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A Review on Study of Properties of Pervious Concrete Mixed with The Plastic (Pet) Fibre

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ABSTRACT

Pervious concrete is a special type of concrete which consist of course aggregate water. As there is no fine aggregate in the concrete mix the void content is more which allow the water flow through its body. So the pervious concrete is also called as permeable concrete and porous concrete. There is lot of research work is going in field of pervious concrete. The compressive strength of pervious concrete is less when compared to the conventional concrete as there are voids and less fine aggregate. Hence uses of pervious concrete are limited even though it has lot of advantages. The main aim of our paper is to improve the compressive strength and maintain permeability of pervious concrete. So we are adding waste (PET) bottles. Fibers which are cut into small thread of waste (PET) bottle and we have taken fibers of that small piece. Different proportion of plastic fibers is added in pervious concrete trial 1%, 2% and 3% after the mixing of plastic fiber. Compressive strength and permeability test perform on these blocks.

Keywords : ***Pervious concrete, Plastic Fibre, Compressive strength, waste (PET) bottle***

1. INTRODUCTION

Pervious concrete is a special type of concrete with high porosity. It can used for concreteflatwork applications that allows water to precipitate, thereby reducing the runoff from a site and allowing ground water recharge. The concrete paste then coats the aggregatesand allows water to pass through the concrete slab. Pervious concrete is traditionally usedin parking areas, areas with light traffic, residential streets, pedestrian walkways, and greenhouses. It is an important application for sustainable construction and is one of many low impact development techniques used by builders to protect water quality.

The pervious concrete strength characteristic is as important as its permeability characteristics. The strength of the system not only relies on the compressive strength of the pervious concrete but also on the strength of the soil beneath it for support. Pervious concrete consists of cement, coarse aggregate and water with little to no fine aggregates. Water to cement ratio of 0.28 to 0.40 with a void content of 15 to 30%. The correct quantity of water in the concrete is critical. A low water to cement ratio will increase the strength of the concrete, but too little water may cause surface failure. As this concrete is sensitive to water content, the mixture should be field checked. A pervious concrete mixture contains little or no sand (fines), creating a substantial void content. Using sufficient paste to coat and bind the aggregate particles together creates a system of highly permeable, interconnected voids that drains quickly. Typically, flow rates for water through pervious concrete are typically around 480 in./hr (0.34 cm/s, which is 5 gal/ft²/ min or 200 L/m²/min), although they can be much higher.

The high flow rate of water through a pervious concrete pavement allows rainfall to be captured and to percolate into the ground, reducing storm water runoff, recharging groundwater, supporting sustainable construction, providing a solution for construction that is sensitive to environmental concerns, and helping owners comply with EPA storm water regulations. This unique ability of pervious concrete offers advantages to the environment, public agencies, and building owners by controlling rainwater on-site and addressing storm water runoff issues. This can be of particular interest in urban areas, or where land is very expensive. Depending on local regulations and environment, a pervious concrete pavement and its subbase may provide enough water storage capacity to eliminate the need for retention ponds, swales, and other precipitation runoff containment strategies. This provides for more efficient land use and is one factor that has led to a renewed interest in pervious concrete. Other applications that take advantage of the high flow rate through pervious concrete include drainage media for hydraulic structures, parking lots, tennis courts, greenhouses, and pervious base layers under heavy- duty pavements. Its high porosity also gives it other useful characteristics: it is thermally insulating (for example, in walls of buildings) and has good acoustical properties (for sound barrier walls).

Although pavements are the dominant application for pervious concrete in the U.S., it has also been used as a structural material for many years in Europe. Applications include walls for two-story houses, load-bearing walls for high-rise buildings (up to ten stories), and infill panels for high-rise buildings, sea groins, roads, and parking lots.

1.1. What is concrete?

Concrete is a construction material composed of cement, fine aggregates (sand) and coarse aggregates mixed with water which hardens with time. Portland cement is the commonly used type of cement for production of concrete. Concrete technology deals with study of properties of concrete and its practical applications.

In a building construction, concrete is used for the construction of foundations, columns, beams, slabs and other load bearing elements.

There are different types of binding material is used other than cement such as lime for lime concrete and bitumen for asphalt concrete which is used for road construction.

1.2. Plastic Fibre:-

Polyethylene terephthalate (PET) is general purpose thermoplastic polymer which belongs to the polyester family is polymers. Polyester resins are known for their excellent combination of properties such as mechanical thermal, chemical resistance as well as dimension stability.

Recycled PET can be converted to fibres, fabrics, sheets for packaging and manufacturing automotive parts.

PET is highly flexible, colourless and semi-crystalline resin in its natural state. Depending upon how it is processed, it can be semi-rigid to rigid. It shows good dimensional stability, resistance to impact, moisture, alcohol and solvents.

Fig.1.:Plastic

Commercially available PET grades include un-reinforced to glass reinforced, flame retardant and high flow materials for various engineering applications that typically require higher strength and or higher heat resistance. Addition of filler s like glass fibres, CNTs etc. help improve impact strength, surface finish, reduce warpage and several otherbenefits.

Plastic pollution is currently one of the biggest environmental concerns. It may seem like large amounts of plastic waste are inevitable in the world we live in, but you can help with the plastic pollution issue by being aware of its dangers and taking steps to reduce waste.

The amount of garbage in the world increases as the population grows, and disposable plastic products, like water bottles and soda cans, accumulate over time. Plastic pollution occurs when enough plastic has gathered in an area that it affects the natural environmentand harms plants, animals, or humans.

Plastic has toxic pollutants that damage the environment and cause land, water, and air pollution. It can take hundreds or even thousands of years for plastic to break down, so the damage to the environment is long-lasting.

2. CAUSES OF PLASTIC POLLUTION

Overuse of plastic is the main cause of plastic pollution. Plastic is cheap and widely available, but people frequently dispose of plastic items. They don't decompose, and they release an incredible amount of toxins into the air if they're burned.

Regular, everyday trash is one of the biggest contributors to plastic pollution. Milk cartons with plastic linings, disposable water bottles, soaps with small plastic beads, and other products end up in the environment or in dumps where they can affect the groundwater and nearby wildlife.

Commercial fishing nets are another big issue. Although fishing is necessary for the economy and for food supply in many regions, nets are often made of plastic. When the nets are submerged in the water, they leak toxins. They can also break or get lost, adding even more pollutants to the water.

2.1 Effects of Plastic Pollution:-

On land, wind can carry plastic waste or litter throughout the environment. It can get stuck in trees, fences, traffic lights, or other structures. When animals come into contact with this plastic waste, they risk consuming the toxins or becoming entangled in the plastic and suffocating. If an animal consumes a piece of plastic, the plastic can clog its stomach while also poisoning it with toxins. Almost 200 different species of animals are known to ingest plastic debris. Air pollution is another issue for humans and animals. When plastic is burned in the open air, it releases large amounts of toxins, which pollutes the air. If the toxins are inhaled for a long period of time, it can lead to respiratory problems.

As the world's population increases, land becomes more valuable, and it will soon become difficult to find places to put garbage. Over time, landfills and dumps will take up more land, invading animals' habitats and coming even closer to groundwater sources.

In addition to harming plants, animals, and people, it costs millions of dollars every year for cleanup of areas exposed to plastic toxins. Many regions have seen a decrease in tourism because of the amount of pollution in their environment, which can have aserious impact on local economies.

3. INGREDIENTS OF CONCRETE:

3.1. Cement:

Ordinary Portland cement, 53Grade conforming to IS: 269 – 1976.Ordinary Portland cement,53Gradewas used for casting all the Specimens. Different types of cement have different water requirements to produce pastes of standard consistence. Different types of cement also will produce concrete have a different rates of strength development. The choice of brand and type of cement is the most important to produce a good quality of concrete. The type of cement affects the rate of hydration, so that the strengths at early ages can be considerably influenced by the particular cement used. It is also important to ensure compatibility of the chemical and mineral admixtures with cement.

3.2. Course aggregate:

Locally available crushed blue granite stones conforming to graded aggregate of nominal size12.5 mm as per IS: 383 – 1970. Crushed granite aggregate with specific gravity of 2.77 and passing through 4.75 mm sieve and will be used for casting all specimens. Several investigations concluded that maximum size of coarse aggregate should be restricted in strength of the composite. In addition to cement paste – aggregate ratio, aggregate type has a great influence on concrete dimensional stability.

3.3. Water

Tap water of ph. value 7.5 is used for study.

3.4. Plastic fiber

Waste plastic like plastic cups, bottles. Various process like re-dusting and washing of collected waste is carried out. Plastic (cups, bottles) cut into fibers of 40mm length and breadth is 2mm.

Mixed design of conventional concrete

Calculation

1) Target strength for mix proportion
   $F'_{ck} = f'_{ck} + 1.65 * S$ {From table 1}
   Standard deviation (S) = 4N/mm²
   $F'_{ck} = 25+1.65\times5 = 33.25$ N/mm²
2) Selection of water contain= 0.4 {From table 2}
   For 20mm aggregate =186 lit Estimated slump is 85mm ∴ Water content = 186 +6 × 186 =197 lit
3) Calculation of cement content W.C = 0.4
   ∴ Cement content = $\frac{197}{0.4}$ = 492.5 Kg/m3

According to IS 456, minimum cement content for severe exposure condition is320 kg/ m^3

∴ 492.5 > 320 kg/ m^3 (hence ok)

1) Proportion of volume of coarse& fine aggregate contentFor zone II = volume of coarse aggregate = 0.62
   ∴Volume of fine aggregate = 1 - 0.62 = 0.38

Part II

The mix calculation per unit volume of concrete be as follow

a) Volume of concrete = 1 m^3
b) Volume of cement = $\frac{mass\ of\ cement}{specific\ gravity\ of\ cement} \times 100$
   = 0.169 m^3
c) Volume of water = $\frac{Mass\ of\ water}{Specific\ gravity\ of\ water}$
   = 0.197 lit

d) Volume of all in aggregate = 1 - (0.169+0.197)
e = 0.634m^3

e) Mass of coarse aggregate = e × volume of CA × specific gravity of CA × 1000
= 0.634 × 0.62 × 2.63 × 1000
= 1033.80 kg

f) Mass of fine aggregate = e × volume of FA × specific gravity of FA × 1000
= 0.634 × 0.38× 2.4 × 1000 =578.20 kg

Mix Proportion:-
Cement= 478.95 kg/m^3 , Water = 197 kg/m^3 , Fine aggregate = 578.20 kg, Coarse aggregate = 1033.80 kg,
Water cement ratio = 0.4
Proportion for M25 grade concreteCement: sand: aggregate is 1: 1.2: 2.11

Calculated quantity:

W/C	= 0.4
Sand	= 578.20 kg/m3
Water	= 197 lit/m^3
Cement	= 478.95 kg/m^3
Aggregate	=1033.8 kg/m3

Cement: sand: aggregate: water
478.95: 578.20: 1033.80: 197
1 : 1.2 : 2.15 : 0.4

PERVIOUS CONCRETE MIX DESIGN ACCORDING TO ACI 522R-06

Pervious concrete of strength 25Mpa, Design average cube strength at 28 days25/0.75 = 33.33 N/mm2
A/C = 3
Optimum W/C ratio = 0.31
Density of Concrete = 2500 Kg/m3
Density of Cement = 1700 Kg/m3
Density of coarse aggregate: 12.5 mm = 1650 Kg/m3
A/C ratio by weight = 3x 1650/ 1700 = 2.91

PERVIOUS CONCRETE
Cement: Aggregate: Water1:2.91: 0.31
Quantities of Materials Per Concrete Block:
Cement: 0.669kg
Coarse aggregate: 1.948kgWater: 0.207litre

4. RESULTS AND COMPARISIONS

Result: Compressive strength of pervious concrete after Adding Plastic fiber and curing After 28 Days

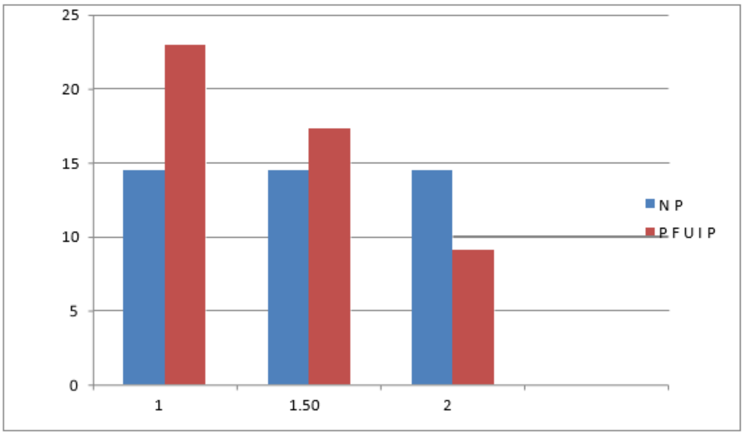
4.1.1. Observation table.

Sr no.	Percentage plastic	No of block	Load (KN)	Area (MM2)	Compressive Strength N/MM2
1	0%	BLOCK NO:1	325000	150*150	14.44
		BLOCK NO:2	327000	150*150	14.53
2	1%	BLOCK NO:1	512000	150*150	22.75
		BLOCK NO:2	520000	150*150	23.11
3	1.5%	BLOCK NO:1	392000	150*150	17.42
		BLOCK NO:2	386000	150*150	17.15
4	2%	BLOCK NO:1	196000	150*150	8.71
		BLOCK NO:2	212000	150*150	9.42

4.1.2. Observation Table of Permeability:

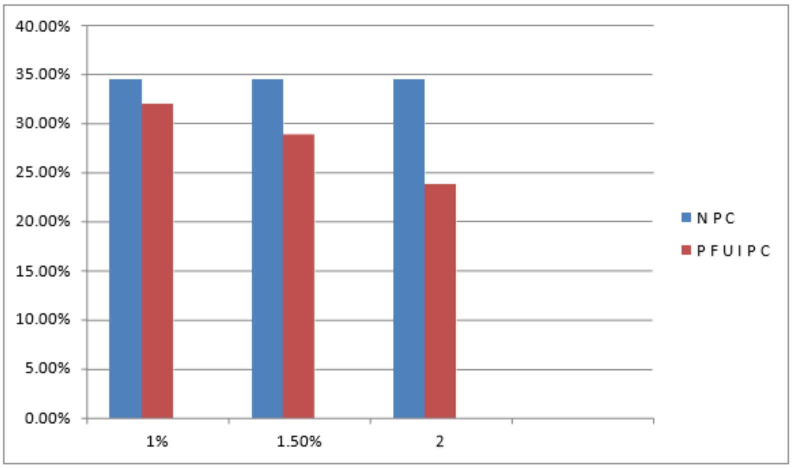
Sr. No.	Percentage Plastic	No. Of Block	Quantity of water Millimetre (cm)	ThicknessOf Specimen (cm)	Pressure Head (cm)	Time (Min)	Permeability K= $\frac{Q}{T\frac{H}{L}}$
1	0.0 %	1	950	10.5	50	9.66	34.4 %
2	1.0%	1	950	10.5	50	10.38	32.02 %
3	1.5%	1	950	10.5	50	11.5	28.9%
4	2.0 %	1	950	10.5	50	14.25	23.8%

Graph 4.1.1: Comparison of compressive strength between different percentage of plastic fibre used in pervious concrete with normal pervious concrete:



Where,N P C = Normal Pervious Concrete
P F U I P C = Plastic Fibre Used In Pervious Concrete

Graph 4.1.2: Comparision of permeability between differentpercentage of plastic fibre used in pervious concrete with normal pervious concrete:



Where,N P C = Normal Pervious Concrete
P F U I P C = Plastic Fibre Used In Pervious Concrete

5. CONCLUSION

Practically the compressive strength of pervious concrete less as compared to conventional concrete.
The 1% of plastic fibre of pervious concrete compressive strength increases 57.81% as comparatively normal pervious concrete. As well as permeability reduced 2.38%.
The 1.5% of plastic fibre of pervious concrete compressive strength increase 20.16% as comparatively normal previous concrete. As well as permeability reduced 5.5%.
The 2% of plastic fibre of pervious concrete compressive strength Reduce 37.61% as comparatively normal pervious concrete. As well as permeability reduced 10.6%.
If percentage of plastic fibre will increase then the compressive strength of pervious concrete will decrease.
If percentage of plastic will increase then then permeability will also decrease.
The best proportion of plastic fibre is 1% for compressive strength as well as permeability.
Therefore we can use 1% of plastic fibre in pervious concrete for the purpose of parking lots, light traffic roadway, and playground etc.

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