FIRE SAFE SERVICE INSTALLATIONS IN TIMBER BUILDINGS

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ABSTRACT: In recent years residential buildings have been increasingly equipped by technological devices and service supplies to gain an appropriate standard of comfort. Despite these service installations and associated penetrations the fire resistance of fire separating elements must not be negatively influenced. There are currently no approved systems or recommendations for fire safe penetration sealing products in separating timber elements. New measures and recommendations can be derived from fire tests conducted in a European research project.

KEYWORDS: Fire exposure, Service installations, Penetration sealing, Timber buildings

1 INTRODUCTION

The separating function for wall and floor elements represents one of the most essential capacities in the case of fire, besides the structural stability. The building occupants and fire service must have confidence in the correct function of these elements.

The evaluation of the fire resistance for such assemblies occurs normally on basis of standardised fire tests, such as EN 1365, as well as approved calculation methods, such as those presented in EN 1995-1-2.

These methods don’t normally take into account any mounting parts, such as wall sockets and switches or penetrations of service installations for the likes of electrical wiring, heating systems, water and sewage pipes. However, these service installations are necessary and essential for the use of a building. Simultaneously the guarantee of fire prevention requires that for all building materials and construction methods certified sealing compounds and fire shutter systems are used, which have the same fire resistance time as the separating building elements, to avoid the spread of fire as well early ignition of wooden panels or combustible materials inside the elements.

However inspections and surveys of new and existing buildings repeatedly report that inappropriately sealed service installations in both walls and floors, due to mistakes in the design and execution, introduces weak spots for fire to spread through and limits the usability of the structure in case of fire.

The concept in these investigations were focused on modifying existing and approved sealing systems for drywall and concrete construction for safe use in timber structures. The primary focus was on developing a fire safe, durable and fail safe design in the execution of the joints and junction for the compartment element and sealing system.

In the first step of the investigation measures for fire safe sealing of single and bundles of electrical wiring in combination with wooden board and solid timber elements were tested. The following materials were used: gypsum putty, mineral fibre plugs, fire retardant avoid unnecessary penetrations in the latter stages of construction.

Three basic concepts are available:

- central distribution in service shafts and ducts
- penetration sealing in each separating element
- continuous encasing of each service line throughout its entire length

All solutions must also satisfy the requirements for acoustic, moisture and thermal performance. Furthermore, the accessibility for revision, maintenance and additional installations must be possible.

Until now, fire tests of penetration sealing systems and sealing compounds for penetrations in timber frame and solid timber constructions are missing and acceptable solutions are rare. Approved sealing systems are typically only available for concrete or drywall construction at the moment.

To check the applicability for timber structures as well as develop design rules numerous fire tests were carried out. The following investigations took into account the sealing for penetrations of electrical wiring, the development of installation conditions for approved penetration sealing systems and fire shutters as well as the fire safe installation of wall sockets and switches in timber frame and solid timber structures.

2 CONCEPT AND EXPERIMENTAL INVESTIGATION

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foams and mastics as well intumescent materials. The second step considered the installation of penetration sealing systems and wall sockets / switches in separating timber elements. Special attention was paid to developing measures for lining the reveal area. All small scale and full scale fire test were carried out in accordance with EN 1366 and the standard fire curve of ISO 834 was used. The failure criteria were measured in terms of integrity (E) and insulation (I).

3 EXPERIMENTAL RESULTS

3.1 PENETRATION OF WIRING

As timber frame and drywall structures have similar failure mechanisms when exposed to fire (attrition, collapse of lining), many of these sealing measures are appropriate for timber construction. For typical single electrical cable, penetrations sealing compounds such as gypsum putty, intumescent mastics, stone wool plugs and fire-retardant polyurethane foam with an annular gap of 5 – 10 mm can be recommended. In the case of an annular gap less than 0.5 mm, no additional sealing is needed for skinny cables.

For thicker cables and cable bundles the conducted heat through the penetration increases and only highly efficient and durable materials, like gypsum putty or intumescent mastics shall be used. A compilation of all individual measures can be taken from [1].

In addition the following conditions must be observed:
- filling of 5 – 10 mm wide annular gap in the complete thickness of lining, for solid timber elements sealing depth at least 40 mm on both sides of the element.
- distance d between cable penetrations d ≥ largest hole diameter
- density of penetrated wooden panel ≥ 400 kg/m³ reaction to fire class at least D ≤ 2 ≤ D (EN 13501-1)
- for smoke proof connections use of permanent elastic sealing compounds or mastics

For variations in design and execution of construction work the application of approved penetration sealing systems becomes necessary (see clause 3.2.).

3.2 PENETRATION SEALING SYSTEMS

3.2.1 Single Systems

The assessed systems contained combustible and non-combustible service pipes in addition to penetrations of cable bundles. It was found that systems with intumescent materials, which expand under temperature exposure, efficiently seal the joint between the shutter system and lining of the timber frame or solid wood elements. For systems with passive sealing materials, such as gypsum putty, in the joint between the lining and shutter system, the fully joint less filling throughout the complete depth is needed to ensure fire safety in the junction area. For thick linings of separating timber frame elements this method requires a technical and material specific high demand.

To optimize these joints an additional 100 mm wide and minimum 12.5 mm thick non-combustible framed lining is strongly recommended.

3.2.2 Multi Systems

For installation of multi penetration sealing systems in compartment timber structures comparable conditions to those used in concrete or drywall constructions must exist. Through this the fire spread inside the timber structure and sidewise passing of the sealing system can be excluded.

The main concept was to line the reveal area of the penetrations / openings with a non-combustible encasing cladding in accordance with EN 13501-2 over the entire thickness of the separating element, including the attachment of an additional framed lining of at least 100 mm wide around both sides of the surface. This was to create joint steps thus avoiding continuous joints in the structure. For the encasing cladding systems with two layers are preferable (Figure 1). In timber frame construction a support infill frame with at least 40 mm in the opening area is necessary to stabilise and support the encasing cladding.

![Figure 1: fire safe lining of reveal area](image)

Fire resistance of encasing cladding*

- (R)EI 30 2 x 10mm
- (R)EI 60 2 x 15mm
- (R)EI 90 2 x 18mm

* recommendation for gypsum plasterboard

4 CONCLUSIONS

The investigations show that the selected approved penetration sealings and systems for separating timber elements are applicable in accordance with the specified design restrictions and no early failure of the penetration will occur in the case of fire. The lining of the reveal area represents an efficient fire safety concept that provides for multiplicity of existing penetration sealing systems similar installation conditions.

National and international knowledge as well the executed fire tests show that existing penetration sealing systems can be used in combination with timber structures to assure fire safety.

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