



## Stack effect of smoke for an old-style apartment in Taiwan

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### ABSTRACT

Many existing apartments in Taiwan allow parking of motorcycles on the 1st floor along the arcade. For the purposes of lighting and ventilation, there is an opening in upper of the gates. Taking motorcycle arson as a fire scenario, this study proved that smoke would move into the building quickly via the opening and flow upward through the staircases, posing a serious risk whenever motorcycle arson was committed. The simulation results from FDS demonstrated that the visibility decline is very fast inside staircase. When the opening was moved to the bottom of the gate, the decline became slow because the stack effect phenomenon was effectively diminished. Image-recording and laser smoke layer measurement equipment was used to measure smoke diffusion, referring to the Australian Standard, AS 4391-1999 “Smoke management systems-Hot smoke test”. The experiments were executed in a five-story building by recording visibility at a height of 1.8 m on each floor. The results indicated the same conclusions when the opening was moved to the bottom of the gate. The results also verified that the door in the attic staircase was open; the stack effect was very significant.

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## 1. Introduction

### 1.1. Statistics of residential fires in Taiwan

During the 1970s, the economy of Taiwan was growing rapidly. Many job opportunities were created in urban areas, resulting in a significant increase in buildings that were less than five floors. Since the establishment of the National Fire Agency of Taiwan in 1995, many fire regulations have been set for the buildings of public places, emphasizing the establishment of fire safety equipment, as well as the implementation of periodic maintenance reports, criteria of flame-retardant testing approval, fire protection management and other systems. As a result, the number of fires has been decreasing with time, as shown in Table 1 [1].

However, the current fire regulations do not include apartments in communities. In February 1995, the National Fire Agency of Taiwan stipulated, according to the “Regulations on improvement on fire-prevention refuge facilities and fire-fighting equipments of existing buildings”, one of the 77th articles in the Building Technical Regulations, that the fire-prevention refuge facilities and fire-fighting equipment of the existing building must be improved [2].

The regulations have been only restricted to the public buildings such as theaters, restaurants, large shopping centers, etc. For buildings that are less than five stories within the implemented urban planning division areas and buildings that are less than four stories outside the urban planning division areas, if the floor area is less than 1000 m<sup>2</sup>, the mentioned regulations do not apply.

According to the Monthly Bulletin of Interior Statistics of Taiwan [1], Fig. 1 shows the proportion of all types of building fires. Despite the gradual decrease in the number of fires over the years, residential fires, both standalone dwelling and group dwellings, constitute more than 60%. Reducing the number of residential fires is one of the main research topics in Taiwan in recent years.

### 1.2. Arcades in Taiwan apartments

Analyzing the existing apartments, a set of housings, especially those constructed during the 1960s, were built with arcades. This was related to the “Urban Planning Law”, published inside Taiwan in 1936. According to Article 33, the roads and construction of building, designated by the government in the urban planning division area should be in accordance with the regulation to provide arcade or similar structures. It was then promulgated in 1947 and amended in 1965 to be the “Regulation of Building Control of Taiwan” that if the width of a road in the urban planning division area is longer than 7 m, an arcade must be built along with

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