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Performance of Ground Granulated Blast Furnace Slag Concrete with Partial Replacement of Sand by Saw Dust

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ABSTRACT: ***The*** *Ground granulated Blast furnace slag (GGBFS) is a waste of industrial materials, it is relatively more recent pozzolanic material that has received considerable attention in both research and application. It* is a non-metallic product consisting essentially of Silicates and Aluminosilicates of calcium's developed simultaneously with iron in a blast furnace and is granulated by quenching the molten material in water or steam, and air. *The present Investigation has been undertaken to study the effect of Ground granulated blast furnace slag and saw dust on the mechanical properties of concrete, when coarse aggregates is replaced by Ground granulated blast furnace slag and saw dust is replaced in different percentages i.e. 0%,5%,10%,15%,20%,and 25% with the Fine aggregates(sand). The main parameters investigated were cube compressive strength and weight of concrete. The tests were conducted on concrete with ratio 1:1.5:3.The test results indicate that with the use of blast furnace slag by fully replacing coarse aggregates and partially replacing saw dust by fine aggregates in different percentages i.e. 0%,5%,10%,15%,20%,and 25%,the weight of concrete decreases with the increase in the percentage of saw dust. The compressive strength decrease with the increase in percentage of saw dust. The reduction percentage in the compressive strength is 27.14%, 44.16%, 50.46%, 64%, 76.53%, 80.60% Replacement of sand by saw dust reduce the unit weight of concrete and make it light weight. The cost of concrete also decreases with the increase in percentage of saw dust. Test result show that, the concrete become lighter than conventional concrete and reducing the environmental hazard and making the concrete economical.*

Key Words: *Compressive strength, Flexural strength, Ground granulated blast furnace slag, Saw dust, Weight of Concrete*

I. Introduction

One of the major challenges of our present society is the protection of environment. Some of the important elements in this respect are the reduction of the consumption of energy and natural raw materials. Big attention is being focused on the environment and safeguarding of natural resources and recycling of wastes materials. In the last 20 years, a lot of work concerning the use of several kinds of urban wastes in building materials has been published. The use of different waste materials is showing prospective application in construction industry as alternative to conventional materials. Such practice conserves natural resources and reduces the space required for the landfill disposal of these waste materials. Ground granulated blast furnace slag is a by-product of steel industry . It is a non-metallic product consisting essentially of Silicates and Aluminosilicates of calcium developed simultaneously with iron in a blast furnace. Different forms of slag product are air-cooled blast furnace slag (ACBFS), expanded or foamed slag, palletized slag, and granulated blast furnace slag depending on the method used to cool the molten slag . Past result GGBFS (Slag) show positive results when used in concrete .Saw dust is the by–product of wood industry .Saw dust can be defined as loose particles or wood chipping obtained as by- products from sawing of timber into standard useable sizes. From past research, it is observed that Clean saw dust without a large amount of barks can show satisfactory results. Saw dust does not introduce a high content of organic material that may upset the reaction of hydration , that why saw dust can be used in concrete to make it light weight concrete. Maslehuddin et. al (2003) investigated in his study that the compressive strength of GGBFS concrete has nearly same result as those of lime stone aggregates concrete. In the study on lime stone dust and saw dust by Paki turgut , Halil Murat Align (2007) Reported that when limestone and saw dust is used in concrete, than concrete does not exhibit sudden brittle failure, it show high energy absorption capacity, reduce unit weight and provided smoother surface ,and decrease in compressive strength with increase of saw dust. From past study it has been shown that saw dust has pozzolanic properties. D.K.Singha Roy (2011) study the effect on blast furnace concrete when class F fly ash is replacing sand up to 60% .The test perform for modulus of elasticity, saltwater effect on compressive strength water absorption and porosity. Result show that with the increase in % replacement of sand by fly ash ,decrease the unit weight of concrete .Water absorption and porosity of BFS concrete decrease upto 40% replacement of sand by fly ash . Past study show the positive result for blast furnace slag and saw dust . D.Taoukil, A.El-bouardi, H.Ezbakhe and T.Ajzoul (2011) study the comparison between the thermal properties of concrete

lightened by saw dust and those lightened by wood shavings The results show, that the concrete from wood shavings present better insulation capacities than those obtained from saw dust**.**

So, Interest in the use of Ground granulated blast furnace slag and saw dust resulted from the strict enforcement of air-pollution measures designed to stop release of the material into the atmosphere. In the present study an attempt has been made to assess the suitability of Ground granulated blast furnace slag and saw dust in concrete making . In this study , Ground granulated blast furnace slag is used as coarse aggregates in place of conventional aggregates in concrete making and saw dust as partial substitute to conventional fine aggregates (sand).

II. OBJECTIVE

2.1. Determine the compressive strength of concrete by replacement of blast furnace slag with coarse aggregates and saw dust replaced with fine aggregates by varying percentage (0%, 5%, 10%, 15%, 20% and 25%) after 7 days and 28 days .

2.2. Comparison of weight of conventional concrete and concrete made by fully replacing coarse aggregates by blast furnace slag aggregates and partially replacing sand by saw dust in varying percentage (0%,5%,10%,15%, 20% & 25%). Effect on weight, with the increase in percentage% of saw dust is also investigated.

III. Experimental Programme

3.1 Properties of Material

In order to achieve the objectives of the present study, an experimental program was planned.The aim of the experiments is to study the properties of the materials used in GGBFS concrete, and check the conformance with codal requirements. It will enable an engineer to design a concrete mix for a particular strength.The different materials used in the present study are cement, sand, coarse aggregate, ground granulated blast furnace slag, saw dust and water Laboratory tests were conducted on these materials and their properties have been reported in Table 1.

Table No. : 1 Physical properties of Materials

S.N0	Material	Source of material	Type of material	Specific Gravity	Water Absorption	Impact Value
1	Coarse aggregates	Nangal-Crushed stone (confirming to IS 383)	Crushed	2.66	0.80%	22.46
2	Fine aggregates	Nangal (confirming to IS 383)	Zone -II	2.67	1.20%	
3	Cement	ACC OPC-43 (confirming to IS 8112)	OPC-43	3.15		
4	Slag	Shiva Alloys (Mandi-Gobindgrah)	Crushed	2.28	2.80%	30.39
5	Saw Dust	Sahibzada Timber (Mohali)	Fine	1.33	13%	

3.2 Preparation of mix

Mixing was done in a small rotary drum mixer. Coarse aggregate, sand, OPC, blast furnace slag, saw dust and water was added to the mixer respectively for quantities as shown in Table No. 2. The mix was prepaid in ratio 1:1.5:3. After the addition of each material, the mixer continue to mix until the mixture became homogenous Six sample of Oiled steel molds of dimensions 150mm x150mm x 150mm were filled in approximately three equal layers and compacted manually. After 24 hours of casting, the specimens were cured by soaking in to water until the age of testing. Six samples for each set of percentage have been taken for compressive strength test , so as to work out an average result and to discard the absurd result if any. The cubes were tested at the age of 7days and 28 days. The specimens were tested on 200 tonnes universal testing machine (UTM). The specimens were removed from curing tank and wiped with cloth for any traces of surface water. After keeping at room temperature for half an hour they were placed in position. According to Indian standard procedure laid down in IS: 516-1959. The cubes were placed in such a way that the load was supplied at the right angle to the faces of cube rotating them at 90^0.

Table No. : 2 Mix proportions

S.No	Percentage (%)	Cement (Kg)	Natural Sand (Kg)	GGBFS (Kg)	Saw Dust (Kg)	Water (Kg)	Aggregates (Kg)	
							10mm	20mm
1	conventional concrete	15.00	31.57			8.94	27.63	24.07
2	0%	15.00	31.57	46.83	00	9.00		
3	5%	15.00	31.57	46.83	0.73	9.81		
4	10%	15.00	28.30	46.83	1.40	10.45		
5	15%	15.00	26.78	46.83	2.11	12.08		
6	20%	15.00	25.26	46.83	2.80	12.29		
7	25%	15.00	23.73	46.83	3.49	12.60		

Load was applied continuously at the rate of 15 MPa per minute until the failure of the specimen takes place. The plate no. 1 shows testing of cube specimens under compression testing machine. Table No. 3 and Table No. 4 shows the result of test.

IV. Test Result And Discussion

The results of various tests conducted on the behavior of GGBFS concrete with varying percentage of saw dust 0%, 5%, 10%,15%,20%,and 25%. For each percentage variation of Saw dust samples were tested and average value of these six observations was taken as final result. Testing was done to investigate the mechanical property of concrete by conducting cube compressive strength test .Weight of concrete is also taken for each percentage variation of Saw dust and final test result shown in Table no.3 and Table no. 4 .

4.1 Weight

The important physical properties of slag and saw dust have been presented in Table no. 1.The specific gravity of slag and saw dust is much less than that of conventional coarse aggregates and fine aggregates respectively. It will cause reduction in the unit weight of concrete. It is also observed that the weight cubes of size 150mm x 150mm x 150mm decreases with the increase in the percentage of saw dust replaces fine aggregates (sand).Therefore the saw dust can be used effectively in GGBFS concrete with partial replacement (up to 15%) by sand. It will make concrete as light weight concrete.

4.2 Compressive Strength

In Fig.1 depicts that the coarse aggregate concrete achieved compressive strength of 40.76 N/mm^2 and 50.25 N/mm^2 at the age of 7 days and 28 days respectively. Compressive strength of GGBFS concrete in which coarse aggregates are fully replaced by Slag aggregates is 41.68N/mm^2 at the period of 28 days of curing .The strength is decreases by 8.57N/mm^2 .The reduction % is 27.14%.The 28 days cube compressive strength results show that the strength of GGBFS concrete mixes decreases with the increase of saw dust by varying percentage 0%,5%,10%,15%,20% and 25%. The corresponding values at the age of 28 days by saw dust replacement levels of 0%,5%10%,15%,20%,and 25% attained strength of 41.68 N/mm^2, 28.11 N/mm^2,17.34 N/mm^2,12.02Nmm^2, 9.9N/mm^2 and 7.93N/mm^2 respectively. From Fig.2 the reduction percentage in the compressive strength is 27.14%, 44.16%, 50.46%, 64%, 76.53%, 84.60%.The compressive strength of GGBFS concrete is less than coarse aggregate concrete. It can be concluded that the compressive strength Decreases with the increase percentage of saw dust .

4.3 Cost

The concrete become economical by using waste Ground granulated blast furnace slag and saw dust in concrete mixes. The slag and saw dust are industrial waste they are available in market at free of cost. It is observed that the cost of concrete decrease with the increase in percentage of saw dust.

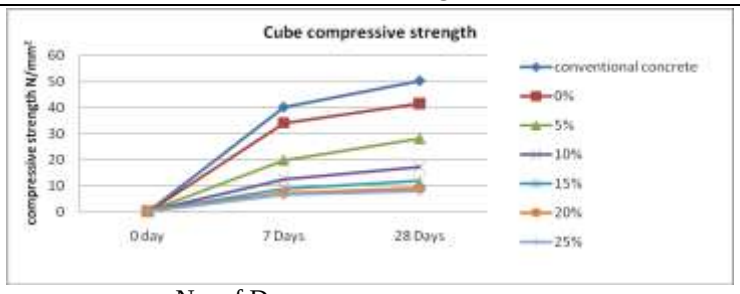
Plate no. 1 Compressive strength test machine

Table no.: 3 Result of weight of cubes

Cube		Weight [Kg]		Average weight [Kg]	
%	No.	7 Days	28 Days	7 Days	28 Days
conventional concrete	A	8.41	8.50	8.41	8.46
	B	8.42	8.39		
	C	8.41	8.45		
0%	A	8.00	7.83	7.86	7.92
	B	7.70	7.95		
	C	7.90	8.00		
5%	A	7.49	7.57	7.54	7.46
	B	7.68	7.69		
	C	7.58	7.33		
10%	A	6.69	6.95	6.84	6.96
	B	6.79	7.01		
	C	7.04	6.30		
15%	A	6.57	6.31	6.46	6.42
	B	6.37	6.44		
	C	6.35	6.57		
20%	A	6.62	6.37	6.20	6.16
	B	6.51	6.24		
	C	6.58	6.01		
25%	A	6.37	5.98	6.04	6.00
	B	6.10	6.01		
	C	6.20	6.05		

Table no. 4 Result of Compressive Strength

Cube		Crushing Load [KN]		Compressive Strength [N/mm2]		Average [N/mm2]	
%	NO.	7 Days	28 Days	7 Days	28 Days	7 Days	28 Days
conventional concrete	A	929.6	1090	41.32	48.44	40.76	50.25
	B	924	1177	41.07	52.31		
	C	898	1125	39.91	50		
0%	A	780.5	950.6	34.66	42.24	34.16	41.68
	B	776.4	935	34.5	41.55		
	C	750.2	928.5	33.34	41.26		
5%	A	442.3	631.4	19.66	28.06	19.82	28.11
	B	435	625.5	19.33	27.8		
	C	460.8	640.2	20.48	28.45		
10%	A	309.4	352.3	13.75	15.66	12.51	17.34
	B	266.2	377.4	11.83	16.77		
	C	268.52	440.9	11.93	19.6		
15%	A	188.3	253.2	8.37	11.25	8.77	12.02
	B	198.5	269	8.82	11.96		
	C	205.3	289	9.12	12.84		
20%	A	156.5	220.5	6.96	9.8	7.25	9.09
	B	172.46	198.2	7.66	8.81		
	C	160.1	194.8	7.12	8.66		
25%	A	137.2	174.3	6.1	7.75	6.59	7.93
	B	157.7	185.5	7.01	8.24		
	C	150	175.2	6.67	7.79		



No. of Days

Fig. 1 Cube Compressive Strength Test Result

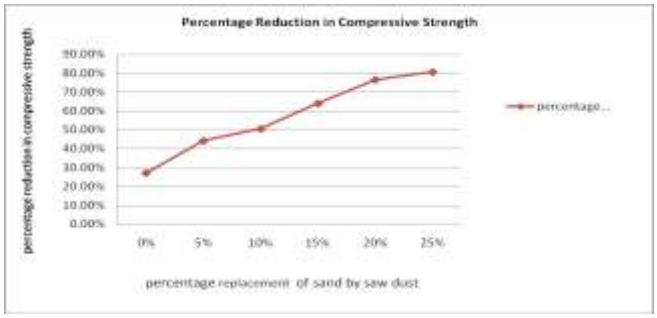


Fig.2 Percentage reduction in compressive strength result

Test result show that ,the concrete become lighter than conventional concrete and reducing the environmental hazard and making the concrete economical.

V. CONCLUSION

On the basis of the results and discussions on this investigation the following conclusions are drawn:

- GGBFS Concrete becomes light weight by partially replacing sand with saw dust.
- The concrete made by using slag as coarse aggregates and partially replacing sand with saw dust used for lean mixes .
- GGBFS Concrete can be effectively used by replacing sand up to 15% with saw dust.
- The cost of concrete is less than conventional concrete.
- The concrete becomes environment friendly, due to use of waste industrial material.

Refrences

[1] A.V.Elinwa, and S.Abdulkadir (2011), "*Characterizing saw dust ash for use as an inhibitor for reinforcement corrosion"* New Clues in sciences 1,(2011)1-10 , Nigeria.

[2] D.K.Singha Roy (2011),"*Performance of blast furnace slag concrete with partial replacement of sand by fly ash"* International journal of earth sciences and engineering, ISSN: 0974-5904, Volume 04 , No 06 SPL, October 2011, PP.949-952 , Durgapur

[3] D.Taokil, A.El-bouardi, H.Ezbakhe and T.Ajzoul (2011), "*Thermal properties of concrete lightened by wood aggregates* ''Research journal of applied sciences ,Engineering and Technology ,3(2): 113-116, 2011,ISSN: 2040-7467 ,Morocco.

[4] Ek. Serafimova, M.Mladenov, I.M.hailova (2011), "*Study on the characteristics of waste wood ash* ," journal of the university of chemical technology and metallurgy , 46, 1,2011, 31-34 , Bulgaria .

[5] F.A.Olutoge (2010) , "*Investigations on saw dust and palm kernel shells as aggregate replacemen*t" ARPN Journal of engineering and pplied sciences , ISSN : 1819- 6608,Volume -5 ,4 april,2010, Nigeria .

[6] Paki Turgut, Halil Murat Algin ,(2007) "*Limestone dust and wood saw dust As brick material''* Science direct building and environment 42 (2007) 3399-3403 ,Turkey.

[7] S.J.Barnett, M.N.Soutsos, S.G.Millard , J.H.Bungey ,(2006)"*strengthdevelopment of motars containing ground granulated blast furnace slag : effectofcuring temperature and determination of apparent activation energies ''* Science direct , Cement and Concrete Research 36 (2006) 434-440 , U.K .

[8] Singh S.P and Murmu , M^2,*"Eco- friendly concrete using by- products of steel industry''*

[9] Maslehuddin M., Sharif M. Alfarabi, Shameem M., Ibrahim M., and Barry M.S., (2003), *" comparison of properties of steel slag and crused limestone aggregates concrete* ," construction and building material , Vol.17,No. 2 ,March 2003, 105-112.