ASH DEVELOPMENT ASSOCIATION

TALLOWA DAM – SHOALHAVEN SCHEME

Alkali – Aggregate Reaction

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CASE STUDY NO. 2

May 1997

INTRODUCTION

Prior to the construction of the Tallowa Dam, an investigation of the properties of the aggregate proposed for use was undertaken by the Snowy Mountains Engineering Authority (SMEC), starting in 1969.

Because the aggregate was found to have the potential for alkali aggregate reaction (AAR), it was decided to use fly ash in the concrete in conjunction with Type C (low heat) cement. The cement had an alkali content of less than 0.6% Na2O equivalent.

At that time it was considered that the Type C cement was adequate to resist the alkali aggregate reaction potential. The fly ash was included as an additional safeguard.

Concrete was to have a design compressive strength of 2000lbf/in2 (14 MPa) at one year. The objective of this case study is to review some of the test data generated, particularly in regard to AAR and to revisit the dam after a quarter of a century. (DBCE DOC.96/142M). For convenience, the old data has been converted to SI units.

DETAILS OF CONCRETE

W/C	Water kg	Fly Ash kg	Cement kg	Air %	Slump mm	Compressive Strength, MPa	
						90 days	9 months
Non-air							
0.65	183		281	1.7	50	30.4	34.2
0.7	183		261	2.0	44	26.3	27.0
1.75	183		244	2.0	50	20.0	24.4
Air							
0.65	148		227	5.7	44	18.2	19.4
0.7	148		211	5.7	50	16.6	19.2
0.75	148		196	6.0	32	14.7	17.2
Air+Fly Ash							
0.65	139	70	143	6.4	50	13.7	22.7
0.7	139	65	133	5.4	25	12.7	23.3
0.75	139	61	124	6.5	50	11.3	20.2

ALKALI – AGGREGATE REACTION

Tests were carried out in accordance with ASTM C441, Standard Method of test for effectiveness of mineral admixtures in preventing excessive expansion of concrete due to the alkali-aggregate reaction. Five samples of fly ash were evaluated with three samples of high alkali control cement. Experience with the ASTC C441 test has shown that it is unusual to get such significant reductions in expansion as were obtained in this series. It is not surprising that the decision was made to use fly ash in the project.

EFFECTIVENESS OF FLY ASH IN PREVENTING AAR EXPANSION

Fly Ash Sample No	EXPANSION, Percent				Reduction in Expansion Fly Ash as Percent of Control	
	CONTROL MIX		FLY ASH MIX			
	14 days	28 days	14 days	28 days	14 days	28 days
4044	.093	0.346	.071	.095	24	73
4047	.099	0.204	.011	.020	89	90
4055	.082	0.190	.020	.025	76	87
4057	.097	0.204	.017	.020	82	90
5006	.097	0.204	.019	.024	80	88

FOLLOW-UP TESTING

During 1995 cores were drilled from the dam crest and from the floor of the lower gallery by Sydney Water Corporation after 20 years of service. Tests conducted on these cores were reported by Shayan, Diggins & Ivanusec as Case Study of Fly Ash Concrete in Tallowa Dam Containing Alkali-reactive Aggregate, DBCE DOC.96/142M. A summary of the findings follows.

By visual inspection, the cores were found to be sound. No evidence of reaction between aggregate and cement could be seen. Microscopic examination of thin sections revealed potentially reactive strained quartz in both greywacke and quartzite, in addition to the reactive chert detected before construction.

Accelerated tests were conducted on mortar bars made from samples of the aggregate reclaimed from the cores, which confirmed the potentially reactive nature of the rocks when results were compared with criteria developed by Shayan.

Prisms sawn from the cores were soaked in caustic soda solution at 40°C. After 14 weeks they showed expansion ranging from 0.005 to 0.015%, compared to about 0.2% for the mortar bars. It was demonstrated with the present day test that the Type C cement alone would not have been sufficient to overcome the alkali aggregate reaction potential.

The authors concluded that the use of a suitable fly ash is very beneficial to the long-term performance of field concrete structures. 'The fly ash concrete in Tallowa Dam has performed well in the past 20 years and is expected to continue this performance in the future'.

In the Tallowa Dam Project, the incorporation of fly ash provided inexpensive insurance against the disruptive expansion of AAR. In many areas, this insurance can be achieved at no additional cost at all. A powerful incentive to specify fly ash concrete.

The cooperation and assistance of Sydney Water in carrying out this study is gratefully acknowledged.

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Supported by: