Ash Development Association

FLY ASH IN BLENDED BINDERS FOR ROAD STABILISATION

FLY ASH REFERENCE DATA SHEET

No 7 2005

INTRODUCTION

With the increasing use of slow setting blended binders in road stabilisation in recent years, there is a need for understanding the properties of these binders to achieve stabilised materials with high performance characteristics.

A major initiative in this regard was a national research project entitled “Road Rehabilitation by Recycling Using Cementitious Binders” which was funded by the Ash Development Association of Australia, the Cement and Concrete Association of Australia, the Commonwealth Department of Industry, Science and Technology, Pavement Technology Ltd, the South Australian Department of Transport and the University of South Australia.

This Technical Note summarises some of the results from this project.

MATERIAL PROPERTIES

The following results are test results from testing a number of binders with the “control” gravel which is described as a non-plastic, silty gravel with an Optimum Moisture Content of 11.2%.

Unconfined Compressive Strength (UCS)

The range of UCS results obtained is summarised in Figure 1 for both a cement:fly ash binder and a lime:fly ash binder. These results indicate there is an optimum fly ash content of about 20% for the cement:fly ash binder to achieve a maximum UCS value and that increasing fly ash contents above this lead to a loss in strength.

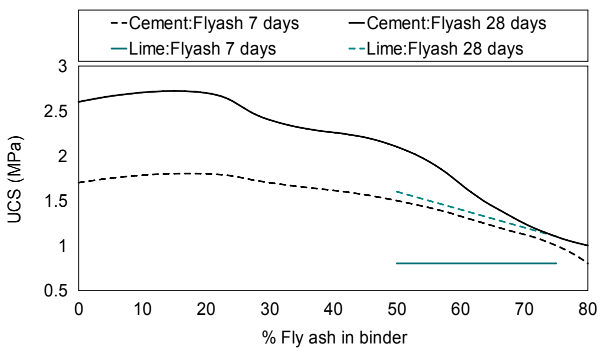

Figure 1: UCS Values for control soil for cement: fly ash and lime: fly ash binders

Typical UCS values are provided in Table 1 below (From the Austroads “Guide to Stabilisation” 1998).

Table 1: Typical Properties of Modified, Lightly-Bound and Heavily-Bound Materials (from Table 4.1 of AUSTROADS Guide to Stabilisation)

Material Type	Layer Thickness (mm)	Design Strength (MPa)[1,2]	Design Modulus (MPa)
Modified	Applicable for any thickness	UCS ≤ 1.0	≤ 1,500
Lightly Bound	Generally ≤ 250 mm	UCS: 1- 4 (7 day strength: 1-7)	1,500-2,000
Heavily Bound	Generally > 250 mm	UCS ≥ 4	2,000-20,000

1 28 day test results

2 For slow setting binders the 28 day test results will be less than the values shown but will continue to increase in the field for at least 6 to 12 months.

Modulus

Modulus testing was carried out at 78 different stress conditions and the maximum and minimum moduli values reported from each test. The maximum modulus value occurred at or near the maximum stress conditions which were intended to simulate the conditions in the road near the surface underneath a wheel loaded to the legal limit.

While all the test results indicated there was some stress dependency of the moduli values measured, all tests were carried out in the early stages of life when strength may have been relatively low compared to ultimate strengths achieved in the road.

Figure 2 indicates that there appears to be an optimum fly ash content of about 30% to maximise the modulus for a fixed total binder content. For fly ash contents above 30% there is a significant degradation in the modulus value.

Figure 3 indicates a different behaviour when a lime:fly ash binder is used. There is substantially more variation between maximum and minimum values of modulus, indicating that the moduli values have a greater stress dependency than when stabilised with cement:fly ash. Also similar maximum moduli values are achieved as for cement:fly ash and the reduction of moduli values with increasing fly ash content appears to be less.

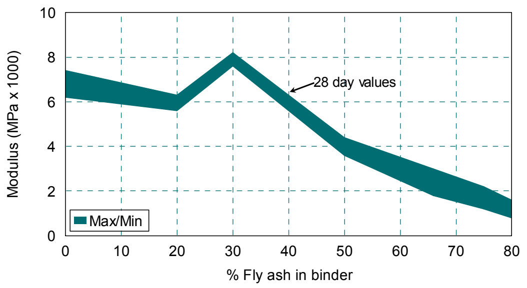

Figure 2: Modulus results for control soil for Cement: Fly ash binder at 28 days

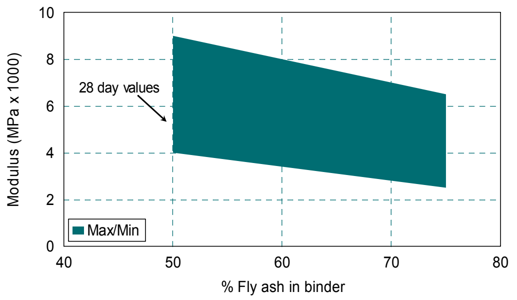

Figure 3: Modulus results for control soil for Lime: Fly ash binder at 28 days

Erosion

Figure 4 presents the erosion results for a 4% total binder content. They indicate that increasing the percentage of fly ash will generally lead to an increase in the susceptibility of the material to erode.

However, there are no standard test procedures or specification requirements for erodability. The authors suggested that, on the basis of American experience, a soil binder loss of 11% for soil with a plasticity index less than 10 and 8% for soil with a plasticity index greater than or equal to 10 might be a reasonable value for acceptance.

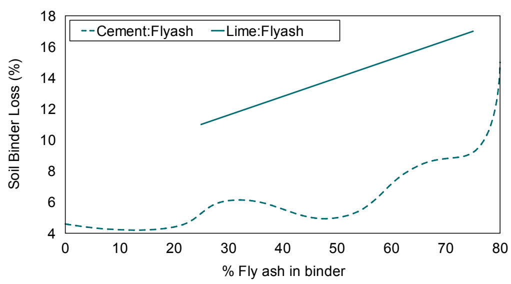

Figure 4: Erosion results for control soil for Cement: Fly ash and Lime: Fly ash binders

On this basis, the results from Figure 4 indicate that only high percentages (>60%) of fly ash in a cement:fly ash binder would constitute a worry from an erodability viewpoint. Other research reported indicates that, for a specific material with a specific binder, there is a binder content above which erosion is minimal. This binder content appears to be in many cases between about 3.5 and 6%. As a large amount of stabilisation is carried out at binder contents between 4 and 6%, current concerns about erosion are not high.

Summary

The results presented indicate that cement;fly ash and lime:fly ash binders can readily meet the strength and stiffness requirements for road stabilisation. However, the results presented here are for one soil and one source of lime, cement and fly ash. For a specific application, the particular binder components should be assessed using the particular material to be stabilised to ensure local specification standards are met. In this regard Austroads Report AP-T16 Mix Design for Stabilised Pavement Materials can provide guidance for testing protocols.

References

AUSTROADS - (1998) - Guide to Stabilisation in Roadworks

Jameson G W - (August 1995) - Response to cementitious pavement materials to repeated loading

Symons M G and Poli D C - (June 1996) - Influence of flyash on properties of stabilised soils

Symons M G and Poli D C - (October 1996) - Experimental procedures for soils stabilised with cementitious binders

Symons M G and Poli D C - (February 1999) - Properties of Australian soils stabilised with cementitious binders Volumes I & II

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