The Effect of Cement Injections on Rock Pile Porous Lightweight Concrete

Abridged Version

of

Final Report

June 1998

by

Dr. rer. nat. M. Höpcke
Y. Junker, Dipl.-Ing.

The research report was funded by the Federal Ministry of Regional and Urban Development and Construction (Ref.: B I 5 80 01 97 - 18) The responsibility for its contents rests with the authors

1. Objective

The contents of the research at issue are building material analyses of rock pile porous light-weight concrete which was cement-lime injected to raise its strength.

Rock pile porous lightweight concrete by comparison with normal concrete has divergent material typical properties like the chemical composition of the light aggregates, porosity and pore structure of the overall building material.

Housing in the new lander with **external wall components of rock pile porous light-weight concrete** showed evidence of defects as e.g. extensive macro-crack structures, damp damage in the vicinity of joints adjacent to windows or insufficient thermal protection /1/.

Foundations were laid for the development of a lasting and all embracing rehabilitation with the aim of eliminating the above mentioned defects of external wall components of rock pile porous lightweight concrete /2/.

With buildings of which the required safety standard can not be proved the **strength and thereby the stability should be increased through a cement-lime injection.**

This gives rise to the potential danger of subsequently creating conditions which facilitate a harmful alkali silicic acid reaction (hereinafter called ASAR).

Cause and effect of ASAR are that some concrete aggregates contain alkali reactive silicic acid. These react with alkali which exist dissolved in alkali hydroxide to form alkali silicates. Under certain conditions this reaction leads to **volume increase and damage to concrete.**

With damp exclusion the alkali silicic acid reaction stops, while progressing relatively fast with damp concrete and unfavourable thermal conditions.

Hitherto there has been no damage to components of lightweight concrete whose cause has been the effect of damaging ASAR and, as far as we know, no attention has been paid to this problem in literature either.

Reasons are e. g. the material typical **high porosity** and a consequently high spatial capacity for possibly expanding reaction products. In addition, **due to the structural solutions of construction components** of rock pile porous light-weight concrete the **damp required** for the process of damaging ASAR would **not** have been **sufficient.**

Through injections these conditions are altered. More water is added. Reactions can be encouraged.

Through building material analyses it is to be established whether the rehabilitation through applied cement-lime injections has an effect on the ASAR behaviour and consequently the permanence of the building material.

2. Realization

The "DAfStb-guideline **"preventive measures against damaging alkali reaction in concrete",** part 1, 2, 3; 8. Draft of May 1997 /3/ applies to concrete to DIN 1045 "concrete and reinforced concrete".

In part 2 and 3 of the named guideline /3/ **all preventive measures** to be adhered to have been codified comprehensively and in detail to the latest level of knowledge to be in a position **to exclude ASAR** with certainty with buildings to be newly projected.

Through **laboratory analyses**, however, the possibility of establishing the **potential ASAR** risk of a material **subsequently** exists. As a rule as a first preliminary analysis the so called fluorescent test is carried out through which after treatment with uranylacetate possibly present alkali silicates (reaction products of ASAR) are made visible in UV-light. If this test produces a positive result, the identification of the following parameters is required:

- **determination of the Na_2O-equivalent through the identification of the K and Na contents in the building material;**
- **identification of the alkali sensitivity of the aggregates;**
- **determination of the residual expansional behaviour of the test specimen (demands under worst possible conditions at 96% relative humidity and 38°C)**

These tests were carried out on **test specimens** taken from **cement-lime injected building walls of rock pile porous lightweight concrete.** For **comparison** fluorescent tests as well as the determination of alkali contents were done **on uninjected lightweight concrete samples.**

3. Results

The **evaluation of all test results** shows that in the **material tested** before as well as after a cement-lime injection **all the necessary factors** for the **process of ASAR are present:**

The evaluation of the results has shown that the material **contains high alkali contents** of analysis values **of 10 to 24 kg/m³.** At the same time **aggregates of a potential alkali sensitivity are present.**

The **permissible content** of alkali in concrete in the presence of alkali sensitive aggregates is stated in the ASAR-guideline /3/ as **3.6 kg/m³.**

Fluorescent tests have shown that through the stress at high humidity made for the ascertainment of the residual expansional behaviour the already **high content of alkali silicates - the reaction products of ASAR -** in light-weight concrete is raised further.

The **residual expansional behaviour** of cement injected lightweight concrete of length variations of **0.72 to 2.46 mm/m** is to be classed as **considerable** and after 175 days stress has not yet stopped. The **permissible residual expansion** in the ASTM-regulation /8/ of a 96 days long stress **is 0,5 mm/m**.

The tests have shown that **all the necessary factors for a damaging ASAR** (high alkali contents, alkali sensitive aggregates and humidity) are present in the injected lightweight concrete samples. Of these cited parameters humidity is the only value that can subsequently be influenced. The only **measure for the avoidance of ASAR damage is the reliable exclusion of humidity.**

For the analysed **cement-lime injected gable walls** according to the rehabilitation concept **thermal insulation is provided.**

This measure would exclude the effect of humidity on the material and consequently effectively prevent damaging ASAR within cement injected lightweight concrete.

However, it must be considered that **through the cement-lime injections an ingress** of water into the hitherto **dry concrete takes place**. Only after a not yet quantifiable period the humidity diffuses from the material and until then is present as an accelerating reaction partner of the ASAR.

For this reason through further tests the **time dependence of drying must** be checked.