EXPERIMENTAL INVESTIGATION OF PERVIOUS CONCRETE WITH USE OF FLY ASH AND SILICA FUME AS ADMIXTURE

A.A.Haji[1], Dr.K.B.Parikh[2], M.A.Shaikh[3], M.A.Jamnu[4]

[1]*PG student, Government Engineering College, Dahod*

[2,3] *Assistant Professor, Department of Applied Mechanics, Government Engineering College, Dahod*

[4]*Assistant Professor, Department of Applied Mechanics, Government Engineering College, Godhra*

ABSTRACT

In many developed countries, pervious concrete is becoming popular for the construction of pavements, car parks and driveways. For the effective use of pervious concrete, it is necessary to evaluate performance of this new type of concrete. The most important property of pervious concrete is its water permeability as it is measure of perviousness of the said concrete. To achieve high porosity only coarse aggregates may be used but it reduces the compressive strength of pervious concrete. So, different categories of coarse aggregates are taken to achieve the required compressive strength. Different Percentage ratio of (20-10) mm and (10-4.75) mm coarse aggregates has been used to cast pervious concrete. As the ratio of 50%-50% has given optimum permeability it has been selected for further work in pervious concrete.

In this study, fly ash and silica fume has been replaced by cement from 0% to 25% and water permeability as well as compressive strength of pervious concrete has been tested. Results showed that Replacement of Fly ash from 5% to 25% shows decrement in strength from 4% to 28%. And permeability also decreased with increment of fly ash mix up to 30% than normal pervious concrete as well as in silica fume, replacement from 5% to 25% shows that with 5% replacement of cement with silica fume increased strength up to 24% higher than normal pervious concrete. But with further increment of this admixture with replaced to cement showed strength loss of 44% then normal pervious concrete

***Keywords*: Pervious concrete, porous concrete, fly ash, silica fume**

I. INTRODUCTION

Pervious concrete or no fines concrete is a different type of concrete which has high porosity and generally used in applications that allows water to precipitate and pass directly through which reduces the runoff water from sites. Generally, this type of concrete made of mostly large coarse aggregates and less fine aggregates allows passing water through this concrete and traditionally it is used in parking areas, some residential streets and pedestrian walkways and some light structure conditions. Due to use of large coarse aggregates and cementitious materials, pervious concrete has very high water permeability and very low compressive strength.

Rough surface texture of this concrete gives traction for vehicles and prevents driving hazards especially beneficial during the most difficult and dangerous of driving conditions, such as in rain and snow. Permeability of pervious concrete gives higher safety against flooding of water on roads and ground areas of building. High

porosity helps to remove excessive water from surface of roads and it also increases safety for vehicle drivers especially in slippery and wet conditions.Pervious concrete is durable enough that parking areas properly constructed will last 20-40 years without or less maintenance.

II. EXPERIMENTAL PROGRAM

In this experiment, total 30 no. of cubes of size 150mm*150mm*150mm were casted for fly ash replacement with cement as well as 30 cubes for silica fume replacement with cement. Also, for permeability test, 15 cylinders of 150mm * 300mm were casted out. Pervious concrete hasn't any specific IS-method. So in this work, approximate mix proportions with reference of ACI 522 Report on Pervious concrete and with reference of ambuja foundation, following design were taken as mix design of pervious concrete:

Water(Litre)	Cement(kg)	Coarse aggregate(kg)	Fine aggregate(kg)
169.0	380.0	1520.0	77.0 (5%)
	1	4	0.20

For given mix design, experimental study carried out for permeability of pervious concrete and also compressive strength of this concrete. For permeability of pervious concrete, water permeameter was prepared as per ACI 522.

Figure shows the apparatus of falling head permeameter setup .Using this approach, the sample is enclosed in a latex membrane to avoid the water flowing along the sides of the specimen. Water is added to the graduated cylinder to fill the specimen cell and the draining pipe. The specimen is preconditioned by allowing water to

drain out through the pipe until the level in the graduated cylinder is the same as the top of the drain pipe. With use of this method, water was allowed to flow through the specimen by opening the bottom valve. It stopped when level became same of in drainage pipe to the graduated standing pipe above concrete specimen. For the calculation of permeability, Darcy's equation is considered as a measurement of coefficient of permeability. Permeability coefficient (k) is calculated according to given equation:

$$K = \left(\frac{aL}{At}\right) \times \ln\left(\frac{h_0}{h_1}\right)$$

Concrete cubes with different coarse aggregate contents & without any addition of admixtures with 10% additional variation is made out to find compressive strength normal pervious concrete:

Table-1 trial mix for compressive strenght of normal pervious concrete for 7 days

trial mixes(C.A.)	days	weight(kg)	Average compressive strength(N/mm²)
20mm(70%)+ 10mm 30%	7	6.8	16.4
20mm(60%)+ 10mm 40%	7	6.9	19.2
20mm(50%)+ 10mm 50%	7	7.1	22.1

Table-2 trial mix for compressive strength of normal pervious concrete for 28 days

trial mixes(C.A.)	days	weight(kg)	Average compressive strength(N/mm²)
20mm(70%)+ 10mm 30%	28	6.9	21.3
20mm(60%)+ 10mm 40%	28	7.1	24.5
20mm(50%)+ 10mm 50%	28	7.3	27.3

Now, for permeability of normal pervious concrete, following results achieved after 28 days:

Table-3 trial mix for permeability of normal pervious concrete for 28 days

trial mixes(C.A.)	days	Average Permeability(mm/sec)
20mm(70%)+ 10mm 30%	28	27.6
20mm(60%)+ 10mm 40%	28	25.8
20mm(50%)+ 10mm 50%	28	23.5

Based on CIP-38, National ready mixed concrete association(NRMCA) for normal pervious concrete, compressive strength ranges between 2.8 to 28 MPa. Normal Pervious concrete with 50% coarse aggregate (20 mm) and 50% Grit(10 mm) gives acceptable strength as well as permeability of this mix is also acceptable. So, trial mix of 50% coarse aggregate (20 mm) + 50% Grit (10 mm) taken for further work.

IV. RESULTS AND DISCUSSIONS

For compressive strength measurement, 30 cubes with fly ash mix and 30 cubes with silica fume mix of standard size are made of 15cm mould size and then tested on CTM. And also for permeability, 15 cylinders were casted for fly ash replacement and also 15 cylinders for silica fume replacement. Following table shows the results of compressive strength and water permeability of pervious concrete with use of fly ash and silica fume admixtures.

Table-4 permeability of pervious concrete with fly ash mix for 28 days

cement (%)	Fly ash(%)	days	Average Permeability (mm/sec)
100	**0**	**28**	**23.5**
95	**5**	**28**	**22.3**
90	**10**	**28**	**20.6**
85	**15**	**28**	**18.7**
80	**20**	**28**	**17.4**
75	**25**	**28**	**16.3**

Table-5 compressive strength of pervious concrete with fly ash mix

cement(%)	Fly ash(%)	days	Compressive strength (N/mm²)	days	Compressive strength (N/mm²)
100	**0**	**7**	**22.1**	**28**	**27.3**
95	**5**	**7**	**21.4**	**28**	**26.1**
90	**10**	**7**	**19.8**	**28**	**24.8**
85	**15**	**7**	**18.7**	**28**	**22.7**
80	**20**	**7**	**17.3**	**28**	**20.3**
75	**25**	**7**	**16.6**	**28**	**19.4**

Table-6 Permeability of pervious concrete with Silica fume mix

cement (%)	Silica fume (%)	days	Average Permeability (mm/sec)
100	**0**	**28**	**23.50**
95	**5**	**28**	**14.18**
90	**10**	**28**	**12.65**
85	**15**	**28**	**12.15**
80	**20**	**28**	**11.82**
75	**25**	**28**	**11.67**

Table-7 compressive strength of pervious concrete with Silica fume mix

cement(%)	Silicafume (%)	days	Compressive strength (N/mm²)	days	Compressive strength (N/mm²)
100	0	7	22.1	28	27.3
95	5	7	27.3	28	33.6
90	10	7	21.6	28	22.4
85	15	7	18.1	28	19.5
80	20	7	16.4	28	17.6
75	25	7	13.2	28	15.3

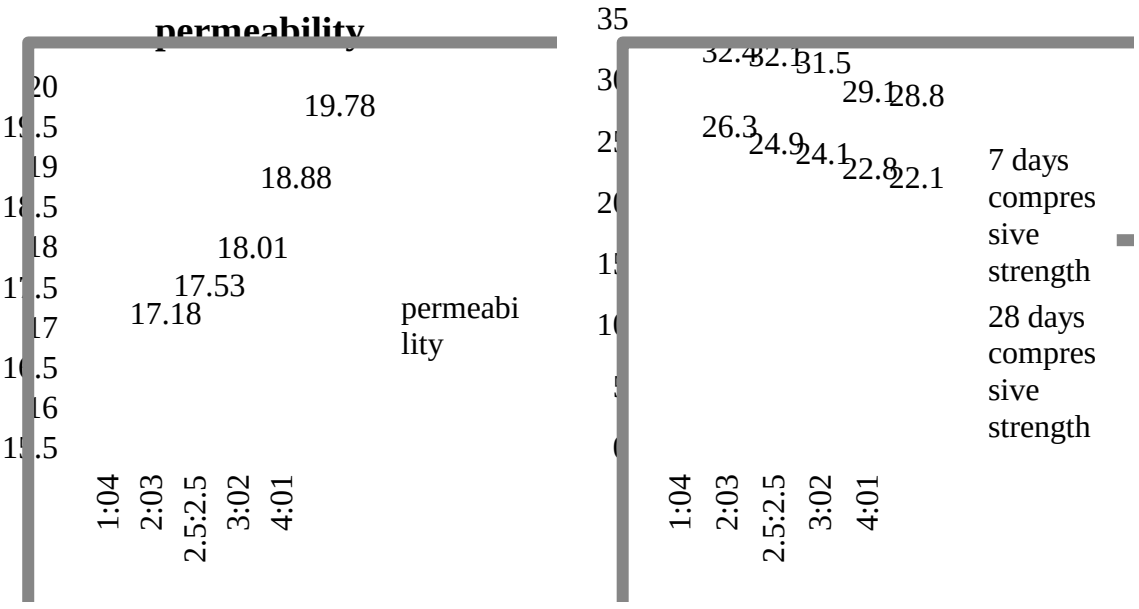
Based on above results, it shows that 5% replacement in fly ash decrease permeability 5% then normal pervious concrete and also 5% replacement of silica fume shows 24% higher strength than normal pervious concrete. So,

it may possible that combination of these both admixtures replaced upto 5% with cement can give acceptable permeability as well as compressive strength. So, different combination of fly ash and silica fume has been made out for further work and results are shown below:

Table-8 permeability and compressive strength of pervious concrete with combination of fly ash and silica fume mix

Cement (%)	Fly ash (%) + Silica fume (%)	days	Average Permeability(mm/sec)	compressive strength(N/mm²)
100	0	28	23.50	27.3
95	1+4	28	17.18	32.4
95	2+3	28	17.53	32.1
95	2.5+2.5	28	18.01	31.5
95	3+2	28	18.88	29.14
95	4+1	28	19.78	28.89

Comparison graphs of permeability and compressive strength of combination of fly ash & silica fume mix replacement with cement in pervious concrete are given below:



V. CONCLUSION

Replacement of Fly ash from 5% to 25% shows decrement in strength from 4% to 28% &permeability is also decreased with increment of fly ash mix up to 30% than normal pervious concrete but with 5% replacement of fly ash shows only 5% decrement in permeability and so still it is acceptable for pervious concrete. With silica fume replacement in pervious concrete, It shows that with 5% replacement of cement gives strength up to 24%

higher than normal pervious concrete. But with increment of this admixture with replaced to cement shows strength loss of 44% then normal pervious concrete.

Based on above results, we found out that if we use fly ash at range of 0% to 5% as a replacement material with cement content in pervious concrete it gives better performance with permeability as it is main parameter of pervious concrete. On other hand, silica fume is much expensive than fly ash and also at a limit of 5%, it gives better compressive strength but permeability of pervious concrete gradually decrease with use of this admixture.

Based on above results, combination of 5% of (fly ash : silica fume) mix has been taken. Different percentage ratios such as, 1: 4, 2: 3, 2.5: 2.5, 3: 2 & 4: 1 have been taken. Ratio 1: 4 shows deduction in permeability upto 26% but as well as compressive strength of this ratio increases upto 15%. Ratio 2:3 shows permeability of pervious concrete decreased upto 25% but compressive strength increases upto 14% than normal pervious concrete. Ratio of 2.5: 2.5 gives decrement in permeability of 23% and compressive strength gets higher upto 13%. 3: 2 ratio gives compressive strength increment of 6% than normal concrete as fly ash is more than silica fume content. Among all ratios, 4:1 ratio has permeability decrement of 19% which is less than other combination mix and also compressive strength increases 5% than normal pervious concrete.

REFERENCES

[1] Sharma Sanket,singlasarita and kaurtaranjeet, "Mechanical Properties of Pervious Concrete", International Conference on Advances in Civil Engineering 2012, ACEE, India.

[2] Ibrahim A, Mahmoud E, Yamin M, "Experimental study on Portland cement pervious concrete mechanical and hydrological properties", Construction and building materials 2013, ELSEVIER

[3] Bonicelli A, Giustozzi F, Crispino M, "Experimental Study on Effects of fine sand addition on differentially compacted pervious concrete'', construction and building materials, Elsevier, may 2015.

[4] Yang J, Jiang G "Experimental study on properties of pervious pavement materials", cements and concrete research, Pergamon, august 2012.

[5] Zhong R, Wille K, "Material design and characterization of high performance pervious concrete", construction and building materials, Elsevier, august 2015.

[6] Huang B, Shu Xiang, "laboratory evaluation of permeability and strength of polymer-modified pervious concrete", construction and building materials, Elsevier, November 2009.

[7] Zaetang Y, Wongsa A, Chindaprasirt P, "Use of lightweight aggregates in pervious concrete", conastruction and building materials, Elsevier, august 2013.

[8] Torres A, Hujiong, Ranos Amy, "The effect of the cementitious paste thickness on the performance of pervious concrete", Elsevier, July 2015.

[9] Khatib J.M., "Performance of self-compact ing concrete containing fly ash", conastruction and building materials, Elsevier, September 2007.

[10] SilAmitva, Kumar D., RoySingha, "Performance of High Volume Fly Ash Concrete Using Local Power Plant Fly Ash", International Journal of Composite and Constituent Materials journals pub, 2015.

[11] Yasar E, Duran C, Kilic A., Gulsen H., "Strength properties of lightweight concrete made with basaltic pumice and fly ash", construction materials, Elsevier, November 2003.

[12] Damirboga R., "Thermal conductivity and compressive strength of expanded perlite aggregate concrete with mineral admixtures", energy and buildings, Elsevier,September 2003.

[13] Sabet F.,Libre N, Shekarchi M., "Mechanical and durability properties of self consolidating high performance concrete incorporating natural zeolite, silica fume and fly ash."

[14] Siddique R., "Compressive strength, water absorption, sorptivity, abrasion resistance and permeability of self-compacting concrete containing coal bottom ash", Elsevier, July 2013.

[15] Nochaiya T., Wongkeo W., Chaipanich A., "Utilization of fly ash with silica fume and properties of Portland cement–fly ash–silica fume concrete", Fuel, Elsevier, October 2009.

[16] Baptiwale V., "Pervious concrete: A Concrete step towards a greener, ambuja cements, India.

[17] ACI 522 Reports on pervious concrete

[18] SHETTY M.S., "Concrete technology : theory and practice"

[19] NEVILLE A.M., "Concrete technology"

[20] Aoki Y. Thesis "Development of pervious concrete", University of Technology, Sydney, June 2009.

[21] IS-3812(2)-2013:PULVERISED FUEL ASH SPECIFICATION

[22] IS-15388(2003):SILICA FUME-SPECIFICATION

[23] IS-516(1959): METHODS OF TESTS FOR STRENGTH OF CONCRETE.