COST EFFECTIVE EMBANKMENT CONSTRUCTION

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ASH DEVELOPMENT ASSOCIATION

FLY ASH TECHNICAL NOTES

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INTRODUCTION

Construction of embankments has traditionally involved the use of natural materials. These materials have performed well and will continue to do so, provided attention is paid to good engineering practice e.g. control of compaction and control of placement moisture content.

Recent experiences with the use of fly ash as an embankment material has demonstrated that it is an excellent engineering fill material and its technical performance has been comparable, if not superior, to natural materials.

In addition, use of fly ash at sites within a radius of 100 kilometres of a power station, may have cost advantages compared to natural materials.

WHY IS FLY ASH AN EXCELLENT ENGINEERING FILL MATERIAL?

The geotechnical properties shown below, make fly ash an excellent engineering fill material. These include its:

- high internal angle of friction (typically > 30º),
- low unit weight (1.2 – 1.3 t/m3) compared to natural materials,
- low compressibility,
- low rates of long term settlements in a fill situation,

An added advantage of fly ash is its availability in large volumes.

Further, there is an environmental benefit of using large volumes of fly ash in fills rather than using natural materials. This is based on conservation of natural fill resources, thereby reducing the environmental impact of mining these resources. In addition, this may help to defer or even eliminate the need for additional ash storage facilities at power stations.

WHAT SPECIAL CONSIDERATIONS ARE REQUIRED WHEN USING FLY ASH AS A FILL MATERIAL?

Fly ash is susceptible to erosion through surface runoff and internal piping. This may be eliminated by using local soils to cap all fly ash surfaces that are exposed to the weather. This would be followed by planting of grass, shrubs and /or trees on the capping.

The use of filter layers ie. sand and filter membranes would also help eliminate internal erosion.

Design of embankments with increased drainage paths eg. by constructing toe berms would help reduce seepage velocities, thereby reducing the risk of internal erosion.

Dust contamination during construction is reduced by transporting ash conditioned with moisture.

Water spraying during placement will reduce dust contamination. Wetting of exposed ash surfaces by spraying creates a crust that prevents the escape of dust.

IS LEACHING A PROBLEM?

Leaching generally occurs when any material is subjected to large volumes of water moving through its mass. One of the prime objectives of embankment construction is to minimise seepage through the fill material. Once ash has been placed and compacted it forms a very stable embankment and very little flow of water is observed. Thus an embankment designed to ensure little or no flow of water would have leachates reduced to negligible amounts.

Recent testing of one of Pacific Power's largest fly ash embankments has revealed no measurable traces of leachates some 12 months after construction.

CONSTRUCTION PROCEDURE

The following is the procedure recommended for the construction of embankments using fly ash.

Laboratory testing

Prior to commencement of construction, laboratory compaction tests to determine the dry density/moisture content relation of the fly ash should be undertaken in accordance with the Standard Method of AS 1289 (1993). This information should be available for ash from the particular power station being considered as a materials source

Conditioning

In a typical operation, such as the one at Vales Point power station in New South Wales, fly ash is extracted dry and conditioned to 15% moisture content. This is approximately 50% of the optimum moisture content.

Transportation

The fly ash is then loaded into conventional tip trucks for transport to the site. Covers to the trucks are recommended for journeys that exceed 15 minutes.

Placement and Compaction

Fly ash is easily placed using conventional earth moving plant provided the moisture content is well controlled.

Spreading of fly ash can typically be carried out using a rubber-tyred front end loader and a dozer (D6 or equivalent)

Prior to final compaction the moisture content of fly ash is brought to approximately 2-3% dry of optimum by water spraying. This also ensures minimum generation of dust from vehicles driving on the embankment.

The amount of compaction to achieve specified dry density ratios should be determined by trials prior to commencement of construction.

A recent project using Vales Point fly ash in the construction of a new embankment wall to the Vales Point ash pond has demonstrated that a few passes of a front-end loader were sufficient to achieve the specified dry density ratio of 95% using the Standard Compaction test in accordance with AS 1289 (1993). There was no requirement to use rollers or any other compaction plant, indicating the ease with which this material can be compacted.

Testing

Control of compaction is achieved by determining the field dry density, field moisture content and the dry density ratio in accordance with AS 1289 (1993).

As a guide it is recommended that one test be carried out for every 1500 cubic metres of fly ash.

It is worth noting that in the Vales Point project some on hundred and fifty tests were carried out over a two year period. The test results are summarised below:

	Range	Average
Max. Dry Density (t/m3)	1.09 - 1.21	1.16
Optimum Moisture Content (%)	25.0 - 34.5	27.8
Placement Moisture Content (%)	-10.0 - +1.0	-3.8
Density Ratio (%)	95.5 - 102	98.9

Finishing

When the ash in the embankment reaches the specified crest level it is recommended that it be trimmed to a cross fall to permit surface runoff. Typically, a cross fall of 1% is recommended.

All finished ash surfaces are capped with 100mm of available local soil. All capped surfaces are seeded or planted with grass, trees and shrubs. Irrigation is recommended until vegetation is established.

Control of Dust

Control of dust is achieved by transporting conditioned fly ash at an appropriate moisture content. If long transport distances are required, then covered trucks are another option.

In addition, areas of exposed ash should be limited to 100 metre strips by capping with top soil and planting of vegetation immediately behind the work face.

Water spraying may be required during hot dry days.

CONCLUSION

Estimates indicate that the use of fly ash for embankment construction may result in cost savings compared to natural materials.

The ease of compaction of ash fill will reduce both the size and quantity of plant required for construction.

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