Experimental Study on Pervious Concrete, Increasing its Flexural Strength

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Abstract- Flexible Pervious Concrete (FPC) is an innovative material that combines the flexibility and durability of bendable concrete with the water permeability of traditional pervious concrete. Flexible pervious concrete refers to a type of concrete that combines the typical characteristics of pervious concrete (its ability to allow water to flow through it) with added flexibility, making it more resistant to cracking under certain conditions. Designed to address challenges such as urban flooding, stormwater management, ground water recharge and the durability of pavements in seismic zones, FPC offers a sustainable solution for modern infrastructure. By integrating fibres such as polyvinyl alcohol (PVA) and incorporating a porous matrix, FPC achieves a balance between mechanical flexibility and high permeability. Keywords: Mechanical Flexibility, Polyvinyl Alcohol, durability.

INTRODUCTION

Flexible pervious concrete is a type of concrete that incorporates additives or fibres to enhance its flexibility and tensile strength road. Unlike traditional concrete, which is brittle and prone to cracking under stress, due to adding polypropylene fibers and silica fume in it the strength & durability will increases and Polyvinyl Alcohol(PVA) increases its flexural strength and resistance from cracks under external load, flexible concrete can absorb more energy and deform without breaking. Pervious concrete, also known as porous or permeable concrete, is a special type of concrete designed to allow water to flow through its road surface. This structure enables rainwater to permeate through, reducing surface runoff and promoting groundwater recharge.

LITERATURE REVIEW

Flexible Pervious Concrete is a type of concrete that is designed to allow water to flow through its surface, facilitating drainage and reducing surface runoff. Unlike traditional concrete, which is impermeable, flexible pervious concrete features a porous structure that enables rainwater and other liquids to infiltrate, promoting groundwater recharge and minimizing the risk of flooding. Overall, flexible pervious concrete serves as an effective solution for managing stormwater while providing a durable and aesthetically pleasing surface for various urban environments.

MATERIALS

- Cement: Ordinary Portland cement (43 grade)Cement is a crucial construction material that acts as a binder, setting and hardening to bind other materials like sand and (aggregate) together, forming concrete or mortar, Cement is a chemical substance that sets, hardens, and adheres to other materials, binding them together.
- Crushed sand: Crushed sand, also known as artificial sand or manufactured sand (M-sand), is produced by crushing rocks such as granite, limestone, or basalt to obtain smaller particles that resemble natural sand.
- Coarse Aggregate: Construction aggregate, or simply aggregate, is a broad category of coarse- to medium-grained particulate material used in construction. We used the 20mm size aggregate which is passes through the 20mm and retained on 10mm sieve.
- Polypropylene Fibers: 0.6% of Polypropylene. It increases the compressive strength, workability and durability of pervious concrete.

Properties of Polypropylene Fibers

Properties of Polypropylene Fibers	Results
Appearance Density (kg/m3)	Crimped white fibers
Thickness	0.6mm
Width	1.1mm

Elongation at break/failure strain	12%-14%
Reaction with water	Hydrophobic
Density (kg/m3)	910 (kg/m3)
Tensile Strength	450 Mpa

- Silica Fume: 10% of Silica Fume by partial replacement of weight of cement. Silica Fume increases the compressive strength, workability than the traditional pervious concrete and durability.

Properties of Silica Fume	Results
Physical State	Micronized powder
Odour	Odorless
Pack Density	0.76 gm/cc
Oil Absorption	55ml/100 gms
Specific Gravity	2.63

- Polyvinyl Alcohol: 1% of Polyvinyl Alcohol to increase its Flexural Strength to resist it from cracks due to external loading, and workability and durability increases.

Properties of Polyvinyl Alcohol

Properties of Polyvinyl Alcohol	Results
Filament diameter	660 microns
Specific gravity	1.3
Tensile strength	800 MPa
Flexural strength	23 GPa
Melting point	225°C

- Water: Water should be clean and drinkable. It should not have any impurities, dust particles any other waste matters.

METHODOLOGY

Experimental Procedure: To investigate the Pervious Concrete, increasing its Flexural Strength by using materials, cement, crushed sand, coarse aggregate(20mm) and admixtures such as 0.6% of Polypropylene by theoretical study for increasing its compressive strength, 10% of Silica Fume by partial replacement of weight of cement for increasing its strength, workability, durability, 1% of Polyvinyl Alcohol (PVA) for flexural strength, workability, durability and to resist from cracks. The grade of

Concrete is M20 & its Proportion is 1:1.5:3.

First of all we casted the pervious concrete blocks size of 150mm x 150mm x 150mm without adding any admixtures (cement, sand, coarse aggregate and water with proper proportion). Cured for 7,14 and 28 days. Tested it after completing the curing period of 7, 14 and 28 days under Compression Testing Machine (CTM). Calculated the average Compressive strength of 3 blocks of pervious concrete of each 7, 14 and 28 days.

Pervious Concrete blocks of 150mm x 150mm x 150mm size of each 3 blocks with adding admixtures such as 0.6% of Polypropylene, 10% of Silica Fume by partial replacement of weight of cement, 1% of Polyvinyl Alcohol (PVA). Cured each 3 blocks for 7, 14 and 28 days. Tested it after completing the curing period of 7, 14 and 28 days under Compression Testing Machine (CTM). Calculated the average Compressive strength of 3 blocks of each 7, 14 and 28 days cured blocks.

RESULTS

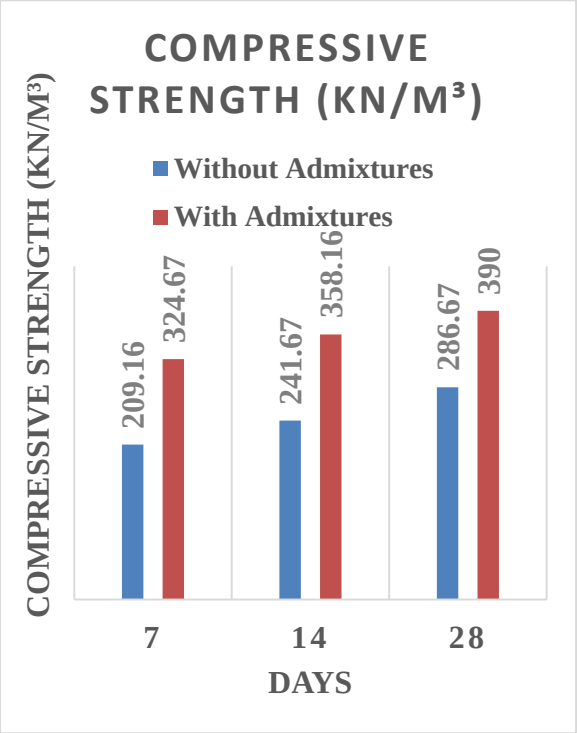
Compare the Compressive Strength of Pervious Concrete 3 blocks of Traditional Pervious Concrete without adding any admixtures and with adding admixtures of each 7, 14 and 28 days of curing period.

The final results after the Experimental study, observed that the Compressive Strength of Pervious concrete with adding admixtures (0.6% of Polypropylene, 10% of Silica Fume partial replacement by weight of cement, 1% of Polyvinyl Alcohol (PVA)) is higher than the traditional Pervious Concrete (without adding any admixtures). It increases the Compressive strength with adding Polypropylene and Silica Fume as well as Flexural Strength due to Polyvinyl Alcohol. Adding of admixtures in Pervious Concrete like Polypropylene, Silica Fume and Polyvinyl Alcohol it increases the additional Compressive Strength and Flexural Strength and workability, durability and resistance from cracks due to flexural strength of pervious concrete.

Results of Compressive Strength of Pervious Concrete with and Without adding Admixtures

Days	Average Compressive strength without admixtures (KN/m^2)	Average Compressive strength with admixtures (KN/m^2)

7	209.16	324.67
14	241.67	358.16
28	286.67	390



CONCLUSION

In the final results the Compressive Strength as well as Flexural Strength of concrete increases after adding Polypropylene Fibers (0.6%), Silica fume (10%) and Polyvinyl Alcohol (1%). Pervious concrete has the ability to absorb heat and sound energy through internal friction. However, this type of concrete cannot be used for structural purpose due to its high porosity and low compressive strength but we have done the experimental study on it, it increases the compressive strength, flexural strength, workability and durability of pervious concrete, so we can be used for structural purpose like, roadways, sidewalks, parking areas, footpath and many more.

Pervious concrete, with its porous structure, offers several advantages, including enhanced stormwater management, reduced runoff, improved water quality, and a reduction in the heat island effect, making it a sustainable and environmentally friendly paving option.

Groundwater Recharge, The stormwater seeps through the pervious concrete and infiltrates through the ground. It ultimately adds up to the groundwater increasing groundwater level. Pervious concrete allows the water to flow through it. The permeability of concrete depends upon the percentage of voids in the concrete, and the size of voids. Typically, 15-25% voids are achieved in hardened permeable concrete.

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