

Test Report

– Translation –

Document No.: (2100/472/15) – NB dated 25/06/2015

Client: Apolo MEA Befestigungssysteme GmbH
Industriestraße 6
86551 Aichach
Germany

Order date: 18/02/2013

Order Ref.: -

Order received: 18/02/2013

Subject: "Apolo MEA Injection System Resifix Pure Epoxi for concrete" bonded anchors, placed in non-cracked RC members 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 for one-sided fire exposure

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

Test material received: 11/06/2008

Sampling: Sampling information is not available to the Testing House.

Test material marking: None

Test date: 27/06/2008, 27/08/2008, 01/09/2008 and 30/09/2008

Valid until: 07 January 2019

This Test Report consist of 8 pages, incl. cover sheet and 8 annexes.

Test Report No. (2100/472/15) – NB dated 25/06/2015 does not replace the building code attestation (General Building Code Test Certificate - abP; National Technical Approval - abZ, ETA) required under the German building code procedure.

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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 “Apolo MEA Injection System Resifix Pure Epoxi for concrete” bonded anchors, which are subjected to centric tension and tested for steel failure / bonding failure on the basis of 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) “Apolo MEA Injection System Resifix Pure Epoxi for concrete”, European Technical Approval ETA-09/0373 of 14-06-2013 issued by DIBt, Berlin,
- (4) is a transfer of Test Report No. (3302/252/08)-NB dated 07-01-2009 (english translation, the german version of Test Report No. (3302/252/08)-NB dated 07-01-2009 is the only legally binding text). 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. (3302/252/08)-NB.

Using the results achieved in the fire test, the “Apolo MEA Injection System Resifix Pure Epoxi for concrete” bonded anchors 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 “Apolo MEA Injection System Resifix Pure Epoxi 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 “Apolo MEA Injection System Resifix Pure Epoxi 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 “Apolo MEA Injection System Resifix Pure Epoxi for concrete” bonded anchor are a two-component mortar cartridge (injection mortar: based on epoxy resin with amine hardener and silica flour) 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 electrogalvanised steel (strength class 5.6). Forces are transmitted by the bond stress between the anchor rod and the anchoring substrate. For the service conditions, the “Apolo MEA Injection System Resifix Pure Epoxi for concrete” bonded anchor is regulated with the European Technical Approval ETA-09/0373 of 14-06-2013.

As specified in the above type approval, the “Apolo MEA Injection System Resifix Pure Epoxi 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 “Apolo MEA Injection System Resifix Pure Epoxi for concrete” bonded anchors were fire tested in a small-sized furnace with the inside dimensions 1,000mm x 1,500mm x 1,500mm (W x D x H). RC slabs (strength class C20/25) formed the horizontal barrier, into the tension zones of which the “Apolo MEA Injection System Resifix Pure Epoxi 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 introduc-

ing the centric loads into the “Apolo MEA Injection System Resifix Pure Epoxi 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 made from Ni-Cr/Ni-Al Ø 1.0mm wire (type K) 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, and 5.1.

4 Test results, evaluation and conclusions

4.1 Evaluation of test results respecting centric tension loading

On 27/06/2008, 27/08/2008, 01/09/2008 and 30/09/2008, a total of 26 “Apolo MEA Injection System Resifix Pure Epoxi 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. (3302/252/08) – NB dated 07-01-2009 list the test results for the 26 “Apolo MEA Injection System Resifix Pure Epoxi for concrete” bonded anchors in connection with anchor rods made from electrogalvanised steel (strength class 5.6) and make reference to the cause of failure.

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.:

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

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

$$\sigma_{Rk,s,fi(120)} = c3 (c1 + c2 / 120min)$$

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 $t_u = 90 \text{ min} / \sigma_{Rk,s,fi(90)}$:

$$\sigma_{Rk,s,fi(30)} = c4 - c5 \times 30min$$

To calculate the tensile stress, the stress cross section A_s of the corresponding diameter of the “Apolo MEA Injection System Resifix Pure Epoxi for concrete” bonded anchors was entered in the computation. Separate assessments were made for dimensions M8 to M20. The assessments for dimensions M24 to M30 are based on the test results for diameter M20.

4.2.2 Presentation of test results and evaluation

The graphs in Fig. 4.1 show the test results as a function of the stress σ_s of the “Apolo MEA Injection System Resifix Pure Epoxi for concrete” bonded anchors made from electrogalvanised steel (strength class 5.6) when subjected to centric tensile loads.

The “Apolo MEA Injection System Resifix Pure Epoxi for concrete” bonded anchors with the dimensions M24 to M30 are evaluated on the basis of the steel stress utilisation level in relation to the stress cross section.

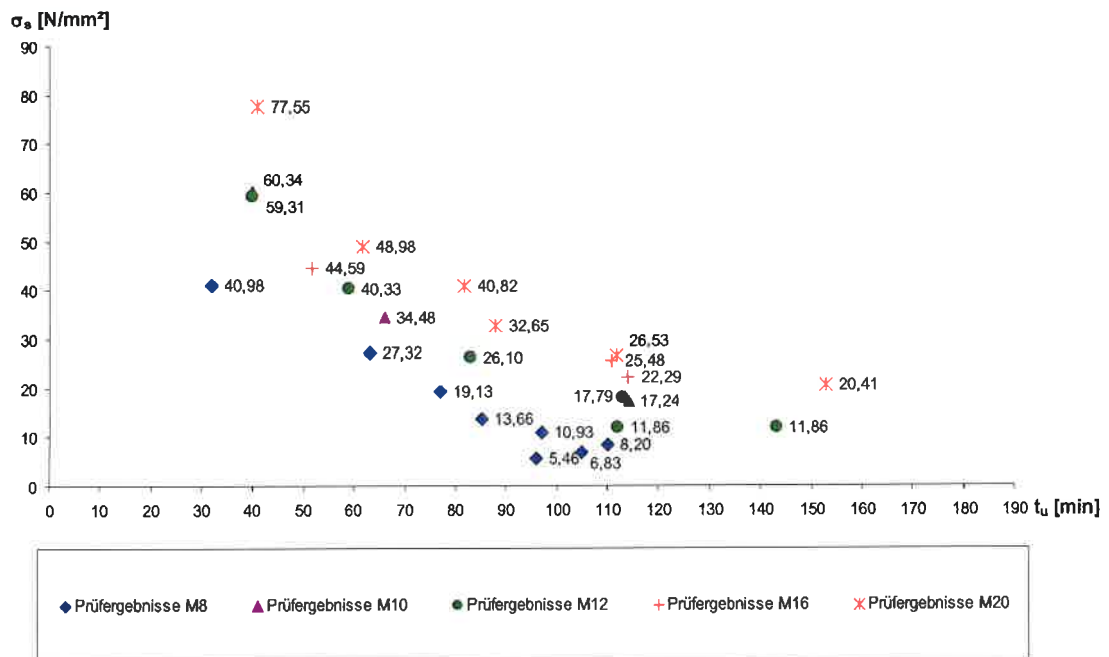


Fig. 4-1: Graphic representation of test results (steel failure, bonding failure) determined for the “Apolo MEA Injection System Resifix Pure Epoxi for concrete” bonded anchors (dimensions M8 to M20) in connection with anchor rods made from electrogalvanised steel (strength class 5.6)

4.2.3 Proposed rating for the “Apolo MEA Injection System Resifix Pure Epoxi for concrete” bonded anchors (dimensions M8 to M30) in connection with anchor rods made from electrogalvanised steel (strength class 5.6)

Using the test results achieved for “Apolo MEA Injection System Resifix Pure Epoxi for concrete” bonded anchors made from electrogalvanised steel (strength class 5.6) as a basis, fire resistance periods are proposed for the “Apolo MEA Injection System Resifix Pure Epoxi for concrete” bonded anchors (dimensions M8 to M30) made from electrogalvanised steel (strength class 5.6, 5.8 and 8.8) as a function of the maximum centric tensile load as shown in table 4-1 below.

Based on the results achieved in the tests, and departing from the evaluation specifications in TR 020 : 2004-05, the ratings for “Apolo MEA Injection System Resifix Pure Epoxi for concrete” bonded anchors made from galvanised steel have been increased with regard to the 30-minute fire resistance time.

Table 4-1: Proposed rating for “Apolo MEA Injection System Resifix Pure Epoxi for concrete” bonded anchors (dimensions M8 – M30) made from electrogalvanised steel, regarding their fire resistance times as a function of stress σ_s when exposed to centric tensile loads, and as a function of the minimum set depth

Designation	“Apolo MEA Injection System Resifix Pure Epoxi for concrete” bonded anchor							
Fire resistance time t_u [min]	Maximum tensile load ¹⁾							
	F [kN]							
	M8	M10	M12	M16	M20	M24	M27	M30
Minimum set depth [mm]	80	90	110	125	170	210	250	280
30	0.90	3.20	4.20	8.25	17.25	24.85	32.30	39.50
60	0.50	1.80	2.30	5.30	10.20	14.75	19.15	23.40
90	0.30	1.10	1.40	3.80	6.70	9.70	12.60	15.40
120	0.20	0.75	0.90	3.00	5.00	7.20	9.30	11.35

¹⁾ Loads resulting from European Technical Approval ETA-09/0373 of 14-06-2013 may be decisive for the service condition.

4.2.4 Proposed rating for “Apolo MEA Injection System Resifix Pure Epoxi 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 “Apolo MEA Injection System Resifix Pure Epoxi for concrete” bonded anchors, when adequate anchor rods and nuts made from stainless steel (material No. 1.4401 (A4) and 1.4571 (A5), 1.4529 (HCR), strength class 50 and 70, respectively) are used.

5 Annotations

- 5.1** This Test Report does not replace the required building code attestation (General Building Code Test Certificate - abP; National Technical Approval - abZ, ETA). It should, in particular, be noted that the fire load density values of "Apolo MEA Injection System Resifix Pure Epoxi for concrete" bonded anchors can be regulated by European Technical Approvals.
- 5.2** The above evaluation shall only apply to the tested "Apolo MEA Injection System Resifix Pure Epoxi 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 Apolo MEA Befestigungssysteme GmbH.
- 5.3** The "Apolo MEA Injection System Resifix Pure Epoxi 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 07 January 2019.



ORR Dr.-Ing. Rohling
Deputy Head of Testing Laboratory



i.A. 
Dipl.-Ing. Bollmohr
Engineer in charge

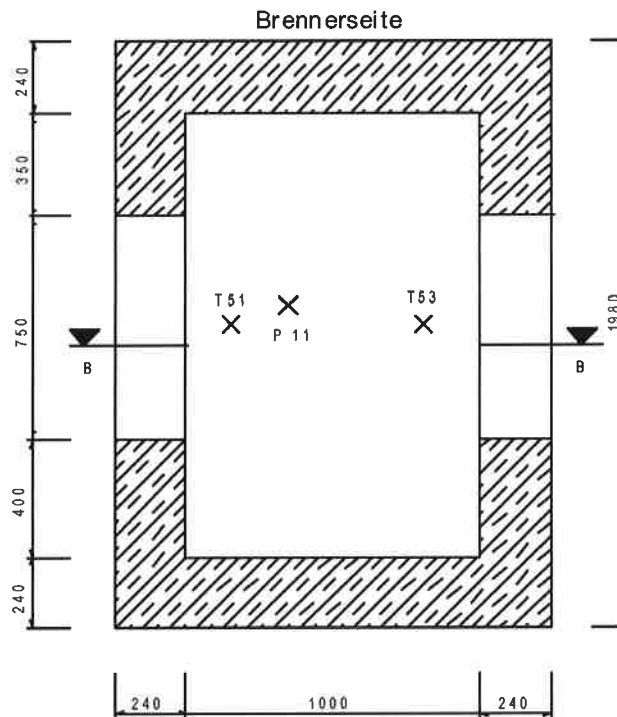
Braunschweig, 25/06/2015

List of annexes

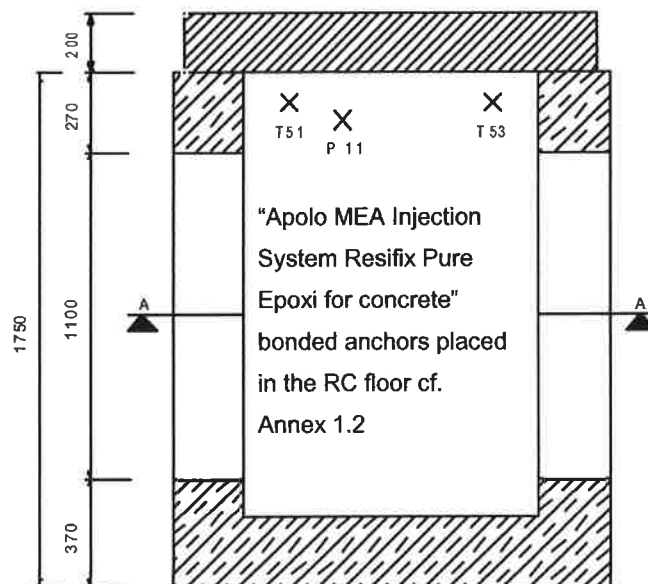
- Annex 1.1 : Structural design of the test installation
- Annex 1.2 : “Apolo MEA Injection System Resifix Pure Epoxi for concrete” bonded anchors after installation
- Annex 1.3 : Technical details of the bonded anchors
- Annex 1.4 : Technical details of the bonded anchors
- Annex 2.1 : Furnace temperatures – test 1
- Annex 3.1 : Furnace temperatures – test 2
- Annex 4.1 : Furnace temperatures – test 3
- Annex 5.1 : Furnace temperatures – test 4

Furnace: chamber 6

Schnitt A-A



Schnitt B-B Deckenelement



T51 and T53 measuring points of furnace temperature, thermocouples with measuring points made of Ni-Cr/Ni-Al-wires (type K)

Dimensions in mm

Structural design of the test installation

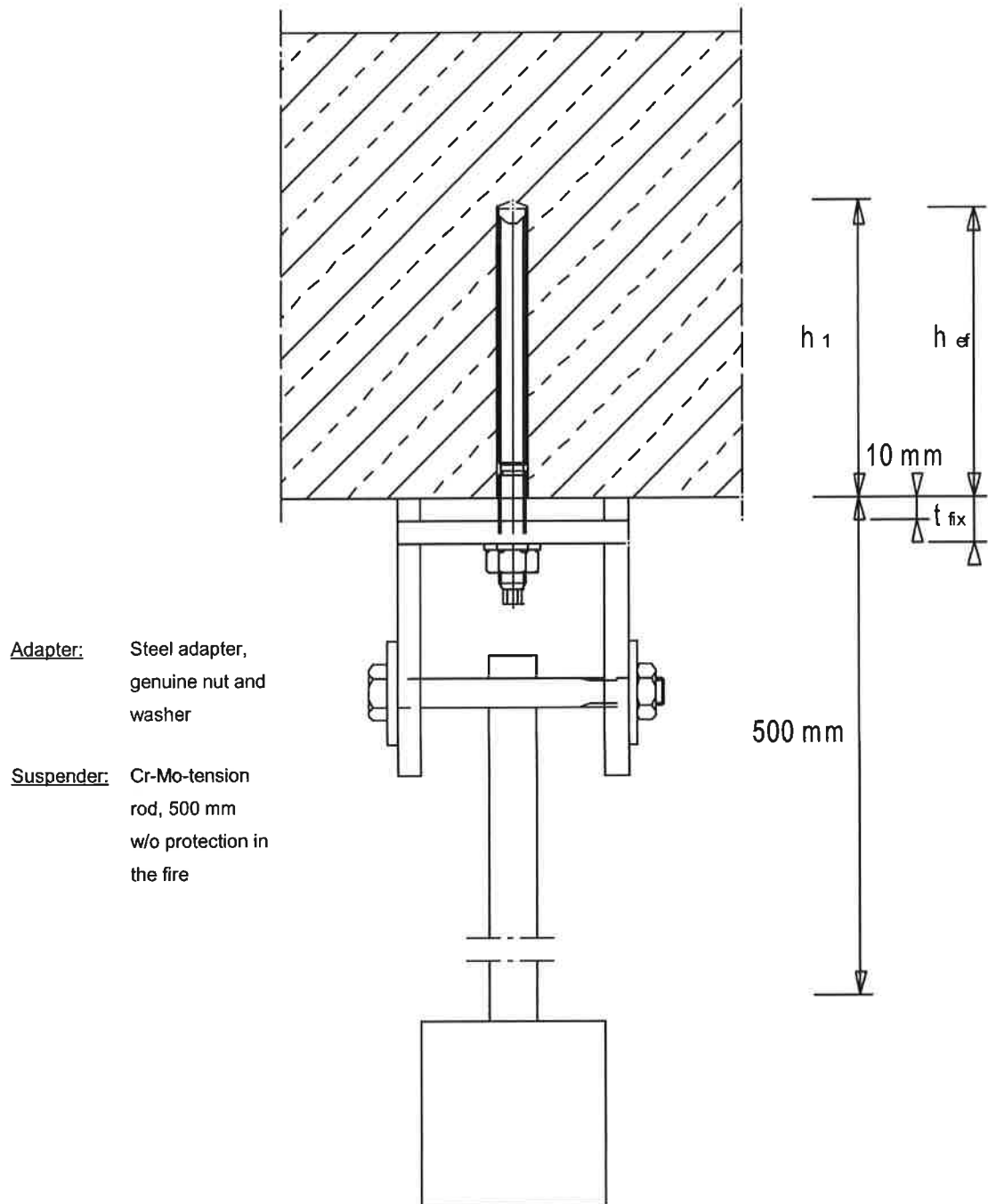
Installation of test chamber

Materialprüfanstalt für das Bauwesen

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Annex 1.1 of
Test Report No.
(2100/472/15)-NB

“Apolo MEA Injection System Resifix Pure Epoxi for concrete” placed in RC slab
 $d \geq 200\text{ mm} / C 20/25$



Installation situation of sample

“Apolo MEA Injection System Resifix Pure Epoxi for concrete”

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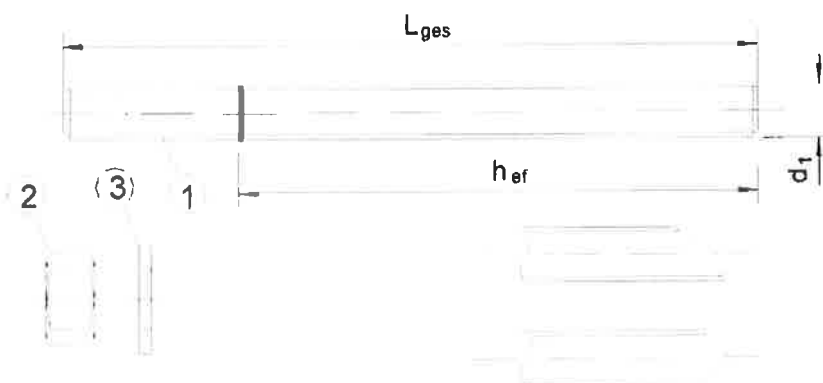
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Annex 1.2 of
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 (2100/472/15)-NB

“Apolo MEA Injection System Resifix Pure Epoxi for concrete”, bonded anchors

Tabelle: Materials

Table 1a: Materials (Threaded rod)



Part	Designation	Material
Steel, zinc plated $\geq 5 \mu\text{m}$ acc. to EN ISO 4042 or Steel, hot-dip galvanised $\geq 40 \mu\text{m}$ acc. to EN ISO 1461 and EN ISO 10684		
1	Anchor rod	Steel, EN 10087 or EN 10263 Property class 4,6, 5.8, 8.8, EN ISO 898-1:1999
2	Hexagon nut, EN ISO 4032	Property class 4 (for class 4.6 rod) EN ISO 898-2, Property class 5 (for class 5.8 rod) EN ISO 898-2, Property class 8 (for class 8.8 rod) EN ISO 898-2
3	Washer, EN ISO 887, EN ISO 7089, EN ISO 7093, or EN ISO 7094	Steel, zinc plated or hot-dip galvanised
Stainless steel		
1	Anchor rod	Material 1.4401 / 1.4404 / 1.4571, EN 10088-1:2005, > M24: Property class 50 EN ISO 3506 ≤ M24: Property class 70 EN ISO 3506
2	Hexagon nut, EN ISO 4032	Material 1.4401 / 1.4404 / 1.4571 EN 10088, > M24: Property class 50 (for class 50 rod) EN ISO 3506 ≤ M24: Property class 70 (for class 70 rod) EN ISO 3506
3	Washer, EN ISO 887, EN ISO 7089, EN ISO 7093, or EN ISO 7094	Material 1.4401, 1.4404 or 1.4571, EN 10088
High corrosion resistance steel		
1	Anchor rod	Material 1.4529 / 1.4565, EN 10088-1:2005, > M24: Property class 50 EN ISO 3506 ≤ M24: Property class 70 EN ISO 3506
2	Hexagon nut, EN ISO 4032	Material 1.4529 / 1.4565 EN 10088, > M24: Property class 50 (for class 50 rod) EN ISO 3506 ≤ M24: Property class 70 (for class 70 rod) EN ISO 3506
3	Washer, EN ISO 887, EN ISO 7089, EN ISO 7093, or EN ISO 7094	Material 1.4529 / 1.4565, EN 10088
Commercial standard rod with:		
- Materials, dimensions and mechanical properties acc. Table 1a - Inspection certificate 3.1 acc. to EN 10204:2004 - Marking of embedment depth		

Technical data

“Apolo MEA Injection System Resifix Pure Epoxi for concrete”

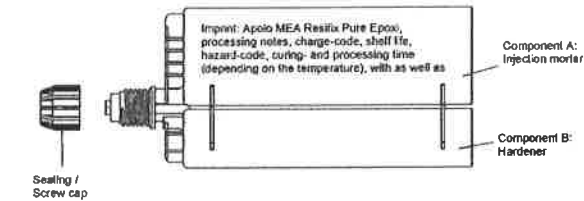
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“Apolo MEA Injection System Resifix Pure Epoxi for concrete”

Cartridge: Apolo MEA Resifix Pure Epoxi

385ml, 585ml, 999ml and 1400ml Injection mortar cartridge (Type: "side-by-side")



Static mixer



Threaded rod M8, M10, M12, M16, M20, M24, M27, M30 with washer and hexagon nut

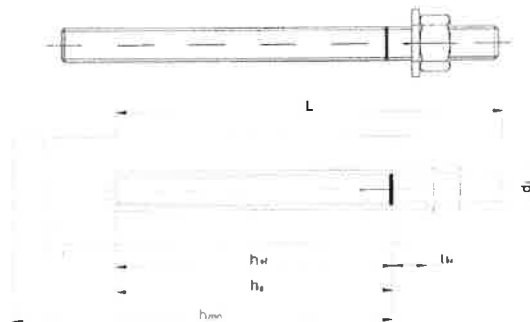


Tabelle: installation details

Anchor name			“Apolo MEA Injection System Resifix Pure Epoxi for concrete”, bonded anchor							
Anchor size			M8	M10	M12	M16	M20	M24	M27	M30
Nominal drill diameter	d ₀	[mm]	10	12	14	18	24	28	32	35
Depth of borehole	h ₀	[mm]	80	90	110	125	170	210	250	280
Minimum set depth	h _{ef}	[mm]	80	90	110	125	170	210	250	280
Min. member thickness	h _{min}	[mm]	110	120	140	160	220	260	304	340
Torque	T _{inst}	[Nm]	10	20	40	80	120	160	180	200

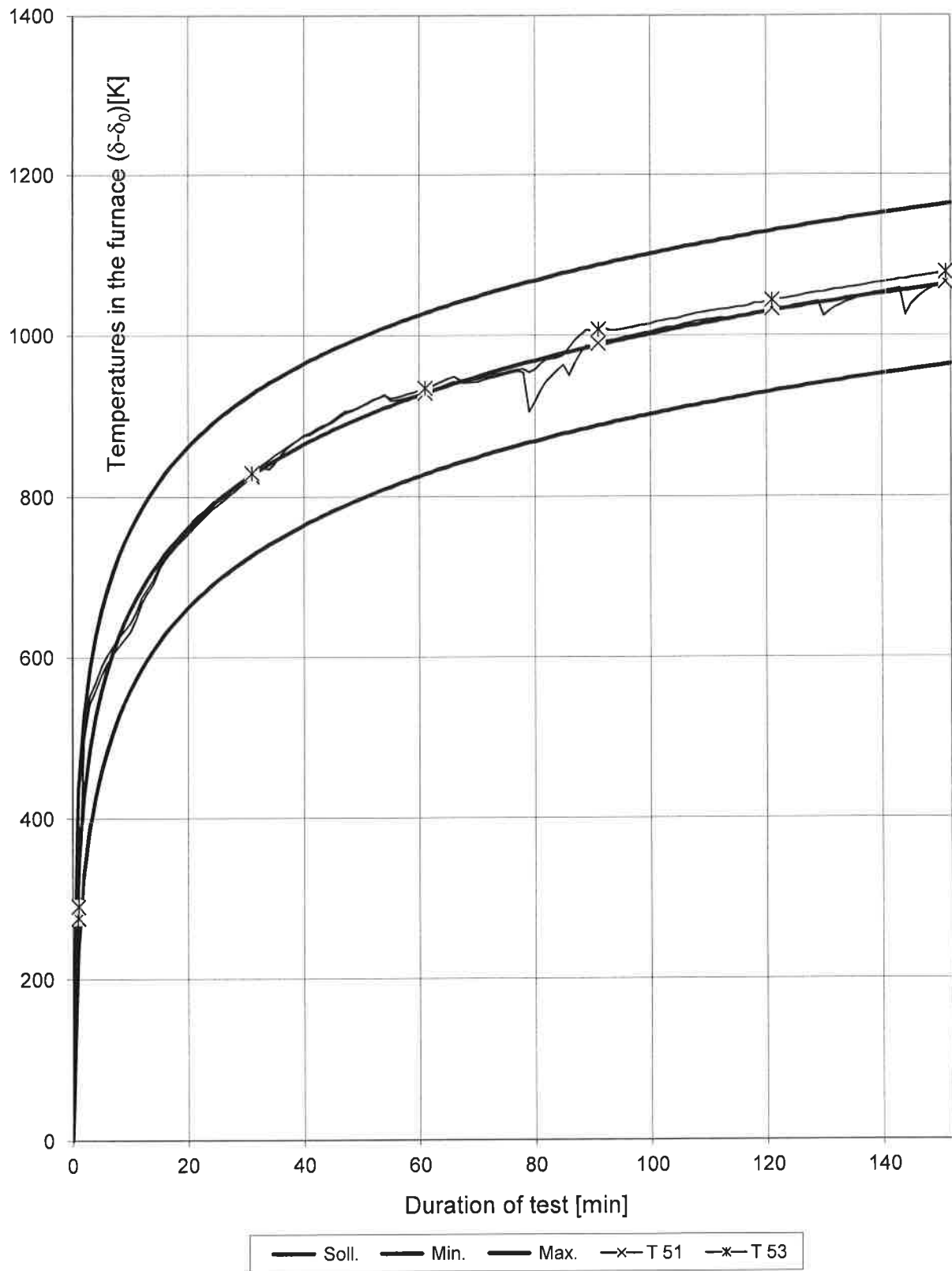
Technical data

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Annex 1.4 of
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(2100/472/15)-NB

ETK DIN EN 1363-1



$\delta_0 = 24 \text{ } ^\circ\text{C}$

test date: 27.06.08

Temperatures in the furnace
test 1

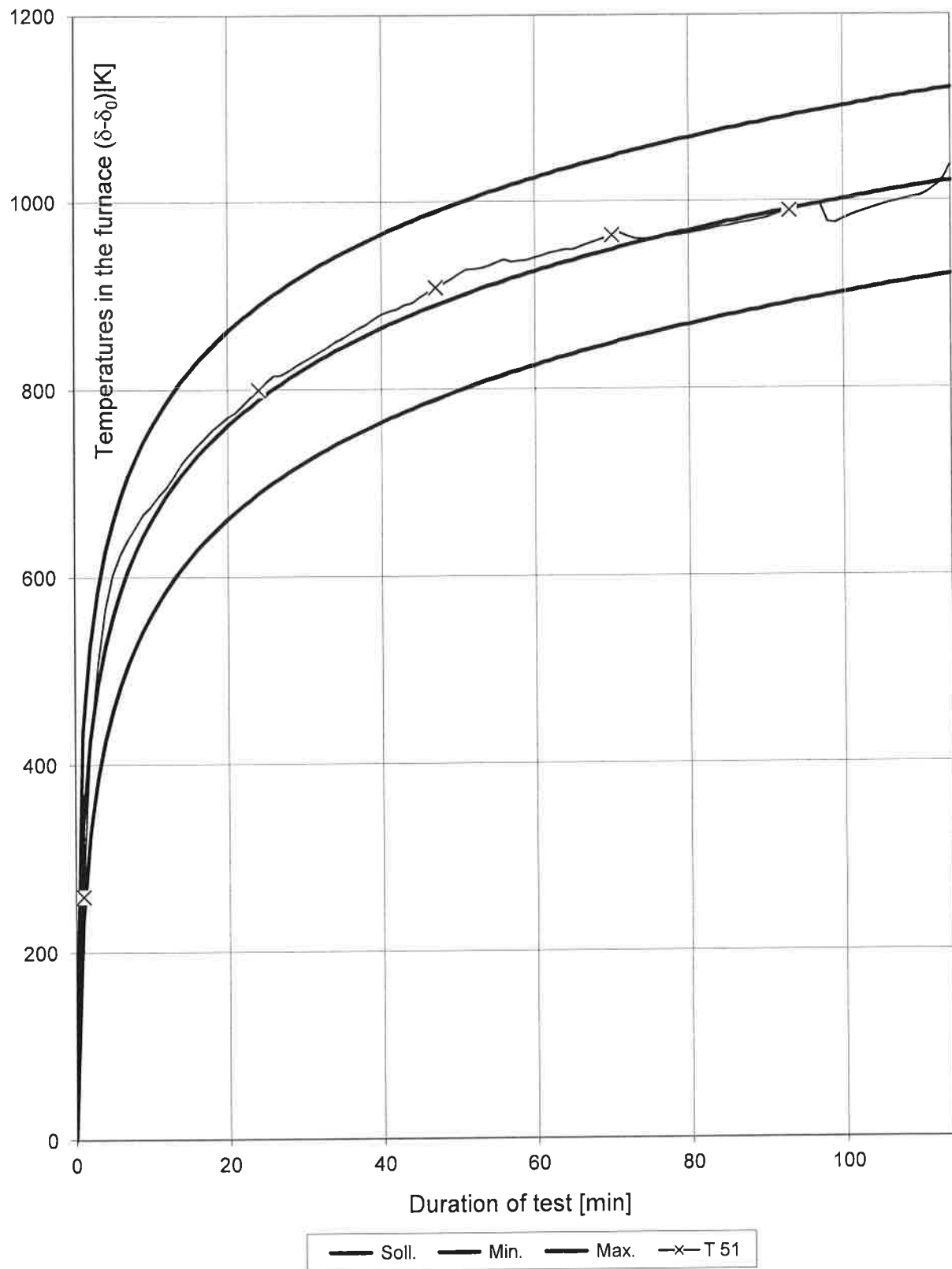
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Annex 2.1 of

Test Report

No. (2100/472/15)-NB

ETK DIN EN 1363-1



$\delta_0 = 21 \text{ }^{\circ}\text{C}$

test date: 27.08.08

Temperatures in the furnace
test 2

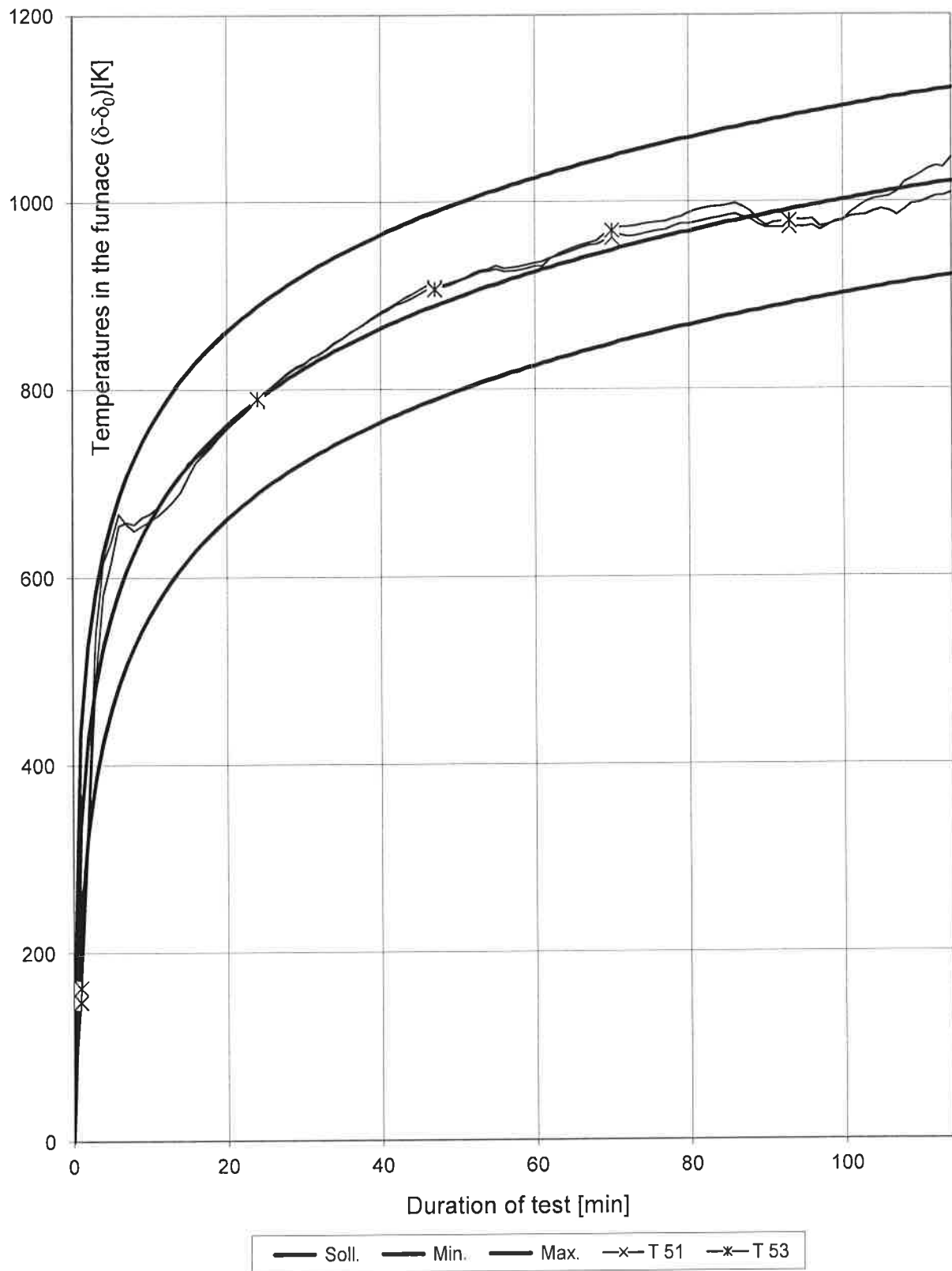
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Annex 3.1 of

Test Report

No. (2100/472/15)-NB

ETK DIN EN 1363-1



$\delta_0 = 21 \text{ } ^\circ\text{C}$

test date: 01.09.08

Temperatures in the furnace
test 3

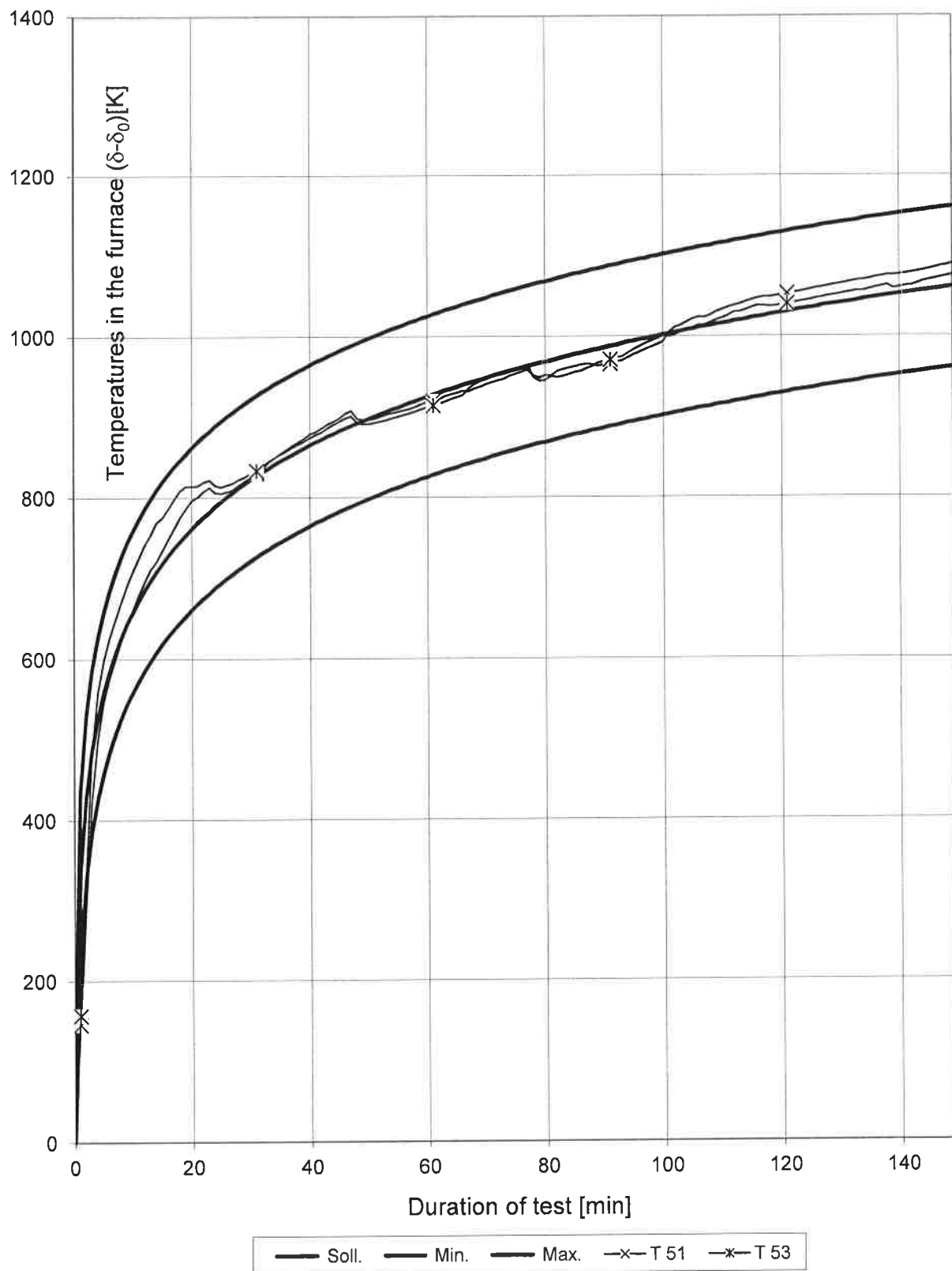
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Annex 4.1 of

Test Report

No. (2100/472/15)-NB

ETK DIN EN 1363-1



$\delta_0 = 18^\circ\text{C}$

test date: 30.09.08

Temperatures in the furnace
test 4

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Annex 5.1 of

Test Report

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