Behavior Of Pavement Pervious Concrete for Partial Replacement of Cement with Ground Granulated Blast-Furnace Slag (GGBS)

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Abstract*— Pervious concrete is a type of lightweight concrete that is porous, obtained by detaching sand from the normal concrete mix, therefore it really known as a no-fine concrete. The advantage of this type of concrete are lower density, less cost due to lower cement content and no use of fine aggregate. Pavements porous concrete is a noble structure design in the urban management development generally enabling water to be permeated within its structure. It has also capable in the same time to cater dynamic loading. Due to the negative effects that derive from large impervious surfaces in urban areas, pervious concrete has been developed, and has become an environmentally friendly pavement material. As a porous and permeable material, pervious concrete presents an overwhelming advantage in solving urban problems, such as flooding, groundwater decline, urban heat island phenomena, etc. The increasing use of pervious concrete as sustainable and environment-friendly paving materials is primarily owed to its ability to reduce pavement runoff. The mechanical and transport properties of pervious concrete with 20% ground-granulated blast furnace slag (GGBS) replacement were examined.

Indexed Terms- GGBS, IRC44, Pervious concrete, Pavement.

I. INTRODUCTION

Concrete is a widely employed construction material globally, retaining its position as a favored and affordable option. This can be attributed to its numerous advantages, such as versatility, adaptability, formability, and cost-effectiveness. While concrete possesses high compressive strength, durability, and workability, its tensile capacity is rather limited. Conventional concrete may result in honeycombs, inadequate consolidation in thin sections, or congested reinforcements, compromising the strength and durability of the structural elements. To construct strong and durable structures, it is critical to improve the performance of concrete. Lightweight concrete mixture is made with a lightweight coarse aggregate and sometimes a portion or entire fine aggregates may be lightweight instead of normal aggregates. It is convenient to classify the various types of lightweight concrete by their method of production. These are.

- By using porous lightweight aggregate of low apparent specific gravity, i.e. lower than 2.6. This type of concrete is known as lightweight aggregate concrete.
- By introducing large voids within the concrete or mortar mass; these voids should be clearly distinguished from the extremely fine voids produced by air entrainment. This type of concrete is variously knows as aerated, cellular, foamed or gas concrete.

By omitting the fine aggregate from the mix so that a large number of interstitial voids is present; normal weight coarse aggregate is generally used. This concrete as no-fines concrete

Fig 1 Pervious Concrete

A. Ground Granulated Blast-Furnace Slag (GGBS)
GGBS (Ground Granulated Blast-furnace Slag) is a cementitious material whose main use is in concrete and is a by-product from the blast-furnaces used to make iron. Blast-furnaces operate at temperatures of about 1,500°C and are fed with a carefully controlled mixture of iron ore, coke and limestone. The iron ore is reduced to iron and the remaining materials form a slag that floats on top of the iron.

Fig 2 Ground Granulated Blast-furnace Slag

II. METHODOLOGY

Preliminary investigations such as concrete structures, coarse aggregate, and fine-grained collection, as well as the process of various inspection processes in accordance with IS codes for the detection of these structures and the mixing parameters obtained from compounding, were discussed in this regard.

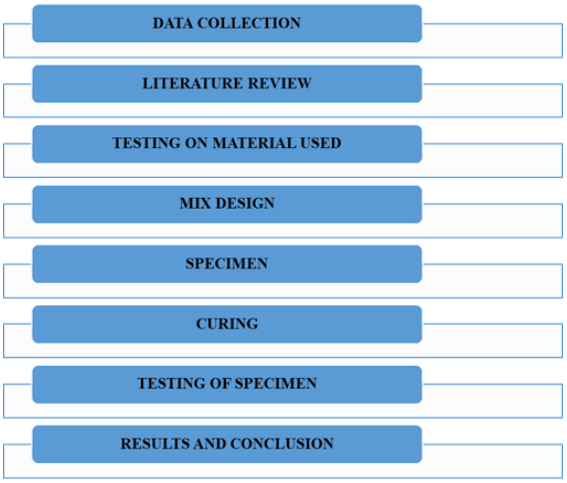


Fig 3 Flow of work

The materials used in the present work are Ordinary Portland Cement (OPC 53 Grade), coarse aggregate and GGBS. For this project Ordinary Portland Cement having 53 Grade also known as (OPC 53 Grade) is selected. As per IS 4031-1988 if the strength of the cement is not achieved less than 53 N/mm2 then it is known as 53 Grade cement.

2.1 Casting of Specimens
After proper mixing of the concrete the specimen will be casted in two shape i.e. cubes and cylinder. The cube will be of size 150mm x 150mm x 150mm. Below table shows the details of the specimen to be casted.

Table 1 Details of Specimen

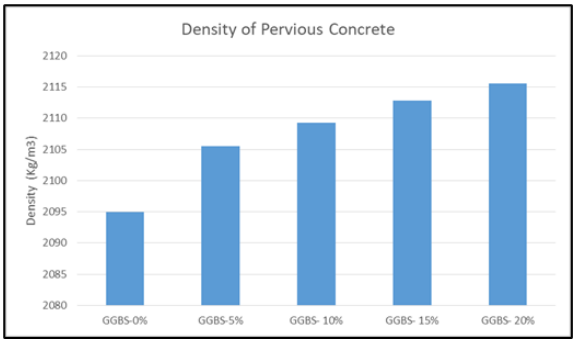
Grade of Concrete	Percentage Replacement of Cement to GGBS (Replacement in %)	No of Cubes
M20	0	5
	5	5
	10	5
	15	5
	20	5

III. EXPERIMENTAL INVESTIGATION

3.1 Density of concrete.

Table 1 Results for Density of concrete

Percentage Replacement	M20 (Kg/m^2)
GGBS-0%	2095
GGBS-5%	2105.48
GGBS- 10%	2109.25
GGBS- 15%	2112.81
GGBS- 20%	2115.53



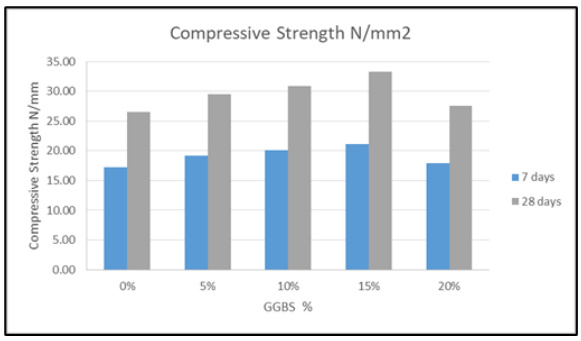
Graph 1 Density of concrete

The density of grade OPC M20 increases with the increase in percentage replacement of GGBS as Cement. The GGBS have high density than cement, Hence GGBS concrete can be considered as High Density concrete. As compare with 0% and 20% it have almost difference of 20.53 Kg/M3 that means it can improve self-weight of structure.

3.2 Compressive Strength

Table 2 Compressive Strength

GGBS %	7 days	28 days
0%	17.23	26.50
5%	19.15	29.46
10%	20.11	30.94
15%	21.11	33.33
20%	17.95	27.61



Graph 2 Compressive Strength

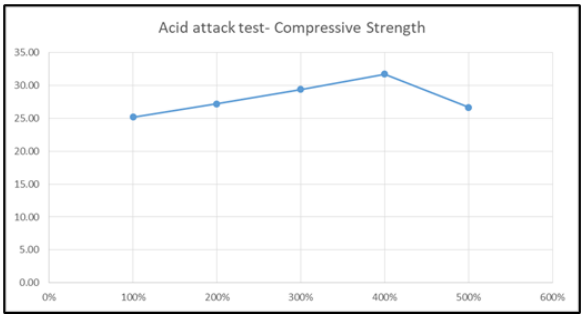
Above Results show that there is a marginal increase in Compressive strength in replacement of GGBS at the 15% of at the age of 7, 14, 28 days and gets slightly decreased at replacement of 30% by 5-10%.

3.3 Durability Test

For acid attack test concrete cube of size 150 ´ 150 ´ 150 mm are prepared for various percentages of silica fume addition. The specimen are cast and cured in mould for 24 hours, after 24 hours, all the specimen are demoulded and kept in curing tank for 28-days. After 28-days all specimens are kept in atmosphere for 2-days for constant weight, subsequently, the specimens are weighed and immersed in 5% sulphuric acid (H2SO4) solution for 10-days.

Table 3 Acid attack test- Compressive Strength

GGBS %	28 Days
GGBS-0%	25.18
GGBS-5%	27.19
GGBS- 10%	29.36
GGBS- 15%	31.71
GGBS- 20%	26.64



Graph 3 Acid attack test- Compressive Strength

Above Results show that there is a marginal decrease in Compressive strength in replacement of GGBS at the 20% of at the age of 28 days. The concrete containing GGBS shows increase compressive strength by 8% than ordinary concrete subjected to acid attack

CONCLUSION

- In the past due to scarcity of cement, the pervious concrete has been used extensively. The pervious concrete has lost is importance after successful production of cement in large quantity. But now a days, the uses pervious concrete has gained its popularity due to many advantages the urban areas all over the world have become CONCRETE JUNGLES. The discharge of storm water is very

difficult problem in the present conditions. By using the pervious concrete we can able to recharge the ground water table and the storm water disposal can be done

- Pervious concrete is made using large aggregates with little to no fine aggregates. The concrete paste then coats the aggregates and allows water to pass through the concrete slab. Pervious concrete pavement becomes more suitable reduce the storm water runoff, to increase the ground water level, to eliminate the costly storm water management practices. From the above case study we conclude that there is an average permeability of tested concrete is 298 liters per minute per meter square and strength of its increases up to the replacement of GGBS up to the 20% of M20 grade concrete. Pervious concrete is the relatively new concrete for the pavement construction.
- The density of grade OPC M20 increases with the increase in percentage replacement of GGBS as Cement. The GGBS have high density than cement, Hence GGBS concrete can be considered as High Density concrete. As compare with 0% and 20% it have almost difference of 20.53 Kg/M3 that means it can improve self-weight of structure
- Marginal increase in Compressive strength in replacement of GGBS at the 15% of at the age of 7, 14, 28 days and gets slightly decreased Compressive strength at replacement of 30% by 5-10%.

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