Fly Ash

FOR PRECAST / PRESTRESSED CONCRETE PRODUCTS

Production of precast concrete products involves intricate, difficult patterns. Fly ash concrete mixes can help precasters solve challenges in many areas of production.

Precast concrete products can be produced with or without reinforcement, but units typically consist of narrow, deep sections which are heavily reinforced, making concrete placement very difficult. Reinforcement typically includes the use of fibers, conventional reinforcing steel, and prestressing steel tendons, either pretensioned or post-tensioned or combinations thereof. Mixtures must have enough workability to flow well under vibration and totally fill the form without segregation. Hand finishing is often required, necessitating a mixture workable enough to allow for this kind of manipulation.

By definition, precast concrete products are cast and cured in other than their final position.[1] This enables the use of reusable forms which, due to economic concerns, are cycled as rapidly as possible. For this reason, these concrete products generally achieve their competitive position in the marketplace by using a limited number of forms with a short production cycle. Normal production schedules allow for one usage of forms per day; however, 10 to 12 hour schedules are common. Accelerated curing, typically employed to enhance early age concrete strength for handling, shipping, and product utilization, accelerates the pozzolanic reaction of fly ash to help develop the necessary early strengths.

Concrete mixtures for these products are proportioned for high levels of performance at early ages. Compressive strengths of 3,500 to 5,000 psi (24 to 28 MPa) are typically required at the time of form removal or stripping. These early concrete strengths are generally achieved with cementitious material contents of 600 to 750 lb/cy (355 to 445 kg/cm). Conventional and high-range water reducing agents are often employed to attain workability at very low water content. Non-chloride accelerating admixtures are also used when necessary. While the early strength gain characteristics of fly ash have generally been considered too slow for use in these mixtures, perceptions are changing toward the use of fly ash in these applications. As is true of all mixtures used

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Revision Date: 1.15.18

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in precast concrete work, mixture proportioning and curing procedures used must produce adequate early strength, or the turnaround time on forms or molds will be increased.[2]

While early age strength levels are required for stripping and handling, higher strength levels are required for the ultimate use of the products. The use of quality fly ash meeting ASTM C618 specifications is a must in the production of high strength concrete of 6,000 psi and higher.[3] The strength gain achieved from the use of 10% to 15% fly ash cannot be readily attained through the addition of a proportionate amount of cement.

Pretensioned hollow-core structural slabs are produced with no-slump concrete. It is consolidated and shaped as it passes through an extrusion machine. The particle shape of the coarse aggregate and the amount of fine aggregate are very important to workability. Fly ash is widely considered to be a beneficial ingredient to increase the workability of these dry, harsh mixes.[4] Early strength performance of these mixtures using Class F fly ash closely parallels mixtures without fly ash in terms of early compressive strength. No early strength reduction is apparent.

Although most concern is directed at obtaining desired early compressive strengths, these concrete products must possess durability to resist destructive attack from numerous environmental factors.[5] Fly ash is seen as a major ingredient utilized in the production of durable concrete and as such should be included in any concrete subject to severe environments. Responding to a questionnaire presented in August 1986, 77 members of the Precast/ Prestressed Concrete Institute (PCI) answered questions about their use of fly ash in prestressed concrete products.[6] Of the total respondents, 32% indicated that they were currently using fly ash in their products, 9% had used fly ash but had stopped, and 58% never used fly ash. Of those that were using fly ash, the average cement replacement was 19%, with the lowest being 12% and the highest being 30%.

Of the respondents using fly ash, 42% stated cost savings and 40% stated increased workability of the mix as major reasons they used fly ash. Other reasons for use of fly ash were: 1) increased 28 day strength, 2) achieved 3,500 psi overnight, 3) better filling of voids, 4) reduction in permeability, and 5) minimization of shrinkage.

Concerns as to the performance of Class F fly ash in prestressed concrete were addressed in a study by Dhir, Munday, and Ho in 1988.[7] Concrete specimens were investigated at ages from 18 hours to 1 year into the areas of strength development (compressive and tensile) and deformation behavior (elastic, creep and shrinkage). With various replacement rates evaluated, it was concluded that concretes

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containing fly ash perform as well as, or better than, concretes containing only rapid hardening cement. The small amount of alkalis, sulfates, unburned carbon and chlorides present in fly ash do not result in problems with regard to corrosion of the reinforcement.[8]

Fly ash may also be valuable as a mineral admixture to enhance product quality. Fly ash used in precast concrete products improves workability, resulting in products with sharp, distinctive corners and edges. Fly ash can also provide improved flowability, resulting in products with better surface appearance. Better flowability and workability properties achieved by using fly ash are particularly desirable for products with intricate shapes and surface patterns and for those that are heavily reinforced. Reduced costs associated with repair of surface defects can be attributed to the use of fly ash.

1 "Cement and Concrete Terminology", American Concrete Institute Committee 116R-90, p. 46.
2 Ravina, Dan, "Efficient Utilization of Coarse and Fine Fly Ash in Precast Concrete by Incorporating Thermal Curing", American Concrete Institute Journal, Proceedings V.78 No. 3, May-June 1981 pp. 194-200.
3 Blick, Ronald L., Peterson, C.F., Winter, M. E., "Proportioning and Controlling High Strength Concrete, Proportioning Concrete Mixes", American Concrete Institute, SP-46, pp. 142, 145, 1974.
4 Juvas, Klaus, "The Workability of No-Slump Concrete for Use in Hollow Core Slabs", Nordic Concrete Research, Publication No. 6, pp. 121-130, 1987.
5 Gerwick, Ben C., Jr., "Practical Methods of Ensuring Durability of Prestressed Concrete Ocean Structures", Durability of Concrete, American Concrete Institute, SP-47, p. 318, 1975.
6 Shaikh, A.F., and Feely, J.P. 1986, "Summary of Responses to a Questionnaire and the Use of Fly Ash in the Precast and Prestressed Concrete Industry", PCI Journal, pp. 126-128, 1986.
7 Dhir, R.K., Munday, J.G. L., and Ho, N. Y., "PFA in Structural Precast Concrete: Engineering Properties", Cement and Concrete Research, Vol. 18, pp. 852-862, 1988.
8 Visvesvaraya, H.C., "Incidence of Corrosion of Steel Reinforcement in Fly Ash Concrete", Cement Research Institute of India, Report RB-3-74, P. 2, 1974.