

## Test Report

Document No.: (3350/801/10) – NB dated 25.06.2010

Client: SOUDAL N.V.  
Everdongenlaan 18-20  
2300 Turnhout

Order date: 04.03.2010

Order Ref.: Herr Filip van Mieghem

Order received: 21.05.2010

Subject: “Soudafix Injection System VE-SF for concrete”, bonded anchors placed in the non-cracked tension zone of RC floor sections, strength class  $\geq$  C20/25, and subjected to centric tension loads, to be tested and evaluated in connection with anchor rods (dimensions M8 to M30) for their reaction to fire to determine their fire resistance time

Test basis: DIN EN 1363-1 : 1999-10

Test material received: Week 46/2006

Sampling: The Testing House does not have any information indicating official sampling.

Test material marking: None

Test date: 21/11/2006, 28/11/2006, 06/12/2006, 24/01/2007 and 20/02/2007

Valid until: 06/03/2013

This Test Report consists of 8 pages, incl. cover and 11 annexes.

The Test Report No. (3350/801/10) – NB dated 25.06.2010 does not replace a General Building Code Test Certificate (abP; abZ, ETA) according to the German Laender Building Regulations.

This Test Report may not be circulated unless as a complete text and without any alterations. Excerpts or abridged versions of the Test Report are subject to approval in writing of MPA Braunschweig. Translations of this document must bear the note "translation of the German original not examined by the Braunschweig Civil Engineering Materials Testing Institute". The first sheet of this document and the page carrying the signatures bear the official stamp of MPA Braunschweig. Documents that do not carry a signature and the official stamp are invalid. The test material has been fully used. Accreditations are valid for the testing methods specified in the current documents. A list showing fields for which accreditation has been obtained can be made available upon request.



## Contents

1	Background and general statement .....	2
2	Description of system tested .....	3
3	Test set-up and testing .....	3
4	Test results, evaluation and conclusions.....	4
4.1	Evaluation of test results respecting centric tension loading .....	4
4.2	Evaluation of test results respecting steel failure .....	4
4.2.1	General .....	4
4.2.2	Presentation of test results and evaluation .....	5
4.2.3	Proposed rating for the “Soudafix Injection System VE-SF for concrete” bonded anchors (dimensions M8 to M30) in connection with anchor rods made from electro-galvanized steel (strength class $\geq 5.8$ ) .....	5
4.2.4	Proposed rating for the “Soudafix Injection System VE-SF for concrete” bonded anchors (dimensions M8 – M30) in connection with anchor rods made from stainless steel.....	6
5	Annotations .....	7
	List of annexes .....	8

## 1 Background and general statement

Under the order placed with the Testing House, a Test Report was to be drawn up on the reaction to fire of “Soudafix Injection System VE-SF for concrete” bonded anchors, which are subjected to centric tension and tested for steel failure in compliance with section 2.3 of TR 020 : 2004-05, when exposed to a fire in compliance with DIN EN 1363-1 : 1999-10 to determine their fire resistance time.

### Related documents:

- (1) DIN EN 1363-1 : 1999-10, Fire resistance tests - Part 1: General requirements,
- (2) EOTA Technical Report TR 020 : 2004-05 - Evaluation of anchorages in concrete concerning resistance to fire,
- (3) “Soudafix Injection System VE-SF for concrete”, European Technical Approval ETA-10/0167 of 10-05-2010, issued by DIBt, Berlin,
- (4) is a transfer of Test Report No. (3290/0966)-NB dated 06-03-2008. The injection adhesive anchors evaluated in the present Test Report are per statement of the client identical with the anchors evaluated in the Test Report No. (3290/0966)-NB. This document is the translated version of Test Report No. (3290/0966)-NB dated 06-03-2008. The german version is the only legally binding text.

Using the results achieved in the fire test, the “Soudafix Injection System VE-SF for concrete” were to be examined and evaluated respecting requirements (steel failure, pullout) specified in EOTA Technical Report TR 020 : 2004-05.

## **2 Description of system tested**

The “Soudafix Injection System VE-SF for concrete” bonded anchor is an injection system that uses the bonding effect between anchor rod, bonding mortar and concrete to become anchored in the substrate. According to the type approval for cold design of anchoring means primarily subjected to static loads, the “Soudafix Injection System VE-SF for concrete” bonded anchor may be used in reinforced and non-reinforced normal-weight concrete (strength class C20/25 as a minimum and C50/60 as a maximum) in the non-cracked concrete.

Main elements of the tested “Soudafix Injection System VE-SF for concrete” bonded anchor are a two-component mortar cartridge (injection mortar: styrene-free vinylester resin system with cement, water and sand) and cold-formed anchor rods (dimensions M8 to M30), together with a hexagon nut and a washer. The anchor rods and the nuts and washers are made from electro-galvanized steel (strength class  $\geq 5.8$ ) and from stainless steel (material No. 1.4401 (A4) and 1.4571 (A5), 1.4529 (HCR), strength class 70). Forces are transmitted by the bond stress between the anchor rod and the anchoring substrate. For the service conditions, the “Soudafix Injection System VE-SF for concrete” bonded anchor is regulated by the above-named approval.

As specified in the above type approval, the “Soudafix Injection System VE-SF for concrete” bonded anchors were installed with the installation tools (hammer drill and drill, cleaning device and injection device) defined in these documents.

Further structural details and details of the as-installed condition of the bonded anchors are shown annexes 1.1 to 1.4 of this Test Report.

## **3 Test set-up and testing**

The “Soudafix Injection System VE-SF for concrete” bonded anchors were fire tested in a small-sized furnace with the inside dimensions 1,000 mm x 1,500 mm x 1,500 mm (W x D x H). RC slabs (strength class C20/25) formed the horizontal barrier, into the tension zones of which the “Soudafix Injection System VE-SF for concrete” bonded anchors were placed.

In compliance with TR 020 : 2004-05, section 2.3.1, external loading systems and protected steel elements (dead loads) of the required weight, which were suspended for an unsupported and unprotected length of  $l \leq 500$  mm with tension rods and an additional steel adapter, were used for

introducing the centric loads into the “Soudafix Injection System VE-SF for concrete” bonded anchors.

The furnace was exposed to a fire in compliance with the standard temperature-time curve (ETK) as specified in DIN EN 1363-1 : 1999-10, section 5.1.1. The temperatures in the furnace were measured with 2 plate thermometers with measuring heads made from Ni-Cr/Ni-Al wire (type K) dia. 1.0 mm in compliance with DIN EN 1363-1 : 1999-10, section 4.5.1.1.

The temperatures measured in the furnace during the fire tests are illustrated by the graphs in annexes 2.1, 3.1, 4.1, 5.1 and 6.1.

## 4 Test results, evaluation and conclusions

### 4.1 Evaluation of test results respecting centric tension loading

On 21/11/2006, 28/11/2006, 06/12/2006, 24/01/2007 and 20/02/2007, a total of 23 “Soudafix Injection System VE-SF for concrete” bonded anchors were placed in the non-cracked tension zone of RC floor sections (strength class C20/25) and tested for their reaction to fire when subjected to centric tension loads in compliance with DIN EN 1363-1 : 1999-10 to determine their fire resistance time.

Tables 4-1 to 4-5 in Test Report No. (3290/0966)-NB dated 06-03-2008 list the test results for the 23 “Soudafix Injection System VE-SF for concrete” bonded anchors in connection with anchor rods made from electro-galvanized steel and stainless steel and make reference to the cause of failures.

### 4.2 Evaluation of test results respecting steel failure

#### 4.2.1 General

The basis used for evaluation was section 2.3.1 of EOTA Technical Report TR 020 : 2004-05:

$$\sigma_{s1} = C_1 + C_2 / t_u \quad \text{equation: regression curve}$$

$$\sigma_{s2} = C_3 (C_1 + C_2 / t_u) \quad \text{equation: design curve}$$

Equations for determination of the characteristic steel stress for fire resistance times of 60 min., 90 min. and 120 min:

$$\sigma_{Rk,s,fi(60)} = C_3 (C_1 + C_2 / 60 \text{ min})$$

$$\sigma_{Rk,s,fi(90)} = C_3 (C_1 + C_2 / 90 \text{ min})$$

$$\sigma_{Rk,s,fi(120)} = c_3 (c_1 + c_2 / 120 \text{ min})$$

Equation for determination of the characteristic steel stress for fire resistance times of 30 min., using the equation of the straight line through points  $t_u = 60 \text{ min} / \sigma_{Rk,s,fi(60)}$  and  $t_u = 90 \text{ min} / \sigma_{Rk,s,fi(90)}$ :

$$\sigma_{Rk,s,fi(30)} = c_4 - c_5 \times 30 \text{ min}$$

To calculate the tensile stress, the stress cross section  $A_s$  of the corresponding diameter of the “Soudafix Injection System VE-SF for concrete” bonded anchors was entered in the computation.

#### 4.2.2 Presentation of test results and evaluation

The graphs in annex 7.1 show the test results as a function of the stress  $\sigma_s$  of the “Soudafix Injection System VE-SF for concrete” bonded anchors made from electro-galvanized steel and stainless steel A4 (diameter M8 to M16) when subjected to centric tensile loads.

The “Soudafix Injection System VE-SF for concrete” bonded anchors with the dimensions M24 to M30 are evaluated on the basis of the steel stress utilization level in relation to the stress cross section.

#### 4.2.3 Proposed rating for the “Soudafix Injection System VE-SF for concrete” bonded anchors (dimensions M8 to M30) in connection with anchor rods made from electro-galvanized steel (strength class $\geq 5.8$ )

Using the results achieved in the tests as a basis, fire resistance periods are proposed for the “Soudafix Injection System VE-SF for concrete” bonded anchors (dimensions M8 to M30) made from electro-galvanized steel as shown in table 4-1 below as a function of the maximum centric tensile load.

Based on the results achieved in the tests, and departing from the evaluation specifications in TR 020 : 2004-05, the ratings for “Soudafix Injection System VE-SF for concrete” bonded anchors made from electro-galvanized steel have been increased with regard to the 30-minute fire resistance time.

Table 4-1: Proposed rating for “Soudafix Injection System VE-SF for concrete” bonded anchors (dimensions M8 – M30) made from electro-galvanized steel and stainless steel, regarding their fire resistance times as a function of stress  $\sigma_s$ , when exposed to centric tensile loads

Designation	“Soudafix Injection System VE-SF for concrete” bonded anchor						
Fire resistance time $t_u$ [min]	Maximum tensile load <sup>1)</sup>						
	F [kN]						
	M8	M10	M12	M16	M20	M24	M30
Minimum set depth [mm]	80	90	110	125	175	210	280
30	1.64	2.60	3.35	6.25	9.75	14.04	18.26
60	1.12	1.77	2.59	4.82	7.52	10.84	14.10
90	0.59	0.94	1.82	3.40	5.30	7.64	9.94
120	0.33	0.52	1.44	2.69	4.19	6.04	7.86

<sup>1)</sup> Loads resulting from European Technical Approval ETA-10/0167 of 10-05-2010 may be decisive for the service condition.

#### 4.2.4 Proposed rating for the “Soudafix Injection System VE-SF for concrete” bonded anchors (dimensions M8 – M30) in connection with anchor rods made from stainless steel

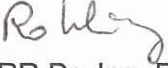
Starting from the results achieved in the tests, the same characteristic tensile stresses (cf. table 4-1) are recommended for the “Soudafix Injection System VE-SF for concrete” bonded anchors, when adequate anchor rods made from stainless steel (material No. 1.4401 (A4) or 1.4571 (A5), 1.4529 (HCR), strength class 70) and nuts made from stainless steel (A4, strength class A-70) are used.



## 5 Annotations


- 5.1** This Test Report does not replace the attestation (General Building Code Test Certificate - abP; National Technical Approval - abZ, ETA) required under the German building code procedure. It should, in particular, be noted that the fire load density values of "Soudafix Injection System VE-SF for concrete" bonded anchors can in the future be regulated by European Technical Approvals.
- 5.2** The above evaluation shall only apply to the tested "Soudafix Injection System VE-SF for concrete", bonded anchors due consideration being given to the boundary conditions shown in the technical annexes attached to this Test Report and/or the technical data sheets of Soudal N.V..
- 5.3** The "Soudafix Injection System VE-SF for concrete" bonded anchors may be used for anchoring applications in non-cracked reinforced concrete (strength class C20/25 as a minimum and C50/60 as a maximum) when primarily subjected to static loads.
- 5.4** The evaluation shall only apply in connection with members made from reinforced concrete, which can as a minimum be classified under the same fire resistance class as that of the anchors.
- 5.5** The validity of the Test Report will expire on 06/03/2013.

This document is the translated version of Test Report No. (3290/0966)-NB dated 06-03-2008. The legally binding text is the aforementioned German Test Report.

  
ORR Dr.-Ing. Rohling  
Head of Testing Laboratory



Braunschweig, dated 25.06.2010

by order   
Dipl.-Ing. Bollmohr  
Engineer in charge

## List of annexes

- Annex 1.1: Structural design of the test installation
- Annex 1.2: “Soudafix Injection System VE-SF for concrete” bonded anchors after installation
- Annex 1.3: Technical details of “Soudafix Injection System VE-SF for concrete”
- Annex 1.4: Technical details of “Soudafix Injection System VE-SF for concrete”
- Annex 1.5: Technical details of “Soudafix Injection System VE-SF for concrete”
- Annex 2.1: Furnace temperatures – test 1
- Annex 3.1: Furnace temperatures – test 2
- Annex 4.1: Furnace temperatures – test 3
- Annex 5.1: Furnace temperatures – test 4
- Annex 6.1: Furnace temperatures – test 5
- Annex 7.1: Evaluation of test results - “Soudafix Injection System VE-SF for concrete”