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Hydraulic performance and physical properties of ICBP by partial replacement of cement with GGBS and fine aggregate with M-sand

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ABSTRACT:*Interlocking cement concrete block pavements concrete is a mixture of cement, sand and water, which plays a vital role in the development of infrastructures like footpath, parking area and gardens for easy laying, better look and finish the rising costs of construction materials hence the need to adhere to sustainability, alternative construction techniques and materials are being sought. To increase the application of concrete paving blocks, greater understanding of product produced with locally available materials and indigenously produce mineral admixture is essential. The present study focuses on investigating characteristic of interlocking cement concrete block pavements with partial replacement of cement with GGBS which varying from 0% to 25% and fine aggregate with M-sand. Physical properties like compressive strength test were investigated, and the results with the replacement 25% were obtained on an average range of 83.77 N/mm^2 for M25 grade. In order to perform the hydraulic behaviour on interlocking cement concrete block pavements, hexagonal shape was precast and gap is created for conducting permeability test. Pervious concrete where introduced between two hexagonal block pavements. The average range of permeability were found to be satisfactory.*

Keywords*: Interlocking cement concrete block pavements, GGBS, M-sand and pervious concrete, compressive strength and permeability test*

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I. INTRODUCTION

The ground water table has been decreases day to day, the price of the materials like cement, fine aggregate and coarse aggregate is increases, so to avoid this problem now a days Engineers are trying for alternative materials with same strength. So, the waste materials like Ground Granulate Blast Furnace Slag (GGBS) and M-sand can be used as the structural materials, from this the price of the materials can be reduced up to 60%. The Ground Granulate Blast Furnace Slag (GGBS) is obtained while steel production and M-sand material. The Ground Granulate Blast Furnace Slag (GGBS) is the material which can replace the cement not totally some percentages, in this study 0% to 25% of GGBS is replacing with the cement. So, at the low volume of roads this combination can be used, as shown in the figure Hexagonal Shaped Interlocking Block Pavement (ICBP) are constructed with the GGBS, the river sand is totally replacing with the M-sand. Between the ICBP the pervious concrete is placed, from this the water can pass easily. At parking lots, low volume roads, sidewalks, etc. these combinations are used. The rate of filtration has to be high, the first flush can have done at these places, as the water filters into the ground the ground water table also increase. In the metro cities, the available of land is very rare, the combination of ICBP and Pervious concrete at the parking lots, footpath, sidewalks the rain water can easily pass to the ground without any resistance. While designing of Interlocking Block Pavement and Pervious concrete is done separately, for ICBP the water cement ratio is 0.4 and 0.4 for pervious concrete. But for both Ordinary Portland cement is used. Fine and coarse aggregate are confirmed confirming to Zone 2, (Table 4 of IS 383: 1997) and confirming to graded aggregate (Table 2 IS 383: 1997) respectively (D. Suresh et al., 2015). The shape of the aggregate affects the permeability of the pervious concrete, the angularity effects the strength. In this case only 12.5 mm sized coarse aggregate are using, if the 12.5 mm down sized aggregates are used the

permeability decreases. As the aggregate covers the voids which are necessary to flow of water. The main intention is to reduce the price of ICBP with same strength and also with a maximum permeability (Andrew Isaac Neptune August, 2008).

II. LITERATURE REVIEW

[1]. **Panda, B.C. and Ghosh, A.K.,2002**: The surface layer of the pavement has to design and it should be stable for long time i.e. durability of the pavement must be good. The abrasion resistance of concrete is strongly influenced by the compressive strength, surface finishing techniques, curing types, aggregate properties and testing conditions, i.e. dry or wet as reported. The abrasion resistance reports of the different concrete types. While the other properties of ICBP decreased with the use of CW fine aggregate, the abrasion resistance of ICBP was increased.

[2]. **Huang Y. H 2004**: This study influences the behavior of pavement surface, the structural behavior of the pavement

[3]. **Tayfun Uygunolu, et al.2011**: Replacement of cement with fly ash (from 10% to 20%) has a significant effect in increasing important properties of ICBPs, replacement of crushed sand stone with concrete waste and marble waste results in lower physical and mechanical properties.

[4]. **Marinkovic S, 2011**: The workability of fly ash-bottom ash concrete was reduced due to the utilization of CBA as total or partial substitute of fine aggregate in concrete. The descending comparative environmental assessment of natural and recycled aggregate concrete. Mixtures on slump values with similar w/c. use of waste marble aggregate in concrete.

[5]. **R. BharathiMurugan 2015**: With changing the shape of the ICBP will be increases the durability and strength.

[6]. **Norbert Delatte et al 2010:** In the urban areas, the land is less to percolate the water, at the parking lots the water can pass easily like first flush, from this the ground water level also increases with the time, in this study Portland Cement Pervious Concrete is used as per the economic condition its cheaper than the other pervious concrete.

[7]. **S.O. Ajamu et al** 2012: The rate of permeability increases with the smaller size of coarse aggregate and compressive strength also increases. At low compressive strength and high permeability rate required places the mixtures of aggregate/cement ratio 8:1 and 10:1 are used for better performance.

[8]. **Mr.V. R. Patil, et al** 2013: For the low volume roads, the previous concrete can be used as economic benefit, the steel fibers has been used to improve the tensile strength of the concrete.

III. MATERIALS

The details of the various materials used in this investigation are given in the following sections.

3.1Cement Used

Ordinary Portland cement of 43 grade of Penna brand conforming to IS: 12269 standards were used in this investigation. The specific gravity of the cement was 3.015. The initial and final setting times were found as 50 minutes and 270 minutes respectively.

3.2 Fine Aggregate Used

Fine aggregate which was collected in an around Ballari conforming IS 383-1970 passing 4.75 mm and with the specific gravity of 2.61.

3.3 Coarse aggregate Used

Crushed granite aggregate available from local sources has been used. The specific gravity of coarse aggregate is 2.63.

3.4Water Used

Potable fresh water available from local sources was used for mixing and curing of mixes.

3.5 GGBS

GGBS is brought from Jindal Industry, Toranagallu Ballari and the specific gravity is 2.7

IV. METHODOLOGY

The main aim of the experimental program is to study the Compressive Strength of concrete. Cement is partially replaced with GGBS in the proportion of 0% (Reference mix), 5%,10%, 15%, 20% and 25% by weight. The materials are weighed and dry mixed thoroughly after the measured amount of water for Water cement ratio of 0.4 is added and the material is mixed thoroughly until it becomes uniform. Concrete produced are filled in Hexagonalmoulds. After 24 hours of casting, the specimens are de-moulded and kept for curing.The specimens

were tested after 7 and 28 days of curing for the Compressive strength in accordance with Bureau of Indian Standards. For each trail, 3 cubes were cast and tested at the age of 7 and 28 days. The average values of compressive strength were adopted in each case.

V. RESULTS AND DISCUSSIONS

5.1. Compressive strength of ICBP at 7 and 28 days:

From the graph it is observed that increase in compressive strength with increase in percentage of GGBS up to 25%. The replacement of OPC with 25% of GGBS increases in compressive strength of 61.17% at 7days and 83.77% at 28 days.

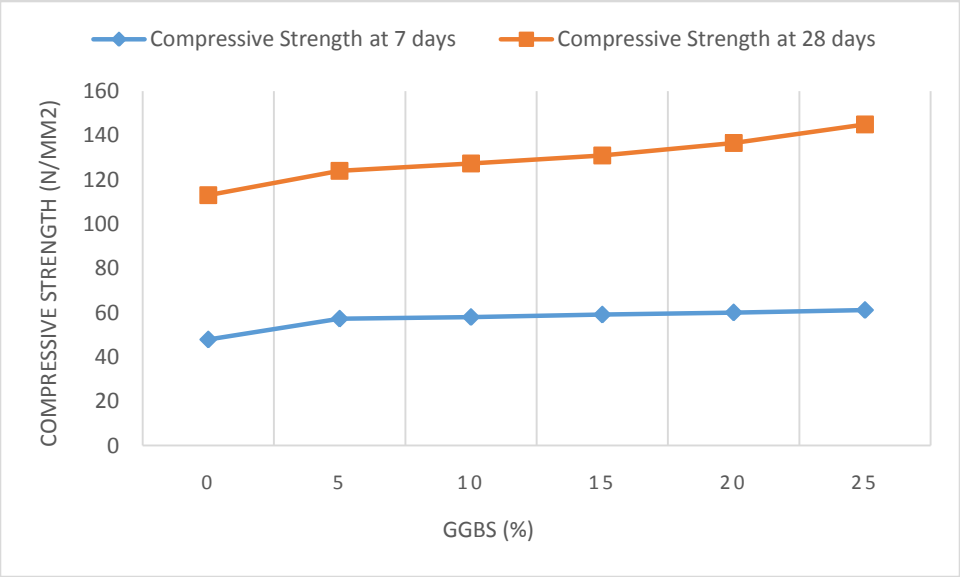

Figure 1: Graph of compressive strength of ICBP at 7 and 28 days

5.2. Compressive strength of Porous Concrete at 7 and 28 days:

From the graph it is observed that increase in compressive strength with increase in percentage of GGBS up to 10%. Thereafter the strength reduces gradually. The replacement of OPC with 10% of GGBS increases in compressive strength of 21.954% at 7days and 22.86% at 28 days and further the strength reduces.

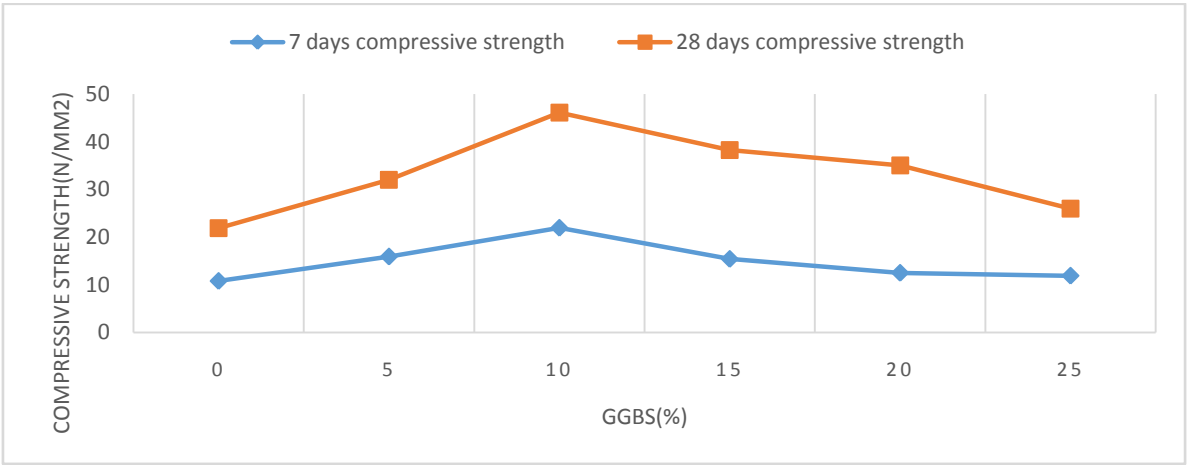

Figure2: Graph of compressive strength of Porous Concrete at 7 and 28 days

5.3. Permeability test

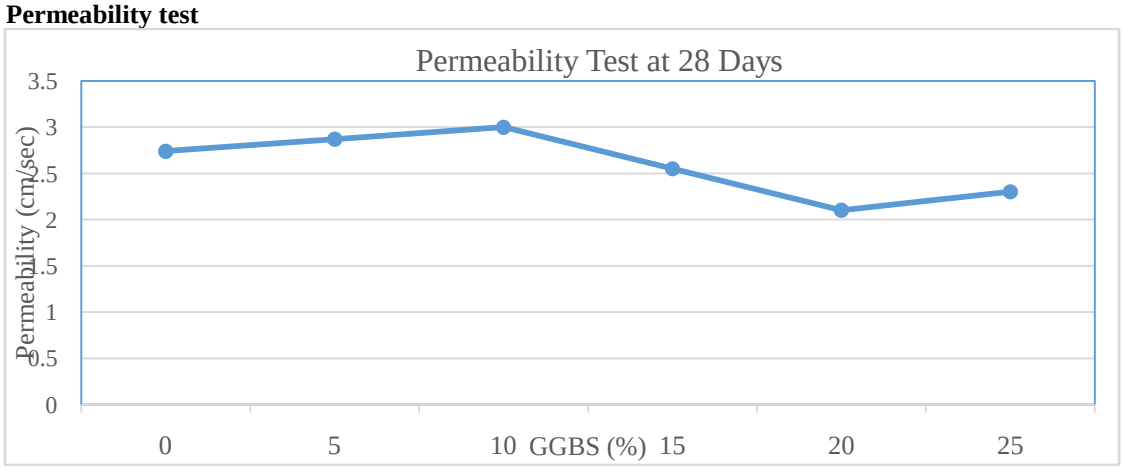

Figure3: Graph of Permeability test at 28 days

The permeability test results for various mixes are tabulated in Table 5.5. The 28 days permeability values vary from 2.08 to 3.18 cm/sec. the maximum permeability of 3 cm/sec. is obtained from 10% GGBS, having 100% of 12.5mm down sized aggregate results in lesser permeability. The variation in permeability of various specimens are tabulated on fig 5.5.

VI. CONCLUSIONS

On the basis of the present experimental investigation, the following conclusion is drawn.

1. The compressive strength of the concrete with partial replacement of GGBS increases with increasing the percentage of GGBS.
2. GGBS can be added to cement concrete as partial replacement of cement up to 25% without any significant reduction in any of the property of concrete. This will result in the reduction in the cost of concrete to some extent.
3. Pervious concrete is the relatively new concrete for the pavement construction in rural areas having cost benefits and pervious concrete can be extensively used worldwide because of their environmental benefits and hydraulic properties.
4. Interlocking Concrete Block Pavements of Hexagonal shape gives the perfect interlocking and good aesthetic appearance.
5. Problems due to stagnant water at parking areas can be eradicated and thus achieving proper parking facility.

VII. FUTURE SCOPE

1. To drain the storm waters into the underground during rainfall and thus recharges the ground Water.
2. To eliminate flood control measures such as constructing expensive retention ponds.
3. Reducing runoff water.
4. Reducing risk of flooding and topsoil erosion.

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