

Of the papers I have to review and summarize it's easiest for me to review the introduction presented by Mr. Worning. I fully agree with practically all of his statements.

Just a little thing I would like to add, more for the sake of curiosity, it is a beneficial effect of alkalis: The presence of alkalis facilitates the formation of the clinker minerals upon burning the cement raw mix in the kiln. This effect is substantial and helps saving energy. Unfortunately, these savings are lost in many cases due to the measures the cement producer has to apply to fight the evil effects of alkalis in the cement-making process.

I don't think it would make much sense to go to the details given in Mr. Worning's introduction. However, I would like you to keep the final message, he gave, in mind.

S H E E T 1

There are two points to make.

1. Don't expect that cement producers will come up in the future with more cement having a lower alkali content. Quite the contrary will be the case. And if, in spite of this general trend, some producers are able and willing to offer low-alkali cement: Be prepared to pay a higher bill! Even those producers, who, by the very nature of the raw materials they use, can manufacture a low-alkali cement without applying special measures, will have to present a higher bill, if they were to survive, because, in general, their production costs, for reasons it would go too far to explain, are significantly higher.

In retrospect, we have to ask our-selves whether the recourse to low-alkali cement as the solution to the alkali-aggregate reaction problem was not the wrong way to tackle it. In any case, - this has been mentioned during this conference - it was and it still is- a waste of valuable resources, and an avoidable charge to the environment.

2. As the second point, I would like to take up a suggestion made by Mr. Worning, Mr. Spellman, and by many others:

It is to seek the remedy of the problem by adding hydraulically active secondary constituents, such as fly ash, slag, silica fume, natural or artificial pozzolans, to the cement or to the concrete. With this proposal I have covered the review of the 3 papers of the session I chaired, dealing with the effect of such additives.

In spite of the many papers published about these aspects of our subject, the designing engineers, the contractors, the building owners and also the state officials are reluctant to accept the utilization of such constituents in the concrete as a reliable remedy. They all are asking for evidence for the reliability of this measure. When considering cases presented in some of the papers here at the conference, we have to admit that there is some justification for their attitude.

In fact, we are at a loss when we were to submit the overwhelming evidence which is necessary to convince these people. It is usually very difficult, if not impossible, to predict or to extrapolate from laboratory data how a comparable concrete system will perform under the field conditions of the specific job.

On the other hand, there exist already numerous concrete constructions where the alkali-aggregate reaction has been prevented by the addition of hydraulically active constituents. Thus, the time has come where it makes sense to review and to assess the performance of these concrete constructions in a systematic manner, if possibly on an international basis. A questionnaire should be established, which has to cover all the relevant factors, including

S H E E T 2

- Design features, also the nature of steel reinforcement.
- Material data, on which I don't have to elaborate, because you are familiar with them. Of course, they should also include the characteristics of the concrete raw materials, the cement, the secondary constituents, the aggregates, the chemical admixtures, and last, but not least, the mixing water.
- Environmental conditions under which the concrete construction is doing its job. I am talking about the micro-climatic conditions, for instance, frequency of wetting of the construction, not so much about annual rain-fall in the respective country.
- Nature and quality of workmanship, including transport, placing, compacting and curing of the concrete, not only their design, but also their execution.

We will soon become aware that there are important gaps in our records of the essential features of the different concreting jobs. However, hopefully, the final goal of this review, to enable us to find ways and means to prevent deleterious reactions reliably, or with an acceptable risk, may be a sufficient incentive to go to the tedious exercise of establishing such records.

This review may also be helpful in directing future research, helpful in the sense that it may enable to distinguish between the more relevant and the less relevant questions.

Finally, as already suggested, the review of the assessments of concrete constructions may lead to an accepted and generally adopted code of practice for concrete construction for preventing the alkali-aggregate reaction, using high alkali cement and alkali-susceptible aggregates with the aid of hydraulically active materials put into the concrete.

It has been pointed out several times during this conference that there are communication gaps between subsequent stages of concrete construction. I believe that the broadest gap is between the engineer's office at the job site and the workers outside. It is a gap not only in knowledge but also in mentality. To close the gap, or at least to narrow it, is one key to improved concrete performance.

The task is a two-fold one:

- The necessary knowledge and skills have to be transmitted to the man at the working place in a manner perceivable by this man.
- Not only this, you need to generate a genuine motivation of the workers to do a good job. This is far easier said than done. It requires a social environment where the worker is proud of achieving a high standard of performance in his profession. However, how could he, if he does not even know these standards.

Very briefly some remarks to other papers of the session I chaired:

- The paper on potassium sulfate may have appeared to tackle an odd subject in our context. As I explained this is not so. Perhaps, I may suggest that investigations of this kind may consider also potassium chloride in kiln dust, and its consequences for the utilization of the dust, because eliminating alkalies combined with chlorine is probably the only technically feasible way to reduce the alkali content in the clinker by operating a by-pass.
- Dr. Forss' paper on his invention of the alkali-activated slag as a binder has revealed a peculiar way of making use of beneficial effects of alkalies. It is their role of activators.
- The paper prepared by members of the Danish National Agency for the Protection of Nature, Monuments and Sites on the Raw Materials Act and concrete aggregates was of a peculiar interest. The general problem it tackled is, which of the conflicting types of utilization of a given ground should have priority:
 - . commercial exploitation of raw materials found in the ground
 - . forestry or agriculture

. ground water storage

. or just the beauty of the landscape,

what are the criteria to decide on that issue, and who finally decides.

In Denmark, I read in the Raw Materials Act, it is the government, that means the bureaucracy, in Switzerland, for example, there are subordinated agencies or just pressure groups, but in neither country there is an orderly process for establishing priority criteria. I wonder, how under these conditions the alkali susceptibility of aggregates can be rated in this context. Officials have to do that, which, due to their very profession, cannot have the slightest idea how to do it. Thus, scientists are called to make their ratings understandable to these people. This is just a specific item of a general task. I think, it belongs to the social responsibilities of the scientists to make their ideas, their assessments, their priorities understandable to the general public in order to bridge the gap between it and the scientific community.

It remains to thank the organizers of this conference, in particular Dr. Idorn, to have given us the opportunity of gathering together and of discussing common interests in such a splendid environment.

MESSAGE ISSUED BY CEMENT PRODUCER:

- less cement with low alkali
- and if cheaper
- go to hydraulically active secondary constituents (slag etc.) as remedies of alkali-aggregate reaction.

SHEET 1

REVIEW AND ASSESSMENT OF PAST AND PRESENT EXPERIENCE

- Design features
- Material data (concrete mix, constituents etc.)
- Environmental conditions
- Nature and quality of workmanship (as designed and as performed)

SHEET 2

Session 1b

"ALKALIS IN CONCRETE -
ENGINEERING EDUCATION ASPECTS"

Chairman: Prof. Torben C. Hansen

- Introductions:
- 1) A.B. Poole:
"Alkalis in Concrete: A matter of
Education for Engineer and Research Scientist"
 - 2) Gunnar P. Rosendahl:
"Quality Assurance and Communication -
Engineering Education Aspects"