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AN EXPERIMENTAL INVESTIGATION ON PERVIOUS CONCRETE

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Abstract—Pervious concrete is also known as porous, gap graded, permeable or porosity concrete. Comparing with nominal concrete, the pervious concrete has little or no fine aggregate. In Pervious concrete the fine aggregate percentage is taken as 0%, 5%, 10%, 15%, 20%, 25% by weight of fine aggregate in nominal concrete mix i.e the mix design is based on IS 10262:2009.The above pervious concrete cubes are tested for a compressive strength of 3, 7, 14, 28days of curing for above percentage of fine aggregates and compared with nominal concrete mix. Permeability of the pervious concrete for the above percentages of fine aggregate will be found out at 28 days by using falling head permeability test.

Key Words: Falling head, Pervious Concrete, Permeability, Porous, Porosity

I INTRODUCTION

Pervious concrete is an application that is used for concrete pavement with a high porosity that allows water from precipitation and other sources to pass through it and reducing the runoff from a pavement site and recharging ground water table levels. The high porosity is due to void content present between the aggregates. For pervious concrete, the cementitious paste and fine aggregate with very little to no fine aggregate is used to coat the coarse aggregate particles without stripping in between the aggregates for surface pavement. The parking areas, very-light traffic areas, pedestrian walking areas, and greenhouses are the major aspect is viewed in pervious concrete. For sustainable construction, the pervious concrete is a crucial role for application used in pavement. The storm water can filter and reduce pollutants which is entering into streams, lakes and waterways. For ground water precious, it functions like a storm water collective basin and permits to penetrate into the soil over a large contact region. In pervious concrete, it is more effective land use. For improvement on trees, pervious concrete can reduce the impact on pavement for allowing the both water and air to the root systems in highly developed areas.

Pervious concrete volume consists of 15%-30% of interconnected void network for which the water is allowing to pass through the concrete. The entry of water can permit 3-5 gallons (0.014 - 0.023m3) of water per minute for each square foot (0.0929m2) of surface area. Pervious concrete is an environmental issues and sustainable growth for unique and effective. It acts as a drainage system automatically when it rains and putting water back. In heavily travelled roadways, it is moderate amount of surface raveling, rough textured, and having honeycombed surface in pervious concrete.During mixing and placing of concrete, the amount of water and cementitious material is used to create a paste for coating the aggregate particles with a thick film to prevent the flowing off paste. A system of interconnected voids is used for enough paste to coat the particles which allow water and air to pass through. It is light in weight around (1600 to 1900 kg/m3) because of high void substance. Pervious concrete void structure gives contamination pollutants which include structural strength. Pervious concrete is very high permeable concrete that quickly drains.

NEED OF PERVIOUS CONCRETE

No-fines concrete is typically used in non-pavements applications and a partial use in pavements applications. For the construction of road pavements, this project purpose is to evaluate the suitability for no fines concrete to be used. This will include study of existing literature on the topic and conducting normal concretetesting on no-fines concrete and conventional concrete todetermine and assess their properties. With the help oftested data, anassumption is made on the utility of nofinesconcrete pavements. In America, the major usage of no-finesconcrete is at low volume residential roads and ground levelparking lots.

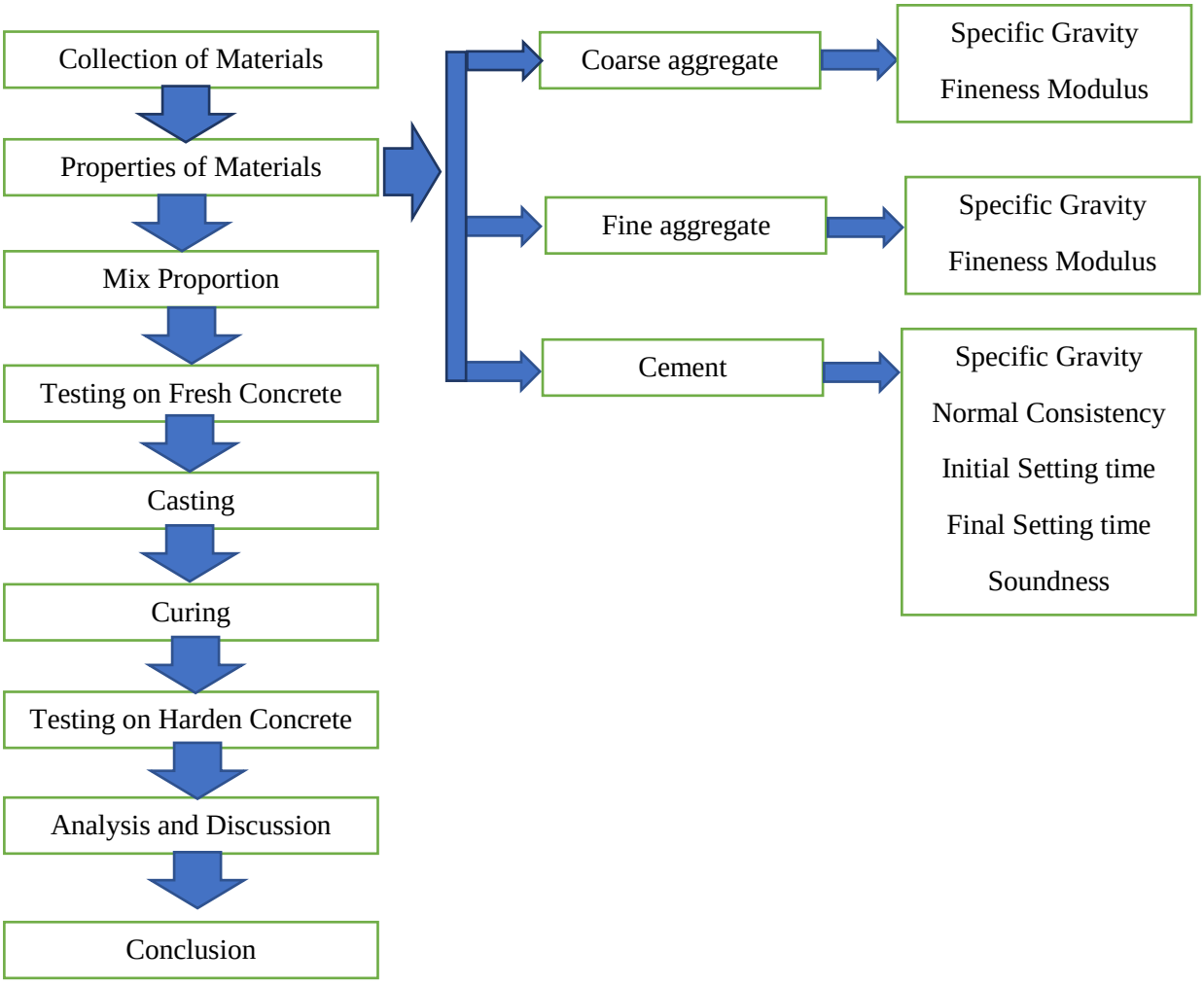
BENEFITS OF THE PERVIOUS CONCRETE

1. It reduces the runoff water on the pavement
2. Recharge the Aquifers and ground water table
3. Allow more efficient land development.
4. Prevent water for getting more pollute.
5. Ease surface runoff.
6. Also prevent water to runoff into the stream.

APPLICATION OF PERVIOUS CONCRTE

1. Pervious concrete as a road pavement.
2. Low volume pavement.
3. Side walk and pathways.
4. Tennis courts.
5. Slop stabilization.
6. Parking lots.

II METHODOLOGY



III MATERIALS USED AND ITS PROPERTIES

Cement

Cement is a binder material, that sets and hardens the concrete and can bind other materials together. Ordinary Portland cement (OPC) 53 grade conforming to IS 12269-1987 was used. The properties of cement were tested and their values are given as shown in Table 1.

Properties	Values
Specific gravity	3.15
Initial setting time	65 min
Final setting time	540 min
Standard consistency	33%
Soundness	1mm

Table 1 Physical properties of Cement

Fine Aggregate

The particles passing through 9.5 mm sieve, almosttotally passing through 4.75 mm sieve, and mostly retained on the 75 µm sieve are called fine aggregate. The river sand confirming to zone as per IS 383-1987 was used. The specific gravity and fineness modulus of sand were 2.63 and 5.09 respectively.

Properties	Values
Specific gravity	2.63
Fineness Modulus	5.09

Table 2 Physical properties of Fine aggregates

Coarse Aggregate

Coarse aggregates are particles greater than 4.75mm. Crushed angular coarse aggregates confirming to IS 383-1987 was used. Coarse aggregates passing from 20mm and retained on 16.5mm are used.

Properties	Values
Specific gravity	2.77
Fineness Modulus	3.6

Table 3 Physical properties of Coarse aggregates

Water

Water is an important ingredient of concrete as it actively participated in chemical reaction with cement. For drinking purpose, it should be quite satisfactory which is used in mixing of concrete.

IV EXPERIMENTAL PROGRAMMES

Preparation of Mixes

The mix samples were prepared according to the Compressive strength procedure, which is widely practiced and popular in India. The coarse aggregates, fine aggregates and cement were mixed according to the adopted mix design for M25 grade of concrete as shown in Table 4. The cube mould has a dimension of 150mmx150mmx150mm and the mould should be apply grease on inner surface for easy removal. The mixed concrete is poured inside the mould for three layers and is compacted with hammer for 25 blows in each layer to avoid the air content present in concrete. The top surface is kept with straight edge. The concrete with mould is kept in casting for 24 hours. After casting, the mould is removed for curing the concrete in water bath for 3,7,14,28 days. For Permeability test, the sample mixes were prepared according to the falling head permeability test procedure. The Cylindrical mould is prepared with a height 12.7cm and diameter 10cm. The sample mixes are poured inside the mould and keep casting for 24 hours. After casting, the cylindrical mould is kept in water bath for 28 days

Material	Water	Cement	Fine aggregate	Coarse aggregate
Kg / m^3	198.03	489.47	603.88	1182.36
Ratio	0.4	1	1.2	2.4

Table 4 Material Quantity required for M25 grade of concrete per cubic meter quantity of concrete

Tests on Mixes

Compressive Strength Test: After curing for required days, the cubes are tested with compressive strength testing machine for determining the maximum load at which the cube failure within the area.

Falling Head Permeability Test: The cylindrical mould is kept at falling head testing machine for determining the coefficient of permeability at which the time required to pass the water from top to bottom of the cylindrical cube mould.

Fig.1 Pervious concrete cylinderFig.2Pervious concrete cylinder casted in pipe

Fig.3 Water passing through cylinder pipe

V Experimental Results

No. of Days	Compressive Strength (N/mm^2)
3	14.37
7	22.21
14	25.9
28	34.59

Table 5 Compressive Strength Test Results for Nominal Concrete Mix

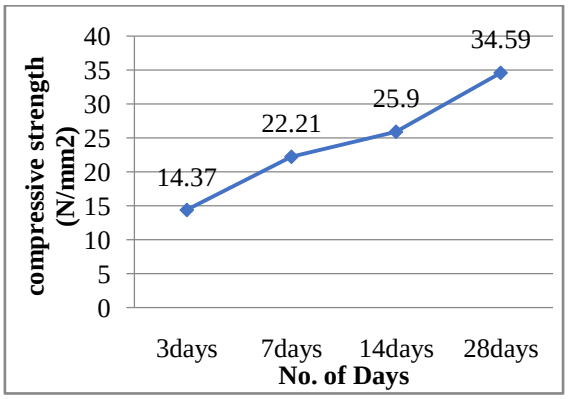


Fig.1 Graph between

Compressive strength vs No. of days for Nominal concrete

Percentage of fine aggregate	Compressive Strength (N/mm^2)			
	3Days	7Days	14Days	28Days
0%	5.55	8.88	14.66	19.66
5%	6.22	9.77	15.77	21.66
10%	7.66	12.77	15.99	22.44
15%	9.88	14	17.22	23.44
20%	10.66	15.22	17.99	24.33
25%	11.66	16.77	18.55	24.77

Table 6 Compressive Strength Test Results for Pervious Concrete Mix

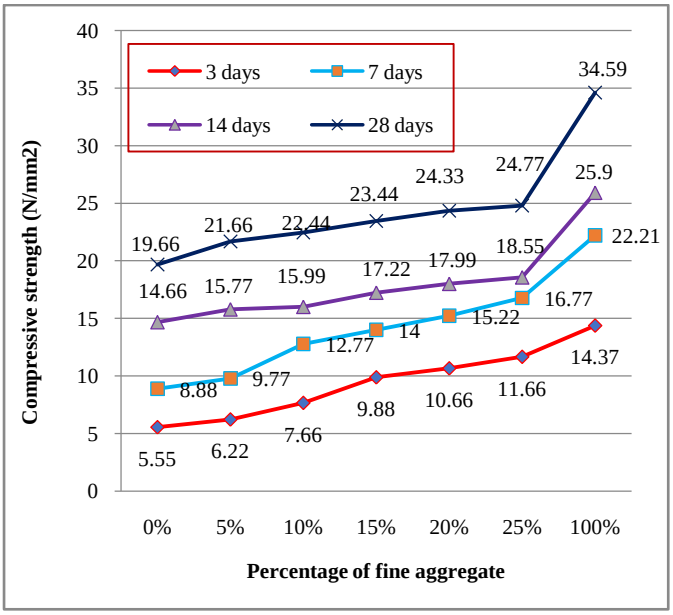


Fig.2 Graph between Compressive strength vs Percentage of fine aggregate for Pervious concrete

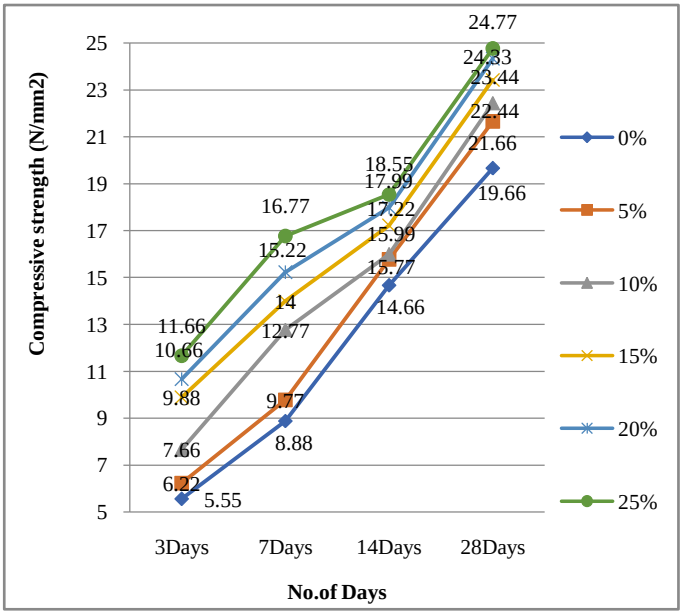


Fig.3 Graph between Compressive strength vs No. of Days for Pervious concrete

Percentage of fine aggregate	Time (s)	Falling Head Permeability Test (cm/s)
0%	3	0.703
5%	3	0.703
10%	5	0.442
15%	7	0.301
20%	8	0.263
25%	10	0.211
100%	0	0

Table 7 Falling Head Permeability Test Results for Nominal and Pervious Concrete Mix

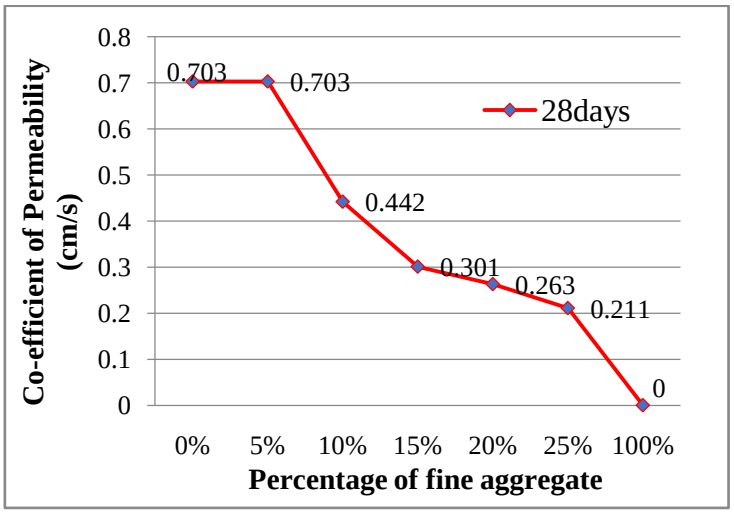


Fig.4 Graph between Co-efficient of permeability vs Percentage of fine aggregate for Nominal and Pervious concrete

CONCLUSION

Pervious concrete mainly depends upon permeability parameter. As the percentage of fine aggregate is increasing, the compressive strength also increases but the permeability is decreases. So, the percentage of fine aggregate is increased only up to certain limit as per our strength requirement. Whereas comparing to 0% & 5% of pervious concrete has same permeability.From the above study, it is concluded that the compressive strength of 5% of pervious concrete has 6% higher strength than 0% of pervious concrete.Hence for economical view 5% is preferable and it is suggested.

REFERENCES

[1] ASTM D1557-00, "*Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort*" Annual Book of ASTM Standards, Vol. 04.08, ASTM International, West Conshohocken, PA, www.astm.org

[2] ASTM C-1701 "*Standard Test Method for Infiltration Rate of In Place Pervious Concrete*" Annual Book of ASTM Standards 4(2), 2009, West Conshohocken, PA ASTM International

[3] Delatte, Prof N. (2007). Portland Cement Pervious Concrete Pavement: Field Performance Investigation on Parking Lot and Roadway Pavements, Final Report, Cleveland State University, December 2007.

[4] Ghafoori, N. & Dutta, S. (1995). "*Development of No-Fines Concrete Pavement Applications"* Journal of Transportation Engineering, May/June 1995.

[5] Haselbach, L.M., Valavala, S. & Montes, F. (2006). "*Permeability Predictions for Sand Clogged Portland Cement Pervious Concrete Pavement Systems*", Journal of Environmental Management Systems 81 (2006).

[6] Kevern, J.T. "*Operations and Maintenance of Pervious Concrete Pavements",* TBR#11-0656 November 15, 2010
[7] Kevern, J., Wang, K. & Schaefer V. (2008). Pervious Concrete in Severe Exposures, Concrete International, July 2008.
[8] Kevern, J.T., Schaefer, V.R., and Wang, K. "*Temperature Behavior of a Pervious Concrete System*". Transportation Research Record: Journal of the Transportation Research Board(TBR), Construction 2009 No. 2098.
[9] Mohammed, A., Nehdi, M. &Adawi, A. (2008). "*Recycling Waste Latex Paint in Concrete with Added Value",* ACI Materials Journal, Technical Paper 105-M42, July-August 2008.
[10] Monahan, A. (1981). Porous Portland cement concrete; the state of the art, U.S. Army Engineer Waterways Experiment Station, Structures Laboratory, Vicksburg, Mississippi, 1981.
[11] National Ready Mixed Concrete Association. (2008). Pervious Concrete When it rains…it drains, Pervious Concrete Frequently Asked Questions, 2008, http://www.perviouspavement.org/benefits,%20structural.htm
[12] Offenberg, M. (2007). The Future of Pervious Concrete Pavements, 23rd Biennial Conference of the Concrete Institute of Australia, Adelaide, Australia, October 2007.
[13] Pervious Concrete Pavement – A Win-Win System, Concrete Technology Today, CT 032, August 2003, Portland Cement Association, Skokie, IL, http://www.cement.org
[14] Pervious Concrete, ACI 522R Report, (under review), ACI International, Farmington Hills, MI, http://www.concrete.org
[15] Pervious Pavement Manual, Florida Concrete and Products Association Inc., Orlando, FL. http://www.fcpa.org.
[16] Richard C. Meininger, "No-Fines Pervious Concrete for Paving," Concrete International, Vol. 10, No. 8, August 1988, pp.20-27.
[17] Recommended Specifications for Portland Cement Pervious Pavement, Georgia Concrete and Products Association, Inc.Tucker, GA, www.gcpa.org
[18] Storm Water Technology Fact Sheet Porous Pavement, United States Environmental Protection Agency, EPA 832-F-99-023, September 1999. www.epa.gov/npdes
[19] Tennis P.D., Leming M.L. & Akers D.J. (2004). Pervious Concrete Pavements, Portland Cement Association, 2004.
[20] Wang, K., Schaefer, V.R., Kervern, J.T. & Suleiman, M.T. (2006). Development of Mix Proportion for Functional and Durable Pervious Concrete, NRMCA Concrete Technology Forum: Focus on Pervious Concrete, Nashville, TN, May 2006.
[21] Walters, D.G. (2006). Significance of Tests and Properties of Concrete, Ed. Lamond&Pielert, ASTM International, May 2006.