Exterior Insulation Finish Systems:

Hazard Considerations for the Fire Service

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Certification Statement

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Abstract

The purpose of this paper was to examine the components of Exterior Insulation Finish Systems (EIFS) and to analyze their combustion properties. This information along with case studies was utilized to identify challenges that firefighters might face when fighting fires in buildings clad in EIFS. Recommendations were made in regards to tactical considerations when mitigating fires involving buildings clad in EIFS.
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Introduction

Exterior Insulation Finish System (EIFS) is a non-load bearing exterior wall treatment which due to its excellent insulation properties and design flexibility has been a popular choice for exterior building cladding for several decades. While the benefits of EIFS in building construction are numerous, the combustion properties of the insulating component provide numerous challenges to firefighting operations involving structures clad in EIFS. The purpose of this paper is to analyze the components of EIFS and their combustion properties. This research will utilize case studies involving fires in buildings clad in EIFS to identify challenges presented to firefighting operations and present recommendations for mitigating fires in these structures.

Background

EIFS is a synthetic, lightweight building material which is available in many colors, shapes and textures. EIFS is non-load bearing, and is able to conform to many building shapes and details. EIFS is a multi-layer system which can be attached to a number of substrates. These substrates can be concrete block, concrete, oriented strand board, plywood, cement-board, or gypsum board sheathing. EIFS is not a complete wall system; therefore, it does not contain windows and doors. EIFS weighs approximately one pound per cubic foot of density foam. Its light weight allows it to be used to span large areas without the need for control joints.
The base layer consists of a foam board usually comprised of expanded polystyrene (EPS) which can range in thickness from ¾-inch to four inches thick. Thicker blocks of foam may be used to create accent details such as cornices, arches, columns, keystones and cornerstones (Wilsse, 2009). The EPS includes a flame retardant to reduce its ASTM E84 flame-spread rating (Havel, 2008). This base is either adhesively or mechanically attached to the substrate using a troweled on adhesive or screwed fasteners and serves as an external insulation layer. The base coat consists of a synthetic, water based, plastic coating which is embedded in a reinforcing fiberglass mesh. The finish coat consists of either a polymer-based (PB) or polymer-modified (PM) synthetic material. This material may include Portland cement (PM) and is applied with a trowel over the fiberglass mesh. This finish coat can be made to look like poured concrete, concrete blocks, bricks or any finish the architect sees fit.

Figure 1. A cross-section of Exterior Insulation Finishing System (EIFS) application.
History

EIFS was developed in Europe in the 1960’s. EIFS was designed to provide the European construction market with a means to insulate older brick buildings without taking valuable interior space while enhancing their appearance. In Europe, EIFS is rarely used on stud/sheathing walls due to most buildings having masonry exterior walls. EIFS was introduced to the United States in 1969 and marketed under the name Dryvit®. The popularity of EIFS increased greatly during the oil crisis of the 1970’s due to its improvement of homes' energy efficiency.

Most early EIFS lacked adequate drainage mechanisms which made it susceptible to failure. This was a result of moisture intrusion either through defects in the top coat or improper moisture barrier, i.e. caulking or flashing, around doors and windows. Trapped water cannot dry out quickly due to the low vapor permeability of the finish. Modern EIFS contains a vapor barrier that includes small channels to allow moisture to drain.

Flammability

Due to the polystyrene foam insulation component, EIFS is considered combustible. Polystyrene foam is a thermoplastic material which means it will melt and flow when heated. “Polystyrene foam will produce combustible and toxic gases at approximately 570°F and will ignite in a range between 900°F and 1,000°F” (Spadafora, 2015). When ignited, a polystyrene fire will create high heat conditions, rapid flame spread, and dense black smoke. The heat release
rate for thermoplastics can be three to five times higher than those of ordinary combustibles such as wood or paper. The heat of combustion for ordinary combustibles generally ranges between 6,000 and 8,000 Btu/lb (13,960-18,600kJ/kg). The heat of combustion for plastics generally ranges between 12,000 and 20,000 Btu/lb (27,900-46,520kJ/kg). (FM Global, 2015).

Several factors can affect the actual performance of EIFS in a fire situation. Material defects, poor workmanship, impact damage, installation errors, and exposed insulation are among the leading causes of fire (Spadafora, 2015). According to White and Delichatsios, “these fires can be ignited in one of two possible ways:

- Fire external to the building (other burning buildings, external ground fires) or
- Fires internal to the building originating in a floor that have resulted in breaking the windows and ejecting flames on the façade.

Once ignited, mechanisms of fire spread include:

- Spread to interior of level above via openings such as windows causing secondary interior fires on levels above resulting in level to level fire spread (leap frogging)
- Fire spread on the external surface of the façade assembly, if combustible
- Flame spread within an internally vertical cavity/air gap or internal insulation layer. This may include possible failure of any fire barriers if present, particularly at the junction of the floor with the external wall.
- Heat flux impacts causing degradation/separation of non-combustible external skin (loss of integrity) resulting on flame spread on internal core
• Secondary external fires to lower (ground) levels arising from falling burning debris or downward fire spread.

• Channeling of convective heat and re-radiation between surfaces such as corners or in channels can accelerate flame spread.” (2014)

The risk of fire spreading through the EIFS when it originates in the interior of a building is small, primarily because of the many layers of drywall and substrates it must first burn through before reaching the insulating EPS (“In Case of Fire”, 2009).

Firefighting challenges

The properties that make EIFS desirable to the construction industry create challenges to firefighting operations in buildings clad in EIFS. The aesthetic flexibility which allows the finish coat to be made to look like other building materials can make size-up difficult. Initial responding fire companies could easily mistake a wood frame structure clad in EIFS for a more fortified block construction building, greatly underestimating the fire resistance of the underlying structure.

Since EPS is protected by a thin layer of synthetic stucco, the extent of fire involvement and fire spread may not be visible. The finish coat may not display indications of heat such as discoloration or displacement, but the EPS underneath may have melted, creating vents which could allow for vertical fire spread (Putaansuu, 2002). This absence of fire indicators could allow the initial responders to misjudge the extent of fire involvement.

The insulating properties of EIFS allow less heat to escape during an interior structure fire which can lead to an increased potential for flashover. Backdraft conditions may also occur
more rapidly in an air–tight enclosure due to the denial of adequate oxygen to sustain burning, “The flammable gases inside the building remain above their ignition temperature however, are unable to ignite due to lack of oxygen”. When firefighters enter the building, fresh air is introduced to the oxygen starved environment which could allow the fire to explosively ignite (Spadafora, 2015).

Once fire penetrates the finish coat of the EIFS, the foam insulation can rapidly ignite. This can lead to rapid fire spread which can generate dense black smoke. “The sudden increase in fire intensity can trap or injure firefighters operating in, on and in the vicinity of the building” (Spadifora, 2015). A large amount of fire inside the walls of a frame structure could cause early failure of interior structural components which could lead to collapse of the structure. If fire is able to penetrate the base coat and reach the EPS component, rapid vertical fire spread is possible, especially if vertical channels are created in the EPS. This upward fire is capable of producing intense heat which is able to cause failure of exterior windows allowing fire to spread to the interior of adjacent floors. As EPS burns, flaming dripping debris can not only injure firefighters operating in the area, but the molten plastic can pool, causing fires below the initial fire object.

Queens Mini Mall Fire

On November 2, 2008, at 1:10 am, FDNY units were dispatched to a structure fire in a strip mall which contained eight businesses including a diner, a Chinese restaurant, two banks, a GNC, a liquor store and two vacant store fronts. The building was approximately 250 feet long and 100 feet deep. Initial arriving companies found heavy fire venting through the window of Lollipops Diner which was located in the center of the strip mall. Before firefighters were able to apply water, the fire ignited the exterior wall and 10 foot deep overhang. The wall and overhang
were clad in EIFS. The fire rapidly spread across the building’s entire frontage. Flaming, molten EPS showered down on firefighters operating in front of the structure. Firefighters were ordered to retreat so that a defensive attack could be initiated, delaying extinguishment of the structure. A second alarm was eventually required to bring the fire under control.

Investigators found that the fire was started by an arsonist who lit a bag of Halloween candy on fire in the diner in order to cover up a robbery in which he stole a pack of cigarettes and the lighter he would use to light the fire. He entered by breaking the front window which provided the fire with an endless supply of oxygen. The fire was able to auto-expose to the façade, igniting the EPS. The rapid fire spread and the resultant dripping, liquid plastic fire, placed firefighters forcing entry and preparing to advance the hoseline into the structure in great danger. Fortunately there were no injuries, but the rapidly spreading fire caused extensive damage to all occupancies (Spadafora et al, 2012).

Figure 2. Fire spread along EIFS cladding Queens, New York. November 2, 2008.

Monte Carlo Hotel Fire

On January 25, 2008, just before 11:00 AM, firefighters were summoned to the MGM Monte Carlo Hotel in Las Vegas, Nevada, for a fire in the upper area of the 32 story hotel/casino. The building was completed in 1995 and consisted of a center tower from which three 240 ft. long wings extended. The exterior of the building was clad in EIFS. “Decorative non-EIFS architectural details constructed of EPS encapsulated in polyurethane resin were also installed on the exterior of the building” (White, Delichatsios, 2014).

The fire, which was started by workers welding on a catwalk on the roof parapet wall in the center tower, spread laterally across the top of the façade via the non EIFS architectural details. Wind helped spread the fire laterally over 170 feet (Spadafora, 2015). The flaming droplets of EPS ignited the façade materials on the horizontal cornice between the 28th and 29th floors. “Heat from the fire broke several windows; however, interior sprinklers were able to halt fire spread to the interior guest rooms” (White, Delichatsios. 2014). A large portion of the fire was out of reach of firefighters’ hose streams, and firefighters were forced to break windows and fight the exterior fire from within guest rooms, which left firefighters hanging precariously out of windows in order to train the fire streams onto the fire. During the investigation, samples of materials were collected. It was found that the EIFS had non-compliant thickness of finish lamina on the EIFS which allowed fire to penetrate to the EPS. Investigators also cited large components containing significant thicknesses of polystyrene foam, not covered with EIFS lamina, which was attached to the EFIS claddings as contributing factors to the fire’s spread (Spadafora, 2015).
Figure 3. Fire involving EIFS, Monte Carlo Hotel Las Vegas, Nevada, January 25, 2008.

Recommendations

- Attempts should be made to identify EIFS cladding during the construction and remodeling process of buildings in a response area. These buildings should be preplanned so that additional safety precautions can be taken into consideration by first arriving fire companies.
- Access to buildings clad in EIFS which have interior working fires, should be highly scrutinized and flow paths must be diligently controlled to minimize the risk of flashover and backdraft.
- Thermal imaging can be useful in determining the extent of fire spread which could potentially be masked by EIFS components.
- Additional manpower should be considered to control a rapidly advancing fire if the EPS component in EIFS becomes involved.
- Large diameter hose streams and copious amounts of water may be required to extinguish a fire involving EIFS cladding due the high Btu’s released when ignited.
- Crews working in the area of a fire involving a structure clad in EIFS must remain vigilant for the possibility of flaming liquid dripping from above.

**Conclusion**

Energy efficiency and flexibility in design applications have made EIFS a popular choice for external cladding for several decades. The properties which make it popular in the building industry also present challenges to firefighters when these buildings become involved in fire. EIFS cladding can be found in nearly every fire response area. Due to the implications that EIFS cladding can have on fire operations and the inherent dangers it presents, the fire service must be aware of the challenges involved, and be prepared for mitigating fires in these structures.
References


