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DURABLE CONCRETE WITH MINERAL ADMIXTURES

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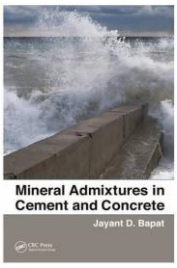
EMPIRE HOTEL, SUBANG JAYA



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What are the benefits of this course?

The behaviour of a structural system throughout its life is the primary concern of an engineer. The training programme has been designed keeping in mind the requirements of structural engineers and of those who are engaged in manufacturing concrete. It should also be useful for students of civil engineering, both at undergraduate and postgraduate levels.

The focus of the training is making good, that is, workable and durable, concrete. The physical, mineralogical, and chemical characteristics of mineral admixtures are discussed keeping that aspect in mind. As the programme has been designed for civil engineers, references to complex issues on microstructure or chemistry have been presented to an extent that help better understanding of the application of mineral admixtures in practice.

INTRODUCTION

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It is now an established fact that durable concrete means concrete with fewer microcracks (10–100 μm). Microcracks in concrete allow ingress of external deteriorating agents such as water, carbon dioxide, chlorides, sulfates, and so on, leading to the deterioration, distress, and destruction of the structure. They can be reduced by using pozzolanic or cementitious materials, collectively called mineral admixtures, to replace cement in concrete. The term includes all siliceous and aluminous materials, which, in finely divided form and in the presence of water, react chemically with the calcium hydroxide generated during cement hydration to form additional compounds possessing cementitious properties. They may be naturally occurring materials, industrial and agricultural wastes or by-products, or materials that require less energy to manufacture. The mineral admixtures covered under the scope of this training are pulverized fuel ash (PFA), blast furnace slag (BFS), silica fume (SF), rice husk ash (RHA) and metakaolin (MK).

C-S-H is a principal strength-giving compound in the hardened concrete. The formation of additional cementitious compounds during secondary hydration leads to a reduction in temperature rise and refinement of pore structure in the hardened concrete. Calcium hydroxide is considered as a weak link in the concrete structure. The consumption of calcium hydroxide to form strength-giving phases, principally C-S-H, during hydration leads to improved durability of the structure in terms of its resistance to deterioration through carbonation, corrosion, sulfate attack, alkali–silica reaction, and so on. Besides the chemical (pozzolanic or cementitious) reaction, the mineral admixtures also act physically.

The finely divided particles act as fillers. This is particularly significant in the interfacial zone, where they produce denser packing at the cement paste–aggregate particle interface, reduce the amount of bleeding, and produce a more homogeneous microstructure and a narrower transition zone. The overall effect is the enhancement in the strength and durability or the service life of concrete structures. These aspects shall be discussed during the course.

The understanding of the materials aspects of the mineral admixtures and their impact on the hydration, strength, and durability of concrete will make a positive contribution, encouraging greater and more fruitful utilization of these and even other wastes in cement and concrete, and lead to construction of stronger and durable structures, besides ensuring sustainable growth of both the cement and construction industry.

COURSE OBJECTIVES

The objective of the training programme is to impart deeper knowledge about the contribution of mineral admixtures in improving strength and durability of concrete. It should equip the practicing engineer make better choice of the type and quality of mineral admixture in concrete mix to optimize the cost on one hand, and build structures with greater reliability, on the other. The engineers on site, with the knowledge on the impact of environmental factors that are responsible for distress and deterioration of structures, shall be in a position to take appropriate preventive measures.

WHO SHOULD ATTEND

- Engineers working at construction site and interested in learning optimum utilisation of mineral admixtures for strength and durability.
- Marketing engineers working with cement, concrete and admixture industry, which frequently face customer queries regarding benefits of blended cement or admixtures.
- Engineers working on product development.
- Students/researchers interested in pursuing studies in the area.

COURSE OUTLINE

Day	Time (h)	Course/Activity
1	0900 - 1030	**Pulverised Fuel Ash (PFA)** Physical characteristics, chemical and mineralogical composition, PFA from fluidised bed combustion, PFA from co-combustion of bituminous coal and petcoke, processing of standard PFA, ultrafine PFA, quality control of PFA.
	1030 - 1045	Tea Break
	1045 - 1115	**Q/A on PFA**
	1115 - 1230	**Blast Furnace Slag (BFS)** Physical characteristics, chemical and mineralogical composition, GGBS quality control, addition of GGBS to cement and concrete.
	1230 - 1330	Lunch Break
	1330 - 1345	**Q/A on BFS**
	1345 - 1500	**Silica Fume (SF)** Physical , chemical and mineralogical characteristics, addition of SF to concrete. **Rice Husk Ash (RHA)** Physical and chemical characteristics and addition of RHA to concrete.
	1500 - 1530	**Q/A on SF and RHA**
	1530 - 1545	Tea Break
	1545 - 1630	**Metakaolin (MK)** Physical and chemical characteristics, addition of MK to cement and concrete.
	1630 - 1700	**Q/A on MK**

Day	Time (h)	Course/Activity
2	0900 - 1030	**Hydration of Cement** Progress of hydration with time (hydration periods), workability period, setting period or active reaction period, hardening period, major reactions occurring in hydration periods, comparison of hydration of alite (C3S) & belite (C2S) , hydration of cement with mineral admixtures.
	1030 - 1045	Tea Break
	1045 - 1200	**Hydration of Cement (cont)**
	1200 - 1230	**Q/A on Hydration**
	1230 - 1330	Lunch Break
	1330 - 1530	**Strength and Durability of Concrete (S&D)** Designing structures for strength and durability, prescriptive approach, performance-based approach, concrete strength, high-performance concrete (HPC), importance of concrete curing, role of mineral admixtures in preventing concrete deterioration, carbonation, alkali–aggregate reactions (AAR), alkali-carbonate reaction (ACR) & alkali-silica reaction (ASR), corrosion, national standards and guidelines on chloride corrosion, external sulfate attack, delayed ettringite formation (DEF), frost or freeze–thaw action.
	1530 - 1545	Tea Break
	1545 - 1630	**Strength and Durability of Concrete (S&D) (cont.)**
	1630 - 1700	**Q/A on S&D**

OUR CONSULTANT

Jayant D. Bapat, B.Tech., M.E., Ph.D. (IIT, Delhi). Stationed at Pune (Maharashtra, India), he currently works as an independent professional consultant for cement manufacturing, concrete, engineering educational institutions and fuel cell power.

Earlier (1994-2011) he was a faculty, Director and Principal at the engineering colleges affiliated to the University of Pune (India). He also worked at senior positions at the National Council for Cement and Building materials (NCB) (1975-1991), New Delhi and Walchandnagar Industries Ltd. (WIL) (1991-1994), Walchandnagar. WIL is a leading cement machinery manufacturer. He has also been a technical consultant to leading companies in the area of research, product development and techno-marketing.

He has 38 years of teaching, research, training and consultancy experience. He is responsible for bringing substantial improvement in the quality of teaching, research and administration of the engineering colleges, where he worked as a faculty and principal. In the engineering colleges, he initiated the studies on fuel cells, which is a modern source of power. His long standing expertise lies in the areas of cement manufacturing, durability of concrete and utilization of industrial and agricultural wastes in building materials. He has gained hands-on experience in preparing technical specifications for modern cement plants and equipment costing. He is an expert techno-commercial negotiator.

He is a reviewer of technical papers for number of international journals, such as the Journal of Cement and Concrete Research, Journal of Waste Management, ACI Materials and ACI Structural Journal and has membership of many professional organizations like American Concrete Institute, ICI, ISSE and Institution of Engineers. He has 42 publications to his credit in the national/ international journals / seminars. His biography has been included in the Who's Who in the World, Who's Who in Asia and Who's Who in Science and Engineering.

He has been distinguished as among "Top 100 Engineers 2012" and "International Engineer of the Year 2012", by the International Biographical Centre, Cambridge, England.