International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue 5, May - 2014

Study on the Properties of Pervious Concrete

Praveenkumar Patil
Assistant Professor, Department of Civil Engineering,
G I T . College of Engineering, Lavel,

Santosh M Murnal
Assistant Professor, Department of Civil Engineering,
B.E.C . College of Engineering,Bagalkot

Abstract: **Pervious concrete is a form of lightweight porous concrete, obtained by eliminating the sand from the normal concrete mix. The advantages of this type of concrete are lower density, lower cost due to lower cement content, lower thermal conductivity, relatively low drying shrinkage, no segregation and capillary movement of water. It has better insulating characteristics than conventional concrete because of the presence of large voids. In the present study M20 pervious concrete is designed by ACI522R-10 design code. The effect of w/c ratio and aggregate size on the strength of pervious concrete are studied. The property of pervious concrete by replacing cement by fly ash is also studied. It is revealed that the compressive strength increases as the water/cement ratio decreases up to optimum w/c ratio and with increase in volume of paste. It is observed that cement can be effectively replaced by fly ash which reduces the cost of pervious concrete.**

Key Words**: Pervious concrete, mix proportioning, compressive strength, coefficient of permeability**

INTRODUCTION:

Pervious concrete, also called porous concrete or enhanced porosity concrete is a macro-porous concrete that is gaining rapid popularity in many parts of the world because of its applications in sustainable constructions (Narayanan.et.al 2010).

no-fines pervious concrete for paving was found that, when a small amount of sand was added to the mixture, the compressive strength of the concrete was increased from 10.3 MPa to 17.2 MPa (Richard Meininger et.al)

Therefore it is a mixture of Portland cement, uniform coarse aggregate, with both a small amount of or without fine aggregate and water. Appropriate amounts of water and cementitious material are employed to create a paste that forms a thin coat around aggregate particles but leaves free spaces between them. Thus, pores are formed in the pervious materials (Montes, 2006).

Water/cement ratios between 0.27 and 0.30 are used routinely with proper inclusion of chemical admixtures and those as high as 0.34 to 0.40 have been used successfully. The relation between strength and water/cement ratio is not clear for pervious concrete because unlike conventional concrete, the total paste content is less than the voids content between the aggregates. Fresh pervious concrete is typically stiff with low workability compared to conventional concrete. Slump values are usually less than 20 mm. For quality control and quality assurance, unit weight or bulk density is preferred (Tennis et.al 2004).

In order to achieve desired pore structure, proportioning of pervious concrete is commonly carried out using gap graded coarse aggregates and little to no fine aggregates. The range of porosity that is commonly reported for pervious concrete is 15 to 30%, and this depends on the compaction method adopted, in addition to the mixture proportions. However, the strength of the material is relatively low because of its porosity. The compressive strength of the material can only reach about 20 to 30MPa. Such materials cannot be used as pavement due to low strength (Jimg Yang & Guoliang 2003). Because of the high void content, pervious concrete generally has low strength, which not only limits its application in cold weather regions but also is responsible for various distresses and failures of the related structures (Wang et.al 2006).

In recent years, pervious concrete pavements have become increasingly popular as an effective storm water management device in areas that receive frequent and sometimes extensive rainfalls. The most popular application is that of light traffic volume road ways such as parking lots, residential roads, driveways, sidewalks .Parking areas properly designed and constructed will last 20-40years with little or no maintenance. Unlike asphalt, surface ravelling (the loosening of surface aggregates) is common only in the first few weeks after the concrete is laid, and it can be reduced with proper compaction and curing techniques (Ghafoori et.al 1995)

EXPERIMENTAL PROGRAMME:

Materials

Ordinary Portland cement (C 43 grade) conforming to the requirements of IS 8112:1989 was used in the study. Crushed angular stones were used as coarse aggregate. Coarse aggregate with combined grading of 50% passing through 20 mm sieve and retained on 13.2 mm and 50% passing through 12.5 mm and retained on 9.5 mm sieve confirming to IS: 383-1970 size aggregate were used. The bulk specific gravity of the coarse aggregate 2.71 as per 2386(part III)-1963 and their water absorption value was 0.5%. The fly ash (Class F) used in the entire investigation was brought from thermal power plant, Raichur. The specific gravity of fly ash was 1.92.

Specimens:

Cubes of size 150 mm were cast and tested for compressive strength at the age of 7 and 28 days and beams of size 150x150x500mm at 28 days for flexural strength as per IS 516.

*Methodology***:**

In the present study, American Concrete Institute reported by ACI Committee 522R-10 design code is utilised for M20 grade concrete.

Proportioning procedure:

A procedure for producing initial trial batches for pervious concrete is shown below. The b/b_0 method applies absolute volume concepts. The b/b_0 method for designing a pervious concrete mixture can be broken up into a series of eight steps:

1. Determine aggregate weight
2. Adjust to SSD weight
3. Determine paste volume
4. Determine cementitious content
5. Determine water content
6. Determine solid volume
7. Check void content
8. Iterative trial batching

The weight of aggregates obtained from the b/b0 method

	b/b_o	
Fineness of aggregate	Size no. 9.5 mm	Size no. 13.2 mm
0	0.99	0.99

Total weight of aggregate = 2646.08 lb
Taking percentage absorbance of 1.15%
Surface saturated dry weight = 2676.51 lb

Using ACI 522R10 and read along required the percentage voids (15% for this example) to the medium compacted curve. Then read down to find the paste percentage at 15%. Thus
Volume of paste = 6.75 ft^3

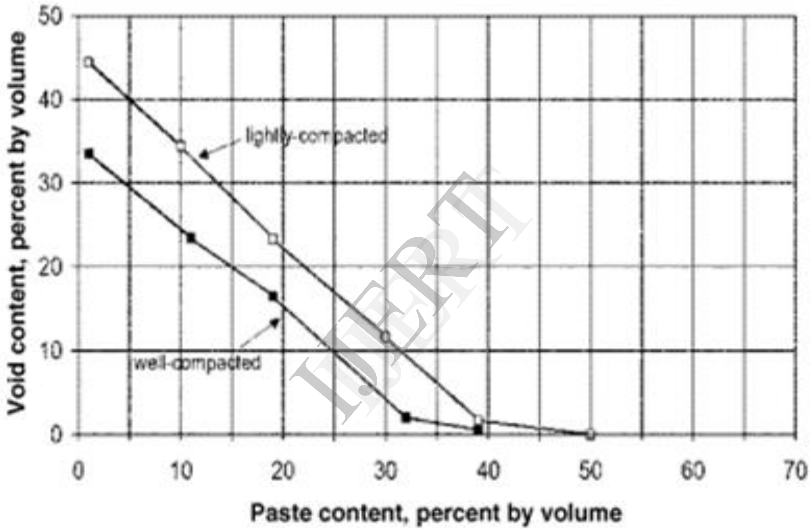


Fig.1 Relationship between paste and void content.

Weight of cement obtained From eq. (6-1), ACI 522R10 for water cement ratio of 0.38 is c = 606.9 lb and amount of water required = 230.62 lb.
Volume of cement, aggregate and water are 3.09 ft^3, 15.82 ft^3 and 3.70 ft^3 Respectively. Percent voids obtained was 15.88%
The proportion mix obtained was 1: 4.41

Table 1 Mix proportion

Cement	606.92 lb	275.87 kg
Water	230.62 lb	104.87 litre
Aggregate	2676.51 lb	1216. 58 kg
Density	130.15 lb/ft^3	2088.90 kg/m^3

ISSN: 2278-0181
Vol. 3 Issue 5, May - 2014

RESULTS AND DISCUSSIONS

Sl no.	Proportion (Cement: Aggregates)	Water/ cement ratio	Compressive strength at 7 days(MPa)	Compressive strength at 28 days(MPa)
1.	1:5.8	0.43	3.2	4.5
2.	1:5.53	0.42	4	5.8
3.	1:5.46	0.40	4.2	5.9
4.	1:4.41	0.40	14.36	19.2
5.	1:4.41	0.38	15.22	20.2
6.	1:4.41	0.36	12.3	17.5
7.	1:4.41	0.34	9.5	14.2

Table 3 Compressive strength at 7 and 28 days with fly ash.

Sl no.	Proportion (Cement: Aggregates)	w/c ratio	Percentage of cement replaced with fly ash	Compressive strength at 7 days(MPa)	Compressive strength at 28 days(MPa)
1	1:4.41	0.38	20	16.52	21.4
2	1:4.41	0.38	40	13.20	17.8
3	1:4.41	0.38	60	6.66	11.2
4	1:4.41	0.38	80	5.02	8.4
5	1:4.41	0.38	100	Not workable	-

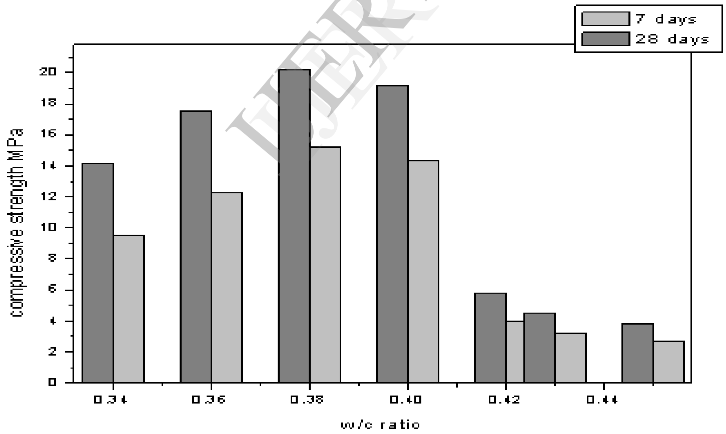


Fig.2 Effect of w/c ratio on compressive strength without fly ash.

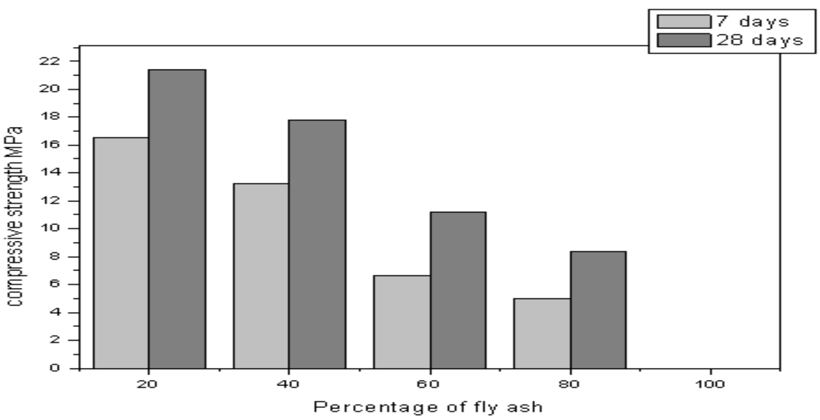


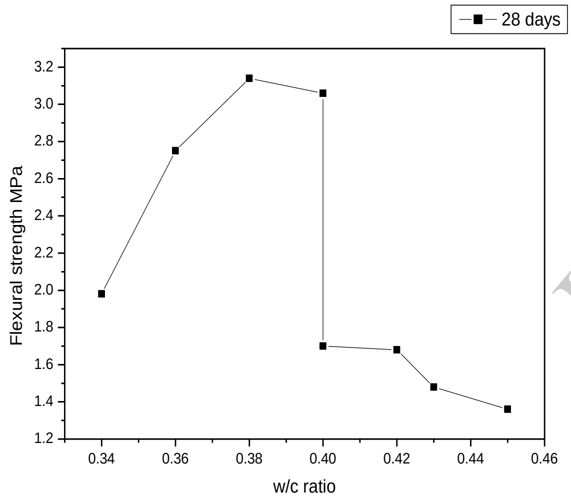
Fig. 3 Effect of w/c ratio on compressive strength with fly ash.

Table 4 Flexural strength at 28 days without fly ash.

Sl no.	Proportion (Cement: Aggregates)	Water / cement ratio	Flexural strength at 28 days(MPa)
1.	1:5.8	0.43	1.48
2.	1:5.53	0.42	1.68
3.	1:5.46	0.40	1.70
4.	1:4.41	0.40	3.06
5.	1:4.41	0.38	3.14
6.	1:4.41	0.36	2.75
7.	1:4.41	0.34	1.98

Table 5 Flexural strength at 28 days with fly ash.

Sl no.	Proportion (Cement: Aggregates)	w/c ratio	Percentage of cement replaced with fly ash	Flexural strength at 28 days(MPa)
1	1:4.45	0.38	20	3.29
2	1:4.45	0.38	40	2.95
3	1:4.45	0.38	60	2.34
4	1:4.45	0.38	80	1.95
5	1:4.45	0.38	100	Not workable



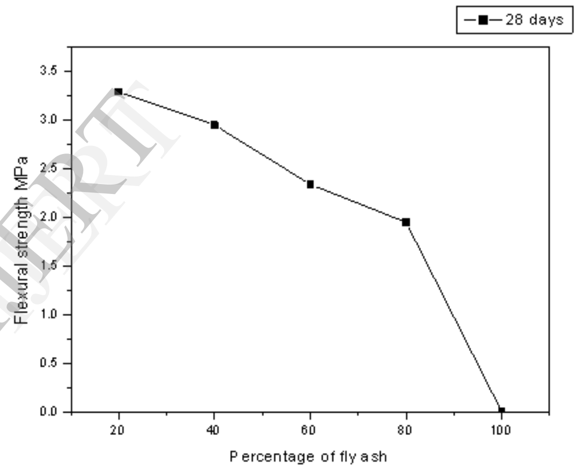


Fig 4 Effect of w/c ratio on flexural strength without fly ash and with fly ash.

CONCLUSIONS:

1. M20 pervious is designed by ACI522R-10 design code.
2. The compressive strength of pervious concrete increases as the water/cement ratio decreases up to optimum w/c ratio of 0.38.
3. Compressive strength increases with increase in volume of paste.
4. The flexural strength of 3.14 MPa is achieved for M20 pervious concrete mix designed.
5. The optimum replacement of cement by fly ash is found to be 20 % in the present study.

REFERENCES

1. Jing Yang, Guoliang Jiang (2003). Experimental study on properties of pervious concrete pavement materials. Cement and Concrete Research 33, 381–386.
2. Montes F. Pervious concrete (2006). Characterization of fundamental properties and simulation of microstructure. Ph.D. Dissertation, University of South Carolina.
3. Narayanan Neithalath, Milani S. Sumanasooriya, Omkar Deo (2010). Characterizing pore volume, sizes, and connectivity in pervious concretes for permeability prediction, Materials characterization, 61, 802-813.
4. Ghafoori N, Dutta S, "Laboratory Investigation of Compacted No-Fines Concrete for Paving Materials", Journal of Materials in Civil Engineering. Vol. 7, No. 3, 1995, pp. 183-191.
5. Wang K, Schaefer V R, Kevern J T and Suleiman M T. "Development of Mix Proportion for Functional and Durable Pervious Concrete", Submitted to Concrete Technology Forum-Focus on Pervious Concrete, National Ready Mix Concrete Association, Nashville, TN, May 24-25, 2006, pp. 1-12.
6. Tennis PD, Leming ML, Akers DJ. (2004). Pervious Concrete Pavements. EB302 Portland Cement Association Skokie Illinois and National Ready Mixed Concrete Association, Maryland: Silver Spring.
7. Richard C Meininger, "No-Fine Pervious Concrete for Paving", Concrete International, vol.10, 1988, pp. 20-27.