IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

# Permeable pavement in the construction of road by using concrete grid pavers

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Received: Accepted:

**ABSTRACT** - *The purpose of this document is to summarize the literature on perverse sidewalks, highlight current trends in research and industry and recommend future areas of research and development. Permeable pavement with a base and sub-base that allow rainwater to move across the surface. The goal is to control rainwater at the source, reduce runoff, reduce costs and improve water quality by filtering contaminants in the substrate layers and increasing the level of groundwater, thus a way to collect rainwater . As we know in Kanpur, fly ash is generated in large quantities in thermal power plants. The removal of fly ash also represents a serious socio-economic problem. Therefore, the use of fly ash up to 10-30% in place of cement can overcome this problem. The use of fly ash will reduce construction costs and also solve the problem of disposal. Porous flooring is a unique and effective means of meeting growing environmental needs. By capturing rainwater and allowing it to penetrate the ground, this flooring technology creates more efficient use of the soil by eliminating the need for retention ponds, surfboards and other expensive rainwater management devices.*

Keywords: - ***Permeable pavement, Sustainable material, Storm water, Filters pollutants, Environmental benefits, Cost, fly ash, replacement***

## INTRODUCTION

Waterproof surfaces were mainly used to reduce the integrity of river basins in urban and urbanized areas. These surfaces are mainly used to serve vehicles, but a maximum part of these surfaces, in particular driveways, parking lots and rigid shoulders, has a minimum traffic load. The car parks are sized to adapt to the maximum use of traffic, which happens only occasionally, so most of the area remains unused for most of the time. The large impermeable surfaces lead to higher maximum current flows which cause the erosion of the banks, a greater transport of sediments, a reduced infiltration which reduces the recharge of groundwater and decreases the flow of basic current. Runoff from waterproof surfaces also increases the amount of contaminants in the surface flow. Pervasive flooring is the best solution to the problem of increasing the outflow of rainwater and reducing the quality of the water in the stream. Perverse sidewalks are alternative pavement surfaces that temporarily capture and store rainwater by filtering runoff through the spaces in the pavement surface in a stone tank below. The filtered runoff can be collected and returned to the transport system or it can partially infiltrate the soil. This system is not used much in India. Pervasive flooring systems are designed to obtain water quality and quantitative advantages by allowing rainwater to move across the surface of the flooring and into a base / sub-base tank. Water goes through gaps in flooring materials and provides structural support like conventional flooring. That's why perished sidewalks can serve as an alternative to conventional parking and streets. These sidewalks have the ability to reduce urban runoff and trap pollutants. It also provides opportunities to reduce the impacts of urbanization on water reception systems by providing treatment at the source.

## 2. PERMEABLE PAVEMENT SYSTEMS

### 2.1 Applications

The perverse flooring systems are suitable for a wide range of applications such as commercial, residential, industrial, but for light uses and for less use, even if these systems can be used for a much wider range of use. In areas where groundwater contaminants can be mitigated, a permeable floor must be built and infiltrated water must be drained into an adequate drainage system. The general applications of perverse flooring systems are as follows:

- For residential roads, roadsides, access and service roads.
- parking areas
- Cycle tracks, jogging tracks
- Erosion control and slope stabilization.
- Irrigation of lands
- Golf cart and parking.
- Tennis court

### 2.2 Types of Permeable Pavements

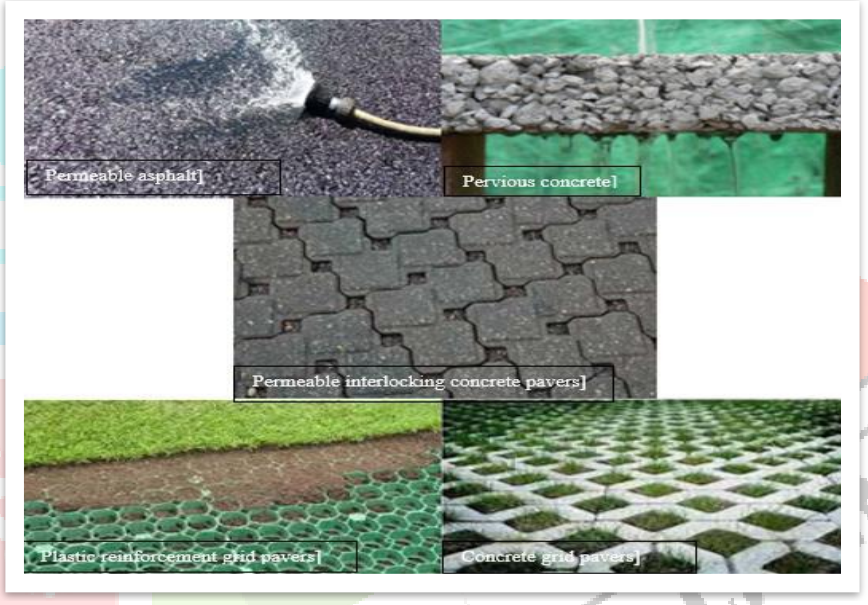



**Fig - 1 Types of permeable pavement.**

Many types of perverse flooring are available. Pervious cement is more common today, but porous asphalt, interlocking concrete flooring, concrete grid flooring and reinforced plastic grid filled with gravel or grass are also available. There are other types and variations, but these are the most popular and versatile designs. The type of flooring itself generally refers only to the surface layer of a structure consisting of several layers. To avoid obstructions, use only clean, washed stones that meet municipal road standards.

Depending on your design needs, you can add perforated pipes near the top of the stone tank to drain excess storm water from important events. Furthermore, instead of allowing rainwater to infiltrate the underlying soil or where the permeability of the underlying soil is not optimal, it is possible to install perforations under the drain pipes to direct the water to an outlet installation structure. It is recommended to install an observation well at the end of the descending gradient of the previous pavement to monitor performance.

#### 2.2.1 Porous asphalt: -

Porous asphalt is a mixture of fine aggregate and coarse standard asphalt bonded by a bituminous binder, except that it uses a less fine aggregate than conventional asphalt. The empty space in the porous asphalt is similar to 15-35 percent of perverse concrete. The surface appearance of porous asphalt is similar to that of conventional asphalt, although porous asphalt has a rougher texture. The surface layer of asphalt is generally thinner than a

Comparable pervious concrete installation. While the compressive strength of perverse concrete is generally lower than that of conventional concrete, the compressive strength of porous asphalt is comparable to that of conventional asphalt. Porous asphalt can be used for

perambulator applications such as greenways and low down volume, low speed vehicular traffic applications such as parking lots, on-road parking lanes and residential or side streets.

**2.2.2 Perverse concrete: -**

Pervious concrete is a mixture of Portland cement, rough aggregate or gravel and water. Unlike conventional concrete, perverse concrete contains an empty content of 15 to 35 percent (on average 20 percent) which is obtained by removing finer particles such as sand from the concrete mix. This empty space allows water to infiltrate the underlying soil instead of accumulating on the surface or discharging as runoff. Sidewalks and car parks are ideal applications for perverse concrete. The structural strong point of perverse concrete, although usually lower than ordinary concrete mix designs, can easily withstand the relatively light loads generated by bicycle and pedestrian traffic. The loads placed on perverse concrete in car parks can be much more substantial and require consideration in choosing the concrete mix and the thickness of the flooring. Although the structural strength of porous concrete can be increased by adding large quantities of cement, porosity will decrease, thereby reducing infiltration rates.

**2.2.3 Paving stones: -**

Concrete Pervious Pavers (PICP) and Clay Brick Pavers (PICBP) and Concrete Pavers (CGP) are similar in installation and operation, but are made of different materials. PICPs are solid concrete blocks that come together to form a pattern. These spaces typically represent 5 to 15 percent of the surface. PICBP is the same as PICP, except that the material is brick rather than concrete. With CGPs, lattice-style configurations for CGPs create large openings or openings. These openings, which can represent 20 to 50 percent of the surface, generally contain soil or grass, although small aggregates can be used. While CGPs have larger openings than PICPs and PICBPs, they are not designed for use with a stone tank, but can be placed directly on the ground or in an aggregate base. As such, the infiltration rate of PICP and PICBP is much higher than that of CGP.

**2.3 Need Of Permeable Pavement**

- To resolve traffic jam problems in highly urbanized areas due to trouble of irrigate logging.
- To decrease the inequality in natural bionetwork.
- Wirth permeable paving method, we can congregate the rainwater/ Storm water by this arrangement and store to ground water table or by constructing a tank.
- Permeable pavement can trim down the attention of some pollutants either physically (by trapping it in pavement or soil), chemically (bacteria and other micro-organisms can go down and consume some pollutants), or biologically (plants that raise in some types of pavements).

**2.4 Life Span**

The time span of porous pavement is mainly depends upon the size of air voids in the media. Due to more voids, there is more opportunity of oxidation, so durability is less. It can be predictable that the life span of permeable pavement is shorter than the impermeable pavements due to oxidation, consequent strip, deterioration by runoff and air permeation.

**2.4 Need for research**

Ordinary Portland cement (OPC) is one of the main ingredients used for the production of concrete, since there is no alternative in the civil construction sector. Unfortunately, cement production involves the release of large quantities of carbon dioxide into the atmosphere, an important contribution to the greenhouse effect and global warming. Therefore, it is inevitable to look for another material or partially replace it with another material. The search for this material, which can be used as an alternative or as a supplement to cement, should lead to global sustainable development and the least possible environmental impact. Various studies are underway in India and abroad to study the impact of using these pozzolanic materials as a substitute for cement.

**3. EXPERIMENTAL WORK**

The materials chosen for the experiment are ordinary Portland cement (OPC), fly ash, coarse aggregate, water. The properties of the materials and the results obtained from the various tests carried out on the materials used for the partial replacement of cement in perverse concrete. To achieve the objective of this study, experimental program was designed to study the effect of fly ash, such as partial cement replacements, on the compressive strength, tensile strength and permeability of concrete.

Various tests have been performed to find out the physical and chemical properties of common Portland cement and the test result is shown in Table 1.

**Table 1 Properties of cement**

| Test | Result |
|---|---|
| **Fineness test** | 7% |
| **Consistency test** | 34% |
| **Setting time test**<br><br>**1.Initial setting time**<br><br>**2.Final setting time** | <br><br>35 minutes<br><br>11.5 hour |
| **Soundness test** | 1 mm |
| **Specific Gravity** | 3.15 |

Fine aggregate substance is some degree of in pervious concrete, and coarse aggregate is kept to a thin gradation. A narrow grading is the significant characteristic. Larger aggregates provide a rougher surface. Recent uses for pervious concrete have paying attention on parking lots, low-traffic pavements, and pedestrian walkways. For these applications, the smallest-sized aggregate realistic is used for aesthetic reasons. The aggregates which are retained larger than IS sieve 4.75mm are known as coarse aggregate. The test results on coarse aggregates is given in table 2.

**Table 2 Properties of aggregate**

| Test | Result |
|---|---|
| **Impact value of aggregate** | 18.29% |
| **Crushing Value of Aggregate** | 21.87% |
| **Abrasion value of natural aggregate** | 23.6% |
| **Specific gravity of coarse aggregate** | 2.86 |

The potable water is generally considered suitable for mixing and curing of concrete. Accordingly drinkable water was used for making concrete accessible in material testing laboratory.

Fly ash is the waste derivative of burning coal in electrical power plants; it used to be landfilled, but now a major amount is used in cement. This material can be used to substitute 5-45% of the Portland cement. Fly ash used in the study was sourced from **Panki Kanpur (Uttar Pradesh).**

## 4. MIXING AND DESIGNING

pervious concrete contains the same essential ingredients as the more ordinary conventional concrete (ie. aggregate, Portland cement, water, and a variety of admixtures), the ratio of ingredients is quite different. One most important difference is the requirement of improved void space within the pervious concrete. With low water to cement ratio, the require for void space inside the mix design, and little to no fine aggregates, the conventional design of concrete needs to be adjusted accordingly. Ranges of materials commonly related with pervious concrete are listed below. These ranges are base on previous researches.

**Table 3 Mixing details**

| Material | Proportional range | Selection Proportion |
|---|---|---|
| Fly ash | 5-20% | 5-10% |
| Coarse aggregate Single size(10to 8mm) | 1190 to 1480 kg/m3 | 1190 kg/m3 |
| w/c ratio | 0.27 to 0.34 (without admixture) | 0.34 |
| Aggregate : cement ratio | 4 to 4.2 : 1 | 3.9 : 1 |

### 4.1 Procedure

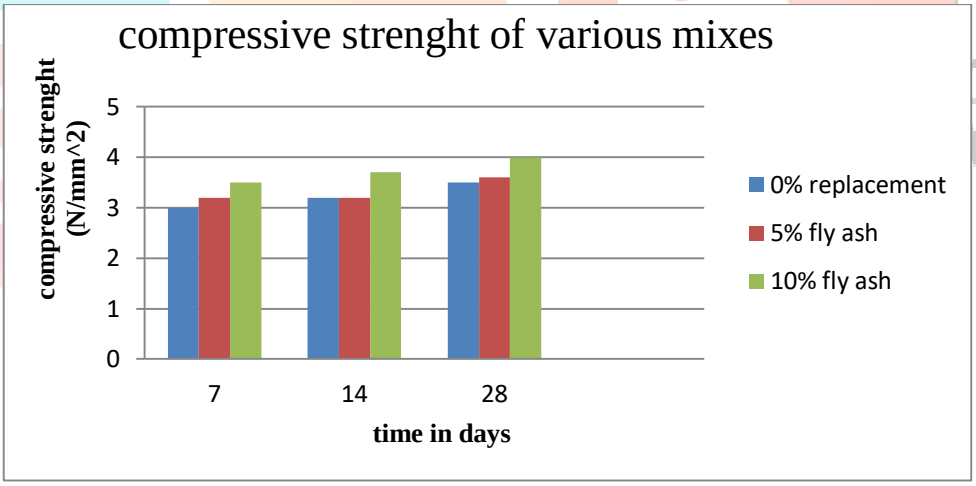
Here are some steps to fallow and complete this project in experimental method and find out the tensile strength, compressive strength, porosity and permeability. To study for all test the cubes of 150mm ×150mm ×150 mm are casted for a variety of mixes. And the compositions are as follows:

1. Cement + Coarse aggregates + water ( No substitution)
2. Cement + Coarse aggregates + water + fly Ash (5% substitution)
3. Cement + Coarse aggregates + water + fly ash (10% substitution)

Six cubes are casted for each composition. The quantity of cement, coarse aggregate, fly ash and water for every batch replacement are weighed separately. The cement and fly ash are mixed dry to a even colour separately.

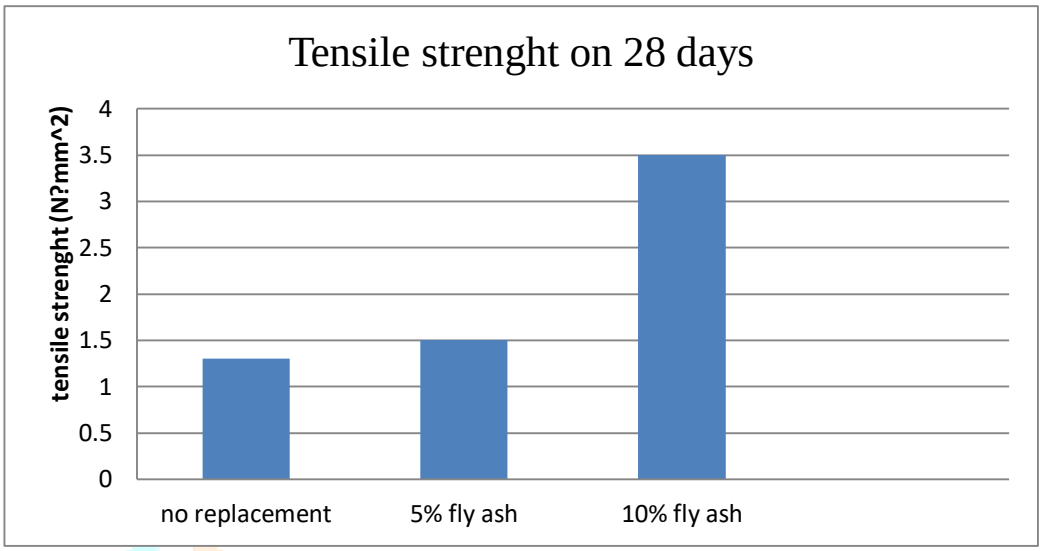
## 5.RESULT AND ANALYSIS

The result on compressive strength, tensile strength and permeability of pervious concrete, due to partial substitution of cement with fly ash and ground granulated blast furnace slag in the concrete mix is discuss. Tests are performed at 7 days, 14 days and 28 days of curing of concrete. No super-plasticizer is used in all the mixes.



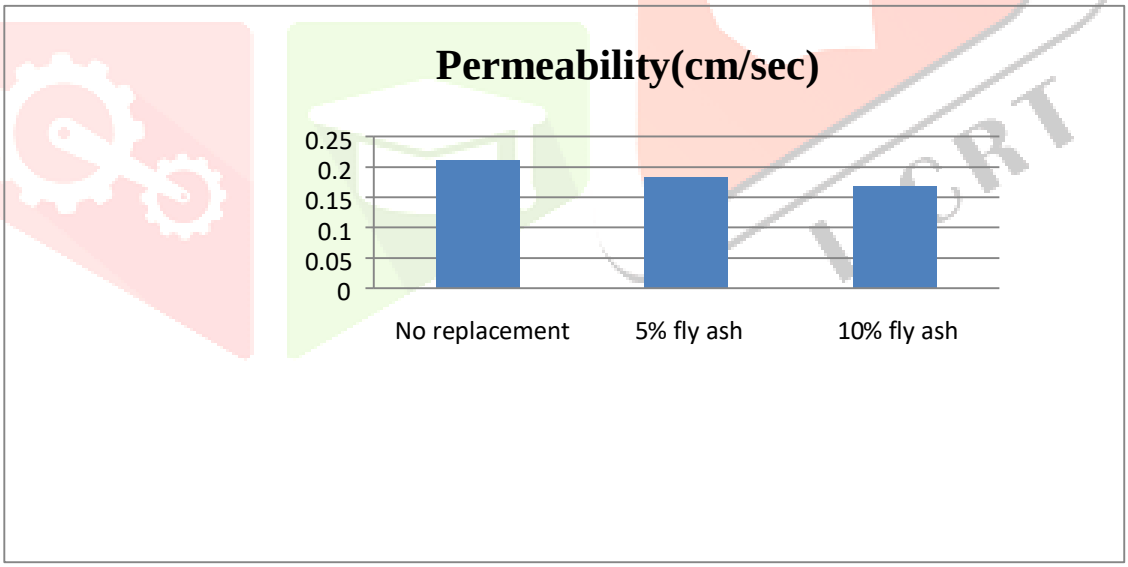

**Graph 1- Plot of compressive test result**

- **Comparison of tensile strenght on 28 days :-**



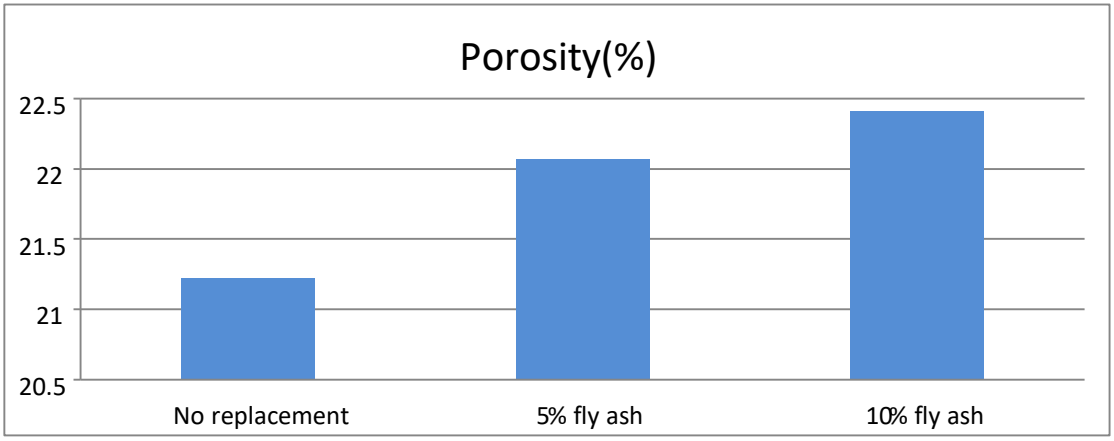

**Graph 2- Plot of tensile strenght test result**

- **Permeability result :-**




**Graph 3- Plot of permeability test result**

# Porosity result :-




**Graph 4:- plot of porosity**

## 6. CONCLUSION

This project attempts to evaluate the compressive strength of the fly ash cement concrete. M30 concrete mixes are designed according to the Indian standard code (IS-10262-2009). The concrete cubes of dimensions 150 X 150 X 150 mm are melted and tested for compressive strength at 7 days, 14 days and 28 days for all the mixtures and comparing the result of the cubes containing fly ash and pure concrete.

Based on tests and results, the replacement of cement with 10% fly ash shows maximum compressive strength and high water permeability. Based on the results, the ratios between porosity and compressive strength, porosity and permeability and tensile strength are established for permeable concrete in the porosity range of 5 to 10 percent. Increasing the% fly ash increases both compressive and tensile strength. And the water absorption increases with the increase of the percentage of fly ash. Finally, as the replacement of the cement increases, the workability of the concrete gradually decreases. Therefore, partial replacement of fly ash is advantageous both from an economic and environmental point of view.

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