Permeability of a Fly Ash Layer in Road Embankment: Changes with Time

A Summary

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One of the areas identified for fly ash utilization was in construction of roads and embankments. In the last decade, the Israeli National Coal Ash Board had undertaken field studies to promote utilization of fly ash in this area.

Fly ash is a heterogeneous mixture of amorphous and crystalline phases and is generally considered to be a ferroaluminosilicate mineral with Al, Ca, Fe, K, Na, and Si as predominant elements (Adriano et al., 1980; El-Mogazi et al., 1988; Mattigod et al., 1990). The mineralogical, physical, and chemical properties of fly ash depend on the nature of the parent coal, conditions of combustion, type of emission control devices, storage conditions and handling methods. Fly ash produced from the burning of coal, in addition to having pozzolanic properties, also has some self-cementing properties when contains CaO. In the presence of water and dissolved CO_2(g), the fly ash will harden and gain strength over time. The objective of the presence study was to determine the permeability of the fly ash layer in the embankment of road 6 to water, as a function of time.

A field study was conducted on highway 6 near Kibbutz Revadim. The fly ash layer was below a sand layer of 45 cm thick, and above the sand it was a clay soil layer of 60 cm thick. The fly ash layer was exposed without damaging the interface between the fly ash and the sand layers and the permeability of the fly ash layer to water was determine using the double ring infiltrometer method.

The steady state water infiltration as function of time given in Table 1.

Table 1: The steady state infiltration rate of the fly ash layer at 4 consecutive years.

Year	Steady rate Infiltration rate mm h^{-1}	STDEV
2005	**21.6**	**5.2**
2006	**11.8**	**3.6**
2007	**7.0**	**2.4**
2009	**12.5**	**4.0**

The average steady state infiltration rate of the fly ash layer right after covering it with sand and clay soil layers was 21.6 mm h^{-1}. A sharp drop was observed a year later and the permeability continue to decrease thereafter to 7.0 mm h^{-1}. It is important to note that the standard deviation (STDEV) decreased with time as well. Due to the fact that olive trees were planted on the site after 2007, we moved south to a new location. The infiltration rate was 12.5 mm h-1 which is close to the value observed at 2006 in the previous site. The value at the new site decreased significantly from the value obtained right after covering the fly ash layer. The higher value obtained at the new site compare to the value obtained in 2007 at the previous site is mainly due to the fact that the fly ash layer was below a sand layer of 100 cm thick, and above the sand it was a clay soil layer of 70 cm thick. In addition plants were seeded in the clay soil and their water consumption is 355 mm/year. The fact that the annual rainfall was 385 mm during 2007-2009, the above mentioned conditions prevent the water (saturated with CO_2(g)) from reaching the fly ash layer and therefore, the processes taking place in this layer were slower.

The results indicate that the pore size and there interconnectivity in the covered fly ash layer decreased with time. It is assumed that the permeability of the fly ash layer will continue to decrease with time. By decreasing the seepage of rain water from the fly ash layer, leaching of heavy metals will diminish and therefore, chances of pollution due to use of fly ash in road embankment under these conditions will be negligible.

References

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