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A Study on the External Wall Insulation System Safety Accidents in a Residential Community in Nanjing, China

Yi Shi[1,2,a], Lu Lu[1,2,b,*], Shan Yun[1,c], Chunyuan Zuo[1,2,d], Xinguo Sun[1,2,e]

[1]*Research Institute of Carbon Storage Science and Engineering, Huaiyin Institute of Technology, Huai'an, 223003, China*
[2]*Jiangsu Smart Factory Engineering Research Centre, Huaiyin Institute of Technology, Huai'an, 223003, China*
[a]*dagongshiyi@163.com*, [b]*llzhxy@aliyun.com*, [c]*yunshan@hyit.edu.cn*, [d]*chunyuan-0227@163.com*, [e]*sunxinguo48144562@hyit.edu.cn*
**Corresponding author*

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Abstract: The external wall insulation system is a critical component for ensuring building energy efficiency and residential comfort. However, such systems typically involve multiple trades, diverse materials, and complex construction processes, placing high demands on material performance, design standards, construction quality, and post-completion maintenance. In 2024, two safety incidents related to external wall insulation systems occurred in Nanjing, China, exposing significant issues in material selection, structural design, construction techniques, and maintenance supervision. These incidents warrant broad attention and discussion within the industry. By analyzing and studying these cases, students can be trained to uphold the fundamental requirements of compliance in engineering quality and safety management. Moreover, it fosters a deep understanding of the principles of "safety first and quality as the foundation."

1. Introduction

In recent years, with the rapid advancement of urbanization in China and the widespread implementation of energy-saving and emission-reduction policies, external wall insulation systems have been extensively applied in both new constructions and energy retrofits of existing buildings. However, the practical application of these systems has revealed a series of safety hazards. Over time, incidents such as exterior wall detachment, fire spread through insulation layers, and structural damage have occurred in some residential communities, posing threats to the safety of residents and their property, and drawing significant public concern [1-3].

This study focuses on typical safety incidents that occurred in Nanjing, China. It systematically examines the background, progression, and causes of these accidents, explores the major issues present in the practical implementation of external wall insulation systems, and proposes corresponding improvements and countermeasures. Through this research, it is hoped to promote in-depth industry reflection on the balance between building energy efficiency and safety, and to

advance external wall insulation technology towards a safer and more sustainable direction[4,5].

2. Problems in External Wall Insulation Systems

With the deepening implementation of building energy-saving policies in China, a number of quality and safety issues have emerged in the application of external wall insulation systems across many projects [6,7]. The main problems faced by these systems include:

(1) Substandard fire resistance of insulation materials

A large number of insulation materials currently on the market have low fire-resistance ratings and are used in high-rise buildings without proper flame-retardant treatment, failing to meet the mandatory requirement for Class A non-combustible materials as stipulated in the Code for Fire Protection Design of Buildings. This issue is particularly prominent in polyurethane thin-plaster systems, which are highly susceptible to ignition and can lead to rapid fire spread along building fa ̧ades, posing significant safety risks.

(2) Weak quality control in construction

Numerous irregularities occur during the construction phase, such as installing insulation boards without proper surface cleaning, improper placement of anchors, uneven thickness of plaster layers, and failure to follow expansion joint procedures. These issues lead to insufficient overall adhesion strength of the system, making it prone to bulging, cracking, and detachment—risks that are especially exacerbated during extreme weather conditions like strong winds and heavy rain.

(3) Material aging and inadequate post-construction maintenance

Some insulation materials deteriorate over time when exposed to humid or high-temperature environments. Common issues include the high water absorption rate and poor weather resistance of rock wool, as well as aging and cracking of polymer-based mortars. Unauthorized alterations to exterior walls by residents and the lack of regular inspection and maintenance by property managers further contribute to safety hazards. If not promptly repaired, these problems can lead to delamination and peeling of the insulation layer, compromising both the structural integrity and aesthetic appearance of the exterior wall.

3. Analysis of External Wall Insulation System Safety Accidents

3.1 Case 1: Fire Spread in Polyurethane Thin-Plaster System

Figure 1 Fire spread in the Polyurethane Thin-Plaster External Wall System

(1) Background

At 4:35 a.m. on February 23, 2024, a major fire broke out in Building 6 of Mingshang Xiyuan Residential Complex, located at No. 9 Xishi Road, Yuhuatai District, Nanjing. Due to the chimney effect, the polyurethane thin-plaster insulation system caught fire, causing the flames to spread rapidly. The resulting fire and high-temperature toxic smoke quickly penetrated the apartments through external windows located within the lightwell, leading to casualties. Figure 1 shows the fire spread on the external wall of Building 6 in Mingshang Xiyuan, Nanjing.

(2) Accident analysis

Although polyurethane foam in thin-plaster systems has excellent thermal insulation and strong adhesive properties, its thermal stability and flame-retardant performance are relatively poor. It is especially flammable when exposed to high temperatures or open flames. In this case, the polyurethane material had not been effectively treated with fire-retardant additives and was classified as a B2-grade combustible material. This did not meet the regulatory requirement that external wall insulation systems for high-rise buildings must use A-grade non-combustible materials, making it a direct factor in the rapid spread of the fire.

3.2 Case 2: External Wall Detachment in Rock Wool Thin-Plaster System

(1) Background

On the evening of August 5, 2024, a sudden heavy rain hit parts of Nanjing. Baiyun Yaju Residential Community, located in Gulou District, was within the affected area. Strong winds caused large sections of the external wall insulation layers on several buildings to peel off. The falling debris damaged cars parked below, and multiple buildings in the community showed signs of exterior wall delamination. The exterior wall of Building 14 in Baiyun Yae Yuan Residential Area in Nanjing City has experienced wall falling off, as shown in Figure 2.

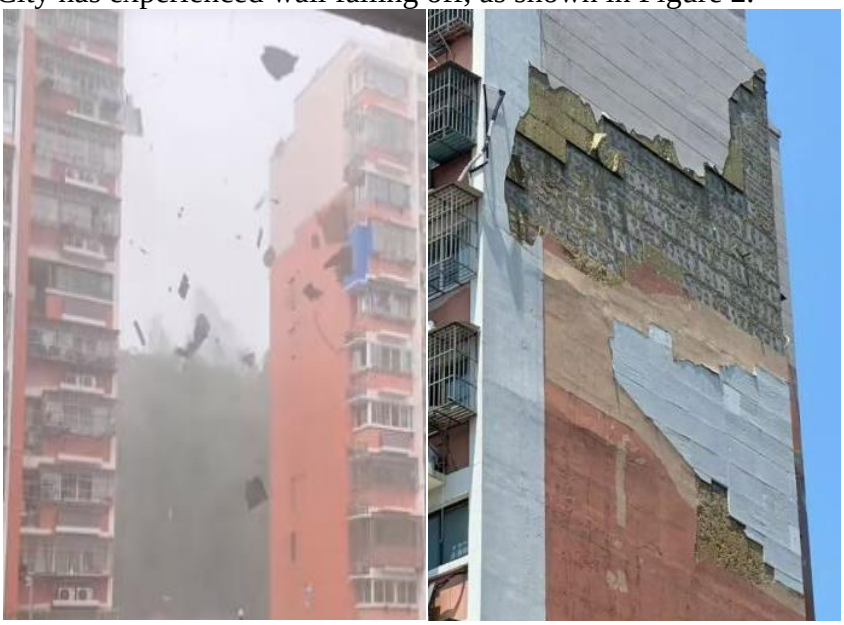

Figure 2 External Wall Detachment of the Rock Wool Thin-Plaster System

On-site observations indicated that the area of detachment extended approximately six stories in height and over four meters in width. The exposed wall surface revealed deteriorated and mottled remnants of rock wool insulation, creating a stark contrast with the intact portions of the wall.

(2) Accident analysis

Preliminary analysis suggests that the primary cause was the aging and cracking of the wall's

plaster layer, which allowed rainwater to penetrate and saturate the adhesive layer, leading to debonding and detachment of the insulation. Additional contributing factors include the building's location at a wind corridor, where the "Venturi effect" exerted long-term shearing forces on the insulation, and unauthorized exterior wall renovations by residents that compromised the insulation layer, allowing water ingress and further weakening adhesion.

4. Conclusions

Through the comparative analysis and objective description of the two incidents, this case study highlights that, in the practical application of building insulation systems, one must not pursue energy efficiency or cost-effectiveness at the expense of overall system safety. For developers, design institutions, construction teams, and regulatory authorities, it is essential to strengthen comprehensive evaluation and coordinated management of external wall insulation systems throughout their entire life cycle. In particular, strict adherence to national standards and industry codes is required concerning material combustibility, fire-resistant construction, wind load adaptability, and anchorage reliability.

This case provides a real-world foundation for teaching and research in architecture-related disciplines. It can effectively guide students and professionals in conducting in-depth discussions and critical thinking around building system safety, enhancing their ability to identify risks and make informed decisions regarding construction quality and safety. As the scale and density of urban buildings continue to grow, the safety of external wall insulation systems is no longer merely a technical issue—it is increasingly tied to public safety and the resilience of urban operations. It urgently calls for industry-wide reflection and continuous improvement.

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