An Experimental Development on Pervious Concrete by Partial Replacement of Flyash, GGBS, Silica Fumes with cement by adding Glass Fiber

K Vandana, Divya Anusha Naidu, Dumpa Venkateswarlu

Abstract*: *Pervious Concrete for the pavements proves to be an effective and a long-term solution for the universal problem of abnormal decrease of ground water table. Pervious Concrete has a unique mix design and giving special properties to the concrete which makes the concrete porous, allowing water from precipitation and other sources to pass directly through , thereby reducing run off volume and increasing ground water table. In order to reduce the damage being caused to the environment by the use of cement , in pervious concrete , cement is replaced with pozzolanic materials such as flyash , GGBS , silica fume sand to increase strength and durability , glass fibers in stipulated ratio are added to the concrete mixture. In this study, the mix designs such as M30 and PC30 are considered. The fine aggregate is replaced with coarse aggregate by different ratios like 0% , 5% , 10% ,15%. by adding different pozzolanic materials like flyash, GGBS, silica fumes with glass fibers. To find the effectiveness of the use of pozzolancic and glass fibers, compressive strength and split tensile strength are conducted.

Index Terms*: *pervious concrete, GGBS, fly ash, silica fume, glass fibers, slag Compressive strength, split tensile strength.

I. INTRODUCTION

Concrete is a paste like material which is made of aggregates or rocks.Some of the materials which were used in the preparation of concrete or Portland cement, water ,fine aggregate and coarse aggregate. Because of all these simply available materials and gives good maintenance, durability longer life and which is economically concrete is a most preferable material for construction purpose. In the preparation of concrete mixture water is a key component as it decides the strength factor of the concrete. If the water has impurities the chemical properties in the water affect the setting time and hardening of the concrete.

Pervious concrete payments are also knows as permeable payments ,it is an environmental friendly payment , as it has the nature of collecting storm water which helps in the improvement of ground water table and also helps to drain off the rain water on the payments very fast. Pervious concrete is made of no fines or little fine aggregate to get the porous type of nature because to give more air voids to the pervious concrete and to get more discharge of water. If the fine aggregate is added we should be careful that is should be more than 15% to 25% of total volume. In Pervious concrete porosity is plays a vital role which impacts the hydraulic, mechanical, durability characteristics. These all characteristics depend on the mix design and method of compaction which we take in pervious concrete mix design coarse aggregate size grade is restructured to 9.5 to 19mm.
Glass fibers are fibrous material which is made from silica based glass. It comes under polymer family. This material helps in increasing of tensile strength pervious concrete.

II. LITERATURE REVIEW

Anush et al. [1] In past few years, use of pervious concrete has been increased in the low volume roads due to its useful environmental benefits . This paper deals with expansion and progress of pervious concrete research and practices. In this study mechanical-hydrological durability property of pervious concrete has been inspected. The purification effiency of storm water has been checked. Some of the field investigations and in-service of pervious concrete has been debated. Some other studies have been made on rehabilitation techniques for the growth of hydraulic effiency of pervious concrete pavement. Due to rapid increase of pervious concrete pavement numerous advantages and vast scope for further studies and research to get a good clarity which helps to make a effective and sustainable road way for future generation.

B. Radha Kiranmaye et al. [2] Conventional Portland cement Concrete is regular material used for pavement construction. The impervious phenomena of concrete pavement helps in the increase of water runoff into the drainage system, overloaded flooding in infrastructure in the built up areas. Pervious concrete is a special type of concrete which has high porosity and helps in increase of ground water and reduces the runoff. Glass fiber is an effective material helps to upgrade the properties of pervious concrete. The mixture of glass fiber with cement gives good strength results for concrete with great extent. In this paper glass fiber is used as an partial replacement of cement with 1.5% and with no fines or little fines is used. The study tells the effect of fine aggregate in various percentage of 0%,10%,and 20% with coarse aggregate. Tests conducted for the analysis of properties are void ratio, compressive strength, flexural strength, split tensile strength and permeability tests with varying fraction of fine aggregate

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LutfurAkand, Mijia Yang, Xinnan Wang [3] Even though the bonding mechanism between fiber and concrete matrix needs comprehensive explanation in literature, fiber reinforcement sustains the crack generation and undoubtedly improves the strength of host matrix. In order to augment the bonding properties of fiber –matrix, myriad mechanical and chemical treatment techniques have been examined by different researchers. The inherent property of high porosity and minimal fiber- matrix bonding edge of fibers invites great challenges in the use of fibers in pervious concrete. The consequence of chemical treatment on short polypropylene fibers and its use in pervious concrete as reinforcement is discussed in this study . The fiber test ability and Atomic Force Microscopy (AFM) can be used to determine the change in fiber surface caused due to the treatment. Chemical treatments are found to be very helpful to evolve the surface roughness, cement matrix interface properties besides improving the total strength of fiber reinforced pervious concrete.

SukamalKanta Ghosh et al. [4] The pervious concrete, the mixture of cement, coarse aggregate ,little fines ,water and admixture , is one of the most efficient and sustainable pavement material to be used. In order to mitigate the pollution caused by cement industries, cement may be fully or partially replaced by waste materials like fly ash, rice husk ash, waste rubber tyre, furnes slag silica fume, solid waste etc. The performance of the pervious concrete with these materials replacing cement and aggregate is demonstrated is this paper.

III. EXPERIMENTAL WORK

A. Binders

Cement:-

The ordinary cement, a fine grey powdered material consists of two main ingredients such as argillaceous and calcareous. Ordinary Portland cement of grade – 53 (KCP cement) which meets the requirements of Indian standards (IS: 12269-1987) has been used in the present study.

Fly Ash:-

Fly ash, a finely divided ash emitting from the burning of pulverized coal or lignite in boilers, is considered to be superior because of its higher lime content. Fly ash a waste product of coal industry is available in plenty in India.

GGBS:-

GGBS (granulated blast furnace slag) is dried and ground to a fine powder like OPC and then it is mixed with OPC. The appropriate mixture of GGBS and cement treated as another constituent is added to the concrete mixture to meet the technical necessity for any desired application

Silica fume:-

Silica fume, a byproduct of producing silicon metal or ferrosilicon alloys, is very useful in concrete due to its chemical and physical properties. The concrete consisting of silica fume can posses high strength and durability as silica fume is a very reactive pozzolan

Table 1: Physical properties of fly ash & GGBS and silica fume

S. No	IS Code	Tests performed	Results			
			Cement	Fly ash	GGBS	Silica fume
1	IS 12089:1987	Specific gravity	3.13	1.90	2.82	2.63
2	IS 12089:1987	Fineness	7.2%	12 %	7%	14 %

B. Fine Coarse aggregate:

Fine aggregate used in this study is locally available river sand of Zone II compiling to IS 383:1970. The specific gravity, water absorption and fineness modulus of fine aggregate used have been 2.55, 0.806% and 2.58 respectively.

Locally obtained coarse aggregate from local quarry has been used in this study. The specific gravity, Bulk density and Water absorption used have been 2.9, 1738 kg/m^3 (compacted), 1512 kg/m^3 (loosely packed) and 0.502% respectively.

C. Water

The chief ingredient in the manufacture of concrete is water which chemically reacts with NaOH (Sodium Hydroxide) pellets in this study. As the binding strength of concrete mainly depends upon the quality and quantity of water, the water without impurities has to be used to get the desired results.

D. Super Plasticizer

In order to enhance the workability of the pervious concrete, conplast SP 430 super plasticizer obtained from FOSROC Constructive Solution Company is used in this study. The use of super plasticizer in pervious concrete considerably reduces the quantity of water required. In this study, 3% of conplast, a brown liquid, is added to the total binder material.

E. Glass fiber

Glass fiber, a modern introduction in the making of fiber concrete, is found in fiberglass insulation, so as to reinforce the concrete. The adding of glass fiber helps concrete insulate, strengthen, prevent the concrete from cracking over time because of mechanical or thermal stress. Besides these, the glass fiber does not interfere with radio signals as the steel fiber reinforcement does.

Test details

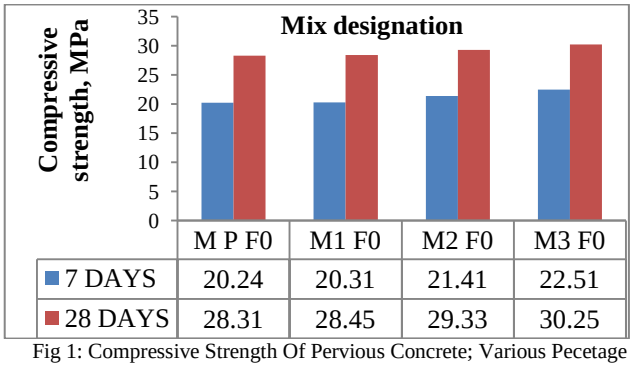
A. Compressive Strength Test

Compressive strength of hardened concrete is the very important among all properties. The compressive strength test was carried out using 200 tons CTM. Testing procedure followed as per IS 516:1959.

B. Split tensile Strength Test

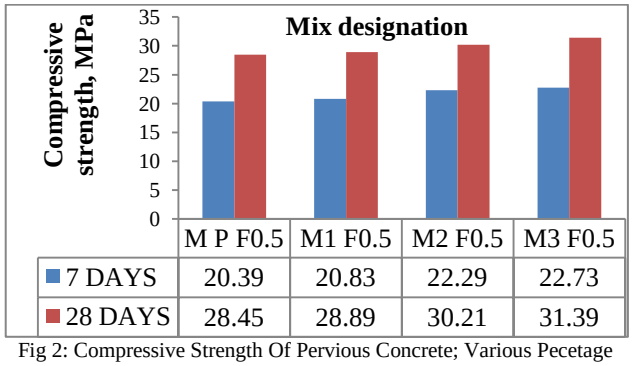
The concrete is very weak in tension due to its brittle nature and is not expected to resist the direct tension. The concrete develops cracks when subjected to tensile forces. Thus, it is necessary to determine the tensile strength of concrete to determine the load at which the concrete member may crack.

IV. RESULTS AND DISCUSSION



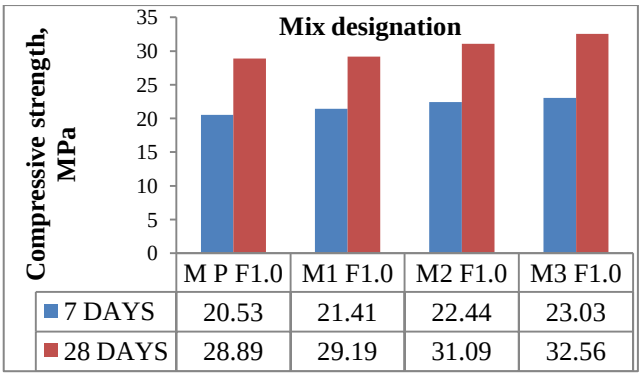
	M P F0	M1 F0	M2 F0	M3 F0
7 DAYS	20.24	20.31	21.41	22.51
28 DAYS	28.31	28.45	29.33	30.25

Fig 1: Compressive Strength Of Pervious Concrete; Various Pecetage Replacements Of Cement With Other Cementatious Material And Different Percenatge Of Fine Aggregate.



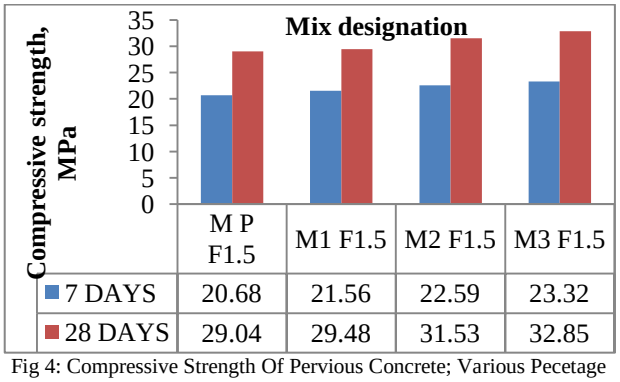
	M P F0.5	M1 F0.5	M2 F0.5	M3 F0.5
7 DAYS	20.39	20.83	22.29	22.73
28 DAYS	28.45	28.89	30.21	31.39

Fig 2: Compressive Strength Of Pervious Concrete; Various Pecetage Replacements Of Cement With Other Cementatious Material And Different Percenatge Of Fine Aggregate And Addition of 0.5% Glass Fibers



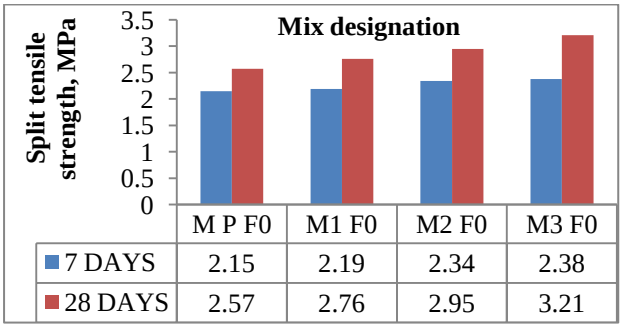
	M P F1.0	M1 F1.0	M2 F1.0	M3 F1.0
7 DAYS	20.53	21.41	22.44	23.03
28 DAYS	28.89	29.19	31.09	32.56

Fig 3: Compressive Strength Of Pervious Concrete; Various Pecetage Replacements Of Cement With Other Cementatious Material And Different Percenatge Of Fine Aggregate And Addition of 1.0% Glass Fibers.



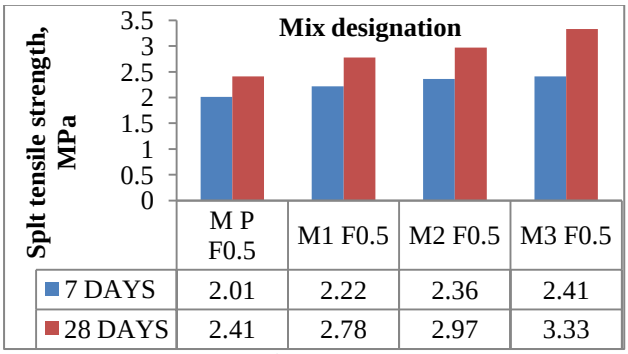
	M P F1.5	M1 F1.5	M2 F1.5	M3 F1.5
7 DAYS	20.68	21.56	22.59	23.32
28 DAYS	29.04	29.48	31.53	32.85

Fig 4: Compressive Strength Of Pervious Concrete; Various Pecetage Replacements Of Cement With Other Cementatious Material And Different Percenatge Of Fine Aggregate And Addition of 1.5% Glass Fibers



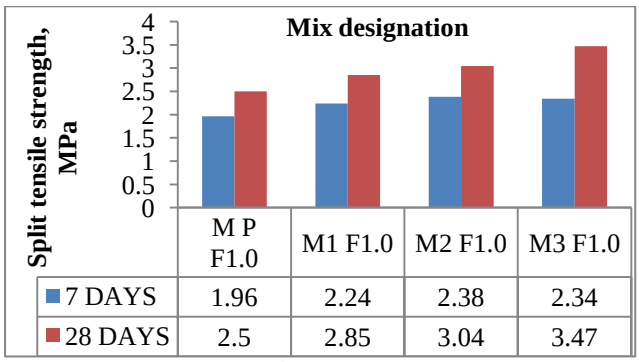
	M P F0	M1 F0	M2 F0	M3 F0
7 DAYS	2.15	2.19	2.34	2.38
28 DAYS	2.57	2.76	2.95	3.21

Fig 4: Split Tensile Strength Of Pervious Concrete; Various Percentage Replacements Of Cement With Other Cementatious Material.



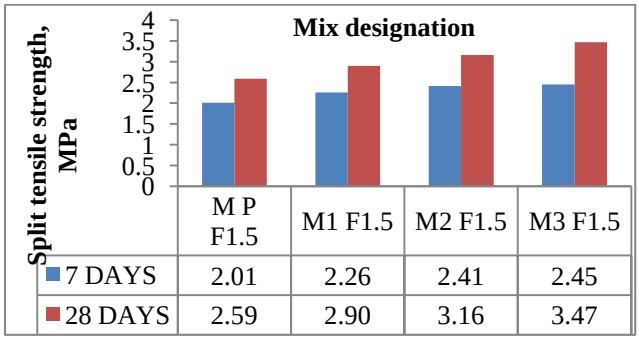
	M P F0.5	M1 F0.5	M2 F0.5	M3 F0.5
7 DAYS	2.01	2.22	2.36	2.41
28 DAYS	2.41	2.78	2.97	3.33

Fig 5: Split Tensile Strength Of Pervious Concrete; Various Percentage Replacements Of Cement With Other Cementatious Material And Different Percentage Of Fine Aggregate And Addition of 0.5% Glass Fibers.



	M P F1.0	M1 F1.0	M2 F1.0	M3 F1.0
7 DAYS	1.96	2.24	2.38	2.34
28 DAYS	2.5	2.85	3.04	3.47

Fig 6: Split Tensile Strength Of Pervious Concrete; Various Percentage Replacements Of Cement With Other Cementatious Material And Different Percentage Of Fine Aggregate And Addition of 1.0% Glass Fibers.



	M P F1.5	M1 F1.5	M2 F1.5	M3 F1.5
7 DAYS	2.01	2.26	2.41	2.45
28 DAYS	2.59	2.90	3.16	3.47

Fig 8: Split Tensile Strength Of Pervious Concrete; Various Percentage Replacements Of Cement With Other Cementatious Material And Different Percentage Of Fine Aggregate And Addition of 1.5% Glass Fibers.

V. CONCLUSION

Based on results and discussions following conclusions were made.

- A significant reduction of workability.
- A progressive addition in both split tensile and compressive strength by increasing the percentage of fine aggregates and pozzolanic materials in mix.
- The inclusion of fine aggregate content in the specimen increases the density and increase the pozzolanic materials addition.
- The addition of fly ash and silica fume and GGBS in the mixtures enhances the split tensile strength and compressive strength performance of the concrete,
- The addition of Fly ash and silica fume and GGBS in the mixtures improve strength.
- The split tensile strength and compressive strength increases even after adding pozzolanic materials. Due to increase of fine aggregate content. For all replacement levels of PC with other mixes goes on decreasing in strength when compared with parent grade ofM30.
- Compressive and split tensile strength slightly increased by adding glass fibers to the all mixes.

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