**TNO Built Environment and Geosciences**

Centre for Fire Research
Van Mourik Broekmanweg 6
P.O. Box 49
2600 AA Delft

www.tno.nl

T +31 15 276 30 00
F +31 15 276 30 25

**TNO report**

**2005-CVB-R0408**

# Fire resistance according to NEN-EN 1364-1:2001 in compliance with NEN 6069:2001 of a Fermacell wall construction, type 1S21

| | |
|---|---|
| Date | November 2005 |
| Author(s) | Ing. M.N. Slappendel<br>Dr. Ir. G. van den Berg |
| Number of pages | 15 |
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| Contractor | Xella Droogbouw Systemen BV<br>P.O. Box 398<br>6600 AJ WIJCHEN<br>The Netherlands |
| Project name | Fire Resistance |
| Project number | 006.55725/01.01 |

# Contents

# 1 Subject

Fermacell wall construction, type 1S21, on both sides plated with fermacell gypsum fiber board.

# 2 Examination

Determination of the fire resistance according to NEN-EN 1364-1:2001 in compliance with NEN 6069:2001.

# 3 Contractor and sponsors

| | | |
|---|---|---|
| Xella Droogbouw Systemen BV<br>P.O. Box 398<br>6600 AJ WIJCHEN<br>The Netherlands | Rockwool Benelux BV<br>P.O. Box 1160<br>6040 KD ROERMOND<br>The Netherlands | Dingemans Elementenbouw BV<br>P.O. Box 65<br>5170 AB KAATSHEUVEL<br>The Netherlands |

# 4 Location and date of test

## 4.1 Location

The investigation took place in the laboratory of the Centre for Fire Research of TNO Built Environment and Geosciences at Rijswijk, the Netherlands.

## 4.2 Date

The wall construction was assembled on 15 June 2005.
The fire test was executed on 21 June 2005.

# 5 Date and number of the report

November 2005, 2005-CVB-R0408.

# 6 Test specimen

## 6.1 General

A non-load bearing Fermacell wall construction, type 1S21, was investigated. It was assembled from steel studs, filled with mineral wool and finished with fermacell gypsum fiber boards. The fixed edge, bottom and head rail were mounted on the concrete test frame.

## 6.2 Wall construction

### *6.2.1 Steel framework*

The framework was assembled from steel profiles and existed of:
- a Dingemans U-stud 75-06 (5)[1], as bottom and ceiling rail, dimensions 78 x 45 x 0,6 mm;
- a Dingemans C-stud 75-06 (4), as mullions, dimensions 75 x 50 x 0,6 mm. The c.t.c. distance of the mullions was 600 mm.

The U-studs and C-stud on the fixed edge were fixed with plugs and screws (Ø 4 x 50 mm) in the test frame. The c.t.c. distance was 800 mm. Between the test frame and the studs were strips of mineral wool with a thickness of 10 mm.

The U-studs and C-studs were held together by the gypsum fiber boards. The length of the C-stud mullions was 15 mm shorter than the height of the wall, in order to create expanding possibilities.

In order to simulate the width of the wall in practice, the right-hand side (seen from the cold side) was not attached to the supporting construction. In order to give the free-edge the possibility of deflecting there was a strip of Rockwool (thickness 50 mm) placed between the test-frame and the wall construction.

### *6.2.2 Filling and finishing*

Between the C-studs plates of mineral wool (Rockwool 204 (Dutch type number), dimensions 1200 x 600 x 70 mm) were clamped.

Fermacell gypsum fiber boards (dimensions 1200 x 2500 x 12,5 mm) were screwed onto the C-studs using fermacell gypsum screws Ø 3,9 x 30 mm. The c.t.c. distance was 250 mm.
On the free-edge a whole board was used, while on the fixed edge an edge panel was used. On the cold side a horizontal board (height 500 mm) was placed on the upper side, on the fire side the horizontal plate was placed on the lower side.

The vertical and horizontal joints were covered with a synthetic wire mesh and then filled with mortar.

[1] The numbers between the parentheses refer to the numbers in figure 3.

### 6.3 Test frame and supporting construction

*Test frame*
Material: steel. The lining of the test frame is made of heat resistant concrete. The inner dimensions of the test frame were: 3000 mm x 4000 mm (h x w).

For detailed information concerning the tested construction is referred to the material list and figures 1 - 3 and the photo's in appendix D.

# 7 Sampling and manufacturing of the construction

| | |
|---|---|
| Centre for Fire Research TNO | - Test frame |
| Xella Droogbouw Systemen | - Delivery of materials |
| | - Mounting and assembling of wall construction |

# 8 Test specimen inspection

### 8.1 General

The materials and components used were inspected during assembly on the basis of the supplied drawings and data.

### 8.2 Conditioning

During the period of assembly of the construction until the performance of the fire test, the wall was located in the test laboratory at the Centre for Fire Research with an ambient temperature of 20 ± 5 ºC and a relative humidity of 50 ± 10 %.

### 8.3 Determination of density and moisture content

The results of the density[2)] and the moisture content[3)] were:

| Material | Density [kg/m$^3$] | Moisture content [%] |
|---|---|---|
| Fermacell gypsum fiber board | 1140 | 0,6 |
| Mineral wool | 32,6 | 0,5 |

[2] Determined before drying.
[3] Determined by drying during 24 hours at 105 ºC, weighing before and after drying. The drying of the Fermacell gypsum fiber board took place at 60 ºC.

### 8.4 Fire test

#### *8.4.1 Conditions*

The fire test was carried out according to NEN-EN 1364-1:2001 in compliance with NEN 6069:2001.

The wall construction was heated at one side using the standard fire curve (see figure B.1 in appendix B).
The targeted overpressure in the furnace was 0 Pa at 0.5 m (20 Pa at 3.0 m) above floor level, see figure B.3.

#### *8.4.2 Measurements*

During the heating the following measurements were made:

Furnace conditions:
- The gas temperatures in the furnace using 8 plate thermocouples, evenly spread over the directly heated wall surface;
- The pressure in the furnace.

Specimen:
- The surface temperatures on the unexposed side of the wall using 5 thermocouples;
- The surface temperatures on the unexposed side of the wall next to the edges and joints using 16 thermocouples ;
- The heat radiation at a distance of 1.0 m from the geometric centre of the wall structure;
- The horizontal displacement of the wall, in the middle and on the free-edge, measured half way up the wall.

Environment:
- The air temperature in the laboratory outside the furnace.

The positions of the thermocouples on the wall are specified in appendix C.

## 9 Observations during the heating

After a heating time of 77 minutes a temperature rise of more then 180°C was measured, next to a vertical joint in the wall, *End of thermal insulation with regard to temperature*.

After a heating time of 96 minutes the cotton wool of the cotton pad ignited. The cotton pad was held in front of a joint, *End of integrity with regard to the sealing*.

For a detailed description concerning the observations, is referred to appendix A. The photos in appendix D show the wall before and during the test.

# 10 Measurements

## 10.1 Measurements

The measurements are presented in appendix B and C.

## 10.2 Uncertainty of measurement

Due to the nature of fire resistance testing, in which several non-linear effects are present in both the test configuration and the test specimen, which influence each other, it is at this moment not yet possible to give stated degree of uncertainty of measurement.

# 11 Summary

The fire resistance of a Fermacell wall construction, type 1S21, is determined. The construction is assembled from:
– steel studs with a filling of mineral wool and finished with gypsum fiber boards.

The fire test was carried out conform NEN-EN 1364-1:2001 in compliance with NEN 6069:2001. The results are summarized in Table 1.

**Table 1**: Summarized results

| Criterion | Time measured from the start of the test during which, conform NEN 6069:2001 and NEN-EN 1364-1:2001, the criterion was reached. | | |
|---|---|---|---|
| | **NEN 6069:2001** | **NEN-EN1364-1:2001** | Criterion reached or not reached |
| a) Integrity | | | |
| – Cotton wool pad | 96 minutes | 96 minutes | reached |
| – Opening gauges | >99 minutes | 99 minutes | not reached |
| – Sustained flaming (> 10 sec) | >99 minutes | 99 minutes | not reached |
| b) Thermal insulation | | | |
| – Average temperature increase | 94 minutes | 94 minutes | reached |
| – Maximum temperature increase | 77 minutes | 77 minutes | reached |
| – Radiation | >99 minutes | 99 minutes | not reached |

After consulting the contractor the heating was terminated after 99 minutes.

# 12 Conclusion

The classification in relation to NEN-EN 1364-1:2001 can be given in a separate document conform NEN-EN 13501-2:2004.

*Conclusion according to NEN 6069:2001*
Because the test, conform NEN-EN 1364-1:2001, is most likely more severe then a test conform NEN 6069:2001, the result is also applicable for the last mentioned.

**Fire resistance**, concerning the separation function, according to NEN 6069:2001 of the investigated wall construction: **77 minutes.**

# 13 Field of application and conditions

The conclusion formulated in chapter 12 is only valid for wall constructions, which are the same in detail to the investigated construction, including materials and means of assembly used. Also the following conditions have to be met:

a) The wall is isolated with mineral with a thickness of at least 70 mm, a density of at least 30 kg/m$^3$ and a melting point greater then 1000 °C.
b) Mounted in a supporting construction with a minimum density of 2000 kg/m$^3$ and a floor of non-combustible material.
c) the single span may be increased up to 4 m, only when the following is met:
   – expansion possibilities of the mullions are increased pro rata.
   – horizontal and vertical joints cross at a T-junction.
d) the width of the wall construction has no limitations.

# 14 Extended application

In extend to the field of application formulated in chapter 13 the following changes in the construction will, in the opinion of TNO, give a fire resistance of at least **60 minutes**.

## 14.1 Type of joints

The test was carried out using the Fermacell Tapered Edge joint (3)[4]. Based on test report “P-3854/1372-MPA BS”, d.d. 2 May 2003 from “Materialprüfstalt für das Bauwesen” in Braunschweig, Germany, the following joints, to finish the joint between the vertical and horizontal gypsum fiber boards, are also applicable:

- Fermacell joint filler 5-7 mm joint (2);
- Fermacell butt joint (4);
- Fermacell jointstick, glue filled joint <1 mm (1).

The different types of joints are represented in Figure 4.

[4] The numbers between the parentheses refer to the numbers in figure 4.

## 14.2 Mullions

The construction was tested with a c.t.c. distance of the mullions of 600 mm. Taking the surplus value of 17 minutes into account this c.t.c. distance may be increased to 625 mm.

## 14.3 Wall construction 1S24

Fermacell also delivers a wall construction similar to the one described in this report. This wall construction consists of double mullions as shown in figure 5 and 6. The fire resistance of this wall construction will be at least 60 minutes on condition that the mineral wool between mullions is one of the following combinations:

- 0 mm on one side and 70 mm (density 30 kg/m$^3$) on the other side or,
- 60 mm (density 30 kg/m$^3$) on both sides.

Ing. M.N. Slappendel

Dr.Ir. G. van den Berg

# Figures

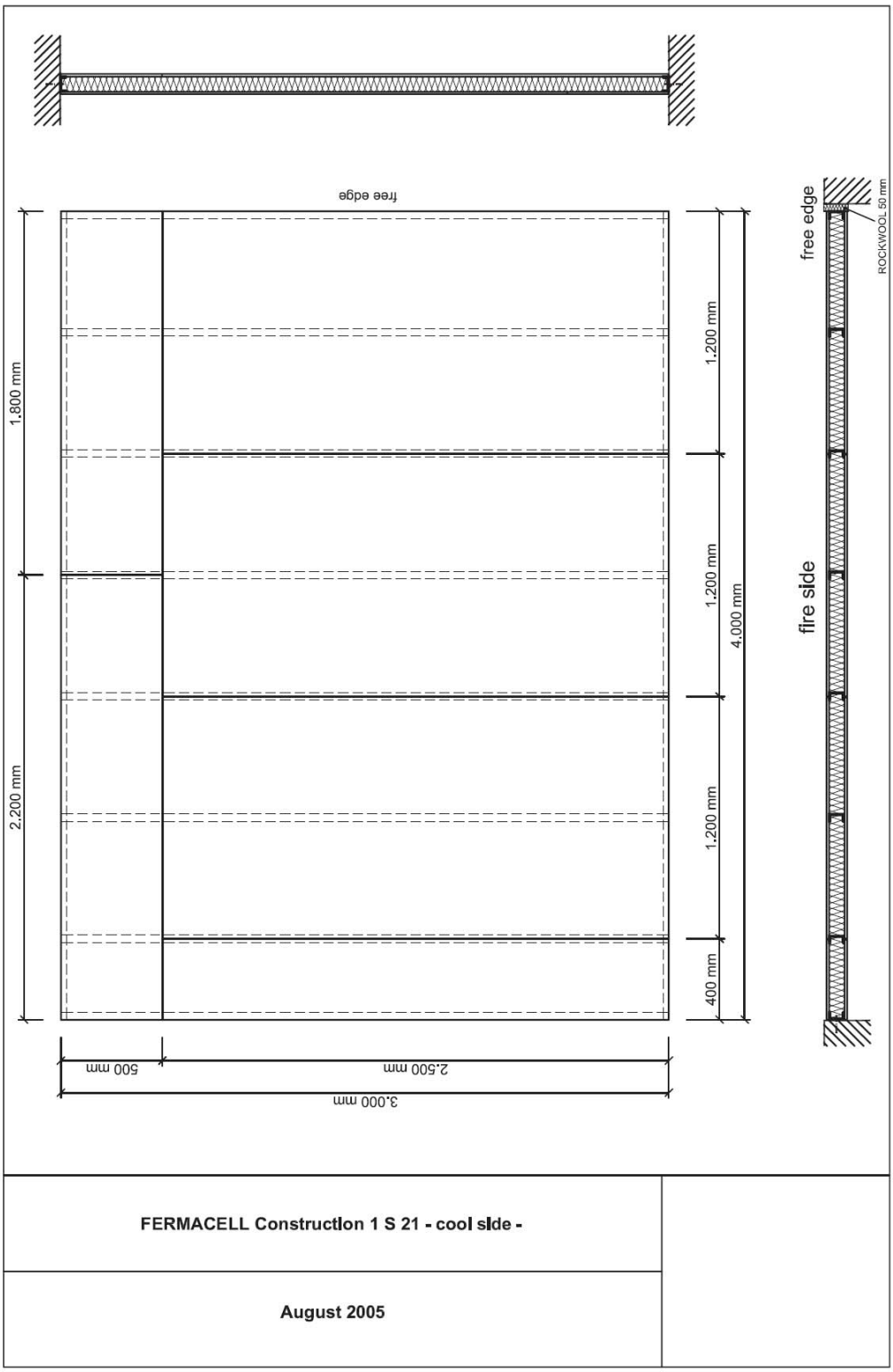


Figure 1: Overview test specimen, seen from cold side.

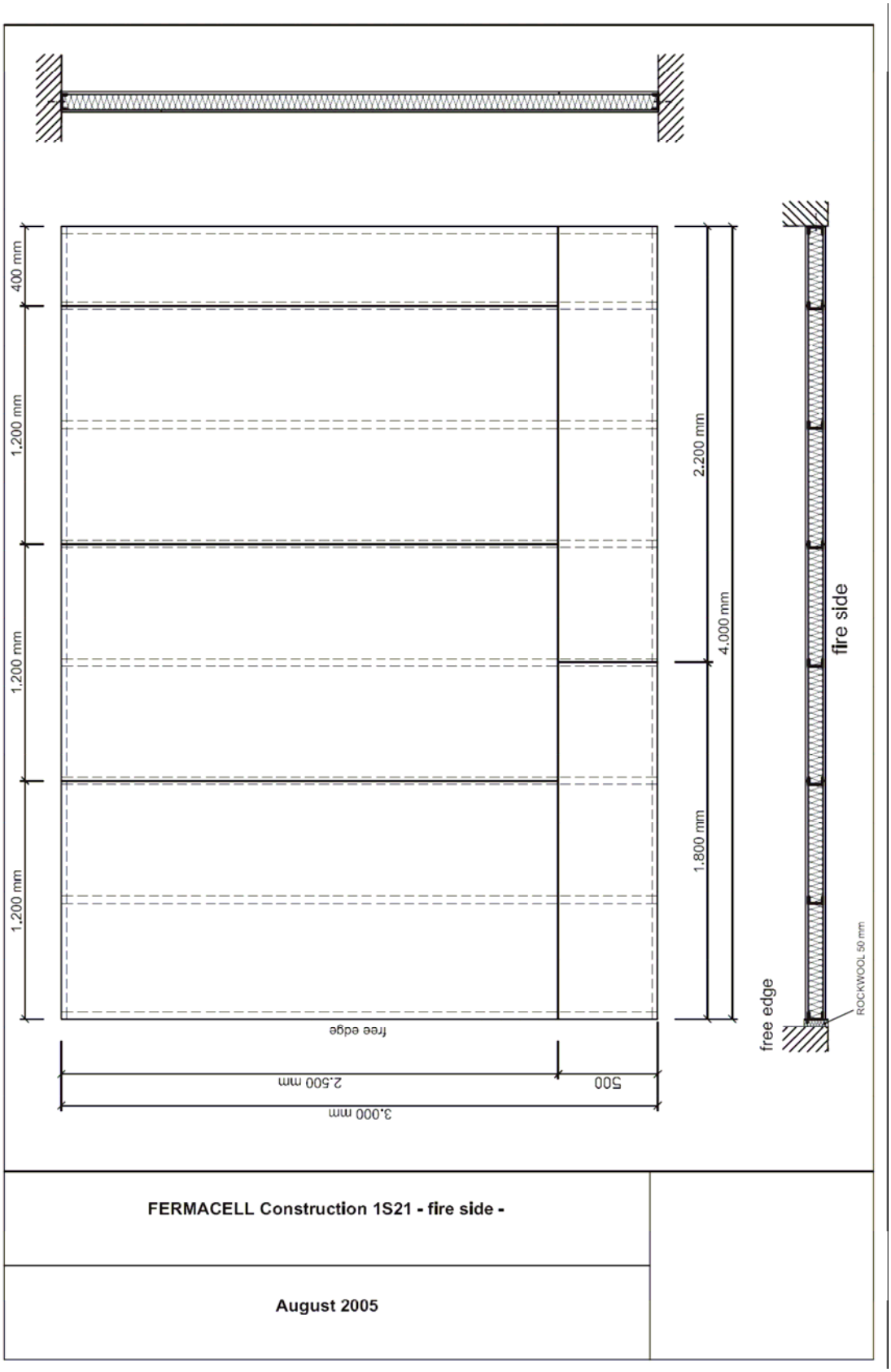


Figure 2: Overview test specimen, seen from fire side.

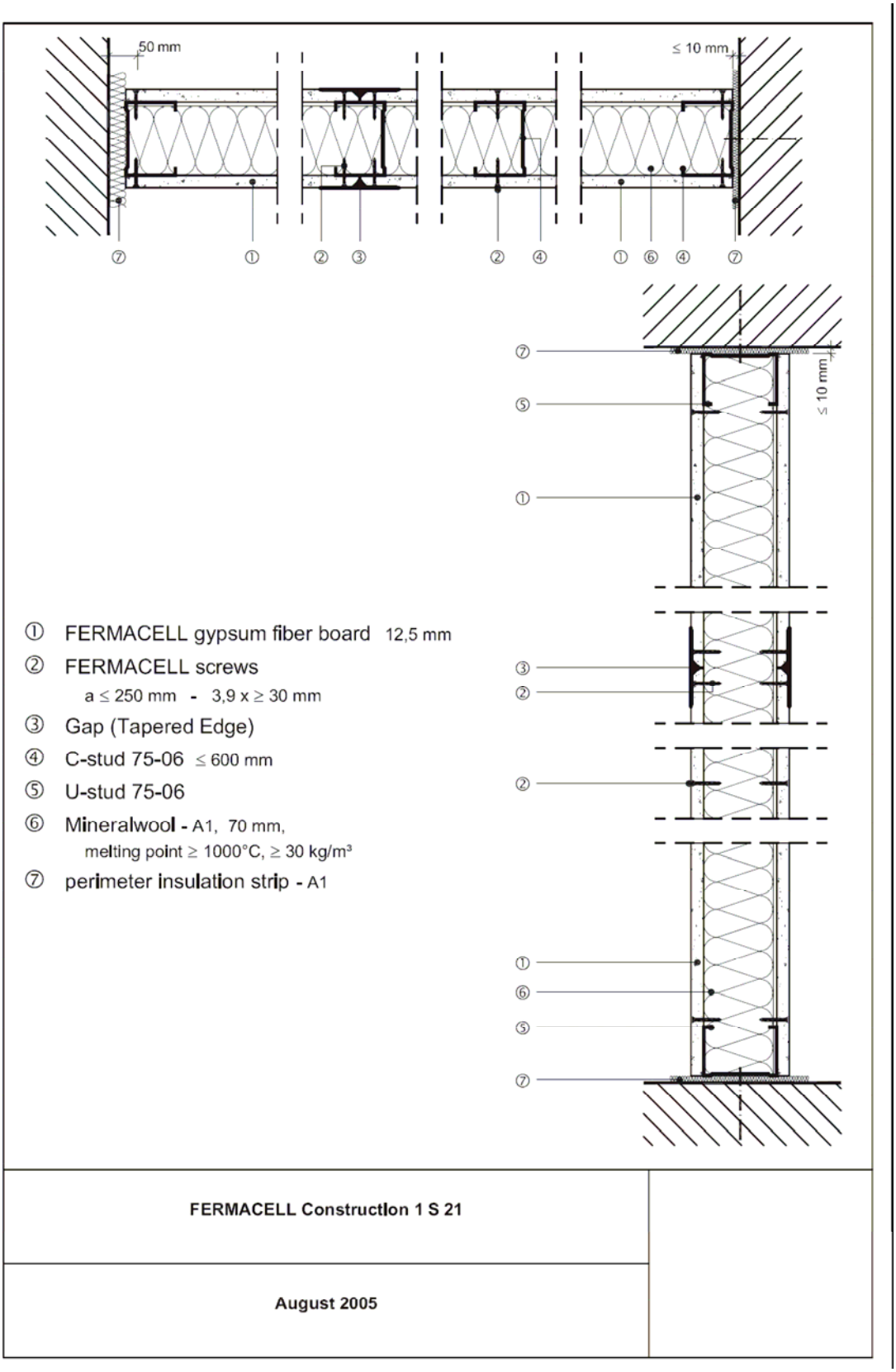


Figure 3: Cross-section overview of test-specimen

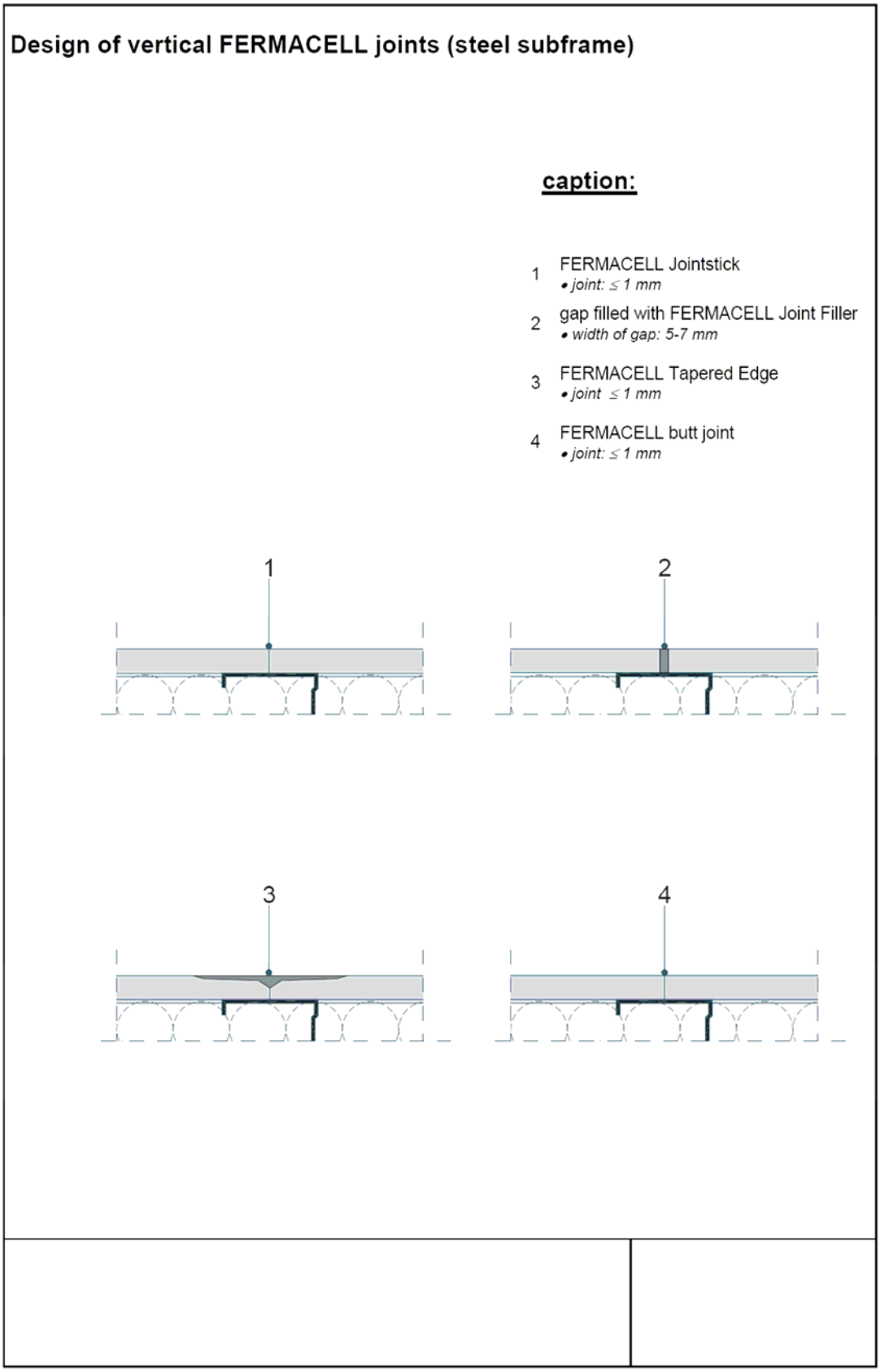


Figure 4: Overview of the different types of joints.

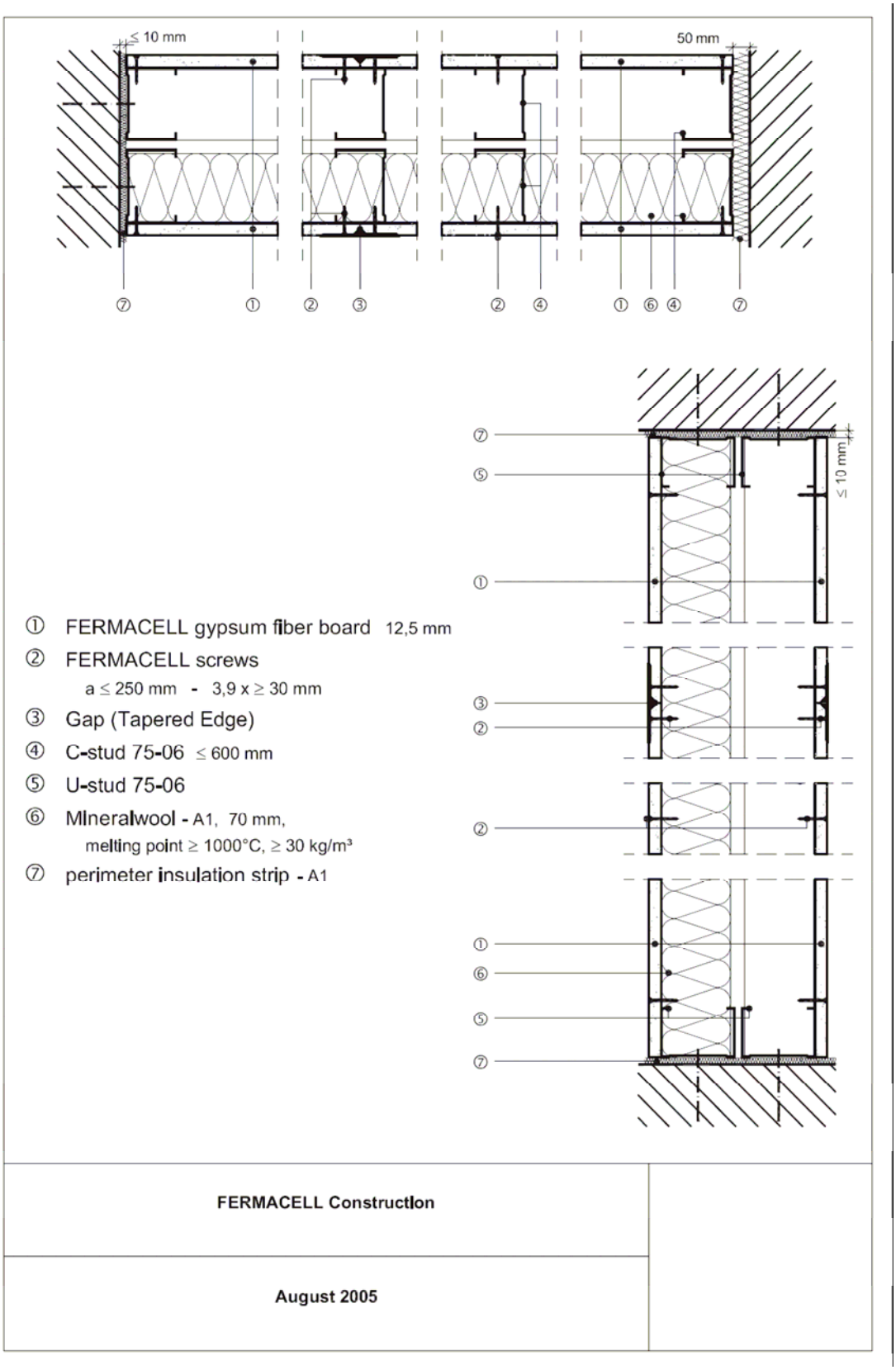


Figure 5: Cross-section overview of the 1S24 wall construction with 1 layer of mineral wool.

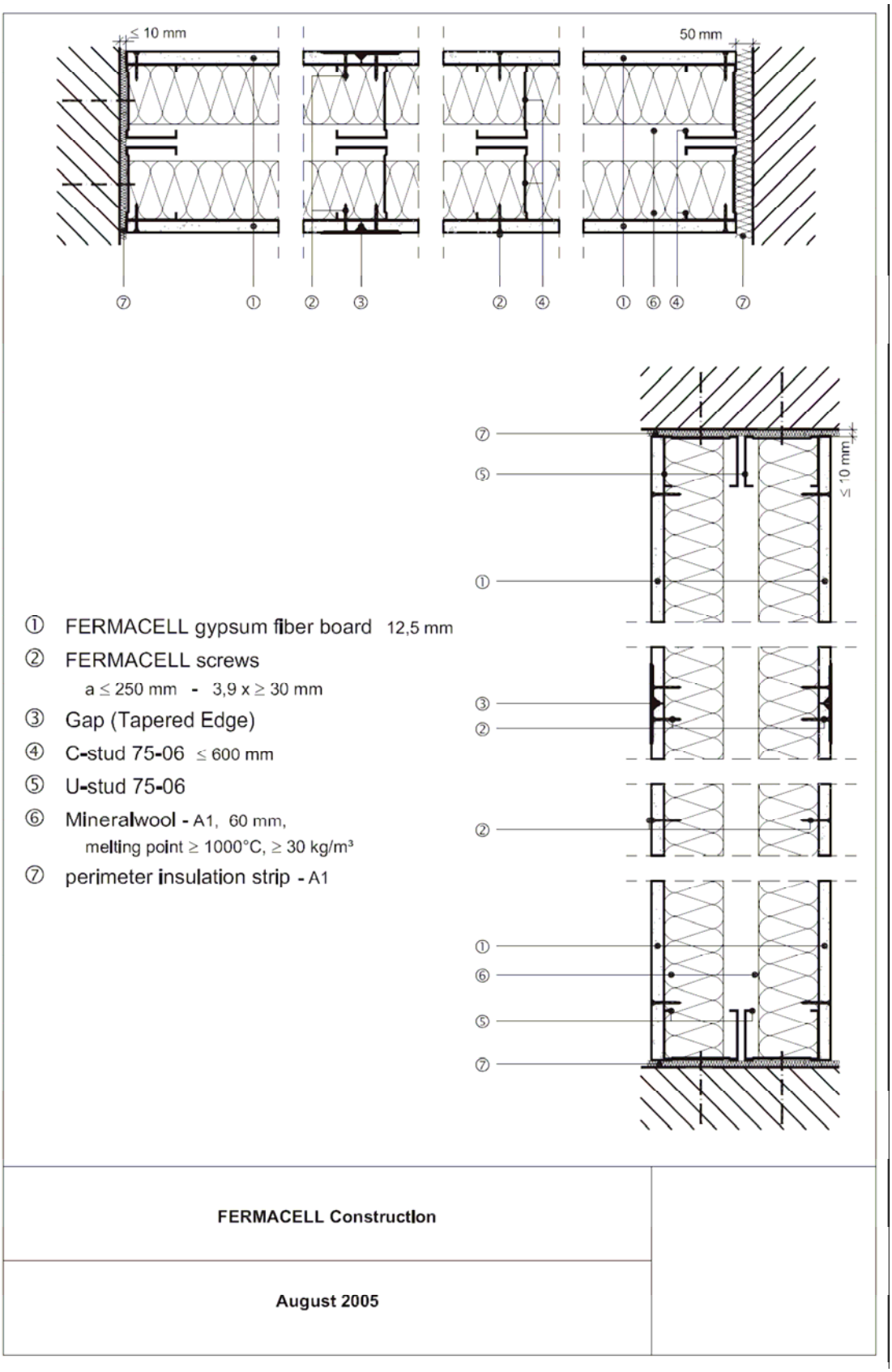


Figure 6: Cross-section overview of the 1S24 wall construction with 2 layers of mineral wool.