INTRODUCTORY REMARKS

by G.M. Idorn

The total quantity of concrete produced over the world in 1973 was about 6900 mill ts, consisting of (approximately):

690 mill ts cement
400 mill ts water
5810 mill ts aggregates

The growth of populations, and consequently the demands on urbanisation, traffic development, and energy production will make the 6900 mill ts concrete move significantly towards 10.000 ps per year in the course of the nearer future, if the social needs become the decisive parameter.

This growth of concrete production will surely be faster than we can match by means of technology innovations which could reduce the volumes of concrete and the consumption of manufacturing energy and yet fulfill the demands to satisfy the consumers.

There *are* promising process and product innovations well under way, and I am confident that within 5-10 years, a large proportion of wood and metals used to-day in construction and civil engineering will be replaced by refined types of silicate based materials, and thus wood and metals can be saved for other purposes.

But these innovations will still only account for a minor fraction of the total needed volume of concrete. Or - in other words: we cannot change the ways of making and using the bulk of ordinary cements and concrete so fast as to eliminate or significantly reduce the volume growth of concrete required to serve man's life in the forthcoming decades.

We shall therefore face resource problems of great order of magnitude regarding:

CEMENT	—	production and capital investment capacity
WATER	—	availability
AGGREGATES	—	availability and environmental protection restrictions
KNOWLEDGE	—	on cement and concrete technology
TIME	—	for any innovation and its implementation

Consequently, we must expect adverse political and socially conditioned reactions during this development towards operating with scarcities. And in a few years' time R&D may be presented with a responsibility for making penetrating technology

innovations possible, which will be felt very different from the general neglect R&D often feels itself surrounded by in its present environments.

This again leads to another prediction:

It will become considered unacceptable irresponsibility on the part of R & D, if the unavoidable growth in the use of concrete results in increased quantities of early and severely deteriorating concrete.

What then, if the present trends towards increasing alkali-silica contents in cements, increasing cement contents in concrete, etc., also create greater risks for deleterious alkali-silica reactions to occur in concrete than we have hitherto experienced.

Let me recall that when alkali-silica reaction was studied intensively in the US from about 1942 - 1950, much of the concrete found deteriorating was rather old or had been rather crudely manufactured, and structural cracking was generally considered unpleasant and also sometimes repair demanding. But no fatal case of collapse was encountered.

— A few years ago an entire road bridge in Europe was demolished after one year's service, due to dangerous development of cracking involving alkali-silica reaction.

When alkali-silica reaction was intensively studied in Denmark about 1951 - 64, we also mostly dealt with rather old structures representing no fine arts of concrete making, and those bridges and sea-walls, etc. needing repair,had suffered progressing disease during one or more decades.

— A few years ago I saw 8 out of 26 quite new highway bridges somewhere in North Europe showing significant expansion cracking.

I am not saying that these recent cases are proofs of an increasing severity of the alkali-silica reaction problem.

But I do know that:

Increasing sizes of cement rotary kilns,
Increasing preference to the dry process,
Increasing use of high quality concrete rich in cement,
Increasing reduction of the structural coefficients of safety, and
Increasing amounts of ignorant people making large volumes of concrete in developing countries,

Will be accompanied by:

Increasing contents of alkalies in cements, 1.0% æ. Na_2O becoming a likely future average rather than the considerably lower average we have enjoyed in many regions up to now.

These are - briefly speaking - the circumstances that have caused the AALBORG PORTLAND R & D Division to arrange for this gathering aiming at creating a collegial, scientifically based environment for exchange and for mutual stimulation regarding new research on alkali-silica reaction.

We do not herewith intend to devaluate this or that of the research carried out, say about 30 - 15 years ago, when investigations on alkali-silica reaction flourished.

We shall still depend much upon the explorative studies made since Th.E. Stanton's early work 1940 - 1942 in the USA, the Australian »system analyses» by Vivian and associates, the detailed examinations by F.E. Jones and associates from England, and also on some results from research in Denmark and elsewhere.

The information gained from these series of studies was applied as technical/economic reasonable directions for avoiding deleterious alkali-silica reaction in ordinary civil-engineering concrete, and the character of the studies through which this was achieved was entirely empiric.

But the conditioning parameters are changing now, and the empiric approaches of past research do not offer us means for adjustments of the accepted safeguards against deleterious alkali-silica reactivity.

This is why we have felt it important to encourage the discussion on the basic features of the reactions we deal with, their nature and their way of affecting concrete.

Fortunately, there is now much new basic physico-chemical knowledge available for application in our studies, and there certainly seem to be uncertainties at hand in recent papers on alkali-silica reaction so as to encourage fruitful discussions.

However, we can make but little use of new fundamental concepts, if they cannot be related to the reacting substances, as these occur in concrete.

And I think that when our meeting is over, there will be little doubt left among us that the classic identification criteria for alkali-silica reactive aggregates now need thorough reconsideration.

We also need to pay some attention to the alkalies themselves; generally characterized by means of the convenient formula

$$Na_2O \text{ eqv.} \sim Na_2O + 0.658\ K_2O$$

There are still uncertainties about the postulated different reactivity, if any, of sodium and potassium.

There is also reason to consider how alkalies are occurring as elements of the constituents of cement, the aggregates, or of pozzolans.

Moreover, somebody may claim that it is only humdrum terminology and an inheritance from the obsolete research terminology which alkali-silica reaction was born in - to speak about sodium and potassium as the primary reacting elements, when they are maybe in reality only like electricity in the energy crisis terminology: the *»energy - carriers»*.

Hence, maybe we do in fact discuss:

»Hydroxyl - silica Reactions»

If we attain clarification on this point, some persistant disagreements on concepts regarding alkali-silica reaction may well vanish. Fortunately, we have now tools and

instruments to assistance, which the researchers 30 - 15 years ago did not even know would come into existence.

One aim of our talks ought to be that we need the background of technology information to forecast and conduct the behaviour of structural concrete and of industry-manufactured concrete products corresponding to a wide variety of structural design and functional criteria. But we must also consider pressures upon our technological capability arising from:

Energy Conservation
Resource Problems
Environmental Regards

This is why the way from the background and basic research to engineering practice has to be made both shorter and more secure than in the past.

For some years I have feared that we might be overrun by the increasing demands on application of obsolete knowledge, so as to be forced into a continuation of the past research activities and ways of working rather than be stimulated to a penetrating reconsideration and renewal of thinking and working methods.

This meeting hopefully will be of some influence on further research, but we must realize that except for a few knowledgeable colleagues that could not attend, there are very few researchers beyond those present who are able to share our efforts at the present time.

Finally: the discussions and being together here intend to stress AALBORG PORTLAND's appreciation of the basic features in a collegial, scientific environment.

We are pleased that you offer us an opportunity to pay back in small measures what we have so often ourselves enjoyed and found helpful abroad.