REVIEW PAPER ON GGBS AND TANNERY WASTE TO COMPLETE REPLACEMENT OF CEMENT

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Abstract: The most crisis the Earth is against nowadays is the environmental pollution and climatic change. Majorly in the construction field the production of OPC causes the emission of Co2 and some harmful pollutants thus results in the environmental pollution. We have the options to reduce the pollution crisis on environment by involving the industrial wastages as a construction material. In this project the geo polymer concrete is prepared by the combination of GGBS, Tannery waste and alkaline solution. The Alkaline solution is for the polymerization process, and it is prepared by the combination of (NaOH) Sodium hydroxide and (Na2SiO3) Sodium silicate. Different molarities of NaOH solution (i.e.) 2M, 4M, 6M, 8M, 10M, 16M are there to prepare the alkaline solution but 16M only used in this project and compressive strength at different ages of each cubes of Tannery waste at different proportion 5%, 10%, 15%, 20 must be calculated and compared to find the optimum one.

SEM (Scanning Electron Microscope) analysis test also conducted to analyse GGBS and Tannery waste. The sieve and water absorption tests are also conducted for the fine aggregate and coarse aggregate. The cube specimen of size 150mmX150mmX150mm are taken. Two different curing techniques are carried out before testing (i.e.) by water curing or by oven curing to accelerate the strength and durability aspects. These geo polymer concrete cubes are tested for the compressive strength at the ages of 1,7,14 and 28th day. The testes conducted on the geo polymer concrete cubes are compression strength, water absorption and bulk density.

1. Introduction

Natural contamination is the greatest threat to humanity on planet. It severely affects the environment. There are numerous reasons which cause contamination. In our construction industry concrete is the primary material for the structure creation. But during the production of OPC it emits CO_2. In India around 2,069,738 thousand of metric huge loads of CO2 is radiated in the time of 2010. The concrete industry contributes about 5% of all out worldwide carbon dioxide discharges and furthermore, the concrete is made by utilizing the earth material such a limestone, clay and other different minerals. To create 1 ton of concrete, about 1.6 huge loads of earthy raw materials are required. On the opposite side the usage of cement is goes on raising in the upcoming days. So, to defeat this issue, we need to use alternatives for the concrete with the industrial wastages, for example, GGBS, Tannery waste, Fly ash, Metakaolin, Silica fume and so on. The innovation geo-polymer concrete is a promising strategy. Ground granulated blast furnace slag (GGBS) is a result from the impact heater used to make iron. During the interaction, slag was framed, and it is then dried and crushed to a fine powder. The term geo-polymer was first instituted by Davidovits in 1978. Geo-polymer concrete is created by a polymeric materials like GGBS, fly ash etc. Geo-polymers have the identical chemical composition like Zeolites, the most widely recognized soluble fluid utilized in the geo-polymerization is the mix of sodium hydroxide or potassium hydroxide and sodium silicate or potassium silicate. This mix builds may increase the reaction and durability. Among 15 Alumino-silicate minerals, all the Al-Si minerals are more dissolvable in NaOH than in KOH.

MATERIAL PROPERTIES

Ground Granulated Blast Furnace Slag (GGBS)

Ground Granulated Blast Furnace Slag (GGBS) is a byproduct from the blast furnaces used to make iron. Blast furnaces are fed with controlled mixture of iron ore, coke, and limestone. And operated at a temperature of about 1500^0C. When iron ore, coke and limestone melt in the blast furnace, two products are formed (Molten iron and Molten slag). The molten slag is lighter and floats on the top of the molten iron. The molten slag comprises mostly silicates and alumina from the original iron ore, combined with some oxides from the limestone. The process of granulating the slag involves cooling of the molten slag through high pressure water jets. This rapidly quenches the slag and forms granular particles generally not bigger than 5mm. The rapid cooling prevents the formation of larger crystals and the resulting granular material comprises around 95% non-crystalline calcium alumino silicates. The granulated slag is further processed by drying and then grinding in a rotating ball mill to a very fine powder, which is then called GGBS.

ISSN (Print): 2204-0595
ISSN (Online): 2203-1731

Chemical composition of GGBS of various authors

COMPOSITION	Mantel (1991)	Tasong et al (1990)	Oner et al (2007)	Hui-sheng (2009)
SiO_2	36.60	35.34	39.18	36.39
Al_2O_3	13.20	11.59	10.18	13.76
Fe_2O_3	0.60	0.35	2.02	2.44
CaO	33.00	41.99	32.82	30.13
MgO	10.70	8.04	8.52	9.36
Mn_2O_3	1.20	0.45	-	-
SO_3	2.50	1.23	-	1.30

Tannery Waste

Tannery waste is a shredded waste material produced in leather industry. It is the by-product of lather after the various tanning process the wastes emitted out as liquid waste. The waste produced from these industries are difficult in disposal. The disposal of such waste can be done either by incineration or by land filling which leads to air or land pollution, respectively. So, to avoid pollution and reduce the cost of construction the experiment is carried out and the results are inferred. The size is maintained by shredding the materials. The shredded waste which is so obtained is used to replacement of cement. When the tannery wastes are subjected to high temperature (incineration) certain gases like Sox, CO, etc. causes major problems to human beings like carcinogen, irritation to eyes etc. so the process of disposal of such wastes becomes more complicated. With the view of above criteria, it can be concluded to use tannery wastes in construction. The properties analyzed include pH, alkalinity, and chlorine, sulfide, silica, nitrate, etc.

Physical properties	Tannery waste
Shape	Irregular
Appearance	Brownish white
Water absorption (%)	0.15-0.20
Moisture content (%)	0.1
Density (Kg/m^3)	240.9
Bulking point (%)	10
Specific gravity	2.56

Alkaline Solution

Sodium hydroxide and sodium silicate are used to form a alkaline solution. 8 molar and 16 molar NaOH solution are used. Since the molecular weight of sodium hydroxide is 40 and to prepare 8 molar solution 8 x 40 = 320g of NaOH is dissolved and to prepare 16 molar solution 16 x 40 = 640g of NaOH is dissolved in 1000ml of distilled water. The optimum mix design ratio for geo polymer paste using GGBS and Tannery waste is approximately 2 is used. (i.e.) Ratio (Na_2SiO_3: NaOH =2).

PROPERTIES OF NAOH

Molecular formula	NaOH
Molar mass	39.9971 g/mol
Appearance	White solid
Density	2.13 g/cm^3
Melting point	318°C, 591K, 604°F
Boiling point	1388°C,1661K
Solubility in water	111 g/100ml
Solubility in ethanol	13.9 g/100ml
Solubility in methanol	23.8 g/100ml
Solubility in glycerol	Soluble
Acidity (pKa)	~13
Refractive index (nD)	1.412

PROPERTIES OF Na_2SiO_3

pH value	Neutral
Assay of Na_2O	7.5 % - 8.5 %
Assay of SiO_2	25 % - 28 %
Free alkali	Yes

Fine Aggregate

The most significant capacity of the fine aggregate is to help with creating workability and consistency in mixture. And it assists with holding the coarse aggregate particles in suspension. This activity advances plasticity in the blend and forestalls isolation of glue and coarse aggregate, and fundamentally

ISSN (Print): 2204-0595
ISSN (Online): 2203-1731

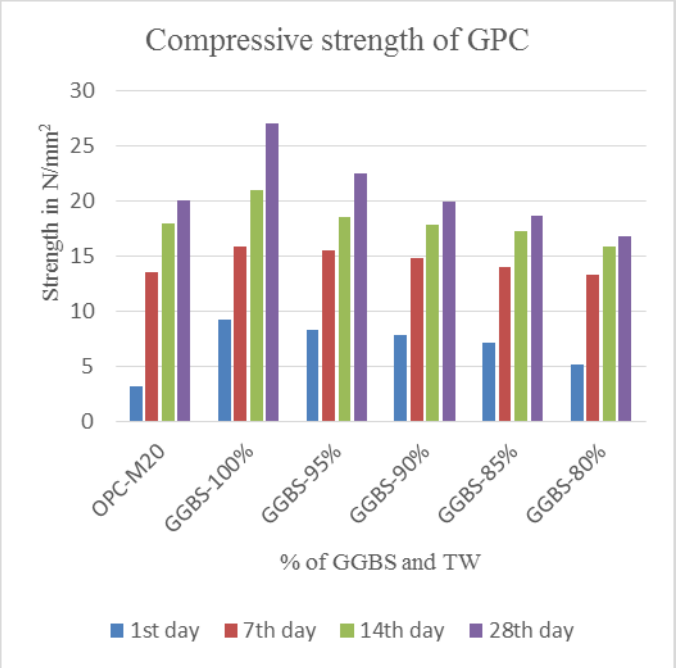
during transport from blending plant to the point of position. In this manner the expense of development can be constrained by the utilization of fabricated sand as an option material. This M-Sand is without dust and the sizes can be effectively controlled so it meets the necessary reviewing for construction.

Coarse Aggregate

It is the strongest and least permeable material of cement. It is progressively steady chemical material. Aggregate going through 20mm strainer and held on 10mm sifter are utilized as coarse aggregate. The coarse total utilized in experimentation were tried according to IS 383-1970 and 2386-1963.

COMPRESSION STRENGTH

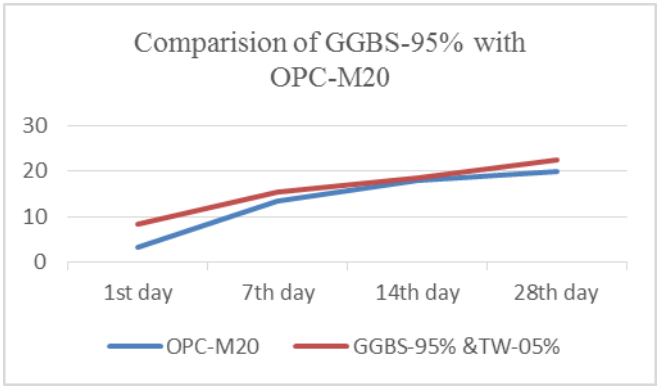
Mechanical property	**Age (Days)**	**Mix ratio of GGBS in %**				
		100	**95**	**90**	**85**	**80**
Compressive strength (N/mm^2)	1	9.2	8.3	7.8	7.1	5.1
	7	15.8	15.5	14.8	14	13.3
	14	21	18.5	17.8	17.2	15.8
	28	27	22.5	19.9	18.7	16.8

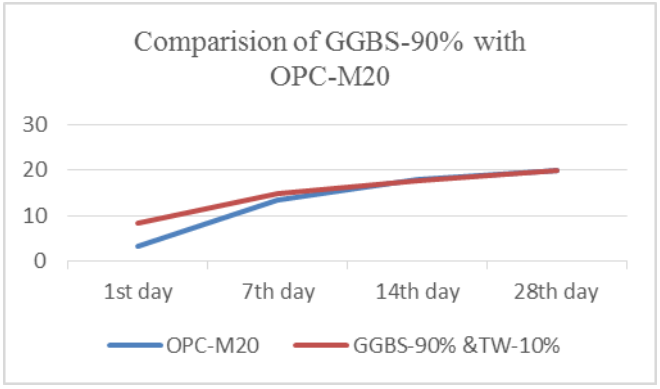


It has been observed that there is an increase in compression strength while increase in percentage of GGBS and reducing the % of tannery waste and has been illustrated with the above bar chart with samples having different proportions with different ages of 1st, 7th, 14th, 28th day of curing respectively in room temperature.

DISCUSSIONS

Based on the results obtained from compressive strength test, the strength of the concrete having 0%, 5%, 10% tannery waste is higher when compared to other samples at different proportions of GGBS and Tannery waste. The samples tested which attain the minimum compressive strength of 15N/mm^2 required for building construction and hence all the sample mix proportions can be used to replace the Portland cement in the concrete because all the cubes of different proportion have more than 15 N/mm$_2$. Comparing GPC with the normal OPC concrete the strength attains lower than the nominal OPC concrete. The percentage of strength attains with different ages of GGBS-95% and 90% while comparing with OPC-M20 grade concrete were shown in the below line graph.





CONCLUSION

In view of researchers, it could be concluded that all of them have invested their energy and time to show the impact of GGBS on Geopolymer Concrete. Anyway, it ought to be noticed that with the variety in the boundaries like Na2SiO3/NaOH Ratio, Molarity of NaOH, curing temperature, curing time makes the Variation in the Strength in various testes. Substitution of concrete made by cement by GGBS builds the

ISSN (Print): 2204-0595
ISSN (Online): 2203-1731

Strength slowly without curing arrangement.

- Oven cured relieved shows higher Compressive and elasticity than that of open room temperature. So, by utilizing GGBS content and tannery waste in Construction industry we can decrease the problem of natural issues like an unnatural weather change and global warming while creation of OPC.

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ISSN (Print): 2204-0595
ISSN (Online): 2203-1731