Fire resistance tests of large glazed aluminium curtain wall test specimens – results comparison

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INTRODUCTION

In this paper comparison of fire resistance test results of large - minimum dimension of 5250×5725 mm (width x height) – glazed aluminium curtain wall test specimens is presented. Comparison has been made for different sides of fire exposure, different material of profile insulation inserts and different thickness of glass panes.

1. TEST SPECIMENS

Four test specimens, glazed aluminium curtain walls in full configuration, were tested. Curtain walls had the same transom – mullion structure, with:

- transoms and mullions made of the same aluminium profiles, with two types of insulation inserts (in each test one type of the insulation inserts),
- glass panes of the same glass product group and dimensions of:
 - 1680×3198 mm (width $\times$ height) for biggest glass pane orientated vertically,
 - 1980×1628 mm (width $\times$ height) for biggest glass pane orientated horizontally.
- non-transparent panels of the same construction and dimensions,
- similar design (profiles, and consequently glass panes and panels of the same construction on the exposed area).

Two test specimens were tested for external fire exposure, and two for standard fire exposure.

Dimensions of exposed surfaces were 5000×4500 mm (width $\times$ height) for external fire exposure and 5000×4800 mm (width $\times$ height) for internal fire exposure. As a result the heated area was over 2 times greater than the minimum heated area required in EN 1364-3:2006 [3]. The distance between the mullion fixing anchors was 5000 mm in both cases.

All tested specimens were of the same transom – mullion structure with aluminium profiles sections of 50×115 mm (transoms) and 50×130 mm (mullions), fig. 1. Two types of insulations inserts were used in profiles, each type for pair of tests (external and internal fire exposure). Two types of glass panes were used in test specimens, each type for pair of tests (external and internal fire exposure). Glass panes were of symmetrical structure.

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Figure 1. Mullions and transoms cross – section.

Figure 2. Thermocouples arrangement on the unexposed surface of tested specimen and location of the thermocouples on the profiles.

Figure 3. Comparison of average temperature rises on unexposed surface of glass pane with the largest area depending on the side of fire exposure; glass pane type 1; G6(30E) – external fire exposure, G6(30I) – internal fire exposure.

Figure 4. Comparison of average temperature rises on unexposed surface of glass pane with the largest area depending on the side of fire exposure; glass pane type 2; G6(60E) – external fire exposure, G6(60I) – internal fire exposure.

Figure 5. Comparison of average temperature rises on unexposed surface of mullions depending on the side of fire exposure; insulation insert type 1; M(30E) – external fire exposure, M(30I) – internal fire exposure.

Figure 6. Comparison of average temperature rises on unexposed surface of transoms depending on the side of fire exposure; insulation insert type 2; T(60E) – external fire exposure, T(60I) – internal fire exposure.

Figure 7. Differences between the average temperature rises on the unexposed surface of specimen tested for external fire exposure and specimen tested for internal fire exposure; insulation inserts type 1, $\Delta M(30E-I)$ – mullions, $\Delta T(30E-I)$ – transoms.

Figure 8. Differences between the average temperature rises on the unexposed surface of specimen tested for external fire exposure and specimen tested for internal fire exposure; insulation inserts type 2, $\Delta M(60E-I)$ – mullions, $\Delta T(60E-I)$ – transoms.

Figure 9. Comparison of average temperature rises on unexposed surface of mullions depending on the type of insulations inserts, external fire exposure; M(30E) – insulation inserts type 1, M(60E) – insulation inserts type 2.

Figure 10. Comparison of average temperature rises on unexposed surface of mullions depending on the type of insulations inserts, internal fire exposure; T(30I) – insulation inserts type 1, T(60I) – insulation inserts type 2.

Figure 11. Differences between the average temperature rises on the unexposed surface of test specimens with insulation inserts and glass panes type No. 1 and type No. 2, external fire exposure; $\Delta G(E30-60)$ – glass panes, $\Delta P(E30-60)$ – panels, $\Delta M(E30-60)$ – mullions, $\Delta T(E30-60)$ – transoms.

Figure 12. Differences between the average temperature rises on the unexposed surface of test specimens with insulation inserts and glass panes type No. 1 and type No. 2, internal fire exposure; $\Delta G(I30-60)$ – glass panes, $\Delta P(I30-60)$ – panels, $\Delta M(I30-60)$ – mullions, $\Delta T(I30-60)$ – transoms.

INSTRUMENTATION

The temperature rise on unexposed surface of the test specimens was measured with surface thermocouples type K specified in EN 1363-1:2012 [1]. Thermocouples arrangement (the same for all of the tests) is given in Fig. 2. Location of the thermocouple on the transom and mullion profiles is presented in Fig. 2.

FIRE RESISTANCE TESTS

Four fire resistance tests of glazed aluminium curtain wall in full configuration (complete assembly) were conducted in Fire Testing Laboratory of Building Research Institute in Pionki:

- two tests of glazed aluminium curtain walls dimensions of 5250 x 5725 mm (width x height) heated from the glazing beads side under external fire exposure in accordance with EN 1363-2:1999 [2],
- two tests of glazed aluminium curtain walls dimensions of 5850 x 5725 mm (width x height) heated from the side opposite to glazing beads (profile side) under standard fire exposure in accordance with EN 1363-1:2012 [1].

TEST RESULTS

The most interesting results obtained during the tests are presented in Figs. 3–12.

Comparison of average temperature rises on unexposed surface of tested specimen depending on the side of fire exposure is presented in Figs. 3–6. Differences between the average temperature rises on the unexposed surface of tested specimen heated from outside and from inside are presented in Figs. 7–8. Comparison of average temperature rises on unexposed surface of the profiles depending on the type of insulations inserts is presented in Figs. 9–10. Differences between the average temperature rises on the unexposed surface of test specimens with insulation inserts and glass panes type No. 1 and type No. 2 is presented in Figs. 11–12.

2. DISCUSSION

In the Figs. 3, 4 it can be observed that average temperature rises on unexposed surface of glass panes are similar despite of the different heating conditions temperatures in the furnace (external or internal fire exposure, Fig. 3).

In the Figs. 5–8 it can be observed that average temperature rises on unexposed surface of profiles are greater for internal fire exposure.

In the Figs. 9–12 it can be observed that the average temperature rises are greater on the unexposed surface of profiles with insulation inserts of type No. 1.

Moreover it can be observed that average temperature rises on transoms and mullions are similar for each test (specified curve and insulation inserts type).

Despite of the difference in cross – section of mullion and transom profiles temperature rises measured on them are similar. This phenomena is probably observed because additional insulation inserts were applied between the profile and the glass pane, providing that dimensions between the insulation inserts and glass pane surface is equal for transom and mullion profiles (see X dimension in Fig. 1).

References

- [1] EN 1363-1:2012 Fire resistance tests – Part 1 General requirements
- [2] EN 1363-2:1999 Fire resistance tests – Part 2 Alternative and additional procedures
- [3] EN 1364-3:2006 Fire resistance tests for non-loadbearing elements – Part. 3: Curtain walling – Full configuration (complete assembly)
- [4] EN 13501-2+A1:2009 Fire classification of construction products and buildings elements – Part 2: Classification using data from fire resistance tests, excluding ventilation services)
- [5] B. Sędlak, “Badania odporności ogniowej przeszklonych ścian osłonowych - Część 1”, *Świat Szkła*, **R.17, nr 9**, 52–54, 2012 (*in Polish*)
- [6] B. Sędlak, “Badania odporności ogniowej przeszklonych ścian osłonowych - Część 2”, *Świat Szkła*, **R.17, nr 10**, 53–58, 2012 (*in Polish*)