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Efectis Nederland-report

2006-Efectis-R0763 [Rev. 1]

Determination of the fire resistance according to EN 1365-2:1999 of a suspended ceiling system of API with Rockfon Sonar E24 Shadowline 900 x 900 ceiling tiles, suspended under an aerated concrete floor supported by steel sections

Date	June 2007
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Number of appendices	3
Sponsor	Rockwool / Rockfon BV Industrieweg 15 6045 JG Roermond Postbus 1160 6040 KD Roermond The Netherlands
Project name	Fire resistance floor ceiling construction
Project number	2006058/101

This report is issued by the TNO company Efectis Nederland BV (previously **TNO** Centre for Fire Research). TNO decided, in response to international developments and requests by customers, to collaborate with two European Egolf partners, both highly experienced in fire safety: the Norwegian **Sintef/NBL** and the French **CTICM**. Thus, through scaling up, a more comprehensive service of high quality and a wider range of facilities can be offered. In order to achieve this, the fire safety related activities of the partners involved have been privatised in this collaboration. With respect to TNO this has lead to the privatisation on the 1st of July of the activities of the TNO Centre for Fire Research via the establishment of the company Efectis Nederland BV.

Contents

1 Subject

A floor / ceiling construction build up of reinforced aerated concrete floor members supported by steel sections IPE 140 with a suspended ceiling system of API Quick-lock 24/38 T grid profiles with Rockfon Sonar E24 Shadowline ceiling tiles with the module size 900 x 900 x 25 mm.

2 Investigation

Determination of the fire resistance according to EN 1365-2: 1999.

3 Sponsor

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Industrieweg 15
6045 JG Roermond
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6040 KD Roermond
The Netherlands

4 Place and data regarding the investigation

The investigation took place at the laboratory of Efectis Nederland BV te Rijswijk, The Netherlands.

Building the walls and floor construction:	30th of October 2006
Installing the suspended ceiling:	1st of November 2006
Fire test:	6th of November 2006.

5 Date and number of the report

Date report: June 2007.
Reportnummer: 2006-Efectis-R0763 [Rev.1].

6 Investigated construction

6.1 General

A floor ceiling construction was the subject of the investigation. The build up was of reinforced aerated concrete floor members supported by steel sections IPE 140 with a suspended ceiling system of API Quick-Lock 24/38, measurements 3.2 x 4.0 m, see figure 12.1. The ceiling tiles are produced by Rockfon and of the type Rockfon Sonar E24 Shadowline with the module size 900 x 900 x 25 mm.

6.2 Materials

6.2.1 Suspended ceiling system

The profiles were made of cold rolled thermally zinc coated steel. Strip steel of 0.20 mm was wrapped around the edges of the profiles. This strip steel was protected by an oven dried epoxy primer with a thickness of 5µm. On the visible side it was coated with a polyester paint with a thickness of 20µm.

The system was build up from the following profiles:

- (1) [1]: Main profile of the type API Quick-Lock 24/38 main measurements 38 x 24 with a material thickness of 0.4 mm.
- (2): Intermediate profile of the type API Quick-Lock 24/38 main measurements 38 x 24 mm length 900 mm, material thickness of 0.4 mm.
- (3): Quick suspender of the type API 4204353, existing of two parts steel wires ∅ 4 mm. and a coupling.
- (4): Wall profiles of the type API 413311, main measurements 19 x 24 x 0.6 mm.

The main profiles were connected to the quick suspenders (3), the positions are given in figure 12.1.
Each main profile was provided with one fire-break and a length connection, see figure 12.1. Also the intermediate profiles had a fire break.

6.2.2 Ceiling tiles

Rockfon, type Sonar E24 Shadowline ceiling tiles, a self supporting tile made of stone wool finished with paint and a structurized mineral membrane on the visible side with the module size 900 x 900 x 25 mm (l x w x t). See also paragraph 8.3.

[1] The numbers in between the brackets refer to the numbers in figure 12.1

6.2.3 Floor and supporting construction

The floor construction was made out of:
- Three steel sections IPE 140, length 4600 mm, span Lt = 4150 mm.
- Six reinforced aerated concrete floor slabs:
  150 x 750 mm, length 3050 mm (4 pieces).
  150 x 400 mm, length 3050 mm (2 pieces).

The floor was build in the steel test frame in which a aerated concrete supporting construction was made with a thickness of 150 mm and inner dimensions of 4000 x 3200 mm.

6.2.4 Fixing materials

- Steel nails galvanically zinced, measurements Ø 3.5 x 60 mm, c.t.c. approximately 250 mm, for fixing the wall profiles (4) to the aerated concrete frame.
- Caddy clip of the type 4-H-24, for the positions see figure 12.1.

6.2.5 Sealing materials

Strips of stone wool, type Rockwool 750, density 115 kg/m³:
- Used for closing the joints between the floor slabs.

6.3 Method of assembly and mounting

The build up of the construction is given in figure 12.1.
The assembly and mounting of the floor / ceiling construction is given in 6.3.1 and 6.3.2.

6.3.1 Floor

- Placing three steel sections IPE 140, c.t.c. approximately 1200 mm, in the longitudinally direction of the aerated concrete frame.
- Placing the aerated concrete floor slabs in the steel test frame.
- Closing the joints between the floor slabs, between the floor slabs and the aerated concrete frame and the openings at the locations of the steel sections.

6.3.2 Ceiling

- Placing the wall profiles (4) on the inside of the aerated concrete frame at a distance of approximately 400 mm from the bottom of the floor slabs fixed with steel nails with a c.t.c. distance of approximately 250 mm.
- Placing the Caddy clip and quick suspenders (3) to the IPE 140 sections, c.t.c. 1200 mm crosswise the span of the steel sections, see figure figure 12.1.
- Shortening the main profiles (1) to lengths of approximately 2630 and 570 mm.
- Connecting the main profiles and placing them to the quick suspenders (3).
- Adjusting the quick suspenders to correct length.
- Intermediate profiles (2), c.t.c. 900 mm.
- Placing the ceiling tiles.

7 Production of the construction

- Rockwool / Rockfon bv:
  Production of the ceiling tiles, placing the suspended ceiling system and tiles.

- API:
  Production of the profiles of the ceiling system

- Efectis Nederland BV Rijswijk, The Netherlands:
  Supporting construction

8 Course of investigation

8.1 Verification of the specimen

Efectis Nederland BV was not involved in the selection procedure of the specimen. During mounting the used materials and parts were verified against the supplied data.

8.2 Conditioning

From the moment of installation until the fire test the construction was stored in the laboratory of Efectis Nederland BV with the following conditions:
- Ambient temperature: 20 ± 5°C.
- Relative humidity: 50 ± 10 %.

8.3 Density and humidity measurements

The density and the moisture equilibrium of the stone wool ceiling tiles was determined.

- Density[2] 190 kg/m^3.
- Moisture equilibrium [3] of 0.3 %.

8.4 Fire test

8.4.1 Test conditions

The test was performed under the conditions as specified in EN 1365-2: 1999, using the standard fire curve. The specimen was heated from the underside only. The aim for the furnace pressure, as measured 100 mm below the ceiling, was 20 Pa.

[2] Determined before drying
[3] Determined after drying for at least 24 hrs at 105 °C

8.4.2 Load

Dead weight was distributed on the aerated concrete floor slabs, resulting in 1.32 kN/m on each of the IPE 140 sections. The load induced by the weight of the construction itself was 1.68 kN/m on each of the IPE 140 sections.
The total load on each of the IPE 140 sections during heating was 3 kN/m.

8.4.3 Measurements

During the heating the following data were measured and registered:

- gas temperatures inside the furnace with ten plate thermometers (TOV 1 to TOV 10), regularly spread over the directly heated surface.
- The temperatures of the flanges of the steel sections with six thermocouples (TK 1 up to 6).
- The temperatures of the web of the steel sections with six thermocouples (TK 7 up to 12).
- The air temperatures in the cavity with five thermocouples (TK 13 up to TK 17).
- The surface temperatures with five thermocouples (TK 18 up to TK 22)
- The pressure inside the furnace at 100 mm below the ceiling.
- The defection at the centre of the test specimen.
- Temperature and air velocity outside the furnace.

The positions of the thermocouples and deflection measurement are given in figure B1.

9 Observations during heating

On request of the sponsor the heating was stopped after 48 minutes. No criteria were met at that time.

For a more detailed description of the observations a reference is made to appendix A.

10 Test results

Test results are given in graphs in appendix B.

During the heating the temperature and airspeed fulfilled the requirements of EN 1365-2: 1999.

10.1 Uncertainty of measurement

Because of the nature of fire resistance testing and the consequent difficulty in quantifying the uncertainty of measurement of fire resistance, it is not possible to provide a stated degree of accuracy of the result.

11 Summary

According to the EN 1365-2: 1999 a floor / ceiling construction was investigated which was build up of reinforced aerated concrete floor members supported by steel sections IPE 140. From these sections a ceiling system of API Quick-Lock 24/38 T profiles was suspended with Rockfon Sonar E24 Shadowline ceiling tiles with the module size 900 x 900 x 25 mm.

The most important results of the investigation are given in table 11.1.

Table 11.1 Summery of test results

Criterion	Time from the start of the heating, during which the criterion was just fulfilled.	
	EN 1365-2: 1999	**Remarks**
1. Load bearing capacity [R]	48 minutes	No failure
2. Integrity [E]		
flames	48 minutes	No failure
cotton pad	48 minutes	No failure
gap gauges	48 minutes	No failure
3. Insulation regarding temperature [I]		
$I_{maximum}$	48 minutes	No failure
I_{mean}	48 minutes	No failure
The test was discontinued after 48 minutes.		

12 Field of application

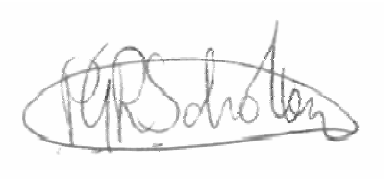
The test results are directly applicable to a similar floor / ceiling construction provided the following is true:

1. With respect to the structural building member:
   Aerated concrete floor, minimum thickness 150 mm, with IPE 140 steel members
   The maximum moments and shear forces, which when calculated on the same basis as the test load shall not be greater than those tested. The load on the steel members was 3 kN/m.

2. With respect to the ceiling system:
   The size of panels of the ceiling lining and suspension system shall not be changed.
   No openings in the lining are allowed.

3. With respect to the cavity:
   The height of the cavity, 400 mm, is equal to or greater than the height tested.
   No combustible or insulating material is added to the cavity.

Regarding this field of application it is also required that construction elements, which are connected to the tested construction have a fire resistance which is at least equal to that of the floor / ceiling construction.



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Dr. Ir. G. van der Berg

13 Drawing

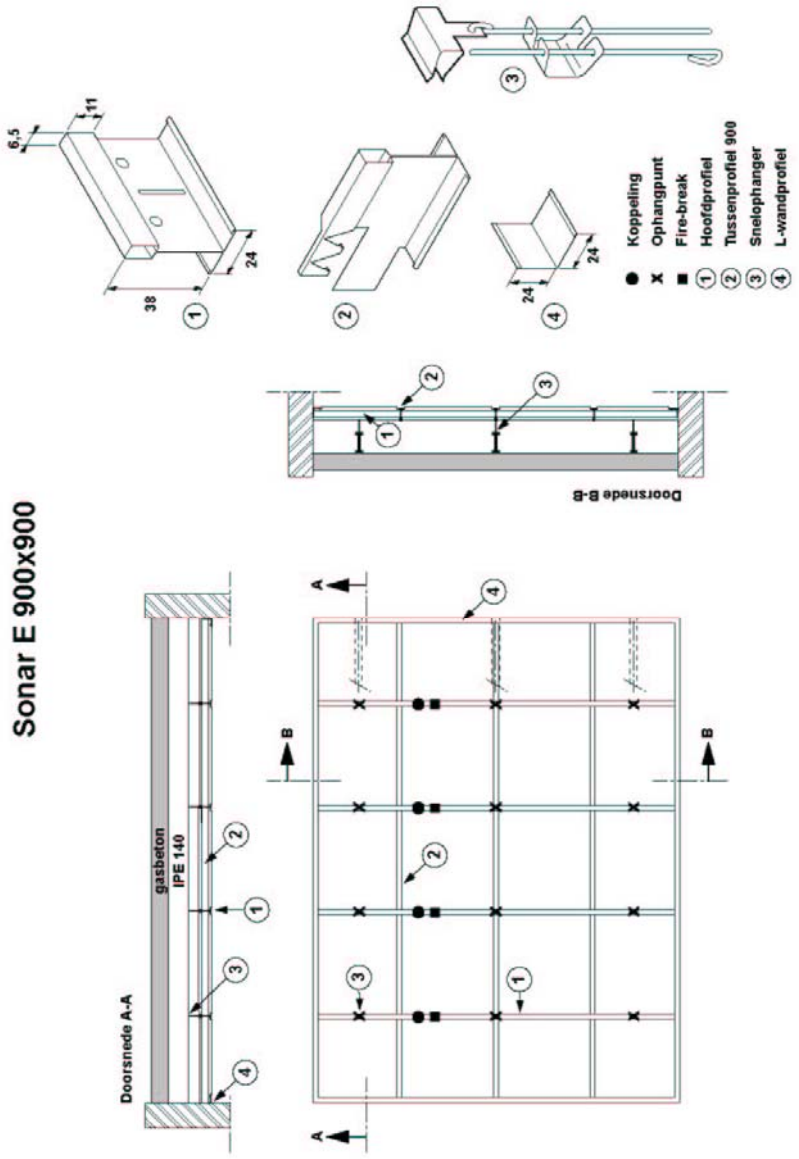

Figure 12.1 Overview of the test set up

A Observations

Time [min]	Observation
0	Start of heating.
5	Fire breaks are functioning. The mineral fleeze is detached from one tile.
21	All tiles are still positioned in the grid
32	All tiles are still positioned in the grid
39	The mineral fleeze is detached from another tile.
40	The mineral fleeze is detached from another tile.
48	The end of the heating after consulting the sponsor. All tiles are still positioned in the grid

B Test results

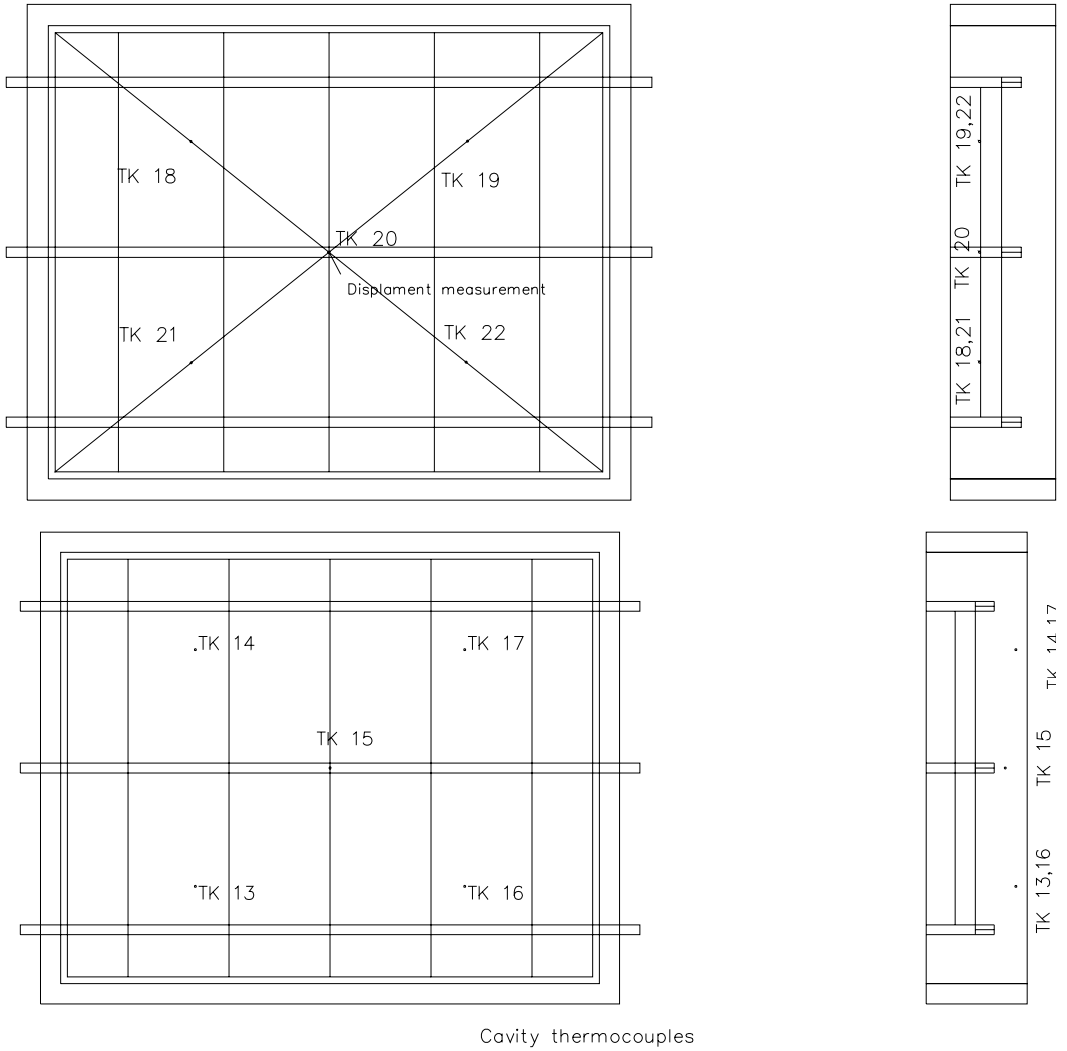

Figure B1 Overview of the thermocouples on the floor and in the cavity

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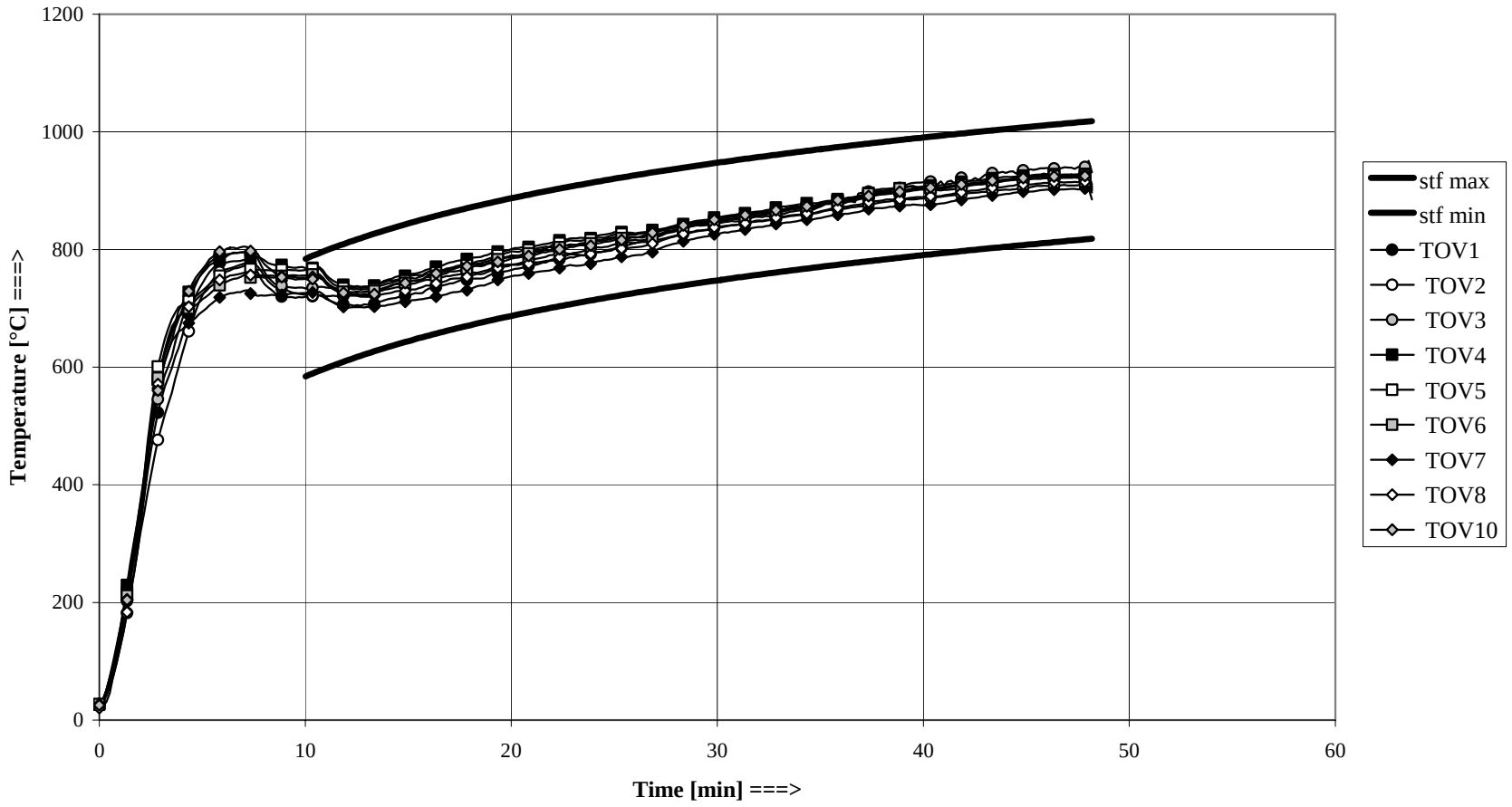

Figure B2: Furnace temperatures

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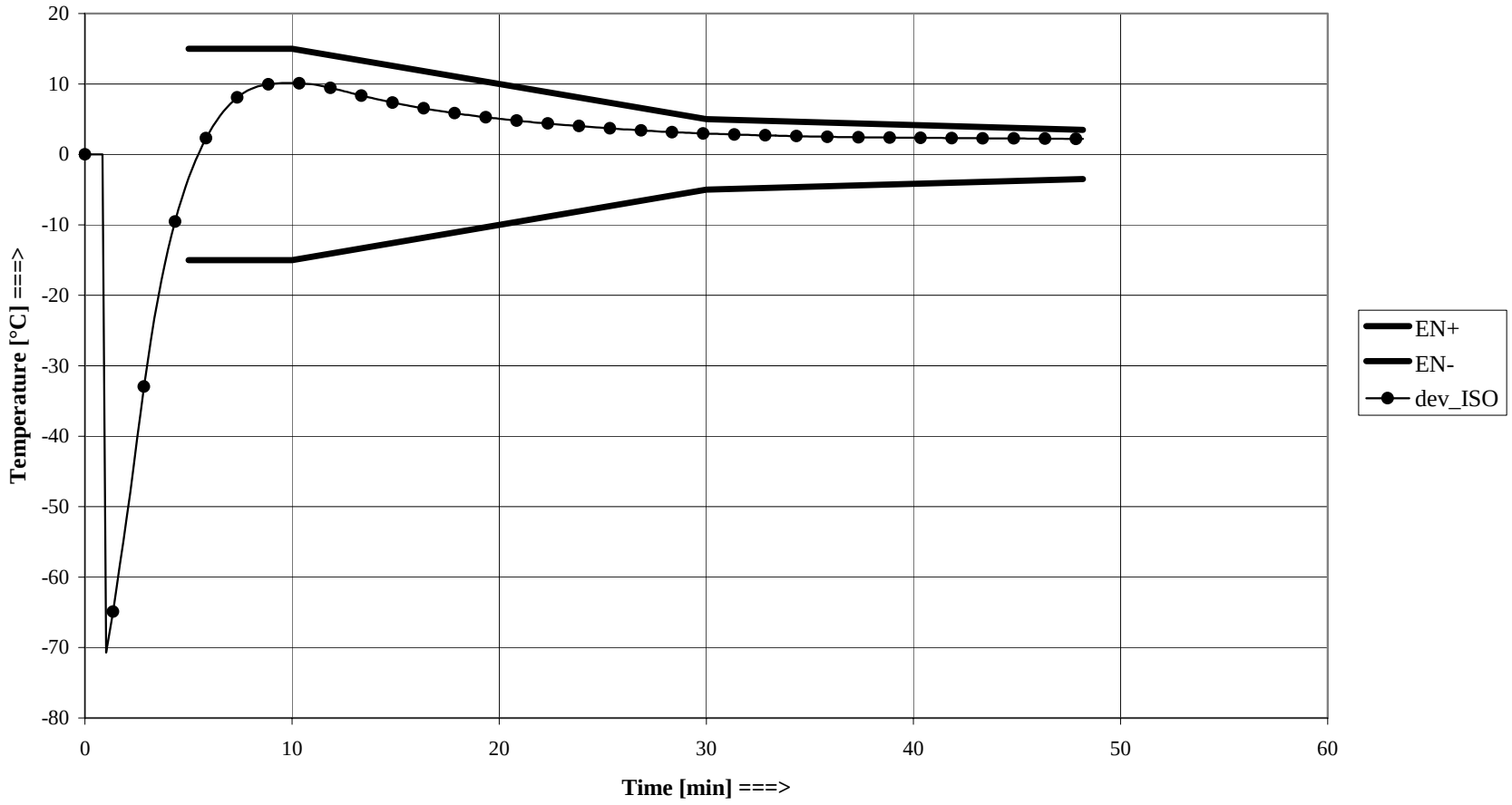

Figure B3: Deviation from fire curve

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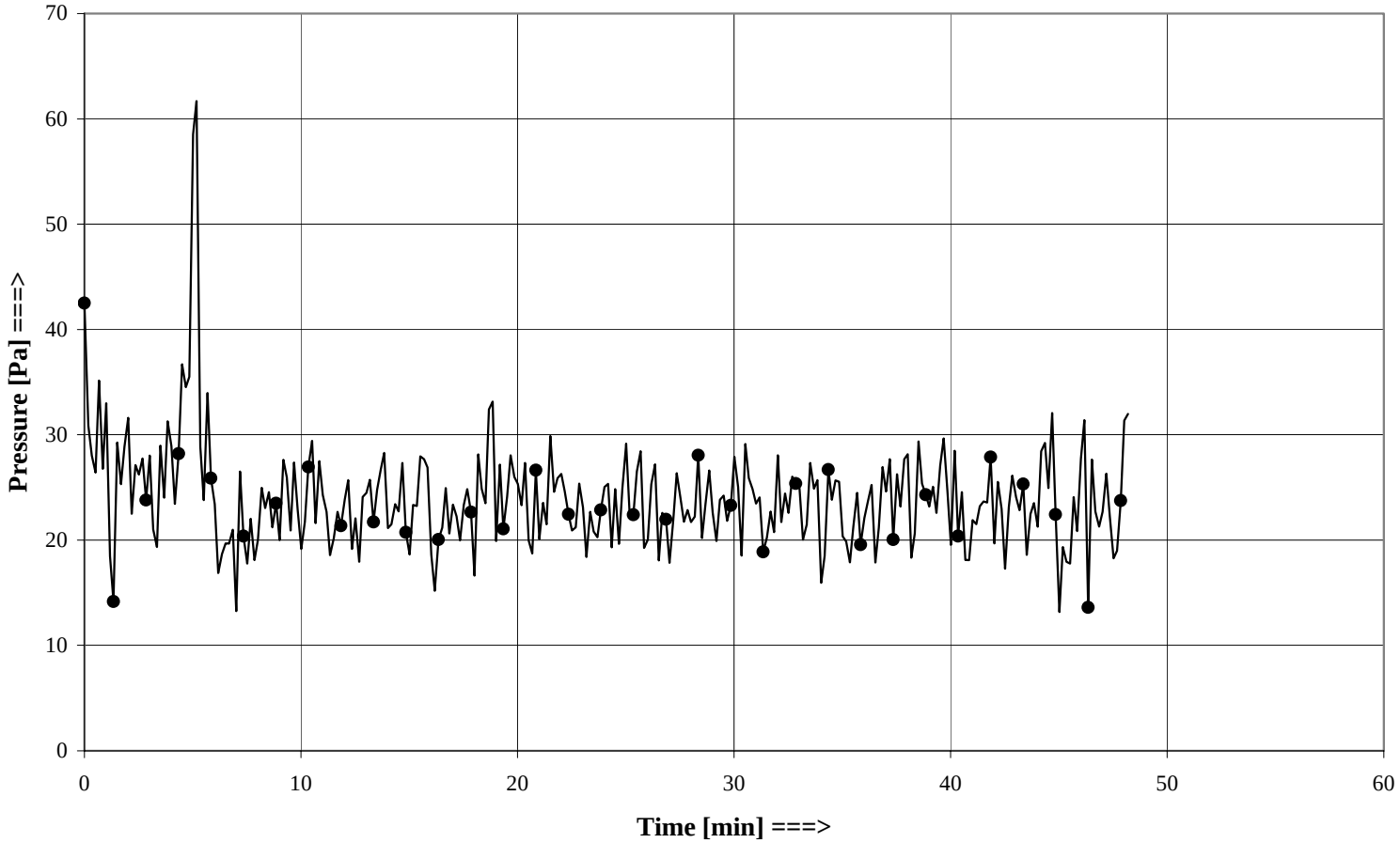

Figure B4: Furnace pressure

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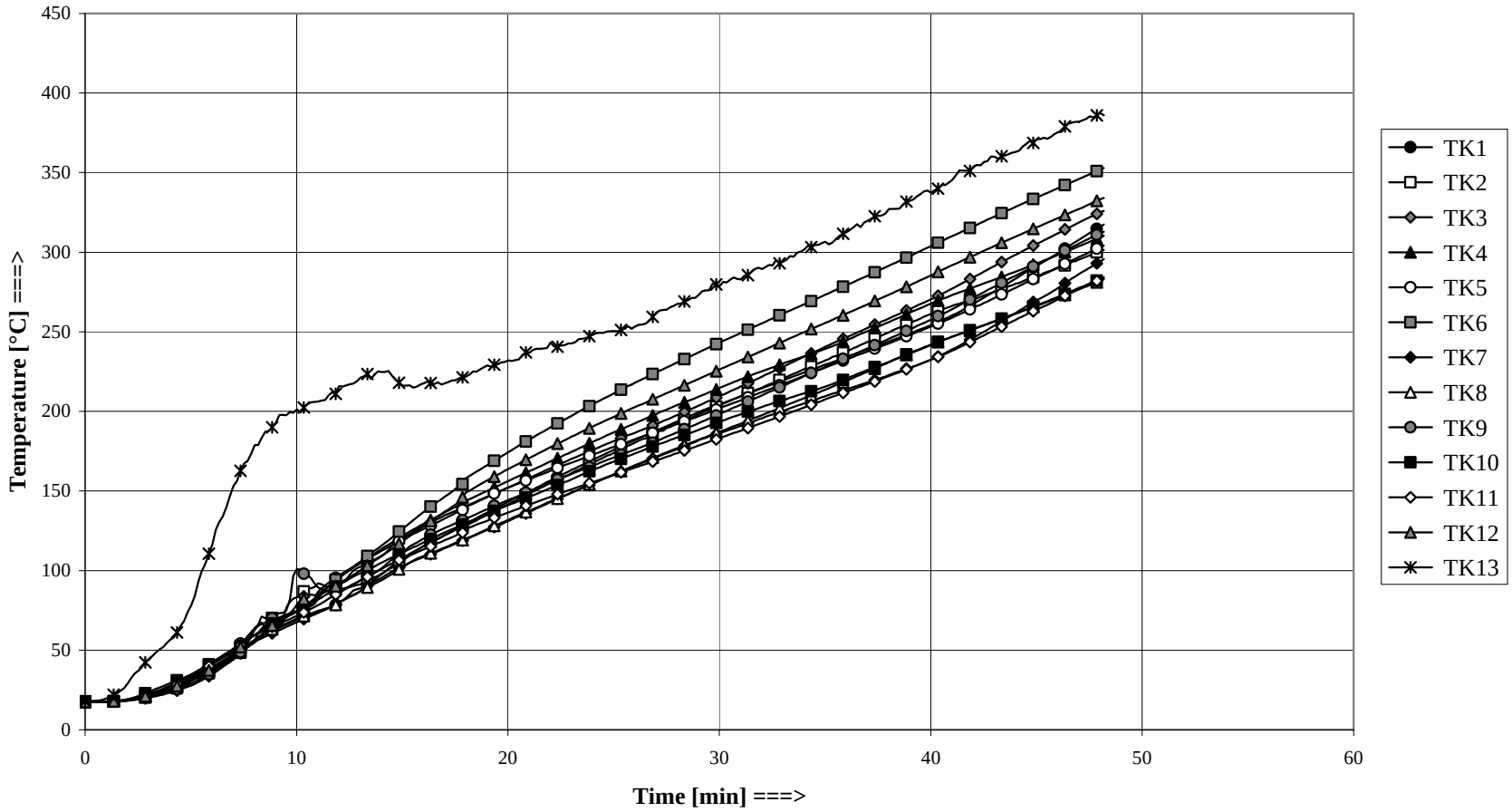

Figure B5: Steel temperatures

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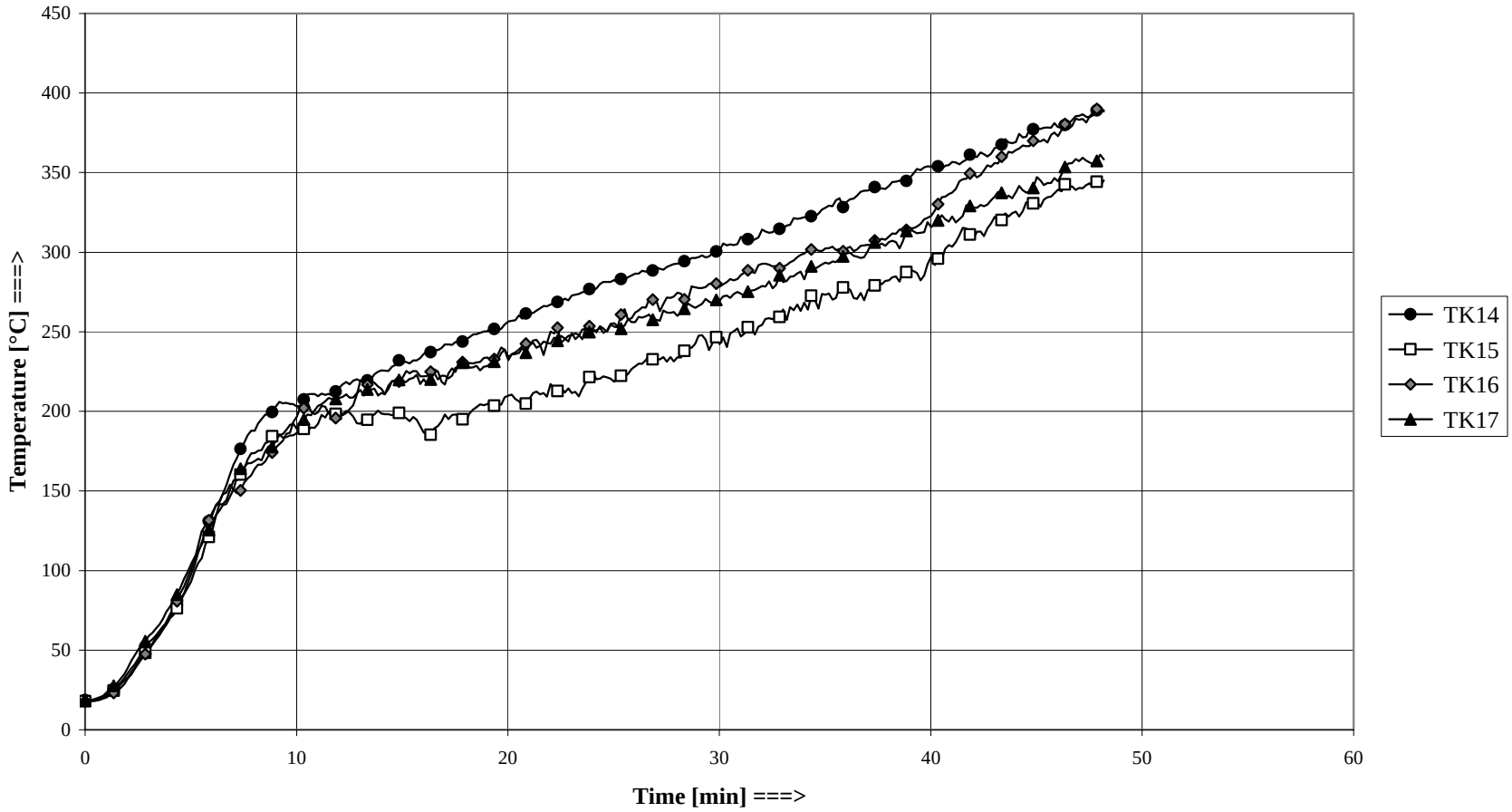

Figure B6: Cavity temperatures

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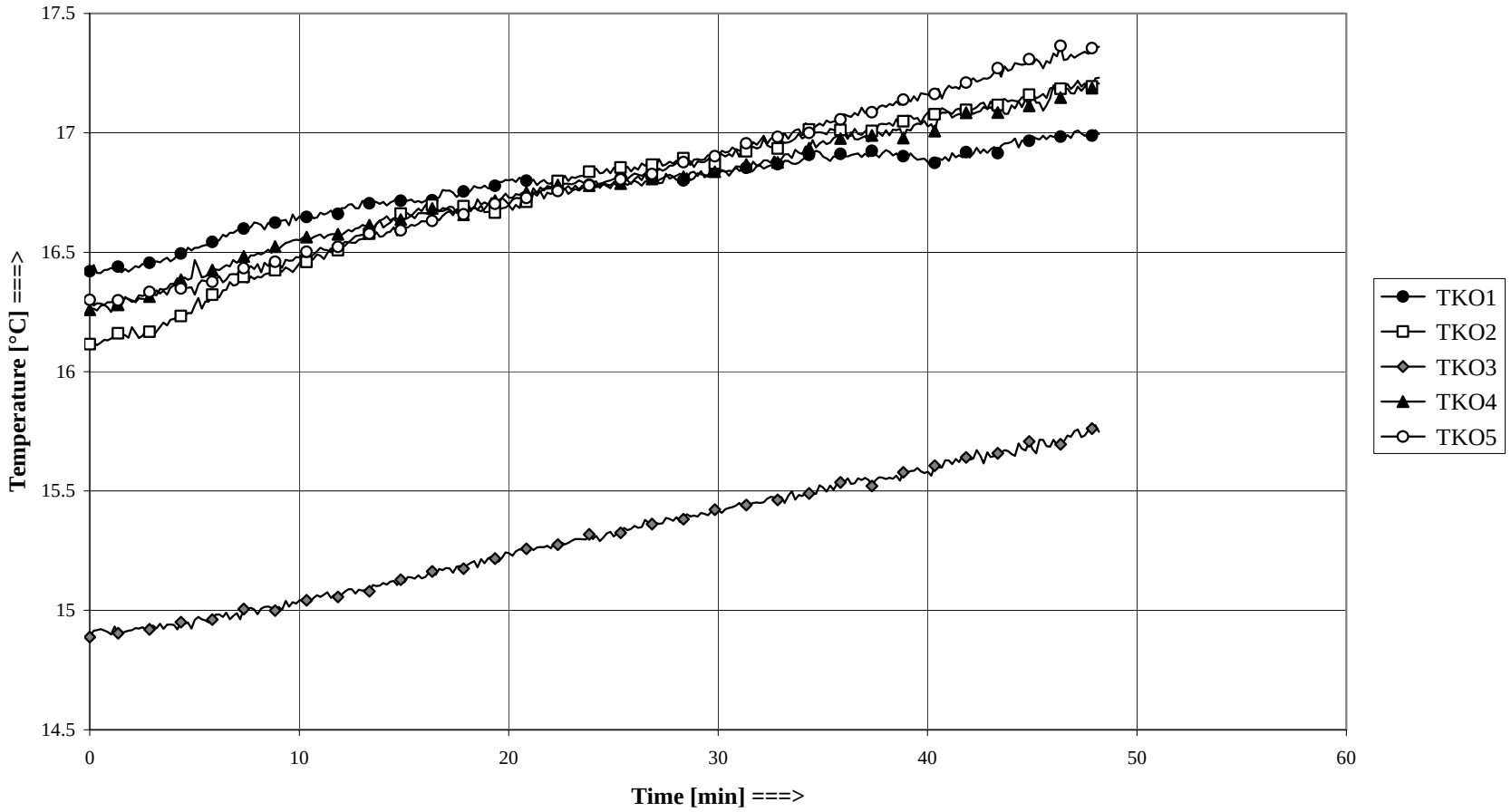

Figure B7: Surface temperatures

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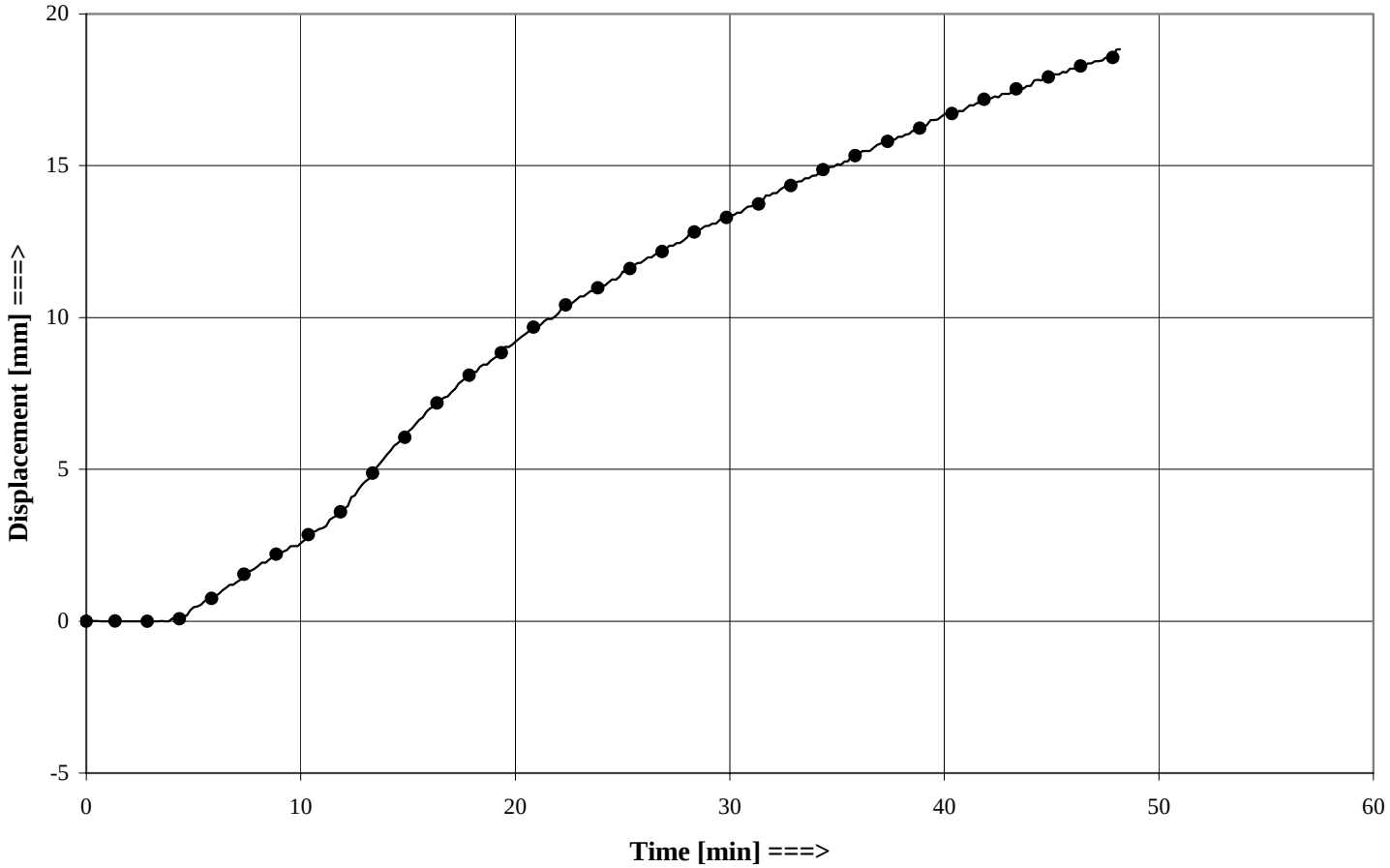

Figure B8: Displacement

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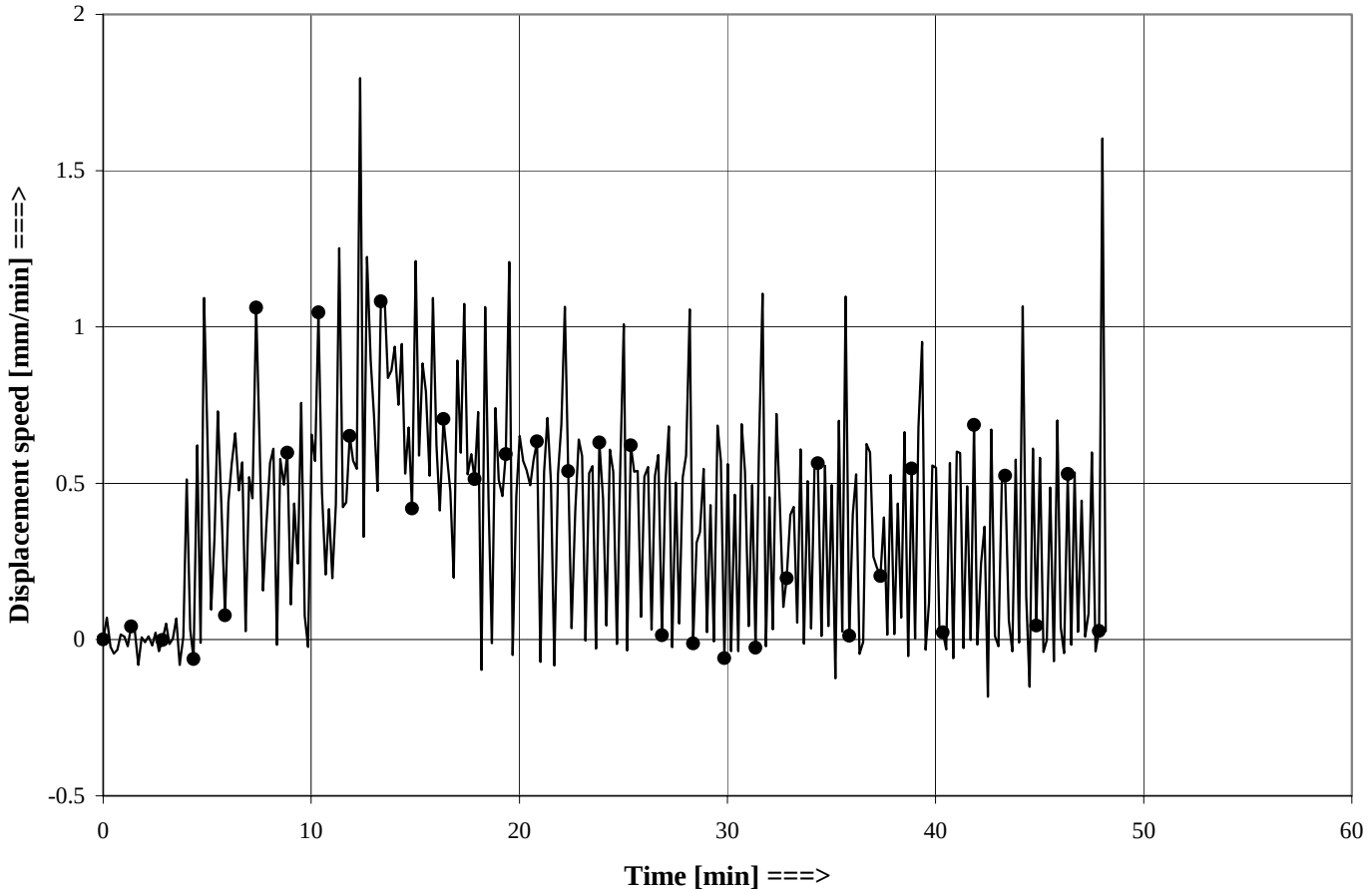

Figure B9: Displacement speed

C Photographs

Figure C1 Specimen from the heated side before the test

Figure C2 Specimen after the test looking into the cavity