

Efectis Nederland BV  
Centre for Fire Safety  
Lange Kleiweg 5  
P.O. Box 1090  
2280 CB Rijswijk

**Efectis Nederland report**

**2009-Efectis-R0105(E)**

Determination of the resistance to fire according to  
EN 1365-2:1999 of a floor construction consisting  
of wooden beams with a Lewis® floor on top.  
Anticipated fire resistance : 90 minutes

[www.efectis.nl](http://www.efectis.nl)

T +31 15 276 34 80  
F +31 15 276 30 25  
E [nederland@efectis.nl](mailto:nederland@efectis.nl)

Date	March 2009
Author(s)	P.W.M. Kortekaas Ing. P.G.R. Scholten
Number of pages	10 (excluding appendices)
Number of appendices	3 (A to C)
Sponsor	Reppel B.V. p.o. box 102 3300 AC Dordrecht The Netherlands
Project name	Resistance to fire of a wooden floor ceiling construction
Project number	2008770

All rights reserved.

No part of this publications may be reproduced and/or published by print, photoprint, microfilm or any others means without the previous written consent of Efectis.

In case this report was drafted on instructions, the rights and obligations of contracting parties are subject to either the Standard Conditions for Research Instructions given to TNO, or the relevant agreement concluded between the contracting parties. Submitting the report for inspection to parties who have a direct interest is permitted.

© 2009 Efectis Nederland BV: a TNO company

This report is issued by Efectis Nederland BV (previously TNO Centre for Fire Research). Efectis Nederland BV and her sister company Efectis France are full subsidiaries of Efectis Holding SAS since 1 January 2008, in which the Dutch TNO and the French CTICM participate. The activities of the TNO Centre for Fire Research were privatized in Efectis Nederland BV since 1<sup>st</sup> July 2006. This is in response to international developments and requests by customers. In order to be able to give a better answer to the customer's request and offer a more comprehensive service of high quality and a wider range of facilities, the international collaboration has been further expanded. This is done with highly experienced partners in fire safety in Norway (Sintef-NBL), Spain (Afiti-Licof), Germany (IFT), USA (South West Research Institute) and China (TFRI). Further information can be found on our website.

## Contents

<b>1</b>	<b>Subject</b> .....	<b>3</b>
<b>2</b>	<b>Investigation</b> .....	<b>3</b>
<b>3</b>	<b>Sponsor</b> .....	<b>3</b>
<b>4</b>	<b>Place and data regarding the investigation</b> .....	<b>3</b>
<b>5</b>	<b>Date and number of the test report</b> .....	<b>3</b>
<b>6</b>	<b>Investigated construction</b> .....	<b>4</b>
6.1	General .....	4
6.2	Method of assembly .....	5
<b>7</b>	<b>Manufacturing of the test specimen</b> .....	<b>5</b>
<b>8</b>	<b>Course of investigation</b> .....	<b>5</b>
8.1	Verification of the specimen .....	5
8.2	Conditioning.....	5
8.3	Density and humidity measurements.....	6
8.4	Fire test.....	6
<b>9</b>	<b>Observations</b> .....	<b>7</b>
9.1	Observations during heating.....	7
9.2	Graphs of the results.....	7
9.3	Uncertainty of measurement.....	7
<b>10</b>	<b>Summary</b> .....	<b>8</b>
<b>11</b>	<b>Field of direct application</b> .....	<b>9</b>
<b>12</b>	<b>Figures</b> .....	<b>10</b>

### Appendices

A Furnace conditions

B Positions of the thermocouples and measurement results

C Photos

## 1 Subject

A wooden floor construction which was protected on the underside by 2 layers of gypsum board and on the top side by a Lewis® floor with a 50 mm thick layer of anhydrite. Between the wooden beams a 100 mm thick layer of Rockwool

## 2 Investigation

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

## 3 Sponsor

Reppel B.V.  
P.o. Box 102  
3300 AC DORDRECHT  
The Netherlands

## 4 Place and data regarding the investigation

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

Mounting of the Lewis floor, the concrete cover and the gypsum boards by the sponsor	26 <sup>th</sup> of September 2008
Fire test:	Thursday the 23 <sup>rd</sup> of October 2008

## 5 Date and number of the test report

March 2009, 2009-Efectis-R0105(E).

## 6 Investigated construction

### 6.1 General

Investigated was a wooden floor construction  
For details we refer to figure 1 and the description mentioned below.

#### 6.1.1 *Wooden beams*

- Material : Pinewood
- Cross section : 100 x 200 mm
- Centre-to-centre distance : 500 mm
- Span : 4150 mm

#### 6.1.2 *Ceiling channel on the underside of the floor*

- Type : BPB resilient ceiling channel
- Centre-to-centre distance : 375 mm
- Fixing : grabber screws 25 mm, 2 per beam

#### 6.1.3 *Gypsum boards*

- Type : BPB Gyproc RF 12.5 mm
- Thickness : 12.5 mm
- Number of layers : 2
- Fixing : 1<sup>st</sup> layer grabber screws 35 mm, c.t.c. distance 300 mm;  
2<sup>nd</sup> layer grabber screws 45 mm, c.t.c. distance 300 mm;
- Joints : covered with paper tape and covered with BPB Promix Premium joint mortar

#### 6.1.4 *Insulation between the beams*

- Type : Rockwool 301
- Thickness : 100 mm
- Density : 35 kg/m<sup>3</sup>

#### 6.1.5 *Lewis® floor*

- Type : Lewis plates
- Overlap between plates : min. 100 mm
- Fixing : the Lewis plates are joint together by self tapping screws Ø 4.2 x 16 mm. The floor is not connected to the wooden beams
- Support : between the Lewis plates and the top of the wooden beams Rockwool of 25 mm thick and 100 mm wide

#### 6.1.6 *Concrete floor*

- Type : anhydrite
- Thickness : 50 mm (34 mm over the top of the Lewis plates)

## 6.2 Method of assembly

- Mounting of aerated concrete frame
- Mounting of the beams
- Mounting of the Rockwool strips on top of the beams
- Mounting of the Lewis plates
- Casting of the Anhydrite floor
- Mounting of the ceiling channels
- Mounting of the Rockwool insulation
- Mounting of the gypsum boards

## 7 Manufacturing of the test specimen

Reppel BV	Lewis floor Concrete floor Gypsum boards
Efectis Nederland BV	Test frame Wooden beams

## 8 Course of investigation

### 8.1 Verification of the specimen

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

### 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<sup>1</sup> and the moisture equilibrium<sup>2</sup> of the materials were determined.

Table 1: material properties

Material	Density [kg/m <sup>3</sup> ]	Moisture content [%]
Wooden beams	392	7.0
Gypsum boards	869	0.6
Anhydrite	2111	0.1
Rockwool	30	0.5

### 8.4 Fire test

#### 8.4.1 Test conditions

The test was performed under the conditions as specified in EN 1365-2:1999.

The test specimen was heated on one side using the standard fire curve  
The pressure in the furnace that was aimed for was 20 Pa at 100 mm below the floor construction.

#### 8.4.2 Load on the floor

A load of 2 kN/m<sup>2</sup> was applied on the floor.

#### 8.4.3 Measurements

During the heating the following data were measured and registered:

##### *Furnace conditions:*

- gas temperatures inside the furnace with plate thermometers, regularly spread over the directly heated surface.
- Pressure in the furnace at measured at 100 mm below the floor construction.

##### *Test specimen*

- The surface temperatures of the floor construction.
- The deformations of the floor construction.

##### *Ambient*

- ambient temperature in the laboratory

The thermocouple positions are given in figure B1.

With a cotton wool pad and calipers the integrity criterion was checked.

---

<sup>1</sup> Determined before drying

<sup>2</sup> Determined after drying for 24 hours at 60°C for the gypsum board and 24 hours at 105°C for the wooden beam and the anhydrite

## 9 Observations

### 9.1 Observations during heating

The pressure in the furnace varied during the test. This was partly caused by the burning of the wooden beams after 1 hour of heating. Before one hour the variations were caused because a pressure meter with a large span was used. Because of this the measurements are less accurate. The graph with the relative deviation shows that the bottom limit line is just hit. This was caused by the furnace operator who failed to follow the required curve. Both the variation in pressure en the relative deviation did not have a significant influence on the result because the test represented slightly more severe conditions.

See the table below for detailed observations during heating.

Time [min.]	Observations
0	Start of heating
3	Gypsum boards color dark
40	Joint of gypsum boards color brown
48	1 gypsum board in the first layer deforms
55	Black hole in second layer of gypsum boards visible
58	Increasingly bigger pieces of gypsum board collapse
62	The ceiling channels are visible
65	All gypsum boards have collapsed, ceiling channels and Rockwool insulation are visible
70	Thermocouple TPL4 increases with 40°C a minute
71	Thermocouple TPL4 is stabilizing again
123	Ceiling channels start to collapse
124	Rockwool starts to collapse End of heating

The photos in annex C show the construction before, during and after heating.

### 9.2 Graphs of the results

The measurement results are presented in the form of graphs in annex B and C.

During heating the temperature and the air speed in the laboratory fulfilled the criteria of EN 1363-1:1999.

### 9.3 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.

## 10 Summary

The fire resistance to fire of a wooden floor construction which was protected on the underside by two layers of gypsum board with Rockwool insulation between the beams and on the topside by a Lewis® floor with a 50 mm thick cover of anhydrite has been determined according to EN 1365-2:1999.

*Table 2: summary of results*

Criterion	Time in minutes from the start of the test till the time a criterion according to EN 1365-2:1999 was reached	
	EN 1365-2:1999	Criterion
a) Load bearing capacity	124	exceeded
b) Integrity (E)		
– Cotton wool pad	124	exceeded
– Gap gauges	124	exceeded
– Sustained flaming	124	exceeded
c) Thermal insulation (I)		
– Average temperature rise	124	exceeded
– Maximum temperature rise	124	exceeded

The heating was terminated after 124 minutes at the request of the sponsor.

The classification according to EN 13501-2 shall be given in a separate document.

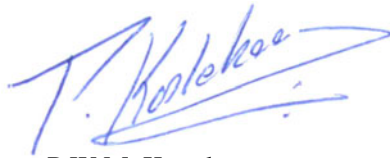


## 11 Field of direct application

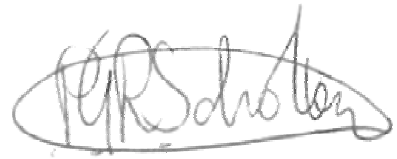
This report details the method of construction, the test conditions and the results obtained when the specific element of construction described herein was tested following the procedure outlined in EN 1363-1, and where appropriate EN 1363-2. Any significant deviation with respect to size, constructional details, loads, stresses, edge or end conditions other than those allowed under the field of direct application in the relevant test method is not covered by this report.

The summary of chapter 10 is only valid for floor constructions with their hardware and materials that are in detail equal to the construction described in this report and that also fulfill the following requirements:

- a) With a height of the plenum of at least 200 mm.
- b) With a centre-to-centre distance of the beams of maximum 500 mm.
- c) With maximum bending moments and shear forced no larger than tested.
- d) With dimensions of the gypsum boards equal or smaller than tested.
- e) With Rockwool 301 insulation of 100 mm thickness between the wooden beams.



P.W.M. Kortekaas



P.G.R. Scholten B.Sc

This report is issued by Efectis Nederland BV (previously **TNO** Centre for Fire Research). Efectis Nederland BV and her sister company Efectis France are full subsidiaries of Efectis Holding SAS since 1 January 2008, in which the Dutch TNO and the French CTICM participate. The activities of the TNO Centre for Fire Research were privatized in Efectis Nederland BV since 1<sup>st</sup> July 2006. This is in response to international developments and requests by customers. In order to be able to give a better answer to the customer's request and offer a more comprehensive service of high quality and a wider range of facilities, the international collaboration has been further expanded. This is done with highly experienced partners in fire safety in Norway (Sintef-NBL), Spain (Afiti-Licof), Germany (IFT), USA (South West Research Institute) and China (TFRI). Further information can be found on our website.

## 12 Figures

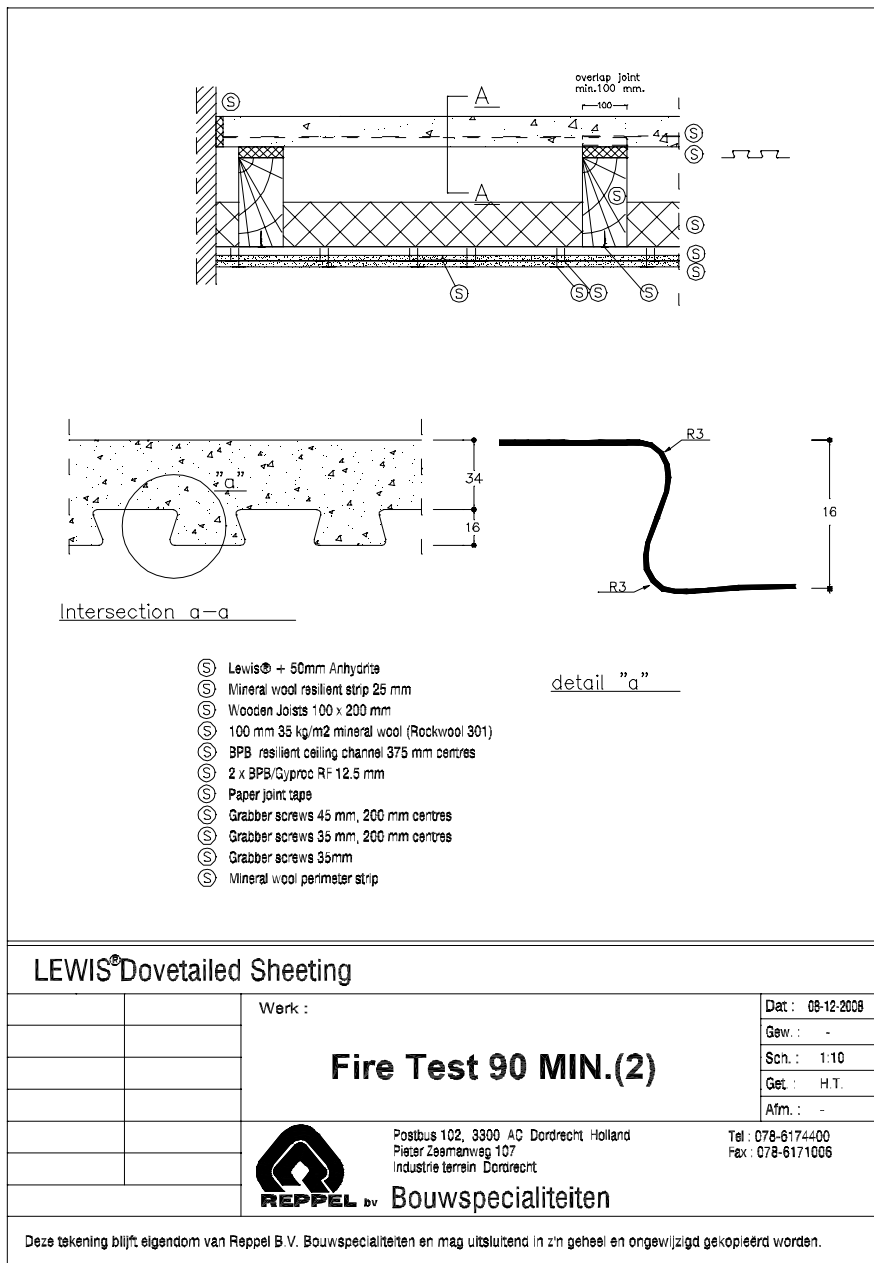


Figure 1: overview of the test specimen

## **A      Furnace conditions**

Figure A1    :    measured gas temperatures in the furnace

Figure A2    :    relative deviation of the furnace temperatures

Figure A3    :    ambient temperature in the laboratory during the test

Figure A4    :    measured pressure in the furnace

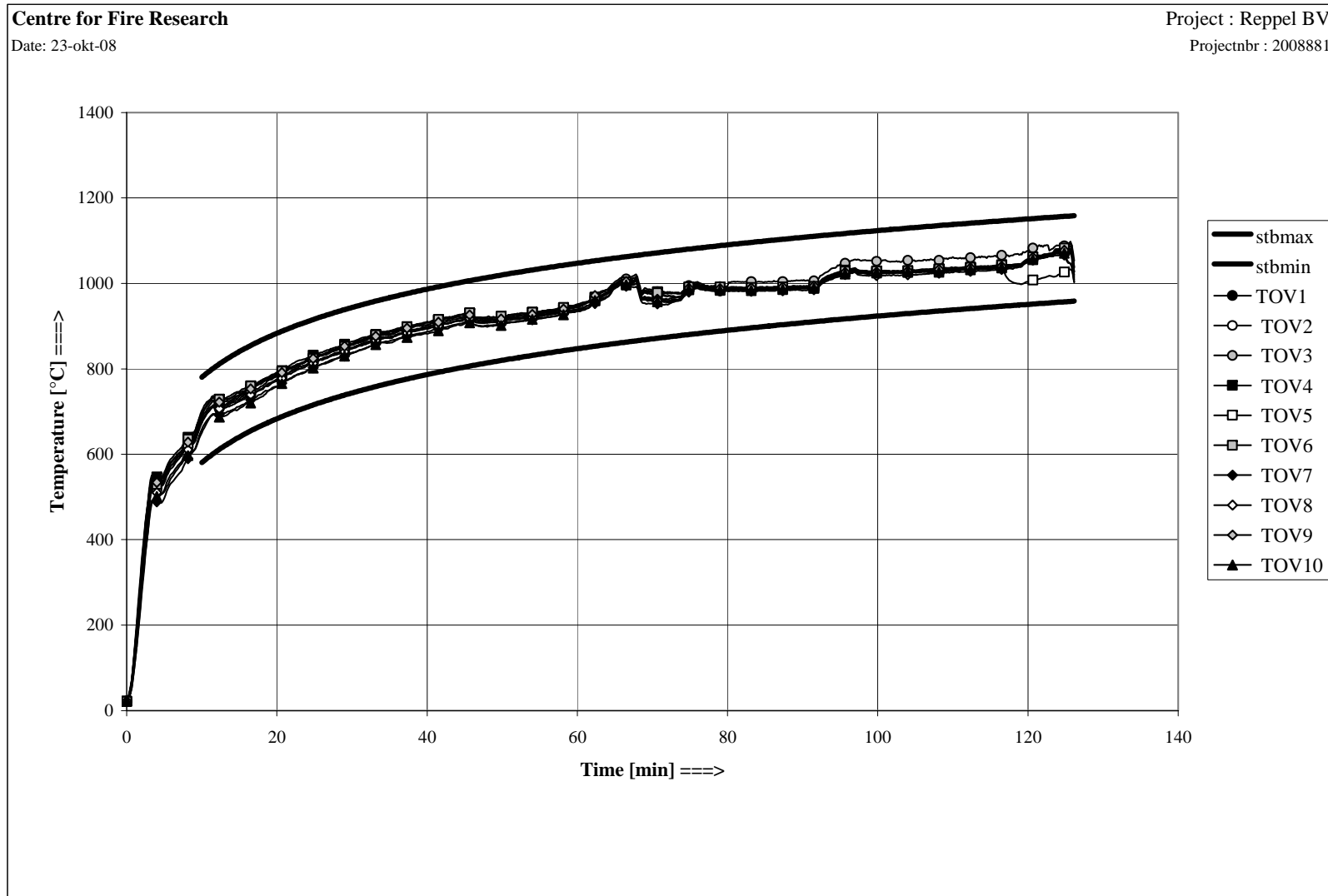


Figure A1 : measured gas temperatures in the furnace

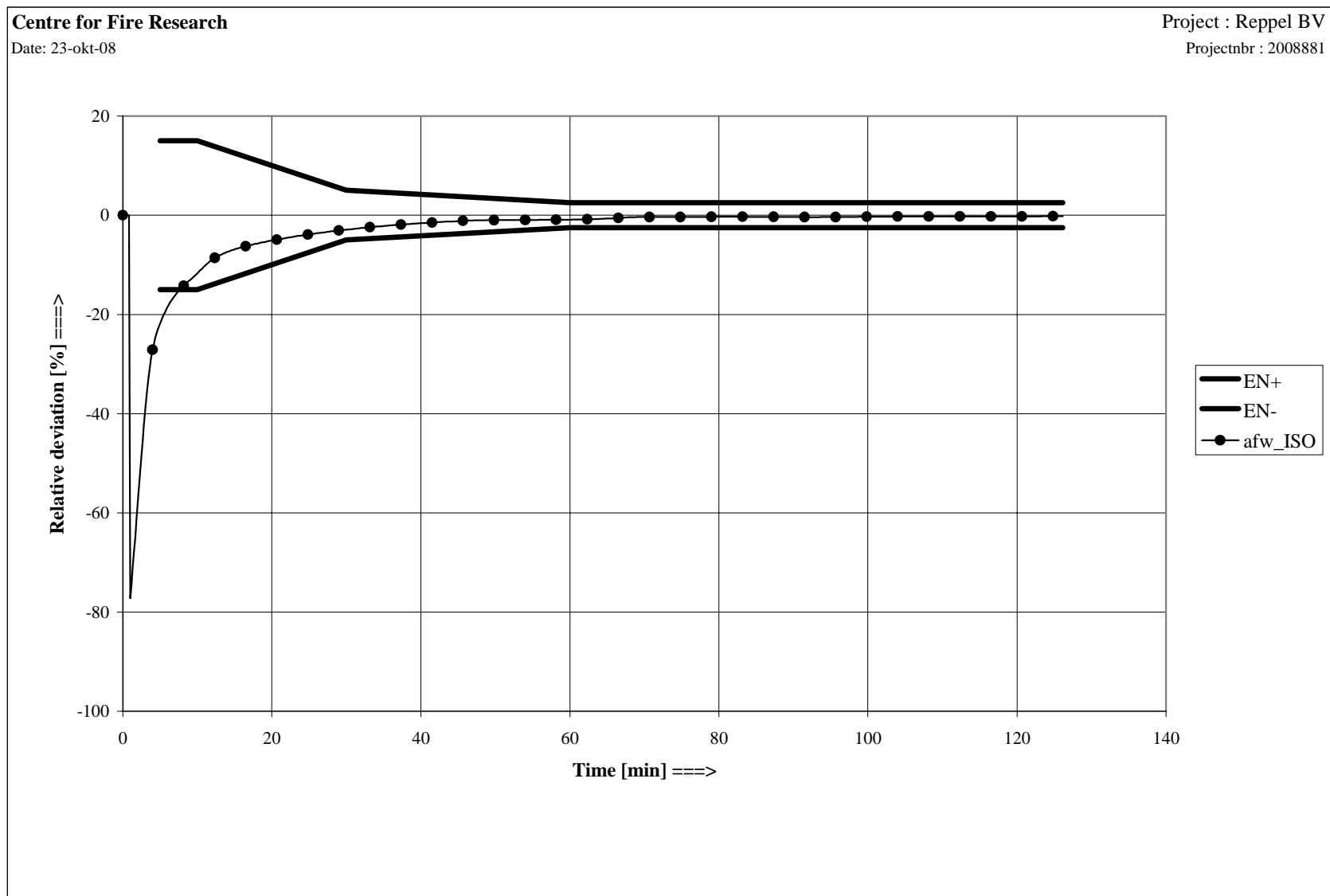


Figure A2 : relative deviation of the furnace temperatures

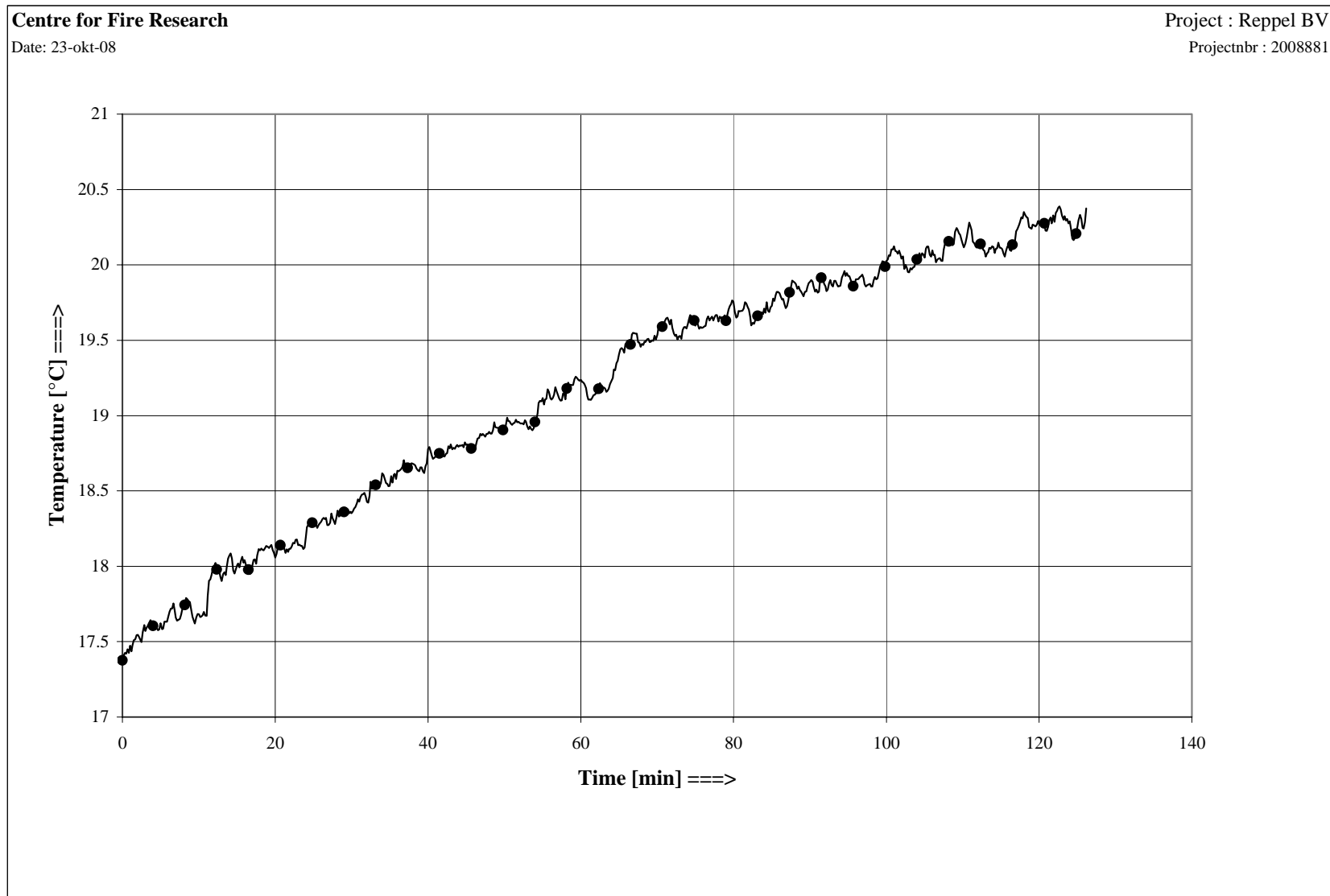


Figure A3 : ambient temperature in the laboratory during the test

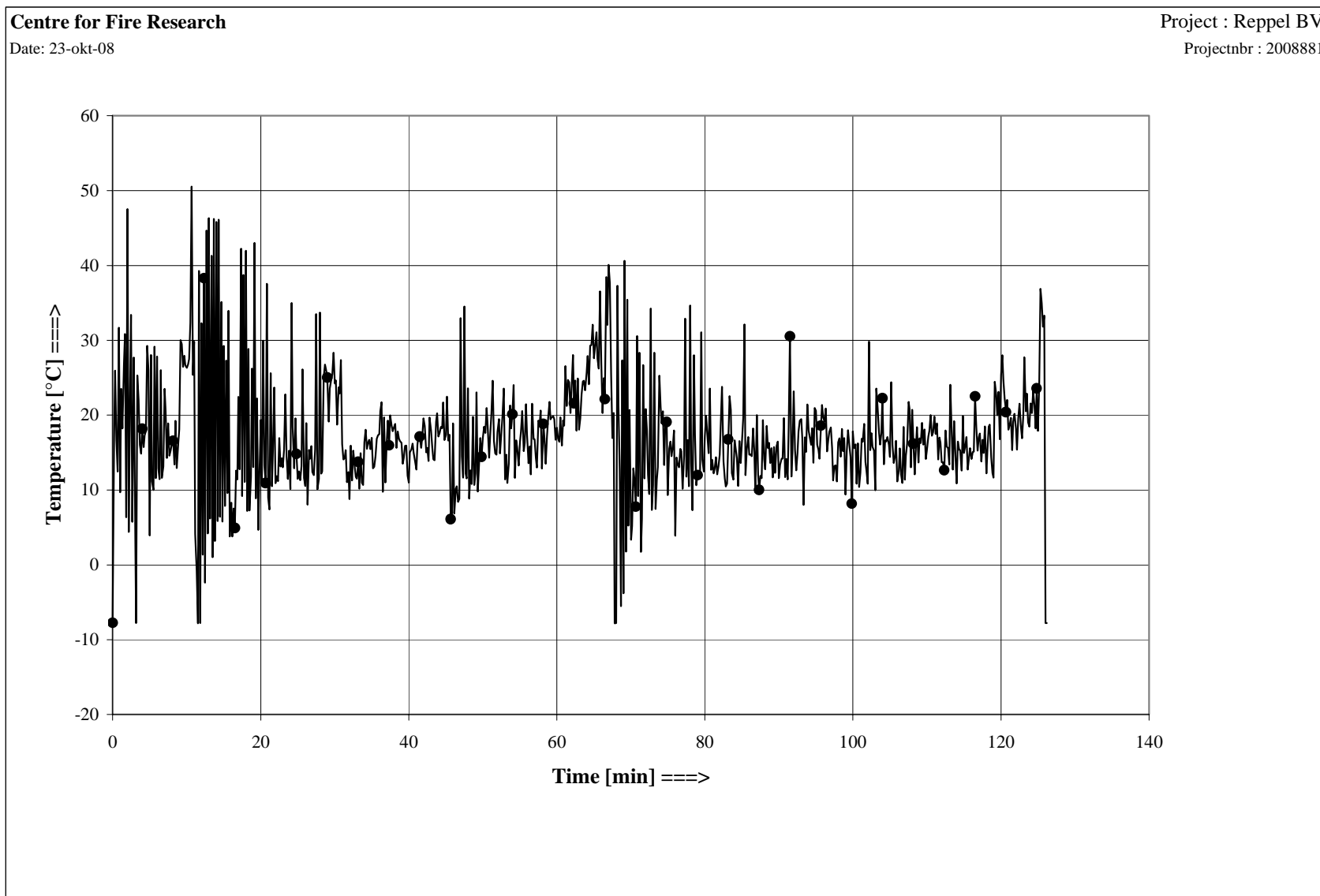


Figure A4 : measured pressure in the furnace

## **B Positions of the thermocouples and measurement results**

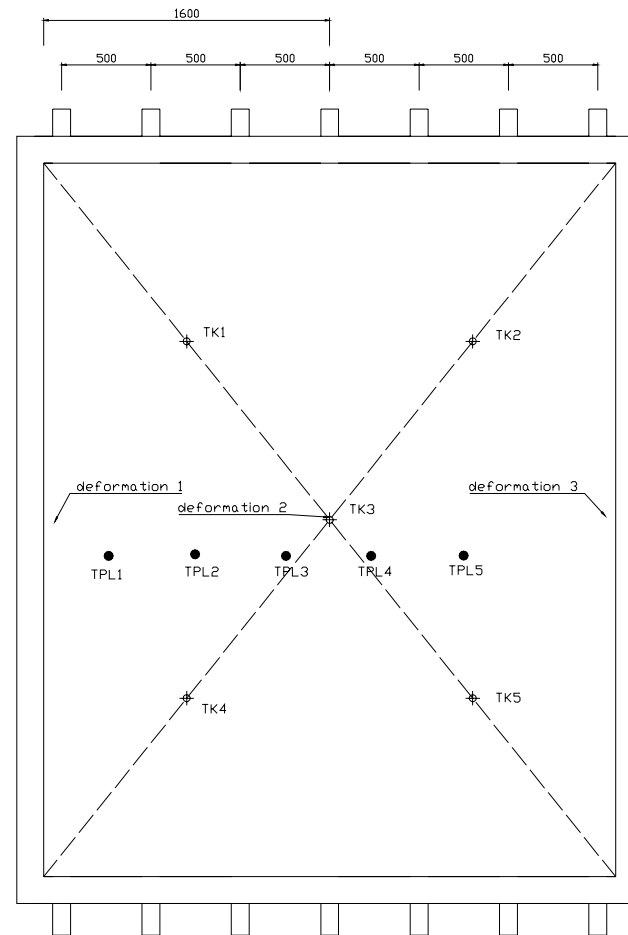
Figure B1: positions of the thermocouples

Figure B2: measured air temperatures in the plenum

Figure B3: measured surface temperatures on top of the floor

Figure B4: measured deformation of the floor





TK1-5 are thermocouples on the concrete floor  
TPL1-5 are thermocouples in the plenum between the wooden beams

Figure B1: Positions of the thermocouples

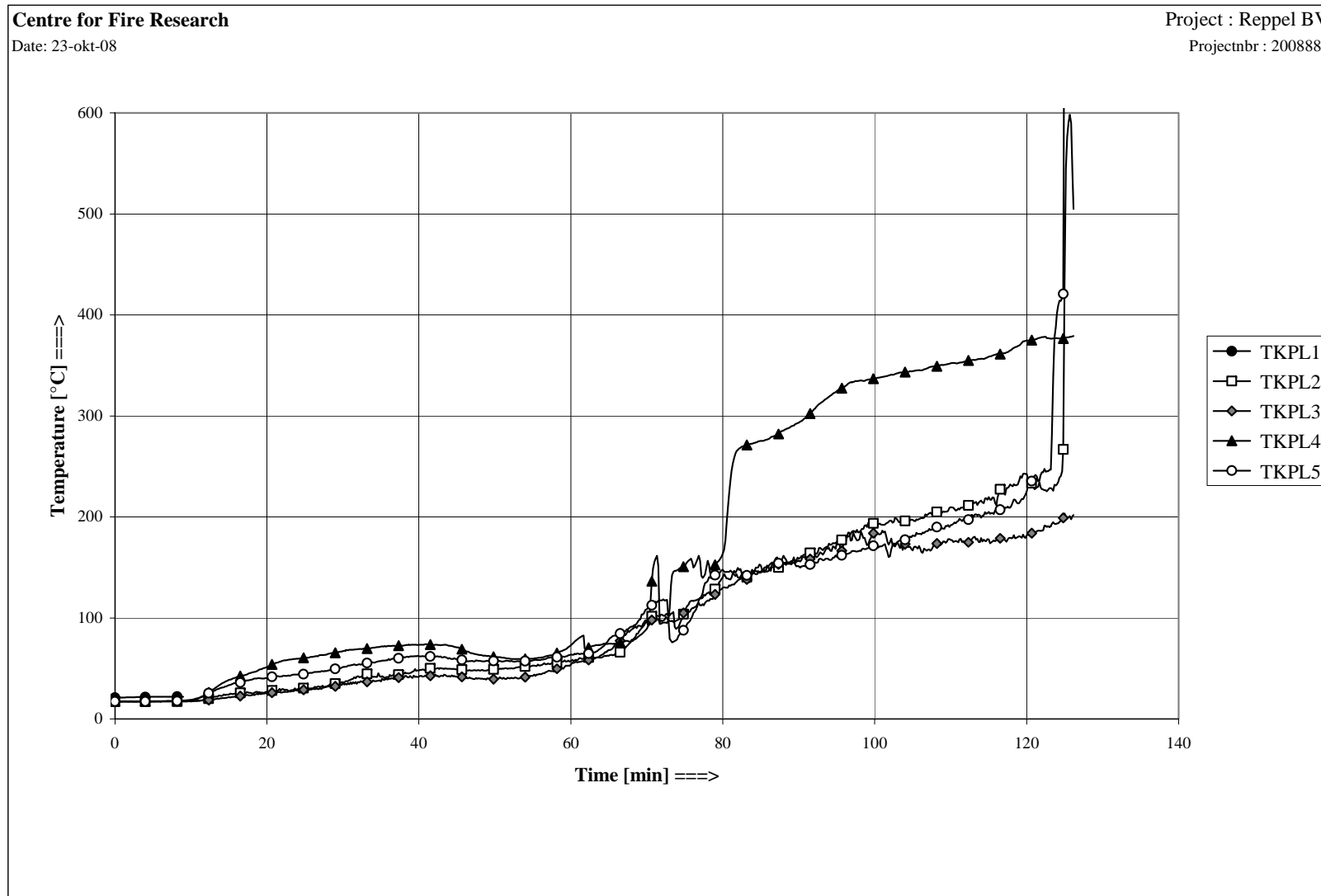


Figure B2: measured air temperatures in the plenum

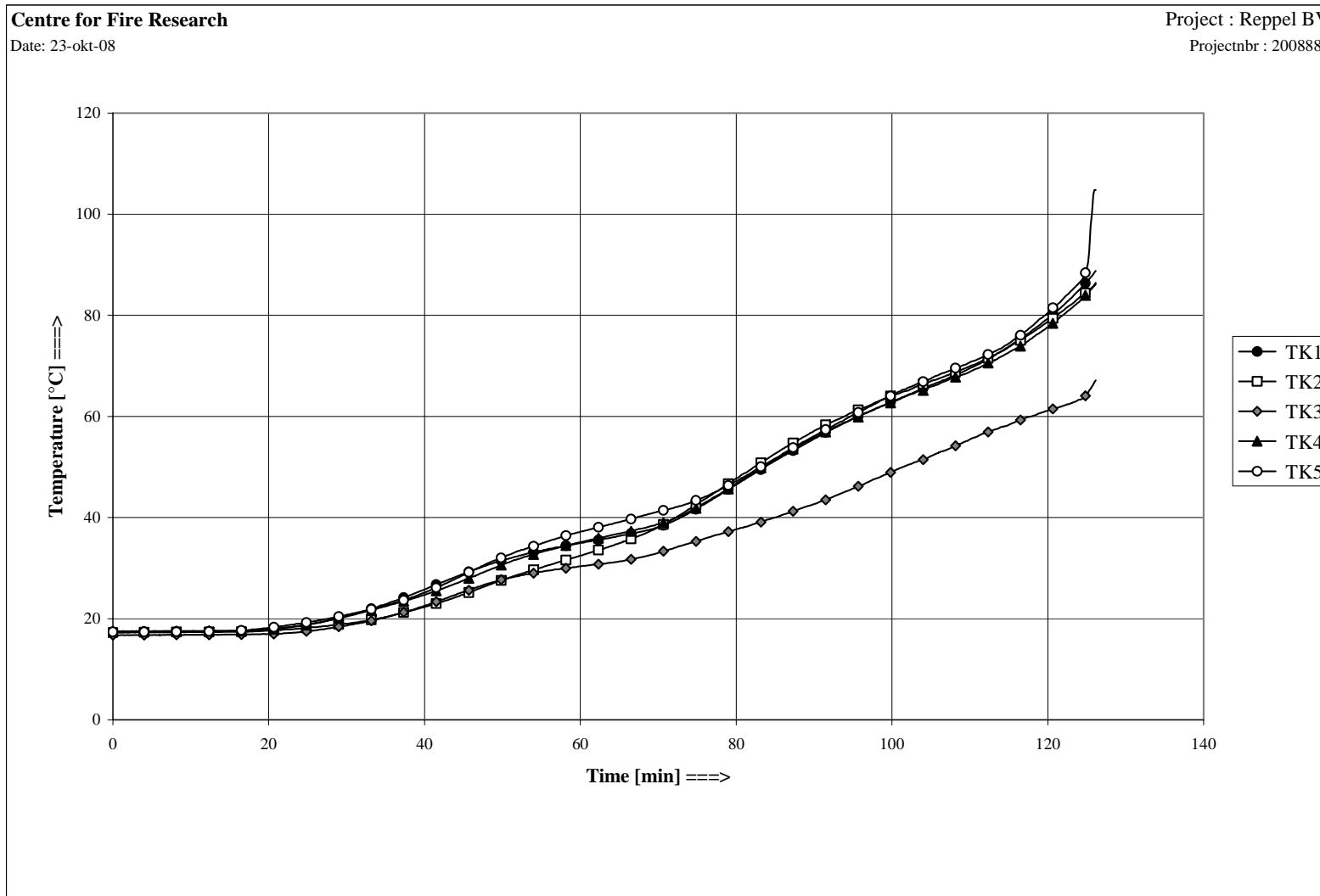


Figure B3: measured surface temperatures on top of the floor

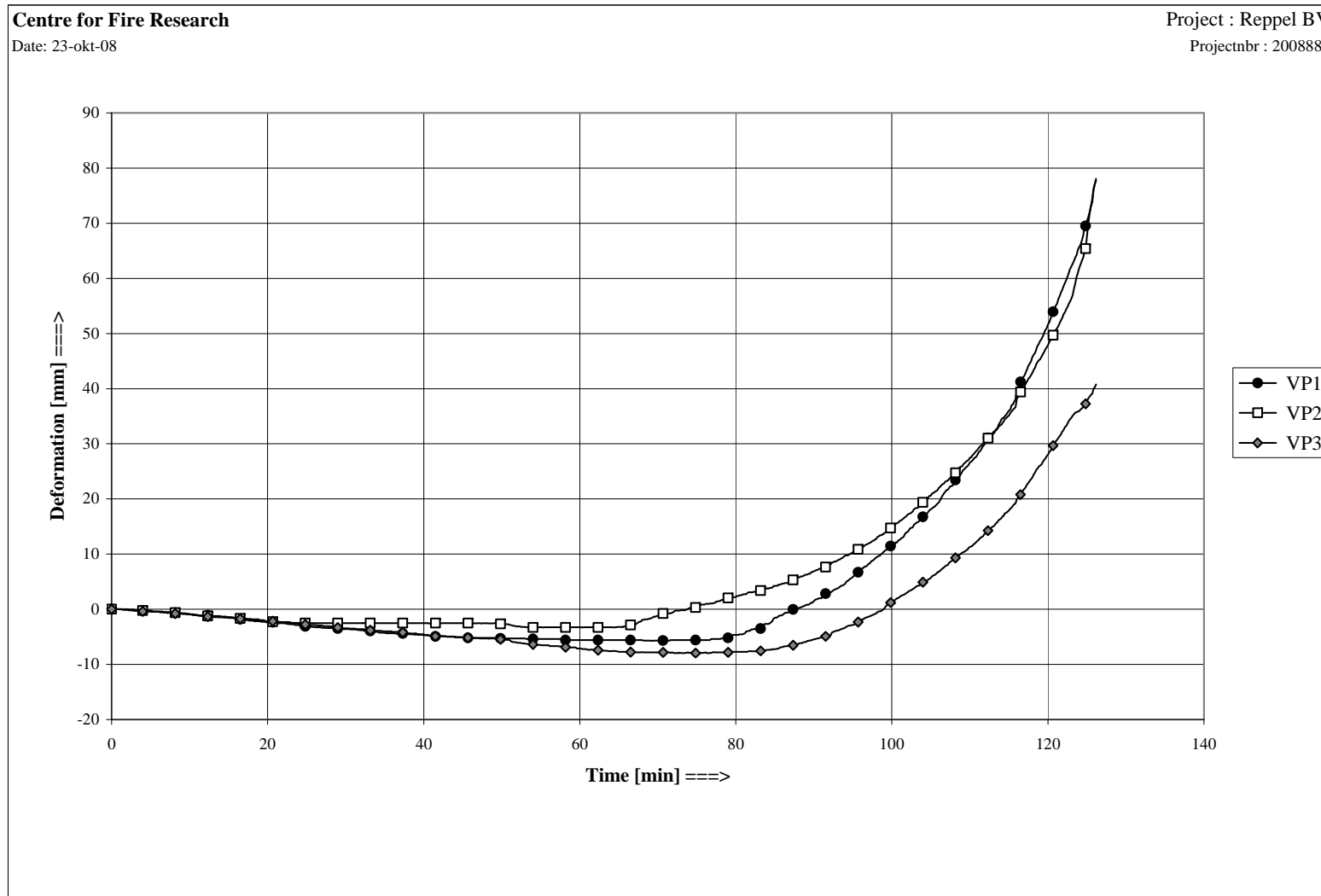


Figure B4: measured deformation of the floor

## C Photos

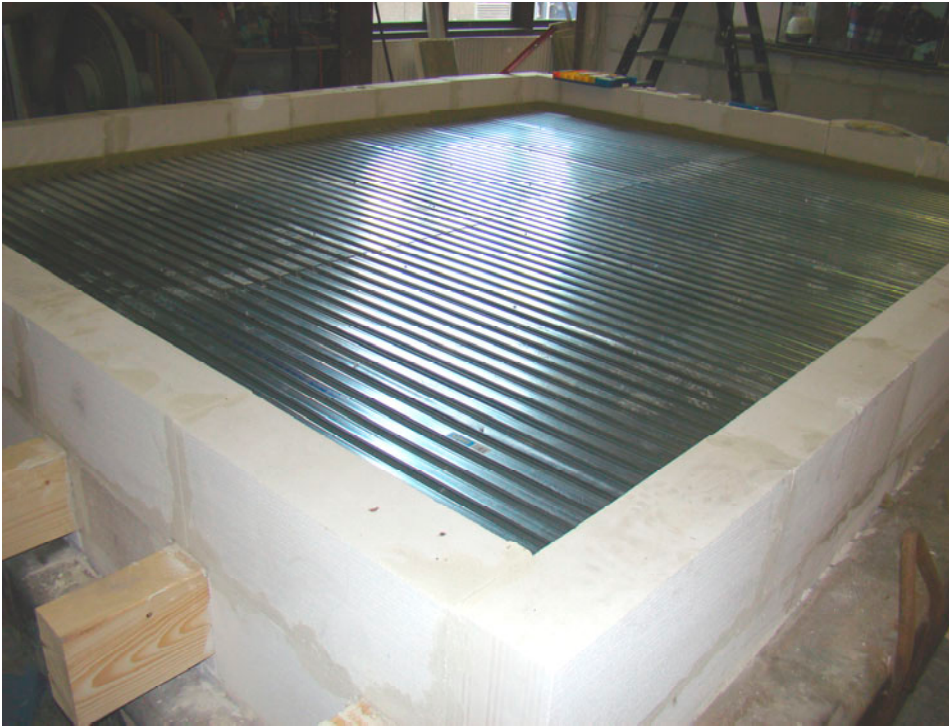


Photo 1: view of the floor before casting the concrete



Photo 2 : detail of the mounting of the ceiling channels

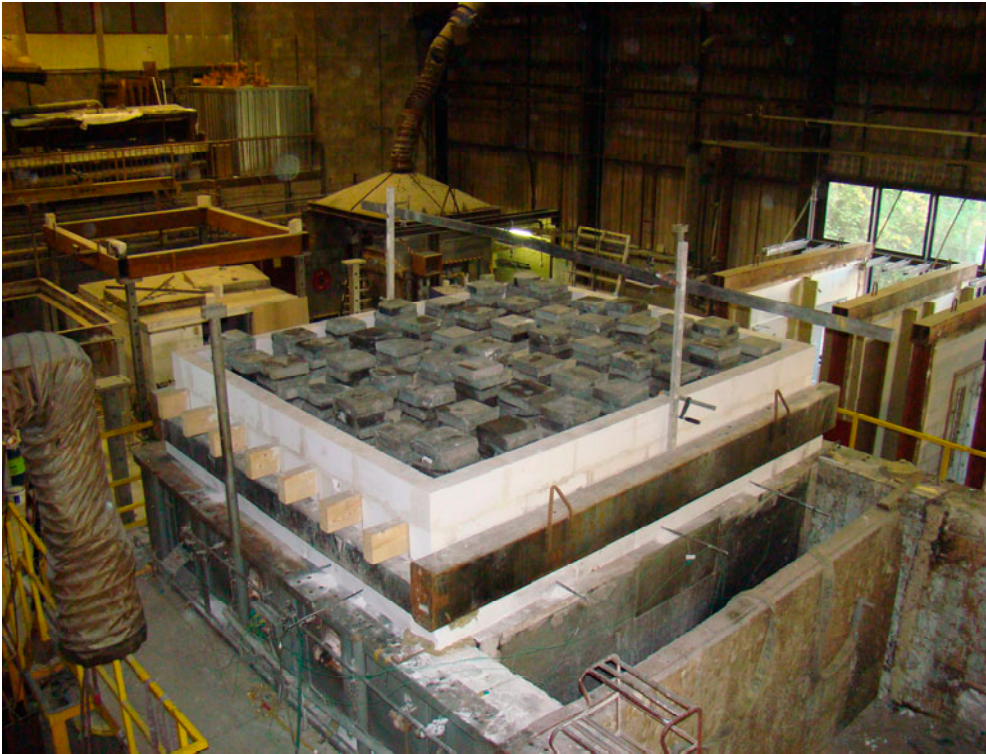


Photo 3 : view of the construction before the test