

Improvement Of Compressive Strength Of Pervious Concrete By Using Mineral Admixtures

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Abstract- Pervious concrete is a special type of concrete, which consists of cement, coarse aggregates, water and if required, admixtures and other cementitious materials. As there are no fine aggregates used in the concrete matrix, the void content is more which allows the water to 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 the field of pervious concrete. "The compressive strength of pervious concrete is less when compared to the conventional concrete due to its porosity and voids. Hence, the usage of pervious concrete is limited even though it has lot of advantages. If the compressive strength and flexural strength of pervious concrete is increased, then it can be used for more number of applications. For now, the usage of pervious concrete is mostly limited to light traffic roads only. If the properties are improved, then it can also be used for medium and heavy traffic rigid pavements also. Along with that, the pervious concrete eliminates surface runoff of storm water, facilitates the ground water recharge and makes the effective usage of available land. The main aim of our project is to improve the strength characteristics of pervious concrete. But it can be noted that with increase in strength, the permeability of pervious concrete will be reduced. Hence, the improvement of strength should not affect the permeability property because it is the property which serves its purpose.

Keywords- Pervious Concrete, Metakaolin, Silica Fume, Cement, Coarse Aggregate etc....

I. INTRODUCTION

Pervious concrete which is also known as the no-fines, porous, gap graded, and permeable concrete and Enhance porosity concrete have been found to be a reliable storm water management tool. By definition, Pervious concrete is a mixture of gravel or granite stone, cement, water, little to no sand (fine aggregate). When pervious concrete is used for paving, the open cell structures allow storm water to filter through the pavement and into the underlying soils. In other words, pervious concrete helps in protecting the surface of the pavement and its environment. It has a rough textured, and has a honeycombed surface. Pervious concrete pavement is a

unique effective means to address the important environmental issues which support green and sustainable growth.

Pervious concrete (also called porous concrete, permeable concrete, no fines concrete and porous pavement) 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 hereby reducing the runoff from a site and allowing groundwater recharge. Pervious concrete is made using large aggregate with little to no fine aggregates. The concrete paste then coats the aggregates and allows water to pass through the concrete slab. Pervious concrete is traditionally used in 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.

II. OBJECTIVES

- The main reason pervious concrete is not used for high-traffic pavements, such as highways, is surface levelling. The compressive strength of the nominal pervious concrete is around 20MPa. So this can't be installed for the heavy load traffic situations.
- The parking areas are generally limited to auto parking and occasional trucks.

III. LITERATURE REVIEW

The typical mix design of pervious concrete used in the United States consists of cement, single-sized coarse aggregate (i.e., between 25mm and 100mm), and water to cement ratio ranging from 0.27 to 0.43. The 28-day compressive strength of pervious concrete ranges from 5 to 20 MPa, with a void ratio ranging from 14% to 31% and a permeability ranging from 0.025 to 0.6 cm/sec.

- **Lianet al. (2010)** investigated that if small amounts of super plasticiser are added to the mixtures containing silica fume, both the permeability and the

compressive strength of the pervious concrete were improved.

- **Jain et al (2011)** investigated that the permeability of pervious concrete is depending upon W/C ratio and size of aggregate. Pervious concrete mix, prepared using smaller size of aggregates produced less permeability in comparison to the mix produced with larger size aggregate.
- **Cameyisi Eet al. (2014)** in the paper "Combined effect of steel fibre and metakaolin incorporation on mechanical properties of concrete" reports the results of an experimental study on mechanical properties of plain and metakaolin (MK) concretes with and without steel fibre. To develop the metakaolin included steel fibre reinforced concrete mixtures, Portland cement was partially replaced with metakaolin as 10% by weight of the total binder content.

IV. MATERIALS USED

Pervious concrete uses same materials as conventional concrete, except that there are usually No or little fine aggregates. The size of the coarse aggregate used is kept fairly uniform in size (most common is 3/8 inch) to minimize surface roughness and for a better aesthetic, however sizes can vary from ¼ incho to ½ inch. Water to cement ratio should be within 0.27 to 0.43.

Ordinary Portland cement and blended cements can be used in pervious concrete. Water reducing admixtures and retarders can be used in pervious concrete. We can also add admixtures to gain compressive strength.

- **Cement**-A cement is a binder, a chemical substance used for construction that sets, hardens, and adheres to other materials to bind them together. Cement is seldom used on its own, but rather to bind sand and gravel together.
- **Aggregates**-pervious concrete does not contain any fine aggregates. This concrete is produced by eliminating fine aggregates from plain concrete. Only cement, coarse aggregate, and water are used. The coarse aggregate particles are surrounded by a thin cement paste coating.
- **Water**-While any potable water can be used for mixing, the amount of water critical for the formation of the voids pervious concrete, Water-to-cement ratios can range from 0.36 to 0.45.
- **Silica fume**-It is a by-product of silicone production. It consists of superfine spherical particles which

significantly increase the strength and durability of concrete. Used frequently for high rise buildings, it produces concrete that exceeds 140MPa compressive strength. Silica fume can replace cement in quantities of 10-15%.



FIG.1: SILICA FUME

- **Metakaolin** - strengthens the matrix of pervious concrete thereby enhancing its mechanical properties. Optimum replacement of cement by metakaolin is observed as 15% for 12.5 mm and 20 mm sized aggregate mixes.



FIG.2: METAKAOLIN

V. COMPRESSION CHARACTERISTICS

- A total No of 16 cubes is casted with various mix proportions.
- Our cubes are tested two times in their entire period i.e., 7 days and 28 days.
- Addition of silica fume and metakaolin is done to improve the compressive strength of pervious concrete.

Proportions: -

- 4 cubes of conventional concrete with nominal mix proportion.
- 6 cubes to test for 7 days with 10%,20% and 30% of silica fume.
- 6 cubes to test for 28 days with 10% ,20%, and 30%of silica fume.
- In the same way 12 cubes with varying proportions of metakaolin are casted to test for compressive strength.



FIG. 3: PERVIOUS CONCRETE CUBES



FIG.3.1

Compressive Strength of Pervious Concrete by Adding Silica Fume

S. No	Nominal concrete +SF	7 Days KN/M ²	28 Days KN/M ²
1	Nominal concrete + 0%SF	6.57	19.86
2	Nominal concrete +10%SF	10.56	21.34
3	Nominal concrete +20%SF	11.26	22.56
4	Nominal concrete + 30%SF	12.78	22.9

Compressive Strength of Pervious Concrete by Adding Metakaolin

S. No	Nominal Concrete +MK	7 Days KN/M ²	28 Days KN/M ²
1	NOMINAL CONCRETE+10% MK	11.07	20.18
2	NOMINAL CONCRETE+20% MK	11.58	21.50
3	NOMINAL CONCRETE+30% MK	11.80	22.32

VI. CONCLUSION

- The size of coarse aggregates, water to cement ratio and aggregate to cement ratio plays a crucial role in strength of pervious concrete.
- The void ratio and unit weight are two important parameters of pervious concrete in the context of mix design.
- The compressive strength and co-efficient of permeability of pervious concrete are inversely proportional to each other up to addition of 8% of fines.
- Among the two methods of increasing compressive strength of pervious concrete, the addition of fines has given more value when compared to replacement of cementitious materials.
- The compressive strength of pervious concrete is increased by 4.36% when 10% of silica fume is added to the standard pervious concrete.
- The compressive strength of pervious concrete is increased by 6.69% when 20% of silica fume is added to the standard pervious concrete.
- The compressive strength of pervious concrete is increased by 12.96% when 30% of silica fume is added to the standard pervious concrete.
- The compressive strength of pervious concrete was increased gradually at all ages when increasing the rate of metakaolin content.
- The compressive strength of pervious concrete was increased gradually by 4% with 10% increasing the rate of metakaolin content.
- The compressive strength of pervious concrete was increased gradually by 6% with 20% increasing the rate of metakaolin content.

- The compressive strength of pervious concrete was increased gradually by 8% with 30% increasing the rate of metakaolin content.

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