(3) The definition of the cracking moment M_{cr} in Equation (6) agrees with that given by Branson and Trost[27,28] for partially prestressed beams. In the presence of axial forces they found that the effective moment of inertia of a partially cracked section was adequately represented by the cubic expression (5) providing that the bending moment at the section was taken as the net moment. There is no doubt that neutral axis shifts in cracked columns are a function of the M/N ratio, however, the relevance of the last sentence of Dr Espion's comments remains unclear.

REFERENCE

30. BAKOSS, S. L., GILBERT, R. I., FAULKES, K. A. and PULMANO, V. A. Long-term deflections of reinforced concrete beams. *Magazine of Concrete Research*. Vol. 34, No. 121, December 1982. pp. 203-212.

An investigation of the pozzolanicity and hydraulic reactivity of a high-lime fly ash*

Joanna Papayianni

Contribution by John B. Ashby

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I was very interested in the paper by Joanna Papayianni in relation to Australian lignite fly ash. As she mentions, lignite fly ash is produced in Australia. In fact, the State of Victoria produces large quantities of fly ash from the burning of lignite coal. Beretka[1] reported that over 300,000 tonnes of lignite fly ash was produced in 1976 in Victoria.

However, Australian experience in attempting to use local lignite fly ash in concrete has not been satisfactory. Concrete has been found to expand significantly and unpredictably. This expansion has been noted at the time test specimens were being removed from their moulds at the age of 24 h after being stored under wet hessian at an ambient temperature in the range 20 to 25°C. The actual expansion was not measured. These test specimens were also characterized by a coating of white crystals considered to be due to the high percentage of soluble salts contained in the fly ash.

Beretka[1] has reported that the lignite fly ash from these sources had a high proportion (25–40%) of soluble salts such as chlorides and sulphates of calcium and magnesium. Research on these materials was discontinued in favour of fly ashes giving more promising results. Beretka has reported also that these lignite fly ashes have poor pozzolanic properties. Typical analyses of two sources of lignite fly ash reported by Beretka[1] are as follows:

Constituents (weight%)	Source	
	Hazelwood	Newport
SiO_2	13·0	9·3
Al_2O_3	4·5	11·7
Fe_2O_3	12·0	30·0
CaO	33·0	9·5
MgO	16·0	24·0
Na_2O	4·5	5·0
K_2O	0·3	0·3
SO_3	14·5	8·5

The author states that the ground lignite fly ash performed very well as a pozzolan and also cites earlier work (reference 4 of the paper) which showed that a high SO_3 content was not detrimental. Our experience with the Victorian fly ashes is not as favourable as the author of the paper has reported of Greek fly ash.

REFERENCE

1. BERETKA, J. Utilization of fly ash in Australia. Proceedings of the 4th International Meeting on Modern Ceramics Technologies, 28 May–1 June 1979, St Vincent, Italy. *Energy and Ceramics*. Editor: P. VINCENZINI. Elsevier Scientific Publishing Company, 1980. pp. 335–46.

*Pages 19 to 28 of MCR 138.

Reply by the author

I would like to thank Mr Ashby for his interest in my paper and the useful information he has provided about Australian lignite fly ashes and their poor performance in concrete compared to the excellent performance of Greek fly ash.

Both of the Australian ashes have a common characteristic. They do not meet the chemical requirements for fly ash for use in concrete according to the standard specifications of different countries[1] although there are significant differences between their chemical composition. For example, the MgO and Fe_2O_3 contents are high while the SiO_2 content is low in comparison with those of Greek fly ash.

Greek fly ash can replace up to 40% by weight of Portland cement. The increase in sulphur trioxide (SO_3) is about 3% and this has proved not to be detrimental as a large number of concrete specimens containing fly ash exposed to weathering for ten years have shown good dimensional stability.

Concrete made with Australian fly ash expands very early. I think this expansion is due not only to the high sulphur content but also to the presence of SO_3 in conjunction with other constituents. I would also mention Professor Mehta's observation that it is the mineralogical composition and not the chemical composition that governs the pozzolanic and cementitious behaviour of a mineral admixture.

REFERENCES

1. BERRY, E. E. and MALHOTRA, V. M. *Fly ash in concrete*. Ottawa, CANMET, 1985. SP85-3.
2. MEHTA, P. K. Pozzolanic and cementitious byproducts as mineral admixtures for concrete. A critical review. *Fly ash, silica fume, slag and other mineral by-products in concrete*. Detroit, American Concrete Institute, 1983. SP-79. Vol. 1. pp. 1–46.