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STUDY ON PARTIAL REPLACEMENT OF CEMENT WITH GGBS AND USE OF LITHIUM SALT AS ADMIXTURE IN CONCRETE

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Abstract : In India there is huge demand of construction materials, out of which cement is one of the important material used in the constructions. Due to large utilization of cement in the construction industry, the manufacturing of cement has to be increased. While production of cement the harmful gases exerted out from the cement kiln which is quite harmful to the health of living beings. To get rid off from such health causing issues either it is need to stop the usage of such toxic materials or replacing such materials with eco-friendly material which posses similar properties to the cement. In this paper M 35 grade concrete is manipulate with some proportion of GGBS which is replaced with cement and further addition oflithium salt at different proportions. The results shows that GGBS and lithium salt helps to improve the properties of concrete and make the concrete comparatively economical.

KEYWORDS: Lithium salt, Ground Granulated Blast Slag (GGBS), Slump of Mix Concrete, Compressive Strength, Tensile Strength, Flexural Strength**.**

I .INTRODUCTION

The global usage of concrete is second to water. Annual worldwide production of concrete is estimated to be around one cubic meter for every person on earth. The increased demand for concrete calls for increased production of cement, undisputedly the most widely used single binder ingredient of traditional concrete. The annual rate of increase of cement production is about 3%. The world cement production was about 1 billion tonnes in 1990, 1.5 billion tonnes in 1995, 1.7 billion tonnes in 2003, 2.6 billion tonnes in 2008 it as against the estimated 2.2 billion tonnes in 2010. By 2020, cement requirement is estimated to be around 3.5 billion tonnes. It is estimated that with the demographic growth and industrialization, the pollution generated by cement production could reach an alarming 17 % of global CO2 emissions which is currently about 7 %.

II. LITERATURE REVIEW

V. Johnpaul-2019
The study states that GGBFS which is dumped generally in pits affects the natural mineral contents of soil. Unengaged lands are destroyed and they become unfitto use,themetal properties in the foundrycontaminate the water resources andit turns astoxic, when used it causes severehealth problems to thepublic and cattle.The studyconcludesthat utilizingthe GGBFS as areplacement of M-sand for constructionpurpose, the environmentalpollution such aslandand watercan bereduced.Also the chances ofharmfulness tothecattle andpublic can be controlled. Itwas clear that whenGGBFS used asareplacementoffine aggregate the flexural strength, modulus ofelasticityandsplit tensilestrength can be increased.This provides thestructurean additionalstrengthanddurability.
Peiyuan Chen et al. (2019)
Worked on ecological upgrade of normal strength of mortar by using high volume of GGBS. The ecological upgrade of GGBS like materials is more meaningful for the sustainable development in the greener way. Comprehensive experiments were conducted to investigate the influence of experimental variables such as content of cement, curing temperature and mass ratio of water to binder on the fresh properties, compressive strength, hydration products, micro structures and pore structures of normal strength mortar. The results shows that the ecological upgrade of normal strength mortar is feasible.
Jin Liu et. al. -2017
Proposed study on effect of lithium salt orientation and percentage on strength of lithium salt reinforced concrete. In this research, the experiments related to lithium salt reinforced concrete are done by taking different fiber percentage and the compressive strength and modulus of rupture value observed. This work concluded that with lithium salt the compressive strength value more or less changed with respect to Plain cement concrete.

P Lakshmaiah Chowdary et.al - 2017

The objective of this study was to evaluate the possibility of usage of GGBS (Ground Granulated Blast Furnace Slag) in concrete. The researches were also focused on the potentiality of hybrid blending by GGBS because mineral incineration could reduce the demands for fossil.This project represents the results of an experimental investigations carried out to find the suitability of GGBS in production of concrete. In this experimental study the effect of GGBS on strength of referral concrete M20 was made using 43 Grade PPC and the other mixes were prepared by replacing part of PPC with GGBS. The replacement levels were 10%, 20%, 30%, 40% (by weight of cement) for GGBS. Test results indicate that use of replacement cement by GGBS in concrete has improved performance of concrete up to 10% to 30%.

L.R. Manjunatha-2015

The research paper deals with how the RMC and concrete industry in India is progressively using GGBS, how the growth and the adoptability is happening through RMC way, case studies which have revealed durability and permeability of concrete in presence of GGBS. The paper findings…

1. It can safely be concluded that GGBS, which tillrecent years has been treated as a waste product ofsteelmaking plant, is in fact a valuable resource material. Its appropriate utilization can provide an economic bonanza worth more than a billion dollars.
2. If we add the value of land which would otherwise be excavated for consumption or for dumping of GGBS, value of agricultural produce from this land area and environmental benefits in terms of reduction in emission of greenhouse gases & reduction in mining activity etc., the total worth of the saving would increase phenomenally. Due to quality, availability, energy effective, low cost, it is widely used for construction purpose which enriches the workability, mechanical properties, durability and sustainability.
3. Because of enriched properties of GGBS, it is widely used for RCC in all types of foundations & Super Structure works, General building construction, Mass Concrete works in dams, spillways, canals, foundations, Underground works, retaining walls, culverts & drainage works, Effluent & sewage treatment plants, Marine work and many more.
4. RMC industry in southern and western Indian market is adopting theuseof GGBS in their concrete mixes for giving value addition to their customers in respect of cost effectiveness, sustainability and durability performance.

Begum Yaziciogly-2011

This invention concerns the use of lithium-bearing additives in concrete or mortar. Such additives are obtainable by a high temperature process wherein lithium-bearing materials such as scrapped lithium-ion batteries are smelted. More particularly, lithium-bearing metallurgical slag is presented as anadditive for reducing the undesired ASR (alkali-silica reaction) in concrete or mortar. The lithium-bearing metallurgical slag substitutes fine or coarse aggregate, and appears as effective in mitigating the ASR as the expensive lithium salts normally needed.

Mr. Richard L. Boudreau-2006

This report has been prepared by the Innovative Pavement Research Foundation under the Airport Concrete Pavement Technology Program. In this paper the effects of lithium nitrate ($LiNO_3$) admixture addition on early age concrete properties were evaluated.The objective of the research was to determine if lithium nitrate has an adverse effecton plastic or early age hardened properties of airfield paving concrete, and if so,to determine an upper limit of dosage. The research was conducted to consider materials and mixture proportions used during a construction project at Hartsfield-Jackson Atlanta International Airport. The findings and conclusions are therefore limited to the specific lithium admixture as well as the cements, fly ash and aggregates used in this study.Based upon the findings there appear to be no significant effects on early age properties of concrete at the recommended dosage of lithium nitrate (i.e., molar ratio of [Li]/[Na+K] of 0.74, or 100%). Specifically, lithium nitrate had no observed measurable effect on unit weight, slump, air content, bleed water, and finish of fresh concrete mixes.

III . METHODOLOGY

To achieve the objectives of the work various experiments are performed are:

1. Slump Test for Workability
2. Compressive Strength Test for Concrete
3. Split Tensile Strength Test for Concrete
4. Flexural Strength Test for Concrete

The test results of M35 grade concrete were obtained by replacing cement with GGBS in various percentagesof 0%,12%,22%, 32%, 42%and 52%and also Lithium salt is Addedin various percentages of 0%, 0.12%, 0.22%, 0.32%, 0.42%and 0.52%. All specimens were cured for 7days and 28 days before testing.

Materials Required

- **Properties of Lithium salt**

A lithium-ion battery or Li-ion battery (abbreviated as LIB) is a type of rechargeablebattery. Lithium-ionbatteriesare commonly used for portableelectronics and electric vehicles and are growing inpopularityformilitaryandaerospace applications.The electrolyte is typically a mixture of organic carbonates such as ethylene carbonate or diethyl carbonate containing complexes of lithium ions. These non-aqueous electrolytes generally use non-coordinating anion salts such as lithium hexafluorophosphate ($LiPF_6$), lithium hexafluoroarsenate monohydrate ($LiAsF_6$), lithium perchlorate ($LiClO_4$), lithium tetrafluoroborate ($LiBF_4$), and lithium triflate ($LiCF_3SO_3$).Pure lithium is highly reactive. It reacts vigorously with water to form lithium hydroxide (LiOH) and hydrogen gas. Thus, a non-aqueous electrolyte is typically used, and a sealed container rigidly excludes moisture from the battery pack.

- **Ground Granulated Blast Furnace Slag**

Alsoknown asGGBS. It isobtained during the manufacturing process of iron in blast furnace. Theslag is a mixture of lime,silica and aluminaandsomeoxides thatmake upPortland cement butnot inthesameproportion.Thecomposition of slagessentiallydepends on the raw materialsused inthe iron production process.

Table 3.1: Chemical Properties of GGBS

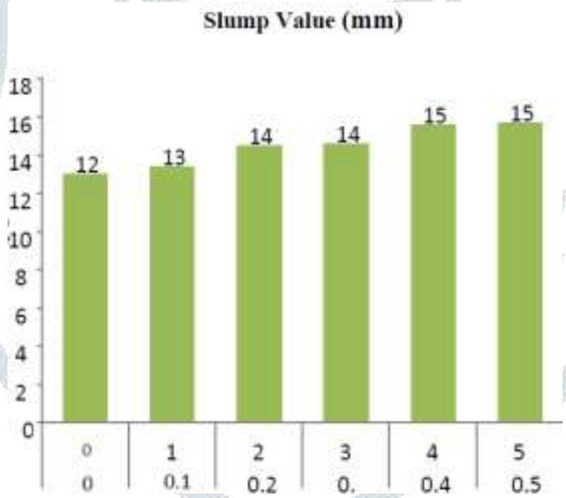
Chemical components	%age of chemicalcomponents
MgO	0.8868
Al2O3	8.6925
SiO2	33.6942
P2O5	0.4752
SO3	0.9498
K2O	0.8946
CaO	21.9869
MnO	2.4709
Fe2O3	23.7346
NiO	6.2144

IV .EXPERIMENTAL RESULTS

Slump Test

Table 4.1: Slump values of concrete using Lithiumsalt and GGBS

Concrete mix		Slump value in mm
Lithium salt	GGBS	
0	0	128
0.12	12	131
0.22	22	140
0.32	32	144
0.42	42	150
0.52	52	155

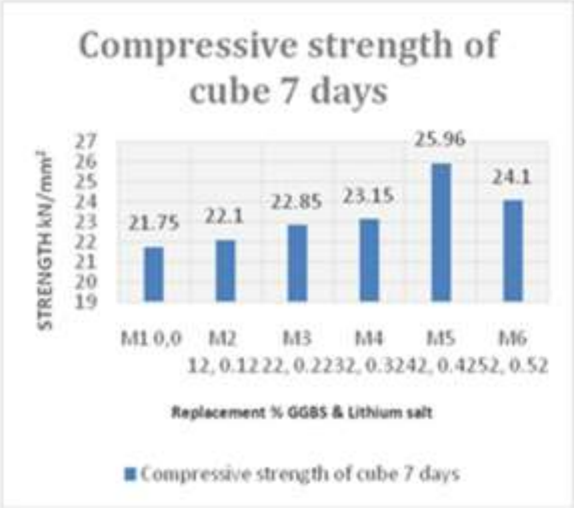


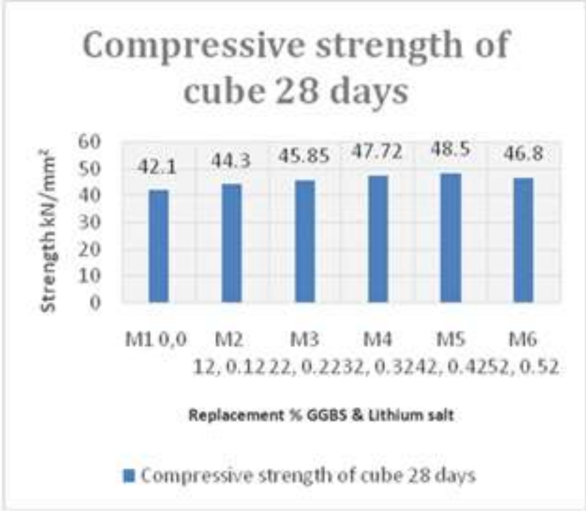
The graph shows the result of slump values which indicate that the slump value of concrete goes on increasing after the replacement and addition of GGBS and lithium salt respectively

Compressive Strength

Table4.2:Compressive Strength of Concrete Cubes Using GGBS and Lithium saltafter7 daysand28 days of Curing

Concretemix		CompressiveStrength@7Days	CompressiveStrength@28 Days
Lithium salt	GGBS		
0	0	21.7	42.1
0.12	12	22.1	44.3
0.22	22	22.8	45.8
0.32	32	23.1	47.7
0.42	42	25.9	48.5
0.52	52	24.1	46.8



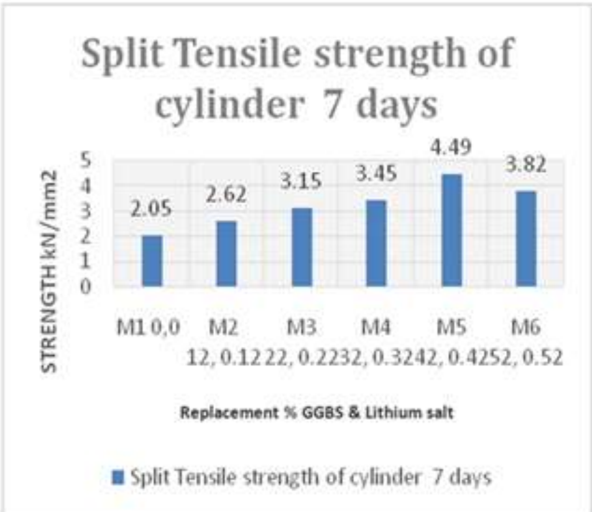


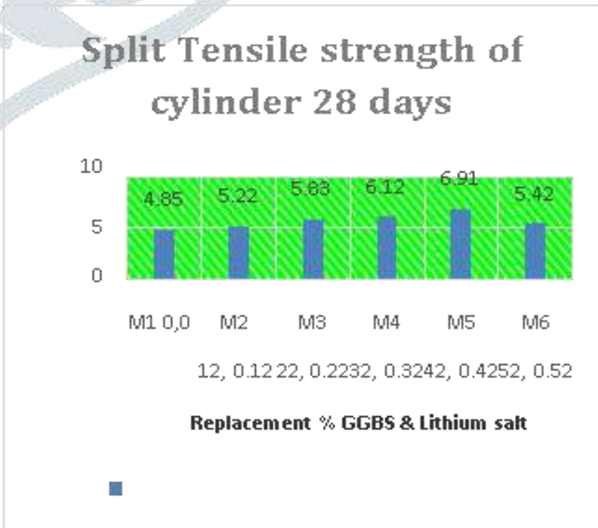
The graphs shows the result of compressive strength at7days and 28 days, Indicate the values of mix goes on increasing the maximum value at 7 days is25.96 kN/mm^{2}at 0.42% of Lithium salt and 42% of GGBS whereas at28 days the maximum compressivestrength valueis48.5 kN/mm^2

Split Tensile Test

Table 4.3: Split Tensile Strength of Concrete using GGBS and Lithium salt after 7 days and 28 days of curing

Concrete Mix		Split Tensile Strength@ 7 Days	Split TensileStrength @28 Days
Lithium salt	GGBS		
0	0	2.05	4.85
0.12	12	2.62	5.22
0.22	22	3.15	5.83
0.32	32	3.45	6.12
0.42	42	4.49	6.91
0.52	52	3.82	5.42



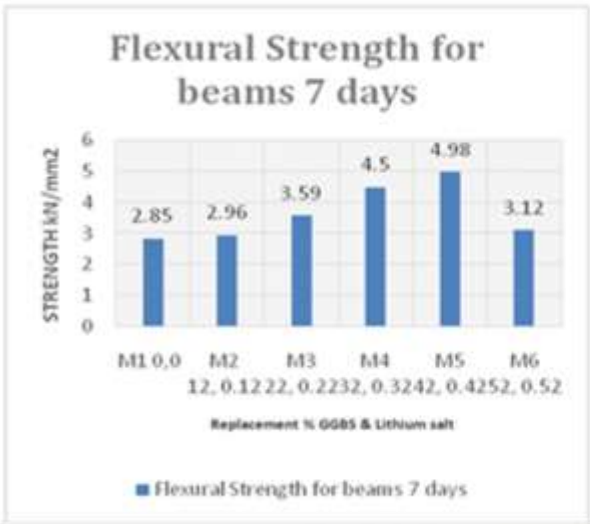


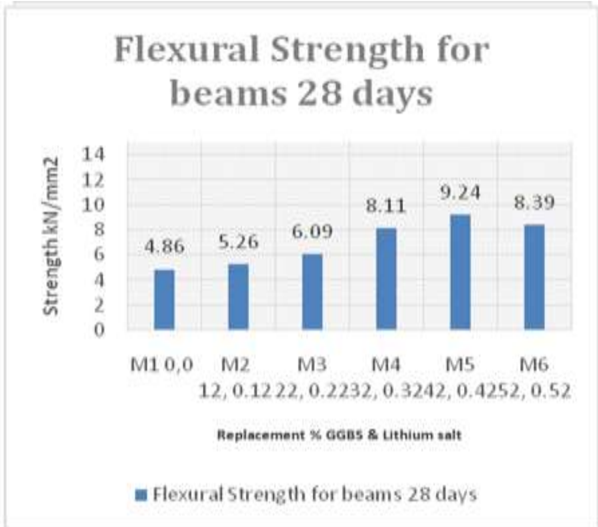
The graphs shows the result of split tensile strength at 7days and 28 days, indicate the values of mix goes on increasing, the maximum value at 7 days is 4.49 kN/mm^2 at 0.42% of Lithium salt and 42% of GGBS whereas at 28 days the maximum value is 6.91 kN/mm^2

Flexural Strength Test

Table 4.4 : Flexural Strength of Concrete using GGBS and Lithium salt after 7 days and 28 days of Curing

Concrete Mix		FlexuralStrength @7 Days	Flexural Strength @ 28 Days
Lithium salt	GGBS		
0	0	2.85	4.86
0.12	12	2.96	5.26
0.22	22	3.59	6.09
0.32	32	4.50	8.11
0.42	42	4.98	9.24
0.52	52	3.12	8.93





The graphs shows the result of flexural strength at 7days and 28 days, indicate the values of mix goes on increasing the maximum value at 7 days is 4.98 kN/mm2 at 0.42% of Lithium salt and 42% of GGBS whereas at 28 days the maximum flexural strength value is 9.24 kN/mm2

V .CONCLUSION

1. The slump value increases 131 mm to 155 mm due to lithium salt percentage ranging from 0 to 0.52%. .Maximum slump 155 mm is observed at 0.52% lithium salt in concrete mix due to the reason that heavy reinforcement of lithium salt is added.
2. The compressive strength of concrete after 28days curing increases gradually by replacement of cement with GGBS percentage and addition of lithium salt.
3. The split tensile strength achieves maximum position of 6.91 N/m2 when 0.42% and 42% of lithium salt and GGBS is added to concrete mix after curing 28days
4. The ultimate flexural strength observed maximum with 42% GGBS and 0.42% of lithium salt i,e 9.24 N/m2 of mix after curing 28days.

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