EXTERNAL WALL ASSEMBLIES AND FACADE CLADDINGS
REACTION TO FIRE

1 SCOPE

This SP method specifies a procedure to determine the reaction to fire of materials and construction of external wall assemblies or facade claddings, when exposed to fire from a simulated apartment fire with flames emerging out through a window opening. The behaviour of the construction and material and the fire spread (flame spread) in the wall/cladding can be studied.

2 FIELD OF APPLICATION

The test method described is applicable to:

- external wall assemblies

- and facade claddings added to an existing external wall.

The test method is only applicable to vertical constructions.

The metod is not applicable for determination of the structural strength of an external wall assembly or facade cladding construction when exposed to fire.

3 REFERENCES

ISO 3261, Fire Tests - Vocabulary

ISO 834, Fire resistance tests - Elements of building construction.

"Facades: Fire testing of materials and constructions, - a first proposal for a test method", Swedish National Testing and Research Institute, Fire Technology, SP AR 1992:64, 1992, (NORDTEST project 969-91).

4 DEFINITIONS

4.1 External wall assemblies

External wall assemblies refer to the whole external wall, e.g. the industrial type of wall consisting of internal and external skins of corrugated steel sheet with insulation in between, a twin skin masonry wall, or a composite masonry and timber construction type.

4.2 Facade claddings

Facade claddings refer to materials and constructions added to an inner facade structure. The inner structure can be of concrete, lightweight concrete, masonry, timber e t c. The cladding may consist of an insulating board with a layer of mortar or corrugated steel sheet as the outer skin.

4.3 Test rig

The test apparatus on which the external wall assembly or facade cladding is mounted on.

4.4 Fire room

The room at the bottom of the test rig with a window opening through the facade in which the fire source is located.

4.5 Light-weight concrete

Concrete with a density of not more than 600 kg/m^3.

4.6 Test specimen

The external wall assembly or facade cladding consisting of the construction and the material in the facade, not including the light-weight concrete wall of the test rig in case of facade claddings.

5 SAMPLING

The test specimen, the external wall assembly or facade cladding, shall in construction and materials be representative of that used in practice.

One sample of the test specimen needs to be prepared for the fire test.

6 METHOD OF TEST

6.1 Principle

This test procedure enables the determination of the reaction to fire of an external wall assembly or a facade wall cladding, when exposed to a simulated apartment fire with flames emerging out through a window. The flame spread can be studied directly on the outside and indirectly on the inside of the external wall assembly or facade cladding.

6.2 Apparatus

6.2.1 Main Apparatus

The fire test shall be performed on a test rig consisting of:

- a vertical (steel) frame which allows an external wall of size (width x height) 4000 mm x 6000 mm to be erected on it , see figure 6.2.1
- a fire room, see figure 6.2.2
- an arrangement at the top of the test rig representing an eave. The eave shall be adjustable so that it always sticks out 500 mm horizontally from surface of the test specimen. see figure 6.2.1 and 6.2.4.

In case the test specimen is:

- an external wall assembly: - the test specimen shall be directly mounted onto the frame (steel) of the test rig.

- a facade cladding: - a facade wall of lightweight concrete, described below, shall be mounted on the test rig as a surface to apply the test specimen onto. This is to represent an external wall on which the cladding shall be mounted.

The facade wall of light weight concrete shall have the following design:

- size (width x height x thickness) ~ 4000 mm x 6000 mm x 150 mm
- one window opening into the fire room, size (width x height) 3000 mm x 710 mm
- two fictitious windows above the fire room, one into each of the above storeys, size 1510 mm x 1200 mm. These windows shall have a window flanning measuring 50 mm.

See figure 6.2.1 - 3.

6.2.2 Fire room

The fire room, and the fire source (section 6.2.3), can be arranged as shown in figure 6.2.2. Other arrangements are permitted provided that the flame and the heat flux meet the requirements stated in section 6.2.6.

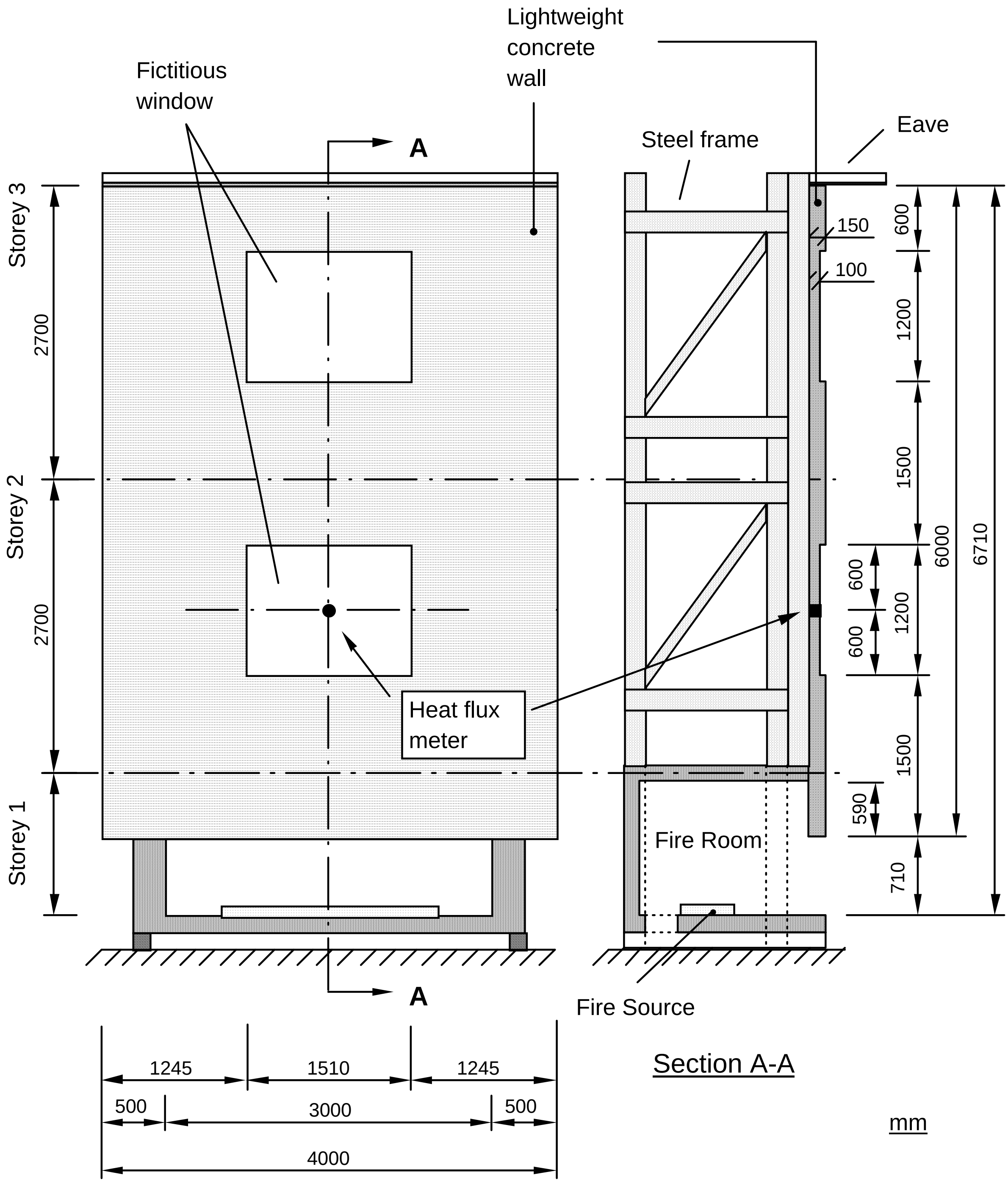
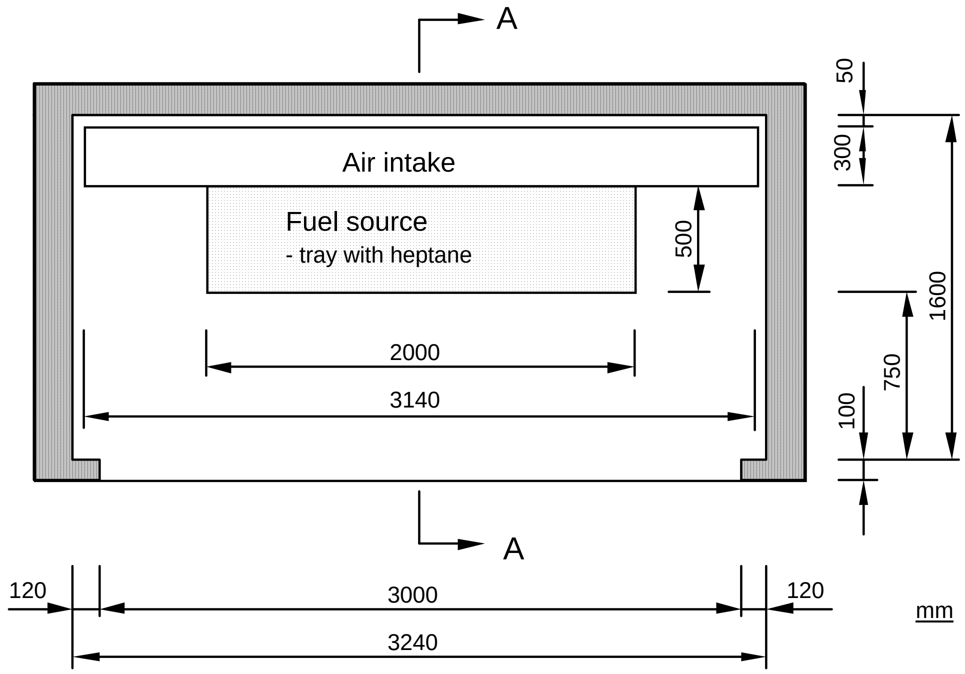
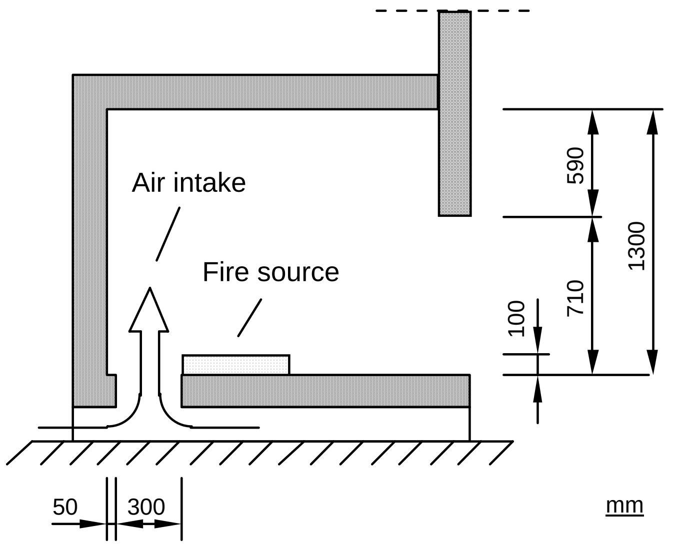


Figure 6.2.1 Test rig.

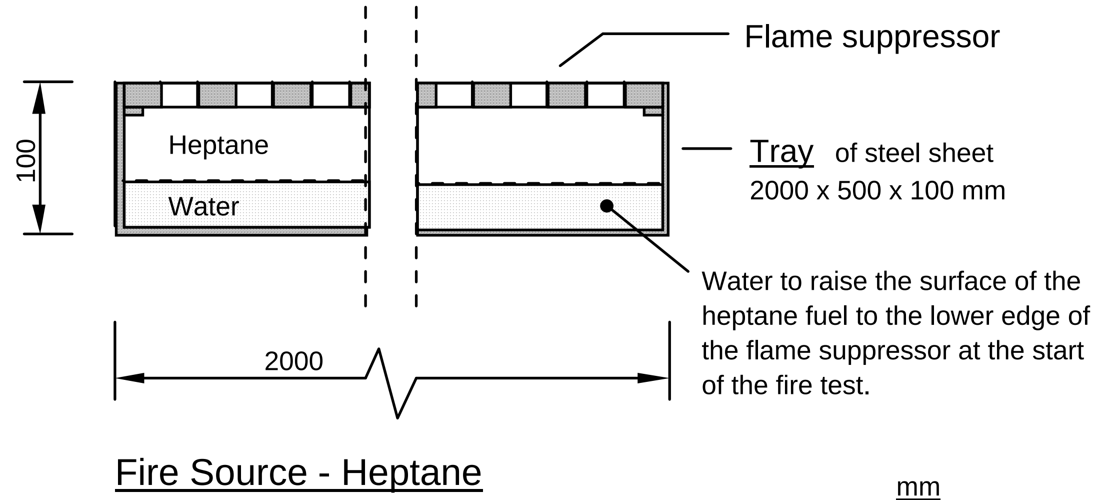


Planview of fire room



Section A-A

Figure 6.2.2 Test rig, - fire room.



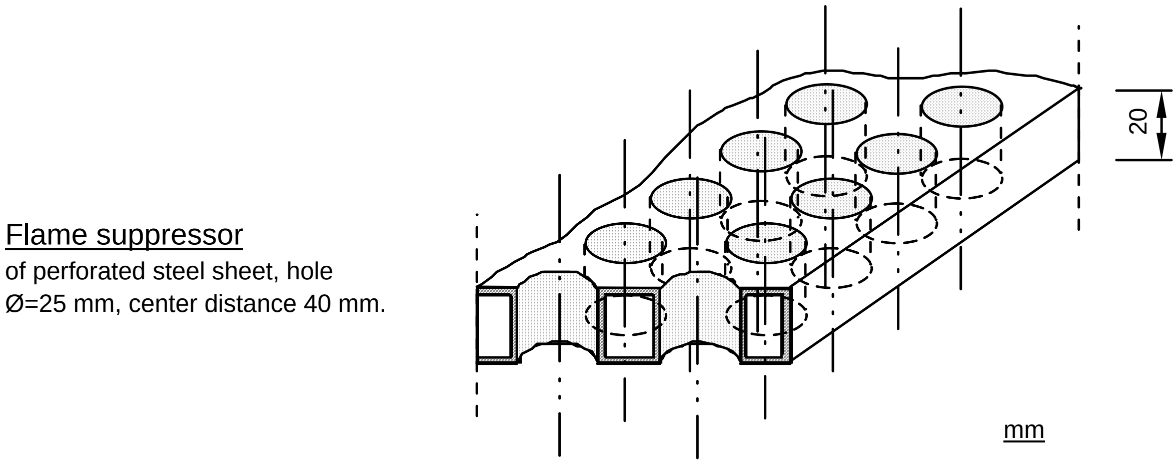


Figure 6.2.3 Fire source.

6.2.3 Fire source

A tray, size (width x length x height) 500 mm x 2000 mm x 100 mm, filled with 60 litre heptane fuel shall be used as fire source. A flame suppressing lattice shall be put on top of the tray edges. See figure 6.2.3.

This will correspond to a fire load of approximately 75 MJ/m^2 total fire room surface.

6.2.4 Heat flux

The total heat flux shall be measured with a flux meter with a detecting surface ø ˜ 10 mm and with a time constant $\tau_{63\,\%}$ less than 1 s. The heat flux meter shall have a measuring range of 0 - 120 kW/m^2. Normally the heat flux only needs to be measured in the centre of the fictitious window on the second storey, the storey above the fire room.

6.2.5 Thermocouples

The temperature in the fumes shall be measured with two thermocouples positioned at the eave of the facade, see fig. 6.2.4.

Additional thermocouples may be positioned elsewhere on or inside the test specimen wherever the testing laboratory finds it suitable and of interest.

Temperatures in fumes and on the structure shall be measured with thermocouples with thickness ø = 0,25 mm, which are welded or twisted together.

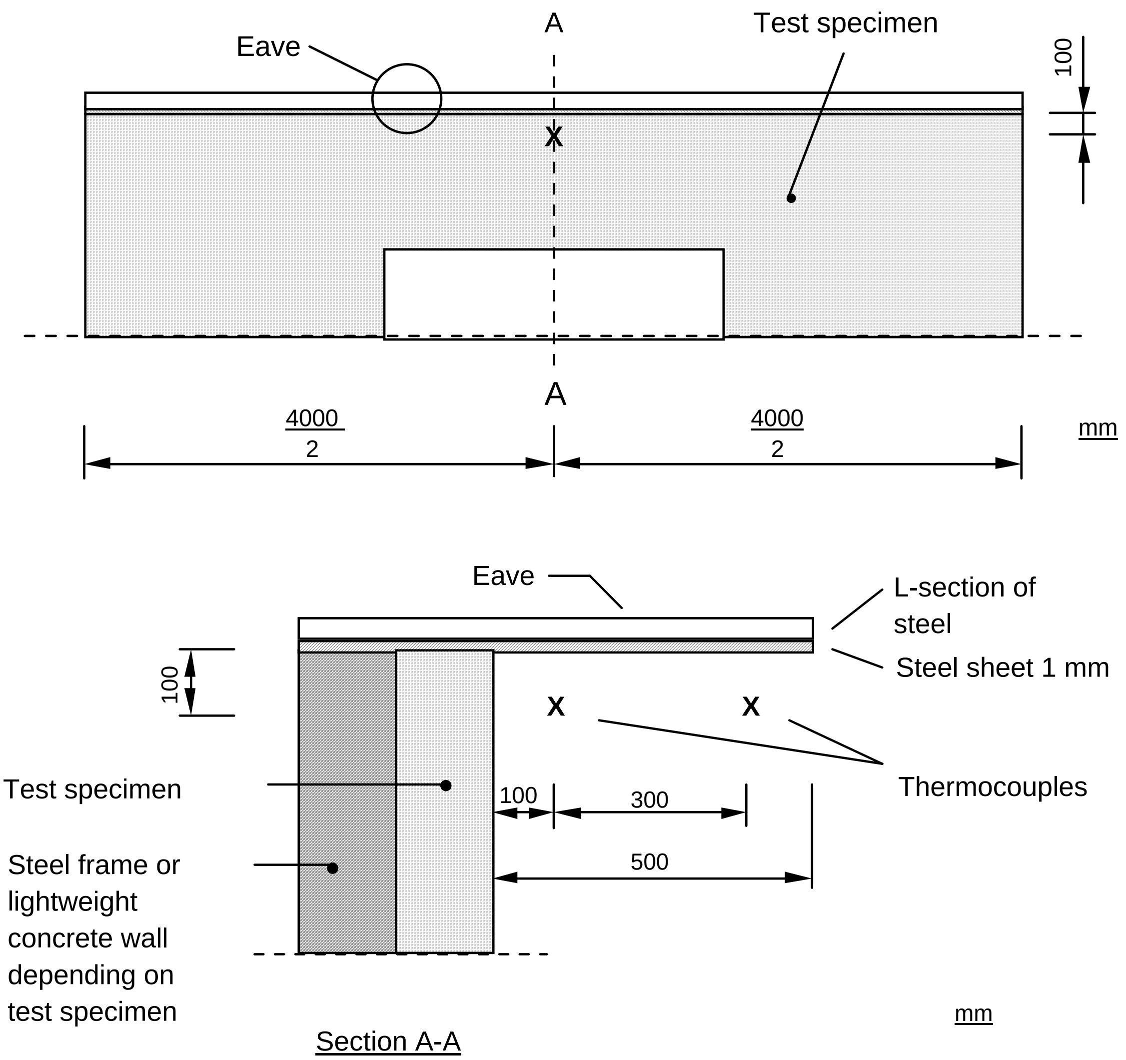


Figure 6.2.4 Position of thermocouples at the eave.

6.2.6 Calibration of test apparatus

The test apparatus shall be calibrated by performing a so-called ”zero test”. Such a test is performed by covering the lower 2 m of the surface of test rig, the lightweight concrete wall, with a 20 mm thick layer of non combustible material such as e.g. mineral wool insulation. During this test the external flame outside the fire room shall have a duration of 10 min. The measured heat flux, at the centre of the fictitious window on the second storey (storey above the fire room), during this time shall be:

= 15 kW/m^2 during at least 7 minutes of the time
= 35 kW/m^2 during at least 1,5 minutes of the time

and never exceed 75 kW/m^2.

A calibration test shall be performed once every year.

6.3 Preparation of Test Samples

6.3.1 Construction

The test shall be performed on a test specimen which in case of:

- an external wall assembly shall be mounted with a construction as intended in practice, directly onto the (steel) frame of the test rig, see figure 6.3.1 next page. (The lightweight concrete wall is not mounted on the test rig in this case.)

- a facade wall cladding shall be mounted on the lightweight concrete wall of the test rig, see figure 6.3.1 next page.

The size and shape of the external wall assembly or facade wall cladding shall correspond to the lightweight concrete wall of the test rig, i.e. size (width x height) 4000 mm x 6000 mm and two window openings, see section 6.2.1 and figure 6.2.1.

The eave shall protrude 500 mm horizontally measured from the surface of the test specimen.

The test specimen shall in construction and materials be representative of that used in practice. The material shall be applicated on the test rig in a way corresponding as closely as possible to that used in practice. Arrangements at window openings shall be as detailed as in practice. Other construction details such as fire stops shall be detailed and positioned in the test specimen as in practice.

The material and standard of workmanship of the test specimen shall be representative of those applying in good practice, as defined by existing national codes and standards.

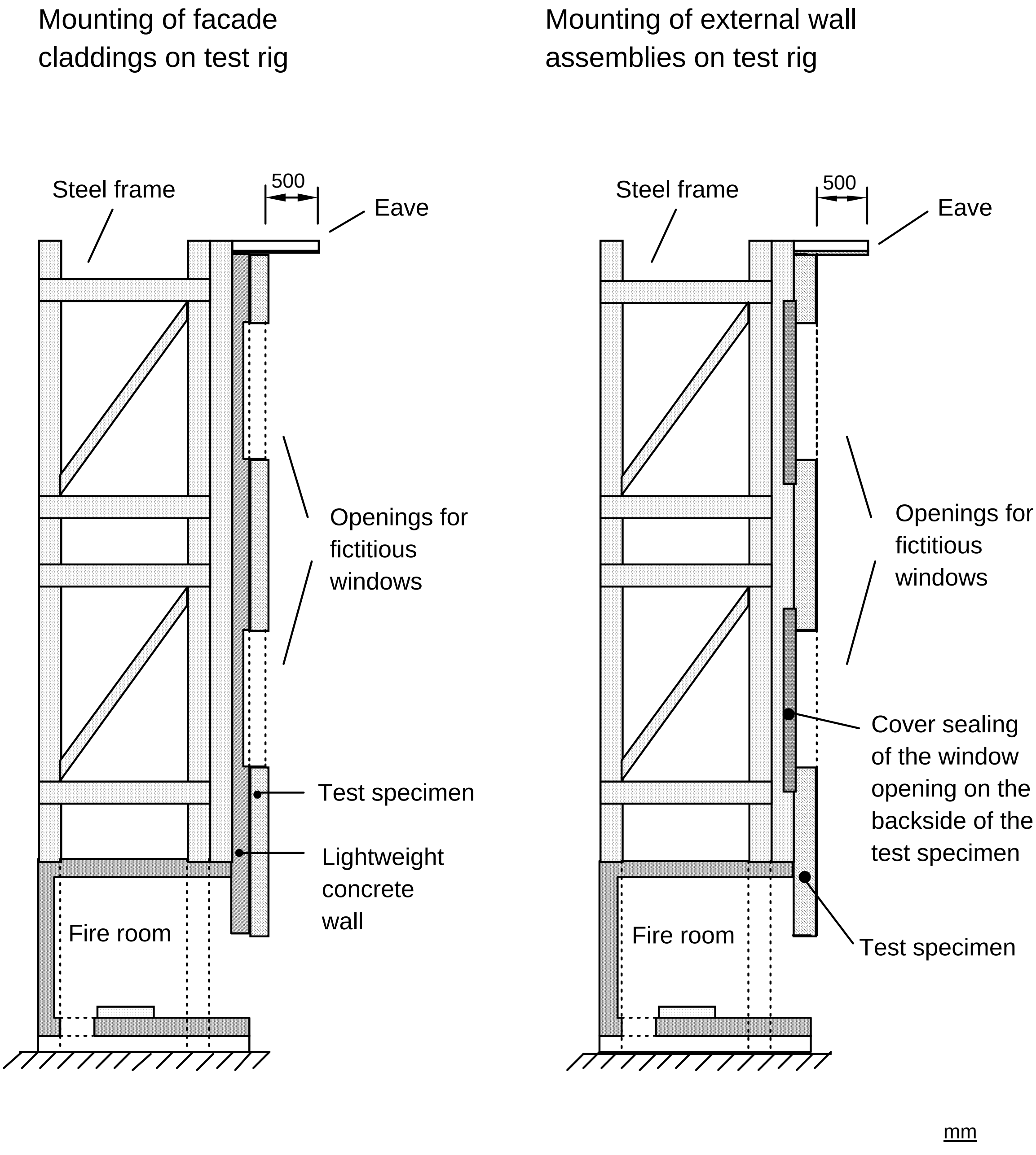


Figure 6.3.1 Mounting of test specimen on test rig.

6.3.2 Conditioning

The test specimen shall be conditioned in such a way that it corresponds as closely as possible, in temperature, moisture content and mechanical strength, to the expected state of similar constructions in service.

Fire testing of materials which will dry, hardened or the like, are to be performed after necessary conditioning.

6.3.3 Properties of the test specimen

The age of hardening materials on the fire test date, such as mortar, shall be stated in the test report.

When possible, the moisture content of the insulating material shall be measured at the time of the test, and the value shall be stated in the report.

6.4 Procedure

6.4.1 Duration of test

The test is started by ignition of the fire source and is terminated when the fuel has burnt out, approximately 15 minutes later. No artificial extinction is permitted.

6.4.2 Heat flux measurement

Heat flux shall be measured at intervals not exceeding 10 s during the test.

6.4.3 Temperature measurements

Temperatures shall be measured at intervals not exceeding 30 s during the test.

6.4.4 Observations during the test

During the test the following observations shall be recorded:

- the spread of the flame at different times
- the length of the head-flame at different times
- the time of drop- off of materials
- the time when cracks or other damages occur
- the time of deflections
- smoke intensity and colour
- if possible, fire spread through air cavities in test specimen.

6.4.5 Observations after the test

After the test is terminated the test specimen shall be thoroughly examined. Among other things the following shall be recorded:

- the extension of the fire spread on the surface and inside the test specimen based on observations of melting, charring or else

- the extension of concealed fire spread inside the test specimen, i.e. behind undamaged surface layers, based on observations of melting, charring or else
- fire damages at window arrangements
- fire damage on participating materials and constructional parts
- the function of fire stops if included in the test specimen.

6.5 Expression of Results

In the test report the heat flux shall be presented in the following way: The testing time shall be divided into parts, each of Δt=30 s length. For each one of these intervals, the mean value of all heat flux measurements during the interval shall be calculated. The mean heat flux values shall then be presented as a function of time in a graph.

7 TEST REPORT

The test report shall include the following information:

a) Name and address of the testing laboratory
b) Date and identification number of the test report
c) Name and address of client
d) Purpose of the test
e) Method of sampling
f) Name and address of manufacturer or supplier of the product
g) Name or other identification marks of the product
h) Description of the tested product:
   - drawings
   - descriptions
   - assembly instructions
   - specification of included materials.
i) Date of supply of the product
j) Date of test
k) Test method
l) Conditioning of the test specimen, environmental data during the test (temperature, relative humidity, e t c)
m) Identification of the test equipment and used instruments
n) Deviations from the test method, if any
o) Test results:
   - heat flux as a function of time in a graph
   - description or name of equipment used for heat flux measuring

- temperatures at the eave as a function of time in a graph
- maximum heat flux, and maximum temperatures at the eave
- temperatures as a function of time in a graph in an event of additional thermocouples
- graphical presentation of the fire damage
- observations during and after the test
- moisture content in the insulation material at the time of the test.

p) Date and signature.

The rest of this document (the Appendix) is not included in SP FIRE 105. It is the part of the test method that was included in NORDTEST project 969-91 reprtet in SP AR 1992:64.

APPENDIX

PERFORMANCE CRITERIA

The performance criterias are divided into two cases.

1. Up to 8 storey high buildings that also can be reached for fire fighting, with the exception of hospitals:

   a) Fire spread (flame and damage) may not reach further up than to the lower part of the window in the second storey above the fire room.
   b) There may not be any large pieces falling down from the facade.

c) There may not be any fire spread to the eave, which means that the temperatures measured at the eave may not exceed 500 °C for more than 2 minutes or 450 °C for more than 10 minutes.

2. For general purpose, also including hospitals:

   a), b) and c) as above under 1.
   d) The heat flux into the centre of the window in the first storey above the fire room may not exceed 80 kW/m^2.

7 References

[1] SP FIRE 105, - Method for fire testing of facade materials, Dnr 171-79-360 Department of Fire Technology, Swedish National Testing and Research Institute, 1985.

[2] Hildebrand C, ”Facade Fire Tests”, report CIB 14 Workshop, Institute für Baustoffe, Leipzig, April 1988. (See Appendix A.)

[3] Ondrus J, ”Fire Hazards of Facades with Externally Applied Additional Thermal Insulation”, Report LUTVDG/(TVBB-3021), Division of Building Fire Safety and Technology, Lunds Institute of Technology, 1985.

[4] Ondrus J and Pettersson O, ”Fire Hazards of Facades with Externally Applied Additional Thermal Insulation, - Full Scale Experiments”, Report LUTVDG/(TVBB-3025), Division of Building Fire Safety and Technology, Lunds Institute of Technology, 1986.

[5] Oleszkiewicz I, ”Heat Transfer From a Window Fire Plume to a Building Facade”, NRCC 31679, Fire Research Section, Institute for Research in Construction, National Research Council of Canada, Ottawa, 1989.

[6] Brein D und Seeger P G, ”Fassadenbrandversuche mit einem schwerentflammbaren und einem nichtbrennbaren Wärmedämmverbundsystem”, VFDB -Zeitschrift 1/1988 s. 1 - 15, Forschungsstelle für Brandschutztechnik an der Universität Karlsruhe.