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# Making Green Porous Concrete for Rain Water Harvesting and Urban Pavements

**Anurag Prabhakar Rangankar[1], Dr. S. G. Makarande[2], Prof. R. S. Kedar[3]**

PG Scholar, Department of Civil Engineering[1]

Professor, Department of Civil Engineering[2]

Associate Professor, Department of Civil Engineering[3]

Bapurao Deshmukh College of Engineering, Sevagram, Wardha, Maharashtra, India

**Abstract:** *Flooding is seen to be a common phenomenon due to urbanization and improper water drainage. Now a day's impervious concert is mainly used for making pavements and courtyards which does not allow rain water to drain and percolate under the ground. Due to improper drainage systems cities like Mumbai gets easily flooded with even less rainfall. Moreover, thermal radiation is emitted by these concrete blocks and create heat enhancing to rise in the global climatic temperature. So, if the material used is pervious in nature, the water will pass through the surface enhancing rain water harvesting and will recharge groundwater. Using impervious material leads to health hazards and leading to serious environmental damage. As a solution to the problem is to make pervious concrete pavement block with a green cover on the top from locally available materials. The more void space in this pavement blocks will allow water to percolate freely into the ground and allow grass to be cultured and grown on top of this pavement block which will lead to eco-friendly environment.*

**Keywords:** Pervious concrete, Ground water, Urban pavements, Water absorption, Porosity, Eco-Friendly.

## I. Introduction

Porous concrete pavement is an effective way to address serious environmental problems and support green, sustainable growth. By collecting stormwater and allowing it to seep into the ground, porous concrete is crucial in recharging groundwater, reducing stormwater runoff. In fact, the use of pervious concrete is among the Best Management Practices (BMPs) recommended by the EPA. This pavement technology uses land by most efficient way by removing the need for ponds and other stormwater management resources. Pervious concrete has the ability to lower overall cost if project. In porous concrete, carefully controlled amounts of water and cementitious materials are used to create a paste that forms a thick coating around aggregate particles. The pervious concrete mixture contains little or no sand, creating void content. Using sufficient paste to coat and bind the aggregate particles together creates a system of highly permeable, interconnected voids that drains quickly. Both the low mortar content and high porosity also reduce strength compared to conventional concrete mixtures, but sufficient strength for many applications is achieved. Pervious concrete is used in many applications but its primarily used for making pavement.

## II. Objectives

- The main objective of this investigation is to develop a strong pervious cement concrete. Comparison between strength of convention as well as porous concrete.
- Evaluation of aggregate suitabile for preparing porous pavement blocks.

## III. Literature Review

**Darshna shah, Prof. Jayeshkumar Pitroda and Prof. J. J. Bhavsar published a research paper „Pervious Concrete: New Era for Rural Road Pavement" in 2013.**

Object of the study was to gauge the cost effectiveness of the pervious concrete compared to normal concrete. During the study, Normal concrete was used as per IS design of M20 grade, which was constituted by 59.25 kg of cement (300rs/50kg), 88.88 kg of Fine aggregate (600rs/1 ton) and 177.8 kg of course aggregate (1000rs/1ton). Pervious concrete was used as per

NRMCA guideline, which was constituted by 46.5 kg of cement (300rs/50kg) and course concrete (1000rs/1ton). They conclude that the pervious concrete reduces the storm water runoff to improve the ground water level to eliminate the costly storm water management practices. And there is considerable saving in amount about 29rs/m3 or 18rs/ft2.

**Husain N Hamdulay, Roshni J John and D R Suroshe published an experiment in 2015 named „Effect of Aggregate Grading and Cementitious by Product on Performance of Pervious Concrete‟.**

Object of the study was to exchange the cement with industrial by-product like fly ash, GGBFS which are used successfully as supplementary Cementous material. In this study, cement of 53 grade (specific gravity 3.15), coarse aggregate (passed through 20 mm and retained on 10 mm sieve), GGBFS (specific gravity 2.88), fly ash and water are used. Now maintaining the W/C ration constant, following mix proportions are used. FA are utilised in 85:15 and 65:35 proportions and GGBFS are utilised in 75:25 and 50:50 proportion. They concluded that the compressive strength of concrete was increased by using GGBFS as supplementary material and grading of aggregate is equally important to provide strength and permeability, grater size have law compressive strength and high permeability vice versa.

**Sukamal Kanta Ghosh, Ananya Chaudhury, Rohan data and D.K.Bera published a review paper named „A Review of Performance of Pervious Concrete Using Waste Material‟ from KIT University from Odisha.**

This review paper illustrates the performance of pervious concrete with solid waste like fly ash, furnace slag, and rice husk ash, silica fume, and solid waste (glass powder, ceramic waste, bottom ash) and its effect on compressive strength and permeability. Fly ash (2-50%), RHA (10-30%), GGBFS (35-70), Silica fume (8-12%), Rubber waste, Glass powder (20-40%) are used replacement of cement. They conclude that the compressive strength and permeability with using waste material are as follows. Fly ash gives long term compressive strength when increase portion then compressive strength decrease. Rice husk ash gives more then 10-12% decrease compressive strength, permeability, and durability. GGBFS gives higher strength but law permeability. Silica fume increases compressive strength but no influence in permeability. Glass powder increases strength durability and workability. Ceramic powder improves durability.

**Alessandra Bonicelli, Filippo Giustozzi, Maurizio Crisino published experimental study named „Experimental Study on Effect of Fine Sand Addition on Differentially Compacted Pervious Concrete‟.**

The main goal of the experiment is to judge the effect on mixture properties caused by the addition of small percentage of sand depends on w/c ratio. The three reference mixes had the identical aggregate distribution curve but different w/c ratios namely, 0.27, 0.30 and 0.35. Three sand mixes were proportioned to possess 5% of the aggregate substituted with fine sand and the latter three sand mixes so that 10% of aggregates was replaced by the fine sand. Two types of sand were used: type 1 (0.25-0.35mm) and type 2 (0.3mm). This experiment shows that addition of sand in pervious concrete favours in improving admissible stress and tensile strength but drain ability was reduced. The effectiveness of sand addition also depends on the water content of the mixes: low w/c ratio did not show benefits after adding sand.

**Saeid Hesami, Saeed Ahmadi and Mahdi Nematzadeh published a paper in 2014 named „Effect of Rice Husk and Fibre on Mechanical Properties of Pervious Concrete Pavement‟.**

In this paper, glass material, steel fibre and PPS fibres and also RHA in numerous pro-portions, were accustomed to improve the mechanical properties of pervious concrete and finding its effect on compressive strength, tensile strength, flexural strength and permeability. Coarse aggregate sized from 2.36 to 19.0 mm, RHA of 0%, 2%, 4%, 6%, 8%, 10% and 12% weight percentage as a cement replacement, PPS fibre 0.3%, steel fibre 0.5% and glass fibre 0.2% are to remain constant at 3 different w/c ratio of 0.27, 0.33 and 0.40. Outcome of Study was as described below. a) The compressive, tensile and flexural strength were found to be maximum at w/c ratio of 0.33. b) For 10% replacement of RHA and w/c ratio of 0.33, the compressive strength of pervious concrete containing fibres increases by 34%, 37% and 36% respectively for glass, steel and PPS fibres. c) For the above-mentioned mix design, the tensile strength increases by 31%, 30% and 28% for glass, steel and PPS fibres respectively. d) Finally, the flexural strength undergoes a 64%, 63% and 69% increase when glass, steel and PPS fibres are used, respectively.

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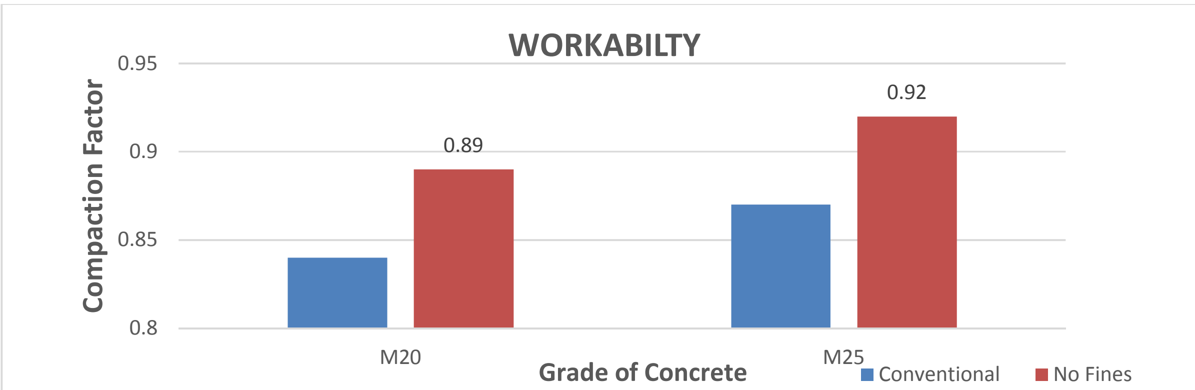
## IV. Methodology

Data Collection: Collection of Material: Testing of Material: Mix Design: Casting of Specimen: Curing of Specimen: Testing of Specimen: Compering the Results

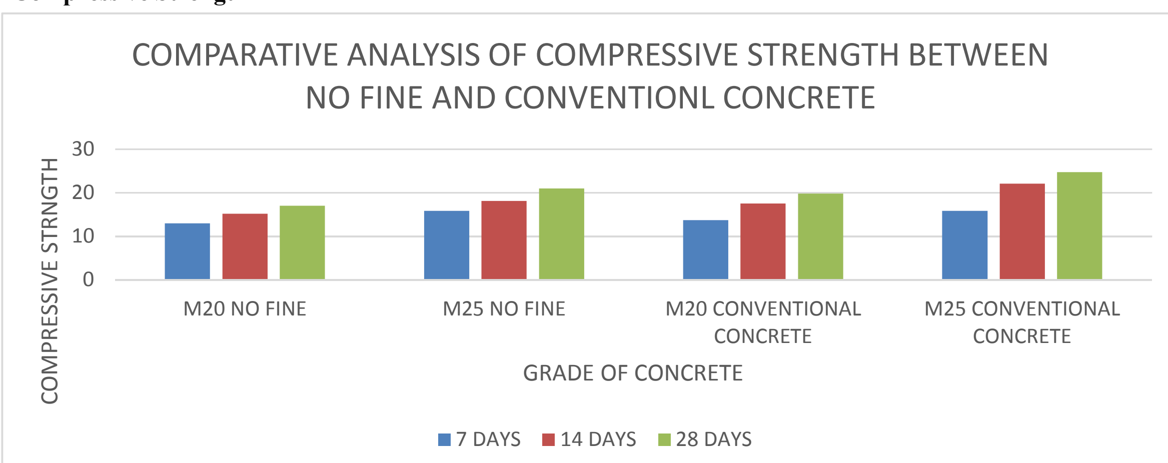
## V. Test Results & Discussion

### 5.1 Workability




Form the calculated workability values it is observed that for $M_{20}$ and $M_{25}$ grades of no fines concrete are increased by 5.6% and 5.4% respectively when compared to the conventional concrete.

### 5.2 Compressive Strength




**7 DAYS:** Experimental observations establish a decrease in the compressive strength of $M_{20}$ and $M_{25}$ grades of no fines concrete by 5.61 %, and 17.17% respectively in comparison with the conventional concrete.

**14 DAYS:** A decrease in the compressive strength of $M_{20}$ and $M_{25}$ grades of no fines concrete by 14.16%, 19.8% and respectively is found compared to the conventional concrete.

**28 DAYS:** A decrease in the compressive strength of $M_{20}$ and $M_{25}$ grades of no fines concrete by 15.36%, 16.35% and respectively is found compared to the conventional concrete.

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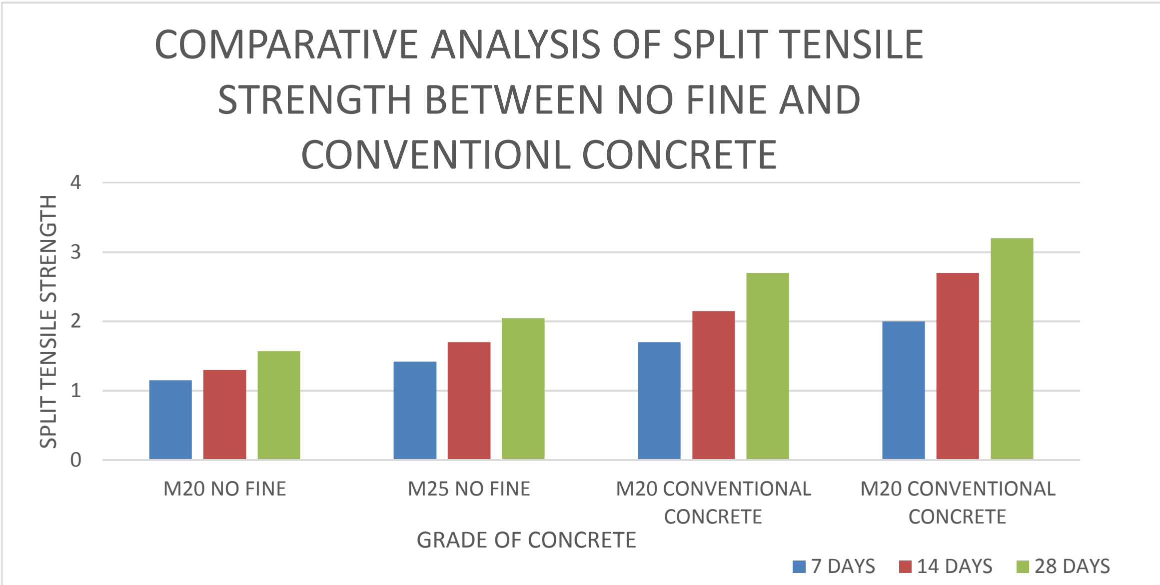
### 5.3 Split Tensile Strength




**7 DAYS:** The split tensile strength of M20 and M25 grades of no fines concrete is decreased by 38.59%, and 33.91%respectively.

**14 DAYS:** The spilt tensile strength of M20 and M25 grades of no fines concrete is decreasedby 49.27% and 45.45% respectively.

**28 DAYS:** The spilt tensile strength of M20 and M25 grades of no fines concrete is decreasedby 52.92% and 43.80% respectively.

## VI. Limitations

1. Although this paved method is very effective in most cases, it may not always be practical.
2. The main reason that flowing concrete is not an option for high-traffic pavements, such as highways, to break up, "said Youngs, noting that a blank tire can loosen the aggregate at the top.
3. The compressive strength of ordinary concrete is about 20MPa. Therefore, this cannot be included in cases of heavy traffic load.

## VII. Advantages

1. It reduces the storm water runoff.
2. Eliminates the need for detention ponds and other costly storm water management practices.
3. Mitigates surface runoff.
4. Replenishes the aquifers and water table.
5. Allows more efficient land development.
6. Prevents water from entering into the stream and also prevents it from being polluted.
7. Green building alternative suitable for many applications.
8. Protects streams and lakes and allows local vegetation to thrive.

## VII. Conclusion

The following conclusions are drawn based on the experimental investigations oncompressive strength, split tensile, flexural, durability, permeability considering the environmental aspects‖ also:

- Pervious concrete has less strength than conventional concrete by 14.5%for M20 and 12.6% for M25.
- Similarly, the tensile values are also comparatively lower than the conventional concrete by 30%.

- Though the pervious concrete has low compressive, tensile strength it has high coefficient of permeability hence the following conclusions are drawn based on the permeability, environmental effects and economical aspects.
- Hence, it is capable of capturing storm water and recharging the ground water. As aresult, it can be ideally used at parking areas and at residential areas where the movementof vehicles is very moderate.
- Further, no fines concrete is an environmentally friendly solution to support sustainableconstruction. In this project, fine aggregates as an ingredient has not been used. Presently, there is an acute shortage of natural sand all around. By making use of FA in concrete, indirectly we may have been creating environmental problems.
- Elimination of fines correspondingly decreases environment related problems.

In many cities' diversion of runoff by proper means is complex task. Use of this concretecan effectively control the run off as well as saving the finances invested on the construction of drainage system. Hence, it can be established that no fines concrete is very cost effective apart from being efficient.

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