EXPERIMENTAL STUDY ON STRENGTH AND DURABILITY PROPERTIES OF CONCRETE BY PARTIAL REPLACEMENT OF BINDER CONTENT WITH GGBS & REDMUD

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Abstract – *In this project Experimental study on strength and durability properties of concrete by partial replacement of binder content with GGBS & Red mud is done. In this project they are two phases of experimental work. In the first phase of work cement is partially replaced with red mud and ggbs with individually. Firstly, the proportion that is partially replaced with red mud in different ratios of 1%,3%,5% and 7% by the weight of the cement. Secondly the proportions were partially replaced with ggbs in different ratios of 5%,10%,15% and 20% by the weight of the cement. The experiment will be conducted on fresh, hardened concrete. In which optimum percentage was selected based on the mechanical properties and then results was compared with conventional concrete. In this project we are using the M30 grade of concrete.*

In the second phase of this project durability experiments was conducted. In that test were conducted for the optimum percentage of red mud and ggbs concrete. In this project durability tests Acid attack test, Alkaline attack and Sulphate attack tests conducted at the age of 28, 56, 90 days for strength and loss of weight of the optimum percentage of red mud and ggbs based concrete.

***Key Words*: Cement, Fine aggregate, Coarse aggregate, Red mud GGBS, HCL, NaOH, and Na2SO4.**

1. INTRODUCTION

The development business utilizes cement to a huge degree. Around 14 bln ton were utilized in 2007. Concrete is utilized in foundation and in structures. It is made out of granular materials of various sizes and the size scope of the created strong blend covers wide stretches. The general evaluating of the blend, containing particles from 300 mm to 320 mm decides the blend properties of the solid. One approach to additionally improve the pressing is to build the strong size range, for example by incorporating particles with sizes under 300mm.

1.1 RED MUD

Red mud or red slop is a strong waste result of the Bayer procedure, the essential mechanical methods for refining bauxite. For the examination, Red Mud is gotten from MALCO, close Mettur Dam in Salem, Tamil Nadu. The strong mass got is evaporated in the daylight until it becomes dampness free. It is then powdered completely and sieved through 90µ sifter. By Pycnometer examination, the particular Gravity (G) is seen as 2.70. Water suspensions red mud could be a exceedingly complex fabric that varies due to the distinction bauxites utilized and different process parameters.

1.2 GGBS

Ground-granulated affect radiator slag is gotten by quenching fluid press slag from a shoot radiator in water or steam, to form a brilliant, granular thing that's at that point dried and ground into a fine powder. GGBS utilized for this examination is acquired from Nandi Cements, Bengaluru which is prepared from slag got from JSW Steel plant, Bellary and SAIL, Bhadravathi. By Pycnometer examination, the particular Gravity (G) is seen as 2.86. GGBS may be a cementitious fabric whose main use is in concrete and may be a by-product from the impact- heater utilized to create press.

1.3 DURABILITY

Toughness of concrete may be characterized as the capacity of concrete to stand up to weathering influence, chemical assault, and scraped spot whereas keeping up its craved mechanical properties the concrete. Strength fabric makesadifference the natural by moderating assets, di minishing the squanders and the natural impacts of repair and substitution.

2. PROPETIES OF THE MATERIAL

The physical properties of the materials used in the work are as follows:

Table 2.1 Physical properties of cement

Sl.no	Property	Value obtained
1	Specific gravity	3.15
2	Fineness modulus	97%
3	Initial setting time	99 min
4	Final setting time	260 min
5	Normal consistency	31.22%

Table -2.2 Physical properties of fine aggregate

Sl.no	Property	Value obtained
1	Specific gravity	2.516
2	Fineness modulus	2.21
	Grading zone	III

Table-2.3 Physical properties of coarse aggregate

Sl.no	Property	Value obtained
1	Specific gravity	2.878
2	Fineness modulus	0.314

Table -2.4 Physical properties of Red Mud

Sl.no	property	Value obtained
1	Specific gravity	2.70
2	Water absorption	0.89

Fig -2.1 Red Mud

Table -2.5 Physical properties of GGBS

Sl. no	Property	Value obtained
1	Specific gravity	2.86
2	Fineness modulus	3.85
3	Water Absorption	0.9

Fig -2.2 GGBS

2.1 HCL, NaOH, Na2SO4

Hydrogen chloride gas and hydrochloric acid are important in technology and industry. Hydrochloric acid, the aqueous solution of hydrogen chloride, is also commonly given the formula HCl.

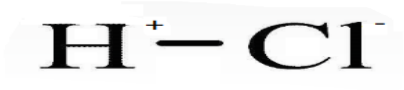


Fig-2.3 structure of HCL

Sodium hydroxide is a highly caustic base and alkali that decomposes proteins at ordinary ambient temperatures and may cause severe chemical burns. It is highly soluble in water, and readily absorbs moisture and carbon dioxide from the air.

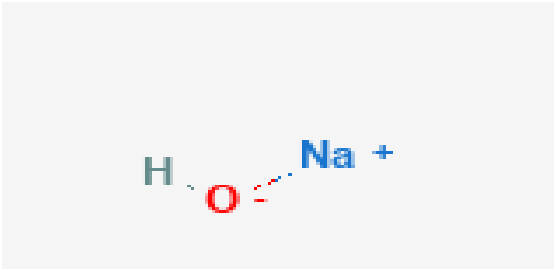


Fig-2.4 structure of NaOH

Sodium Sulphate is the sodium salt of sulphuric acid. It is an important component compound of sodium.it is a white crystalline solid of formula Na_2SO_4

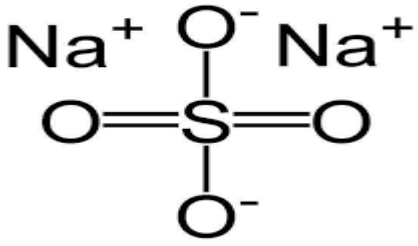


Fig-2.5 structure of Na2SO4

3. MECHANICAL PROPERTIES

PHASE-I

Firstly the proportion that is partially replaced the cement with Red mud in different ratios of 1%,3%,5%,and 7% by the weight of the cement. Secondly the proportions were partially replaced with GGBS in different ratios of 5%,10%,15%, and 20% by the weight of the cement. The experiment will be conducted on fresh, hardened concrete.

Table 3.1 Compressive strength (N/mm^2) of replacement with Red mud

S.No	Red Mud %	7 Days	14 Days	28 Days
1	Nominal Concrete	28.3	35.7	42.02
2	1%Redmud	29.2	36.2	40.8
3	3%Redmud	30.12	37.9	41.5
4	5%Redmud	31.22	39.16	42.8
5	7%Redmud	28.7	35.2	39.5

Table 3.2 Flexural strength (N/mm2) of replacement with Red mud

S.No	Red Mud %	7 Days	14 Days	28 Days
1	Nominal Concrete	3.63	4.12	4.62
2	1%Redmud	3.69	4.04	4.53
3	3%Redmud	3.72	4.25	4.62
4	5%Redmud	3.79	4.37	4.78
5	7%Redmud	3.32	3.96	4.12

Table 3.3 Split Tensile strength (N/mm2) of replacement with Red mud

S.No	Red Mud %	7 Days	14 Days	28 Days
1	Nominal Concrete	2.91	3.65	4.56
2	1%Redmud	2.99	3.72	4.59
3	3%Redmud	3.15	3.89	4.68
4	5%Redmud	3.32	4.05	4.78
5	7%Redmud	3.05	3.8	4.12

Table 3.4 Compressive strength (N/mm2) of replacement with GGBS

S.No	GGBS %	7 Days	14 Days	28 Days
1	Nominal Concrete	28.3	35.7	42.02
2	5% GGBS	30.3	37.8	41.2
3	10% GGBS	31.9	38.8	42.5
4	15% GGBS	33.3	39.9	43.7
5	20% GGBS	34.4	40	44.6

Table 3.5 Flexural strength (N/mm2) of replacement with GGBS

S.No	Specimen	7 Days	14 Days	28 Days
1	Nominal Concrete	3.63	4.12	4.62
2	5% GGBS	3.73	4.16	4.71
3	10% GGBS	3.86	4.34	4.86
4	15% GGBS	3.93	4.43	5.02
5	20% GGBS	3.95	4.65	5.12

Table 3.6 Split Tensile strength (N/mm2) of replacement with GGBS

S.No	Specimen	7 Days	14 Days	28 Days
1	Nominal Concrete	2.91	3.65	4.56
2	5% GGBS	3.02	3.76	4.63
3	10% GGBS	3.19	3.92	4.72
4	15% GGBS	3.35	4.12	4.87
5	20% GGBS	3.42	4.14	4.89

Table 3.7 Compressive strength (N/mm2) of replacement with Red Mud+GGBS

S.No	Red mud + GGBS (%)	7 Days	14 Days	28 Days
1	Nominal concrete	28.3	35.7	42.02
2	1%Redmud+5	32.22	38.2	41.4
3	3%Redmud+10	32.7	39.6	43.6
4	5%Redmud+15 % GGBS	33.8	40.2	45.6
5	7%Redmud+20 % GGBS	31.5	38.6	40.6

Table 3.8 Flexural strength (N/mm2) of replacement with Red Mud+GGBS

S.No	Specimen	7	14	28
1	Nominal concrete	3.63	4.12	4.62
2	1%Redmud+5% GGBS	3.69	4.45	4.68
3	3%Redmud+10% GGBS	3.83	4.55	4.84
4	5%Redmud+15% GGBS	3.96	4.88	5.16
5	7%Redmud+20% GGBS	3.37	4.07	4.22

Table 3.9 Split Tensile strength (N/mm2) of replacement with Red Mud + GGBS

S.No	Specimen	7	14	28
1	Nominal concrete	2.91	3.65	4.56
2	1%Redmud+5% GGBS	3.12	3.81	4.69
3	3%Redmud+10% GGBS	3.26	3.97	4.86
4	5%Redmud+15% GGBS	3.43	4.29	5.06
5	7%Redmud+20% GGBS	3.05	3.89	4.29

Chart 3.1 Compressive strength (N/mm^2) of replacement with Red mud

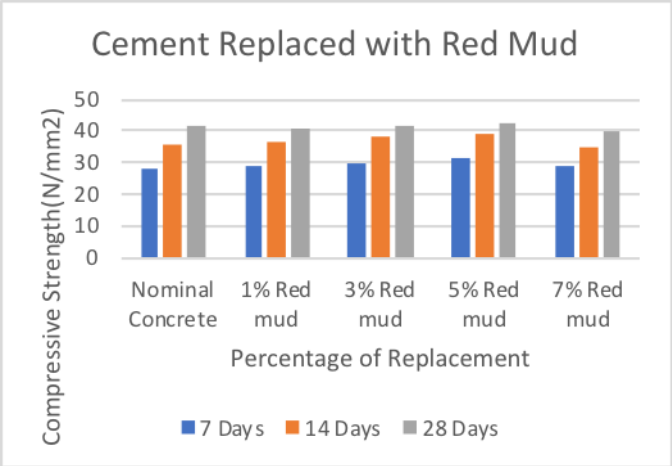


Chart 3.2 Flexural strength (N/mm2) of replacement with Red mud

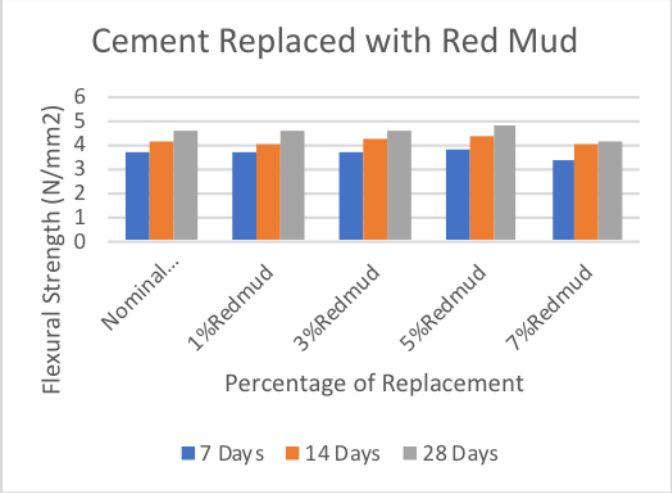


Chart 3.3 Split Tensile strength (N/mm2) of replacement with Red mud

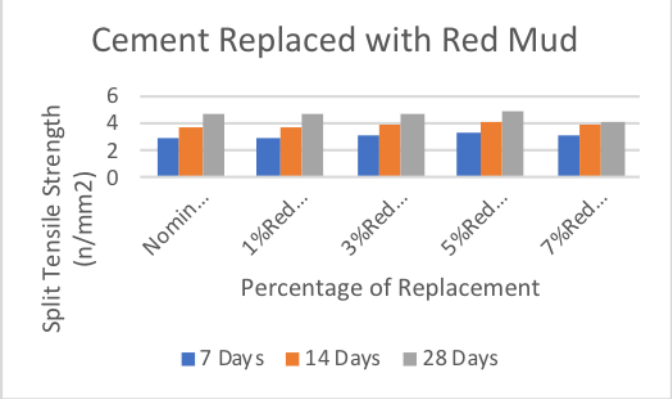


Chart 3.4 Compressive strength (N/mm2) of replacement with GGBS

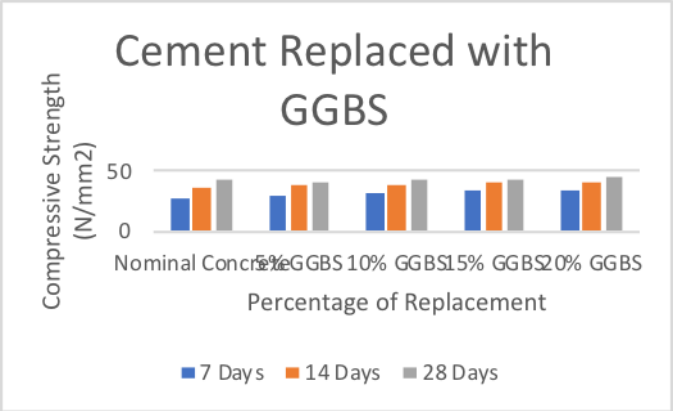


Chart 3.7 Compressive strength (N/mm2) of replacement with Red Mud+GGBS

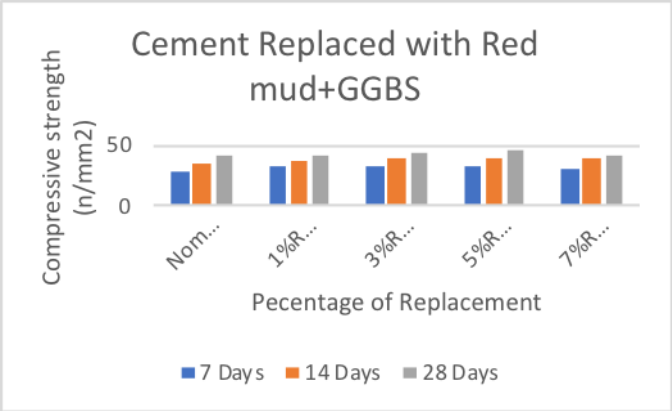


Chart 3.5 Flexural strength (N/mm2) of replacement with GGBS

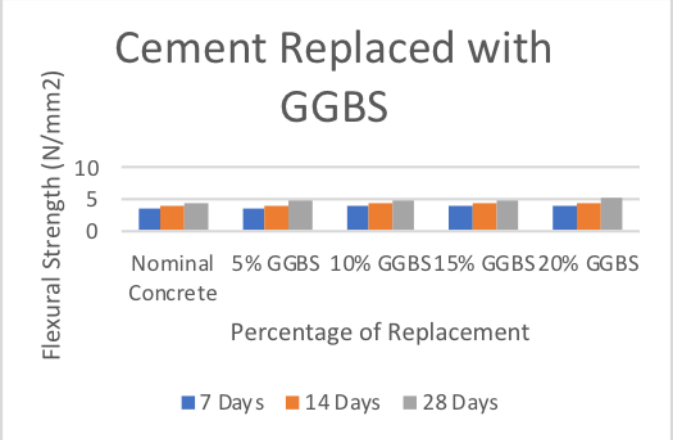


Chart 3.8 Flexural strength (N/mm2) of replacement with Red Mud+GGBS

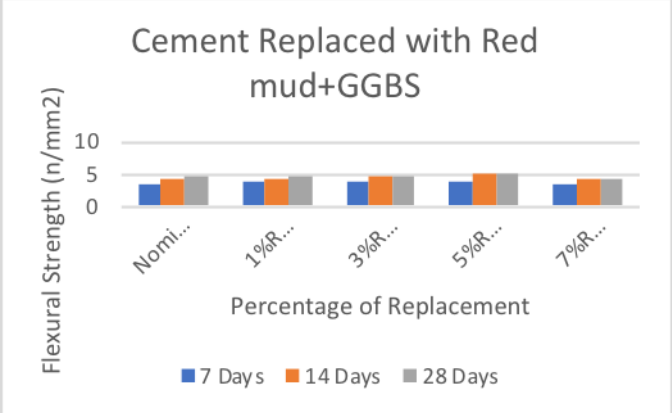


Chart 3.6 Split Tensile strength (N/mm2) of replacement with GGBS

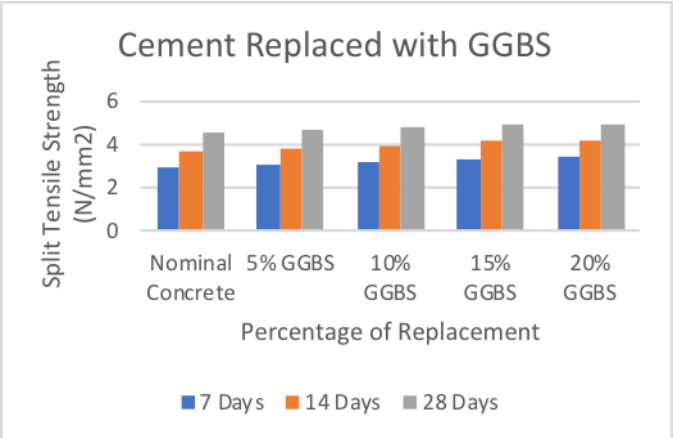
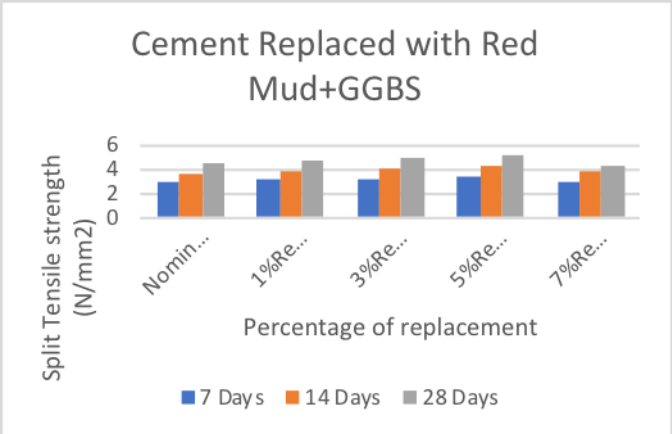


Chart 3.9 Split Tensile strength (N/mm2) of replacement with Red Mud + GGBS



PHASE-II

Table 4.0 ACID ATTACK TEST

Mix	Average Compressive strength (N/mm2)					
	28 days before acid attack	28 days After acid attack	56 days before acid attack	56 days After acid attack	90 days before acid attack	90 days After acid attack
Design mix	42.02	31.94	47.27	35.88	50.84	38.58
RM-5%+ GGBS15 %	45.6	35.37	51.3	36.61	55.18	39.37

Table 4.1 SULPHATE ATTACK TEST

Mix	Average Compressive strength (N/mm2)					
	28 days before Sulphate attack	28 days After Sulphate attack	56 days before Sulphate attack	56 days After Sulphate attack	90 days before Sulphate attack	90 days After Sulphate attack
Design mix	42.02	33.84	47.27	38.02	50.84	40.88
RM-5%+ GGBS 15%	45.6	38.87	51.3	40.24	55.18	43.28

Table 4.2 ALKALINE ATTACK TEST

Mix	Average Compressive strength (N/mm2)					
	28 days before Alkaline attack	28 days After Alkaline attack	56 days before Alkaline attack	56 days After Alkaline attack	90 days before Alkaline attack	90 days After Alkaline attack
Design mix	42.02	35.9	47.27	40.33	50.84	43.37
RM-5%+ GGBS 15%	45.6	39.05	51.3	40.43	55.18	43.48

Chart 4.0 ACID ATTACK TEST

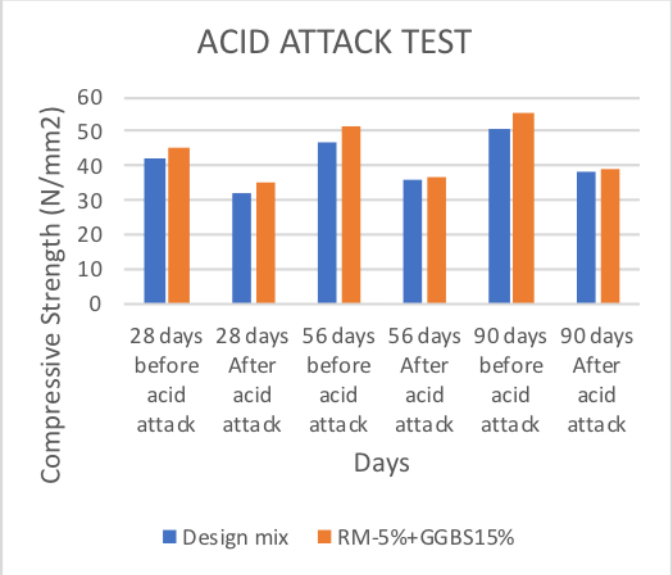


Chart 4.1 SULPHATE ATTACK TEST

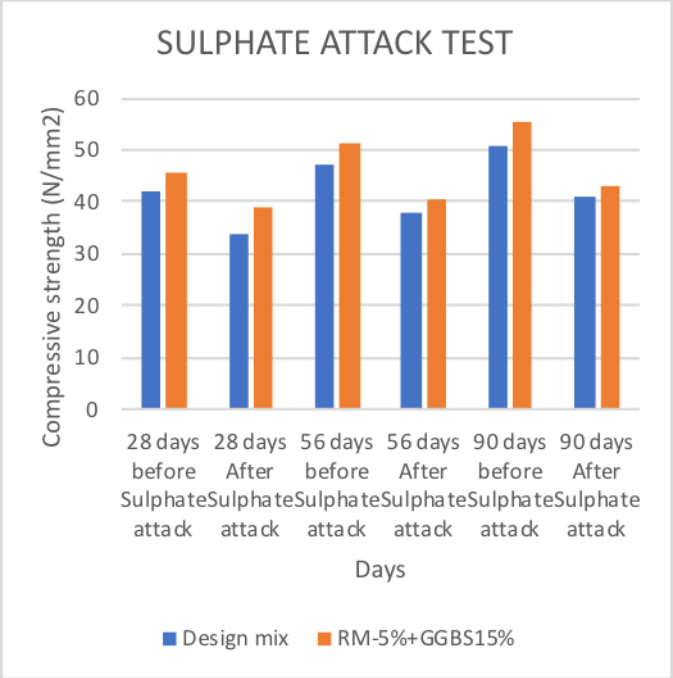
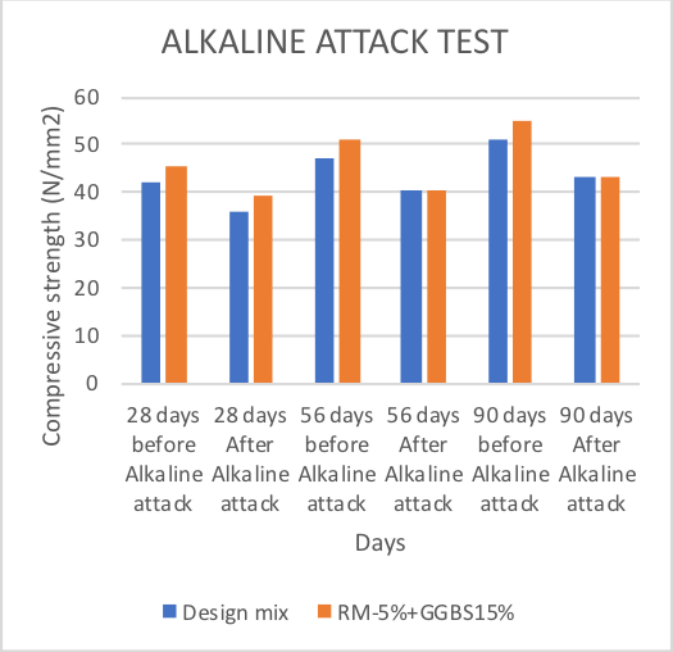


Chart 4.2 ALKALINE ATTACK TEST



4. CONCLUSIONS

Based on the investigation carried out on the GGBS and Red Mud the following conclusions were drawn,

- The optimum compressive strength, split tensile strength, flexure strengthwas obtained in the ratio ofRed mud 5%.
- The percentage increase in Compressivestrength of concrete when replaced with Red mud-5% to the normalconcreteis 1.856 %
- The percentage increase in Split tensile strength of concrete whenreplaced with Red mud-5% to the normalconcreteis4.825 %
- The percentage increase in Flexural strength of concrete whenreplaced with Red mud-5% to the normalconcreteis3.463%
- The optimum compressive strength, split tensile strength, flexure strengthwas obtained in the ratio ofGGBS 20%.
- The percentage increase in Compressivestrength of concrete when replaced with GGBS-20% to the normalconcreteis6.140 %
- The percentage increase in Split tensile strength of concrete whenreplaced with GGBS-20% to the normalconcreteis 7.237 %
- The percentage increase in Flexural strength of concrete whenreplaced with GGBS-20 % to the normalconcreteis 10.823 %
- Acid attack on optimum mix replacement concrete the percentage loss of compressive strength will be 22 %.
- Sulphate attack on optimum mix replacement concrete the percentage loss of compressive strength willbe 15 %.
- Alkaline attack on optimum mix replacement concrete the percentage loss of compressive strength will be 14.5 %.
- The maximum loss of weight is occurred due to the acid attack test for M 30 grade concrete are 1.4 %.
- The maximum loss of weight is occurred due to the Sulphate attack test for M 30 grade concrete are 1.2 %.
- The maximum loss of weight is occurred due to the Sulphate attack test for M 30 grade concrete are 1.4 %.
- The cost of optimum replaced concrete was more economical when compared to the normal mix and strength will be increased. Hence it will be more economical.

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