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# Review of Pervious Concrete as a Drain Cover Slab

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***Abstract:*** *In recent decades, the pervious concrete is widely used in the construction industry as pavement materials, stormwater management, permeable surface requirement areas, pedestrians, parking lots & many more etc. The main purpose of this review paper is to find further scope for pervious concrete as a drain cover slab. This paper is reviewed on findings, developments, future scope, research gaps on pervious concrete material in various aspects. Then pervious concrete is reviewed on materials, properties, lifecycle cost have been discussed and enlisted. The pervious concrete prospect and their potential are highlighted for further research work are outlined.*
***Keywords:*** *pervious concrete, pervious slab, porous concrete, stormwater management.*

## I. Introduction

Pervious concrete is a combined mix of cement, coarse aggregate, water and admixture for bonding. Pervious concrete creates a very porous medium that allows water to drain to the underlying surface. Pervious concrete is an eco-friendly pavement is also known as a little or no fine aggregate. Being a void contained pavement, pervious concrete does not give more strength, so it is used in parking areas, footpaths, internal roads joining one or two buildings or campus roads.

This pervious surface replaces conventional pavement, by allowing stormwater to infiltrate directly, permitting a naturally occurring form of water treatment. pervious concrete has a more percentage of void space 15%-30% which can infiltrate storm water from any significant storm event. pervious concrete is also introduced as a sustainable practice because it can reduce the runoff to the drainage system and can increase the recharge to the groundwater as well. One drawback though for the porous concrete is the lack of structural strength and very less compressive strength. careful mix design and construction have to be special care to achieve the required strength needed.

## II. pervious concrete

Pervious concrete is a special type of concrete with high void & porosity which highly used for flatwork concrete placement that allows water to pass through the surface. The pervious concrete is based on the composition and combination of materials, admixture and standard mix, installing procedures.

### 2.1. Cementitious material

Normally the pervious concrete is produced using the OPC grade 1 Ordinary Portland Cement as a binding material. The improvement of binding materials are studied using various materials, here the fly ash with high calcium is used as geopolymer binder to study properties of pervious concrete with a combination of lignite fly ash and coarse aggregate with ratio 1:8 the results showed the increase in compressive strength[1].
The latex polymer is used with sand, fiber to evaluate the effect of polymer modification on physical and mechanical properties. The result showed using at acceptable permeable ness and mix[5]. Silica fumes are used in partial replacement of cement in various percentage to study strength properties. The compressive strength increased with 10-15% of replacement [3]. Pervious concrete with various cement content is studied with uniform graded coarse aggregate sizes 19.5mm-4.75 with w/c ratio of 0.34, permeability test, the compressive test showed the increase in cement content high compressive strength with less permeability [20]. Fly ash & silica fume are used in partial replacement in cement various percentage 10%,20%,30% showed the resulting increase in compression, flexural strength for 30% [17].

### 2.2. Aggregate

In the pervious concrete, the aggregate is the major material, the selection of aggregate based on type, size, shape results in high strength or low strength. The effect of aggregate grading and ground limestone is used in different

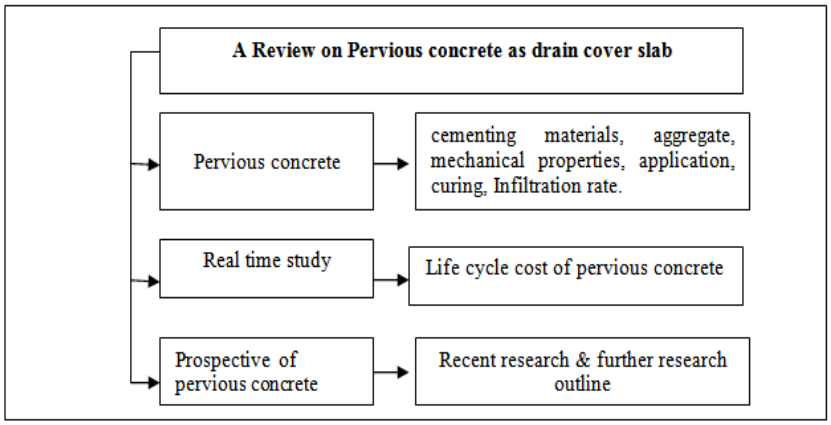


**Fig.** 1.Research review outline

mix ratio with w/c 0.28-0.35, total 22 samples are studied, The high compressive strength obtained 10% sand,11-16mm aggregate size, high permeability of 2.19cm/s is obtained for single graded 8-16mm aggregate in pervious concrete[14]. The different shape aggregate is selected in a laboratory as an angular number with different mixes, different ratio of water content are tested, results showed an increase in w/c ratio can accumulate the concrete in bottom surface making impervious [1]. Fine aggregate and cement to coarse aggregate ratio is studied based on addition fine aggregate 5% -10 %, results showed an increase in compression, flexural strength. Further addition of fine aggregate decreased in strength[13].

**2.3. Mechanical Properties**

The pervious concrete has very less compressive strength due to high void content compared to conventional concrete. so, the studies carried on the improvement of properties of pervious concrete in various aspects. The pervious concrete is made with partial replacement with rice husk ash in cement, fibers like glass, steel, polyphenylene sulfide are added to volume fraction with different w/c ratio, the results showed the good tensile strength for steel, glass. The compressive strength & porosity test showed high in the glass, steel fiber with w/c ratio 0.33 [26]. The pervious concrete is made with supplementary cementitious material & polymer modified the material, results indicate the increased strength of pervious concrete can be achieved using admixture, superplasticizer for supplementary cementitious material. flexural strength is very sensitive to porosity[28]. To study the properties of hardened concrete based on flexural, compression, split tensile strength for the mix ratio is prepared 1:6, 1: 8, 1:10 with different size of gravel 18.75 mm, 9.375 mm. test results indicate the smaller size aggregate had a more compressive strength, flexural strength with 1:6 mix proportion for OPC 53 cement [9]. The evaluation of strength for pervious concrete on the addition of polypropylene fiber in different proportions. The samples are cast to cube & cylinder, beam. Results showed the 0.6% of fiber increase in compressive strength, flexural strength. permeability reduced in increased fiber percentage but on limited permeability[7].

**2.4. Application**

The pervious concrete is a special type of concrete which requires different installation procedure, cares to produce good porous concrete in real time. These pervious concrete has been facing drawbacks in the implementing, effects due to natural climatic conditions. The pervious concrete pavements are composed of a base & surface layer, these studies on water-infiltration, resistance to abrasion, and freezing & thawing durability of the materials are also found to be very good. results showed difficultness to produce high strength material by using common material, proportion. usage of polymer, the smaller sized aggregate can give strength but permeability reduces in polymer filling [12]. The pervious concrete is evaluated based on comparing laboratory and field produced mixtures. The test is carried on permeability, air voids, compressive and split tensile strengths, as well as Cantabro and freeze-thaw durability tests. mixes were used with limestone, granite and latex paint, air-entraining admixture, water reducers. a comparison study on field mix and laboratory mix shows latex, limestone shows lower porosity but high strength in abrasion resistance, these both mixtures could meet the permeability, strength, and durability in the field [27]. The pavement application of pervious concrete with fine aggregate addition and coarse aggregate range 4.75-19.5mm with w/c ratio 0.34, mix 1:4.75. Results showed the permeability of concrete, increase in compressive strength, flexural strength and split tensile strength, further addition of fine aggregate result in void volume reduction [20].

**2.5. Curing**

The curing is a major time period for the concrete to achieve the specified strength. These curing process will provide the moisture content for hydration of cement.

The pervious concrete is cured with a special technique due to the void percentage. The best curing of pervious concrete is studied by internal curing method by the superabsorbent polymer (SAP), compared with the no superabsorbent polymer curing. Test are done for field pervious concrete which is covered with a plastic cover and controlled curing with SAP results showed the mixture of Superabsorbent Polymer as low shrinkage, moisture loss, and abrasion. The uncured Superabsorbent Polymer field mixture had performance equal to the control cured mixture under plastic. hence SAP has good potential to reduce curing requirements for pervious concrete under many environmental conditions [16]. Pervious concrete is cured internally by using lightweight aggregate, these study showed the pre-wetted condition of aggregate in concrete. results showed replacing the little portion of sand within a pervious mixture & mixture with pre-wetted lightweight fine aggregate. similar moisture loss. The available moisture content within the samples provided internal curing with high hydration for all of the mixture sample. Nearly 10% increase in hydration percentage was noted at 90 days. All the mixtures containing pre-wetted fine aggregate showed high strength at 28 days than the control mixture at 28 days. The mixtures cured internally showed a compressive strength increase between 7 and 28 days where little strength occurred for the control mix [15]. The effect of super absorbant polymer in concrete. This SAP is added in different proportions from 0.15% to 0.6%, the mix is used here is M30 and these samples are cast to cubes. They were tested on the compressive strength for 7,14,28 days & flexural strength is tested for 28 days. The results show that 0.3% without curing of the super absorbant polymer is higher in compressive strength and the flexural strength. Then Split tensile strength test shows an increase in the percentage of SAP from 0.15 % to 0.30 %. With 0.30 % SAP the increase in strength for 28 days. UPV test is carried out and it found that all % of SAP had a good quality concrete with less permeability and less honeycomb structure [4].

**2.6. Infiltration**

The infiltration is the importance of pervious concrete or permeable concrete. The infiltration rate of pervious concrete is the main parameter to select the efficient mix proportion for making porous concrete. The study related to pervious concrete as water purification properties. here two sizes of coarse aggregate used 5-10mm & 10-20mm with absolute volume ratio paste are used. results showed the smaller aggregate & smaller paste aggregate ratio compressive strength is increased. For purification, the consumption of dissolved oxygen, removal of phosphorus, total nitrogen is examined. results showed high void and industrial by-product can purify water effectively [15]. The study on surface infiltration rate of pervious pavement is done with digital imaging. Here the samples are taken in the grayscale image and analyzed for the parameters. The analysis showed the measured surface infiltration in both pavements were proportional to the inverse of the mean of the distribution done by ASTM falling head method.

**2.7. Real-time study**

The real-time studies will help to find the importance of pervious concrete, real-time problems facing by urbanized areas. The study on the impact of urbanization on stormwater runoff in urban areas. These study showed the storm hydrographs of the degree of the area serviced under storm drainage. The impervious areas showed deviation in hydrograph. results state the peri-urban catchment showed a high impervious cover from 11% to 44% in the 2010s, and a large-scale storm drainage system is accompanied by a 50% reduction characteristic flood duration by over50% while increasing peak flow by over 400%. the increased peak flows and reduces in flood duration and catchment response time is high at low levels. This study shows clearly considering when using hydrological models with impervious cover data and while designing flood mitigation measures [10]. In situ performance of pervious concrete in British Columbia have monitor the capacity of embedded perforated pipes used in pervious layers. These techniques are measured for strength parameters, results showed a lack in a compression test, raveling of concrete. Percolation capacity of the pavement was monitored, some parts of the pavement have reduced percolation capacity due to clogging, the overall capacity of the pavement and its effectiveness in capturing surface runoff remains high compared to impervious area [28]. The concrete & asphalt pavements in India are evaluated on rainwater in the parking area, streets. This study shows the water logging and runoff source to rivers. here to overcome the problem pervious concrete with partial replacement of fly ash and slag in cementations material. Further monitoring showed the permeability of water. These mixes are tested, results showed a change in pervious concrete properties is found due to the size of aggregates used and assessed [9]. To manage the stormwater run-off in urban areas using pervious concrete are studied. based on the high infiltration of water through pervious layer, so rainfall is collected. The areas with pervious layer eliminate the precipitation runoff containment strategies. This the study determines the advantages of using the material to increase storm-water collection, to reduce flooding and improve water filtration by using pervious concrete in the parking area at the University of Jordan campus. The research studies

showed of the research support that storm-water management using Pervious surfaces is a sustainable and good environmental way of water-storming[7].

**2.8. Need for study**

A large quantity of rainwater falling on impervious land surfaces such as parking areas, sidewalks, drive area and streets rather than into the drain or soil. This creates an impact on the natural system and leading to the origin of problems related to soil erosion, flooding, groundwater level depletion. The solution to avoid these future problems by reducing the construct of impervious surfaces that block water infiltration into the soil or drain.

## III. Life cycle cost of pervious concrete

The pervious concrete is widely used for the pavement of roads in lower volume. Pavement industry has large scope for future research to better understand the material, which will make it material for sustainable future roads [21]. The pervious concrete is analyzed based on cost including the actual cost for permeable pavements. The study is compared with the cost of conventional pavement. Results show the same initial cost, less cost for pervious concrete which does not require any storm water drain system [20]. The pavements with the permeable road surface are installed to reduce the impact of sound traffic. These permeable pavements have a short life duration compared to conventional pavements, cause maintenance, environmental impact & economic loss. This study conducts to replace the normal cement based binder used in the pervious pavement by synthetic material as a binder to increase the life duration of the pavement. The overall final value of the investment was analyzed resulting in the same cost as normal conventional pavement than the permeable pavement produced with the synthetic material as a binder. Synthetic materials lifespan is ten times greater, which brings positive impact on the environment and high economic benefits for the urban area drainage system in the Holland country [24]. The study on pervious pavement based on filtration character. They are examined based on three types full, partial, no filtration type pavements were compared for benefits and cost [22].
Considering the literature, very limited research work done on cost analysis of pervious concrete. Further, that literature showed that pervious concrete is high initial cost than conventional concrete due to the skilled construction & lack of durability performance data. The environmental benefits by pervious concrete based on the quality of runoff reduction, natural filtration, groundwater recharge, land utilization. Additionally, most of the studies are considered only in the field of stormwater runoff mitigation benefits.

## IV. Prospective of pervious concrete applications

pervious concrete or porous concrete is the alternate material for replacing conventional concrete based on the permeability benefits. They are used widely in recent years for stormwater management. The scope of future research to be done on the pervious concrete are

**Standard Design mix and proportion:** In the present situation, no standard mix design and proportions are available. The research finding with different material compositions, with different criteria, are obtained. These are not applied in large scale application due to lack of results.

**Design steps and standard implementation:** There is a large research development to be done on the preparation of pervious concrete to obtain the required pervious concrete benefits. These research can highly benefit the study of pervious concrete material in different aspect and their applications.

**Maintenance and Durability performance**: porous concrete is used in recent years only. so, the problems like clogging the pores & regular periodic maintenance are carried out. These help to find the effective maintenance method and duration based on the long term. Then these study can be monitored on the long term durability and behavior of concrete.

**Modeling:** The pervious concrete is studied based on models in lab conditions which lack in relation to real field application. so, the pervious concrete is studied based on the real situation and developed modeling technique. The test methods are improved to obtain the field related result in lab conditions.
**Life cycle cost**: The actual cost and periodic maintenance cost for pervious concrete need to be a monitor for long term durability, so these results show the benefit and recommendation for the application.

## V. Recent research

The author and college student went on the development of pervious concrete as pervious tile specimens.

The pervious concrete mix proportions samples are prepared based on the mix 1:4 and aggregate size 9.5mm-12.5mm. The admixture is used for the production of good concrete.

The sample is made with the dimension of 195mm x 115mm x 55mm-**fig[2]**. with a combination of geo-textile fiber mesh, steel mesh-**fig [3].** The samples are tested for the compressive test for 7days,14days,28days. The infiltration rate is also tested for 28days of specimens. These comparative study helped to know the pervious concrete behavior of a pervious tile and merits & demerits. Future scope of work is identified based on the results.

**Fig. 2**.sample size

**Fig. 3.**sample with the combination of fibers

## VI. Conclusion

The wide range use of pervious concrete in recent decades as road pavements, parking lots etc. all over the world has attracted the researchers to do research on the study of pervious concrete in different aspects and different scenarios.

This review paper has enlisted the research work carried on pervious concrete in recent decades and their findings, future scopes. The main objective of the review paper is to find the pervious concrete benefits, properties, finding research gap. These studies can help to develop or provide a solution for major problems in pervious concrete. These lead to learning the properties of pervious concrete as pavement material, design aspect and right implementation for an efficient outcome.

Overall, the past & recent studies showed the importance of pervious concrete in stormwater management, ground recharge, filtration requirements. But this pervious concrete is used in low volume areas due to strength. So, I conclude the possible suggestion of replacing the conventional drain cover slab along the stormwater drains or the open runoff drains to fulfill by the pervious concrete drain cover slab.

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