Consulting Engineers
Raupach ▪ Bruns ▪ Wolff

Ingenieurbüro Raupach Bruns Wolff GmbH & Co. KG
Büchel 13/15 · D-52062 Aachen

Drytech S.A.
Via Industrie 12
6930 Bedano TI
SCHWEIZ

project: B 5640

contact: Dipl.-Ing. M. Bruns

phone: +49 241 94 37 74 08
fax: +49 241 94 37 74 16
E-mail: bruns@rbw-aachen.de

date: 2012/02/17

Expert report on the corrosion risk for the reinforcement in contact with Dryflex 3-S™ in honeycombs and concrete cracks

B 5640-2

Employer: Drytech S.A.
Via Industrie 12
6930 Bedano TI
SCHWEIZ

This expert report includes 7 pages.

Ingenieurbüro Raupach Bruns Wolff GmbH & Co. KG
Büchel 13/15 · D-52062 Aachen
Telefon: +49 241 94 37 74 08
Telefax: +49 241 94 37 74 16
E-mail: info@rbw-aachen.de

Business Manager: Prof. Dr.-Ing. M. Raupach
Dipl.-Ing. M. Bruns
Dr.-Ing. L. Wolff
Commercial Register: Amtsgericht Aachen, Germany
Register Number: HRA 7269

Bank Account: Sparkasse Aachen
Acc. No.: 1071660532 Bank Code: 390 500 00
IBAN: DE07 3905 0000 1071 6605 32
SWIFT-BIC: AACSDE33
VAT Id. Nr.: DE 815021675

CONTENTS

1. CONTRACT

On February 14th 2012 Drytech S.A. placed an order with Consulting Engineers Raupach Bruns Wolff GmbH & Co.KG (in the following: RBW) via Email to write an expert report regarding the corrosion risk of the reinforcement in honeycombs in concrete which had been injected with the acrylic gel Dryflex 3-S™.

Basis for the expert report is a material testing carried out at the Institute of Building Materials Research (ibac) at RWTH Aachen University. The test procedure and the test results are described in the Test Report M 1281/2 /1/.

2. MATERIAL TESTING

When honeycombs or cracks in reinforced concrete are injected by use of acrylic gels, the gel gets in direct contact to the steel surface of the reinforcement which is crossing the honecombs or the cracks. To be sure that in such cases significant macrocell corrosion of the reinforcement does not occur, it has to be ascertained that the use of the gel does not lead to unacceptable corrosion enhancing effects at the steel surface in the injected area.

In order to examine if the acrylic gel Dryflex 3-S™ can be used as injection material for reinforced concrete structures in the area of cracks or honeycombs without the risk of inducing unacceptable reinforcement corrosion the tests described in the test report M 1281/2 /1/ was carried out at the Institute of Materials Research (ibac).

For the tests a test procedure was used, which was developed during the research project F 947 “Anwendungsbedingungen für den Einsatz von Acrylatgelen in Arbeitsfugen und in Rissen von Stahlbetonbauteilen” at ibac /2/. The test setup is schematically shown in figure 1. For the test a steelbar is embedded in a borehole (Ø = 50 mm) which is placed centrically in a concrete cylinder. The borehole is filled with a mixture of aggregate and the gel which is to be tested. During the test the steel is polarised stepwise (100 mV/24h) to a potential of +500 mV versus the initial free corrosion potential of the steel electrode by use of a potentiostat and a counter electrode. During the test the resulting element current is measured.

This test simulates the corrosion situation in a honeycomb, where it has to be assumed that the steel surface is surrounded by a huge amount of the acrylic gel and can be anodically polarised by the surrounding reinforcement which can act as cathode of the corrosion element.

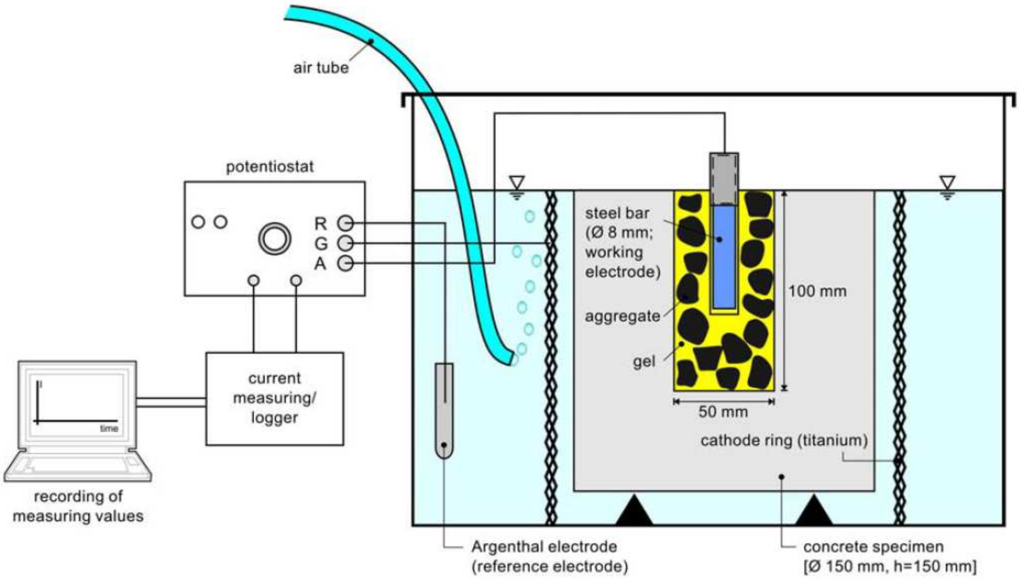

Figure 1: Schematic test set-up of the tests described in M 1281/3

According to the report M 1281/2 /1/ three identical specimens were tested as described. As result of the tests the measured element currents are given in Figures 2, 3 and 4 as mean surface current densities related to the steel surface.

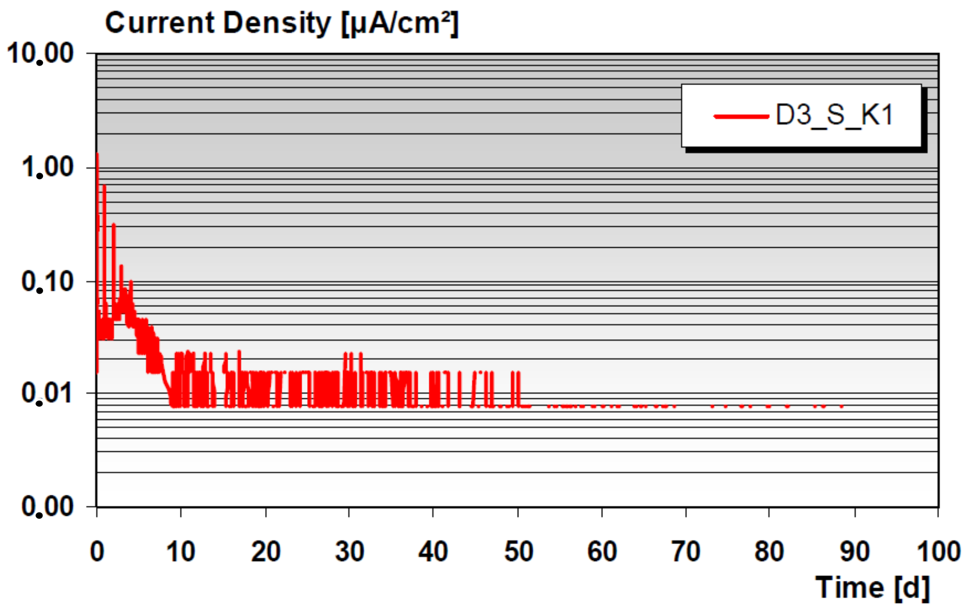

Figure 2: Measured mean element current density of the specimen K1 prepared with Dryflex 3-S^{TM} (taken from M 1281/2 /1/)

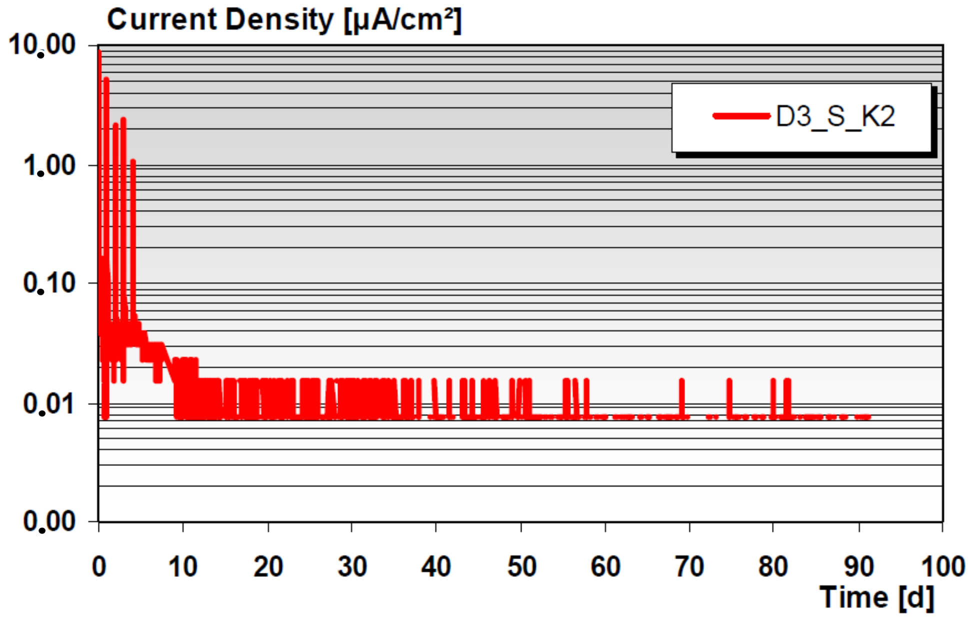

Figure 3: Measured mean element current density of the specimen K2 prepared with Dryflex 3-S™ (taken from M 1281/2 /1/)

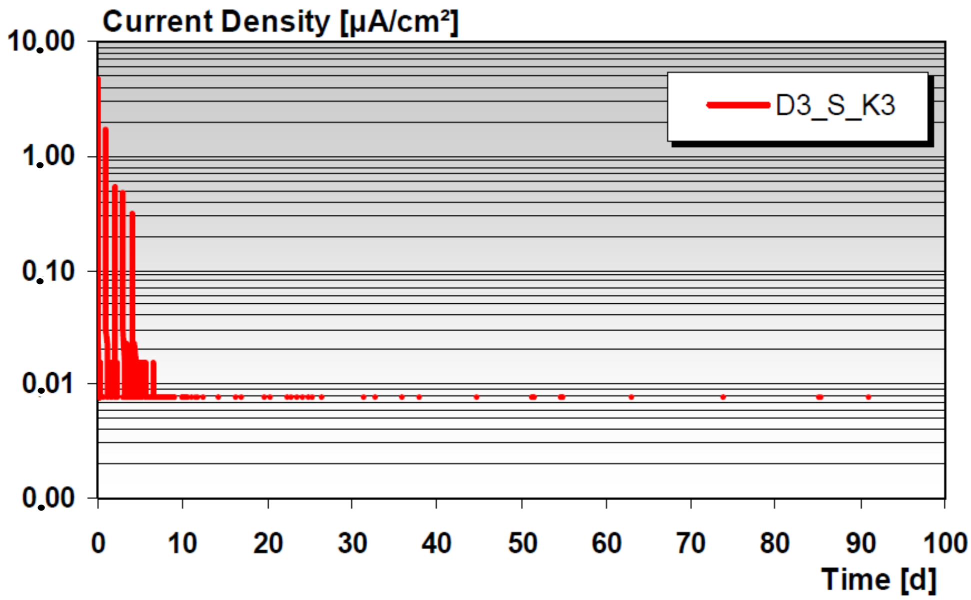

Figure 4: Measured mean element current density of the specimen K3 prepared with Dryflex 3-S™ (taken from M 1281/2 /1/)

3. INTERPRETATION OF THE TEST RESULTS

In the first 5 days of testing in all three cases the effect of the stepwise polarisation can be seen by rapidly increasing element currents. But at each polarisation step the current then again rapidly decreases to very low values which are in the range of passive current densities. Even at an anodic polarisation of +500 mV (relative to the initial free corrosion potential) the current densities remain in the range of a current density which is typical for steel in concrete in passive state. Therefore the steel is obviously also in passive state, when it is embedded in the acrylic gel Dryflex 3-S™ within a honeycomb.

4. CONCLUSIONS

From the results of the material testing in M 1281/2 /1/ it can be concluded that the reinforcement embedded in the acrylic gel Dryflex 3-S™ seems to be in passive state as long as no corrosion promoting substances (e.g. chlorides) are present.

If the acrylic gel Dryflex 3-S™ is used for injection in the area of honeycombs or cracks in concrete no relevant corrosion damage has to be expected if:

- the concrete especially in the honeycombs or cracks is not contaminated by chlorides (e.g. from seawater or de-icing salts)
- the honeycombs, the cracks and the gel system are not exposed to any chloride source (e.g. from seawater or de-icing salts).
- the components and the mixture of the gel are identical to those tested in M 1281/2 /1/.

The tests carried out in M 1281/2 only simulate the situation under static conditions. When moving cracks or frequent wetting and drying of the gel is possible the situation could be different. Therefore an assessment of the corrosion risk for these conditions (moving cracks and wet/dry changes) is not possible form the test results.

When the acrylic gel Dryflex 3-S™ is used for injection of reinforced concrete structures relevant corrosion of the reinforcement in the area of cracks has not to be expected under compliance with the requirements given above in honeycombs or static cracks without significant changes in crack width and without frequent wet/dry changes.

M. Bruns

Dipl.-Ing. M. Bruns

L. Wolff

Dr.-Ing. L. Wolff

LITERATURE

/1/ ibac; AG5; Helm, C.; Reichling, K.; Test Report M 1281/2: Corrosion Tests on Reinforcement in Contact with Acrylate Gel Dryflex 3-S^{TM}. Aachen: Institut für Bauforschung, RWTH Aachen University, 2011.- Test Report Nr. M 1281/2

/2/ Raupach, M. ; Harnisch, J. ; Wolff, L.: Anwendungsbedingungen für den Einsatz von Acrylatgelen in Arbeitsfugen und in Rissen von Stahlbetonbauteilen. Aachen : Institut für Bauforschung der RWTH Aachen, 2007. - Forschungsbericht Nr. F 947