A Comparison between Lift Designs in Asia and Europe

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Abstract

Modern cities are concrete jungles, where the lift is an important transportation medium and a daily necessity. Owing to the variations in geographical characteristics, economic development and general living standards, the design of lift changes from country to country. Every country has its own regulations and ordinances to ensure the safety of the lift system. This paper will compare these differences between Asia and Europe. The different practices in lift design and construction will be discussed, and attention will be focused on technical aspects such as speed requirements, car sizes, laboratory testing of safety equipment. A brief analysis of the market demand in China, Hong Kong and European countries will be given.

Introduction

Vertical transportation has become more and more important as the number of high rise buildings expands quickly in modern cities. However, lifts may not be as popular in some countries owing to the difference in environmental factors. In this paper, a comparison of the lift designs in Asia and Europe will be given. The paper will start with an analysis on the demand for lift systems and the regulations in Asia. This should provide a general picture of the lift industry in the region. The lift designs in Asia and Europe will also be compared, especially on general lift speed, car cage size and laboratory test requirement on lift components.

(I) Demand in Hong Kong/China

Hong Kong

Hong Kong is known throughout the world for its high population of density. There are over six million people living in a total area of 1,070 km^2. The majority of the population is concentrated in 117 km^2 of the urban area.[1] So, most people live in high rise residential buildings and the lift is a major transportation medium in their daily lives. In order to alleviate the housing supply problem in Hong Kong, the Hong Kong SAR Government has committed to constructing further public housing estates over the coming 5 years. The intention is to provide 85,000 flats per year. With a limited area for land supply, the only way to achieve this commitment is to build more multi-storey residential buildings. Therefore, highly efficient lift systems are in great demand. At present, over half of the population live in residential buildings under the management of the Housing Authority.[2] More and more people will move to the public estates in the future. Therefore, it is expected that the rate of lift installation will continue to grow.

The expectation of lift systems is not only related to quantity, but also quality. Lifts nowadays generally have high speed design and large cars in order to meet the demand of increased passenger flow.

As the living standards and technology development in Hong Kong gradually increases, people expect more reliable and comfortable lifts. Before 1970, AC2 and M-G lift control systems were commonly used in Hong Kong. With more recent technological development, the ACVVVF control system has replaced the old types of lift control system. The ACVVVF control system provides better performance in terms of lift stability, reliability and power efficiency. [2]

Apart from the lifts for residential buildings, lifts for commercial buildings also occupy an essential part of the market. In Hong Kong, most of the new commercial buildings are over 50 storeys. So, the requirements of speed, comfort and power efficiency of lift system are higher. The speed may be up to 500m/min. for a building with 70 storeys.

For other kinds of buildings like factories, shopping centers and car parks, hydraulic lifts are commonly used. Goods have to be transported up and down in the buildings, freight lifts are therefore required. Hydraulic systems require short installation time, flexible allocation of machine room and good performance for the lifting of large loads. Therefore, the hydraulic lifts share a portion of the lift market in Hong Kong.

China

As the living standard of people in China has improved over the past years, so the demand for vertical transportation has increased significantly, especially for passenger lifts. Because of the limitation in certain environmental factors, technology development in China did not keep pace before 1980. Lifts were not a popular means of transportation at that time. There were only 10,000 lifts installed for the period from 1949 to 1979 (i.e. around a few hundred per year). After 1980, the situation changed as the demand for lift systems increased sharply. The number of local lift manufacturers increased accordingly and there are now about 300 manufacturers in China. The production of lifts by local manufacturers reached 24,000 units in 1995. It is estimated that the total demand will reach 200,000 units for the period of 1996 to 2000.[3]

In the last decade, the economy of China has expanded quickly. In order to increase the production efficiency, lifts have become widely used, especially in some public places like airports, railway stations, hotels, office buildings and residential buildings. As China has over 12,000 million people, there is definitely a confident future in the development of the lift industry.

The major problems of the lift industry in China, are the poor quality of lift components and insufficient supervision on lift installation and maintenance, consequently the failure of lift systems is regular. The Chinese Government has been making efforts to develop new regulations in order to provide comprehensive supervision on the lift industry. With the smooth development in lift technology, the local manufactures have grasped the essential techniques in producing micro-control AC2 and ACVV lifts for replacing the old type of direct current lifts. Now, the two new types of control system are the main stream in lift installations in China.

(II) Regulations in Hong Kong/China

Hong Kong

Fundamentally, the regulation of lifts and escalators can be divided into two categories. They are : technical and administration.

Technical regulations:

- Building (Lifts) Regulation Chapter 123
- Building (Escalators) Regulations Chapter 123
- Code of Practice of Lifts and Escalators on the Construction
- Code of Practice on the Design and Construction of Lifts & Escalators
- British Standard 5655 & 5656

Administration regulations:

- Building Regulation Chapter 123
- Lifts and Escalators (Safety) Ordinance, Chapter 327

- Code of Practice on the Examination, Testing and Maintenance of Lifts and Escalators [1]

Among the above regulations, the "Lifts and Escalators (Safety) Ordinance Chapter 327" and the "Code of Practice on the Design and Construction of Lifts & Escalators" are the major ones. Chapter 327 originated in 1960 and is mainly for administrative purposes. It authorizes the Electrical and Mechanical Service Department (EMSD) to regulate and control the design, operation, examination and testing of lifts and escalators in Hong Kong.

The "Code of Practice on the Design and Construction of Lifts and Escalators" was published by the EMSD in 1993. It is applicable to all lifts and escalators subject to Chapter 327. Most of the technical information of specification on different types of lifts can be found in the Code. It sets out technical details, methods and procedures related to lifts and escalators for safeguarding passengers and objects associated with lifts and escalators.

The technical requirements of the Code are similar to BS5655 and BS5656 except for some requirements which were modified to match the local conditions. For example, the Code and the BS have different requirements on "Emergency trap doors" and "Locking of the door". Although the Code was derived from the BS, it has become more localized after years of development in the lift industry.

Table 1 and 2 show the major differences between the current "Code of Practice on the Design and Construction of Lifts and Escalators"[4] and the European Standard (Final Draft of EN81-1, March 1997).

Differences of Lifts Requirements

Items	Description on the COP Requirements in Hong Kong
Landing Door Lock Bridging Device	• A landing door lock bridging control station has to be provided in lift machine room • To make sure that the landing door lock safety circuits are bypassed only during inspection mode of operation • The use of jumper for short-circuiting the landing door lock safety circuit should be avoided.
Overload Device	• To safeguard passengers and properties of lifts subjected to overloading • The device should be of fail safe design. i.e. any failure of the device will act as if the lift is overloading and not operate • The device would not be damaged by excessive overloading • The device is also essential for hydraulic lift
Counterweight Screen	• From a height 300mm above the floor of lift pits to a height not less than 2.1m above such floor
Lighting of Lift well	• Each lamp shall not less than 60W
Emergency Lighting	• 1 W for 2 hours
Emergency Trap Door	• Fixing of the emergency trap door in closed position by means of suitable spot welding of the door onto the car roof may be allowed.

Items	Description on the COP Requirements in Hong Kong
Disables Lifts	• Extra requirement has been imposed on the door re-opening device for lifts for person with disability on both car door and landing door • An emergency alarm push button with a buzzer, intercom and a CCTV camera shall be provided in the lift car and be connected to the building management office or caretaker's office and the machine room • Special requirement for lift provided for person with a disability is also included. • Indication blinking light for acknowledgment together with explanation notice have to be provided.

Table 1

Differences of Escalator Requirements

Items	Description on the COP Requirements in Hong Kong
Vertical Obstruction Guard	• To safeguard passengers riding on escalators where building obstacles and crisis-cross escalators can cause injuries, a set of vertical obstruction guard replacing the old triangular guard shall be placed above balustrade decking.
Distance between the Outer Edge of Handrail and Adjacent Wall / Building Obstacles Escalators	• The horizontal distance between the outer edge of the handrail and any obstacles shall not be less than 200mm and shall be maintained to a height of at least 2.1m above the steps. Under certain stiputated conditions, the distance may be reduced to 80mm.

Table 2

China

The formulation of safety regulations and standards was developed later than some other parts of the world. In 1974, the government published the first standards for lift systems - GB 816, aimed at improving the quality and safety of lifts within the region. [5]

Since the international standards of lift safety has been developed for a long time, lift systems governed by those regulations should reach a certain safety level. The Chinese Government therefore adopted the international standards and converted them to local safety standards and regulations. Consequently, a series of lift standards and regulations were formulated that can be categorized into two parts: the technical part-safety standards and the administrative part-safety regulation.

GB 7588 was the current major guideline on lift construction and installation in China. It was formulated in accordance with EN81- Part 1. GB 7025 (Lift - Main specifications and dimensions, arrangements for lift car, well and machine) was derived from the international standards (ISO4190-1, ISO4190-2 and ISO 4190-3). All lifts with a speed under 2.5 m/s have to fulfill the dimension requirement described in the specifications of GB7025. With reference to European and international standards and upon consideration of the current situation in China, another three sets of standards were derived. They are GB10058 (Lifts-Specification), GB10059 (Lifts-Test method) and GB10060 (Lifts-Regulation on acceptance of installation). GB10058 describes the technical requirements and quality of all kinds of lifts. GB10059 describes the testing methods of all kinds of electric lifts using traction machine, listed in

GB7025. GB 10060 describes the lift testing methods and regulations, together with the requirements for acceptance of an installation.

Since these regulations were mainly derived from EN81 Part-1, their stipulated requirements are more or less the same. However, throughout years of development in the lift industry, there are some differences between the standards in China and EN81. A typical example is the testing procedures of progressive safety gear.

On the administrative aspect, the government have established regulations on lift systems to ensure safety. The regulations are divided into 4 major parts: Design and Construction, Installation and Maintenance, Operation and Management, Test and Monitoring.

The regulations define the responsibility of different parties involved in design, installation, maintenance and testing. Relevant documents and certificates which have to be submitted to the government are also included. The penalties for breaching regulations are clearly stated in the last part of the regulation. [5]

(III) General Requirements of Fire Services Department (FSD) regulation

In Hong Kong, requirements for fireman lifts are stipulated in the "Code of Practice for Minimum Fire Service Installation and Equipment And Inspection And Testing of Installations And Equipment". Similarly, there are some recommendations related to fireman lifts requirements in EN81.

Basically, the FSD regulations in Hong Kong were formulated in accordance with Reg. 38 C of Building (Lifts) Regulations. It includes the general specifications of lift shaft, lift car, lift lobby, lift door, fireman's switch, power supply and operation. For instance, the net internal floor area shall be at least 1.35 m^2 with a minimum rated load of 680 kg. While in Europe, there is a small difference that the available area shall be not less than 1.4 m^2 and the rated load shall be at least 630 kg.[6] Furthermore, an important requirement is that the complete travel from the lowest discharge point to the highest discharge point should not exceed 1 minute. There is a smilar requirement in the European Standard. A fireman lift system shall enable the Fire Service personnel to reach any floor without having to transverse more than two floors. The power supply for fireman's lift in Hong Kong shall be connected to a sub-main circuit which shall be exclusive and independent of any other sub-main circuit[7]. According to EN81, a standby supply, if there is one, is recommended to maintain the firemans lift service in the event of failure of the normal supply.[6]

The original requirements for the operation of the firemans lift has been amended and the relevant provisions in respect of the operational, electrical and mechanical requirements for fireman lifts have been established as Section F in the Code of Practice on the Design and Construction of Lifts and Escalators and have come into operation since 1 April 1996.

Apart from the requirements for the fireman lift, the occurrence of a fire accident related to lift works aroused attention of the public and the Hong Kong Government, to the need for fire prevention in the lift industry. According to paragraph 11.2 of the "Code of Practice for Fire Resisting Construction 1996", a door provided at a lift landing to give access to the lift car should have a fire resistance period of not less than 1 hour with regard to integrity. In order to provide adequate resistance to the spread of fire, a landing door should normally remain in a closed position unless a lift car stops at the floor of the landing door. Besides, in circumstances where landing doors have been removed, fire resisting temporary hoardings shall be provided. Also, only scaffolding made of non-combustible material should be used for working in a lift well.

On the other hand, the revised safety requirements on welding and cutting (Section7.7) were incorporated into the "Code of Practice for Safety at Work (Lift and Escalator Works)". The safety measures against fire accident related to those involved lift and escalator work are explained in details. It stresses that the fire safety measures in maintenance work is very important.

(IV) Car Cage Standard Size

The size of a lift car depends on many factors. Despite the constraints from physical constructions, the major factor is the handling capacity that the lift has to fulfil.

In Hong Kong, a city of high population density, many people live in large housing estates. Each building has about 18 flats on each floor. Under the assumption of four persons living in one flat, there will be several thousand tenants living in a 30 storey building. According to the Hong Kong Housing Authority, all lifts under their management should fulfill the 5 Minutes Handling Capacity (5MHC) (i.e. the lift system must cater for 5% to 7% of the population in 5 minutes).[2] The car size is a dominant factor affecting the handling capacity of a lift system. A lift with a large car could obviously handle more passengers in a trip and attain a higher handling capacity. As a result, most of the lift systems in Hong Kong are equipped with a larger car cage than normal.

As the population density in Europe is relatively low, most residential buildings are mid-low rise buildings with only a single family or a few families. Therefore, the required rated load of lift is smaller, and the size of lift car in Europe is generally smaller than in Hong Kong and China. (See Table 3-5)

Hong Kong :

Residential Buildings	Public Housing Estate	PSPS Building	Private Building
Rated Load (kg)	1000	900	900
Area (m^2)	2.4	~2.1	~2.1

Table 3

China (Requirements of GB7025-86) :

Lift Type	Passenger Lift	Residential Lift	Bed Lift	Goods Lift
Rated Load (kg)	1000	1000	1600-2500	1000
Area (m^2)	2.24	2.31	3.36-4.86	2.21

Table 4

Europe (According to EN81-1, requirement on lift car size of selected rated load is as follow):

Rated Load (kg)	800	900	1000	1200	1500
Max Available Area (m^2)	2.00	2.20	2.40	2.80	3.40

Table 5

(V) Speed

Hong Kong

Speed is an important parameter of the performance of lifts system, especially for those installed in high-rise buildings.

In Hong Kong, mega-storey buildings are erected side by side on the streets. Buildings of forty storeys can be found not only in the area of commercial centres, but also in public housing estates. Therefore, the speed of lift must be able to fulfill the demand of passenger flow rate. According to the requirements of the Fire Services Department, the speed of lift should enable fireman to reach the top-most discharge level of the building within one minute if that is a firemans lift.

There are three major types of residential building in Hong Kong: Public Housing Estate, Private Sector Participation Scheme (PSPS) and Private Building. The general lift speed is shown in Table 6:

Types of Building	Speed
Public Housing Estate (26 storeys, 36 storeys and 38 storeys)	150 m/min.
Private Building (40 storeys)	150 m/min.
Private Building (23 storeys)	105 m/min.

Table 6

For most residential buildings, 105m/min is the minimum required speed. In general, the speed of lifts installed in new residential buildings is 150m/min and is expected to be increased to 210m/min in the near future.

China

Owing to the living standard and geographical conditions, residential buildings in China are mainly low-rise buildings. The majority of lifts have been installed in commercial buildings. As the buildings are not so high, the average speed of lifts is comparatively lower than in Hong Kong. They range from 60m/min. to 150m/min. The current popular speeds adopted are 60m/min and 90m/min.

Europe

In Europe, low density's residential buildings with 2-6 storeys are the most popular. In developed countries, people expect a high living standard and a comfortable living environment to make their lives more enjoyable. So, even the buildings in Europe popularly have a few storey, lift installed. An hydraulic passenger lift is the major type, of which the speed ranges from 25m/min to 45m/min. For traction lifts, the speed may be up to 150m/min., but they are not commonly used in residential buildings in Europe.

(VI) Laboratory Test Requirement

Certain lift and escalator components are required to have type test certificates or certification from the manufacturer, in particular for newly installed lifts in Hong Kong. Such type test certificates must be issued by an independent testing institute approved by the EMSD, such as BS approved laboratory. The components are landing door locking device, safety gear, overspeed governor and buffers for lifts; steps or pallets for escalators and handrails for public service escalators.[8]

Difference of Laboratory Test Requirement between BS and GB

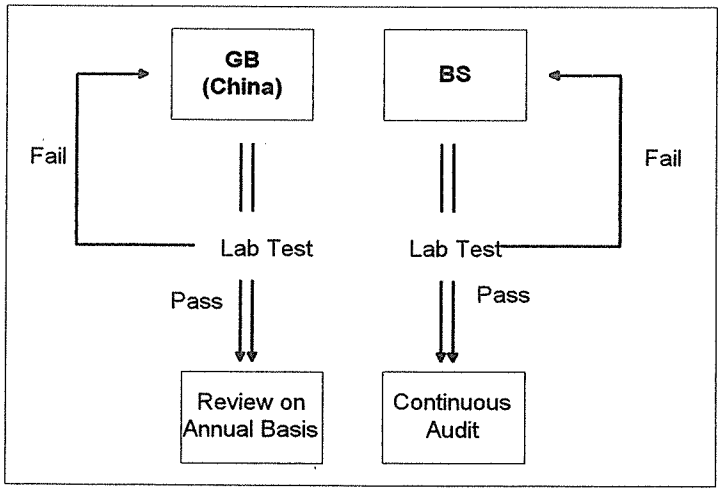

Figure 1

Basically, GB lift standards are almost the same as British Standards. One of the major differences between them is the type test system of lift and escalator components. According to the GB standard, all lift components certificates have to be reviewed annually. Yet, the British Standard adopts a continuous audit system to maintain the quality of components. See Figure 1.[9]

(VII) Special Features

In a modern high-rise building, if there are many stops in one car trip, it will be time-wasting for the passengers. In order to reduce the travel time, most commonly a lift car will serve only some selected floors clustered together to form a zone.

At present, zoning in a high rise building may either be static or time-scheduled. Static zoning is commonly used in Hong Kong. For example, a public housing estate of Hong Kong can be separated into three zones (i.e. low, medium and high) with two lifts for each zone. A duplex down collective automatic control is used to serve the daily operation. The car groups are permanently assigned to serve a number of adjacent floors in the building, so it is known as static zoning. A major advantage of zoning is that it can increase the lift system handling capacity. Time-scheduled zoning refers to temporary zoning of the building during a pre-scheduled period of time. The periods chosen are usually the peak traffic hours or rush hours. For safety reason, emergency doors must be installed in appropriate locations for releasing passengers in case of accidents.[10]

In Europe, buildings mostly have only two to six storeys. Zoning is therefore not necessary as a single lift is good enough to cater for the demand for such buildings.

In Hong Kong, the design of lift system can be modified due to certain social factors. The permission of spot welding on emergency trapping door at the lift car top is a typical example of design modification for coping with the crimes associated with lifts. Certainly, the design of a lift system should fulfil the local requirements and the safety of passengers.

Conclusion

Due to the difference in some objective factors, lift design in Asian and European countries show a certain degree of contrast. In a city with a high population density and mass vertical transportation, like Hong Kong, the requirements for lift designs tend to be more comprehensive. Lifts of high speed and large car sizes are generally used to cope with the mass demand. Different safety devices are used to safeguard the passengers. On the contrary, the lift design in Europe tends to be less restricted by regulations and codes. As the population density in Europe is low, most people live in individual houses or low-rise buildings. The lifts installed are of a smaller scale which can suit the small demand. In China, the requirement of lifts is increasing gradually due to a continuous improvement of the living standard. The major market of the lift industry concentrates on low-rise building at the moment. With the comparison given in this paper, readers should have a better understanding of the lift design in Asia and Europe. The future development of lift industries can be certain.

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