

FIRE LOAD DENSITY SURVEY IN FOUR SHOPPING MALLS IN HONG KONG

Carmen C.S. Fong and W.K. Chow

Research Centre for Fire Engineering, Department of Building Services Engineering
The Hong Kong Polytechnic University, Hong Kong, China

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ABSTRACT

Fire loads in four shopping malls with 301 retail shops in Hong Kong were surveyed and reported in this paper. It was observed that fire loads are different under different seasons. Shops might have higher fire load in summer, but lower value in winter. About 16% of the retail shops exceeded the upper limit of fire load density of $1,135 \text{ MJm}^{-2}$ specified in the local code. The highest fire load density was observed in shops selling bedroom products such as curtains, blankets, pillows and mattresses. The survey results are also compared with those reported elsewhere in the literature. The fire load density for malls in Hong Kong is higher. Finally, it is interesting to note that fire load is related to the floor area, higher fire load density in smaller retail shops.

1. INTRODUCTION

Shopping malls in the Far East used to be crowded with people in weekends and holidays. Regulations requirement on occupancy follows the means of escape code [1]. The usable floor area that can be occupied by every occupant in a shopping centre from basement to 2/F is 3 m^2 . At levels 3/F and above, the usable floor area is 4.5 m^2 per person.

Storing high amount of combustibles would give fire hazard. Fire load density FLD (in MJm^{-2}) is a key factor which should be studied carefully. It was estimated in the code [2] by inspecting the numbers and types of combustibles within a retail shop. FLD is given by:

$$\text{FLD} = \frac{\text{Sum over all mass of contents (kg)} \times \text{Calorific value of contents (MJkg}^{-1}\text{)}}{\text{Floor area (m}^2\text{)}} \quad (1)$$

This formula is outlined in the local fire service installations (FSI) code [2].

Basically, items like storage racks, furniture owned

by the shop owner, lighting fittings and partitions are fixed fire loads. Commodities sold are the movable loads found inside a shop. FLD in shopping malls had also been surveyed in detail in UK with CIB report [3] and later in New Zealand [4]. Calorific values of the combustibles had been reported in many similar studies. FLD has two parts [5-12]: fixed fire load and movable fire load.

Fire safety provisions in shopping malls in Hong Kong required by the Authority are different in 4 periods classified as before 1972 (Class 4), during 1972 to 1987 (Class 3), during 1987 to 1998 (Class 2), and after 1998 (Class 1). Class 4 constructions are far too old. Refurbishment of old buildings would give shops complying with new regulations. Therefore, Class 4 shopping malls would then become Class 1. Class 3 buildings are still commonly found in Hong Kong.

A field survey on fire load in classes 1 to 3 shopping malls was started in mid-January 2004. Four shopping malls were with main features summarized in Table 1.

Table 1: Shopping malls surveyed

Shopping mall	Location	Year of construction	Class	Target customers	Number of retail shops inside	Estimated total floor area (m^2)	Range of FLD (MJm^{-2})
Mall A	Mongkok	1996	2	Students	123	4,500	320 to 1,670
Mall B	Homantin	1975	3	Residents and Students	57	12,300	190 to 2,440
Mall C	Shamshuipo	2002	1	Residents	58	6,100	100 to 2,530
Mall D	Central & Western	1997	2	Tourists	63	12,500	75 to 1,730

2. FIELD SURVEY

Four shopping malls labeled as A, B, C and D were selected for conducting the FLD survey. Malls A and B were surveyed during the Chinese New Year in 2004. The shopping centres were decorated with plants, lanterns, poetic couplets, happy wishes written on red papers, and movable Chinese New Year background. The fire load densities within a shopping mall are expected to be higher. Further, those goods would block the evacuation paths of occupants in case of fire.

Among the four shopping centres surveyed, Mall A generally sold watches, toys, stationeries, sportswear and clothing. FSI such as fire shutter, fire detection and sprinkler system were provided as required [2].

Malls B and C sold daily necessities with target customers to be residents living nearby. Basic FSI were provided for fire fighting.

Mall D was located in a popular tourist district selling special souvenirs, golden accessories, and other brand name clothing at relatively high prices up to HK\$80,000 (US\$10,000) per item. To protect the valuable products, the shops, in general, even provide portable extinguishers for property protection.

Combustible items commonly stored in the retail shops were polyvinyl chloride (PVC), polystyrene (PS), acrylonitrile butadiene styrene (ABS), polycarbonate (PC) and wood. These materials can be ignited easily by the incident heat flux under an accidental fire. These combustibles were almost placed on floors or racks adhered to walls. Therefore, hazards of the surveyed FLD under

flashover fire can be studied using radiation heat flux at floor level of 20 kWm^{-2} ; and 35 kWm^{-2} at vertical wall [13,14].

3. FLD ANALYSIS

FLD for the four shopping malls are estimated and summarized also in Table 1.

The upper limit of FLD under the local code [2] is $1,135 \text{ MJm}^{-2}$. A high value of $2,530 \text{ MJm}^{-2}$ was found in a retail shop (at Mall C), because of storing high amount of bedding products. Blanket (wool), pillow (polyester), and mattress (polypropylene) have calorific values of 20.67 MJkg^{-1} , 23.25 MJkg^{-1} and 51.15 MJkg^{-1} respectively. The higher the value of FLD, the higher is the fire risk of the shop.

After estimation of FLD for the retail shops, the cumulative frequency of FLD of the 301 retail shops is further calculated and shown in Fig. 1. The limit for the cumulative frequency is set at FLD above $1,135 \text{ MJm}^{-2}$. It is shown that 84% of the shops are below the upper limit while the rest are over the value of $1,135 \text{ MJm}^{-2}$. Shopkeepers should reduce the combustible contents in order to lower the FLD.

Values of FLD summarized in these four malls are also compared with literature in Fig. 2. It is observed that malls in HK have higher values of FLD. This is because shops in Hong Kong are packed with goods. Shop owners and storekeepers have to pile up stocks as land price is too high. Malls in other countries such as New Zealand [4] would have more spaces.

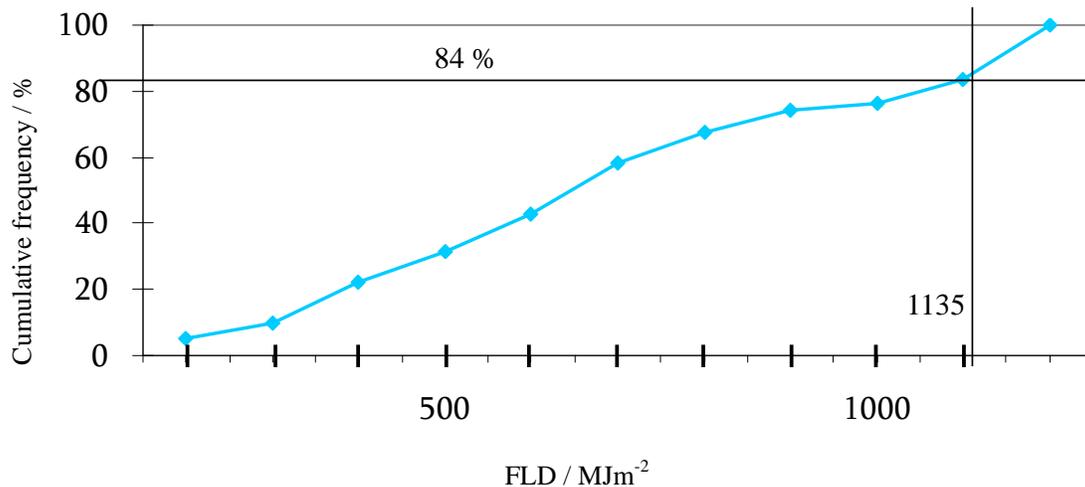


Fig. 1: Distribution of FLD

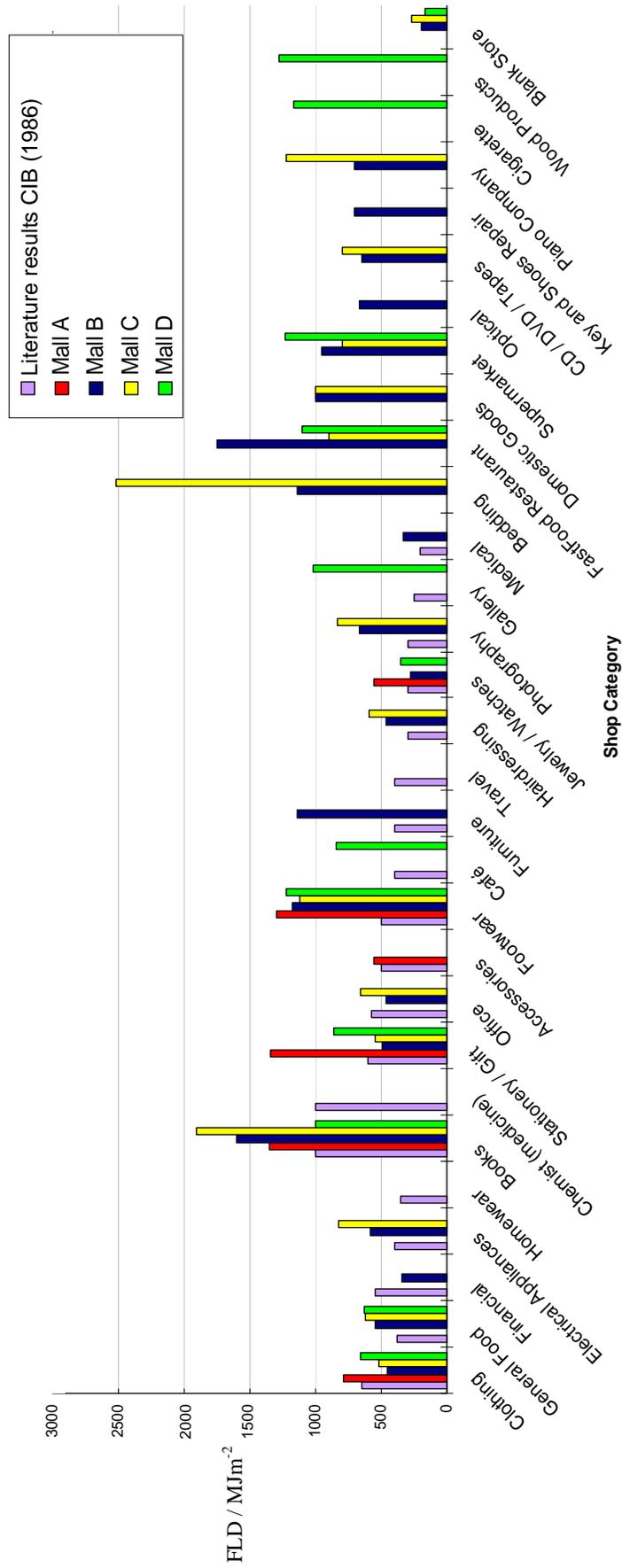


Fig. 2: Comparison of FLD with literature

4. FIRE SAFETY MANAGEMENT

A fire safety plan should be worked out in fire safety management [15,16] for handling fire hazards of a shopping mall. There are at least three parts on maintenance plan, staff training plan and fire action plan.

From the survey on FLD of shopping malls, the maintenance plan should include regulation on checking of stock height inside retail shops, and not to pile up too much stock. This would help to reduce movable loads of a retail shop. Reducing the use of combustible furnishings would reduce the fixed fire load of a shop.

In the staff training plan, storekeepers of retail shops and security staff in the mall should be properly notified on limiting the FLD within the allowed values. A handbook on identifying the type of combustibles with fire load values should be issued and updated. Staff should be trained regularly to identify the fire load of combustibles and take appropriate action in a fire.

5. CONCLUSION

Fire load in three different classes of shopping malls in Hong Kong were surveyed. Field survey results on FLD were analyzed. The observations are summarized as follows:

- A retail shop selling bedding products in Shopping Mall C has the highest FLD due to its compacted display and high calorific values contained.
- 84% of the retail shops have FLD below the upper limit of 1,135 MJm⁻² under the local code [1,2]. This indicated that there are still 16% of the shops possessing high fire risk in which their FLD has exceeded the limit.
- Relationship can be further established between price, quantity of goods, shop area, insurance, and also the fire services provision inside a retail shop.
- For shops selling fundamental commodities at relatively low price, stocks are piled up while the shop itself is small. Only minimum fire service installations are provided. Some sprinklers are even blocked by the goods. The major reasons for piling up stock are because of convenience and high stock turnover.
- Shops selling fundamental commodities may not cover high insurance as compared to those shops selling gold or jewelry, which means fire safety and security are being underestimated.

Finally, FLD is related to floor area. Smaller retail shops would have higher FLD as goods are stacked up high.

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