Construction fires: insulation fire in Evere

1 Introduction

On Tuesday, November 3rd in 2015, the fire department of Brussels was called out to a fire on Cicero Avenue in Evere. The standard response for fire in Brussels is two engines, two ladder trucks, one ambulance and one command vehicle. These units add up to a total of 19 firefighters. One engine and one truck are dispatched from the station in Schaarbeek. The other appliances ride out from Helihaven, the main fire station of Brussels FD.

2 The building

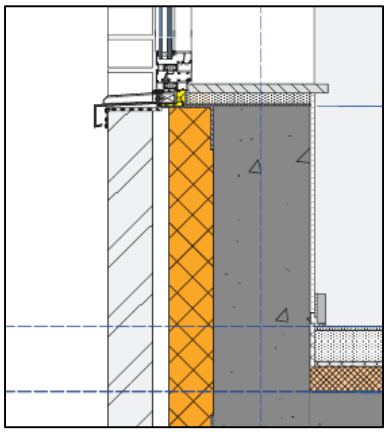
The building to which the fire service responds is a newly constructed high rise with 16 floor levels above ground.

Next to the building there's a side building of which the wall is completely made up of glass. In between the main building and the side building, there's a small section of flat roof on the second floor.

Upon arrival, the fire crews notice that the walls are partially covered with bricks and partially plastered (see Figure 1). The composition of the wall is not really clear at the start.

Figure 1 Illustration of the building. The white panes are exterior plaster while the darker parts of the wall are bricks. At the front left, the side building can be seen. *(© Drawing: A2RC)*

It is assumed that the brick wall is traditional masonry. This means that the interior wall is brick or concrete. Next, going from the inside out, there's a layer of insulation. In this case polyurethane (PUR). The outside wall layer are the bricks visible from the street (see Figure 2).



The officer in charge assumes that the plastered walls are insulated on the inside. These walls are layered as follows (from inside to outside): insulation, concrete paneling, exterior plaster. This form of insulation is used frequently in apartment construction. Before joining the fire service, the battalion chief was a project engineer in construction. Most of the apartment buildings he had built, were made up entirely as described above. This is consistent with his frame of reference.

Figure 2 Construction details of the masonry wall. From left to right: brick, cavity, insulation, concrete wall. *(Drawing: A2RC)*

Just above the flat roof on the second floor, part of the building is in cantilever. This means the wall is protruding in relation to the other walls.

3 Situation upon arrival

Figure 3 The situation upon arrival of Helihaven fire station. Schaarbeek crews are working the fire with a high pressure line. *(Photo: Pieter Maes)*

Upon arrival, the crews of Schaarbeek station are greeted by roofers. These were busy placing roofing on the section of flat roof in between the two buildings. The flame of the blow torch that they were using, was accidentally directed up the brick wall. This caused the PUR insulation in between the brick and the inner wall, to burn. However the outer brick layer is making it very hard for fresh air to reach the fire. This in turn, causes the fire to smolder.

The construction workers on site had already reacted when they first noticed the fire themselves. They emptied a dry chemical fire extinguisher in the cavity of the wall. This brought the fire partially under control, but it did not fully extinguish it.

The fire service has set up a ladder truck and deployed a high pressure booster line. Water was being flowed both onto the wall and into the cavity in order to extinguish the fire.

4 Course of the incident.

4.1 CAN report

Upon arrival of the Helihaven crews, the chief officer is being briefed by the captain of Schaarbeek. He describes the situation at hand. The chief officer decides to call for backup in the form of a rescue. The rescue has a set of piercing nozzles and a heavy duty Hilti power drill. The drill can be used to create various holes in the brick outer wall. Next the piercing nozzles will be inserted right up to the PUR insulation so that the fire can be extinguished.

4.2 Further size up

The chief officer wants to take a closer look at the flat roof, together with the captain. The two officers consult the roofer crew as well as the lieutenant in charge of the ladder truck. The fire seems to have been extinguished completely. However, when taking a closer look with the Thermal Imaging Camera (TIC), there's still heat being registered on the brick wall.

Also there's a hotspot at the connection between the wall and the cantilever section. Seeing as that's where the smoke was exiting the wall cavity, this is not unusual. And since the cantilever section is made out of concrete, the officers aren't immediately concerned about the fire spreading there. The wall is cooled down further with the high pressure line. The TIC is showing all grey on the screen and there are no longer traces of heat buildup.

Figure 4 The wall is looking fine. However, the TIC is clearly showing traces of heat buildup. The mortar joints and some of the bricks are highlighting. *(Photo: Karel Lambert)*

After about 30 seconds, the joints light up again on the TIC followed by an entire section of bricks located in the middle of the wall. The bricks are taking a lot longer to warm up however (in between four to nine minutes). This leads the officers to conclude that the fire is still smoldering. They will have to wait for the piercing nozzles to fight the fire in the insulation layer.

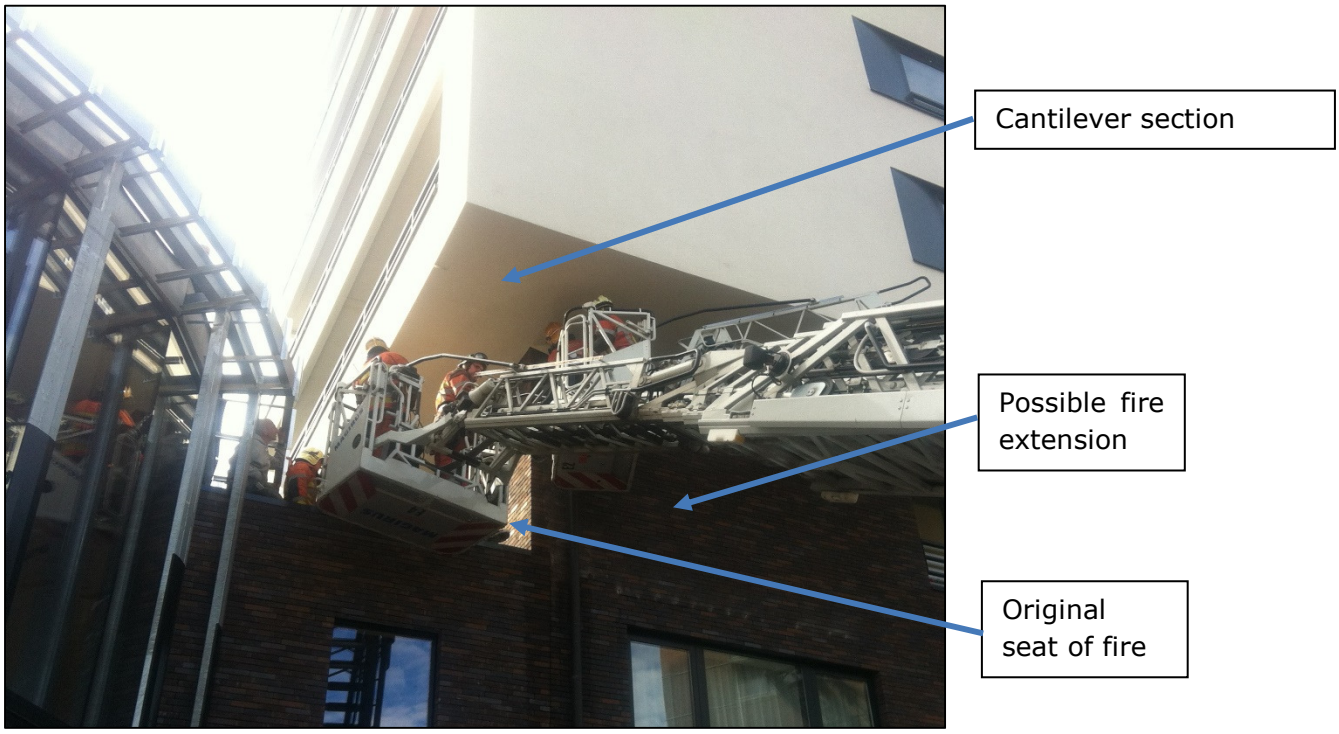


Figure 5 Left on the image, the ladder crew of Schaarbeek station is working. Several firefighters are on the flat roof. That's where the fire started in the brick wall between the roof and the cantilever section. The section of wall indicated with the bottom blue arrow is about 2 meters wide. There's a possibility that the fire will pass the corner and create possible fire extension across the entire brick wall. *(Photo: Pieter Maes)*

The Incident Commander heads back down to brief police crews of the situation at hand. A crew of two firefighters is sent inside with a carbon monoxide meter. They're instructed to check the apartments near the fire for smoke and perform CO measurements. They'll also ask the residents to immediately report any smoke that's entering their homes.

When the rescue arrives, crews are ordered to drill holes with the Hilti in the brick wall in places where the fire is situated. Next, the piercing nozzles can be used.

4.2.1 Extra information

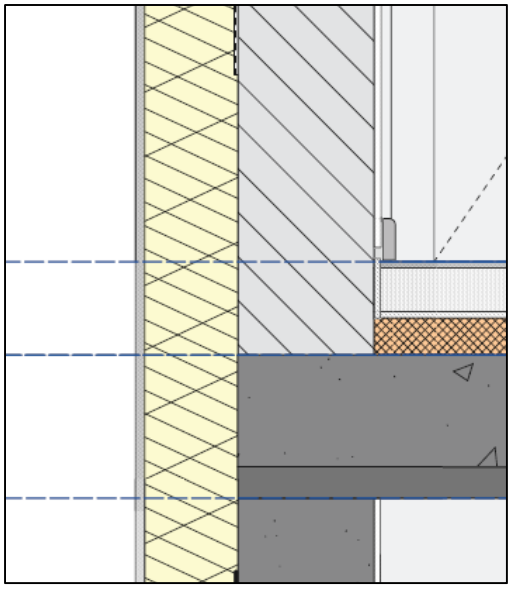


Figure 6 Buildup of the plaster sections. From left to right: exterior plaster, EPS insulation, concrete. *(Drawing: A2RC)*

The IC is a bit worried that the fire will pass around the corner. He decides to take a closer look at the masonry around the corner with the TIC. The second ladder truck is set up for this task. Especially the part where the rain pipe is fixed in the concrete overhang seems to be a hotspot. Upon closer inspection the concrete turns out to be something else entirely. The initial assumption about how the sections in plaster are made up, turns out to be completely wrong. This emphasizes once more the importance of the frame of reference. Consciously or subconsciously, certain assumptions are made on the fire ground. These assumptions are influenced by the firefighter's knowledge and his previous experiences. Because of this, firefighters can be misled.

The real buildup is as follows (from outside to inside): exterior plaster, EPS insulation, concrete. When the plaster is removed around the rain pipe, the insulation is seen smoldering underneath. A lieutenant is then ordered to clear the section around the rain pipe with the goal of checking how far the fire has spread inside the insulation. This is done using a technical rescue chainsaw. This tool can make cuts in the insulation.

Shortly after, crews report that the fire has spread in the section around the rain pipe. The rain pipe is situated about half a meter from the side corner. A section of 50 cm by 50 cm has been cleared and the fire has already spread beyond this section. Soot stains along with partially melted and discolored insulation are proof of this (see Figure 8).

A crew is then asked to move about five meters further down the wall underneath the overhang and make another cut in the insulation. Again they need to check whether the fire has spread that far (see Figure 7). This takes some time to accomplish, but again the crew reports that the fire has spread beyond this point. This means that the fire has already travelled over 6 meters horizontally.

It turns out later that the fire has mostly spread along the connection between the vertical brick wall and the cantilever section.

Then the fire crew that was sent inside to perform CO measurements and to alert the residents, report that there's a strong burning smell in the apartment located directly above the fire. On top of that, large amounts of soot are detected on the wooden floor in the apartment above the fire. The smoke of the fire has found a way up and has entered the room. This creates the impression that the fire is still spreading.

Figure 7 The crew moves five meters down the wall and makes a new cut with the technical rescue chainsaw. *(Photo: Pieter Maes)*

On the (third floor) terrace, firefighters are asked by the IC to clear the plaster. The IC asks them to make a horizontal cut in order to check whether the fire has reached this point.

The situation at this time is as follows:

- There's a fire in the vertical brick wall next to the flat roof on the second floor. This is a fire in a vertical pane.
- The fire has spread to the insulation at the bottom of the cantilever section. This is a fire in a horizontal pane.
- There's a large amount of soot inside the third floor apartment. There's a possibility that the fire has spread vertically and is now smoldering on the third floor.
- The fire in the overhang has passed the corner of the building and is now spreading horizontally. It is unknown however, how far the fire has spread and how fast it is spreading.

Figure 8 Photograph of the partially burned EPS insulation. The upper part was smoldering and has blackened. The rest of the piece has retained its original grey color. *(Photo: Pieter Maes)*

4.2.2 Analysis

The fire is progressing slowly but steadily. It's unclear how far the fire has spread. The fire started in a single vertical wall section (bottom arrow of Figure 5) and is now in the horizontal pane at the bottom end of the overhang. Aside from that, the fire has probably passed the building corner inside the brick wall. So there's also a smoldering fire in a second vertical pane indicated as "possible fire extension" on Figure 5. There's a very clear distinction being made here between a smoldering fire in a vertical pane and a smoldering fire in a horizontal pane. After all, the fire will spread much quicker upwards than it will sidewards in the vertical pane of the overhang.

Crews are worried that the fire will reach the edge of the overhang and will start travelling upwards again. The cantilever section has nine floors in total. It's feared that the consequences will be grave if the fire reaches the vertical pane.

4.2.3 Further handling of the incident

After consulting the senior officer on call for major incidents (deputy chief), it's decided to call for extra piercing nozzles. The station of Zaventem of fire department Vlaams-Brabant West is also asked to bring their piercing nozzles to the scene. A third ladder truck is called out to speed up extinguishment because there's limited time frame which needs to be taken into account. The fire must not be allowed to reach the border between the horizontal and vertical sections.

Figure 9 Three ladder trucks are working to clear the plaster and the EPS insulation. *(Photo: Robert Dekock)*

The strategy for extinguishment is to remove the fuel and extinguish/remove the burning bits. A distinction needs to be made between the brick and the plastered sections.

The same as in forest fire fighting, "firebreaks" are made in the plastered sections. When the fire has been outlined, it can't spread any further. This is done by making saw cuts. The technical rescue chainsaws of FD Brussels are critical for this task. After the first cut is made, a second one is made parallel to the first one at about 15 cm. Next the insulation between the two cuts is removed.

The tactic of making two parallel cuts and removing the fuel in between the cuts in order to create a "firebreak" is called making a *trench cut*. This tactic will prove valuable in the future when facing (smoldering) fires in flammable insulation or exterior wall linings. The tactic isn't new though. It has been used successfully in the past when tackling fires in walls made up of sandwich panels.

Crews check whether the edges of the cuts consist of unburnt material. If they do, then the firefighters are certain the fire has been cut off. Next, all of the burnt insulation is removed from the building. This is a very time consuming chore that's being done from the baskets of the ladder trucks in the outside air so BA's aren't necessary. The crews are wearing dust masks because of the EPS particles that are flying around. Also, some of these particles are charred.

Aside from outlining the fire in the plaster wall section, the brick section is taken care off by drilling holes in several places and putting in a piercing nozzle (see Figure 10).

To achieve the goals set by the strategy, three crews are operating simultaneously. The fire service succeeds quickly in removing enough insulation to outline the fire.

Figure 10 Piercing nozzles in use. First a hole is made in the brick wall using a Hilti power drill. Next a piercing nozzle is used to flow water inside. The water is running downwards over/through the insulation. The photographs show the water running back out through the weep holes. *(Photo: Robert Dekock)*

5 Final damage

5.1 Masonry wall

The final damage is relatively limited after the intervention is finished. The brick wall has been punctured at about a dozen places. Over an area of 30 m², a dozen holes have been drilled to allow the use of piercing nozzles.

In times before piercing nozzles, such a fire could only have been extinguished by tearing down a section of the brick wall. That would have been the only way to reach the smoldering insulation. There's a very large drawback to this method. A soon as a brick is removed, air can rush in and the fire can spread. Often fire crews are one or two steps behind the fire if they choose this method of operation. So in the old days, a large section of bricks had to be torn down before the fire could be halted. On the other hand, there's much less doubt whether all of the insulation has been put out when the bricks are removed entirely.

5.2 Plaster

In the plastered sections there's substantially more damage. The bottom side of the overhang needs to be replaced almost entirely. The fire has travelled primarily along the connection of the vertical brick wall and the horizontal EPS insulation, so a section of only 20-25 cm needed to be cleared in the area furthest from the original seat of fire (see Figure 11).

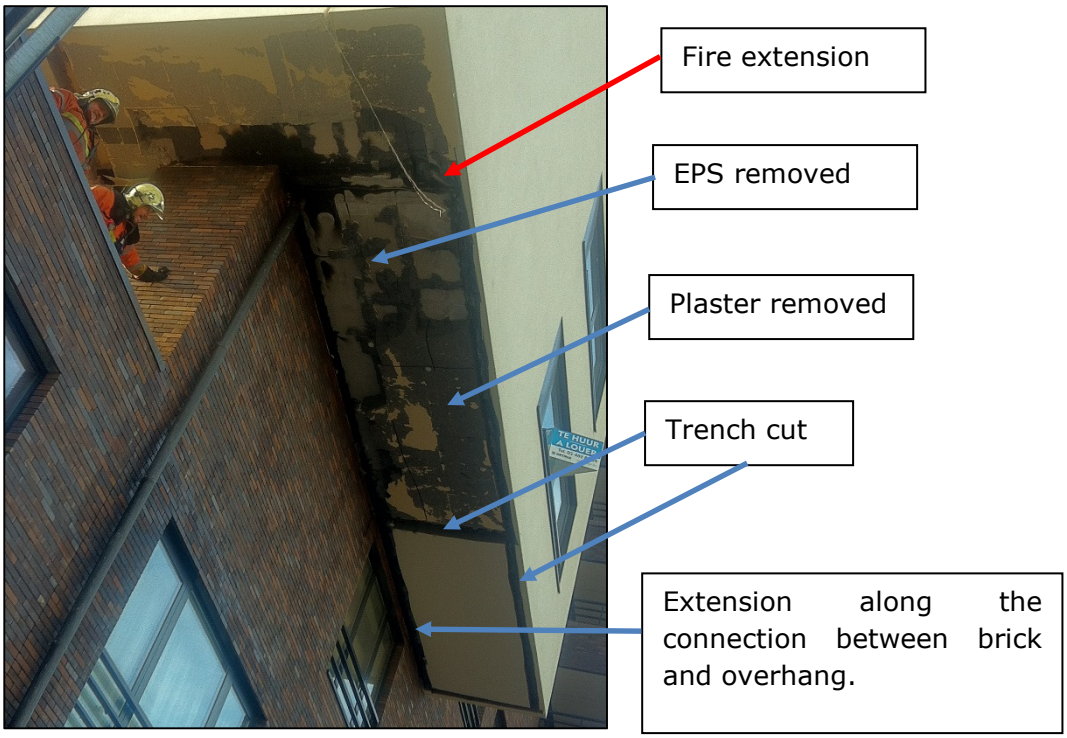


Figure 11 Damage at the overhang exposed. The black spot at the corner indicates the most intense place of burning. The red arrow shows that the fire had spread up to 20-30 cm of the edge. The blue arrows indicate different areas where fire crews have removed building materials. *(Photo: Pieter Maes)*

The rest of the overhang has been more heavily damaged. The exterior plaster has been removed over a large surface area. Figure 9 shows a band of plaster hanging down. After removal of the plaster there was often a clean and unburnt piece of EPS visible. That did not mean however, that there wasn't a smoldering fire inside the material or between the insulation and the concrete. Figure 11 shows us several sections in different colors. Far right there's the unburnt plaster. This section is outlined by trench cuts. In the section next to that, there's unburnt EPS. This is the dark grey section. In the area around the corner, there's a light grey section visible. Here the EPS insulation has been removed. The light grey color is that of exposed concrete.

One important detail is that all of the cuts at the bottom of the overhang are made a few centimeters away from the edge of the overhang. By doing this, the vertical walls have remained undamaged. This will facilitate the repairs.

Figure 11 also shows how far the smoldering fire had gotten in the insulation. The fire has left soot stains on the concrete. The red arrow indicates how far the fire got. The fire service succeeded in halting the fire at about 20 to 30 cm from the edge of the overhang.

Figure 12 Overview of the facade. *(Photo: Robert Dekock)*

Figure 12 is a picture of the building facade. This picture clearly shows what would have happened if the fire had reached the edge of the overhang.

Two different elements become important in that case. Firstly, a fire spreads a lot faster travelling vertically than when it's travelling horizontally.

Secondly, air will reach the fire more easily when it breaks through the plaster in the vertical pane.

Youtube hosts numerous films in which a fire starts in flammable wall linings or flammable wall insulation. These fires often result in massive infernos. Because of the smart actions of the roofers (first attempt at extinguishment, then alert emergency services), the adequate intervention of the fire service and the luck that the fire had not yet reached the vertical section, a catastrophe was avoided.

6 Word of thanks

This fire was a tough one to analyze properly. First, there's very few experience in dealing with such fires. Construction fires are a relatively new phenomenon. Therefore it's very hard to estimate how bad things were or could have been. How big was the effect of the initial extinguishment by the roofers and what can be attributed to the fire crews? The next quote is applicable:

> *The whole problem with the world is that fools and fanatics are always so certain of themselves, and wiser people so full of doubts.*
>
> *- Bertrand Russel*

In writing this article I was helped by the following colleagues to better understand and describe the events on the fire ground: Major Christian Gryspeert (Midwest FD), Captain Peter Roseleth (Brussels FD) and Captain Nathalie Van Moorter (zone 1 FD).