

8th International Conference on Alkali-Aggregate Reaction

AN HISTORICAL PERSPECTIVE ON ONE-AND-HALF DECADES OF AAR RESEARCH

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INTRODUCTION

The flurry of research on alkali-aggregate reactivity in the late 1940s and early 1950s eventually established as principle preventive measure the use of low-alkali cement - meaning cement not containing more than 0.6% sodium oxide equivalent (calculated as $\text{Na}_2\text{O} + 0.658\% \text{K}_2\text{O}$).

For about two decades relatively few new cases of deleterious alkali-aggregate reaction were encountered and these examples could be regarded essentially as due to marginally reactive aggregates or neglecting to observe the recommended guidelines for avoidance of deleterious AAR.

By the early 1970s, "exceptions to the rule" had reached significant numbers and an international group of researchers decided that it was time to re-evaluate the situation, particularly since it was also apparent that accepted tests for the detection of reactive aggregates were sometimes unable to identify expansive materials and in other instances would categorise as innocuous, aggregates which in practice were responsible for damaging reactions.

At that time the main areas of concern were Denmark, Iceland and West Germany, although the Channel Islands (UK) had already suffered from one case of ASR damage. This small gathering, unbeknownst to its participants, formed the first of the series of symposia on alkali reactions in concrete, now eight in number including the present one in Kyoto, Japan.

THE SERIES OF CONFERENCES

Figure 1 shows in graphical form the statistics of the series of conferences: viz. numbers of delegates and technical presentations and the size of the published symposium volumes. In terms of the activities of delegates it is interesting to note that the quotient of the number of published papers divided by the number of delegates reached its apogee at Reykjavik in 1975; it has been downhill all the way ever since!

Køge, Zealand, Denmark (1974)

Prime movers for this initial gathering of researchers were Katherine and Bryant Mather and Professor Sidney Diamond (USA), Dr Gunnar Idorn (Denmark) and Professor Friedrich Locher (West Germany). Organisation was by the Danish Concrete Research Laboratory (BFL), Karlstrup. The conference was held in the Hvide Hus Hotel, famous for its internal courtyard garden with flamingo pool (the vivid colours of the birds being enhanced by feed containing Vitamin A).

Of principal concern was the means of identifying new types of reactive aggregates, especially those involving minor amounts of secondary silica such as the green sandstone of Schleswig-Holstein and beekite veins in diorite (Rozel, Channel Islands). Lighter, more porous chert (flint) forms found in Denmark and Germany were also confirmed as being implicated in damaging ASR.

The technical visit to BFL Karlstrup marked the heyday of this Institution, since rationalised and incorporated into the Cement Research Laboratory at Aalborg. Bryant Mather also delivered a lecture to the Danish Concrete Association in Copenhagen as an integral part of the Koge conference.

Only synopses of papers were recorded [1] since it was anticipated that the authors would publish their papers elsewhere.

Reykjavik, Iceland (1975)

The second meeting followed only 15 months after the first, because of great concern in Iceland where deleterious reactions affected owner-occupier homes as well as threatening larger industrial structures.

The main difficulties in Iceland are that the raw materials make it virtually impossible to produce low alkali cement and almost all Icelandic aggregates are volcanic with glassy reactive constituents. During the meeting cement production techniques and alkali-reduction methods were reviewed and the early results of the utilisation of highly reactive pozzolanic materials were discussed (ferro-silicon in particular).

It was at this meeting that the need for continuing international contacts was recognised and plans were laid for a further conference in England.

The Icelandic Building Research Institute, joint organisers of the Reykjavik meeting with Icelandic Cement, also arranged a technical tour to bridges and hydro electric plants where ASR problems were being tackled. The route included spectacular volcanic scenery and an overnight stop at a district school where geothermally heated baths could be taken.

The Reykjavic conference was supported by the European Research Office of the US Army Corps of Engineers and the Landsvirkjun (State Power Authority). Otto Halldorson acted as Conference Secretary. As a purely social event, Haraldur Asgiernesson and his wife, Haldora Einarsdottir, arranged a delightful buffet supper for delegates in their home by Reykjavik fiord.

The conference proceedings [2] form the first publicly available documentation from the series of meetings.

Wexham Springs, Slough, UK (1976)

The Cement & Concrete Association (now the British Cement Association) played host for the third symposium, held in the Meynell Building in the beautiful Victorian landscaped grounds of the C&CA. Organisation was by John Figg and Dennis Palmer (C&CA) and Alan Poole (Queen Mary College). Delegates were accommodated in the residential wings of the Training Centre at Fulmer Grange, and the accommodation arrangements had all the elements of a Whitehall Farce since the Training Centre had only single study-bedrooms. The Bursar's

Office had located all ladies in rooms overlooking the rose garden because of the fine views - leading to much nocturnal cross-corridor coming and going as couples sought out one another.

Technical sessions at Wexham included, for the first time, Middle East problems, a reconsideration of pessimum effects, and an attempt to co-ordinate testing methods.

The Wexham meeting is often referenced as "London" because of the co-sponsorship by Queen Mary College, London University, and delegates spent one whole day in London visiting QMC, the Thames Barrier (at that time under construction) and the Thamesmead residential development. That evening delegates also attended a reception at the home of Dr Alan and Mrs Heather Poole before returning late to Fulmer Grange (in fact so late that the gates had been locked!)

The 1976 meeting also included a formal dinner at the Old House Hotel, beside Windsor Castle on the banks of the River Thames, and an optional one-day excursion by air to the Island of Jersey to see the Val de la Mare dam and the Rozel quarry (this trip was arranged by the Jersey New Waterworks Company).

The Wexham conference was the first for which a separate accompanying persons' programme was arranged, which included shopping in London and a tour of Buckinghamshire and Hertfordshire with a visit to Milton's cottage at Chalfont St Giles, morning coffee at the village inn at Chipperfield, lunch at historic Salisbury Hall (where the World War II Mosquito aircraft was designed and the prototype constructed), and a guided walk around St Alban's Abbey.

The conference proceedings [3] were published by C&CA and reprinted by the US Government Printing Office, because of partial funding of the meeting by the US Army Corps of Engineers.

Purdue University, West Lafayette, Indiana, USA (1978)

Two years elapsed before the fourth conference during which time deterioration of a number of structures in SW England had been identified as being due to ASR and problems in South Africa had been found to be rather extensive.

The Organising Committee for the Purdue Conference was chaired by Prof. Sidney Diamond and technical material from the conference was compiled and arranged by Bryant Mather and Mrs Harriet Diamond. The conference was supported by the US Department of Energy, the Portland Cement Association, and the US Army Research Office.

Possible exacerbating effects of electricity were debated, Middle East concrete problems assumed greater importance and an up-to-date literature review was made available to all delegates. It was noted that despite the long-standing efforts in the USA not all ASR problems had been overcome. First efforts were made to agree on an internationally recognised standard reactive aggregate (Beltane opal).

Whilst the conference was in session, the accompanying persons visited a reconstructed pioneer village and the Indianapolis race track. Delegates were entertained to Californian wine and American cheeses and also banqueted in the

University Faculty where the Dean disclosed that he was a C.B. buff. Delegates never did get used to the Paternoster-type toasting machine in the college refectory.

A final technical session was held at the Portland Cement Association, Skokie, near Chicago, and delegates also toured the facilities of the PCA. Once again the conference proceedings [4] were part-funded by the US Army Corps of Engineers.

Cape Town, Republic of South Africa (1981)

The fifth symposium at the Holiday Inn, Cape Town marked a change from a gathering of research workers to a large International Conference. The venue also included an exhibition area and well-organised audio-visual arrangements with back-projection of slides. Dr D.E. Davis, Director of the Portland Cement Institute, chaired the Organising Committee and Dr Rupert Oberholster acted as both Conference Secretary and Editor. Marieta Swart ran the Secretariat.

Inevitably conference sessions dealt significantly with alkali-silicate problems: in particular the slowly-expansive Malmesbury hornfels. Delegates grappled with the difficult problem of standardising test arrangements and further discussions took place on possible standard reactive aggregates (fused quartz was considered for the first time).

Local residents entertained overseas delegates to supper in their homes and the Mayor of Cape Town hosted a conference reception. Technical visits were made to see ASR-affected bridges and sea defences in Cape Town, the Steenbras Dam and cracking of the pavement of the N2 motorway at Somerset West. Rather less technical visits were made to the top of Table Mountain and to a vineyard at Stellenbosch.

Accompanying persons visited the Botanic Gardens, took tea with the Cape Town Ladies Circle and saw demonstrations of native crafts.

The conference volume [5] reached uncomfortably large dimensions but included photographs and potted biographies of the contributors.

Lyngby, Copenhagen, Denmark (1983)

The sixth symposium at the Technical University of Denmark was a multi-sponsored event which attracted a large attendance by both overseas delegates and Danish engineers. Conference sessions included dual slide projection arrangements in a spacious, raked auditorium. Steen Rostam chaired the Organising Committee and Gunnar Idorn was Chairman of the Scientific Programme Committee.

The technical sessions included pragmatic measures for the management of ASR-affected structures and, as befitted ten years of activity, a reappraisal of research efforts to date as well as recognition of the worldwide viewpoint necessary to understand alkali reactions.

A major technical excursion was made to see the Farø bridge, linking Zealand to the islands offshore at its southernmost tip; the bridge significantly shortens the ferry crossing to Germany.

The published volume [6] warranted an International Standard Book Number.

Ottawa, Ontario, Canada (1986)

August 1986 brings us up-to-date with this series of alkali symposia. The Chairman of the Organising Committee was Dr Paddy Gratton-Bellew of DSIR, Division of Building Research, the meeting was co-sponsored by Ontario Hydro and supported by a total of 15 organisations. Technical sessions were held at the University of Ottawa and delegates were amazed at the warren-like network of underground tunnels linking accommodation blocks to the tuition centres (a defence against the severe Canadian winter).

Spoken and poster presentations were used and the tradition of microscopic/petrographic practical demonstrations was continued. Dual language English/French sessions were only moderately successful; the sequence of Japanese-to-English-to-French seemed to produce results rather like the well-known General's message: "Send three and fourpence, we're going to a dance", (Send reinforcements, we're going to advance!).

Technical excursions were made to inspect alkali-silica affected structures (Henry Seguin bridge and Beauharnois hydro-electric plant) and alkali-carbonate affected concrete at Lancaster and Cornwall. Delegates (and mosquitoes) enjoyed a barbecue at Fort Wellington. Accompanying persons toured the sights of Ottawa and cruised round (some of) the thousand islands in the St Lawrence River.

The University accommodation also produced hilarious interludes due to the shared bathroom-between-adjacent-bedrooms layout of some blocks.

The Conference proceedings have been edited into a hard-back book [7].

WHERE ARE WE NOW ?

Concrete, as a construction material, has a record of successful use which exceeds 1.5 millenia. Portland cement concrete now has a continuous history of more than 1.5 centuries and our modern world, quite literally, is built on it. In these perspectives, 1.5 decades of research endeavours is a short time, and yet remarkable progress has been made through international co-operation and collaboration.

Various manifestations of alkali aggregate reactions in structures have engendered a healthy respect for the expansive forces which can be created. Yet the safety record is good; no injuries have occurred to people through such reactions, even if financial damages have proved bruising.

AAR is not a disease or malignant growth, although some of the journalistic comment and newspaper reporting has been far from benign. The unwelcome behaviour of some concretes is due to chemical reactions which in other circumstances are regarded as normal and beneficial.

The published record [2-7], together with the present proceedings, mark the progress to date. Much remains to be accomplished before a complete understanding of reaction mechanisms and energetics is attained. We have come a long way and, with sustained efforts, it will be possible to utilise the advantageous chemistry of alkali reactions whilst avoiding the unexpected and undesirable manifestations of excess.

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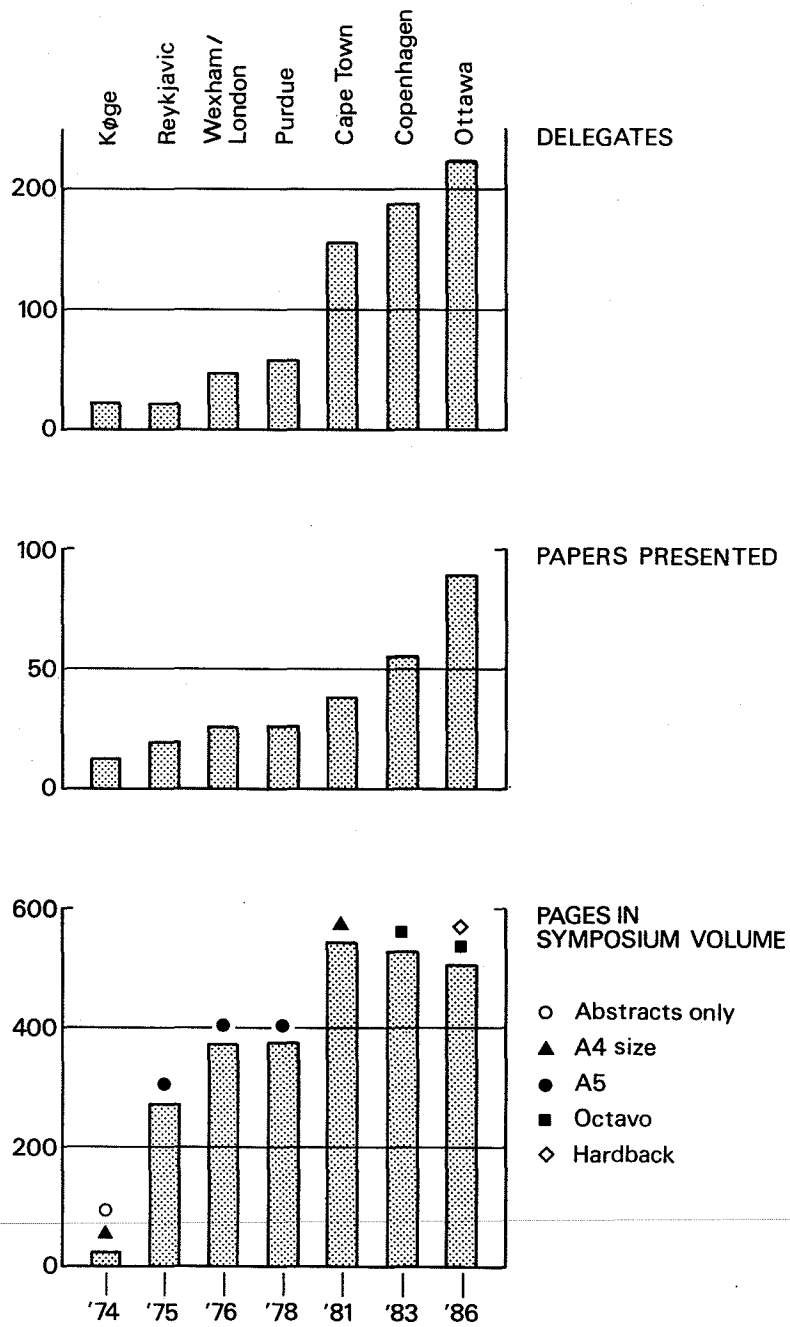


FIGURE 1 At a glance statistics for the series of international symposia on alkali reactions in concrete

