



# REPORT

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Brandkonsulten AB  
Gävlegatan 12 B  
113 30 STOCKHOLM

Handläggare, enhet / *Handled by, department*  
Pär Johansson, Fire Technology  
Tel +46 (0)33 16 50 00

Datum / <i>Date</i>	Beteckning / <i>Reference</i>	Sida / <i>Page</i>
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## Fire test of loadbearing columns

### Test method

SIS 02 48 20, edition 2, dated 1977-07-01 (ISO 834-1975)

### Product

Columns

### Product designations

Givent system

### Sponsor

Brandkonsulten AB

SP, Sveriges Provnings- och Forskningsinstitut, Box 857, 501 15 BORÅS, Tel 033-16 50 00, Telefax 033-13 55 02, E-mail info@sp.se, Org.nr 556464-6874  
SP, Swedish National Testing and Research Institute, Box 857, S-501 15 BORÅS, SWEDEN, Telephone + 46 33 16 50 00, Telefax + 46 33 13 55 02, E-mail info@sp.se, Reg.No 556464-6874

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## **1 Purpose of the test**

The purpose of the test was to determine the fire resistance of the test specimens described under item no. 2.

## **2 Test specimens**

The test specimens were selected by the sponsor and were manufactured at SP May 16, 2000. Manufacturer of the test specimen was Givent support AB.

### **2.1 Description of the constructions**

Two columns with an outer dimension of (width x thickness x height) 200 x 200 x 2950 mm. The columns are designated column type 1 and 2 in the report.

Column type 1: The column was constructed by a shell of steel plates with thickness 0,7 mm. Inside the shell of steel plates was four reinforcement bars with diameter 16 mm mounted. The column was filled up with concrete. The recipe of the concrete can be seen in enclosure 1.

Column type 2: The column was constructed of three steel plates with thickness 0,7 mm. Two of the steel plates was used to a shell. The third steel plate was perforated with holes with diameter approx 100 mm and was mounted through the middle of the column and replaced the reinforcement bars. The composition of the concrete can be seen in enclosure 1.

Both columns was insulated at two directions with 100 mm mineral wool designated Gullfiber 3663-050S with density approx. 100 kg/m<sup>3</sup>.

The construction can be seen from the sponsor's drawings in enclosures 1 - 2. In case that the sponsor's drawings fail to correspond with the construction SP has crossed details or altered the drawings.

### **2.2 Supporting construction**

Around the columns was a supporting wall with dimension (width x thickness x height) 2950 x 226 x 2750 mm mounted. The wall was built of 200 mm thick girders and a 13 mm thick gypsum plaster board at each side. The wall was not attached to the columns.

The construction of the wall can be seen in enclosure 3.

### 2.3 Mounting of the test specimen

A steel plate was attached in the bottom of each column. Each column was attached to a 200 mm thick concrete block in the bottom of the furnace with two expansion-shell bolts designated Essve TB-Anchor FZB M10 x 80 mm.

The top of the columns was placed in two holes in the roof of the furnace and was not attached in any way. The hole dimensions was (width x depth) 270 x 230 mm. Mineral wool was used to sealed between the top of the columns and the roof of the furnace. The fire exposed length of the columns was 2750 mm.

The placing of the columns in the furnace can be seen in enclosures 3-4.

### 2.4 Conditioning

The test specimen was stored in SP's furnace hall before the test. The temperature in the furnace hall was in average 21 °C and the relative humidity was in average 55 % during this time.

### 2.5 Control

#### 2.5.1 Properties of included materials

<i>Test specimen</i>	<i>Thickness (mm)</i>	<i>Density (kg/m<sup>3</sup>)</i>	<i>Moisture ratio <sup>1)</sup> (%)</i>	<i>Moisture ratio <sup>2)</sup> (%)</i>	<i>Loss due to burning <sup>3)</sup> (%)</i>
Concrete	-	-	-	4,5	-
Mineral wool	50	110	-	0,60	1,7
Gypsum board	12	770	0,32	-	-

1) Moisture ratio calculated from weight loss after being heated at 40 °C.

2) Moisture ratio calculated from weight loss after being heated at 105 °C.

3) Loss due to burning calculated from weight loss after heated at 550 °C.

The verification was performed on June 15, 2000 on samples taken from the test specimen.

The purpose of the control is to verify and/or determine material data and dimensions of materials and components included in the test specimen. The extent of performed measurements and applied methodology can deviate from standardized method. The results shall therefore not be considered as formal material data.

**2.5.2      Concrete strength**

<i>Cube</i>	<i>Length [l] (mm)</i>	<i>Width [b] (mm)</i>	<i>Height [h] (mm)</i>	<i>Density (kg/m<sup>3</sup>)</i>	<i>Compression strength (N/mm<sup>2</sup>)</i>
1	149,9	149,9	150,6	2762	126,0
2	149,6	149,6	150,0	2755	122,8
3	148,9	148,9	150,8	2783	129,4

The verification was performed on June 5, 2000 (Cube 1) and on June 9, 2000 (Cube 2 and 3). The cubes was founded of concrete from the same concrete mixture as the columns on May 16, 2000.

**3            Test procedure and test results**

The test was performed on June 9, 2000. The test lasted 122,5 minutes

**3.1         Witness of test**

The test was witnessed by Christian Ståleker and Fredrik Finnman from Brandkonsulten AB and Anders Olson from Bloco AB.

**3.2         Furnace control**

The furnace was controlled in accordance with SIS 02 48 20, edition 2, dated 1977-07-01 (ISO 834-1975)

**3.2.1       Temperatures**

The furnace temperature rise was measured with 12 thermocouples (T1 – T12). The junction of the thermocouples were positioned approximately 100 mm from the fire exposed surface of the test specimens at the commencement of the test. The placing of the thermocouples can be seen in enclosure 6.

The average temperature rise in the furnace (of T1 – T12) in relation to the standard time-temperature curve is shown in enclosure 7.

The temperature rise at each thermocouple (T1 – T12) in relation to the standard time-temperature curve is shown in enclosure 8.

The percent deviation of the area under the average furnace time-temperature curve from the area under the standard time-temperature curve and permitted deviation, is shown in a graph in enclosure 9.

During the beginning of the test did some of the temperatures deviate from the standard. The deviations were small an for short periods. SPs assessment is that the deviation has not influenced on the test result.

### **3.2.2 Pressure**

The pressure in the furnace was controlled so that an overpressure of approximately 10 Pa was kept at the upper three-quarters height of the columns.

The furnace pressure is shown in enclosure 10.

## **3.3 Measurements on the test specimen**

### **3.3.1 Temperatures**

The temperature rise inside the columns was measured with 50 thermocouples. The thermocouples were positioned as shown in enclosures 11-14.

The temperature rises are shown in graphs in enclosures 15-22.

The average temperature of thermocouples inside the columns at beginning of the test was 20,3 °C.

### **3.3.2 Loading**

The columns were loaded with a vertical and central load. The load was applied onto the test specimens through a load-distributing plate made of steel.

A load of 120 kN was applied at each of the test specimens 30 minutes prior to the test, and was kept constant during the test.

The load during the test was decided by SP and was limited to 120 kN because of the test equipment.

### **3.3.3 Deformations**

The deformation of the columns during the test was measured by a potentiometer. The measurements were performed at the top of each column.

The measuring results are shown in enclosure 23.

### 3.4 Observations

Photographs taken in connection with the test are shown in enclosures 24-25.

#### 3.4.1 Observations during the test

<i>Time min:s</i>	<i>Observations (the observations refer to the exposed/unexposed side if nothing else is stated)</i>
-43:45	The loading of the columns begins.
-37:00	Full load at the columns.
00:00	Fire test starts.
04:20	The wall around the columns starts to get discoloured.
16:50	The plasterboard in the middle of the connected wall starts to fall down at the eastern side.
17:50	The plasterboard in the middle of the connected wall starts to fall down at the western side.
23:00	The plasterboard nearest column type 2 falls down.
23:40	The plasterboard nearest column type 1 falls down.
25:10	The steel plate around the columns start to get embossed.
31:50	The steel plate and the flange at the northern side of column type 1 has split open in the middle. The concrete is fire exposed.
92:40	Small flames occurs from the columns.
105:40	The fire exposed concrete at column type 1 has spalled in a thin layer.
122:30	The columns unloads.
122:30	Test terminates.

#### 3.4.2 Observations after the test

The gypsumboard on the wall has fallen down and the girders has disorted because of the heat. The mineral wool insulation was still on place and looks undamaged.

Column type 1: The steel plate and the flange at the northern side has split open in the middle. The opening is around 70 mm wide and around 500 mm long. The concrete has spalled in a thin layer in certain spots at the northern and eastern side. Most of the spalling was located in connection to the opening in the steel plate.

Column type 2: The steel plate was embossed. No damage can be seen at the concrete.

## 4 Summary

Two columns, described under paragraph No 2, has been fire tested according to SIS 02 48 20, edition 2, dated 1977-07-01 (ISO 834-1975) during 122,5 minutes. The following results were obtained:

### *Load-bearing capacity*

Both columns kept the load-bearing capacity during the whole test.

### *Temperatures in columns*

The temperature in the columns are described in enclosure 15-22.

The test results relate only to the behaviour of the test specimens during the conditions of the test. At other conditions, for instance another fire curve, the behaviour of the construction may differ from the presented test results.

**SP Swedish National Testing and Research Institute  
Fire Technology, Fire Resistance**



Lars Boström  
Head of Section



Pär Johansson  
Technical Officer

### **Enclosures**

1 – 25 (one page per enclosure)

ENCLOSURE 25

Report no:  
P005566

Picture no: 4  
*After the test*

The columns and the wall  
after the test.



Picture no: 5  
*After the test*

The columns without the  
outer steel profiles.



Picture no: 6  
*After the test*

Spalling at column type 1.







ENCLOSURE 24

Report no:  
P005566

Picture no: 1  
*Before test*

Column type 2 from above  
before the concrete was  
filled with concrete.



Picture no: 2  
*Before test*

The columns mounted in the  
furnace.



Picture no: 3  
*Before test*

The gypsum plasterboard  
wall around the columns.