TALLOWA DAM – SHOALHAVEN SCHEME

Concrete Permeability

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ASH DEVELOPMENT ASSOCIATION

CASE STUDY NO. 1

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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.

Concrete was to have a design compressive strength of 2000lbf/in^2 (14 MPa) at one year. The objective of this case study is to review some of the test data generated, particularly in regard to permeability. 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

PERMEABILITY

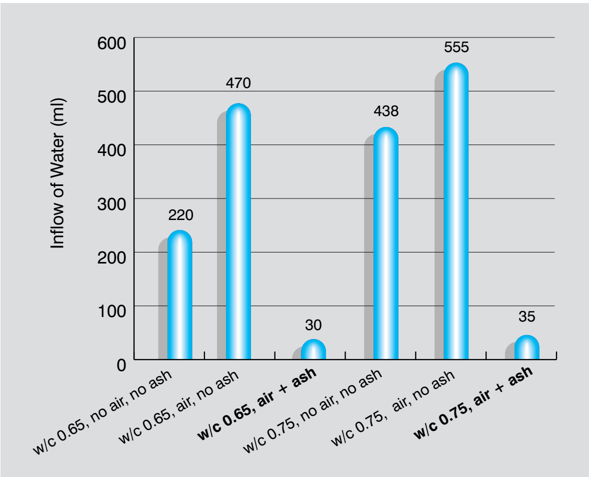
Three types of concrete were tested, namely plain low heat, air entrained low heat and air entrained low heat with 33 % of the cement replaced by fly ash. For each type, concrete was prepared at 0.65, 0.70 and 0.75 water/cementitious material ratios.

After curing for 6 months and 9 months, pressure equivalent to 70 m of head was applied and readings taken of flow of water along a graduated nylon tube. For simplicity, results are shown only for the nine month situation, in the figures overleaf.

SUMMARY OF READINGS AFTER 9 MONTHS CURING - INFLOW, ML

Elapsed Time Hours	W/C 0.65			W/C 0.75		
	Non-air No fly ash	Air No fly ash	Air Fly ash	Non-air No fly ash	Air No fly ash	Air Fly ash
45	18	49	6	26.5	39	8.5
162	43	105	12	73	102	15.5
349	79	180	16	136	182	21
467	97	218	18	174	230	23
659	126	277	22	227	300	26.5
892	154	336	24	291	378	29.5
1204	200	426	28	390	495	34
1366	220	470	30	438	555	35

PERMEABILITY INFLOW READINGS AT 9 MONTHS



DISCUSSION

In view of the fly ash concretes having lower binder content and lower strength than the control mixes, the improved resistance to water inflow is impressive. If the comparison is made against the air entrained mixes without fly ash, both the strength performance and relative impermeability are outstanding.

Almost thirty years later, the situation has changed for the better. Fly ash generally available in the 1990's in Australia is much improved from that on offer in 1969. These days, loss on ignition of the ash commercially available is commonly below 2% and the fly ash is generally finer and hence more reactive.

SIGNIFICANCE OF LOW PERMEABILITY

In some situations, such as water-retaining structures, low permeability is of importance directly. In most other situations, low permeability is desirable indirectly.

Water is involved in both the good and bad things that happen in concrete. Without water for setting and hardening, concrete would not exist at all. Moist curing is still the optimum means of getting the best from concrete.

On the down side,

- damage from freezing and thawing,
- alkali – aggregate reaction,
- sulphate attack,
- corrosion of steel reinforcement,

all require the presence of water to proceed. Drying shrinkage cracks result from evaporation of surplus water (water of convenience) from the concrete.

When concrete is properly proportioned with fly ash, the unit water content is reduced, with attendant reduction in shrinkage potential and permeability. Because the concrete is watertight and has less cracking, the potential for the normal threats to durability, outlined above, is minimized. Fly ash concrete is durable concrete.

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