MINIMASING THE RISK OF CONCRETE DAMAGE - CAUSED BY ALKALI AGGREGATE REACTIONS IN NORWAY

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1. INTRODUCTION

A wide variety of aggregate types in common use across Europe, particularly those with a siliceous composition, are vulnerable to attack by the alkaline pore fluid in concrete. This attack, which in wet conditions produces a hygroscopic and hydraulic gel, can cause cracking and disruption of the concrete. The deterioration mechanism is termed **A**lkali **A**ggregate **R**eaction (AAR) or, more specifically, for siliceous aggregates, **A**lkali **S**ilica **R**eaction (ASR).

More than a decade of research and development in Norway has provided reliable and reproducible testing methods regarding AAR. This is the case both for classification of amount of reactive aggregates, the reactivity of the aggregate itself and the potential of the reactivity of various concrete mixes. Today a critical limit of up to 20% reactive aggregates is accepted for making a non-reactive concrete, if non other preventive action is carried out. A critical limit (0.10%) is also set for the accelerated expansion of mortar prisms exposed in 1N NaOH at 80^{o}C for 14 days. Yet, the reliability of the present acceptance/rejection criteria for aggregate material is still somewhat uncertain, since currently no sufficient data are available as to how these criteria relate to the properties of actual alkali-reaction damaged concrete in the field. To reduce these uncertainties, quantitative data on alkali-reaction damaged concrete from existing structures need to be gathered and evaluated.

2. THE PROJECT

During 1999, a new project was initiated, comprising quantitative measurements on drilled cores from existing concrete structures. The project is scheduled to run until the end of this year (2002). The national society for aggregate producers (*PGL*) hosts the project, in which aggregate-, precast- and concrete producers, cement producer Norcem, both the road and the railroad authorities, the Control Council for Concrete Products, the Norwegian Concrete Association and the Norwegian army corps of engineers all participate. SINTEF Civil and Environmental Engineering, Department for Cement and Concrete, manages the whole project, while ERGO Engineering Geology Ltd is in charge of the steering committee. Total budget is set at NKR4.7 million, and the Norwegian Research Council sponsors the project with NKR1.5 million.

The aims of the project are to:

- use experience from concrete structures in the field, together with quantitative measurements of concrete cores (environment, type of aggregates and mix design of concrete), to carry out an assessment of the current critical limits given by the Norwegian petrographical method and the accelerated mortar bar test.
- find correlation between type of structures, local environment (humidity) and degree of damage in the field, with the ambition of obtaining more competent guidelines for production of non-reactive concrete.
- make revision of the current guidelines for production of durable concrete given by the Norwegian Concrete Association.

In the project we have been dealing with the following topics;

Evaluation of the petrographic method and petrographical data:

- Collection of petrographical data (amount of reactive constituent) in a national database
- Statistical evaluation of variation in petrographical data and judgment of the Norwegian petrographical method to determine reactive aggregate.

Field inspection and sampling:

- Field inspection and classification of concrete structures, and degree of damage, based on a new developed registration scheme.
- Sampling of concrete cores.

Laboratory examination and testing:

- Assessment of degree of damage on polished sections of half-cores.
- Separation of aggregates from sampled concrete cores with a new method assessed and tested in this project.
- Point counting of reactive constituent in thin-sections of separated aggregates, by petrograhical microscope according to the Norwegian petrographic method (This method is recommended adopted as a RILEM method, and will also be assessed further in a new project regarding AAR funded by the European Union).
- Accelerated mortar-bar testing of separated aggregates from concrete cores.
- Measurements of total alkali content in field-concrete.
- Documentation of non-reactive mix design (pozzolans, alkali content etc.).

3. RESULTS AND IMPLICATIONS

The major laboratory results and the organisation of field results will be completed this autumn (2002). With the new obtained results, the present critical limits as given by the petrographic analysis and accelerated mortar bar test of aggregate material can be evaluated. Subsequently this will lead to a more specific revision of the publication of; "*Guidelines for production of durable concrete*" given by the Norwegian Concrete Association. The publication is due to be completed autumn 2003.

Specifications for the production of durable, non-AAR concrete could perhaps even be differentiated to meet variable exposure conditions per type of structure, or per structural element.

Increased reliability of such criteria will have its effect on the exploitation of resources, both for regional use as well as for export purposes, and of course on the quality of any structures built with approved materials. Due to a better definition of alkali-reactivity, the economical value of occurrences will increase.

The final report from the project will be completed during the end of this year. Further information regarding the project could be found on the project web-site at; www.this.is/ergo/AAR

For more information about AAR in Norway, including a picture atlas with micrographs of reactive rock types, please visit the website of the **F**orum for **A**lkali aggregate **R**eactions **I**n **N**orway (**FARIN**) at; www.this.is/ergo/efarin