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Fire tests of PUR insulation with different fire protecting claddings

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INTRODUCTION

The Danish prescriptive code for fire protection of buildings [1] require an insulation material which holds a reaction to fire class poorer than class D-s2,d2 to be protected with at least a covering class K_1 10 B-s1,d0 (or a protecting construction of class EI 30). According to the Danish approach the reaction to fire class of insulation materials must be evaluated on the insulation alone, that is, without any kind of facing [2].

In order to find the best solution to comply with the prescriptive code a Danish manufacturer of steel faced sandwich panels with PUR (polyisocyanurate) insulation asked DBI to carry out some exploratory fire tests to evaluate 4 different solutions.

EXPERIMENT SETUP

Four test specimens sized 600 mm × 600 mm was mounted horizontally on a 100 mm thick concrete frame with four 500 mm × 500 mm holes (with the specimens covering the holes). The frame was placed at the top side of a so called "model test furnace". This test is referred to as the "4-hole test".

The size of the specimens is significantly smaller than the specimen size required in EN 14135 [3]. To obtain an authorized classification the system must be tested in a larger scale.

Description of specimens (from exposed side):

1. 16 mm cement based chipboard, PUR insulation, 0.55 mm steel sheet
2. 0.55 steel sheet, 10 mm fibre gypsum board, PUR insulation, 0.55 mm steel sheet
3. 10 mm plaster, 30 mm mineral wool, PUR insulation, cardboard
4. 10 mm plaster, 15 mm glass fibre reinforced concrete plate, PUR insulation, 0.55 steel sheet.

TEST PROCEDURE

Except for the reduced dimensions of the test specimens the test was run according to EN 14135 [3], that is, a 10 minute test with a heat exposure following ISO 834, though, due to a malfunctioning gas burner there was a substantial deviation from the prescribed temperature curve. In each specimen two thermocouples was mounted between the PUR insulation and the protecting layer in order to measure the heat exposure to the PUR insulation. The thermocouples were facing the protecting layer.

After the 10 minute fire test the concrete frame (with the 4 test specimens on top) was removed from the furnace and the specimens were detached as quickly as possible to allow for visual observation of possible damages to the PUR insulation.

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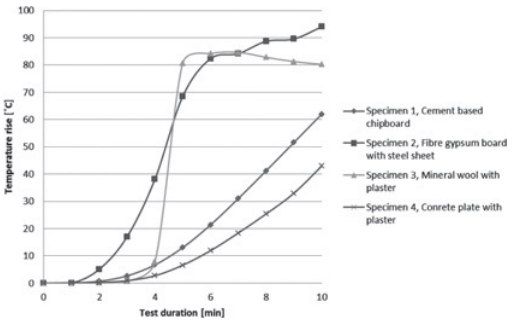

Figure 1. Average temperature rise between PUR insulation and protecting layer during the "4-hole test".

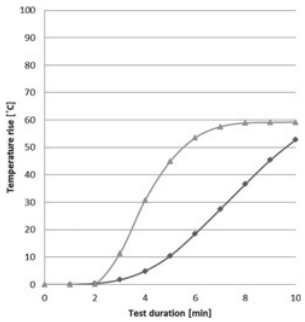

Figure 2. Average temperature rise between PUR insulation and protecting layer during the large-scale test.

RESULTS

Temperature rise measurements between PUR insulation and the protecting layer during the "4-hole test" are presented in Figure 1.

According to EN 13501-2 [4] the maximum allowed average temperature rise on the unexposed side of the K_1 covering is 250 °C (and 270 °C in a single thermocouple). Besides that, no combustion, melting, shrinkage or deformation of the substrate (the PUR insulation) is allowed. None of the criteria were exceeded during the test in any of the four test specimens.

ADDITIONAL LARGE-SCALE TESTING

Based on the test results from the "4-hole test", combined with other essential properties (e.g. purchase costs and application span), construction type 1 (cement based chipboard) and 3 (mineral wool with plaster) were selected for further development and fire testing.

A large-scale test was conducted with all relevant parameters according to EN 14135 [3], including the prescribed specimen size (2.4 m × 2.8 m) and representative joints and connections.

Temperature rise measurements between the PUR insulation and the protecting layer during the large-scale test are presented in Figure 2.

For some unknown reason, the temperature rise measured on the PUR insulation in the large-scale test is significantly lower than in the 4-hole test even though the furnace temperature was higher.

CONCLUSION

The intermediate-scale and large-scale tests indicated that the Danish prescriptive code regarding fire protection of PUR insulation can easily be satisfied with various types of protective layers.

The "4-hole test" was found to be a valuable tool to choose between different alternatives before the large-scale testing.

References

[1] Energistyrelsen (The Danish Energy Agency), "Eksempelsamling om brandsikring af byggeri 2012 (The Danish prescriptive code on fire protection of buildings)," 2012.

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[3] CEN, "EN 14135 Coverings - Determination of fire protection ability," European Committee for Standardization (CEN), Aug. 2004.
[4] CEN, "EN 13501-2 Fire classification of construction products and building elements - Part 2: Classification using data from fire resistance tests, excluding ventilation services," European Committee for Standardization (CEN), Nov. 2009.