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EXPERIMENTAL STUDY ON PERFORMANCE OF PERVIOUS CONCRETE USING RECYCLED AGGREGATE AND GGBS

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ABSTRACT - *Pervious concrete is a tailored-propertyconcrete with high water permeability which allow the passage of water to flow through easily through the existing interconnected large pore structure. This paper reports the development of pervious concrete with reduced cement content and recycled concrete aggregate for sustainable pavement construction. High fineness ground granulated blast furnace slag was used to replace up to 50% & 70% of cement by weight. The properties of the pervious were evaluated by determining the compression strength at 7 and 28 days, void content and water permeability under falling head. The compressive strength of pervious concrete increased with the reduction in the maximum aggregate size from 20 to 13 mm. the relationship between the 28 days compression strength and porosity for pervious concrete was adversely affected by the use of recycled concrete aggregate instead of natural aggregate. This project will also show that the water permeability of pervious concrete is primarily influenced by the porosity and not affected by the use of recycled concrete aggregate in place of natural aggregate. The empirical inter relationship developed among porosity, compressive strength and water permeability could be used in the mix design of pervious concrete with either natural or recycled concrete aggregates to meet the specification and the requirement of compressive strength and water permeability.*

Key Words: Recycled aggregate, ggbs, Porosity,compressive strength test, Water permeability test, Split tensile test, Flexural test.

1. INTRODUCTION

Pervious concrete is a composite material consisting of coarse aggregate, Portland cement and water.It is different from conventional concrete in that it contains no fines in the initial mixture, recognizing however, that fines are introduced during the compaction process. Pervious concrete is a special type of concrete with a high porosity used for concrete flatwork applications that allows water from precipitation and other sources to pass directly through there by reducing the run-off from a site and allowing ground water recharge. Pervious concrete characteristics differ from conventional concrete in several ways. Compared to conventional concrete, pervious concrete has a lower compressive strength, higher permeability and a lower unit weight, approximately 70% of conventional concrete.

1.1 OBJECTIVES OF STUDY

This study is conducted to achieve the following objectives:

1. To assess the feasibility of utilizing the recycled aggregates for producing an economical concrete by studying the properties like Compressive Strength, Water Absorption and Tensile strength
2. To find the optimum proportion of GGBS (Ground Granulated Blast furnace Slag) that can be used as a replacement substitute material for cement in concrete
3. To evaluate mechanical properties by use of GGBS in concrete specimens.
4. To determined Strength, Workability, Durability by using GGBS
5. To determine the water absorption of recycled aggregate concrete containing various content of GGBS as partial cement replacement material.
6. To study the compressive strength , flexural Strength ,Split Tensile Strength of pervious concrete for different mix proportions.
7. The study the permeability rate at which the water infiltrates in pervious concrete for different mix proportions.

1.2 SCOPE OF STUDY

2. Flexural Strength of structural members can be improved.
3. Proper usage of waste materials from environment can be made.
4. Basic strength characteristics, such as Compressive strength, Flexural strength and Split Tensile strength studies of concrete are the main focuses in this project in order to study the quality and performance of concrete.

2. LITERATURE REVIEW

The usage of industrial by-products especially industrial wastes in making of concrete is an important study of worldwide interest. Many researchers have investigated the possible use of recycled aggregates, ggbs as a concrete aggregate. For this investigation, some of the important literatures were reviewed and presented briefly.

2.1. PERVIOUS CONCRETE

Jiang Zheng-wu su ,Sun Zhen-ping, Wang Pei-ming (2005 Journal Of Building Materials),conducted astudy on effects of Some factors on Properties Of Pervious concrete. They considered factors such as gradation and particle size of aggregate, mass ratio of water to cement, mass ratio of aggregate to cement, admixtures and mixing process and also the properties like porosity ,permeation coefficient and compressive strength .

Manoj Chopra , Marty Wanie lista , Ann Marie Mulligan (2007) , conducted a study onCompressive Strength of Pervious Concrete pavements .Under this project they conducted the experimental studies on the compressive strength on pervious concrete as it relates to Water/Cement ratio , aggregate/cement ratio , aggregate size and compaction. From this research they confirmed that pervious concrete does in fact provide a lower compressive strength than that of conventional concrete; compressive strengths in all acceptable mixtures only reached 1700 psi. In all these cases, high permeability rates were achieved regardless of the compressive strength.

Norbert delatte , Stuart S. Schwartz (2010,Presentation at Second International Conference On Sustainable Materials And Technology) , conducted astudy on sustainability Benefits of pervious concrete pavement . From this study they concluded that ,Pervious concrete pavement offers most important sustainability. They are an important tool for storm water management and offers considerable environmental benefits. They also concluded that, these pervious concrete pavements must be developed and it must be placed, compacted and cured

S.O. Ajamuso , A.A. Jimoh, and J.R. Oluremi (2012, International Journal of Engineering And Technology),evaluated a study on the structuralperformance of the pervious concrete in construction. They concluded that, the smaller size of coarse aggregate should be able to produce a higher compressive strength and at the same time produce a higher permeability rate. The mixtures with higher aggregate cement ratio 8:1 and 10:1 are considered to be useful for a pavement that requires low compressive strength and higher permeability rate.

Aleksandra Radlinska , Andrea Welker , Kathyrn Greising , Blake Campbell and David Littlewood (2012), Advances in Civil Engineering, conducted study on Long term field performance of Pervious concrete Pavement. They concluded that improper placement and curing led to uneven pavement thickness , irregular pore distribution within the pervious concrete and highly variable strength values across the site , as well as sealed surfaces that prevented infiltration.

Rasiah Srivindrarajah, Neo Derek Huai Wang, Lai Jian Wen Ervin (2012, International Journal of Concrete Structures and Materials), conducted a study onMix design for Recycled aggregate concrete. This paper reports the results of an experimental investigation into the development of pervious concrete with reduced cement content and recycled aggregate for sustainable permeable pavement construction . This results also showed that the water permeability of pervious concrete is primarily influenced by the porosity and not affected by the use of recycled aggregate in place of natural aggregate.

Darshan. S. Shah, Prof. Jayesh kumar Pitroda, Prof. J.J Bhavsar (2013, International Journal Of Engineering Trends And Technology), conducted a studyon pervious concrete pavement in rural areas becomes more suitable to meet the rural area requirement such as to reduce the storm water run-off to increase the ground water level ,to eliminate the costly storm water management practices. They also concluded that pervious concrete is relatively a new concrete for pavement construction in rural areas having cost benefits and pervious concrete extensively used worldwide because of their environmental benefits, hydraulic and durability properties.

2.2 RECYCLED AGGREGATES

Tam C.M *et al.*, (2005), proposed a new approach in concrete, namely, "two-stage mixing approach (TSMA)", intended to improve the compressive strength for recycled aggregate concrete and hence lowered its strength variability. The study revealed that the quality of aggregate is classified according to the absorption rates. The experiments showed that the compressive strength of RAC was enhanced by two-stage mixing approach. When examined under scanning electron microscopy (SEM) both the new interfacial zone and old interfacial zone of recycled aggregate concrete were identified. This two stage mixing approach gave way for the cement slurry to gel up the recycled aggregate by which a stronger ITZ is provided and as a result cracks and pores within the recycled aggregates were filled.

M Etxeberria *et al.*, (2006), specified recycledcoarse aggregates obtained by crushed concrete were used for concrete production. Four different recycled aggregate concretes were produced; made with 0%, 25%, 50% and 100% of recycled coarse aggregates, respectively. The mix proportions of the four concretes were designed in order to achieve the same compressive strength. In general the workability of recycled aggregate concretes is affected by the absorption capacity of the recycled aggregates. The shape and texture of the aggregates can also affect the workability of the concrete. Concrete crushed by an impact crusher achieves a high percentage of recycled coarse aggregates without adhered mortar. Concrete made with 100% of coarse recycled aggregate requires high amount of cement to achieve a high compressive strength and consequently is not an economic proposition as it is not cost effective. Concrete made with 100% of recycled coarse aggregates has 20–25% less compression strength than conventional concrete at 28 days, with the same effective w/c ratio and cement quantity.

Kiyoshi Eguchi *et al*., (2007), developed aproduction method for recycled aggregate concrete. As per the research, characteristics of strength, durability, fire-resistant property, structural performance and workability of the recycled concrete were investigated. Eventually, the economics and environmental loads of the developed method were evaluated and its effectiveness was confirmed. The CO2 emission was higher in the production method which the amount of material transported was more. According to mechanical properties tested, among the concrete properties of the recycled concrete, the compressive strength, the elastic modulus and the drying shrinkage strain were affected by the replacement ratio of the recycled coarse aggregate. When recycled concrete was produced by the present method, the cost and the environmental loads was decreased in comparison to construction without recycling.

Falkner H. *et al.,* (2007), investigated the bondbehavior between recycled aggregate concrete and steel rebars. This paper considered thee RAC replacement percentage and the steel rebar style as the main experimental parameters. Pull out test was carried out. The monotonically increased load was applied by the testing machine. The bond between recycled aggregate concrete and deformed rebars depended much more on the mechanical anchorage and friction resistance, whereas the bond between recycled aggregate concrete and plain rebars mainly depended on the adhesion between steel and concrete, which was strongly influenced by RCA replacement percentage. For the recycled aggregate concrete, the bond strength between deformed steel rebars and concrete was approximately 100% higher than the one between plain steel rebars and concrete, coefficient of variation for the bond strength of the plain steel rebar was much higher than the one for the deformed steel rebar.

Padmini A.K. *et al*., (2009), studied about theinfluence of parent concrete on the properties of recycled aggregate concrete. Some of the salient observations of these studies are the method of crushing of parent concrete, particle shape, water cement ratio those which has significant effect on recycled aggregates. As per the results the water absorption capacity of recycled aggregates increased with increase in strength of parent concrete from which recycled aggregates was derived. The resistance against mechanical actions was lower than fresh crushed granite aggregate. In order to achieve a design compressive strength, recycled aggregate concrete requires lower water-cement ratio and higher cement content with respect to fresh granite aggregate.

Pilar Alaejos Gutierrez *et al.,* (2009), summarized the study on the influence of attached mortar content on the properties of recycled concrete aggregate. It was well known that cement mortar content affected some properties of recycled aggregates as absorption was higher, Los Angeles abrasion coefficient was lower etc.,. This research has analyzed data from experimental works that were carried out in CEDEX. In addition, other properties required to aggregates from structural concrete have been studied: density, absorption, Los Angeles abrasion and sulphate content.

Mathews M.S. *et al.,* (2009), investigated thewater absorption of recycled aggregate increases with an increase in strength of parent concrete from which the recycled aggregate is derived, while it decreases with an increase in maximum size of aggregate. Higher water absorption of recycled aggregate necessitates adjustment in mix water content to obtain the desired workability. For achieving a design compressive strength, recycled aggregate concrete requires lower water–cement ratio and higher cement content to be maintained as compared to concrete with fresh granite aggregate. For a given target mean strength, the achieved strength increases with an increase in maximum size of recycled aggregate used. For a given compressive strength of concrete, the split tensile and flexural strengths are lower for RAC than parent concrete.

2.3 GROUND GRANULATED BLAST FURNACE SLAG (GGBS)

Venu Malagavelli et alstudied on high performanceconcrete with GGBS and robo sand nd concluded that the percentage increase of compressive strength of concrete is 11.06 and 17.6% at the age of 7 and 28 days by replacing 50% of cement with GGBS and 25% of sand with ROBO sand.

Luo et al. experimentally studied the chloridediffusion coefficient and the chloride binding capacity of Portland cement or blended cement made of Portland cement and 70 % GGBS replacement with or without 5 % sulphate.They found that (i) chloride diffusion coefficient decreased; (ii) chloride ion binding capacity improved in samples of blended cement.

Oner and Akyuz studied on optimum level of GGBSon compressive strength of concreteand concluded that the optimum level of GGBS content for maximizing strength is at about 55–59% of the total binder content.

Qian Jueshi and Shi Caijun studied on highperformance cementing materials from industrial slag and reviewed the recent progresses in the activation of latent cementitious properties of different slag. They opined that Alkali-activated slag, such as blast furnace slag, steel slag, copper slag and phosphorus slag should be a prime topic for construction materials researchers.

Ganesh Babu and Sree Rama Kumar studied onefficiency of GGBS in Concrete.

Wainwright [7] conducted Bleed tests inaccordance with ASTM C232-92 on concretes in which up to 85% of the cement was replaced with ground granulated blastfurnace slag (GGBS) obtained from different sources. They observed that delaying the start of the bleed test from 30 to 120 min reduced the bleed capacity of the OPC mix by more than 55% compared with 32% for the slag mixes. The reduction in bleed rate was similar for all mixes at about 45%.

Tamilarasan et al. studied on Chloride diffusion ofconcrete on using GGBS as a partial replacement material for cement and without and with Superplasticiser. The study results showed that, with the increase in percentage of GGBS, the Chloride diffusion of concrete decreases. Also it is found that the Chloride diffusion in the M25 concrete is less than M20 concrete.

Soutsos et al. [8] studied on fast track constructionwith high-strength concrete mixes containing Ground Granulated Blast Furnace Slag. They showed that the existing maturity functions like the Nurse-Saul and the Arrhenius equation may not be suitable for GGBS concretes.

Pavia and Condren studied the durability of OPCversus GGBS Concrete on Exposure to Silage Effluent. This research concluded that PC composites incorporating GGBS are more durable than those made with PC alone in aggressive environments under the action of acids and salts such as those produced by silage.

Ashish kumar dash et al researched on differentmaterials like rice husk ash, GGBS, silica fume to obtain the desired needs.

Higgins [11] discussed on the effect of addition of asmall percentage of calcium carbonate or calcium sulfate on the sulfate resistance of concrete containing GGBS.

Pazhani and Jeyaraj conducted experimentalinvestigation to assess the durability parameters of high performance concrete with the industrial wastes.

Shariq Prasad et al. studied the effect of curingprocedure on the compressive strength development of cement mortar and concrete incorporating ground granulated blast furnace slag is studied. The compressive strength of OPC concrete shows higher strength as compare to the GGBFS based concrete for all percent replacement and at all ages. Incorporating 40% GGBFS is highly significant to increase the compressive strength of concrete after 56 days than the 20 and 60 replacement. Among GGBFS based concrete 40% replacement is found to be optimum.

2.4 POLYPROPELENE FIBRES

Naaman A.E, Al-khairi F.M, and Hammoud H. Showed that use of steel fibres in lower strength concretes increases their compressive strength significantly compared to plain unreinforced matrices and is directly related to volume fraction of steel fibre used. This increase is more for hooked fibres in comparison with strength polypropylene fiber, steel fiber or glass fiber.

Siva kumar.A and Manu Santhanam. Studied onhigh strength concrete reinforced with hybrid fibres (combination of hooked steel and a non metallic fibre) up to a volume fraction of 0.5% and found the flexural toughness of steel polypropylene hybrid fibre concrete was better to steel fibre concrete.

Jain Tong Ding and Zongjin Li. Studied about theeffect of metakaolin and silica fume on properties of concrete. Seven concretes were cast at a water/binder ratio of 0.35 with 0, 5, 10 and 15% cement replaced by metakaolin or silica fume. The incorporation of both metakaolin and silica fume in concrete can reduce the free drying shrinkage and restrained shrinkage cracking width.

X. Qian and Z. Li. Reported the results of a study ofstress – strain relationship in compression, tension and flexural strength measurements for concrete incorporating 0%, 5%, 10% and 15% metakaolin. The test results show that the tensile strength and peak strain increase with increasing metakaolin content where as the tensile elastic modulus shows only small changes. The lowering/downward-moving/originating area over peak stress is improved when 5% and 10% of cement is replaced by metakaolin. Also, the modulus of rupture and compressive strength increase with increasing metakaolin content. The compressive elasticity modulus of concrete shows a small increase with increasing metakaolin replacement,

Cengiz Duran Atis and Okan Karahan. Study theinfluence of using fly ash, polypropylene fibers, and steel fibers in concrete showed that strong relation existed between abrasion and flexural tensile strength, than between abrasion and compressive strength of the concrete containing either fly ash or fibers or both.

Ramadevi K, venkatesh babu D.L. Concluded theworkability of hybrid fiber reinforced concrete mix was increased by addition of a super plasticizer. The test results of the research shows that use of hybrid fiber reinforced concrete improves flexural performance of the beams during loading.

Scott R and Singh S.P. The high performanceconcrete is concrete which secures/makes sure of long-time ability of last in structures exposed to aggressive surrounding conditions. Ability to last of concrete is its ability to resist weathering action, chemical attack, scrape/injury and all other worsening/rusting, crumbling, etc. processes. Weathering includes related to surrounding conditions effects such as exposure to cycles of wetting and drying, heating and cooling, as also freezing and thawing. Chemical worsening/rusting, crumbling, etc. process includes acid attack, big and wide chemical attack due to moisture and chloride ingress.

2.5 LITERATURE SUMMARY

From all the above literature reviews, it was evident that GGBS can be used as a cement replacement, recycled aggregates can be used as a coarse aggregate replacement individually in a concrete mix.

The optimum percentage of replacement was also identified for all industrial materials individually. But there was no literature available on the utilization of all the above mentioned replacement in the same concrete mix.

Hence it is planned to use GGBS as cement replacement, recycled aggregates as coarse aggregate respectively together as an ingredient of the concrete.

3. MATERIAL USED

The materials used for the project is collected and made sun dried before as initial testing and for further usage. The amount of material to be used should be noted in advance based on the preparation of mix design. From the results of mix design the quantity of each component such as cement, CA and water will be finalized, then the collection of materials to be done and to be stored in a specified place free from impurities. Based on the availability of the materials and its condition the following tests were performed.

3.1 CEMENT

Ordinary Portland cement of 53 grade having specific gravity of 3.1 and fineness modulus of 6.5% was used. The Cement used has been tested for various proportions as per IS 4031-1988 and found to be confirming to various specifications of IS 12269-1987.

3.2 RECYCLED AGGREGATE

Recycled aggregates fractions larger than 4.75mm are termed as recycled aggregates. The fraction of aggregates used in the experimental work passed in 20mm sieve and retained on 10mm IS sieve comes under Zone II aggregates conforming to IS: 383-1970.

3.3 GROUND GRANULATED BLAST FURNACE SLAG (GGBS)

The ground granulated blast furnace slag is a waste product from the iron manufacturing industry, which may be used as partial replacement of cement in concrete due to its inherent cementing properties. It is observed from the investigation that the strength of concrete is inversely proportional to the % of replacement of cement with ground granulated blast furnace slag. It is concluded that the 20% replacement of cement is possible without compromising the strength with 90 days curing.

3.4 POLYPROPELENE FIBRE

Polypropylene fibers are hydrophobic, that is they do not absorb water. Therefore, when placed in a concrete matrix they need only be mixed long enough to insure dispersion in the concrete mixture. The mixing time of fibrillated or tape fibers should be kept to a minimum to avoid possible shredding of the fibers .The type of polypropylene fiber recommended by manufacturers for paving applications is the collated fibrillated fiber. The length of fiber recommended is normally tied to the nominal maximum size of aggregate in the mixture. Manufacturers recommend that the length of the fiber be greater than twice the diameter of the aggregate. This would be consistent with past experiences with steel fibers and also with current theories on fiber dispersion and bonding".

Table 3.1: Physical properties of OPC & GGBS

SL. NO.	PROPERTY	OPC VALUE	GGBS VALUE
1	Specific Gravity	3.1	3.44
2	Initial Setting Time	45 min	< 60min
3	Final Setting Time	385 min	< 985 min
4	Fineness Modulus	6.5%	3.36%
5	Bulk density(Dense)	1.55g/ cm^3	480Kg/ cm^3
6	Bulk density(Loose)	1.13g/ cm^3	400Kg/ cm^3

Table 3.2: Chemical Properties of OPC & GGBS

Materials	OPC	GGBS
SiO_2	20.25	34.4
Al_2O_3	5.04	21.5
Fe_2O_3	3.16	0.2
CaO	63.61	33.2
MgO	4.56	9.5
Na_2O	0.08	0.34
K_2O	0.51	0.39

Table 3.2: Physical Properties of Coarse Aggregate and Recycled aggregate

Materials	Specific Gravity	Finess Modulus (%)	Bulk Density (Kg/m3)	Water Absorption (%)
Coarse Aggregate	2.71	3.18	2400 kg/m^3	0.33
Recycled aggregate	2.35-2.58	2.78	2150 kg/m^3	12.49

Table 3.4: Properties of Polypropelene fibre

Properties	Test data
Diameter(D) ,mm	0.0445
Length (l) ,mm	6.20
Aspect Ratio (l/D)	139.33
Tensile strength Mpa	308
Specific gravity	1.33

Table 3.4: Properties of Polypropelene fibre

4. TESTING AND RESULT

4.1 MIX DESIGN

The mix proportion was done as per the IS 10262:2009 the target mean strength was 42 Mpa (30) for the OPC control mixture. Mix design is a term used for determining quantities of different constituents, which in our experiment was done with Indian standard method. The quantities of cement, ggbs, recycled aggregate were found out with help of this method. The proportions for normal mix of M30 Normal Mix were: - Cement: Sand: Coarse Aggregate: Water. After calculating the quantity, all constituents were weighed using electronic weighing machine.

First of all cement and ggbs were thoroughly mixed in dry state, recycled aggregate were later added to the mixture. To the above mixture polypropelene fibre were added. Now the whole mixture was mixed manually. Water was finally added to the dry mixture.

After mixing operation, moulding was done and as the moulds were filled tamping was done simultaneously for compaction. After 24 hours demoulding was done and the specimen was placed in curing tank for 7, 14 and 28 days.

4.2 TESTING

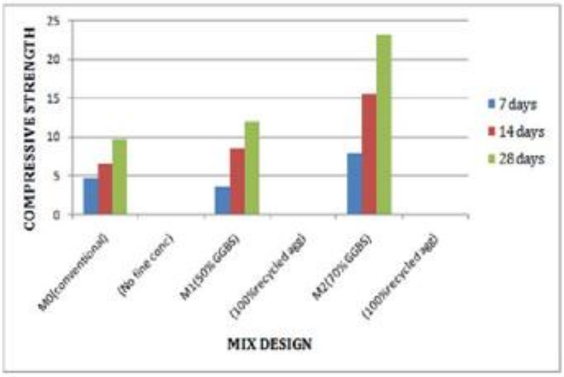
Compressive Strength: To examine thecompressive Strength Standard cubical moulds of size 150mm × 150mm×150mm made of cast iron were used.

To determine the compressive strength we casted cubes with different percentage of GGBS and recycled aggregate in the concrete. After that the specimen are tested at 7, 14 and 28 days at compression testing machine (CTM) as per I.S. 516-1959. The optimum percentage of GGBS and recycled aggregate were again casted and tested at 7, 14 and 28 days.

Table 4.1: Compressive Strength Result

MIX DESIGN	Compressive Strength		
	7 days	14 days	28 days
M_0(conventional) (No fine conc)	4.67	6.55	9.67
M_1(50% GGBS) (100%recycled agg)	3.55	8.44	12
M_2(70% GGBS) (100%recycled agg)	8	15.55	23.11

Fig 4.1 Compression Strength



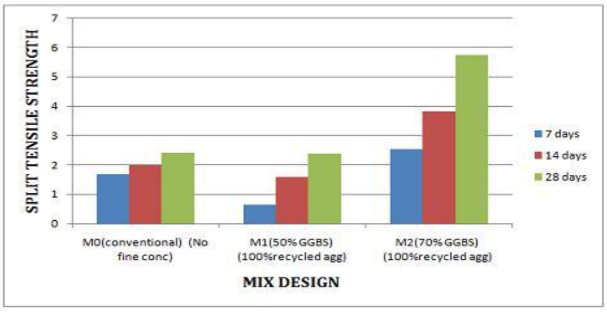
Split Tensile Strength: To examine the Split tensilestrength of plane mortar and mortar of various percentages of GGBS and recycled aggregate contents in concrete has been investigated by testing cylinders of 200mm × 100mm under CTM of 2000 KN capacity.

After that the specimen were tested at 7, 14 and 28 days at compression testing machine (CTM) as per I.S. 516-1959. The optimum percentage of GGBS and recycledaggregate were again casted and tested at 7, 14 and 28 days.

Table 4.2: Split Tensile Strength Result

MIX DESIGN	Split Tensile Strength		
	7 days	14 days	28 days
M_0 (conventional) (No fine conc)	1.69	1.99	2.40
M_1 (50% GGBS) (100%recycled agg)	0.63	1.59	2.38
M_2(70% GGBS) (100%recycled agg)	2.54	3.82	5.73

Fig 4.2 split tensile Strength



Water permeability test: pervious concrete is madeby eliminating most or all fine aggregates from the concrete mix. Its internal interconnected void space allows storm water to percolate and thus to reduce the amount of run-off. The permeability or the saturated hydraulic conductivity of the pervious concrete signifies its capacity to drain the ponding water from the concrete surface. And it was determined using a falling head permeability setup.

Table 4.3: Water Permeability test Result

(i)For 50% 0f GGBS

Time (sec)	Height(cm)	Coefficient of permeability k (cm/sec)10^-3
0.0	100.0	-
5.0	88.6	2.38
10.0	78.6	2.61
15.0	66.3	3.45
20.0	56.3	3.49
25.0	47.0	4.22 Avg.K=3.23

(ii) For 70% 0f GGBS

Time (sec)	Height (cm)	Coefficient of permeability k (cm/sec)10^-3
0.0	100.0	-
5.0	86.4	2.71
10.0	75.6	3.15
15.0	62.7	3.71
20.0	51.9	4.43
25.0	40.3	5.44 Avg.K=3.88

5. CONCLUSIONS

1. Concrete is homogeneous and composite material which is composed of coarse aggregate, fluid cement and fine aggregate.
2. Pervious concrete is a special type of concrete with a high porosity used for concrete flatwork applications that allows water from precipitation and other sources to pass directly through, thereby reducing the runoff from a site and allowing groundwater recharge.
3. It is made using coarse aggregate with no fine aggregates and with cement. Here we replacing the cement partially with the ground granulated blast furnace slag (GGBS) and coarse aggregate fully by the recycled aggregate. And additionally with polypropelene fibres.
4. Which the mixture gives good results than the conventional one by casting the concrete with different proportions and tests have been carried through and founded out.
5. Polypropelene fibres are used to keep binding in the concrete and for improving density in concrete. Whereas the concrete strength is been increased by it drastically.
6. Compressive strength and Split Tensile strength increase with increasing the percentages of GGBS and recycled aggregate in concrete.
7. Strength achieved in various proportions and best in encountered.
8. The combination of 70% GGBS with recycled aggregate have increased strength compared to conventional concrete. And with 2% polypropelene fibre in addition to the mixture.
9. And water permeability is founded by falling head method and its setup. And permeability is achieved in the concrete with 70% GGBS with recycled aggregate.
10. The water permeability of the permeable concrete should be reported with the applied pressure and the associated testing method.

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