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(on the Development of Performance-based Fire Code)

Performance-based fire safety engineering assessment of national museum of marine science and technology

Ang- Cian Li^a, Chi-Min Shu^{a,b}, Yi-Ting Teng^c, Tzu-Sheng Shen^c, Pin-Ping Hsieh^{c,*}

^aDoctor Program, Graduate School of Engineering Science and Technology, National Yunlin University of Science and Technology (YunTech), Yunlin 64002, Taiwan

^bCenter for Process Safety and Industrial Disaster Prevention, School of Engineering, YunTech, Douliou, Yunlin, 64002, Taiwan

^cGraduate School of Fire Science, Central Police University, Taoyuan 33304, Taiwan

Abstract

The concept of ocean current and fishery industry is expressed from the architectural design in using crossed exterior corridors to perform ocean current. The contrast between modern and obsolete is represented by the staggered interior design and antiquated building structure of the heritage, which is used to be North Thermal Power Plant. It is therefore partial areas which cannot fulfill the article 79-2 of Building Design and Construction Regulation mandated by Taiwan government that stipulate the requirement of any void space over 3 floors. Requirement of smoke extraction system and smoke curtain is also exempted from article 188 of Standard for Installation of Fire Safety Equipment Based on Use and Occupancy. Performance-based design is adopted by fire engineering approach as an alternative. This project passed the expert panel review of fire engineering strategies and smoke management assessment. At the stage of construction by auditing and reviewing, full-scale hot smoke test was conducted due to the safety consideration raised by local government. The results of tests are significantly different from the simulation modelling and smoke management report approved by National Fire Agency, Ministry of Interior. Visibility in partial areas is around 10 m which is not regarded as a tenable condition. After the improvement of smoke management, the study of full-scale hot smoke tests and computational simulated results are carried out. Acceptance criteria, usually smoke temperature, smoke layer height and visibility in Taiwan, are reached regardless of differences between FDS model and on-site full-scale tested values. This project provided design considerations to designer during design process, including the environmental differences of internal and external building, local weather impact, and grid size used in FDS model. The limitation and discrepancy of chosen software among different versions should be understood so that simulation results would more fit the realistic circumstances.

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Keywords: performance-based design, FDS, full-scale hot smoke test, smoke management, visibility

1. Introduction

Captioned project is located in Pa-Tou-Tzu district, Keelung City, Taiwan, where emphasized on developing local culture and environmental features. By holding exhibitions, educations, collections, and research activities, the development of marine science and fishery technology is interpreted. Architectural design is to express ocean current and fishery industry, utilizing crossed exterior corridors to represent ocean current. The contrast between modern and obsolete is represented by the staggered interior design and antiquated building structure of the heritage, which is used to be North Thermal Power Plant. It is therefore partial areas cannot fulfill the article 79-2 of Building Design and Construction Regulations that stipulate the requirement of any void space over 3 floors [1]. Requirement of smoke extraction system and smoke curtain should be exempted from article 188 of Standard for Installation of Fire Safety Equipment Based on Use and Occupancy. In article 188, smoke control by natural ventilation should keep the opening area larger than 2 % of floor area. Performance-

* Corresponding author. Tel.: +886-973-602-151

E-mail address: apple001423@gmail.com

based design in using fire safety approach is required in accordance with article 3 of General Rules for Building Technical Regulations. Expert review for smoke management strategy is required in accordance with article 6 of Fire Services Act. Fire engineering approach is adopted to justify the reasonable and safety building design is therefore achieved.

2. Expert panel review of fire safety assessment and smoke management strategy

2.1. Building information

National Museum of Marine Science and Technology is an eight-story building with reinforced concrete structure. The site area, building area and total floor areas are 55,124.55 m², 16,676.34 m² and 57,882.5 m² respectively. Four buildings are situated in the same building base, including the Main Exhibition Building, IMAX Theater, Administrative Education Center, and the Regional Exploration Building. Only main exhibition building is involved in performance-based design. The building from east to west is divided into section A, section B, section C and section D, as shown in the Fig. 1.

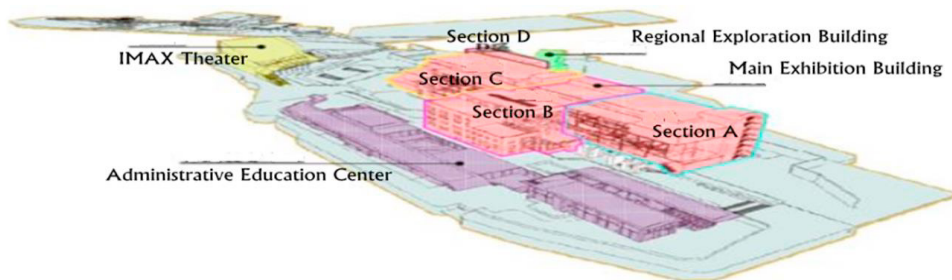


Fig. 1. Illustration of four buildings in National Museum of Marine Science and Technology, Keelung, Taiwan.

2.2. Applications and acceptance criteria of performance-based design

(1) Scope of application

The article 79-2 of Building Design and Construction Regulations has specified the requirement of any void space over 3 floors. This provision could be exempted in using performance-based fire engineering assessment. Areas exempted from code compliance regulation are listed in Table 1.

Table 1. Areas exempted from building regulation

| Purpose of usage exempted from regulation | No. of floors passed through | Total floor areas |
|---|------------------------------|----------------------|
| Section A/ Corridors | 1F-7F above ground | 1,468 m ² |
| Section B/ Corridors, main hall and entrance hall | 1F-7F above ground | 2,334 m ² |
| Section C/ Corridors, main hall and entrance hall | 1F-7F above ground | 2,398m ² |

Source: He-Ruenn Industrial Co., Ltd., 2009. Fire safety strategy of assessment report of main exhibition building in National Museum of Marine Science and Technology. Unpublished [2].

(2) Acceptance criteria and assessment results

According to article 4 of application of approval regulations for fire safety strategy assessment, areas exempted from article 79-2 of Building Design and Construction Regulations should provide analysis of fire spread prevention assessment and total evacuation safety assessment [2].

a) Fire spread prevention assessment

According to government document no. 0982905788 issued by Construction and Planning Agency, Ministry of Interior, on 1 April, 2009, fire spread through voids space is analyzed in terms of flame height and heat radiation calculation as approaches of fire spread prevention assessment. Assume that fire size is 5 MW with dimension of 2 m x 2 m, the intermittent flame height is 5.53 m which is less than floor height between each floors. The maximum heat flux received

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