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Influence of flyash on Fineness, Porosity and Permeability of Flyash blended Cement paste

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Abstract - *This paper investigates the effects of the fineness of flyash cement paste on the porosity and permeability of mortar mixtures with replacement of cement at different percentages. The fly ash were used to replace Portland cement at replacement percentage of 0% (which was the control mix), 10%, 20%, 30%, 40%, and 50% by cement weight. Test results demonstrate that using fly ash as a cement replacement resulted in a reduction in the maximum temperature rise in mortar because of the fineness of the fly ash. The effects of the fineness and shape of fly ash on the porosity and air permeability of cement pastes were investigated. Portland cement was outmoded with fly ash at the dosages of 0, 10%, 20%, 30%, 40% and 50% by weight replacement. The results show that the porosity and air permeability of the pastes are influenced by the shape, fineness, and replacement level of fly ash. The permeability of cement fly ash pastes decreases with the increase in re- placement level and fineness. Decrease in porosity and permeability are due to a combined effect of the packing of fine particles, the pozzolanic reaction of fly ash, and the hydration of cement.*

Key Words: **Flyash, Fineness, Permeability, Porosity, Cement flyash paste.**

1. INTRODUCTION

In designing concrete structures, durability is one of the most paramount properties to be considered, in additament to the competency of the structure to resist all loads. Concrete durability depends largely on fluids in form of liquid or gas mi- grating through hardened concrete. Concrete is a porous material; ergo, moisture kinetics' can occur by flow, diffusion, or absorption. The ingress of sundry ions, liquid, and/or gas from the environment is responsible for deterioration and damage of concrete .It is generally accepted that the pore structure and porosity of pastes, mortars, or concrete are among the most consequential properties and vigorously affect both its mechanical properties (creep, and shrinkage) and convey properties (permeability, diffusion, and absorption). Convey properties are intimately cognate to the resistance of concrete structures to sundry durability quandaries and controlled by the pore size distribution network of hardened cement pastes and concrete. Fly ash is a pozzolanic material and a by-product from combustion of pulverized coal in an electricity power plant. Characteristics of fly ash vary due to coal type and combustion condition. Utilization of this fly ash is still constrained due to the lack of understanding on the characteristics of fly ash itself and the properties of fly ash concrete. Albeit many re- searchers investigated the influences of fly ash on the porosity and air permeability of coalesced cement pastes, few re- searchers were found dealing with the fineness and shape of fly ash and their influences on the properties of hardened cement pastes. Understanding the effects of the fineness and shape of fly ash on the porosity and air permeability of cement pastes will lead to an incrementing utilization of fly ash in concrete.

2. Experimental Program

The chemical composition of cement and flyash with the percentage is tabulated in Table 1.

Table 1. Chemical composition of cement and flyash

Oxide Composition	Cement (%)	Fly Ash (%)
SiO_2	21.28	56.58
Al_2O_3	5.6	27.83
Fe_2O_3	3.36	4
CaO	64.64	4.3
MgO	2.06	1.4
SO_3	2.14	-

Fineness's of cement and fly ash is shown in Table 2. It can be observed that the fineness of the raw material is increasing from cement to fly ash after being processed. From the Blaine fineness test, the fineness of cement resulted is 3100.43 cm^2/g; while the fineness of fly ash as collected is 5502.62 cm^2/g. From these results, it can be seen that fly ash is finer than cement.

Table 2. Fineness of cement and fly ash

Material	Fineness (cm^2/g)
Cement	3100.43
Fly ash	5502.62

A constant dihydrogen monoxide-to-binder ratio (w/b) of 0.35 was maintained in this study. Cylindrical paste specimens with 38 mm in diameter and 65 mm in height were cast for porosity and air permeability tests. After being remedied in saturated lime dihydrogen monoxide for 28 days, the terminuses of samples were cut with a diamond optically discerned to obtain 50-mm-high cylinders. Samples were then dried in an oven at 105±5°C for approximately 24 hour until constant weight was reached and kept in a dessicator with silica gel for cooling for another 24 hour respectively. The categorical surface area of fly ash is, however, very high at 8200 m2/kg.

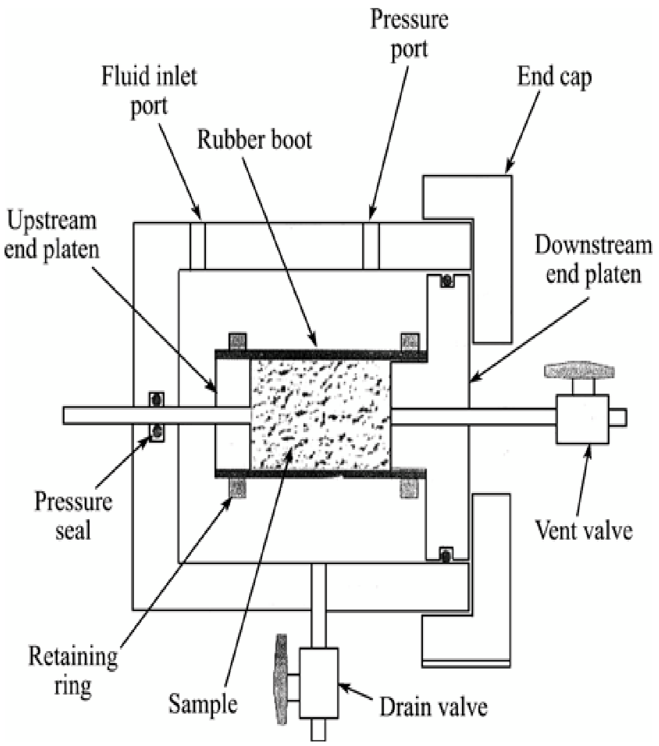

Fig. 1. Cell and specimen holder

High categorical surface area despite kindred median particle size to that of PC suggests that its surface is eccentric highly. Concrete surface areas of the medium and fine fly ashes and ground river sand remotely increase with incrementing fineness, as expected. There are no standards for gas permeability tests, a method by which air flow is utilized to determine the intrinsic permeability of rock is available in ASTM standard D4525.

A cell permeable meter as shown in Fig. 1. This equipment was used prosperously in petroleum technology to quantify the permeability of rock cores was to determine the permeability of the sample, air at a initial pressure (upstream pressure) was applied to coerce air to permeate the length of the sample. The sample was sealed along its length. The flow rate of air out of the other cessation of the sample was quantified.

The permeability of the sample was calculated utilizing Darcy's law through the cognizance of upstream pressure, flow rate during test, atmospheric pressure, air viscosity, and the length and cross section of the sample.

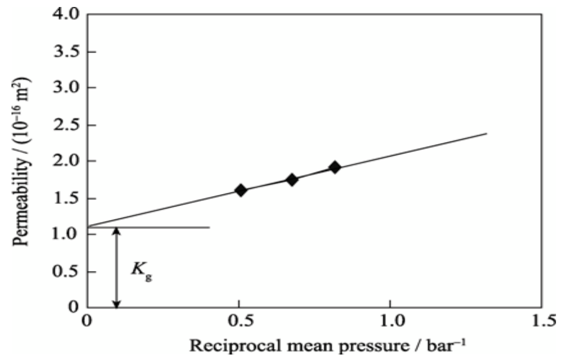

Fig. 2. Relationship between permeability and reciprocal mean pressure.

Results of porosity of the pastes are plotted in Fig. 2. As anticipated, the porosity of fly ash pastes decreases with the increase in fly ash replacement level. The porosity of the pastes containing fly ash is significantly lower than that of cement at all replacement levels and ages. The porosities of cement fly ash pastes with 20% replacement at 28 day is 21.2% respectively. Whereas the porosities of cement pastes ta 0% flyash is 19.1% at 28 days.

Decrement in porosity is mainly a result of the utilization of fine fly ash. The porosity of fly ash pastes is lower than that of cement pastes due mainly to the difference in particle morphology.

The shape and surface of cement are high anomalous since they are composed at low temperature of the fluidized combustion system, while those of fly ash are spherical and the ash has a relatively smooth surface due to high-temperature combustion.

In integration, fine fly ash particles withal engendered dispersing and packing effects resulting in a more homogeneous and denser matrix. Fly ash particles incremented the available space around cement particles and expedited hydration reaction. The mechanisms of reducing the porosity of fly ash pastes, thus, consisted of hydration, pozzolanic reaction, and dispersing and packing effects.

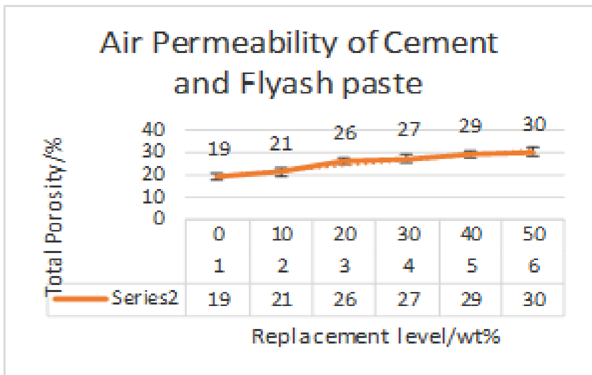

Fig 3. Air-Permeability of the cement and flyash paste

Results of air permeability of the pastes are shown in Fig. 3. As conventional, the air permeability of all pastes de- creases with remedying time as the capillary pores are gradually reduced resulting from hydration and pozzolanic reactions. It can be observed that incorporation of fly ash significantly amended the air impermeability of the pastes with the increment in fly ash fineness and supersession levels. It has been suggested that the presence of fly ash leads to a more preponderant precipitation of cement gel products in comparison to that of PC alone. This results in an efficacious blocking of pores and, thus, avails in reducing permeability. In addition, pozzolanic reaction of fly ash engenders supplemental cementitious compounds that block channels, and fill pore space and, thus, further reduce the permeability of the hardened pastes. The fineness of fly ash is a primary physical characteristic that influences the pozzolanic activity. The glass content of fine fly ash parti- cles is higher than that of coarser ones from the same source. When fine fly ash is incorporated, the pastes are more homogeneous and denser as a result of pozzolanic reaction and packing effects; the air permeability of the pastes is, consequently, decremented. The air permeability of fly ash pastes additionally decreases with the increase in fineness of fly ash.

3. CONCLUSIONS

(1) The porosity and air permeability of the pastes are influenced by the curing time and incorporation of fine materials. Reductions in porosity and air permeability of the pastes with increasing curing time are a result of the increase in hydration of cement. Influences of the incorporation of fine materials are related to particle shape, fineness, replacement level, and degree of pozzolanic activity.

(2) The air permeability of cement pastes is higher than those of cement and fly ash pastes at the same porosity. This is due primarily to the highly irregular shape and surface of cement.

(3) The fly ash is from conventional pulverized coal combustion and consists of spherical and relatively smooth surface particles and, thus, produces a good packing of fine particles. The relatively low permeability of cement flyash pastes is from a reasonably good packing of fine particles.

(4) The pozzolanic activity of fly ash further reduces the permeability and porosity of fly ash pastes. The pozzolanic reactivity of fly ashes also increases with the increase in their finenesses. This contributes to lower porosity and permeability, as the pozzolanic activity of fine fly ash is greater than that of the cement particles. Decrease in porosity and permeability are due to a combined effect of the packing of fine particles, the pozzolanic reaction of fly ash, and the hydration of cement.

REFERENCES:

1. K. Kiattikomol, C. Jaturapitakkul, and J. Tangpagasit, Effect of insoluble residue on properties of Portland cement, Cem. Concr. Res., 30(2000), p.1209.

2. M.I. Khan, Permeability of high performance concrete, Mater. Civ. Eng., 15(2003), No.1, p.84.

3. S.G. Patil and B. Bhattacharjee, Size and volume relationship of pore for construction materials, J. Mater. Civ. Eng., 20(2008), No.6, p.410.

4. J.J. Koller, The determination of the permeability of concrete to oxygen by the cembureau method - a recommendation, Mater. Struct., 22(1989), p.225.

5. S. Tsivilis, J. Tsantilas, G. Kakali, E. Chaniotakis, and A. Sakellariou, The permeability of Portland limestone cement concrete, Cem. Concr. Res., 33(2003), p.1465.

6. S. Tsivilis, E. Chaniotakis, G. Batis, C. Meletiou , V. Kas-selouri, G. Kakali, A. Sakellariou, G. Paulakis, and C Pseimidas, The effect of clinker and limestone quality on the gas permeability, water absorption and pore structure of lime- stone cement and concrete, Cem. Concr. Compos., 21(1999), No.2, p.139.

7. A. Abbas, M. Carcasses, and J.P. Ollivier, Gas permeability of concrete in relation to its degree of saturation, Mater. Struct., 32(1999), p.3.

8. M. Carcasses, A. Abbas, T.P. Ollivier, and J. Verdier, An op-timised precondition procedure for gas permeability meas-urement, Mater. Struct., 35(2002), p.22.

9. R.K. Dhir, P.C. Hewlett, and Y.N. Chan, Near surface char-acteristics of concrete: intrinsic permeability, Mag. Concr. Res., 41(1989), p.87.

10. P. Chindaprasirt, C. Jaturapitakkul, and T. Sinsiri, Effect of fly ash fineness on compressive strength and pore size of blended cement paste, Cem. Concr. Compos., 27(2005), No.4, p.425.

11. R.F.M. Bakker, Permeability of blended cement concretes, [in] V.M. Malhotra ed., Proceeding of the First International Conference on Fly Ash, Silica Fume, Slag, and other Mineral By-products in Concrete, Montebello, 1983, p.589.

12. E.J. Garboczi, Computation materials science of cement-based materials, Mater. Struct., 26(1993), p.191.

13. E.J. Garboczi, Permeability, diffusivity and microstructural parameters: A critical review, Cem. Concr. Res., 20(1990), p.591.

14. J. Payá, J. Monzó, E. Peris-Mora, M.V. Borrachero, R. Ter-cero, and C. Pinillos, Early-strength development of Portland cement mortars containing air classified fly ash, Cem. Concr. Res., 25(1995), No.6, p.449.

15. K. Erdogdu and P. Turker, Effect of fly ash particle size on compressive strength of Portland cement fly ash mortars, Cem. Concr. Res., 28(1998), No.9, p.1217.