

Fire Prevention in Exterior Insulation System of External Wall

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Abstract- As exterior thermal insulation system in China has been widely employed in energy conservation in buildings, fire disasters have arisen in some places due to the improper use of the exterior insulation materials, which caused serious consequences of injuries, mortality and economic losses. Based on several typical cases of fires caused by external thermal insulation materials, this paper is intended to analyze the safety of external thermal insulation system and explore with great detail the countermeasures of fire prevention in exterior thermal insulation system.

Keywords- Energy Conservation; Fire Prevention; External Thermal Insulating Composite System (ETICS); Fire Safety; Countermeasures

I. INTRODUCTION

Energy conservation in buildings is the main content of national environmental protection and conservation of national energy policy in China. It is one of the important measures to achieve the "21st Century Strategies for Sustainable Development". Over the years, driven by national energy policy and the relevant technical specifications, China's energy conservation has been improving and energy efficiency standards have been enhanced. The external wall insulation technology and performance in particular are developing rapidly. As the heat loss of the external structure is huge, and external structure constitutes 45% of the total exterior wall area, enhancing the external wall thermal performance is vital to energy conservation in buildings.

In China, wall insulation is usually classified into interior insulation of external wall, sandwich insulation, exterior insulation of external wall and comprehensive thermal insulation. Among them, the exterior insulation is the chief means of thermal insulation advocated by China's Ministry of Housing and Urban-Rural Development, for its effect is the most direct and the best. Therefore, it is one of the means of thermally upgrading buildings in China at present, among which Polystyrene boards used in external wall insulation system are commonly used in China in

recent years. However, in the process of fixing and application of the polystyrene boards, some defects arise in terms of insulation, such as hollowing, cracks, droppings, and virtual stickers; defects in terms of appearance quality, such as cracks, and droppings; and some thermal and overall deficiencies, such as wall body mould, condensation, seepage, or even the loss of energy-saving features. What's worse, the fire control of polystyrene boards under construction in external insulation system is a serious problem.

Fire prevention in the construction of buildings becomes increasingly important in modern life. The organic materials used in modern architecture in recent years have become a major source of building fire. Even if not the fire source, they are the contributing factor for fire spreading. When the fire breaks out, the release of smoke, gas and heat is the major injury to human beings. Fires caused by organic materials employed in external insulation systems spread fast, and bring about difficulties in evacuating and fighting, thus resulting in a series of serious fire disasters.

II. CASES STUDY

In recent years, there have been many cases of fire accidents related to polystyrene boards used in exterior wall insulation. Analyse the periods of these fire breakouts, and it is found that fires could occur when the insulation materials were being stacked in the construction sites, such as the fire on December 22, 2005 in the construction site of Shanghai Thomson Riviera, two 44-story high-rise buildings, and the fire in a hotel site located on Hong Kong Middle Road, Qingdao in 2007. Other similar situations occurred in Beijing, Harbin and other cities of China.

Fires could also break out when insulation materials were installed on the wall, such as the fire outbreak in the construction site of a high-rise complex building of water supply in Urumqi on July 6, 2006, two fire outbreaks on Beijing Shangdi MOMA site within half of the year, and

those in Jinan, Jining, Wuxi and other places of China.

Still other fires broke out when the external thermal insulation system was being employed, such as the fire outbreak in Buyun Mountain of Huanggu district in Shenyang on February 24, 2007 and the fire in “e Era” Internet cafe in Xi’an, as well as the Las Vegas Monte Carlo hotel fire in the United States.

Most of these fires were caused by overlapping operations in the construction site when polystyrene boards meet the combustible materials or welding slag; other fires broke out due to the fire in buildings nearby or the fire inside the buildings, which ignited the building’s external wall insulation systems and other combustible materials, leading to the spreading of heavy fires under the “chimney effect”. Therefore, fire safety must be highlighted, especially in exterior insulation system of high-rise building construction.

III. ANALYSIS OF FIRE SAFETY IN EXTERNAL THERMAL INSULATION SYSTEM

A. Causes of Fires in External Insulation System

Insulation materials for the building’s exterior wall include three categories. The first category is the anti-fire materials, made of inorganic materials, such as wool or glass wool. The second is composed of the polystyrene-based organic-and inorganic insulation materials, which are difficult to catch fire. The third is the polystyrene board insulation and polyurethane-based organic material, which is flammable. Fire will not break out in the thermal insulation system when non-combustible materials or flame-resistant materials are used. However, polystyrene or polyurethane and other flammable materials in our building insulation system are applied. These flammable materials have a broad, low ignition and internal micro-bubble structure, which make quick breakout and spreading of fires.

B. Fire Hazards in External Insulation

Based on the corresponding test of the fire rescue process and analysis, it is found that the direct harm caused by the organic insulating materials can be reduced to the following aspects: harm in the first place is flame; the second is the hot gas and thermal radiation in the fire; the third

is oxygen suffocation; the fourth is smoke; and the fifth is toxic gases and toxic substances. Among the above five fire hazards, according to the statistical analysis, smoke and toxic gases cause 80% of deaths in the fire.

C. Fire-proof Performance in External Insulation System

Two things decide whether the exterior insulation system of buildings is fireproof; one is the ignition of materials; the other lies in the condition if the system itself or material can be easily transmitted to flames.

D. Key Factors Affecting the Fire-proof Performance of External Insulation System

In the current technological conditions, the ignition of the insulation materials and the flame propagation do exist. And the flame-retardant indicators of polystyrene and rigid polyurethane foam fail to meet the high requirements due to the restrictions in current economy in China. There must be other measures to satisfy the fire safety requirements in thermal insulation system. The factors affecting the fire safety performance of exterior insulation system involve the composition of external insulation materials and their construct methods, which is the key factor affecting the fireproof performance of exterior insulation system. The constructs include the thickness of protective layer or surface layer, bonding or fixing mode (without cavity), and the constructs of fire blockings and so on. Among them, the thickness of the protective layer and its quality stability decide the protective ability of external insulation materials to the organic internal insulation materials when the external insulation system is attacked by heat or flames. Fire blockings can effectively prevent the spread of fire while the presence of the cavity can accelerate the spread of fire by providing sufficient oxygen and chimney channel for the burning of thermal materials in the system.

IV. COUNTERMEASURES OF FIRE SAFETY IN EXTERNAL INSULATION SYSTEM

External wall insulation in China’s buildings has a wide range of applications, and it also causes a lot of fires, bringing about casualties, economic losses and severe damage to the environment. Before the new thermal technology is invented, external wall insulation in construction works still occupies a dominant

position. In order to reduce the loss caused by fire accidents, we must pay adequate attention to fire safety in external insulation system, conduct some relevant research and take effective measures.

A. Strengthen Fire Prevention in Construction Sites

In the long run, the fire danger of building external insulation after being put into use cannot be ignored. But nearly 70% fire of the exterior insulation happened at the construction site, mainly because the construction site is a multi-type, and overlapping working place. In the course of construction, there is insecurity risk of the exposed insulation materials failing to avoid the splash of sparks, which leads to fire outbreak and spreading. Thus, it is very important to manage the construction and it reveals the most direct effect to strengthen the fire prevention in the construction site.

For the fire prevention of external insulation system in the construction site, firstly fire safety education should be strengthened for the corporate representative and the project manager, who should be fully aware of the importance of fire safety, and the serious consequences of fires, and ensure specific measures to prevent the fire; then education should be strengthened for the individual in charge of the external insulation, the full-time security managers, and more importantly for the on-site workers. Effect of the education rather than the formality should be highlighted and a variety of methods can be adopted, such as lectures, discussions, audio-visual lectures, security activities, and even role-playing. For instance, fire-fighting exercises can be performed at every period of applying the external thermal insulation.

Secondly, a responsibility system for fire safety should be established, not only for the chief leader in charge of the construction companies or project managers or sub-unit leaders, but also for the group leaders and group workers, making each participant in the construction of the external insulation attach great importance to fire safety responsibilities.

Thirdly, practicable and effective safety inspection and supervision system should be established involving the government administrations, corporations, project performers, working group, and even social forces.

At the national and local requirements of the mandatory standard, the external wall insulation system has been employed in a large scale across the country in recent years. The system involves new materials, new methods, and new techniques. Compared with traditional materials, construction methods, and techniques, it takes time for project managers, technicians and workers to grasp the new system. Therefore, specific construction programs in great detail, and targeted fire-fighting schemes and measures in particular should be established to implement the system. When construction is going on, adequate fire-fighting equipment, materials and part-time fire-fighters should be available. For the stacking and fire prevention of the external insulation materials, great attention should be given to the following.

1) The flammable, combustible insulation materials used in the construction site should be strictly managed and supervised for safety. Material properties must meet the standards of "Code for Construction and Acceptance of Building Energy Conservation" (GB50411).

2) When the insulation materials are accepted by the construction site, they must meet the standards on the varieties, specifications, packaging, appearance and size approved by the project management engineer. Then the corresponding records should be made.

3) The certification of the products and statutory inspection test report issued by the legally authorized department should be examined meticulously. Re-examination of the product samples according to the provisions is also required. The combustion of insulation materials must meet the standards of "Combustion Grading of Building Materials and Products" (GB8624). If materials are found disqualified, they will be strictly prohibited and rejected.

4) The insulation materials and boards should be stored far from fuel and fire; neither should they be stored in the construction place for a long time. If the bare boards are collectively stored, they must be covered with anti-fire materials. Floors of Construction work surface must be equipped with adequate fire fighting equipment.

5) The insulation materials which have been brushed with interface agent, when stored in the working place, must meet the fire safety requirements, and material storage requirements; in other words, the materials should be stored far from the fire and fuel, and with adequate fire fighting equipment. Smoking is forbidden and fire should be used with caution. Inflammable, explosive materials and dangerous goods are prohibited from being stored in the working place. High power lighting should not be used at night. Overlapping operation should be avoided while the external insulation system is installed.

B. Improve Technology of External Insulation System

1) By learning from the foreign advanced technology and innovation standards suitable for China's conditions, a new external insulation system should be developed, which has independent intellectual property rights and can solve the existing problems caused by the traditional system. The new system will provide more choices for the external insulation technology after the rating system of fire protection being published and meanwhile it's the insulation industry's future development direction.

2) By conducting experiments on various kinds of external insulation systems and the properties of insulation materials to prevent fire, it's urgent to formulate the experimental methods of fire protection in external insulation system, which is fit for China's conditions. And by learning from other countries' standards, the rating evaluation of fire-protection performance and the application range of external insulation system should be made to form the mandatory standards. In exterior walls of high-rise and super high-rise buildings, the external insulation system should be employed with more fire safety to further standardize the market of exterior insulation market, reduce fire risks, lower the bad effect of the external thermal insulation system on fires, and gradually grasp the advanced fire protection technology of the international exterior insulation system.

V. CONCLUSIONS

As the saying in China goes, hidden danger is more serious than the obvious fire, and so prevention is better than disaster relief. Relevant research institutes and enterprises should make further effort and more research on fire prevention of the external wall insulation system. The relevant functional departments of the government in accordance with laws and regulations should take exertion on inspection, control and sanctions of fire protection. Also the relevant authorities should strengthen legislation and the development of standards. Moreover, construction companies should perform their duties according to standard specifications for construction. Finally, the community should play its supervisory role, so that the whole society shows great concern to fire safety in external thermal insulation system.

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