QUALITY ASSURANCE AND COMMUNICATION
- ENGINEERING EDUCATION ASPECTS

ROSENDAHL, GUNNAR P.
Managing Director, M.Sc.,
Greenland Technical Organization (GTO), Copenhagen, Denmark

ABSTRACT

In May 1982 the Danish Academy of Technical Sciences created a Committee on the "Durability of Concrete Structures".

The overall objectives of this Committee are partly to prevent premature deterioration of concrete structures by implementing quality assurance routines and increasing information, partly to avoid further development of ongoing deterioration by ensuring coordinated inspection and improved maintenance procedures.

The Committee attempts to develop rational quality assurance routines by investigating all phases of the building process and thereby detecting weak spots.

New and intensified research are not the only activities needed at present. Much valuable knowledge is already available today but remains more or less unused because of insufficient means of coordinated education and communication within the established construction industry.

Among the intentions of the Committee is the creation of an officialized education for concrete craftsmen, as well as an improvement of the other technical educations on all levels.

Keywords: Durability, quality assurance, communication.

THE PUBLIC IS WORRIED

Head lines on the front page of a major Danish newspaper announced a couple of years ago that 80% of our concrete structures are falling apart.

This, of cource, is a modern version of one of Hans Christian Andersen´s fairy tales. The tale where one lost feather turns into 5 dead hens through sensation-seeking public relation activities. Although the head line exaggerates the situation, it is true that extensive repairs have to be carried out, and the public is worried about the economical consequences. We are talking about an increase in the absolute amount of money to be used for maintenance and repair of concrete structures. But before this fact leads us to harsh conclusions, we should also realize that we have sharply increased the total volume of concrete structures.

At a figure showing the cement consumption in Denmark - year by year since 1920 - you may note, that more than 60% of that cement has been used in the period 1960-1980. From a purely statistical point of view one should not be surprised that maintenance and repair is increased, when the number and volume of structures in use is increased.

You would also expect this increase in maintenance and repair to be timewise

delayed some years. This may to some extent explain the present situation - including the newspaper head lines - but the absolute volume of the potential problems is certainly of no comfort.

It is evident that the engineering profession will have to consider its role in the design and construction of new - and hopefully better - concrete structures as well as in the maintenance and repair of existing structures. We will have to consider whether the engineering education is adequate and that question applies to the formal education of the engineering schools as well as to the additional education and training provided during a life long practice.

VIOLATION OF SIMPLE RULES AND POOR MAINTENANCE

An assessment of the damages encountered in Danish concrete structures reveal the well known phenomenon, that when damage occurs you often find that fairly simple and supposedly well known rules have been violated. It is our impression that much would be gained, if mistakes of this simple type could be avoided.

Secondly, the damage situation shows us that maintenance is important. We are familar with the idea that wood and steel must be maintained. We have not yet familiarized ourselves - and particularly our customers - with the idea that this also applies to concrete structures. We must agitate for a better understanding that it is cheaper to inspect and in due time maintain a structure, instead of repairing it when extensive damage has occured. And last - but not least - maintenance should be considered and planned as part of the design process.

The Danish Academy of the Technical Sciences decided one year ago, that special efforts should be made to communicate messages of this type among the engineering profession to improve in more general terms the utilization of existing knowledge in ordinary concrete practice. This initiative is supported by producers and users of concrete structures, and by private as well as by public organizations.

BETTER QUALITY ASSURANCE PROCEDURES

It is evident, that when you want people to improve their use of existing knowledge, you have to recognize, why they have not already done so. You have to locate the barriers and then figure out ways to remove them- We have reached the conclusion, that our efforts should be concentrated in two main areas:

One of them is to improve the existing quality assurance procedures. These procedures must effectively act as the management system which at the same time ensure, that know how on at number of different technical subjects is available at the right time. The quality assurance procedures should ensure a reasonable consistency in the decisions, which determine the quality - and thus the durability - of the concrete structure. This should be so, even though these decisions are taken by different persons and at different points in time.

Secondly, one should aim at a situation where the know how to be used is available in the form of directly useful routines, which are adapted to the quality assurance system. Time limits and economical restrictions will often

be too easy excuses not to utilize the available, but not readily applicable know how.

Research reports, state-of-art reports etc. are necessary steps in this context, but usually a fair amount of work is required in order to adapt know how from these sources into a practical routine. Research people probably feel that this adaption is the practitioners problem, while the practitioner might want the researcher to be somewhat more practical. There is no reason to make a battle out of this, but it is important to note that the adaption proces has not been functioning in a sufficiently good manner. It also appears, that researchers as well as practitioners have underrated the importance and the magnitude of the adaption proces.

THE EXISTING KNOW HOW ?

So far, I have used the term "existing know how" without further specification, and as a non-specialist, I am not even tempted to make a definition. In fact, in this destinguished audience of specialists in concrete technology, I am much more inclined to refer the problem to you. I may suggest, however, a few questions for your consideration.

As far as I can see, our know how in concrete technology is to a large extent of an empirical nature. We have lots of test results and curve fitting has been used often and succesfully. It appears, however, that most of the results have not been explained and understood in a framework of basic models describing the physical and chemical processes occuring in the concrete. It may therefor be pertinent to ask if the empirical data obtained from research in the fifities and the sixties are also relevant, when dealing with concrete in the eighties. The concrete we use today and the manner in which we produce it is certainly different from the concrete and the technique that was used 20 or more years ago. Can the emperical know how on the old concrete be extrapolated to cover the modern situation, without the support of reliable, basic models? As an example, might accelerated freeze-thaw tests on a high density silica fume concrete according to the same procedure as used for ordinary concrete be relevant?

As a spectator, one may also notice, that the aggreement among specialists is not necessarily overwhelming. As an example, I may point out that today a number of testing methods are used to determine the alkali reactivity of aggregates. I am told, that a given aggregate may well be accepted on the basis of one testing method and rejected, if another method is used. It might be justified if the practitioner is sceptical about the usefullness of such know how.

I may sum up my question marks in the following way: If we had used - 10 years ago - our present, generally accepted know how, we would have been able to build a <u>perfect</u> concrete structure. We would have been able to choose the best possible materials, the best mix at that time etc. But if we were to find out if less than perfect materials could be used to build a <u>sufficiently</u> good concrete structure, the generally accepted know how might not be enough. We might have to exploit know how of a less generally accepted nature. This will be even more pronounced, if we also want to employ some of the more modern techniques and not only the techniques available 10 years ago.

THE COMMITTEES ON THE "DURABILITY OF CONCRETE STRUCTURES"

An assessment of the present situation along these lines formed the background when the Academy of the Technical Sciences organized its activity on this subject. The technical work is supervised by three committees. One of them has the primary object to initiate the process of adapting know how into readily applicable, practical routines. A second technical committee shall make sure, that a sufficient and rational system is developed to communicate the adapted know how at all levels and to all categories of personal involved in concrete construction. The third technical committee deals with the planning of basic research. High priority will be given to activities, which can support the adaptation process by filling some of the know how gaps. Finally, an administration committee takes care of the coordination between the three technical committees and of the financial support of the activities.

Our chairman professor Torben Hansen has at an earlier conference a few month ago pointed out, "that it is no longer possible for any person to have the collectiv, theoretical and practical background, which is necessary in order to solve the problems. It is clearly a task for professional societies, who should appoint committees with construction experience to evaluate the requirment for the concrete construction process and then to develop standards to provide interface for the contributing parts to the process".

And that is in my eyes exactly what the Danish Academy of Technical Sciences has done.

You will notice that the committee primarily will focus on training of the already graduated civil enginner rather than on the classical educational system, at our universities. We will focus on the bread-and-butter type training rather than on the use of sophisticated science.

I may point out that this is the result of a short term consideration. We may - here and now - act in the real and in the political world and this outside world, expect us to repair the acute and conspicuous damages.

But it does not mean that university education and scientific research should be overlooked. A long term consideration would of course emphasize these aspects. Among the intensions of the Committee is an improvement of the technical educations on all levels as well as the creation of an officialized education for concrete craftsmen.

However, as already mentioned, we need - here and now - a strengtening of the existing practice and therefore we have given top priority to the short term consideration.

ASR-QED

AN ATTEMPT TO PROVIDE AN EXPLANATION FOR ENGINEERS OF THE EXPANSIVE REACTION BETWEEN ALKALIES AND SILICEOUS AGGREGATES IN CONCRETE

John Figg

Ove Arup and Partners
London, England

1. ABSTRACT

1.1 Alkali silica reactions (ASR) in concrete are only partially understood and are poorly explained. In consequence "alkali" may mean "hydroxyl ion" or sometimes "alkali metal (ion)". One of the many varieties of silica may be involved, but the reacting material may be hydrated or can be a silicate. A number of three-variant (ternary) relationships have been reported to be involved in the extent of ASR in concrete, all contributing to the worst credible (pessimum) conditions for reaction, expansion and damage, and having an intriguing association with the three-branched (Manx) cracking frequently found in affected concretes (delta-star relationship).

KEYWORDS: Delta, Triangular, Manx, Star

2. INTRODUCTION

2.1 Although intended to provide an engineering image of ASR, this paper is written in "materials scientist" language to aid discussion. A suitable translation will be provided in due course.

2.2 Considerable misconception prevails concerning the reactions between alkalies and silica (ASR) in concrete and the mechanism of damage caused through this phenomenon. In part this is due to the reluctance of various parties to recognise that any problem exists, the rarity of the occurrence induces a lack of awareness and laissez-faire attitude amongst the users of concrete, and there are the usual communication difficulties between scientists and engineers. On top of all this is a veneer of media inspired scaremongering and alarmist propaganda about "concrete cancer" and "foreign disease" having connotations (as far as the British are concerned) of something nasty picked up on the Continent or imported in the much-feared German cement.

2.3 "Alkali" is often used rather loosely and can mean alkali metal, alkali metal ion i.e. the chemical elements (usually) sodium and potassium (and perhaps extended to lithium, rubidium and caesium). Or "alkali" may be used to mean hydroxyl ion or alkaline (high-pH) solution.