

Fly Ash Concrete Design for Chicago's 100-Year Road Structure

After years of heavy use, Wacker Drive, a major two-level viaduct in downtown Chicago, Illinois needed to be rebuilt. The Chicago Department of Transportation (CDOT) set ambitious goals for the \$200 million concrete structure because of its central location and importance to downtown traffic flow. The end result is a more durable roadway with a service life of 75 to 100 years.

Originally built in the 1920s, the artery has supported thousands of vehicles per day, and the old concrete structure had experienced deterioration through heavy deicing salt application in the harsh winter months. Corrosion damage to the reinforcing steel ultimately caused the need for reconstructing the concrete structure. According to a landmark study conducted by Battelle Memorial Institute for the National Bureau of Standards, corrosion damage in the United States is 4.2% of the Gross National Product (GNP). Projecting this percentage out to the current GNP, corrosion is estimated to cause \$350 billion in damage annually. Battelle estimates that over \$139 billion (40%) of these costs could be avoided through application of existing technologies and best-known practices. To provide resistance against future corrosion, Class F fly ash was selected as a proven existing technology along with other materials to enhance the new cast-in-place concrete structure.

High Performance Concrete (HPC) Used

Wiss Janney, Elstner Associates Inc. (WJE) and the University of Illinois-Chicago (UIC) were selected to design the concrete mixes. The final specifications included concrete compressive strengths between 6,000 and 9,500 psi in 28 days with chloride permeability in ponding tests to be less than 2000 coulombs to prevent the ingress of deicing salts into the concrete. The mix design included 525 lb/yd³ of cement, with 10% Class F fly ash, 15% ground granulated blast furnace slag, and 5% silica fume. The supplementary cementitious materials were used to achieve a less permeable cementitious matrix for corrosion protection. The combination of materials was used to offset the potential weaknesses of one material with the strengths of another. Class F

fly ash was also used in combination with other materials to help mitigate possible alkali-silica reactivity (ASR) from local fine aggregates.

Coulomb Range	Chloride Permeability
> 4000	High
2000 – 4000	Moderate
1000 – 2000	Low
100 – 1000	Very Low

Prairie Concrete supplied the concrete on this year-round, two-year project. Maintaining the consistent supply of materials involved strict attention to scheduling and coordination. Because they were transporting different HPC mixes to various locations on the project, they had to anticipate possible problems, including faster setting times in the summer, slower setting times in the winter, normal weather related fluctuations of air entrainment, and Chicago traffic. Years of experience with HPC mixes and constant vigilance by quality control personnel helped the designers to realize their 100 Year Concrete Design goal.

CDOT's policy is to achieve an ice-free pavement in the winter on all its main streets. Because Wacker Drive is one of the most traveled corridors in Chicago, it is expected to receive generous amounts of deicing salts, which was the primary cause of the first structure's failure. HPC is part of the 100 year design system, and will help prevent deterioration by deicing salts and corrosion. The deck is covered with a sacrificial latex-modified concrete (LMC) overlay, and the reinforcing bars are epoxy-coated. The more than 10 thousand tons of type F fly ash from Petersburg power station has again proven its technological advantage. Fly Ash concrete technology of today will aid visitors traveling Wacker Drive for the next century to drive on a more durable, low maintenance concrete surface. Travelers probably will not appreciate its state of the art design, but to the designers, contractors and suppliers, satisfaction comes with knowing they reached their end goal. HPC that lasts 100 years is more than a dream, it is reality in Chicago.

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High performance concrete mixes including fly ash, ground granulated blast furnace slag, and silica fume are part of CDOT's 100-year design system.
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For more information or answers to questions about the use of fly ash in specific applications, contact your nearest Headwaters Resources Technical Sales Representative or call 1-888-236-6236.

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