compressive Strength



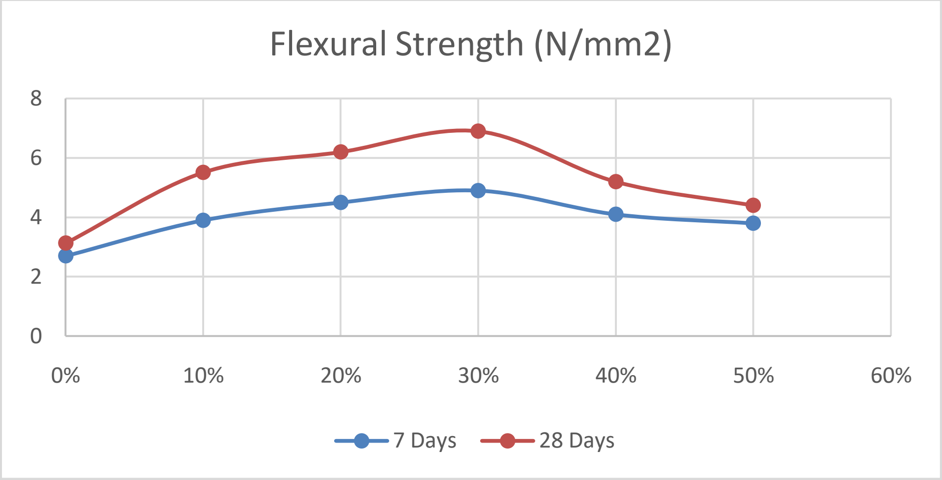
% -GGBS

Graph 8: Split Tensile Strength



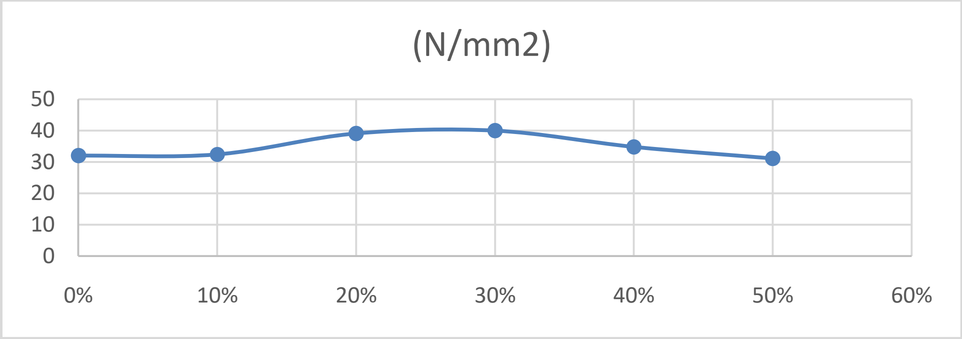
% - GGBS

Graph9: Flexural Strength



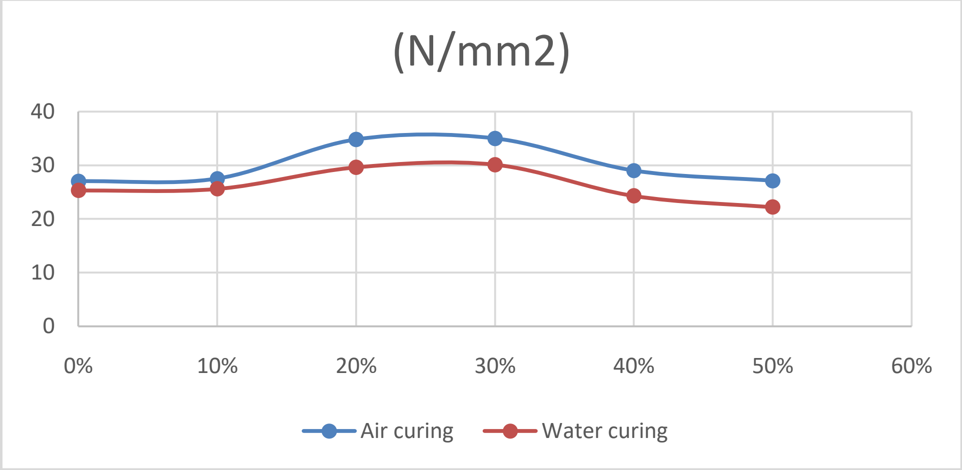
% - GGBS

Graph 10: Fire resistance for Compressive strength for 28 Days



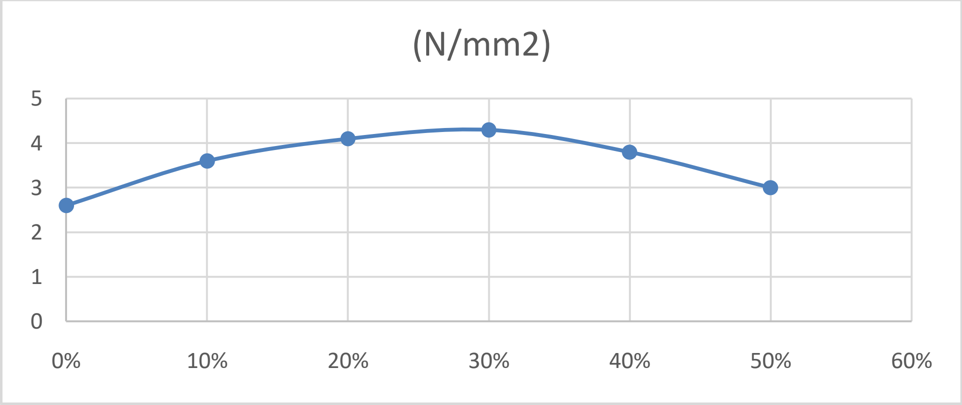
Before fire exposure

Graph 11: Fire resistance for Compressive strength for 28 Days



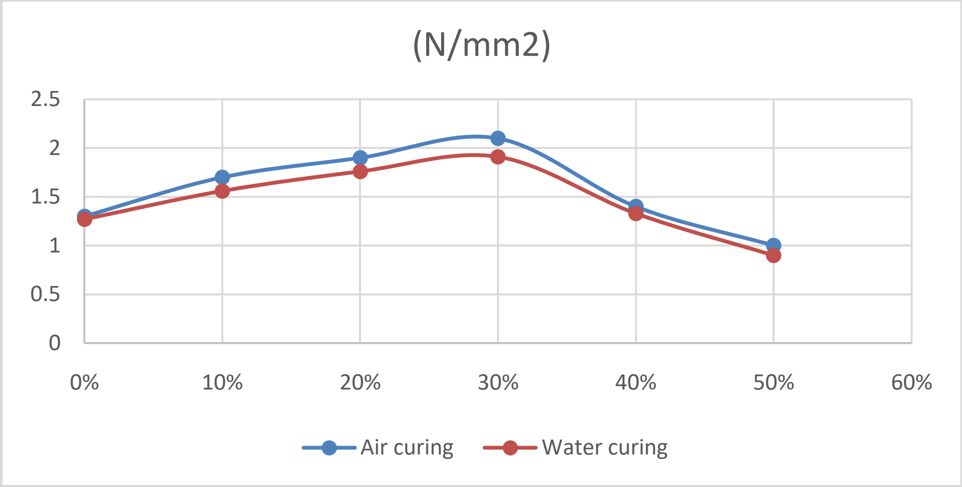
After fire exposure

Graph 12: Fire resistance for Split Tensile strength for 28 Days



Before fire exposure

Graph13: Fire resistance for Split Tensile strength for 28 Days



1. After fire exposure

5. CONCLUSIONS

- Concrete loses its compressive and Split Tensile strength when it is exposed to high temperature more than 200°C.
- After fire exposure 30% cement replaced with GGBS have effective strength than other percentage replacement.
- Color changes is absorbed in fire exposure specimen.
- Free fire exposure concrete specimens have much strength capability then Fire exposed concrete specimens.
- At 10% and 20% GGBS concrete started to increase the compressive and Split Tensile strength
- At 30% GGBS concrete maximum the Compressive and Split Tensile strength obtained.
- At 40% and 50% GGBS concrete started to Decrease the Compressive and Split Tensile strength.

REFERENCES

[1] Md. Moinul Islam, Dr. Md. Saiful Islam, Md. Aftabur Rahman and Amrita Das, “Strength Behaviour of Mortar Using Slag as Partial Replacement of Cement”, Department of Civil Engineering, Chittagong University of Engineering and Technology.

[2] T.S.Viswanathan, K.Srnivasan, V.Sairam1, M.Giriraj, “Influence of temperature on behaviour of concrete.” School of Civil and Chemical Engineering, VIT University, Vellore. JCHPS Special Issue 3: August 2016

[3] Chao-Lung Hwang and Chao-Yin Lin, “Strength Development of Blended Blast Furnace Slag Cement Mortars”, Journal of the Chinese Institute of Engineers, Vol. 9, Issue 3, 1986, pp. 233-239, e-ISSN: 2158-7299

[4] Atul Dubey, Dr. R. Chandak and Prof. R.K. Yadav, “Effect of Blast Furnace Slag Powder on Compressive Strength of Concrete”, International Journal of Scientific & Engineering Research (IJSER), Vol. 3, Issue 8, Aug. 2012, ISSN: 2229-5518

[5] A. Oner and S. Akyuz, “An Experimental Study on Optimum Usage of GGBS for the Compressive Strength of Concrete”, ELSEVIER (Cement and Concrete Composites), Vol. 29, Jan. 2007, pp. 505-514, doi:10.1016/j.cemconcomp.2007.01.001

[6] Kamran Muzaffar Khan and Usman Ghani, “Effects of Bleeding of Portland Cement with Ground Granulaed Blast Furnace Slag on the Properties of Concrete”, CI-Premier PTE Ltd., http://cipremier.com/100029040, Aug. 2004

[7] Reshma Rughooputh and Jaylina Rana, “Partial Replacement of Cement by Ground Granulated Blast Furnace Slag in Concrete”, Journal of Emerging Trends in Engineering and Applied Sciences (JETEAS), Vol. 5, Issue 5, 2014, pp. 340-343, ISSN: 2141-7016

[8] Yogendra O. Patil, Prof. P.N. Patil and Dr. Arun Kumar Dwivedi, “GGBS as Partial Replacement of OPC in Cement Concrete –An Experimental Study”, International Journal of Scientific Research (IJSR), Vol. 2, Issue 11, Nov. 2013, pp. 189-191, ISSN: 2277-8179

[9] Sabeer Alavi.C, I. Baskar and Dr. R. Venkatasubramani, “Strength and Durability Characteristics of GGBFS Based SCC”, International Journal of Emerging trends in Engineering and Development (IJETED), Vol. 2, Issue3, Mar. 2013, pp. 510-519, ISSN: 2249- 6149 and Mr. Gulfam Pathan, “Evaluation of Concrete Properties Using Ground Granulated Blast Firnace Slag”, International Journal of Inovative Research in Science, Engineering and Technology (IJIRSET), Vol. 1, Issue 1, Nov. 2012, pp. 71-7