The impact of reinforcing profiles on the fire resistance of aluminium glazed partitions

Part 1.

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In this paper, the impact of using this type of additional profiles on the fire resistance of a glazed wall was analysed. The results of two walls with identical external dimensions and the same static scheme, made on the basis of the same glazing, from the same aluminium profiles have been compared, with additional reinforcing profiles applied in one of the tests. This article discusses the results obtained and the conclusions from the tests conducted.

A partition is a form of inner wall of a building. It does not constitute a part of the building structure and therefore is not designed to be subjected to any loads other than its own weight and those related to the conditions of its use. However, since it separates rooms within a building, it should meet certain soundproofing and fire resistance requirements.

According to the regulations of many European Union countries, for buildings with a specific purpose, e.g., hospitals, hotels or those with significant height [1-3], partition walls, as non-load bearing elements of a building, should be designed and constructed in such a way that in the event of a fire, it will limit the spread of fire and smoke in the building, enable the evacuation of users and ensure the safety of the rescue team. Therefore, in this type of buildings, partition walls must fulfil fire resistance requirements.

Partition walls, which are prepared to achieve specific fire resistance class, are usually designed as a masonry walls, built of lightweight small-elements [4-6] or light construction reinforced with a metal or wooden frame, e.g. made of plasterboard [7], [8] or chipboard [9], [10]. The most common solutions with optimum fire properties are walls made of sandwich panels [11-14]. These materials, however, despite their excellent properties for stopping fires, are aesthetically poor and they are increasingly being replaced by far better-looking transparent elements (glazed [15-18] or made of glass blocks [19]) [20].

Glazed partitions are usually made of metal [21-23] or timber [24], [25] profiles as a transom-mullion structures. The areas formed between the profiles are filled with opaque or transparent special glazing with fire resistance properties [26-29]. This type of glazing is usually constructed as a multi-layer glass unit, with thermal breaks (fire resistant layers) or intumescent gel between the layers of tempered or semi-tempered glass panes.

Profiles which are used in fire resistant glazed partitions usually have a symmetrical cross-section. The timber ones are made of laminated or solid wooden elements. The metal profiles are composed of aluminium or steel elements connected with a thermal separator in most cases made of polyamide reinforced with glass fibre (three-chamber profiles, example in Figure 1) [30]. It is very important to properly fill the profile chambers in order to ensure insulation and reduce the adverse impacts of thermal stress [31]. Special insulating inserts, usually made of gypsum plasterboards, silicate – cement boards, silicate – calcium boards or mineral wool plates, or increasingly used timber infills [32], [33] are placed inside the chambers of the profiles. Not only the material employed but also the volume of the infill is important, which was presented in articles [15], [21], [34]. For partitions with significant height, the profiles are additionally equipped with reinforcements, usually made of the same material. The reinforcing profiles are fixed to one or both sides of the main profile, increasing the cross-section dimensions and loadbearing capacity.

An example of a three-chamber aluminium profile with a fixed glazing is shown in Figure 1. It clearly shows intumescent gaskets between the profile and the glazing. These elements, usually made of expandable graphite [35], [36] increase their volume under high temperature and close the gaps that fire could use to get through to the unexposed side.

The 'fully glazed partition' [37], [38] is an increasing common solution in the market. The partitions of this type have aluminium or steel profiles used only along the perimeter of the partition, mullions are replaced by a special fireproof silicone or intumescent gaskets, and the transoms in most cases do not occur.

Classification of fire resistance according to european standards

The glazed partition design or project does not give a clear indication as to whether it will maintain fire integrity and insulation throughout the specific period; therefore, a fire resistance test must be performed.

Aluminium glazed partitions in the European Union are classified in accordance with standard EN 13501-2 [39], and the fire resistance classes are confirmed on the basis of the results of the test conducted in accordance with EN 1364-1 [40].

The classification takes into account the performance criteria presented below:

■ fire integrity (E) – is the ability of the glazed partition test specimen, when exposed to fire on one side, to prevent the passage through it of hot gases and flames and to prevent the occur-

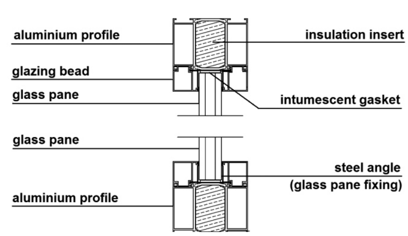

Fig. 1. Example of three-chamber profile cross-section [21]

Fig. author's archives

▶

rence of flames on the unexposed side; it is assessed on the basis of three aspects: ignition of the cotton pad, sustained flaming on the unexposed surface or gaps exceeding the permissible dimensions; the cotton pad inflammation criterion is not taken into account if the element is classified only for fire integrity without considering the fire insulation classification;

- fire insulation (I) – means the ability of a certain test specimen to function as a separating part of the building structure and is subjected to fire on one side to limit the temperature rise on the unexposed surface above a given level (the average temperature rise is limited to 140ºC above the initial average temperature, while the maximum temperature rise at any point in the tested partition is limited to 180ºC above the initial temperature); the maximum and average temperature rises on the unexposed surface of the test specimen are checked with thermocouples attached to the test specimen by means of a temperature resistant adhesive [50];
- radiation (W) – is the ability of a structural element to withstand fire applied on one side thereby limiting the probability of transferring the fire to adjacent materials as a result of significant heat radiation by the element or by its unheated surface; the measurement method is defined by standard EN 1363-2 [41]; radiation is assessed on the basis of the time in which the maximum value of the radiation measured in accordance with EN 1363-2 [41] does not exceed 15 kW/m^2;
- resistance to mechanical impact (M) – resulting from damaging other structural elements or items exposed to the fire may influence the fire resistance of the partition; it is assessed (after reaching the required classification time) on the basis of the time after which the specimen has withstood the impact in accordance with EN 1363-2 [41], without deterioration of its fire integrity and/or insulation performance.

Standard EN 13501-2 [39] for partitions defines the fire resistance classes shown in Table 1.

In the classification document of a glazed partition, in addition to a detailed technical description of the element, there should be a point referring to the field of application of the test results, containing all the changes that are possible to make in the design of the partition, which does not cause the reduction of its fire resistance properties. We can distinguish the direct field of application, which is presented in a testing standard [40] and extended field of application, which is described in the EXAP standard [43]. Glazed partition classification methodology, with possible extensions according to the EXAP standard [43], has been widely discussed in articles [42], [44]–[47].

Fire resistance testing

According to the European Union provisions, the partitions should be tested in accordance with EN 1364-1 [40], maintaining the procedures outlined in EN 1363-1 [48], and where appropriate, EN 1363-2 [41]. The fire resistance test is carried out by applying heat to one side of the partition. For walls with a symmetrical cross-section option, it is enough to check them only from one side, and for non-symmetrical solutions, it is necessary to test them from each side.

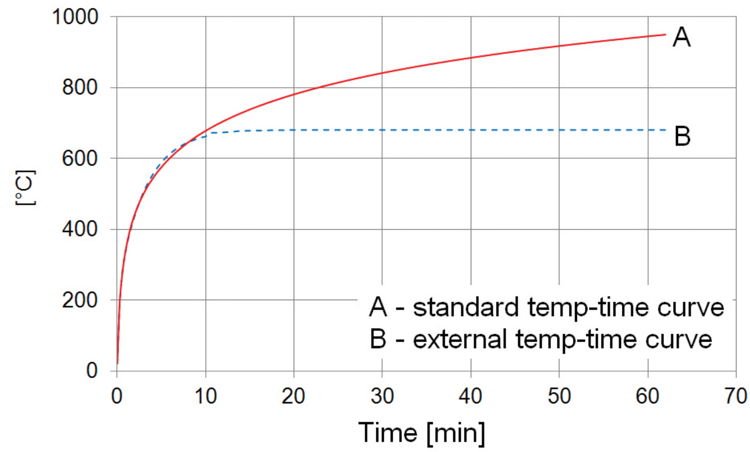

Fig. 2. Temperature-time curves, A – standard curve, B – external fire curve [49]

The test specimen is heated in accordance with the standard time-temperature curve (presented by the solid line in Figure 2), assumed as a characteristic for reflection of a fire inside a building (fully developed, following the flashover).

During the glazed partition fire resistance test, the following performance criteria are checked:

- fire integrity (E),
- fire insulation (I),
- radiation (W),
- resistance to mechanical impact (M).

Moreover, the deflection of the test specimen should be measured although it is not associated with any performance criteria. The deflection of the test specimen may be important in determining the direct and/ or extended field of application of the test result [25].

Glazed partitions in practice are often equipped with doorsets which also have to meet the requirements of fire resistance and, in certain cases, smoke control. Testing of this type components is carried out according to a different standard. In this specific case, the doorset is a test specimen and glazed partition is only an associate (for fire resistance) or supplementary (in case of smoke control) supporting construction. Cases of this type and testing methodology in the field of fire resistance are presented in the articles [50-57], and in the field of smoke control in the articles [54], [55], [58-60].

Table 1. Fire resistance classes [42]

E	-	20	30	-	60	90	120	-	-
EI	15	20	30	45	60	90	120	180	240
EI-M	-	-	30	-	60	90	120	180	240
EW	-	20	30	-	60	90	120	-	-

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Abstract: The inner walls of a building, which do not constitute its structure and therefore do not have loadbearing properties, are called partition walls. The main task of this type of element is the separation of rooms in a building, which is why they should be designed and constructed in a way that ensures, among others, compliance with fire safety requirements, including those related to fire resistance. There are many types of fire-resistant partition walls both on the European and global construction market, among which the most impressive effect is achieved by those using glass elements in their structure. These include aluminium glazed partitions, which are the subject of this paper. These structures are usually made of special fire-resistant glass positioned in three chamber profiles, made of two aluminium sections, connected by a thermal break, usually made of glass fibre reinforced polyamide. The chambers created in this way are filled with special insulating inserts, and the degree of filling depends on the expected fire resistance class, which is determined by an appropriate test. Large wall-height profiles of this type are usually further reinforced by screwing to them additional, special aluminium profiles. In this paper, the impact of using this type of additional profiles on the fire resistance of a glazed wall was analysed. The results of two walls with identical external dimensions and the same static scheme, made on the basis of the same glazing, from the same aluminium profiles have been compared, with additional reinforcing profiles applied in one of the tests. This article discusses the results obtained and the conclusions from the tests conducted.

Keywords: fire safety, fire engineering, fire resistance, fire integrity, fire insulation, aluminium profiles, aluminium glazed partition systems, glass panes

Streszczenie: WPŁYW PROFILI WZMACNIAJĄCYCH NA ODPORNOŚĆ OGNIOWĄ ALUMINIOWYCH PRZEGRÓD PRZESZKLONYCH. Ściany wewnętrzne budynku, które nie stanowią jego konstrukcji, a tym samym nie mają właściwości nośnych, nazywane są ścianami działowymi. Głównym zadaniem tego typu elementów jest wydzielenie pomieszczeń w budynku, dlatego należy je projektować i wykonywać w sposób zapewniający m.in. zachowanie wymagań bezpieczeństwa pożarowego, w tym w zakresie odporności ogniowej. Na europejskim, a także światowym rynku budowlanym istnieje wiele rodzajów przeciwpożarowych ścianek działowych, z których najbardziej spektakularny efekt osiągają te, które wykorzystują w swojej konstrukcji elementy szklane. Należą do nich przeszklone przegrody aluminiowe które są przedmiotem niniejszego artykułu. Konstrukcje te są zwykle wykonane ze specjalnego szkła odpornego na działanie ognia, umieszczonego w trójkomorowych profilach składających się z dwóch profili aluminiowych, połączonych przekładką termiczną, najczęściej z poliamidu wzmocnionego włóknem szklanym. Powstałe w ten sposób komory wypełnione są specjalnymi wkładami izolacyjnymi, a stopień wypełnienia jest uzależniony od oczekiwanej klasy odporności ogniowej, która jest określana odpowiednim badaniem. Tego typu profile o dużej wysokości ścian są zwykle dodatkowo wzmacniane poprzez przykręcenie do nich specjalnych profili aluminiowych. W artykule przeanalizowano wpływ zastosowania tego typu dodatkowych profili na odporność ogniową przeszklonej ściany. Porównano wyniki dwóch ścian o identycznych wymiarach zewnętrznych i tym samym schemacie statycznym, wykonanych na podstawie tego samego schematu oszklenia, z tych samych profili aluminiowych, z dodatkowymi profilami wzmacniającymi zastosowanymi w jednym z badań. W artykule omówiono uzyskane wyniki oraz wnioski z przeprowadzonych badań.

Słowa kluczowe: bezpieczeństwo przeciwpożarowe, inżynieria przeciwpożarowa, odporność ogniowa, szczelność ogniowa, izolacja ogniowa, profile aluminiowe, aluminiowe przeszklone systemy ścian działowych, przeszklenia