A Review of Strength Properties of Calcined Kaolin and Silica Fume

Anil Kumar Chakrawarti[1] Prof. Anubhav Rai[2]

[1]M Tech. Student [2]Assistant Professor

[1,2]Gyan Ganga Institute of Technology & Science Jabalpur (M P)

Abstract— *Since the beginning of its use in concrete in Canada, silica fume has been used as a cement replacement material in normal strength concrete so as to obtain a desired 28-day compressive strength. It is presently used in the as produced form or in the form of blended cement. The two major cement producers in Canada are presently marketing what is called Type 10SF silica-fume blended cement. Whether it is used in the as-produced form at a concrete plant or blended with Portland cement, its dosage is always less than 10% by weight of cement. In fact, 10% is the maximum dosage that is permitted by the A23.6 Canadian standard (Isabelle 1986). On some occasions, it has been deliberately used for other applications, such as to control potential alkali/aggregate reaction and to make very high-strength concrete (Aitcin et al. 1985; Ryell and Bickley 1987). Recently, Carette et al. (1987) expressed concern regarding the lack of information on the long-term compressive strength of silica-fume concrete. They reported compressive strengths up to 2 years on a series of laboratory concretes, some of which contained silica fume. While nonsilica-fume concrete exhibited an ascending compressive strength during the testing period, the silica-fume concretes exhibit a plateau or a small decrease in the compressive strength after 1 year.*

Keywords— Calcined Kaolin, Silica Fume

I. INTRODUCTION

Silica fume (SF) is a byproduct of the smelting process in the silicon and ferrosilicon industry. The reduction of high-purity quartz to silicon at temperatures up to 2,000°C produces SiO2 vapours, which oxidizes and condense in the low temperature zone to tiny particles consisting of non-crystalline silica. By-products of the production of silicon metal and the ferrosilicon alloys having silicon contents of 75% or more contain 85–95% non-crystalline silica. The by-product of the production of ferrosilicon alloy having 50% silicon has much lower silica content and is less pozzolanic. Therefore, SiO2 content of the silica fume is related to the type of alloy being produced (Table 2.1). Silica fume is also known as micro silica, condensed silica fume, volatilzed silica or silica dust. The American concrete institute (ACI) defines silica fume as a ‘‘very fine noncrystalline silica produced in electric arc furnaces as a by product of production of elemental silicon or alloys containing silicon’’. It is usually a grey colored powder, somewhat similar to Portland cement or some fly ashes. It can exhibit both pozzolanic and cementitious properties. Silica fume has been recognized as a pozzolanic admixture that is effective in enhancing the mechanical properties to a great extent. By using silica fume along with superplasticizers, it is relatively easier to obtain compressive strengths of order of 100–150 MPa in laboratory. Addition of silica fume to concrete improves the durability of concrete through reduction in the permeability, refined pore structure, leading to a reduction in the diffusion of harmful ions, reduces calcium hydroxide content which results in a higher resistance to sulfate attack. Improvement in durability will also improve the ability of silica fume concrete in protecting the embedded steel from corrosion.

Fig. 1: Silica fume

II. HEAT OF HYDRATION

Silica fume is amorphous in nature and may contain some crystalline silica in the form of quartz or cristobalite. The higher surface area and amorphous nature of silica fume make it highly reactive. The hydration of C3S, C2S, and C4AF are accelerated in the presence of silica fume . Grutzeck et al. concluded that silica fume experiences rapid dissolution in the presence of Ca(OH)2 and a supersaturation of silica with respect to a silica-rich phase. This unstable silica-rich phase forms a layer on the surface of the silica fume particles. The layer is then partly dissolved and the remainder acts as a substitute on which conventional C–S– H is formed.

III. ADVANTAGES OF USING SILICA FUME

- High early compressive strength
- High tensile, flexural strength, and modulus of elasticity
- Very low permeability to chloride and water intrusion
- Enhanced durability
- Increased toughness
- Increased abrasion resistance on decks, floors, overlays and marine structures

IV. LITERATURE

Viscosity modifying admixtures VMAs have proven to be very effective to stabilize the rheological properties and the fluidity of cement grout, self-compacting concrete, and underwater concrete. Recently, there has been a growing interest in the use of cement grout containing viscosity admixture for repairs, injection, embedding of anchors and posttensioning, rock and oil-well grouting.

A cement-based grout should be stable enough to reduce sedimentation, bleeding, and water dilution. Cement-based grouts are widely used in injection grouting of cracks in massive structures since their physical and mechanical properties can be easily controlled. This is assured by judicious choice of the type and fineness of cement, water-to-binder ratio W/B, chemical and mineral admixtures

Warner 2004. VMAs are used to enhance cohesion and stability of cementbased systems. VMAs are generally water-soluble polysaccharides or synthetic or semisynthetic that enhance the water retention capacity of paste Kawai 1987; Ghio et al. 1994; Khayat 1995. Starch is a natural polysaccharide obtained from potato, maize, wheat, etc.

For example, potato starch contains 80% amylopectin and 20% amylase Terpstra 2005. The use of VMA increases the yield stress and plastic viscosity of the cement-based grout, thus necessitating an increase in W/B or high-range water reducer HRWR dosage to insure a low yield stress necessary for proper penetrability and spreading in cracks or self-compacting slurry infiltrated fiber concrete Sonebi 2006; Svermova et al. 2003 . An increase in the W/B results in a reduction in mechanical properties, a reduction in durability, and an increase of permeability of grouts Svermova et al. 2003; Khayat and Ballivy 1996.

References

[1] Aiftcin, P. C, and Vezina, D. (1984). "Resistance to freezing and thawing of silica fume concretes." Cement, Concrete and Aggregates, 38-42.

[2] P. C, Laplante, P., and Bedard, C. (1985). "Development and experimental use of a 90-MPa (13,000 psi) field concrete." Report ACI SP-87, 51-70.

[3] P. C, et al. (1984). "Very high strength cement for very high strength concrete" Proc, Material Res. Society, 201-210.

[4] P. C, et al. (1987). "Microstructure of a two-year-old, very high strength field concrete (100-MPa)" Proc. Symp. in Utilization of High Strength Concrete, 99-109.

[5] Asselanis, J., Ai'tcin, P. C, and Mehta, P. K. (1989). "Influence of curing conditions on compressive strength and elastic modulus of very high strength concrete specimens." Cement, Concrete and Aggregates.