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Efectis Nederland report

2006-Efectis-R0460

Determination of the fire resistance according to EN 1365-2:1999 of a suspended ceiling system of CMC with Rockfon Sonar Dzn1/A 1800 x 600 concealed ceiling tiles, suspended under an aerated concrete floor supported by steel sections

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Project name Fire resistance floor ceiling construction
Project number 2006058/101

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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 CMC Bandraster profiles of the type CMC 3100-001 and Z profiles with Rockfon Sonar Dzn/A concealed ceiling tiles with the module size 1800 x 600 x 20 mm.

2 Investigation

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

3 Sponsor

Rockwool / Rockfon BV
Industrieweg 15
6045 JG Roermond
Postbus 1160
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:	20 th of July 2006
Installing the suspended ceiling:	4 th of August 2006
Fire test:	8 th of August 2006.

5 Date and number of the report

Date report: June 2007.
Report number: 2006-Efectis-R 0460.

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 CMC Bandraster grid profiles and Z profiles, measurements 3.2 x 4.0 m, see figure 12.1. The concealed ceiling tiles are produced by Rockfon and of the type Rockfon Sonar Dznl/A with the module size 1800 x 600 x 20 mm.

6.2 Materials

6.2.1 *Suspended ceiling system*

The profiles were made of cold rolled thermally zinc coated steel. On the visible side the Bandraster profile was coated with a polyester paint with a thickness of 25µm.

The system was build up from the following profiles:

- (1)¹: Main profile of the type CMC 3100-001 main measurements 100 x 35.4 mm with a material thickness of 0.6 mm.
- (2): Intermediate Z profile of the type CMC 117-99-00 main measurements 40 x 19 mm, material thickness of 0.6 mm.
- (3): Intermediate Z profile with hook of the type CMC CR 117-99-00 main measurements 40 x 19 mm, material thickness of 0.6 mm.
- (4): Caddy clip of the type 4-H-24
- (5): Suspender of the nonius type held together by two R clips.
- (6): Wall profiles of the type CMC 1420-001, main measurements 24 x 24 x 0.5 mm.

The main profiles were connected to the nonius suspenders (5), the positions are given in figure 12.1.

6.2.2 *Ceiling tiles*

Rockfon, type Sonar Sonar Dznl/A concealed 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 1800 x 600 x 20 mm (l x w x t). See also paragraph 8.3.

6.2.3 *Floor and supporting construction*

The floor construction was made out of:

- Three steel sections IPE 140, length 4600 mm, span $L_t = 4150$ 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).

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

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 zincd, measurements $\varnothing 3.5 \times 60$ mm, c.t.c. approximately 250 mm, for fixing the wall profiles (6) to the aerated concrete frame.
- Caddy clip (4) 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 an the aerated concrete frame and the openings at the locations of the steel sections.

6.3.2 *Ceiling*

- Placing the wall profiles (6) 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 (4) and nonius suspenders (5) to the IPE 140 sections, c.t.c. 1800 mm along the span of the steel sections, see figure 12.1.
- Shortening the main Bandraster profiles (1) to lengths of approximately 2713 and 487 mm.
- Connecting the main profiles and placing them to the nonius suspenders (5).
- Adjusting the nonius suspenders to correct length and locking them with two R-clips.
- Intermediate profiles (2 and 3), c.t.c. 600 mm.
Every fourth Z profile was a Z profile with hook (3).
- Placing of the ceiling tiles.

7 **Production of the construction**

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

- Chicago Metallic:
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: $20 \pm 5^\circ\text{C}$.
- Relative humidity: $50 \pm 10\%$.

8.3 Density and humidity measurements

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

- Density² 171 kg/m^3 .
- Moisture equilibrium³ 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.

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 .

² Determined before drying

³ Determined after drying for at least 24 hrs at 105°C

8.4.3 Measurements

During the heating the following data were measured and registered:

- gas temperatures inside the furnace with ten plate thermometers (TPL 1 to TPL 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 deflection 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

In the 39th minute two ceiling tiles fell from the system. On request of the sponsor the heating was stopped after 39 minutes.

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 CMC 3100-001 Bandraaster profiles was suspended with Rockfon Sonar Dznl/A concealed ceiling tiles with the module size 1800 x 600 x 20 mm.

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

Table 11.1 Summary of test results

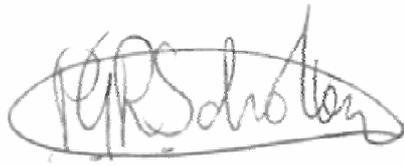
Criterion	Time from the start of the heating, during which the criterion was just fulfilled.	
	EN 1365-2: 1999	Remarks
1. Load bearing capacity [R]	39 minutes	No failure
2. Integrity [E] flames cotton pad gap gauges	39 minutes	No failure
	39 minutes	No failure
	39 minutes	No failure
3. Insulation regarding temperature [I] I_{maximum} I_{mean}	39 minutes	No failure
	39 minutes	No failure
	The test was discontinued after 39 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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13 Drawing

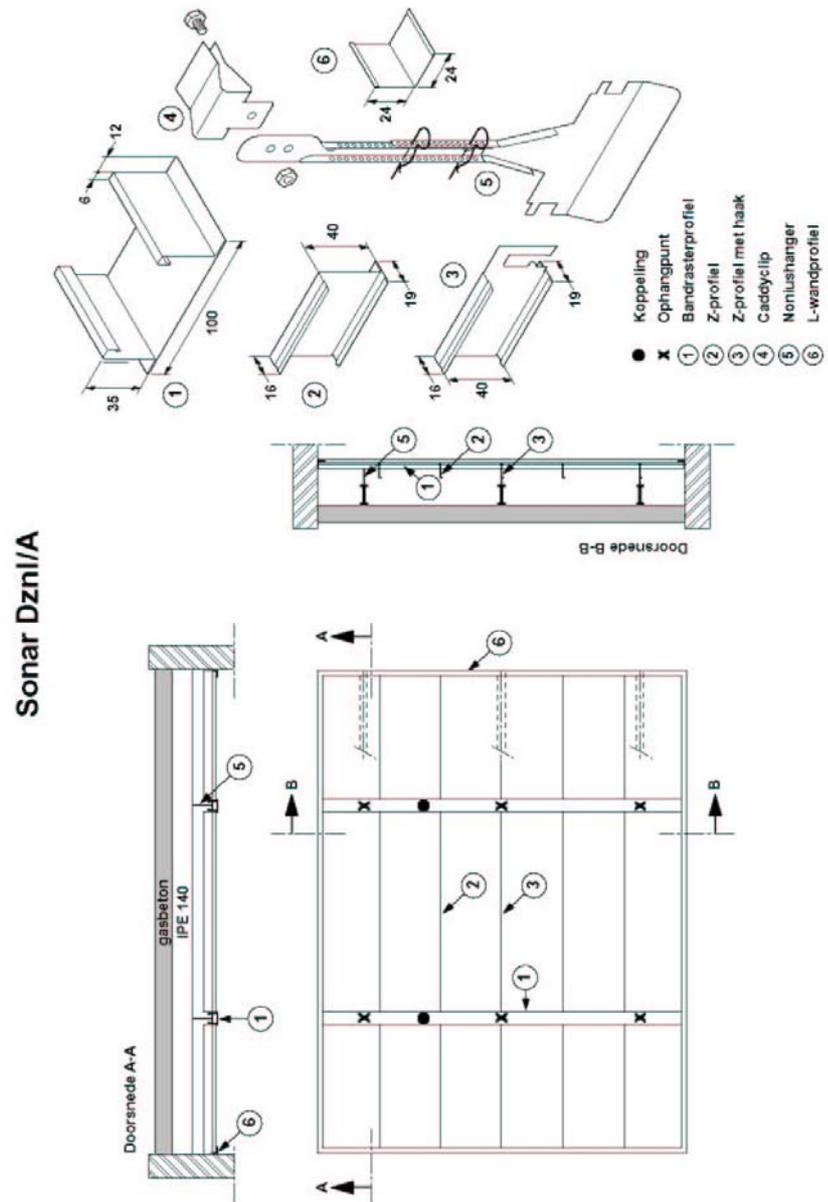


Figure 12.1 Overview of the test set up

A Observations

Time [min]	Observation
0	Start of heating.
5	Wall profiles deform
15	Mineral fleeze loosens from the ceiling tile near A
21	The mineral fleeze at A is covering a furnace thermocouple
31	All criteria are fulfilled, all ceiling tiles are in the grid
36	The cracks between the ceiling tiles and the grid are increasing in width along the total surface
39	Two ceiling tiles have fallen down at B
39	The end of the heating after consulting the sponsor.

B Test results

Figure B1 Overview of the thermocouples

Figure B2: Furnace temperatures

Figure B3: Deviation fire curve according to EN 1363-1

Figure B4: Furnace pressure

Figure B5: Steel temperatures

Figure B6: Cavity temperatures

Figure B7: Surface temperatures

Figure B8: Displacement

Figure B9: Displacement speed

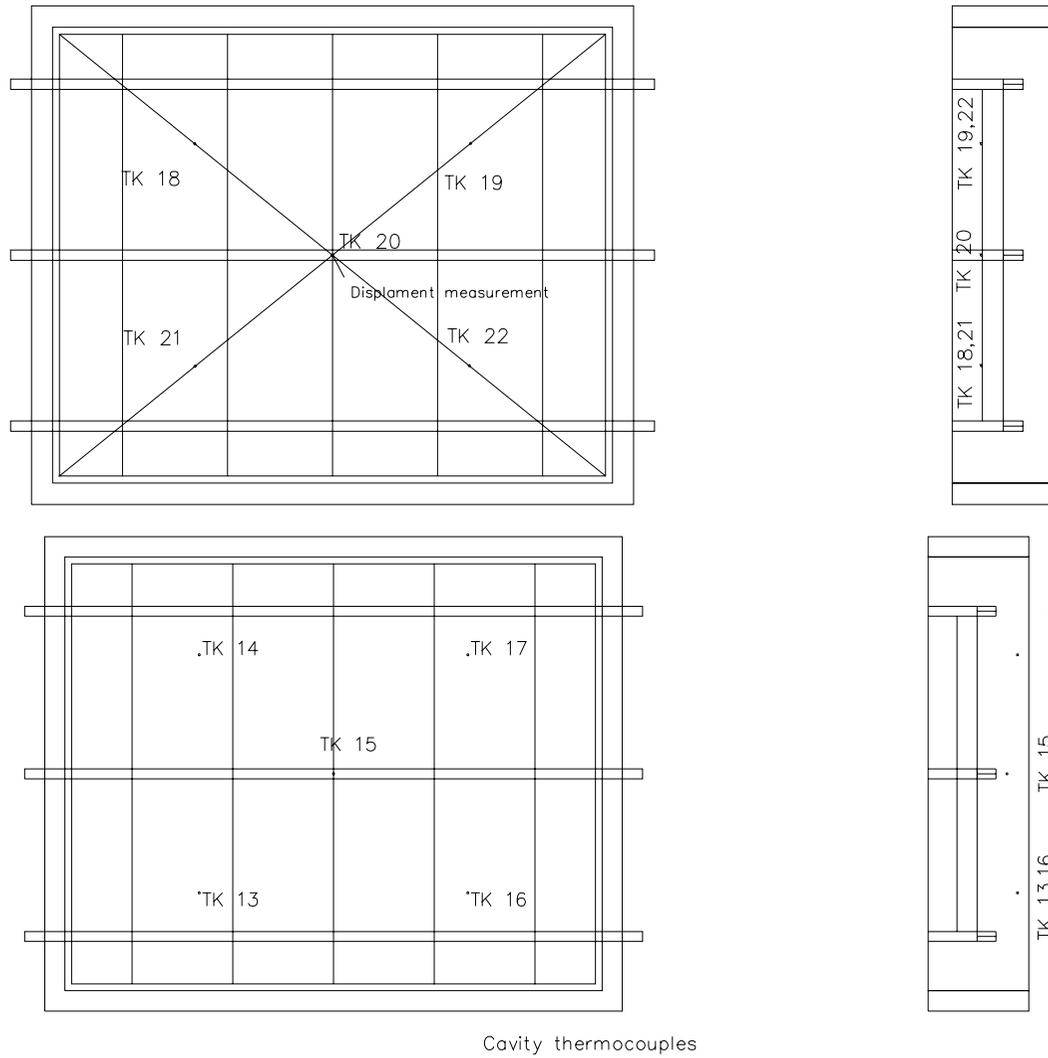
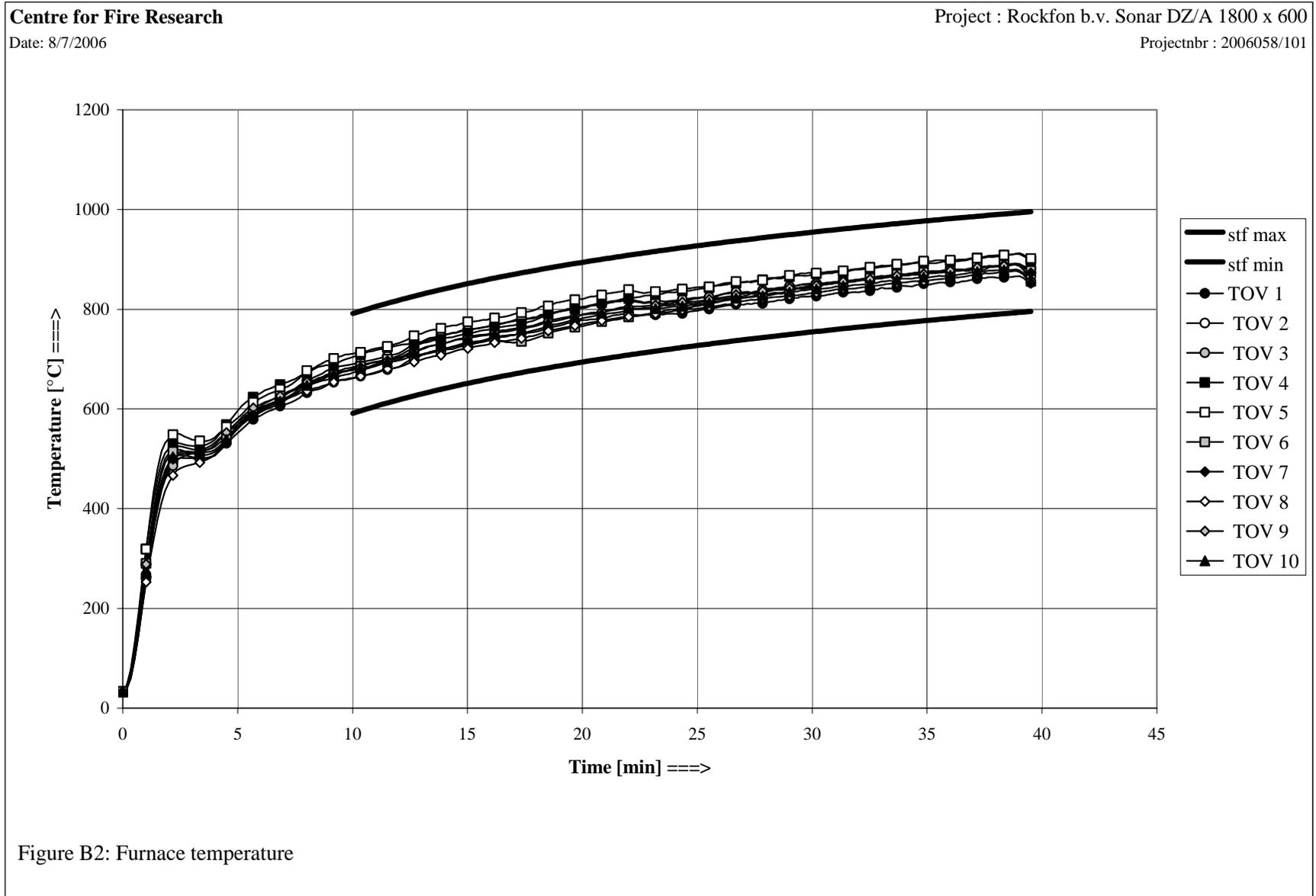


Figure B1 Overview of the thermocouples on the floor and in the cavity



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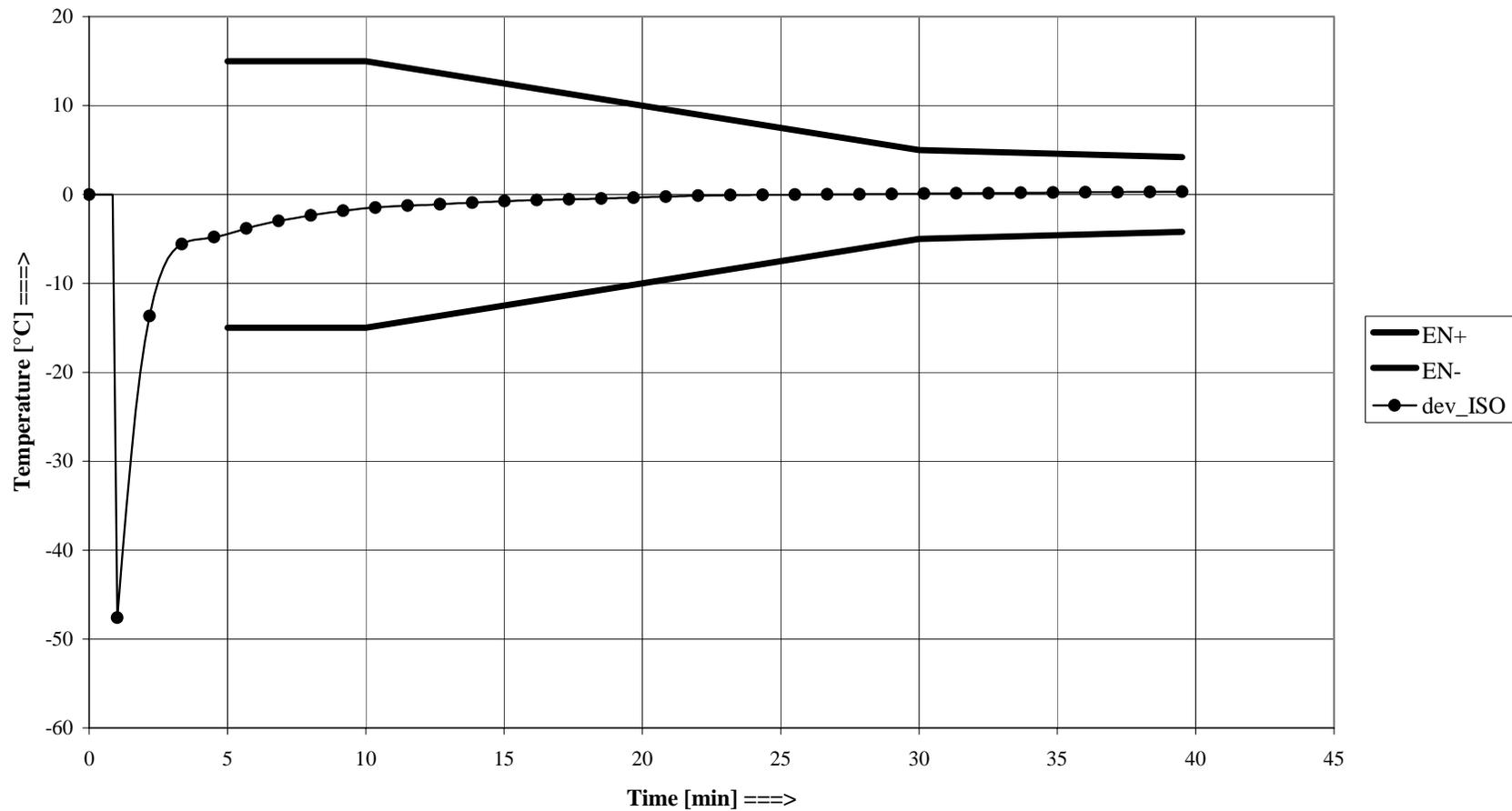


Figure B3: Deviation Fire curve

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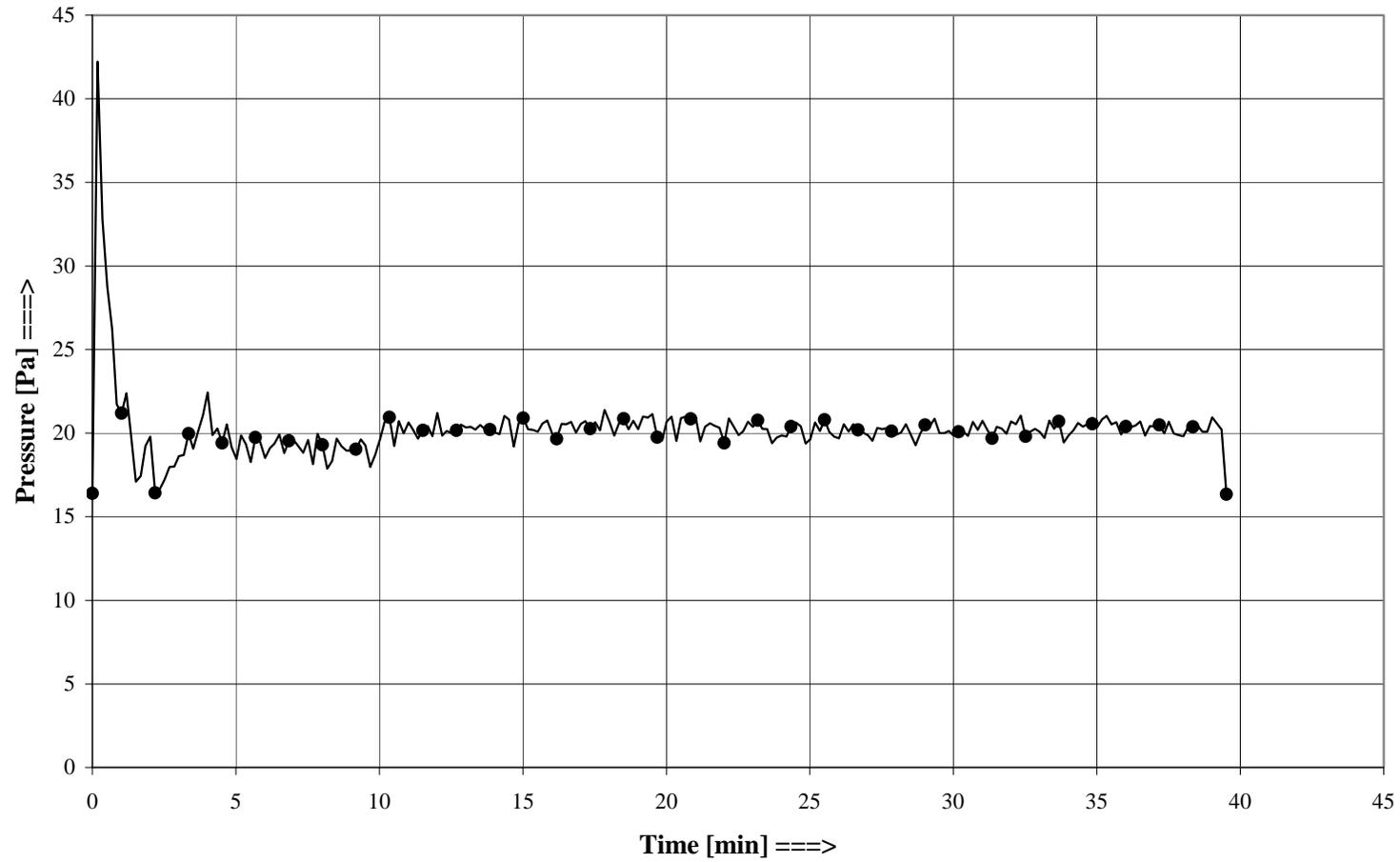


Figure B4: Pressure

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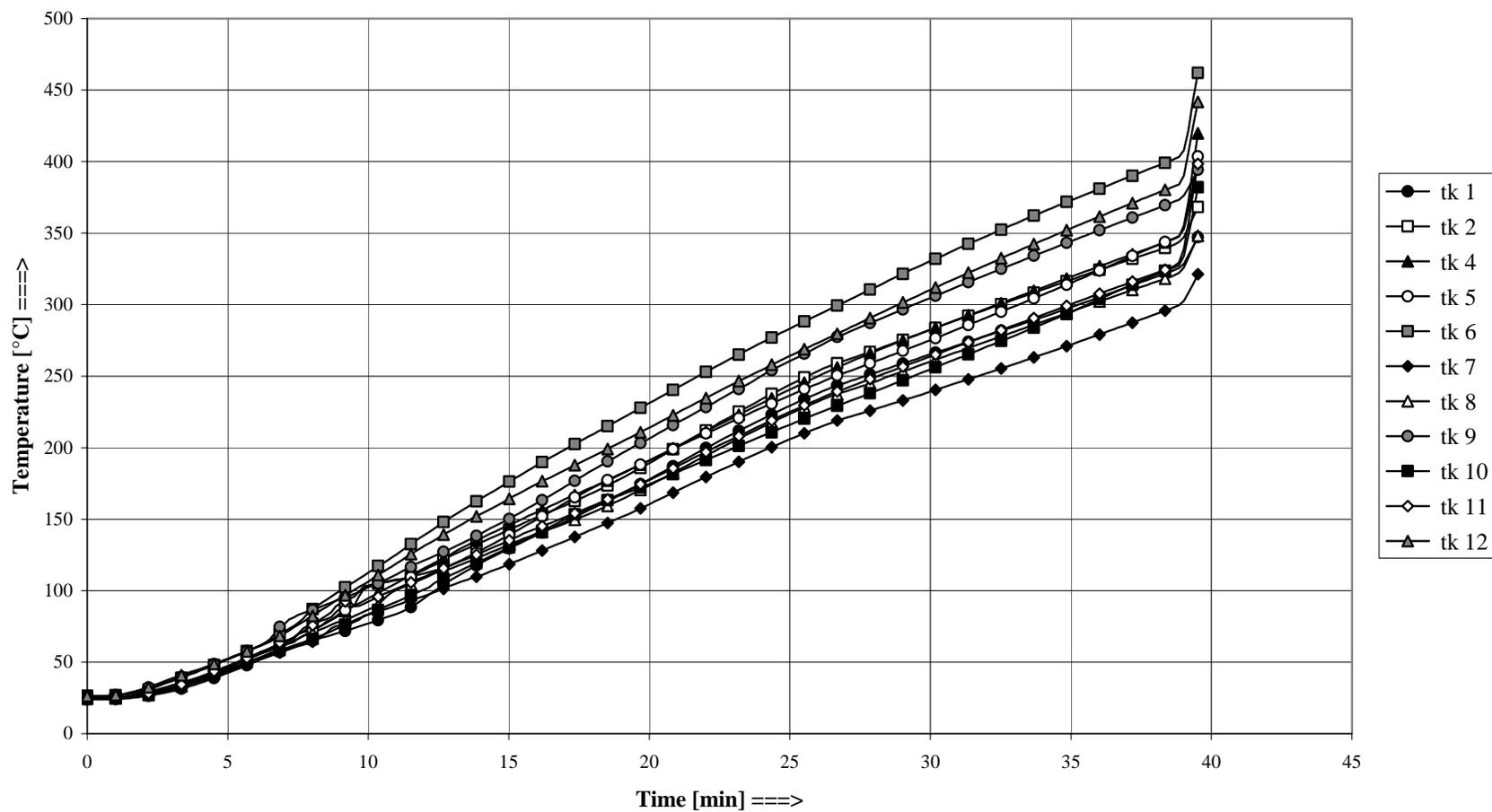


Figure B5: Steel temperatures

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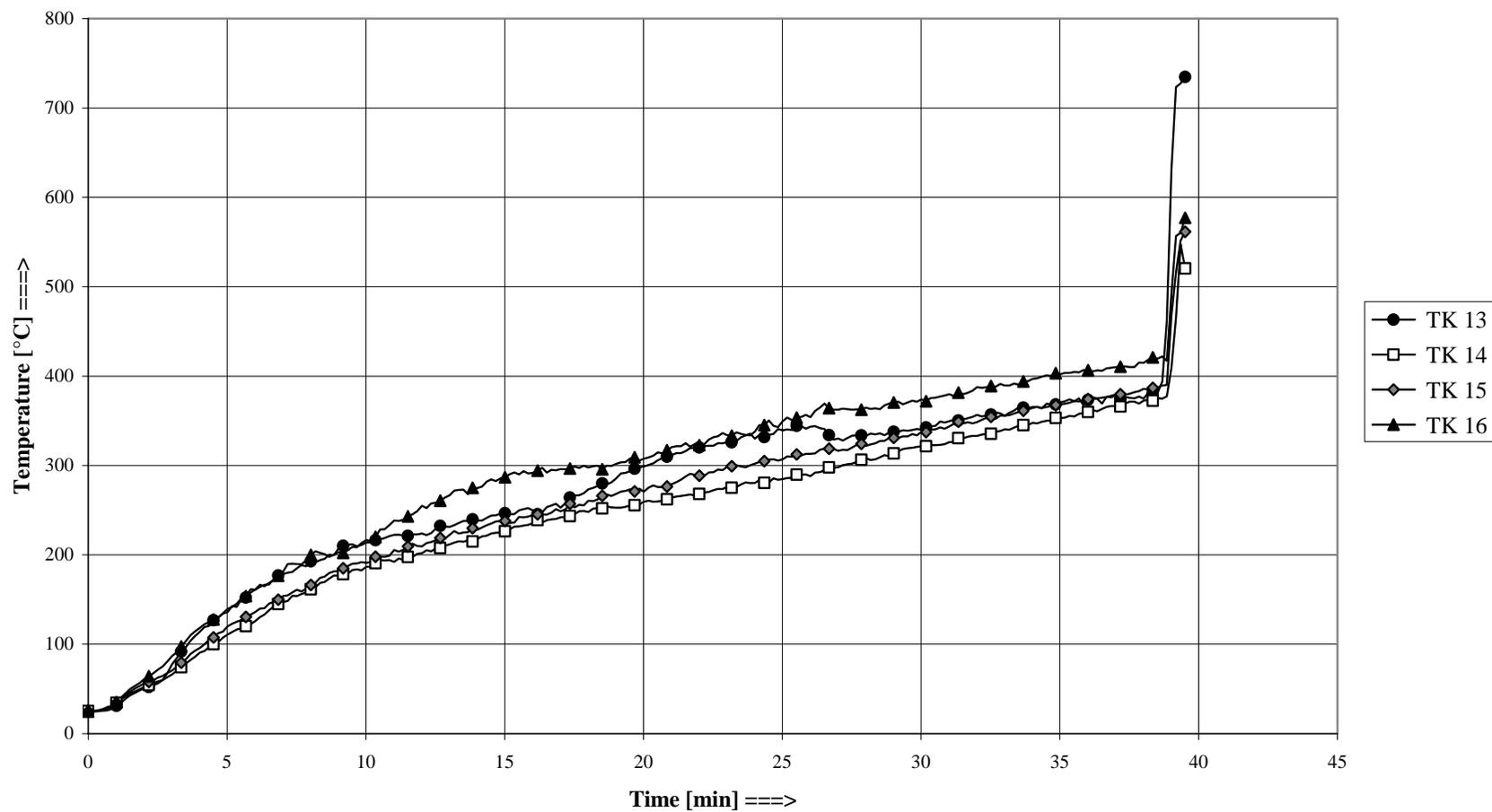


Figure B6: Cavity temperatures

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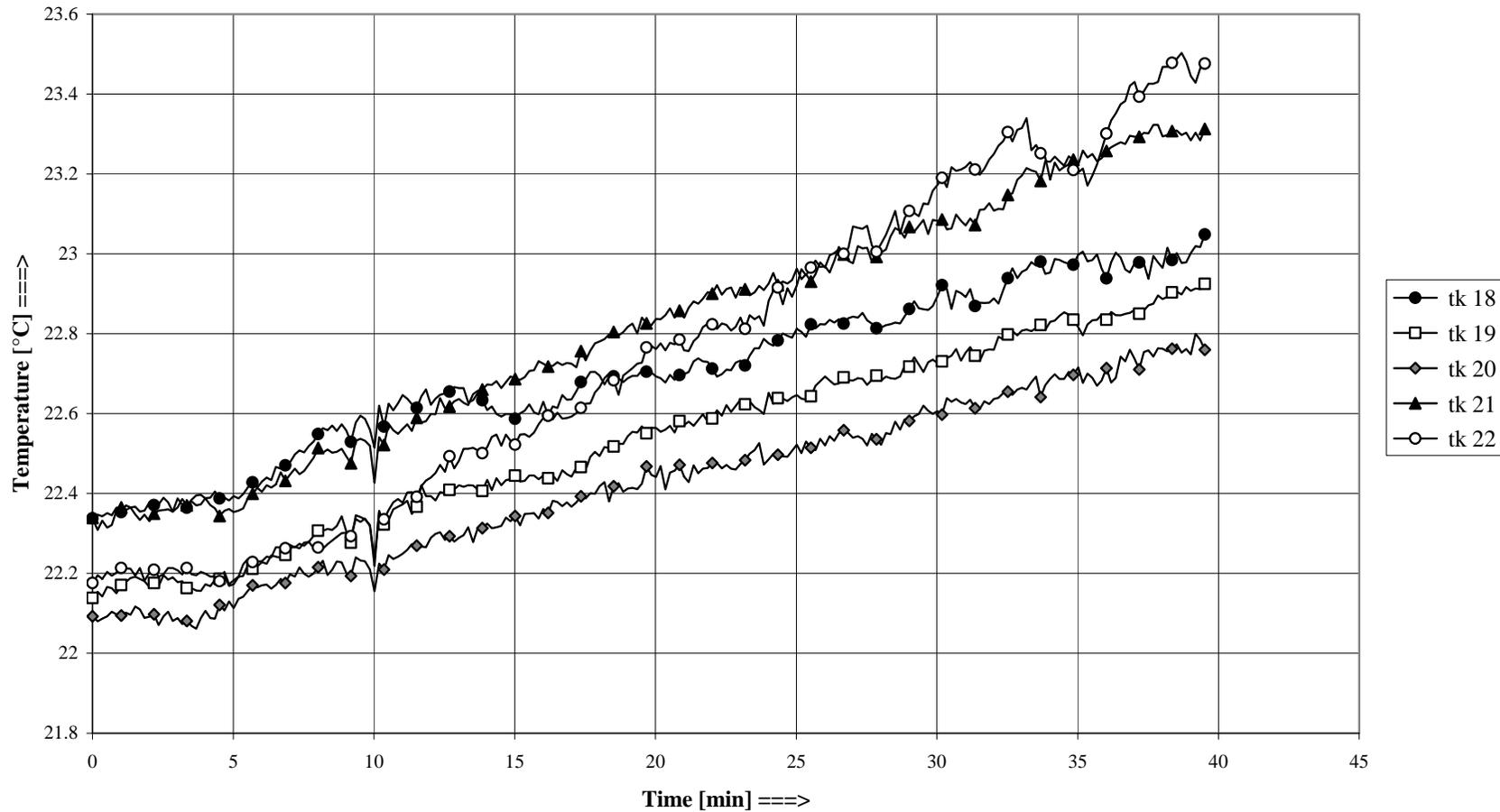


Figure B7: Surface temperatures

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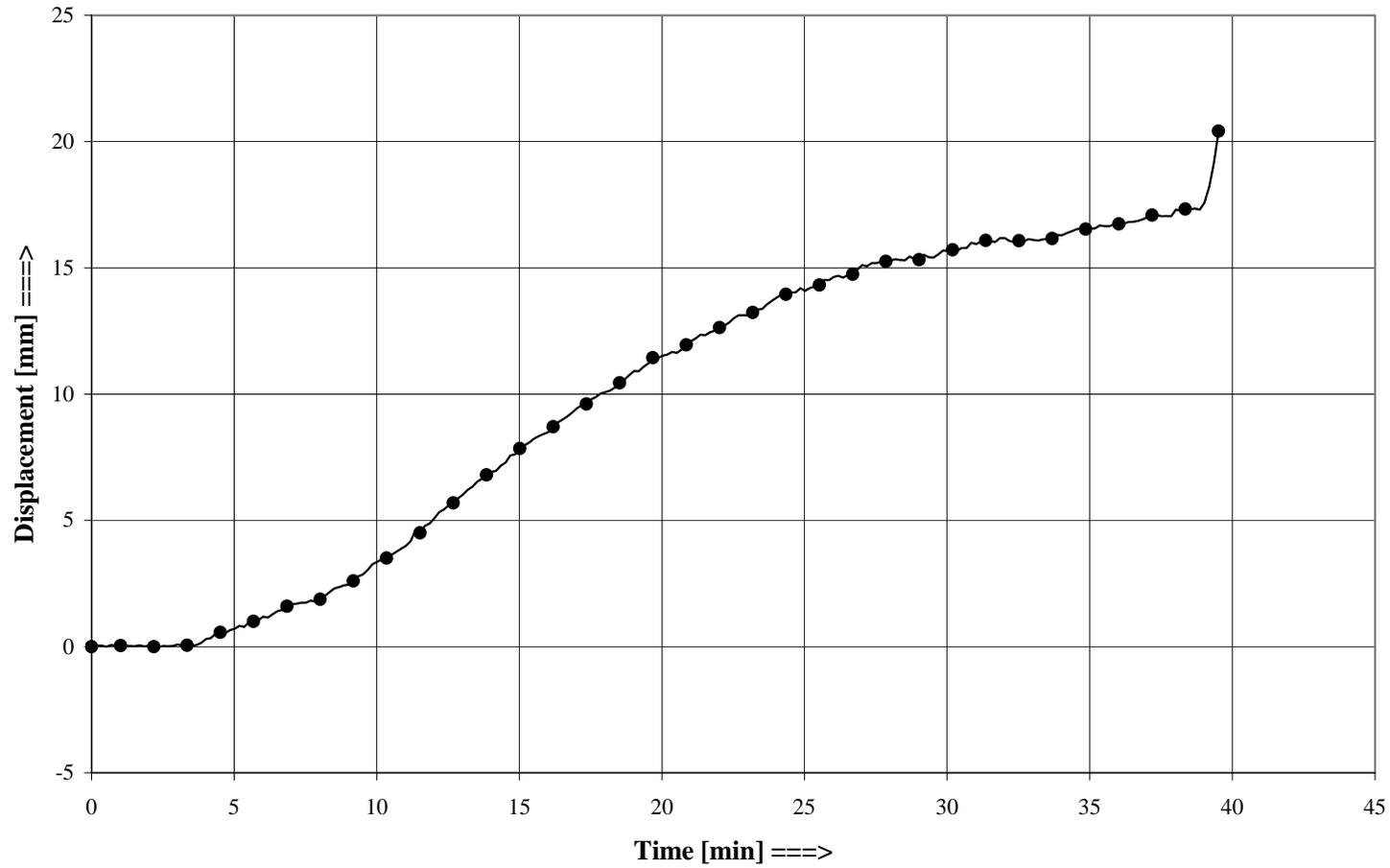


Figure B8: Displacement

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Projectnr : 2006058/101

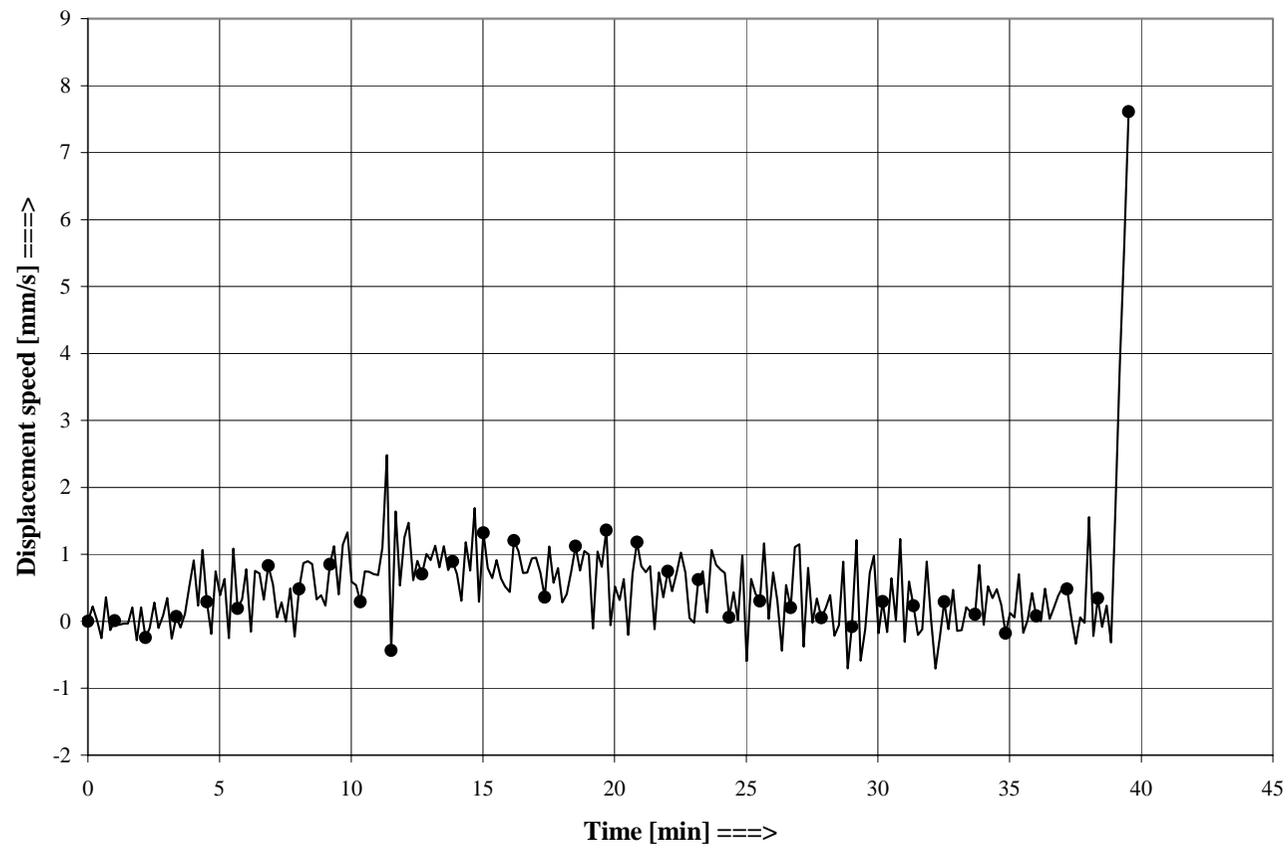


Figure B9: Displacement speed

C Photographs



Figure C1 Specimen at the beginning of the test



Figure C2 Specimen after the test