WEACAU-III: International Workshop on
Environmental Aspects of Coal Ash Utilization
Tel Aviv, Israel
December 11th – 12th 2012

The use of coal ash in concrete according to the Israeli standard and practice

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Abstract

Introduction

Coal ash has been in use in Israel for decades as a component in cement products, and its use has increased in line with imports of coal as a fuel for electricity production by the Israel Electric Corporation (I.E.C.)

Coal ash as a raw material for concrete production came into use in the mid-1990's, when the Israeli Coal Ash Board proposed to the Israeli Ready-Mixed Concrete Producers to use coal ash as one of the concrete mix design component, and the Ready-mixed industry itself, some of its members are owned by international parent companies, learnt about the use of coal ash in Western Europe and U.K.

Until 2008 the Ready-mixed Concrete Industry used coal ash (fly ash) as a replacement for sand in the mix design in view of the fact that the relevant Israeli Standard did not allow the use of the pozzolanic properties of the fly ash as an alternative for cement .However, the Ready-mixed Concrete producers discovered that concrete mixes containing fly ash produce a concrete of a higher strength than those without fly ash.

In June 2008 Israeli Standard SI 118 which complied with European Standard EN 206, came into effect ,and from then on the Ready-mixed Concrete Industry has been using fly ash both as a replacement for sand and as a replacement for cement in the concrete mix design (in compliance with the SI 118).

Today, 2012, the figures of fly ash consumption in the Concrete Industry are close to that of the Cement Industry- about 550,000-600,000 tons/year. In the event that the Cement Industry's consumption of fly ash should diminish for whatever reason then the Ready-mixed Concrete Industry would be able to increase its consumption immediately by 25%-35%.

The Users of Coal ash in Various Industries

As mentioned above coal ash is being used by two main industries: Nesher Israeli cement Enterprises Ltd which uses fly ash and bottom ash as a components in the clinker burning process and fly ash also as an additive in the grinded cement (in accordance with SI 1 based on EN 197-1), whilst the Ready-mixed concrete Industry uses the fly ash only as an alternative for cement and sand in the concrete mix, and in special mixes such as CLSM, grout, etc., in accordance with SI 118. (The Standards do not allow the use of fly ash in concrete industrial products such as pipes, pre-stress elements, hollow core slabs etc.).

The relevant Standards.

The following standards, based on the European Standards (excluding SI 5098) dictate the types of cement, the type of fly ash and its quality, the type of concrete mixes allowed containing fly ash and the quantity of fly ash which can partially replace cement in the concrete mix.

SI 1 – Cement, common cement

27 cement types, of which 8 types may contain fly ash. Of these only two are permitted for use in Israel.

SI 1209 – Fly ash for concrete

Defines two types of fly ash, the physical and chemical properties of the fly ash, and which type of fly ash may be used in concrete mixes.

SI 466 – Concrete code, general principles

Determines the design guidance, the permits for the materials used in concrete construction, amongst which a permit to use fly ash as a mineral addition replacing part of the cement in the concrete mix.

SI 118 – Concrete, specification, performance and production

Determines the design process of the concrete mix, the process of production and its quality control and the restriction on the use of cement and fly ash in various concrete mixes

SI 5098 – Content of natural radioactive elements in building products

Determines the system of measuring radioactivity in the concrete elements and indicates the required limitation.

Restrictions on the use of fly ash (technological, economic, administrative)

Israel standards IS 466 and IS 118 like European Standard EN 206, have defined 11 exposure classes for the production of durable concrete. These classes were defined according to the environmental conditions at the location of the concrete structure-whether located in dry desert regions, marine environment, or exposed to chemicals. For each exposure class, rules for concrete mix design were determined, including rules for the cement quantity and the use of fly ash.

At present, the use of fly ash in concrete mixes as a partially replacement for cement is approved only for exposure classes 1-4 out of the 11 classes. The reasons that prevent expanding the use of fly ash to cover exposure classes 5-11 as well are technological, economic, and administrative as detailed hereunder:

- Lack of sufficient information about the properties of the fly ash supplied by the I.E.C. The only information received is the fly ash LOI (Loss On Ignition).
- No definite correlation between the fly ash efficiency being used as addition in the concrete mix originated from different sources and the cement being marketed in Israel today.

- The use of existing superplasticizers as admixtures in the concrete mix does not enable adding fly ash to the concrete in quantities that exceed 100-120 kg/cm (due to workability and durability demands).
- A lack of storage silos at the concrete plants.
- A lack of fly ash supply, on the one hand, and irregular supply on the other hand.
- The high cost of fly ash at the concrete plant, versus the cost of fine aggregate (sand) supplied from a nearby quarry reduce the rentability of utilizing fly ash. It will be used only as a cement replacement.
- An Environment Ministry administrative regulation to ensure a low radiation threshold for concrete products – maximum 160 kg of fly ash in one cm of concrete.

And at last

- The government's decision to introduce the use of gas as a fuel in electricity production will reduce the quantity of fly ash that will be "throw" into the market which is already in need for larger quantities.
- In the near future – the implementation of SCR (Selective Catalytic Reduction) coal burning system for the production of electricity, which could produce fly ash with ammonia. This procedure requires a tight control, supervision and constantly reporting by I.E.C. in order to maintain the safety level of ammonia in the fly ash. Otherwise the Concrete Industry will diminish totally the usage of fly ash.

Conclusion and a view to the future

Today, after it has been using fly ash in ready mixed concrete mixes for over 15 years, either as a replacement for sand or as a replacement for both sand and cement, the Ready-mixed Concrete Industry knows how to use fly ash and its pozzolanic properties whilst taking into account the above mentioned restriction.

At present, fly ash is used by the Ready mixed Concrete Industry as an important component in the concrete mix both technologically and economically, and offers an ideal solution for the environment protection by disposing the fly ash.

An abolition of some of the restrictions can be accomplished by widening research, using state of the art superplasticizers, as well as proper curing of the concrete, including willingness on the part of I.E.C. to submit a more extensive data base and perhaps also classifying the fly ash. Those steps can increase the use of fly ash and expand it to the inclusion of exposure classes 5-11.

On top of the mentioned above the unforeseeable question-will there be a sufficient quantities of fly ash in the future is today a major factor in the concrete industry.