TECHNICAL INFORMATION

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PV Systems on EPS Flat Roofs Reduces Fire Spread Through Glass Fleece Installation

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Background

Various fire incidents involving PV systems on flat roofs have raised questions about how flat roofs can be safely constructed in new buildings and during modernisation. The IVH, together with Eumeps, has addressed this issue by conducting a series of fire test experiments.

The test results for EPS-insulated flat roofs under PV systems reveal various solutions for ensuring fire-safe flat roof contstructions.

Introduction

The use of photovoltaic (PV) systems on flat roofs can represent a forward-thinking solution for sustainable energy generation. Considering the increasing demand for renewable energy and the growing utilisation of roof surfaces, PV systems on flat roofs are becoming increasingly important. They provide an efficient means of generating electricity for both new constructions and building renovations—whether on industrial lightweight roofs or flat roof constructions with reinforced concrete ceilings.

Figure 1: Flat roofs insulated with EPS are ideal for the installation of PV systems

PV systems may pose a fire risk to the flat roof underneath, mainly due to poorly installed or inadequately maintained PV systems. The type of insulation material used in the flat roof has little relevance in this context.

The materials installed above the insulation layer, such as the waterproofing layer or the protective and separation layers between the insulation and the waterproofing, are far more critical in determining the fire behaviour of flat roofs.

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Proposals to simply replace combustible insulation products with so-called non-combustible insulation do not necessarily improve fire performance on flat roofs. This has been demonstrated by past fire tests. Such recommendations often lead to uncertainty among clients, planners, and contractors, resulting in unnecessarily costly construction measures that are neither economical nor ecological. Moreover, they do not inherently achieve a higher level of fire safety.

However, installing a PV system on a roof adds additional fire load due to the PV components themselves. Simultaneously, the heat reflection from a fire underneath PV module increases the stress on the underlying roof structure.

Flat roofs insulated with EPS have proven to be reliable constructions for both new and existing buildings for decades. They continue to be safe options for industrial lightweight roofs as well as flat roofs with reinforced concrete structures.

In 2024, the Industrieverband Hartschaum e. V. (IVH) commissioned large-scale fire tests under real-scale conditions. These tests were conducted and evaluated by the Dutch testing institute Kiwa BDA Testing B.V.[1]

Applied Testing Methodology

Flat roof systems with EPS in Germany are tested according to Technical Specification 11872[2], which evaluates the resistance of roofing systems to flying sparks and radiant heat.

To account for the additional fire load introduced by PV systems, the tests described below were conducted in accordance with the methodology outlined in CLC/TR 50670[3]. This testing procedure was selected to enable comparability with prior fire tests conducted by other industries.

In this test, a 15 kW gas burner was used to create a test fire lasting 10 minutes, followed by an observation period of 50 minutes. The goal of the test is to evaluate fire spread over a 7 m x 7 m roof area.

[1] 24L0474/2; Comparative test on fire behaviour of flat roof waterproofing systems with different roof buildup and equipped with identical photovoltaic systems.

[2] TS 1187; Test method for exposure of roofs to external fire

[3] CLC/TR 50670; External fire exposure to roofs in combination with photovoltaic (PV) arrays - Test method(s)

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Fire Test with Single Layer Glass Fleece Between PVC Membrane and EPS Insulation (standard construction)

In an initial test, the influence of the glass-fibre fleece, which is typically used in EPS flat roof constructions underneath the PVC membranes, was examined. This test[4] already demonstrated a significantly reduced horizontal fire spread on the PVC membrane compared to tests conducted with other insulation materials (**Figure 2**). During the observation period, the fire self-extinguished.

Figure 2: Damage and fire spread of different insulation materials: Flat roof with polyurethane rigid foam (left) with mineral wool (centre), IVH fire test with EPS rigid foam (right).

Test with Glass Fleece and Maximum Overlap of Individual Strips Between PVC Membrane and EPS Foam

In a subsequent test, the individual glass fleece strips were laid with a maximum overlap of one metre between the PVC membrane and the EPS insulation. Based on previous results (see Figure 2), further tests were performed with a maximum 1-meter overlap of the glass fleece strips to ensure better functionality even with thicker insulation layers, as required in modern roofs.

A PV system with glass-foil modules and an east-west orientation was tested on a 7 mx 7 m EPS flat roof surface (**Figure 3**).

Figure 3: Tested PV system consisting of glass-foil modules in an east-west orientation.

[4] 0151-L-20/4; Comparative test on fire behaviour of flat roof waterproofing systems with different thermal insulation materials and equipped with identical photovoltaic systems

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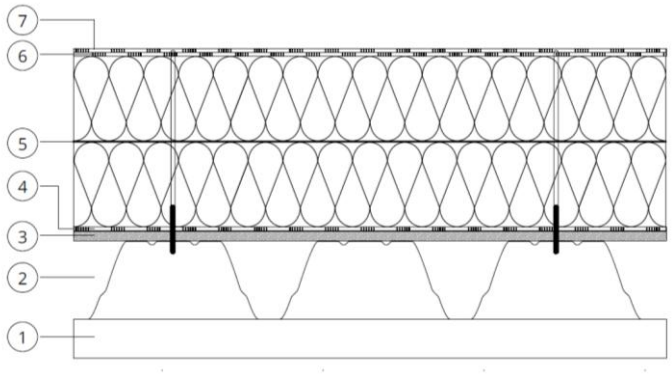
As a flat roof (**Figure 4**), a trapezoidal steel deck was selected, with a 12 mm thick cement-bonded particleboard installed on top. This setup allows assessment as both a classic concrete roof and an industrial lightweight roof with a single test.

On top of the cement-bonded particleboard, a polyethene vapour barrier was installed, followed by a double layer of EPS with a total thickness of 220 mm and a compressive strength of 150 kPa (DAA dh), and a PVC membrane with a thickness of 1.8 mm.



1. **Substructure:** Square tubing, 50 x 50 mm
2. **Trapezoidal sheet metal:** Type M 100/275, thickness 0.75 mm
3. **Cement-bonded particleboard:** Thickness 12 mm
4. **Vapour barrier:** Polyethylene, 250 µm, with sd-value > 100 m
5. **EPS insulation:**
   a. **First layer:** EPS DAA dh, 110 mm
   b. **Second layer:** EPS DAA dh, 110 mm
6. **Glass fleece:** Weight 120 g/m², overlap approximately 1 m
7. **PVC membrane:** Type M18

Figure 4: Cross-section of the roof structure: Tested industrial lightweight roof construction with EPS foam and a maximum overlap of glass fleece installation (Layer 6) beneath the PVC roof membrane.

Figure 5: Flat roof with EPS foam and a maximum overlap of glass fleece installation – damage demonstrates the effectiveness of the glass fleece and minimal fire spread underneath the completely destroyed PV system.

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Figure 6: Once the glass fleece and melted EPS insulation residues were removed, the undamaged vapour barrier (blue) on the cement-bonded particleboard was revealed.

Figure 7: Beneath the undamaged cement-bonded particleboard, the trapezoidal sheet deck is also intact. No burn-through of the trapezoidal sheet occurred.

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Summary

The largest glass-fleece overlap results in further reduced fire spread on flat roofs.

- The cement-bonded particleboard, installed as the lower layer of the flat roof, prevents fire penetration through the roof into the building.
- The fire self-extinguished during the observation period.

These observations demonstrate that even initially undetected fires in PV systems do not pose additional fire risks in such roof systems. The results are comparable to tests conducted with other combustible and so-called non-combustible insulation materials.

PV systems can be safely installed on flat roofs with EPS insulation—whether on concrete flat roofs or industrial lightweight roofs. Consequently, the efficient and safe deployment of renewable energy utilisation on EPS flat roofs does not present an increased risk. EPS enables safe, efficient, and cost-effective new constructions and modernisation of buildings.

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