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Characterisation Of Microstructure Properties Of Concrete Using Fly Ash

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ABSTRACT

Concrete is highly heterogeneous and has very complex microstructure. Therefore, it is very difficult to constitute a realistic model of its microstructure in order to understand the behavior of the material. The microstructure of concrete also changes with age, cement content, the water: cement ratio, curing, chemical admixtures, and incorporation of pozzolonic material (slag, fly ash, etc.).The principle aim of this study is to formulate the mix design for concrete with mineral admixtures like fly ash up to 20% as cement replacements and to characterize the microstructure properties of concrete.

1. INTRODUCTION

Microstructure-property relationship is at the heart of modern material science. Furthermore many concrete in service are subject to deterioration by various chemical and physical processes, all of which modify their internal structures as well as their end-use properties. The service life and durability of a concrete structure strongly depend on its material transport properties, such as permeability, sorptivity, and diffusivity which are controlled by the micro structural characteristics of concrete.

- In order to achieve high strength, low permeability, and durable concrete, it is therefore necessary to reduce the porosity of cement paste.
- It is well known that the incorporation of pozzolanic materials as partial replacement of cement refines the porosity and pore size distribution of the paste.
- Fly ash is known to be a good pozzolanic material for use in concrete, and many researches have established its effect on the physical properties and pore structure of concrete.
- The pore structure changes due to differences in fly ash fineness are not well established. So this project is to characterize the microstructure property such as the pore size ,air pockets, particle distribution and cement matrix in concrete with partial replacement of cement by fly ash.
- Scanning electron microscopy (SEM) has been a primary tool in the investigation of the complex internal structure of concretes and hydrated cement pastes for many years.

2. LITERATURE REVIEW

Yasutaka Sagawa, Hiromichi Matsushita, et al (2006). In this study, the strength and the carbonation speed of the mortar incorporating recycled fine aggregate were examined. Strength and carbonation speed could be evaluated by total water-cement ratio, which was obtained by summation of water content and total water absorbed in aggregate. Pore volume between 50nm and 2μm in new cement matrix phase was porous and loose when recycled fine aggregate with high water absorption was used in mortar. Performance of mortar incorporating recycled fine aggregate correlated closely with pore volume between 50nm and 2μm in new cement matrix phase. It was suggested that water included in recycled aggregate moved to new cement matrix phase during cement hydration.Yasutaka Sagawa, Hiromichi Matsushita, et al (2006). In this study, the strength and the carbonation speed of the mortar incorporating recycled fine aggregate were examined. Strength and carbonation speed could be evaluated by total water-cement ratio, which was obtained by summation of water content and total water absorbed in aggregate. Pore volume between 50nm and 2μm in new cement matrix phase was porous and loose when recycled fine aggregate with high water absorption was used in mortar. Performance of mortar incorporating recycled fine aggregate correlated closely with pore volume between 50nm and 2μm in new cement matrix phase. It was suggested that water included in recycled aggregate moved to new cement matrix phase during cement hydration. N. Arreshvhina , Z. Fadhadli , et al(2006). This paper reports the compressive strength and micro structural changes in two types of aerated concrete mix, exposed to various curing conditions. The two types of mix is one with 100 percent OPC (MCTR), while the other one with 65 percent slag replacement (M65) . The compressive strength was tested at 14, 28, 90, and 180 days, while micrograph of the internal structure was and L.J. Powers-Couche (1996) focused on microstructure of cement pastes / aggregates, micro voids or cracks, and separation of cement paste from aggregate in heated concrete samples. They observed that concrete exposed to temperature below 300ºC was dominated by only localized boundary cracking. Cracking around aggregate particle boundaries and intra paste cracking were observed between 300ºC and 500ºC. Above 500ºC in serous cracks within the cement and around aggregate particle.

3. MATERIAL REQUIRED

The ordinary Portland cement of grade (53) is used for the present investigation and tested as per IS 4031-1988. Natural river sand with fineness modulus of sand is around 3.01 with specific gravity around 2.65. Coarse aggregate of size 20 mm has been selected for the study Specific gravity of coarse aggregate should be around 2.70. Fly ash is used replacement of cement

4.MIX PROPORTION

Ingredients	**Cement**	**Fine aggregate**	**Coarse aggregate**	**Fly ash**	**Water**
Unit weight (Kg/m3)	440	785	1060	0	173
Mix proportion	1	1.784	2.409	0	0.39

5. COMPRESSIVE STRENGTH

Cube specimens of size 100 mm ×100 mm × 100 mm were cast for each mix proportion. After taken at the age of 14, and 180 days. The micrograph was taken using scanning electron microscope (SEM). The results show that mix MCTR exhibits much less strength compared with M65, for all curing conditions Wei-Ming, T.D. Lin curing for required period the specimens were tested using compressive testing machine. The axis of the specimen was aligned with the center of thrust of the spherically seated platen. The load was applied without shock and increased continuously at a rate of approximately 140 kg/cm^2/min until the resistance of the specimen to the increasing load breaks down and no greater load can be sustained. The maximum load taken by specimen was recorded. Figure 1 shows the typical compressive testing setup.

Compressive strength is determined using the following formula

Compressive strength (MPa) = Maximum load (N) /cross sectional area (mm^2)

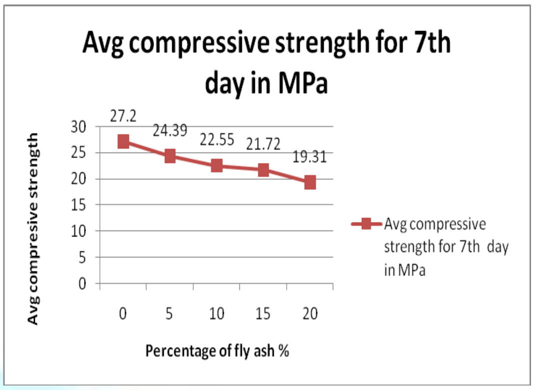
Fig1: Compressive strength testing

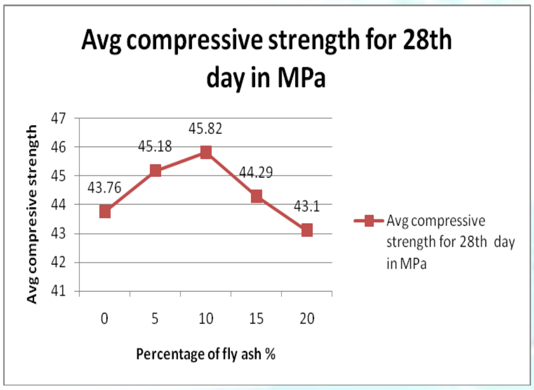
The strength development of Fly ash concretes in 7 and 28 days curing were shown in table1 . The compressive strength of M35 grade of fly ash concrete decreases with the percentage added at early stage and found to gain strength in the final stage.

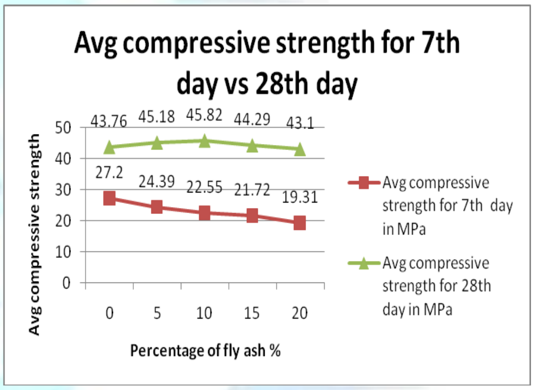
Table1: strength development of Fly ash concretes in 7 and 28 days

Sl.no	Percentage of fly ash %	Avg compressive strength for 7th day in MPa	Avg compressive strength for 28th day in MPa
1	0	27.20	43.76
2	5	24.39	45.18

3	10	22.55	45.82
4	15	21.72	44.29
5	20	19.31	43.10







For the 28th day compressive strength for M35 grade 10% replacement of cement by fly ash gave the optimum strength.

6.METHOD OF PREPARING CONCRETE SPECIMEN BY DRY POTTING

Dry potting is used when the specimen has been dried before, when drying shrinkage-related cracking is not of concern, or when a rapid preparation is needed.

- Dry specimen potting involves taking a sawn section or block of material and drying the specimen at low temperature (less than 65°C). Removal of water is necessary as it can interfere with polymerization of the epoxy.
- The specimen is then placed in a container and surrounded by epoxy leaving a top surface exposed to the laboratory air, allowing the epoxy to be drawn into the microstructure by capillary suction.
- To speed the infiltration, the specimen may be completely immersed in epoxy, and a vacuum drawn to remove remaining air. Upon release of the vacuum, the epoxy is forced into the pore system.
- The epoxy is cured at low temperature (65° C), and then is ready for the cutting and polishing.

7. IMAGES OBTAINED FROM SEM ANALYSIS

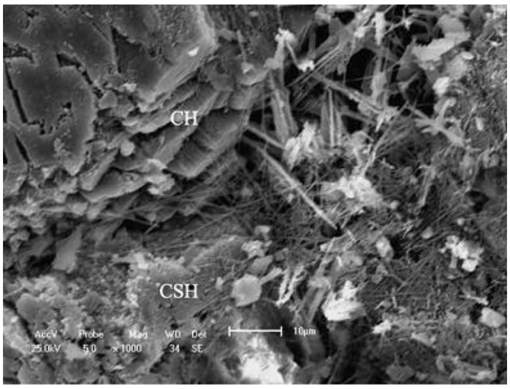


Fig (a).Micrograph of 10% fly ash concrete

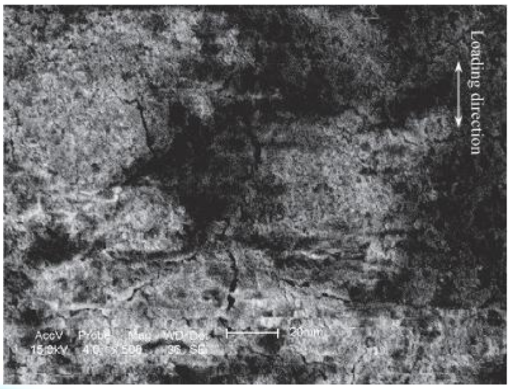


fig (b) Surface cracking for the 10% fly ash concrete

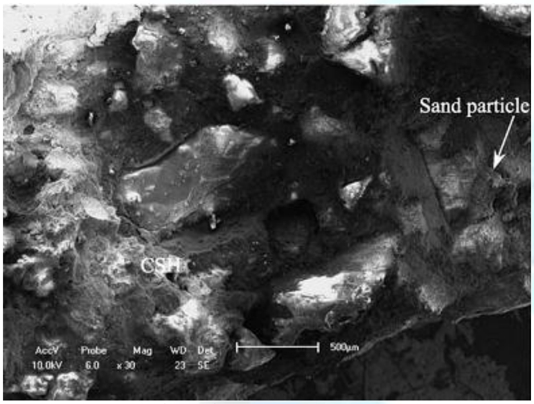


Fig (c).Micrograph of 20% fly ash concrete

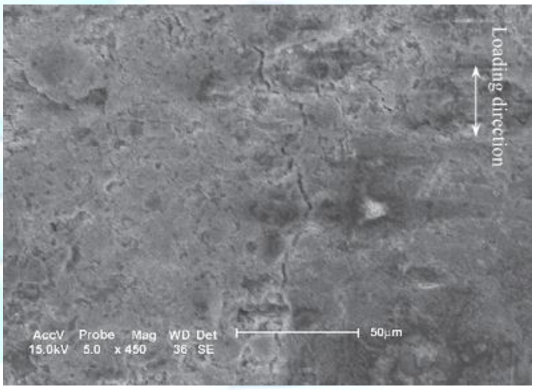


fig (d) Surface cracking for the 20% fly ash concrete

8. RESULS AND DISCUSSIONS

It is clearly seen from Fig. (a) that an abundance of hydrated phases and pores, as well as cores such as Ca(OH)2 dendrite crystals or other crystals (marker bCHQ), and intermixed with calcium silicate hydrate (C-S-H; marked bCSHQ), as well as granular structure, exists in concrete containing 10% fly ash(A). However, concrete containing 20% fly ash(B) possesses different microstructures, as shown in Fig. 2(c) The microstructures may be characterized in terms of porosity and hydration progress.

Furthermore, the hardnesses of the two types of concrete depend on their microstructures too. The hardness of type A is higher than that of type B because the microstructure of the former is rather dense. However, their compressible strength depends not only on their hardness but also on their crack initiation and propagation mechanism. Besides the effect of the applied stress on the microcracking of concretes, the temperature environmental plays an important role in the microcracking of concretes.

The characteristics of microcrack initiation and propagation are similar to those as shown in Figs b. and fig d. But these microcracks did not continually propagate along the loading direction as the temperature increased. Therefore, the micro-crack initiation and propagation mechanism of type A concrete is analogous to that of type B concrete. But the density of microcracks for type A concrete is smaller than that for type B concrete at the same temperature.

9. CONCLUSION

SEM is an important tool in characterising various microstructure properties of engineering materials such as cement, aggregates,bricks,concretes etc . This tool helps us in better understanding of the materials and its behaviour. Since SEM plays a vital role in civil engineering for innovative and research works it could be rightly said that it is one of the improvement techniques in modern construction.

10.REFERENCES

1. Poon, C.S., Shui, Z. H. and Lam, L. (2004) Effect of microstructure of ITZ on compressive strength of concrete prepared with recycled aggregate, Construction and Building Materials, Vol.18, pp.461-468
2. GalleC. Effect of drying on cement-based materials pore structure as identified by mercury intrusion porosimetry; A comparative study between oven, vacuum, and freeze–drying. Cem Concr Res 2001;31:1467–77.
3. Konecny L, Naqui SJ. The effect of different drying techniques on the pore size distribution of blended cement mortars. Cem Concr Res 1993;23(5):1223–8.
4. Xi-Shu Wanga,, Bi-Sheng Wua, Qing-Yuan Wangb, Online SEM investigation of microcrack characteristics of concretes at various temperatures, Cement and Concrete Research 35 (2005) 1385– 1390.
5. Gao Peiwei , Lu Xiaolin, Yang Chuanxi, Li Xiaoyan, Shi Nannan, Jin Shaochun, Microstructure and pore structure of concrete mixed with super fine phosphorous slag and superplasticizer, Construction and Building Materials 22 (2008) 837–840.
6. A. Amouche, J. Riss, D. Greysse, J. Marchand, Image analysis for the automated study of microcracks in concrete, Cem. Concr. Compos. 23(2/3) (2001) 267–278.