



Investigation of Fire Protection Status for Nanjing Representative Historical Buildings and Future Management Measures

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Abstract

The field investigations including the statuses of fire protection layout, fire hazards and fire protection facilities for Nanjing representative historical building (Yuejiang Tower, Tianfei Palace, Jiangnan Examination Institute and Confucius Temple) have been conducted. The problems of the investigated historical buildings are found to be: extensive distribution of combustibles, high fire loads, deficiency of fire separation distance, shortage of fire facilities, unreasonable fire detector and extinguisher selection, backward fire regulations etc. Taking Yuejiang Tower as an example, the design of minimum extinguisher configurations has been performed according to the code and investigated data. Finally the optimal proposals and measures to improve the fire protection and management system are presented.

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Nomenclature

Q	fire rating(A/B)
K	correction coefficient
S	protected area (m^2/A or m^2/B)
U	extinguisher configuration level of configured site relevant dangerous rating(m^2/A or m^2/B)
Q_s	the fire rating of actual configuration extinguisher for each site
Q_e	the fire rating of required configuration extinguisher for each site
N	quantity of configuration site

1. Introduction

Historical buildings are important cultural fortunes of China with a high appreciation of heritage, scientific and artistic values of civilization, and for non-renewable cultural resources [1]. While historical buildings always show large fire hazards and can cause significant losses of civilized values once fires occur [2]. With a deep accumulation of historical cultures and as ever onetime capital for ten dynasties, Nanjing in Jiangsu province is an important represent of Chinese historical civilization. Till the end of 2007, there are more than 2029 cultural resource spots, among which 298 ones are historical buildings [3].

In recent years, fire accidents of Nanjing historical buildings occurred frequently. For example, in January of 2008, Nanjing "comfort houses " relics of Japanese invading army was burned by fireworks; in April of 2011, Nanjing "Lu Xun's

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floor " in Jiangnan Army College of late Qing Dynasty was burned severely, and in May of 2011, an electricity fire occurred in tower of pharmacists of Jiming Temple [2]. Thus, the fire risk assessment and systematical fire protection design are rather important to the historical buildings.

In previous studies about fire protections of the historical buildings, ZhouBiao et.al[4] , used the tool of Fire Dynamics Simulation to simulate a fire in the Tianjin group-living yards of Ming Dynasty, and found that the fire extinguishing systems could take rather effects and fire retardant coating settings have improved the fire resistance levels; M.N. Ibrahim et.al[5], applied the analytic hierarchy process (APH) for fire risk assessment of historical buildings in Malaysia, and noted that the advantages and disadvantages of active fire protection systems and combustion level of building materials are important factors to the fire risk; Du Feng and You Fei [6] proposed the application possibilities of new types of flame retardant materials such as nano-materials and bio-chemical protection materials (like extraction of chitin) on the historical building protection.

In this paper, four Nanjing representative historical buildings including Yuejiang Tower, Tianfei Palace, Jiangnan Examination Institute and Confucius Temple have been selected to conduct field investigation. The statuses of fire protection layout, fire hazards and fire protection facilities were investigated. The design of minimum extinguisher configurations for Yuejiang Tower was performed. Besides, according to the investigated results, the feasible measures of fire management have been put forward.

2. Field Investigation of Nanjing Representative Historical Building

2.1 Fire hazards of Nanjing representative historical buildings

(1) High fire load and low fire resistant level.

The main structural components (like column, beam, rafter, joist, bucket arch, door, windows, floor and staircase) of investigated buildings are manufactured from pine, fir and camphor woods. The theoretical value of fire load is about 31 times that of reinforced concrete buildings [7]. These historical buildings show a low fire resistant level of class three or class four, especially in the Great Hall of Confucius temple as showed in Fig. 1(a). Under the effects of the natural aging, cracking, paint peeling, mildewing and rotten metamorphism, the wood largely present as the porous structure. This kind of wood contains a lot of vegetable oils, and the surface is coated with a layer of paint. The conditions of stack frame brackets, caisson, different shapes of the windows and doors and wooden structure of the splicing gap greatly expanded the contact interface between air and combustibles. Thus they are prone to large area burning and even lead to a flashover.

(2) Grouping layout favoring the spread of fire and is difficult to control.

The layout of the investigated buildings is compact as they are connected in groups or based on kinds of single buildings like quadrangle dwelling and cloister, lanes, corridors and small squares (such as Tianfei Palace and Jiangnan Examination Institute as shown in Fig. 1(b)). The buildings are usually constructed symmetrically and displayed along horizontal and vertical axes. Fire proofing spacings are thus not enough. Neighboring wood structures can be burned in large areas. It is rather disastrous for suppression.

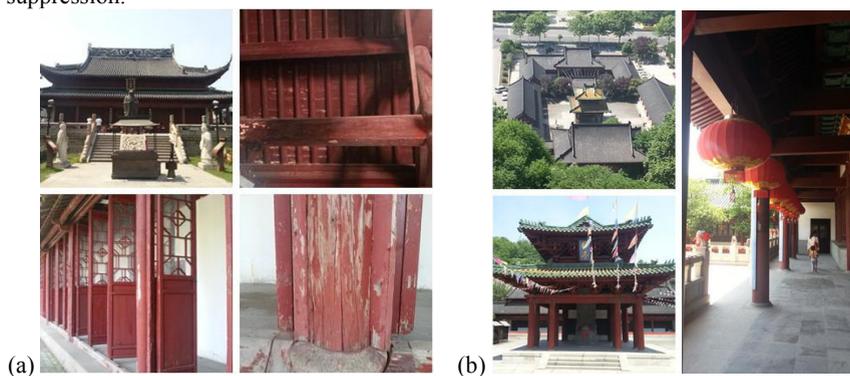


Fig. 1. (a) Wood-frame Hall in Confucius Temple. (b) Cloister Layout in Tianfei Palace

(3) Extensive distribution of combustible and flammable materials.

Many combustible decorative materials which are made of cotton, flax, silk and wool fabric like streamers, antependium, folding screens, wall pictures, draperies are involved in investigated historical buildings as well as the large amount of wood

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